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Potential for the Reduction of CO_2 in the Mid and Long Term Through the Modernisation of Coal-fired Power Plants in Germany

June/2010

By employing modern power plant technology, CO_2 emissions from German coal-fired power plants can be reduced by 82% to only 21 million t annually by 2050.

- Coal-fired power plants in Germany are, on average, more than 30 years old; the need to modernise and replace all of these facilities will be essential.
- The high degree of efficiency at which modern power plants operate saves 20% in coal consumption and also reduces CO_2 emissions by about 20%.
- The continuous modernisation and replacement of the power plants yields an improvement in the degree of efficiency which could reduce the CO_2 emissions from 111 million t a in 2008 to 98 million t a in 2015 (≙ -12%) and to as low as 90 million t a (≙ -21%) in 2050.
- The rollout of CCS technology, which should be available commercially by 2020, could lead to further declines of 19 million t annually by 2030 and 70 million t annually by 2050. This would correspond to a reduction of the CO_2 emissions from coal-fired power plants of 82%.
- Coal-fired generation of electricity has the long-term potential of making a contribution to a power mixture which is both low in CO_2 emissions and safe.

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CO_2 emissions from coal-fired power generation would be substantially reduced with the implementation of a new technology offensive in German coal-fired power plants.

The following possible models show how CO_2 can be reduced by improvement in the degree of efficiency and by using CCS technologies.

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Age Structure of Coal-fired Power Plants

- Coal-fired power plants in Germany are currently, on average, over 30 years old.
- Only very few new facilities using advanced power plant technology have been constructed recently. As a consequence, the degree of efficiency of today's power plants as a whole is approx. 40%.
- Modern power plants achieve an efficiency rate of 46%. They are not only more efficient consuming 20% less coal, but are above all, less harmful to the climate.
- Modernisation of the power plants is an urgent necessity, not only for economic reasons; but most importantly to meet Germany's targets in terms of climate policy and goal of reducing CO_2. This will simultaneously contribute to the conservation of global resources.

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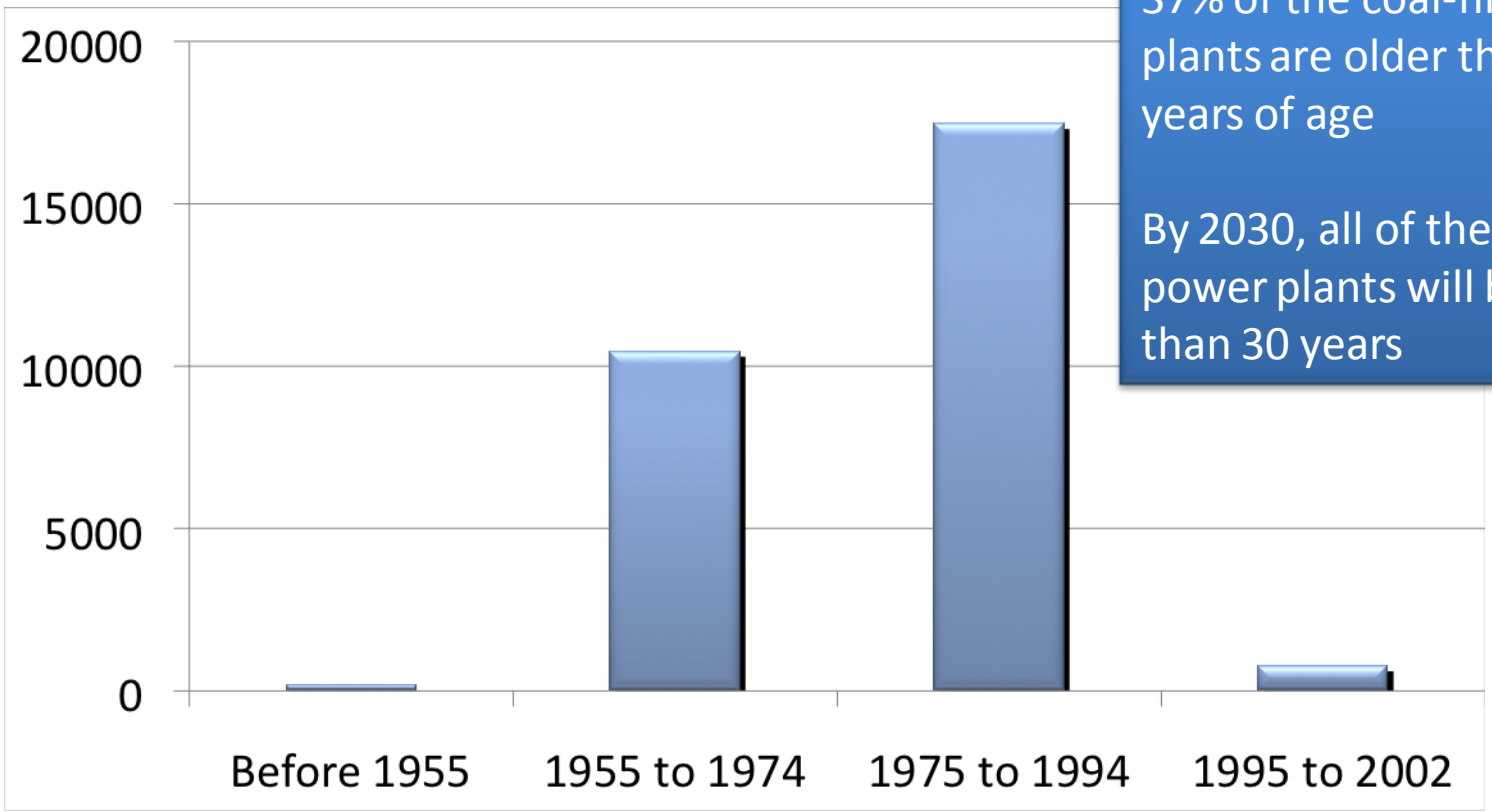
Age Structure of Current Coal-fired Power Plants in Germany



37% of the coal-fired power plants are older than 30 years of age

By 2030, all of the existing power plants will be older than 30 years

As per 2008/2009

Source: bdew

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The analysis here is based on the following assumptions:

- Based on the bdew project list as of October 2009 and current market data (cf. Slide 7)
- It will not be possible to construct all of the new power plant projects planned for operations in 2012 in the bdew list as scheduled, so the schedule of the project realisation has been smoothed for the model calculation (Slide 10).
- Existing power plants have an average lifetime of 40 years.
- The level of total capacity remains constant over the study period (i.e., capacities taken from service are replaced by new capacities).
- CO_2 emissions for new plants (without CCS) are 20% lower than for older plants.
- CO_2 emissions for power plants with CCS are about 77% lower than for new plants without CCS.
- By 2030 30%, by 2040 60% and by 2050 100% of the power plants will be converted to CCS.

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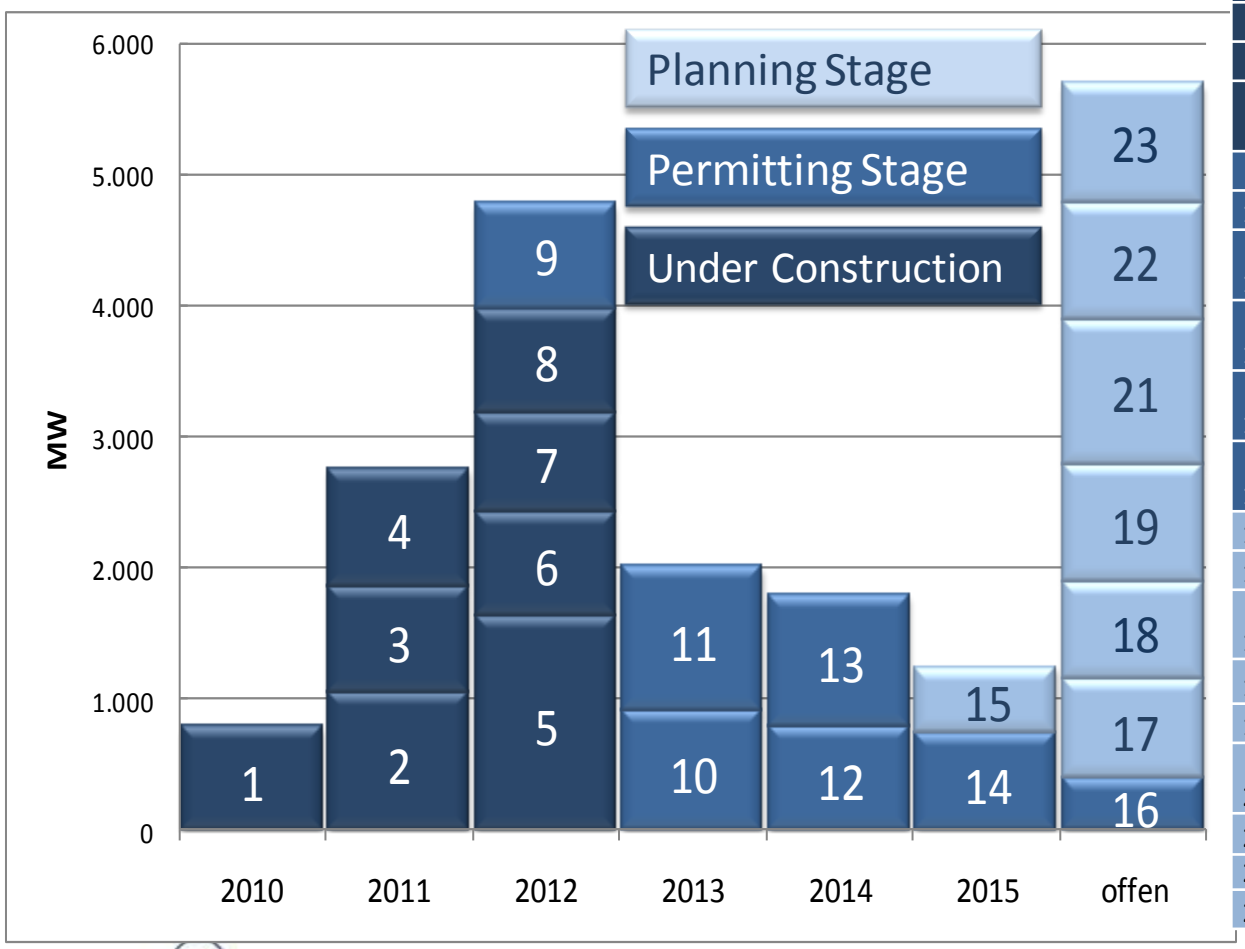
New Construction Projects for Coal-fired Power Plants in bdew List – Single Projects



1	Duisburg Walsum 10, Evonik Steag / EVN AG
2	Datteln 4, E.ON
3	Hamm (1. Block), RWE Power
4	Karlsruhe/Rheinhaven RDK 8, EnBW
5	Hamburg-Moorburg, Vattenfall Europe
6	Hamm (2. Block), RWE Power
7	Lünen, Trianel Power
8	Wilhelmshaven, GDF Suez Energie /BKW FMB Energie AG
9	Brunsbüttel, GDF Suez Energie
10	Mannheim Block 9, GKM
11	Staudinger 6 (Großkrotzenburg), E.ON / Stw. Hannover
12	Brunsbüttel / Bayer Industriepark, GETEC Energie AG
13	Stade (2 Anlagen) (Erdg. / Steink.), Dow Chemicals / EnBW
14	Krefeld / Chemiepark Krefeld-Uerd., Trianel Power
15	Wilhelmshaven, E.ON
16	Düsseldorf Lausward, Stw. Düsseldorf
17	Herne 5, Evonik / Stadtwerke
18	Lünen (noch offen), Evonik Steag
19	Marl, Evonik / Infracor
20	Sachsen Anhalt (mglw. Arneburg bei Standal), RWE Power
21	Stade, E.ON
22	Brunsbüttel (1), Südweststrom / Rätia Energie
23	Brunsbüttel (2), Südweststrom / Rätia Energie

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Source: bdew, Market data

New Power Plant Construction

- Slightly more than 39% (7.547 MW) of the planned capacity (19.100 MW) is under construction. If the projects currently in the planning and permit processes progressed as scheduled, 44% of the planned new construction would be realised by 2012, increasing the average degree of efficiency of German coal-fired power plants to just under 44%.
- By 2015, 46% of the older power plants could be replaced by more efficient new facilities causing less harm to the climate.
- However, project delays arising from the permitting process and in individual projects will likely postpone the realisation of these goals to a later point in time.
- To account for this inn the analysis, we have postponed the commissioning of some of the projects scheduled for 2012 to 2013, 2014 and 2015 as being a more realistic projection.
- If the new construction projects progress in this way, 50% of the new construction capacities currently under construction, in planning and in the permit process can be realised by 2013 and 70% by 2015.

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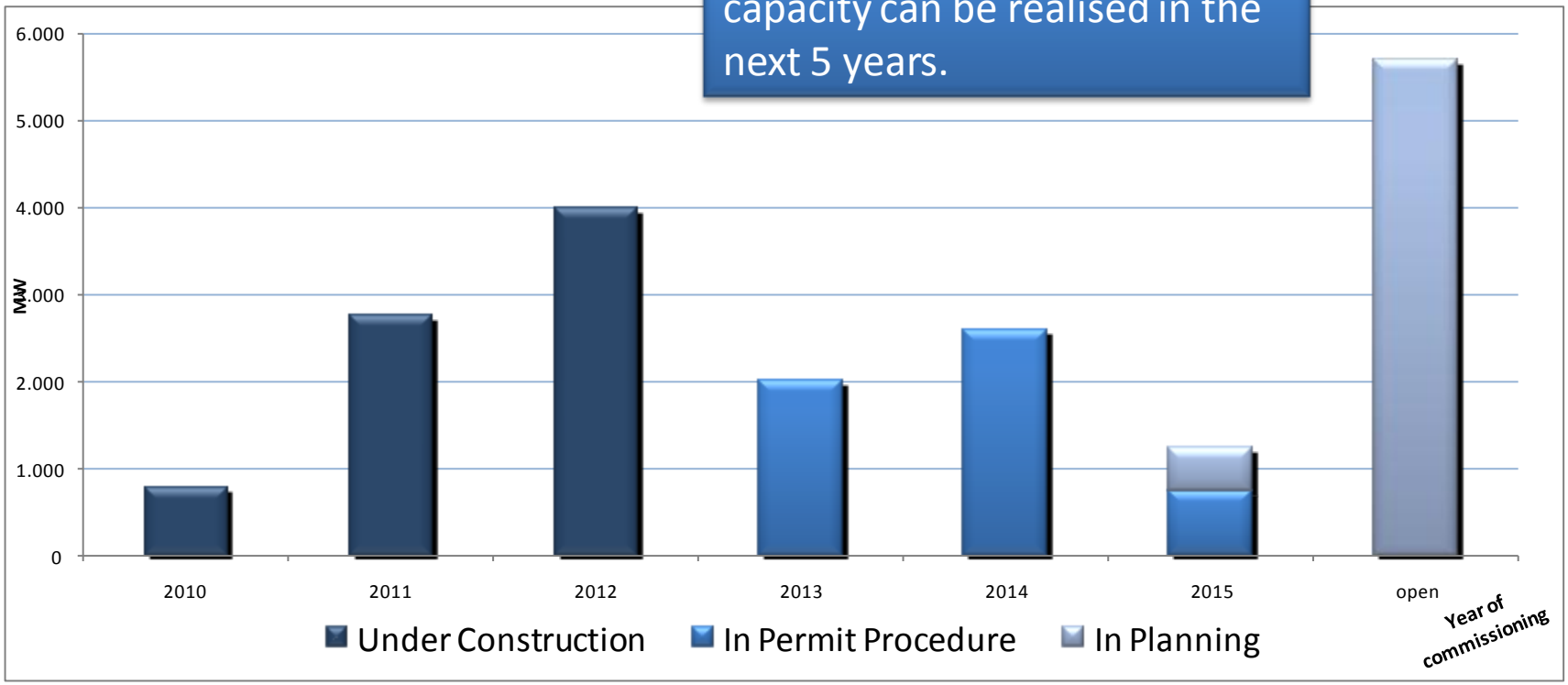
Smoothed Course of Commissioning for the Construction of Coal-Fired Units

70% of the new construction capacity can be realised in the next 5 years.



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Source: bdew, Market Data

Capacity Development

- Coal-fired power plants must be built parallel to the expansion of renewable energy sources to guarantee stable Electricity service. For example wind energy, operates approx. only 1,600 to 1,800 hours a year and is dependent on short run weather.
- An extension of the operation of nuclear plants is assumed in the model calculation. The capacity of the coal-fired power plants is maintained as a stable factor to secure comparability of the emissions values of the power plants in their entirety.

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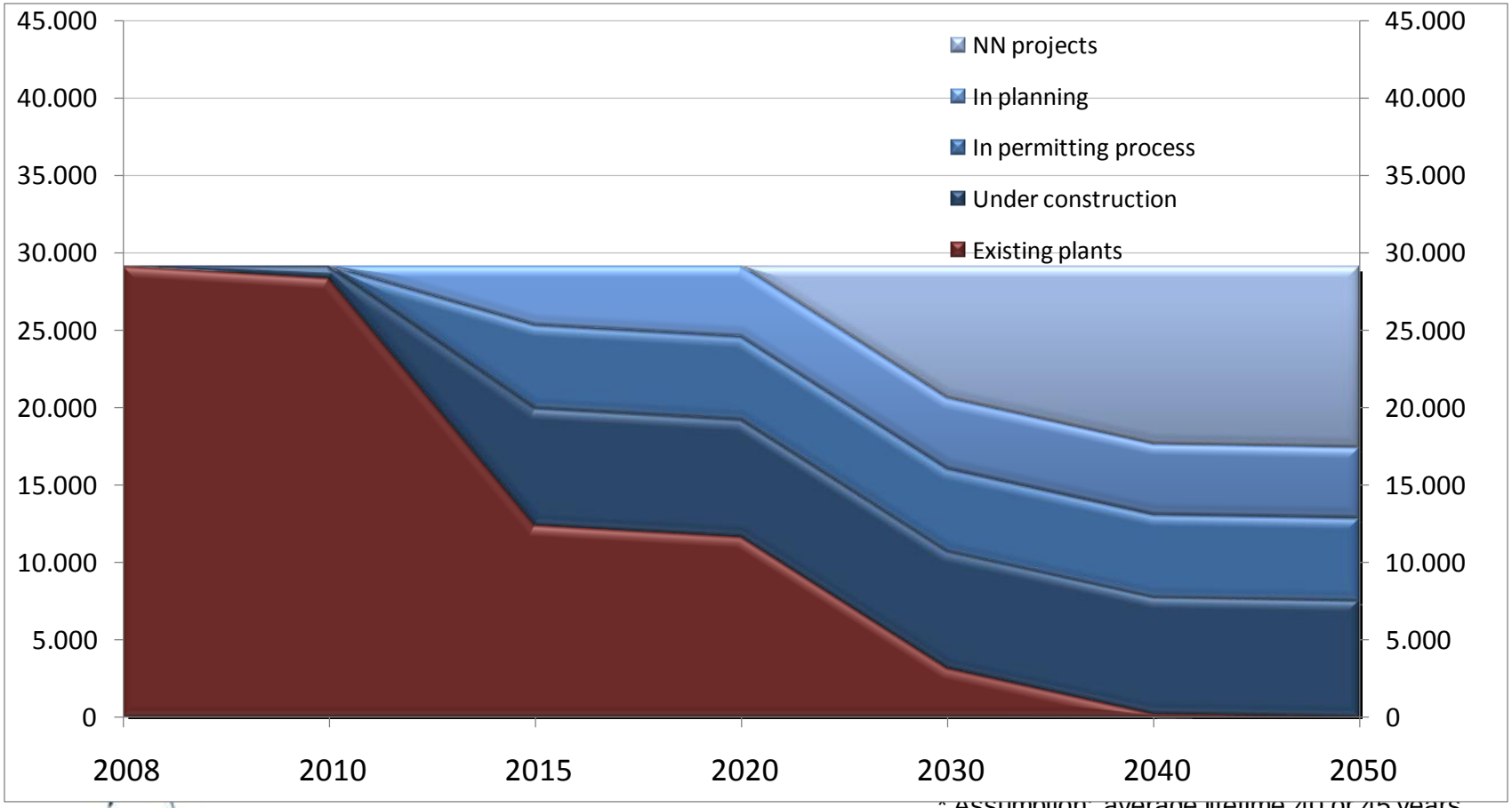
Stable Capacity Level for Analysis



* Assumption: average lifetime 40 or 45 years

Source: German Federal Environmental Agency
bdew, Market Data, Own Calculations

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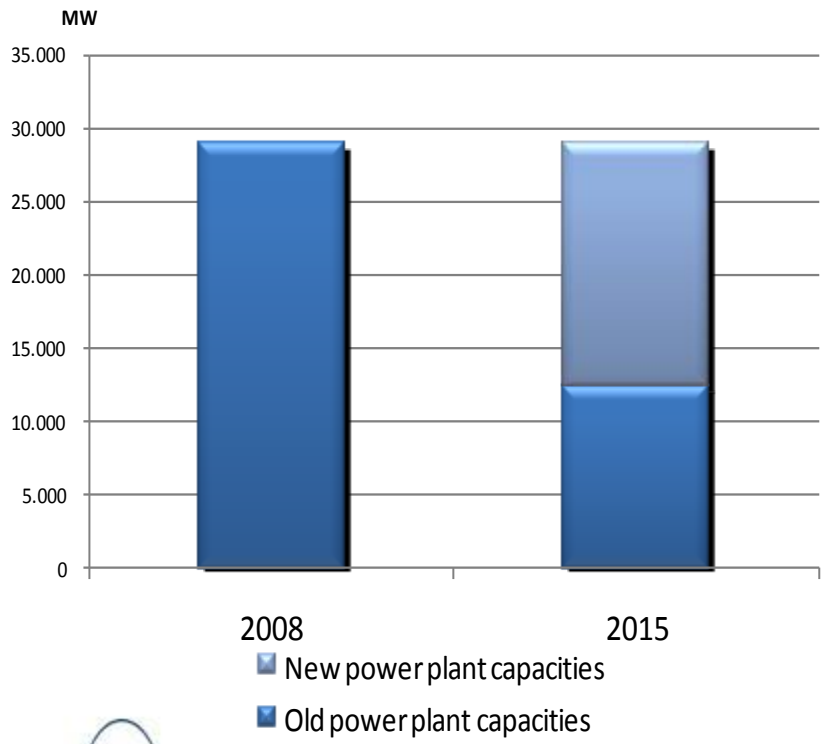
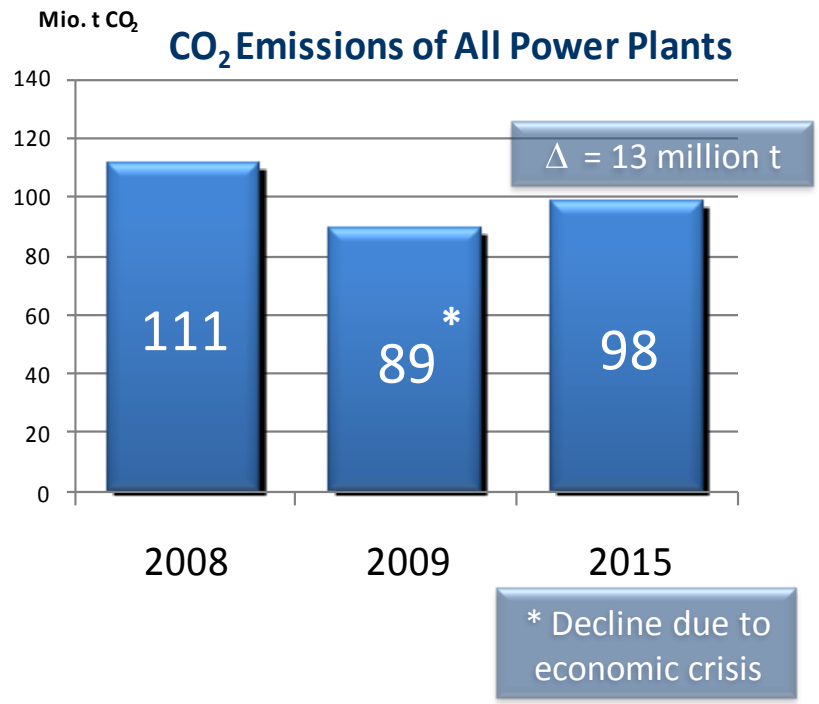
An Efficiency rate of 46% leads to CO_2 Emission Abatement

New power plant projects will replace 57% of the previous power plant capacities by 2015

reduction of about 12% or 13 million t annually in CO_2 emissions through construction of new power plants by 2015





Source: bdew
Own Calculations

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Retrofitting for CCS

From 2020 on, the carbon capture & storage (CCS) technology should be available at an application-ready stage.

This model calculation assumes that CCS will be included by retrofit or new build of new plants:

- By 2030: 30%
- By 2040: 60%
- By 2050: 100%

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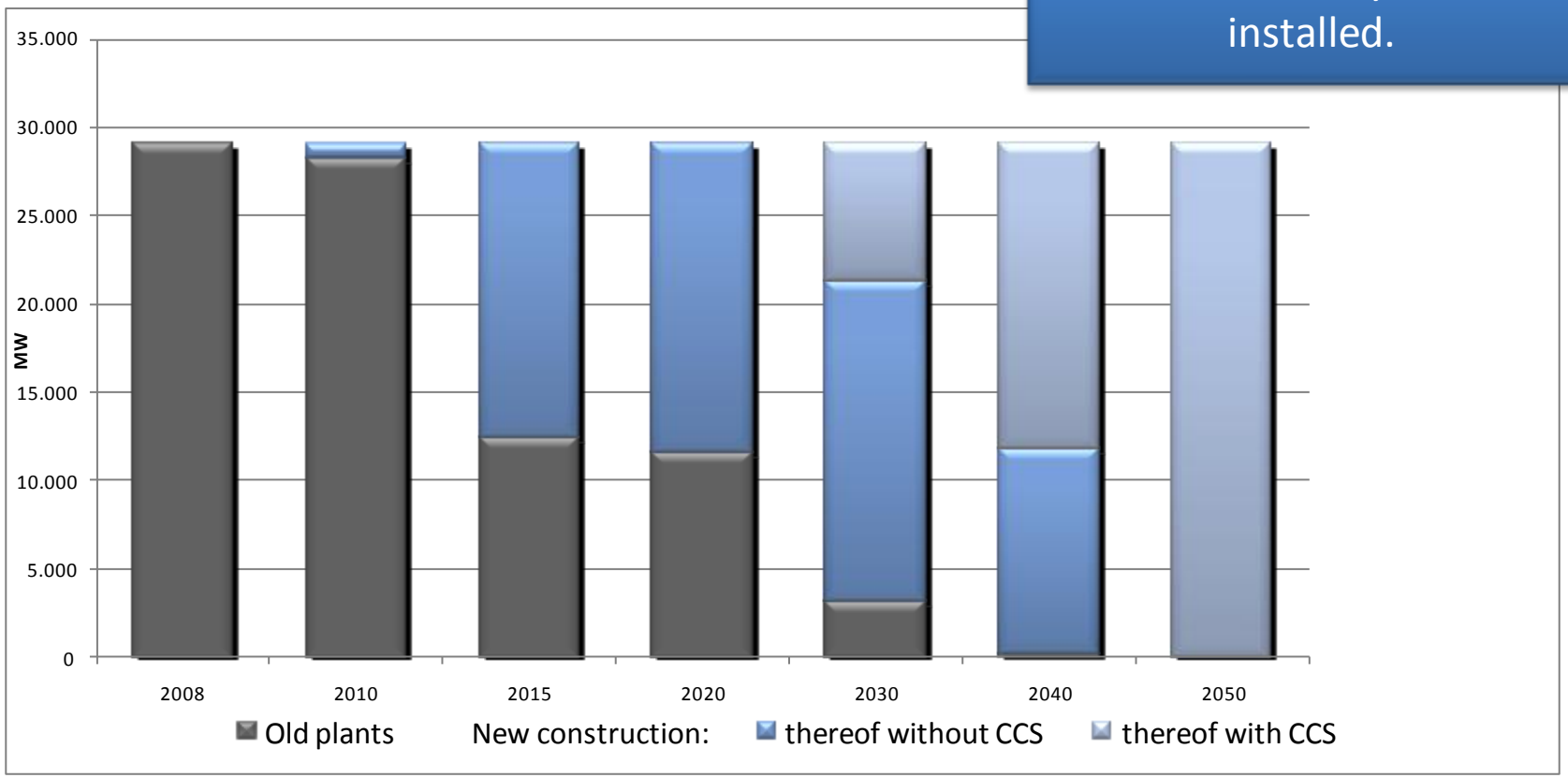
Retrofitting for CCS

Starting in 2020, new plants will incrementally have CCS installed.



Assumption: Conversion by	2030	⇨	30%
	2040	⇨	60%
	2050	⇨	100%

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CO_2 Development

- Starting in 2020, power plants retrofitted with CCS technology along with those planned and built “capture-ready” can capture and save a large part of their CO_2 emissions.
- The CO_2 emissions of such a power plant will be reduced by 75%–85%. This would mean a reduction in CO_2 emissions by about 80% for the coal-fired power plants as a whole by 2050.
- This would give hard coal the best emission values in comparison with the current emission values of all other fossil energy sources and could make a significant contribution to assuring a supply of power in the Germany energy mixture.

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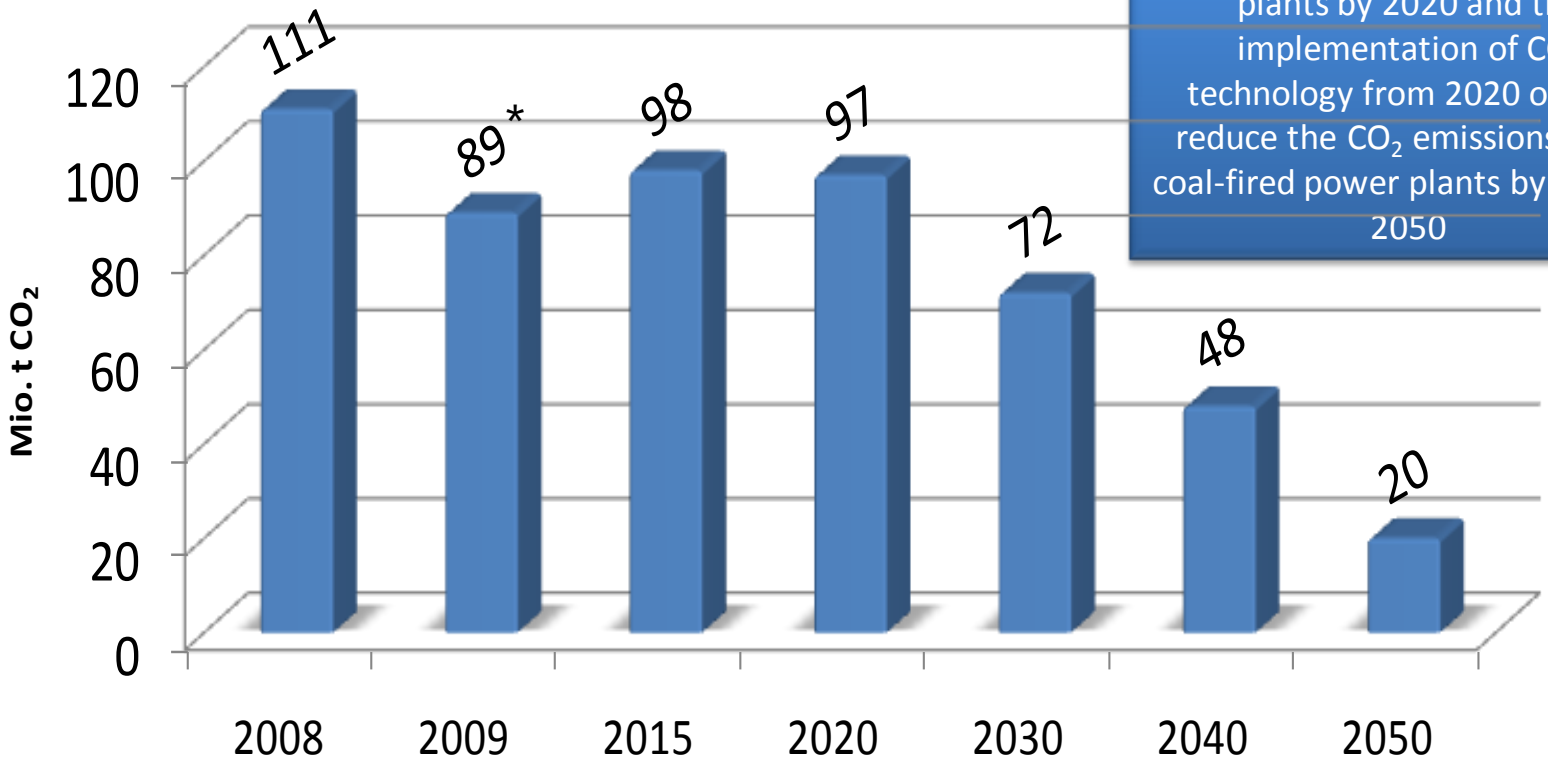
Development of CO_2 Emissions from Coal-fired Power Plants

The modernisation of the power plants by 2020 and the implementation of CCS technology from 2020 on will reduce the CO_2 emissions from coal-fired power plants by 82% by 2050



Assumption: Constant power plant capacity

* decline due to economic crisis

Sources: Arbeitsgemeinschaft Energiebilanzen, 12/2007
Arbeitsgemeinschaft WI, DLR, ZSW, PIK
Own calculations

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