

Energy Flexibility challenges for Energy Transition

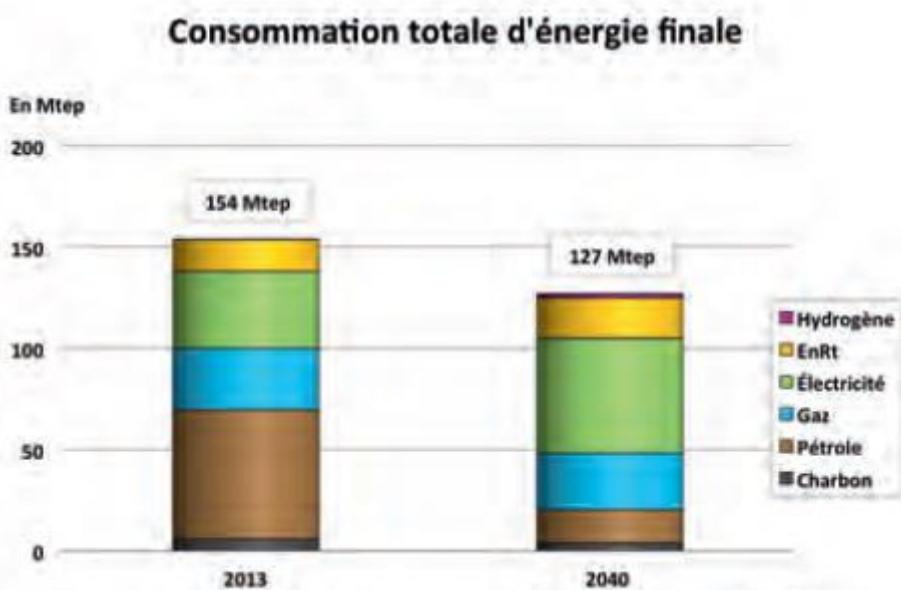


N. HADJSAYD
Professor Univ. Grenoble Alpes/Grenoble INP/G2Elab & President of Think SmartGrids Scientific Council

Some highlights vs. Energy Transition & Prospective

2015-2017

- **Warmest years** ever recorded (1909 most cold)
- **Energy transition** Bill and COP 21
- **~US\$ 300 Milliards** investment in RES (world) *.
 - ~1000 GW PV & Wind
 - Towards 2000 GW by 2023
- **EV:** more than 50%
- **Overs 300 millions** people gained access to energy (world) .



More ELECTRIC



- **Electricity** demand driven by “decarbonation and energy shift to usages, smart devices, ...
- **2X** Electric demand increase compared to energy by 2040

More DISTRIBUTED

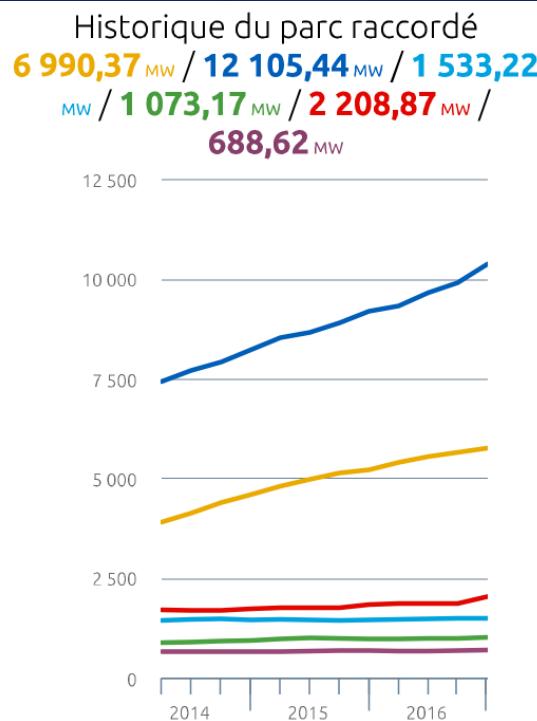


- **Decentralized Energies** close to end users, dispersed, EVB/EVT, microgrids, local management of energy, consum'actpro ...
- **70%** of new generating units will be RES by 2040

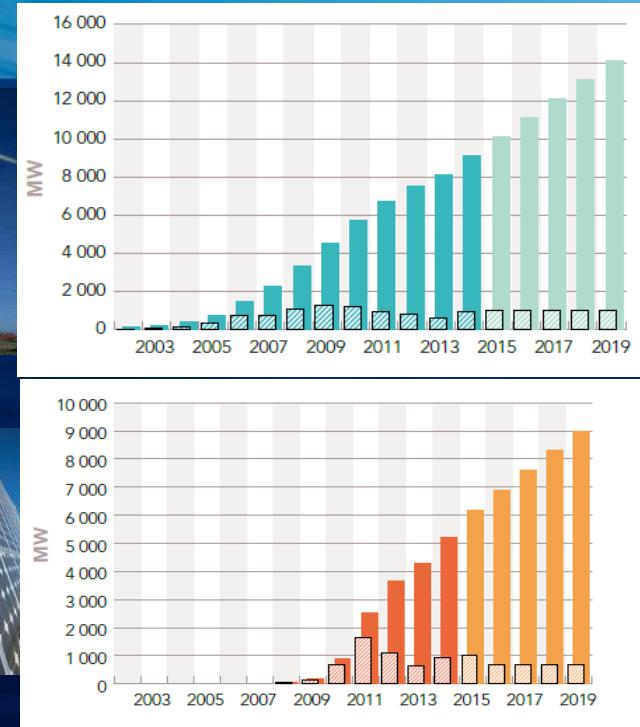
Projected solar PV system deployment cost (2010-2020)



Evolution France and worldwide...



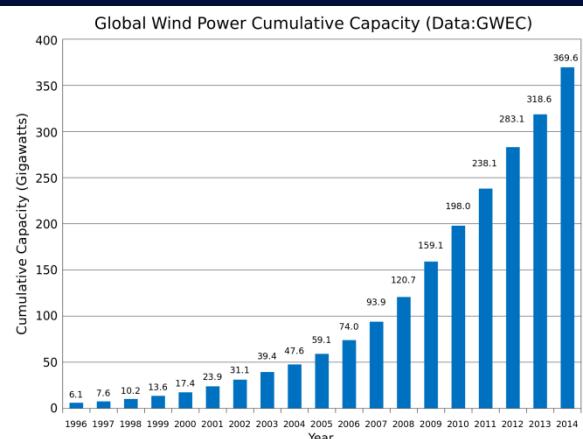
Total raccordé
24 599,69 MW
à la fin du trimestre T2 2018



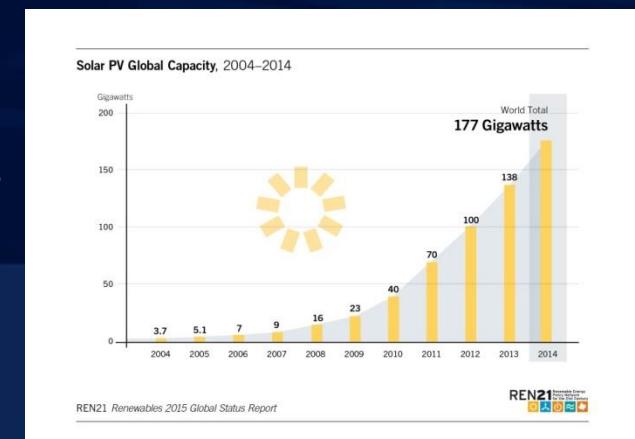
Source: ENEDIS

Source: ENEDIS

Source: RTE

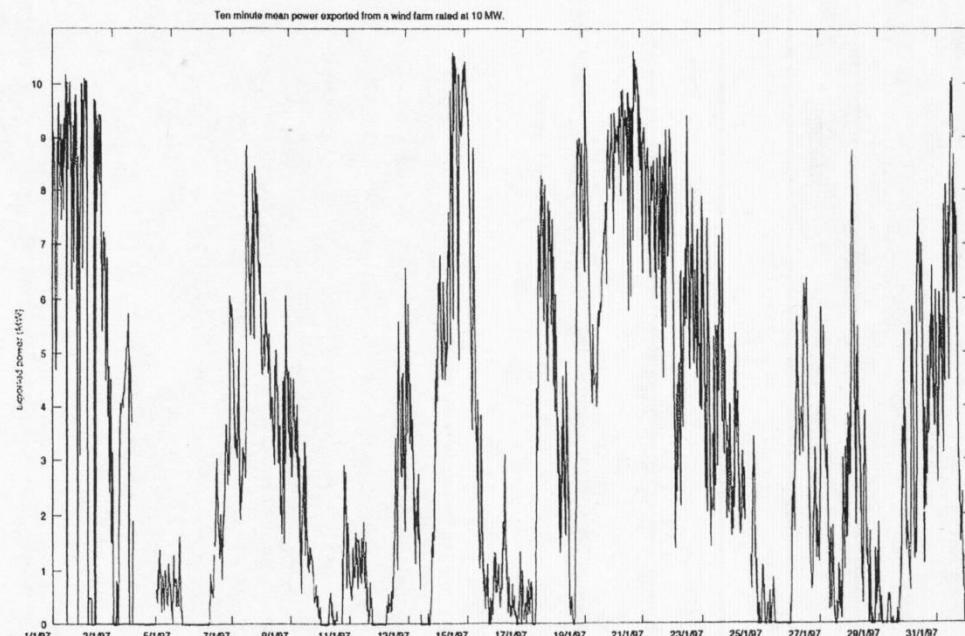


Worldwide

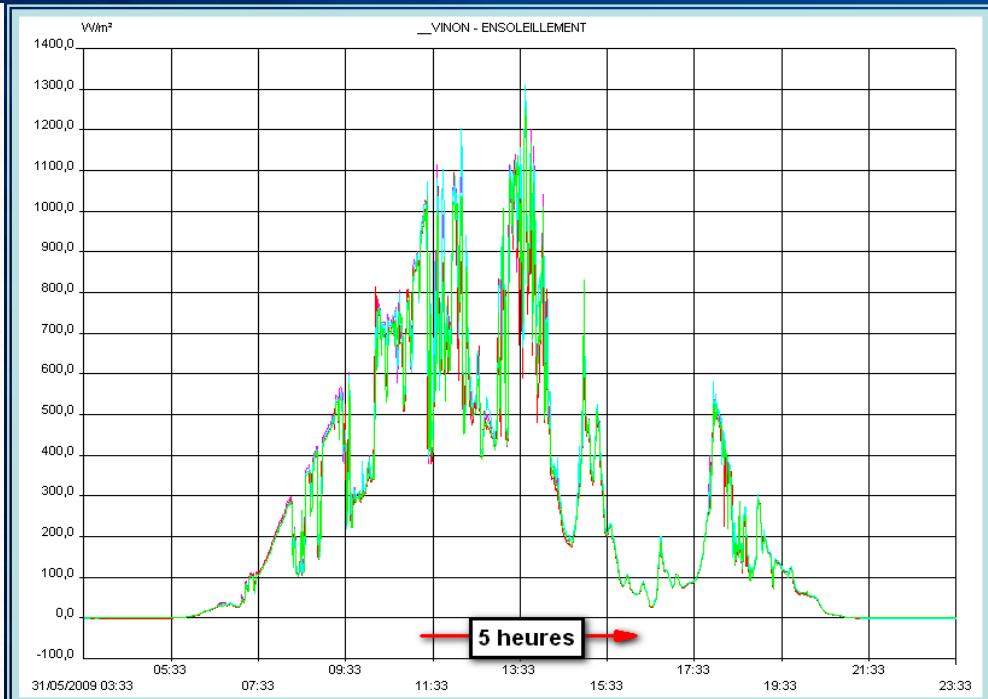


Integration of variable production (intermittency) & Plug-in HEV

Wind farm over output over 1 month, UK

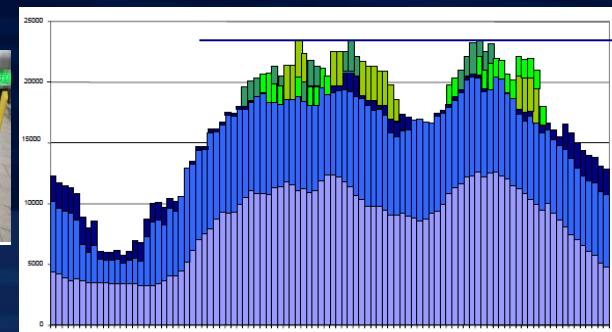


Ex : Vinon sur Verdon (May 31st)



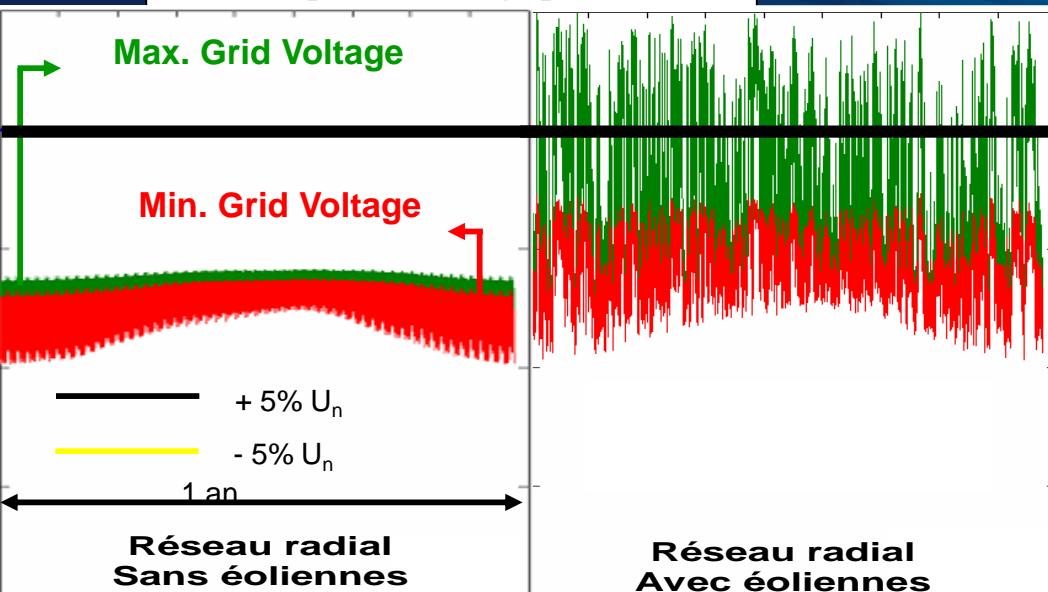
■ Plug-in HEV

- Charging stations (Fast, accelerated, slow)
- Stochastic effects – geographical et temporal



Some technical impacts...

Impact on voltage profile



Impact on harmonics

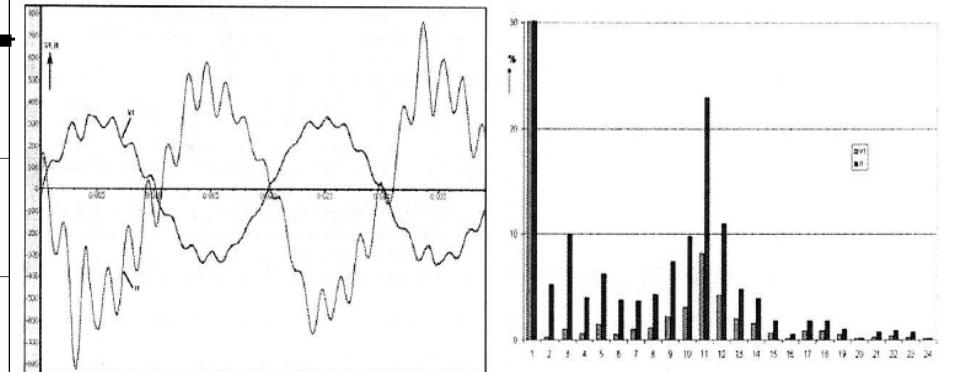
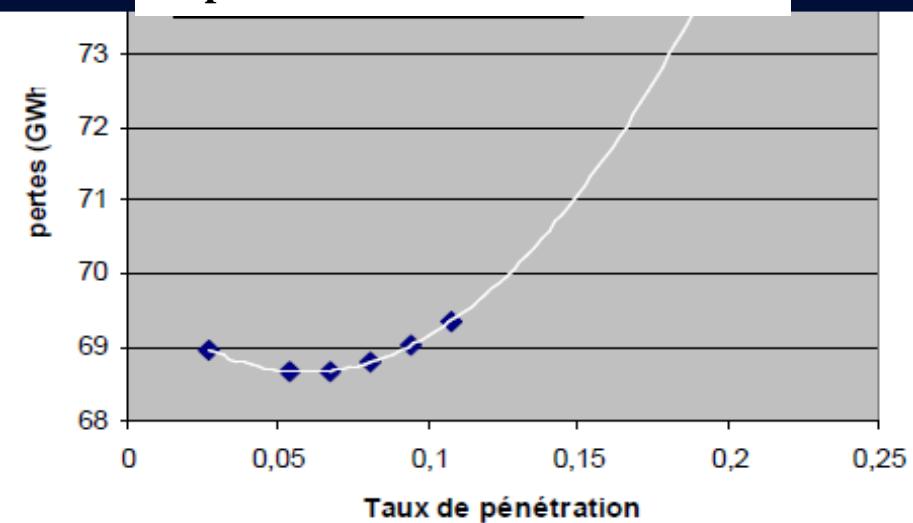


Figure 2. Voltage and current waveforms at the low voltage side of a MV/LV transformer, and spectral distribution of harmonics with the 11th harmonic salient due to grid resonance (Bosman 2006)

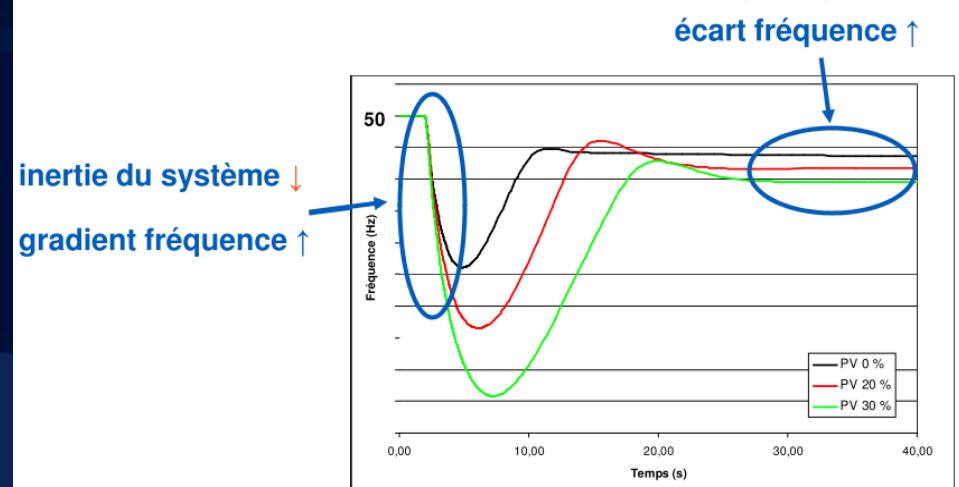
Impact on technical losses



→ moins de groupes classiques

énergie réglante ↓
écart fréquence ↑

inertie du système ↓
gradient fréquence ↑



Source: EDF

RES grid integration vs RES variability....

▪ Technical stakes

- **Global**: stability and overall balance in a context of high variability
- **Local**: constraints V, I, ...
- **Operation and Planning**
 - Provide short-term flexibilities for solving real-time constraints
 - Link operational flexibilities to planning challenges

▪ Forecasting RES production

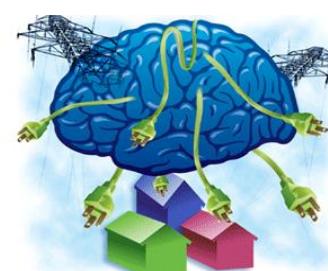
▪ Grid Pooling

- **Geographical** scale (continent complementarities)
- **Complementarities** of different RES types: PV, Wind, ...

▪ Flexibility

- **Generation dynamics** (back up) including RES
 - Requirement for specific dynamic (covering different reserves time scales)
- **Storage**
- **Demand** elasticity and response
- **Self-consumption**
- **VPP**

▪ Smartgrids: « system» vision necessary



Lithium-ion pour le stockage à l'échelle du réseau (Source : www.grist.org)

SmartGrids evolution and value chain

SmartGrids deployment: Same fundamentals, different priorities

SmartGrids value chain

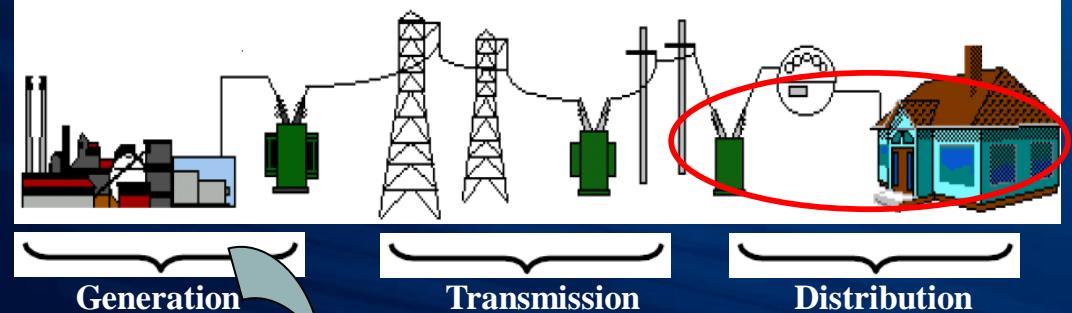
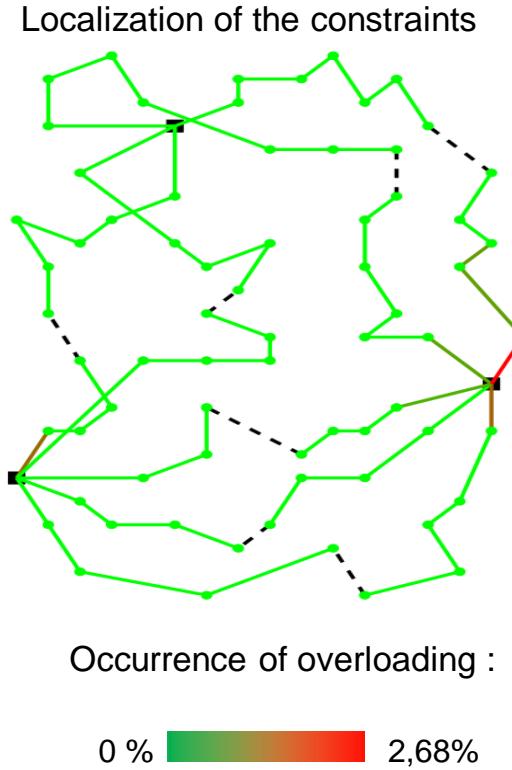


Illustration of impact of operational flexibility solutions on planning decisions

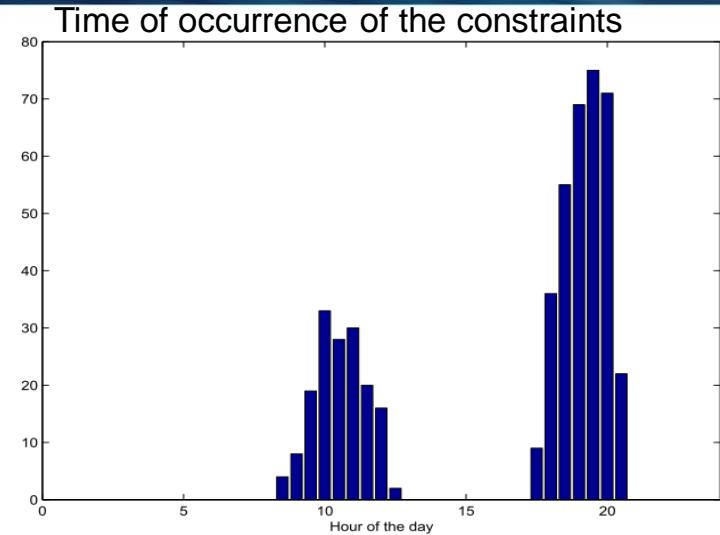
Constraints in the network:

- 3 HV/MV substations
- 69 MV/LV substations
- 77 MW
- Period of study: 30 years
- 20% of insertion of DGs per MV/LV substation



Operation vs planning strategies:

- Reinforcement
- Reconfiguration (switching devices)
- Reconfiguration and load control
- Load control

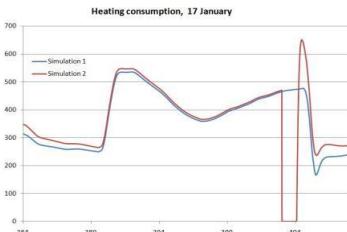


Number of the line under constraint	Duration of constraints per year	Reinforcement cost	Cost of reinforcement per hour of constraint
10	0,5 h	183.99 k€	367.98 k€/h
18	2 h	145.46 k€	72.73 k€/h
19	146 h	130.10 k€	0.89 k€/h
29	70 h	205.71 k€	2.94 k€/h
37	82 h	183.99 k€	2.24 k€/h
51	234 h	156.64 k€	0.67 k€/h
52	87 h	252.57 k€	2.90 k€/h
53	93 h	91.99 k€	0.99 k€/h
64	136 h	156.64 k€	1.15 k€/h

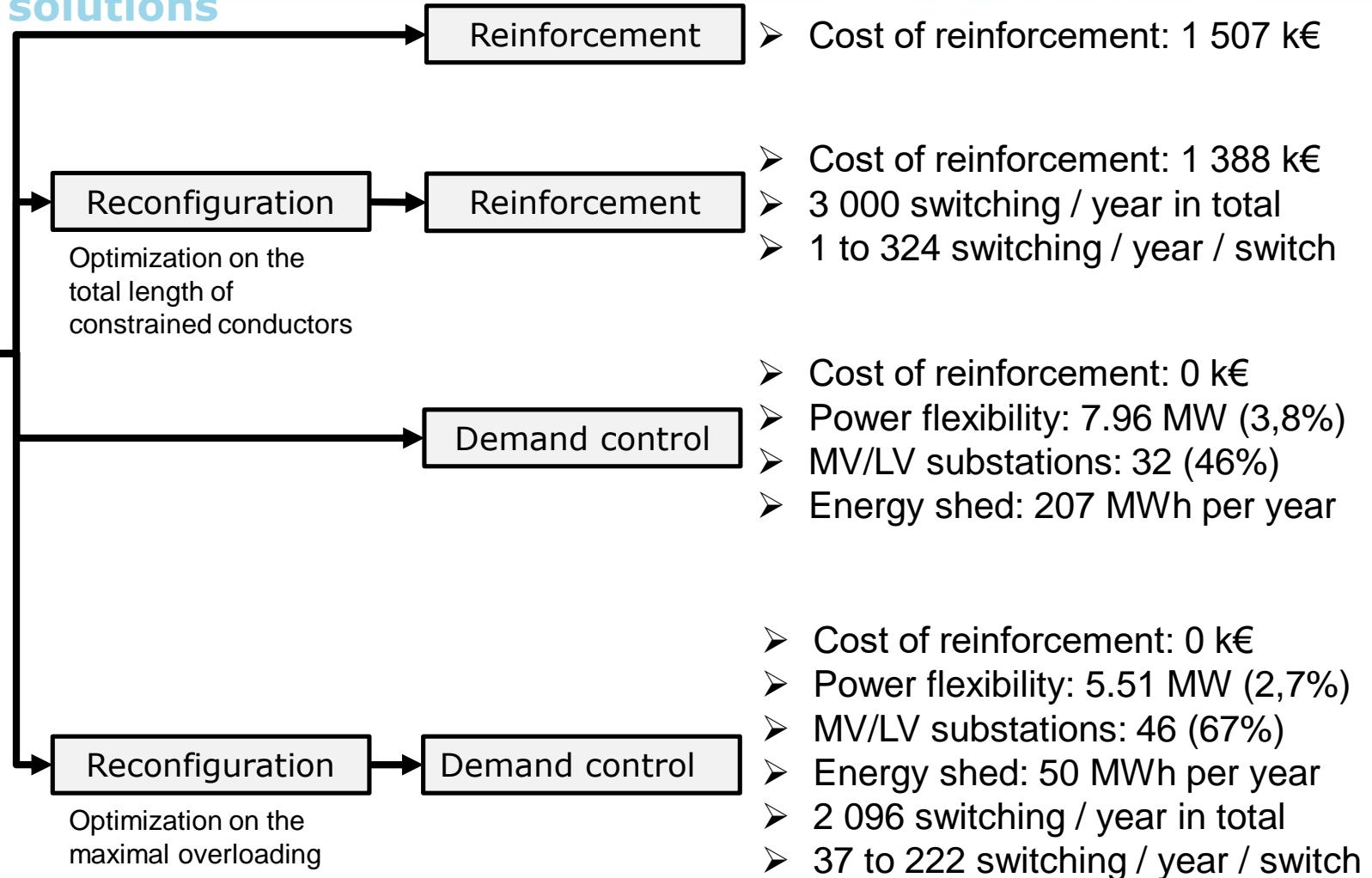
Illustration of impact of operational flexibility solutions on planning decisions

Comparison of solutions

Network with constraints

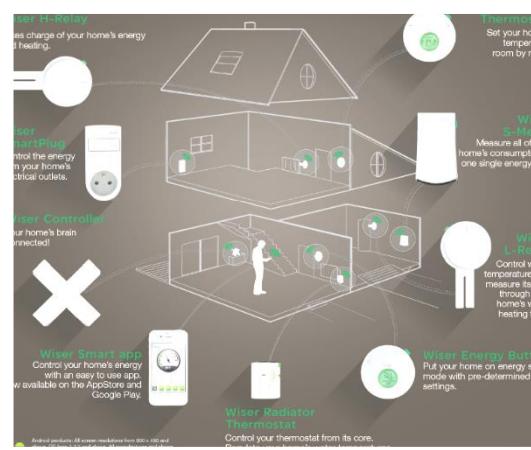
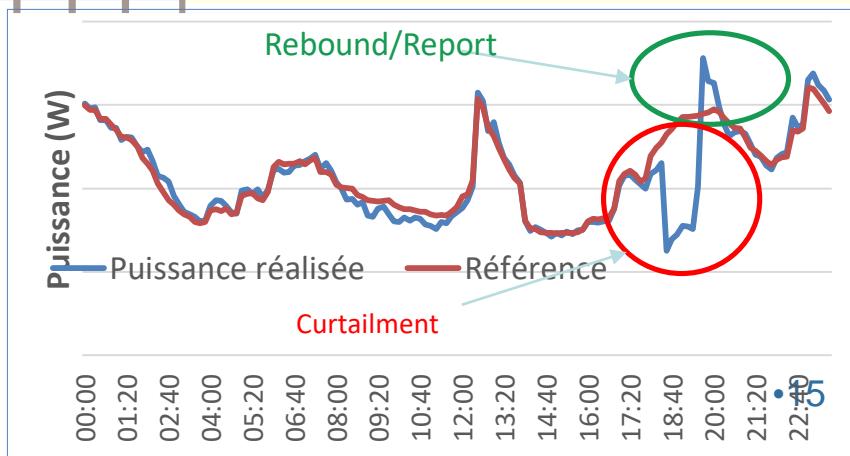
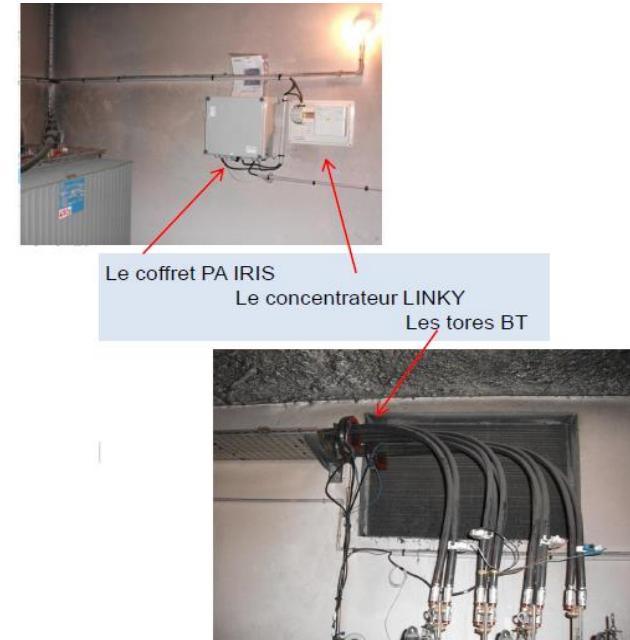
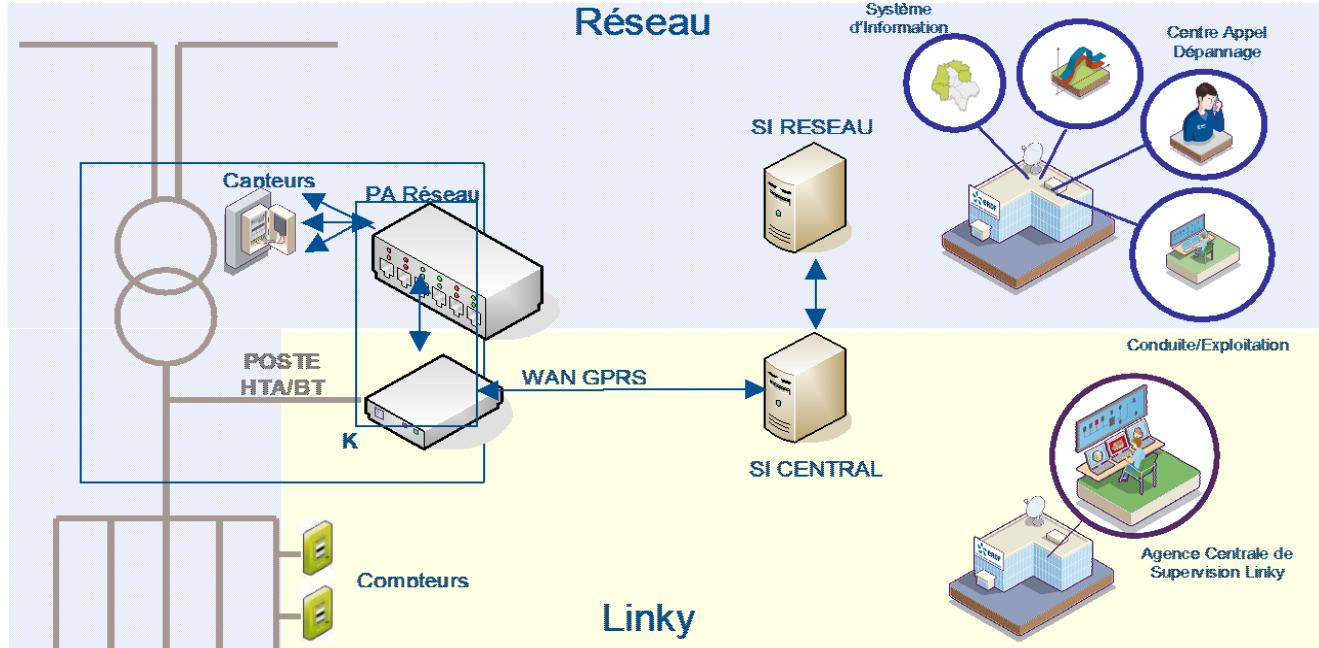


GreenLys



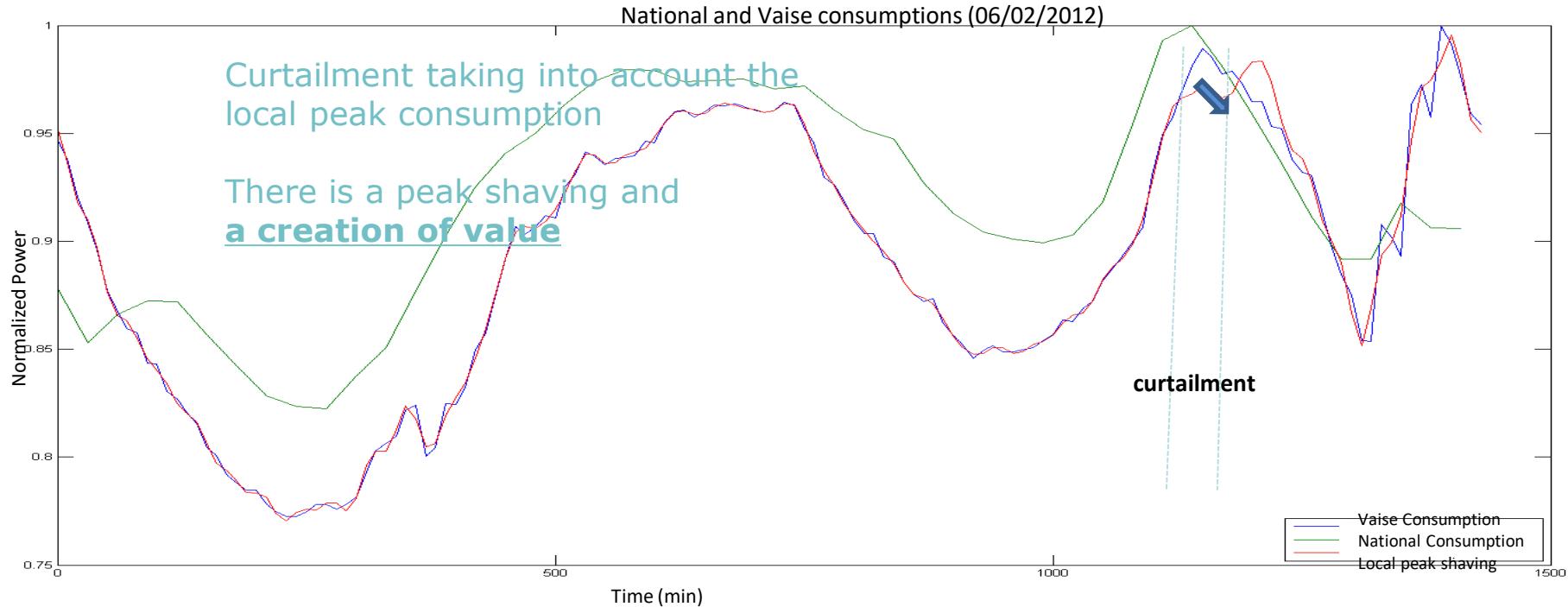
In situ testing of Demand Flexibility in GreenLys

Linky infrastructure and IT platform for DR and observability





Interaction Demand Flexibility– Grid management: Need for coordination and system approach

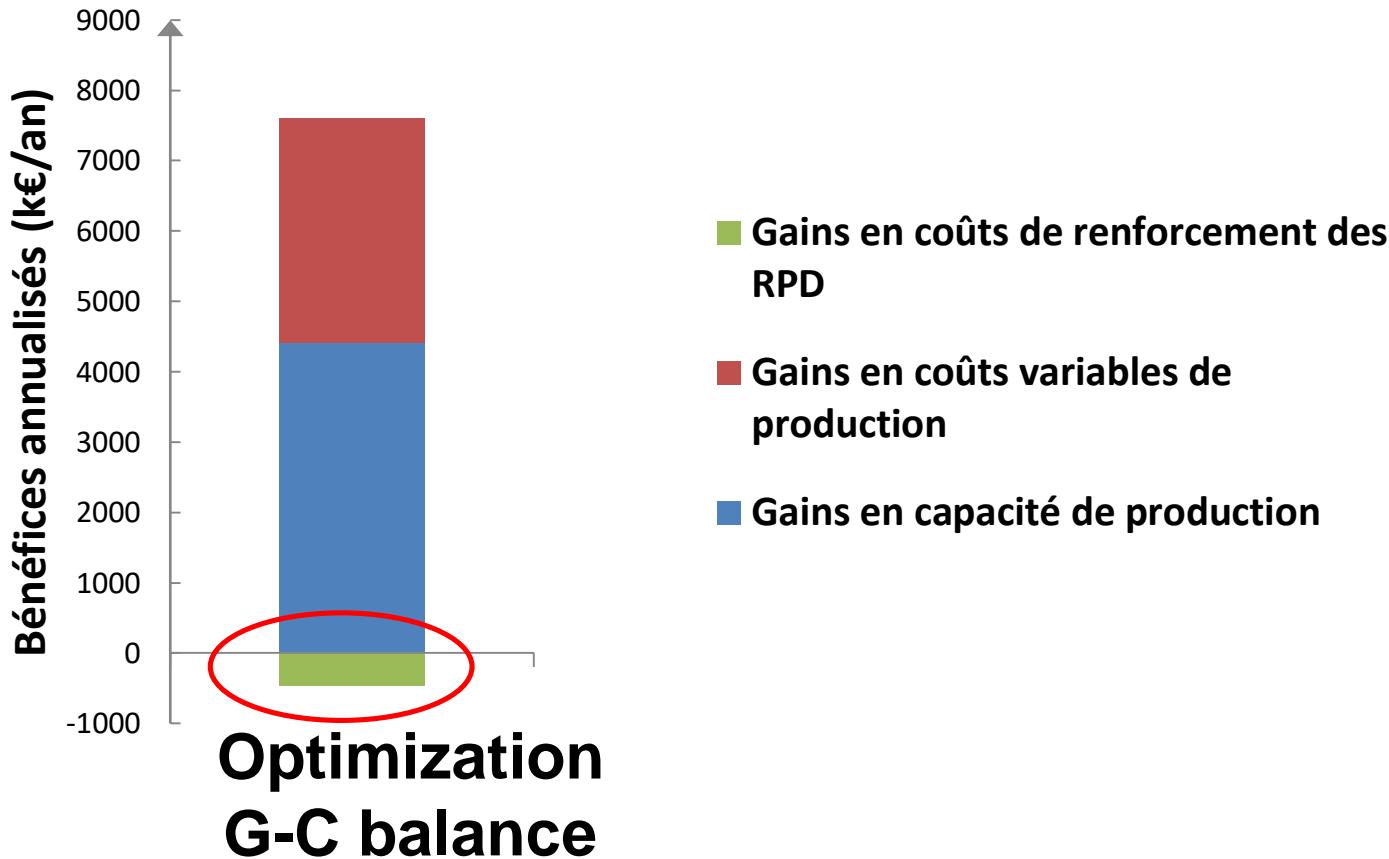


Actors coordination :

- DSO need to be associated to the loop of flexibility programs certification
- Need of flexibility programs certification
- Advise the aggregator on the location of curtailments

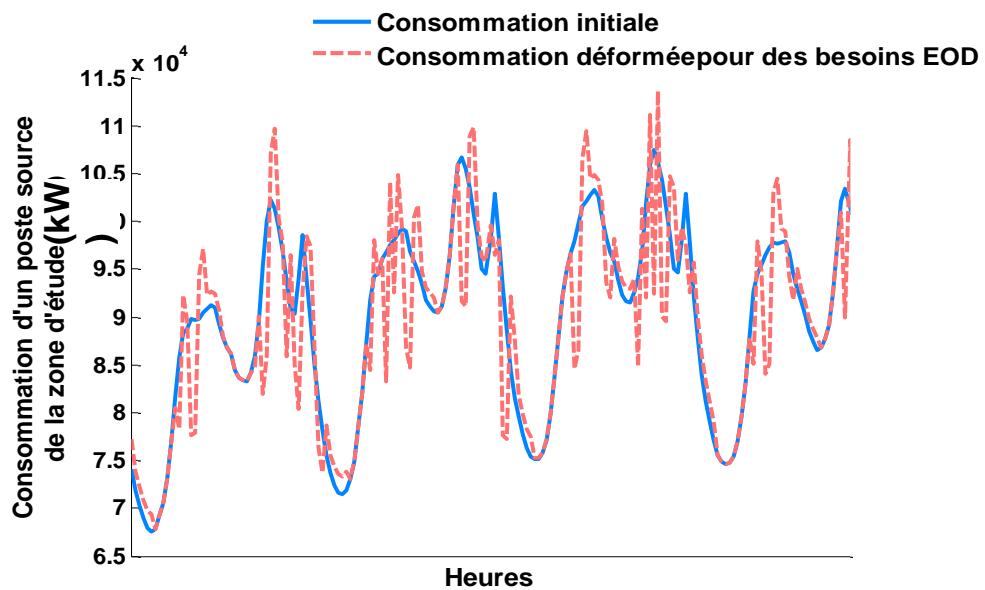
Demand flexibility: Optimization for the G-C balance capacity

Optimization for the generation-demand

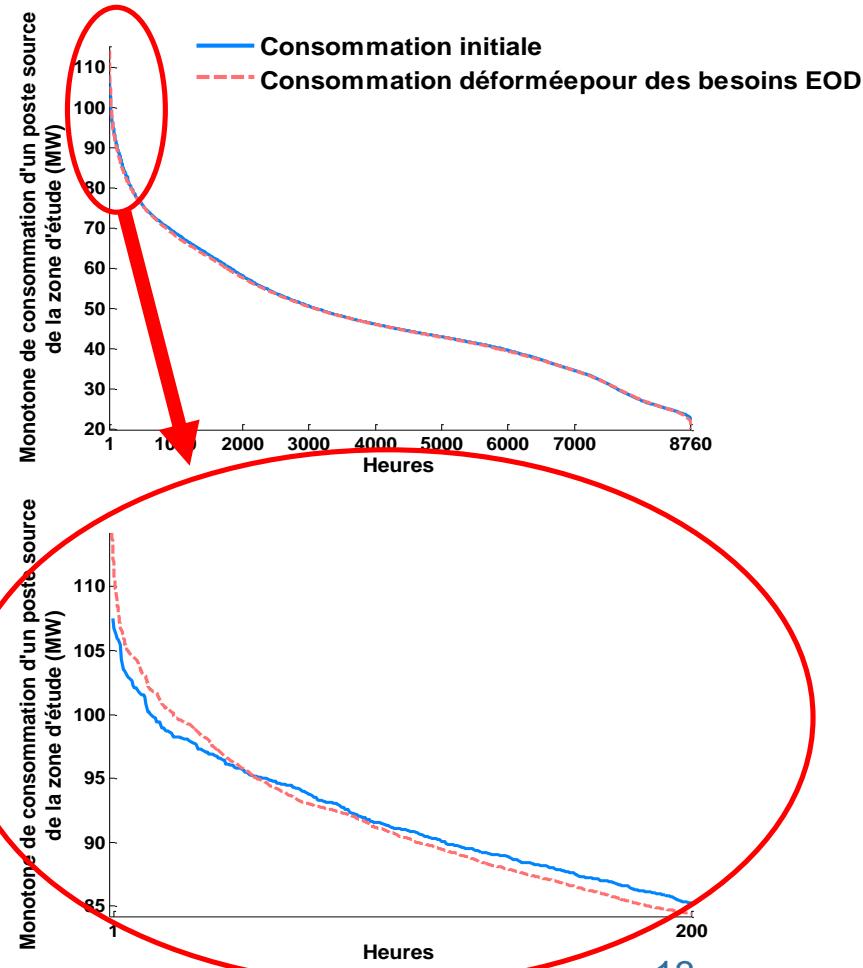


Demand flexibility: Optimization for the G-C balance capacity

Optimization for the generation-demand

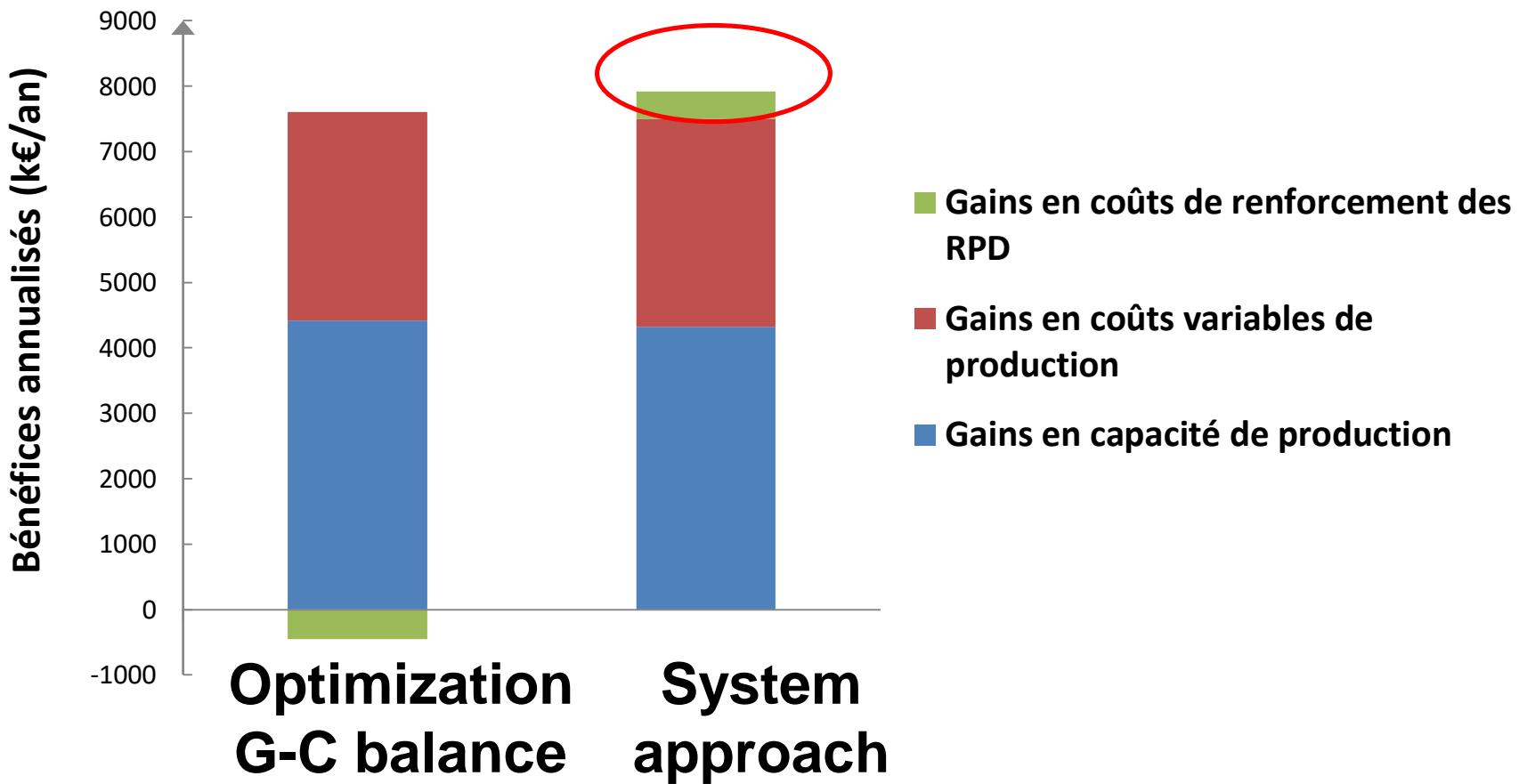


The effects of rebound/report are superposed to high demand level



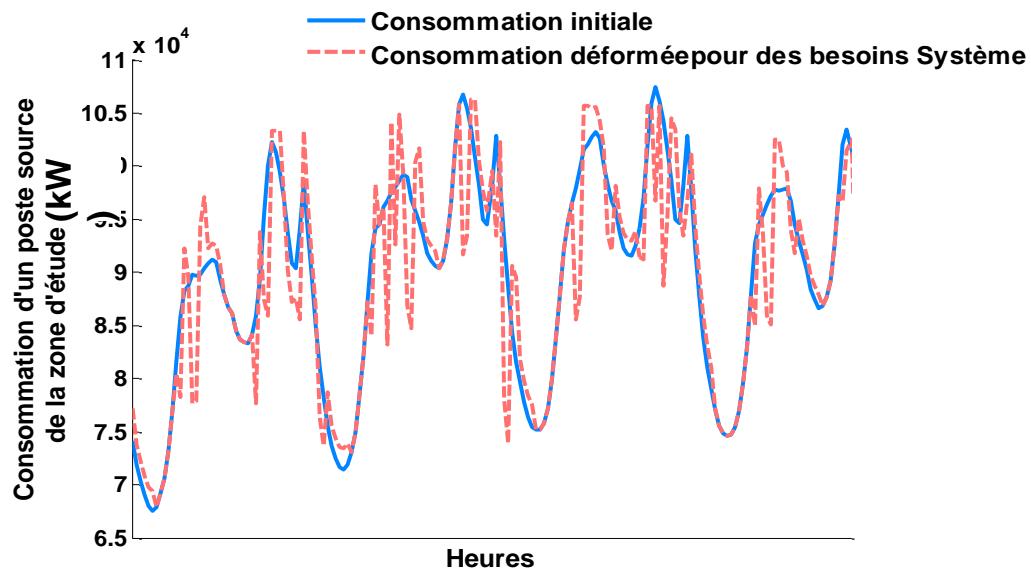
Demand flexibility: Optimization with system approach

Optimization for the electrical system

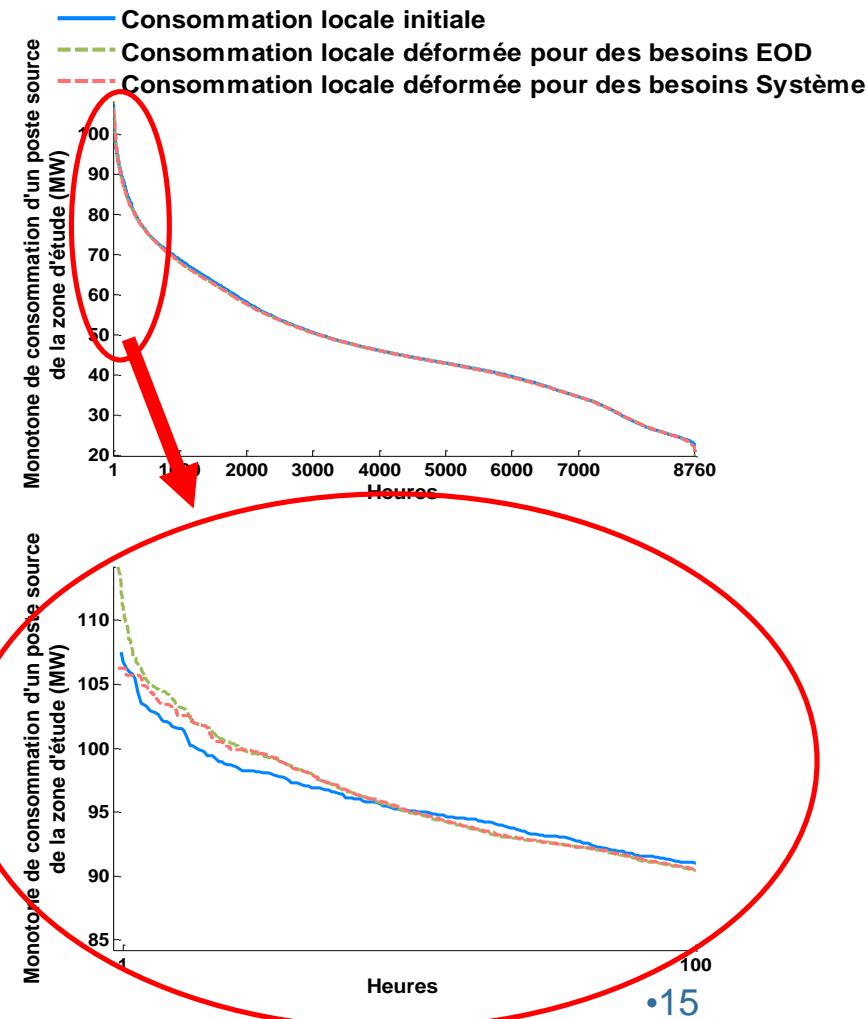


Demand flexibility: Optimization with system approach

Optimization for the electrical system



Capacity of customers **flexibilities** to manage **peak** consumption



Some messages...

■ Major societal stakes

- Climate – Energy – security of supply
- Energy transition and paradigm change

■ Integration of RES

- RES on the rise and evolution of usages
- Opportunities vs. Impacts
- Some tendencies but often case by case...

■ Flexibility added value

- Key solution for RES development and new usages
- Need for system view: avoid flexibility consideration by segment
- Complementarities of flexibility means: technology, global and local actions, business models
- Market in loop but not only...

■ SmartGrids for system optimized integration...

