Energy Technology Perspectives
Past Trends and Future Outlook

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Looking Back

Energy Use and CO₂ Emissions in IEA Countries the Last Three Decades
Recent trends show steady increase
IEA CO₂ Emissions per GDP
1973 - 2001

Rate of decline has slowed since 1990
IEA-11 CO₂ Emissions Technology Frozen at 1973-level

Without changes in fuel mix and energy efficiency emissions would have increased 2.2-2.5%/year
IEA-11 CO₂ Emissions
Impact of Changes in Fuel Mix

Changes in supply and end-use fuel mix moderated growth in emissions by 0.5%/year
IEA-11 CO₂ Emissions
Impact of Fuel Mix & Energy Savings

Slowing energy savings rates primary reason for accelerated growth in emissions after 1990
Without energy savings achieved since 1973 energy demand in 1998 would have been 50% higher.
Future Outlook:

Energy Technology Perspectives
Scenarios and Strategies to 2050
Energy Technology Perspectives (ETP)

- Investigating the role energy technologies can play in long-term energy markets
- Contributes to the IEA response to the G8 Plan of Action ("Advising on scenario strategies aimed at a clean, clever and competitive energy future")
Global CO₂ Emissions in the WEO 2005 Reference & Alternative Scenarios

CO₂ emissions are 16% less in the AS in 2030 but still up more than 50% from 1990-levels
More is Needed....

- **Global Energy Technology Perspectives** will look further and investigate how technologies can help changing the energy future

- **Covers both demand side;**
  - transport
  - buildings
  - industry

- **and supply side;**
  - renewables
  - Carbon Capture and Storage
  - nuclear
  - hydrogen
ETP 2006 Focus

- Status and perspectives for key energy technologies in different sectors
- Global scenario analysis to illustrate how technologies can make a difference out to 2050
- Technology Strategies:
  - How much can different technologies deliver?
  - By when can they deliver?
  - What barriers have to be overcome to make them deliver both in the short term and over the next 3-5 decades?
  - Pathways to overcome barriers
Outline of Book

Part I Potential for Energy Technology to Impact the Global Energy Economy to 2050
1. Overview
2. Scenarios to 2050: Energy Demand, Supply and CO₂ Emissions
3. Technology Strategies for a Clean, Clever and Competitive Energy Future

Part II Energy Technology Status and Outlook
4. Electricity Generation Technologies
5. Building and Appliance Technologies
6. Industry Technologies
7. Road Transport Technologies and Fuels
Scenario Analysis

- Scenarios analysed:
  - Baseline, building on WEO Reference Scenario
  - Accelerated Technology Scenarios (ACT)

- Analytical framework
  - ETO’s ETP model (global multi-region energy technology model based on cost optimization)
  - Supplemented with new improved versions of demand side models developed in collaboration with EAD/LTO for WEO
  - Technology data collected and assessed in previous IEA projects on CCS, hydrogen and fuel cells, renewables and efficiency
Accelerated Technology Scenarios (ACT)

- A family of scenarios to demonstrate how technologies that are already commercial or under development can help towards a sustainable energy future.
- All scenarios analyse the impact from measures to accelerated R&D, demonstration and deployment efforts as well as measures aimed at giving incentives for low-carbon technologies.
- The scenarios differ in terms of assumptions for nuclear, CCS, renewables, advanced biofuels, hydrogen fuel cells and energy efficiency progress.
We can depart from our current unsustainable energy path. By using a portfolio of current and emerging technologies, the world can enhance energy security, stimulate economic growth and avert the trend of increasing CO₂ emissions.

The most important technologies and practices are:
- Improved energy efficiency;
- Clean coal with CCS;
- Renewables, including biofuels;
- Nuclear;
- Efficient use of natural gas;
- Hydrogen and fuel cells.

A lot can be done even if certain key technologies would not deliver and more can be achieved if R&D efforts succeed with technologies such as hydrogen-fuel cells and advanced biofuels.

Urgent action is needed to unlock the potential of existing technologies and ensure that new are developed.
Example of the Analysis:
Opportunities for Energy Efficiency and CO2 Emissions:
Coal Fired Electricity Generation in China

Coal consumption per kWh for coal-based generation relative to 2003 level

CO2 emissions per kWh from coal based generation relative to 2003 level

% of 2003 Chinese Coal Consumption and CO2 Emissions

Japan 2003 Average
Best Available Technology
2030 WEO 2004 Reference Scenario
2050 IEA ETP Scenario

CCS impact
Energy Technology Perspectives
Scenarios and Strategies to 2050

NEW IEA PUBLICATION
May 2006
Extra slides:
Examples of past IEA Technology Scenario Work
Prospects for CO₂ Capture and Storage

- Technology status report
- CCS prospects – scenario analysis
- RD&D and policy challenges
Results of model analysis:
Annual emissions with 50 $/t CO₂ penalty with and without CCS

50$\$/t CO₂ : 2050 emissions would be 25% higher in absence of CCS
Electricity production from power plants fitted with CCS, by region
50$/t CO2

Energy Technology Scenarios
Prospects for H₂ and Fuel Cells

An analysis of H₂/FC potential using the IEA ETP model (scenarios to 2050)

Published December 2005
H₂/FC vehicles in transport if ...

- Decisive policies for reducing emissions and oil use
- Substantial advances in fuel cells, H₂ on-board storage, H₂ distribution systems, CO₂ capture & storage
- Hydrogen cost can be reduced 3-10 time and fuel cell cost can be reduced 10-50 time

**Under these conditions ...**

- H₂/FC would enter the market in 2020-2025 and power up to 30% of vehicles by 2050 (700 million cars), using less than 3% global energy, saving 13% oil import
- Along with other emerging technologies, H₂/FC could help halve global CO₂ emissions by 2050
With less favorable conditions ...

(if no decisive policy to curb emissions, or insufficient cost reduction and technology advance … )

$\text{H}_2/\text{FC}$ vehicles are unlikely to reach the critical mass needed for market uptake

and

other technologies (synfuels, biofuels) may gain market share.
Market Scenarios

GLOBAL H₂ USE

H₂ FC VEHICLES SHARE

A - Weak CO₂ policy and tech. development
B - Strong CO₂ policy in Kyoto countries and tech. development
C - Strong CO₂ policy in Kyoto countries and tech. lag
D - Strong CO₂ policy world wide and tech. development

Up to 30% H₂ fuel cell vehicles by 2050