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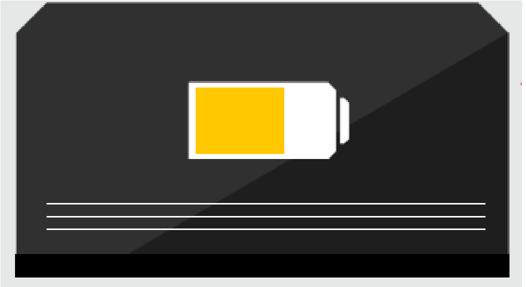
BATTERY ENERGY STORAGE SYSTEM

Kristiina Siilin, 3.10.2018

CONTENTS

SUVILAHTI BESS 1.2 MW/ 600 KWH

- **INVESTMENT DECISION WAS MADE AS A RESULT OF CITYOPT PROJECT**
- **BESS WAS COMISSIONED IN 2016**
- **TOSHIBA'S TECHNOLOGY (SCiB, LITHIUM TITANATE CELLS)**
- **1.2 MW / 600 KWH (1.8 MW OVER POWER FOR 30 SECONDS)**
- **CONNECTED TO LOCAL 10 KV GRID**
  - **Same grid connection point as with the 340 kWp solar power plant**
- **LIFETIME 10 YEARS / 15 000 CYCLES**
- **PROVIDES A RESEARCH PLATFORM FOR BENEFIT STACKING STUDIES**



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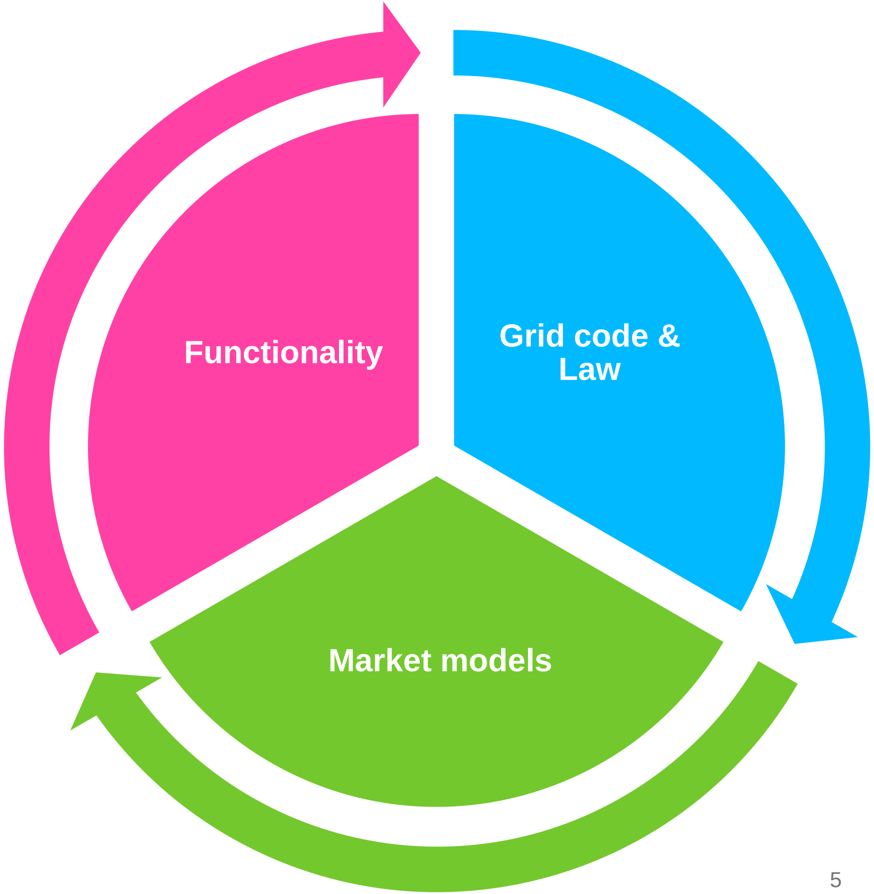
FINGRID HELEN HELEN SÄHKÖVERKKO

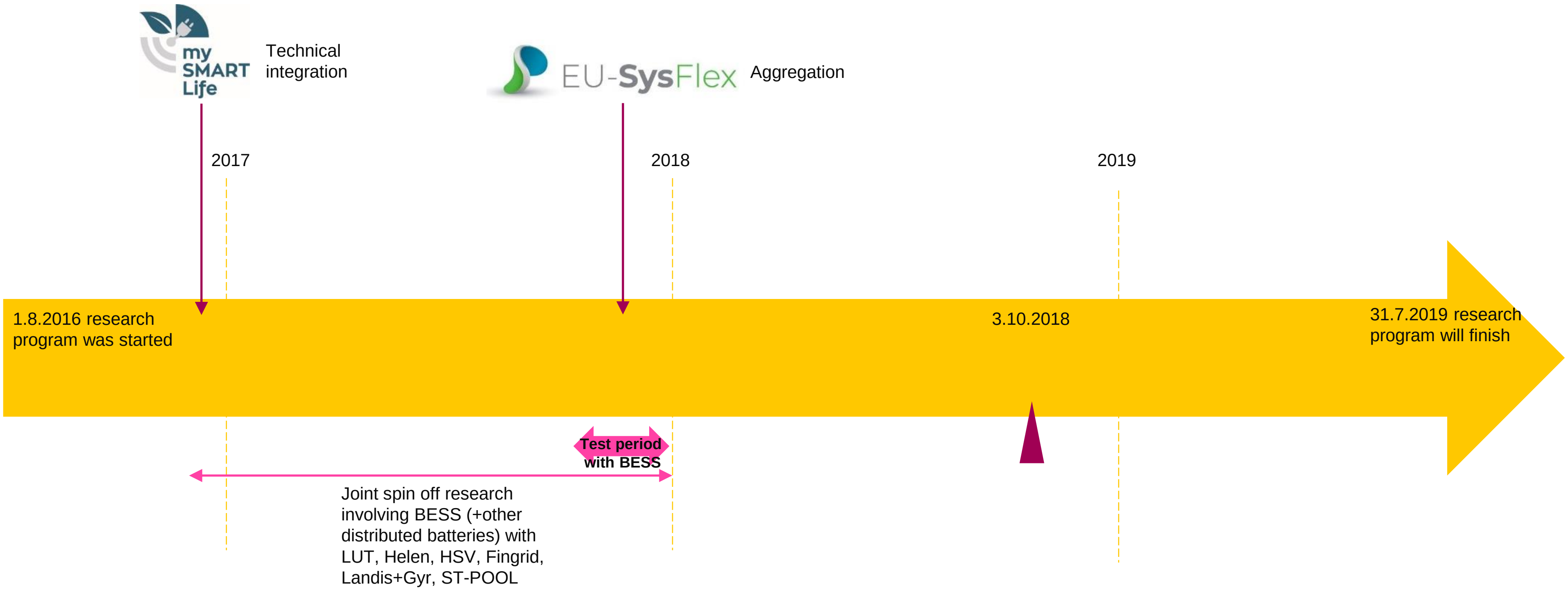
3 YEAR RESEARCH PROGRAM ON-GOING (2016-2019)

OBJECTIVE OF THE PROJECT

- **Use cases and benefit of BESS**
- **Who controls and determines the priority of BESS functionality?**
- **Optimized return on investment, how to combine different market positions?**
- **How many functions can be run simultaneously by the BESS?**
- **What is the role, demands and impact of the BESS in the future energy system?**



3 YEAR RESEARCH PROJECT



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AIMED OUTCOMES OF THE PROJECT

- Suitable market environment for the BESS
  - ✓ Cancellation of double taxes
  - ✓ Valuable market place to provide ancillary services
  - ✓ No conflicts of interest between stakeholders

- Reliable operation of the system
  - ✓ Reliability of service provision
  - ✓ Preparation for external conditions

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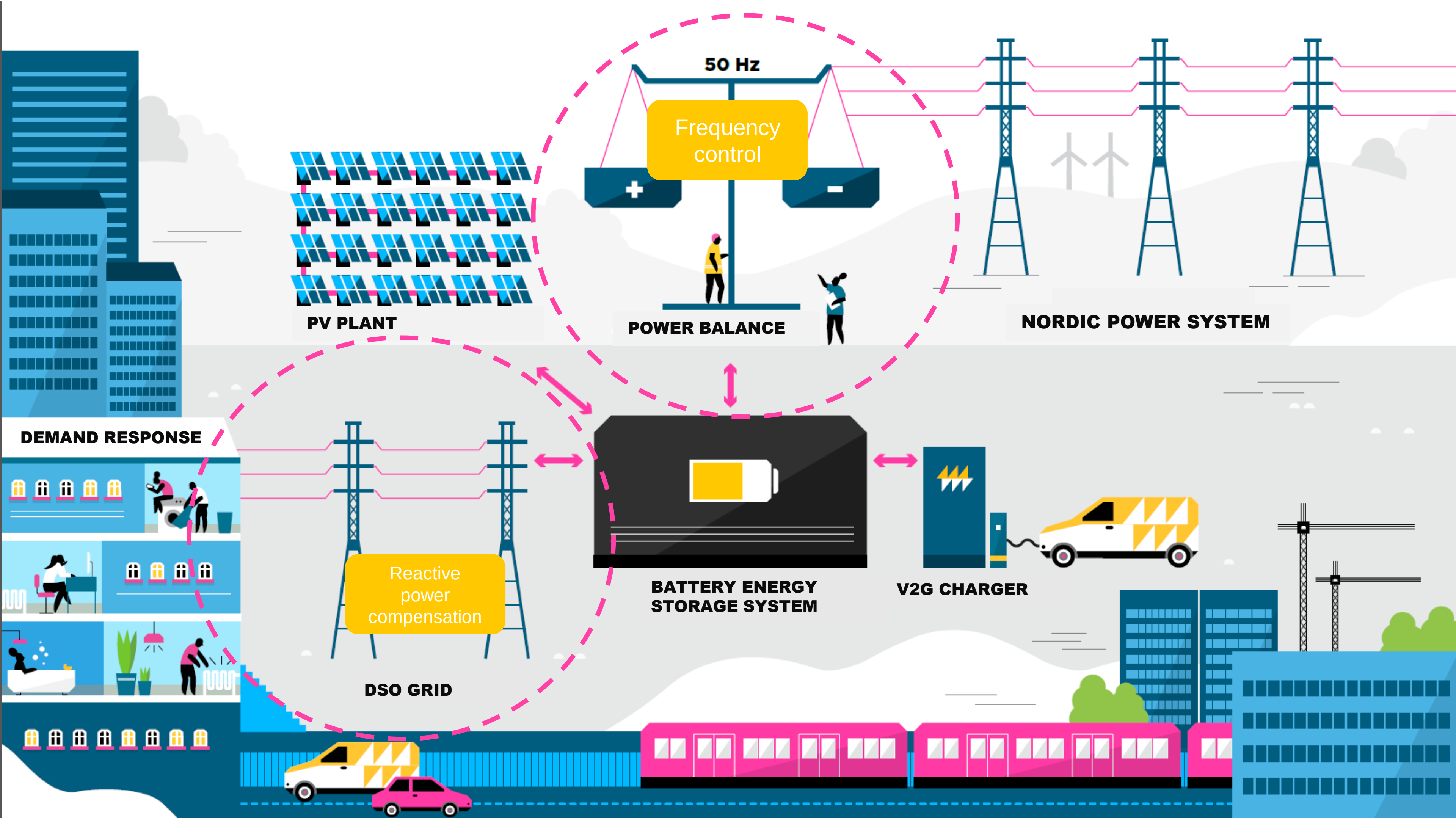
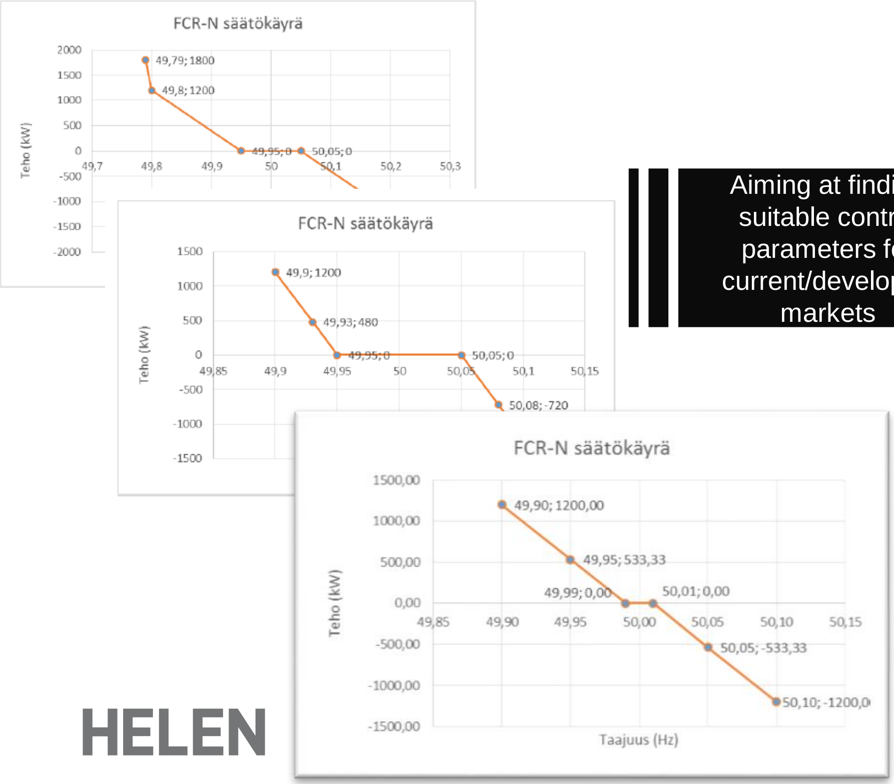

50 Hz
Frequency control
PV PLANT
POWER BALANCE
NORDIC POWER SYSTEM
DEMAND RESPONSE
Reactive power compensation
DSO GRID
BATTERY ENERGY STORAGE SYSTEM
V2G CHARGER

BESS STUDY CASES

Frequency control



Aiming at finding suitable control parameters for current/developed markets

Bisnes use case: FCR-N

Market place	Type of contract	Minimum bid size	Market gate closure (EET)	Activation time	How often activated	Price level 2018 *)
Frequency controlled normal operation reserve	Yearly and hourly markets	0,1 MW	Yearly market previous autumn, hourly market day before at 18:30	3 minutes	Several times a day	14 €/MW,h (yearly market)

Market restrictions:
BESS must be controllable for 30 min. with accepted power to both directions
→
Available capacity of Suvilahti BESS in FCR-N market is only 600 kW

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RELEVANT QUESTIONS

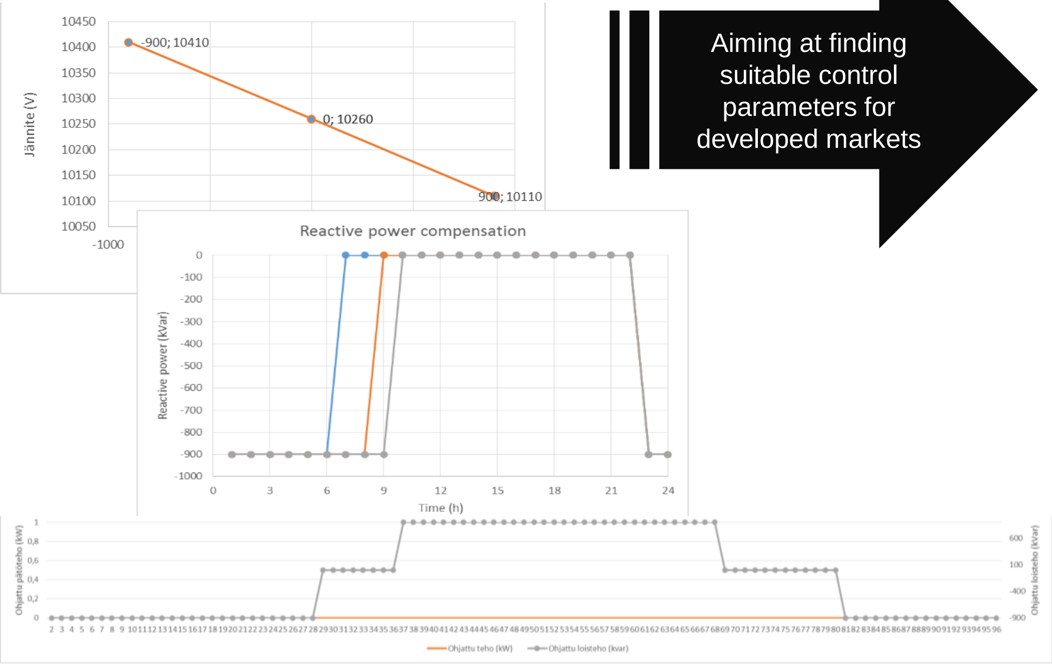
WHAT IS THE RELIABILITY OF SERVICE PROVISION?

WHAT ARE THE COSTS AND REVENUES?

HOW TO AGGREGATE DIFFERENT RESOURCES INTO ONE MARKET?

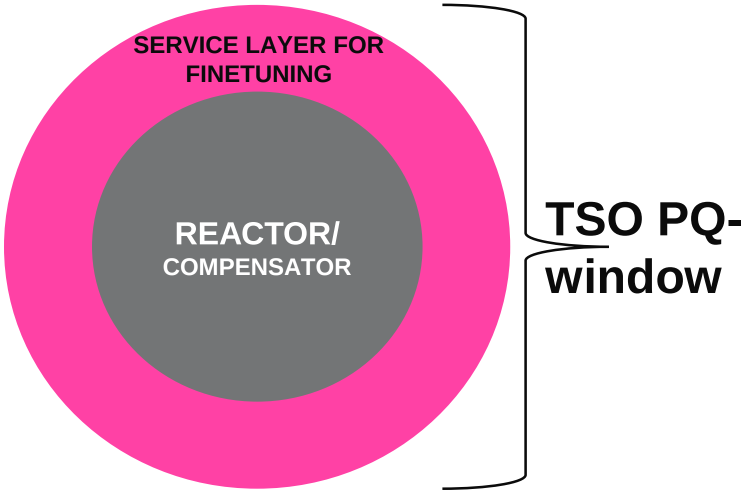
BESS STUDY CASES

Voltage control



Aiming at finding suitable control parameters for developed markets

SysFlex project, Bisnes use case: Reactive power market place



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RELEVANT QUESTIONS

MARKET SPECIFIC QUESTIONS: MARKET LOGIC

ECONOMICAL QUESTIONS: VALUE OF THE RESOURCES/MARKET

TECHNICAL QUESTIONS: LOCATION OF REACTIVE POWER

COMPENSATION NEEDS, FEASIBILITY OF THE RESOURCES

PUBLICATIONS

- **Benefits of Battery Energy Storage System For System, Market and Distribution Network – Case Helsinki** http://cired.net/publications/cired2017/pdfs/CIRED2017_0810_final.pdf

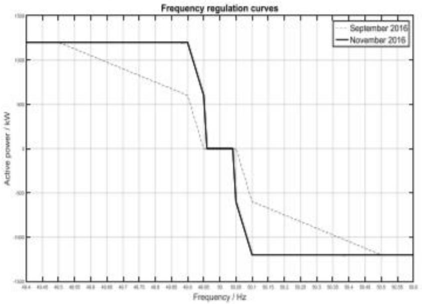

Figure 1: Frequency regulation curves in September and November 2016.

- Abstract for 2nd CIRED paper has been submitted and if accepted the full paper will be presented in June 2019 in Madrid

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CIRED 24th International Conference on Electricity Distribution Glasgow, 12-15 June 2017

Paper 0810

BENEFITS OF BATTERY ENERGY STORAGE SYSTEM FOR SYSTEM, MARKET, AND DISTRIBUTION NETWORK – CASE HELSINKI

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ABSTRACT

This paper presents the first performance results of a large battery energy storage system (BESS) that is connected to a medium voltage distribution network and used simultaneously by multiple stakeholders. The paper presents the background of the purpose of a BESS as part of the Nordic power system and markets, and the functionalities it is able to perform. The first test cases ran in the fall 2016 included simultaneous controls of frequency, reactive power and voltage according the requests from Transmission and Distribution System Operators. The results showed that the first functions of the BESS performed were successful. Valuable experience has also been reached when observing e.g. the energy capacity limits of the batteries.

INTRODUCTION

In August 2016, Helen Ltd commissioned the largest Battery Energy Storage System (BESS), "Suvilahden sähkövarasto", in Nordic countries. The BESS, rated 1.2 MW / 600 kWh, was built by Toshiba Transmission and Distribution Europe S.p.A. using Toshiba's state-of-the-art SCIB battery modules and supplied to Helen by Landis + Gyr Ltd. It is located in Suvilahti, an urban district in downtown Helsinki, the capital of Finland. The BESS is installed next to a primary substation of the local Distribution System Operator (DSO), Helen Electricity Network, where Helen commissioned Finland's first large-scale (380 kWp) solar power plant in April 2015. Both the BESS and the solar power plant share the same connection point to the DSO's 10 kV medium voltage network.

BACKGROUND

During the first three years of operation, the storage is used as a research platform by Helen, an energy retailer and producer, Fingrid, the national Transmission System Operator (TSO), and Helen Electricity Network, the DSO of Helsinki. The main objectives of the research are to:

1) investigate the practical feasibility of the benefit stacking on a single BESS for multiple services and beneficiaries,
2) determine the value of the fast and accurate response of the BESS in ancillary service markets and finally,
3) further develop the open market places to extract the most benefit from the storage technology.

Helen as an energy retailer pursues the electricity storage for the smart grid integration, ancillary market operations and the development of end customer services. Fingrid's main aim is to test the electric storage as a versatile resource for power system frequency control, and Helen Electricity Network will investigate the usage of the BESS for the control of reactive power and voltage, the demand response, and the peak shaving functionality. Similar research projects of multiuse of a BESS have previously been presented e.g. in [1] and [2].

The three-year research period started in the beginning of August 2016 and the first set of practical tests has been concluded. The first tests focused on the technical capability of the BESS to execute simultaneous functionality requests from multiple stakeholders.

Frequency control

Fingrid is responsible for reserve power markets that include Frequency Containment Reserve for Normal operation (FCR-N) to maintain the system frequency in the normal area between 49.9 Hz and 50.1 Hz. FCR-N must be able to both increase and decrease power. It shall be activated in full in three minutes. In addition, there is the Frequency Containment Reserve for Disturbances, FCR-D. FCR-D is activated in low frequency 49.5-49.9 Hz and only needs to control the frequency upwards by increasing generation or decreasing load. The time frame for FCR-D is 5 to 30 seconds. In the interconnected Nordic system, the amount of FCR-N is 600 MW, and the amount of FCR-D is normally 1200 MW. The share of Finland is approx. 140 MW of FCR-N and 220-265 MW of FCR-D. [3]

One of the most promising applications of the BESS is the participation in FCR. The BESS can perform either FCR-

LESSONS LEARNED

- Technical lessons to learn
  - In which conditions does the BESS operate most reliably?
  - What constraints does the TSO set for service provision?
- The inputs into the operating environment take long time

- Barriers: markets have not evolved as anticipated in 2016

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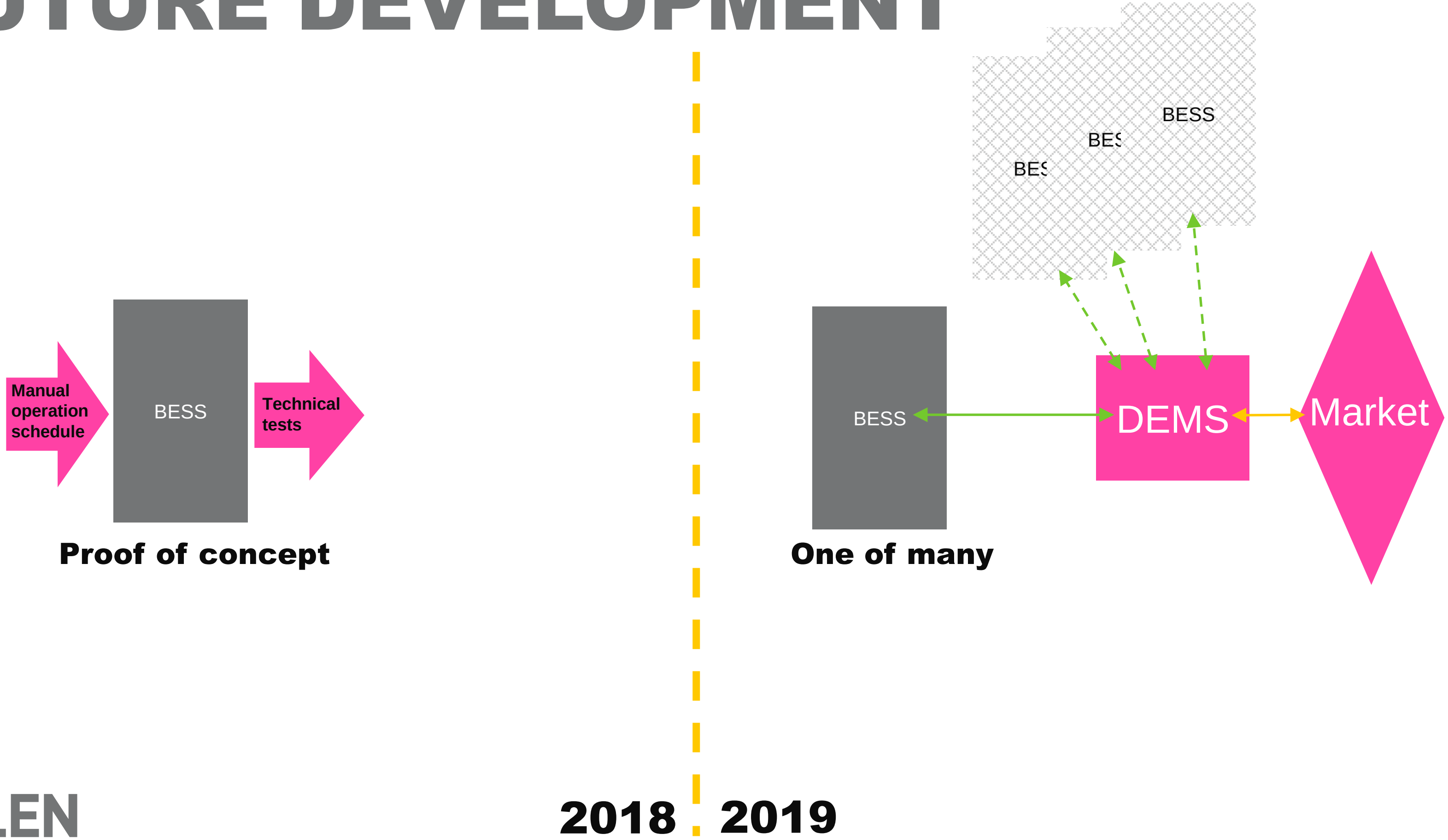
FUTURE DEVELOPMENT



CONCLUSIONS

- Three-year research project is coming to an end
- Technical feasibility and limitations have been comprehensively studied
- Market environment is not quite ready for fast grid support
- Value from the market can only provide secondary revenue stream for end-customers

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THANK YOU!

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