ECOLOGICAL FOOTPRINT OF SLEAT

Universität Flensburg

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EXECUTIVE SUMMARY

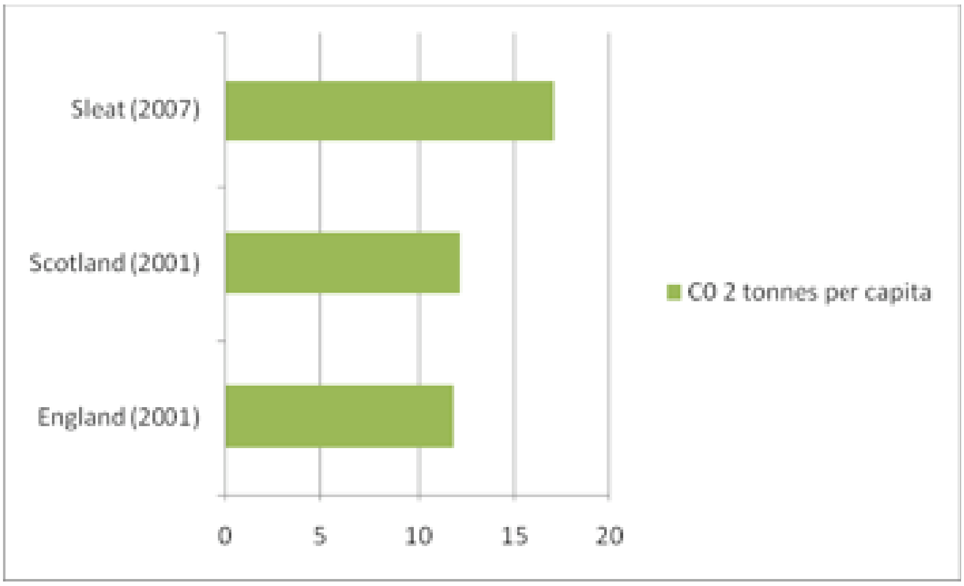
The ecological footprint of Sleat Peninsula was conducted by SESAM students from the University of Flensburg (Germany) in coordination with the Highland and Island Community Energy Company (HICEC) and the Sleat Community Trust (SCT). The aim of the study was to determine the ecological footprint of Sleat Peninsula and develop and assess alternative scenarios towards sustainability.

The ecological footprint is a sustainability indicator, which expresses the relationship between humans and the natural environment. The ecological footprint accounts the use of natural resources by a region's population. It considers the amount of productive land and water ecosystems in hectares with an average global biocapacity (gha) that Sleat requires to provide the goods and services that it consumes and to assimilate the wastes that it produces.

This study also emphasised on the CO_2 emissions (Carbon footprint). It focused on direct energy, water, transportation, material, waste and food. The following were the findings of the study:

Ecological Footprint

- The total ecological footprint for Sleat in 2007 was 4,927.49 gha which translates to 5.82 gha per capita.
- The total CO_2 emissions (carbon footprint) were 14,397 tonnes or 17 tonnes per capita.



Comparison of CO_2 emissions with other countries

The figure compares CO_2 emissions of Sleat with that of Scotland and England 2001.

Direct energy

- The total consumption of direct energy was 16.6 GWh of direct energy.
- The annual CO_2 emissions from direct energy use were 4,283 tonnes.
- The ecological footprint for direct energy was 971 gha (1.147 gha per capita)

Water

- The total water consumption was 130.10 mega litres.
- The energy required to supply and treat waste water was 168,730 kWh
- The total CO_2 emissions from water supply were 72.10 tonnes (0.085 tonnes per capita).
- The ecological footprint of water supply was 15.39 gha (0.02 per capita)

Transportation

- The total kilometers travelled by car, public transport and air were over 14 million.
- The total CO_2 emissions from transportation were 4,044 tonnes (4.77 tonnes per capita).
- The ecological footprint of transport was 1,330 gha (1.57 gha per capita).

Material

- The CO_2 emissions from material were 4,511 tonnes (5.3 tonnes per capita).
- The total material ecological footprint was 970 gha (1.15 gha per capita).

Waste

- The total waste generated was 475 tonnes.
- The CO_2 emissions from waste were 837 tonnes (0.99 tonnes per capita).
- The total ecological footprint of waste was 764 gha (0.90 gha per capita).

Food

- The total food consumption was 483 tonnes
- The CO_2 emissions from food were 650 tonnes (0.77 tonnes per capita).
- The ecological footprint for food was 1,033 gha (1.03 gha per capita)

Several scenarios were developed to show the impacts of future options on ecological and carbon footprint. The next below shows the summarized impacts of these scenarios.

Summary Impacts of Scenarios

Scenario	CO2 saving (tonnes)	Carbon footprint reduction (%)
	Direct Energy	
Biomass Heating for college and part of residential homes	485	11% of total energy footprint
Small Embedded Generation from wind energy	113	3% of total energy footprint
	Transportation	
Car Sharing 4 people	1,110	27% of total transport footprint
Car Sharing 3 people	986	24% of total transport footprint
Car Sharing 2 people	740	18% of total transport footprint
Better shopping and service facilities in Sleat	145	4% of total transport footprint
Fuel switch to LPG for cars which travel more than 35,000 km per year	219	5% of total transport footprint
	Waste	
Highland Targets of waste management (13% composting, 23 % recycling, 27% waste to energy)	140	17% of total waste footprint
Centralized Composting Plant	171	20% of total waste footprint

Source: SESAM, 2008

A scenario with a wind farm of 5 MW capacity was simulated to see its benefits in CO_2 savings. However, due to the responsibility principle of the study, the CO_2 savings are shared among all users of electricity. This gives minimal savings when distributed to all users. If the CO_2 saving is attributed to Sleat residents, the carbon footprint can be reduced substantially. The above scenarios illustrate the potential of different options for reducing the ecological and carbon footprint of Sleat. They represent only a certain set of options that aim to include some of the most feasible in both short and medium term solution.

As the ecological footprint is a useful indicator and monitoring tool to measure the progress of the community towards sustainability over time, it can be used to raise awareness among the members of the community on the impacts of their consumption.

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LIST OF ABBREVIATIONS

CFL : Compact Florescent Lamp
CO_2 : Carbon Dioxide
DEFRA : Department for Environment, Food and Rural Affairs
ECIP : European Common Indicator Programme
EFW : Energy from waste
EF : Ecological Footprint
GEMIS : Total Emission Model of Integrated Systems
GIS : Geographic Information
HICEC : Highland and Islands Community Energy Company
IEA : International Energy Agency
IPCC : International Panel for Climate Change
LPG : Liquid Petroleum Gas
MSW : Municipal Solid Waste
RCV : Refuse Collection Vehicle
SCT : Sleat Community Trust
SEPA : Scottish Environment Protection Agency
SESAM : Sustainable Energy System and Management
SMO : Sabhal Mor Ostaig
WWF : World Wide Fund for Nature
UK : United Kingdom

LIST OF UNITS

t : tonnes

m^2	:	Square meter
MJ	:	Mega Joule
l	:	Litre
gha	:	Global hectare
ha	:	Hectare
KJ	:	Kilo Joule
Km	:	Kilometer
KWh	:	Kilowatt hour

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CHAPTER 1: INTRODUCTION

Background of the study

The Sleat peninsula comprises of the south eastern tip of the Isle of Skye in the Highland council area of Scotland. The population of Sleat in 2007 was 847 with 378 households[1]. The Sleat Community Trust (SCT) was set up in September 2003. The main objective of the Trust is to identify the needs and aspirations of local residents and lead the sustainable regeneration of the community[2].

MAP OF SLEAT PENINSULA

There are several Trust' projects in progress which include woodchip supply company, and community wind energy development. The Trust was interested to find out the impacts of the community's current energy consumption and related CO2 emissions on the environment as well as the contribution of their projects to overall sustainability.

The Trust contacted the Highland and Islands Community Energy Company (HICEC) for assistance in conducting the ecological footprint study with emphasis on the Carbon footprint. Apart from determining the ecological footprint of the Sleat peninsula, the objective of the study was to develop and assess alternatives scenarios towards sustainability.

On invitation by HICEC, the study was done by students of the department of Sustainable Energy Systems and Management (SESAM) of the University of Flensburg, Germany in collaboration with the Sleat Community Trust. The SESAM students conducted the study from 16 February to 19

[1] Adapted from Sleat Community Trust, 2005, p.5

[2] www.sleatcommunitytrust.co.uk, printed on 10.03.2008

March, 2008.

CHAPTER 2: ECOLOGICAL FOOTPRINT

The ecological footprint is a sustainability indicator, which expresses the relationship between humans and their natural environment. The Ecological Footprint (EF) is a resource accounting tool, like a bank statement, that tell us on one hand how many resources do we have and on the other hand how many of these resources do we use. That means on one hand we have our capital which is our ecological assets and on the other hand is our expenditure (our production and consumption). The ecological footprint then helps us to see to what extent we are dipping to the overall capital or to what extent we are living within the means that nature provides us. “The Ecological Footprint account documents how much of the annual regenerative capacity of the biosphere, expressed in mutually exclusive hectares of biologically productive land or sea area, is required to renew the resource throughput of a defined population in a given year, with the prevailing technology and resource management of that year”[3].

The largest share of the ecological footprint is caused by direct and indirect energy consumption, also known by most people as the carbon footprint. Carbon footprint has become a widely used term and concept in many public debates and is mainly associated with the threat of global climate change. Though widely used there is still some confusion on what it really means and what it measures and what unit is to be used[4]. Without a well defined methodology this makes carbon footprint almost impossible to compare as it is still not clear on what to include and exclude with such an approach.

The Global Footprint Network[5] interprets the Carbon footprint as a synonym for the 'fossil fuel footprint' or the demand on 'CO_2 area' or 'CO_2 land',where CO_2 land[6] refers to the land (mainly forest land) needed to absorb that fraction of fossil CO_2 that is not absorbed by the ocean.

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[3] Wackernagel et al, 2005, p. 4

[4] Wiedmann et al 2007, p. 2

[5] Global footprint network is an organization which is in forefront of Ecological footprint.

[6] http://www.footprintnetwork.org/gfn_sub.php?content=glossary, printed on 10.03.2008

Wiedmann (2007) defines carbon footprint as “a measure of the exclusive total amount of carbon dioxide emissions that is directly and indirectly caused by an activity or is accumulated over the life stages of a product”[7]. This definition is widely compatible with the well defined ecological footprint methodology. Wiedmann proposes to express the carbon footprint in tonnes of CO_2. In our study we expressed the carbon footprint in both, global hectares and tonnes of CO_2.

The methodological approach of the ecological footprint has been well defined and developed with clear standards over the past decade. Moreover the ecological footprint is broader, than a pure carbon footprint and gives a holistic picture of humanity’s demands on the biosphere. Rather than concentrating only on the land needed to sequester CO_2, the ecological footprint goes much further in considering the total land area much essential for human survival.

The basic understanding behind the concept of the ecological footprint is that the Earth’s land area is of an absolute and limited magnitude, whereas the number of human beings is increasing, as well as the use of land associated with all human activities. All human activities require the use of land, primarily biologically productive land, on both local and global levels. Therefore rather than asking how many people the earth can support, the footprint analysis ask how much land is needed to support humanity[8]. Biologically productive land provides the majority of the earth’s biomass and concentrates the bulk of the biosphere’s regenerative capacity. In 2003 this land was estimated to be only 11.2 billion hectares or roughly one quarter of the earth’s surface. Where arable land is only 10%, forest and woodlands are 33%, pasture land is 23% and build land constitute only 2%. The remaining surface area consists of lower productivity categories including deserts, polar ice caps, and deep oceans, which is about 32%.[9]

Hence, to calculate the ecological footprint, the land and sea area of a community or nation is divided into different basic types[10]; these are:

1. Bioproductive land; this is land required to produce crops, grazing (pasture), timber (forest) etc. The use of these land types is usually calculated separately, using the following three sub-categories:

    a) Arable or crop land

    b) Pasture land

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[7] Ibid p.4

[8] Wackernagel et al (2000), p. 60

[9] Wackernagel et al, (2005) p. 8

[10] Chambers et al. 2000, p.62

c) Forested land

2. Bioproductive sea and inland space; area required to supply fish and seafood.
3. Built land; this is land used for buildings, roads and all other infrastructure.
4. Energy land (land and sea area required for the absorption of carbon emissions)
5. Biodiversity land (area of land and water that would need to be set-aside to preserve biodiversity)

In an ecological footprint analysis the land necessary for the protection of biological diversity is often set at 12 per cent of the total consumption of land, according to recommendations from the World Commission's report "Our Common Future" (1987)[11].

BOX 2.1

Example 1:

A cooked meal of fish and potatoes would require arable land to grow the potatoes, bioproductive Sea land to provide the fish, and 'energy' land to re-absorb the carbon emitted during processing and cooking.

Example 2:

Driving a car requires built land for roads, and parking the car, as well as 'energy' land (forested area) to reabsorb the carbon emissions generated from fuel use. In addition, energy and materials are used for construction and maintenance of the vehicle.

To make possible comparisons between countries, which have different bioproductive capabilities, the ecological footprint is expressed in a standard unit of global hectares (gha). One global hectare is equivalent to one hectare of biologically productive space with world average productivity. Two conversion factors are used to standardize local hectares into global hectares.

1. Yield Factor; this factor accounts for the differences between countries in the productivity of a given land type. Each country has its own yield factors, one for each land type of productive area and it varies each year[12]. This factor is much dependent on the local yield.
2. Equivalence factor; this factor captures the productivity difference among land-use categories, for instance arable land has a higher productivity than the other land types. This factor is the same for each land type across the globe and is different for each year.

[11] Chambers, 2000, P. 65

[12] Wackernagel et al, (2005) Pg. 11

Table 2.1

Example: Sheep rearing on 1 ha pasture land in Scotland

Physical area:	1 ha	
Equivalence factor:	0.49	1 ha of pasture land in Scotland has the same productivity as 0.49 ha world average arable land
Yield factor	2.7	Scottish farmers rear 2.7 times the number of sheep of world average farmers
Footprint	1.39 gha	0.49*2.7*1ha

The Ecological Footprint relies on two fundamental concepts: the *ecological footprint* itself, and the *biocapacity*. In more economic terms, these would correspond respectively to human demand on the environment, and to the environmental supply. Biocapacity or biological capacity is defined as the capacity of ecosystems to produce useful biological materials and to absorb waste materials generated by humans, using current management schemes and extraction technologies[13]. Hence biocapacity refers to the bioproductive supply that is available within a certain area.

Once the ecological footprint is calculated a sustainability assessment is carried out. This is done by comparing the footprint with available biocapacity. By comparing the ecological footprint (demand) with biocapacity (supply) it is possible to assess the ecological sustainability of current consumption[14].

When the total calculated Footprint is compared with the total biocapacity, this reveals whether existing natural capital is sufficient to support consumption and production patterns. If the calculated Footprint of a population exceeds total biocapacity available, to support that population it means that, that a country or population runs what is called an ecological deficit. This basically means that the area or the country's area alone cannot meet its population's consumption demand. Conversely, an ecological reserve exists when the biocapacity of a region exceeds its population's Footprint. Generally, an ecological deficit means that a country is either importing biocapacity through trade or liquidating its ecological assets[15]. In a modern economy it cannot be expected that each area meets its population's demand. An urban area with a high population density will always have a footprint that is larger than its biocapacity, while rural areas require a biocapacity that is larger than its footprint to support the urban population.

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[13] http://www.footprintnetwork.org/gfn_sub.php?content=glossary 10.03.2008

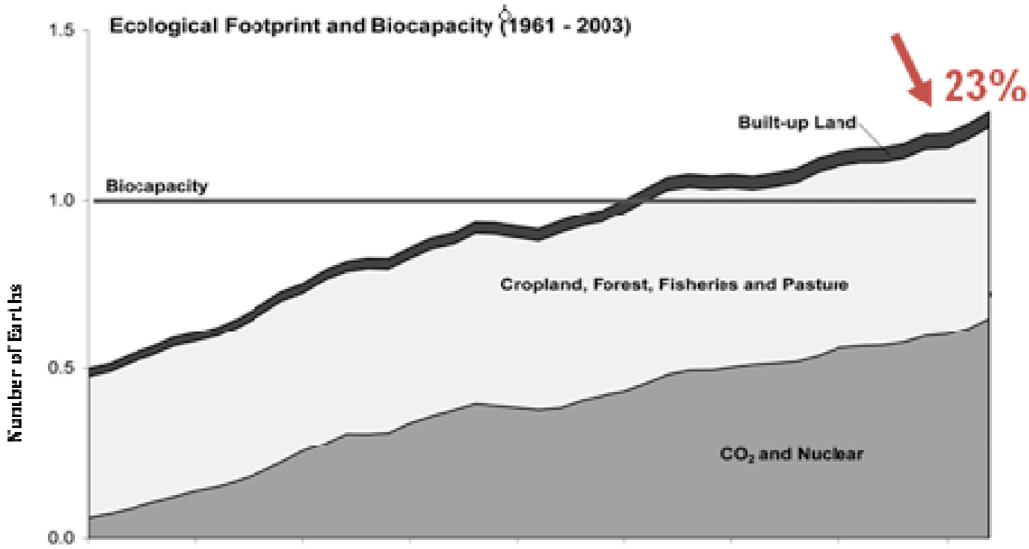
[14] Chambers et al 2004 p. 58

[15] Wackernagel et al 2005, p. 19

On the other hand if Ecological deficits is not balanced through trade it means local demand is met through the overuse of domestic resources, resulting in degraded cropland and grazing land, depleted fisheries, degraded forests, and the accumulation of carbon emissions in the global atmosphere. This phenomenon is called ecological overshoot, which basically refers to a state in which biological resources are used more rapidly than the biosphere can replenish them or assimilate their waste, thereby violating the principle of strong sustainability[16].

Biological capacity can also be expressed per person (*or* per capita): For instance there were 11.2 billion hectares of biologically productive land and water on this planet in 2003[17] and the available global biocapacity per capita was 1.8 hectares. This figure is also known as the *fair earth share,* as it indicates the average amount of biocapacity available on this planet per person. However in the same year the global Ecological Footprint was 14.1 billion global hectares, or 2.2 global hectares per person[18]. This shows an overshoot of 23%. The global ecological footprint for 2003 is show in Figure 2.1.

Figure 2.1 World Ecological Footprint 2003



Source: Wackernagel et al, (2007), Vol: 4 No: 1 pg 2

Humanity's footprint first grew larger than global biocapacity in the 1990's. This overshoot has been increasing every year since, with demand exceeding supply by about 23 % in 2003. This means that it took approximately a year and three months for the Earth to produce the ecological resources we used in that year. The CO_2 footprint, also called carbon footprint, from the use of

16 Ibid p. 20

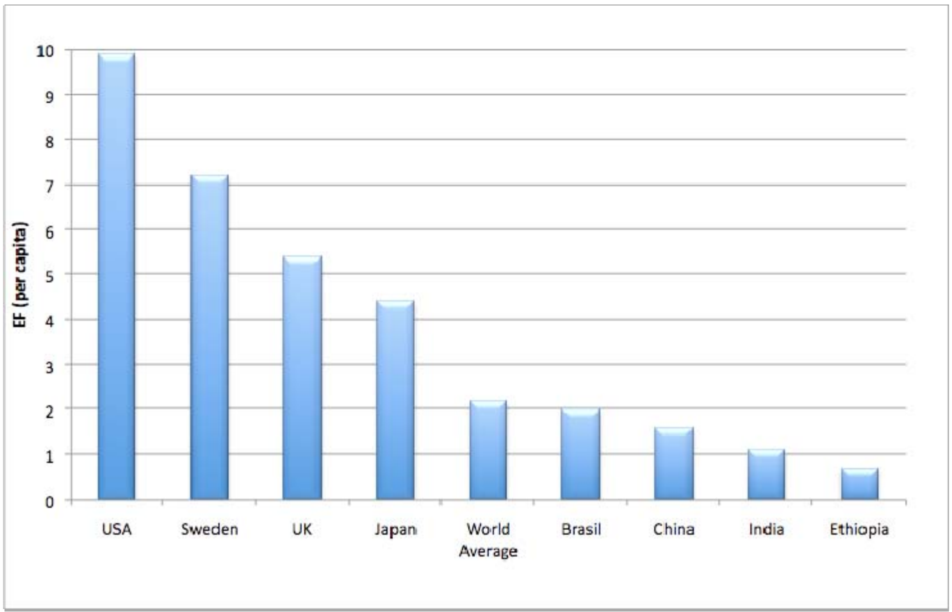
17 Wackernagel et al, 2005, p. 4

18 Living Planet Report, p.14

fossil fuels, was the fastest growing component, increasing more than nine times from 1961 to 2003.

What is more interesting is to note the global inequality that exists among nations in terms of ecological impact. The footprint analyses of nations shows that a disproportionate amount of productive area is required to support the lifestyles of those in industrialized countries. The largest portion of the ecological footprint of these nations is mainly due to the high energy consumption. Energy is the drive engine of the economies of these countries and the CO_2 emissions from the energy activities makes up more than half of the total ecological footprint. The ecological footprint of selected countries is shown in Figure 2.2.

Figure 2.2 Ecological Footprint of Selected Countries (2001)



Source: Birch et al 2006

2.1 Calculation Methods

Two distinct methods are used for calculating Ecological Footprints: component-based and compound Foot printing[19]. The component-based method is a bottom up, approach. It sums up all the Ecological Footprints of all relevant components of a population's resource consumption and waste production. This is achieved by first breaking down the resource flow into different components and identifying all the individual items, and amounts thereof, that a given population consumes, and second, assessing the Ecological Footprint of each component using life-cycle data.

[19] Wackernagel et al, 2005

Meanwhile the compound method is a top down approach. This method uses national production, as well as import and export data to determine the total consumption of a nation and thereof calculating the footprint. Hence it is mainly used on the level of areas where such statistical data are available (i.e nations, regions, districts). However this method faces the challenges of data availability at local community levels like Sleat where exports and imports of goods and services are not available.

2.2 Boundaries

The ecological footprint analysis faces boundary issues in relation to what to include and what to exclude. Therefore it is important to define the boundaries of the ecological footprint clearly so that the range of activities included in each study is clearly understood. Moreover this is essential in order to compare any footprint study with other footprint studies. The selection of study boundaries depends strongly on the specific goals of the Footprint study. There are two principles of defining a boundary of the study.

1. Geographical (administrative) boundaries – This is based on whether the study should calculate footprints within the geographical or administrative border. In this case this means all activities that occur within the geographical boundaries of that community or country.
2. Responsibility boundaries - Based on the consumption of local residents regardless of where it occurs either within the boarders or outside.

Table 2.2

Examples for boundary issues

	Geographical boundaries	**Responsibility boundaries**
Sleat resident uses train from Mallaig to Fort William	Footprint is attributed to Lochaber area	Footprint is attributed to Sleat
Slaughter house in Inverness	Footprint is attributed to Inverness	Footprint is shared among all communities served by the slaughter house.
Coal power plant in London	Footprint is attributed to London	Footprint shared among all electricity consumers in England

Problem: It is not always possible to stick 100% to one approach. Consumption by tourists for example is always difficult to completely separate from that of residents. Consumption of a small business that provides service to customers outside the region is difficult to separate from the residential consumption of its owner.

2.3 Double Counting

Double counting is one of the common mistakes which should be avoided when calculating the ecological footprint. Double counting refers to counting the impact of the same product or service more than once. For instance if the total energy consumption of a nation is already calculated, accounting for the energy used to supply and treat water would in this case result into double counting. Similarly, if food consumption of a local restaurant has already been captured it will be double counting if eating out of the local residents is also taken into account. In order not to exaggerate human demand on nature, it is important to be more than careful to avoid double counting.

CHAPTER 3: METHODOLOGY OF THE STUDY

This chapter discusses the methodology that was used for this study. The reference year for the study was 2007. All formulas and conversion factors which were used for calculating the ecological footprint are attached as Annexes 2 and 3.

3.1 Approach and methods

The Ecological Footprint of Sleat was calculated mainly using the component method. However, the compound method was used where statistical data was available. Both methods are explained in Chapter 2.

The impact areas according to activities were divided into Direct Energy, Water, Transportation, Material, Waste and Food. The component method was used to calculate the footprint of the Direct Energy, Transportation, Food and Material, where local data was collected though questionnaires. Waste and Water footprint were calculated using the compound method with statistical data for Sleat from the Municipal Waste department of Highland Council and Scottish Water respectively.

Ecological supply or biocapacity was calculated for the Sleat Peninsula according to defined land types – Arable, Pasture, Sea land, Forest and Built-up Land.

3.2 Defining boundaries

The responsibility principle was applied to define the boundaries of this study. As explained in Chapter 2, this means that all consumption of Sleat residents is attributable to the Sleat area. Therefore, the consumption of Sleat residents when they are outside Sleat is still part of their ecological footprint.

According to Scotland's footprint study conducted in 2004, the responsibility principle is compatible with other global, regional, city studies, and sustainability assessments using the average earth share[20]. In addition, based on the European Common Indicators[21] emissions (especially CO_2) generated by a community has to be considered both inside and outside the area.

Tourism is one of the main activities in Sleat Peninsula. It was not possible to completely separate consumption of tourists from that of residents. Therefore, a part of the ecological footprint of Sleat is attributable to tourists. Box 3.2 explains how tourists' consumption was estimated.

BOX 3.2
Tourists' food consumption was separated from resident's consumption in hotels. The average tourist food consumption was assumed to be similar with resident's daily food consumption. The total tourist food consumption was calculated by multiplying total number of bed nights in hotels with the average daily food consumption. The tourists' food consumption was deducted from the total food consumption in Sleat. Part of Sleat direct energy consumption, waste and water attributable to tourist could not be separated.

The Table 3.1 explains what was included and excluded in Sleat ecological footprint for 2007:

Table 3.1

Categories Included and Not Included in the Study

	Included	**Not Included**
Direct Energy (excluding transport) and Water	• Energy and water consumption within Sleat region in all sectors. • Energy and Water consumption of tourist staying in hotels, B&B and self catering accommodation	• Energy and water consumption of Sleat resident outside Sleat boundaries. • Domestic water, which is provided through local sources.
Transportation	•All modes of travel of Sleat residents	•Tourist transportation to and within Sleat
Material	• Long lifetime material consumption within Sleat region in all sectors. Short lifetime material considered under waste. • The material required for infrastructure both private (new houses) and shared e.g. road	

[20] Best Food Forward, 2004, p.59

[21] It is a tool for sustainable policy making for urban and local perspective in European Union.

Table 3.1

Categories Included and Not Included in the Study

Waste	• Waste generation within Sleat region in all sectors. • Waste treatment outside Sleat boundaries	• Bulk waste (considered as material). • Construction waste(assumed to be reused). • The specific waste produced by commercial sector which are not collected by Municipal Solid Waste (MSW)
Food	• Food consumption by resident and tourist within Sleat. • Average eating outside by Sleat resident.	• Food consumption of self catering tourist.

Source: SESAM, 2008

3.3 Data collection

The required data to calculate the ecological footprint of Sleat Community was collected under the following categories

- Direct energy
- Water
- Transportation
- Material
- Waste
- Food

Data was gathered by using extended (more detailed) and brief (short and less detailed) questionnaires. The extended questionnaire was used to collect detailed information on the above categories and it was administered through face to face interview. The brief questionnaire was used to get information on key questions to cover a wider section of Sleat Community. Both questionnaires are attached as Annexes 1.1 and 1.2.

The brief questionnaires were sent out to 320 households through post. Out of the 320 brief questionnaires, 55 were returned. Face to Face Interviews were done using extended questionnaires. The sample for the interview was selected randomly according to the household size and house type. 58 households were interviewed using extended questionnaires. Therefore, the total sample size was 113 which represent 30% of the total.

Data was also collected from primary school, college, medical centre, hotels and small businesses utilising specific detailed questionnaires. Two hotels out of 5 and 8 small businesses were interviewed. Data from households and hotels was extrapolated to derive the total consumption respectively. Specific data sources on the different categories are mentioned in Chapter 3.5.

3.4 Major assumptions and limitations

Assumptions:

- 12% of the total biocapacity was set apart for the other species as biodiversity area as explained in chapter 2.
- The fuel consumption and mileage of diesel boats was very minimal hence it was included in the diesel cars.
- The household bin waste composition was assumed to be similar with that of the Highlands.
- The recycled waste composition was assumed to be similar with that of Skye and Lochalsch.
- Holiday cottages were assumed to be heated to 14 degrees when they are not occupied.
- Tourists' daily food consumption was assumed to be same as that of residents.

Limitations:

- Data on residential energy consumption and transport is largely based on the experience of the residents over the past year. It can therefore be assumed that these data rather represent average data over the past years than data of 2007.
- Information from some of the major hotels was not provided. Therefore information for these hotels was extrapolated from that of hotels which responded to the questionnaire.

3.5 Biocapacity

Biocapacity is expressed as local or global average biocapacity. The global average biocapacity is referred to as the average 'earthshare' which is 1.8 gha per capita as explained in Chapter 2. The local biocapacity of Sleat is calculated in this study.

Data Sources

The following data sources were used to collect required data.

Table 3.2
List of Data Source

Data on:	Source:
Total land area of Sleat	Highlands and Islands Enterprise, Community land unit, GIS maps and “KMAP mapping tool”, 2007
Forest land in Sleat	Forestry Commission; “Forest Research, Biometrics, Surveys and Statistics” - Division Woodlands, “Land Cover Scotland project”, 2002
Built land in Sleat	Highlands and Islands Enterprise, Community land unit, “Ordnance Survey Strategy Small Urban Areas”, 2007
Cropland in Sleat	Skye Forum, “Isle of Skye data atlas”, p.137
Inland water in Sleat	Highlands and Islands Enterprise, Community land unit, “Ordnance Survey Strategy Inland Water”, 2007
Sea land of Sleat	Derived from “Best Foot Forward Island State – An Ecological Footprint Analysis of the Isle of Wight, p.35
Equivalence factor	National Footprint Accounts comments October-November 2007
Yield factor for pasture land in Sleat	Information from local farmers
Yield factor for the rest of the land types	Best Foot Forward, 2004 (Scotland Footprint), 2002

The local biocapacity of Sleat has been estimated by following the steps.

1. The different land use types within Sleat Peninsula were defined by using the area types used in the *National Footprint Accounts* of other regions in Scotland.
2. The total area of each type of land use was determined with information from sources mentioned above. The pasture land area was derived as a difference between the total land area in Sleat and the total area of cropland, forest, built land, and inland water.
3. Both equivalence and yield factors were then applied to each land use type, in order to convert the physical available area of each land use type into global hectares (gha).

3.6 Categories

3.6.1 Direct Energy

Direct energy includes energy used by households, hotels, small businesses, college, primary school and medical centre used for;

- Lighting
- Space and water heating
- Electrical appliances, communication and entertainment
- Stationary machines

The direct energy sources used in Sleat include electricity, Liquefied Petroleum Gas (LPG), Oil, Wood, Coal and Peat.

Data Sources

The data on direct energy gathered from the questionnaire provided details on the fuel types used in Sleat. This data was collected on units of energy consumption or expenditure on the energy. The information on the expenditure was converted into consumption units using the average unit price. All energy consumptions were converted into the standard unit of kilowatt hours (kWh). Conversion figures were obtained from the Inter-governmental Panel for Climate Change (IPCC). CO_2 emissions related to direct energy sources in Scotland were obtained from Scottish Energy Study[22]. The Conversion factors and CO_2 emission factor are given in the Table 3.3.

Table 3.3
Conversion Factor and CO_2 Emission Factor

Energy Source	Conversion Factor	Unit	Kg CO2 per kWh
Electricity			0.41
LPG	7.4	kWh/litre	0.19
Oil	10.8	kWh/litre	0.26
Wood	3,055.6	kWh/tonne	-
Coal	6,154.5	kWh/tonne	0.30
Peat	2,711.1	kWh/tonne	0.38

Source: Compiled from IPCC and Scottish Energy Study

[22] Scottish Energy Study, 2006, p.23

CO_2 emissions due to direct energy use were calculated according to the fuel type. The data on the sustainable yield of forest in Sleat was taken from the Renewable Energy Study of Sleat[23]. The embodied energy for the fuel wood, wood chip and the wind turbine were taken from the GEMIS 4.2 software developed by Oeko Institute in 2004[24].

Direct Energy Ecological Footprint Calculation

Direct energy consumption in the footprint calculation for each sector was done by the fuel type and related CO_2 emission. The energy land (forest area) required to sequester CO_2 emissions from the direct energy use was calculated.

The embodied energy is the sum of all energy inputs used during all stages of a product's entire life cycle, e.g. the embodied energy of wood chips is the energy used to harvest, chip and transport wood chip.

The embodied energy for fuel wood, wood chip and wind turbine are used to calculate the energy land requirement to sequester CO_2 emissions.

Additionally, the fuel wood and wood chip require area to grow, which is calculated taking into account sustainable yield of forest. Similarly the wind turbines need area for their foundation and access road.

The sum of land requirements gives the total ecological footprint for direct energy. The mass of CO_2 emissions from electricity generation, combustion of fossil energy carriers and the embodied energy of fuel wood, woodchips, wind turbine represent the carbon footprint.

3.6.2 Water

The water component includes energy required to supply water, treat wastewater and collect waste water from septic tanks. Domestic water, which is provided through local sources such as wells or boreholes, was not included.

[23] Renewable Energy Device Solutions, 2006, p.68

[24] Oeko Institute, 2004 in GEMIS 4.2

Data Sources

Since water consumption is not metered, information on the total water consumption was collected from Scottish Water. The data on energy required for water supply, treatment, quantity of water supplied and water leakage was obtained from Scottish Water.

Water Ecological Footprint Calculation

The CO_2 emission from the energy required represents the carbon footprint for water supply and waste water. It is then converted into energy land to calculate the ecological footprint for water.

It was not possible to breakdown the total water footprint into different sectors since the information gathered was not disaggregated for the whole Sleat community.

3.6.3 Transportation

Transportation includes all modes of travel used by Sleat residents ranging from walking, bicycle, car (including taxi), bus, boat, tractor, train, ferry and airplanes.

Data sources

Fuel consumption and passenger km travelled were the main data sets used to derive the transport footprint in Sleat. This information was collected through interviews with households. The college students were also interviewed for the study to have the full representation of the populations´ travel mileage. There are 100 full time students but only 85 are residing at the campus.

Transport Footprint Calculation

The Footprint for transport was calculated utilizing the distances covered for each sector and the fuel consumption. The fuel consumption was used to estimate the related CO2 emissions for each mode of transportation which represents the carbon footprint of transport. The energy land required to sequester the CO_2 emissions from transportation was calculated.

The built land required for road transportation was also calculated as indicated in Annex 2. The UK average road space demand of 0.06 gha per 10,000 passengers Km was used to estimate the built land for roads[25]. The summation of built land and energy land for all modes of transportation gave the total ecological footprint for transport.

[25] Chambers et al,2000, p.74

3.6.4 Material and waste

In this study, materials and waste are grouped together. Data on waste production were used as an indicator for the material consumption. Short life time products were considered as part of the residential waste. As data on bulk waste was not available data on the consumption of long life time products were collected through the questionnaires.

The waste was categorized according to Municipal Solid Waste (MSW) from the Highland Council (plastic, paper, glass, textiles, hazardous waste, and organic waste) where as material was divided according to material bought by Sleat residential, public and commercial sectors in the past year. In addition, the material required for infrastructure both private (new houses) and shared e.g. the UK road network was considered.

Data Sources

The information on type and quantity of materials bought was collected from household, public and commercial sectors through questionnaire. The sub categories of material bought by residents are shown in Annex 4.

The average weight of each material was taken from Furniture Reuse Network[26]. The percentages of the material make up are assumed in order to calculate the material ecological footprint in the different land types.

Sleat residents benefit from infrastructure in other parts of the country, such as hospitals, Universities and other government services. The material requirement for thisshared infrastructure is based on UK data on construction material and was taken from the ecological footprint study of Inverness.

Information collected from Municipal Waste Department of Highland Council includes the following:

- total waste data both landfill and recycled,
- waste proportion of household and commercial sector,
- waste composition of household bin in Highland,
- recycling waste composition of Skye and Lochalsh,
- waste treatment location and freight transport.

[26] http://www.crn.org.uk/projects/tonnage/frnweights2005.pdf, printed on 11.03.2008

Waste production per capita gathered from the questionnaire was cross checked with the data from the Municipal Waste Department, Scotland and UK as shown in the table below:

Table 3.4
Waste Production per capita from Different Sources

Source	Waste production per capita (kg/capita/a)
SESAM Survey 2008	322.7
Municipal waste department data	349.47
National UK (DETR 2000)	441
Scotland (2004)	375.57

It was found that the waste production per capita had 8% difference from the data provided by Municipal Waste Department. However, the survey did not cover the entire public and commercial sector in Sleat, therefore, data from municipal waste department was used. Composting data gathered from the questionnaire was used to calculate the composting rate in Sleat.

Material and Waste Footprint Calculation

Material for furniture was segregated into different types of raw materials like wood, plastic, steel, etc to calculate the ecological footprint. For the rest of materials, the raw materials were not segregated.

The ecological footprint for shared infrastructure for Sleat was derived from the average shared infrastructure ecological footprint per capita in the UK (0.923 ha/capita)[27]. The ecological footprint for houses built in 2007 was calculated by using the material's embodied energy and energy used for transportation of these materials.

The waste ecological footprint considers the following:

1. The total embodied energy of the landfill waste.
2. 49% of the embodied energy of recycled waste[28].
3. Energy used to transport waste.

Energy requirements of landfill processing, which is approximately 80 MJ per tonne[29].

[27] Birch R et al,2004, p.62

[28] Best Foot Forward, 2004, p. 64

[29] Wiedmann, p.38

3.6.5 Food

Food includes animal and plant based products and beverages.

Data Sources

Quantity of food consumed by residential, public, and commercial sectors was gathered from the questionnaires. The food categories listed in the questionnaires were based on the Family Food survey[30].

Data was collected in terms of unit weight, except eggs (number), tea and coffee (cups) and beer and wine (volume). All food categories were converted into unit weight (kg) to calculate the ecological footprint.

The food consumption data of college students was collected from the canteen. The estimation of tourists' food consumption was explained in 3.2 above.

Food Ecological Footprint Calculation

The ecological footprint of food considers the productive area (forest land, crop land, pasture land, and sea land) required to supply the food/drinks products. It also considers the energy land required to sequester the CO_2 emissions from the embodied energy of food. The mass of CO_2 emissions from embodied energy represents the carbon footprint of the food consumed in Sleat.

3.6.6 Builtland

This component includes all areas that have been built on like roads, houses etc.

Data Sources

The built land data for Sleat was collected from Highlands and Islands Enterprise, Community land unit, "Ordnance Survey Strategy for Small Urban Areas", 2007.

Built Land Ecological Footprint Calculation

To calculate ecological footprint of built land, crop yield factor and equivalence factor were used. However this gave a result of 2.7 gha per capita, which more than 5 times than that of an average Scottish residents. Therefore, the data was not used as it was considered not reliable.

[30] Defra 2006

CHAPTER 4: CURRENT SITUATION

4.1 Sectors

This chapter shows the current situation in Sleat as to the various sectors (residential, public and commercial), as well as the categories on which the EF is based on.

4.1.1 Residential Sector

Sleat had 366 households in 2005[31]. Based on the interpolation of the population figures from the Sleat Community Plan, Sleat had 378 households with a total population of 847 in 2007. There are four main types of housing units in Sleat namely, detached, semi-detached, terraced house and flat/maisonette.

4.1.2 Public Sector

There is one primary school in Sleat with approximately 60 pupils. The school is divided into nursery, lower and upper primary. The school has a canteen and serves lunch for the students.

The Sabhal Mor Ostaig college has around 100 students, 85 of them residing in the college student hostel. All college students are considered as Sleat residents. The college has catering facilities. The students usually take their meal in the college canteen.

Sleat community is served by one medical centre.

4.1.3 Commercial Sector

The commercial sectors includes hotels, restaurants, shops and offices. There are five hotels in Sleat. These are :

- Ardvasar Hotel
- Kinloch Lodge

[31] A community Plan for Sleat, 2005

- Isle of Ornsay Hotel
- Toravaig Hotel
- Duisdale House

4.1.4 Agriculture and Forestry

Sleat has the following forest reserves namely Tormore, Lord Sainsbury and Kinloch. These forests are used as source of wood fuel as well as for commercial timber products[32]. Sleat does not have good soils for agriculture. As a result, the share of cropland is very small (275.4 ha) There is however a substantial amount of sheep rearing.

4.2 Categories

4.2.1 Direct Energy

All the energy requirements are met through imports except fuel wood and peat. Electricity for the Sleat Peninsula is supplied by the national grid. Presently, there is no electricity generation in Sleat. Fuel wood is locally supplied with the major supplier being the Clan Donald Land Trust while peat is cut individually by the residents. Electricity is mainly used for lighting, heating, cooking, communication and entertainment. LPG and Oil are used for heating and cooking.

4.2.2 Water

Water for Sleat is supplied by Scottish water based in Broadford with few households having their own water supply. Waste water is collected by tankers and treated in Broadford.

4.2.3 Transportation

The A851 is the main dual carriage way under construction in Sleat running from Broadford down to the ferry terminal at Armadale with the total distance of 24.15Km (15miles). There are also 2 peripheral single track roads leaving the main road connecting the outlying townships in Tarskavaig, Torkavaig and the Aird of Sleat with distances of 27.37km (17miles) and 7km (4.35 miles) respectively.

The main modes of travel by road in Sleat are private cars and two public bus services running from Ardvasar to Broadford and a school bus to Portree. There is one taxi service and two privately owned school buses which operate within Sleat.

[32] Sleat Community, Renewable Energy Study, p.68

The other mode of travel is by ferry from Armadale to Mallaig. Currently there is no connecting service linking the townships that lie outside the A851, to the Public Bus Service or the Ferry.

4.2.4 Waste

The largest portion of Municipal Solid Waste (MSW) arising from Sleat Peninsula is collected by compacting refuse-collection vehicles (RCVs) once a week on Fridays and Thusdays. The total mass of MSW collected by RCV in 2007 was 423 ton. All RCV collected waste ends up at the transfer station in Portree. Furthermore, the waste is transported by articulated lorry by road to Falkrik landfill site[33].

There are two recycling points in Sleat which are located at Sabhal Mor Ostaiag College and Armadale Pier (recycle waste including paper, can and glass). Papers and cans are collected together once a month while glasses are collected separately. The lorry also collects waste from other 188 recycling points in Highlands which end up at the transfer station in Inverness. From there they are sent to the recycling location: glasses are recycled near Glasgow, the papers are sent to a paper mill in Cheshire and the cans are sent to a steel factory in South Wales. Afterwards, all recycle products are sent back to Inverness[34]. Other solid waste such as plastic, textiles, and batteries end up in landfill. Many Sleat residents dispose recyclable waste in Broadford, Portree, and Inverness while some send their old clothes to the charity shop in Broadford.

4.2.5 Food

Sleat residents purchase their food from supermarkets in Broadforad, Portree and Inverness. Some of them grow their own food and raise animal.

[33] Email correspondent with Ewan Huc Waste Management Officer, Highland Council

[34] Ibid

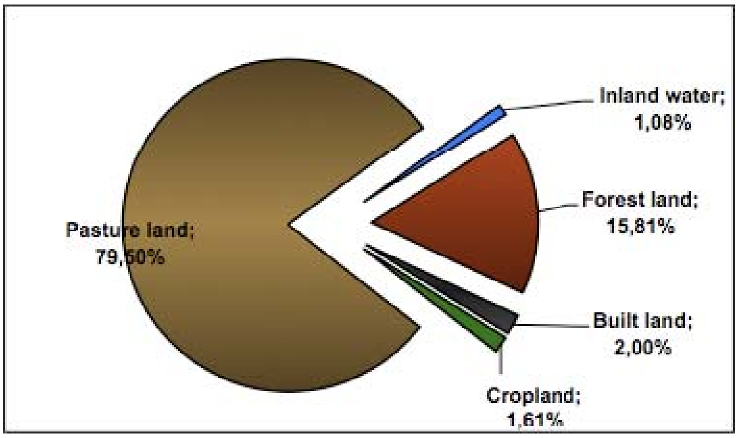
CHAPTER 5: RESULTS OF THE STUDY

The detailed results of the ecological footprint analysis of Sleat for the year 2007 are presented in this chapter with a focus on biocapacity and the total footprint as well as the various categories (direct energy, water, transportation, materials, waste and food)

5.1 Biocapacity

The geographical size of Sleat is 17,124.82 hectares (171 km^2). The figure 5.1 below shows the land type distribution in Sleat. The predominant land type in Sleat is pasture land.

Figure 5.1 Types of Land in Sleat



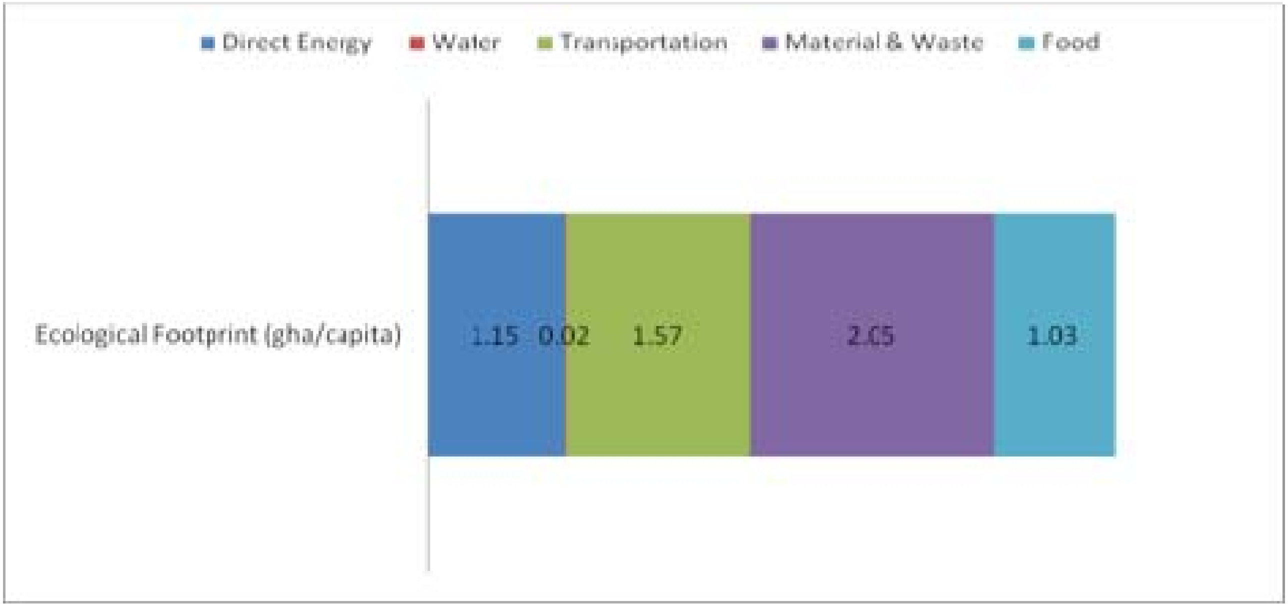
Source: SESAM, 2008

The forest land is the second largest land type. The total biocapacity of Sleat is 26,458.31 gha (31.24 gha per capita) assuming that biodiversity share is 12%. The low population density of Sleat (5/km²) is one of the reasons which leads to a high per capita local biocapacity. The data entered for the calculation of biocapacity is attached as Annex 4.5.

5.2 Total ecological footprint

The total ecological footprint of Sleat in 2007 was 4,927.49 gha which translates to 5.82 gha per capita. Material and waste was the highest. The break down of the ecological footprint by categories is shown in the Figure 5.2.

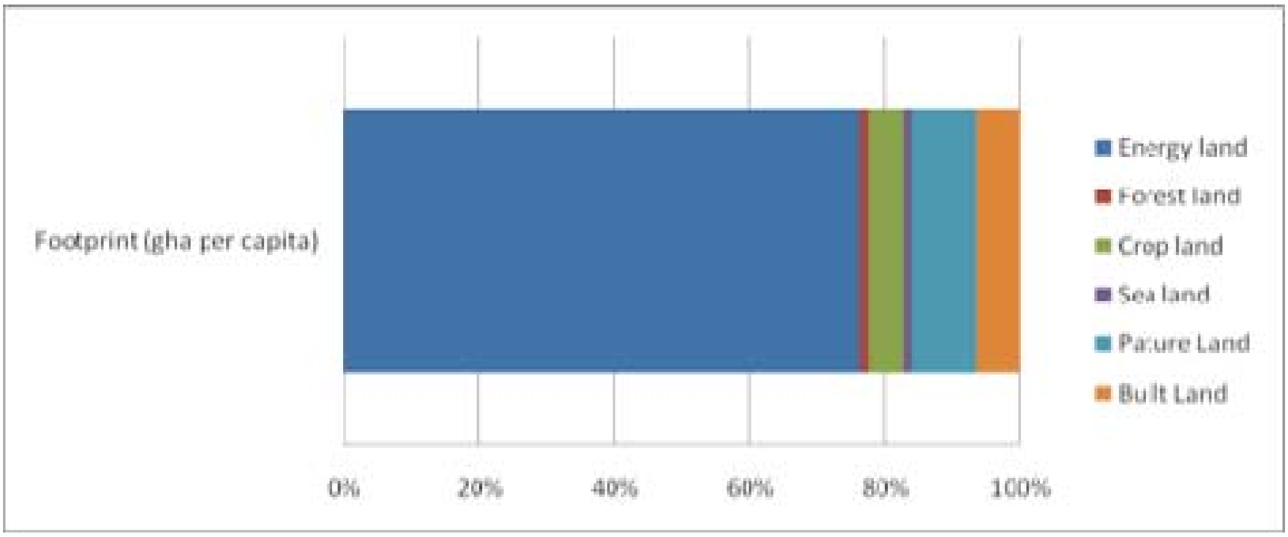
Figure 5.2 Ecological Footprint by Categories



Source: SESAM, 2008

The ecological footprint disaggregated into land types help in understanding more detailed resource demands. Figure 5.3 shows a breakdown of Sleat's residents' ecological footprint by land types. Energy land (land required to absorb CO2 emissions) was the highest land type with 76%. This shows the importance of energy in meeting lifestyle needs either through direct energy (e.g. electricity, gas, oil) or indirect energy (e.g. embodied energy in materials, food).

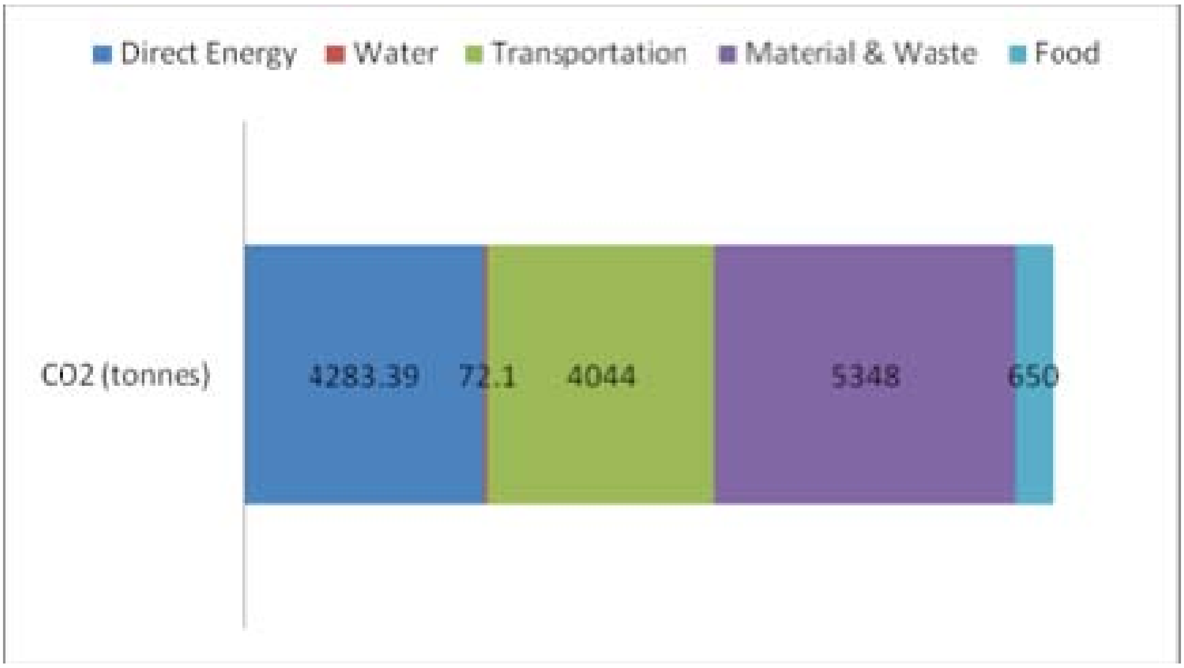
Figure 5.3 Ecological Footprint by Land Types



Source: SESAM, 2008

The total CO_2 emissions (carbon footprint) were 14,397 tonnes which corresponds to 17 tonnes per capita. The CO_2 emissions according to the categories are shown in the Figure 5.4 below.

Figure 5.4 CO_2 Emissions (tonnes) according to the categories



Source: SESAM, 2008

Material and waste category has the highest CO_2 emissions. This is due to the accumulation of embodied energy during the process of converting raw materials into final products. This shows how important waste minimization initiatives could be in reducing CO_2 emissions.

The ecological footprint of these categories is in detail discussed in the following sections.

5.3 Direct Energy

Direct Energy Consumption

The total direct energy consumption of Sleat's residents for lighting, space and water heating, electrical appliances, communication, entertainment and stationary machines in 2007 was 16.6 GWh. The total annual CO_2 emissions (carbon footprint) from direct energy consumption were 4,283 tonnes. The per capita CO_2 emissions were 5.05 tonnes per capita.

Table 5.1 shows the energy consumption and related CO_2 emissions according to different fuel type.

Table 5.1
Total Direct Energy Consumption and CO_2 Emissions According to Fuel Type

Fuel type	Annual consumption	Unit	Consumption (GWh/y)	Annual CO2 emissions (tonnes)
Electricity	5,387,692	kWh	5.4	2,187
LPG	549,238	litres	4.0	768
Oil	452,85	litres	4.9	1,266
Wood	674	tonnes	2.1	4
Coal	28	tonnes	0.2	52
Peat	6	tonnes	0.02	6
TOTAL			**16.6**	**4,283**

Source: SESAM, 2008

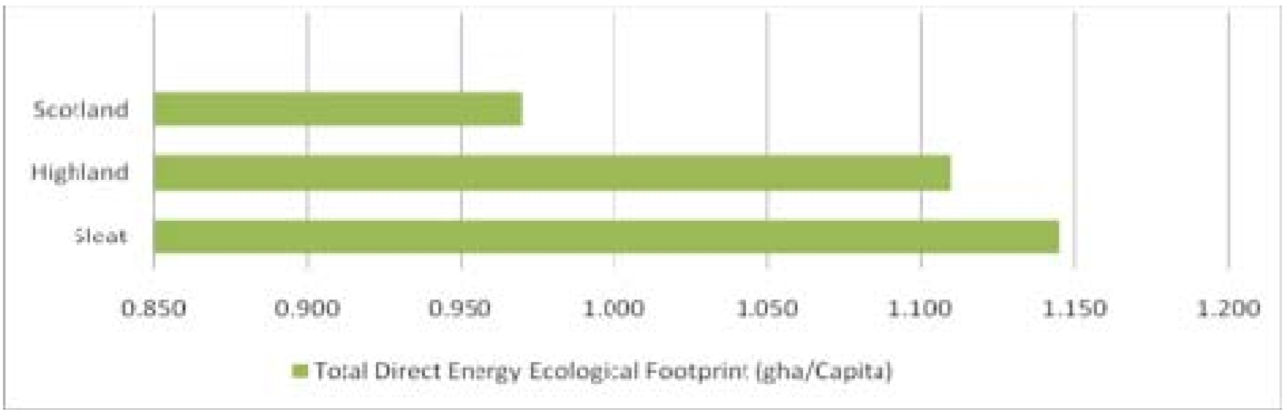
The total direct energy consumption of Sleat households was higher than the average consumption of Scottish households. The total direct energy consumption for Scotland was 12.8 MWh per capita where as per capita consumption for Sleat was 15.5 MWh. This includes all the domestic, commercial and public sectors.

Total Direct Energy Ecological Footprint

The total ecological footprint for direct energy in 2007 was 971 gha which translates to 1.147 gha per capita. This accounts for 20% of the total ecological footprint.

Figure 5.5 showing the comparison of direct energy footprint of Sleat with other footprint studies is given below:

Figure 5.5 Comparison of direct energy footprint with other studies



Source: SESAM, 2008

The Scotland study was conducted with 2001 data and the Highland study with 2006 data.

Table 5.2 shows the ecological footprint of direct energy of the Sleat resident's according to the sectors.

Table 5.2
Total Direct Energy Consumption and Ecological Footprint

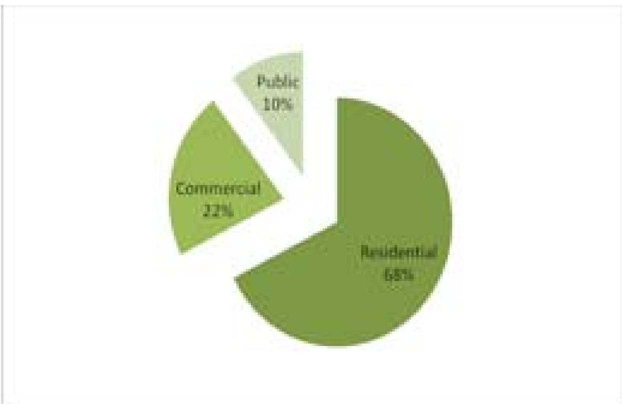
Sector	Fuel Type	Total Consumption (GWh/y)	Total Ecological Footprint (gha)	CO_2 emissions (tonnes)
Residential	Electricity	2.8	242.06	1,134.15
	LPG	2.2	90.24	422.82
	Oil	4.6	254.28	1,191.43
	Wood	2.1	57.66	3.94
	Coal	0.2	11.13	52.13
	Peat	0.02	1.29	6.02
Commercial	Electricity	1.9	160.38	755.59
	LPG	0.9	36.40	170.54
	Oil	0.3	14.47	67.79
	Wood	0 .003	0.10	0.007
Public	Electricity	0.73	63.53	297.67
	LPG	0.92	37.31	174.82
	Oil	0.025	1.39	6.5
TOTAL		**16.60**	**971.00**	**4283.39**

Source: SESAM, 2008

Figure 5.6 Percentage Share of Direct Energy Footprint by Sector

Direct Energy Footprint by Sector

The residential sector has the highest share in the total footprint of Sleat followed by commercial and public sector. Figure 5.6 shows the percentage share of direct energy footprint by sectors.

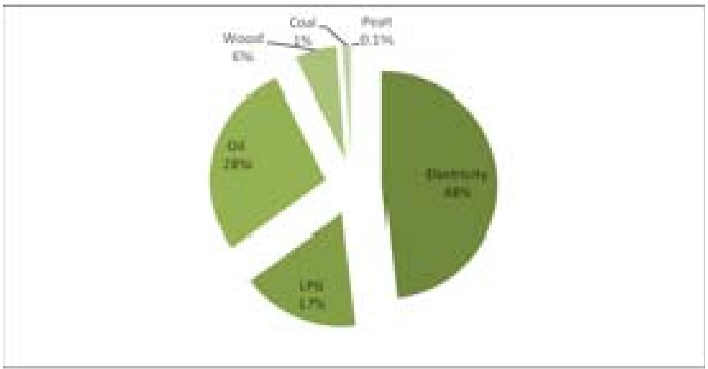


Source: SESAM, 2008

Figure 5.7 Percentage Share of Direct Energy Footprint by Fuel Type

Direct Energy Footprint by Fuel Type

Electricity and oil are major energy sources in Sleat. Figure 5.7 shows the percentage share of the direct energy footprint by fuel type.



Source: SESAM, 2008

Direct Energy Footprint by Land Type

The total footprint of direct energy footprint comprises of the energy land (land required to sequester CO_2 emission) and forest land (land required to grow the trees for amount the wood being consumed). The total forest land in the footprint was 56.92 gha where as the total energy land was 914.18 gha.

5.4 Water

Water Consumption

The total water consumption by Sleat residents in 2007 was 130.10 million litres. The total leakages were 16.39 million litres in the same year. According to the Scottish Water office in Broadford, the energy required to supply and treat waste water was 168, 730 kWh.

The total CO_2 emissions due to water consumption were 72.10 tonnes. Table 5.3 shows the component breakdown of CO_2 emissions related to energy used to supply and treat waste water.

Table 5.3
Energy Consumption for Water and CO2 emissions

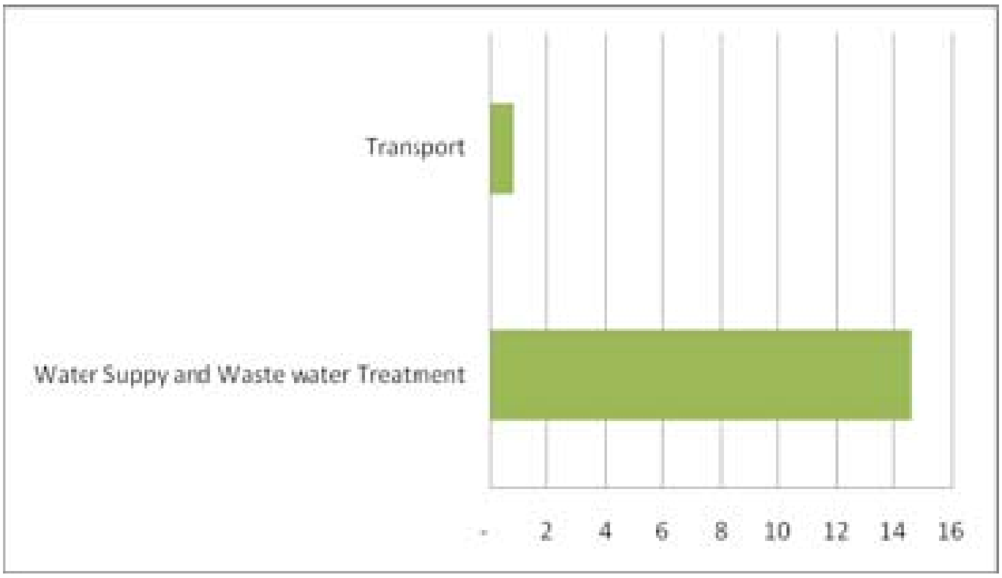
Water Demand	Energy Consumption	Unit	CO2 (tonnes)
Water Supply and Treatment	168,730.00	kWh	68.50
Transport	595.45	Litres	3.59
Total			***72.10***

Source: SESAM, 2008 with data from Scottish Water

Water Footprint

The ecological footprint of water consumed in Sleat was 15.39 gha which correspond to 0.02 gha per capita. This is equal to Scotland 2001 water footprint per capita. Figure 5.8 shows the water footprint.

Figure 5.8 Water Footprint (gha)



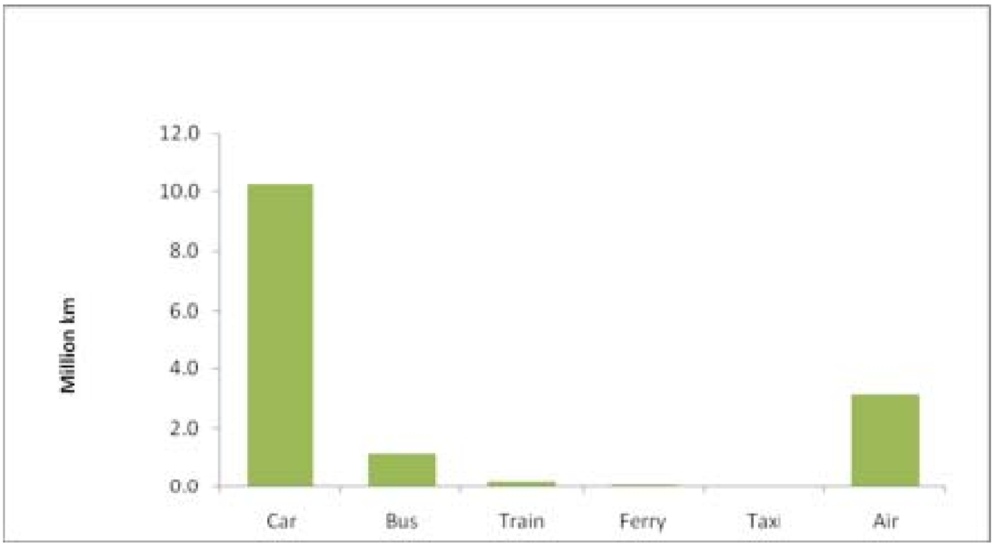
Source: SESAM, 2008

The ecological footprint of waste water treatment was calculated using the total energy consumption of the waste water treatment plant in Broadford for 2007. It was difficult to allocate part of the energy consumption of the waste water treatment plant to Sleat as data on the total number of communities served by this plant was not available.

5.5 Transportation

The total kilometres travelled by the Sleat residents in 2007 were over 14 million of which the major contribution came from personal car travel. Air travel was the second highest. Figure 5.9 shows passenger km by mode of transport.

Figure 5.9 Passenger km by Transport Mode



Source: SESAM, 2008

This translates into 17,000 passenger km per Sleat resident , compared to a Scottish average of 13,000 passenger km per capita in 2001(see Table 5.4). However the Scottish data on air travel in 2001 might not represent todays reality, considering the boom of cheap airlines in the past years.

Table 5.4
Comparison of Scotland and Sleat passenger km per capita

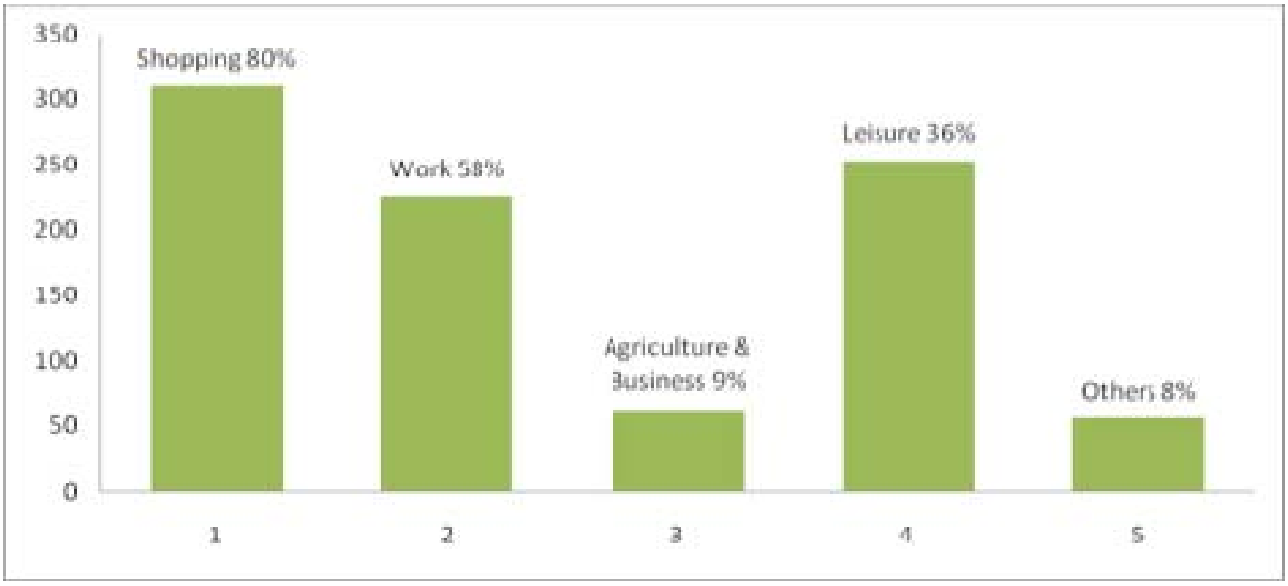
	Scotland (2001)	**Sleat (2007)**
Mode of travel	Passenger Km /capita	Passenger Km /capita
Car and van	10, 733	12, 115
Bus & coach	918	1, 363
Rail, tram, metro etc	880	299
Air travel	539	3, 731
Total (km)	***13, 070***	***17, 508***

Source: SESAM, 2008

According to the study, there were 565 personal cars in Sleat (2007) giving an average of 1.6 cars per household. The total fuel consumption of personal cars was 637,745 litres in 2007.

The purpose of car usage was for shopping, work, leisure and business. Figure 5.10 summaries the uses of personal cars. From the graph, it shows that shopping was the main purpose of using a car, due to the fact that there is no supermarket, bank or other amenities in Sleat. Therefore, improved shopping and service facilities in Sleat could reduce travel mileage as proposed in chapter 7.

Figure 5.10 Purpose of Vehicle Use



Source: SESAM, 2008

CO_2 emissions

The total CO_2 emissions were 4,044 tonnes. The per capita CO_2 emissions were 4.77 tonnes. This is higher compared to England CO_2 emissions per capita of 2.76[35] tonnes. The emissions according to modes of transportation are as shown in the Table below.

Table 5.5
***CO_2* Emissions by Transportation Mode**

Transport mode	Passenger km	CO2 emission in tonnes
Car	10,261,569	2,595
Bus	1,153,081	202
Train	221,477	13
Ferry	31,829	2
Air	3,138,128	1,232
Total (km)	***14,808,062***	***4,044***

Source: SESAM, 2008

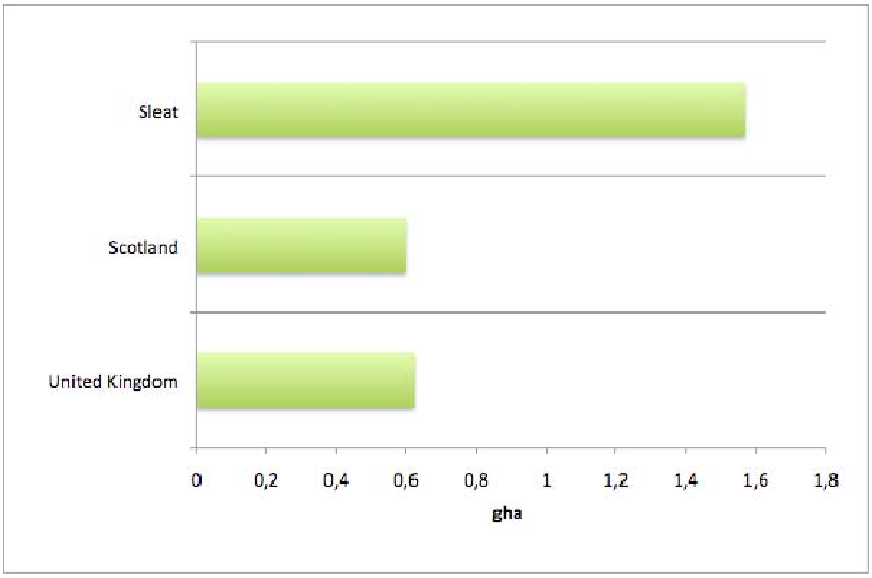
Taxi has been excluded in the table above because its CO_2 emissions were very insignificant due to low usage by the Sleat residents.

[35] SEI, 2007

Transportation Footprint

Transport represents 23% of the Sleat Footprint and is 1,330 gha (1.57gha per capita). The figure below shows the ecological footprint of Sleat compared with UK and Scotland.

Figure 5.11 Comparison of Sleat Transport Footprint with Other Studies



Source: SESAM, 2008, Best Foot Forward 2004, SEI 2003

Sleat has a higher transport footprint than Scotland and the United Kingdom because Sleat residents' usage of public transportation is low. In addition to this, Sleat residents travel a lot by air. Broadford, which is 15 miles away is the nearest place where Sleat residents do much of their shopping. Hence, this increases the transport footprint.

Transportation Footprint by Sector

Households account for about 88% of the total mileage with a footprint of 967.28 gha. The sector wise footprint is shown in the table below.

Table 5.6

Transport Footprint by Sector

Water Demand	Residential	Commercial	Public
-Passenger km (1000 km)	13,088.92	306.22	1,395
% of transport mode-km	88.50	2.07	9
Total CO2 Emissions in tonnes	3,456.18	264.49	328
% of CO2 emission	85.36	6.53	8

Table 5.6

Transport Footprint by Sector

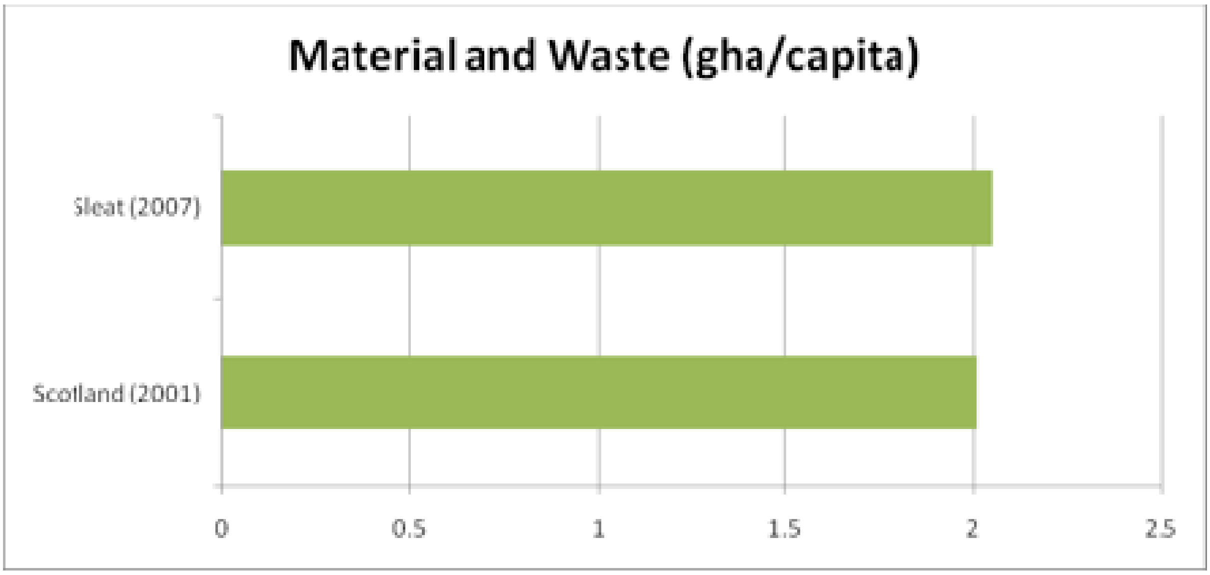
Built land (gha)	111.27	111.27	111.27
Total Footprint for transport	953.90	174.36	197
% of transport footprint	72%	13%	15%
			Source: SESAM, 2008

5.6 Material

Material footprint

The total material ecological footprint was 970 gha (1.15 gha per capita). The CO_2 emissions due to embodied energy of materials were 4511 tonnes (5.33 tonnes per capita). The total material and waste footprint in Sleat was 2.05 gha per capita, while the Scotland's material and waste footprint in 2001 was 2.01 gha per capita (see Figure 5.12).

Figure 5.12 Comparison Material and Waste (gha/capita)

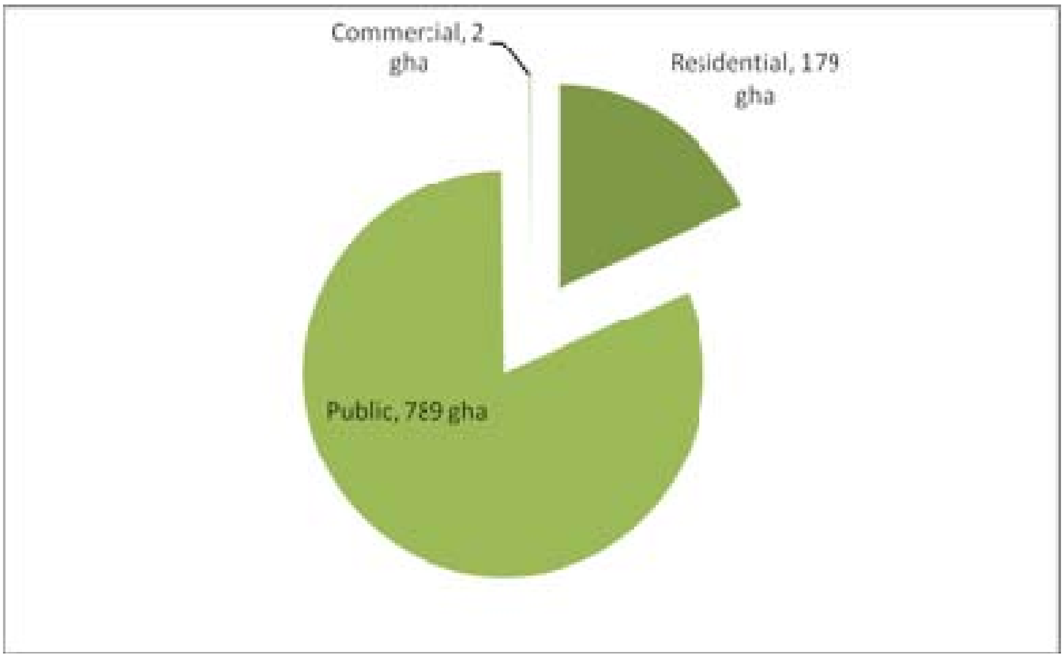


Source: SESAM, 2008,

Material Footprint by Sector

The public sector has the highest footprint with 789 gha as shown in Figure 5.13. This is due to the shared infrastructure that accounts for 99% (782 gha) of the material ecological footprint of the public sector.

Figure 5.13 Material Ecological Footprint by Sector



Source: SESAM, 2008

Material Footprint by Items

Shared infrastructure has the highest footprint with 81% whereas housing is 10% of the material footprint (see table below).

Table 5.7
Footprint and CO_2 emissions by Material Categories

Items	Ecological Footprint (gha)	CO_2 emissions (tonnes)
Kitchen Appliances	26.12	122.37
Entertainment	6.55	30.697
Office Equipment	21.02	98.49
Other appliances	0.55	2.59
Car	22.27	104.34
Furniture	14.59	34.76
New houses	97.10	454.94
Shared infrastructure	781.78	3663.04

Source: SESAM, 2008

5.7 Waste

Waste generation

The study shows that 475 tonnes of waste was generated in Sleat in 2007. The waste was divided into recycled and land fill waste. The composted waste was not taken into account in the waste footprint to avoid double counting.

The total recycled waste was 52 tonnes and 423 tonnes of waste were land fill waste.

The composition of waste from both household and commercial sectors is given in Table 5.8. The organic waste was the largest component with 29% of the total waste generated. Paper waste was the next largest quantity of waste generated from both sectors with 27%.

Table 5.8

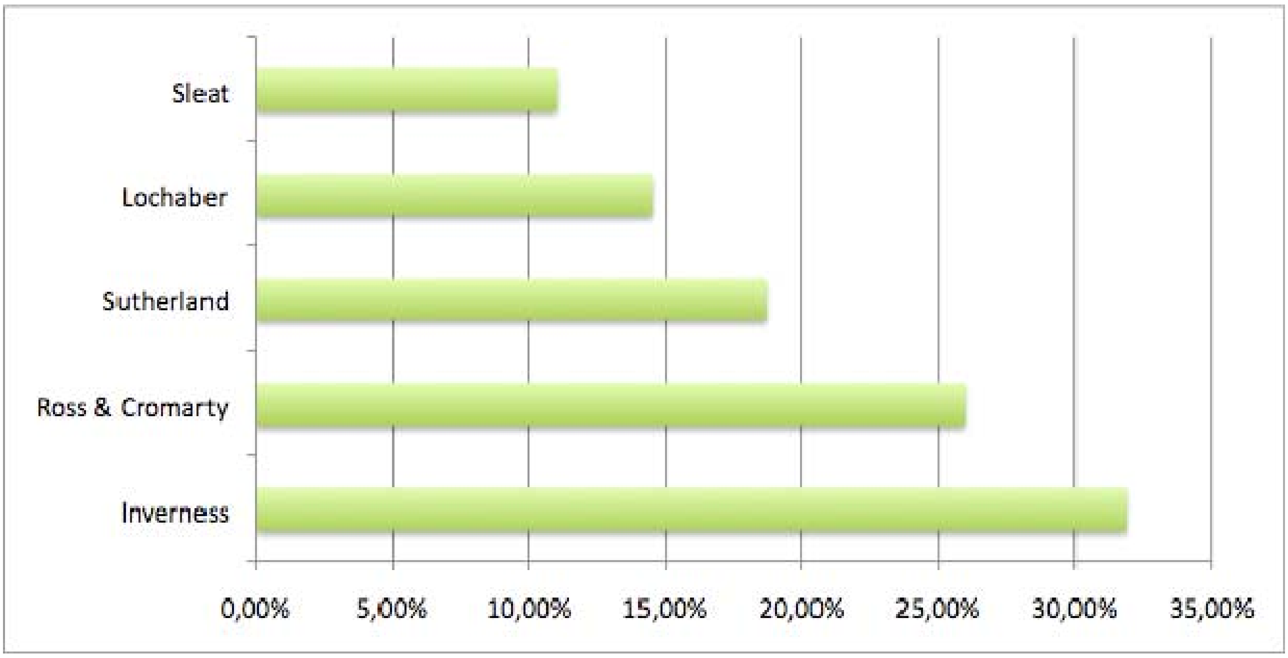
Waste Composition for Sleat in 2007

	Household		**Commercial/public**	
	Land fill waste	**Recycled waste**	**Land fill waste**	**Recycled waste**
	[ton/a]	**[ton/a]**	**[ton/a]**	**[ton/a]**
Plastic	23	-	10	-
Paper	77	13	33	6
Glass	26	19	11	8
Textiles	11	3	5	1
Metal	8	1	4	0.3
Hazardous	53	-	23	0.2
Organic waste	97	-	42	-

Source: SESAM, 2008 based on Municipal Waste Department of Highland Council data

Comparing with other areas in Highland, Sleat has the lowest recycling rate of 11% as shown in figure 5.14.

Figure 5.14 Recycling Rates in the Highland Area

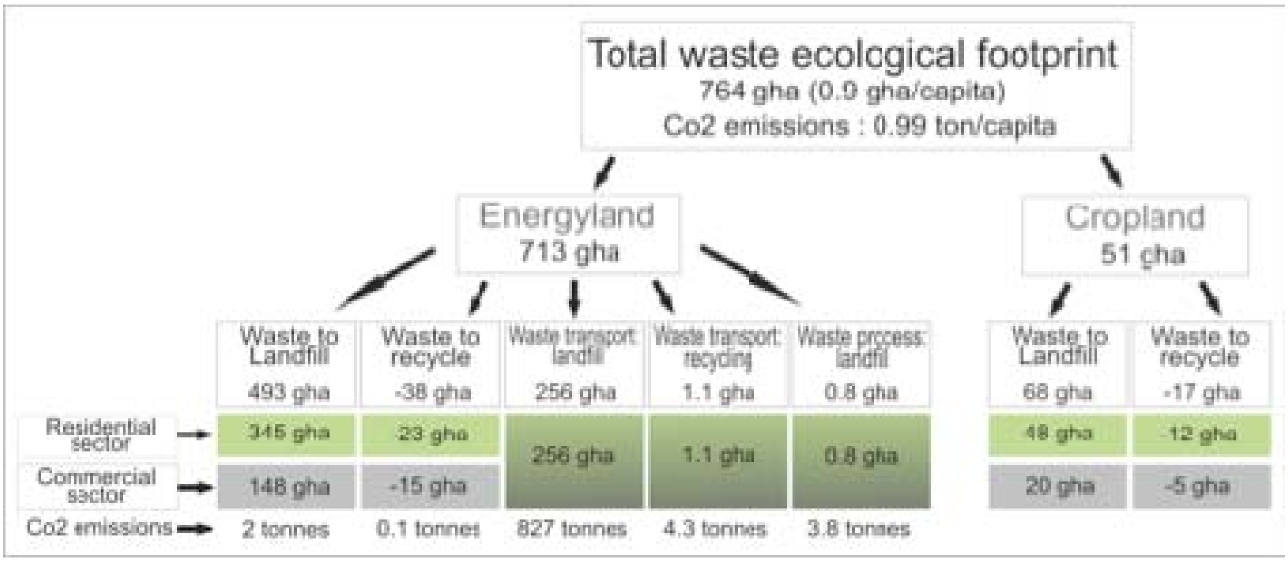


Source: SESAM, 2008 based on Annual Waste Report of Highland Council

Waste footprint

The total ecological footprint of waste was 764 gha (0.90 gha per capita). Figure 5.15 shows a summary of the waste ecological footprint for Sleat in 2007, by consumption and area type demand.

Figure 5.15 Waste Ecological Footprint for Sleat Residential and Commercial/Public Sectors



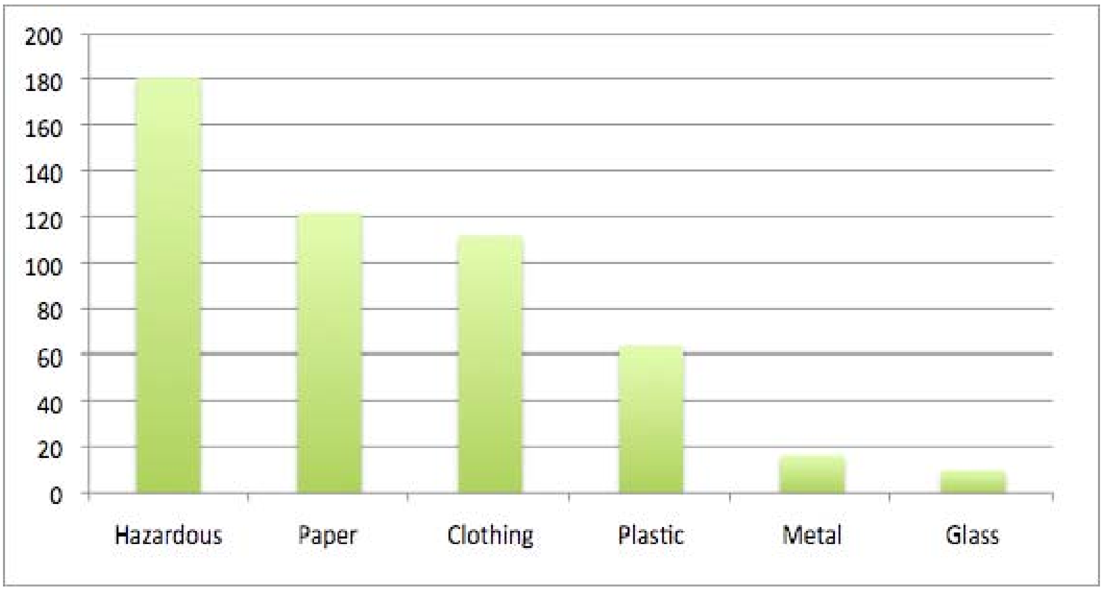
Source: SESAM, 2008

The total CO2 emissions due to waste generation is 837 tonne (0.99 tonne/capita).

Waste Footprint by Items

Among the different waste materials hazardous has the highest footprint with 181 gha (see Figure 5.16), as the embodied energy from this materials are is very high. The lowest was glass with 10 gha.

Figure 5.16 Items Waste Footprint



Source: SESAM, 2008

5.8 Food

Food consumption

The total food consumption in Sleat for 2007 was 483 tonnes. This includes food consumed by residents and tourists. (Pet consumption is not considered (see Box 5.1)).

The total food consumed in Sleat by residents (excluding tourist) in 2007 was 457 tonnes. This translates to an annual per capita consumption of 540 kilograms of which 2.7% was consumed outside home. The tourists accounted for 5.3% of the total consumption.

The annual food consumption profile of Sleat residents is shown in Table 5.9. Milk and milk products were the largest quantity of food consumed with followed by vegetables and fruits.

Table 5.9
Food consumption profile of Sleat residents in 2007

	Eating at home	Eating out*	Total eating

Table 5.9

Food consumption profile of Sleat residents in 2007

			kilograms per person per year
ANIMAL BASED			
Meat (red + white)	47	4.5	52
Fish and seafood	24	0.7	25
Milk/Milk products	121	-	121
Eggs	10	0.4	10.4
PLANT BASED			
Cereal & bread	48	1.2	49.5
Potatoes	62	3.8	65.5
Oil products	9.5	-	9.5
Sugar	13	1.8	14.9
Coffee & tea	3.2	-	3.2
Vegetables	77	2.7	80.1
Fruits	66	0.7	67.2
BEVERAGES			
Soft drinks/fruit juice	46	0.1	46
Wine & beer	44	31	75
Spirits	2	-	2

* Data obtained from the Family Food survey in 2005-2006 a National Statistics publication by Defra

Source: SESAM, 2008

Comparing household consumption of Sleat with other regions of UK* (see Table 5.10), there is little difference, though Sleat residents seem to be consuming more fish and seafood probably due to its geographical location surrounded by the sea.

There is also a slight difference concerning the consumption of vegetables and fruits. Sleat residents

X 5.1

What about pet consumption?

Pet consumption is considered in other ecological footprint studies in the food component.

In the ecological footprint analysis of the Isle of Wight pet consumption was calculated to be 67 kilograms per household per year, contributing 5% to the ecological food footprint[36].

36 Best food forward, Island State: An Ecological Footprint Analysis of the Isle of Wight

consume 28% more vegetables and 11% more fruits.

Table 5.10

Food Consumption Profile of Sleat and other Regions

	Sleat*	North West**	Scotland**	England**
				grams per person per year
ANIMAL BASED				
Meat (red + white)	1021	1118	1046	1046
Fish and seafood	492	161	142	164
Milk/Milk products	2540	2286	2070	2130
Eggs	197	90	96	120
PLANT BASED				
Cereal & bread	948	1642	1611	1601
Potatoes	1301	864	780	828
Oil products	184	190	172	184
Sugar	205	140	127	133
Vegetables	1592	1034	907	1145
Fruits	1307	1116	1104	1243
BEVERAGES				
Soft drinks/fruit juice	885	1735	2209	1768
Alcoholic drinks	37	928	822	802

* Data obtained from the Family Food survey in 2005-2006 a National Statistics publication by Defra

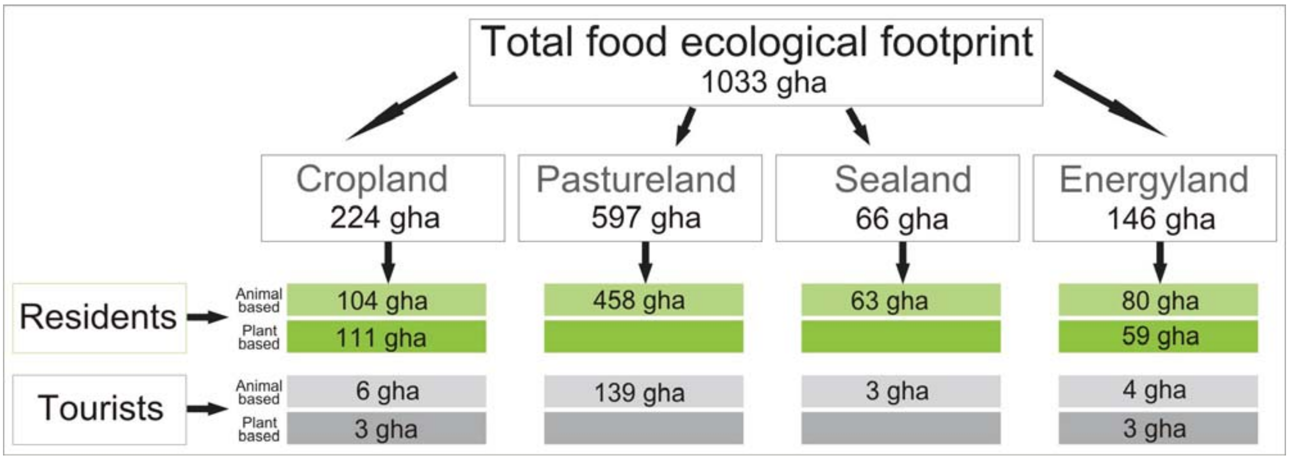
***Source: SESAM, 2008*

Total Food Ecological Footprint

The ecological footprint for food by residents and tourists in 2007 was 1033 gha. The tourists were responsible for 15% (158 gha) of the total food ecological footprint. The footprint per capita excluding tourists was 1.03 gha.

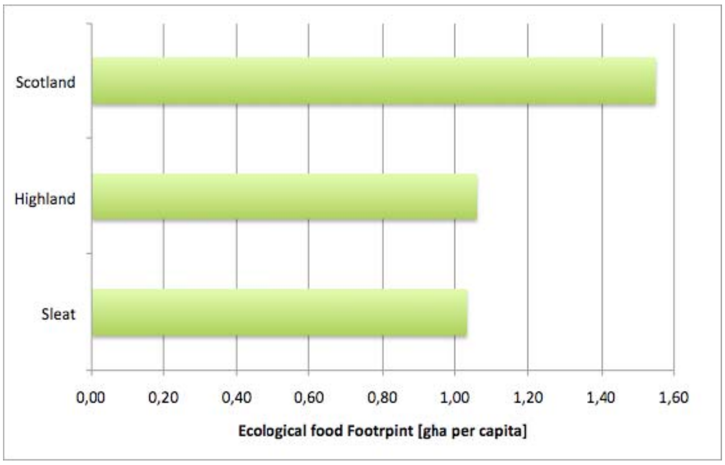
Figure below shows the detailed footprint according to the land types required for food production. The CO2 emissions due to embodied energy in food were 650 tonnes in Sleat (0.77 tonnes per capita). In comparison this is lower than England's per capita CO_2 emissions of 1 tonne per capita for food.

Figure 5.17 Food Ecological Footprint for Sleat Residents and Tourists



Source: SESAM, 2008

Figure 5.18 Comparison with Other Footprint Studies



Source: SESAM, 2008

Comparing the food footprint with other ecological footprints studies, Sleat has the lowest food ecological footprint (see Figure 5.18). This might be due to the higher consumption of fruits and vegetables. The food footprint of Sleat did not include soups and ice cream. However, it is still comparable with Scotland's footprint study, as the footprint of these items is less that 0.001 gha.

Food ecological footprint by sector

The study found that the residential sector was the highest with 849 gha, followed by the commercial sector (hotel) with 95 gha. The public sector (college) had the lowest share with 52 gha.

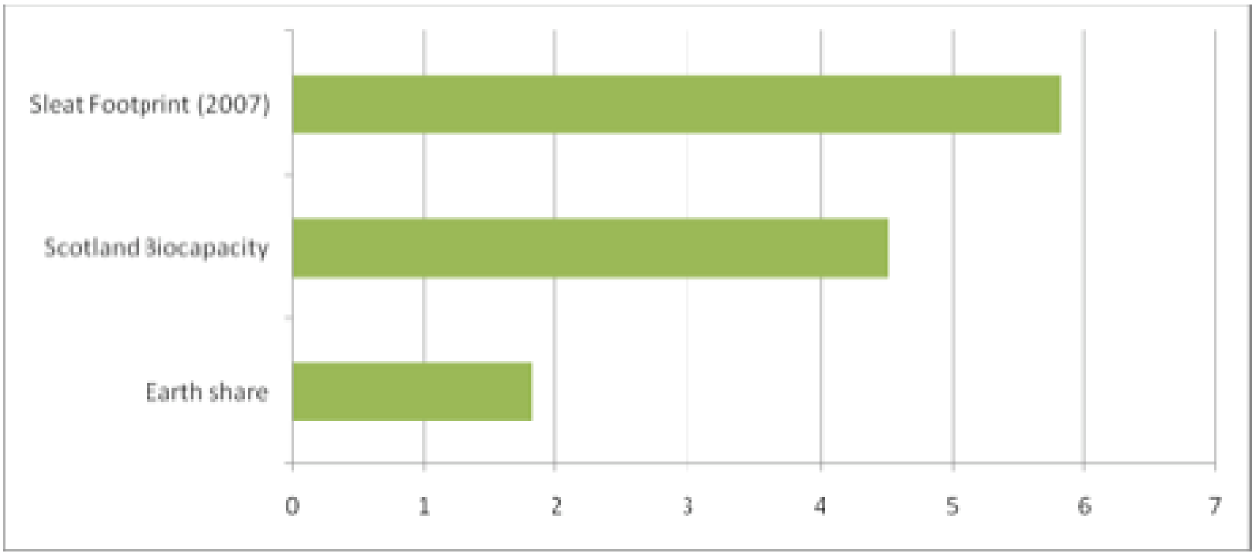
CHAPTER 6: SUSTAINABILITY ASSESSMENT

The footprint of Sleat measured the demand of the residents on the biocapacity to estimate the area's sustainability. The total biocapacity of Sleat was 31 gha/capita. The biocapacity of Sleat is high partly because the population density is low compared to other regions. Despite the biocapacity of Sleat being high, Sleat residents are highly dependent on products and services outside Sleat. Moreover, it is difficult to compare the footprint of small communities like Sleat with their biocapacity. This is mainly because resources and land space of any nation are not equally distributed. For example, people living in cities need more space to provide what they consume while they are concentrated in a small area. They are highly dependent on land space outside the cities. Therefore, in this study the ecological footprint of Sleat is compared with national and global biocapacity.

The ecological footprint of Sleat was 5.82 gha/capita, whereas national biocapacity is 4.53 gha/capita. This is an indication that the current consumption and waste generation in Sleat is not sustainable. By comparing Sleat's footprint with the average global biocapacity (earth share) of 1.8 gha/capita, it is possible to measure ecological sustainability. This assessment indicates that a Sleat resident is using 3 times more than the average earth share. This is higher than the a Scottish resident who is using 2.5 times more than the earth share. Figure 6.1 shows Sleat´s ecological footprint compared to the national (Scotland) and global biocapacity.

Figure 6.1 Sleat´S Ecological Footprint Compared

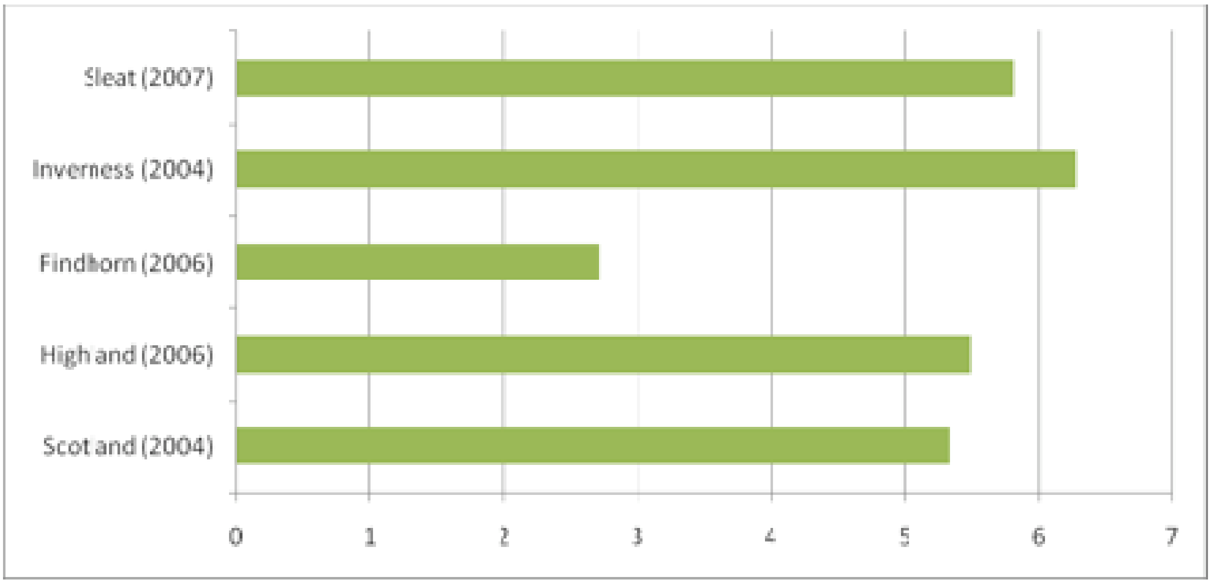
With National Biocapacity and Global Earthshare



Source: SESAM, 2008 and Best Foot Forward, 2001

Compared with other regional ecological footprints, as can be seen in the figure below, the ecological footprint of Sleat is the second highest after Inverness.

Figure 6.2 Comparison of Total Ecological Footprint with Other Studies (gha/capita)



Source: SESAM, 2008

Findhorn has the lowest footprint, however a different methodology was used to calculate the footprint therefore it can not be exclusively compare with other studies.

The carbon footprint of Sleat is 14,397.49 tonnes which corresponds to 17 compared to a Scottish average of 12.2 tonnes/capita.

Although the ecological footprint of Sleat is high, there are several opportunities to improve the utilization of resources thereby reducing ecological demand. To show some of the possibilities that could lead Sleat residents towards sustainable lifestyle, several scenarios are presented in the next Chapter.

CHAPTER 7: ALTERNATIVE SCENARIO DEVELOPMENT

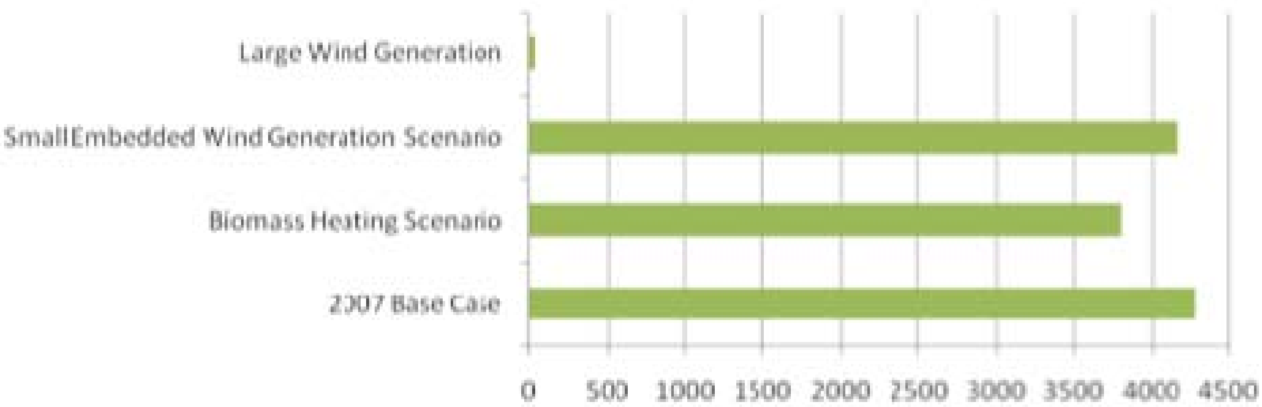
This chapter discusses the impacts of alternative scenarios developed to show the impacts of future options on the reduction of the ecological and carbon footprint. National and regional strategies were also used to identify the scenarios. The scenarios focus on alternatives of meeting people's demand with lower impact on the supply side and reducing the levels of consumption on the demand side. These scenarios present the picture on what could happen if certain actions are taken. For each scenario, the reduction in the Ecological Footprint resulting from the suggested measures has been estimated.

7.1 Direct Energy

Direct energy contribution to the ecological footprint of Sleat was 20 % of the total footprint. Alternative scenarios were identified according to the already existing plans and project ideas in Sleat. The scenarios analyze the generation of energy from renewable sources (biomass and wind) and the reduction of energy demand through energy efficiency measures.

Figure below shows an overview of possible savings in carbon emissions according to the different scenarios.

Figure 7.1 Comparison of CO_2 Emissions From Direct Energy Consumption In Base Case And Alternative Scenarios (Transport Not Included)



Source: SESAM 2008

The details of the scenarios are explained in the following sections.

7.1.1 Biomass Heating Scenario

A majority of Sleat residents is mainly dependent on electricity, LPG and Oil for space heating. The substitution of LPG and Oil for space heating by biomass has been analyzed under this scenario.

The area required to grow wood is calculated taking into account a sustainable yield of 14.2 tonnes/hectares[37]. The energy required for harvesting, chipping and transportation of wood (embodied energy) is 0.9% of the energy content[38].

The biomass heating scenario will save 485 tonnes CO_2 emissions. The energy land (forest land to sequester CO_2 emission) footprint would be reduced by 104 gha while forest land (forest required to grow wood) increases by 43 gha. The biomass heating of ongoing and potential sites are discussed below.

Table 7.1

Biomass Heating Scenario

Description	Fuel replaced	Wood requirement [tonnes] [39]	CO2 savings [tonnes]	Energy land reduction [gha]	Forest land [gha]
Replacement of LPG heating by Wood Chip in Sabhal Mor Ostaig	LPG (118,742 litres) [40]	298	166	35	25.2
Replacement of 20% LPG and 20% Oil Consumption in Household by fuel wood[41]	LPG (60,462 litres), oil (85,254 litres)	445	320	68	38

Source: SESAM, 2008

[37] Renewable Energy Device Solutions, 2006, p.68

[38] Oeko Institute, 2004 in GEMIS 4.2

[39] Highland Wood Energy, 2006, p.22

[40] Ibid, p.23

[41] Renewable Energy Device Solutions, 2006, p.70

7.1.2 Wind Energy for Electricity Generation

Sleat Peninsula has excellent wind resource and is suitable for large scale wind development. The possibility of the wind energy development is hindered by limitations of grid for export of electricity generated[42].

Nevertheless it was interesting to analyze the impact of a large scale wind generation on the carbon emissions and energy footprint. This scenario also analyses the option of developing the small and micro embedded wind generation identified in the Sleat Renewable Energy Study.

The embodied energy of a wind turbine is 3% of the energy production. The land requirement associated with a wind turbine is 333.33 m^2 for a capacity of 1 MW and 284.21 m^2 for capacity of 100 kW[43].

a) Large Scale Wind Turbine

This scenario considers the development of a wind farm of 5 MW (5 x 1 MW) capacity in Sleat. If this wind farm operates 3500hrs in a year at full capaciy, the total electricity generated will be 17.5 GWh per year. This can easily replace the total energy demand in Sleat which is 16.5 GWh/year.

If the wind energy generated is considered as part of national energy mix, total CO_2 savings are attributed to the whole of Scotland rather than Sleat. Even though there are no CO_2 emissions from the generation of electricity by the wind farm, CO_2 emissions due to embodied energy of the wind plant are taken into account and added to the total CO_2 emissions from electricity generation in Scotland. This however does not offer any meaningful CO_2 savings as the electricity generated from the Sleat wind farm is very low compared to national generation.

Nevertheless, if we consider that the CO_2 savings under this scenario are only attributed to Sleat , 4065 tonnes of CO_2 could be saved and the direct energy footprint could be reduced by 924.31gha. The footprint for the embodied energy of the wind farm will be 45.91 gha which includes energy land of 45.49 gha and built land of 0.415 gha.

b) Small embedded wind energy generation

The Sleat Renewable Energy Study identified three small wind sites for Clan Donald Land Trust, Sabhal Mor Ostaig and Fearann Eileann Iarmain. These wind sites will have total built land

[42] Ibid, p.22-23

[43] Oeko Institute, 2004 in GEMIS 4.2

footprint of 0.21 gha. The CO_2 savings and the net energy land footprint reduction are shown in the table below:

Table 7.2

Small Embedded Wind Generation Scenario

Wind Site	Capacity (MWh/year)	CO_2 Saving (tonnes)	Energy Land Reduction (gha)
Clan Donald Land Trust (50kW,)	170	69	14
Fearann Eileann Iarmain (15 kW)	80	32	7
Shabal Mor Ostaig (30 kW)	30	12	2.6

Source: SESAM, 2008

7.1.3 Energy Efficiency

The energy consumption could be reduced by the application of simple energy efficiency measures which could further reduce CO_2 emissions. For this scenario only the introduction of Compact Fluorescent Lamp (CFL) lamps and loft insulation were considered.

a) CFL

Table 7.3

Energy Efficiency Scenarios

Description	Energy savings [kWh]	CO_2 savings [tonnes]	Energy land reduction [gha]
Replacement of a 60 watt incandescent bulb with a 20 Watt CFL bulbs in each house	19,315.80	7.8	1.674
Loft insulation in 20 households	104,000 [44]	27.37	6.4

Source: SESAM, 2008

[44] http://www.nationalinsulationassociation.org.uk/housholder/householder-nia.html 10.03.2008

The above energy efficiency scenarios show that simple energy efficiency measures can have significant impact on the reduction of direct energy footprint of Sleat.

7.2 Transportation

Scenarios for transport will mainly focus on personal travel because it contributes to 63% of transportation ecological footprint. This amounts to 2593 tonnes of CO_2 emissions. The main scenarios developed are soft policies built on flexibility and responsibility in change of behaviour and attitude towards car usage.

Three scenarios were developed on car sharing of households and these are; 4 people sharing the car, 3 people sharing the car and 2 people sharing the car. The car sharing scenarios take into account the car occupancy rate of 1 for Sleat which is derived from the household car ownership of 1.5 from the study. The car sharing of 4, 3 and 2 people reduces the car carbon footprint by 27%, 24% and 18% respectively.

The fourth scenario assumes that there are improved shopping and service facilities in Sleat, which influences residents to travel to Broadford. This reduces the car carbon footprint by 4% .

The summary of the scenarios discussed above are shown in Table 7.4.

Table 7.4

Transport Footprint Development Scenarios

Scenarios	Business As Usual Distances (million passenger km)	Scenario Distances (million passenger km)	Business As Usual Footprint	Scenario Footprint	Percentage Reduction (from total transportation footprint)
4 people per car	9.7	2.4	0.7	0.18	27%
3 people per car		3.3		0.23	24%
2 people per car		4.8		0.35	18%
Improved Shopping Facilities in Sleat		8.7		0.63	4%

Source: SESAM, 2008

The last scenario is based on switching of fuel from diesel to LPG. The cars which travelled more than 35,000 km per year were considered under this scenario. The LPG cars have proven to be economically viable if they travel at least 35,000 km. SESAM 2008 survey has shown that 40 cars in Sleat have a yearly total distance travel of 35,000 km. The usage of LPG as fuel for these cars leads to a CO_2 emissions savings of 220 tonnes. This represents a reduction of 5% on the transport carbon footprint of Sleat.

7.3 Waste Management

The new area waste plan targets in 2010 are 13% composting rate, 27% recycling rate, 33% of waste to landfill and 27% Energy from Waste (EfW). As mentioned in the result part of waste component that Sleat has reached the composting target in 2007 (17%). However an improvement is needed in recycling rate, which was 11% in 2007 to achieve 2010 Highland's target.

The total landfill organic waste generated in Sleat region last year was 3 tonnes /week, which was 30% from total waste generated in Sleat. There is big potential to improve the waste management of the organic waste by composting. Through SESAM 2008 survey, it was found that residents who are willing to compost, mentioned that limited space in their house or odour from the waste were obstacles towards composting. Therefore it would be beneficial for the community to have the a centralized composting plant.

Due to the big potential of the waste management in Sleat Peninsula, two scenarios were developed according to the strategies.

1. To recycle 27% of household waste, to generate energy from waste with 27% of total waste and dispose 33% of total waste to landfill
2. To compost 80% of total organic waste generated in 2010, with 27% of recycling rate

The table below shows the comparison among between the total ecological footprint (gha), per capita ecological footprint (gha/P) and the total CO_2 emissions (ton) of the Sleat in 2007 footprint,compared to the result from scenario 1 and 2 in Sleat 2010.

Table 7.5

Summary of impact reduction options

	Description	Total EF	EF percapita	Carbon EF	Carbon EF per capita	Total CO2 emissions	CO2 emission per capita
		[gha/a]	[gha/P/a]	[gha/a]	[gha/P/a]	[ton/a]	[ton/P/a]
2007	Base Case	764	0.90	713.00	0.84	837	0.99
2010	Waste growth rate:2% annually	796	0.94	742.05	0.88	857	1.01

Table 7.5
Summary of impact reduction options

Scenario 1	Highland target waste plan 2010 composting rate 13% ,recycling rate 27%, Efw 27%, landfill 33%	566	0.67	562.12	0.66	714	0.84
Scenario 2	Community composting plant, with 80% organic waste composted, and recycling rate of 27%	558	0.66	555.39	0.66	686	0.81

Source: SESAM, 2008

As seen from the table the waste footprint in 2010 rises by 4%. The 2010 footprint was calculated using the Highland annual waste growth rate of 2%. By implementing Scenario 1, the waste ecological footprint will be reduced by 29% while with scenario 2, 30% will be reduced. In terms of CO_2 emissions, for scenario 1 and 2, the reduction would be 17% and 20% respectively.

The lowest waste footprint could be attained from scenario 2, due to the reduction of the mileage to transport the waste to landfill, as well as the footprint of landfill processing.

The increase of recycling waste will increase CO_2 emissions due to transportation of waste to the recycling centre. However, the overall footprint will be reduced as 51% of the embodied energy of recycled waste will be recovered.

All the scenarios above looked at the potential for different ways of dealing with the current amount of waste, in order to recover at least some of its value. However, it is always good to reduce the amount of waste created in the first place.

CHAPTER 8: CONCLUSIONS

The main objective of this study was to determine the ecological footprint of Sleat Peninsula and develop and assess alternatives scenarios towards sustainability. The result of the study shows that the ecological footprint of Sleat residents is 4,927.49 gha. It is worth mentioning that the findings of the study have raised a number of important facts:

- Material and Waste has the highest ecological footprint with 35%. This shows the importance of employing waste minimization initiatives as suggested in Chapter 7 to reduce carbon footprint.
- Car Travel accounts for 27% of the ecological footprint of Sleat. The proposed scenarios for transportation in Chapter 7 can contribute in reducing the carbon footprint.
- Direct energy consumption accounts for 20% of the ecological footprint of the community. This supports the necessity to promote renewable energy and energy efficiency programs. The responses of the survey show that the community is aware of the opportunities that can be exploited from such initiatives. The implementation of the planned projects of the Sleat Trust would contribute considerably towards reducing carbon footprint of Sleat.

It is anticipated that the results of this study will be useful and assist in making informed decisions. The analysed ecological footprint is a useful indicator and monitoring tool to measure the progress of the community towards sustainability over time. Furthermore, the results of the study can be used to raise awareness among the members of the community on the impacts of their consumption and lifestyle. As this is the first study done in Sleat, it is hoped that it will be used as a baseline for follow up studies to be conducted to monitor the effectiveness of future renewable and energy efficiency projects of the Sleat Community Trust.

GLOSSARY

Biocapacity or biological capacity: The capacity of ecosystems to produce useful biological materials and to absorb waste materials generated by humans, using current management schemes and extraction technologies. How much of renewable resources are made available by the biosphere's regenerative capacity?

Biological productive land/area**:** Is land and water (both marine and inland) area that supports significant photosynthetic activity and biomass accumulation that can be used by humans.

Carbon footprint: is the measure of the impact human activities have on the environment in terms of the amount of greenhouse gases produced measured in units of carbon dioxide. In other words it is the demand human activities places on biocapacity in terms of the amount of land required to sequester CO_2 emissions from all energy activities.

Double counting: refers to counting the same Footprint area more than once. In order not to exaggerate human demand on nature, it is important to be more than careful to avoid double counting.

Ecological debt: Is the imbalance between human demand on biocapacity and the available biocapacity**.** If you take more than your fair share of the earth's finite natural resources you run up an **ecological debt**. If you have a lifestyle that pushes an ecosystem beyond its ability to renew itself, you run up an **ecological debt**.

Ecological deficit: When a country's ecological footprint exceeds the biologically productive area of its borders, the country runs an ecological deficit. Therefore this is the difference between the biocapacity and Ecological Footprint of a country or region. The opposite of an ecological deficit is ***ecological reserve***. A country or region is said to have an ecological reserve when its biocapacity exceeds its ecological footprint. In this case the calculated ecological footprint is lower or less than the available biocapacity.

Embodied energy: This is the sum total of all energy inputs used during all stages of a service, material or product's entire life cycle. This account for energy used from raw material extraction, transport, manufacture, use and dispose of the product. Footprint studies often use embodied energy when tracking trade of goods.

Ecological Overshoot: occurs when humanity's demand on the biosphere exceeds the available biological capacity of the planet.

Equivalence Factor: This is the ratio between the worlds average potential productivity of a given bioproductive area and the world average potential productivity of all biproductive areas. The equivalence factor is one of the key factors that allow land of different types to be converted into the common unit of global hectares. This factor is constant for all countries however vary for each year.

Global hectare: is one hectare of biologically productive space with world-average productivity. Global hectare is a common, standardized unit used for reporting the land area needed to support natural resources consumption of the area under study. Global hectares allow the meaningful comparison of the ecological footprints of different countries, which use different qualities and mixes of land types. Therefore the use of global hectares recognizes that different types of land have a different ability to produce useful goods and services for humans. For example one hectare of cropland can produce a greater quantity of useful and valuable food products than a single hectare of grazing land. Hence by converting both cropland and pasture into global hectares, they can be compared on an equal basis.

Yield factor: This is the ratio between productivity of a given land type to the global world average productivity of the same world type. Within a given land type, such as cropland, the ability of an area to produce useful goods and services can vary dramatically based on factors such as climate, topography, or prevailing management. Yield factors therefore, allow different areas of the same land type to be compared based on the common denominator of yield. Yield factors are calculated for each land type in each nation every year.

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ANNEXES

ANNEX 1. QUESTIONNAIRES

Annex 1.1 Household Brief Questionnaire

Questionnaire for Ecological/Carbon Footprint Study

The way we eat, travel, use energy, water, materials, and dispose of our waste affects the quality of our environment.

To maintain our life, we need land to produce food, energy and materials. We need space for our houses, roads and waste disposal. If the productive area available on the earth is divided by the total population, then 4.5 acres would be available for each person for sustainable way of life. However, our consumption is exceeding what nature can sustainably support: our "ecological footprint" is larger than 4.5 acres per person. The ecological footprint of an average Scot is 13.22 acres while for a Zambian it is only 1.48 acres. If we continue to deplete our nature's resources the future generations will have nothing left. To ensure the same quality of life for future generation, we need to learn to live on smaller footprint.

Energy is one of the main areas where we can effectively reduce our footprint. Energy is used directly for e.g. lighting, heating and transport and indirectly, embodied in the products we use in our daily lives.

This Ecological/Carbon Footprint study is envisaged to assess the impacts of the activities of the community of Sleat on the environment and also provides the basis for suggestions on how the community can minimize such impacts through use of renewable energy. Therefore we rely on the inputs of this survey for successful completion of the ecological/carbon footprint study. We are looking forward to your kind cooperation. Your responses will be treated strictly confidential and none of this information will connect with any particular names or addresses.

1. **Please indicate your housing type.**
   [1] Detached (single family dwelling)
   [2] Semi Detached
   [3] Terraced house
   [4] Flat/maisonette
   [5] Other *(please specify)* ______________________

2. **How many bedrooms does your house have?** _________________

3. **Please fill in the types of vehicles, fuel used and their mileage in the table below.**

Vehicle Type [1]Car, [2]van, [3]lorry, [4]motor cycle, [5]boat and Others : please specify	**Main Purpose** [1]Shopping, [2]Going to Work, [3]Agriculture & Business, [4]Leisure, [5]others	**Miles/year**	**Fuel Type**	**Fuel Consumption (litres /year)**
3.1.1	3.1.2	3.1.3	3.1.4	3.1.6
3.2.1	3.2.2	3.2.3	3.2.4	3.2.6
3.3.1	3.3.2	3.3.3	3.3.4	3.3.6

4. **How much money in total does your household as a whole *spend on food weekly* (buy in *Supermarket*)?**

Red Meat	**White Meat**	**Sea food/Fish**	**Others**
4.1 £	4.2 £	4.3 £	4.4 £

5. **If you purchase food *from local farmer or produce and consume on your own*, please indicate the type and quantity of food:**

   ____

   ____

6. **If you purchased any major furniture and electrical appliances in past year, please indicate the type and quantity:**

   ____

   ____

7. **Check the types of energy source used by your household annually. If you know the figures, please fill in the quantity consumed or cost.**

Energy source	Quantity consumed	Unit	Approximate cost (£)
Electricity			
a) Heating	7.1.1	kWh	7.1.2
b) Other purposes	7.2.1	kWh	7.2.2
LPG			
a) Cooking	7.3.1	Litres	7.3.2
b) Heating	7.4.1	Litres	7.4.2
Oil	7.5.1	Litres	7.5.2
Wood	7.6.1	Tonnes	7.6.2
Coal	7.7.1	Tonnes	7.7.2
Peat	7.8.1	Tonnes	7.8.2
Others including renewable (specify)	7.9.1		7.9.2

8. How could you personally contribute towards a more sustainable lifestyle?

____

____

9. What do you think the community can do to contribute towards more sustainable lifestyle?

____

THANK YOU FOR YOUR ANSWERS.

Annex 1.2 Household Extended Questionnaire

HOUSEHOLD CATEGORY

1. Please indicate your housing type.

1 Detached (single family dwelling)
2 Semi Detached
3 Terraced house
4 Flat/maisonette
5 Other *(please specify)* ______________________

2. What is the area/size of the house?

___________________ (square feet) OR ____________________ (square metres)

3. How many bedrooms does your house have? _________________

4. How many people lived your house on average per weekday and weekend in the past year?

Number of people Weekday	Number of people Weekend
4.1	4.2

5. Do you use any of your bedrooms for bed and breakfast?

1 Yes Go to question 6
2 No

6. What was the total number of bed nights in your B&B in the past year?

____

ENERGY

7. Please estimate how much energy your household consumed in the past year. (If you have your utility bills, please check them; otherwise please give us an estimate.)

Energy source	Quantity consumed	Unit	Approximate cost (£)
Electricity	7.1.0		
c) Heating	7.1.1	kWh	7.1.2
d) Other purposes	7.1.3	kWh	7.1.4
LPG	7.2.0		
c) Cooking	7.2.1	Litres	7.2.2
d) Heating	7.2.3	Litres	7.2.4
Oil	7.3.1	Litres	7.3.2
Wood	7.4.1	Tonnes	7.4.2
Coal	7.5.1	Tonnes	7.5.2
Peat	7.6.1	Tonnes	7.6.2
Others including renewable (specify)			
	7.7.1		7.7.2
	7.8.1		7.8.2
	7.9.1		7.9.2

8. Where and how do you think you can reduce your energy consumption?

____

____

HOUSEHOLD TRANSPORTATION

9. Did you own a vehicle in the past year?

[1] Yes

[2] No Go to question 11

10. Please fill in the types of vehicles, fuel used and their mileage in the past year in the table below.

Vehicle Type [1]Car, [2]van, [3]lorry, [4]motor cycle, [5]boat and Others : please specify	Main Purpose [1]Shopping, [2]Going to Work, [3]Agriculture & Business, [4]Leisure, [5]others	Miles/year	Fuel Type	Fuel Consumption (litres /year)
10.1.1	10.1.2	10.1.3	10.1.4	10.1.5
10.2.1	10.2.2	10.2.3	10.2.4	10.2.5

11. Do you own a bicycle?

[1] Yes

[2] No Go to question 13

12. What do you use your bicycle for?

[1] Leisure

[2] Shopping

[3] Work

[4] Other *(Please specify)* ________________________________

13. What means of transport do you use for going to work?

[1] Car

[2] Bus

[3] Motorbike

[4] Bicycle/walk

[5] Others

14. What means of public transport do you use when travelling outside Sleat? Please fill in the approximate mileage travelled last year.

	Bus	Train	Ferry	Taxi
Member 1[a]	14.1.1	14.1.2	14.1.3	14.1,4
Member 2[b]	14.2.1	14.2.2	14.2.3	14.2,4

15. How often did you travel by air transport last year? *(times)*

Member 1	Member 2	Member 3	Member 4	Member 5
15.1	15.2	15.3	15.4	15.5

16. Where did you go by air transportation?

	Place 1	Place 2	Place 3	Place 4	Place 5
Member 1[a]	16.1.1	16.1.2	16.1.3	16.1.4	16.1.5
Member 2[b]	16.2.1	16.2.2	16.2.3	16.2.4	16.2.5

17. Would you be able and willing to reduce your travel mileage?

[1] Yes

[2] No Go to question 19

18. How would you reduce your travel mileage?

[1] Bicycling

[2] Walking

[3] Public transport

[4] Sharing car

[4] Others *(Please specify)*____

19. What measures should the community of Sleat put in place to reduce the mileage?

[1] Bicycle tracks

[2] Walking tracks

[3] Public transport

[4] Car Sharing Scheme

[4] Others *(Please specify)*____

FOOD CONSUMPTION

20. What type of plant and animal based food *your families* consume at home?
Please check the box, which corresponds to the type of food you eat at home (If you know how much you consumed please fill the consumption column)

Type of food	Consumption	Unit
1. Animal based		
Red Meat	20.1.1	lbs /week
White Meat	20.1.2	lbs /week
Fish and seafood	20.1.3	lbs /week
Milk	20.1.4	Litre/week
Milk products (butter, cheese, cream)	20.1.5	lbs /week
Egg	20.1.6	Number/week
2. Plant Based		
Cereal and bread	20.2.1	lbs /week
Potatoes	20.2.2	lbs /week
Oil products (margarine)	20.2.3	lbs /week
Sugar (includes candies and chocolates)	20.2.4	lbs /week
Coffee & Tea	20.2.5	cups/week
Vegetables	20.2.6	lbs /week
Fruits	20.2.7	lbs /week
3. Beverages		
Fruit juice and Soft drinks	20.3.1	Litre/week
Wine and Beer	20.3.2	Litre/week
Spirits	20.3.3	Litre/week

21. How much money in total does *your household spend for eating inside house* weekly?

1. In supermarket

Red Meat	White Meat	Sea food/Fish	Others
21.1.1 £	21.1.2 £	21.1.3 £	21.1.4 £

2. From farmer, fisherman

Red Meat[2a]	White Meat[2b]	Fish[2c]	Others[2d]
21.2.1 £	21.2.2 £	21.2.3 £	21.2.4 £

22. **How many times do the members of *your household eat out of Sleat region per week*, on average? (Include stops at drive-through and fast-food restaurants)**

Member	Never	1	2 -3	Others, specify
[a] Member 1	❍	❍	❍	
[b] Member 2	❍	❍	❍	
[c] Member 3	❍	❍	❍	
[d] Member 4	❍	❍	❍	
[e] Member 5	❍	❍	❍	
[f] Member 6	❍	❍	❍	

MATERIAL AND WASTE

23. **Did you purchase any furniture and electrical appliances and other equipments in the past year?**

[1] Yes   Go to question 24

[2] No

24. **Please list the items you purchased.**

____

____

____

Note: Number & Type of Material (furniture)

25. **How many bags of waste per week do you dispose?**

Type of waste bags	Number of bags per week	Bag size (Litre)
Un-separated Waste	25.1.1	25.1.2
Separated Waste		
Plastic /Food waste (excluding composted waste)	25.2.1	25.2.2
Paper	25.3.1	25.3.2
Glass	25.4.1	25.4.2
Textiles	25.5.1	25.5.2
Cans	25.6.1	25.6.2
Others (specify) ______________	25.7.1	25.7.2
Composted Waste	25.8.1	25.8.2

26. **Are you able and willing to compost your waste?**

[1] Yes

[2] No

27. **What was the water consumption of your household in the past year?**

____

Annex 1.3 Hotels Brief Questionnaire

HOTELS

FOOD CONSUMPTION

1. **What is the amount of food cooked or served in your hotel in the past year (2007)?**

Type of food	Average Consumption	Unit
1. Animal based		
Red Meat	1.1.1	lbs /year
White Meat	1.1.2	lbs /year
Fish and seafood	1.1.3	lbs /year
Milk	1.1.4	Litre/year
Milk products (butter, cheese, cream)	1.1.5	lbs /year
Egg	1.1.6	Number/year
Others (specify)_____________	1.1.7	
2. Plant Based		
Cereal and bread	1.2.1	lbs /year
Potatoes	1.2.2	lbs /year
Oil products (margarine)	1.2.3	lbs /year
Sugar (includes candies and chocolates)	1.2.4	lbs /year
Coffee & Tea	1.2.5	litre/year
Vegetables	1.2.6	lbs /year
Fruits	1.2.7	lbs /year
Others (specify)_____________	1.2.8	
3. Beverages		
Fruit juice and Soft drinks	1.3.1	Litre/year
Wine & Beer	1.3.2	Litre/year
Spirits	1.3.3	Litre/year

2. **What was the total number of bed nights in the past year?**

____

MATERIAL AND WASTE

3. **Did you purchase any furniture and electrical appliances and other equipments in the past year?**

   1 **Yes Go to question 4**

   2 **No**

4. **Please list the items you purchased.**

   ____

   ____

Note: Number & Type of Material (furniture)

5. **How many bags of garbage per week do you dispose?**

Type of garbage bags	Number of bags **per week**	Bag size (Litre)
Un-separated Waste	5.1.1	5.1.2
Separated Waste		
Plastic /Food waste (excluding composted waste)	5.2.1	5.2.2
Paper	5.3.1	5.3.2
Glass	5.4.1	5.4.2
Textiles	5.5.1	5.5.2
Cans	5.6.1	5.6.2
Others (specify) _______________	5.7.1	5.7.2
Composted Waste	5.8.1	5.8.2

ENERGY

6. **Please estimate how much energy your hotel consumes annually. (If you have your utility bills, please check them; otherwise please give us an estimate.)**

Energy source	Quantity consumed	Unit	Approximate cost (£)
Electricity			
e) Heating	6.1.1	kWh	6.1.2
f) Other purposes	6.2.1	kWh	6.2.2
LPG			
e) Cooking	6.3.1	Litres	6.3.2
f) Heating	6.4.1	Litres	6.4.2
Oil	6.5.1	Litres	6.5.2
Wood	6.6.1	Tonnes	6.6.2
Coal	6.7.1	Tonnes	6.7.2
Peat	6.8.1	Tonnes	6.8.2
Others including renewable (specify) _______________	6.9.1		6.9.2

7. **Where and how do you think you can reduce your energy consumption?**

____

_

8. **What was the water consumption of your hotel in the past year?**

____

TRANSPORT

9. **Does the hotel have its own means of transportation?**

[1] Yes **Go to question 9**

[2] No

10. **Please fill in the table below.**

Vehicle Type [1]Car, [2]van, [3]lorry, [4]motor cycle, [5]boat and Others : please specify	**Miles/year**	**Fuel Type**	**Fuel Consumption (litres /year)**
10.1.1	10.1.2	10.1.3	10.1.4
10.2.1	10.2.2	10.2.3	10.2.4
10.3.1	10.3.2	10.3.3	10.3.4

Annex 1.4 Small Businesses Brief Questionnaire

SMALL BUSINESSES

ENERGY

1. **Please estimate how much energy your business consumed last year. (If you have your utility bills, please check them; otherwise please give us an estimate.)**

Energy source	Quantity consumed	Unit	Approximate cost (£)
Electricity			
g) Heating	1.1.1	kWh	1.1.2
h) Other purposes	1.2.1	kWh	1.2.2
LPG			
g) Cooking	1.3.1	Litres	1.3.2
h) Heating	1.4.1	Litres	1.4.2
Oil	1.5.1	Litres	1.5.2
Wood	1.6.1	Tonnes	1.6.2
Coal	1.7.1	Tonnes	1.7.2
Peat	1.8.1	Tonnes	1.8.2
Others including renewable (specify) ________________	1.9.1		1.9.2

2. **Where and how do you think you can reduce your energy consumption?**

____

MATERIAL AND WASTE

3. **Did you purchase any furniture and electrical appliances and other equipments in the past year?**

   [1] Yes Go to question 4

   [2] No

4. **Please list the items you purchased.**

____

____

Note: Number & Type of Material (furniture)

5. **How many bags of waste per week do you dispose?**

Type of waste bags	Number of bags per week	Bag size (Litre)
Un-separated Waste	5.1.1	5.1.2
Separated Waste		
Plastic /Food waste (excluding composted waste)	5.2.1	5.2.2
Paper	5.3.1	5.3.2
Glass	5.4.1	5.4.2
Textiles	5.5.1	5.5.2
Cans	5.6.1	5.6.2
Others (specify) ________________	5.7.1	5.7.2
Composted Waste	5.8.1	5.8.2

6. **Do you produce any other kind of waste that was not listed in the previous table?**

Type of waste	Quantity	Units	Collected by
6.1.1	6.1.2	6.1.3	6.1.4
6.2.1	6.2.2	6.2.3	6.2.4

TRANSPORT

7. **Please fill in the types of vehicles used for your business, their fuel consumption and their mileage in the table below.**

Vehicle Type [1]Car, [2]van, [3]lorry, [4]motor cycle, [5]boat and Others[6] (specify) ___________________	Miles/year	Fuel Type	Fuel Consumption (litres /year)
7.1.1	7.1.2	7.1.3	7.1.4
7.2.1	7.2.2	7.2.3	7.2.4
7.3.1	7.3.2	7.3.3	7.3.4

PRODUCTION

8. **Please indicate the product and the quantity of the product that you produced, exported outside Sleat or sold to local people in the past year. If you sell your product to local people, please indicate the average price.**

Product	Quantity produced (Tonnes)	Quantity exported outside Sleat (Tonnes)	Quantity sold to local people (Tonnes)	Average price (only when sold to local people)
8.1.1	8.1.2	8.1.3	8.1.4	8.1.5
8.2.1	8.2.2	8.2.3	8.2.4	8.2.5
8.3.1	8.3.2	8.3.3	8.3.4	8.3.5
8.4.1	8.4.2	8.4.3	8.4.4	8.4.5

Annex 1.5 College Brief Questionnaire

COLLEGE

FOOD CONSUMPTION

1. **How much money did the college spend on food in the past year?**

____

2. **What is the amount of food cooked or served for students in the past year?**

Type of food	Average Consumption	Unit
1. Animal based		
Red Meat	2.1.1	lbs /year
White Meat	2.1.2	lbs /year
Fish and seafood	2.1.3	lbs /year
Milk	2.1.4	Litre/year
Milk products (butter, cheese, cream)	2.1.5	lbs /year
Egg	2.1.6	Number/year
Others (specify)______________	2.1.7	
2. Plant Based		
Cereal and bread	2.2.1	lbs /year
Potatoes	2.2.2	lbs /year
Oil products (margarine)	2.2.3	lbs /year
Sugar (includes candies and chocolates)	2.2.4	lbs /year
Coffee & Tea	2.2.5	litre/year
Vegetables	2.2.6	lbs /year
Fruits	2.2.7	lbs /year
Others (specify)______________	2.2.8	
3. Beverages		
Fruit juice and Soft drinks	2.3.1	Litre/year
Wine & Beer	2.3.2	Litre/year
Spirits	2.3.3	Litre/year

3. **How many full time students did the College have in the past year?**

[1] Campus Residents ________________

[2] Non Campus Residents ____________

4. **Please fill in the information for the short courses held in the past year.**

Course	Duration (days)	No. of Participants		
		Campus Residents	Non-Campus Residents	
			Local	Non Local
4.1.1	4.2.1	4.3.1	4.4.1	4.5.1
4.1.2	4.2.2	4.3.2	4.4.2	4.5.2
4.1.3	4.2.3	4.3.3	4.4.3	4.5.3
4.1.4	4.2.4	4.3.4	4.4.4	4.5.4

5. **How many staff did the college have in the past year?**

[1] Sleat Residents ________________

[2] Non Sleat Residents ____________

6. **Did you purchase any furniture and electrical appliances and other equipments in the past year?**

[1] Yes Go to question 7

[2] No

7. **Please list the items you purchased.**

Type		Quantity	Unit
Furniture			
Items	**Material**		
7.1.1	7.2.1	7.3.1	7.4.1
7.1.2	7.2.2	7.3.2	7.4.2
7.1.3	7.2.3	7.3.3	7.4.3
7.1.4	7.2.4	7.3.4	7.4.5
7.1.5	7.2.5	7.3.5	7.4.6
7.1.6	7.2.6	7.3.6	7.4.7
Electrical & Electronic Appliances			
7.1.7		7.2.7	7.3.7
7.1.8		7.2.8	7.3.8
7.1.9		7.2.9	7.3.9
7.1.10		7.2.10	7.3.10
7.1.11		7.2.11	7.3.11
7.1.12		7.2.12	7.3.12
7.1.13		7.2.13	7.3.13
7.1.14		7.2.14	7.3.14
Other items			
Paper		7.2.15	7.3.15
Books		7.2.16	7.3.16
Others (specify)__________________________		7.2.17	7.3.17

8. **How many bags of waste per week do you produce?**

Type of waste bags	Number of bags per week	Bag size (Litre)
Un-separated Waste	8.1.1	8.2.1
Separated Waste		
Plastic /Food waste (excluding composted waste)	8.1.2	8.2.2
Paper(excluding composted cardboard)	8.1.3	8.2.3
Glass	8.1.4	8.2.4
Textiles	8.1.5	8.2.5
Cans	8.1.6	8.2.6
Others (specify) ________________	8.1.7	8.2.7
Composted Waste	8.1.8	8.2.8

ENERGY

9. Please estimate how much energy your college consumed last year. (If you have your utility bills, please check them; otherwise please give us an estimate.)

Energy source	Quantity consumed	Unit	Approximate cost (£)
Electricity			
i) Heating	9.1.1	kWh	9.2.1
j) Other purposes	9.1.2	kWh	9.2.2
LPG			
i) Cooking	9.1.3	Litres	9.2.3
j) Heating	9.1.4	Litres	9.2.4
Oil	9.1.5	Litres	9.2.5
Wood	9.1.6	Tonnes	9.2.6
Coal	9.1.7	Tonnes	9.2.7
Peat	9.1.8	Tonnes	9.2.8
Others including renewable (specify) ________________	9.1.9		9.2.9

10. Where and how do you think you can reduce your energy consumption?

____

____

TRANSPORT

11. Please fill in the types of vehicles, their fuel consumption and their mileage in the table below.

Vehicle Type [1]Car, [2]van, [3]lorry, [4]motor cycle, [5]boat and Others: please specify	Miles/year	Fuel Type	Fuel Consumption (litres /year)
11.1.1	11.2.1	11.3.1	11.4.1
11.1.2	11.2.2	11.3.2	11.4.2
11.1.3	11.2.3	11.3.3	11.4.3

Annex 1.6 Schools Brief Questionnaire

SCHOOLS

FOOD CONSUMPTION

1. **How much money did the school spend on food in the past year?**

____

2. **What is the amount of food cooked or served for students in the past year?**

Type of food	Average Consumption	Unit
1. Animal based		
Red Meat	2.1.1	lbs /year
White Meat	2.1.2	lbs /year
Fish and seafood	2.1.3	lbs /year
Milk	2.1.4	Litre/year
Milk products (butter, cheese, cream)	2.1.5	lbs /year
Egg	2.1.6	Number/year
Others (specify)_____________	2.1.7	
2. Plant Based		
Cereal and bread	2.2.1	lbs /year
Potatoes	2.2.2	lbs /year
Oil products (margarine)	2.2.3	lbs /year
Sugar (includes candies and chocolates)	2.2.4	lbs /year
Coffee & Tea	2.2.5	litre/year
Vegetables	2.2.6	lbs /year
Fruits	2.2.7	lbs /year
Others (specify)_____________	2.2.8	
3. Beverages		
Fruit juice and Soft drinks	2.3.1	Litre/year
Wine & Beer	2.3.2	Litre/year
Spirits	2.3.3	Litre/year

3. **How many staff did the school have in the past year?**

[1] Sleat Residents _______________

[2] Non Sleat Residents ____________

4. **Did you purchase any furniture and electrical appliances and other equipments in the past year?**

   [1] Yes   Go to question 5

   [2] No

5. **Please list the items you purchased.**

Type		Quantity	Unit
Furniture			
Items	**Material**		
5.1.1	5.2.1	5.3.1	5.4.1
5.1.2	5.2.2	5.3.2	5.4.2
5.1.3	5.2.3	5.3.3	5.4.3
5.1.4	5.2.4	5.3.4	5.4.5
5.1.5	5.2.5	5.3.5	5.4.6
5.1.6	5.2.6	5.3.6	5.4.7
Electrical & Electronic Appliances			
5.1.7		5.2.7	5.3.7
5.1.8		5.2.8	5.3.8
5.1.9		5.2.9	5.3.9
5.1.10		5.2.10	5.3.10
5.1.11		5.2.11	5.3.11
5.1.12		5.2.12	5.3.12
5.1.13		5.2.13	5.3.13
5.1.14		5.2.14	5.3.14
Other items			
Paper		5.2.15	5.3.15
Books		5.2.16	5.3.16
Others (specify)__________________________		5.2.17	5.3.17

6. How many bags of waste per week do you dispose?

Type of waste bags	Number of bags per week	Bag size (Litre)
Un-separated Waste	6.1.1	6.1.2
Separated Waste		
Plastic /Food waste (excluding composted waste)	6.2.1	6.2.2
Paper	6.3.1	6.3.2
Glass	6.4.1	6.4.2
Textiles	6.5.1	6.5.2
Cans	6.6.1	6.6.2
Others (specify)	6.7.1	6.7.2

7. Do you produce any other kind of waste that was not listed in the previous table?

Type of waste	Quantity	Units	Collected by
7.1.1	7.1.2	7.1.3	7.1.4
7.2.1	7.2.2	7.2.3	7.2.4
7.3.1	7.3.2	7.3.3	7.3.4
7.4.1	7.4.2	7.4.3	7.4.4
7.5.1	7.5.2	7.5.3	7.5.4
7.6.1	7.6.2	7.6.3	7.6.4
7.7.1	7.7.2	7.7.3	7.7.4

ENERGY

8. Please estimate how much energy the school consumed last year. (If you have your utility bills, please check them; otherwise please give us an estimate.)

Energy source	Quantity consumed	Unit	Approximate cost (£)
Electricity			
k) Heating	8.1.1	kWh	8.1.2
l) Other purposes	8.2.1	kWh	8.2.2
LPG			
k) Cooking	8.3.1	Litres	8.3.2
l) Heating	8.4.1	Litres	8.4.2
Oil	8.5.1	Litres	8.5.2
Wood	8.6.1	Tonnes	8.6.2
Coal	8.7.1	Tonnes	8.7.2
Peat	8.8.1	Tonnes	8.8.2
Others including renewable (specify) _______________	8.9.1		8.9.2

9. Where and how do you think you can reduce your energy consumption?

____

TRANSPORT

10. Does the school use its own or hired means of transportation?

1 Yes **Go to question 11**

2 No

11. Please fill in the types of vehicles, their fuel consumption and their mileage in the table below.

Vehicle Type [1]Car, [2]van, [3]lorry, [4]motor cycle, [5]boat and Others: please specify	**Miles/year (2007)**	**Fuel Type**	**Fuel Consumption (litres /year)**
11.1.1	11.1.2	11.1.3	11.1.4
11.2.1	11.2.2	11.2.3	11.2.4
11.3.1	11.3.2	11.3.3	11.3.4

Annex 1.7 Medical Center Brief Questionnaire

MEDICAL CENTRE

ENERGY

1. **Please estimate how much energy the medical centre consumed last year. (If you have the utility bills, please check them; otherwise please give us an estimate.)**

Energy source	**Quantity consumed**	**Unit**	**Approximate cost (£)**
Electricity			
m) Heating	1.1.1	kWh	1.1.2
n) Other purposes	1.2.1	kWh	1.2.2
LPG			
m) Cooking	1.3.1	Litres	1.3.2
n) Heating	1.4.1	Litres	1.4.2
Oil	1.5.1	Litres	1.5.2
Wood	1.6.1	Tonnes	1.6.2
Coal	1.7.1	Tonnes	1.7.2
Peat	1.8.1	Tonnes	1.8.2
Others including renewable (specify) ________________	1.9.1		1.9.2

2. Where and how do you think you can reduce your energy consumption?

____

____

MATERIAL AND WASTE

1. **Did you purchase any furniture and electrical appliances and other equipments in the past year?**

[1] Yes Go to question 4

[2] No

2. Please list the items you purchased.

____

____

Note: Number & Type of Material (furniture)

3. How many bags of waste per week do you dispose?

Type of waste bags	Number of bags per week	Bag size (Litre)
Un-separated Waste	5.1.1	5.1.2
Separated Waste		
Plastic /Food waste (excluding composted waste)	5.2.1	5.2.2
Paper	5.3.1	5.3.2
Glass	5.4.1	5.4.2
Textiles	5.5.1	5.5.2
Cans	5.6.1	5.6.2
Others (specify) _______________	5.7.1	5.7.2
Composted Waste	5.8.1	5.8.2

4. Do you produce any other kind of waste that was not listed in the previous table?

Type of waste	Quantity	Units	Collected by
6.1.1	6.1.2	6.1.3	6.1.4
6.2.1	6.2.2	6.2.3	6.2.4
6.3.1	6.3.2	6.3.3	6.3.4
6.4.1	6.4.2	6.4.3	6.4.4
6.5.1	6.5.2	6.5.3	6.5.4
6.6.1	6.6.2	6.6.3	6.6.4
6.7.1	6.7.2	6.7.3	6.7.4

ANNEX 2. FORMULAS USED IN THIS REPORT

Direct Energy Ecological Footprint

CO_2 emission (tonnes) =CO_2 emission factor for different fuel (tonnes/kWh) x quantity of energy consumed (kWh)

CO_2 area (ha) = (CO_2 emission (tonnes) x Carbon responsibility)/CO_2 sequestration factor (t/CO_2 ha yr)

Ecological Footprint of Direct Energy (gha) = CO_2 area (ha) x equivalence factor for forest land (gha/ha)

Area to grow the wood (ha) =Quantity of wood consumption (tonnes)/sustainable yield of the forest (tonnes/hectare)

Ecological foot print of Forest Land (gha) =Area required to grow the wood (ha) x equivalence factor for forest land (gha/ha)

Ecological Footprint of Built Land (gha) =Built area required (ha) x equivalence factor for built land (gha/ha)

Transport Ecological Footprint

Car Travel

Total Carbon Emissions (Kg) = Total fuel consumption (liters) x uplift factor x weight of $C0_2$ per liter of fuel (Kg)

Ecological Footprint Energy Land(gha) = Total Carbon Emissions (Kg) x Carbon responsibility /Sequestration Rate (t/CO2/ha/yr) x Equivalence factor of forest land (gha/ha)

Ecological Fooprint Built Land for Road (gha) = Total Road Area (ha) x Road Share x Equivalence factor of built land (gha/ha)

Air Travel

Total Carbon Emissions = Total distance traveled(Km) x Carbon emission per passenger Kg/Km x Uplift factor 1x Uplift factor 2

Ecological footprint for energy land (gha) = Total Carbon Emissions x Carbon responsibility/ Sequestration Rate (t/CO2/ha/yr) x Equivalence factor of forest land (gha/ha)

Material Ecological Footprint

Energy Land (ha) = Weight of material(ton) x Emboided energy of material (MJ/ton) x CO_2 emission (kg/kwh) x Carbon responsibility/Sequestration rate (t/CO_2/ha/yr)

Ecological Footprint of Energy Land (gha) = Energy Land (ha) x Equivalence factor for energy land(gha/ha)

Ecological Footprint of Forest Land (gha) = Weight of paper (ton) x (Volume of wood (m^3/ton) / average yield (m^3/ha/y)) x equivalence factor for forest land (gha/ha)

Waste Ecological Footprint

Energy Land(ha) = Total landfilled waste generated (ton) x emboided energy of waste(MJ/ton) x CO_2 emission(kg/kWh) x Carbon responsibility/Sequestration rate(t/CO_2/ha/yr)

Ecological footprint of Landfilled Waste (gha)= Energy land (ha) x Equivalence factor for energy land (gha/ha)

Ecological Footprint of Forest Land (gha) = Paper waste (ton) x [Volume of wood (m^3/ton) / average yield (m^3/ha/y)] x equivalence factor for forest land (gha/ha)

Ecological Footprint of Recycled Waste (gha) = Total embodied energy x % embodied energy savings for recycling x carbon responsibility x equivalence factor of energy land(gha/ha) x [CO_2 emission (kg CO_2/kWh) /sequestration rate (ton CO_2/ha/a)]

Ecological Footprint of Waste Transportation(gha) **=** [emission factor kg CO_2/km x travel distance (km/y) / average load per waste truck (tonnes)] x uplift factor /CO_2 emission sequestration x equivalence factor of energy land(gha/ha)

Food Ecological Footprint

Step 1:

Area(ha) =Total consumption of food (kg) x Yield(kg/ha)

Step 2:

Energy Land (ha) = Area (ha) x Emboided energy(MJ/kg) x CO_2 emission(kg/kwh) x Carbon responsibility/Sequestration rate(t/CO_2/ha/yr)

Step 3:

Ecological Footprint of Energy Land (gha) = Energy Land (ha) x Equivalence factor for energy land (gha/ha)

Ecological Footprint of Crop Land (gha) = Total consumption from crop land (kg) x Equivalence factor for crop land(gha/ha)/Yield factor(kg/ha)

Ecological Footprint of Sea Land (gha) =Total consumption from sea land (kg) x Equivalence factor for sea land/Yield factor (kg/ha)

Ecological Footprint of Pasture Land (gha) = Total food consumption from pasture land (kg) X Equivalence factor for pasture land / Yield factor (kg/ha)

ANNEX 3. CONVERSION TABLES

Area	$distance^2$
volume	$distance^3$
velocity	distance/time
force	mass x acceleration = mass x distance / $time^2$
energy	force x distance = mass x $distance^2$ / $time^2$
power	energy/time = mass x $distance^2$ / $time^3$

Length

1 meter (m)	= 3.281 feet (ft)
1 mile (mi)	= 1609 m = 1.609 km = 5280 ft = 1760 yd

Area

1 hectare (ha) (metric unit)	10000 m^2 = 2.47 acre=0.01 km^2
1 m^2	= 10.76 ft^2 = 1.196 yd^2 = 10^{-6} km^2
1 km^2	= 10^6 m^2 = 0.388 mi^2
1 acre	= 43560 ft^2 = 4047 m^2 = 0.4047 ha

Volume

1 liter (l)	= 10^3 cm^3 = 10^3 ml = 1.057 US quarts (qt) = 0.2642 gallons (gal)
1 m^3	= 10^3 liters = 264.2 US gal = 35.31 ft^3
1 cord (of wood)	= 128 ft^3
1 gallon (gal)	= 3.785 liters
1 barrel petroleum (bbl)	= 42 U.S. gal = 0.159 m^3

Time

1 year (yr)	= 3.15 x 10^7 seconds (s) = 8760 hour (hr) = 365 day (d)

Mass

1 kilogram (kg, the mass of one liter of H_2O)	= 10^{-3} gram (g) = 2.205 pounds* (lb) = 10^{-3} tonne (te)
1 tonne (te, metric ton)	= 10^6 g = 2205 lb = 1.1 short ton
1 ton (English short ton)	= 2000 lb = 0.907 te = 907 kg

Energy

1 foot-pound (ft-lb)	= 1.356 j = 0.324 cal
1 joule (j)	= 0.239 cal. = 9.48 x10^{-4} Btu
1 kilocalorie (kcal)	= 1000 cal = 1 Calorie (food)
1 kilowatt-hour (kWh)	= 3.6 x10^6 j = 3412 Btu = 859.1 kcal
1 quad (quadrillion Btu)	= 10^{15} Btu = 1.055 x10^{18} j = 293 x10^9 kWh = 33.45 GWy
1 therm	= 10^5 Btu
1 tonne of coal equivalent (tce)	= 25.8 Gj = 22.14 x 10^6 Btu
1 tonne of oil equivalent (toe)	= 7.33 bbl oil = 45x10^9 j = 4.3 x 10^6 Btu

Source:IPCC

ANNEX 4. SUMMARY CALCULATION

Annex 4.1 Material Footprint Calculation

SUMMARY MATERIAL FOOTPRINT	Residential			Public			Small business			Clan Donald			5 Hotel			Commercial			Total weight	Total EF	Total CO2
	Weight	EF	CO2 [tonnes]	Weight	EF	CO2 [tonnes]	Weight	EF	CO2 (ton)	Weight	EF	CO2 (ton)	Weight	EF	CO2 (ton)	Weight	EF (gha)	CO2 [tonnes]	[tonnes]	[gha]	[tonnes]
APPLIANCES																					
Kitchen	18,45	26,12	122,37																18,45	26,12	122,4
Entertainment	0,98	6,55	30,70																0,98	6,55	30,7
Office	1,76	12,44	58,28	0,98	7,08	33,16	0,21	1,50	7,05							0,21	1,50	7,05	2,95	21,02	98,5
other appliances							0,20	0,49	2,29				10,44	0,06	0,30	10,64	0,55	2,59	10,64	0,55	2,6
other items	0,00	0,00	0,00										0,32	0,00	0,009		0,00	0,01	0,00	0,00	0,0
Car	0,00	22,27	104,34																0,00	22,27	104,3
Furniture	8,59	14,36	34,69				0,15	0,13		0,01	0,10	0,05		0,00	0,02	0,16	0,23	0,06	8,74	14,59	34,8
New houses	712,66	97,10	454,94																712,66	97,10	454,9
Shared infrastructure					781,78	3663,04														782	3663,0
																				970	4511
																			per capita	1,15	5,33

Annex 4.2 Waste Footprint Calculation

Summary Waste Footprint	Description	Energy/forest land					Energy from Waste	Crop land		Total Ecological Footprint	Total CO2 emissions	EF percapita
		Landfill	Recycling	Transportation		Landfill processing		Landfill	recycling			
				Landfill	Recycling							
		gha	gha	gha	gha	gha	gha	gha	gha	gha	ton	[gha/P]
2007												
Residential		345,1	-23,0					48	-12			
Commercial		148,1	-15,1					20	-5			
Total		493,2	-38,1	256,0	1,1	0,8	**713,0**	68	-17	1477	837	1,74
CO2 emission [kg]		2094,4	152,6	827368,3	3423,2	3816,4						
2010	waste growth rate:2% annually	513,0	-34,2	262,1	1,1	0,8		70,7	-17,5	796	857	0,94
CO2 emission [kg]		2178,2	121,0	846943,2	3500,9	3969,1						
scenario 1	highland target waste 2010 composting rate ,recycling rate 27%, E 27%, landfill 33%	425,39	-83,395	216,7	3,1	0,31401	0,97	45,318	-42,834	566	714	0,67
CO2 emission [kg]		1825,3	293,9	700401,3	9903,1	1471,3						
scenario 2	community composting plant, with composting rate 33% , and recycling rate 27%	425,39	-83,395	209,9	3,1	0,47754		45,31848	-42,83373	558	686	0,66
CO2 emission [kg]		2178,2	121,0	678126,7	3500,9	2237,5						

Annex 4.3 Food Footprint Calculation

Categories		Crop land	Pasture land	Sea Land	Energy/forest land	Total EF	Porcentage of contribtion to the total food footprint	EF percapita
		[gha]	[gha]	[gha]	[gha]	[gha]	[%]	[gha/P]
Household	Animal based	99.81	442.59	60.98	77.53			
	Plant based	112.63			55.21			
		212.44	442.59	60.98	132.74	849		
Hotel	Animal based	12.91	55.24	7.41	9.14			
	Plant based	6.33			3.81			
		19.24	55.24	7.41	12.95	95		
College	Animal based	6.09	36.40	2.07	3.70			
	Plant based	2.41			1.38			
		8.51	36.40	2.07	5.09	52		
Total	Animal based	104	458	62	80			0.83
	Plant based	112			59			0.20
		215	458	62	139	874.71		**1.03**
Tourist	Animal based	6	139	3	4			
	Plant based	3			3			
		9	139	3	8	158	15.3%	-

Annex 4.4 Transportation Footprint Calculation

Unit	Transport Type & Mode							
	Petrol Cars	Diesel Cars	Bicycles	Bus	Train	Ferry	Taxi	Air
Transport mode-kms	5,319,913.88	4,352,656.81		657,233.63	132,630.66	25,635.76	96.88	2,600,748.23
Average km travelled per Liter	15.43	14.86		14.86				
Total fuel consumption (£)	344,787.10	292,958.31		44,235.52				
Transport mode-kms per Person	5,410.86	4,427.07						
Average unit price of fuel (£/L)	1.02	1.05						
kg of CO2 emission per passenger km				0.05	0.06	0.28	0.11	0.16
Uplift factor	1.45	1.45	0.05	1.60				
Weight of CO2 in Kgs per litrel of fuel	2.36	2.5	0	2.5				
Sequesterial Area (m2/Kg of CO2 per year)	2.58	2.58	2.58	2.58	2.58	2.58	2.58	2.58
Total Carbon Emissions (Kgs)	*1179861.473*	*1061973.88*	*0*	*176942.096*	*7957.8396*	*7178.013*	*10.65735*	*1022257.65*
Carbon responsibility	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
Equivalent Factor of forest land	1.34	1.34	1.34	1.34	1.34	1.34	1.34	1.34
Equivalent Factor of built land	2.21	2.21	2.21	2.21	2.21	2.21	2.21	2.21
Percentage of land used mode of transport	86%	86%	5%	86%				
Total area of roads/run ways (m2)	61.98	61.98	61.98	61.98				
Energy Land(gha)	*281.19*	*253.09*	*0.00*	*61.12*	*1.90*	*1.71*	*0.00*	*243.63*
Built Land (Degraded Land) gha	*117.79806*	*117.79806*	*6.84872*		-			*0.00*
Foot print	281.19	253.09	0.000	61.12	1.90	1.71	0.0025	243.63
Footprint per capita	0.37	0.33	0.00	0.08	0.00249	0.00	0.00	0.32
Total Foot Print	*967.28*							
Total Foot Print per capita	*1.27*							

Annex 4.5 Biocapacity Calculation

Types of land	Physical area	Area	Equivalence Factor	Yield Factor	Biocapacity	Biocapacity
	[ha]	[ha/cap]	[gha/ha]	[-]	[gha/cap]	[gha]
CROPLAND	275,40	0,33	2,50	2,44	1,98	1.679,94
PASTURE LAND	13615,04	16,07	0,49	2,70	21,27	18.017,60
SEA LAND	847,00	1,00	0,36	1,00	0,36	307,22
INLAND WATER	185,30	0,22	0,36	0,06	0,005	4,03
FOREST LAND	2707,12	3,20	1,34	2,26	9,70	8.215,82
BUILT LAND	341,96	0,40	2,21	2,44	2,17	1.841,66
				SUB-TOTAL	35,50	30.066,26
				BIODIVERSITY(12%)	4,26	3.607,95
				TOTAL SUPPLY	31,24	26.458,31

Annex 4.6 Energy Calculation

Categories	Energy Source	Consumption	Unit	Unit (kWh)	CO_2 (Tonnes)	CO_2 Area (ha)	Area (ha)	EF(gha)	EF(per Capita)	Land Type
Household	Electricity	2,793,476.72	kWh	2,793,476.72	1,134.15	201.71		242.06	0.32	Energy
	LPG	302,310.79	litres	2,225,343.31	422.82	75.20		90.24	0.12	Energy
	Oil	426,271.61	litres	4,582,419.84	1,191.43	211.90		254.28	0.33	Energy
	Wood	672.58	tonnes	2,055,111.53			47.35	56.82	0.07	Forest
					3.94	0.70		0.84	0.00	Energy
	Coal	28.24	tonnes	173,781.86	52.13	9.27		11.13	0.01	Energy
	Peat	5.82	tonnes	15,783.75	6.02	1.07		1.29	0.00	Energy
Small Business	Electricity	250,420.22	kWh	250,420.22	101.67	18.08		21.70		Energy
	LPG	346.85	litres	2,553.19	0.49	0.09		0.10		Energy
	Oil	2,080.00	litres	22,360.00	5.81	1.03		1.24		Energy
Shabal Mor Osatig	Electricity	610,000.00	kWh	610,000.00	247.66	44.05		52.86	0.62	Energy
	LPG	124,992.00	litres	920,080.00	174.82	31.09		37.31	0.44	Energy
Hotels	Electricity	382,359.59	kWh	382,359.59	155.24	27.61		33.13		Energy
	LPG	118,392.13	litres	871,497.59	165.58	29.45		35.34		Energy
	Oil	14,640.00	litres	157,380.00	40.92	7.28		8.73		Energy
	Wood	1.20	tonnes	3,666.67			0.08	0.10		Forest
					0.007	0.0012		0.0015	0.00	Energy

Office	Electricity	34,563.00	kWh	34,563.00	14.03	2.50		2.99		Energy
Ferry Terminal	Electricity	24,491.50	kWh	24,491.50	9.94	1.77		2.12		Energy
Medical Centre	Electricity	22,222.22	kWh	22,222.22	9.02	1.60		1.93		Energy
	Oil	2,325.58	litres	25,000.00	6.50	1.16		1.39		Energy
Clan Donald Trust	Electricity	519,966.00	kWh	519,966.00	211.11	37.55		45.06		Energy
	LPG	3,196.00	litres	23,526.11	4.47	0.79		0.95		Energy
	Oil	7,533.29	litres	80,982.87	21.06	3.74		4.49		Energy
Primary School	Electricity	100,945.60	kWh	100,945.60	40.98	7.29		8.75		Energy
Holiday Cottages	Electricity	649,247.87	kWh	649,247.87	263.59	46.88		56.26		Energy
TOTAL	**Electricity**	**5,387,692.72**	**kWh**	**5,387,692.72**	**2,187.40**	**389.04**	**-**	**466.84**		**Energy**
	LPG	**549,237.76**	**litres**	**4,043,000.20**	**768.17**	**136.62**	**-**	**163.95**		**Energy**
	Oil	**452,850.48**	**litres**	**4,868,142.71**	**1,265.72**	**225.11**	**-**	**270.13**		**Energy**
	Wood	**673.78**	**tonnes**	**2,058,778.20**	**-**	**-**	**47.43**	**56.92**		**Forest**
					3.94	**0.70**	**-**	**0.84**		**Energy**
	Coal	**28.24**	**tonnes**	**173,781.86**	**52.13**	**9.27**	**-**	**11.13**		**Energy**
	Peat	**5.82**	**tonnes**	**15,783.75**	**6.02**	**1.07**	**-**	**1.29**		**Energy**
							GRAND TOTAL	**971.100**	**1.15**	