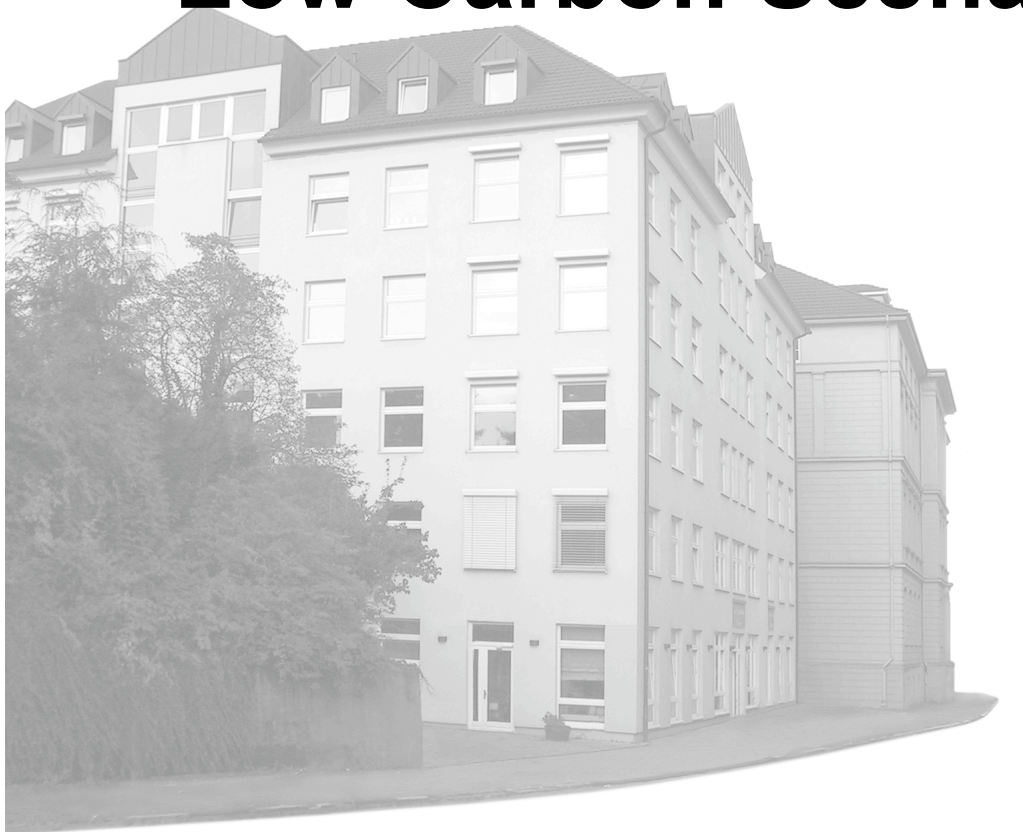
Wuppertal Institute
for Climate, Environment
and Energy

Low Carbon Scenario for Germany



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Definition of "Low Carbon Society"

- **The term has not yet been established in the German discussion (so far rather: Sustainable Energy System, decarbonisation need)**
- **How low? – Long term target**
  - 2°C-Target of the EU
  - > 60% Reduction of GHG emissions vs. 1990 worldwide (UN Foundation)
  - > 80 - 95% Reduction for industrialised countries (EU Environment Ministers)
  - 80% Reduction vs. 1990 (German target, Parliamentary Enquete Commissions)
  - Global emission budget < 750 billionen t CO2 until 2050 (WBGU approach)
- **"Low Carbon" has to be achieved within a framework of other sustainability criteria – trade off's have to be considered**
  - Reduction of material flows and availability of resources
  - Security of energy supply and risk minimisation
  - Respecting economic constraints (competitiveness)
  - etc.

LCS Research in Germany

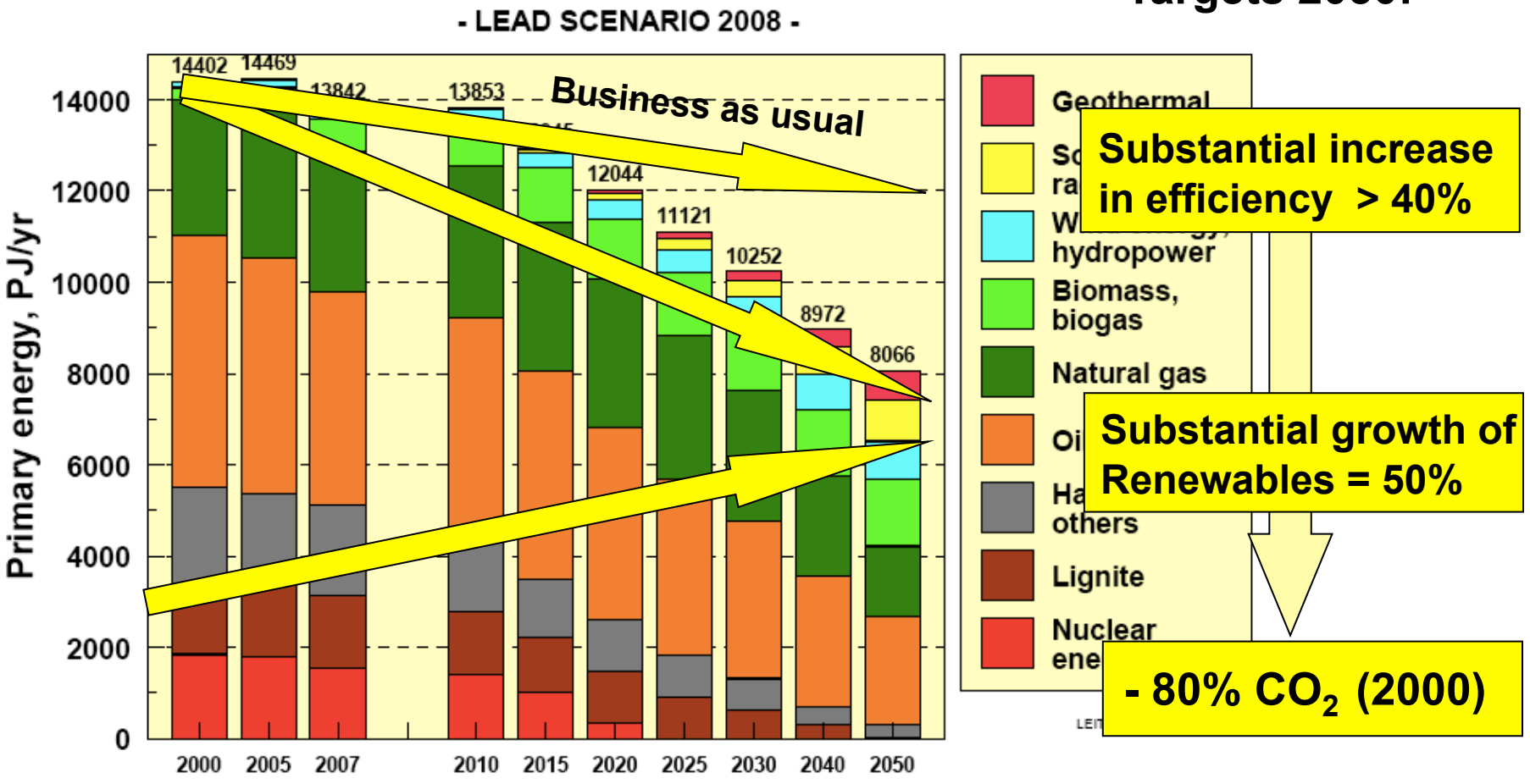
- Long term energy and emission targets have been discussed since 1990
- Climate protection analysis mostly have a mid term focus (2020, 2030)
- Some institutes have made long term energy scenarios (for 2050), e.g.
  - German Aerospace Center (DLR)
  - Research Center Jülich
  - University of Stuttgart (IER)
  - Öko-Institut
  - Ecofys
  - Potsdam Institute for Climate Impact Research
- Mainly focused on the German and European energy system (using simulation, linear optimisation and macro-economic modelling approaches)
- **A strong German network on LCS research is missing**

  At least: “Modelling experiment network (MEX)” between 1998 and 2004 (discussion platform: model theory and comparison, not problem oriented)

LCS Research in Germany

Lead Scenario for the German Ministry for Environment: Climate Protection based on renewable energies and energy efficiency improvement (DLR 2008)

Primary energy demand in PJ



Efficiency method; actual values are not temperature-adjusted

LCS Research in Germany and its policy impact (examples)

Long term energy scenarios have been used for instance for

- Enquête Commission of the German Parliament
  - 1990 - 1998: Commission on “Protection of the Earth” I and II
  - 1999 - 2002: Commission on “Sustainable Energy Future”
- Enquête Commissions of several “Bundesländer”
  - Bavaria
  - Northrhine Westphalia (impact on climate policy an energy price stability and energy import dependency)
- Energy Dialogue of the German Chancellor (2006 and 2007)
- Energy and Climate advisory boards on national and regional level (e.g. Energy and Climate Council of NRW)
- Elaboration of German position in the global and European climate protection debate
- etc.

LCS scenario research at the Wuppertal Institute

Sustainable Low Carbon Society Research at Wuppertal Institute

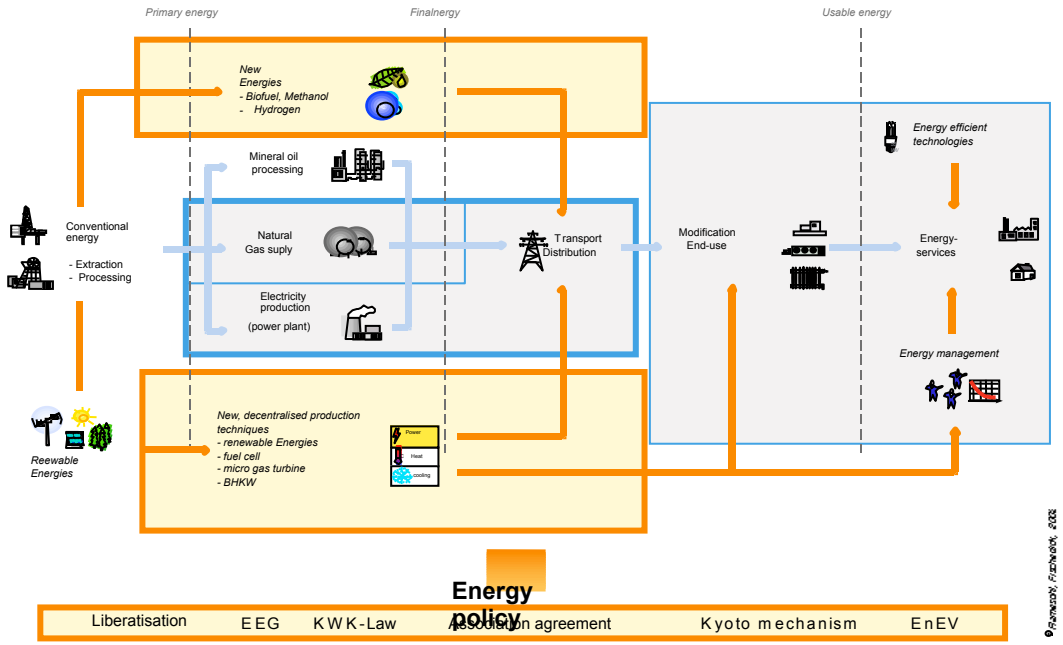
- The WI has a long tradition in doing long term sustainability research
  - Analysis of long term technologies
  - Identification of strategies and policies towards LCS
  - Development of long term scenarios
    - Time horizon 2020/30/50/2100
    - Global, European, National, Regional Level
    - Transformation pathways for municipalities
  - Sustainable Production and Consumption (WI-UNEP Collaboration Centre: CSCP)

Important LCS Research by WI

- **1990: Parliamentary Enquete Commission "Protection of the Earth"**
  - Setting of a long term target: -80% GHG by 2050
  - Prof. Hennicke was member of that commission
- **1995: WI flagship study: Sustainable Germany**
  - Groundbreaking study for German sustainability discussion
  - Mainly qualitative recommendations on "basic needs"
  - First quantitative scenario analysis for 2050
- **1996: Long term integration of renewable energies (EU, 2050)**
- **2000: Long term energy scenarios for Germany (Fed. Environmental Agency)**
- **2002: Parliamentary Enquete Commission "Sustainable Energy Future"**
  - Prof. Hennicke & Dr. Lehmann were members of that commission
  - Quantitative energy scenarios for Germany: -80% GHG by 2050; competing analysis WI vs. IER (lead by Manfred Fischedick)
- **2004: Ecologically optimised expansion of renwable energies**
  - Quantitative energy scenarios for Germany: -80% GHG by 2050, with DLR
  - Basic studies for the annual "Leitstudie 2050" of German MOE
- **2009: Pathways to a carbon free Munich 2058**
  - Commissioned by Siemens as part of their sustainable urban infrastructures project

LCS scenario research (methodological approach: energy system modelling)

- Bottom-up oriented technological energy modelling (from energy service demand to primary energy exploitation technology)
- Detailed technological analysis of the energy systems
  - Supply side
  - Demand side (high disaggregation level considered)
- Simulation approach (determination of market shares via expert knowledge)



Bottom up Energy system Modelling
Characteristics of simulation approach

Criteria for determination of market shares

- General scenario philosophy
- Distinguished driving forces (technology status, market, society, government etc.)
- Costs
  - from national perspective
  - from individual perspective
- Market barriers
- Available policy measures for overcoming barriers
- Expected opposition against implementation of suitable policies
- Continuity principles for development processes (e.g. market introduction and penetration path of new technologies) - avoiding structural breaks

The result is not the optimum from the mathematical point of view but may be a more realistic solution

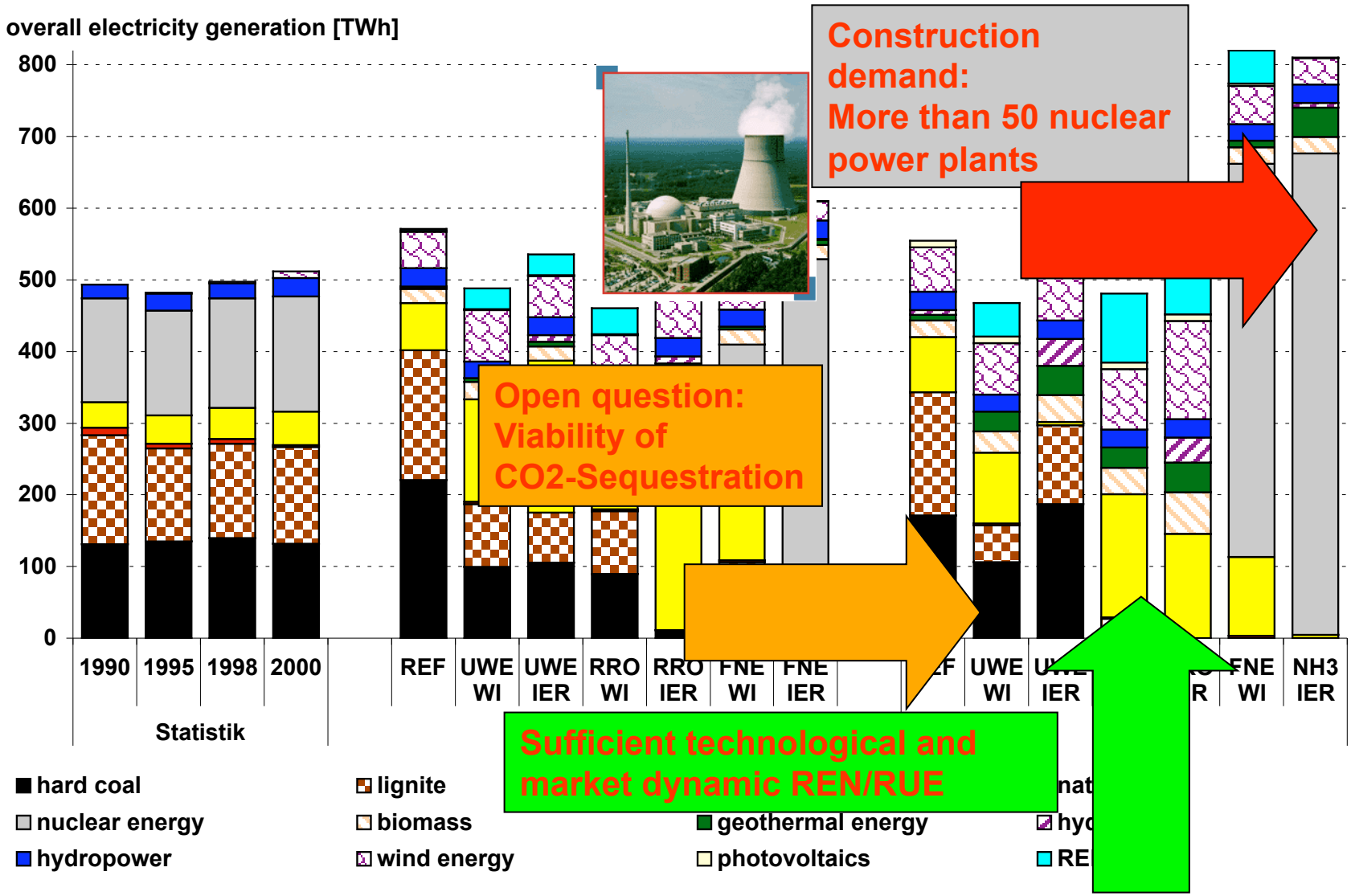
Philosophy of Wuppertal Institutes Scenario Work

- Scenarios are quite different from predictions
- Scenarios are asking “what happens if ….”
- Scenarios are based on a consistent set of assumptions which should be outlined transparently
- Scenarios are necessary
  - to pick up future uncertainties
  - to identify the corresponding range of possible future paths (including the branching points)
  - to describe the major impacts and dangers of those paths
  - to deal with new challenges and significant changes of crucial frame conditions
  - to gain more experience about the manifold interactions in the system
  - to enable an elaborate discussion about suitable policy and technology strategies following defined targets
- Scenarios should include a broad spectrum of opinions and expert views from different stakeholders (e.g. via interviews)

  ➔ **For policy makers it is worthwhile to present set of different scenarios to mark the decision range**

Selected projects I: Long Term Energy Scenario on behalf of the German Enquete Commission

Different pathways for 80 % GHG reduction compared to 1990 by 2050



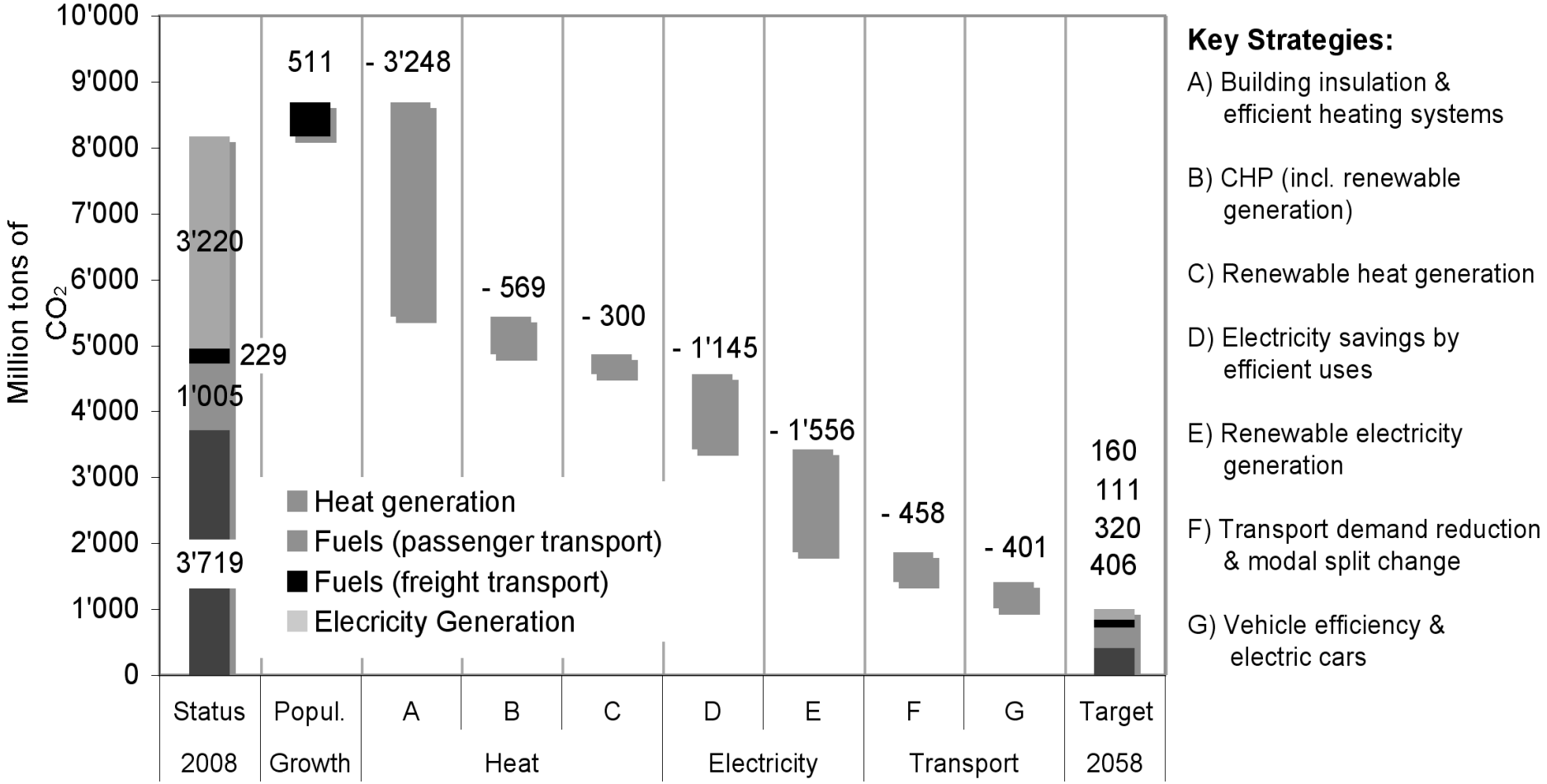
Selected projects II: Sustainable Urban infrastructure on behalf of Siemens

Munich 2058 – Pathways to a Carbon Free Future

- Blueprint for the restructuring of cities
  - 50% of the worlds population lives in cities, but they consume more than 70% of the energy
  - cities are determining nodes of ressource use and core to the solution
  - 50% of cities of 2050 are still to be built
  - 50% have been already built (including infrastructural backbones)
- Project components:
  - Technology matrix (100 local technologies for a CO_2 free future)
  - Scenario analysis „Vision Munich 2058“
    - Two scenarios (Target & Bridge) 750 / 1300 kg CO_2/cap
  - Pilot district „CO_2 free“ by 2038
  - ***Economic chances of being a low carbon frontrunner***

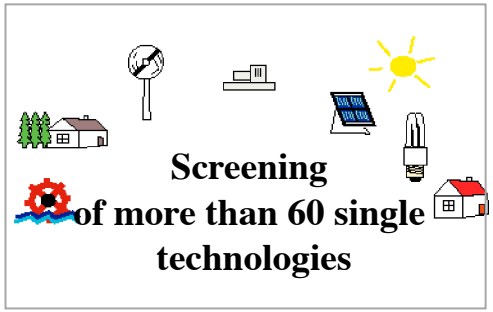
Selected projects II: Sustainable Urban infrastructure on behalf of Siemens

Munich 2058: Key strategies for 90% CO2 reduction



Selected projects III: Future Technology Demand

Using long term scenarios for identification of robust technology needs (Technology push and demand pull approach)



Screening of more than 60 single technologies

Global challenges and resulting future markets:

– Carbon reduction
– Dematerialisation
– Sustainable mobility and urbanisation
– Power supply in rural areas
– Water supply
– Sustainale supply of food and renewable ressources

Analysis of trends

backcasting

Analysis

Expert estimation

Scenario-analysis

Global market potential
Importance for NRW
State of the art
Competitive position of NRW

Relevance-tree

Review of the contribution to systems solution

Preselection of nearly 40 technologies

Expert review

Final selection:
9 key technologies
5 system solutions

Selected projects III: Future Technology Demand
Promising (needed) technologies are often system solution

Thinking in Systems:

- **Efficient Buildings (Demand side)**

  Residential buildings with focus on passive houses

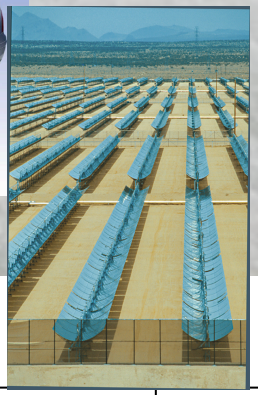
  Commercial buildings, (including air conditioning engineering,energy management)

  Sustainable cooling (including passive cooling, solar cooling)

- **Efficient Buildings (Supply side)**
  Efficient buildings + combined heating/cooling and electricity generation

Thinking in Systems:

- **Intelligent Energy Systems for Integration of Renewable energies**
  (including net connection, system integration, storage battery, load management, virtual power stations
- **Rural Electrification**
  (including stand alone sytems)
- **New Fuels & Energy Carriers**
  (E-Mobility, Hydrogen)



Further research questions for Low Carbon Society Research Network (research gaps and challenges)

- **How can LCS (in particular sustainable energy and mobility) structures be shaped in the future?**
- **How to implement changes towards LCS?**
  - How can the transition to such structures take place
  - Further analysis of technology needs: Are there robust technologies? What are the needs and possible priorities for R&D policy?
  - Analysis of the role of behavioural changes: How a LCS culture looks like and how it can be shaped, how can behavioural changes be introduced?
  - Analysis of policy towards LCS and necessary institutions
  - etc.

Sustainable Development is more than "Low Carbon"

- Identification of further challenges and environmental goals: further development of Low Material Society scenarios and instruments (cross problem oriented, cross sectoral system analysis: sustainability scenarios)

Wuppertal Institut
für Klima, Umwelt, Energie
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Thank you for your attention!

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