



SUMMARY OF THE POSITION PAPER

Change in the Raw Materials Base

Driving innovation throughout various fields, the chemical industry is the basis of numerous value chains and exerts a strong influence in almost all areas of our economy. Thus, ensuring the supply of raw materials at reasonable prices represents one of the greatest challenges for the chemical industry in the 21st century. Due to ever increasing population growth and the demand for raw materials in emerging countries in Asia, there are shortages in the raw material supply. Even though this situation has relaxed somewhat during the

creation of this position paper, in the long term one can expect that important raw materials will be more expensive and in shorter supply. Most of all, the chemical industry, which especially depends on the availability of organic and inorganic raw materials, must devise strategies for guaranteeing the raw material supply. According to the German Chemical Industry Association VCI, raw materials and energy represented 30% of the gross value for German chemical companies in 2007.

Living nature and the largest fraction of the value chain of the chemical industry are based on carbon compounds. Over the geological eras and via biomass as the intermediate, all fossil raw materials from atmospheric carbon dioxide have been generated from the sun's energy and promoted by biocatalysis. Consequently, the chemical industry can only access three carbon sources:

- **Fossil raw materials such as coal, natural gas and petroleum;**
- **Biomass as a source for renewable raw materials;**
- **Carbon dioxide/carbonates.**

With petroleum-based raw materials as the backbone for many products in the chemical industry, it is likely that their supply will be depleted first; thus, alternative resources need to be developed. In order to ensure the supply of raw materials, broadening the base of raw materials is essential for guaranteeing the worldwide competitiveness of Germany in the field of chemistry. The following core scenario is expected for the change in the raw materials base:

- For the mid-term, petroleum will remain the leading carbon-containing raw material for the chemical industry: however, it will be gradually supplemented and replaced by other raw materials.
- Natural gas will play an increasing role in the production of short-chained olefins as im-

portant basic products via the intermediate of synthesis gas. Whereas the indirect synthesis via methanol has already reached technical maturity, numerous questions still need to be addressed regarding the selective olefin production from synthesis gas according to the Fischer-Tropsch method. This increasingly applies for the direct conversion of natural gas into aromatic compounds or functionalized products.

- Coal – because of its high reserves and availability in important industrial countries – could play a long-term, more significant role as raw material for the chemical industry. Nonetheless, a great amount of carbon dioxide results from the chemical exploitation of coal. One solution might be capturing carbon dioxide and storing it underground.
- Taking into account the further growing world population, the demand for raw materials for the chemical industry must not be reached at the expense of producing foodstuffs or feed. There are two time frames regarding renewable raw materials upon disregarding markets artificially created by subsidies: In the mid-term, one can expect a further development of cooperative production with the foodstuff and feed industries in which cost-effective side streams can be used for manufacturing chemical products. From a long-term perspective, the integrative processing of non-food biomass will predominately emerge in the union of energy, biogas, fuels and chemicals. Also feasible is the application of biogenic methane

that can be exploited as a material similar to natural gas.

- Further in the future, renewable hydrogen produced from water without creating carbon dioxide could be significant as a raw material. Its possible basis will be electrolysis in connection with solar energy, photovoltaic, wind farms, electricity generated by nuclear power, high-temperature circuit processes as well as chemical or biological photocatalysis. Hydrogen produced by such means would be the key for the environmentally friendly conversion of coal, carbon dioxide and biomass into valuable products for the chemical industry.

Here, a bridge will span between fossil and renewable raw materials by linking them to the existing, highly efficient value chains. This will allow the usage of existing infrastructure with integrated resource-conserving production and energy systems and the chemical process know-how accumulated over many years. Thus, considered in parallel to an energy mix, the future supply of raw materials will be expectedly marked by diversification and a raw-material mix (biotechnological-petrochemical hybrid chemistry).

With all due considerations, it should not be forgotten that research still needs to be continued with regard to the fossil fuel production of petroleum, natural gas, oil sand and oil shale. For example, should success be attained in increasing the degree of deoiling (currently at 30-40%) of petroleum deposits, the oil reserves could be stretched by many years. Moreover, the reserves

could be clearly augmented by new exploration and production (E&P) techniques.

Furthermore, one should recognize that the time scale for the material exploitation of fossil raw materials will be broadened through success in significantly reducing the competition in energy use. This can be realized, for example, by battery-operated automotive drives, energy-efficient construction of homes or energy-efficient process optimization. Regarding concepts for using carbon-containing wastes, the thermal use should be considered equal to the material recycling with the latter being primarily used where recycled materials are qualitatively as valuable as 'virgin' material.

For metal or mineral raw materials, work should be devoted to improve the techniques for the production, increase in the recycling quota and substitution of dwindling raw materials with more available ones.

The active design of this change in raw materials, however, can only work by rapidly and drastically promoting research in the following areas:

- **Intensive fundamental research** in the field of material conversion for improving existing and creating new value chains, e.g. on the basis of synthesis gas, methane or lignocellulose;
- **Development of large-scale usable techniques** for producing hydrogen without automatically yielding carbon dioxide;

- **Priority-setting** with respect to catalysis, biocatalysis as well as reaction and process engineering with the aim for higher energy- and resource efficiency; and
- **Transfer of research results** to new economically and ecologically sustainable products and technologies as well as their increased pilot-scale testing.

This must be accompanied by the following activities:

- **Improving the availability of raw materials** by increasing the degree of efficiency of reservoirs (further development of production techniques), decreasing the competing energy use

as well as improving the recycling techniques for mineral raw materials; and

- **Creating public acceptance** through good quality and environmental compatibility of the new products and technologies.

The objective of this paper is to highlight the necessity and urgency of these research activities and to sensitize the political actors to create reliable framework conditions necessary for this change in raw materials. As an industrial country deficient in raw materials, Germany, in particular, depends on actively exploiting the opportunities linked with this change in the raw materials base in order to maintain and strengthen its competitiveness.

- GDCh** Gesellschaft Deutscher Chemiker e.V.
(German Chemical Society)
Varrentrappstraße 40-42, 60486 Frankfurt am Main, www.gdch.de
- DECHEMA** Gesellschaft für Chemische Technik und Biotechnologie e.V.
(Society for Chemical Engineering and Biotechnology)
Theodor-Heuss-Allee 25, 60486 Frankfurt am Main, www.dechema.de
- DGMK** Deutsche Wissenschaftliche Gesellschaft für Erdöl, Erdgas und Kohle e.V.
(German Society for Petroleum and Coal Science and Technology)
Überseering 40, 22297 Hamburg, www.dgmk.de
- VCI** Verband der Chemischen Industrie e.V.
(German Chemical Industry Association)
Mainzer Landstraße 55, 60329 Frankfurt am Main, www.vci.de

