

**CITIES workshop** 

Motivations	Problem	AS4.0	Case study	Results	Conclusions

### Outline

- Motivations
- Coordinating flexible resources: problems
- Proposed methodology: AS4.0
- Case study
- Results
- Conclusions



#### The electricity supply service Penetration of RES



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### The electricity supply service Challenges introduced by RES

Adding the RES to the generation portfolio affects the quality of service and power system operation because of:

**Stochasticity** 



The generation from RES **cannot be planned** in the same way as conventional power plants.



Non-linearity

The generation can follow a **non-linear trend.** 

**Dynamics** 



Different dynamics can occur in **space** and **time**.



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### The electricity supply service Consequences for the AS

This is particularly affecting the provision of the ancillary services:



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### The electricity supply service Exploiting the energy flexibility

#### **Flexible resources**

Flexible loads, storage and generation are able to **adapt** their **behaviour** according to the **necessity** of the grid.

They need to be **coordinated** in a **fast** and **efficient** manner in order to be valuable.



Time

- Baseline consumption
- Reduced demand
- Shifted demand





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### Coordinating the energy flexibility The electricity price



For the retail price, there is no flexibility and the **prosumers do not consider the** condition of the grid in their actions.

It is fundamental to **reconsider the formulation** of the **retail electricity price** to exploit the **price responsiveness** of the **flexible** energy resources.

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## Coordinating flexible resources AS4.0: Idea

What if system operators could formulate real-time varying prices according to the flexibility needed and exploit indirect controls?



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### Simulations Case study





We simulate the model for 5 minutes.

The code is implemented in GAMS and Matlab.

29 different load categories



### Conclusions

We present **AS4.0**, a control based-approach to solve the ancillary services problem in smart grids.

Such methodology is able to solve all the problems in one set, taking into account **stochasticity**, **non linearity** and **dynamics**.

It is able to exploit the **potential** of flexible resources at the prosumers' level of **any size**. Also, being based on indirect controls, it is **fast** and fully **automated** at different levels.

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### Published papers & current work

- Utilising Flexibility Resources in the Future Power System Operation: Alternative Approaches (IEEE Access)
- Ancillary Services 4.0: A Top-to-Bottom Control-Based Approach for Solving Ancillary Services Problems in Smart Grids (IEEE ENERGYCON 2018)
- Consumers' Flexibility Estimation at the TSO Level for Balancing Services (submitted)
- Ancillary Services Provision from the Flexibility of Electricity Customers (in progress)

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# Thank you