German-Japanese Expert Workshop and Site Visits on Waste Heat Utilization

27th February 2023
Gas- und Wärme-Institut Essen e.V.

28th February 2023 – 1st March 2023
Site Visits

Report

March 2023

ECOS Consult ❖ Westerbreite 7 ❖ 49084 Osnabrück ❖ Germany ❖ Tel: +49 (0)541 9119 0990 ❖ Email: info@ecos.eu
adelphi ❖ Alt-Moabit 91 ❖ 10559 Berlin ❖ Germany ❖ Tel: +49 (30) 89 000 68 361 ❖ Email: narita@adelphi.de

Table of Content

1. Summary 3

1.1. Opening and Welcome Remarks 4

1.2. Session 1: Current Status and Outlook of Waste Heat Utilization in Germany and Japan 5

1.3. Session 2: Waste Heat Utilization in Various Sectors 8

1.4. Session 3: Infrastructure for Waste Heat Utilization 10

1.5. Closing Remarks by Peter Beck (ECOS) and Kazuyuki Imazato (NEDO Europe) 13

2. Site Visits 14

2.1. Site Visits on the 28th of February 14

2.2. Site Visits on the 1st of March 15

3. Impressions 16

1. Summary

For mastering the energy transition and reaching 'net zero', it is crucial to minimize the consumption of finite resources and to move away from the dependence on fossil fuels. In this regard a wide variety of measures - such as increasing energy efficiency, the expansion of renewable energies, or the increasing integration of energy storage systems - are being developed and promoted. So far, little notice has been taken of the use of waste heat, which is a huge untapped energy source and offers enormous advantages for many different users.

Even though waste heat is generated as a by-product in almost all technical processes, it is often lost without being utilized. This reduces the overall energy efficiency of technical processes, since a significant part of the thermal energy is wasted, leading to unsustainable processes. Heat recovery technologies exist that can use excess heat from industries, wastewater facilities, data centers, supermarkets, metro stations and commercial buildings. Excess heat can either be reused to supply a factory with heat and warm water or exported to neighboring homes and industries through a district energy system. Thus, an improved utilization of waste heat can lead to higher energy efficiency and can at the same time reduce energy costs.

In order to exchange information on political instruments and innovative technologies as well as concepts and projects for the utilization of industrial waste heat in several application sectors, and to identify cooperation and business opportunities and initiate cooperation projects, 34 experts from Japanese and German industry, research institutes and administration gathered at the Gas- und Waermeinstitut e.V. in Essen (Germany) on February 27, 2023 for a one-day workshop.

The workshop was divided into three sessions, with Q&A and discussion at the end of every session. The first session provided information on the status and outlook of waste heat utilization in Germany and Japan, focusing among others on the political framework of both countries. The implementation and utilization of waste heat sources in different sectors was discussed in the second session, while the necessary infrastructure for waste heat utilization was the topic in the last session.

In the concluding panel discussion, the following take-aways were identified:

- One of the biggest challenges is that society is running out of time to achieve CO_2 neutrality. However, innovative waste heat concepts can help to accelerate the sustainable heating transition worldwide.
- The panelists are optimistic that heat pumps will be used more often in the near future and that they are a step in the right direction. For a fast roll-out and implementation, heat pumps must become more economically viable. Also process adjustments are necessary so that also the lowest waste heat temperatures can be handled.

- In general, it is crucial that supplied temperature levels are matched with the demand.
- Policies in both countries must become a driver of waste heat utilization as companies will not use solutions if it does not come with a benefit for them financially or in another way. Thus, frameworks and regulations must be built to make waste heat utilization economically worthwhile.

In the closing remarks, Peter Beck of ECOS and Kazuyuki Imazato of NEDO Europe reflected on the constructive exchange and the innovative ideas from the participating experts and pleaded for further workshops in the future in Japan as well as in Germany.

To get a first-hand impression of innovative technologies and concepts for waste heat utilization in Germany, 15 representatives of Japanese industries, research and administrative bodies visited innovative waste heat utilization projects in the Rhine-Ruhr area and Lower Saxony in the steel production and food industry following the workshop.

The workshop and excursion were organized by ECOS in cooperation with adelphi and the New Energy and Industrial Technology Development Organization (NEDO) and with the support of the Japan External Trade Organization (JETRO) within the framework of the Working Group “Energy Transition” of the Japanese-German Energy Partnership on behalf of the German Federal Ministry for Economic Affairs and Climate Action (BMWK) and the Japanese Ministry of Economy, Trade and Industry (METI).

1.1. Opening and Welcome Remarks

Opening Remarks by Peter Beck from ECOS
Peter Beck, Project Manager at ECOS Consult GmbH, opened the event with a short greeting of the participants of the German-Japanese Expert Workshop on Waste Heat Utilization and stressed the need for innovative developments in the area of waste heat utilization for both countries. In his remarks, he specifically mentioned the potential of future cooperations between German and Japanese institutions, companies, and politicians to promote the transformation of the heating sector. Thus, both countries can benefit and learn from each other.

Video Message by Dr. Falk Boemeke from the BMWK
Dr. Falk Boemeke, Head of Division on General Issues of Bilateral and Regional Climate and Energy Cooperation at the BMWK, stated in his welcoming video message, that the German government has put a lot of work into the energy transition in recent months. This transition has been accelerated due to the Russian-Ukrainian war since Germany must become more independent from Russian energy sources. Further he explained that the net zero goal and other sustainable objectives are a great driver for improving the utilization of waste heat. One of the most important aspects here is the efficient usage of energy and heat.

Video Message by Masashi Hoshino from METI
Masashi Hoshino, Director Overseas Energy Infrastructure Office, International Affairs Office, Agency for Natural Resources and Energy (ANRE) at METI, emphasized that cooperation between Germany and Japan has become more important than ever, especially in the energy sector. He stated that companies and scientific institutions from both countries should continue to enter excellent cooperation in order to ensure energy security, since Japan as well as Germany want to achieve their sustainability goals (decarbonization) while at the same time staying competitive. Further cooperations can help to reach these goals.

1.2. Session 1: Current Status and Outlook of Waste Heat Utilization in Germany and Japan

As the chair of the first session and representing the hosting facility**, Margit Thomeczek, Cluster and Network Managing Director at the Gas-Waerme Institut (GWI) Essen,** welcomed all experts and explained that Essen also has a partner city in Japan (Koriyama) and that she is particularly pleased about further cooperation-possibilities between Germany and Japan. Furthermore, she gave a short introduction about the GWI which was founded in 1937 as a research institute. The GWI is structured into a R&D department, a test center, and a section for further education & training. The whole facility of the GWI has an intelligent control of electricity, gas and heat including a fuel cell plant from Mitsubishi, which is the first plant of its kind outside of Asia. The GWI deals with industrial waste heat in research projects, analyzes and scenario modeling.

Presentation: "Heat Transition in German Industry – Waste Heat Utilization as a Contribution to Decarbonize Industrial and Residential Heat Demand"
The first presenter of the workshop**, Markus Fritz from Fraunhofer ISI, in his work** is engaged with questions on the energy transition (especially from the political perspective). Furthermore, he is one of the hosts of the enPower Podcast in which he talks about the energy transition addressing several thousand listeners. In his presentation, he presented a study, which shows that waste heat represents a huge untapped potential at the European level. Therefore, the heat transition is very relevant and has acquired a completely different status both socially and politically in recent months – not only on a European scope but nationally in German politics as well. He showed that the potential in Germany is at 36.6 TWh/year. However, there are regional differences as some municipalities have very much waste heat and others very little. Thus, it is very important to consider the local heat demand and the local waste heat potential.He underlined that in some municipalities the complete heat demand could be covered by the unused waste heat potential. Another aspect to consider is the temporal availability and need of waste heat. When actors are considering to implement new projects, an existing heating network does not necessarily have to be in place in order to start waste heat projects (the network can be expanded through the projects). He summarized his presentation by stating, that there is still a lot to be done in the energy and heat transition, but through cooperation it is possible to overcome the existing challenges.

Presentation: "Waste Heat Utilization in Japan: Current Status and Policy"
Haruto Shinoda, Assistant Director for Energy Efficiency and Renewable Energies at the Energy Department of ANRE at METI, started his presentation by saying that rising energy prices and the goal of carbon neutrality make the topic of waste heat utilization important. The Japanese strategic energy plan set energy targets to be reached by 2030. However, with no additional measures, the energy consumption will even increase by 2030. Hence, further energy saving measures through regulatory and political intervention are necessary. In this regard, the decarbonization of heat is becoming more important: Unused waste heat should be used increasingly. Mr. Shinoda said that using steam in the low temperature range is already executed very well (heat pumps provide a good basis), but that for the medium to high temperature ranges where it is difficult to install heat pumps, other measures have to be implemented. Here technological innovations such as high-performance insulation and high-temperature heat pumps come into play and are financially supported by the METI. Further, energy efficiency measures are introduced by the ministry to support small and medium-sized enterprises (SMEs), including energy audits which visualize the potential of energy efficiency (industry potential approx. 10% and in office buildings even more than 10%). He continued by explaining, that in Japan companies are classified in different classes based on their energy efficiency and tis information is published online (Class S the best - is a requirement for some grants etc.).

Panel Discussion: "Political Framework in Japan and Germany for Waste Heat Utilization – What Positive Effects Already Exist and What Obstacles Still Need to be Overcome?"
Panellists:

- *Mr. **Haruto Shinoda**, Assistant Director, Energy Efficiency and Renewable. Energy Department, ANRE, METI*
- *Mr. **Takahiro Asahi**, Manager, International & Technical Research Department, Heat Pump and Thermal Storage Technology Center of Japan*
- *Dr. **Susanne Stark**, Head of Energy Policy and General Energy Issues, Stadtwerke Düsseldorf*
- *Mr. **Johannes Dornberger**, Advisor Energy Economics & Politics, AGFW (Energy Efficiency Association for Heating, Cooling and CHP)*

After a quick introduction of the participating panelists, the definition of industrial waste heat in Germany and Japan was discussed. It became clear, that there is no uniform definition in Germany and therefore, waste heat is characterized differently in various reports and funding guidelines depending on the background. Especially the definition from the EU is difficult to understand which leads to different interpretations. For now, technical, and political differences arise with regard to the definition and the Federal government is on the way to clarify this with involvement of the AGFW The panelists generally characterized waste heat as a by-product of a process. In Japan, industrial waste heat is not yet consciously perceived by many companies, so there is no uniform definition either.

The panelists continued to argue, that waste heat should be put on an equal footing with renewable energies (because energy is not put in for the waste heat, but for the creation of the product/service). However, important questions that must be answered first are: “Is the waste heat unavoidable? What waste heat cannot be prevented?” Only waste heat that is unavoidable should be equated with renewable energies. Distinguishing between avoidable and unavoidable waste heat is not an easy task.

Another topic discussed in the panel was funding programs and how they are implemented. In Japan, the energy efficiency policy package does not only include subsidies for waste heat projects but for all energy efficiency measures. Through this package, companies can get a subsidy for the usage of waste heat as a by-product. The waste heat can be used for the company itself or sold to others. This is counted as an energy efficiency measure for both, customers, and suppliers of waste heat. Both can deduct the saved energy in their bill as “negative energy” / “negative CO2-billing”. Thus, incentives are given for sellers and buyers of waste heat. Last year the package contained around 50 billion JPY (around 350 million EUR) that were funded to introduce new systems in the industrial sector (with a maximum of 15 billion yen, i.e., approx. 100 million EUR per project). In both countries, a lot of bureaucracy and effort is needed for companies to be funded (application for funding is very tedious and should be improved). In Japan, there are energy audits funded by the government that advise companies in this process.

Further, the untapped potential of waste heat utilization was on the agenda. In Germany there are large quantities of unused waste heat, some of which are unknown. In general, it is still known too little about waste heat which calls for more research projects and statistical analyses in the field. There is a lack of knowledge in industry about waste heat sources (which should be closed via audits). It is also important, that processes, temperature levels and load curves are known to be able to fully exploit waste heat potential. In the long run, a big amount of waste heat will be available at a low temperature. Therefore, the use of heat pumps must be considered. The high-temperature processes are used differently, possibly through electrolysis. In both countries there is a gap between supply and demand and this needs to be further examined. To proceed, it must first be known, how much waste heat can be used by a company. This can be achieved by regular reporting or via waste heat registers with all necessary data of supply and demand within one region. Furthermore, specialists must be trained since waste heat recovery is complex requiring engineering know-how and innovative technologies. Concerning legal and contractual situations between heat producers und users, Germany and Europe are very advanced in terms of district heating and the use of waste heat. In Japan it is more difficult since the regions are very different. To use waste heat in Japan, it is important for companies to communicate well. All in all, this needs to be improved in Japan.

In the panel there was a specific question raised to AGFW: How open are the AGFW members to the utilization of industrial waste heat/district heating? Regarding this question, Mr. Dornberger stated that all district heating providers want to offer sustainable sources (climate-neutral waste heat) and that the pressure is on utilities to decarbonize. For him it is crucial, that those heat sources that are already available should also be used (no space problems

such as with new biogas plants, etc.). In this regard, the information deficit was once more addressed as it is one of the main barriers to using waste heat. Further, he mentioned a great uncertainty for companies regarding energy prices etc., which makes it difficult to make long-term investments.

The panel was closed with the realization, that we must get away from the fact that waste heat projects are predominantly carried out by pioneers. Automatisms and systemic conditions must be created such that projects come about even if there are no close personal links between the heat supplier and the user. Only then, the waste heat utilization will successfully advance in the next years in both countries.

1.3. Session 2: Waste Heat Utilization in Various Sectors

The chair of this session, **Kazuyuki Imazato, Director General at NEDO Europe,** shortly welcomed everyone back after the lunch break and explained, that the following session takes a deeper dive into individual industry sectors and their utilization of waste heat. He introduced the presenters and promised detailed information from Japanese and German industry sectors regarding the usage of technologies such as heat pumps, absorption, and adsorption solutions as well as energy storage with regard to waste heat utilization.

Presentation: "Research and Development of Industrial Heat Pumps in Japan"
Yoichi Fujita, Technical Researcher of the Energy Conservation Technology Department at NEDO, started his presentation by stating that in Japan, about 30% of the primary energy is lost during the supply phase (mainly as heat). Furthermore, the distribution of unused heat and the temperature requirement of companies overlap, leading to a so far unused potential. From a technological point of view, heat pumps could be used to cover heat requirements below 200° with waste heat. NEDO has various activities regarding the research and development of heat pumps in this temperature segment. This way, unused heat can be recovered and energy efficiency increased, contributing to the energy transition and decarbonization. Unused heat of about 80-100° can be recovered by heat pumps. High temperature heat pumps can also be used and they have an overall efficiency that is 1.8 times higher than the efficiency of conventional technology. One company (Maekawa) is researching high temperature heat pumps that can heat up to 200°. Further, several international R&D projects are currently underway. In general, it was stated by Mr. Fujita, that for the low temperature range below 200°, heat pumps make a lot of sense, and the government would like to support this. In his eyes, heat pumps are a key technology for decarbonization of the heat supply.

Presentation: "Waste Heat Utilization in the Food Industry – Example Projects, Framework Conditions, Core Ideas from Japan"
At the start of his presentation**, Takahiro Asahi, Manager at the International and Technical Research Department of the Heat Pump & Thermal Storage Technology Center of Japan (HPTCJ),** explained the Japanese plans for decarbonization. The aim is to reach carbon neutrality by 2050 and to reach this, several laws and regulations are in place. The "Green Transformation" (GX) takes industrial heat pumps as one of the pillars of government policies and

especially sees electrification technologies as a way for decarbonizing the heat supply. This resulted in large subsidies of 350 million EUR from the Japanese government for industrial heat pumps. One example of a project that was subsidized, is the use of a high-temperature heat pump in distillation: The heat was wasted in the condenser before the project. Now the waste heat of the condenser is used at about 86°. Further, the installation of a heat pump has been made possible for the processes by reducing process heat (distillation temperature was reduced) and a water heat pump was installed. This way cold and heat supply can be provided simultaneously (heat pumps produce 75° for heating and 25° for cooling water at the same time). For him it is crucial, that spatial and temporal proximity between waste heat generation and use is coordinated. This way a dramatic reduction in energy consumption and CO2 emissions can be reached. For the future political measures such as incentives or CO2 taxation as well as technological progress and know-how are crucial to further expand the utilization of industrial heat. Due to different strengths and weaknesses between Germany and Japan he emphasized, that future cooperation between stakeholders from both countries are a win-win situation in which all participants can learn a lot from each other.

Presentation: "Absorption Cooling and Heating: Waste Heat Utilization for Industrial and Commercial Applications"

Ivo Eiermann, Product Manager at Johnson Controls Building Efficiency, argued that many topics regarding waste heat utilization are similar in Germany and Japan. Further he stated that the heat transition only works if there is a coexistence of synthetic and natural refrigerants. He then proceeded to explain the absorption process including the four basic components of the technology: the generator, the condenser, the absorber, and the evaporator. A crucial aspect in the usage of this technology is that water as a resource must be used very sparingly in the future. For the Central and Northern European markets dry cooling is used to conserve water as a resource. Further, he explained two types of heat pumps in his presentation:

- Heat pump type 1: Could be used e.g. by municipal utilities (e.g.: biomass power plant for district heating with a coefficient of performance (COP) of 1.7 and high CO2 savings and good return on investment (ROI))
- Heat pump type 2: Reverse process so that the absorber can be heated to 140° (disadvantage: requires (re)cooling tower). The electrical consumption is very low and there is pure use of waste heat.

The type 2 heat pump is hardly available or known in Germany, but there are model plants in Japan. Johnson Controls develops their technologies by themselves, but they can build upon the know-how from the Japanese company Hitachi due to a joint venture.

Presentation: "Clean Power from Waste Heat in Energy-Intensive Industries"

Veronica Schwarz, Sales Engineer at Orcan Energy AG, said in her presentation, that unused waste heat sources can be used in a simple and economical way. Her company sells their solutions across many different industries (metal, cement, automobile etc.) and they already developed 600 plants worldwide and saved approximately 140000t CO2. The company uses

the organic rankine cycle (ORC) and organic refrigerant instead of water. This way, electricity can be generated at lower temperatures and at lower pressure. There are no custom builds by Orcan Energy and standard modules are used leading to readily available components and very reliable technical parts with an easy level of maintenance. The generated waste heat is usable in the form of hot water, steam, hot air and any other medium. Further, the integration of the system is very simple (only connection to the water circuit and to the electric circuit needed). The operation of the plant runs completely automatic. In summary, she stated that the plants allow for an economical, flexible, and robust way of waste heat utilization. According to Ms. Schwarz, one thing that should change in the future is the bureaucracy: The application regarding permits takes a long time and the project cannot be implemented before the bureaucratic process has been settled. Therefore, accelerated procedures are desirable for the future.

Presentation: "Development of High-Temperature Thermochemical Energy Storage Utilizing Metal Hydride"
Dr. Itoko Saita, Senior Researcher at the Global Zero Emission Research Center (GZR) of the National Institute of Advanced Industrial Science and Technology (AIST), mainly deals with thermal storage systems. And even though there is no separate department for waste heat usage at AIST, it is still a very relevant subject within her institute. She conducts research onCarnot batteries and thus on heat that is converted into electricity and stored, and vice versa. For this storage process (e.g. chemical reactions for heat storage), heat storage materials are very crucial. This thermochemical energy storage involves the chemical reaction of titanium and hydrogen (Ti+H2 = TiH2). In the process, temperature increases very quickly from room temperature to 900° and thermochemical energy can be stored as long as metal and hydrogen are kept apart. The efficiency of the system has been increased through tests but is not fully evaluated yet. The research project has already run 200-300 test cycles.

1.4. Session 3: Infrastructure for Waste Heat Utilization

As chair of this session, **Prof. Dr. Peter Radgen, Head of graduate and research school energy efficiency Stuttgart (GREES) and Head of research department Efficient Energy Use at the University of Stuttgart,** started the last session of the workshop by citing an AI-generated speech from Chat GPT on waste heat utilization in Germany and Japan. He especially focused on differences in technology, acceptance, and economical issues. The AI-generated speech stated that both Japan and Germany rely on waste heat to achieve energy efficiency and emission reduction and that both countries have their own strengths and weaknesses and that they can learn from each other.

Presentation: "Infrastructure for Waste Heat Utilization in Germany: Current Status and Challenges"
Johannes Dornberger, Advisor Energy Economics & Politics at the AGFW (Energy Efficiency Association for Heating, Cooling and CHP), presented different aspects of the waste heat infrastructure in Germany. The AGFW has over 600 members from which two-thirds are heat suppliers, the other third is distributed among manufacturers, planning offices and research

institutions. A project group about waste heat developed the guidelines for waste heat utilization. In his opinion, waste heat is also becoming increasingly important at the federal political level as it is possible to use potentials and energies that already exist. There are three steps that should be followed regarding waste heat: The first step is to avoid waste heat if possible; the second step is to use waste heat internally; and only then in a third step, the external use comes into play. However, a problem occurs about the third step: Waste heat is usually not generated where the demand is (separation between industrial and residential areas). Thus, the waste heat must be distributed via heating networks to fully use its potential. Other ways to transport heat are not often used. Next to those local discrepancies that can be overcome by heating networks, there are also temporal discrepancies which can be overcome by heat storage and temperature discrepancies which can be overcome via large heat pumps. To ensure that enough heat can be supplied at all times, redundant heat generators can be used. Mr. Dornberger then proceeded to present the non-technical infrastructures such as insurance solutions which are not available yet. Therefore, a public fund or insurance solutions from the state to hedge against risks are used. Another important aspect to uncover and utilize the waste heat is a waste heat register or platform that provides valuable information. He summarized that funding programs and regulations can help, but the central point will be municipal heat planning in order to promote regional solutions. The temperature level of heating networks cannot be planned across the board but must be considered on a case-by-case basis.

Presentation: "Overview of Heat Supply Business in Japan"
Yoshihiko Kikukawa, Chairman of Management Committee at The Japan Heat Supply Business Association, stated that the heat for district heating in Japan is provided regionally and collectively. In this regard, 75 companies operate in 132 regions and the total supply volume is approximately 1 billion EUR. Regarding the consumption of thermal energy, more and more cold has been sold in recent years. After 2011 (earthquake catastrophe) more energy was saved so that the consumption decreased. After the introduction, Mr. Kikukawa gave an example of a project in the Tokyo Waterfront Odaiba. In Odaiba, waste heat is used, so that energy consumption can be decreased by 36.3% and CO2 emissions can be reduced by 44.4%. In general, he stated that there are regional differences in the use or deployment of heat pumps in Japan.

Panel Discussion: "Efficient District Heating and Cooling Networks of the Future"
Panelists:

- *Prof. Dr. **Peter Radgen**, Head of graduate and research school energy efficiency Stuttgart (GREES) and Head of research department Efficient Energy Use, University of Stuttgart*
- *Mr. **Johannes Dornberger**, Advisor Energy Economics & Politics, AGFW (Energy Efficiency Association for Heating, Cooling and CHP)*
- *Mr. **Yoshihiko Kikukawa**, Chairman of Management Committee, The Japan Heat Supply Business Association*

In the panel discussion which Prof. Peter Radgen moderated, it became clear that there are small differences in concepts for the forward and reverse flow of heat and cold. In Japan heat consumers are not connected to the return/reverse line. In Germany this is possible but not often executed. Further, in Germany and Japan cities are the places where the heating networks are most dense and a focus on urban areas and large cities remains in Germany. In Japan there is a law regarding heat distribution, but it is difficult to secure external supply in rural areas because there are not many big customers, and the initial costs are very high in rural areas. Therefore, rural places are supported by the Japanese Ministry of Environment (MOE) to promote decarbonization. In Japan there are also obstacles to expand heating networks in densely populated regions like Tokyo as it is difficult and costly, but there is already a very large network (greater chances when new building or housing areas are built). In Germany, the challenges of expanding infrastructure within cities are just as present, it is difficult to connect buildings to the grid at all since regulatory obstacles must first be overcome and there are different regulations per region/city. A big advantage of district heating networks and thus a reason for further development in rural as well as urban regions is their sustainability (climate-neutral heat sources can be integrated). Further, the expansion of the cooling supply (district cooling) can be relevant in the future, but the demand is not as high as for district heating now.

Input: "Key Findings of the Topical Paper on Waste Heat Utilization Potential in Germany and Japan of the German-Japanese Energy Transition Council"
Peter Beck, Project Manager at ECOS, presented the key findings of a topical paper from 2023 on waste heat utilization in Germany and Japan. He explained that both countries have different approaches regarding processes and that there is also complementary know-how in both countries which could be shared with each other. Some suggestions were made for future actions: Regarding framework conditions and policies in both countries it is important to identify existing usable waste heat potentials from providers and users. This can for example happen via waste heat mapping. Also, there should be greater incentives for suppliers to offer their waste heat (e.g. subsidies). Most importantly, a German-Japanese exchange of experience on subsidy programs can help to learn from each other. When looking at the market design, it becomes clear, that in both countries large-scale waste heat markets do not yet exist and that political action is needed. While the German waste heat infrastructure mainly consists of district heating grids, Japan is experienced in the construction and operation of cooling systems. Again, a bilateral exchange regarding technologies and systemic concepts would be helpful, to enable further synergy effects for both countries. And lastly, with regard to technologies, industrial heat pumps, heat storage systems and thermoelectric generators can be further developed through German-Japanese cooperations.

Panel Discussion: "Waste Heat Utilization – New Chances for Cooperation between Japan and Germany"
Panelists:

- *Mr. **Masanori Kobayashi**, Director General, Smart Community and Energy System Department, NEDO*

- *Mr. **Gregor Westphal**, Project manager, Energy & Utilities, Evonik Operations GmbH*
- *Mr. **Markus Fritz**, Researcher, Fraunhofer ISI*

Mr. Westphal started the panel discussion, by stating that he looks at heat pumps with a lot of hope but also a little disillusionment. On the one hand, he realized that there are a lot of possibilities and potentials involved, but on the other hand the components are still very expensive (especially in Germany) so it cannot yet be used efficiently and economically. However, he is still optimistic that heat pumps will be used more often in the near future, but process adjustments are necessary, so that also the lowest waste heat temperatures can be handled. In the chemical park in Marl where his company is located, most of the waste heat is used internally in the park; but there is also a connection to the district heating network for the city of Marl. One of the biggest challenges in his opinion is that society is running out of time to achieve CO_2 neutrality.

Concerning heat pumps, Mr. Kobayashi explained, that NEDO is committed to achieving higher temperature in heat pumps, but it is also important to match the temperature level with the demand. Therefore, an optimization of overall concepts and design is very important. NEDO also includes AI and other innovative topics in their research to overcome future problems. The panelists agreed that integrated concepts are the future (e.g. waste heat from data centers should be used for near-by residential areas).

Regarding waste heat storage, there is lots of potential that still must be exploited (district heating is not the only way to transport heat). It was discussed, that storage technologies for using transport in Germany and Japan are very interesting and that heat storage is highly valued in Japan. However, it is difficult for Japan to carry out transports over longer distances due to earthquakes and other geological circumstances. The issue of earthquakes and risk of damages to infrastructure was then picked up in the discussion and it was asked, how Japan prepares for potential earthquakes? It is the case, that most pipelines are laid underground but are sturdily built and quick action is taken in the event of earthquakes. Many countermeasures are taken, to ensure a safe and resilient heat supply in Japan. The security of supply and the resilience of the system is also given in Germany.

At the end of the panel, it was stated that the political institutions in both countries should strengthen their promotion of waste heat utilization and that companies will not use solutions if it does not benefit them financially or in another way. Thus, frameworks and regulations must be built to make waste heat utilization economically worthwhile.

1.5. Closing Remarks by Peter Beck (ECOS) and Kazuyuki Imazato (NEDO Europe)

At the end of the workshop, Peter Beck said, that he was very glad that so many experts participated and especially thanked the Japanese experts for taking upon themselves such a long travel to be part of this important exchange. He summarized the event by noting the importance of the right steps towards reasonable waste heat utilization (1. Avoid waste heat, 2. Internal use, 3. External use). Further, he learned, that existing networks are not absolutely

necessary and thus their absence is not a boundary for new actions, since they can also be expanded at the start of new projects. He closed his speech by saying that he would be glad if the cooperative exchange between both countries continues and stated that a similar concept could be held in Japan next time.

Kayuzuki Imazato agreed with Mr. Beck and added that this long, but very interesting workshop was worth the travel. Also he continued by saying that there is still a lot to do within the field of waste heat utilization. But he is certain, that those barriers can be overcome. He was very impressed that through exchanges and networks a common vision of the goal and potentials have been reached but also that barriers were discussed in all presentations and panels. For him, future exchanges and cooperations would be very desirable to leave a good and sustainable world for the next generation.

2. Site Visits

2.1. Site Visits on the 28th of February, 2023

Thyssenkrupp AG

For a first site visit, the delegation went to thyssenkrupp Steel Europe in Duisburg. This facility in Duisburg is not only the location of thyssenkrupp's head office, with a total of five plants it is also home to every step of the diverse process of steel production. This includes the efficient production facilities for pig iron and crude steel as well as a large part of the rolling mill and further processing plants. The visit of the "Warmbandwerk 2" (hot strip mill) demonstrated the production of steel in extremely large quantities. With a capacity of around 6 million tons per year, the "Warmbandwerk 2" in Beeckerwerth is thyssenkrupp Steel Europe's largest production site. In hot strip production, steel blocks are rolled into thin sheets at more than 1,000 degrees Celsius in several rolling stands arranged one behind the other. At the end of the process a nearly 2km long steel roll is the outcome. Regarding waste heat utilization, a presentation was held by Dimitri Tulin, Senior Engineer at thyssenkrupp AG. He explained that they utilize part of their waste heat internally and also feed part of it into the heat supply network of the city of Duisburg. The waste heat network of this facility consists of 250 km pipelines and there is an additional 50 km grid for the internal utilization of steam.

Evonik Industries AG

After the first successful site visit, the group went on to visit Evonik Industries AG at the chemical park in Marl. This large park consists of multiple other companies such as Dow Chemical, Sasol or The Linde Group. The park is part of a bigger cluster in which internally and externally, resources and energy are supplied. This exchange between companies happens via a network of in- and outbound pipelines as well as via ships, trains and trucks. In the case of energy, a complex energy network exists with customers and energy markets. As part of the chemical parks goals to reduce emissions, the utilization of waste heat takes up an important part. Heat pumps are for instance used for an innovative way of waste heat upcycling. In the chemical park the network includes 13 producers and 35 consumers of waste heat and is stretched over a network of pipeline which is 11km long. The city of Marl is also being supplied with district

heating since 2016. Three heat exchangers are used for balancing and the power input is around 53 MW. Within the network there is a hot side which is above 80°C and a cold side which is below 60°C. In total, the utilization of waste heat saves an approximate amount of 100t CO_2/year. For the future, an investigation of new sources for waste heat shows a great potential with an additional capacity of around 50 MW (temperature range above 80°C).

2.2. Site Visits on the 1st of March 2023

Georgsmarienhuette GmbH

The second day started with a site visit to Georgsmarienhuette GmbH, which showed, that even though the steel industry in general is very energy-intensive, this large steel factory implements sustainable processes. Raimund Laermann, Head of Energy Management, explained to the group that the efficient use of waste heat generated during the production and processing of steel saves many tons of emissions in the plants of the GMH Group every year. The first goal is always to use as little energy as possible for all processes. In addition, GMH developed techniques to use waste heat (only waste heat which cannot be avoided) as efficiently as possible. The waste heat is used on-site for the production and excess process heat is fed into the regional district heating network. By feeding waste heat from steel production into the district heating network of the municipal utility, GMH saves more than 1500 tons of CO_2 every year. The heat from the facility supplies public and residential buildings in Georgsmarienhuette. This raises a significant heating potential in the Osnabrück region and makes an important contribution to climate protection.

Venner Energie eG

In 2012, the idea arose that the waste heat that is generated during the production of waffles by the company Meyer zu Venne should not go to waste, but that it gets utilized instead. After extensive preliminary talks and feasibility studies on the part of the municipality of Ostercappeln and the company Meyer zu Venne, the INeG engineering office developed a plan that was presented to the citizens of the Venne district of the municipality of Ostercappeln: The waste heat is used to heat several buildings in the village of Venne. In doing so, more than 1,200 t of CO_2 and more than 400,000 l of heating oil are saved. Until now, 174 buildings in the center of Venne were connected to the local heating network. Including an elementary school, a kindergarten, the village community center with local fire station, a nursing home, and a supermarket. With the recycled waste heat from Europe's largest ice cream cone factory, a nationwide model for protecting the climate has been created. The site visit and the presentation from Rainer Ellermann and Christian Meyer zu Venne, both are part of the Board of Directors, interestingly demonstrated the successful project, by also explaining challenges and barriers that had and still have to be overcome for such a pioneering waste heat project.

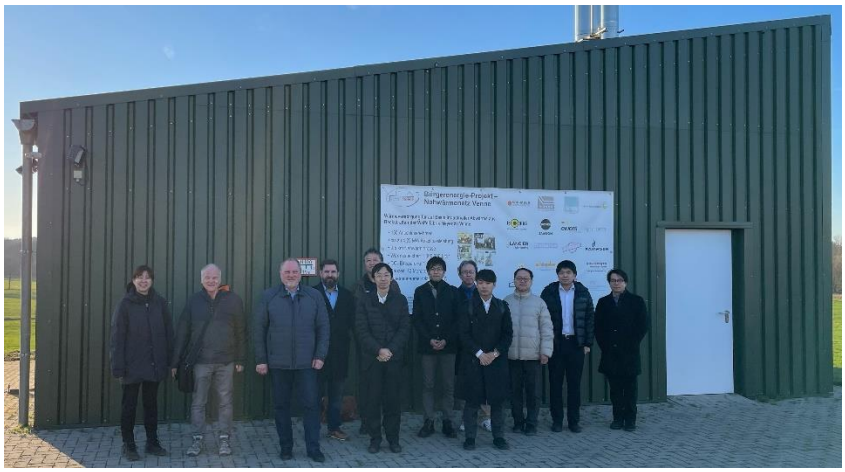
3. Impressions

Peter Beck from ECOS welcomed the participating experts from Germany and Japan.

In the workshop, 34 experts from Japan and Germany participated and discussed in several panels crucial aspects of waste heat utilization.

The workshop was simultaneously translated which enabled an efficient way of communicating and exchanging ideas.

Future German-Japanese exchanges and cooperation for waste heat utilization offer synergies for both countries.



Site visit at Venner Energie eG and Waffelfabrik Meyer zu Venne GmbH & Co. KG

Site Visit at Evonik Industries AG at the Chemical Park in Marl