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SUPPORTING THE ENERGY TRANSITION WITH THE INTERNET OF THINGS

OPTIMISING LOCALLY PRODUCED ENERGY ON THE ISLES OF SCILLY

EXECUTIVE SUMMARY

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Supporting the energy transition with the Internet of Things. Optimising locally produced energy on the Isles of Scilly.

Smart Energy Islands project - final report. Executive Summary.

Lead Author: Anna Wieckowska

E-mail: Anna.Wieckowska@hitachi-eu.com

Contributors: Moixa, PassivSystems and the Hitachi Project Team:

Justin Beasley, Douglas Cheung, Makiko Hisatomi, Graeme Hodgson, Hiroyuki Kishira, Yosi Kwaw, Reema Patil, Kelvin Porter, Rakesh Shah, Elizabeth Stevenson, John Whybrow and Eiji Yoshida

Autor's Note

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Achieving the Net Zero greenhouse gas emissions 2050 target set by the UK Government while maintaining security and affordability of electricity supply will require an unprecedented level of change and innovation in the energy system. With low levels of energy-efficient housing, high electricity bills resulting from a lack of a gas grid, no electric vehicle charging infrastructure, low penetration of renewable generation and being located on a constrained part of the electricity grid, the Isles of Scilly exemplified many of the challenges that will need to be overcome nationally if the 2050 target is to be achieved.

To increase sustainability, resilience and reduce fuel poverty, in 2015, the Isles of Scilly set ambitious goals in their Smart Islands Programme: to satisfy 40 percent of electricity demand through local renewable energy, reduce electricity bills by 40 percent and convert 40 percent of vehicles to low carbon by 2025.

Hitachi joined Scilly's Smart Islands Partnership, which also comprises the islands' main landowners and stakeholders, as a founding member to bring technological and social innovation expertise to the programme.

The first project delivered by the Smart Islands Partnership was a smart energy project led by Hitachi Europe Ltd. and supported by the European Regional Development Fund, delivered between December 2016 and December 2019.

Hitachi worked in partnership with UK-based companies Moixa and PassivSystems to demonstrate how PV and smart domestic devices, managed by an 'Internet of Things' (IoT) solution, could provide better and cheaper services to households while supporting the transition to a low carbon energy system. Specifically, a combination of rooftop PV, air source heat pumps (ASHP), hot water tank controls, and domestic batteries were installed in 82 council owned homes along six larger PV arrays, storage batteries and a smart EV charger in the Council's commercial buildings.

On a household level, the primary objective was to meet the requirements for heating and hot water at the lowest possible cost to the household, making best use of behind the meter solar PV and the Economy 7 tariff. This involved complex decision-making by AI-based algorithms developed by PassivSystems, including learning the thermal characteristics of hot water tanks and granular control of heat pumps to achieve the objectives at the best possible efficiency.

The IoT platform prioritised households' heating and hot water comfort choices set by them for their home – only spare capacity was used to manage flexibility within the energy network. Homes involved in the scheme reduced their energy bills by around 20 percent, demonstrating the value of long-term adoption of energy management in supporting the Isles of Scilly's 2025 targets.

On an Island level, the project explored whether curtailment of local PV generators could be mitigated by turning up demand at the time of surplus generation. This element of the project was delivered in collaboration with Western Power Distribution (WPD), the distribution network operator (DNO) in the south west of the UK. Specifically, Hitachi's IoT platform was able to receive curtailment signals from WPD's Active Network Management, translate it into a flexibility request that two separate aggregators, PassivSystems and Moixa, could respond to, obtain a confirmed order and ultimately deliver the required flexibility from multiple devices (EV, ASHP, Batteries and Hot

Water). The aim was to absorb the surplus generation and enable the local PV to continue to produce, thus making better use of locally generated electricity.

Communication between parties and the 'energy flexibility' trading approach was governed by the Universal Smart Energy Framework (USEF)[1], with Smart Energy Islands (SEI) being the first implementation of the framework in the UK. USEF was selected as the most comprehensive and implementation ready framework available at the time. The core of the IoT solution is Hitachi's Energy Flex Trader platform developed as part of the project, securely hosted on a public cloud and designed within a micro-services, event-driven architecture. This approach was selected on the premise that it delivers a solution that is easily replicable, scalable and configurable.

A series of trials explored energy demand turnup as well as turndown use-cases, applicable to a range of real-life requirements for energy flexibility. For example, turnup can enable the accommodation of an increased amount of distributed renewable generation on low voltage networks and turndown can reduce peak demand from electric heating and EV charging, thus avoiding or deferring expensive network reinforcements. The key learnings from the trials included:

- The system was able to successfully execute flexibility while maintaining comfort levels within the required user settings (temperature and hot water availability)
- USEF proved an effective way for communication between parties, with 97% of trading cycles completed successfully in the final trial
- Distributed domestic devices can be significant sources of flexibility. In the turnup scenario, a response of up to 31% of the total installed capacity of participating devices was achieved, while turndown proved more challenging, achieving 9%. These values are indicative of what could be achieved if the system was scaled up. For example, to fully offset the curtailment of a 40kW solar garden, approx. 61 participating homes would be required
- Distributed domestic assets can cost-effectively provide flexibility to address grid constraints. While the price range was large (£0-130/ MWh) and did not include aggregator's operating cost, it is well below the current commercial value (e.g. £300/ MWh under WPD's Constraint Management Zone (CMZ))
- Bringing flexibility trading closer to real time would facilitate the participation of domestic demand response. The availability of flexibility is highly dependent on factors which are difficult to predict accurately in advance, most importantly user behaviour. At the same time commercial arrangements often require declarations in advance, for example a week ahead, which may create an unacceptable level of risk for the aggregator
- Ideal asset mix is use-case dependant. The mix of generation (solar PV) and heating assets is not an ideal match from the point of view of the curtailment avoidance scenario. Heating devices were less able to provide demand turn up in the summer, when PV is at a higher risk of curtailment. This ability could be more valuable in combination with a different mix of generation, for example for the purposes of avoiding curtailment of wind power
- DNO flexibility services could bring additional income to the Isles, but cost and benefits of participation need to be balanced. The value of these services is location dependant and

[1] 'Energy flexibility' refers to the ability to shift electricity consumption patterns. This ability can be traded and USEF is a standardized framework which enables such trading https://www.usef.energy/

under the current CMZ scheme demand turn-down on the islands is required mainly during April. The current scheme would generate a revenue of approx. £1,300 in 2020, which was deemed insufficient to cover the administrative cost. However, this may change in the future, depending on WPD's requirements

- Baselining of domestic flexibility and creating transparency for the DNO is crucial to enable market participation of domestic flexibility providers. The difficulty lies in distinguishing between the device's 'flexed' demand and what the device would be drawing under normal circumstances. As the latter can be highly variable, thus estimating a realistic baseline is not straight forward.

The project also developed a community-based business model with the aim of preserving its legacy and delivering the benefits of the system to the residents. The Isles of Scilly Community Venture was established as a Community Interest Company in 2017. The initial business case indicated that the organisation could become financially self-sustaining, once it accumulated a sufficient asset base. Any surplus generated by the Community Venture would be distributed back to the community in the form of reduced energy costs. Innovative commercial and regulatory arrangements were explored with Ofgem's Innovation Link and a licenced supplier was brought on board as a partner to launch the Isles of Scilly Energy-Share tariff in the Autumn of 2018. The tariff was postcode-restricted and available only to the residents on Scilly, with all locally generated renewable electricity allocated to the tariff by the supplier, with the aim of it becoming cheaper and greener over time. Despite only word-of-mouth marketing, the tariff enjoyed a rapid uptake, exceeding 50 customers within the first few months, testament to the trust of the community in the Community Venture. Complementary to the tariff, a model to charge for behind-the-meter self-consumption at a reduced rate, 40% below the available tariffs, was developed. This meant that the households where PV was installed would benefit from cheaper electricity, while at the same contributing to the Venture. Metering, data collection and provision of billing data was implemented as part of the IoT solution.

Regulatory exemptions were explored with the objective of creating a Local Energy Market that would allow retention of the value of local generation within the community, incentivising further rollout of renewables and creating further incentives to shift local demand in line with generation. These included licence-exempt supply and a virtual meter arrangement. However, this element of the project was significantly impacted by external changes. Firstly, the selected licenced supplier partner, Our Power, went out of business in January 2019 as a result of unfavourable market conditions, which have led to bankruptcies of several smaller suppliers. Secondly, wider changes to the ways network cost are allocated to customers were initiated by Ofgem in the form of the Targeted Charging Review in August 2017 to create a fairer cost recovery mechanism. This meant that derogations from existing regulation for the purposes of innovation were put on hold and created significant uncertainty in the market regarding the future revenue streams for demand response.

Overall, the project has delivered direct and lasting benefits for the islands, valuable learning and replicable technologies for the delivery partners, as well as informed the wider energy market transition agenda. For the Isles, the journey towards sustainability continues with the ERDF-supported Go-EV project, which will install 27 EV chargers across the islands, 10 of them with vehicle-to-grid capability, deploy a fleet of electric vehicles and a car share scheme, as well as additional solar PV generation. The project builds directly on the legacy of SEI with Hitachi and Moixa both involved as technology partners. Go-EV contributes to Hitachi's strategic priorities in the area of mobility and will complement the learning from Optimise Prime, the world's largest corporate EV trial project, led by Hitachi in collaboration with UKPN and SSEN, who operate the electricity distribution networks in London and the South of England.

More broadly, this project has highlighted improvements and further work needed to make domestic flexibility a reality and enable wider market access for aggregators and flexible device owners.

Challenges identified include the need for fair and verifiable baselining approaches, forecasting accuracy and dependence on portfolio size and the nature of the devices controlled. The administrative costs of running a DSR scheme with many small assets and complex commercial arrangements, as well as building customer trust and acceptance of automation are also important aspects to be considered in any scheme. Many of these challenges are currently being addressed by other projects, for example SPEN's FUSION and WPD's Intraflex[47], that the Hitachi project team follows with interest.