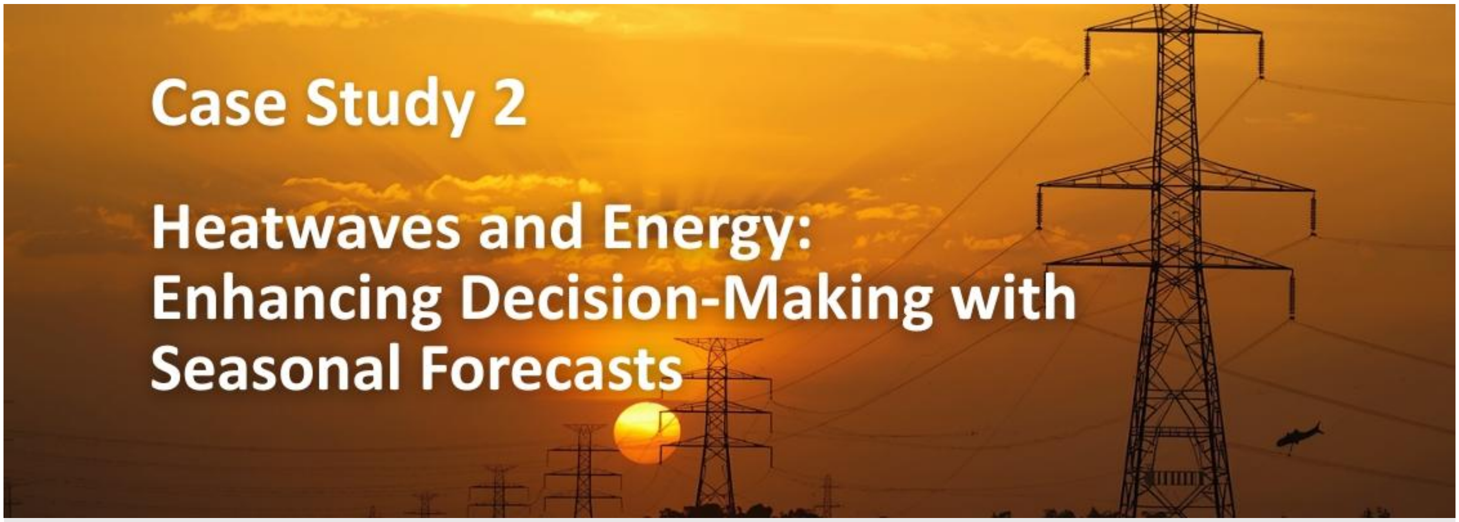

PROJECT OVERVIEW

Due to global warming heat waves are increasing in frequency and intensity, with cascading impacts on power systems. These include surges in electricity demand driven by increased air-conditioning use, reduced renewable energy production due to unsuitable operating conditions, and rising market price.

Within the **H2020 SECLI-FIRM project**, the World Energy and Meteorology Council (WEMC), the funding agency of Inside Climate Service (ICS), partnered with Enel, a global leader in the power and gas sector, to explore how seasonal climate forecasts can improve power price management, generation portfolio decisions, and energy market strategies.

Partner	Site / Location	Industry	Duration	Funding Body
Enel	**Italy**	**Energy & Climate**	**24-month**	**EU Horizon 2020**

THE PROBLEM

In summer 2015, Italy experienced a strong heat wave linked to a climatological pattern similar to the record-breaking 2003 event. July temperatures reached **5°C** above the climate normal, driving exceptional electricity demand of approximately **32 TWh in July,** higher than the maximum recorded for the same month during 2010–2014. The event was short-lived: temperatures returned close to normal in August, when energy demand dropped by about 7 Twh **(Figure 1).**

In forward energy markets, electricity is sold in advance at prices set through cautious business decisions.

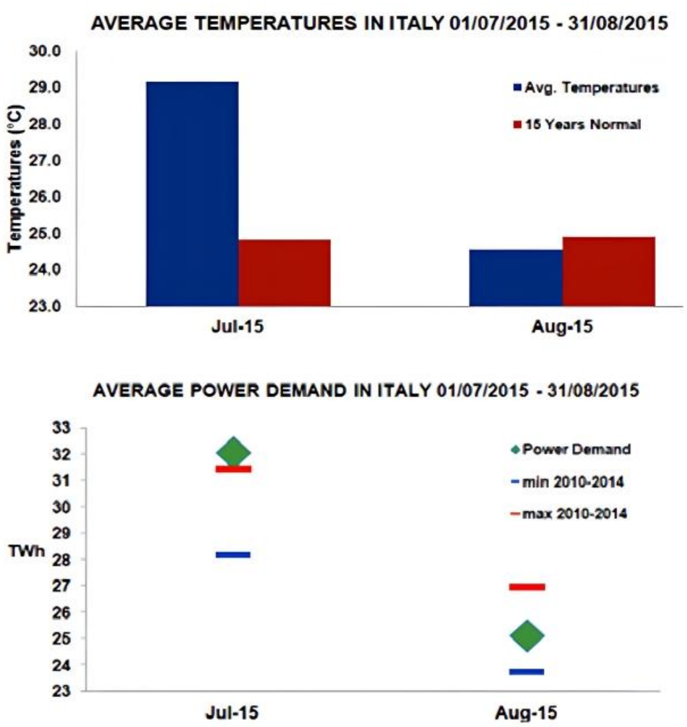

Figure 1: Top: Average temperatures in Italy (July–August 2015) vs 15-year normal.
Bottom: Corresponding power demand compared with the 2010–2014 min–max range.

During heat waves in Italy, prices are driven by two compounding forces: demand spikes, primarily due to air conditioning, and reduced renewable output. Solar panels lose efficiency at very high temperatures, while drought can lower hydro reservoir levels. Because renewables enter the market at zero marginal cost, their reduced share shifts the bidding curve, leaving more expensive thermal plants (gas and oil) to set the market price. With early warning of climate extremes, producers could better anticipate energy production and market fluctuations, and time transactions closer to the delivery period.

OUR SOLUTION

Weather information is a key input for the econometric models used by energy producers to forecast power production and market prices for future deliveries, helping reduce risk and optimize profit.

Seasonal forecasts are generated by running the same atmospheric model multiple times with slight variations in initial conditions, producing an ensemble that captures uncertainty in climate conditions over a 2–6 month horizon. Compared with climatological averages, seasonal forecasts can provide a more robust and physically consistent basis for energy market decisions.

Within the **SECLI-FIRM project**, WEMC coordinated a comparison study to quantify the value of seasonal forecasts of near-surface air temperature and wind speed, and total precipitation, in Enel's decision-making process. Three decision trees were compared using different inputs:

1. multi-year monthly climatology (Enel's baseline),
2. SECLI-FIRM seasonal forecasts, and
3. observed climate data (the perfect-forecast benchmark).

All datasets were spatially aggregated over Enel's geographical domains and fed into Enel's econometric models. Seasonal forecasts came from two sources:

a) A single-model forecast from ECMWF's System 5,
b) A multi-model ensemble (MME) combining forecasts from 4 models: ECMWF, Météo-France, the UK Met Office, and the Deutscher Wetterdienst. Forecasts were initialized one (M-1), three (M-3), and five (M-5) months before July 2015.

RESULTS & IMPACTS

To evaluate the economic value of each decision tree, a Performance Indicator (PI) was computed as the difference (in millions of euros) between realized margin and residual portfolio financial risk (Profit-at-Risk). The PI reflects the sensitivity of key weather variables to the extreme temperatures observed in July 2015. By comparing the PI derived from seasonal forecasts or climatology (base-case scenario) with the PI derived from observed climate data (perfect-forecast scenario), seasonal forecasts add value if they reduce the deviation from the perfect case.

Results show that when forecasts indicate temperatures significantly above climatology, PI values move closer to those of the perfect-forecast scenario, maximizing the risk-adjusted margin. The multi-model ensemble (MME) performs better than the single-model forecast (ECMWF), while the climatology baseline shows the lowest performance (**Figure 2**).

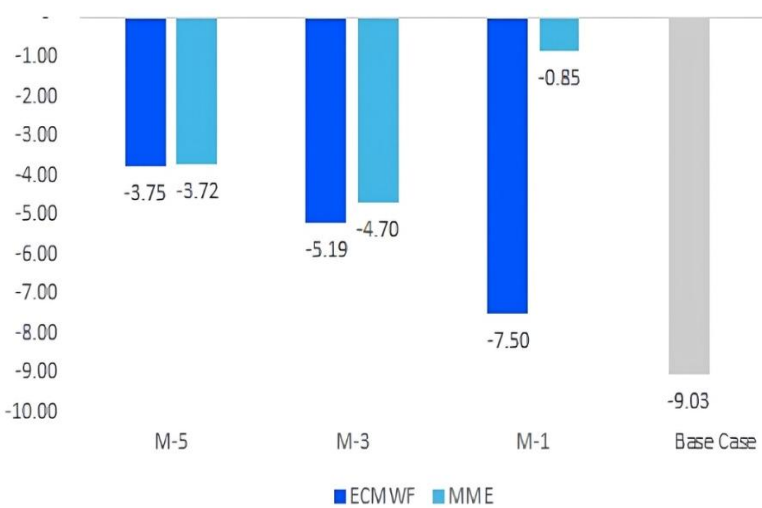

Figure 2: Example of differences in performance indicators (in millions of euros) between seasonal forecasts (ECMWF and MME) or climatology ("base case") and the "perfect forecast" scenario (observed climate). ECMWF refers to the single-model forecast, while MME is the multi-model ensemble combining four models: ECMWF, Météo-France, Met Office, and Deutscher Wetterdienst.

The SECLI-FIRM project demonstrated how seasonal forecasting tools can support real energy market decisions. It also initiated a long-term collaboration with Enel, leading to the customization of the Climate Service Teal Tool developed by Inside Climate Service to integrate ERA5 historical data, ECMWF and MME seasonal forecasts, and operational short-term forecast product.

DURATION & SCOPE

This case study was one of nine developed under the SECLI-FIRM project (The Added Value of Seasonal Climate Forecasting for Integrated Risk Management), a four-year H2020 initiative (2018–2021) bringing together public and private research institutions, energy companies, and industry partners. The project aimed to demonstrate how long-term seasonal climate forecasts can deliver practical and economic value to decision-making in the energy and water sectors. The SECLI-FIRM project was funded by the European Union's Horizon 2020 Research and Innovation Program under Grant Agreement 776868.

COLLABORATION

Partner: Enel, an Italian energy company globally operating in the business of power generation, distribution and sales of electricity and gas.

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