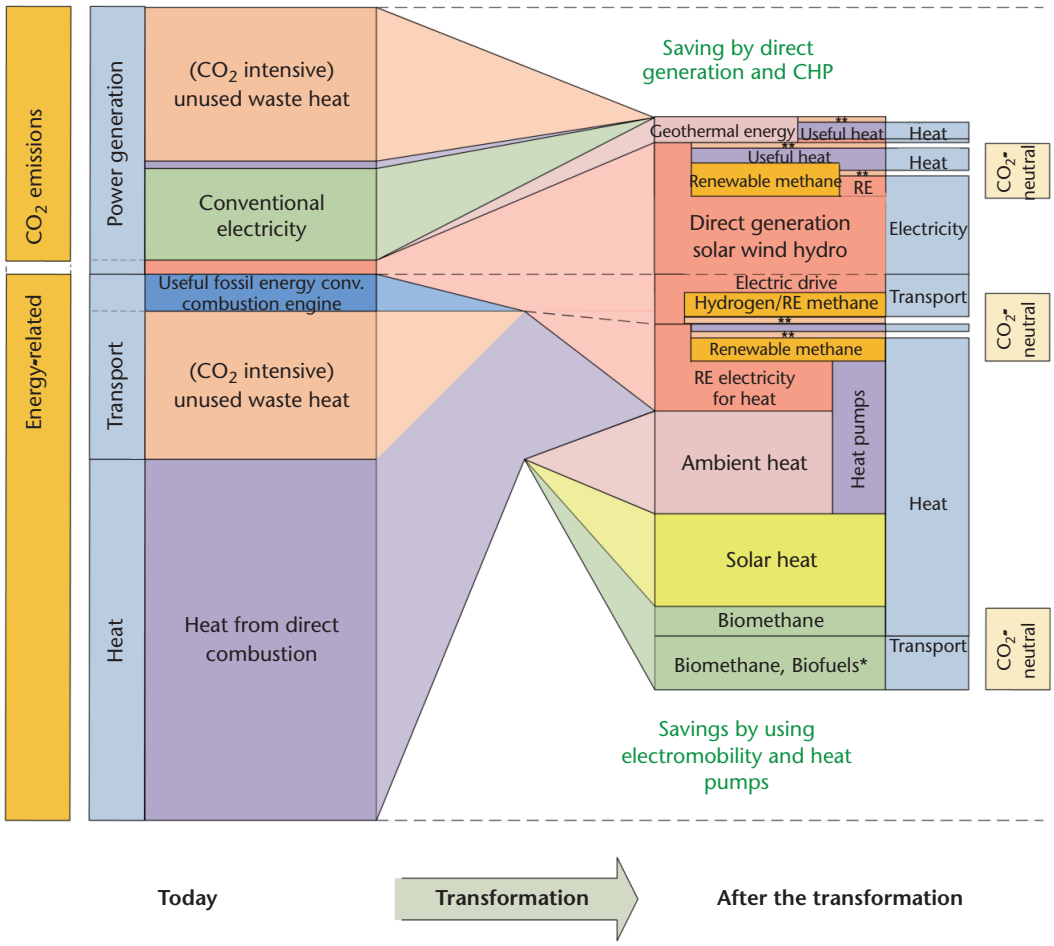
2. Transformation of current energy systems into the Sustainable Energy System 2050

Converting the energy system in Germany and in Europe into a sustainable energy supply implies a profound change in the current industry and service economy, which will extend in an evolutionary way over four decades. Here, the transition from the current energy system to the sustainable and largely emissions-free system which is described in Chapter 1 should be designed in such a way that it avoids technological errors, and that security of supply is also guaranteed during the transformation phase (no regret strategy).

Figure 8 summarises the essential components for transforming the energy system, using the example of the industrialised country of Germany:

In 2005 in Germany, primary energy demand, excluding the non-energy share, (such as crude oil for the chemical industry) amounted to 13.4 EJ, of which 34% was for the electricity sector, 43% for the heating sector and 23% for transport.

If we look at final energy, other relationships emerge: the share of electricity falls (18%) and



Source: Fraunhofer IWES

Figure 8
Diagram of total energy transformation from today to the Energy System 2050. The wedge-shaped areas in the middle of the chart symbolise the gradual transition from today's energy mix to the future mix.

The diagram is based on the volume breakdown for the 100% RE scenario 2050 (Chapter 2.5.1)

** = can also be other renewable fuels, such as e.g. renewable kerosene*
*** = unused CO_2-neutral waste heat*

Adjusted in accordance with [17, 26] and [17], using BMWi data [31] and Chapter 2.6

both the other sectors become correspondingly bigger (heat 54%, transport 28%). Electricity is already used today for transport, but this only amounts to a share of 2% in the transport sector, and has therefore not been included in the diagram.

In the future, direct combustion for heat usage should be replaced by heat from CHP, solar thermal energy and electroheat pumps which are supplied by renewable electricity.

The share of heat which is obtained from electricity, including heat from CHP, is included in the chart under power generation. Electricity should mainly be generated by direct production from solar, hydro and wind energy. For the load management of fluctuating energy sources, as well as a massively expanded electricity transmission and distribution grid and connected storage power plants (Pumped storage, compressed air, hydrogen or renewable methane in the natural gas network), heat pumps should be available both for the transport sector (electrically driven cars) and also for the use of heat, which are linked to a broadly expanded information network (smart grid). Power use in the heat and transport sector amounts to a total of 25% of electrical energy supply. Such a transformation is conceivable by 2050.

2.1 Structural change in the space heating sector

About 40% of final energy consumption comes from building operations, this makes it one of the main sectors for contributing to Germany's energy consumption. In order to achieve the target of a sustainable energy supply and the necessary climate policy goals, there is a need to reduce energy demand for heating and air conditioning in buildings, as well as an increase in meeting energy demand with renewable energy.

As a particularly large amount of energy can be saved in the building sector, it follows that the Federal Government's goals on energy efficiency will mainly be either achieved or missed in the building sector or in the area of space heating [30]. In the short-term, new buildings must be changed into energy plus houses, and the building stock must be brought to the level of a low energy house. This will result in reductions in consumption in Germany, which will exceed the 2008 targeted contribution from renewable energy by a factor of 3 or 4.

The Energy Concept 2050 states that the space heating sector must go through a serious structural change by 2050.

2.2 From natural gas supply to renewable methane

As already stated in section 1.2.3.2, as well as hydrogen, renewable methane can also be produced from surplus renewable energy. A paradigm shift in the philosophy of energy storage can be seen here. Large amounts of renewable electricity can therefore be stored chemically in existing gas networks, and can again be converted into electricity, heat or fuel, depending on demand. Gas and steam power plants with an electrical efficiency rate of up to 60% provide reverse current.

The construction of power plants which will initially operate on gas, and on combined heat and power, can begin immediately. The initial increase in demand for fossil gas will be offset in the medium-term by the reduction in gas-consuming heating for buildings and replacement by combined heat and power and electric heat pumps.

The Energy Concept 2050 assumes that total gas demand will already have fallen by 10% by 2020. [9]. In the long-term, gas demand will move towards zero, increasingly replaced by sustainably produced bio methane and by renewable methane from electrical surpluses. This means that the existing gas networks must also be adapted to the changing location of future energy sources. As with the electrical network, -