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Smart4RES: Improved weather modelling and forecasting dedicated to renewable energy applications.

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In this paper we present the research directions and innovative solutions developed in the European Horizon 2020 project Smart4RES (http://www.smart4res.eu) for better modelling and forecasting of weather variables necessary to optimise the integration of renewable energy (RES) production (i.e. wind, solar, run-of-the-river hydro) into power systems and electricity markets. Smart4RES gathers experts from several disciplines, from meteorology and renewable generation to market- and grid-integration. It aims to contribute to reach very high RES penetrations in power grids of 2030 and beyond, through thematic objectives including:

- Improvement of weather and RES forecasting (+10-15% in performance),
- Streamlined extraction of optimal value through new forecasting products, data market places, and novel business models,
- New data-driven optimization and decision-aid tools for market and grid management applications.
- Validation of new models in living labs and assessment of forecasting value vs costly remedies to hedge uncertainties (i.e. storage).

Smart4RES focuses both on improving forecasting models of weather (e.g. physical models, data assimilation, Large Eddy Simulation) and RES production (e.g. seamless models, highly resolved predictions), and on addressing applications in power grids. Developments in the project have been formalized in Use Cases that cover a large range of time frames, technologies and geographical scales. For example, use-cases on power grids refer to the provision of ancillary services to the upper-level grid (e.g., balancing power) and the local grid (e.g., voltage control and congestion management), where the accurate forecasts of variable generation are key for accurate decision-making. A grid state forecasting will quantify dynamically the flexibility potential of RES in distribution grids. Collaborative forecasting investigates the improvement associated to local data sharing between distributed RES plants. This data sharing paves the way to a data market where agents exchange measurements, predictions or other types of valuable data. Lastly, data-driven approaches will streamline decision-making by simplifying the model chain of bidding RES production, storage dispatch or predictive management electricity grids. They will also provide interpretable hindsight to decision-makers by integrating the decisions of experts (human-in-the-loop) and will be tested in realistic laboratory conditions (software-in-the-loop).

In this paper we focus on the work done for improving modelling and forecasting of weather variables; i.e. through innovative measuring set-ups (i.e. a network of sky cameras in Germany); through the development of seamless numerical weather prediction (NWP) approaches to be able to couple outputs of NWP models with different resolutions; through ultra high resolution NWPs based on Large Eddy Simulation. We present results using data from real world test cases considered in the project. Finally we assess how the new forecasting products may bring value to the applications.

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