The Importance of fossil-fired Power Plants for a secure Energy Supply

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Abstract

In the landscape of German energy technology changes are currently taking on an unprecedented scale. The development of renewable energy sources has reached a momentum that was neither foreseeable nor planned years ago by anyone in any way. Additionally a political decision had to be made - due to the nuclear disaster in Fukushima - exit from nuclear energy by the year 2022. Therefore, the question poses itself whether it makes any sense at all to further advance the technological development in the field of conventional energy sources, in particular in the areas of coal and lignite. The renewable energy sources clearly have the disadvantage that for a fully comprehensive and round-the-clock power supply to a highly developed economy they are only suitable on a limited basis. Whether the electric current can be obtained from storages in the required order of magnitude, is more than questionable. To ensure a reliable and sufficient energy supply more conventional power plants will therefore also be mandatory in the future. But in order to survive the competition in generation units, power plants with low labor costs and fast start-up times are needed. Low labor costs require high levels of efficiency and these in turn can only be achieved using higher steam parameters and new materials.

Presentation GKM

The Großkraftwerk Mannheim AG (GKM) (Large-scale Power Plant Mannheim) has been operating for over 90 years in Mannheim, one of the most efficient coal-fired power plants in Europe. GKM generates electricity for more than 1.5 million people, commerce and industry and district heating for about 120,000 households - through combined heat and power (CHP) which is environmentally friendly and economical. For the DB Energie GmbH, GKM is also a major supplier of single-phase electricity.

The installed plant capacity (5 coal blocks) is 1675 MW gross or net 1520 MW, and the installed heating power (hot water) is 1,000 MWth. In September, a district heating storage tank (1,500 MWh, 250 MWth) was put into operation. Out of the net electric power 190 MW is available for the production of single-phase electricity. GKM is the largest power plant in Baden-Wuerttemberg.

Since 2010, block 9 has been producing a gross electrical output of 911 MW at the site. Intended is a 500 MWth of district heating and power generation of 100 MW.

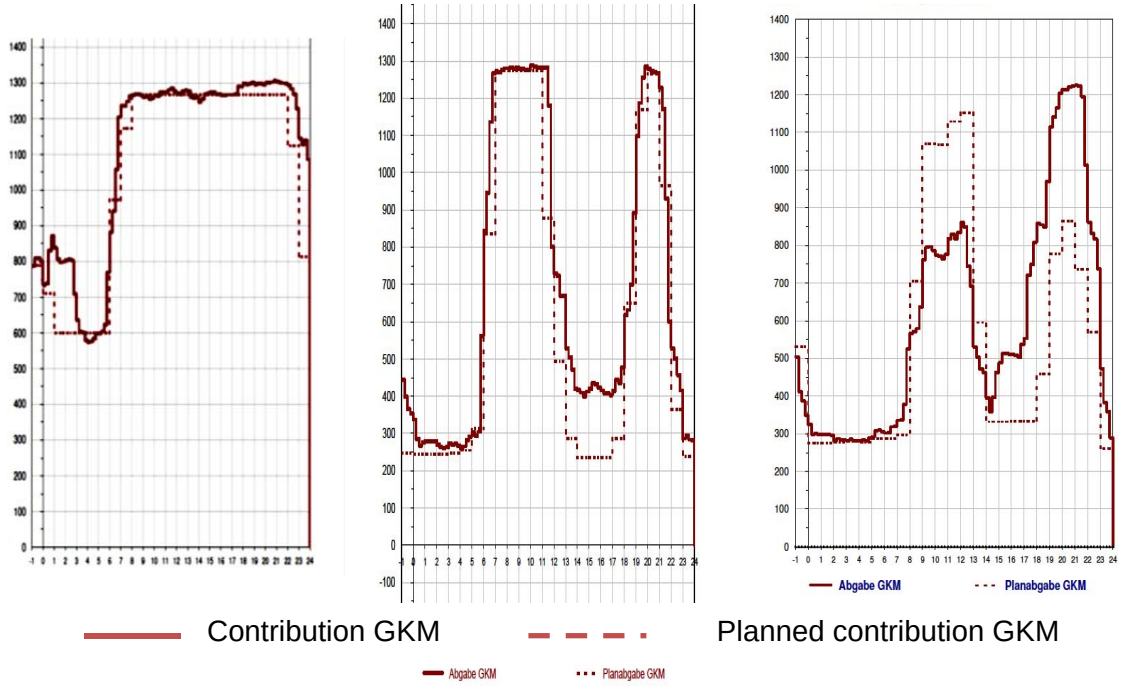
GKM is a joint venture of RWE Generation SE, Essen, ENBW Kraftwerke AG, Stuttgart and MVV RHE GmbH Mannheim.

Macroeconomic Data Regarding Energy

The development of renewable energy sources is strongly promoted in Germany. The volatile supply of wind and solar power has a significant impact on the operation mode of conventional power plants. While in previous years, after the reduction during the nights the full load was driven during the days, a power reduction now takes place around noontime made use of in particular by the massive photovoltaic usage. Moreover, there are in contrast to earlier times also significant differences between the planned and actual use. Current requirements mean much higher loads on equipment and personnel.

Method
earlier and today with plan deviation

Wednesday, 21.03.2007 Wednesday, 28.03.2012 Saturday, 16.04.2011



Contribution GKM Planned contribution GKM

Fig 1: Effect of the change in energy production on GKM-Power Plant implementation

At the end of 2012 the installed capacity of renewable energy in Germany was 74.2 GW, as about 136 TWh was generated, and the increase will continue in the coming years.

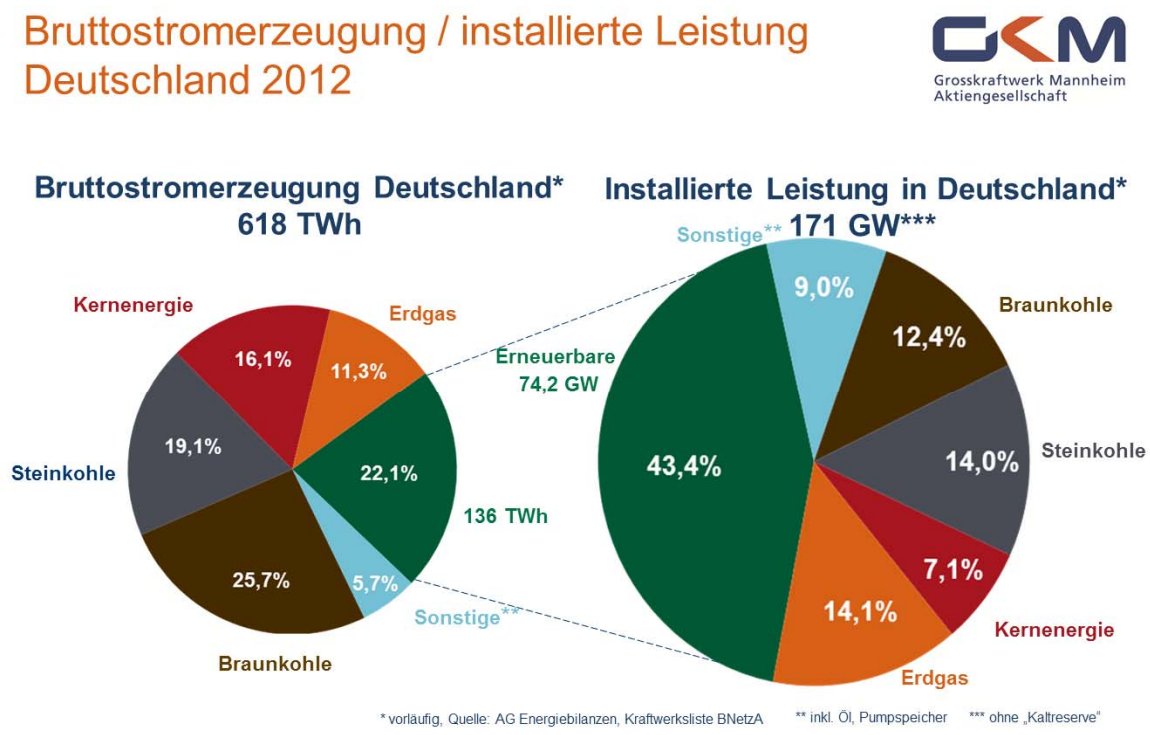


Fig. 2: Gross electricity production and installed performance in Germany

In February 2012 there was little wind and sun and due to low ambient temperatures this led to a high demand on conventional power plant capacity. Due to a permit issued in the summer, GKM could ensure the safety of the power grid within a 5-block operation. Of the approximately 54 GW of installed wind power and photovoltaic power there were at times only 2% on the grid. (Figure 3).

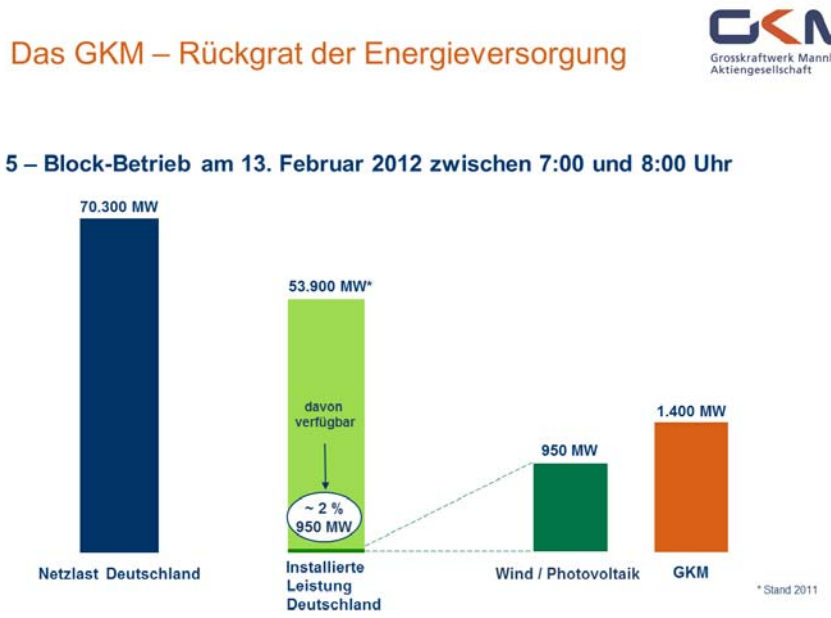


Fig 3: Comparison of performance data 13th February 2012 7:00 – 8.00 hrs

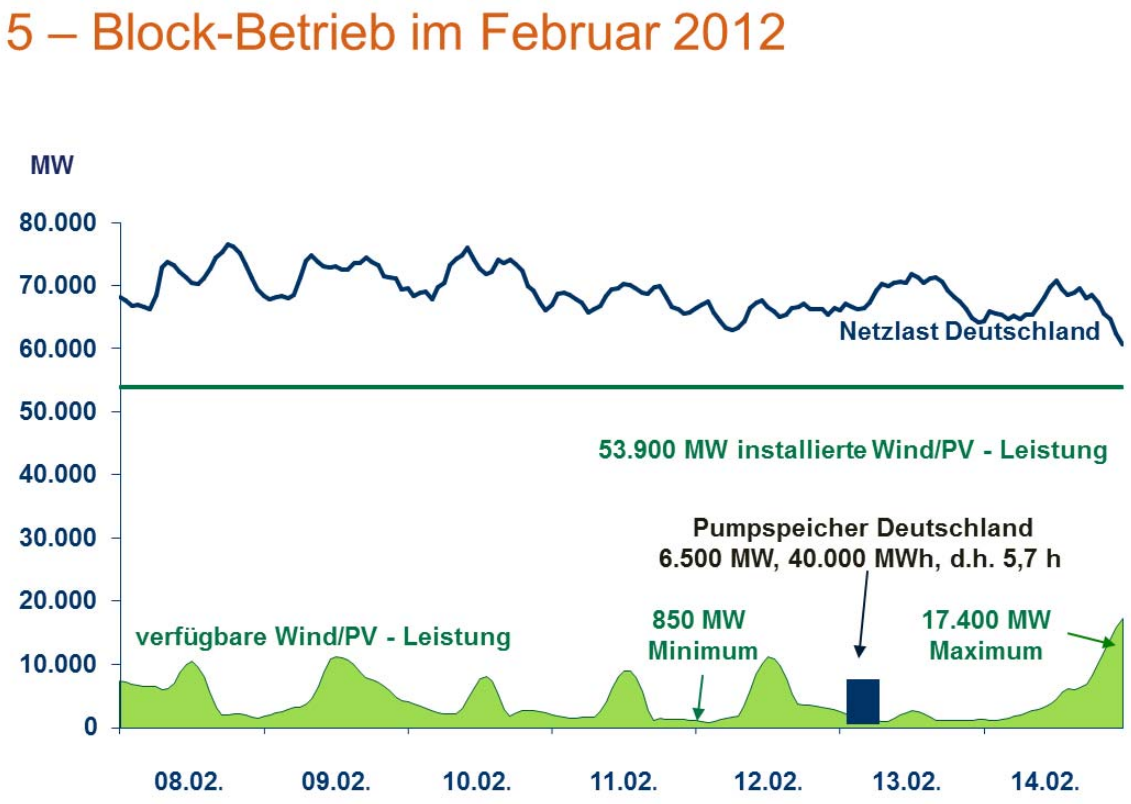


Fig. 4 Grid load and wind and photovoltaic performance in February 2012

From this slide three important conclusions can be drawn:

1 The unreliable availability of renewable energy sources:

The biggest part of the problem is the lack of reliable regenerative availability. By the end of 2012, 74.2 GW of installed capacity, only 12 GW can be considered reliable.

2 Storage possibilities for electricity can not compensate for the unreliable availability:

The pumped storage capacity of about 6,500 MW currently available in Germany is not even enough for 6 hours. This raises the question of how the provision of electricity can be ensured at times when there is a lack of availability of renewable sources. One approach is the further expansion of storage technologies, but does not at present have the state of sufficient capacity to ensure grid stability. A proven method for storing electricity are pumped storage power plants. However, due to the geographical characteristics of the country an expansion of pumped storage power plants in Germany is limited. Regarding the fact that electricity prices are constantly rising the question of whether alternative storage projects are both politically and economically feasible is also permanently being raised. In addition, the technical feasibility of alternative storage concepts of large-scale storage can not be predicted.

3 Only conventional power plants can ensure the power supply

Due to the weather independence conventional power plants are required to provide a reliable power supply.

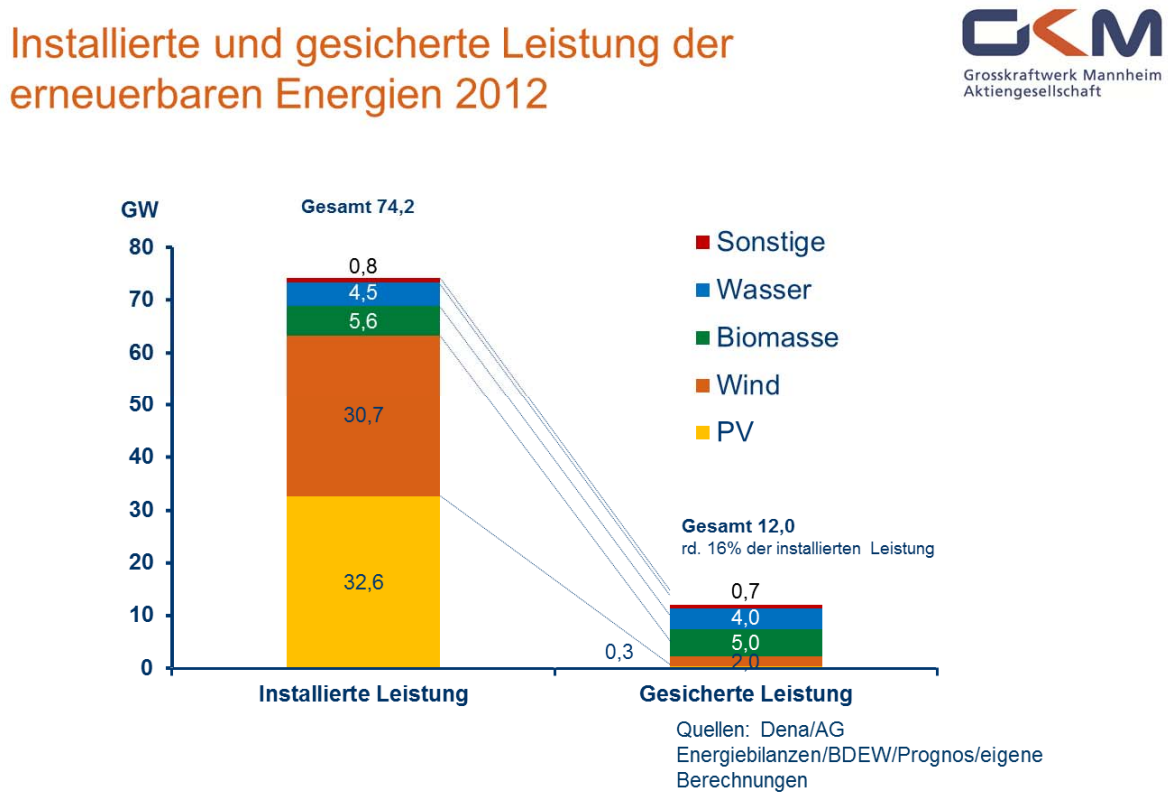


Fig. 5 Installed and ensured performance of renewable energy 2012

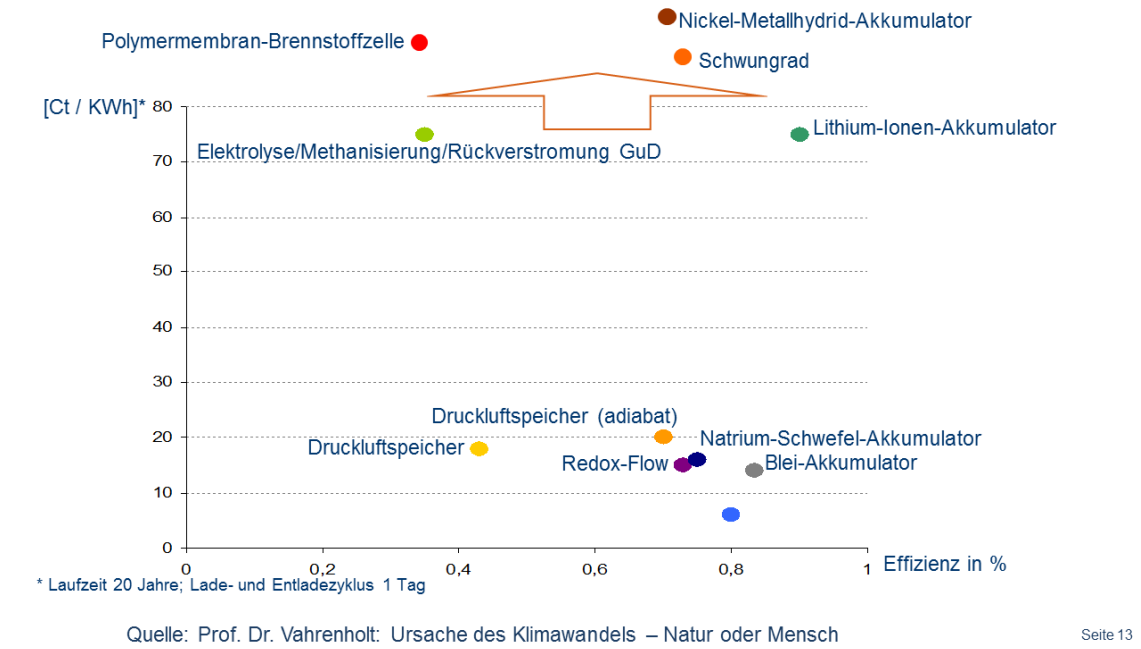


Fig. 6: Costs of alternative electricity storage

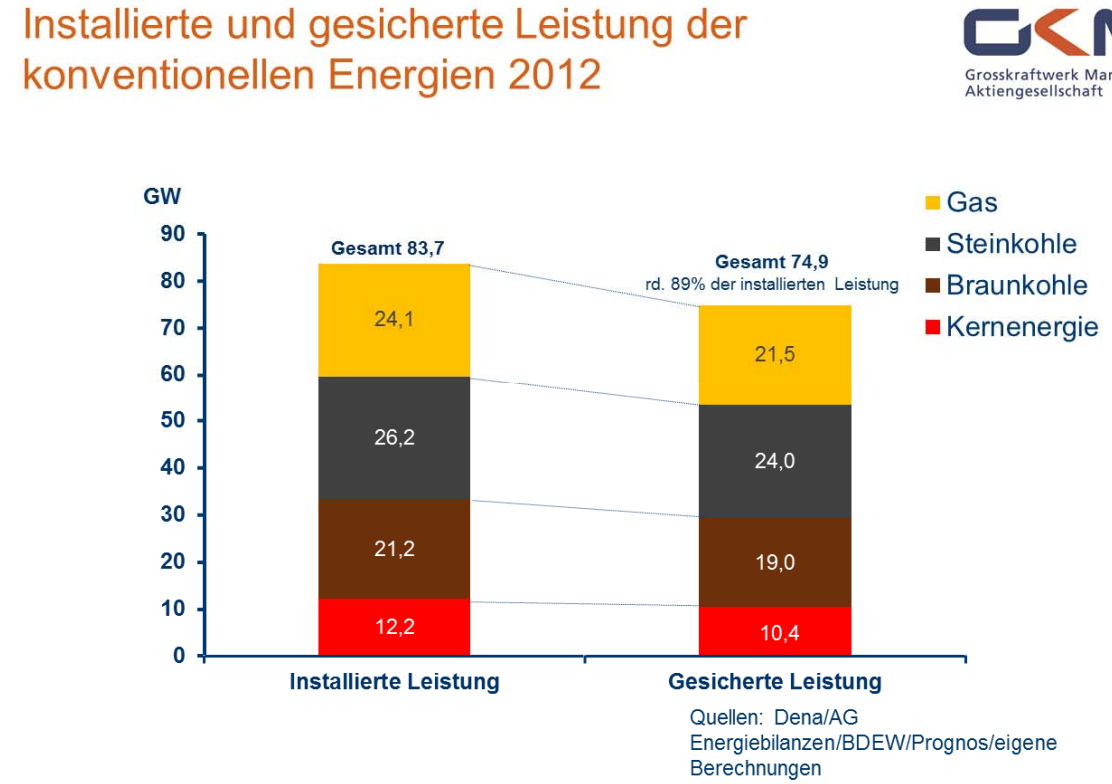


Fig. 7: Installed and reliable performance of conventional power generation 2012

The forecasting study "Importance of thermal power plants for energy transition" has come to the conclusion that the thermal power plants also play an important role in the long-term to ensure security of supply. In 2050, at least 46 GW secure power plant capacity will be needed. Thermal power plants must also be built in the future. Which power plants should be built in future in order to ensure the lack of performance is provided for: This is dependent on the investment costs, fuel costs and deployment time, i.e. the economy. The medium-term availability of fuels has also been taken into account.

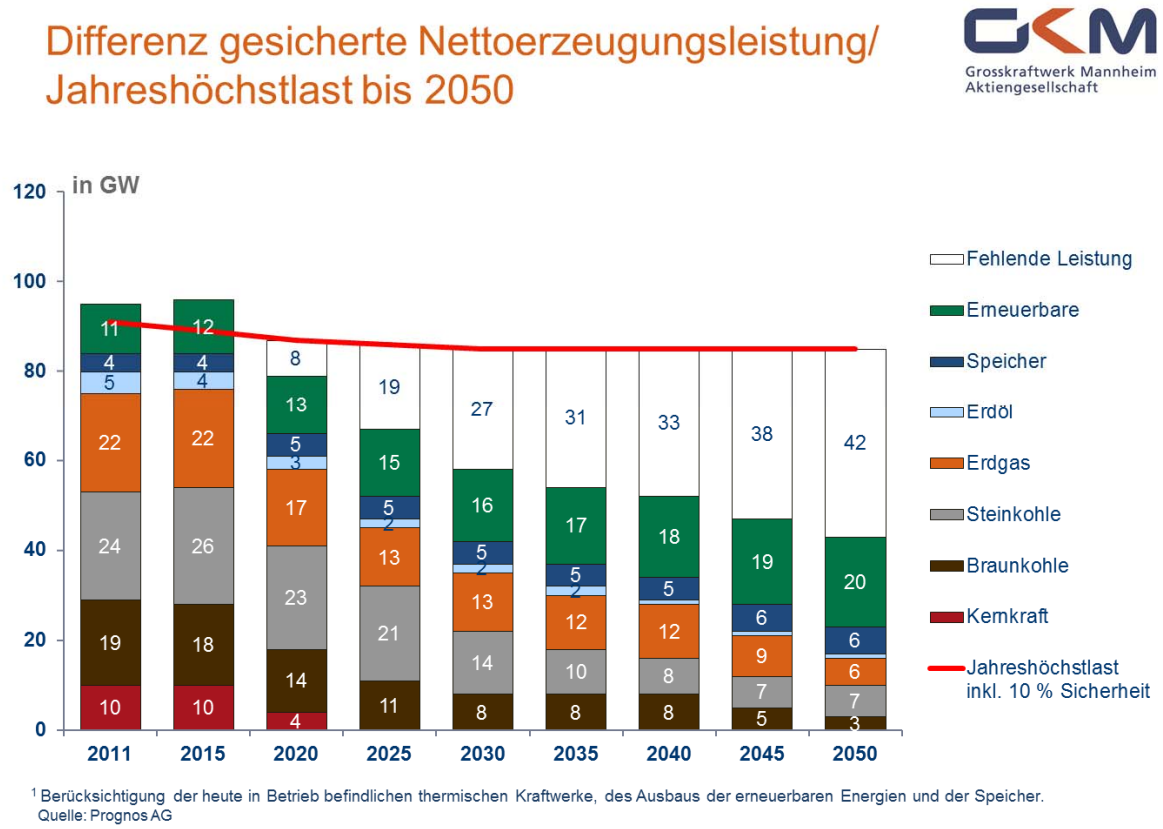


Fig. 8: Expected requirements on reliable performance

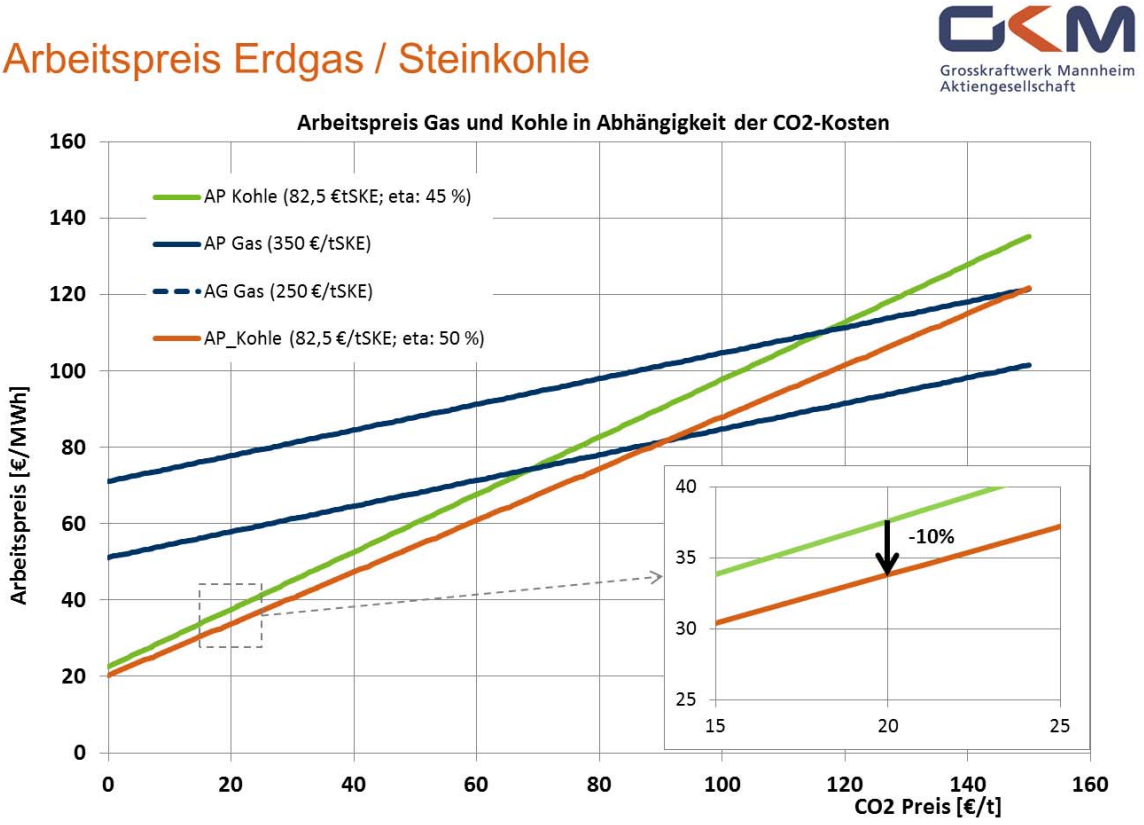


Fig. 9 Comparison of fuel costs, gas – coal with different CO2 prices

It can be seen that coal is much cheaper than natural gas. The global coal reserves are by factors greater than that of natural gas. The extent to which the specific CO2 price is to develop in the future is unpredictable. With the currently existing prices a fuel shift from coal to gas in Germany in the coming years is unlikely. Therefore, new coal-fired power plants would not only have higher efficiencies, they would also have to meet flexibility requirements that come into the vicinity of CHP plants.

The technical minimum load is important amongst other things for operation to reduce additional costs for the start-up and shut-down of the block.

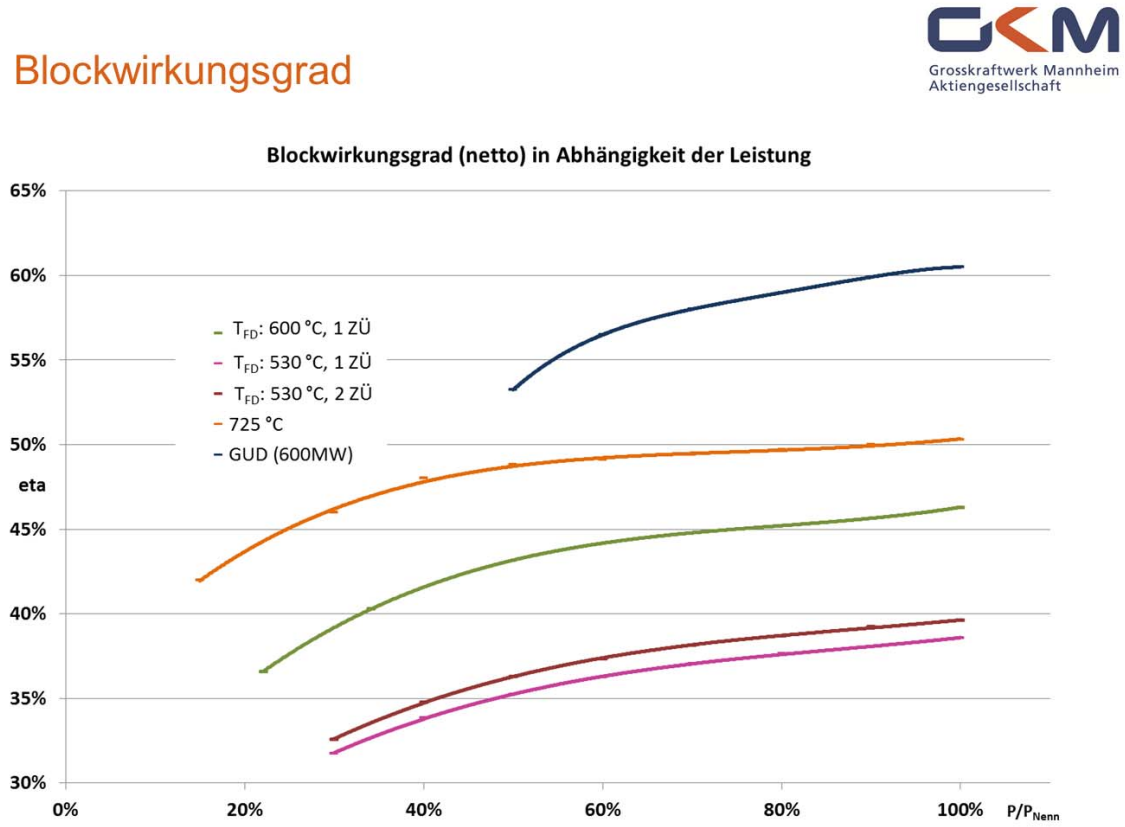


Fig. 10: Unit efficiency of different Power Plants

State of power plant research and development:

In response to the nuclear disaster in Fukushima and the phasing out of nuclear energy in Germany which is planned up to the year 2022, in addition to the already decommissioned nuclear power plants, a further outage capacity of approximately 13 MW will result. Against the background of the unresolved storage problem, regardless of further expansion of the use of renewable energy sources, the need arises for additional fossil-fueled power plants, i.e. gas and coal power plants.

The development of gas prices shows that a further expansion of the gas turbine power plants is limited for economic reasons. This leads to the consequence that the future coal-fired power plants are needed to produce electricity.

To meet the requirements for a reduction of CO2 emissions laws, new power plants must be built with increased efficiency compared to previous systems. The increase in efficiency is thereby directly related to the parameters for steam, see Figure 10.

Apart from the saving of CO2 emissions for climate protection resulting from the increase of efficiency, the associated fuel savings when operating with economic benefits stand opposite the additional cost of installation.

The following conditions must be met by future systems:

• High load change flexibility
At Steep start-up and shut-down gradients in cold, warm and hot start
• High efficiency:
Efficiency, high utilization, part-load performance
Improved process control with efficient use of staff
High availability, low- cost monitoring and repair
• Reduction of emissions through improved flue gas cleaning systems and therefore improved efficiency
• Low operating costs

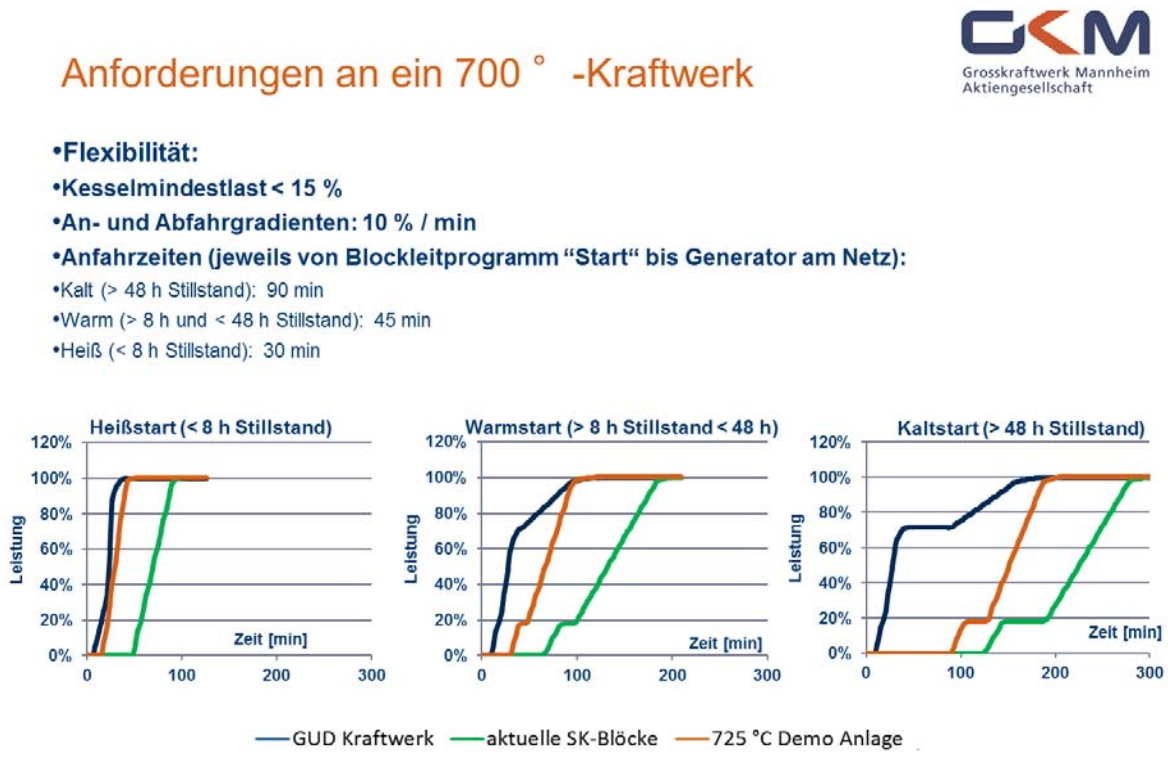


Fig. 11: Flexibility demands on a 700 °C power plant

In order to meet the challenges of future fossil fuel power plant generations, the Großkraftwerk Mannheim is involved in numerous research projects to increase efficiency, reduce harmful emissions and economic implementation of ambitious technologies.

Power plant research at GKM

In the Großkraftwerk Mannheim AG since its founding in 1921, research and the use of advanced methods for efficient and low-emission power generation are being implemented continuously. For example, the first high-pressure system in Germany was put into operation in 1928. The steam reaches a pressure of 100 bar and a temperature of 470 ° C.

In continuation of its tradition as a pioneer of modern technologies, the Großkraftwerk Mannheim AG participated in numerous research projects. Representative of these are high-temperature material test tracks that are driven with steam temperatures of 725°C which are installed at GKM in boiler 17, Block 6. Materials and components for future highly flexible and

highly efficient steam power plants are tested there. The positive operating experience that has been achieved provides a fundamental basis for the future implementation of highly efficient and flexible load changes in steam power plants as a partner of renewable energy sources in the future energy mix.

Summary and Outlook

The future energy supply can only be ensured if in addition to the expansion of renewable energy sources, highly flexible and highly efficient fossil-fired power plants are built. The technical issues that arise in this context concern, mainly the use of materials in this temperature and pressure range. Qualification and testing of suitable measures are currently being initiated in Germany, and in Europe several research projects, which certainly occupy a special position in the high-temperature material test tracks at GKM.

The results of the research are used to gain insights for future operating of highly flexible and low-emission power plants in order to accomplish the next step in the implementation of research activities in power plant application.