CASE STUDY 4
HIGH/LOW WINDS IN SPAIN AND ENERGY GENERATION

Focus: Sustained high and low wind speeds in Spain and energy generation in high penetration markets

Industry 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 ENDESA, part of the ENEL group, which has important assets in Spain.

Boosting decision making

- The main objective of this case study is to illustrate the benefits of designing adequate decision-support products to predict energy production in markets with high penetration of wind technology.

The seasonal forecasting context

- This case study focuses on demonstrating the impact of using wind speed seasonal forecast information for a big utility with multiple generation assets of different technologies. As well as assessing the skill of such forecasts, the case study will explore the value of this information.

Sectoral challenges and opportunities

- To know in advance the expected energy production from renewable sources, especially wind, to plan the generation with conventional plants.
- When will I need higher generation from nuclear or gas plants? How much energy will I need to complement the wind energy? Can I reduce my fossil fuel costs by planning my future needs? Can I optimize the operation of my energy assets to increase my revenue?

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Wind conditions and the power system

This case study is subdivided into two selected periods:

1. January 2014 – March 2014. During this period, wind and hydro generation both yielded greater production than average due to favourable meteorological conditions (in particular, higher wind speeds), and the spot prices reached very low values (almost the lowest record in the observed time series).

2. December 2014 – January 2015. Wind speeds were lower than average, and higher spot prices were sustained due to this shortage of wind power.

Wind in the Spanish power market

Wind electricity production in the Spanish peninsular power system reached 47,298 GWh in 2016, which represented about 18.9% of the corresponding electricity demand. Yearly average wind capacity factor in the Spanish peninsular power system is currently 24.7%, but it has had yearly values ranging between 23.1% and 27.3% in the 2011-2016 period. The dispersion in the values of the wind capacity factor is greater over quarterly time intervals, as shown in Figure 1.

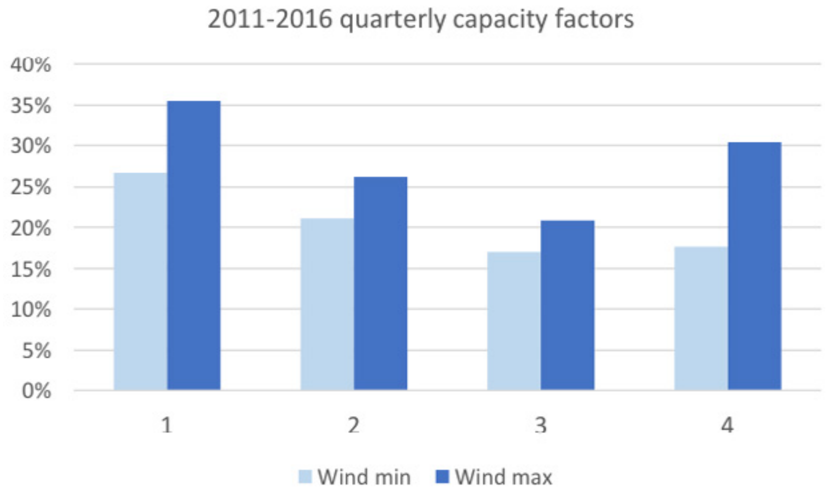

Figure 1: 2011-2016 quarterly wind capacity factors for Spain

The industry context

The Spanish electricity market is managed jointly with the Portuguese market since July 2007. The electricity price is set through a mechanism referred to as the Daily Market. Generally speaking, electricity price increases with demand and reduces with renewable share, because these power plants are offered at their variable cost (very low). In particular, wind is a very important driver of the spot price in Spain, as 22% of the installed power and 18% of the generation connected to the transport grid are from wind farms.

Climate event

Sustained high and low wind conditions in Spain

Sector impact

Energy generation from wind farms determines the energy needs from other sources and the spot market price

Industry context

Utility
Power generation

The business process

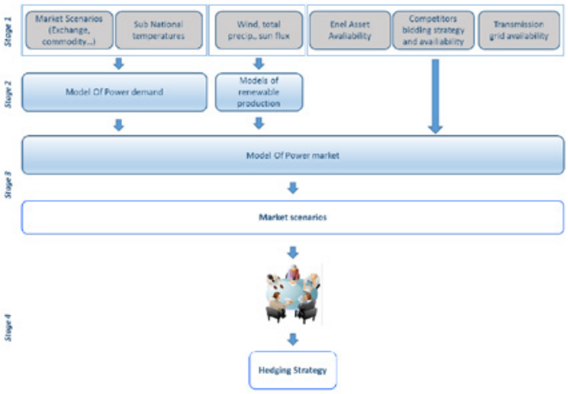

Figure 2: Flowchart for ENDESA business process

Figure 2 shows the general framework of the decision process to manage the business within ENDESA. A control group and test group have been established. 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

To evaluate the impact of seasonal climate forecasting models on the decision-making process, the following steps shall be implemented (Figure 3)

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 by using three sets of input data: climatology, SECLI-FIRM forecasts and actual data, that represents the target.

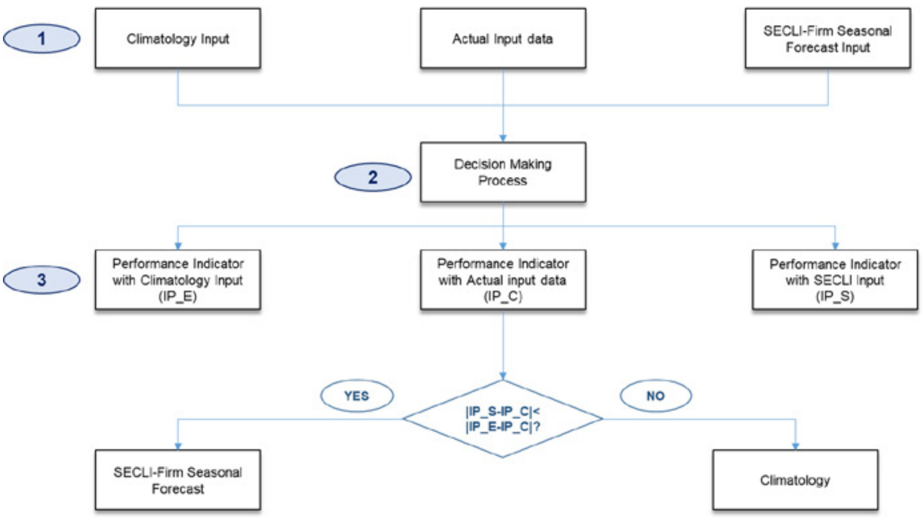

Figure 3: Enel Decision Making Tree: Performance Indicator Comparison

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

In order to capture most of the high and low wind that occurred in Spain during the periods of January-March 2014 and December 2014-January 2015, two solutions of seasonal forecasts were taken into account: the ECMWF and the combination of four different models (ECMWF, Meteo-France, DWD and Met Office). These two solutions were interpolated on points of interest (Figure 3) representative of the entire wind production/demand in Spain for the 2m temperature and 10m wind speed. Similarly, the spatial aggregation is applied to ERA5 historical data for the same reference period as the forecast models (1993-2014) in order to get one time series for actual values and one for climatology. The latter has been used to obtain a base case scenario – i.e. the current use of climatology by Enel -- while the actual time series has been used as a benchmark for testing the performance in the case of a "perfect forecast". Both seasonal forecasts solutions, climatology and actual, have been used as input in the decision-making tree (Figure 5). The output of this flowchart consists of a performance indicator for evaluating the added value of the seasonal forecast (IPs), Base Case (IPe) with respect to "perfect forecast" (IPc).

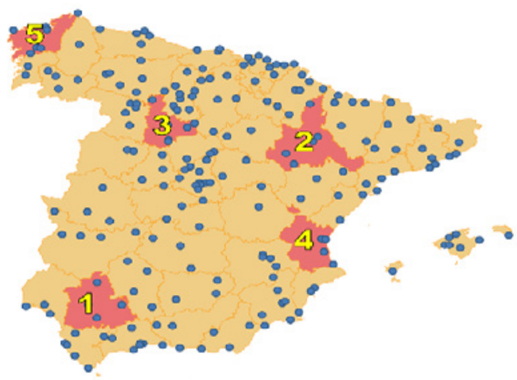

Figure 4: Map of Spain with WMO Meteorological Stations (blue points), and the five Enel's areas of interest (highlighted in red).

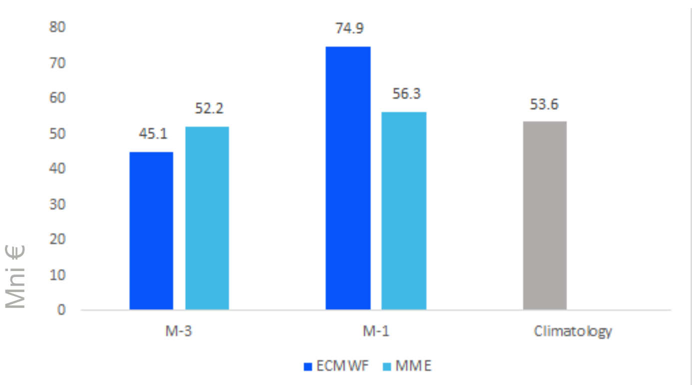

Figure 5: Example of comparison between IPs from ECMWF (blue bars), MME (light blue bars) and Climatology (Gray) with respect to perfect forecast scenario during the period of January-March 2014

Case study highlights

- Comparison among ERA5 and ECMWF/MME forecasts
- Error analysis of multi-model forecast on Enel's areas of interest
- Application of ECMWF and MME forecasts to internal econometric models
- Estimation of the added value from the decision tree with both ECMWF and MME solutions

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 these tools and about the reanalysis database. The profitable interaction with seasonal forecast experts allowed us to acquire an awareness about the topic of seasonal forecasting, including the caveats related to a technology that is still a research frontier. Nowadays, seasonal models provide different scenarios of forecasts that do not give unique information. Therefore, the technique to translate 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 behavior was observed for both Single and Multi-Model solutions. In fact, in both periods the climatology is still confirmed as the best performance with respect to the two solutions of seasonal forecasts. In conclusion, although the seasonal models at the present day do not offer performances that are able to perfectly reproduce the 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 (Figure 6) and going forward it will be fed by the ERA5 dataset, for historical analyses, with the seasonal forecasts (ECMWF and NMME) and with the operational short term forecasts. Enel remains committed to following the future technological and scientific evolution of seasonal models in order to use them as a tool for improving operational skills.

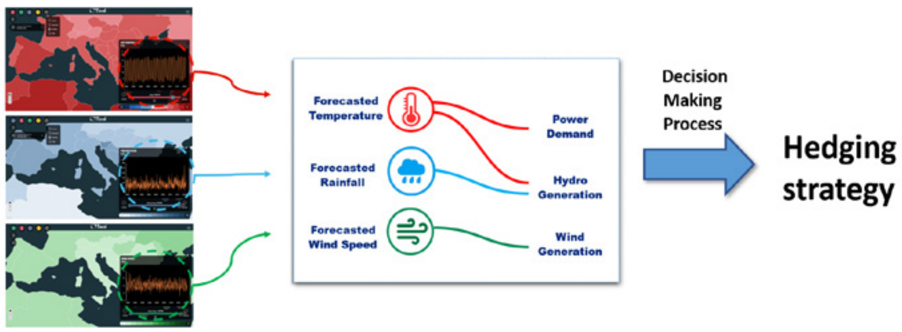

Figure 6: Example of the use of Teal Tool weather forecasts in Enel's decision-making process

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

For more information visit:

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

The future

The implementation of seasonal forecasts within the Teal Tool.

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

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