



## Low Energy Scenarios for Germany

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[http://www.inforse.org/europe/seminar09\\_Artefact.htm](http://www.inforse.org/europe/seminar09_Artefact.htm)

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## 1 Discussed scenarios

- **„Weiterentwicklung der Ausbaustrategie Erneuerbare Energien: Leitstudie 2008“ (2008)**
  - By: Dr. Nitsch in cooperation with the DLR-Institut for Technical Thermodynamics
  - For: Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU)
  - In the following „Leitstudie“
  - Analyzed here are the „Leitszenario“ and the most ambitious „Effizienz-Szenario“
- **„Energiezukunft 2050“ (2009)**
  - By: Forschungsstelle Energiewirtschaft e.V. (FE)
  - For: EnBW, E.ON Energie, RWE Power and Vattenfall Europe.
  - Analyzed here is Scenario 3 (in the following „Energiezukunft 2050“)



Nitsch / DLR (2008): Weiterentwicklung der Ausbaustrategie Erneuerbare Energien: Leitstudie 2008



FE (2009): Energiezukunft 2050. Langfassung Teil II. Szenarien, Munich

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## 1 Ctd.

- **„Modell Deutschland Klimaschutz bis 2050“ (2009)**
  - By: Ökoinstitut, Prognos AG and Dr. Ziesing
  - For: WWF Germany
  - Analyzed here are the „Innovationsszenario“ and the „Modell Deutschland“
  - The Innovationsszenario includes one scenario with CCS and one without CCS
- **„Klimaschutz: Plan B 2050“ (2009)**
  - By: EÜtech
  - For: Greenpeace



WWF / Ökoinstitut / Prognos / Dr. Ziesing (2009): Modell Deutschland Klimaschutz bis 2050. Vom Ziel her denken, Berlin, Baud



Greenpeace / EÜtech (2009): Klimaschutz: Plan B 2050. Langfassung, Hamburg

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## 2.1 Comparison- Emission Reduction

- **Emission reduction until 2050, compared to 1990**
- **Energiezukunft 2050 (FE, EnBW, E.ON Energie, RWE Power and Vattenfall Europe): 70% (CO2)**
- **Leitstudie (BMU, Nitsch, DLR) (CO2)**
  - Leitszenario: 78,5%
  - (most ambitious) Effizienzzenario: 85%
- **Modell Deutschland Klimaschutz bis 2050 (WWF, Ökoinstitut, Prognos AG, Dr. Ziesing)**
  - Innovationsszenario with CCS: 86% (all GHG)
  - Innovationsszenario without CCS: 87% (all GHG)
- **Klimaschutz: Plan B 2050 (Greenpeace, EÜtech): 90% (CO2)**
- **Modell Deutschland (WWF, Ökoinstitut, Prognos AG, Dr. Ziesing): 95% (all GHG)**

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## 2.2 Comparison - Initial conditions

- **Nuclear energy**
  - Klimaschutz: Plan B 2050: early nuclear phase out in 2015
  - Scenarios of the Leitstudie and of the Modell Deutschland Klimaschutz bis 2050: phase out in 2022/23
  - Energiezukunft 2050: extension of the life duration of nuclear power plants to 60 years
- **Social acceptance:**
  - Innovationsszenario and the Modell Deutschland: necessity to protect the climate is accepted in the society
  - Energiezukunft 2050: builds especially upon the environmental friendly behaviour of consumers

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### 2.3 Frameworks of the scenarios

- All scenarios include laws and incentives.
- **Modell Deutschland:**
  - Integrated climate protection and energy program until 2030 (IKEP 2030)
  - National climate protection law, by which IKEP 2030 becomes legally binding
  - Creation of a council of specialists for climate policy ("Rat von Sachverständigen für Klimapolitik")
- **Leitstudie:**
  - Europe wide strategic action plan such as the introduction of an European electricity network
- **Energiezukunft 2050:**
  - Assumes behavioural change
- **Klimaschutz: Plan B 2050:**
  - All electricity is produced in Germany → EU-ETS and CDM are not included

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### 2.4 Comparison – Primary energy

- Changes in the shares of the different energy sources occur in all scenarios
- **Energiezukunft 2050:**
  - Renewable energies: 36%
  - Less than 10% of the primary energy will be produced by mineral oils.
- **Leitszenario:**
  - Share of fossil fuels is reduced by 37% in comparison to 2005
  - Renewable energies cover half of the primary energy production
- **Innovationsszenario with CCS:**
  - Shares of hard coal and lignite: -88% resp. -68% in comparison to 2005
  - Share of renewable energies is multiplied by a factor of approx. 4.6 until 2050 = share of ~ 59%.
- **Effizienzzenario:**
  - Share of fossil energy sources: -27% in comparison to 2005
  - Share of renewable energies: 65%

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### 2.4 Ctd.

- **Innovationsszenario without CCS**
  - Share of renewable energies is multiplied by a factor of approx. 6 until 2050 = share of ~ 73%
  - Share of coal: -98% and share of mineral oil products: -91% in comparison to 2005
  - Amount of diesel used is reduced to 4 PJ and benzene is not used anymore
  - Share of gas: -71%
- **Modell Deutschland:**
  - Share of renewable energies: 75%
- **Klimaschutz: Plan B 2050**
  - Oil covers only a very small percentage and coal is not used anymore
  - The main part of primary energy will be provided by renewable energies
  - Natural gas will still be used, yet a lot less than before

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### 2.5 Comparison – Delivered energy

- Great reduction until 2050 in all scenarios.
- **Energiezukunft 2050:**
  - Reduction by 37,4% in comparison to 2005 to ~ 7000 PJ/yr
- **Leitszenario:**
  - Reduction to 5845 PJ/yr
  - Share of renewable energies: 52,1%
- **Effizienzzenario:**
  - Reduction to 5591 PJ/yr
  - Share of renewable energies: 64,2%
- **Innovationsszenario without CCS:**
  - Reduction by 58% in comparison to 2005 to 3857 PJ/yr
  - Share of renewable energies: 36,6% (resp. 76,2% incl. share of conversion)

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### 2.6 Comparison – Heat supply

- **Leitszenario:**
  - -77% until 2050 in comparison to the point of time when the study was completed
  - Share of renewable energies: 48%
- **Energiezukunft 2050:**
  - Heat demand increases at first but reaches until 2050 the level of 2015 again
- **Effizienzzenario:**
  - Share of renewable energies: 52,5%

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### 2.7 Comparison – Electricity sector

- **Leitstudie:**
  - Reduction of the gross electricity production by 7,5% in 2020 in comparison to 2007
- **Innovationsszenario (with and without CCS):**
  - Reduction by 37% until 2050 in comparison to 2005
- **Modell Deutschland:**
  - Reduction by 35% (including the electricity demand for electric mobility)
- **Energiezukunft 2050:**
  - Very small reduction of the electricity demand
  - ~490 TWh/yr will be used in 2050

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### 2.7 Ctd.

- Share of renewable energies:**
  - Energiezukunft 2050: SEITE 315 FF
  - Leitszenario: 50% in 2030
  - Innovationsszenario with CCS: 65,8% of the net electricity production in 2050
  - Innovationsszenario without CCS: 83,7% of the net electricity production in 2050
  - Effizienzzenario: 94% in 2050
  - Modell Deutschland: 95% in 2050
  - Klimaschutz: Plan B 2050: 100% in 2040 (together with combined heat and power)
- Share of combined heat and power:**
  - Leitszenario: 25% in 2030
  - (Least ambitious) Effizienzzenario: 25% in 2030
  - Energiezukunft 2050: 34% in 2050
  - Klimaschutz: Plan B 2050: 46% in 2030, yet it decreases again until 2050 to 30%
  - Innovationsszenario: Decrease by more than 50% (2050)

Geopower / Eltech (2009), S.92  
Nitsch / DLR (2008), S.16  
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### 2.7 Ctd.

- Construction of new coal fired power plants**
  - Klimaschutz: Plan B 2050: no construction of new plants
  - Modell Deutschland: only for electricity production, if CCS-technology is available
  - Leitszenario: New plants with capacities of 9 GW until 2020
  - Innovationsszenario without CCS: Construction of new hard coal (6,6 GW) and lignite (5,3 GW) power plants
  - Innovationsszenario with CCS: Construction of new hard coal (6,6 GW + 3 GW hard coal + CCS) and lignite (5,3 GW + 10 GW lignite-CCS) power plants
- CCS:**
  - Leitstudie: CCS is an option from 2020 on
  - Innovationsszenario: CCS is possible from 2025 on
  - Modell Deutschland: CCS is an option
  - Energiezukunft 2050: CCS is possible, but will not be used very much, since nuclear energy is still used
  - Innovationsszenario without CCS: CCS is not an option
  - Klimaschutz: Plan B 2050: CCS is not an option

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### 2.7 Comparison – Electricity sector - Measures

- Innovationsszenario:**
  - Reduction of overall electricity consumption
  - Increase of use of renewable energies and exclusion of plants which use a lot of fuels rich of CO2
- Leitstudie:**
  - Extension of renewable energy use for covering the electricity and heat demand
  - Engagement of communal actors and public services for combined heat and power electricity production projects in the context of the construction of new buildings or the restoration of quarters
  - Construction of more combined heat and power installations and modernization of old ones
- Modell Deutschland:**
  - Preparation of infrastructure so that a great import of biomass can take place
  - Moratorium for coal fired power plants until CCS-technology can be used
  - CCS-technology shall be used more in the industry sector than in the electricity sector and pilot projects should be realized as soon as possible
  - Development of a German CCS-development plan
  - For process related CO2-emissions in the lime, cement, iron and steel industry should the use of CCS-technology be obligatory
- Klimaschutz: Plan B 2050:**
  - Phase out of coal usage for electricity production
  - Abolishment of subsidies for lignite open mining
  - Reformation of combined heat and power law in terms of promotion systems and the time frame for compensation for operational heat use
  - Public realities should be more often connected to community heating
  - It should be clearly defined where it is possible for cities and communities to be – as far as legally possible – obliged to be connected to community heating
  - Geothermal energy should be preferred over CCS-technology

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### 2.8 Comparison – Traffic sector

- Reduction potential**
  - Innovationsszenario: reduction of energy consumption by 40% of the delivered energy consumption in the period 2005-2050
  - Leitszenario: reduction of energy consumption by 73%
  - Energiezukunft 2050: reduction of energy consumption by 75%
  - Klimaschutz: Plan B 2050: reduction of emissions 99% in 2050 in comparison to 2007
- Fuels:**
  - Leitszenario: Fossil fuels cover about 50% in 2050
  - Energiezukunft 2050: share of aircraft fuels: 22%, of diesel: 16%, of natural and liquid gas: 7%
  - Innovationsszenario: aircraft fuels are reduced by about 10% in comparison to 2005, natural gas and liquid gas are reduced by 11%
  - Klimaschutz: Plan B 2050: 50% of the vehicle fleet will be emissions free in 2050
  - Effizienzzenario: 51,4% of the fuels will be provided by renewable energies

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### 2.8 Ctd.

- Biofuels**
  - Leitszenario: share of 17% in 2050
  - Innovationsszenario: they replace diesel and benzene
  - Energiezukunft 2050: share of 27%
  - Effizienzzenario: share of 56% (together with electricity) 56%
- Electricity**
  - Energiezukunft 2050: share of 11%
  - Innovationsszenario: increase of its demand by 221% from 2005 to 2050
- Hydrogen:**
  - Innovationsszenario: share of less than 1% in 2050
  - Energiezukunft 2050: share of 13%

WWF / Okobiodiesel / Prognos / Dr. Ziesing (2009), S.125  
Galle / Reg/Net / Prognos 2009  
FIE (2009b), S.310  
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### 2.8 Comparison – Traffic - Measures

- Innovationsszenario:**
  - Reduction of the traffic flow,
  - Great support of alternative fuels
  - Efficiency increase
- Modell Deutschland:**
  - Incentive program for electric vehicles depending on their efficiency
  - Replacement of mineral oil fuel for airplanes by bio fuels
  - Separation of railways for passenger and freight traffic
  - Creation of extra lanes for busses and trams
  - Limit for passenger cars: 80g CO2/km in 2020 and 70g CO2/km in 2030, for freight vehicles: value of 30% below today's consumption rate
  - Increase of road charge (until 2030 up to 50 ct/km) with reduction possibilities for the most efficient vehicles (Top-Runner-System), extension of the road charge to all freight vehicles and all streets
- Klimaschutz: Plan B 2050:**
  - Obligation to use railways for commercial transport from a certain distance on
  - Introduction of transit restrictions, car free zones, road charge for certain areas, promotion of low carbon vehicles and a more environmental friendly legislation on business cars taxation
  - Introduction of a speed limit of 120 km/h

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## 2.9 Comparison – Industry sector

- **Energiezukunft 2050:**
  - Increase of energy consumption of 500PJ until 2050 in comparison to 2005
- **Klimaschutz: Plan B 2050:**
  - Reduction of delivered energy consumption from 678 TWh/a (2007) to 459 TWh/a (2050)
- **Innovationsszenario:**
  - Reduction of 53% of delivered energy consumption to 1.149 PJ in comparison to 2005
  - Share of renewable energies: 9%
  - Share of low emission energy sources: 80% (40% electricity, 40% gas)
- **Modell Deutschland:**
  - Share of renewable energies and low emission energy sources: 90% until 2050

## 2.9 Comparison – Industry sector - Measures

- **Energiezukunft 2050:**
  - Increase of the emission taxation, from which one can be exempted if one can proof to have an energy management system, continuous measures or to have taken part in energy efficiency talks
  - Not only the industry sector but all actors should according be obliged to reduce emissions
- **Modell Deutschland:**
  - Obligation to introduce energy management systems
  - Offering a greater set off against tax liability for energy efficiency measures
  - Special rules for energy intensive businesses in the renewable energy law, the combined heat and power law and the ecotax shall be linked to flexible load management
  - Cap for the EU-ETS to 60% below the value of 2005; installations which are not covered by the EU-ETS shall be obliged to pay a GHG-emission tax of 30€/t CO<sub>2</sub>
  - Substitution of iron or the usage of CCS-technology while producing pig-iron in the area of iron and steel production
  - Substitution of natural gas by bio methane at the process heat production
  - Storing of biogenic CO<sub>2</sub>, emerging from the production of bio fuels, with CCS-technology
- **Klimaschutz: Plan B 2050:**
  - Tax reliefs for the improvement of energy management systems and energy transparency
  - Categorization of electric installations in efficiency classes and prohibition of those which do not fall in the best categories
  - Combined heat and power installations should continue to receive emission certificates doubled

## 2.10 Comparison – Household sector

- **Delivered energy consumption**
  - Klimaschutz: Plan B 2050:
    - Delivered energy consumption decreases from 702 TWh/yr (2007) to 298 TWh/yr (2050) = - approx. 57%
    - Due to an efficiency increase
  - Innovationsszenario:
    - Reduction of 75%
    - Due to an efficiency increase and behavioural changes

## 2.10 Comparison – Household sector - Measures

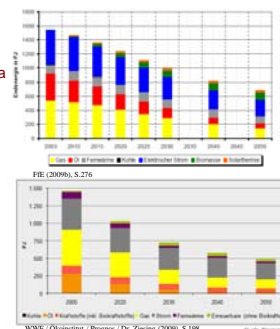
- **Household:**
  - Reductions mainly due to efficiency increase and change of behaviour
  - Energiezukunft 2050:
    - Necessity to increase the energy efficiency of household-, information-, and communication appliances
    - Abolishment of the standby modus
  - Klimaschutz: Plan B 2050:
    - Necessity of an energy efficiency law
    - Labelling of appliances according to their energy efficiency
- **Heating systems:**
  - Energiezukunft 2050:
    - Circulation pumps and heating circulation pumps should be turned off in periods in which they are not used
  - Modell Deutschland:
    - Prohibition of night storage heating and sponsorship for its exchange
  - Klimaschutz: Plan B 2050 and the Leitstudie:
    - Faster abolishment of night storage heating

## 2.10 Ctd.

- **Buildings:**
  - Leitstudie:
    - Improvement of efficiency of buildings
    - Existing buildings should also be covered by the market incentive program
    - Need of an efficiency increase of space heating for apartment buildings and non-residential buildings
    - Renewable energy should be used more often for space heating
  - Modell Deutschland:
    - Introduction of limits for space heating for the retrofit of old buildings
    - 2020: Obligation for new houses to do space heating without fossil fuels
    - Introduction of tax incentives for retrofits
    - Introduction of contracting models for existing houses
  - Energiezukunft 2050:
    - Introduction of a building TÜV (technical inspection agency)
- **Climate friendly behaviour:**
  - Energiezukunft 2050:
    - Lowering the room temperature by 1°C
    - Using water and light responsibly, efficient cooking
    - Car purchase in compliance with the purpose of the car
    - Lowering the meat consumption to 20kg/yr per person until 2050 and limiting the animals/area with regulatory measures and/or by offering incentives for the reduction of the livestock

## 2.11 Comparison – Business, commerce, services sector

- **Klimaschutz: Plan B 2050:**
  - Reduction of almost 50% of delivered energy from 407 TWh/a (2007) to 208 TWh/a (2050)
- **Energiezukunft 2050:**
  - Reduction of 55% in comparison to 2003
- **Innovationsszenario:**
  - Reduction of 67% in comparison to 2005



## 2.12 Comparison – Investment and Costs

- **Acquisition costs for electricity:**
  - Leitszenario: in the long rund 4-8 ct/kWh
  - Innovationsszenario without CCS: 8,4 ct/kWh (2050)
  - Innovationsszenario with CCS: 8,6 ct/kWh (2050)
- **Investment:**
  - Leitszenario: ~10 bn €/yr (2005) up to >20 bn €/yr (2050)
  - Innovationsszenario: until 2033: max. 32 bn €/yr, in 2050 max. 22 bn €/yr)
- **Savings:**
  - Innovationsszenario without CCS: up to 29 bn €/yr →no more costs from 2044 on
  - Innovationsszenario with CCS: 30 bn €/yr →no more costs from 2044 on
  - Klimaschutz: Plan B 2050: savings until 2020 (145 bn €) > costs until 2020 (110 bn €)
  - Leitszenario: no differential costs in the field of renewable energies from 2022 on

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## 3 Conclusion

- **Scenarios differ widely in terms of**
  - their aimed at emission reductions
  - their initial political assumptions (e.g. nuclear energy policy, CCS)
- **Together they offer a wide range of measures which are suitable for reducing energy and therefore for reducing emissions**

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## Sources

- FfE (2009b): Energiezukunft 2020, Langfassung Teil II, Szenarien, Munich.
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<http://www.wwf.de/themen/klima-energie/modell-deutschland-klimaschutz-2050/modell-deutschland-klimaschutz-2050-zentrale-ergebnisse/>, visited; 27.10.2009, Berlin, Basel.

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