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, while the main research partner is UL, a company that brings expert knowledge in the use of meteorological information for the renewable energy industry. UEA is also a research partner. UL has recently brought on board a new energy industry partner, Enerfín, to collaborate on the project and act as an end-user.

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.

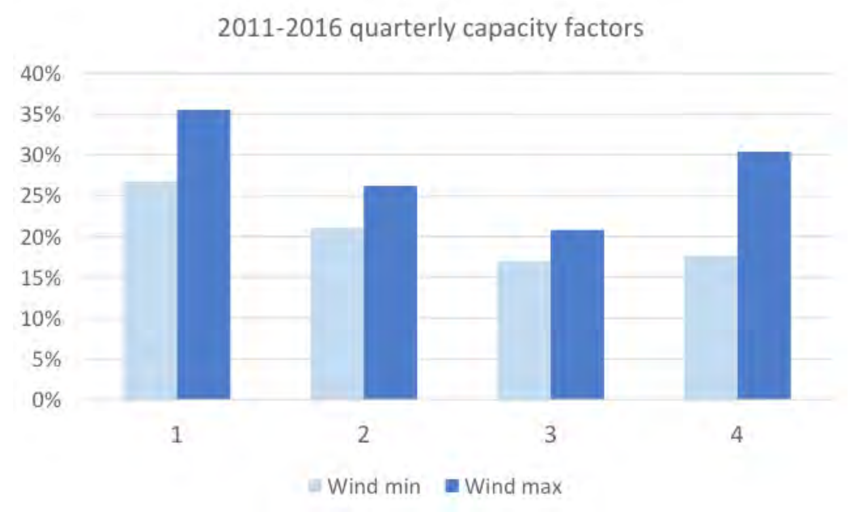

Figure 1: 2011-2016 quarterly wind capacity factors for Spain

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

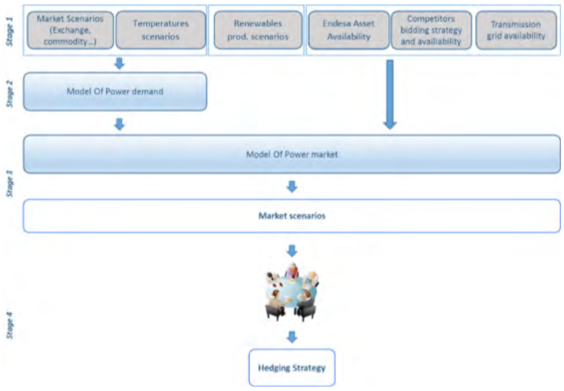

Figure 2: Flowchart for ENDESA business process

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.

Progress update - Enel

Power models were applied to ERA5 wind field as function of the distribution of existing power plants in order to catch the anomalous Spain wind production during 2014-2015. Before that a climatological study on wind variable has been performed to assess how to apply the wind-power model and which regional domains is better to consider in the analysis in order to capture most of the CS4 event. The study has been implemented selecting the regional domain more fitting with the national wind power production. Climatologies over 1993-2013 and anomalies for the period of interest have been computed for Spain national average of monthly mean 2m temperature, 10m wind speed and total precipitation. These results obtained from ERA5 reanalysis and ECMWF system 5 model data have been compared to assess the weather added value deriving from the use of seasonal forecasts.

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.

Business process

Data gathering (market and meteo)

Simulations of the power market

Hedging committee

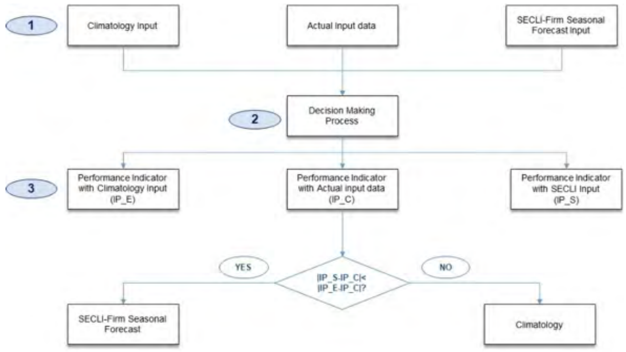

Figure 5: Enel Decision Making Tree: Performance Indicator Comparison

Next steps - Enel

- Power models application to ECMWF system 5 wind speed seasonal forecast to get the resultant wind production.
- 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.

Progress update - UL

After discussion with several relevant stakeholders in the Spanish market, UL has reached an agreement with the developer, Enerfín (www.enerfin.es) to collaborate on the project as a new industry partner and act as an end-user. Enerfin has more than 1000 MW wind projects in operation or under construction in Brazil, Canada and Spain, with over 445 MW in Spain alone.

Next steps - UL

To obtain information about current decision-making process methods and use of long-range forecasts or climate information in this process. This will provide information on the current use of seasonal forecasting information, as well as an understanding of the preferred final delivery method of the information gathered from the tailored seasonal forecasts.

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

For more information visit:
www.secli-firm.eu

or contact the SECLI-FIRM team at:
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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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