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INDUSTRIAL EXCESS HEAT

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Industrial Excess Heat Recovery

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Introduction

The main background for Annex XV is the increasing awareness about industrial excess heat as a potential resource for contributing to an improved economy and sustainability in larger systems. Although industrial excess heat has been used and is being used to a large extent internationally, the potential for an even wider use is considered to be substantial. It can be used

- internally in an industry for primary energy saving
- in another industry or other industries in an industrial cluster
- between an industry/ industrial cluster and a district heating system
- between an industry/industrial cluster and e. g. greenhouses
- as a heat source in refrigeration plants for industrial or district cooling

Annex XV takes on a multi-disciplinary approach to the concept of excess heat recovery integrated in industrial complexes, aiming at the optimization of energy efficiency in global terms. The approach is based on industry needs and application, combining the knowledge of industrial technologies with energy efficiency and cost-effectiveness.

The findings from earlier work in the Annex lead to a number of areas of future work for Task 3. Thus, in this task the scope broadened and included some new aspects, which may not be considered separately for changed framework conditions within an industrial environment. The identified Subtasks of Task 3 are:

- **Subtask 1:** Combination of methods for excess heat identification and quantification
- **Subtask 2:** Consequences for excess heat levels of future changes in industrial energy systems
- **Subtask 3:** Operational aspects in industrial energy systems
- **Subtask 4:** Opportunity and risk assessment for excess heat projects
- **Subtask 5:** Compilation of innovative excess heat projects

Subtask 1: Combination of Methods for Excess Heat Identification and Quantification

Through questionnaires, information about excess heat opportunities can be collected with a reasonably small effort for the industry. A main problem, however, is the low rate of response or completion, reported by all participating groups. Regarding quality of received data in questionnaire approaches, it seems to differ between industry types and individual plants. The larger and more energy-intensive the industry is, the better the level of knowledge available in-house. On the other hand, complex energy-intensive industries often have complex heat exchanger networks, which may make it more difficult to identify the real excess heat levels, both amounts and temperature levels, without a deeper study. The directly observable level may sometimes lead to an underestimation.

With process integration methods, a more detailed picture of excess heat opportunities can be achieved. However, these methods require considerably more information about the energy system and more time and efforts from both energy managers and process integration experts. These more advanced methods are primarily of interest in energy intensive industries with complex heat exchanger networks.

The aim of this subtask was to create a network between groups working on and/or who are interested in developing a combination of methods. It was noted that industrial systems can be quite different from each other, leading to complexity when trying to find common and replicable solutions. Hence, it was highlighted the need for clear, replicable strategies and guidelines regarding concept development, flexible control systems, monitoring and self-learning assessments to empower industry to make informed decisions to meet their operational and environmental needs.

Subtask 2: Consequences for Excess Heat Levels of Future Changes in Industrial Energy Systems

Due to the need for deep decarbonization in industry and existing/planned policy instruments for that, industrial energy systems will probably undergo a big change into lower future levels of energy usage and, partly, novel process and energy technologies. This will mean a radical change in the situation for excess heat. Excess heat amounts will probably change substantially, whereas temperature levels can be both increased and decreased depending on which novel technologies and system solutions that will be used. Hence, planning future excess heat usage systems using today's data may lead to wrong decisions.

In this subtask, future changes in industrial energy systems that could possibly influence the amount of available excess heat and its temperature levels was investigated. Examples of such changes are radical energy efficiency measures, technology changes, integrated biorefineries, electrification (based on renewable electricity), CCS/CCU/BECCS, renewable heat sources, and industrial heat storage systems.

Excess heat is available in a short-term perspective, whereas some of the measures listed above will not be introduced earlier than in a 10-15 year perspective, for technical, economic, and/or political reasons. Hence, it is crucial to develop implementation strategies that adopts both short-term and long-term perspectives in order to achieve deep decarbonization of the industrial sector. Future scenario studies should therefore always be performed in big industrial excess heat projects.

Subtask 3: Operational Aspects in Industrial Energy Systems

Excess heat in industry is often characterized by short-term and seasonal variations of both amounts and temperature levels. In some industries, such variations are minor whereas they are substantial in others. This can complicate its usage both internally and externally. Excess heat can be subject to different optimal integration concepts and combinations with other sources. An optimised system must benefit from the flexibility of the system and interconnections. Industry is overwhelmed by the number and complexity of such possibilities and needs clear answers and strategies in terms of concept development, flexible control systems, monitoring and self-learning assessment.

Therefore, new concepts for industrial energy supply systems, which support the integration and work like flexible consumer for electric grids, increases efficiency by optimal control of the overall system, as well as utilizes excess heat are very promising, using the possibilities of digitalization.

Data measurement, monitoring and control in excess heat usage and other renewable projects are sometimes crucial. In addition, internal industrial processes can be involved, as the whole system should be optimized. Hence, monitoring and control serve two purposes, i.e. to make the whole system operational and to optimize it technically, economically and ecologically in an online flexible perspective.

Subtask 4: Opportunity and Risk Assessment for Excess Heat Projects

Excess heat projects have not yet reached their full potential due to a number of risks and challenges; these include informational risks (within organizations and externally amongst stakeholders), which, amongst other manifestations, can lead to economic risks. There are also technical risks and uncertainty regarding the long-term availability of excess heat and lock-ins associated with existing technologies. Thus, there are several reasons why excess heat projects are not implemented as much as could be expected.

A robust policy framework can provide the necessary certainty that is required for all relevant counterparts to confidently explore the potential that excess heat from industry offers, but if not in place, can cause uncertainty and a lack of confidence from investors and companies seeking to tap into excess heat potential. Thus, it is imperative that risk assessments-whereby all risks are assessed from a variety of perspectives such as technical, legal, social and investment-are thoroughly explored with mitigation plans outlined.

This sub-task seeks to capture the experience from projects that are exploring excess heat use, from a number of different angles. The projects outlined help to illustrate how the aforementioned risks and challenges arose in their respective projects, and the strategies that can be deployed to counteract this.

Overall, the consensus from the project surveys was that strong policy frameworks can provide the certainty for all parties to be able to pursue excess heat opportunities. On the project level, iterative risk analysis and mitigation, along with strong stakeholder engagement, were identified as crucial strategies to employ to enable greater risk identification and mitigation. The insights gained can help all stakeholders (i.e., users, investors, suppliers and policy makers) to obtain a clear understanding of the associated risks and to develop mitigative strategies when deciding to develop an excess heat usage activity or endeavor in order to give it the greatest chance of success.

Subtask 5: Compilation of Innovative Excess Heat Projects

In participating countries, many excess heat projects are ongoing or planned. Some projects are of a more innovative nature, dealing with possible solutions for or improving knowledge about aspects for facilitating increased use of industrial excess heat.

The projects reported deal with many different technologies, systems, types of industry and aspects. They clearly show the fast and interesting development in novel technologies/systems for industrial excess heat usage. The variety of industry types included shows that there is a potential in most types, which should be considered when building new plants, introducing new technologies/systems for e. g. decarbonization, and in revamping situations. As has been shown in the projects in this task, cooperation between industries or between an industry and a district heating/cooling system is in many cases a fruitful and economically interesting way of using industrial excess heat. A key issue, discussed in many reports, is the importance of putting the excess heat into a system perspective, thereby identifying optimal use of the excess heat together with or in competition with other measures for energy efficiency/GHG mitigation.

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About the IETS TCP

The IEA TCP on Industrial Energy-Related Technologies and Systems (IETS TCP), founded in 2005, is dealing with new industrial energy technologies and systems.

The mission of IETS is to foster international cooperation among OECD and non-OECD countries for accelerated research and technology development of industrial energy-related technologies and systems. In doing so, IETS seeks to enhance knowledge and facilitate deployment of cost-effective new industrial technologies and system layouts that enable increased productivity and better product quality while improving energy efficiency and sustainability.

Through its activities, IETS will increase awareness of technology and energy efficiency opportunities in industry, contribute to synergy between different systems and technologies, and enhance international cooperation related to sustainable development.

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