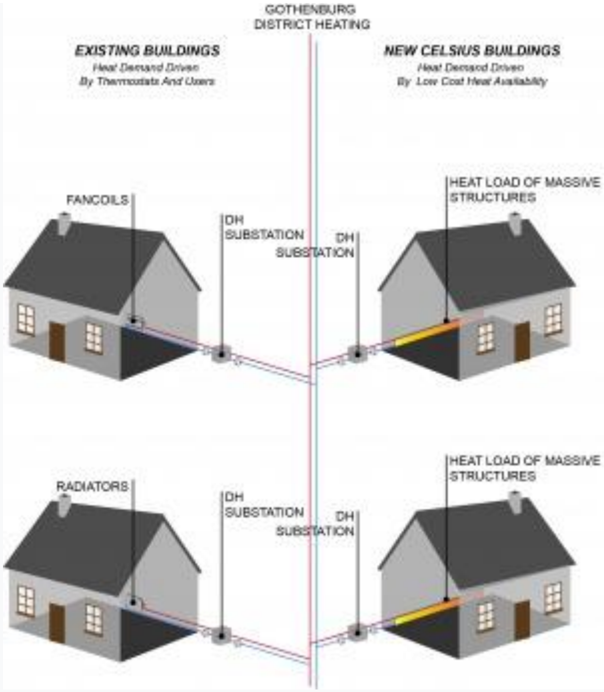
Buildings for short-term storage in Gothenburg

The **Buildings for short-term storage** demonstrator is a CELSIUS demonstrator in Gothenburg. The overall objective is to cut production peaks in the district heating production system – i.e. saving peak production capacity, often fossil fuels and fossil CO2, by increasing heat from the district heating system during low consumption hours and decrease the heating accession during peak hours.

Asset

Idea and Layout



Illsutration of connections for buildings used for short term storage

The idea underlying the demonstrator “Using building as short term storage” is to exploit the thermal capacity of apartments’ structural elements (e.g.: floors, ceilings and walls) for heat storage and enhanced heat control purposes. The mentioned elements will be “loaded” with energy during low consumption hours (and the indoor temperature will slightly increase); as a consequence there will be a minor temperature increase during night time, when the heat demand is low, and a minor decrease during demand peak hour, i.e. in the morning. The inhabitants should not notice these temperature changes but the implementation of this technology allow keeping the heat production at a lower level during peak hours.

Impact

The objective is to connect an entire area of buildings consisting of 21 buildings (2000 flats). The long term target (outside of the Celsius project) is to apply this concept in 25% of all buildings using district heating in Gothenburg, creating a “storage” capacity of 65 MW, which will save approximately 15,000 ton of CO_2 annually.

The overall demonstrator’s performance is summarized in the following table according to 5 evaluation criterions. It can be noticed that the assignment of all the scores is directly linked to the values calculated for the Key Performance Indicators, except for socio-economic benefits where a qualitative assessment is carried out based on this cluster’s indicators and on separate interviews.

Overall Impact	**Fair/Medium**				
Size [MWh/y]	1-100	100-1000	1000-5000	5000-10000	>10000
Primary Energy Savings	0-10%	10-20%	20-40%	40-60%	>60%
GHG Emissions Reduction	0-10%	10-30%	30-60%	60-90%	>90%
Pollutant Emissions Reduction	0-10%	10-30%	30-60%	60-90%	>90%
Socio-Economic Benefits	Low	Fair	Medium	High	Extrem

Replicability

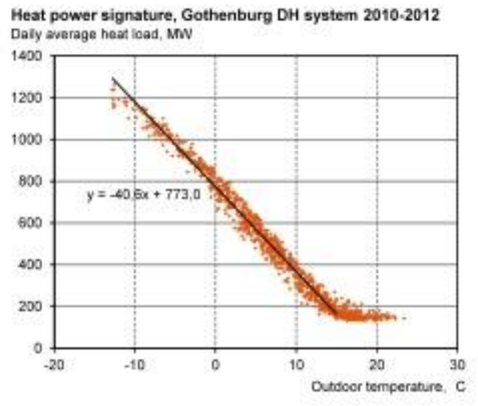
Replication Potential

Replicability	Low	Medium	High
Authorizative easiness			X
Adaptability to different climate conditions			X
Technology easy-to-implement (No needs of specific technical requirements)			X
Easy-to-implement (No needs of specific technical requirements)			X
Easy-to-operate (No needs of specific technical requirements)			X
Opportunity of integrating waste energy sources			X
CAPEX needed for the deployment of the solution		X	

Technical Requirements

- The use of buildings as short-term heat storage to manage heat load variations without installing new heat storage capacity is particularly suitable for applications in the northern and central part of the EU, where the high heat demand during peak hours and for extended periods could overload heat production facilities, requiring additional thermal production capacity.
- Since this technology aims at cutting production peak in the district heating production system (i.e. benefit for the energy company) proper business models should be developed for customers (e.g., tenants, house owners, etc.) to obtain benefits and advantages in making their real estate available for “short term storage technology” installations;
- The system installation is suitable for buildings characterized by components’ (e.g., walls, ceilings, floors) materials with high energy storage capacity, to enable to “load” the building with thermal energy during the low consumptions hours and to unload it during the peak hours for maintaining the indoor temperature and, at the same time, keeping the heat production at a lower level;
- Availability of a large number of buildings to be connected for guaranteeing demonstrator’s technology impact on production peaks’ cut. Another option is to select a smaller number of buildings that are known to greatly affect production peaks.

Large-scale Replication Potential in GO1



Heat power signature for the Gothenburg DH system. Average daily values from 2010-2012. The linear trend line is based on values up to 15 °C [1]

Göteborg Energi has been investigating this idea for a number of years, based on preliminary estimations that showed a large potential to store heat in buildings. The limit is set by how many buildings are used for heat storage, and how much the indoor temperature is accepted to change. One way to estimate the large-scale potential is to calculate the approximate outdoor temperature dependence. The heat power signature for the Gothenburg system indicates a heat demand of roughly 40 MW/°C. As mentioned above, the induced outdoor temperature changes used in Göteborg Energi's tests of the short-term storage technology was up to ±7 °C during 9 hours without causing noticeable changes in the indoor temperature. With these assumptions, if 100 % of the heat load was available for heat storage, the daily heat storage capacity would be about 2500 MWh and the unloading rate approximately 280 MWh/h (at outdoor temperatures up to approximately 8 °C). Using the analysis of heat load variations means that if an implementation rate of 50 % of the heat load is possible to reach, this technology has the potential to eliminate 99 % of the daily variations in the Gothenburg system.

On the other hand, if the technology is targeted at predominantly reducing peaks during periods of high demands (cold days) in order to avoid starting certain peak boilers, a smaller storage capacity could suffice. For example, the coldest day 2012 had a daily variation of only about half of the maximum value (630 MWh compared to 1200 MWh), being possible to eliminate with an implementation rate of 25 % using the assumptions above. Also, at lower implementation rates, the storage would still reduce the peaks, albeit not eliminating them.

It should be noted that these results are theoretical estimations and that the actual potential may be reduced by a number of factors, including reduced heat power reduction due to well-functioning thermostats (as mentioned above) and the fact that not all buildings are suitable for short-term storage, for example buildings with supply air that is pre2-heated by the same system as the space heating, in which a heat power reduction could lead to uncomfortably cold air from the ventilation system. However, the potential may also be bigger, since some heavy buildings could probably tolerate larger reductions than the ones used in Göteborg Energi's tests, and possibly the indoor temperature variations could be allowed to increase slightly more. Furthermore, it is not necessary to aim at fully eliminating daily variations; even at lesser implementation rates, the most unwanted variations in terms of economic and environmental impact could be reduced. The optimal implementation rate should thus consider a number of economic and environmental parameters. The potential for peak reductions with a large-scale implementation of this technology is very large based on the estimations presented above.

Stakeholders

Stakeholders	Organization Name	Organization Type	Organization Domain	Benefits from demo

District heating network operator	Goteborg Energi AB	Publicly owned	Utility	Peak shaving for thermal energy production

Lessons learnt

Demonstrator development

- A key element for the implementation and diffusion of this technology is the development of proper business models to attract building owners to adopt “short term storage” technology. Different business model options have been investigated during the course of the project. In particular, one possibility could be to stipulate an energy agreement between the energy company and the construction company for the costs that the latter has to sustain for the installation of the mechanism that enables the building to be used as short term storage. Another option could be to cut or eliminate the taxation of water return temperature at least during the testing period (the water return temperature affects the efficiency of production in the facilities);
- Thermal energy supply for buildings provided with short term storage technology is managed by a control system directly connected to the energy production facility. This control system has to be properly optimized to manage simultaneously multiple buildings connected to the same production site.

Demonstrator performance monitoring

The system has been tested during some periods of the winter season 2014-2015 showing positive results on tenants’ indoor comfort as the indoor temperature, measured at the sensors installed in rooms, was not affected by the operation of the new system. Additional information on the performance of this technology will be provided within the course of the next two winter seasons (2016-2017) according to the monitoring protocol defined in the first phase of the CELSIUS project. Then, it will be possible to assess globally the “short term storage” technology performance in different domains taking into account the technical, environmental, social and economic dimensions through the estimation of proper set of key performance indicators. Those estimations will be referred to a specific baseline situation that is the same buildings without the implementation of the active heat load control.

This section will be updated as soon as the demonstrator will be fully operated and monitored, enabling the quantification of technology’s impact in terms of performance indicators. Consolidated monitored data will be available during winter season 2015-2016.

References

1. Jump up↑ CELSIUS cities. (2015). D5.6 Concepts for storage and load control .pdf (No. C2 Task)

CELSIUS contacts

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For further engagement on this subject you are welcome to turn to your CELSIUS city contact person or use the contact form for guidance to relevant workshops, site visits or the expert team.