Short-Term hourly electricity demand forecasting in Spain using optimised multiple seasonal Holt-Winters modeling

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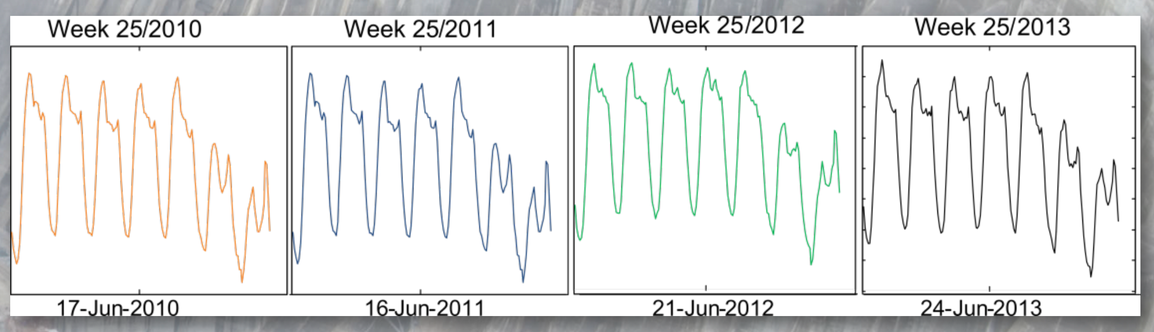
Background

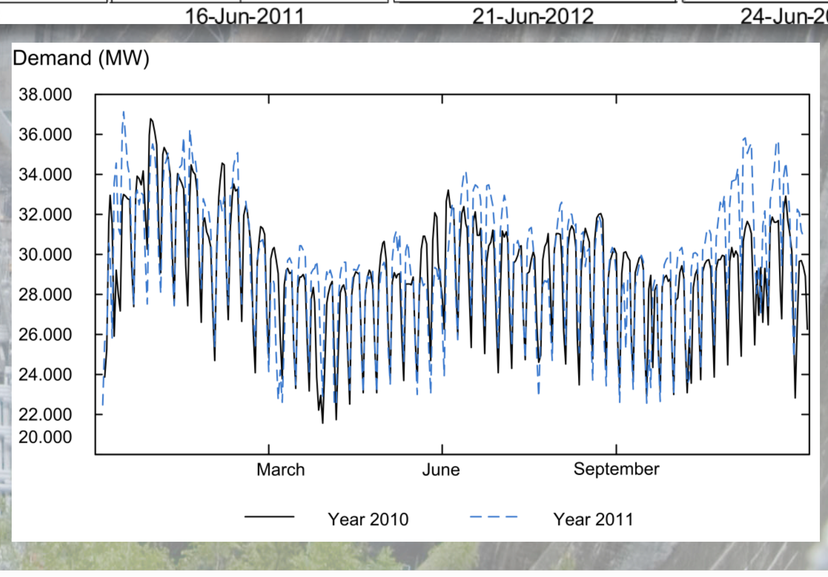
The production and consumption of the electricity energy must match precisely since it cannot be stored in huge quantities and any mismatch produces severe losses for both producers and consumers.

Time series forecasting provides very powerful techniques to make predictions of the future electricity consumption. Within this methodologies, Holt-Winters models highlights.

Motivation

There is a strong appeal from the distribution network operators to improve on the techniques used to make forecasts. Double and Multiple Seasonal methods become as a very interesting opportunity .





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These figure show some typical electricity demand curves in which man can appreciate the multiple seasonal patterns.

The new approach tries to catch all effects produced by each seasonal pattern.

State of the Art

The Double and Triple seasonal modelling has been introduced in ARIMA time series methods , as well as in exponential smoothing, even using State of Space modelling or Holt-Winters.

Some other approach using Artificial Neural Networks, Seasonal decomposition, etc. have been also implemented. But nowadays, Holt-Winters offers very accurate forecasts with simple models.

Double Seasonal Holt-Winters models is shown here:

Level

$$S_t = \alpha(X_t / (D_{t-s_1} W_{t-s_2})) + (1-\alpha)(S_{t-1} + T_{t-1})$$

Trend

$$T_t = \gamma(S_t - S_{t-1}) + (1-\gamma)T_{t-1}$$

Seasonality

$$D_t = \delta(X_t / (S_t W_{t-s_2})) + (1-\delta)D_{t-s_1}$$

$$W_t = \omega(X_t / (S_t D_{t-s_1})) + (1-\omega)W_{t-s_2}$$

Forecast

$$\hat{X}_t(k) = (S_t + kT_t) D_{t-s_1+k} W_{t-s_2+k}$$

Application

The basical application that funded this work is to provide electricity demand forecasting of 24 hours ahead. It can also provide longer forecasts but is not the aim.

Further applications can be applied to forecast weather conditions, prices, passengers arrival , and any other kind of time series that include seasonal patterns.

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