Sistemas de almacenamiento energético para generación fotovoltaica

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Summary

1. Overview of the PV integration issues
2. Energy storage applications for PV integration
3. Saft Field Experience on PV plant Integration with Li-Ion
4. Intensium Home. Li-ion for Residential Energy Storage

SAFT in numbers

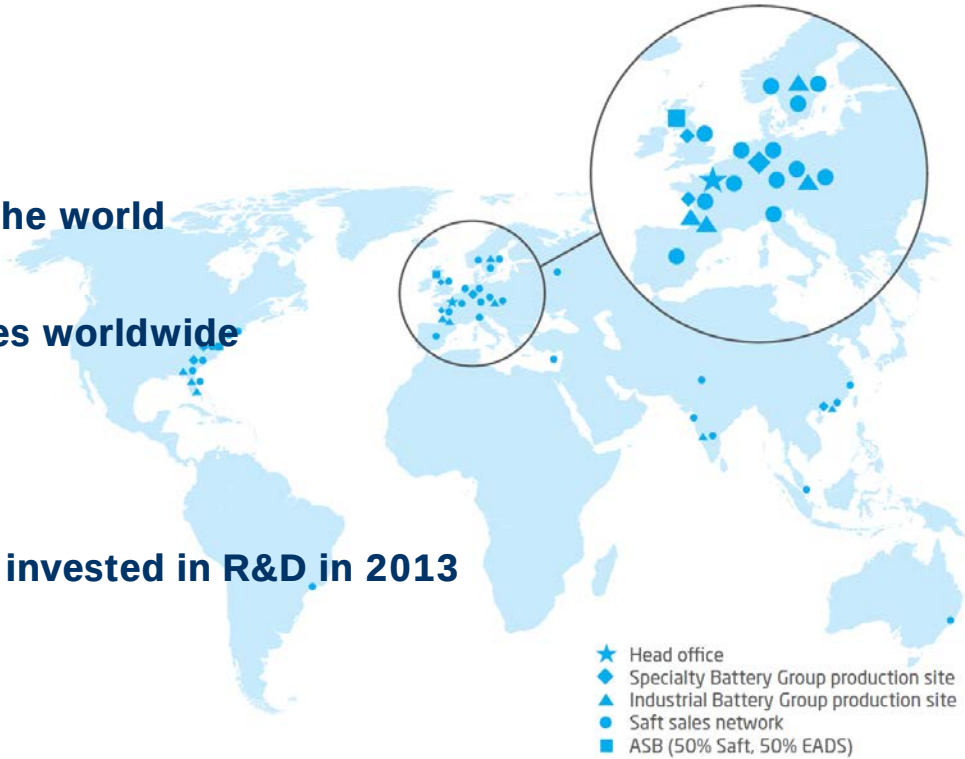
3856 staff worldwide

18 countries around the world

14 manufacturing sites worldwide

624 M€ Sales in 2013

9,3 % of Group Sales invested in R&D in 2013

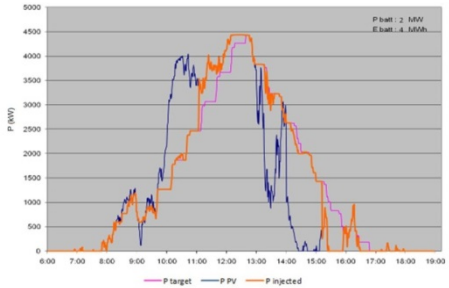


1. Overview of PV integration issues

Overview of PV plants integration issues

- PV power plants have **high power variability**
  - More than wind plants in the very short term

  (30 seconds to 5min)



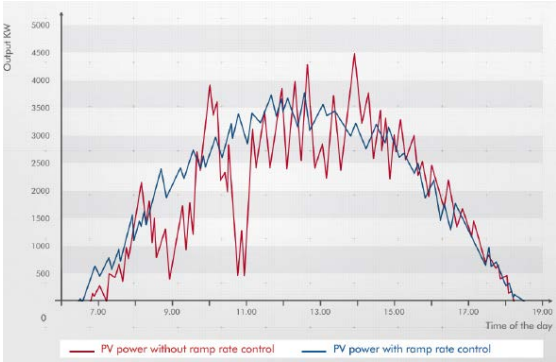
- PV plants have **limited predictability**
  - Forecasting errors remain high as per today
  - Energy storage always needed since forecast can never be perfect
- High PV penetration levels create **voltage issues** and **congestions** in feeders/substations

- **No inertia** (contrary to conventional groups)
- **Energy Storage Systems** can solve all these issues while other smart grid solutions provide partial solutions

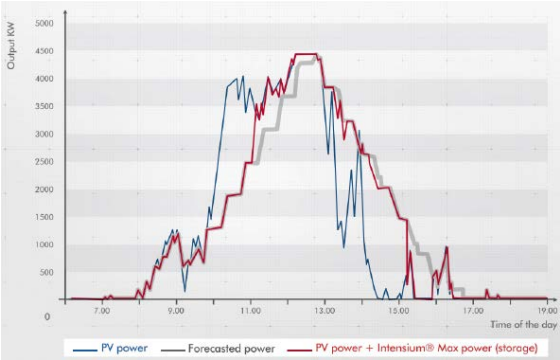
2. Energy Storage applications for PV plants integration

Typical storage applications for PV Integration

1- PV Ramp control

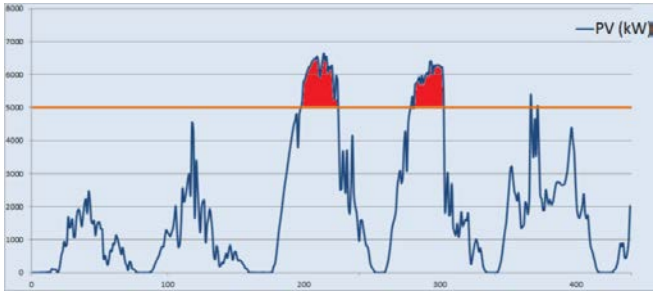


2- PV smoothing / Imbalance Management



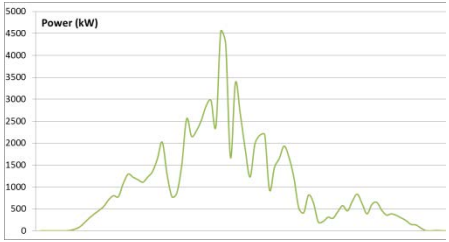
3 - PV Shaping/firming

4 - PV Curtailment Avoidance

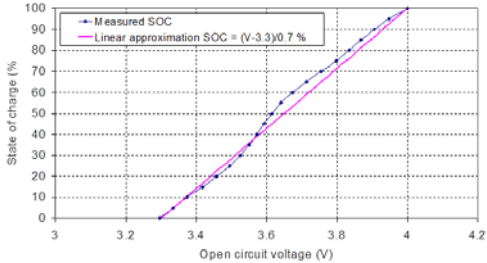


Why Li-Ion for PV integration

- Suited to dynamic cycling
  - Changing and unpredictable power patterns
  - Prolonged partial SOC



- High Power capability
  - In comparison to other batteries (Na based, Redox, Lead based)
  - Constant in a large SOC and T range



- Accurate SOC indication in real-time
  - Allows smart energy management strategies
  - Key for day-ahead market and scheduling
- Excellent roundtrip efficiency maximizing PV injection to grid
- 20 years lifetime is possible!

3. Field Experience on large PV plants with Li-Ion batteries

Installed base of Utility Scale containerized ESS

In partnership with:

ILIS Project (Tudela, Spain)

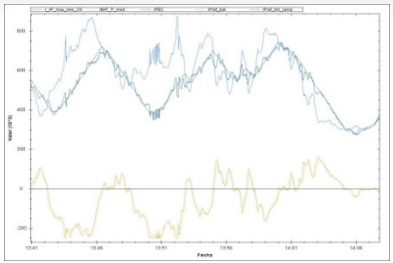
- First European PV + Battery MW plant connected to mainland grid
- Associates **1.2MWp PV plant** and **1100kW/580kWh Li-Ion system**
- 4 modes of operation: 1 - defined P & Q set-points 2 - ramp rate control
  3 - frequency regulation 4 - voltage regulation
- Acciona control system able to adapt to different Grid Codes and to offer services based on hourly PV production predictions, electricity prices

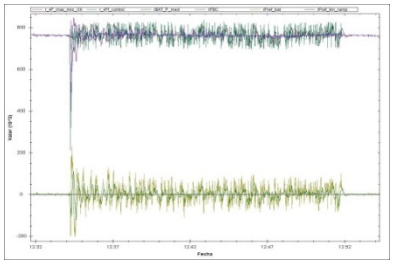
ILIS Tudela Operation modes

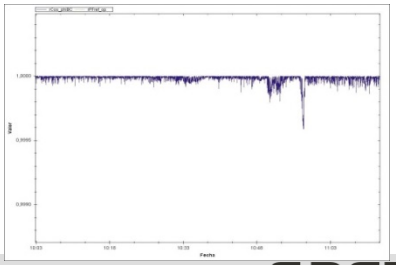
- **Ramp rate control:** fluctuations in active power can be regulated according pre-defined maximum ramp rates depending on set parameters (i.e. 2.5% per minute)

- **Frequency regulation**: active power production of the plant is regulated based on grid frequency.
  - Battery power +/-200kW (20% of Pmax)
  - Accuracy +/-10%
  - Time response with PCS 0,5 Sec

- **Reactive power control**:
  - voltage regulation at grid connection point
  - Cos phi control regulation
  - Q setpoint from operator



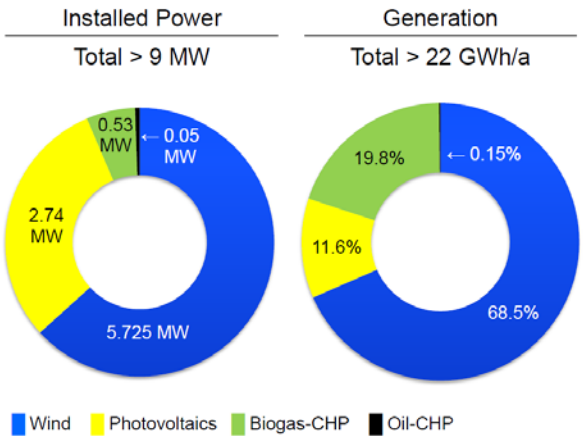




PV curtailment avoidance in Germany

Pellworm island - Smart Region project

- Renewable Island in North of Germany (100% renewables generation)
- Generation is 22 GWh per year while consumption is 7GWh per year (3 times!!)
- Renewable surplus is transported to mainland Germany with 2 sea cables but congestions occur sometimes leading to Renewable curtailment
- Hybrid energy storage plant (**Li-Ion 1100kW/580kWh** + Redox 200kW/1600kWh) to achieve **renewable curtailment avoidance**

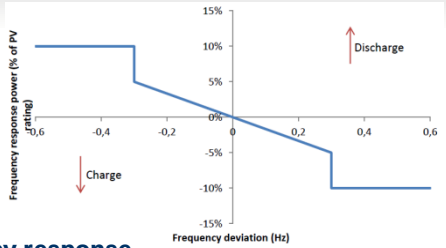


PV ramp control in Puerto-Rico

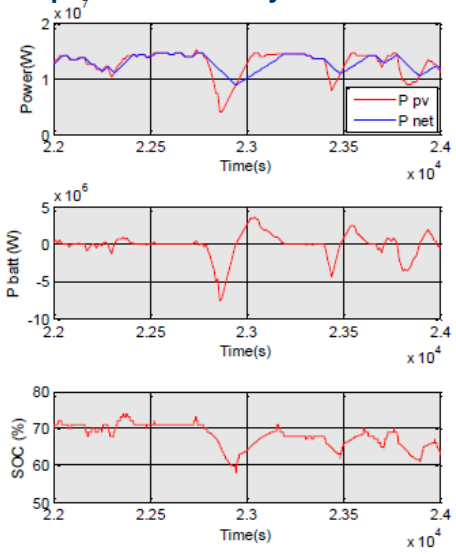
Salinas 10MWp PV Power plant (Puerto Rico)

PREPA Minimum Requirements

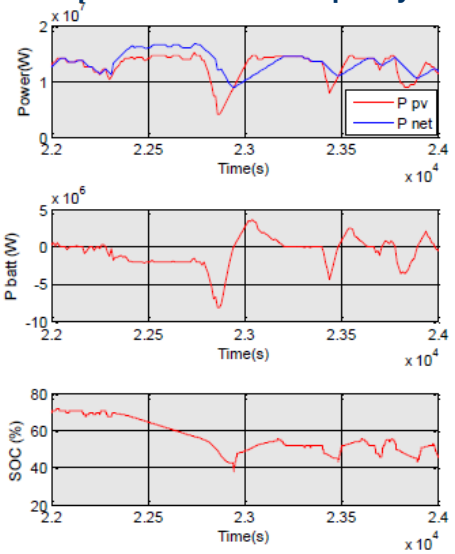
- **PV ramp rate control**: 10% per minute
- **Frequency response** with 5% droop , up to 9 minutes in case of large under-frequency events



Ramp Rate Control only



Ramp Rate Control + Frequency response

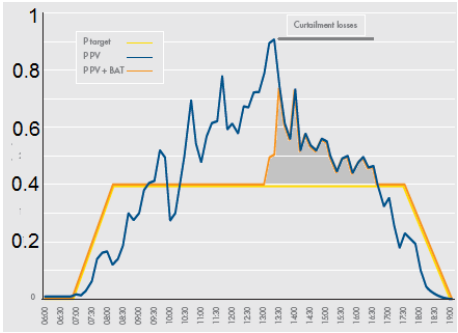


Shaping application in La Réunion Island

Bardzour PV+Battery project (La Réunion Island)

- **Akuo Energy** is one of the first IPPs to develop and operate a PV+Battery plant in a commercial manner

- 9MWp PV Plant with ESS to meet **EDF SEI** requirements
  - Shaping at 40% of maximum power
  - Primary reserve : 10% of maximum power / 15 minutes
  - Voltage control with reactive power



- Optimum sizing is 9MWh/4.5MW Li-Ion system
  - 2 systems in 20 years

Energy capacity	Losses	Average DOD	Lifetime
9 MWh	11.3%	69.8%	>12 years
14 MWh	3.5%	56.3%	>17 years
21 MWh	0.7%	44.9%	>20 years

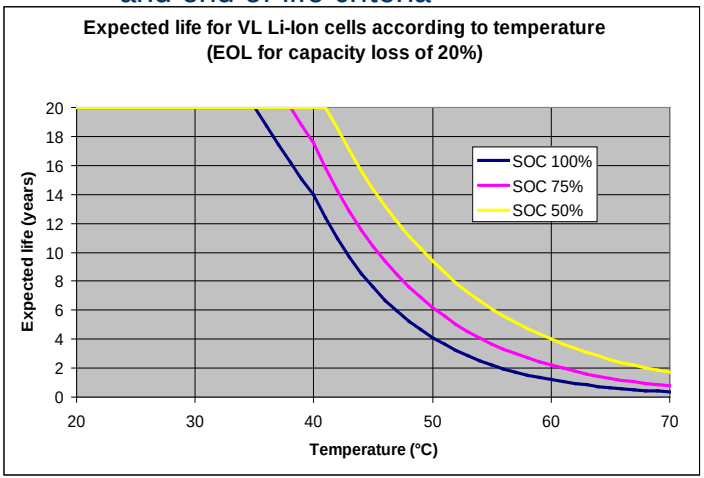
Operational
Oct 2014

4. Intensium Home. Li-ion for residential Energy Storage.

Calendar life and cycle life

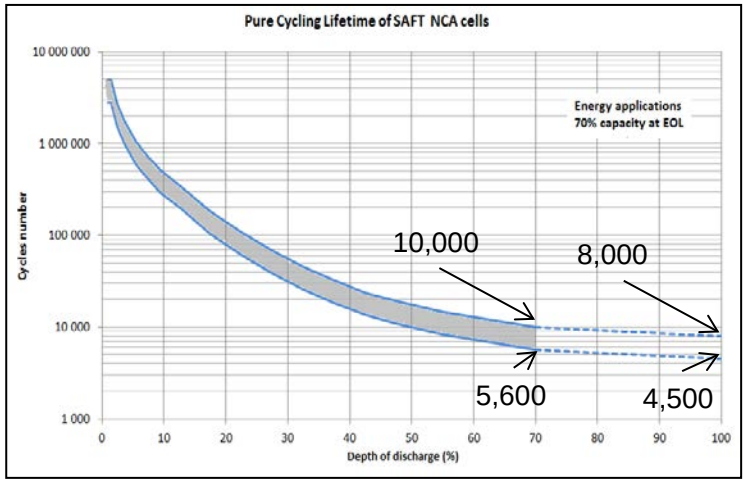
Calendar life

- in years
- depending on SOC & temperature
- and end of life criteria



Cycle life

- in nb of cycles
- depending on DOD and charge rate
- and end of life criteria



SOC: state of charge

DOD: depth of discharge

Modular Battery concept for ESS PV self-consumption

High DC Voltage Serial connected

- Energy Module 48V, 2.2 kWh,
  serial connection up to 720V
  - 33 kWh

Example Shown
6 Module – 1 BMM

288V, 13kWh

48V DC

48V, 4 kWh Unit,

Example shown
2 Module – 1 BMM

48V, 4KWh

High Performance

- 97% roundtrip efficiency
- 20 years lifetime @ 1 cycle per day (60% average)
- Maintenance free

Safety

- BMM: built-in safety with communikation
- Hihg reliability and safety
  - Safety oriented development IEC 61508
- Certification
  - UN, EMC, SIL , IEC 60950-1 und IEC 62040*)
  - VDE tested in Germany

*) *IEC 60950-1 Information technology equipment – safety, general requirements*
IEC 62040 general & safety requirements for UPS used in operator access areas

Residential ESS for PV self-consumption / back-up

Integrated storage system with inverter

Separate storage system and inverter

BPT S 5 Hybrid

Energie Manager

Sunny Island

PowerRouter

XW6048

48V

Intensium Home

Intensium Home 4kWh

Technical data:

Nominal characteristics at + 25°C	
Voltage (V)	48
Capacity (C/5) (Ah) at + 25°C	84
Rated energy (C/5) (Wh)	4000
Mechanical characteristics	
Width (mm)	535
Height (mm)	700
Depth (mm)	520
Weight (kg)	85
Electrical characteristics at + 25°C	
Voltage (V)	42 to 56
Maximum continuous discharge current (A)	160
Maximum continuous discharge power (W) at 50% SOC	7600
Peak discharge power in 3 s (W) at 50% SOC	15100
Maximum continuous recharge current (A)	82
Maximum continuous recharge power (W) at 50% SOC	4100
Peak recharge power in 5 s (W) at 50% SOC	12100
Operating conditions	
Operating temperature	0 to 40°C
Cycle efficiency (one way)	>95%
Self-discharge	<7% per month
Calendar lifetime at + 25°C	>20 years
Cycling lifetime at 60% DOD	>7000 cycles

Intensium Home - Complete System for Installation

Sunny Island

PowerRouter

XW6048

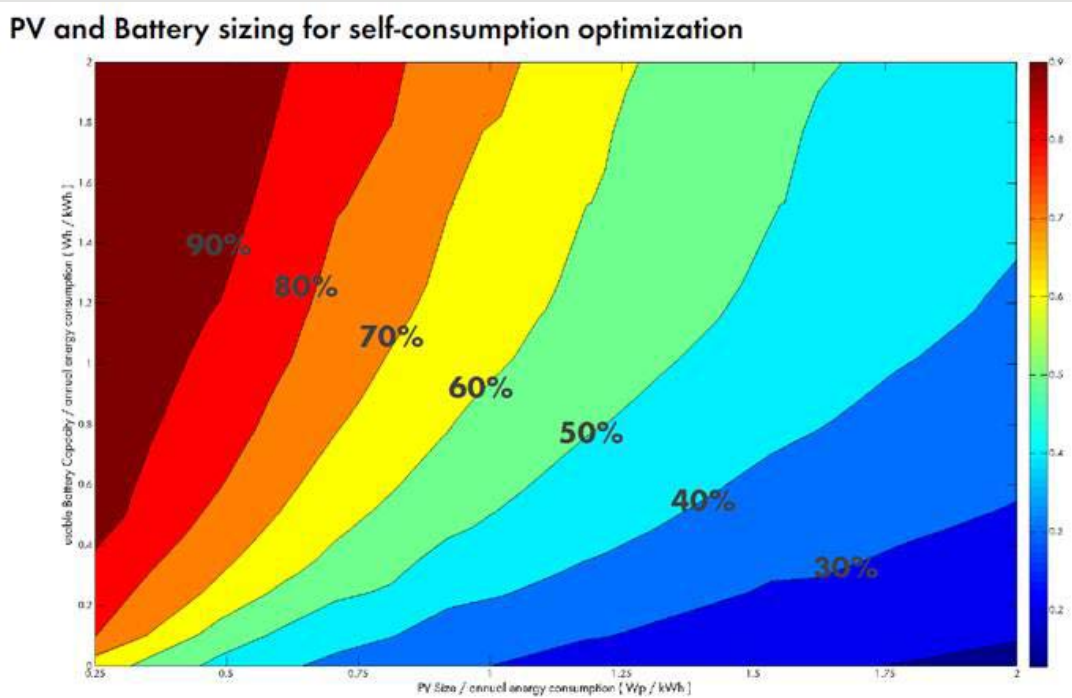
+

4kWh battery system

compatible with

5kW inverter & EMS

PV Self-consumption application



Assessing % self-consumption vs. Battery size

Example:
5kWp House, yearly:
5000 kWh consumption

A: 0 kWh batt -> 30%
B: 2kWh -> 48%
C: 4kWh -> 55%
D: 8,8kWh -> 68%

- **But ! Self-consumption is not the only benefit of storage**

=> Back-up power in case of black-out ... but what is the value of it?

Germany as example about self-comsumption policies

During the last years Germans householders are more focused to raise their energy “self-consumption” rather than feeding it into the grid.

Energy Storage is the way to target the self-consumption increasing and frees against the electricty rates.

Intensium Home offers everything to minimize the grid dependece in a 5,39KWp PV installation:

1. Life duration > 20 years (one cycle per day)
2. Compact and lightweight
3. (Almost) Free of maintenance
4. 15Kw of peak pulse and 7,5Kw of continuous output.

Thank you !

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