Executive Summary

Limiting the increase in temperature to a maximum of 2° C requires a reduction of at least 90% in energy-related carbon dioxide emissions in the European Union and Germany, and thus the complete reorganisation of the entire energy system. Achieving the target is possible by using different technological paths.

In this Energy Concept, an energy scenario is presented which is based on a significantly more efficient use of energy resources, and for all residual energy to be supplied by renewable energy. The scenario has many advantages: there is enough potential available in Germany, Europe and in neighbouring countries, the operating risks of renewable energy are low, and the scenario is sustainable, as renewable energy is always available.

The following shows how such a system of energy supply, distribution and consumption, based on 100% renewable energy, would look and how it can function in 2050, how a high degree of supply security can be guaranteed, and for such a system to be cost-effective.

Implementing the Energy Concept 2050 means that the energy system must be transformed from a centralised, load-optimised system to a decentralised, intelligent, load and supply-oriented energy supply structure. Decentralised production will be supplemented by the construction of a high voltage direct current transmission network (HVDC) in Europe and North Africa. The networks require intelligent control, which allows energy demand and supply to be balanced on a regional and Europe-wide basis (Smart Grid).

An important element of the Energy Concept is a clear increase in energy efficiency by reducing energy demand, for example using very good thermal insulation, and through the efficient conversion and use of energy, for example by the use of electric motors instead of combustion engines, or by using heat from combined heat and power.

In order to devise as robust an energy supply system as possible, this consists of a mix of all renewable energy, in other words wind and hydro power, photovoltaics, solar thermal power plants (in southern Europe and North Africa), solar thermal heat production, the utilisation of biomass waste, geothermal energy and wave energy. In Germany and Europe the potential for renewable energy is significantly higher than energy demand, although solar energy and wind have the greatest potential. Biomass is mainly used as a material, and in the Energy Concept there is only marginal energy use, mainly in the form of biomass waste, because of the limited resources and the current competition for use with food production.

Electricity, as a universally applicable and easily transportable energy source, is a mainstay of future energy supply, as new power applications such as electromobility emerge, and at the same time, heat demand is significantly reduced by efficiency measures. In the Energy Concept 2050, power production is mainly undertaken by wind and photovoltaics. This is supplemented by combined heat and power plants, which are powered by biogas, as well as by methane or hydrogen, which is produced using renewable energy.

Heat demand is significantly reduced by using efficiency measures, which require the renovation of the entire building stock by 2050. Residual demand is supplied by solar thermal plants, by heat pumps using renewable power and by combined heat and power. Demand for cooling will increase because of the climate, and the supply of cooling will increasingly take place via cooling grids.

In 2050, mobility is above all electromobility, as electric motors are very efficient and primary energy consumption can thus be reduced by a quarter by using renewable-generated electricity. Biofuels, which have only limited availability, are mainly used in long-distance and freight transport, and in aviation. Renewable fuels from wind and solar energy offer an alternative to biofuels. In addition, electromobility makes available storage capacity for the entire energy system.

The construction and integration of large storage capacity in the energy supply system is a basic requirement for a large share of fluctuating energy sources. Here, storage capacity is kept as low as possible by a mix of different renewable energies, by balancing temporary regional over- and under-capacity at European level, as well as by the intelligent control of supply and demand.

For residual storage demand, different power storage is available. Electro-chemical power storage in particular balances short-term fluctuations. Medium- to long-term energy storage takes place chemically, either using hydrogen or synthetic methane, which are both produced using renewable energy. Heat storage is used as short-, medium and seasonal

storage. It is installed in individual buildings and is integrated as a large storage unit in heat and cooling grids, and allows full renewable heat supply and energy recovery from combined heat and power. The current water storage tanks will in the future be supplemented by latent-heat storage and chemical storage.

Synthetic methane is also used as a storage medium, produced by renewable energy from hydrogen and CO2. This allows the storage of renewable-generated electricity which is not required when it is produced, and which can be used as a fuel, for power generation in combined heat and power plants and to provide high temperatures. Synthetic methane is a substitute gas for natural gas, it can be mixed with natural gas in the transformation phase, and it allows the use of the existing gas infrastructure, such as gas grids and storage.

Economic calculations show that in the next few decades, transforming the energy system will lead to additional costs, but that from 2030 it will be cheaper than the comparable fossil-nuclear system.