

# ***MONTE CARLO FORECASTING OF RESIDENTIAL NATURAL GAS AND DISTRICT HEATING DEMAND AND TARIFFS, AND COMPARISONS BASED ON THE CURRENTLY USED HEATING DIESEL, IN A CITY IN NORTH GREECE.***

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## **Overview**

A very interesting case study is currently under development in the city of Serres, North Greece regarding its energy supply. A new district heating distribution system is currently under construction by a privately owned company. Investing in a new Combined Heat and Power plant (CHP) at the suburbs of the city, they will supply the hot water by-product of their Power Plant to the city's residences for heating and cooling use. In parallel, it is starting the construction of a competitive natural gas distribution network for the supply of the same city residences.

The interest of this case study arises from the capability given to the end users (given also that the whole scheme will receive the necessary support, mainly political, to the end) to switch at short notice between different heating sources/fuels (hot water, heating gas oil and natural gas) under a full competition environment, something unprecedented for the Greek energy market.

## **Methods**

Official local climate and census data as well as heating diesel consumption and respective price data were collected for the period of the last five years. The city mainly consists of blocks of flats, with a few commercial consumers on the ground floor, and family houses, all having diesel central heating systems (blocks and houses).

District heating demand forecasting implementation is based on the available heating diesel consumption profile, by taking also into account the respective efficiencies, since the district heating network is connected as a by-pass to the block's central heater/boiler system, with the latter remaining in place as back up.

Natural gas demand forecasting presents more difficulties since its use is not limited for central heating only but extends to others uses also (cooking, etc.). For this reason, not only the heating diesel consumption profile was used but also census and respective empirical data available from the use of Natural gas in other cities as well as electricity consumption and tariff data.

Tariffs estimation and forecasting is based on the supply contract available for district heating and on prices of natural gas in nearby cities respectively. Monte Carlo simulations for forecasting and uncertainties estimations were employed in all cases.

## **Results**

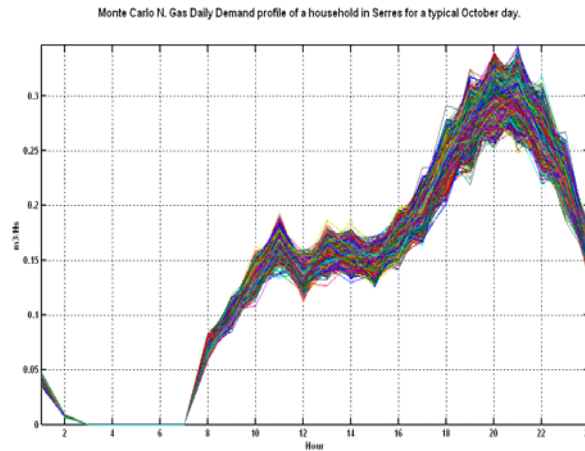
Serres' Buildings age follows an unfavourable distribution. The buildings constructed before 1980 correspond to 67.7% of the total number of buildings. None of these buildings are thermally insulated and exhibit a poor energy performance, while the vast majority of them they are equipped with old heating installations. It was estimated that there was a total annual consumption of heating oil of around 1,297 litres per household and 13.06 litres per household and per m<sup>2</sup>. These were the basic data used for the further development of Natural gas and district heating demand forecasting models by Monte Carlo methods. None of the buildings constructed before 1980, corresponding to 67.7% of the total number of buildings, are thermally insulated and exhibit a poor energy performance, while the vast majority of them they are equipped with old heating installations. These had as an effect an extensively wide variability to be observed in heating oil consumption and tariffs data collected in terms of the heating oil consumption per household and per m<sup>2</sup> of heated area.

Based on hourly and monthly domestic energy use load factors, some of them previously published and others properly adjusted for Serres, daily, weekly and annual residential energy demand profiles were obtained and multiple scenarios uncertainties were estimated as shown in figures 1. Respective tariff profiles were also obtained based on the information available as shown in figure 2.

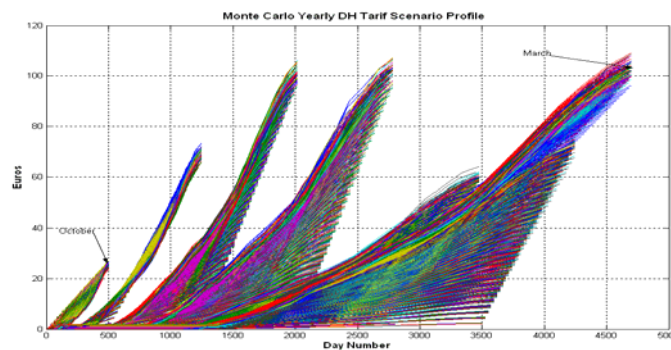
## **Conclusions**

Heating diesel consumption but also tariff profiles of the various blocks of flats revealed an excessive variability, for reasons that are varied and are extensively presented. The new District Heating central system under development in the city of Serres brings substantial potential savings to the consumers with the introduction of competition with heating oil. With the future introduction of Natural gas, where its demand and consumption depends on uses other than only central heating, additional saving benefits will be offered to the same consumers in the long run. In the era of rapid change, uncertainty is a rule, not an exception and companies

that understand that have the greatest chance to produce spectacular project successes. We are in the process of a revolutionary change in the way we can analyze, and thus manage, uncertainty. And Monte Carlo methods along with the ever increasing computational power can provoke this much faster than we can imagine. The time has come to rethink some of the traditions in project management but also of business administration in general



**Figure1. Monte Carlo Natural Gas daily demand profile for a typical October day in Serres.**



**Figure 2. Monte Carlo Yearly DH Tariff profile (per Month) for a typical household in Serres**

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