Presentation 1.4: Energy technology perspectives, Scenarios and Strategies to 2050

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Abstract
Secure, reliable and affordable energy supplies are fundamental to economic stability and development. The threat of disruptive climate change, the erosion of energy security and the growing energy needs of the developing world all pose major challenges for energy decision makers. They can only be met through innovation, the adoption of new cost-effective technologies, and a better use of existing energy-efficient technologies. Energy Technology Perspectives presents the status and prospects for key energy technologies and assesses their potential to make a difference by 2050. It also outlines the barriers to implementing these technologies and the measures that can overcome such barriers.

The substantial changes demonstrated in the ACT scenarios are grounded in:
• Strong energy efficiency gains in the transport, industry and buildings sectors.
• Electricity supply becoming significantly decarbonised as the power-generation mix shifts towards nuclear power, renewables, natural gas and coal with CO2 capture and storage (CCS).
• Increased use of biofuels for road transport.

In industry there is huge potential to reduce energy demand and CO2 emissions through improved efficiency of motors, pumps, boilers and heating systems; increased energy recovery in materials production processes; increased recycling of used materials; adoption of new and more advanced processes and materials; and a higher efficiency of materials use. New cutting-edge industrial technologies with substantial potential to save energy and CO2 emissions in the pulp and paper industry include: black liquor gasification and advanced drying technologies

Energy Technology Perspectives
Scenarios & Strategies to 2050

International Seminar on Energy and the Forest Products Industry

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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"

GPA request of IEA

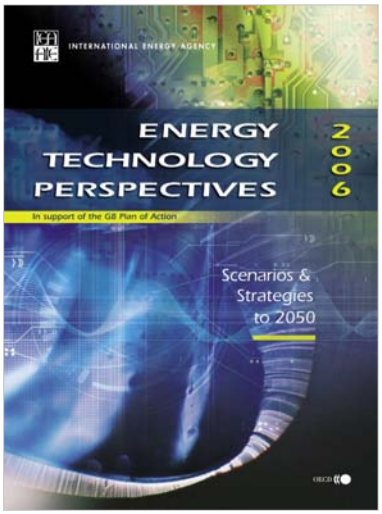
Contain 14 specific references to roles that the IEA is asked to play, amongst which:

- **Partner in the Dialogue -** advise on alternative energy scenarios & strategies;
- **Transforming the way we use energy** (End-use efficiency)
  - Review codes and standards and identify best practices in buildings, appliances, industry and surface transport
  - Assess energy efficiency performance in industry;
  - Identify areas for further analysis of energy efficiency measures by industry;
  - Develop indicators to assess energy efficiency
- **Extended to include CO_2 reduction**

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

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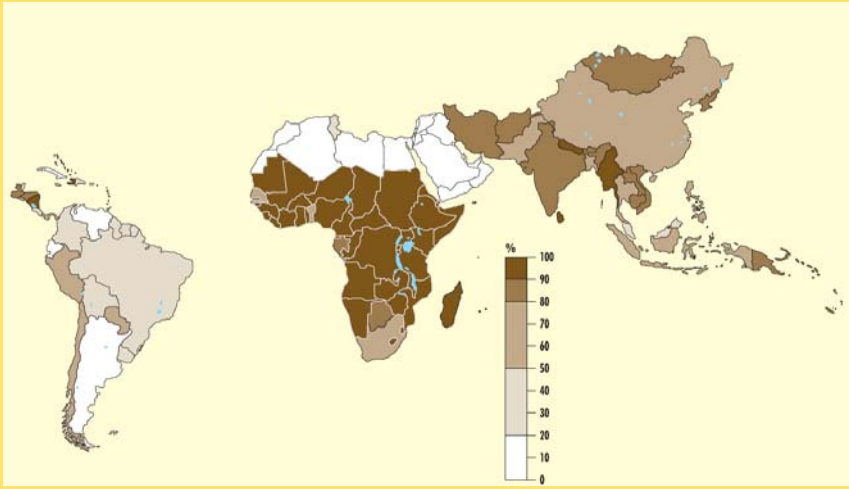
World Energy Outlook 2006

Share of Traditional Biomass in Residential Consumption



Biomass provides 10% of all primary energy today and 90% is traditional biomass. Over 2.5 billion people in developing countries depend on traditional biomass

World Energy Outlook 2006

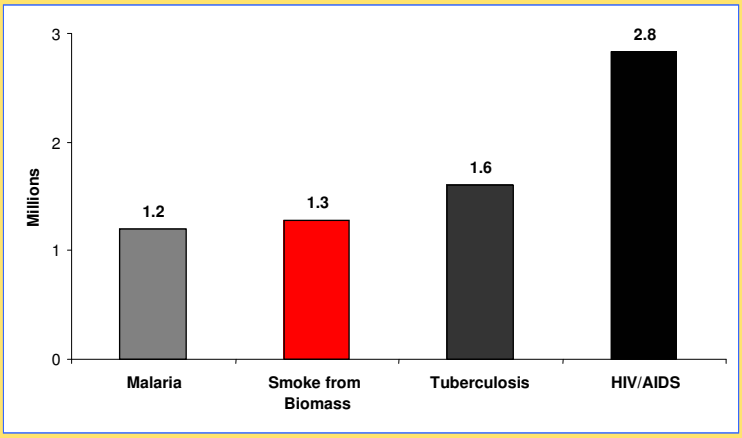
Share of Traditional Biomass in Residential Consumption

In the *World Energy Outlook 2006*, we estimate that today over 2.5 billion people, or over half of the population in developing countries, depend on traditional biomass as their primary fuel for cooking. More than half of these people live in India, China and Indonesia. But the proportion of the population relying on biomass is highest in sub-Saharan Africa.

Without strong new policies to expand access to cleaner fuels and stoves, the number of people in developing countries relying on traditional biomass as their main fuel for cooking will continue to increase as the global population increases.

World Energy Outlook 2006

Annual Deaths from Indoor Air Pollution

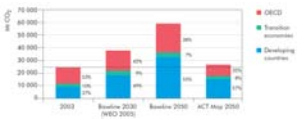


IEA estimate based on World Health Organization figure for all solid fuels.

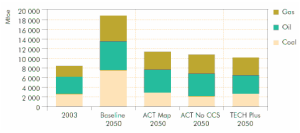
World Energy Outlook 2006

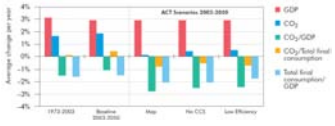
Annual Deaths from Indoor Air Pollution

We estimate that 1.3 million premature deaths per year are directly attributable to indoor air pollution from the use of biomass. This means that indoor air pollution associated with biomass use is directly responsible for more deaths than malaria. More than half of the deaths are among children under five years of age.



Results from the Scenario Analysis





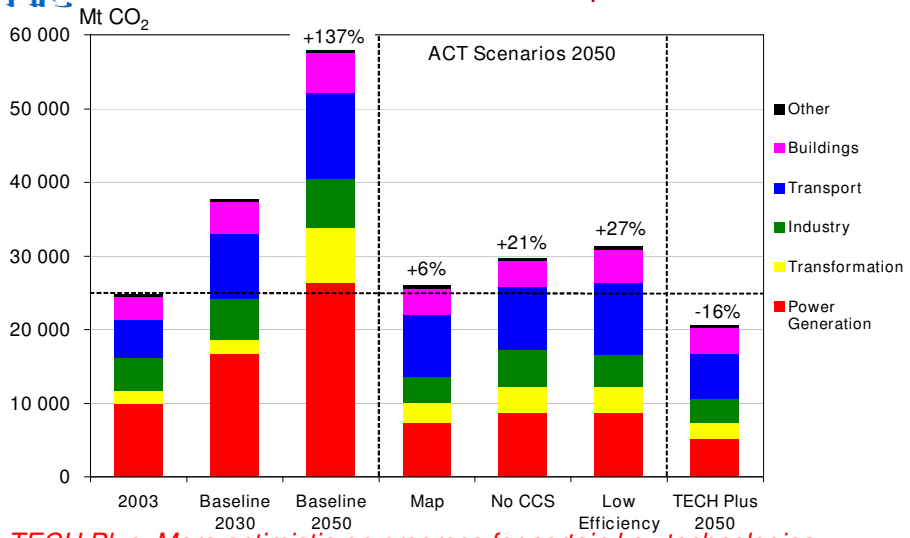
Scenario Analysis

- 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

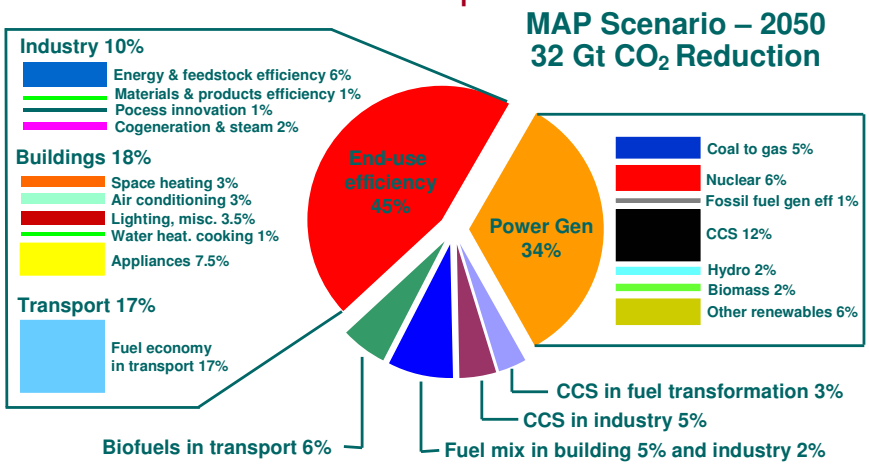
Scenario	Renewables	Nuclear	CCS	H_2 fuel cells	Advanced biofuels	End-use efficiency
ACT Map	Relatively optimistic across all technology areas					2.0 % p.a. global improvement
ACT Low Renewables	Slower cost reductions					
ACT Low Nuclear		Lower public acceptance				
ACT No CCS			No CCS			
ACT Low Efficiency						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

Emission Reduction by Technology Area
ACT Map Scenario



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

Emission Reduction by Technology Area ACT Map Scenario

Of the 45% reduction under the ACT Map scenario 10% will come from **Industry**. The majority of this will be from energy and feedstock efficiency.

Under the ETP model we assume that the benefits of black liquor gasification in the pulp and paper sector will be in the form of power generation. See 2% biomass in power generation. A portion is BLGCC. (not biofuels in transport, although this is a definite possibility and to some degree that way that both Sweden and the US are leaning towards)

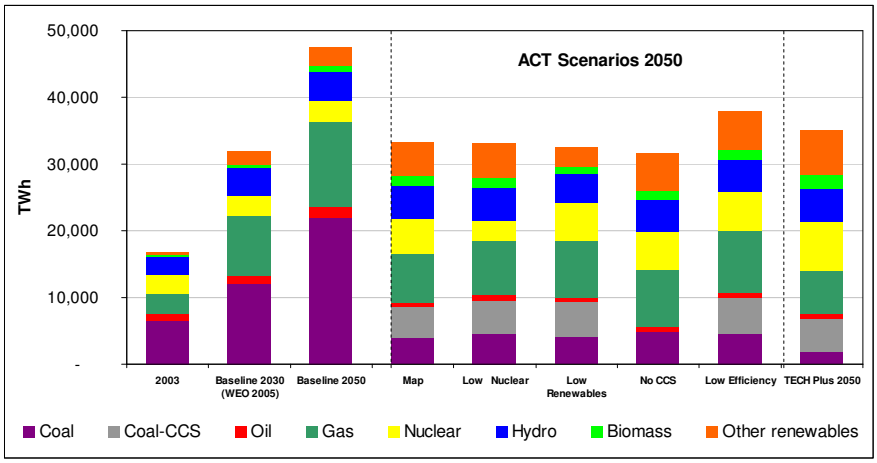
Background notes:

Gasification offers opportunities to increase the efficiency of using black liquor. In gasification, hydrocarbons react to syngas, a mixture mainly of carbon monoxide and hydrogen. The syngas cam be used in a gas-turbine power generation or as a chemical feedstock (and also DME a replacement for diesel fuel). As a chemical feedstock This technology called black liquor gasification – combined cycle (BLGCC) allows the efficient use not only of black liquor but also of other biomass fuels such as bark and wood chips.

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



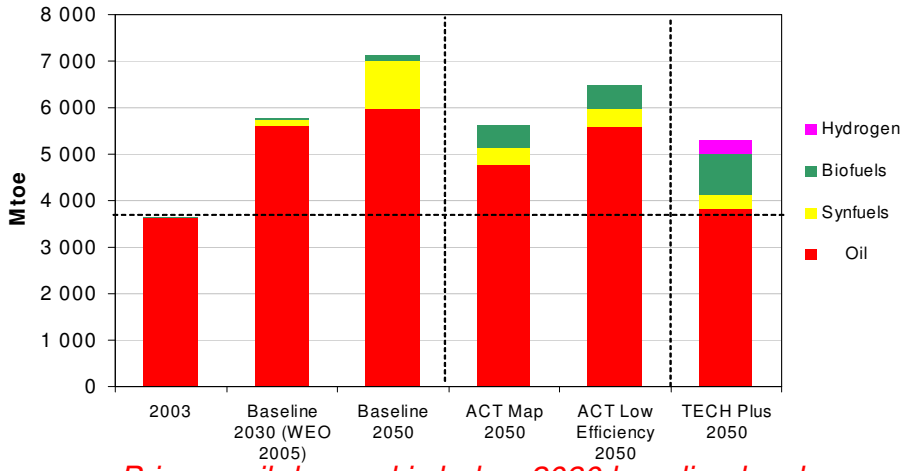
ACT Scenarios: Important role for CCS and strong growth in the shares for renewables and nuclear.

Electricity Generation

CO_2 Capture and Storage a Key Option

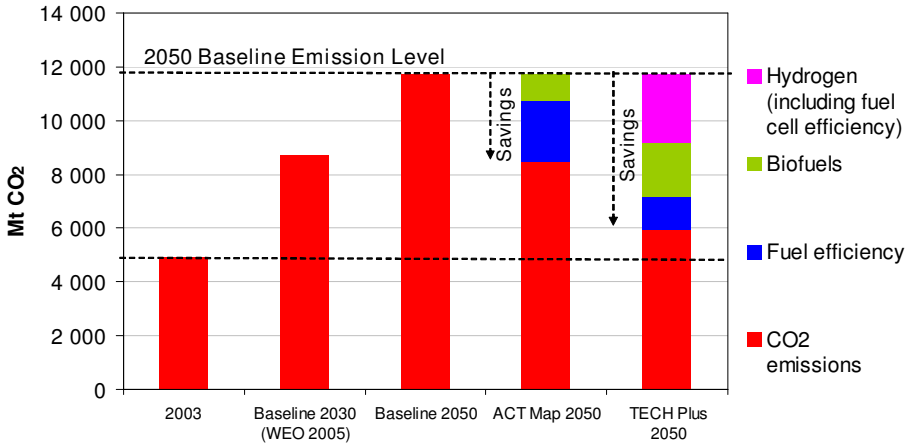
- CCS can be applied to Black Liquor Gasification
- Generation from renewables can quadruple by 2050
- CCS is crucial for the role coal can play in a CO_2 constrained world – without CCS coal-fired generation in 2050 drops below today's level
- By 2050 more than 5 000 TWh electricity globally can be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

World Liquid Fuel Supply by Scenario 2003-2050



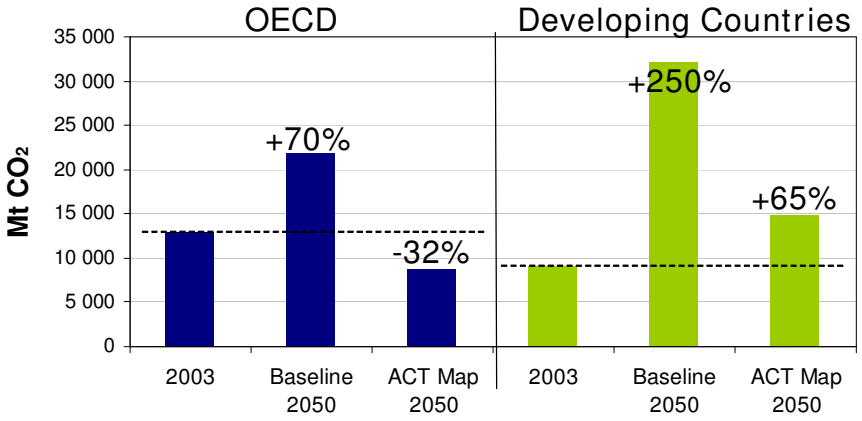
Primary oil demand is below 2030 baseline level and is returned to about today's level in TECH Plus.

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.

CO_2 Emissions
Baseline and Map Scenarios



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

Bioenergy Insights

- Traditional biomass represents 10% of world energy use today
- 100-200 EJ primary biomass potential
- Bioenergy use may double between now and 2050
- Reduction traditional biomass, strong increase new biomass use

ETP – Biomass Use

- 3 key markets for biomass use in 2050
  - Heating 40EJ
  - Power Generation 10 EJ
  - Transport 40EJ Act Map, 80EJ Tech Plus
- Biomass for heating and power generation stable or declining
- More efficient use of biomass for heating
- Strong growth expected in biofuels
- Biomass use in transport will be limited by cost and not supply

Scenario Analysis Pulp & Paper

- Analysis on the level of major pulp & paper technologies
- Total demand growth 2005-2050: 25-60% (2 scenarios)
- Important efficiency gains of 20-30%
- Important changes in power generation
- Black liquor boilers with CCS to provide additional PJ of electricity
- Recycling rate grows to 55-63%

Scenario Analysis Pulp & Paper

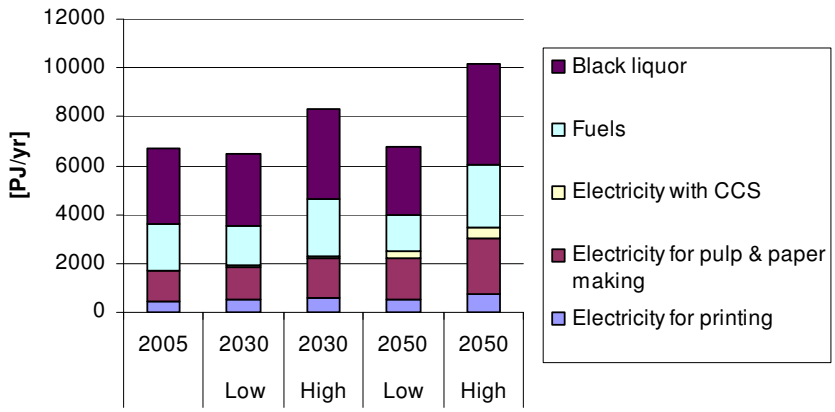
Three scenarios have been analysed: a baseline scenario without new policies and two ACT scenarios with a CO_2 reduction incentive of USD 25/t CO_2.

Paper production is projected to grow by 25-60% between 2005 and 2050. The difference between the Low and High demand ACT scenarios reflects the uncertain impact of the digital economy on paper demand and the uncertain prospects for packaging paper and board under tighter waste policies. Also policies for increased efficiency of materials use may affect paper demand in a CO_2 -constrained scenario.

In the low demand growth scenario the paper production growth is completely covered by increased paper recycling while in the high demand scenario, primary fibre supply grows by 35%. The amount of recycled paper grows by 72 to 95%.

The baseline scenario w/o CO_2 policies assumes a demand that grows in line with the high scenario. Black liquor gasifiers capture only half the market, and paper recycling grows only to 250 Mt (300 Mt in the High ACT scenario). Energy efficiency gains over the 2005-2050 period amount to 10-20% and there is no CCS applied.

Global Pulp, Paper and Print Final Energy Supply



Global Pulp, Paper and Print Final Energy Supply

Energy efficiency in pulp and paper making processes in the ACT scenarios improves by 15-30%. This outweighs the increased production volume in the Low demand scenario. In the High demand scenario, final energy demand grows by 47%. Electricity use increases significantly in both scenarios. Black liquor accounts for half of all energy use in the pulp, paper and printing industry.

It is assumed that all black liquor boilers are replaced with gasifiers by 2050. Both the Low and the High scenario assume that CO_2 capture and storage is introduced for black liquor gasification units. CO_2 capture and storage is introduced for black liquor gasifiers from 2015 onward. In both scenarios it is assumed that 75% of all black liquor gasifiers are equipped with CCS by 2050. The use of CCS generates additional demand for electricity for CO_2 capture and pressurization.

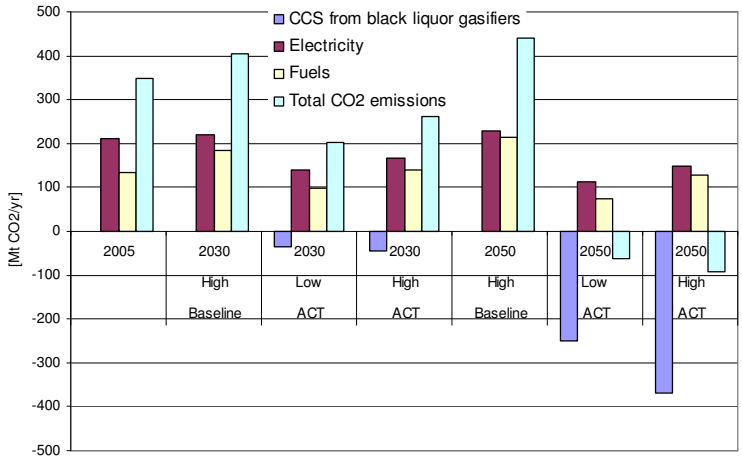
Background notes:

Black liquor is a by-product of the chemical pulping process. The spent liquor produced from de-lignifying wood chips is normally burned a a large recovery boiler (Tomlinson boiler). Because of the high water content of black liquor the efficiency of existing recovery boilers is limited.

Categories black liquor and fuels are for energy used in heat production. Last 3 categories are electricity use.

Global Pulp, Paper and Print CO_2 Emissions

500 Mt Emissions reduction in 2050



Global Pulp, Paper and Print CO_2 Emissions

In the Baseline scenario, the world average CO_2 intensity of electricity is virtually constant while the CO_2 -intensity of fuels increases. These trends can be explained by the rising oil and gas prices and the modest rise of coal prices. In the ACT scenarios, the CO_2 intensity of electricity decreases by two thirds and the CO_2 intensity of fuels decreases by one third, compared to 2005. In 2050, 250 - 370 Mt of CO_2 is captured and stored.

In both ACT scenarios, the sector becomes a net CO_2 sink. In fact the difference in emissions between both scenarios is small. A higher production volume entails a higher energy use, but allows for more CO_2 capture from black liquor gasifiers. In both scenarios, the emissions reduction compared to the Baseline scenario amounts to 0.5 Gt CO_2 per year.

Background notes:

Gasification offers opportunities to increase the efficiency of using black liquor. The syngas cam be used in a gas-turbine power generation or as a chemical feedstock (and DME as a replacement for diesel fuel). BLGCC – black liquor gasification-combined cycle.

Biomass in combination with CCS results in an energy chain that removes CO_2 from the atmosphere, a unique feature that may offset emissions in other parts of the energy system. This may become especially important if ambitious low emission targets are established.

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
- Important role for bioenergy (13-20% primary), good prospects for energy efficiency and CO_2 reduction in pulp and paper industry

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

Policy Implications for Pulp and Paper

- Advanced technologies can increase energy efficiency
- BLGCC with CCS would allow the pulp and paper industry to remove CO_2 from the atmosphere
- Co-production of pulp and other biomass products may result in new business models and high overall energy efficiency

Thank you!