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OVERVIEW OF ELECTRIC AND AGEING MODELS OF ELECTROCHEMICAL STORAGE SYSTEMS FOR DISTRIBUTION GRIDS APPLICATIONS

Dimitri Torregrossa (DESL-EPFL)

Fabrizio Marzolini (Leclanché)

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Introduction (Fabrizio Marzolini)

Overview on the project "100 millions pour les énergies renouvelables et l'efficacité énergétique" funded by Vaud Canton

Scientific Results

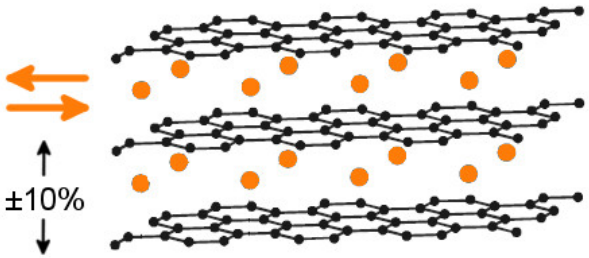
Perspective activities

Lithium Titanate cell technology

	Lithium Titanate		Lithium Graphite/NMC
Cycle life	15,000 (100% discharg >20,000 (80% discharge)		4,500 (100% discharge) 8,000 (80% discharg
Optimal DoD	100 %		80 %
Charge time	4C (Less than 15 minutes)		1C (1 hour)
Energy Density	65 Wh / kg		150 Wh / kg
Temperature range	-20°C to +55°C		0°C to +45°C
Ideal Use	• Power intensive applications • Long lasting applications • Applications needing rapid response • Grid stability projects		• Energy intensive applications • Low cycle applications • Bulk storage or weight critical applications • Renewable energy integration projects

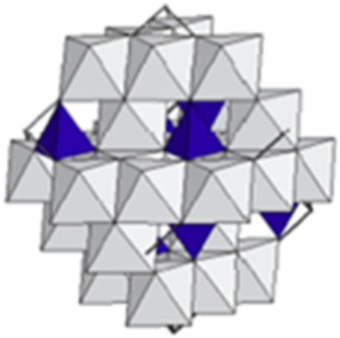
Difference between graphite and LTO

Graphite



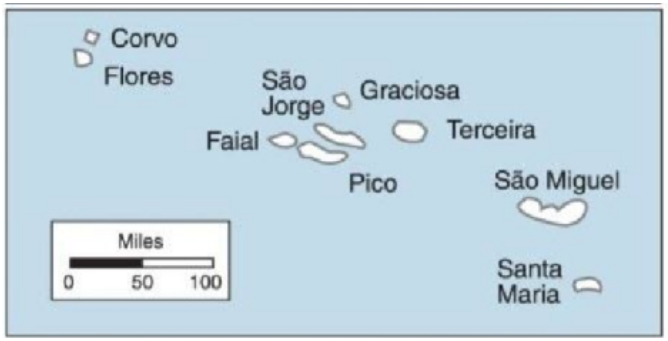
Strain upon lithium insertion leading to mechanical stress and reduced cycle ability

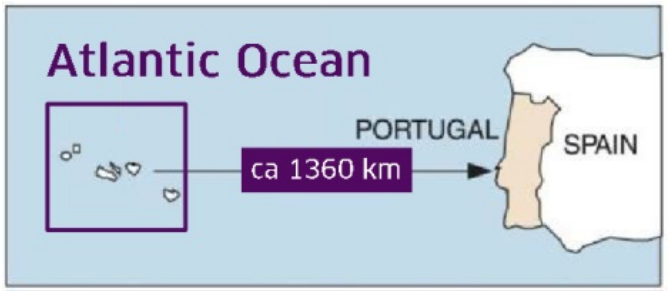
LTO



No strain upon lithium insertion, so called zero strain insertion material, thereby enabling higher cycle ability.

Ongoing Projects





Graciosa Island

- 4500 Inhabitants
- 13,6 GWh energy consumption per year (2012) 2,3 peak load
- The only power source is a 4.6 MW diesel power plant
- Annually the power plant consumes 3.3m litres of fuel and a diesel tanker arrives every two weeks

Battery Plant

- 3.2 MWh installed BESS / 6 MW installed inverter power
- 20 years performance warranty
- Delivery and commissioning in December 2015

Customer Economics

- Sustainable concept which can be replicated
- Sustainable business model IRR > 10%
- Revenue stream secured by a PPA contract
- Over 60% fuel consumption reduction
  leading to more than 9 GWh of Green Electricity per year
- 2.4 million litres of diesel saved per year
- Massive CO_2 reduction
- Less dependence on fossil fuel

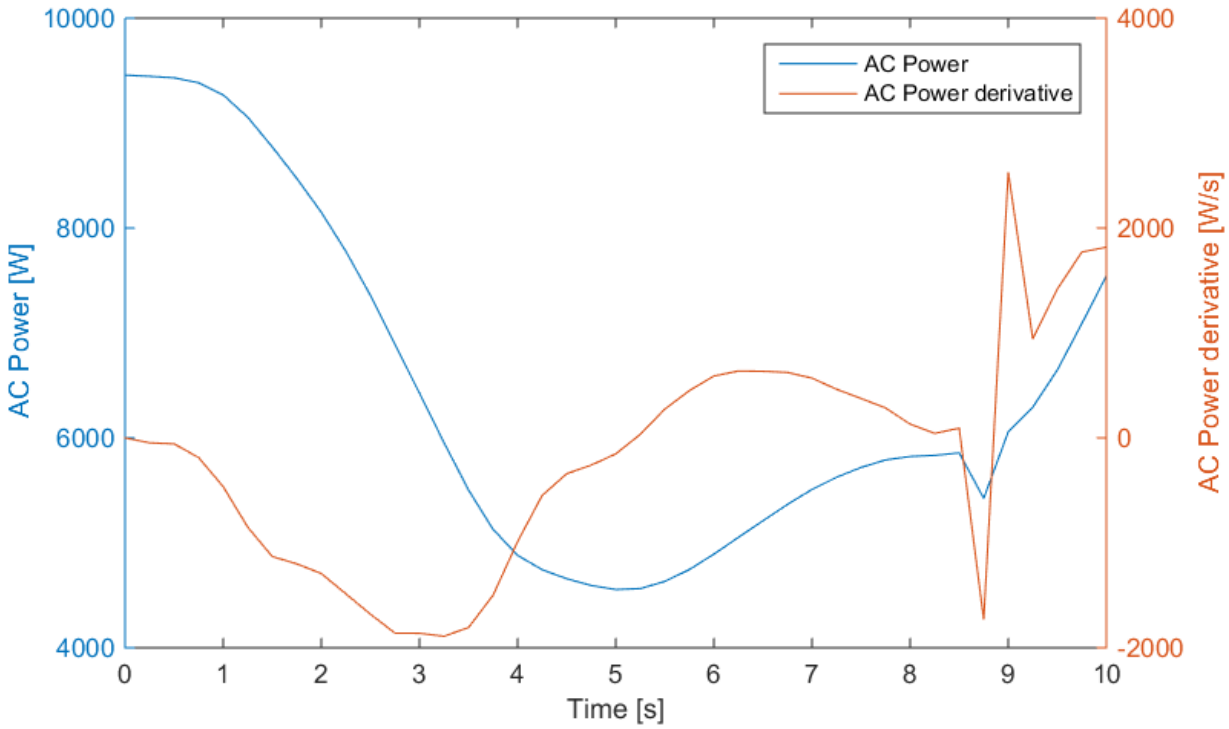
Overview on the targeted project

560 kWh- 720 kVA

LTO cell;

15.000 cycles at DoD of 100%

Overview on the targeted project



AC PV Power variations of 50% in 3.5 s

High-pulsed currents should be delivered by LTO cells

Novelties on Ageing of Supercapacitors

Current extraction is an ageing factor in both SCs and Li-ion cells. Why?

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Current extraction is producing impurities

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These impurities are partially filling the pores of the electrodes and they change the electrolyte properties

Novelties on Ageing of Supercapacitors

How we can take temporarily benefits from current extraction?

Current extraction, especially if pulsed, also

Increases the temperature

Higher electrolyte conductivity

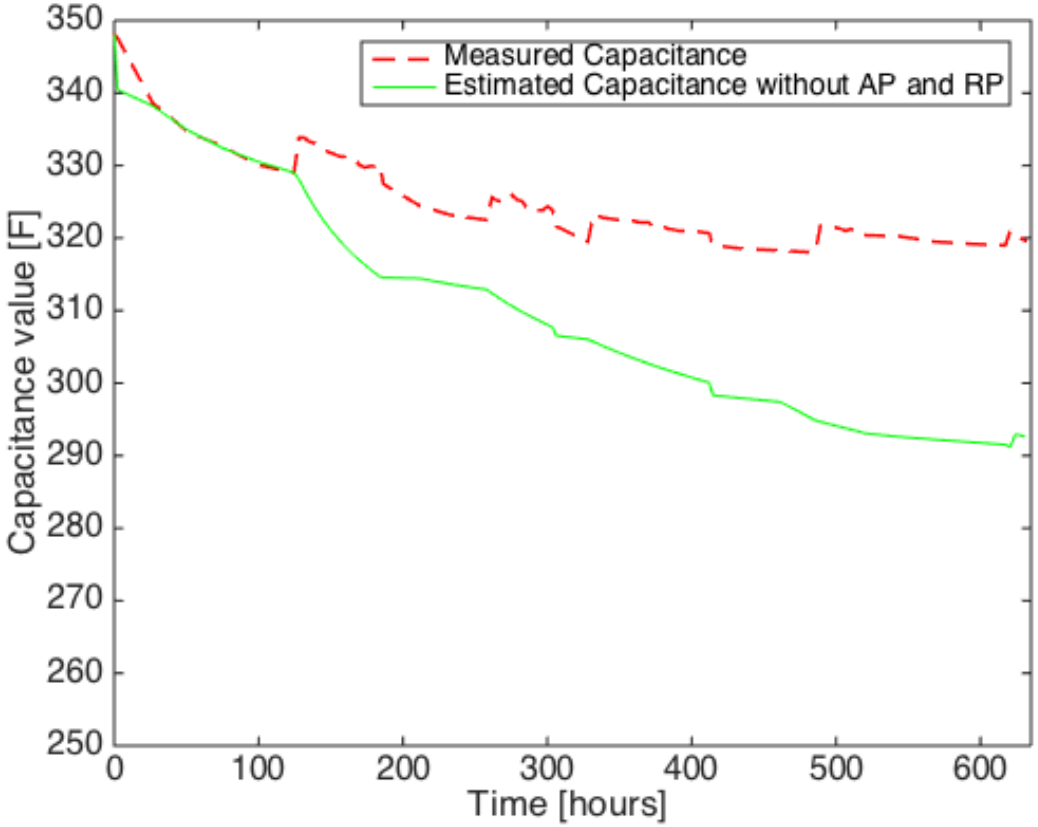
Remove the impurities

Higher electrolyte and electrode interaction

Temporary higher capacitance: *Recovering phase*

Novelties on Ageing of Supercapacitors

This recovering phase has been experimentally observed and then modelled for SCs



Increase of capacitance of 1.3% during 6 hours

Observed during 3 months with more than 220.000 cycles

Perspective activities-first results for LTO

Similar experimental investigations are under development for LTO cells.

First results show a recovering phase of 0.8-1% of temporary increased capacitance.

This investigation should be accounted by an enhanced Battery Management System.

Questions?

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Associated Publications

D. Torregrossa, M. Paolone "Modelling of Current and Temperature Effects on Supercapacitors Ageing. Part I: Review of Driving Phenomenology", Journal of Energy Storage 2015, 10.1016/j.est.2015.11.003

D. Torregrossa, M. Paolone "Modelling of Current and Temperature Effects on Supercapacitors Ageing.Part II: State-of-Health Assessment", Journal of Energy Storage 2015, 10.1016/j.est.2015.11.007