THE NEED FOR CHARGING REFORM TO SUPPORT COMMUNITY ENERGY PROJECTS

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ABSTRACT

Community-owned renewable energy projects provide environmental benefits, increase the deployment of decentralised generation, enhance public engagement and can also be designed to reduce fuel poverty and boost the local economy. The regulatory and market framework of the UK (and similarly in other countries) was created in the era of top-down planning and centralised generation, and have not changed to reflect the growth of decentralised and community owned generation. As such the market may have the unintended effect of penalising novel projects in some circumstances. Uniper has been responsible for the engineering and design of a community energy project planned for the UK, with support from the local council and community groups, and has reached the conclusion that whilst technically feasible, the scheme will struggle to form a sustainable business case in part due to the regulatory, tax and charging obligations placed onto the group.

INTRODUCTION

At the beginning of 2017, Uniper was approached by a representative from a local council within the UK and commissioned to work with a community group to design and develop a Local Energy System (LES) that could utilise the renewable potential of resources within a village. The LES was intended to be a community owned asset, with representatives from the village population involved in the decision-making process. In addition to this, energy produced by the scheme could be sold to residents in the area at a discount to the market rate to alleviate fuel poverty which is a particular problem in many rural areas even in the most economically developed countries.

The local distribution network in this area is also old and weak, with a single connection feeding a large area through one circuit. This means the area already suffers from voltage problems, and additional generation is not permitted to be connected in this location due to thermal constraints on the network. The LES was therefore required to be designed to work in a weak network without introducing any additional difficulties for the network operator, and if possible to mitigate some of the existing network difficulties.

TECHNICAL DESIGN

An initial feasibility study for a hydroelectric installation on a local watercourse was available, and this formed the basis of the generation aspect of the scheme. A 180 kW turbine was selected, which under the high-head/low-flow conditions present in this location would produce approximately 475000 kWh per year. Historical river flow data from the National River Flow Archive at the nearest measurement point was scaled to match the survey data, and then converted using a power curve provided by a turbine manufacturer into a daily energy output from the hydroelectric generator.

The targeted participation rate is 100 – 250 customers, which is less than the total number of metered connections in the area, but is a large enough proportion to prove the validity of the scheme without needing the unlikely case of complete uptake. The OFGEM Electricity Class 1 profile states a standardised annual demand for each of these customer connections of 3100 kWh. A simplified seasonal profile was developed to match the aggregated metered data provided by the local network operator, with the winter demand 50% greater than the summer demand following a roughly sinusoidal profile. This suggests that the hydro system can supply approximately 150 customers based on an annual energy balance metric.

Photovoltaic generation is also included in this LES, but as the project is planned for construction in a protected environmental area there can be no ground mounted panels. A railway line crossing the site also restricts the amount of connections that can be made, and this results in a limit of 80 kWp for the PV installation.

Sizing this battery requires a balance between a Battery Energy Storage System (BESS) large enough to cope with periods of low generation and to cover increases in the number of participant customers and the desire to reduce CAPEX by using as small a BESS as possible. It was noted in the early conceptual design that the BESS would be a significant proportion (>60%) of the total system cost. 90% annual self-supply by the LES was determined to be the optimal size, corresponding to a 6 MWh (4.8 MWh usable) capacity battery.

Control and Coordination

To protect the weak network against future problems, the system has been designed to directly match the instantaneous output from the generation assets with the demand from the scheme participants. This means that no impact will be seen on the wider network and that customers connected into the scheme will in effect disappear from the net import as if they were off-grid.

The local 11kV distribution network is owned and operated by Scottish Power Energy Networks (SPEN). Several hydro generation schemes have been connected to the circuit supplying the village, and the voltage is at times at the upper allowable voltage limit. Because of this, no additional uncontrolled generation can be connected to the distribution network without significant network investment.

The conventional approach to enabling the connection of renewables to a voltage-constrained network is to install an in-line voltage regulator. SPEN's charging methodology states that any network reinforcement that exceeds £200/kW shall be charged in full as a connection charge. As the costs of network reinforcement do not scale linearly with power at low power levels, the costs to connect a small generation project are disproportionately high, and can make integrating small projects such as this financially unviable.

The hydro generation and battery system will be integrated such that there is a single point of connection to the DNO network. The inclusion of the battery with the hydro generation scheme decouples the power generated from the power delivered to the network, allowing the power delivered to the network to be controlled. Integrating the generation sources and battery system at the single point of connection minimises the installed electronics, maintains the highest possible efficiency by allowing the turbine to operate at variable rather than fixed speed, reduces the complexities associated with multiple network connections and simplifies the control system. It also allows reactive power control strategies to be implemented that can ensure that the voltage is reduced when necessary, mitigating the problems that exist and ensuring no net negative effect of this new scheme. An approach such as this could demonstrate the capability of networks presently thought of as constrained to accept additional local generation schemes.

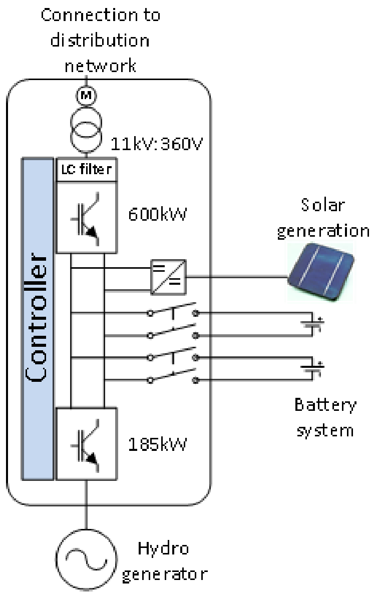

Figure 1: Hybrid Power Plant Connection

To allow the system to deliver the power directly matching the customer load, the instantaneous consumption for each property needs to be measured and communicated to the central controller. With the installation of smart-meters, consumption is measured instantaneously and communicated through a home area network to any registered devices and through a wide area network to a Data and Communications Company (DCC), who then manage the data and allow access to suppliers to retrieve information necessary for billing.

The communication path through the DCC is not designed for fast data retrieval and is unlikely to be sufficiently fast to allow the community energy scheme to control the instantaneous power to match the consumption of all connected customers. This route would also put a significant burden on the communication infrastructure if 150 smart meters need to update their power rating at a high rate.

The preferred approach for the communication of the instantaneous power is to install a local communication system. The power measurement can be taken by either

1) Installing an additional device that connects to the communication hub and transmits the power measured from the smart meter

2) Installing a separate metering device that independently measures power consumption for re-transmission.

As a standardised proposal, the second approach is more versatile and replicable, with no dependency on the smart meter infrastructure. This separate device will also work for customers who do not yet have a smart meter and can be removed if required without affecting the fiscal and statutory metering systems.

For the communication of the instantaneous consumption data back to the central controller, there are three viable approaches:

1) Powerline carrier, both at 415V and across the 11kV distribution system

2) Dedicated mobile data connection at each location to a central server

3) Mesh radio network.

Of these, the mesh radio network is considered the best compromise of low operating cost and impact on the distribution system. In this case, each customer would install a dedicated metering and communication system (similar size to a smart meter) to their supply, and each meter communicates with others across the network.

Performance Modelling

A daily energy balance model was created to understand the technical performance of the system and to act as a basis for financial modelling. This integrates the generation profiles with the simulated demand, and calculates the net energy required to be sunk or sourced by the BESS each day throughout a five-year performance profile based on the historic data.

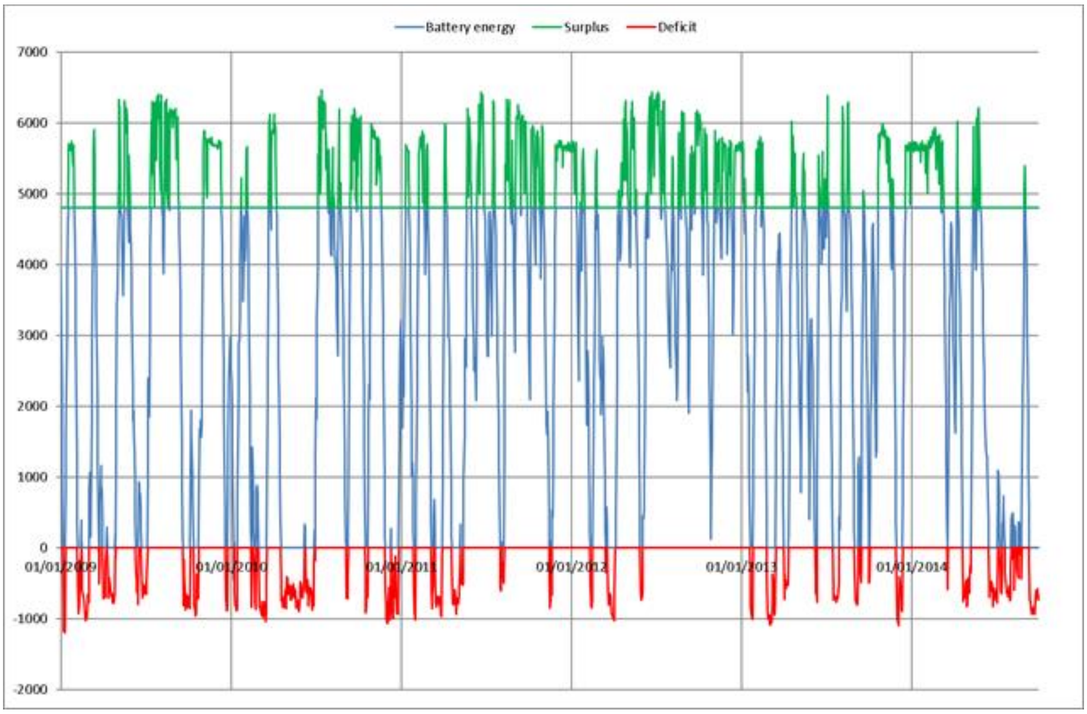

Figure 2: Five-year system performance

In the figure above, the central area (coloured blue) represents the times at which the battery system is fully buffering the daily mismatch between supply and demand, and no energy is being imported or exported via the distribution network for scheme participants. The top area (coloured green) represents the energy generated in excess of demand during periods where the battery is already full, and this would therefore be exported to the external system as normal for embedded generation (assuming commercial provisions exist). The lowest area (coloured red) shows the periods where the battery is empty, usually during summer drought conditions, and any demand that is not immediately supplied by the generation must be imported from the distribution network as is the present situation.

In the base case simulation of 150 customers, the system self-supplies 88% of the annual demand, therefore importing 12% of demand, and exports energy equivalent to 23% of the annual demand. Climatic impact can be seen by the prolonged period of import required during the drought in Q2 2010, and by the significant surplus shown through most of the summer months in both 2012 and 2013 in this simulated dataset.

A sufficient contractual relationship with a licenced supplier is assumed so that both import and export can be handled at appropriate costs.

BUSINESS MODELLING

A set of commercial terms were agreed with the community representatives to use in modelling the financial viability of the scheme. Given that much of the CAPEX funding was to be covered by European development funds, this was primarily focused as an OPEX model.

Standing Charge	18p per day
Imported Energy	14p per kWh
Exported Energy	5p per kWh
DUoS	1.8p per kWh self-supply
Renewable Obligation	1.9p per kWh self-supply
Discount Offered	25%

Table 1: Financial Assumptions

The system was modelled for varying numbers of scheme participants to assess the sensitivity of the business model to uptake and interest, and to validate the discount rate chosen by the community group as an initial target.

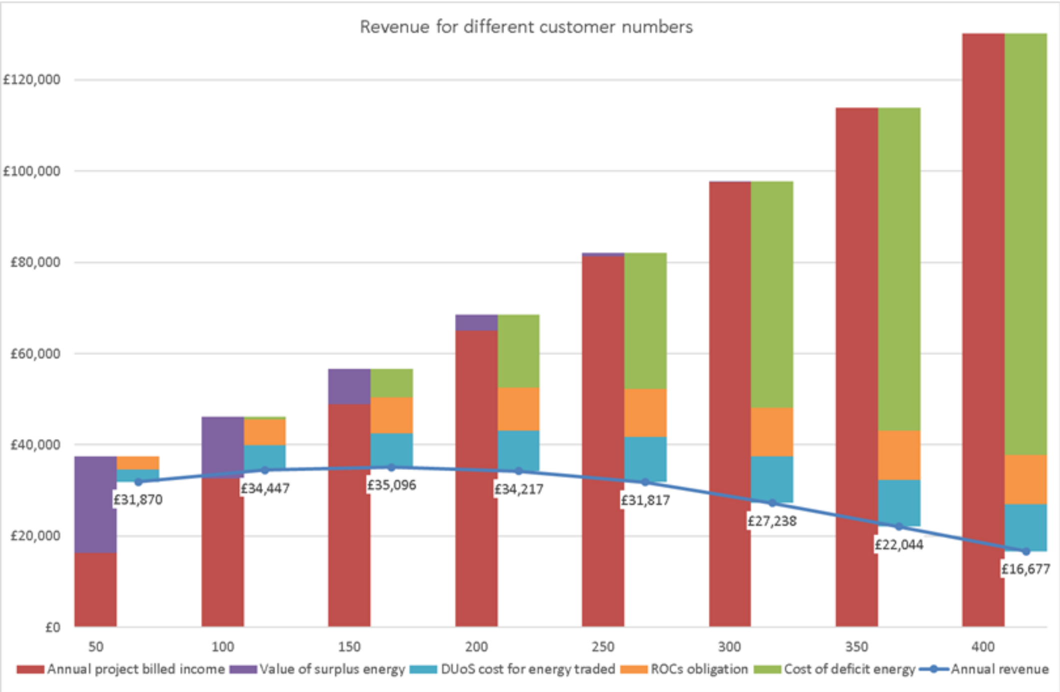

Figure 3: Customer Number Sensitivity

The optimum number of scheme participants was shown to be 150, with a residual system revenue of £35k per year after payment of regulated obligations. This matches the design capacity of the system, proving the viability of the discount rate chosen. If the additional obligations were excluded the optimum number of participants would be 200, and the residual revenue would rise to over £50k per year.

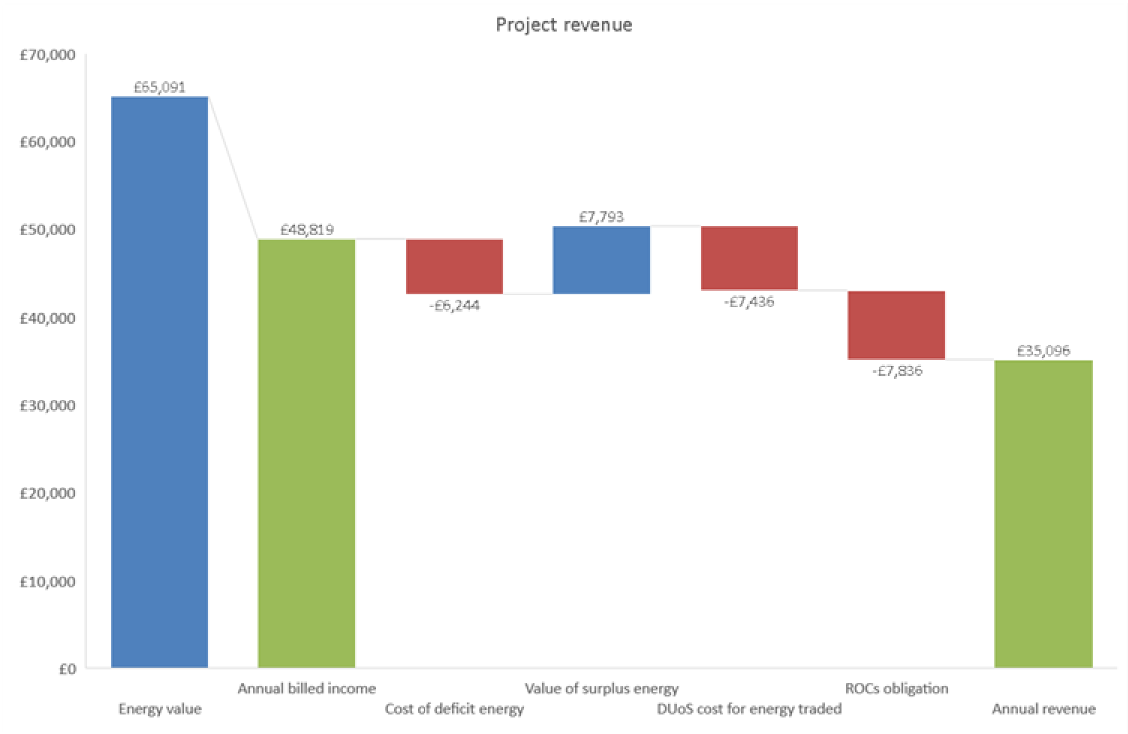

Figure 4: 150 Customer Waterfall Breakdown

Operating costs for this scheme are expected to be around £20k per annum, and this would suggest the scheme is technically viable and able to offer the desired 25% discount. The obligations take around a third of the free revenue in the most common circumstances, and the edge cases are dominated by either the sale or import of energy and are not considered pertinent in this design.

OBLIGATIONS AND CHARGES

The first charge that any commercial enterprise will face is business rates. These are assessed on non-charitable operations and are based on the capital value of assets owned by the operating company. In this case the CAPEX is forced high by the inclusion of the BESS to deal with the network conditions, and therefore the business rates are expected to be very high. An accurate assessment of business rates cannot be made without direct valuation of an installed asset by council representatives, but indications from other local schemes would suggest a rates liability significantly higher than the residual revenue in this case.

There are existing powers available to the UK and regional governments to vary or exempt certain schemes from business rates where they are desirable, and this would be the appropriate route for negotiation for schemes like this LES in the future.

The two major obligations placed on the LES from the utility industry side are Distribution Use of System (DUoS) charges and the Renewables Obligation (RO) or Contracts for Difference (CfD) that were consuming 30-40% of the project income.

There are significant differences in the way DUoS, RO and CfD charges operate for private-wire networks compared to public networks as in this case. This results in a materially different cost model for the operation of LES schemes and is the major reason why, with only a small number of exceptions, such schemes do not currently operate on the public network.

There are two key regulatory differences between operating a LES scheme on a private network compared to the public network:

Firstly, only a licensed supplier can supply customers connected directly to the public network, whereas an unlicensed supplier can supply customers in a private network. This means that a LES scheme operator must either become a licensed supplier or engage with a licensed supplier to operate a scheme on the public network.

Secondly, and more importantly from a cost perspective, a private network is a single "super customer" with a single meter in the industry retail and settlement arrangements. This means that only net import to / export from a private network is visible to these arrangements – and not the individual imports and exports of customers and generators within the network.

Meter level volumes drive several industry and regulated charges and this results in a materially different cost model for the operation of a LES scheme on a private network from one on the public network.

Engaging with a licensed supplier does not pose a barrier to LES schemes operating on the public networks as the competitive retail market place facilitates the offering of such services. However, the different ways in which industry charges are levied does provide a significant barrier.

<table>
<tr><th colspan="6">DUoS - Public Network</th></tr>
<tr><th>Charge</th><th>Number</th><th>Tariff</th><th>Cost (£)</th><th>Total (£)</th><th>Overall (£)</th></tr>
<tr><td>Single Rate Standing Charge</td><td>150</td><td>4.16p / MPAN / day</td><td>2278</td><td rowspan="2">17819</td><td rowspan="3">10592</td></tr>
<tr><td>Single Rate Units</td><td>543026</td><td>2.862p / kWh</td><td>15541</td></tr>
<tr><td>Export Units</td><td>651631</td><td>- 1.109p / kWh</td><td>-7227</td><td>-7227</td></tr>
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Table 2: Public Network Charges

DUoS - Private Network					
Charge	**Number**	**Tariff**	**Cost (£)**	**Total (£)**	**Overall (£)**
Standing Charge	1	7.63p / MPAN / day	28	4876	3069
Unit rate 1 (red)	5657	13.067p / kWh	739		
Unit rate 2 (amber)	26710	0.580p / MPAN / day	155		
Unit rate 3 (green)	23022	0.233p / MPAN / day	54		
Capacity charge	202	5.29p / kVA / day	3900		
Export Units	162908	-1.109p / kWh	-1807	-1807	

Table 3: Private Network Charges

These show an indicative value for the difference in charges resulting from the different network configurations. In this example case (based on real tariffs from 2015/16) the private network is liable for only 30% of the charges applied to the public network LES. This would act to incentivise the building of private wire networks, which is counter-intuitive and contrary to the modern practice of finding flexible optimisation solutions for more complete use of existing assets.

PROPOSED MODIFICATIONS

The costs and benefits to the public network of an LES are very similar, regardless of whether the local wires connecting the elements of a LES scheme happen to be part of a private network or part of the public network. It follows that the DUoS charges should be very similar in each case. This is not the case at present.

Some benefits to scheme members arise from the local distribution network; and some arise from the upstream distribution network. The extent of these benefits is sometimes a function of the scheme as a whole, and sometimes it is a function of the individual scheme participants. All members of the scheme will benefit from the local distribution network in connecting the local generation and demand – and the extent of these benefits is a function of their respective individual imports / exports. Likewise, all members of the scheme will benefit from the upstream distribution network as it provides them with the security of still being supplied should the local generation fail or be taken out for maintenance – and the extent of these benefits is a function of their respective individual capacities.

The only required change from the current charging regime for DUoS to address this issue is to replace the single unit based charge for use of the entire distribution network with two unit based charges - one meter based charge with a tariff that is reflective of the short-haul use of the local distribution network; and one (net) scheme based charge with a tariff that is reflective of the long-haul use of the upstream distribution network.

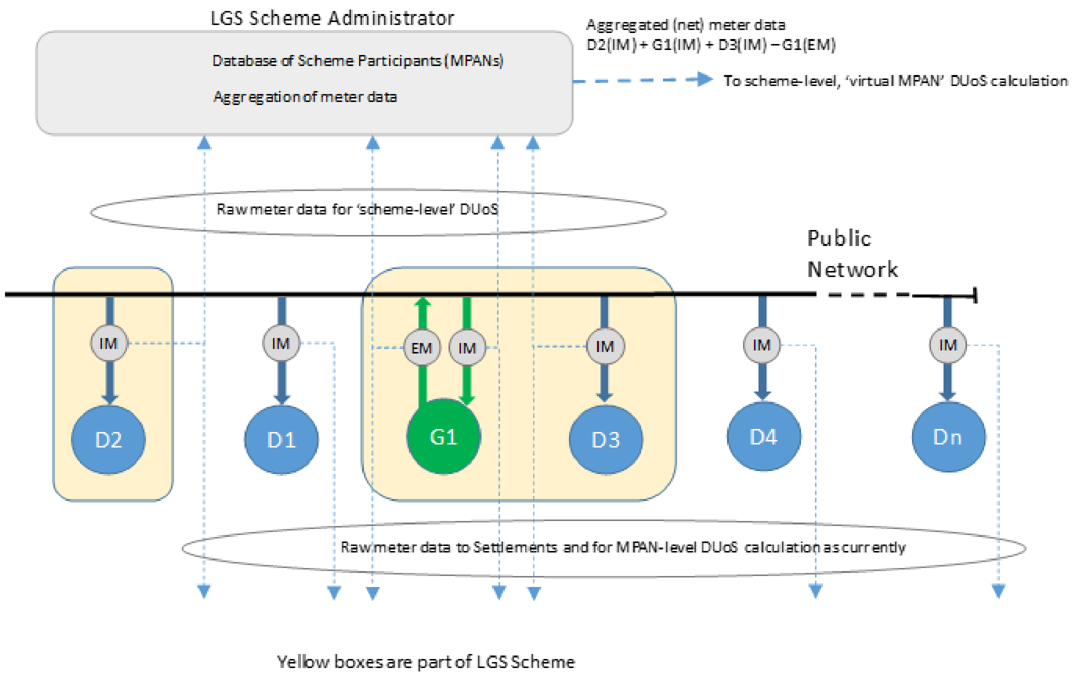

Figure 5: New DUoS Charging Structure

With regards to the RO or CfD charges, a decision will need to be made as to the purpose of these obligations to ensure that they apply either to each of the public and private cases equally or to neither. Making this clarification would avoid the present issue of private-wire customers being 'hidden' from this obligation by virtue of existing 'behind-the-meter'.