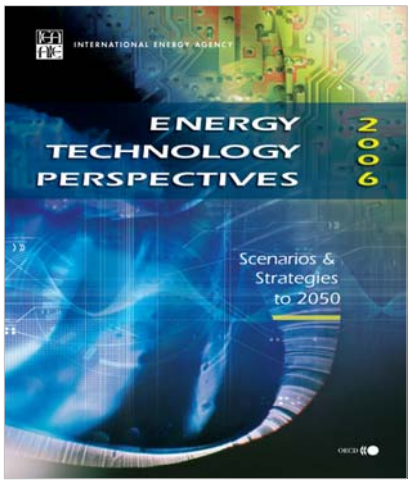
Energy Technology Perspectives
Scenarios and Strategies to 2050



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International Energy Agency

INTERNATIONAL ENERGY AGENCY AGENCE INTERNATIONALE DE L'ENERGIE

This Presentation

- ETP background
- Results from the Scenario Analysis
- Policy Consequences
- Next Steps

The Framework

- Response to G8 request for advice on alternative energy scenarios & strategies
- Guided by CERT and in close cooperation with the IEA Working Parties and Implementing Agreements
- Building on the Energy Technology Perspectives project
- Supported by many member countries

G8 - Gleneagles Communiqué July 2005

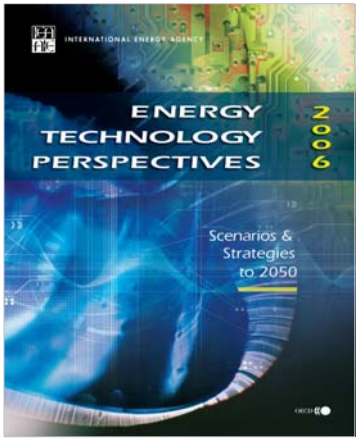
"We will act with resolve and urgency to meet our shared multiple objectives of reducing greenhouse gas emissions, improving the global environment, enhancing energy security and cutting air pollution in conjunction with our vigorous efforts to reduce poverty"

"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

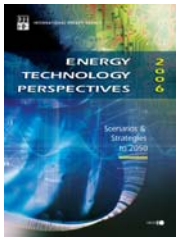
ETP 2006 presents a groundbreaking review of technologies across all sectors and assess how they together can make a difference



ETP launch

- Released 22 June
- >1500 copies sold, 2nd edition is now printed
- Presentations in many capitals:
  - Berlin, Brussels, London, Madrid, Mexico, Oslo, Ottawa, Paris, Rome, Seoul, The Hague, Tokyo, Washington DC
- Intensive discussions with IPCC , Stern report group, Shell, McKinsey
- Input to World Energy Outlook 2006

ETP
Scenarios & Strategies 2050



- "The WEO scenarios are not sustainable" (Claude Mandil)
- ETP supplements WEO as it shows new pathways to a sustainable future
- Emissions can be stabilised by 2050, if proper energy policies are implemented
- Technology plays a key role
- Key technology options and policies have been identified

Energy Technology Perspectives Presents

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

Key Findings

- Current policies will not bring us on a path towards a sustainable energy future
- A more sustainable energy future is possible with a portfolio of clean and efficient technologies
- Using technologies that have an additional cost of less than 25 $/tonne CO_2 avoided:
  - Global CO_2 emissions can be returned to today's level by 2050
  - Expected growth in both oil and electricity demand can be halved
- Requires urgent action to promote, develop and deploy a full mix of energy technologies
- Collaboration between developing and developed nations will be essential

Results from the Scenario Analysis

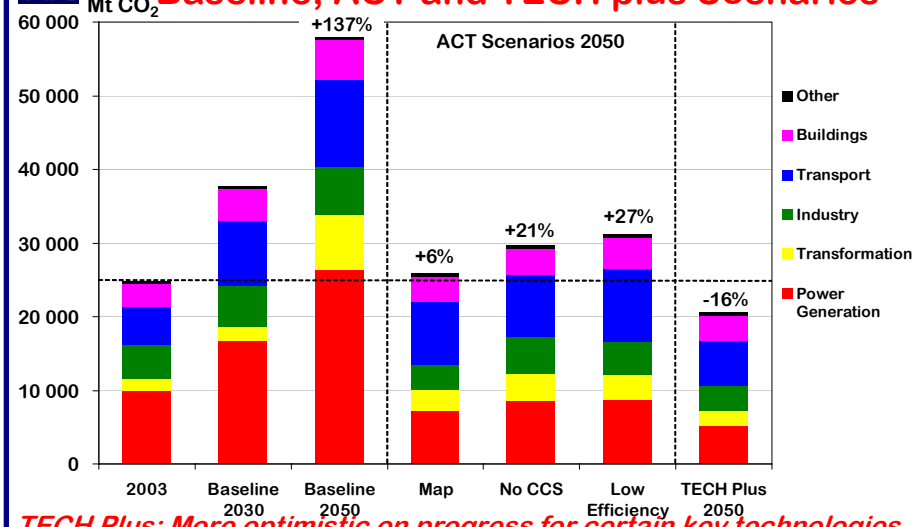
Scenario Analysis

- 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	

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



TECH Plus: More optimistic on progress for certain key technologies

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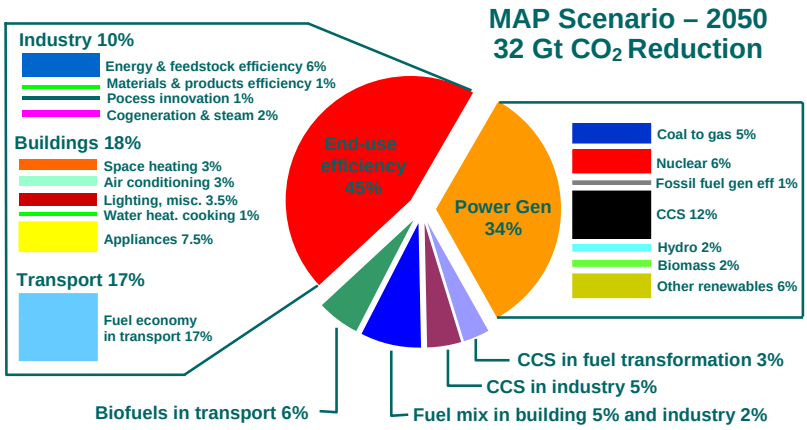
Emission Reduction by Technology Area
ACT Map Scenario



Improved energy efficiency most important contributor to reduced emissions

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Energy Efficiency - A top Priority

- Improved energy efficiency saves about 15 Gt 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

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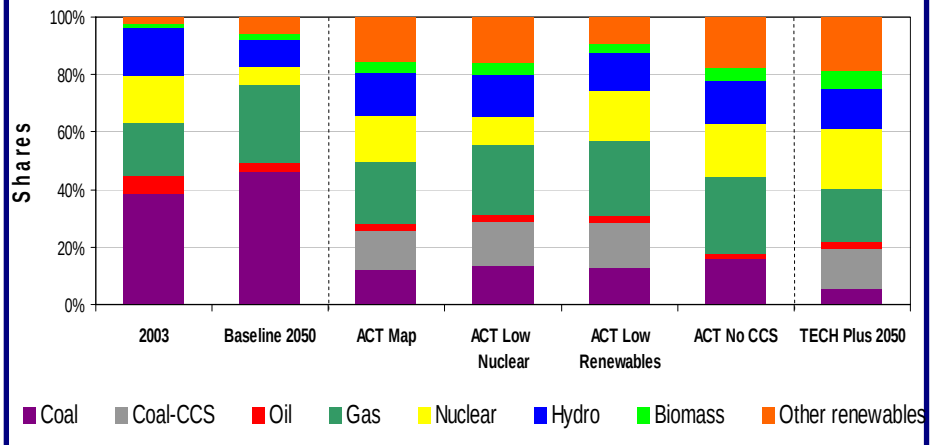
Global Electricity Generation by Fuel



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

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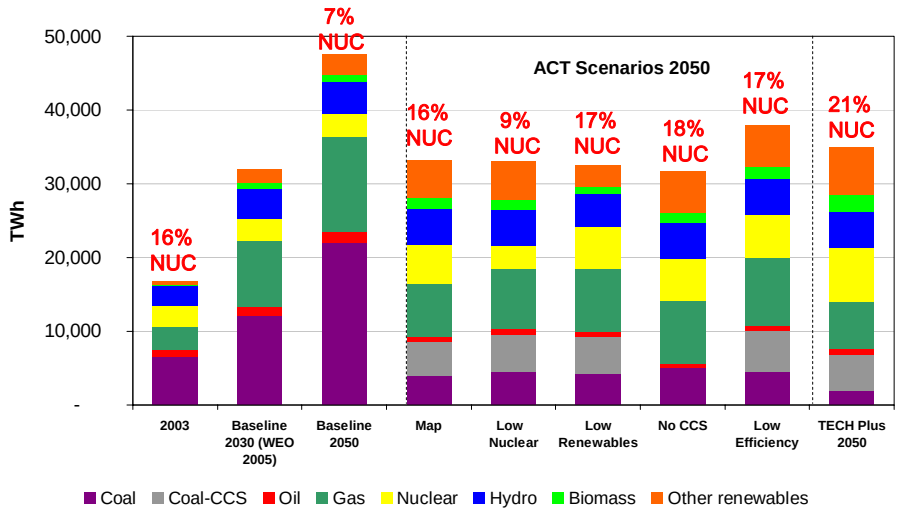
Power Generation



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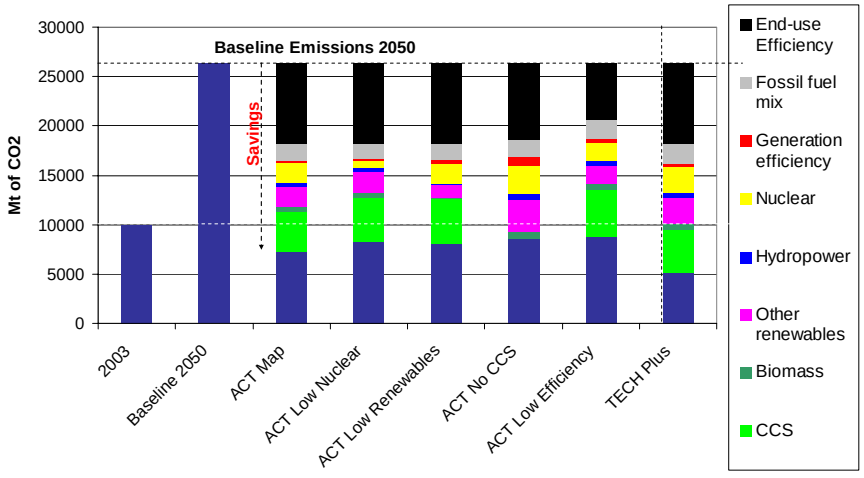
CO_2 Emissions in Power Generation



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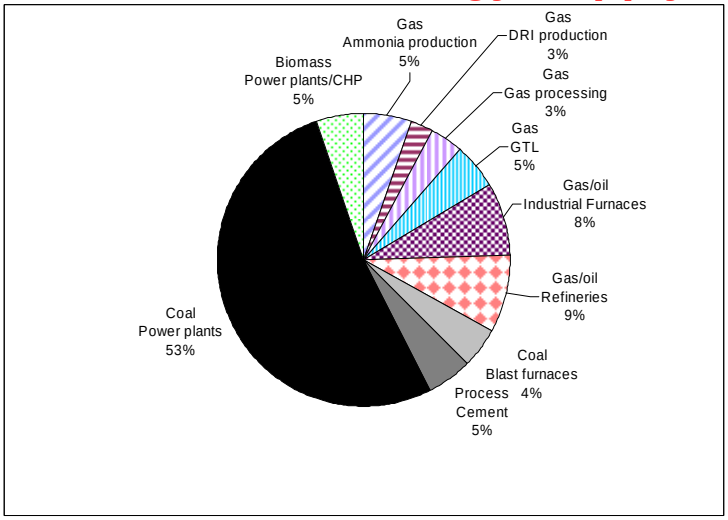
Electricity Generation

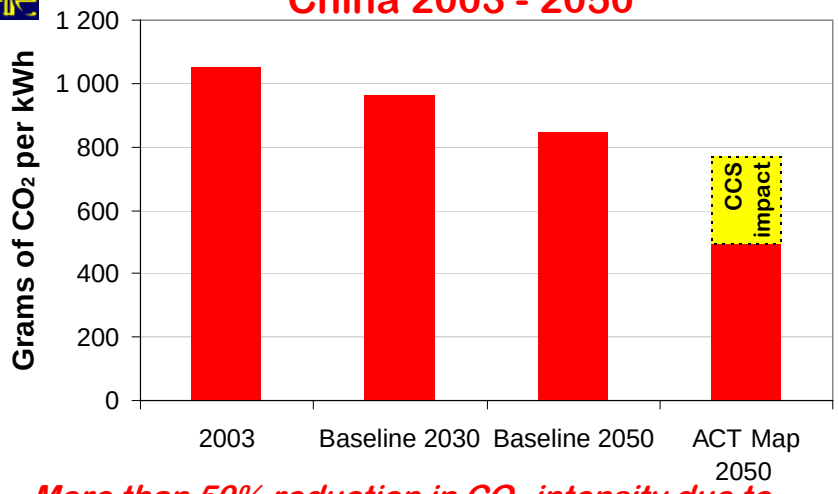
CO_2 Capture and Storage a Key Option

- 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 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

CCS also in Industry and for Other Parts of the Energy Supply



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

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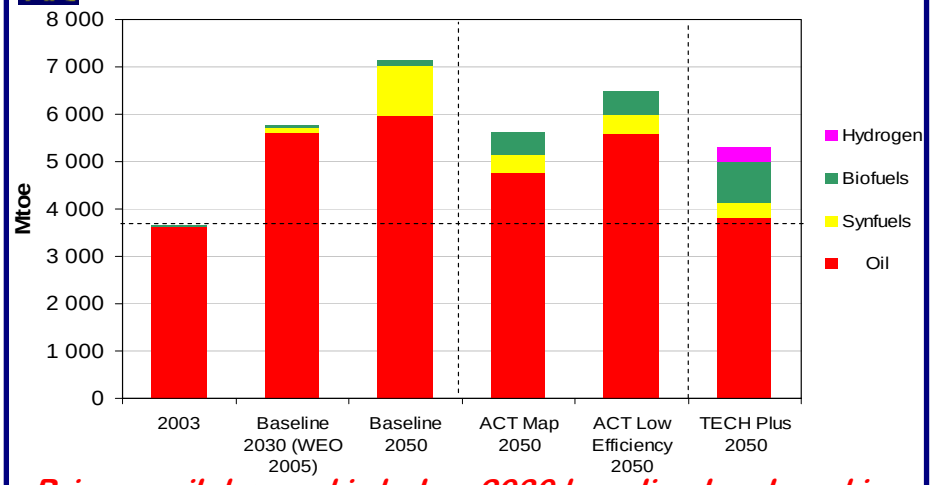
World Liquid Fuel Supply by Scenario 2003-2050



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

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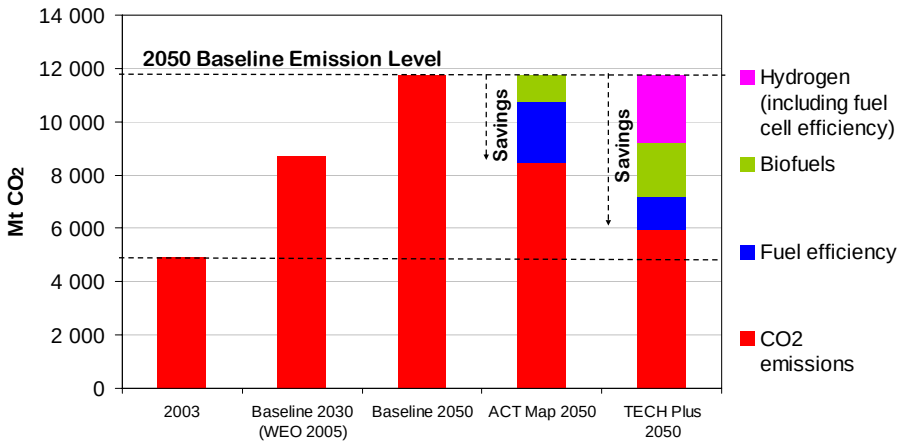
Transport CO_2 Emissions by Scenario



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

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Transport

CO_2 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

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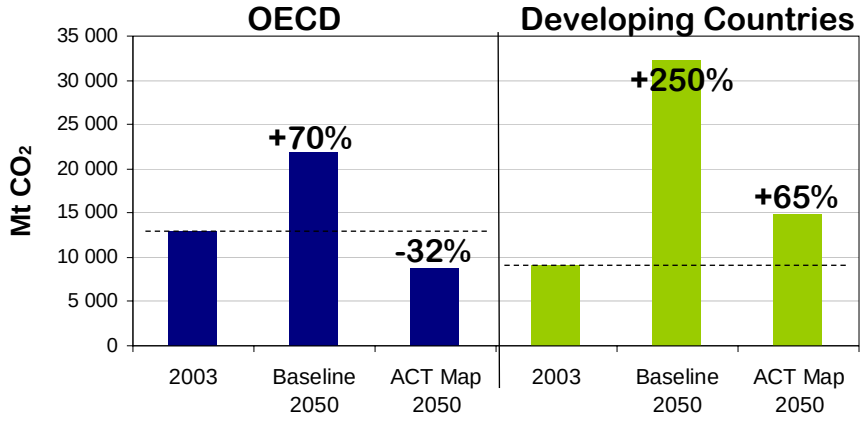
CO_2 Emissions
Baseline and Map Scenarios



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

Policy Consequences

Technology is the Key

- 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

Costs

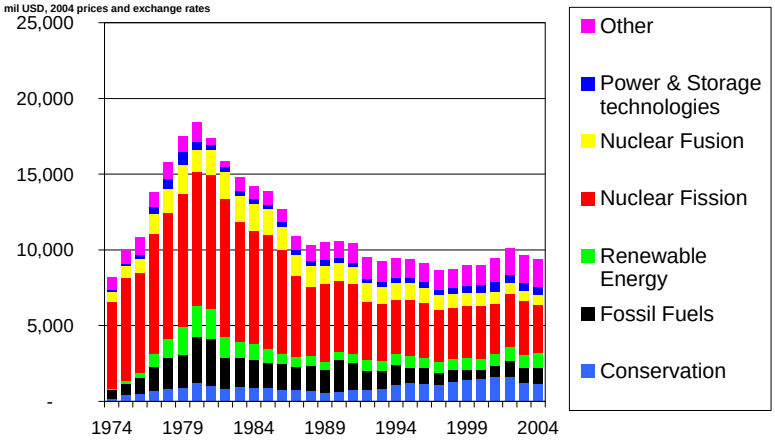
- 25 $/tonne CO_2 incentive is upper limit for the incremental costs of technologies included
- Significant transitional costs for RD&D and deployment programs
- Progress in efficiency and CCS key to keep mitigation costs down
- Investment costs in the energy system may increase by half

Investment Needs 2005-2050

This is a Big Challenge

CCS (20%)	1000 500 MW coal fired power plants w CCS. 100 ammonia plants, 300 blast furnaces, 500 cement kilns w CCS
Renewables (14%)	New plantations the size of South Africa 200,000 3 MW wind turbines 175 X growth solar-PV/CSP 22X growth geothermal
Nuclear (6%)	An additional 250 1 GW nuclear plants
Industrial energy efficiency (10%)	All motor systems 25% more efficient Maximum coal injection in blast furnaces
Transport efficiency (17%)	Fuel efficiency cars improves by 40% 13% biofuels worldwide 20-40% hybrids
Efficiency built environment (18%)	80% fluorescent lighting and CFL Electric appliances 50% more efficient

RD&D Trends
Public Funds in IEA Countries



RD&D Needs

- 2050 stabilisation does not require more basic R&D (but longer term emission reductions will)
- More funding needed for applied R&D (technology development)
- Unclear if increased funding alone will be sufficient
- Unclear if reallocation of funding is needed
- More international collaboration could enhance the efficiency, e.g. extension of the IEA Implementing Agreements
- Deployment cost matter, e.g.:
  - 720 billion learning investments for renewables 2005-2050
  - 0.5 billion/year for CCS demonstrations

Policy Needs

- Urgent action is needed in public and private sectors:
  - Overcome barriers for adoption of energy efficient demand-side technologies
  - Enhance R&D
  - Accelerate demonstration and deployment
  - Provide clear and predictable incentives
- Collaboration between developed and developing countries essential

Next Steps

Early Feedback for ETP2006

- This study fills a gap
- A valuable reference book for technology data
- The first time that IEA comes with a pro-active scenario study
- The scenarios are credible and well balanced
- It puts technology policy on the map

Requests for further analysis

- Scenario results for 2015 and 2030
- More regional detail
- What does this mean for energy investments
- How do you results compare with our own scenario analysis, and why are there differences
- What actions are needed by whom and when to get on the ACT pathway
- What does this mean for our national energy technology policies
  - What RD&D strategy do you recommend
  - What does this mean for international cooperation and the Implementing Agreements
- What if developing countries do not cooperate
- My favorite technology is missing

Energy Technology Perspectives publication 2008

- Part of G8-deliverables
- Use the ETP2006 scenarios (no new scenarios)
- Much shorter technology characterization section
- Special technology topic chapters:
  - Biofuels
  - CCS
  - Wind energy
- Special interest chapters (*proposal*):
  - Energy and CO_2 emission indicators
  - Technology learning and deployment policies
  - Energy RD&D policies
  - Energy transitions

ETP2008

- ETP will become a bi-annual IEA publication, complementing the World Energy Outlook
- Elaboration of ACT scenario policy consequences for 2015/2030 on a technology level
- More regional detail

- 2006/7: Building blocks
- G8 Energy Efficiency Indicators + Industry publications (ongoing)
- Transport Analysis (MoMo)
- New Energy Technology Analysis publication:
  - CO_2 Capture and Storage: A Key Abatement Option
  - Prospects for Bioenergy
- 2007/8
- New Energy Technology Perspectives

Indicators Publications

- Getting the starting point & past trends right is essential for forecasting
- Provides a better handle for short & medium term need for action
- Update 30-years of energy use in IEA countries (April 2007)
- Next step: include +5 countries (early 2008)
- Detailed analysis of industrial energy efficiency and CO_2 emissions (April 2007)
- More detailed presentations will follow

CO_2 Capture and Storage: A Key Abatement Option

- Rapid technology development requires an update
- Lessons from pilot/demonstration projects
- Focus on retrofit and capture-ready plants
- Industry & transformation sector opportunities
- Incorporate the insights from G8 CCS activities
- Additional ETP model analysis

Prospects for Bioenergy

- High interest topic worldwide
- Up to 25% biofuels by 2050 (ETP)
- Competing biomass use for power generation, heat, transportation fuels and materials
- Competing transportation sector options
- Rapid technological change
- Special attention for second generation biofuels (lignocellulosic ethanol, FT-biodiesel, etc.)

Thank You

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