HOW TO CONNECT SECTORS

If the energy transition is to succeed, the electricity, mobility, and heating sectors must move closer together. Here the chemical industry is playing an important role

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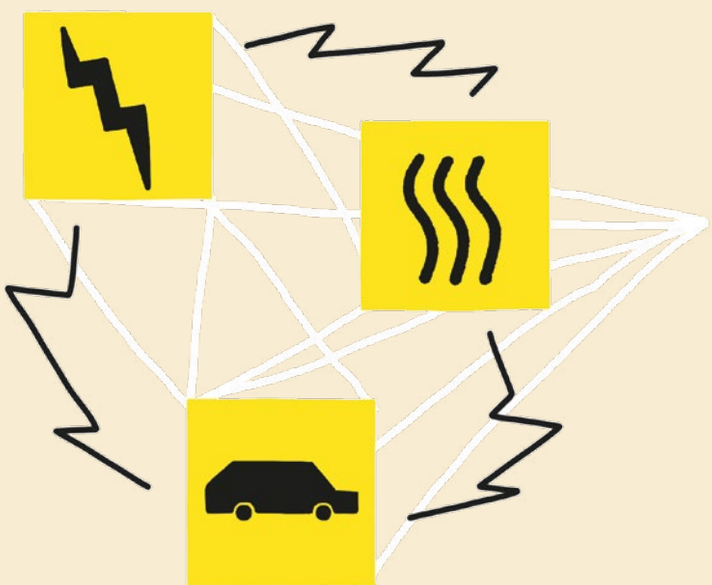

"The separation of the energy sectors cannot be sustained"

The German federal government has set itself the goal of reducing greenhouse gas emissions by 80 to 95 percent by 2050, compared to 1990 levels. In order to reach this goal, the use of fossil-based energy resources must be reduced to practically zero and, conversely, the proportion of renewable energies must be massively increased. With the exception of biomass and solar thermal energy, renewable energy sources are mainly available in the form of electric energy generated by wind turbines and photovoltaic systems.

Our energy system has traditionally been divided into three sectors: mobility, heating, and electricity. These sectors are supplied by a variety of energy sources. Mobility is primarily supplied by oil; heating primarily by natural gas, but also by oil, coal, renewable energies, and electricity; and electricity by coal as well as renewable energies, nuclear energy, and natural gas. The heating and mobility sectors are not greatly electrified today, but when they start to rely much more on electrical energy in the future, it will no longer be possible to sustain the traditional separation of the three sectors.

CUSHIONING FLUCTUATIONS IN SUPPLY

However, these sectors also offer the possibility of using flexible loads to cushion the fluctuations in supply that naturally occur when the sun and the wind are used as energy sources. So far, this cushioning has been done to a small extent through electric night storage heating systems, which transform surplus electrical energy from nuclear and lignite-fired power plants into low-temperature heating at night. In the future there will be a stronger focus on similar systems, such as those that charge electric vehicles with renewable energy during periods when there is an energy surplus. As a result, electric energy is becoming a link for connecting sectors that generally used to be separate.

The important role that this link between the sectors will play in the success of the energy transition was recently emphasized by a position paper and analysis that was part of the Academies' Project "Energy Systems of the Future."* This study concludes that the direct use of electric energy in the mobility and heating sectors will be considerable—and that it will also be the least expensive, as a rule. Conversely, synthetic fuels for vehicles and heating will play a significant role in a future energy system that will largely depend on renewable sources.

CHALLENGES FOR CHEMISTRY

This prediction involves an economic sector that has not been mentioned before in this connection: the chemical sector. The chemical industry is a relatively insignificant consumer of oil, which is its key raw material.

It consumes less than ten percent of the total oil produced. The decreasing use of oil as a source of energy poses two challenges to the chemical industry—but at the same time, these challenges could help it to open up new areas of business. Firstly, in the future oil as a raw material may not be available for many production processes in the same amounts or at the same levels of quality and prices as in the past. As a result, the chemical industry will have to find other production routes. Secondly, the increasing incorporation of electrical energy into chemical production processes will make available an additional component of value creation: the function of balancing loads in an energy system that is largely based on a fluctuating supply of electrical energy.

HYDROGEN PRODUCTION

Electrolysis is probably the most important process that can link the electricity system with the chemical sector. In all of the relevant scenarios, the production of hydrogen is a crucial element. In the abovementioned Academies' Project study of the energy transition, the authors conclude that a water electrolysis capacity of 15 to 30 gigawatts would be suitable for a system that is largely based on renewable sources of energy. This would correspond to about one third of Germany's current average electrical load!

In addition, hydrogen could be used in various value chains of the chemical industry, and carbon from CO_2 would definitely also be incorporated into the products. For example, hydrogen could be used to produce synthesis gas, which is needed to manufacture many chemical products. However, the costs of such a production process would be much higher than those of conventional methods. The prices of the conventional fuels produced with this chemical process would thus be considerably higher than the current market prices. As a result, it's especially important to initially develop such synthesis processes for high-priced or completely new products, because the additional cost of using electrical energy to make these products would be relatively insignificant. Such processes could be used for the market entry phase, and cost reductions could be achieved later on through economies of scale. That would make it a realistic alternative to expand the production of really large-scale fuels for vehicles and heating, such as Fischer-Tropsch fuels, methanol or oligomethylene ether.

* F. Ausfelder et al., *Sektorkopplung – Untersuchungen und Überlegungen zur Entwicklung eines integrierten Energiesystems*, publication series "Energiesysteme der Zukunft," Munich 2017

"The Rheticus approach is highly interdisciplinary"

PIONEERING TECHNOLOGY

The Rheticus project has the potential to eventually produce a pioneering technology of this kind. In this project, two especially interesting aspects come together. For one thing, the Rheticus approach does not begin with the generation of the hydrogen from which synthesis gas has to be produced. The synthesis gas is produced directly. In addition, the Rheticus concept aims to produce not relatively inexpensive fuels such as methanol and gasoline but much higher-value products such as butanol and hexanol.

These two factors, taken together, could lead to an interesting process that is not only convincing in economic terms but also could fulfill a desirable systemic function in the linkage between the electricity and chemical sectors. In addition, butanol is a promising fuel molecule that could create a direct link with the mobility sector as well.

AN INTERDISCIPLINARY APPROACH

Another striking aspect of the Rheticus project is its highly interdisciplinary nature. It draws on expertise from the fields of electrical engineering, chemistry, and biotechnology. This is a general characteristic of projects that aim to link various sectors. As a rule, they are so complex and cross-disciplinary that they can only be pursued through a collaborative approach—by scientists and technologists from a variety of disciplines, academic research, and industry. This is the only way to successfully mobilize the combined innovation potential of all of these fields in order to realize the energy transition through a strengthened linkage of the sectors. —

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