



**Crown Estate
Scotland**
Oighreachd a' Chrùin Alba



Offshore Generation Energy Systems

VALUE CASE STUDY

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EXECUTIVE SUMMARY

Xodus Group Ltd. (Xodus) are pleased to present this report to Crown Estate Scotland. This report is the deliverable for Phase 2 of the Offshore Generation Energy Systems Project Landscaping and Value Study commissioned by Crown Estate Scotland. This study is part of a broader workstream on the state of offshore generation energy systems in Scotland carried out for Crown Estate Scotland.

The purpose of this report is to demonstrate, through use of a case study, the additional value that can be generated for a community when an energy systems project is introduced. Through a combination of desk and phone-based research, modelling, questionnaires, and in-house expertise we have compiled an in-depth case study of a Scottish energy systems project and the value it has generated for the local community.

The Surf 'n' Turf project (illustrated in Figure 1.1) (SnT) is an innovative energy system located in the Orkney Islands, off the north coast of mainland Scotland. The project produces hydrogen using curtailed onshore wind and tidal power from the island of Eday. The hydrogen is then transported to Kirkwall harbour on the island of Orkney Mainland where it is used to generate electricity and heat for ferries berthed there and for harbour buildings.

The onshore wind power comes from a community Enercon 900kW turbine that is owned and operated by the Eday Development Trust. The tidal power is provided by turbines using the tidal test site of the European Marine Energy

Centre (EMEC) at the Fall of Warness, in the sea just west of Eday. To date, this has been a 2MW SR1-2000 tidal turbine owned and operated by Orbital. EMEC are also the owners of the 500kW electrolyser.

The Surf 'n' Turf project has faced numerous obstacles since it began and has so far been unable to operate as intended. Once these are resolved, Community Energy Scotland is committed to 12 months of operation, but this has yet to be achieved. A brief summary of the key issues is presented below:

- › Eday wind turbine was developed to generate money for the local community but faced much higher curtailment than had been anticipated – over 50%.
- › This cost the Eday Development Trust £250k a year in lost revenue opportunity and the turbine was barely making enough money to cover interest payments to the bank, let alone generate any income to reinvest locally.
- › Surf 'n' Turf was designed to help overcome this curtailment issue – one that faces many projects in remote locations without sufficiently high local demand to justify a private wire network.

Local Multiplier 3 Model

The LM3 (or Local Multiplier 3) modelling process was designed and developed by the New Economics Foundation (with input from The Countryside Agency). The process is designed to track where money is spent in a local economy and to show how the wider community can benefit from investment into one part of it. It is designed to be accessible and useful for non-economic specialists with the intention that local projects can make use of it without external assistance. This was one of the reasons that Xodus decided to use the LM3 model for this study, as we wanted to select something that was easily replicable by other energy systems projects and which would be accessible for non-specialists. We also wanted a model that would allow us to quantitatively assess how local communities benefit from the introduction of an energy systems project even when they do not have an ownership stake.

Local Multiplier models approximate how much money is generated for the local economy per each pound of investment. The more iterations of spending that are taken into consideration, the more accurate the calculation. That being said, a very good approximation can be achieved after only a few iterations and the LM3 model – as the name suggests – is based on measurements from three rounds



of spending. After three rounds, it becomes increasingly difficult to accurately track spending and there are diminishing returns.

The data-collection exercise carried out in conjunction with Community Energy Scotland yielded the following results:

- › Round 1 – estimated direct income of SnT: £31,692.70
- › Round 2 spending – local spend of SnT: £28,700.00
- › Round 3 spending – estimated local spend of Round 2 spending: £15,893.42

The LM3 Score for the Surf 'n' Turf project is therefore 2.41 (with 1 being the lowest possible score and 3 being the highest possible score). This means that every pound that comes into Orkney due to the Surf 'n' Turf project has an equivalent value of £2.41 to the local economy. In other words, each £1 of income to Surf 'n' Turf generates an additional £1.41 for the local economy. This amounts to 141% additional value to the local economy.

Wellbeing Analysis

The second element of the Surf 'n' Turf case study was to ascertain the importance of wellbeing i.e. the state of being comfortable, happy and healthy and the potential to develop a model type approach to the assessment of wellbeing when considering future marine energy systems in Scotland. A short questionnaire was developed (available in Appendix B), to ascertain the importance of wellbeing and how Surf 'n' Turf (and other similar projects) have the potential to influence wellbeing. A range of 'stakeholders' representative of the wide range of organisations and individuals involved with / influenced by the project were identified and agreed with Crown Estate Scotland ahead of interviews.

The Surf 'n' Turf project is considered to have had a positive influence on various aspects of wellbeing. There is an overwhelming acknowledgement that Eday (and the wider Orkney) community is proud to be part of such a world first and ground-breaking project. The project contributes to the vision and purpose of these communities and the fact that the local community (in the form of Eday Renewable Energy) is a partner in the project instils community ownership and responsibility.

The project provides a pathway to decarbonisation and together with other projects including 'BIG HIT', provision of hydrogen power to the existing inter-island ferries while berthed and a pathway to future hydrogen powered ferries,

contributing to the identification of Orkney as a hydrogen hub. This and other energy / hydrogen related projects have showcased the ability of the Orkney and its outer island communities to contribute to high tech decarbonisation and research projects.

The Surf 'n' Turf project in particular has contributed to the provision of jobs / work and training in:

- › Maintenance;
- › Gas engineering;
- › Hydrogen transportation (onshore and ferries); and
- › Emergency and response.

The project has also provided the stimulus to develop hydrogen related training locally in Orkney to train the local workforce. Hydrogen related projects are also considered to have contributed to the retention of working population and graduates in Orkney.

Other benefits and by-products that SnT and related projects have enabled (but weren't part of the original aims of the project), include:

- › Shapinsay school insulation and hydrogen heating;
- › Business tourism on the island of Eday;
- › Eday heritage centre upgrade; and
- › Annual fieldtrip to the island of Eday by Edinburgh University Masters students.

When considering the replicability of this or other EMEC-like projects it is important to consider that, like Orkney, many remote island communities have constrained grid connections and space and resource to develop onshore wind projects. It is likely that any energy systems project with the capability to reduce or relieve this grid constraint would, initially at least, be powered by an onshore turbine as these are much lower cost and lower risk to develop. However, this does not limit the overall findings that an energy systems project powered by floating offshore wind or tidal energy has significant capacity to multiply its local economic impact and provide wider positive impacts on social wellbeing.

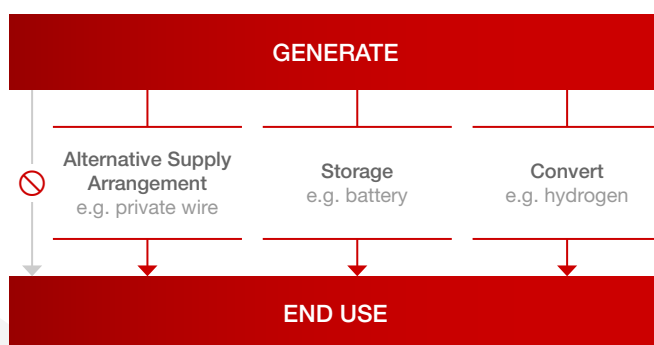


INTRODUCTION

1

The purpose of this report is to demonstrate, through use of a case study, the additional value that can be produced for a community with the introduction of an offshore generation energy system.

Here an energy generation system is defined as being any generation that has more than a passive connection to the main grid e.g. through including a storage element, such as hydrogen, or through connection to a microgrid or private wire network. This is illustrated in Figure 1.1 below. Crown Estate Scotland can then use this research to inform their investment strategy and policy thinking as they seek to ensure that assets are enjoyed and developed sustainably to deliver benefits to Scotland and its communities.



1.1 Scope of Document

This document assesses the local impact of the SnT project, an innovative energy systems project that has been developed and led by Community Energy Scotland.

Surf 'n' Turf was selected for several reasons:

- › It is based in Orkney where there is considerable renewable energy resource but significant challenges facing development, most notably grid constraint. Orkney also provided a clearly definable local boundary aiding measurement of local impact.
- › Surf 'n' Turf clearly meets the criteria for an energy systems project given its inclusion of hydrogen as an energy vector and the fact that it has a well-defined non-grid end user
- › It is technology agnostic – the project is not being led by a technology developer and includes two types of generation asset (remote island onshore wind and tidal), neither of which is included in the project on behalf of a developer.
- › Although we were aware that the SnT project was not yet operational when it was selected, it was felt by both Xodus and Crown Estate Scotland that there was sufficient information to warrant a study, especially given the project's pioneering nature.

This report begins by describing the SnT project and explaining the motivations behind it and the barriers that it has faced to date. It then goes on to evaluate the impact that SnT has had, both on the local economy and wellbeing. To assess the local economic impact, it was decided that the use of a Local Multiplier 3 model was appropriate. This model was designed to be easy to use and accessible for those with no formal economic training. The methodology is therefore easily replicable by other energy systems projects, especially those based within a community.

The report discusses the methodology and results of the Local Multiplier 3 model Xodus developed to quantitatively assess the impact of the Surf 'n' Turf project on the local economy. Further to the LM3 model, Xodus conducted questionnaires with key stakeholders of the project in Orkney to qualitatively assess the impact that it has had on their wellbeing. While the LM3 tool is very useful for assessing economic benefits, this doesn't necessarily translate to the perceived wellbeing of the local community. Further qualitative assessment was therefore required to gain a holistic understanding of the true local impact of SnT and to compliment and contextualise the findings of the economic analysis. The methodology and results of this qualitative survey are presented, before the report concludes with an analysis and discussion of the local impact of the Surf 'n' Turf project, informed by both the quantitative and qualitative results.



1.2 Glossary of Key Terms and Abbreviations

TERM	DEFINITION
Anode	The positively charged electrode by which electrons leave an electrical device
Cathode	The negatively charged electrode by which electrons enter an electrical device
Electrode	A conductor through which electricity enters or leaves an object, substance, or region
EMEC	European Marine Energy Centre
ERE	Eday Renewable Energy
GDHI	Gross Disposable Household Income
LM3	Local Multiplier 3 – the type of economic model used to measure the economic impact of the SnT project
MCA	Maritime and Coastguard Agency
NEF	New Economics Foundation – developers of the LM3 modelling methodology
NI	National Insurance
OIC	Orkney Islands Council
ONS	Office for National Statistics
PEM	Proton Exchange Membrane – the type of electrolyser used in SnT
ROC	Renewable Obligation Certificates
SnT	Surf 'n' Turf

SURF 'N' TURF

2

2.1 Project Overview

The Surf 'n' Turf project (illustrated in Figure 2.1 below) is an innovative energy system located in the Orkney Islands, off the north coast of mainland Scotland.

The project produces hydrogen using curtailed onshore wind and tidal power from the island of Eday. The hydrogen is then transported to Kirkwall harbour on the Orkney Mainland where it is used to generate electricity and heat for ferries berthed there and for harbour buildings.

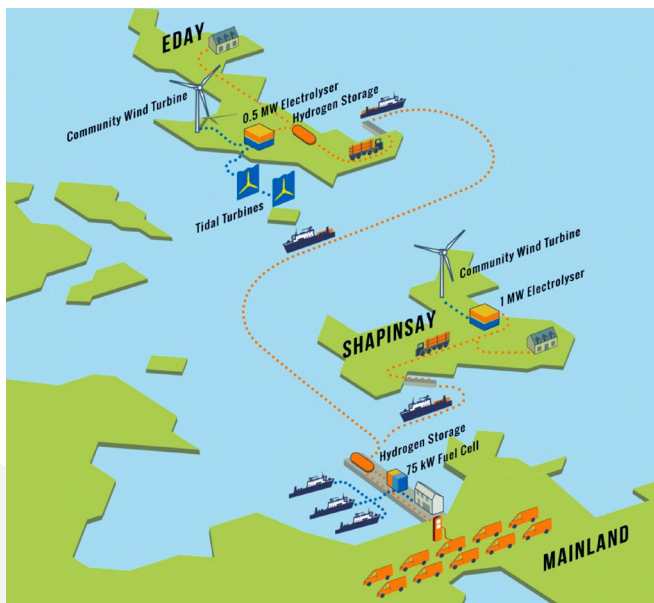


Figure 2.1
Illustration of Surf 'n' Turf energy system – courtesy of
Community Energy Scotland

The onshore wind power comes from a community Enercon 900kW turbine that is owned and operated by the Eday Development Trust. The tidal power is provided by turbines using the tidal test site of the European Marine Energy Centre (EMEC) at the Fall of Warness, in the sea just west of Eday. To date, this has been a 2MW SR1-2000 tidal turbine owned and operated by Orbital. EMEC are also the owners of the 500kW electrolyser.

Both the wind and tidal turbines export electricity to the grid whenever possible, but when they are curtailed this energy is redirected to the electrolyser which splits water to produce hydrogen (see Appendix A for an explanation of the electrolysis process). This allows both turbines to maximise generation and remain viable investments for their owners.

The hydrogen is transported via light-weight trailers (each of which is capable of transporting 250kg of hydrogen at a pressure of 200 bar and which were specially designed for use on Orkney's roads) and ferry to Kirkwall harbour on the Orkney Mainland. Here it supplies three 25kW (75kW total) fuel cells, producing electricity that is used to power the Kirkwall harbour buildings and the ferries when they are berthed. The waste heat generated by the fuel cell is also used to heat a harbour building.

2.2 Current Status

The Surf 'n' Turf project has faced numerous obstacles since it began and has so far been unable to operate as intended. Once these are resolved, Community Energy Scotland is committed to 12 months of operation, but this has yet to be achieved.

The largest obstacle has been the technical malfunctioning of the EMEC electrolyser, which has had to be sent away for an upgrade. This has left the Surf 'n' Turf project without a dedicated electrolyser and hence has prevented constrained electricity generated by both the Eday wind turbine and the EMEC tidal sites from being used to produce hydrogen. Until the electrolyser returns (expected 2020), Surf 'n' Turf will be unable to operate.

The second obstacle has been transporting of hydrogen on the ferries between Eday and Mainland. Initially, the plan was for the hydrogen to be transported using the existing ferry service for a set price.



However, the Maritime and Coastguard Agency (MCA) has since changed their regulations for the transportation of Dangerous Goods (including hydrogen). This means that hydrogen is not allowed to be transported on a vessel with more than 25 people on board. Ferries between Eday and Mainland currently run on a first-come-first-served basis with no booking system in place. This means that there is no way for Community Energy Scotland to know how many people will be travelling on any given vessel, and hence there is no way to schedule hydrogen deliveries. As a result, Community Energy Scotland will now have to charter a vessel for this specific purpose, at considerable expense. A viable alternative has yet to be worked out.

Finally, while SnT proposes to use both wind and tidal energy to generate hydrogen the vast majority of this is likely to come from the Eday community wind turbine. This is because of curtailment limits. Tidal energy from the EMEC test site will only be constrained when it exceeds 4MW e.g. if 6MW of tidal turbines are connected and generating, then 2MW of this will be fed to the electrolyser rather than being exported to the grid. However, to date this limit has never been reached and so no tidal energy has been redirected to the electrolyser. All power to date has come from the Eday community wind turbine.

2.3 Who is Involved?

Surf 'n' Turf involves a number of partners.

The project is being led by Community Energy Scotland, who also own the fuel cells and sell the electricity to OIC. The wind turbine is owned and operated by the Eday Development Trust, and the tidal turbine is owned by Orbital Marine Power (formally Scotrenewables Tidal Power). As well as providing berthing space for the Orbital tidal turbine, EMEC provides the electrolyser that generates the hydrogen. In addition, there are a number of organisations involved in providing funding and project development support. These organisations and their roles are summarised opposite.

Organisations involved in Surf 'n' Turf



Community Energy Scotland – Project lead, owner of 3 x 25kW fuel cells



Eday Development Trust – Owner of Enercon 900kW wind turbine, via subsidiary Eday Renewable Energy Ltd



European Marine Energy Centre (EMEC) – Site of tidal turbine, owner / operator of 500kW PEM electrolyser



ITM Power – Supplier of 500kW PEM electrolyser, lead on SnT system's technical design and integration



Orbital – Owner and developer of the SR1-2000 2MW tidal turbine



Orkney Island Council – Purchase the electricity from the fuel cell



Scottish Government's Local Energy Challenge Fund – Provided £1.46 million in development funding



Fuel Cells and Hydrogen Joint Undertaking, part of the European Union Horizon 2020 funding – Co-funders



2.4 Motivation behind Surf 'n' Turf

Surf 'n' Turf was devised as an alternative route to market when the Eday turbine experienced much higher than expected curtailment (50%+) when connected to the grid, thus significantly reducing income that was to be reinvested in the community.

While the conversion of electricity to hydrogen for transportation and then reconversion to electricity is 'inefficient' in an engineering sense, the proposal was that it would be more efficient commercially than absorbing the lost potential income. This technology is still in its infancy and therefore Community Energy Scotland provided funding and support to create the project, as it would be unlikely to be viable without this help.

A brief summary of the key issues is presented below:

- › Eday wind turbine was developed to generate money for the local community.
- › Faced much higher curtailment than previous anticipated – over 50% costing the Eday Development Trust £250k a year in lost revenue.
- › The project was barely making enough money to cover interest payments to the bank, let alone generate any income to reinvest locally.
- › Surf 'n' Turf was designed to help overcome this curtailment issue – one that faces many projects in remote locations without sufficiently high local demand to justify a private wire network.

2.5 Barriers Faced by Surf 'n' Turf

To date the Surf 'n' Turf project has been unable to operate as originally intended. This is due to two factors. Firstly, the electrolyser on Eday broke down and has had to be sent away for maintenance. Secondly, the initial plan was to transport the hydrogen via the pre-existing ferry service that operates between Eday and Mainland.

However, a change in the Dangerous Goods regulations by the MCA means that hydrogen is now considered to be a dangerous good. As a result, it is not allowed to be transported on any vessel carrying more than 25 passengers. The ferry does not operate a booking system and thus there is no way of knowing ahead of time whether the hydrogen could be transported or of scheduling a time when transportation could occur.

Hence, Community Energy Scotland are now investigating the costs of chartering vessels specifically for this purpose and are in the process of redesigning the Surf 'n' Turf business model to accommodate this unexpected, and significant, cost. As a result, the Surf 'n' Turf project is still in development and has yet to become operational in any meaningful sense.

LM3 MODEL METHODOLOGY

3

The LM3 (or Local Multiplier 3) modelling process was designed and developed by the New Economics Foundation (with input from The Countryside Agency).

The process is designed to track where money is spent in the local economy and to show how the wider community can benefit from investment into one part of it. Furthermore, it is designed to be accessible and useful for non-economic specialists with the intention that local projects can make use of it without external assistance. This was one of the reasons that Xodus decided to use the LM3 model for this study, as we wanted to select something that was easily replicable by other energy systems projects and which would be accessible for non-specialist readers. We also

wanted a model that would allow us to quantitatively assess how local communities benefit from the introduction of an energy systems project even when they do not have an ownership stake.

The LM3 model measures how 'hard' each pound of income works for the local community. This concept is best illustrated with an analogy, adapted from the LM3 Handbook provided by NEF. Imagine that every pound of revenue made by a project is coated in red powder and every time it changes hands some of that colour is transferred. The first people to get red on their hands will be the staff and suppliers to the project as wages are given and money is spent on the daily upkeep. Colour will then transfer again as this money is spent as rent, at shops, on activities. And then again, and again as the money gets re-spent. Of course, with each iteration some of these coloured pounds will leave the local economy as people spend money elsewhere, at shops in different towns, or to landlords that live elsewhere etc. The LM3 model measures, in a sense, how many red hands remain in the community and therefore how much the community benefits from that initial income. This is illustrated in Figure 3.1 below where you can see the red colour slowly diminishes as money leaves the local economy.

Figure 3.1 also shows how money that stays in the local economy brings extra value. Say £1 of initial revenue is passed onto a local member of staff who then spends it in a local shop. This is then the equivalent of £3 investment into the community.

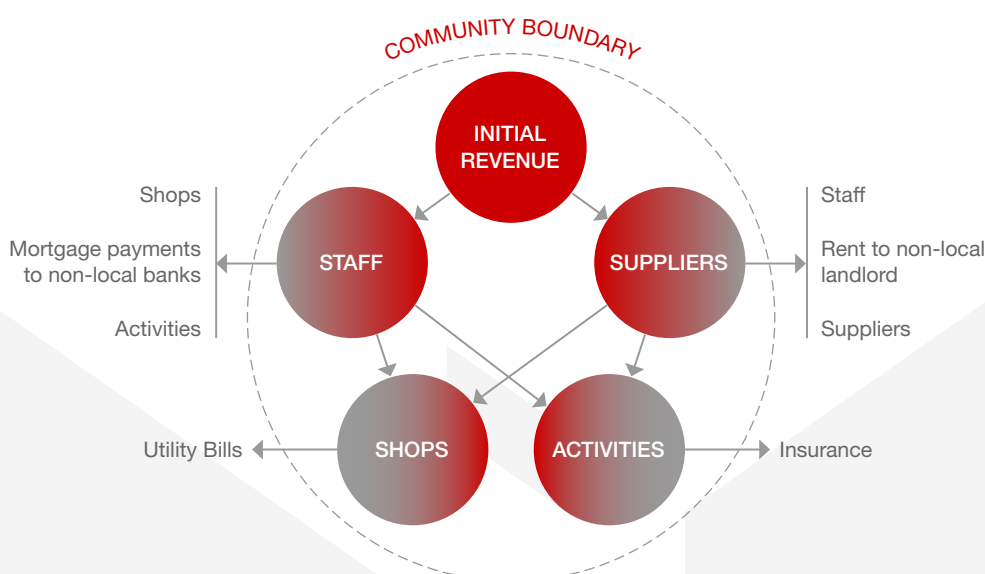


Figure 3.1

An illustration of monetary flows within and out of a community



Local Multiplier models approximate how much money is generated for the local economy per each pound of investment. The more iterations of spending that are taken into consideration, the more accurate the calculation. That being said, a very good approximation can be achieved after only a few iterations and the LM3 model – as the name suggests – is based on measurements from three rounds of spending. After three rounds, it becomes increasingly difficult to accurately track spending and there are diminishing returns.

3.1 The LM3 Process

The LM3 model considers data from three rounds of spending:

1. Round 1 – Initial income

This is the money that comes into the project/company/initiative as income over a pre-determined period (normally one calendar year). For Phase 2, this will be the income of the Surf 'n' Turf project in Orkney with the data being supplied by Community Energy Scotland.

2. Round 2 – Local spend by project/company/initiative

To calculate Round 2, it is first necessary to determine the geographic boundaries of the model i.e. what is meant by 'local'. In Phase 2, the geographic boundary has been taken to be that of the Orkney Islands. Data has been supplied by Community Energy Scotland

Local spend includes, but is not limited to:

- › Staff
- › Contractors and sub-contractors
- › Suppliers of goods and services
- › Investors
- › Rent/Mortgage

Note: these are only included if they are based in the local area.

3. Round 3 – the local spend of those who receive money from the project/company/initiative

Round 3 is the most complicated of the three to measure. For the sake of efficiency, Xodus decided to estimate the proportion of local spend of Surf 'n' Turf beneficiaries based on data from the National Office of Statistics.

These three values are then fed into a simple equation to calculate the LM3 score. The highest possible LM3 score is 3. This occurs when all income (Round 1) is spent locally (Round 2) and then re-spent locally again (Round 3). The lowest possible LM3 score is 1. This occurs when none of the income (Round 1) is spent locally (i.e. Round 2 = Round 3 = 0). This, along with the equation, is illustrated in Figure 3.2 below.

The highest possible LM3 Score occurs when Round 1 = Round 2 = Round 3:

$$\begin{aligned}
 \text{Highest LM3 Score} &= \frac{\text{Round 1} + \text{Round 2} + \text{Round 3}}{\text{Round 1}} \\
 &= \frac{\text{Round 1} + \text{Round 2} + \text{Round 3}}{\text{Round 1}} \\
 &= \frac{3 \times \text{Round 1}}{\text{Round 1}} \\
 &= \frac{3}{1} \\
 &= 3
 \end{aligned}$$

The lowest possible LM3 Score occurs when Round 2 = Round 3 = 0:

$$\begin{aligned}
 \text{Lowest LM3 Score} &= \frac{\text{Round 1} + 0 + 0}{\text{Round 1}} \\
 &= \frac{\text{Round 1}}{\text{Round 1}} \\
 &= \frac{1}{1} \\
 &= 1
 \end{aligned}$$

Figure 3.2

LM3 Calculations for the Highest and Lowest Possible Scores



3.2 The LM3 Model Applied to Surf 'n' Turf

To calculate the LM3 value of the Surf 'n' Turf project, Xodus built a model in MS Excel. Separate inputs for Rounds 1, 2, and 3 were calculated and fed into the LM3 Score equation to calculate the value of each pound of input to the local economy.

Prior to determining the inputs for Rounds 1-3, it was first necessary to define which aspects of SnT would feed into the measurements. As shown in Figure 2.1 and described in Section 2, SnT involves numerous parties and is comprised of multiple elements. These include the Eday wind turbine, the EMEC tidal test site, the EMEC electrolyser, and the fuel cell at Kirkwall harbour. Each of these parts are not uniquely associated with SnT and have their own separate monetary flows. Incorporating all of these monetary flows is beyond the scope of this report and would likely confuse the results. It was therefore decided that Community Energy Scotland, as the project lead and coordinator, and the monetary flows associated with them would be the focus of the LM3 model.

When curtailed and therefore unable to export to the grid, energy from the Eday wind turbine and tidal turbines at the EMEC test site is used to power EMEC's electrolyser. These turbines receive government subsidy for this energy, reducing the opportunity cost of not being able to export to the grid. Community Energy Scotland transports the hydrogen to Kirkwall where it is used to power their fuel cells to generate electricity, which is then sold to Orkney Islands Council at market rates. This is the source of income that is assessed in the LM3 model. Government subsidies and other sources of income to the original wind and tidal generators are excluded from this study. Surf 'n' Turf Round 1.

Due to complications outlined in Section 2.5, the Surf 'n' Turf project has been unable to operate as intended. As a result, Community Energy Scotland were unable to provide Xodus with the actual income of the Surf 'n' Turf project. Nor were they able to provide a costed business model as this has yet to be updated to accommodate the additional expense of chartering bespoke ferries to transport the hydrogen from Eday to Mainland. Community Energy Scotland were, however, able to provide Xodus with data for their Round 2 spending i.e. annual spend on SnT staff salaries, local suppliers of goods and services, and office rent. This is discussed in greater depth in Section 3.2.1 below.

Xodus used this Round 2 data to estimate an appropriate figure for Round 1. This required us to make several assumptions:

- › Surf 'n' Turf does not produce any profit for Community Energy Scotland and any money generated by SnT is reinvested back into it. This is a reasonable assumption of a small-scale demonstration project, especially one run by a non-profit organisation. It is further backed up by the fact that, were SnT operational, the electricity generated by the fuel cell in Kirkwall would be sold to Orkney Island Council at no higher a rate than standard electricity prices. Community Energy Scotland informed us that they think the model would be more profitable were the hydrogen sold on the open market and that profits are limited by the current sale model.
- › As well as the money that is spent locally in Round 2, Community Energy Scotland are legally required to pay national insurance contributions for the staff involved in SnT as well as pensions contributions for those that do not already have other arrangements. Xodus has assumed that Community Energy Scotland pays the minimum required pensions contribution of 3% on pensionable earnings¹. It is further assumed that all the members of staff are eligible for this².
- › An online tax calculator was used to calculate the National Insurance contributions Community Energy Scotland must pay for their staff. It is assumed that the results of this calculator are accurate.

To estimate Round 1 spending, Xodus took the Round 2 data provided by Community Energy Scotland and added the necessary pensions and national insurance contributions to this (in line with the assumption that the Surf 'n' Turf project results in no additional revenue).

¹ Pensions contributions are payable on earnings between the lower and higher thresholds of £6,136 and £50,000.

² To be eligible for the work-based pension scheme, workers must be: between the ages of 22 and the State Pension Age, earning over £10,000, working in the UK, and not already in a qualifying pension scheme.



3.2.1 Surf 'n' Turf Round 2

All data for Round 2 spending was provided directly by Community Energy Scotland.

This included:

- › Number of staff involved with Surf 'n' Turf
- › Amount of staff time dedicated to working on Surf 'n' Turf
- › Staff salaries
- › Monthly spend on goods and services provided by local suppliers (from which Xodus was able to generate an annual figure)
- › Annual rent paid to a local landlord.

Four members of Community Energy Scotland staff – all of whom live in Orkney – spend approximately a quarter of their time on Surf 'n' Turf. Therefore, the model assumes one full-time equivalent (FTE) for salary spend.

3.2.2 Surf 'n' Turf Round 3

The Surf 'n' Turf Round 3 data came from the Office of National Statistics (ONS) Dataset of Detailed Household Expenditure by Countries and Regions.

This dataset shows the average weekly household expenditure on goods and services across the UK for 2016-2018. To gain an estimate of weekly household expenditure on Orkney, Xodus used the 'Scotland' data from the ONS dataset.

While spending on Orkney is likely to be similar to that of mainland Scotland, there are various costs where discrepancies are expected (e.g. heating costs as Orkney is not connected to the mains gas supply). ONS acknowledge this and have published a separate report: "Investigating household expenditure in island communities". This qualitative study has gathered data from the Scilly and Orkney islands and captures resident views of comparative costs.

While no additional figures are provided, key findings include:

- › Housing is generally cheaper in Orkney than in the Highlands, the nearest region of mainland Scotland. It ranges significantly in quality, with newer builds being more energy efficient than the old stone houses.
- › Orkney does not have mains gas so residents rely on a combination of heating oil, bottled gas, coal, wood (though this is difficult to source), and renewable energy. Numerous residents felt that this was likely to be more expensive than

if they lived on mainland Scotland, not least because of additional freight charges.

- › 55% of Orkney residents live in fuel poverty (i.e. the household spends more than 10% of its income on energy).
- › Prices were seen to be higher on the outer islands than on Mainland, Orkney.

To accommodate the likely cost discrepancy between Orkney and mainland Scotland, Xodus adjusted some of the elements of the Scottish average weekly household expenditure:

- › 'Housing, Fuel, and Power' expenditure was increased by 10% to accommodate the higher energy prices and the additional costs of maintaining a dwelling when labour and building supplies must be imported.
- › 'Operation of personal transport' was also increased by 10% as the ONS report on Island Expenditure indicated petrol costs are 5-10p more per litre than on mainland Scotland. In addition, spares and accessories often have to be imported.

Further, as the LM3 model only takes into account money that is spent locally, Xodus removed those aspects of the average weekly household expenditure that would likely result in money leaving the local boundary of Orkney. The following costs were removed for this reason:

- › Communication, including Telephone and telefax equipment and services and internet subscription fees
- › Computer software
- › TV Licences
- › Holidays abroad
- › Interest on credit cards
- › Clothing and footwear, as the report suggests this is predominantly bought from online retailers or on trips to the Scottish mainland.

The resulting figure is an estimate of the average weekly household local spend on Orkney. This was then multiplied by 52 to gain an estimate of total annual average spend for one full-time employee.

As well as the local spend of Community Energy Scotland employees, it is necessary to estimate the local spend of the businesses of which Community Energy Scotland are patrons. This total expenditure amounts to approximately 9% of the annual wage of an SnT staff member, and so it has been assumed that these local businesses spend 9% of the average annual local spend of an Orkney household.

LM3 MODEL RESULTS

4

Round 1 = £31,692.70

Round 2 = £28,700.00

Round 3 = £15,893.42

$$\text{LM3 Score} = \frac{\text{Round 1} + \text{Round 2} + \text{Round 3}}{\text{Round 1}}$$

$$\text{LM3 Score} = \frac{31,692.70 + 28,700.00 + 15,893.42}{36,892.70}$$

$$\text{LM3 Score} = \frac{76,286.12}{31,692.70}$$

$$\text{LM3 Score} = 2.41$$

The data-collection exercise carried out in conjunction with Community Energy Scotland yielded the following annual results:

- › Round 1 – estimated direct income of SnT: £31,692.70
- › Round 2 spending – local spend of SnT: £28,700.00
- › Round 3 spending – estimated local spend of Round 2 spending: £15,893.42

The LM3 Score for the Surf 'n' Turf project is therefore 2.41 (with 1 being the lowest possible score and 3 being the highest possible score). This means that every £1 that comes into Orkney due to the Surf 'n' Turf project is equivalent value of £2.41 to the local economy.

In other words, each £1 of income to Surf 'n' Turf generates an additional £1.41 for the local economy. This amounts to 141% additional value to the local economy.

Table 4.1 – Summary of model components and annual assumptions

ROUND	TOTAL	COMPONENTS	ASSUMPTIONS
1	£31,692.70	Round 2 spending: £28,7000.00	All SnT profit is reinvested into the project
		Staff pensions: £595.92	Minimum pension contribution of 3% on pensionable earnings
		Staff NI contributions: £2,396.78	Estimate based on online tax calculator
2	£28,700.00	Staff salaries: £26,000.00	All data supplied by Community Energy Scotland
		Suppliers of goods/services: £1,200.00	
		Rent/mortgage: £1,500.00	
3	£15,983.42	Staff spending: £14,581.12	Data was taken from the ONS Survey on average weekly expenditure for goods and services in Scotland. The following areas were increased by 10% to account for higher costs on Orkney: 'Housing, Fuel, and Power' and 'Operation of Personal Transport'. Further, these areas were excluded as assumed to be spending outwit the local boundary: Communication, Computer Software, TV Licences, Holidays Abroad, Credit Card Interest, Clothing and Footwear
		Employees of local suppliers: £1,312.30	Assumed 9% of the average annual local spend of an Orkney household as total amount given is 9% SnT staff salary



4.1 Discussion

As a local multiplier, 2.41 is a robust score showing that a significant proportion of the revenue brought into Orkney by the Surf 'n' Turf project remains in the local economy and generates additional value for the community³.

There are a number of reasons why we might expect this to be the case and which must be taken into consideration when deciding where to locate other energy systems projects hoping to achieve similar results.

First, the fact that Orkney is an island community with a significant population greatly increases the likelihood of money remaining within its local economy. Approximately 22,000 people live in Orkney and 75% live on the island Mainland. As a result, towns on Mainland such as Kirkwall – where the majority of SnT staff reside – and Stromness are large enough to provide sufficient demand to many local businesses. Kirkwall has numerous restaurants, supermarkets, shops, cinemas, leisure facilities, and other businesses that have developed to meet the needs of the local population. As a result, for the sake of convenience and to avoid paying additional fees to import goods from the Scottish mainland, many residents rely on these businesses to source most of their goods and services. Our research suggested that some retail areas – such as clothing – are underserved in Orkney and so residents rely on online deliveries or wait until they visit the Scottish mainland to make such purchases. For this reason, we excluded clothing from our calculations of local spend, but most other retail areas are included. Residents are therefore incentivised to spend money locally by the fact that most goods and services are locally available and spending money elsewhere a) is inconvenient as there would be a delay and b) will likely incur additional costs.

For other energy systems projects to achieve a similarly high LM3 score, they will first need to minimise economic leakage from their local economy. Hiring local residents

and purchasing materials and services from local suppliers and businesses is one step that an energy systems project can take, as is working with the local community to ensure that residents retail needs are able to be met within the community boundary. This is particularly challenging for communities that are either too small to host sufficient businesses to meet the majority of their needs (e.g. supermarkets, clothing stores, entertainment) or for which it is easy for residents to travel to other locations that offer more choice or lower prices. Introducing energy systems into economies that are already robust will result in greater local benefit than placing them in areas with limited opportunities for local monetary flows; definition of projects and measuring their benefits should consider local boundaries.

Secondly, we have assumed that all income to the Surf 'n' Turf project will be reinvested into the project. This is not unreasonable given that the project is being led by a non-profit organisation and is pre-commercial. This, coupled with the strong local economy discussed above, explains why the values for Rounds 1, 2, and 3 are of a similar magnitude – a requirement for a high LM3 score. Lower LM3 scores are generally the result of higher differences between Round 1 and Round 2 values. This is unlikely to ever be the case for Surf 'n' Turf (or similar model), even if it were to become commercially viable. This is because of the ethos of Community Energy Scotland whose remit is to support the development of local energy systems for local benefit. Should significant profit occur, it is likely that this would be used to further benefit Orcadian residents.

This is another reason why a similarly high LM3 score could not necessarily be expected of other energy systems. If the project is commercial and privately owned by a non-local developer then large portions of the income can be expected to leave the local boundary e.g. as shareholder dividends, non-local staff salaries, etc. If a project is locally owned, as Surf 'n' Turf is, then its income is more likely to remain in the local economy.

³ It is worth noting that, while SnT is not yet operational, we would not expect the LM3 score to significantly differ when it becomes so. This is because this score is based on the income that Community Energy Scotland is expected to make from selling electricity to OIC. Once operational, the greatest change in income is likely to be in relation to the Eday wind turbine (which is currently suffering an opportunity cost from being heavily curtailed). Once SnT is operational, the Eday wind turbine will be able to generate more, resulting in greater income – income that is then to be reinvested in the local community. A separate LM3 score would have to be calculated to quantify this local impact.



Finally, it is worth noting that while the LM3 Model indicates that Surf 'n' Turf has the potential to provide significant value to Orkney, it does not accurately capture indirect benefits that are already emerging. For example, Orkney has become a centre of European hydrogen innovation. Numerous jobs have been created as a direct result of the innovation taking place on the islands, from more hydrogen specialists at EMEC to the UK's first dedicated Hydrogen Officer at Orkney Islands Council. This has happened despite the SnT project not yet being operational. The innovative work that went into setting up SnT has fed into wider work across the islands that is leading to the development of hydrogen expertise and encouraging similar ventures to locate in this area. This value is not captured in the LM3 model. As a result, it was necessary to use qualitative measures to try to capture some of this additional value that such projects can bring. This is discussed in Sections 5 and 6 below.

4.2 Other Observations

While researching the Orkney economy and stress testing our assumptions, Xodus Group reviewed a document from OIC⁴ based on data from the ONS researching the Gross Domestic Household Income for UK regions.

During the period 2005 to 2011, Orkney experienced an unprecedented spike in GDHI. This increase in GDHI (111.3%) outstripped every other region of the UK and occurred during a period of global recession. From review of the EMEC news archive, this period also coincided with significant investment and activity in establishing the centre as a marine renewable testing hub. While significant further research would be required to understand if there is a causal relationship behind the correlation, it would be surprising if the investment and development – bringing, as it did, high-skilled jobs – was unrelated to the higher than expected GDHI. This research is outside the current scope of this project, but initial observations suggest that further consideration is merited and could provide further evidence of the strong additional socio-economic value of similar projects aligned with remote island communities.

When considering the replicability of this or other SnT-like projects it is important to consider that, like Orkney, many remote island communities have constrained grid connections and often have space and resource to develop onshore wind projects. It is likely that any energy systems project with the capability to reduce or relieve this grid constraint would, initially at least, be powered by an onshore turbine as these are much lower cost and lower risk to develop than offshore alternatives. However, this does not limit the overall findings that an energy systems project powered by floating offshore wind or tidal energy has significant capacity to multiply its local economic impact.

It is also important not to underestimate the importance that a driving body, such as Community Energy Scotland, has had on bringing the SnT project into existence and ensuring that it will be of local benefit. Community Energy Scotland – with its community focus – initially supported Eday to develop its turbine to help provide an income to the local community. When this income was threatened by grid constraint, it was then Community Energy Scotland who worked with local partners to help devise an alternative that would overcome this obstacle. This has helped ensure that the SnT project has maintained a strong community focus throughout.

⁴ https://www.orkney.gov.uk/Files/Business-and-Trade/Economic_Review/Economic_Review_2017.pdf

WELLBEING SURVEY METHODOLOGY

5

The second element of the Surf 'n' Turf case study was to ascertain the importance of wellbeing – defined in the Oxford English Dictionary as *'the state of being comfortable, healthy, and happy'* – and the potential to develop a replicable approach to the assessment of wellbeing when considering future marine energy systems in Scotland.

A short questionnaire (available in Appendix B) was developed, to ascertain the importance of wellbeing and how Surf 'n' Turf (and other similar projects) have or have the potential to influence wellbeing. A range of 'stakeholders' representative of the wide range of organisations and individuals involved with / influenced by the project were identified and agreed with Crown Estate Scotland ahead of interviews (Table 5.1).

Table 5.1 – Wellbeing questionnaire survey participants

ORGANISATION	ROLE / INTEREST IN THE PROJECT	INTERVIEW	NOTES
EMEC	Project partner, provided tidal power and electrolyser	×	Provided input to the economic aspects of the case study and felt other partners more appropriate from social aspects
Community Energy Scotland	Project partner, responsible for project management and programme design	✓	Face to face interview
Eday Renewable Energy Limited	Project partner (supplying renewable energy from the community wind turbine to the island)	✓	Teleconference interview
Eday Community Council	Represent the local community on the island of Eday	✓	Teleconference interview
Orkney Islands Council – Hydrogen Officer	Project partner, local authority and transport (Orkney Ferries) operator	✓	Face to face interview
Orkney Islands Council – Orkney Ferries	Project partner, local authority and transport (Orkney Ferries) operator	✓	Face to face interview
Orkney Islands Council – Transport Manager	Project partner, local authority and transport (Orkney Ferries) operator	×	Less direct involvement in the Surf 'n' Turf project compared to others identified for interview
Orkney College, UHI	Developing training opportunities provided locally by Orkney College defining the standard excellence in Hydrogen industry standards	×	–
Eday doctor	Provide a feeling of issues at local community level	×	Unable to schedule a suitable time for interview in the time available
Eday School	Provide a feeling of issues at local community level	×	–



ORGANISATION	ROLE / INTEREST IN THE PROJECT	INTERVIEW	NOTES
Orkney Renewable Energy Forum	OREF has been an integral part of the development of a diverse and successful Renewable energy industry in Orkney. As a membership organisation, OREF is open to businesses and individuals with an involvement or interest in Orkney's Renewable energy sector. Can advise on strategy / policy (social benefits).	✓	Face to face interview
Northwards Limited	Road haulier, transporting hydrogen to and from the ferry	×	Unable to schedule a suitable time for interview in the time available
Eday Harbour Master	Responsible for operation of Eday pier – can provide an indication of any implications on the operations of the harbour	×	–
Kirkwall Harbour Master	Responsible for operation of Kirkwall harbour – can provide an indication of any implications on the operations of the harbour and hydrogen end users	×	–

Interviews were conducted by Orkney based, Xodus Specialist, Liz Foubister. Interviews were held with six of the 14 identified interviewee organisations (42% success rate) which allowed a range of views on the wellbeing issues associated with the project to be collated. All but 2 interviews were face to face and in some instances more than one organisation participated in a single interview. It is recognised that most of those interviewed were project partners which, it is appreciated has potential for a particular perspective to be reflected in responses.

While Eday Community Council were the only group that directly represented the community in the interviews carried out, the other groups interviewed all involved people who live and work locally and as such were able to indirectly represent a community view. As a result, the findings of the survey can be taken to be indicative of local sentiment, although it is recognised that interviews with more groups that directly represent the community would have provided a fuller understanding of impacts on community wellbeing.

Topics covered in the questionnaire were:

- › The importance of wellbeing;
- › Positive influences on wellbeing from the Surf 'n' Turf and other relevant projects;
- › Negative influences on wellbeing from the Surf 'n' Turf and other relevant projects;
- › Communication of the Surf 'n' Turf project to the local community; and
- › Consideration of wellbeing in / by policy and funding bodies.



WELLBEING SURVEY RESULTS

6

6.1 The Importance of Wellbeing

Responses to the questionnaire indicated, that although some aspects of wellbeing might be considered slightly less or more important than others, overall, all aspects of wellbeing are considered to be important.

The questionnaire was modified slightly after the first two interviews to focus on the identification of those aspects of wellbeing that projects like Surf 'n' Turf influence. Responses received clearly indicated that marine energy systems projects cannot be expected to influence all aspects of wellbeing. Common aspects that can be influenced by marine energy systems projects identified by interviewees are summarised below.

Aspects of marine energy systems that can impact on wellbeing:

- › Sense of pride
- › Sense of purpose / social feeling of worth
- › Resilience
- › Confidence
- › Community empowerment, feel they can contribute to decisions
- › Quality of relationships (strong and positive) between people from different backgrounds
- › Opportunity – people from different backgrounds having similar life opportunities
- › Job quality
- › Skills development and training opportunities
- › Mobility and transportation – hugely important for rural / island communities

- › Value of local knowledge, skills and capacity
- › Balanced demographics structure – difficult to influence, have to work with what you have
- › Sustainable energy future
- › Fuel poverty

Another common issue raised during the interviews was the fact that in small / remote communities, individual personalities and historic relationships can have a significant influence on wellbeing issues, including on those issues considered to be a priority in / by these communities. As members of the community change over time, so can wellbeing priorities.

It was also identified that wellbeing issues may need to be considered on multiple levels when a project has the potential to impact different aspects of a community. For example, with SnT, both the Eday community and the Kirkwall community will be affected. It cannot be assumed that the wellbeing issues of both communities are the same.

6.2 Positive Influences on Wellbeing

The SnT project is considered to have had a positive influence on various aspects of wellbeing.

There is an overwhelming acknowledgement that Eday (and the wider Orkney) community is proud to be part of such a world first and ground-breaking project. The project contributes to the vision and purpose of these communities and the fact that the local community (in the form of Eday Renewable Energy) is a partner in the project instils community ownership and responsibility.

The project provides a pathway to decarbonisation and together with other projects including 'Big Hit' and the Fall of Warness tidal test site, provision of hydrogen power to the inter-island ferries while berthed and a pathway to future hydrogen powered ferries, contributes to the identification of Orkney as a hydrogen hub. This and other energy / hydrogen related projects have showcased the ability of the Orkney and its outer island communities to contribute to high tech decarbonisation and research projects.

Wellbeing was recognised as one of the key drivers for the Surf 'n' Turf project in order to provide an alternative export market for the curtailed electricity production from

the island's community wind turbine (and associated lack of revenue) and the EMEC tidal test site. In this aspect, the Surf 'n' Turf project has contributed to building resilience and risk mitigation on the island of Eday.

The project has required different communities, groups and organisations (Eday Renewable Energy, Community Energy Scotland, EMEC, Orkney Ferries and the local road haulier, amongst others) to work constructively together. The constructive working relationships established between these organisations has been a particularly successful aspect of the project and demonstrates the ability for these types of multi partner and diverse supply chain projects to be true working partnerships.

One area where the project has had a positive influence on wellbeing is in skills development and training. Personnel involved in the funding application and pre-development work for the project learnt new skills that they didn't previously have. These will be an advantage in the future to help secure similar future projects.

The Surf 'n' Turf project in particular has contributed to the provision of jobs / work and training in:

- › Maintenance;
- › Gas engineering;
- › Hydrogen transportation (onshore and ferries); and
- › Emergency and response.

The project has also provided the stimulus to develop hydrogen related training locally in Orkney to train the local workforce. Hydrogen related projects are also considered to have contributed to the retention of working population and graduates in Orkney.

The creation of high-skilled and good quality jobs and job opportunities in Orkney is to be expected to have a positive effect on local wellbeing. Higher wages help employees to achieve better comfort levels and have also been associated with better health outcomes. This can be, for example, because the increase in expendable income facilitates healthier lifestyle choices e.g. gym memberships, higher quality food, or – particularly on Orkney – equipment for engaging in outdoor pursuits. Higher skilled jobs are also associated with a greater sense of job satisfaction and fulfilment, which are both linked to reported happiness levels. Furthermore, the creation of job opportunities can also have a positive impact on local wellbeing as

it minimises the extent to which people born in these communities feel they must leave to find fulfilling work. The provision of new high-quality jobs allows workers to remain in the communities in which they grew up, helping to foster a greater sense of community and enhancing familial ties, both of which have been shown to increase senses of happiness.

The project has inspired cultural research in the form of 'The Newton Machine' (see inset below).

Other less apparent benefits and by-products that the Surf 'n' Turf and related projects have enabled (but weren't part of the original aims of the project), include:

- › Shapinsay school insulation and hydrogen heating;
- › Business tourism on the island of Eday;
- › Eday heritage centre upgrade; and
- › Annual fieldtrip to the island of Eday by Edinburgh University Masters students.

Other potential positive wellbeing issues that could be realised in the future if marine energy systems project became more widespread include:

- › Increased transportation and mobility – if a critical mass of projects can increase transportation and mobility this is seen as a huge positive in rural and island communities; and
- › New settlement in rural / island communities in the longer term.

Surf 'n' Turf inspired a cultural research and innovation project based on Eday – Diary of the installation of the Newton Machine on the island of Eday (Scotland), a project that challenges the energy culture through citizen participation.

<https://sand14.com/the-newton-machine/>
<http://lab.cccb.org/en/making-energy-futures-at-the-island-edge/>

The project won the International Cultural Innovation Prize 2017 and was the subject of an exhibition in Barcelona





6.3 Negative Influences on Wellbeing

The questionnaire responses highlighted a mixture of views on the more negative aspects of wellbeing.

One observation was that overall the Surf 'n' Turf project hasn't considered how it may affect wellbeing of the island community, but on the other hand Community Energy Scotland highlighted that addressing wellbeing issues was one of the central aims of the project. That said, the Surf 'n' Turf project hasn't been operating reliably and therefore financial contributions to the local community have not been fully realised. Projects such as Surf 'n' Turf need reliable operation for wellbeing benefits to be fully realised and sustained. The projects' technical challenges have also led to reduced confidence in the project and future progression of the technology.

The potential to use hydrogen on the island of Eday (rather than it be shipped to Kirkwall on the Orkney mainland) is perceived to be a missed opportunity.

Some interviewees were of the opinion that some of the positive aspects of wellbeing have been diluted due to spin-off opportunities not having enough local content, both in an Eday and Orkney wider perspective. A related issue is the need for longer term added value for those communities which host demonstration and / or prototype projects. This will allow for longer term wider project roll out, capacity building and the maintenance of positive wellbeing.

Other perceived negative impacts on wellbeing were:

- › Some areas of the community felt they hadn't been adequately included in the project, and some were unaware of how the project might be of benefit to them.
- › Some members of the community felt that they lost a sense of ownership of projects that were primarily led by people who had moved to Orkney from elsewhere, with a risk of resentment developing. However, these respondents agreed that a risk of resentment shouldn't detract from exploring the opportunity for these types of projects.
- › Need to recognise that there is the potential for negative impacts on wellbeing from projects of this nature but which through constructive and sensitive management can be successfully mitigated that need to be absorbed / managed in order to reap longer term benefits.

- › Negative views have the potential to derail a project, and it's important to positively engage with stakeholders to avoid projects being undermined.
- › The health of individual project objectors can be negatively impacted due to stress.

6.4 Communication of the Project

Interviewees were asked to identify how information about the Surf 'n' Turf project has been / is communicated to all members of the community and comment on the effectiveness of how information is disseminated.

Official communication on the project has been co-ordinated centrally through Community Energy Scotland. Below is a summary of the communication mechanisms that interviewees were aware of.

Communication of the Surf 'n' Turf project

- › Community consultation events, including community engagement evenings on hydrogen safety
- › Informative project website <http://www.surfnurf.org.uk/>
- › Official opening ceremony for the project involving local and national stakeholders
- › Communication of project details at project start up via local radio and the press
- › Monthly posters & leaflets on the ferries (in the early days of the project)
- › Inclusion of relevant details in the 'Eday newsletter'
- › Public access to the project sites inc. information board at fuel cell site in Kirkwall harbour
- › OIC Hydrogen officer engagement with the local schools, including the north Isles
- › Eday Renewable Energy (ERE) issues a monthly bulletin to Eday Development Trust (their parent company) which includes an update on the Surf 'n' Turf project, as well as wider energy related issues
- › Project updates at the Eday renewable Energy AGMs
- › Inclusion of hydrogen related activities in the Orkney annual Science Festival family day.



Due to the project having a number of challenges and not currently operating as initially intended, it has been difficult to maintain communication on the project, for example:

- › Monthly posters & leaflets are not currently being provided on the ferries;
- › The project website hasn't been updated since October 2017, however given the project has been on stand-by as the electrolyser is away for maintenance there has been a diminished requirement for regular communication; and
- › There is currently a lack of knowledge in the wider Eday community (beyond those directly involved in the project) on the status of the project and any forward plans.

There has been considerable effort made to communicate the Surf 'n' Turf project, however a number of interviewees identified that for personnel not directly involved in the project it's easy to forget about the project and reminders and updates are helpful to maintain local interest / knowledge, ownership and support. One potential mechanism for this would be the development of an 'Orkney Energy Trail' to showcase the myriad renewable energy projects happening on the islands.

Other issues that have influenced the effectiveness of the communication of the project were identified as:

- › Where there are multiple project partners there are challenges around maintaining a consistent story (even if core communication is through a central organisation);
- › There was a lack of understanding in the local community of EMEC's role in the project;
- › It's important to ensure projects make use of local knowledge in a constructive way that communities are engaged with positively and that efforts are made to genuinely understand and address community concerns; and
- › Each project needs to consider the most effective mechanisms of communication in order to identify how best to engage with and 'tease out' involvement / views from the local communities. The Surf 'n' Turf consultation events on the island of Eday were attended by a core 10-15 people, which out of community of 130 represents ~10%.
- › Overall, there has been considerable effort put into the communication aspects of the project, and effective communication of these types of projects in rural / remote communities is considered key. However, the effort required in order to ensure effective communication shouldn't be underestimated. Ensuring effective

communication that is undertaken by the best placed individuals and in the most relevant and effective manner is an important aspect of project success.

Regular communication of the project status, even when there is minimal activity on which to update, was identified as one means of mitigating negative impacts on wellbeing. Frustration at a lack of progress and the corollary negative impacts on wellbeing can be reduced to a certain extent once people are aware of the reasons behind the lack of progress and the actions being taken to overcome these.

6.5 Consideration of Wellbeing In / By Policy and Funding Bodies

To date wellbeing has generally been considered incidentally and/or used to justify a project. It's a 'nice to have' rather than being a core aspect from project outset.

There needs to be a systematic process for the consideration of wellbeing, that ensures its consideration from project outset. Engaging with the local community early in the project to communicate project ideas and establish possible community benefits from the proposed project.

Interviewees considered that policy (local & national) has the potential to influence wellbeing issues associated with energy systems projects, but to date hasn't addressed wellbeing in any real detail. It was also considered that wellbeing should be a formal part of the project planning / consenting process to ensure appropriate consideration (in the same way as impacts on local / native communities are considered in onshore energy projects in other countries).

With regards to funding sources, EU funding objectives currently include a focus on social and carbon saving issues; but this isn't reflected to the same degree at a UK / Regional / Local funding level.

Funding sources / schedules need to match project timelines. There have been instances to date where projects have had to be implemented in timelines that put huge pressure on both project developers and project administrators / funding bodies, for example payments from the Fossil Fuel levy had a 12-month deadline which was particularly challenging. Such pressure can mean potential positive wellbeing issues are not fully realised.



Projects need to include community organisations with a formal structure e.g. a local development trust / company. Such organisations not only provide a commercial and technical structure for community representation in a project, but also provide the ability for local communities to maximise positive wellbeing. In the SnT project, Community Energy Scotland has played such a role in partnership with the Eday Development Trust. They provide a point of contact for stakeholders within the community as well as a medium for better engagement by developers.

6.6 Discussion

This case study has demonstrated the viability and desirability of direct engagement with the local community to define wellbeing impacts of the project.

The in-person engagement enabled stakeholders to identify and explore their own perceived wellbeing needs, and to clearly identify their own priorities in these terms. It ensured that community and stakeholder voices could be heard in an equitable and inclusive manner. The interviews as part of this study support the identification of opportunities to maximise mutual benefits from projects, and hence provides a springboard to appropriate local community development and sustainable asset management.

The greater understanding of the social context through the investigation of wellbeing metrics is key to future discussions in the community around aspirations and associated project outcomes and objectives. This holds true not only for the SnT project, but for any other energy systems projects being developed where communities will

be affected. The incorporation of wellbeing metrics is critical for communities in their discussions with renewable energy businesses and will guide and enhance the alignment of project objectives with those of the community. As a result, investment can be understood in both economic and social terms, which together are fundamental to ensuring a legacy of sustainable development at the local and regional scale.

Moving forward, it is recommended that Crown Estate Scotland consider the development of a process / procedure that can be implemented from the outset of marine energy systems (or any) projects in remote rural / island communities to understand the wider social impacts of the projects, with wellbeing being one metric by which this can be measured.

A defined process will ensure that each project considers how best to engage with local and wider communities' relevant to the specific project, and from project outset. Engaging with the local community at the project outset will give it the opportunity to understand project aims and objectives and set out community expectations as part of project planning. A defined process will also enable specification through the use of sufficiently experienced individuals who are trusted by the communities.

Wellbeing issues will be unique to each project and differ between project locations, but the establishment of a common engagement process which is fit-for-purpose and replicable across different project scenarios and locations will ensure wellbeing is considered, as appropriate, for each project. Measuring wellbeing is a useful metric as part of an overall process considering a project's social impacts and understanding how best to implement engagement and community benefit or ownership offerings.



CONCLUSIONS

7

The Surf 'n' Turf project is an energy systems project located in Orkney. It allows a community wind turbine and tidal turbines at the EMEC test centre (both on Eday) to generate electricity when they are curtailed due to grid constraints by powering an electrolyser to generate hydrogen.

This hydrogen is then transported to Kirkwall where it is used to power fuel cells to generate electricity that is then sold to OIC for use in the harbour and on berthed ferries. This report provides an assessment of what the impact of this project has been and is likely to be on Orkney. The local impact was assessed quantitatively via an LM3 model which measured the economic value to the local community of income to the SnT project. This was then complimented with a qualitative wellbeing survey, which looked to capture further impacts on local wellbeing that have been perceived to occur. The key points of both the quantitative and qualitative analysis are summarised as follows:

1. The SnT project achieved an LM3 score of 2.41. This is a robust score showing that a significant proportion of the revenue brought into Orkney by the Surf 'n' Turf project remains in the local economy and generates additional value for the community. There are a number of reasons why we might expect this to be the case and which must be taken into consideration when deciding where to locate other energy systems projects hoping to achieve similar results.

2. The fact that Orkney is an island community with a significant population greatly increases the likelihood of money remaining within its local economy. Approximately

22,000 people live in Orkney and 75% live on the island Mainland. As a result, towns on Mainland such as Kirkwall – where the majority of SnT staff reside – and Stromness are large enough to provide sufficient demand to support many local businesses. Kirkwall has numerous restaurants, supermarkets, shops, cinemas, leisure facilities, and other businesses that have developed to meet the needs of the local population.

3. For other energy systems projects to achieve a similarly high LM3 score, they will first need to minimise economic leakage from their local economy. Hiring local residents and purchasing materials from local suppliers and businesses is one step that an energy systems project can take, as is working with the local community to ensure that residents are able to meet retail needs within the community boundary. This is particularly challenging for communities that are either too small to host sufficient businesses to meet the majority of their needs (e.g. supermarkets, clothing stores, entertainment) or for communities where it is easy for residents to travel to other locations that offer more choice or lower prices. Introducing energy systems into economies that are already robust will result in greater local benefit than placing them in areas with limited opportunities for local monetary flows.

4. Xodus has assumed that all income to the Surf 'n' Turf project will be reinvested into the project. This is not unreasonable given that the project is being led by a non-profit organisation and is pre-commercial. This, coupled with the strong local economy discussed above, explains why the values for Rounds 1, 2, and 3 are of a similar magnitude – a requirement for a high LM3 score. Lower LM3 scores are generally the result of higher differences between Round 1 and Round 2 values. Further projects should be developed with the same community ethos in mind to ensure similar levels of multiplier effect.

5. If a project is locally owned, as Surf 'n' Turf is, then its income is more likely to remain in the local economy. If a project is commercial and privately owned by a non-local developer then large portions of the income can be expected to leave the local boundary e.g. as shareholder dividends, non-local staff salaries etc.

6. Finally, it is worth noting that while the LM3 Model indicates that SnT has the potential to provide significant value to Orkney, it does not accurately capture wider



benefits that are already emerging but that are out with their purview. For example, Orkney has become a centre of European hydrogen innovation. Numerous jobs have been created as a direct result of the innovation taking place on the islands, from more hydrogen specialists at EMEC to the UK's first dedicated Hydrogen Officer at Orkney Islands Council. This value is not captured in the LM3 model but was highlighted through our qualitative assessment.

7.1 Wellbeing

There is an overwhelming acknowledgement that Eday (and the wider Orkney) community is proud to be part of such a world first and ground-breaking project.

The project contributes to the vision and purpose of these communities and the fact that the local community (in the form of Eday Renewable Energy) is a partner in the project instils community ownership and responsibility.

The project provides a pathway to decarbonisation and together with other projects including 'Big Hit', provision of hydrogen power to the inter-island ferries while berthed and a pathway to fuelling future hydrogen powered ferries, contributes to the identification of Orkney as a hydrogen hub. This and other energy / hydrogen related projects have showcased the ability of the Orkney and its outer island communities to contribute to high tech decarbonisation and research projects.

Some negative aspects were identified relating to the effect of the project and it is important to engage with local communities constructively to address concerns.

Talking in person to community stakeholders can help them to identify and explore their own wellbeing needs and is an

effective way of enabling them to clearly identify their own priorities in wellbeing terms. It is important to ensure that the voices of all sectors of the community can be heard. This can in turn, enhance the partnership between communities and the project developer. A better working relationship is crucial for identifying mutual opportunities that will allow both the developer and the community to gain maximum benefits, as well as for ensuring that local community development occurs in a sustainable manner.

The project has also provided the stimulus to develop hydrogen related training locally in Orkney to train the local workforce. Hydrogen related projects are also considered to have contributed to the retention of working population and graduates in Orkney.

Other potential positive wellbeing issues that could be realised in the future if marine energy systems project became more widespread include:

- Increased transportation and mobility – if a critical mass of projects can increase transportation and mobility this is seen as a huge positive in rural and island communities; and
- New settlement in rural / island communities in the longer term.

When considering the replicability of this project it is important to consider that, like Orkney, many remote island communities have constrained grid connections and potential space and resource to develop onshore wind projects. It is likely that any energy systems project with the capability to reduce or relieve this grid constraint would, initially at least, be powered by an onshore turbine as these are much lower cost and lower risk to develop. However, this does not limit the overall findings that an energy systems project powered by offshore wind or tidal energy has significant capacity to multiply its local economic impact.



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APPENDIX A ELECTROLYSERS AND FUEL CELLS

A.1 An Overview of Electrolysis and Electrolysers

Electrolysis is the process whereby compounds are broken down into their constituent elements by passing an electric current through them. For example, water (H_2O) is broken down into hydrogen (H_2) and oxygen (O). This reaction takes place in a unit known as an electrolyser. While electrolyzers can vary in size and capacity, all contain the same three basic parts:

- › An anode, which is a positively charged electrode
- › A cathode, which is a negatively charged electrode
- › An electrolyte, which separates the cathode and anode

The Surf 'n' Turf project uses a 500kW Proton Exchange Membrane (PEM) electrolyser. This means that the electrolyte that separates the anode and cathode is a solid, specialty plastic material.

This works as following and is illustrated in Figure A.1 below:

1. A power supply is connected to an anode and cathode which are placed into water either side of a Proton Exchange Membrane.
2. The water reacts at the anode in the presence of a catalyst (most commonly Platinum) to form oxygen (O_2) and positively charged hydrogen ions (H^+).
3. These positive hydrogen ions flow through the membrane to the negatively charged cathode.
4. Here, the positive hydrogen ions combine with electrons (e^-) from the power supply to form hydrogen gas.

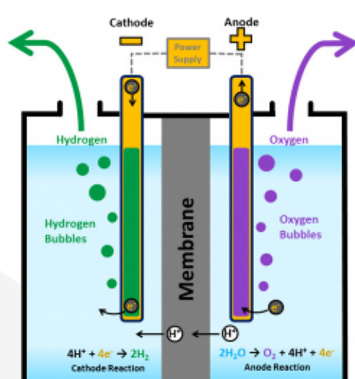
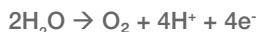


Figure A.1 – Illustration of the inner workings of a PEM electrolyser

Source: <https://www.energy.gov/eere/fuelcells/hydrogen-production-electrolysis>

In this way, water is broken down to produce oxygen and hydrogen gas. The hydrogen gas is then collected and pressurised for transport, where it is fed into a fuel cell at Kirkwall harbour and used to generate electricity.

A.2 Fuel Cells

Fuel cells can be thought of as inverse electrolyzers and operate in much the same way. Rather than water going in and hydrogen and oxygen coming out, the process is reversed, and hydrogen and oxygen chemically react to produce water and electricity.

Like an electrolyser, a fuel cell contains three components:

- › An anode – the positively charged electrode
- › A cathode – the negatively charged electrode
- › An electrolyte membrane

Figure A.2 illustrates how a fuel cell functions:

1. Hydrogen is passed through the anode where the hydrogen molecules are broken down into electrons and positive hydrogen ions (aka protons).
2. The electrons are forced through a circuit, thereby generating an electric current (as well as heat).
3. The protons are attracted to the negative cathode and so pass through the electrolyte membrane. Here they react with oxygen (which is passed through the cathode) to produce water as a by-product.

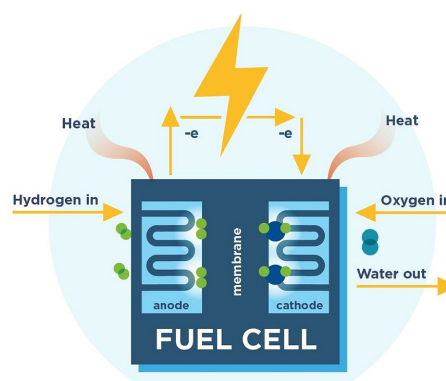


Figure A.2 – Illustration of the inner workings of a fuel cell

Source: <http://www.fchea.org/fuelcells>

NB: The electrons required to complete this come from those returning to complete the electric circuit.



APPENDIX B QUESTIONNAIRE FOR WELLBEING SURVEY

Please consider your answers in relation to the Surf 'n' Turf project. You might compare this with experience with other energy projects you've had experience with, but please let us know when/if this is the case:

(i) What factors do you think are important for (community) wellbeing in your local community? Rank each on a scale of 1 to 5, 5 being very important, 1 being not important at all.

Allow for all responses. Additional prompts / tick list as appropriate:

- › Shared future vision and sense of belonging / sense of place
- › Quality of (strong and positive) relationships between people from different backgrounds
- › Access to and use of the internet
- › People who feel they can influence decisions in their locality – and how information is communicated
- › Independent participation (includes having something to do during the main part of the day that is useful and productive, leisure activities, knowing the community and its rules)
- › Opportunity – people from different backgrounds having similar life opportunities
- › The way you feel about your own lives, personal wellbeing and resilience, as well as other attributes such as income or health
- › Sense of personal safety
- › Sense of vulnerability, crime, unemployment
- › Personal health and social support
- › Sense of financial security
- › Sense of housing security
- › Job quality (to be defined by the interviewee... may include issues of pay, access for young people, career progression, benefit to community etc.)
- › Training opportunities and availability
- › Quality of local area and environment, access to shared spaces, collective activities
- › Family and relationships

- › Value of local knowledge skills and capacity
- › Education
- › Mobility and transportation
- › Sense of purpose (a community knowing what its role is)
- › Balanced demographic structure (important for sustainability)
- › Sustainable energy future
- › Change management / adaptability in a community (ability to manage change locally, rather than being influenced nationally)

(ii) Do you feel that the project has or might (for example if it were to grow to a full rather than a demonstration project) affect the wellbeing of your community? Why?

(iii) Can you think of any specific examples where wellbeing has or might have been affected positively, by the Surf 'n' Turf project (in which case, please specify) – and to what extent is this important to you or to the people or community affected? Rank each on a scale of 1 to 5, 5 being very important, 1 being not important at all.

(iv) Can you think of any specific examples where wellbeing has or might have been affected negatively, by the Surf 'n' Turf project – and to what extent is this important to the people or community affected? Rank each on a scale of 1 to 5, 5 being very important, 1 being not important at all.

(v) Are you aware of / can you describe how information about this (and related) projects is communicated to all members of the community? Are there strengths / weaknesses in these mechanisms?

(vi) What do you see as the level of support for this type of project, both in terms of personal wellbeing as we've discussed above, but also in terms of the levels of awareness of formal support for community energy at Local Authority level (e.g. including information on support services, different business models and ownership structures, finance opportunities and grid and land access issues)?