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.

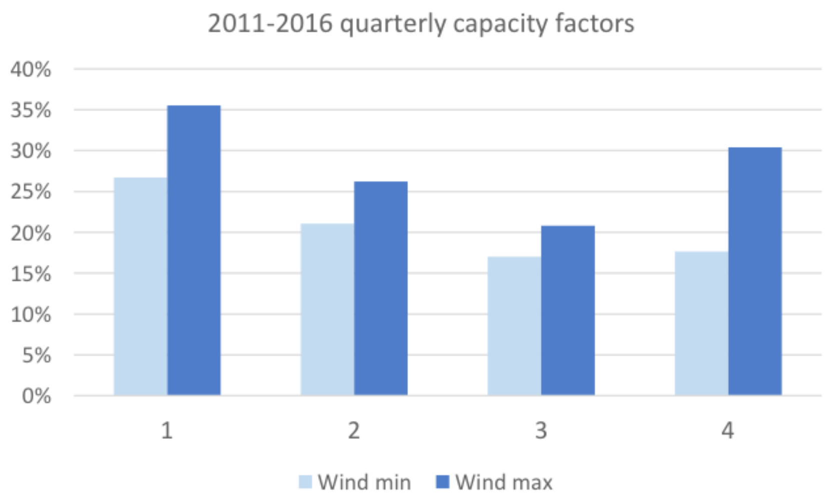


Figure 1: 2011-2016 quarterly wind capacity factors for Spain

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

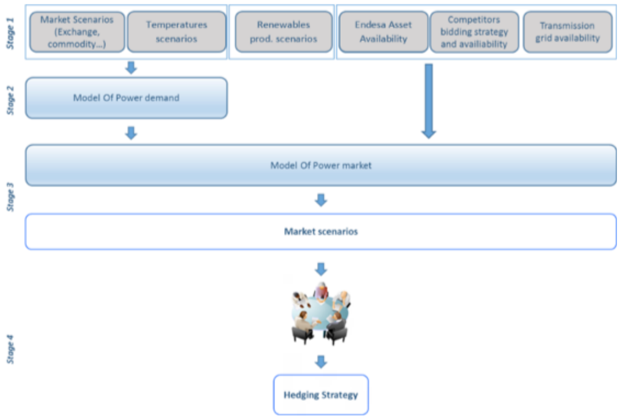


Figure 2: Flowchart for ENDESA business process

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.

Progress update: assessment of Spanish wind data

Five areas of interest were selected according to the location of World Meteorological Organization (WMO) wind stations (Speedwell) in order to capture the sustained high and low winds that occurred in Spain during the periods January-March 2014 and December 2014-January 2015 (Figure 3). The ECMWF ERA5 points related to these areas have been used to derive 10 m wind speed time series (Figure 4) that will be further analyzed together with downscaled ECMWF SEAS5 forecasts. Downscaling is an ongoing process based on ERA5 reanalysis. We will ideally upscale the SEAS5 forecast at 100km of resolution to the 25km grid of ERA5 with a calibration of physical value over the ERA5 data.

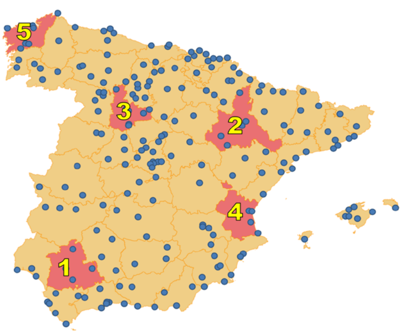


Figure 3: Map of Spain with WMO Meteorological Stations (blue points), and the five Enel's areas of interest (highlighted in red).

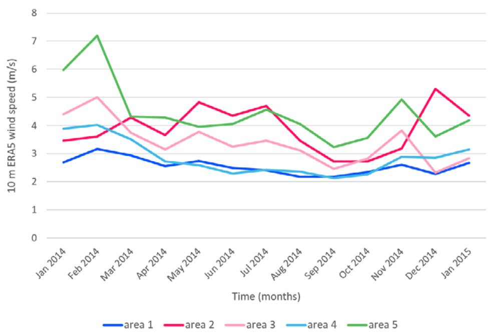


Figure 4: Comparison between ERA5 monthly-mean time series of 10 m wind speed data for the five selected areas during the months of interest.

Business process

Data gathering (market and meteo)

Simulations of the power market

Hedging committee

Forecast Evaluation

Tailored forecasts are now ready to be run in Enel's econometric models

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.

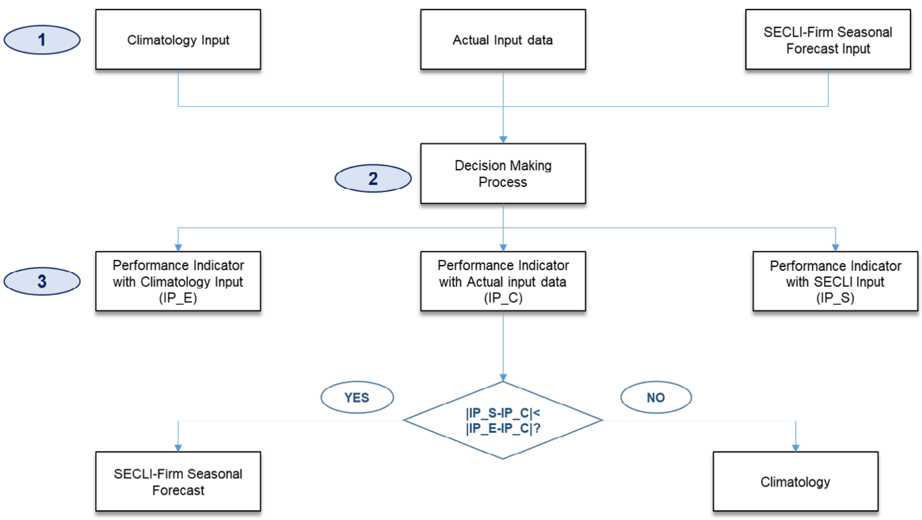


Figure 5: Enel Decision Making Tree: Performance Indicator Comparison

Next steps

- Application of downscaled seasonal forecasts to areas of interest
- Application of seasonal forecast to internal econometric models
- Error analysis of multi-model seasonal forecast combination
- 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)

For more information visit:

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

Decision trees

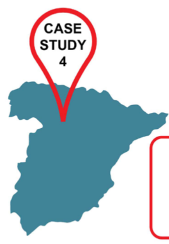
Evaluating the impact of seasonal forecasting models

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.

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



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