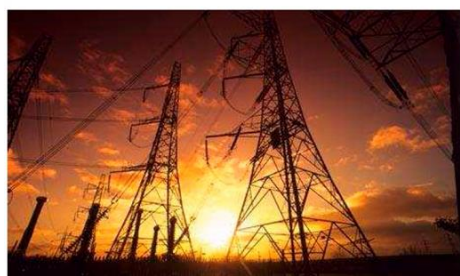


ELECTRIFICATION OF CHEMICAL INDUSTRY



TNO innovation
for life

With more solar and wind energy being produced, sustainable electricity supply in North West Europe is constantly increasing. This can offer great opportunities for the Chemical Industry! The supply of sustainable energy can bring reductions in energy costs, but it can also offer numerous opportunities to develop new, high-value products.

Applied knowledge institutes TNO and ECN, industrial and academic partners have initiated an ambitious research program focusing on the use of sustainable electricity in the chemical industry.

GREAT OPPORTUNITIES

The production of sustainable electricity from solar and wind in North West Europe is expected to be rising quickly in the coming decade. This source of inexpensive energy might be exactly what the Chemical Industry needs to enhance its competitive position. The supply of sustainable energy can bring reductions in energy costs, but it can also offer numerous opportunities to develop new, high-value products. And also the energy sector will benefit by overcoming the issues caused by fluctuating electricity supply.

This creates great potential to establish a frontrunner position, especially in areas where the chemical industry and the energy sector come together, as new wind capacity is planned at locations where extensive infrastructure is present, such as the Rhine and Eems Delta.

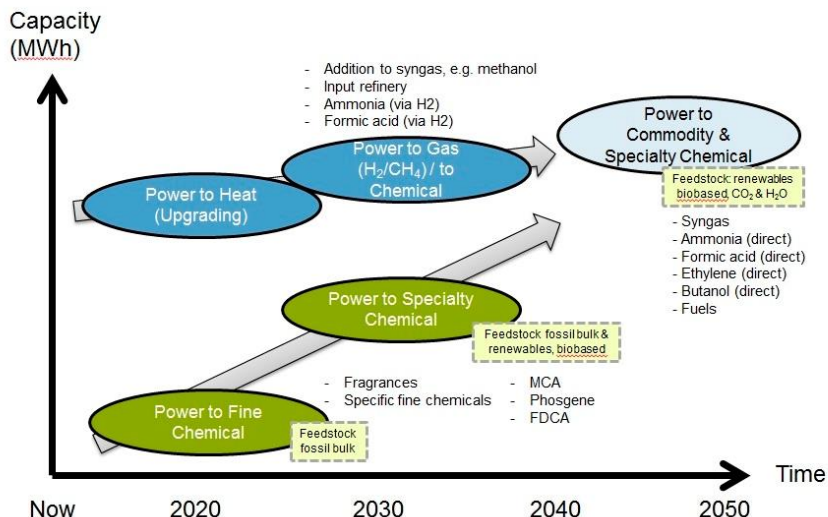
COLLABORATIVE PROGRAM

TNO and ECN have started an open innovation program that aims to initiate and facilitate collaborative development of technology and relevant business models with the right partners that can bring innovation faster to commercial implementation. The program addresses both the indirect and direct use of electricity within the chemical industry, and looks at the topic from a systemic point of view.

The activities span across four program lines:

- | Power-2-integrate: Exclusive discussion group, working on roadmap updates and high-level system studies.
- | Power-2-heat: use of electricity to generate or upgrade heat.
- | Power-2-hydrogen: use of electricity for direct chemical transformations via hydrogen.
- | Power-2-chemicals: use of electricity for direct chemical transformations via direct electro-conversion.

High level Road Map of Electrification



High-level roadmap for electrification of the chemical industry

The program aims to:

- Develop business-cases for electrification in the short- and long-term.
- Perform collaborative applied R&D to address the challenges.
- Bring technologies into industrial practice by pilot/demo activities.
- Spark larger shared innovation activities with growing involvement of academia and industry.

POWER-2-HEAT

This program line looks at how electricity can be used to upgrade heat and steam for efficient use in chemical processes. One example is the use of electric driven heat pump technology, but other ideas exist as well. Specific challenges within this line refer to those posed by load-following at flexible electricity supply, the feasibility of a retrofitting approach, process integration and the development of a sound business case.

POWER-2-HYDROGEN / POWER-2-GAS

Addressing the use of electricity for direct chemical transformations via hydrogen, this line looks at the production of hydrogen as well as further reactions (e.g. methanol, ammonia, formic acid). Main challenges that will be addressed within this line are the development of low-cost electrolyzers and the selection of financially attractive follow-up conversions.

POWER-2-CHEMICALS

This program line looks at the direct synthesis of higher value intermediates and products using sustainable feedstock (e.g. CO₂, biomass-derived). The main challenges that will be addressed are:

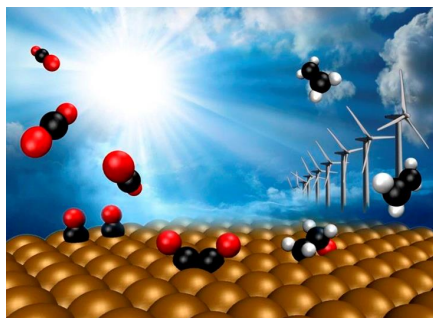
- Developing the right electro-chemistry and choosing the right platform.

- Reducing capital costs for electro-chemical cells.
- Increasing energy density and selectivity, choosing & using catalysts.
- Downstream processing.

HOW TO PARTICIPATE

There are four ways that you can participate in this program:

- Community participation: Exclusive discussion group, roadmap updates, high-level results.
- Shared R&D project: Pre-competitive R&D within collaborative program with a duration of 2-3 years; Participants get non-exclusive rights to the results and can influence the scope of the project along the way.
- Sponsored project: Pre-competitive linear development; small projects with pre-defined scope/time/budget. Participants get non-exclusive rights to the results and determine the scope upfront.
- Commissioned project: Exclusive bilateral project with pre-defined scope/time/budget.



MORE INFORMATION

Do you want to find out more about this Shared Innovation Program and how your company can participate and benefit?

Please contact us! We are more than happy to discuss your needs and interest in the program and find out how we can work together!

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