Technology Collaboration Programme on Heat Pumping Technologies (HPT)

Annex 57

Flexibility by Implementation of Heat Pump in Multi-Vector Energy Systems and Thermal Networks

Executive Summary

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November 2024
Report no. HPT-AN57-3

Published by Heat Pump Centre
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Report No. HPT-AN57-3
DOI-number: 10.23697/pw50-jg63

Preface

This project was carried out within the Technology Collaboration Programme on Heat Pumping Technologies (HPT TCP), which is a Technology Collaboration Programme within the International Energy Agency, IEA.

The IEA

The IEA was established in 1974 within the framework of the Organization for Economic Cooperation and Development (OECD) to implement an International Energy Programme. A basic aim of the IEA is to foster cooperation among the IEA participating countries to increase energy security through energy conservation, development of alternative energy sources, new energy technology and research and development (R&D). This is achieved, in part, through a programme of energy technology and R&D collaboration, currently within the framework of nearly 40 Technology Collaboration Programmes.

The Technology Collaboration Programme on Heat Pumping Technologies (HPT TCP)

The Technology Collaboration Programme on Heat Pumping Technologies (HPT TCP) forms the legal basis for the implementing agreement for a programme of research, development, demonstration, and promotion of heat pumping technologies. Signatories of the TCP are either governments or organizations designated by their respective governments to conduct programmes in the field of energy conservation.

Under the TCP, collaborative tasks, or "Annexes", in the field of heat pumps are undertaken. These tasks are conducted on a cost-sharing and/or task-sharing basis by the participating countries. An Annex is in general coordinated by one country which acts as the Operating Agent (manager). Annexes have specific topics and work plans and operate for a specified period, usually several years. The objectives vary from information exchange to the development and implementation of technology. This report presents the results of one Annex.
The Programme is governed by an Executive Committee, which monitors existing projects and identifies new areas where collaborative effort may be beneficial.

Disclaimer

The Heat Pump Centre

A central role within the HPT TCP is played by the Heat Pump Centre (HPC).

Consistent with the overall objective of the HPT TCP, the HPC seeks to accelerate the implementation of heat pump technologies and thereby optimise the use of energy resources for the benefit of the environment. This is achieved by offering a worldwide information service to support all those who can play a part in the implementation of heat pumping technology including researchers, engineers, manufacturers, installers, equipment users, and energy policy makers in utilities, government offices and other organisations. Activities of the HPC include the production of a Magazine with an additional newsletter 3 times per year, the HPT TCP webpage, the organization of workshops, an inquiry service, and a promotion programme. The HPC also publishes selected results from other Annexes, and this publication is one result of this activity.

For further information about the Technology Collaboration Programme on Heat Pumping Technologies (HPT TCP) and for inquiries on heat pump issues in general contact the Heat Pump Centre at the following address:
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Germany; Frauenhofer ISE/IEE
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Abstract

The present report documents the results of HPT Annex 57 “Flexibility by implementation of heat pumps in multi-vector energy systems and thermal networks”. The Annex was initiated in the spring of 2019 and started officially in January 2020. The planned work was three years, and the project is finalized within the planned period, despite the Covid-19 pandemic which caused an abnormal startup without physical meetings. The active Annex group consisted of five countries (Austria, Denmark, Germany, the Netherlands, and Sweden).

Annex 57 has focused on solutions where heat pumps can create flexibility to the electrical grid. When the project was initiated, the aim was to focus on flexibility from heat pumps connected to district heating as the project was based on the results from HPT Annex 47 Heat Pumps in District Heating and Cooling Systems. Flexibility from individual heat pumps have also been included in the scope of this annex during the project as some participants and the IEA HPT Executive Committee had a wish to extend the scope to include individual heat pumps as well. The focus has been to describe what is flexibility and what the is potential of flexibility.

The working group has carried out an analysis on a national basis for the participating countries on the potential to create flexibility and the potential for heat pumps in the participating countries.

Templates and detailed descriptions as well as a shorter template have been developed to describe cases. 22 cases have been collected and described. The cases show that it is possible to create flexibility with heat pumps in different ways.

Collecting data from existing plants has been a part of the work and is described in a separate report from Aalborg University.

Identifying barriers and solutions for individual heat pumps as well as large-scale heat pumps in district heating grids has been a part of the work. This was done in a workshop held at the 14th Heat Pump Conference in Chicago in May 2023.

The project shows that heat pumps can create flexibility to the electrical grid and that the demand for flexibility is growing.

1. Executive Summary

HPT Annex 57 has focused on solutions where heat pumps can create flexibility to the electrical grid. When the project was initiated, the aim was to focus on district heating as the project was based on the results from HPT Annex 47 Heat Pumps in District Heating and Cooling Systems. However, flexibility individual distributed heat pumps have also been included in the scope of the annex. The focus has been to describe what is flexibility, and what is the potential of flexibility.

As global electricity demand rises, driven by a shift from fossil fuels to electrification, heat pumps are becoming crucial in enhancing grid flexibility. These technologies effectively manage the variability of renewable energy sources, ensuring a resilient energy infrastructure that can adapt to fluctuating demands

- **Creation of flexibility in the electrical grid is possible using both individual heat pumps and heat pumps for district heating.**

Key findings:

Heat pumps significantly enhance grid management and energy efficiency, playing a transformative role in the energy sector.

1: The market for heat pumps in district heating systems is growing
The market for district heating is growing throughout entire Europe, and scenarios show that heat pumps have a potential to cover from 16 % to 38 % of the annual production in most of the markets. Potential Coverage in District Heating: Heat pumps are projected to provide about 25% of Europe’s district heating by 2050, underscoring their importance in sustainable heating solutions

2. Flexibility Services: Heat pumps are key in delivering ancillary services, such as frequency regulation, which contributes to the stability of the electrical grid.
It can briefly be shown by the referred demonstration cases that heat pumps are well operated within the energy trading markets of day-ahead and intraday. As large-scale thermal power plants are phasing out, and the implementation of renewable sources like PV-plants and wind-power plants are growing, the market for flexibility services is diversified and growing. Heat pumps might address this and can play a significant key role in the balancing of the market for the electrical grid. It is shown by various analyses that large heat pumps for district heating have a high economical potential to operate accordingly and act into the ancillary service market. Flexibility is also possible to create with individual heat pumps, hybrid heat pumps, and heat pumps in district heating systems.

3. Versatility Across Applications: Whether in individual installations, hybrid systems, or largescale district heating setups, heat pumps show remarkable adaptability to various environments and needs.
Heat pumps can be implemented in combination with other technologies such as gas boilers, wood, pellets and straw boilers. This means that the implementation of heat pumps can be expanded but also that the energy coverage provided by the heat pumps can be increased.
Heat pumps are also showing large versatility in the use of different energy sources from waste heat from sewage clearing stations, to air and exhaust heat from processes including excess heat from data centers.

4. Ancillary Service Market Participation: Heat pumps engage in diverse market segments, including day-ahead, intraday, and ancillary services, meeting the dynamic requirements of the energy market.
Some of the cases show that heat pumps can act in the ancillary service market, especially if they are combined with electrical boilers and weekly storages. However, this is a new way to control heat pumps, and there are still barriers to overcome.

5. Barriers and Business Models: Despite facing technical, regulatory, and economic hurdles, innovative business models that involve aggregating distributed heat pumps for balancing services are proving effective

The annex describes some of the barriers and business models. One of the barriers is that in people's mindset, heat pumps cannot technically create high temperatures for district heating, but the development of the heat pump technology is moving fast now, and the first district heating heat pumps which provides 90°C is starting up in Vienna in 2024.

Regarding business models that involves aggregating distributed heat pumps, has projects from Sweden showed good results. In these projects which provide various balancing services showed promising reductions in overall energy costs. Different types of FCR and aFRR showed the highest cost reduction, while mFRR was slightly less profitable. In Denmark, aFRR showed the best results, followed by FCR and then mFRR. In Austria, aFRR showed significantly higher cost reductions than mFRR www.heatpumpingtechnologies.org

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