Local Energy Challenge Fund Case Studies: Using Electricity Locally

Background and Overview

This module provides an overview of four examples of innovative electricity projects funded under the Scottish Government's Local Energy Challenge Fund (LECF), and the opportunities and lessons learnt for future projects.

Local energy projects are increasingly considering using new and innovative ways to address energy issues. There are two main drivers for undertaking these innovative electricity use projects:

- To supply energy that is generated locally to supply local consumers. This might offer consumers lower cost energy, with a higher income for the community energy project than selling at wholesale energy prices.
- Necessity, where constraints, or costs, of connecting to and using electricity networks may be a problem. To address these problems may require use of technologies that have not yet entered mainstream use by the electricity industry.

These, and other, motivations are leading developers of local energy schemes to implement a range of innovative ideas, often bringing together a number of technologies for the first time.

The participants in these projects often include stakeholders beyond a community energy generation project, for example: energy consumers, other local generators, electricity network operators, meter operators and energy suppliers.

This module is organised into the following sections:

1. **Context:** An overview of the drivers that have led to these innovative projects, the different situations where they would be relevant and a summary of the lessons learnt. This will help communities understand which, if any, of the innovations might be relevant to the circumstances of their projects.
2. **Four Examples:** Details of the costs, benefits, practical issues and the types of project that the solution could be relevant to.
3. **Conclusions:** A summary of the key features of each of the four examples.
4. **Further Information:** Useful sources of information.

Context

As highlighted in the introduction, the drivers that led to the development of the innovative ideas presented in the four case studies include:

- Supplying electricity that is generated locally to supply local consumers.
- Offering local electricity consumers with lower cost energy.
- Higher income for local renewable electricity generators by selling energy directly to local energy consumers.
- Reducing the costs of connecting renewable electricity generators to the electricity network.
- Addressing constraints in offers to connect to the electricity network.

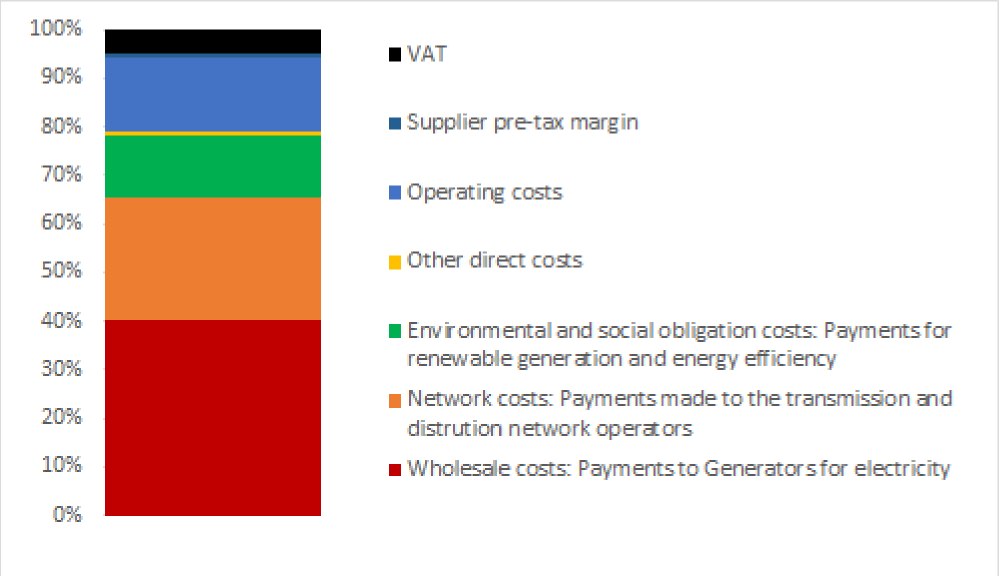
The four case studies were motivated by one or more of these issues; hence they illustrate some of the innovative ideas that could be used by other communities.

As there are a range of additional solutions that are not featured in the four case study examples, the first section of this module provides an introduction to the wider issues and a wider range of solutions.

Electricity Sales

The conventional business model for renewable electricity generators is to sell the electricity produced to a licenced electricity supplier. The legal agreement is known as a Power Purchase Agreement (PPA) and sets the price for each kWh of electricity sold. This payment is in addition to any incentives (e.g. the Feed in Tariff).

The price that a licenced electricity supplier will charge a consumer is made up of the PPA price, plus a range of charges for networks, environmental costs, operating costs, profit and VAT. The contribution of these elements to a typical domestic electricity bill is shown in the bar chart below.



Source: Ofgem

A number of organisations are investigating options for local electricity supply – to see if some of the costs in the bar chart can be avoided and offered to the generator and/or to local electricity consumers. While this is a simple concept, the details are complex.

Electricity supply is normally licenced, i.e. any organisation will need to comply with a set of detailed codes and conditions in order to obtain a licence to supply customers. The licence conditions cover issues such as customer rights, metering and participation in energy efficiency and renewable energy programmes – in total the licence conditions document is over 500 pages long.

As a result the costs of setting up a licenced supplier are significant. Recent market entrants have suggested that around 60,000 domestic customers are needed to make a new licenced supply business breakeven, though 200,000 customers or more is likely to be a level needed for a viable business. So setting this up for individual community renewable energy projects is not practical.

Small scale and local electricity supply is known as unlicensed supply. The unlicensed supply regulations were extended in 2000 to cover sale of electricity from generation, however the rules are complex. In addition, an unlicensed supply business will require a licenced supplier to provide services to support the operation of the unlicensed supplier, e.g. dealing with metering and balancing generation with demand etc. Payment for these services will eat into the potential benefits. As a result there are few examples of this, with very little information on the likely costs.

So two of the case study examples in this module cover examples where the innovative project is working with an existing licenced supplier – as this is the simplest option and does not incur start-up costs. Smart Fintry has arranged a deal with a licenced supplier to buy local electricity and offer a local electricity tariff. Tower Power is investigating the aggregation of demand for several hundred consumers behind a single virtual meter in order to purchase the energy collectively from a licensed supplier.

Grid Constraints

To sell electricity requires a connection to the local grid, normally the distribution network operator (DNO), this is SSE in the North of Scotland or Scottish Power in Central and South Scotland. DNOs are regulated by Ofgem, so the charges they are allowed to make are governed by detailed rules to be fair to all types of electricity system customers.

The costs for connecting a specific renewable energy generator are influenced by a wide range of factors:

- Distance to the nearest suitable connection point on the distribution network.
- The voltage at which the connection is made and the use of overhead lines vs. underground cables.
- The ability of the local distribution network to carry the extra energy without affecting other customers.
- The potential need for reinforcement of the local distribution network.
- The connection offers made to other generation and demand customers.
- The potential for costs to be shared with other network users.

There are few rules of thumb on the likely cost of grid connection – but many renewable energy projects in Scotland are in rural or remote locations, where the distance to the connection point may be significant and the ability of the local network to carry extra power may be limited.

Two common issues for grid connection of renewable energy projects in Scotland are:

- A limit in power export of 50kW until a future reinforcement enables the full capacity of the generator to be exported onto the distribution network. The future increase to full connection capacity may be dependent on a major upgrade which may be 4, 5 or more years in the future.
- A non-firm connection. This allows the distribution network operator to curtail export to the network to manage power flow, voltage levels etc in the network. This allows a project to proceed, but the project carries forward a risk of reduced income.

Both these types of grid connection offer have important impacts for renewable energy generation.

A limit of 50kW for several years will significant reduce income in the early years of the project. For most projects this will halt development – as the project needs to raise debt and equity funding – which requires repayment during the early years of operation. So without a solution this is likely to be a deal breaker. The Mull ACCESS project addresses this situation.

Non-firm connections have enabled projects to be constructed, however there is an on-going risk that the curtailment of export, and hence income, is increased to a point which is not acceptable. The most serious case would be curtailment to levels that made a project unable to repay debt. The Heat Smart Orkney (HSO) project addresses an example where curtailment has increased.

In addition to these two case study examples, there are a number of other potential solutions:

- The grid offer made depends on offers made to other generation and demand customers. If one of these withdraws this may result in a revised offer with better terms. With this is a result of luck rather than a planned solution, so regular contact with the network operator is recommended.
- Build a private wire network – bypassing the existing distribution network. This would entail capital costs (overhead lines, underground cables, transformers etc.) plus paying on-going operating costs (maintenance and debt repayments), purchase of electricity to cover periods when the generator does not match customer demand and persuading sufficient local customers to disconnect from the existing network. There are significant costs and barriers for this route. Costs will be higher in rural and remote areas with few electricity customers and large distances for the private wire network to cover.
- Using Advanced Network Management (ANM). This option uses the simple fact that most renewable generation has a firm grid connection offer, however most of the time the output of the generator is less than the capacity in the grid offer. ANM allows two or more generators to agree a sharing of grid connection capacity – but ANM is a form of non-firm connection and hence includes the risks outlined above.
- Increasing local electricity demand to match the output of the renewable energy generator. This is a concept used in the Mull ACCESS and Heat Smart Orkney examples.

- Energy storage can be used to smooth the variable output of a renewable generator. This might reduce the peak grid connection capacity required. At the moment battery based energy storage systems are economic in specialist applications – as battery prices continue to fall this may become a more commonly used option.

These are not the only solutions available, plus these solutions could be combined.

Lessons learnt from using electricity locally

The examples in the next section illustrate four innovative energy systems that were selected for grant support under the Local Energy Challenge Fund (LECF) and offered grant and loan funding from the Scottish Government. The summaries include a description of the local context, the local energy issues, a summary of the technical aspects of the idea plus the pre-requisites needed for a successful replication of the idea.

The LECF four cases studies on innovative energy systems are:

Project	Summary
Smart Fintry	Working with a licenced electricity supplier to offer a cost attractive local electricity tariff, using demand control to further reduce energy costs for local consumers.
Tower Power	A pilot project, aggregating the metering of domestic electricity consumers to enable collective participation in the energy market – gaining better prices for electricity through collective purchasing, balancing demand against local generation, and demand control.
Mull ACCESS	Addressing grid constraints for new renewable generation by increasing local electricity demand to match the output of a local 400kW hydro scheme.
Heat Smart Orkney (HSO)	Addressing grid constraints for existing renewable generation by increasing local electricity demand to match the output of a local wind turbine.

In each case the projects are still under development, hence the final technical solutions, the costs and the benefits are not yet known.

In each case study there are sections that are intended to help other projects decide if the example is relevant to their circumstances:

- Energy Context – a summary of local energy generation and demand characteristics.
- Motivation – the issues that drove the community to develop the project.
- Pre-requisites – the aspects that would need to be present in a future project.
- The costs – are these fixed or variable and how would they scale for a new project?
- The benefits – are these fixed or variable and how would they scale for a new project?

Smart Fintry

Location

Fintry is located 17 miles south west of Stirling and 14 miles north of Bishopbriggs with a population of approximately 700. It is characterised by a number of traditional stone build properties on the main street, plus a number of newer properties along the main street and in small developments off the main roads. The village includes a small primary school, sports clubs, a pub and café.

Travel time to nearby towns is typically 30 minutes or more (Stirling, Kilsyth, Glasgow etc.). Hence village is somewhat isolated, which means that there is a degree of self-reliance in the community.

Energy Context

The village is off the gas grid, with heating mainly from electricity and some use of oil and LPG. In 2012 a survey found that 20% of Fintry households were in fuel poverty.

There are already a number of energy initiatives in the area; these include energy efficiency projects (insulation) and renewable energy (biomass). The most well-known is the Fintry Renewable Energy Enterprise project, where the community own a share of a local commercial wind farm. As well as providing income to the Fintry Development Trust (FDT), this project means that the community has developed significant expertise in innovative energy projects, plus the community has prior and good experience of participating in FDT projects.

Innovative Energy Solution: Smart Fintry

The focus is to provide local electricity supply. This will combine local renewable electricity generation and real time management of local electricity demand, to offer a 100% renewable electricity tariff at prices that are lower than standard market prices.

The project partners are:

- Fintry Development Trust (FDT) - The project leaders and bringing a track record in local renewable generation and energy efficiency for Fintry.
- Veitch Cooper - The main technical advisors on electricity issues.
- Good Energy - The licenced electricity supplier.
- Energy Assets - The meter system provider.
- Heriot Watt University – Providing software to model the energy system.

The motivation for the SMART Fintry project stems from several local needs:

- To reduce the cost of energy for households in the village.
- To switch from fossil fuels for heating to renewable energy.
- Replace traditional electricity heating systems that do not provide affordable and controllable heating.
- The opportunity to use electricity produced by local renewable energy generators.

The pre-requisites for the Smart Fintry solution include:

- An electricity supplier who is willing to work with a community to develop and offer a local electricity tariff that is more competitive than the market offers.
- A team of project partners with expertise in electricity regulation, electricity metering and data systems, demand side management and electricity supply who are able to develop a new metering, communications and billing system to support the allocation of electricity costs to each household.
- Sufficient consumers signed up to make the Fintry Local Tariff worthwhile, which is aided by FDT's past work with the community on energy issues.
- Local generators who are willing and able to switch their Power Purchase Agreements to the new electricity supplier.

To achieve this there are several elements to the Smart Fintry project:

- Negotiation of the Fintry Local Tariff with a single licenced electricity supplier (Good Energy).
- Installation of smart meters and communications systems to gather real time electricity consumption data.
- Installation of controls to manage electricity use, for example control of heating systems or energy storage systems.
- Purchase of electricity generated by AD, wind and solar PV systems in the local area.
- Using the electricity data, predictions of demand and generation to optimise energy demand in real time and offer greater savings via the Fintry Local Tariff.

In year 1 the initial version of the Fintry Local Tariff has been launched with 84 signed up customers. This initial version offers a typical saving of £106 per year per household a 20% reduction on Good Energy's standard rates. The metering has been installed and data is starting to be collected for analysis.

The project has faced a number of challenges including:

- Standard domestic Smart meters do not provide live half hour consumption data, so commercial meters have been installed, introducing some regulatory and commercial issues.
- Some Fintry customers are on Economy 10 or Total Heat Total Control tariffs, with much higher electricity prices. Changing the metering and switching of these 14 homes to the Fintry Local Tariff has proved more difficult, this may be possible in year 2.
- The plan included use of Ground Source Heat Pumps as a key element of the control of local demand. Funding and timescale issues mean that this element may be scaled back.

The next steps for the Smart Fintry project include the key technical aspects, including:

- Adding new options to provide a greater degree of control over electricity load. This might be a form of energy storage or perhaps electric vehicles or heat pumps.
- Further development and implementation of the monitoring, prediction and energy demand control elements of the project, further reducing electricity use and electricity costs.
- Increasing the number of customers on the Fintry Local Tariff.

Costs & Benefits

Smart Fintry was awarded a grant of £840k toward totals costs of £ £2,075,929.

The main cost elements and how they might differ for a future project are listed below:

Main project elements	Potential for cost reduction
Research and innovation	This is a new concept that includes work to understand and address the regulatory barriers. Should be lower in future.
Installation of Meters	Commercial meters are being used, as domestic smart meters do not yet have the functionality needed. A future project might be able to use lower cost meters.
Installation of data communications	Use of Zigbee switch and modem systems. These will be more expensive in sparsely populated areas and lower cost in densely populated areas – as signal strength is an important factor.
Sign up for Fintry Local Tariff	This included local marketing and holding sign up events. Response has been high. Fintry is a small community and FDT has an excellent local track record. Other projects might need to use more effort on this element.
Demand reduction	This may include energy storage or heat pumps – the details are not finalised. So it is too early to identify any potential cost reduction.
Control of demand	This will need testing and on-going review.
Project management, consultancy, legal and marketing	These will be much lower in future projects, as Smart Fintry is a first of a kind.

As the Smart Fintry project is still in its first year, the system is not fully operational, the expected benefits include:

Main benefits	Potential for improvement
Reduced electricity bills for households.	The savings are estimated as £106 per year in year 1, with potential for this to increase in year 2 through increasing numbers of customers and adding local demand control.
100% renewable electricity supply	Cant improve on 100%
Better control of heating,	Better control of heating, e.g. for those on Economy 10 or Total Heat Total Control. If more of these customers can be added the benefit will increase. These customers are on expensive tariffs, so will gain most from the cost savings.
Income for local renewable generation	The PPA offer was higher than the FIT export tariff, so switching was worthwhile. In year 2 the generators may be better matched to local electricity demand – offering better prices.
Ancillary services	The ability to flex generation or flex demand offers the potential for earnings in the ancillary services markets operated by National Grid. This would be an additional income stream.

Conclusions

Smart Fintry has implemented some initial elements that already offer local consumers cost savings. In year 2 the project should add the control elements and offer greater savings to a larger number of customers.

The unique aspects of Smart Fintry include:

- Aggregating domestic customers to gain a price advantage in the electricity market – through development of a unique local tariff with a licenced electricity supplier.
- Installing new metering and communications systems to monitor and then predict and ultimately control local electricity demand.
- Controlling demand to enhance the benefit of the local tariff for customers and to earn new revenue streams from National Grid for the project.

Tower Power

Location

The Tower Power project is seeking to demonstrate an urban project concept which could be replicated in tower blocks and densely-populated areas across Scotland.

Energy Context

The project aims to find an approach and model that will work for properties that have both a mix of ownership and heating types ,. Focused on densely populated urban areas, the project is working on a model that will support low-income areas with high fuel consumption and pre-payment electricity meters. Fuel poverty and quality of life is the key driver for this project concept.

Innovative Energy Solution: Tower Power

Tower Power's objective is to establish a community electricity supply initiative through aggregating the electricity demand of around 500 households behind a single half-hourly meter. By doing so the aim is to secure a lower price for the electricity that is purchased, passing the savings on to customers.

The motivation for the Tower Power project stems from several local needs:

- To address fuel poverty – enabling neighbourhood-level communities to establish local supply projects which secure cheaper energy - and end inequalities for people on pre-payment meters
- To develop a replicable system that could be used in multiple locations.
- To provide a means to harness real economic value from balancing energy use against local renewable generation; strengthening the business case for community energy generation, while combating fuel poverty through reducing domestic electricity costs.
- The need for consumers to have greater control over the energy that they purchase

The pre-requisites for this solution include:

- An electricity supplier who is willing to step outside 'business as usual' customer engagement, and work with the project to enact the metering configuration changes required for local aggregation.
- An engaged and active community organisation willing and able to take a long term role in facilitating local supply.
- Sufficient consumers to attract an electricity supplier to offer a lower electricity price.
- A high number of customers in a small geographic area allowing aggregation.

To achieve this there are several elements to the Tower Power concept:

- Aggregation of the consumption of many domestic consumers behind a single half hour meter. Aggregation offers two potential benefits in the energy market. One is that greater quantities of electricity are bought through a single contract and this means lower prices.

Secondly, where there is local generation within the aggregated supply point, significant benefits can be gained through balancing generation against local demand.

- Developing a metering, communications and pre-payment system to support the allocation of electricity costs to each household. This requires installation of a communications system, to collect electricity use data for each flat.
- Flats in high rise blocks are often electrically heated, with high costs. As well as the electricity supply benefits, these properties may benefit from use of modern storage heating. This will reduce electricity consumption for heating and should also smooth the profile of electricity demand. They also allow the opportunity for demand side response services which can further reduce energy costs for consumers.
- Energy efficiency advice to residents, further reducing electricity bills.

The proposed aggregation element of the Tower Power project uses a little known feature of the electricity market known as complex site metering arrangements. This was set up to cover sites such as airports, where there could be several separate businesses, with different electricity suppliers, operating at the same location. A project by City West Homes in London proved that establishment of a complex site could be applied to domestic electricity consumers.

The use of electricity metering arrangements which are a relatively obscure part of the electricity market codes means that many of the players are not familiar with how this should be applied. Examples of complexities that have been encountered include:

- It appears that each property may need to have two separate electricity meter IDs (MPAN's)–to provide visibility of individual households to the distribution network operator
- Some homes on unusual types of tariff (e.g. Comfort Plus) have metering systems which new electricity suppliers are unwilling to take on. This penalises these customers by impeding their ability to switch to a lower cost electricity supplier, including Tower Power.

The initial stages of the Tower Power project have focused on:

- Addressing the regulatory issues, a process which is on-going with the network operator Scottish Power Energy Networks, Elexon, and Ofgem; particularly in finalising the metering solution.
- Recruitment of participating households through local communication and home visits to recruit participants and to provide advice on energy efficiency.
- Finding a licensed electricity supplier able to engage on the project and perform the necessary metering configuration changes.

The project has faced a number of challenges including:

- The withdrawal of the electricity supplier who was an original partner in the project.
- The discovery that system compatibility issues may require two electricity meter ID's (MPAN;s) in each flat.
- Delays and changes of scope in the smart meter roll-out impacting the availability of meters able to provide a pre-payment function and settle on a half hourly basis

The next steps for the Tower Power project include the key technical aspects, including:

- Resolving the metering issues.
- Working with the supply partner to prepare their systems for the new metering configuration
- Developing the proposals for suitable communications and pre-payment systems.
- Recruiting participants for a small 'proof of concept' trial

Costs & Benefits

Tower Power was awarded a grant of £865k with total costs of £2,075,929. The main cost elements and how they might differ for a future project are listed below:

Main project elements	Potential for cost reduction
Development of Tower Power project	This includes the development and testing of the technical solutions. This is a fixed cost, but future installations should benefit from the lessons learnt by Tower Power.
Recruitment of households	This includes developing the proposition and marketing materials, and a sustained door knocking programme and community events. This cost would scale with the number of households needed – as door knocking is a key part of the sign up strategy.
Metering	With development and roll out of more sophisticated domestic Smart meters, future projects should be able to eliminate this cost through using industry standard 'MAP' financing practices.
Communications	Installation of communication systems to collect electricity data needed for each flat. Ultimately, these systems will be incorporated within the standard metering installation.
Operation of system	On-going operation a new community energy services company to manage the contract with the energy supplier and be responsible for signing up/maintaining Tower Power members.
Solar PV system	The costs of solar PV systems are continuing to fall.
Installation of new storage heating systems	This element will help to reduce consumption and increase control of electricity use and so would help reduce bills. However, a future project could proceed without this element.
Project management, consultancy, legal and marketing	These will be much lower in future projects, as Tower Power is a first of a kind.

Tower Power offers three types of benefit to households who sign up to the project:

- Reduced electricity bills – the exact details are not known yet, a level of 10% to 20% is hoped for.
- Reduced electricity consumption and electricity costs through energy efficiency advice and installation and control of modern electric storage heating.
- Better comfort levels – for those flats with the new electric storage heating.
- Access to a local organisation to speak to and learn about energy supply

The benefits to the electricity supplier include winning the business of hundreds of customers, building local profile, and gaining PPAs with local generation.

Main benefits	Potential for improvement
Electricity costs for householders.	The details of the savings are not known yet – which would be a barrier to signing up households.
Increased revenue to local generators	This will benefit existing local generation, but will only be able to strengthen the business case for building new community generation when the level of benefit is clearly quantifiable through existing projects and the model is seen as established enough to be accepted by project financers.
Earning income from National Grid's ancillary services markets.	A potential source of additional income could be through using the control of the heating systems to participate in National Grid's frequency response market.

Conclusions

Tower Power is at an early stage in its technical development. Hence the solutions for technical success and the financial details of the costs and benefits are not yet clear.

The unique aspects of the Tower Power project include:

- Aggregating large numbers of domestic customers to gain a price advantage in the electricity market.
- Developing and testing the concepts for metering, communications and billing systems to run this system.
- Addressing complex regulatory issues over metering.
- Learning how to engage with and motivate customers in an urban area to sign up for a local community energy initiative.

Mull ACCESS

Location

Mull is the fourth largest Scottish island with a resident population of 2,800, with a significant amount of tourists increasing this figure during the holiday season. The island is served by three ferry routes, and two electricity connections to the grid on the mainland.

Energy Context

Mull is off the gas grid, with heating mainly from electricity and some use of oil and LPG. The import of oil and LPG as a heating fuel has a high cost and there is a risk of disruption of supplies as these energy sources are dependent on the ferry.

Many homes on Mull are of traditional stone built construction, which are hard to make more energy efficient. The combination of high energy use and use of high cost energy sources means that fuel poverty is an important concern for many residents. Hence developing local renewable energy resources contributes to local reliance, fuel poverty and economic objectives.

Innovative Energy Solution: Mull Access

Like many parts of Scotland, Mull has significant renewable energy opportunities, in particular wind and hydro, but the electricity network has constraints that reduce the capacity that can be connected.

A common case is that renewable electricity generators are offered a grid connection of 50kW in the short term, with a potential increase offered some years in the future. For most projects this is not acceptable, as a full connection and full income is needed from the outset – otherwise the project cannot repay the funding raised to build the project.

The Mull ACCESS project (Assisting Communities to Connect to Electric Sustainable Sources) is developing and testing a solution to this problem. Using the existing 400kW hydro scheme at Garmony on the East side of Mull, the project tests a solution to address this type of network constraint.

The Mull ACCESS project partners are:

- Mull and Iona Community Trust (MICT) – Focused on improving the quality of life for Mull residents.
- Community Energy Scotland (CES) – The lead consultants on the development of the project.
- SSE Energy Supply – The licenced electricity supplier who buys electricity from the hydro scheme and sells to the local consumers.
- SSE Energy Solutions – The innovation team at SSE.
- Element Energy – Specialist consultants on technical and economic aspects.
- VCharge – manufacturers of hardware and software to control electricity loads.

The motivation for the Mull ACCESS project stems from several local needs:

- The opportunity to use electricity produced by local renewable energy generators.
- Replacing traditional electricity heating systems to provide affordable and controllable electric heating systems.
- To switch from fossil fuels for heating to renewable energy.

The pre-requisites which will make this solution relevant for other locations and projects include:

- Having an electricity network pinch point that needs to be addressed – in the case of Mull this is the capacity for renewable electricity to be exported from the island – this occurs when renewable generation on Mull is high and local electricity demand on Mull is low.
- Having a renewable generator or generators willing to take part.
- Having the involvement of SSE, the electricity network operator, who provided expertise and contributed some funding. SSE's motivation is to learn about the use of this solution.
- The culture of co-operation and resilience amongst Mull residents – which brings an appetite for solutions.

In summary the solution increases local electricity demand when the local hydro scheme has generation available above the 50kW level. By matching local generation with local electricity demand this helps to balance the local electricity network.

The main elements of the project include:

- The 400kW hydro generator at Garmony on Mull, owned by Green Energy Mull, but originally conceived and developed by MICT.
- The installation of new electricity heating systems that could be controlled remotely, or using existing heating that was suitable for control. The new electric storage systems are Dimplex Quantum heaters. These were used in homes that have previously had electric storage systems. For homes that had LPG or oil heating electric flow boilers were used. These use an electric element to heat the water that supplies the existing radiators.
- Each electricity heating system has a controller provided by project partner VCharge.
- The installation of the communications systems to control the electric heating and to measure activity at key substations on the electricity system on Mull.
- The development of a new control system and software that co-ordinates the different elements of the system.

Operation of this system includes:

- Controlling the operation of electric heating in the participating homes – increasing and decreasing the amount of electricity used to allow the hydro system to operate without constraint.
- Monitoring the hydro system output and the local electricity network to ensure that the system is operating correctly.

Around 100 homes were recruited on Mull; each was visited to assess the suitability for changing the heating system and adding the communication and control systems. Following this 73 properties were included in the project. The majority are privately owned, with 18 homes owned by West Highland Housing Association.

Each householder was offered £100 at the start of the trial and £150 at the end of the trial for the inconvenience of the installation work. Householders are also offered a rebate payment for extra electricity costs.

At the end of the trial, the heating systems will be left in place, but will be controlled by the householder not by the Mull ACCESS system. Hence there are short term and long term benefits for the participating households.

For future projects an important consideration is to have sufficient homes to match the scale of the generator – in this case there are 73 homes to match a single 400kW generator.

The installation and testing of monitoring systems, and the development and testing of the software, took significant time. The first full test of the system took place over 5 hours at the end of March 2017, almost 2 years since the project started, and a measure of the complexity of the first demonstration of a new technology solution.

Key success factors for the Mull ACCESS project include:

- The interest from several parities in finding a solution to this common problem.
- The collaboration of key parties with the expertise (CES, SSE, Element Energy & VCharge).
- Having expertise in electricity regulation within the team.
- Finding and training up local installation engineers.
- An experienced project team.
- Good community engagement via the Mull and Iona Community Trust.

The lessons learnt included:

- The expectations for the timescales and outcomes need to be managed carefully.
- The commitment needed from participants needs to be clear and agreed.
- The time for testing a new and innovative solution should not be underestimated.
- Having local engineering expertise makes this much quicker – as travel to Mull is a significant factor in terms of timing and cost.
- When combining different technology solutions from different providers there are likely to be issues on the compatibility to transfer data and control operation.
- The regulatory issues can be significant and unexpected. Expert analysis is needed to navigate through these issues and to provide the evidence that addresses regulatory barriers.
- A call centre facility is needed to handle questions from householders.

Costs & Benefits

A grant of £1,865,000 was awarded towards total costs for the Mull ACCESS project of £2,500,000.

The major cost elements include:

Main project elements	Potential for cost reduction in future projects
Recruiting and incentivising households to join the scheme	• The costs of recruitment could be reduced if a housing association with multiple properties joins the project. • The results of the Mull ACCESS projects can be used to provide evidence to help convince households to join. • Some of the cost elements are fixed – producing welcome packs, publicity campaigns etc.
Installation of heating systems	The cost of new electric storage of flow boiler systems is a high cost element of the site. This cost will scale with the number of homes. Options to reduce this cost include: • More homes, so better purchasing power. • Finding homes where the existing heating system is suitable for control. • Using local installers – which may be an issue on smaller islands.
Installation of controllers	The number of VCharge controllers scales with the number of homes and hence scales with the income.
Installation of grid monitoring	The number of monitoring points will depend on the number of generators involved and the topography of the local electricity network.
Development of system	This is a significant cost as this is the first trial of its type. Following the Mull ACCESS project these costs should be significantly lower.
Project management, consultancy, legal and marketing	These will be much lower in future projects, as Mull ACCESS is a first of a kind with significant development elements. For example this needed a full time project manager – which may not be needed for a future project.

Conclusions

For Mull ACCESS the benefits are low – as this was testing the new system with an existing generator which was not suffering from lack of income from constraints.

While there will be potential cost reductions for a future implementation of the Mull ACCESS solution, there is unlikely to be a grant available. So the cost of finance would need to be added to the equipment costs for a new renewable energy generator.

The costs need to be carefully judged against the additional income from removing the constraint. The income available to new renewable energy generators is falling – due to lower Feed in Tariff levels. Hence the potential benefit needs to be assessed for future examples.

As a result the potential benefits vs. costs of a future implementation of the Mull ACCESS solution would need to be considered very carefully.

Heat Smart Orkney

Location

This project is based on three islands in the Orkney archipelago: Rousay, Egilsay & Wyre. These three small islands are off the North of the Orkney mainland, with a total population between them of around 260 people. Each island has a number of farms, which is the main economic activity.

The Rousay Egilsay & Wyre Development Trust (REWDT) was set up in 2006, with the aim to help the three islands to be both vibrant and sustainable.

Energy Context

In energy terms the Orkney Islands have many notable features, aspects that are relevant to this project include:

- The wind energy resource on Orkney is very good, hence there are many wind turbine installations, many of which have very high load factors, i.e. the electricity generated is higher than experienced in turbines located in more sheltered locations.
- The high amounts of wind generation can often exceed electricity demand, hence there is an Active Network Management (ANM) system in operation. This curtails the output of wind turbines so that generation does not exceed the combined total of the island's electricity use and electricity export capacity.
- The ANM system chooses which turbines are switched off. The last generator to accept a grid connection offer is restricted before the first. This list of generators, ordered by their grid connection acceptance, is also referred to as the priority stack.
- The operation of the ANM system takes place in separate zones across Orkney, using separate measurement points to assess the flow of electricity and hence the need for curtailment of generation.

Wider energy issues include that all Orkney Islands are off the gas grid, with heating mainly from oil, plus coal, LPG and electricity.

Many homes will be of traditional stone built construction, which are hard to make more energy efficient. The combination of high energy use and use of high cost energy sources means that fuel poverty affects 63% of homes on Orkney. Hence developing local renewable energy resources contributes to local reliance, fuel poverty and economic objectives.

Innovative Energy Solution: Heat Smart Orkney

In 2011 REWDT commissioned a 900 kW community-owned wind turbine on Kingarly Hill, Sourin, Rousay to produce energy from a local resource for community benefit. It was expected that the ANM scheme would result in curtailment of operation and hence income from the turbine. However in 2012 the level of curtailment was 25%, higher than expected. This meant that the income to repay funding and community benefits was lower than expected. Other community wind projects on Orkney have experienced curtailment of up to 60%.

REDT started a search for solutions to this problem. They applied for a number of grants to conduct investigations into demand side management (i.e. managing the electricity use on the islands) and use of electric vehicles (to increase local electricity consumption). The demand side management trial tested remote control of heating systems in 6 households to increase electricity demand and hence use electricity generated by the wind turbine on Rousay.

Heat Smart Orkney (HSO) implements a full demand side management solution for the 900kW wind turbine on Rousay.

The HSO Partners are:

- REWDT – the local development trust who conceived and developed the 900kW wind turbine project on Rousay. The curtailment of the turbine output was the motivation for the Heat Smart Orkney project.
- Community Energy Scotland (CES) – The lead consultants on the development of the project.
- VCharge – manufacturers of hardware and software to control electricity loads.
- Catalyst – a local electrical engineering company based on the island of Hoy.

The motivation for the HSO project stems from several local needs:

- To reduce the curtailment of the wind turbine on Rousay and hence restore income for the community to expected levels.
- To address fuel poverty by providing low cost supplementary heating using low cost electricity.

The pre-requisites for this solution include:

- Having a constrained output wind turbine – in this case constrained by the ANM system.
- Using grant funding to assess different options to address the constraint problem.
- Using a grant funded pilot to test some of the technical and organisational issues with demand side management.
- Having sufficient numbers of homes where there is space to fit the additional heating systems and where the household will accept the operation of the secondary heating.
- A level of Feed in Tariff payment for generation which is sufficient to invest in the demand side management solution. This means that investment can be made to restore the value of the lost generation.

The system responds to the curtailment of the wind turbine by increasing local electricity demand though controlling new secondary electrical heating systems to local homes. The project will install the secondary heating systems: electric flow boilers, storage heaters and hot water immersion heaters, these will operating in addition to the existing primary heating.

In operation the turbine sends a signal to the HSO control system running on the Cloud. This happens just before the turbine is due to be switched off. This allows the control system to send a "switch on" signal to the secondary heating systems. A VCharge Dynamo unit is connected via the internet to control the secondary heating in each home.

The secondary heating systems add to local electricity demand and should reduce the amount of wind turbine electricity output that is curtailed. This will operate independently of any existing contractual agreement or tariff already in place with the Distribution Network Operator (DNO) Scottish and Southern Energy (SSE).

HSO tackles fuel poverty by providing supplementary heat and hot water with a rebate payment for the running costs of the additional electricity bought to run the heating systems.

The initial stages of the project have focused on:

- Identification of properties that are on the same parts of the electricity network as the wind turbine.
- Recruitment of participating households through local advertising and home visits to confirm suitability for the HSO supplementary heating systems. A number of households have declined to participate or were not suitable for the project.
- Tendering for the installers to fit the supplementary heating.

The next steps for the HSO project include the key technical aspects, including:

- Completing recruitment of households.
- Development of the control system.
- Installation and testing of the systems.

Costs & Benefits

HSO was awarded a grant of £1,282,000lin towards full project costs of £1,615,700. The main cost elements and how they might differ for a future project are listed below:

Main project elements	Potential for cost reduction
Development of HSO project	This includes the development and testing of the technical solutions. This is a fixed cost, but future installations should benefit from the lessons learnt under HSO.
Recruitment of households	This includes developing the proposition and marketing materials, advertising and home visits to ascertain if the homes are suitable. This cost would scale with the number of households needed.
Installation of secondary heating systems	Payment for the flow boilers, storage heaters and hot water systems and their installation. This cost would be similar per household for a future project.
Project management, consultancy, legal and marketing	These will be much lower in future projects, as HSO is a first of a kind.

HSO offers three types of benefit to households who sign up to the project:

- An incentive payment of £50 when signing up to participate in HSO.
- Rebates on the electricity used for supplementary heating.
- A loyalty payment of £100 per household at the end of the trial.

The benefits offered by HSO used insight from the Mull ACCESS project.

The benefits to householders will be taken from the additional Feed in Tariff income earned from the wind turbine.

Main benefits	Potential for improvement
Extra FIT and export tariff income for the 900kW wind turbine	Owned by REWDT, so can be used for repayment of debt, community benefit and for operation of HSO.
Rebate and incentive payments for participating households	Fixed and variable payment to attract households to join and also to tackle fuel poverty. The rebate payment levels have not yet been calculated.
Installation of secondary heating systems	The flow boilers, storage heaters and hot water systems will be left in the homes.

Conclusions

HSO is at a very early stage in its technical development. Hence the key factors for technical success, and the financial details of the costs and benefits are not yet clear.

It shares some common aspects with the Mull ACCESS project, in that it addresses a grid constraint. The unique aspects of the HSO project include:

- The system addresses the curtailment impact of an ANM system. ANM systems are likely to be more common place in future – so this solution may be increasingly important.
- The control system and payments to consumers do not involve the electricity sector players – so this solution is less reliant on these parties.
- The main heating systems remain the same. So there is less risk for householders.

Conclusions

The projects outlined in this document are exploring innovative local electricity projects, driven by multiple motivations and with a range of final outcomes.

Examples of issues that should be considered in the development of future local electricity projects include:

- Are there sufficient numbers of consumers needed to participate in the scheme?
- How can sufficient numbers of local consumers be encouraged or incentivised to participate in the scheme? This may be more difficult and cost more in areas which do not have a track record of past community initiatives.
- Is the extra income that could be gained likely to pay for the extra development costs and capital costs to implement an innovative solution?
- Some of these examples include generators that benefit from earlier, and higher, levels of FIT payment. So the benefits of increasing generation have a higher value. Is the potential additional FIT income lower for your project?
- Does the project have access to the specialist expertise needed to develop an innovative solution?

A number of cross cutting factors needed for success were apparent from the four case studies:

- That a wide range of expertise is needed including technical, regulatory and marketing expertise.
- These different skills need to be combined as an effective team under a capable project manager.
- That difficulties and delays should be expected – as these are innovative solutions.
- Licenced electricity suppliers and DNOs are subject to a complex set of regulations and licence conditions. This has a big impact on what they can do and how they need to operate. This can prevent DNOs sharing data or require specific sets of steps to be followed. This can make their participation appear slow or unresponsive.
- That mobilising interest and sign up of local consumers for a new electricity supply concept requires significant and sustained effort.
- Community buy-in is essential.
- That local electricity consumers will have a wide range of existing metering and tariff arrangements. Any new systems will have to deal with all of the legacy systems, including pre-payment meters and two rate meters (economy 7 and its variants). This can delay and increase the costs of setting up local electricity supply arrangements.

In considering delivery of a similar project, the lessons for consideration are as follows:

- Community buy-in is essential. The community's needs and appetite should be considered at the outset.
    - If engaging with the wider community, a clear product should be available for individuals, with easily understandable benefits and project journey (which can be difficult to achieve if by its nature the project is 'innovative').
- Inter-dependent funding can create issues where timescales are not aligned. Contingency plans should be in place for any funding which may not be secured.

The following table provides a summary of the pre-requisites and expertise needed, which may help you decide of these innovative solutions are relevant to your project:

	SMART Fintry	Tower Power	Mull ACCESS	HSO
Pre-requisites				
An electricity supplier willing to work in partnership	✓	✓		
Constrained generation project			✓	✓
Expertise in:				
Electricity regulation	✓	✓	✓	
Electricity metering	✓	✓	✓	✓
Data systems	✓	✓	✓	✓
Demand side management	✓	✓	✓	✓
Electricity supply	✓	✓	✓	✓
Recruiting householders	✓	✓(in a geographically small area)	✓	✓
Community involvement	✓	✓	✓	✓
Local generators willing to work in partnership	✓		✓	✓
Involvement of the network operator	✓	✓	✓	

Additional Information

Project web sites:

SMART Fintry: http://smartfintry.org.uk/
Tower Power: https://www.towerpower.scot/
Mull ACCESS: http://www.accessproject.org.uk/
HSO: https://www.facebook.com/Heat-Smart-Orkney-1673997559581858/

Further Guidance:

For further information about typical network connections, see the Grid Connection Module.

Reports on different options for local electricity sales:

Local Electricity Supply: Opportunities, archetypes and outcomes Dr Stephen Hall and Dr Katy Roelich March 2015:

https://research.ncl.ac.uk/ibuild/outputs/reports/local_electricity_supply_report_WEB.pdf

Regen SW: Local Supply: Options for Selling Your Energy Locally:

https://www.regensw.co.uk/Handlers/Download.ashx?IDMF=9b4bd983-7ee6-4b65-b45f-25d22c5f277d

Ofgem: Summary of responses to Non Traditional Business Model consultation:

https://www.ofgem.gov.uk/ofgem-publications/96943/non-traditionalbusinessmodels-summaryofresponsestodiscussionpaper-pdf

For information on the electricity licence exemptions see:

https://www.gov.uk/guidance/electricity-licence-exemptions

Other Case studies:

Energy Local: Selling electricity from a small hydro scheme:

http://www.energylocal.co.uk/

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