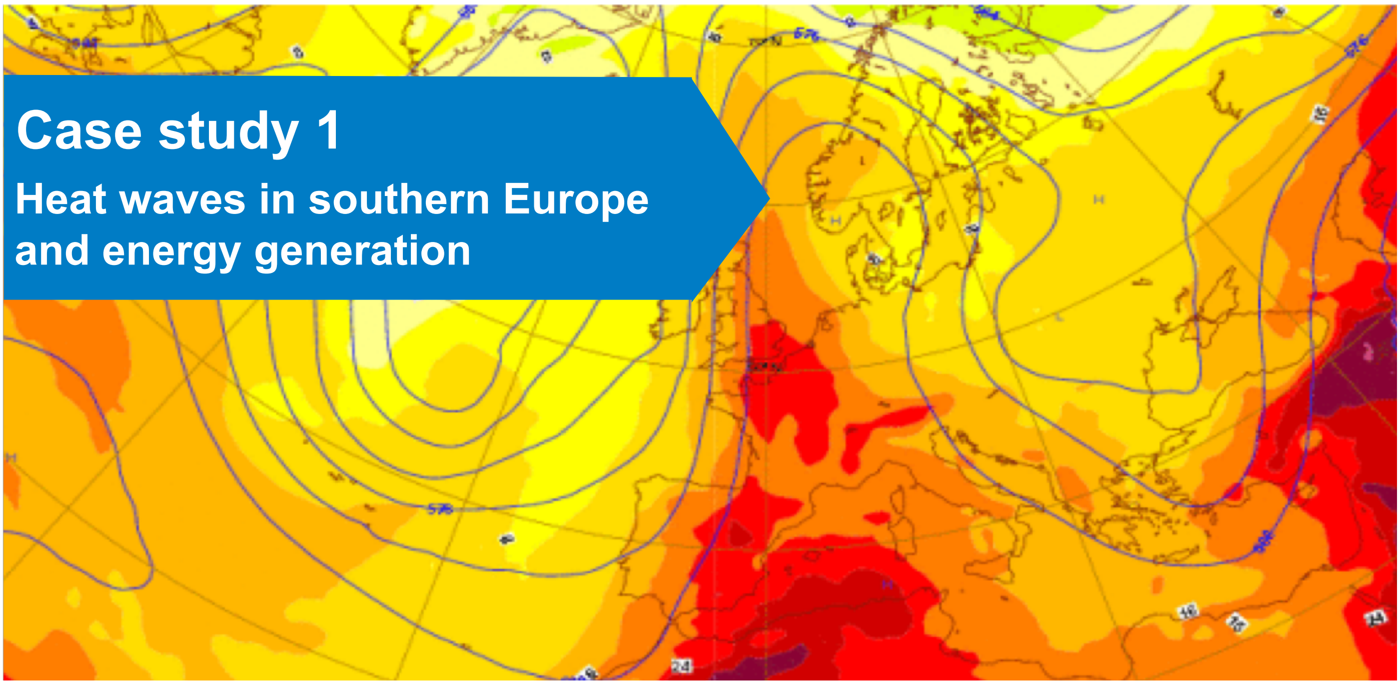
Case study 1

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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Grant Agreement n. 776868

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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.

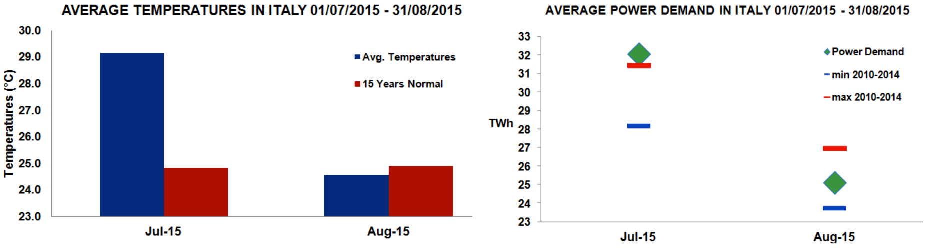

Figure 1: Jul/Aug temperatures and correlating power demand

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%).

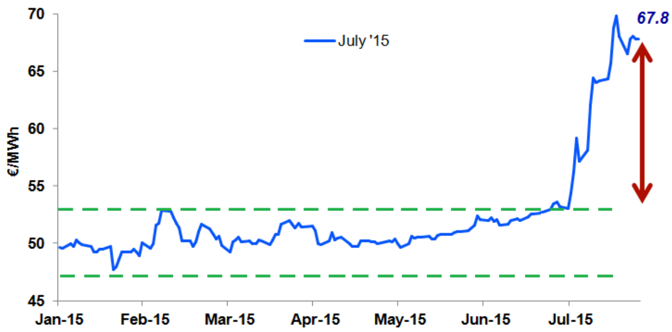

Figure 2: Italian spot power prices in July

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

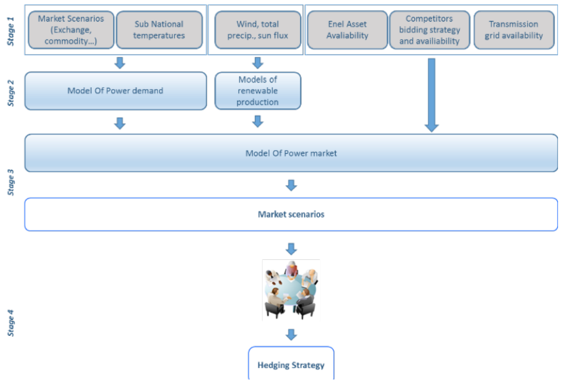

Figure 3: Flowchart for ENEL business process

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.

Progress update: tailoring input for Enel models

The ECMWF forecasting system SEAS5, initialized respectively for one (M-1), three (M-3) and five (M-5) months lead times before July 2015, has been spatially aggregated on ENEL's geographical domains of interest (Figure 4a). The seasonal forecasts of 2 m temperature, total precipitation, and 10 m wind speed are now ready as input for ENEL's internal econometric models. In addition, SEAS5 outcomes have been compared with ERA5 monthly-mean data and multi-year monthly climatologies (1993-2014), derived from spatial aggregation over the same areas (Figure 4b).

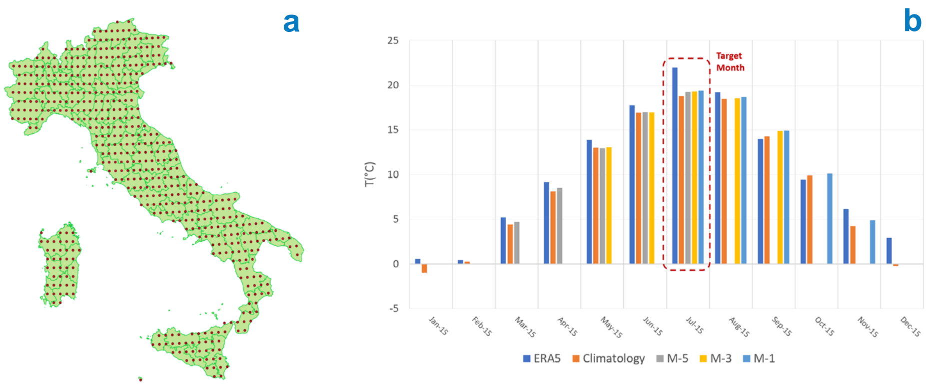

Figure 4 - (a) Enel's area of interest for Case Study 1, where ERA5 and SEAS5 data are spatially aggregated. The red dots represent ERA5 grid points. (b) Comparison between monthly-mean 2 m temperature of ERA5 (blue), ERA5 climatologies (orange), and SEAS5 M-5 (grey), M-3 (yellow), and M-1 (light blue) simulations.

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.

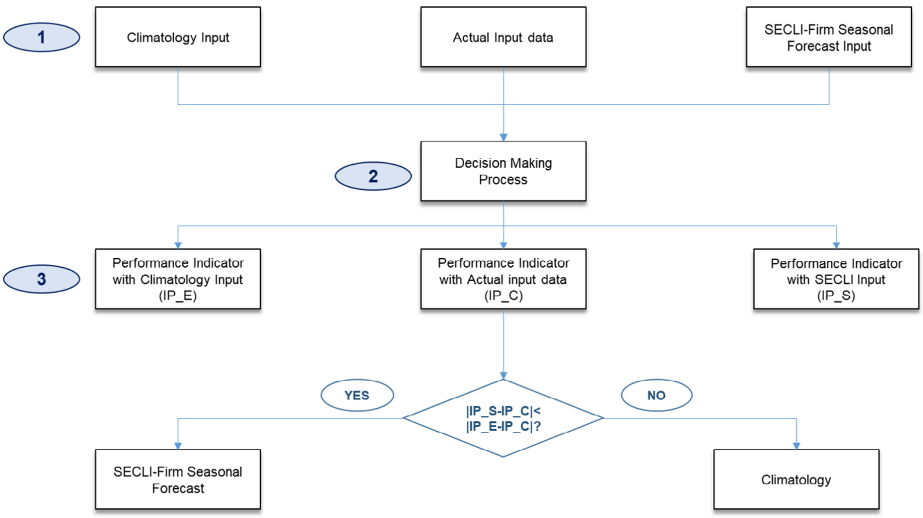

Figure 5: Enel Decision Making Tree: Performance Indicator Comparison

Next steps

- Extend the error analysis to multi-model seasonal forecast combination;
- Deterministic and probabilistic application of seasonal forecast to internal econometric models;
- Estimate the added value from the decision tree with the new SECLI-FIRM seasonal climate forecast.

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**

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

SFCS1: 03.2020

Grant Agreement n. 776868