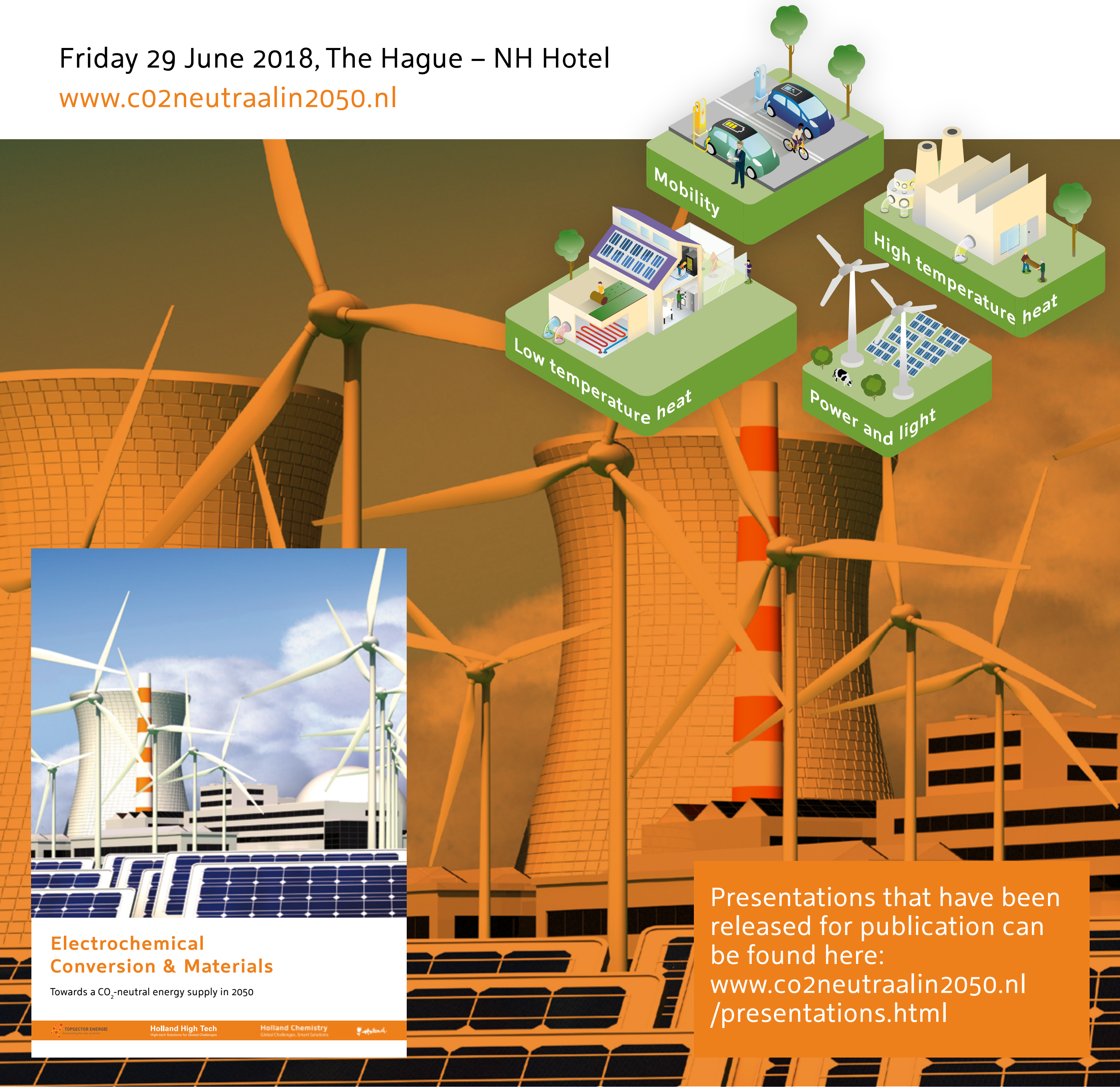
Netherlands conference on Electrochemical Conversion & Materials (ECCM)

Summary and results

Friday 29 June 2018, The Hague – NH Hotel

www.c02neutraalin2050.nl



Presentations that have been released for publication can be found here: www.co2neutraalin2050.nl /presentations.html

Ministry of Economic Affairs and Climate Policy

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Introduction

The Electrochemical Conversion and Materials (ECCM) conference took place on 29 June 2018. This conference was organized by the ECCM advisory committee that was established by the Ministry of Economic Affairs and Climate Policy and the top sectors for HTSM, Energy and Chemistry. The Ministry asked the advisory committee to organize the conference as a way to take the first steps towards establishing an ECCM knowledge platform. The current document provides a summary of the conference's most important conclusions and the suggested next steps.

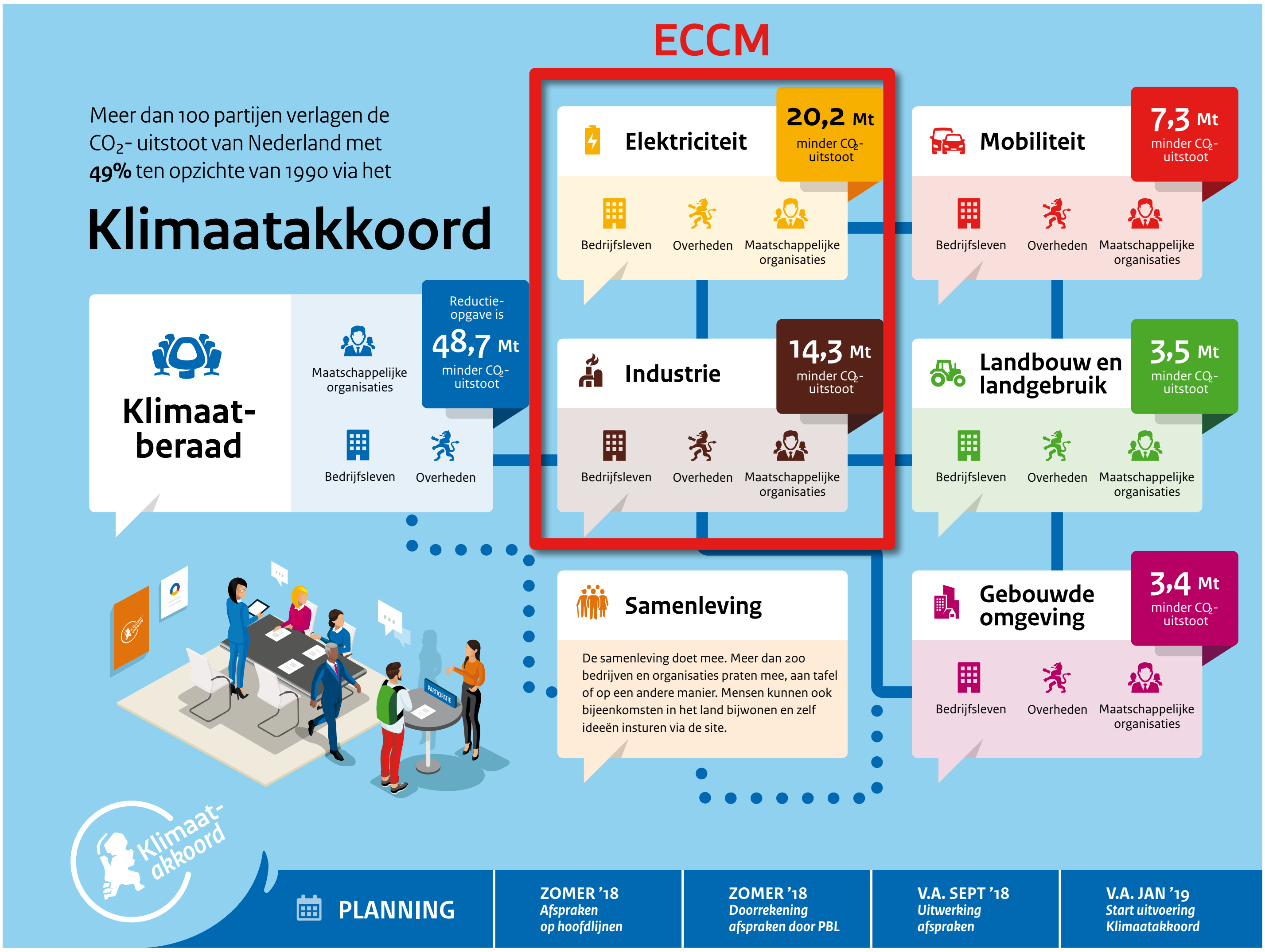
Opportunities

The opportunities for using hydrogen in the future energy supply will be strengthened by a rapid rollout of renewable energy solutions, required to achieve the targets of the Paris climate agreement. The reduction in costs of renewable energy sources over the past few years will help make this more feasible. For example, the costs of offshore wind fell from €0.16/kWh in 2009 to €0.0545/kWh in 2016. Costs of solar power (PV) will fall to 1 cent/kWh in the foreseeable future. This is equivalent to less than US$20 for a barrel of oil. These predictions for wind and solar exclude the costs to connect new capacity to the grid.

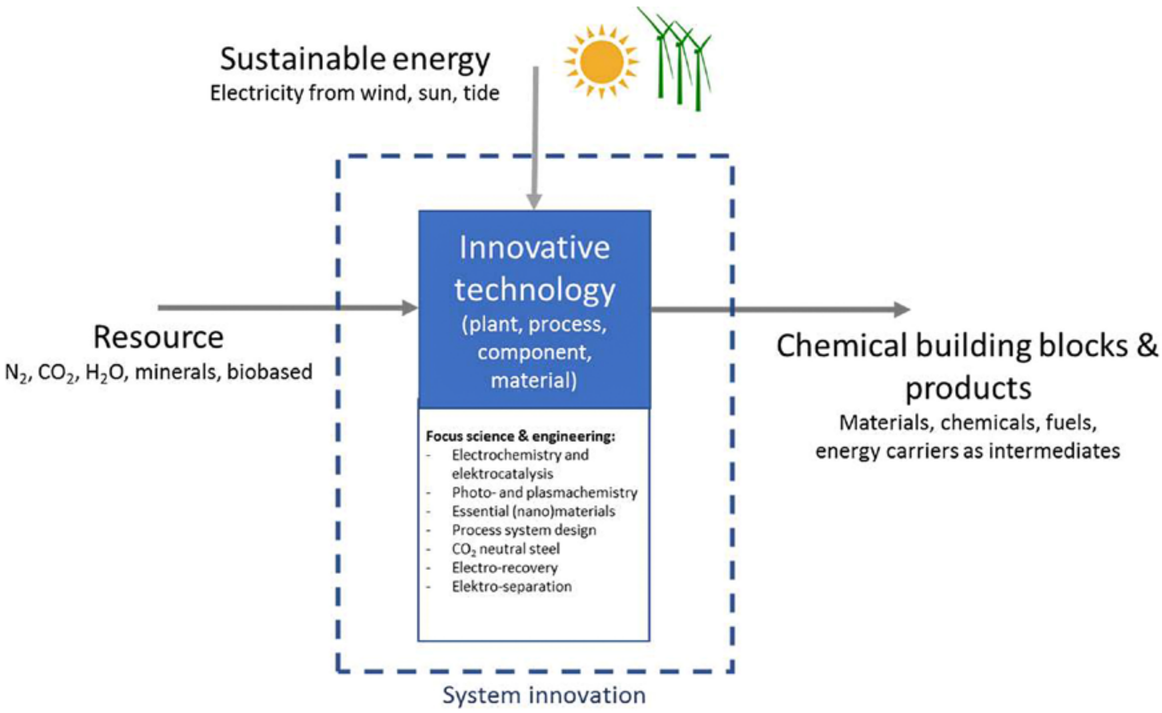
Challenges

'Energy systems cannot be decarbonized, they can be defossilized.' Our final goal must be a closed carbon cycle. Consumers will use more electricity directly, but not everything can be electrified. The biggest challenge for companies which are heavily dependent on fossil fuels for most of their income, is to make the transition from a molecule-based to an electron-based business model, and also to invest in green hydrogen so that they can deploy more electricity in those sectors where molecules will continue to play an important role. At the same time, chemicals and materials companies will need to start obtaining their carbon from renewable sources, which will also require the deployment of green hydrogen.

Outline of the Dutch climate agreement (in Dutch). The scheme highlights the major CO_2 reduction goals (in megatons reduction by 2030) of sectors involved: Electricity, Mobility, Industry, Agriculture and land use, Society and the Built Environment.



Electrochemical conversion & materials



Innovation

Innovations will be required to achieve this closed carbon cycle. Various short-term options and long-term visions of innovation were presented during the conference, for example in the fields of system integration, chemical conversion, electrolysis, materials and modelling. Among these were:

- replacing iridium as anode material in acid electrolyzers and researching and developing various anode/cathode materials, membranes and new cell designs
- modelling the distribution of water, gas bubbles and pH gradients in an electrolyzer
- controlling product specificity with electricity
- improving our understanding of interfaces (essential to improve the performance of electrochemical processes)
- oxygen catalysis (for electrolyzers) and oxygen reduction (for fuel cells)

The integrated vision of good governance for energy technologies was discussed as well, including how to deal with controversies such as populism, technocracy, social acceptance, exclusivity and ethical aspects.

Europe has the capacity to play a strong role and compete with countries like China and the United States, but this will require intensification and acceleration of the innovation agenda. To develop a robust position in this field and make the most of the opportunities for the Netherlands, an innovation fund of some €20-30 million per year will be required for R&D for fundamental mission-driven research, the development of a stronger knowledge base and further development of knowledge and technology. Resources will also be required for upscaling and demonstration projects.

Upscaling

Innovation will also require upscaling, most importantly the upscaling of electrolyzer technology from the MW to the GW scale, and eventually the TW scale. The current commercial electrolyzers have a capacity of 1-2 MW and are installed in 40 foot containers, which is also the scale of the planned ECCM-ISPT/EnTranCe demonstration project in Groningen. The long-term ambition is to scale up to 1 GW within 10 years. The major technical challenges for scaling up to high capacity electrolyzers are:

- finding and modelling the right electrode materials
- finding the optimal membrane
- building the perfect electrochemical cell
- carrying out electrolysis under high temperatures

Some of the projects in the planning phase have a capacity of 10-20 MW, and €80 million has been invested in an integrated pilot project at the Karlsruhe Institute of Technology's 'Energy lab 2.0', where in addition to electrolysis, solar PV, CCU and the production of fuels using the Fischer–Tropsch process are being studied. Eventually, 10,000 TWh of electrolyzers will be required, which amounts to a capacity of > 1000 GW, i.e. > 1 TW.

Human dimension

In order to successfully implement the ECCM agenda, it will be important to foster more trust between the stakeholders in the value chain, just as in the semiconductor industry, international cooperation is essential, and it is important to involve the public and maintain close ties with society in general. A programmatic long-term public-private approach will be required, and the use of scenarios and roadmaps is recommended.

Next steps

Inspired by the lectures held throughout the day, a working session was held with the international plenary speakers at the end of the conference during which the Netherlands' strengths in the field of ECCM were discussed and how they can be deployed to develop a robust position.

Building on the Netherlands' strengths

The Netherlands has a strong reputation in multidisciplinary cooperation. The Netherlands has highly educated and knowledgeable experts in many fields, in particular process intensification, catalysis, CO/syngas chemistry, basic electrochemical engineering, nanotechnology, high-tech materials science, solar/PV technology, membrane technology (including Proton Exchange Membranes - PEM), fluid mechanics and smart/green mobility. The Netherlands is home to many global leaders in the manufacturing and chemicals industries, who often conduct their R&D activities here too. It also has a strong SME sector (e.g. Evoqua, HyET, Nedstack and Avantium), relevant start-ups (e.g. Elestor and Hydron), many integrated engineering companies (e.g. Frames and MTSA) and there are plenty of highly skilled metalworkers. The ECCM website has an extensive list of active companies and SMEs: **www.co2neutraalin2050.nl/bedrijven.html**.

Invest in the future!
It is important to build on the top sectors policy, whereby the climate targets for 2030 and 2050 are an ambitious social challenge. This policy is already paying attention to urgent matters such as the lack of technically trained employees, social innovation, social support and international cooperation.

By annually investing some €20-30 million in research and development, the Netherlands can build a solid position in the field of ECCM to help meet the social challenges put before us by the energy transition. Knowledge can be made to flow, and applications can be developed, by making sure to distribute the funding throughout the innovation chain and encouraging strong cooperation between the various actors. Taking into account the recommendations produced by the working session with the keynote speakers, we recommend the following:

- Blue Sky/fundamental research (€3-5 million/year) is required in the field of membrane technology, new non-scarce and recyclable catalysis materials and Direct Air Capture & Conversion (improved absorption, efficiency, radical new concepts, process intensification and new upscaling concepts).
- Applied research and development (€15-20 million/year) is required for continued development, particularly in the fields of:
    - catalysis; by establishing a central national laboratory for testing catalysis materials and scaling up the production of these materials
    - electrolyzer/battery product stability; to be able to deploy this variable efficiently based on variable production of renewable energy sources
    - cell design; involving managing the variability of load, pressure and temperature (electrode design, membrane design, fluid mechanics, electrolysis and electrocatalysis of anodes and cathodes)
    - hydrogen storage, technology and conversion
    - CO_2 capture (CCAS or directly integrated with the electrolysis process)
    - CO_2 conversion, production of energy carriers, converting hydrogen into hydrocarbons for non-electric applications
    - system integration (total process = industry 4.0)
- Investments in advanced analysis equipment (€2-5 million/year) are required to support this fundamental and applied research.

In addition to resources for mission-driven research, it is also essential to reserve resources for upscaling and demonstration facilities. The ECCM advisory report proposes making a budget available of €200 million/year to this end through the existing investment programmes (RVO JIPs, SDE+/HER, DEI, SBIR, MIA-VAMIL, Next Level Investment Fund), supplemented by private contributions of €150-200 million.

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