PI System Applications in EV Battery Manufacturing

Presented by Jean-Luc Monfort, General Manager
Agenda

- Intro to Blue Solutions
- LMP® challenges
- PI System dashboard exemples
  - Global Process Overview
  - Downtime tracking with Event Frames
  - Production dashboard with Asset Analytics driven yield calculations
  - Battery Cycle Monitoring for quality control using Element Relative displays
- Conclusion
A FAMILY GROUP WITH A LONG-TERM STRATEGY in a diversified Group across 3 large sectors

**TRANSPORT & LOGISTICS**

- One of leading group in freight forwarding and logistics
- Leader in transport and logistics in Africa
- #1 port and rail concessions operator

**COMMUNICATION**

- One of the world leaders in communication
- 2nd biggest French free daily newspaper
- 4G and WIFI operator

**ELECTRICITY STORAGE & SOLUTIONS**

- LMP batteries and supercapacitors
- Mobility applications
- Stationary applications
- Intelligence and consulting service

**KEY FIGURES H1 2016 (FY2015)**

- 54,000 employees in 155 countries
- Turnover: €4.95bn (€10.8bn)
- EBITDA: €0.5bn (€1.1bn)
- Net income: €409m (€564m)
- Net Debt: €4.5bn (€4.3bn)
- Market capitalization (march, 2016): €10.7bn
An integrated electricity storage solutions provider
Bolloré Strategical Approach

- Development of energy-storage technologies

- Integration in clean transportation systems
  - Scaps in tramways and stop-start systems
  - Batteries in electric vehicles and buses

- Development of Power train and electric vehicles

- Development of a complete clean electro-mobility solution based on:
  - Electric vehicles
  - Intelligent charging and renting stations
  - Supervision system for optimizing car availability

- Development of solutions for stationary businesses
Challenges of a New Technology

- LMP® technology is unique and Blue Solutions property
- Blue Solutions is developing both the product and the processes for films production and packs assembly.
- In order to optimize the product and manufacturing processes, data is key and as proven to be vital for success.
- Blue Solutions as therefore selected the PI System in order to accelerate process and product optimization.
Objective: TRANSFORMING ENERGY STORAGE

Nano-Structured Capacitive Energy Storage Devices…

- High energy density, no capacity fading
- Non-flammable & non-explosive
- Rapid charge and discharge
- Environmentally friendly and recyclable
- Low-temperature operation
- Solid-state, virtually unlimited lifetime
LMP battery: A unique, state-of-the-art technology and production tool.

**BATTERY MANUFACTURING PROCESS**

1. Extrusion of ultra thin films used as anodes, electrolytes and cathodes

2. Manufacturing of cells by stacking of films to create modules

3. Assembly of modules in series to create battery packs

**PRODUCTION CAPACITIES**

- **Ergué-Gabéric (France)**
  - Current (Year End 2013)
    - Circa 10,000 LMP batteries (eq. 30 kWh)
  - +135 MWh per year eq. to 4,500 batteries per year
  - 300 MWh
  - c. 1 GWh

- **Boucherville (Canada)**
  - Current (Year End 2019)
    - Circa 32,500 LMP batteries (eq. 30 kWh)
  - c. 1 GWh

**Notes:**
- Circa 10,000 LMP batteries (eq. 30 kWh)
- Circa 32,500 LMP batteries (eq. 30 kWh)
... with key strengths

### TECHNICAL CHARACTERISTICS (LMP TECHNOLOGY)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
<th>Key Strengths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific energy density</td>
<td>~120 Wh/kg</td>
<td>• Strong energy density</td>
</tr>
<tr>
<td>Cycle life</td>
<td>circa 5,000 cycles</td>
<td>• Long cycle life</td>
</tr>
<tr>
<td>Capacity</td>
<td>Limited capacity decrease</td>
<td>• Strong performance under extreme conditions</td>
</tr>
<tr>
<td></td>
<td>over time</td>
<td>• Strong safety track record (no significant incidents),</td>
</tr>
<tr>
<td>Key technological risk &amp; safety</td>
<td>Solid-state</td>
<td></td>
</tr>
</tbody>
</table>

### PRODUCT CHARACTERISTICS (35 KWH LMP BATTERY)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume (l)</td>
<td>300</td>
</tr>
<tr>
<td>Weight (Kg)</td>
<td>300</td>
</tr>
<tr>
<td>Nominal voltage (V)</td>
<td>410</td>
</tr>
<tr>
<td>Internal temperature</td>
<td>60°C/80°C</td>
</tr>
</tbody>
</table>

Source: Company information
The expected lifecycle of the LMP battery

1. First utilisation: mobility applications
   - The battery is first used for mobility applications
   - In the first stages of its life, the battery delivers high power energy necessary for mobility needs

2. Second utilisation: stationary applications
   - Once the battery has lost 20% of its power or capacity for mobility applications, it can be used for specific stationary applications which require less power demand

3. Recycling the battery
   - Blue Solutions developed a specific process to recycle LMP batteries
   - Enables Blue Solutions to recover a significant proportion of the polymers and metals used

Optimised life cycle of LMP batteries enables to maximise efficiency of utilization
Increasing concerns about climate change and pollution...

**Increasing level of atmospheric CO₂**

1960: 317 ppm/year
2012: 394 ppm/year

Source: NOAA – Atmospheric CO₂ at Mauna Loa observatory (1960-2012)

50% of CO₂ emissions coming from transportation

5 years life expectancy loss due to pollution in Pekin
...and environmental challenges coming from urbanization...

Global number of cars booming

Today = 7bn inhabitants

3bn cars

2035 = 9bn inhabitants

700m cars

+29%

+329%

Source: International Energy Agency

- Over 50 cities ~ 10 million inhabitants by 2025
- 4.6bn people living in cities by 2025 (vs. 3.6bn in 2010)

Today = 7bn inhabitants

Source: International EnergyAgency
...encouraging the development of new mobility solutions

1 out of 5 vehicles operated in car sharing schemes expected to be a battery-powered electric vehicle by 2016

Car sharing vehicles

Source: Frost & Sullivan (February 2012)

500,000 cars by 2020

120,000 cars by 2015

44,000 cars by 2012

Provider of eco-friendly transportation solutions

Bluecar

Bluebus

Autolib

Bluetram

Car sharing vehicles

1 out of 5 vehicles operated in car sharing schemes expected to be a battery-powered electric vehicle by 2016

Source: Frost & Sullivan (February 2012)
Autolib’: a successful real-life test for the technology

Already c. 150,000,000 km cumulated and no major incident

Launch of Autolib’ with 250 cars
DECEMBER 2011

1,740 cars
600 stations
15,000 total subs
JUNE 2012

1,800 cars
820 stations
84,348 total subs
JUNE 2013

c. 4000 cars
1100 stations
6500 Charging points
300 000 total subs
125 000 yearly subs
AUGUST 2016

- An in-depth real-life test, challenging the technology in tough conditions
- A commercial success reflecting public’s interest for carsharing
- A success driving interest from other large cities

c. 150,000,000 km cumulated
>16,500,000 rental uses
>2,100,000 rental uses
c. 150,000,000 km cumulated
>16,500,000 rental uses
>2,100,000 rental uses
‘Always Connected’ User Experience & Real Time availability
Deployment

- **autolib’**
  - Paris (France)
  - 4,000 Evs
  - Launched in Dec. 2011

- **bluely**
  - Lyon (France)
  - 250 Evs
  - Launched in 2013

- **bluecub**
  - Bordeaux (France)
  - 200 Evs
  - Launched in 2014

- **blueindy**
  - Indianapolis (USA)
  - 500 Evs
  - Launched in 2015

- **source London**
  - Source London & Bluecity
  - Londres (UK)
  - 2014: Took over of Source London, 1,400 charging points
  - 2016: Launch of Bluecity, EV sharing

And in 2016 Roma and Turin in Italy
Our 100% EV car-sharing service for Singapore

✔ Starting mid 2017 with tentatively 50 stations, 200 charging points, 100 EV Bluecars

✔ Within 4 years: 500 stations, 2000 charging points, 1000 Bluecars

✔ 80% of the stations to be located in HDB and residential areas

✔ 20% of the charging points available for any EV
Bluezones

Bluezones integrate LMP battery and solar panels for producing, storing and distributing clean electricity in locations without network connections.

It will allow the feeding of Bluezones with buildings dedicated to health, education providing water and Internet access, as well as the development of usage of tools for the local benefit of the population.

Bluezones have been invested in Benin, Togo, Guinea, Congo and Niger.
Use cases review
- Single page: provides information on the entire process
- Real-time production data
Downtime Tracking

- Production summary over a period of time (production start/stop, startup time, downtime, ...)
- Leveraged in daily production meetings
- **Digital Dashboard (production vs target, status, scrap, startup time)**
- **Real-time update**
Battery cycling monitoring

- AF and PI ProcessBook one page to monitor 21 different bays cycling data.
PI ProcessBook SPE profile monitoring

- Allows the operator to view the profile of the SPE in real time in order to adjust the production machine to produce a conforming product according to the specifications.
- Allows the operator to view real-time critical data in order to adjust the production machine to produce a compliant product within the specification limits.
- Screen developed according to ASM
PI System in EV Battery Manufacturing

COMPANY and GOAL
Accelerate transition to a low carbon sustainable economy by developing new products and processes.

CHALLENGE
Develop the products, processes for films manufacturing and packs production, and battery applications all at the same time.
- Track production from raw material to end user application
- Lower production cost
- Support R&D and production

SOLUTION
In order to quickly optimize the product and process, data access is vital.
- The PI System was implemented to perform all data acquisition
- This enables process supervision, early problem detection and future investment priorities based on data-driven decisions.

RESULTS
The PI System is used on a daily basis by all the company and facilitates data analysis.
- Downtime tracking and cause and effect analysis as allowed the implementation of the most effective corrective actions to increase productivity.
- Event Frames reports are use for daily production planning.
- A continuous improvement team was implemented to keep up the pace.
Questions

Please wait for the microphone before asking your questions

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