

Preamble

At the beginning of 2010, the ForschungsVerbund Erneuerbare Energien (FVEE) [Renewable Energy Research Association] was encouraged by the German Federal Environment Ministry to devise a concept for a German energy supply system in the year 2050, which is 100% based on renewable energy. The Energy Concept 2050, which has been developed by 7 of the research association's member institutes, is a contribution to the Federal Government's Energy Concept which is scheduled to be adopted in October 2010. It includes the future energy demand of all areas of use: electricity, heat and fuel.

This Energy Concept should also form the basis for an FVEE paper which will be prepared subsequently, with recommendations on the 6th German Energy Research Programme which should be adopted by the Federal Government at the beginning of 2011.

Chapter 1 introduces the Energy Concept 2050 and shows which technological components are required to facilitate a sustainable, low-cost, secure supply using 100% renewable energy. Chapter 2 explains which technological transformation processes are needed to implement the Energy Concept 2050.

Chapter 3 describes the importance of research and development for this process.

Chapter 4 provides recommendations for political action which can initiate the process of transformation and/or which can speed this up.

Terminology

- **“Renewable”**: The Energy Concept 2050 defines an energy source as “renewable” either if it renews itself in the short-term, or if its use does not contribute to resource depletion. These are then called sustainably available energy resources. This definition applies to all direct solar energies, to indirect solar energies such as wind, hydro power and biomass, and also to geothermal energy and tidal power. According to this definition, nuclear fusion is not a renewable energy.
- **“Sustainability”**: The term sustainability is described as a triad of ecology, economics and social acceptability. It is based on the definition of the 2002 final report of the German parliament Enquete Commission “Sustainable energy supply against the background of globalisation and liberalisation”, which primarily gave the ecological dimension a certain precedence.

The following points characterise the Energy Concept 2050:

- **A range of options to guarantee supply reliability**: The Energy Concept 2050 describes a reliable, secure, low-cost and robust energy supply on the basis of a variety of renewable energies. Even with lower input or the temporary failure of a technology, this range of renewable energies, whose potential is very much higher than total energy demand, ensures that alternatives are available, so that 100%-supply based on renewable energy is guaranteed in every case.
- **Priority is given to energy efficiency**: Increasing energy efficiency is given the highest priority in terms of strategic requirements: The institutes advocate a substantial expansion in decentralised combined heat

and power (CHP), in order to increase the efficiency of energy use in renewable energy conversion technology. The improvement in the energy performance of the current building stock will largely be concluded by 2050 (see Chapter 1.3.7).

- **Electricity as a mainstay:** Electricity supply and consumption from renewable energy has a central position in the Energy Concept 2050.
- **Chemical energy carriers:** Renewable electricity thus becomes a primary energy, so that chemical energy carriers (hydrogen, methane) can also be derived from it, these are needed in particular for the long-term storage of renewable energy, including for the transport sector. The production of “renewable methane” implies a paradigm shift for energy storage.
- **E-mobility:** Transport in the Energy Concept 2050 is largely covered directly by electricity, or indirectly by electricity being converted into hydrogen or methane.
- **Combined cycle renewable power plant:** The “Combined cycle renewable power plant” principle (Chapter 1.3.6) is rolled out across Germany, with its systems engineering interaction of renewable energy and energy storage.
- **European interconnected electricity network:** The low loss transmission of electricity over long distances and energy balancing at European level play a key role in the use of fluctuating energy sources.
- **Role of biomass:** The use of biomass for energy is treated as a limited resource. In the medium- to long-term, energy crops should mainly be used for the production of synthetic fuels like kerosene for planes and ships, as well as the production of raw materials for the chemical industry. Energy recovery from biomass waste supplements this concept.
- **Solar heat:** in the Energy Concept 2050, solar thermal collectors make a major contribution to heating drinking water, to space heating, process heat and cooling supply in domestic buildings, and in local, district heating and cooling systems.
- **A high level of use with costs remaining relatively constant:** with optimal design, the Energy System 2050 is economically no more expensive than the current system. This is because of the link between the technological components described in the Energy Concept 2050, with the effects of learning and experience, and a cost/benefit analysis (Chapter 2.5).