4.4 Demand side management

Demand side management is applied to the DH with the aim of minimizing the thermal peak requests. Figure 9 shows results of three experimental tests conducted in a distribution network of the DH system. Peak shaving in terms of thermal power reduction are depicted. Three tests have been performed in different days characterized by different weather conditions. In all the tests considered peak reduction between 0.4 and 0.6 MW are achieved for peak demand ranging from 7 and 10 MW. The error bar represents the range of peak reduction estimated by means of the simulation. The range has been obtained by considering the uncertainty of the input values and supply network dynamic. Peak shaving achieved are around 5-10 %.

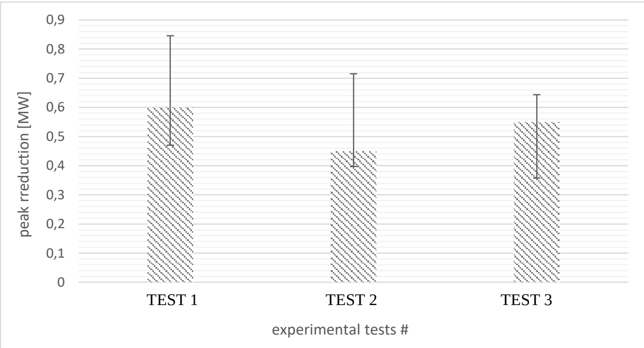

Figure 9. Peak reduction achieved in the experimental tests

Results presented in Figure 9 have been obtained with specific limitations, since a) only a fraction of the heating systems can be subjected to demand response, (i.e. that having signed a specific agreement with company) b) only anticipation limited to 20 minutes are considered. In order to show peak reduction achievable with different fraction of buildings and various range of possible anticipation, Figure 10 is reported. Results show that, results strongly vary depending on the limitations. In particular, the percentage of building subjected to demand side management strongly affect the results. Compared to case where the maximum peak reduction is achievable (that has an assigned value of 100 %), with the same load shifting limitation, the benefit drop to 25 % if only 30 % of buildings are subjected to demand side management. These results show that high potential exists for application of demand side management for thermal peak shaving when modification can be done in a large number of buildings.

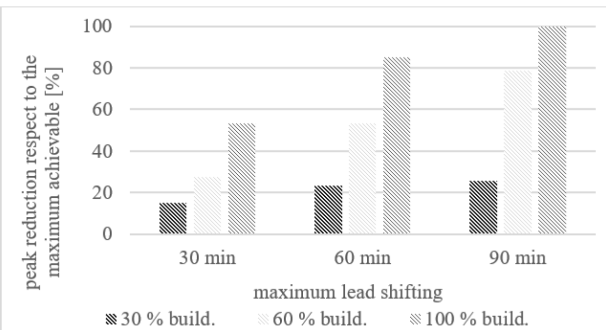

Figure 10. Potential for thermal peak reduction. Peak reduction fraction that can be obtain respect to the best case (100 % and 90 min)

Peak shaving bring significant benefits to the DH system since this allows connecting other buildings, reducing heat from heat only boiler (used for supplying peaks) and simplify the malfunction management.

5. CONCLUSIONS

In this work, authors present a multi-purposes platform, for the smart management of DH networks. The platform has been developed for being applied to large DH networks. The platform is the results of a two year activity spent for conceiving the modelling approaches, the platform design and carrying out the experimental tests. The prototype has been applied and tested on the Turin DH system. The platform is able to perform the following analysis:

(1). Charging, pre-processing, and reorganization, of the data collected by smart meters installed in the DH substations; this makes data suitable for modelling purposes.

(2). Automatic detection of the fouled heat exchangers in the DH substations and plot on a map of the most critical occurrence.

(3). Forecast of the building thermal request for the daily evolution.

(4). Demand side management for thermal peak shaving; this is done by optimally shifting thermal loads.

The proposed prototype only relies on data that are usually available in DH networks, i.e. data monitored for billing purposes. This enhance the applicability of the software to a large number of DH systems; this is very important since in the author knowledge, this represents the first complete application to a real network of a prototype for smart management including fouling detection, demand evaluation and demand side management. The software allows to significantly improve performances of DH systems, since reduction of peaks from 5 to 30 % can be achieved. Furthermore cleaning procedure allows saving primary energy since the return temperature are significantly lower. This makes DH technology more efficient.

Options for the future platform development, consist in including further blocks:

Model simulator to combine demand side management and thermal energy storage

Use of different types of regulation technologies with the aim of implementing not only load shifting but also a modification of the request shape.

Including delay or different rescheduling for the various part of the day.

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NOMENCLATURE

A	exchange area, m^2
F	Coefficient for non perfectly countercurrent heat exchangers, -
G	mass flow rate, $kg.s^{-1}$
h	convective heat transfer coefficient $W.m^{-2}. K^{-1}$
k	thermal conductivity, $W.m^{-1}. K^{-1}$
K	Stiffness matrix
M	Mass matrix
Rf	Fouling resistance, $m^2. K. W^{-1}$
T	Temperature, K
U	Global heat exchange coefficient, $W.m^{-2}. K^{-1}$

Greek symbols

ϕ	Thermal power, kW

Subscripts

ext	From the extern
i	in
o	out