Solo Energy Ltd.

FlexiGrid Interim Report

SEAI – RDD/00101

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1 Introduction

1.1 Solo Energy

Solo Energy is a disruptive new energy supplier business launching in Ireland in 2017, using energy storage to offer low-cost 100%-renewable electricity supply to customers. Solo Energy deploys advanced Li-ion battery systems in homes and businesses across the grid and operates this cloud-connected and centrally controlled network as a 'Virtual Power Plant' (VPP). Solo Energy charges the network during times of peak local renewable generation (either onsite or from the grid) and low wholesale electricity prices and discharges to the host building or back into the grid at times of low renewable generation and high electricity prices. Solo Energy's Virtual Power Plant system delivers affordable, renewable and reliable electricity to all customers.

Figure 1 – Solo Energy's Virtual Power Plant

1.2 Project Background

To demonstrate the value and potential of distributed energy storage, Solo are targeting a first pilot Virtual Power Plant on the Irish grid in 2017. In advance of this, Solo have commissioned the *FlexiGrid* project as a precursor to physical deployment. *FlexiGrid* will model the impact of Solo's storage network on the existing and future grid infrastructure, using advanced Power Systems analysis software. Solo Energy are leading the project in collaboration with pioneers of the Irish renewable industry, DP Energy and the national DSO, ESB Networks (ESBN).

FlexiGrid sets out to investigate the extent to which a distributed network of controllable energy storage nodes can maximise self-consumption of locally generated renewable energy, provide peak demand load reduction (Demand Response) and provide grid balancing services on both the transmission and distribution grid networks.

The project has achieved grant funding status from the Sustainable Energy Authority of Ireland (SEAI) as part of the Sustainable Energy Research, Development and Demonstration Programme (RD&D) 2016. It is noted that due to a number of unavoidable factors, as communicated with the SEAI RD&D team, the scope of the *FlexiGrid* project has deviated somewhat from the original scope. Specifically, Solo Energy had difficulty in procuring the required battery storage system for testing on the Lir-NOTF Microgrid[1] as proposed in the project application. However, following extensive discussions and workshop sessions with the project collaborators and bearing in mind that ESBN, the national DSO, is the preeminent authority on the distribution grid, the collaboration is satisfied that the current scope of work is significantly more robust in terms of grid modelling and that the originally specified microgrid testing would have been unachievable within the required project timescales. This was the primary reason for requesting a scope and budget change, as agreed with the SEAI[2].

[1] UCC National Ocean Test Facility Microgrid (http://www.lir-notf.com/microgrid/)

[2] 'RDD00101 Amendment to Grant Agreement.pdf', dated 20/10/16

2 Project Scope

2.1 Context

Solo Energy are collaborating with DP Energy and ESBN to carry out a system impact study of connecting a fleet of aggregated behind the meter battery units on a representative housing development in a representative location[3] on the Irish distribution network. The collaboration has commissioned DNV GL to undertake advanced grid modelling of the impact of Solo's demonstration scale 'Virtual Power Plant' on the distribution network. ESBN use a specialist software package called Synergi Electric, a DNV GL product, for analysing distribution grid operation and to plan grid upgrades. DNV GL were therefore the obvious choice as expert consultant to undertake this aspect of the work. Furthermore, DNV GL have recently added a new module within Synergi Electric to model battery storage – this will allow them to accurately represent Solo's distributed energy storage network operating within a real representation of the distribution grid, from grid model data provided by ESBN.

A Synergi Electric network model has been developed by DNV GL, using inputs provided by the project partners, and it is currently being used to evaluate the impact of the energy storage systems on the representative distribution network. This model is being used to simulate and analyse the various power flows, as well as evaluate the benefits to the distribution and transmission networks under a variety of operational programs as detailed in Section 3.

This study will provide an improved understanding of the impact of standalone solar PV systems on the ESBN network, and demonstrate the potential for energy storage coupled with solar PV to limit the negative impact on the grid by smoothing the intermittency of PV generation, while further benefitting the grid and enabling increased renewable generation by creating flexible demand. There will be important lessons on the operation of the distributed generation systems and the benefits and restrictions that will apply. The modelling work will also provide an indication of the maximum demand and renewable generation capacity that could be absorbed by smart energy storage on LV (Low Voltage) networks, thereby avoiding the need to build in over-capacity in the grid.

2.2 Key Activities

The *FlexiGrid* project will study the impact of a 30 home new-build housing estate equipped with ground source heat pumps and a 13.5kWh / 5kW rated Li-Ion Energy Storage System (ESS) on a representative semi-rural ESBN network. The study will concentrate on the following components of the ESBN network: -

- LV network and Distribution transformers supplying the new build housing estate and any existing connected customers
- MV (20kV/10kV) network and any Distribution transformer connection points on the feeders
- MV 38kV/(20kV/10kV) substations and their voltage control equipment

The key activities will include: -

1. Network Model set up
    a. Receipt and review of MV model supplied by ESBN – add model for the MV 38kV/(20kv/10kV) substation
    b. Augment the MV model with models for the MV/LV distribution transformers and set estimated nominal tap positions

[3] Actual location of the housing development will remain confidential due to data privacy obligations.

    c. Create representative LV model
    d. Apply time domain MV and LV load profiles to the models
    e. Set up an interface between the Synergi Energy Storage System (ESS) model and the Synergi Power Flow Model

2. Modelled Outputs – time stamped analysis

   MV and LV feeder voltage and power flow profile charts at extremes (high, low and emergency configurations) for the following scenarios

    a. Base configuration – no additional Distributed Generation (DG)
    b. PV generation modelled at various rates until maximum is met on the LV network
    c. PV with battery systems and no "Virtual Power Plant (VPP)"

3. Modelled Outputs – time series analysis

   MV and LV feeder voltage and power flow profile charts over a 7-day period (high load and low load periods) based on actual feeder diurnal load curves for the MV feeder and representative customer class diurnal load curves for customers modelled on the LV network including: -

    a. Base configuration – no additional Distributed Generation (DG)
    b. Solar PV generation at various rates based on actual weather data for the period studied
    c. Solar PV coupled with onsite battery energy storage systems

This study will establish the methodology for modelling individual domestic solar PV coupled with battery systems and examine their impact on local LV and MV systems. This study will build a foundation for future roll-out of energy storage systems on the distribution grid network and wider system studies of: -

- Impact on urban and more rural MV networks
- More extensive application of LV and MV connected Solar PV with battery systems on the distribution network along with other DER types
- VPP operating in ESS Microgrid/embedded grid configuration
- VPP coordination for providing a certain number of Demand Response events
- VPP coordination for providing ancillary services to the grid operators
- Outputs that can be used for analysing the impact on the Transmission network

A graphical representation of the data and information flows using the Synergi Electric software package is presented in Figure 2 overleaf.

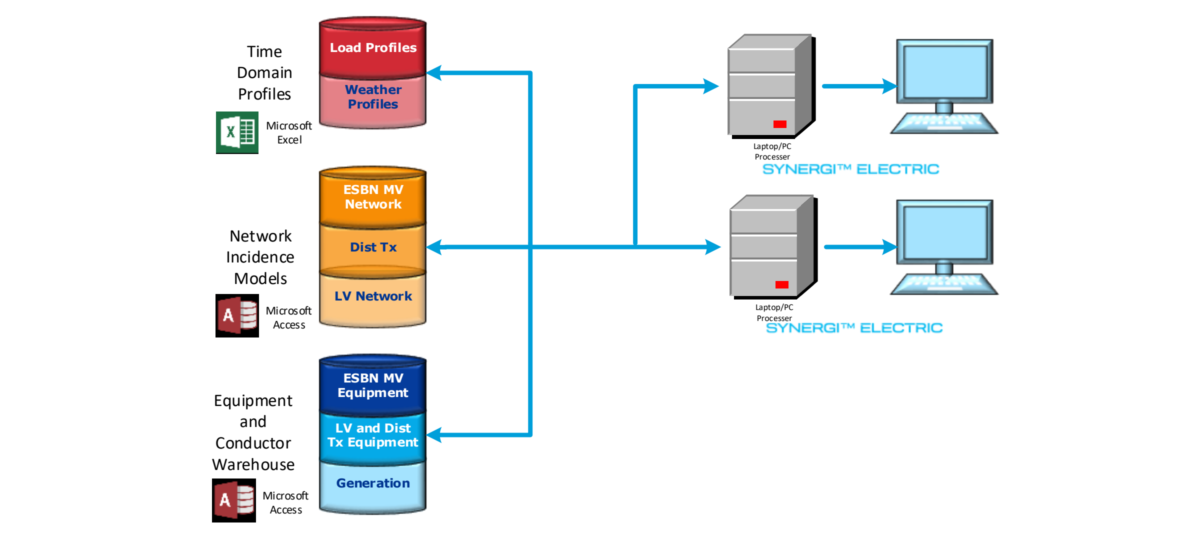

Figure 2 – Synergi Electric Data Flows

3 Schedule

As noted in Section 1, the project scope has been modified and updated. Key project tasks are presented in the Table below along with completion status. It is anticipated that the project will be complete and a final report submitted to the SEAI in February 2017.

Task	Description	Resources	Status
1.	Project planning	Solo, DP	Complete
2.	Technical review of Solo Energy ancillary services study	Solo, DP, ESBN, DNV GL	Complete
3.	Refine project objectives, partners, consultants, site location, technology partner etc,	Solo, DP, ESBN, DNV GL	Complete
4.	Scoping Workshop	Solo, DP, ESBN, DNV GL	Complete
5.	MV network model setup	Solo, ESBN, DNV GL	Complete
6.	LV network model development	Solo, ESBN, DNV GL	Complete
7.	Completion of network model	DNV GL	Complete
8.	Distributed generation model development	Solo, DP, ESBN, DNV GL	Complete
9.	Load and generation profiling	Solo, DP, ESBN, DNV GL	Ongoing
10.	Base Case Study	ESBN, DNV GL	Ongoing
11.	Solar PV **only** study	DNV GL	Starting Dec 2016
12.	Solar PV **coupled with storage** study	DNV GL	Starting Dec 2016
13.	Time domain studies	DNV GL	Starting Dec 2016
14.	Maximum impact studies	ESBN, DNV GL	Starting Dec 2016
15.	Reporting	Solo, DP, ESBN, DNV GL	Ongoing