INNOVATION STRATEGY CLOSE-OUT REPORT

PROJECT TITLE	RESERVE
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ESB NETWORKS

BRIEF OVERVIEW OF PROJECT & EXPECTED BENEFITS

The requirement to significantly decarbonise the Irish economy presents specific challenges in relation to the cost-effective facilitation of small-scale renewable generation & storage and the provision of infrastructure to enable the electrification of heat and transport. Such challenges are emphasised by the predictions for mass adoption of Electric Vehicles (EVs), Air Source Heat Pumps (ASHPs), solar Photovoltaic (PV) generation and battery storage systems at both a global and national level.

ESB Networks engaged in the EU H2020 funded RESERVE project with 10 other consortium partners to develop solutions capable of enabling 100% renewable generation on electricity networks. As the sole Distribution System Operator (DSO) in the consortium ESB Networks focused on voltage control techniques which utilise inverter-based technologies to provide voltage support to the distribution network. ESB Network's expectation was to gain a better understanding of the challenges associated with the mass deployment of Distributed Energy Resources (DERs), their integration into a single control and monitoring platform, the integration of additional LV network monitoring devices and the realisation of network services by such a deployment.

All project documentation published by the project is publically available on the re-serve.eu website.

RESULTS

In order to validate the voltage control concepts developed in the RESERVE project ESB Networks led the co-ordination and management of the disparate range of tasks and activities required to deliver and validate field trials on the Irish distribution network. This required the mapping of control techniques, ICT architectures and renewable technologies to suitable trial sites. ESB Networks succeeded in procuring, permitting and commissioning operational renewable and storage technologies at a total of six DER trial sites which included;

- Solar PV Array at ESB Networks' National Traning Centre, Portlaoise, Co Laois [Figure 1]
- Vehicle to Grid (V2G) Charging System at ESB Networks, Leopardstown, Co. Dublin [Figure 2]
- Air Source Heat Pump at Youghalarra National School, Newtown, Co Tipperary
- Domestic Scale Battery Systems at locations in Cork and Tipperary.

FIGURE 1: SOLAR PV ARRAY TRIAL SITE, PORTLAOISE, CO. LAOIS

The successful deployment of voltage control techniques at the various trial sites served to validate their capability to support distribution networks utilising multiple DER technologies.

Through engagement with a third party commercial aggregator, a suite of domestic scale battery installations were supplemented into the project. At these sites the aggregator's communication infrastructure was successfully integrated into the project's control and monitoring platform allowing further trials and most importantly confirming the platform's ability to scale and integrate new market actors.

The implementation of the trials also served to facilitate our first successful mass deployment of innovative autonomous remote Low Voltage (LV) monitoring devices which served to both validate field trial performance and provide a solution for the real-time monitoring of LV networks.

ESB Networks succeeded in delivering all trial site infrastructure and LV monitoring devices into a single scalable monitoring and control platform SERVO. This successful deployment represents the first realisation of a Distributed Energy Resource Management System (DERMS) on an Irish network.

FIGURE 2: IRELAND'S FIRST V2G CHARGING SYSTEM, LEOPARDSTOWN, CO. DUBLIN

All project documentation published by the project is publically available on the re-serve.eu website, see here for documentation.

LEARNINGS

The project proved successful in demonstrating the complete end to end realisation of voltage control in numerous real-world scenarios. The realisation of this success demonstrated the viability of all elements of the project's field trials incorporating;

- Delivery of relevant DER infrastructure;
- Tuning of the control algorithms to specific site conditions and objectives.
- Integration of trial site technologies into a number of distinct ICT communications architectures;
- Implementation of a business model incorporating a commercial aggregator.
- Delivery of a network monitoring solution capable of verifying the control technique's implementation.

Electricity generation and storage technologies are experiencing significant and accelerating demand as the focus on decarbonisation and increased electrification intensifies globally. Many of these new technologies include inverters due to the fact they are coupling DC based devices to external AC networks. This presents a distinct opportunity for the RESERVE project's solutions to be implemented at scale as they can leverage inverter technology that is already being deployed for other purposes without requiring installations purely dedicated to its realisation. Indeed, many of the system stability challenges that the voltage control technique's deployed in the project were designed to alleviate, are themselves exacerbated by a proliferation of new electricity generation and storage installations. Realisation of the RESERVE project's solutions should both facilitate the installation of an increased level of DER technologies and allow for more intensive deployment on existing networks without requiring the level of investment associated with traditional electrical network capacity uprating.

The voltage control technique algorithm deployed in the trials proved itself flexible and capable of providing a menu of optimisation solutions across a range of network topographies containing a broad mixture of DER technologies. The collation of the detailed data required to be inputted into the algorithm proved to be somewhat cumbersome as system records at LV are historically less detailed and robust than those recorded for infrastructure rated for higher voltages. Nevertheless, the voltage control technique proved itself robust through its capability to achieve the desired objective of network performance despite the degree of uncertainty regarding the submitted baseline parameters.

In the case of the Solar PV trial in particular the voltage control scheme demonstrated its capability to determine an optimised configuration in a scenario where multiple independent sources of generation were present on the immediate local network. This scenario is indicative of the likely future configuration of substantial portions of distribution networks and indicates the feasibility of the technique to support same.

The field trials built on the initial implementation of voltage control through the introduction of additional energy system actors which allowed for the realisation of an alternative model of implementation. Collaboration with a commercial aggregator in the case of the domestic scale battery sites allowed the trials to expand to additional locations. By leveraging this commercially deployed infrastructure we were able to expand the scale of the trials at minimal cost to the project as the cost of the battery hardware, installation and communications solution costs was borne by the aggregator. The expansion of the trials which was achieved in this manner can serve as a template for what is achievable when multiple market actors are engaged in the provision of voltage control services. This success highlights the requirement for suitable market mechanisms to be established so that what has been proven tehcnically implementable can also be made commercially viable.

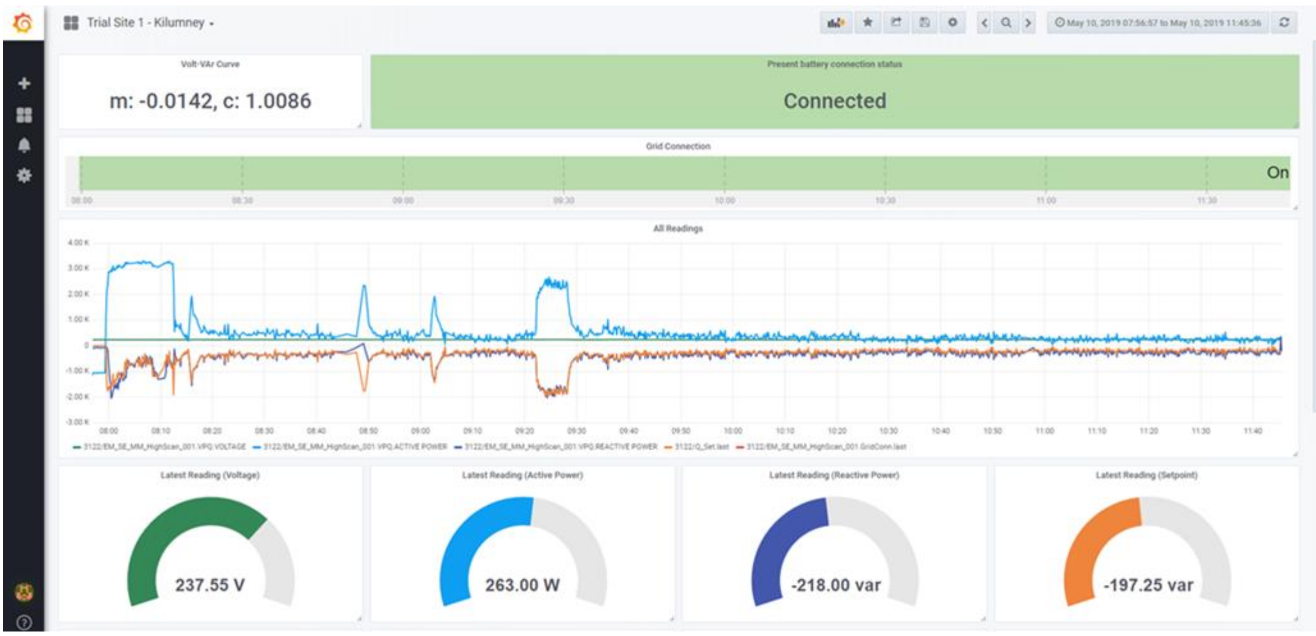

FIGURE 3: CONTROL & MONITORING PLATFORM SHOWCASING REACTIVE POWER SET POINT TRACKING AT A BATTERY TRIAL SITE

From the perspective of the trial site implementation of the algorithms and monitoring during the trials it was noticed that there are significant barriers to the implementation of such concepts centred around the diversity and capabilities of the inverters and interfaces available at the edge of the network. These interoperability factors came in many forms including communication capabilities, low level configuration access, vendor specific factors like vendor lock in and 3rd party platform integration factors.

ESB Networks engagement in the RESERVE project also served to demonstrate the systems and infrastructure necessary to implement transformed distribution networks incorporating intelligence, controllability and real-time vision at LV. Central to this was the successful mass deployment of LV monitoring devices across the trial sites and their integration in a standardised manner into the SERVO platform. The devices were successfully integrated into both ground mounted and pole top secondary substations. These rapid deployments were achieved without network outages impacting existing customers highlighting the relative ease with which they can be further scaled. The mass deployment of these sensors also served to demonstrate the viability of a new format of electricity network architecture which is necessary to accommodate an array of emerging business models.

In summary the RESERVE Field Trials demonstrated that a Voltage Control technique solution can be implemented in real world scenarios, is inherently scalable, can be integrated with additional external monitoring devices and is capable of positively contributing towards the resolution of constraints encountered by the distribution network.

NEXT STEPS – BAU, TRANSFER OF OWNERSHIP

Participation in the RESERVE project has been valuable to ESB Networks in deepening our understanding of the impact of rapidly emerging Distributed Energy Resources (DERs) on distribution networks and introducing us to innovative solutions to mitigate this impact.

The overall lessons from RESERVE with regard to options for achieving up to 100% Renewable Generation on the system have fed into our organisation’s innovation strategy and are helping to guide our thoughts with regard to how best to enhance the level of electrification of both the transport and heating sectors.

In particular the project has highlighted to us the specific challenges associated with the integration of diverse DER technologies sourced from multiple OEMs into a single standardised communications and monitoring platform.

The monitoring platform and dashboards developed to monitor the RESERVE field trial sites are now being further enhanced to provide these same services on a much larger scale in our latest large scale test bed development in Dingle.

ESB Networks successfully hosted an Open Day conference to disseminate the specific learnings from the trial site deployment to a diverse audience of key stakeholders including research partners, OEM device manufacturers, regulators and energy sector participants.This has assisted in developing a common understanding of how best to achieve decarbonisation on a national basis.

FIGURE 4: ESB NETWORKS HOSTED THE RESERVE PROJECT OPEN DAY IN DUBLIN IN MAY 2019

The many valuable relationships developed with project partners are being leveraged in order to identify further opportunities for future collaboration and knowledge sharing.

FINAL TIMELINES

The project delivery programme ran from September 2016 to end September 2019 in line with its originally envisioned timeframes.

Note: A number of project elements including Final Review by EU Commission and External Audit have continued beyond this date due to the availablility of relevant personnel and statutory timelines for reporting,

FINAL COSTS

Original EU Grant award of €803k, this was reduced to €789k following re-allocation of funds amongst project partners following the mid-term review in April 2018.

Final project expenditure is expected to come in below this figure and will be finalised as the output of an external EU financial audit that is in progress.