INTESEM
Intelligent Solar Energy Management Pipeline from Cell to Grid

Project Duration: 01.2014 to 06.2017
Final report submitted: 11.2017

Publishable Summary

Solar energy will be a major source of electricity in the future. When more and more solar and other intermittent generation enters the system, we need new ways to balance load and generation to keep the energy system stable. A promising solution to optimise intermittent generation and storage assets, and to facilitate efficient distribution of energy to end users is a Virtual Power Plant (VPP).

A virtual power plant project "Intelligent Solar Energy Management Pipeline from Cell to Grid (INTESEM)" has targeted to optimise a distributed solar energy system (holistic from cell to grid) in a Virtual Power Plant model. The aim was to see if this would enable high photovoltaic (PV) penetration levels and at the same time minimise costs. The project has taken place in cooperation with Fortum and a Swedish solar inverter and energy storage provider Ferroamp. Ferroamp's bidirectional inverter brings smart flexibility and technology that increases the output of the system.

We have built a network of distributed solar assets with six commercial-scale PV plants located in Finland and Sweden. Aggregation of the separate PV sites in a VPP model has positive effects on a PV-based systems' production profile. The production becomes smoother and more stable from day-to-day meaning that the production profile becomes more predictable. Measured site data suggests that positive effects of aggregation are enhanced by sites far away from each other, as well as by PV panels with different directional and tilt angles. The aggregation of PV production from several sites is beneficial in many ways. The aggregation attenuates effectively fast power ramp ups and downs of single sites caused by changing cloudiness and the production profile of the aggregate is more constant from day to day than that of single sites. This improves the predictability of the daily production. With large number of sites, aggregation provides access to several markets that are not accessible to single PV sites which brings additional value to PV production. Even a relatively small number of PV sites (six in the study) is enough to induce positive aggregation effects.
The original target with the project was to gain a 15% reduction of solar energy cost per kWh and to capture a better value for energy with an intelligent system compared to a conventional one. The monetary effect of improved forecasting in a solar VPP without batteries is hard to estimate but for a PV-based VPP with storages the simulations show a 10-20% better revenue on the day-ahead market compared to a normal PV site. A solar VPP with batteries could even operate in a base-load like operation without excessive

oversizing of batteries about half a year in Finland and Sweden.

Project consortium

Coordinator and contact details:

Full name of organisation:	Fortum Oyj
First and family name of coordinator:	Riitta Ståhl
Full address:	Keilaniementie 1, 02150 Espoo, Finland
E-mail:	riitta.stahl@fortum.com

Participating countries and financing:

Country	**Number of organisations involved**	**Project costs in EUR**	**Public funding in EUR**
Finland	2	241’102	84’386
Sweden*	1	314’000	177’060
Total	*3*	*555’102*	*261’446*

Funding agencies involved and contracts

Funding Agency	**Contract N° and Title**
Tekes – the Finnish Funding Agency for Innovation	1243/13 18.12.2013 Intelligent Solar Energy Management Pipeline from Cell to Grid
Tekes – the Finnish Funding Agency for Innovation	-
Energimyndigheten (Swedish Energy Agency)	38323-1 INTESEM - Virtuellt kraftverk med distribuerade solceller och energilagring