Case study 3
Wind strength variability in Italy and energy generation

Focus: During the first days of March 2016 there was a strong variability in the wind regime over Italy linked to particular synoptic systems over the Mediterranean Sea which had implications for supply-demand balance

Industrial and research partners

The SECLI-FIRM project aims to demonstrate how improving and using long-term seasonal climate forecasts can add practical and economic value to decision-making processes and outcomes, in the energy and water sectors. To maximise success, each of the nine SECLI-FIRM case studies is co-designed by industrial and research partners. For this case study, the industrial partner is utility company, ENEL, and the research partners are ENEA, KNMI and UEA.

Boosting decision making

- The main objective of this case study is to illustrate the benefits of designing adequate decision-support products to identify variability in the wind regime that impacts on the power system.
- How can ENEL effectively manage the risks associated with extreme climatic events?

The seasonal forecasting context

- This case study focuses on seasonal forecasts of strong wind events and their probability of occurrence.
- A challenge is the time sampling of such events that is usually shorter than a month. A suitable approach for temporal downscaling of seasonal forecasts will be investigated.

Sectoral challenges and opportunities

- Power price management and hedging of generation portfolio – when to hedge the power production?
- Managing variable wind power production in a multi-asset system to achieve supply-demand balance.

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Weather conditions and the power system

Around 3rd March 2016 the presence of a cold pool over Central Europe favoured the formation of a deep depression centred over the Adriatic Sea. It created a strong pressure gradient over the Tyrrhenian Sea causing strong westerly winds over Southern Italy. The quasi-stationary nature of the synoptic pattern favoured the persistence of strong winds over the southern portion of Italy. On 10th March there was a weak low between Sardinia and Algeria as part of a cyclonic pattern extended towards the Black Sea. The presence of a secondary low over the Southern Balkans generated a saddle over Southern Italy. With an almost zero pressure gradient at the ground, there were very weak winds over the southern regions of Italy in this latter period.

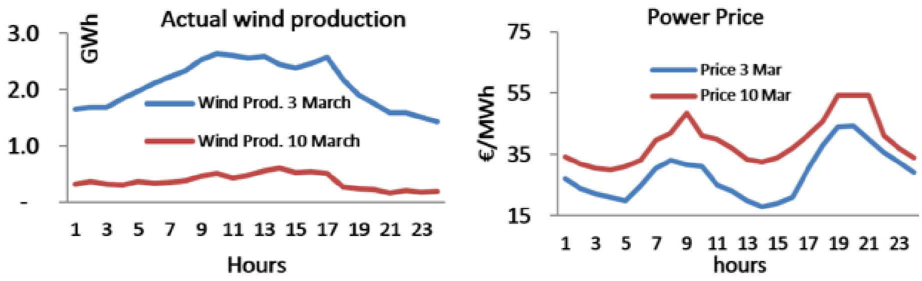

Figure 1: Hourly wind production and the effect on market prices

Figure 1 shows the hourly wind power production (left) and evolution of the market power prices (right) during March 2016 in Southern Italy. Coherently with the meteorological scenario on 3rd March, there was a high level of power production by wind farms, especially during the middle hours of the day. The effect was to lower market prices due to the strong offer of renewable energy. For a wind producer it was a good day because they sold a large volume of production, even if at low price, and as they do not pay for the wind there are no merchant costs involved.

Better strategy management

In this case, given the lower power price as a consequence of the strong wind output, the thermal producer was 'kicked out' of the market. For a producer with both thermal and wind production assets, it is not easy to quantify the combined effect of strong winds for its production strategy. However, it is critical to estimate such cross interactions in order to consistently plan the operations of the different assets and fuels. If the producer knows, by means of seasonal forecasts, the wind production and at which level it will be forced to turn off the thermal assets,they can optimise the fuel reserves and supplies to improve their final margins.

The industry context

In Italy there is an open market system for power, where price is determined by the balance between offer and demand. The Italian power market is divided into six geographical zones that, in some situations, behave as insulated systems. In terms of the power market, electricity price correlates positively with demand and negatively with renewable production because, in the bidding curve,renewable power plants are offered at zero price. Therefore, a measure of tightness could be defined as the demand net of renewable production.

Climate event

Variable wind speeds in Southern Italy in the first two weeks of March 2016

Sector impact

Variations in wind power production and price and implications for thermal power production and price

Management strategy

Using seasonal climate data to forecast energy demand linked to weather conditions

Industry context

Utility
Power generation

The business process

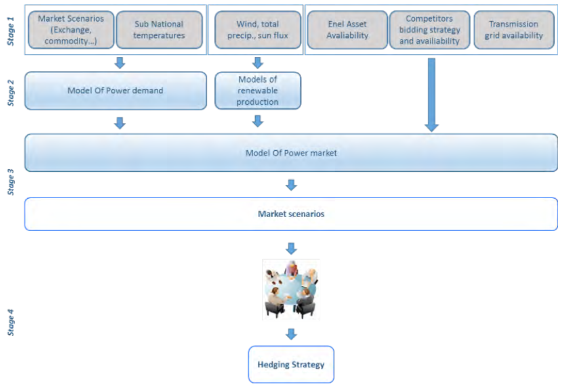

Figure 3: Flowchart for ENEL business process

Figure 3 shows the general framework of the decision process to manage the business within ENEL. A control group and a test group will be established by ENEL. In terms of climate conditions, the control group will only be able to access widely known climatological conditions (currently the most common approach) while the test group will also be given current tailored seasonal climate forecasts.

Progress update

To study the anomalous wind production on March 2016, seasonal forecast by ECMWF system 5 model initialized respectively one (M-1), three (M-3) and six (M-6) months before the event, have been compared with ERA5 March climatologies in order to evaluate the added value given by the use of seasonal forecast instead of historical climatologies. The added value has been quantified by comparing these results with the actual ERA5 raw values, as shown in Figure 4.

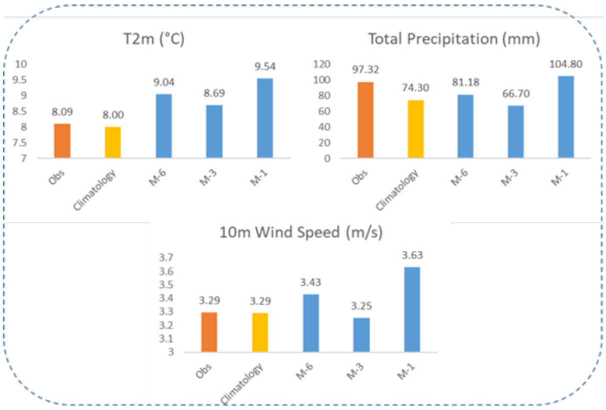

Figure 4: Italian monthly averages of (upper left) 2m temperature, (upper right) total precipitation and (bottom) 10m wind speed for ERA5 raw values ("Obs", orange), ERA5 Climatology (yellow), ECMWF system 5 calibrated seasonal forecast (blue) initialized one (M-1), three (M-3) and six (M-6) months before the event month on March 2016.

Business process

Data gathering (market and meteo)

Simulations of the power market

Hedging committee

Decision trees

To evaluate the impact of seasonal climate forecasting models on the decision-making process, the following steps shall be implemented (Figure 5):

1. Define three input data based on the same information set except for weather variables. The input data set used shall be:
   - I. Climatology input for a given delivery period
   - II. Seasonal forecasts developed within SECLi-FIRM
   - III. Reanalysis ERA 5 (as Actual Weather Data)
2. Perform the decision-making tree three times based on input data of point 1.
3. Compute the associated Performance Indicator.

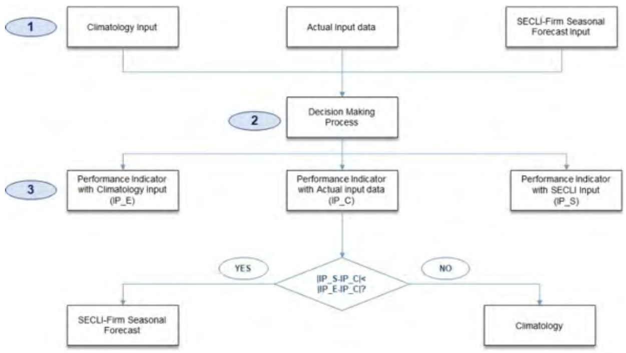

Figure 5: Enel Decision Making Tree: Performance Indicator Comparison

Next steps

- A further analysis of the wind monthly profile to better understand which type of spatial and temporal aggregation is more representative of the March 2016 event.
- Application of wind power model to weather data of ERA5 and ECMWF system 5 model in order to assess the added value in the renewable generation scenarios.
- Extend the error analysis to multi-model seasonal forecast combination.
- Deterministic application of seasonal forecast to internal econometric models.
- Probabilistic application of seasonal multi-model forecast to internal econometric models.
- Estimate the added value from the decision tree with the new SECLI-FIRM weather input.

The Added Value of Seasonal Climate Forecasting for Integrated Risk Management (SECLI-FIRM)

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Decision trees

Evaluating the impact of seasonal forecasting models

Let us denote with IP_E, IP_S and IP_C performance indicators linked to climatology, SECLI-FIRM seasonal forecast and Actual Weather Data, respectively.

The impact of the seasonal climate forecasting model has added value to the decision tree if $[IP_S-IP_C]<[IP_E-IP_C]$.

Indeed, seasonal forecasts add value, even when the decision taken is as similar as possible to the one that would be taken knowing the exact weather variables actually measured at delivery.

Find out more

For more about this and other SECLI-FIRM case studies, visit www.secli-firm.eu

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