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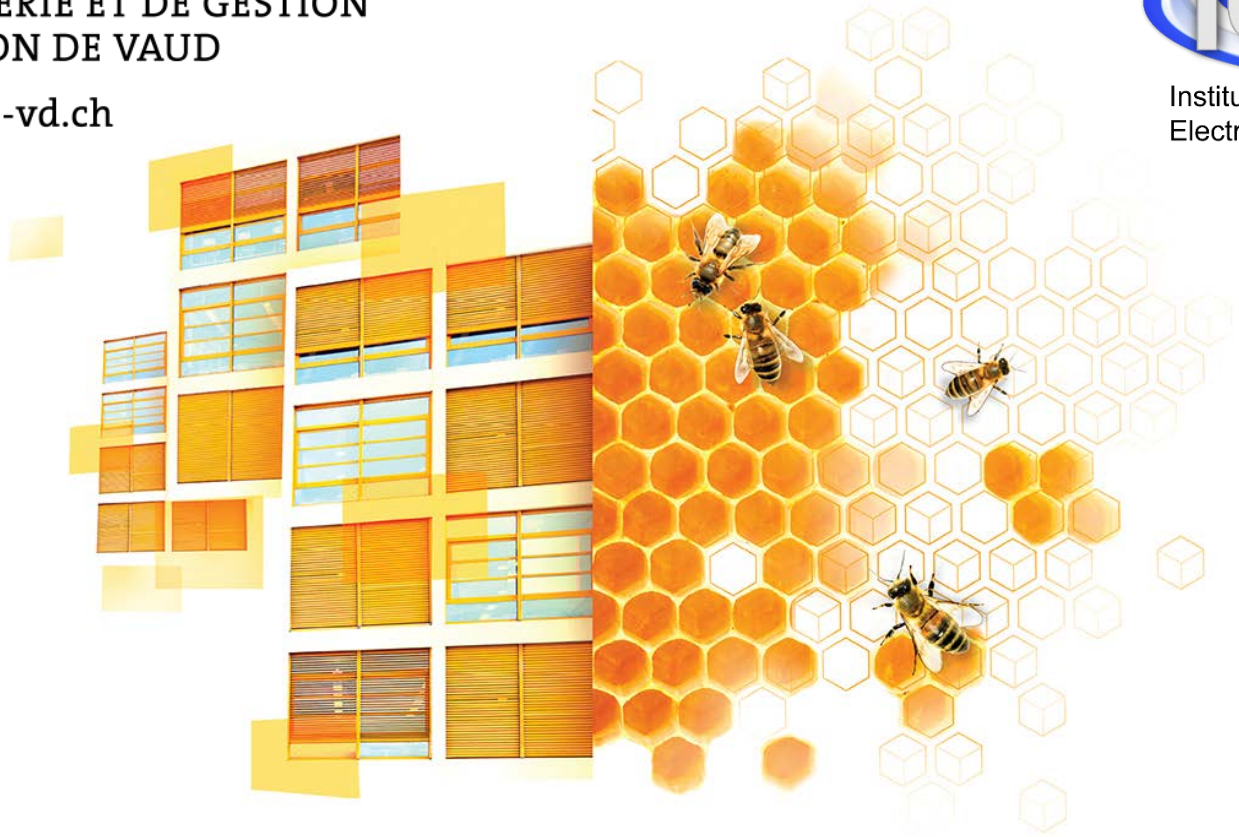
HAUTE ÉCOLE
D'INGÉNIERIE ET DE GESTION
DU CANTON DE VAUD

www.heig-vd.ch

Institut d'Energie et Systèmes
Electriques de la HEIG-VD



SCCER School

Field test of a 63kWh/100kW storage for grid applications

Philippe Morey, October 2017

Hes·so
Haute Ecole Spécialisée
de Suisse occidentale

HEIG-VD / IESE is…

5 professors

Affolter Jean-François
Besson Christophe
Bossoney Luc
Carpita Mauro (Director)
Capezzali Massimiliano

16 Engineers R&D

FTE, average last 2 years

Beguin Mathias
Bozog Mokthar
Gavin Serge
Carrard Fanny
Crottaz Michael
Duc Jérôme
Houmard Douglas
Morey Philippe
Monzillard Gilles
Pointet Marc-André
Pidancier Thomas
Rigazzi Luca
Savary Alain
Scherer Ludovic
Schiesser Matthias
Wasterlain Sébastien

- Key areas : Energetics, Power systems, Power electronics, Electric machines
- Effort : Approx 1.5 Mio/Year
- Location: Yverdon-les-Bains
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A 63kWh/100kW looks like…

Partner: Leclanché

Technology:

- Lithium-Titanate (LiTiO)

Quizz:

In general / LiTi

- Energy density [Wh/kg]?
- Number of cycles [-]?
- Max Current [xC]?

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A 63kWh/100kW looks like…

Partner: Leclanché

Technology:

- Lithium-Titanate (LiTiO)

Quizz:

	In general	/ LiTi
• Energy density [Wh/kg]?	30-250	/ ~70
• Number of cycles [-]?	500-5'000	/ ~15'000
• Max Current [xC]?	~2C	/ ~10C

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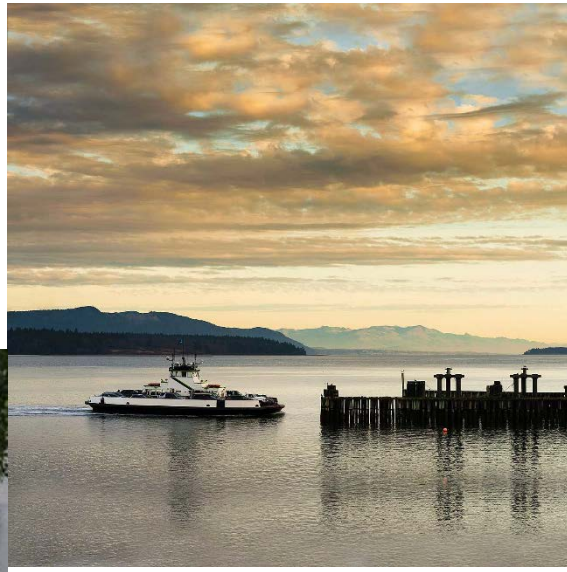
Examples of applications of LiTiO

Energy density not as critical + Large number of cycles needed

Stationnary
Anxilliary services for the grid
Example Graciosa Poject:
https://vimeo.com/164569977
(Leclanché)

Fast charging
For buses services
Example bus TOSA (ABB):
400 kW – 30 sec
3-7 stations (line 23, Geneva)



Ferry
Many cycles/day
http://www.leclanche.com/fileadmin/user_upload/20150609_press_release_leclanche_ferry_fr.pdf

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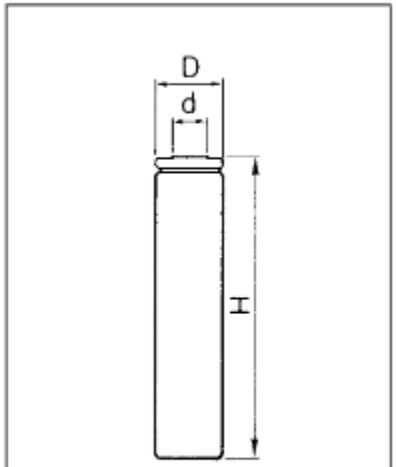
What for a Tesla ?

comparison is not reason ! (mobility ≠ stationnary)

Tesla Model S P85: (about. 400 km, ~ 90'000 CHF)

- 335 kg for 85 kWh = ~240 Wh/kg (without packaging)
- ~7'100 cells (type NCR, ~400 cycles)



Dimensions(Typ.) of Bare Cell		
	H	64.93mm
	D	18.2mm
	d	7.9mm

Discharged State after Assembling

Cell Type NCR18650B

Specifications

Rated Capacity (at 20°C)		Min. 3200mAh
Nominal Capacity (at 25°C)		Min. 3250mAh
		Typ. 3350mAh
Nominal Voltage		3.6V
Charging Method		Constant Current -Constant Voltage
Charging Voltage		4.2V
Charging Current		Std. 1625mA
Charging Time		4.0hrs.
Ambient Temperature	Charge	+10～+45°C
	Discharge	-20～+60°C
	Storage	-20～+50°C
Weight (Max.)		47.5g
Dimensions (Max.) Maximum size without tube	(D)	18.25mm
	(H)	65.10mm
Volumetric Energy Density		676Wh/l
Gravimetric Energy Density		243Wh/kg

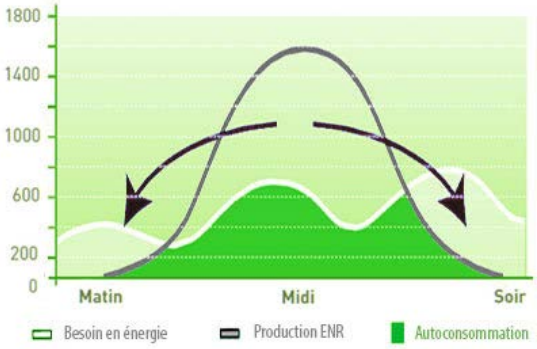
Sources: http://blog.erios.org http://www.vroom.be

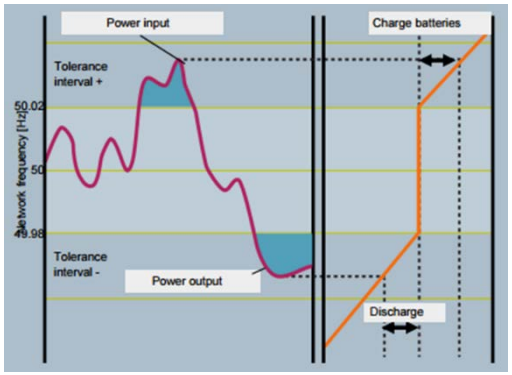
Back to the grid

Auxiliary services; different uses

Different services of a battery in a Grid:

- User (locally)
  - Peak shaving
  - Self-consumption
  - Voltage control
  - Filtering
- Power System (large systems)
  - Frequency control
  - Energy optimization
  - Economic optimization





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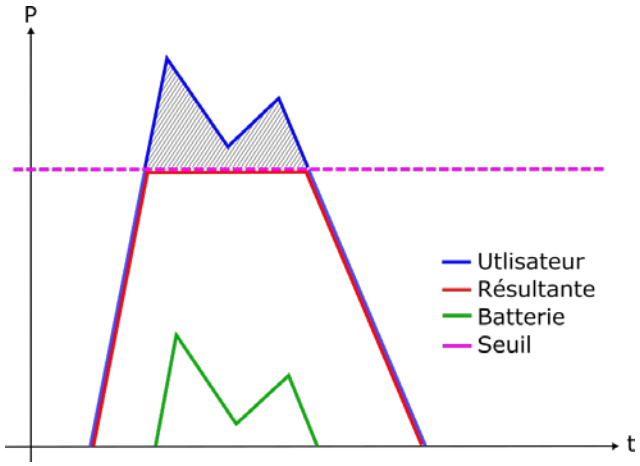
Example: peak shaving

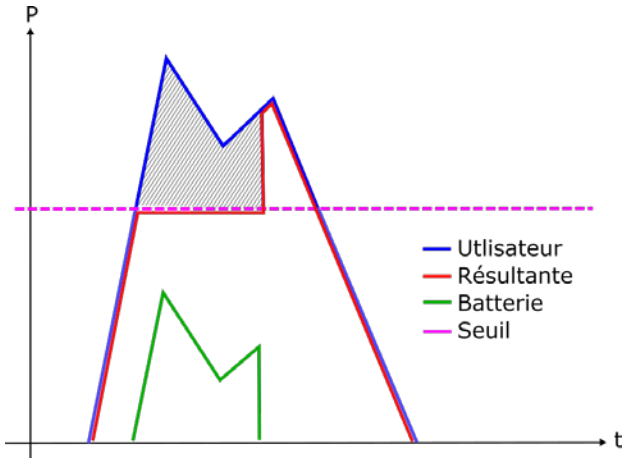
Using fuzzy logic

Challenges in peak shaving :

- *Battery* has a limited capacity and *inverter* a limited power
- The future consumption is unknown
    - Might be influenced by stochastic parameters



Successful



Unsuccessful

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Meteorological influence on consumption?

Figures for France

Quizz:

France: about 80’000 MW at peak power, 70 Mio People

- What is the consumption variation in France for…:
- 1 °C colder ?
- Variation of nebulosity of 1 Octa ?

NB: Octa: is the unit of measure of cloudiness. From a human observation of the sky, it is expressed on a scale of 0 to 8 (0 corresponding to a clear sky, 8 to a cloudy sky)

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Meteorological influence on consumption?

Figures for France

Quizz:

France: about 80’000 MW at peak power, 70 Mio People

- What is the consumption variation in France for…:
- 1 °C colder ? **+ 1’600 to 2’400 MW**
- Variation of nebulosity of 1 Octa ? **+ 650 MW**

NB: Octa: is the unit of measure of cloudiness. From a human observation of the sky, it is expressed on a scale of 0 to 8 (0 corresponding to a clear sky, 8 to a cloudy sky)

Source: http://www.rte-france.com/sites/default/files/2015_bilan_electrique.pdf

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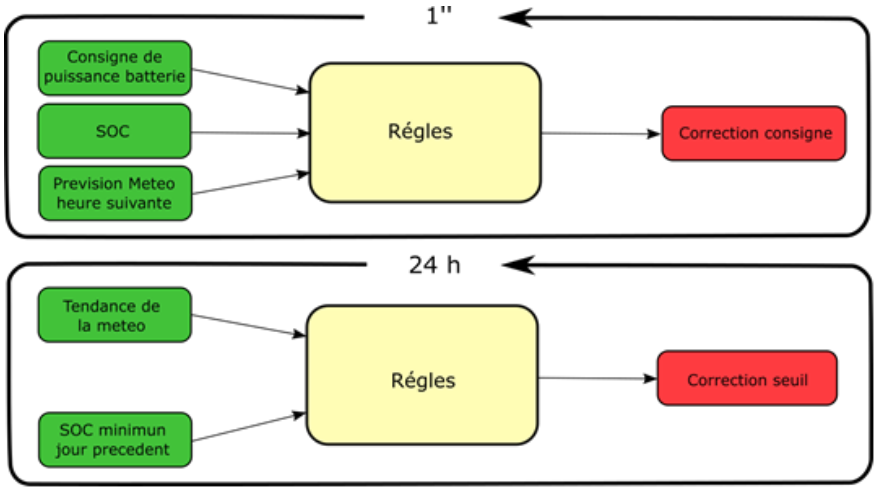
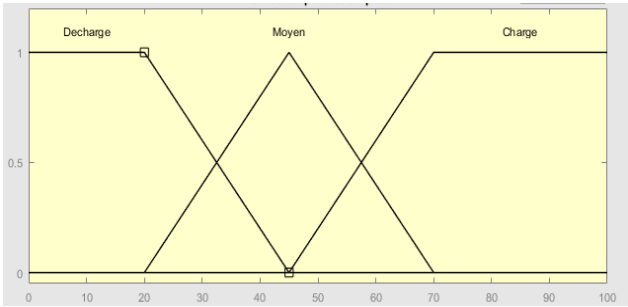
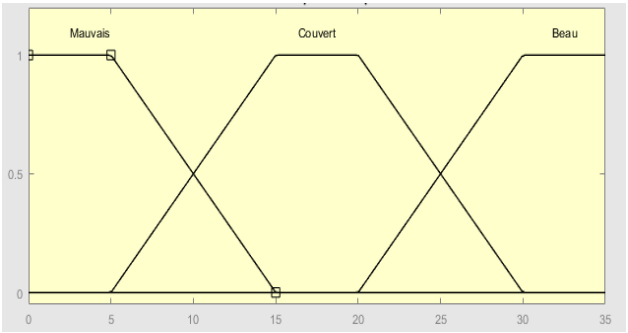
Fuzzy logic

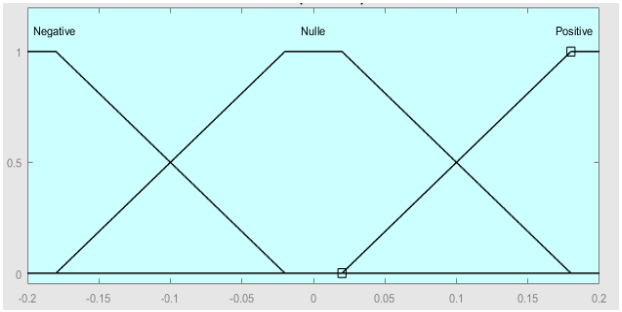
But intelligent rules are needed

Definition of rules:









Example:

	Tendance Météo	operateur	SOC jour précèdent	Facteur correction seuil
Règle 1	Positive	**et**	Moyen	Nulle
Règle 2	Négative	**et**	Moyen	Positive
Règle 3	Négative	**et**	Déchargé	Positive
Règle 4	Positive	**et**	Chargé	Négative
Règle 5	Stable	**et**	Déchargé	Positive

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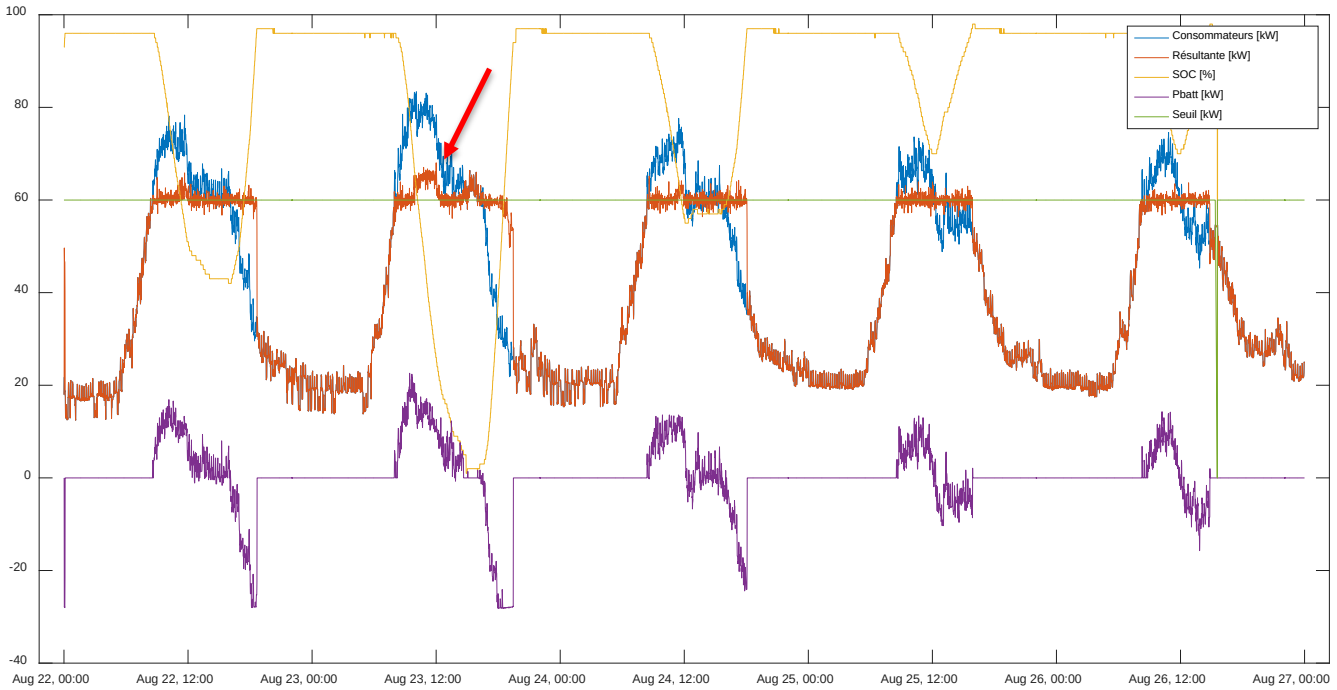
Test results

Example for a working week



Blue = if without battery

Arrow = example of «smooth» correction (load > than usual)

Week-Ends: operation «high/low tarif» (arbitrage)

economic parameters not yet convincing but excellent behavior of the regulation

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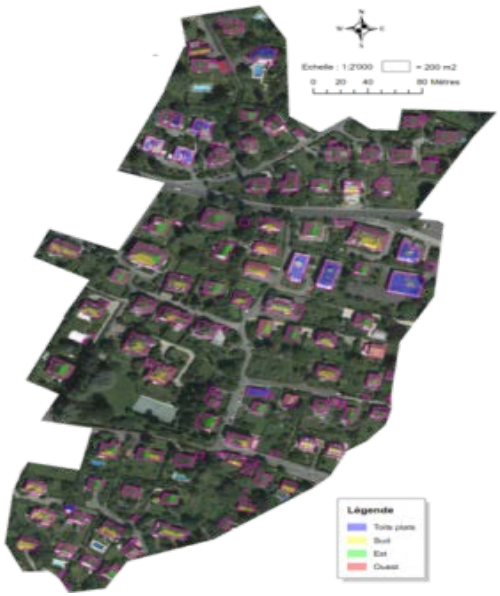
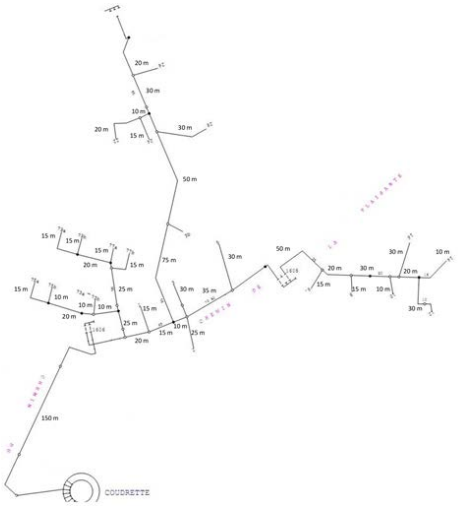
Study Case « DSO »

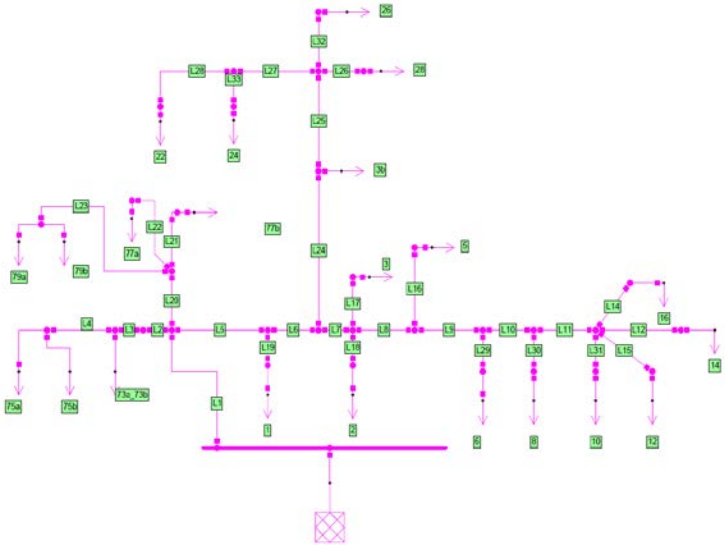
Domestic vs centralized storage

Case study for « Coudrettes » disctrict, Lausanne

- Base case: no PV, no Battery
- Case 1: every house with PV but no battery
- Case 2: every house with PV has a battery
- Case 3: the battery is located in the distribution station







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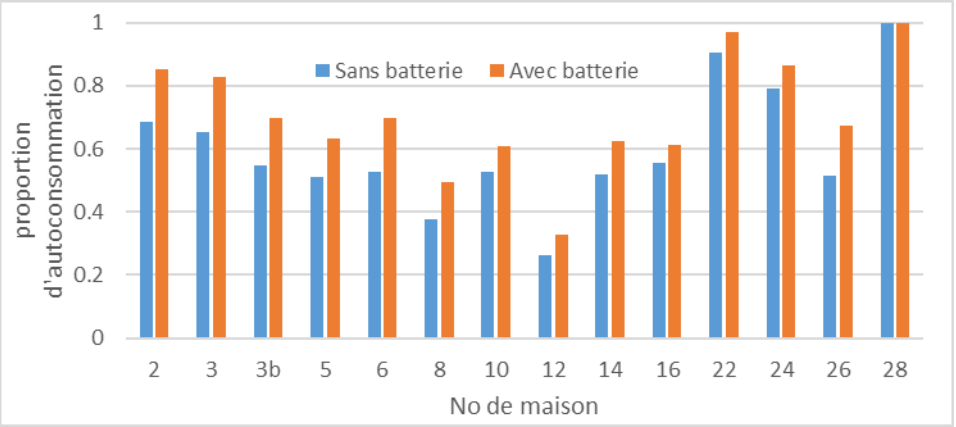
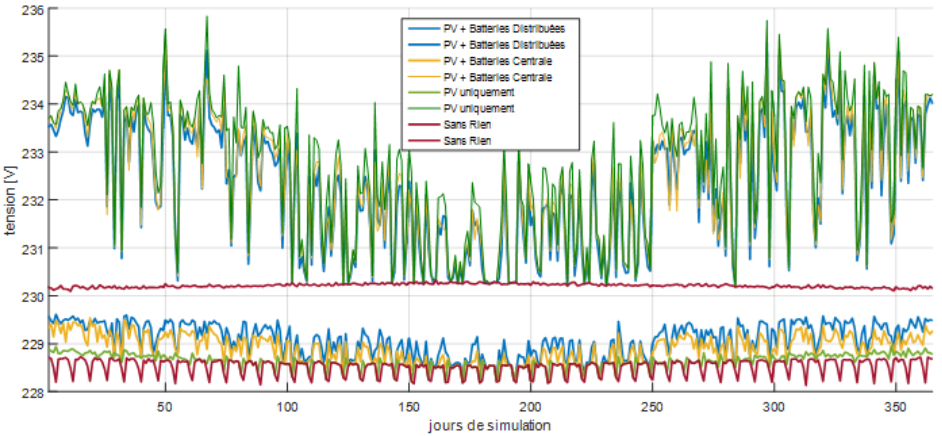
Influences…

Self-consumption, voltages

- The domestic batteries improve the self-consumption
  - Obvious, but also interesting on economical side for customer
- When the central battery arrives full or empty, the load on the network changes suddenly
  - The domestic batteries are more “smoothing”
- The batteries (de- or centralized) are too «small» to have a real influence on the voltage





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Conclusion

Batteries : many technologies and still developing

- i.e. LFP, LTO, LMO, LCO, NCA, NMC…

For a domestic usage, batteries present an interest with a PV production

- But the cost is still too high
- Electric cars can be a good solution
- **Quizz:** how long could you feed your home with a car battery ?
    - But “practical” problems to solve

For an industrial usage, technically a battery is interesting but financially not (so far)

From the point of view of the network operator, investing in a central battery would have little interest

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Questions ?

http://iese.heig-vd.ch/

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