



## **Grid scale energy storage**

Energy storage using electrochemical technologies are more and more popular. The battery price erosion and the li-ion battery technology benefits are key factors to explain the market growth. Multiple MWh systems are yet deployed and in operation

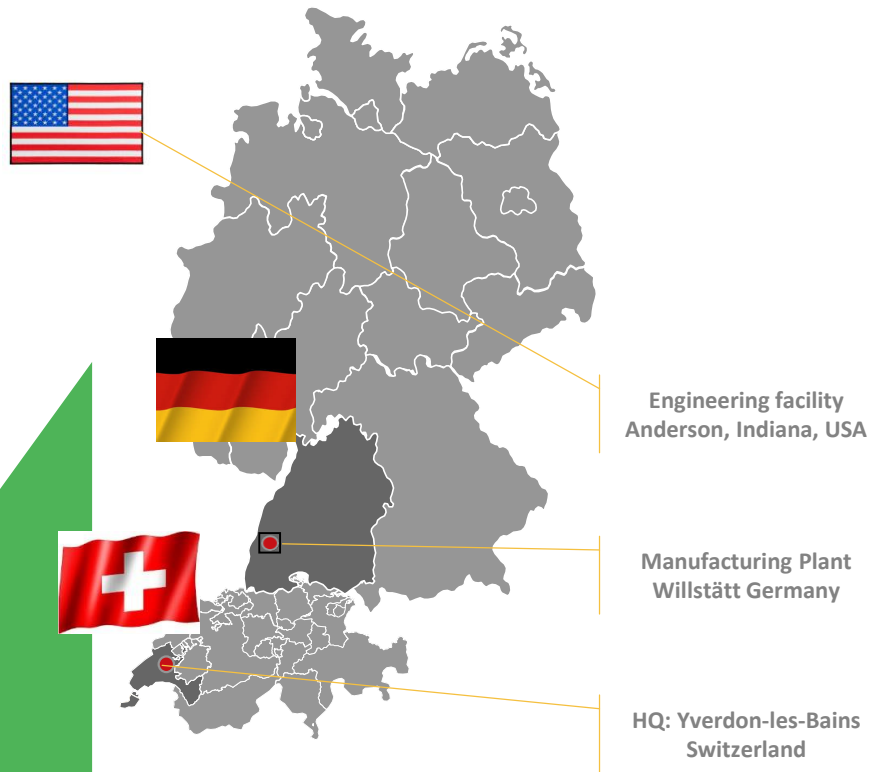
Fabrizio Marzolini, Head of Systems Development, Leclanché  
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**TUESDAY, AUGUST 21, 2018, 8h15 – 10h30**

**Location: Y-Parc, 6 Rue Galilée, 1400 Yverdon-les-Bains**






Leclanché provides innovative and customized energy storage solutions that meet and exceed the requirements of its customers:

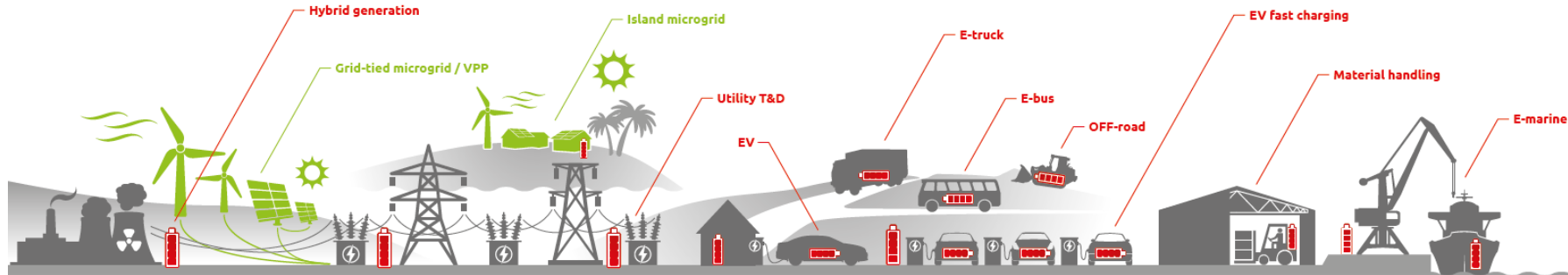


- Founded to industrialize dry cells invented by Georges Leclanché in 1909
- Headquarters in Switzerland
- More than 100 patents in Lithium-ion Titanate development and production processes
- Multi-chemistry mass production facility for up to 1M cells per annum in Germany
- Full range of Energy Storage Systems
- Listed on Swiss Stock Exchange (LECN)
- Average Market capitalization: CHF 120 million

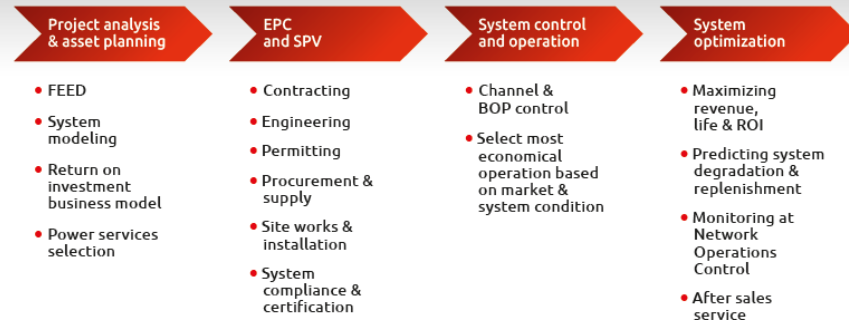
# Leclanché- Applications Driven Market Focus



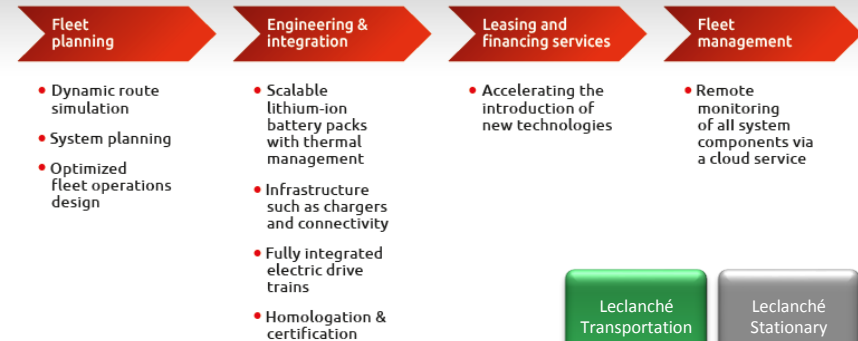
Market		Applications	Addressable market segments and current success/ proof-points
<b>Electrified Transportation and Industrial Machines</b>		<ul style="list-style-type: none"> <li>■ Fleet of Buses and Trucks</li> <li>■ Ferries and Tugboats</li> <li>■ Trains and Trams</li> <li>■ AGVs, Forklifts, Cranes, Lifts, Mining machines</li> </ul>	<ul style="list-style-type: none"> <li>■ \$0.5B in 2014 to over \$10B in 2020 (Automotive sector excluded - Sources : McKinsey Insight)</li> <li>■ Worldwide presence</li> <li>■ Advance bids in Bus and Ferries fleets</li> </ul>
<b>Electricity Generation and Transmission</b>		<ul style="list-style-type: none"> <li>■ Diesel and PV coupling</li> <li>■ Utility-scale Power Capacity augmentation and peak shifting</li> <li>■ Grid stabilization: reserves, frequency and voltage regulation</li> <li>■ 'Behind the meter' peak shavers</li> </ul>	<ul style="list-style-type: none"> <li>■ \$1.5B estimated in 2014 to over \$8B in 2020 (Sources : Navigant Research, OKME estimate)</li> <li>■ Worldwide presence</li> <li>■ Current reference projects in grid-coupled solutions and home storage systems. Short-listed a large Island Solution with PV and Diesel coupling</li> </ul>
<b>Specialty Battery Systems</b>		<ul style="list-style-type: none"> <li>■ Defense and Security</li> <li>■ Medical systems</li> <li>■ Smart Cities- Street Lighting</li> <li>■ Telecom backup systems</li> </ul>	<ul style="list-style-type: none"> <li>■ \$7B in 2013 to over \$20B in 2020</li> <li>■ Current references in European Defense, Medical Systems and Street Lighting Solutions</li> </ul>



## UTILITY-SCALE GENERATION, T&D & MICROGRID VALUE PROPOSITION



## eMOBILITY VALUE PROPOSITION

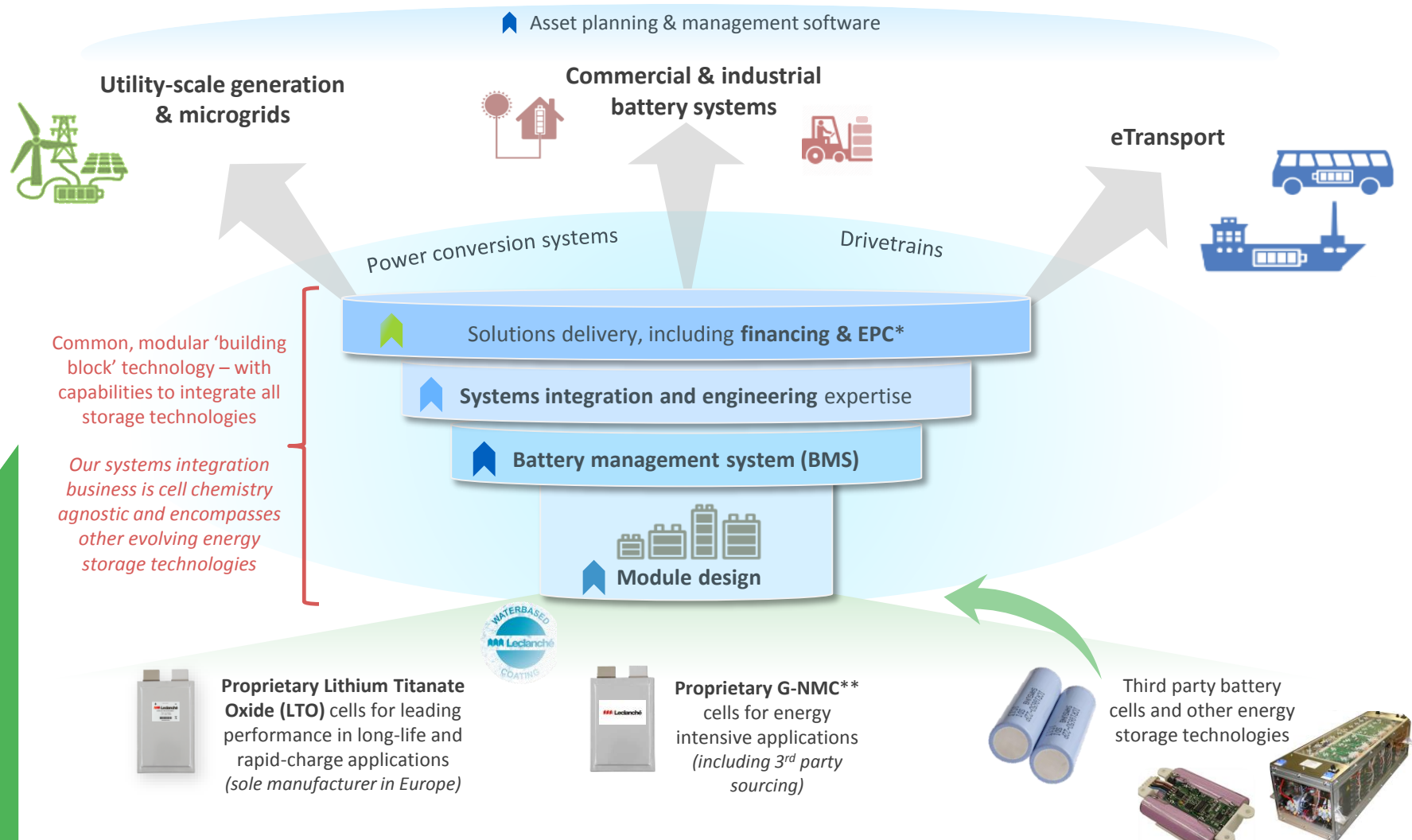


Leclanché  
Transportation

Leclanché  
Stationary

Leclanché  
Products

# Our common technology stack is applicable across multiple markets



\*Engineering, Procurement & Construction.

\*\*Graphite anode and Nickel-Manganese-Cobalt cathode.

## Electricity and storage momentum

A promotional banner for Leclanché products, divided into three sections. The left section shows a person in a lab coat holding a rectangular battery cell. The middle section shows a close-up of a battery cell being processed by a machine. The right section shows a large-scale energy storage system with solar panels and a wind turbine.

**LecCell 30Ah**  
The only Lithium-Titanate cell with water-based coated electrodes  
> PRODUCTS AND SOLUTIONS

**WATERBASED**  
**Leclanché**  
**COATING**

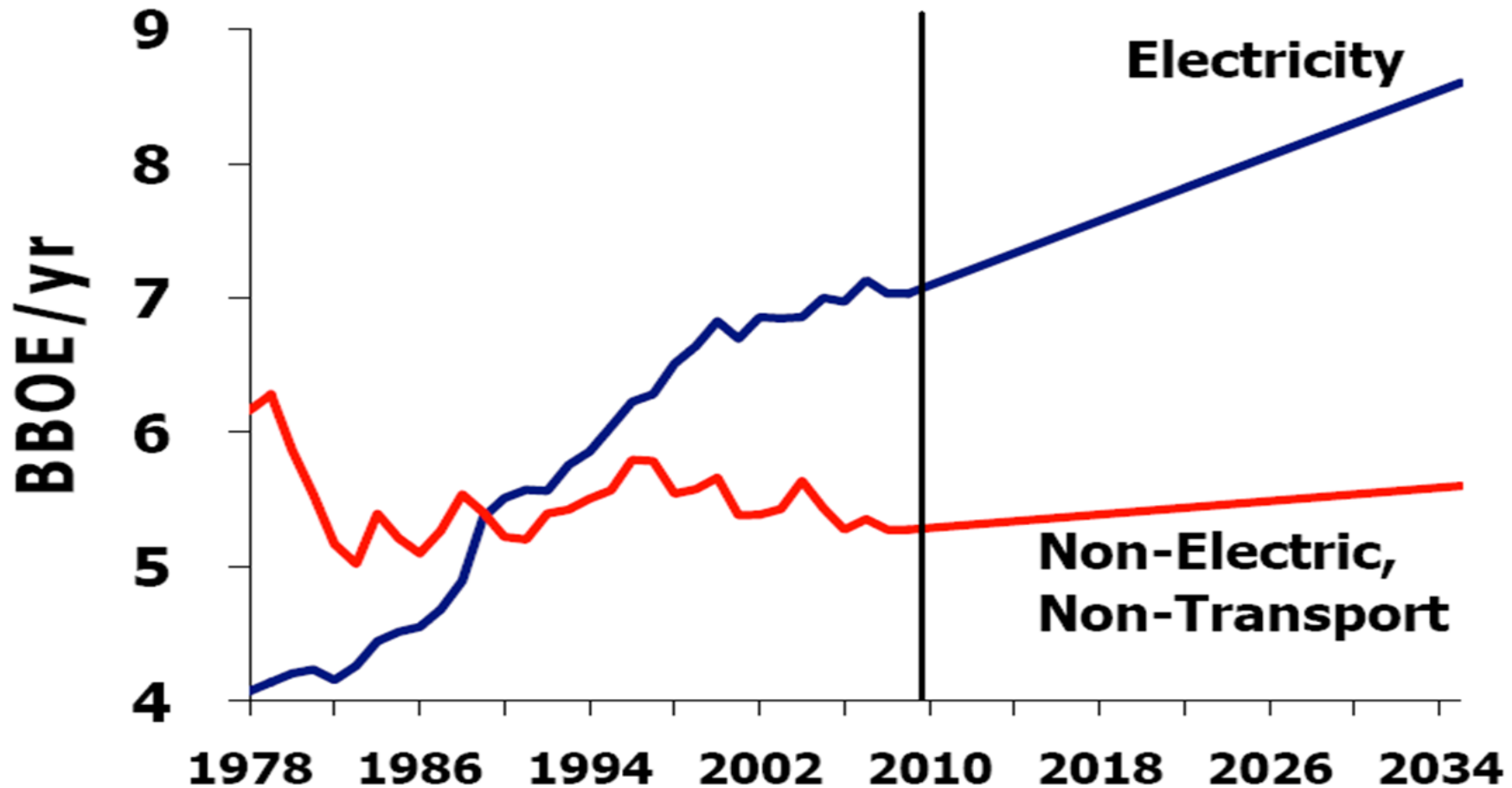
**TiBox**  
The intelligent energy storage system with Lithium-Titanate  
Available now!



### Common statement

- You cannot store electricity at industrial scale
- the demand/response fluctuate extremely fast
- To fulfill supply constraints, the Grid operators must be able to deliver a just-in-time energy flow instantly and inescapably
- If you don't balance demand and response, the system collapse

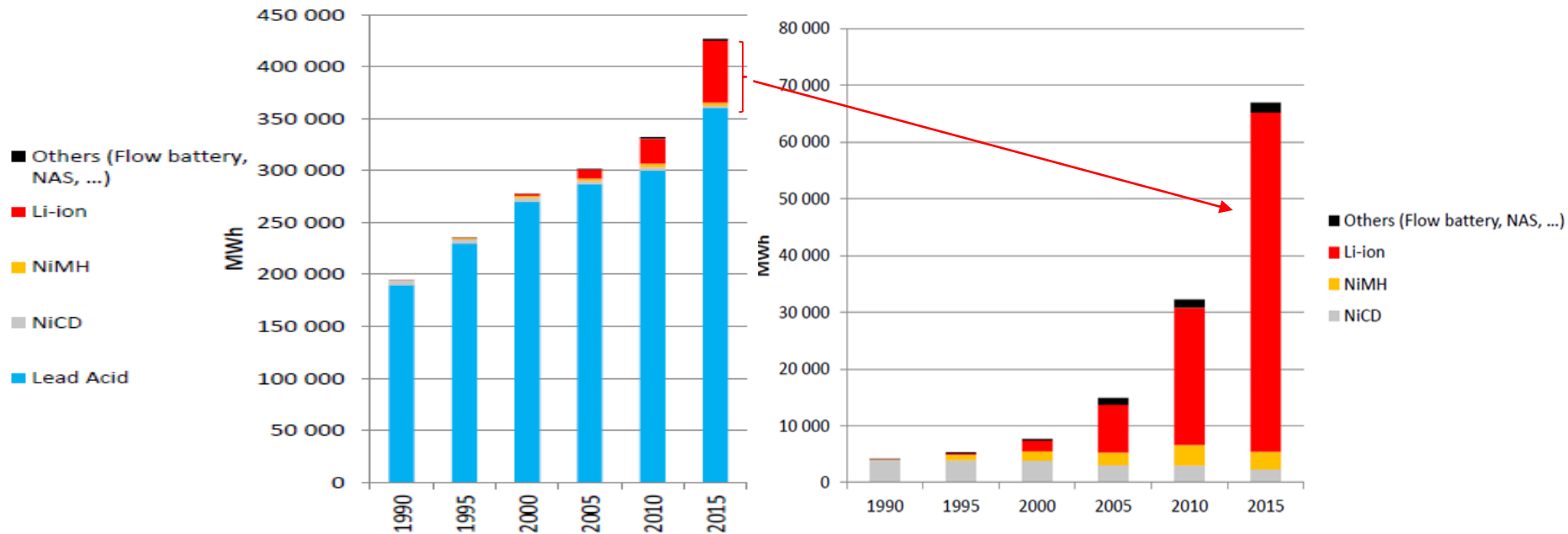




- Electricity is the most deployed energy vector
- Storing electricity is crucial and is yet common sense



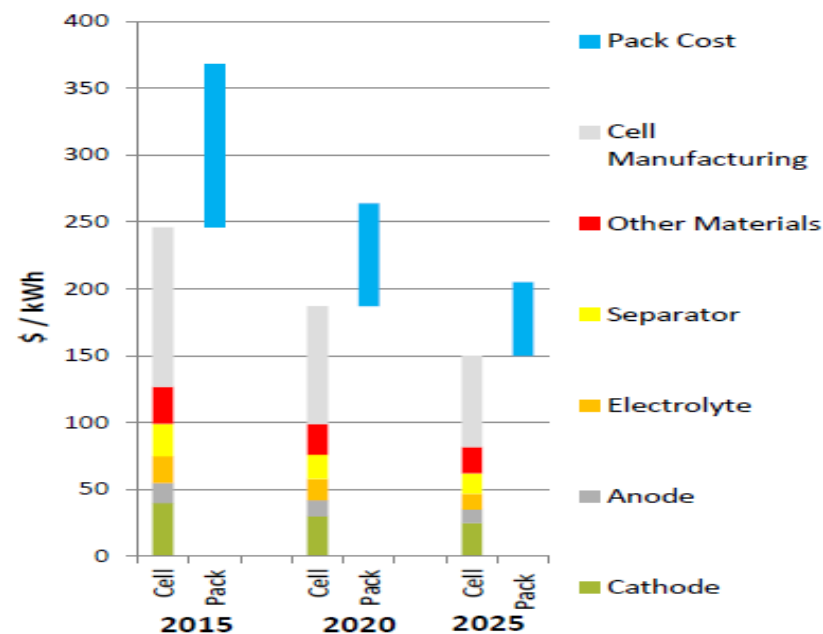
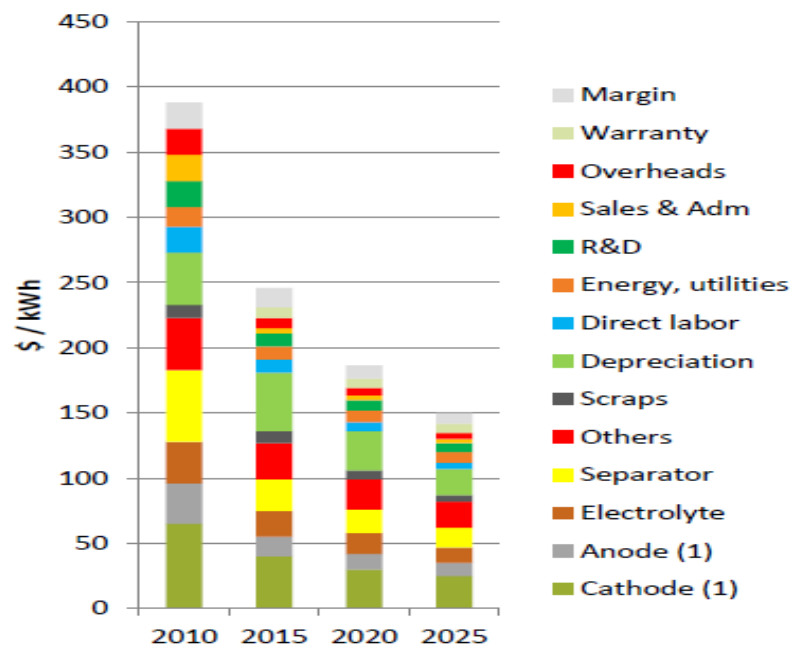
# BATTERY MARKET SEGMENTATION



- Lead acid is clearly still the market driver, but Li-ion shows the strongest growth
- Lead acid is mainly used for
  - SLI (automotive starter battery)
  - UPS (uninterruptible power supply)
- Li-ion is inevitably substitute NiCd and NiMH in most of the portable application
- Li-ion is generating new market opportunities in both mobility and stationary domain
  - electric vehicles, buses, ferries, AGV, forklift, etc.
  - Hybrid and virtual power plant, ancillary services, PV self-consumption, etc.

Source: Avicenne Energy

# BATTERY COST BREAK DOWN (NMC)

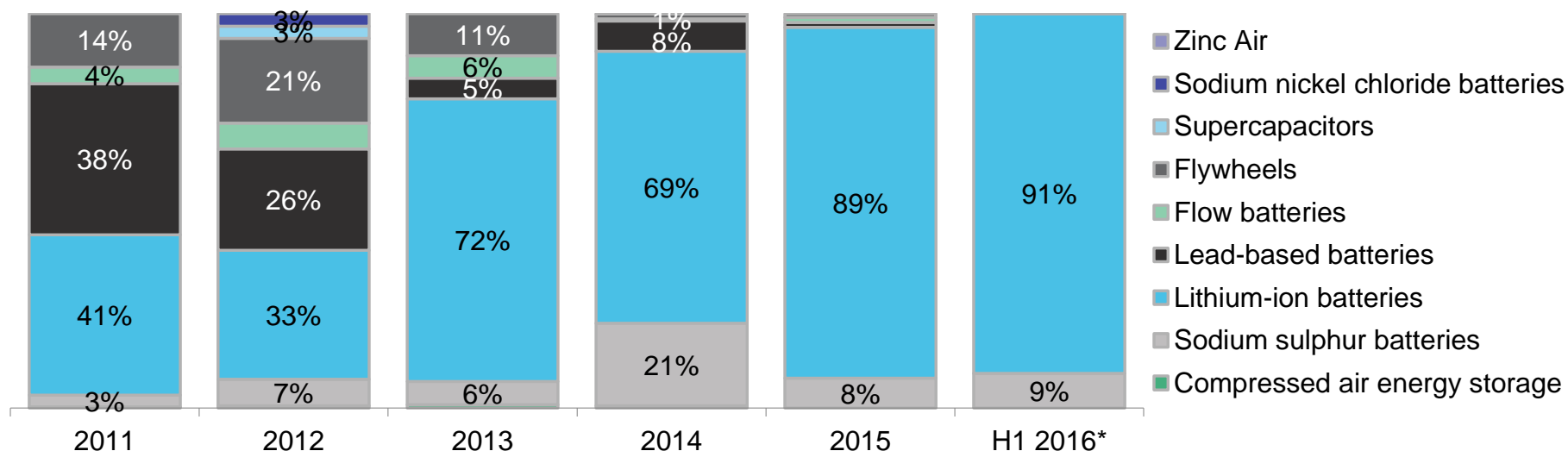


Raw material	72%
Production	8%
COGS	80%
R+D	4%
Admin	8%
Margin	4%

Li-on cells	68%
Integration	32%

Source: Avicenne Energy

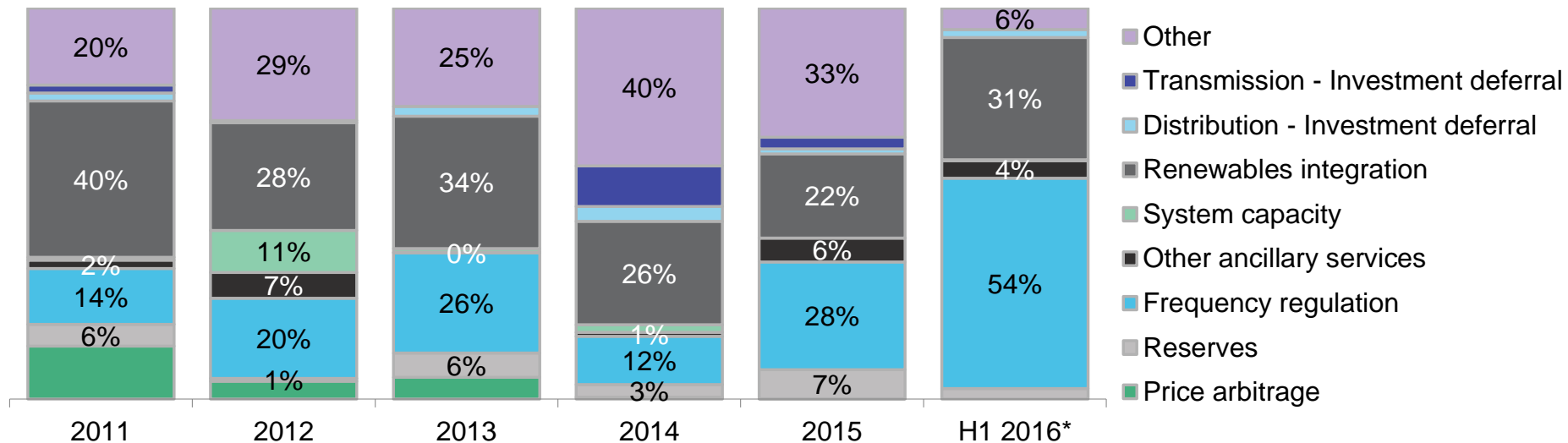
## TECHNOLOGY MIX OF COMMISSIONED ENERGY STORAGE PROJECTS (% BY MW)



### Storage technologies trend

- Clearly moving to and dominated by Li-ion
- Li-ion will probably continue to consolidate because of costs and performance improvement
- Li-ion offers energy and power capabilities which optimizes the positioning in this particular market
- Li-ion BESS are already designed to comply with smart grid applications because of BMS and EMS features

# APPLICATION MIX OF COMMISSIONED ENERGY STORAGE PROJECTS (% BY MW) (before the meter)



## The market before the meter clearly focus in the direction of two main applications

- ancillary services (frequency regulation via power balancing)
- integration of renewable (balancing of production volatility)
- The business model is not conflicting with utility and TSO activity and exception of local or case to case regulation, the feasibility is proven

## Beyond the meter so called C&I, can and will offer the same services, but in a highly decentralized space

The main barriers to deploy such technology are:

- C&I is in the end user space, where utility and TSO make and secure revenues
- C&I approach is conflicting with traditional revenue stream and will take some time to impose new rules, but this will happen as telecoms in 90's faced internet revolution

## Frequency regulation

A promotional banner for Leclanché battery products, divided into three main sections. The left section shows a person in a lab coat holding a large battery cell. The middle section shows a factory production line with battery cells. The right section shows a wind turbine and solar panels, with a central graphic of a battery cell and a bar chart.

**LecCell 30Ah**

The only Lithium-Titanate cell with water-based coated electrodes

> PRODUCTS AND SOLUTIONS

WATERBASED  
Leclanché  
COATING

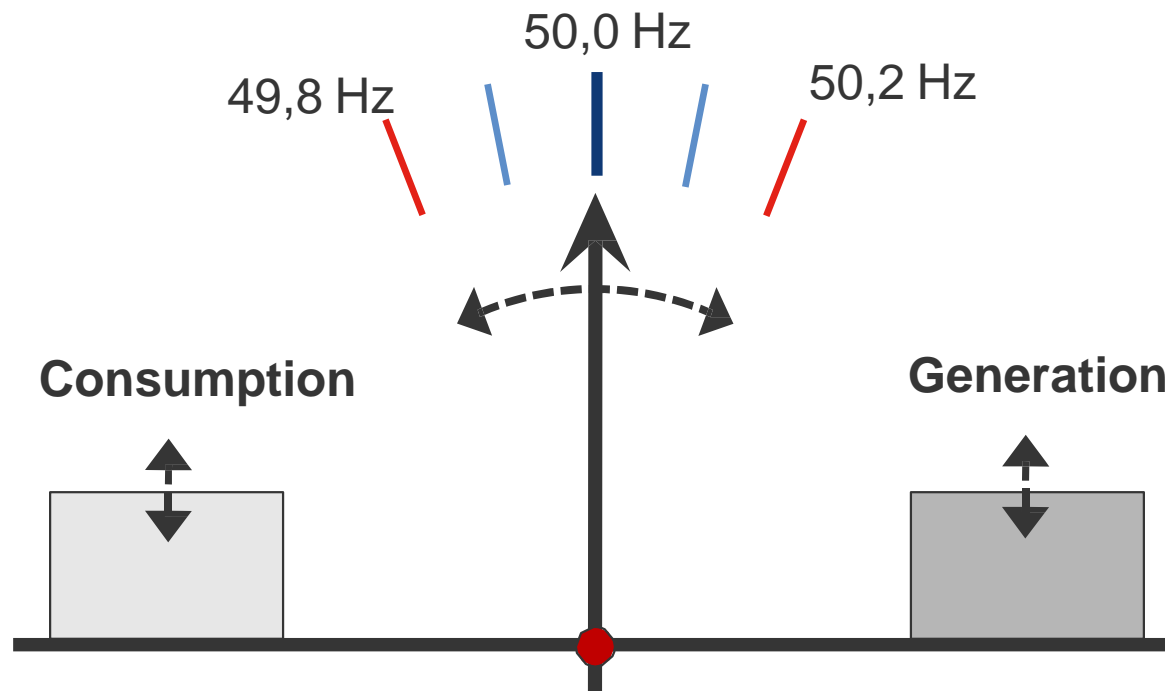
**TiBox**

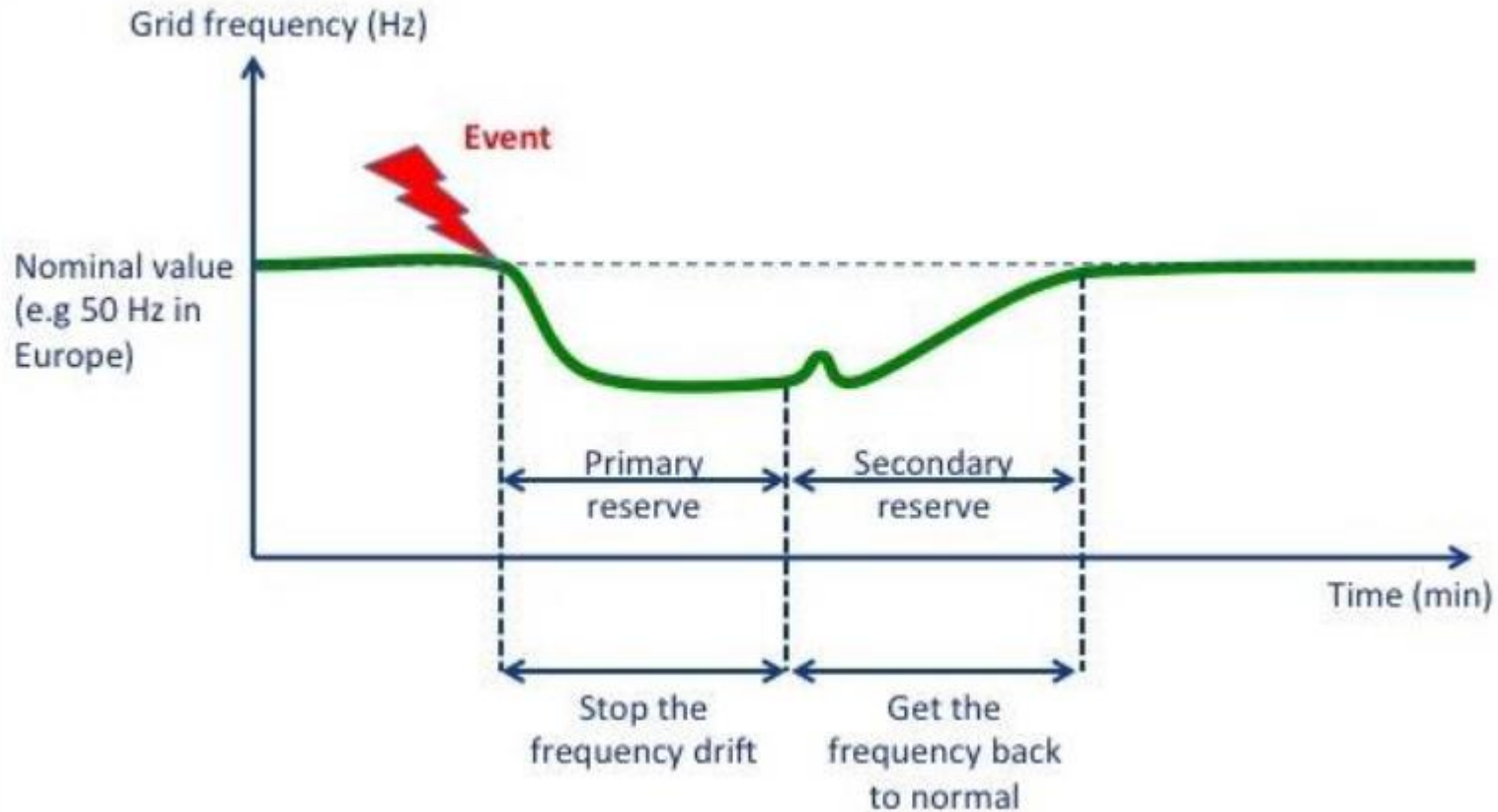
The intelligent energy storage system with Lithium-Titanate

Available now!

# GRID SYSTEM BALANCE: FREQUENCY REGULATION

POWER FREQUENCY NEEDS TO BE KEPT WITHIN A VERY SMALL RANGE AROUND THE NOMINAL FREQUENCY OF 50Hz






## In case of frequency deviation

- correction mechanism are kicking in to absorb or release power
- Battery is the perfect match as being
  - bi-directional in power
  - having instant response

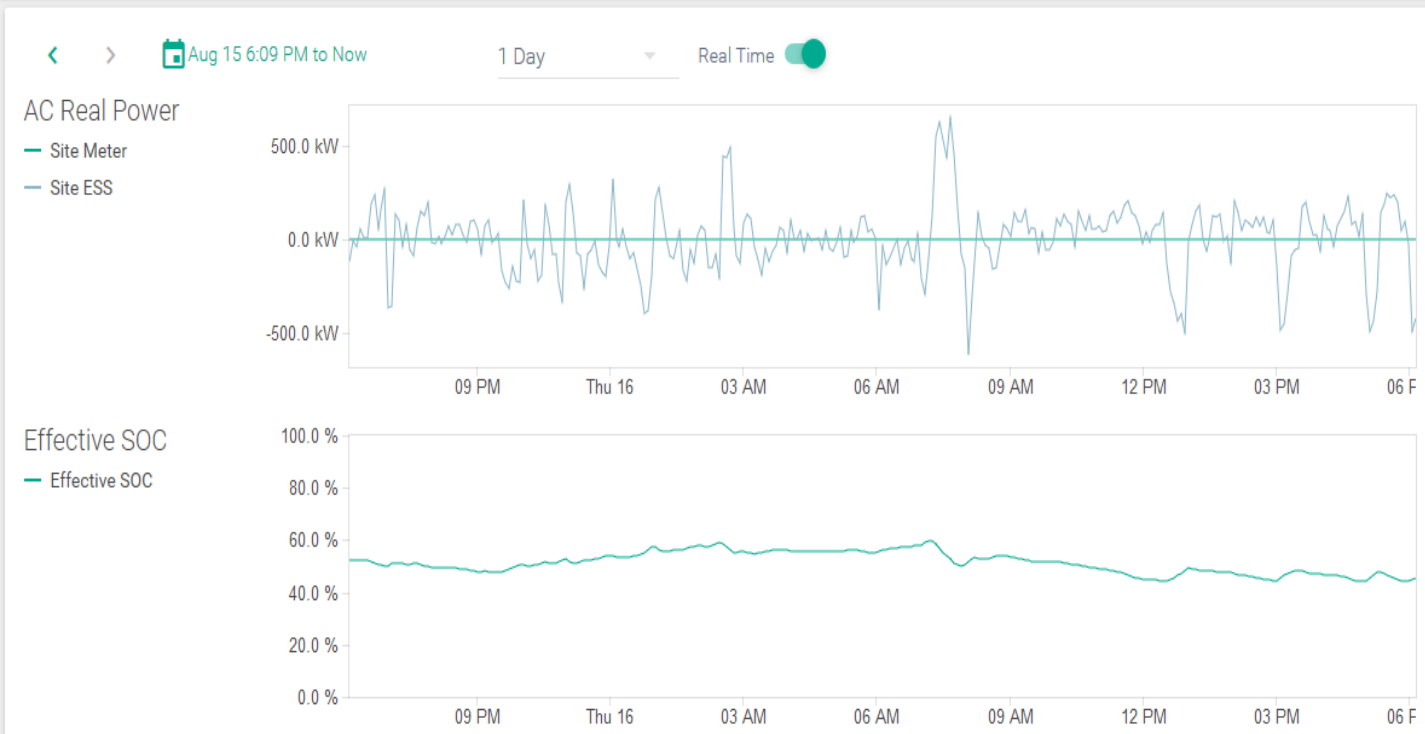


# GRID SYSTEM BALANCE: REAL INSTALLATION 2.8MW/1.7MWh

STATUS	ALLOWED DISCHARGEABLE AC ENERGY	ALLOWED CHARGEABLE AC ENERGY	AC CHARGE POWER LIMIT	AC DISCHARGE POWER LIMIT
 Good	1.248 MWh	1.599 MWh	2.600 MW	2.600 MW

ACTIVE ALARMS
No Active Alarms

EXTERNAL OPERATION STATUS	
PRL Positive Activation Power	2.000 MW
PRL Negative Activation Power	2.000 MW
Power Offset	184.000 kW
Uploaded Power	0.000 W
Uploaded Time	18Q2
AP2	0.000 W
AP1	-500.000 kW
AP1 + L	-316.000 kW
Remote Control	Yes
Energy Sufficient	Yes
Site Available	Yes



 Power Plant  ON

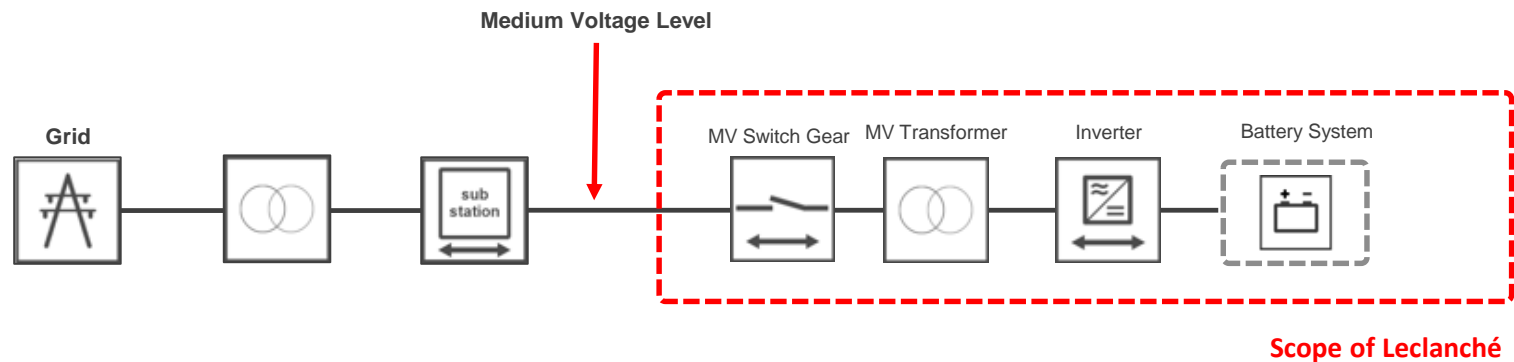
DETAILS

AC Real Power  
0.000 W

AC Reactive Power  
0.000 VAR

Battery power correction and SOC

# GRID SYSTEM BALANCE: REAL INSTALLATION 2.8MW/1.4MWh



Battery power correction/half day resolution

## Ramp control



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> PRODUCTS AND SOLUTIONS




**TiBox**

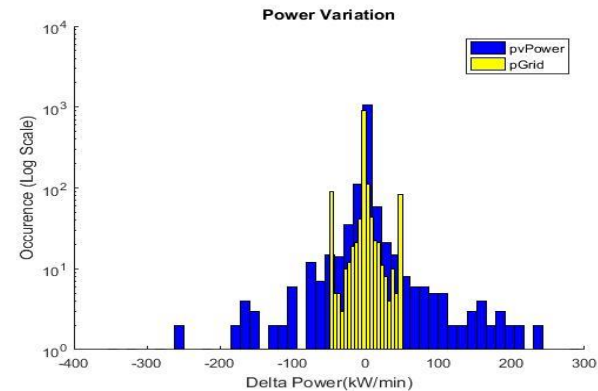
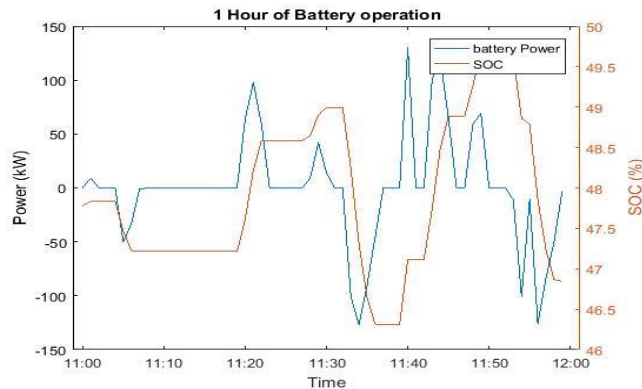
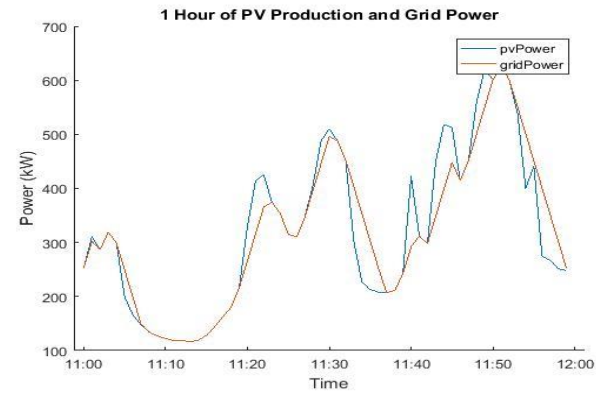
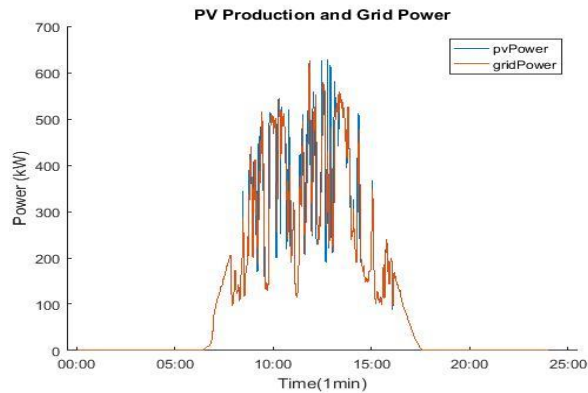
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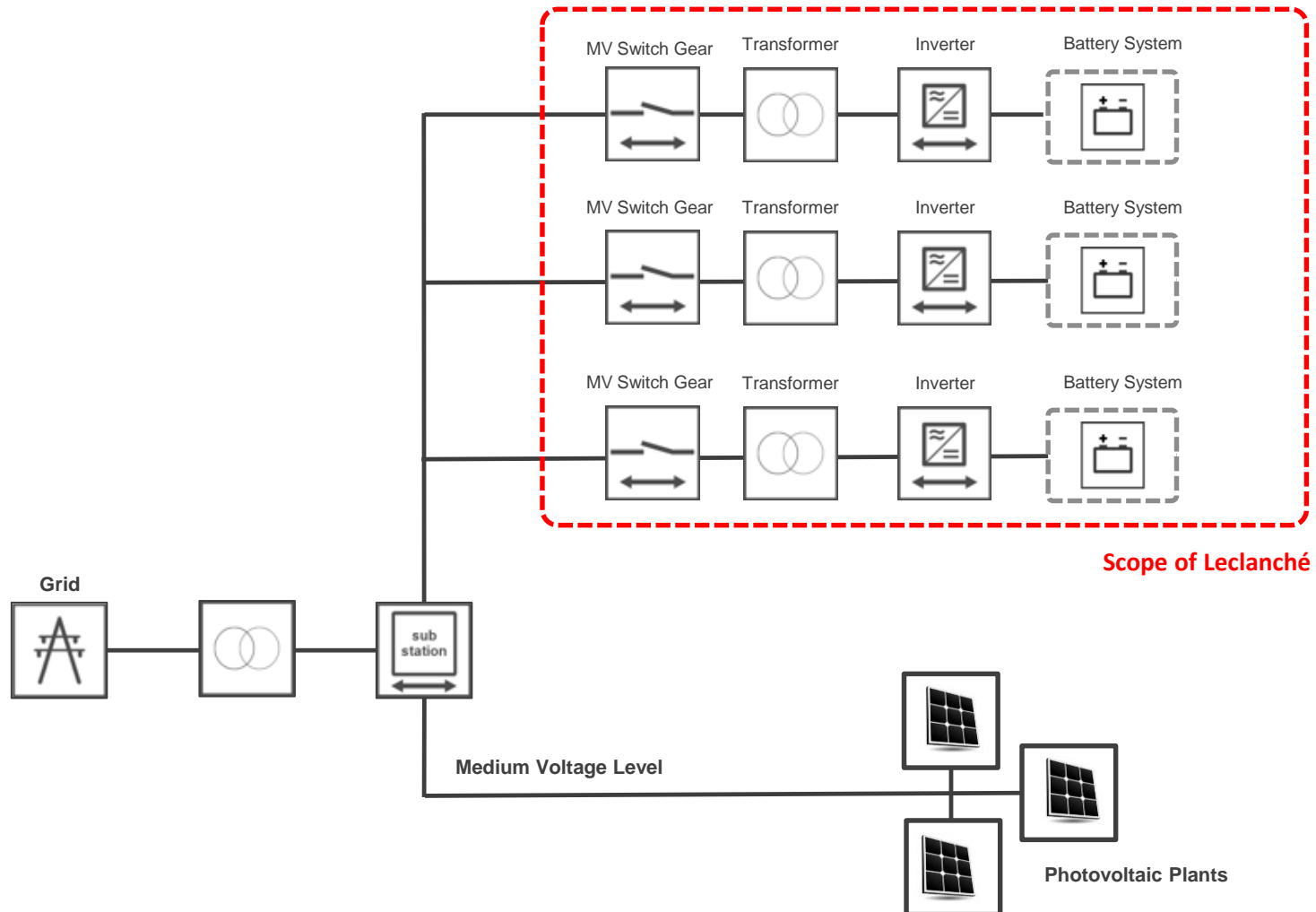


**Objective:** The battery will limit the power variation seen at grid level to  $\pm 5\%/min$

**Logic:** The battery will start the day with 50% SoC and it will provide services in charge and discharge the whole day



Energy throughput: 114 kWh in / 109 kWh out per 1MWp PV







**Thank you**