ORKNEY-WIDE ENERGY AUDIT 2014

Report to Orkney Renewable Energy Forum &
Community Energy Scotland
Issued by Aquatera Ltd, December 2014
Part 1: Energy Sources and Uses

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The Orkney-Wide Energy Audit 2014

Part 1: Energy Sources and Uses

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Steering for this project was provided by Community Energy Scotland and OREF. The wider OREF membership and Orkney Islands Council provided comment on the draft report.

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Executive Summary

For over 30 years Orkney has been at the forefront of the development of a variety of new renewable energy technologies. Over the last 15 years locally generated renewable energy has made a progressively greater contribution to Orkney's electrical energy demand.

In 2013 Orkney generated renewable output equivalent to 103% its electrical demand a feat unrivalled for an area of similar scale and energy capacity in the UK.

However, the grid infrastructure has not seen the necessary investment to allow this success to continue. Whilst the UK is striving to de-carbonise the electricity system, Orkney now has to turn off renewable generation at times when, and in places where, the distribution grid has insufficient capacity to cope with energy being generated. Furthermore the lack of future connection opportunities is hindering the growth of renewable energy within Orkney.

These grid inadequacies have had a series of profound impacts upon the potential for Orkney to maximize the opportunities associated with renewable energy generation. In particular the situation is also threatening the financial viability of established community energy schemes and indeed other locally owned energy schemes. As a result Community Energy Scotland (CES) were funded to commission an energy audit for Orkney. The aim being to establish more precisely the dynamics of energy generation and demand across the Orkney Islands and then to evaluate a number of potential options to tackle energy issues identified.

The results of the 'Energy Audit' are presented in this document. An evaluation the possible 'Switching Options' are presented in a separate accompanying document. The two documents are however interdependent.

'Switching Options' examines a wide range of possible means to better use the abundant renewable generation in Orkney and allows a comprehensive comparison. In doing so it shows options that may be regarded as preferential. The options themselves need further discussion as they fall to different groups / companies, each of whom will have different perspectives / appetite / ability to act.

It is strongly recommended that the options found most favorable following wider discussion should be acted upon with urgency. The audit shows what is happening, the options are laid out, the opportunity to act is upon us.

The Commission

CES worked with the Orkney Renewable Energy Forum (OREF) who commissioned local consultancy Aquatera to undertake an audit and propose elements of a switching strategy. Aquatera carried out the work in conjunction with Dr. Edward Owens from Heriot–Watt University, School of the Built Environment who provided Demand Side Management expertise.

Aquatera also gratefully acknowledge the input from the companies, individuals and organisations in Orkney who willingly contributed data and other assistance to help achieve a successful outcome to this study.

Aims

The specific aims of the commission were:

- To quantify Orkney's existing energy sources and energy uses;
- To indicate the potential suitability and value of mechanisms for energy conversion and new energy uses which could lead to an increase in local electrical energy demand; and
- To seek energy adaptation strategies with both short and medium term benefits, but to focus upon solutions that could be delivered at an appropriate scale by 2017.

Alongside these primary aims it was desired that any energy adaptation strategies should:

- decrease energy costs;
- provide grid balancing by moving electrical demand to the outlying production zones; and
- reduce CO_2 emissions.

Background

As a remote rural island community, with no gas network, Orkney has over recent decades had a high dependency on imported oil and coal as its main sources of energy. Due to the transportation costs involved in delivering such fossil fuels to Orkney they are more expensive in Orkney than in other parts of the UK. The higher costs of fuel together with the age and setting of the housing stock and the cool and windy climate means that Orkney suffers high rates of fuel poverty. Statistically Orkney is amongst the worst affected areas in the United Kingdom (UK) along with the Western Isles and Shetland.

The combination of harsh climate and high fuel costs make renewables a cost effective way of harvesting the energy needed.

Previous energy audits for Orkney have been undertaken, most recently in 2005 by the Northern and Western Isles Energy Efficiency Advice Centre a now defunct part of Orkney Islands Council (OIC). Since the last audits were undertaken the energy environment within Orkney has changed considerably due to the growth of renewables.

Orkney now boasts the highest proportion of electricity from renewables (mainly large wind), but also has the greatest number of micro-wind generators of any county in the UK. Homeowners and businesses within the county have installed renewable technologies, some with the support of government funded schemes. Orkney now has a number of community owned wind turbines, hundreds of micro-turbines and a world leading marine tidal and wave energy industry.

However, there is a limit to the amount of renewable energy that Orkney can accommodate without further grid upgrades and that limit has been reached. Therefore Orkney is faced with the need to find innovative solutions in order to continue producing, and increase the amount of, renewable energy generated within the county. Some of the problems are only limitations of capacity at particular pinch-points within the local electrical distribution network. Some limitations are due to the capacity limitations on the main cables linking Orkney to the national grid.

Report structure

The report seeks to provide an overview of the energy status of the islands and proposes 'switching options' to alleviate curtailment challenges and to minimise fuel imports. The report is split into three main sections across two documents:

In the 'energy sources and uses' document

- The first section analyses the current energy sources in the county.
- The second section gives an overview of the energy usage on the islands and

In the 'switching options' document

- The third section outlines potential switching options.

The third section outlines potential 'Switching Options'. These options have the potential to alleviate some of the problems that are currently being faced, by: managing the existing grid; increasing electrical demand by switching from other fuels or creating new demand; storage or demand management. A number of these possible options arose from the work of the Orkney Grid Group, which was established by OIC and supported by OREF after the new connection moratorium imposed by Scottish and Southern Energy (SSE) in September 2012.

Overview of Energy Sources

Included in this analysis is all the energy produced on the Orkney Islands and exported, as well as the fuel imported into the islands. The energy sources are categorised as follows:

- Imported fossil fuels
- Imported biomass
- Imported and exported electricity
- Indigenous biomass
- Local electricity generation

Most of the fossil fuels described below are imported into Orkney. The exception is the gas used at the Flotta Oil Terminal which is derived from the inward flow of oil and gas from the North Sea fields. This gas is used at the terminal for heating and electrical generation.

Electricity is imported/exported to and from Orkney via two 33kV (20MVA) submarine cables. In addition over the last decade or so Orkney has seen a large increase in the amount of renewable energy generations. Renewable energy production from wind in particular has increased dramatically. Renewables are now the predominant source of electricity in Orkney.

The following pie chart (Figure 1) shows an average of annual use of electricity, fossil fuels and peat used (2009 - 2013).

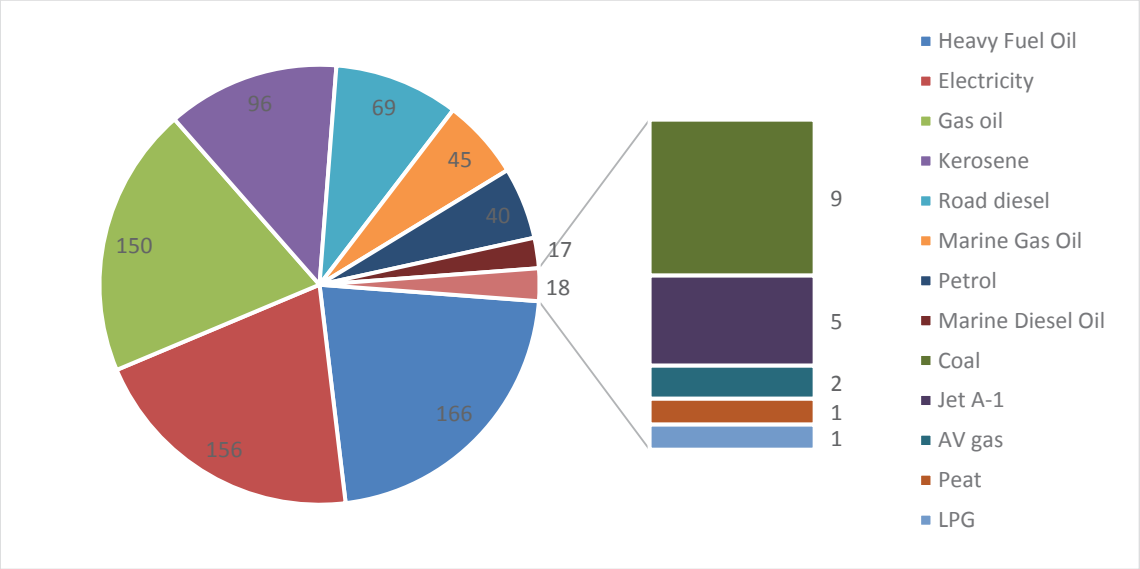

Figure 1 Average fuel use 2009 - present (GWh)

The audit showed that where data is available the use of fossil fuels that their consumption looks to have stayed fairly stable over the last decade, with the exception of coal for which the use has more than halved in the last decade.

Figure 2 shows that renewable energy generation, on the other hand, has increased significantly over the last 10 years from around 17GWh in 2003 to about 140GWh in 2013. At the same time the net amount of electricity imported has fallen from around 50GWh in 2009 to almost zero in 2013.

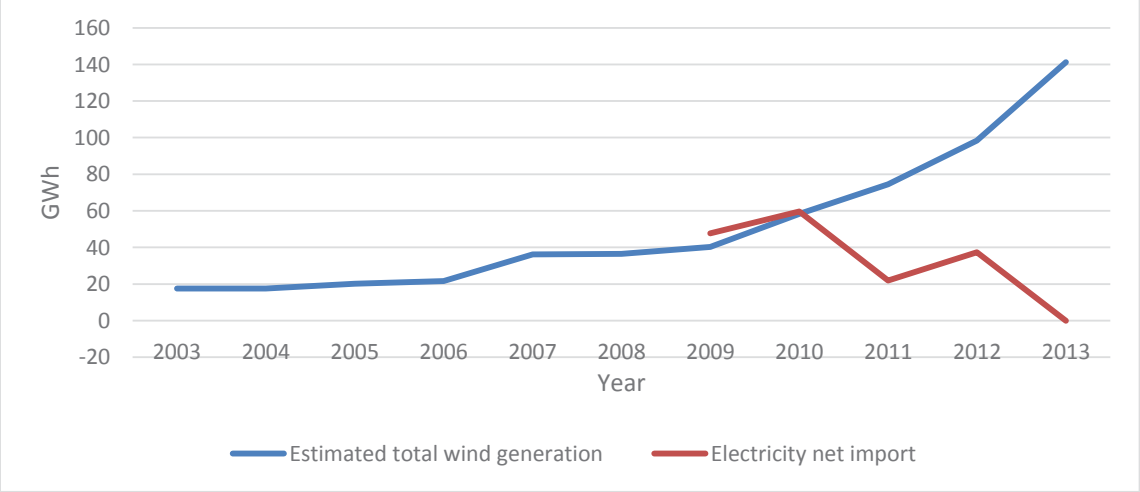

Figure 2 Estimated total wind generation and net import of electricity

In 2009 an Active Network Management (ANM) system, which monitors the electrical network and controls the grid, was set up in Orkney to allow additional generation on the system without expensive grid upgrades. However even with this system in place the growth of the wind (and other renewables) has meant that in September 2012, Scottish and Southern Energy Power

Distribution (SSEPD) imposed a moratorium on all new generation, except the very smallest generators.

The Audit shows over 48MW of wind energy generators are currently operational in Orkney. These turbines range in size from less than a kW to several MWs. The total energy generated from wind is now estimated to be around 140GWh per year (as shown in Figure 2). Photovoltaic systems have also become increasingly common but to a lesser extent than wind generators with a total of 1.2MW of photovoltaic panels now installed.

A growing wave and tidal energy industry in Orkney is set to contribute substantially to the overall renewable energy generation picture in the future. In 2011, the Crown Estate held a leasing round for commercial and demonstration marine energy project in the Pentland Firth and Orkney waters. There are currently leases held for 550MW of wave energy projects and 530MW of tidal projects in Orkney waters. Currently these technologies are still at an early stage of development and therefore the number of GWh is small day-to-day, but this is expected to rise in the future as the testing periods increase and the industry moves towards commercial projects.

Data Gaps

In terms of data collection for these first two sections, there were limitations to the data collected for several reasons:

- The length of time to obtain data;
- Format of data;
- Confidentiality of data relating to areas such as grid; and
- Concern in the business community as to whether the overall approach to moving away from existing fuel types and behaviours would impact upon their current business.

Consequently certain assumptions were made in estimating the energy sources and uses were necessary. Where assumptions have been made they are highlighted in the body of the report.

Important data gaps to note are:

- Modelled data (from Department of Energy and Climate Change (DECC)) was used for most of the fossil fuel analysis due to lack of real world data. It may be important in the future to verify this modelled data.
- Crude oil, of which the majority of the energy embodied simply passes through Orkney's Flotta Oil Terminal and was not considered in this audit.
- Of the crude oil, passing through the Flotta Oil Terminal a small fraction is used at the oil terminal for heating and electrical generation. The oil terminal uses gas extracted from the crude oil on site for heating and to produce electricity. The total energy used in this way is equivalent to 0.49GWh but it is not clear how much energy is used for heating, electricity generation or flared as data from Talisman was unavailable.
- Kirkwall Power Station ceased regular operation in the late 1990's after the second cable to the mainland was commissioned. It still runs monthly for test purposes and covers faults and system outages on mainland links. This small contribution to the overall electricity supply was not considered in this audit.
- Indigenous biomass in the form of peat is used at Highland Park as part of the whisky making process in addition peat is still used as a fuel source in Orkney for domestic heating however it is difficult to estimate the extent of peat cutting for domestic use as no records are kept.
- Short rotation wood crops and fuel produced from anaerobic digesters have also been on Orkney but on a trial basis. No assessment was made of the uptake.
- Imported biomass comes into Orkney as logs, wood pellets, eco-logs, peat and waste wood. This was not possible to quantify but is likely to increase in the future due to the Renewable Heat Incentive (RHI), a government financial support programme, which pays participants of the scheme that generate and use renewable energy to heat their buildings.
- Marine fuel was analysed using a bottom up approach. Many of the major energy users are included in the study but it is understood that the larger fishing vessels and a number of dive boats have direct contracts with the main fuel suppliers. Therefore the data presented in this report is not a complete picture of fuel use by boats operating in Orkney.
- Air transport data only includes any fuel imported into Orkney. A significant portion of the fuel used on routes to and from the County will come in on planes refuelling at other airports and could not be accounted for in this report.

Recommendation 1. The data gaps identified should be proactively filled on a continuous basis. The necessary data flows be identified, managed, commissioned and the audit should therefore be maintained as a decision informing device.

Overview of Energy Uses

Energy use in Orkney can be broadly categorised into three main energy uses and further broken down by sector as follows:

1. Buildings and Utilities:
    - Domestic;
    - Commercial/industrial;
    - Public administration
2. Transport:
    - Road ;
    - Marine;
    - Air
3. Residual fuel use, which encompasses all other terrestrial energy i.e. the use of red diesel (gas oil) for non-road transport and other static powered machinery in the following sectors:
    - Industrial;
    - Agriculture;
    - Public administration

Figure 3 shows transport is the major energy use (343GWh) followed by buildings and utilities (268GWh). Note that air transport figures included here is likely to be significantly underestimated for routes to and from Orkney due to refuelling elsewhere.

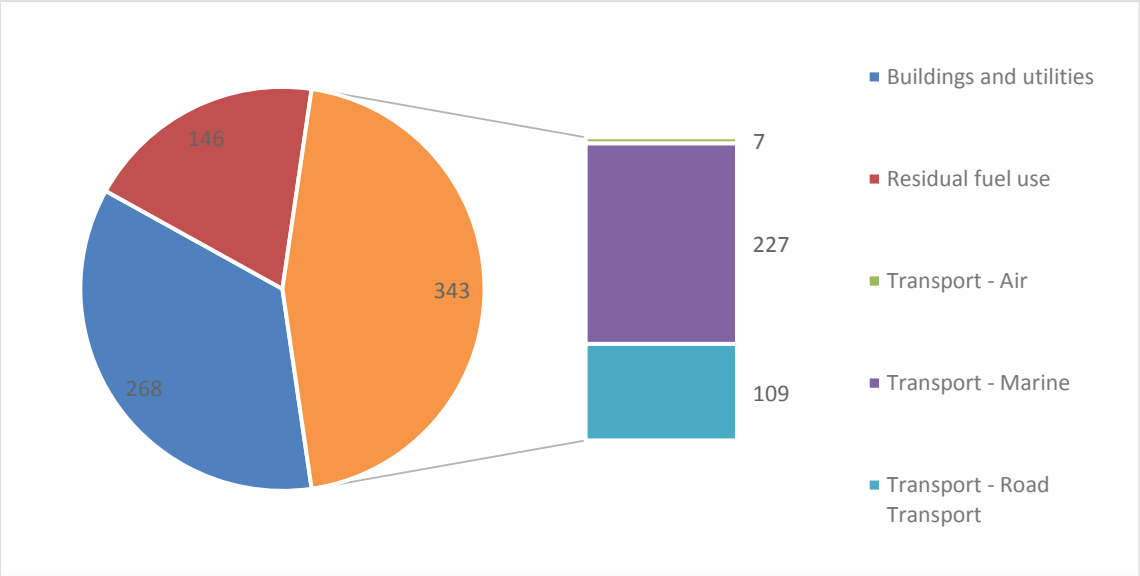

Figure 3 Energy use by end use

The following charts further break down Figure 3.

The transport section of the Figure 3 is broken down further by sector in Figure 4a and shows that the largest energy use in the transport sector is for ferry services to the mainland (184GWh) followed by domestic road transport (61GWh).

As explained above air transport is included but is likely to be significantly underestimated.

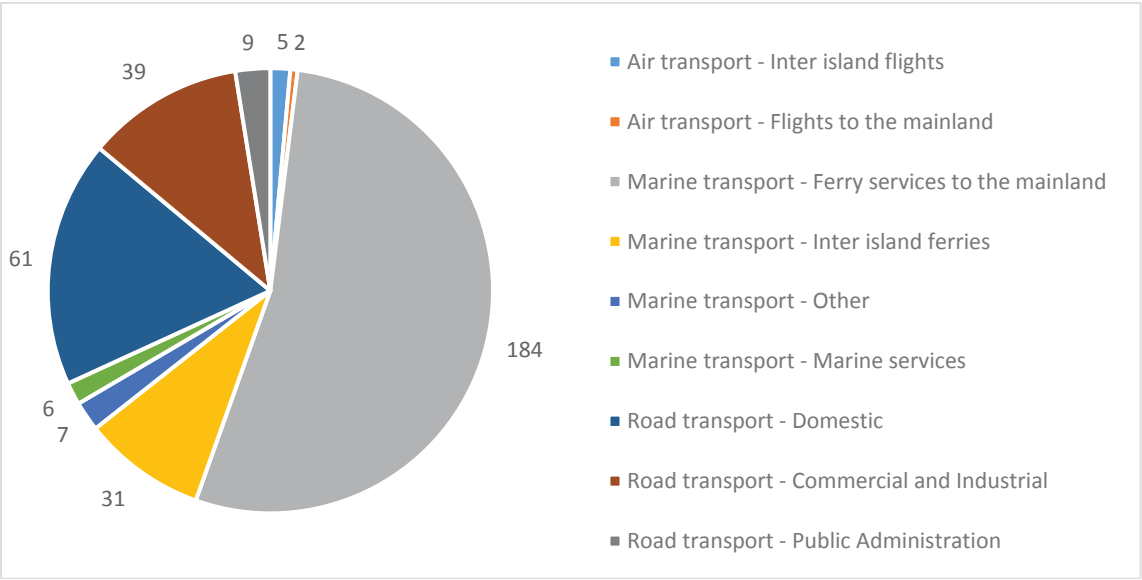

Figure 4a Energy use by sector - Breakdown of energy use in the transport sector

Figure 4b shows that the largest energy use in buildings and utilities is for domestic energy use (170GWh) and Figure 4c shows that for 'residual fuel' is mostly for agricultural uses (112GWh).

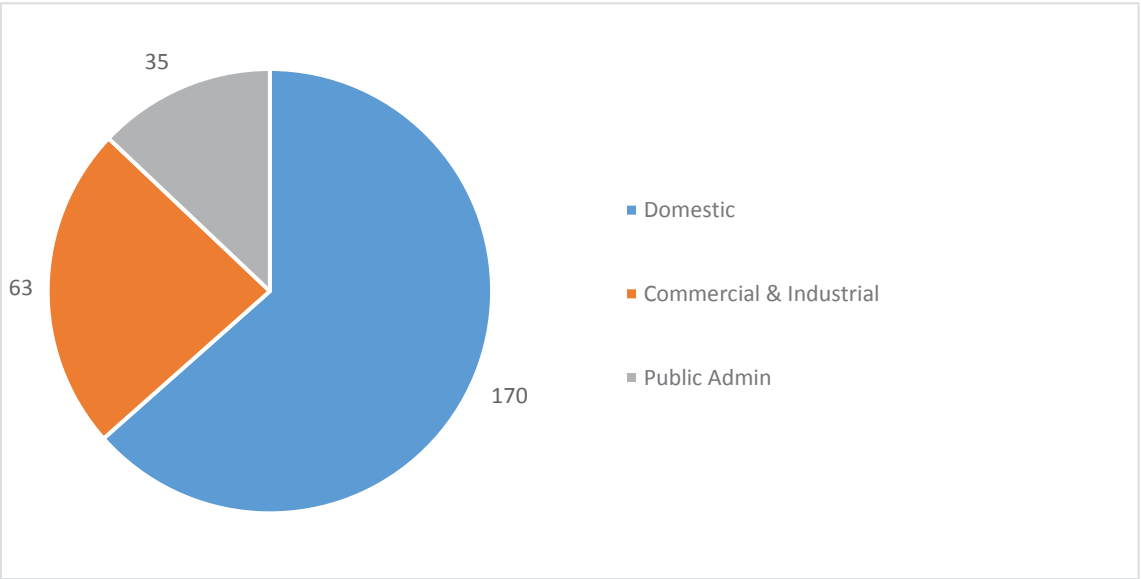

Figure 4b Energy use by sector - Breakdown of energy use by buildings and utilities by sector

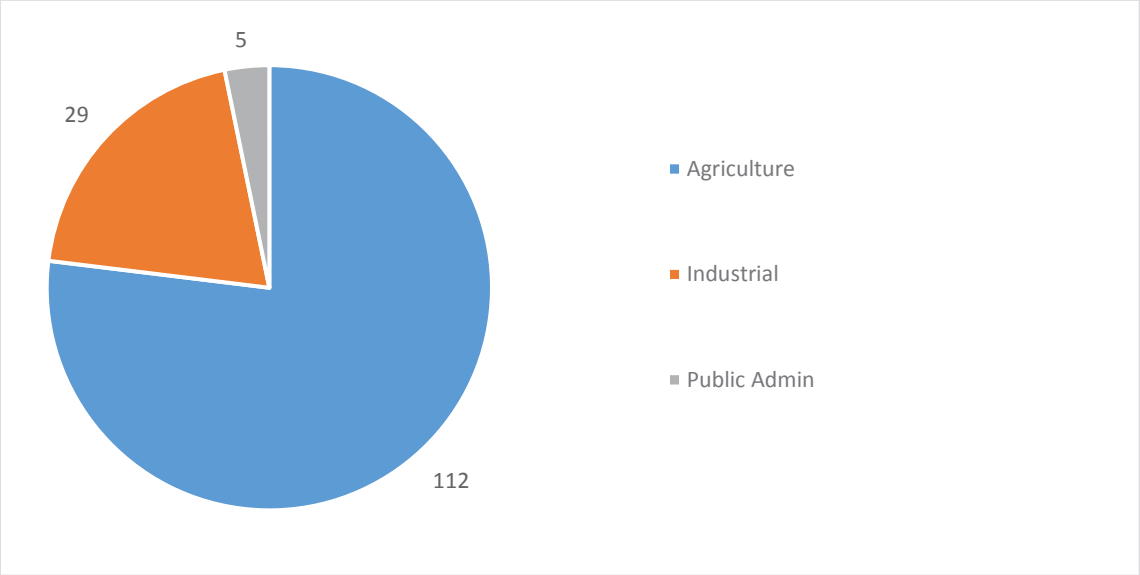

Figure 4c Energy use by sector - Breakdown of residual fuel use by sector

The Sankey diagram (Figure 5) below shows the different fuels in the middle and who uses them on the left and the purpose on the right. The size of each of the blocks is proportional to the total amount of energy. The width of the lines is proportional to the energy flow.

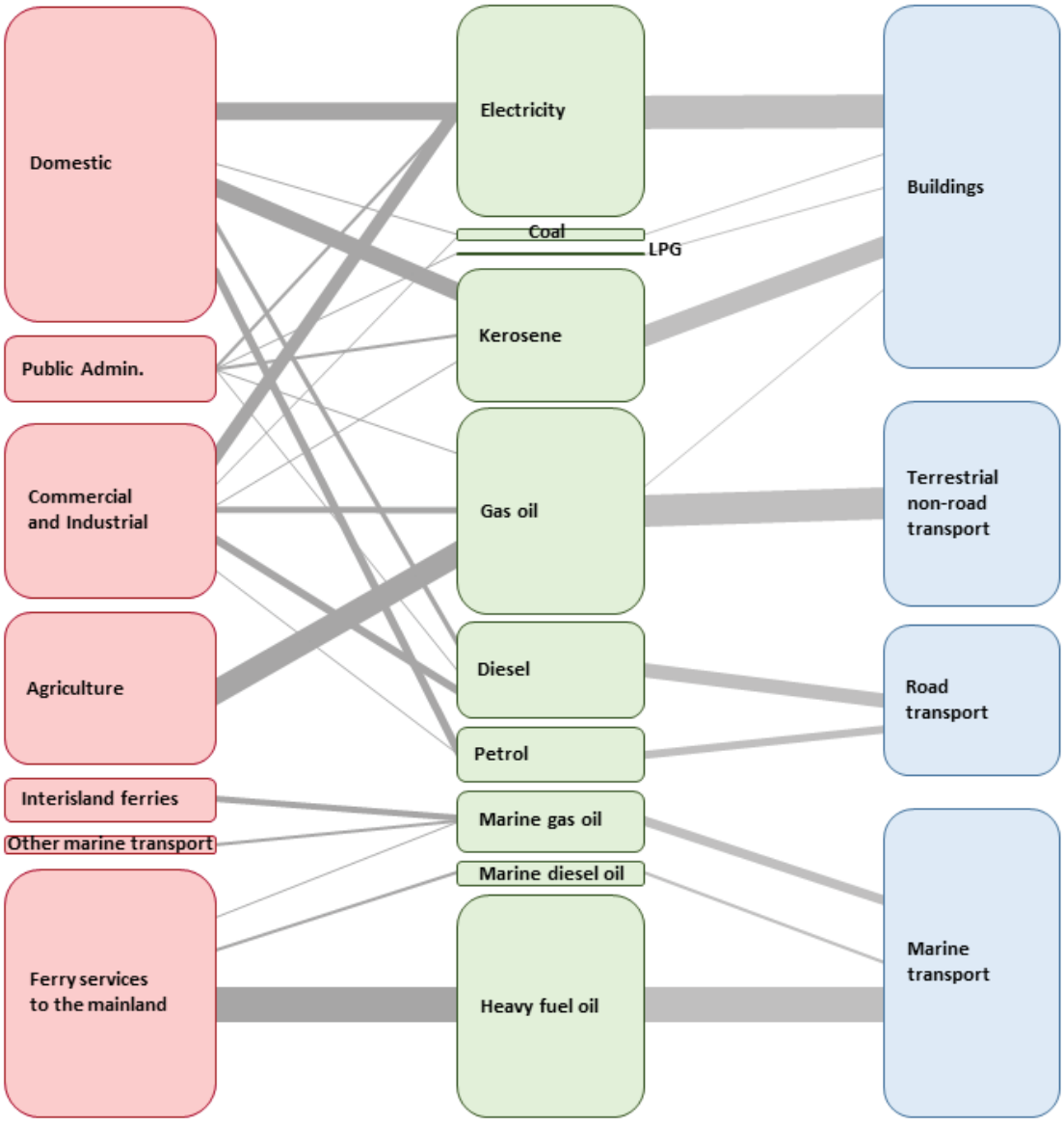

Figure 5 Sankey diagram (excluding air transport and peat)

Note: This diagram only considers present fuel uses. It does not represent imported commodities which have a high embodied energy and which could feasibly be produced in Orkney. The diagram only shows what is happening, not what could happen.

Potential Energy Strategies

Any energy strategy adopted will need to consider the options available. The 'Switching Options' section of the report considers a wide range of ideas and will seek to inform the strategy to be developed. Systematic examination seeks to quantify the benefits and costs of each proposal.

In the project brief it was made clear that options should aim to:

- decrease the target market's annual spend on fuel;
- provide grid balancing by moving electrical demand to the outlying production zones; and
- reduce CO_2 emissions.

The energy switching options considered have been grouped into four broad categories: grid management, time-switching strategies, fuel switching and demand increase strategies as shown in Figure 6. The colours indicted the suitability of each option where dark green shows the most promising options and dark red the least promising.

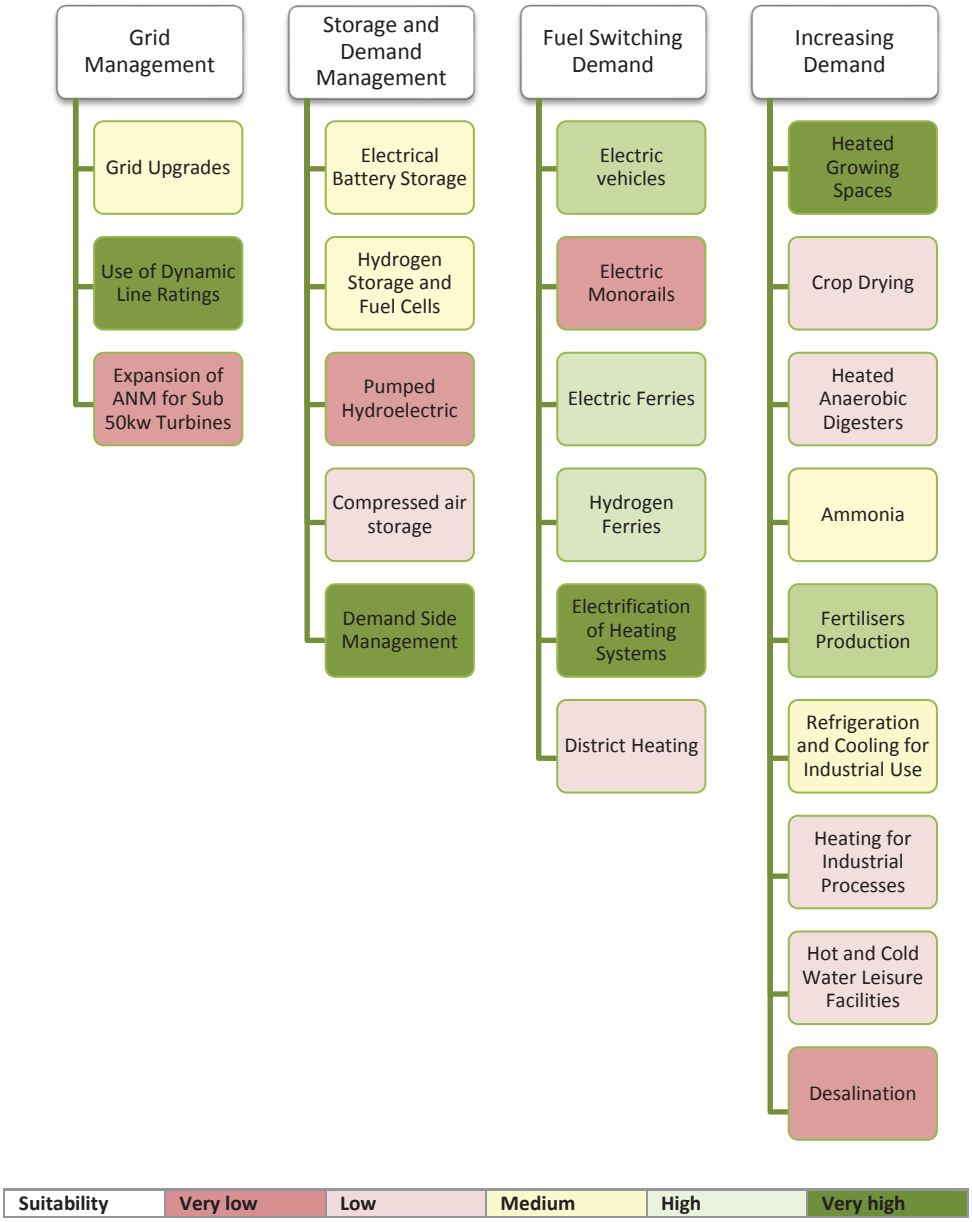

Figure 6 Summary of switching options

The options that have been deemed to be most promising are those that are at an appropriate stage of development and appropriate for the nature, scale and culture of Orkney. Initial investigations show that business cases should be developed to take forward the preferred options.

The most promising options are listed below:

- Use of dynamic line ratings
- Demand side management
- Electric vehicles
- Electric ferries
- Hydrogen ferries
- Electrification of heating systems
- Heated growing spaces
- Fertiliser production

Note: This is not an order of priority.

In order for any of these options to be adopted a number of specific actions will need to be taken, these are outlined in the following table:

Strategy	Action
Use of dynamic line ratings	• Further engagement with the network operator to explore the potential to role this out further.
Demand side management	• Further engagement with Heriot-Watt University to maximise outcomes and opportunity for transferring outcomes from Findhorn to Orkney. • Further investigation, if data is available, to look at the scale of the grid balancing benefit on the individual DNO zones.
Electric vehicles	• The installation of 'Rapid chargers' at key locations to support the use of EVs. • Extensive installation of 'Fast Charge' points throughout the county. • Direct engagement with constrained turbine owners to encourage a shift to EVs. • Engagement with national grant awarding bodies to support a shift towards procurement of EVs.
Electric ferries	• Undertake a feasibility study into the potential of replacing existing diesel ferries which are at the end of their commissioning periods with electric ferries or hybrid electric ferries. • Engagement with other relevant stakeholders that have experience with electric ferries (e.g. Caledonian Maritime Assets Ltd.) to learn from their experiences. • Engagement with battery technology developers to match the demand of the vessels for longer routes. • Exploration of the potential for 'cold ironing' should be explored with the ferry operators.
Hydrogen ferries	• Undertake a feasibility study into the potential of replacing existing diesel ferries which are at the end of their commissioning periods with hydrogen ferries or hybrid hydrogen ferries. • Engagement with other relevant stakeholders that have experience with electric ferries (e.g. Caledonian Maritime Assets Ltd.) to learn from their experiences. • Engagement with fuel cell technology developers to match the demand of the vessels for longer routes. • Exploration of the potential of conversion of engines to directly burn hydrogen.
Electrification of Heating Systems	• Analysis of EST home analytics data to look at the heating systems used in the current housing stock to give a better estimate of the market. • Determine and publicise impact on customers looking at installation costs versus running costs of different heating systems including RHI payments for applicable technologies. • Investigate the likely demand created by switching fuels for small turbine owners

	who are currently using non electrical heating for hot water and space heating. • Economic analysis cost of wind to heat versus selling to the grid and electric heating. • Engage with national and local grant awarding bodies to establish grant for local residents encouraging shift from fossil fuel to electric for installation costs • Engagement with SSE or other operator to establish opportunity for Orkney specific tariff to encourage a shift from fossil fuel to electric.
Heated growing spaces	• Discussions with Eday and Benbecula projects to discuss opportunities and pitfalls. • Engagement with grant awarding organisations i.e. Rural Payments and Inspectorate Directorate in relation to agricultural land. • Engage with local shops to establish demand and willingness to participate and purchase locally grown produce. • Research cooperative style food supply business to support number of small farms supplying local shops.
Fertiliser production	• Undertake a feasibility study into the cost effective production of locally produced ammonia fertilisers. • Identification of applicable locations to determine possible sites of operation that minimise impact. • Determining the seasonal demand for ammonia based fertilisers could highlight the level of production and storage that would be required. • Gathering data on the use of ammonia based fertilisers of neighbouring regions to Orkney. • Data on the variety of fertilisers used within Orkney.

Recommendation 2. The actions above need to be allocated to specific organisations following review and agreement.

In addition to the above there is also a need to consider the following:

- How Orkney as a whole (i.e. different organisations) will approach the strategic delivery of such projects(s) in order that the Orkney communities benefit from the decisions and actions taken, by working together and supporting each other;
- Who the key organisations are within Orkney to take forward the outcomes? Will it be a number of existing organisations, is it a single organisation, is it a new organisation?
- What relationships need to be established and/ or strengthened outwith Orkney to maximise opportunities within Orkney;
- How can Orkney businesses be provided with/secure the support (skills, knowledge) to maximise the opportunities for new business streams (i.e. shifting away from fossil fuels); and
- Understanding and calculating the risks associated with individual projects or the wider ambition based on different future scenarios (helping alleviate concerns or identifying previously unknown risk factors).

Conclusions

The 'Energy Audit' and the 'Switching Options' reports together provide the most comprehensive baseline of energy information for Orkney to date. They should now be used as a benchmark to help determine energy related policy and decision making within and outwith Orkney.

This study has shown what Orkney has achieved so far. Over the last 15 years Orkney has installed enough capacity to generate 103% of its electricity demand in 2013. The islands have now reached the point where further increases in generation capacity are limited by the grid.

There is however still a desire and a need to develop more renewables energy projects on Orkney in order to decrease our dependence on fossil fuels and to further increase the economic and social contribution made by renewable energy to the Orkney Islands.

The proposed options provide highlight where potential is most likely to be found as well as indicating the actions that need to be taken to deliver in these areas. The benefits to Orkney as a whole for investigating and strategically switching the way it sees and used energy can enhance its reputation as an energy laboratory as well as achieve the direct financial and environmental benefits associated with increased electrification.

Further initiatives and work is now required to turn this list of options into real 'on the ground' activities and projects. It is hoped that these documents will help focus discussions in order that the next level of decision making can take place and action to address the energy issues facing Orkney can be taken.

The Options show that delivery will be a community wide activity. It will need to be delivered by different agencies working together. Undertaking such actions in the Orkney community will take a considerable effort and need strong co-ordination to be successful.

However the potential of the options to give communities real energy security and a range of income generating projects is clear.

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1 Introduction

1.1 Purpose

Limits within the electrical distribution network both around Orkney and to the UK national grid are restricting the productive use of renewable resources, therefore limiting the potential to limit CO_2 emissions and contribute to climate change targets.

The purpose of this report is twofold. Firstly, to provide a baseline of information relating to energy sources and uses within Orkney in order to understand fully the currently pattern of fuel use within the islands and to help identify fuel uses that could be replaced with energy produced from renewable resources. The purpose also involves presenting options that could help alleviate some of the problems and maximise the socio-economic and environmental benefits for Orkney.

It is recognised that energy efficiency, in parallel with renewable energy generation and reducing the use of but switching from fossil fuels, however it was not within the remit of this report to examine energy efficiency measures.

This report is aimed at policymakers, planners, business community, entrepreneurs and community groups to help identify opportunities that would support socio-economic and environmental benefits for Orkney.

1.2 Background

Orkney has a population of around 21,530[1] and one which is ageing but boasts a relatively low unemployment rate in comparison to the rest of Scotland with agriculture, fishing and tourism the main sectors.

As a remote rural island community with no access to the gas network, the transportation costs imported fossil fuel prices tend to be higher than on the mainland and together with the nature of the housing stock and the northerly climate Orkney is frequently being quoted as suffering the highest rates of fuel poverty in the United Kingdom (UK) along with the Western Isles[2] and Shetland. With the increasing costs of fossil fuels the ability to generate renewable energy within the islands and maximise its natural resources is one that Orkney has taken advantage of.

On the other hand in 2013 Orkney produced over 100% of its electricity demand from renewable energy sources exceeding Scottish Government target by seven years. Over the years homeowners and businesses have introduced other micro-renewable technologies supported through government funded schemes. Orkney has a number of community owned wind turbines, hundreds of micro-turbines and a world leading marine tidal and wave energy industry. However without further grid upgrades, the amount of renewable energy Orkney can generate is limited. Therefore Orkney is faced with opportunity of establishing innovative solutions in order to continue producing, and increase the amount of, renewable energy generated in the county.

[1] http://www.orkney.gov.uk/Files/Business-and-Trade/Economic_Review/Orkney_Economic_Review_2012-13.pdf

[2] http://www.sruc.ac.uk/info/120428/rural_scotland_in_focus/1265/2014_rural_scotland_in_focus_report

1.3 Aims of the Study

The specific aims of the study were set out in the original tender document, these are described below:

- To quantify existing energy sources and energy uses; and
- To indicate the potential suitability and value of converting uses of imported energy into indigenous, electrically driven demand.

Crucial to the second aim were three priorities including:

- to decrease the target market's annual spend on fuel;
- to provide grid balancing by moving electrical demand to the outlying production zones; and
- to cause a reduction in CO_2 emissions.

1.4 Scope

The scope of the project involved collecting data associated with the sources and uses of energy in those islands that are populated within Orkney. It focused on key areas such as buildings and utilities, transport and commercial activity. The data collected refers largely to time periods over the last 10 years but is of a variable nature depending on what data that was available and accessible.

In relation to the second aim the geographical scope extends beyond this to consider key locations such as Shetland, Caithness and Aberdeen. These are locations from which Orkney receives imported goods and has established transport routes. Where such goods are products that could be suitable for manufacturing in Orkney and have high energy demand then these were also considered. The project sought opportunities to generate short/medium term benefits using technologies available at an appropriate scale by 2017.

1.5 Report structure

The report seeks to provide an overview of the energy status of the islands and proposes 'switching strategies' to alleviate curtailment challenges and to minimise fuel imports. The report is split into three main sections across two documents:

In the 'energy sources and uses' document (this document)

- The first section analyses the current energy sources in the county.
- The second section gives an overview of the energy usage on the islands and

In the 'Switching Options' document

- The third section outlines potential switching options.

The third section outlines potential 'Switching Options'. These options have the potential to alleviate some of the problems that are currently being faced, by: managing the existing grid; increasing electrical demand by switching from other fuels or creating new demand; storage or demand management. A number of these possible options arose from the work of the Orkney Grid Group, which was established by OIC and supported by OREF after the new connection moratorium imposed by Scottish and Southern Energy (SSE) in September 2012.

1.6 Previous Studies

The last energy audit was undertaken for Orkney by the Northern and Western Isles Energy Efficiency Advice Centre (NWEEAC) a part of the Orkney Islands Council (OIC) in 2005. Before this a further two audits were undertaken in years 1991 and 1996. The focus of the 2004 report was on the quantification of local energy production and the balance of energy supplies imported from outwith Orkney.

Since the last audits were undertaken the energy environment within Orkney has changed considerably particularly in relation to the growth of renewables. As a result monitoring and reporting of energy performance has increased particularly for public sector and energy intensive businesses through various legislative and regulatory requirements (i.e. Climate Change Agreements, European Trading Scheme, and Carbon Reduction Commitments). As a result this report has been able to use this information. The large number of small and medium sized enterprises within Orkney do not have such stringent requirements and therefore accurate data for industry sectors as a whole is harder to establish.

Even with this in mind this report is the most comprehensive energy audit undertaken for Orkney to date.

1.7 Limiting Factors

The following were deemed to be limiting factors:

- The length of time to obtain data;
- Format of data;
- Confidentiality of data relating to areas such as grid; and
- Concern in the business community as to whether the overall approach to moving away from existing fuel types and behaviours would impact upon their current business.

Due to these limiting factors certain assumptions in estimating the energy sources and uses were necessary. These have been highlighted throughout the body of the report.

1.8 Commercially Sensitive

The data in this report has received appropriate approvals for its inclusion and dissemination. In some cases parties that were approached deemed the information that was requested to be commercially sensitive and as a result this has either not been included or the data has been presented in a way that does not directly link it to an individual or organisation. Where information is available but not accessible it has been identified as a data gap. Where data gaps have been identified further discussions to establish how these should be approached will need to be held.

2 Energy Sources

2.1 Overview

Included in this analysis is all the energy produced in Orkney and exported, as well as the fuel imported into Orkney. The energy sources are categorised as follows:

- Imported fossil fuels
- Imported biomass
- Imported and exported electricity
- Indigenous biomass and biofuel
- Local electricity generation

The following pie chart shows an average of annual use of fossil fuels and peat used (2009 - 2013). Where data is available the use of fossil fuels looks to have stayed fairly stable over the last decade, with the exception of coal for which the use has more than halved in the last decade. Infographics alongside each fuel section in the following chapter indicates the proportion of the fuel use compared to the total average fuel use from 2009- present.

Renewable energy generation, on the other hand has increased significantly over the last 10 years as shown below around 17GWh in 2003 to about 140GWh in 2013. At the same time the amount of electricity imported has fallen from around 50GWh in 2009 to almost zero in 2013.

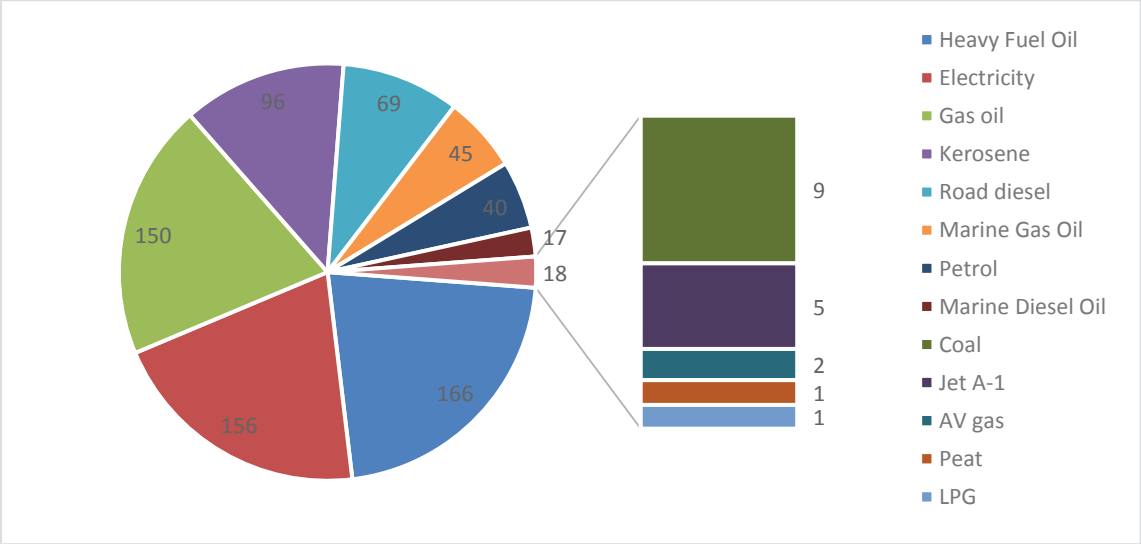


Figure 2.1 Average fuel use 2009-present (GWh)

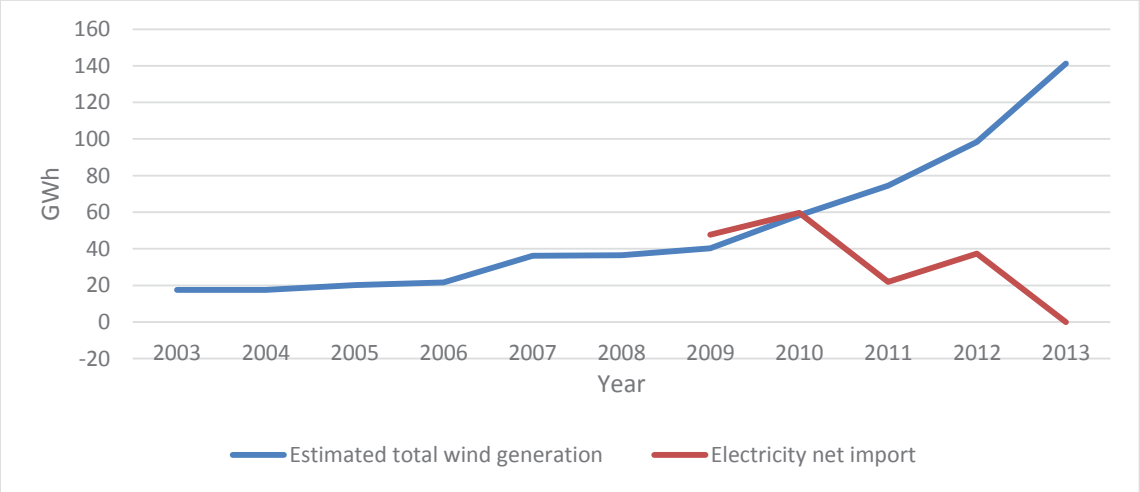


Figure 2.2 Estimated total wind generation and net import of electricity

2.2 Imported Fossil Fuels

The fossil fuels described below are all imported into Orkney, with the exception of the gas which is extracted from the oil that passes through the Flotta Oil Terminal and is used at the terminal for heating and electrical generation.

For the most part data directly from suppliers in Orkney has been difficult to obtain therefore DECC's 'sub-national consumption datasets[3], which are published annually, have been used where no local data was available. Although this DECC data actually related to consumption rather than actual imports of fuel it can act as a surrogate as the amount of fuel storage will be relatively small.

DECC's sub-national energy consumption statistics are derived from the National Atmospheric Emissions Inventory. The methodology used to estimate these figures is summarised in,

- Sub-national methodology and guidance booklet[4] , and
- UK sub-national consumption of other fuels for 2005 – 2012: Estimates of non-gas, non-electricity and non-road transport energy consumption[5]

The data comes from two sources:

- Point sources – the National Atmospheric Emissions Inventory (NAEI) receives detailed data about individual large consumers of fuel in the industrial and commercial sector
- Spatially disaggregated data - national estimates of fuel consumption are spatially disaggregated throughout the United Kingdom based on various factors such as population

DECC advises users to recognise the limitations of the information contained in the datasets as they are based on modelled rather than real data, and as such are subject to potential modelling

[3] https://www.gov.uk/government/statistical-data-sets/sub-national-energy-consumption-statistics

[4]https://www.gov.uk/government/statistics/regional-energy-data-guidance-note

[5]https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/358018/uk_sub_national_consumption_of_other_fuels_2012.pdf

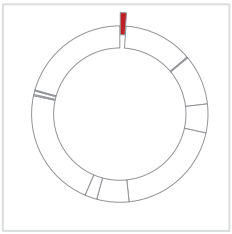
error, particularly the spatially disaggregated data. We have noted for each fuel use/sector how the estimates are made but there is no way to know how accurate these figures are.

It should also be noted that for some of the datasets the data available at the time of writing this report covered 2005 - 2011. 2012 data has recently been released.

The study obtained some data on imports of Kerosene, Gas Oil, DERV and Jet A1 from Scottish Fuels but no data from Highland Fuels was obtained therefore it was not possible to get a complete picture of what is imported into Orkney. Another route explored was the tonnage of fuel coming into Orkney by ship, this was provided by OIC Marine Services but is not broken down by fuel type.

Where there are dashes in the tables below no data was available.

2.2.1 Coal and Coal-Based Products



In Orkney, coal products are used largely for domestic heating purposes. The majority is imported into Orkney by bulk carrier and has decreased in the last few years to around 1000 tonnes per annum as shown in Table 2.1.

Table 2.1 Bulk coal imports

Unit	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Tonnes	2898	3873	3641	2443	1437	1486	985	1122	1067	1001	914
GWh	24.31	32.49	30.54	20.49	12.05	12.47	8.26	9.41	8.95	8.40	7.67

Source: OIC Marine Services

2.2.2 Kerosene

Kerosene is commonly used for commercial and domestic heating purposes. Kerosene is also called paraffin, heating oil or 28-second oil. It is supplied to end-users in Orkney by Scottish Fuels and Highland Fuels. DECC publishes statistics on total energy use at a local authority level which have been used to assume an annual use of kerosene. Note that this data does not break the petroleum products down into different fuel types so it is therefore assumed that for non-gas, non-electricity and non-road transport fuel applications that the fuel use in the domestic and commercial sectors would be for heating.

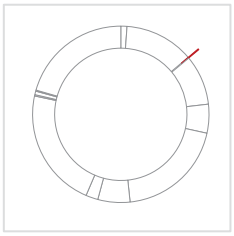
Table 2.2 below shows the assumed kerosene use in the domestic and commercial sectors published by DECC from 2005 - 2011 and data from OIC and NHS Orkney for kerosene use in public sector. Note that only 2010 data was available for NHS Orkney.

Table 2.2 Kerosene imports

Unit (GWh)	Source	2005	2006	2007	2008	2009	2010	2011	2012	2013
Domestic	DECC	80.63	85.02	74.96	79.04	78.58	89.58	69.23	-	-
Public Administration	OIC	14.58	12.62	15.01	15.00	14.75	15.36	12.96	15.71	13.13
	NHS	-	-	-	-	-	0.27	-	-	-
Commercial	DECC	3.97	3.29	2.44	2.91	2.01	2.35	2.25	-	-

Source: NHS Orkney, OIC and DECC (https://www.gov.uk/government/statistical-data-sets/estimates-of-non-gas-non-electricity-and-non-road-transport-fuels-at-regional-and-local-authority-level)[6]

2.2.3 LPG



Liquid Petroleum Gas (LPG or LP gas), also referred to as propane or butane, is used as a fuel in heating appliances, cooking equipment and some vehicles. There is no mains gas in Orkney but there will be a certain amount of LPG used in Orkney from bottled gas and supplied by road tankers. There are several bottled suppliers in Orkney but it was not possible to obtain data on consumption within Orkney from these suppliers, additionally DECC does not supply figures for bottled gas.

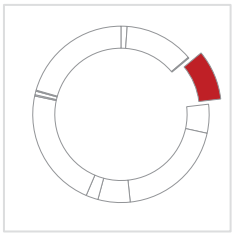
The data that is available is from OIC, which uses LPG at various properties (see Section 3.2.3). No long term data was available.

Table 2.3 LPG import by road tanker

Unit	Estimate of annual energy use
Litres	190000
GWh	1.37

Source: OIC

2.2.4 Road Diesel



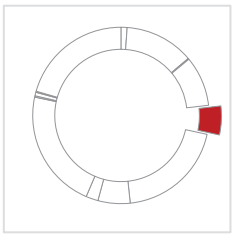
In the UK, diesel fuel for road use is commonly abbreviated DERV (Diesel Engine Road Vehicle). It is also known as auto diesel or white diesel. DECC publishes statistics on road transport which have been used to estimate the total road diesel usage in Orkney as shown in Table 2.4. This shows a slight upward trend.

Table 2.4 Road diesel imports

Unit	2005	2006	2007	2008	2009	2010	2011	2012
Tonnes	4416	4826	5148	5544	5416	5620	5559	5445
GWh	55.57	60.73	64.78	69.76	68.15	70.72	69.95	68.52

Source: https://www.gov.uk/government/statistical-data-sets/road-transport-energy-consumption-at-regional-and-local-authority-level.

2.2.5 Petrol



DECC publishes statistics on road transport which have been used to calculate the total petrol usage in Orkney as shown in Table 2.5. This shows a slight downward trend.

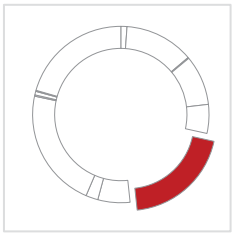
Table 2.5 Petrol imports

Unit	2005	2006	2007	2008	2009	2010	2011	2012
Tonnes	4105	4140	3917	3598	3445	3272	3037	2818
GWh	52.22	52.66	49.83	45.77	43.83	41.62	38.64	35.85

[6] Original data converted from ktoe to GWh. See Section 6.1.2 for conversion factors.

Source: https://www.gov.uk/government/statistical-data-sets/road-transport-energy-consumption-at-regional-and-local-authority-level.

2.2.6 Gas Oil



Gas oil (red diesel) is a low-duty form of diesel fuel[7]. Red diesel is dyed red and chemically marked in order to easily detect its use. It is used extensively throughout the construction, civil engineering, agricultural, marine[8], leisure and commercial industries. It is also used in static diesel powered machinery such as generators, pumps and industrial heating and cooling systems. Older domestic heating systems may also use red diesel[9].

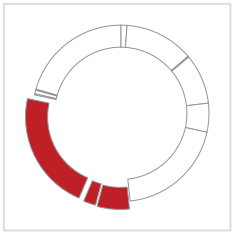
DECC publishes statistics on residual fuel use at a local authority level which have been used to derive an annual use of gas oil. Table 2.6 below shows that statistics published by DECC from 2005 - 11. Note that as this data does not break the petroleum products down into different fuel types, it has been assumed that the industrial and agricultural portion of their figures are gas oil. In addition a small amount of gas oil is used for heating systems by NHS Orkney.

Table 2.6 Gas oil imports

Unit	Source	2005	2006	2007	2008	2009	2010	2011
GWh	DECC	148.56	137.81	133.88	151.03	151.26	156.46	113.43
GWh	NHS						4.690	

Source: NHS and DECC (https://www.gov.uk/government/statistical-data-sets/estimates-of-non-gas-non-electricity-and-non-road-transport-fuels-at-regional-and-local-authority-level)[10]

2.2.7 Marine Fuels



The figures estimated by DECC do not include the marine sector which will be a major energy use in Orkney. In addition, one of the two suppliers of fuel was unable to provide data on fuel imported into Orkney. This should be noted as a data gap.

It has however been possible to collate a large proportion of the data based on the fuel usage of the inter-island and mainland ferries, data from OIC Marine Services on harbour craft and tugs as well as several of the main fuel suppliers which will constitute a large part of the overall usage of marine fuel.

Table 2.7 Total marine fuel oil and gas oil

Unit	Estimated annual fuel use 2009-present
Marine Gas Oil	44.60
Marine Diesel Oil	16.91
Heavy Fuel Oil	165.79
GWh	**227.3**

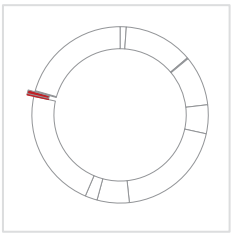
[7] https://www.gov.uk/fuel-duty

[8] https://www.gov.uk/government/publications/excise-notice-263-marine-voyages-excise-duty-relief-for-mineral-hydrocarbon-oil/excise-notice-263-marine-voyages-excise-duty-relief-for-mineral-hydrocarbon-oil

[9] http://www.chorleybottlegas.co.uk/docs/reddiesel.pdf

[10] Original data converted from ktoe to GWh. See Section 6.1.2 for conversion factors.

2.2.8 Aviation Fuel



There are two types of aviation fuel used in Orkney, Jet A-1 and AV Gas. Jet A-1 is conventional kerosene-based jet fuel, whilst AV Gas is a high-octane alternative used in lighter aircraft.

The aviation sector in Orkney is supplied by S & JD Robertson North Air Ltd, who have the capacity to hold 120,000 litres of Jet A-1 and 62,000 litres of AV Gas. North Air sources Jet A-1 and AV Gas from Scottish Fuels, are the sole importers of aviation fuel into Orkney. Imports of Jet A-1 over the last few years are shown in Table 2.8. In addition, approximately, 198,000 litres (1.8GWh) of AV Gas is imported into Orkney per annum[11]. These estimates do not include any refuelling at airports outside of Orkney which is likely to be the majority of fuel used on these routes.

Table 2.8 Jet A-1 imports

Unit	2011	2012	2013
Tonnes	368.875	299.237	571.470
GWh	4.42	3.59	6.85

Source: Scottish Fuels

2.2.9 Crude Oil

A large amount of crude oil comes ashore at the Flotta Oil Terminal. As the majority of the energy embodied in the oil simply passes through Orkney (by pipeline/ship), it has not been considered in this audit however a small fraction is used at the terminal for heating and electrical generation. This is considered in Section 0.

2.3 Biomass Imports

Biomass comes into Orkney in a number of different forms (Table 2.9). It has been difficult to obtain data from individual suppliers of biomass products within Orkney making it impossible to calculate a total annual energy supply figure for these fuels. The one supplier that did provide data (Forever Fuels a company based in Caithness) had imported 24 pallets of wood pellets in the last 18 months.

Table 2.9 Biomass imports

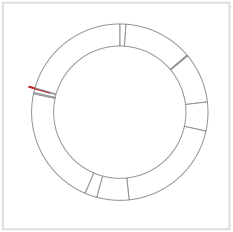
Logs	Wood pellets	Eco-logs	Peat	Waste wood
				
Suppliers to Orkney				
Shearers Orkney Aggregates Isbister Brothers	Shearers, Orkney Sustainable Energy Ltd,	Shearers Orkney Aggregates	Isbister Brothers Orkney Aggregates	NA

[11] Source: S & JD Robertson North Air Ltd

	Forever Fuels, Jewsons			

2.4 Indigenous Biomass and Biofuels

2.4.1 Peat



Highland Park uses peat in the whisky making process; cutting less than 300 tonnes of peat every year. Highland Park don't have accurate records going back to 2003 but the 300 tonnes per year varies by only 5 - 10 tonnes.

Peat is still used as a fuel source in Orkney for domestic heating however it is difficult to estimate the extent of peat cutting for domestic use as no records are kept.

Table 2.10 Peat cutting

Unit	Approximate annual amount cut by Highland Park
Tonnes	300
GWh	1.43

2.4.2 Short Rotation Wood Crops

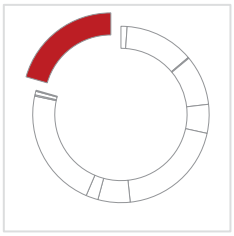
The Agronomy Institute at Orkney College (University of Highlands and Islands, UHI) have been carrying out experimental trials of willow as a biomass crop since 2002. Trials run by the Agronomy Institute showed that biomass yields of around six oven dry tonnes (ODTs) per hectare per year are achievable in Orkney. The Agronomy Institute research programme on short rotation coppice (SRC) willow started in 2002 as a result of interest in using the crop as a wood fuel by Orkney Housing Association Ltd (OHAL).

One of the main problems with small scale use of SRC willow is both the lack of specialist machinery and the cost of this machinery for harvesting and processing on a small scale. It is much too labour intensive to harvest and process manually. Partly as a result of the difficulties in harvesting SRC willow on a small scale, the Agronomy Institute has recently started to investigate short rotation forestry (SRF) which uses fast growing tree species but at a lower planting density than SRC willow. This would be more suited to harvesting manually and could be used to supply logs for domestic burning (willow stems are usually of too small a diameter for this). In collaboration with Forestry Commission Scotland (FCS), the Agronomy Institute has now helped to establish two SRF trials in Orkney (one on Shapinsay and one at Muddisdale Road) and is monitoring these trials for FCS as part of a UK-wide series of trials.

2.4.3 Anaerobic Digesters

There are no longer any operational AD plants in Orkney (pers. comm. Colin Risbridger), however the Westray Development Trust were successful in securing financial support through the Scottish Community and Householder Renewables Initiative (SCHRI) to research anaerobic digestion.

2.5 Electricity



The info graphic shown here shown total electricity consumption which is a combination of imported electricity and locally generated electricity mostly from renewable sources.

2.5.1 Description of the Orkney Network and the ANM system

Orkney is currently connected to the national grid via two 33kV (20MVA) submarine cables. This allows generators on Orkney (mainly wind but also wave, tidal, solar and gas) to export electricity to the Scottish Mainland and for energy to be imported from the mainland when generators on the island are not generating. Internally there are several spurs and circuits, one of these circuits connects the north isles to the mainland.

In 2009 an Active Network Management[12] (ANM) system was set up in Orkney which has allowed operators to connect to the grid at their own risk without substantial upgrades being necessary.

The ANM system monitors the electrical network and controls the distributed generation. The system receives real time information from network measurement points. These points represent constraints on the network (pinch points) on account of the additional generation. The network is divided into DNO (Distribution Network Operator) zones based upon the pinch points (as shown in Figure 2.3). When a limit at these points is breached the system will control the ANM generation that contributes to it by temporarily reducing their output[13].

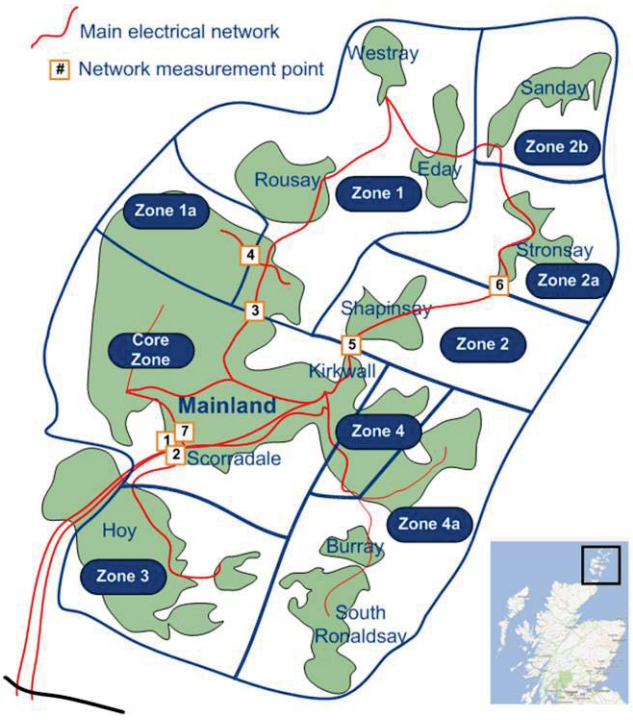


Figure 2.3 Orkney Electrical Grid

2.5.2 Grid Connections

When someone (the operator) wishes to install a renewable generation technology and connect to the grid there is a need to gain approval from the Distribution Network Operator (DNO). There are three different types of connections that can be allocated by the DNO (i.e. Scottish and Southern Energy, SSE). These include a:

- Firm Generation (FG)
- Non-Firm Generation (NFG)

[12] http://anm.ssepd.co.uk/

[13] http://anm.ssepd.co.uk/Documents/Orkney%20ANM%20%E2%80%93%20Live%20Flyer.pdf

- New-Non-Firm Generation (NNFG)

Firm Generation (FG)

Operators with a Firm Generation (FG) connection are able to operate without constraint in the event of the loss of either one of the two submarine cables to the mainland. The amount of generation that can be connected in this way is based on the capacity of the smaller mainland submarine cable circuit (20MVA) plus the minimum demand on Orkney. This amounts to a maximum of 26MW (based on a previous minimum demand condition of 6MW).

Table 2.11 Firm generation

Generator	Type	MW
Bu Farm (Stronsay) - Decommissioned	WIND	0
Flotta	GAS	10.5
Kirkwall Diesel	DIESEL	15
EMEC (Wave)[14]	WAVE	7
Sigurd (Burgar Hill)	WIND	1.5
Thorfinn (Burgar Hill)	WIND	4.3
TOTAL (not including Kirkwall Power Station)		23.3

Source: SSE

Non-Firm Generation (NFG)

Operators with a Non-Firm Generation (NFG) connection are able to operate as long as both submarine circuits are in service plus the minimum demand condition (this total has been determined by network studies at a previous minimum demand of 7MW). This group will be tripped in the event of a loss of a submarine cable circuit and the power export flow exceeding 20MVA (the capacity of the smaller submarine cable). The Non-Firm capacity group has already been contracted, some of which has connected.

The theoretical capacity for NFG plus FG amounts to 47MW which is made up of both submarine cables plus the local minimum demand. The amount of non-firm connection capacity is therefore:

NFG = Capacity of both submarine cables + local minimum demand – FG

NFG = 20+20+7-26 = 21MW

Table 2.12 Non-firm generation

Generator	Type	MW
Burgar Hill	WIND	6
Burray (St Marys)	WIND	0.9
Gallow Hill (Westray)	WIND	1
EMEC (Eday)	TIDAL	4
Spurness (Sanday)	WIND	7.5
West Hill (Flotta)	WIND	2
TOTAL		**21.4**

Source: SSE

[14] It is understood from EMEC that this is actually a non-firm connection.

New-Non-Firm Generation (NNFG)

NNFG is actively managed based on the capacity available on the Orkney network due to load variation and diversity in output from existing Firm and Non-Firm Generators. The original Department of Trade and Industry project completed in 2004 suggested that Orkney could accommodate 25MW of NNFG capacity; however, it is expected that around 15MW will prove to be economical to connect[15].

Table 2.13 New non-firm generation

	Type	MW
Barns of Ayre	WIND	2.7
Braefoot (Shapinsay)	WIND	0.9
Burgar Hill Renewables	WIND	2.3
Cleat	WIND	0.08
Dale Spot	WIND	0.08
Distgen	WIND	0.5
Eday Community (Eday)	WIND	0.9
Fea	WIND	0.08
Hammars Hill	WIND	4.5
Hammer	WIND	0.5
Hatston	WIND	0.9
Holodyke	WIND	0.9
Kingarly (Rousay)	WIND	0.9
Ore Brae (Hoy)	WIND	0.9
Rennibister	WIND	0.9
Rothiesholm (Stronsay)	WIND	0.9
Scapa	WIND	0.08
Spurness 2 (Sanday)	WIND	2.5
Thorkell	WIND	0.9
Tower hill	WIND	0.08
Tuquoy (Westray)	WIND	0.9
Total		**22.4**

Source: SSE

2.5.3 Local Renewable Electricity Generation

Wind

Over the last decade or so Orkney has seen a large increase in the amount of renewable energy generation particularly from wind.

Small scale wind turbines (up to 50kW)

Data on planning permissions granted by OIC[16] show a total capacity of 6031.6kW for small turbines (under 50kW)[17]. The majority of these turbines are between 5 and 20kW as shown in (Figure 2.4). The number of turbines granted planning permission peaked sharply in 2012 (as shown in Figure 2.5) in line with reductions in feed-in tariff which were applied in 2012 [18]. In September 2012, SSEPD imposed a moratorium on all new generation, except the very smallest

[15] https://www.ssepd.co.uk/WorkArea/DownloadAsset.aspx?id=992

[16] Planning application data obtained from OIC. Turbine size and type extracted from the OIC planning portal:http://planningandwarrant.orkney.gov.uk/online-applications/

[17] All turbines with a decision date of 17 July 2014 or before.

[18] https://www.ofgem.gov.uk/ofgem-publications/58940/fit-tariff-table-1-april-2013-non-pv-only.pdf

generators that are classed as G38 which has a limit of 3.6kW per phase. This will also have had an impact on turbine planning application post 2012.

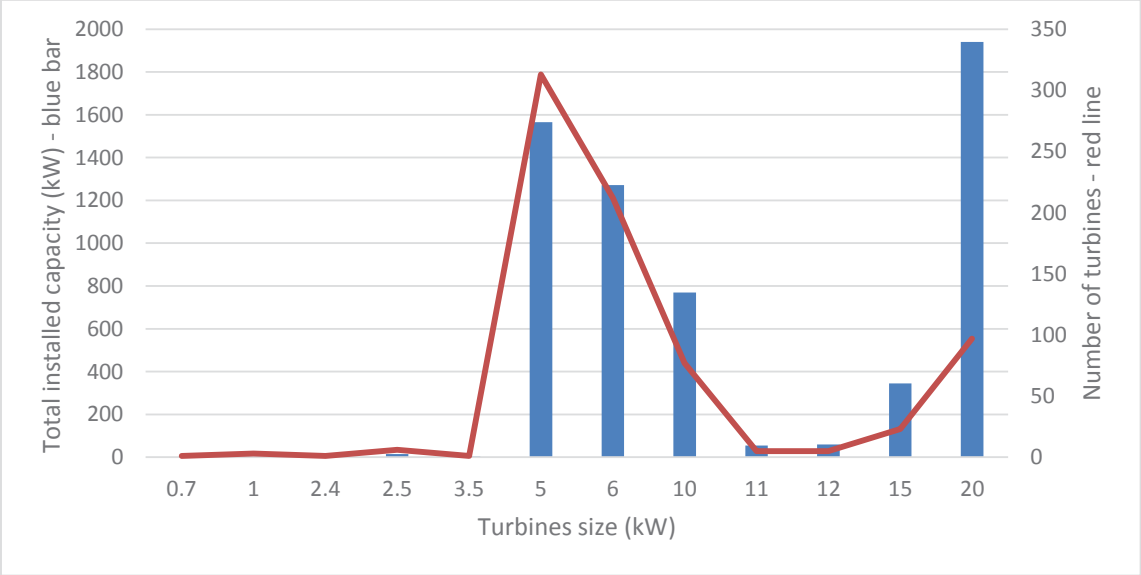


Figure 2.4 Planning permissions granted - Total capacity granted by turbine size (small turbines up to 50kW). Source: OIC

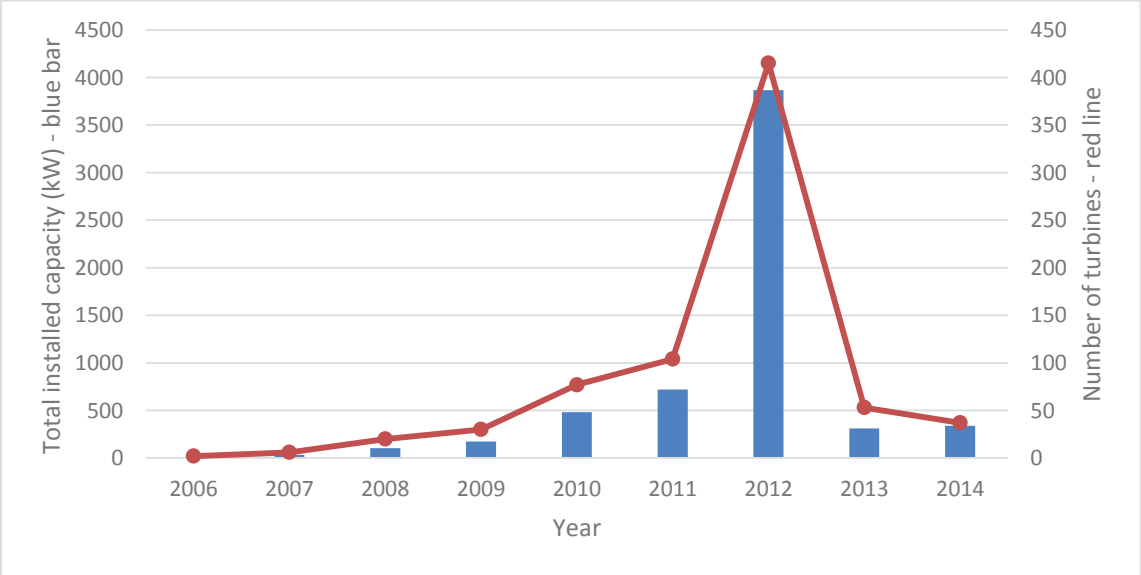


Figure 2.5 Planning permissions granted - Total capacity granted by year (small turbines up to 50kW). Source: OIC

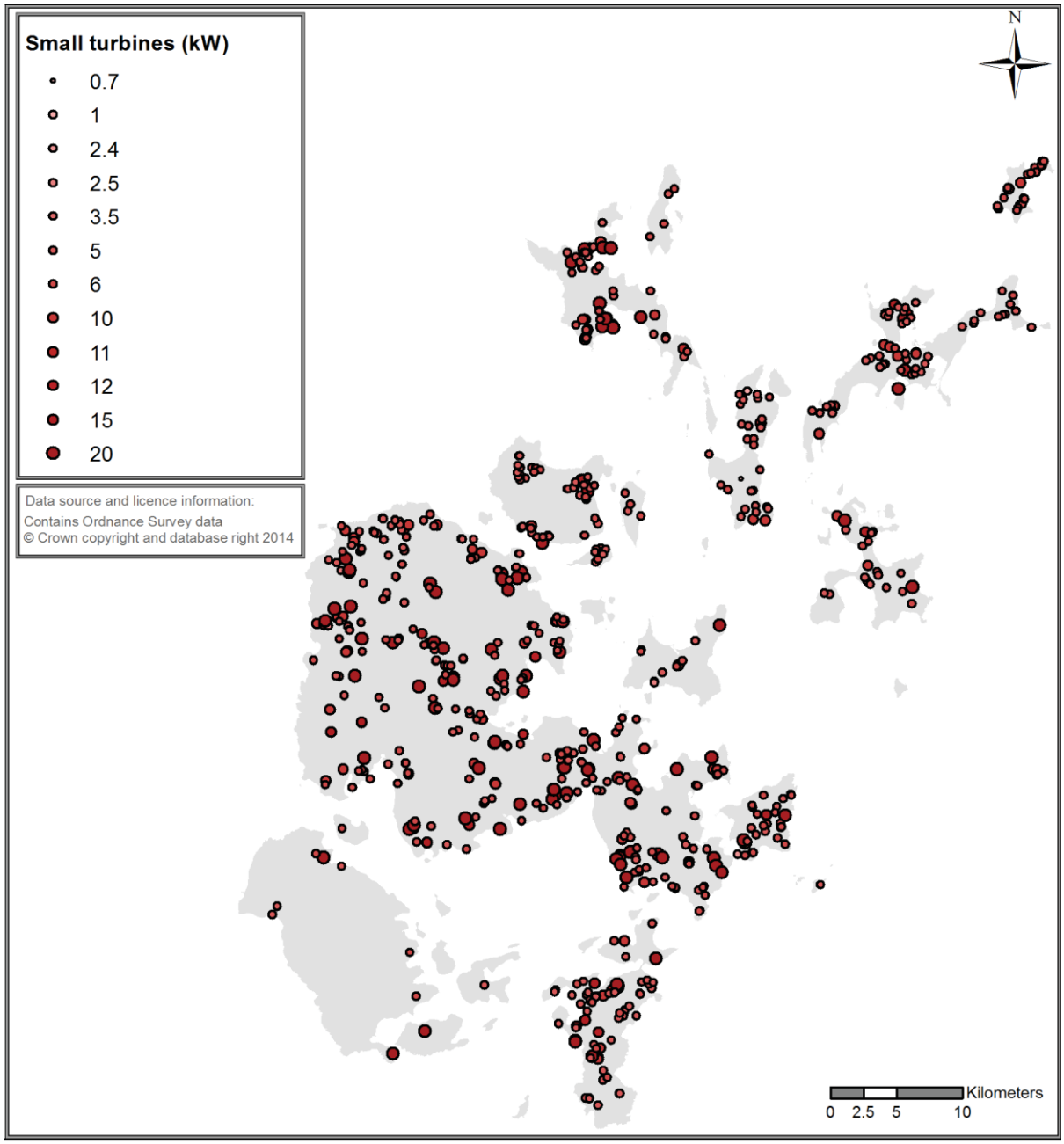


Figure 2.6 Location of small wind turbines (up to 50kW) with planning permission in Orkney

It is unknown what proportion of the turbines, shown above, that have been granted planning permission have actually been installed, however it is possible to see from the data published by Ofgem[19] that a total of 4720.3kW of small wind turbines (under 50kW) are registered for the Feed-In Tariff (FITs)[20]. The majority of these being commissioned in 2012 (Figure 2.7 and Figure 2.8). The difference between the FITs data and the data from planning permissions will mostly be due to the fact that some turbines which have obtained planning permission but have

[19] Ofgem Renewables and CHP Register https://renewablesandchp.ofgem.gov.uk/

[20] https://www.ofgem.gov.uk/publications-and-updates/feed-tariff-installation-report-30-september-2014

not yet been built and there may be slight difference due from permission granted for turbines that are slightly larger than those installed.

Orkney currently has about 11% of all the wind turbines in the UK and 5% in terms of installed capacity, which are register for FITs[21]. It should be noted though that not all of these are in the under 50kW turbine size bracket. As shown below in Table 2.15 a number of these are commercial or community projects which are generally larger turbines.

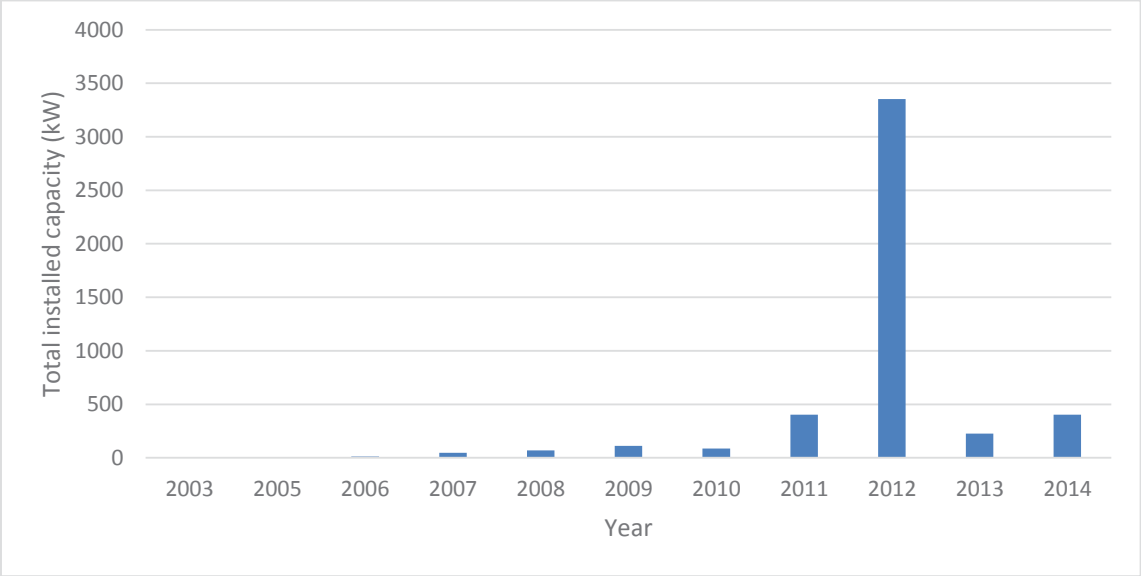


Figure 2.7 Total installed capacity by commissioning date (small turbines up to 50kW). Source: Ofgem Renewables and CHP Register

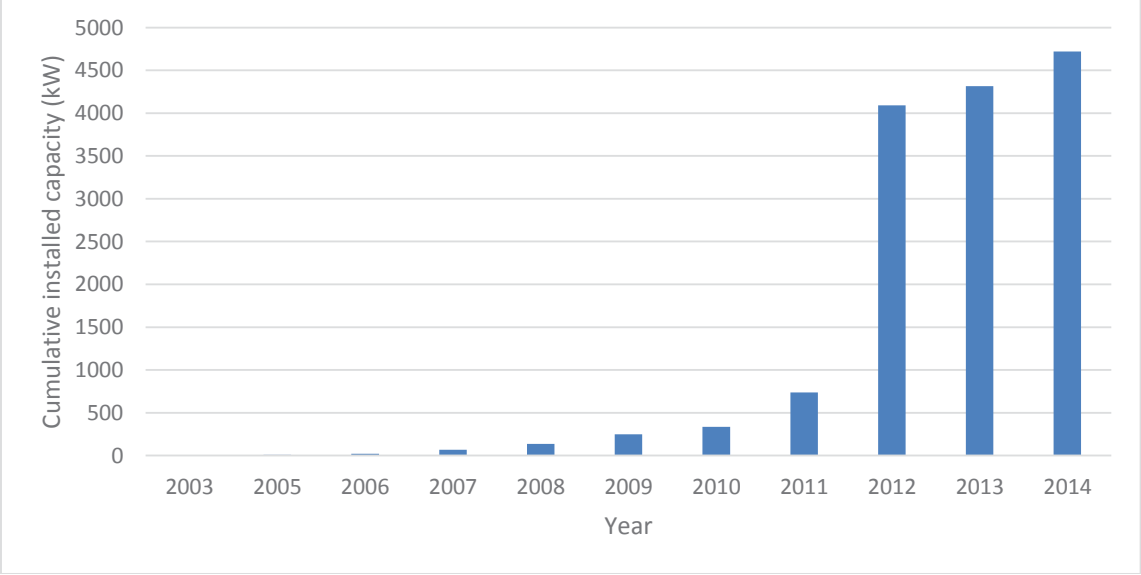


Figure 2.8 Cumulative installed capacity by commissioning date (small turbines up to 50kW). Source: Ofgem Renewables and CHP Register

[21]https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/371646/september_2014_sub-regional_feed_in_tariffs_confirmed_on_the_cfr_statistics.xls

OREF has set up a database of micro wind generators in order to track the long term performance of the different machines in different locations and detect any patterns or problems by allowing users to submit their performance readings every month into a free, confidential, automated database. Analysis of the readings in this database shows an average load factor of 36%. If this load factor is applied to the FIT data then an estimate of the total number of GWh can be estimated (Figure 2.9 and Table 2.14). Note that the FIT register data only gives postcodes and total installed capacity for each generator, no energy generation statistics are given. The type and partial postcode for the turbines on the FIT register is given in Table 2.15.

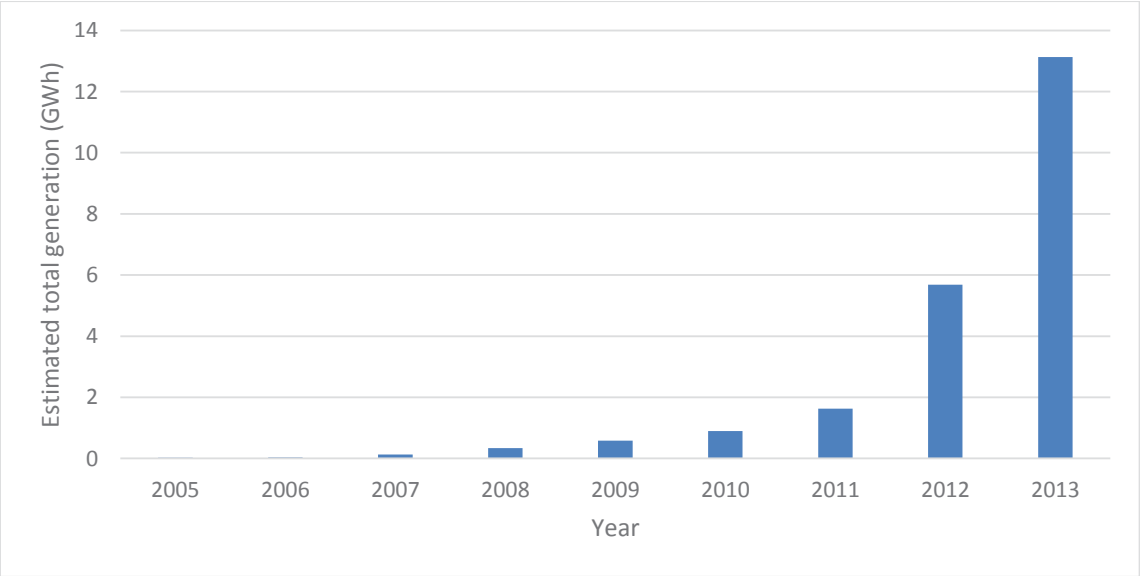


Figure 2.9 Estimated total generation by year (small turbines up to 50kW), assuming a 36% load factor.

Table 2.14 Approximate generation from small turbine (up to 50kW)

Unit	2005	2006	2007	2008	2009	2010	2011	2012	2013
GWh	0.02	0.04	0.13	0.34	0.58	0.90	1.63	5.68	13.12

Source: Ofgem Renewables and CHP Register and OREF microgeneration database

Table 2.15 Total installed capacity by partial postcode and type of installation from FIT register (small turbines up to 50kW).

Declared Net Capacity (kW)	Community	Domestic	Commercial	Industrial	Total
KW15		342	136		**478**
KW16	16	389	66		**471**
KW17	30	3319	382	40	**3771**
Total	**46**	**4050**	**584**	**40**	**4720**

Source: Source: Ofgem Renewables and CHP Register

Large scale turbines (above 50kW)

As shown in Table 2.16 below there is 43.623MW of installed capacity from large wind turbines (of 50kW and above) in Orkney[22]. Another 17.143MW has planning permission but is not yet constructed (Table 2.17). The location of these turbines (both operational and approved but not yet built) is shown in Figure 2.10.

Table 2.16 Planning application details for wind farms in Orkney (Operational)

Location	Developer	Turbine size (MW)	Total MW	Generator name	Commission date	Stations number at www.variablepitch.co.uk	DNO Zone
Burgar Hill, Evie	Thorfinn Wind 'A' Ltd	2.75	2.75	Thorfinn Wind Farm	1.4.2000	1905	Zone 1a
Burgar Hill, Evie	Thorfinn Wind 'A' Ltd	1.5	1.5	Thorfinn Wind Energy Project (NM1500)	1.4.2000	656	Zone 1a
Burgar Hill, Evie	Triodos Renewables Ltd	1.3	1.3	Burgar Hill	1.11.2000	113	Zone 1a
Northfield, Burray	Orkney Renewable Energy Ltd	0.9	0.9	Northfield Wind Energy Project Burray-A,C	1.2.2005	486	Zone 4a
Burgar Hill, Evie	RWE Innogy UK Limited (Wind)	2 x 2.5	5	Burgar Hill Wind Farm – A	1.12.2006	114	Zone 1a
Holodyke, Dounby	Birsay Energy Limited	0.9	0.9	Birsay Energy	1.9.2009	854	Core zone
Gallow Hill, Westray	Westray Renewable Energy Ltd	0.9	0.9	Gallowhill	11.9.2009	906	Zone 1
Burgar Hill, Evie	Burgar Hill Renewables Ltd	2.3	2.3	Burgar Hill Renewables 1	1.10.2009	772	Zone 1a
West Hill, Flotta	Scotrenewables (Flotta) Ltd	2	2	Flotta Wind Farm	18.6.2010	925	Zone 3
Hammars Hill	Hammars Hill Energy Ltd	5 x 0.9	4.5	Hammars Hill	23.8.2010	926	Zone 1
Trumland Farm, Rousay	Trumland Enterprises Ltd	0.08	0.08	Trumland	18.2.2011	111	Zone 1
Hoy Community Turbine, Ore Brae, Hoy	Hoy Energy Limited	0.9	0.9	Ore Brae Wind Farm)	21.9.2011	128	Zone 3
Kingarly, Rousay	Rousay Egilsay & Wyre Islands Renewable Energy Development	0.9	0.9	Kingarly Hill Wind Turbine	22.9.2011	1287	Zone 1
Crowness Business Park, Hatston	Orkney Energy Gateway Turbine Ltd	0.9	0.9	Hatston Wind Turbine	5.10.2011	1436	Core zone

[22] This figure excludes the turbines in Rothiesholm, Stronsay that are due to be decommissioned this year

Location	Developer	Turbine size (MW)	Total MW	Generator name	Commission date	Stations number at www.variablepitch.co.uk	DNO Zone
Industrial Estate, Kirkwall							
Howe, Shapinsay	Shapinsay Development Trust	0.9	0.9	Braefoot Wind Farm	21.10.2011	1323	Zone 2
Rothieshol m Head, Stronsay	Stronsay Renewable Energy Limited	0.9	0.9	Rothiesholm Head Wind Farm	17.11.2011	1462	Zone 2a
Upper Stove, Deerness	Orkney Renewable Energy Ltd	0.9	0.9	Thorkell Deerness	9.3.2012	1800	Zone 4a
Cleat, Work Road, St. Ola	Rendall & Scott Ltd	0.08	0.08	Cleat Wind	17.9.2012	2046	Core zone
Spurness, Sanday	SSE Generation Ltd	5 x 2.0	10	Spurness Wind Farm II	22.10.2012	2269	Zone 2b
Fea, Holm	Gaudie & Muir	0.08	0.08	Fea Wind Generating Station	6.11.2012	2288	Zone 4
Sandybanks, Eday	Eday Renewable Energy Limited	0.9	0.9	Sandybank Wind Farm	27.11.2012	2274	Zone 1
Wasbister, South Ronaldsay	DJ & JA Fairbairn	0.053	0.053	DJ & JA Fairbairn	28.11.2012	3121	Zone 4a
Dale Spot Hill, Kirkwall	S & J D Robertson Group Limited	0.08	0.08	Dalespot Hill	29.1.2013	2150	Core zone
Hammer, Skelwick, Westray	Windflow Hammer Limited	0.5	0.5	Hammer Farm Westray	27.2.2013	2744	Zone 1
Barns of Ayre, Deerness	Ayrenergy Ltd	3 x 0.9	2.7	Barns of Ayre	3.7.2013	3601	Zone 4a
Scapa, St Ola	S & J D Robertson Group Limited	0.08	0.08	Scapa Wind	26.9.2013	3111	Core zone
Mount Pleasant, Haybrake Road South Ronaldsay	Duncan Oswald	0.06	0.06	Mount Pleasant Harbon Installation	8.10.2013	3120	Zone 4a
Blackawall Cottage, Flotta	Blackawall Developments Ltd	0.08	0.08	Blackawall	16.10.2013	3415	Zone 3
Newark, Skelwick, Westray	Distgen	0.5	0.5	DG Westray	17.10.2013	3092	Zone 1
Towerhill, St Ola	Grimsetter Limited	0.08	0.08	Towerhill Wind Turbine	3.3.2014	3468	Core zone
Rennibister, Firth	Rennibister Wind Power Ltd	0.9	0.9	Rennibister Wind Turbine	28.3.2014	3385	Core zone
Total			**43.623 MW**				

Source: OIC and Variablepitch.co.uk

Table 2.17 Large turbines with planning approval but not yet operational

Address	Application No.	Decision date	Turbine size (MW)	Total MW
Ore Brae	08/249/PPF	13/01/2008	2 x 0.9	1.8
Gallowhill, Westray	08/491/PPF	02/03/2009	2 x 0.9	1.8
Burgar Hill, Evie	09/045/PPF	07/10/2009	2.3	2.3
Nearhouse, Rousay	11/329/TPP	02/11/2011	0.08	0.08
Berriedale, South Ronaldsay	11/060/TPP	29/11/2011	0.9	0.9
New Holland, Stratheast Road, Holm	11/568/TPP	16/12/2011	0.5	0.5
East Hammer, Skelwick, Westray	11/593/TPP	26/01/2012	0.053	0.053
Herston Head, South Ronaldsay	11/691/TPP	24/02/2012	0.5	0.5
Banks, Sourin, Rousay	11/586/TPP	02/03/2012	0.08	0.08
Ludenhill Farm, Stoneymildars, Swannay	11/703/TPP	12/05/2012	0.5	0.5
Southfield, Burray	12/058/TPP	05/07/2012	0.5	0.5
Orkney Auction Mart, Grainshore Road, Kirkwall	12/097/TPP	24/08/2012	0.08	0.08
Swanbister, Orphir	12/610/TPP	10/11/2012	0.5	0.5
Gill Pier, Westray	12/230/TPP	29/11/2012	0.08	0.08
Akla, Orphir	10/631/PP	17/12/2012	0.9	0.9
Lochend, Westray	12/561/TPP	09/01/2013	0.06	0.06
Work Farm, St Ola	12/699/TPP	31/01/2013	2 x 0.9	1.8
Hunton, Stronsay	12/787/TPP	02/04/2013	0.06	0.06
Bu Wind Farm, Stronsay	12/725/TPP	12/04/2013	3 x 0.85	2.55
New Holland, Stratheast Road, Holm	13/261/TPP	06/11/2013	2 x 0.5	1
Lingro, St Ola	14/197/TPP	13/05/2014	0.5	0.5
Skerryvoe, Evie	12/766/TPP	04/06/2014	0.06	0.06
Total				**16.603MW**

Source: OIC

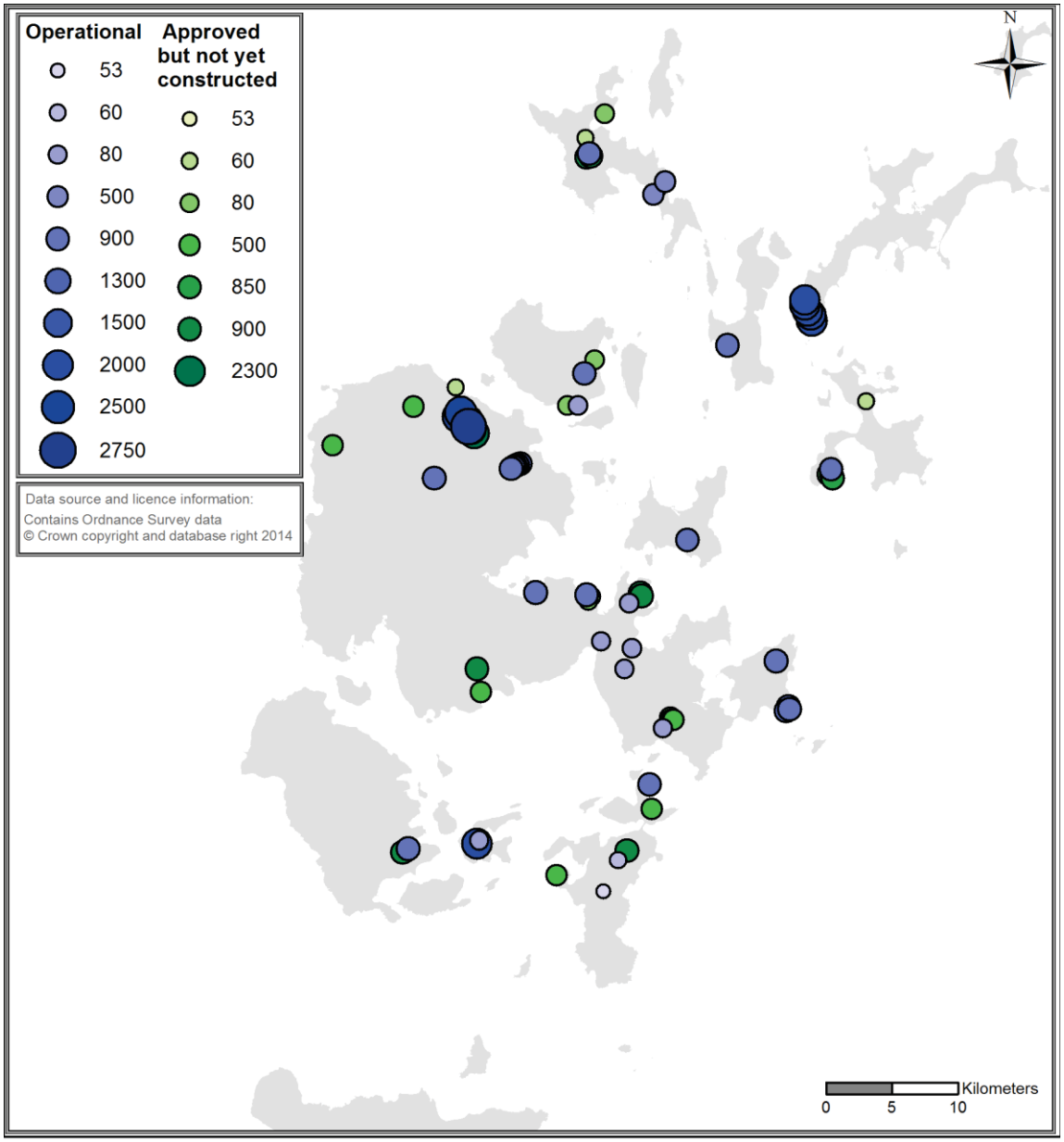


Figure 2.10 Location of large wind turbines (50kW and above) operational and approved but not yet operational

It can be seen that there has been a steady increase in the total installed capacity between 2005 and 2012 with a peak in 2012 mainly due to the 10MW windfarm at Spurness in Sanday (Figure 2.11 and Figure 2.12). In additional the moratorium on all new generation imposed by Scottish and Southern Energy Power Distribution (SSEPD) in September 2012 will be partly the reason for reduction in turbines being installed after 2012.

The most common size of turbine, which are already operational, are the 900kW and 2MW turbines (Figure 2.13). There is also planning permission granted for a significant number of turbines between 500kW and 900kW (Figure 2.14).

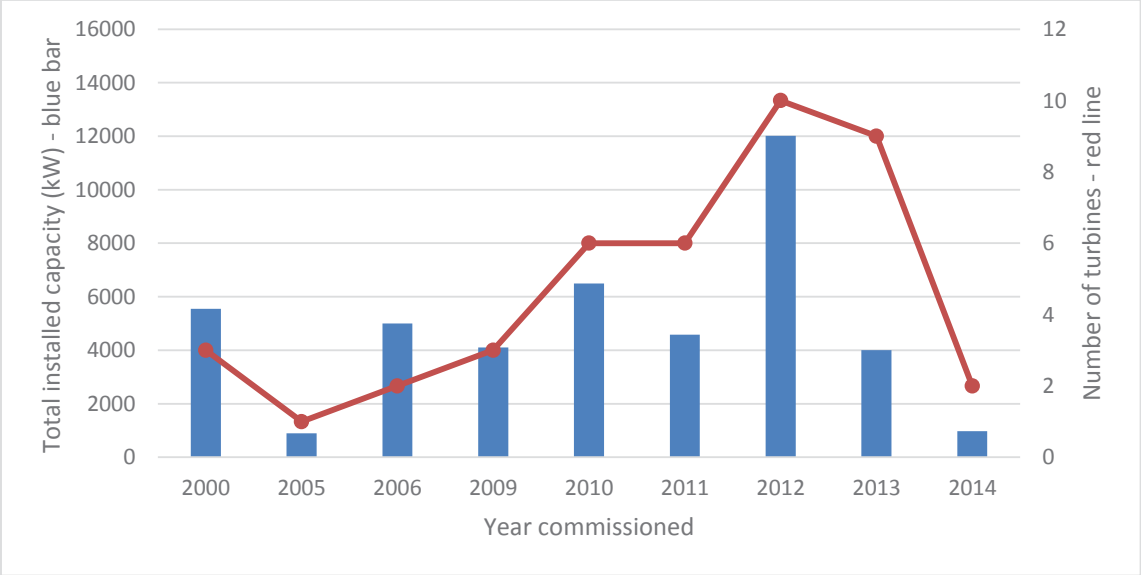


Figure 2.11 Total installed capacity by year (large turbines 50kW and above). Source: OIC and Variablepitch.co.uk

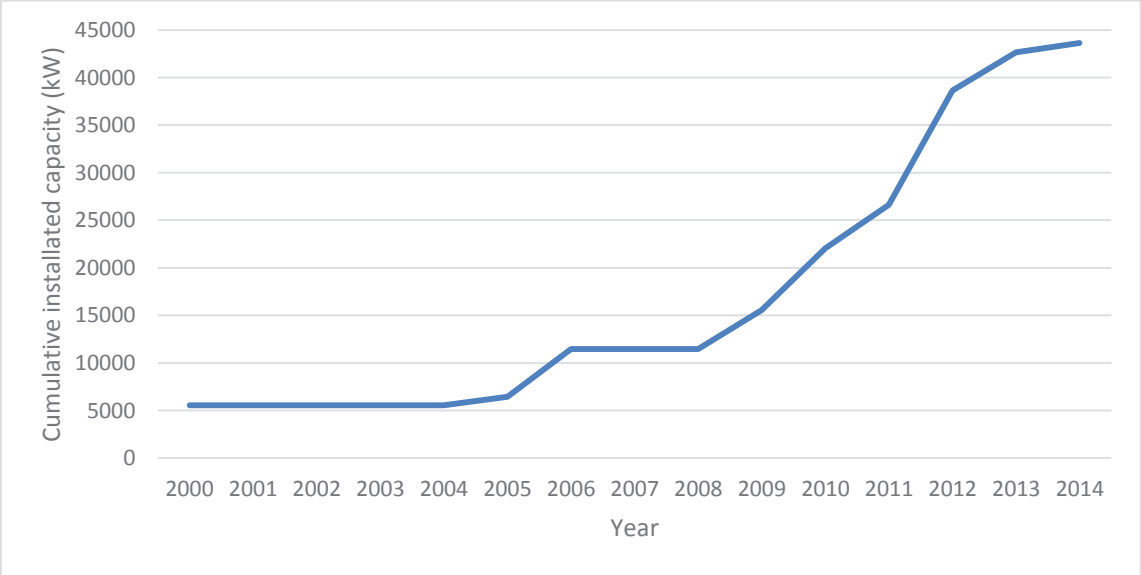


Figure 2.12 Cumulative installed capacity (large turbines 50kW and above). Source: OIC and Variablepitch.co.uk

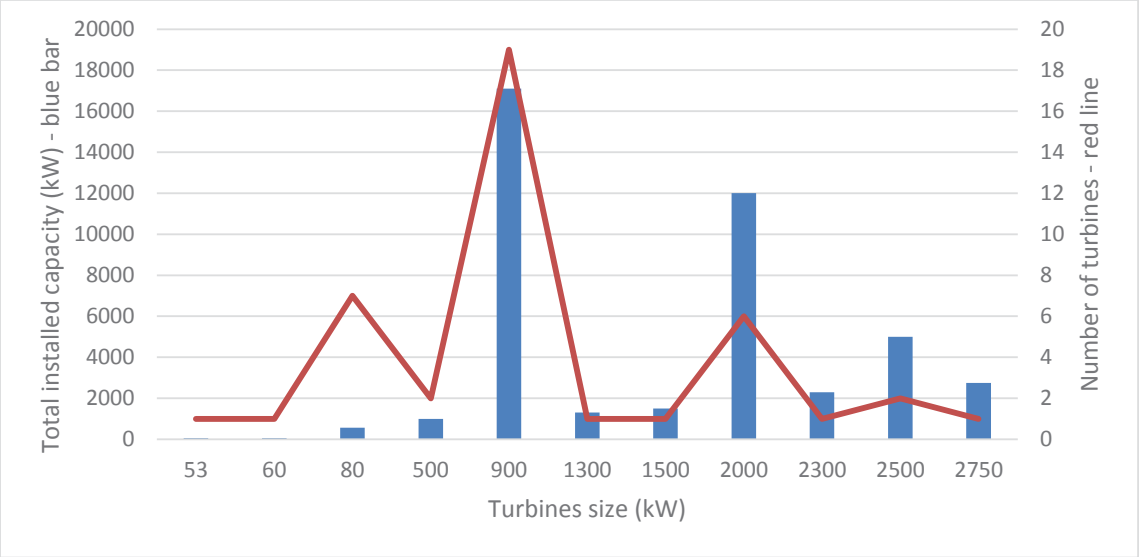


Figure 2.13 Total installed capacity by turbine size (large turbines 50kW and above). Operational turbines only. Source: OIC

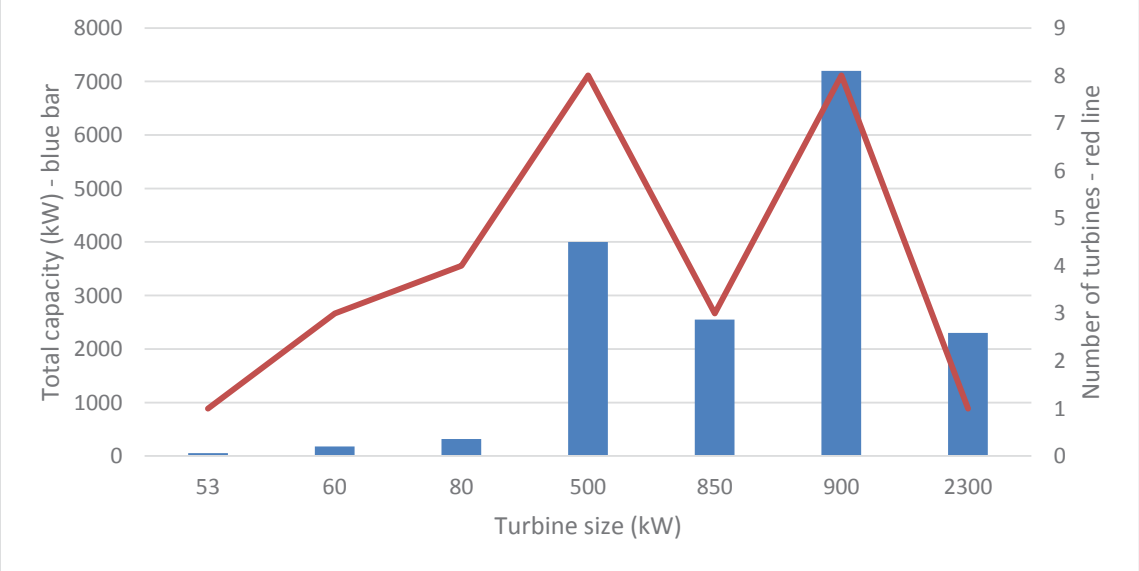


Figure 2.14 Planning permissions granted – Total capacity by turbine size (large turbines 50kW and above). Approved but not yet constructed only. Source: OIC

As shown in Table 2.18 and Figure 2.15 the monthly generation output from the operational turbines shows, as expected, a seasonal variation with higher outputs during the winter as well as the impact of increasing generation capacity. These outputs will also be affected by the ANM scheme. Note that there was no recent output shown for the DJ & JA Fairbairn wind turbine.

Table 2.18 Generation output by for large wind turbines in Orkney (November 2011 – August 2014)

	Thorfinn Wind Farm	Thorfinn Wind Energy Project (NM1500)	Burgar Hill	Northfield Wind Energy Project Burray A.C.	Burgar Hill Wind Farm – A	Birsay Energy	Gallowhill	Burgar Hill Renewables 1	Flotta Wind Farm	Hammars Hill	Trumland	Ore Brae Wind Farm	Kingarly Hill Wind Turbine	Hatston Wind Turbine	Braefoot Wind Farm	Rothiesholm Head Wind Farm	Thorkell Deerness	Cleat Wind	Spurness Wind Farm II	Fea Wind Generating Station	Sandybank Wind Farm	Dalespot Hill	Hammer Farm Westray	Barns of Ayre	Scapa Wind	Mount Pleasant Harbon Installation	Blackawall	DG Westray	Towerhill Wind Turbine	Rennibister Wind Turbine	Total
Nov-11	906	443	368	240	1991	248	429	1109	787	2051	12	278	303	170	366	158															9859
Dec-11	777	378	420		969	325	420	1077	394	1950	4	374	318	321	385	311															8423
Jan-12	936	443	525	59	2156	364	431	1034	374	2160		311	401	292	380	408															10274
Feb-12	915	603	569	384	2187	346	379	1147	875	2065	18	300	392	341	348																10869
Mar-12	971	609	583	360	2384	346	368	1146	835	2017	20	275	283	323	327	366	5														11218
Apr-12	684	393	360	256	1447	217	244	691	591	1320		184	204	221	239	257	11														7319
May-12	636	366	299	89	1154	200	91	602	464	1089		104	162	163	176	197	112														5904
Jun-12	344	391	303	66	884	200	183	551	486	1139		132	214	178	188	212	190														5661
Jul-12		370	292		1151	153	148	547	425	1021		111	169	137	147	163	142														4976
Aug-12		399	296	147	1169	201	199	606	506	1141		121	210	159	173	206	160														5693
Sep-12		675	538	5	2380	177	373	1174	875	2091		278	410	308	343		292	4													9923
Oct-12	18	476	418	276	1551	237	295	818	667	1542		189	300	220	253	274	241	15	658												8448
Nov-12	626	593	474	304	1950	252	311	887	780	1613		226	178	229	279		282	19	2971	18											11992
Dec-12	593	520	12	335	1680	334	362	986	621	1734		298	315	333			353	24	3140	26											11666
Jan-13	752	626	280	392	2068	326	382	1026	881	1825		310	322	305	334		370	28	3654	28											13909
Feb-13	749	449	366	291	1626	243	268	759	651	1442		222	215	258	220	273	265	21	3097	20		11									11446
Mar-13	791	468	378	231	1496	256		762	670	1372	9	233	141	253	252	283	287	25	3144	22		18									11091
Apr-13	707	484	184	297	1716	235	258	802	700	1439		221	187	234	176	223	252	22	3657	21		7									11822
May-13	870	512	395	284	1564	251	245	750	667	0	13			215			207	20	3491	20		15	36								9555
Jun-13	619	370	274	180	1113	155	141	549	412	0	8	104		140		114	129	14	2325	2	78	10	23								6760
Jul-13	966	575	236	223	1844	233	200	666	537	0	10	117		156		100	163	15	3108			10	21								9180
Aug-13	620	308	271	188	1336	178	163	512	474	0	12	131		146		73	159	14	2650			3	25								7263
Sep-13	652	479	369	285	1576	233	244	768	618	0	7	200		214		105	242	22	3331	15		3	29								9392
Oct-13	914	536	442	344	1535	282	300	901	732	0		250		246			292	24	3498	23		17	35		16						10387
Nov-13	784	609	522	397		289	330	1024	1001	614		350	274	354	331	273	339	31	3874	26		20	84		25			26			11577
Dec-13	1119	442	575	447		382	461	1147	1177	584		384	132	388	423		348	34	1654	28		20	112		27	19		90			9993
Jan-14	575	691	447	481		412	486	1207	1169	1921		406	403	383	315		449	36	4463	31		24			26	26	13	2			13966
Feb-14	1119	478	453	403		351	394	1107	940	1654		351	253	296	119	139	382	33	4919	27		25		1197	26	25	21	79			14791
Mar-14	986	621	358	384		350	390	1139	912	1630		304	311	321	192		355	30	4581	24		21		1086	23	22	14	99			14153
Apr-14	726	545	264	300		259	264	851	699	0	36	176		224		125	239	21	3591	16	194	14		675	13	17	13	107			9369
May-14	403	349	284	179	527	105	157	332	411	0		54		79		73	80	8	1860	6	89	5	19	210	5	9	8	52	20		5324
Jun-14	397	264	190	143	612	106	101	364	313	0		72		111		66	117	11	1877	8	95	7	25	315	7	6	7	39	6	22	5281
Jul-14	465	359	271	163	1096	134	136	553	415	0		93		124			113	13	1747	11		8	31	421	9	8	8	54	10	10	6252
Aug-14		450	311	268	1466	202	261	571	700			186		215			243	22	3501	17		13	45	615	12	14	15	81	16	101	9325

Source: Variablepitch.co.uk

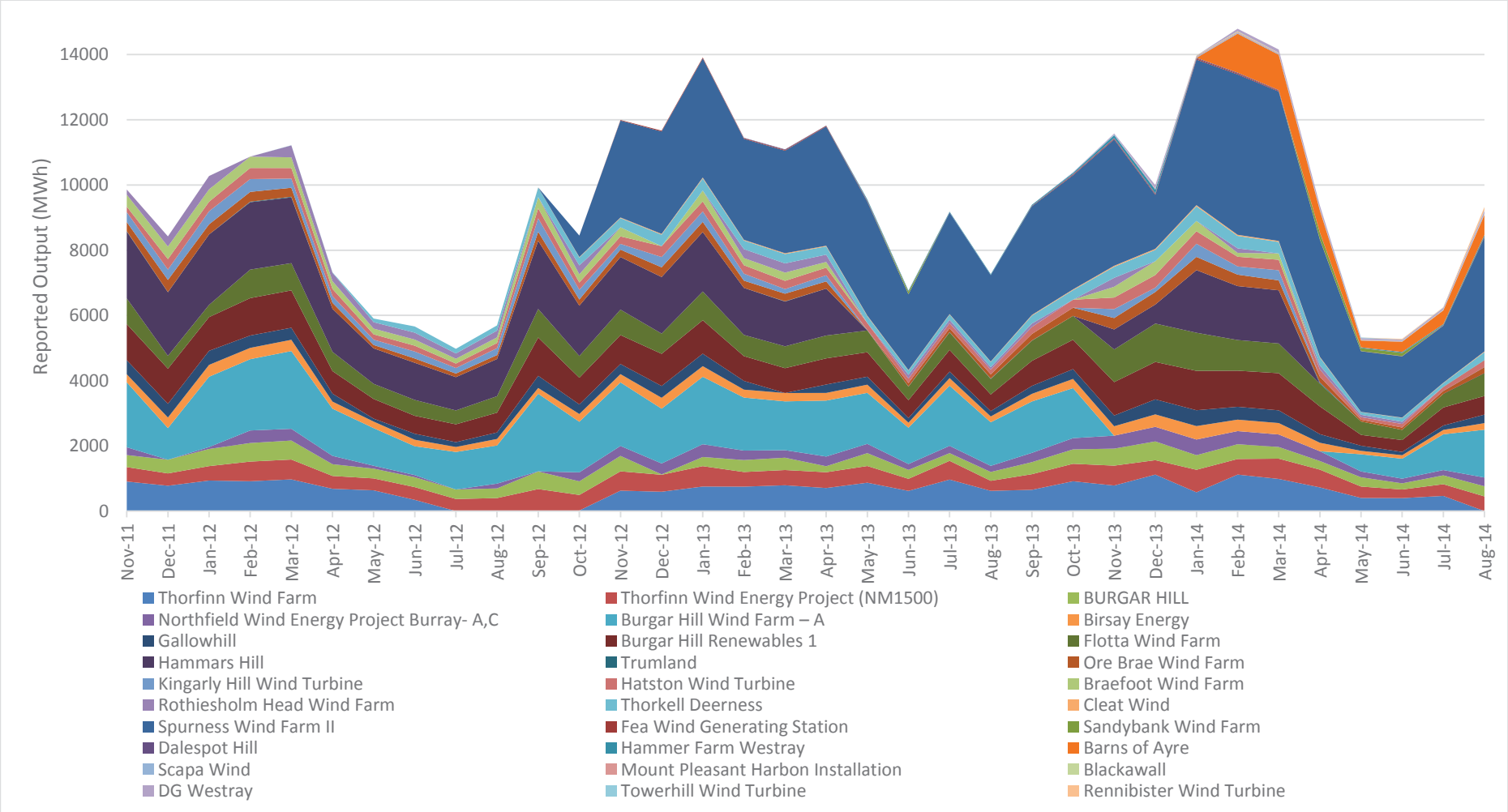


Figure 2.15 ROCs issued per year for wind farms in Orkney. Source: Variablepitch.co.uk.

Note: The graph key starts with Thorfinn Wind Farm (blue) at the bottom with Thorfinn Wind Energy Project (NM150) second from the bottom and so on working from left to right on the key.

As the graph above only gives data back to November 2011, the total generation from all the large wind turbines was estimated by applying the same assumptions as for the small turbines as shown in Figure 2.9 to the large wind turbines (capacity factor of 0.36 and the commissioning dates shown in Table 2.16).

The capacity factor used here of 36% should be regarded as the lower end of what might be seen for individual wind turbines in Orkney given the average wind speed as. Reports published previously have estimated the capacity factor to be between 40 and 50%[23] but this does not take into account the present curtailment. Comparing the estimated output using this load factor with the actual output for 2012 and 2013 matches fairly well as shown in Table 2.19.

Table 2.19 Estimated versus actual output for large turbines in 2012 and 2013

GWh	Estimated	Actual
2012	93	104
2013	128	122

The estimated total generation from all wind turbines in Orkney over the last ten years is shown in Figure 2.16. A geographical representation based on estimated total generation in 2013 is shown Figure 2.17.

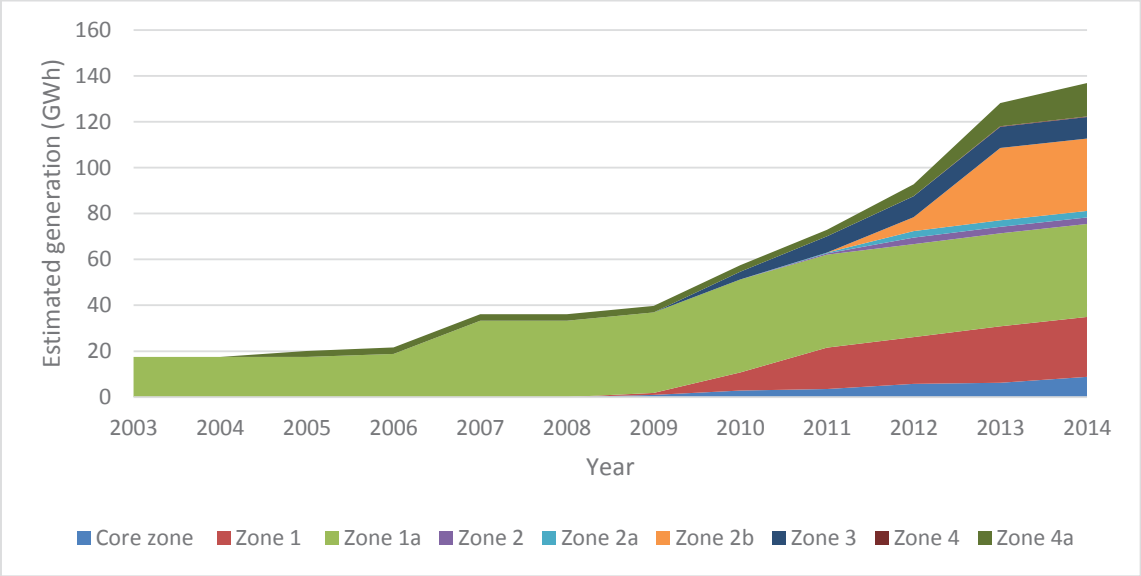


Figure 2.16 Estimated total generation by year and zone (large turbines), assuming a 36% load factor. Source: OIC

[23] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/39275/file46739.pdf

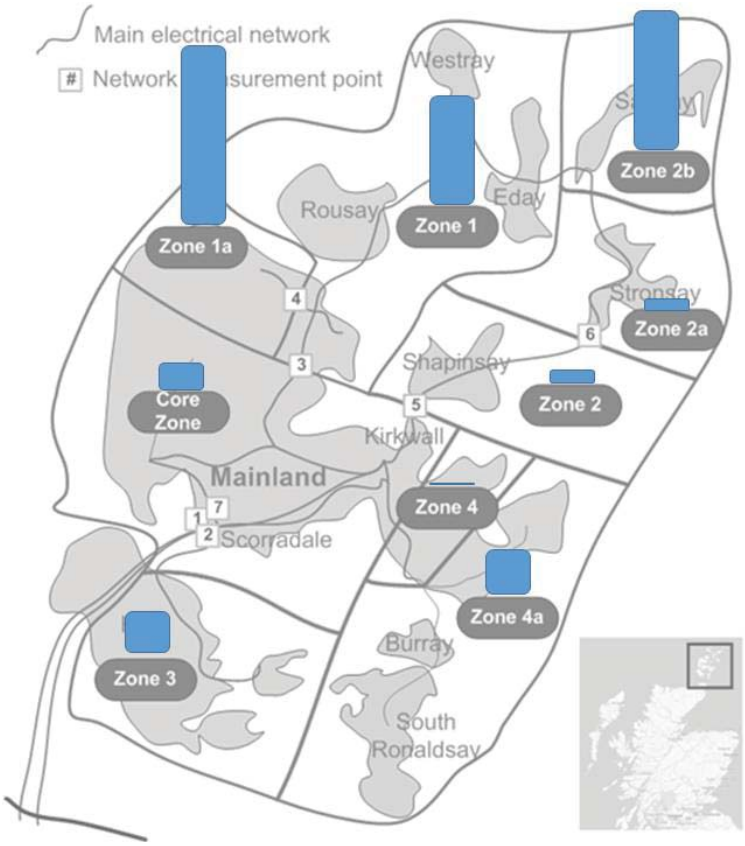


Figure 2.17 Estimated total generation for 2013 by zone (large turbines), assuming a 36% load factor. Source: OIC

All turbines

Taking the information from Figure 2.8 and Figure 2.12 together the total installed capacity in Orkney is around 48.343MW. The total installed capacity by year is shown in Figure 2.18. The total estimated generation by year from all wind turbines is shown in Figure 2.19 (and is a combination of the data from Figure 2.9 and Figure 2.16).

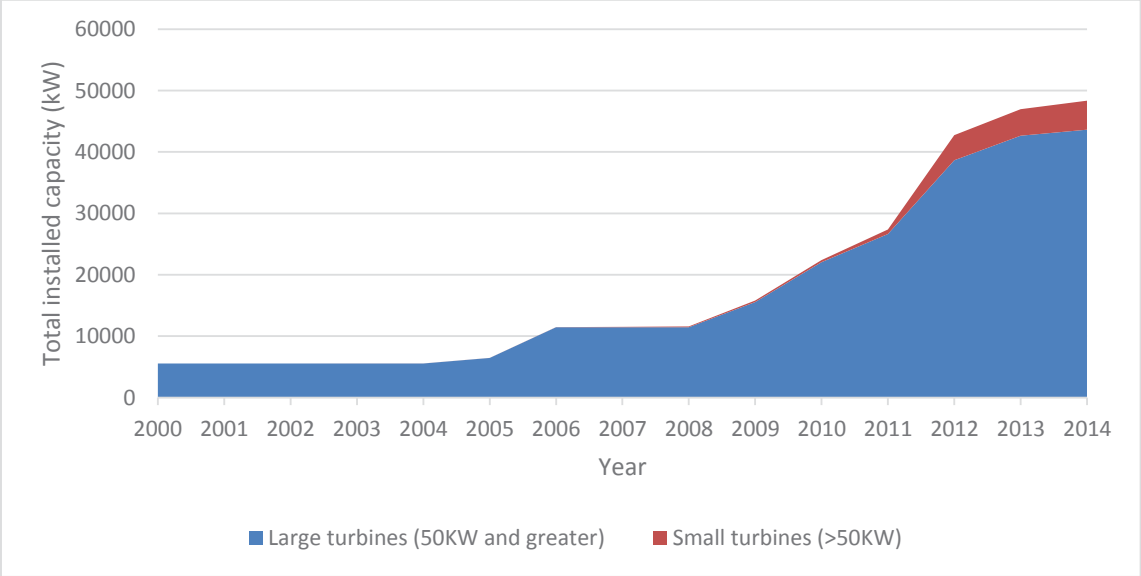


Figure 2.18 Total installed capacity of all turbines in Orkney

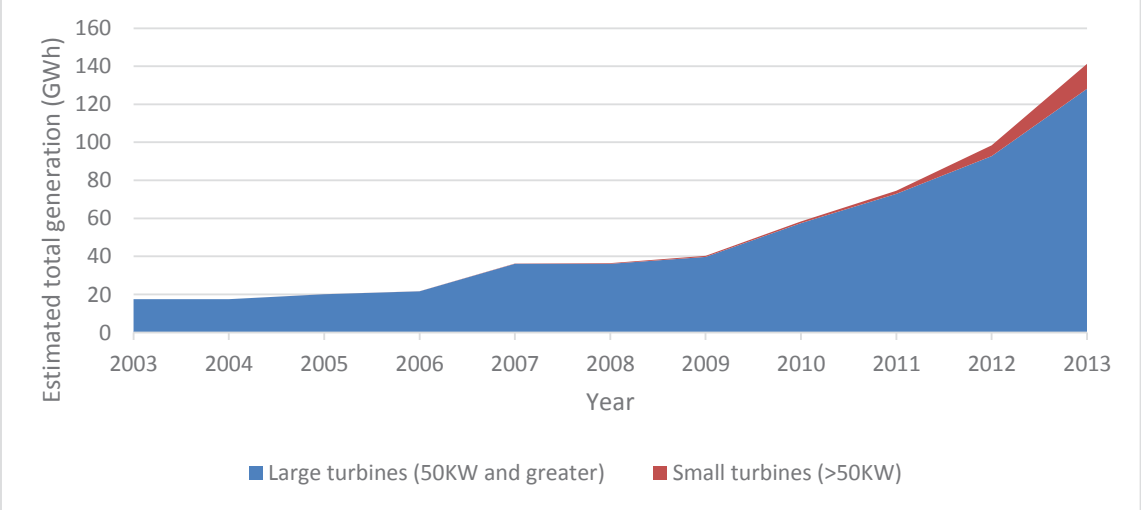


Figure 2.19 Estimated total generation by year (all turbines), assuming a 36% load factor. Source: Ofgem Renewables and CHP Register and OREF microgeneration database & OIC

Solar PV

Photovoltaic systems like wind turbines are eligible for FITs and have become increasingly common in Orkney with a total of 1183kW of photovoltaic panels now installed. FITs were introduced on 1st April 2010 and replaced UK government grants as the main financial incentive to encourage uptake of renewable electricity generating technologies. The tariff payment rates vary depending on various factors such as whether the units are stand alone, mounted on a new building, retrofitted to a building, the energy efficiency of the building and the installed capacity.

Orkney currently has about 0.1% of all the PV installations in the UK and 0.05% in terms of installed capacity which are registered for FITs[24].

In Orkney installations of PV systems peaked in 2012 and have tailed off probably due to the decreasing tariffs that are now being offered (Figure 2.21 and Figure 2.22), with the most common size being 3 - 4kW.

Table 2.20 PV installations by postcode and year

Installed capacity (kW)	Post Code	2008	2009	2010	2011	2012	2013	2014	Total
Domestic	KW15	0	0	0	68	164	55	11	298
	KW16	0	0	0	43	213	19	4	279
	KW17	1	5	12	142	378	50	15	603
Commercial	KW15	0	0	0	0	0	4	0	4
Total		**1**	**5**	**12**	**254**	**755**	**127**	**30**	**1183**

Source: Ofgem Renewables and CHP Register

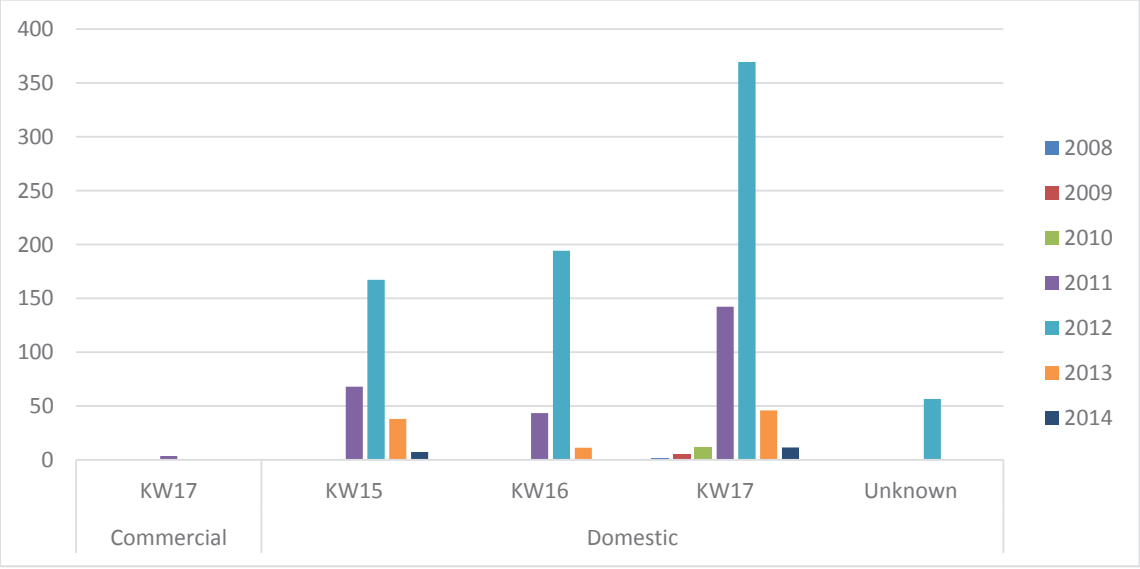


Figure 2.20 PV installations by postcode and year. Source: Ofgem Renewables and CHP Register

[24]https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/371646/september_2014_sub-regional_feed_in_tariffs_confirmed_on_the_cfr_statistics.xls

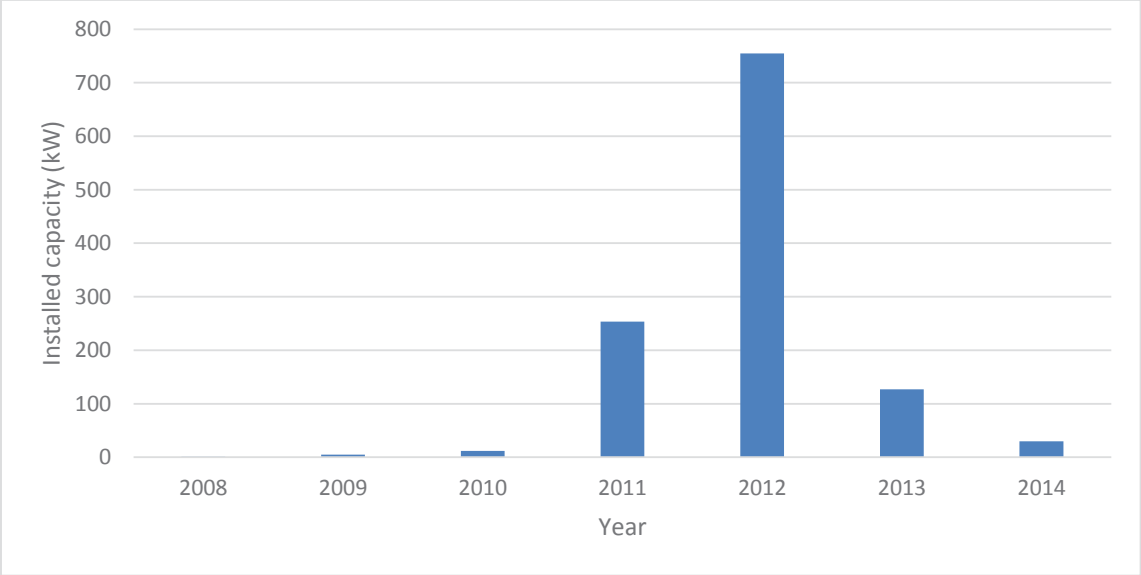


Figure 2.21 Installed capacity for Photovoltaic panels by year. Source: Ofgem Renewables and CHP Register

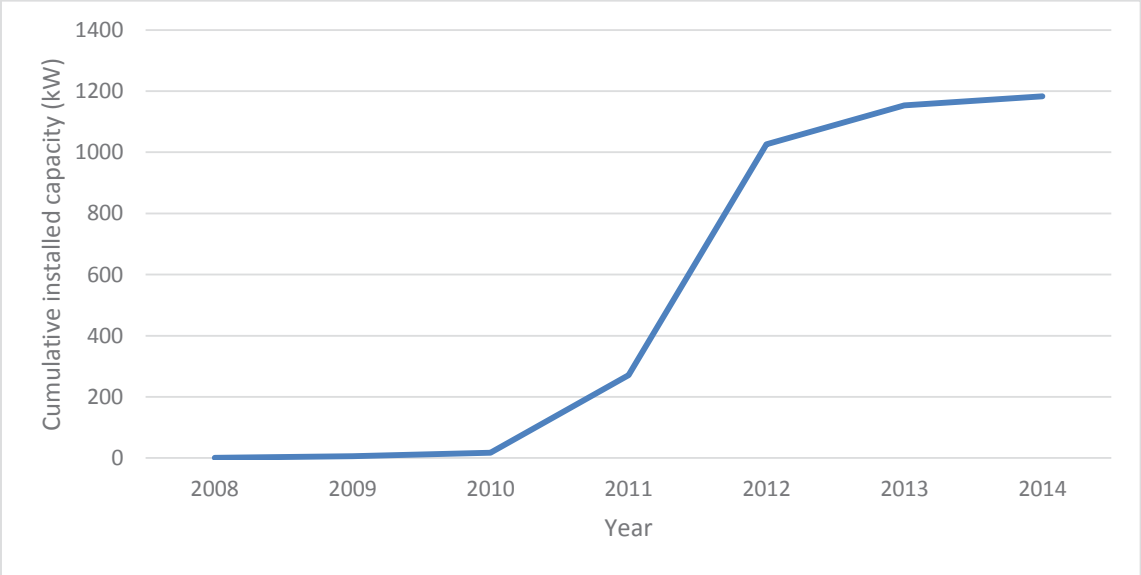


Figure 2.22 Cumulative installed capacity for Photovoltaic panels. Source: Ofgem Renewables and CHP Register

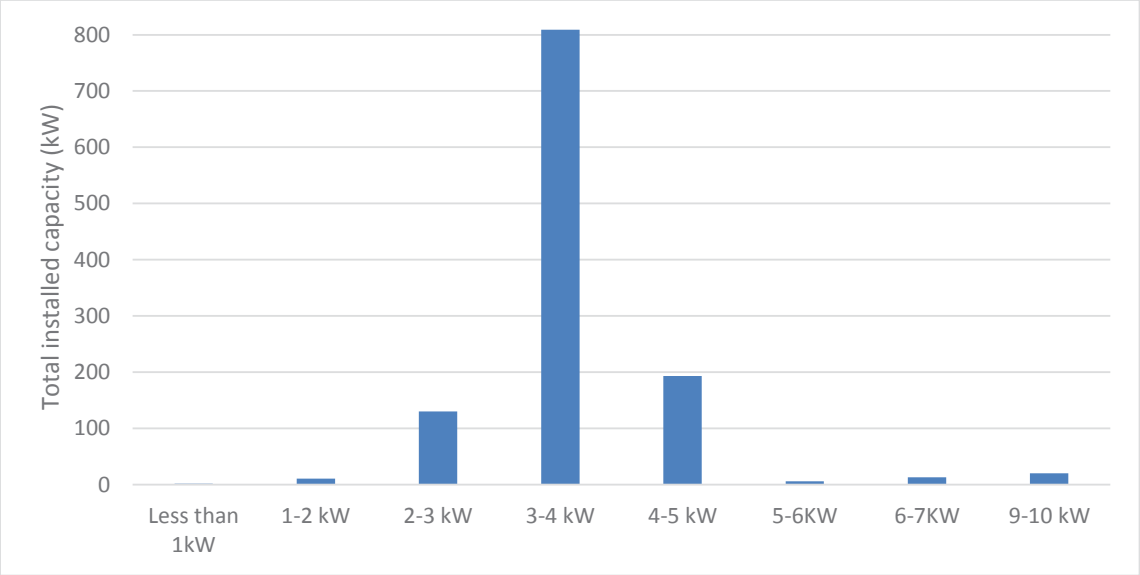


Figure 2.23 Total installed capacity by PV installation capacity. Source: Ofgem Renewables and CHP Register

Wave & Tidal

Orkney holds a prominent position in the wave and tidal industry with the world leading testing facility EMEC and the world's first leasing round for commercial wave and tidal projects.

Since its establishment in 2003 EMEC has attracted many developers to its wave and tidal test facilities located at Billia Croo and the Fall of Warness respectively; 12 companies are currently using the test sites. The tidal test site has a non-firm grid connection of 4MW and the wave test site has a non-firm grid connection of 7MW. These technologies are still at an early stage of development and therefore the number of GWh generated is small day-to-day, but this is expected to rise in the future. Some data is available via the ROC register but as some developers choose not to register for ROCs, this is not a complete picture. In addition it does not give a realistic idea of what generation levels are likely in the future as it is a test site.

In 2011, the Crown Estate held a leasing round for commercial and demonstration marine energy project in the Pentland Firth and Orkney waters. There are currently leases held for 550MW of wave energy project and 530MW of tidal project in Orkney waters.

2.5.4 Supplied Grid Import/Exports

The graphs below (Figure 2.24 to Figure 2.29) show the imports and exports via the subsea cables. Positive values show exports from Orkney and negative values show imports into Orkney. The general trend over the last decade has been towards more and more export as increasing amounts of renewable energy are installed in Orkney. It is also interesting to look at the variation in imports and exports averaged over several years which shows the expected trend of more imports during the winter months when demand is higher (Figure 2.30). Figure 2.31 shows the total imports, exports and net flow of electricity for each of the last five years, which shows that in 2013 Orkney was a net exporter of electricity.

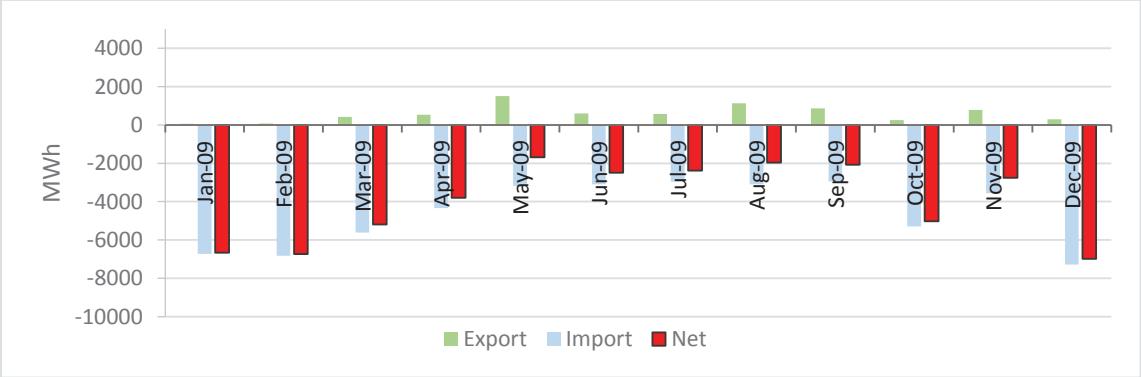


Figure 2.24 Monthly totals for Import, Export and Net Flows calculated from half hourly average values (January 2009 – December 2009). Source SSE.

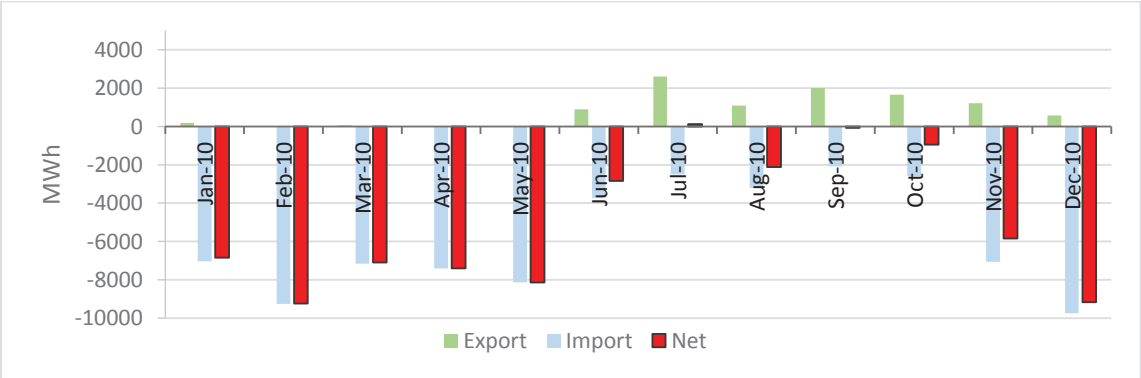


Figure 2.25 Monthly totals for Import, Export and Net Flows calculated from half hourly average values (January 2010 – December 2010). Source SSE.

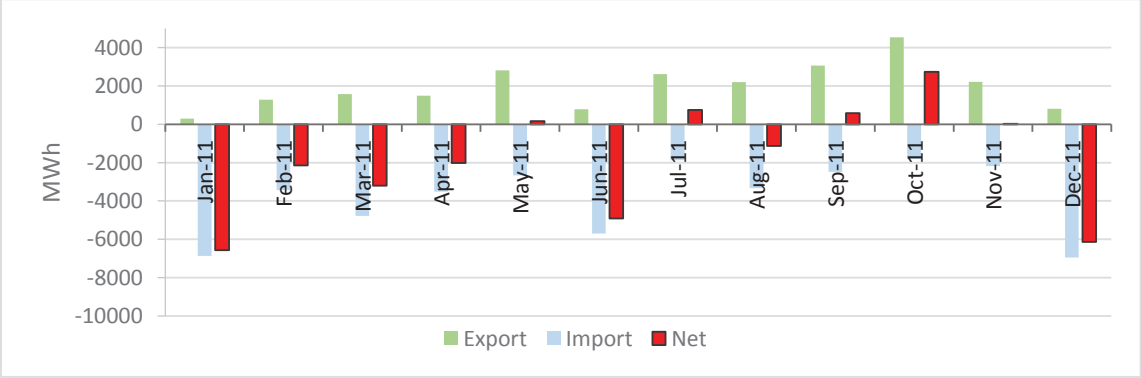


Figure 2.26 Monthly totals for Import, Export and Net Flows calculated from half hourly average values (January 2011 – December 2011). Source SSE.

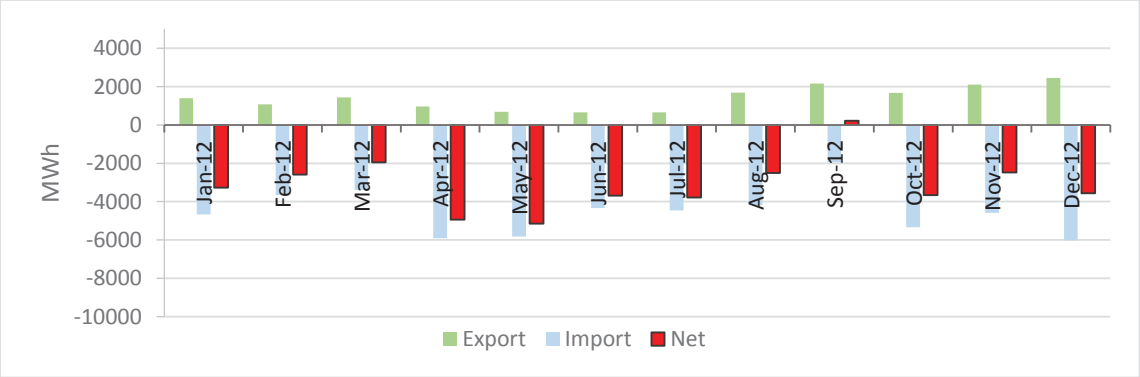


Figure 2.27 Monthly totals for Import, Export and Net Flows calculated from half hourly average values (January 2012 – December 2012). Source SSE.

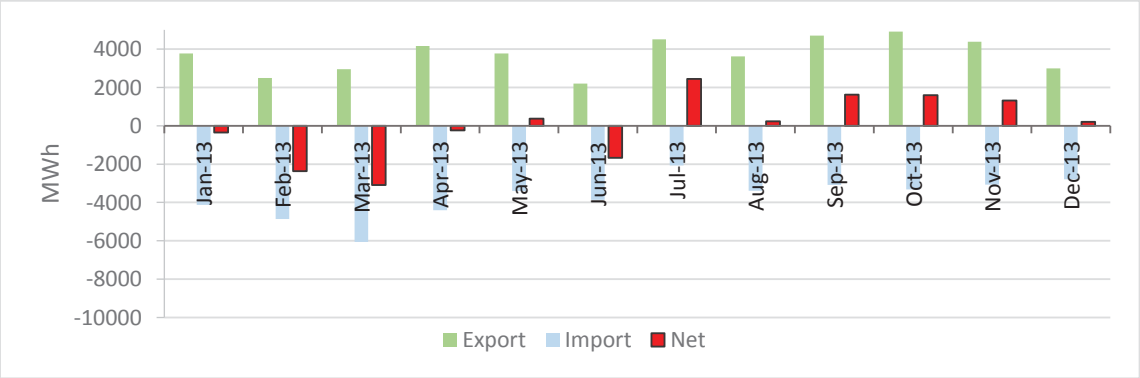


Figure 2.28 Monthly totals for Import, Export and Net Flows calculated from half hourly average values (January 2013 – December 2013). Source SSE.

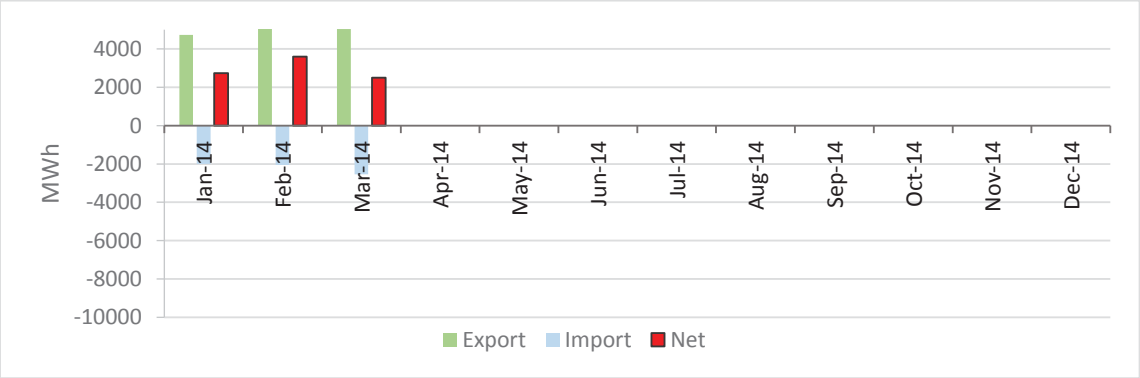


Figure 2.29 Monthly totals for Import, Export and Net Flows calculated from half hourly average values (January 2014 – March 2014). Source SSE.

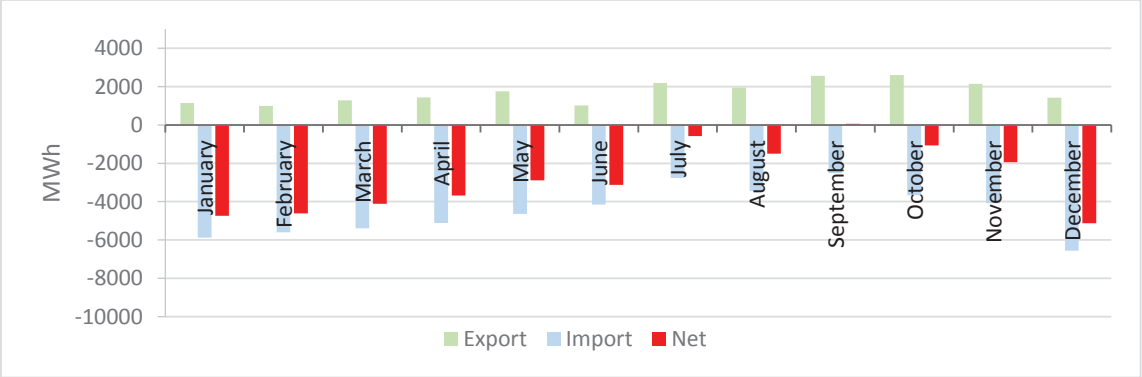


Figure 2.30 Average monthly variation in totals for Import, Export and Net Flows calculated from half hourly average values, average over 5 years (January 2009 – March 2013). Source SSE.

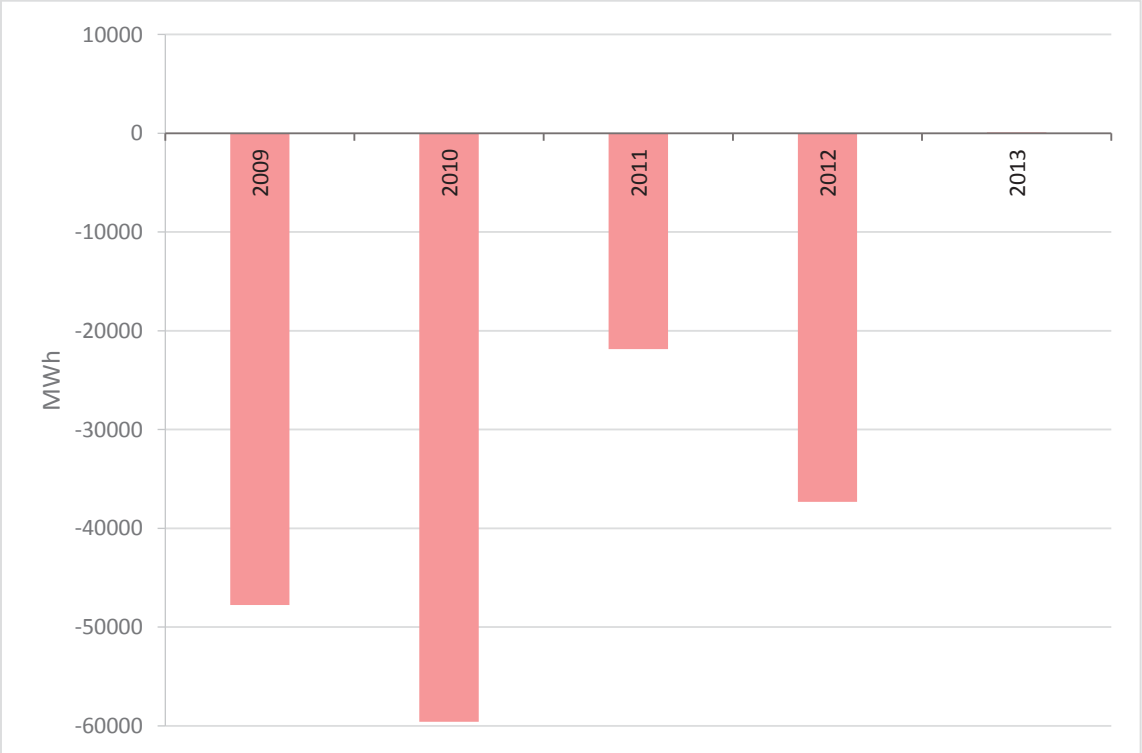


Figure 2.31 Yearly Net Flows calculated from half hourly average values (January 2009 – December 2013). Source SSE.

2.5.5 Local Non-Renewable Electricity Generation

Kirkwall Power Station

Up until the late 1990's the power station at Kirkwall supplied power for the island with the submarine cable across the Pentland Firth acting as a backup. Kirkwall Power Station ceased regular operation in the late 1990's after the second cable to the mainland was commissioned. It still runs monthly for test purposes and covers faults and system outages on mainland links.

Flotta Gas Turbine

As previously stated a large amount of crude oil comes ashore at the Flotta Oil Terminal and a small fraction is used at the terminal for heating and electrical generation. The oil terminal uses gas extracted from the crude oil for onsite heating and to power five (3MW) gas turbine generators. Peak terminal demand is 4MW with excess exported to National Grid[25] via its firm 10.5MW grid connection.

Figure 2.32 below shows that approximately 130,000 tonnes of CO_2 were emitted by Flotta in 2012. Assuming that the majority of this is methane which produces 2.8kg CO_2/kg of fuel, this equates to 46.43 tonnes of methane burnt. Methane has a calorific value of 38MJ/kg therefore the total energy is equivalent to 0.49GWh. It is not clear how much energy is used for heating, electricity generation or flared as data from Talisman was unavailable.

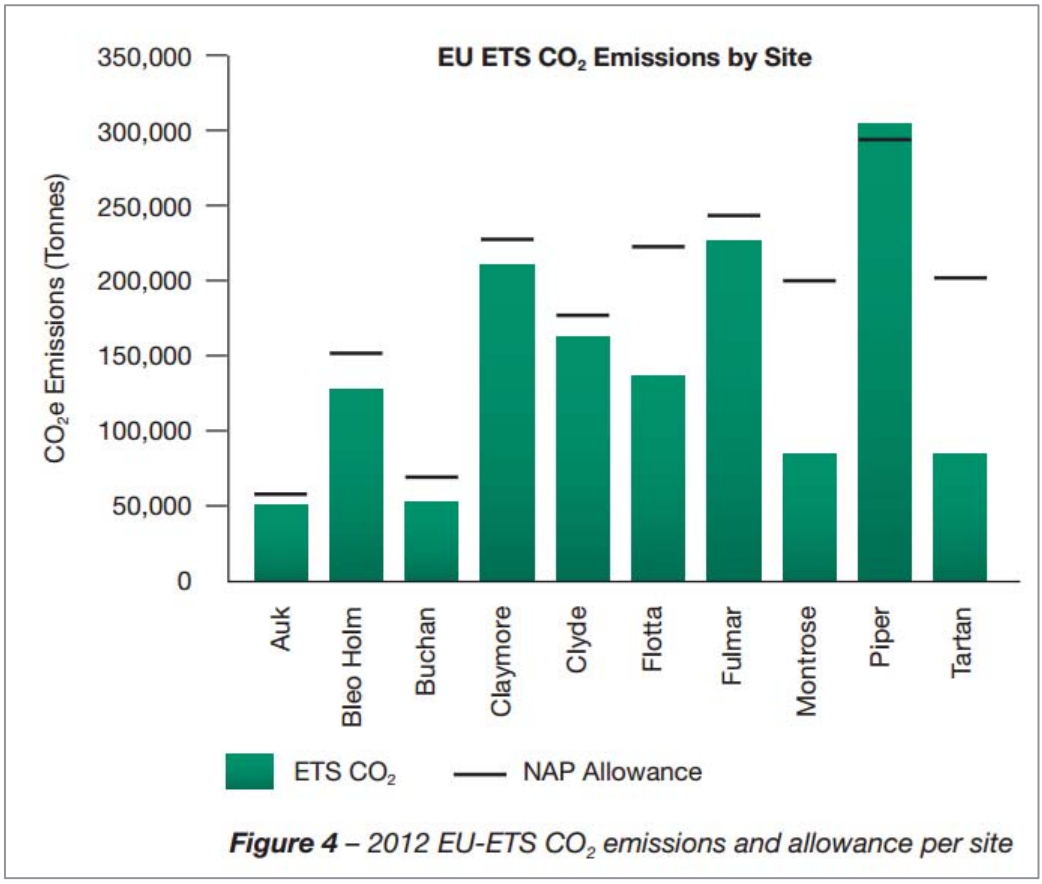


Figure 2.32 2012 EU-ETS CO_2 emissions for Flotta

[25] http://www.talisman-energy.com/upload/media_element/62/02/flotta.pdf

Source: https://itportal.decc.gov.uk/web_files/ems/2013/Talisman_EMS.pdf

3 Energy Uses

3.1 Overview

Energy use in Orkney can be broadly categorised into three main energy uses and further broken down by sector as follows:

- Buildings and Utilities
  - Domestic; Commercial/industrial; Public administration
- Transport
  - Road transport; Marine transport; Air transport
- Residual fuel use, which encompasses all other terrestrial energy i.e. the use of red diesel (gas oil) for terrestrial non-road transport and other static powered machinery in the following sectors
  - Industrial; Agriculture; Public administration

Examining energy consumption by end use (Figure 3.1) shows transport taking up the largest portion (298GWh) followed closely by buildings and utilities. Note that air transport is included here but is likely to be significantly underestimated for fuel used on routes to Orkney, although details were available for the study on the fuel imports into Orkney the majority of fuel used in this sector will be from planes that have refuelled in other airports on mainland Scotland.

The transport section of the pie chart in Figure 3.1 is broken down further by sector in Figure 3.2 which shows that the largest energy use in the transport sector is for ferry services to the mainland (140GWh) followed by domestic road transport (61GWh). As explained above air transport is included but is likely to be significantly underestimated. Figure 3.3 shows that the largest energy use in for buildings and utilities is for domestic energy uses (170GWh) and Figure 3.4 shows that for 'residual fuel' is mostly for agricultural uses (112GWh).

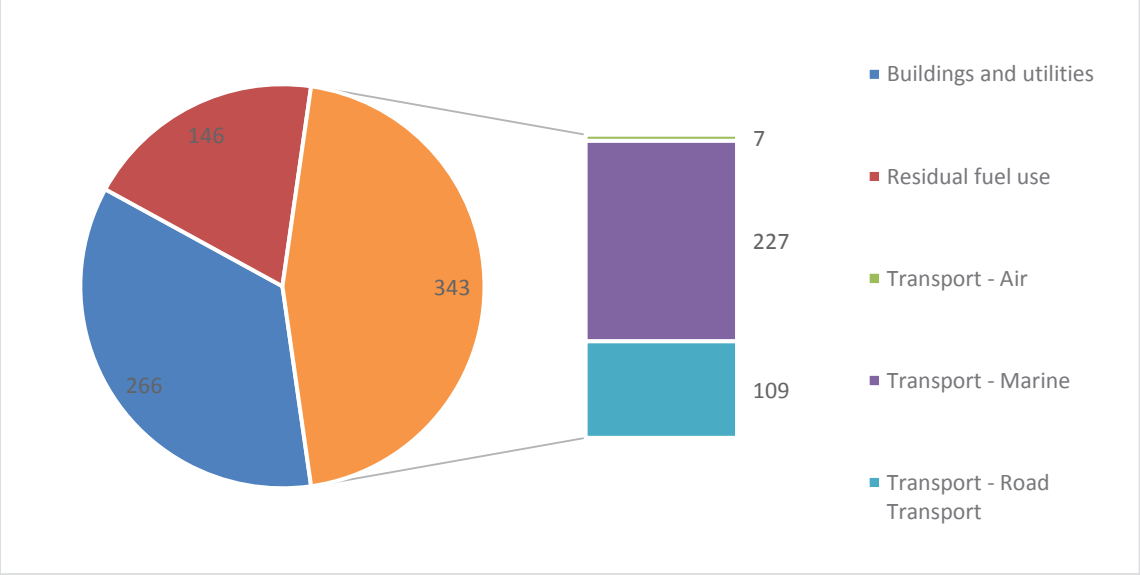


Figure 3.1 Energy use by end use

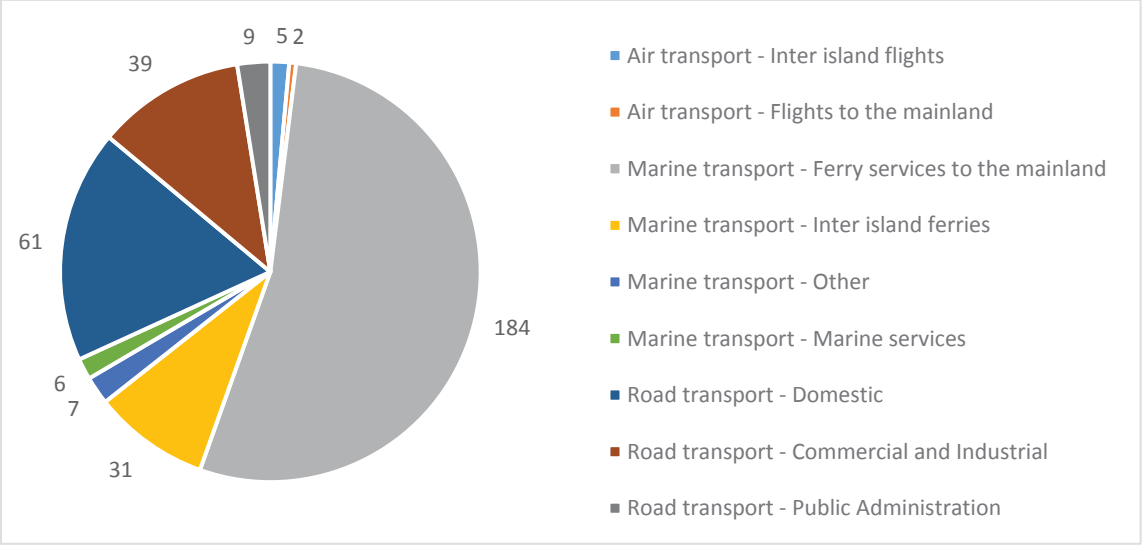


Figure 3.2 Energy use by sector - breakdown of energy use in the transport sector

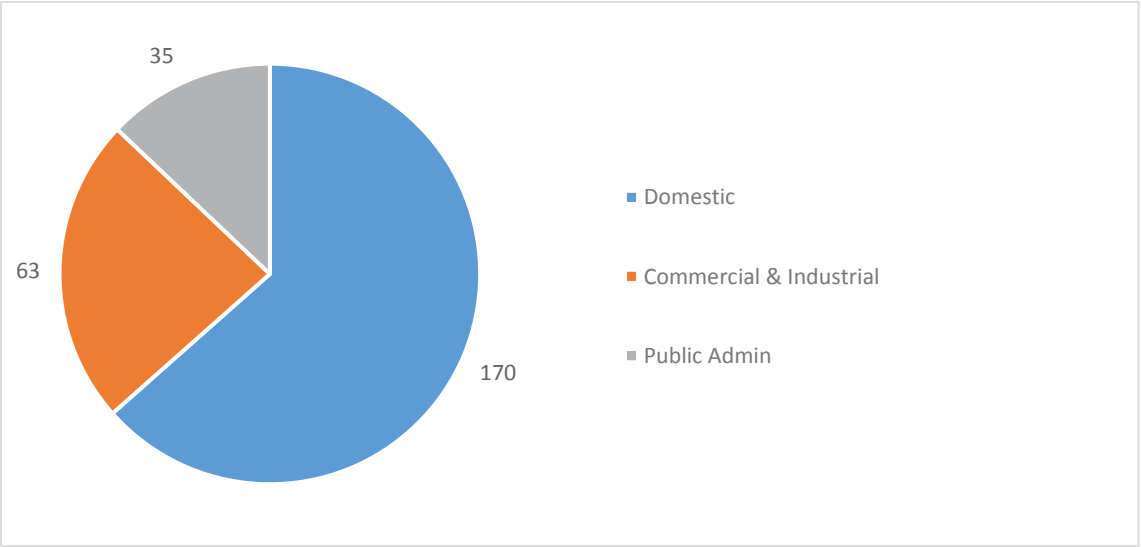


Figure 3.3 Energy use by sector - breakdown of energy use by buildings and utilities by sector

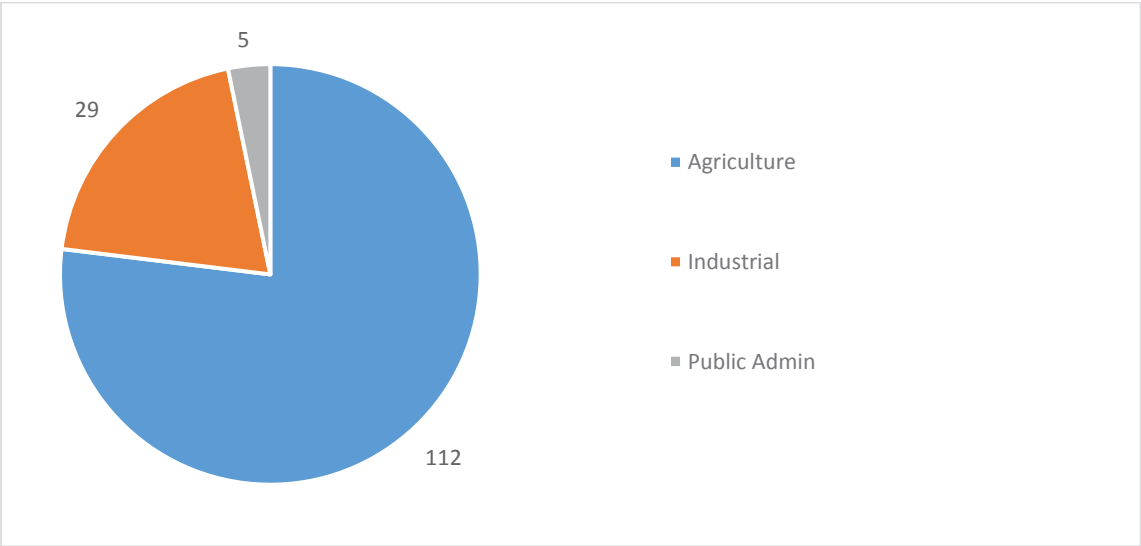


Figure 3.4 Energy use by sector - breakdown of residual fuel use by sector

The Sankey type diagram below (Figure 3.5) shows the different fuel sources as bars in the middle of the diagram. The size of each of the bars is proportional to the total amount of energy for either the fuel (green bars in the middle), end use (blue bars on the right) or sector (orange bars on the left). The width of the arrows is also proportionally energy flow.

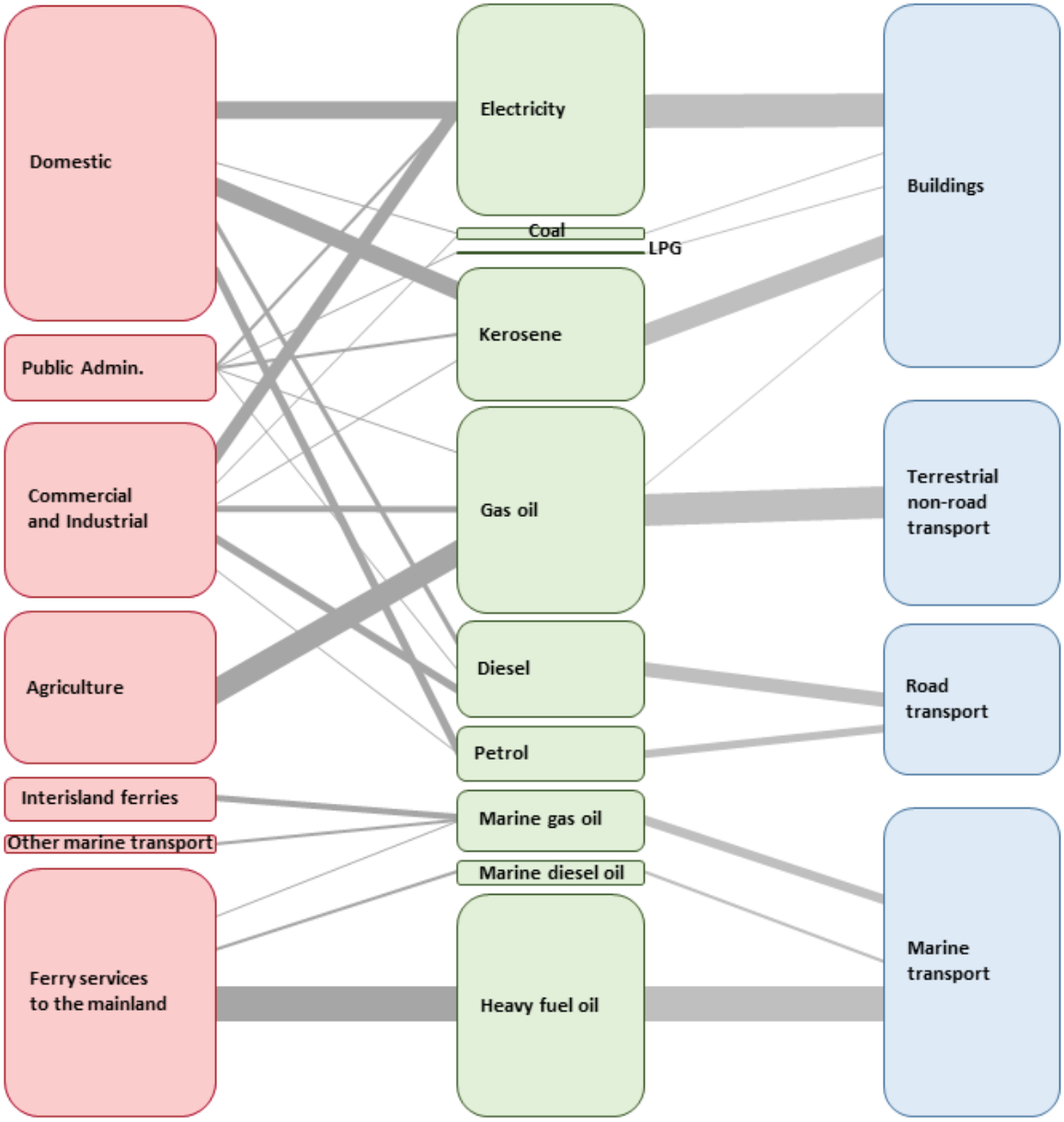


Figure 3.5 Sankey diagram (excluding air transport and peat)

3.2 Buildings and Utilities

3.2.1 Coal

As discussed previously coal products are used largely for domestic heating purposes. According to figures published by DECC a small percentage (5% on average over the years for which there is data) is used in the industrial and commercial sectors. It was not possible to obtain data directly from coal merchants but as the majority is imported into Orkney by bulk carrier, OIC Marine Services were able to detail how much is imported.

As the DECC figures do not match the figures provided by OIC Marine Services, the DECC total was disregarded but used the percentage split between domestic and industrial/commercial as shown in Table 3.1.

Table 3.1 Coal use in domestic commercial/industrial sector

Unit (GWh)	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Domestic	23.10	30.87	29.02	19.47	11.45	11.84	7.85	8.94	8.50	7.98	7.28
Industrial/commercial	1.22	1.62	1.53	1.02	0.60	0.62	0.41	0.47	0.45	0.42	0.38
Total	**24.31**	**32.49**	**30.54**	**20.49**	**12.05**	**12.47**	**8.26**	**9.41**	**8.95**	**8.40**	**7.67**

Source: OIC Marine Services and DECC

3.2.2 Kerosene and Gas Oil

Kerosene is commonly used for commercial and domestic heating purposes. Gas oil is also used in some instances.

DECC publishes estimates of non-gas, non-electricity and non-road transport fuels (also referred to as 'residual fuels') at local authority level. Table 3.2 shows statistics published by DECC from 2005 - 2011. Note that this data does not break the petroleum products down into different fuel types so it is therefore assumed that for non-gas, non-electricity and non-road transport fuel applications that the fuel use in the domestic and commercial sectors would be for heating. For agriculture and industrial sectors the fuel is more likely to be red diesel (see 3.3). For the public sector data was obtained from OIC and NHS and these figures have been used in preference to data from DECC as the figures from DECC will include energy for heating as well as non-road transport fuel (Table 3.3 and Table 3.4). Table 3.5 shows a summary of energy use from all three sectors; domestic, commercial and public.

Table 3.2 Kerosene use for domestic and commercial heating

Units	2005	2006	2007	2008	2009	2010	2011
Domestic Unit (toe)	6.933	7.310	6.445	6.796	6.757	7.703	5.953
Commercial Unit (toe)	0.341	0.283	0.210	0.251	0.173	0.202	0.193
Domestic Unit (GWh)	80.63	85.02	74.96	79.04	78.58	89.58	69.23
Commercial Unit (GWh)	3.97	3.29	2.44	2.91	2.01	2.35	2.25

https://www.gov.uk/government/statistical-data-sets/estimates-of-non-gas-non-electricity-and-non-road-transport-fuels-at-regional-and-local-authority-level[26]

Table 3.3 Kerosene use for public buildings

Unit (GWh)	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14

[26] Original data converted from ktoe to GWh. See Section 8.1.2 for conversion factors.

Unit (GWh)	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14
Community Social Services	1.81	1.63	1.73	1.52	1.39	1.55	1.38	1.56	1.41
Corporate Property	1.27	1.29	1.28	1.22	1.21	1.07	1.00	1.22	1.06
Development & Protective Services	0.30	0.32	0.37	0.30	0.32	0.47	0.33	0.68	0.44
Education (Non Schools)	1.57	1.43	1.54	1.56	1.70	1.66	1.30	1.85	1.29
Education (Schools)	7.62	5.68	7.64	8.25	8.07	8.45	7.16	7.92	6.09
Housing	0.02	0.02	0.03	0.01	0.08	0.04	0.02	0.04	0.02
Leisure & Recreation	1.42	1.77	1.85	1.59	1.51	1.57	1.29	1.79	2.28
Museums	0.58	0.48	0.57	0.54	0.47	0.55	0.48	0.64	0.56
Total	**14.58**	**12.62**	**15.01**	**15.00**	**14.75**	**15.36**	**12.96**	**15.71**	**13.13**

Source: OIC

Table 3.4 Summary of energy consumption across NHS Orkney 2010/11

GWh	Gas Oil	Kerosene	Total (Kerosene and Gas oil))
Accommodation	0.163	0.000	0.163
Child Health Clinic	0.000	0.000	0.000
Dental Surgery	0.074	0.060	0.134
GP Surgery	0.044	0.210	0.254
Hospital and Health Centre	4.359	0.000	4.359
Office	0.050	0.000	0.050
Total	**4.690**	**0.270**	**4.960**

Source: NHS

Table 3.5 Kerosene and gas oil use for domestic and non-domestic heating

Unit (GWh)		2005	2006	2007	2008	2009	2010	2011	2012	2013
Domestic		80.63	85.02	74.96	79.04	78.58	89.58	69.23		
Public Administration	OIC	14.58	12.62	15.01	15.00	14.75	15.36	12.96	15.71	13.13
	NHS						4.69			
Commercial		3.97	3.29	2.44	2.91	2.01	2.35	2.25		
Total		NA	NA	NA	NA	NA	NA	NA	NA	NA

Source: OIC, NHS and DECC

Table 3.6 Gas oil use for domestic and non-domestic heating

Unit (GWh)	2005	2006	2007	2008	2009	2010	2011	2012	2013
Public Administration						4.690			

Source: NHS

3.2.3 LPG

The OIC use LPG in the new Stromness Primary, the new Kirkwall Grammar School and the new Papdale Halls of Residence. The gas is used to run boilers which service high temperature loads such as ventilation systems and domestic hot water. The boilers can also supplement the heat pumps (supplied by Gleaners) if required. At the moment no long term data is available but estimates of annual usage are shown below in Table 3.7.

Table 3.7 LPG estimates for OIC properties

Property	Litres	MJ	TJ	GWh
Kirkwall Grammar	134300	3491800	3.49	0.97
Papdale Halls	35500	923000	0.92	0.26
Stromness Primary	20200	525200	0.53	0.15
Total	**190000**	**4940000**	**4.94**	**1.37**

Source: OIC

3.2.4 Electricity

DECC publishes electricity consumption figures on a local authority level (Table 3.8) which show that the annual consumption of electricity in Orkney and the split between domestic and commercial/industrial. Electricity data is divided between domestic and non-domestic categories according to the meter's profile type. For the majority of premises the domestic category is based on properties using standard domestic and economy 7 type tariffs where the consumption is less than 100,000kWh annually[27]. Therefore public buildings will be included in the commercial and industrial portion of the DECC figures.

Data obtained from OIC and NHS Orkney shows the split between the different OIC and NHS departments (Table 3.9 and Table 3.10 respectively). Table 3.11 shows the total electricity if the OIC electricity consumption is subtracted from the DECCs commercial and industrial portion.

Table 3.8 Orkney Islands regional and local authority electricity consumption statistics: 2005 to 2012

Unit (GWh)	2005	2006	2007	2008	2009	2010	2011	2012
Domestic	84.51	84.18	85.46	84.00	80.96	83.12	83.87	82.45
Commercial and Industrial	53.59	59.72	64.12	54.26	52.59	65.97	58.10	59.92

Source:https://www.gov.uk/government/statistical-data-sets/regional-and-local-authority-electricity-consumption-statistics-2005-to-2011

Table 3.9 Total Electricity consumption by department for OIC properties

Unit (GWh)	2005 - 06	2006 - 07	2007 - 08	2008 - 09	2009 - 10	2010 - 11	2011 - 12	2012 - 13	2013 - 14
Community Social Services	1.51	1.50	1.41	1.37	1.60	1.55	1.50	1.51	1.28
Corporate Property	2.25	2.01	2.20	2.12	2.36	2.02	2.08	2.15	2.03
Development & Protective Services	0.13	0.13	0.09	0.13	0.10	0.21	0.21	0.58	0.54
Education (Non Schools)	0.69	0.58	0.68	0.77	0.90	0.78	0.70	0.73	0.76
Education (Schools)	3.60	3.85	3.67	3.44	3.47	3.17	3.23	3.26	4.09
Harbours	2.71	2.74	2.52	2.52	2.74	2.48	2.74	2.87	3.19
Housing	0.01	0.01	0.01	0.01	0.00	0.02	0.01	0.00	0.00
Leisure & Recreation	0.98	1.07	0.66	0.47	1.08	0.99	0.96	1.09	1.96
Museums	0.26	0.30	0.25	0.29	0.33	0.30	0.21	0.21	0.27
Closed	0.12	0.07	0.44	0.02	0.06	0.00	0.00	0.00	0.00
Total	**12.26**	**12.25**	**11.93**	**11.14**	**12.64**	**11.53**	**11.64**	**12.41**	**14.12**

Source: OIC

Table 3.10 Summary of electricity consumption across NHS Orkney 2010/11

GWh	Electricity
Accommodation	0.010
Child Health Clinic	0.000
Dental Surgery	0.068
GP Surgery	0.131

[27]https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/324877/Sub-national_methodology_and_guidance_booklet.pdf

GWh	Electricity
Balfour Hospital and Health Centre	1.191
Office	0.020
Total	**1.420**

Source: NHS

Table 3.11 Summary of electricity consumption statistics

Unit (GWh)		2005	2006	2007	2008	2009	2010	2011	2012	2013
Domestic		84.51	84.18	85.46	84.00	80.96	83.12	83.87	82.45	
Public Administration	**OIC**	12.26	12.25	11.93	11.14	12.64	11.53	11.64	12.41	14.12
	NHS						1.42			
Commercial and Industrial		53.59	59.72	64.12	54.26	52.59	65.97	58.10	59.92	

Source: OIC and DECC

Electricity consumption statistics from DECC also show that the average domestic consumption per consumer has been decreasing over the last decade whereas there has been a slight increase in average consumption for industrial and commercial per customers (and Figure 3.6). These same consumption statistics are shown for smaller zones (known as Intermediate Geography Zone, Figure 3.7) see Table 3.13 and Figure 3.8 and Figure 3.9.

Table 3.12 Electricity consumption statistics for Orkney per customer 2005 to 2012

	2005	2006	2007	2008	2009	2010	2011	2012
Average domestic consumption per consumer (kWh)	6816	6601	6615	6354	6027	6081	6013	5859
Average industrial and commercial per consumer (kWh)	23690	26285	28374	23891	23638	29998	25962	26560

Source: DECC (https://www.gov.uk/government/statistical-data-sets/regional-and-local-authority-electricity-consumption-statistics-2005-to-2011).

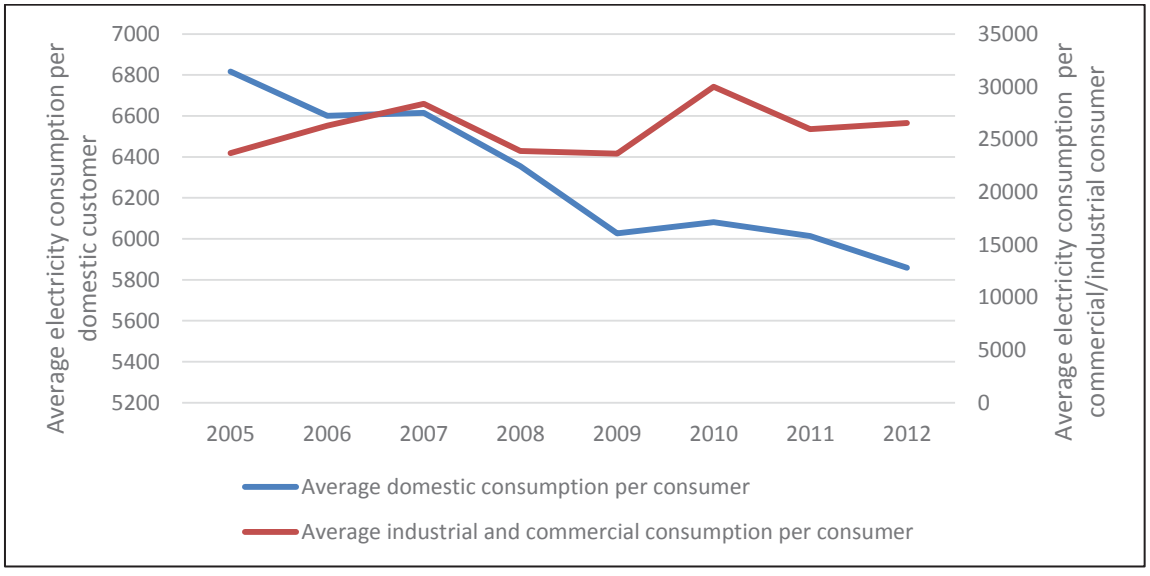


Figure 3.6 Average electricity consumption for domestic, commercial and industrial consumers per customer

Table 3.13 Electricity consumption data down to middle layer super output area (MLSOA) level and down to intermediate geography zones (IGZ) for Scotland

Domestic electricity

Domestic electricity								
(GWh)	2005	2006	2007	2008	2009	2010	2011	2012
East Mainland	13.18	12.72	13.11	12.75	12.94	13.69	14.04	14.15
West Kirkwall	17.41	17.48	17.75	16.87	16.34	16.75	16.76	16.15
East Kirkwall	12.99	12.81	13.24	12.48	11.78	11.84	11.76	11.54
Stromness, Sandwick and Stenness	12.27	11.99	12.48	12.32	11.76	12.11	11.97	12.00
Isles	14.97	14.74	14.93	15.29	14.34	14.99	15.24	14.78
West Mainland	13.23	13.27	13.54	13.59	13.54	13.69	13.87	13.81
Unallocated	0.45	1.18	0.43	0.72	0.25	0.05		
Total	**84.51**	**84.18**	**85.46**	**84.00**	**80.96**	**83.12**	**83.63**	**82.44**
Industrial and commercial electricity								
(GWh)	2005	2006	2007	2008	2009	2010	2011	2012
East Mainland	7.72	6.45	7.04	6.62	6.53	6.90	7.82	7.58
West Kirkwall	6.97	7.36	7.79	7.09	6.89	7.97	7.48	7.63
East Kirkwall	3.21	3.04	3.40	3.21	3.32	3.41	3.58	3.59
Stromness, Sandwick and Stenness	5.81	6.07	6.07	5.84	5.67	5.92	5.58	5.85
Isles	7.27	7.60	6.78	6.63	7.19	7.56	7.39	7.97
West Mainland	3.93	3.81	3.69	3.46	3.29	3.57	3.78	4.05
Unallocated	0.22	0.39	0.17	0.10	0.16			
Total	**35.13**	**34.72**	**34.95**	**32.95**	**33.04**	**35.33**	**35.64**	**36.67**

Source:http://webarchive.nationalarchives.gov.uk/20121217150421/http://decc.gov.uk/en/content/cms/statistics/energy_stats/regional/mlsoa_llsoa/mlsoa_2006/mlsoa_2006.aspx

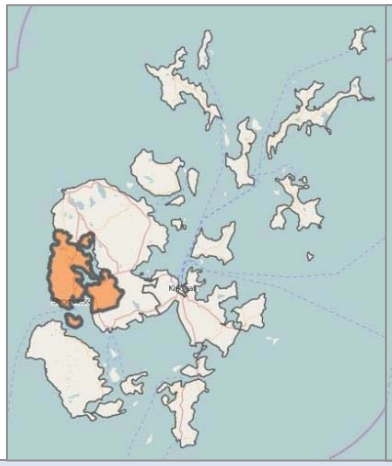
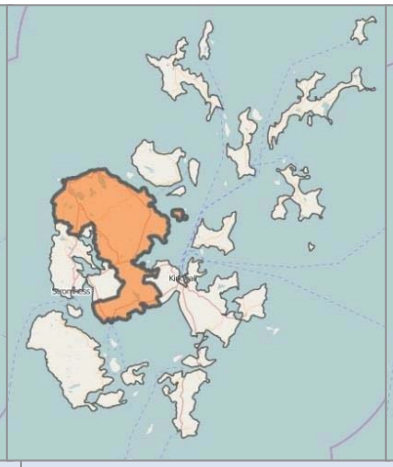
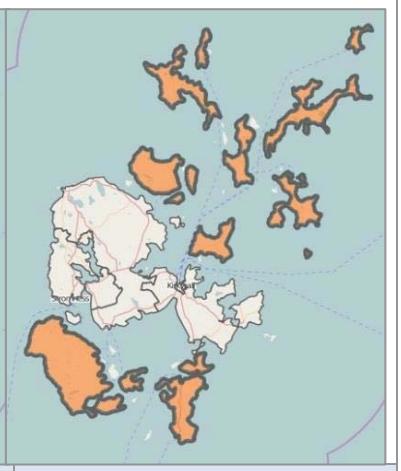
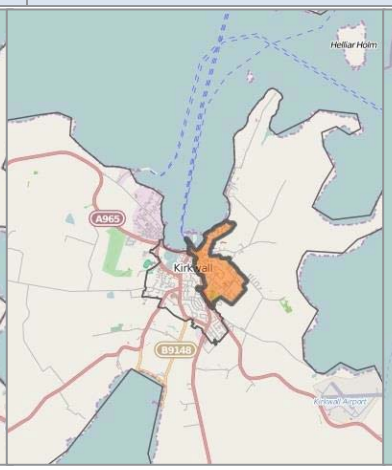
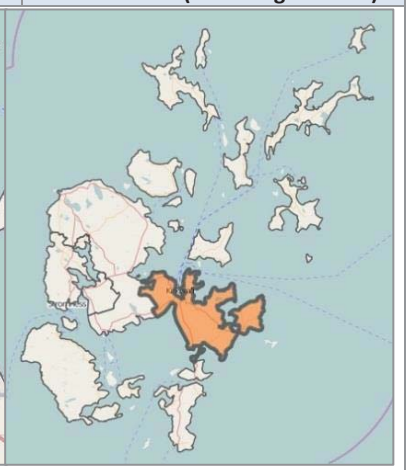
Stromness, Sandwick and Stenness	West Mainland	Isles
		
West Kirkwall	**East Kirkwall**	**East Mainland (excluding Kirkwall)**
		

Figure 3.7 IGZ areas

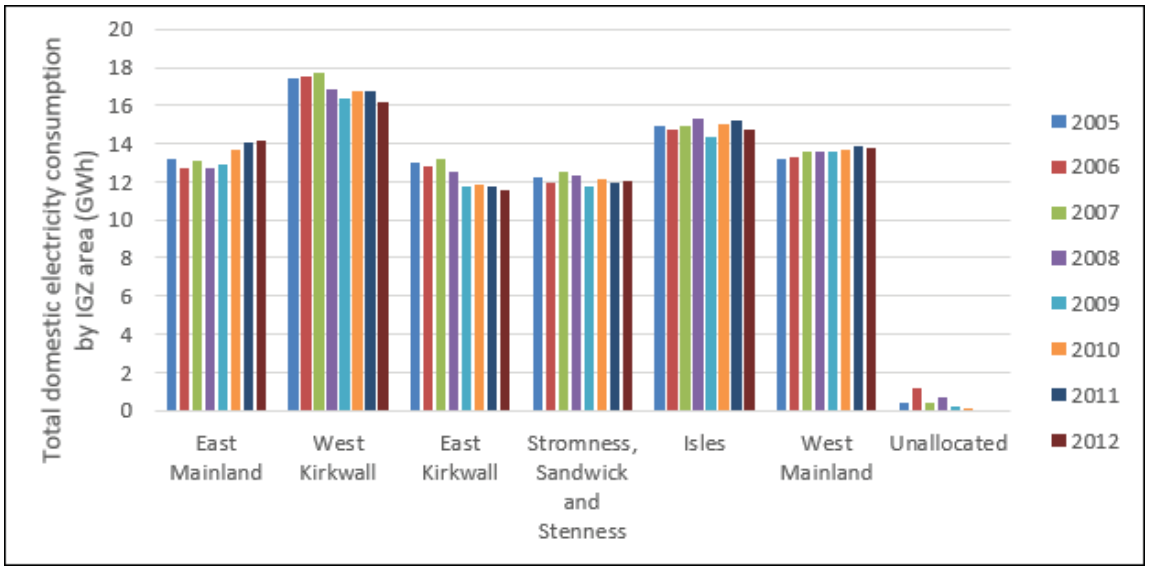


Figure 3.8 Total domestic electricity consumption by IGZ area

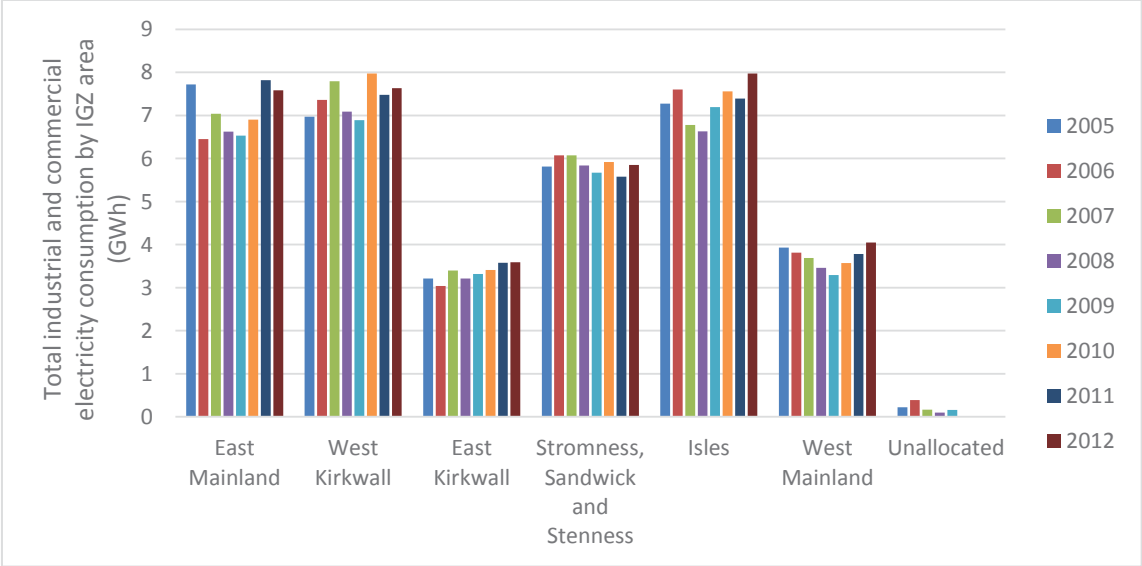


Figure 3.9 Total industrial and commercial electricity consumption by IGZ area

Table 3.14, below, illustrates the population and number of dwellings within the IGZs. It also includes the domestic annual electricity demand. From these figures the average electrical demand, per capita and per dwelling, have been extrapolated. Figure 3.8 demonstrates that the annual demand in each IGZ does not vary greatly between 2005 and 2012.

Table 3.14 Domestic electricity demand, per capital and dwelling, in 2011

IGZ Name	Population (mid-year estimates)	Number of dwellings	Domestic electricity (GWh)	Electricity Demand (MWh)	
				Per Capita	Per Dwelling
East Mainland	3,526	1,597	14.15	4.013	8.860
West Kirkwall	3,477	1,960	16.15	4.645	8.240
East Kirkwall	2,460	1,234	11.54	4.691	9.352
Stromness, Sandwick and Stenness	2,958	1,548	12	4.057	7.752
Isles	4,015	2,314	14.78	3.681	6.387

West Mainland	3,724	1,854	13.81	3.708	7.449

Figure 3.10, below shows the electricity usage per capita and per dwelling for the different IGZ zones. This of course only represents the portion of the total energy use that is made up by electrical energy demand. This does not represent the use of other fuels (e.g. coal, oil, etc.) or any microgeneration output consumed on site.

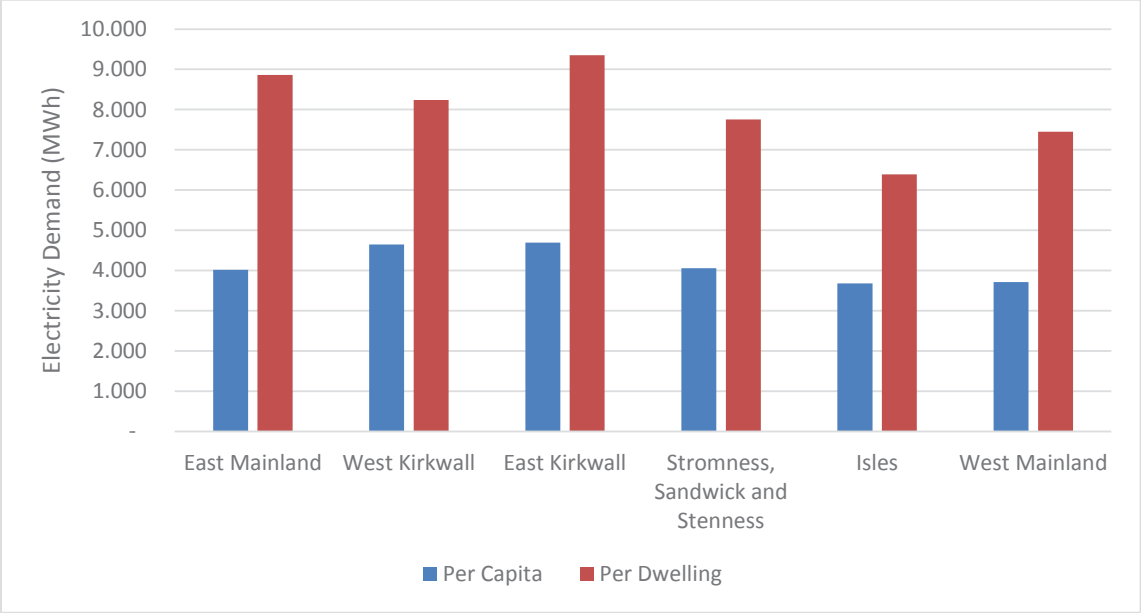


Figure 3.10 Domestic electricity demand, per capital and dwelling, in 2011

3.2.5 Heat Pumps

Ground and air-source heat pumps have become increasingly common in Orkney over the last few years as shown in Table 3.15. The numbers shown are from only a few of the installers, some of which are no longer operating so will be an underestimation of the true number of installations.

In addition OIC have plans for heat pumps at Evie School, St Rognvald's care home and the Children's Resource Centre all currently in later stages of design. They are included here in the energy uses section of the report as they use electricity in their operation. It should be noted that the energy used to run them is already accounted for within the electricity statistics.

There are a number of different types of heat pump:

- **Ground source heat pumps -** use pipes which are buried in the garden to extract heat from the ground by circulating a mixture of water and antifreeze around a loop of pipe. Heat from the ground is absorbed into the fluid and then passes through a heat exchanger into the heat pump. This heat can then be used to heat radiators, underfloor or warm air heating systems and hot water in your home.
- **Air source heat pumps** - absorb heat from the outside air in the same way that a fridge extracts heat from its inside. This heat can then be used to heat radiators, underfloor heating systems, or warm air convectors and hot water.
- **Solar water heating systems** – use solar panels (sometimes called collectors) to collect heat from the sun which is then transferred via pipes to heat up the water stored

in a hot water cylinder. A conventional boiler or immersion heater can be used to make the water hotter, or to provide hot water when solar energy is unavailable.

- **Seawater heat pump** – work in a similar way to ground source heat pumps but the pipes are immersed in seawater rather than being buried in the ground.

Table 3.15 Heat pumps in Orkney

Type		Approximate no. of installations in Orkney	Approximate average system capacity	System efficiency[28]	Public buildings with heat pumps
Ground source heat pumps		45	3 - 12kW[29]	2.82	KGS, Picky (600kW), Stromness primary, Papdale Halls, Glaitness primary, Stromness pool, Sanday primary school, Smiddybrea care home, Kalisgarth.
Air source heat pumps	Air-to-water	167	Most are in the 6 - 8kW range. average rating of 8kW	2.45	Stromness community centre, the picky campsite and Kirkwall museum store
	Air-to-air	202	average rating of 1.75kW each	CoP 4.6 [30]	
Solar thermal		15	~1.5kW/m^2 [31]	1.47 [32]	Eday Primary and St Andrews Primary
Seawater heat pump		1	Unknown usually larger developments	5.3 - 5.9 [33]	Pierhead redevelopment in Stromness soon to be commissioned

Renewable Heat Incentive Installations

The Renewable Heat Incentive (RHI) is a government financial support programme for renewable heat. The RHI pays participants of the scheme that generate and use renewable energy to heat their buildings. There are two schemes covering domestic and non-domestic. The non-domestic RHI was launched in November 2011 and the domestic RHI in April 2014.

Technologies eligible for RHI support are[34]:

- Biomass (wood fuelled) boilers
- Biomass pellet stoves with integrated boilers providing space heating
- Ground to water heat pumps
- Air to water heat pumps
- Solar thermal panels (flat plate or evacuated tube only) providing hot water for your home

[28] System efficiency is the amount of useful heat the heat pump produces compared with the amount of electricity needed to run the entire heating system (including domestic hot water, supplementary heating and pumps). https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/225825/analysis_data_second_phase_est_heat_pump_field_trials.pdf

[29] http://www.kensaheatpumps.com/

[30] http://www.worcester-bosch.co.uk/homeowner/heat-pumps/air-to-air-heat-pump

[31] http://www.worcester-bosch.co.uk/specifier/solar-water-heating/greenskies-solar-lux-12

[32] http://ample-energy-services.co.uk/Solar_Hot_Water_System.htm

[33] https://www.climatemaster.com/downloads/EP011.pdf

[34] http://www.energysavingtrust.org.uk/scotland/domestic/improving-my-home/renewable-heat-incentive

Air to air heat pumps, all log stoves, pellet stoves without back boilers and hybrid PVT are not supported by RHI.

Ofgem keep a register of RHI installations and publishes details of accredited installations/registered biomethane producers within the RHI Scheme as well as heat/biomethane produced and subsequent payments made. The publically available data collates data for the whole of Scotland[35] and shows a total installed capacity of about 194MW (mostly made up of solid biomass boilers). DECC also published monthly updates at a local authority level[36] which show that the installed capacity in Orkney is zero as of July 2014.

Microgeneration Certification Scheme (MCS) registered installers for biomass in Orkney and Caithness were also contacted to find out how many installations have been carried out which would be eligible for the RHI. Of the three installers contacted only one had carried out an installation for this scheme, which was a commercial installation in their own office. The other two installers had not undertaken any installations in Orkney yet.

3.2.6 Data from Significant Energy Users

Section 7 provides an initial list of commercial premises that may use significant quantities of energy. These companies were contacted to see if they were willing to provide data for this energy audit, only two companies replied. The energy used by these companies will already have been included in the overall figures for Orkney but are highlighted here in order to provide a baseline for potentially going forward with a particular switching option outlined in 'Orkney Energy Audit - Switching Options' report. This is perhaps particularly important for those commercial premises that are located in zones where there is currently curtailment due to grid constraints.

3.3 Terrestrial Non-Road Transport, Industry and Agriculture

DECC publishes statistical estimates of non-gas, non-electricity and non-road transport fuels (also referred to as 'residual fuels') at local authority level. Table 3.16 below shows statistics published by DECC from 2005 - 2011. Note that this data does not break the petroleum products down into different fuel types but it can be assumed that for non-gas, non-electricity and non-road transport fuels application that the fuel use would be for heating in the domestic and commercial sectors. For agriculture and industrial sectors the fuel is more likely to be red diesel.

Table 3.16 DECC estimates of residual fuel consumption in industry, public sector and agriculture

Sector	Unit	2005	2006	2007	2008	2009	2010	2011	Assumed fuel type
Industrial	Ktoe	2.16	1.98	2.09	3.66	3.53	3.89	3.14	Red diesel
Agriculture		10.61	9.87	9.43	9.32	9.48	9.56	9.75	Red diesel
Industrial	GWh	25.14	23.00	24.26	42.60	41.04	45.23	36.55	Red diesel
Agriculture		123.42	114.81	109.62	108.43	110.22	111.23	113.39	Red diesel

Source: https://www.gov.uk/government/statistical-data-sets/estimates-of-non-gas-non-electricity-and-non-road-transport-fuels-at-regional-and-local-authority-level

[35] https://rhi.ofgem.gov.uk/Public/ExternalReportDetail.aspx?RP=RHIPublicReport

[36] https://www.gov.uk/government/statistics/rhi-and-rhpp-deployment-data-july-2014

Data was obtained from OIC on their non-road transport fleet (Table 3.17) which have been used in preference for DECCs figures as the figures from DECC will include energy for heating as well as non-road transport fuel.

Table 3.17 Non-road transport fuel for public sector

Red Diesel	2004 - 05	2005 - 06	2006 - 07	2007 - 08	2008 - 09	2009 - 10	2010 - 11	2011 - 12	2012 - 13	2013 - 14
Litres	1,286,491	662,891	445,136	370,802	404,807	591,013	462,680	481,706	526,408	368,609
GWh	13.47	6.94	4.66	3.88	4.24	6.19	4.84	5.04	5.51	3.86

Source: OIC

Table 3.18 Estimates of residual fuel consumption in industry, public sector and agriculture

Sector	Unit	2005	2006	2007	2008	2009	2010	2011
Industrial	GWh	25.14	23.00	24.26	42.60	41.04	45.23	0.04
Public Administration		6.94	4.66	3.88	4.24	6.19	4.84	5.04
Agriculture		123.42	114.81	109.62	108.43	110.22	111.23	113.39

Source DECC and OIC

3.4 Transport

3.4.1 Road Transport

Petrol

Table 3.19 shows the total petrol consumption in Orkney. The majority of this consumption is domestic petrol cars (Table 3.19).

Table 3.19 Road transport petrol consumption in Orkney

Fuel type	Vehicle type	2005	2006	2007	2008	2009	2010	2011	2012
Kilo-tonnes	Motorcycles	0.05	0.05	0.05	0.04	0.05	0.04	0.04	0.04
	Petrol Cars	3.93	3.96	3.74	3.44	3.30	3.14	2.91	2.70
	Petrol LGV	0.13	0.14	0.13	0.12	0.10	0.09	0.08	0.08
	Total	**4.10**	**4.14**	**3.92**	**3.60**	**3.45**	**3.27**	**3.04**	**2.82**
GWh	Motorcycles	0.58	0.58	0.63	0.55	0.61	0.52	0.50	0.48
	Petrol Cars	50.00	50.36	47.61	43.75	41.94	39.94	37.07	34.40
	Petrol LGV	1.65	1.72	1.60	1.46	1.27	1.16	1.07	0.97
	Total	52.23	52.66	49.84	45.76	43.82	41.62	38.64	35.85
	Domestic sector (cars and Motorcycles)	**50.58**	**50.94**	**48.24**	**44.3**	**42.55**	**40.46**	**37.57**	**34.88**
	Commercial and Industrial sector (LGV)	**1.65**	**1.72**	**1.6**	**1.46**	**1.27**	**1.16**	**1.07**	**0.97**

Source: https://www.gov.uk/government/statistical-data-sets/road-transport-energy-consumption-at-regional-and-local-authority-level

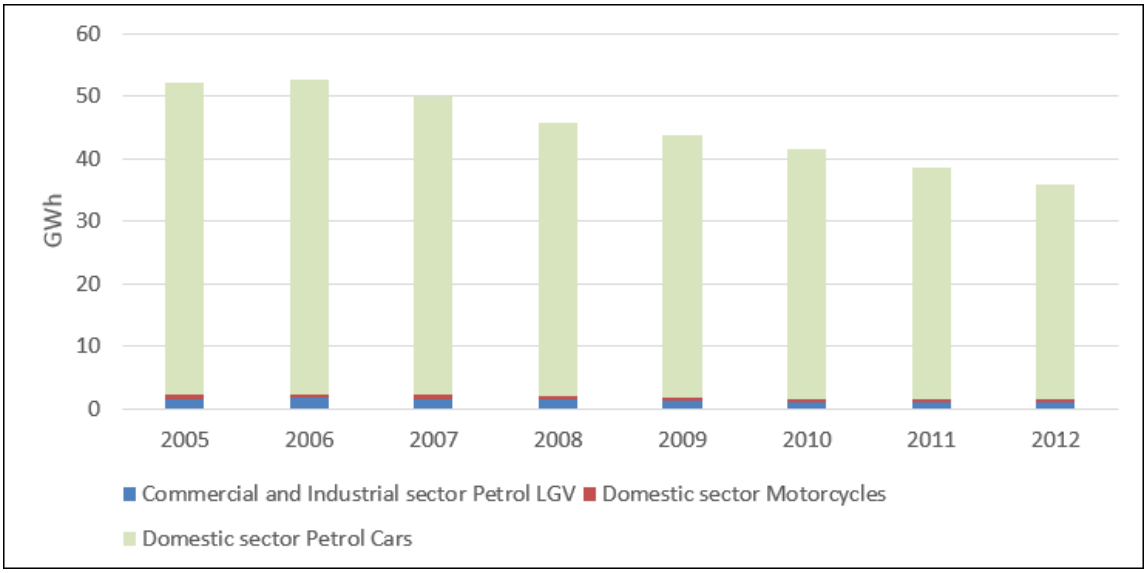


Figure 3.11 Road transport petrol consumption in Orkney

Diesel

Table 3.20 shows the diesel consumption for Orkney from DECCs road transport energy consumption data which shows that diesel consumption has been increasing slowly over the last few years with the biggest increase seen for diesel cars. Information obtained from OIC of their fleet of vehicles is detailed in Table 3.21. Table 3.22 shows the adjusted totals for domestic, public, commercial and industrial sectors incorporating the OIC data.

Table 3.20 Road transport diesel consumption in Orkney

Fuel type		2005	2006	2007	2008	2009	2010	2011	2012
Kilo-tonnes	Diesel Cars	1.31	1.48	1.57	1.74	1.76	1.78	1.80	1.85
	Buses	0.53	0.55	0.62	0.66	0.66	0.73	0.69	0.69
	Diesel LGV	1.46	1.56	1.67	1.72	1.62	1.65	1.65	1.62
	HGV	1.12	1.23	1.28	1.43	1.38	1.47	1.42	1.28
	Total	**4.42**	**4.83**	**5.15**	**5.54**	**5.42**	**5.62**	**5.56**	**5.45**
GWh	Diesel Cars	**16.45**	**18.64**	**19.77**	**21.85**	**22.13**	**22.36**	**22.65**	**23.25**
	Buses	6.66	6.93	7.85	8.25	8.26	9.15	8.62	8.72
	Diesel LGV	18.36	19.66	21.02	21.63	20.39	20.71	20.82	20.42
	HGV	14.1	15.5	16.15	18.03	17.37	18.49	17.86	16.14
	Total diesel	55.57	60.73	64.79	69.76	68.15	70.71	69.95	68.53
	Domestic sector (cars)	**16.45**	**18.64**	**19.77**	**21.85**	**22.13**	**22.36**	**22.65**	**23.25**
	Public sector (buses)	6.66	6.93	7.85	8.25	8.26	9.15	8.62	8.72
	Commercial and Industrial sector (LGV and HGV)	32.46	35.16	37.17	39.66	37.76	39.2	38.68	36.56

Source: https://www.gov.uk/government/statistical-data-sets/road-transport-energy-consumption-at-regional-and-local-authority-level

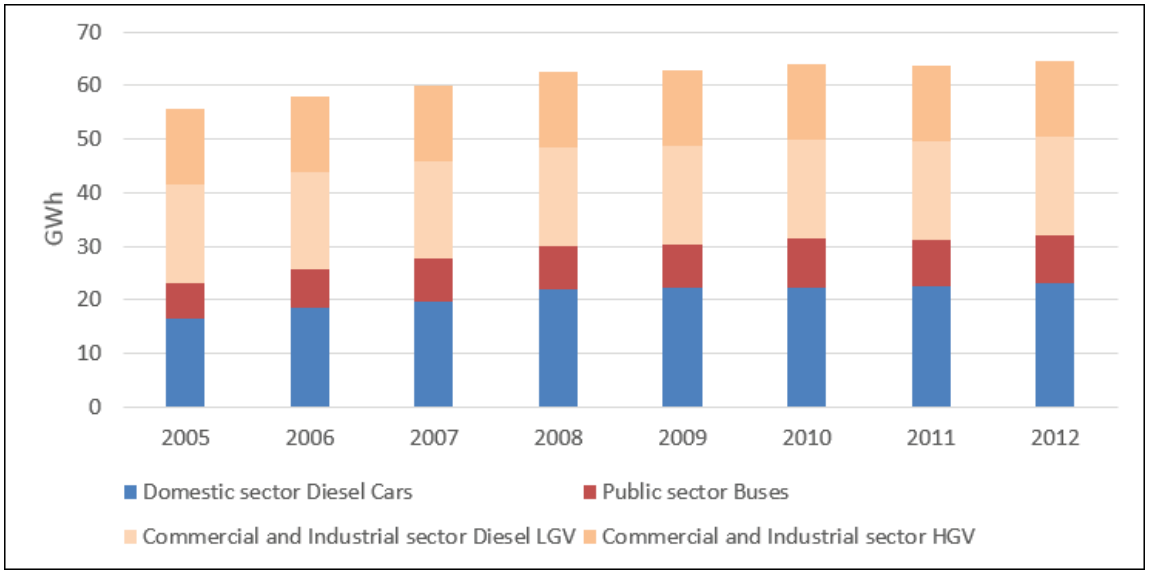


Figure 3.12 Road transport diesel consumption in Orkney

Table 3.21 OIC DERV data

Diesel	2004 - 05	2005 - 06	2006 - 07	2007 - 08	2008 - 09	2009 - 10	2010 - 11	2011 - 12	2012 - 13	2013 - 14
Litres	338798	348335	341855	363076	297153	304499	306754	313170	314836	289437
GWh	3.55	3.65	3.58	3.80	3.11	3.19	3.21	3.28	3.30	3.03

Table 3.22 Road transport diesel consumption in Orkney

GWh	2005	2006	2007	2008	2009	2010	2011	2012
Domestic sector (cars)	16.45	18.64	19.77	21.85	22.13	22.36	22.65	23.25
Public sector (buses plus OIC data)	10.31	10.51	11.65	11.36	11.45	12.36	11.9	12.02
Commercial and Industrial sector (LGV and HGV minus OIC data)	28.81	31.58	33.37	36.55	34.57	35.99	35.4	33.26

Source: OIC and DECC

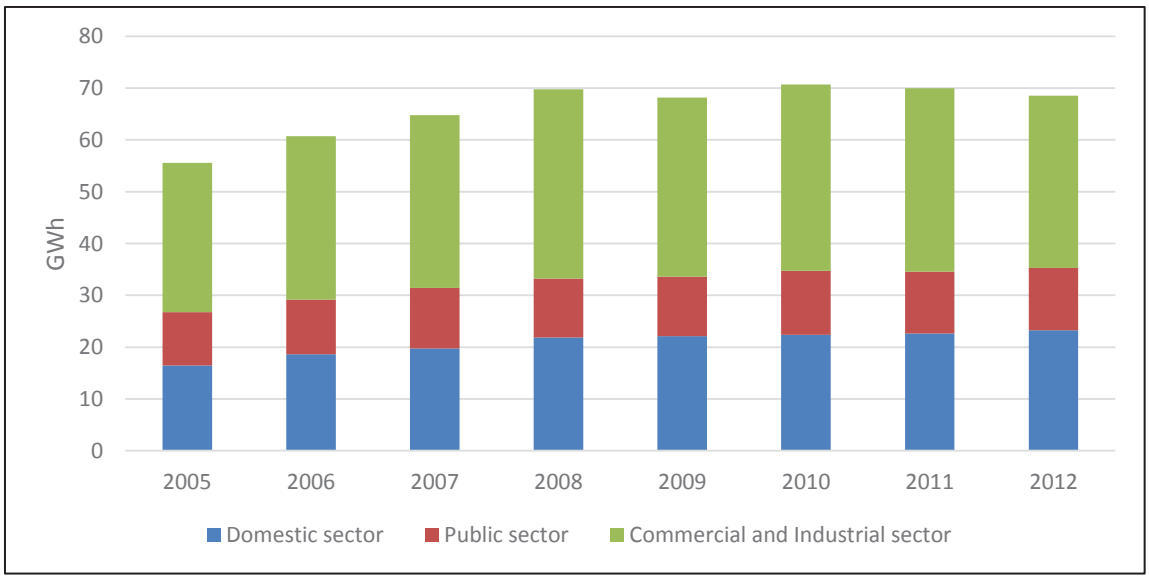


Figure 3.13 Road transport diesel consumption in Orkney by sector

Electric vehicles

OIC installed the first electric car charging point in 2011 in the car park at School Place, Kirkwall and at the same time purchased two electric vehicles. This was subsequently followed by the installation of further charging points across the county and the lease of further vehicles by local businesses. There is currently just one supplier which deals exclusively with electric vehicles in Orkney. Ecocars have sold two cars in 2013 and have sold at least 17 so far in 2014. It is believed there are >40 electric vehicles in Orkney at the time of writing.

Orkney's Electric Vehicle Infrastructure Strategy will be released by OIC shortly. In addition it has also been noted that OIC have backed a plan to increase the number of charging points for electric vehicles across the county.

3.4.2 Marine Transport

The majority of fuel used by vessels in Orkney comes in by road tankers from Scottish Fuels and Highland Fuels. One of these suppliers was unable to provide data on fuel imported into Orkney. In addition the data aggregated by DECC in its sub-national statistics does not include marine fuel use. Therefore a bottom up approach was used to looking at the fuel use for each marine sector.

Marine Services

Marine Services is a division of Orkney Islands Council, which incorporates the Harbour Authority, Orkney Towage and Orkney Ferries. Orkney Ferries operate nine dedicated inter-island ferries between Orkney's Mainland and thirteen island destinations. Fuel usage for the Harbour Authority, Orkney Towage and Orkney Ferries are shown in Table 3.23 and Table 3.24 below. Marine Services do not supply fuel to any third party at the moment but there are plans to have their own bunkering.

Table 3.23 Tugs & Harbour Craft and Inter-Island Ferries - Annual consumption of marine gas oil (Litres)

Litres	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14
Orkney Ferries	2,708,915	2,668,670	2,708,642	2,653,982	2,849,191	2,775,956	2,986,693	2,893,130	2,850,614	2,792,629
Towage	1,134,089	842,430	874,911	695,777	539,480	672,051	441,686	326,673	265,144	268,104
Harbour Craft	221,535	186,145	208,596	154,279	133,320	108,810	144,440	132,650	120,501	114,360
Total	**4,064,539**	**3,697,245**	**3,792,149**	**3,504,038**	**3,521,991**	**3,556,817**	**3,572,819**	**3,352,453**	**3,236,259**	**3,175,093**

Table 3.24 Tugs & Harbour Craft and Inter-Island Ferries - Annual consumption of marine gas oil (GWh)

GWh	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14
Orkney Ferries	29.08	28.65	29.08	28.49	30.59	29.80	32.07	31.06	30.61	29.98
Towage	12.18	9.04	9.39	7.47	5.79	7.22	4.74	3.51	2.85	2.88
Harbour Craft	2.38	2.00	2.24	1.66	1.43	1.17	1.55	1.42	1.29	1.23
Total	**43.64**	**39.70**	**40.71**	**37.62**	**37.81**	**38.19**	**38.36**	**35.99**	**34.75**	**34.09**

Ferries to mainland Scotland

There are a number of ferry services that provide links between Orkney and the Scottish mainland, as shown in Table 3.25. Figures obtained from Pentland Ferries show the litres of fuel used per year over the last number of years. The Pentland Venture fuel use has decreased to

around 80,000 litres per annum (approx. 0.9GWh) and the Pentalina uses about 1,570,000 litres (approx. 16.5GWh) (see Table 3.26). A study carried out by Professor Alfred Baird, at the Transport Research Institute (Edinburgh Napier University), and Roy Pedersen (Pedersen Consulting)[37] gives an estimate of the fuel usage on the other ferries as shown in Table 3.27.

Table 3.25 Ferry Services to Mainland Scotland

Company	Service	Ports	Vessel
John O'Groats Ferries	passenger	Burwick and John O'Groats	Pentland Venture
Pentland Ferries	vehicle and passenger	St. Margaret's Hope and Gills Bay.	Pentalina
Northlink Ferries	Freight	Kirkwall to Aberdeen (and Lerwick)	Hildsay/Hellier
	vehicle and passenger	Kirkwall to Aberdeen (and Lerwick)	Hrossey Hjaltland
	vehicle and passenger	Stromness to Scrabster	Hamnavoe

Table 3.26 Marine gas oil and marine fuel oil consumption for Pentland Ferries and John O'Groats Ferries

	Vessel (Fuel)	2005	2006	2007	2008	2009	2010	2011	2012	2013
Litres	Pentland Venture (marine gas oil)	111300	100000	101500	84850	93600	87700	77485	79227	83342
	Pentalina (marine diesel oil)								1567376	1581992
GWh	Pentland Venture	1.19	1.07	1.09	0.91	1.00	0.94	0.83	0.85	0.89
	Pentalina								16.83	16.99

Source: Pentland Ferries and John O'Groats Ferries

Table 3.27 Marine fuel oil consumption for ferry services to Mainland Scotland

Vessel	Fuel[38]	Number of crossings per annum	Litres/ crossing[39]	Approximate litres per annum	Approximate GWh per annum
Pentland Ferries	Marine diesel oil	2202	708	1559016	16.74
Hildsay[40]	Heavy Fuel Oil	260	12395	3222700	38.23
Hjaltland & Hrossey	Heavy Fuel Oil	320	20240	6476800	76.83
Hamnavoe	Heavy Fuel Oil	1584	2700	4276800	50.73

Source: RGS-IBG Annual International Conference Edinburgh, 3rd July 2012

[37] Analysis of Freight Transport CO_2 Emissions for Island Ferry Services. RGS-IBG Annual International Conference Edinburgh, 3rd July 2012. Professor Alfred Baird Transport Research Institute, Edinburgh Napier University & Roy Pedersen, Pedersen Consulting

[38] It is understood that the Northlink vessel currently used Heavy Fuel Oil

[39] Pentalina - 6 crossings per day, except 9 Saturdays in May and June which have 8 crossings. Total of 2202 crossings per year. Hamnavoe - 4 crossings per day, except 13th June to 26th August which have 6 crossings per day Monday to Saturday. Total of 1550 crossings per year. Hildsay 5 Kirkwall Aberdeen crossing crossings per week. Hjaltland/Hrossey – 1 Kirkwall Aberdeen crossing per day except Mondays and Tuesdays between 1 Nov and 31 March.

[40] Litres per crossing are figures given for the Hellier (Northlink's other freight vessel).

Although the ferries are likely to refuel on the Scottish mainland, the fuel use has been included in this report as there is a potential for a fuel switching strategy which could displace this fuel which could be implemented on Orkney; especially considering that the ferries berth overnight in Orkney.

It should be noted that new regulations are coming into force in January 2015 which will effectively bans heavy fuel oil unless emission abatement methods employed. In October 2008 the International Maritime Organization (IMO) adopted a set of amendments to Annex VI of the MARPOL Convention. These amendments, among other things, require there to be progressive reduction of the sulphur content of marine fuels. In 'Sulphur Emission Control Areas' (SECAs) of which the North Sea is one, as from 1 July 2010, the maximum sulphur limit has been reduced to 1.00%, while from 1 January 2015, the limit will be further reduced to 0.10%[41].

Other marine fuel use

Other fuel use within the marine transport sector will include fuel used for fishing boats, charter vessels, aquaculture vessels and vessels used in the marine renewables sector.

It is understood that the larger fishing vessels and a number of dive boats have direct contracts with the main fuel suppliers (either Highland Fuels or Scottish Fuels). Therefore the data presented below here is not a complete picture of fuel use by boats operating in Orkney but it does give a baseline that we know it is not less than the figure. The data is from several fuel providers in order to maintain and protect the commercial sensitivity of the data.

Table 3.28 Approximate marine gas oil by fishing boats, charter vessels, aquaculture vessels and others

2013	Approximate litres per annum	Approximate GWh per annum
Total	690,944	7.42

Fishing Boats

Orkney's fishing fleet consists of a wide variety of vessels services different requirements. Statistics show that the number of active fishing vessels registered to Orkney changes slightly each year. Table 3.29 highlights this changing number and breaks them down into categories of length.

Table 3.29 Orkney's fishing vessel count

Vessels	2006	2007	2008	2009	2010	2011	2012
10 metres & under	111	115	109	110	105	109	102
> 10 < 15 metres	31	29	30	31	33	34	32
15 < 18 metres	5	4	4	4	4	4	3
18 < 25 metres	1	1	1	1	1		1
25 < 35 metres	5	5	5	5	5	5	3
35 < 50 metres	0	1	1	1	1	0	1
Total Vessels	**153**	**155**	**150**	**152**	**149**	**152**	**142**

Source: OIC[42]

[41] http://ec.europa.eu/environment/air/transport/pdf/Report_Sulphur_Requirement.pdf
[42] http://www.orkney.gov.uk/Files/Business-and-Trade/Economic_Review/Orkney_Economic_Review_2012-13.pdf

On top of the previously mentioned fishing vessels, there are a number of vessels registered in Orkney that support the numerous fish farms located throughout the Orkney Islands. The fuel usage for the fishing and aquaculture sector is extremely difficult to estimate as it will change according to type of fishing, type of vessel and time of year. The figures are also a large part of a fishing business costs and are therefore commercially sensitive which adds difficulty in obtaining accurate figures. The study therefore uses the figures in Table 3.28 in the understanding we know the figures is a lot higher.

Private Visiting Boats

There are significant numbers of private boats visiting Orkney each year. Orkney currently has three marinas servicing these visitors: Kirkwall, with 95 berths; Stromness, with 72 berths; and Westray, with 17 berths (Figure 3.14[43]). Only the marinas situated at Kirkwall and Stromness are capable of supplying fuel to vessels berthed within them, both of which can supply red diesel[44].

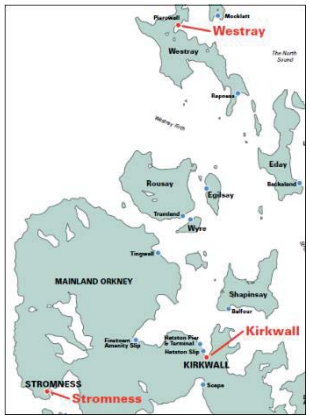


Figure 3.14 Marinas

The marinas cater for locally berth vessels as well as visiting vessels, both of which have access to the fuelling system.

Among these three marinas in 2010 and 2011, a combined total of 1,186 vessels berthed for an undisclosed period of time. From the available information it is not possible to determine if these are all individual vessels, or whether a number visited more than one marina while in Orkney. Figure 3.15 illustrates the numbers visiting the three marinas throughout each month in 2010 and 2011; the most up to date information available.

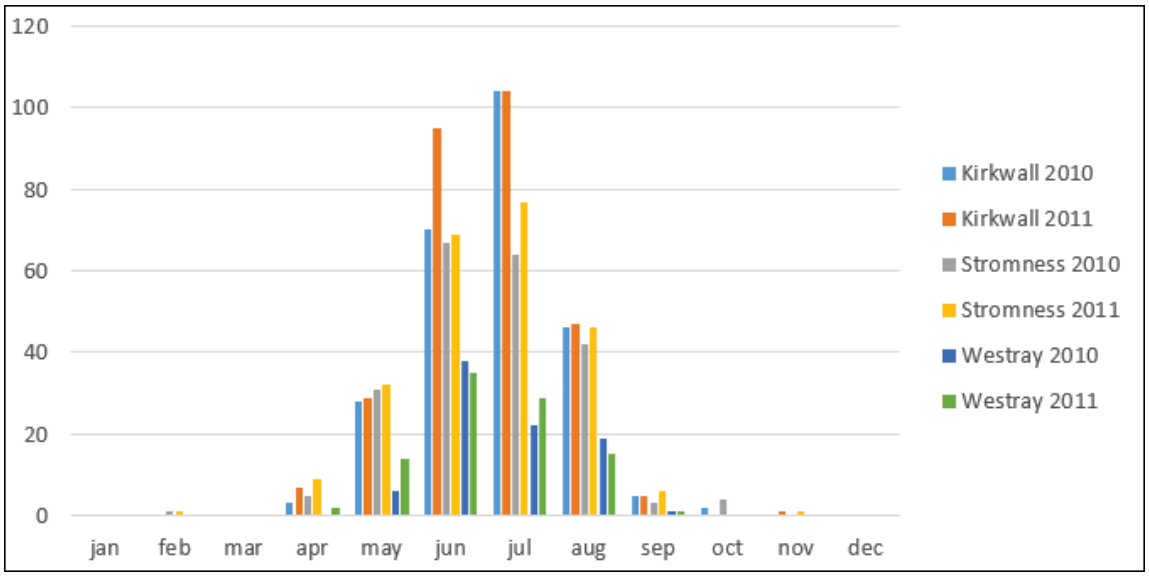


Figure 3.15 Marina numbers

Dive Boats

[43] http://www.orkneyharbours.com/pdfs/PortsHandbook-2013-v5.pdf

[44] http://www.orkneymarinas.co.uk/

Orkney has between eight and ten vessels solely serving the recreational diving industry in Orkney. The majority of these spend the greatest amount of time in and around the wrecks of Scapa Flow. A couple of larger vessels travel among the outer islands as well.

Dockside services to visiting vessels

OIC Marine Services supply electricity (both 240v and 440v) at most of the piers they operate. Consumption figures for 2013/14 are given in Table 3.30 below, but it should be noted that this energy is also included in the total figures given in Section 3.2.3 under OIC Harbours. Additionally a small amount of electricity is sold through Orkney Marinas to yachting and leisure crafts as shown in Table 3.31.

Table 3.30 Orkney pier electricity consumption 2013/2014

Electricity (kWh)	kWh	GWh
Burray pier	149	0.00015
Holm pier	0	0.00000
Kirkwall harbour	364606	0.36461
Hatston terminal	69918	0.06992
Kirkwall marina	22750	0.02275
Lyness ferry terminal	13	0.00001
Lyness Golden Wharf	107852	0.10785
Longhope pier	0	0.00000
Rousay pier	963	0.00096
Sanday pier	1056	0.00106
Loth pier Sanday	1128	0.00113
Scapa pier	2101	0.00210
Stromness harbour	227104	0.22710
Coplands dock	0	0.00000
Stronsay pier	8117	0.00812
Tingwall jetty	11	0.00001
Westray harbour	4121	0.00412
Rapness pier	0	0.00000
Total	**809889**	**0.80989**

Source: OIC

Table 3.31 Orkney Marinas electricity usage 2012-2013

Electricity (GWh)	2012	2013
Kirkwall	0.03189	0.03634
Stromness	0.00761	0.01163

Source: Orkney Marinas

3.4.3 Air Transport

The airport in Kirkwall operates both inter-island flights and links to mainland Scotland. As described in Section 2.2.7, there are two types of aviation fuel used in Orkney; Jet-A1 and AV Gas. Jet A-1 is conventional kerosene-based jet fuel, whilst AV Gas is a high-octane alternative used in lighter aircraft. Data on the total fuel consumption of these types of fuel are given in Section 2.2.7. It has not been possible to ascertain the split of these fuels between the inter-island routes and the route to the mainland.

There is presumably a contribution of fuel that comes into Orkney after the planes have been refuelled in other airports on mainland Scotland.

3.5 Storage

Scottish Hydro Electric Power Distribution (SHEPD) has connected the UK's first large scale battery to the local electricity distribution network on Orkney[45]. This 2MW battery was commissioned in 2013 and is now operational. By introducing energy storage, this project aimed to further develop the ANM scheme to allow energy that would otherwise be constrained from the network to be stored, and thus allow more renewable generation onto the network. The trial project will investigate how large scale batteries could play a role in the release of capacity on the electricity distribution network and explore how the intermittency issues affecting renewable generation could be resolved.

3.6 Embodied Energy in Major Commodity Imports

3.6.1 Fertiliser

Approximately 30,000 tonnes of fertiliser are imported annually to Orkney[46]. In terms of embodied energy, the major component in agricultural fertiliser production is nitrogen in the form of Ammonium nitrate (NH_4NO_3), Urea (CH_4N_2O) or Ammonia (NH_3). Actual rates of application vary depending on the crop to be planted, soil type, the previous crop, rainfall range[47] but application rates have been obtained from Scottish Agricultural College[48] which give a fairly accurate estimate of what will be used in Orkney. The four types of fertiliser in Table 3.32 account for approximately 80% of the total annual fertilisers in Orkney with Phosphate and Pot ash making up the rest. The majority of farmland on Orkney is used either for cereals or grass[49].

Assuming this rate of application on the cereal and stock feeding crops in Orkney, the total nitrogen usage for fertiliser is 5,645,127kg (5,645 tonnes).

Table 3.32 Application rates for most common fertiliser types used in Orkney

Fertiliser mix					Application rate		
N	P	K	Use	Total fertiliser cwt/acre per year	Total fertiliser kg/acre per year	Kg/ha of total fertiliser	Kg/ha of Nitrogen
16	16	16	Barley and Hay	3	152	377	60
25	5	5	Spring grass growth	3	152	377	94
20	10	10	Grazing and silage	6 (3cwt, twice a year)	305	753	151
34.5	-	-	Grazing and silage	2	102	251	87

Table 3.33 Kg of nitrogen used in Orkney for fertiliser

Crop	Agricultural Land Use in Orkney 2012 (Hectares)	Kg/ha of Nitrogen[50]	Total kg of Nitrogen
Cereals	4,394	60	263,640

[45] http://www.energyefficiencynews.com/articles/i/5594/

[46] Pers .comm. (Birsay Farmers Ltd)

[47] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69469/rb209-fertiliser-manual-110412.pdf

[48] Pers. comm. (Sue Pirie, SAC)

[49] http://www.orkney.gov.uk/Files/Business-and-Trade/Economic_Review/Orkney_Economic_Review_2012-13.pdf

[50] For Stockfeeding crops an average of the three different types of fertiliser was used.

Grassland	50,857	111	5,645,127
Total kg			5,908,767
Total tonnes			**5,908 tonnes**

Source: Orkney Economic review, 2012-13 and SAC

3.6.2 Malted Barley

Malted barley is a commodity that is high in embodied energy. Both breweries (Orkney Brewery and the Highland Brewing company) and distilleries (Highland Park Distillery and Scapa Distillery) use malted barley in their production processes. However Highland Park carry out their own malting whereas the Scapa Distillery and the breweries will get their malted barley from large maltings on mainland Scotland and due to economies of scale it is unlikely that this process could efficiently be moved to Orkney.

3.6.3 Animal Feeds

Animal feeds are imported in bulk into the county. It has been suggested that this may be an area to look at in terms of embodied energy of imported goods. However there is little opportunity to produce the raw materials in Orkney as the majority of farmland is already in use. Therefore all the raw material would need to be imported which is generally not competitive on an island and there would be no economies of scale compared to producers on mainland Scotland.

3.6.4 Purification and/or Compression of Bulk Gases

There are small amounts of compressed gas used in the diving industry and at the hospital but these amounts are too small and the applications too specialised to warrant further investigations.

3.6.5 Energy Value in Buried/Exported Waste

Embodied energy within waste streams can be a useful energy source. Currently much of Orkney's waste (up to 10,000 tonnes per year[51]), that would otherwise go to landfill or incinerated, is currently sent to Shetland. Here, the majority of it is used in their waste to heat plant, and the rest is composted, recycled or landfilled. The Energy Recovery Plant is operated by Shetland Islands Council (SIC) and provides the principal heat source for the Lerwick District Heating Scheme; run by Shetland Heat Energy and Power Ltd.[52]. The District Heating Scheme provides low-cost heating to around 1100 domestic, commercial and public-sector customers throughout Lerwick. Up to August 2013 there were a total of 1200 connections and 1174 of these are receiving heat[53].

The Energy Recovery Plant comprises a moving grate furnace which consumes around 22,000 tonnes of municipal waste per annum. This includes all of Shetland's combustible waste imported from Orkney; from shipping; and from oil installations offshore. On average, the facility generates 6.5MW of heat output and operates 24-hours per day, seven days a week. The

[51] Pers. comm. Jonathan Walters.

[52] http://www.scottish-places.info/features/featurefirst90246.html

[53] http://www.sheap-ltd.co.uk/

waste shipped from Orkney has a calorific value of about 11 MJ per kg[54] (11 GJ/tonne). Table 3.34 below shows the energy value in the waste sent to Shetland in 2011 and 2012.

Table 3.34 Orkney household waste disposed by incineration, 2012 data

Household and similar wastes (tonnes)	Disposed by incineration (tonnes)	Total GJ (at 11 GJ/tonne)	GWh
2011	5,432	59752	16.60
2012	6,169	67859	18.85

Source: http://www.environment.scotland.gov.uk/get-interactive/data/household-waste/

Other recycling streams are of interest if there are waste streams where the recycling of the produce is energy intensive, and which is currently done off island. Recycling on Orkney could produce an energy demand. In order to increase Orkney's energy demand through recycling the different methods of doing so should be investigated to determine which has the greatest potential of reducing the volume of waste which still required exporting to Shetland and still remain financially viable.

The Table 3.35 below shows a detailed breakdown of waste management in Orkney. It provides a summary of the different waste streams in Orkney and how these are dealt with (all figures in tonnes per annum).

Of particular note is glass of which, in 2012 471 tonnes were sent elsewhere to be processed. Crushed recycled glass can be used as a complete fine aggregate replacement in concrete or ground into a fine power to use as a pozzolanic additive in concrete production[55],[56]. A plant in Shetland currently processes about 600 tonnes a year[57]. There is a glass crusher in Rousay which they are about to start using.

Table 3.35 Summary of Orkney household waste arising and management (recycling, recovery and disposal), 2012 data

Waste type	Orkney household waste (Tonnes)				
	Arising	Composted	Disposed by incineration	Landfilled	Recycled
Batteries and accumulators wastes	2				2
Discarded equipment (excluding discarded vehicles, batteries and accumulators wastes)	156				156
Glass wastes	471				471
Household and similar wastes	7,596		6,169	2,721	
Metallic wastes, mixed ferrous and non-ferrous	268				235
Mixed and undifferentiated materials	9				42
Paper and cardboard wastes	540				540
Plastic wastes	42				42
Rubber wastes	7				7
Textile wastes	54				54
Used oils	62				62

[54] Neville Adrian Martin; William Spence. Proceedings of the ICE - Energy, Volume 163, Issue 3, 01 August 2010 , pages 131 –138

[55] http://www.concrete.org.uk/fingertips_nuggets.asp?cmd=display&id=783

[56] http://www.buildingconservation.com/articles/pozzo/pozzo.htm

[57] http://www.zerowastescotland.org.uk/sites/files/zws/ZWS%20Glass%20Options%20Appraisal%20IMR001-002_2.pdf

Waste type	Orkney household waste (Tonnes)				
	Arising	Composted	Disposed by incineration	Landfilled	Recycled
Vegetal wastes	1,026	691			
Total	**10,233**	**691**	**6,169**	**2,721**	**1,611**

Source http://www.environment.scotland.gov.uk/get-interactive/data/household-waste/[58]

[58] http://www.environment.scotland.gov.uk/get-interactive/data/household-waste/

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5 Abbreviations, Acronyms & Definitions

5.1 Abbreviations & Acronyms

Acronym	Meaning
AD	Anaerobic Digester
ANM	Active Network Management
CES	Community Energy Scotland
CHP	Combined Heat and Power
CO_2	Carbon Dioxide
DECC	Department of Energy and Climate Change
DNO	Distribution Network Operator
DSM	Demand Side Management
FCS	Forestry Commission Scotland
FG	Firm Generation
FIT	Feed-in Tariff
GWh	Gigawatt hour
IGZ	Intermediate Geography Zone
kWh	Kilowatt Hour
LPG	Liquid Petroleum Gas
MCS	Microgeneration Certification Scheme
MJ	Megajoule
MW	Megawatt
MWh	Megawatt Hour
NFG	Non-Firm Generation
NHS	National Health Service
NNFG	New Non-Firm Generation
ODT	Oven Dry Tonne
OIC	Orkney Islands Council
OREF	Orkney Renewable Energy Forum
RHI	Renewable Heat Incentive
ROC	Renewable Obligation Certificate
SRC	Short Rotation Coppice
SRF	Short Rotation Forestry
SSEPD	Scottish and Southern Energy Power Distribution
TOE	Tonne of Oil Equivalent

5.2 Definitions

Anaerobic Digester

Anaerobic Digesters are used in order breakdown biodegradables with the use of microorganisms. This is used to manage waste and produce fuels.

Active Network Management

The Active Network Management system is a form of DSM that relies on the smart use of information relating to supply and demand, then making alterations to them in order to balance the network.

Community Energy Scotland

Community Energy Scotland is an independent Scottish charity established in 2008 that provides advice and financial support for renewable energy projects developed by community groups in Scotland. The stated aim of Community Energy Scotland is 'to build confidence, resilience and wealth at community level in Scotland through sustainable energy development'.

Combined Heat and Power

A Combined Heat and Power unit will provide both heat and power energy from a fuel source. An example would be a unit that combusts fuel to power an electrical generator and the heat from this combustion is captured to meet a dwellings thermal demand as well.

CO_2

Carbon dioxide (chemical formula CO2) is a naturally occurring chemical compound composed of 2 oxygen atoms each covalently double bonded to a single carbon atom. The environmental effects of carbon dioxide are of significant interest. Carbon dioxide is an important greenhouse gas and burning of carbon-based fuels since the industrial revolution has rapidly increased its concentration in the atmosphere, leading to global warming.

Department of Energy and Climate Change

The Department of Energy and Climate Change is a UK government body set up in 2008 to manage the countries issues of energy security, renewable energy, and issues relating to climate change.

Distribution Network Operator

Distribution Network Operators manage the distribution networks that lay between the transmission network and the end users. DNOs do not sell electricity; this is done by electricity suppliers.

Demand Side Management

Demand Side Management is another means of balancing the power grid. It relies on the modification of consumer demand for energy through various methods such as financial incentives and education. Usually, the goal of demand side management is to encourage the consumer to use less energy during peak hours, or to move the time of energy use to off-peak times such as night-time and weekends. Peak demand management does not necessarily decrease total energy consumption, but could be expected to reduce the need for investments in networks and/or power plants for meeting peak demands.

Forestry Commission Scotland

Forestry Commission Scotland work toward expanding and protecting Scotland's forests, but to also increase their social and environmental value.

Firm Generation

Connected generators that are guaranteed to be able to feed the grid with generated energy at any time.

Feed-in Tariff

The Feed-in Tariff (FIT) scheme is a government programme designed to promote the uptake of a range of small-scale renewable and low-carbon electricity generation technologies. If a householder, community or business has an eligible installation, FITs pays them a tariff for the electricity they generate and a tariff for the electricity they export back to the grid.

Gigawatt hour

A Gigawatt Hour is a measure of energy. This can be used to represent a measure of work done over a given period of time. For example, a 1 GW generator generating for one hour will produce 1GWh of energy.

Intermediate Geography Zone

The intermediate geography is a geography used for small area reporting of statistics in Scotland. Intermediate zones are built from clusters of data zones and fit within council area boundaries. Each intermediate zone contains between 2,500 and 6,000 people.

Kilowatt Hour

A Kilowatt Hour is a measure of energy. This can be used to represent a measure of work done over time. For example, a 1kW turbine generating for one hour will produce 1kWh of energy.

Liquid Petroleum Gas

Liquid Petroleum Gas is natural gas produced during oil refining that contains propane and butane. It can also be extracted during the natural gas production process. LPG can be used for powering cars as well stationary generators.

Microgeneration Certification Scheme

Microgeneration Certification Scheme (MCS) is an internationally recognised quality assurance scheme, supported by the Department of Energy and Climate Change. MCS certifies microgeneration technologies used to produce electricity and heat from renewable sources.

MCS is also an eligibility requirement for the Government's financial incentives, which include the Feed-in Tariff and the Renewable Heat Incentive.

Megajoule

A Megajoule is a measure of energy. It equals 1,000 kilojoules. One joule per seconds also equals one watt.

Megawatt

A Megawatt is a measure of power. It is equal to 1,000kW. One Joule per second is equal to one Watt.

Megawatt Hour

A Megawatt Hour is a measure of energy and work. It is equal to 1,000kWh. For example, a 1MW turbine operating continuously for one hour will generate 1MWh.

Non-Firm Generation

Non-Firm Generation is the portion of Orkney's wind turbine portfolio that was added under the intertrip system. It was originally conceived so that if one of the two cables across the Pentland Firth is lost then these turbines are shut off to ensure the turbines with a firm connection still have their contracted capacity to export to the grid.

NHS

The four publicly funded health care systems in the countries of the United Kingdom are referred to as the National Health Service (NHS).

New Non-Firm Generation

New Non-Firm Generation is the generation capacity added to Orkney network as a direct result of the ANM system. It is ramped up and down as demand dictates.

Oven Dry Tonne

An Oven Dry Tonne is a unit of measure used to express the unit weight of a dried agricultural commodity.

Renewable Heat Incentive

The Renewable Heat Incentive is a financial support programme incentivising the heating of buildings from renewable energy but paying customer for doing so.

Renewable Obligation Certificate

Renewable Obligation Certificates are used by energy suppliers to demonstrate they are sourcing sufficient levels of power from renewable generators. Operators of renewable generators earn ROCs for certain levels of green energy produced. Then these ROCs can be traded to other parties for additional income. ROCs are generally only for larger scale generators.

Short Rotation Coppice

Short Rotation Coppice is the practise of growing fast growing biomass trees (such as Willow), cutting down the tree when mature near the base of the trunk, as this promotes the growth of multiple stems.

Short Rotation Forestry

Short Rotation Forestry is similar to Short Rotation Coppice but the tree are left growing for between 8-20 years (depending on the species).

Scottish and Southern Energy Power Distribution

The regional distribution network operator in Orkney and the north of Scotland.

Tonnes of Oil Equivalent

Tonnes of Oil Equivalent is a measurement of the amount of energy released from burning one tonne of crude oil (approximately 42 gigajoules).

6 Standard conversion factors

6.1.1 Scientific prefixes

The following prefixes are used for multiples of joules, watts and watt hours:

- kilo (k) = 1,000 or 10^3
- mega (M) = 1,000,000 or 10^6
- giga (G) = 1,000,000,000 or 10^9
- tera (T) = 1,000,000,000,000 or 10^{12}
- peta (P) = 1,000,000,000,000,000 or 10^{15}

6.1.2 Energy

1 tonne of oil equivalent (toe) = 41.868 GJ = 11,630kWh

Ktoe	toe	GJ	kWh	MWh	GWh
1	1000	41868	11630000	11630	11.630
	1	41.868	11630	11.630	0.011630
		1	278	0.278	0.000278
		0.0036	1	0.001	0.000001

6.1.3 Weight

1 kilogramme (kg) = 2.2046 pounds (lb)
1 pound (lb) = 0.4536 kg
1 tonne (t) = 1,000kg = 0.9842 long ton = 1.102 short ton (sh tn)
1 Statute or long ton = 2,240 lb = = 1.016 t = 1.120 sh tn

6.1.4 Volume

1 cubic metre (cu m) = 35.31 cu ft
1 cubic foot (cu ft) = 0.02832 cu m
1 litre = 0.22 Imperial gallons (UK gal)
1 UK gallon = 8 UK pints = 1.201 US gallons (US gal) = 4.54609 litres
1 barrel = 159.0 litres = 34.97 UK gal = 42 US gal

6.1.5 Length

1 mile = 1.6093 kilometres
1 kilometre (km) = 0.62137 miles

6.1.6 Temperature

1 scale degree Celsius (C) = 1.8 scale degrees Fahrenheit (F)
For conversion of temperatures: $^oC = 5/9\ (^oF - 32)$; $^oF = 9/5\ ^oC + 32$

6.1.7 Area

1 acre = 0.404686 hectares

7 List of commercial premises

Energy Uses	Associations	Location
Fish processing	Orkney Fisherman's Society	Stromness
	Westray Processors	Westray
	Cooke Aquaculture	Kirkwall
Construction & Engineering	Hamnavoe Engineering	Stromness
	Craigie Engineering	Kirkwall
	Casey Construction	Kirkwall
Concrete production	Orkney Aggregates, Heddle Quarry	Finstown
Quarries	OIC Cursiter Quarry & Asphalt Plant	Finstown
	Cruaday Quarry	Sandwick
Oil and Gas	Flotta Oil Terminal	Flotta
Hotel industry	Kirkwall Hotel	Kirkwall
	The Albert Hotel	Kirkwall
	West End Hotel	Kirkwall
	The Shore	Kirkwall
	Foveran	Kirkwall
	Quoyburray	Tankerness
	Commodore	Holm
	The Creel	St Margaret's Hope
	Murray Arms	St Margaret's Hope
	Bellevue Inn	St Margaret's Hope
	Merkister Hotel	Harray
	Smithfield	Dounby
	Barony	Birsay
	Woodwick House	Rendall
	The Standing Stones Hotel	Steness
	Houton Hotel	Houton
	The Stromness Hotel	Stromness
	The Ferry Inn	Stromness
	Orca	Stromness
	Hoy Hotel, Lyness	Hoy
	Balfour Castle	Shapinsay
	Pierowall	Westray
	Clayton House	Westray
	Stronsay Hotel	Stronsay
	Kettletoft	Sanday
	Bells Ayre	Sanday
	Taversoe Hotel	Rousay
Food processing and supply	Orkney Meat (Oic)	Kirkwall
	Orkney Cheese Co Ltd	Kirkwall
	Highland Park	Kirkwall
	Scapa Distillery	Kirkwall
	Orkney Brewery	Sandwick
	Highland Brewery Co.	Swanney
	Fudge Factory	Stromness
	Stockan’s Oatcakes	Stromness
	Crantit Dairy	Kirkwall
Printing	The Orcadian	Kirkwall
Water supply and treatment	Scottish Water	Various Locations

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