Multi-Objective Role of Battery Energy Storages in Energy System

ETIP-SNET, Riga, 7.12.2017

Ville Tikka – LUT

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Outline

- The consortium
- The project overarching objectives
- The main lessons learned and barriers to innovation deployment
- The next project steps
- Needs for future R&I activities coming out of the project (if any !)
- Deployment prospects of the most promising solutions.

Partners and funding

Partners and funders:

Sähkötutkimuspooli (Electricity Research Pool), STEK (Promotion Centre for Electrical Safety), Helen, Helen Electricity Network, Fingrid, Landis+Gyr, LUT

Budget and schedule:

140 k€, 12/2016 – 12/2017

Sähkötutkimuspooli
(Finnish Elecrcity Reseach Pool)

Landis+Gyr

STEK

Sähköturvallisuuden Edistämiskeskus ry

(Promotion Centre for Electrical Safety)

FINGRID

HELEN

HELEN SÄHKÖVERKKO

Open your mind. LUT.
Lappeenranta University of Technology

Motivation

- EC currently encourages 1) the increase of efficiency, flexibility, safety, and power quality in distribution grids and 2) to fully exploit potential advantages from RES, DG, DR, and Energy Storage Systems
- Stationary and mobile BESS play a significant role in modern energy systems
- Multi-objective operation of distributed BESS could lead to lower socio-economic costs, but might also cause conflicts of interest

The main research questions

I. **How to optimize the stakeholder -specific utilization of an individual BESS for different purposes** (e.g. peak-cutting, control of frequency and voltage, optimization of reactive power balance, electricity trade in day-ahead, intraday, and ancillary markets, back-up power for end-user / network, etc.)?

II. **How to optimize the operation of a system with multiple battery energy storage systems** with different sizes, locations, and owners?

III. **Implementation of control system?**

Present project and further questions

Multi-objective role of battery energy storages

- **Interactions** between different storage applications different owner/operator background
- **Operation strategy** of individual and multiple storages
- **Stakeholder** –specific strategy
- **Feasibility and profitability** of battery energy storages in different multi-use cases
- **Implemantion** of control strategies into existing storages (Suvilahti, Suomenniemi, LUT Greencampus)

PHASE I

New business models for energy storages

- Role of different stakeholders
- New services for energy markets
- …

Network effects of energy storages

- Impacts of distribution business
- Technical effects of storages
- Integration of energy storages in the long-term planning of networks
- …

Legislation and regulation

- Barriers of present regulation
- New market rules for energy storages
- …

Test sites, (build on earlier projects)

Suvilahti, 2016
(Helen)

600 kWh, 1.2 MW
~15 000 LTO Li-ion cells

Green Campus, 2016
LUT

132 kWh, 188 kW
230 pcs $LiFePO_4$

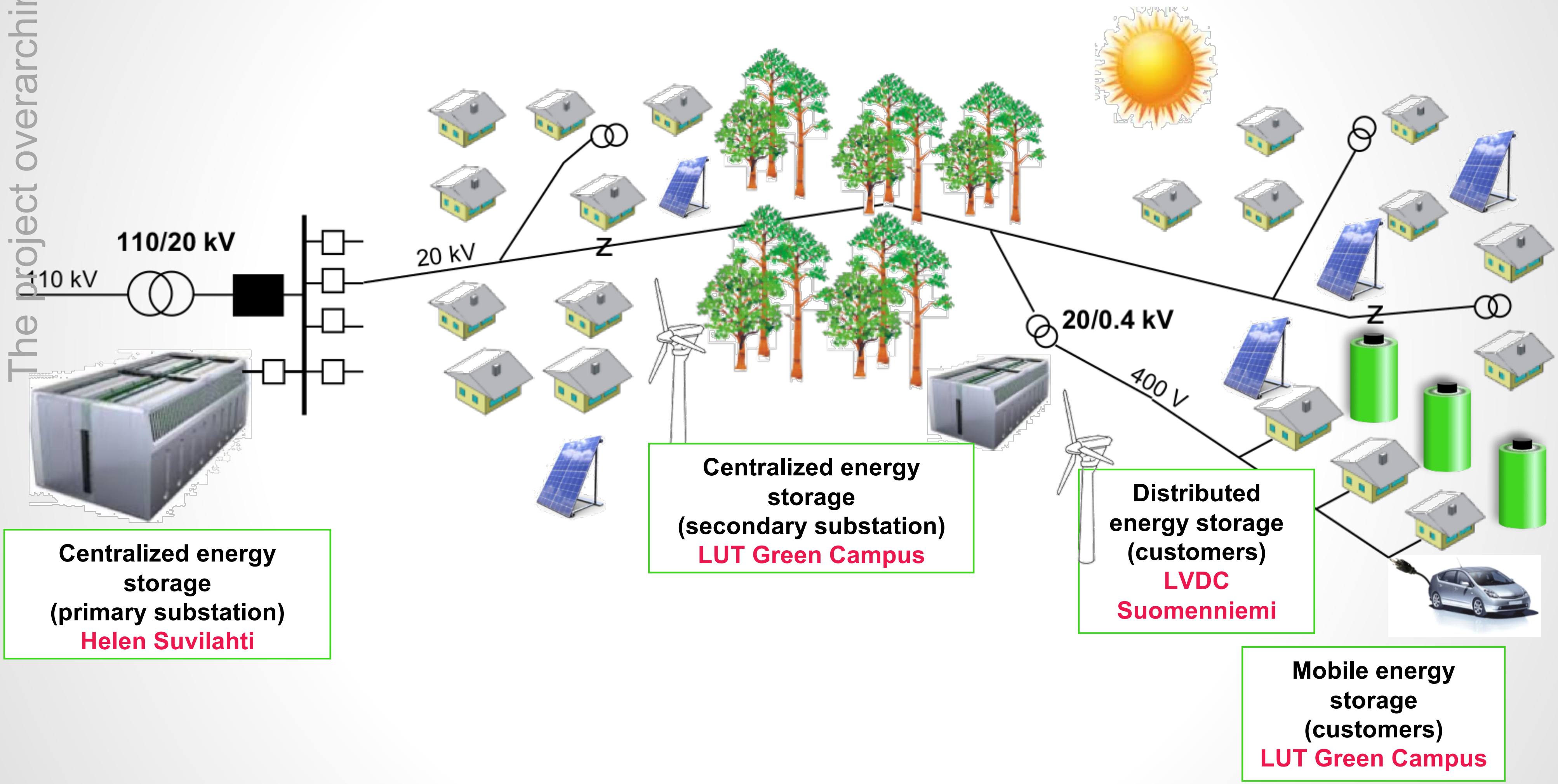
LVDC microgrid, 2014
(Suur-Savon Sähko/LUT)

2x30 kWh, 2x30 kW
2x235 pcs $LiFePO_4$

V2G hybrid, 2014
LUT

1.3kWh, 27 kW (NiMH) + 4.3 kWh, 3 kW ($LiFePO_4$)

Test sites, (build on earlier projects)



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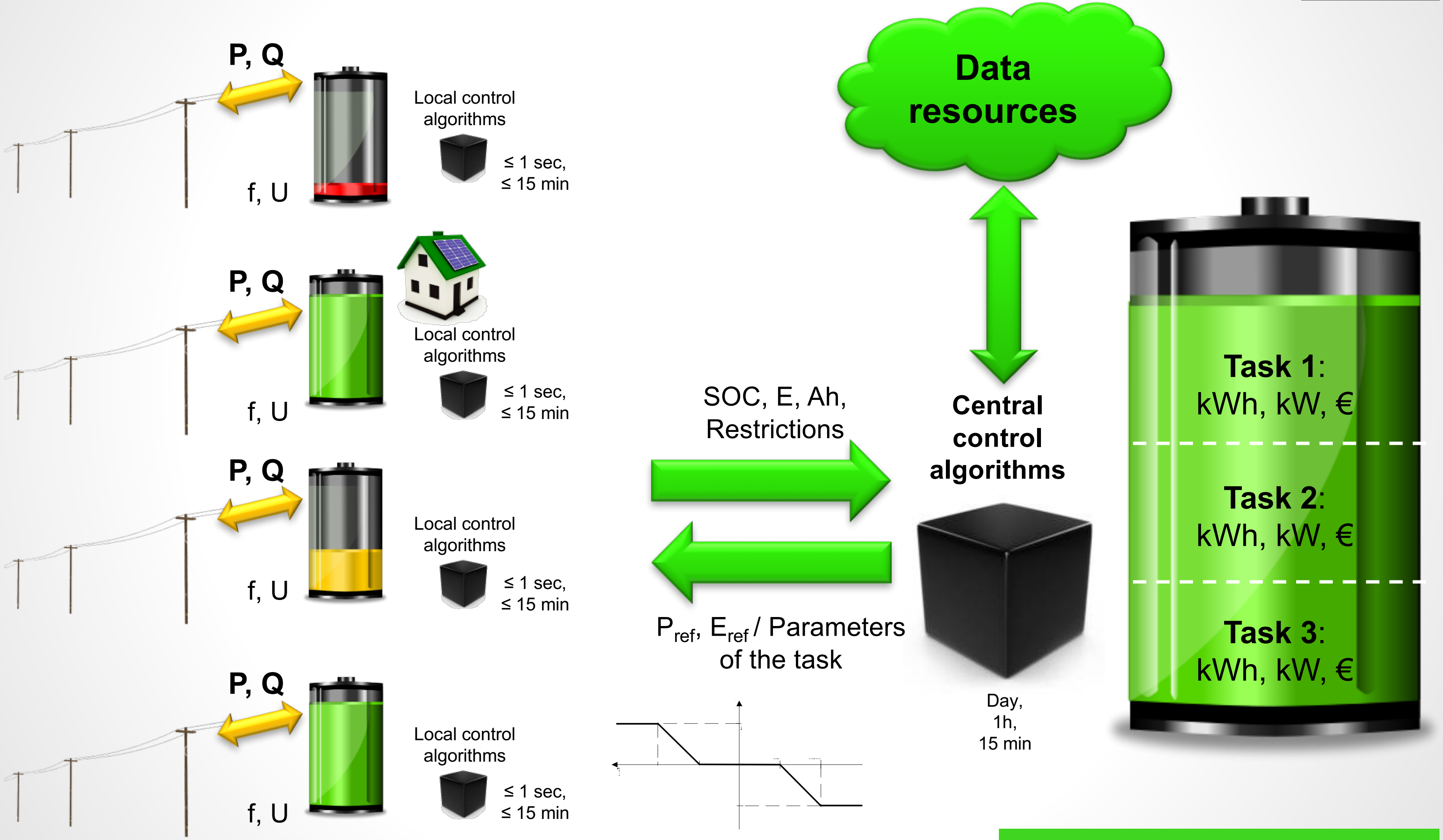
Multi-objective control concept for distributed BESS



Multi-objective control concept for distributed BESS (generic control architecture)

Control system communication

Control system level	Control system tasks	Input data for control
Centralized, data center / cloud computing	Decisions for next n hours	Data resources • Electricity markets • Weather forecasts • Weather observations • Etc.
Distributed on site	Centralized control plan execution	Data resources • Local grid status • Other locally observed variables
Hardware control on site	Hardware control, U, I, P, f, etc.	Data resources • Grid frequency • U, I, P

Master server and monitoring UI

- “Standard” VPS Linux server running control algorithms
- All applications based on open source software
- Open VPN and Cisco VPN solutions in parallel
- Web based monitoring UI

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Lessons learned

- Difficult to replace existing communication infrastructure
  - Novel communication architectures aren't that easy to sell

- Legislation, regulation (not really barrier to research)

- System integration may be challenging in technology implementation oriented projects
  - closed vs. open source approached
  - System integration has certain challenges (even when there are experts doing integration), communication, sharing information

- Complexity of the optimization problem increases rather quickly as unique resources are added to system

Needs for future R&I activities coming out of the project

Open questions and future research

- Optimization of resource utilization?
  - What are optimization methods suitable for the job?
- Business models for battery storage resources?
  - Battery storages as service for DSO (does not meet with winter package)
  - FCR, demand response, balance management, etc.
- Communication architecture development?
  - IoT approach?
  - Are present IEC standardized protocols fit for the job?
- How to enable easier access to markets?
  - What is market for such a resource?
- Legislation?
  - Taxing, regulation models, subsidies
- Network effects?
  - Different effect on different levels of the grid
- …

Project status and next steps

- Project targets mostly fulfilled by December 2017
- Resource testing will continue till the closing of the project December 2017
- Final seminar will be held in Helsinki 19.12.2017 (in Finnish)
- Final report will be published within the December 2017
  - In English and available via Finnish Electricity Research Pool
- Preparation of continuation in some form (following project/s)

Deployment prospect of the most promising results

- Control/communication architecture is industry-proven
  - Similar centralized control approach can be implemented
- Control logics developed within the project
  - Payback is noticeably shorter if batteries are operated on multi-application fashion
- Batteries enable microgrids (island mode, UPS applications, etc.)
- Pilots sites provide enormous amount of “real life” data

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