CASE STUDY 1

HEAT WAVES IN SOUTHERN EUROPE AND ENERGY GENERATION

Focus: Heat waves in southern Europe and the implications for energy generation and demand

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 and EURAC.

Boosting decision making

- The main objective of this case study is to illustrate the benefits of designing adequate decision support products for the identification of extreme summer heat waves, which have a major impact 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 surface temperature. It explores the skill in predicting extreme summer weather such as occurred in Italy in July 2015.

Sectoral challenges and opportunities

- Electricity price dynamics associated with air conditioning demand spikes (net of total renewable production).
- Power price management and hedging of generation portfolio – when to hedge the power production?
- How are market and asset portfolio decisions affected by the (un)availability of water for thermal electricity plant cooling?
- Accommodating enhanced demand model uncertainty due to extreme events.

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Weather conditions and the power system

Figure 1 (left) shows the average temperatures recorded in Italy during July and August 2015 compared with the 15-year average. Temperatures in July were ~ 5 °C above these climatological values. Figure 1 (right) shows the effects of the weather extreme on power demand. In July 2015, it reached a value of ~ 32 TWh, above the maximum over the last five years. It is interesting to compare the July situation with respect to August when more 'normal' weather predominated.

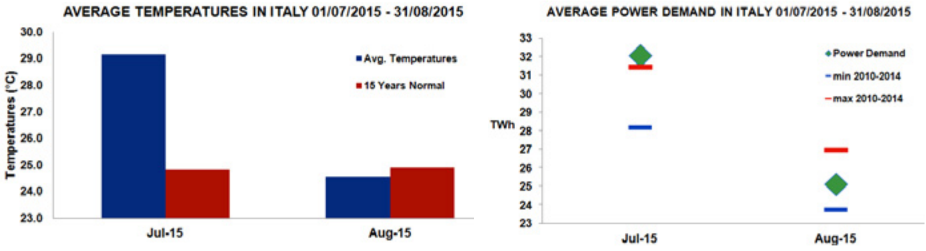

Figure 1: Jul/Aug temperatures and correlating power demand

Better strategy management

Assume an energy producer decided to sell 1 TWh (Figure 2) for the Q3/2015 product at a power price level consistent with market prices in May, within the range 45-55 €/MWh. If temperature forecasts correctly identifying the enhanced heat wave risk had been available, the producer could have taken the decision to keep its long position until the delivery period, selling its own production later at about 60 €/MWh (a differential of +10 €/MWh, or 20%).

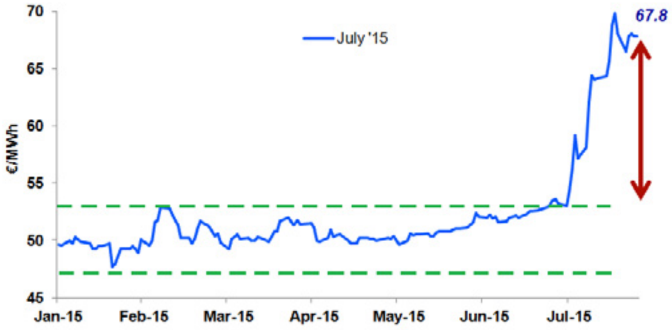

Figure 2: Italian spot power prices in July

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

Extreme heat wave
in southern Europe
July 2015

Sector impact

Increase in power prices
associated with spike
in summer

Management strategy

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

Industry context

Utility
Power generation

The business process

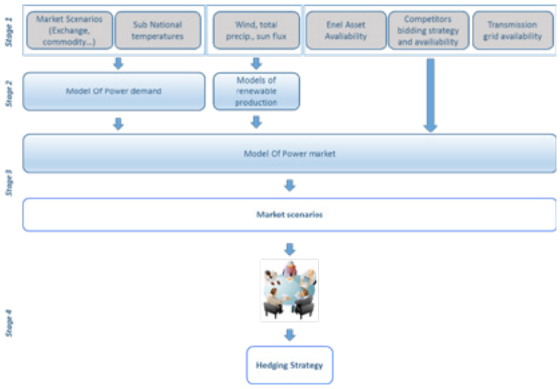

Figure 3: Flowchart for ENEL business process

Figure 3 shows the general framework of the decision process to manage the business within ENEL. A control group and 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

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.

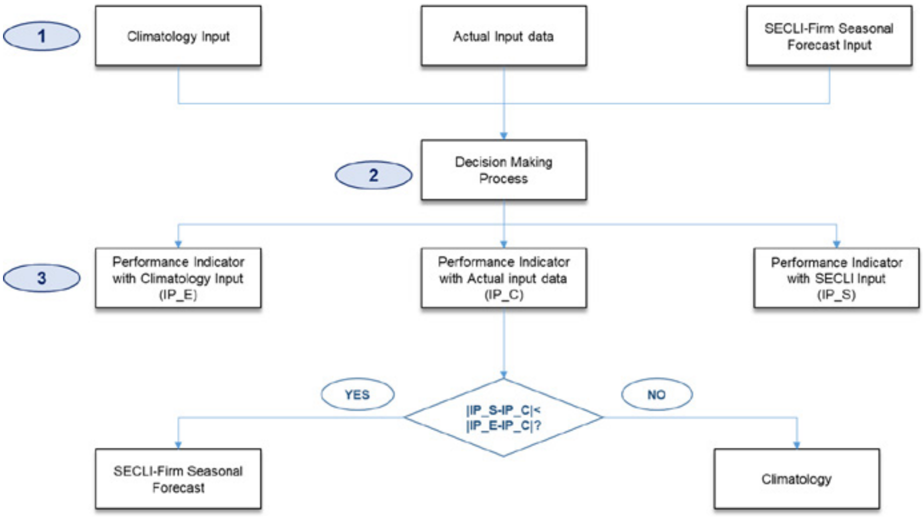

Figure 4: Enel Decision Making Tree: Performance Indicator Comparison

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 ECMWF single model forecasts and the MME combination of four different models (ECMWF, Meteo France, DWD and Met Office) are initialized respectively one (M-1), three (M-3), and five (M-5) months before July 2015. The seasonal forecasts of 2 m temperature, total precipitation, and 10 m wind speed have been spatially aggregated on ENEL's geographical domains of interest and used as input for ENEL's internal econometric models. In addition, econometric simulations using multi-year monthly climatologies (1993-2014) and actual value - spatially aggregated over the same areas - have been computed in order to obtain a base case scenario and a "perfect forecast" scenario. The first represents Enel's current use of the seasonal forecast. The latter is used as a benchmark for testing the performance of the seasonal forecast. A Performance Indicator allows us to measure and evaluate the added value of the seasonal forecast, tailored to Enel's decision-making process (Figure 4). This indicator was computed for the economic output of Seasonal forecasts (IPs), Climatology (IPe) and Actual (IPc). The indicator performance (Figure 5) reflects the weather variables' behavior and sensitivity to the high temperature of July-15. The results show that when seasonal forecasts indicate temperature significantly higher than climatology, the IPs react by approaching the "perfect" forecast value.

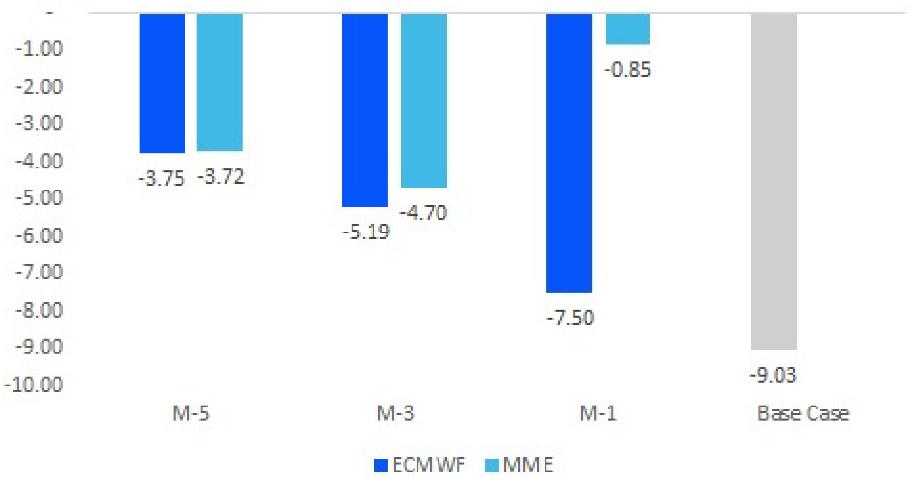

Figure 5: Example of comparison between Indicator performances of Case Study 1 in Mni€ with respect to "perfect forecast" scenario.

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 given by the seasonal forecast. This enabled us to learn scientific and technical skills for using these tools and about the reanalysis database. The profitable interaction with the WP2 allowed us to acquire an awareness about the topic of medium-term weather 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 conclusion, although the seasonal models to 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 (referring to D1.1 and D1.3) and 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. However, Enel will remain committed to following the technological and scientific evolution of seasonal models in order to use them as a tool for improving operational skills.

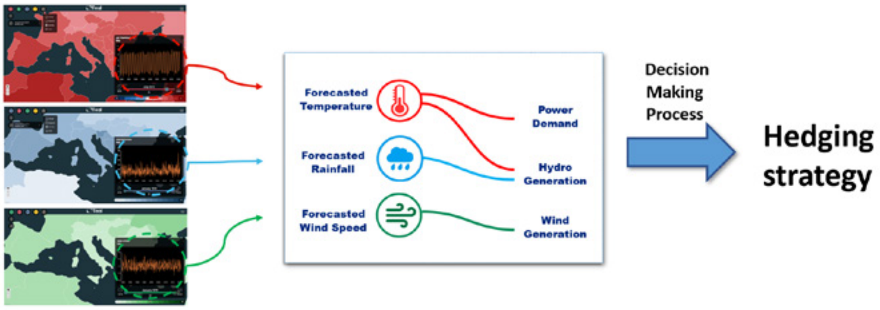

Figure 6: Example of the use of Teal Tool weather forecasts in Enel's decision-making process.

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

For more information visit:

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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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