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Energy in Buildings and
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International Energy Agency

IEA EBC - Annex 84 - Demand Management of Buildings in Thermal Networks

Case Studies – Projects and Implementation of Demand-Side-Management in Thermal Networks

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Abbreviations

Abbreviations	Meaning
IEA	International Energy Agency
EBC	Energy in Buildings and Communities
DHC	District Heating/Cooling
GHG	Green House Gas
LTDH	Low-temperature district heating
DSM	Demand-side-management
DR	Demand response
PV	Photovoltaic
CHP	Combined heat and power
MPC	Model Predictive Control
DHW	Domestic Hot Water

Introduction

A significant share of households relies on district heating/cooling (DHC) networks to meet their heating and/or cooling needs. For instance, in countries such as Iceland, Denmark, Lithuania, Estonia, Sweden, Finland, and Northern China, approximately 50 % of the building stock is connected to DHC networks.

Although increased evidence from monitoring data shows that 50-60 % of all building heating/cooling systems have faulty operation leading to higher volume flows and return temperatures and in consequence to unnecessary heating/cooling use and inefficient operation of DHC systems, today optimization of DHC focuses on the system side and does not integrate building systems. Addressing the challenge of demand side management decidedly needs a technological approach.

However, the success and effectiveness of new initiatives and solutions increasingly hinges on resident/user engagement. As expectations evolve and roles and responsibilities shift, there is a pressing need to address these aspects alongside technological advancements.
The overarching aim of IEA EBC Annex 84 is to provide a comprehensive knowledge and tools for successful activation of the demand management of buildings in DHC networks. The project investigates both the social and technical challenges and how these can be overcome for various building typologies, climate zones and local conditions. Furthermore, it explores how digitalisation of heating/cooling demand facilitates the use of demand side management overall and the activation of demand response specifically.

The Annex includes four main objectives. Firstly, it aims to provide knowledge on the various stakeholders in the energy chain and on effective collaboration models for demand side management. Secondly, the Annex is dedicated to evaluating and designing solutions for heating and cooling substations in buildings to enhance demand side management. Thirdly, it focuses on developing methods and tools to use smart heat meter data for real-time data modelling and identifying building dynamics. Lastly, it intends to share insights through case studies to facilitate the adaptation and visualization of project outcomes.

Flexibility in building heat demand can be utilized through Demand-Side Management (DSM). This involves demand response, which actively leverages building flexibility. In the context of this IEA EBC Annex, demand response objectives such as peak shaving (load shedding), load shifting, and on-site generation utilization have been considered. These strategies can help increase the share of renewable energy in total energy production and reduce reliance on peak-only boilers, which are predominantly fossil-based.

This brochure aims to showcase a selection of case studies that illustrate various ways of implementing demand side management in buildings connected to thermal networks. It presents 13 detailed case studies, all integral parts of the comprehensive research project. Each case study is thoroughly examined, covering aspects such as research objectives, collaboration models, and demand response control mechanisms. Furthermore, it describes the results and conclusions of each study, highlighting valuable lessons learned and best practices observed throughout the project duration.

Peak shaving in Turin District Heating

With the development of a genetic optimizer algorithm, the optimal anticipation time could be found to reduce the morning peak loads.

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The district heating network in Turin is the largest in Italy. This project tested load shifting with some of the buildings connected to a distribution network in the Turin DH grid. The heat is generated in two large, combined heat and power plants and in various boilers.

The heating systems in most of the buildings are turned off overnight and reactivated in the morning between 5 and 6 am. This results in a load peak due to the system cooling down overnight. The peak is characterized by the mass flow rate and, consequently the thermal profile.

The implementation of demand response aims to reduce the peak load and the proportion of heat generated by the heat-only boilers. To mitigate peak loads, an optimizer has been designed to adjust the schedules of the heating systems installed in buildings to flatten the total thermal load as much as possible. The primary aim was to find the best timing for activating a building's heating system to achieve maximum peak shaving.

The best anticipation time is found by using a genetic algorithm optimizer. The optimization considers the predicted thermal demand for each building, utilizing data collected at substation level.

The genetic algorithm is incorporated to a network simulator. Combined, these tools can determine the optimal time for activating the heating systems.

Peak can be reduced by 5 % when fewer than 30 % of the buildings are considered, with a maximum anticipation of 20 minutes. Generally, these results support the inclusion of demand response strategies in DH networks.

Throughout the project, the maximum anticipation time was limited to 20 minutes to minimize effects on the internal temperature. However, simulation analyses show the peak effects can be entirely avoided by setting the maximum anticipation to 60 minutes.

Data-driven automated DSM technology

The aim of the project is to reduce peak loads through the Development of an automated, data-driven DSM technology of small district heating networks.

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The project "DataDrivenLM" developed an automated, data-driven DSM technology to reduce load peaks and tested it within a typical Austrian medium-sized low temperature DH network, supplying a few hundred customers in a rural area with continental climate.

The primary aim of the study was to reduce load peaks mostly caused by building operation in winter, while also evaluating the impact of load management on the optimization of the central heat pump.

Simultaneous activation of heating systems leads to peak heat load in the early morning, particularly at low outside temperatures, typically covered by a peak boiler. The DH system is optimized by an intelligent control strategy with DSM to reduce peak boiler operation. For this, DH network customers are divided into flexible customers with load flexibility and fixed customers without load flexibility for DSM. A data-driven thermal load model is developed to forecast the load of fixed customers and optimize the flexible customers to avoid load peaks and flatten the overall load.

The developed DSM solution is entirely data-driven, requiring no additional hardware or sensor equipment, minimal parameterization, and no extra investment for end customers. This solution enables direct cost savings by avoiding operation of the peak load boiler and indirectly through the reuse of existing infrastructure to accommodate new customers.

Preheating the distribution grid with the centralized heat pump to cover peak loads enhances overall system efficiency by transferring electricity demand from the peak load boiler to the centralized heat pump, consequently reducing the peak load boiler's share from 22 % to 10 %.

The developed DSM solution aligns well with typical network infrastructures, ensuring adaptability to common boundary conditions. This technology is straightforward to implement and cost-effective, enabling a rapid transition to renewable energies and offering scalability as a purely digital solution. Its effectiveness for complex buildings might be limited, as the approach utilizes highly simplified building models.

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100 % renewable District Heating

Increasing efficiency and flexibility of Leibnitz's DH system utilizing nearly 100 % renewable energy by bidirectional coupling of two DH networks and a high-level predictive control

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The DH supply of Leibnitz (Austria) and surrounding communities will be massively expanded over the next few years with plans to utilize nearly 100 % renewable energy from biomass and waste heat.

As part of the research project "ThermaFLEX" two existing DH networks were interconnected by a bi-directional heat transfer station. Furthermore, an overarching energy management system was implemented also incorporating DSM.

The project examined a DSM method using predictive control including a model to calculate supply capacity limits for each substation, aiming to facilitate the use of only renewable energy and fluctuating industry waste heat. The investigated DSM method aims to regulate the temperature of both the primary and secondary flows. Further, the efficiency of the district heating network as well as the energy producers should be increased.

In addition to the technical implementation, a comprehensive communication campaign on various communication channels was launched to inform citizens about the expansion of the district heating systems.

The primary goal was to emphasize the importance of these projects for climate protection and establish Leibnitz as leader in proactive climate policy.

A preliminary evaluation using historical data and simulations of the DH network revealed a cost reduction of approximately 9 % and a 45 % decrease in GHG emissions for the entire network. This was achieved by integrating the networks, allowing for heat exchange, and ensuring efficient, sustainable heating with renewables, thereby reducing fossil fuel usage.

First practical tests of the DSM approach qualitatively showed reduction of larger peaks, but also oscillations of the load curve, due to a synchronization of the safety measures. Fossil fuel usage could be decreased, while waste heat and biomass utilization increased, thanks to a comprehensive control strategy covering all components, including thermal storage.

Flexible energy system integration

Optimal dispatch plan to increase flexibility in DH network to stabilize the future energy system.

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This project aims to increase the demand flexibility, so heat and electricity sectors can complement each other to promote efficient use of renewables and waste heat in the energy system. While "Flexi-Sync" includes six demo sites in total, this case focuses on the demo site in Maria Laach, Austria. The DH network spans 1.5 km and serves 30 customers. During the study, five various buildings, were examined, which collectively account for approx. half of the total energy demand.

The study explored the potential for enhancing flexibility by remotely controlling substation settings to leverage the thermal inertia of connected buildings. An optimization software is used to generate an operation plan considering the weather forecast and building flexibility. For this, demand forecasts with detailed data from every substation, system component model libraries to enable detailed configuration and finally an optimization model generator and solver to find the optimal energy dispatch are utilised. The DH network operation involved collaboration with optimization and control companies as key participants.

Customer were informed about the project at an early stage but were not involved in the testing phase. Several substations were equipped with buffer storages to act as storage tanks for the whole plant and new substation controllers with software interfaces.

Practical tests confirm the viability of generated optimal dispatch plans. With the optimization, the peak load could be reduced (shifted) by about 80 kW, or about 6 % of the contracted load compared to regular operation. Live tests conducted over one spring month showed that approximately 6 MWh, or 7 % of the energy demand for that month, could be saved. Furthermore, there have been no increase in complaints from tenants about thermal comfort in tested buildings. The increase of flexibility in actual operation can be realized.

In the future, excess electricity from a CHP plant could also be used for load compensation and stabilizing the power grid. Moreover, finding a low-cost solution is necessary because the cost of the implementation is too high, especially for small rural grids.

Smart energy in Homes

Online monitoring of energy consumption and voluntary DSM with the goal to save energy.

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In this case study the energy consumption of 140 households were monitored over a period of 1.5 years. The households monitored are located in southern Denmark within detached, town or row houses. In 72 buildings are supplied by district heating for space heating and production of domestic hot water. It should be mentioned that the project was conducted without an active participation of the DH utility.

The project aimed to save energy and enable households to track consumption via an online portal. Throughout 1.5 years, DR events and measurements were conducted to analyse occupants' involvement and potential drop-out effects in DR participation. In this process, the residents were able to voluntarily change the set-point temperature profile. Therefore, the DSM is very much end-user-driven.

Each household could track its energy consumption in an online portal and was equipped with remote controlled smart thermostats. The control could be done remotely via smart control system in the whole house or manually in every radiator by the occupants. In the case of a multi-family house a common agreement has been made.

Additionally, the costumers had the opportunity to get in touch with a consultancy company that provided them guidance on how to improve the energy use performance.

At the end of the project, an annual energy reduction of 6.5 % for all customers (including individual boiler customers) and 2.6 % for DH customers was achieved.

Evaluation of the project shows that it is important to consider the building and their residents as entities capable of delivering flexibility to the DH system. Buildings do not provide flexibility is their occupants by chancing habits and comfort preferences can modulate the energy load profiles. Hence, the residents should be engaged in the process to improving heating control and demand response.


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Substitution of conventional radiator controllers

Substitution of conventional controllers to reduce energy consumption with minimal investment costs.

SubReg is a subproject of CAMPER-MOVE, which was supported by the Federal Ministry for Economic Affairs and Climate Action (grant number 03ET1656). It investigates if the substitution of conventional radiator controllers has positive effects of the heating consumption in three historic university building on the campus of the Technical University Dresden.

The radiators in the buildings were equipped with electronic controllers and accompanied by monitoring. The user can adjust the setpoint on the electronic thermostatic control valve. It is possible to implement a night/weekend setback routine.

The heating systems in the three buildings were monitored. On this basis, the energy consumption was analysed and the thermal comfort in the rooms evaluated.

The set-point could be set by the users themselves. During the analysis, particular attention was paid to the motivation of users to adopt energy-saving behavior. Load shifting can be realized by preheating the thermal mass before the start of working hours on selected days or by adjusting intermittent heating using room specific timetables.

The energy saving potential resulting from the use of modern radiator controllers and load shed was quantified as part of various scientific studies. The energy saving for the entire building can be assumed to approx. 10-15 %. If the initial state is correspondingly poor, energy saving can be larger. Through the load shift, load peaks can be reduced, and higher peak cost could be avoided.

It can be analysed how load shifting in individual buildings can reduce peak loads in the campus area and avoid higher peak costs. Energy savings of approximately 15 % in the examined buildings were confirmed in the 2023/2024 heating period.

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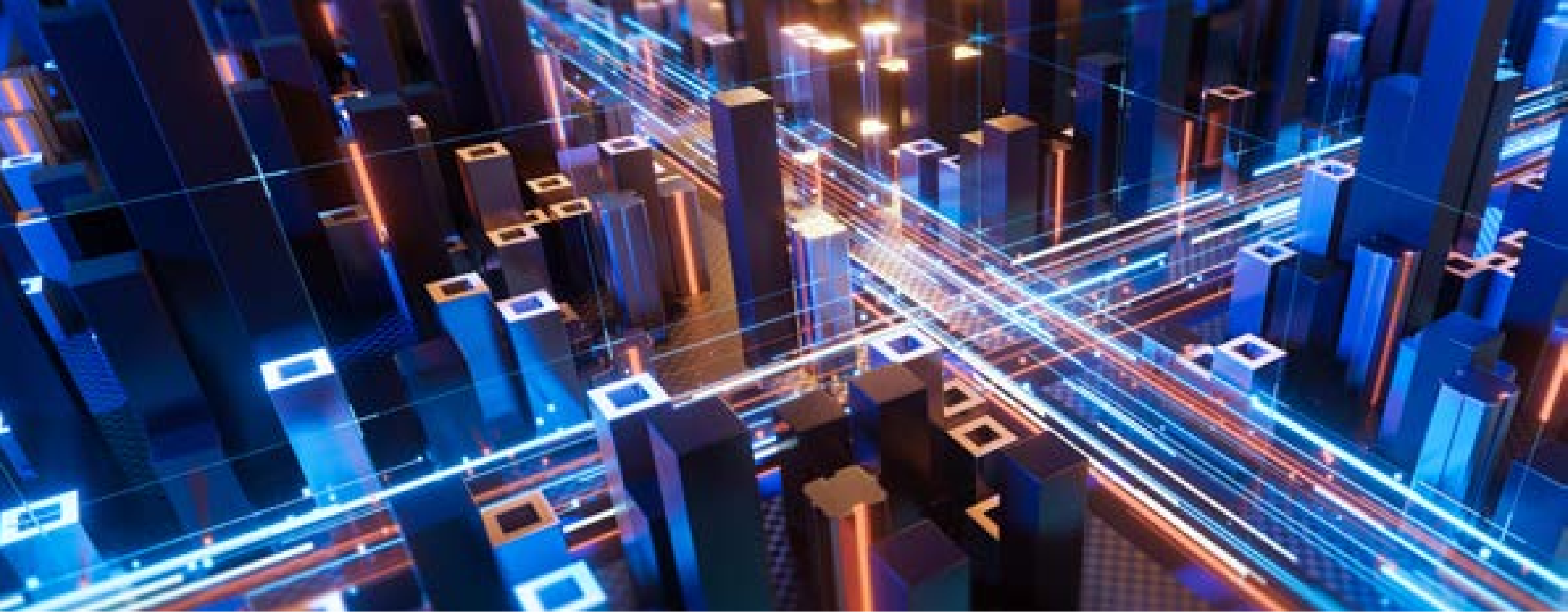

Digitizing DH supply infrastructure

Investigating the possibilities and potential of the digitalization in the Hannover DH grid.

The project "SmartHeat" aims to digitize the DH supply infra-structure within a virtual power plant framework. The research project focused on exploring and assessing the potentials and possibilities for digitizing substations in the DH sector, concentrating on upgrading existing heat supply structures.

As part of the project, this case study focused on simulative quantification of flexibility potentials in buildings connected to the Hannover DH grid as well as practical implementation in short-term tests. Thereby suitable control, regulation procedures and data exchange methods were examined. Furthermore, the potential of fault detection with digitized substations as well as flexible tariffs to improve collaboration between customer and supplier have been investigated.

The study focused on 10 building pairs supplied by the DH network with similar boundary conditions . Three different control mechanism are implemented to achieve load smoothing:
1) stepwise increase of reduced room set point temperature after night-setback, 2) priority control for charging the DHW storage, 3) charging of the DHW storage overnight.

Simulation shows reduction of peak demand hours per year, by DSM scheme: 1) between 5 and 35 %, 2) between 42 and 88 %, and 3) between 0 and 15 % depending on the building.

Several DHW charging process in short period sometimes led to reduced indoor temperatures. Practical tests were too short-term and exemplary to draw conclusions but were conducted successfully; due to covid pandemic long-term tests could not be realized.

Results from a customer survey showed high acceptance (about 70 %) for dynamic tariffs if they offer lower prices during low-demand periods. However, only about 10 % accepted higher prices during high-demand periods. Room-wise heating control was more acceptable (around 60 %) compared to sharing heat demand and power data with the utility (around 50 %). Additionally, 60 % of customers were willing to install thermal energy storage in their homes to increase flexibility.

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Flexible and innovative operation of DH network

Flexible and innovative operation of local DH network with decentralized solar thermal collectors and central CHP plant.

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The case study in 'Freiburg-Gutleutmatten' under the 'EnWiSol' project aims to implement, verify, and derive guidelines for the long-term use of solar thermal energy in residential areas, especially considering the evolving energy supply structure.

The primary aim is to assess how solar thermal systems can be integrated in the supply of urban districts under the conditions of the current and future energy market with a focus to demonstrate an innovative integration of the solar thermal systems into the local DH network in Gutleutmatten. In the process, decentralized solar thermal energy should be coupled to enable deactivating the DH system during the summer.

The project comprises 38 building connection units with 525 living units. The decentralised buffer storages are directly connected to the CHP based DH system and are supplied by the rooftop installed solar-thermal systems as well. All systems are owned by the DH utility. The system components are connected via local wireless lan system.

In this project, innovative DH network operation modes are developed and tested. First, the central CHP plant intermittently supplies the buildings by forecasting buffer storage operation. Second, the decentralized buffer storages cooperate, sending optimized heat pulses from fully loaded to nearly empty storages.

Simulation studies project that renewable energies could supply over 20 % of this heat demand. Intermittent operation and heat pulses support CHP electricity strategies, prevent network overheating, and enable heat sharing among consumers. Decentralized thermal collectors boost the renewable share, extend heat self-sufficiency, and reduce distribution losses. In areas with high PV penetration, decentralized solar DH systems with thermal collectors work synergistically with the power grid when CHP operates based on heat demand.

Under current conditions, the decentralized solar DH system has heat generation costs 3 to 4 ct/kWh higher than the standard DH system, depending on the CHP operating mode. However, with rising gas prices and heating demand, the economic viability of both systems becomes more comparable.

Remote control of radiator thermostats

Engagement of occupants in reduction of peak loads by remotely controlling radiator thermostats.

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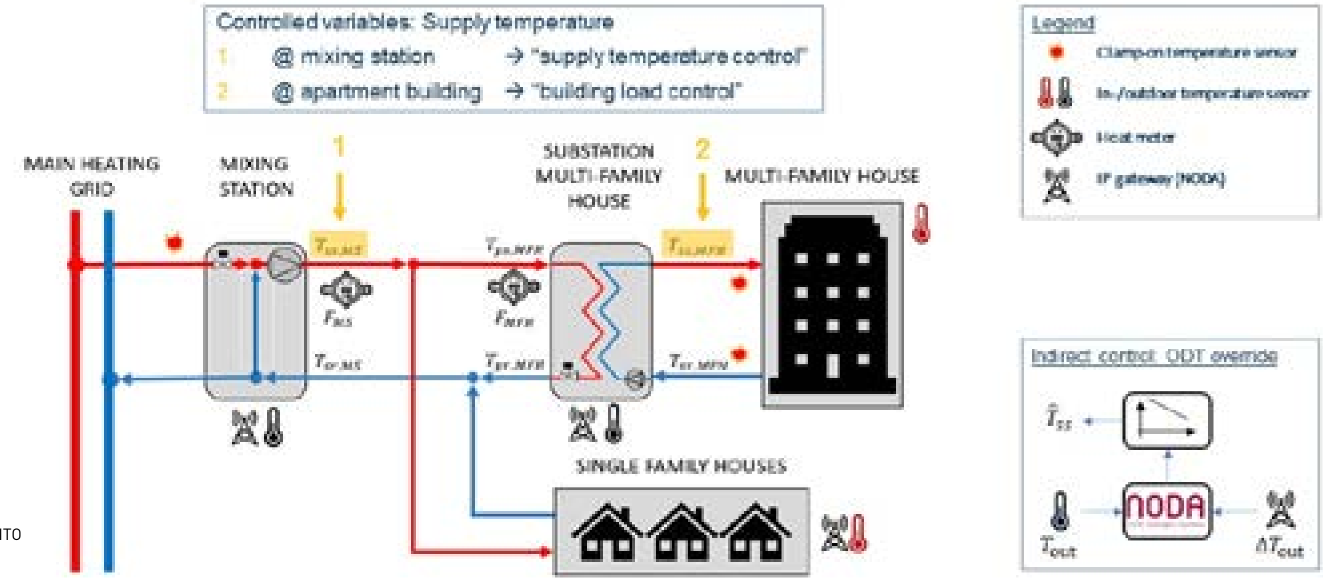
This case study refers to a pilot site from the H2020 "RESPOND" project, which aims to reduce energy consumption during peak demand periods in exchange for financial incentives. This study of 10 three-story multi-family houses in Aarhus, connected to the local DH network Kredsløb, evaluates the effects on both room temperature and DH load, as the DH supplier aims to reduce peak demand to avoid the need for infrastructure upgrades.

The heating systems were managed by temporarily controlling radiator thermostats to reduce the morning peak. Three DSM methods were tested:
1) Lowering room temperature setpoint to 16 °C from 7 to 8 am. 2) Lowering room temperature setpoint to 16 °C from 6 to 9 am. 3) Preheating: setpoint increase by 1 °C from 4 to 6 am, followed by 16 °C from 6 to 9 am.

All installed thermostats followed the same schedule, except for the bathroom ones, which were manually controlled to ensure maximum thermal comfort and reduce mold risk. Tenants engaged in the DR process via a smartphone app but were unaware of the specific actions taken.

The DR actions effectively conserved energy and redistributed demand. Overall, this study achieved a 14.4 % reduction in energy consumption across the buildings, with heating demand during DR periods cut by about 50 %. The first method saved 6.3 % of energy, reducing the load peak by 33 kWh; the second method also saved 9.4 % of energy, significantly lowering the load peak by 90 kWh; and the third method achieved 9.4 % savings, initially increasing the load peak before reducing it by 30 kWh. These results highlight the effectiveness of DR strategies in managing energy consumption and demand, particularly with targeted incentives and active participation.

For designing a DSM program that reduces heating, it's crucial to offer options for occupants to adjust setback schedules, minimum temperatures, and fluctuations according to their needs. Information about the plan and financial incentives can increase the residents' acceptance. The collective achievement of social goals play an important role in connecting residents to the project.



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Temperature optimisation for LTDH

Dynamic control of network supply temperature in Brescia´s DH Network for peak shaving purposes.

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The case study is part of the "TEMPO" (Temperature Optimization) project and was conducted in a multi-story residential apartment complex with of 43 buildings connected to the main DH network in Brescia. The study was carried out in 2018, examining dynamic control of the network supply temperature to the buildings.

The objective was to reduce the peak energy consumption of the DH network branch through demand response in the apartment building, as these power peaks are expensive to supply by the peak load plants.

The apartment building consists of 43 flats and is in a peripheral branch of the network. A mixing station is located between the main network and the building, mixing hot water from the main network with return water from the building. Two test periods were carried out with varying outdoor temperatures.

Temperatures ranged from 8 to 14 °C during the first period in autumn and ranged from 1 to 6 °C during the second period in winter.

To impact energy consumption of the building and achieve peak shaving, the outdoor temperature measurement was overridden, specifically by adding a positive or negative offset to the actual outdoor temperature reading. Since the building's heating system is regulated by a common heating curve, altering the outdoor temperature reading affects the set point of the secondary supply temperature to the heating circuit, effectively influencing the building's heat consumption.

In the first period, the daily peak energy consumption was reduced by an average of 330 kWh, reaching up to 700 kWh. This reduction amounted to 60 to 70 % compared to the baseline. However, during the second period, the substation behaved unexpectedly. The results could not be attributed to the behaviour of the control algorithm but were instead caused by a capacity issue in the heat exchanger.

Throughout the project, it was observed that indoor temperature sensors were removed or relocated. Moreover, the involvement of multiple stakeholders in practical implementation, communication, and consultation is essential.


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Energy and cost savings in office building

Investigation of energy and cost savings by two control strategies in an office building considering motivational tariffs.

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This study aims to investigate energy and cost savings of two different control strategies for a Danish office building. The heating system has existing one-string convectors operated with high flow and small temperature differences.

Typical motivational tariffs employed by Danish DH utilities were considered. These assume a bonus or penalty of 1% in the end-users heating bill per each degree of the average return temperature below or above a reference temperature.

The scope of this investigation was to compare a) night setback control and b) continuous heating with minimized supply temperature curves by simulating and testing the proposed strategies in the office building.

The test took place during December 2020 and January 2021, without internal heat gains due to COVID-19 restrictions, presenting conservative test conditions. Prior to testing, all thermostatic valves were set to 3, equal to an indoor temperature of 20-22 °C in the offices.

The central building management system was adjusted to implement the night setback strategy reducing the supply temperature by 20 °C between 6 pm and 6 am. The new control curve resulted in supply temperatures below 55 °C in all conditions securing adequate indoor temperatures of approx. 21 °C in all rooms. An energy-weighted average return temperature of 43.7 °C could be achieved, 12 °C lower than initial operations.

Dynamic simulations demonstrated that both strategies yielded comparable energy savings, approximately 11 %. Moreover, due to lower average return temperatures, additional cost savings were realized through motivation tariffs, with savings of 23.1 % for the continuous low-temperature heating and 18.6 % for the night setback strategy.

Notably, the continuous low-temperature heating strategy has the capacity to mitigate peak heat demand during the mornings while still delivering comparable energy savings as the night-setback control approach.

Fade-out effect from demand response program

Long-term evaluation of persistence and preferences with occupant-controlled DR interventions in single-family houses connected to DH.

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This study was part of a demonstration project conducted in southern Denmark in the years 2012-2015. It presents unique long-term insights into DR events in 72 single-family houses connected to a DH network.

The project aimed to investigate the long-term effectiveness of DR strategies, particularly the "night setback" approach. Further, it examines residents' adjustments to and persistence with DR interventions over 17 months, to inform the transition towards more energy-efficient and renewable energy-powered district heating networks.

All houses were equipped with monitoring and control equipment, which allowed the deactivation of the heating system, so the indoor temperature doesn't drop below a threshold. The occupants controlled the DR events settings and could at any time stop using it. Occupants had access to monitored data and control options via a homepage, where setting could be modified according to the individual household preferences.

The study revealed a decrease in participation from 89 to 81 % over the two heating periods. Approx. 60 % of the DR events, the night setback was initiated at 8 pm with indoor temperatures dropping between 0.5 and 4 K. The most common duration of night setback was 7 hours on weekdays, extending up to 14 hours. The energy savings ranged between 4 and 10 % of the total heat demand. The study indirectly confirmed the already identified four critical factors for successful DSM application in residential buildings: set indoor climate conditions, timing and magnitude of load shifts, individual control, and communication. The reason why occupants continued to apply the DR strategy could be that they were in full control over the DR events and could easily adjust settings according to the household's demands.

These findings emphasize the importance of considering buildings and their occupants not merely as demand-side variables but as active participants capable of contributing to systemic interventions, thereby accelerating the transition towards carbon-neutral heating systems.

Intelligent Controller for the DH network in Rottne

Testing and evaluation of the STORM controller in the Rottne DH network.

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This case study, conducted in 2018 in Rottne (Sweden), was part of the "STORM" project. The DH system, commissioned in 1998, achieved 100 % fossil fuel-free status by 2012. To meet the climate goals of the city, the efficiency and sustainability of the Rottne DH system were further improved by the STORM controller.

The aim was to lower the peak energy consumption of the DH network beyond a set peak power threshold through demand response in buildings, testing and evaluating the peak shaving control strategy of the STORM controller. The STORM controller consists of a Forecaster estimating future heat demand and thermal flexibility of buildings, a Planner designing optimised head load control plan, a Tracker sending control signal to individual buildings and building agents negotiating their contribution based on local constraints.

The test was conducted in nine of the largest customer substations within Rottne's network, accounting for 34 % of Rottne's total heat consumption.

The strategy of STORM is designed to minimize heat production from peak units, which incur higher fuel costs, by prioritizing base load units up to their full capacity. Therefore, it seeks to shift heat loads greater than the base load capacity to times of lower heat demand.

During the evaluation period from March 2018 to January 2019, the STORM peak shaving control strategy shifted heat production from expensive peak loads above to more economical baseloads below 2.5 MW. This shift resulted in a 3.1 % (7.4 MWh) decrease in peak heat production, compared to the reference period. Despite an overall increase in total heat load due to a rise in uncontrollable heat demand, the controllable heat load consistently remained lower than the reference in all evaluated months, indicating a reduction of 12.7 MWh. The total heat load increased by 69.1 MWh, primarily due to the uncontrollable heat demand. These results demonstrate that the STORM controller can optimize the distribution of heat production, even when faced with increased uncontrollable demand.

Further Information

Peak shaving in Turin District Heating

- Guelpa et.al. (2019): Demand side management in district heating networks: A real application. https://doi.org/10.1016/j.energy.2019.05.131

Data-driven automated DSM technology

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- Conference Presentation: S. Demet, Flexible and synchronized local energy systems-concept development and demonstration – A case study of a rural district heating network in Austria. https://www.tugraz.at/fileadmin/user_upload/tugrazExternal/738639ca-39a0-4129-b0f0-38b384c12b57/files/pr/Session_E5/551_PR_Schmid.pdf
- Conference Presentation: C. Fuchs, Electricity Market Participation of Flexible District Heating Networks in Austria – A case study of a rural district heating network in Austria. https://www.tugraz.at/fileadmin/user_upload/tugrazExternal/738639ca-39a0-4129-b0f0-38b384c12b57/files/pr/Session_A5/155_PR_Fuchs.pdf
- Webinar: Flexi-Sync Webinar #7:
  Cost-optimal flexibility and flexibility price models.
  https://www.ivl.se/projekt/flexi-sync/webinars.html
- Webinar: Flexi-Sync Webinar #6:
  Demo of district energy flexibility optimization tool.
  https://www.youtube.com/watch?v=G7X_1l30cI4
- Webinar: Flexi-Sync Webinar #5:
  Austrian rural district heating at the power market.
  https://www.youtube.com/watch?v=tE3-H1Hsz-8
- Webinar: Flexi-Sync webinar 2:
  Austrian and Swedish demos.
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Smart Energy in Homes

- Final Report:
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Substitution of conventional radiator controllers

- Project website SubReg:
  https://tu-dresden.de/ing/maschinenwesen/iet/gewv/forschung/forschungsprojekte/projekt-camper

Digitizing DH supply infrastructure

- Project website SmartHeat:
  https://www.iee.fraunhofer.de/de/projekte/suche/2019/smartheat.html

Flexible and innovative operation of DH network

- Project website EnWiSol:
  https://www.ise.fraunhofer.de/de/forschungsprojekte/enwisol.html

Remote control of radiator thermostats

- Project website RESPOND:
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https://annex84.iea-ebc.org

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EBC is a Technology Collaboration Programme (TCP) of the International Energy Agency (IEA)

A significant share of households rely on district heating and cooling (DHC) networks for their thermal needs. However, monitoring data shows that 50-60 % of these systems are operating inefficiently due to faults, resulting in excessive energy consumption and increased inefficiencies across DHC networks. Despite this, current optimisation efforts focus mainly on system-level improvements, often overlooking the integration of building-specific systems.

The IEA EBC Annex 84 project aims to address these challenges by providing comprehensive knowledge and tools for effective demand side management (DSM) in DHC networks. The project examines both social and technical barriers across different building types, climate zones and local conditions, and focuses on how digitalisation can enhance DSM and activate demand response strategies such as peak shaving, load shifting and on-site generation. These approaches can boost renewable energy integration and reduce reliance on fossil fuel-fired boilers.

This brochure presents 13 case studies that provide valuable insights into the implementation challenges and benefits of DSM in buildings connected to thermal networks.

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