MULTI-SCENARIO SIMULATION AND EXERGY ANALYSIS OF A DISTRICT HEATING NETWORK FOR A CASE STUDY IN THE CITY OF VIENNA

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INTRODUCTION

District heating networks are systems for the transport and distribution of thermal energy, responding efficiently to consumers´ needs. They are an important part to take into account inside urban energy facilities.

Between all possible methods and procedures to analyse the urban energy strategy, a proper hydraulic simulation able to calculate automatically mass, energy and exergy balances reveals itself as a fundamental previous step before beginning any project or design related to this field. Likewise, calculated energy and exergy efficiencies gives advice to urban planners about which is the best option between different considered scenarios, like changes in installations or operation conditions.

PROBLEM DESCRIPTION AND METHODOLOGY

In order to answer these questions, one of the districts of the city of Vienna has been taken as a case study, consisting of 21 residential buildings with different characteristics, all of them connected to the local district heating network, with its corresponding substation that exchanges heat with the primary network.

Each simulation is constructed from each of the hypotheses proposed at the beginning of the study. A hypothesis is traslated into a scenario, that is, a new configuration and/or operational conditions under which the district heating network must operate. For example; verifying the performance after a 30% reduction of the feed temperature.

8 scenarios were defined, based on the following main considerations:

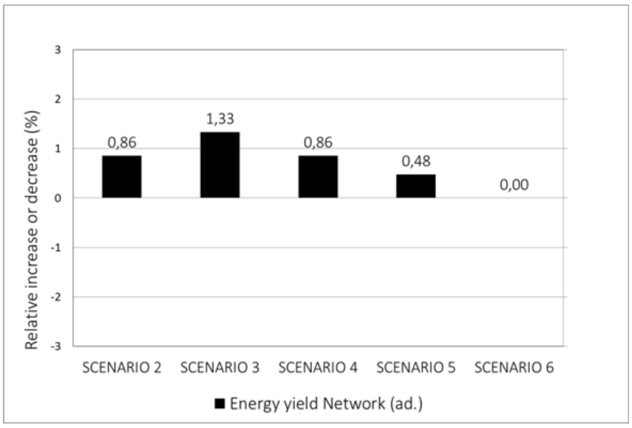
- Actual situation
- Replacement of current heating systems (from radiators to heated floors), with the corresponding buildings´ refurbishment.
- Reduction of system´s temperature, considering Low Temperature District Heating (LTDHN) knowledge [1].
- Introduction of heat pumps in combination with district heating networks, allowing a higher use of electricity in the system [2].

RESULTS AND DISCUSSION

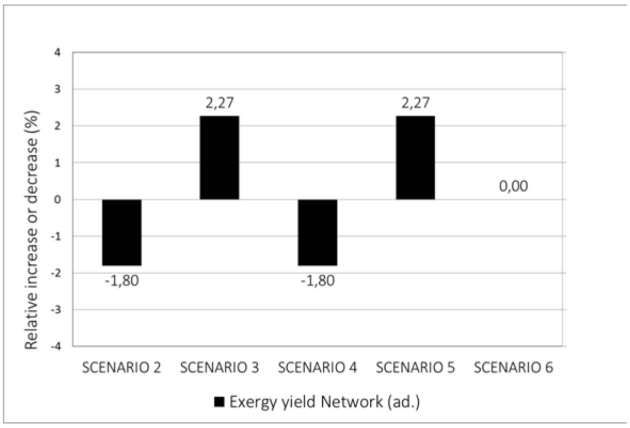
Analysing these balances allows the observation of several behaviours, some of them described below:

A decrease of network´s energy and exergy losses is observed for all those scenarios that establish a reduction of feed temperature, producing an increase of 1.33% in energy efficiency (Picture 1).

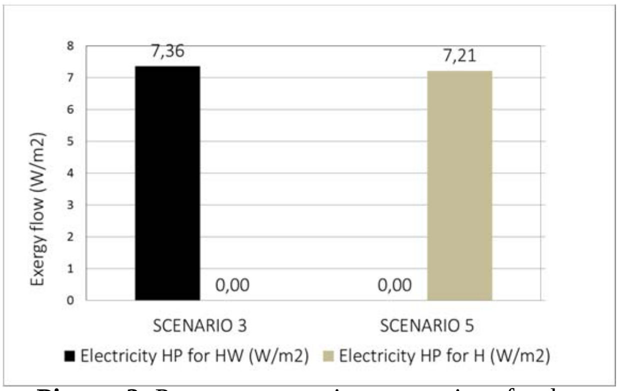
Furthermore, this situation leads to a 2.27% increase of the exergy yield (Picture 2).



Picture 1: Energy yield comparison respect to scenario 1



Picture 2: Exergy yield comparison respect to scenario



Picture 3: Power consumption comparison for the heat pumps

However, these improvements bring the introduction of heat pumps as a counterpart to support heating or hot water branches integrated within buildings' facilities. Picture 3 shows the high electrical power to be supplied to the heat pumps in order to heat domestic hot water (Scenario 3 = 7.36 W / m^2) or support the heating system (scenario 5 = 7.21 W / m^2), respectively.

CONCLUSIONS

The developed model worked correctly and without failures for the studied scenarios, being able to solve all equations systems accurately. Obtained results are realistic and coherent.

Both pros and cons for all scenarios were studied using exergy balances as a measurement of the system´s efficiency and power consumptions.

The present project analyses the real possibility of adapting the current Viennese thermal grid to a low temperature system, advancing towards the 4^{th} generation of district heating networks [3].

An extension of this project is possible, in order to increase computation speed and improve the process of orchestration between the different softwares involved. In addition, there are other hypotheses that could be simulated, such as the introduction of renewable energies in combination with the district heating network

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