Modelling of energy storage

Examples on Fortum's energy storage cases

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Short intro about me

Ilari Alaperä, D.Sc. (Tech)
Business Development Manager
Fortum Spring

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Work history

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+4 years with Fortum Spring
Responsible for our battery business

ABB

6 years with ABB
Various roles in R&D and product management

Education

LUT University

Doctor of Science (Technology)
In the field of Energy Systems

UNIVERSITY OF OULU

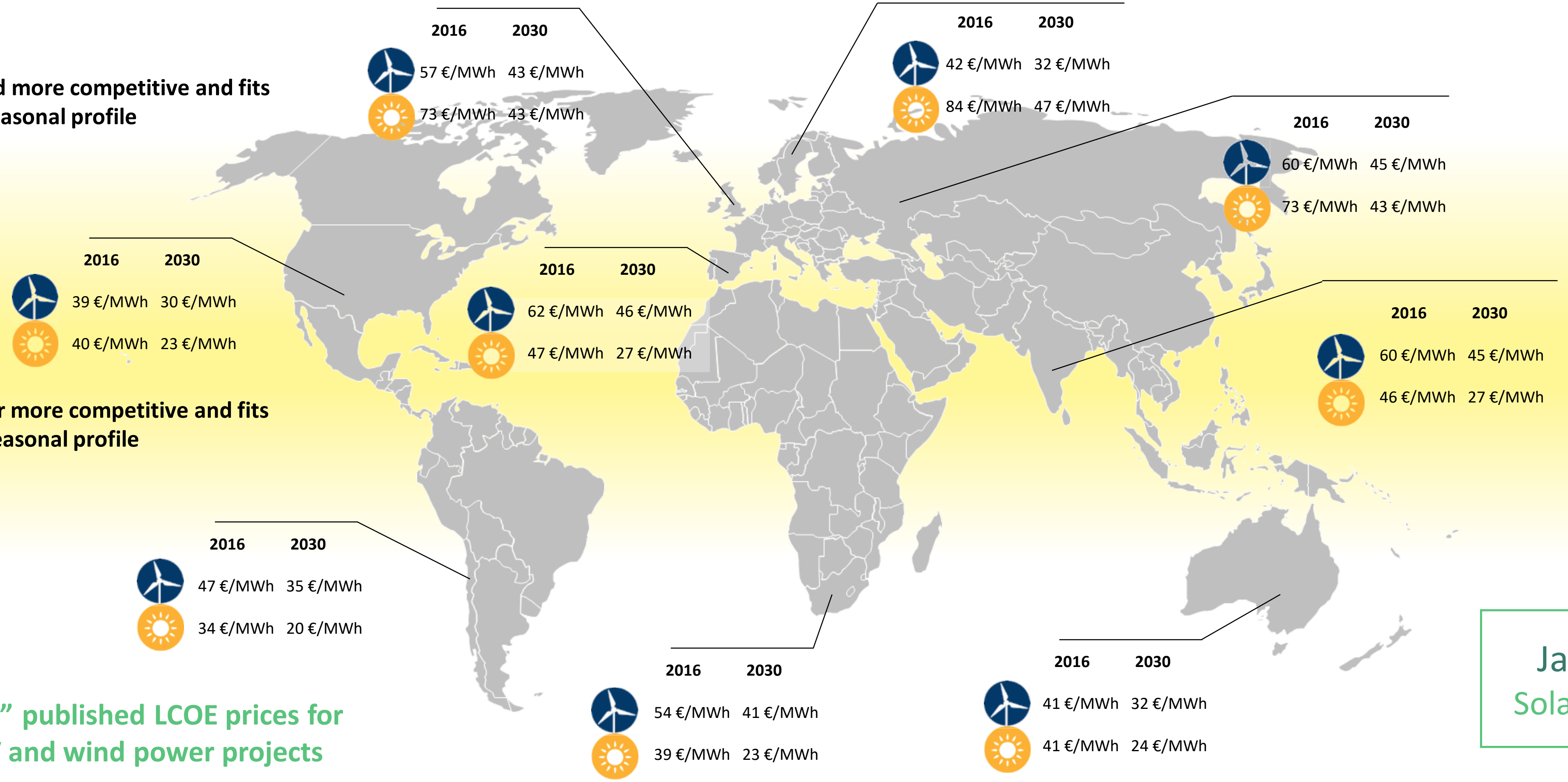
Master of Science (Technology)
In the field of Electrical Engineering

Future energy system

Increase in renewable energy is drive by cost, not (only) by environmental values

Wind more competitive and fits to seasonal profile

Solar more competitive and fits to seasonal profile



- **Clear seasonality**
- **Wind most competitive**
- **Intermittent power**

- **Low seasonality**
- **PV most competitive**
- **Intermittent power**

“Recently” published LCOE prices for solar PV and wind power projects

Jan 2020, Qatar
Solar PPA: 13€/MWh

NOTE: Solar and wind resources and CAPEX may largely vary by individual projects, even on same region, thus impacting LCOE. Hence, figures are indicative and do not aim to present our geographical preferences for given technologies but rather illustrate progress of wind and solar globally, long-term.

PV LCOE assumptions based on EU PV Technology Platform report and EU PVSEC 2015 paper. Wind CAPEX and OPEX Sweco: Incitamenten för investeringar i kraftproduktion, Capacity factors from BNEF LCOE low case. Indicative wind capacity factor for Russia from IFC Advisory: Services Russia’s New Capacity-based Renewable Energy Support Scheme

LCOE assumptions:
- 6% real WACC
- CAPEX, OPEX globally uniform; lifetime solar 30y, wind 25y
- Assumption that capacity factor will increase for solar 7,5% and wind by 15% from 2016 to 2030
- 20% higher CAPEX for the rest of the world compared to low cost Nordic
- Uniform 20% corporate tax assumed

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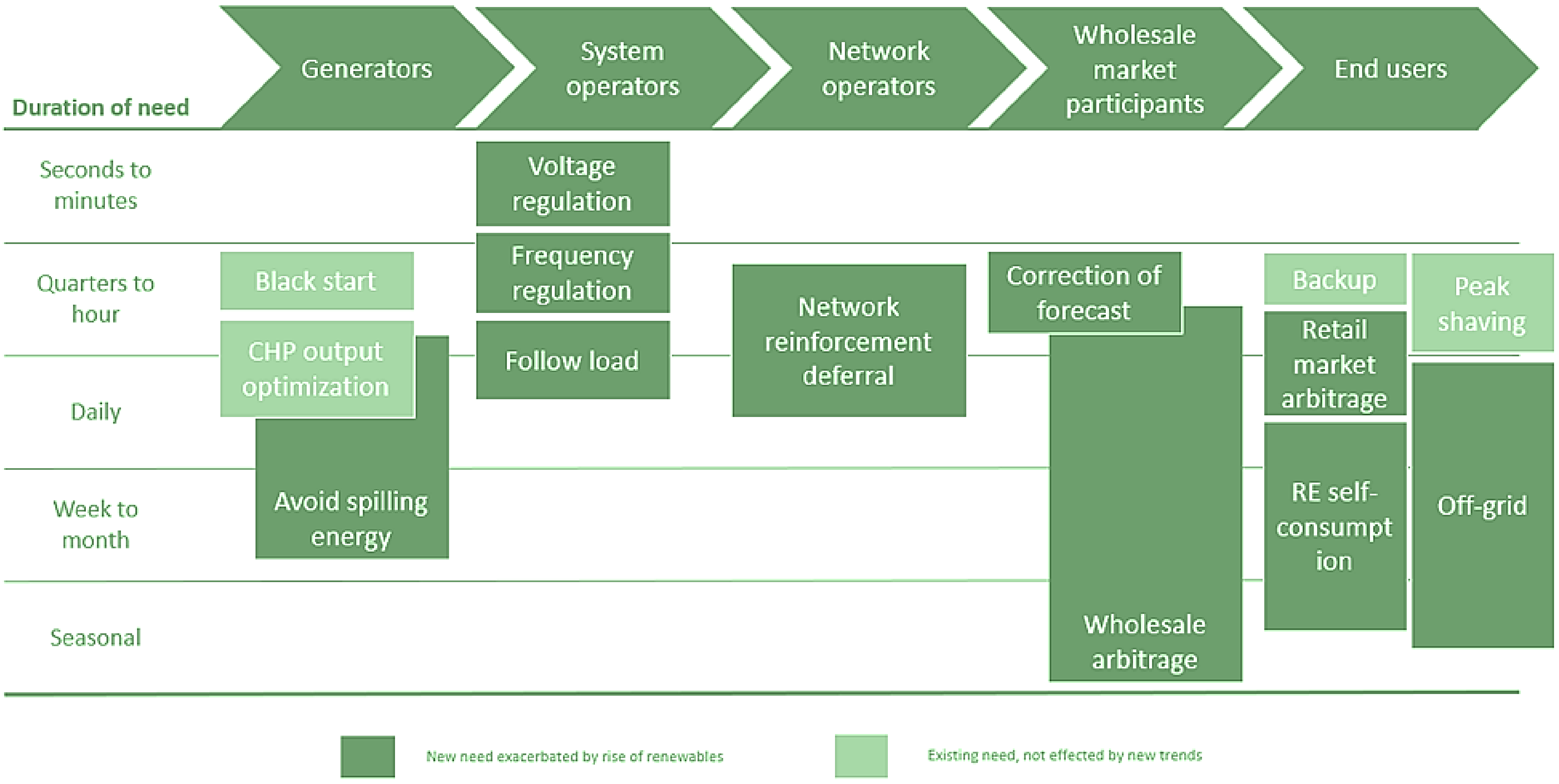
Need of energy storages along the value chain

Need of storages is directy or indirectly driven by increasing amount of renewable energy



Data Source: IEA, Roland Berger

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Fortum’s battery references

Piloting in different areas

Fortum generation

BatCave (2 MW / 1 MWh)
Operational since March 2017

Fortum's first battery project, installed to our CHP plant in Järvenpää, Finland. Main application is FCR in (virtual) combination with Fortum's Finnish hydropower assets

Bat2 (5 MW / 6.3 MWh)
Operational since May 2018

Fortum's first Swedish battery project, installed at a Fortum hydropower plant in Forshuvud, Sweden. Main application is to locally support the hydro turbines in FCR

Distribution system operators (DSOs)

Kuru (0.3 MW / 0.22 MWh)
Operational since August 2019

A first DSO battery case, installed near Tampere, Finland. Main applications are to provide local security to supply and reactive power management services for the DSO and to participate for FCR when not used for DSO needs

Degerö (1MW / 1 MWh)
Start of operations August 2020

A larger DSO battery case, to be installed near Espoo, Finland. The main applications and usage are similar as in the case above

Other customers

Aurora (0.1MW / 0.1 MWh)
Operational since September 2019

A first datacentre battery case, installed at Oulu, Finland. In the case Fortum invested in a battery system of a datacentre UPS. The main applications are local back-up for the IT-loads of the datacentre and FCR

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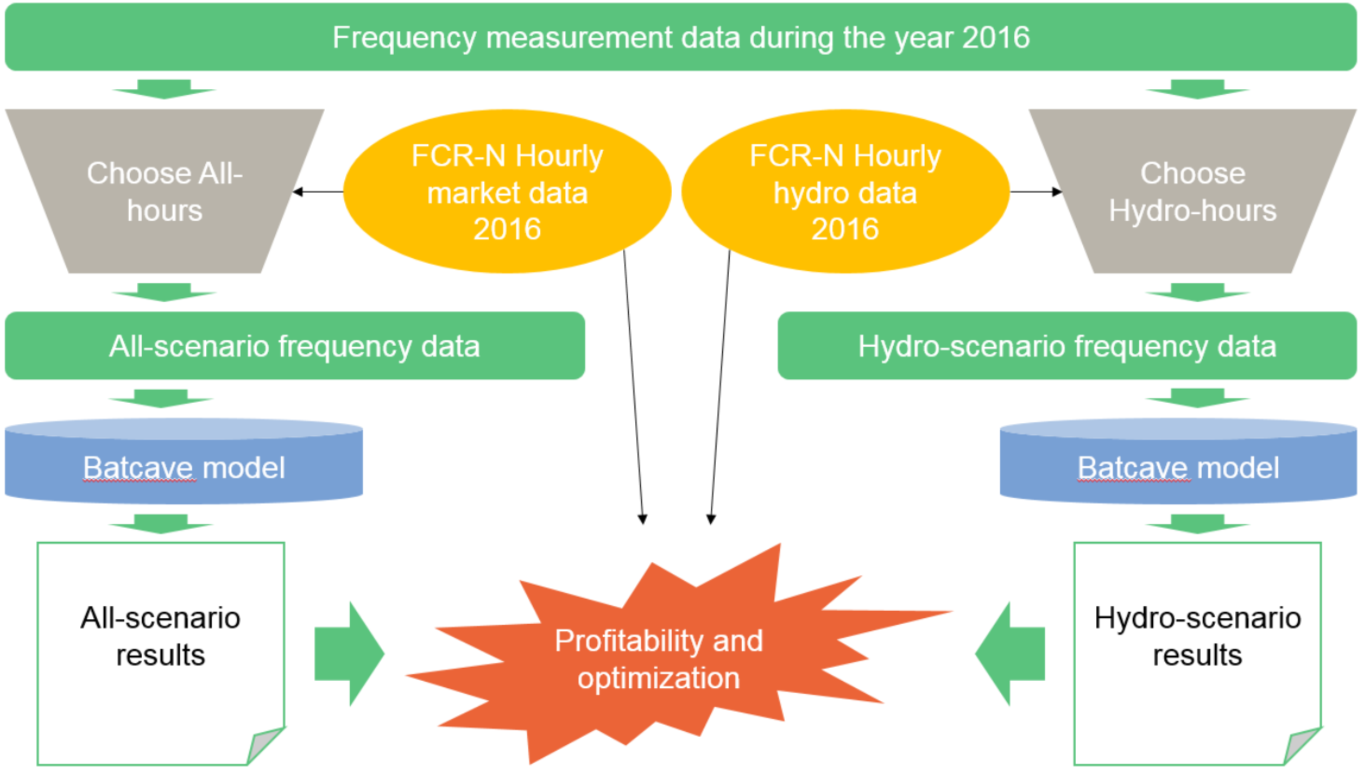
Energy storages with Fortum generation

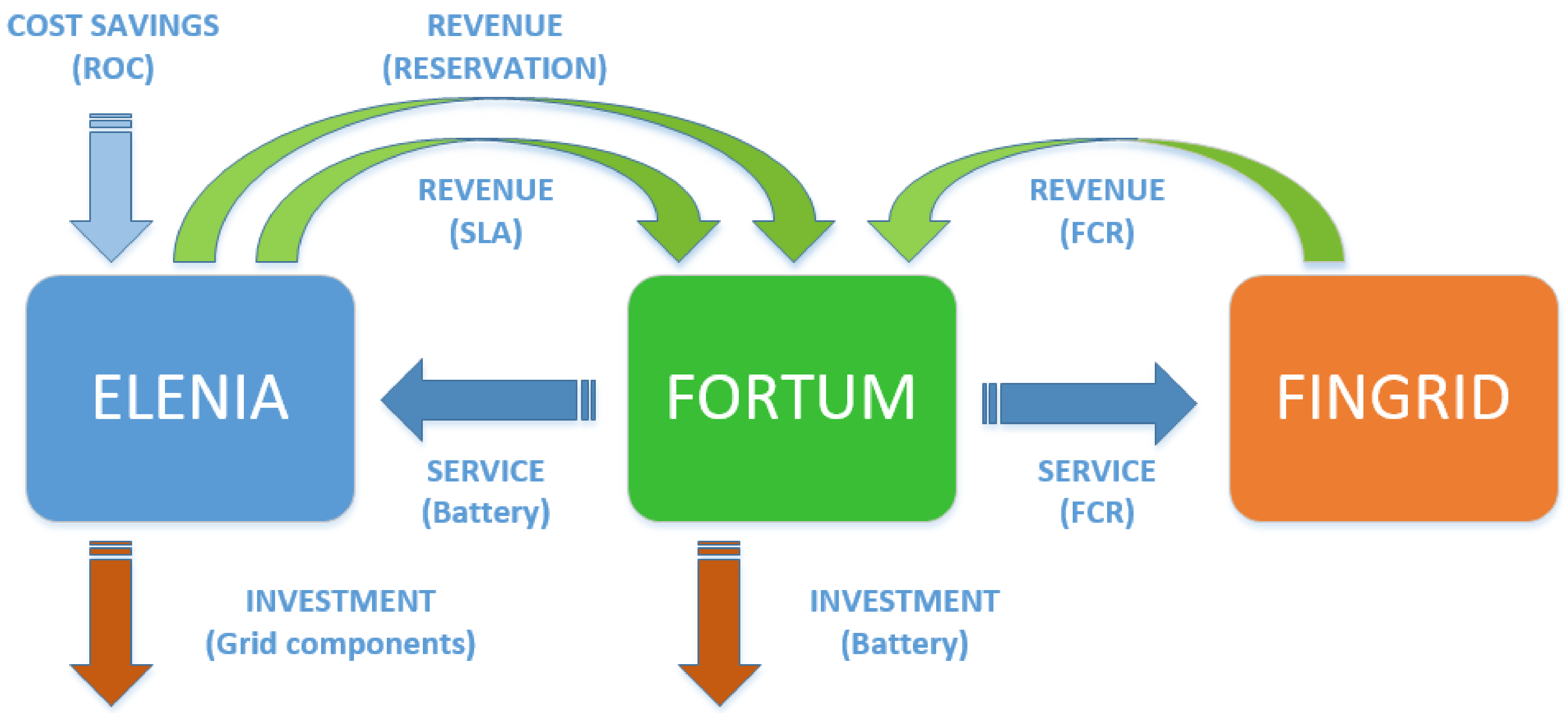
BatCave and Bat2 | Operational synergy with hydro power



Source: N. Saulny Operation and Profitability of Batteries in Electricity Reserve Markets

Energy storages in DSO networks

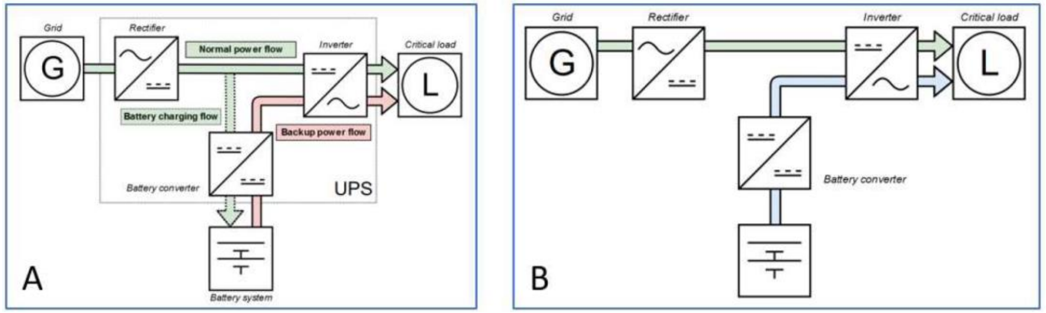
Using capacity services to defer grid reinforcement

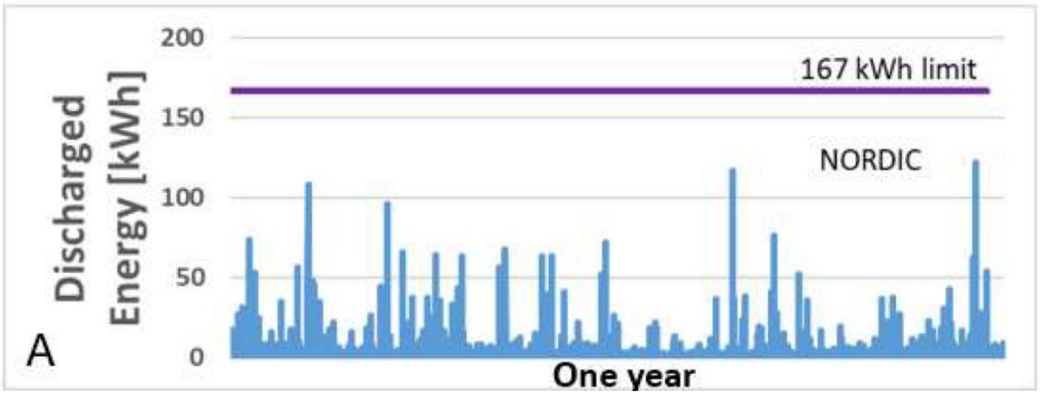


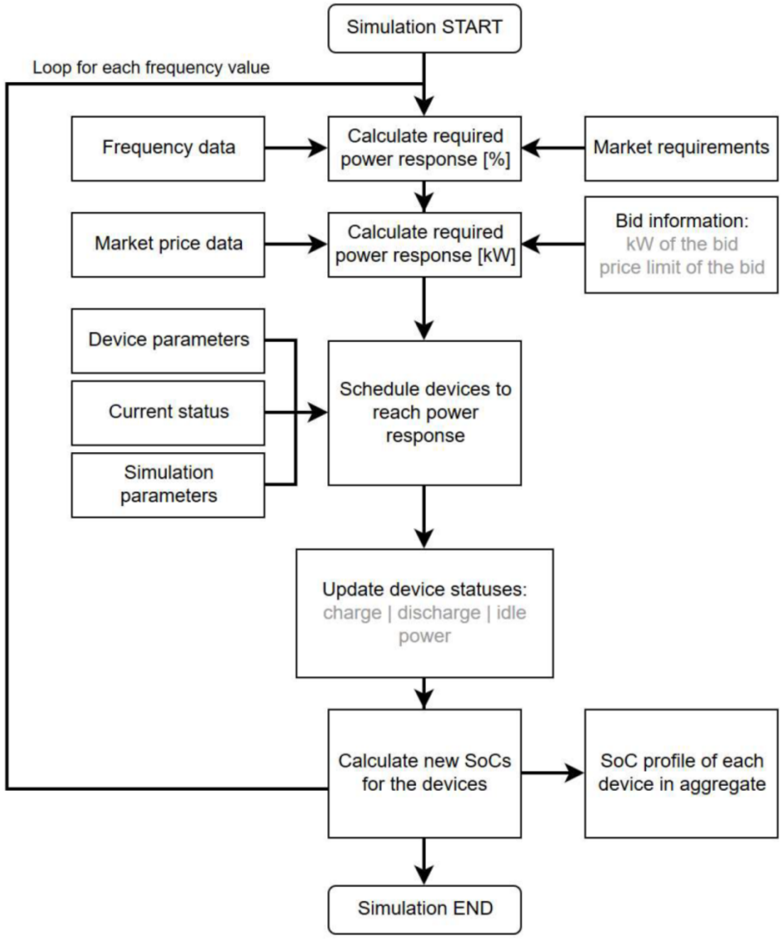
Source: I. Alaperä Grid Support by Battery Energy Storage Secondary Applications

Energy storages in datacenters

Utilizing existing batteries and/or datacenter infrastructure







Source: I. Alaperä Grid Support by Battery Energy Storage Secondary Applications

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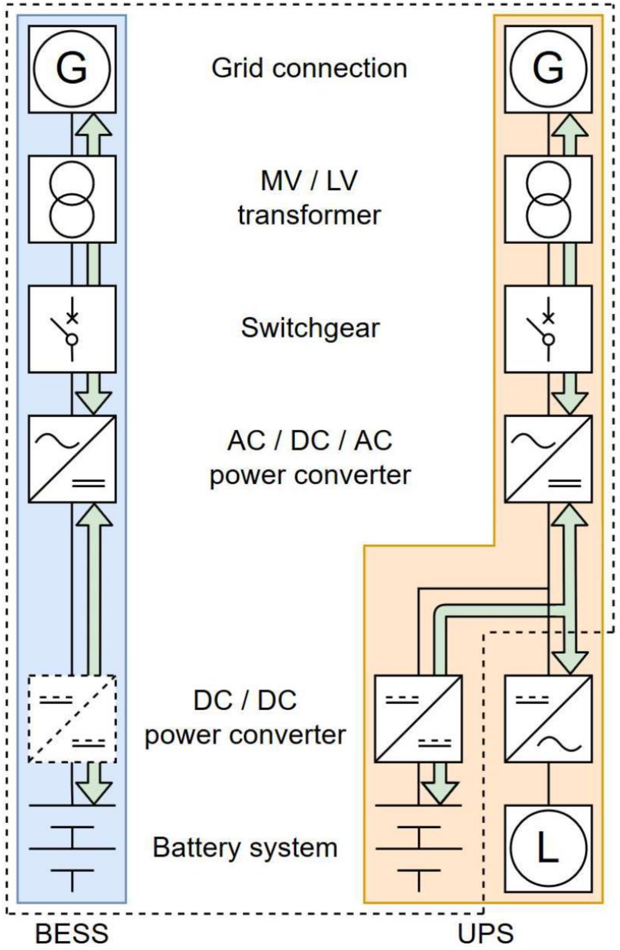
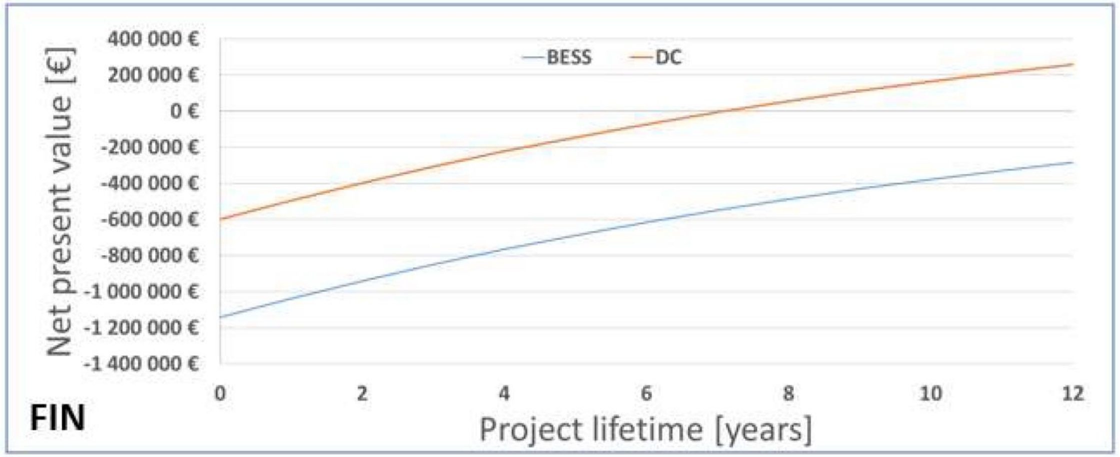
Energy storages in datacenters
Utilizing existing batteries and/or datacenter infrastructure





$$R_{exp} = \beta * \sum_{h=0}^{h} (C_h * MP_h * \alpha_h)$$

$\beta = Bid\ acceptance\ percentage$

$h = hours\ on\ the\ market$

$C_h = Bidded\ capacity\ (for\ the\ hour)$

$MP_h = Market\ Price\ (for\ the\ hour)$

$\alpha_h = Availability\ (for\ the\ hour)$

Source: I. Alaperä Grid Support by Battery Energy Storage Secondary Applications

Questions and answers

Feedback, discussion and comments

Thank you!

Feel free to add me on LinkedIn or to contact me by email in case you would like to clarify something or continue the discussions