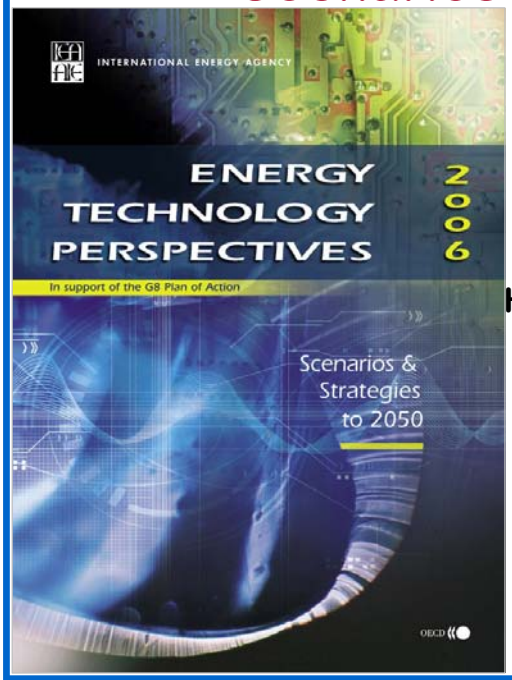
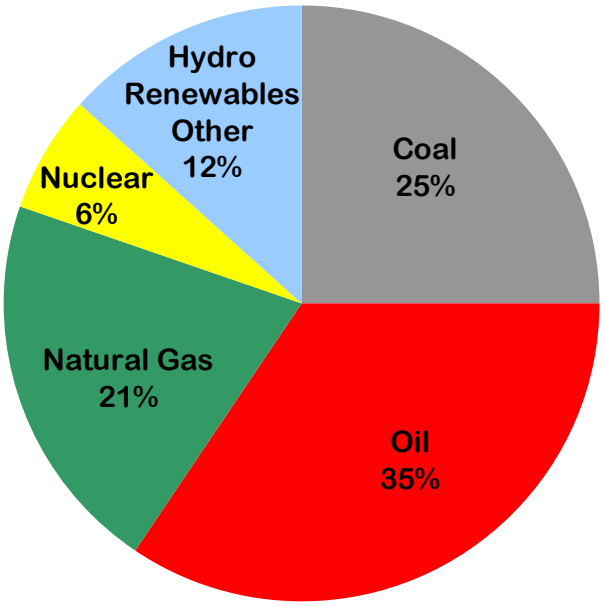
Energy Technology Perspectives
Scenarios & Strategies to 2050



Dr. Robert K. Dixon

Head, Energy Technology Policy Division
International Energy Agency

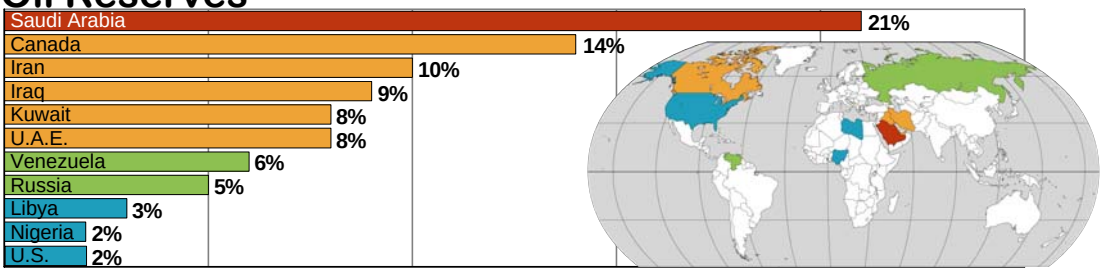
World 2004
Total Primary Energy Supply



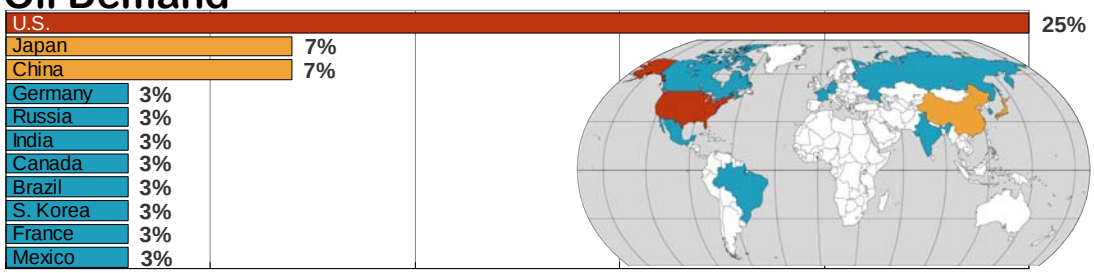
Source: IEA-ESD Energy Balances

Imbalance Between Oil Demand & Reserves

Oil Reserves

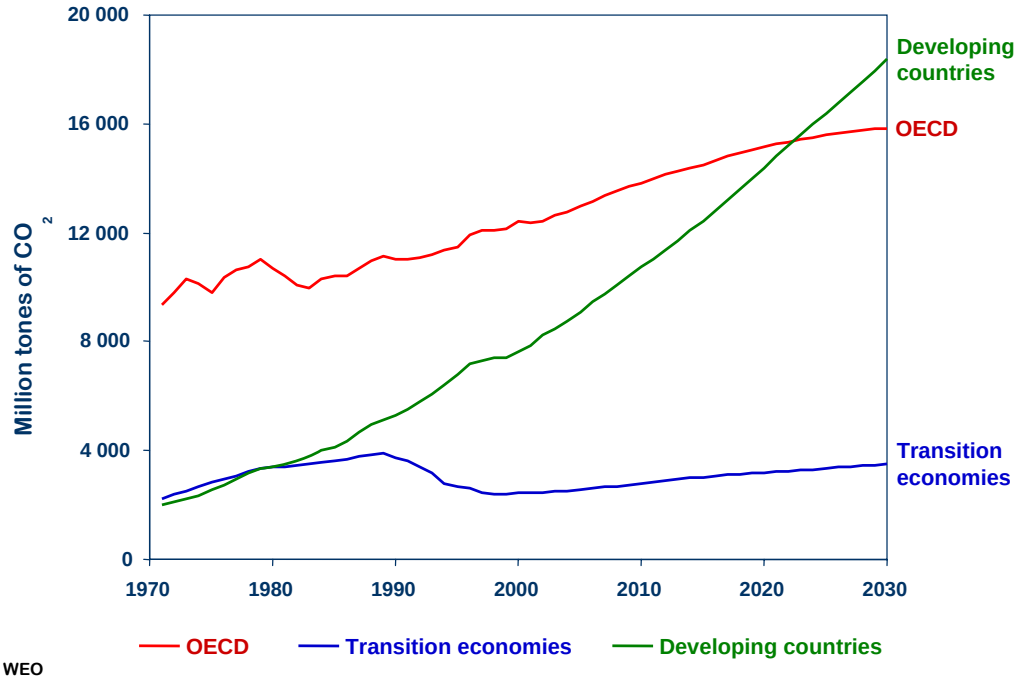


Oil Demand



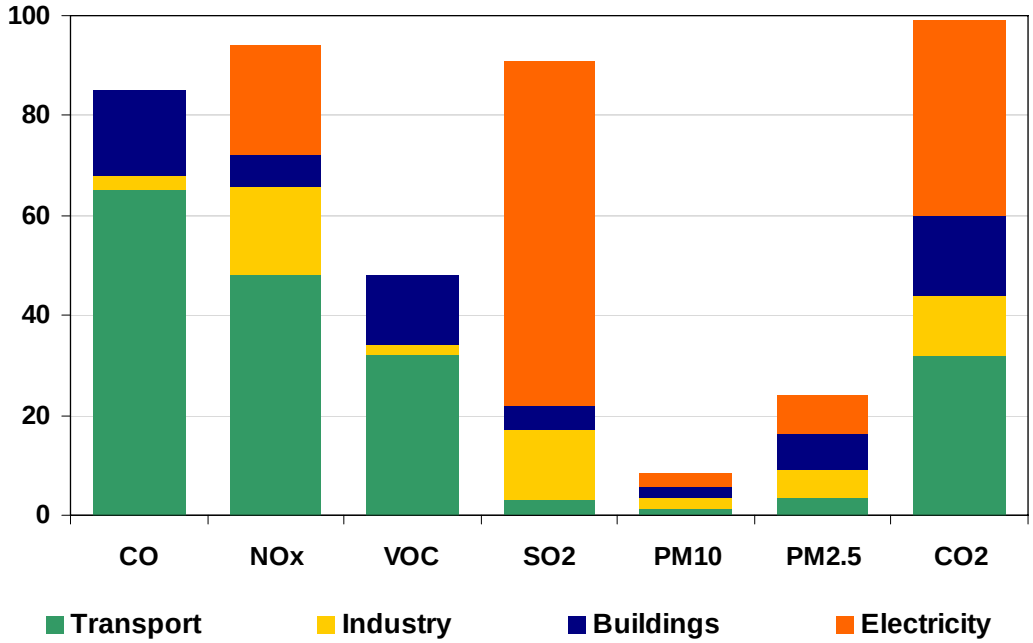
Updated July 2005. Source: International Energy Annual 2003 (EIA). Canada's reserves include tar sands.

Global CO_2 Emissions Increasing



Source: IEA WEO

Environmental Impacts of Fossil Energy Use



Source: US EPA; U.S. 2001 Energy-Linked Emissions as Percentage of Total Emissions

G8 - Gleneagles Communiqué July 2005

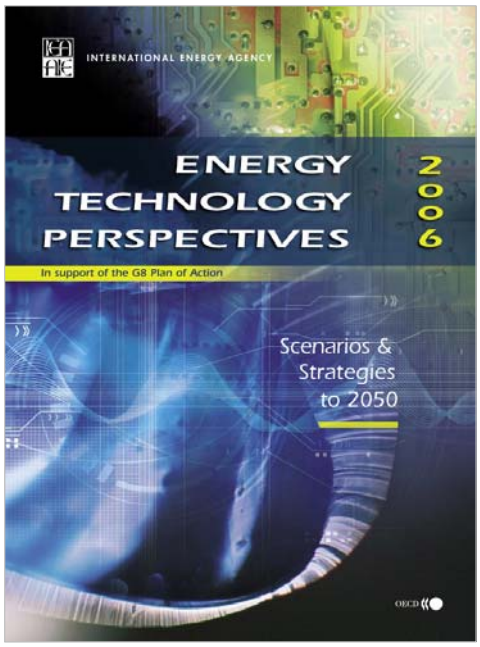
"We will act with resolve and urgency to meet our shared multiple objectives of reducing greenhouse gas emissions, improving the global environment, enhancing energy security and cutting air pollution in conjunction with our vigorous efforts to reduce poverty"

"The IEA will advise on alternative energy scenarios and strategies aimed at a clean, clever and competitive energy future"

Energy Technology Perspectives 2006

ETP 2006 provides part of IEA's "advice on scenarios and strategies" at St. Petersburg

ETP 2006 presents a groundbreaking review of technologies across all sectors and assess how they together can make a difference



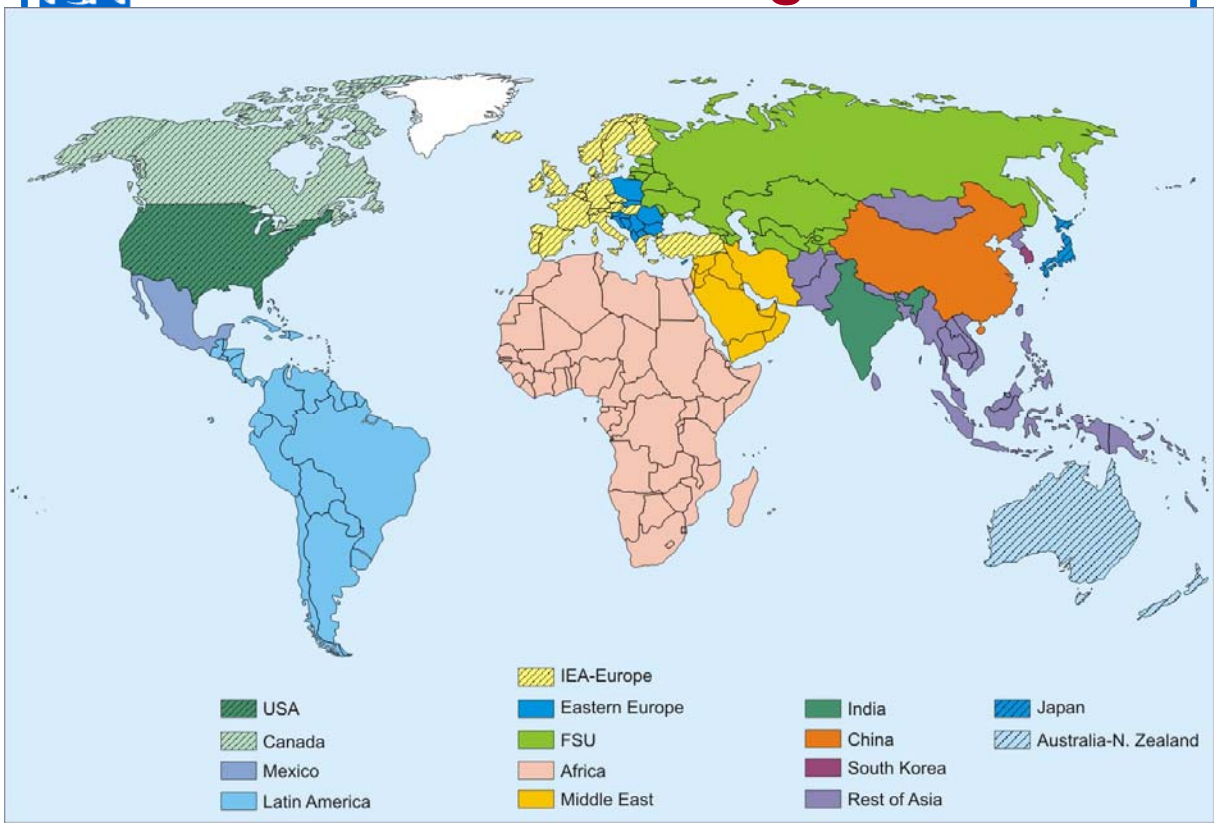
Energy Technology Perspectives Presents

- Status and perspectives for key energy technologies in:
  - Electricity Generation
  - Road Transport Technologies & Fuels
  - Buildings & Appliances
  - Industry
- Global scenarios to illustrate potentials for different technologies under accelerated policies
- Strategies for helping key technologies make a difference

ETP Modelling Framework

- Proven, validated modelling framework
- Captures technological change
- Accounts for competing resource use (e.g. biomass, CO_2-free electricity)
- Accounts for competing technologies
- Endogenous fuel price response
- Carbon leakage effects
- Easy sensitivity and scenario analysis

15 ETP model regions

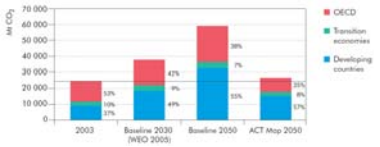


Scenario Analysis

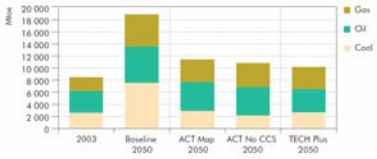
- Scenarios analysed:
  - Baseline Scenario
  - Accelerated Technology Scenarios (ACT)
  - TECH Plus scenario
- ACT and TECH Plus scenarios:
  - Analyse the impact from R&D, Demonstration and Deployment measures
  - Incentives equivalent to 25 $/tonne CO_2 for low-carbon technologies implemented world-wide from 2030 and on
  - Individual scenarios differ in terms of assumptions for key technology areas

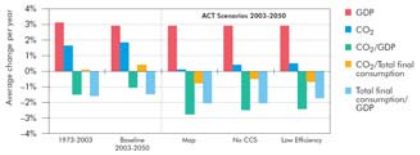
Technology Assumptions

Scenario	Renewables	Nuclear	CCS	H_2 fuel cells	Advanced biofuels	End-use efficiency
ACT Map	Relatively optimistic across all technology areas					2.0 % p.a. global improvement
ACT Low Renewables	Slower cost reductions					
ACT Low Nuclear		Lower public acceptance				
ACT No CCS			No CCS			
ACT Low Efficiency						1.7 % p.a. global improvement
TECH Plus	Stronger cost reductions	Stronger cost reductions & technology improvements		Break-through for FC	Stronger cost reductions & improved feedstock availability	

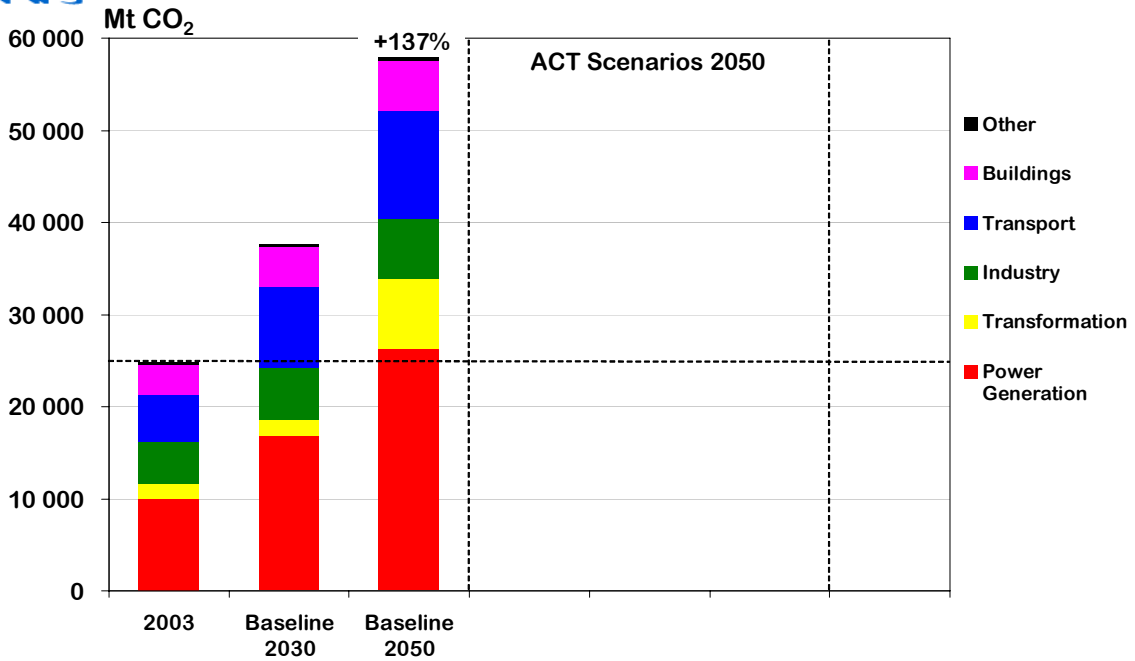


Results from the Scenario Analysis



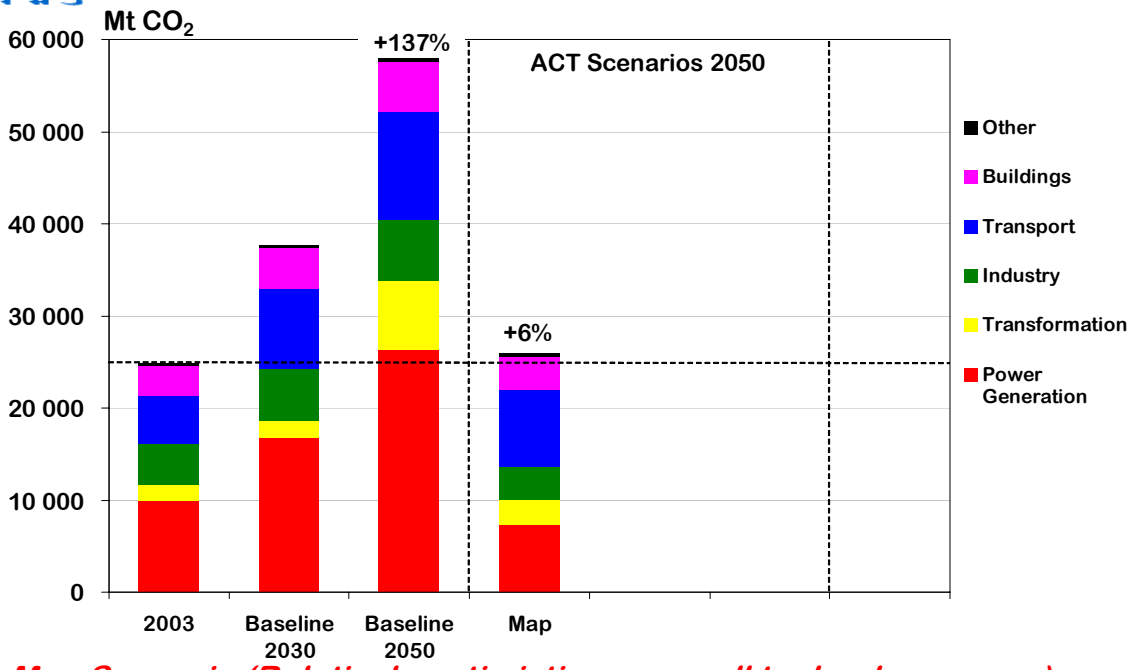


Global CO_2 Emissions 2003-2050
Baseline Scenario



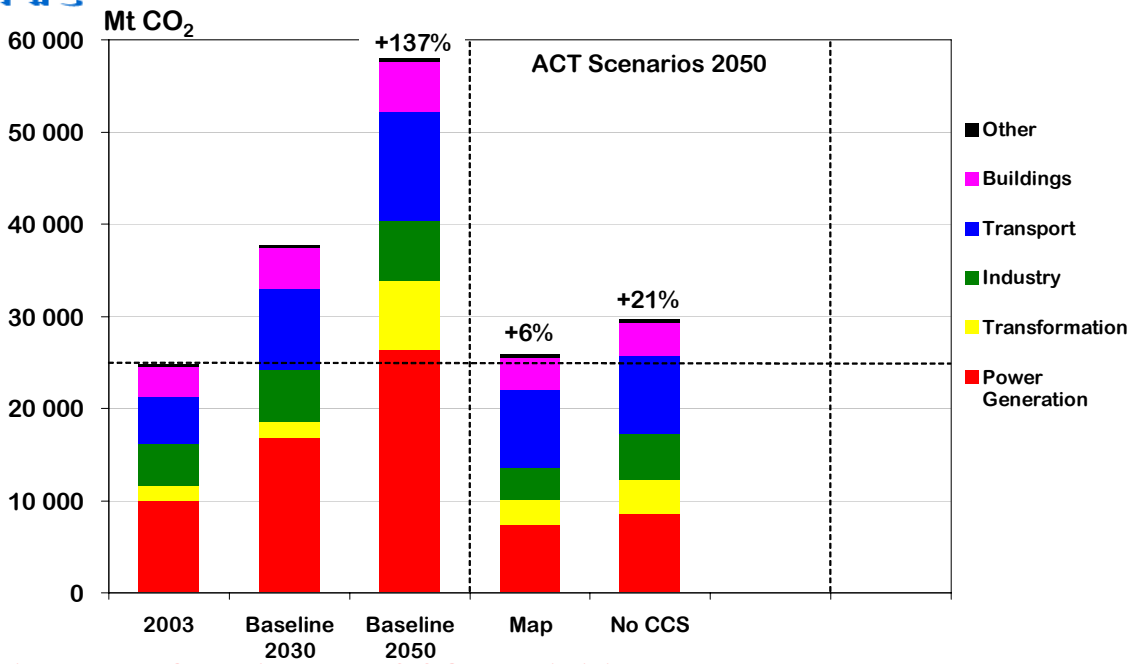
Emissions increase 137% from today's level

Global CO_2 Emissions 2003-2050
Baseline and Map Scenario



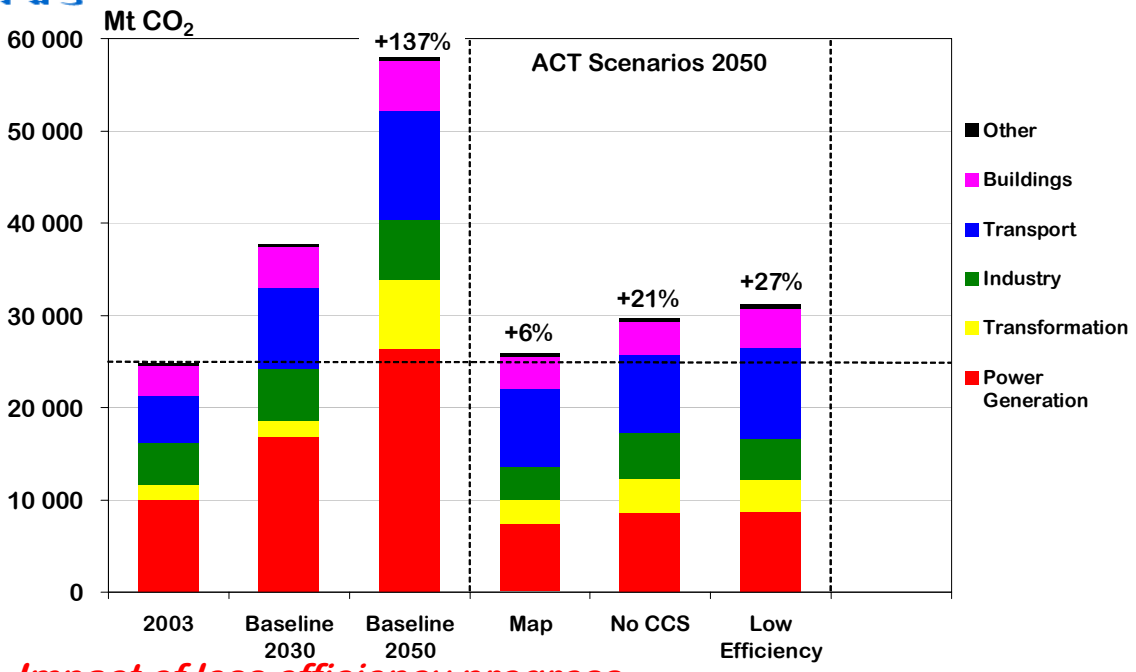
Map Scenario (Relatively optimistic across all technology areas) : Emissions returned towards today's level

Global CO_2 Emissions 2003-2050
Baseline and ACT Scenarios



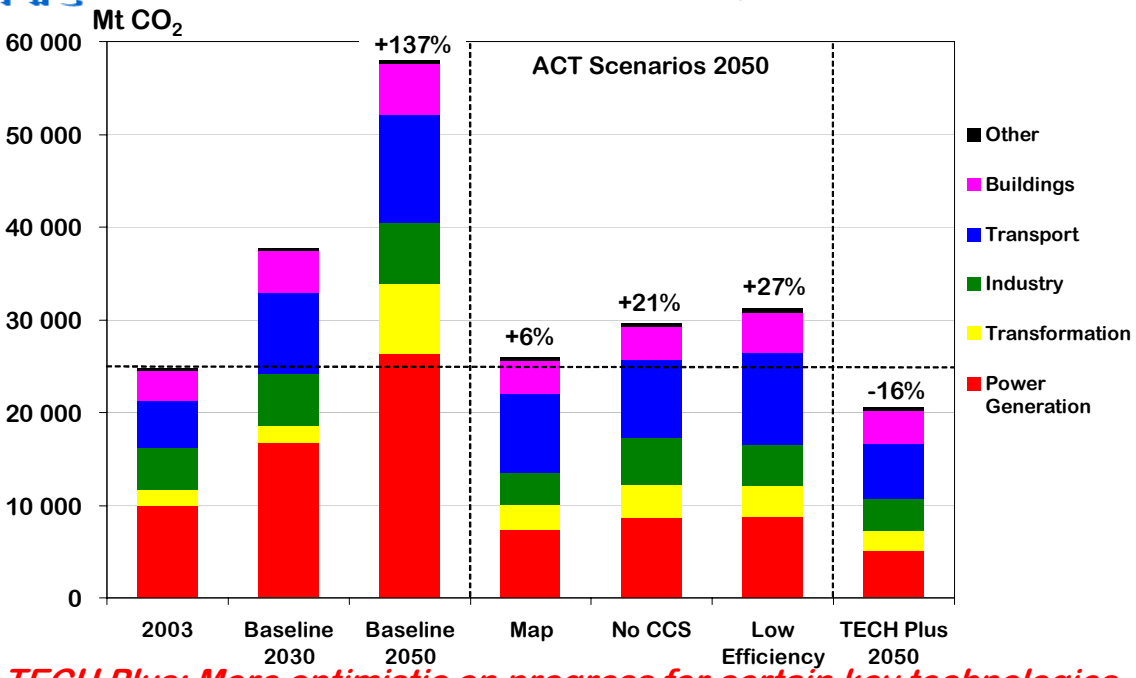
Impact of not having CCS available

Global CO_2 Emissions 2003-2050
Baseline and ACT Scenarios



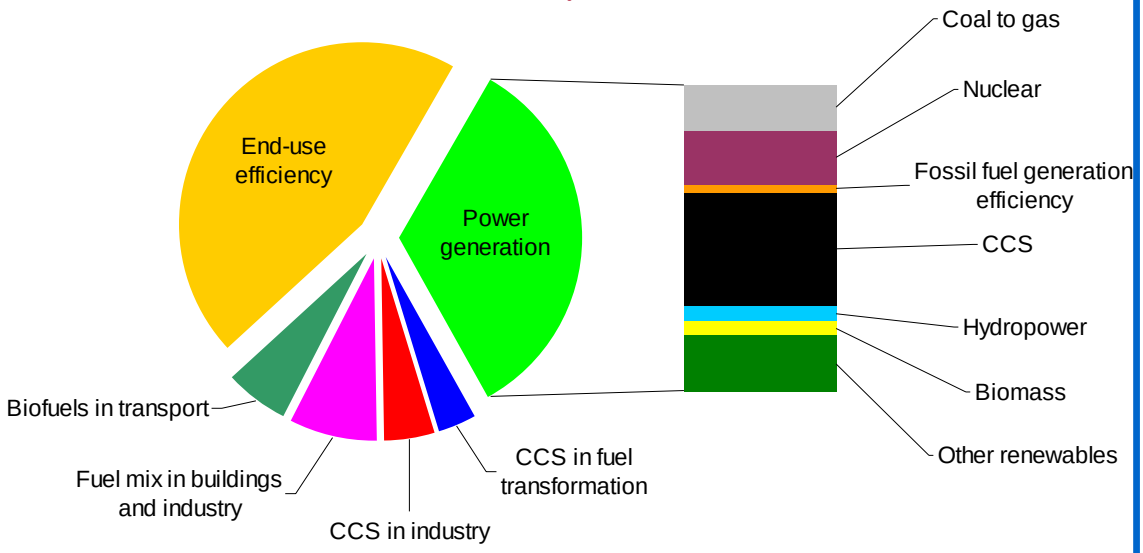
Impact of less efficiency progress

Global CO_2 Emissions 2003-2050
Baseline, ACT and TECH plus Scenarios



TECH Plus: More optimistic on progress for certain key technologies

Emission Reduction by Technology Area ACT Map Scenario

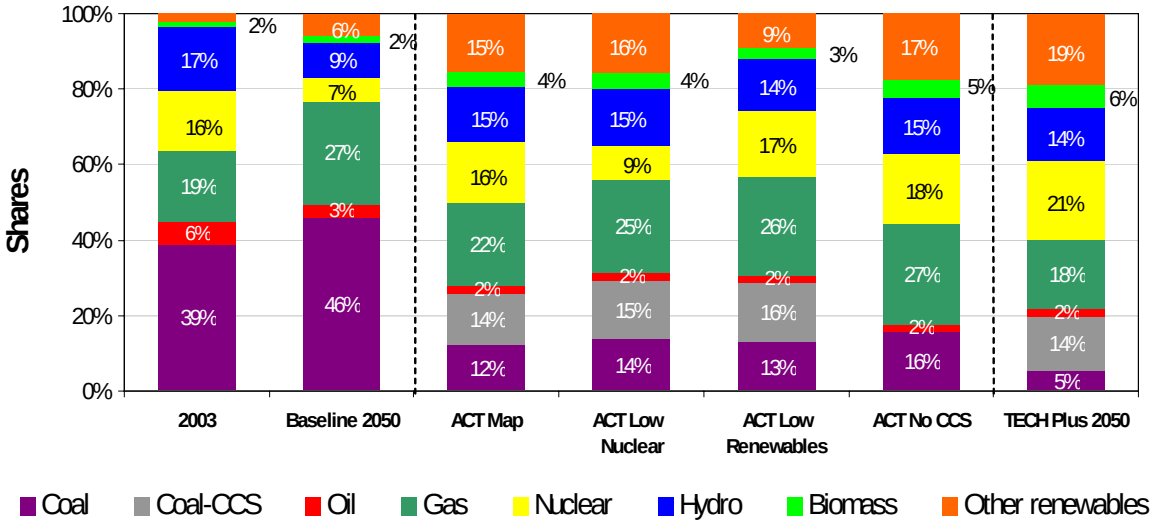


Improved energy efficiency is the most important contributor to reduced emissions!

Energy Efficiency - A top Priority

- Improved energy efficiency saves about 15 000 Mt CO_2 by 2050 - equivalent to 60% of current emissions
- Improved efficiency halves expected growth in electricity demand and reduces the need for generation capacity by a third
- In a scenario with less progress in efficiency, CO_2 emissions increase more than 20%
- Lower efficiency progress increases supply-side investments and costs of reducing CO_2 emissions

Global Electricity Generation by Fuel



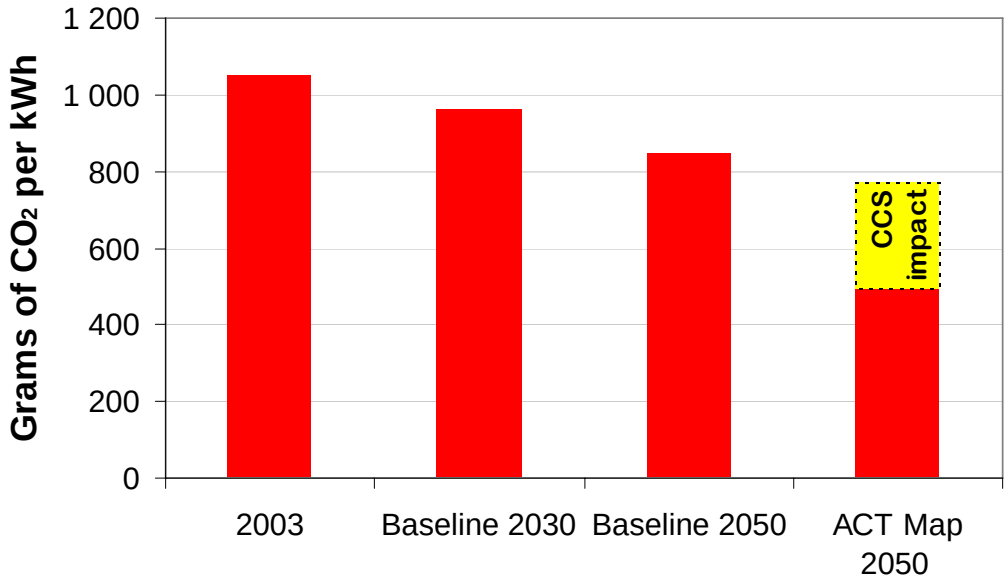
ACT Scenarios: Important role for CCS and strong growth in the shares for renewables and nuclear.

Electricity Generation

CO_2 Capture and Storage a Key Option

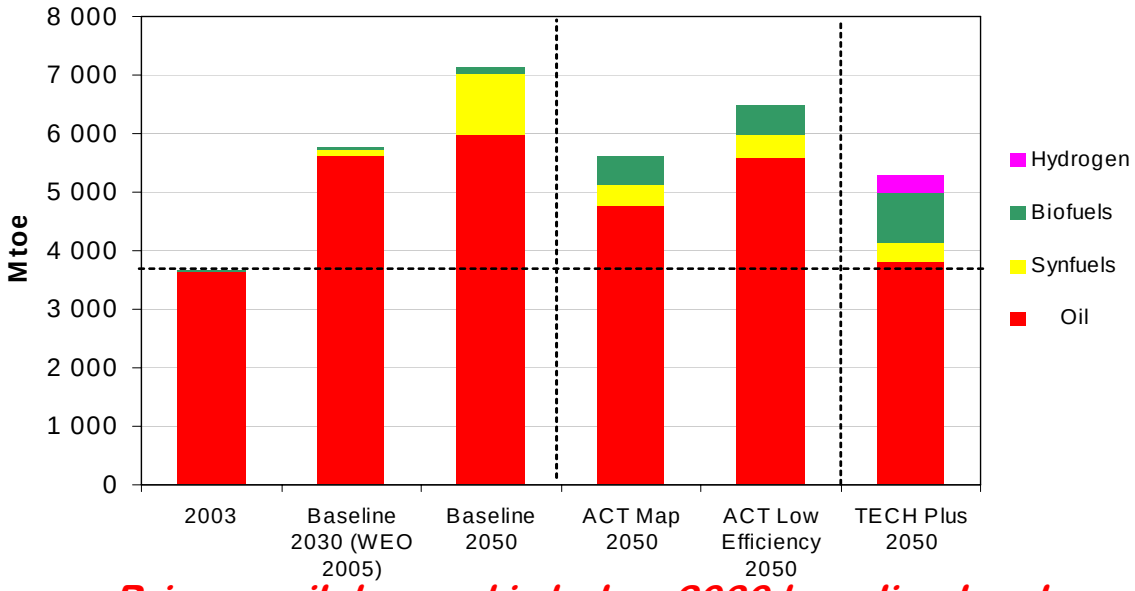
- CCS is crucial for the role coal can play in a CO_2 constrained world – without CCS coal-fired generation in 2050 drops below today's level
- By 2050 more than 5 000 TWh electricity globally can be produced by coal-plants equipped with CCS
- There is an urgent need for more R&D and for full-scale CCS demonstration plants
- Generation from renewables can quadruple by 2050
- Nuclear can gain a much more important role in countries where it is acceptable

CO_2 Intensity Coal Fired Power Generation China 2003 - 2050



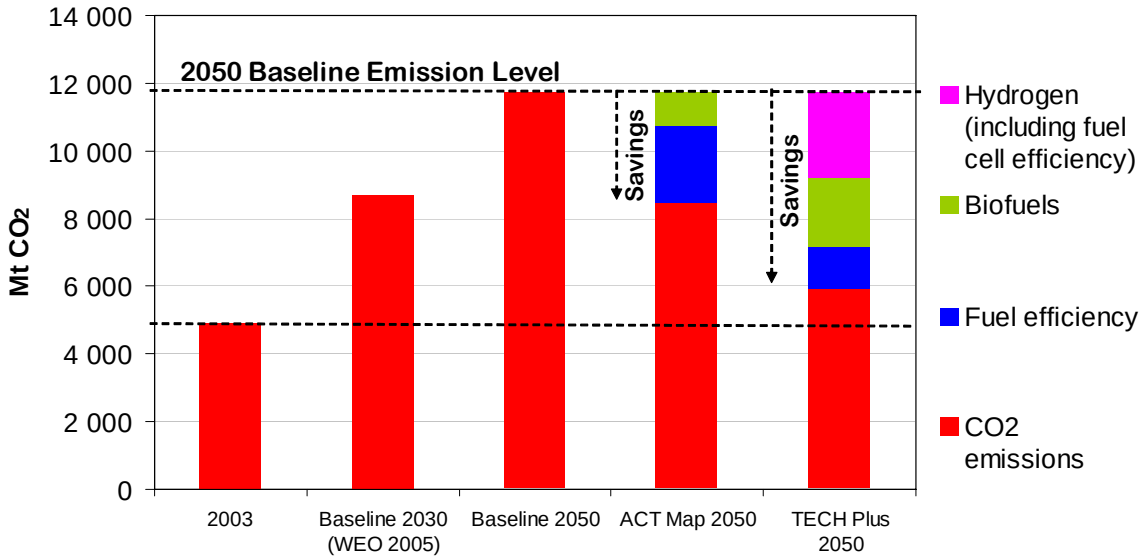
More than 50% reduction in CO_2 intensity due to improved generation efficiency and CCS .

World Liquid Fuel Supply by Scenario 2003-2050



Primary oil demand is below 2030 baseline level and is returned to about today's level in TECH Plus.

Transport CO_2 Emissions by Scenario

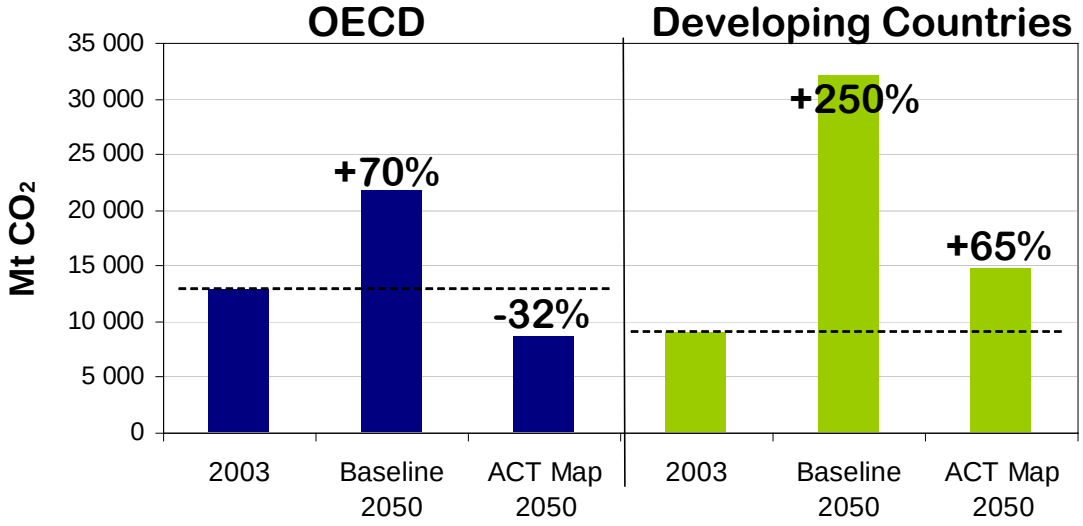


Map Scenario: Two-thirds of CO_2 emissions reduction is from improved fuel efficiency and one-third from biofuels.

Transport
Key to Reduce Growth in Oil Demand

- **Share of biofuels by 2050 is 13% and average 2050 vehicle is almost 50% more efficient than today**
  - **Reduce expected growth in transport oil demand by almost 50%**
- **Transport accounts for 62% of the 42 mbpd total oil savings by 2050, which more than halves the expected growth in total oil demand**
- **Hydrogen and Fuel Cells can reduce transport oil demand and CO_2 emissions even further and can be crucial for long-term sustainability**

CO_2 Emissions
Baseline and Map Scenarios



Map: OECD Emissions 32% below 2003 level, while emissions in Developing Countries are 65% higher.

Scenario Analysis
Key Findings

- Most energy still comes from fossil fuels in 2050
- CO_2 emissions can be returned towards today's level by 2050
- Growth in oil and electricity demand can be halved
- Power generation can be substantially de-carbonised by 2050
- De-carbonising transport will take longer but must be achieved in the second half of the century

Technology Implications

- A technology portfolio will be needed
- Improving energy efficiency is top priority
- CCS is key for a sustainable energy future
- Other important technologies:
  - Renewables, including biofuels
  - Nuclear
  - Efficient use of natural gas
  - In time and with effort, hydrogen and fuel cells

Policy Implications

- A more sustainable energy future is possible with known technology
- The costs are not out of reach
- But urgent action is needed in both, public and private sectors:
  - Overcome barriers for adoption of energy efficient technologies
  - Enhance R&D
  - Accelerate demonstration and deployment
  - Provide clear and predictable incentives
- Collaboration between developed & developing countries is essential

Thank you!

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