Who is Saft today?

GROUP PROFILE

- ~100 years of history
- Leadership position on 75-80% of revenue base
- 9% invested in R&D with 3 main technologies
- €738m revenue FY 2016

INTERNATIONAL PRESENCE

- 35% North America
- 32% Europe
- 33% Asia, MEA, LatAm

- 4,100+ people
- 3,000+ customers
Saft innovative energy solutions for smart rail transportation
SEPTA 1 - Letterly substation (Philadelphia)

The first installation for trackside Li-ion battery energy storage

- High Power Intensium Max 20P container 1.5 MW - 420 kWh
- Partners: ABB, Viridity
- Applications:
  - Recovery of braking energy
  - Participation in the frequency regulation market (PJM)

Started operation in April 2012
**SEPTA 1: Operation principle**

- The superposition of 2 services (illustration on 30 minutes)
  - regulation (red line) of 1MW according to PJM control requirement (blue line)
  - pulses in charge to recover trains braking energy (« Regen »)
SEPTA 1: Economic model

- The revenues are around 200 k$/year, providing a ROI < 5 years
  - ~25%: Braking energy recovery
    - 800 kWh/day (≈2000 peaks of 0.4 kWh in average)
  - ~75%: Frequency regulation (PJM)

- Regulation part is seasonal
- Braking part follows day usage

Operation revenue (k$)

<table>
<thead>
<tr>
<th>Month</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Jan</th>
<th>Feb</th>
<th>March</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenue (k$)</td>
<td>100</td>
<td>200</td>
<td>300</td>
<td>400</td>
<td>500</td>
<td>600</td>
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</table>

Energy recovery (kWh/day)

- Total energy throughput: 4/5 times a day
SEPTA 2: Griscom substation (Philadelphia)

The first installation for trackside Li-ion battery + supercapacitors as hybrid energy storage

- Medium Power Intensium Max 20M container 1,1 MW - 580 kWh
- Partners: ABB (conversion 1.5MW + supercapacitors Maxwell), Viridity

Started operation in August 2014
**SEPTA 2: Evolutions on ESS operation**

- **Expected evolutions:**
  - Increase braking energy recovery (~15%)
  - Increase the « performance score » for the frequency regulation (from ~0.7 on Septa 1).

- ... but the hybrid solution is too expensive!
SEPTA 3: 7 substations (Philadelphia)

Li-ion racks instead of containers to fit available space in the substations

- High Power Li-ion ESU: 29 syn24P gen3
  - 42kWh/210kW
  - Dimensions: 2.23m x 1.74m x 0.65m
  - Mass: 911kg
- Distribution cabinet (MBMM)
  - Dimensions: 2.23m x 0.76m x 0.65m
  - Mass: 318kg

**Operation**: Recovery of braking energy when combined with charge for frequency regulation

- 8.7MW additional battery capability (>10 MW in total)
**Takeaways**

- ROI can be optimized by combining several value streams (braking recovery, participation to grid regulation), additional services depend upon operation (increased headway without infrastructure reinforcement, emergency traction back-up when grid power loss,...)

- Combination of different technologies can increase the system performance, still high power Li-ion technologies can be fine tuned to answer your global need (Saft will select with you the most adapted electrochemistry)

- Battery sizing is key in the process: define your best location and condition of use, and we’ll identify together the most adapted solution to bring you the energy efficiency you are looking for
Thanks for your attention

Stay tuned!

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