Introduction to Panel 4 Technology, products and systems

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Note: this summary includes the presentation made at the final plenary by the panel leaders (attached)

The improvement of technology, products and systems optimization in industry plays a major role to unlock the existing energy efficiency potential and deliver energy savings. Besides increasing industrial productivity, the approach to the whole system optimization, in a way that is cost-optimized for the end-user, can bring social and environmental positive impacts.

This panel is dedicated to all types of technologies, products and systems which undertake high impact on the support of energy and competitiveness strategy of the industrial sector, focusing on new developed technologies, innovative products and the whole system optimization towards improvements in processes and in energy efficiency. The main panel objective is to be stimulated by the latest developments in the whole industry sector.

From the papers presented in this panel, based on the topics submitted, we organized 5 thematic sessions, namely: cleaner production & climate mitigation, efficiency rise and saving options in industry – part I and part II, waste heat recovery, energetic networks – integration and micro grids, and energy efficient systems in the food industry.

Cleaner production & climate mitigation

Joeri Wesseling et al. (paper 4-088-16) describe the common characteristics of the energy-intensive processing industries (EPIs) in terms of their industry structure, markets, innovation strategies, networks, regulations and public policy, as well as sector specific deviations. Factors that drive or hamper high efficiency and decarbonisation related to the socio-technical systems within EPIs are identified and a research agenda with directions for fruitful research is outlined.

Model-based quantification of the contribution of industrial heat pumps to the European climate change mitigation strategy is presented by Stefen Wolf & Markus Blesl (paper 4-061-16). What is presented is the application of a detailed model using a combined top-down and bottom-up approach allowing the quantification of the final energy conservation and the CO_2 abatement potential resulting from the application of heat pumps to the EU-28 industrial sector. The CO_2 abatement potential for HPs is presented in a graphical way for the EU-28. In an industrial branch and country specific analysis both potentials are examined with regard to technical and economic boundaries. The possible contribution of industrial heat pumps to the European climate and energy targets is evaluated.

Christina-Stavrula Hatzilau et al. (paper 4-102-16) present energy saving incentives for the European glass industry in the frame of the EU Emissions Trading Scheme. The article develops an analysis on the potential for energy efficiency gains in the European Union glass industry resulting from a production process innovation by implementing a batch preheater to allow for waste heat recovery. This is presented as a competitiveness enhancing possibility in the context of the III phase of the EU ETS. The technological breakthroughs as well as case studies in the preheater operation are presented. Some results of the SILC I (Action 67/G/ENT/CIP/13/D/N03S02) EU project CO2Glass are presented as well.

Volker Weinmann (extended abstract 4-145-16) present the case of increased energy and resource efficiency for an air conditioner and heat pump system using R32 as refrigerant. Considerations for the refrigerant choice are mentioned and the relevant benefits such as increased resource and energy efficiency are analysed. The potential for free access to 93 patents for the use of R32 in air conditioning, heat pump and refrigeration equipment is also mentioned. As presented, the use of R32 seems to be a good solution for new and environmentally friendly refrigerants. Its low flammability does not provide any significant issue in its use.

Efficiency rise and saving options in industry – part I

Osamu Kimura et al. (paper 4-156-16) present a prototype tool that generates energy saving advice for small- and medium-sized enterprises (SMEs) based on smart meter data. This type of audit tool could expand the target of energy audits to almost all small and medium-sized enterprises (SMEs) with smart metering at a low cost per customer. The main objectives of the work are to provide customised energy saving advice that is generated automatically using (almost sorely) smart-meter data. The target customers are SMEs which are mainly active in the commercial sector and the users can be utilities, Energy service providers and multi-site companies with interval electricity meters.

Clemens Frassine et al. (paper 4-030-16) present energy saving options for industrial furnaces with the example of the glass industry. EU28 countries including Switzerland, Norway and Iceland are examined in a timeframe from 2015 to 2030. The diffusion of the efficiency technologies on a site level is facilitated through proprietary bottom up simulation model for energy demand. Potential impacts of energy efficiency technologies in the glass sector are presented while also the transferability of the specific approach to other sectors is addressed. The main impacts on energy demand that should be taken into consideration are the ageing of furnaces, the operation and load cycles, the use of cullet and the energy efficiency measures.

Francesca Bazzocchi et al. (paper 4-070-16) present an analysis of 208 real energy efficiency projects in the Italian steel and food industries quantifying the thermal and electrical energy savings potential. According to the analysis, the energy saving potential in steel sector is 6 %, corresponding to 811 ktoe per year. This savings could be achieved mainly (583 ktoe) for the thermal consumptions. The energy saving potential in the food sector is 8 % corresponding to 235 ktoe, also achieving mainly (160 ktoe) for the thermal consumptions.

The position of the cement industry as one of the largest industrial energy consumers in Taiwan underscores the need to understand the potential for improvement in terms of energy efficiency in this sector. Yun-Hsun Huang et al. (extended abstract 4-064-16) presents an estimation of energy efficiency improvement opportunities, considering a bottom-up model-based assessment to conduct a scenario analysis on the available energy saving potentials up to the year 2035.

Jürgen Peterseim et al. (extended abstract 4-170-16) present work on flue gas condensation – an option to maximise cycle efficiency of renewable and fossil fuel-fired power plants. The study shows the efficiency potential of flue gas condensation in power plants by analysing two case studies, one process heat and one electricity optimisation. The case studies are based on actual plants and include technical results, such as efficiency increase, economic results, such as investment and fuel savings and environmental benefits, such as emission savings.

Efficiency rise and saving options in industry – part II

Patricio Aguirre et al. (extended abstract 4-171-16) presents work on Oxygen Enrichment of Air Combustion of Natural Gas Furnaces in Steel Mills. Tests with and without oxygen injection have proven that the process is technically and economically viable for the re-heating furnace of the rolling mill process in the steel sector. In particular they have shown that a 6.5 % NG consumption reduction and a 5 % CO_2 emissions reduction is possible. These results came out of the OXY-RICH SILC 67/G/ENT/CIP/13/D/N03S02 SI2.666081 financed by the EU.

Motivated by the question "What are the economic energy efficiency improvement potentials and their associated costs in major Swiss industrial sectors", M. Jibran S. Zuberi et al. (extended abstract 4-099-16) present the results of a recent study that developed energy efficiency supply curves for both industrial motors and waste heat recovery systems, using a bottom up model. These analyses are a valuable tool for understanding policies and decisions of companies to comply with the ambitious reduction targets. The main conclusions are that the economic potential for process heat recovery is 14 % of the total final energy demand. Therefore, measures related to process heat integration and high temperature heat recovery offer large final energy saving potentials. Nearly 55 % of the process waste heat is estimated at temperature <150 °C (low or low-medium) and this low temperature heat can be recovered by e.g. heat pumps if a suitable end use is available and economically viable. ORC can also be an attractive option for low-medium temp. heat recovery if sufficient heat quantities are available. However, thermal energy savings potentials may be exploited with a slow rate due to several barriers associated with some of the measures including long payback times, high initial investment and space, transportability and process specific issues.

Benedicte Ballot-Miguet et al. (paper 4-011-16) present practical examples that illustrate the advantages of system level optimization in motor systems, achieving huge energy savings and encourage authorities and regulators to focus less on component efficiency and more on system efficiency in legislation and regulation.

Norbert Hanigovszki & Aksel Jepsen (extended abstract 4-056-16) et al. present work on savings with variable speed motor drives. Four case studies scenarios are analysed and a test case on a wastewater treatment plant is presented. System level optimization results in the highest energy savings and there are some key elements which make this possible, such as freedom of choice to combine VSD with the right motor technology for the specific application; the open availability of efficiency data, also in part load conditions, to be used in optimal system design; the use of energy optimized motor control is key to harvest the efficiency potential of electric motors; and the authorities and regulators which are encouraged to focus both on component efficiency and on system efficiency in legislation and regulation.

Waste heat recovery

"Extending building simulation software to include the organic Rankine cycle for factory waste heat recovery" is presented by Richard Greenough et al. (paper 4-096-16). The paper describes an extension of the functions of a commercial building energy modeling software IES to include ORC simulation. The use of the software is illustrated by its application to the waste heat from an iron foundry, which is typical of industries with significant waste heat.

Industrial excess heat exploitation in energy intensive industries is addressed by Daniele Forni et al. (paper 4-106-16). The paper analyses the configuration, specification, working data, economics and emission reductions of some ORC based waste heat recovery systems in Europe in the glass, steel and cement sectors. The paper also shows possible further developments of the ORC based waste heat recovery for electricity generation systems increasing the recovered energy, the efficiency of transformation and lowering the investment cost.

Richard Gurtner (extended abstract 4-042-16) presents a new design thermal energy storage system for discontinuous industrial waste heat recovery for temperatures up to 300 °C, which offers considerable advantages, compared to alternative storage concepts. So the project described aims at the identification of suitable solid materials (rocks), the determination physical properties, the determination thermal/chemical resistance and the optimization oft he bulk density. The aim after the construction of the test facility is to perform tests under real conditions, to determine the capacity, thermal output and efficiency, as well as the pressure drop.

Energetic networks – integration and microgrids

With the increasing power generation from intermittent renewable energy sources, the predictability of electricity generation is reduced and the need for flexibility in electricity demand increases. Since demand response is considered to be one of the most cost-effective balancing options and it can be applied by different sectors ranging from large industrial electricity customers to smaller consumers. Arzu Feta et al. (paper 4-126-16) evaluates the technical DR potential of the integrated steelmaking site of Tata Steel in IJmuiden, and concludes that if the availability rate requirements for emergency balancing programs in the Netherlands do not drop Tata Steel would need to pool with other suppliers in order to participate in the current emergency capacity programs.

Heat integration is important for increasing the energy efficiency of industrial processes. However, the increased interdependencies caused by heat integration can result in process operability issues. In order to investigate operability issues of heat integration for implementation in the oil refining industry, Sofie Marton et al. (paper 4-074-16) present a systematic overview of a wide variety of potential implications of heat integration projects and their connections to various operability factors and implementation issues. The analysis, based on qualitative assessments of actual suggestions for heat integration retrofits taken from an ongoing case study, concluded there is a need to consider operability for heat integration projects in order to identify additional design constraints, benefits and costs related to different design proposals.

Recognizing the importance of heat integration and industrial symbiosis to foster energy efficient and low carbon manufacturing industries, Clemens Schneider & Stefan Lechtenböhmer (paper 4-134-16) propose a strategy to model and improve the overall steel production process in Germany, from a cost and energy consumption perspective, by identifying site specific potentials for vertical integrated production of German steel production.

IIoT (Industrial Internet of Things) adds the industrial context to the IoT. The IIoT approach to an industry plant design devises a comprehensive interconnection of the system components, from sections up to single devices, in order to get a general and punctual understanding of the process. Stefano Farné et al. (paper 4-114-16) describe the principles that identify the new industrial era called Industry 4.0. In their paper, considerations about the innovative field bus EtherCAT have been made showing how it fits with Industry 4.0. The scenarios opened by the IIoT are remarkable and bring ”intelligence” to the factory and plants, increasing exponentially the speed of decisions, drastically reducing the possibility of errors and allowing to make the best choices thanks to the processing of a large amount of data.

Energy efficient systems in the food industry

Biogas production feasibility in food industry clusters is examined in the study of Emma Lindkvist et al. (paper 4-023-16). For each cluster three factors were analysed: global warming potential (GWP), acidification potential (AP) and eutrophication potential (EP). In addition three different types of systems were created and analysed; system real, system CHP, where the produced biogas is used to produce heat, and electricity and system vehicle, where the produced biogas is used as vehicle fuel.

Hardware in the loop evaluation of CHP-friendly hot water supply concepts in the dairy industry is presented by Gregor Shumm et al. (paper 4-132-16). As the high system temperature results in significant energy losses and a more efficient energy supply, for example by means of cogeneration, heat recovery or heat pumps, cannot be integrated in the rigid steam system, the development of a hybrid heater enabling the direct use of hot water (<95 °C) via heat exchangers is examined. Different process integration concepts are evaluated.

Panel 4. Technology, products and systems

Paula Fonseca, Sotirios Karellas

Main discussion topics (1/2)

- Decarbonization
- Heat pumps for waste heat upgrading
- New, environmental friendly refrigerants (R32)
- Smart metering
- Flue gas condensation

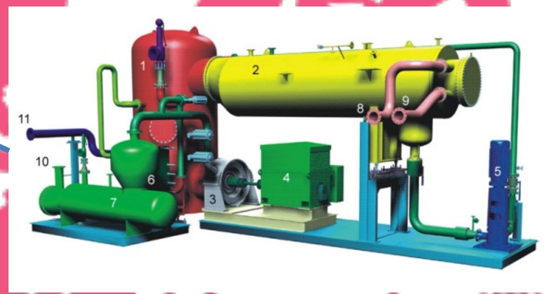
Main discussion topics (2/2)

- Tools for energy savings in the industry
- Advanced control in motor systems for rising of the Energy efficiency in the Industry
- Energetic Networks
- Microgrids
- Monitoring

Cement, Glass, Steel, Foundry Industry, waste heat utilization options and energy efficiencyrise

Electricity Generation

- Steam Rankine Cycle
- Organic Rankine Cycle (ORC)



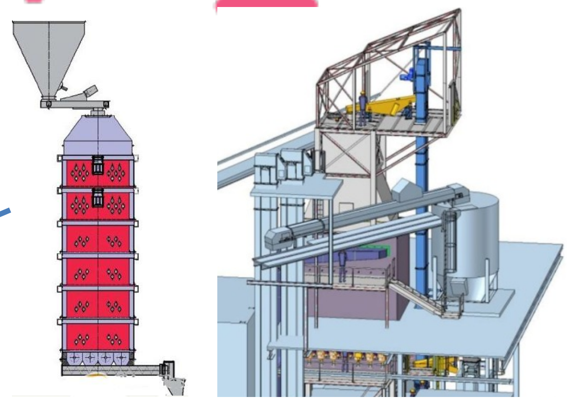
Oxygen Enrichment

- Natural Gas saving
- Emissions savings

Batch & Cullet Preheating

BAT

- Cullet only/Batch & Cullet Preheaters
- Direct/Indirect systems
- Flue gas / Steam as heating medium



PANEL 4

Thank you for your attention!

Ich danke Ihnen für Ihre Aufmerksamkeit !

Ευχαριστώ για την προσοχή σας!

Obrigado!