Potential of long-range forecasts in the energy market

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We concentrate on the usability of monthly to seasonal, i.e. **long-range**, forecasts in the energy sector. The potential of long-range forecasts as part of the flexible energy management system is examined based on the needs of a large Finnish energy company, Helen Oy.

Introduction

Energy systems are in transition:

- **Rapid increase in energy demand**, especially in developing economies,
- significant **reduction of greenhouse gas** (GHG) emissions,
- shift from oil to gas through new reserves and environmental aspects.

Weather and climate play here an essential role:

- They provide **the potential** (e.g., solar, water, wind, wave energy).
- They **disturb** (e.g., storms, heat, snow, freezing).

Accurate weather forecasts for various temporal scales are needed (Table 1). Their **reliability** can be expressed **according to their purpose of usage**.

Table 1: Definitions of meteorological information on various time scales. Adapted from World Meteorological Organization (WMO).

DEFINITIONS	RELIABILITY	SCALE&OTHER
OBSERVATION	~Precise (depends on the parameter)	Momentary in time and space
• **CLIMATE**	~Precise	30-year statistics of observations
FORECAST		
• **NOWCAST**	Excellent	Observed and modeled 0-2 hours ahead
• **VERY SHORT AND SHORT RANGE**	Good	Up to 72 hours
• **MEDIUM RANGE**	Good	72-240 hours
• **EXTENDED RANGE**	Moderate	10-30 days
• **LONG RANGE**	Moderate	30 days – 2 years
◦ **MONTHLY**	Moderate	Departure (deviation, variation, anomaly) of the averaged weather parameters from the climate values for that month.
◦ **3-MONTH OR 90-DAY**	Moderate	As above but for longer period.
◦ **SEASONAL**	Moderate	As above but for seasons.
• **CLIMATE PREDICTION**	Moderate	Beyond 2 years. Expected future climate including the effects of natural and human influences.

Background, motivation and methods

Helen Oy produces and provides electricity and district heating and cooling to Helsinki:

- The **production and consumption** is largely governed by the temperatures.
- Spring and autumn are the most important times of the year: **decisions** have to be made regarding how much energy to be purchased and sold from/to stock.
- **Seasonal forecasting** of temperature would be highly useful for Helen Oy **if the forecast skill is good enough** (i.e., better than a value based on climate).

Here, we examine the **heating degree days:**

- We validate the operational usability (skill) of the long-range forecasts to estimate the demand for heating for one year 2015-2016
- We start from the temperature as it has been found to be the "easiest" to forecast.

Results*

Validation for 03/2015-08/2016 shows that:

- The forecasts **have skill** even up to 60 days(!)
- Skill has **monthly variation**: May is the worst but can be handled with bias-correction
- The Jan 2016 very **short and cold** period **was difficult to forecast**; however, it was out of ordinary based on the climate as well

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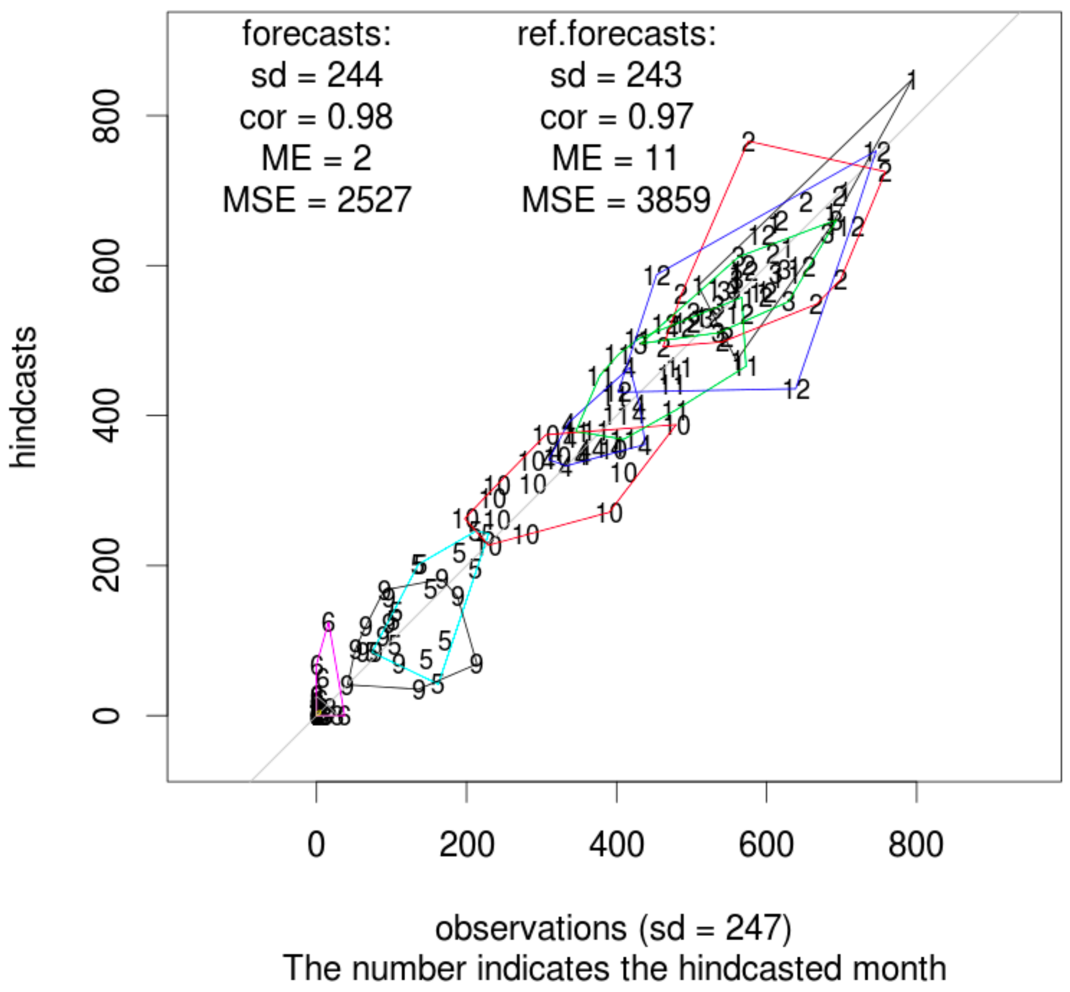
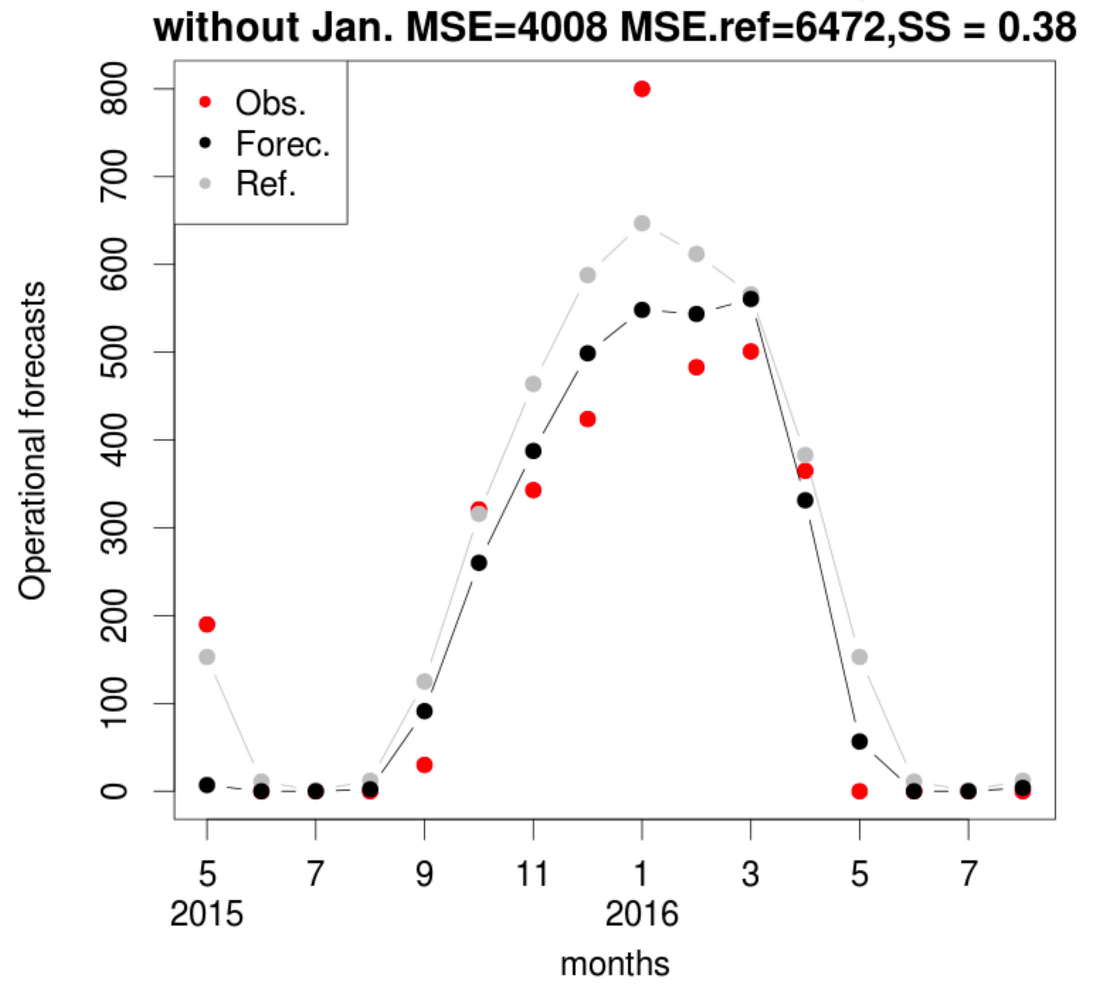
Heating degree days, one month, leadtime=1d
(Bias corr.) MSE Skill Score = 0.35



Heating degree days, one month, leadtime= 60 d
with Jan. MSE=7715 MSE.ref=7531,SS = -0.02
without Jan. MSE=4008 MSE.ref=6472,SS = 0.38



Conclusions

The long-range forecasts used here had **surprising skill**. However, only one ~year of data. **Next steps**

- **To collect more data and make the analysis again;**
- **Semi-operational testing?**

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*Hyvärinen O, Mäkelä A, Kämäräinen M, Gregow H, 2016: Potential of long-range forecasts in the energy market. EMS Annual Meeting, Vol. 13, EMS2016-364, 2016, 16th EMS / 11th ECAC, Italy.