Purpose and Benefits of Battery Storage on Island Grids

- Overcome technical limits in integrating intermittent renewables:
  - Smoothing of highly variable generation, control of ramp rates
  - Stick to the forecast:
    - PV & wind power become firm and predictable components of energy mix

- Provide ancillary services
  - Cheaper than fossil based generation

- Avoid loss of revenue due to curtailment

- Avoid investments in balancing reserves
# Major Functions of Storage

## Wind & Solar generation

- **Ramp control**
  - Limit up & down ramp rates

- **Smoothing**
  - Keep production in forecast window

- **Shaping**
  - Stable power output
  - Controlled ramp up/down

## Grid

- **Frequency Regulation**
  - Injection/Absorption of active power

- **Peak Shaving**
  - of consumption peaks
  - of generation peaks
La Réunion – CRE Tender

- 9 MW PV PV plant
  - First project out of 16 contracts CRE (50MWp)

- 9 MWh Li-ion Energy Storage System
  - Consortium Saft, Ingeteam, Corex
  - 9 containers Intensium Max 20+E
  - 5.6 MVA converters in 4 containers

- EDF SEI specification
  - Constant power injection @ 40% Pmax
  - Primary reserve : 10% Pmax / 15 minutes
  - Voltage support by PCS reactive power

- Battery Optimization

<table>
<thead>
<tr>
<th>Energy capacity</th>
<th>Losses</th>
<th>Average DOD</th>
<th>Lifetime</th>
</tr>
</thead>
<tbody>
<tr>
<td>9 MWh</td>
<td>11.3%</td>
<td>69.8%</td>
<td>&gt;12 years</td>
</tr>
<tr>
<td>14 MWh</td>
<td>3.5%</td>
<td>56.3%</td>
<td>&gt;17 years</td>
</tr>
<tr>
<td>21 MWh</td>
<td>0.7%</td>
<td>44.9%</td>
<td>&gt;20 years</td>
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</tbody>
</table>

Installation
Octobre 2014
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
  - Required compliance > 98.5% in a week period

Ramp Rate Control + Frequency response
Salinas 10MWp PV Power plant (Puerto Rico)

Optimal sizing

- Compromise between ESS peak power and compliance of MTR
- PREPA requires 98.5% compliance of MTR during a week period.

The chosen solution

<table>
<thead>
<tr>
<th>PV Farm</th>
<th>Building blocks</th>
</tr>
</thead>
<tbody>
<tr>
<td>10MW</td>
<td>3x (IM20P+PCS)</td>
</tr>
</tbody>
</table>

1,3 MWh
5 MW

Operational Oct 2014
Takeaways

- One single device to provide multiple functions and to address multiple value streams

- Each system is unique: optimum Power & Energy versus requirements and cost

- Integration is key
  Battery – Conversion – Controls
Energy Storage installations 2012/14

- Lithium-ion technology, containerized systems only
Thank You

michael.lippert@saftbatteries.com