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DEEP DECARBONIZATION IN INDUSTRY

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Prof. Thore Berntsson, Chalmers Institute of Technology, Chair of the IETS TCP, and chair of the Programme Committee

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

Information about current projects can be found at the IETS website.

Background

The industrial sector is one of the highest GHG emitting sectors globally. For global GHG mitigation, all sectors must be seen in a sector cross-cutting context. This is, not the least, true for the industrial sector. Also, within this sector, a large number of competences, scientific disciplines and industry sector types must cooperate in order to achieve a deep decarbonization.

Introduction

The IETS TCP orginazed the workshop, which was intended for invitees only, and the main objectives were:

- To highlight the importance of process industry in radical GHG mitigation.
- To point out opportunities and hurdles.
- To identify hotspots for further RD&D.
- To improve international collaboration between disciplines and RD&D areas.
- To improve knowledge transfer to strategic industrial and policy decision makers.

Sessions

Based on the general objectives the workshop dealt in a broad way with most major aspects for deep decarbonization. Five industry-specific presentations served as a background and base for the further discussions in the subsequent sessions.

Technologies

In addition to existing and promising new efficient process technologies presented in variuous industrial roadmaps, there is a large number of R&D and development activities ongoing for technologies towards next generation of highly efficient and low-emitting processes. However, there is a strong need for further developments. Also, international cooperation and knowledge transfer are key aspects for effective and rapid industrial conversion.

There is not one single solution and hence a number of novel technologies and systems are needed in order to achieve deep decarbonization, although possible mixes of measures of course differ between different industry types and conditions. This means a radical change in industrial process and utility systems.

Although there is still a need for R&D on the technologies for carbon capture utilization and storage (CCUS) to reduce the cost and the energy consumption, emphasis should be put on system and integration aspects, infrastructure, financing, acceptance and better understanding of real GHG mitigation in carbon utilization (CCU) systems.

Regarding electrification, green electricity is essential to achieve decarbonization, however it will also be needed in other sectors, notably in transportation. Given the amount of energy involved, using electrification for deep decarbonization in industry alone would need enormous amounts of green power production. Different sectors will therefore most probably compete with available green power. A better understanding of optimal use of green power in society is therefore critical.

The need for radical change means a need for knowledge transfer to industry and development in industry as well as, e. g., new expert resources in industry. The complexity of the changes requires a new type of expertise. This was recognized in general terms for all new technologies and can become an important obstacle for industrial energy and process conversion.

Industrial Systems

Due to the need for radical changes to achieve a deep decarbonisation of the industrial sectors, process integration and other system-oriented methods should play an important and possibly enhanced role in identifying complex interplay between novel and traditional technologies in both existing and new processes.

Ex-ante evaluation methods (including prospective LCA), now being developed, will help decision-makers in industry and governments substantially in identifying robust long-term solutions, both in terms of economy and climate.

Systems for negative emissions in industry are seen as increasingly important for maintaining the atmospheric CO2 at an acceptable level. Opportunities for this and possible system level solutions have so far not been studied in much detail, although the potential especially in bio-based industrial systems is huge and should be further investigated.

The importance of industrial symbiosis, where industries exchange feedstocks and resources including industrial excess heat, is not fully understood or explored leaving another large potential unexploited. In order to use this to its full capacity, new business models and new system thinking in industry is needed. However, it is recognized that risk mitigation measures are needed to introduce flexibility and reduce dependency between facilities in case of, for instance, unexpected shutdowns in one facility.

Industry in a Circular Economy

Recycling of materials in a circular economy perspective should be developed considerably as a strategy for decarbonizing the industry. By doing so, the product lifetime is increased (with the same or different function), the energy use is lower than for producing new product, and for carbon-based products the carbon retention time is also increased.

Many products currently pose important challenges regarding their recyclability (i.e. quality, composition) and new products suitable for recycling and corresponding processes should be developed. However, knowledge about system consequences for industrial processes with recycling and new materials is not totally understood and should be improved.

Current infrastructure to facilitate the collection, reprocessing, reuse and recycling should be redesigned in a symbiotic way to improve the overall efficiency and reduce the overall cost.

To achieve further decarbonization, synergy between circular economy and renewable energy in industry should be identified for different processes and industry types for which improved or new infrastructure for hydrogen, heat, CO2 and residues are needed.

Innovation, Business Models, Risk

Possible lock-in effects, accentuated by the need for capital & planning intense and risky industrial conversion, can be substantial. Knowledge about how to avoid such effects should be improved.

Climate risk, be it regulatory, market driven, or direct damages, is a new dimension in risk-taking. Examples are future uncertainties about technical economic and climate consequences for new technologies/systems as well as uncertainties about e. g. future policy instruments and social acceptance. Risk-sharing and governmental responsibility are important aspects to develop further.

Both pilot and commercial scale demo plants are crucial for industrial acceptance of new technologies. However, such plants are expensive and available funding is by far too small.

Governments should have a big role in accelerating new investments in industry at all stages in the innovation and commercialization process. This role is directional and financial. A key factor for this is also cooperation between countries and industry types. Experiences of different approaches and types of policy instruments should be shared internationally.

Policy, Strategy, International Cooperation

Policy instruments for CCUS are unclear and one of the reasons for the slow development of this technology. Examples are policies for fossil, biogenic and direct-air CO2 and responsibility-distribution for CCU.

Regional policy systems can lead to “CO2 leakage”. Mechanisms for avoiding this should be developed.

A holistic infrastructure view, including benefitting from existing structures and industrial symbiosis is a key issue.

Openness, global trade, standardization and governmental involvements are of high importance.

The relatively low degree of international global cooperation on industry (compared with some other sectors) should be improved.

General Discussion

In the general discussion at the end of the workshop four main areas were discussed:

Roadmaps

Roadmaps create transparency about strategies, potential uncertainties and “forks in the road”, needed infrastructure development as well as investment and policy challenges. They are produced at different levels in industry, nationally and internationally (e. g. IEA). Besides regional expansion there is a need for sharing existing roadmaps and studies, and for analysis and understanding of e. g. the influence of different national and regional conditions.

Technologies and Systems

For all novel key technologies the system aspects and the understanding of future huge consequences for industrial energy systems are of special importance. Hence, process integration, respective scenario development and ex-ante evaluation as well as opportunities for negative emissions and industrial symbiosis should be included in the international collaboration.

Sector integration, in which industrial symbiosis is a part, was recognized as an increasingly important aspect for industrial GHG mitigation.

GHG mitigation consequences

The real GHG mitigation consequences of different measures are complex due the various interactions and there is an important need for improved knowledge as well as international knowledge transfer in this area. Two examples are real GHG mitigation consequences for CCU systems and differences between fossil and biogenic system measures. Robust and uniform procedures based on a system approach and life-cycle perspective are needed.

Implementation of novel GHG-mitigation measures

To improve the slow pace for implementing novel technologies and systems in industry, innovation and business models as well as supportive instruments that allow a more open knowledge transfer about results from demonstration projects and new real plants should be developed. In addition, and equally important, studies on how important parameters within and around an industry influence the performance of a new measure should be developed. One part of this work could be to improve the knowledge of how different measures are influenced and stimulated by changes in policy instruments and hence give inputs to decision-makers about the needs for future policy instrument types and levels.

As a general conclusion, it was unanimously recognized that there is a strong need for expanding the international cooperation within IEA in the industrial sector. In addition, the complexity and urgency of transforming industries towards more sustainable systems together with the limited availability of some resources such as biomass and renewable electricity calls for a closer collaboration with other societal sectors and other R&D areas.

CONTACT IETS TCP

Thore Berntsson, Chair: thore.berntsson@chalmersindustriteknik.se

About IETS

The IEA TCP on Industrial Energy-Related Technologies and Systems (IETS), 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.

Disclaimer

The IETS TCP was established as part of the IEA Technology Collaboration Programme. The IEA created the Technology Collaboration Programmes as a network of independent collaborations that enable governments and industries from around the world to lead programmes and projects on a wide range of energy technologies and related issues.