Frequency-Regulation Reserves by DERs: barriers to entry and options for their resolution

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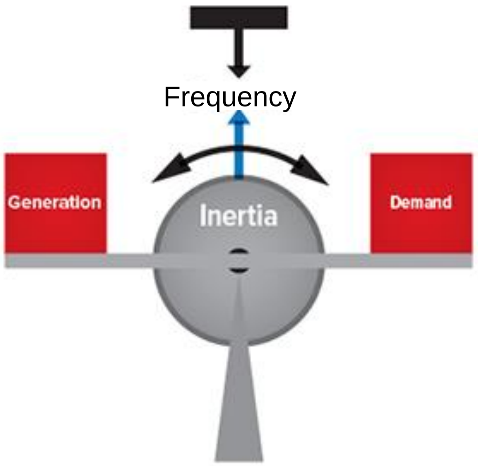
Agenda

Introduction

Balancing Production and Consumption in the Electricity System

- Generation and consumption have to be balanced at any time in the electricity system
  - *A deviation of the frequency of the system (50 Hz in Europe) is the indicator of an imbalance*
  - *An imbalance which lasts more than few seconds may destabilize the entire European network*



Introduction

Balancing Production and Consumption in the Electricity System

- In order to be able to balance the system, transmission system operator (TSO) asks some actors to be able to change their output (cons. or prod.) very quickly. This service is called frequency-regulation reserve.
  - *Historically, this service was provided by large generators, because only generation was controllable.*
  - *Now, with smart grids technology, other actors such as consumers, distributed generation or EVs have the technical ability to deliver this service*
  - *These actors could provide resources through* ***aggregators,*** *because they can't propose sufficient amount of reserve alone*
  - ***But Markets were not designed originally to allow participation of these actors***

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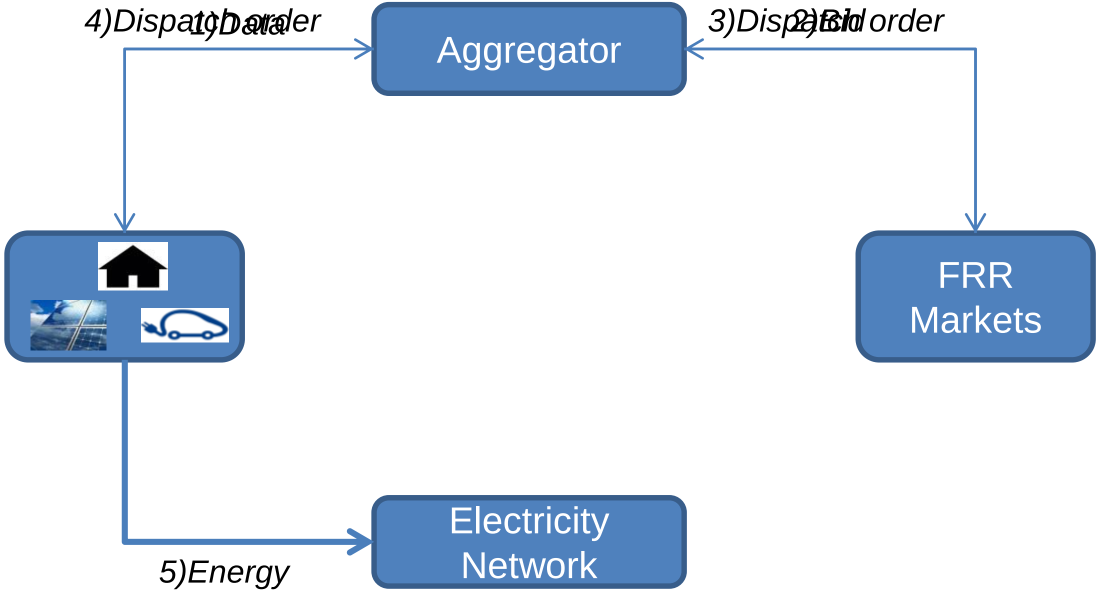

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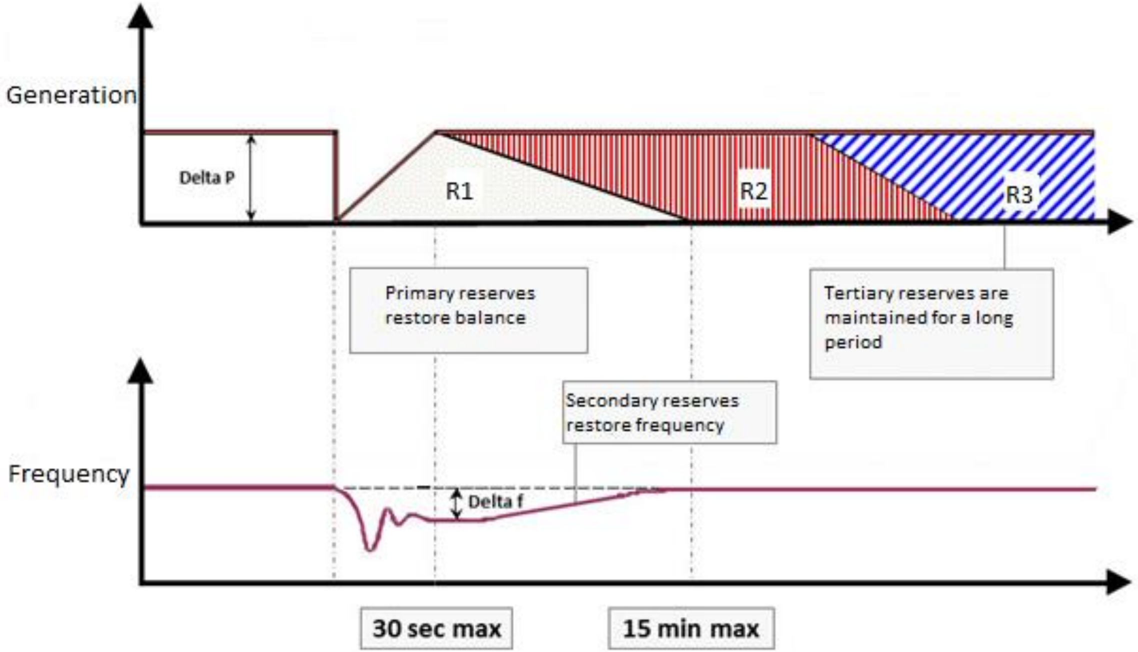


Introduction

Impact of large penetration by Renewable Energy Sources

Increasing share of renewables

- European and national targets of CO_2 emissions
- Decreasing share of nuclear power

Balancing of the system more difficult to manage

- More imbalances due to forecast errors
- Decreased stability of the system

Major flexibility issues if Business-as-Usual

- Less centralized units…
- …which are not replaced by other flexibility sources

NEED TO REDESIGN MARKETS IN ORDER TO ALLOW DERs TO PARTICIPATE

Costs of opening provision to DERs

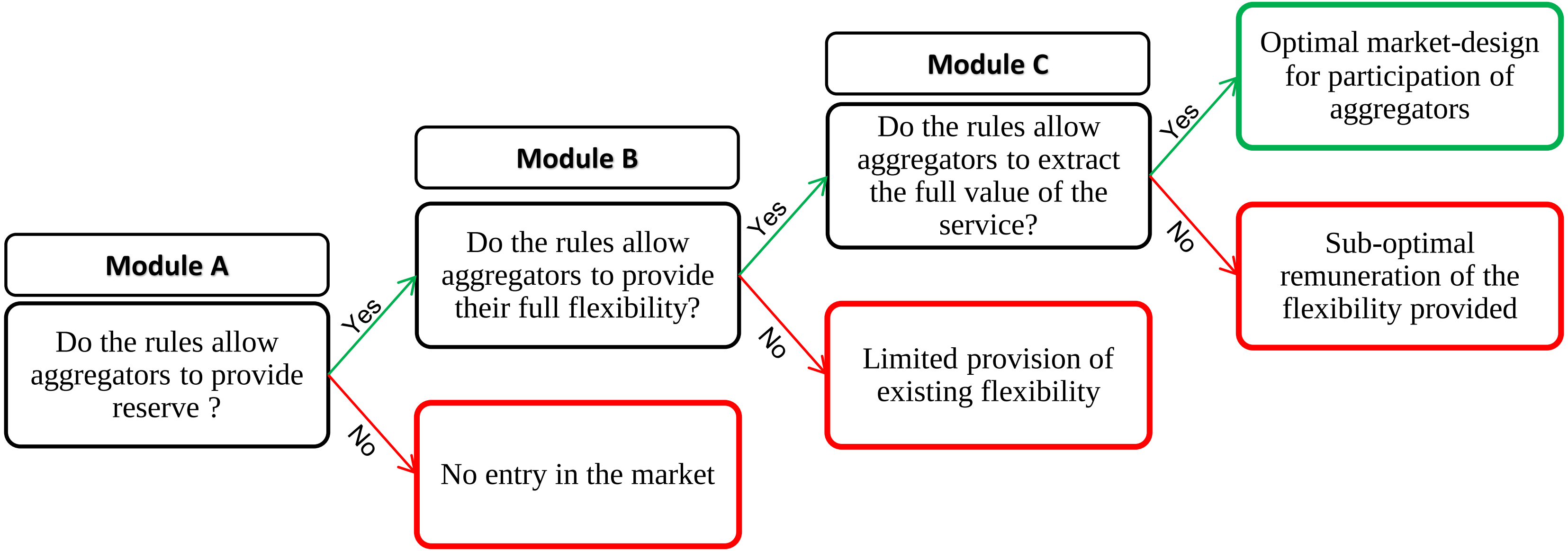
- Opening the provision is not a free process for the TSOs. The costs should be assessed.
  - ***Learning costs:*** *build new process for prequalification, post-assessment, real-time management*
  - ***Transaction costs:*** *number of actors will increase, number of products will increase*
- TSOs is responsible for balancing the system. There may exist some additional risks when opening the provision to DERs
  - *But there are solutions to mitigate these risks (mutualize reserves, imbalances…)*
- TSOs have to consider opening the provision at some point the provision if the share of RES increases
- They should anticipate these costs before facing important flexibility issues that might impact security of supply

Benefits for Electrical Vehicles

- Vehicles stay idle 94% of the time. When the vehicle is connected to the grid, flexibility of the battery could be exploited.
- FRR provision is a remunerated service. Total Cost of Ownership would be reduced by participation to provision
  - *Potential remuneration is uncertain*
- Different costs for the provision of this service
  - *Battery wear*
  - *Upgrading of supply equipment to allow reverse flow of electricity*
  - *Telecom equipment*
- The first service an electric vehicle is providing is mobility.
  - *Charge must be managed smartly*

Presentation of the modular framework

- We built a modular framework in order to understand where the barriers are, and to rank them:



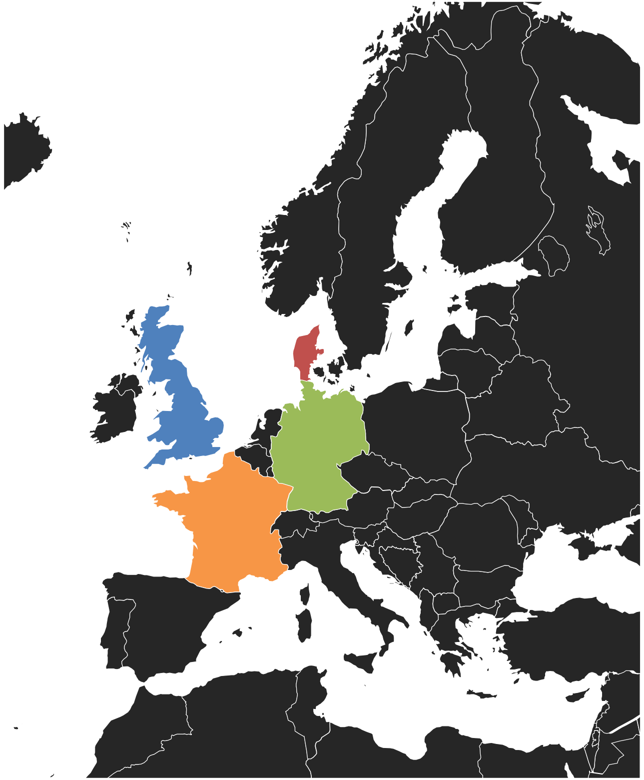
Presentation of the modular framework

- We built a modular framework in order to understand where the barriers are, and to rank them:

Module		Rule	Best option for aggregators
Module A: Aggregation of distributed resources	A1	*Technical discrimination*	*No discrimination*
	A2	*Interoperability Among DSOs*	*Full interoperability*
	A3	*Level of Aggregation*	*Telemetry*
Module B: Definition of the products on the market	B1	*Minimum size*	*As low as possible*
	B2	*Time definition*	*As short as possible*
	B3	*Distance to real-time*	*1 hour*
	B4	*Symmetry of products*	*Assymetric*
Module C: The payment scheme of grid services	C1	*Nature of payment*	*Pay as cleared*
	C2	*Extra-bonus*	*Existence of a bonus*

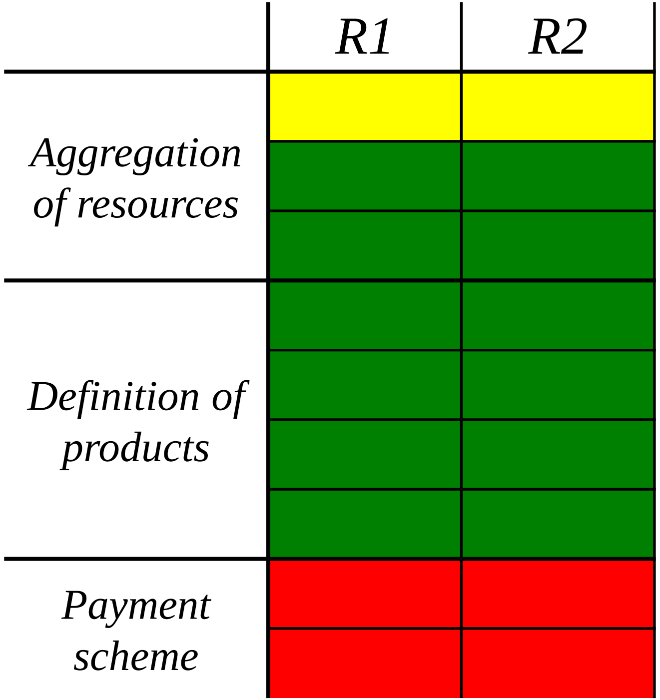
Barriers to entry and option for their resolution

Countries included in our comparison



Barriers to entry and option for their resolution

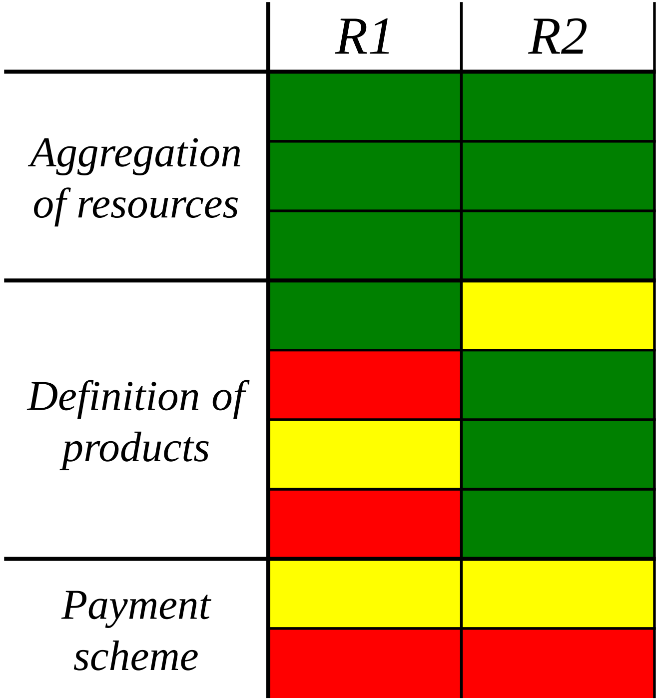
France: Still no market



- Opening of the market limited by administrative rules
  - *Limitation of volume provided by DERs*
  - *Mandatory provision by large producers*
- Test phase? But which results?
- Regulated tariff gives no incentives to reveal costs
  - *Uncertainty about the viability of this regulated tariff*

Barriers to entry and option for their resolution

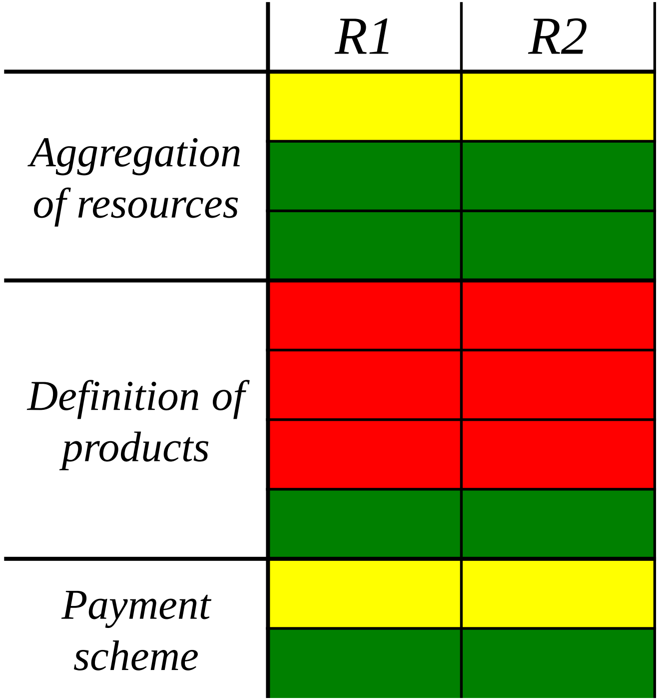
Germany: can do better…



- No administrative barrier to provision for DERs
- Primary reserve products doesn't allow DERs to provide their full flexibility
  - *Weak-long products*
  - *Symmetrical products*
- Pay-as-bid remuneration doesn't give incentives to reveal costs

Barriers to entry and option for their resolution

UK: Is it really an opening ?



- Mixed signals for DERs in UK. Too much complexity in market-design
  - *Three different schemes to procure the same service*
  - *Need to implement a unified scheme, in order to procure reserves at the least cost*
- Pay-as-bid remuneration
- Implementation of a new scheme to remunerated high flexibility
  - *UK is facing more flexibility issues because it is a small system*

Barriers to entry and option for their resolution

Denmark – DK1: For better and for worse

	R1	R2
Aggregation of resources		
		N/A
		N/A
Definition of products		N/A
		N/A
		N/A
		N/A
Payment scheme		N/A
		N/A

- Denmark is paving the way for opening the market for DERs…
  - *…For primary reserve: Asymmetrical, short products, pay-as-cleared remuneration*
  - *Secondary reserve is provided by a long-term contract which lasts until 2020*

Conclusion

- Increasing share of renewables means **increasing needs of reserves**. In order to procure reserve at the least cost, there is a need to implement **well-functioning market design**.
- Opening the market is associated with **costs**, but it might not be optional. It is important to change before facing flexibility issues, **to manage these costs** effectively.
- **No ideal market design** in our benchmark for DERs. However, every country is trying to adapt its market to allow DERs to particpate.
- We don't observe for the moment large provision of regulation reserves by distributed resources. However, some projects are promising (Nikola project in Denmark, provision of primary reserve by Evs can be made)

Quick Look into Nikolai preliminary results thanks to P Codani

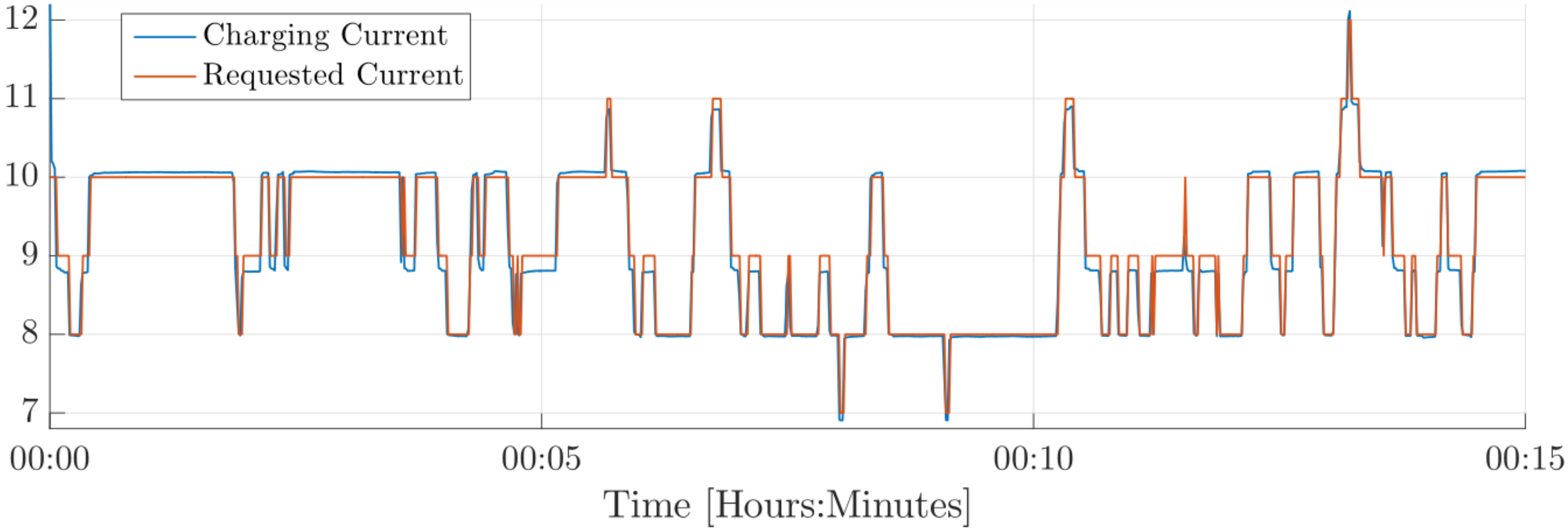
BERLINGO ELECTRIC CHARACTERISTICS USED IN THE EXPERIMENT

- Light duty vehicle
  - Battery: 22,5kWh
  - Charging in mode 2/3
  - Charging up to 3,7kW

- Possibility to control the charging rate of the vehicle by means of the IEC 61851-1 standard
  - From 6A to 16A, i.e. from 1,4kW to 3,7kW

Available line current	**Nominal Duty Cycle provided by EVSE (Tolerance ± 1 percentage point)**
Digital communication will be used to control an off-board DC charger or communicate available line current for an on-board charger.	5% duty cycle
Current from 6 A to 51 A:	(% duty cycle) = current[A] / 0,6 10 % ≤ duty cycle ≤ 85 %
Current from 51 A to 80 A:	(% duty cycle) = (current[A] / 2,5) + 64 85 % < duty cycle ≤ 96 %

Table 1 Pilot Duty Cycle provided by EVSE [1]



1. Accuracy
2. Response time

RESULTS (1/2)

Request and Charging currents from the Berlingo (over 15 minutes)

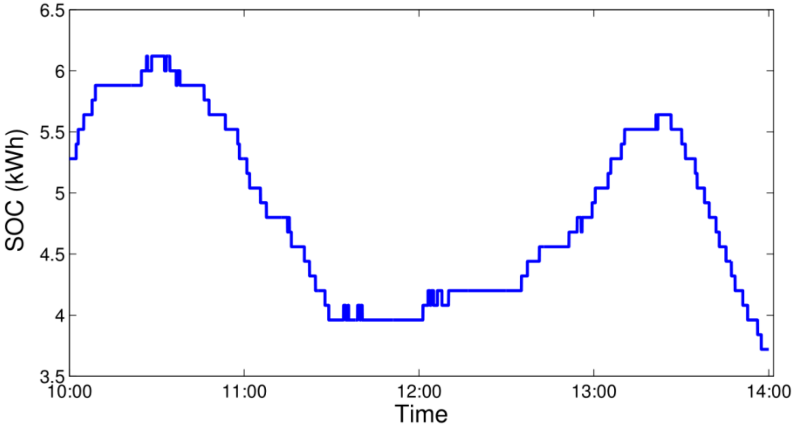
PEUGEOT ION CHARACTERISTICS

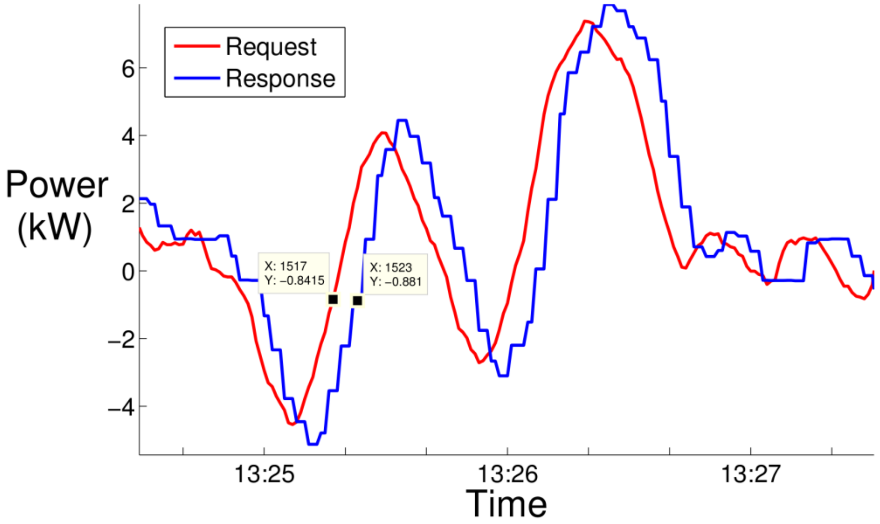
- Passenger vehicle:
  - Battery capacity: 16kWh
  - AC charging up to 3,7kW in AC mode 2/3
  - DC bidirectional charging ± 50kW (Chademo protocol)

- The Chademo protocol enables bidirectional power exchanges based on CAN communication
- ENDESA bidirectional charging stations are available

RESULTS (2/2)

1. Accuracy
2. Response time





SOC variations and zoom in requests and responses

CONCLUSION

- Experimental results of two different PSA Groupe vehicles, using different HW & SW solutions
  - A unidirectional Berlingo Electric
  - A bidirectional Peugeot iOn

- Vehicles have been proved efficient FNR providing units
  - Accuracy very satisfactory
  - Response time <5s for the whole IT chain