Wind and Li-ion energy storage on the Faroe Islands

ACEF, Manila 8 June 2018

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1. Introduction: Saft and ESS
2. Specifying the need
3. Designing a solution
4. The Hushagi BESS
5. Operational experience and results
6. Lessons learnt

Who is Saft today?

GROUP PROFILE

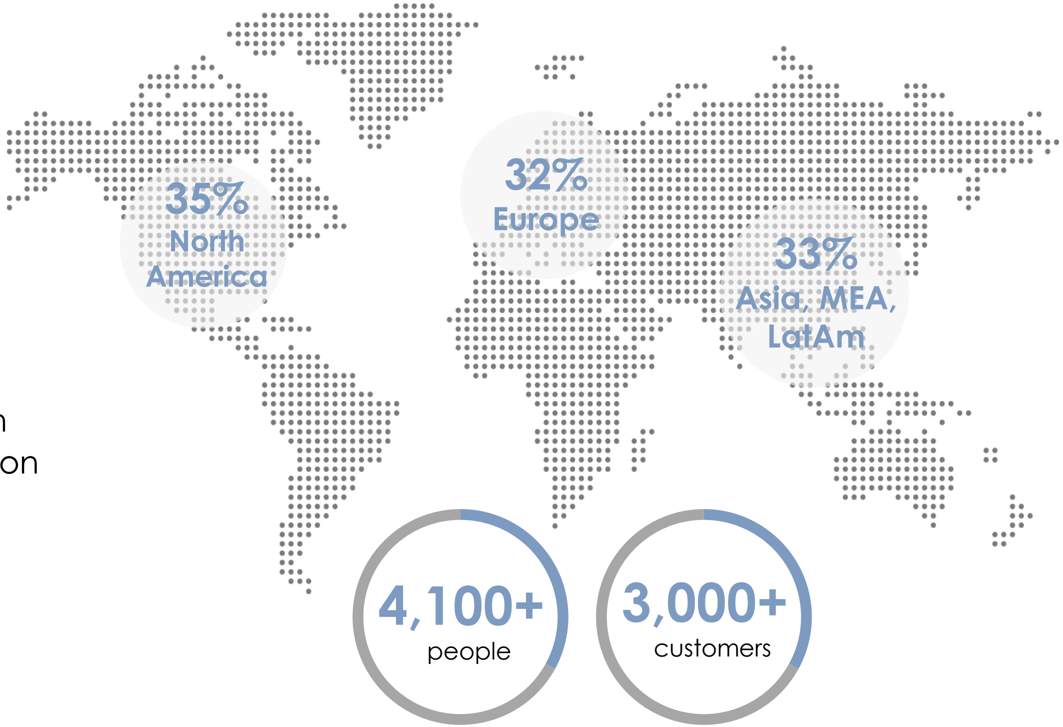
100 years of history

Leadership position on 75-80% of revenue base

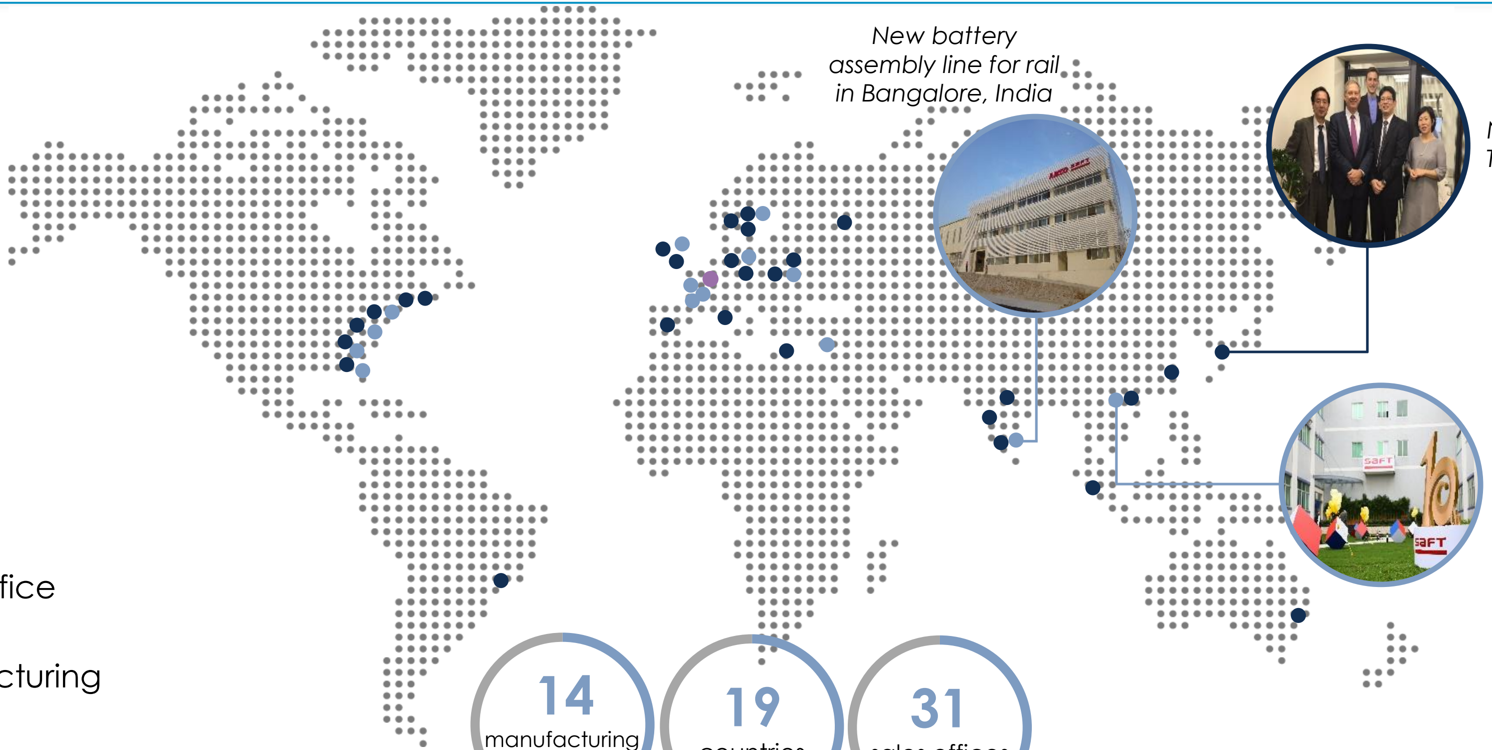
9.7% invested in **R&D** with **3** main technologies; primary lithium, lithium-ion & nickel-cadmium,

€744m revenue FY 2017

GLOBAL PRESENCE - SALES



Global presence



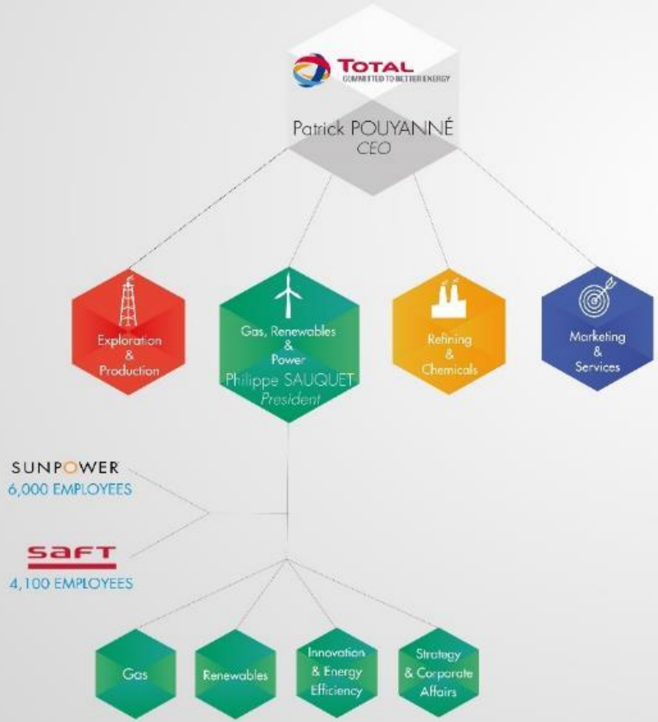
- Head office
- Manufacturing sites
- Sales offices

14 manufacturing sites

19 countries

31 sales offices

Where we fit in Total



4TH LARGEST OIL & GAS COMPANY

100,000 EMPLOYEES

130 COUNTRIES

We serve multiple customer segments for specific applications

Aviation
AIRBUS
BOEING

Defense
NAVAL GROUP
GE

Grid
ENEDIS
Kaua'i Island Utility Cooperative

IoT
libelium
WORLD SENSING

Marine
Rolls-Royce
Benetti

Medical
CARDIAC SCIENCE
Berlin Heart

Metering
Landis+Gyr
manage energy better
Itron

Mobility
Linde
KALMAR MOTOR AB

Oil & Gas
TOTAL
Shell

Rail
中国中车 CRRC
BOMBARDIER
SIEMENS

Space
AIRBUS
LOCKHEED MARTIN

Telecom
Reliance Jio Infocomm

Utilities
ديوا dewa
एनटीपीसी NTPC

saft

Energy Storage Solutions (ESS)

Large power plants

Grid compatibility

Photovoltaic Power Plants
Wind Power Plants

Grids

Demand-supply flexibility

Transmission Grids
Distribution / Smart Grids
Microgrids
Private Grids (e.g. railways)

Behind the Meter

Residential, Commercial, Industrial

Self-consumption

Smart Buildings
Industrial / Commercial

Applications	Large power plants	Grids	Behind the Meter
Energy Shifting	■		■
Smoothing / ramp control	■		
Frequency regulation	■	■	□
Peak Shaving		■	■
Hybrid Power Generation	■	■	■

Intensium® Max+ 20 Power & Medium Power

VL45E/41M/30P cell

Module Synerion® 24 E/M/P

Energy Storage System Unit (ESSU)

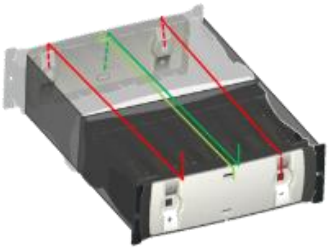
Container

NMC/NCA blend technology

Gemini module
(2 x Synerion modules in series)
Rated voltage 48V

15 Gemini modules in series
1 BMM/ESSU for charge/discharge control

- 18 ESSU in //
- Voltage 630-867V
- 1 MBMM for all BMMs control



Mastering the Value Chain

Battery manufacturer

- Performance
- Lifetime
- Sizing
- Operation modeling
- Configuration

System integrator

- Power Conversion
- Controls
- Monitoring

Project manager

- System engineering
- Contracting
- Execution

local project offices

Long term service provider

- Warranties
- Maintenance
- Training
- Field support
- Asset services

We offer a strong **long-term committment** to reliable, efficient and long life system operation

- ❑ Battery and System technology mastership
- ❑ Application understanding
- ❑ Integration & project competence
- ❑ Bankability

- ❑ Optimium system sizing and configuration
- ❑ Energy efficiency , low Opex
- ❑ Reliability and long life
- ❑ System and performance warranties

Saft Intensium® Max & Mini footprint

Faroe Islands Wind-Battery project

SEV: vertically integrated utility

– Target 2020: 75% renewables with hydro & wind
  - 60% reached in 2015

New 12MW wind farm with ESS in 2015

– Total wind capacity 18MW
– 30% of total generation capacity
– 18% of yearly energy consumption
  - 42% hydroenergy, 40% thermal generation

Long term vision

– Two-fold increase of energy consumption by 2030
– Target: 100% renewables

18 islands - 50 000 inhabitants, 300 GWh/year

Requirements

– Volatility of wind generation
  - Impact on voltage and frequency
  - Stress on diesel generation to compensate short term fluctuation

– Lack of inertia

– Substitution of synchronous generation by inverter based generation

Priority for ramp control

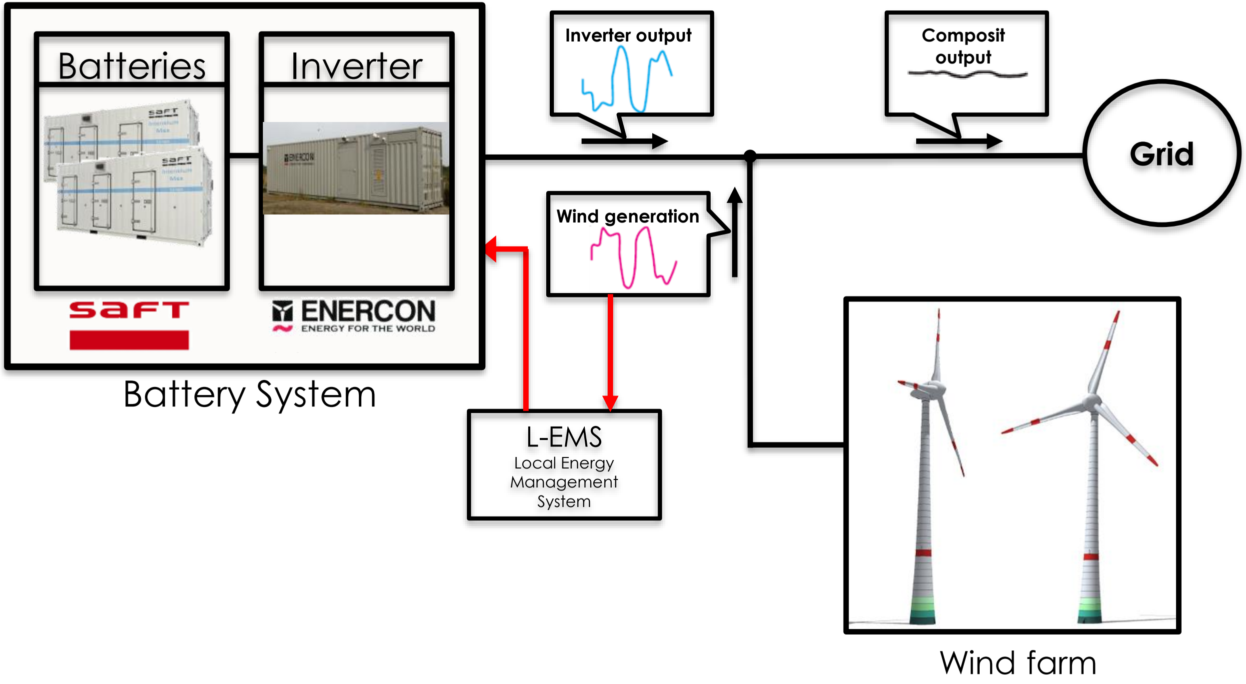
maximum

1MW / minute

upramp

downramp

Schematic overview of battery system

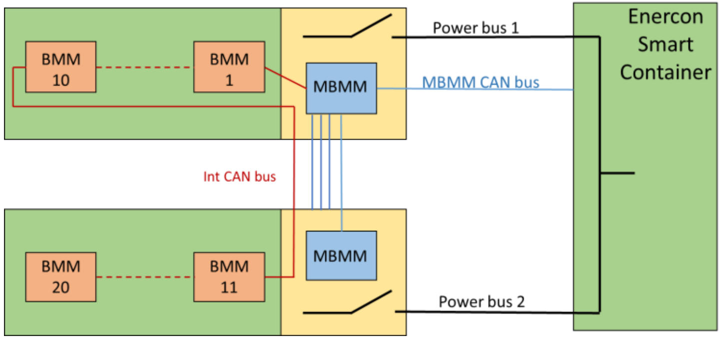


SEV project – BESS description

BESS = 2 containers IM20P 2.4 MW + 1 PCS ENERCON 2.1MVA + LEMS

2 Intensium Max 20P	
Energy	707 kWh
Continuous discharge power	2 400 kW
Continuous charge power	1 500 kW
Nominal voltage	623 V
Voltage range	525V – 700V

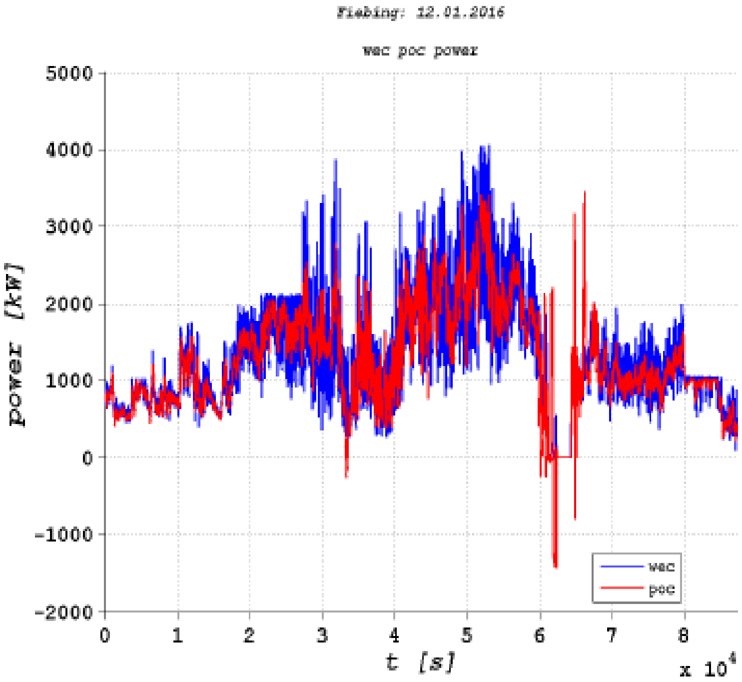
Overview of the IM20 container



Enercon Smart Container	
Apparent power	2300 kVA
AC Voltage	LV: 400V MV: 20 kV
DC Power	2 400 kW
DC Voltage Range	345 – 705 V
DC Current	1000 A

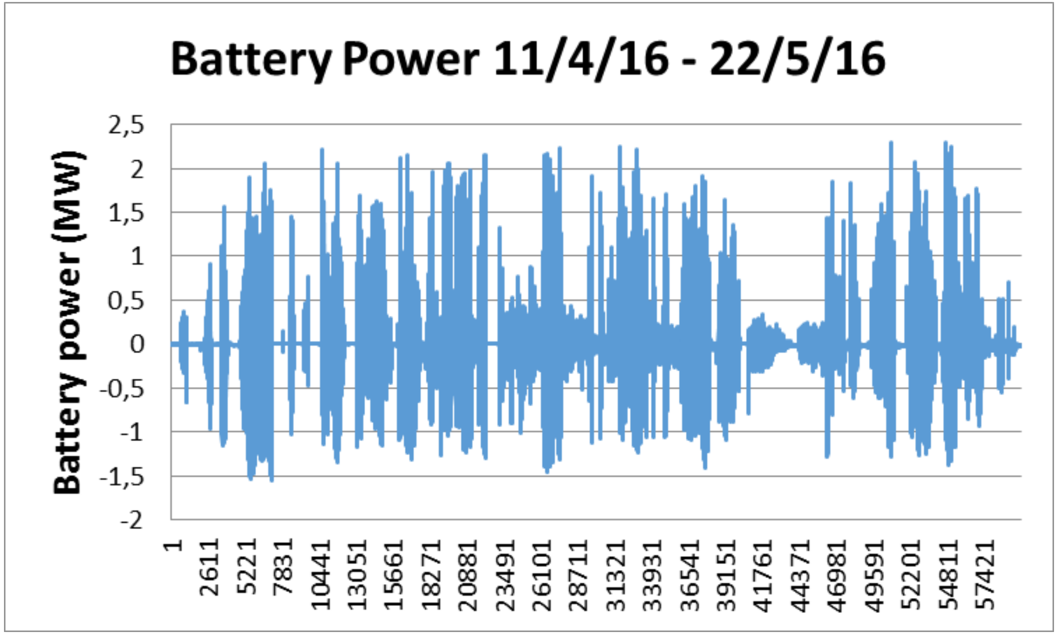
Simulation results

- Compliance of 1MW /min ramp rate > 99%
- DC roundtrip efficiency 97.6%
- AC roundtrip efficiency including PCS & auxiliaries 86.2%
- Total efficiency losses of wind energy generated 0,22%
- Avge daily energy throughput of BESS 261%
- Capacity loss after 20 years operation 20,9%
- Impedance increase after 20 years 83%



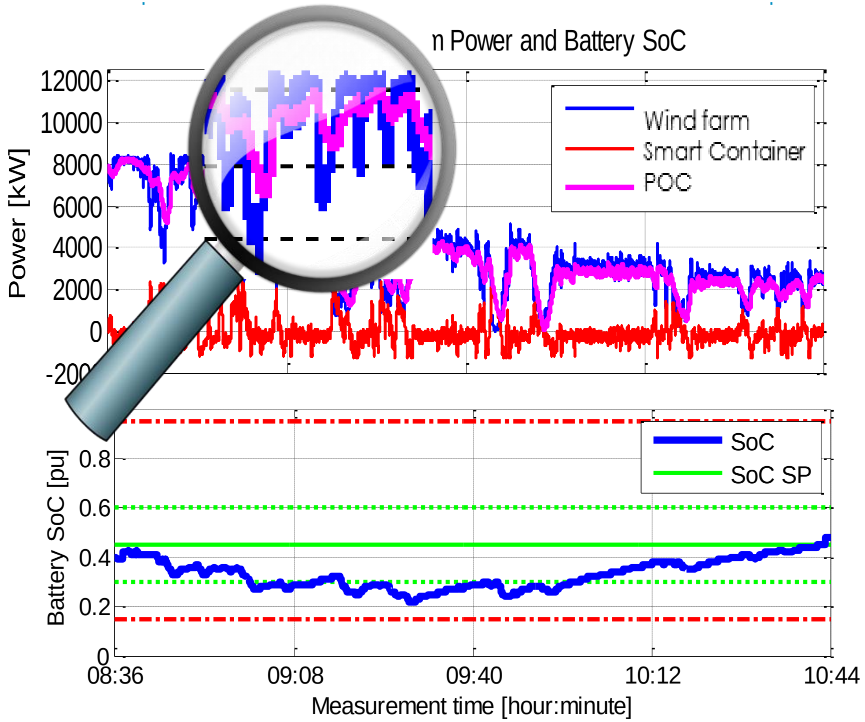

saft
Intensium Max
FHFU 500003 8

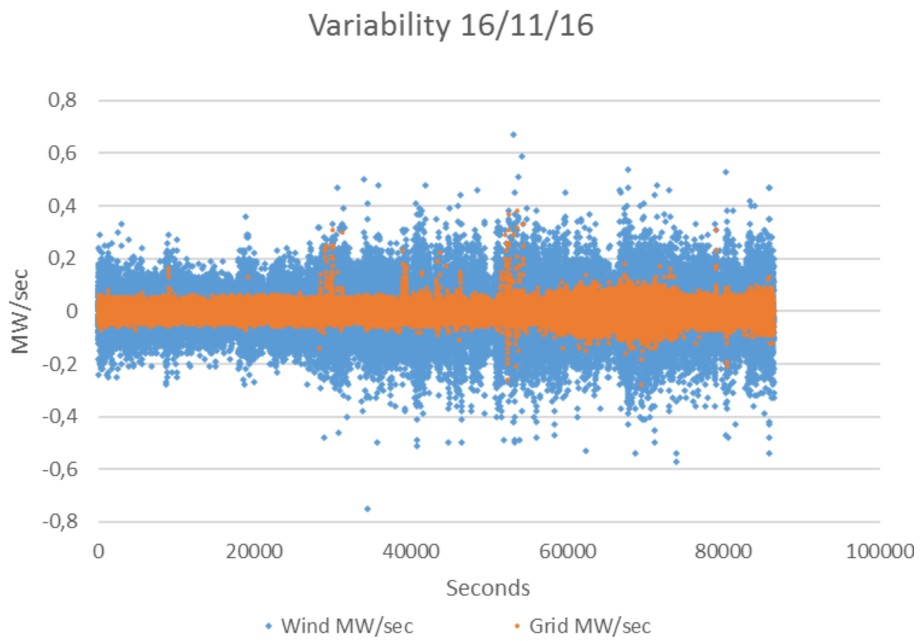
Results (1/4) - Battery operation



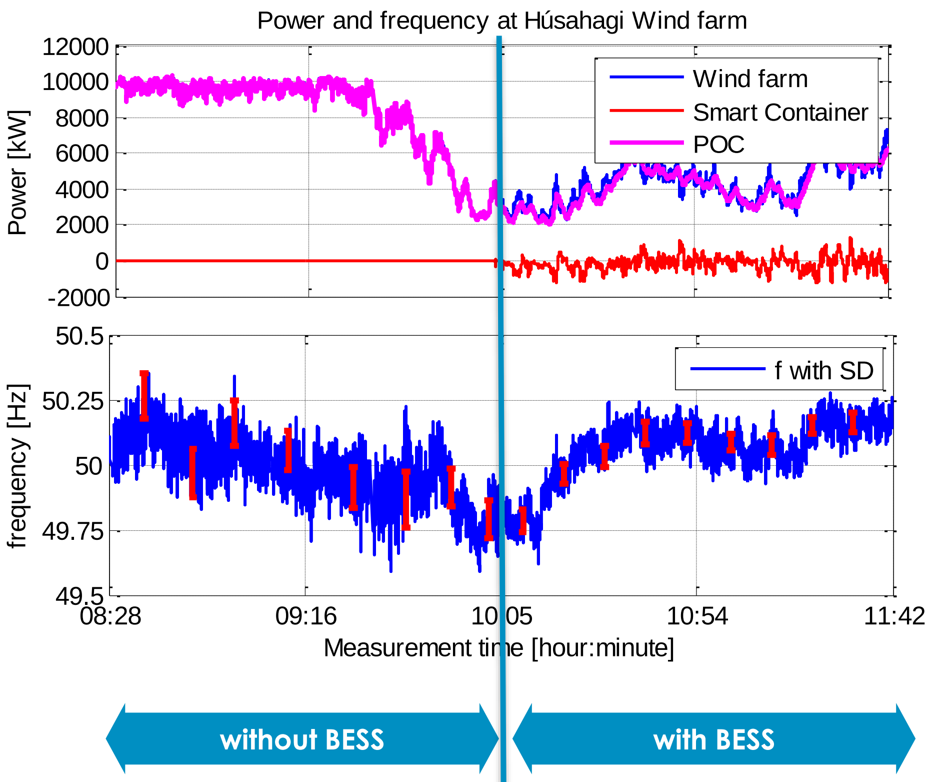
- About 80MWh charged during 40 days
- represents **300% daily throughput** (2 MWh per day / 700kWh battery)
- Maximum battery power frequently required

Results (2/4) – Impact on the electricity System

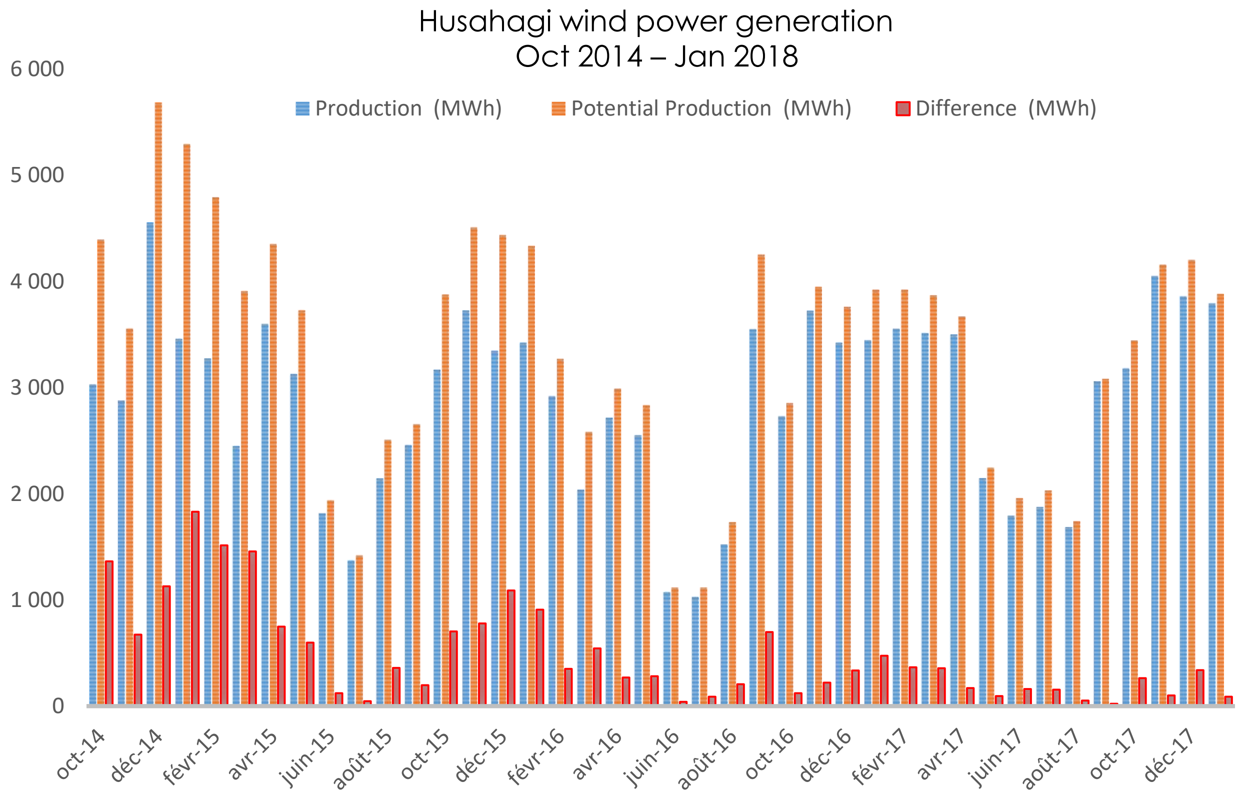




Results (3/4) – Benefit for the electricity system



Results (4/4) - Curtailment



Significant reduction since 2014

Winter 2014/15	28%
Winter 2015/16	19%
Winter 2016/17	9%
Winter 2017/18	5%

Lessons learnt

Operation of the SEV system with 85% of load covered by wind is possible and stable

3 main business case levers:

1. **A small ESS to reduce CAPEX**
   Managing short term variability needs power, but only little energy
2. **Very high wind harvesting**
   Avoidance of > 6000 MWh of diesel generation
3. **Avoidance of other grid investments**

THANK YOU

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https://www.youtube.com/watch?v=TUa0QAT9KaM

https://www.youtube.com/watch?v=HUMRt9HSzAk