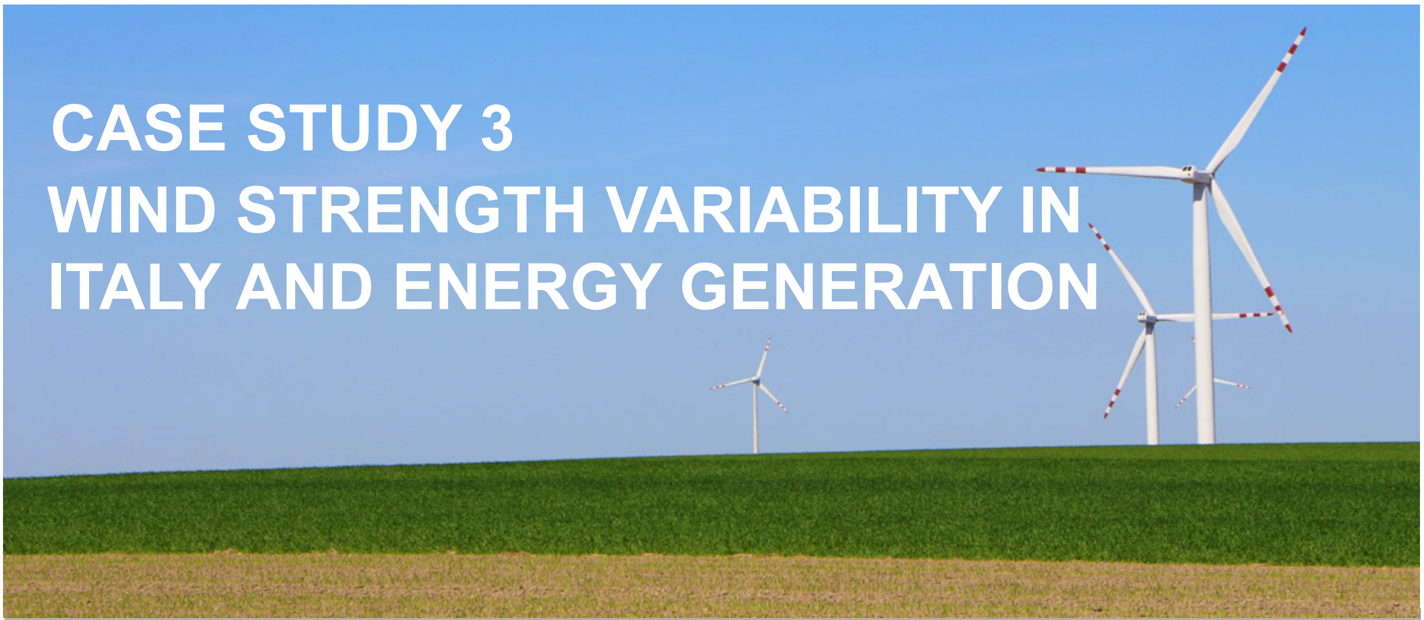

CASE STUDY 3
WIND STRENGTH VARIABILITY IN ITALY AND ENERGY GENERATION

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.

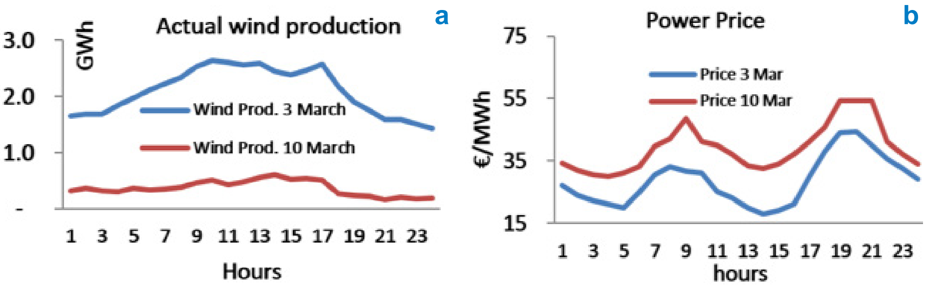

Figure 1: (a) Hourly wind production and (b) the effect on market prices

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

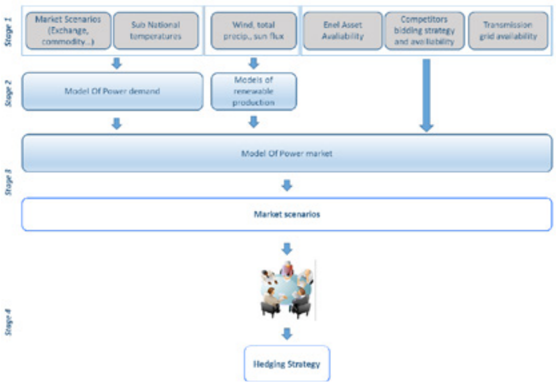

Figure 2: Flowchart for ENEL business process

Figure 2 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.

Decision trees

The decision tree here represents the strategic decision making process and has the aim to evaluate the impact of seasonal climate forecasting models. The valuation is based on the comparison of results obtained using three sets of input data: climatology, SECLI-FIRM forecasts and actual data, that represents the target.

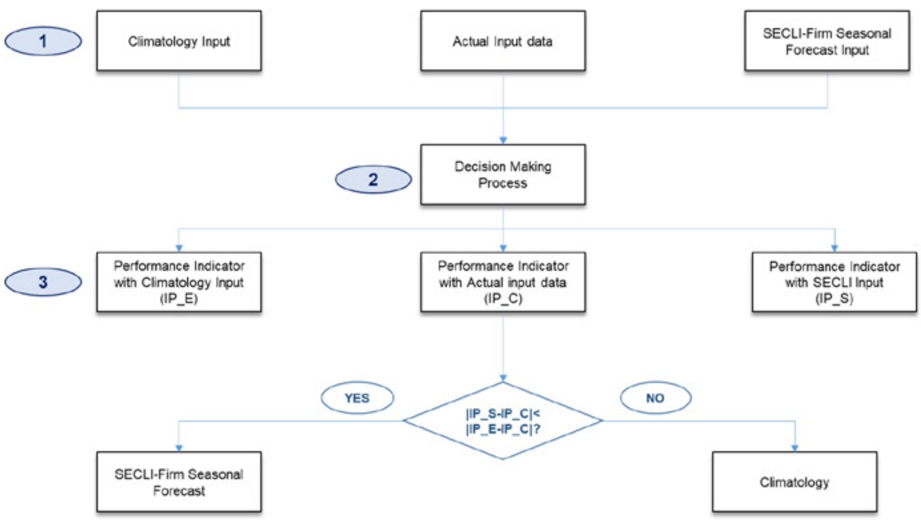

Figure 3: Enel Decision Making Tree: Performance Indicator Comparison

Business process

Data gathering (market and meteo)

Simulations of the power market

Hedging committee

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.

Case Study Highlights

The main weather variable for analyzing the high variability of wind generation in March 2016 is the wind speed at daily time resolution scale. Unfortunately, most forecast models do not provide such temporal resolution. For this reason, 10 m wind speed daily profiles were modeled combining daily data of ERA5 reanalysis with ECMWF, DWD, Meteo France and Met Office monthly forecasts. The results of the daily forecasts consist of two solutions: a Single Model from ECMWF and a Multi-Model (combination of the models mentioned above). The two solutions were initialized one (M-1), three (M-3) and five months (M-5) before March 2016 and compared with ERA5 and Climatology after performing the spatial aggregation over the area of interest.

Then, the weather forecasts, climatology and actual values are used as input of Enel's decision-making process in order to obtain a value of indicator performance (IP) for each initialization involved. This indicator was computed for the economic output of Seasonal forecasts (IPs), Climatology (IPe) and Actual (IPc). The IPe (Base Case) represents Enel's current use of the seasonal forecast while IPc was used as a benchmark for testing the performance of the seasonal forecast as if it had been available as a "perfect" forecast.

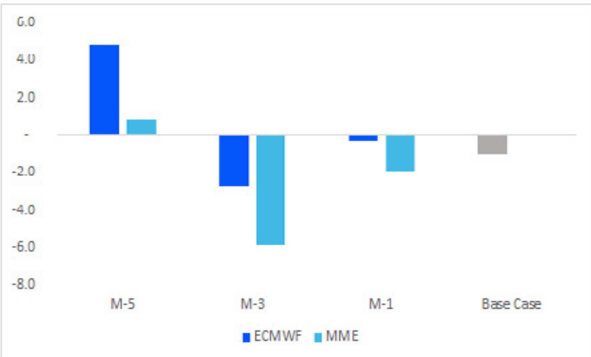

Figure 4: Example of comparison between indicator performance in Mni€ with respect to the "perfect forecast" scenario for Case Study 3

Case Study Highlights

- Wind forecast montly-to-daily resampling
- Comparison between ERA5 and ECMWF plus multi-model forecasts
- Error analysis of multi-model forecast for Enel's areas of interest
- Application of ECMWF and multi-model forecasts to internal econometric models
- Estimation of the added value from the decision tree

The future

The SECLI-FIRM Project was a great opportunity to investigate a recent technology, i.e. seasonal forecasts. This enabled us to learn scientific and technical skills for using this technology as well as the reanalysis database. The profitable interaction with the SECLI-FIRM seasonal forecast scientists allowed us to acquire an awareness about the topic of forecasting, including the caveats related to a technology that is still a research frontier. Nowadays, seasonal models provide different scenarios or probabilistic information rather than a unique outcome. Translating these different forecasts into a deterministic value tends to produce average results that may not reflect the magnitude of large signals observed in the case of extreme events. For this reason, the evaluation of an extreme event may be subject to errors. In this case study, this obstacle was addressed by using re-sampling at daily scale. In conclusion, although the seasonal models at the present day do not offer performances that are able to perfectly reproduce extreme events, the use of these models by Enel should be considered as a stepping stone.

The climate service Teal tool was customized to Enel's needs and it will be fed by the ERA5 dataset for historical analyses, with seasonal forecasts (ECMWF and NMME) and with operational short term forecasts. Enel remains committed to following the technological and scientific evolution of seasonal models in order to use them as a tool for improving operational skills.

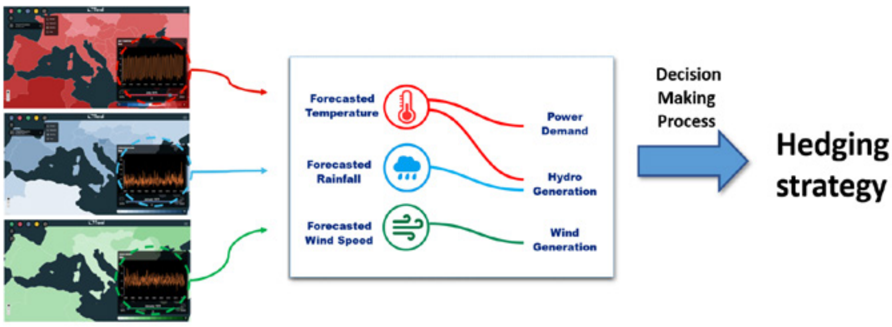

Figure 5: Example of the use of Teal Tool weather forecasts in Enel's decision-making process

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

For more information visit:

www.secli-firm.eu or contact us at: **info@secli-firm.eu**

The Future

Implementation of Seasonal forecast within the Teal Tool

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

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