Port of Ramsgate

Royal Harbour Marina

Energy and Carbon Audit of the Port of Ramsgate

Newform Energy™

Redefining Renewables

Report for

Full Project Address: The Port of Ramsgate, Royal Harbour Marina, The Harbour Office, Military Road, Ramsgate, Kent CT11 9FT

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Client: Port of Ramsgate

Project Name: Energy and carbon audit of the Port of Ramsgate

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Disclaimer

All calculations that have been used in this report for total energy consumption have been based upon the bills provided. In some cases estimated bills are present which require extrapolation so that we have full annual amounts that are needed for analysis of total costs and carbon emissions. In addition often a mixture of monthly, quarterly, day and night rates and/or primary and secondary rates are given on bills that require summarisation. This is why in some cases there is a difference between what is paid for utilities annually and what is actually consumed.

All estimated costs of measures, resulting savings and payback periods should be viewed as indicative of standard expectations. Due to the nature of environmental technologies, costs, outputs and financial support systems are constantly changing on a regular basis. As such further survey work would often be necessary to provide definitive data for each individual site.

Also, whilst every effort is made to provide robust data, Newform Energy Ltd. does not accept any liability for any products or implementations suggested in this report. Liability lies with each products manufacturer, supplier and/or installer.

Please note that all prices are listed without VAT which would need to be added at the current rate.

Project Introduction

NewForm Energy has been appointed to carry out an assessment on the potential for carbon reduction through energy efficiency improvements and renewable energy generation opportunities on the port of Ramsgate.

This report provides an overview of a variety of solutions and it provides indications about the potential costs, return on investment, payback periods and carbon reduction.

Sincerely,

Jae Mather Non-Executive Director

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1.0 Executive Summary

The Port of Ramsgate Energy and carbon audit report provides an in-depth look into the solutions outlined in the Executive Summary, highlighting additional information to key stakeholders. In addition, the document contains a general background to sustainability, as well as funding and financial drivers for implementing the solutions contained within the report. Each section provides an outline of the basic function of the sustainable system and technical details. The solutions are presented in order of return on investment, from highest return to lowest.

The report is divided into two sections: Part I & Part II. The first part focuses on solutions that are tailored specifically to The Port of Ramsgate, whilst the second part of the report focuses on more general solutions, many of which can be implemented at little to no cost, but warrant further investigation to support a sustainable strategy.

2.0 Report Objectives

The carbon and energy audit report is designed so that the reader gains a solid understanding of the current energy costs and carbon emissions. Using the Energy Hierarchy as a foundation for the work, the primary focus is on identifying energy saving solutions and secondary investigation looks at low/zero carbon energy production solutions. Included within the report are estimated costs, carbon reduction calculations, return on investment and pay back periods, so that The Port of Ramsgate is outfitted with the information that will enable future decision making.

A full evaluation is made including any issues that may exist with regards to key benefits and possible pitfalls of each identified solution.

The Energy and Carbon Audit report provides a range of recommendations designed to address the four areas below:

1) To establish the entire organisations expected energy consumption and requirements and to enhance the various properties and assets held in line with a sustainability strategy.

2) To identify best value energy saving and renewable energy generation systems that will help mitigate the risks of rising energy costs.

3) Environmental & Social / Educational Benefits. In addition to the core financial benefits, the recommendations in this report are also designed to deliver environmental and social (educational) benefits alongside the core financial benefits.

2.1 Business Activities

The Port of Ramsgate is a harbour situated in Ramsgate, south-east England, serving cross-Channel freight traffic and smaller working and pleasure craft. It is run on behalf of the public by the local authority, Thanet District Council. The construction of Ramsgate Harbour began in 1749 and was completed in about 1850. The port includes inner and outer marinas, boat launch facilities, a ferry terminal and a wide number of buildings.

Figure 1: The Port of Ramsgate

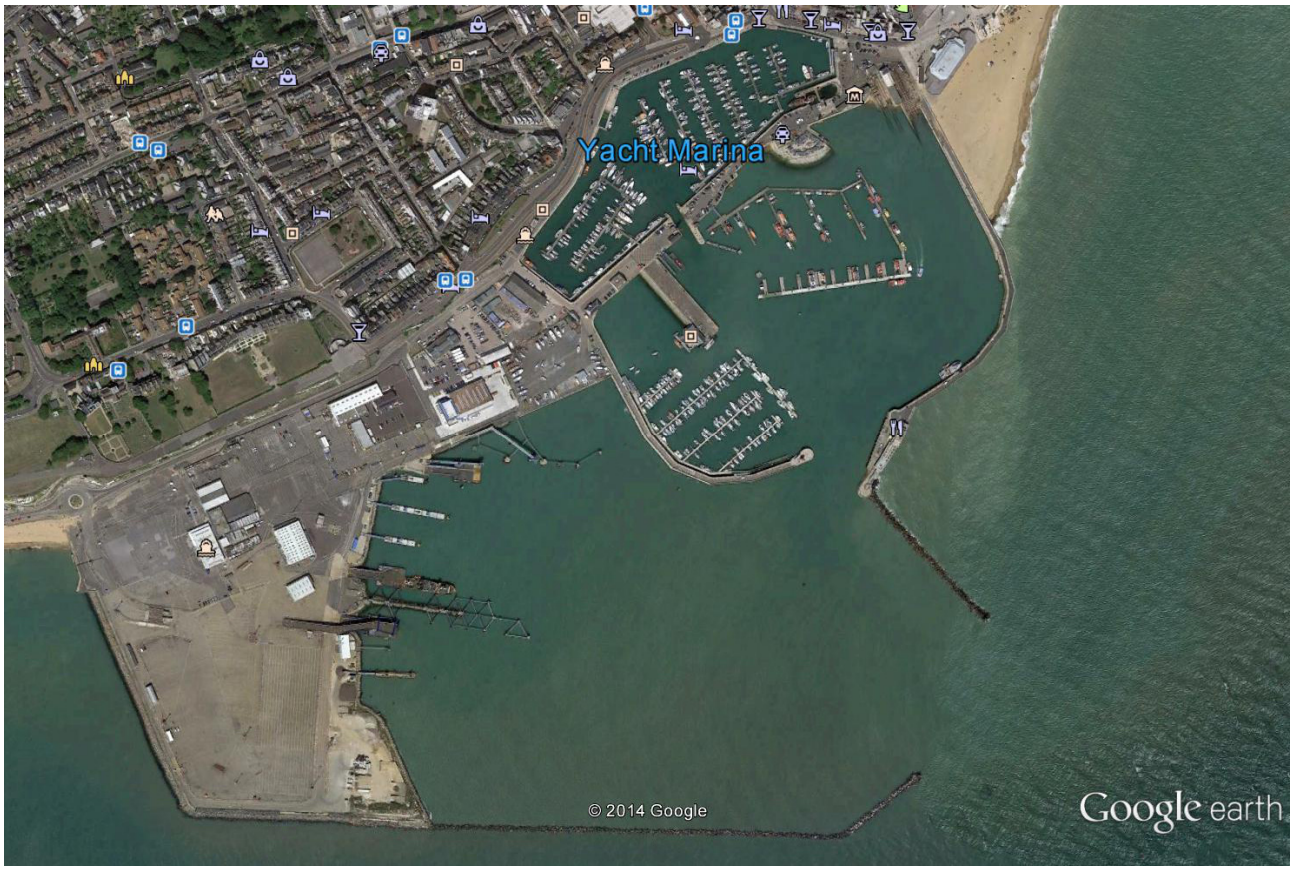


Figure 2: The Port of Ramsgate

3.0 Overview of Energy Saving and Generation Opportunities

The tables below summarise the energy saving and energy production measures recommended in this report.

Table 1: Recommended Energy Saving Solutions

Energy Saving Measures	Estimated Savings p.a.	Estimated Cost	Payback (Yrs)	ROI
(8.7) LED Lighting Upgrades	£17,169	£62,792	3.7	27.3%
(8.8) Voltage Optimisation	£20,152	£90,685	4.5	22.2%
Totals	**£37,321**	**£153,477**	**4.1**	**24.3%**

Table 2: Recommended Energy Generating Solutions

Renewable Energy Production Measures	Estimated Saving /Income p.a.	Estimated Capital Cost	Payback (Yrs)	ROI
(8.3) 160kWp Hydro Power	£45,891	£416,512	9.1	11.0%
(8.1) 806kWp PV Systems	£137,913	£805,690	5.8	17.1%
Totals	**£183,804**	**£1,222,202**	**6.6**	**15.0%**

Table 3: Complete Summary of Energy Savings and Generation Solutions

Actions	Annual Savings	Total Cost	Payback Period (yrs)	ROI
Energy Saving	£37,321	£153,477	4.1	24.3%
Energy Generation	£183,804	£1,222,202	6.6	15.0%
ALL MEASURES	**£221,125**	**£1,375,679**	**6.2**	**16%**

4.0 Background to Sustainability

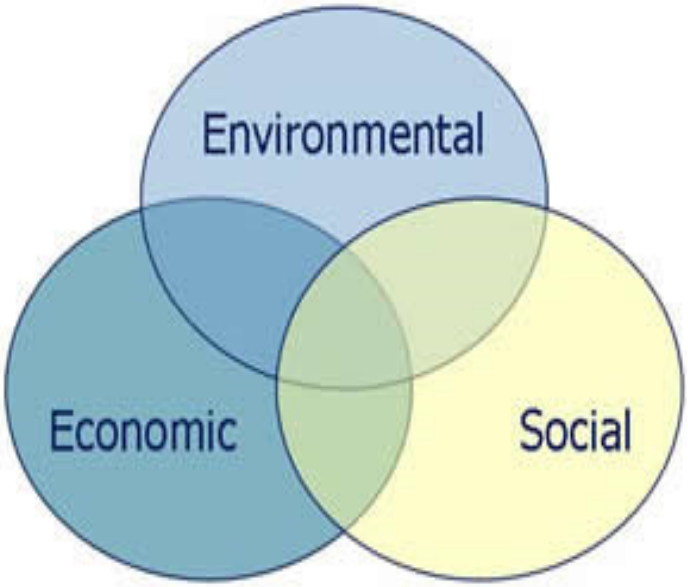
In the face of mounting pressure for organisations to rise to the challenge of combating climate change, both sustainability and the question of corporate social responsibility (CSR) are increasingly found to be moving up the business agenda. Global trends, government legislation and the demands of shareholders and stakeholders alike call for organisations to be transparent about their environmental performance. Sustainability reporting aims to describe and measure an organisation's "triple bottom line" performance. Triple bottom line (TBL) reporting unites the social and environmental impact of an organization's activities to its economic performance in order to demonstrate improvement or make a more in depth evaluation. The Port of Ramsgate already has an Environmental Policy and a Environmental Practice Statement and it has endorsed the principles of the European Sea Ports Organization (ESPO) environmental code of practice.

Global efforts to reduce carbon emissions have put enormous pressure on large corporations and it is now common place for these organisations to adopt sustainability strategies and report annually on their performance. In keeping with their CSR policy these corporations will often focus not only on their own performance but also on that of key suppliers, demanding a clearly defined and transparent sustainability strategy in operation. Other businesses, in particular SMEs are not yet under close scrutiny to demonstrate a commitment to improved sustainable practice nor are they affected by government mandate. This often results in lack of understanding of the issues surrounding sustainability or a belief that adopting a sustainability strategy will offer no benefits either to business performance or the

environment. This is not the case, although sustainability reporting is currently voluntary for most organisations, it offers a number of opportunities and benefits, in particular improved risk management, increased stake holder trust, greater cost and energy efficiency in addition to serving as a powerful marketing tool. A company who chooses to report on its environmental performance gains a competitive edge, appearing more transparent, whilst also adhering to the standards of those companies who consider environmental credentials throughout their supply chain.

In accordance with the Carbon Reduction Commitment Energy Efficiency (CRC) sustainability reporting is mandatory for companies in the UK consuming more than 6,000MWh, affecting only the top 2%. However, with ever increasing pressure to meet ambitious carbon reduction targets the need to demonstrate improved environmental performance will extend beyond this small proportion of companies down too small to medium sized enterprises (SME's). The UK already has legislated carbon reductions in place that equate to a reduction of 50% (on 1990 levels) by 2027 and 80% by 2050, as such increased legislation around both reporting and emission reduction is inevitable. In the current absence of strict reporting guidelines we feel that there is a clear gap in the market and have set up the The Port of Ramsgate Sustainability Group which provides a comprehensive sustainability reporting service.

4.1 What is Sustainability?



Put simply sustainability is our ability to meet the needs of the present without compromising the ability of future generations to meet their own needs. When aiming to improve sustainable performance an organisation must take into consideration the impact of social, environmental and economic elements of their operations. A strong Corporate Social Responsibility (CSR) policy will drive the business to adhere to the Triple Bottom Line (as demonstrated by the above diagram where environmental, economic and social impacts are taking into account when making decisions) allowing them to operate responsibly whilst demonstrating long term economic viability.

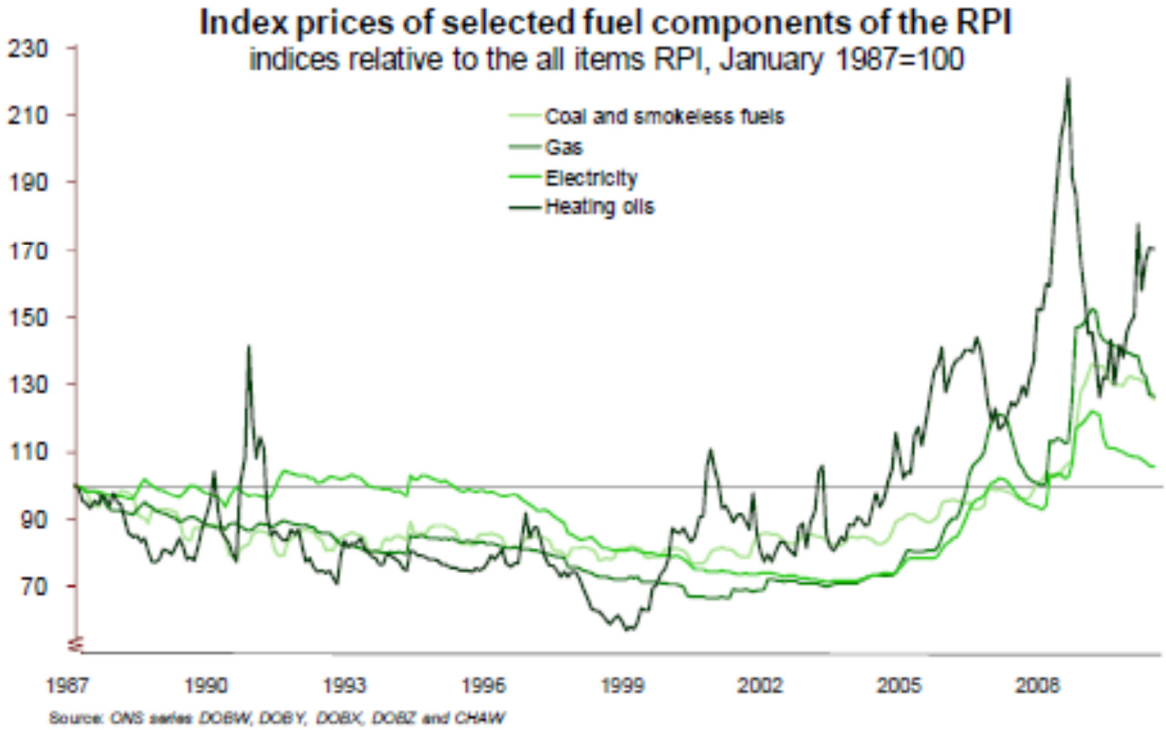
4.2 A Sustainability Strategy

A sustainability strategy is often the next stage of work after carrying out an Energy & Carbon and Solutions Audit. Is a continual piece of work that commits an organisation to becoming aware of and minimisation of its impact on the environment. The development of a Corporate Social Responsibility (CSR) policy is at the heart of any sustainability strategy, providing the framework for organisations to set out their environmental, social and economic targets and how they intend to achieve them. Once this is in place a process of continual review and improvement is put in place to measure manage and reduce their carbon footprint, improve cost efficiency and continue to demonstrate environmental best practice. A sustainability strategy is also about managing the threats that are coming from climate change as well as embracing the business opportunities it presents.

5.0 Funding and Financial Drivers

5.1 Current Economic Climate

Energy prices are expected to continue to continually increase for the foreseeable future. As the global recession comes to an end the price of oil (and thus natural gas as its price is directly linked to that of oil) is anticipated to rise sharply. The emerging economies such as China and India are steadily increasing their demands for primary fossil fuels which is increasing the price due to demand, and the world's population is ever increasing, which also increases demand. In addition to this the concept of Peak Oil is steadily becoming accepted, which simply defined means the moment at which the new finds of oil reserves are less than that which is extracted globally and thus the level of supply begins to diminish as demand increases. Climate change and carbon trading are slowly beginning to increase the cost of fossil fuels as well. All such issues lead to an inevitable likelihood that primary fossil fuels and their related outputs (including electricity) will rise in price steadily for the foreseeable future. As such generating energy on site with renewable systems, offers the opportunity to disconnect (to varying degrees) from these future price increases through independence from the fossil fuel markets.



Source http://www.parliament.uk/briefingpapers[1]

5.2 Financing Options

In addition to the private financing option from Henry Howard Finance that will be outlined in a future Executive summary there are a number of other financing options available to businesses seeking to invest in energy efficient or generating equipment. These options are designed specifically so that financing payments are offset against the anticipated energy savings. Installation of energy saving equipment such as Photo-Voltaic (PV) panels will save money and after the initial payback period will continue to generate revenue. We therefore recommend that you do not look to pre-existing maintenance and refurbishment budgets to fund such sustainability initiatives but look at it as a separate investment and consider alternate funding such as loans or investigate pre-existing schemes such as those set up by the Carbon Trust. Please see below for more information on the Carbon Trust and Siemens Financial Services and the ECA Energy Scheme:

The Carbon Trust and Siemens Financial Services

The Carbon Trust and Siemens Financial Services offer a scheme designed to provide flexible financing options to all types of organisations seeking to make their operations more efficient and lower their energy costs.

[1] http://www.parliament.uk/briefingpapers/commons/lib/research/briefings/snsg-004153.pdf

Introduction to the Scheme:

"Investing in energy efficient systems makes sound business and environmental sense."

The Carbon Trust Implementation Services and Siemens Financial Services have joined forces to offer organisations leases, loans and other financing options to enable implementation of the latest energy efficient systems.

The scheme is available to a broad range of businesses and organisations. Financing from Siemens Financial Services can be arranged from £1,000 and there are potentially no upper limits.

Benefits of the scheme include easier budgeting, as payments are fixed and not subject to fluctuations in interest rates. In addition, it allows businesses to conserve working capital, so they have the flexibility to conserve existing working capital for other projects.[2]

5.3 Current Financial Drivers for Renewable Energy Generation

There are currently a number of financial support mechanisms available for renewable technologies. Listed below is a short summary of the different mechanisms and how they work.

Feed in Tariffs (FITs)

The current primary financial driver in **England** for the production of electricity from renewable energy systems is the Feed in Tariff (FIT). In order to receive the payments from FITs, technologies need to be Microgeneration Certification Scheme (MCS) certified and installed by an MCS certified installer. The level of financial support varies for each qualifying technology (currently this includes Anaerobic Digestion, Hydro-Electric, Micro CHP, PV and Wind); with the exact tariff being tied to the specific size of the system being installed (this is based upon the maximum theoretical electrical output). The tariff came into effect in April 2010. The length of time that the tariff will be paid out is specific to each qualifying technology and these generally are for 20 years. The tariff recently went through some major changes with many of the PV FIT rates dropping by over 50%. As such if renewable technologies become of interest it is important to see what the current rates of the tariff are set at, see

[2] http://www.energyefficiencyfinancing.co.uk/customers/pages/default.aspx

Ofgem[3] for further information about the scheme and the levels of financial support for the various qualifying technologies.

Renewable Obligations Certificates (ROCs)

These are the current primary financial drivers in the **UK** for **Large Scale** renewable electricity:

A Renewables Obligation Certificate (ROC) is a green certificate issued to an accredited generator for eligible renewable electricity generated within the United Kingdom and supplied to customers within the United Kingdom by a licensed electricity supplier. One ROC is issued for each megawatt hour (MWh) of eligible renewable output generated. They are offered for a maximum of 20 years from the point of certification by Ofgem.

Various technologies qualify for 0.5, 1, 2 or even 4 ROCs per MWh of electricity generated. The value of a ROC varies but generally they are at around 4.5p.

**Renewable energy generation systems over 50kWp have the option of utilising either the ROC or FIT for income.*

Renewable Heat Incentive (RHI)

To meet the 2020 15% renewable energy target, the Department for Energy and Climate Change (DECC) needed to develop new ways of generating renewable energy in all sectors, including heat. Heat generated from renewable sources accounts for approximately 1% of total heat demand – this may need to rise to 12% to meet the binding EU targets.

The incentive came into effect as of November 29th 2011 for industrial, commercial, public sector, not-for-profit and community installations.

6. Carbon Reduction

6.1 Defining Scopes of Emissions

The objective of the assignment was to calculate a carbon footprint for The Port of Ramsgate. As part of the work, we conducted a detailed review of energy, fuel and business travel expenses incurred by the firm. The carbon footprint calculation is designed to act as a baseline for accurate cost benefit analysis and the development of a sustainability plan.

[3]hhttps://www.ofgem.gov.uk/publications-and-updates/feed-tariff-scheme-tariff-table-1-april-2014-31-march-2015-pv-only

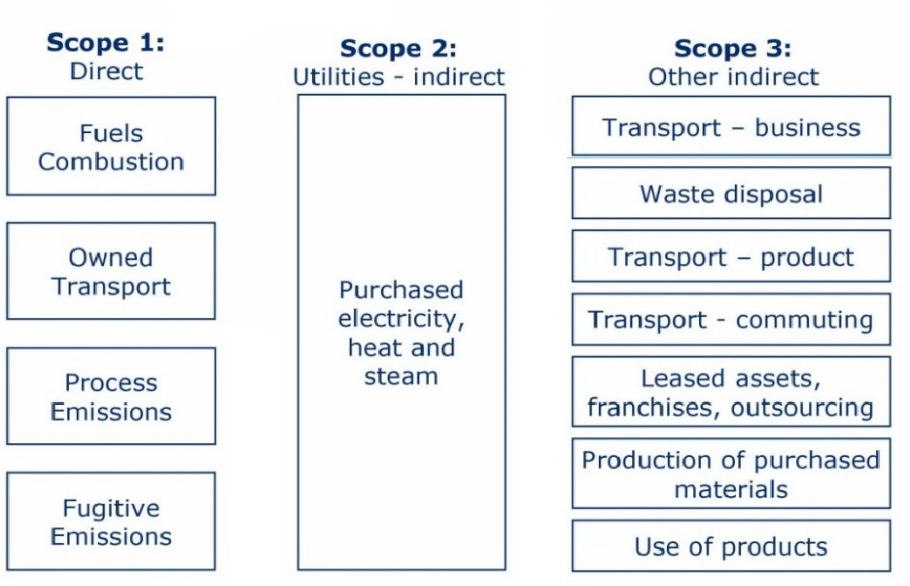


Figure 3: Summary of Emissions by Scope

The solutions report is based upon the findings from the The Port of Ramsgate carbon audit. The results of the carbon audit reveal that the vast majority of The Port of Ramsgate's carbon emissions stem from electricity consumption, which is a scope 2 emission. Scope 2 emissions, also known as indirect emissions are those created directly on behalf of the company in the generation of electricity or the delivery of energy.

The second greatest source of emissions arises from partner and staff travel, which are scope 3 emissions.

7. Carbon Dioxide Emissions

Carbon Dioxide Emissions

Total Carbon Emission Summary (Tonnes CO_2e)

Natural Gas **Scope 1** *Source CRC Emission Factors = 0.1836 KG/kWh
Electricity **Scope 2** *Source CRC Emission Factors = 0.541 KG/kWh

Potential **Carbon savings**	Tonnes/yr.
Voltage Optimisation of the Ferry Port	**118.4**
LED Lighting Upgrades	**65.5**
160kWp Hydro	**132.5**
806kWp PV Systems	**447.2**
Total	**645.3**

8. Energy Saving & Generating Opportunities

This section highlights energy saving and generating opportunities for The Port of Ramsgate, where appropriate an analysis of cost and energy savings. For full details and explanations of all recommendations please see the Detailed Solutions Report. All payback periods and return on investments are calculated using current energy prices and based on 0% inflationary rate. Typical inflation rates would result in shorter pay back periods and greater Return On Investment (ROI).

8.1 806kWp Photo Voltaic (PV) and Photo Voltaic Thermal (PV-T)[4]

PV

Solar panel electricity systems, also known as solar photovoltaics (PV), capture the sun's energy using photovoltaic cells. These cells don't need direct sunlight to work – they can still generate some electricity on a cloudy day. The cells convert the sunlight into electricity, which can be used to run household appliances and lighting.

PV cells are made from layers of semi-conducting material, usually silicon. When light shines on the cell it creates an electric field across the layers. The stronger the sunshine, the more electricity is produced. Groups of cells are mounted together in panels or modules that can be mounted on your roof. The power of a PV cell is measured in kilowatts peak (kWp). That's the rate at which it generates energy at peak performance in full direct sunlight during the summer. PV cells come in a variety of shapes and sizes. Most PV systems are made up of panels that fit on top of an existing roof, but you can also fit solar tiles but they are less efficient and more expensive.

Photo Voltaic Thermal (PV-T)

PV has a linear drop-off in efficiency as the surface temperature of the panel rises. Given that PV panels are typically black and mounted in such a way as to get maximum exposure to the sun, this rise in panel temperature is inevitable. PV panels typically lose efficiency of up to 0.5% per degree rise in panel temperature. PV-T combines both the PV and Solar Thermal elements onto a single panel. This has two main advantages; firstly, by drawing heat away from the panel the electrical output is maintained at a higher level for a longer period, and secondly, with the PV and Thermal elements combined on a single panel less roof area is required, allowing for greater outputs on equivalent roof space.

[4] http://www.newformenergy.com/#!pv-photovoltaic/c1wh8

This system benefits from a combination of income streams that include the Feed In Tariff (FIT), the Renewable Heat Incentive (RHI) and offsetting grid purchased electricity and natural gas for heating.

PV roof systems are shown in **Red**. Note that these do not cover the roof lights.

Frame mounted PV over parking/vehicle movement areas is shown in **Green**.

Wall mounted systems are shown in **Blue**. Cost include wall frame mounting and bird protection at the top of the panels. The system would end a few meters from the ground for security purposes.

PV-T is shown in **Orange**. This would replace the existing SHW system.

Array number	No. of Panels	kWp e	System Cost	ROI (years)	Est. Annual Electrical kWh Output	Est. Annual Thermal kWh Output
1	168	42.0	£50,400	5.1	43,554	n/a
2	242	60.5	£72,600	5.5	62,739	n/a
3	99	24.8	£29,700	4.7	26,730	n/a
4	56	14.0	£16,800	4.8	14,784	n/a
5	270	67.5	£81,000	5.4	71,415	n/a
6	42	10.5	£12,600	4.7	11,130	n/a
7	42	10.5	£12,600	4.7	11,288	n/a
8	18	4.5	£5,400	4.4	4,986	n/a
9	12	3.0	£3,600	4.2	3,294	n/a
10	1760	440.0	£528,000	6.6	459,360	n/a
11	156	39.0	£46,800	5.2	39,702	n/a
12	156	39.0	£46,800	5.2	39,702	n/a
13	72	18.0	£21,600	6.5	13,374	n/a
14	124	31.0	£37,200	6.8	23,033	n/a
15	8	1.4	£11,995	13.9	1,570	2032
Total		805.7	£805,690	5.8	826,661	2032
PV Panels:	3217			ROI	17.1%	
PV-T Panels:	8					

Income from FITs, RHI, export of electricity and supplied electricity to site: £137,913

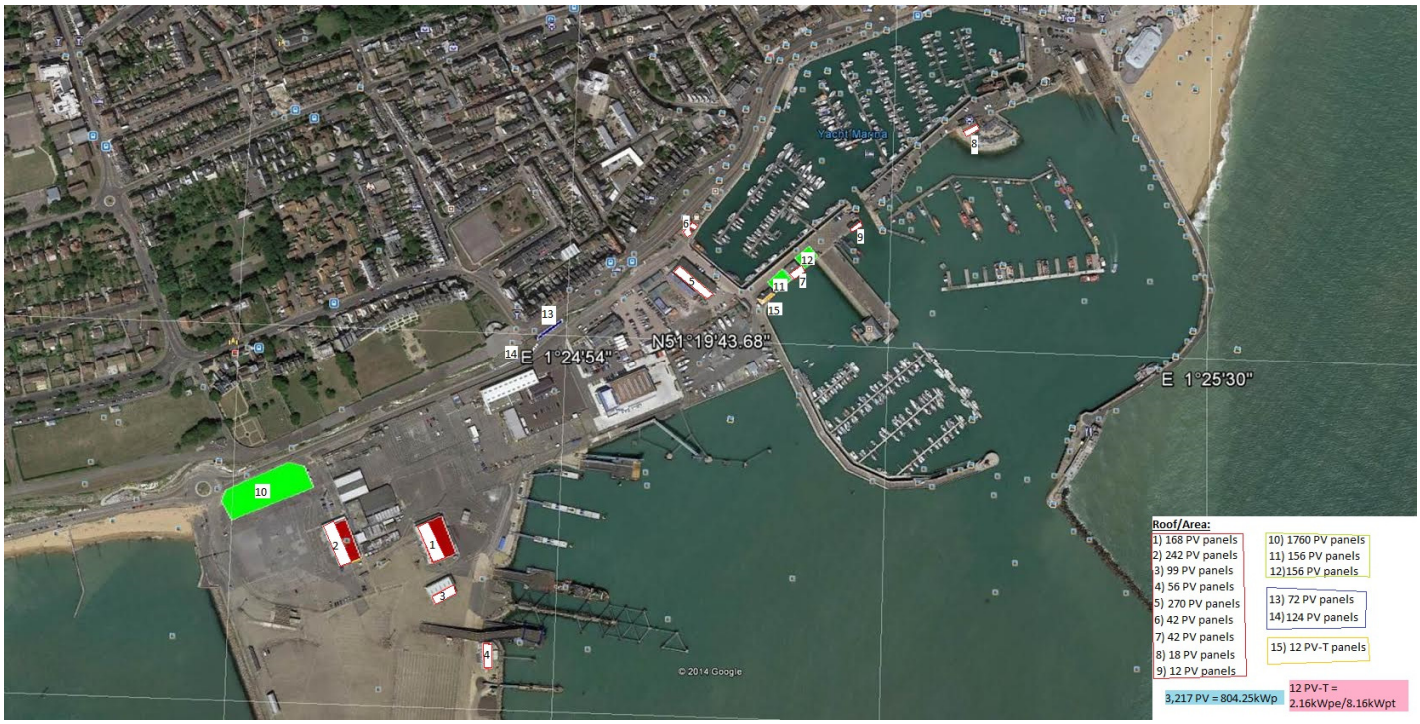


Figure 4: Port and Marina PV Opportunities Overview, *Source Google Earth

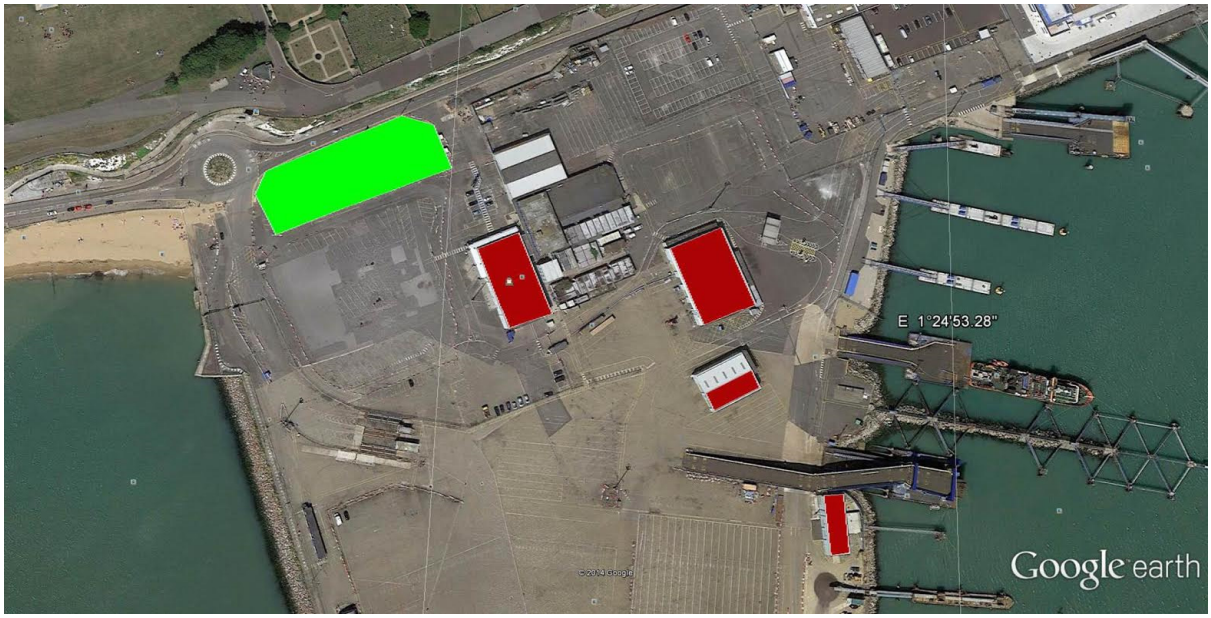


Figure 2: Ferry Port PV Opportunities *Source Google Earth

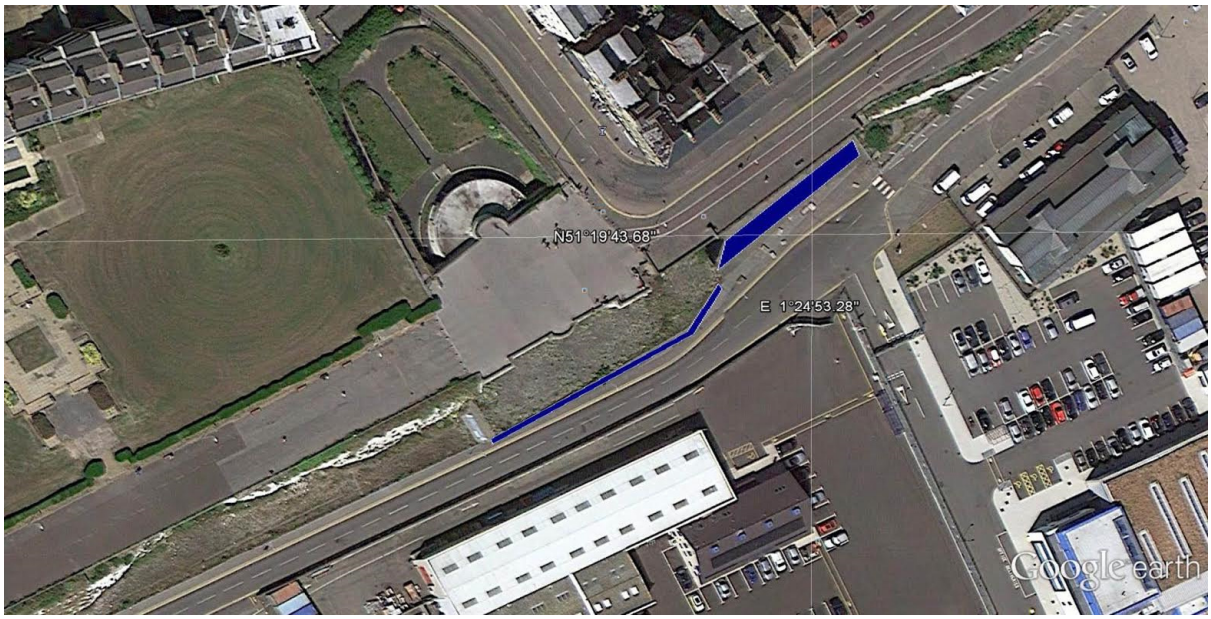


Figure 6: Wall Mounted PV Opportunities *Source Google Earth

Figure 7: Wall Mounted PV Opportunity 1 *Source Google Earth

Figure 8: Wall Mounted PV Opportunity 2 *Source Google Earth

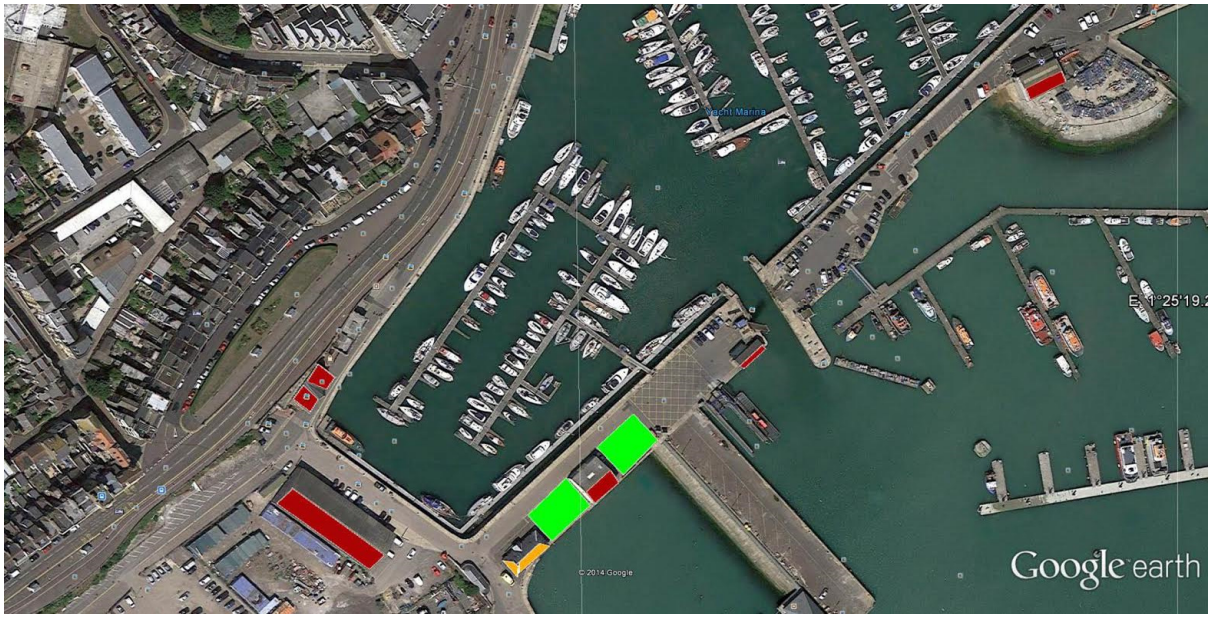


Figure 9: Marina PV Opportunities *Source Google Earth

806kWp PV Systems	
Estimated installed cost	£805,690
Estimated Electricity Generated per year (kWh):	826,661

Estimated annual income from FITs, electricity sold to grid and energy supplied to site:	£137,913
Estimated payback period (Years):	5.8
Estimated return on investment:	17.1%
Estimated CO2 savings in Tonnes per year:	**447.2**

The performance of Micro generation Photovoltaic thermal systems is impossible to predict with certainty due to the variability of the climate and its subsequent effect on the electric production. This estimate is based on the best available information but is given as guidance only and should not be considered as a guarantee. The payback time is calculated allowing for an average 5% energy price inflation and an average RPI of 3% per annum (which affects Feed in Tariffs (FITs), Renewable Heat Incentive (RHI) and the price paid for electricity that is exported to the grid).

Cost: £805,690	**Savings/Revenue: £137,913**
Payback period: 5.8years	**Return on Investment: 17.1%**

Carbon Savings per year: 447.2 Tonnes

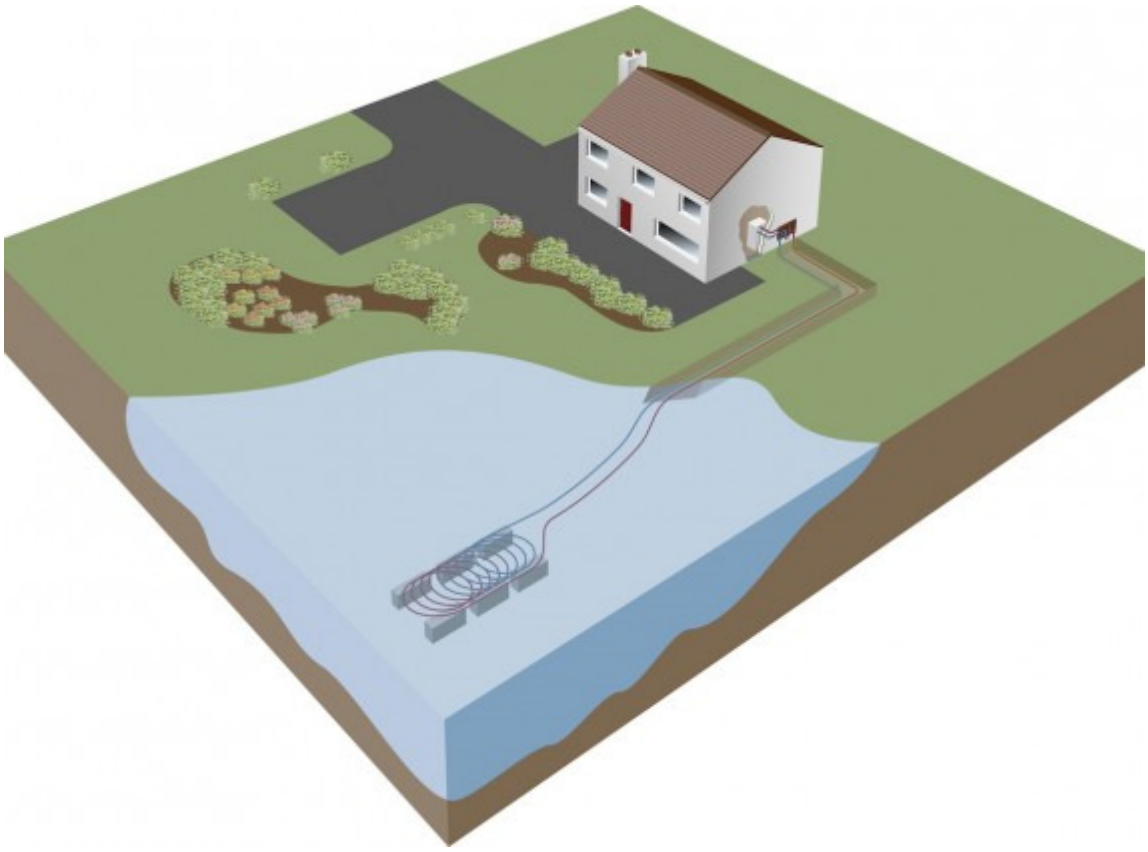
8.2 Heat Matts For Water Sourced Heat Pumps (WSHP)

Heat Matts were evaluated for the Port and Marina to establish the viability of using the harbour/marina water as a source of heat for water sourced heat pumps (WSHP). **The variable heat demands of the relatively thermally inefficient buildings make this option unlikely to be viable in current circumstances. With that said the Marina and Port areas have significant potential for providing a heat source if a network of buildings were to be connected together with heat pumps. As the majority of existing buildings are thermally inefficient they would have significant peak heating loads and therefore would likely require thermal improvements to make WSHP viable.**

Typically heat matt water collectors take the form of closed loop systems that are constructed of slinky pipe attached to corrosion resistant stainless steel frames which are sunk to the bottom of the water source or secured underneath a floating pontoon.

As with all closed loop systems, the principle of a closed loop water mat is that at no point does the fluid in the water mat collector leave the system, it is continually cycled through the closed system. The benefit of using a closed loop water system over an open loop water system includes a reduced risk of freezing within the heat pump and reduced maintenance

as there is no need for any filtration units.



Cost: N/A	**Savings/Revenue: N/A**
Payback period: N/A	**Return on Investment: N/A**

Carbon Savings per year: N/A Tonnes

8.3 Hydro Power[5]

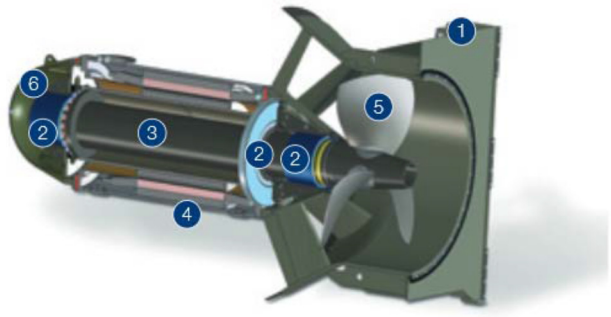
The potential for generating hydroelectric power at the Port of Ramsgate has been investigated to ascertain whether or not the prospect of a tidal energy project at Ramsgate appears to warrant expenditure on further development studies.

The existing civil infrastructure and impounding gates provide potential opportunities for operating the port as a tidal lagoon system by discharging sea water either between the Yacht Marina and the Royal Harbour, or between the Royal Harbour and the main port area.

The potential for using the Royal Harbour as a lagoon is quickly discounted due to high civil costs but the inner harbour is analysed in more detail.

[5] http://voith.com/en/t_3390_StreamDiver_screen.pdf

Flexing the cash-flow model indicates that the projection is most sensitive to unit output and capital costs. The figure indicate that the proposal may warrant further investigation which should focus initially on refining cost and output estimates. Indirect costs and benefits should also be considered in further detail in order to assess the overall attractiveness of the scheme.



1	Turbine housing with guide vanes
2	Radial and axial bearing coating on shaft ends
3	Shaft
4	Generator
5	Runner
6	Bulb nose

See Appendix 1 for further information.

Cost: £416,512	**Savings/Revenue: £45,891**
Payback period: 9.1 years	**Return on Investment: 11%**

Carbon Savings per year: 132.5 Tonnes

8.4 Anaerobic Digestion (AD)[6]

Anaerobic Digestion was evaluated for the Port and Marina to establish the viability of using organic fraction from the organic waste streams from the community, restaurant, marina and harbour waste for the creation of either gas or electric power on site. **The variability in the types of organic waste and the volumes appear to be insufficient to justify the investment required to deliver a financially viable AD system at this point in time.**

Anaerobic digestion is a collection of processes by which microorganisms break down biodegradable material in the absence of oxygen.

The process is used for industrial or domestic purposes to manage waste and/or to produce fuels. Much of the fermentation used industrially to produce food and drink products, as well as home fermentation, uses anaerobic digestion.

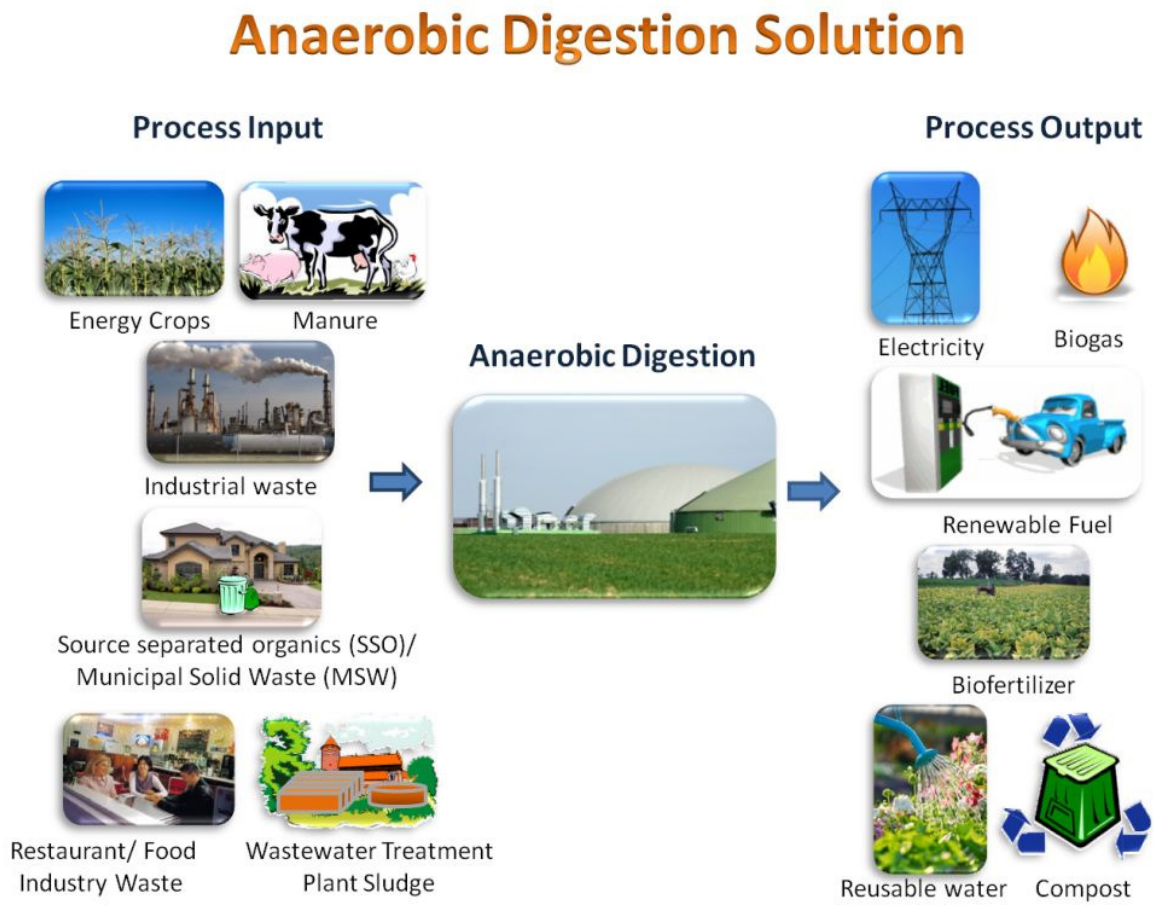
[6] http://seabenergy.com/products/mb400/

Anaerobic digestion occurs naturally in some soils and in lake and oceanic basin sediments, where it is usually referred to as "anaerobic activity".

The digestion process begins with bacterial hydrolysis of the input materials. Insoluble organic polymers, such as carbohydrates, are broken down to soluble derivatives that become available for other bacteria. Acidogenic bacteria then convert the sugars and amino acids into carbon dioxide, hydrogen, ammonia, and organic acids.

These bacteria convert these resulting organic acids into acetic acid, along with additional ammonia, hydrogen, and carbon dioxide. Finally, methanogens convert these products to methane and carbon dioxide the methanogenic archaea populations play an indispensable role in anaerobic wastewater treatments.

It is used as part of the process to treat biodegradable waste and sewage sludge. As part of an integrated waste management system, anaerobic digestion reduces the emission of landfill gas into the atmosphere.



Power generation

Methane and power produced in anaerobic digestion facilities can be used to replace energy derived from fossil fuels, and hence reduce emissions of greenhouse gases, because the carbon in biodegradable material is part of the carbon cycle. The carbon released into the atmosphere from the combustion of biogas has been removed by plants for them to grow in the recent past, usually within the last decade, but more typically within the last growing

season. If the plants are regrown, taking the carbon out of the atmosphere once more, the system will be carbon neutral.

Cost: N/A	**Savings/Revenue: N/A**
Payback period: N/A	**Return on Investment: N/A**

Carbon Savings per year: N/A Tonnes

8.5 Combined Heat and Power (CHP)[7]

The reuse of waste oil from wind farm support vessels was assessed to establish the feasibility of using the oil as a fuel source for a combined heat and power (CHP) plant. **The low volumes of waste oil supplies, minimal and variable heat demands and the high capital costs of purchasing and maintaining a CHP plant make this option unviable.**

CHP integrates the production of usable heat and power (electricity), in one single, highly efficient process. CHP generates electricity whilst also capturing usable heat that is produced in this process. This contrasts with conventional ways of generating electricity where vast amounts of heat are simply wasted.

Cost: N/A	**Savings/Revenue: N/A**
Payback period: N/A	**Return on Investment: N/A**

Carbon Savings per year: N/A Tonnes

[7] http://helec.co.uk/products/combined-heat-power/

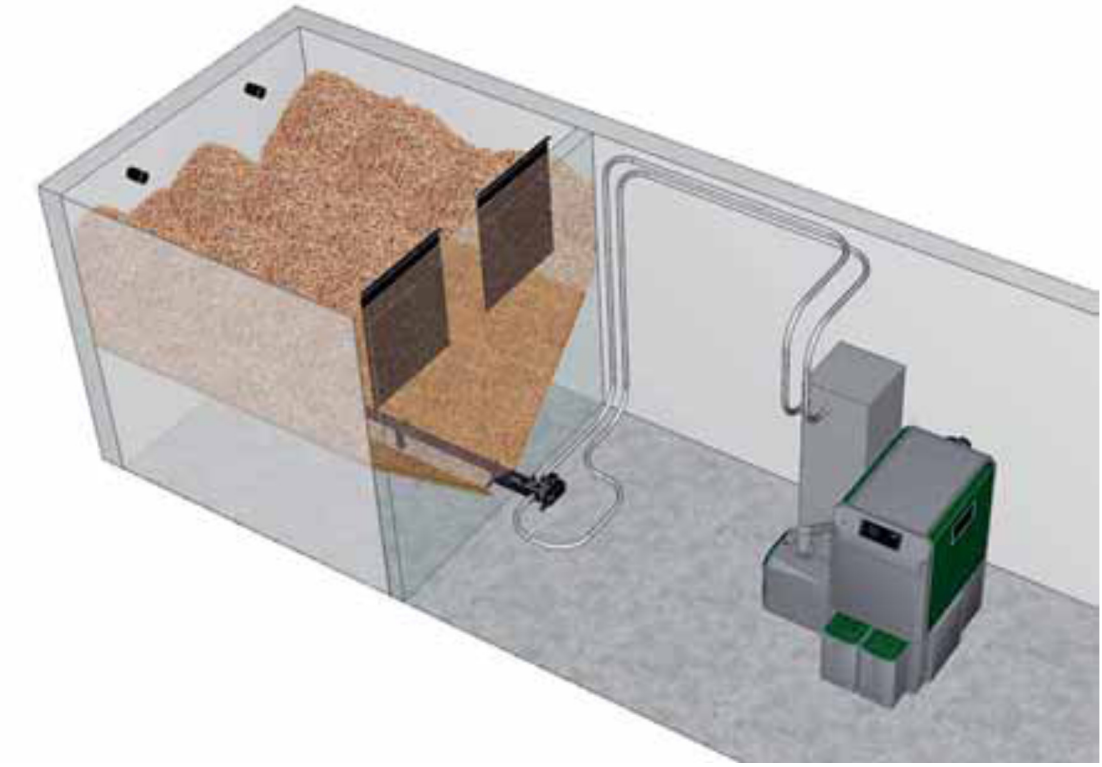
8.6 Biomass Heating[8]

Biomass heating was evaluated for the Port and Marina to establish the viability of burning wood fuel to produce heat on site. **The minimal and variable heat demands and the high capital costs of installing a heat distribution main and purchasing/maintaining a biomass plant make this option unviable.**

Fuel	Price per unit	kWh per unit	pence per kWh
Wood chips (30% MC)	£110 per tonne	3,500 kWh/t	3.1p/kWh
Wood pellets	£210 per tonne	4,800 kWh/t	4.4p/kWh
Natural gas	4.9p/kWh	1	4.9p/kWh
Heating oil	58p per litre	10 kWh/ltr	5.8p/kWh
LPG (bulk)	43p per litre	6.6 kWh/ltr	6.5p/kWh
Electricity	15.0p/kWh	1	15.0p/kWh

[9]

[8] http://www.myriadceg.com/biomass/
[9] http://www.biomassenergycentre.org.uk/portal/page?_pageid=75,59188&_dad=portal



Cost: N/A	**Savings/Revenue: N/A**
Payback period: N/A	**Return on Investment: N/A**

Carbon Savings per year: N/A Tonnes

8.7 LED Lighting Upgrades[10]

A large number of lamps were identified throughout the site that present an opportunity for replacement with more efficient LED lighting alternatives. See the tables below for further details about how 520 existing lamp fittings can be replaced with LED's. The suggested LED lamps have been specified to deliver the same or in many cases increased lighting while at the same time still reducing the total electricity consumption to a significant degree.

Suggested LED Replacement Lamps

Ferry Port	Current Lighting	LED Proposal
Total Number of Light Fixtures	80	80
Total Wattage Consumed Per Year (kWh)	154,176	70,080
Energy Cost of Light Fixtures Per Year	£12,565	£5,712
Maintenance & Lamp Replacement Cost Per Year	£1,952	£0
Total Cost Lighting Per Year	£14,517	£5,712
Total Cost Savings Per Year	**n/a**	**£8,805**
CAPEX Required	n/a	£35,239
Estimated Installation Costs	n/a	£6,800
Total Cost	n/a	£42,039
Payback	n/a	4.8
ROI	n/a	20.9%
Annual CO2	**83.4**	**37.9**
Annual CO2 Reduction	**n/a**	**45.5**

Marina	Current Lighting	LED Proposal
Total Number of Light Fixtures	420	420
Total Wattage Consumed Per Year (kWh)	73,886	36,823
Energy Cost of Light Fixtures Per Year	£6,022	£3,021
Maintenance & Lamp Replacement Cost Per Year	£5,363	£0
Total Cost Lighting Per Year	£11,385	£3,021

[10] http://minimiseleds.com/about-us/

Total Cost Savings Per Year	**n/a**	**£8,364**
CAPEX Required	n/a	£20,538
Estimated Installation Costs	n/a	£7,015
Total Cost	n/a	£27,553
Payback	n/a	3.3
ROI	n/a	30.4%
Annual CO2	**40.0**	**19.9**
Annual CO2 Reduction	**n/a**	**20.1**

The replacement lamps all demonstrate opportunities for financial and carbon savings. The life span of each lamp is also significantly higher and as such savings on maintenance and improved amenity present an opportunity for key added value with these upgrades. All of the payback and return on investment calculations have been based upon the current prices for electricity and lamp replacement. The LED lamps significantly increased life span which would effectively remove the need for storing replacement lamps. In addition when LED's fail they gradually fade in light output over a long period of time, thus they provide a warning for a number of years before they completely go out. This is helpful when it comes to planning for replacements.

The LED lights would improve the overall light quality significantly due to the high RA rating of the fittings (colours will stand out more and visual acuity will be clearer).

See Appendix 2 & 3 for further information.

Cost: £62,792	**Savings/Revenue: £17,169 or 121,159kWh**
Payback period: 3.7 years	**Return on Investment: 27.3%**

Estimated Carbon Savings: 65.5 Tonnes

8.8 Voltage Optimisation[11]

Voltage Optimisation is a technology that improves the efficiency of your electrical equipment, and can deliver substantial reductions in your maintenance and capital costs after installation.

[11] http://powerperfector.com/

It works by reducing the mains voltage to the level that is required by electrical equipment, which is often much lower than the standard 240V. Therefore, energy savings can be made by optimizing and reducing supply voltage. Installing a ***power Perfector*** will reduce electrical energy consumption, as supplying equipment at the correct voltage prevents energy from being wasted.

Power quality plays a critical role in the integrity of your organisation. Inferior power quality means replacing equipment before its natural lifespan and higher maintenance costs. Following installation, it is anticipated that this cost will be reduced by approximately 9%.

The power we receive in the UK is not as "clean" as we would like it; worse still, its quality is deteriorating. By 2015, at peak demand, the UK may consume 23% more electricity than it can supply (LogicaCMG Whitepaper – Mind the Gap). We're fast reaching that point, resulting in more switching between power grids – a common source of transients. These transients (huge spikes in voltage and harmonics) harmful currents produced by electrical equipment, are particularly destructive to electrical circuits.

Note that Voltage Optimisation does not improve the efficiency of LED lighting and as such if the lighting is upgraded to LED then the payback period of the Voltage Optimisation system would increase (typically by 25-35%).

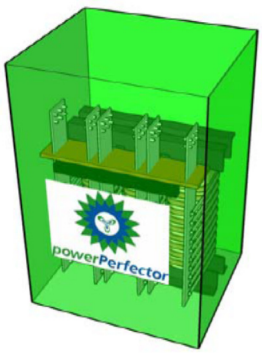
Benefits:

"power Perfector protects your business from these potentially damaging occurrences and in doing so improves security and supply and business continuity."

• A ***power Perfector*** makes an electrical supply more robust, and the site better protected. Transients – which are very brief surges in voltage from the grid – are eliminated provided they are less than 25,000V.

• The ***power Perfector*** is able to **filter harmonics** on the mains incomer. Harmonic distortion is on the increase, leading to apparently random failures of electronic equipment.

• The technology comes with a 10 year warranty and a 3 month money back guarantee (including instillation costs).



Estimated costs and savings of Voltage Optimising the Ferry Port

Estimated Pp Unit Installation Cost: £90,685

9% estimated average savings across the site = 218,773 kWh per year = £20,152

Payback Period: 4.5 years

ROI: 22.2%

Cost: £90,685	**Savings/Revenue: £20,152 or 218,773 kWh**
Payback period: 4.5 years	**Return on Investment: 22.2%**

Carbon Savings per year: 118.4 Tonnes

8.9 Meter-MACS SMART Utility Metering[12]

An assessment has already been carried out on the marina by Meter-MACS to evaluate the viability and cost effectiveness of installing SMART Utility Metering. Smart metering is steadily becoming a standard tool of any facility that want's to understand where utilities are being consumed as the data enables much greater levels of management control and cost management. In addition unmetered areas encourage waste and expose the marina to the risks associated with utility price rise and environmental impact.

Meter-MACS have developed a range of bespoke, technologically advanced applications specifically designed for the leisure, commercial and industrial sectors.

Harbours and Marinas

There are several additional benefits for marina and harbour clients, including:

- Customer Facility to check 'Pre-paid Balance' and 'Top-up' by phoning the office
- Secure Auto Disconnect Feature
- Boat Unplugged Alert
- LCD Display with Messaging Capability
- KeyPad Interface with Messaging Capability
- Mifare and Ibutton Interface Options
- Integrated Access Control

[12] http://meter-macs.com/

Increased management control is delivered via:

- Real-time readings
- Secure readings
- Absolute SMART Meter readings
- Instant Meter readings
- Instant Balance reading
- The Remote Suspend Account Capability
- Office Control – Remote On, Remote Off
- Office Real Time Status Information – Socket Vacant, Socket in Use, Who is Using
- Office Real Time Status Information – Alarms e.g. Power Fail, RCD Trip
- Access to data from the office
- Instant Tariff Changes
- A Self-Monitoring System
- Management Reporting
- Financial Reporting
- Automatic 30 Minute CRC Profile Reporting
- Pre-paid and Account Modes
- Multiple Service Capability – Electricity, Water, Gas, Access Control

The economic regulators Ofwat and Ofgem stipulate rules for resellers of utilities that no direct profit can be made from purchasers in the resale at a site. In certain circumstances, only a standing charge can be recovered on a pro-rata basis according to the usage of all those supplied at a particular property or site. Therefore, effective and accurate management of reseller utilities is vital so that it does not become a drain on the business, and on the bottom line.

Rob Brown, Harbour Master at Royal Harbour Marina in Ramsgate, said:

"Previous to having the Meter-MACS system in place, we were running with an all-inclusive, un-metered energy agreement, which was included in the overall berthing fee to clients. After close analysis of the numbers, we found that it was very inefficient and wasteful – we needed something that would give us better overall management and control".

It is understood that after the success of the initial installation, Ramsgate Marina are now looking to the future and are considering moving to a cloud-based platform, offering a roaming service for customers.

Cost: N/A	**Savings/Revenue: N/A**
Payback period: N/A	**Return on Investment: N/A**

Carbon Savings per year: N/A Tonnes

8.10 Membrane Bioreactor (MBR)[13]

Membrane bioreactors were evaluated for the Port and Marina to establish the viability of using harvested rainwater, waste water and sea water for the purpose of purification for re-use on site for toilet flushing, drinking water or manufacturing such as concrete production. **The water requirements at the Port of Ramsgate appear to be insufficient to justify the investment required to deliver a financially viable MBR system at this point in time. If a manufacturing facility were to be built at the site that required large volumes of water then a MBR could prove viable.**

A membrane bioreactor (MBR) is a wastewater treatment process combining membrane filtration with biological treatment. This innovative technology offers several advantages over the conventionally activated sludge process. Among these advantages are higher biomass concentration, eliminating the needs of secondary clarifiers and improved effluent quality. Sewage is transformed into clear and high quality water.

Cost: N/A	**Savings/Revenue: N/A**
Payback period: N/A	**Return on Investment: N/A**

Carbon Savings per year: N/A Tonnes

8.11 Battery Backup

Battery backup systems would enable the Port and Marina to continue providing power if the grid were to go down. Providing a backup battery system is of little value to most customers especially as the majority of the boats possess their own backup power sources. **The costs of introducing backup battery systems would be very high at the moment with little benefit/gain, as such this solution does not currently appear to be viable.**

Cost: N/A	**Savings/Revenue: N/A**
Payback period: N/A	**Return on Investment: N/A**

Carbon Savings per year: N/A Tonnes

[13] http://www.thembrsite.com/about-mbrs/what-are-mbrs/

10.0 Part 2:

In addition to the aforementioned solutions, there are a number of additional ideas designed to enhance sustainability within the building. Each offer low investment, high return sustainability solutions. The report provides an overview of the solutions that warrant further investigation.

10.1 When white goods are to be replaced; A+ or better rated versions should be chosen

Appliances such as dishwashers, fridges, cookers, computers, kettles etc. are also known as white goods. These come with an efficiency rating ranging from E – A++, with A++ being the most efficient. We recommend that white goods with ratings B-E are replaced with A++, or at least A, rated appliances. Higher rated white goods use significantly less energy than their lower rated counterparts whilst the cost difference tends to be minimal. The more energy efficient goods will have an overall result of reduced operating costs due to lowered energy spend as well as a reduced carbon footprint.

Note that many new computers actually consume more electricity than some old ones due to the larger processors and graphic cards. All modern flat screen monitors are much more efficient than the old TV type monitors. The way to reduce energy consumption is to either purchase lap top computers as they use typically 80% less electricity than a desktop equivalent or to use specialist low energy systems like Very PC. Their computers typically cost 10-15% more than conventional equivalent systems but they can often use 50-60% less energy and thus offer the possibility of a payback. They also offer low energy servers as well. See http://www.very-pc.co.uk/

Appliance Assumptions

Savings quoted in the table below are calculated based on the assumption that replacing an average appliance purchased new in 1998 with an Energy Saving Recommended model of similar size and an electricity cost of 12.5p/kWh.

Appliance	EU Energy rating	Saving a year (up to)	CO_2 saving a year (up to)
Fridge freezer	A+ or A++	£38	155 kg
Upright/ Chest Freezer	A+ or A++	£23	95 kg
Refrigerator	A+ or A++	£13	55 kg
Dishwasher	A	£11	47 kg
Integrated digital televisions	(no EU label for TV's)	£7	24 kg

Source http://www.energysavingtrust.org.uk/Energy-saving-assumptions

Cost: Variable	**Savings/Revenue: Variable**
Payback period: Typically 4-8 years	**Return on Investment: Typically 25-12.5%**

Estimated Carbon Savings: Variable

10.2 Good House Keeping

Good housekeeping refers to simple measures which can help to reduce carbon emissions and energy costs. The following tables give a number of suggestions which can yield significant energy savings:

Lighting: ***Artificial lighting can account for 30-45 % of the electricity use in a typical office building***
• Use natural lighting where levels are satisfactory • Switch off lighting if you are leaving the room for more than 1 minute • Buy high efficiency light bulbs and fittings, which typically use two-thirds less energy than regular lighting, it is key to understand the light output (Lumens) and colour (degrees Kelvin) of the lamp that you are replacing so that you get an equivalent replacement • Check that lighting controls (where provided) are set properly • Agree a maintenance schedule for cleaning and replacing lamps • External lighting, such as car parks should only be used where necessary • Agree a schedule for cleaning windows, to ensure that natural light is utilised to the full potential

Heating, cooling & hot water
• Only heat those areas that require heating • Ensure heating controls are set at levels appropriate to the area requiring heating • Report faulty heating and hot water controls • Minimise the use of air conditioning. Open windows where appropriate • Set air-conditioning systems to 23°C which is the recommended industry temperature

Water

- Optimise the use of water when cleaning
- Installing low-flow fixtures and aerators on faucets in your building will conserve litres of water each year, and solar pre-heating systems will cut your water-heating costs. Make sure to report leaky faucets or pipes to your building manager
- Also installing a water meter is a great way of not only saving water but also saving money

Refrigeration

- Try to ensure fridges / freezers are kept as full as possible

Computers: *Each year, computers in the business sector waste £1.5 billion worth of unnecessary electricity*

- Check that office PCs are switched off at the end of the day
- Don't switch on equipment until it is required for use that day
- Switch off computer monitors if the computer is required to be "on"
- Activate and utilise standby facilities on PCs, printers and photocopiers
- Turn off the computer at the power strip it's plugged into-when you leave work
- During the day, setting your computer to automatically go to sleep during short breaks can cut energy use by 70 %
- Invest in energy saving computers, monitors and printers and make sure that old equipment is properly recycled. Look for a recycler that has pledged not to export hazardous e-waste and to follow other safety guidelines
- Old computers that still work, and are less than five years old, can be donated to organisations that will refurbish them and find them new homes

Printing: *The average office worker goes through 10,000 sheets of copy paper per year*

- A survey conducted by research firm Loudhouse on behalf of Kyocera, found that the average employee uses 10,000 sheets of paper per year, and as many as 6,800 of those sheets are wasted
- Print on both sides of the paper or use the back side of old documents for faxes, scrap paper, or drafts
- Avoid colour printing and print in draft mode whenever feasible

- Buy paper with a higher percentage of post-consumer recycled content or consider switching to a lighter stock of paper or alternatives made from bamboo, hemp, organic cotton, or kenaf
- Recycle toner and ink cartridges and buy remanufactured ones. According to Office Depot, each remanufactured toner cartridge "keeps approximately 1 Kilogram of metal and plastic out of landfills... and conserves over 2 Litres of oil."
- Think before you print: could this be read or stored online instead?
- Consider printing multiple pages per sheet when reviewing documents
- When you receive unwanted catalogues, newsletters, magazines or junk mail, ask to be removed from the mailing list. Then recycle the item
- Post employee manuals and similar materials online rather than distribute print copies. They are also easier to update

Recycling and Disposal

- Any electronic waste that cannot be refurbished should be disposed of properly
- Everything from monitors to scanners to batteries can be given to e-waste disposal and recycling services for little to no cost
- Provide an electrical goods recycling box for employees so that they can dispose of old mobile phones, batteries etc. responsibly
- Recycle everything your company collects. Just about any kind of paper you would encounter in an office, including fax paper, envelopes, and junk mail, can be recycled
- Place recycling bins in accessible, high-traffic areas and provide clear information about what can and cannot be recycled
- Recycle or refill used printer cartridges or toners and think about buying recycled products as well
- Remember that you're not truly recycling unless you're buying recycled goods

Maintenance

- Maintain your boiler every 12 months to increase its effectiveness and reduce energy consumption
- Blocked filters and the build-up of dust and dirt on fan heaters reduces outputs and efficiency. This increases the time it takes to reach optimum temperature and encourages people to use additional systems
- Ensure that equipment that produces heat is not located near cooling vents

General Office

- Use non-toxic, eco-friendly cleaning products
- Brighten up your office with plants, which absorb indoor pollution
- Buy furniture, carpeting, and paint that are free of volatile organic compounds (VOCs) and won't off-gas toxic chemicals
- Look to replace your current office products with Greener, environmentally friendly alternatives. It's not just paper and envelopes that can be re-cycled. You can now obtain environmentally friendly staplers, hole-punches, marker pens and almost every other product you use regularly

Travel & Commute

- Take the train, bus, or tube when feasible instead of a rental car or taxi when travelling on business. If you have to hire a car or take a taxi, know that some rental agencies now offer hybrids and other low/zero emission vehicles
- Invest in videoconferencing and other technological solutions that can reduce the amount of expensed business travel
- Carpool, bike, walk, or public transport to work when possible
- Encourage telecommuting and make it easy for employees to take alternative modes of transportation when they come to the office, by subsidising commuter checks, offering bike parking, or organizing a carpool board

On behalf of NewForm Energy Ltd.

Jae Mather

Non-Executive Director

Accreditations & Awards