Alumni Workshop 2015

Addressing Resilience and Sustainability in Energy Management

EUROPA-UNIVERSITÄT FLENSBURG

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Addressing Resilience and Sustainability in Energy Management

Alumni Workshop 2015

25 years of development oriented studies at the University of Flensburg

DAAD

Europa-Universität Flensburg

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Workshop Programme: 21. September 2015 - 25. September 2015

Day one	**21.September 2015 – Public Opening Event at University of Flensburg, EB 63**
7:30	Breakfast
8:30	Bus to Campus from Sankelmark
09:15	*Welcome* Prof. Dr. Werner Reinhart, President of the Europa-Universität Flensburg Swetlana Krätzschmar, Stadtpräsidentin of Flensburg Dr. August Schläpfer, former EEM Director
10:00	*25 years international study programmes for sustainable development at the University of Flensburg* State Secretary Thomas Losse-Müller, Head of the State Chancellery
10:35	*From Artes to SESAM to EEM: postgraduates programmes for development cooperation in Flensburg* Dipl.-Ing. Wulf Boie and Dr. Dieter Klein, Europa-Universität Flensburg
11:00	Coffee Break
11:30	*Resilience and sustainability in EM – Future development of energy related study programmes at the University of Flensburg* Prof. Dr. Bernd Möller, Europa-Universität Flensburg
11:45	*Renewable Energy for Community Resilience* Nicholas Gubbins, Community Energy Scotland, Eric Dodd, Highland Council
12:15	*Learning for international development cooperation* Assoc. Prof. Mona-Lisa Dahms, UNESCO Chair of Problem Based Learning, Aalborg University
13:00	Lunch Break **Establishment of working groups; preparation of the parallel sessions A-D** Tea and coffee at Market of Opportunities
15:00	Opening: *Market of Opportunities* (EB entrance hall) – Poster exhibition with signature of MoU *Welcome*- Prof. Dr. Bernd Möller, Europa-Universität Flensburg

15:15	*Remarks by* Prof. Holger Jahnke, delegation member, Department of Geography, Europa Universität Flensburg Mr. Shivashankarappa, leader of Indian delegation Prof. Dr. Werner Reinhart, President of the Europa-Universität Flensburg
15:30	Joint signature of Memorandum of Understanding between JSS Mahavidyapeetha, Mysuru, India and Europa-Universität Flensburg
16:00-19:00	*Renewable energy as catalyst for local economy* Björn Meyer, Flensburg Chamber of Commerce and Industry Buffet- get together from 17:30 o´clock
17:00	*FAEM Nepal – their contribution after the earthquake in Nepal* – Dr. Narayan Chaulagain, President FAEM Nepal (tbc)
18:50	Bus back to Sankelmark

Day two	**22. September 2015 – Moderated parallel sessions – 2 working groups at European Academy Sankelmark**		
8:00 8:00	Breakfast Bus to Sankelmark for the students at the bus stop at “Feuerwehr-Haltestelle” (Fire brigade) in Bahnhofstrasse, crossing Munketoft		
8:45	Plenary session for all participants		
	Parallel session I (4 Presentations Speakers) Chair: Dan Otieno Ong´Or	**Parallel session II (4 Presentations Speakers)** Chair: Susy Simarangkir	**Parallel session III (4 Presentations Speakers)** Chair: Arun Balamatti
9:00 - 9:45	Dr. Narayan Prasad Chaulagain	Patrick Maina Kimari	Nhien Ngo Thi To
10:00-10:45	Yacouba Sambore	Hai Anh Tran	Fumi Harahap
10:45-11:15	Coffee break		
11:15-12:00	Arif Md. Waliullah Buihyan	Resha Piya Shrestha	Nele Rumler

12:15-13:00	Lady Johana Rivera Forero	Elizabeth Mosqueda	Maria Ana Gonzalez Casartelli
13:00	Lunch		
14:00	Parallel session A ***Rural Electrification and Community Resilience*** Moderator: John Kuteesakwe, Nicholas Gubbins, Annika Groth	Parallel session B ***Barriers and Drivers towards 100% renewable energies for all*** Moderator: Wulf Boie, Eric Dodd	
	Result-oriented discussion and elaboration of working paper	Result-oriented discussion and elaboration of working paper	
16:00	Tea and coffee		
17:00-18:00	Parallel session A ***Rural Electrification and Community Resilience*** Moderator: John Kuteesakwe, Nicholas Gubbins, Annika Groth	Parallel session B ***Barriers and Drivers towards 100% renewable energies for all*** Moderator: Wulf Boie, Eric Dodd	
	Result-oriented discussion and elaboration of working paper	Result-oriented discussion and elaboration of working paper	

Day three	**23. September 2015 – Moderated parallel sessions –2 working groups at European Academy Sankelmark**		
8:00	Breakfast		
	Parallel session IV (4 Presentations Speakers) Chair: Evans Hervie	**Parallel session V (4 Presentations Speakers)** Chair: Arum Sari	*Reintegrations- Seminar*
9:00-9:45	Mona Doctor-Pingel	Qiying Hu	*Reintegrations- Seminar*
10:00-10:45	Muhan Maskey	Jorge Lossley	*Reintegrations- Seminar*
10:45-11:15	Coffee break		

11:15-12:00	Susy Simarangkir	Mi Mi Maw	*Reintegrations- Seminar*
12:15-13:00	Pushkar Manandhar	Alexander Komakech-Akena	*Reintegrations- Seminar*
13:00	Lunch		
14:00	Parallel session C ***Policies and Planning for Resilience and Sustainability*** Moderator: Bernd Möller, August Schläpfer	Parallel session D ***Education and Institutional Learning for Resilience and Sustainability*** Moderator: Holger Jahnke, Maria Mercedes Vanegas	*Parallel session E* *Reintegrations- Seminar*
	Result-oriented discussion and elaboration of working paper	Result-oriented discussion and elaboration of working paper	*Result-oriented discussion and elaboration of working paper*
16:00	Tea and coffee		
17:00 -18:00	Parallel session C ***Policies and Planning for Resilience and Sustainability*** Moderator: Bernd Möller, August Schläpfer	Parallel session D ***Education and Institutional Learning for Resilience and Sustainability*** Moderator: Holger Jahnke, Maria Mercedes Vanegas	*Parallel session E* *Reintegrations- Seminar*
	Result-oriented discussion and elaboration of working paper	Result-oriented discussion and elaboration of working paper	*Result-oriented discussion and elaboration of working paper*

Day four	**24. September 2015 - Plenary Synthesis Session at European Academy Sankelmark and Excursion**
8:00	Breakfast
9:00	Presenting the outcomes of session I-V (Reintegration)
10:00	Coffee break

10:30	Global Alumni Networking Future development of energy related study programmes at the University of Flensburg – the alumni perspective Short presentations of alumni coordinators and plenary discussion (3-4)
12:00	Lunch break
12:50	Bus ready for departure
13:00	Field trip: visit of renewable energy projects in the vicinity of Flensburg – gathering at artefact
18/19:00	Artefact Grillabend – Rücktransport gegen 21 h

Day five	**25. September 2015 - Wrapping up and Graduation of EEM students at University of Flensburg (EB)**
8:00	Breakfast
8:40	Bus to Campus
09:15	Arrival of guests
9:25	Musical opening
9:30	Welcome - Prof. Dr. Werner Reinhart, President of the Europa-Universität Flensburg
10:00	Welcome and review - Prof. Dr. Bernd Möller, Course Director
10:15	Welcome - student and alumni representatives
9:40	Musical break
10:40	Graduation ceremony
11:50	Tribute to 300th graduate
11:55	Musical closing
12:00	Photo session
12:30	Buffet

Environmental and Sustainability Issues in the Curricula for Ethiopian Teacher Education Colleges: Implications for Environmental Sustainability and Resilience

Aklilu Dalelo
Associate Professor of Geography and Environmental Education,
Addis Ababa University, Ethiopia
Email: akliludw@gmail.com; dalelowa@leuphana.de

ABSTRACT
Institutions of teacher-education are believed to hold the key to equipping teachers to address sustainability in their classrooms and thereby shape the future of communities and nations around the world. It is suggested, however, that very few of the 60-70 million teachers in the world have had any exposure in their training to sustainability issues. Investigating the extent to which the curricula in Ethiopian teacher education colleges expose prospective teachers to environmental and sustainability issues lies at the core of the study the result of which is partly reported in this paper. To this end, content analysis was used as a principal technique for gathering information. The result indicates that some of the important aspects of environment and sustainability have been integrated across the curricula, albeit to a different degree. Geography and Civics and Ethical Education contain, for instance, a larger number of courses directly related to environmental and sustainability education than other disciplines. Among the subjects in the Natural Science and Mathematics cluster, Biology and Chemistry offer a relatively better opportunity to integrate issues related to sustainability. The paper also suggests implications of the findings to environmental sustainability and resilience; and ways as to how the observed limitations could be addressed.

Key words/phrases: Agenda 21, Content analysis, Curriculum, Sustainability, Teacher education

INTRODUCTION

> *Although teachers are often unsung heroes in our communities, they are our hope for creating more sustainable societies. Furthermore, teacher-education institutions hold the key to equipping teachers to address sustainability in their classrooms and thus shape the future of communities and nations around the world (McKeown and Hopkins, 2002, p.252).*

Following the ever intensifying call for ensuring a sustainable future, there seems to be a renewed emphasis on the potential role of school teachers and institutions that train them. Stimpson [1] argues, for instance, that teachers in the classroom and the curricular choices they make are central to the success of environmental education initiatives. It is also noted that teachers as individuals need the understanding, skills and commitment to environmentalize their teaching without which it is unlikely that programmes will be effective in producing environmentally literate pupils.

Teacher-education institutions, as a whole, have the opportunity to contribute to advancing global understanding of sustainability; reorienting education to address sustainability; and promoting sustainable lifestyles [2]. In line with this, UNESCO underscores that effective teacher education in the field would produce an environmentally literate population which in turn could result in environmental action. Incorporation of environmental education into teacher training is therefore considered as "crucial, not only to the future of the discipline but also to the future of the

environment" [3]. Others present teacher education as a good, non-economic, example of a multiplier effect in action. The justification presented here is that if a teacher learns something, then all of the students in his/her care over the duration of his/her career can be influenced by the learning of that teacher [4]. It has also been noted that the multiplier effect of educating teacher educators about EfS is even greater than that for teacher education students. All these arguments on the potential of teacher education led to the growing recognition of teacher education as the 'priority of priorities', as far as environmental and sustainability education is concerned. It was also suggested that "... nations should include teacher education institutions in their national sustainability plans" [5].

More specifically, teacher education institutions are expected to train new teachers; update the knowledge and skills of in-service teachers; create teacher-education curriculum; provide professional development for practicing teachers; contribute to textbooks; consult with local schools; provide expert opinion to regional and national ministries of education; and perform similar services for school principals ([5]; [6]; [7]). A document produced by the European Commission ([8], p.7). presents the following specific strategies to build the capacity of teachers, trainers and school leaders to promote and include the principles underlying sustainability in their approaches to teaching and management:

- raising awareness among teachers, trainers and school leaders (at all levels of education and training) of the importance of ESD/EfS, and of the benefits of using this as a particularly useful tool in promoting transversal key competences;
- ensuring that teachers and trainers are equipped to teach complex issues linked to ESD/EfS, through initial as well as in-service training, and providing them with adequate tools and learning materials;
- encouraging cooperation between teachers of several subjects in the same school to promote teaching and learning on cross-cutting ESD/EfS issues; and
- promoting networking, including on-line networking, among teachers in different schools to ensure the continued development and exchange of new ideas on ESD/EfS.

THE PROBLEM

The theoretical literature presented in the forgoing section provides a strong justification for involving primary school teachers in efforts aimed at ensuring a sustainable future. However, the reality on the ground in many countries seems to give a different picture. Beckford [6], for instance, suggests that environmental education concepts and knowledge are often perceived as 'caught' rather than taught. Other barriers to the implementation of EE in pre-service programs include problems with management of cross-disciplinary approaches or infusion, shortage of qualified and experienced environmental teacher educators, and few opportunities for novice teachers to undertake environmental education teaching and to observe good EE practice during their pre-service experience in schools [6]. A study that reviewed the status of EE in primary education in ten southern and eastern African countries (including Ethiopia) identified three notable barriers to further development of environmental education: inadequate provisions for EE in education policy; deficiencies in teacher training in EE; and a lack of instructional materials [9].

One should also underscore here that teachers can effectively fulfil what is expected of them only if they have, among other things, a curriculum which adequately and properly addresses environmental and sustainability issues; and the knowledge and skills required to deal with such issues. Previous studies indicated, however, that very few of the 60-70 million teachers in the world have had any exposure in their training to sustainability issues [10] (Sterling, 2004).

Similarly, studies conducted in Ethiopia show mixed results with regard to teachers' awareness of and attitudes about environmental and sustainability issues ([11]; [12]; [13]; [14]). The results seem to be generally positive when it comes to the integration of environmental and sustainability issues into the school curricula. With regard to teachers' knowledge of and attitudes about issues related to environmental protection and natural resource management, the findings seem to be less promising.

According to Girma [14], nearly half of the trainees in the Teachers' Training Institutes of Ethiopia who took part in a study had no mastery of environmental knowledge. Gebrekidan [13] also reported that there was a severe shortage of teachers with adequate training on issues related to population and environment. Another study [12] found a divided view (between favourable and unfavourable) regarding the use and protection of natural resources. A noticeable gap was observed between what educators in Ethiopia thought and what was being advocated by the proponents of the philosophy of sustainability. It was therefore recommended, 17 years ago, that efforts be made to empower Ethiopian teachers to address issues related to environment and development [12].

In the meantime, remarkable developments took place in Ethiopia particularly in the policy arena. A series of proclamations and policies related to environment and sustainable development have been issued; and offices in charge of environmental protection established at federal and regional levels. Whether such policy provisions have brought commensurate improvements in the ways in which environmental- and sustainability issues have been handled in Ethiopian teacher education colleges is not systematically investigated yet. This paper reports part of the results of a study aimed at assessing the current status of environmental- and sustainability education in Ethiopian teacher education colleges.

OBJECTIVE OF THE STUDY

As indicated above, noticeable efforts have been made in Ethiopia, since early 1990s, both at policy and practical levels to enable the country's educational sector to address issues related to environment and development. The policy provisions following the regime change in 1991 seem to have created a unique opportunity for institutions of higher education in general and collages of teacher education (CTE) in particular to revise their programme goals, objectives, content and teaching strategies so as to make a meaningful contribution to environmental protection and sustainable development. Investigating the extent to which such efforts have been made by Ethiopian teacher education colleges to address environmental and sustainability issues lies at the core of the study the results of which is partly reported here. This paper presents the part of the study aimed at assessing the degree to and ways in which environmental- and sustainability issues have been addressed in the curricula for primary school teachers' education colleges.

METHODOLOGY

Education for Sustainability focuses largely on the major social, economic, and environmental issues that threaten the sustainability of our planet. Many of these key issues have been identified at the Earth Summit in Rio de Janeiro and outlined in Agenda 21 [2]. Agenda 21 is a document with forty chapters grouped under four broad sections: (I) social and economic dimensions; (II) conservation and management of resources; (III) strengthening the role of major groups; and (IV) means of implementation. It has been argued that understanding and addressing the issues identified in Agenda 21 lie at the heart of education for sustainability [2]. In line with this, this study selected 14 issues, which are more likely to be addressed in the curricula for teacher

education colleges in Ethiopia, for analysis from the first and second sections of Agenda 21 (Table 1).

Table 1. Key issues addressed in Agenda 21 and identified for analysis

Section/ Chapter	Issue/theme	Section/ Chapter	Issue/theme
I/3	Combating **poverty**[1]	II/14	Sustainable **agriculture and rural development**
I/5	**Demographic dynamics** and sustainability	II/15	Conservation of **biological diversity**
I/6	Protecting and promoting **human health**	II/16	Management of **biotechnology**
II/9	Protection of the **atmosphere**	II/18	Protection of the quality and supply of **freshwater** resources
II/10	Planning and management of **land resources**	II/19	Management of **toxic chemicals**
II/11	Combating **deforestation**	II/20	Management of **hazardous wastes**
II/12	Combating **desertification and drought**	II/21	Management of **solid wastes and sewage**

Source: United Nations [15]

As indicated earlier, the major aim of this study was assessing the extent to and ways in which environmental and sustainability issues have been addressed in the curricula for primary school teacher education colleges. To this end, content analysis was used as a principal technique. Content analysis is defined as "a research technique for objective, systematic and quantitative description of the manifest content of communication" (Berelson, 1952 quoted in [16], p.3). Content analysis as a research technique is also described as a careful, detailed, systematic examination and interpretation of a particular body of material in an effort "to identify patterns, themes, biases, and meanings" ([17], p.303-304). The technique is often accomplished through the use of objective language, categorization, and systematic surveys (Burns-Bammel *et al*., 1988 quoted in [18], p.39).

The recently revised curricula (2009 version) for primary school teacher education colleges in Ethiopia has been analyzed based on the following steps:

Step One: Determining analytical categories

- The core courses (both major and minor area) offered in the three clusters: social science; natural science and mathematics; and language have been considered in this chapter as key analytical categories. According to the revised curriculum, prospective teachers are expected to take 56 credit hours worth courses of this category (which make up half of the total credit hours required for graduation). The other half is composed of professional and practicum courses which are not covered in this study.

Step Two: Establishing units of analysis

- The specific courses in the three clusters, indicated in step one, have been used as units of analysis. According to the revised curriculum, prospective teachers are expected to take about 19 three-credit hour courses in their major and minor areas.

[1] The highlighted words or phrases will represent the whole theme in the analysis of results and discussions thereof in this paper.

Step Three: Determining criteria for sorting data into analytic categories

- The criteria used here is having sustainability issues clearly (manifestly) mentioned in the statements of objectives and/or corresponding content outline. Fourteen such issues likely to be addressed in the curricula for teacher education colleges have been identified (Table 1).

Step Four: Counting the number of entries in each of the three categories

- This has been undertaken by counting cases (specific courses with objectives and/or contents related to sustainability issues). The counting was done by the writer himself.

FINDINGS

The Position of CTE in the Educational Structure

Ethiopia witnessed a regime change in 1991 which resulted, among other things, in promulgation of a new education and training policy and an entirely new educational structure. The 1994 Educational and Training Policy changed the structure of general education from 6-2-4 to 8-4 [19]. The current structure thus constitutes of basic, general, higher and specialized education on a formal and non-formal basis (FDRE, 1994). The components are:

1. a kindergarten system for children aged 4-6 years;
2. a primary education from Grades 1-8 subdivided into two sections of basic (Grades 1-4) and general (Grades 5-8) education;
3. a general secondary education from 9-10;
4. a preparatory senior secondary education of 2 years and a system of vocational and technical education in parallel with it;
5. higher education of 1-2 years of diploma and 3-5 years for undergraduate degree and an additional 1-3 years for post graduate degree;
6. a system of vocational/technical training in parallel with the academic education; and
7. a special education system and distance learning.

According to the new structure, the colleges of teacher education (CTE) which prepare teachers for primary schools fall under the *fifth* category (see the above structure); and are responsible to prepare teachers for the first and second cycles of primary education (those in the *second* category according to the new structure). The curriculum for the first cycle primary school teachers' education is designed following the cluster modality where different subjects are brought under such clusters as social science; natural science and mathematics; and language. The curriculum for the second cycle follows, on the other hand, a linear modality whereby prospective students specialize in different disciplines like Biology or Geography. The following section presents results of assessment of the place of environment and sustainability in the curricula for CTE in Ethiopia, on stream basis.

Sustainability Issues in the Social Science Stream

Social Science forms one of the clusters that make up the first cycle primary school teachers' education; and is composed of Geography, History and Civics and Ethical Education. Prospective teachers are supposed to take a total of 122 credit hours for graduation. Half of the credit hours goes to the three subject areas whereas the other half goes to general education courses, professional courses and practicum. On graduation, prospective teachers are supposed to teach three different subjects (Geography, History and Civics and Ethical Education).

Analysis of the existing curricula for the Social Science stream shows that Geography and Civics and Ethical Education contain a greater number of courses directly related to environmental and sustainability education (Table 2). One should particularly underline here that courses in Geography address all the three dimensions of sustainability, namely environment, economy and society. Geography offers (both in its cluster and linear modalities) seven courses that address some of the key sustainability issues of local and global relevance (Table 2).

Table 2. Courses addressing issues related to sustainability (Social Science stream: Geography)

Subject	Course	Issues related to sustainability
Geography	Introduction to climate	○ Meaning and scope of weather and climate ○ Elements and controls of weather and climate ○ Global warming: causes and effects ○ Ozone: Formation, depletion and effect ○ Energy balance of the earth and atmosphere ○ Spatial and temporal variation of temperature ○ Variation and distribution of precipitation ○ Variability and dependability of weather and climate
	Introduction to landform geography	○ Erosion and deposition; and resulting landforms
	Economic geography	○ Environmental perception and behavior ○ Man-environment interrelations ○ Factors affecting agriculture ○ Types of forests and their exploitation
	Geography of population	○ Factors affecting population distribution (physical, human, socio-economic and historical) ○ Population and resource balance ○ Origin and types of population policy
	Geography of Africa	○ Characteristic and distribution of temperature and rainfall in Africa ○ Soil conservation and management in Africa ○ Vegetation conservation and management in Africa ○ Utilization, conservation and management of forests in Africa ○ Wild animals conservation and management in Africa ○ Resource and population in Africa ○ Drought in Africa
	Geography of Ethiopia	○ Water resources and their significance ○ Types and distribution of natural vegetation ○ Conservation and management of natural vegetation ○ Types and distribution of wild animals ○ Conservation and management of wild animals ○ Soil erosion and conservation ○ Population policy of Ethiopia ○ Environmental policy of Ethiopia ○ Factors affecting agricultural activities
	Environmental education	○ Environment and development ○ The need for environmental education ○ Inception and aims of environmental education ○ Principles of environmental education ○ Environmental education in schools ○ The environmental education curriculum ○ The environmental education subject matter ○ Methods used in environmental education ○ Environmental education activities and equipment ○ Evaluation in environmental education ○ Environmental impact assessment

Courses in History, on the other hand, contain no themes directly related to environmental and sustainability education, except one. In History, a course entitled "History of the World" discusses the social, economic and political consequences of industrial revolution. This course could thus lay a strong foundation for understanding the environmental and sustainability crisis the world has gone through in the 20th century. Table 3 indicates some of the specific issues addressed in History and Civics and Ethical Education.

Table 3. Courses addressing issues related to sustainability (Social Science stream: History and Civics and Ethical Education)

Subject	Course	Issues related to sustainability
History	History of the world	○ Consequences of industrial revolution (social, economic, political)
Civics and Ethical Education	Advanced civics and ethical education I	○ Prevention of environmental pollution and wildlife destruction ○ Protection and preservation of historical and cultural heritages ○ Proper utilization of natural resources and cultural heritages
	Advanced civics and ethical education II	○ Major issues of development ○ Theories of development ○ Development in developing countries ○ Understanding the basis of Ethiopian economy ○ Policies and strategies of development in Ethiopia
	Selected topics in civics and ethical education	○ The issue of environment and heritage ○ The issue of gender ○ The issue of HIV/AIDS ○ The issue of population explosion ○ North-South debate
	Introduction to international relations and contemporary global issues	○ The issue of poverty, development and hunger ○ HIV/AIDS ○ The environment ○ Gender
	Environmental resources and heritage management	○ Understanding the environment ○ Biodiversity ○ National parks ○ Geological features ○ Water bodies ○ Climate ○ Current condition of the environment and the Ethiopian heritage ○ Factors accountable for environmental degradation ○ Deterioration of the Ethiopian cultural heritage ○ Mechanisms of safeguarding environment and heritages

Civics and Ethical Education has five courses that contain almost all the important dimensions of sustainability education. What is more, the courses try to balance the need for protection and preservation of natural and cultural heritages, unlike previous efforts in environmental education in Ethiopia which tended to focus on the natural environment. The courses in Civics and Ethical Education also appear to take a broader view of poverty and development and introduce the North-South divide in the level of economic development and resource utilization which forms a very important part in any discussion on sustainable development.

Sustainability Issues in the Natural Science and Mathematics Stream

The Natural Science and Mathematics cluster is composed of four subjects, i.e. prospective teachers trained in this cluster are prepared to teach one of the four subjects in the first cycle primary schools: Biology, Chemistry, Mathematics and Physics. Among the subjects in this cluster, Biology and Chemistry have a relatively better provision for inclusion of issues related to sustainability (Table 4). Biology has three courses dealing mainly with ecology, conservation and human health. The efforts to emphasize on the link between population growth, health and economic development are worth underlining here. The course entitled "Ecology and Conservation" covers issues ranging from greenhouse gases to global conventions.

Table 4. Courses addressing issues related to sustainability (Natural Science and Mathematics stream: Biology)

Subject	Course	Issues related to sustainability
Biology	General Biology	○ Conservation of natural resources ○ Rapid population growth and its effects on health, economy and the environment
	Ecology and Conservation	○ Global environmental change ○ Greenhouse gases ○ Global climate change ○ Conservation of natural resources ○ Values of biodiversity and ecosystem services ○ Threats to biodiversity (habitat degradation and loss, habitat fragmentation, overexploitation, invasive species) ○ Combating desertification ○ International conventions, and national policies and institutions
	Health Sciences	○ Environmental sanitation ○ Personal hygiene ○ Public health laws ○ Rapid population growth and its effects on health, economy and environment
	Microbiology and Biotechnology	○ **Note:** *Here is a missed opportunity to introduce the debate on the pros and cons of genetically modified organisms (GMOs)*

Chemistry has two courses that focus mainly on energy and environmental pollution (Table 5). Almost every aspect of the contemporary environmental issue has been considered thereby creating a tremendous opportunity for the lecturers/teachers to engage their students so as to seek locally relevant solutions to some of these problems (e.g. solid waste management). Physics appears to be less engaged in sustainability education with only one of its courses, namely, "Earth Science and Astronomy" offering a significant opportunity to deal with sustainability issues. There is another course in Physics that slightly touches energy efficiency (Table 5).

Table 5. Courses addressing issues related to sustainability (Natural Science and Mathematics stream: Chemistry and Physics)

Subject	Course	Issues related to sustainability
Physics	Heat and Thermodynamics	○ The efficiency of engines
	Earth Science and Astronomy	○ Major global climate zones and changes in weather ○ Human impacts on weather and climate
		○ Chemistry and environment

Chemistry	General Chemistry III	○ Concept of environment ○ Environmental pollution ○ Air pollution ○ Water pollution ○ Soil pollution ○ Global warming ○ Greenhouse effect ○ Natural resources, energy and environment ○ Soil fertility and productivity ○ Agrochemicals
	Applied Chemistry	○ Water pollution and its prevention ○ Energy sources and consumption in industries ○ Factors for selection of fuels ○ Alternative energy sources ○ Ethiopian energy sources and consummation ○ Impact of anthropogenic chemicals on the environment ○ Soil and water pollution ○ Atmospheric pollution ○ Global warming and the consequences ○ Ozone depletion and its causes ○ Waste from industries and municipalities ○ Reducing waste generation ○ Recycling waste ○ Effects of toxic chemicals on the health of animals and plants

Though there are noticeable efforts in Biology curriculum to link population issues with ecological and economic consequences, the Natural Science and Mathematics curriculum generally tends to focus on the ecological component of sustainability much more than the other components, namely social and economic. The debates surrounding the effects of chemicals being used in Ethiopian industries (e.g. horticultural industries) and the controversies on use of genetically modified organisms could have been integrated into the curricula. In this regard, the course in Biology, entitled "Microbiology and Biotechnology" exemplifies a missed opportunity to introduce the debate on the pros and cons of genetically modified organisms.

Sustainability Issues in the Language Stream

The Language stream is composed of English, Amharic and a local languages. Prospective teachers in this cluster where local languages are not taught will take Civics and Ethical Education as a third subject. Compared to the other clusters, the integration of sustainability seems very modest in the case of courses in the Language stream. Table 6 shows issues related to sustainability addressed in this cluster. Three important issues have been addressed in English. These issues have been presented as reading texts in two of the courses; Communicative English I and Communicative English II (Table 6). One can thus see that there are opportunities to include more issues related to sustainability not only in English but also Amharic (official language) and other local languages.

Table 6: Courses addressing issues related to sustainability (Language stream)

Subject	**Course**	**Issues related to sustainability**
English	Communicative English Skills I	○ Sense of responsibility
	Communicative English Skills II	○ Poverty and globalization ○ Ethiopian water resources

Integration of Issues in Agenda 21

As indicated in the methodology section, this study attempted to see the degree to which sustainability issues identified in Agenda 21 have been 'manifestly' addressed in the revised curricula for CTE in Ethiopia. To this end, 14 issues likely to be addressed in the Ethiopian context have been selected (Tables 1 and 7). It is important to underscore that 13 out of the 14 issues have been integrated into the existing curricula, albeit to a different degree. Issues that have been integrated into three or more courses include protection of the atmosphere (integrated into 5 courses); planning and management of land resources (into 4 courses); and protection of fresh water resources (into 4 courses); and demographic dynamics (into 3 courses). The following are issues integrated into two courses: Combating poverty; combating deforestation; combating desertification and drought; sustainable agriculture and rural development; and conservation of biological diversity. Four of the issues have been integrated into one course whereas one issue, namely, management of biotechnology, has not been integrated anywhere in the curricula examined here (Table 7).

Table 7: Sustainability issues in Agenda 21 integrated into the curricula for CTE in Ethiopia

Section/ Chapter	Issue/theme	Department	Course
I/3	Combating **poverty**[2]	Civics and Ethical Education	➢ Introduction to International Relations and Contemporary Global Issues
		English	➢ Communicative English Skills II
I/5	**Demographic dynamics** and sustainability	Geography	➢ Geography of Population
		Civics and Ethical Education	➢ Selected Topics in Civics and Ethical Education
		Biology	➢ General Biology
I/6	Protecting and promoting **human health**	Biology	➢ Health Sciences
II/9	Protection of the **atmosphere**	Geography	➢ Introduction to Climate
		Biology	➢ Ecology and Conservation
		Chemistry	➢ General Chemistry III ➢ Applied Chemistry
		Physics	➢ Earth Science and Astronomy
II/10	Planning and management of **land resources**	Geography	➢ Introduction of Landform Geography ➢ Geography of Africa ➢ Geography of Ethiopia
		Civics and Ethical Education	➢ Environmental Resources and Heritage Management
II/11	Combating **deforestation**	Geography	➢ Geography of Africa
		Biology	➢ Ecology and Conservation
II/12	Combating **desertification and drought**	Geography	➢ Geography of Africa
		Biology	➢ Ecology and Conservation
II/14	Sustainable **agriculture and rural development**	Geography	➢ Economic Geography ➢ Geography of Ethiopia
II/15	Conservation of **biological diversity**	Civics and Ethical Education	➢ Environmental Resources and Heritage Management

[2] The highlighted words or phrases will represent the whole theme in the analysis of results and discussions thereof in the paper.

		Biology	➢ Ecology and Conservation
II/16	Management of **biotechnology**	---------	--------
II/18	Protection of the quality and supply of **freshwater** resources	Geography	➢ Economic geography
		Civics and Ethical Education	➢ Environmental Resources and Heritage Management
		Chemistry	➢ General Chemistry III ➢ Applied Chemistry
II/19	Management of **toxic chemicals**	Chemistry	➢ Applied Chemistry
II/20	Management of **hazardous wastes**	Chemistry	➢ Applied Chemistry
II/21	Management of **solid wastes and sewage**	Chemistry	➢ Applied Chemistry

Table 7 shows, among other things, that most of the sustainability issues identified in Agenda 21 are already integrated into two or more of the courses in the revised curricula for Ethiopian teacher education colleges. This, by itself, is quite encouraging. One should also underline here that integration alone does not ensure appropriate handling of the issues in and outside a college classroom. In any case, results of this study give an important clue as to where we have good entry points to build the capacity of college teachers to address key environmental and sustainability issues in the future. In relation to this, Down ([20] p.398) advises that "lecturers need to use 'natural' entry points to the introduction of the concept of sustainability, that is, areas of the subject that can dovetail easily with reflection on and learning about sustainability". On the other hand, this study also shows areas which need more work so as to make environmental and sustainability education a nationwide agenda embraced by all departments (and not left to individual subjects and lecturers/teachers).

CONCLUSION

It is strongly argued that 'if education is a solution in working toward a sustainable future then initial teacher training (ITT) provides a strategic opportunity for ensuring that all teachers are able to teach for sustainability when they begin their teaching carriers" ([21], p.599). For this to happen, environmental education "should become a requisite component of pre-service teacher education and that faculties of education make EE a teachable subject and expose all teacher candidates to it" [6].

In Ethiopia, colleges of primary school teacher education occupy a pivotal position which helps them play a leading role in enhancing a culture of critical thinking among the various segments of the society. *First*, they are fairly widely distributed across the country thereby having a great chance to reach local communities, particularly rural communities which make up more than 80% of the country's population. *Second*, they are responsible for training teachers for primary schools which house millions of kids, a good proportion of whom having little chance to go beyond grade eight. *Third*, it is easier to integrate place-based environmental and development issues at this level than, for instance, at a university level. *Fourth*, it is possible to utilize the already existing networks between these colleges and the schools in their areas of influence to maximize the impact of possible interventions (without a need for additional resources or with relatively much less resources). Achieving all this requires, among other things, provision of adequate curricular time for environmental and sustainability issues in the CTE. This study tried to examine whether or not this was the case by analyzing the revised curricula.

The results of the study indicate that most of the sustainability issues identified in Agenda 21 have already been integrated into two or more of the courses. Discipline wise, Geography and Civics and Ethical Education contain a larger number of courses directly related to sustainability education. It is particularly underlined that courses in Geography address all the three dimensions of sustainability, namely, environment, economy and society. Likewise, Civics and Ethical Education offers courses that contain almost all the dimensions of sustainability education. What is more, the courses in Civics and Ethical Education take a broader view of poverty and development and introduce the North-South divide in level of economic development and resource utilization. Among the subjects in the Natural Science and Mathematics cluster, Biology and Chemistry have a relatively better provision for inclusion of issues related to sustainability. The effort made in Biology to emphasize the link between rate of population growth, health and economic development is worth underlining here. Chemistry has courses that focus mainly on energy and environmental pollution. Almost every aspect of the contemporary environmental issue has been duly considered in Chemistry courses.

Based on the major findings of the study, it is possible to conclude the existing curricula for Ethiopian CTE already address a range of environmental and suitability issues and, therefore, provide a huge potential to contribute towards environmental sustainability and resilience. At the same time, one should also underscore that the making full use of the curriculum requires (a) strengthening those areas that have been addressed only slightly (e.g. loss of biodiversity); (b) including issues which have not been addressed; and (c) ensuring that aspects of sustainability are integrated into as many disciplines as possible. Achieving all this, in turn, requires consideration of environmental and sustainability issues as a 'priority' by educational policy makers, educational administrators and teachers [9].

Finally, as the issues already integrated into the curricula give adequate entry for environmental and sustainability education in these institutions, the Colleges or other stakeholders should consider conducting an on-the-job training for teachers with a focus of active learning methodologies. Some scholars put a special emphasis on the contribution of school focused continuous professional development (CPD) in achieving the aims of educational for sustainability [22]. It has thus been underlined that "whatever the educational system, CPD provision in environmental/sustainability education must have a significant school focus" ([22], p.380).

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THE UGANDA ENERGY SECTOR – TRACING SUSTAINABILITY IN THE FACE OF A BURGEONING OIL SECTOR -A POLICY REVIEW-

Alexander Komakech-Akena[1]*
1: Senior Energy and Power Engineer
AOT Consulting (EA) Limited
P.O. Box 10061 Kampala, Uganda
e-mail: a.komakech@aotconsulting.co.ug

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Abstract

This paper critically assesses the current status quo of the energy sector in Uganda, particularly highlighting such important aspects as the contributions of the various energy alternatives (fossil fuel-base and renewable sources), government strategic plans, as well as the electricity consumption and supply. A projection of the growth, for aggregate energy production, consumption and GHGs is then made. Basing on the observations, the paper projects the expected rise in CO_2 emission level resulting from increased oil usage mostly in transport and power sub-sectors. Further analysis of the economic and social cost related to developing renewable energy sources against fossil fuel based plants is made. The paper also discusses the potential impacts of climate change on hydrological base power plants.

The paper answers such pertinent questions as: Can we keep the CO_2 levels below acceptable thresholds and protect the environment, even in an oil-complemented energy sector? How must Uganda modify the current energy policies and strategies to ensure that energy development shall be done sustainably when the oil and gas sectors become big players in the energy market? What are the lessons regarding sustainable energy development that we can learn from countries that have only recently started exploiting oil resources?

The paper concludes with a proposed path for Uganda to develop her energy sector, even with oil, in a sustainable fashion.

1. INTRODUCTION

Hitherto, Uganda's electricity has been generated mainly from renewable hydrological sources, and only supplemented by a small percentage of fossil fuels. For that reason alone, CO_2 emission level has so always been low, below 3,784ktCO2 annually- representing 0.1% of the World[3] which is considered non distressful. That is all bound to change with commencement of commercial oil production in Uganda, scheduled for 2017/18. A remarkable increase in fossil fuel usage, especially in the transport and energy sector once commercial production starts. This will in turn increase the GHGs emission level of Uganda, bringing the question of sustainable energy development into focus. The challenge, therefore, is how to develop a sustainable and strategic development plan for the evolving energy industry where the contribution from oil and gas products is on the increase.

[3] Word Bank Databank - http://data.worldbank.org/indicator/EN.ATM.CO2E.KT/countries?display=m , May 2013

2. ENERGY SITUATION

The energy sector of Uganda is dominated by biomass, which accounts for more than 90% of the total primary energy supply (TPES). Electricity contributes only 1.3% while the remaining 8.7% is from Oil and petroleum products [source?].The generation mix is of the order 52% from hydropower – contributed by; Kiira (200MW), Bujagali (250MW), Nalubaale (180MW) and eight small hydropower plants (56.5MW), 43% thermal power and 5% utilizing small generation source based on renewable sources such as mini hydro and bagasse. The total installed capacity of the country is 818.5MW, with an actual output of about 580 MW [4].Figure 2-1 outlines a summarized representation of the major power plants in Uganda. At peak time, the electricity demand rises to 650MW(1), which leaves about 28% of the electricity demand unmet. With this shortfall, power rationing is necessary to balance the rising peaks. Electrification rates remain low, at 12%(2). This can be further broken down to 10% for urban and 6% for rural areas. The low electrification rates are attributed to delays - caused by "lack of finances or access to funding, to construct new power plants" [insert source]. The rise in demand for new electricity connections, as registered by the Power Utility (Umeme), is estimated at 20% per year, further increasing pressure on the supply side.

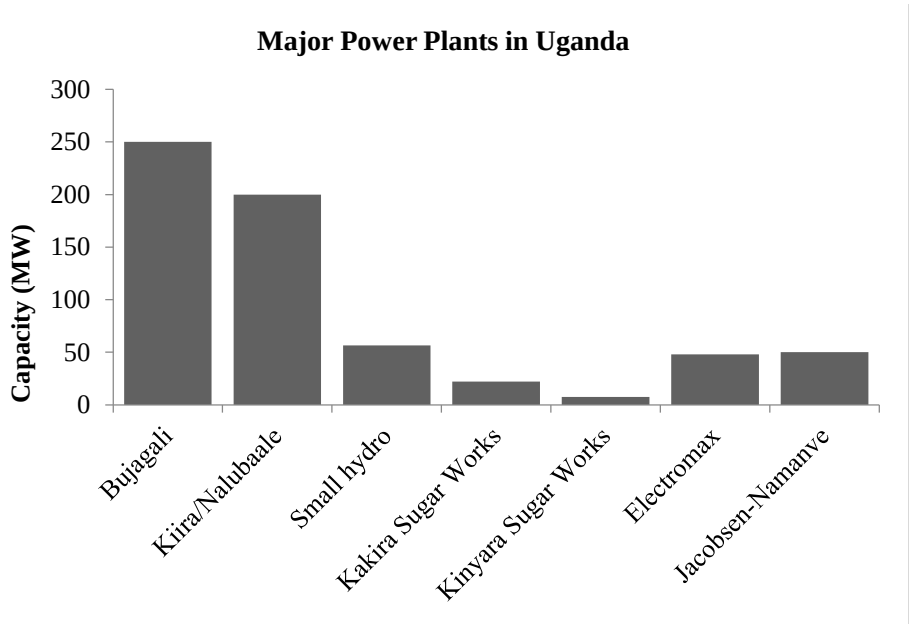

Figure 2-1: Power Plants in Uganda

Source: Author compiled

Despite the seemingly gloomy energy situation, Uganda is abundantly endowed with energy resources, a large portion of which is renewable and remains largely un-tapped. Together with the discovery of oil, these resources, if well exploited, would comfortably meet the country's power demands, and even export to the neighbouring countries.

2.1. Share of Renewables

Renewable energy resources have a high share in Uganda's power generation mix, contributing almost 95% of the power generated. Hydropower plants and biomass sources such as bagasse jointly produce about 780MW towards the total national power production in the present day.

[4] Counting all power plants including the thermal diesel generation sets at district levels

Fossil-fuelled power plants are intentioned to serve as a temporary coping strategy to manage the run-away demand at peak times. This trend is set to change when all the planned and proposed hydro power plants are implemented by 2030. Figure 2-1 illustrates how the power generation sector has benefited from renewable resources since 1980. The shortfall in 2005 and 2006 in the growth show how the power sector was affected by long draughts and erratic rainfalls of those years.

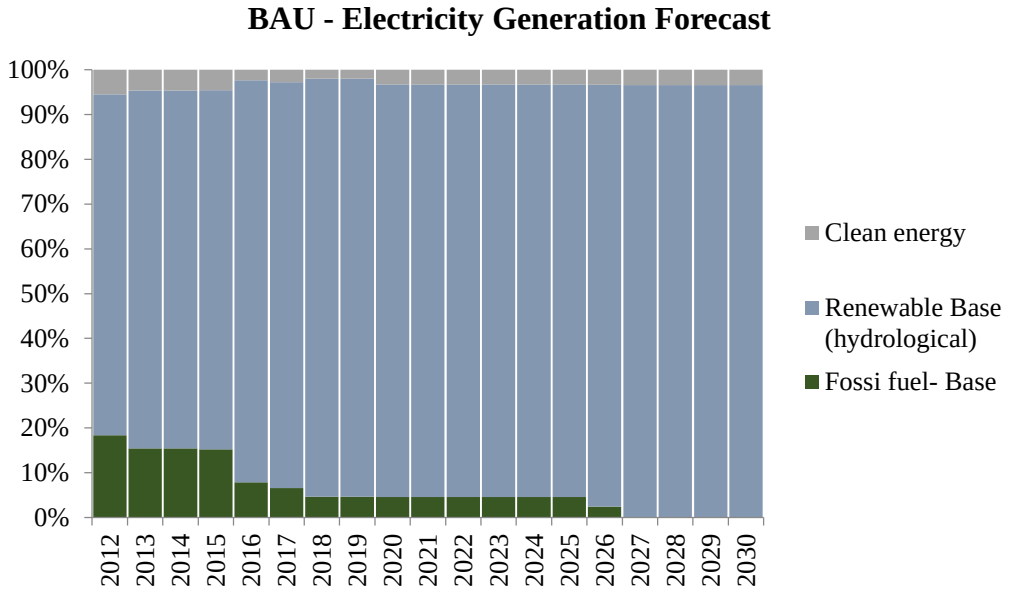

Figure 2-2: Capacity Percentage Share by Resource type

Source: Compiled by Author from PSIPD, MEMD

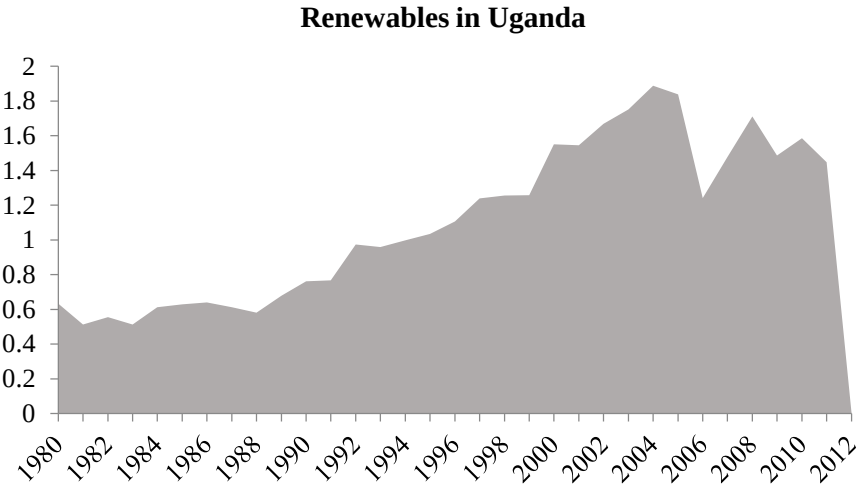

Figure 2-3: Renewable energy contribution power generation in Uganda

Source: CIA database, 2014

2.2. Oil in Uganda

Traditional '*oil nations'* in Africa have long comprised of Libya, Angola, Nigeria, Algeria, Egypt and Sudan until the recent entry of newcomers like; Ghana, Uganda and Mozambique. As international oil companies intensify their exploration for oil and gas on the continent, the number of newcomers is set to rise, as more and more oil deposits are discovered. For Uganda, the burgeoning oil sector is a welcome 'gift of nature.' After the confirmation of commercial deposits of oil and gas in the Albertine Graben[5] in 2006, preparations have since been made to explore and exploit the resource. It is estimated that some 3.5 billion barrels in reserve lie untapped and due for commercial production by 2017[6].

About 40% of Albertine Graben has been explored, with over 90 wells drilled on tilted fault blocks, rollover anticlines and flower structures of significant sizes. Wells drilled on a number of structures during 2002—2013 confirmed the presence of multiple exploitable accumulations of hydrocarbons making 21 discoveries and providing up over 3.5 billion barrels of Oil equivalent. Flow testing of the Waraga, Mputa, Kingfisher, Kigogole and Kasamene prospects has yielded flow rates between 3,550 and 12,000 BOPD (2)

The Government plans to utilise the first fruiting of this oil to increase electricity generation capacity through thermal power plants. In the Grid Development Plan (GDevP) reviewed, UETCL has plans to evacuate over 6000MW of electricity generated by heavy fuel oil (HFO) and CCGT technologies through 400kV transmission line (3) from the Albertine Graben region. However, in the short term, slightly over 50MW of electricity is to be generated from the region. Plans are already underway to implement the evacuation of this power through the proposed 220kV Hoima – Kafu line. In addition to increasing the share of modern energy for end-users in the commercial and household subsectors, the Ugandan community shall benefit from other by-products such as kerosene, diesel and LPG.

The immediate social challenge is to develop the new oil sector in a way that will ensure that benefits and opportunities are equally and equitability distributed, and in an ethical manner. This would require good management and transparency right from the infancy stages of developing this sector. By national policy, the citizens in the oil-rich regions of the country -e should enjoy preferential social and economic benefits directly accruing from the exploitation of this oil resource. In order to accommodate such a requirement, Uganda might need to set up the entire sector anew, with new institutions that will supervise, manage and develop the oil resource sustainably. New policies and strategies that will govern and regulate the operations of the new emerging policy and market will be necessary.

2.3. Affected sectors of the Economy

An adequate supply of cheaper petroleum and gas products in the near future is bound to have tremendous impact on the economy as a whole. Considering that Uganda's transport sector is heavily dependent of oil products such as (diesel, petrol, aviation fuel, fuel oil, kerosene, lubricants and bitumen, it is certainly one of the key sectors to be most influenced by burgeoning oil and gas production. That petroleum products are imported exposes the country's economy to fluctuating

[5] The Albertine Graben forms part of the Western arm of the East African Rift System. The Graben is a unique physiographic region comprising the rift escarpments, the block of the Rwenzori Mountains and an extensive graben. The area has several lakes including Albert, Edward and George(16).

[6] Adjustment of year from 2014 to 2017

and exorbitant prices together with a significant level of uncertainty with regard to their availability.
With commercial oil production in Uganda, the impact of oil price shocks and the erratic supply of imported petroleum products on the economy is expected to reduce. The country will also enjoy growing supplies of foreign exchange by importing some of its oil products and the resulting electricity.

The electricity sector is yet another that will be heavily impacted. Oil products have traditionally been used in thermal power plants to supplement what the country generates from hydro power dams. Oil products are also the main fuel for most stand-alone power systems as well as well as off-grid electrification schemes.

In summary, it is envisaged that the power and transport sectors will benefit most from the burgeoning oil industry. It is therefore reasonable to anticipate a surge in commerce, trade, production and the general economy once the commercial production kicks off.

3. EXISTING FRAMEWORK

This section provides assessment and analysis of the existing policy framework. We outline only those legislative documents that are expected to impact new oil and gas sector, and have relevancy to *increasing access to clean modern energy* and *environment protection.*

3.1. Sector Acts and Policies

The Electricity Act, 1999

The electricity act, establishes a strong foundation for which the entire electricity sub-sector is managed and regulated. The act mandates the establishment the sub-electricity sector as well as providing for formation of the responsible institutions.
It is this act that established the Electricity Regulatory Authority (ERA) and unbundled the Uganda Electricity Board (UEB) to form three electricity companies to manage the electricity infrastructural utilities of Uganda. Under Part VII, Section 63 (1) and (2), sustainable development is discussed in inference to 'Rural electrification'. The act allows for renewable energy power generation by utilising renewable energy resources such as solar photovoltaic power, mini hydropower and wind energy.

The Energy Policy for Uganda, 2002

The policy goal is to meet the energy need of Uganda's population for social and economic development in an environmentally sustainable manner. At a high level, the policy introduces the various energy sources available in Uganda, and the opportunities and challenges surrounding their exploitation, strategically. It also outlines the guiding principles for exploiting these very resources. At the time of its drafting, the petroleum industry/exploitation in Uganda was at its exploration stage. This exploration was in the Albertine region. The challenge of sustainable fossil energy development was therefore not given any attention in this policy, however environmental and sustainable development is explicitly discussed.

The Renewable Energy Policy of Uganda, 2007

The goal of this policy is to increase use and share of modern renewable energy from 4% to 61% of the total energy consumption by the year 2017. The main driver of this ambitious goal is: the ever-increasing price fossil fuel, the unpredictability of the future supplies of fossil fuels and the need for the energy sector to comply with the requirements of the Kyoto protocol. The renewable energy sources of Uganda include but are not limited to hydrological sources, wind, solar, biomass and geothermal. The estimated total electrical potential of the renewable energy sources is estimated at 5,300 MW. The large hydropower potential alone is estimated at about 2,000 MW, mainly from six potential hydro sites along river Nile. The six major hydro power sites are Bujagali 250MW, Kalangala 450 MW, Karuma (Kamdini) 650 MW, Ayago North 300 MW, Ayago South 250 MW, and Murchison falls 600 MW. The level of electrification is about 10% countrywide and 5% in rural areas. Interesting to note is that the policy too is silent on fossil fuel exploitation path and the sustainability challenges that would come along this path.

The Petroleum Act, 2013

The purpose of this act is to operationalize the Oil and Gas Policy of Uganda. It is aimed at establishing an effective legal framework and institutional structures to ensure that the exploration, development and production of petroleum resources of Uganda is carried out in a sustainable manner that guarantees optimum benefits for all Ugandans, both the present and future generations. It creates a conducive environment for efficient management of the petroleum resources. Establishes institutions to manage the petroleum resources and regulate the petroleum activities. It regulates petroleum activities including licensing, exploration, development, production and cessation of petroleum activities or decommissioning, Ensuring public safety and protection of public health and the environment in petroleum activities. It supports the development of state participation and national content in the petroleum industry in Uganda and ensures transparency and accountability in the conduct of all activities regulated under this act.

The National Oil and Gas Policy, 2008 (NOGP)

The NOGP confirms government of Uganda's intention to the extraction and exploitation the oil and gas reserves found on the Albertine Graben and anywhere else in the country. The goals of this policy include; Promotion of valuable utilization of the country's oil and gas resources, promotion of the development of suitable transport and storage solutions which give good value to the country's oil and gas resources and ensuring that oil and gas activities are undertaken in a manner that conserves the environment and biodiversity.

Oil and Gas Revenue Management policy, 2012 (OGRMP)

The policy provides details on how the anticipated revenues shall be managed and integrated into the existing Government system, with a view of managing the overall impact of these revenues on the economy. The policy establishes an appropriate framework to aid the sustainable management of the oil and gas revenues. It calls for the highest level of transparency and accountability in the management of oil and gas revenue and gives the institutional and governance structures to be used to achieve it. Furthermore, it promotes harmony and social cohesion, by providing for a mechanism for sharing royalty revenues with local governments within the oil producing region. The document was developed in fulfilment of the NOGP requirement.

Since oil revenues and their management present opportunities as well as unique policy challenge, the key of the OGRMP is to avoid the so called resource curse[7]

The National Environment Act, Cap 153 (1995)

The Act provides for the planning requirement, preventive measures, enforcement actions and control mechanism during execution of projects that are likely to impact on the environment. The Act established NEMA as the corporate body mandated to co-ordinate monitoring and enforcement of environmental standards.

According to section 57(1) of the Act, no person shall discharge hazardous substances, chemical, oil or mixture containing oil in any waters or other segment of environment except in accordance with guidelines prescribed by NEMA. Section 4(3)(c) requires that an on-going activity shall be subjected to an environmental audit in accordance with section 23 of the Act while section 4(3)(d) requires that an on-going activity undertakes environmental monitoring in accordance with section 24 of the Act. Section 3(2) (g) addresses the issue of establishing adequate environmental standards and to monitor changes on environmental quality. Section 3(2) (k) ensures that the cost of pollution will be borne by the polluter.

3.2. Sector Programs and Initiatives

a) Strategic Environmental Assessment of Oil and Gas Activities (SEA), 2013

The objective of SEA was to ensure that the environmental issues associated with the Oil and Gas sector are considered and integrated into regulations, major decisions connected to policies, plans and programmes (PPP) and specific strategic aspects related to petroleum activities at the earliest stage in order to achieve the goals of the NOGP.
With regard to Uganda, the SEA is aimed at supporting sustainable development, which defines the environment as comprising of the physical environment, cultural heritage and socio-economic effects due to petroleum-related activities in the Albertine Graben.

b) SE4ALL

The sustainable Energy for All initiative is a multi-stakeholder partnership amongst governments, the private sector and civil society. Launched by the UN Secretary General in 2011, it has three inter-linked objectives to be achieved by 2030:
Ensure universal access to modern energy services, double the global rate of improvement in energy efficiency and double the share of renewable energy in the global energy mix.
All the three objectives are equally important and reinforce each other in important ways.

c) Grid Development Plan 2011-2027

A review of the GDevP shows an extensive plan by government to evacuate power from Albertine Graben region that will be generated by the resultant oil. A 400kV transmission line is planned.

[7]Resource curse is phenomenon through which several economic, institutional and political economy transmission mechanisms, oil and gas revenues translate into economic stagnation and waste.

Table 3-1: Proposed/Planned thermal power plants and associated power lines

Plant Ref.	Capacity (MW)	Interconnection from power plant
Gas– CCGT, Albertine A	1500 (2X750)	400kV DCST-Quadruple Albertine region to Nakasongola
HFO, Albertine A	1500 (2X750)	
Gas – CCGT, Albertine B	1500 (2X750)	Mputa – Hoima – Kafu 400kV DCST- Quadruple. Karuma – Kafu – Nakasongola - Kawanda Second line (400kV DCST Quadruple) Karuma – Lira – Opuyo – Tororo second line , 400kV DCST bundled
HFO, Albertine B	1500 (2X750)	400kV DCST-Bundle Nakasongola- Kawanda
HFO, Albertine B	1500 (2X750)	400kV DCST-Bundle Nakasongola- Kawanda

Source: GDevP, 2015

3.3. Analysing the gaps and grey areas within the policy frameworks (NT/AK)

A summary of the reviewed legal framework documents of Uganda energy sector is outlined in Table 3-2. It can be noted that the founding policies in the sector have semblance of strong sustainability. This is the case because the country's energy resources are mainly of the renewable nature, and hence the focus of these documents. The legal frameworks establish a strong mindedness towards developing the energy sector in a sustainable manner, even with the oil and gas sector. Key interest was noted to be put on utilising the renewable energy base of Uganda as opposed to fossil fuel.

However, still as shown by the table some these legal documents did not have a clear strategy and plan of how sustainability of the energy and environment sector will be achieved.

Table 3-2: Summary of Reviewed Policies

Document	Key areas addressed			Sustainable development approached	Existence of a clear strategy and plan of how to achieve SD
	Modern energy access	Fair share of per capita end use	Emphasis on clean and renewable energy		

Energy Policy	YES	YES	YES	YES	YES
Renewable Energy policy	YES	YES	YES	YES	YES
Electricity Act	YES	NO	YES	NO	YES
National Environment Act	NO	NO	NO	YES	YES
National Oil and Gas Policy	NO	NO	NO	YES	NO
Petroleum Act	NO	NO	NO	YES	NO
Oil and Gas Revenue Management Policy	NO	YES	NO	YES	NO

Source: Compiled by Author

4. SUSTAINABILITY OF THE ENERGY SECTOR

4.1. CO_2 Emissions

Uganda's CO_2 emissions compared to the rest of the world is very low, accounting only 0.1% tCO_2. Figure 4-1 shows the prognosis of CO_2 emissions in Uganda since the year 1980. The contribution of CO_2 emissions from thermal power plants can be noticed by an increase between 2005 and 2012 when Aggreko I,II&III[8] where commissioned.

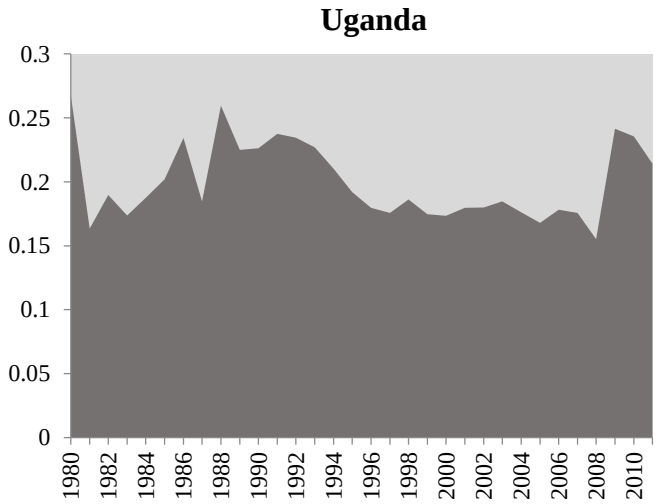

Figure 4-1: kgCO2 in Uganda

Source: CIA country data

[8]Most of the Aggreko Thermal power plants have since been decommissioned. Currently

4.2. Sustainability

We understand 'sustainability' in context of energy supply and consumption by attempting to define *sustainable energy development*. Energy and therefore adequate energy supply is fundamental to human and society development. "Energy is golden thread that connects economic growth, increased social equity, and an environment that allows the world to thrive," - UN Secretary-General Ban Ki-moon. Energy is universally regarded the centre of any human activity and it is required for development, as in turn energy consumption patterns influence development patterns It influences on production processes and service delivery. Energy is argued to be at the centre of any human activity as it is in turn influence development patterns.
On the other hand, 'development' is a value word, implying a change that is desirable, - usually dictated upon by goals or objectives. Development depends on what social goals are being advocated by government and development agencies or people. If we therefore take development to be a vector (D) of desirable social objectives, such as a list of social objectives which society/communities seeks to achieve or maximize, then the elements of this vector might include: (1) increasing income (2) improvement of health (3) education (4) access to resources (5) basic needs freedom and etc. We propose a mathematical expression incorporating all the above as in equation 1 below.

$$D(x_1, x_2, x_3, \dots x_n) \qquad (1)$$

Where: D is the development vector and,
x_1x, x_2x are elements of the vector D (desirable social objectives)

Achieving these goals requires time, thus, time becomes the basis upon which all factors are measured, whether the goals are reached or not. Therefore, modifying the vector (D) as in equation 2; indicating the changes that would be achieve with a small change in time. In this case Sustainable development is where the development vector does not decrease overtime.

$$\frac{\partial D(t)}{\partial t} > 0 \qquad (2)$$

Environmental economics however holds that to achieve satisfactory development, we need to bear in mind that our share of natural resources available should be equitable, efficient and equal to support across generational existence. In this sense, sustainability is achieved if we bear in mind that the earth's resources are finite and our actions impact the environment. The simple objectives of sustainable energy development can then be summarized as; *(1) improving quality of final energy, (2) a fair share of per capita energy use and (3) access to energy resources and benefits.*

Robert Repetto's in his definition of Sustainable development declared "Sustainable development is a development strategy that manages all assets, natural resources, and human resources as well as financial and physical assets for increasing long term wealth and well-being. Sustainable development, as a goal rejects policies and practices that support current living standards by depleting the productive base, including natural resources and that leave future generations with poorer prospects and greater risks than our own." – (Repetto, 1986 p15). His definition gives more

clarity and understanding to the Brundtland[9] Commission's definition of Sustainable development that specificies "Social, Economic and Environment" aspects being inter-linked.

Understanding the concept of sustainability would therefore mean making policies that ensure and support equity, efficiency, and equality a resources. At the same time, protection of the environment should be put into consideration as society strives to achieve her development objectives. For Uganda, this policy framework exists; but there remain uncertainties over whether these well-intentioned policies will be fully implemented.

In the discussion of sustainable energy in Uganda, it should be noted that there is a very high dependency of the energy sector on biomass. This needs very urgent attention. The escalating rate of clearing vegetation for cooking and charcoal means that the national carbon sink is steadily dwindling. One suggestion to counter this trend is to have gas from Uganda's oil replace biomass as the primary fuel for cooking in households. Conservation of vegetation cover in Uganda will play a pivotal role in managing tour country's carbon footprint and in turn ensuring sustainable energy development.

4.3. Vulnerability of energy systems in Uganda

a) High dependence on biomass energy resource

Of the TPES, electricity contributes 1.3%, fossil fuels 8.7% with 90% coming from biomass resources. This high dependence and escalated harvesting of biomass puts a lot of stress on the country's natural vegetation and has resulted in massive deforestation in many parts of the country. This pattern of energy consumption is a major threat to the country's economic development.

b) Hydropower generation sensitivity to rainfall variations

Reliance on a large hydrological power generation resources has its pros and cons. Because Uganda's hydropower generation is highly dependent on the amount of water-flow in the rivers, seasonal changes in the amount of rainfall directly affect the power generated. In many cases, this causes load shedding and in certain instances has caused completely power cut-offs. Electricity production in Uganda is therefore highly vulnerable to climate variability.

c) High Investment Costs for the Large-Hydro Power Plants

Uganda is looking to build more large hydro power plants to further boost its power production capacity. Much as this is a welcome development, the investment costs of these power plants are massive, so much that the country cannot fund them. The alternative is international financing which attracts interest and hence a high cost per unit of power produced. That is not to mention a growing national debt burden that might adversely affect the national economy and future power projects financing.

[9] The Brundtland Commission's brief definition of sustainable development as the "ability to make development sustainable—to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs"

d) Low income per capita and Electricity access challenges

The cost of extending the transmission grid remains prohibitively expensive. Even where the grid has been extend to some parts of the country, owing to low levels of economic activity and hence low incomes, the intended beneficiaries might not afford to pay for the electricity.

5. CONCLUSION AND POLICY IMPLICATION

The paper draws conclusions based on discussions of the policy framework, development trends and challenges faced by the energy market in Uganda. It is observed that Uganda's installed capacity increased two folds over the last seven years to stand at 818.5MW in 2012. The annual growth rate of the country's installed capacity set to increase twice as much as it is currently.

The policy review reveals that the country is equipped with appropriate and adequate policy instruments to keep the energy development on a sustainable path, even with this emerging sector. However, there remain uncertainties over with strategies and implementation plans for the policies. And given the reliance of the country on biomass, the management of this resource will determine whether or not the country stays on course of sustainable energy development.

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Developing self-sustainable solar-run community schools: Case study from Light of Hope's digital school in Bangladesh

Arif Md. Waliullah Bhuiyan
Light of Hope, H#282, R#19/C, Mohakhali DOHS, Dhaka – 1206, Bangladesh
bhuiyan.waliullah@gmail.com

ABSTRACT

There are about 50,000 primary schools in Bangladesh located in off-grid areas where communities around those schools have limited access to information, opportunity to get internet based services. The main objective of the study was to develop a financially self-sustainable solar-run school model for developing countries that will create employment opportunity, generate revenue besides providing quality education to the children.

Survey was conducted initially to understand the market demand for mobile charging, internet services and printing facility in rural Bangladesh. Financial analysis is conducted based on the initial market research and field research data. 'Light of Hope' – a tech-based educational organization has developed world's lowest energy consuming multimedia classroom solution and installed the system in two primary schools in off-grid and semi-off-grid areas. Each school requires an investment of Euro 1370 that will generate yearly revenue of Euro 1093 from mobile charging, internet-based services and printing. The estimated ROI is 8 years which also makes it financially attractive.

KEYWORDS

Solar system, multimedia classroom, e-education, internet-based service, off-grid.

INTRODUCTION

While Bangladesh is on track to achieve universal primary education by the end of 2015 to meet the MDG target, quality of the education services and the outcomes are still very low. New global target or Sustainable Development Goals (SDGs) are giving higher priority on the quality of the education. Improving the quality of education requires long term commitment and large government funding for infrastructure development, teacher capacity development and inclusion of technology at the school level. Bangladesh government allocation for education in the budget is decreasing over the years. Government of Bangladesh spends only 1.8% of the GDP on education whereas countries like Vietnam spent 6.3%. (Habib, 2015) Investment on technology in education is still a far cry for Bangladesh because of its high initial investment and consequent operation and maintenance cost.

Only 65% of the population has access to electricity while over 40,000 primary schools are located in off-grid areas and don't have electricity connection. While lack of electricity poses a major treat in providing ICT-based quality education in rural areas, it also opens up an opportunity to develop school-based business model to ensure quality education and also cover the operational and maintenance cost of the provided technology to the schools.

Light of Hope – tech-based non-profit develops an innovative solar-run multimedia classroom solution for rural off-grid schools capable to provide other services like mobile charging, 2

internet use, printing to develop revenue for schools. Light of Hope engineers developed the solar-run system and installed in 3 different schools. Market research on the various service demands is conducted. Financial analysis on the school business model shows promising signs as recovery of the initial investment and covering O&M costs seems viable.

METHODOLOGY

The action research under Light of Hope's 'Digital School Project' was initiated in March 2014. The research and operation team consists of engineers, educators, project management professional and university students. The overall work was divided into three major parts – development of the solar-run multimedia classroom solution, collection, development of educational contents and capacity building training to the teachers and finally developing the business model for the schools depending on the initial market survey conducted on mobile charging, internet and printing services at the community.

Based on the initial solar-run classroom design development and available educational contents three pilot schools are supported. Experience and learning from the pilot is also being considered at the business model development and potential future expansion of the project.

DIGITAL SCHOOL PROJECT

The overall objective of Digital School project is to strengthen the capacity of the rural schools to provide quality education to the children. Light of Hope provides necessary technical, management and training supports to the local schools to develop their own revenue generation business model and quality education services. The development of the overall project is on-going and so far Light of Hope through its pilot schools realized the project's tremendous opportunity to scale-up a sustainable country-wide model in Bangladesh that also has potential to be replicated in other developing and under-developed countries too. The different steps and components of the 'Digital School Project' are briefly covered along with the business model in sub-sequent sections.

Formulation of Digital School project concept

Coming back from their engineering background, the Light of Hope founders wanted to build a solar-system coupled with multimedia classroom solution with necessary e-educational contents to ensure the schools in off-grid rural areas have access to modern ICT-based education services. While designing of the system was the prime part of their task, making the whole system self-sustainable was another underlying objective. To the working team, the examples and business models for revenue generation from solar-system through services like mobile charging, solar lantern charging was available. What was absent however is how this revenue generation activities could be coupled with the school so that the school itself can generate revenue to cover the operational and maintenance cost of its multimedia classroom.

Developing a low energy consuming multimedia classroom solution

The multimedia classroom should have a laptop (computing device), projector, sound box, LED lights with enough battery backup to run the system for 4 hours. Light of Hope engineers looked into different low energy consuming products available in the market. Both the local and international markets are explored to have a comprehensive solution that is replicable in large scale. The comparison between a conventional multimedia classroom system and Light of Hope's solution shows the difference in energy requirement for both the systems. 3

Table 1. Comparison between conventional & Light of Hope multimedia classroom system

Load	Conventional system	Light of Hope system
	Energy consumption (W)	Energy consumption (W)
Laptop	35	30
Projector	2000	15
Sound box	15	5
LED Light (3 nos.)	15	6
Total	2065	56

Because of this large difference in energy consumption, government and other organizations in Bangladesh has a perception that solar-run multimedia classroom requires high initial investment which is one of the main reasons why the off-grid schools are not considered to be digitalized. Light of Hope with their low energy consuming solutions proves that a very low initial investment (less than 500 euro) is sufficient to have a solar system to support the multimedia classroom.

Develop e-education database for primary level

The next step is to provide all the necessary educational contents at the laptop for the teachers to take the classes with multimedia projector. Although developing e-educational contents for secondary and higher secondary level was getting quite momentum in Bangladesh, finding educational contents for primary level was a daunting task. First of all, not many organizations were involved in this and not many contents were available. So Light of Hope employed 30 volunteers for 3 months to find out what is available in Bangladesh and then outside. Hundreds of videos on different science and other topics were downloaded from the internet and then translated into Bengali according to the National Curriculum. Currently Light of Hope posses the largest database of primary level contents in Bangladesh. It partnered with national and international NGOs like BRAC, Save the Children to collect many e-educational contents. All the contents are provided according to class, subject and topic.

Capacity building of the rural school teachers

In the rural areas, many teachers didn't even see a laptop. Light of Hope provides basic computer skill training, teaches method on how to use e-educational materials in the classroom to stimulate interest and ensure engagement Refresher training is very important for the teachers to retain their knowledge of the initial training and to provide feedback on challenges to the Light of Hope team.

Ensuring continuous technical support

Light of Hope will provide rigorous and quick after-sale support for the solar system to the schools and other technical support for the laptops and other equipments so that any problem can be solved with minimum disruption at the classroom learning. In case of longer servicing time, Light of Hope retained a certain percentage of laptops (usually 10% of the total laptop in the schools) as backup. These are called 'Buffer Laptop'. The buffer laptops already have all the software, e-educational materials needed to conduct the classroom teaching. The buffer laptops will be delivered to the schools after it's identified that the school's laptop requires more than a week to service.

MAKING 'DIGITAL SCHOOLS' SUSTAINABLE

Light of Hope's self-sustainable primary school business model is unique in many ways. Each school will have one or several income generation activities supported by the solar system.

Different options are being considered to ensure regular revenue generation from the school to cover the operational and maintenance cost of the multimedia classroom system. The options for individual schools depend on the existing context of the locality, demand of different services and available support to continue the operation of the provided services. Services like mobile charging, internet use, printing etc. are few options those are under consideration. The generated revenue and the feasibility and likelihood of making the service profitable will reflect on the financial analysis of the investment and revenue. Light of Hope made several hypothetical scenarios to see the business viability of the provided services. Depending on several criteria like availability of the electricity at the locality, population, mobile and internet network, average household income at the surrounding locality, livelihood options for households etc. the revenue will vary from school to school.

The market research conducted by Light of Hope team at the coastal village in Noakhali district of Bangladesh shows that in coastal off-grid areas an average adult who owns a mobile phone spends about 240 hours a year just to walk to the far market to charge his mobile. Villagers also travel to city to in expense of travel cost, service cost and time to get various internet based services provided by government. The existing market condition allows initiating several income generation activities like mobile charging, internet café where people can use internet and get other internet-based services, printing etc. are incorporated with the school's solar system. These activities will earn enough revenue to cover the operational and replacement cost of the laptop, battery, other equipment and the salary of the operator.

Financial analysis of Digital School intervention

The financial analysis of the school intervention shows encouraging potential for covering the operation and maintenance cost and recover of the initial investment at the school in off-grid areas. Interventions like mobile charging, internet use, printing are considered. The initial investment, revenue and operation cost estimation for one school is provided below:

Table 2. Initial ivestment for a single school

Investment Item	Budget (euro)
Solar system	560
Laptop	400
Mobile charging facility	25
Mini-projector	300
Internet Modem	35
DC Printer	50
Total	1370

The total initial investment for each school is 1370 euro. The budget for solar system includes cost for solar panel, battery, charge controller, LED lights and other components. Investment may slightly vary with price change of individual components. With continuous improvement of technology in terms of efficiency the price is likely to decrease in future.

The yearly operation cost is 840 euro which includes the salary of the local operator and the internet bill. The maintenance costs have different frequency ranging from 5 to 10 years for different components. Any maintenance cost before the projected frequency will be covered by the warranty service provided by the manufacturer or the local distributor. The detail of the operation and maintenance (O&M) cost for a single school is provided below in Table 3.

Table 3. Operation & Maintenance cost for a single school

Operation & Maintenance (O&M) Item	Amount
Operator's salary	50 euro/month
Internet bill	20 euro/month
Laptop replacement	400 euro/5 year
Solar battery replacement	250 euro/5 year
Other replacement	220 euro/10 year
Solar panel	On 20th year*

*not considered in the financial analysis as the project duration is considered 20 years.

The revenue from each school through various services depend on different factors like potential customer size, frequency of service, duration of service period in a year etc. Service charges for different services are estimated to be lower than the existing market price to attract more customers. Incentives like time savings and additional expenditure (e.g travel cost to the service point) will also ensure that the school will get regular customer. The yearly income for different services provided from the school is provided below in Table 4.

Table 4. Revenue from a single digital school

Revenue item	Per unit charge (euro/unit)	Monthly service unit/duration	Yearly income (euro)
Mobile charge	0.044/charge	750 mobile charge/month	320
Internet use	0.33/hour	40 hours/month	400
Video calling	1/day	20 days	240
Printing	0.55/day	20 days	133.33
Total			1093.33

The revenue model will vary depending on the locality. For example, in on-gird or semi-on-gird areas there will be no income from mobile charge as the households can charge their mobiles at their homes. Similarly in semi-urban areas, the demand for internet based services is likely to be higher compared to the rural areas.

Light of Hope's financial model shows the return on investment (ROI) is 8 year considering zero percent interest rate over the investment. However, there is a negative cash flow on 10th year due to replacement cost for laptop and battery. But after that period, the cash flow is always positive. The financial projection for the school is already encouraging and with increased revenue from services it could be financially attractive for government and other organizations to invest under social development project.

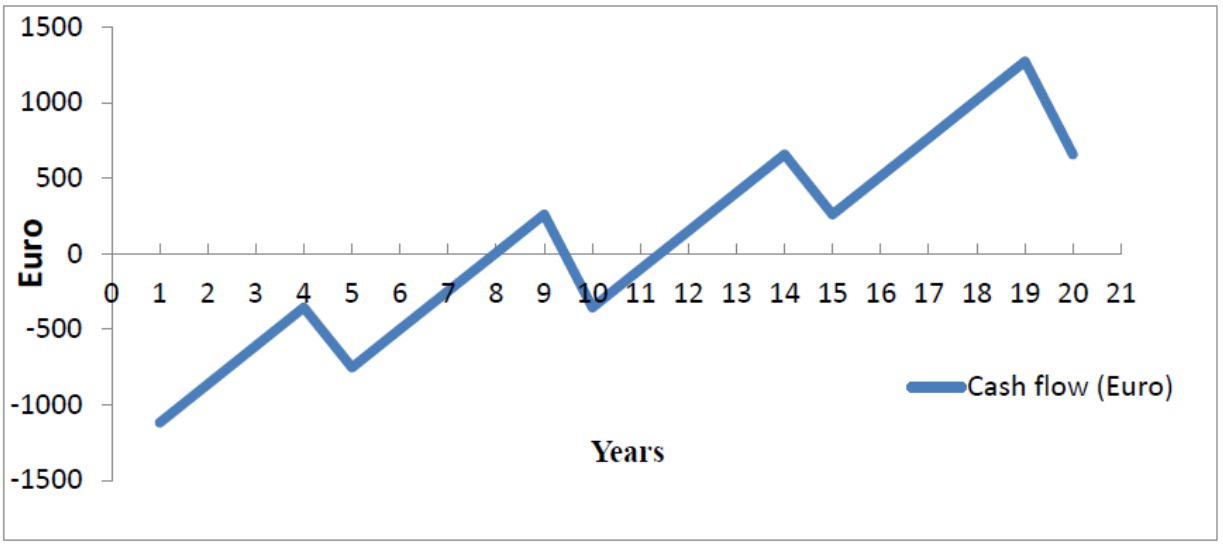

Figure 1. Yearly cash flow of the digital school

MAJOR CHALLENGES

During last one year of intervention Light of Hope faces various challenges from programme design point of view and the intervention strategy. Initial challenges were to design the compatible low-cost solar system design, finding and developing educational materials etc. Capacity development of the local teachers on using the laptop and taking class with educational contents is still a major challenge. An appropriate training design and the cost for an effective training are very high. Funding for the capacity building training of the teachers is inadequate and financially non-returnable although it contributes significantly on the improvement of the education service delivered at the school.

Analyzing the existing market demand for the services provided from the school is another challenge and requires caution during the investment. Training up the local operator to provide various services also required for customer satisfaction which is directly linked with the potential revenue generation.

Monitoring and evaluation of the multimedia classroom activity is another area of concern. In order to ensure that regular class is taking place using the multimedia setup, Light of Hope is planning to develop software that will keep track of the number of hours the teachers are actually using the setup which will be automatically uploaded to the central server online. This will significantly reduce the monitoring cost of the project. For evaluating the outcome of the digital school, Light of Hope is developing a standard tool that will check the improvement of children learning over the period of time.

CONCLUSION

Delivering quality education comes at a cost with high investment on infrastructure, technology, capacity building of teachers etc. which is often difficult for a government in a developing country. Light of Hope intended to develop a low-cost solution with potential income generation activity from the school to reduce that burden on investment and operation and maintenance cost. The first phase of the intervention is already completed with a complete setup with 3 pilot schools currently running proves the system's efficiency. The second phase will start soon with income generating services in school and the financial analysis looks attractive. Once successfully completed in

Bangladesh, Light of Hope's Digital School project can be replicated in other developing countries with similar context, especially in South-Asia and Africa.

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Scheme for Promoting Biodiesel Production in Indonesia

Fumi Harahap
Division of Energy and Climate Studies
KTH Royal Institute of Technology
School of Industrial Engineering and Management
Brinellvägen 68, SE-100 44 Stockholm, Sweden
Email: harahap@kth.se

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ABSTRACT

In the last decade, the Government of Indonesia has put considerable effort to reduce enormous burden to the country's economy caused by energy subsidy. The past subsidy structure had failed to execute the social considerations idea to provide basic need at a price affordable to the poor, on the contrary benefiting mostly the richest. Phasing out fossil fuel subsidy becomes important agenda of the government for better-targeted subsidies and providing other social supports in particular for the low-income groups. Since January 2015, GoI maintains subsidy for diesel, kerosene and electricity while eliminating subsidy for gasoline. As a net oil importer country, fuel subsidy cost correlates with US Dollar (USD) – Indonesian rupiah (IDR) exchange rate due to the reflection of domestic market price to international price in USD. In an unwell adjusted retail price, a weakening of IDR increases the domestic market price, results to higher subsidy cost. Development of national biodiesel industry becomes urgent to restrict higher price imported fossil fuel-based diesel for domestic use. This study evaluates current policy instruments governing promotion of biodiesel production for domestic use. It performs economic analysis to compare biodiesel production cost against diesel retail price and biodiesel producer price. Sensitivity analysis is performed to investigate feasibility of Crude Palm Oil Supporting Fund (CSF) that may become available to promote biodiesel expansion at high feedstock price while meeting biodiesel target in 2015. The results show that biodiesel industry is currently benefited from attractive biodiesel producer price and low feedstock price. To certain extent of CPO price, CSF is feasible to cover the price gap between biodiesel production cost and diesel price at high CPO price. The study indicates that the feasibility would depend on government decision to allocate the fund. While the adoption of CFS is expected to boost biodiesel production for domestic use, decline in export volume appears to increase uncertainty of fund available.

Key words: biodiesel production cost, crude palm oil price, diesel retail price, subsidy

INTRODUCTION

Energy subsidy has been place in Indonesia since the late 1970s, affected by first oil price shock [1], [2]. Constitutional Article 33 (3) specifies that the natural resources is controlled by the state and shall be used to the greatest benefit of the people. This serves as prerequisite to subsiding energy below the market prices [1]. Between 2007 and 2014, fossil fuel subsidies have consumed on average of 11% of state expenditure or 70% from total subsidy allocation [3], see **Figure 2**, demonstrating considerable burden for the country's economy. The social considerations idea to

provide basic need at a price affordable to the poor, was distorted to benefiting mostly the richest [4], [5].

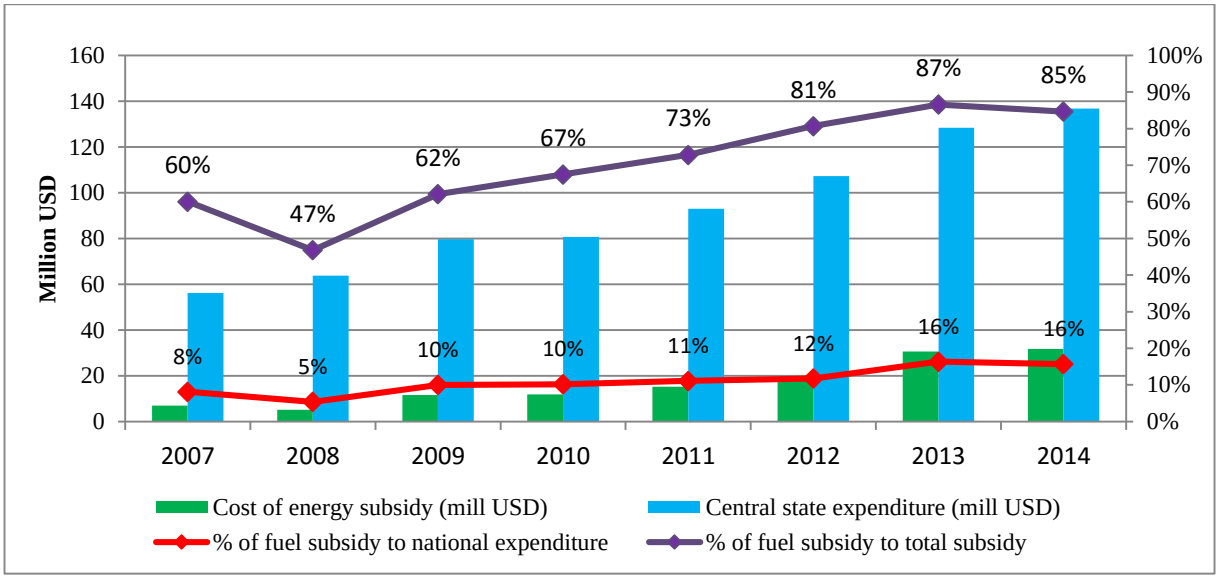

Figure 2 Fuel subsidy expenditure

Source: [3]
Note: Exchange rate 2010 constant value USD 1 = IDR 8,991 [6]

The GDP growth of 5.5% in 2013 [3] and rapid growing of middle class has led to high fuel demand in Indonesia. This has forced Government of Indonesia (GoI) to allocate significant amount of money to cover the discrepancy between international and domestic fuel prices. Until the end of 2014, GoI provided subsidy for petroleum products i.e. gasoline (*premium*), diesel (*minyak solar*) and kerosene (*minyak bakar*); and electricity. After that, only subsidy for diesel, kerosene and electricity are appeared in the state budget (**Figure 3**).

The country energy subsidy policy is mostly concentrated on consumer price in the form of under-pricing of energy, although tax incentive for producer exists in few cases [7]. The price discrepancy between domestic retail price and economic price[10] is paid to Pertamina – the state owned oil enterprise that receives mandate to provide and distribute subsidised fuels in Indonesia [4]. **Figure 3** draws subsidy commodities and the subsidy costs reflected in the national budget.

[10] The economic price consists of four components: (1) the border wholesale price of refined products referring to Mid Oil Platt's Singapore (MOPS); (2) costs of transportation, storage and distribution; (3) value added tax and fuel tax; and (4) profit margin of retail stations." [4]

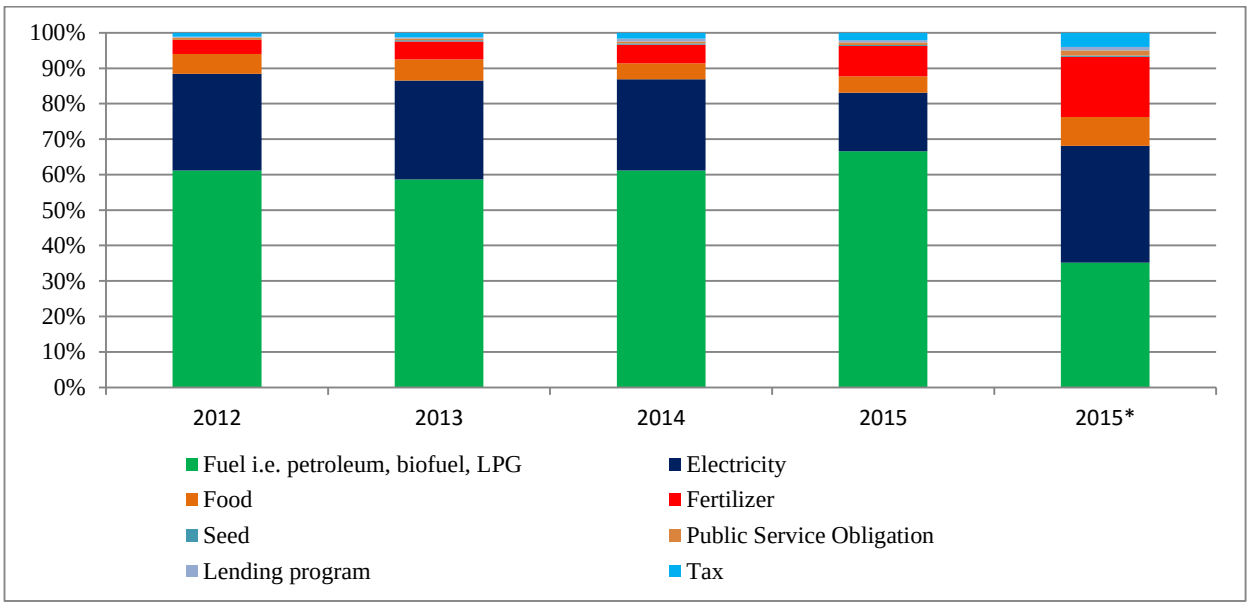

Figure 3 Cost of fuel and non-fuel subsides reflected in national budget 2012-2015

Source: [3], [8]
Note: * 2015 revised budget following the presidential election in October 2014

The massive subsidies reduce government's fiscal space to promote investment in infrastructure and human capital and also ability to provide better targeted subsidies and other social supports in particular for the low-income groups [4]. Dartanto (2013) outlines few studies that discussed the adverse impact of cutting subsidies which is mostly perceived by the low-income groups. Fuel spending demonstrates 5% of total spending of the poorest households [5]. An increase of $0.25 per liter in the price of fuel products reduced the household real income by 17.3% in Ghana and 12.1% in Jordan [9] causes reduction of the purchasing power. The adverse impact can be minimised through effective compensation e.g. direct cash transfer, transferring fuel subsidies from middle income to poor households [4], [10].

Indonesia energy agenda focuses on energy independence by diverting the export volume to domestic supply and optimises the energy balance between fossil and non-fossil fuel. The future energy matrix remains with the domination of fossil energy despite the spur of renewable share to at least 23% in 2025 and 31% in 2050 (see **Figure 4**). Reduce fossil oil consumption is an important agenda of the ruling government together with phasing out energy subsidy. Liquid biofuels, viz. bioethanol and biodiesel, offer attractive solution to substitute fossil oil, expected to contribute 5% in renewable energy share by 2025. Biofuel mandate (for transport, industry, commercial and power sectors) in the form of progressive blending rate to fuel products have been enacted since 2008 through the Ministry of Energy and Mineral Resources (MEMR) Regulation 32/2008 jo. 12/2015. The regulation was formulated to restrict higher price oil imports for domestic use which had caused current budget deficit [11].

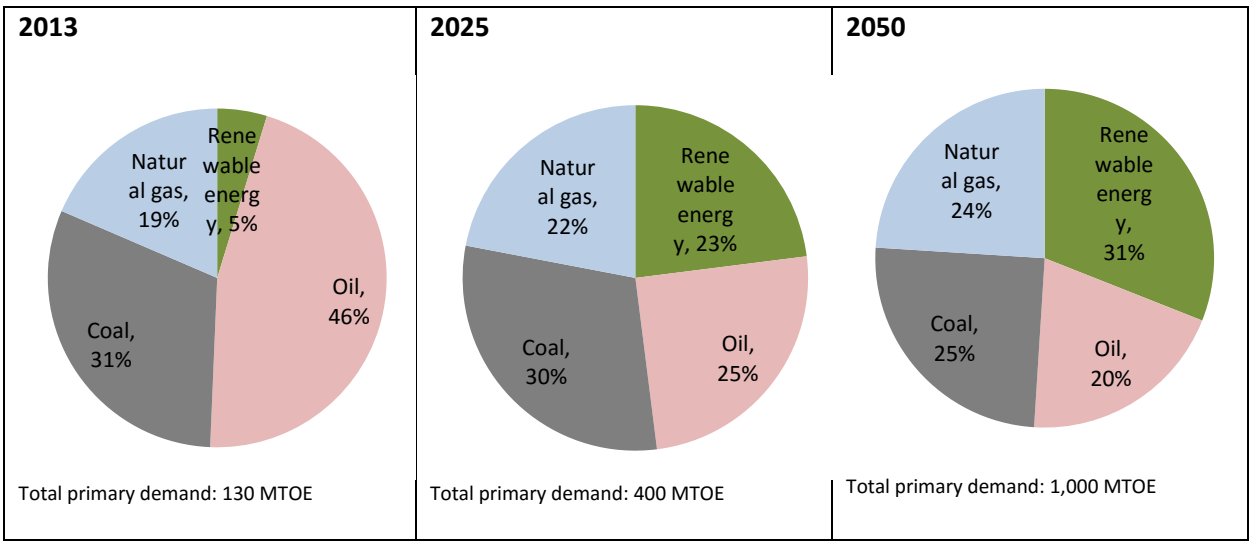

Figure 4 Indonesia energy matrix present and future

The figure excludes biomass for non-energy used
Source: [6], National Energy Policy (Government Regulation 79/2014)

The promotion of industrial scale production and the use of liquid biofuels in Indonesia are backed up by financial support from the government through various policies. Despite the establishment of a significant biodiesel production in the country in the past few years, the potential is much larger since Indonesia is responsible for more than half of the world's palm oil production totalling 29 Mton of crude palm oil (CPO) in 2014 [12]. Nevertheless, meeting these targets has been challenging. In 2014, approximately 1.1 billion liters were used domestically and 1.3 billion liters were exported [13]. That resulted to 6.7% of domestic biodiesel blend rate which had failed to meet the 10% target for transport sector in 2014. Currently 13% of total CPO produced in Indonesia is being used for biodiesel production in the country [12], [14]. A domestic use of a larger share of the CPO presently being export could contribute to reduce dependence on fossil fuel import [15]. MEMR Regulation 12/2025 aims at achieving 30% biodiesel blending rate for the targeted sectors by 2025, equivalent to 11 folds from domestic biodiesel consumption in 2014, illustrating increased ambition to biodiesel deployment.

Biodiesel production is vulnerable to oil and feedstock prices. In 2007, decline of oil price and the spike of palm oil feedstock price caused 17 biodiesel companies to have reduced or temporarily suspended their production and led to deviation of biofuel production cost proportionate to petroleum fuel and losing government's will to support the industry [2], [16]. Setting attractive price mechanism could create supportive environment for biofuels which could lead to materialising the mandate. Through MEMR Regulation 3239/2015 government regulates monthly biodiesel market price, subject to evaluation of at least every 6 months' time. Further encouragement to divert export volume to domestic supply is by imposing levy to palm oil industries exporting the products, named as CPO Supporting Fund (CSF). The fund is partly dedicated to cover the gap between diesel retail price and biodiesel producer price (Presidential Regulation 61/2015). The question is then whether the existing policy instruments governing biodiesel production including the price structure, retrench state expenditure can be confirmed. This study aims at examining both aforementioned schemes that promotes biodiesel in the country. It performs price-cost comparison of: (1) biodiesel production cost presented by the life cycle cost, (2) biodiesel producer price and (3) diesel retail price. Also, it assesses the impact of CPO price

fluctuation to biodiesel production cost to estimate the price gap between biodiesel production cost and diesel retail price to evaluate the feasibility of CSF scheme to cover that gap.

The remaining chapters are organised as follows. Part 2 describes materials and method used in this article comprises the historical of energy subsidy reform to understand the level of success and the government eagerness to overcome budget deficit; projection of biodiesel consumption; policy instruments to stimulate biodiesel production at different level of its supply chain; and mathematical methods used in cost analysis. Part 3 discusses main findings, performs cost sensitivity and analyses the government support. Part 5 provides some concluding remarks.

MATERIALS AND METHOD

Energy Subsidy Reform

The urgency of gradually removing the fuel subsidies was first highlighted in the National Development Programme 2000-2004. Using that as a basis, GoI took the first initiative on deregulating the subsidy from domestic retail fuel prices and at the same time adopting scheme to limit the risk of increase in poverty due to phasing out the fuel subsidies targeting the low income groups, through the adoption of Presidential Decree 135/2000. The decree enacted compensation fund in form of direct cash distributed to low income households, recorded the state spending of IDR million 800 in 2000 and IDR trillion 4.4 in 2003 [17]. Since 2000, various adjustments of retail fuel prices to the fluctuation of international prices are undertaken to reduce subsidy costs (see **Figure 5**), with numerous level of success [1], [4]. Also, GoI continues to adopt the compensation programme for the poor which includes cash transfer, health insurance, education subsidies and also rural infrastructure development between 2005 to 2008 [4].

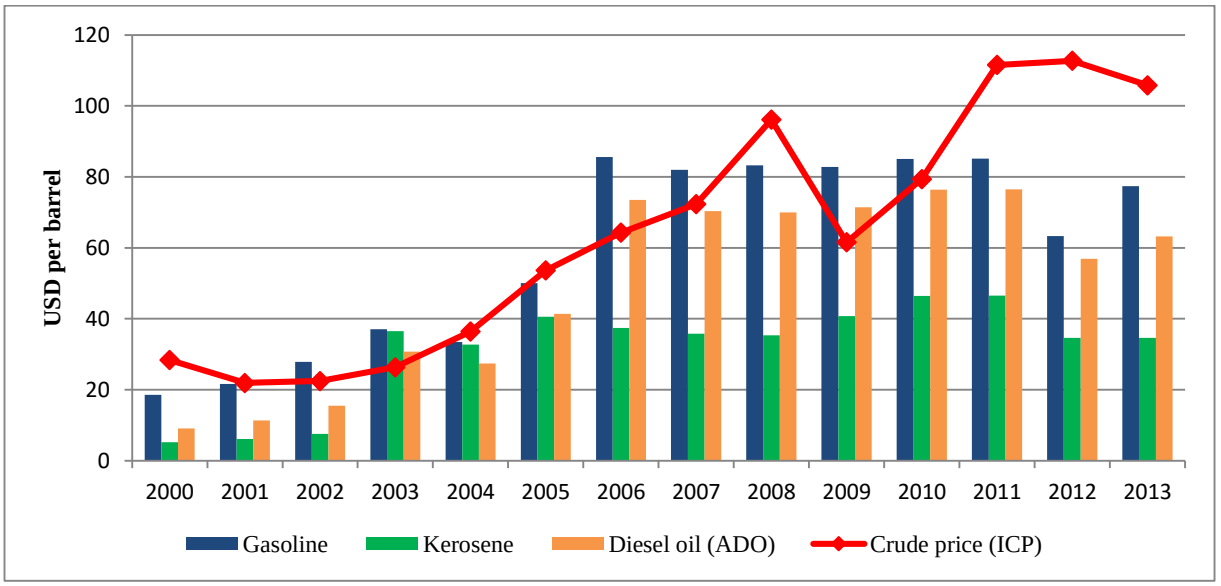

Figure 5 Domestic fuel prices of gasoline, kerosene and diesel oil and Indonesia Crude Oil Price (ICP) 2000 – 2013

Source: [6]

The subsidy costs in Indonesia is vastly exposed to oil market price and exchange rate fluctuations [1]. In the high oil price, government has to bear the incremental cost, while in the low oil price, government cuts the retail price. The recent momentous subsidy cut on gasoline fuel in November 2014 demonstrates government's strong willingness to allocate the state budget for the better

purpose. The adoption of incremental change approach in subsidy reform by GoI, demonstrates the promotion of a better allocating subsidy scheme. **Figure 2** shows 44% reduction of fuel subsidy and 30% increase of non-fuel subsidy. **Table 3** summarises subsidy reforms since the past 15 years.

Table 3 Summary of subsidy reforms since the past 15 years

1998	Fuel price hike as a consequence of global oil crisis, led to riots. This was coincided with government reformation.
2000	The National Development Program 2000-2004 indicated the need to gradually cut the fuel subsidies that are false targeted by 2004. In the program, government introduced the mechanism to compensate the fuel subsidy cut targeting low-income households (Presidential Decree 135/2000). The cash transfer realisation started later in 2005.
2001	Presidential Decree 45/2001 deregulated the retail fuel prices for industries to gradually equalising to the level of international prices.
2003	Alignment of domestic petroleum prices to international market prices led to public protest due to poor communication. Government had to roll back most of the increase.
2005	Two large fuel price hikes in February and October (adoption of Presidential Regulation 22/2005 and 55/2005), respectively more than double for gasoline and nearly triple for diesel compared to 2003. Presidential Instruction 12/2005 defined the mechanism of cash transfer (*Bantuan Langsung Tunai*) distribution. Compensation to mitigate the impact of subsidy cut in the form of cash payment of USD 10/month to 19 million low-income individuals. The program continues until now at the level of USD 20/month.
2008	Phased out subsidy to large industrial electricity consumers and subsidy is restricted for public transport and motorcycle. Gasoline price rose up by 25% while diesel by 21% compared to 2005.
2010	House of representative agreed to raise fuel subsidy budget.
2013	The MEMR Regulation 1/2013 controls subsidised fuel by prohibiting the use in government fleet vehicles, mining activities and plantation activities (except community and individual owned plantation).
2014	Significant fuel price adjustment following the presidential election. Gasoline price rose up by 23% while diesel by 26% compared to 2005. Relatively small community resistance, due to good communication and supports from the economists.
2015	Effective from January 2015 GoI only maintains subsidy for diesel and kerosene (MEMR Regulation 39/2014). Fuel prices have been adjusted four times between January to March 2015 to the global oil price.

After the inauguration of the new government in October 2014, the initial state budget was revised to accommodate their prioritised programs. Total state expenditure presents the reduction of 2.2% (or IDR 44,594 mill ~ USD 3.747 mill[11]) from the initial budget. The reduction comes from savings made of phasing out fuel subsidies totalling IDR 186,267 mill ~ USD 15.653 mill, of which 65% (or IDR 120,475 mill ~ USD 10.124 mill) is reserved for prioritised programs i.e. (1) development of key sectors e.g. food, energy, maritime, tourism, industry; (2) fulfilment of basic citizens obligations e.g. education and health; (3) reduction of gap in income distribution of residents; (4) infrastructure development to improve connectivity [3].

[11] Exchange rate 1 USD = 11,900 IDR [3]

Future Biodiesel Consumption

The recent regulation defines increase of 2.5 and 7.8 folds respectively in 2015 and 2020 from current biodiesel domestic use, see **Table 4**. Green line drawn in **Figure 3** presents consumption target from 2012 to 2014 which were significantly above the actual consumption (green bar), caused by high biodiesel export volume (red bar).

Table 4 Projected Diesel consumption, biodiesel consumption and CPO use 2015 – 2025

Year	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
(1) Diesel consumption (bill liters)	32.7	34.3	35.9	37.6	39.4	41.2	43.2	45.3	47.4	49.7	52	54.5
(2) Biodiesel blending rate (%)		**15%**	20%	23%	**25%**	28%	**30%**	30%	30%	30%	30%	**30%**
(3) Biodiesel (bill liters)	1.6	5.6	7.8	9.2	10.7	12.4	14.1	14.8	15.5	16.2	17	17.8
(4) CPO use (mill ton)	3.2	6.2	8.6	10.2	11.9	13.7	15.6	16.4	17.1	17.9	18.8	19.7

Note:
(2) Biodiesel blending rate is based on MEMR Regulation 12/2015, highlighted value is stated in the regulation, others are interpolated.
(3) & (4) calculated based on diesel consumption data from [18] using 5% of annual increase. Biodiesel consumption applies proxy of blending rate to diesel consumption according to energy content of Diesel (35.1 MJ/liter) and Biodiesel (32.2 MJ/liter).

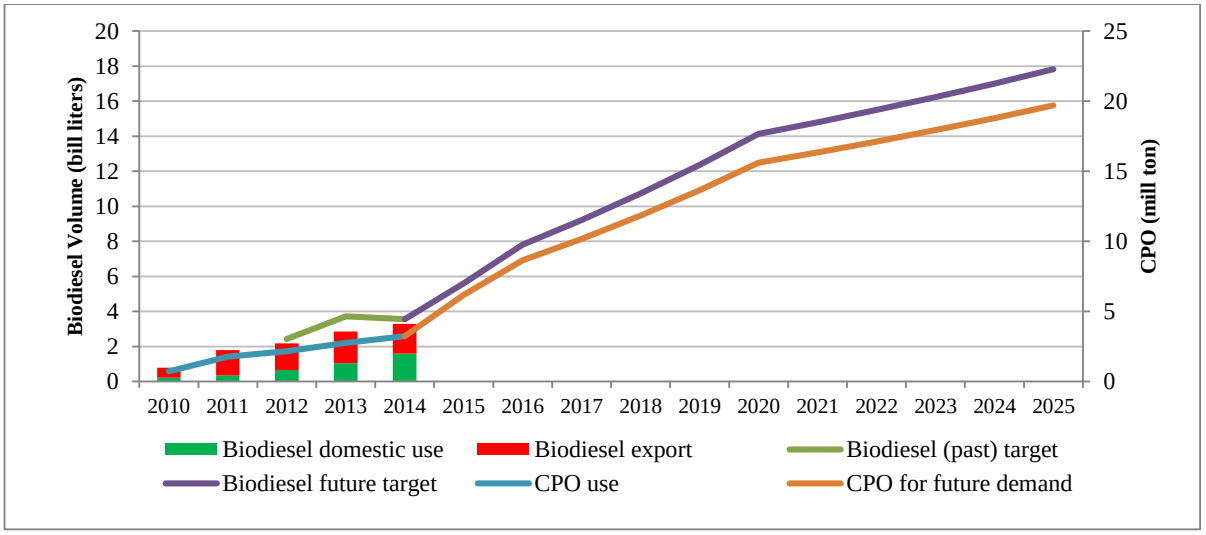

Figure 6 Past, present and future of biodiesel domestic, export, and CPO use (2010-2025)

Fiscal Support to Biodiesel

I follow classification of biofuel subsidies outlined by Dillon (2008): (1) subsidies for production of biofuels in the form i.e. subsidies to intermediate inputs (e.g. feedstock crop, energy, water), subsidies to value-adding factors (e.g. labour, capital, land), production linked payments and tax credits, tax exemptions and market price support; (2) subsidies for consumption such as subsidies for the purchase of biofuel e.g. output linked-support.

Following the enactment of Presidential Instruction 1/2006 on mandatory supply of biofuel, major subsidies policies and incentives put forward are as follows.

(1) Production

Numerous subsidies measures to intermediate inputs are in place to promote the development of biofuel feedstock plantation such as improve seedling quality, training, research and development. In the context of fiscal incentive, Ministry of Finance (MoF) Regulation 117/2006 and 79/2007 jo. 198/2010 adopts special lending rate for biofuel development and plantation revitalisation. GoI covers the gap between the market rate and the farmer's rate. The rate for oil palm is 7% for 5 years whereas the average present market rate is 18% (as of May 2015[12]). According to data from Bank Indonesia, IDR 1 trillion (USD 110 million) was allocated for lending rate subsidies in the 2007 financial year [2]. Dillon (2008) calculated that total subsidy spent for biofuel development from the state budget was IDR 15 trillion ~ USD 1.6 billion.

(2) Consumption

The agricultural commodity prices spike in end of 2007 led to uneconomic biofuel production. GoI instructed Pertamina to continue biofuel blends and to set similar price as subsidised petroleum fuels without providing the price gap creating major burden to Pertamina. They had to suffer IDR 360 billion (US$ 40 million) from biofuel blending from 2006 to 2008. Consequently, Pertamina cuts biodiesel content down to 1% in May 2008 [2]. High CPO prices together with inadequate government support had interfered industry's operation. In May 2015, through Presidential Regulation 61/2015 GoI imposes export levy to strategic agriculture industries, including oil palm as indicated above, named as CSF. This compulsory fund charges palm oil companies for exporting CPO or its derivative products. The unprocessed CPO is subject to payment of 50 USD/ton whereas refined palm oil (including biodiesel) is 20 USD/ton.

Table 5 indicates type of palm oil products and the export levy included in the analysis. Smallholder industry is exempted from this obligation. CSF will be allocated to upstream and downstream palm oil business such as for capacity building, research and development as well as for biofuels development. GoI appoints an agency to manage CSF's collection, management, allocation and distribution. As interpreted from the formal policy, CSF is an additional obligation on top of custom duty but can partly relieve company's income tax. CSF's utilisation in the context of biofuel development would close the gap between diesel retail price and biodiesel producer price.

Table 5 Palm oil products and CSF tariff

Palm Oil Products	CSF Tariff (USD/ton)
Unprocessed CPO including kernel oil, olein, stearin, kernel olein, kernel stearin	50
Refined, Bleached and Deodorized (RBD) palm oil including kernel oil, olein, stearin, kernel olein, kernel stearin, biodiesel	20

Source: MoF Regulation 114/2015, [12]

[12] Bank Indonesia prime lending rate: http://www.bi.go.id/id/perbankan/suku-bunga-dasar/Default.aspx as of May 2015

This structure implies that currently direct fiscal support for biodiesel expansion at consumption level is independent from national budget.

Definition

To meet the objective of the study, I review recent formal policy, government planning documents, scientific papers and information from the trusted websites. The analysis performed in this study starts by estimating biodiesel production cost using secondary data then compares it with diesel retail price and biodiesel producer price. Biodiesel production cost is reflected by life cycle cost defined as "an economic model for pricing equipment and processes over the life span of a production plant" [19]. The life cycle cost of biodiesel is predominantly built from study conducted by Ong et al (2012) on life cycle cost of palm biodiesel production in Malaysia. This article adopts mathematical formulas and a number of economic indicators used in that study. Indonesia data is applied appropriately to better reflect the country condition. Diesel retail price refers to price paid by the consumer to retailer such as Pertamina, Shell. Biodiesel is sold to consumer in the form of blend fuel with diesel. Biodiesel producer price indicates price paid by biodiesel blender such as Pertamina to biodiesel producer. Price gap is defined as the gap between biodiesel production cost and diesel retail price.

Life Cycle Palm Biodiesel

This article considers feedstock procurement as the initial activity in the life cycle analysis and ends at biodiesel consumption. Life cycle stage can be divided into three: agricultural, production and consumption processes (see **Figure 7**). Generally, biodiesel is produced through transesterification process. The process involves a short chain of alcohol e.g. ethanol or methanol and could be with the help of catalyst such as sodium hydroxide to accelerate the reaction rate [20], [21]. It converts ester that separates the triglycerides, takes the glycerol of the triglyceride and replaces it with alkyl radical of the alcohol used [20]. The process results fatty acid methyl ester (FAME) and glycerol as by-product.

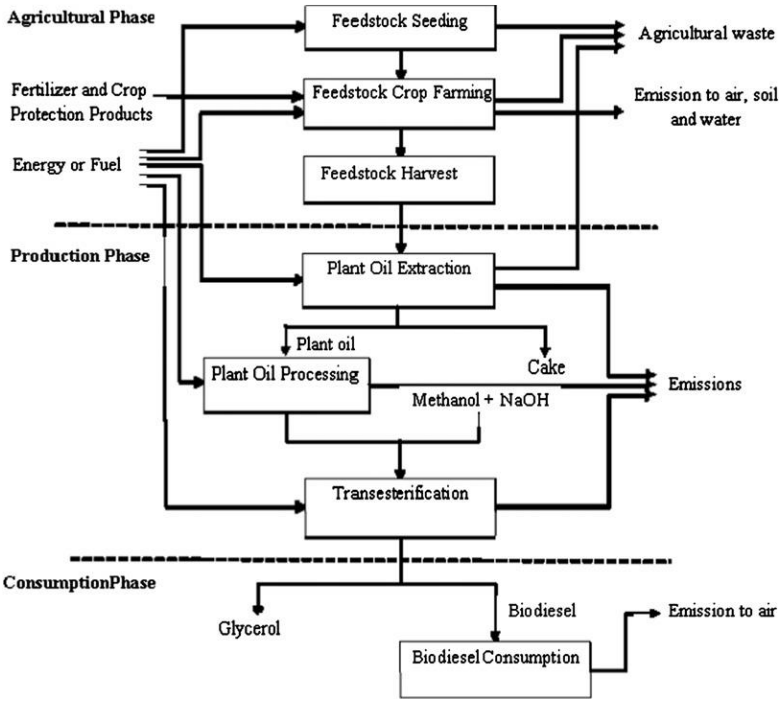

Figure 7 Life cycle analysis diagram for palm biodiesel production
Source: adopted from [19]

The following assumption is applied in the study: approximately 100 tons of CPO reacts with 10.7 tons of methanol to produce 98 tons of biodiesel and 9.85 tons of glycerol as the only by-product counted in the analysis [19].

Method and Data to Calculate Life Cycle Cost

The article adopts method applied by Ong et al (2012) in estimating palm biodiesel production cost in Malaysia.

Nomenclature

BP	by product credit (USD)	LCC	life cycle cost (USD)
CC	capital cost (USD)	MC	maintenance cost (USD)
CE	biodiesel conversion efficiency	MR	maintenance ratio (%)
CPO	crude palm oil	n	project life time (year)
d	depreciation ratio (%)	OC	operating cost (USD)
FC	feedstock cost (USD/ton)	OR	operating rate (USD/ton)
FP	feedstock price (USD/ton)	PC	annual biodiesel production capacity (ton/year)
FU	feedstock consumption (ton)	RC	replacement cost
GCF	glycerol conversion factor from feedstock oil	r	interest rate (%)
GP	glycerol price (USD/kg)	SV	salvage value (USD)
i	year		

The cost model is developed into six groups:

LCC = Capital cost + Operating cost + Maintenance cost + Feedstock cost – Salvage value – by product credit

In the form of present value model,

$$LCC = CC + \sum_{i=1}^{n} \frac{OC_i + MC_i + FC_i}{(1+r)^i} - \frac{SV}{(1+r)^n} - \sum_{i=1}^{n} \frac{BP_i}{(1+r)^i}$$

(1) Capital cost

Capital costs take into account the required land area, building construction, equipment and instrumentation required for the plant. The land acquisition cost varies widely. Ong et al. (2012) indicates capital cost per unit capacity of 240 mill USD/ton, whereas Indonesian Oil Palm Research Institute suggests 144 mill USD/ton[13]. Data from Indonesia Investment Coordinating Board (IICB) shows wide range of capital cost per unit capacity between 75 to 366 mill USD/ton[14]. For this article, the median value of IICB data, 160 USD/ton, is applied. That represent plant capacity, PC = 200 ktons with estimated capital cost, CC = 32 mill USD.

(2) Operating cost

[13] http://www.datacon.co.id/Biofuel2008Ind.html , accessed on 12/9/2015

[14] http://unisosdem.org/article_detail.php?aid=8370&coid=1&caid=28&gid=2, accessed on 12/9/2015

Operating cost includes industry overhead costs, waste water and sludge treatment processing, all other material and energy flows except of the CPO feedstock. The cost reflects the annual operating rate and plant capacity.

$$OC = \sum_{i=1}^{n} \frac{OR\ x\ PC}{(1+r)^i}$$

(3) Maintenance cost
The annual maintenance cost is assumed as a constant proxy over the project lifetime, MR = MR = 2% of capital cost [19].

$$MC = \sum_{i=1}^{n} \frac{MR\ x\ CC}{(1+r)^i}$$

(4) Feedstock cost
Recent average CPO price in August 2015 is applied in the analysis. It is based on daily palm oil prices published by Malaysian Palm Oil Council is FP = 500 USD/ton. Annual feedstock consumption (FU) is determined by plant capacity (PC) and the conversion efficiency or plant capacity factor (CE).

$$FU = \frac{PC}{CE}$$

$$FC = \sum_{i=1}^{n} \frac{FP\ x\ FU}{(1+r)^i}$$

(5) Salvage value
The salvage value is defined as assets value at the end of the project lifetime by considering the depreciation rate (d). In this study, it involves replacement cost (RC) instead of initial capital cost (CC).

$$d = \frac{(r(1+r)^n)}{((1+r)^n - 1)}$$

$$SV_{PV} = \frac{RC\ x\ (1-d)^{n-1}}{(1+r)^n}$$

(6) By product credit
Glycerol is the by-product credit that can be sold. Calculation is based on setting a fixed price for glycerol with production determined by a plant capacity to glycerol conversion factor.

$$BP = \sum_{i=1}^{n} \frac{GPxGCFxPCx1000}{(1+r)^i}$$

(7) Sensitivity analysis
Sensitivity analysis examines outputs performance responding the change in key assumptions on which the projections are based. This article highlights the effect of CPO price to the level of

biodiesel production cost particularly due to biodiesel vulnerability to feedstock price as described in Part 0.

Table 6 Summary of economic data and indicators

Item	Data
Project lifetime	20 years
Plant capacity	200 ktons
Capital cost	32 mill USD
Operating rate	280 USD/ton of FAME
Maintenance cost	2% of capital cost annually
Replacement cost	10 mill USD
Taxes	10%
Crude palm oil price	500 USD/ton
Glycerol price	0.25 USD/kg
Interest rate	8%
Biodiesel conversion efficiency (based on energy content)	92%
Glycerol conversion factor	0.0985

Biodiesel Producer Price

In the national market, MEMR Decree 3239/2015 enacts recent of biodiesel market price as follows:

Biodiesel producer price = CPO market price + 125 USD/metric ton x 870 kg/m^3 + transportation cost

CPO market price is based on publication of average 1 month price of *Kharisma Pemasaran Bersama Nusantara unit Belawan dan Dumai* before value added tax. 125 USD/metric ton is the conversion factor of CPO to biodiesel.

RESULTS AND DISCUSSION

Biodiesel Life Cycle Cost

Life cycle cost (LCC) is calculated for 200 ktons biodiesel plant using data summarised in **Table 6**. Results are presented in **Table 7**. CPO cost accounts for the largest share in final biodiesel production cost which is 66% or 0.232 USD/liter followed by operating cost at 34% or 0.119 USD/liter. The structure of the unit cost closely follows previous studies which accounts feedstock cost 70-80% of cost of biodiesel's production [19], [22]. The sale of glycerol product contributes to 48 mill USD over the life of the project. LCC of palm biodiesel after tax is 0.385 USD/liter. At CPO price of 500 USD/ton biodiesel presents price competitiveness because the production cost is below diesel retail price and biodiesel producer price of 0.424 USD/liter[15] and 0.544 USD/liter[16] respectively.

Table 7 Total production cost of biodiesel production plant

[15] Diesel retail price as of August 2015 is 5,900 IDR/liter. GoI provides subsidy 1,000 IDR/liter. OANDA exchange rate of 31 August 2015 1 USD = 13,900 IDR

[16] Biodiesel producer price excludes transportation cost

Item	Life cycle cost (USD)	Unit cost (USD/liter of biodiesel)
Total capital investment	32,000,000	0,007
Feedstock cost	1,070,239,050	0.233
Operating cost	549,816,255	0.120
Maintenance cost	6,283,614	0.001
Salvage value	- 278,698	$- 6x10^{-5}$
By product credit	- 48,354,376	- 0.011
Total LCC	1,609,705,845	before tax: 0.350 after tax: 0.385

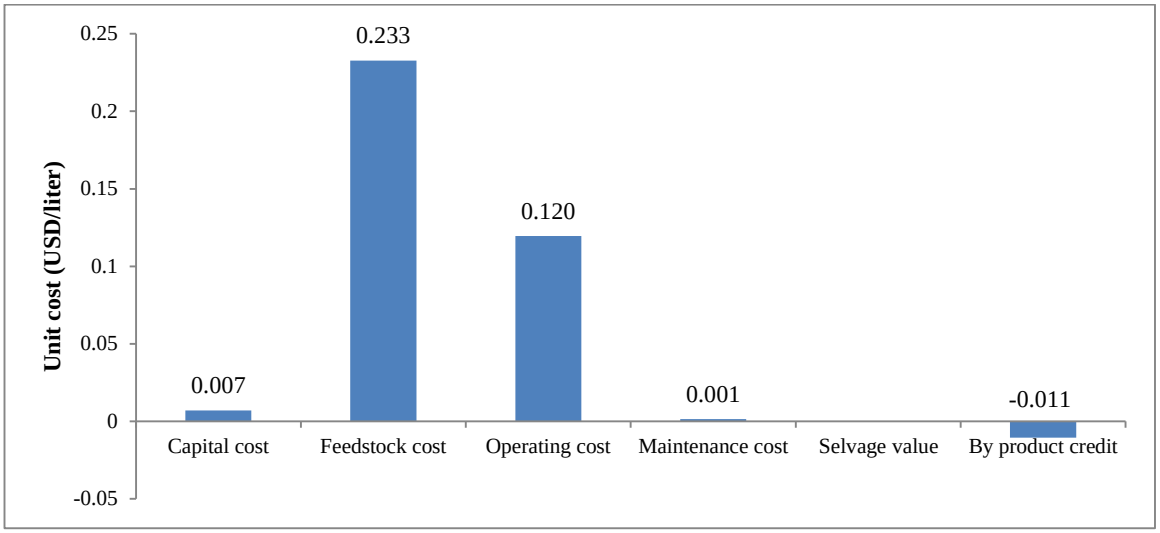

Figure 8 Distribution of unit cost of palm biodiesel

Sensitivity Analysis

This study performs sensitivity to one key assumption which is CPO price. The objectives are: (1) to analyse at what level of CPO price, biodiesel would remain competitive to diesel; (2) to estimate the price gap between biodiesel cost and diesel retail price.

Figure 9 draws world CPO and crude oil prices development and the future forecast. To date, CPO price has been more than two folds below the price in 2011. CPO data is used to determine assumption for sensitivity analysis.

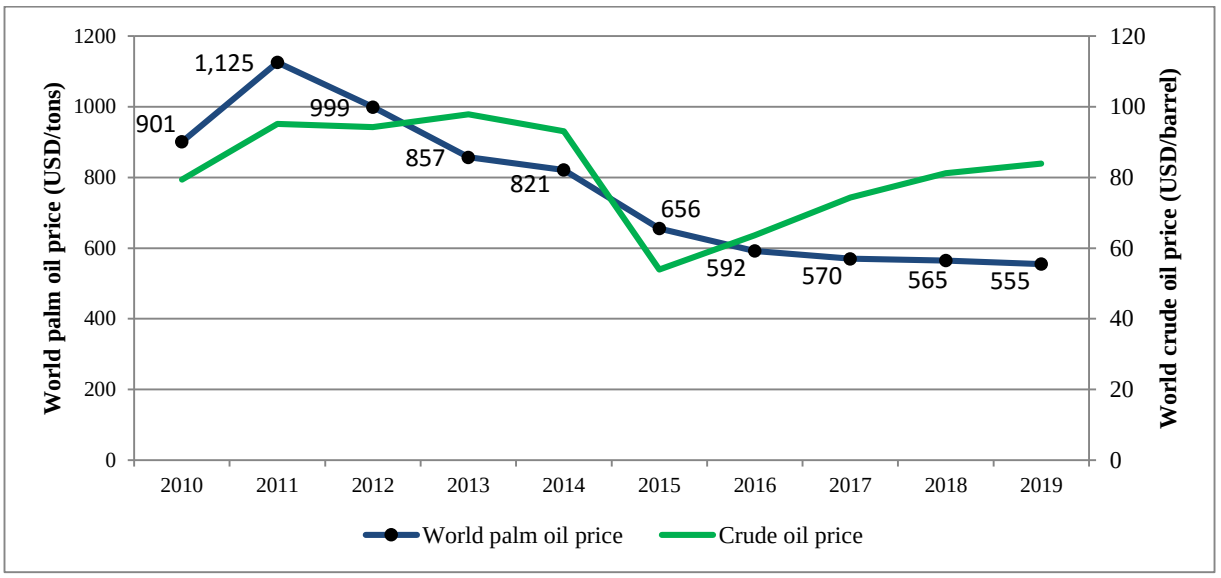

Figure 9 Development of world palm oil price 2010 – 2019 (USD/tons)
Source: EIU Economic and Commodity Forecast, July 2015[17]

Three different CPO prices are examined: (1) Base price (BP) = 500 USD/ton presents to date price which is the average CPO price in August 2015 published by Malaysian Palm Oil Council; (2) Price sensitivity 1 (PS_1) = 587 USD/ton presents the average price in Figure 9 from 2015 until 2019, reflecting future price; (3) Price sensitivity 2 (PS_2) = 940 USD/ton presents the average price in Figure 9 from 2010 until 2014, reflecting high CPO price.

Table 8 Results of sensitivity analysis

	BP CPO = 500 USD/ton	PS_1 CPO = 587 USD/ton	PS_2 CPO = 940 USD/ton
LCC palm biodiesel after tax (USD/liter)	0.385	0.430	0.610
Diesel retail price (USD/liter)	0.424	0.424	0.424
Price gap (USD/liter)	- 0.039	0.005	0.186

The exercise shows that at PS_1 and PS_2, biodiesel production cost is more than diesel retail price; hence price gap is expected. Assume that biodiesel producer price should at least cover the production cost, therefore biodiesel producer price is equal to the production cost. Fiscal support is required to cover the gap to maintain biodiesel competitiveness, respectively 0.005 USD/liter and 0.186 USD/liter for PS_1 and PS_2.

[17]http://knoema.com/wxgcxde/commodity-prices-forecast-2015-2019-charts-and-tables?variable=Palm%20oil%20(US%24%2Ftonne)

Evaluate the feasibility of CSF fund to promote biodiesel expansion

This part assesses the feasibility of CSF fund that may become available to cover the price gap at high CPO price to meet biodiesel target in 2015.

Table 9 Subsidy costs at high CPO price

	PS_1 CPO = 587 USD/ton	PS_2 CPO = 940 USD/ton
(1) Biodiesel consumption in 2015 (bill liters)	5.6	5.6
(2) Price gap (USD/liter)	0.005	0.186
(3) Total subsidy (mill USD) = (1) x (2)	29.21	1,041.70

Based on data presented in

Table 5, I calculate the amount of CSF that may become available generated from palm oil products export volume. The fund is calculated based on palm oil data in 2012.

Table 10 Calculation of CSF that may become available

Palm oil products	Export volume in 2012 (ton)	Volume available to generate CSF (ton)	CSF tariff (USD/ton)	**Possible CSF available (mill USD)
	(1)	(2)	(3)	(4)
Crude palm oil	7,262,831	1,814,414*	50	90.72
Solid fractions of unrefined palm oil not chemically modified	221,841	221,841	50	11.09
Unsolid fractions of unrefined palm oil not chemically modified	591,983	591,983	50	29.60
Solid fractions of refined palm oil packing of a net weight_20 kg	149,083	149,083	20	2.98
Solid fractions of refined palm oil packing of a net weight>20 kg	1,110,308	1,110,308	20	22.21
Unsolid fractions of refined palm oil packing of a net weight_20 kg	742,543	742,543	20	14.85
Unsolid fractions of refined palm oil packing of a net weight>20 kg	8,772,249	8,772,249	20	175.44
Total	18,850,838	13,402,421		346.90

Note:

(1) Data on export volume is derived from [12]

(2) *CPO volume available to generate CSF is deducted by CPO volume to satisfy biodiesel target in 2015, equal to 5.6 bill liters (see Table 4). Part of that is already fulfilled by the consumption in 2012 (0.67 bill liters), hence 4.93 bill liters of additional biodiesel needs to be produced.

CPO volume available to generate CSF = 7,262,831 ton – [(5.6 bill liters - 0.67 bill liters) / 905 liters FAME/ton CPO x 10^9)]

= 1,814,414 ton

(3) CSF Tariff is based on MoF Regulation 114/2015

(4) Possible CSF available = (2) x (3)

The analysis indicates sufficient fund available to cover subsidy costs at CPO price 587 USD/ton, but inadequate at the level of 940 USD/ton. The former implies to utilising 8% of total CSF that may become available. As explained in Part 0, CSF will be distributed for various downstream and upstream biodiesel industries. The availability of CSF for subsidising the price gap would highly depend on GoI's priorities of allocating the fund. Using backward calculation, I calculated the ceiling price for CPO assuming 50% of CSF is available to cover the price gap. The calculation results to CPO price of 637 USD/ton and biodiesel production cost of of 0.455 USD/liter (after tax). With similar calculation method, biodiesel production cost is equal to diesel price (price gap = 0) at CPO price of 576.82 USD/ton.

CONCLUDING REMARKS

This paper points out the urgent need to develop domestic biodiesel aiming at restricting import of high price crude oil which had caused current budget deficit. Biodiesel industry is currently benefited from attractive biodiesel producer price and low feedstock price making it competitive to diesel. High feedstock price creates uncertainty to the level of support needed. The sensitivity analysis particularly highlights the feasibility of newly introduced scheme, CSF, to cover the price gap between biodiesel production cost and diesel price at high CPO price. The study indicates that the feasibility would depend on government decision to allocate the fund. While the adoption of CFS is expected to boost biodiesel production for domestic use, decline in export volume appears to increase uncertainty of fund available. This paper primarily looks at different level of feedstock price affecting government level of support. Future analysis should include the following parameters such as crude oil price, world CPO price and its derivatives products and international demand to palm oil commodity to acknowledging complexity of biodiesel economy.

Note:

Quoting information from this paper is subject to consulting with author.

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Local Officials' Concerns of Climate Change Issues in China: A Case from Jiangsu

Qiying Hu
Jiangsu Low Carbon Development Project, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
Changjianglu No. 9 Block Bld. B2, Room 704 Dengfuxiang 18
210018 Nanjing, Jiangsu Prov. PR China
Email: qiying.hu@giz.de

ABSTRACT

To successfully implement climate policy at different levels, local officials should have a better understanding of climate change issues. Using 191 valid questionnaires collected in 13 district cities in Jiangsu, China, this study found that local officials are aware of climate change and that they demonstrate a strong willingness to improve their understanding of climate science, management approaches, and climate policy. Further analysis reveals that officials working outside of the climate-related field showed stronger demands for enhancing their knowledge about climate change than those working in the field. The research suggests that the Jiangsu government would need to integrate capacity building into climate policy and take a systematic approach to equip local officials with newest scientific knowledge, policy developments, and necessary capacities for addressing climate change and pushing forward local low carbon development.

KEYWORDS

awareness of climate change, CO2 emissions reductions, capacity building for officials

INTRODUCTION

Jiangsu province is one of the most developed and economically active regions in China, which was the third biggest CO2 emitter in China. Jiangsu is vulnerable to climate change and facing pressure in reducing its carbon intensity.

In China, it is local officials who practice measures and instruments, oversee low carbon progress, and connect climate policy processing with diverse individuals. Officials' performances and actions play a critical role to determine whether or not CO2 emissions reduction and energy saving policies are implemented successfully. With this regard, this study aims to understand local officials' awareness, beliefs and attitudes towards climate change, evaluate their capacity need to implement policy and respond to climate change risks, and provide information for the government to develop effective policy to enhance capacity building for local officials to help individuals to translate their intentions of CO2 emissions reductions into actions.

RESEARCH DESIGN & DATA COLLECTION

Research area

Jiangsu province is located in the eastern coast of China and the downstream of the Yangzi River. The entire province nestles in the Yangzi River Delta, one of the most developed, densely populated, and economically active regions in China. Like most of the world's river lower deltas, Jiangsu is

vulnerable to climate change, especially sea level rise, which causes flooding from ocean storms and has potential to place tens of thousands of people at risk (Fan and Li, 2006; James, et al.,2009). Over the past years, the Jiangsu government has issued several policies and measures to respond to the central government's actions on energy conservation and emissions reductions, facilitate its transition towards low carbon development, and address climate change risks. In 2009, the Jiangsu government compiled the Planning for Addressing Climate Change at the provincial level required by the central government, which prioritizes areas and policy measures for mitigating GHG emissions and adaptation to climate change risks, such as saving energy in key sectors and cities, optimizing and escalating industry structure, developing renewable and clean energies, and improving energy efficiency by using innovative technologies.

During the 11th Five Year Plan, Jiangsu accomplished its target of energy conservation and emissions reduction allocated by the central government, reaching an accumulated decrease of 20.45% in energy consumption per unit of GDP. For the 12th Five Year Plan (2011-2015), in response to the new emissions reduction target set by the central government, by 2015 Jiangsu should reduce its CO_2 emissions and energy consumption per unit of GDP by 19% and 18%, respectively, compared with the 2010 levels, increase Jiangsu's share of no-fossil fuels of overall primary energy consumption by 7%, and increase forest coverage rate by 22% and forest stock by 6 million m^3. These low carbon indicators have been officially included in the Jiangsu 12th Five Year Plan and mandated to be reached within the next five years under the average, annual economic growth rate of 10% (JDRC, 2011b).

As one of the most developed regions in China, Jiangsu has begun to address the emerging challenges of building a low carbon society and coping with climate change risks. It is hoped that the information on local officials' concerns about climate change from Jiangsu would be helpful for the Jiangsu government as well as the central and other provincial governments to initiate effective programs to improve officials' capacity in implementing climate policy at different levels.

Questionnaire design

This study explored three specific research questions: 1) How do local officials understand climate change issues and what are their beliefs and concerns of China's climate and energy issues; 2) How are local officials willing to improve their ability in dealing with climate change risks and what do they need to address climate change; and 3) How would climate policy at Jiangsu reflect local officials' responses and capacity needs to manage climate change?

To answer the questions, a questionnaire was designed on the basis of previous research related to both climate change science and policy measures as well as capacity building theories. A desktop literature review was conducted to survey the newest development of climate change science (e.g. IPCC reports), popularly used instruments to measure climate change awareness and concerns (e.g. Stanford University, Globe Scan, Yale and George Mason Universities, etc.), research work related to impacts of climate change on China, China's policy and actions responding to climate change, as well as China's real situations facing climate change challenges. This previous work was reflected in and informed the three main sections of the questionnaire developed for this study to examine local officials' views on climate change in the Chinese contest.

Based on capacity building theories and practices derived mainly from the literatures and reports released by the UN system (UNDP, 2009; UNDP, 2010a; UNDP, 2010b; FAO, 2010; GEF et al., 2010; WB, 2006), this research developed a capacity building framework for addressing climate

change in China, which served as a guideline for designing the questionnaire to examine Chinese officials' needs for capacity improvement. The capacity building framework focuses on the individual capacities that are considered as requirements for officials to understand and make decisions on climate change policy and implement governmental policy at different levels (Table 1).

Table 1. Capacity framework for officials addressing climate change

Capacities	Descriptions
Technical capacity	• Accounting GHG emissions and energy consumption and managing emissions data • Analyzing and assessing vulnerabilities and impacts of climate change risks • Assessing low carbon performance and monitoring low carbon development processing • Monitoring and managing policy implementation procedures, results, and expected performance, assessing and monitoring climate programs, providing feedback
Knowledge capacity	• Improving awareness and knowledge of climate change and its causes and risks • Understanding national low carbon development and climate policy • Obtaining relevant information and applying scientific results to support decision-making • Analyzing impacts of climate change on individuals and understanding low carbon lifestyle • Thinking of climate change issues systematically and comprehensively
Policy capacity	• Forming and designing market-based emissions reduction and intensive mechanisms • Integrating climate change risk management into low carbon development plan • Including climate change mitigation and adaptation into low carbon green development • Using decision-making tools to develop climate policy • Coordinating with different stakeholders to implement climate policy • Analyzing impacts of climate policy on individual and industrial sectors • Explaining national, regional and local policy and their implementation

The questionnaire developed to collect data for this research consists of four major parts. The first section included the basic demographic information, such as gender, age, educational and academic background, employment history, relevance of participants' work to climate change related fields, membership of environmental organizations, and volunteering environmental events or activities.

The second section of the questionnaire developed 12 climate change related topics to examine how well respondents' knowledge about the issues. A three-point scale was used to measures participants' knowledge level on climate topics, such as "never heard about it", "heard about it", and "know about it."

In the third part of the survey, 15 statements regarding the climate science and China's situations were designed to examine respondents' attitudes and beliefs about the climate issues. The statements were framed from perspectives of the causes of climate change, social and

environmental impacts, and potential solutions to climate issues. Respondents were asked to indicate their levels of agreement/disagreement of each statement on a 5-point scale.

Following, three questions regarding China's energy situation were included. The first question asked participants to express their concerns about China's energy security under the circumstance that China is expected to import 70% of its oil from overseas. The second one asked participants' attitudes towards future nuclear development in China after the Fukushima Daiichi nuclear disaster. The third one asked participants to indicate their concerns using renewable energies.

The fourth part of the questionnaire surveyed local officials' willingness to raise their awareness of climate change and about what topics they desire more knowledge. The first question asked participants if there is a need to improve their knowledge about climate change. The following questions investigated specific themes that participants would think important for enhancing their understandings of climate change issues. This part was organized as 7 climate sciences, 8 climate change management approaches, and 9 climate policies. A 5-point scale from "very important "to "not important" was used for participants to indicate their needs for capacity improvement on managing climate change.

Survey procedures

Before the official survey, the questionnaire was sent to climate experts, governmental officials, and climate change program managers for review. Meanwhile, several graduate students were invited to test the entire questionnaire. Based on feedback ascertained from expert reviews and pre-testing, the questionnaire was revised in wording, grammar, and scientific expressions to ensure its validity and reliability. In the official survey, an open question was added to ask participants to evaluate the effectiveness of the questionnaire. Thirty-five participants responded to this question and all of them indicated that the questionnaire is comprehensive and covers all necessary topics, targets the audience appropriately, and is clear and easy to read and understand. This information helped to confirm the reliability and quality of the questionnaire.

Compared with officials from central governmental agencies, local officials in this research refer to those who are taking a post at governmental agencies from districts, cities and counties in Jiangsu province, excluding those from the provincial governmental agencies. The survey was conducted from November to December 2011 and the Jiangsu Development Reform Commissions (JDRC) helped to distribute 250 questionnaires to governmental bureaus, offices, and administrative units across all 13 district cities of Jiangsu province, including most of the 31 county-level cities and 33 counties, as well as a workshop for local officials. Participants from the diverse agencies were voluntarily and anonymously took part in this research and they were given detailed instructions on how to respond to the questions, especially the importance of answering the questions frankly and giving their true thoughts. Finally, 191 valid questionnaires were used for the data analysis.

As shown in Table 2, the majority of participants (64%) are male and the average age is 35.3. Participants are well educated, 96.9% of them with a college degree or above, and most (80%) are trained in the social sciences. More than half of the participants (56%) were employed before 2000, nearly 40% of participants are working in the climate change related field, around 60% of participants volunteered to environmental protection activities, and only 5.2% of them are official members of an environmental organization.

Table 2. Profile for participants

Variables	Number of sample	Mean/frequency
Participants	191	
Male	122	63.9%
Female	69	36.1%
Age	172	35.4 (S.D=8.338)
Education		
College	148	77.5%
Masters and above	37	19.4%
High school	6	3.1%
Academic background		
Engineering/Natural sciences	37	20%
Humanities /Social Sciences	149	80%
Year of employment		
Before 2000 (including 2000)	103	56%
After 2000	81	44%
Work relevance to climate change		
Relevant	86	46%
Not relevant	102	54%
Member of environmental organization	10	5.2%
Volunteering in environment activities	113	59.2%

SURVEY RESULTS

Knowledge of climate change

As shown in Table 3, global warming was well recognized by respondents, with more than 90% of them knowing the trend of global climate change. International climate policies like the Kyoto Protocol (63%) and the Framework Convention on Climate Change (55%) were also well known topics, with only 7% of participants having never heard of them. More than half of the respondents (52%) knew the Chinese government's emissions commitment for 2020, and nearly half of them understood key issues like energy and climate change security, China's emissions status in the world, and adaptation and mitigation strategies. Only 40% of participants acknowledged China's low carbon practices and emissions trading. Although China's CDM has the biggest share of the world's project-based carbon market, 34% of respondents have never heard of CDM. Similarly, nearly 40% and 30% of respondents indicated that they have never heard about CCS and carbon sinks, respectively.

Table 3. Knowledge of climate topics (N=191)

Knowledge items	Know about it	Heard about it	Never heard about it
Global climate is becoming warmer over the past hundred years	91.10%	8.40%	0.50%
Carbon capture and storage (CCS)	27.20%	34.00%	38.70%

Carbon sink or carbon sequestration	36.10%	35.10%	28.80%
United Nations Framework Convention on Climate Change (UNFCCC)	55.50%	37.20%	7.30%
Kyoto Protocol	62.80%	30.40%	6.80%
CDM（Clean Development Mechanism）	38.70%	27.20%	34.0%
Emissions trading	40.30%	41.90%	17.80%
Climate /energy security	49.70%	46.60%	3.70%
China's provincial and city low carbon pilot programs	39.70%	42.90%	17.50%
China is the world biggest GHG emitter since 2007	47.90%	38.90%	13.20%
China will cut its carbon intensity by 40-45% by 2020 against the 2005 level	52.40%	31.90%	15.70%
Adaptation and mitigation are the two major strategies for coping with climate change challenges	46.60%	41.90%	11.50%

Attitudes and beliefs in climate change

As illustrated in Table 4, respondents showed a better understanding of the relationship between human-induced GHG emissions and climate change issues. The majority (93%) of respondents recognized changes in climate in their daily surroundings, 91.2% considered deforestation as one of the sources of CO_2 emissions, 84.4% knew GHG comes from burning fossil fuels, 82.7% believed that GHG emissions from human activities contribute to climate change, and 81.7% thought energy-related emissions are the major source of GHG emissions.

For the 5 statements related to the consequences of climate change, 92.7% of respondents believed that climate change impacts social and economic development and people's daily lives, 89.5% agreed sea level rise associated with climate change causes flooding in China's coastal regions, 81.7% thought climate change would lead to disasters if no actions are taken immediately, 77.6% agreed that climate change would reduce water availability and result in water shortage problems in northern China, and 83.7% supported the view that climate change may cause some diseases to spread and threaten public health in China.

On the topic of solutions to climate change, the majority (94%) of respondents indicated that energy conservation is an important solution to reducing GHG emissions, 87.4% supported China's earlier actions to mitigate GHG emissions despite associated with high cost, and 80% were optimistic about the future, since they believed that humans would find ways to deal with climate change issues as they grow more severe. However, the results indicated a trend that respondents did not favor climate change solutions that require individuals to pay extra money from their own pockets. For example, 50% of respondents supported a carbon tax mechanism, while 21.4% opposed it. Fifty-five of respondents were willing to pay for extra money to support the rise of oil prices for climate protection, but 19% of them were not willing to take this action.

Table 4. Attitudes and believes in climate change

Statements	1-5 Likert-Scale (N=191)	
	Mean	S.D
I have observed climate change in my daily surroundings.	4.44	.591
Burning fossil fuels such as coal, oil and natural gas emits GHG	4.24	.996
GHG emissions from human activities are the main cause of global warming	4.00	.863
CO_2 is the most important GHG , and is mainly emitted by burning fossil fuels	4.01	.707
Deforestation is one of the major factors that contribute to GHG emissions	4.11	.721
Sea level rise associated with global warming would cause flooding disasters in China's coastal areas.	4.19	.683
Global climate change would affect Chinese people's daily life and living standards.	4.18	.671
Climate change would intensify water shortages in northern China and affect water resource availability.	4.04	.716
The increase of temperature may cause some diseases to spread and threaten public health in China.	4.01	.658
As predicted by scientists, if temperatures keep rising, we will face catastrophic consequences.	4.07	.804
Energy conservation is an important strategy to reduce GHG emissions.	4.12	.621
China should levy a carbon tax on energy consumption to encourage individuals to cut CO_2 emissions.	3.40	1.087
I am willing to pay a higher price for petroleum if the money is used to support climate protection.	3.42	1.036
Although climate change mitigation is very costly, China should act immediately to reduce emissions.	4.19	.710
Climate change is a serious problem, but I believe we can find solutions to the issue.	3.99	.754

The data also indicates respondents' great concerns about China's energy problems. The majority (96%) of respondents believed that China would face energy shortage problems in the future, and 90% thought that China's energy security would be affected by its heavy dependence on imported oil. After the Fukushima Daiichi nuclear accident, 62% of respondents believed that China should slow down its nuclear development and place safety as the top priority, but 38% insisted China should speed up its nuclear development to meet the rapidly increased energy demands.

In regards to renewable energy, Table 5 reveals that respondents' biggest concern is the price of renewable energy, followed by the stability of energy supply and renewable energy's contribution to CO_2 emissions cuts. It seems respondents are least concerned about the link between renewable energy and economic development and job creation.

Table 5. Concerns of using renewable energy

Factors that affect the use of renewable energy	Percentage (N=191)
Price of renewable electricity	40.30%
Stable supply of renewable electricity	28.30%
Contribution to CO_2 emissions reductions	23.00%
Contribution to economic development and employment	8.30%

Improving understandings of climate change

When asked if respondents are willing to raise their understandings of climate change issues, 94% answered positively and 61% showed interests in knowing more about specific climate topics.

As Table 6 shown, climate change sciences, climate change mitigation (88.7%), and impacts of climate change on society, economy and eco-system (88.1%) were prioritized as important topics, followed by scientific information on climate adaptation (82.7%), climate change trend, causes, and consequences (81.7%), the relationship between green development and addressing climate change (81.1%), and the link between low carbon society and managing climate change disasters (77.8%). Relatively, fewer respondents believed that climate change risks is an importance topic for understanding climate issues (72%), despite the fact that China has been listed as one of the vulnerable countries in the world to climate change impacts.

Table 6. Scientific knowledge on climate change

Climate change scientific topics	1-5 Likert Scale(N=191)	
	Mean	S.D
Climate change: changing courses and causes	4.03	.064
Climate change risks and risk management	3.86	.062
Impacts of climate change on the environment, society and economy	4.17	.058
Climate change mitigation	4.19	.057
Climate change adaptation	4.12	.065
Green development and addressing climate change	4.18	.065
Low carbon society and resilience of climate risks	3.85	.070

For approaches to managing climate change, as indicated in Table 7, low carbon technology development and deployment (84.3%) and developing of low carbon indicators (83.5%) were prioritized as important topics, followed by the international MRV systems on GHG emissions (82%), methods for decomposing Chinese emissions reduction targets for the 12th Five Year Plan (82%), energy auditing (80%), and energy management contracting (78.5%). China's GHG emissions monitoring and accounting, carbon cap-and-trade mechanism, and climate financial systems were favored by 75% respondents, respectively. In addition, 73.7% of respondents were interested in techniques that would be put into practice for local climate change adaptation. Only 71% of respondents responded to CDM methodologies as an important topic to learn.

Table 7. Techniques for managing climate change

Techniques	1-5 Likert Scale (N=191)	
	Mean	S.D
Energy auditing	3.97	.069
Energy Management Contract (EMC)	3.96	.062
China's GHG emissions monitoring and accounting	3.97	.061
International systems on measuring, reporting and verification of GHG emissions	4.03	.064
Methodologies of decomposing energy and carbon intensity reduction targets for China's 12th Five Year Plan	4.11	.069
Practical techniques for local climate adaptation	3.95	.066
Development of CDM project: procedures and methodologies	3.88	.067
Carbon cap-and-trade mechanism	3.87	.062
Climate /low carbon financial systems	3.87	.060
Low carbon technologies and R &D	4.08	.065
Indicator system for low carbon development	3.97	.065

Table 8 reveals that China's strategic planning for energy and renewable energy, measures to fulfill the emissions targets set by the 12th Five Year Plan, and GHG emissions reduction policy were prioritized as important topics, each gaining 85% support rate by respondents. Policy impacts on social and economic development, international cooperation and technology transfer between developing and developed nations, and new developments on climate negotiations were preferred by 80% of respondents, respectively. Seventy-eight percent of respondents were interested in China's long-term strategies on addressing climate change issues, and 69% of them favored international climate regulations and policies.

Table 8. Policy approaches for addressing climate change

Climate change policy and mechanisms	1-5 Likert-Scale(N=191)	
	Mean	S.D
International climate regulations and policies	3.72	.064
China's strategies and planning for addressing climate change issues	3.89	.066
China's strategic planning for energy and renewable development	4.06	.061
Socio-economic impacts of China's climate and energy policy	4.02	.059
Effective policies for controlling and reducing GHG emissions	4.15	.056
Measures for China to reach its energy conservation and emissions reduction target set by the 12th Five Year Plan	4.17	.061

International climate cooperation and technology transfer	4.10	.067
International climate negotiations and developments	3.96	.064

Responses from different groups

Further data analysis was conducted to identify differences in views of climate change and demands for capacity development among groups from different social and professional backgrounds. There were no significant differences between female and male respondents regarding awareness about climate issues. However, male respondents showed significantly lower interest than females for knowing more about climate change risks and management ($p<0.05$), climate change mitigation ($p<0.05$), low carbon development and resilience of climate risks ($p<0.05$), and the techniques on developing low carbon indicators ($p<0.10$).

Compared with respondents with natural science background, respondents with a social science background had stronger beliefs in climate change trend ($p<0.10$) and human being's ability to solve climate change issues ($p<0.05$), and they prioritized practical strategies for local climate change adaptation higher than those with a natural science background ($p<0.05$).

Respondents employed before 2000 showed significantly stronger attitudes towards the contribution of fossil fuel burning to climate change ($p<0.05$), CO_2 as the most important GHG ($p<0.000$), and China's early actions on emissions control ($p<0.00$). They considered practical strategies for local climate adaptation as a significantly more important topic than those employed after 2000($p<0.05$).

Compared with respondents within the climate field, respondents outside of the climate field demonstrated significantly stronger beliefs that severe catastrophic consequences are caused by global temperature rise ($p<0.00$) and that China should take actions immediately to mitigate climate change despite the higher cost ($p<0.05$). Most significantly, respondents outside of the climate field showed greater demands for improving their awareness of climate change. Specifically, 6 climate science topics, 10 techniques on managing climate change, and all 8 climate policies were considered as important topics for awareness improvement(at least $p<0.05$) by respondents out of the climate field.

CONCLUSION

This research found that local officials in Jiangsu are aware of climate change and show a strong need for capacity building for addressing climate change risks. Furthermore, those who are not working in the climate field demonstrate a stronger demand for improving abilities in understanding of climate change science, managing low carbon processing, and analyzing climate policy than those who are working in the climate-related field. The results may imply that the Jiangsu government would have to pay adequate attention to enhancing local officials' awareness of climate change by investing in capacity building programs which need to expand beyond officials in the climate field. Climate change issues are complicated in nature and solutions to the issues require integrated policies, systematic approaches, and close cooperation and coordination among different sectors, agencies and departments as well as managers, business leaders, and all stakeholders. If equipped with accurate information and knowledge on climate change through capacity building, those actors from different sectors would gain clear thoughts and insights on how to exercise low carbon practices in their own workplaces and what to do to effectively

implement national, provincial and local climate policies.

In order to strengthen capacity building for addressing climate change issues, the Jiangsu government would need to integrate capacity development into regional climate policy. Apart from the improvement of local officials' awareness and knowledge of climate change, capacity building should emphasize changing local officials' traditional beliefs on development. Repeatedly, the Jiangsu government addresses that Jiangsu is currently pursuing the quality and efficiency of economic development rather than a rapid GDP growth based on high carbon emissions and low resource efficiency. This requires local officials to understand climate protection in an innovative way, recognizing the importance of addressing climate change and its link to maintaining a safe, stable and sustainable economic development. Through capacity building, local officials would be able to judge and analyze local situations, assess the impacts of climate policies on social development, and strengthen capabilities for implementing climate policies. At the end, local officials will not only enhance their awareness of social services, but will take the lead to implement low carbon actions and plans required by both individuals and professionals, such as shifting toward a low carbon lifestyle and consumption models.

This investigation shows that participants may have not paid much attention to market-based mechanisms and they may not have considered those mechanisms and carbon financing as the prior needs for addressing climate change issues. The results may imply that there is a need to fill the gap between climate policy and local officials' capacities for supporting and implementing these policies. The Jiangsu government should set up a long-term goal and take a systematical strategy for officials' capacity development to ensure newly developed low carbon technologies and advanced management approaches applied at practices.

To fulfill the emissions reduction target set by the central government, the Jiangsu government needs to take further actions, including setting up emissions targets and a timetable for major energy-intensive industries and emitters, legalizing energy conservation and emissions reduction actions, establishing an institution to be responsible for monitoring the progress of policy implementations, encouraging R&D in low carbon technologies, and regulating local governments and officials' behavior. It should be noted that the ability of local officials to understand these measures and implement them in practice is essential for Jiangsu to reach its low carbon targets for the 12th Five Year Plan and maintain its economic development in a sustainable way under a climate-threatened and resources constrained world.

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Energy Management and Conservation Action Program
A Market Model to improve Energy Performance into Business and Entrepreneurship.

Jorge Lossley Jiménez
Director AEG Consultores en Ingeniería S.A.
Naranjo, Alajuela, Costa Rica
jlossley@aegcr.com

ABSTRACT

The Energy Management and Conservation Action [EMC@] model is a tool which provides a project evaluation matrix focused on energy conservation and management. The matrix organizes the projects and provides the customer an educated decision tool. It has five areas of interest which are based on initial investment, technical feasibility, return of investment, impact on business operation and employee/community awareness.

Each area of interest is ranked from 1 to 5, based on its feasibility. The higher values correspond to the more feasible evaluation. Each category has also a representative weight or percentage of relevance. The 100 % is distributed among the five categories under consideration at the end user preference.

The EMC@ model had been implemented in high technology and medical devices industries. The last year results yield three projects which accounts for an initial investment of US$ 1.400.000 and annual savings of US$ 1.750.000, indeed less than a year paybacks.

The EMC@ model also provides new f ields of business for consulting and engineering services. It is the initial path for project development and in conjunction with the complementary economical evaluation, design and construction and monitoring, it is a comprehensive solution to improve customer competitiveness based on an adequate energy use.

KEY WORDS

1. Energy
2. Management
3. Matrix
4. Evaluation
5. Projects
6. Feasibility

INTRODUCTION

The Energy Management and Conservation Action program [EMC@] is a market model developed to improve Business and Entrepreneurship in the Energy Performance field. The model considers five areas of interest in which each proposal is allocated and evaluated by the consultant and the end user/client.

The output of the evaluation is a ranked matrix of the potential projects which can be implemented in order to lower the energy consumption and improve the business competitiveness. The matrix organizes the projects and provides the customer an educated decision tool.

The areas of evaluation are indicated as follow

1. Initial investment
2. Technical feasibility
3. Return of investment
4. Impact on business operations
5. Employee awareness.

Each category has a ranking from 1 to 5, where 5 represent the more feasible value and 1 represents the lower feasibility. Each category will also have a representative weight or percentage of relevance. The 100 % is distributed among the five categories under consideration at the end user preference.
The method provides an array of projects which considers the evaluation of the indicated categories and the ranking according the customer preference. This method allows the decision makers to have an objective tool to decide upon the investment of projects.

EMC@ PROJECTS

The experience of the EMC@ program on Medical Device and High Technology Industry has created a matrix of typical areas of interest which are feasible and most like to be implemented.
These projects are focused to reduce the energy consumption of indoor environment control. Indeed air conditioning systems. These areas of common interest are indicated as follow:

1. Management the Energy profile to take advance of the electrical tariff structure. Under this approach the Energy Storage for Air Conditioning Systems (ICE Storage Device) project had been designed and summit to a bidding process.
2. Incorporate into design and construction the use of waste heat sources to substitute energy demand for heating and/or reheating purposes. Under this concept, the use of condensed water heating coils to substitute electric reheat in Air Conditioning Systems had been designed, bid and built. Current projects are in monitoring phase.
3. Improve the energy consumption profile by introducing renewable generation at end user. Introduction of PV panels and storage batteries, “Smart Grid”. These projects are in the feasibility phase and preliminary design.
4. Incorporate technology to reduce energy consumption of humidity control. Introduction of Liquid desiccant technology. These projects had been designed, bid and built. Currently into monitoring phase.

The following chart presents the state of the art of these EMC@ projects for the 2014-2015 terms.

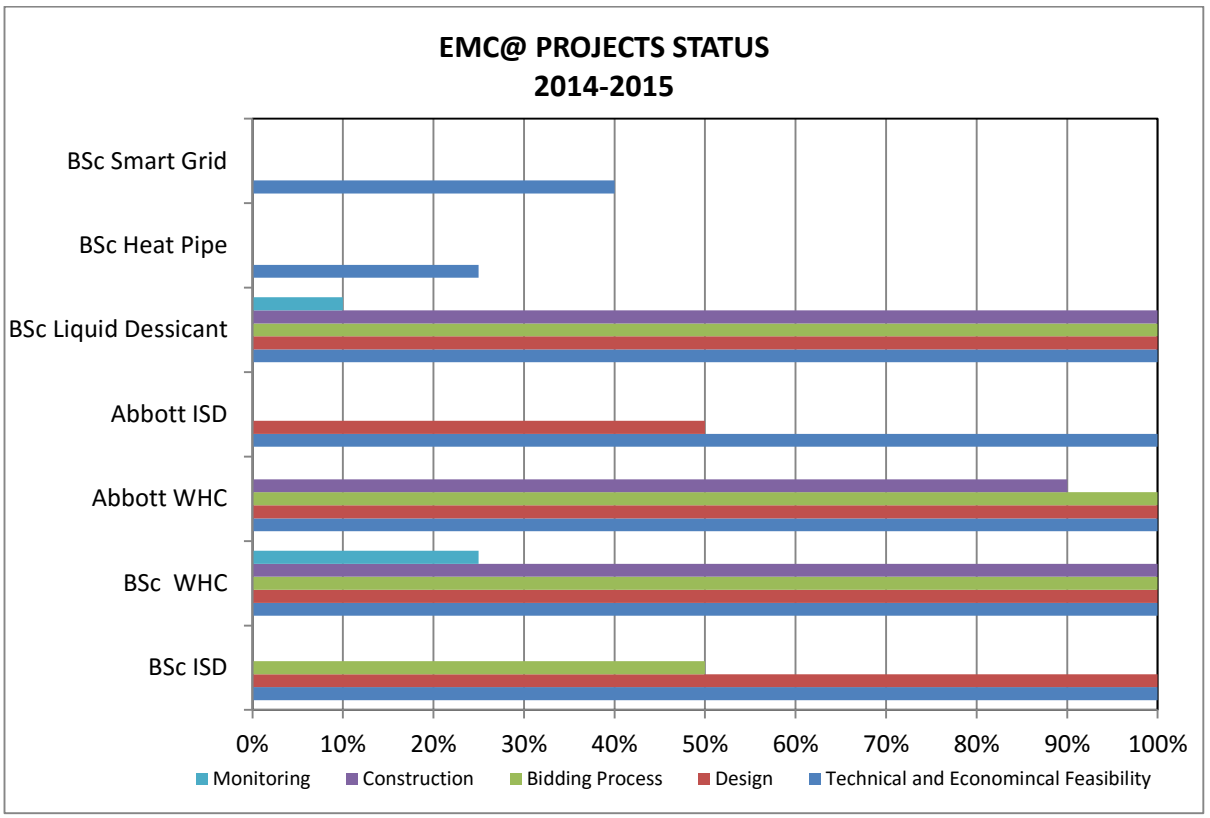

Chart 1: EMC@ Projects Status, 2014-2015 period

The following Case of Study will present the development of the EMC@ projects from the initial idea, customer approach, feasibility, ranking and current status.

Case of Study I: Ice Storage Device (ISD)

The Costa Rica current electrical tariff structure allows the end user to obtain an economic benefit if the energy profile is shift from the peak periods (10:00 to 12:30 and 17:30 to 20:00) to the night period (20:00 to 6:00). In general terms the electricity cost at night period is a quarter of the cost at peak period.

The general concept is to introduce a device that allows the end user to shift its cooling demand. The ice storage device is the prefer method to achieve this operational condition, the concept rely on ice building at night period and ice melting during the peak period.

The following chart presents a typical cooling demand load profile for office building with an Ice Storage Device.

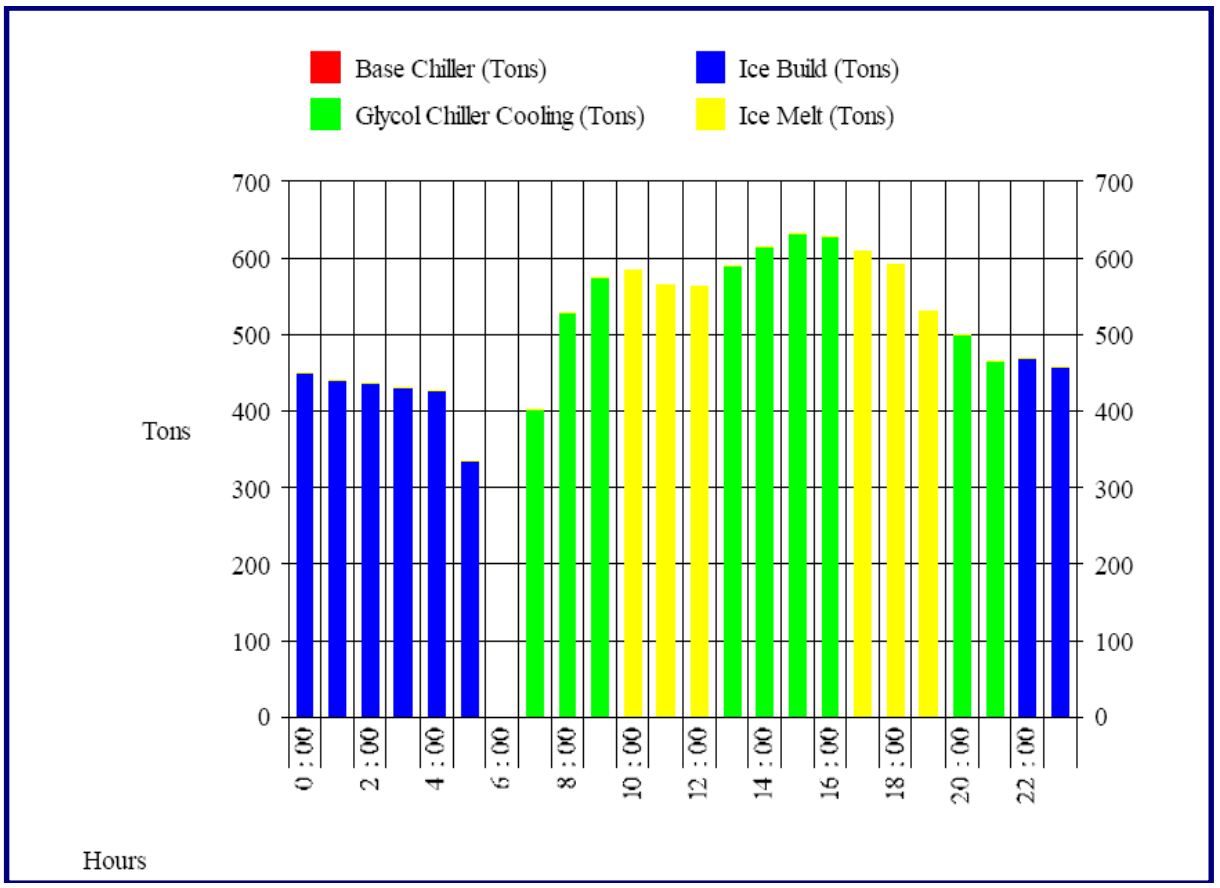

Chart 2: Typical Office Building Load Profile with ISD[18]

These projects have certain limitations:

1. It can be only apply on air conditioning systems which are water based (chilled water), chillers must be able to operate at lower temperature for ice built (-5.5 ºC). Certain equipment is just not suitable for this condition.
2. During the ice build period, the chiller cooling capacity is shared with the building load and the ice making process. For buildings with high night cooling demand, the ice building may not be suitable.
3. On ice building mode, chillers are normally de-rated by 30%, therefore the capability to build ice is limited to this operational condition.

The typical payback period of these projects with current ice making chillers is just over 2 years and it is extended to over 4 years when additional ice making chillers need to be added-

The initial investment varies with the size of the project; however a unit cost per kWh of ice storage is ranked within a range of 75 to 60 US$/kWh.

The electricity generation at night period is, in general terms, produced from renewable sources. At peak period the renewable sources are complemented by fuel based generators.

[18] Calmac Ice Storage Device System

The Ice Storage projects have a positive impact on the environment as well, due the fact the electricity consumption for the ice built is mainly obtained from renewable sources. At Ice melt mode (peak period), the ISD lowers the consumption from fossil based generators.

A particular project currently under biding phase, is forecast to have an initial investment of US$ 480.000, annual savings of US$ 119.600 and Ice Storage Capacity of 7920 kWh. The project accounts for annual CO_2 savings of 510 tons.

Case of Study II: Condensed Water for reheat purpose.

This project had been raked as top priority in those companies which have the conditions to use the condensed water as heating source for reheat purpose. The reheat system is mainly used to control the room temperature in those air conditioning system which demand a humidity control within a range of 50 +/- 10 %

The common approach to maintain room temperature and humidity under the operational parameters is due by an over cooling process which lower the moisture content of the air stream and a reheat process which condition the air stream in order to address the room temperature.

In order to achieve this operational principle, the cooling coil operates under the setting of a relative humidity set point and the reheat under room temperature setting. The reheat system is based on electric coils, which in the majority of applications, rise up the air stream temperature from 12ºC, leaving the cooling coil condition, up to 18 ºC, before enters the controlled space.
The condensed water system, which is used to remove the heat from the chillers, has a typical operational range of 27 ºC to 32 ºC. If the reheat system operates the air stream from 12 ºC to 18 ºC, it is worth to consider a reheat system which can use the condensed water as primary heating source.

The condensed water is a heating source at free cost. It is generated as part of the cooling process of the chiller as a form of reject heat. Indeed, if the reheat system is based on condensed water heating coils instead of electric heaters, the operational cost will be negligent.

The following chart presents the operation of the reheat system in a medical device industry prior the project implantation.

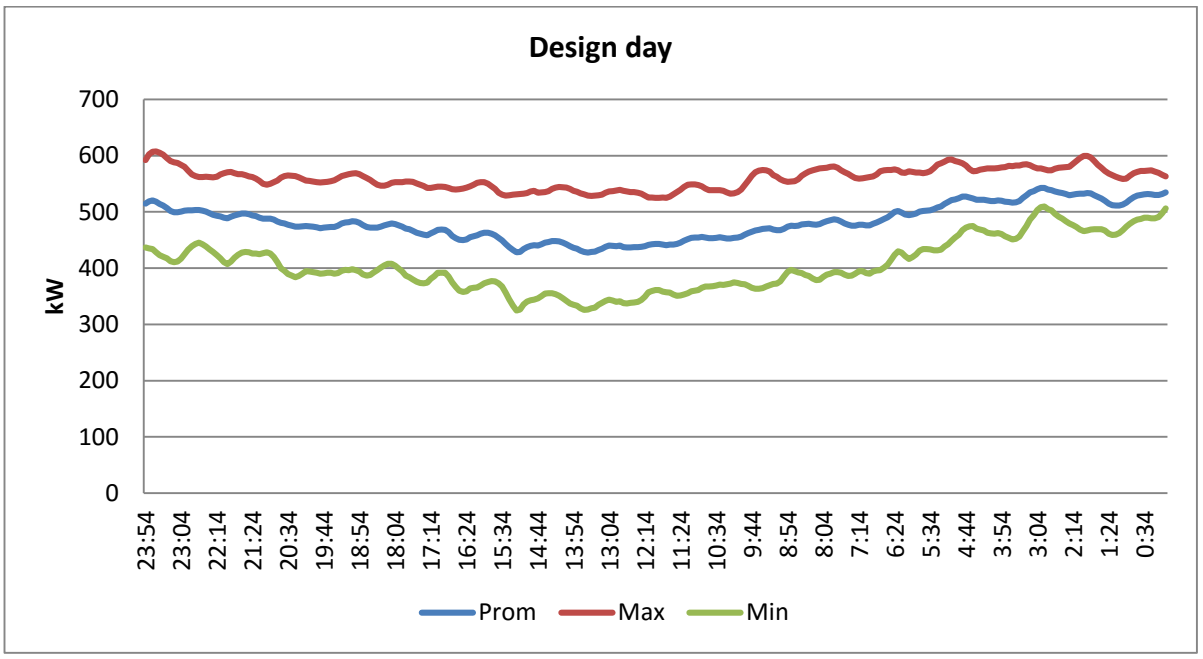

Chart 3: Reheat System Operation Profile (electrical consumption)

The electrical consumption of the reheat system represents 20% to 25% of the total electrical bill of the company.

A project recently installed forecast an annual saving of US$ 425.000. It had an initial investment of US$ 560.000 and a simple payback of 1.3 years. It lowers the facility electric consumption by 25%.

Case of Study III: Liquid Desiccant Technology

Conditioning air stream which will provide the psychometric to control indoor environments has intensive energy use. In those applications which require controlled humidity, the energy use becomes an important issue.
The typical array for low humidity application is the use of desiccant wheel technology. This technology accomplishes the humidity settings with a high reheat demand.

The operational principle is to pass an air stream towards a hygroscopic material which absorbs the moisture. This is called process air. The leaving conditions of the air stream after the desiccant wheel, present low humidity and high temperature, indeed post cooling may be required.

The desiccant wheel material needs to be regenerated, indeed at a later stage; the hygroscopic material is reheated by a high temperature air stream in order to remove the previous absorbed moisture. This process requires a high energy demand either by electricity or by gas in order to produce enough heat to remove the moisture from the hygroscopic material. This is called reactivation process.

The following figure represents the schematic of the reactivation process of a desiccant wheel currently installed in a medical device industry

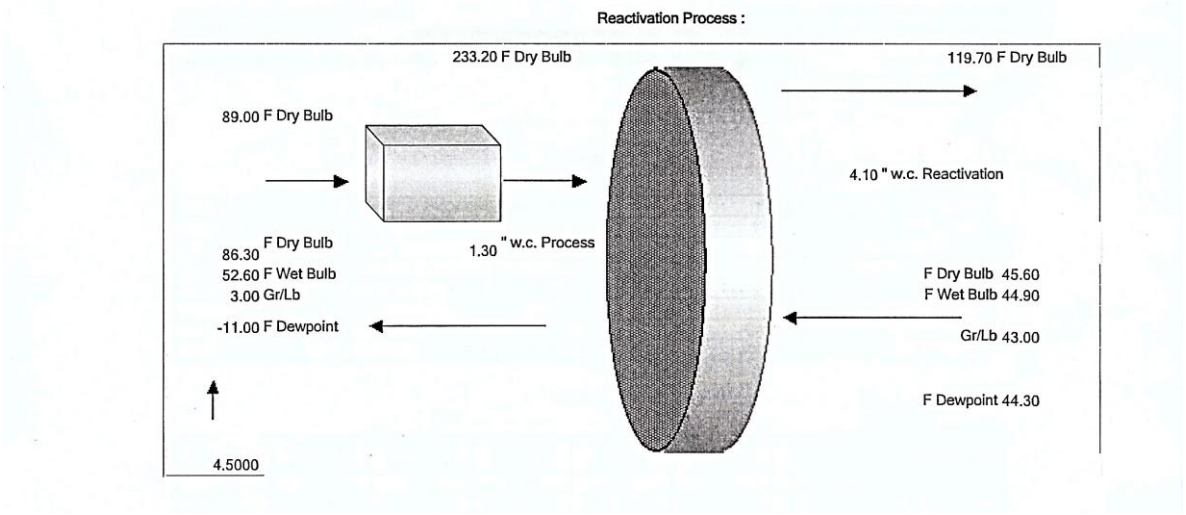

Figure 10: Desiccant Wheel Reactivation and Process Schematic[19]

The liquid desiccant technology takes advantage of the hygroscopic principle of a brine solution which to be regenerated used the heat rejection of a cooling device, which provides the cooling to the leaving air stream, therefore, instead of having low humidity and high temperature, as the desiccant wheel process, the liquid desiccant provides equivalent humidity level at a lower temperature.

The liquid desiccant technology is limited to certain humidity range applications. Typical relative humidity over 30% can be accomplished by liquid desiccant technology. For lower relative humidity requirements the technology is not suitable and desiccant wheel should be considered.

The following figure represents the operational principle or a liquid desiccant system which will substitute the operational use of the desiccant wheel unit for applications with higher than 30% relative humidity requirements.

[19] Munters Corporation,

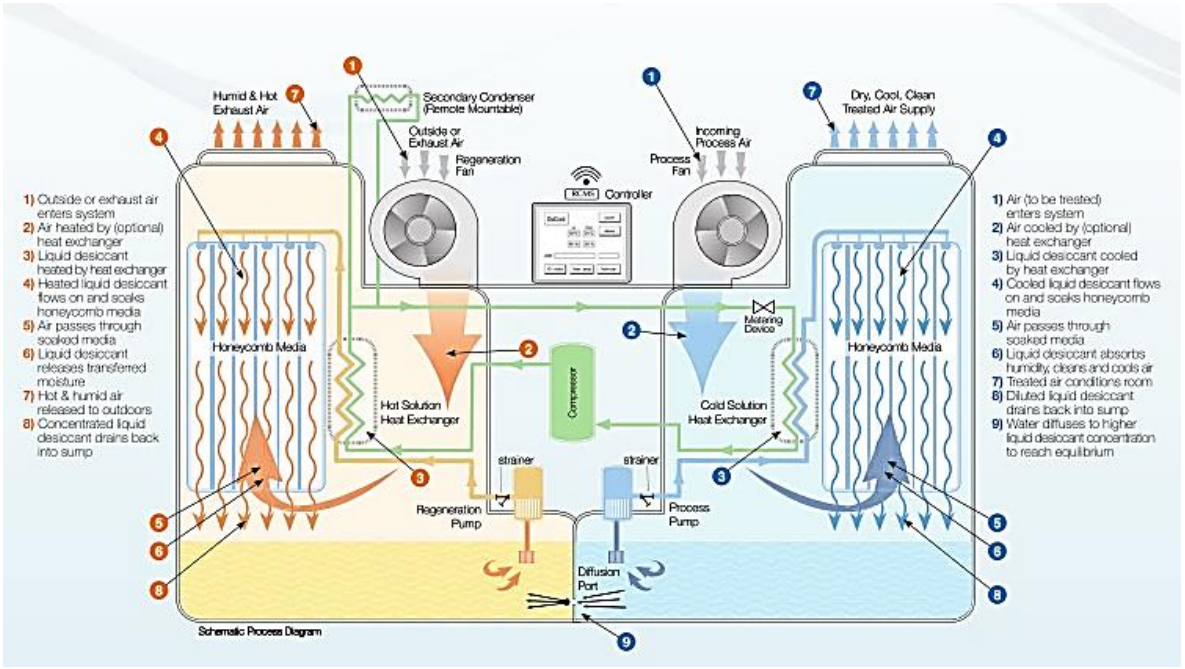

Figure 11: Liquid Desiccant Operational Principle Schematic[20]

The liquid desiccant project under monitoring phase forecasts an initial investment of US$ 250.000, annual savings of US$ 230.000 and a payback of 1.1 years.

Conclusions

The EMC@ model has been in place for the last two years and has already projects in high technology (electronic) and medical device industries. The implemented projects are in monitoring phase and the pace of results had proven that the energy consumption profile can be improved and customers received an economic benefit.

The EMC@ model had been implemented in high technology and medical devices industries. The last year results yield three projects which accounts for an initial investment of US$ 1.400.000 and annual savings of US$ 1.750.000, indeed less than a year paybacks.

The economic benefits of the implemented projects may save within 10 to 15 % of the electrical invoice of these added values industrial sectors. The typical paybacks are in the 1 to 5 year term. The EMC@ projects also provide a hedge to electrical cost fluctuations.

Extended benefits of the EMC@ model are the new fields of business for consultants, suppliers and energy managers. The program is looking forward for an Energy Management Mature Modeling in order to support the energy management services.

EMC@ projects are key drivers in the Supply / Demand Balance. The offset of Demand from peak periods improves the plant factor and provides economic benefits to the parties. They delay the need of new investment into energy generation, increment the grid efficiency and preserve the environment.

[20] Advantix Systems.

Policy Makers and Governments need to promote EMC@ at the end users, either by tariff benefits or by taxing over excessive demand. The economic benefit obtained at the end users under these policies may accelerate the investment pace due to the reduction in the payback and increment in the return of investment (ROI)

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IMPLEMENTATION OF SOLAR ENERGY SYSTEMS FOR COMMUNITY RESILIENCE IN COLOMBIA. CASE STUDY: SAN VICENTE DEL CAGUÁN.

Rivera Forero, Lady Johana[21]**.** Associate Professor at Universidad EAN, Colombia, Director of Master in Mining and Energy Industry Management . Master Eng. In Energy and Environmental Management. Universität Flensburg, Industrial Engineer. DAAD Alumni. Email. ljrivera@ean.edu.co.
Higuita Peña, Juan Fernando[22]**.** Management, Development and Innovation Professional at EPM, Colombia. Master Eng. In Energy and Environmental Management. Universität Flensburg, Computer Science Engineer. Email. JUAN.HIGUITA@epm.com.co.

ABSTRACT
For remote places and Non Interconnected Areas (NIA) in Colombia, national government in cooperation with public utilities and private companies, are building Rural Electrification projects to bring energy for non-interconnected areas mainly based on non-conventional sources of energy (renewables, excluding large hydropower plants).
In order to bring more than electricity service, based on pioneer projects experience, this paper will expose the Case Study of implementation of solar energy systems in Colombia, specifically in San Vicente del Caguán municipality, which benefits 469 inhabitants giving them electricity connection and household appliances.
This case exhibits a methodology for implementation of solar energy systems in grid off areas. This paper shows how this contributes to community resilience in many ways, building social capacity, strengthening economic sustainability for energy systems management, increasing energy independency and delivering more tools for adaptation to climate change.

KEY WORDS
Solar energy systems, management, empowerment, community resilience, sustainability, non-interconnected areas, Colombia, San Vicente del Caguán.

1. GLOSSARY

IPSE: Institute for Planning and Promotion of Energy Solutions for Non Interconnected Areas

NIA: Non Interconnected Area

NIS: National Interconnected System

PV: Photovoltaic

[21] Associate Professor at Universidad EAN, Colombia, Director of Master of Mining and Energy Industry Management Master Program. Master in Eng. In Energy and Environmental Management. Universität Flensburg, industrial Engineer. DAAD Alumni.
[22] Management, Development and Innovation Professional at EPM, Colombia. Master in Eng. In Energy and Environmental Management. Universität Flensburg, Computer Science Engineer.

2. INTRODUCTION

Colombia has a 1.141.748 km2 surface, it has a National Interconnected electricity System (NIS) which covers 34% of total country area, and there are 66% of Non-Interconnected Areas (NIA). Grid off areas are located in remote places, where there are not infrastructure and road access. NIA are highly biodiverse (geographically and socially), public services such as health, water supply, sewage, education and communication are scarse and deficient. Currently, most of the NIA (96,3%) are using diesel generators for producing energy, this kind of service is costly, people have to pay twice than in NIS and this is a limited service for an average of 6 hours per day. (Florez, Tobón. y Castillo, 2009).

Nowdays, Colombia has been testing and making decisions about to introduce renewable energy technologies (IPSE, 2014). Particularly for Solar PV, since NIS mostly runs on hydro and coal thermal power plants, it will take longer to switch for Solar PV share in the short term, therefore it is feasible to introduce renewables primarily for Non Interconnected areas rather than in National Interconnected System (ESTEVE GÓMEZ, 2011), due to climate change in a local context, rural communities are highly exposed to reduce their life quality and Solar PV Systems gives responses in many ways to improve their community resilience competences. (Africa EU Renewable Energy Cooperation Programme, 2014)

This paper answers the question **¿How to implement solar energy systems for community resilience in off grid areas in Colombia?** This results come from an analysis of San Vicente del Caguán experience, about key factors, implementation methodology, strategies, screen of community resilience competences (earlier and later), learned lessons and conclusions.

Relevant literature was reviewed, and data from primary sources was analyzed such as: interviews, photos and mainly from the public utility (EPM) project information. First, literature will be reviewed and a theory framework will be built. Then, through a deductive analysis, a methodology is formulated for implementation of solar energy systems in off grid areas in Colombia. This methodology is implemented in the Case Study in San Vicente del Caguán - Colombia, then, results, learned lessons and conclusions are discussed in this paper.

As **a limitation** to be mentioned**,** there are a few data about ex post-project monitoring phase, due to this project will be finished on January 2016.

3. CONCEPTUAL FRAMEWORK

In 1973 Holling introduced the concept Resilience to environmental matters, it emphasized in complex systems and its status, constancy and change, predictability and unpredictability. This is our starting point, resilience "*measured by the magnitude of disturbance that can be absorbed before the system redefines its structure by changing the variables and processes that control behavior*" (Gunderson, Holling, Pritchard, & Peterson, 2002) meaning complex systems and its dynamics. This paper refers to ecological resilience rather than engineering resilience concept, because more than finding a known stable state, alternative stable states will be explored. (Gunderson, Holling, Pritchard, & Peterson, 2002)

Community Resilience has several dimensions, social, infrastructure, economic and institutional resilience, (Schuschny, 2014).

- Social resilience: Refers to group capacity to overcome adversity and to be able of becoming stronger and modify itself. It depends on the demographic profile.
- Infrastructure resilience: Adaptation, sensibility to risk identification, response capacity, capacity to learn lessons and buildings, transportation systems, health security systems vulnerability, and providing emergency systems.
- Economic resilience, it is related to economic activities, diversity, employment conditions, capacity to bear emergency or radical changes.
- Institutional resilience, it means, society and government institutions sufficiency to cope and respond facing an emergency, contingency or changes.

In order to set up a baseline, follow up changes, monitor index, Resilience measurements are used, to facilitate assessment, to forecast impact scenarios and for policy making decisions. (Schuschny, 2014)

In fact, communities in Non interconnected Areas have a particular dynamic, far away from cities and with no access to electrification services, usually *t**he extension of the national electricity grid** should only be done for densely populated areas with enough demand potential to justify the high investment cost of transmission lines*, (Africa EU Renewable Energy Cooperation Programme, 2014) . Then, this paper will characterized a community in San Vicente del Caguán, Colombia, with no electricity access and its own social, economic and environmental dynamics.

There are several rural electrification approaches, extension of main grid, mini-grids, stand alone systems i.e. solar home systems pico PV, in this case San Vicente del Caguán due to small size of the community, low population density, long distance to the existing national grid, topography and general socio-economic factors such as low energy demand and low economic growth potential, it is suitable for implementation of standalone systems. ***Stand Alone Systems*** are mostly small diesel gensets and photovoltaic systems in the form of Solar Home Systems (SHS, up to 150Wp) or pico-PV systems (up to 10Wp). The systems are installed directly at the enduser's house without any distribution network. Their advantages are affordability in terms of initial investment, compared to the extension of national grid or mini grid and the immediate benefits (replacing kerosene, battery or other expensive energy sources). The main disadvantage about this model, it's the limitation in terms of electrical power, which allows only low load applications to be connected. (Africa EU Renewable Energy Cooperation Programme, 2014).

In Colombia, there are current solar projects; particularly it is an increased number in pico PV (IPSE, 2014), San Vicente del Caguán region has an average potential resource of 4-4,55 kWh/m2 and 4-5 sun light hour per day according to the irradiance and bright solar maps (UPME, 2009).

Municipalities to be studied, are located in the rural area of San Vicente del Caguán, they are La Cabaña, La Ilusión, La Media, El Reflejo, la Nueva Etapa, Nuevo Horizonte. Total beneficiaries: 100 families - 479 people, project total cost USD 300.000. (GAIA S.A.S, 2015)

4. PROJECT DEVELOPMENT

Project development started in September 2014; phases are illustrated in Figure 12 Project Stages, along with the estimated duration of each stage:

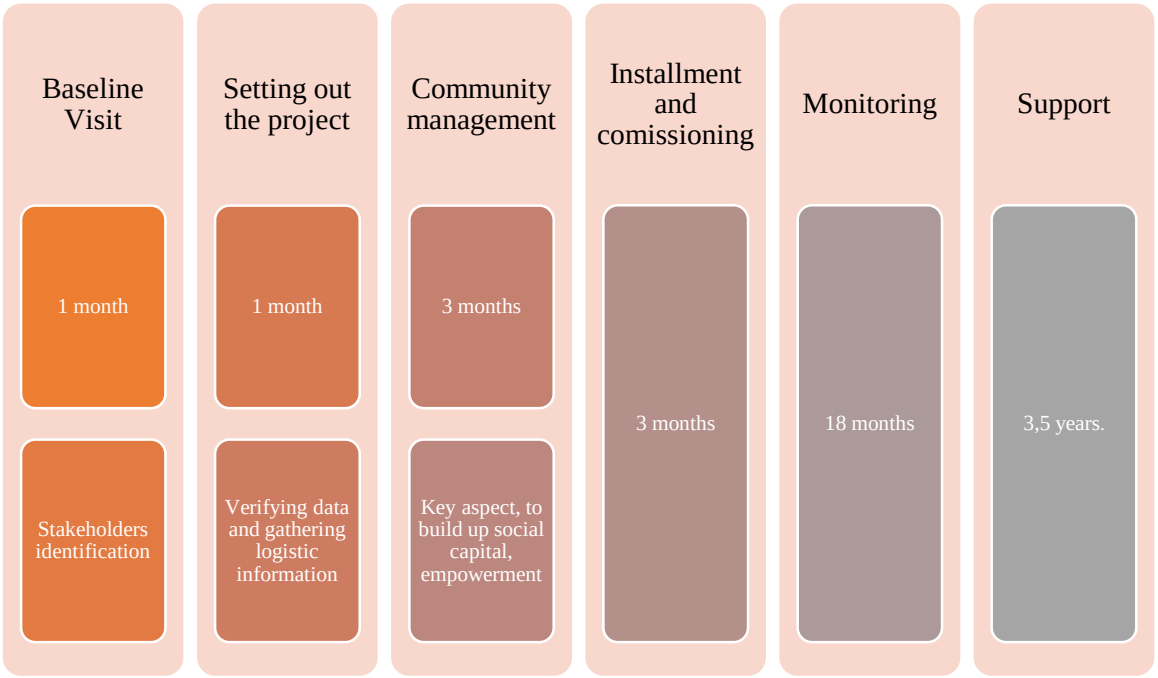


Figure 12 Project Stages - Author.

In that vein, below, the main aspects of project development are described:

4.1 Project Planning

The initiative came from government, it was proposed by IPSE (Institute for Planning and Promotion of Energy Solutions for Non Interconnected Areas) to EPM (Public Services Utility of Medellin), and official utility with around 21% Colombian electricity market share. IPSE characterized the community and nominate it for a solar pv stand alone project. (Higuita, 2014)

4.2 Baseline Visit

All started with a stakeholders meeting, with local authorities to socialize the Project. Sponsors, contractors and government, involved in the Project IPSE, EPM, and contractors firm, meet local authorities and sight the territory. As a result, key contact information for Project execution is identified and logistics, storage, etc., are coordinated.

4.3 Project Beneficiaries

The object area of this study covers five villages that belong to San Vicente del Caguán Municipality. In the next table is shown the number of households and average distance from municipality. Most of the households are made in wood, see Table 11 Beneficiaries data.

Table 11 Beneficiaries data

Villages	Households	# of people	Average Distance KM	Households made in wood	
				Yes	No
El Reflejo	18	93	25	18	
La Cabaña	17	82	23	17	
La Ilusión	18	92	19	18	
La Media	17	75	22	17	
Nueva Etapa	14	61	24	14	
Nuevo Horizonte	16	76	27	15	1
Total	100	479	140	99	1

(EPM, 2014)

Here, Figure 13 San Vicente del Caguan locationshows municipality location in Colombia.

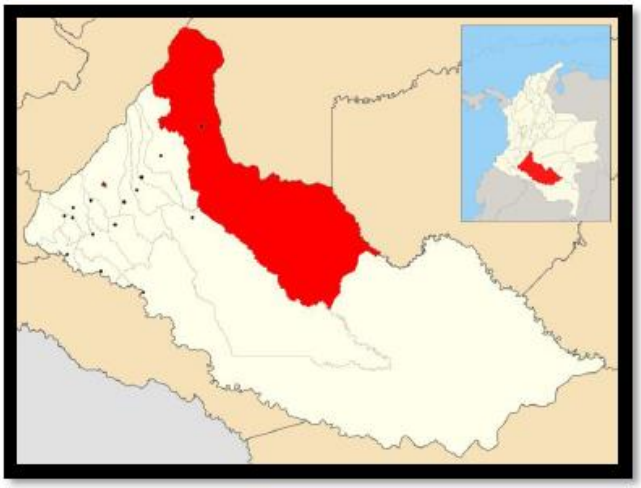


Figure 13 San Vicente del Caguan location

In the following lines, some relevant data about the region under study are mentioned:

- Municipality Name: Municipio San Vicente del Caguán.
- Total area: 28.300 Km2
- Elevation: 280 m
- Average Temperature: 25ºC
- Reference Distance: 151 Kms. From Department capital Florencia –Caquetá.
- Population density: 2,28 (inhab/Km2)
- Total Inhabitants per municipality:
    - No. Urban area: 37,302
    - No. Rural area: 25,937
    - Total: 63,239

In order to establish the specific location of the place and reach beneficiaries accurately, GPS points had to be determined, distances were estimated with GoogleMaps tool, and finally, an

elevation profile between urban area and villages was drawn, hilly conditions to reach the beneficiaries households were clear. See Figure 14

Figure 14 Distance households profile. (EPM, 2014)

Below, Figure 15 shows the georeferenced points for the five (5) villages.

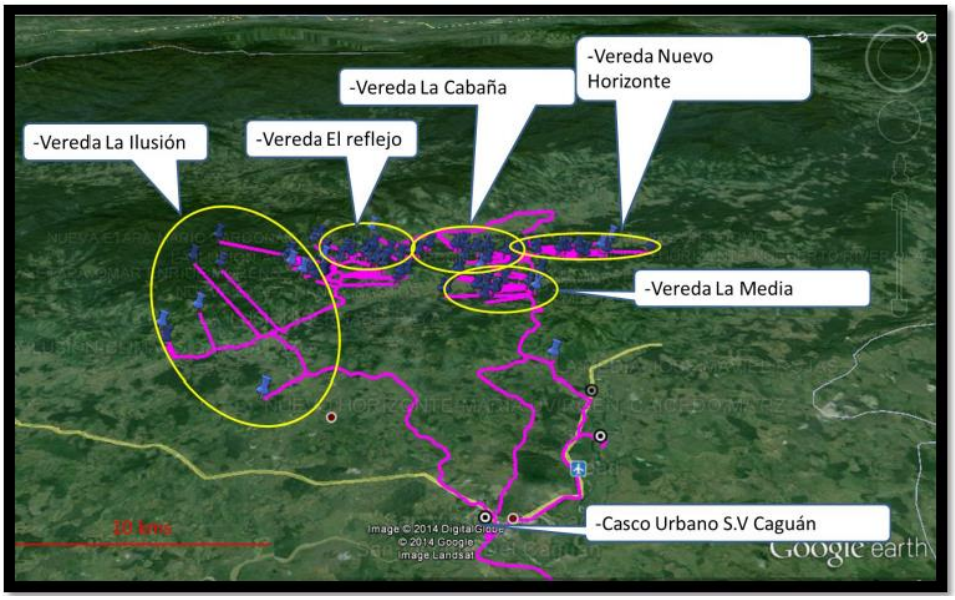


Figure 15 Villages location. (EPM, 2014)

4.4 Project Scope

It was a pilot scheme, where IPSE provided the electrical elements for Solar PV: Panels, batteries, regulators, and other required elements for solar pv system installation. Moreover, IPSE has been providing community professional managers on each project stage.

EPM finances the household appliances KIT, refrigerator, TV-antenna, lighting system, radio, purifier, phone charger and cabling.

EPM performed an initial visit and all preliminary field work. Moreover, EPM performed procurement, transportation and installation of appliances, furthermore its administration, operation and maintenance (OAM) around 18 months.

Likewise, EPM facilitated mobile phone to a community leader for community communication to report damages and failures, and EPM accompanies the community for 5 years monitoring.

Among the deliverables and household appliances supplied by EPM, we have:

Deliverables:

1. 2 Solar Panels Installed
2. 1 Support structure
3. 2 Charger batteries
4. 1 Control operation cabinet
5. 1 Outdoor screening system and cabinet connection.

Household appliances:

1. 1 TV LED 22 inches with DVD, 12 VDC
2. 1 Refrigerator 219 Liter capacity, 24 VDC
3. 4 LED - 10W, 24 VDC plus one spare.
4. 1 Radio charging DC-DC, AC-DC and batteries.
5. 1 energized point for charging mobile phone socket.
6. 1 water purifier.
7. User manual.

4.5 Project funding scheme

The total cost is 551.000 USD, IPSE funds 66% and EPM 34%, each kit costed 4800 USD.

4.6 Project Schedule

Estimated project duration is 5 years, breakdown activities structure is illustrated below. See Table 12

Table 12 Project Schedule

	July-August 2014	September-December 2014	2015	2016	2017	2018	2019
Planning stage							
Installation and Commissioning							
Monitoring							
Support							

(EPM, 2014)

4.7 Preliminary community approach

It is a key factor, to assess social conditions, logistics and area's safety, specially, when there are consolidation regions in presence of outlaw armed groups. Information gathered in this step, helped to minimize incidental costs and precises logistics for execution. It has been relevant to apply learned lessons from other projects, using best practices to reduce time, efforts, risks and resources.

5. IMPLEMENTATION

Next, principal aspects about implementation process are described.

5.1 Setting out the site

This phase started when the technical commission, three technicians and two local people for guidance and assistance were hired. The following information has been defined:

- Geographic Area: Villages Nuevo horizonte, El reflejo, La cabaña, La media, Nueva etapa y La ilusión.
- Documentation of setting out information: materials location, storage, panels location, household geometry, coordinates GPS confirmation, verification of beneficiaries' information, access routes, and transportation times.
- Deliverables: start off report, plot for electric installation, final record signed by beneficiaries.

5.2 Community Management

Two community management professionals scheduled three visits to each village in order to report:

1. Community profile of characterization
2. Build up community commitment about solar PV solution maintenance.
3. Socioeconomic conditions characterization
4. Assessment to determine fee for maintenance and project sustainability in the long term.

5.3 Equipment Procurement and transportation

The contractor firm issued purchase order for equipment and electrical household appliances, with national and international providers. Since EPM financed appliances and IPSE financed the equipment.

The contractor firm used their own funds to make the advance payment, until they received reimbursement from EPM and IPSE payments to submit invoice.

Duration:
Two weeks, for negotiation, purchase order issues and advance payments.
Two weeks for purchase orders total payment

Time Schedule:

- International deliverables : nov 15th to dic 05th
- Deliverables on Main city: nov 15th to dic 15th
- Deliverables on site final users: nov 30th to dic 31st.

5.4 Installation and commissioning

It was necessary counting on community's help to transport the equipment until top of the mountain.

Technicians had to take 2 days for installation per household, including installation, transportation and incidentals.

Work scheme:
From the furthest to the nearest point reference to the storage area.

- Twelve (12) groups for installation:
- 1 Technician
- 1 senior assistant
- 1 junior assistant. Most of the assistants were provided by local communities.
- Two (2) for each village
- Nine (9) households per group

Duration: 18 to 25 days.

Deliverables:

- Solar PV system installed.
- Household appliances installed and working.
- Commissioning Records.
- Safety, payments and vaccination records.
- Photos, plots and User Manual for each kit.
- Sensibilization workshops.
- Creation of an energy committee and community leaders elected.
- Definition of Maintenance plan and maintenance community fee.

5.5 Final Project location Map

Once activities were performed and solar PV systems were installed, the final project location map of each beneficiary was made.

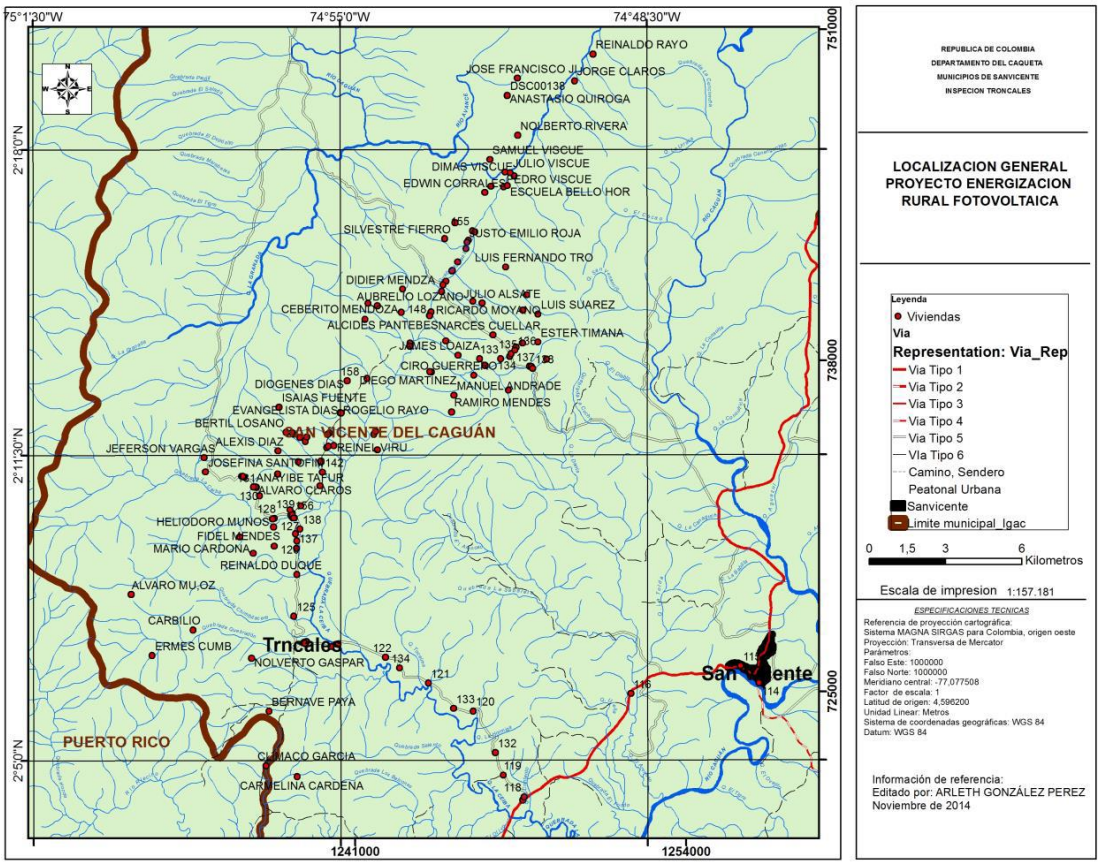


Figure 16 shows the georefenced map.

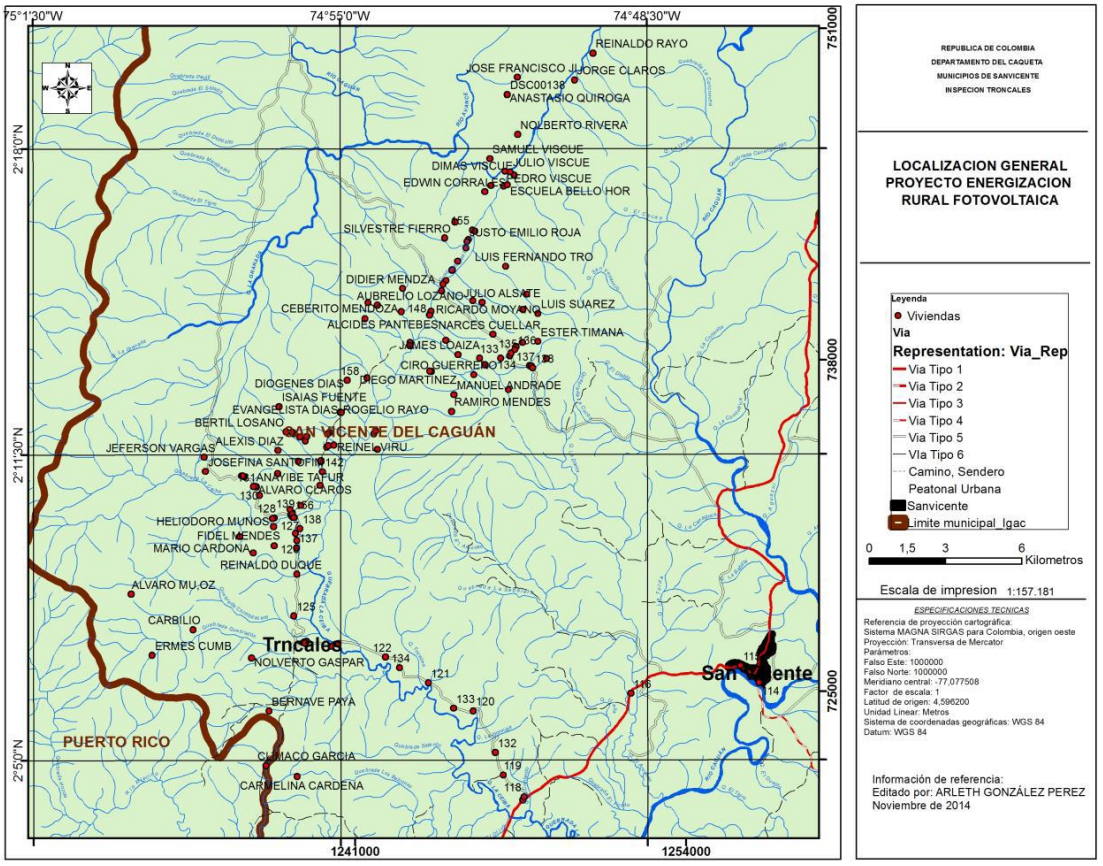


Figure 16

Final beneficiaries map (GAIA S.A.S, 2015)

6. RESILIENCE

Regarding this project, there are four main contributions to the community resilience in San Vicente del Caguán:

- Territorial sustainability and rural electrification.
- Strength of community network.
- Technical and social installed capacity.
- Environmental impacts.

The following describes each of the above topics:

6.1 Territorial sustainability and rural electrification

Earlier, village people used to buy weekly candles for illumination and triple A batteries for lanterns and radios. Starting with this pilot Project, village people have diminished in 95% their demand for candles and batteries. Therefore, they are be able to save money to spend in other activities.

In the same way, there are positive impacts for the whole family income, because now some families sell ice and ice cream. Communities think about save money for maintenance and repairment of the Solar PV Systems. See Figure 17

Figure 17 Refrigerated food

Moreover, there is an improvement in dietary conditions, thanks to the refrigerator, because they can store food (vegetables, meat, and dairy, among others) longer than before, this means also reductions in time and money for them.

6.2 Strength of community network

This process also strengthened a new culture about territory, based on “good neighbor” values, where people can share their concerns, problems, needs and yearnings, in order to find together

wellness solutions. These communities become stronger and more effective to face disasters, contingencies and threats. This quality is called community growth, and it means a community can meet regularly, promoting member participation and to learn from mistakes and make right decisions, thinking from an aggregate perspective instead of an individual decision making process.

Specifically, a community oversight committee for energy issues –Energy Committee - was created in this project; this is an evidence of commitment and empowerment for the whole system. Communities believe that every item belong to them and they accept the responsibility to take care and invest in their maintenance and sustainability in the long term. This committee consists of – four people, Community Technician manager – Treasurer, Observer – Secretary.

Energy Committee has some responsibilities, signed commitment letter with all beneficiaries and to vote for a representative whose will manage the community savings for Project sustainability. Savings were estimated in 0,16USD per day, at the end of the month each household will have 5 USD savings for maintenance and repairs, any time the Committee can review this quote.

A determinant factor is to involve local political authorities; this Project considered their participation and it will be a good practice for the long term. Besides, people have some respect and acknowledge for firms involved with the Project.

6.3 Technical and social installed capacity

The Project has an impact about social integration, family integration and health . It includes people from remote areas to a healthier life style.

In fact, there are people from the community who have been trained by EPM, IPSE and contractors, in order to be able to repair their own system, knowing it and to manage it locally.

6.4 Environmental impacts

Along this project, all the stages: planning, construction, installation, commissioning, environmental management plan were accomplished. Main impacts were:

Each one of installation teams were responsible for handling all matters relating to this work, in which case the leftover materials were collected and transported to the main warehouse in San Vicente, where they are recycled for reusing. Materials collected or that remain, were not delivered to the community, these items consist mainly on: Cables, nails, aluminum tubes, wires, screws, plastic, cardboard. Some houses requested that carton were given to them for domestic use, for that matter used as low mat users beds, wardrobes, or packaging system of several materials. Community is assessed for appropriate disposal of solar systems batteries.

Through this project, no tree or vegetation was cut down; neither any ecosystem suffered any modification. Landscape impact was minimized, due to, outdoor installation didn't have air cabling; wire was installed underground. The solar panel module consists of two panels, it has an area of 2 square meters, located 7 or 9 meters distance from house, energy poles protrude between 2 and 2.2 meter from the surface.

7. RESULTS

There are significant results to stand out. Next, the most representative ones are mentioned:

7.1 Replicable Methodology

In first place, based on other similar pioneer projects and literature review, a replicable methodology is formulated for implementation of solar energy systems in NIA.

0. Characterization
1. Planning,
2. Social and environmental benefits
3. Preliminary protocol
4. Community Strategy empowerment
5. Building Social and Technical capacity
6. Environmental aspects
7. Installment
8. Commissioning & Operation.
9. Monitoring & Support

7.2 Population benefits

In *second place*, methodology was implemented in San Vicente del Caguán, where there are around 100 beneficiary families with low consumption electricity services such as: TV, radio, mobile phones charger, electrical water purifiers, lightening, electricity connection and electrical cabinets. These families were provided with 2 solar panels of 300 peak watts per family, one TV, electrical water purifiers and a refrigerator, all this household appliances are DC systems. See Table 13 Households.

Table 13 Households

Number of households	Number of inhabitants
100	479

(GAIA S.A.S, 2015)

For instance, Figure 18 shows an actual meeting among community members, some of the beneficiaries of this project

Figure 18 Community meetings (GAIA S.A.S, 2015)

The following image (Figure 19) shows some household appliances supplied and installed in one of beneficiaries homes. It can see a water purifier, a refrigerator, a TV and a light bulb.

Figure 19 Household appliances

(GAIA S.A.S, 2015)

In the same way, Figure 9 shows a Solar PV System properly installed in one of beneficiaries homes.

Figure 20 Electricity connections and cabinets.

(GAIA S.A.S, 2015)

Moreover, there are environmental and social benefits such as:

Environmental benefits:

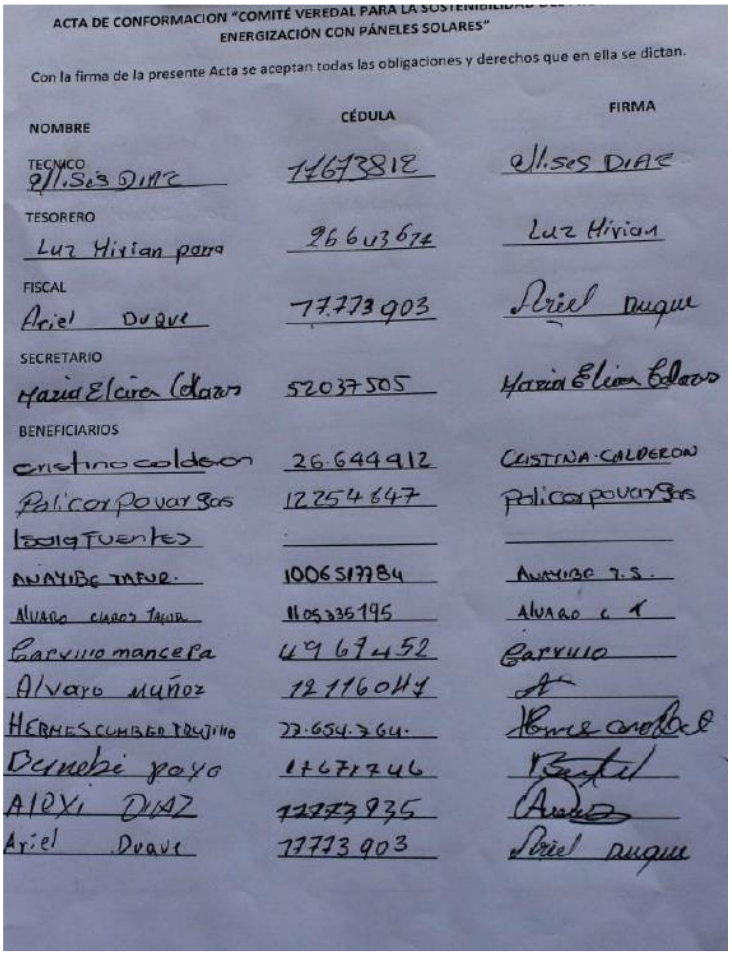
1. Reduction of NOx, SO2, CO y CO2 fossil fuel emissions.
2. Health benefits due to reduction from fossil fuels emissions.
3. Use of clean solar energy, and low consumption household appliances.

4. Reduction in deforestation rate for producing energy.
5. Increase in energy independency, low dependency from external fossil fuels.
6. Cutting off hazard remains disposal from diesel generation, like oil, refrigerants, sludge, etc.
7. Solar energy systems do not require to remove soil, it means it does not contribute to soil erosion.

Social benefits:

1. Generation of new life expectations and local economy strengthening.
2. Improvement in life quality in terms of uses of new technologies for food conservation, refrigeration and communications.
3. More time to take care of children, to study, to work.
4. Strengthening of social capacity, in health, public services, and communications.
5. Increase of products and services demand.
6. Promotion of new and structure community organizations in order to become formal energy users with duties and rights regarding the energy system sustainability.
7. Training and certification for local people about electricity and management energy systems.
8. Solar Kit and appliances, free or charge for community.
9. 100 installed solar kits in 100 households.
10. Better quality lives for 423 beneficiaries, 223 of them are children.
11. 6 Village Energy committees for project sustainability in the long term.
12. During 18 months, committees received technical assistance and support.

Even, an ***Energy committees*** were conformed, with total empowerment from the community to manage the solar energy systems to guarantee long term sustainability. Figure 21 shows the record signed by community members.



ACTA DE CONFORMACION "COMITÉ VEREDAL PARA LA SOSTENIBILIDAD
ENERGIZACIÓN CON PÁNELES SOLARES"

Con la firma de la presente Acta se aceptan todas las obligaciones y derechos que en ella se dictan.

NOMBRE	CÉDULA	FIRMA
TECNICO Ulises Diaz	1167381E	Ulises Diaz
TESORERO Luz Hivian para	96603674	Luz Hivian
FISCAL Ariel Duque	17773903	Ariel Duque
SECRETARIO Maria Elcira Cobos	52037505	Maria Elcira Cobos
BENEFICIARIOS		
cristino calderon	26.649912	CRISTINA CALDERON
Policarpo vargas	12254647	Policarpo vargas
Isaias Fuentes		
ANAYIBE TAFUR	1006517784	ANAYIBE T.
ALVARO CUBAS TAFUR	1105336195	ALVARO C T
Carrillo mancera	4967452	Carrillo
Alvaro muñoz	12116044	
HERMES CUMBE TRUJILLO	77.654.364	
Bernabe payo	17671746	
ALEXI DIAZ	1117373935	
Ariel Duque	17773903	Ariel Duque

Source. (GAIA S.A.S, 2015)

Figure 21 . Committee creation record signed by community members

7.3 Case study

At last, the case study allows to validate implemented methodology and identifying improvement opportunities.

8. CONCLUSIONS

1. There are particular conditions for NIA, they are spread, far from cities, in remote areas, highly biodiverse, costly electricity fees and with few energy services, goods and services demand.
2. There are solutions like solar energy systems for Colombian communities that allow to build community resilience, economic and technical capacity to improve their life quality and adaptation to climate change.

3. The implementation methodology looks for the formulation of a set of steps which can be replicable in other cases for NIA communities. The formulated methodology considers the following stages: 0. Characterization 1. Planning, 2. Social and environmental benefits 2. Preliminary protocol 3. Community Strategy empowerment, 4. Building Social and Technical capacity, 5. Environmental aspects, 6. Installment, 7. Commissioning & Operation. 8. Monitoring. Finally, it will be discussed some learned lessons and conclusions from the Case Study.
4. The formulated methodology is coherent and effective with San Vicente del Caguán community.
5. Monitoring phase would give more data for ex-post evaluation.
6. Community resilience was a positive influence in terms of building social capacity, strengthening economic sustainability for energy systems management, increasing energy independency and delivering more tools for adaptation to climate change.
7. Social component for Colombian NIA communities is the most important of all above.
8. Supplier development is essential to guarantee quality and cost effective solutions.
9. A success key is to work in communities with at least a basic participative structure and sense of belonging.
10. Robust technological items are essential for rural applications.
11. In order to develop Colombian territory in Posconflict age, local and sustainable solutions are required to bring opportunities to all Colombian people.

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Social Implications of Carbon Taxes

María Ana Gonzalez
Arrieta 698, Viña del Mar, Chile
mariaanagonzalez@yahoo.com.ar

ABSTRACT

The present report studies some of the energy policies used to address climate change and comment whether the application of those policies can have negative distributional effects, thus increasing the income gap between the rich and poor. It is usually stated that the negative externalities from the use of fossil fuels should be included in the energy prices, however, poor people could be mostly affected by increased energy prices given that they pay a larger percentage of their income in transportation, fuel, electricity, natural gas, and even food if we consider that food prices can also be affected by increased fuel costs. In this way, these energy policies act as regressive taxes affecting mostly the people with lower incomes. Real cases of policies applied in different countries are studied and those that are suspected to have an adverse social impact will be discussed. Finally, a case study of the tax on kerosene fuel in Chile is presented to evaluate numerically the social impacts of this tax.

KEYWORDS

Carbon tax, distributional effects, policies, energy, externalities.

INTRODUCTION

It is usually heard among environmentalists the need to internalize the environmental impacts of fossil fuels into its costs. However, a further analyses is required to understand the impacts of this internalization on the poorer people, given that they spend a greater part of their income in basic goods, which are very affected by increasing energy prices.

In August 2014, during the launch of a report named "Getting Energy Prices Right" [0], the IMF stated that all countries in the world should be collecting higher pollution taxes on fossil fuels in order for them to reflect the long-term climate change related global damage [0]. The idea behind the article is well known and usually recommended by environmental and climate change organizations, however, further consideration of the possible unwanted social effects of the recommendations should also be studied, mainly the impact that the increasing energy prices could have on the people with lower incomes. Thus, the aim of the present study is to analyse further the implications of bringing in the so-called externalities into the fossil fuel prices, and thus, increasing the energy prices. However, it is worth noting that it is not the objective of this report to argue that externalities should not be considered, but that all their impacts should be studied before implementing certain carbon mitigation policies and for those cases where the unwanted social impact is considerable, a mitigation measure should be designed in order to reduce the unwanted effect.

Climate change mitigation policies are widely perceived to have regressive effects putting a higher financial burden as a proportion of the household income on the poor than on rich households [0]. However, the issue has not impacted much the debate on social policies. The social repercussion of the tax has two effects [0], the first is related to the question of fairness of the burden of climate change mitigation policies, while the second is related to the acceptability of the policies and the likelihood that governments will adopt them. Even if there are several papers that deal with the social impacts generated by climate change mitigation policies, most of them study the impact on

developed countries. This is really strange given that the distributional effects are much more negative in countries where the income gap between rich and poor is bigger, as is the case in several Latin American countries (e.g. Brazil, Chile and Mexico are countries with very high inequality levels). Thus, the aim of the present report is to fill in this gap by studying the distributional effects of carbon taxes in Latin American countries.

In order to study the possible negative distributional effect of taxes, a review of present carbon policies in different countries will be presented to identify those that could have a greater impact on the poorer people and further on, a case study will be developed to show numerically how important the impact could be.

As it will be shown, the social implications of taxing energy products can be important, and further actions should be taken when establishing carbon taxes in order to compensate for the unwanted effects of the carbon tax.

SOCIAL EFFECTS OF DIFFERENT TYPES OF CARBON TAXES

Basically, two different types of methods are used to internalize the climate change externalities of fossil fuels, the most common and widely used is the carbon tax, and lately some countries (like European countries) also applied the cap-and-trade system. As stated by the Centre for Climate and Energy Solutions [**Error! Reference source not found.**], both the tax system and the cap-and-trade system can be used to correct the market failure that exists when the environmental damages are not included in the market price of a fossil fuel, however, cap-and-trade system sets the maximum level of emissions and let the market decide the price, thus, the environmental outcome is known but the resulting price is unknown. Instead, the tax system sets the price and lets the market determine the environmental outcome and thus, the price is known and the environmental impact is unknown. As both methods internalize the higher costs of energy and could pass it to the final consumer, the social or distributional effects are the same, as both could increase the energy prices to the final consumers. There is still, however, some discussion, as the defenders of the cap-and-trade system state that this system will allow for a lower increase in energy prices as the market will reduce GHG emissions where it is cheaper to do so. However, most of the authors suggest that unless accommodations are made [0] the impact of a carbon tax or a cap-and-trade program is likely to disproportionally affect low-income households, which generally spend a higher percentage of their income on energy.

Mitigation efforts can be applied at different levels of the economic activity: up, middle or downstream in the chain of production running from resource extraction to the end user. The advantage of an upstream tax [0], as for example, a tax to the production of fossil fuels, is that it achieves boarder coverage and minimizes the number of authors involved in the scheme, facilitating the administration tasks. A mid-stream tax would be applicable to companies in specific sectors, and a down-stream tax applies to individuals and some businesses. According to some authors [0], there is a general consensus that downstream taxes on home and energy use are regressive (that is, they impose a greater burden on the poor than on the richer) and thus, have unfair distributional effects. The effects of these taxes covering electricity and heating fuels are particularly regressive as home energy use is evenly distributed among different income households, while representing a larger share of their incomes to poorer households in comparison with richer ones. The following graph shows a study performed by Dresner and Ekins [**Error! Reference source not found.**] that estimated the distributional effects of a carbon tax of 0.43 p/kWh for electricity consumption and 0.19 p/kWh for natural gas consumption on UK households. The populations was divided in 10 groups according to their incomes and the decile

1 contains the 10% of households with lower income, and decile 10 the 10% with higher income. As shown in the graph, lower income deciles pay a much higher proportion of their income in the taxes than higher income deciles.

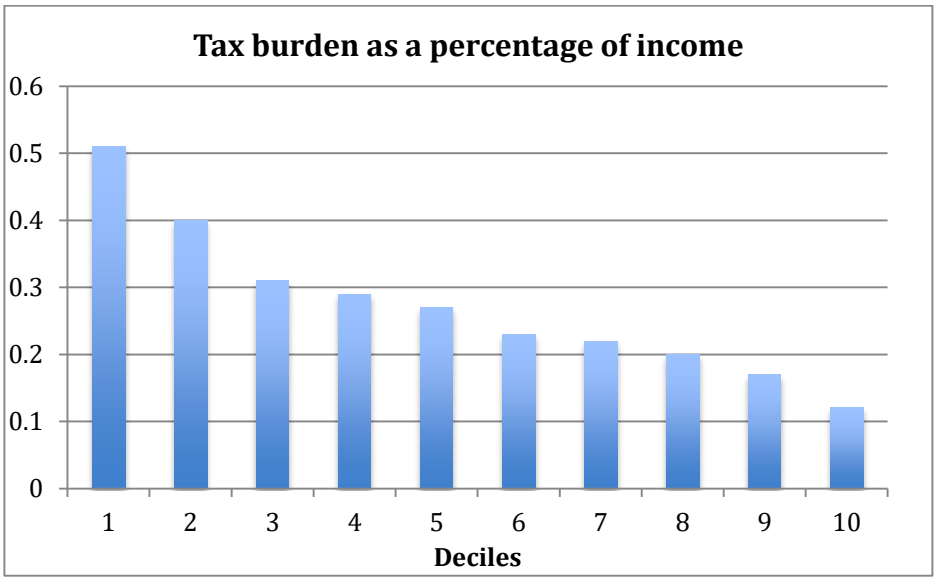

Figure 1. Estimated distributional effect of a carbon tax on home energy use in UK households, based on study by Dresner and Ekins

The social implications of taxes applied higher up in the energy chain can also be quite important if the taxes are transferred to the final energy prices as they will have an impact not only in energy products such as gasoline and natural gas, but also in other basic products such as food (given they require transportation). This situation will also affect lower income households the most as they spend a higher percentage of their income in basic goods. Metcalf and Weisbach [0] performed a study in the United States using data from 2003 that calculated the direct and indirect distributional burden of a 15 US$ carbon tax across different income groups. Direct burden refers to the effect due to fuel consumption and indirect burden refers to higher prices of goods due to the higher energy prices required for their production. The table below shows the average carbon tax burden as a percentage of the annual income and it shows that the indirect burdens created by taxes applied in the higher part of the energy chain can also have important regressive effects, even though they are generally lower than the effect of direct taxes.

Table 1. Effects of carbon tax for different income deciles in the United States according to study by Metcalf and Weisbach

Income Decile	Direct	Indirect	Total
Bottom	2.12	1.60	3.74
Second	1.74	1.31	3.06
Third	1.36	0.99	2.36
Fourth	1.19	0.88	2.06
Fifth	0.97	0.78	1.76
Sixth	0.85	0.68	1.53
Seventh	0.69	0.61	1.30
Eighth	0.61	0.63	1.23
Ninth	0.53	0.49	1.01
Top	0.36	0.45	0.81

Finally, there is a differentiation of the social implications of taxes according to the sector they are applied in. The social implications of taxes applied to energy consumption in households are not the same as those applied to transportation fuels (such as gasoline) or to industrial or commerce energy consumption. Based on the study by Büchs et all [0], the main exception to the general rule of regressivity seems to be when reducing emissions from transportation, even more, it seems that taxes applied on transportation fuels can even be progressive, reducing inequality. This is explained as poorer households generally fly less and are less likely to own their own cars. At the same time, there is evidence that gasoline taxes are regressive among car owners, as low-income households that own a car spend a much higher share of their income on gasoline fuels than high-income households. Also, the effects of the public transportation system shall be also studied, as studies within the United States show regressivity for all transportation fuels taxes, even when considering all the population, given their car dependency.

ALTERNATIVES TO REDUCE THE UNWANTED EFFECTS OF CARBON TAXES

The unwanted distributional effects of carbon taxes can be reduced in several ways. In a report prepared by Metcalf and Weisbach [0] they consider the optimal tax design on greenhouse gases for the United States in order to internalize externalities associated with anthropogenic climate change. In the report [0], they state that "adjustments should be made to the income tax to ensure that a carbon tax is revenue neutral and distributionally neutral". However, they emphatically state that no "exemption should be built into the carbon tax to reduce its regressivity" as "redistributing income through adjustments to a commodity tax is in general less efficient than redistributing through adjustment to direct taxes" such as taxes on income. Thus, their idea is that the distributive effects of a carbon tax should be offset through adjustments to the overall tax system, and the carbon tax should be left untouched to adequately represent the externalities of the fuel use and its impact on climate change. This same recommendation is presented by other authors [0] that recommend tax shifting options that will lessen the burden on low-income households, for example, by raising the threshold exemptions for personal income taxes or introducing lump-sum rebates to target households in order to provide greater relief to the lower income families.

Regarding the use of the money collected through the carbon tax, Metcalf and Weisbach [0] propose several alternatives. The first alternative is to use the revenues from the carbon tax to reduce the income tax for the low-income families in order to maintain the same level of

government revenues. Another alternative is to use the revenues to compensate the undesired effects of the carbon tax, such as loss of working places of fossil fuels workers (eg: carbon labours). Another way of spending the tax revenue is to invest it in government promotion towards a low-carbon economy, such as research funding, funding of abatement technologies (such a carbon capture and storage), or support of energy efficiency measures. Other authors [0] suggest the use of the funds to facilitate adaptation to climate change or to provide transition relief to particular industries or communities with economies highly dependent on fossil fuels.

On the other hand, some authors [0] recommend an alternative approach given that their studies showed that due to the extreme variation in the energy use in low-income households, it is not possible to provide compensation to all of them and thus, they propose a totally different approach based on incentives to reduce energy consumption, as for example, to introduce cost-effective energy efficiency measures. This way, poorer households will be provided with economic support to improve the efficiency of their houses, lowering the fuel consumption and thus, the climate change impact. Instead, higher-income households will be required to implement energy efficiency measures without any subsidy but on their own expense.

DISTRIBUTIONAL EFFECTS OF CARBON TAXES APPLIED IN DIFFERENT COUNTRIES

The following section includes a description of some tax schemes applied in some countries or regions around the world. Based on the discussion from the above section, an analysis is performed to determine whether the applied tax could have regressive effects. Just to have an overview of the tax schemes mostly applied, also European countries will be discussed, however, usually European countries have a very equal distribution of wealth and thus, the regressive effects are not so important. However, it is the purpose of this paper to show the impacts of the taxes in some countries in Latin America in which there is a much wider gap between the rich and poor.

Europe

European Union

In order to reduce carbon dioxide emissions, in 2005, the European Union created the European Union Emissions Trading Scheme (EU ETS) based on a cap-and-trade system very similar to the Kyoto Protocol. The idea is to set a maximum (cap) emissions level to industries, power stations and other energy-intensive installations and the governments will either give for free or in an auction the emissions allowances (during the fist periods there were more free allowances given out, later, however, this was changed to auctioning).

As stated before, the cap-and-trade system is thought to establish a lower price for the ton of carbon reduced than a fixed tax system, as it is the free market the one setting the value of the ton of carbon reduced. However, this system can also be regressive if the companies pass the additional costs to the final consumer affecting the low-income people the most, as they spend a larger share of their income in basic goods that are affected by higher energy prices. However, further studies should be done to perform a conclusive evaluation of the regressivity of the system.

Denmark

Denmark is a leader regarding climate change policies, as since 1990 energy consumption was kept constant while economic growth was at 35% and emissions were reduced by 7.2%. Denmark has also established a goal to reach complete independency from fossil fuel by 2050.

Regarding taxes, in the 1990s the country fixed a number of environmental taxes including taxes on coal, oil, natural gas and electricity [**Error! Reference source not found.**] and also to vehicle fuels. Taxes are fixed as at 31 US$/ton of carbon equivalent [0] and the money collected is used to promote the use of less carbon-intensive fuels (like biodiesel) the use of electric cars and alternative transportation systems.

Given the nature of these taxes, affecting the final consumer on its direct energy consumption, as mentioned before, this can have regressive effects. However, it should be consider that there are a lot of other progressive taxes in place in Denmark that ensures a very equal distribution of richness in the society and thus, the possible regressive effects are probably not so considerable.

On the other hand, regarding the business sector, the Danish government passed a law in 2010 establishing a 10-year energy-saving programme that promotes energy efficiency measures (such as energy management, energy-conscious planning, exploitation of surplus heat, etc.). Regarding industrial emissions, since 1996 the Danish government used two different tools to promote energy efficiency in energy intensive industries: taxes and a voluntary energy agreement. The revenue from the taxes goes to trade and industry. Regarding the voluntary agreement, those companies entering the agreement receive a rebate on the taxes [0].

It is less probable that the costs of the energy efficiency measures in businesses and the voluntary agreements in the industrial sector will be passed to the final consumer and if this is the case, these mitigation measures will not have an adverse effect in the distribution of richness as carbon taxes would have.

Sweden, Norway and Finland

The carbon tax was introduced in Sweden in 1991 and aims at reducing the use of fossil fuels and promote the use of renewable fuels. The tax is set at approx. 168 US$ per ton of carbon equivalent [0] and it covers natural gas, coal, light and heavy fuel oil, liquefied petroleum gas (LPG) and home-heating oil, including energy and transport sectors. Finland originally introduced a carbon tax in 1990, which was later modified. Actually, it covers heat and electricity production, transportation and heating fuels and it is rated at approx. 40 US$/ton of carbon equivalent. As most Scandinavian countries, Norway also has a carbon tax that was implemented on 1991. It taxes fossil fuels and the amount of the tax varies from 4 to 69 US$/ton of carbon equivalent [0].

Thus, most of Nordic countries use carbon taxes. While, as mentioned above, this is considered regressive, it must be considered that these societies have a very equal distribution of wealth, and thus, the regressive effects of these taxes are not really considerable.

Latin American Countries

The only three Latin American countries that have a carbon tax are Costa Rica, Chile and Mexico, which will be discussed in detailed below.

Costa Rica

In 1997 [0] Costa Rica passed a law that taxed all fossil fuels at 3.5% and it also announced its intention to become carbon neutral by 2021. This carbon tax allows for the collection of 21 million dollars per year [0] that is mainly used for the protection of natural forests through the FONAFIFO (Fondo Nacional de Financiamiento Forestal). In this case the tax is designed affecting all fossil fuels, and thus, as mentioned before, the taxes applied on fuels used at homes can have regressive effects. Also, given that the money collected is not used to compensate for the inequalities it generates, the tax has possible regressive effects.

Chile

In 2014, President Bachelet announced a new carbon tax that will affect energy-intensive industries with an installed capacity of 50 MWth (thermic MW) or more, and the final objective of the tax is to reduce GHG emissions and thus, comply with the 20% GHG emission reductions by 2020 [0]. In case it is finally implemented, the way the tax will work is that each industry should pay around 5 US$ for each ton of carbon dioxide equivalent that they emit. This new tax is expected to be implemented by 2018, and the government expects to collect 174 million US$ with the tax [0], 82% of which comes from the use of carbon and 7% from the use of petroleum. The estimated impact of this tax is to achieve a reduction in GHG emissions of 6% by 2020 (representing 3 million tons of CO_2 equivalent) and 11% of total emissions by 2030 (representing 6 million tons of CO_2 equivalent).

The way this tax is designed applied in the mid-stream range of the energy production chain, it could potentially have high regressive effects in case the industries pass the additional costs of the tax to the final consumer. However, further analysis must be performed as, as mentioned before, the effect of indirect taxes can be lower than the effect of direct taxes to final energy users.

Mexico

Since 2014, a new tax is imposed to all fossil fuels in Mexico. The tax fixes a value of approx. 3 US$ per ton of carbon dioxide equivalent, instead of fixing a value per fuel consumption [0]. The money collected with the tax is expected to be around 1000 million US$ per year which will be used to avoid contamination and to mitigate the effects of climate change [0]. There is a very interesting and innovative aspect about this tax scheme, and is that people will have the option of purchasing carbon credits (from CDM or other carbon credit in carbon markets) instead of paying the tax. Thus, people will be allowed to select which kind of mitigation projects they will like to support with their money and purchase those certificates instead of paying the taxes.

Since the tax is applied to the final consumer, the social effects of the tax should be considered regressive for the fuels used at homes, while the distributional impacts of the fuels used for transportation is uncertain and should be evaluated. Given that the money collected from the tax will not be used for mitigating the negative social impacts of the tax, but rather, to mitigate climate change, the net effect of the tax could be regressive.

CASE STUDY: KEROSENE USE IN CHILE

In this section, a special case will be numerically studied in order to verify the hypothesis proposed so far, that carbon taxes could have regressive effects.

The tax established for kerosene in Chile will be studied. It must be mentioned that the kerosene tax was implemented to raise the revenue of the government, and not to reduce the effects of climate change, thus in theory it was not designed as a carbon tax. However, as the effects are the same independently of the reason why the tax was created, it is a good example to show the social effects of carbon taxes.

Kerosene is a fossil fuel used in Chile for heating purposes in households and it is taxed at 16% of its final value. According to the statistics provided by the Chilean national statistics institute INE [**Error! Reference source not found.**], the people with lower income levels spend a greater percentage of their total expenses in kerosene than people with higher incomes. This is represented in the following graph, which shows the percentage a household spends in kerosene with respect to the total expenses of the household. This was done separating the population in five groups according to the income level of the households, the 1st quintile representing the poorest 20% of the population, and the 5th quintile, the 20% richer (the quintiles were defined using the total income of the household, independently of the number of people living in the household).

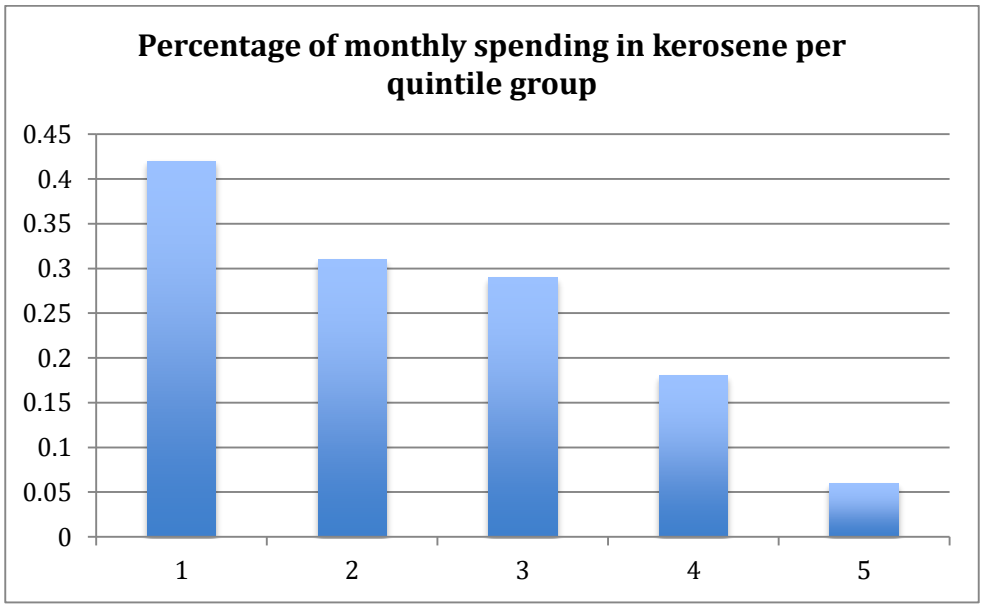

Figure 2. Percentage of monthly spending in kerosene per quintile group graph prepared based on data from INE (2007)

From the above graph, it is clear that lower-income families (lower quintiles) spend a greater amount of their expenses in heating their homes than higher-income families (higher quintiles). Considering that kerosene has a tax of 16% of the total final price of the kerosene, it is therefore clear that people from lower quintiles spend a greater percentage of their expenses in the kerosene tax than people from higher quintiles. Thus, it can be demonstrated that poorer households bear a greater burden of the tax than richer households, at least in comparison with their total expenses.

Further on, considering the net expense paid on the kerosene tax per quintile, it can also be demonstrated that even in this way there is an unfair distribution of the tax. As shown in the

following graph, the middle-class households use more kerosene and thus, pay more tax than richer ones, even considering the net payment and not as a percentage of income.

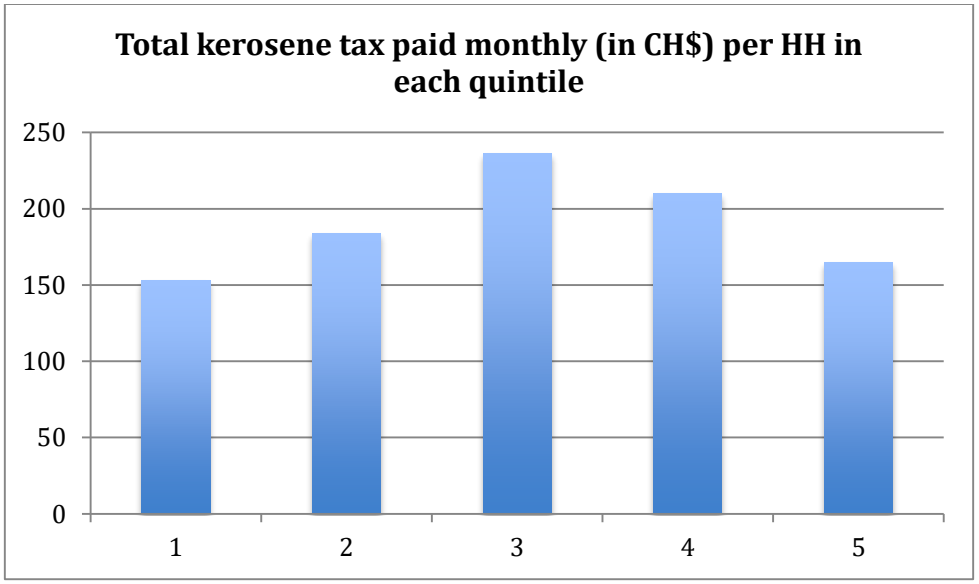

Figure 2. Total expense in kerosene tax per quintile group graph prepared based on data from INE (2007)

CONCLUSION

From the literature review and case study analysed in Chile, it is quite clear that carbon taxes could have regressive effects. It is therefore recommended that, before applying a carbon tax, further studies should be done to determine whether it could have negative distributional effects and in those cases, compensatory measures should be taken to reduce them, mostly in those societies that already have a very unequal distribution of wealth.

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"Decentralized Approach (or) Participatory Approach to Development Projects"
Based on Success Story of Pilot Project on Capacity Building and Empowerment of Women Self-Help Groups Through Micro-Credit and Social Mobilization

Ms. Mi Mi Maw (B.Ag, M.Sc -ARTES, Germany)
Country Project Director, Myanmar
e-mail: mimimaw06@gmail.com

ABSTRACT

The objective of this paper is to examine the project status and to assess the impact of decentralization in the project villages. The methodology was implemented with the decentralized approach active participation of villagers. According to this approach, the project started in 1999 is still going strong.

On the basis of the findings and experience it was a success story, the decentralized approach is strongly advised in any development projects to achieve the desired goals and for sustainability. ARTES, SESAM and EEM Alumni are advised to consider and to conduct the projects relating to energy supplies for rural people by using this approach.

KEYWORDS

Decentralized Approach (or) Participatory Approach to Development Projects

INTRODUCTION

Myanmar has a total area of 676,577.km. Geographically, Myanmar shares borders with Bangladesh, India, China, Laos and Thailand. The total population of Myanmar stood at 50 million in 2014. More than 75 per cent of the people in Myanmar live in rural areas and earn their livelihood from agriculture and allied activities. Myanmar consists of 14 states and divisions, 66 districts, 325 townships and more than 60,000 villages. The average family size is 5.2 people.

In Myanmar, like other developing countries, there is poverty especially in remote and border areas. The looming large poverty circle reflects the inability of a large number of people to meet their basic needs. According to the World Bank analysis, the poverty estimate for rural Myanmar is 22.4 per cent while for urban Myanmar is 23.9 per cent.

The objective of this paper is to examine the status of decentralization in the project villages and to assess the impact of decentralization on rural development and poverty alleviation. The highly decentralized planning approach to development projects was introduced by most of the international organizations such as International Development Enterprise (IDE), Japan International Cooperation Agency (JICA) and German Agro Action (GAA).

On the basis of the findings of the pilot project experience, it is suggested that the decentralized approach is the best practice to apply in any development projects for achieving desired goals and sustainability. These experiences may be suggested to ARTES/ SESAM and EEM Alumni for further improving the format to suit the country situation. The approach, form and content vary because of differences in the country's history, administration, social system, cultural values,

economic and the political situation. This approach will be contributing academically in conducting any projects or programs. It has led policy makers and development practitioners to emphasize on the need for proper evaluation of the decentralization method in order to gain knowledge on the best practices that could be shared with others.

As for Myanmar, about 40 per cent of villages out of more than 60,000 still lack electricity which directly influences the basic needs and quality of life. It is essential for the development strategy of Myanmar to recognize that the sustainable energy supply, particularly in renewable energy supply, results in the improvement in the living standards and quality of life of rural people. Therefore, ARTES, SESAM and EEM Alumni are advised to consider conducting the energy supply projects.

Decentralized approach itself can't remove poverty. The government institutions and related agencies along with properly designed planning structures are essential prerequisites for development projects to succeed. The best and innovative practices in decentralization will also be incorporated to enhance the impact of effective decentralization policies.

PROJECT IMPLEMENTATION

Background history

The Pilot Project on Capacity Building and Empowerment of Women Self-Help Groups through Micro-Credit and Social Mobilization has been implemented in two villages in Myanmar since July 1999 with the time frame of 3 years. It was funded by the Government of Japan through CIRDAP (Centre on Integrated Rural Development for Asia and the Pacific) situated in Bangladesh. Myanmar is one of the fourteen member countries of CIRDAP. Department of Agricultural Planning (DAP) is a line department and the Ministry of Agriculture and Irrigation (MOAI) is the contact ministry for CIRDAP. Department of Agricultural Planning (DAP) received this pilot project.

Mechanisms of people's participation at grass-root level in decision making processes play important roles for success and sustainability in development efforts. The Decentralization approach was initiated and introduced in conducting the project. Due to the success effect of this project, the regional office of UNESCO (United Nations Educational Scientific and Culture Organization) Bangkok, Thailand provided financial assistance to replicate the project. With this project fund the same type of the project has been replicated at another village nearby. That is why it has been implementing in three villages in parallel. The project started from 1999/2000 is still running effectively and efficiently. Most data described in this paper are represented for three villages.

Objectives of the project

The overall goal of the project is to improve the quality of life of the women in project village. The objectives are to promote women self help groups under social mobilization process, to provide access to credit and mobilize savings, to provide portfolios of opportunities to generate additional income and to provide women groups access to basic social services. Baseline Survey data was collected before initiating the project activities to compare with the situation after the projects intervention.

Project cycle management (PCM) workshop

As part of the decentralized approach to rural development methodology which focuses on people's participation in the process of planning, implementation and evaluation of the project, a two-day Project Cycle Management Workshop (PCM) was conducted in all three villages. This pilot project seeks to encourage the SHGs to take charge of the development process that affect their lives.

The objectives of the PCM workshops were to introduce the pilot project to villagers; to discuss the problems faced by the villagers; to identify the needs of the villagers by way of brain storming and participatory analysis; to formulate the Project Design Matrix (PDM) and Plan of Operation (POP) and to motivate people to participate in the process of planning, implementation and evaluation of the project.

The workshop was successfully organized and received good feedback from the participants in terms of its usefulness in planning and implementing their respective projects. As a result, Problem Tree, Objective Tree, Project Design matrix (PDM) and Plan of Operation (POP) were emerged. This POP and PDM were utilized as an instrument and guideline for project implementation. Sample of problem tree, objective tree, plan of operation and project design matrix for one village are shown in the appendix.

Photo 1.Project cycle management workshop (PCM) in a session

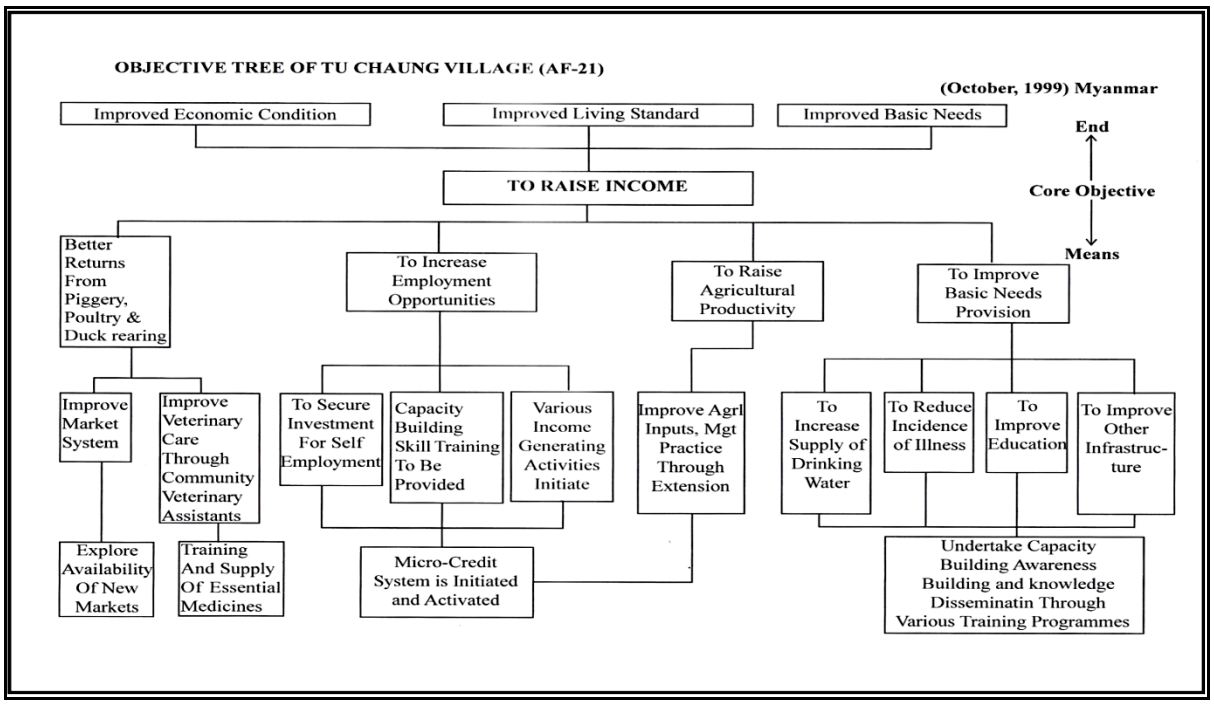

Figure 1.Objective tree of one village (Sample)

Project Activities

The major project activities are disbursement of micro-credit and saving mobilization, community development activities, capacity building programs and social welfare activities. The poorest and poor households are given priority to select the project beneficiaries. After the selection of target beneficiaries, they themselves formed Self-help Groups (SHGs) with five members in each group.

A Project Steering Committee (PSC) and Project Implementation Committee (PIC) were formed with the members of state and local governments to supervise and monitor the project. All issues to be submitted to the PSC were discussed by the SHGs and villagers together with PIC members at village level.

Organization of women and Loan disbursement . The SHG members are mostly from poorest and poor households who have no cultivable land. In total 23 SHGs of 115 members and 64 SHGs of 320 members were formed in 2000 and 2015 respectively. Loans from revolving funds for Income Generating Activities (IGAs) were disbursed to the SHGs members. Compulsory saving for capital formation is also motivated. The first loan size varied from K 15,000 to K 35,000 in 2000. The loan size always increases year after year, ranging from 15,000 K to more than 100,000 K. Total beneficiaries and loans in the 5 year interval can be seen clearly in the following table 1.

Table 1.Total beneficiaries and loan

Year	Total Beneficiaries	Total Loan (million kyat)
2000	115	3.28
2005	216	13.21
2010	291	30.86
2015	320	45.00

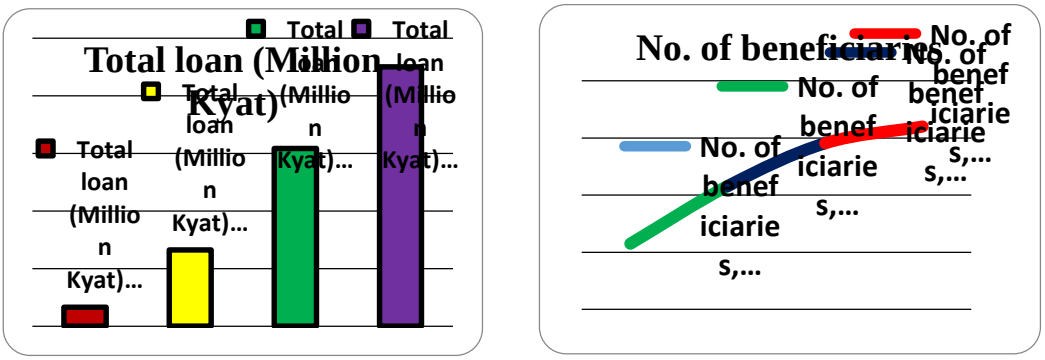

Figure 1.Total loan (million kyat) and total beneficiaries

All loan term are one year with the monthly interest of 2 per cent. The interest collected is used for revolving funds. Most preferred IGAs are small trading, grocery shops, bicycle workshops, cattle rearing, bamboo handicrafts, rice production, tailoring, agricultural and stock rearing, and transportation services.

Training under the capacity building program . Capacity building is of great importance in poverty alleviation programs. To enhance the skill of group members as well as to orient them on some issues of rural development the project organized some training courses and field visits. Capacity building is like building a structure which needed support at the beginning.

During the project period the following workshops and training courses were conducted. Leadership and book keeping, basic farming practices, basic health awareness and tailoring training were facilitated. All training courses were organized with the assistance from concerned departments. Keeping in view the capacity building program, the Agri-Business weekly news journals were supplied to the beneficiaries.

Table 2.Various training programs under capacity building

Sr.No	Training courses	Trainee
1.	Participatory project cycle management workshops (PCM)	50
2.	Leadership& book keeping training	52
3.	Health awareness workshops	200
4.	Basic animal care training	200
5.	Participatory monitoring and evaluation workshops (PME)	200
6.	Tailoring training	37
7.	Participatory village mapping and poverty assessment workshops	200
8.	Basic agriculture training	195
9.	Mushroom cultivation training	195
10.	Study tour	100

Photo 2.Various training in progress

Participatory monitoring and evaluation (PME) workshop. Participatory Monitoring and Evaluation (PME) workshops were organized with technical support from CIRDAP after 6 months of the project period. It is aiming at ensuring the materialization of the projects motivation. The purpose of this workshop is to develop a monitoring and evaluation system for the project with the participation of the project beneficiaries as well as other community members. In this important workshop a PME tool kit was developed to use as a guideline for project beneficiaries.

PME tool kit (monitoring chart) with 14 indicators was framed by the project team with the villagers. Some indicators were conducting group meetings, attendance of members in the group meeting, small saving, loans received, participation in decision making, use of loans, repayment of loans, maintenance of accounts and group contribution to the village welfare fund and so on. Through time, projects will be able to be monitored with the impacts of the program, thus determining whether the situation is improving, worsening, or staying the same. Through this workshop, a community based project monitoring system has emerged that is low cost, easy to sustain. It can be used to monitor problems or difficulties faced by the SHGs so that appropriate measures can be taken up by relevant project staff and the groups themselves.

Social mapping for PME

Photo 3.Participatory monitoring and evaluation workshop (PME) in progress

Community development activities: Development interventions depend on what the information from the monitoring system express about local problems and needs. In the case of community development activities, the followings were carried out by people's participation and linkages with the local administrative organizations, government service agencies and local NGOs.

Based on the beneficiaries' desire, the PSC had decided on the payment of an additional 6 per cent interest on saving mobilization by the villagers and contributions of 25 per cent interest earned from the revolving fund to the community development activities. Some amount of the project fund was also sanctioned for community development works which are directly effecting rural living standards. Community development works such as construction of school building, improving village roads, building drinking water facilities, sanitation facilities and electrification of the village were carried out what the individual village needs. Construction, renovation and necessary work done in each village can be clearly observed in the table 3 below.

Table 3.Community Development Activities

Tuchaung Village	Yintaikkwin Village	Kungyankon Village
-Reconstruction of a primary school	-Reconstruction of a primary school	-Flooring and roofing of the existing primary school (2004)
-40 Nos of fly- proofing latrines	- Road lighting facilities	-Gravel road construction (2500ft x 4ft) (2005)
-4 Nos of improved drinking water pond	- Flooring and partition of the primary school (2004)	-Gravel road construction (3500ft x 4ft) (2007)
-Small road construction leading to primary school	- Construction of a brick wall of an existing school building (40ft x 20ft x 10ft) (2008)	

- Flooring of a primary school		
- Reconstruction of a small bridge		
-Purchase of a small land and construction of a community hall		
-Expansion of a drinking water pond		

Photo 4.School building before demolishing and after construction (Yintaikkwin village)

Photo 5.School building before demolishing and after construction (Tuchaung village)

Social Welfare Activities : All SHGs members believed the additional funds would be good for social welfare. They decided to contribute some amount of interest to the village welfare fund. The monthly aids from the village welfare fund were provided to the Old, Disables and Poor school children. As a nutrition promotion program all school children at all primary schools in the project villages were fed with boiled rice at frequent intervals. Vitamins or micro-nutrient supplements were also provided to all pregnant women. Social welfare activities conducted in the project period can be observed in the table 4 below.

Table 4.Social Welfare Activities

Particular	Population	Monthly assistance
The old	56	1000 K/person

The disabled	20	1000 K/person
Poor school children	50	1000 K/person
Supplementation of vitamins or micro-nutrients to pregnant women	all	60 pills/person
Feeding school children	all	weekly


Photo 6.Social welfare activities

ACHIEVEMENT OF PROJECT OBJECTIVES

Monthly, quarterly reports and observations were combined into an annual estimate. Annual records, discussions with the beneficiaries and through observation can give a clear overview of the project. This comparison is always relevant and important. Comparisons of current to previous performances are applicable to all programs. The following table 5 shows the achievements of the project objectives.

Table 5.Self-help group formation

Particulars	Before the project (1999)	After the project (2015)
Number of SHGs formed	Nil	64 SHGs
Number of members enrolled	320 unorganized women from poor households	now organized

Table 6.Provision of credit and saving mobilization

Particulars	Before the project (1999)	After the project (2003) (End survey was carried out in 2003.)
Mobilized saving amount	Nil	257 poor women could save K 1116800 with per capita savings of K 7000.
Revolving funds received	Nil	257 beneficiaries received K 5,184,520. Per capita revolving fund K 36,000
Dependence on credit from moneylenders	Continued	Reduced to the extent of 70 per cent

Use of revolving funds	Nil	grocery shops, pig raising, small trade, trishaws, poultry farming , cattle rearing, tailoring, bamboo handicrafts, rice production, vegetable gardening, battery charging and maintainance

Table 7.Additional income from various IGAs

Additional net income from revolving funds	Before the project (1999)	After the project (2003)
- grocery shops	- K 900 per day	- K 1200 / day
- trishaws	- Nil	- K 500 / day
- Battery charging	- Nil	- K 30,000 / monthly
-small trading	- K 7000 / month	- K 10,000 / monthly
-paddy cultivation	- K 10000 / season/ac	- K 15,000 / season / ac
-cattle rearing	- Nil	- K 300,00 / season (3 months)
-tailoring	- Nil	- K 400 / day
-Pig rearing(one pig)	- Nil	- K 35,000 / year
-Use of additional income	- Nil	- School expenses, house repairs, food and health

PROJECT IMPACT

To evaluate the progress and effectiveness of welfare-focused decentralized interventions, an end of survey was conducted after 3 years of the project period. Data was collected from the beneficiaries only. Whenever loans were released from time to time, the beneficiaries were interviewed using semi-structured questionnaires, informal interviews and other participatory tools in a timely way. The most recent data on outcome achieved by each beneficiary can be collected and compared. It can be used to assess their performance. The data in Table 8 indicates that the comparison before and after the project intervention articulates the outcome of the project.

Table 8.Comparison before and after project implementation
(Data collected base on beneficiaries' household)

Particular	Before the Project (1999)	After the Project (2003)
Households (HH) having cattle	Nil	22%
HH having a trishaw	Nil	8%

HH having cultivable land	Nil	11%
HH having a T.V	Nil	2.19%
HH bought a bicycle	Nil	16%
HH bought home appliances	Nil	23.4%
HH bought cassette	Nil	8.8%
HH bought homestead land	Nil	8%
HH bought a piece of gold	Nil	14%
House repairs	Nil	33.6%
HH converted bamboo floor into wood floor	Nil	20.4%
HH converted thatched into corrugated iron sheet	Nil	8%
HH installed tube well and hand pump	Nil	1.46%
HH built a small shop	Nil	3.65%
HH with a private house	90%	93.65%

SUSTAINABILITY

Since this project is highly beneficial to the rural and poor in Myanmar, the PSC handed over the project to the PIC and to village organizations for sustainability. Within the project period from 1999 to 2005, the project was operated by project director and self-help groups. From 2005 to 2013, it was run by self-help groups with the help of a project implementation committee. It is now run by self-help groups with less assistance from project implementation committee.

- 1999-2002 (run by Country Project Director with CIRDAP project funds)
- 2002-2005 (run by Country Project Director with DAP fund for administration cost)
- 2005- 2013 (run by Project Implementation Committee with revolving funds)
- Today (run by SHGs with less assistance from PIC)

CONCLUSION AND RECOMMENDATIONS

According to this approach, the project started in 1999 is still going on very well and the achievements of the desired goals can be seen clearly. Therefore, it is fully recommended that the decentralized approach is effective for all developing projects.

Local people realize their situation, environment, limitations, natural resources, problems and difficulties, advantages and disadvantages more than outsiders. It is important that project planners and policy makers take into account the interests of the target beneficiaries. The best and most appropriate approach in a totally transparent way is essential for sustainability.

NOMENCLATURE

Agri	Agriculture
ARTES	Appropriate Technology and Extension Skill
CIRDAP	Centre on Integrated Rural Development for Asia and the Pacific
DAP	Department of Agricultural Planning

EEM	Energy and Environmental Management
GAA	German Agro Action
IDE	International Development Enterprise
IGA	Income Generation Activities
JICA	Japan International Cooperation Agency
MOAI	Ministry of Agriculture and Irrigation
NGO	Non-Government Organization
PCM	Project Cycle Management
PDM	Project Design Matrix
PIC	Project Implementation Committee
POP	Plan of Operation
PSC	Project Steering Committee
SESAM	Sustainable Energy System and Management
SHG	Self-help Group
UNESCO	United Nations Educational Scientific and Culture Organization

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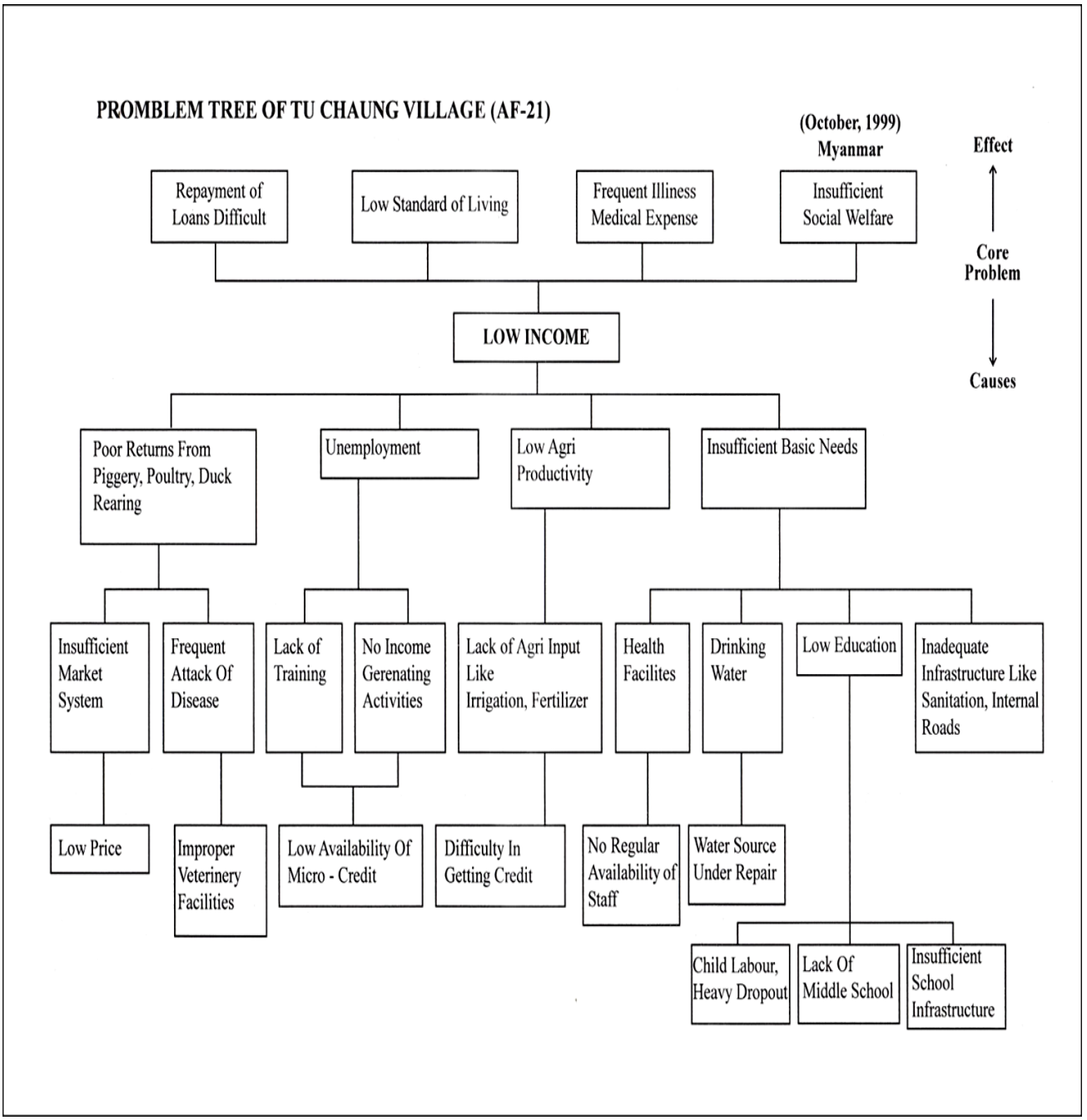
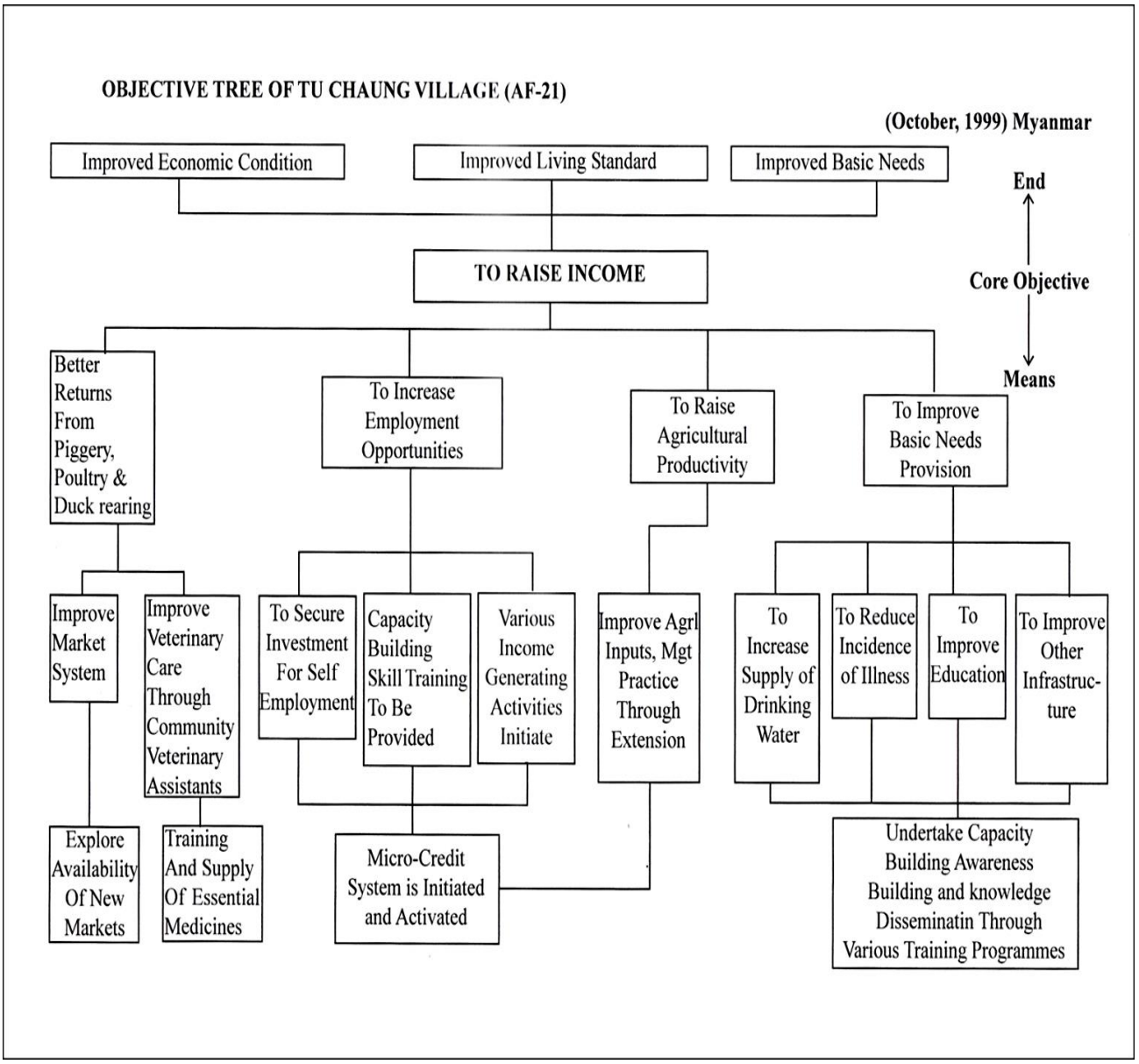

PROMBLEM TREE OF TU CHAUNG VILLAGE (AF-21)
(October, 1999)
Myanmar
Effect
Repayment of Loans Difficult
Low Standard of Living
Frequent Illiness Medical Expense
Insufficient Social Welfare
Core Problem
LOW INCOME
Causes
Poor Returns From Piggery, Poultry, Duck Rearing
Unemployment
Low Agri Productivity
Insufficient Basic Needs
Insufficient Market System
Frequent Attack Of Disease
Lack of Training
No Income Gerenating Activities
Lack of Agri Input Like Irrigation, Fertilizer
Health Facilites
Drinking Water
Low Education
Inadequate Infrastructure Like Sanitation, Internal Roads
Low Price
Improper Veterinery Facilities
Low Availability Of Micro - Credit
Difficulty In Getting Credit
No Regular Availability of Staff
Water Source Under Repair
Child Labour, Heavy Dropout
Lack Of Middle School
Insufficient School Infrastructure


OBJECTIVE TREE OF TU CHAUNG VILLAGE (AF-21)
(October, 1999) Myanmar
Improved Economic Condition
Improved Living Standard
Improved Basic Needs
End
TO RAISE INCOME
Core Objective
Means
Better Returns From Piggery, Poultry & Duck rearing
To Increase Employment Opportunities
To Raise Agricultural Productivity
To Improve Basic Needs Provision
Improve Market System
Improve Veterinary Care Through Community Veterinary Assistants
To Secure Investment For Self Employment
Capacity Building Skill Training To Be Provided
Various Income Generating Activities Initiate
Improve Agrl Inputs, Mgt Practice Through Extension
To Increase Supply of Drinking Water
To Reduce Incidence of Illness
To Improve Education
To Improve Other Infrastruc-ture
Explore Availability Of New Markets
Training And Supply Of Essential Medicines
Micro-Credit System is Initiated and Activated
Undertake Capacity Building Awareness Building and knowledge Disseminatin Through Various Training Programmes

Project Design Matrix of Tu Chaung Village (AF-21)
Myanmar (October, 1999)

	Narrative Summary	Verifiable Indicator	Means of Verification	Important Assumptions
Overall Goal	To improve the quality of life of the women in the Village	-Increase the household income (by 60% Of thebaseline) - Increase employment by (30-40% of the baseline) - Increase saving (by 30% of the baseline) - 95% coverage of safe drinking water - Reduce incidence of illness by 60% of the baseline - Reduce dropout level from 64% to15% of the baseline	- Baseline and End survey - Baseline and End survey - Interview with villagers. - Baseline and End survey - Baseline and End survey - Baseline and End survey - Baseline and End survey - School Attendance Register. - Interview with teachers & parents	- Villagers will actively participate & support activities. - Local government official will cooperate and support the project activities.
Objectives	1.To provide opportunities to generate additional income through better returns from Piggery, Poultry& Duck rearing	1.1 Increase income by 60% of the base line 1.2 Increase 25% yield of the animal husbandry of baseline yield.	1.1.1 Baseline &End Survey 1.2.1 Baseline &End Survey and Interview with the beneficiaries.	- No natural disaster will take place during that period. - No adverse consequences will take place during project period.
	2. To increase employment opportunities by providing micro credit to women self-help groups	2.1 Increase self employment by 40% of the baseline 2.2 Increase income by 60% through various income generating activities	2.1 Baseline &End Survey 2.2.1 Baseline &End Survey 2.2.2 Interview with the beneficiaries.	
	3. To raise agricultural productivities.	3.1 Improve supply agricultural inputs by 25-30% of the baseline	3.1 Baseline &End Survey	
	4. To improve basic needs provision.	4.1 Increase coverage of safe drinking water by 95% of the baseline 4.2 Reduce incidence of illness by 60% of the baseline. 4.3 Reduce the dropouts level from 64 % to 15% of the baseline	4.1.1Interview with the beneficiaries. 4.1.2 Baseline &End Survey 4.2.1 Interview with the villagers. 4.2.2 .Baseline &End Survey 4.3.1 Baseline &End Survey 4.3.2 School record 4.3.3 Interview with the teachers & parents	

Output	1.Strengtheringof existing and creation of more animal husbandry schemes	1.1 Number of people to whom animal husbandry scheme is sanctioned 1.2 Number & amount of credit provided for this sector 1.3 Number of person trained veterinary care 1.4 Amount, type & the number of family covered by supply of essential medicine 1.5 Number & type of market linkage established	- Baseline report - Monitoring information system - Report from training institute.	
	2. Create self-employment opportunities	2.1 Number of person trained for selfe mployment 2.2 Number & amount of credit provided 2.3 Number & value of product sold. 2.4 Number & type of market linkage established	- Baseline report - Monitoring information system - Report from training institute.	
	3. Enhance agricultural productivities	3.1 Number & amount of credit provided. 3.2 Number of farmers trained. 3.3 Number & type of inputs supplied 3.4 Number of people obtained transfer of technology. 3.5 Change income by farm size & crop type.	- Baseline report - Monitoring information system - Report from training institute.	
	4. Increase coverage of basic needs	4.1 Number of drinking water sources renovated, 4.2 Number of household covered by safe drinking water. 4.3 Create of new source for drinking water 4.4 Health officials will be persuaded to visit the village frequently. 4.5 Awareness building on the importance of retaining children in the school 4.6 Improve school facilities.	- Baseline report - Monitoring information system - Report from training institute.	

Input	Activities 1.1 Training for Animal Husbandry 1.2 Credit 1.3 Marketing linkages 1.4 Supply of essential medicine forward animal husbandry 2.1 Training for improvement of skill. 2.2 Credit 2.3 Marketing linkages 3.1 Credit 3.2 Training for improvement of skill 3.3 Supply of inputs for agri-productivities. 4.1 Renovation of drinking water sources. 4.2 Creation of new source of drinking water 4.3 Arrange & visit health officials 4.4 Capacity building & bareness building programmers for the villagers on importance of basic needs. 4.5 Renovation of school building.	Physical Input/Budget - Budget as sanctioned - Project will endeavour to rotate if financial is resources I try to converge with the programme of other departments *I* organization.		

ENERGY EFFICIENCY IN BUILDINGS – A CASE STUDY FOR NATURALLY

VENTILATED BUILDINGS IN THE WARM-HUMID TROPICAL ZONE IN SOUTH INDIA

Mona Doctor-Pingel

Architect-Auroville mona@auroville.org.in

1. ABSTRACT

India is an emerging giant with a growing population, an expanding economy, and a quest for an improved quality of life. India"s building energy use accounts for 33% of the nation"s energy use, and this is growing by 8% annually (Climate Works, 2010).

India has a rich tradition of passive architectural design practice. There has been, however, little effort to study these design strategies to evaluate their effectiveness. This paper will present the scientific work being carried out since two years under The U.S.-India Joint Center for Building Energy Research and Development (CBERD). It will present detailed analysis of different passive strategies employed to create sustainable low energy buildings in terms of construction and maintenance, using locally available craftsmen and materials.

These studies represent a strong case for constructing sustainable buildings which could address the energy crisis in many countries.

2. KEYWORDS

Naturally ventilated buildings, Innovative technologies, low energy buildings, analysis and data logging.

3. INTRODUCTION

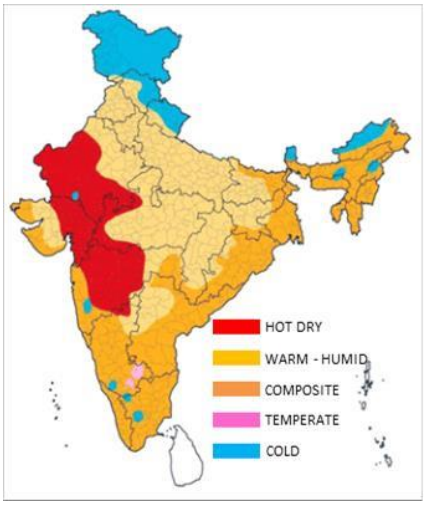


Figure 1. Climatic zones of India
Source: National Building Code 2005

India lies in the northern hemisphere, between 6° 44' and 35° 30' North latitude and 68° 7' and 97° 25' East longitude. Climatically India can be divided into 5 main climate zones- Hot Dry, Warm Humid, Composite, Temperate and Cold (Figure 1)

It is well known that passive building design can reduce energy consumption by reducing or eliminating the need of an HVAC (Heating Ventilation Air Conditioning) system. For low- or net-zero energy buildings in tropical climate, passive strategies, which essentially consist to reduce the solar heat gain and to promote natural ventilation, help to reduce the operational energy consumption and the peak demand.

This design approach is the first critical first step before consideration of efficient mechanical equipment or integration renewable sources of energy. As such, passive design can pave the path for low-carbon development, where buildings use favorable outdoor conditions to provide comfortable interiors. But there is still surprisingly little well established scientific quantitative data about how various passive strategies are performing as intended in diverse climate conditions.

3.1 Background

Lawrence Berkeley National Laboratory United States and CEPT University India have jointly proposed the United States–India Joint Centre for Building Energy Research and Development (CBERD). The main focus of CBERD is to conduct collaborative research that results in measurable and significant reduction in energy consumption in buildings for both nations. The primary objective of one of the subtask is to scientifically evaluate passive design strategies which have been already deployed in Auroville/Pondicherry area.

3.2 Auroville context

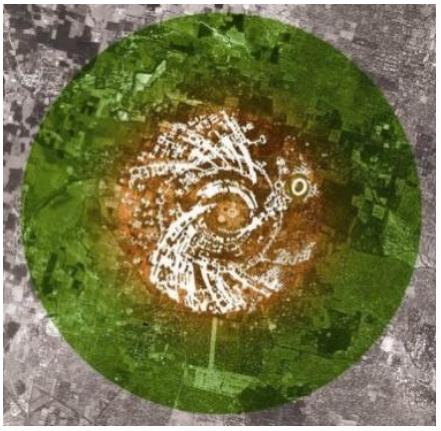


Figure 2. Auroville proposed master plan

Figure 3. Auroville existing master plan

Over the past 50 odd years since its inception, Auroville has produced several indigenous and experimental solutions to the warm humid coastal climate. Naturally ventilated buildings have been the preferred typology in Auroville out of necessity in the beginning due to the many power cuts. Many architects and designers from different countries have made successful innovative attempts at designing energy efficient buildings using intuition- based design process and decision-making methods. However, hardly any detailed scientific data exists on the performance evaluation of these buildings.

Fact File: Auroville lies in warm and humid climatic zone of India – 12 °N latitude

- Summers (March – May) temperatures range from 28°C to 41°C.
- Sea breeze provides reprieve from the heat at late evening and early morning
- Annual average rainfall is 1,200 mm
- North East monsoon (October-December) about 60% of the annual rainfall
- South-West monsoon (June -September) - about 20% of the annual rainfall

- High relative humidity in the atmosphere causes thermal discomfort as there is less evaporation, resulting in sweating. Relative humidity varies from 60% to 90% throughout the year and wind velocity varies from 1m/s to 8m/s (AV weather station data)

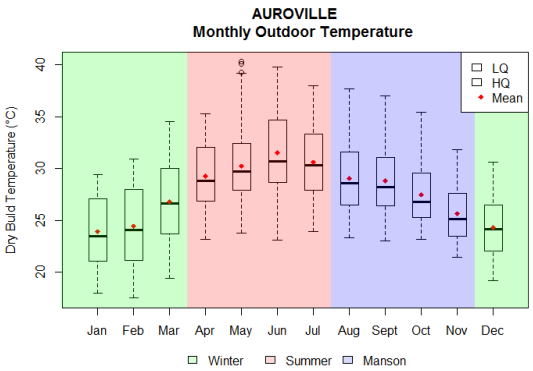


Figure 3, Average monthly temperature range

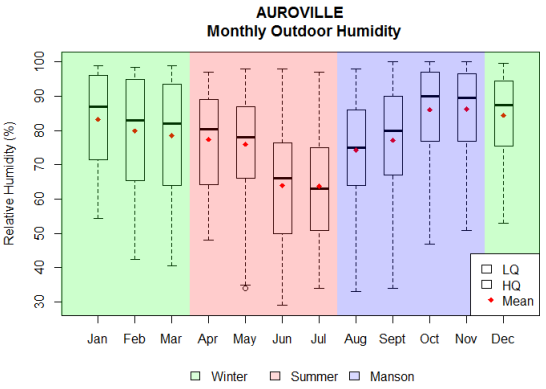


Figure 4, Relative Humidity distribution

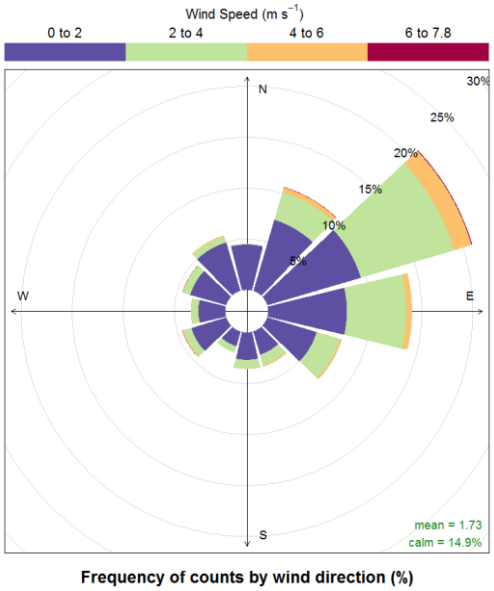


Figure 5, Wind velocity range (Winter)

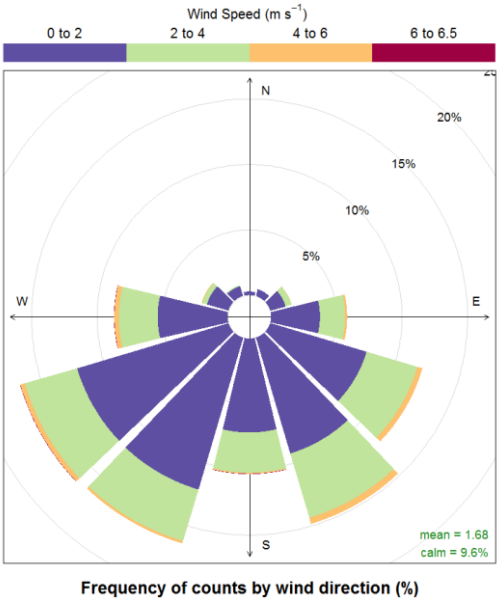


Figure 6, Wind velocity range (Summer)

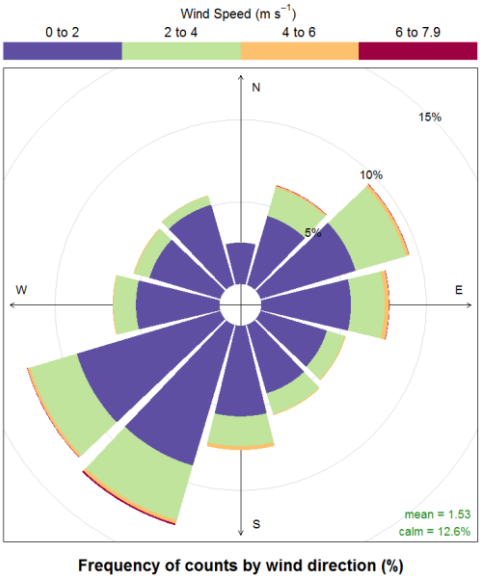


Figure 7, Wind velocity range (Monsoon)

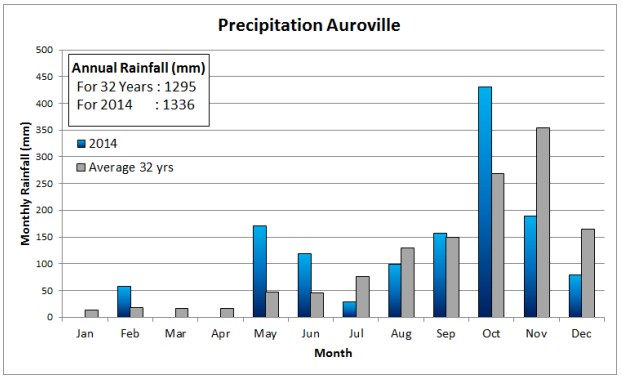


Figure 8, Monthly precipitation, AWS - Automatic Weather Station, Auroville 2013-2014

4. RESEARCH OBJECTIVES

- Under CBERD Task the objective is to monitor, collect exhaustive data (minimum 1 year, hourly data logging) and determine the performance for each of the selected seven buildings with different passive strategies.
- To develop measurement protocols for Indian conditions. In particular taking into account the challenges faced in taking the data in occupied buildings for logger and hand held and logger measurements.
- To gather quantifiable data which can be later used for analysis of individual strategies and lead to prototype in-situ experiments and simulation models for the same.
- Training of architects and engineers for this task so that a widespread interest and work force can be made available for future research works.
- To find through the data collected a conclusion that is useful for designers to practice passive designs. Improving the design and performance of mentioned passive features for this climatic zone.
- To make significant energy savings by driving development of cost-effective technologies and their implementation across buildings.

5. METHODOLOGY

After detailed feasibility and documentation, following methodology of work was chosen.
In total seven buildings were selected from the list of 25 based on the different passive strategies employed. Two buildings were selected for a whole building monitoring and five buildings for the monitoring of a specific strategy. A market survey was done and the most appropriate loggers / sensors were identified and procured from abroad.

Type of loggers used: [HOBO]

	ONSET loggers	
	U12-012	temp, RH,Lux
	U12-013	temp, RH,
	U12-006	4 channels
	UX100-011	temp, RH,
	UX90-001	state logger

Figure 09. Logger information

	ONSET sensors	
	TMC6-HE 6' (6 ft)	surf temp sensors thermistors
	T-DCI-F900-L-O	air-velocity sensor thermistors

Figure 10. Sensor information

Table 2, Full buildings under study

Title/type	Strategies incorporated
1. Golconde (collective residential G+4)	orientation, insulation, shading, cross ventilation, micro climate (landscape), double roof (ventilated roof), shading - overhangs and passages

2. Blessing house (individual residence)	composite wall section, thermal mass, night time cooling, roof and wall insulation, shading and overhangs, cool roof, orientation

Table 3, Buildings for individual strategies under study

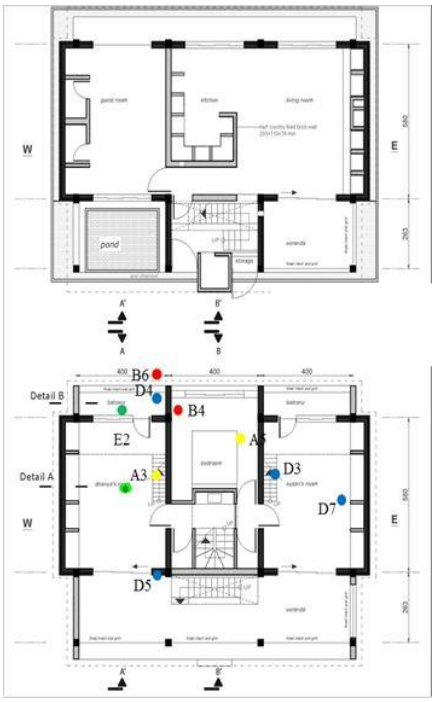
Title/type	Strategies incorporated
3. Mukuduvidu (residence/office)	stack effect in the dome, thermal mass with lime mortar and reflective broken china mosaic on vaults and domes, wind exhaust for domes
4. Afsanah Guest house (light commercial)	orientation, shading, double tile roof (insulation), cross ventilation, micro climate (ponds, landscape)
5. Luminosity apartments (collective residential G+2)	shaded roof (light weight roof – double roof), orientation, cross ventilation
6. Intach office building	thermal mass with lime mortar and plaster, courtyard with passages around. (an example of traditional Tamil typology)
7. Solar kitchen (public collective dining and kitchen)	solar chimney

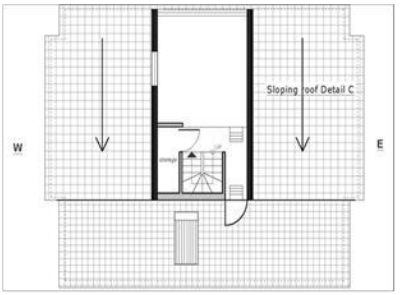
For the purpose of this paper we have selected four buildings.

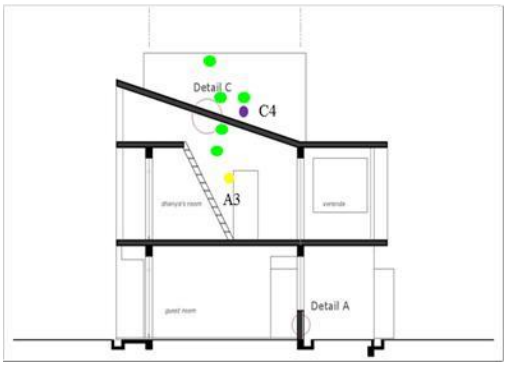
5.1 Full building under study

- **BLESSING HOUSE** (July 2013 - Nov 2014)

Strategies: Composite wall section and Night Flushing
Materials: Compressed earth blocks and Aerated Cement Concrete block (ACC), hurdi terracotta blocks, white ceramic tiles for the roof top.
Loggers: 11 loggers, 4 surface temp sensors
Description: Blessing house is situated within Verite Community in the industrial zone of the International City of Auroville. It has been built and designed by the owner himself in 2005 (with some help from the contractor and building physicist Dr Chamanlal Gupta). It has a composite wall structure (with ACC blocks outside and stabilized compressed earth blocks inside), hollow terracotta blocks for roofing, north-south orientation, deep overhangs and verandahs. The building runs fully on solar energy, harvests the rain in a tank (used for swimming and gardening) and has a solar water heater. The owner is very conscious of the temperature and RH fluctuations and uses night ventilation as an effective strategy to keep the house cool. The house is fully mosquito proof and has glass windows with metal grills.







1 First Floor | 2 Second Floor *3 Mezzanine plan | 4 Section AA*

Figure 11, Placement of loggers, plan, elevation, section, Blessing house

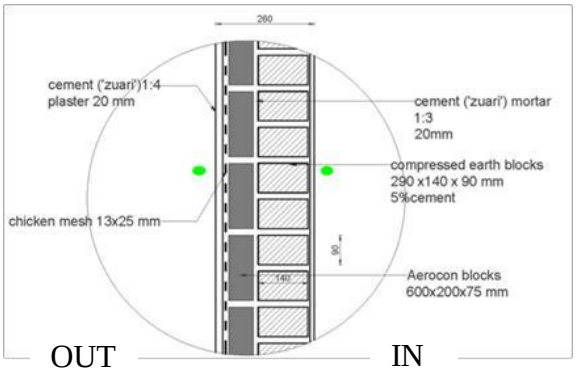


Figure 12, Composite wall detailed

Figure 13. Composite wall (construction) With ACC and Earth blocks

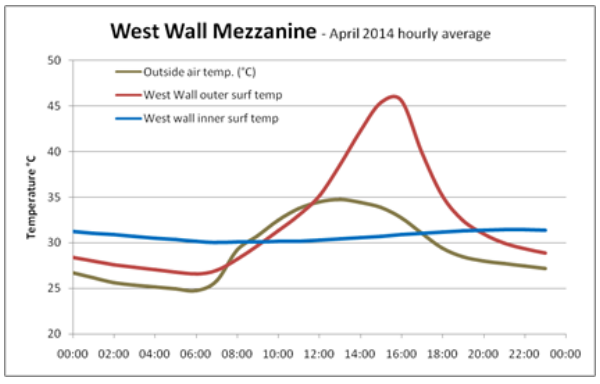


Figure 14. West composite wall Surface temp in vs. out (April 2014)

Fig 14. Shows that for the month of April 2014, the maximum mean of the outer surface temperature is reached at 16:00, while the maximum mean of the inner surface temperature is reached at 20:00. **The thermal lag of the west wall is 4 hours.** From 20h to 9h30 the inner surface is hotter than the outer surface which induces a heat transfer inside the room during the night.

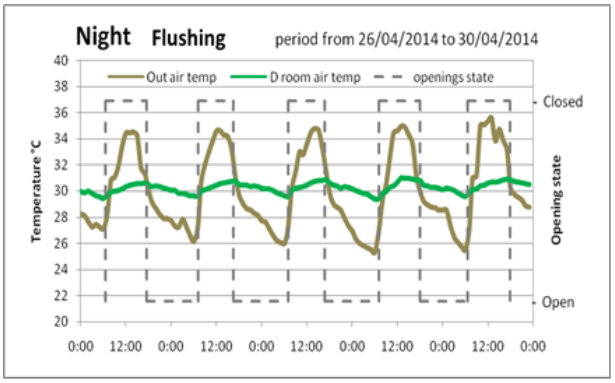


Figure 15. Night flushing graph

Figure 15. Occupants of the house were opening all the glass windows and doors (towards verandas and balconies) for night cooling by cross ventilation and closing in the morning to keep the cool air in the house throughout the day. We were monitoring these opening times using a gate opening sensor on one of the windows. We can see that there is less fluctuation in the inside room temperature.

- **GOLCONDE** Under Study since August 2013 (Collective Residential G+3)

Strategies: Ventilated cavity roof, Shading and Insulation
Materials: RCC frame structure, asbestos louvers
Loggers: 17 loggers; 17 surface temp sensors

Description: Sri Aurobindo Ashram‟s dormitory, Pondicherry. An iconic building considered as India‟s first „modern‟ building, built from 1936-42, with exposed RCC frame structure. It was designed by Antonin Raymond along with George Nakashima and Franticek Sammers. Built without any contracting company it has been made by ashram devotees and is maintained immaculately. It has ventilated double roof, operable louvered windows, covered passages and north-south orientation. Permission to study this building was granted due to special request and not all rooms and not all surfaces were made available to us. We are monitoring this building for its orientation, insulation, shading (over hangs and passages), cross-ventilation, micro climate (landscape) and double ventilated roof.

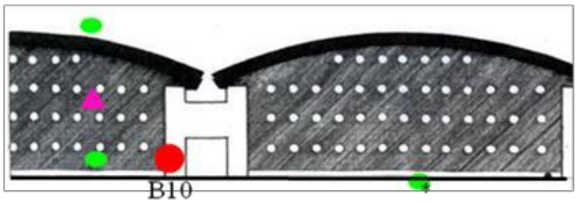


Figure 16. Placement of sensors, Ventilated roof shell detail

Figure 17. Ventilated roof top view

The following graph shows following range of temperatures:

- Surf Temp Shell Out (24-56°C)
- Surf Temp Shell In (28-37°C)
- Surf Temp Ceiling (29-38°C)
- Air Temp Outside (27-36°C)

The efficiency of this ventilated roof allows a reduction by 18°C under warm and shiny conditions.

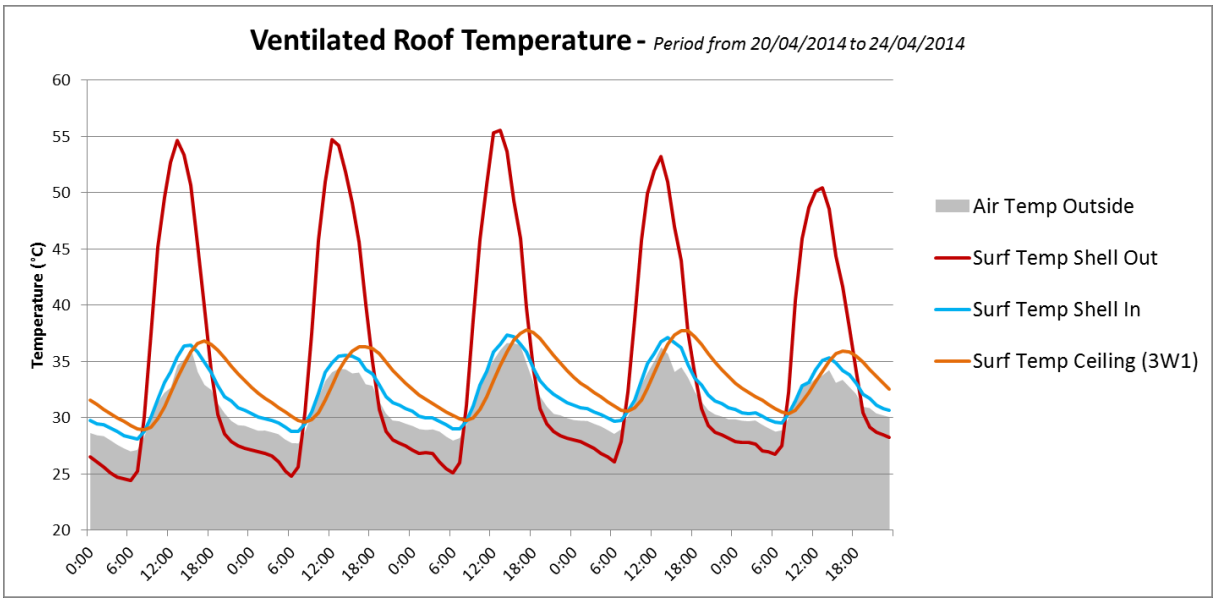


Figure 18. Roof surface temp comparison

5.2 Buildings for individual strategies

- **MUKUDUVIDU HOUSE** Under Study since December 2013

Strategies: Masonry Domes, Stack Effect and Thermal mass

Materials: 22cm load bearing fired country brick with lime mortar, reflective broken china Mosaic

Loggers: 10 loggers; 1 outside; 7 surface temp sensors

Description: Designed in 1992 by architects Poppo Pingel and Mona Doctor–Pingel, within Auroville International Township. The Residence–cum- office complex is a structure with high thermal mass domes and vaults provided by 0.22 m low fired country brick with lime mortar and plaster, 1.2 m overhangs in the south and north, wind exhausts for domes, maximum large openings on the south, less large on the north side (rain direction, sun in the summer) with minimum opening of the east and west side. It has extensive landscaping with large trees on the west and north, water bodies and Zen sand garden to the south.


Figure 19. Panoramic view, Mukuduvidu house complex

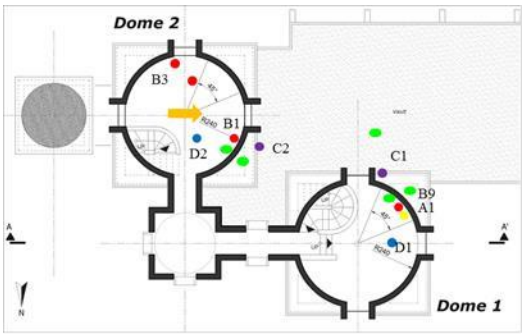


Figure 20. Logger placement in Dome
Dome 1: With Wind Exhaust
Dome 2: With Wind extractor

Figure 21. Roof top view

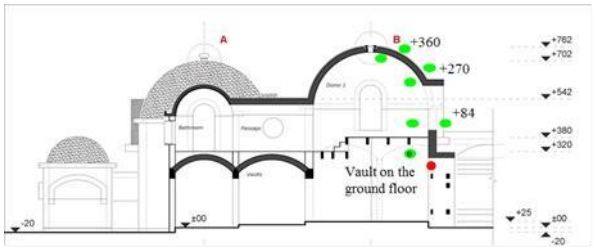


Figure 22. Section AA logger placement

Figure 23. Temp sensor placement Dome1

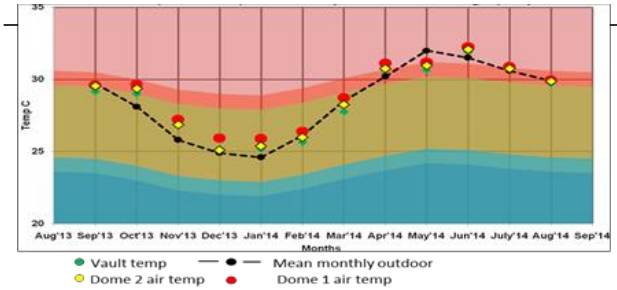


Figure 24. Values of mean temperature in Dome 1, Dome 2 and Vault from Sep 2013 till Aug 2014 with Adaptive comfort zones (CARBSE), for Naturally Ventilated Buildings, *(13^0 N, Chennai)*

Fig 24, Overlapping the mean monthly temperatures of the building with the adaptive thermal comfort zones elaborated by CARBSE for Chennai, we can observe that the vault remains within the comfort range from September to May, whereas domes are within the comfort range from September to April (without any electrical ventilation system). Dome 2 is slightly cooler than the Dome 1, the major difference coming from the wind extractor proving that wind extractor helps to reduce the indoor temperature by increasing hot air extraction. We can also conclude that vaulted space shows better thermal performance.

Figure 25. Dome 1 air temperature with 3 different opening scenarios (weekly mean in April-May 2014): Windows closed throughout day & night; Windows open throughout day & night; Windows open at night and closed during the day

Fig 25, Compares the air temperature for three windows opening scenarios in Dome 1 and clearly indicates that the strategy to close the windows during the day to keep the fresh air and opening at night to cool down shows the best results. Detailed analysis of our data shows that windows open at day (09-18hrs) increases the indoor air temperature by 2°C more than when they are closed. Also windows open at night (18-09 hrs) allows an extra cooling of 1.2 °C than when they are closed.

- **AFSANAH GUEST HOUSE (**under study since mid July 2013)

Strategies: Performance of two different roof strategies: insulated terracotta tile roof & terracotta hollow block with ACC BLOCK ASSEMBLY

Materials: RCC columns with country fired brick 22 cm, sloping roof (precast concrete rafters and combination of 12 mm pre-fab cement board with sawdust (BISON), 4 cm thick thermocol and thin galvanized iron sheets below the terracotta Mangalore tile), flat roof with hollow terracotta "hurdi" blocks and light grey ceramic tile finish

Loggers : 4 loggers; 2 loggers outside; 4 surface temp sensors.

Description: Designed by architect Poppo Pingel, in 2003, the Afsanah guest house is located within Auroville International Township. The building under study, Dining hall of the guest house has a flat roof on the ground floor made of hurdi blocks and a tile roof for the first floor. It is fully naturally ventilated with wire mesh and grills with almost no walls. It has no glass. The transparency enables one to enjoy the exterior-interior connection. It has sand garden on one side and a pond integrated within the landscape on the other, which makes for an interesting study. We were monitoring the Dining area for micro climate, orientation, shading, and cross ventilation.

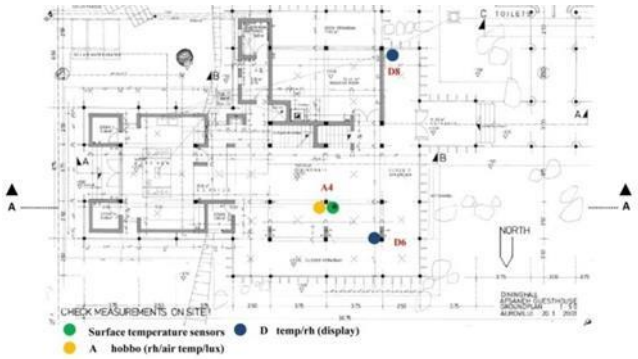


Figure 28, Logger placement, plan

Figure 29, Dining hall protruding into pond, Afsanah guest house

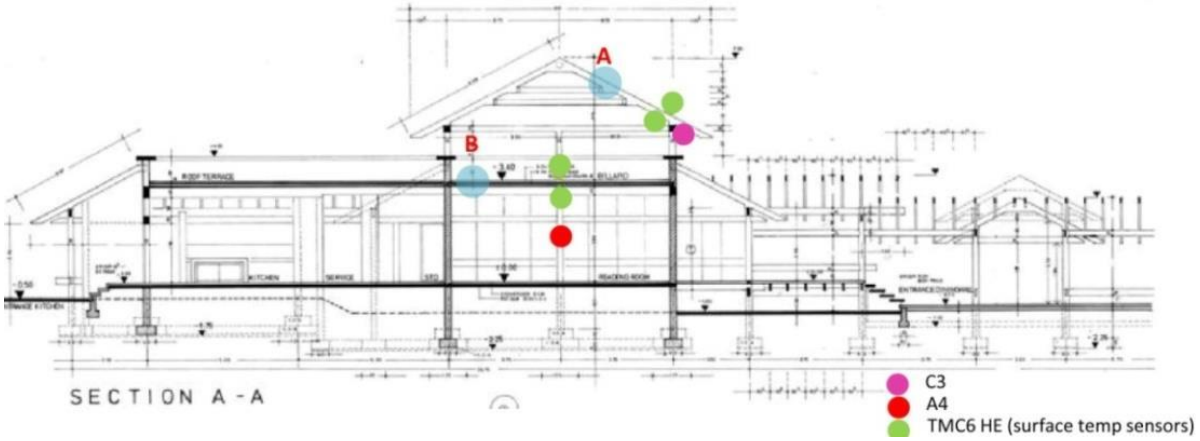


Figure 30, Temp sensor placement

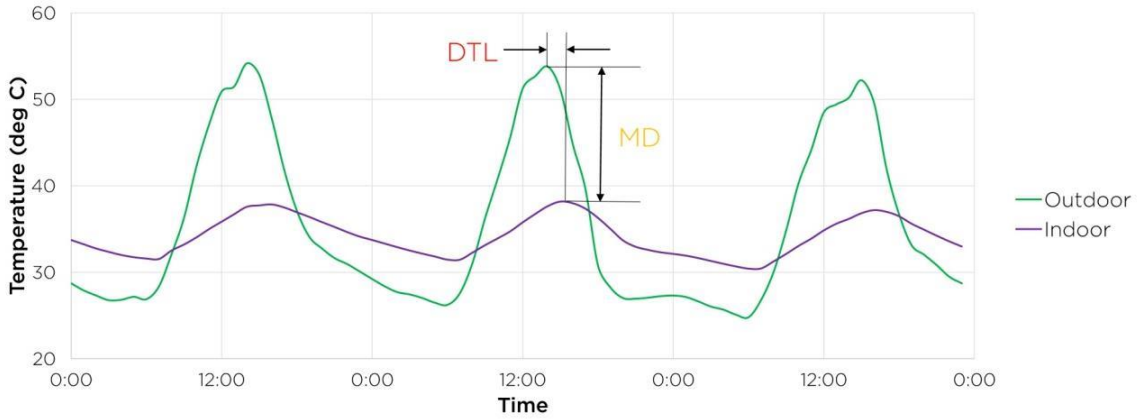


Figure 31, Hourly Indoor & outdoor Terra Cotta Surface Temperature (09/06/14 – 21/6/14)

1. We can see that the roof assembly provides a reduction of 13 ^{o}C surface temp , i.e. {Max OUT temp – Max IN temp} in day time at its peak whereas in night time, inside surface temp is warmer by 4 ^{o}C compared to outside surface temp. (without any electrical ventilation)
2. The roof assembly shows a thermal lag of 2 hours when at its peak maximum surface temperature.

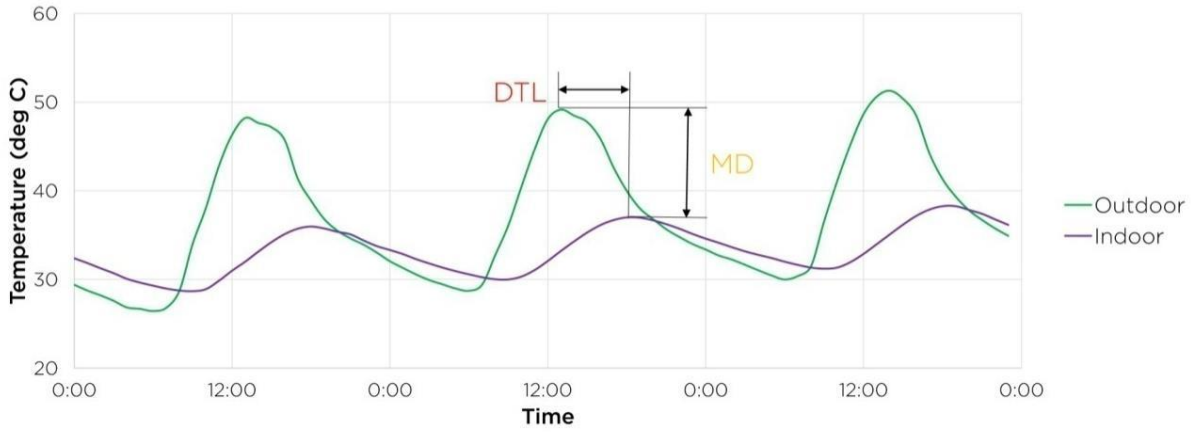


Figure 32, Hourly Indoor & Outdoor Hollow Block Surface Temperature (01/07/14 – 03/07/14)

1. We can see that the roof assembly provides a reduction of 8 ^{o}C surface temp , i.e. {Max OUT temp – Max IN temp} in day time at its peak whereas in night time, inside surface temp is warmer by 2 ^{o}C compared to outside surface temp.
2. The roof assembly shows a thermal lag of 4.5 hours when at its peak maximum surface temperature

6 CONCLUSION

Thermal comfort can be achieved in a naturally ventilated building under a warm and humid climate using passive strategies.

Mukuduvidu has showed that the overall performance of the vault is more satisfactory than the dome due to its larger openings enhancing cross ventilation and lesser solar heat transmission. The use of thermal mass for the vault and dome serve as a climate moderator. The massive building envelop reduce the temperature fluctuation and reduce the indoor peak temperature. A high thermal mass shows also a thermal time lag effect by shifting the indoor peak temperature from the outside peak temperature. The thermal mass of the domes and vaults ensures a time lag of 2 to 4 hours for the air temperature; domes being less than the vault.

In Afsanah Guest House, the study of two different roof strategy shows that the thermal time lag is better for the flat hollow block roof than for the slopped terracotta roof. However, with a damping of 13°C compared to 8°C, the terracotta roof has a better maximum damping. The smaller time lag of the terracotta roof avoids an indoor temperature peak during the night.

In Blessing house, day openings and night time cooling strategy show good results in preventing excessive temperature rise in the building. Compared to an all open and all closed windows schedule, night time cooling leads to cooler indoor temperature during the night as well as the day. According to the utilization of the building (residential) this scenario is adaptable but would be difficult to implement for an office building which need to be closed during the night. Composite wall section of ACC block and CSEB performs well in the hot and humid climate by providing a time lag of 4 hours.
In Golconde building, the 18°C of temperature reduction from rooftop to ceiling surface for the ventilated double roof acts as a very efficient insulator. The height of the building (G+3) improves the performance of this strategy due to a higher and more constant outside air speed which allows a better air flow in the shell.

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Ensuring Sustainability of Decentralized Renewable Energy Systems through Creation of Rural Economic Zone (REZ)

Muhan Maskey
Alternative Energy Promotion Centre (AEPC)
Khumaltar, Lalitpur, Nepal
muhan.maskey@aepc.gov.np / muhan.maskey@gmail.com

Biraj Gautam
People, Energy & Development Association (PEEDA)
Mid Baneshwor, Kathmandu, Nepal
biraj@peeda.net / jibiraaj@gmail.com

ABSTRACT

The extension of the national grid is, technically and financially, very challenging in Nepal where off-grid renewable energy seems to be the only viable solution. Over the last 30 years, Nepal has installed over 2,500 off-grid micro hydro plants benefitting over 300,000 rural households. The electricity produced is primarily used for lighting purposes and powering some low capacity equipment. Most such systems have issues of financial sustainability due to heavy under-utilization of available power. In this context, the concept of REZ has been developed with valuable experiences from similar activities in rural India. REZ is an entrepreneurship model which pivots around an assured power supply and creating rural enterprises. Around these, economic activities are encouraged based on traditional skills and value addition. REZ is owned and managed by private promoters under the public private partnership model. REZs overcome the twin barriers of promoting renewable energy and demonstrating sustainable growth.

KEYWORDS

Off-grid, renewable energy, financial sustainability, rural economic zone, entrepreneurship, rural enterprises, public private partnership

INTRODUCTION

Nepal is a land locked country located in South Asia between India and China. It contains 8 of the 10 highest mountains peaks in the world, although some of its low lying areas are near mean sea level. Thus there is an extreme spatial climate variation in Nepal, from tropical to arctic within a span of only 200 kms. Despite its natural beauty, Nepal is one of the poorest countries in the world with 25.16% of the population living below the poverty line[23] [1].

As compared to other under developed countries, "Energy Poverty" remains a major source of concern for development in Nepal. With a population growing towards 28 million [2], the total power demand of Nepal at present is around 1200 MW. With an annual increase of 10%, the power requirement will peak at 4500 MW by 2030. Compared to the per day demand, the installed capacity is only around 687.7 MW contributed mainly from hydro generations [3]. The situation turns grim in the winter season, when electricity of around 300 MW only is available, plunging the entire country into 12-16 hours of power cuts, especially in urban areas including the capital, Kathmandu. Thus,

[23] The Nepal Living Standard Survey (NLSS) measures poverty considering 2,200 calories per person per day consumption and access to basic non-food items as the threshold in Nepal

economic activities are badly affected, increasing the dependency on fossil fuel import from India thereby draining substantial foreign reserves.

Apart from electricity consumption, Nepal relies heavily on traditional energy resources in the overall national energy sector, as no significant deposits of fossil fuel are available. Out of the total energy consumption in Nepal in 2008/09, 89.1% was consumed by the residential sector while only 3.3% by the industrial sector. Based on the fuel type, biomass provided 87% of the total energy consumption, petroleum 8% (mainly consumed in urban areas), electricity only 2% and renewables less than 1% of the total energy consumption [4].

Nepal faces numerous challenges both similar and different to other developing countries. Its unique geography and culture provide a base for solutions for these challenges. Energy consumption in Nepal is increasing and critical component for development. A variety of rural renewable energy technologies are commonly being utilized and promoted in Nepal such as biogas, biomass, solar and micro hydro power (MHP). The promotion of these technologies has focused on rural Nepal where other source of modern energy is absent. Lighting has been primary use of the energy source and there has been a dire need to balance daily the use of the energy produced from these system and to generate income to ensure long term financial sustainability.

It is well established that Micro and Small Enterprises (MSEs) forms the backbone of any economy be it rural or urban. MSEs promote economic growth that is employment oriented. The one of the major barriers identified for growth of this sector are the availability of "reliable power supply", lack of clean energy efficient technologies for MSE production sector and marketing of these products; notably food processing, agro products, building materials, textiles, crafts, etc. Micro-enterprises gets lowest opportunity of grid based electricity supply, forcing production units to rely on diesel run generators.

CONTEXTUAL ANALYSIS

Over 80% of the people in Nepal live in rural areas with overwhelming dependence on traditional biomass for fuel. Despite huge hydropower potential, Nepal has one of the lowest per capita electricity consumptions in the world. Still about 40% of the population does not have access to electricity [5]. Considering the difficult terrain, subsequent cost involved and institutional barriers, extension of the national grid is very difficult to the remote rural areas. Off-grid renewable energy (RE) systems are essential to reach these areas still lacking electricity. Only about 15% of the rural population of Nepal has access to electricity from off-grid RE systems [6]. In this pursuit, Nepal has installed over 2,550 micro hydro plants (MHPs) over the past 30 years with a gross installed capacity of 36.8 MW utilizing variety of development aid and local matching funds benefitting over 300,000 households of rural Nepal [7]. However, electricity produced is primarily used for lighting purposes and powering low capacity equipment. According to very rough estimates by Alternative Energy Promotion Centre (AEPC), the national nodal agency for promotion of rural and renewable systems in Nepal, around 30% of the systems are no longer in operation for variety of reasons – technical, social, institutional, etc. Off-grid RE systems have issues of financial sustainability lacking enough revenues for operation and maintenance (O&M) and repair. The utilization of these systems is very low. Although some rural enterprises mainly agro-processing has come up in the vicinity of MHPs, it is estimated that the load factor of MHPs in Nepal is only about 19% [8]. Productive energy use, through the establishment of rural enterprises, to make

productive use of the power generated for income generating purposes is a way to increase utilization.

However, the notion of promoting rural enterprises is very challenging in Nepal considering that MSE sector is also at a very nascent stage. Considering that off-grid RE systems are based in remote rural areas of this mountainous country, the operational cost of setting up such enterprises as well as the operational cost is very high; thus, directly hampering the profitability of such an establishment. There is, then, a distinct lack of knowledge and skills required for establishing and operating such enterprises at the local level. Compounding the whole process is the fact that most previous individual efforts have resulted in poor quality products thereby restricting the market and profits, which directly acts as deterring factor for any potential investors and enthusiasts. Although many external actors have been playing an important part in developing the capacity in these aspects, there seems to be lack of post-project mentoring necessary to support the rural enterprises at the difficult initial stages of establishment and operation.

RATIONALE BEHIND PROMOTING RURAL ENTREPRISES

It is assumed that rural electrification in Nepal will generally serve for social and economic development of the beneficiaries with electricity access as the entry point. The past efforts in off-grid RE system promotion, to a large extent, have been able to impact positively on this development front. It was thought that increasing electricity access would inevitably boost economic development. However, past experiences have shown that although electricity is a pre-requisite condition for increased income and employment generation at the rural areas, it is not the only pre-condition. A well supported mechanism for promotion of productive use of electricity is necessary to foster the development. This generally helps to encourage private sector to participate in the productive use of electricity thereby increasing income and employment generation opportunities, reduction of drudgery, quality production at the comparatively lower prices that can be marketed at the local market, etc. This ultimately helps in positively impacting on the social and economic development of rural areas [9].

The energy consumption in Nepal is typically very low which shows both lack of demand and lack of access. Especially in the rural areas where the settlements are very much sparse and widely distributed, the cost of generation and distribution seems to be unviable in most areas. Even with provisions of subsidy from the Government and many development partners, the systems suffer from issues of long- and short-term financial sustainability. In many cases, the systems cannot even generate enough revenue for normal operation and maintenance of the systems primarily due to under-utilization of the plants and in some cases, due to tariffs being unaffordable to some users. On the other hand, there are experiences in Nepal where off-grid RE systems have been in operation for many years, primarily, in large load centres (local or regional market areas) where the demand for electricity is comparatively higher and revenue generation from the plants includes quite a few commercial and industrial loads. Based on these experiences, it is assumed that promoting rural enterprises increases productive uses thus improving the utilization of the systems thereby improving economic and financial sustainability of the systems. The whole rationale of promoting rural enterprises is adding commercial and industrial loads rather than only the domestic load as observed in majority of the rural areas at present.

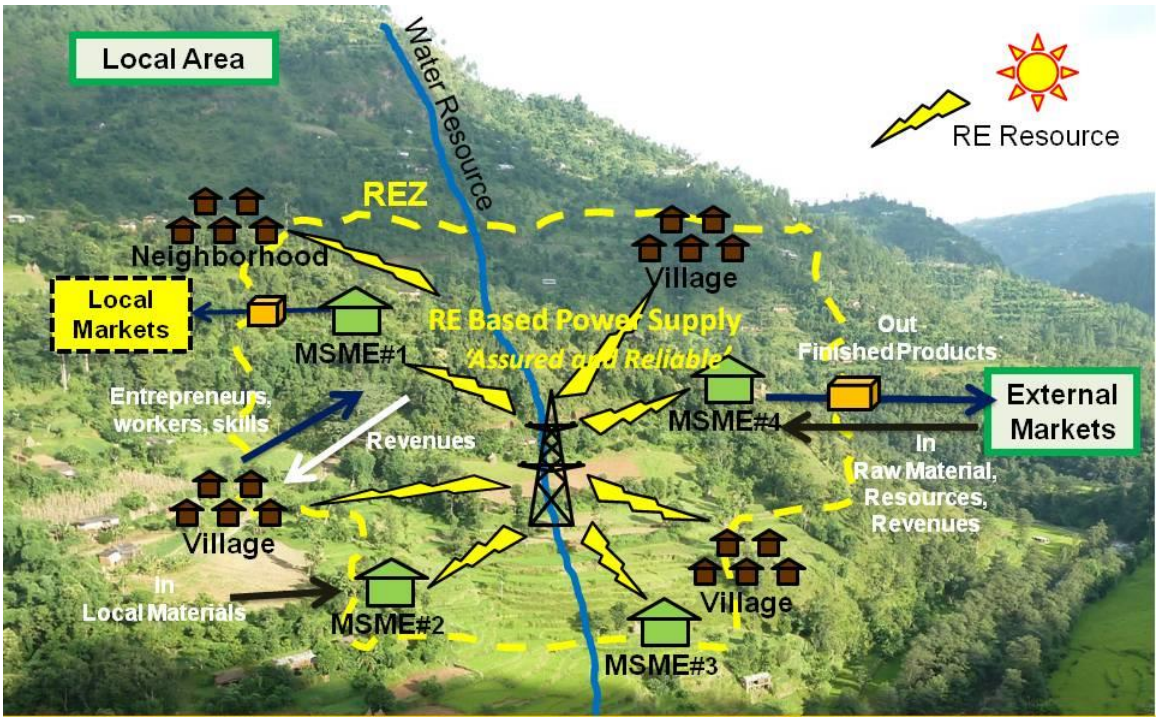
CONCEPT

The present concept aims to overcome the twin barriers by promoting green power and clean technologies and demonstrate sustainable growth through the concept of "Rural Economic Zones (REZ)." The concept of REZ revolves around renewable energy generation and distribution systems. In a REZ, a reliable RE source will allow energy-reliant businesses to flourish, and vice-versa, the businesses will provide the needed fees to pay for and maintain the energy operation, be it a business or cooperative.They are set up in energy starved areas or existing stand alone systems with potential for clustered industries. Around these assured power supply zones, economic activities are encouraged based on traditional skills, value addition and waste utilization.

The focus of the project is on stimulating viable economic activity based on local resources, local entrepreneurs, and local stakeholders with the addition of some outside knowledge, skills and examples. The MSEs consist of connected businesses that create a unique value proposition for the customer and provide assured services and green power to enterprises. Uninterrupted power supply to value adding enterprises is provided by RE generation systems at scales ranging from 10 kW to 1000 kW. The REZ thus acquire a brand value for quality products for various products and skills.

The proposed project envisages strong self-sufficiency and "Equal Opportunity Partnerships" between investors, users and management. Enabling policy and financial support is also sought for overall development. Land for setting up REZ is identified and transferred through Local Governments. Capital cost of the RE based power generation and distribution system is partially financed through financial institutions (FIs) and equity and incentives from government agencies. Commercial banks or apex body FIs is engaged in this process to leverage risk free loans.

Figure 1. Rural Economic Zone concept

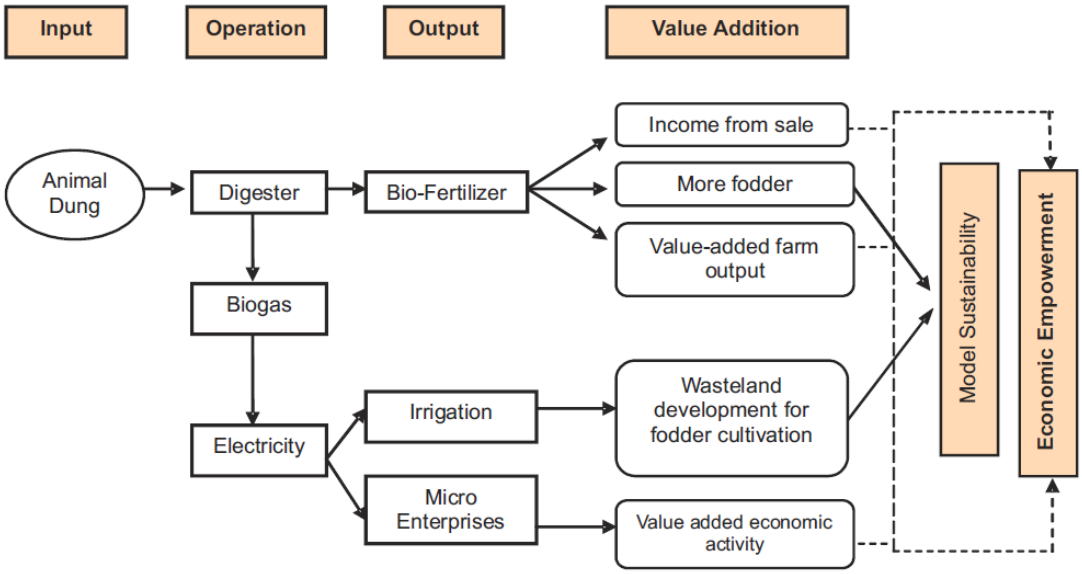


PAST EXPERIENCES – "GAUSHALA MODEL"

The concept of REZ is derived from previous similar experiences from neighbouring India, where Development Alternatives (DA), a national level NGO working at the community level, through its social enterprise, Technology and Action for Rural Advancement (TARA), has been successfully implementing the "Methane-Powered Energy Service Hub" in parts of Indian States of Uttar Pradesh (UP) and Madhya Pradesh (MP). The popularly known "*Gaushala Model*"[24] has been demonstrating the techno-commercial viability of the model through scientific disposal of dung or any biodegradable waste with high replication possibility in cattle-rich communities, in dairy/poultry farms and in *Gaushalas* (cowsheds). The model has been tested at three *Gaushalas* of Bundelkhand region in UP and MP namely, Lalitpur - UP, Orchha - MP and Mauranipur - UP.

Energy crisis in the rural areas has intricate linkages with the social, economic and environmental factors. With growing population, the demand for energy increased for various activities. Realizing this situation, DA sought to understand the need for energy in rural areas and undertook micro-level energy planning for several villages in Bundelkhand for fulfillment of basic needs and livelihood enhancement for sustainable development through the *Gaushala Model*.

Figure 2. "Gaushala Model" from India



The REZ Gaushala in Orchha was initiated in 2008 with the installation of a 7.5 kW biogas plant. The community management of this energy service model focuses on methane-capturing, using flammable gas for electricity generation, for irrigation, enterprise and domestic use. The *Gaushala* workers have been trained to operate the biogas plant, maintain the gas engine and to work on fodder management. The increased use of treated slurry as an organic manure is gradually reducing the use of chemical fertilizer to lower the input cost. Both these activities lead to climate change

[24] All information of the "*Gaushala Model*" has been derived based on field visits and information collected by Mr. Biraj Gautam, a one-year exchange participant from People Energy and Environment Development Association (PEEDA) to Development Alternative (DA), during May 2011 and March 2012.

mitigation. The use of energy services and enriched organic compost transformed the *Gaushala* at Orchha into a profit centre from their usual status as cost centre.

The detail of the model tested at Orchha in MP is tabulated below:

Table 1. Details of *Gaushala Model* tested at Orchha, MP

	Sri Ram Raja Gaushala, Orchha, MP
Power generating system	• 60 m^3 digester • 5-pit slurry tank • Gas engine 5 kVA single phase generator • Power controlling and distribution unit
Other infrastructure	• Vermi-compost bed • 2 submersible pumps of 2 & 5 horsepower capacity • Bore well • Spice grinding unit • De-husking unit • Expeller unit • Flour milling unit
Energy use	Water pumping, milling/grinding/expelling operations, lighting & fans, biogas for cooking
Products	Green fodder, organic vegetables, digested slurry, vermi-compost

The current financial performance of REZ Gaushala, without considering the secondary benefits to the community by the introduction of new enterprises, has not been as expected due to insufficient supply of cow dung and the plant is unable to produce enough biogas for energy. The daily energy required is 60 kWh to run all the electricity-based enterprises simultaneously for 8 hrs. But the biogas is able to produce only around half of that each day. The individual processing units – expeller, de-husking, flour milling and spice grinder – are running only for 2-3 hours per day thereby restricting revenue of the plant. The enterprises pay Rs. 9 per kWh as commercial tariff which is able to meet only the operating expenses of the plant.

Figure 3. Biogas plant and generator to produce electricity

The individual enterprises have been categorized into two units – service unit and production unit. The service unit basically provides services to the community and not focus on commercial production. The flour milling and groundnut de-husking units are considered as service-oriented for the community. Due to low service costs, the both service units are making losses. On the other hand, spice grinder and expeller units have been established as production units which are mainly used for commercial purposes. The produce from the production unit are processed, packaged and

marketed at the local markets and thus, making profits on the sales. The processed and packaged spices are marketed under the brand name of "*Shakti*" [11].

Presently Datia in Madhya Pradesh has a REZ based on building materials. The REZ Datia has gasifier for the generation energy which utilizes biomass of *Ipomea* plant. The energy generated is used for preparation of building and constructing materials such as cement bricks, fly ash blocks, micro concrete roofing tiles, interlocking pavers, hollow blocks, fiber concrete roofing tiles, mosaic tiles, etc. These days variety of alternative building materials are available which provide better, efficient, durable, cost effective construction and eco-friendly and also ensure judicious utilization of available limited resources with least possible degradation of environment. Some of the materials are manufactured by using various waste materials such as fly ash and stone dust as the raw material for their production.

Similarly, Radhapur village in Shivpuri district of Madhya Pradesh has a REZ based on rural micro agro-processing enterprises.

KEY CONSIDERATIONS

MSE development and growth are driven by both exogenous and endogenous factors, which together form the basis of an enabling condition. While some of the enabling attributes already exist prior to MSE development, others need to be nurtured and helped to grow in the local environment. At the same time, the drivers of an enterprise cluster are seen to be influenced by factors such as entrepreneurship development, business development support, assessing products and factor markets, technology, branding, etc. While the enabling conditions are more exogenous to any local cluster, the drivers are more endogenous and hence are influenced by local conditions.

More MSE friendly enabling conditions to rural people

There has been progress in creating enabling conditions for MSE growth in rural areas that are being served by MHPs. There is scope to strengthen both exogenous and endogenous factors to further make the enabling conditions more MSE-friendly to rural people. Among the exogenous factors, most challenging and essential is related to government/bureaucratic rules and procedures. Dealing with exogenous factors is always a challenge to rural people and could even discourage investments; hence, facilitating MSE growth and development should be made a part of helping these "infant industries" grow in rural areas.

Choice of RE system and modality

Among the endogenous factors, the growth of independent RE system, primarily mini/micro hydro, is the single most powerful driver in rural areas for MSE development. The choice of technology is governed by the availability of resources and willingness of the community to adopt it for electricity access. The development of MHP in Nepal has generally followed two approaches namely a cooperative led and an entrepreneurial led approaches. While both approaches have proved to be very successful in many places, there are also cases where it has been not-so-successful. The key aspect of the modality is maintaining the social capital within the user community that is attributed to binding the community together in Nepal [10].

Production for the local markets

Prompting MSEs that produce for the local market should be encouraged as it has greater change of generating income and employment in rural areas. This is not to say that MSEs with export potentials should be discouraged. The issue is to promote MSEs that produce for local consumption stand a better chance of survival and have larger local multiplier (employment and income) effect.

Access to finance

Access to finance and the availability of capital is another key aspect of the project. While access to commercial loans and financing is not constraints with genuine entrepreneurs, there is scope to shorten the procedures, which local people have to go through to obtain loans to venture into MSE establishment.

Continued training and skill development

Formal training to develop entrepreneurship, i.e., capacity and willingness to develop, organize and manage a business venture by taking necessary risk to make a profit, is needed. While many rural entrepreneurs have the knack to conduct business, the quality of training and skills is still inadequate. For MSEs to grow and sustain, it is therefore necessary that besides the provision of basic infrastructure like roads, electricity, and other goods and services, entrepreneurship development should also be given equal priority and must be a continuous process.

Prospective entrepreneurs in rural areas

Many potential rural entrepreneurs lack knowledge, skills, information but appear to have investment funds. How to identify these people needs to be facilitated as well. Three approaches could be followed namely, i) to capitalize on the trainees that have already been trained on entrepreneurship/business by different organizations in Nepal; ii) an apprenticeship approach to develop necessary required manpower and also a way to generate employment opportunities for the youths and iii) to identify interested youths on entrepreneurship.

Right technology

Prospective rural entrepreneurs may be unable to select the appropriate technologies and often 'low cost" approach seems to be the guiding principle for selection. While 'low cost' approach is also rational, efficiency of the technology from several angles (energy use, productivity, automation, etc) that help reduces unit cost also needs to be considered. Guidance is required in this aspect such that investments made become profitable to the rural entrepreneurs, or else can lead to investment failures. When mismatch occurs, the loan recovery can be problematic and can be a prime cause of the failure of new businesses, and the creditors' will have to find other means to pay back. This sends negative signals to prospective rural investors and a major setback for MSE development.

Branding

Branding is a way to give a unique identity to a product. Nepali community is familiar with branding, for example "Khukuri (Nepali knife) from Bhojpur district" and "Dhaka (local cotton) from Palpa district". Such quality products develop a market niche and command a higher premium in return. Branding has scope to give rural products a new place in consumers' mind and help make rural enterprises competitive too.

Infant Industry Protection

It needs to be emphasized that MSE development requires a great deal of nurturing. Without nurturing, there is no way the MSEs will survive. This has been an important strategy of all developed nations in the past. Small rural enterprises normally are unable to face competition when targeting larger markets. Given the uphill battle, some level of selective protection over a defined period of time and clear exist strategy of protection may be necessary.

Support Service Package

SME cluster development requires careful interventions in terms of support service package to help business grow, such that the entrepreneurs do not have to reach urban centers like Kathmandu for support. This could be achieved through strategically placed business support service center. The success of a SME cluster will very much depend on how effectively the needed services can be provided as per the needs of the entrepreneurs.

REZ governance

The governance of REZ is another very critical aspect. Since the concept is more of a business modality rather than a purely social venture, participation and interest protection of all stakeholders including the private sector, financial institutions and local community is paramount to the success of REZ. An appropriate institution needs to be set up to ultimately manage both the assured power supply system and the cluster of enterprises being served by the system.

EXPECTED IMPACTS

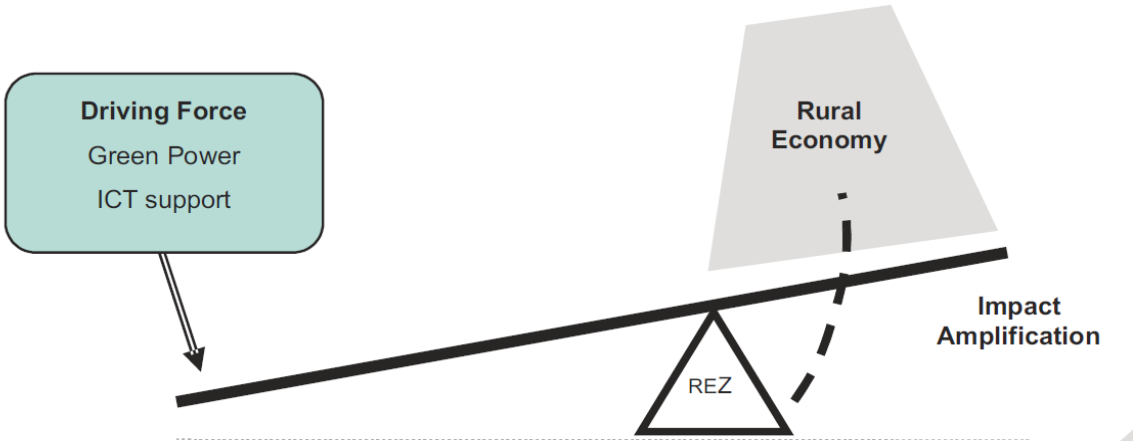


Figure 3. Impact illustration of REZ

The demonstration of successful operation of REZs will result in the sustainable economic growth of enterprise clusters in selected rural and semi-urban areas of Nepal. The REZ along with green power utilities will be managed to ensure growth of the enterprises and the economic viability of the energy provider. The revenues and cash flows will be substantially enhanced through the realization of carbon revenues. Value addition to products and clustered production will enhance market visibility and brand of the REZs. The project will focus on transforming the federation/cooperative into credible "energy service providers" managed with local participation.

The project will setup an example of facilitation of renewable energy based power generation and distribution systems reducing the dependency on fossil fuel energy. Coupled with service approach for supporting enterprises towards uptake of the power being generated, it will bring in an economic independency in rural areas. It will also significantly reduce emissions and promote economic independencies. Successful demonstration will create interest amongst Government agencies and policy makers to adopt and implement the systems thereby reducing energy demands.

Successful demonstrations of project objectives are expected to realize the following impacts in the regional and national scenario of the energy scenario of the country.

- Energy access and security
- Economic opportunities and benefits
- Environmental impacts
- Policy impacts
- Maintenance of cultural heritage

CONCLUSION

The development of entrepreneurship can be a major means of fighting economic inertia in rural areas that are located far from the main industrial center of a country. The notion of "rural entrepreneurship" is not limited to agriculture and related activities such as food processing, but rather it covers industrial development in general. In addition, the concept is not restricted to the villages but also is relevant to small towns and peri-urban areas. The concept aims at representing the strategies for spurring economic activity in underdeveloped areas. In this regards, access to modern forms of energy access is a major constraint to such a development initiative due to remoteness of the areas. Clubbing the provision of assured energy access with rural entrepreneurship, rural economy can positively be enhanced.

There have been concerted efforts from the Government and its development partners in enhancing access to modern forms of energy in the remote rural areas of Nepal through the promotion of off-grid RE systems. However, such off-grid systems are facing problems of long term financial sustainability due to under-utilization of energy generated. The promotion of rural enterprises through the energy generated from such off-grid RE systems helps to improve the utilization of energy generated thus improving the revenue generated from the systems thereby attaining long term financial sustainability of the systems.

The underlying approach of REZ, thus, should play a positive role in:

- Improve access to modern forms of energy
- Improve the utilization of off-grid RE systems thus impacting on ensuring financial sustainability of the systems
- Increase the number of enterprises and small businesses
- Increase employment generation opportunities
- Consolidate and expand already existing businesses, and
- Attract investment

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Promoting Energy Efficiency in Nepal: Issues, Challenges and Opportunities

Dr. Narayan Prasad Chaulagain
Energy Efficiency Expert, Nepal
Email: narayanchaulagain@gmail.com

ABSTRACT

Despite a low level of per capita energy consumption, Nepal's energy intensity is one of the highest in South Asia and almost double of that of India or China. Relative to other countries in the Asian region, Nepal lags behind in offering a clear and forward looking energy efficiency policy direction. The main shortcomings of energy efficiency in Nepal have been the lack of policy, strategy, institution and a robust legal provision for developing, implementing and managing the energy efficiency agenda. The absence of legal, regulatory and institutional framework makes it challenging to find a consistent platform to evolve, build and deepen energy efficiency activities. The efficient use of energy has not yet been an integral part of national energy planning. Integrating energy efficiency into broader development goals might help Nepal in addressing its complex set of interrelated challenges of the energy sector on energy poverty, energy access, import dependence and low levels of embedded energy efficiency.

KEY WORDS: Energy Efficiency, Energy Intensity, Energy Security, Energy Audit

INTRODUCTION

Nepal has been experiencing an acute shortage of power for the past several years. In the past five years, country's demand has increased by 46%, whereas installed capacity has increased by only 16%. Country recorded 1,201 MW of electricity demand during the evening peak (on November 3, 2013); whereas the total supply was 791 MW and about 410 MW was deficit which was managed through load-shedding [1]. Power experts estimate, the actual electricity demand of Nepal could easily go over 2,000 MW provided there is enough supply in the system, but due to supply deficit, the demand is suppressed. It may be noted that high dependency on the run-off-river type hydropower plants is one of the major reasons for acute power deficit in dry and winter seasons. Nepal's rivers have high variation in their flow pattern. Currently, storage-type plant represents only 14% of the total hydro capacity. The electricity import from India is growing over the years, despite a good hydropower potential. It was contributing about 116 MW to the total national grid supply in 2013 AD.

Reliable and affordable power supply is essential for economic development. However, acute power shortage has forced many industries either to shut down or to run at under capacity. It is estimated that the industries are currently utilised only at about 40-50% of the capacity. Most of the industries have to rely on diesel generator, adding up to 25-40% in production cost. This makes hard for Nepalese industries to compete with the industries from India and abroad. Nepal's per capita electricity consumption is terribly low, which is only 108 kWh per year [2], the lowest in South Asia. The peak power and energy demand are growing at an average of 10% annually about 120 MW each year.

There is a need of a huge investment to develop necessary infrastructures for power generation and transmission. Government needs to explore alternative ways to reduce power shortages

besides increasing generation. In this backdrop, energy efficiency initiatives could play an important role to overcome the current energy crisis. Energy intensity in Nepal is almost 4 times higher than the world average and almost the double of India or China. International Energy Agency reports that Nepal's energy intensity in 2010 was 1.02 ton of oil equivalent (toe) per thousand dollars of GDP (at 2005 US dollar), whereas, India had 0.56 toe, China 0.60 toe and Asian average 0.47 [3]. Nepal currently spends more than the amount of all its foreign currency earnings from exports for the import the petroleum products. Import of petroleum product makes more than 40% of total national import, which is equivalent to about US$100 million/month; whereas, Nepal's total merchandise export is merely US$ 70 million/month [4]. Enhancing efficient use of energy would save the energy and reduce the foreign currency spending, energy saving is another way of increasing energy generation.

Recent technological innovations have demonstrated that it is possible to minimize the demand by 20-25% through various energy efficiency initiatives. It is estimated that, with the nationwide implementation of various energy efficiency initiatives, Nepal can reduce almost 260 MW of peak demand in the current use combined with energy savings of 430 GWh per year by 2020 [5]. This is sufficient to reduce the minimum of 6 hours of load shedding each day. These considerable benefits will enable the Nepal's electricity system to avoid generation capacity worth NRs 38 billion, with an investment by Nepal Electricity Authority of approximately NRs 3 billion. Clearly, these benefits greatly exceed the costs, while also assisting in meeting the future projected electricity system peak demand.

The electricity and thermal energy saving potential in industrial sector is estimated to be in the order of 160 GWh and 8 million gigajoules respectively through the implementation of different energy efficiency measures [6]. However, Nepal is yet to realize the importance of demand side management and the role of energy saving solutions, despite many other countries have been already investing a lot in managing the demand through the use of innovative approaches and technologies. Given the current energy crisis, it is important that Nepal pays immediate attention to energy efficiency initiatives in the process to overcome current energy crisis. Such initiatives includes real time energy management system, intelligent motor energy controller, air conditioner energy saver, capacitor banks, high efficiency LED lights, solar street lights etc.

OBJECTIVE

In the backdrop of the above context, the main objective of this paper is to offer a robust way forward of institutionalizing energy efficiency in Nepal. In this endeavour, this paper seeks to develop an overarching framework that offers recommendations on an institutional platform, policy vision, energy savings potential across measures, targets, implementation modalities, and monitoring

METHODOLOGY

In order to achieve the set objective, the following tools and methods were used:

- Review and analysis of energy supply/consumption, GDP and population data
- Use of bottom-up cost minimization energy system model -MARKAL
- Review of good practices of other countries
- Proposition of appropriate options of Nepal

RESULTS

Review of the energy, economic and demographic data has shown that traditional (or non-commercial) energy is by far the most dominant energy source, accounting for approximately 89% of the total final energy consumption in 1996-97 and 80% in 2010-11. Almost all of the traditional energy use occurs within the residential sector, largely in cooking, though trace amounts of it are also in the industrial and commercial sectors. Within commercial energy use, transport is the largest user of energy followed by residential sectors. Industrial, commercial, agriculture and other sectors collectively use less than the residential sector at 8,100 PJ against 9,300 PJ in residential sector in 2010. The low levels of energy use in the commercial, industrial and the agriculture sectors signify the low levels of mechanization and reinforce the fact that as a strategy, energy efficiency must enable the expansion of energy use. Although non-commercial energy use is the more dominant source being used, its growth is declining. There is an increasing shift from traditional energy to commercial energy use, along with the fact that economic growth is promoting the use of commercial energy. During the period of 1997 to 2010, the commercial energy consumption in Nepal grew from 30 PJ to 64 PJ (i.e. 5.5% annually) whereas non-commercial energy consumption grew from 267 PJ to 279 PJ (i.e. 0.3% annually). The growth in energy use is a function of three factors, i.e. economic growth (or GDP growth), the switch from traditional energy to commercial energy, and the changing energy intensity of the economy. These three factors are co-mingled and are simultaneously in play.

Energy use has a direct and strong correlation to GDP or economic growth. All else equal, higher economic activity will invariably require an expansion of energy use. The switch to commercial energy could be a function of many factors, like higher income induced by increased economic growth, urbanization, increased availability of commercial energy and increased reliability in supply of commercial energy. Economic growth, industrialization and the growing use of commercial energy also mean that there is a change in the energy intensity (i.e. amount of energy required per unit of GDP).

Modelling Outputs

The MARKAL model projects that the total primary energy supply will grow at an annual average growth rate of 1.8%, from 374 PJ in 2010 to 540 PJ in 2030. The total final energy consumption is forecasted to grow at 1.9% (i.e., from 369 PJ in 2010 to 536 PJ in 2030). The sector specific final energy consumption is projected to grow at 5.8%, 5.0%, 5.0% and 3.3% in the industrial, transport, commercial and agriculture sectors respectively (see Table 1).

Table 1: Final energy consumption with biomass in Nepal during 2010-2030 (PJ)

Sector	2010	2020	2030	Growth (2010-2030)
Transport	18.9	30.7	49.8	5.0%
Industrial	22.4	39.4	69.6	5.8%
Residential	304.7	328.9	357.9	0.8%
Commercial	19.4	28.6	51.1	5.0%
Agriculture	3.9	5.5	7.5	3.3%
Total	**369.2**	**433.1**	**535.9**	**1.9%**

The base-case results confirm the trend of higher growth in the commercial energy relative to non-commercial energy. The total residential sector energy consumption including traditional biomass (fuelwood, agriculture residue and animal dung) is expected to increase at the average growth rate of 0.8%, while the residential sector consumption of commercial energy increases by 4.2% annually. This is largely due to a switch from biomass to higher grade fuels (kerosene, LPG and electricity) for cooking as a result of increased urbanization. The annual total final energy consumption excluding traditional biomass is estimated to grow at 5.1% (i.e., from 61 PJ in 2010 to 167 PJ in 2030) as illustrated in Table 2.

Table 2: Final energy consumption without biomass in Nepal during 2010-2030 (PJ)

Sector	2010	2020	2030	Growth (2010-2030)
Transport	18.9	30.7	49.8	5.0%
Industrial	16.6	28.4	51.8	5.9%
Residential	16.5	25	37.7	4.2%
Commercial	5.4	9.8	20.4	6.9%
Agriculture	3.9	5.5	7.5	3.3%
Total	**61.3**	**99.5**	**167.2**	**5.1%**

Over the 2010 to 2030 period, the consumption of imported fossil fuel (consisting of petroleum products, LPG and coal) grow at an annual average growth rate of 4.1%. This indicates that the future energy supply will be increasingly more dependent on the imported fossil fuels.

The use of hydropower is projected to increase at the rate of 8.4% per annum; while biomass energy supply will increase at an average annual growth rate 0.8%. Power generation capacity, dominated by hydro, is estimated to nearly double between 2010 and 2030, while annual electricity generation is estimated to increase nearly triple over the same period. The share of hydropower (excluding micro-hydro) and other renewables in annual electricity generation will increase gradually from 75% of the total in 2010 to 98% of the total in 2030, while the share of thermal generation decreases during the study period.

PROPOSED ENERGY EFFICIENCY POLICY SCENARIO

Double the Rate of EE Penetration by 2030

According to UN's Sustainable Energy for All (SE4ALL) Rapid Assessment and Gap Analysis, the goal of SE4ALL was to double the rate of energy efficiency by 2030 [7]. In modelling the energy efficiency (EE) policy scenario, EE measures were selected so as to approximately double the levels of EE penetration, i.e. double the annual rate of decline in the energy intensity of total final energy consumption relative to the base case. In the base case, the average energy intensity of total final energy consumption between 2010 and 2030 for commercial energy would decline by approximately **0.84%** annually. The energy intensity of Nepal in 2010 AD is 1.02 toe per USD 1000 GDP [7])**.** The mix of EE proposed measures under the EE policy scenario were designed with the target rate of doubling the decline in energy intensity of total final energy consumption to **1.68%** between 2010 and 2030**.**

Proposed Measures

EE measures have been proposed across all five sectors, i.e. residential, commercial, industrial, agriculture and transport. Potential measures were designed for each sector based on similar measures being adopted in other countries and its expected applicability in Nepal. The selection of measures reflects two points of emphasis. First, the measures were selected based on the stage of energy market. For instance, EE measures that require a switch from other fuels to electricity, or would lead to increased electricity use in some way, have limited applicability in the stage where there is an energy deficit. It would be meaningless to promote technologies that switch demand from other fuel to electricity, where the supply of electricity itself is limited. The measures are then broadly staged to be consistent with the outlook on energy market as defined by the three stages. Second, the measures have been based on global trends and on the recognized reduction potential in certain sectors. The list of measures is not offered as the best solutions that exist in their respective sectors. It is presented as an indicative list of potential EE measures that can be undertaken with the target of achieving a doubling in the reduction of energy intensity relative to the base-case by 2030. The lighting measures for Nepal, for both residential and commercial sectors, encourage the switch from incandescent bulbs to CFLs and ultimately to LEDs.

The industrial sector also offers good potential for a reduction in energy intensity. However, energy consumption across sub-sectors varies widely as they reflect a range of different technologies and end-use. That is why the first stage for the industrial sector must begin with a period of data collection, analysis and measure design. Significant adoption of energy efficiency can then be anticipated in the subsequent stages. In the transport sector, an increased penetration of large buses could drastically reduce the total miles driven per capita, reducing the need for smaller vehicles. Near term plan includes a higher use of diesel buses, but electrical buses will gradually capture more industry shares as electricity might become more abundant. Other measures push for the use of higher efficiency technologies within the same fuel category. Such higher efficiency technologies are already available in the market and its use needs to be supported through awareness and fiscal incentives.

NEPAL'S ENERGY EFFICIENCY STRATEGY AND ITS IMPLEMENTATION

The energy efficiency strategy must be based on energy savings against a forward looking baseline energy use. Nepal has an aspirational goal of graduating from LDC by 2022 – a goal that is endorsed by the government and is recognized as a national target. Achievement of this goal implies that the economy must achieve an annual average GDP growth rate of 9.2%. Such a growth rate would require a cumulative investment of NPR 9,697 billion through 2022, which is 6.3 times the GDP of 2012/13. Clearly, if Nepal were to be on that trajectory, the bulk of economic activity is yet to occur, and when it does, it will easily be one of the most intense periods of economic activity in its history. Nepal's energy efficiency strategy must be consistent with the fact that most of the country's economic activity is yet to unfold. Energy efficiency programs, measures, incentives and technology choices must target upcoming choices rather than requiring retrofits or changes to the existing stock of technology.

Comprehensive and Broad-based Energy Efficiency Strategy

To be effective, Nepal's energy efficiency strategy must be broad-based and comprehensive that should facilitate implementation to overcome the barriers across many different dimensions, as illustrated in Figure 3 below.

Figure 3: Barriers to energy efficiency in Nepal

To overcome these barriers to energy efficiency, a strategy must include a legal framework that provides an institutional basis for promoting and implementing energy efficiency. It must also provide a legal definition and mechanism for creating and sustaining energy efficiency markets. The strategy must be supplemented by policies that incentivise fair pricing of energy and remove of price distortions. It must allow for participants to have access to technology that can help them reduce their energy intensity and allow them to manage their energy use more efficiently. It should help create a strong pool of expertise through proper information, education and training, and then can support implementation of the measures and policies. The strategy must also be built around partnerships that allow it use existing institutional mechanism and delivery channels, such as industry association or formal banking channels. Finally, a key component of an energy efficiency strategy is to ensure the availability of financing based on models that allows energy savings to be monetized.

Time-Frame

The proposed EE strategy is divided into three phases - evolution, transition and maturity - consistent with the evolution of the broader energy market as described in Figure 4 below.

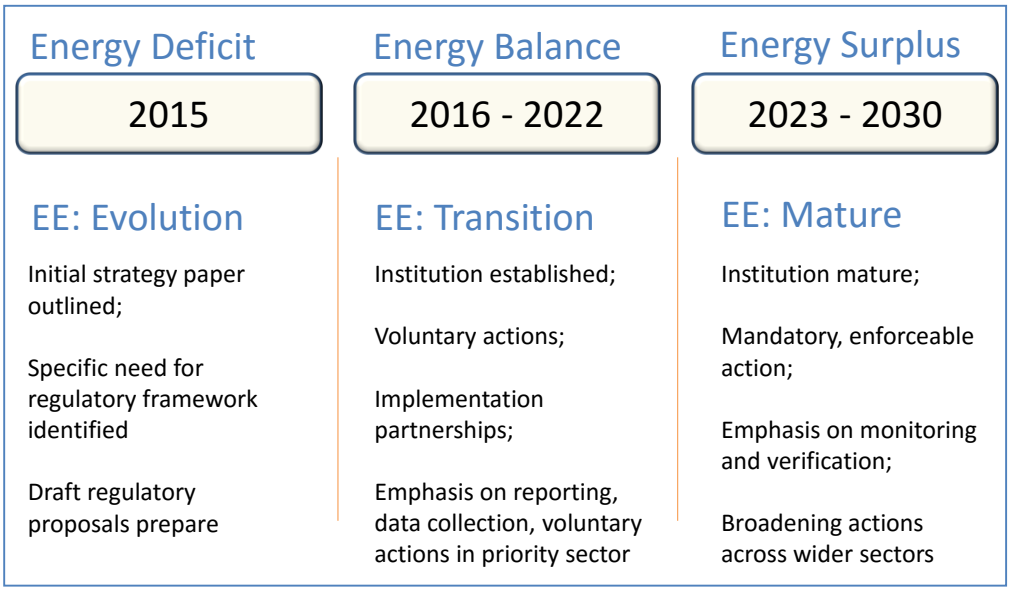

Figure 4: Proposed time line for an energy efficiency strategy

As described in an earlier section; 2015 AD, 2016 – 2022 AD and 2022 – 2030 AD have been associated with the three phases of energy deficit, balance and surplus respectively. The year range identified with each phase is not crucial to the analysis and simply offers one "hypothetical" view of when the transition between the energy phases will occur.

In the initial deficit period, policies and institutions will begin to be defined. In the next transition phase, the emphasis is on data collection and reporting, and almost of all the required actions is voluntary in nature. Beyond that, in the surplus phase, efficiency strategy moves into a mature stage. Institutional and legislative frameworks are well rooted by this time and required actions change from voluntary to mandatory requirements. There should be a greater emphasis on monitoring and evaluation. The energy strategy is pegged to the broader context of energy availability - deficit, balance and surplus - and not the specific years over which the phases occur.

Appropriate Regulatory Framework

No country has successfully implemented an energy efficiency strategy without a clear institutional structure. The prerequisite for an institutional structure is a legal framework, an act or executive order that clearly provides the legal basis for an energy efficiency strategy.

Ideally, the legal basis would create an institution, an Energy Efficiency Agency for example, that is charged with the objective of implementing the act. It must clearly define, for the institution, three of its key components: jurisdiction, regulatory authority and enforcement authority.

Practical Approach to the Implementation of EE Measures

As validated by the modelling results under the energy efficiency scenario, a large number of energy efficiency measures can be implemented. It will be impossible to implement all of them together. An important part of the strategy is, therefore, to offer a set of principles for how these measures could be implemented in a manner that is practical, achievable and meaningful. The analysis recommends for implementing EE measures in three broad time-horizon zones: short, medium and long term.

Short-term: Measures that offer a minimum accepted threshold of savings and are the easiest to implement are implemented in the short-term. The ease of implementation also depends on the instrument or approach being used to implement the measure. Command-and-control approaches, for example, are easier to implement than market based approaches.
Medium-term: Measures that require more capable systems of monitoring, evaluation and financial support are implemented in the mid-term. The environment and supporting framework should have been developed by then though it still may not have matured yet.
Long-term: All energy efficiency measures should be considered for implementation for the long-term.

The proposed implementation matrix based on an illustrative set of measures is outlined in Table 3.

Existing Gateways to End-users for Implementation

Despite endowing the energy efficiency agency with regulatory and enforcement authority, implementation of energy efficiency measures must use existing gateways to end-users to be effective. Having to build new implementation channels, even if its jurisdiction provides it the authority to do so, could mean significant duplication of effort and considerable inefficiency. This means that the implementation of energy efficiency must rely extensively on partnerships for implementation.

Broad-based Stakeholder Engagement

Energy efficiency is a cross-cutting issue puling across many different sectors, institutions and authorities. Stakeholder engagement is a crucial component of an overall energy efficiency strategy. It can also help build political consensus and ensures broad buy-in for policy implementation. Private sector co-operation during EE policy development and implementation ensures that policies take full advantage of the resources and commercial acumen of the private sector. EE issues are pervasive and the key target groups and/or stakeholders for EE intervention should be comprehensive. The primary stakeholders to energy efficiency in Nepal consist of government (including ministries and agencies), industry and business associations, civil society

organizations, consumer forums, development partners, universities and research institutions. Effective stakeholder engagement must include the following:

- Stakeholder diversity should be a goal of engagement;
- The legislative framework should make stakeholder engagement a mandatory requirement;
- Mechanisms that provide for ongoing stakeholder engagement are particularly useful;
- There is no single, best method for engaging stakeholders, the approach must be inclusive.

Table 3: Proposed energy efficiency measures

Priority	Sector	Measure Proposed	Rationale	Cost	Difficulty	Time Horizon
1	Industrial	Adoption of higher efficiency technologies	Holds strong reduction, as most potential industries are relying on low efficiency and low cost power solutions today. Even with the just limited penetration of high efficiency technologies, total reduction achieved will be significant	Moderate	Moderate	Mid/ Long term
2	Resident. & commerc.	Adoption of CFLs and LEDs	Global communities are rapidly moving away from low efficiency lighting source s As energy access increases in future, a large portion of future demand will come from lighting, reduction potential in the long run is big.	High	Easy	Short/Midterm
3	T&D losses	Reduce technical losses	Nepal has one of the highest level of losses The country is projected to rely heavily on locally generated electricity.	High	Moderate	Mid/Long term
4	Transport	Penetration of large diesel and electric buses	Large buses can dramatically reduce total miles driven per capita They can help reduce traffic congestion	High	Easy	Short/Mid term
5	Agricul.	Adoption of higher	Higher technologies already exists	Low	Easy	Short/Mid term

		efficient technologies with the same fuel	They have the highest reduction cost and fuel efficiency			
6	Resident. & commerc.	Adoption of higher efficiency technologies	Support a switch to a higher efficiency technology for future demand Several countries already have minimum efficiency requirement in place for certain appliances	Moderate	Easy	Short/Mid term

Enabling Pre-requisites for Implementation of EE Measures

In addition to an energy efficiency regulation and establishment of an agency, implementation of energy efficiency will require three key pre-requisites: human capital, testing facilities and enabling market.

Human Capital: Development and implementation of an energy efficiency strategy will require an industry of professionals with expertise in the sector. Essential among them are energy auditors and validators that work with companies, financial institutions, rating agencies and a range of other stakeholders to measure and monitor energy use and provide analysis of energy use and identify options for reductions. In addition, development of an energy efficiency industry also requires a critical mass of entrepreneurs who are willing to engage in the business of energy efficiency. Development of a critical mass of such experts requires training and certification facilities, which will enable these professionals to acquire these skills and have the supporting environment to grow with such careers.

Technical Testing Facilities: Implementation of energy efficiency programs requires a strong base of testing facilities that can provide independent reports on energy use of appliances and machinery. These facilities must be adequately resourced with current equipment that handle advances in consumer appliances, or must alternatively keep pace with international certification processes.

Enabling EE Market: Implementation of EE requires an enabling market that provides the base on which these activities can be built. An energy efficiency market consists of components which must come together within an integrated mechanism. Energy service companies (or ESCOs) are entities that help companies meet their energy efficiency objectives. They are effectively the delivery agents of the energy efficiency mission. Their business is, in turn, enabled by other factors, such as access to finance, contracting instruments and independent verification. One of the key challenges in developing an energy efficiency market is the legal contracting instrument. Many developing countries, including Nepal, lack the appropriate legal anchor for performance based contracts. A performance based contract is one where a service provider charges based on the realized performance. The challenge in implementing such contracts are that financial institutions

are typically not ready to project finance such contracts, in part because the independent monitoring and verification mechanism does not work.

A critical component for enabling an energy efficiency market is the readiness of financial institutions to invest in that sector. Financial institutions understand the energy dynamics but are still at an early stage of recognizing energy efficiency as a clear and distinct business opportunity. To support investments in that segment, however, they also need everything else to come together: such as contract sanctity, certainty of measurement and monitoring, availability of human and technical resources and companies that are in the business of delivering energy efficiency services. The ability to provide independent measurement, monitoring and verification (MM&V) is central to successful energy efficiency program. For this, there must be an agreement on the methods and protocols for conducting the MM &V. Such MM &V can only work if the users of the information have confidence in its independence and reliability. This is particularly important when financial contracts are involved.

CONCLUSION

Energy efficiency in Nepal can play a very meaningful role in supporting the country's development goals. In particular, if approached correctly, it could help enhance energy access and energy security. A wide range of potential measures are available to provide reductions on energy use. They can be implemented in a staggered, practical manner as the capacity for the design and implementation improves.

The biggest opportunities for Nepal's energy efficiency are yet to come. The energy efficiency strategy, therefore, must be prospective, rather than retrospective, in order to be consistent with future growth. The proposed energy efficiency measures and policy proposals for Nepal are based on **doubling the reduction in energy intensity by 2030 from what would otherwise have occurred in a business as usual case**. In order to implement these proposals, Nepal must also develop and put in place the necessary regulatory and institutional framework. Following this, the country must develop a draft action plan that outlines the sectors, measures, financing requirement and implementation strategy in greater detail.

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Living Laboratory – a new approach to engineering education

Nele Rumler
University of Applied Sciences Ruhr West, Bottrop, Germany
nele.rumler@hs-ruhrwest.de

ABSTRACT

Laboratory education plays an important role in engineering education. But there is criticism that in traditional laboratory courses intended learning outcomes are sometimes not achieved. That is why a new approach for laboratory courses, the living laboratory, is being developed. In the living laboratory the components of the energy supply system of the university building are being used for experiments by the students. The goal is to develop a learning environment which increases the intrinsic motivation and supports the development of competences of the students through job relevant, practical tasks. Based on first results a prototype design, the engineering office, is developed. The approach helps to modernize engineering education and is a chance for future engineering education for sustainable energy use.

KEYWORDS

Engineering education, laboratory courses, living laboratory, role of laboratory

INTRODUCTION

The working environment is changing continuously so that engineers of today are faced with new challenges in their work compared to the past. To prepare engineering students adequately for this, always changing work environment, engineering education has to adjust to the new challenges. The importance of this process is being underlined by the UNESCO Engineering Initiative, which has the goal to modernize engineering education [1]. This paper presents work of the PhD research project of the author, which is done to contribute to the modernization of engineering education. The main research question is: what are the characteristics of a technical and didactical concept for a living laboratory that increases the motivation and supports competence development of the students. The concept of the living laboratory is aimed at contributing to future engineering education for sustainable energy use. To examine the background of the study, the role of laboratory education and competence development is explained, followed by a description of the idea of the living laboratory, the methodology, and first results.

Laboratory education

An important part of engineering education are laboratory sessions, which are used besides lectures, seminars and tutorials. Abdulwahed and Nagy give the following explanation for this important role: *"The essential role of laboratories can be correlated with the fact that engineering is, in general, an applied science that requires hands-on skills and involves elements of design, problem solving, and analytical thinking."* [2]. As early as 1958 the role of laboratory education in engineering education was discussed at a panel discussion during the National Electronics Conference in Chicago [3]. Three of the points mentioned at this panel discussion can be found in the literature until today:

- Students should become familiar with technical systems (see for example [3–8])

- Laboratory sessions should show the relations between theory and practice (see for example [3, 5, 6, 8–10])
- Through laboratory education students should get a feeling for real-life problems (see for example [3–8])

In the literature since 2002 two new roles are mentioned several times:

- In laboratory sessions job relevant methods and procedures should be learnt (see for example [5–8, 10])
- Through laboratory education social competences should be developed (see for example [5, 7, 10])

Much attention is given to the paper of Feisel and Rosa [7], because they give a list of 13 learning outcomes of laboratory education. The five roles of laboratory education mentioned above are further detailed within these 13 learning outcomes.

There are not many studies which investigate the students' point of view regarding laboratory education. Edward explains that students see laboratory education as an important part of their studies to gain experience and to connect theory and practice [5]. Students see themselves as practitioner, which is why it is important for them to have laboratory sessions in their education [5]. In a study of Lin and Tsai students point out that data of experiments is helping them to understand the theory [11].

Summarizing it can be said that lecturers and students point out the importance of laboratory sessions in engineering education. The first three goals of laboratory education mentioned above underline this importance, because it is hard to achieve these goals with a lecture or seminar. But there is also criticism that the intended learning outcomes of laboratory sessions are sometimes not achieved. The complexity of the task in laboratory sessions is reduced so that it matches the level of knowledge of the students and can be solved in a given time [12]. But due to this reduction the relevance for practice is questionable [12]. Furthermore, it is often hard for students to see the relation between laboratory experiments and the real world [13]. Besides, there are often detailed laboratory instruction, so that students just follow these instructions so that no deep learning is taking place [13]. If laboratory experiments are designed in such a way, that students have to plan which experiments they want to do and how they conduct them, a deeper comprehension of the problem is promoted.

Focus on development of competences

As said before the working environment is changing due to a pursuit of more flexibility and individualism. There are studies which investigate which influence this change has on what students need in their future professional life. Minks e.g. states that technical knowledge is only one part of the requirements needed for a job and key competences is the other important part [14]. The European Commission states in its communication about lifelong learning from 2001*: "Yet people, their knowledge and competences are the key to Europe's future."* [15].

That means that the role of competences is stressed which has already been discussed in the scientific community since 1973 [16]. This discussion has intensified since the Bologna-Reform.

Now universities lay a focus on competence development [17]. That is why the concept for the living laboratory should be designed in such a way that competence development is supported.

THE LIVING LABORATORY

In the course of the construction of the campus of the University of Applied Sciences Ruhr West in Bottrop, Germany, the idea was developed to use the university building as a living laboratory. That means that the technical components of the energy supply system of the building can be used in the education. Instead of conducting experiments at laboratory setups, the energy supply system of the building can be used in laboratory sessions. The goal is to develop a learning environment which increases the intrinsic motivation and supports the development of competences of the students through job relevant, practical tasks. In the following the technical preparations and preliminary didactical considerations are described.

Technical preparations

The heat energy for the university building is being supplied by a connection to the district heating system of the city. But in order to be able to give students the opportunity to get to know and experiment with different energy supply systems, an advanced energy supply systems has been developed. Additional pipes have been installed to connect the energy supply systems of the Institute of Energy Systems and Energy Management to the main energy supply systems. The institute has different energy supply systems like two combined heat and power plants, two heat pumps and a pellet boiler. Furthermore, a heat exchanger is installed in a nearby wastewater pipe and it is planned to purchase a solar thermal system to install. As these systems supply energy on different temperature levels, a hydraulic system has been developed which operates on three different temperature levels. A schematic plot of this is shown in
Figure 22.

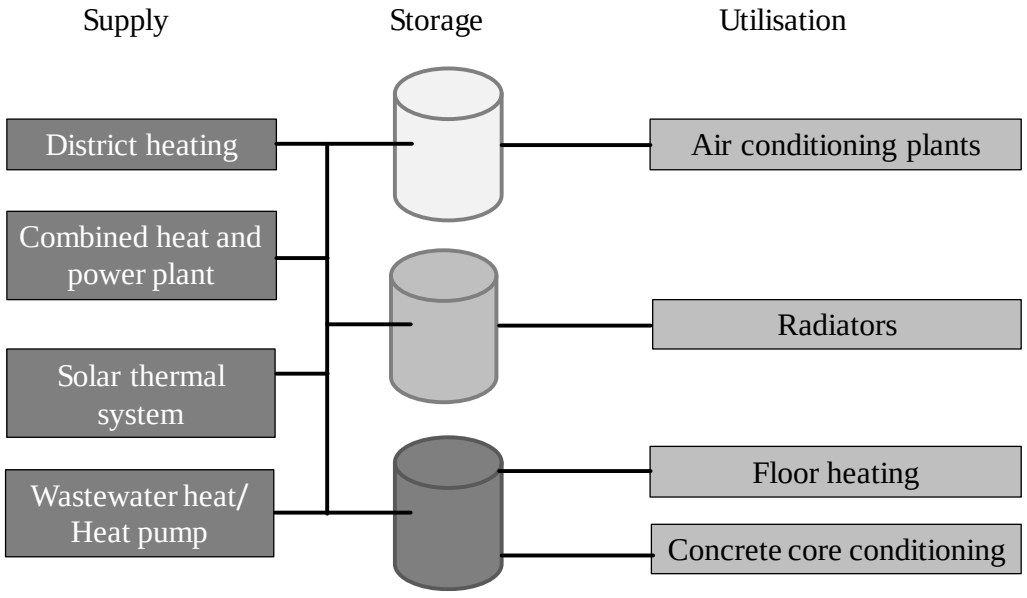

Figure 22. Energy supply system of the university building

With this hydraulic system the energy supply systems can provide the energy on the temperature level they produce. Through this, exergy losses can be reduced, because, for example, the heat of the combined heat and power plant which is produced on a high temperature level does not need to be cooled down by mixing with the return flow to be used for floor heating. To supply the floor heating, heat pumps can be used.

Furthermore, an energy monitoring system has been installed. A standard system only comprises certain sensors which are essential for controlling the system. In order to offer the students the opportunity to have a detailed insight into the energy supply system of the building, additional temperature sensors and flow meters have been installed. It is now possible to plot not only the energy flow of the whole system but also to look into, for example, one single floor.

With this system students get to know the operation mode of different energy supply systems as well as the interaction of the different technologies within the whole system. The system was designed as flexible as possible to allow the implementation of additional energy supply systems when there are technological innovations.

Didactical considerations

As explained before, there is criticism that in traditional laboratory session the intended learning outcomes are not achieved, because no deep learning is taking place. According to Prosser and Trigwell, lecturers can design the learning environment in such a way that students are encouraged to use a deep learning approach [18]. Wildt states that learning environments should be designed in such a way that there are complex tasks in an authentic setting which allow for multiple perspectives and reflection in the working process, to support competence development [19]. One approach to do so is problem-based learning (PBL). In PBL a problem is the starting point of the learning process. With the help of this problem students find out on their own what information and knowledge they need to understand and solve the problem. Examples of how PBL is implemented in engineering education can be found, for example, in [20, 21]. With PBL realistic tasks can be integrated in the education and the social-communicative and the technical-methodical competence is being supported [22].

For the living laboratory a didactical concept should be developed that prevents students from just following instructions without comprehending why they do an experiment in a certain way. Furthermore, the competence development should be supported. That is why PBL was chosen as the basis of the concept.

METHODOLOGY

The study is conducted as design-based research. According to Plomp *"educational design research is the systematic study of designing, developing and evaluating educational interventions (such as programs, teaching-learning strategies and materials, products and systems) as solutions for complex problems in educational practice, which also aims at advancing our knowledge about the characteristics of these interventions and the process to design and develop them."* [23]. The design-based research process is cyclical; first a need and context analysis is done by literature review and site visits, then a prototype of the design is developed and in iterative cycles tested and refined in practice and the process is being reflected to produce design principles [23]. An important part of design-based research is reporting through progress reports, articles etc., because

the design evolves over time [24]. That is why the first prototype design is being presented in this paper.

During the following month the prototype will be further detailed and the technical concept to implement it will be developed. The first implementation is envisaged for the summer semester 2016. The living laboratory will be first offered as an elective course in the study courses Industrial Engineering – Energy Systems and, Energy and Environmental Engineering. Later, it is planned to include it also in mandatory courses like Thermodynamics, Energy Efficiency, Renewable energy systems etc. The implementation will be evaluated by analyzing the motivation and competence development of the students to refine the prototypes.

FIRST RESULTS

To develop a technical and didactical concept for the living laboratory a literature review was done, to identify similar projects. Based on the findings of the literature review and site observations a first prototype design has been developed.

Literature review and site observations

At many universities projects are done which investigate one aspect on their own campus. But these are isolated projects and the university building is not integrated into education on a regular basis. Four examples were found which are similar to the idea of a living laboratory at the University of Applied Sciences Ruhr West:

- At the University of Colorado, Boulder the "Integrated Teaching and Learning Laboratory" was designed as a "building as a learning tool" in 1997. The building technology is being exposed, additional sensors have been installed and there are two identical classrooms next to each other and it was planned that in one of them the students can control the climate. [25] In an inquiry about today's use of the "building as a learning tool" Sullivan stated, that there has been little sustained use of the building systems data [26].
- In 2005 the Engineering and Design Department of the Eastern Washington University moved into a new building which was designed as a Living-Building Laboratory. It was planned to install many additional sensors for a monitoring system, but due to financial difficulties only part of it has been implemented. The data was used for two experiments, one in thermodynamics and one in fluid mechanics. [27] In 2015 the building data is not used any longer in the education, because of difficulties in gaining access to the data and maintaining the data [28].
- A third project was planned at the University of Nebraska. In the Peter Kiewit Institute additional sensors were installed to monitor the electricity consumption [29]. But they were not activated so that it is not used as a living laboratory [30].
- At the Technische Universität Berlin an experimental building was planned by Architecture students and the design of the technical installations was done by students of Building Service Engineering. The concept envisaged a building with two rooms, one lecture room and one room for the technical equipment. With the experimental building the widest possible variety of energy concepts should be made experienceable. [31] It was planned to construct the building in summer 2010, but the plan was abandoned [32].

In the research no example was found, where, at the moment, a university building is being used for experiments by the students. The first two examples underline the importance of including a strategy for the sustained use of the living laboratory in the concept.

It is envisaged to use the living laboratory in an elective course for two study courses. There are other courses where the students work on a project for a whole semester. From the authors' observation and through discussion with her colleagues the author identified that some groups have problems with these long projects. Some do not start working at the beginning of the semester, they do not work continually during the semester and some groups divide the work and solve it individually and not as a group work. To support groups with these difficulties the facilitator could address them. In project or problem-based learning the tutor has to find the right balance for facilitation, because neither being too directive nor being too laissez-faire facilitates the learning process [33].

Prototype concept

Having in mind, on the one hand, the problem other living laboratories had with the sustainability of their projects and, on the other hand, the challenge to find the right balance of facilitation in PBL, a new approach to the concept of the living laboratory of the University of Applied Sciences Ruhr West is developed. The idea is to create an engineering office which has the mission to analyze the energy supply system and identify energy saving measures at the University. The head of the engineering office is a professor who is responsible for the course. A research assistant is the managing director and the students are the project engineers. The students work for one or two semesters in the office and get credit points for it so that it accounts for one respectively two elective courses. Furthermore, they get a job reference.

The challenges with project work mentioned above can be mitigated by regular meetings with the managing director of the engineering office. During the meetings the results will be discussed, but even more important, the process and teamwork will be reflected. In the beginning, these meetings can be more frequent and during the semester the students will resume more and more responsibility.

The identification of the tasks the engineers will work on in the office can be achieved in different ways: the students identify a problem on their own, the tutor points them to a problem, or the facility management has identified a problem they want to have analyzed. While working on the projects and doing experiments, the students have to consider as a sub-target if some of the measurements they are doing can be used in a short laboratory experiment of two hours. Like this the living laboratory can be integrated into the curriculum as demonstrated in Figure 23.

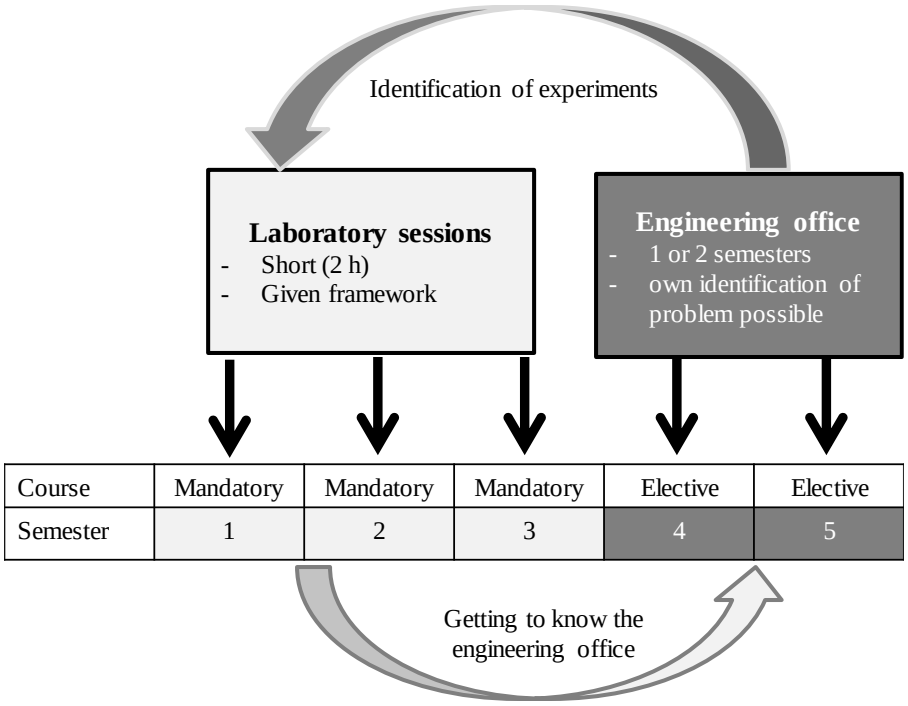

Figure 23. Integration of the living laboratory in the curriculum

The students get to know the living laboratory during the first three semesters in short laboratory sessions in mandatory courses. In this context the engineering office will be presented. In the fourth and fifth semester the students can then choose the engineering office as an elective course.

Furthermore, the engineering office will publish semi-annual reports and monthly news on the website, so that the office is visible within the university. This is important to achieve a sustainable use of the living laboratory. If there is a demand by the students to work in the engineering office it is more likely that the project will continue even after the current research project ended or when the faculty staff changes. The incentive for the students to work in the engineering office is, on the one hand, the credit points. On the other hand, it is the job reference and practical experience they gain. And they see the relevance of the work, because it is envisaged to have regular meetings with the facility management and the university management.

SUMMARY AND OUTLOOK

The concept for a living laboratory should contribute to the modernization of engineering education. It has to consider criticism of traditional laboratory session, which says that intended learning outcomes are sometimes not achieved, because no deep learning is taking place or the practical relevance of the experiments are questionable. Therefore, PBL is chosen to be the basis of the new concept.

Through the literature review it was found that the most important aspect of a living laboratory is a strategy for its sustained use. Observations at the site show that the right balance of facilitation is a crucial point for the PBL approach to be successful. Based on these findings the first prototype concept, the engineering office, is developed. In the engineering office the students work as project engineers and identify energy saving measures for the university campus. By regular publications

and by demonstrating the relevance of the work of the engineering office a demand of the students for working in the office will be created. Through this a sustainable use of the living laboratory should be assured, because if there are always students who want to work for the engineering office it is more likely that the concept will be used even when faculty staff changes. The observed challenges for students doing project work can be reduced by having regular meetings with the managing director of the engineering office, where results are discussed and the process and team work is being reflected.

The next steps will be to define the intended learning outcomes of the engineering office to refine the didactical concept. Based on this, the measures to evaluate the implementation will be developed. A first implementation of the concept is planned for summer semester 2016.

To allow transferability of the living laboratory approach to other universities all over the world, two measures will be taken. First, a training concept for lecturers will be developed and second, generalizations with regard to climate conditions will be done so that different energy supply systems will be considered. The living laboratory approach is a chance for future engineering education for sustainable energy use and helps to modernize engineering education which is also the goal of the UNESCO engineering initiative.

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Promoting Climate Adapted Housing and Energy Efficient Buildings: Chances and Challenges

ABSTRACT

This contribution discusses ways and limits to energy-efficient and climate adapted building in Ho Chi Minh City (HCMC) in the context of current socio-economic development and the resulting new energy-use behaviour and life-style changes. Constraints resulting from socio-economic and the institutional context towards energy-efficiency in housing are introduced. The climate in HCMC and the related characteristics of thermal comfort perception are discussed as the natural context of new buildings as well as the existing building stock that is to be retrofitted. In this context bioclimatic and passive measures in tropical climate, mechanical cooling and building design concepts are discussed as practical measures. Further policies and other means to promote energy-efficient housing in the distinct market of Vietnam are introduced.

KEYWORDS

Energy-Efficient Housing, Climate Adapted Building, Tropical Climate, Mega-Urban Region, Energy-Use Behaviour.

INTRODUCTION

The world is facing major challenges related to the process of urbanization and population growth. Since 2007 already, more than half of the global population is living live in urban rather than rural areas, with still rapidly increasing urbanisation in Asia and Africa. In this way, the cities will be confronted with numerous challenges such as clean water and air, sewage, food, shelter, transportation, affordable housing and – adequate energy provision, as well. Adding to this, many urban agglomerations face serious risks related to global climate change.

Currently, urban spatial expansion in Vietnam is mainly driven by suburbanisation processes of the emerging urban middle class. The new social stratum has an increasing ecological footprint due to changed nutrition behaviours, the switch to cars and the purchase of new housing. This is also a global phenomenon: The World Development Report 2010 assumes that by 2050 a large share of the population in today's developing countries will have a middle-class lifestyle. If no adequate measures are taken, energy demand will increase dramatically – and related greenhouse gas emissions will explode. But the planet will not be able to sustain 9 billion people with the carbon footprint of today's average middle-class citizen. Annual emissions would almost triple. Urbanisation in combination with economic growth will see increased construction of buildings for housing, business and government. In this context, housing offers enormous potential for the reduction of greenhouse gas emissions.

Vietnam's dynamic development in the past decades went along with immense construction activities as a result of increasing demand for new residential and non-residential buildings as well as for new infrastructure. In the same time a change of living conditions for a growing number of urban population within the mega-urban region of Ho Chi Minh City (HCMC) occurred. With rising living standards and a larger share of income being available for life-style changes and new consumption behaviour, also new ways of building and the use of buildings are emerging. The

construction industry is strongly involved in this development and a large volume of construction activity is currently on-going with concepts and systems different to the climate-adapted traditional ways. Also the existing building stock is retrofitted with modern technology for comfort conditioning, although the buildings themselves are not designed for being conditioned. The climate in HCMC is demanding and the new ways of building conditioning are usually very energy intensive.

In Vietnam electricity is being massively subsidised in order to provide for the basic needs of the wider population and in order to enhance the competiveness of large industrial companies (UNDP 2012: 16). These subsidies reduce the pressure for the emerging urban middle class to consider energy-efficiency and other environmental aspects in their life-style. However, since subsidies will be gradually reduced and energy costs will rise, energy costs will become more relevant in the budget considerations of households in future. Further the growing overall energy demand is exceeding the capacities of the available energy supply systems. This increases the need for public investments into new energy infrastructure on all spatial levels and requests policies to promote energy efficiency. With extreme weather events, increasing flooding events and sea level rise being recognized as major climate change related threats to large areas of Vietnam and especially to HCMC, the burning of fossil fuels and the emission of greenhouse gasses need to be limited in order to mitigate global and local climate change threats.

This chapter introduces design strategies, construction principles and advice for building occupants on how to achieve energy-efficient and comfortable performance in residential buildings in the climate of HCMC. While the measures are presented for the individual building project and its users, they are in a larger context effective for resource saving and climate change mitigation on the urban scale and beyond. Finally, it will be discussed how these measures can be implemented in Vietnam given socio-economic and institutional constraints.

SOCIO-ECONOMIC DIMENSIONS AND DEVELOPMENT OF ENERGY-USE BEHAVIOUR IN RESIDENTIAL BUILDINGS

Mega-urban regions in the making, such as HCMC or Hanoi, indeed offer strategic potentials for reducing the consumption of resources and human-induced greenhouse gas emissions below the otherwise expected trend. For example, energy consumption of all economic sectors in HCMC is about 2.5 times higher than national average (Lindlein 2012: 13). Households play a major part in energy consumption: They account for about 35-40% of the city's total energy use in Vietnam (AUS 2012: 2). In general, the transition of Vietnam's urban society has led to increasing social differentiation in terms of income, education, family size, consumption patterns, etc., to produce hitherto unknown class divisions. As a result of the economic boom, the urban middle classes in Vietnam have increased dramatically. According the market research company TNS, in the four biggest cities of Vietnam the number of households with a disposable income of more than US$500 increased fivefold to 37% between 1999 and 2008 (TNS 2009). Further, many households, particularly in the South, are benefiting from huge money transfers from their relatives living in the U.S. or Australia for example. In 2014 Vietnam received 14.00 billion USD in overseas remittances, a significant part of this amount was poured into the country's real estate market (Viet Nam News 12/02/2015).

All this is reflecting an enormous rise of purchasing power among the urban middle class population and – from a western perspective – the delayed development towards a modern consumer society in Vietnam. Furthermore, the Vietnamese baby-boom generation of the 1980s is now reaching the age of active consumption that will lead to a constant demographic increase of these well-funded strata (Waibel & Schwede 2009). Consequently, this social stratum is adopting more and more resource-intensive life-styles.

Here, the urban middle class population has expanded to an astonishing degree, especially during the first decade of the new millennium (Waibel 2010). On a global scale, these beneficiaries of transition augment the group of so-called "new consumers" (Myers & Kent 2003), who can be considered a key target group for future economic and ecological sustainability. The number of new consumers had already reached 1 billion people in 2000, mostly located in China, India, Brazil, Russia, and various Southeast and East Asian countries. The Economist estimated the size of the global middle classes at up to half of the world's population in a special report on the new middle classes in emerging markets published in 2009 (The Economist 2009). The lifestyles and the consumption patterns of the new middle classes will influence the ecological balance of our planet significantly, especially against the background of climate change (see also Lange & Meier 2009). Myers & Kent (2003) showed that in the case of India, the per-capita energy consumption of the new consumers has been causing CO2 emissions 15 times greater than those of the rest of the population. Further, the new middle classes appear to be moving to newly built peripheral urban areas, a development that implies increased mobility costs and promotes urban sprawl. These suburbanization processes have significantly increased the distances from private residences to work places and have therefore led to higher energy use for daily transportation.
So far, the environmentally conscious behaviour does not seem to be very distinct among the new urban middle classes in Vietnam (Waibel & Schwede 2009). On the contrary, social prestige appears to be very much based on the purchase of status symbols and consumerism in general (Waibel 2008, Waibel 2013).

The horizontal social differentiation into different life-style groups, which is already underway in other metropolis of Southeast Asia such as Jakarta and Bangkok (Robinson & Goodman 1996; Chua 2000) or Chinese cities (Goodman 2008), is still at the very beginning in urban Vietnam. Post-materialistic or so-called "alternative" lifestyles can be hardly found there so far. The advocacy and adoption of energy- and carbon-efficient lifestyles is still very much in the infant stage.

Empirical Survey Results

In the following, some empirical results gained through a representative survey (Waibel 2009) among 414 middle class members living in different house types in HCMC illustrate the consumption profiles of the new consumers in comparison to those of the "old consumers" in the established industrial countries. For example, one surprising result was that the amount of living space among the urban middle classes in HCMC is almost the same as in Germany (an average of 42 m2/capita). With an average living space of 36 m2 per capita, the new consumers have exactly the same living space at their disposal as the inhabitants of the city-state of Hamburg in Germany, for example. Many articles on housing in Vietnam in the past have highlighted the shortage of living space; but nowadays, at least among the urban middle class population, the amount of living

space per capita does not seem to be a big problem anymore. The national housing census of April 2009 generally confirms the picture drawn by the author's empirical survey: It shows that in HCMC, the average living space available to inhabitants of solid houses is 34 square metres per capita (Housing Bureau 2009). This is the highest figure for all of Vietnam.

In terms of electricity consumption, the situation is not very different from the one in Germany anymore either. However, it should be taken into account that in tropical Vietnam, a large part of the electricity is used for cooling, whereas in Germany, energy consumption for heating is usually based on fossil fuels and usually not included in the electricity bill. Another difference is that in Germany, energy used for cooking is a very important share of electricity consumption. In Vietnam, cooking is mainly done with gas ovens.

As an analysis of electricity consumption patterns reveals, there seems to be much potential for energy saving. House owners in HCMC, for example, complained about the insufficient air-tightness of their buildings, which leads to high losses of cooling energy. A study by Schwede (2010) showed that a significant amount of energy is lost through insufficient airtight buildings and natural ventilation in mechanically cooled buildings. Much energy for cooling could simply be saved by shading through trees surrounding the building or through sunscreens to reduce the solar gains through the façade openings. In that respect, much can be learned from the tropical architecture erected in Vietnam during the 1960s till the 1980s. Also, much can be learnt from traditional rural architecture, particularly regarding effective natural ventilation and constructive shading (Waibel 2012).

Air conditioning is by far the highest single share of electricity consumption in private households. About two-thirds of all interviewed new consumers (62%) reported that they owned A/C devices, in contrast to an average possession rate of just 24% among HCMC's population in 2010 (in 2002, the share was only 10%) (HCMC Statistical Office 2011: 328). Air conditioning devices are most commonly used among villa (nhà biệt thự) and town house (nhà phố) owners. In the future, prevalence of A/C equipment and of other energy-intensive home appliances such as washing machines or dishwashers is expected to increase further. Currently, the second most important source of electricity consumption are electrical water heaters.

Quite remarkably, only a small part of households (16%) in HCMC had installed solar water heaters in 2009. Most recently, this share has increased, though, particularly among new town house constructions. Solar water heaters are not very expensive (on average US$ 500-1,000), particularly compared to the overall generally high building costs. Solar water heaters offer a great energy-saving potential and comparatively short payback times.

Changing the culture of consumption among the new consumers (or other social groups) in urban Vietnam is certainly difficult. For example, the World Bank stated in a recent report that behavioural lethargy is one of the main barriers to reach energy efficiency in Vietnam (Taylor et al. 2010). But this complex terrain is not completely impervious to policy intervention. In his ground-breaking publication on sustainable consumption, Jackson (2006) proposes a comprehensive catalogue listing a wide range of possible action fields (see figure below), which he groups into four main avenues (Enable, Encourage, Engage, and Exemplify).

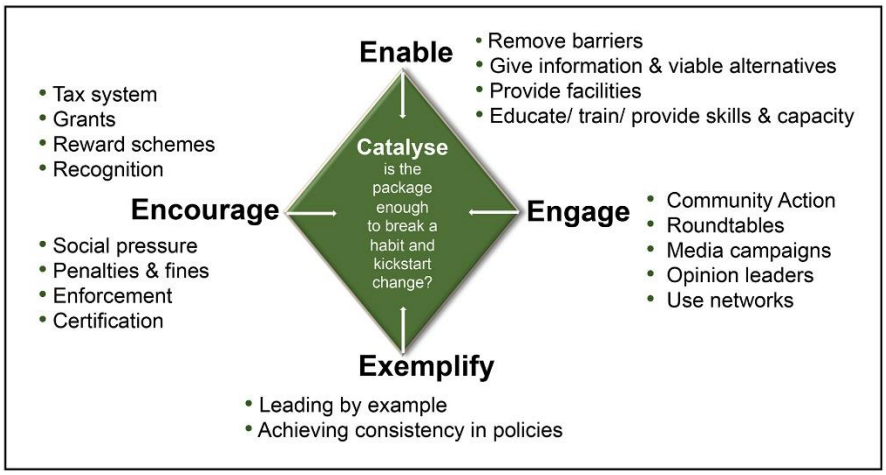

Figure 1. Model for Behaviour Change Policy (own design after Jackson 2006)

By means of a comprehensive catalogue, as shown in the figure above, policy-makers or NGOs could fine-tune their approaches towards the promotion of climate-adapted housing and energy-efficient buildings, helping to overcome value-action gaps and to re-instate behaviour change.

In Vietnam, the installation of solar water heaters could be further supported by an appropriate set of economic instruments. Policy makers already reduced the value added tax to persuade people to install solar water heaters, for example. However, this specific economic instrument is not strong, as is has been observed that many customers evade payment of value added tax anyway. This shows, that the development of adequate polices and guidelines to promote energy-efficient housing needs excellent knowledge of the local institutional framework and of socio-cultural conditions. Economic incentives could also support the dissemination of energy efficient construction and environmentally friendly construction materials, which currently suffer from a "vicious circle of low demand – high cost" in Vietnam (Lindlein 2012: 41).

In terms of the promotion of energy-efficient housing, encouragement through economic and fiscal incentives (tax system, grants, rewards schemes and fines) have probably proven to be most effective in Western countries in the past. For example, German Kreditanstalt für Wiederaufbau (KfW) has been very successful in providing beneficial loans and investment grants to homebuyers who want to make their new house (or who would like to refurbish their house) more energy-efficient than demanded by the current energy conservation ordinance (EnEV). But this requires a solid surveillance and control system, including investments in creating expertise such as capacity building among architects, engineers, energy auditors, the state apparatus and last but not least a trustworthy local bank system.

Interim Conclusion

As far as socio-economic factors are concerned, the rapidly emerging urban middle class (new consumers) should become a key target group for increased sustainability. The new consumers can also behave as trendsetters and pioneers of environmentally conscious behaviour. Education for sustainable development should be further promoted in general. It should become integral part already of kindergarten and primary school education, already and not only implemented by state institutions alone. For example, activities by non-state organisations such as "Live & Learn"

aiming to raise the environmental awareness among the urban youth deserve full support from international donors as well as from the national and local policy level (Waibel 2012). The promotion of behaviour change is a comprehensive and challenging strategy, after all.

CONSTRAINTS TOWARDS ENERGY-EFFICIENCY IN HOUSING IN VIETNAM

In the case of China, for example, Richertzhagen et al. (2008) showed that the incremental costs for new energy-efficient buildings are rather low, accounting for five to seven percent of the entire investment costs of a new building. Their analysis demonstrate that the expenses for energy-efficient buildings are often overestimated and that not only households, but also key players in the real estate sector often misjudge the costs and benefits of energy-efficient buildings and are therefore reluctant to invest in efficiency.

The analysis of the building stock and the current construction activities in Vietnam illustrates, in contrast, that new buildings are usually equipped with energy-intensive air conditioning technology and that double glazed windows are rather rare, for example. Another problem is that a lot of properties are bought for investment purposes only. The speculators usually have little interest in energy efficiency because they will not benefit from it themselves but only want to sell their properties for the highest price achievable. According to a report from 2010, currently only 38% homebuyers purchase real estate for their own housing needs (Lindlein 2012: 7). But for them, the construction of their own house usually remains the most expensive investment of their lifetime. As land prices are exorbitantly high, they focus to minimize all other costs and do not pay attention to utilize natural ventilation or energy from the sun. On bigger scale you can observe a split of owner and consumer particularly regarding commercial buildings: For example, often the constructor of a building is not the same as the operator of a building. Usually, the owner of the building is not the same as the building user. Whereas the operator of a building might be able to charge higher rents because the tenants effectively benefit from a higher standard and reduced energy costs, the constructor usually has no direct benefits. In addition, a very strong interest in extremely short return-of-investments periods can be observed from the side of the investors in Vietnam who often lack of more medium-term thinking.

DISCUSSION OF THE CLIMATE IN HCMC

The climate in HCMC is the most important boundary condition for thermal comfort perception, the resulting energy use and energy-efficient operation in buildings. HCMC has tropical climate with temperatures ranging from minimum of 20°C and to a maximum of 36°C. In the hottest months (March, April) the average daily temperatures are below 29°C and in the cooler months (June, July and November) average temperatures are only slightly cooler around 27°C. The temperature shift is up to 12K. But since daily average levels are high, temperature remain above 20°C all year around. The day-night temperature shift is larger on days with high maximum temperatures, when the cloud cover is open and allows solar insolation during day and cooling outward longwave radiation in the night. This condition is seldom and more overcast conditions prevail, resulting in small temperature day night variations.

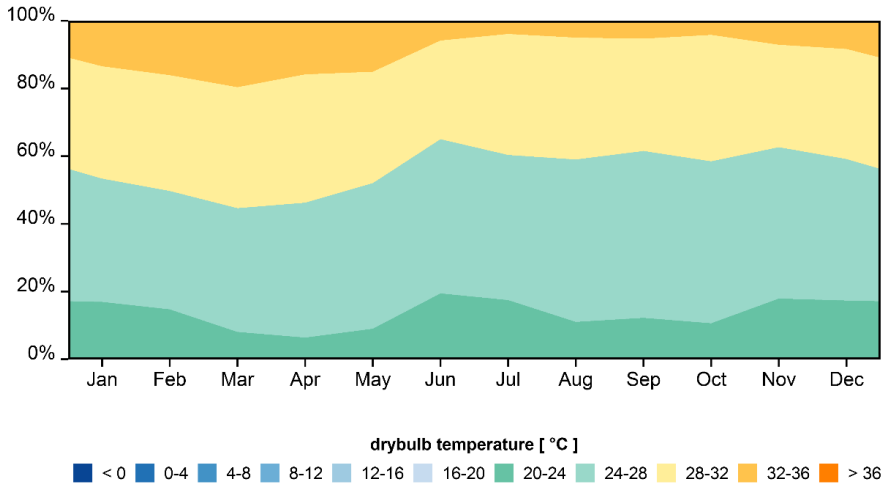

Figure 2. Monthly Average Daily Temperatures Bands (Source: Schwede und Hesse 2014)

Humidity of the air is in the range between 12g/kg$_{\text{dry air}}$ and 24 g/kg$_{\text{dry air}}$ with rather low diurnal variations. As a result of the temperature shift the relative humidity is just below 100% when the temperatures are low and in the range of 40%-60% in the warmer period of the day. Frequently the relative humidity reaches 80% in times when outdoor temperature are high. In general it can be said that the humidity is always too high to be in comfort under natural conditions (Schwede und Hesse 2014).

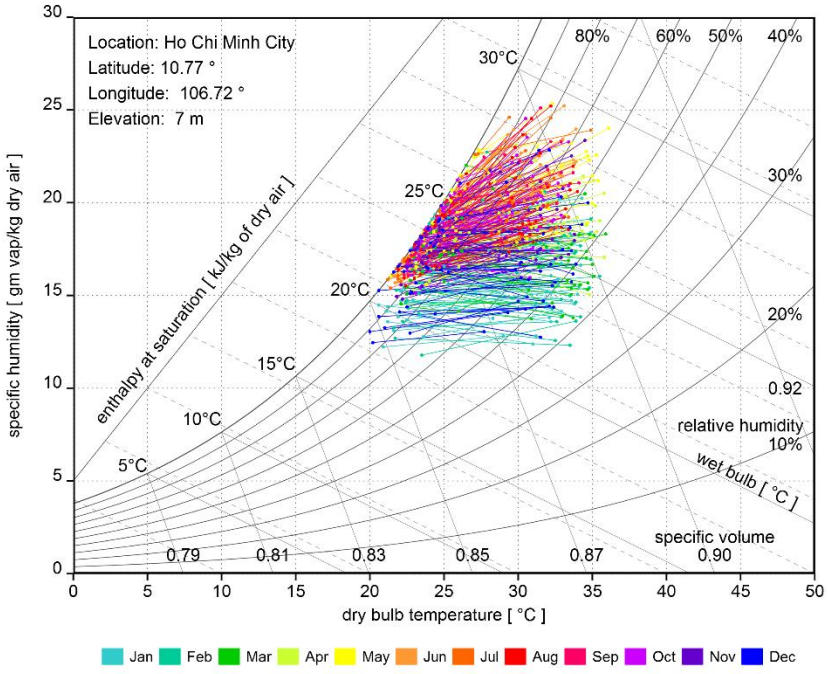

Figure 3. Psychometric Chart of Climate Conditions in HCMC, Temperature and Humidity of Outdoor Air, Daily Pairs of Coolest and Warmest Hours of the Day (Schwede und Hesse 2014)

During the rainy season, between May and October the cloud cover does reduce the solar radiation with the result that outdoor temperatures are slightly lower, than in the dry season between November and April. In the rainy season the air is more humid. Due to the low latitude and the frequent overcast condition the diffuse and global radiation is high throughout the year and does not show the annual variation, as can be observed in in our latitude (see Fig. 4). The number of sunshine hours per month is 270h in the dry season and around 160h per month in the rainy season.

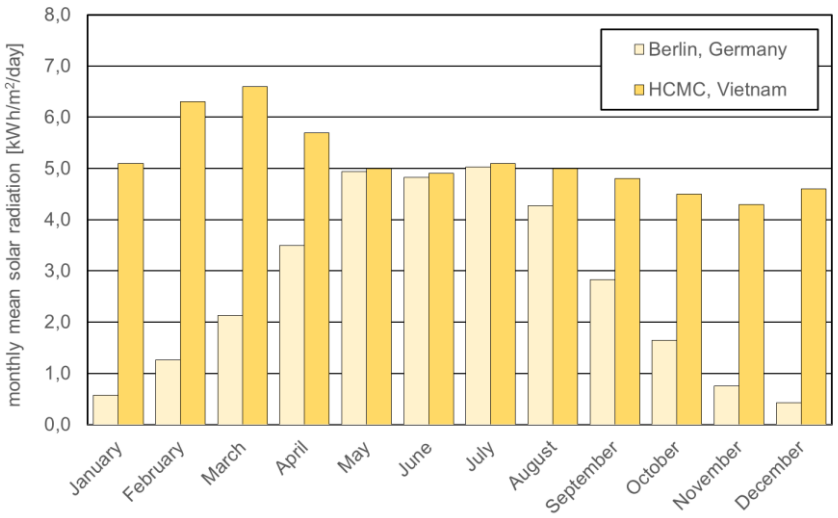

Figure 4. Comparison of Monthly Mean Solar Radiation in HCMC and Berlin (Schwede und Hesse 2014)

COMFORT CONSIDERATIONS AND ADAPTIVE USE BEHAVIOUR

Warm and humid climates are not as hostile as the cold climates we know, but the climatic conditions in these regions are often perceived as not supportive to productive activity. In hot and humid climates people are used to these conditions and they have ways to adapt to make themselves feel more comfortable. The adaptation takes place by selection of clothing, reducing of activity and by taking a position that allows more effective heat release from the body. In order to increase comfort people rest in the shade and consume cool drinks, such as iced coffee.

In residential settings occupants are free to adapt through adjustment of posture, activity and clothing. In professional settings occupants might have less adaptive opportunities, so that non-residential building are more likely to required mechanical conditioning. Adaptation is also more constraint in the urban environments than in rural settings, but also urban residences can provide opportunities for individual adaptation, if designed well and aware of the processes required.

Thermal comfort is influenced by a number of physical and individual conditions. The air temperature and the radiative temperature will define the perception of heat and the ability of the body to expel heat through radiation and convective heat transfer. Air movement will increase convective heat exchange on the skin surface and will also support the evaporation of sweat through exchange of the air layer close to the skin. The air humidity will influence the ability of the skin to cool through transpiration of sweat. Depending on the air movement and the air humidity the sweat will evaporate and cool the body. Therefore air movement has great influence

on the comfort perception in tropical regions. Even if the air temperature and air humidity is high comfort can be improved, when the body is exposed to moderate air movement.

Besides these classical thermal comfort parameters the exposure to direct insolation and the perception of glare caused by high levels of diffuse solar radiation will influence thermal comfort in tropical climates. For this reason shading is a crucial measure to improve thermal comfort. When people are in direct contact with surfaces, material conductivity and the surface temperature will be effective.

Additional to the physical conditions the human factors, such as activity, closing and body posture can be utilised to achieve a higher degree of comfort. In buildings occupants can also change the location in- and outdoors in order to bring themselves into better comfort.

In naturally ventilated and not mechanically conditioned buildings the occupants must be aware of the response of the building to the climatic influences. The thermal conditions might move in the building during the day, so that people are comfortable in the bedroom at night, and might stay in the lower level living room during the day and on the roof terrace in the evening. Since the climate conditions in tropical regions are rather uniform with little variations in temperature, humidity and sunshine the course of the indoor climate conditions is predictable.

In well-designed free running buildings natural air draft is induced by external wind and internal buoyant forces. Air movement can also be effectively supported with little energy demand through passive ventilation cowls or active fans in the room.

BUILDING DESIGN FOR ENERGY SAVING IN TROPICAL CLIMATES

The design of sustainable buildings in tropical climates will rely on traditional design features combined with the technical means now available. It is good practise to resort back to low-tech and passive design solutions, before the integration of sophisticated technical features. In this sense a modern sustainable building project can be implemented within the local financial capabilities and under application of local construction materials and craftsmanship.

The building design will show a specific form and orientation, with a reduced area of the external surface exposed to the sun. The short façade in a modern town house would be oriented in North-South direction, while the long compartment wall on the East and the West of the building are usually protected by the neighbouring buildings. If it is not possible to shade the compartment walls by external structures, secondary spaces (staircase, storage rooms and bathrooms) should be located along these walls. These walls should be executed with an external ventilated shell or an insulation layer in order to reduce the heat transfer through the wall from the low standing sun in the morning or the evening. Also the façade openings, such as windows must be kept small in West and East oriented walls.

When these principles are followed most radiation will be received by the roof and south façade. Hence the design of the South façade and the roof and their adjacent zones (such as balconies and roof terraces) is crucial for the thermal performance of the building. Effective design features for the façade are overhangs and louvers to provide structural shading. In the higher levels of the

building loggias and balconies will block the thermal gains before they can enter into the interior spaces.

Also at the roof sun protection measures need to be implemented. The easiest is a double layered shell that can be ventilated. These shells could consist of solar panels, which would then serve the sun protection and the energy production (hot water or electricity). Green roof and roof planting would reduce the surface temperatures by evaporation and light coloured roof surfaces would reflect incoming solar radiation back to the sky. Shading of the surface, radiation to the sky and convective heat transport can be enhanced by rough textures on the small scale and by roof shapes (vaulted or pitched) or the larger scale. Such roofs expose more surface to cool down the building during the night than flat roofs.

In reference to the discussion above, a modern townhouse should be designed to utilized natural ventilations as much as possible. The layout of rooms must allow cross-ventilation and all room should be able to be connected to central ventilation shaft or stair case in order to make use of buoyant forces for ventilation.

The orientation of the façade openings must be optimized between the insolation protection requirements and the prevailing wind direction. The building can be readjusted by about 30° from the prevailing wind direction in order to secured optimal sun protection without losing the cooling effect of the breeze. In HCMC the prevailing wind is from southeast during the dry season and from southwest in the wet season, so that the building can be turned towards south for effective sun protection. All façade openings, door and windows should be built as large as possible for ventilation and must be protected to prevent solar gains from entering the building.

Inlet opening on the windward side must located on the lower side of the room and outlet openings should be located on the leeward side at a higher point of the room. Such positioning will result in a cooling breeze in the occupied lower zone of the rooms.
Cross-ventilation will be advantageous compared to single sided ventilation. In order to enable cross-ventilation free air paths need to be provided between the windward façade and the leeward façade. To achieve such ventilation schemes internal separation walls are to be avoided or provisions are to be made that air can move freely between the rooms (openings above doors, ventilation lattice in doors). If sufficient air paths are provided buildings of up to 15m depth between the facades can be ventilated naturally. In many buildings central air shafts are used to make use of the stack-effect for ventilation.

The spatial composition of the building will result from the climate and the occupancy requirements. All spaces used during the day would be located preferably in the northern part, such rooms would include for example the kitchen, dining room, working spaces and the children’s rooms.

In tropical climates it is recommended to reduce the thermal capacity of the structure to allow for faster cooling of the room during the night so that the available natural temperature shift is not consumed by the storage capacity of the material, but will benefit the occupants instantly. Lightweight rooms must be protected from overheating during the day, but the fast response to

moderate thermal changes is advantageous to restore more comfortable conditions during the night.

Rooms with heat and moisture loads, such as kitchens, bathrooms and the laundry, must be separated from the living areas and arranged to the leeward side of the building or atrium, so that heat and moisture loads can be expelled to the outside and additional heat and moisture burden on the interiors will be avoided.

A modern building (such as in Fig. 6) consist of independent zones which each can be conditioned separately to the condition favourable to the user. At the same time the building is designed to be naturally ventilated and to create pleasant indoor conditions. In modern sustainable buildings it is the objective to minimize the use of mechanical cooling in order to reduce energy consumption.

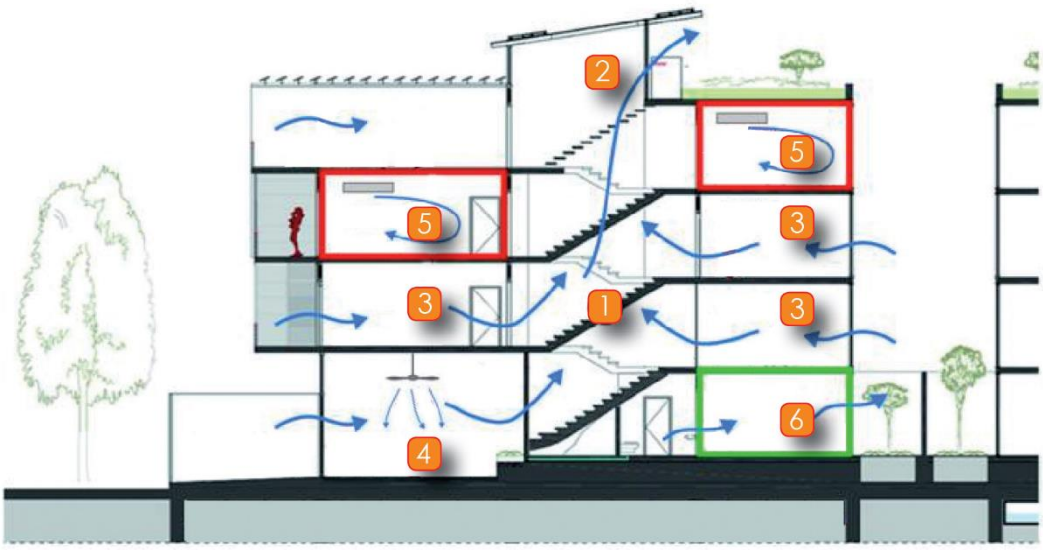

Fig. 6. Principles and modes of natural ventilation in modern town houses
(Source: Own design after: Hesse, Schwede and Waibel 2011)

1. Free air path to allow stack effect and cross ventilation
2. Ventilation opening at the highest point of the building
3. Operable windows for cross ventilation
4. Air draft induced by fans for energy efficient thermal comfort provision
5. Airtight zones with mechanical cooling
6. Separate air path in zones with thermal or hygric loads

MECHANICAL CONDITIONING IN TROPICAL CLIMATE

Since the air humidity is high throughout the year, dehumidification is the most energy demanding conditioning mode in tropical climates. In the night time hours, when the outdoor temperatures are slightly cooler, often only dehumidification is needed and no cooling. During the day however

cooling and dehumidification are operated in parallel. Since outdoor humidity levels are too high throughout the year, discharge of humidity loads or drying of material through natural air movement is restricted in tropical climates.

Systems exist that allow air dehumidification based on adsorption and absorption processes in porous material or salt solutions. Since such technology is not available in small units its application is mainly found in larger buildings. In such buildings dehumidification and heat- and moisture recovery based on the same principles is usually economic in tropical climates with rather short payback times. It can be expected that similar phenomena will be made available and that these technologies will be part of the solution for energy-efficiency and comfort in tropical climates in future.

Dehumidification through condensation is more commonly used. In this case the air is cooled below its dew point temperature and vapour is condensed to water, which is then discharged in fluid form. The air is undercooled in this case and needs to be reheated for achieve comfort conditions. As the energy expense for reheating is saved in many cases, spaces with dehumidification demand often appear to be chilled and uncomfortably cool especially in contrast to the high outdoor temperature and humidity levels.

Such undercooling then has the effect that indoor temperatures are lower than the outdoor dew point temperature, so that unwanted condensation occurs on the external surfaces of (single pane) glassing and on solid building parts. This can then lead to damages, reduced durability of the building construction and a higher maintenance and cleaning demand.

Dehumidification is highly energy-consuming and therefore the volume of the conditioned rooms or to be more precise the air volume to be conditioned must be reduced to the minimum functional. A related measure is to reduce the energy demand for dehumidification is to ensure a high degree of air tightness and to reduce the uncontrolled infiltration of outside air.

In situations where air conditioning units are retrofitted to previously only naturally ventilated buildings, cooling modes are often combined with natural ventilation, which then will result in high energy loss.

A further strategy is to ensure demand controlled operation of mechanical conditioning equipment. It is appropriate that air conditioning appliances are turned off, when the room is not in use. For such operation to be effective and functional high thermal mass exposed to the room should be avoided so that the room can respond fast to the requirements of the occupant and does not waste energy for cooling the structure. According to the survey of Waibel (2009) mentioned above, occupants in HCMC operate systems usually to their needs only in the hours, when the room is occupied.

STRUCTURE AND ENVIRONMENTAL FRIENDLY MATERIALS

There is an enormous potential in rethinking the construction methods and use of materials of town houses. The following suggestions will show how to increase the quality and life span of the building, while saving energy and energy cost. Choosing the tradition of the skeleton frame as the

supporting structure allows the possibility of being free and flexible in creating the floor plan as well as approaching a basis of an economic and ecological system. By standardizing the process it is possible to lower the costs. Adjusting the frame back and forward allows construction methods of cantilevers that provide a simple way of sun protection. Shaped and staggered like terraces overhangs like balconies or canopies are effective to shade the south façade of the building.

In order to keep temperatures inside cool, using the air-conditioning system less and preventing a temperature gradient, the infill of the skeleton framework comes along with an insulation layer. The walls of the town house can be made of bricks without any chemical substances or harmful outgassing.

There are environmentally friendly bricks made of clay or fly ash in Vietnam. Not only the materials reduce the costs, also the method of producing the product is efficient. The brick does not have to be baked at large energy use so there is no emission of carbon dioxide. With a low consumption of energy it only has to be pressed and dried over two weeks.

The material bamboo can be used in several ways. Shutters, blinds, doors and the frames of the windows can be made of this advantageous material. In compressed form it is an extremely tough and durable material and can even be used in bathrooms or outside. The advantages are convincing. It has got an outstanding growth rate, it is a local natural material meaning it is available at low cost and has less impact of carbon emission on the environment resulting from a short transport. Bamboo absorbs carbon dioxide when growing in huge amounts and produces more oxygen than most other plants.

There can be a huge difference between qualities of windows. The ordinarily used aluminium framed window with one layer windowpane is one of the biggest temperature leaks in the house. By choosing a wooden frame with a double-glazed window the air inside the room can be kept cool.

The aluminium as the main material of the frame exchanges temperature very well transmitting heat to the inside. Although it is completely recyclable it requires a massive amount of energy to be produced. During the production of 1 kilogram aluminium 25.5 kilogram carbon dioxide are being released (NSW 2008: 2).

In former times and still today tainted and mirrored glazing was applied to keep the sun out. Today glazing systems can also be equipped with invisible coatings, which are effective to reduce the solar gains to the room, while letting natural light in. The heat gain through the windows must be observed when ordering windows, particularly if constructive shading is not effective.
The risk of harmful outgases from building materials should be minimized. For the coating of the walls, it is recommend to use water-based paint without chemical thinner.

Plants can also be used as effective materials. They can be attached on the exterior to help creating a buffer zone casting shadow and preconditioning the inflowing air and in the interior alongside the airflow by evaporative cooling. Within a highly polluted city like HCMC the advantages are obvious. The living plants drain the fine particles out of the air converting carbon dioxide to

oxygen and bringing out cleaner air. The overall increased utilization of green leads to a more healthful climate in the city for all.

POLICIES FOR ENERGY-EFFICIENT HOUSING

The Vietnamese government has very ambitious plans regarding the future housing development. Within the "Natioank Strategy on housing development through 2020, with a vision toward 2030" there is the aim to increase the average living space per capita from 16.7 m^2 (2009) to 22 m^2 (2015) and 25 m^2 (MOC 2011:3). Following this plan, over 92 million m^2 will need to be constructed each year on average. This is a huge amount of construction activity. Therefore, chances and opportunities should be maximized to do this with the highest degree of energy-efficiency. However, the Ministry of Construction apparently only focus on the development of flooring in terms of quantity and not so much in terms of quality or sustainability.

In general it can be said that achieving more energy-efficient structures in the Vietnamese housing sector remains a tremendous challenge. Official regulations like the Vietnamese existing energy efficiency building code from 2005 get largely ignored. National programs such as the Vietnam National Energy Efficiency Programme (VNEEP) frequently postulate over-ambitious aims and do not pay enough attention to the socio-economic dimension. State representatives are currently often not leading by example. Sectorial approaches dominate whereas more horizontal cooperation is needed. Civil society organisations do act rather isolated. A balanced set of economic incentives to promote energy efficiency does not exist, yet. Briefly, successful policies towards more sustainability need to be less top-down, more holistic and more inclusive.

CONCLUSION

This contributions discusses ways and limits to energy-efficient and climate adapted building in HCMC in the context of current socio-economic development and the resulting new energy-use behaviour and life-style changes. Constraints resulting from socio-economic and the institutional context towards energy-efficiency in housing are introduced. The climate in HCMC and the related characteristics of thermal comfort perception are discussed as the natural context of new buildings as well as the existing building stock that is to be retrofitted. In this context bioclimatic and passive measures in tropical climate, mechanical cooling and building design concepts are discussed as practical measures. Further policies and other means to promote energy-efficient housing in the distinct market of Vietnam are introduced.
Promoting climate adapted housing and energy efficient buildings in Vietnam does not imply a need to reinvent the wheel. Many policies can be derived simply from the ongoing sustainability discourse (Waibel 2012). The toolbox of sustainability development offers various solutions to promote green buildings. Thereby sustainable development should be understood as a holistic concept involving not only the field of architecture, but also state bodies and the urban (civil) society. In the case of Vietnam, efforts towards promoting green growth in the Vietnamese construction and housing sector need financial support from the donor community and international expertise carefully adapted to the local socio-economic situation.

Evidently, the promotion of energy efficient building cannot happen in a top-down manner, alone. In this context, the emergence of broad stakeholder coalitions such as during the process of

developing and disseminating the Handbook for Green Housing and the Handbook for Green Products may serve as learning fields for reorganising institutions in a broader context and to creative new innovative alliances between the state and the private sector (Waibel 2014). Of course the handbook approach can only be one cornerstone of a more comprehensive policy set. In general, innovative forms of governance coalitions may contribute to overcome one of the biggest problems in Vietnam: Institutional fragmentation and the lack of cross-sectorial cooperation.

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Energy Management Practice in Developing Countries: A Review of Kenya's Policy, Regulatory and Institutional Framework

Kimari M. Patrick
Dedan Kimathi University of Technology,
P.O Box 657-10100, Kenya
Email: Patrick.kimari@dkuct.ac.ke; kimari@gmail.com

ABSTRACT

Energy management practice in developing countries such as Kenya takes a markedly different tangent and is informed by different factors in comparison to energy management practice in developed economies. For developing countries, energy management practice has to be balanced with the need to grow economically. Increased economic growth calls for expansion in power generation capacity and increased energy consumption. But through prudent government policies and legislations, it is possible to strike a balance between the two competing interests. This paper takes a look at Kenya's policy and regulatory framework that guides energy management practice in the country. Key legislations reviewed are: The Energy Policy Document 2004, Energy Acts 2006-Sections 104, 105 and 106 and the Energy (Energy Management) Regulations 2012. The review of Kenya's policy and regulatory framework in respect to energy management is a pointer to what is being practiced in other developing countries.

KEYWORDS

Kenya, Regulatory, Policy, Institutional Framework, Energy Act 2006, Energy Management

INTRODUCTION

Background

Energy management practice in developing countries such as Kenya takes a markedly different tangent and is informed by different factors in comparison to energy management practice in developed economies. The country's energy management programs/strategies have to be balanced against the country's economic growth goals and aspirations.

Being a developing economy, increasing the country's economic output is at the core of most of Kenya's government development policies. Kenya Vision 2030 is Kenya's development blueprint covering the period 2008 to 2030. It aims at making Kenya a newly industrializing, "middle income country providing high quality life for all its citizens by the year 2030" [1]. Vision 2030 has three pillars: Economic, Social and political. The economic pillar aims at providing prosperity of all Kenyans through an economic development programme aimed at achieving an average Gross Domestic Product (GDP) growth rate of 10 % per annum the next 25 years [1].

To achieve an annual 10% GDP growth rate, the country need to double its commercial, service and industrial output from the current output levels. A doubling of the country's economic output means Kenya's annual energy consumption will increase significantly from the current consumption levels. As table 1 show, the growth in consumption between financial year (FY) 2010/2011 and 2009/2010 was 9% [2].

The growth in demand for electricity has been significant over the last 5 years driven by a combination of normal growth, increased connections in urban and rural areas as well as the country's goal to transform into a newly industrialized country as articulated in the Vision 2030 [1, 2]. As table 2 and figure 1 show, Kenya's electric energy consumption is projected to increase 16 times from 7272GWh in 2011 to 118,294GWh in 2032 while the installed power generation capacity is expected to grow from 1191MW to 19015MW over the same period [2, 3].

Table 14. Kenya electric energy consumption (in GWh)[25]

	Year	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11
LV	Domestic (Including REP and IT)	1,247	1,384	1,569	1,547	1,605	1,769
	Small commercial	522	558	590	823	823	904
	Street lighting	9	11	13	15	16	18
	Total LV	**1778**	**1,953**	**2,172**	**2,385**	**2,444**	**2,691**
MV	Commercial and Industrial (11 and 33kV levels)	885	901	985	996	1,040	1,122
HV	Commercial and Industrial (66 and 132kV levels)	1776	1,877	2,054	2,108	2,113	2,279
	Total Consumption	**4,439**	**4,731**	**5,211**	**5,489**	**5,597**	**6,092**
	Local Supply	**5,682**	**6,156**	**6,359**	**6,459**	**6,654**	**7,272**
	Imports	15	13	26	30	38	31
	Total supply	**5,697**	**6,169**	**6,385**	**6,489**	**6,692**	**7,303**
	Growth Rates	**7%**	**8%**	**4%**	**2%**	**3%**	**9%**
	Peak Demand	**920**	**987**	**1,044**	**1,072**	**1,107**	**1,194**

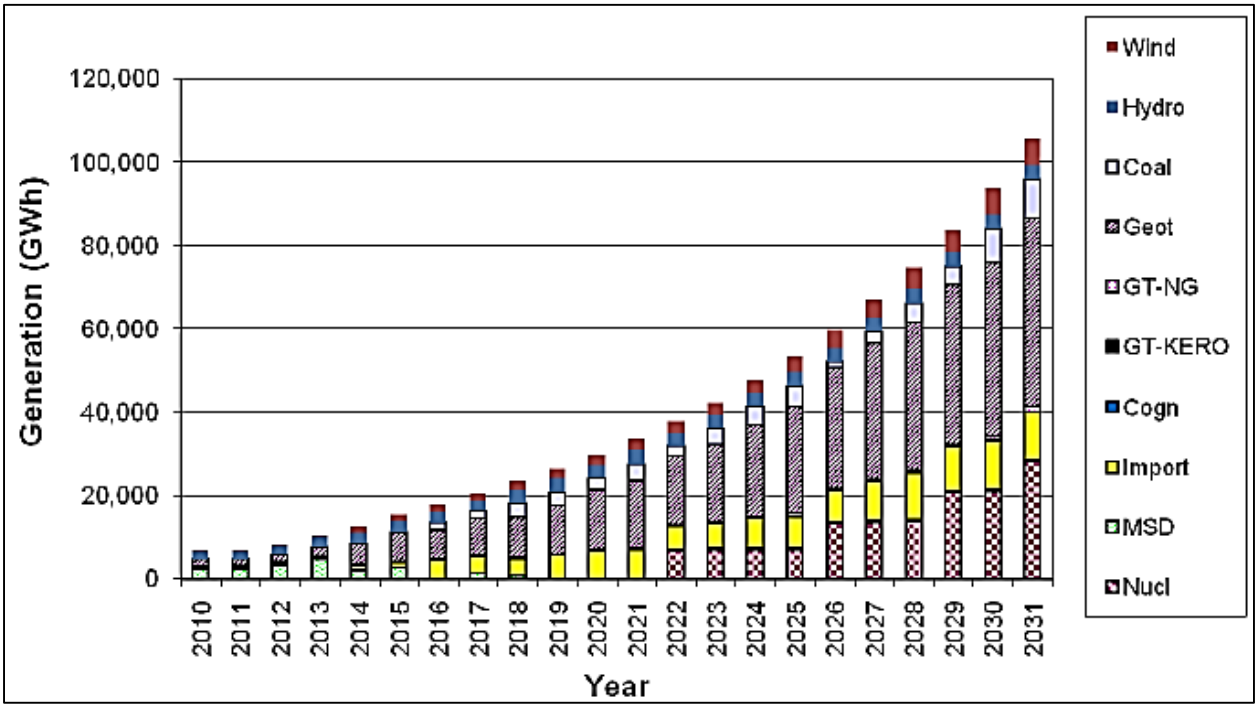
To cope with the increase the country will have to invest in increased installed power and generation capacities. To this end, the country is implementing an ambitious programme to quadruple the country's installed power capacity to 6000MW by the year 2017.

[25] ERC

Table 15. Kenya's power demand forecast 2012-2032

Year	GWh	MW	Load Factor	Growth Rates
2011	7272	1191	69.79%	9.10%
2012	7855	1286	69.70%	8.01%
2013	8650	1417	69.71%	10.13%
2014	9596	1571	69.77%	10.94%
2015	10794	1763	69.93%	12.48%
2016	12204	1997	69.80%	13.06%
2017	14277	2340	69.66%	16.99%
2018	16786	2743	69.86%	17.58%
2019	19570	3191	70.00%	16.58%
2020	22805	3711	70.15%	16.53%
2021	26415	4292	70.25%	15.83%
2022	30605	4965	70.36%	15.86%
2023	35371	5731	70.46%	15.58%
2024	40796	6602	70.54%	15.34%
2025	46756	7561	70.59%	14.61%
2026	53480	8644	70.63%	14.38%
2027	61134	9876	70.66%	14.31%
2028	69849	11278	70.70%	14.26%
2029	79774	12874	70.74%	14.21%
2030	91079	14674	70.86%	14.17%
2031	103800	16704	70.94%	13.97%
2032	118294	19015	71.02%	13.96%

Figure 24. Kenya electric load forecast



Energy Management in Kenya

Parallel to the ambitious program of increasing the Kenya's power generation capacity, the country is implementing a multi-sectorial, countrywide energy management program targeting individual households, commercial, institutional and industrial energy consumers.

The country's aspiration to improve on energy use efficiency and conservation was first documented in Sessional Paper No. 4 on Energy. In section 6.6.6 of the paper, the Government recognizes the need to remove barriers and constraints to adoption of energy efficiency and conservation technologies and committed itself in putting in place appropriate measures.

In operationalization of the Energy Act 2006, The Energy Regulatory Commission (ERC) was created from the former Electricity Regulatory Board (ERB) [4]. Part of the commission mandate is to regulate the electrical energy, petroleum and related products, renewable energy and other forms of energy and also to maintain a list of accredited energy auditors [4].

In the year 2012, in its execution of the Energy Act (No. 12 of 2006), the commission enacted the Energy (Solar Water Heating) Regulations, 2012 and The Energy (Energy Management) Regulations, 2012. The two regulations are meant to guide both the solar and energy management sectors respectively.

Methodology

The paper employed desktop review of publicly available documents on the subject matter. The documents reviewed included policy documents on the subject by different government agencies and third party documents on the same.

POLICY, REGULATORY AND INSTITUTIONAL FRAMEWORK

Kenya is one of the countries in Africa which has an active and enforceable Energy Act, Energy Bill and Energy Management Regulations. Besides the legislations on energy management, Kenya also has an operational Feed-in Tariff (FiT) program under its Renewable Energy Act. The energy sector in the country is administered by The Ministry of Energy with its agency, Energy Regulatory Commission. Energy Regulatory Commission is established under the Energy Act, 2006 [6].

Policy

Energy management in Kenya is governed by Session Paper Number 4 of 2004 section 5.6 and Section 6.6.6. Sections 5.6 state the aim being to reduce energy consumption without compromising productivity or increasing cost while at the same time at national level calling for adoption of energy efficiency and conservation so as to reduce the foreign exchange costs of oil

imports and deferment in additional investment in power generation capacity [6, 7]. Energy Efficiency and Conservation activities are governed and regulated as per the Energy Act 2006 and Energy (Energy Management) Regulations 2012 [8].

Energy Acts 2006, Sections 104, 105 and 106 describe how the energy efficiency should be governed. The energy management institutional framework in Kenya places the role of legislation and enforcement of energy management laws on the Energy Regulatory Commission (ERC) that acts on behalf of Ministry of Energy and Petroleum (MoEP) [6].

In operationalization of the Energy Act (No. 12 of 2006), the Energy (Solar Water Heating) Regulations, 2012, which makes it mandatory for owners of commercial and public institutions such as hotels, motels and schools to install solar water heating systems to provide at least 60% of their hot water demand on annual basis was enacted.

Operationalization of the regulations is aimed at curtailing the high amount of electric and thermal (wood fuel and charcoal combustion) energy needed to heat water for commercial use. The regulations are expected to significantly increase the use of solar water heating (SWH) systems in the country.

On the other hand, The Energy (Energy Management) Regulations, 2012, also a section of the Energy Act (No. 12 of 2006), calls for mandatory energy audit every three years by owners of public institutions, commercial and industrial concerns that consumes 180,001kWh or 648,00MJ of energy (electric or thermal) per year [9]. The act states: The Commission shall, in consultation with the Minister, designate factories or buildings and electrical appliances by types, quantities of energy use, or methods of energy utilization for purposes of energy efficiency and conservation. Article 106 states the owner of a building designated under the act, shall conserve energy, audit and analyse energy consumption in his building in accordance with the standards, criteria, and procedures as prescribed by regulations.

The law came into effect in September 2012 and there are more than 3300 facilities regulated by it. Under the regulations, the facilities are supposed to have carried out the mandatory energy audit by September 2015 to avoid penalties imposed by the law.

Regulatory and Institutional Framework

In discharge of its regulatory role, ERC is in charge of licensing of energy auditors and solar PV/Solar thermal systems installers to practice in Kenya. This was necessary because before the two regulations: The Energy (Solar Water Heating) Regulations, 2012 and The Energy (Energy Management) Regulations, 2012 came into force, any person residing in Kenya or a company operating in Kenya could practice as an auditor/auditing firm or an installer of solar systems.

The law sets out the minimum educational and professional background of persons desirous of being licensed as an energy auditor or solar systems installer.
The commission is currently working with different government agencies to implement a number of energy management programs aimed at curtailing the ever increasing demand for additional power generation in the country.

At household level, working in collaboration with the government owned power distribution utility company-Kenya Power Company, the two have been distributing for free, compact fluorescent lamps (CFL) and Light Emitting Diodes (LED) lamps.

At commercial level, the commission since May 2014, is discharging its regulatory mandate under the Energy (Solar Water Heating) Regulations, 2012 which places a penalty of disconnection from national grid power for owners of commercial and public institutions such as hotels, motels and schools who have not installed solar water heating systems to meet at least 60% of their hot water demand on annual basis.

Besides ERC, a number of non-state actors are involved in energy management. One of the actors is Kenya Association of Manufactures (KAM). KAM in conjunction with the Ministry of Energy and Petroleum Development established the Centre for Energy Efficiency and Conservation (CEEC) in 2006. The Centre runs energy efficiency and conservation programs designed to help companies identify energy wastage, determine saving potential and give recommendation on measures to be implemented. The Centre provides professional technical services for developing, designing and implementing energy efficiency projects to suit the needs of commercial, institutional and industrial consumers [10].

Challenges

Even though the two legislations guiding the practice of energy management in Kenya requires only licensed professionals carry out energy audits and install solar systems, Kenya is experiencing a shortage of energy audit professionals to carry out audits for the 3300 plus identified facilities.

Currently there are about 15 licensed energy auditing firms with individual licensed energy auditors being less than 50. The shortage of licensed energy auditors is a barrier to ERC set target to have all designated facilities undertake mandatory energy audit by close of September 2015.

CONCLUSION

As presented, Kenya has active policy, regulatory and institutional framework to guide its energy management strategies. It is the government's expectation that all these measures will lead to considerable reduction in energy demand in the country based on current consumption levels thus reducing pressure on the need for new power generation capacity.

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Cross Border Power Trade in South Asia: Opportunities and Challenges for Nepal

Pushkar Manandhar
Kathmandu, Nepal
pushkar.man@gmail.com

ABSTRACT

This paper examines opportunities and challenges of the cross border power trade for Nepal. Nepal's enormous hydropower potential which exceeds its current demand, increased demand of electricity in India and geographical proximity with power hungry Indian states form the solid basis for Nepal to trade electricity with India. Recent signing of i) agreement between Nepal and India on electric power trade, cross-border transmission interconnection and grid connectivity and ii) SAARC framework agreement for energy cooperation provide much needed impetus to deepen economic ties between two countries thorough collaboration in energy sector. The paper concludes that insufficient policy and regulatory frameworks in Nepal, limited cross border infrastructures, and inadequate in-country infrastructures to facilitate cross border power exchange are major hindrances for Nepal to increase cross border power trading with India. Strong independent regulatory bodies with minimum or no interference from political authorities must be ensured to enhance private sector participation in addressing many shortcomings of the energy sector in Nepal.

KEYWORDS

Cross border, electricity demand, economic cooperation, regulatory body

INTRODUCTION

The South Asian region politically comprises of Afghanistan, Bangladesh, Bhutan, Maldives, Nepal, India, Pakistan and Sri-Lanka. The region has a population of nearly $1.5 billion-23% of the world's population; however, the combined gross domestic product (GDP) of the region is only $3860 billion[26] in the year 2009- which is less than 3% of the world's GDP [1]. In recent days, South Asia is experiencing unprecedented economic growth. It is already the fastest growing region of the world, surpassing East Asia and Pacific region after the third quarter of 2014 [2]. India is leading the growth and this impressive growth in South Asia will no doubt reduce widespread poverty, but at the same time, it will significantly increase energy demand of the region. Ensuring reliable, efficient and clean sources of energy to sustain its economic growth will be one of the most pressing challenges that the region is likely to face.

ENERGY RESOURCE BASE OF SOUTH ASIA

Energy system of South Asia offers diverse and complementary characteristics in terms of availability of primary energy resources for electricity generation and its demand. India and Pakistan has substantial coal, natural gas reserves and hydropower potential; Nepal and Bhutan has significant hydropower potential. Bangladesh has substantial natural gas reserve. These different sources of energy are unevenly distributed among the countries and not matching with possible requirement of their economies and energy demand. For example; hydropower potential

[26] The GDP is in purchasing power parity basis.

of Nepal and Bhutan far exceeds their current domestic demand, while hydropower potential of India and Pakistan being substantial is not sufficient to sustain their growth.

Due to lack of coordinated investment and coordination among the member countries, full potential of a varied energy resource of the region is yet to be realized. Countries like Nepal, Bangladesh and India are suffering from deficit supply of electricity. Sri Lanka and Maldives are increasingly relying on imported fuel to meet its future energy demands due to lack of domestic resources The current dominance of certain energy resources- hydropower in Nepal and Bhutan, coal in India, gas in Bangladesh on the other hand has led to over dependence on certain resources at the country level making a countries vulnerable from energy security aspects. For example, electricity sector of Nepal and Bhutan are highly dominated by hydro resources, while India, Pakistan and Bangladesh have predominantly thermal generation. In order to diversify the supply side for enhancing energy security in country level, meet the demand and supply gap by optimal use of energy base, regional cooperation in energy trade that facilitate cross border energy trade has become imperative for a member countries in the region.

OVERVIEW OF THE ELECTRICITY SITUATION IN NEPAL

Perennial flow of water originating from high Himalaya flowing through a high gradient offers huge potential of hydropower generation in Nepal. It is estimated that the commercial hydropower generating potential of Nepal is estimated to be 42000 MW. Nepal developed its first hydropower plant in 1911 and in more than 100 years period, it is able to add only 787 MW [3] of power which is around 2% of its total hydropower potential. The peak demand of electricity in 2014-15 has been around 1,200 MW while the installed capacity is 787 MW. The compounded annual growth rate (CAGR) of electricity demand during the period 2007-08 to 2013-14 is around 9% while the CAGR for electricity generation has been only 4.3% [4]. As a result, the gap between demand and supply of electricity is increasing and the country is experiencing acute shortage of electricity. Nepal Electricity Authority (NEA)-state owned utility is importing power in the range of 150-170 MW [5] from India to reduce the gap but rest is being met through load shedding. NEA is constructing 11 numbers of hydropower projects with total installed capacity of 1044 MW. Similarly 83 numbers of hydropower projects owned by Independent Power Producers (IPP) with installed capacity of 1521MW are under construction [3].

OPPORTUNITIES

Favourable political consideration

Development of hydropower resource has been long identified as the corner stone for socio economic development in Nepal. The common benefits in optimal utilization of electricity generating resources have been recognized by all member countries in the South Asia. Key policies to accelerate reform needed for better energy sector response are being devised in member countries while at the same time there has been significant progress in regional cooperation to promote economic cooperation and efficient development of the energy sector in the region. Recently signed SAARC Framework Agreement for Energy Cooperation (Electricity) and the Agreement between Nepal and India on Electric Power trade, Cross-Border Transmission Interconnection and Grid Connectivity are the testimonies of an increased political commitment in South Asia to enhance regional cooperation. These agreements will provide much needed impetus for deepening cooperation in electricity sector between Nepal and India. They offered greater economic cooperation thereby increasing economy of

scale and creating favourable environment for foreign direct investment in hydropower sector in Nepal.

Increased Hydropower Generation in Nepal

In the power system with installed capacity of 787 MW, Nepalese power system will see significant additional of installed capacity in coming few years. NEA is currently executing 11 numbers of large to small scale hydropower projects (HP) ranging from 456 MW-14 MW. Independent Power Producers (IPP) is constructing 83 HP projects with combined capacity of 1521.28 MW [3]. With these additions, Nepalese power system is likely to have surplus of electricity in wet season starting from 2016/17. However there will be deficit of energy in dry season as most of hydropower under construction are of run of type in which generation decreases substantially during those period.

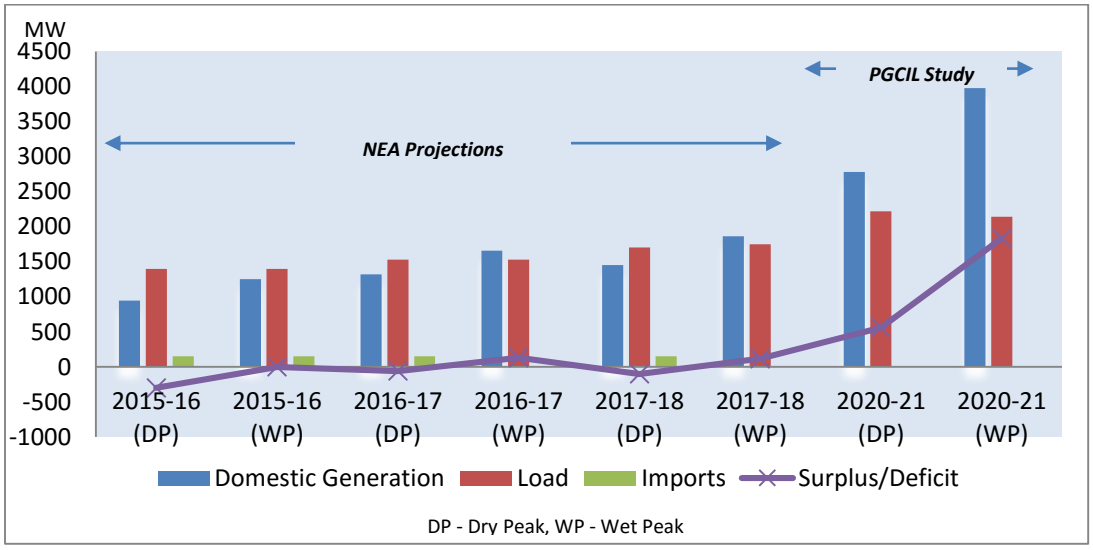

Figure1. Load generation balance of Nepalese power system [5]

	Dry Peak	Wet Peak	Wet Off Peak
Generation (in MW)	2782	3977	3997
Load (MW)	2221	2143	1058
Surplus(+)/Deficit (-) (in MW)	561	1834	2939

Table1. Load Generation Balance of Nepal Grid in 2020-21 [5]

The figure 1.shows the study on load generation balance of Nepalese power system carried out by Power Grid Corporation of India for NEA. As per the study, there will be surplus of power throughout the year starting 2020-21 (both dry peal and wet peak). This provides an opportunity for Nepal to manage seasonal surplus power by exporting it to India from 2016/17.

Monetizing free power

Government of Nepal (GoN) has already undertaken power development agreement (PDA) with GMR Group and Satluj Jal Vidyut Nigam Limited (SJVNL) of India for development of two large

scale export oriented HP projects –Upper Karnali HP (900 MW) and Arun 3 (900 MW) respectively. As per the PDA signed with these companies, Nepal will get 12% of free power from Upper Karnali and 21.9% from Arun 3 [4]. Efforts are being placed to execute PDA with other three major hydropower projects- Tamakoshi 3, Upper Marsyangdi II and Upper Trishuli 1 with cumulative installed capacity of 1,466 MW. These projects also could have free power allocation to GoN [4]. By the time, these power plants would be operational; there will be a surplus power from the hydropower projects built for the domestic purpose. This provides good opportunity to trade the free energy available from these projects and similar subsequent projects to monetize the free power available to GoN.

Increased Electricity Shortage in India and complementary demand profile with Nepal

An increased demand of electricity in India offer good opportunity for Nepal to harness its enormous hydropower resources. There is already gross deficit of electricity in many states of India. The peak demand of electricity increases from 100 GW in 2006/07 to 144 GW in 2012/13. Similarly energy demand increases from 690 TWh in 2006/2007 to 995 TWh in 2012/13 [6]. The Indian states adjoining Nepal- Uttar Pradesh(UP) and Bihar witnessed surge in peak deficit from 1725 MW to 2915 MW and 100 MW to 499 MW in the period between February 2013 and February 2014 [7]. The closer proximity to these power hungry states of India favours excess hydro power generation and cross border power trade with India.

The complementary characteristics of electricity demand and its supply potential can optimize available energy resources for electricity generation both in Nepal and India. Nepal is essentially a winter peaking system. During the winter, Nepalese electrical demand peaks as heating and lighting systems kick-in. This is unlike in the India where peak loads generally occur in the summer as a result of heightened cooling demand. In winter, the generation reduces in Nepal when its demand increases due to fall in water level in the snow fed rivers. While in the summer, with increased water level in the rivers, the generation exceeds the demand in Nepal. The figure 2 and 3 below shows monthly energy and peak demand deficit in Indian state of Uttar Pradesh and monthly discharge in Nepalese rivers. A higher level of coincidence of season electricity deficit in India and generation potential of Nepalese hydropower offers good solution to meet electricity demand in both country. This creates an opportunity for Nepal and India also to manage capacity surpluses on a seasonal basis. It also helps Nepal to avoid additional generation investments to meet winter peak demand by importing electricity from India.

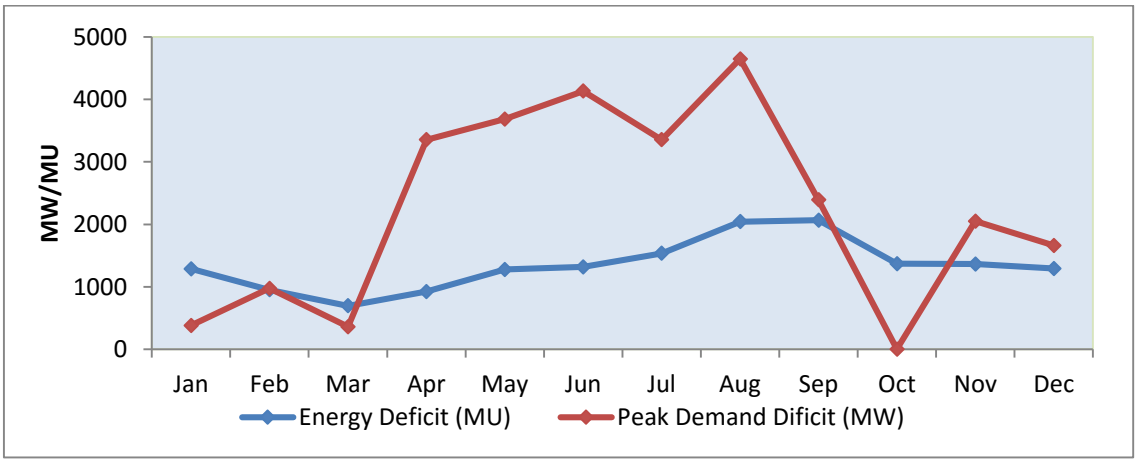

Figure 2- Monthly Electricity Supply Gap Profile-Uttar Pradesh (India) [7]

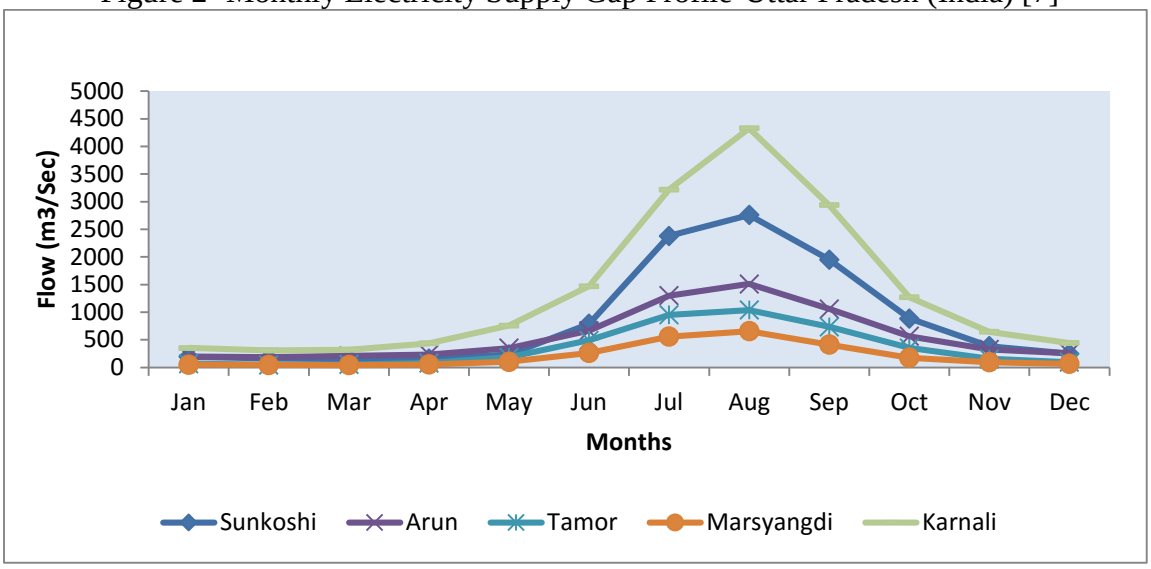

Figure 3- Source: Monthly Discharge in Typical Nepalese Rivers [8] IPPAN, 2010

Implication for energy security and reliability

The key factors in increasing energy security are diversity of country's fuel mix, its dependence on imports and concentration of import sources and political stability [9]. Nepal stands in a poor situation in terms of energy security if we consider these factors. Hydropower contributes to 99.8% of total electricity generation in Nepal in 2014 [3], rest 0.2% comes from multi fuel thermal plants for which required diesel are also imported from India, or other third countries using Indian routes. The focus of energy security planning varies over time and across countries [9]. Interconnection to Indian power systems improves the system's reliability in completely two different scenarios. For example, the total electricity demand in wet peak may exceed by 2016/17 if large hydropower project like Upper Tamakoshi (456 MW) and several number of IPP projects with estimated capacity of 1521 MW under construction [3] are fully operational. Under this scenario, ongoing cross border interconnector- 400 kV Dhalkebar (Nepal)-Muzaffarpur (India) transmission line project would serve for exporting excess energy to India. If Nepal attains surplus power by 2016/17, the unserved energy in Nepal could be decreased from 0.3% to 0.1%[27] with this interconnector. The interconnector would help reduce reliance on expensive gas, oil based generation in India and also reduces unserved energy to some extend [10]. Similarly if Nepal continues to be in a deficit state, the interconnector would help Nepal importing additional power from India.

Environmental benefits

Apart from reliability, and underlying economic cooperation benefit, cross border power trading with India hold significant environment benefits to the region. Energy generation from hydropower would be the form of energy that would trade with India. Such trading will offset emission of greenhouse gas emission in regional power system. For example hydropower generation from Bhutan alone can displace 40,000 GWh of thermal generation in India thereby reducing 40 million tons of CO2 emission by 2020/21 [10].

[27] Assuming the total capacity by 2016/17 exceed 2500 MW in comparison to project peak demand of 1640 MW.

MAJOR CHALLENGES

Lack of Sufficient Energy Infrastructure

Currently Nepal is interlinked with Indian power system via 33 kV links in 14 locations importing approximately 50 MW and 132 kV links in 3 locations importing approximately 130 MW from India [11]. After completion of 400 kV Dhalkebar (Nepal)-Muzaffarpur (India) transmission line project, the transferred capacity between two countries would increase by 1000 MW. However, many hydropower projects in Nepal are located in mountainous region and in-country transmission links are not sufficient to accumulate the power and transfer to the Indian side. So along with limited cross border infrastructures, inadequate in-country infrastructures to facilitate cross border power exchange have been major issue for Nepal to increase cross border power trading with India.

Lack of effective and independent regulatory bodies:

Bilateral transactions of course can provide first step towards greater regional power integration, but the presence of effective and independent regulatory bodies would be essential to review to ensure that electricity consumers within the country will benefit from cross border trading [12]. There is a lack of effective and independent regulatory bodies in Nepal-both at the operational and commercial levels. Nepal Electricity Regulatory Commission Act (NERC) is still in draft stage which is yet to be ratified .The electricity tariff fixation committee established in 1994 gives some impression about the presence of regulatory body in Nepal. However, the mandate of ETFC is neither adequate nor it has been completely independent. It only deals with fixing the retail tariff and operates with the government funding. Required human resources are also being met with government employees. The regulatory harmonization necessary to ensure full interfacing with India due to sheer size of Indian power system would be difficult without effective and independent regulatory bodies in Nepal.

Lack of power trading company:

A vibrant power market with competitive segments offers better opportunities for power trade [13]. Power trading is not recognized as a distinct licensed activity in Nepal and no power trading company as such do exists currently to deal with cross border power trading. NEA is importing power from India through bilateral transaction to reduce the supply shortage in Nepal. In longer term, a full fledge power trading company backed by a sound and enabling legal framework would be required for i) procuring power to meet NEA's deficits and manage NEA's seasonal surplus ii) managing free power allocated to the GoN in various export oriented projects iii) entering into commercial arrangements with sellers and buyers [4].

Poor operational efficiency of utility:

Non-cost-covering tariff system and high system loss has been deteriorating the financial health of NEA. An accumulated loss of NEA has again reached around $267 million in fiscal year 2014/15 [3] despite of financial restructuring in December 2011 by increasing the NEA's capital share to NRs50 billion, wrote off its accumulated losses and converted interest due by the NEA to the government to equity. The total system loss decreased by only 4.47% point in last four years-28.91% in 2010/11 and 24.44% in 2014/15 [3,14]. This resulted in lack of creditworthiness of NEA which is not conducive environment for private sector participation and cross border power trading.

Political Unrest

The political instabilities and circumstances in Nepal do not provided conducive environment for reforming energy sector. Draft Electricity Act and Nepal Regulatory Commissioning act are pending for approval since 2006 due to political unrest diverting the attention of politicians in other agendas. Lack of regulatory framework due to absence of these acts has been bottleneck to enhance private sector participation in large scale hydropower development.

PRIORITIES FOR DOMESTIC ACTIONS

The level of power trade between Nepal and India has been very low despites of various opportunities it offers to both countries. Nepal needs to focus on several actions as follows to enhance cross border power trading with India and other countries in the region.

Strengthen in-country transmission links

Invest in strengthening in-country transmission network to facilitate evacuation of power from hydropower stations to domestic load centres and to accumulate surplus power and export to India via cross border transmission links.

Enhance operational efficiency of utility

In 2014; import from India contributed 27.37% of total available energy for NEA. During the same year, NEA's system loss was 24.64%. As a result the country was not able to take benefits from import of power from India. Enhancing operational efficiency of NEA will be critical in reaping the benefits from cross border power trade.

Create sound legal framework

The proposed new electricity act should be approved early identifying power trade as a licensed activity and ensure non-discriminatory open access for transmission for cross border power trade [13]. Proposed new Nepal regulatory commission act should be also enacted soon to the pave way for creation of an autonomous electricity regulatory agency.

Create efficient and independent regulatory body

Regulatory body backed by sound law should be created not only for promoting cross border but for developing whole energy sector in Nepal. While doing so, strong independent regulatory body with minimum or no interference from political authorities must be ensured.

Harmonization of technical standard

For physical transfer of power between the countries, the technical standards code must be harmonized between the trading countries. India, due to its strategic positioning in South Asia, market size and maturity of power market against other member countries in the region, it would be beneficial for Nepal to harmonize technical standard with India.

CONCLUSION

The paper discussed the electricity supply situation in South Asia with focus on Nepal and India. It explores opportunities and challenges for Nepal from cross border electricity trading with India. The paper concludes that limited policy and regulatory frameworks in Nepal and inadequate infrastructure are the major challenge to harness hydropower resource in Nepal and trade surplus electricity with

India. Improvement of political situation, efficient and independent regulatory framework will leads to accelerated hydropower development in Nepal thereby increasing cross border electricity power between Nepal and India.

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Energizing Sustainable Rural Livelihood through Market System Development

Resha Piya Shrestha
reshapiya@gmail.com

ABSTRACT

Practical Action South Asia Regional Office (Practical Action) in partnership with Alternative Energy Promotion Centre (AEPC) is working towards making Micro Hydro Plants (MHP) sustainable by improving supply reliability; realizing sustainable energy-based rural enterprises and achieving impact at scale through influencing the government programme National Rural and Renewable Energy Programme (NRREP) adopt process and tools of the project for promotion of energy-based rural enterprises.

The project's goal is to contribute towards poverty reduction through energizing rural livelihood in Nepal. The project worked for ensuring sustainability MHPs through increased energy utilisation by enterprises. The project is supporting market development of MHPs and rural energy based enterprises through adopting Practical Action's Participatory Market System Development (PMSD) approach.

The project improved the quality of electricity supply from 25 MHPs providing reliable services to 9,571 households and established or upgraded 128 rural enterprises contributing to revenue of MHPs.

KEYWORDS

Micro hydro plant, enterprises, income generation, sub-sector, Participatory Market System Development, market chain actor, services and inputs providers, enabling environment, MSME

INTRODUCTION

More than 2000 micro hydro plants (MHP) have been installed in rural Nepal to serve communities not connected to national grid in rural areas. Most of MHPs are operating at under capacity (~25% plant load factor) because they serve mainly households for lighting during night, some institutional clients like health centres, school, VDC buildings etc. and few microenterprises. Hence, MHPs have weak cash inflow facing problems in operation, maintenance and management. This is main reasons of MHPs being unsustainable. On the other hand, opportunity for rural enterprises and income generation activities are not fully developed. They are operated at very low productivity and efficiency because of lack of proper technical, management skill and lack of access to modern energy. Hence, there is need to strengthen rural energy access by creating supply and demand interdependency.

There has been effort in past also for rural enterprise promotion under MHPs by different programmes/projects. But they are more subsidies driven with little focus on capacity building and other supports. The past experience suggests just subsidy is not enough to create rural enterprises. The technical support in different stages: preparation/planning to operation - incubation support is more important than subsidy.

The key gaps can be summarized as : i) inappropriate enterprise selection and design; ii) lack of market awareness and link of local market with outside markets; iii) lack of adequate capital and financing for investment and start-ups; and iv) poor managerial capacity and technical skills.

PROJECT APPROACH

The project is led by Practical Action and providing technical back-up support, quality assurance and monitoring of activities. Practical Action is working closely AEPC, a government focal organization to promote renewable energy technology in Nepal. The project is being implemented through local partner NGOs in four cluster area viz Achham, Dolakha, Tanahun and Myagdi.

The project adopted PMSD approach in planning, executing, operate and maintain the energy systems and enterprises in all stage of the project and achieve its objectives. Sub-sector analysis is carried-out to identify potential market systems and enterprises. PMSD approach is used to do sub-sector analysis. Practical Action is using PMSD to make markets more inclusive, reduce poverty on a large scale and protect the environment.

The project activities were carried out following three principles, three ecosystems and three wheel of change of PMSD as shown in the figure 1 as far as possible and suitable.

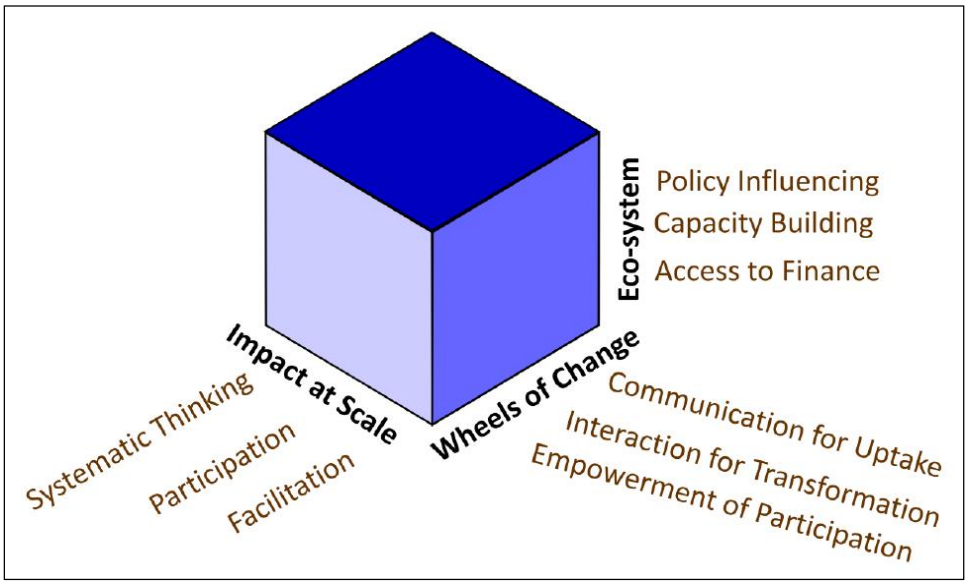

Figure 25. Project focus 3X3 PMSD approach

The approach is designed to bring all of the key people within a particular market together. These people are known as market actors. Information on market system is collected on three main levels a) market chain actors including the MHP management committee, MHP manufacturing companies, enterprise as well as the end users, b) supporting services and inputs providers including associations, capacity building institutions, equipment suppliers, financial institutions, government organizations etc. and c) the enabling environment including policy, guideline as well as standards and quality control. Efforts are made to build trust and a joint vision of change among

the market actors. They were involved in market mapping to understand & design intervention to strengthen market systems of MHPs and rural enterprises.

Sub-sector analyses were carried out with relevant stakeholders comprising local bodies, political representatives, private sectors and their associations, Micro hydropower management committees, Local enterprise development committee, local entrepreneurs, teachers, political representatives, potential beneficiaries, technical expert etc. to identify the subsectors that have potential to drive economic growth in MHP catchment area. Moreover, they were involved collectively in indentifying obstacles opportunity affecting their market system.

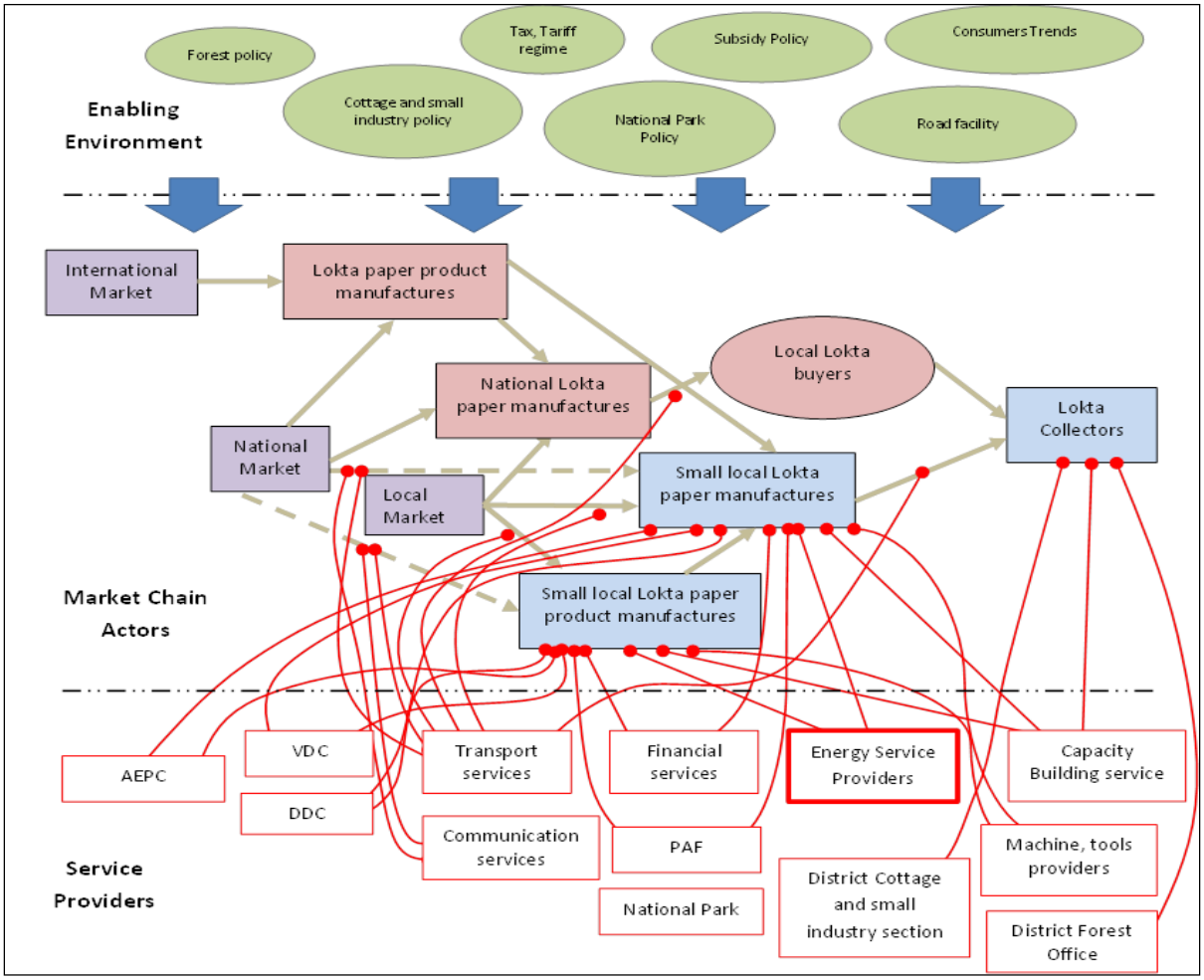

Figure 2. Market system of MHP is one of service provider for other market system of subsector

Baseline study is conducted with these market actors to identify the barriers and issues in the market system and suitable measures is taken to remove the barriers and address issues for establishment of vibrant market system in participatory way.

The efforts were placed to make MHP management aware of opportunities of better income by selling reliable electricity to Anchor, Business and Community (ABC) clients and building their capacity to make profitable business. Also making them understand that provision of MHP energy

to microenterprises in the catchment areas is one of the many inputs and services that these enterprises need to thrive.

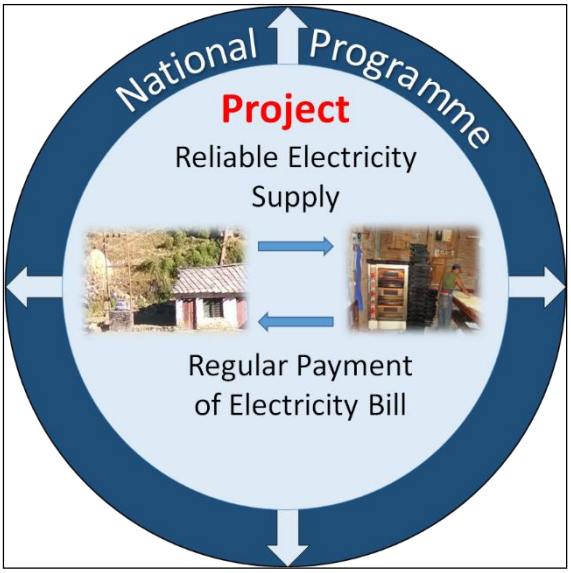

Figure 26. Project doing

In addition, the project helped rural enterprises to establish or upgrade with proper analysis of market system, counselling and capacity development support to them to boost confidence to understand business and manage risk through planning, incubation, market linkages, skills etc.

The project carried out several activities to empower market actors for their engagement in the market system. The activities were designed as per the need of market actors so that they are able to see potential benefits and opportunities, capable to bring their knowledge and participate, able to interact to get their things done, build relationship that work for them, add value to other actors in the market system.

The project focused on empowering marginalized actors so that they are able to actively participate in market system for their livelihood improvement. Furthermore, the project also focused on empowering powerful actors such as representative from AEPC, local bodies, policy makers showing benefits of shifting from enterprise focus to market development and influencing them to improve the policy and adopt process and tools of the project approach for making MHPs sustainable through improving reliability and realizing sustainable energy based rural enterprises.

The project facilitated several activities to create appropriate conditions for market actors to interact and build their confidence for change in their practices, behaviors, attitudes, level of trust etc. The activities were designed as per the requirement of market actors. The project facilitated interaction among MHP management committee and electricity buyer (next villagers and entrepreneurs) making them realize and understand benefits to both parties by developing interdependence. Moreover, the project supported rural enterprises to establish or strengthen with proper analysis of market system and shifting from production focus to market focus.

The project shared knowledge and learning of the project and advocated for using PMSD approach for ensuring sustainability of MHPs through increased energy utilisation by enterprises that enhanced rural livelihoods. The project with support of AEPC developed training manual for Local Enterprise Development Committee (LEDC) which includes process and tools of PMSD particularly market selection, market map, stakeholder analysis, gap identification and prioritizing activities. Besides, the project organized district level and national level sharing workshop to share the learning of the project.

RESULTS

The project results in availability of quality and reliable electricity supply from MHPs thereby increased use of energy in livelihood activities to increase their productivity as well as efficiency contributing to the sustainability of livelihood activities immensely and at the same time support to sustain energy infrastructure like MHPs by improving their cash-flow.

The project was able to achieve reliability of 25 MHPs providing reliable services to 9,571 households. The project helped increasing revenue of MHPs by establishing and upgrading 128 rural energy based enterprises, 35 income generation activities additional connection to 120 HHs. The project also initiated project to electrify additional 550 HHs.

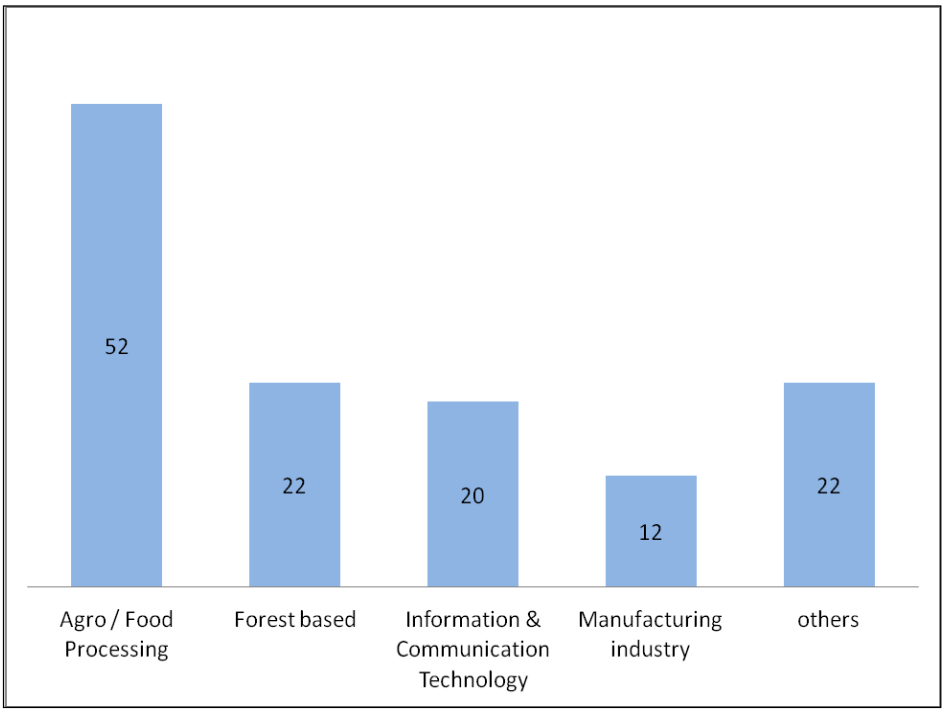

Figure 3. Type of enterprises promoted under the project

In addition to technical support, the project also strengthened linkage between market system and agro and non-agro based product market system, capacity built up of MHPs management committee and entrepreneurs on energy planning and utilization. Besides, the project shared knowledge and advocated for ensuring sustainability of MHPs through energy utilization by enterprises that enhanced rural livelihood. During project period, total 408 market actors were

trained on PMSD approach for promotion of energy based rural enterprises development and 475 market actors were trained on technical and management aspects of MHPs, rural enterprises and income generation activities.

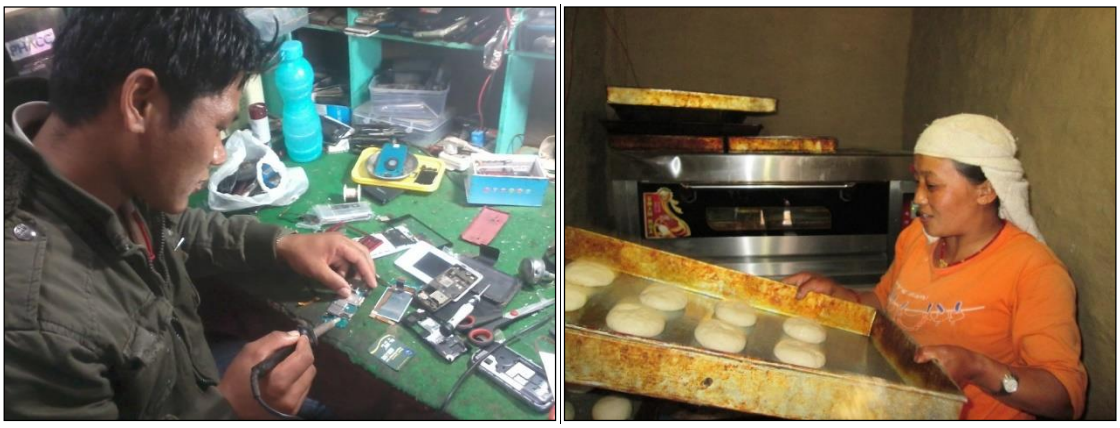

Figure 4. Mobile repair and bakery training to entrepreneurs using MHP electricity

One of the major achievements of project is that PMSD approach has been recognised as one of the approach to promote Micro, Small and Medium (MSME) in MSME promotional guideline developed AEPC.

LEARNINGS

Partnership with government program AEPC/NRREP was effective to carry out the project activities at scale with their leverage funding and technical support. In addition, they take responsibility to manage for providing further support to MHPs and enterprises.

Market actors particularly MHP management committee members and rural entrepreneurs are not confident about potential benefits and opportunities that they could gain from changing their present practices and increasing their interdependency. Hence, the project could work on empowerment of market actors.

Energy based rural enterprises are in need of appropriate technologies for processing, drying, heating etc. They are looking for technologies that are user friendly, affordable, easy to transport and robust. The project should work on research and development of such technologies. Likewise, rural small scale producers finds difficult to compete with large producers due to poor quality and lack of market linkages. The project should facilitate for quality enhancements, branding and market linkages. Also, linkages between rural entrepreneurs and external market actors is challenging because of lack of information, communication services, transport services etc. Hence, the project should facilitate to narrow this gap.

Lack of financing is one of the constraints to start up enterprises in rural areas. Practical Action could encourage financing institutions or social investors from cities to invest in rural enterprises.

CONCLUSION

The project/programme relying on subsidies too much to promote the creation of enterprise in MHP catchment areas is not sustainable and scalable. The need, therefore, is to address real requirements and create an enabling environment where these enterprises as well as MHPs can flourish and run sustainably. The approach used in the project has possibility of scaling up and to provide significant contribution in terms of employment opportunities and income generation of rural poor and excluded group.

The project creates win-win scenario to improve rural livelihood as well as energy infrastructure operation and sustainability.

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ASSESSMENT OF RENEWABLE ENERGY DEVELOPMENT TO THE SUSTAINABLE ELECTRICITY SUPPLY IN THE ASSOCIATION OF SOUTHEAST ASIAN NATIONS

Susy M. Simarangkir
Freelance Consultant, Jakarta, Indonesia
E-mail : susyms07@gmail.com

Abstract

Ten ASEAN Member States (AMS) share the same need on the security of energy supply in the respected countries. The ASEAN Plan of Action for Energy Cooperation 2010-2015 (APAEC 2010-2015) has measured the electricity supply in 2020 and 2030 in two scenarios : Business-as-Usual (BAU) and Alternative Policy Scenario (APS). In APAEC 2010-2015, the share of Renewable Energy (RE) is agreed at the level of 15% of the total installed power capacity mix in 2015. Evaluated the share of RE was already exceeded in 2013, the new plan on higher RE contribution in draft of APAEC 2016-2025 is projected to be 30% of the electricity generation mix in 2020.

The purpose of study is to evaluate the growth of RE up to 2013 and projected it to the the electricity generation in 2020. Further assessment on the readiness of ASEAN to response to the plan on multilateral agreement on the electricity consumption has shown the target is achievable by clearly arrangement on technical, financial and administration..

Keyword :

Renewable Energy, ASEAN Plan Activities for Energy Cooperation, ASEAN Power Grid, Generation Cost

1 INTRODUCTION

The Association of Southeast Asian Nations (ASEAN) was established on 8 August 1967 with the signing of ASEAN Declaration by the Founding Fathers of Indonesia, Malaysia, Philippines, Singapore and Thailand. The other five (5) ASEAN Member States (AMS), Brunei Darussalam, Cambodia, Lao PDR, Myanmar and Viet Nam, were joined during period of 1984-1999. The leading purpose of ASEAN is the enhancement of peace, stability and security by promoting greater political, economic and socio-cultural cooperation in the region.

With the total of population of more than 625 million (2013) or near 9% of the world population and the GDP's growth rate of 5.4% (2003-2013), ASEAN has been recognizing as the next dynamic markets that attracts the investor and multinationals. South East Asia is well known as the region with rich on natural resources of hard coal, lignite, natural gas and oil. ASEAN production was 4.9% of the world's oil production, 6.2% of the world's natural gas production and 7.1% of the world's coal production in 2013.

In period of 2000-2013, the growth rate of ASEAN primary energy consumption was 3.5% and it reached of 606 Mtoe in 2013, while being accountable less from ASEAN primary energy production of 778 Mtoe. Although ASEAN energy production was larger from the energy consumption. ASEAN was the net oil importer but in natural gas and coal, the region kept its position as the exporter.

In 2013 :

Land Area : 4.43 million km^2
Population : 625 million people
Population density : 141

34.2% of world's land area
8.7% of world's population
> 50% living in rural area

GDP/capita : 3,832 USD

High disparity in the region
Myanmar : 0.08x of the world GDP
Singapore : 5.1x of the world GDP

Primary Energy Prod. : 778 Mtoe

Oil Prod. :4.9% of the world prod.
NG Prod. : 6.2% of the world prod.
Coal : 7.1% of the world prod.

Figure 1 : ASEAN Region
Source : [1, 8, 12]

The ASEAN Plan Activities for Energy Cooperation (APAEC) is the blueprint of energy cooperation of 10 AMSs which covers 7 program areas, including RE. AMSs had agreed to achieve a collective target of 15% for RE in ASEAN installed power capacity mix by 2015. The draft of the new APAEC 2016-2025 is aggressively setting the share of RE tentatively to be 25% in ASEAN primary energy supply mix and 30% in power generation mix by 2020. The new APAEC 2016-2025 is in the midst of finalization and it is plan to be announced by the end of 2015.

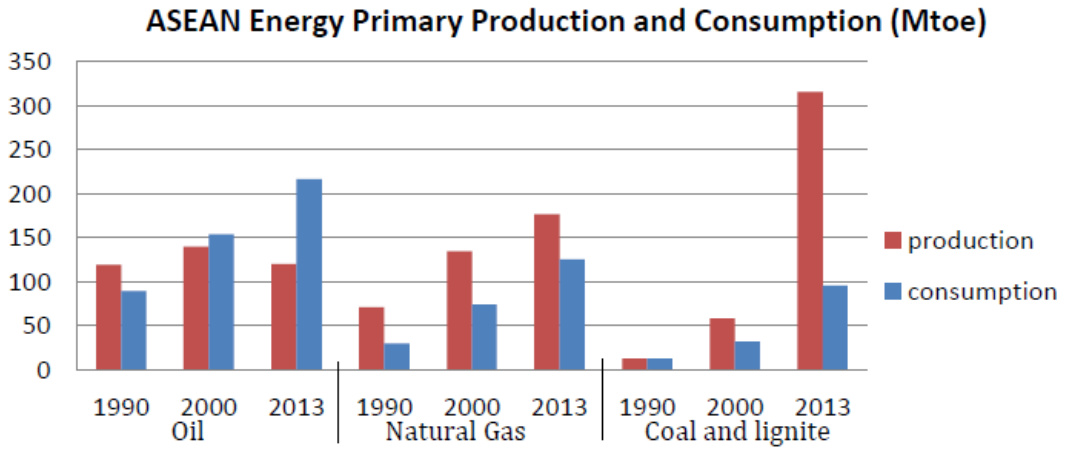


Figure 2 : ASEAN Energy Primary Production and Consumption (Mtoe)
Source : [3]

In 2013 the electricity generation mix was 821 TWh, of which 79% was dominated by non RE (coal, oil and natural gas) and the rest, 21%, by RE. The accumulative of the electricity generation mix in Indonesia, Thailand and Malaysia was more than 70% of ASEAN electricity generation mix and heavily on non RE resources. The main contributor of ASEAN RE electricity generation was Viet Nam (37%) and followed by Indonesia (15.7%) and Thailand (12.4%).

The electricity generation mix in 2020 is projected to be 1,310 TWh1 but this target is lower from the target in the draft of APAEC 2016-2025, which opens for the difference of 61 TWh.

2. METHODS AND MATERIAL

The study assess technical and financial responses to the development of RE resource up to 2020. Simplified approaches and business-as-usual scenario towards projecting the future of the electricity generation and installed power generation, both for RE and non-RE, were applied. The base year of calculation is 2013 and the data source for both parameters is from ASEAN Centre for Energy (ACE). The levelized cost of electricity (LCOE) of RE technologies published by IRENA is adopted to calculate the generation cost of the development of RE in 2020.

3. RESULT AND DISCUSSION

3.1. Potential of RE

Hydro has been proven as the reliable RE resources for the electricity generation in many years in region. Nine AMS have hydro potential and it is a major source of electricity in Cambodia, Lao PDR and Myanmar. Lao PDR was electrified nearly 100% by hydro and it contributed more than 70% in Myanmar and 57% in Cambodia. In term of the amount of electricity generation by hydro, Viet Nam is the country with the highest amount of 61 TWh electricity generation by hydro compared to other countries.

Indonesia is the country with a huge potential of geothermal, 27 GW, but Philippine leaded in the installed power capacity of 1.9 GW. Biomass and solar are available in all AMSs but both has different challenge on parameters affected the generation cost. Thailand is the most advance in implementing biomass (including biogas and waste), in which 2.6 GW or 14 TWh of biomass projects in 2013.

The development of solar PV is slow due to the highest LCOE compared to the other RE technologies. With the cost declination of solar PV's module, solar PV is expected to take more roles in the near future. The aggregate of solar PV in ASEAN was less than 1 GW, in which 86% of it were installed in Thailand. Wind is another option in coming near future since it has the same trend as solar PV in the price's declination in wind turbine technology. Out of RE resources availability, the database of biomass, wind and ocean require detail assessment.

Table 1. Potential of RE in AMS
Source : [6]

AMS						
Brunei	5.3 kWh/m^2/d	N/A	1.3 TWh/y	N/A	372 MW	0.7 GW
Cambodia	5 kWh/m^2/d	10 GW	√	N/A	>5m/s	√
Indonesia	4.8 kWh/m^2/d	76 GW	49.8 GW	27 GW	9.29 GW	√
Lao PDR	3.6-5.3 kWh/m^2/d	26 GW	1.2 GW	0.05 GW	3.6 m/s	N/A
Malaysia	4.5 kWh/m^2/d	29 GW	0.6 GW	N/A	1.2-4.1 m/s	√
Myanmar	5-5.3 kWh/m^2/d	40.2 GW	42.4 Mt/y	N/A	4 m/s	√
Philippines	5 kWh/m^2/d	10.5 GW	0.24 GW	1.2 GW	76.6 GW	170 GW
Singapore	3.1 kWh/m^2/d	N/A	√	N/A	√	√
Thailand	5-5.5 kWh/m^2/d	15 GW	2.5 GW	N/A	5.3-6.4 m/s	√
Vietnam	4-5 kWh/m^2/d	35 GW	0.56 GW	0.34-0.4 GW	≥6 m/S	0.1-0.2 GW

3.2. Renewable Energy Development

a. Installed Power Capacity

184 MW of power capacity mix had been installed in ASEAN and the share of RE was 25%. The hydro was the most RE resource that had been installed in almost AMS, excluding Brunei Darussalam and Singapore. The second position was filled by bioenergy (biomass and biogas). The actual share of bioenergy should be higher due to no available data from Indonesia, Myanmar and Viet Nam during of the study. Indonesia and Philippines installed 3,214 MW or 99.9% of the total installed power capacity of geothermal. On the other side, Thailand share on geothermal was 300 kW.

In relation to APAEC 2010-2015 by targeting the RE installed power capacity in the share of 15% of the installed power capacity mix by 2015, the installed power capacity in 2013 was more than the target. The composition of RE was 20% in 2006 and the raising of share was started in 2010 with near to 4,000 MW of new installation of hydro in Indonesia. Geothermal was in the 2nd position in 2006 but it sifted to the 3rd after biomass in 2013.

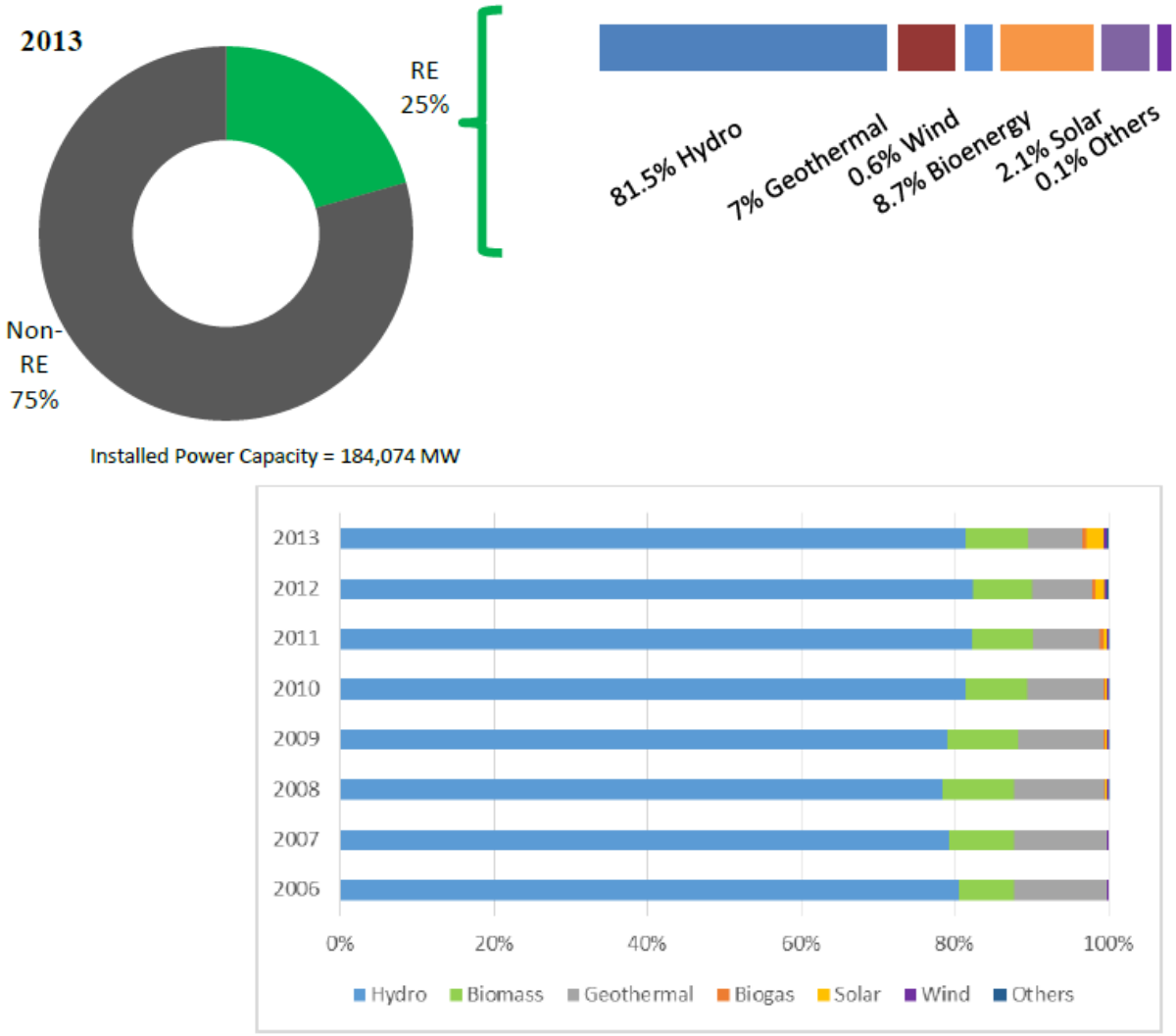


Figure 3 : ASEAN RE Installed Power Capacity
Source : [4]

b. Electricity Generation

Out of 821 TWh of the electricity generation in the base year, 169 TWh was from RE resources, in which the main share was hydro (78%). The other RE resources that generated more than 10% were geothermal (11%) and bioenergy (10%) and the remaining 1% was from solar PV, wind and others.

Viet Nam's hydropower generated 61.86 TWh or 47% of ASEAN electricity generation from hydro. Philippines and Indonesia were the major countries for geothermal in the amount of 19 TWh or almost 100% of ASEAN electricity generation from geothermal. In bioenergy, Thailand's share was 80% or 12 TWh from the accumulative target.

The share of RE was 16% of the electricity generation mix in 2006 and raised to 21% in 2013. It leaded by hydro of 16% and followed by geothermal (2.3%) and biomass (3%). In the 3rd ASEAN Energy Outlook, RE has significant contribution in the electricity generation with its share of

25.3% of the electricity generation mix or 332 TWh in 2020. In relation to 30% of RE share in electricity generation mix in 2020, the RE share based on APAEC 2015-2020 is 61 TWh higher than in the 3rd ASEAN Energy Outlook.

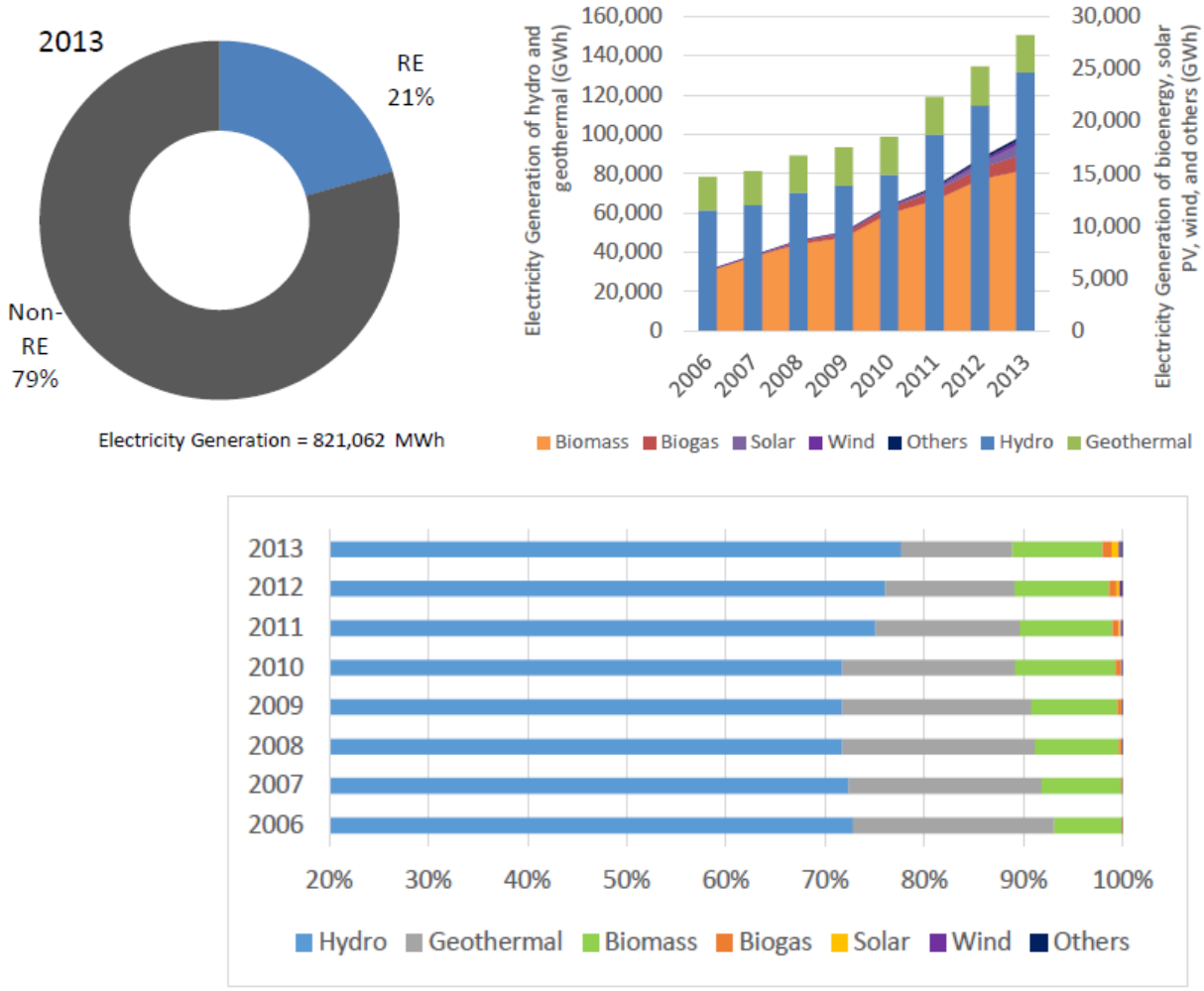


Figure 4 : ASEAN RE Electricity Generation in 2013
Source : [4]

3.3. RE Resources Composition and Cost of RE Development in 2020

ASEAN projected the energy composition in 2020 and the RE share is 225 TWh of hydro, 40 TWh of geothermal and 67 TWh of others. There are some possibilities to increase the electricity generation from each of RE resources but the generation cost, long running operation and technology viability are main factors to select RE resources.

The ASEAN Power Grid has shown the large scale of interconnection development in northern system of ASEAN. The five countries in northern system are rich in hydro, solar PV and biomass. Therefore the reliable RE resource to overcome the 61TWh will be the additional of installed power capacity from these 3 RE resources. In term of the generation cost, hydro will be the first option to share electricity larger from others followed by biomass and solar PV.

The development of world's RE technology nowadays is offering the up-to-date data on cost and performance of RE technology. The target of the electricity generation in 2020 requires a significant cost that is measured as the generation cost. The assumption of the weighted average LCOE for each of RE technologies is adopted from International Renewable Energy Agency (IRENA); USD 0.032-0.07/kWh for hydropower project, USD 0.05-0.06/kWh for biomass, USD 0.05-0.09/kWh for geothermal, USD 0.08-0.12/kWh for onshore wind and USD 0.15-0.31/kWh for solar PV2.

Table 2 : RE Shares and RE Development Cost in 2020

AMS	Electricity Generation (TWh)		LCOE (USD/kWh)	Additional Generation Cost (MUSD)
	2013	2020	Benchmark	
Biomass	17	36	0.05 - 0.06	357
Geothermal	19	44	0.05 - 0.09	1,766
Solar PV	1	3	0.15 - 0.31	441
Wind	0	1	0.08 - 0.12	35
Hydro	131	305	0.03 - 0.07	11,598
Total	**169**	**389**		14,196

The additional generation cost will come up to 14 billion USD and the distribution of this huge amount of RE among AMSs has not being agreed due to some technical, financial and administration difference in AMSs.

In addition, the reduction of RE price for solar PV, wind and biomass technologies due to various technologies will enter the market. It is important to note the fluctuation cost feedstocks of biomass and climate change impacts to the availability of RE resources have to be one of parameters justified from planning stage.

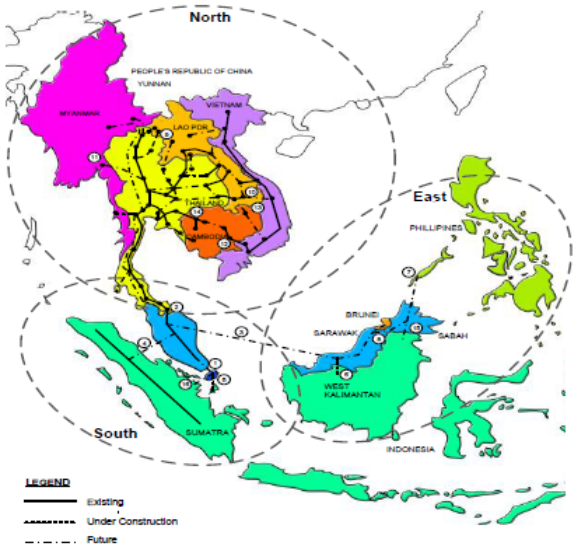
3.4. ASEAN Power Grid

The ASEAN Power Grid (APG) is a flagship programme mandated by ASEAN Leaders in 1997 which the purpose is to help AMSs to meet increasing demand for electricity and improve access to energy services by enhancing trade in electricity across borders, optimising energy generation and development and encouraging possible reserve sharing schemes3.

Sixteen interconnection programmes cover all AMSs and the highest installation is in the northern system (Cambodia, Lao PDR, Myanmar, Thailand and Viet Nam) with 25.5 GW or 76% of the total interconnection capacity plan. The nature of the electricity trading in bilateral agreement and to upgrade into region integration, it requires deep analysis on policy, regulatory, legal, commercial and technical viability.

Some technical issues in term of grid code, smart grid and modernizing the local grid have been discussing and it has less difficulty from other factors, such as the electricity price, tax, subsidy, scheme for Public Private Partnership involvement, transmission operator and ASEAN regulatory body. The first multi interconnection in ASEAN will link four AMSs, Lao PDR, Thailand, Malaysia and Singapore in 2018. It will be a comprehensive lesson-learned for the future multi AMSs' interconnection. In addition, the other three projects: Lao PDR-Cambodia, Sarawak (Malaysia)-Brunei and Peninsula Malaysia and Sumatera (Indonesia) are identified and agreed as the priority projects.

The development in ASEAN interconnection until 2020 is projected to reach 21 GW and focusing to country that mostly has high RE resources with lower growth rate of economy to the low RE resources potential with medium or high growth rate of economy.



unit : MW

	Interconnection	Existing	On-going	Future	Total	COD
	Northern System	**2,659**	**3,942**	**18,924**	**25,525**	**2015-2023**
9	Thailand - Lao PDR	2,111	3,352	1,865	7,328	2015-2023
10	Lao PDR -Vietnam	248	290		538	TBC
				11,709-	11,709-	
11	Thailand - Myanmar	0	-	14,859	14,859	2018-2026
12	Vietnam - Cambodia	200	-		200	TBC
13	Lao PDR - Cambodia	0	300		300	2017
14	Thailand - Cambodia	100	-	2,200	2,300	post 2020
	Southern System	**450**	**600**	**1,800**	**2,850**	**2020 and up**
1	P.Malaysia - Singapore	450	-	600	1,050	post 2020
4	P.Malaysia - Sumatra	0	600		600	2020
5	Batam - Singapore	0	-	600	600	2020
16	Singapore - Sumatra		-	600	600	post 2020
	Eastern System	**0**	**430**	**600**	**1,030**	**2015 and up**
6	Sarawak - W.Kalimantan	0	230		230	2015
7	Philippines - Sabah	0	-	500	500	2020
8	Sarawak - Sabah - Brunei	0	200	100	300	2018-2020
15	E.Sabah - E.Kalimantan		-			post 2020
	Northern - Southern System	**380**	**100**	**300**	**780**	
2	Thailand - P.Malaysia	380	100	300	780	existing, TBC
	Southern - Eastern System	**0**	-	**3,200**	**3,200**	
3	Sarawak- P.Malaysia		-	3,200	3,200	2025
				21,674-	30,235-	
	Grand Total	**3,489**	**5,072**	**24,824**	**33,385**	

Figure 5 : ASEAN Power Grid Plan and Progress
Source : [9]

4. Conclusion

The cooperation among AMS on energy security is very important. From the geographic point of view, the electricity trading is positively possible from north to south and to east part of ASEAN. The bilateral cooperation has been running up to now and one recent agreement connecting 4 AMSs is designed to be finalized in 2018. Thailand and Singapore are two major electricity consumers in ASEAN while have limited in energy resources. Most of its electricity are imported from the neighbouring countries, whom the local's electricity demand is lower from the electricity supply's potential.

The cost effective is always the first priority on energy supply decision either to utilize local energy resources or buying from neighbouring countries. The high LCOE in solar PV is not in the same side as solar PV's potential in all AMSs. The same condition of high LCOE is for wind technology, where the low wind speed is common in ASEAN. The prediction on cost reduction within the coming years for solar PV and wind technology must be responded in higher implementation

compared to the target in APAEC 2010-2015. The biomass is abundant in ASEAN and it has been proven by its development significantly. The price of biomass will be arising when the feedstocks become major commodity for other purposes and to ensure the share of biomass for the electricity generation the feedstocks have to be secured continuously.

The improvement in RE database, especially on RE potential, installation and standard methodology on measurement and monitoring is a must. With the credible data, the plan on energy security in medium and long run, both in local and regional context, will be realistic. The APAEC 2010-2015 has targeted the 15% of RE shares in installed power capacity mix in 2015 and in actual the target is exceeded. The new APAEC 2016-2025 tentatively set 30% of RE share in the electricity generation mix in 2020. In 2013, the share of RE was 21% of the electricity generation mix. The tendency of reduction on capital cost in some RE technologies should support the target achievement.

The interconnection entails clarification on technical, financial and administration. The intermittent resources, located in remote area and less skills and knowledge are reasons sounded for the technical lack of RE development. The subsidy, tax, electricity buying and selling price, distribution of project cost among AMS, transmission system operator and regulatory body for controlling and monitoring the electricity trading are significant factor for the successful of energy cooperation among 10 AMSs and have to be realized in before 2025.

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Developing self-sustainable solar-run community schools: Case study from Light of Hope's digital school in Bangladesh

Arif Md. Waliullah Bhuiyan
Light of Hope, H#282, R#19/C, Mohakhali DOHS, Dhaka – 1206, Bangladesh
bhuiyan.waliullah@gmail.com

ABSTRACT

There are about 50,000 primary schools in Bangladesh located in off-grid areas where communities around those schools have limited access to information, opportunity to get internet based services. The main objective of the study was to develop a financially self-sustainable solar-run school model for developing countries that will create employment opportunity, generate revenue besides providing quality education to the children.
Survey was conducted initially to understand the market demand for mobile charging, internet services and printing facility in rural Bangladesh. Financial analysis is conducted based on the initial market research and field research data. 'Light of Hope' – a tech-based educational organization has developed world's lowest energy consuming multimedia classroom solution and installed the system in two primary schools in off-grid and semi-off-grid areas. Each school requires an investment of Euro 1370 that will generate yearly revenue of Euro 1093 from mobile charging, internet-based services and printing. The estimated ROI is 8 years which also makes it financially attractive.

KEYWORDS

Solar system, multimedia classroom, e-education, internet-based service, off-grid.

INTRODUCTION

While Bangladesh is on track to achieve universal primary education by the end of 2015 to meet the MDG target, quality of the education services and the outcomes are still very low. New global target or Sustainable Development Goals (SDGs) are giving higher priority on the quality of the education. Improving the quality of education requires long term commitment and large government funding for infrastructure development, teacher capacity development and inclusion of technology at the school level. Bangladesh government allocation for education in the budget is decreasing over the years. Government of Bangladesh spends only 1.8% of the GDP on education whereas countries like Vietnam spent 6.3%. (Habib, 2015) Investment on technology in education is still a far cry for Bangladesh because of its high initial investment and consequent operation and maintenance cost.

Only 65% of the population has access to electricity while over 40,000 primary schools are located in off-grid areas and don't have electricity connection. While lack of electricity poses a major treat in providing ICT-based quality education in rural areas, it also opens up an opportunity to develop school-based business model to ensure quality education and also cover the operational and maintenance cost of the provided technology to the schools.

Light of Hope – tech-based non-profit develops an innovative solar-run multimedia classroom solution for rural off-grid schools capable to provide other services like mobile charging, internet use, printing to develop revenue for schools. Light of Hope engineers developed the solar-run

system and installed in 3 different schools. Market research on the various service demands is conducted. Financial analysis on the school business model shows promising signs as recovery of the initial investment and covering O&M costs seems viable.

METHODOLOGY

The action research under Light of Hope's 'Digital School Project' was initiated in March 2014. The research and operation team consists of engineers, educators, project management professional and university students. The overall work was divided into three major parts – development of the solar-run multimedia classroom solution, collection, development of educational contents and capacity building training to the teachers and finally developing the business model for the schools depending on the initial market survey conducted on mobile charging, internet and printing services at the community.

Based on the initial solar-run classroom design development and available educational contents three pilot schools are supported. Experience and learning from the pilot is also being considered at the business model development and potential future expansion of the project.

DIGITAL SCHOOL PROJECT

The overall objective of Digital School project is to strengthen the capacity of the rural schools to provide quality education to the children. Light of Hope provides necessary technical, management and training supports to the local schools to develop their own revenue generation business model and quality education services. The development of the overall project is on-going and so far Light of Hope through its pilot schools realized the project's tremendous opportunity to scale-up a sustainable country-wide model in Bangladesh that also has potential to be replicated in other developing and under-developed countries too. The different steps and components of the 'Digital School Project' are briefly covered along with the business model in sub-sequent sections.

Formulation of Digital School project concept

Coming back from their engineering background, the Light of Hope founders wanted to build a solar-system coupled with multimedia classroom solution with necessary e-educational contents to ensure the schools in off-grid rural areas have access to modern ICT-based education services. While designing of the system was the prime part of their task, making the whole system self-sustainable was another underlying objective. To the working team, the examples and business models for revenue generation from solar-system through services like mobile charging, solar lantern charging was available. What was absent however is how this revenue generation activities could be coupled with the school so that the school itself can generate revenue to cover the operational and maintenance cost of its multimedia classroom.

Developing a low energy consuming multimedia classroom solution

The multimedia classroom should have a laptop (computing device), projector, sound box, LED lights with enough battery backup to run the system for 4 hours. Light of Hope engineers looked into different low energy consuming products available in the market. Both the local and international markets are explored to have a comprehensive solution that is replicable in large scale. The

comparison between a conventional multimedia classroom system and Light of Hope's solution shows the difference in energy requirement for both the systems.

Table 1. Comparison between conventional & Light of Hope multimedia classroom system

Load	*Conventional system*	*Light of Hope system*
	Energy consumption (W)	Energy consumption (W)
Laptop	35	30
Projector	2000	15
Sound box	15	5
LED Light (3 nos.)	15	6
Total	2065	56

Because of this large difference in energy consumption, government and other organizations in Bangladesh has a perception that solar-run multimedia classroom requires high initial investment which is one of the main reasons why the off-grid schools are not considered to be digitalized. Light of Hope with their low energy consuming solutions proves that a very low initial investment (less than 500 euro) is sufficient to have a solar system to support the multimedia classroom.

Develop e-education database for primary level

The next step is to provide all the necessary educational contents at the laptop for the teachers to take the classes with multimedia projector. Although developing e-educational contents for secondary and higher secondary level was getting quite momentum in Bangladesh, finding educational contents for primary level was a daunting task. First of all, not many organizations were involved in this and not many contents were available. So Light of Hope employed 30 volunteers for 3 months to find out what is available in Bangladesh and then outside. Hundreds of videos on different science and other topics were downloaded from the internet and then translated into Bengali according to the National Curriculum. Currently Light of Hope posses the largest database of primary level contents in Bangladesh. It partnered with national and international NGOs like BRAC, Save the Children to collect many e-educational contents. All the contents are provided according to class, subject and topic.

Capacity building of the rural school teachers

In the rural areas, many teachers didn't even see a laptop. Light of Hope provides basic computer skill training, teaches method on how to use e-educational materials in the classroom to stimulate interest and ensure engagement Refresher training is very important for the teachers to retain their knowledge of the initial training and to provide feedback on challenges to the Light of Hope team.

Ensuring continuous technical support

Light of Hope will provide rigorous and quick after-sale support for the solar system to the schools and other technical support for the laptops and other equipments so that any problem can be solved with minimum disruption at the classroom learning. In case of longer servicing time, Light of Hope retained a certain percentage of laptops (usually 10% of the total laptop in the schools) as backup. These are called 'Buffer Laptop'. The buffer laptops already have all the software, e-educational

materials needed to conduct the classroom teaching. The buffer laptops will be delivered to the schools after it's identified that the school's laptop requires more than a week to service.

MAKING 'DIGITAL SCHOOLS' SUSTAINABLE

Light of Hope's self-sustainable primary school business model is unique in many ways. Each school will have one or several income generation activities supported by the solar system. Different options are being considered to ensure regular revenue generation from the school to cover the operational and maintenance cost of the multimedia classroom system. The options for individual schools depend on the existing context of the locality, demand of different services and available support to continue the operation of the provided services. Services like mobile charging, internet use, printing etc. are few options those are under consideration. The generated revenue and the feasibility and likelihood of making the service profitable will reflect on the financial analysis of the investment and revenue. Light of Hope made several hypothetical scenarios to see the business viability of the provided services. Depending on several criteria like availability of the electricity at the locality, population, mobile and internet network, average household income at the surrounding locality, livelihood options for households etc. the revenue will vary from school to school.

The market research conducted by Light of Hope team at the coastal village in Noakhali district of Bangladesh shows that in coastal off-grid areas an average adult who owns a mobile phone spends about 240 hours a year just to walk to the far market to charge his mobile. Villagers also travel to city to in expense of travel cost, service cost and time to get various internet based services provided by government. The existing market condition allows initiating several income generation activities like mobile charging, internet café where people can use internet and get other internet-based services, printing etc. are incorporated with the school's solar system. These activities will earn enough revenue to cover the operational and replacement cost of the laptop, battery, other equipment and the salary of the operator.

Financial analysis of Digital School intervention

The financial analysis of the school intervention shows encouraging potential for covering the operation and maintenance cost and recover of the initial investment at the school in off-grid areas. Interventions like mobile charging, internet use, printing are considered. The initial investment, revenue and operation cost estimation for one school is provided below:

Table 2. Initial ivestment for a single school

Investment Item	Budget (euro)
Solar system	560
Laptop	400
Mobile charging facility	25
Mini-projector	300
Internet Modem	35
DC Printer	50
Total	1370

The total initial investment for each school is 1370 euro. The budget for solar system includes cost for solar panel, battery, charge controller, LED lights and other components. Investment may

slightly vary with price change of individual components. With continuous improvement of technology in terms of efficiency the price is likely to decrease in future.

The yearly operation cost is 840 euro which includes the salary of the local operator and the internet bill. The maintenance costs have different frequency ranging from 5 to 10 years for different components. Any maintenance cost before the projected frequency will be covered by the warranty service provided by the manufacturer or the local distributor. The detail of the operation and maintenance (O&M) cost for a single school is provided below in Table 3.

Table 3. Operation & Maintenance cost for a single school

Operation & Maintenance (O&M) Item	Amount
Operator's salary	50 euro/month
Internet bill	20 euro/month
Laptop replacement	400 euro/5 year
Solar battery replacement	250 euro/5 year
Other replacement	220 euro/10 year
Solar panel	On 20th year*

*not considered in the financial analysis as the project duration is considered 20 years.

The revenue from each school through various services depend on different factors like potential customer size, frequency of service, duration of service period in a year etc. Service charges for different services are estimated to be lower than the existing market price to attract more customers. Incentives like time savings and additional expenditure (e.g travel cost to the service point) will also ensure that the school will get regular customer. The yearly income for different services provided from the school is provided below in Table 4.

Table 4. Revenue from a single digital school

Revenue item	Per unit charge (euro/unit)	Monthly service unit/duration	Yearly income (euro)
Mobile charge	0.044/charge	750 mobile charge/month	320
Internet use	0.33/hour	40 hours/month	400
Video calling	1/day	20 days	240
Printing	0.55/day	20 days	133.33
Total			1093.33

The revenue model will vary depending on the locality. For example, in on-gird or semi-on-gird areas there will be no income from mobile charge as the households can charge their mobiles at their homes. Similarly in semi-urban areas, the demand for internet based services is likely to be higher compared to the rural areas.

Light of Hope's financial model shows the return on investment (ROI) is 8 year considering zero percent interest rate over the investment. However, there is a negative cash flow on 10th year due to

replacement cost for laptop and battery. But after that period, the cash flow is always positive. The financial projection for the school is already encouraging and with increased revenue from services it could be financially attractive for government and other organizations to invest under social development project.

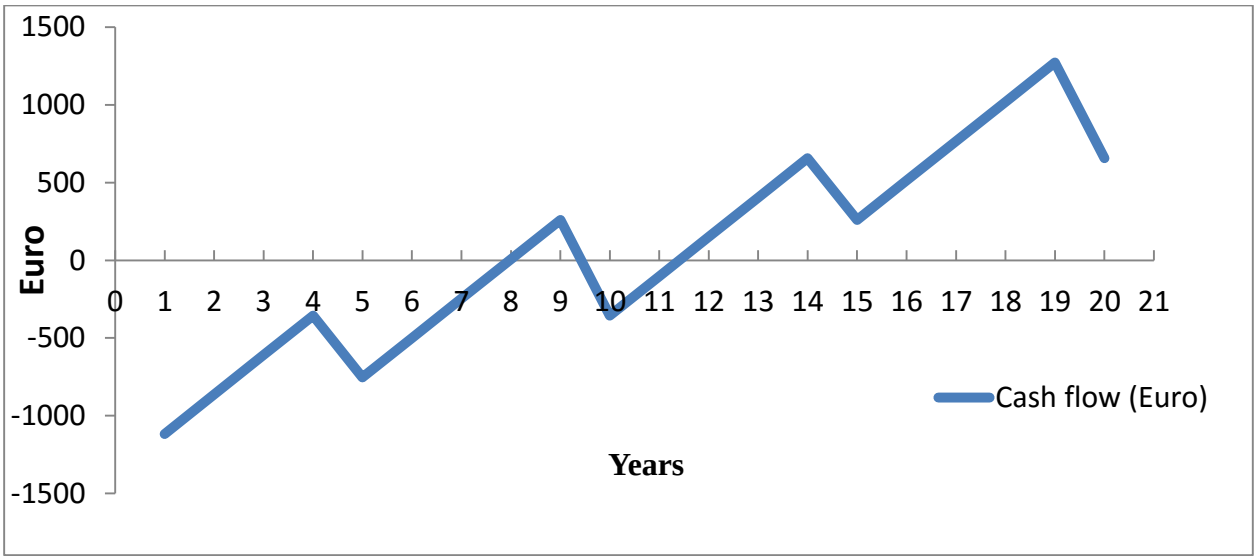

Figure 1. Yearly cash flow of the digital school

MAJOR CHALLENGES

During last one year of intervention Light of Hope faces various challenges from programme design point of view and the intervention strategy. Initial challenges were to design the compatible low-cost solar system design, finding and developing educational materials etc. Capacity development of the local teachers on using the laptop and taking class with educational contents is still a major challenge. An appropriate training design and the cost for an effective training are very high. Funding for the capacity building training of the teachers is inadequate and financially non-returnable although it contributes significantly on the improvement of the education service delivered at the school.

Analyzing the existing market demand for the services provided from the school is another challenge and requires caution during the investment. Training up the local operator to provide various services also required for customer satisfaction which is directly linked with the potential revenue generation.

Monitoring and evaluation of the multimedia classroom activity is another area of concern. In order to ensure that regular class is taking place using the multimedia setup, Light of Hope is planning to develop software that will keep track of the number of hours the teachers are actually using the setup which will be automatically uploaded to the central server online. This will significantly reduce the monitoring cost of the project. For evaluating the outcome of the digital school, Light of Hope is

developing a standard tool that will check the improvement of children learning over the period of time.

CONCLUSION

Delivering quality education comes at a cost with high investment on infrastructure, technology, capacity building of teachers etc. which is often difficult for a government in a developing country. Light of Hope intended to develop a low-cost solution with potential income generation activity from the school to reduce that burden on investment and operation and maintenance cost. The first phase of the intervention is already completed with a complete setup with 3 pilot schools currently running proves the system's efficiency. The second phase will start soon with income generating services in school and the financial analysis looks attractive. Once successfully completed in Bangladesh, Light of Hope's Digital School project can be replicated in other developing countries with similar context, especially in South-Asia and Africa.

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THE ECONOMIC AND SOCIOECONOMIC ASPECTS OF WOOD ENERGY SYSTEMS IN BURKINA FASO

Yacouba Sambore
C/o FAO Wood Energy Programme/ SamConsult International
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ABSTRACT:

Burkina Faso is a landlocked country with no significant fossil fuel resources. In 1992, although these fuels represented only 8% of the energy balance, their importation consumed 58% of the country's total exportation receipts (Lapointe and Zaccour, 1993) reported by Minvielle (2001) [1]. In this context wood energy, representing 84% of the total energy consumption and used by 97% of households (DGE, 2003) [2] constitute an asset for the social and economic development of the country; but the way of its production and use may generate ecological problems. This study entitled ***the economic and socioeconomic aspects of wood energy systems in Burkina Faso*** *was realized with the Food and Agriculture Organization of the United Nations (FAO)'s Wood Energy Programme/ Wood Energy Planning and Policy Development (WEPP) component of the project on sustainable forest management in African, Caribbean and Pacific (ACP) countries funded by the FAO-European Commission Partnership Programme GCP/RAF/354/EC. It aims at highlighting the potential economic, socioeconomic, environmental, political benefits of wood energy systems in order to generate a shift in political decisions for their sustainable management. It shows that wood energy and woodfuels properly managed contribute to economic and social development, to environmental protection and the cultural diversity preservation. Also, wood energy and woodfuels appear to be environmentally friendly sources of energy for households but also for industrial and commercial energy, locally available.*

Keywords: RE, developing countries, economic aspects, socioeconomic aspects

1 PURPOSE OF THE WORK

In Burkina Faso, more than 45% of the population are living under the poverty line (MEF, 2000) [3]. In this context, wood energy appears to be the most important and affordable source of energy and participates to all important element of the country's economy. From households to small and medium enterprises, wood energy is the engine of their development. Although this utilization of wood energy presents several benefits at all the social and economic levels, this is not generally perceived by decision and policy-makers.

Also, meanwhile fuelwood represented the form of wood energy mostly used in the past, the current trend of urbanization requires the use of other forms of energy.

Due to its affordability and other qualities, charcoal appears to be the transition source of energy per excellence for most of the households. However, the way in which charcoal is produced in the country with a production efficiency of 11% (Minvielle, op. cit.) is a big concern for the preservation of the forest resources. It is also important to note that with a population growth rate of 2.7%, the total population of the country is expected to double by 2020 according to Mukanda-

Badu (1994) reported by Minvielle (ibid.). So urbanization phenomenon linked with demographic growth and production methods forecast a danger for the future of forests resources.
Therefore, the potential benefits derived from the use of wood energy for the country's development could be hampered by the methods and the lack of sound management and planning policies.

The purpose of this work is then to highlight the potential economic, socioeconomic, environmental and political benefits of wood energy systems in order to generate a shift in political decisions for their sustainable management and sound planning in a context where no substitution is envisageable in a near future.

2 APPROACH

The approach used in this study includes analyses of the economic, socioeconomic, institutional and legal aspects of wood energy systems at a national level.

Conscientious of the social and economic stakes of wood energy systems in Burkina Faso, the Government adopted since the early of the 1980s legal measures for their sustainable management in order to generate income for rural people and contribute to the protection of the forest resources. Examples include the forest code adopted in 1997 [4] by the national assembly which states: "Forest resources must be sustainably managed in order to generate income to surrounding villages and contribute to poverty alleviation and improve the level of life of the population" (article 4).

Institutional aspects refer to the institutional development of the country promoted by the sustainable management of forest resources for wood energy production. Institutions include several governmental bodies, development projects, non governmental organizations etc. Examples include the Regional Programme for the Traditional Energy Sector (RPTES), the Department of traditional energies, the Department of forest resources management, etc.

The economic aspects present the impact of the utilization of wood energy systems on both the local and national economy. The duality rural and urban levels is considered. Also, impacts at the macro and microeconomic levels are presented.

Regarding the socioeconomic level, aspects such as the social value of wood energy are presented at both the rural and urban areas. While in rural area households are self-supplied in wood energy chiefly by women and small girls involving physical loads at distances longer and longer, in urban areas, wood energy is a precious commodity that should be purchased. However, it is important to note that wood energy still remains unaffordable to certain category of the urban population.

The socioeconomic benefits generated are multiple and various, including the income generation to actors involved in the business chain, the women empowerment, the preservation of the cultural diversity, food security etc.

3 SCIENTIFIC INNOVATION AND RELEVANCE

According to most of current and past researches, sustainable development relies generally on the social, the economical and environmental viabilities of projects.

This appears to be widely accepted by researchers and development experts. Although these three pillars present a big importance on the steps to sustainable development, one should note that a global world where cultures are homogenized and unified is a big concern for humanity. Such development with all its importance is missing a fourth pillar that is the cultural diversity (Chirac, 2002)[5]. By using wood energy as a cooking fuel, humanity preserves an important part of its culture. As an example, numbers of well-appreciated local dishes in Burkina Faso are cooked with wood energy. Nowadays, a common case in the country is that important shares of the population with relatively high income move to rural areas - where wood energy is still widely used as a cooking fuel - to have access to these types of local dishes.

Other important aspect is the fact that number of women prefers cooking several local dishes with wood energy because of a better taste and other benefits including the variety and diversity of proposed dishes.

Examples reported by A. D. Karve in an Internet discussion of the FAO energy forum in 2003 [6] reveal that the feeding habits of the population has drastically changed in India over the past 50 years due to the highly subsidized introduction of fossil fuels. In this trend the large quantity of dishes proposed in the past is going to disappear compromising the future generations of an important heritage such as culture. Sustainability appears then to be doubly threatened. So technologies should take into account cultural aspects.

Also, a sustainable wood energy management contributes to the preservation of local vegetal essences used to produce local music instruments (drums, flutes, etc.) that participate widely to the cultural promotion.

4 RESULTS

4.1 Weight of fossil fuels importation on the economy

Although fossil fuels represented only 8% of the country's total energy balance in 1992, they consumed 58% of the national total export receipts. This presents the effect to limit all the efforts made by the country to realize investment in basic social sectors such as education, health, nutrition, etc.

Also, 35% of the electricity production costs are attributed to fossil fuels used in thermal power plants (UCL, 2000) [7]. With more than 45% of the population living under the poverty line, this makes that electricity, sharing 2% of the energy balance (DGE, op. cit.) affordable only to a small number of privileged persons.

These factors linked with the level of environmental damages generated by these old-aged power plants (emissions levels, noises, wastes disposal, etc.) represent a big concern for the socioeconomic development and environmental protection of the country. Therefore it appears important to look for alternatives presenting more beneficial impacts than damages. Wood energy

seems to present these beneficial requirements at both the economic and socioeconomic levels. But before presenting these beneficial impacts of wood energy systems, a fresh look on the present way of management of these resources is necessary. A special attention is paid to the role of forests resources and the way in which charcoal is nowadays produced in the country.

4.2 Role of forest resources and trend of charcoal consumption

A study made by FAO (1999) [8] says that while traditionally fuelwood represented the biggest share of cooking energy, economic and social changes related to urbanization will lead to the progressive replacement of fuelwood by charcoal; increasing its importance in the energy, environmental, economic and social aspects. In Burkina Faso and in a very recent past, charcoal was traditionally collected as a by-product of cottage breweries and used in small quantities for barbecuing, traditional ironing and by some small restaurants. But a recent study made in the country showed an increase rate of 5.5% for charcoal consumption compared to 4.39%, 4.36% and 2.76% for butane, electricity and fuelwood respectively (Burkina Faso, 2000) [9]. Also the annual consumption of charcoal in Burkina Faso was estimated to be 1.07 Petajoules by FAO (1997) in the forest energy data [10]. It is important to note that charcoal production was legally forbidden in the country until recent exceptions allowed its production in forest management fields remote from the consumption centers of the country.

Also, results of the study made by Mukanda-Badu (op. cit.) who, considering an annual population growth rate of 2.7% forecasts an increase by a factor 2 of the total population and by a factor 4 of the country's urban population - estimated to 2,014,277 inhabitants by the national department of demography in 2003 [11] - by the year 2020. With all the aforementioned factors it is important to have a look on the methods and the context of the production of this charcoal.

In Burkina Faso, wood energy is produced in the form of fuelwood or charcoal. Due to the preference given to fuelwood in the near past for cooking, forest management plans included aspects related only on sustainable production of fuelwood. Therefore the production of charcoal was simply unauthorized.

The effect of rapid urbanization and changing habits of cooking led to a more and more increasing demand of charcoal. As a commercial production of charcoal was not organized, a network of clandestine and illegal producers was created. Due to archaic techniques of production, efficiencies achieved could hardly reach 11% (Minvielle, ibid.).

Such techniques and methods of production are a big concern for the sustainability of forest resources already degraded.

Also, in opposition to fuelwood that is collected mostly from farm cleaning and trees outside forests, charcoal is produced by cutting trees presenting a big trunk diameter or these trees are generally the one favoring the regeneration of the forest. Utility species such as *Tamarindus indica and Butyrospermum parkii are* preferred for charcoal production or these essences contribute widely to the local nutrition, the production of commodities locally used (butter, soap, etc.) or dedicated to exportation in foreign countries. This represents an important source of income for both the country and local communities.

It is therefore important to look for adequate solutions for the sustainable production of charcoal, more and more appreciated for its different qualities (high net heating value, easy to handle, smoke-free combustion, etc.) but generating high pressures on the forest resources. This presents several benefits at the economic, social and environmental levels.

4.3 Macroeconomic benefits of wood energy

Macroeconomic benefits include the impact of wood energy utilization on the major economic indicators such as the Gross Domestic Product, the balance of payment, and the trade balance. Results of a study made by Kessler and Gerling (1994) [12] showed that the business of wood energy generated a turnover of $53,435,115 in 1994. This appeared to be greater than the turnover generated by the national company of electricity (SONABEL) accounting for $31,692,308 the same year (INSD, 2003) [13]. This shows that wood energy well managed contributes to all important element of the economic development by substituting fossil fuel import, reducing levels of emissions etc. As an illustration, generating electricity by using biomass contributes to the emissions reduction of the country by 760 to 960 grammes per kilowatt-hour (UCL, op. cit.). All these aspects present direct and indirect benefit for the economy of the country. It is now important to have a look at the microeconomic level.

4.4 Microeconomic benefits of wood energy

Microeconomic benefits of wood energy include the development of small and medium enterprises (SME), wood energy serving as the engine of the business.

Activities such as local bakeries, traditional breweries, restaurants, food conservation, crafts (pottery, ceramic, etc.) local soap and local aroma production, barbecue processing, etc. are fuelled with wood energy in the form of fuelwood or charcoal. Although figures to point out the earnings generated by these activities to those involved in these businesses are unavailable, one should note that they employ 80% of the urban active population (MEF, op. cit.). All these aspects present socioeconomic benefits and their overview appear to be important and necessary.

4.5 Socioeconomic benefits of wood energy

In a country where poverty is a way of life of more than 45% of the population and where fuels derived from fossil are not accessible to the population, wood energy appears to be a social commodity presenting several stakes.

As situations differ from the urban to the rural area, a dual consideration is required. This will be done first at the rural level and secondly at the urban level.

In rural area

In rural areas where wood energy is used by almost 100% of households, the cost of the commodity is valued by the physical effort made by women and small girls to collect the products at distances longer and longer due to the degradation of the resources and lack of management.

This presents the effect of reducing the enrollment level of children in education, chiefly small girls. It is useful to note that while the enrollment rate of children under 15 represents 41% for small boys, only 35% of small girls under 15 are enrolled in the primary education (MEF, ibid.). Factors include the necessity for them to assist their mothers in tasks such as wood energy

collecting, water procurement, considered traditionally as reserved to women. Therefore, a sustainable management of wood energy contributes to improve the education level of women and young girls primarily and participates to their empowerment. More than a necessity this represents an urgent need to promote social equity.

In Urban area

In opposition to the rural area, wood energy is a precious commodity that should be purchased in urban areas. Due to the low income level of people all substitution initiatives undertaken since 1980, often highly subsidized did not meet the expected successes. Through a simulation, Minvielle (ibid.) calculated the substitution cost of wood energy by propane gas for an averaged-household size (5 persons). Results achieved valued the initial cost of investment at $214 and $120 the other years only for gas supply. With an average annual income level of households estimated to $133 (DGE, ibid.), the substitution of wood energy by fossil fuels appeared then to be quite impossible.

Again, wood energy remains the only source of energy on which the future of most of the country‘s households still relies for several decades.

Also, one should note that at both rural and urban areas, a preference is given to wood energy to cook some local dishes. Reasons of this preference include factors such as the special taste and the suitability for cooking these dishes for large family sizes. What is it then?

4.6 Wood energy and food security

Wood energy contributes to a large extent to the security of food supply. As aforementioned, in a context where modern electricity is not affordable to the poor, the conservation of perishable food (fresh fish, meat, fruits etc.) is made by using wood energy for drying. Also, the sustainable use of wood energy coming from well managed forest contributes to the preservation of utility plants that participate to a large extent to the local food supply.

Examples include the *Parkia bigloboza, Tamarindus indica, Butyrospermum parkii etc. The fruits coming from* these plants are widely used to complement nutrition in the country and serve also as raw material for the production of some local utility commodities or dedicated to exportation in foreign countries such as butter extracted from the nuts of *Butyrospermum parkii.*

Sustainable wood energy supply to households save time for women and increases the level of their participation to the process of agricultural development regarding the important role they are playing in this sector.

The following case study presents an overview of benefits gained from well managed wood energy systems.

Results presented are the main findings of the final assessment report of the project made in 1998 [14] unless specified.

4.7. Case study: Project FAO/UNDP/BKF/93/003

This project on sustainable forests management called “Amenagement des Forets Naturelles” was funded by the United Nations Development Programme and implemented by FAO from 1985 to

1998. The period 1998 to 2002 was dedicated to prepare the transfer of competencies of the management field to the local populations.

Results achieved through this project are presented as follows:

Employment generation
Employment generated by this project concerned both the rural areas where employment generation appears to be very difficult and the urban areas. In rural areas, 11,000 temporary employments including 50% of women have been created and activities cover the dry season when no agricultural or other type of activity is anylonger available.

In urban areas a total of 61,000 employments concerning more than 50% of women were generated by the project (MMCE, 2003) [15]. A rapid comparison with the SONABEL with 1292 employees and a turnover of $31,692,308 (INSD, op. cit.) shows that amongst all type of fuels wood energy and woodfuels are the biggest provider of employments per unit of turnover (Trossero, 2002) [16].

Annual average income generation
It should be noted that the project generated an average annual income of $95 to the producers. This appears to be very close to the households' average income estimated to $133 (DGE, ibid). It is still important to note that these activities were done in cohabitation with agricultural activities.

Environmental impacts
Environmental achievements include a total forest area of 725,000 hectares representing 20% of the total forest area of the country managed and being managed. Also, the forests are more protected by the local populations. Other environmental impacts include the rapid reconstitution of exploited forests and biodiversity (flora and wildlife). The country could also respect its international engagements such as the convention on biodiversity, desertification, climate change etc. that it ratified.

Energy impacts
Energy impacts include the regular supply of wood energy that was frequently disrupted mostly during the rainy season. Also 30% of wood energy consumed in the 3 main consumption centers of the country come from managed forests.
Organizational impacts
Through the project, 448 cooperative groups including more than 1, 000 members with 50% of women have been created.

Institutional impacts
The project achieved institutional strengthening with the creation of the Departments of traditional energies and those of forest resources management etc.

5 CONCLUSION

All the above mentioned results achieved show that if properly operated, woodfuels and wood energy contribute to the steps towards sustainable development.

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PV Application for Increasing Rate of Electrification in Indonesia

Abdul Hamid Budiman, Adjat Sudradjat

Center for Energy Conversion and Conservation Technology, BPPT

Background

- Indonesia as an archipelago country, which consists of many small and isolated islands, is barely reachable by centralized power grid. Therefore the current rate of electrification is only about 70-80%.
- Solar energy in Indonesia is abundant and available throughout the year: 4.8 kWh/m^2/day e.q. to 1,800 TWh/year.
- The promotion of renewable energy utilization, especially solar energy by using photovoltaic systems, will accelerate the rate of electrification in particular and national energy supply security sustained in general.
- The present project was installed in Boalemo Village, one of the remote areas in Gorontalo province, Indonesia.
- The project was installed in October 2014 and consists of 15 .6 kWp PV modules, 3 x 5 kVA inverters and 144 kWh batteries.

Figure 1. Rate of electrification in Indonesia

Objective

- Increase the rate of electrification in East Indonesia
- Improve the social condition of people in Boalemo village
- Fulfill the energy demand of people in Boalemo village

Figure 2. Components of the PV project in Boalemo village

Methodology

- Data collection
- Review of the system
- Evaluation of the system

The System Operation

- Daily Energy PV output : 52.5 kWh
- Households : 90 x 350 = 31.5 kWh
- Public Facility : 5 kWh
- Daily Total Load : 36.5 kWh.

Result

The evaluation was done 3 months after installation.
It shows that the average daily load is 11.75 kWh.
The load is still under estimation, but has increased by 35 %

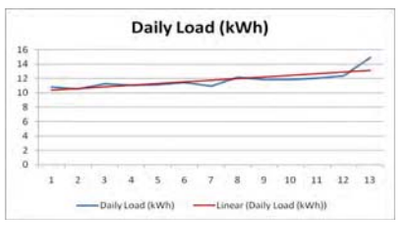

Figure 3. Daily Load in Boalemo Village

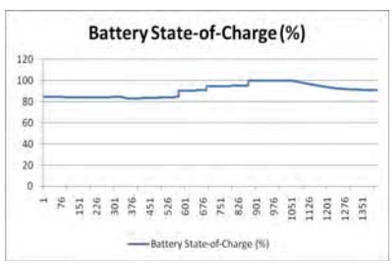

Figure 4. Battery state of Charge

Conclusions

- The project could improve the community resilience.
- The energy demand of people is increased by about 30%.
- The social services such as education and health care have been improved as well as the socio economic condition.
- The project could contribute to the national electrification and promote the national energy security and sustainable development.

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Center for Energy Conversion and Conservation Technology
Agency for the Assessment and Application of Technology, BPPT
Building 625 Energy Cluster Kawasan PUSPIPTEK Serpong, Tangerang Selatan, Banten – Indonesia
Telp. +62 -21 - 75791366
Email : hamid.budiman@bppt.go.id

DAAD

Europa-Universität Flensburg
Interdisciplinary Institute of Environmental, Social and Human Sciences
Department of Energy and Environmental Management

Resilience of rural energy in developing countries

Dr. Md. Ahiduzzaman

Bangabandhu Sheikh Mujibur Rahman Agricultural University, Bangladesh

Corresponding email: ahid72@yahoo.com

Introduction

Energy is the key ingredient for social and economical development. Energy resilience appears in a vulnerable manner in rural areas of developing countries. Energy is required for agricultural production and processing, cooking, lighting, shops, health centers, schools and small industries in rural areas of the developing countries. Small demand and a scattered pattern of load distribution in rural areas often fail to attract the energy providers. Rural people mostly depend on the locally available biomass and diesel for farm operation and kerosene for lighting or cooking. Renewable energy (RE) could play an important role to make a resilient energy system in rural areas.

Objective

To analyze the supply chain of a resilient rural energy system in Bangladesh as a developing country.

Energy in rural areas of Bangladesh

Biogas:

- About 45,000 biogas plants are in operation in Bangladesh.
- They save about 80,000 tonnes of firewood and 1,000 tonnes of kerosene ever year (GIZ 2012 and IDCOL 2014).

Biomass:

- Field crop-residues, agro-industrial by-products (husk and bagasse), firewood, leaves and twigs are the main sources of biomass. Biomass briquette produced from agro-residues also is used as alternative of firewood (Ahiduzzaman 2009).

Solar PV:

- About 13 million people are getting benefits of solar lighting from 3 million solar home systems (SHS) in Bangladesh.
- More than 65,000 SHSs are now being installed every month (IDCOL, 2014).

Diesel:

- About 1.0 million tonnes of diesel are consumed in the agriculture sector of Bangladesh (BBS 2014).

Electricity:

- About 42% of rural people have electricity access.
- Only 2% of irrigation pumps are electrically operated.

Challenges for a resilient rural energy

- To find a sustainable source of biomass.
- Processing of agro-waste for fuel.
- Dedicated land for biomass plantation.
- Price hike and shortage of diesel at peak irrigation season.
- High investment cost for renewable electricity generation.

Scope for rural energy resilience

- Solar mini-grid for rural electrification to adjacent shops, health center and school.
- Solar irrigation pump to replace diesel pump. Govt. initiatives taken for a target of 1,550 solar pumps by 2017.
- New type high yielding *Jatropha curcas* variety cultivation on boundaries between individual land fragments for biodiesel production as alternative to diesel.
- Karoch (*Pongamia pinnata*) seed oil as a source of bio-diesel having a potential of 837,000 tonnes per year from a road side plantation throughout the country.
- Pelleting of agro-waste for providing value added biomass fuel.
- Biogas from agro-waste as a source of farm energy.

Jatropha

Karoch

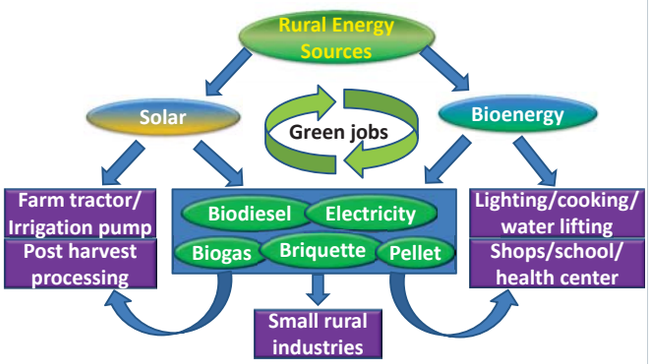

Fig.1. A resilient rural energy system for developing countries

Conclusion

Bioenergy (biodiesel, briquette, pellet, biogas) from plantation and agro-waste and electricity from solar PV have a great potential to supply energy at starving rural areas to make a resilient and sustainable energy system in developing countries that will also create green jobs.

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Department of Energy and Environmental Management

Environmental and Sustainability Issues in the Curricula for Ethiopian Teacher Education Colleges

Aklilu Dalelo

Addis Ababa University, Ethiopia

Introduction and Objective

Introduction

Institutions of teacher eductaion are believed to hold the key to equiping teachers to adress sustainability in their classrooms and thereby shaping the future of communities and nations around the world. It is suggested, however, that very few of the 60-70 million teachers in the world have had any exposure in their training to sustainability issues.

Objective

To assess the extent to and ways in which environmental and sustainability issues have been adressed in the curricula for Ethiopian teacher education colleges.

Table: Key sustainability issues assessed from Agenda 21

A21 Section/ Chapter	Issue/theme	A21 Section/ Chapter	Issue/theme
I/3	Combating **poverty**	II/14	Sustainable **agriculture and rural development**
I/5	**Demographic dynamics** and sustainability	II/15	Conservation of **biological diversity**
I/6	Protecting and promoting **human health**	II/16	Management of **biotechnology**
II/9	Protection of the **atmosphere**	II/18	Protection of the quality and supply of **freshwater** resources
II/10	Planning and management of **land resources**	II/19	Management of **toxic chemicals**
II/11	Combating **deforestation**	II/20	Management of **hazardous wastes**
II/12	Combating **desertification and drought**	II/21	Management of **solid wastes and sewage**

A primary school teacher demonstrating how to plant a tree, southern Ethiopia.

Conclusions and Key References

Major findings

Geography and Civics and Ethical Education address the largest number of issues related to environment and sustainability.

The two subjects also address all the three dimentions/pillars of sustainabl development.

Biology and Chemistry also offer a substantial opportunity to integrate issues related to sustainability.

However, they focucs mainly on the physical environment or ecological dimention of sustainable development.

Conclusion

Almost all the sustainability issues (13/14) identified from Agenda 21 have been addressed across the different disciplines albeit to a different degree.

A primary school in a very dry region, northern Ethiopia (students keep the plants alive by bringing water from home!). The text in front of the statue reads: *‚Love of a country must be expressed in action‘*

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Aklilu Dalelo (PhD)
Associate Professor of Geography and Environmental Education
Addis Ababa University, Ethiopia

P.O. Box 150203, Addis Ababa, Ethiopia
Email: akliludw@gmail.com; dalelowa@leuphana.de

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Interdisciplinary Institute of Environmental, Social and Human Sciences
Department of Energy and Environmental Management

The Uganda Energy Sector – „Tracing Sustainability in the face of an Emerging Oil Sector“

Policy Review

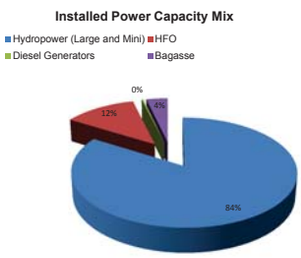
Alexander Komakech-Akena,

AOT Consulting (U) Limited

Introduction

Hitherto, Uganda's electricity has been generated mainly from renewable hydrological sources, and only supplemented by a small percentage of fossil fuels. For that reason alone, CO_2 emission levels have always been low, below 3,784ktCO_2 annually- representing 0.1% of the World, which is considered non distressful. That is all bound to change with commencement of commercial oil production in Uganda, scheduled for 2017/18. A remarkable increase in fossil fuel usage, especially in the transport and energy sector once commercial production starts. This will in turn increase the GHGs emission level of Uganda, bringing the question of sustainable energy development into focus. The challenge, therefore, is how to develop a sustainable and strategic development plan for the evolving energy industry where the contribution from oil and gas products is on the increase.

Word Bank Databank - http://data.worldbank.org/indicator/EN.ATM.CO2E.KT/countries?display=m , May 2013



Objectives

•Assessment of the status quo of the energy sector in Uganda, particularly highlighting such important aspects as the contributions of the various energy alternatives (fossil fuel-base and renewable sources), government strategic plans, as well as the electricity consumption and supply.

•Projection of the growth, for aggregate energy production, consumption and GHGs is then made

Legal Framework Assessment

Document	Key areas addressed			Sustainable Development (SD) Approached	Existence of a clear strategy and plan of how to achieve SD
	Modern energy access	Fair share of per capita end use	Emphasis on clean and renewable energy		
Energy Policy	YES	YES	YES	YES	YES
Renewable Energy policy	YES	YES	YES	YES	YES
Electricity Act	YES	NO	YES	NO	YES
National Environment Act	NO	NO	NO	YES	YES
National Oil and Gas Policy	NO	NO	NO	YES	NO
Petroleum Act	NO	NO	NO	YES	NO
Oil and Gas Revenue Management Policy	NO	YES	NO	YES	NO

The Uganda Oil Sector

- About 40% of Albertine Graben has been explored.
- Over 90 wells drilled on tilted fault blocks, rollover anticlines and flower structures of significant sizes.
- 21 discoveries and providing up over 3.5 billion barrels of Oil equivalent.
- Flow testing of the Waraga, Mputa, Kingfisher, Kigogole and Kasamene prospects has yielded flow rates between 3,550 and 12,000 BOPD
- Production set to commence in 2017 under the new schedule

Sector Vulnerabilities

In the discussion of sustainable energy in Uganda, it should be noted that there is a very high dependency of the energy sector on biomass. This needs very urgent attention. The escalating rate of clearing vegetation for cooking and charcoal means that the national carbon sink is steadily dwindling. One suggestion to counter this trend is to have gas from Uganda's oil.

1. High dependence on biomass energy resource

Electricity contributes 1.3%, fossil fuels 8.7% with 90% coming from biomass resources. This high dependence and escalated harvesting of biomass puts a lot of stress on the country's natural vegetation and has resulted in massive deforestation in many parts of the country..

2. Hydropower generation sensitivity to rainfall variations

Hydropower generation is highly dependent on the amount of water-flow in the rivers, seasonal changes in the amount of rainfall directly affect the power generated. In many cases, this causes load shedding and in certain instances has caused complete power cut-offs. Electricity production in Uganda is therefore highly vulnerable to climate variability.

3. High Investment Costs for the Large-Hydro Power Plants

Uganda is looking to build more large hydro power plants to further boost its power production capacity. Much as this is a welcome development, the investment costs of these power plants are massive, so much that the country cannot fund them. The alternative is international financing, which attracts interest and hence a high cost per unit of power produced. That is not to mention a growing national debt burden that might adversely affect the national economy and future power projects financing.

4. Low income per capita and Electricity access challenges

The cost of extending the transmission grid remains prohibitively expensive. Even where the grid has been extended to some parts of the country, owing to low levels of economic activity and hence low incomes, the intended beneficiaries might not afford to pay for the electricity.

Effects on Economy

Increased production of oil and gas in Uganda, will increase self reliance and numerous sector growth

The supply and demand sector alike are impacted.
- Increased and adequate supply of modern energy source (LPG)
- More power plants (CCGT and HFOs)

Upstream → **Midstream** → **Downstream**



Conclusions and Recommendation

It is observed that Uganda's installed capacity increased two folds over the last seven years to stand at 818.5MW in 2013. The annual growth rate of the country's installed capacity set to increase twice as much as it is currently.

The policy review reveals that the country is equipped with appropriate and adequate policy instruments to keep the energy development on a sustainable path, even with this emerging sector. However, there remain uncertainties over with strategies and implementation plans for the policies. And given the reliance of the country on biomass, the management of this resource will determine whether or not the country stays on course of sustainable energy development.

1. A clear strategy and implementation plan for the relevant policies and other regulatory instruments
2. A balanced and empowered Oil sector management body that will play oversight and advisory roles to the government
3. Intensive capacity building of key sector personnel on production, management an sustainable development
4. Observing a culture of transparency in the sector – for purposes of accountability and shared community interest and responsibility

Alexander Komakech-Akena
AOT Consulting (U) Limited, Uganda Office
T: +256 414 696827
E: a.komakech@aotconsulting.co.ug

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Interdisciplinary Institute of Environmental, Social and Human Sciences
Department of Energy and Environmental Management

Sustainable Renewable Energy Technologies: an Approach Towards Resilience

Anita Bohara Thapa

Renewable World, Nepal

Introduction and Objective

80% of the population in Nepal depends on subsistence agriculture and the agriculture sector provides employment opportunities to 66% of the population, contributing to more than one third of the total Gross Domestic Production (GDP) of Nepal. However only 27% of Nepal's population has year round irrigation systems. Therefore, the climate change process like change in precipitation has direct impact on the productivity, income and livelihoods of the people in the country.

The people of Nepal, especially in the rural part of the country, face the challenge of building their ability to adapt and reducing their vulnerability to the impacts of climate change. The rural community in Nepal can build resilience towards the natural hazards such as climate change through building adaptive capacity to the climate change. Building adaptive capacity includes access to sustainable renewable energy technologies and opportunities to raise incomes.

Renewable energy technologies can help the people of Nepal to build resilience towards the natural hazards due to climate change. Nepal has abundant water resources in the form of streams, rivers, springs and ground water. Technologies like Hydraulic Ram Pumps and Solar water pumping can lift the water from the streams, springs and the water table river up to certain height and reserved in the tank which could be distributed to the communities through gravity system, providing water on demand at times of scarcity. This reduces the dependence of the community on rain fed irrigation systems, which are vulnerable to changes in precipitation patterns.

Hydraulic ram pump

Solar MUS system

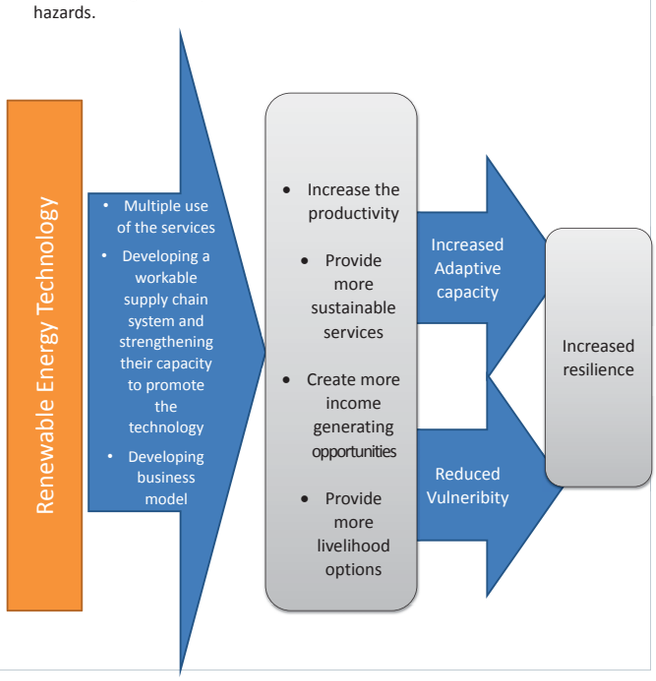
The eastern and central Terai region of Nepal has huge ground water resources but they are not being utilized up to their potential, and farmers in this region have very poor accessibility to the irrigation facility in the dry season. Also there is a large number of ponds which can be used for the storage of water for irrigation purpose as well as could be used for fisheries business. Only few farmers access the irrigation resource in this region and only a fraction of cultivable areas is under dry season crops like wheat and pulses. Most of the marginal farmers migrate to urban areas for labor in dry months because of the unavailability of irrigation facility in the dry season. One of the reason behind the lack of irrigation facility for dry season is the poor availability of technology and limited agricultural innovation. Demand for dry season crops such as off seasonal vegetables is increasing and have very high value. Access to year round water for irrigation would significantly promote the productivity of agriculture increasing the income and food security.

The objective of this paper is to :

- Discuss the role of renewable energy technologies to build resilience towards climate change in the agriculture sector of Nepal
- Discuss the challenges for the sustainability of renewable energy technologies to assure the benefit in long run
- Discuss the recommendations for the sustainability of the technologies based on the previous experience of the implementation of various renewable energy technologies

Conclusion and Recommendation

- Small renewable energy technologies to pump the water for irrigation, drinking water and sanitation not only save the time of the people to collect the water from long distance but also build the resilence towards uncertainity in rainfall due to climate change.
- As well as reducing vulnerability to climate change, these renewable energy technologies have other livelihood related benefits. The time saved in collecting water can be utilized for new income generating activities.
- Access to year round water for irrigation using renewable energy technology in this region would significantly promote the productivity of agriculture increasing the income and food security.
- Communities should be linked to the supply chain systems to recieve the services for technology and facilitate them to link with the market to sell their agricultural produces.
- The services delivered by the technology should be used for multiple uses including productive end uses to sustain the project financially.
- The communities should be trained for the optimal utilization of water using micro irrigation technology and awareness must be created among the community to understand the value of water.
- Countries like Nepal need various R&D of appropriate renewable energy technologies which can address the vulnerability and the livelihoods of the people due to natural hazards due to the climate change process. Developing and testing new technologies, which can increase the efficiency and reliability of the technologies is required to increase the resilience towards the natural hazards.



Anita Bohara Thapa | Project Manager | Renewable World

Tel: +977 01 5520943 | Email: anita.thapa@renewable-world.org | Skype: Anita Bohara

Address: c/o iDE Nepal, Bakhundole, Lalitpur, Nepal

Charity No: 1119467

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Interdisciplinary Institute of Environmental, Social and Human Sciences

Department of Energy and Environmental Management

SUPPORT TO NORTH SUMATRA'S ENERGY PLANNING INITIATIVE

Arum Satya Sari

North Sumatra Advisor, Indonesian Clean Energy Development Project, USAID

Background

- North Sumatra (NS) province has been experiencing a prolonged energy crisis that causes not only industrial shut downs in the region, but also public outrage leading to adverse effects on North Sumatra's economy and social sectors.
- Reflecting on the energy crisis, energy planning is imperative in order to avoid electricity shortage in the future.
- The task to develop local energy planning is mandated under the Law No. 30/2007 on Energy. In line with the Law, the NS government aimed to establish the Provincial Energy Planning (RUED) in 2014.

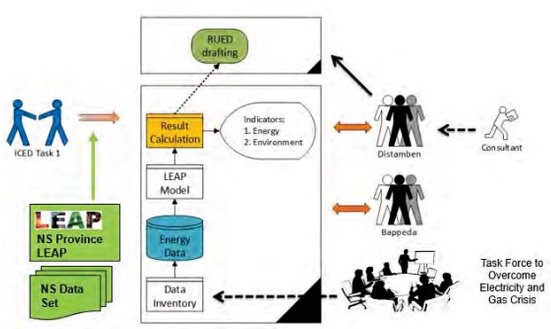
Objective

The USAID project called Indonesia Clean Energy Development (ICED) provided technical assistance to the North Sumatra government in developing a regional energy planning.
ICED chose to assist because the province is one of the project focus areas. In addition, ICED also has resources (LEAP and governance experts) in NS Province.

Methodology

RUED consists of some elements, such as description of province condition, projection of energy demand and supply as well as policy formulation that is based on local resources. These activities are quite complex and require a lot of consultation process with various stakeholders.

- ICED experts in collaboration with NS Regional Planning Agency (Bappeda) and NS Energy Office (Distamben) formed a technical team to develop a provincial model that consists of 33 districts/municipalities using excel-sheet database and Long-range Energy Alternative Planning (LEAP) software. This activity is the first district/municipality based energy modeling ever developed in Indonesia.
- Beyond data processing and modeling works, an appropriate development of RUED would require implementation of good governance. Therefore activities such as high level meeting on strategy alignment, training on energy data processing and roundtable discussions were conducted during the model development.



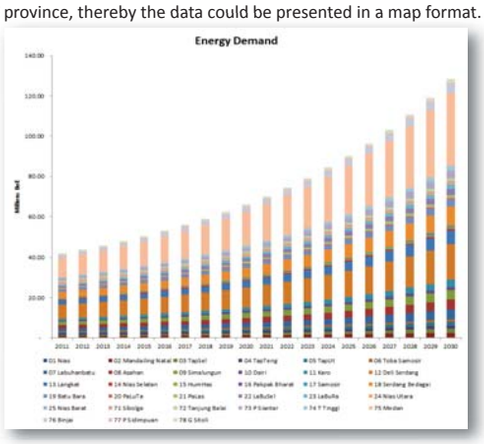
Results

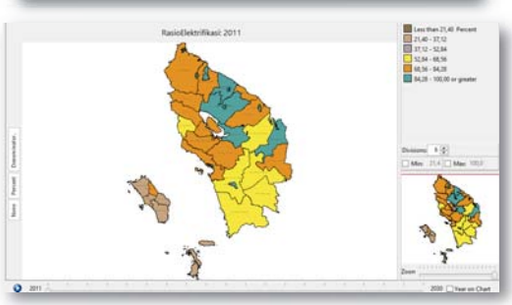
Compliance towards good governance principles

- Transparency and active participation were seen from the training and regular discussions, in which stakeholders shared the data in their institutions.
- Stakeholders could maintain, update, review and revise the database and LEAP model if necessary to ensure the accountability. Stakeholder's capacity was improved during the trainings.

Completed data set and LEAP model

- An energy database of 33 districts/municipalities was produced, which consists of socio-economic data, energy consumption data and energy supply data. With the completion of the database, the technical team was able to export the data more easily into LEAP.
- The NS LEAP multi-region has incorporated a GIS map of district/municipality in NS province, thereby the data could be presented in a map format.





Conclusions

- The assistance succeeded to introduce and embody the good governance principles as it was designed to actively engage and empower its counterparts.
- The North Sumatra LEAP multi-region model allows the province to have supply demand projection by district/municipality, enables the province to have the energy balance sheet, as well as emission trajectory by district/municipality.

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Arum Satya Sari
arum.satyasari@gmail.com
+62 817 997 1394
www.iced.or.id

DAAD

Europa-Universität Flensburg
Interdisciplinary Institute of Environmental, Social and Human Sciences
Department of Energy and Environmental Management

Asian Alumni Networking

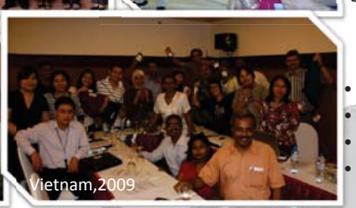
Dr. Arun Balamatti

President, GANES

Programme Coordinator, ICAR JSS Krishi Vigyan Kendra

Mysuru, Karnataka State, India

Alumni Networking Initiatives



Status of GANES

GANES Registered on **10.09.2012** as a **TRUST**
As a constituent organization of **JSS Mahavidyapeetha** (JSS MVP) in Mysore, India
First Trustees: 3 Indian alumni (2 ARTES + 1 PPRE), 2 representatives from JSS MVP

GANES Membership

Asian Alumni
Individual Alumni
Similar Institutions & Individuals Representative
JSS MVP
National Alumni Networks
- German Universities

GANES accomplishments

- Database compilation – 271 Alumni
- Setting up Indian alumni network – ANGIRAS
- Organized Indian Alumni Convention, 2013
- Cooperation between Europa-Universität Flensburg, Germany and JSS University, Mysuru, India

Objectives

Overall objective

The main object of GANES shall be to promote sustainable energy solutions in a variety of contexts from the perspectives of reducing energy poverty, improving energy efficiency, natural resource management, climate change ecosystems /land use as well as to promote sustainable energy solutions which could lead to an enhanced quality of life for all.

Specific objectives

- To initiate, improve and strengthen networking among Asian Alumni who have studied at the University of Flensburg and Oldenburg;
- To establish functional & institutional relationship with Universities in Germany, offering professional courses in renewable energy & sustainable development/living;
- To establish contacts, exchange information, experiences and knowledge with similar alumni associations in other countries/continents;
- To provide information and guidance to students aspiring to seek higher education in Germany;
- To create public awareness on renewable energy, efficiency, entrepreneurship and innovations, in collaboration with national and international organisations;
- To design and implement programs and projects based on innovative and inclusive sustainable planning and development practices;
- To conduct research and studies in the fields of renewable energy, sustainable rural and urban development, publish reports, bulletins and papers;
- To organize workshops, seminars, conferences, orientations and training events on appropriate technology, renewable energy and sustainable development;
- To provide consultancy services to individuals, institutions and agencies on different aspects of renewable energy and sustainable habitats;
- To facilitate transfer of knowledge and technology related to renewable energy systems and management between the developing and developed nations;

Roles of Trustees

Board of Trustees	First Trustees Co-opted members	-Register GANES, promote membership -Formulate policy to promote its objectives -Mobilize projects, manage GANES Secretariat
Office Bearers	President Secretary, Treasurer	-Run office (correspondence, bank, audit etc) -Submit proposals to donors & follow up
Members	National Networks Individual Members	-Conduct events, implement RE & SD projects -Individual & Institutional networking: membership, student & faculty exchange
Operations of GANES Secretariat & Members	Develop alumni database	
	Member proposals → GANES Secretariat → Funding Agencies → Funds to Members → Project Implementation	

Conclusion

Fighting energy poverty demands energy & enthusiasm from alumni!

Bangladesh	China	India	Indonesia	Iran	Myanmar
Nepal	Pakistan	Papua New Guinea	Thailand	Vietnam	New Zealand
Palestine	Philippines	Singapore	South Korea	Syria	Bhutan

Dr. Arun Balamatti, INDIA
arun_balamatti@yahoo.com
++91 9448832186

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Europa-Universität Flensburg
Interdisciplinary Institute of Environmental, Social and Human Sciences
Department of Energy and Environmental Management

HOUSEHOLD COOKING FUELS IN ANAMBRA STATE, NIGERIA

ANOWAI, CHINWE CHRISTIANA
WOMEN DEVELOPMENT PROJECT CENTRE

Introduction

World over, sources of cooking energy are electricity, gas, kerosene, and biomass (i.e. firewood, charcoal, saw dust, plant residues etc.), all of which have implications for sustainable development. In Nigeria, there is limited empirical information on the state of usage of the different cooking energies and their associated technologies including factors that influence their choice.

Objectives of the study are to:

- Ascertain types of cooking fuels used by female teachers in their homes.
- Determine factors that influence choice of cooking fuels.
- Find out practices used in ensuring sustainable supply of wood fuel.

Methodology

- Descriptive survey was used, Anambra State, Nigeria was the area of study.
- 47 married female teachers were purposively sampled, questionnaire and focus group discussion were used to collect data

Results

Average of 2 – 3 different types of cooking fuels were used by teachers in urban and rural areas respectively, which in their ranked order were: kerosene, gas, biomass and electricity for the urban teachers, while biomass, kerosene, gas and electricity were the ranked order of usage of the fuels by teachers in rural areas.

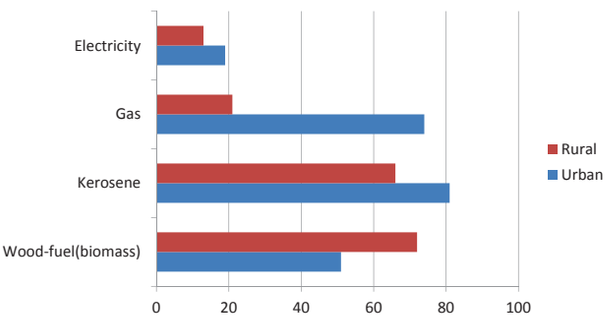

Fig. 1.0: Percentage Distribution of Choice of Cooking Fuels by Female Teachers in Urban and Rural Areas of Anambra State of Nigeria.

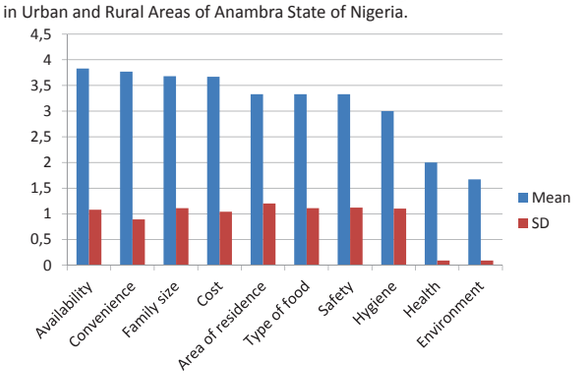

Fig. 2.0: Factors Influencing Choice of Cooking Fuels in Anambra State, Nigeria

Both rural and urban households have not adopted usage of any wood fuel efficient cookstoves. The use of stone and tripod open air cookstoves are the convention.

Fig.3.0: Different Types of Cooking Stoves and Fuels in Anambra State Nigeria.

No systematic efforts like tree planting and dissemination of mud constructed wood fuel efficient cook stove or any other prototype are being made to ensure sustainable supply of biomass fuel which are in use by 54 % and 72% of the teachers in urban and rural areas respectively.

Conclusion

Rural and urban female teachers in Anambra State of Nigeria use a minimum of 2 - 3 different cooking fuels in their household meal preparation respectively. Usage of biomass fuel ranking first, followed by kerosene for those in rural areas while usage of kerosene ranked first, followed by gas and biomass for those in urban areas. Fuel efficient improved biomass cook stoves have not been adopted by the households. Factors that influence choice of cooking fuel were: availability, convenience, family size, cost and area of residence among others.

Recommendations

Governments and CSOs in Anambra State of Nigeria should design and disseminate culturally acceptable wood-fuel efficient cookstoves in the interim even as tree planting and energy saving cooking practices should be promoted. Strategies towards adoption of cleaner cooking fuels (gas, electric and solar energy) should equally be put in place by them. Efforts should be specially made towards promotion of solar energy in cooking at household level in reducing climatic problems associated with the use of fossil fuels.

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WOMEN DEVELOPMENT PROJECT CENTRE
9 ANAKU STREET, IFITE-AWKA, ANAMRA STATE, NIGERIA. PO.BOX 36 AMAWBIA, ANAMBRA STATE, NIGERIA. (chinwcanowai@yahoo.com)

DAAD

Europa-Universität Flensburg
Interdisciplinary Institute of Environmental, Social and Human Sciences
Department of Energy and Environmental Management

Assessment of vulnerabilities, resilience and sustainability of rural communities' energy systems in watersheds of the Nyando river basin of Lake Victoria, Kenya

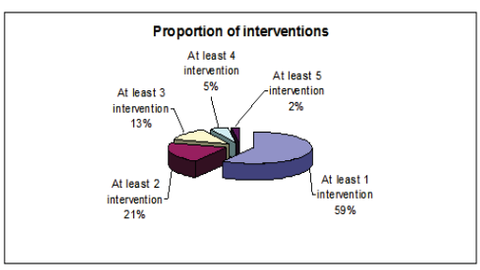
Ongor Dan Otieno
Dedan Kimathi University of Technology

Introduction

This paper provides a participatory assessment and analysis of community and institutional roles in energy resource management, technology extension and education for community based climate change adaptation, mitigation and resilience in river watersheds of Nyando basin in Kenya. Participatory Rural Appraisal, other participatory methodologies and documented data analysis were used for vulnerability and resilience assessment of the energy systems among twenty four communities in the Nyando river sub catchments.

Objectives

- To assess energy resource production and management practices in the basin
- To determine climate change adaptation practices in energy use in households
- To assess technology transfer mechanisms and use patterns of agricultural bio residues for energy supply among small scale farmers in Nyando river basin in Kenya.



The interventions

Solar cooking in the basin

Conclusions

- The results indicate that the energy systems show varied vulnerability and community attempts to adapt new coping strategies to energy deficiency and efficiency.
- Adoption and Adaptation of improved energy interventions.
- Policy intervention should focus on enhancing efficiency on energy converter technologies.

Problem Ranking/Pair wise

Problems were ranked by the community and the PRA team.

Problems	FL	LT	WR	CY	RN	HF	LD	FW	Scores	Rank
Flood		FL	FL	FL	FL	FL	FL	FL	7	1
Latrines			WR	CX	RN	HF	LT	LT	2	6
Water				WR	WR	WR	WR	WR	6	2
Crop yield					CY	CY	CY	CY	5	3
Road network						RN	RN	RN	4	4
Health facility							HF	HF	3	5
Livestock diseases								LD	1	7
Fuel wood									0	8

KEY:

List o f Ranked Pr oblems:

1. Flood-FL
2. Water -WR
3. Crop Yield-CY
4. Road network-RN
5. Health Facility-HF
6. Latrines-LT
7. Livestock diseases-LD
8. Fuel Wood-FW

Figure above shows vulnerabilities of the basin community in Bwanda Village as ranked (Source: Author)

Discussing community energy resource map (Source: Author)

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Dan Otieno Ongor
Dedan Kimathi University of Technology
Email: danongor@yahoo.com

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Europa-Universität Flensburg
Interdisciplinary Institute of Environmental, Social and Human Sciences
Department of Energy and Environmental Management

Seawater desalination as a potential water supply for Comodoro Rivadavia city

Energy consumption and sustainability issues

Diego Alejandro Distel

Agencia Comodoro Conocimiento

Introduction

Safe clean drinking water supply is crucial for the proper development of a community. Comodoro Rivadavia, today a city of ca. 200,000 inhabitants on the coast of Patagonia has stuggled to adequately supply itself with safe water since its founding in 1901. Today the main water source used by the city is surface water pumped from Musters Lake, which is located 130 km away (straight line). Two 224 km long aqueducts, built in 1963 and 1999, serve this purpose and supply also the neighbor cities of Rada Tilly and Comodoro Rivadavia with a combined capacity of 115,000 cubic meters per day. In recent years, the rapid growth of the three cities, combined with lack of adequate infrastructure planning led to a shortage in the supply. In recent years, during the summer seasons, when the water demand is higher, supply to the whole city is interrupted, in order to limit the demand and recover the water level in the buffer storage tank at the entrance of the city.

Seawater desalination has historically been considered the most expensive alternative for water supply. However, during the past decades, several technological advances have taken place, leading to the reduction in investment costs and energy consumption.

State of the art of desalination

Reverse osmosis has emerged over the years as the most convenient technology for seawater desalination. Most newly constructed plants use this technology. The energy consumption has dropped from 15 kWh/m^3 in the 70's to 3.5 kWh/m3 for newly constructed plants. (1). Moreover, reverse osmosis has the advantage of less corrosion problems, when compared to thermal processes.

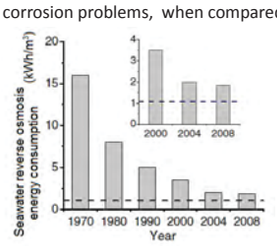

Figure 1: Seawater reverse osmosis energy consumption (Elimelech and Phillip)

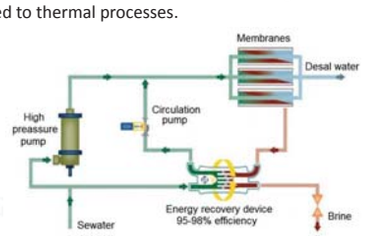

Figure 2: Seawater reverse osmosis system common state of the art configuration (2)

Environmental concerns

Environmental concerns about seawater desalination mainly comprise CO_2 emission due to energy consumption, the change in the marine environment due to brine discharge, the discharge of chemicals, and the impingement and entrainment of marine life in the seawater intake. (3)

- **CO_2 emissions.** Seawater desalination requires more energy than the current pumping of surface water (3.5 kWh/m^3 vs. 1.0 kWh/m^3). The higher energy consumption leads to additional emissions. Considering a desalination plant of 10,000 m^3/day operating at full capacity, the additional emissions would be 4453 tons of CO_2 per year (Argentinean grid emission factor is 0.488 tCO_2/MWh).
- **Brine discharge.** Brine usually has the same constituents as seawater but its concentration is doubled. Because of its higher density, it tends to sink in seawater and spread along the seabed. Mixing is not immediate, but depends on discharge engineering and water currents and agitation. There is a mixing zone near the discharge where salt concentration is higher. Organisms' ability to adapt to higher salt concentration depends on species. (3)
- **Chemicals discharge**. Different chemicals are used in the pretreatment stage to ensure water of adequate quality reaches the reverse osmosis membranes: flocculants, antiscalants, biocides. These chemicals remain in the brine and end up in the sea. (4)
- **Seawater intake.** Open intakes collect seawater directly and could catch marine life to the system or damage it against bar screens. Subsurface intakes pose no risk to marine life but require adequate ground permeability and are more expensive to construct. They are increasingly being used but so far mainly in small size plants. (5)

Seawater desalination vs. surface water pumping through aqueduct for Comodoro Rivadavia

Although seawater desalination has the drawbacks of its high investment costs and its high energy demand it also has some benefits that makes it appealing when considering water supply alternatives.

Seawater desalination	Surface water pumping
Can be constructed in a modular way, so that investment can be spread over time.	Requires a large investment in a short period of time.
Modularity allows to adjust planning in the short term.	Requires long term (20-30 years) planning.
(Almost) independent to draughts. Reduces vulnerability to climate change.	Vulnerable to draughts and climate change.
Higher energy consumption and costs.	Lower energy consumption and costs.

Conclusion

Although desalination remains the least convenient alternative, in terms of energy consumption and costs, other considerations may favor the installation of a desalination plant: desalination is an alternative source, which is independent to drought and aqueduct failure, bringing reliability to the whole system and reducing the vulnerability of the city to climate change. The desalination plant could be operated seasonally, in order to minimize energy consumption. Desalination plants can be expanded in a modular way, making planning and financing securing easier. Environmental impacts should be fully understood and assessed. Impact minimization can should be attempted with adequate engineering design.

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M. Eng. Diego Alejandro Distel
e-mail: diegoddd80@yahoo.com.ar
Cell: +54 9 297 5164812
Address: Francisco Rosa Cristina 1564
(U9005GSD) Comodoro Rivadavia,
Chubut - Argentina

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Department of Energy and Environmental Management

BIOCLIMATIC APPLIED CRITERIA EXTENSION EXPERIENCE ON A HILL HOUSE

ARQ. EDGARDO A. QUINTANA, M.Sc. (ARG.)

Affiliations: Enzo Rodrigo Coronel; Roger Dennis Teran Baptista; Nicolás Eugenio Vazquez (ARG.)

EXPERIENCE OBJECTIVES:

Lastly years the need to re-involve University in its own social enviroment problems has grown; incorporating comunity service activities to the learning curricula; generating fruitful discussiones and experiences.

In this contex, it has been developed an extension experience among student´s team and members of the architecture and Urbanism school at Argentina. The work consisted on the design and construction of a rural weekend house with applications of bioclimatic criteria.

experience objectives

academic achivments

- learning whit practice concept (learning-service method)
- performance on real instances
- experience systematization
- academic curricula´s feedback
- enviroment impact (awareness concience)

planimetry and general view

The village water supply is discontinuous because of the postponement of infrastructre improvements.

In relation to this, housing project seeks to ensure the supply by harnessing rainwater to minimize the consumption and reserve water for secondary uses (irrigation and cleaning, for exaple).

rain water harvesting

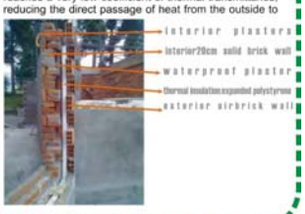
energy saving guidelines

daily water solar heating

The villa in particular has high values of solar radiation. The population depends on the use of refillable tanks of compressed natural gas. The project tries to conditionate the temperature of water for hygiene, using solar collector minimizing the use of compressed natural gas

insulation skin features

the villa has wide temperature range throughout the year. In winter temperature can drop to 0ºC . In summer reaches 35ºC. The relative humidity is generally high. In order to stabilize the conditions of comfort inside the house, walls has been designed whose composition reaches a very low coefficient of thermal transmittance; reducing the direct passage of heat from the outside to



EXPERIENCE CONCLUSIONS:

CURRENT PHASE:

use a commercial commission as a learning space

The currest phase of the process is measurement. The results of operating systems are observed and conclusions are made. The learning-service method of this exercise has beented in different subjects of the architecture career and exhibited in international conferences as held in La Habana, Cuba in November 2014 about renewable energy and sustainable architecture.

OBSERVATION > MEASUREMENTS

Contact: edgardo_quintana@live.com

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Towards a climate change cap-and-trade system in Mexico and the example of the EU

Elizabeth Mosqueda

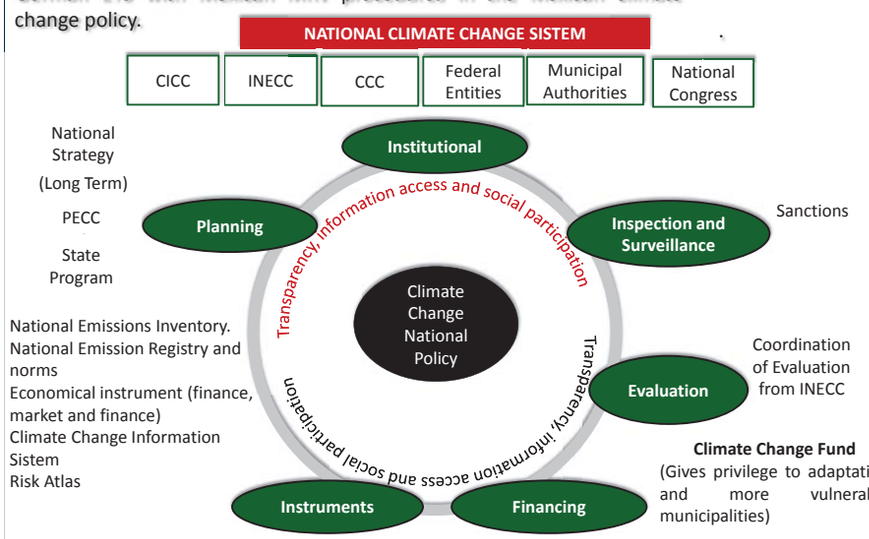
EEM 2012/ Mexican Environmental Ministry Director

INTRODUCTION. Mexico enacted the General Climate Change Law setting an aspirational goal of reducing 30% of GHG emissions by 2020. To help achieve these goals, an emission trading scheme (ETS) is planned. The European ETS monitoring, report and verification (MRV) scheme is an example for Mexican MRV climate policy.

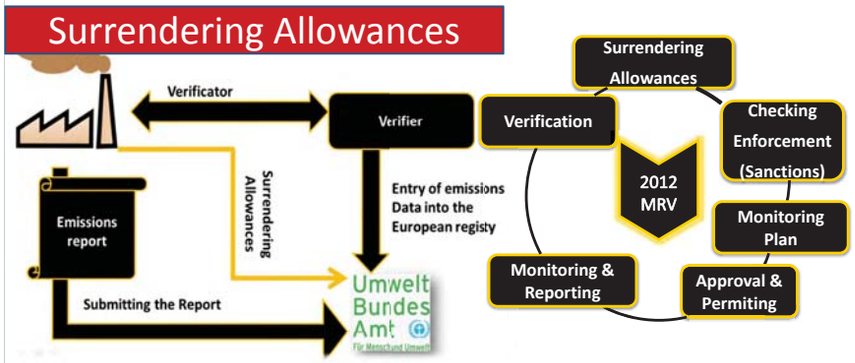
OBJECTIVE. To understand ETS concepts through the comparison of German ETS with Mexican MRV procedures in the Mexican climate change policy.

CONCLUSIONS. There is a need of allocation and issues the EU allowance, operators approval, monitoring plans and revision of emission reports in order to stablish an ETS to contribute to the GHG reduction.

REFERENCES. Source: ICAP Status Report 2015 on Emissions Trading Worldwide. Environmental Ministry.



Surrendering Allowances



Gases covered:
1st and 2nd trading period (205-2012): CO2 only
3rd trading period (2013 ff): N2O and perfluorocarbons (PRFC)
In total: 1929 installations emitting 481 million tCO2eq/a

	Goals European Union			Goals Mexico	
Year	**GHG Emission reduction**	**Share of renewable energy**	**Improvements in energy efficiency**	**GHG Emission reduction**	**Share of renewable energy**
2050	-80-95%	To be defined	To be defined	50%℗	
2030+	-40% (at least)/ ETS: -43%*/ Non-ETS: - 30%*	27% (at least)	27% (at least)		
2020₪	-20% ETS: -21%* Non- ETS: -10%*	20%	20%	30%℗	35% to 2024
(as compared to 1990 (*2005) level/ +Conclusions of EU Council (Oct 2014) ₪EU, Climate and Energy package			℗ Compared to emissions registered in 2000.		

Elizabeth Mosqueda
Mail: evmr1983@gmail.com
Director of Global Environmental Policies
Secretaría del Medio Ambiente y Recursos Naturales
Ejército Nacional 223, Colonia Anáhuac, Sección I,
Delegación Miguel Hidalgo
C.P. 11320, Mexico City

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ALUMNI NETWORKING, CASE STUDY OF RENEWABLE ENERGY AND ENVIRONMENTAL EXPERTS-AFRICAN NETWORK

Evans Mensah Hervie

RENEWABLE ENERGY AND ENVIRONMENTAL EXPERTS-AFRICAN NETWORK

INTRODUCTION:

THE RENEWABLE ENERGY AND ENVIRONMENTAL EXPERTS-AFRICAN NETWORK (REEE-AAN) IS REGISTERED AS AN INTERNATIONAL NGO OF EXPERTS IN THE AREA OF RENEWABLE ENERGY AND ENVIRONMENT SINCE 2009. ITS MEMBERS ARE GRADUATES FROM UNIVERSITIES OF FLENSBURG, OLDENBURG AND BONN WHO HAVE RETURNED TO AFRICA AFTER THEIR PROGRAMME OR RESIDING ABROAD BUT IN CLOSE CONTACT WITH THE ACTIVITES IN THEIR HOME COUNTRY. CURRENT MEMBERSHIP IS 117 WITH THE BREAKDOWN IN THE TABLE BELOW:

item	Country	Membership no.
1.	Cameroon	29
2.	Burkina Faso	1
3.	Kenya	16
4.	Ethiopia	13
5.	Ghana	19
6.	Zambia	3
7.	Swaziland	1
8.	Niger	1
9.	Nigeria	3
10.	Tanzania	11
11.	Togo	1
12.	Sierra Loene	2
13.	Uganda	6
14	Benin	1
15.	Malawi	1
16.	Egypt	1
17.	Eritrea	1
18.	Madagascar	1
19.	Rwanda	1
20.	Sudan	3
21.	Tunisia	1
22.	Botswana	1

IN 2014, THE NETWORK ADOPTED A BOTTOM UP APPROACH WHERE VOLUNTEERS FROM COUNTRIES WERE INDENTIFIED TO MAINLY RUN THE ACTIVITIES IN THEIR LOCAL COUNTRIES. THE FIRST LOCAL NETWORK WAS SUSTAINABLE ENERGY NETWORK OF EXPERTS (SENEC), IN CAMEROON WITH KAMDOM LYDIE AS THE COUNTRY COORDINATOR, THEN THE GREEN ENERGY GROUP (GEG) – UGANDA WAS FORMED BY ALEXANDER KOMAKECH. MELIS TEKA IS THE COUNTRY COORDINATOR OF ETHIOPIAN LOCAL NETWORK AS WELL AS DAN OGOR WHO IS THE COORDINATOR OF THE KENYAN LOCAL NETWORK.

GENERAL OBJECTIVE:

- ❑ TO CREATE A NETWORK OF EXPERTS IN RENEWABLE ENERGY AND ENVIRONMENT WHO HAD STUDIED IN GERMANY AND RETURNED TO AFRICA

SPECIFIC OBJECTIVES:

- TO HAVE A POOL OF RENEWABLE ENERGY AND ENVIRONMENTAL EXPERTS WHO WOULD USE THEIR EXPERTISE TO IDENTIFY AND EXECUTE POVERTY ALLEVIATION PROJECTS IN AFRICA
- TO CREATE A PLATFORM WHERE MEMBERS WOULD BE UPDATED ON LATEST SCIENTIFIC SUBJECT MATTER IN THE AREA OF RENEWABLE ENERGY AND ENVIRONMENT
- TO CREATE JOB OPPORTUNITIES FOR MEMBERS THROUGH NETWORKING AND COLLABORATION WITH RELEVANT GERMAN DEVELOPMENTAL ORGANIZATIONS AND OTHERS ORGANIZATIONS IN THE RENEWABLE ENERGY SECTOR

CONCLUSION:

- ✓ BY ADOPTING A BOTTON UP APPOACH TO OUR ACTIVITIES COLLABORATION BETWEEN MEMBERS IN EACH COUNTRY IS ENHANCED AS OBSERVED IN CAMEROON AND ETHIOPIA
- ✓ THE COUNTRY COORDINATORS IN THEIR SKYPE MEETING INDENTIFIED IMPROVED COOKSTOVES AS A NATIONAL PROJECT AND EACH LOCAL NETWORK IS ALSO IDENTIFYING COUNTRY SPECIFIC PROJECTS
- ✓ BY COLLABORATION WITH ECONOLER, A CANADIAN BASED CONSULTANCY FIRM IN THE RENEWABLE ENERGY SECTOR, THE CV OF OUR MEMBER IN MADAGASCAR WAS USED FOR AFD/SUNREF PROGRAM WHERE THE APPLICATION WAS SUCCESSFUL WITH A DESKTOP SURVEY

P. O. BOX AN 7331,
ACCRA-NORTH
GHANA W/A
TEL: 00233275361988
E-MAIL: evanshervie@yahoo.com

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Europa-Universität Flensburg
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Department of Energy and Environmental Management

Review of Policy Coherence: Investigating Land Availability for Biodiesel Feedstock Production in Indonesia

Fumi Harahap, Semida Silveira, Dilip Khatiwada

Division of Energy and Climate Studies, School of Industrial Engineering and Management
KTH Royal Institute of Technology, Sweden

Background

Promotion of liquid biofuel in Indonesia aims at substituting the petroleum oil in transport, industry, commercial and power sectors, as well as addressing domestic oil scarcity. The effort has been mostly tied up by setting blending mandates as part of the national policy. However, meeting these targets has been challenging [1]. In terms of liquid biofuel production, the international and domestic market for biodiesel from crude palm oil (CPO) presented considerable growth in the past few years. Meanwhile, Indonesia is responsible for more than half of the world's palm oil production and thus the opportunities for biodiesel expansion are quite significant.

When aiming at deployment of sustainable biofuel, the cross-sectoral interplay of various activities needs to be orchestrated. An evaluation of policy coherence is proposed to verify the conditions to achieve synergies. This study investigates the level of policy coherence when it comes to addressing pressure on land and the impact to biodiesel feedstock (oil palm) production.

Evaluation and Discussion

Internal coherence	Temporal coherence	External coherence
(+) Policy goals and regulations push for sustainable palm oil production. (-) Degraded land fits to the general goal reducing pressure on land, but insufficient instrument in place to promote its use for biofuel feedstock production. (-) Inconsistent policy instruments in addressing land requirement for oil palm.	(-) The likelihood of increased stringency of future sustainability standard could further reduce forest area available for conversion.	(-) General policy prioritises food security. Land conflict across food crops, oil palm plantation, and forest conservation appears to occur in forest category of production forest – primary forest. This increase uncertainty to access new site for oil palm expansion. (-) Strong government's will to reduce deforestation and forest degradation hinders the access to new plantation area. (-) Regulation to convert non-forest area to forest area (exchange forest area) discourages the oil palm cultivation on forest production area.

(+) is to mark coherent, (-) is to mark incoherent

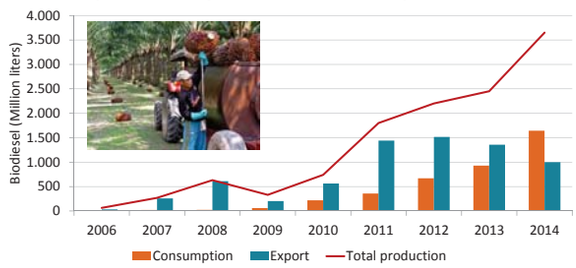
Promoting mutual benefits can be generated by the instruments that support the improvement of land use governance and confirm the achievement of environmental and socio-economic objectives.

- ❖ Develop suitable map to facilitate new site selection
- ❖ Introduce land swap mechanism to change legal land use classifications
- ❖ Revise the sustainability principles of ISPO to further promote environmental benefit

Concluding remarks

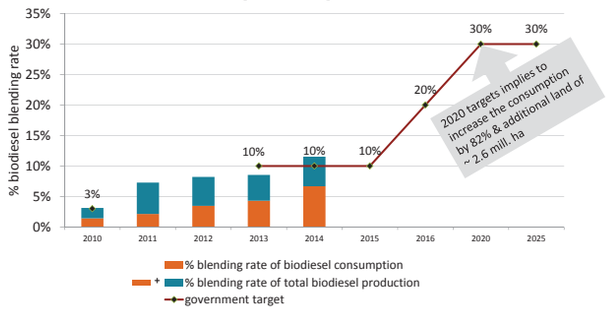
The policy coherence on policy analysis was successful in assessing interactions of the policy related signals and identifying incoherent policies that potentially thwart the achievement of biofuel policy goal. Our analysis shows that discords on CPO feedstock production are generated by inconsistency of instruments across sectoral policy areas and inadequate instruments to support the policy goals, causing concern for policy conflict. The study demonstrates supporting effect of one policy area to meeting goal of other area. In this case, pushing coherent at instrument level promotes synergies. Therefore, careful mapping of policy instruments needs to be made in all policy area related to CPO feedstock production.

Total production, export and domestic use of palm oil biodiesel



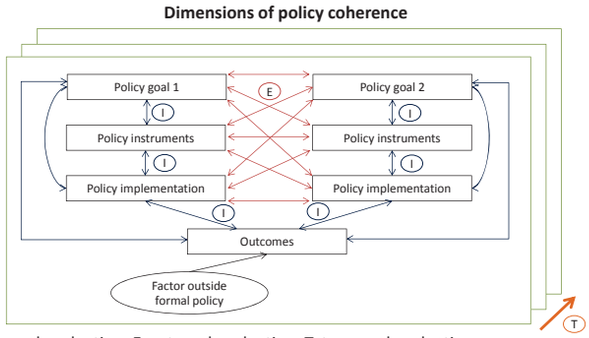
Source: [2]

Biodiesel blending rate – target vs achievement



Source: calculated based on data [3]

Dimensions of policy coherence



I: internal evaluation; E: external evaluation; T: temporal evaluation.

Method is adopted and modified from [4]& [5].

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The project is part of INSISTS (Indonesian-Swedish Initiative for Sustainable Energy Solutions) Program, funded by Swedish Energy Agency. The goal of the program is to exchange experiences in the field of renewable energy and energy technology and in particular to develop strategies for sustainable bioenergy deployment in Indonesia. The project duration is 2014 – 2017.

Fumi Harahap
Email: harahap@kth.se
Postal address: Brinellvägen 68, SE-100 44 Stockholm, Sweden

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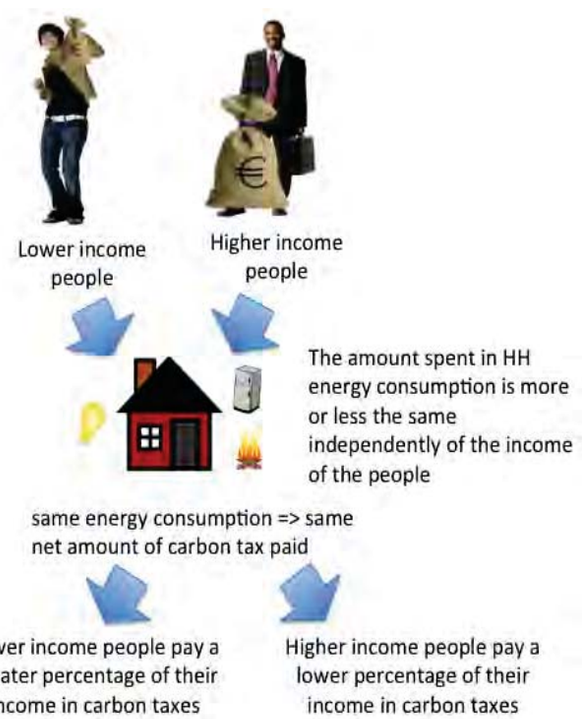
Interdisciplinary Institute of Environmental, Social and Human Sciences
Department of Energy and Environmental Management

Social implications of taxing externalities

María Ana Gonzalez

Introduction and Objectives

- It is usually stated that externalities should be internalized in the price of fossil fuels is to reflect their environmental costs…
- However, is it socially fair?
- Who bears the mayor part of the burden of the higher energy prices?



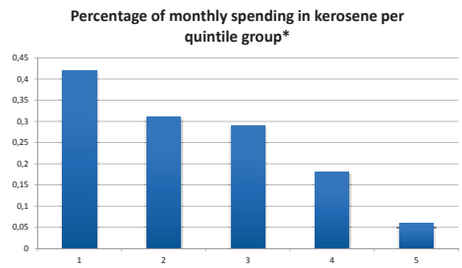
- Taxing final household energy consumption can be regressive, putting a greater burden on lower income households.

Objectives:

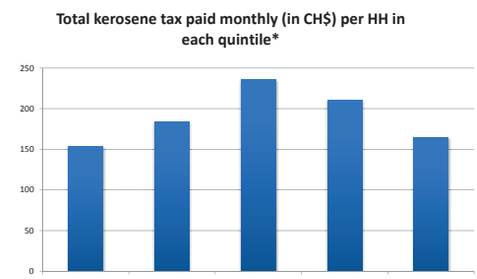
- The objective of the present paper is to discuss policies implemented in different countries suspected to have negative social impact.
- A case study will be selected to perform a numerical evaluation of the applied energy policy showing the negative social impact of its application.

Case Study and Conclusions

- Case Study: taxing of kerosene fuel in Chile.
- Kerosene is mostly used for household (HH) heating.
- The following graph shows how much of the total expenses spent in kerosene according to the quintile group, being the quintile 1 the 20% poorer and quintile 5 the 20% richer (based on income per HH):



- As kerosene is taxed at 26% of its price, it is clear from the graph above that poorer HH spend more of their expenses in paying the tax than richer HH => there is an unfair distribution of the tax on kerosene as the people with lower income bears a larger part of the burden.
- Further more, when considering the net amount paid for the tax by each quintile, this also shows an unfair distribution, being the middle classes the mostly affected as middle classes use kerosene the most and thus, they pay the higher amount of the tax:



- Conclusions: The distributional effects of carbon taxes should be studied before applying them, and in case they are considered to have regressive effects, measures should be taken to reduce them.

*Reference: Information used in the elaboration of the two graphs was sourced from document from INE (Instituto Nacional de Estadística) Chile, ("VI Encuesta de Presupuestos Familiares – Noviembre 2006 – Octubre 2007)" Vol III

Mrs. María Ana Gonzalez Casartelli
E-mail: mariaanagonzalez@yahoo.com.ar
Tel: +56 32 27 3435 2
Address: Arrieta 698, 12-C, Viña del Mar, Chile

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Interdisciplinary Institute of Environmental, Social and Human Sciences
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Energy Management and Conservation Actions

Jorge Lossley

AEG Consultores en Ingeniería S.A, Costa Rica

A Market Model to improve Energy Performance into Business and Entrepreneurship.

The Energy Management and Conservation Action program [EMC@] is a market model developed to improve energy performance in the Business and Entrepreneurship sector. The model considers five areas of interest in which each proposal is allocated and evaluated by the consultant and the end user client/customer.

The output of the evaluation is a ranked matrix of the potential projects which can be implemented in order to lower the energy consumption and improve the business competitiveness. The matrix organizes the projects and provides to the customer an educated decision tool.

The areas of evaluation are indicated as follow: (1) Initial investment; (2) Technical feasibility; (3) Return of investment; (4) Impact on business operations; (5) Employee / Community awareness.

Each category has a ranking from 1 to 5, where 5 represent the more feasible value and 1 represents the lower one. Each category will also have a representative weight or percentage of relevance. The 100 % is distributed among the five categories under consideration at the end user preference.

The methodology provides an array of projects which considers the evaluation of the indicated categories and the ranking according to the customer preference. This method allows the decision makers to have an objective tool to decide upon the investment of projects.

The EMC@ model has been in place in several industries, both local and corporative ones, and has proven cases of success in which the energy consumption profile can be improved and customers received an economic benefit.

Extended benefits of the EMC@ model are the new fields of business for consultants, suppliers and energy managers. They may save within 10 to 15 % of the electrical invoice. The typical paybacks are in the 2 to 5 year term. The EMC@ projects also provide a hedge to electrical cost fluctuations.

EMC@ projects are key drivers in the Energy Supply / Demand Balance. The offset of Demand from peak periods improves the plant factor and provides economic benefits to the parties. They delay the need of new investment into energy generation increments the grid efficiency and relief a burden on the environment.

Policy Makers and Governments need to promote EMC@ at the end users, either by tariff benefits or by taxing over excessive demand. The economic benefit obtained at the end users under these policies may accelerate the investment pace due to the reduction in the payback and increment in the return of investment (ROI).

Success Cases of Study

The experience of the EMC@ program on Medical Device and High Technology Industry has created a matrix of typical areas of interest which are feasible and most like to be implemented. These projects are focused to reduce the energy consumption of indoor environment control. Indeed air conditioning systems. These areas of common interest are indicated as follow:

Management the Energy profile to take advantage of the electrical tariff structure. Introduction of Energy Storage for Air Conditioning Systems (ICE Storage Device)

The Costa Rica current electrical tariff structure allows the end user to obtain an economic benefit if the energy profile is shift from the peak period (10:00 to 12:30 and 17:30 to 20:00) to the night period (20:00 to 6:00). In general terms the electricity cost at night period is a quarter of the cost at peak period.

The general concept is to introduce an ice storage that can be built at night period and melt during the peak period. The project has certain limitations, it can only apply on air conditioning systems which are water based (chilled water), chillers must be able to operate at lower temperature for ice built (-5.5 ºC).

The typical payback period of these projects with current ice making chillers is just over 2 years and it is extended to over 4 years when additional ice making chillers need to be added.

The electricity generation at night period is, in general terms, produced from renewable sources. At peak period the renewable sources are complemented by fuel based generators. The Ice Storage projects have a positive impact on the environment as well, due the fact the electricity consumption for the ice built is mainly obtained from renewable sources. At Ice melt mode (peak period), the ISD lowers the consumption from fossil based generators.

Incorporate into design and construction the use of waste heat sources to substitute energy demand (electrical/fuel based) for heating and/or reheating purposes. Introduction of condensed water coils to substitute electric reheating in Air Conditioning Systems.

This project had been raked as top priority in those companies which have the conditions to use the condensed water as heating source for reheat purpose. The reheat system is mainly used to control the room temperature in those air conditioning system which demand a humidity control within a range of 50 +/- 10 %

A project recently installed in a Medical Device Facility, forecasts an annual saving of US$ 425.000. It had an initial investment of US$ 560.000 and a simple payback of 1.3 years. It lowers the facility electric consumption by 25%

Incorporate technology to reduce energy consumption of humidity control. Introduction of Liquid desiccant technology.

The liquid desiccant technology takes advantage of the hygroscopic principle of a brine solution which to be regenerated used the heat rejection of a cooling device, which provides the cooling to the leaving air stream, therefore, instead of having low humidity and high temperature, the liquid desiccant provides equivalent humidity level at a lower temperature.

A project under construction forecast an initial investment of US$ 250.000, annual savings of US$ 230.000 and a payback time of 1.1 years.

AEG Consultores en Ingeniería S.A.
Designs for a sustainable future
506-89393974 / jlossley@aegcr.com
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Youth and Energy Management in household in Cameroon

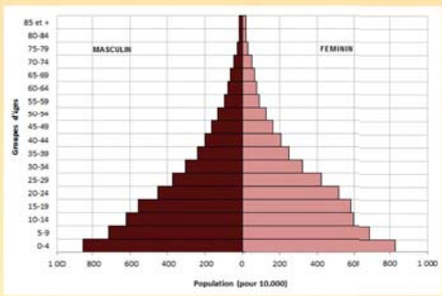
By **Lydie Kamdom**

Development consultant for CENTRE POUR LE ENVIRONNEMENT ET LE DEVELOPPEMENT

Young people are key consumer of energy

when talking about energy,often we tend to forget that young people may also be concerned by energy discussions

Source : BUCREP, 2011



- **10.84** % of the population are **15** to **20** year old and **9,84** % of the population are between **20** to **25** year old.
- Youth consumption due to computer games, cell phones Television and others youth attractive electrical appliances etc cost about 20% of the electricity bill in most families.
- Budget allocate for the transport of youth during the school time is represents 2/3 of the family budget allocated for transport.

Conclusions:

- Urgent need to educate the youth on energy efficiency.
- Necessity to sensitize the youth on the use of bicycle as a means of transport to school.

KAMDOM LYDIE
BP 5475 Douala
Email lkamdom_lydie@yahoo.fr
Tel: 00237 6 99 90 01 01

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Europa-Universität Flensburg
Interdisciplinary Institute of Environmental, Social and Human Sciences
Department of Energy and Environmental Management

Energy Management Practice in Developing Countries: A Review of Kenya's Policy, Regulatory and Institutional Framework

Kimari Maina Patrick

Member, Association of Energy Engineers, Registered Professional Engineer (Kenya) and Licensed Energy Auditor (Kenya)

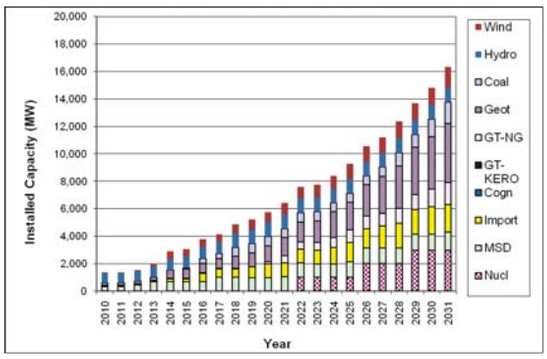
Introduction and Objectives

Energy management practice in developing countries such as Kenya is informed by markedly different variables as compared to factors that inform energy management practice in developed economies.

In developing and economies in transition such as Kenya, the driving force of the energy system is the quest to fill the wide gap between energy demanded and what is supplied.

In their quest to improve the living and economic conditions of their populace, developing economies places greater emphasis on increasing their installed electrical power generation capacity and exploitation of other non-electrical energy sources such as fossil fuels and biomass.

In the case of Kenya, the country is implementing an ambitious programme to triple the country's grid connected installed power capacity to 6000MW by the year 2017 from the current 2294MW.



Even though Kenya plans to add approximately 5000MW of additional generating capacity by 2018 as it implements different phases of the country's Least Cost Power Development Plan (LCPDP) 2011-2031; since 2012 there has been a change of approach to the country's power sector and the wider energy field development through incorporation of energy management in the country's energy planning.

To lower Kenya's energy consumption while maintaining same level of output and comfort, the country came up with a number of policy, regulatory and institutional framework to guide the process.

This paper therefore explores in depth the policy, regulatory and institutional framework that guides energy management in Kenya. In particular the paper looks at the following policy documents: Session Paper Number 4 of 2004 section 5.6 and Section 6.6.6, Energy (Energy Management) Regulations 2012, Energy Acts 2006, Sections 104, 105 and 106 and Energy (Solar Water Heating) Regulations, 2012.

The paper takes a snap shot of the current status in terms of operationalization, effectiveness and challenges facing the implementation of the various policies. Legal structures put in place to enforce the policies and implementing institutions are also explored.

The paper is a product of desktop study of publicly available and private literature on the topic. To validate the information, a number of face to face , telephone and email conversations were carried out.

Conclusion and References

Kenya's ministry of Energy and Petroleum (MoE&P) through the Energy Regulatory Commission (ERC) one of its agencies, is currently implementing a number of energy management programs aimed at curtailing the ever increasing demand for additional power generation in the country.

At household level, working in collaboration with the government owned power distribution utility company-Kenya Power Company, the two have been distributing for free, compact fluorescent lamps (CFL) and Light Emitting Diodes (LED) lamps.

At commercial level, in its execution of the Energy Act (No. 12 of 2006), the Energy Regulatory Commission (ERC), in the year 2012, enacted, the Energy (Solar Water Heating) Regulations, 2012, which makes it mandatory for owners of commercial and public institutions such as hotels, motels and schools to install solar water heating systems to provide at least 60% of their hot water demand on annual basis. Penalty for non-compliance with the regulation is the premises disconnection from national grid power and/or imprisonment.

On the other hand, The Energy (Energy Management) Regulations, 2012, also a section of the Energy Act (No. 12 of 2006), calls for mandatory energy audit of public institutions, commercial and industrial concerns that consumes 180,001kWh or 648,004MJ of energy (electric or thermal) per year. The law came into effect in September 2012 and there are more than 3300 facilities regulated by it.

Under the regulations, the facilities are supposed to have carried out the mandatory energy audit by September 2015 to avoid the penalties imposed by the law. Under the mandatory energy management program for medium to heavy energy consumers, the government expects to save between 25MW-30MW of power per year.

But the country is experiencing a shortage of professionals to carry out the audits. Currently there are about 10 licensed energy auditing firms with individual licensed energy auditors being less than 50. Evidently the September deadline is not tenable.

Just like the Solar Water Heating regulations whose deadline for implementation expired in May 2014 with less than 30% compliance levels and no prosecution carried out so far for non-compliance, the Energy Management Regulations 2012, risks suffering the same fate of being a piece of legislation that is good on paper but hard to enforce or achieve its intended purpose and objectives.

It is the government's expectation that all these measures will lead to considerable reduction in energy demand in the country based on current consumption levels thus reducing pressure on the need for new power generation capacity.

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Eng. Kimari Maina Patrick
Dedan Kimathi University of Technology
P.O Box 657-10100 Nyeri
KENYA
Patrick.kimari@dkut.ac.ke
kimarip@yahoo.com

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IMPLEMENTATION OF SOLAR ENERGY SYSTEMS FOR COMMUNITY RESILIENCE IN COLOMBIA. CASE STUDY: SAN VICENTE DEL CAGUAN

Johana Rivera Forero[1] , Juan Fernando Higuita[2]

[1] Associated Professor University EAN, Bogotá, Colombia

Industrial Engineer, Project Management specialist, M.Eng. Energy And Environmental Management, Project Management Doctorate Programme candidate.

[2] Computer Science Engineer, M.Eng. Energy and Environmental Management. Professional in Solar Energy Projects at EPM utility company Medellín, Colombia.

Introduction & Results

GENERAL ABSTRACT

- Colombia has an 1.141.748 km² surface.
- The national Interconnected electricity system (NIS) covers 34% of total country area, non-interconnected zones (NIZ) -66%.
- Currently, most of the NIZ (96,3%) are using diesel generators for producing energy, service is costly, people have to pay twice as much as in NIS and this is a limited service for an average of 6 hours per day. (Florez, Tobón. y Castillo, 2009).

- ***Stakeholders*** : National government, public utilities and private companies, communities at non-interconnected areas.

PROBLEM

¿How to implement solar energy systems for community resilience in off grid areas in Colombia?

METHODOLOGY

Primary sources were analyzed, such as: interviews, photos and project information mainly from the public utility (EPM). Through a deductive analysis, a methodology is formulated for implementation of solar energy systems in off grid areas in Colombia.

RESULTS

First among the main results, a replicable methodology is formulated for implementation of solar energy systems in NIZ, based on other similar pioneer projects and literature review:

0. Characterization
1. Planning,
2. Social and environmental benefits
3. Preliminary protocol
4. Community Strategy empowerment
5. Building Social and Technical capacity
6. Environmental aspects
7. Installment
8. Commissioning & Operation
9. Monitoring

Location: San Vicente Caguán (south Colombia)

Beneficiaries:	Number of households	Number of inhabitants
	100	479

Household appliances provided: TV, radio, mobile phone charger, electrical water purifiers, lighting, refrigerator, electricity connection and electrical cabinets. 2 solar panels of 300 peak watts per family, household appliances are DC systems.

(GAIA S.A.S, 2015)

Conclussions & Recomendations

1. There are particular conditions for NIZ, they are spread, far from cities, in remote areas, highly biodiverse, costly electricity fees and with few energy services, goods and services demand.
2. There are solutions like solar energy systems for Colombian communities that allow to build community resilience, economic and technical capacity to improve their life quality and adaptation to climate change.
3. Monitoring phase would give more data for ex-post evaluation.
4. Community resilience was a positive influence in terms of building social capacity, strengthening economic sustainability for energy systems management, increasing energy independency and delivering more tools for adaptation to climate change.
5. Social component for Colombian NIZ communities is the most important of all above.
6. Supplier development is essential to guarantee quality and cost effective solutions.
7. A success key is to work in communities with at least a basic participative structure and sense of community ownership.
8. Robust technological items are essential for rural applications.
9. In order to develop Colombian territory in the Post-conflict age, local and sustainable solutions are required to bring opportunities to all Colombian people.

Committee creation record signed by community members.

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Johana Rivera Forero
johanariveraforero@gmail.com
Skype. Tutorajohanarivera.

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Department of Energy and Environmental Management

"Decentralized Approach (or) Participatory Approach to Development Projects"

Success Story of a Pilot Project on Capacity Building and Empowerment of Women Self-Help Groups Through Micro-Credit and Social Mobilization

Ms. Mi Mi Maw
Country Project Director, Myanmar

Introduction: This paper is presented based on a success story of a pilot project. A decentralized approach will be an immense contribution to the existing body of knowledge and in any development projects for effectiveness and sustainability.

Objectives:

❖To examine and assess the impact of decentralization on project villages

❖To share knowledge of successful on-going projects among EEM Alumni

❖To increase realization of importance of decentralization concerns in development.

Conclusions:

❖ A decentralized approach results in an active participation of villagers

❖Recommendation of a decentralized approach for all development projects for effectiveness and sustainability

References:

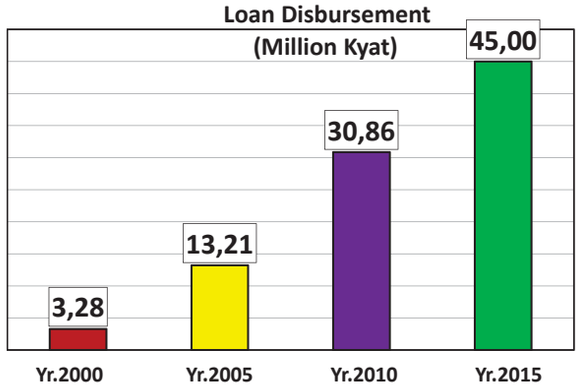
❖Pilot Project on Capacity Building and Empowerment of Women Self-Help Groups through Micro-Credit and Social Mobilization

❖Annual reports of the project

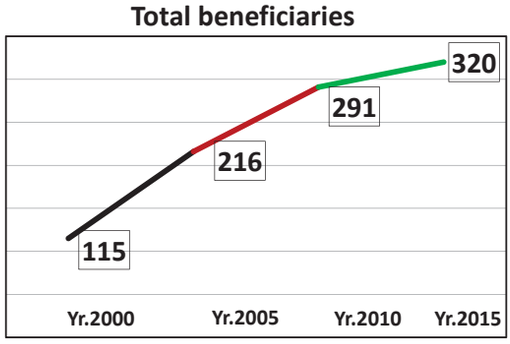
❖Impact assessment report of the project.

Participatory Workshop

Loan Disbursement (Million Kyat)



Total beneficiaries



School built by the project

Contact details :
Ms. Mi Mi Maw
B.Ag, M.Sc (ARTES-Germany)
Country Project Director, Myanmar
E.mail : mimimaw06@gmail.com
Ph : 0095-9-5010048 / 5018244

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Europa-Universität Flensburg
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Department of Energy and Environmental Management

Potential of Bagasse in Electricity Production in West Kenya

Michelle Akute

The Kenya Power Company

Introduction and Objectives:

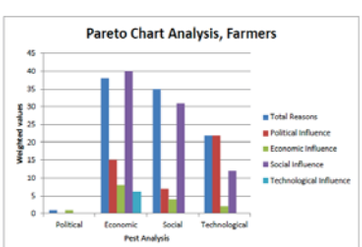
Introduction:

- The West of Kenya is largely a rural agrarian population (70%), most being smallholder farmers. It also has the largest sugarcane growing areas with the most sugarcane factories in the country.
- The region is dominated by power woes, characterized by blackouts due to insufficient generation. Most of the sugarcane factories have not attained self-sufficiency in meeting their electricity demands and depend on the grid.
- Mumias Sugar Company (MSC), the biggest in the country, is located in this region, and is currently the only sugar factory with a cogeneration plant .
- This study sought to find out the potential of power that exists from bagasse and if the same can be harnessed and used to increase the access to reliable electricity within the factories first, and then in the West Kenya region.

Figure 1: Bagasse production and storage in the factories

Objectives:

- To establish methods used by MSC to harness energy through cogeneration from Sugarcane bagasse
- To assess the ease of applicability of the same methods used by MSC in other sugar companies in the vicinity
- To determine challenges inhibiting the development of cogeneration in the West Kenya region
- To establish ways through which the factories in West Kenya can enhance power supply in this region through cogeneration
- To assess the impacts of Implementing cogeneration in West Kenya
- To evaluate the policies in place for the development of cogeneration using bagasse



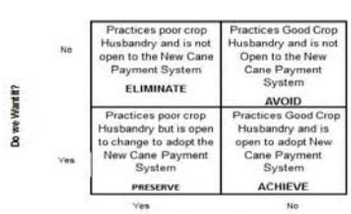


Figure 2: Pareto Chart Analysis and Goal grid tool for the farmers

Conclusions and References:

Recommendations:

The Government

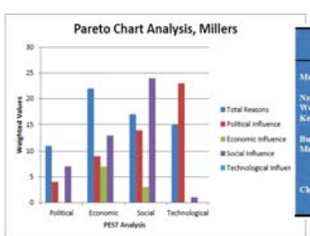
- Introduce tax incentives that support technologies for cogeneration
- Provide necessary support that intensifies research into cogeneration

The Millers

- Create better and stronger relationships with the farmers by adopting a revenue sharing scheme to share the proceeds from sale of power
- Enhance relationships amongst themselves to work together and assist each other in developing cogeneration plants e.g. by supplying each other with bagasse

The Farmers

- Reduction of farmers' dependency on millers through farmer empowerment
- Practice better methods of farming and harvesting cane with the help of outgrower and research institutions



	Boiler Parameters	Efficiency of Boiler	Type of Turbine	Efficiency of Turbine
Mumias	87Bar 170TPH with Economiser	80%	Condensing Extraction	90%
Nzoia West Kenya	54TPH Pressurized Boiler with Economiser, 45kg/m² 70TPH		Back pressure Back pressure	92.8%
Butali Muhoroni	N/A Suspension burning & Heap burning with economiser 21Bar, 40TPH	N/A 80	N/A Back Pressure	N/A 75%
Chemelil	Stoker Boiler with economiser 20TPH, 21 bar	80%	Back Pressure	60%

Figure 3: Pareto Chart Analysis and Matrix comparison for the millers

Conclusion:

The study looked at various aspects of the sugar industry as a whole in relation to cogeneration from bagasse. Highlights were made of the potential of power that exists from cogeneration with different possibilities from sugarcane production and factory production in place, the factors that inhibit cogeneration and the impacts of cogeneration if some of the potential is tapped. It was then recommended that the Government, the farmers and the millers need to work together to realize the potential of power that exists from bagasse based cogeneration.

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Kenya Power
Stima Plaza, Kolobot Road
P.O. Box 30099-00100
Nairobi, Kenya
Mobile: +254720968467
Email: polanedo@gmail.com

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Europa-Universität Flensburg
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Department of Energy and Environmental Management

ENERGY EFFICIENCY IN BUILDINGS – A CASE STUDY FOR NATURALLY VENTILATED BUILDINGS IN THE WARM-HUMID TROPICAL ZONE IN SOUTH INDIA

Mona Doctor-Pingel

Architect, Auroville

Introduction

India is an emerging giant with a growing population, an expanding economy, and a quest for an improved quality of life.

- The potential for energy savings through the construction industry is immense. India is ranked 2nd in the world in terms of the rate of growth of energy use and associated carbon emissions. This is due not only to lifestyle changes, but the rate of construction in India is phenomenal, and it's estimated that the country will add the equivalent built area of Chicago (approx 8 billion square feet) every year.
- India is now the world's seventh largest energy consumer, sixth largest source of greenhouse gas (GHG) emissions, and second in terms of annual GHG emissions growth (Bureau of Energy Efficiency, 2011).
- India's building energy use accounts for 33% of the nation's energy use, and this is growing by 8% annually (Climate Works, 2010).

Analysis in India has demonstrated that systems-level integration through innovative technologies can reduce energy consumption by at least 60% in new construction. The influence of indoor environment on human comfort and productivity often necessitates the use of Heating, ventilation and air conditioning systems (HVAC) which accounts for about 50-60 % of building's electricity use in the commercial & residential sector. However, heavy reliability on air conditioning systems increases the energy use which is one of the primary causes of climate change in the southern countries. **Natural ventilation** having a huge potential for energy savings in buildings can prove to be a great mitigation step towards global warming along with maintaining the desired comfort & health conditions in the buildings.

Naturally ventilated buildings have been the preferred typology in Auroville's warm humid coastal climate. Many successful innovative attempts at designing energy efficient buildings using intuition-based design process and decision-making methods exists. However hardly any detailed scientific data exists on the performance evaluation of these buildings.

- This paper will present the scientific work being carried out since two years under The U.S.-India Joint Center for Building Energy Research and Development (CBERD). It's a 5 year joint research programme and it's main focus is to accomplish collaborative research and promote clean energy innovation in energy efficiency with measurable results and contributing to significant reduction in energy use in both nations. www.cberd.org Detailed analysis of different strategies employed to create low energy buildings in terms of construction and maintenance, using locally available craftsmen and materials is presented here.

Objectives:

- Under CBERD Task the objective was to monitor, collect exhaustive data (minimum 1 year, hourly data logging) and determine the performance for each of the selected seven buildings with different passive strategies.
- Quantifiable data which can be later used for analysis of individual strategies and lead to prototype in-situ experiments and simulation models for the same.
- Training of architects and engineers for this task so that a widespread interest and work force can be made available for future research works.
- To find through the data collected a conclusion that is useful for designers. Improving the design and performance of mentioned passive features for this climatic zone.

Strategies studied for naturally ventilated buildings in Auroville/Pondicherry region (warm-humid climate zone):

- Composite wall I Night Flushing

Figure 1 : Entrance view, Blessing house

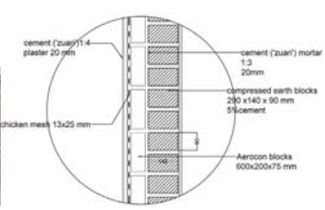

Figure 2 : Composite wall detail, Blessing house

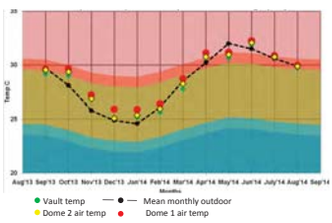

Figure 3 : Values of mean temperature in Dome 1, Dome 2 and Vault of Mukuduvidu house from Sep 2013 till Aug 2014 with Adaptive comfort zones (CARBSE), for Naturally Ventilated Buildings, *(13° N, Chennai)*

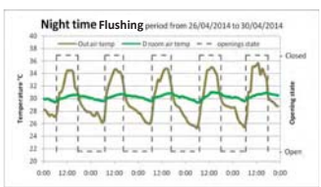

Figure 4: Values of mean air temperature at particular hour throughout four days. Occupants of the house were asked to open all the glass windows and doors (towards verandas and balconies) for night cooling by cross ventilation and closing in the morning to keep the cool air in the house throughout the day.

- Masonry domes I Stack effect I Thermal mass

Figure 5 : Roof top view, Mukuduvidu house

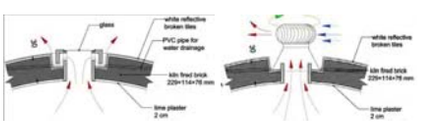

Figure 6 : Dome 1 air vent and Dome 2 air vent with wind extractor, Mukuduvidu House

- Ventilated cavity roofs I shading I Insulation

Figure 7,8 : Roof top and street view Golconde building

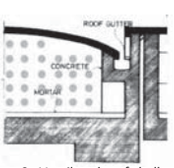

Figure 9 : Ventilated roof shell detail, Golconde building

- Insulated roof I Cross-ventilation

Figure 10 : Afsanah guest house, dining hall protruding into the pond

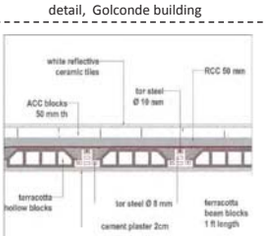

Figure 11 : Composite roof section, Afsanah Guest House

Conclusions:

- The study suggests that thermal comfort could be achieved substantially in warm and humid climate with passive measures like night flushing, composite wall and roof assemblies, ventilated cavity walls and roofs, stack effect with thermal mass, along with simple measures like large openings and overhangs, cross ventilation etc, which are common sense responses to the prevalent climate.
- These studies represent a strong case for constructing sustainable buildings paving the path for low-carbon development, which could address the energy crisis in many countries.

References:

- CARBSE online 'Comfort and Weather Analysis' tool developed by Centre for Advanced Research in Building Science and Energy (CARBSE) at CEPT University http://www.carbse.org/resource/tools/
- Climate Consultant 5.5 Beta is for climate study http://www.energy-design-tools.aud.ucla.edu/
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- ISHRAE and ASHRAE 55 comfort standards

Mona Doctor –Pingel

Studio N a q s h b a n d i / Center for Scientific Research
Yantra | Irumbai p.o.| Auroville | 605 111
Tamilnadu | India | mona@auroville.org.in I +91 413 2622 900

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Interdisciplinary Institute of Environmental, Social and Human Sciences
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RE Rural Economic Zone (REREZ)

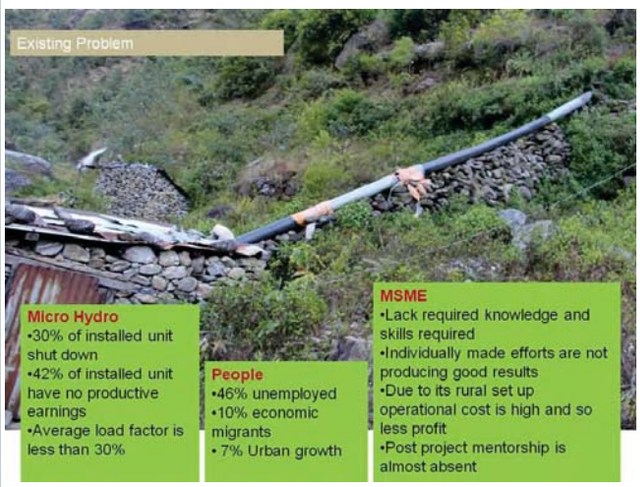
Muhan Maskey

Alternative Energy Promotion Centre, Nepal

Introduction

Nepal faces numerous challenges both similar and different to other developing countries. Its unique geography and culture provide a base for solutions for these challenges. Energy consumption in Nepal is increasing and a critical component for development. A variety of rural renewable energy technologies are commonly being utilized and promoted in Nepal such as biogas, biomass, solar and micro hydro. The promotion of these technologies have focused on rural Nepal where other sources of modern energy are absent. Lighting has been the primary use of energy and there has been a dire need to balance daily the use of the energy produced from these system and to generate income to ensure long term financial sustainability.

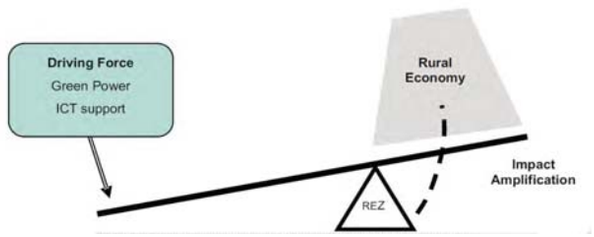
Nepalese Context



A Way Forward-REREZ

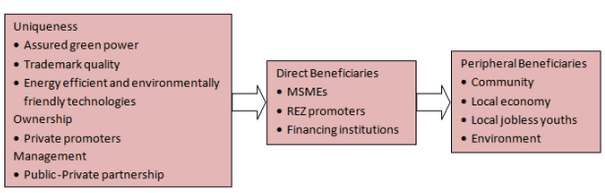
Concept

A concept is proposed to overcome formally tie together green power with entrepreneurial development through the formation of *Renewable Energy Rural Economic Zones (REREZ).* In a REREZ, a reliable Renewable Energy (RE) source will allow energy-reliant businesses to flourish, and vice-versa, the businesses will provide the needed fees to pay for and maintain the energy operation, be it a business or cooperative. REREZ are proposed to be set up in areas with existing off – grid renewable energy (RE) sources, and also in energy-starved areas with potential for clustered industries.



The larger goal of this project is to stimulate viable economic activity based on local resources, local entrepreneurs, and local stakeholders with the addition of some outside knowledge and examples. The MSEs will consist of connected businesses that will create valuable products and services for local and distant customers and provide green power and services to other enterprises

Beneficiaries



Impacts

- Increased energy access and security
- Economic opportunities and benefits
- Environmental impacts
- Policy impacts
- Maintenance of cultural heritage

References

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- PEEDA report of SESI (unpublished)

Policy and Institutional Strengthening Expert
Alternative Energy Promotion Centre (AEPC)
Renewable Energy for Rural Livelihood Programme (RERL)
Kathmandu, Nepal
Telephone: + 977 98510 95987
muhan.maskey@aepc.gov.np / muhan.maskey@gmail.com

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Europa-Universität Flensburg
Interdisciplinary Institute of Environmental, Social and Human Sciences
Department of Energy and Environmental Management

Promoting Efficient Use of Energy in Nepal

Dr. Narayan Prasad Chaulagain

Energy Efficiency and Climate Change Expert

Background and Objective

Background and Rationale:

- Despite a low level of per capita energy consumption, Nepal's energy intensity is one of the highest in South Asia and almost double of that of India or China
- Due to increasing gaps between the supply and demand of electricity resulting in up to 12 hours of daily power cuts particularly in dry season, much of the focus has been currently concentrated on how to increase the supply of electricity
- The efficient use of energy has not yet been an integral part of national energy planning and largely not a priority issue
- Integrating energy efficiency into broader development goals of Nepal might help Nepal in addressing its complex set of interrelated challenges of the energy sector on energy poverty, energy access, import dependence and low levels of embedded energy efficiency
- The main issues in energy efficiency in Nepal have been the lack of policy, strategy and a robust legal provision for developing, implementing and managing the energy efficiency agenda
- Nepal lacks an institutional entity with jurisdiction, authority, resources and accountability to address this issue. An absence of legal regulatory and institutional framework makes it challenging to find a consistent platform to evolve, build and deepen energy efficiency activities
- Existing fiscal, taxation and pricing policies do not encourage an efficient use of energy rather distort the energy prices and undermine energy efficiency
- Limited information and awareness makes it difficult to create a broad interest in energy efficiency
- Lack of access to technology and technical capacity is making energy efficiency an expensive option

Objective:

The main objective of the paper is to highlight the needs and benefits of improved energy efficiency in Nepal and possible way outs including the policy and institutional set-up for improving efficient use of energy in Nepal.

Methodology:

- Review and analysis of energy supply/consumption, GDP and population data
- Use of bottom-up cost minimization energy system model -MARKAL
- Review of good practices of other countries
- Proposition of appropriate options of Nepal

Results:

- Nepal needs a clear and forward-looking energy efficiency policy direction
- The proposed institutional and policy set up needs to enhance energy security and improve energy access
- In the period of 15 years (1995-2010) , Nepal's commercial energy use has grown almost twenty times faster than non-commercial energy use
- Energy use growth is driven by three concurrent factors : a) increase in energy use by increase in GDP; b) decrease in energy use through switch from non-commercial to commercial energy use; and c) change in energy intensity

Projections till 2030 based on MARKAL Model :

- Under the base-case scenario, energy supply is projected to grow at 1.8% per annum, fuel imports to grow at 4.1% per annum between 2010 and 2030
- Annual GHG emissions estimated to double in 20 years under the base case
- Under the base-case, the energy intensity of total final energy consumption declines by 3.92% annually through 2030; within commercial energy only, the decline is 0.84% annually through 2030
- Energy efficiency policy principle : doubling the rate of energy efficiency penetration by 2030 compared to that of 1995-2000.

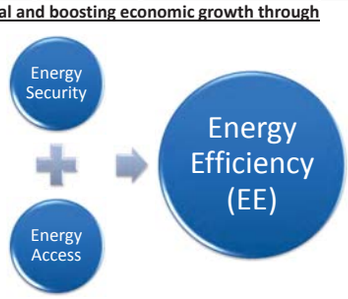
Suggested EE Measures and Conclusions

Suggested Energy Efficiency Measures for Energy-use Sectors

Priority	Sector	Measure Proposed	Rationale	Cost	Difficulty of Implementation	Time for Implementation
1	Industrial	Adoption of higher efficiency technologies	1) Holds a strong reduction potential as most industries are relying on low efficiency, low cost power solutions today 2) Even with just 30% penetration of high efficiency technologies by 2030, total reduction achieved was strong	Moderate	Moderate	Medium/Long Term
2	Residential & Commercial	Adoption of CFLs and LEDs	1) Countries are rapidly moving away from low efficiency lighting sources 2) As energy access increases in the future, a large portion of the future demand will come from lighting; reduction potential in the long run is big	High	Easy	Short/Medium Term
3	T&D Losses	Reduce technical losses	1) Nepal has one of the highest levels of losses 2) The country is projected to rely heavily on locally generated electricity in the future	High	Moderate	Medium/Long Term
4	Transport	Penetration of large diesel and electric buses	1) Large buses can dramatically reduce total miles driven per capita 2) They can help reduce traffic congestion	High	Easy	Short/Medium Term
5	Agricultural	Adoption of higher efficiency technologies within the same fuels	1) Higher technologies already exist 2) They have the highest reduction cost efficiency	Low	Easy	Short/Medium Term
6	Residential & Commercial	Adoption of higher efficiency technologies	1) Supports a switch to a higher efficiency technology for future demand 2) Several countries already have minimum efficiency requirements in place for certain appliances	Moderate	Easy	Short/Medium Term

Components of Comprehensive Energy Efficiency Strategy

Energy Efficiency Strategy for reducing economic vulnerability, increasing social/human capital and boosting economic growth through



Conclusion:

- Three enabling pre-requisites for achieving energy efficiency: human capital, testing facilities and enabling energy efficiency market
- A wide range of potential measures can be implemented in a staggered and practical manner as the capacity for the design and implementation improves
- Energy efficiency in Nepal can play a very meaningful role in supporting the country's development goals. In particular, if approached correctly, it could help enhance energy access and as well as energy security
- The proposed goal for Nepal is based on doubling the rate of energy efficiency improvement by 2030 from what would otherwise have occurred in a business as usual case

Kusunti Height, Lalitpur
G.P.O. Box 8975, EPC 1076
Kathmandu, Nepal
Tel. + 977 1 5542252
Email: narayanchaulagain@gmail.com

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Europa-Universität Flensburg
Interdisciplinary Institute of Environmental, Social and Human Sciences
Department of Energy and Environmental Management

Living Laboratory

- A new approach to engineering education

Nele Rumler

University of Applied Sciences Ruhr West

The idea

Living laboratory = the components of the energy supply system of the university building can be used for experiments by the students

Educational Background

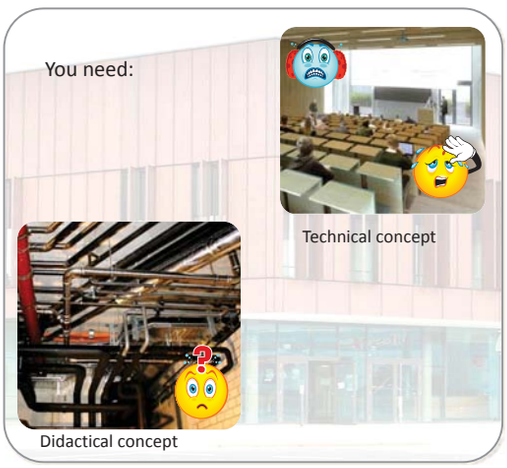
Goals of laboratory education:

- Getting to know technical systems
- Showing the relation between theory and practice
- Getting a feeling for real-life problems
- Learning job relevant methods

Criticism of traditional lab courses:

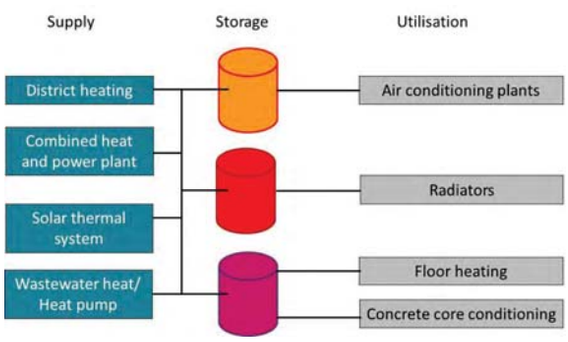
- Complexity of problem reduced ➔ relevance for practice questionable
- Students have difficulties to see the connection between experiments and reality
- Students follow detailed instructions so that they do not comprehend why they do an experiment in a certain way

Because of the changing working environment students need more than technical knowledge ➔ Focus on development of competences



The goal

The goal is to develop a learning environment, which increases the intrinsic motivation and supports the development of competence of the students through job relevant, practical tasks.



Heat supply system of the university building

Technical Background

Technical setup:

- Energy monitoring system with additional sensors
- Experimental area on the rooftop
- Redundant installation of the energy supply system with different, interconnected energy supply technologies and energy storages

Implementation

- Avoiding that students just follow instructions without having fully understood the underlying problem, **Problem-based Learning** should be the basis for the didactical concept of the living laboratory
- First implementation as a selective course in the study courses Industrial Engineering – Energy Systems and Energy and Environmental Engineering
- Later implementation in mandatory courses like Energy Efficiency, Renewable energy systems etc.
- Evaluation of this new approach through assessment of acceptability, motivation and development of competence

Nele Rumler, M.Eng.
University of Applied Sciences Ruhr West
Lützowstr. 5
D- 46236 Bottrop, Germany
Phone: +49 (0) 208882 54 857
nele.rumler@hs-ruhrwest.de

HRW HOCHSCHULE RUHR WEST UNIVERSITY OF APPLIED SCIENCES
INSTITUT ENERGIESYSTEME + ENERGIEWIRTSCHAFT

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Europa-Universität Flensburg
Interdisciplinary Institute of Environmental, Social and Human Sciences
Department of Energy and Environmental Management

Promoting Climate Adapted Housing: Chances and Challenges

Ngo Thi To Nhien

Megacity Research Project TP. Ho Chi Minh

Introduction and Objectives

This project introduces design strategies, construction principles and advice for building occupants on how to achieve energy-efficient and comfortable performance in residential buildings in the climate of HCMC, Vietnam.

Distinctive Middle Class Housing Typologies in HCMC

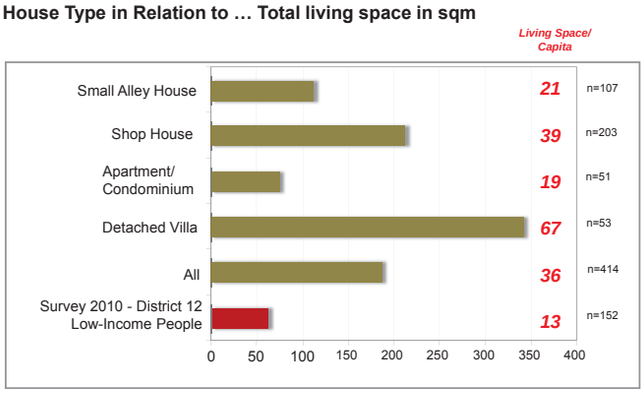
Detached Villa

Shop Houses

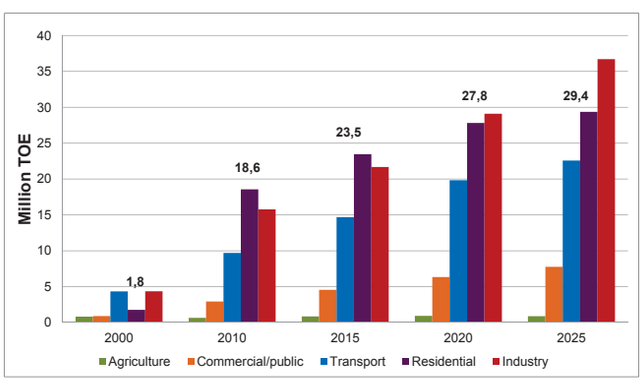
Apartments/Condominiums

Small Alley Houses

House Type in Relation to … Total living space in sqm



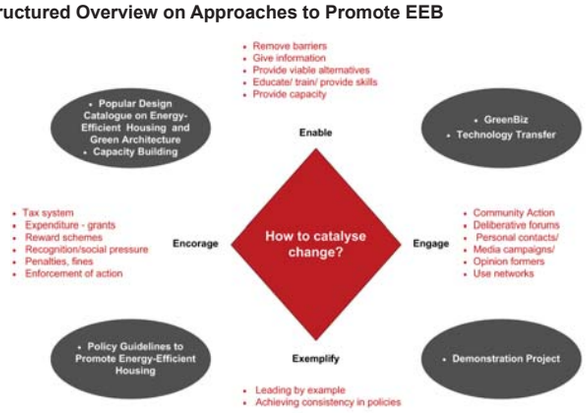
Vietnam energy demand forecast by sector



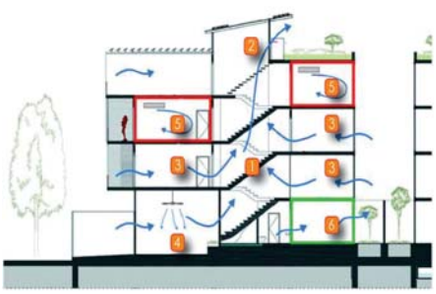
Conclusion

- As far as socio-economic factors are concerned, the rapidly emerging urban middle class (new consumers) should become a key target group for increased sustainability.
- The new consumers can also behave as trendsetters and pioneers of environmentally conscious behaviour. Education for sustainable development should be further promoted in general. It should become integral part already of kindergarten and primary school education, already and not only implemented by state institutions alone.
- A modern townhouse should be designed to utilized natural ventilations as much as possible.
- Since outdoor humidity levels are too high throughout the year, discharge of humidity loads or drying of material through natural air movement is restricted in tropical climates.
- The promotion of energy efficient building cannot happen in a top-down manner, alone. In this context, the emergence of broad stakeholder coalitions such as during the process of developing and disseminating the Handbook for Green Housing and the Handbook for Green Products may serve as learning fields for reorganising institutions in a broader context and to creative new innovative alliances between the state and the private sector

Structured Overview on Approaches to Promote EEB



Principles and modes of natural ventilation in modern town houses



1. Free air path to allow stack effect and cross ventilation
2. Ventilation opening at the highest point of the building
3. Operable windows for cross ventilation
4. Air draft induced by fans for energy efficient thermal comfort provision
5. Airtight zones with mechanical cooling
6. Separate air path in zones with thermal or hygric loads

References

Hesse C, Schwede D, Waibel M (eds) (2011) Handbook for Green Housing: *Climate-Adapted and Energy-Efficient Building Solutions for Ho Chi Minh City*. Edition 1: Town Houses, Transport Publishing House, Hanoi. ISBN 978-604-76-0031-1.

Schwede D (2010) *Climate-Adapted and Market Appropriate Design Guidelines for HCMC's New Residential Building Stock – a Hand Book on How to Design HCMC's Residential Buildings for a Sustainable Future.*

NGO TO NHIEN
Centre for Technological Progress
Ministry of Science and Technology
Hanoi, Vietnam
e-mail: ntnhien@most.gov.vn

DAAD

Europa-Universität Flensburg
Interdisciplinary Institute of Environmental, Social and Human Sciences
Department of Energy and Environmental Management

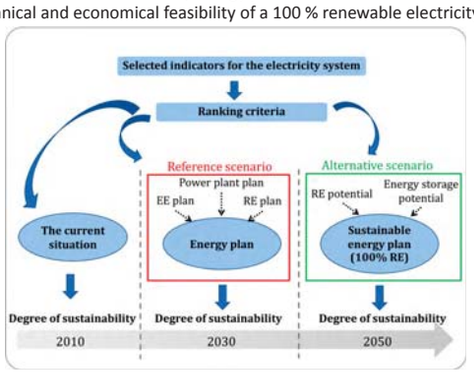
Shaping the electricity system of Thailand towards sustainability

Pitoon Junthip , Dipl.-Ing. Wulf Boie, Prof. Dr. August Schläpfer

Department of Energy and Environmental Management, University of Flensburg

Introduction:

In Thailand, many people may doubt about how to measure the degree of sustainability in the electricity system and a possibility of promoting a 100% renewable electricity system. The concept of this research is to select indicators and determine criteria to assess the degree of sustainability for the electricity system in the current situation, energy plan and alternative scenario, to consider a technical and economical feasibility of a 100 % renewable electricity system.

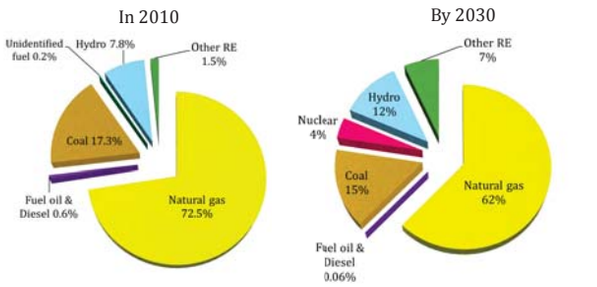


Objectives:

- to assess the degree of sustainability for the electricity system in the current situation, energy plan and proposed scenario.
- to propose an alternative scenario of promoting a 100 % renewable electricity system by 2050 for Thailand.

Key findings:

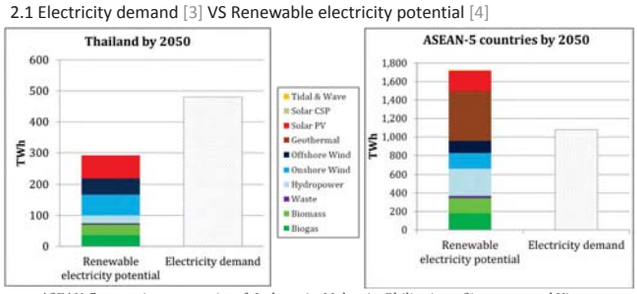
1. The electricity generation between the current situation [1] and energy plan [2]



Total generation amounted to 161 TWh. Total generation will amount to 389 TWh.

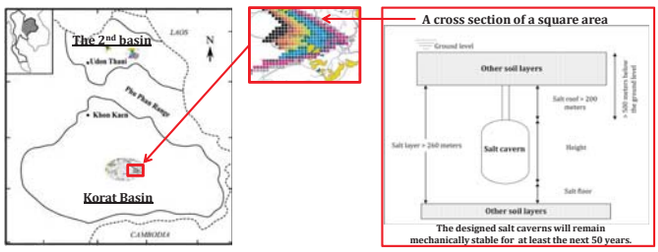
2. Alternative scenario towards a 100 % renewable electricity system

2.1 Electricity demand [3] VS Renewable electricity potential [4]



ASEAN-5 countries are consist of: Indonesia, Malaysia, Philippines, Singapore and Vietnam.

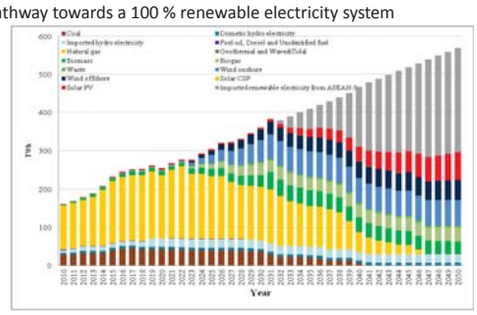
2.2 Salt cavern potential of Thailand [5]



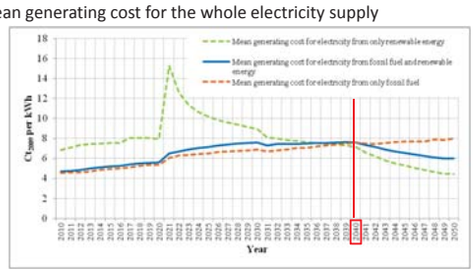
2.3 Energy storage potential for AA-CAES [6]

Final summary of AA-CAES potential	A single cavern	A double cavern
Number of salt caverns (caverns)	958	1,916
Total volume of salt caverns (million cu.m)	350	700
Energy storage potential for AA-CAES (TWh)	59	118

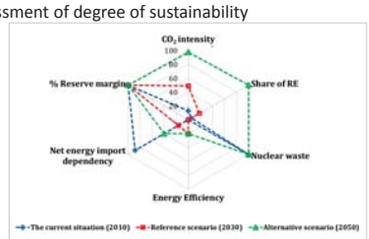
2.4 The pathway towards a 100 % renewable electricity system



2.5 The mean generating cost for the whole electricity supply



2.6 The final assessment of degree of sustainability



Conclusion:

- It is possible to promote a 100 % renewable electricity system by 2050.
- There is no need to promote new nuclear power plant suggested in the energy plan.
- The proposed scenario is more sustainable than both the current situation and energy plan.

References: [1] Author based on Statistical Report Year 2010, Annual report, Power Forecast and Statistics Analysis Department, System Control and Operation Division, EGAT, p. 40 [2] Author based on the Power Development Plan 2010 revision 3, Ministry of Energy [3] Author based on the PDP 2010 Rev.3 and Global low energy demand scenario-[R]evolution 2008, Ecofys [4] Author based on Global Biomass Potential: Investigation and assessment of data Remote sensing in biomass potential research Country-specific energy crop potential, German Biomass Research Centre (2008) and Role and Potential of Renewable Energy and Energy Efficiency for Global Energy Supply, German Federal Environment Agency (2009) [5] Fuenkajorn, K.(2010), Assessment of mechanical potentials of rock salt for compressed air energy storage in the north-eastern of Thailand, DEDE [6] Author based on Kepplinger et al. (2011), Present Trends in Compressed Air Energy, SMRI Fall 2011 Technical Conference, p. 7, York, KU: SOLUTION MINING RESEARCH INSTITUTE

More information:
Mr.Pitoon Junthip
E-mail: pitoon_jun@yahoo.com
Mobile phone: +66-87595-2555
190/2 M.4, T.Maemao, A.Maemao, Lampang 52220
Thailand

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Europa-Universität Flensburg
Interdisciplinary Institute of Environmental, Social and Human Sciences
Department of Energy and Environmental Management

Enhancing Energy Security in South Asia through Cross Border Electricity Trade - Opportunities and Challenges

Pushkar Manandhar

Introduction:

- Increasing growth rate of GDP- 5.1% (2012), 6.5%(2013),6.9%(2014); Estimated 7.2%(2015) and 7.6%(2016)
- Rapidly increasing energy demands- Total primary energy supply in 2009 increases by 175% compared to 1990.
- Diversity in resource endowment and varying degree of need for energy.
- Unleashing energy potential by each member countries and optimizing the use of resources through regional cooperation is need of an hour.

Objectives:

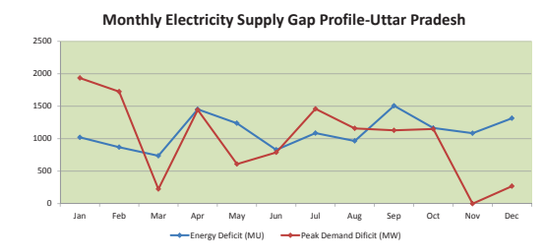
Objectives: To access opportunities and challenge for enhancing energy security in South Asia through Regional Cooperation with focus on Nepal and India.

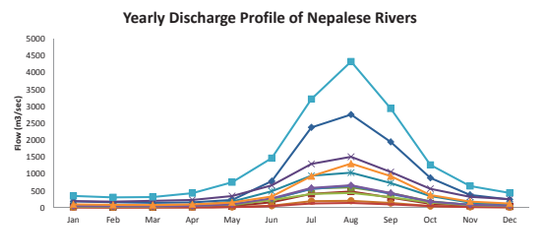
Opportunities:

And more importantly

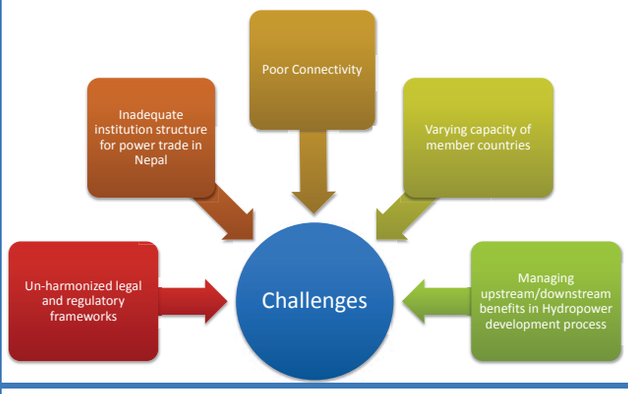
Enabling Political environment:

A long awaited landmark power trading agreement was signed between Nepal and India on 21 Oct. It will enable cooperation in the power sector, including developing transmission interconnections, grid connectivity, power exchange and trading through the governmental, public and private enterprises of the two countries on mutually acceptable terms.





Challenges:



Way forward:

- Recognize power trading as licensed activities by law.
- Establish independent regulatory agency-clarify transmission function, wheeling charge etc.
- Establish suitable power trading company in Nepal.
- Invest in increasing connectivity through joint efforts.
- Learn from similar initiatives-GMS, SAPP, NORDPOOL etc.

Pushkar Manandhar
pmanandhar@gmail.com
Phone: +977 9851121960

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Europa-Universität Flensburg
Interdisciplinary Institute of Environmental, Social and Human Sciences
Department of Energy and Environmental Management

Local Officials' Concerns of Climate Change Issues in China: A Case from Jiangsu

Hu Qiying

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Introduction and Objective

Jiangsu province is one of the most developed and economically active regions in China, and the third biggest CO_2 emitter in China. Jiangsu is vulnerable to climate change and facing pressure in reducing its carbon intensity.

In China, it is local officials who practice measures and instruments, oversee carbon reduction progress, and connect climate policy processing with diverse individuals. Officials' performances and actions play a critical role to determine whether or not CO_2 emission reduction and energy saving policies are implemented successfully. With this regard, this study aims to understand local officials' awareness, beliefs and attitudes towards climate change, evaluate their capacity need to implement policy and respond to climate change risks, and provide information for the government to develop effective policy to enhance capacity building for local officials to help individuals to translate their intentions of CO_2 emissions reductions into actions.

A questionnaire was designed on the basis of a desktop literature review. The questionnaire was also sent to climate experts, governmental officials, and climate change program managers for review and revised accordingly.

The questionnaire developed to collect data for this research consists of four major parts. The first section includes the basic demographic information, such as gender, age, educational and academic background, employment history, relevance of participants' work to climate change related fields, membership of environmental organizations, and volunteering environmental events or activities.

The second section of the questionnaire contains **12** climate change related topics to examine respondents' knowledge about the issues. A three-point scale was used to measures participants' knowledge level on climate topics, such as "never heard about it", "heard about it", and "know about it."

In the third part of the survey, 15 statements regarding the climate science and China's situations were designed to examine respondents' attitudes and beliefs about the climate issues. The statements were framed from perspectives of the causes of climate change, social and environmental impacts, and potential solutions to climate issues. Respondents were asked to indicate their levels of agreement/disagreement of each statement on a 5-point scale.

The fourth part of the questionnaire surveyed local officials' willingness to raise their awareness of climate change and about what topics they desire more knowledge. This part was organized as 7 climate sciences, 8 climate change management approaches, and 9 climate policies. A 5-point scale from "very important "to "not important" was used for participants to indicate their needs for capacity improvement on managing climate change.

250 questionnaires were distributed across all 13 district cities of Jiangsu province. Participants from the diverse agencies took part in this research voluntarily and anonymously and finally, **191** valid questionnaires were used for the data analysis.

Information about the participants

- More male than female (valid 191 participants)
- Young group: 35 year old in average
- Majority (80%) majored in social sciences, including economics, management science, humanities and art sciences
- 88% from the governmental agencies
- Well-educated: 97% received college and above education
- Majority of members of the communist party
- 45% of participants working directly on the climate related field

Conclusions and References

This research found that local officials in Jiangsu are aware of climate change and show a strong need for capacity building for addressing climate change risks. The results may imply that the Jiangsu government would have to pay adequate attention to enhancing local officials' awareness of climate change by investing in capacity building programs which need to expand beyond officials in the climate field.

It also shows that participants may not have paid much attention to market-based mechanisms and they may not have considered those mechanisms and carbon financing as the prior needs for addressing climate change issues. The results may imply that there is a need to fill the gap between climate policy and local officials' capacities for supporting and implementing these policies.

It should be noted that the ability of local officials to understand relevant measures and implement them in practice is essential for Jiangsu to reach its low carbon targets and maintain its economic development in a sustainable way under a climate-threatened and resources constrained world.

To fulfill the emissions reduction target set by the central government, the Jiangsu government needs to take further actions, including setting up emissions targets and a timetable for major energy-intensive industries and emitters, legalizing energy conservation and emissions reduction actions, establishing an institution to be responsible for monitoring the progress of policy implementations, encouraging R&D in low carbon technologies, and regulating local governments and officials' behavior.

It should be noted that the ability of local officials to understand these measures and implement them in practice is essential for Jiangsu to reach its low carbon targets for the 12th Five Year Plan and maintain its economic development in a sustainable way under a climate-threatened and resources constrained world.

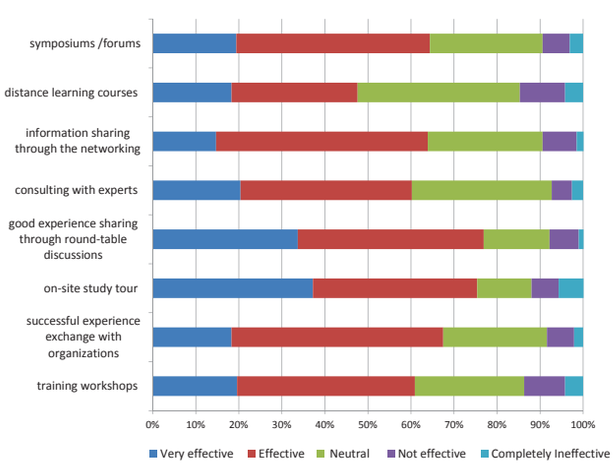

Figure 1: Effectiveness of capacity building approaches

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
Changjianglu No. 9 Block, Bld. B2, Room 704, Dengfuxiang 18
210018 Nanjing, Jiangsu Prov. PR China
M (+86) 182 6008 2528
T (+86) - (0)25- 8473 0932 ext. 803 F (+86) - (0)25- 8473 0902
E qiying.hu@giz.de W www.giz.de/china

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Department of Energy and Environmental Management

Energising Sustainable Rural Livelihood

Resha Piya Shrestha

Introduction and Objective

Project implementers: Practical Action South Asia Regional Office + Alternative Energy Promotion Centre (AEPC)

Figure1: MHP in Achham District

- Micro Hydropower Plants (MHPs) installed in Nepal are not reliable and sustainable due to weak cash flow performance, resulting in lack of fund for proper O&M.
- Rural IGA and enterprises have very low productivity and efficiency due to lack of proper technical and management skills as well as lack of access to modern energy services.
- An opportunity to strengthen rural energy access by creating supply and demand interdependency.

The project used a Participatory Market System Development (PMSD) approach in the project to create a win-win scenario to improve rural livelihood as well as energy infrastructure (MHPs), rural enterprises operation and sustainability.

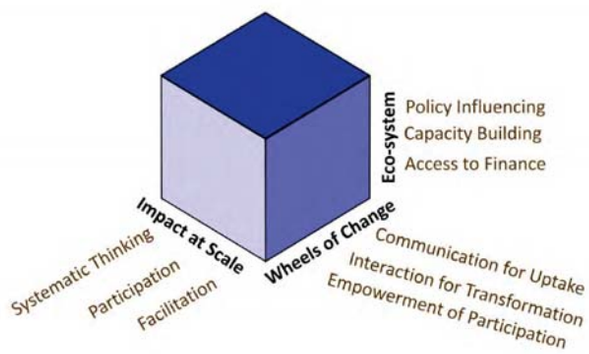

Figure 2: Project focus 3X3 PMSD approach

Conclusions and References

- **Relying on subsidies too much is not sustainable and scalable. There is a need to address real requirements and create an enabling environment where rural enterprises as well as MHPs can flourish and run sustainably and contribute to improvement of rural livelihood.**

Figure 3: project doing

Project Achievements

- Reliability of 25 MHPs improved providing reliable service to 9,571 households.
- Establishment or upgrading of 128 enterprises and 35 IGAs contributing to revenue of MHPs.
- Additional 120 HHs electrified and project to electrify additional 550 HHs initiated.
- 408 market actors trained in PMSD approach for energy based rural enterprise development.
- 475 market actors trained on technical and management aspects.
- PMSD approach has been recognised as one of the approach to promote MSME in MSME promotional guideline developed AEPC

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RESHA PIYA
reshapiya@gmail.com
Phone: 977 9851095045
Post Box: 5027 Kritipur Sadak 3, Balkhu
Kathmandu

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Europa-Universität Flensburg
Interdisciplinary Institute of Environmental, Social and Human Sciences
Department of Energy and Environmental Management

THE READINESS OF *ASEAN* MEMBER STATES IN RENEWABLE ENERGY UTILIZATION

Ir. Susy M. Simarangkir M.Sc.

Senior Advisor of ASEAN Centre for Energy

INTRODUCTION

Founded in 1967, the Association of Southeast Asian Nations comprises 10 Member States: Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand and Vietnam. With the total of population of more than 625 million or near to 9% of the world's population, and a GDP per capita of 3,831.8 USS (2013) in this region, ASEAN Member States (AMS) have been recognized as the next dynamic markets to attract investors and multinationals.

The economic growth is in close relation with energy access, and the ability to provide energy is a main factor to increase the welfare of the country. Only 1 AMS has reached 100% of electrification rate and 3 AMS are below 50%. Despite of promising RE potentials in region, all the ASEAN Member States depend heavily on fossil fuels.

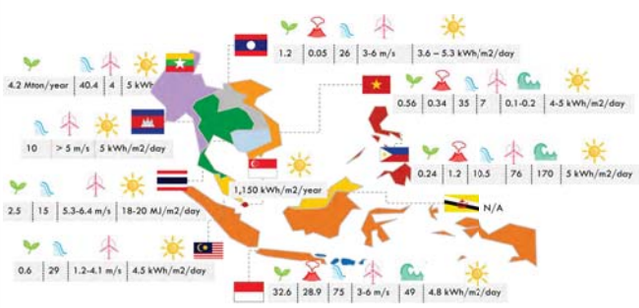

Figure 1. Renewable Energy Sources in 10 AMS
Source : ACE, 2015

AMS have looked at the importance of RE in supplying energy and also to reduce the dependency of fossil fuel. The ASEAN Plan Activities for Energy Cooperation (APAEC) is the blueprint of energy cooperation among AMS, and in APAEC 2010-2015 the installed power capacity has been determined. The new APAEC 2016-2025 is in the midst of finalization and the contribution of RE as the primary energy and as the source of electricity generation will be set to be more aggressive compared to the previous APAEC.

OBJECTIVES

- To disseminate the potential of RE and its utilization in AMS
- To review the contribution of RE in supplying energy in AMS
- To review the projection of RE contribution until 2025
- To disseminate the policy/regulation for supporting RE development in AMS

CONCLUSION

The growth of electricity generation in 2006-2012 has shown the significant role of RE to meet the electricity demand.

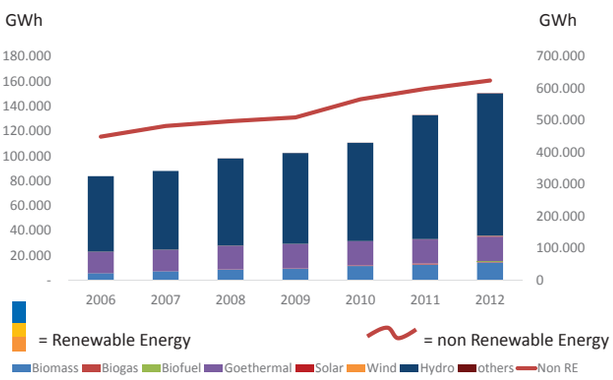

Figure 2. Electricity Generation from Renewable Energy Sources (2006-2012)
Source : ACE, 2015

In 2012, hydro power is the main source of renewable energy utilized in ASEAN in which the prominent country is Vietnam and followed by Indonesia and Lao PDR. The second position is geothermal although it is developed only in two countries; Indonesia and the Phillippines. Biomass is the main renewable energy in Thailand, followed by bydro, biogas and solar. Brunei Darussalam, well known as a fossil fuel exporter, is exploring the potential of renewable energy and has stepped into solar PV in implementation. The growth of renewable energy in the energy supply portfolio has been influencing strongly by regulation/policy and plan on renewable energy annunciated by the government of AMS.

Country	Hydro Plan/Target	FiT	Fiscal Incentives
Brunei Darussalam	-	-	-
Cambodia	√	-	-
Indonesia	√	√	√
Lao PDR	√	Drafting	√
Malaysia	√	√	√
Myanmar	√	-	-
Philippines	√	√	√
Singapore	-	-	-
Thailand	√	√	√
Vietnam	√	-	√

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Susy Marisi Simarangkir
Senior Advisor of Renewable Energy Support Programme for ASEAN (ASEAN RESP)
ASEAN Centre for Energy (ACE)
T : +62-21-5278027
E-mail : susy.simarangkir@aseanenergy.org
Skype : susyms2010

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Department of Energy and Environmental Management

Self-sustainable solar school

Arif Md. Waliullah Bhuiyan

Light of Hope

Using solar systems to provide quality education and reduce school operation cost.

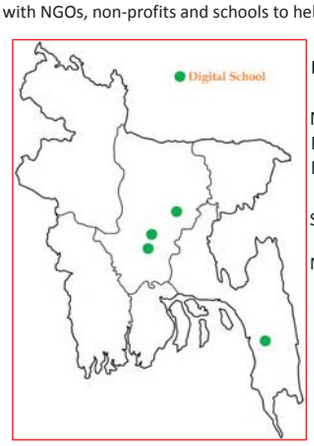
Light of Hope – a non-profit organisation in Bangladesh – developed a low-cost solar-run multimedia classroom solution for rural off-grid schools that consumes less energy than a 60W bulb. It is claimed to be the world's lowest energy consuming multimedia classroom solution capable to provide quality education through provision of e-contents developed aligned with naational curriculum.

The system consists of a laptop, a mini-projector, sound box, LED lights, solar panel, battery and other components. Light of Hope already piloted the system in 4 different schools in off-grid and semi-offgrid locations.

Now, Light of Hope is planning to develop a self-sustainable system that will not only provide quality education but also generate revenue through various services like mobile charging and internet based services.

Picture: Light of Hope's Digital School in rural areas

So far, Light of Hope supported 4 schools at different locations in Bangladesh to establish a digital classroom. Some more are in pipeline. Light of Hope is working with NGOs, non-profits and schools to help them installing the system.



Light of Hope ‚Digital School' project:

Number of school: 4
Number of students: 332
Number of teachers: 16

Solar system is installed in 5 more schools.

Mobile charging station in 1 school.

After the successful pilot project with the schools, Light of Hope is planning to incorporate income generating provision to the schools to cover the operation and maintenance cost of the system.

The services that Light of Hope is planning to provide in these off-grid areas through the schools are listed below:

1. Mobile charging facility
2. Internet use
3. Printing service

Our financial calculation and estimates show that the initial investment at the schools can be recovered within 6 years. It will vary depending on the services provided by the school.

The initial investment, revenue from the school and the operation & maintenance cost estimates are given below:

Initial investment item	Cost (€)
Laptop	400
Mini-projector	244
Solar system	555
Mobile charging station	23
Internet Modem	35
DC Printer	44
Total Investment	**1300**

Operation & Maintenance cost Item	Cost (€)
Internet bill (monthly)	15
Operator salary (monthly)	45
Laptop replacement (5 yr)	400
Battery replacement (5 yr)	250
Other replacement (10 yr)	220
Solar panel change (20 yr)	-

Investment and Operation & Maintenance cost of Digital School

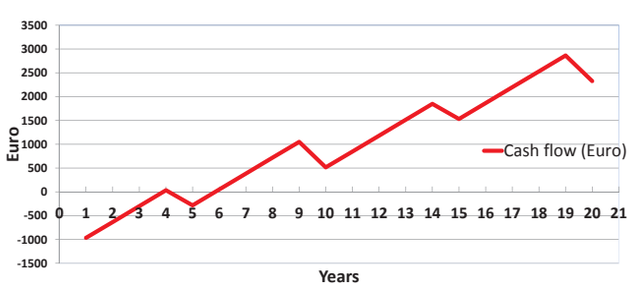
Yearly revenue from one Digital School is estimated to be 1053 euro.

Financial analysis of Light of Hope Digital school:

Intial investment: 1300 euro

Return on Investment (ROI): 6 year (assuming zero interest rate)

The graph below shows the revenue curve from the digital school.



The financial feasibility will change depending on the initial investment, which will vary for different countries, operation and maintenance cost variance and revenue potential from the locality where the school is located.

Interested to develop Digital Schools in your country?

Arif Md. Waliullah Bhuiyan
Founder & CEO, Light of Hope
Email: wali@lohbd.org
Mob: +880-1777800866
Skype: walibhuiyan
Web: www.lightofhopebd.org

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Interdisciplinary Institute of Environmental, Social and Human Sciences
Department of Energy and Environmental Management

Assessment of vulnerabilities, resilience and sustainability of rural communities' energy systems in watersheds of the Nyando river basin of Lake Victoria, Kenya

Ongor Dân Otieno
Dedan Kimathi University of Technology

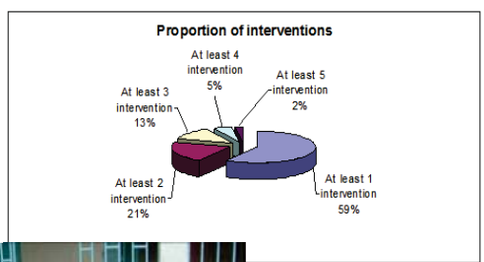
Introduction

This paper provides a participatory assessment and analysis of community and institutional roles in energy resource management, technology extension and education for community based climate change adaptation, mitigation and resilience in river watersheds of Nyando basin in Kenya. Participatory Rural Appraisal, other participatory methodologies and documented data analysis were used for vulnerability and resilience assessment of the energy systems among twenty four communities in the Nyando river sub catchments.

Objectives

- To assess energy resource production and management practices in the basin
- To determine climate change adaptation practices in energy use in households
- To assess technology transfer mechanisms and use patterns of agricultural bio residues for energy supply among small scale farmers in Nyando river basin in Kenya.

The interventions



Solar cooking in the basin

Conclusions

- The results indicate that the energy systems show varied vulnerability and community attempts to adapt new coping strategies to energy deficiency and efficiency.
- Adoption and Adaptation of improved energy interventions.
- Policy intervention should focus on enhancing efficiency on energy converter technologies.

Problem Ranking/Pair wise

Problems were ranked by the community and the PRA team.

Problems	FL	LT	WR	CY	RN	HF	LD	FW	Scores	Rank
Flood		FL	FL	FL	FL	FL	FL	FL	7	1
Latrines			WR	CX	RN	HF	LT	LT	2	6
Water				WR	WR	WR	WR	WR	6	2
Crop yield					CY	CY	CY	CY	5	3
Road network						RN	RN	RN	4	4
Health facility							HF	HF	3	5
Livestock diseases								LD	1	7
Fuel wood									0	8

KEY:

List o f Ranked Pr oblems:

1. Flood-FL
2. Water -WR
3. Crop Yield-CY
4. Road network-RN
5. Health Facility-HF
6. Latrines-LT
7. Livestock diseases-LD
8. Fuel Wood-FW

Figure above shows vulnerabilities of the basin community in Bwanda Village as ranked (Source: Author)

Discussing community energy resource map (Source: Author)

Reference

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Dan Otieno Ongor
Dedan Kimathi University of Technology
Email: danongor@yahoo.com

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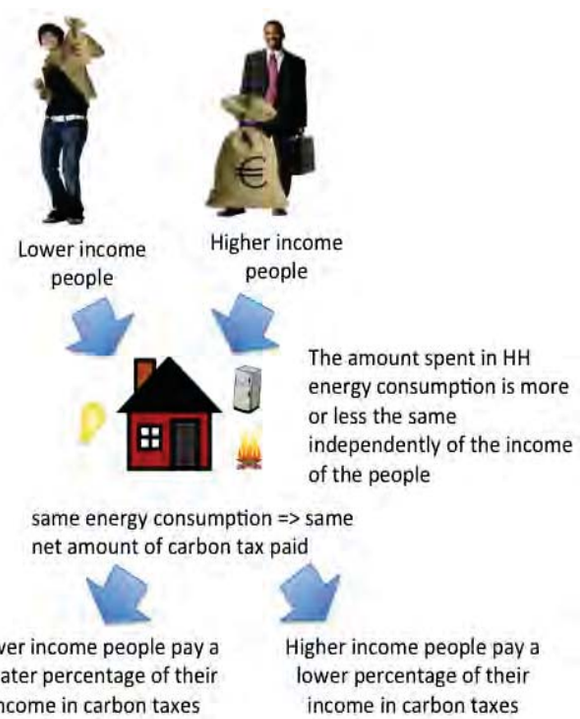
Department of Energy and Environmental Management

Social implications of taxing externalities

María Ana Gonzalez

Introduction and Objectives

- It is usually stated that externalities should be internalized in the price of fossil fuels is to reflect their environmental costs…
- However, is it socially fair?
- Who bears the mayor part of the burden of the higher energy prices?



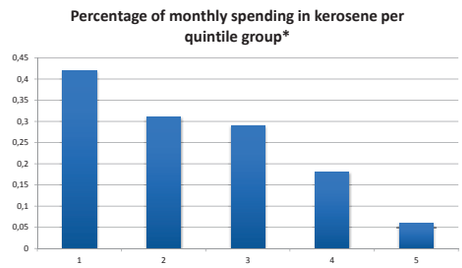
- Taxing final household energy consumption can be regressive, putting a greater burden on lower income households.

Objectives:

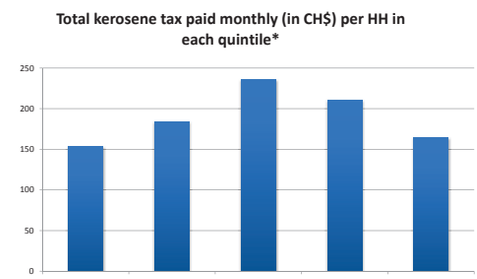
- The objective of the present paper is to discuss policies implemented in different countries suspected to have negative social impact.
- A case study will be selected to perform a numerical evaluation of the applied energy policy showing the negative social impact of its application.

Case Study and Conclusions

- Case Study: taxing of kerosene fuel in Chile.
- Kerosene is mostly used for household (HH) heating.
- The following graph shows how much of the total expenses spent in kerosene according to the quintile group, being the quintile 1 the 20% poorer and quintile 5 the 20% richer (based on income per HH):



- As kerosene is taxed at 26% of its price, it is clear from the graph above that poorer HH spend more of their expenses in paying the tax than richer HH => there is an unfair distribution of the tax on kerosene as the people with lower income bears a larger part of the burden.
- Further more, when considering the net amount paid for the tax by each quintile, this also shows an unfair distribution, being the middle classes the mostly affected as middle classes use kerosene the most and thus, they pay the higher amount of the tax:



- Conclusions: The distributional effects of carbon taxes should be studied before applying them, and in case they are considered to have regressive effects, measures should be taken to reduce them.

*Reference: Information used in the elaboration of the two graphs was sourced from document from INE (Instituto Nacional de Estadística) Chile, ("VI Encuesta de Presupuestos Familiares – Noviembre 2006 – Octubre 2007)" Vol III

Mrs. María Ana Gonzalez Casartelli
E-mail: mariaanagonzalez@yahoo.com.ar
Tel: +56 32 27 3435 2
Address: Arrieta 698, 12-C, Viña del Mar, Chile

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INCLUSIVE GREEN BUSINESS FOR BIOMASS STEAM PRODUCTION (BSP)

Tran Hai Anh

Nam Thai Nguyen Ltd. Co

The BSP project promotes inclusive green businesses of using "acacia waste wood" biomass steam for production, which generates incomes for local smallholders, reduces fuel expenses for local industries, generates jobs for local boiler manufacturers and reduce global GHGs emission. The project promotes low-carbon-industrial products as well as contribute to sustainable reforestation/afforestation in Vietnam.

The project is expected to ignite the business of generating steam from low-value plantation wood-waste and selling steam for productive uses as well to further encourage local people to do reforestation/afforestation in order to earn additional income from selling waste wood.

Reference: Innovation Norway Hanoi final application for Nordic Climate Fund's 4th Call for proposal (author: Tran Hai Anh)

Since 1980s, thanks to high productivity and soil improvement ability, plantation of acacia tree has played an important role in Vietnam poverty reduction and reforestation, which provides up to 65% of mountainous smallholder farmers' incomes. While Vietnam acacia annual production is estimated at 16-20 million tons of green wood p.a., only 50% of this figure can be used for sawlogs and pulpwood, the remain is low value waste- wood to be used for domestic cooking or abandon.

On the other hand, Vietnam production facilities are willing to shift from fossil fuels to renewable biomass which is cleaner, probably cheaper and having more diversified supply as the result of (i) the abundant of plantation biomass resource; (ii) the need of improving competiveness by reducing production cost; and (iii) the government encouragement of low carbon products.

However, the main barriers preventing using biomass as industrial fuels are (i) technology is not fully proven in Vietnam's condition; (ii) lack of initial investment capital; and (iii) it is not clear if biomass resources are stable and sufficient.

While there are a number of projects promoting generating electricity/heat from rice husk, there is no project promoting use of low-value plantation wood-waste as industrial fuels, especially no project combining the local manufacturing industrial boiler with inclusive participations from local people.

This project is initiated based on willingness of Nam Thai Nguyen to invest in an R&D project of producing biomass boilers and the need of Viet Tri paper factory to shift from coal-fired boiler(s) to biomass boiler(s).

The project promotes inclusive green businesses of using biomass steam to be produced from acacia waste wood for production, which generates incomes for local smallholders/local workers, saves fuel expenses for local producers, generates jobs for local boiler manufacturers and reduce GHGs emission.

The project is expected to ignite the business of generating steam from low-value plantation wood-waste and selling steam for productive uses as well to further encourage local people to do reforestation/afforestation in order to earn additional income from selling waste wood.

Under the project, fossil fuelled boiler(s) at a local paper factory will be replaced by biomass boiler(s) to be manufactured by Nam Thai Nguyen Ltd. Co, the local boiler maker. Furthermore, an inclusive 'acacia waste wood' supply chain, with active participation from local smallholders, will be set up; and a business model of replacing fossil boilers by biomass boilers and selling biomass- steam to local industrial producer(s) will be tried out.

This is the first time in Vietnam, the biomass boiler business is greatly combined with active participation of local smallholders. The project provides excellent linkage among green productions, sustainable reforestation, job creation and poverty reduction, which will not only bring huge benefits to the investor(s) but also generate additional incomes to local smallholders as the result of selling none-use acacia waste wood.

It is estimated that the project will generate additional incomes of €1.12 million p.a. for local people participating in the inclusive acacia waste wood supply chain as well as will yield profit of approx. €0.5 million p.a. for the investor (the payback of 1.5 years). Furthermore, 5,000 man-days p.a. will be generated for local boiler maker/operators and 53,849 tons of CO_2 emission will be reduced by 2025 as the direct result of the project implementation.

The project provides excellent linkage among green productions, sustainable reforestation, job creation and poverty reduction, which address the following development cross cutting issues:

- Enhance livelihood and poverty reduction by improving farming outcome for local smallholder farmers, especially for extremely poor people living in project sites.

- Provide excellent environmental services by encouraging acacia planation, which are preventing soil erosion, transforming denuded hills to plant-able land and providing stepping stones to reforestation.

- Increase competitiveness of Vietnam local industries by producing low carbon products.

- Competence building and job creation for local boiler makers.

- Contribute to sustainable value chain of Vietnam wood industry by turning low value waste wood to money.

- Contribute to Vietnam national energy security by increasing use of renewable energy and reducing Vietnam dependent on imported fossil fuels.

- Contribute to sustainable of Vietnam furniture industry by reducing Vietnam dependent on imported timbers.

- Contributes to Vietnam sustainable value chain of local productions such as paper, wood, etc. by producing low carbon products, by turning wood waste to energy and by promoting industrial use of renewable biomass.

- Contributes to reduce local environmental pollution caused by smokes from fossil boilers which will be replaced by least smoked biomass boilers.

The project has high possibility of replication. Vietnam paper industry, consisting of 239 factories, grows rapidly with annual growing rate of 15%-17%. In 2013, the industry produces 1.38 million tons of papers p.a., supplies 64% of the domestic demand. Of this figure, this factory production is 80,000 tons, accounting for 6% only. According to Vietnam Paper and Pulp Association (VPPA), there is huge demand of shifting from fossil fuels to wood waste, which is cleaner, probably cheaper and having shorter lead times, provided that the technology is fully proven, studies of wood waste supply are sufficient and investment documents are bankable.

If the project is successful, the project lessons learnt will be valuable to these potential biomass-steam users and local bankers. Especially, the business of selling biomass steam is more attractive for banks since the investor, cum the boiler maker, bears most of the technical and financial risks. Moreover, it is clear to local bankers where cash-flow coming from which enable banks to provide loan to green projects.

During and after this project, Nam Thai Nguyen has a plan of cooperating with VPPA to scaling up the BSP projects among its members in order to do the business of selling biomass steam. It is targeted that 36,000 tons/month of saturated steam will be sold to its customers from 2026-2019. The figure is expected to be doubled from 2019 onward.

Furthermore, the same technology is also workable for other sectors such as tobacco, foodstuff, and textile. After this project, more market survey(s) will be done in order to find out the business feasibility of selling biomass steam to these sectors.

The project is in-line with Vietnam Green Development Action Plan of promoting low carbon products, encouraging use of renewable energy and reducing 8%-10% GHGs emission p.a., which is foundation for developing Vietnam NAMA in the future.

Figure: Biomass boiler feed by wood chips – source: Nam Thai Nguyen - http://ntn.xemweb.net/index.php?mod=article&func=view&id=2569&cid=1713

Tran Hai Anh
Market Adviser – Innovation Norway Hanoi
Email: Tranh@innovationnorway.no
Mobile: +84903433318

Europa-Universität Flensburg
Interdisciplinary Institute of Environmental, Social and Human Sciences
Department of Energy and Environmental Management

Options for the Implementation of Net Metering in Honduras

Jorge Núñez

National Electric Utility of Honduras

Introduction

The electric power sector of Central America has an installed capacity of approximately 13.7 GW of which 59.1% is based on renewable energy (RE), including large hydropower plants. Costa Rica has the highest percentage of electricity generation coming from renewable energy with 89.7%, followed by Guatemala with 69.6%. Honduras has a RE share of 40.6%. The electricity coverage reaches almost 90% or more in most of the countries with the exception of Nicaragua with 75.8%.

The most common energy policies, worldwide, to scale up the deployment of renewable energy generation systems are feed-in tariffs, tax incentives, quotas, and net metering. The Honduran Government supported the installation of utility-scale photovoltaic power plants, up to a cumulative capacity of 300 MW until the year 2015, through economic incentives by the Decree No. 138-2013, an amendment to the Renewable Energy Law (Decree No. 70-2007). The Electric Power Industry Law of Honduras (Decree No. 404-2013) requires the electric utility to use net metering for residential and commercial customers who have self-generating systems based on RE.

Figure: Timeline of main regulations in force ruling renewable energy in Honduras.

Under a net metering scheme, customers with renewable power plants can feed their electricity surplus into the grid. How is it offset? If imported electricity > exported electricity ⇒ the net electricity consumption has to be paid. If imported electricity < exported electricity ⇒ a compensation (either an energy credit or an economic credit) is given in the following month.

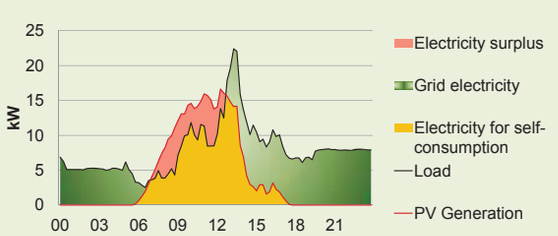

Figure: Customer with a photovoltaic system of 30.5 kW_p delivering electricity excess to the grid.

While the Honduran regulation in force already defines that an economic credit must be used as compensation, the absence of a more detailed regulation prevents its application to date.

Objectives

Provide design options for the implementation of net metering in Honduras based on the Central American experience. The work is aimed to cover various net metering regulations in terms of:

- eligibility,
- compensation,
- billing cycle,
- grid usage, and
- interconnection rules.

Findings

Provision		Costa Rica		Guatemala	Panama
Eligibility	Voltage level	≤ 1000 V	> 1000 V and ≤100 kV	No restriction	< 115 kV
	Maximum capacity	≤ 100 kVA	> 100 kVA and ≤ 1000 kVA	No restriction	≤ 500 kW
Compensation		energy credit		energy credit	energy credit
Banking period		one year		unlimited	one year
Grid usage payment		yes, kWh basis		yes, for rates based only on kWh	no
Interconnection rules	Personal safety	Electrical Code of Costa Rica		not specifically defined	Electrical Code of Panama
	Island operation	not allowed	allowed	not allowed	not specifically defined
	Protective relaying	yes, by request		yes	not specifically defined
	Power quality compliance	Power Quality Standard (AR-NT-SUCAL)		Technical Standard for Distribution (NTSD)	Power Quality Standard (AN No.6001-ELEC)
	Disconnecting device	yes, by mutual agreement		not specifically defined	yes, by mutual agreement

Table: Summary of net metering provisions in Central America (selected).

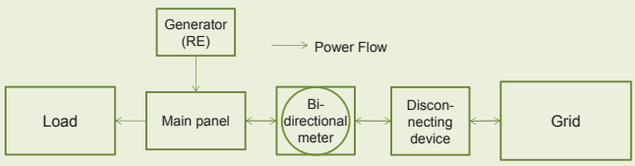

Figure: Electrical system, including an optional disconnecting device, for users with self-generation connected to the grid.

Conclusions

In Central America, net metering schemes allow a wide range of utility customers with RE generation systems. Country-specific regulations can restrict the power plant capacity by means of individual or added installation caps. The net electricity surplus is commonly compensated with an energy credit; however, grid usage can be charged to customers. In addition, the accumulated surplus could be rewarded at the end of a year. Interconnection technical rules deal with personal safety, operational safety, and power quality issues.

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Jorge Orlando Núñez Pagoaga
Empresa Nacional de Energía Eléctrica
Res. El Trapiche, MAFERSA building, 4th Floor
Tegucigalpa, Honduras
Phone: +504 98273838
E-mail: jorge.pagoaga@yahoo.com

Europa-Universität Flensburg
Interdisciplinary Institute of Environmental, Social and Human Sciences
Department of Energy and Environmental Management

Energy Management Practice in Developing Countries: A Review of Kenya's Policy, Regulatory and Institutional Framework

Kimari Maina Patrick

Member, Association of Energy Engineers, Registered Professional Engineer (Kenya) and Licensed Energy Auditor (Kenya)

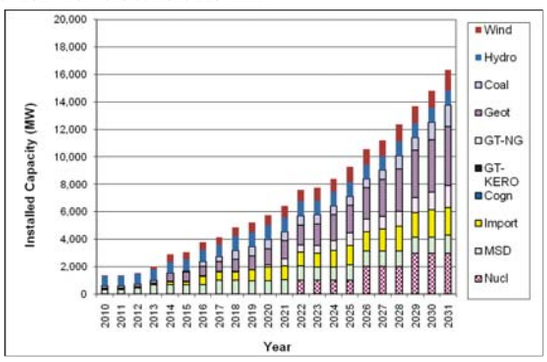
Introduction and Objectives

Energy management practice in developing countries such as Kenya is informed by markedly different variables as compared to factors that inform energy management practice in developed economies.

In developing and economies in transition such as Kenya, the driving force of the energy system is the quest to fill the wide gap between energy demanded and what is supplied.

In their quest to improve the living and economic conditions of their populace, developing economies places greater emphasis on increasing their installed electrical power generation capacity and exploitation of other non-electrical energy sources such as fossil fuels and biomass.

In the case of Kenya, the country is implementing an ambitious programme to triple the country's grid connected installed power capacity to 6000MW by the year 2017 from the current 2294MW.



Even though Kenya plans to add approximately 5000MW of additional generating capacity by 2018 as it implements different phases of the country's Least Cost Power Development Plan (LCPDP) 2011-2031; since 2012 there has been a change of approach to the country's power sector and the wider energy field development through incorporation of energy management in the country's energy planning.

To lower Kenya's energy consumption while maintaining same level of output and comfort, the country came up with a number of policy, regulatory and institutional framework to guide the process.

This paper therefore explores in depth the policy, regulatory and institutional framework that guides energy management in Kenya. In particular the paper looks at the following policy documents: Session Paper Number 4 of 2004 section 5.6 and Section 6.6.6, Energy (Energy Management) Regulations 2012, Energy Acts 2006, Sections 104, 105 and 106 and Energy (Solar Water Heating) Regulations, 2012.

The paper takes a snap shot of the current status in terms of operationalization, effectiveness and challenges facing the implementation of the various policies. Legal structures put in place to enforce the policies and implementing institutions are also explored.

The paper is a product of desktop study of publicly available and private literature on the topic. To validate the information, a number of face to face , telephone and email conversations were carried out.

Conclusion and References

Kenya's ministry of Energy and Petroleum (MoE&P) through the Energy Regulatory Commission (ERC) one of its agencies, is currently implementing a number of energy management programs aimed at curtailing the ever increasing demand for additional power generation in the country.

At household level, working in collaboration with the government owned power distribution utility company-Kenya Power Company, the two have been distributing for free, compact fluorescent lamps (CFL) and Light Emitting Diodes (LED) lamps.

At commercial level, in its execution of the Energy Act (No. 12 of 2006), the Energy Regulatory Commission (ERC), in the year 2012, enacted, the Energy (Solar Water Heating) Regulations, 2012, which makes it mandatory for owners of commercial and public institutions such as hotels, motels and schools to install solar water heating systems to provide at least 60% of their hot water demand on annual basis. Penalty for non-compliance with the regulation is the premises disconnection from national grid power and/or imprisonment.

On the other hand, The Energy (Energy Management) Regulations, 2012, also a section of the Energy Act (No. 12 of 2006), calls for mandatory energy audit of public institutions, commercial and industrial concerns that consumes 180,001kWh or 648,004MJ of energy (electric or thermal) per year. The law came into effect in September 2012 and there are more than 3300 facilities regulated by it.

Under the regulations, the facilities are supposed to have carried out the mandatory energy audit by September 2015 to avoid the penalties imposed by the law. Under the mandatory energy management program for medium to heavy energy consumers, the government expects to save between 25MW-30MW of power per year.

But the country is experiencing a shortage of professionals to carry out the audits. Currently there are about 10 licensed energy auditing firms with individual licensed energy auditors being less than 50. Evidently the September deadline is not tenable.

Just like the Solar Water Heating regulations whose deadline for implementation expired in May 2014 with less than 30% compliance levels and no prosecution carried out so far for non-compliance, the Energy Management Regulations 2012, risks suffering the same fate of being a piece of legislation that is good on paper but hard to enforce or achieve its intended purpose and objectives.

It is the government's expectation that all these measures will lead to considerable reduction in energy demand in the country based on current consumption levels thus reducing pressure on the need for new power generation capacity.

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Eng. Kimari Maina Patrick
Dedan Kimathi University of Technology
P.O Box 657-10100 Nyeri
KENYA
Patrick.kimari@dkut.ac.k
e kimarip@yahoo.com

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Europa-Universität Flensburg
Interdisciplinary Institute of Environmental, Social and Human Sciences
Department of Energy and Environmental Management

IMPLEMENTATION OF SOLAR ENERGY SYSTEMS FOR COMMUNITY RESILIENCE IN COLOMBIA. CASE STUDY: SAN VICENTE DEL CAGUAN

Johana Rivera Forero[1] , Juan Fernando Higuita[2]

[1] Associated Professor University EAN, Bogotá, Colombia

Industrial Engineer, Project Management specialist, M.Eng. Energy And Environmental Management, Project Management Doctorate Programme candidate.

[2] Computer Science Engineer, M.Eng. Energy and Environmental Management. Professional in Solar Energy Projects at EPM utility company Medellín, Colombia.

Introduction & Results

GENERAL ABSTRACT

- Colombia has an 1.141.748 km² surface.
- The national Interconnected electricity system (NIS) covers 34% of total country area, non-interconnected zones (NIZ) -66%.
- Currently, most of the NIZ (96,3%) are using diesel generators for producing energy, service is costly, people have to pay twice as much as in NIS and this is a limited service for an average of 6 hours per day. (Florez, Tobón. y Castillo, 2009).

- ***Stakeholders*** : National government, public utilities and private companies, communities at non-interconnected areas.

PROBLEM

¿How to implement solar energy systems for community resilience in off grid areas in Colombia?

METHODOLOGY

Primary sources were analyzed, such as: interviews, photos and project information mainly from the public utility (EPM). Through a deductive analysis, a methodology is formulated for implementation of solar energy systems in off grid areas in Colombia.

RESULTS

First among the main results, a replicable methodology is formulated for implementation of solar energy systems in NIZ, based on other similar pioneer projects and literature review:

0. Characterization
1. Planning,
2. Social and environmental benefits
3. Preliminary protocol
4. Community Strategy empowerment
5. Building Social and Technical capacity
6. Environmental aspects
7. Installment
8. Commissioning & Operation
9. Monitoring

Location: San Vicente Caguán (south Colombia)

Beneficiaries:	Number of households	Number of inhabitants
	100	479

Household appliances provided: TV, radio, mobile phone charger, electrical water purifiers, lighting, refrigerator, electricity connection and electrical cabinets. 2 solar panels of 300 peak watts per family, household appliances are DC systems.

(GAIA S.A.S, 2015)

Conclusions & Recommendations

1. There are particular conditions for NIZ, they are spread, far from cities, in remote areas, highly biodiverse, costly electricity fees and with few energy services, goods and services demand.
2. There are solutions like solar energy systems for Colombian communities that allow to build community resilience, economic and technical capacity to improve their life quality and adaptation to climate change.
3. Monitoring phase would give more data for ex-post evaluation.
4. Community resilience was a positive influence in terms of building social capacity, strengthening economic sustainability for energy systems management, increasing energy independency and delivering more tools for adaptation to climate change.
5. Social component for Colombian NIZ communities is the most important of all above.
6. Supplier development is essential to guarantee quality and cost effective solutions.
7. A success key is to work in communities with at least a basic participative structure and sense of community ownership.
8. Robust technological items are essential for rural applications.
9. In order to develop Colombian territory in the Post-conflict age, local and sustainable solutions are required to bring opportunities to all Colombian people.

Committee creation record signed by community members.

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Johana Rivera Forero
johanariveraforero@gmail.com
Skype. Tutorajohanarivera.

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Department of Energy and Environmental Management

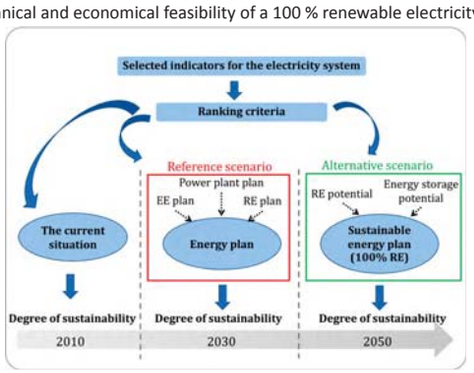
Shaping the electricity system of Thailand towards sustainability

Pitoon Junthip

Department of Energy and Environmental Management, University of Flensburg

Introduction:

In Thailand, many people may doubt about how to measure the degree of sustainability in the electricity system and a possibility of promoting a 100% renewable electricity system. The concept of this research is to select indicators and determine criteria to assess the degree of sustainability for the electricity system in the current situation, energy plan and alternative scenario, to consider a technical and economical feasibility of a 100 % renewable electricity system.

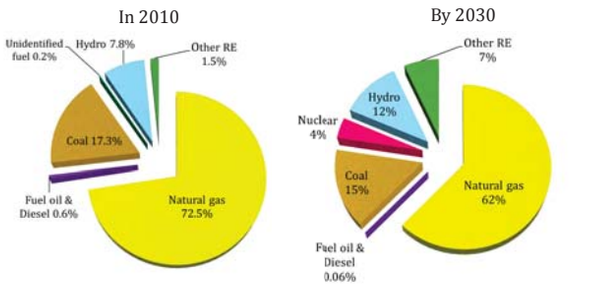


Objectives:

- to assess the degree of sustainability for the electricity system in the current situation, energy plan and proposed scenario.
- to propose an alternative scenario of promoting a 100 % renewable electricity system by 2050 for Thailand.

Key findings:

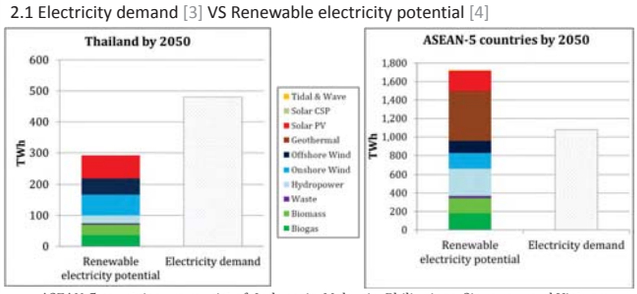
1. The electricity generation between the current situation [1] and energy plan [2]



Total generation amounted to 161 TWh. Total generation will amount to 389 TWh.

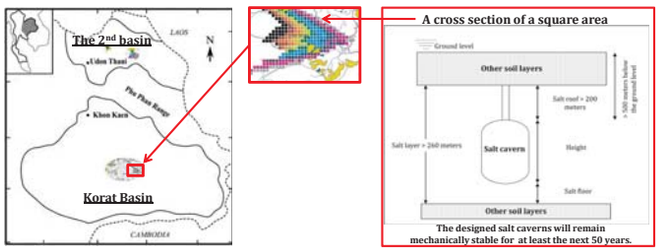
2. Alternative scenario towards a 100 % renewable electricity system

2.1 Electricity demand [3] VS Renewable electricity potential [4]



ASEAN-5 countries are consist of: Indonesia, Malaysia, Philippines, Singapore and Vietnam.

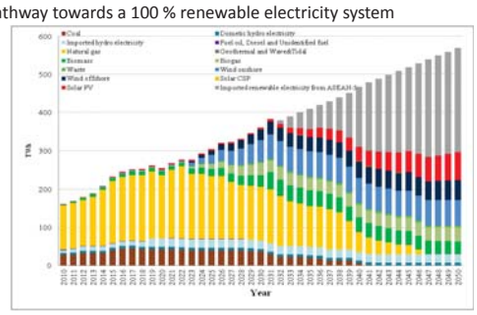
2.2 Salt cavern potential of Thailand [5]



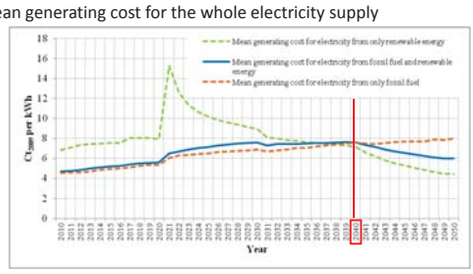
2.3 Energy storage potential for AA-CAES [6]

Final summary of AA-CAES potential	A single cavern	A double cavern
Number of salt caverns (caverns)	958	1,916
Total volume of salt caverns (million cu.m)	350	700
Energy storage potential for AA-CAES (TWh)	59	118

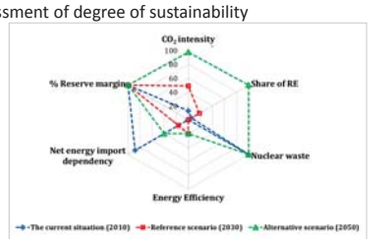
2.4 The pathway towards a 100 % renewable electricity system



2.5 The mean generating cost for the whole electricity supply



2.6 The final assessment of degree of sustainability



Conclusion:

- It is possible to promote a 100 % renewable electricity system by 2050.
- There is no need to promote new nuclear power plant suggested in the energy plan.
- The proposed scenario is more sustainable than both the current situation and energy plan.

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More information:
Mr.Pitoon Junthip
E-mail: pitoon_jun@yahoo.com
Mobile phone: +66-87595-2555
190/2 M.4, T.Maemao, A.Maemao, Lampang 52220
Thailand

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Europa-Universität Flensburg
Interdisciplinary Institute of Environmental, Social and Human Sciences
Department of Energy and Environmental Management

Increasing Nutrition Security through Greenhouses in the High Himalayas

Yogi Kayastha

Nepal Greenhouse Promotion Programme

Introduction

- Greenhouse promotion programme started in 2010 in remote high Himalayan region (Humla district).
- Beneficiaries: People living in an altitude between 2000 m to 4200m in the Himalayan region of Humla, Dolpo, Helambu & Everest region.
- Few types of green vegetables available only during 5 months of a year before greenhouse was introduced.
- People were very thin, lacked many important vitamins and minerals, and growth of children very slow.

Objectives

- Provide access to many different green vegetables to families living in high Himalayan region throughout the year.
- Introduce new nutritious vegetables which do not grow under normal condition in high Himalayas.
- Increase intake of nutritious food by the people living in high Himalayan region and thus improve their health.
- Increase income of families by selling vegetables during harsh Himalayan winter.

Methodology

- Programme provides locally unavailable materials and families have to contribute locally available resourses such as rocks, timber, labour etc.
- Cost of greenhouse materials (16x30 ft Silpauline plastic, nuts, bolts, handle, lock, hinge, garden pipe, water can etc) approx $80 and transportation cost range between $20 - $50.
- Cost of rocks and timber needed to build 15x30 ft greenhouse varies from $150 (Helambu) to $500 (Limi valley in Humla and in Upper Dolpo).
- Programme provides greenhouse materials, training, greenhouse construction & operation manual, seeds of vegetables.
- Supervision during construction and advises on management and operation of greenhouses to farmers.

Results

- Over 450 families have access to green vegetables year round.
- Total of 450 greenhouses built in Humla, Helambu and Everest region providing nutrition security to over 6000 people.
- Families with greenhouse earning from $ 200 to $1500 per year by selling vegetables grown inside greenhouse.
- Greenhouse owners in remote villages using bartering system of green vegetabels, e.g. exchanging vegetables grown inside greenhouse with basic commodities such as salt, suger, oil, etc.

Greenhouse Support Programme
The Development Fund Norway
Kathmandu, Nepal
Mobile: +977-9848 30 47 42
Email: yogi.kayastha@gmail.com

Europa-Universität Flensburg
Interdisciplinary Institute of Environmental, Social and Human Sciences
Department of Energy and Environmental Management

Community based waste to energy

S.M. Zahid Hasan

towards sustainability

Waste to energy project in Keraniganj addressing communal resilience

Waste disposal is an emerging problem in almost all urban areas of Bangladesh including semi-urban area, Keraniganj, an outskirt of Dhaka City. Success stories of managing municipal waste in a meaningful way for its transformation to energy and environmental value product is still absent. The major causes so far addressed by interest groups are technological, management and project implementation failure or lack of initiatives, project financing etc. A decentralized communal approach for waste to energy generation, management system and end use for the betterment of waste disposal, its value chain and environmental benefits in Keraniganj is not yet examined. **It is to be noted that decentralized plant has a positive effect on regional development (jobs, fiscal revenues, decentralized energy solution). This study examines possibility and addresses a communal approach for waste to energy solution towards sustainability considering communal resilience.**

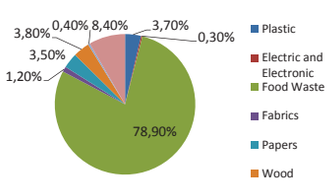
Picture 1 : River side waste dumping

Picture 2 : Waste handling in Keraniganj

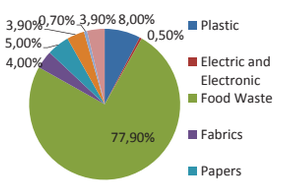
The specific objectives are to Identify the sources of solid waste and its physical composition, major dumping sites and rough estimation of waste amount; to oversee existing system and find out partner organizations working on waste management and their mutual connectivity. To recommend suitable technology for waste to energy and power evacuation sustainably considering communal resilience, improved technological and management system and bi-product utilization pattern.

The waste collection system is underdeveloped and feedstock availability and logistics are not up to the mark in Keraniganj. Waste Concern Group, a social business enterprise prepared a database on waste generation and composition of urban areas in Bangladesh. For Keraniganj waste data analysis, this comparable data is used. The daily household waste generation considering 2.5 M population is 600 MT and Commercial waste 1,000 MT can be estimated. **So, total generated waste amount is 1,600 MT per day. Considering landfilling, recycling and other uses (agricultural, construction etc.) the roughly estimated disposable waste amount potential is around 200 MT/day for waste to energy project and using this waste a 5~7 MW capacity combined heat and power project based on dry fermentation biogas plant can be installed.** The capacity could be varied on moisture content in the waste and or on choice of technology. **Firstly, as a pilot phase using 6-8 dry box fermenters and about 60 MT HH and commercial waste around 1 MW energy can be generated and finally after successful piloting multiplication of dry box fermenters could be possible to generate more energy.**

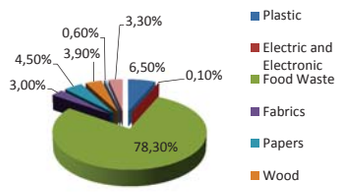
The waste composition can be estimated according to Waste Concern (2015) as described in Picture 3 and 4.



Picture 3: HH waste Composition comparable to Keraniganj (Waste concern, 2015)

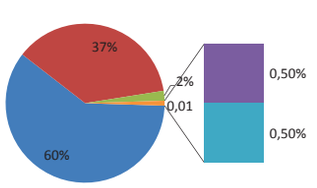


Picture 4: Composition of commercial waste in regions comparable to Keraniganj, Waste Concern (2015))

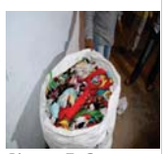


Picture 5: Composition of Landfill Waste in area comparable to Keraniganj, Waste Concern (2015)

In Keraniganj textile waste is generated from 5,985 small and medium garment factories and 58 large garment factories (BBS, 2013). While two thirds of the textile waste generated is delivered to the recycling industry up to 10 MT of textile waste (2-3 trucks per day), which is approximately 3,650 MT per year, is disposed at the dump sites. Insofar the potential of textile waste for thermal treatment is much higher and can be achievable through implementing waste incineration plant, Refused Derived Fuel (RDF) production and by motivating Garments owners/workers to supply garment wastes for proposed project.



Picture 6: Composition of Garment Waste



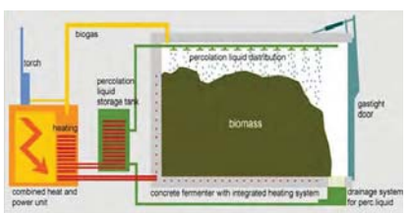
Picture 7: Garment Waste

As per perception developed by this pre-feasibility study, possible scenarios for the implementation of a Waste to Energy Pilot Plant in Keraniganj can be;

Scenario-1: Implementation of a biogas plant (dry fermentation) for household waste, market waste and commercial waste from restaurants, hotels or comparable organic wastes. Waste heat could be used for heating HFO at nearby Power Plant or for Compost fertilizer processing.

Scenario-2: RDF-generation from textile waste, screened overflow of compost production and comparable high-calorific wastes to co-incinerate it in brick kilns could cut GHGs emissions significantly.

Dry box system fermenter seems to be the best option in Keraniganj. A detailed feasibility study is recommended for piloting such project.



Picture 8: Single stage fermentation process scheme (BEKON, 2009)

Picture 9 : Box Fermenter, Saalfeld (Germany) (http://www.bekon.eu/files/Media/Referenzen

Are you ready to use waste in a meaningful way at your community?

S.M. Zahid Hasan
Executive Engineer, BPDB
Email: sumon233@yahoo.com
Mob: +880-1552-464524
Skype: zahid.de
Web: www.bpdb.gov.bd

Europa-Universität Flensburg
Interdisciplinary Institute of Environmental, Social and Human Sciences
Department of Energy and Environmental Management

Solar Garment - Business Model and Current Status

Kandasamy Ravikumar

Mahatma Gandhi Institute for Rural Industrialisation, Wardha, India

BACKGROUND

The usage of a charkha (manual spinning wheel) is a common practice within rural India to produce Khadi (hand-spun clothes) and of it is associated with Mahatma Gandhi's vision for a self-reliant village economy which can change the economic conditions of the rural masses through employment generation and use of locally available resources. Currently Khadi is facing problems of non availability of spinners and weavers due to low wages, human tragery.

The Mahatma Gandhi Institute for Rural Industrialization (MGIRI) is an institution formed with the vision to accelerate the process of rural industrialization in the country. MGIRI is trying to address the problem through innovative usage of solar technology in the decentralized production of garments. It has developed and tested an entire range of solar technologies which are involved in Khadi production (solar charkha, solar power loom and solar cone). Studies have been conducted as field trials, pilot projects and feasible business model development has been initiated by GIZ, India in 2012 for implementation through Ministry of New and Renewable Energy (MNRE), Govt of India in two phases on the feasibilities of implementing technologies for Solar Garment industries and developing business models for further promotions.

KEY OUTCOMES:

Feasibility Report assessed the feasibility of utilizing solar powered garment manufacturing technologies as means for increasing business opportunities with a value addition for small local entrepreneurs within the cotton producing regions of Maharashtra, where farmers commit suicide due to poor economic conditions.

The key factors working in favor of the technology are its increased productivity, reduction in drudgery and improved earnings for the workers.

The key challenge that the model faces is product positioning. For this purpose three independent models (Independent Spinner, Independent Weaver, Independent Garment maker) and four composite model (Composite model of Solar Loom+ Solar Charkha-(ASHTI MODEL), Composite model of Solar Loom+ Solar Charkha + Solar Sewing machine, Composite model of Solar Loom+ Solar Sewing machine ,Composite model of Solar Charkha + handloom) were assessed for their feasibility

Thus, the solar technology has feasibility scope in all existing independent and composite models except the proposed independent spinner model.

After establishing the feasibility, business plan has been developed in phase II of the project.

PHASE II: BUSINESS PLAN DEVELOPMENT

KEY OBJECTIVE: Develop a business plan for a rural entrepreneur identified by MGIRI for piloting solar garment cluster within the region and thus reduce the drudgery of the spinners and enhance productivity and wages and create entrepreneurial models for production of 'Solar Garment' which is marketable.

PURPOSE OF BUSINESS PLAN

Few of the social and financial objectives that an entrepreneur should follow are as following

Employment Generation

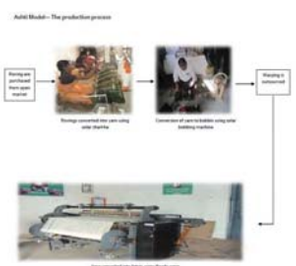
Empowerment and Gender equality

Drudgery

Profitability

WHOM DOES IT TARGET: This document aimed at developing a business plan for a generic entrepreneur, who decides to setup a solar unit for fabric production using the solar charkha as well as the solar loom adopting the MGIRI technologies.

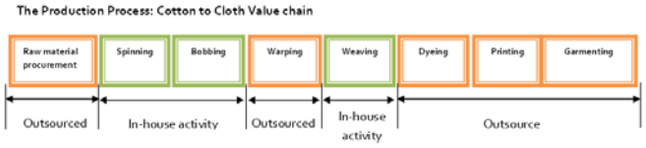
Asti Model: The working model in Asti, which was established by dynamic entrepreneur with the help of MGIRI, has been studied and based on that the business models have been proposed.



Proposed Business Model 1

This model can be applied on any existing charkha or loom for producing the solar garment at very low power consumption. The major purpose of developing the solar charkha and loom is to reduce the drudgery among the spinning and weaving community

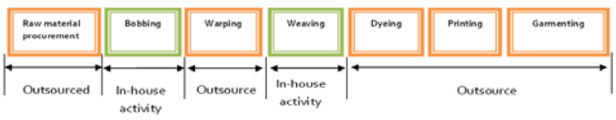
The Production Process: Cotton to Cloth Value chain



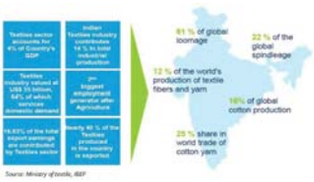
Proposed Business Model 2

It is all about the use of solar technology on looms. This model has been derived from an understanding of creating a business opportunity for the entrepreneur who wants to set up this technology particularly on loom and can earn the profit.

The Production Process: Cotton to Cloth Value chain



CURRENT STATUS OF TEXTILE INDUSTRIES IN INDIA



PROPOSED ENTERPRISE MARKETING STRATEGY

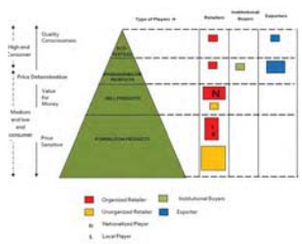
The evaluation of various positioning platform for the product suggests that "Solar Garment" is the unique and most suitable positioning platform.

Positioning Platform	Rationale	Risk Associated	Likely Outcome
Khadi	Use of charkha and handloom operated by one artisan	Machine involved, violation of definition	Low acceptability
Handloom	Use of hand loom operated by one artisan	Machine involved, violation of definition	Low acceptability
Solar garment	Solar energy used which is eco friendly	New concept , needs huge efforts in positioning, may command little premium than green garment	High acceptability
Green cloth (zero carbon, zero chemical)	Use of solar power and natural dyes makes it eco friendly, can command high premium	Raw material not made from organic cotton, may not be accepted as eco friendly unless all processes conform	Moderate acceptability
Pure cotton garment	Uses only cotton for production	Undifferentiated products , Competition with power loom, lowers profitability	Moderate Acceptability

Customer Segment	Customer profile	Type of Market	Challenges
Retailers	• Unorganized (Maharashtra emporium)	Local/regional	• Meeting design & specification requirement • Selling at lower price
	• Organized (Vaniveilasa, Fab India)	National / Regional	• Meeting design & specification, • High quality requirement
Institutional buyers (large)	• Railways, Defense, health department etc,	National / Regional	• Meeting design & specification, • High quality requirement
Small institutional buyers	• Khadi institutions • Hospitals, Schools, hotels	Local/regional	• Quality consistence • Timely delivery
Exporters	Export houses, Institutions	International	• Meeting design & specification, • High quality requirement

EXISTING MARKET SEGMENTS

The current trend indicates that the Solar Garments have huge potential for export.



KEY CONCLUSIONS

- The key factors working in favour of the technology are its increased productivity, reduction in drudgery and improved earnings for the workers.
- The current pilot model is not viable due to high cost of production vis a vis price of output it can command in regional market
- We propose a solar garment unit (Model 1 or Model 2) to be set up to run the unit profitably
- We recommend the pilot being extended to more entrepreneurs to develop a solar garment cluster in the region. The generic entrepreneurs should be encouraged to take up the pilots.

- Tie ups for capacity building, marketing of products, raw material and outsourced production processes.
- The business model carries maximum risk in terms of marketing linkages followed by technology roll out
- Also, the solar fabric has promise of success in domestic and export market provided right product positioning is created.
- The solar technology has shown that it can reduce the drudgery levels of spinner and weaver significantly by reducing their physical involvement to a large extent. This can revive the interest of artisan who abandoned it due to drudgery and low returns.
- The solar garment being new entrant in market lack identity of its own. Unique positioning is critical to command premium and a precondition to gain desired acceptance among retailers and prospective consumers.

CURRENT STATUS OF THE BUSINESS MODEL

Many more pilot projects have been developed in Karnataka, Tamilnadu, Bihar, Gujarat and many parts of Maharashtra.

In Bihar, India one of the Khadi Institution has installed 100 Solar Charkhas and planned to supply yarn to handloom sector and later wanted to extend the business model for garment manufacturing.

Initiation has been taken by the Ministry of MSME promoting the Solar Charkha through PMEGP Scheme with a target of installing 500,000 solar charkhas in all over India in few years with a plan of supplying yarn to Handloom sector in collaboration with Ministry of Textiles, Ministry of New and Renewable Energy (MNRE)

Private players are also showing interest in implementing Solar power loom in North Eastern and Southern states

Reference:

DPR developed by REI Division of MGIRI, July 2011

GIZ Report on Business Plan for Decentralised Solar Technology based Garment manufacturing units in Vidarbha Region of Maharashtra, August 2012.

Ravikumar Kandasamy
Deputy Director (Rural Energy&Infrastructure)
Mahatma Gandhi Institute for Rural Industrialisation (MGIRI)
Maganwadi, Wardha-442001, India
Tel 0091 9423885810
Email : karavikumar@gmail.com (or) karavikumar@yahoo.com
Web: www.mgiri.org

Europa-Universität Flensburg
Interdisciplinary Institute of Environmental, Social and Human Sciences
Department of Energy and Environmental Management

Cross Border Power Trade in South Asia: Opportunities and Challenges for Nepal

Pushkar Manandhar

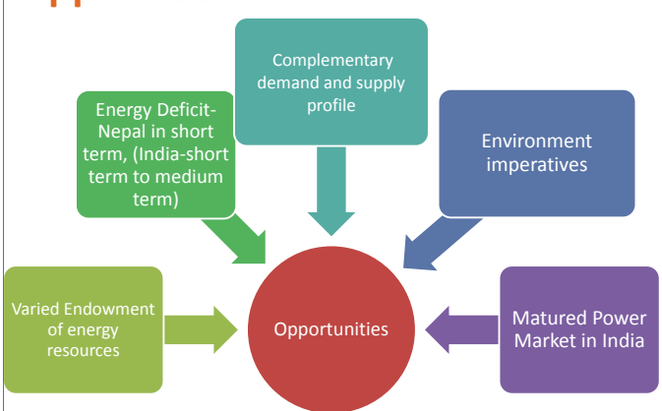
Introduction:

- Huge hydropower generation potential- 42000 MW commercial potential against current max peak demand of 1291 MW.
- Compounded annual growth rate (CAGR) of electricity demand from 2007-08 to 2013-14: 9%
- CAGR for electricity generation has been only 4.3% ➡ Increased electricity shortage.
- Import of power from India as short tem measure to fill the gap in supply and demand of electricity.
- Exporting Power to India would be essential to maximize the exploitation of hydropower resources for economic development of Nepal.

Objectives:

Objectives: To access opportunities and challenge for Nepal in deepening economic cooperation with India though cross border power trading.

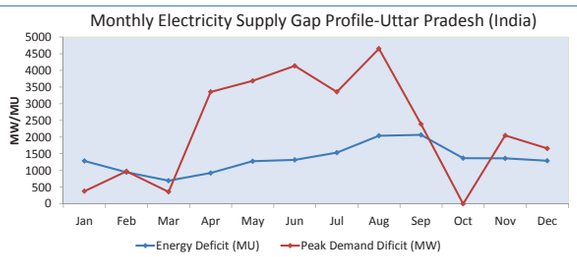
Opportunities:

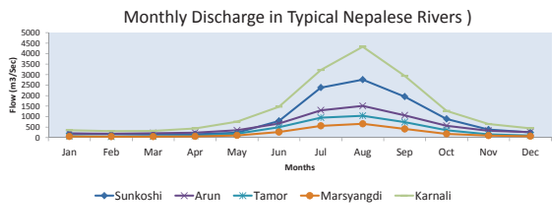


And more importantly

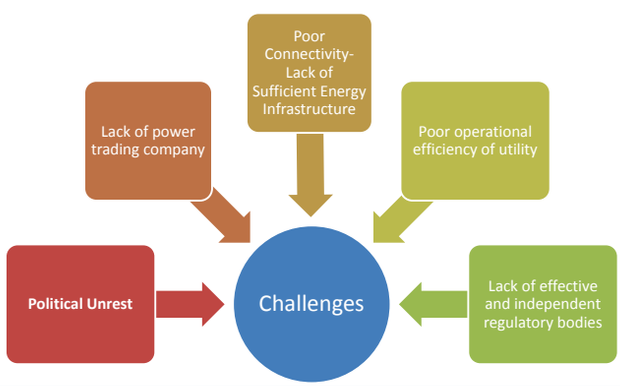
Enabling Political environment:

- *Signing of long awaited landmark power trading agreement was signed between Nepal and India*
- *Signing of SAARC SAARC Framework Agreement for Energy Cooperation (Electricity).*





Challenges:



Priorities Domestic Actions:

- Strengthen in-country transmission links;
- Enhance operational efficiency of utility
- Create sound legal framework- Enact New electricity act and Nepal Regulatory Commission Act
- Create efficient and independent regulatory body
- Harmonization- Regulatory requirement and technical standards

Pushkar Manandhar
pmanandhar@gmail.com
Phone: +977 9851121960

Europa-Universität Flensburg
Interdisciplinary Institute of Environmental, Social and Human Sciences
Department of Energy and Environmental Management

Participants Alumni Workshop 2015

Last Name	First Name	Country
Distel	Diego Alejandro	Argentine
Quintana	Edgardo Alejandro	Argentine
Bhuiyan	Arif Md. Waliullah	Bangladesh
HASAN	S.M. ZAHID	Bangladesh
Sambore	Yacouba	Burkina Faso
Gonzalez Casartelli	Maria Ana	Chile
Hu	Qiying	China
RIVERA FORERO	LADY JOHANA	Colombia
Lossley	Jorge	Costa Rica
Rumler	Nele	Germany
HERVIE	EVANS MENSAH	Ghana
Nyaku	Joseph	Ghana
Núñez Pagoaga	Jorge Orlando	Honduras
Ravikumar	Kandasamy	Indian
Doctor-Pingel	Mona	Indien
Balamatti	Arun	Indien
Sari	Arum	Indonesia
Simarangkir	Susy	Indonesia
Budiman	Abdul Hamid	Indonesia
LYDIE	KAMDOM	Kameroon
Michelle	Akute	Kenia
KIMARI	MAINA PATRICK	Kenia
ONG'OR	DAN OTIENO	Kenia
Mosqueda	Elizabeth	Mexiko
Maw	Mi Mi	Myanmar
Bohara	Anita	Nepal
Piya Shrestha	Resha	Nepal
Maskey	Muhan	Nepal
Chaulagain	Dr. Narayan Prasad	Nepal
Manandhar	Pushkar	Nepal
Kayastha	Yogendra	Nepal

ANOWAI	CHINWE	Nigeria
Hararap	Fumi	Schweden
Junthip	Pitoon	Thailand
Komakech-Akena	Alexander	Uganda
Ngo Thi To	Nhien	Vietnam
Hai Anh		Vietnam