IETS TOPIC SHEET
No 17
October 2022

CONSEQUENCES FOR EXCESS HEAT LEVELS OF FUTURE CHANGES IN INDUSTRIAL ENERGY SYSTEMS

Reference

Based on the final report from IETS TCP, Annex XV, Task 3, Subtask 2:
Consequences for excess heat levels of future changes in industrial energy systems

Authors:
René Hofmann, Anton Beck, Leisa Burrell, AIT, Center for Energy, Austria
Thore Berntsson, Chalmers University of Technology, Sweden

Topic sheet prepared by Per-Åke Franck, IETS TCP Secretariat.

Introduction

Annex XV, Task 3 includes five subtasks. In this topic sheet subtask 2 on *Consequences for excess heat levels of future changes in industrial energy systems* is presented.

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 were 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 usually 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.

In this subtask three general projects were included in the analyses.

Analysed Projects

Sweden (CIT, Chalmers): Effect of process decarbonisation on future targets for excess heat delivery from an industrial process plant.

This project developed a systematic approach that can be used to analyse how different decarbonisation options may affect the potential future availability of excess heat at a specific plant site. The approach is based on the use of consistent, energy targeting methods based on pinch analysis tools, and therefore relies on comprehensive data about process heating and cooling demands. The results from case studies, in which different decarbonisation measures are assumed to be implemented, show that deep decarbonisation can have significant impact on the availability and temperature profile of industrial excess heat, illustrating the importance of accounting for future process development when estimating excess heat potentials. The effect of these decarbonisation pathways will be different depending on the technology used, the type of industry, and specific site conditions. Availability of excess heat might increase as well as decrease, and the effect will be different depending on the temperature level considered for the excess heat The case studies included: primary steel production, olefin production (chemical industry), oil refining, pulp production.

Italy (ENEA): SFERO, Systems for Flexible Energy Reusing CarbOn

Calcium looping (CaL) process as inherently circular process is a good candidate for capturing CO2 from hard-to-abate sectors such as the steel and cement industries. The CaL process exploits the reversible reaction between CaO and CO_2 at high temperature and it is composed by two reactors, a carbonator, where CO_2 is put into contact with the sorbent (CaO). The exothermic carbonation reaction occurs and the solid stream reach in $CaCO_3$ exiting the carbonator is sent to another reactor called calciner. In the calciner the endothermic calcination reaction takes place. The heat needed to maintain the calciner temperature around the set value is usually provided with combustion of fossil fuel with oxygen, for example coal or natural gas.

In the project optimal integration of the calcium oxide-based capture process for the decarbonisation of cement making process on a large scale was presented. Different processes was defined and, for each configuration,, the mass and energy balances along with carbon footprint was evaluated with particular attention to the thermal integration between the CaL process, the energy-intensive industry and energy production, in order to maximize energy recovery

Canada (CanMet Energy): Eco-Efficient Processes for Deep Decarbonization of the Industrial Sector

With the decline of market demand for newsprint and the rising demand for packaging material, Canadian thermomechanical pulping (TMP) mills have to evaluate their potential to enter new markets and produce new products. In response to these challenges, TMP mills should explore different transformation avenues. In this project, different business transformation paths for TMP mills are presented, considering the production for new pulp and paper products and the implementation of biorefinery technologies, highlighting the associated barriers, challenges, and key success factors.

A key message delivered to industry was that regardless of the avenue taken, a site-specific process integration study is recommended for a more efficient energy management of the entire system, relatively early in the process. In particular, in case the opportunity to recover water and heat synergistically between existing and new equipment could tip the scale between competing avenues, it should be identified early. It was also concluded that excess heat plays a central role in the argument that some product diversification avenues may be better suited in some TMP mills than others It was shown that the product mix and selected technologies have a direct impact on the amount of excess heat.

General Conclusions

In all three included general projects, the importance of putting excess heat opportunities in an industrial system perspective is highlighted.

In the Swedish project, possible consequences for excess heat availability in the case studies are reported. The results show clearly that possible and probable future changes can have a huge impact. However, no general conclusions on increases or decreases can be drawn, as the site-specific situation has a high influence. Also in the Canadian project, possible new technologies or routes in TMP plants will have a significant influence on energy efficiency and excess heat usage opportunities. In the Italian project, big changes in opportunities for excess heat-based power production or heat recovery in cement production of future technology changes are reported. In all three projects, the importance of identifying such consequences via system studies with e. g. pinch analysis is highlighted. This aspect seems to be crucial in real projects, as large changes in industrial energy systems will be very probable for the transmission in society towards deep decarbonization and as big projects for excess heat usage are expected to have a long lifetime. Future scenario studies should therefore always be performed in big industrial excess heat projects.

CONTACT Annex XV

René Hofmann, AIT, Center for Energy, Austria, rene.hofmann@ait.ac.at

CONTACT IETS

Thore Berntsson, Chair of the IETS TCP
Email: thore.berntsson@chalmersindustriteknik.se

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.