LESSONS LEARNED FROM LOCAL ENERGY PROJECTS IN SCOTLAND

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ABSTRACT

As a country rich in renewable energy resources (including wind, tidal and hydro), many of which are in remote areas lacking electricity network capacity, Scotland is a country at the forefront of the challenges associated with the future smart grid. This paper disseminates key learnings from local energy projects in Scotland and their contribution to meeting societal objectives of a secure and sustainable electricity system at an affordable cost.

INTRODUCTION

Driven by challenging environmental targets, the transition to a low carbon economy is a major focus of energy policy in the UK. The Scottish Government's first energy strategy sets out a target for the equivalent of 50% of energy for Scotland's heat, transport and electricity consumption to be supplied by renewable resources by 2030 [1]. One of the six priorities identified in the strategy to support the target is in developing innovative local energy systems. Such systems are considered to have the potential to unlock many economic, carbon reduction, and efficiency benefits, empowering and energising local stakeholders to play a significant role in the low carbon transition [2] [3] [4]. Through a coordinated approach, local energy projects and investments would eventually link with national scale developments and infrastructure. This requires consolidation of lessons learned from demonstration projects and from this, selection of the most viable technologies for further roll-out. It is noted that while smaller scale energy projects can provide a good demonstration and understanding of technology, without follow on funding, policy support or evolving investment mechanisms they often remain uneconomical or too location specific for further deployment. So the path is not obvious for local energy.

In parallel, the incumbent energy system is predominately concerned with the least cost generation and transfer of energy from centralised sources to passive consumers. The disruption of this model with the introduction of Local Energy Infrastructure (LEI) presents many challenges to regulation, technical and commercial operation of the system [5].

BACKGROUND

Scotland has seen significant quantities of distributed generation deployed by local, or community, energy projects with support for community energy in Scotland dating back to 2002. The Scottish Government Community Energy Policy Statement (Sept 2015) [6] summarised the progress made in supporting community energy and set out a future policy support in the context of a 2020 target for 500 MW installed capacity of community and locally-owned renewable energy generation. Since 2013, £35 million has been made available through the Community and Renewable Energy Scheme (CARES) to support nearly 600 operational community and locally owned projects.

The energy saving trust publish an annual update on the status of progress against the 500 MW target. The update of June 2016 [7] states: *An estimated minimum of 595 MW of community and locally owned renewable energy capacity resulting from a total of around 15,570 individual renewable energy installations, was operational in Scotland.* The broad ownership categories of this installed capacity is shown in Figure 1.

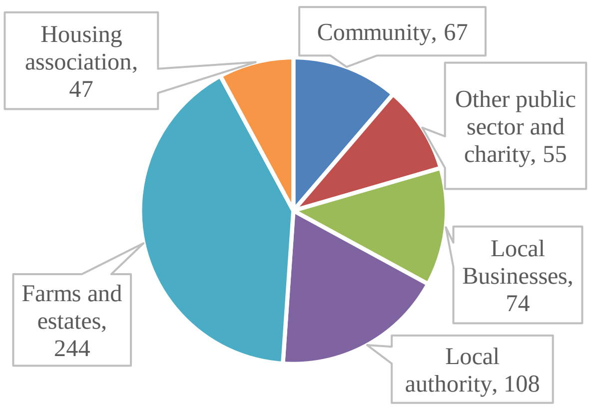

Figure 1: Capacity of operational installations (MW) at June 2016, by ownership capacity (reproduced from [7]*).*

LOCAL ENERGY DEVELOPMENTS IN SCOTLAND

There has been a shift of policy direction in the Scottish community to a wider focus on local energy systems. The concept of 'Local Energy Economies' has been advanced – referring to the concept of integrating low carbon energy sources in local energy systems and supply chains in a way that maximises system efficiency and adds value for local stakeholders [1] [8].

Local Energy Infrastructure Project Funding

The Scottish Government's policy support for local energy systems has primarily manifested in two funding mechanisms aiming at supporting the innovation and demonstration of energy projects delivered by local actors. The Local Energy Challenge Fund (LECF) and the Infrastructure and Innovation Fund (IIF) both sit within the CARES funding portfolio [9].

The LECF is orientated towards the support of large-scale (community level rather than household) low carbon demonstrator projects. A local energy economy approach is desired, with energy generation linked to energy use. Projects are expected to include innovative technology and business models that have an overall aim of creating more local value and benefit.

The IIF fund has similar motivation and focus to the LECF; however, the scope places greater emphasis on smaller grants for early feasibility funding. The IIF was motivated by experience of CARES recipients in developing generation projects and a rising perception of the need to unlock potential for local renewable energy generation. The following areas are priorities:

- overcoming barriers relating to grid capacity issues
- energy storage and active network management (ANM)
- linking local energy demand with local renewable energy generation
- delivering renewable heat and electricity to local consumers
- addressing barriers that communities face in areas of constrained electricity networks

Focus of LECF and IIF project activity
In total, 36 LECF projects and 32 IIF projects have been considered. The distribution of projects across key activity themes is shown in Figure 2. For projects focused on electrical energy, the majority of activity has been in connecting local generation and demand with either a private wire network or a virtual private network.

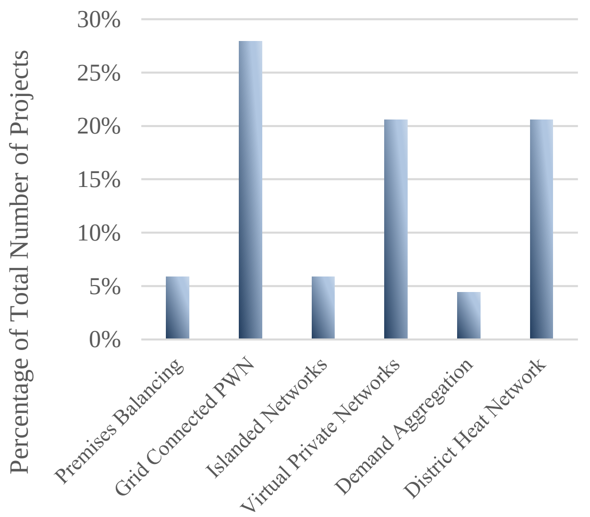

Figure 2: LEI project activity per theme

KEY CHALLENGES FOR LOCAL ENERGY SYSTEMS IN SCOTLAND

A local energy project that moves beyond solely deploying distributed generation must fulfil the functions of supply and distribution. For a party to become a generator, distributor or supplier, they must obtain the relevant licenses from the regulator (Ofgem). The licenses set out the obligations and conditions in relation to becoming a party to, and complying with, technical codes and standards relating to balancing and settlement, metering, safety, efficiency, and security and quality of supply, of networks. Small distributers (< 2.5MW) and those distributing 'on-site' or to non-domestic customers can be eligible for a license exemption. For small suppliers that intend to supply over the public network, exemptions are possible but are extremely rare. Class A exemptions allow supply of electricity, generated by the supplier themselves, of up to 5 MW in total, with no more than 2.5 MW supplied to domestic customers [10]. However, a contract is still required with a fully licensed supplier to provide exempt supply services including metering and settlement. The cost and complexity of becoming fully licensed is a significant barrier to local energy projects. In particular, meeting the requirements of the Balancing and Settlement Code (BSC) is usually beyond the capacity of a local energy project [11].

New models for local supply have been proposed [12] [13], mostly involving a partnership between a local supplier and a senior supplier. The senior supplier provides 'back-stopping' services for code compliance on the junior supplier's behalf. This arrangement allows direct supply of local generation to local customers and avoids the complexity of obtaining a full licence; however, there are still costs of operating the local supply function. The senior supplier handles meter registration and BSC compliance, representing the local trading within the national balancing and settlement functions, and hence absorbing a degree of imbalance risk. The agreement with the senior supplier must also provide for the 'top-up' supply or export 'spill' if the local generation does not meet the local demand. Considering the extent of the requirements on the senior supplier, a significant cost could be expected.

Private wire ('on-site' distribution) may be an attractive commercial workaround, however in many cases additional network infrastructure may be technically unnecessary and will duplicate local Distribution Network Operator (DNO) assets. An alternative is the use of virtual private wire [3] which relies on the concept of a *local aggregator*. Utilising ICT infrastructure (e.g. smart meter), the aggregator gathers and 'nets' all half hourly meter readings from participating consumers and generators in the local area. In this way, an aggregate profile for a 'Virtual MPAN' from the local area can be presented to the rest of the system.

LOCAL ENERGY CASE STUDIES

Smart Fintry - adopts the principle of the virtual private wire for peer to peer trading and Local Supply and Pooling, similar to [14] [15]. With this approach a local aggregator aims to provide local supply, re-localising energy spend to obtain local benefit – e.g. reduced tariffs.

Aims: The overall objective of the SMART Fintry project is to pilot a replicable local energy economy that links local, sustainable generation with consumption and which can be beneficially adopted by other communities across the UK. This includes developing and demonstrating a replicable means of trading and charging for electricity that allows UK consumers to buy their power direct from nearby renewable energy generators – without the need to install duplicate grid infrastructure. The objective is to drive down electricity costs and reduce carbon for consumers who are located near renewable electricity generators.

Achievements and Lessons Learned: Smart Fintry has negotiated a local tariff for over 100 participating households from 100% renewable electricity supplier Good Energy (who also handles the PPA's for the community generation). Local generation includes a 500 kW anaerobic digester, a 1/15th share (equating to 2.5 MW) of a local wind farm output, 110 kW wind generation on local farms and a 50 kW PV array. Heat pumps were installed in homes as well as insulation to improve energy efficiency. The project installed smart meters linked by ZigBee Mesh and built a web based dashboard[16] that displays generation and consumption, thus enabling the demonstration of how these could be netted off in a virtual private wire arrangement. The project has demonstrated a platform for half hourly settlement and explored the impacts on local customers. Smart Fintry has successfully demonstrated all the essential elements of local balancing and peer-to-peer trading. Additionally the project has identified that barriers remain to full integration of this concept with the current market arrangements and balancing and settlement process. The Good Energy local tariff is considered competitive once licensed supply costs, network charges and renewable obligation costs are factored in. Domestic customers are not yet being settled half hourly, despite having smart meters, and Good Energy are maintaining established practice for suppliers to settle domestic customers based on Elexon demand profiles.

Generally, in wider deployments local balancing is unlikely to provide major network benefits where there is no network constraint (as is the case in Fintry). The system benefit of matching generation to demand locally could be limited to reducing losses which can be up to approximately 9% on average at distribution level in a rural area [17].

ACCESS Mull - is an example of an actively managed network for constraint alleviation, similar to [18]. This approach is attractive where local embedded generation is constrained due to network capacity. Operating behind the constraint, local demand is aggregated and then dispatched to match the generator output. In this way, the local area maintains its net export position below the public network capacity constraint limit and increases the overall generator export volumes. Integration with DNO control is required (e.g. an ANM scheme where the DNO monitors the upstream constraint and retains the ability to curtail the local generation if required).

Aims: The aim of the ACCESS project is to allow renewable generation to connect on the island of Mull behind the mainland export constraint. It is also aimed to provide customers with a 'virtual district heating' option when no gas connection is available.

Achievements and Lessons Learned: ACCESS focuses primarily on demonstrating the technical aspects of local balancing. New domestic thermal demand was installed behind the constraint point. This thermal demand is controlled, aggregated and netted against a local hydro generator output, allowing the generator to increase its output without breaching an agreed limit. In order to demonstrate this new system safely, an unconstrained hydro generator was chosen and a 'false limit' set up.

Commercially, the underlying principle was that the value of potentially constrained generation could be shared with participating households and businesses, via a rebate payment. As the unconstrained generator was not realising new revenue in this demonstration, this aspect was simulated with funding from the project. The rebate was designed to ensure that whatever the time of consumption instructed by the ACCESS system, the household wasn't any worse off. Participating consumers retained a standard retail tariff with a national energy supplier who provided the rebate as a credit on their bills.

Levenmouth (Bright Green Hydrogen) - a private wire network is used to connect an 8 building campus with on-site generation.

Aims: The Levenmouth project aimed to demonstrate the potential for green hydrogen for use in transport and energy storage.

Achievements and Lessons learned: excess wind (750 kW turbine) and solar (160 kW) power is converted to hydrogen in a micro-grid connected by private wire. The project also has flexible demand in the form of 15 electric and hydrogen/diesel mix vans and a 100 kW fuel cell which uses stored hydrogen to supply electricity when there is no other on-site generation.

In terms of project economics, UK policy changes such as reductions in renewables support have had an impact.

Also developing novel designs (e.g. hydrogen equipment) resulted in overrun in costs and time. From a commercial standpoint, the Levenmouth project is a good example of the benefits of a private wire network. It has the advantage of being on a business park without the complication of domestic customers and complex supply arrangements. Generators have PPAs with the other buildings on the microgrid network. Supply is through an Import/Export meter and the site aims to minimise import and maximise export within a 750kW export constraint that is managed by the smart grid system. There is potential for the site to provide ancillary services as part of a Scottish Power Energy Networks innovation project called FUSION.

DISCUSSION – COMMON THEMES

Private wire (on-site balancing) solutions can deliver local objectives, but viability is situational. The advantages of bypassing complex licensing regulations are balanced against the costs of implementation and only really apply to non-domestic systems. Technical implementation of virtual private wire has been achieved on the Scottish network. However, establishing local supply and incorporating local balancing into the BSC framework still faces barriers. The case studies from Scotland demonstrate either commercial 'work arounds' or local balancing frameworks that have yet to be accepted fully by a licensed supply company.

Without a change in the supply regulations (such as reduced costs/obligations for local energy suppliers), the benefits of a local market in terms of closing the gap between the price paid to the generator and by the customer is yet to be demonstrated. This could change with the phase out of the Feed-In-Tariff subsidy which could make generators more likely to change from the business as usual approach. In Fintry, different revenue streams are being considered such as demand response (possibly via a distribution system operator model) and reduced losses from local matching. One option to give local energy projects more flexibility and potential value is forming a local supply co-operative within a common connection point. This has been carried out by Energy Local who have implemented dynamic tariffs and local demand matching using smart meters [15]. However, these co-operatives are using complex site licensing arrangements which are less attractive to the regulator as they can result in lowered network charges which may need to be covered by other network users.

CONCLUSIONS/RECOMMENDATIONS

Local energy projects in Scotland have made good progress in demonstrating local energy economy solutions. They have developed benefits to local consumers such as reduced tariffs and improved energy efficiency. The scalability of these projects largely depends on the evolution of regulation with respect to supply and network charging. As much as anything else the projects have identified areas where existing regulations are hampering local supply and balancing.

Three different projects have been reported in this paper but further analysis of the whole system implications of local energy systems is required to understand the trade-offs between local benefits and wider system costs. Initiatives such as Ofgem's non-traditional business models consultation [4] and future insights series [3] are important and fully capturing the lessons from the plethora of funded local energy projects as the Scottish Government intends is essential.

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