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Industrial Waste Heat Usage

German-Japanese Expert Workshop
19 - 22 April 2021 (online)

Short report

Background

Both Japan and Germany as fully industrialized countries are equally committed to achieve the goal of Greenhouse gas neutrality by 2050. However, this cannot be reached by substituting fossil fuels with renewable energies alone. "Efficiency First" is the order of the day, especially in the industrial sector.

Process heat is required in the industry for the generation of steam for drying processes, galvanizing, pasteurizing, distilling or thermal separation processes. A high proportion of the energy used is often lost as unused waste heat at different temperature levels. If this waste heat is made usable, a great deal of energy can be saved - not only in production itself: the waste heat can also be used in swimming pools, greenhouses, or buildings in the vicinity. While there are already several best practice examples in Germany, the potential for municipal heating networks in Japan has hardly been considered so far.

How can waste heat from industrial plants be used efficiently as process heat or electricity? Which technologies are necessary, which utilization concepts are available? How can heating networks be set up? These were the questions addressed by the intensive four-day German-Japanese expert workshop.

The four-day online workshop offered around 50 selected German and Japanese experts from industry, research, and administration the opportunity to exchange information on political framework conditions, available technologies, exemplary projects in the field of industrial waste heat utilization and to explore cooperation and business opportunities.

Project examples and innovative technologies from both countries were presented, partly in the form of virtual tours. Open roundtables at the end of each workshop day offered the opportunity for direct and in-depth exchange and networking.

The event was translated simultaneously into German and Japanese. The cooperation partner on the Japanese side was the New Energy and Industrial Technology Development Organization (NEDO).

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Day 1: Overview of importance and applications on an industrial scale, outlook on municipal applications

On the first day, representatives of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), the Federal Ministry of Economic Affairs and Energy (BMWi) and the Japanese Ministry of Economy, Trade and Industry (METI) gave a political overview of the importance of industrial waste heat utilization for the implementation for climate protection goals in Germany and Japan.

The program also included overview presentations on the role of waste heat utilization in the heat transition in Germany (Institute for Resource Efficiency and Energy Strategies IREES GmbH), the available technologies for waste heat utilization in Japan (NEDO) and successful examples of municipal waste heat utilization in metropolitan and rural regions in Germany (Institute for Future Energy and Material Flow Systems IZES GmbH).

An open roundtable at the end of the conference asked which political measures would be necessary to promote the increased use of waste heat in Germany and Japan in order to achieve the self-pledged climate targets.

Take-aways of Day 1:

- In both Germany and Japan, large amounts of energy are still lost as unused waste heat. Waste heat must be considered as a new source of energy; this is not only a technological question, but a system and awareness issue.
- Companies have various options for waste heat utilization; for example, they can always achieve the temperature level required for production/ heating/ air-conditioning through high-efficient heat pumps or cooling absorption.
- Crucial points are the economic viability and long amortization period. Without funding, companies can hardly be motivated to invest, even though climate protection awareness is increasing. On the other hand, measures for waste heat utilization have a particularly high funding efficiency and a high CO₂ reduction effect.
- Japan does not only rely on the proven 'Toprunner' program for appliances and components, but also obliges companies to regularly report and take measures to continuously increase energy efficiency.

Day 2: Demand-side thermal management and heat storage technology

The second day was kicked off with a plea from the energy supplier TEPCO for electrification of industrial processes and for "green" electricity as an important path to a CO₂-neutral industry. Heat pumps are playing a central role in this respect.

Two interesting heat storage materials were presented and discussed: HAS Clay (Takasago Thermal Engineering), which, due to its high adsorption capacity, is suitable for absorbing waste heat from industry. If transported by truck, it can provide heat e. g. to swimming pools or similar facilities in the surrounding area. Further, a microencapsulated latent heat storage material developed by Hokkaido University was presented, which is suitable for a variety of applications due to its formability (honeycombs, granules, pellets).

In the Open Roundtable, the advantages and disadvantages as well as possible applications of mobile and stationary heat storage systems for demand-side heat management were discussed in detail.

Take-aways of Day 2:

- Heat pumps can heat or chill efficiently; due to technological innovations (especially in Japan), there are application possibilities in almost all input and output temperature ranges.
- However, the relatively high investment costs are an obstacle. Due to the change in awareness in companies (also in Japan), there is a willingness to invest in efficiency and climate protection.
- Regarding heat pump technology, there is definitely still COP development potential, especially in lowering the temperature of heat sinks (e.g. through underfloor heating), less so in compressor development.
- Both Takasago Thermal Engineering and Hokkaido University showed great interest in cooperating with German institutes and the industry to realize initial test and demonstration projects in Germany on possible applications of heat storage materials.
- Possibilities for cooperation lay, for example, in the combination of innovative latent heat storage systems with Carnot batteries, in the development of thermoelectric generators or in the application opportunities of high-performance heat pumps for low input temperatures.

Day 3: Project examples from Germany and Japan

As a pioneering example of systematic heat planning, the North Rhine Westphalia (NRW) State Office for Nature and Environmental Protection presented an energy atlas at the beginning of the third day. It catalogues industrial heat sources and heat demand throughout NRW and can thus serve as a basis for waste heat utilization projects. Using the example of a paper factory in Lower Saxony, the Energy Competence Centre of the Osnabrueck University of Applied Sciences showed how different scenarios can be developed for waste heat utilization with heat storage, heat pumps and the combination with wind energy and electricity storage. The idea of the MosEN project is to close the gap between potentials and utilization possibilities of waste heat through modelling on potentials and economic efficiency.

The Japanese experts from the National Institute of Advanced Industrial Science and Technology (AIST) presented the R&D project TherMAT, in which different processes and systems for waste heat storage and utilization in industrial plants are being investigated. The methods range from high-temperature heat pumps and thermal management for industrial furnaces to newly developed thermoelectric modules and ORC systems for generating electricity from waste heat. Finally, Evonik Operation GmbH showed how thermoelectric modules can be manufactured cost-effectively. The modules can be used for process and radiant waste heat, exhaust heat, heating systems, etc.

The Open Roundtable on the third day dealt with the question of how a circular economy with waste heat can succeed.

Take-aways of Day 3:

- The topics of heat cadastres, energy neighborhoods and targeted "matching" between heat sources and heat consumers are currently still neglected in Japan. Japan can learn a lot from the experiences in Germany.
- Japan, on the other hand, is a leader in the development of highly innovative materials and technology for heat utilization and storage.
- The development of heat networks is a matter of persuasion; the "matching" between supply and demand is very important; the "chemistry" between industry, and heat network operators and heat users must be right; a "caretaker" is often needed to coordinate the different interests; another question that needs to be clarified is how the failure of heat supplies can be insured.

Day 4: Technologies for heat generation and storage

On this last workshop day, the focus was once again on the heat pump and new trends in waste heat utilization in the low-temperature range. At the beginning, the European heat pump association AISBL advocated heat pumps as the "anchor technology of the energy transition", but also showed that some potential areas of application are not yet technologically accessible. The Japanese Heat Pump and Thermal Storage Technology Centre confirmed that heat pumps could in principle replace all fossil-fired boilers in the industry in the future and convert "green" electricity into thermal energy efficiently.

The participants were able to pay a "virtual visit" to two projects of the Japan Electro Heat Centre via video, in which high-performance heat pumps are used: a chemical factory in Kashima and a brewery in Sendai. Technologies for efficient heat recovery from urban wastewater (UHRIG Energy GmbH) were presented as well as waste heat utilization in data centers (pilot project by Vattenfall) and a new type of absorption chiller (Johnson Controls), which can be used from 60°C input temperature.

In the last Open Roundtable, the German and Japanese experts discussed the question to what extent industrial heat pumps are the key to utilizing low-temperature waste heat.

Take-aways of Day 4:

- Heat pumps are particularly interesting in places where the largest possible share of electrical energy from renewable sources is available. Attractive applications are, for example, if both heating and cooling are needed at the same time or when waste heat and required heat/cooling are close to each other (in terms of time and/or location), as shown in the example of the food industry.
- In Japan as well as in Germany, data centers will develop into an important industrial sector with great potential for waste heat utilization as an outcome of the advancing digitalization. This will result in various opportunities for cooperation.
- Further opportunities for cooperation are in the application opportunities for high-performance heat pumps for low input temperatures, also for refrigeration.
- Both sides agree that the bilateral exchange should be continued on the occasion of the BMU symposium on "Industrial waste heat utilization" in autumn 2021.

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Program:

Day	Time (CET)	Time (JST)	Program
Mon April 19, 2021	8:30-11:45	15:30-18:45	German-Japan expert workshop Part 1: Energy efficiency and industrial waste heat in Germany and Japan for CO2 reduction
	8:30	15:30	Opening Words: Peter Beck, ECOS GmbH
	8:35	15:35	Greeting addresses: Hisashi YOSHIOKA, Director General, Energy Conservation Department, NEDO; Ann-Sophie Weihe-Feijó, Division IK III 5 (Climate Protection and Energy Efficiency), Federal Ministry for the Environment, Nature Conservation and Nuclear Safety BMU
	Chair: Dr. Matthias Reckzügel, Hochschule Osnabrück		
	8:45	15:45	Energy Efficiency in Japan Ryutaro NAKAYAMA, Assistant Director, Energy Efficiency Division, Agency for Natural Resources and Energy (ANRE) / Ministry of Economy, Trade and Industry (METI)
	9:00	16:00	Importance of industrial waste heat utilization for the implementation of climate protection goals in Germany Dr. Hartmut Versen, Division IIB2, Federal Ministry for Economic Affairs and Energy BMWi
	9:15	16:15	Q&A / Discussion
	9:45	16:45	Break
	10:05	17:05	Heat transition of the German industry – excess heat as an option for decarbonisation and flexibilization of energy supply in energy intensive industries Dr. Jan Steinbach, IREES GmbH - Institute for Resource Efficiency and Energy Strategies
	10:20	17:20	The Potential of Advanced Heat Technologies, Technology Developments for Utilizing Waste Heat in Japan Masanori KOBAYASHI, Director, Energy Conservation Technology Dept., NEDO
	10:35	17:35	Waste heat in the municipal context: Successful examples of metropolitan and rural regions Patrick Hoffmann, IZES gGmbH
10:50	17:50	Q&A / Discussion	

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	Chair: Patrick Hoffmann, IZES gGmbH		
	11:05	18:05	<p>Open Roundtable</p> <p>Key Question: Which policies are needed to promote the increased use of waste heat in Germany and Japan for accelerated CO2 reduction?</p> <p>With introductory speech by Nobutaka TAKEO, Director General, of NEDO Representative Office in Europe</p>
	11:45	18:45	End
Tue April 20, 2021	8:30- 11:00	15:30- 18:00	German-Japan expert workshop Part 2: Demand Side Heat Management
	8:30	15:30	Opening Words: Peter Beck, ECOS GmbH
	Chair: Masanori KOBAYASHI, NEDO		
	8:35	15:35	<p>Implementation of Carbon Neutral --Electrification, Demand Side Heat Management-- Takashi YATABE Producer, Engineering Strategy unit, Engineering Management Office, Tokyo Electric Power Company Holdings, Inc.</p>
	8:50	15:50	Q&A / Discussion
	9:05	16:05	Break
	9:15	16:15	<p>Development of Adsorption Thermal Storage System Utilizing Low-temperature Waste Heat 【Including a video】 Dr. Masayuki TANINO, Principal Research Engineer, Research & Development Center, Takasago Thermal Engineering Co., Ltd.</p>
	9:35	16:35	Q&A / Discussion
	9:50	16:50	<p>Recent advance on high-temperature latent heat storage technology based on micro-encapsulated phase change material Dr. Takahiro NOMURA, Associate Prof., Faculty of Engineering, Hokkaido University</p>
	10:05	17:05	Q&A / Discussion
	Chair: Masanori KOBAYASHI, NEDO		
10:20	17:20	Open Roundtable	

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			Key Question: Thermal Storage for Demand Side Waste Heat Management, mobile and stationary, which materials are already available today?
	11:00	18:00	End
Wed April 21, 2021	8:30-11:25	15:30-18:25	German-Japan expert workshop Part 3: Project examples (Germany and Japan)
	8:30	15:30	Opening Words: Peter Beck, ECOS GmbH
	Chair: Dr. Jan Steinbach, IREES GmbH		
	8:35	15:35	Potential and Use of Industrial Waste Heat in North Rhine Westphalia – Provision of information in the provincial heat cadaster Nils Dering, State Agency for Nature, Environment and Consumer Protection (LANUV NRW)
	8:50	15:50	Q&A / Discussion
	9:05	16:05	Thermal management R&D project for industrial waste heat usage in Japan Dr. Haruhiko OBARA, Vice-President, Director-General, Department of Energy and Environment, National Institute of Advanced Industrial Science and Technology (AIST)
	9:20	16:20	Q&A / Discussion
	9:35	16:35	MosEN - Modelling of local cross-sectoral energy systems Prof. Matthias Reckzuegel, University of Applied Sciences Osnabrueck / Energy Competence Center 'Science to Business'
	9:50	16:50	Q&A / Discussion
	10:05	17:05	Break
	10:15	17:15	Heat Recovery with Thermoelectric Modules – New Production Process for the Production of TEG and applications Yikalo Tecele, Evonik Operations GmbH
	10:30	17:30	Q&A / Discussion
	Chair: Dr. Matthias Reckzuegel, Hochschule Osnabrueck		
	10:45	17:45	Open Roundtable Key Question: How can a circular economy for waste heat utilization be realized?
	11:25	18:25	End

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Thu April 22, 2021	8:30-12:20	15:30-19:20	German-Japan expert workshop Part 4: Industrial heat pumps for waste heat utilization
	8:30	15:30	Opening Words: Peter Beck, ECOS GmbH
	Chair: Tetsushiro IWATSUBO, NEDO		
	8:35	15:35	Closing energy cycles with heat pumps Thomas Nowak, Secretary General, European Heat Pump Association (AISBL)
	8:50	15:50	Q&A / Discussion
	9:00	16:00	Heat pump technologies & Case studies in Japan Koki WATANABE, Deputy Director, Business Coordination Department and International & Technical Research Department, Heat Pump & Thermal Storage Technology Center of Japan
	9:15	16:15	Q&A / Discussion
	9:25	16:25	High efficient industrial heat pump utilizing waste heat 【Video】 <Provided by Japan Electro-Heat Center>
	9:35	16:35	Q&A / Discussion
	9:45	16:45	Break
	10:05	17:05	Heat transition with energy from waste water - The underestimated potential in the sewer Rouven Zeus, UHRIG Energie GmbH
	10:20	17:20	Q&A / Discussion
	10:30	17:30	Heat re-use from data Centers- challenges and opportunities Dr. Birger Ober, Sustainable Digital Infrastructure Alliance
	10:45	17:45	Q&A / Discussion
	10:55	17:55	Implementations and case studies of novel heat driven chillers developed in a NEDO project Tatsuo Fujii, Chief Engineer, Johnson Controls Building Efficiency Japan
	11:10	18:10	Q&A / Discussion
	Chair: Tetsushiro IWATSUBO, NEDO		
	11:20	18:20	Open Roundtable Key Question: Industrial Heat Pumps – the key for using low-temperature waste heat?

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	11:50	18:50	Closing words, Masanori KOBAYASHI, NEDO
	12:00	19:00	End

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Participant list:

	title	name	first name	company/institute
Mr.		Asahi	Takahiro	International & Technical Research Department, Heat Pump and Thermal Storage Technology Center of Japan
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Mr.		Beck	Peter	ECOS GmbH
Mr.		Bothmer	Stephan	UHRIG Energie GmbH
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Mr.		Guo	Junqing	Material Research & Development Department, Furukawa Co., Ltd.
Mr.		Hamayashiki	Tsuyoshi	Planning Dept., Japan Electro-Heat Center
Mr.		Hanzawa	Koki	Representative office in Europe, NEDO
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Mr.		Hoffmann	Patrick	IZES gGmbH
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Mr.		Nowak	Thomas	Secretary General European Heat Pump Association AISBL
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