Case study 2

Dry winters in northern Italy and energy generation

Focus: A mild, dry winter 2015/16 due to a persistent, high-pressure system over the Mediterranean basin and southern France - the impacts on 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 partners are utility companies, ENEL and Alperia, 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 to identify winter conditions in the Alps and Apennines that impact on the power system.
- How can ENEL and Alperia effectively manage the risks associated with extreme climatic events?

The seasonal forecasting context

- This case study focuses on seasonal forecasts of precipitation and hydrological balance.
- Seasonal forecasts of precipitation and snow pack will be used to forecast hydroelectric production and the amount of potential energy stored by snow and ice.

Sectoral challenges and opportunities

- Power price management and hedging of generation portfolio – when to hedge the power production?
- Prediction of gas price movements in a context of low hydroelectric power production and changing
- demand net of total renewables.
- Optimising efficiency in hydropower production management (Alperia).

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Weather conditions and the power system

Due to a prolonged drought with an extremely dry fall and mild temperatures, the end of 2015 and the beginning of 2016 were characterized on one hand by a low level of power and gas demand and on the other hand by a deficit in hydro supply production (Figure 1). During the first three months of 2016 the actual hydroelectric production (red line) was almost half of the energy produced during the same period of 2015 (red ellipse). It was even lower than the minimum of the 5-year range. There was a similar situation in the period of October to December 2016 (green circle).

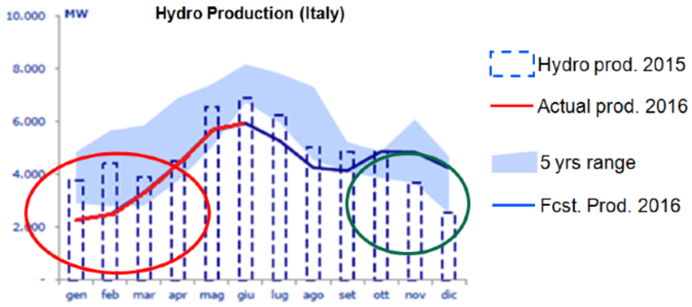

Figure 1: Italian hydro production

The combined effect of low demand (Figure 2) and hydro deficit led to an increasing Italian spark spread level. The spark spread level is the difference between power prices and gas prices. In other words the revenue of a power generator minus the costs linked to the power energy produced.

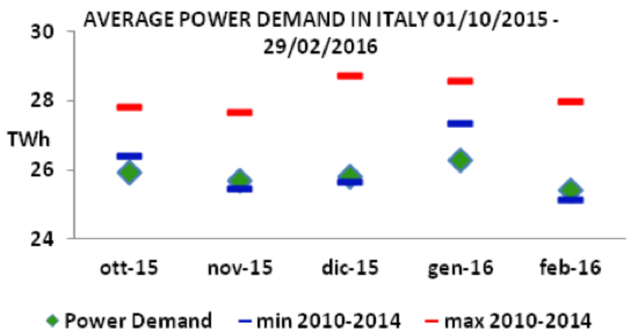

Figure 2: Monthly power demand in Italy from Oct - Feb 2016

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

Mild and dry winter 2015/2016 in the Alps and Apennines

Sector impact

Gas price movements in the context of low demand and hydroelectric production

Industry context

Utility
Power generation

The business process

In the broad context of the business process within ENEL (Figure 3), Alperia, which produces renewable energy, cannot interfere directly with the market scenario. It can only try to sell the energy at the most advantageous price.

In the control and test groups established by ENEL, 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.

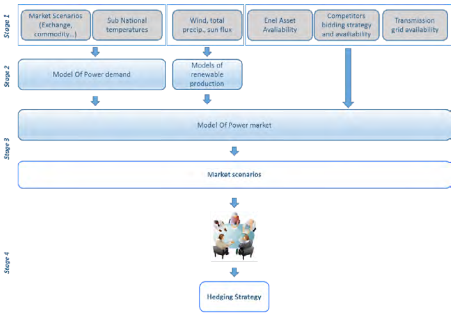

Figure 3: Flowchart for business process

Business process

Data gathering (market and meteo)

Simulations of the power market

Hedging committee

Progress update

To study the water cycle over Alps and Apennines, an analysis of the following ERA5 variables has been carried out:

a) monthly mean temperature (°C),
b) monthly cumulated total precipitation (m),
c) monthly cumulated snow fall (m of equivalent water),
d) monthly mean snow depth (m of equivalent water),
e) monthly cumulated snow melt (m of equivalent water)

in the 1979-2017 time period. Monthly climatologies and single annual time series (respectively red and blue thin lines) are shown in Figure 4 for each one of these variables. An analysis of the weather added value given by the use of C3S ECMWF seasonal forecast instead of ERA5 climatologies has been evaluated for 2 m temperature, total precipitation and 10 m wind speed variables.

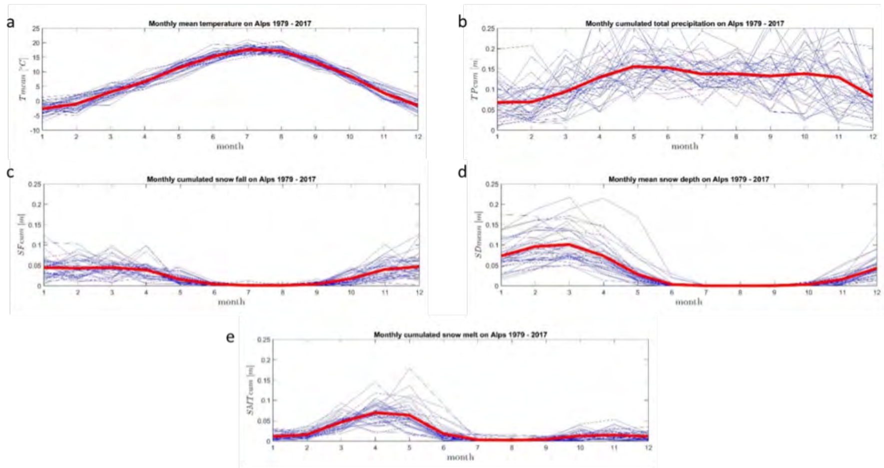

Figure 4: ERA5 reanalysis data of (a) monthly mean temperature [°C], (b) monthly cumulated total precipitation [m], (c) monthly cumulated snow fall [m of equivalent water], (d) monthly mean snow depth [m of equivalent water], (e) monthly cumulated snow melt [m of equivalent water] over the Alps.

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 whole decision-making tree three times based on input data of point 1.
3. Compute the associated Performance Indicator.

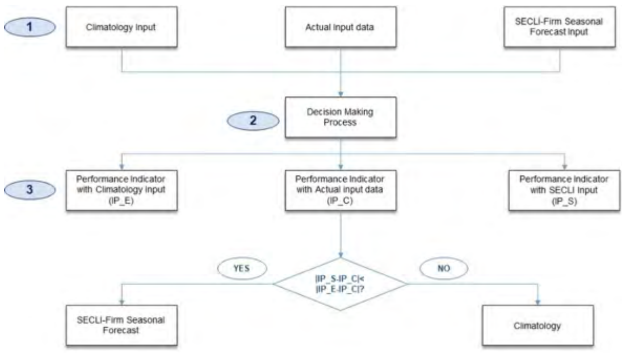

Figure 5: Enel Decision Making Tree: Performance Indicator Comparison

Next steps

- Application of hydropower model to weather variables of ERA5 and C3S ECMWF forecast database in order to assess the added value in the renewable generation scenarios.
- 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.

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

For more information visit:
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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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