Presentation of an innovative thermal loop combining phase change material thermal storage, solar energy and demand-side management

Dr. R. BAVIERE[+,*], Dr. M. VALLEE[+], Dipl.-Ing. C. PAULUS[+], Dipl.-Ing. F. BENTIVOGLIO[+], Dipl.-Ing. E. LE GOFF[++], Dipl.-Ing. N. GIRAUD[++]

[+] : CEA, LITEN, 17, Rue des Martyrs, F-38054 Grenoble, France

[++] : CCIAG, 25 Avenue de Constantine, 38036 Grenoble

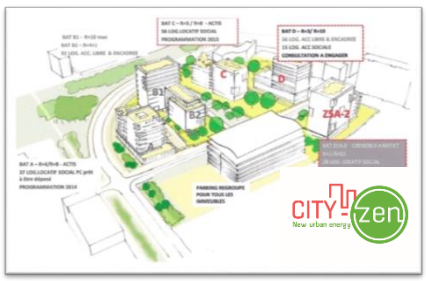
[*] : corresponding author and presenter : roland.baviere@cea.fr

Key words : Low temperature heating loop, Phase change material heat storage, Thermal-solar energy, Demand-side management, Thermal load shedding, Model predictive control

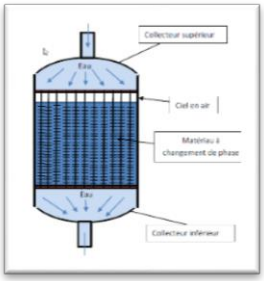
The Grenoble district heating network ranks second by size in France, with an annual heat delivery of 800 GWh. The network is currently powered by 55 % of recovery and renewable energy, 30 % of coal and 15 % of gas & heating oil resulting in a CO2 content of 140 g per kWh. Within the FP7 City-Zen project the Grenoble district heating operator namely CCIAG and CEA will develop and demonstrate an innovative network extension with the aim of improving this figure.

For this purpose, we are designing a new low pressure and medium temperature (70°C – 40°C) loop supplying heat to 380 dwellings and to 11 000 m^2 of tertiary activity buildings. The innovative loop is mainly fed by the current Grenoble heating network. To limit the use of energy when peak generators are operated, the loop will firstly be equipped with a 500 kW.h phase change material heat storage module. To increase peak-shaving opportunities and to improve operational flexibility we are implementing advanced control solutions based on simulation, model predictive control and linear optimization. One goal is to take advantage of building thermal mass for modulating space heating demand while guaranteeing comfort. Finally, CCIAG will install and operate thermal solar panels connected to the loop. Depending on the total panel surface, it may be possible in summer conditions to fulfill the demand by optimally combining the available solar energy and the use of the heat storage module.

The purpose of the present paper is to report on the design phase of the demonstrator. We firstly show a virtual dynamic simulator has been established using a new MODELICA model library called *DistrictHeating*, which provides accurate results in limited computation time. The innovative modules and the connected buildings have all been represented. On the other hand, we have developed a first version of an advanced control strategy including heat load forecasting and demand-side management. We have finally simulated the system on a yearly time-basis in order to assess the overall performance of the proposed demonstrator. Future steps of the present work will consists in preparing the actual implementation, building the system and finally monitor its actual performance during the 2017-2018 heating season.



Buildings connected to innovative loop.



Thermal storage module