

Big data - Energy and Networks, 12-13 Oct 2017 - Trondheim, Norway

Energy digitalisation and integration of renewable energy sources - the role of forecasting

Georges Kariniotakis

Prof., Head of Renewable Energies & Smart Grids Group

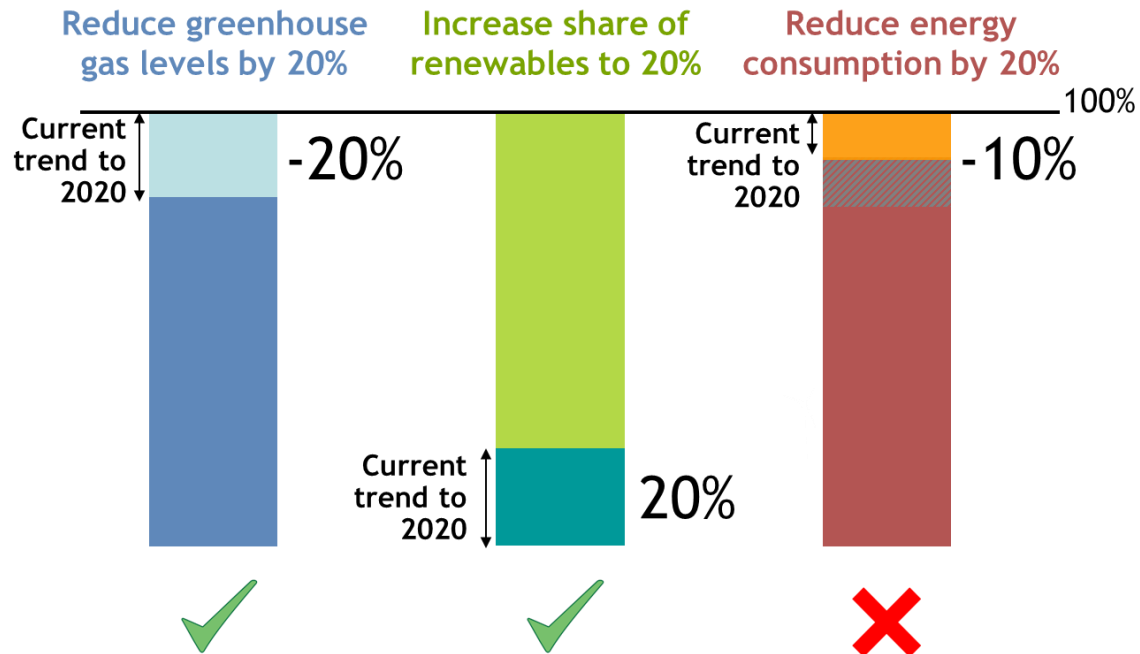
MINES ParisTech, Centre PERSEE

georges.kariniotakis@mines-paristech.fr



Context

- In 2007 the EC set the target of **20-20-20** by **2020** for EU-27



- Recently an updated target of **40-27-27** by **2030** was issued

Context

- This translates to ambitious targets for **2030** for:
 - **Wind: 251-392 GW** of installed capacity (today: 154 GW).
 - **Solar PV: 230-367 GW** (end 2015: 94.6 GW)
- Transition towards a more and more “**weather-dependent**” power system.

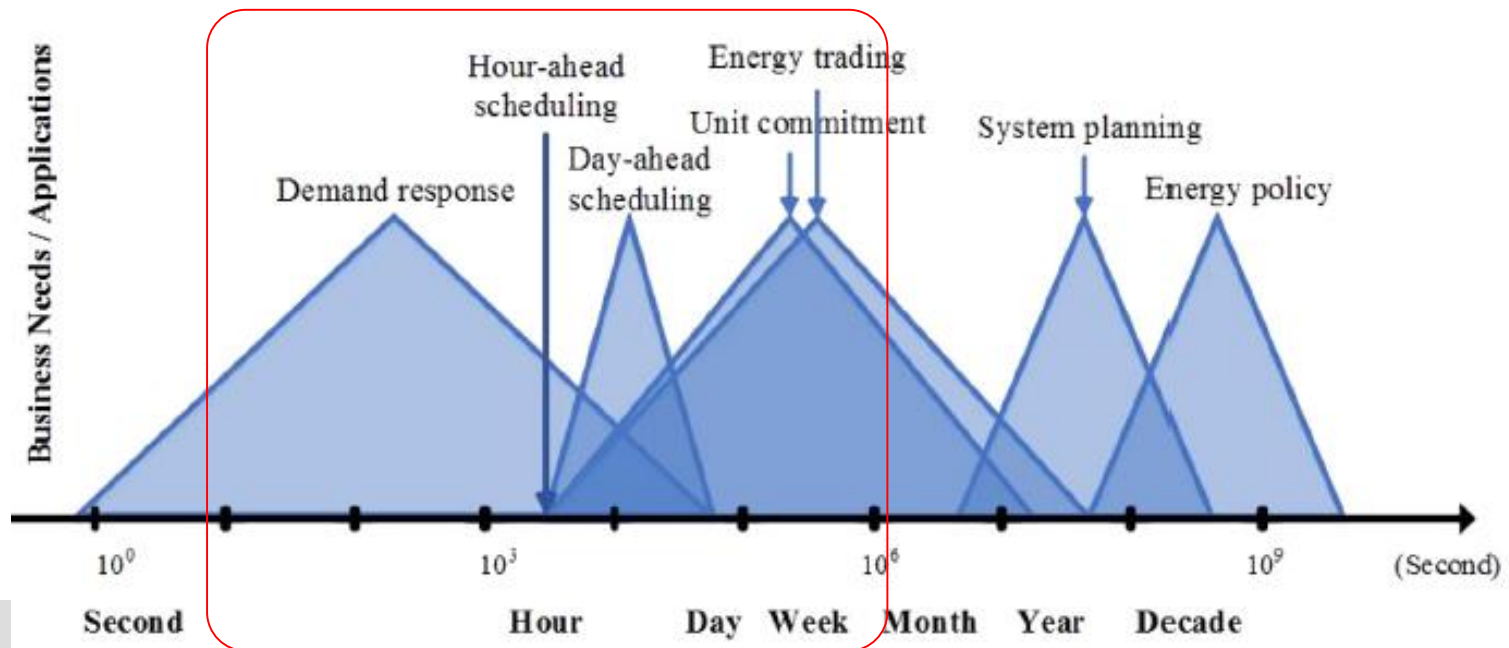


Challenges

- The development of **smart grid** technologies aims among others at facilitating renewables (RES) integration
- Some new **challenges**:
 - Need for efficient hedging over increased **uncertainties** (i.e. storage)
 - High share of demand should become **active** to fit generation
 - RES power plants should have capability to provide **flexibilities** (i.e. ancillary services) in a similar way as conventional plants
 - Appropriate **market schemes** should be developed to trade flexibilities at different spatial scales.
 - **Use of the electrical grid should be improved** (i.e. through dynamic line rating)
 - ...

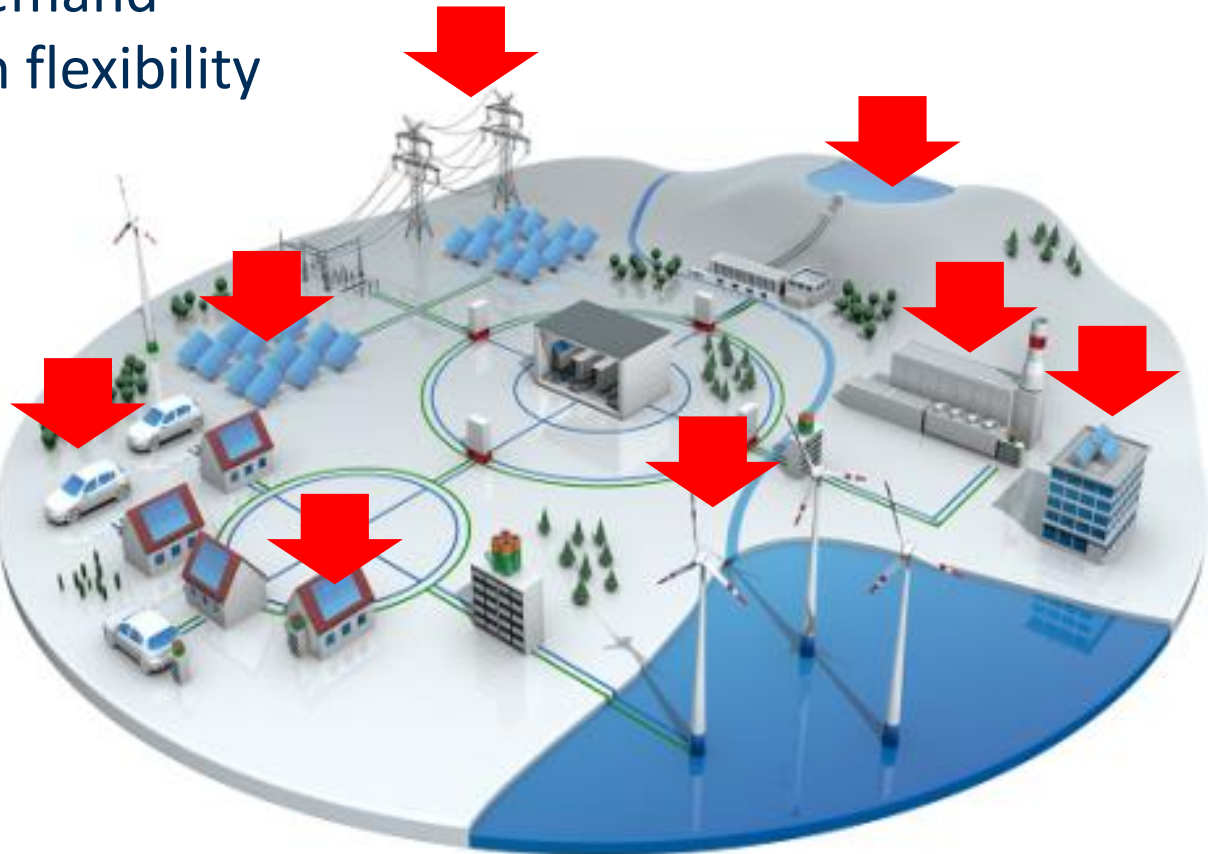
Predictive management and forecasts

- To address these challenges, it is needed to develop appropriate tools of **predictive management**:
 - at different **spatial** scales:
 - house/customer > microgrid/feeder > regional/national
 - for different **actors**:
 - aggregators, producers, retailers, TSO, DSO...
 - for different **functions**:



Predictive management and forecasts

- All these functions require different types of short term (few minutes – few days ahead) forecasts for:
 - Renewable generation (PV, wind,..)
 - Electricity & heat demand
 - Demand/generation flexibility potential
 - Electricity prices
 - Dynamic line rating
 - ...



Increased information

- **Smart grid:** Available information increases
- Is this an opportunity for reducing uncertainties through improvement of forecasting capabilities?



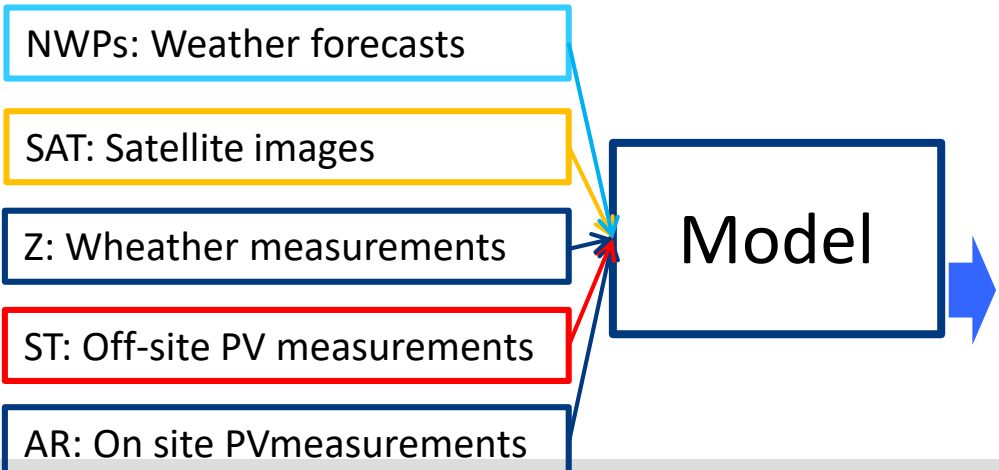
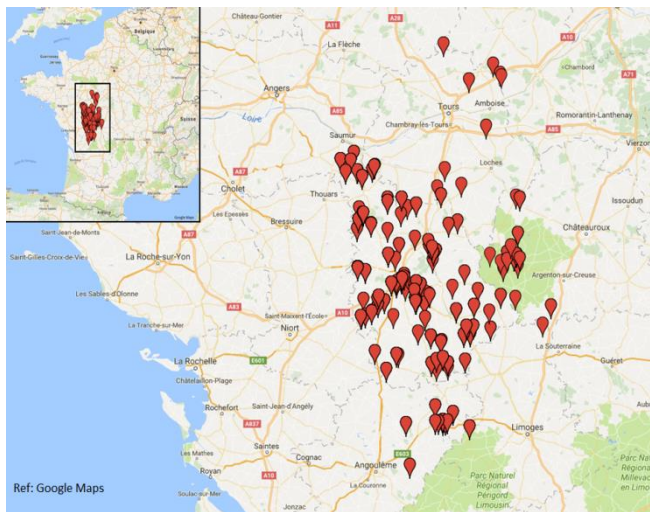
- Emerging approaches to forecast local demand with smart meter data
- Significant improvements of very short term wind and PV forecasts through spatio-temporal approaches
- Predictive analytics for electric vehicles
-



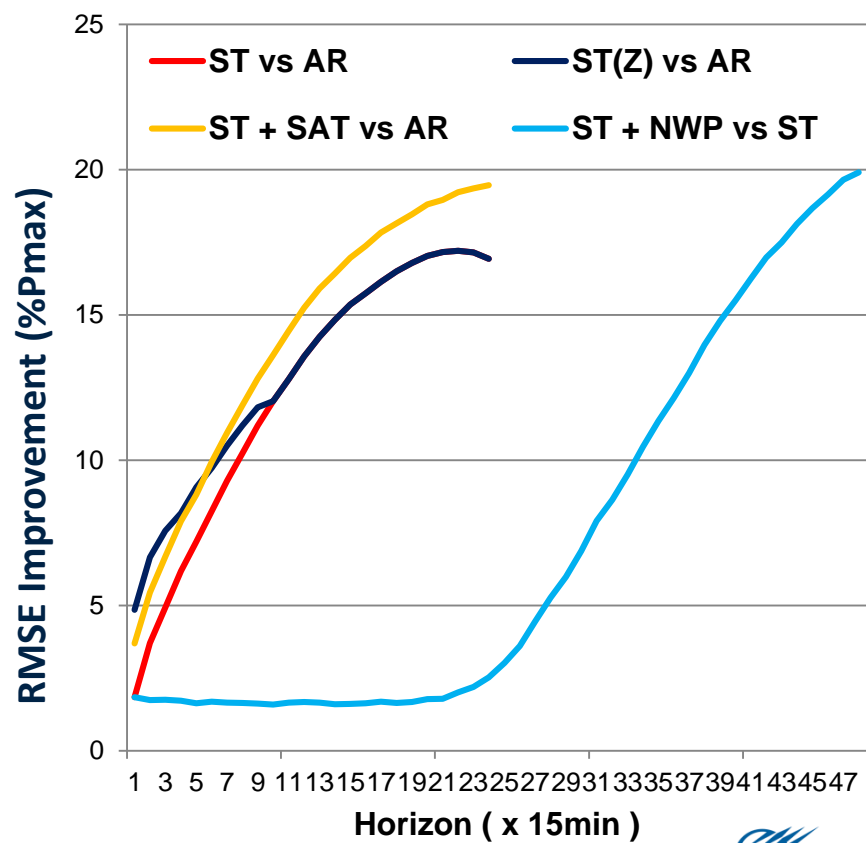
- High uncertainties in RES production and demand at local level cannot necessarily be explained by more data
- Curse of dimensionality is a limit for classical forecasting techniques
- Need for adapted models to handle large amounts of inputs
-

Example: spatio-temporal PV forecasting

- Improvement of short-term predictability (0-6h) of PV production using off-site data, NWP's & satellite images

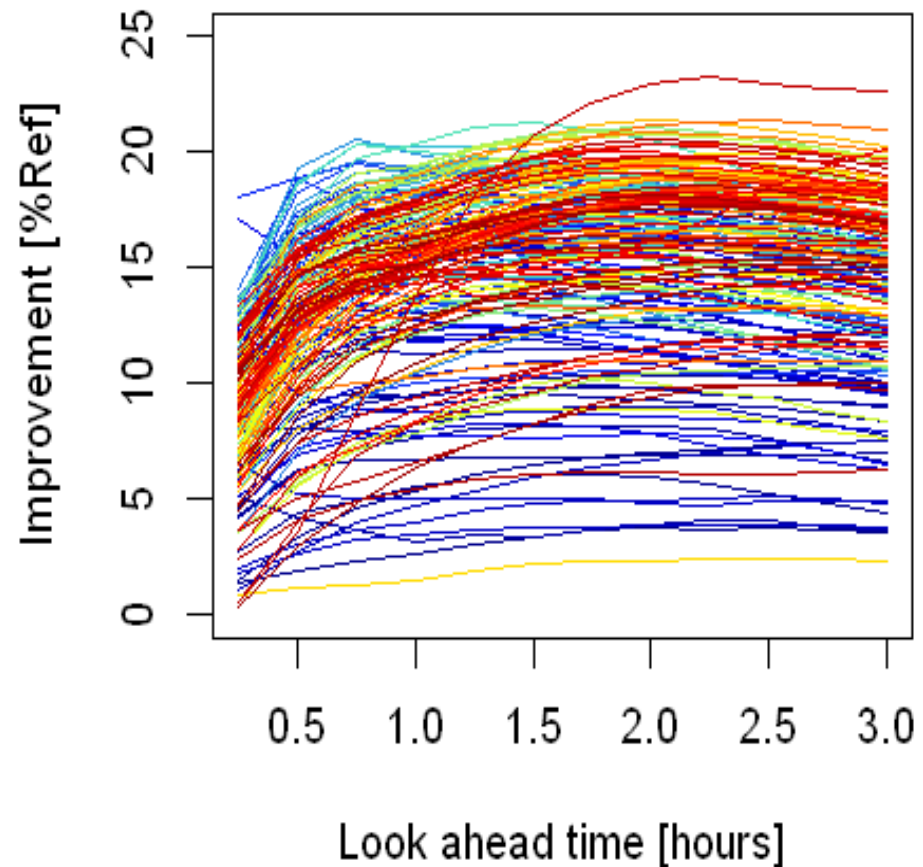


RMSE Improvement over reference AR



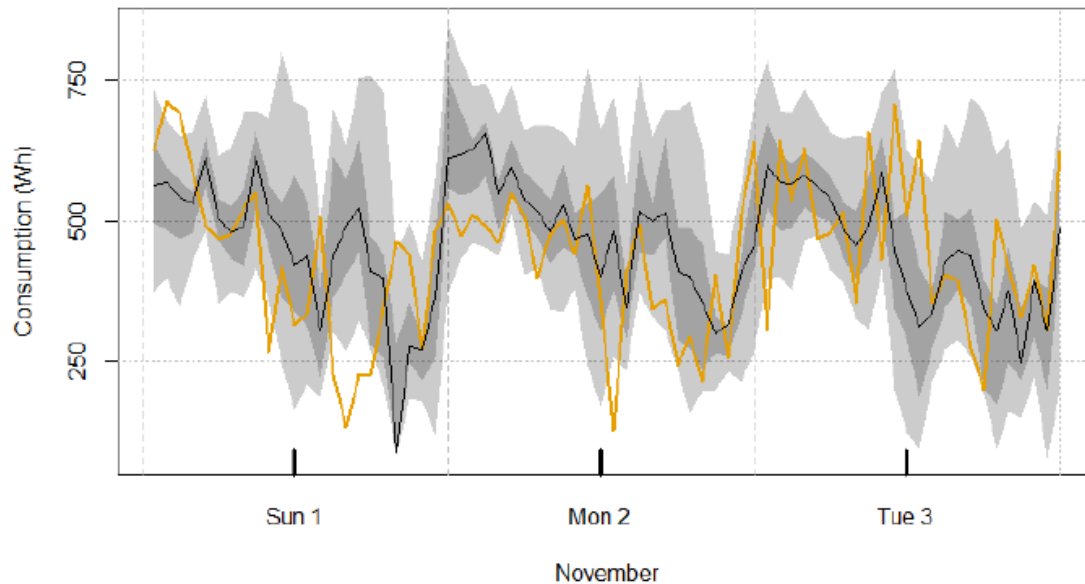
Example: spatio-temporal wind forecasting

- Improvement of short-term predictability (0-3h) of wind production using off-site data. Case of Denmark

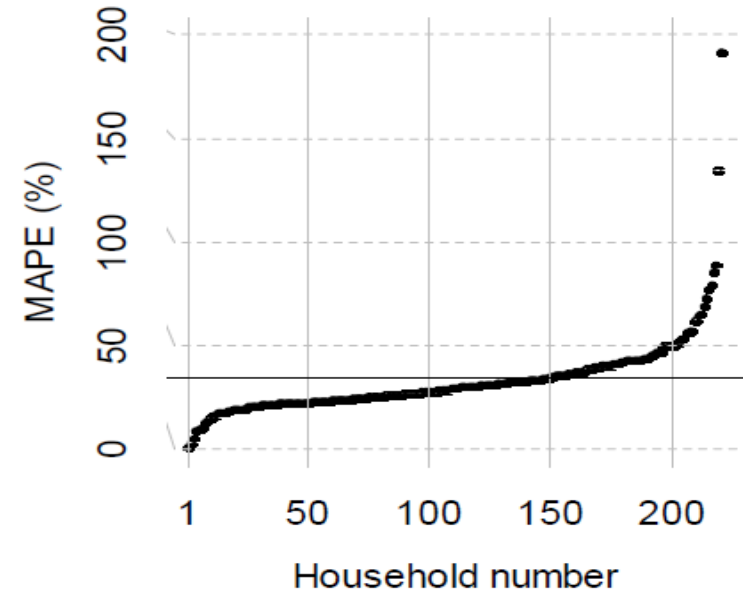


Example: household demand forecasting

- Demonstration project SENSIBLE
- 226 households at Evora (PT)
- Forecasts based on smart meter data (15 min) and NWP



Example of forecasts for a household.



Average performance is 29% for houses with good quality data or 34% otherwise

Conclusions

- The actual RES forecasting technology is quite **mature**
- However, still in some situations large forecast errors may have an **important impact** on power system operation
 - **R&D objectives:** Improve the predictability RES production (wind, solar) at different **temporal** (i.e. 5 min – 10 days) and **spatial scales** (local, regional,...)
 - **Challenge: Complexity** of the considered phenomena at different temporal and spatial scales.
- Forecasting of local **electricity consumption & heat demand** is an emerging area thanks to the availability of data from smart meters etc.
- Tendency towards **big data techniques** to exploit the large amount of data that become available (measurements, satellite images, weather predictions, off-site measures etc).
- However, the aim is **large-scale application** and compromises should be found between accuracy, plug&play capabilities, model chain complexity...

Materials

Processes

Integration

- **Materials for energy**

Mobility



Storage



Demand



Energy transition



- **Sustainable technologies & processes**

Sustainable fuels



RES



- **Renewable energies & smart grids**

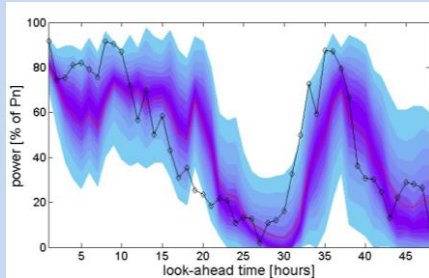
Grids



Research axis « Renewable energies & smartgrids »: Development of methods and tools to facilitate the integration of distributed generation and renewable energies (RES) into power systems and electricity markets.

Forecasting

- *Wind*
- *Solar*
- *DLR*
- *Demand*
- ...



Multi energy hybrid systems

- *Dimensioning/ design*
- *Optimal operation and management*

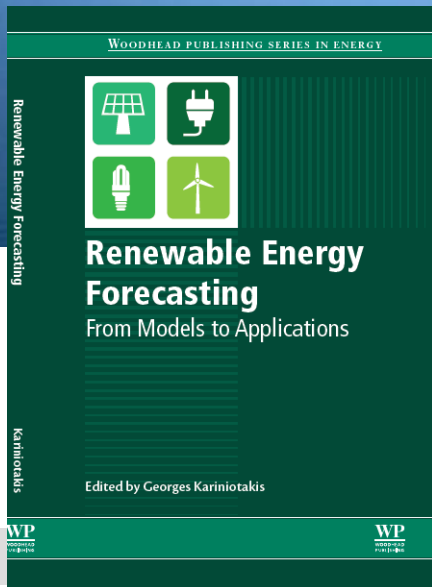


Smart grids

- *Modelling/simulation*
- *Predictive management*
- *Long-term planning*
- *RES market integration*

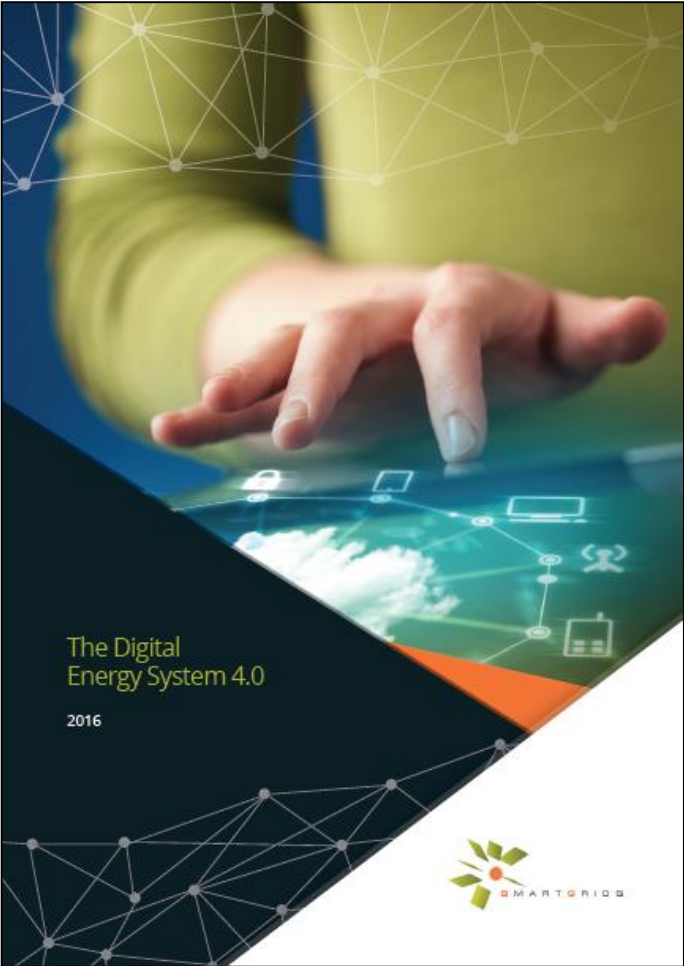


Thank you for your attention



New book on RES forecasting by
ELSEVIER/WP – published June 2017.

More to read...



The **Digital Energy System 4.0** by the European Technology Platform on Smart Grids.