X Modelling Week

Master's Degree in Mathematical Engineering UCM June 2016

Services GTS Direction – Demand Forecasting

System Development & Studies

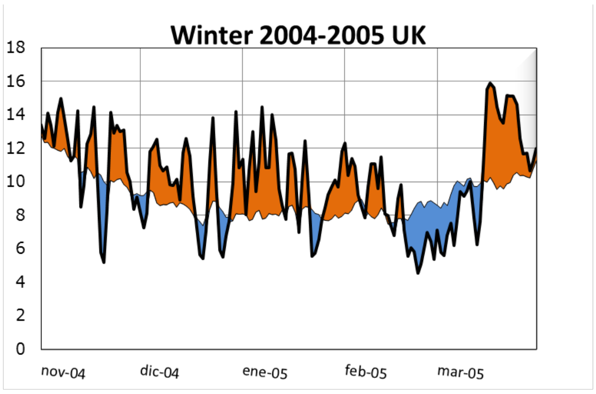
TRANSPORTATION OPTIMIZATION IN EXTREME EUROPEAN DEMAND CONDITIONS

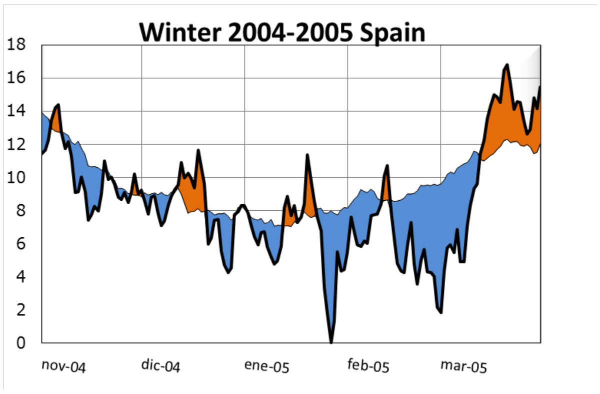
Enagas has been involved for many years in ENTSOG (European Gas Transporter Association), which promotes the development of the European System in coordination with the European Commission. After the publication of the Network Code of Balancing, the current trend is to move towards European market integration.

Forecast demand department attend SUPPLY & DEMAND European Group which studies and proposes new methodologies in order to improve the accuracy of the analysis related to the juncture of this sector and guarantees customers natural gas supply in any situation, not only climatological but also economic or geopolitical.

The main challenge is to calculate the European peak of natural gas demand. This value lets us know whether the system is well defined and if the European security of supply can be guaranteed.

Peak of natural gas demand $\mathrm{D}_{\mathrm{P_i}}^{\mathrm{max}}$ and temperature forecasts T_{P_i} are available for each country member of Europe; however, their different sizes and conditions make us think of the impossibility of simultaneously extreme low temperatures. As an example, the following image compares the temperatures registered in Spain and UK in the winter 2004-2005:





In order to calculate the European peak we propose the next steps:

1. Get the European Temperature T_E by weighting each country temperature T_{P_i} in such a way that the demand's behavioral explanation is maximized.

$$T_E = \sum_{i=1}^{N} w_i \cdot T_{P_i}$$
$$\sum_{i=1}^{N} w_i = 1$$

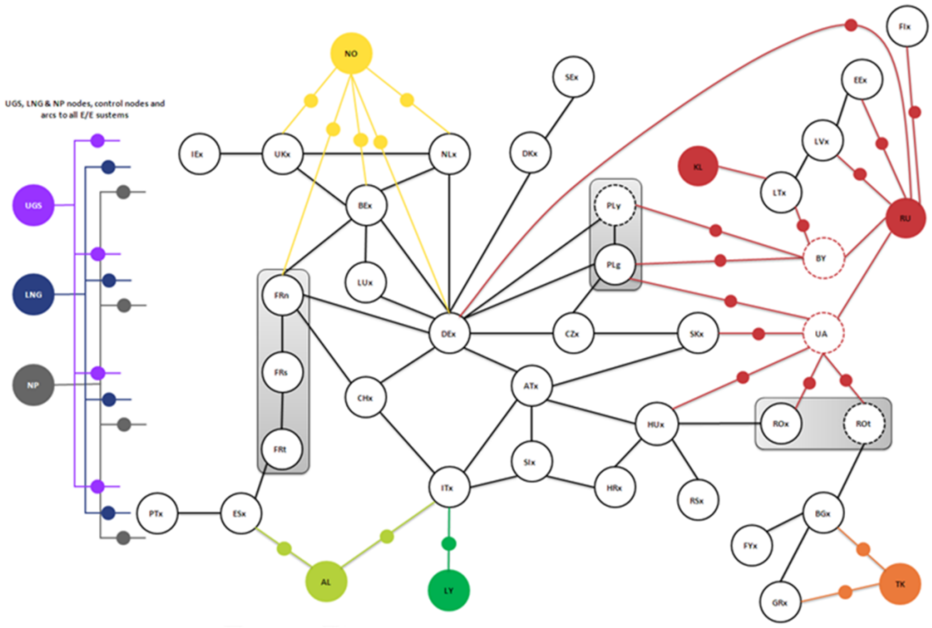
2. Identify which k European zones $Z_1, \ldots, Z_k$ present a similar temperature and afterwards determine the temperature of each Zone T_{Z_j}, $j \in \{1, \ldots, k\}$ (similar to part 1). Once calculated, analyze the simultaneity of them.

3. Identify the adequate dynamic model for each constructed temperature, $T_E, T_{Z_1}, \ldots, T_{Z_k}$, which let us simulate episodes of extreme low temperatures.

4. Estimate the European natural gas demand increments D under cold conditions, as well as the European peak of natural gas demand D^{max}.

The importance of a well estimated value is high as it is used in other European groups, such as the Network Modelling Kernel Group. The management of System Development & Studies attends this group to analyze the network capacity and interconnections level, identifying new transport restrictions and its solutions.

Once the demand of each European country has been calculated and given the next transportation system:

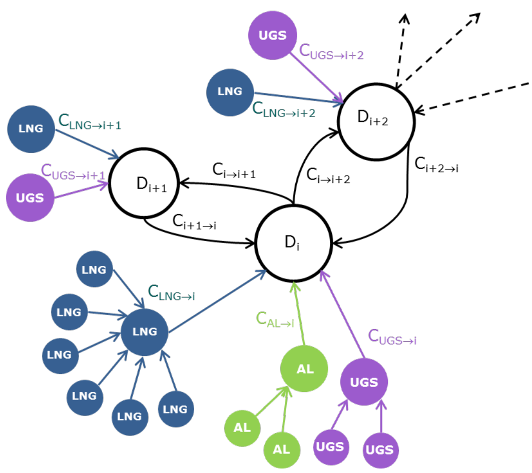


Where the nodes corresponding to points of supply are the following:

- **KL** Kaliningrado
- **AL** Argelia
- **LY** Libia
- **NP** Producción nacional
- **LNG** GNL, planta regasificación
- **RU** Rusia
- **TK** Turquía
- **UGS** Almacenamiento subterráneo
- **NO** Noruega

Each such node corresponds to a different source of supply with an associated price. The price assigned to each source will be always the same.

For each country the nodes from which it receives supply, the countries it is connected with and the interconnection capacity are defined:



Where Di corresponds to the demand in every node and Cij to the capacity between them. For each Cij a maximum and minimum capacity is defined, the minimum capacity being always bigger than zero.

As it can be seen in the image, the set of sources of the same kind will be simplified as a single entry node.

The objective of the problem is to guarantee coverage of the European gas demand minimizing costs and using the minimum number of interconnections possible.