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ENERGY TECHNOLOGY PERSPECTIVES 2008: FACT SHEET – THE BLUE SCENARIO

A sustainable energy future is possible – How can we achieve it?

Global energy needs are expected to grow, with fossil fuels remaining the dominant source and sharply pushing up CO_2 emissions. On our current trajectory, the global temperature could increase by 6° C by 2100 with dramatic implications for all countries. Energy security and climate change are global concerns and require global solutions. The challenge for all countries is to put in motion a transition to a more secure, lower-carbon energy supply and demand, without undermining economic growth. An energy technology revolution is needed to set us on a more sustainable energy path.

To meet the most ambitious IPCC scenario aimed at keeping temperature increases below 2.4°C, global CO_2 emissions would need to be halved by 2050 compared to their current levels. G8 leaders at the Heiligendamm summit in 2007 agreed to seriously consider such a 50% reduction option. The ETP BLUE scenario explores the least-cost solutions to achieve this goal and limit the risks of severe climate change.

End-use efficiency and a virtually CO_2-free power sector can yield emissions stabilisation in 2050 at today's level. Emissions halving requires also significant fuel switching and CO_2 capture and storage in end-use sectors. End-use efficiency accounts for 36% of all savings in the BLUE scenario. Renewables account for 21%. And CO_2 capture and storage contributes 19%. The remaining 24% is accounted for by nuclear, fossil fuel switching and efficiency in power generation.

While emissions stabilisation requires options with a cost up to USD 50/t CO_2, emissions halving in BLUE requires options with a cost up to USD 200/t. If technology progress is less than we expect, the cost may rise to USD 500/t.

Total additional investment needs for the period 2010-2050, on top of the investments in the Business-as-usual scenario, amount to USD 45 trillion. Total learning investments (investment needed to get to a mature technology) for the next 20 years alone are USD 1.75 trillion, and another 5.25 trillion between 2030 and 2050. A massive increase of energy technology Research, Development and Demonstration (RD&D) is needed in the coming 15 years, in the order of USD 10-100 billion per year. These financing needs may be affordable, but important burden sharing issues exist.

The average year-by-year investments between 2010 and 2050 needed to achieve a virtual decarbonisation of the power sector include, amongst others, 55 fossil-fuelled power plants with CCS, 32 nuclear plants, 17 500 large wind turbines, and 215 million square metres of solar panels. BLUE also requires widespread adoption of near-zero emission buildings and, on one set of assumptions, deployment of nearly a billion electric or hydrogen fuel cell vehicles.

While energy efficient equipment is available now, more ambitious standards and regulations are needed to implement its uptake. The average energy efficiency in 2050 needs to be twice the level of today, a significant acceleration compared to the developments in the last 25 years.

To meet the BLUE scenario, we need to urgently develop and implement far-reaching new policies to a degree unknown in the energy sector and to substantially decarbonise power generation. A significant discrepancy exists between current developments and the BLUE scenario targets. We will need in the coming decade a global revolution in the way we produce and use energy, with a dramatic shift in government policies and unprecedented co-operation amongst all major economies.

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ENERGY TECHNOLOGY PERSPECTIVES 2008:
FACT SHEET – ROADMAPS FOR 17 KEY ENERGY TECHNOLOGIES

What energy technologies can make the most difference on the path to a more sustainable energy future?

There is currently no single technology solution that can lead to a sustainable energy future – all energy technologies must contribute. 17 key groups of technologies can bring about the energy technology revolution to achieve the ETP BLUE scenario of halving emissions by 2050 compared to current levels. Each roadmap outlines the steps needed to bring the technology through to the commercialisation phase, and the role different regions could play in stabilising both our energy and climate future.

Table: Key roadmaps in this study

Supply Side	Demand Side
• CCS fossil-fuel power generation • Nuclear power plants • Onshore and offshore wind • Biomass IGCC & co-combustion • Photovoltaic systems • Concentrating solar power • Coal: integrated-gasification combined cycle • Coal: ultra-supercritical • 2nd generation biofuels	• Energy efficiency in buildings and appliances • Heat pumps • Solar space and water heating • Energy efficiency in transport • Electric and plug-in vehicles • H_2 fuel cell vehicles • CCS industry, H_2 and fuel transformation • Industrial motor systems

In the ACT scenario (which assumes bringing emissions back to the 2005 level by 2050), deployment of these 17 technologies could contribute 27 Gt or 77% of CO_2 savings. In the BLUE scenario they contribute 42 Gt or 87%.

While RDD&D spending has declined in recent years, we need to reverse this trend. Total research, development, demonstration and deployment (RDD&D) investment costs for energy technologies are estimated at USD 4.5 to USD 5.5 trillion in ACT and rise to USD 13 to USD 16 trillion in BLUE, as more expensive transport technologies such as fuel cell and electric vehicles are needed.

The roadmaps outline what needs to be done and can be used as a starting point for a framework on international technology co-operation. The IEA recommends that the international community, including major industrial and emerging economies develop these roadmaps further.

CO_2 capture and storage (CCS) development is critical to reducing CO_2 emissions

CCS in power generation is an example of a key roadmap. CCS is a priority technology for combating climate change, as the largest contributor to both emissions stabilisation and a halving of emissions by 2050. CCS captures CO_2 from large emissions sources, transports and stores it underground in cavities or saline water bodies (aquifers). The main challenge is large-scale demonstration of this technology.

Emissions reduction from CCS accounts for 14% and 19% of CO_2 savings under a scenario of emissions stabilisation (ACT) and a halving of emissions by 2050 (BLUE), respectively. Anywhere between 16 and 30% of all power is generated by plants equipped with CCS in the ACT and BLUE scenarios in 2050.

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ENERGY TECHNOLOGY PERSPECTIVES 2008: FACT SHEET - TRANSPORTATION

How to sustain transportation without oil?

Oil is the fuel of choice for 98% of motorised transportation today. This has to change in the coming decades, not only because of energy security concerns rising from dependence on one energy source with no viable alternatives, but also because "oil" will likely come increasingly from very high carbon-intensive sources such as tar sands and synfuels from coal which would result in a significant increase of emissions in production. The transport sector may pose the greatest challenge to meaningful CO_2 emissions reduction of any energy sector.

- A halving (or greater) of global energy emissions will require significant emissions reduction in the transport sector. Given a projected 3-fold rise in travel demand to 2050, average emissions per kilometre must be cut by two thirds just to stay even; cuts of 75% or greater are needed for a substantial emissions reduction.

- While most attention is focused on light duty vehicles, the other half of demand – trucks, airplanes and ships – may pose an even greater challenge because of the shortage of viable alternatives to oil (such as CO_2-free electricity or hydrogen). The largest demand could be for biomass-to-liquids (BTL) fuel for trucks, airplanes and ships.

- One medium- to long-term solution for all transport modes, however, must be to improve fuel efficiency. Cars and light/medium trucks can achieve an estimated 50% reduction in fuel intensity by 2050, through existing commercial technologies, at relatively low cost-per-tonne CO_2. Heavy trucks, shipping and aircraft can all achieve at least a 30% improvement, perhaps more, at reasonable cost.

- Plug-in hybrids and electric vehicles have emerged as an important option, bolstered by the rapid progress in battery technology. Plug-in hybrids could be introduced gradually as infrastructure develops. However, important technological challenges must be overcome before this will become a mass production option. Through efficiency improvement and electrification, light-duty vehicle oil use and tailpipe CO_2 emissions could be cut by 75% or more by 2050. The reduction of well-to-wheel emissions (the total of production, processing and tailpipe emissions) would be even more substantial.

- Important progress has been achieved in improving fuel cell vehicle (FCV) technologies but barriers remain (such as the cost of fuel cell systems and viability of existing energy storage options). FCVs are likely to need at least another 10-15 years of RD&D before major deployment efforts can begin.

- Though an outright reduction in travel demand is not considered in this analysis, a specific combination of increased rail investments and investments in urban transit and non-motorised transport infrastructure could, together, cut passenger and freight travel around the world by about 10% by 2050 (relative to the baseline).

- Overall, through a combination of strong efficiency gains, partial electrification of some transport modes and significant use of 2nd generation biofuels, a reduction of about two thirds in transport GHGs and of 9.5 Gt in tailpipe emissions can be achieved relative to baseline 2050. This would represent a 30% reduction compared to 2005 emissions levels. To go beyond this, a major shift to either pure electric vehicles or H_2 fuel cell vehicles, across all modes will be necessary but there remains great uncertainty as to when these technologies may become available at acceptable cost.

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ENERGY TECHNOLOGY PERSPECTIVES 2008: FACT SHEET - RENEWABLES

How can a shift to renewables be accelerated?

Renewable energy accounts today for around 13 % of primary energy supply of which 90% is traditional biomass for cooking and heating in developing countries. Biofuels contribute less than 2% of total transport liquid fuel supply. Hydropower accounts for 16% of world electricity supply, and wind, solar and biomass together account for another 2% of electricity supply. The share of renewables in energy supply has been declining in the last two decades – a trend that must be reversed to achieve climate change and energy security policy objectives.

- There are signs that recent massive investments of over USD 100 billion in a range of renewable energy technologies are already changing this trend. More than 1000 GW (gigawatt = 1 billion watt) of renewable power generation capacity is operational, three quarters of which is large hydro. This is nearly a quarter of total power generation capacity worldwide. About 30% of the additional power capacity in 2007 (33 GW) was coming from renewable sources. Investments in wind energy amounted to 20 GW. About 2 GW of solar capacity was added in 2007. Investments in new renewable power technologies are growing exponentially.

- In the BLUE Map scenario, in which CO_2 emissions are halved by 2050, biomass would become by far the most important renewable energy source. Its use would increase nearly four-fold by 2050, accounting for around 23% of total world primary energy. Such a level of use would require approximately 15 000 Mt of biomass to be delivered to processing plants annually. Around half of this would come from crop and forest residues, with the remainder from purpose-grown energy crops. This high level of biomass consumption would require the equivalent of around a quarter of the agricultural land area in the United States.

- Most recent attention and controversy have focused on biofuels, which have been growing at a rapid rate. Some of the current "1st generation" biofuels (derived from grains and oil-seed crops) raise questions of sustainability, as they compete with food production and contribute to environmental degradation, with dubious CO_2 benefits. However, introduction of "second generation" biofuels, e.g. from grasses, trees and biomass wastes, should help overcome most problems and provide sustainable fuels with large GHG reductions. Major deployment of 2nd generation biofuels could begin within the next 5-10 years. In the report's most ambitious scenario, advanced biofuels supply about 700 million tonnes of oil equivalent, representing 26% of total transport fuel demand, by 2050.

- In the BLUE scenario, the share of renewables in power generation could grow from 18% today to 46% in 2050 (19 000 TWh [terawatt hour]); about 5 000 TWh each from hydro, wind, and solar, in combination with 4 000 TWh in total from all other renewable power generation options. Total renewable power generation in 2050 would then equal total power generation today.

- Such a development depends critically on sufficient RD&D and deployment investment to achieve the necessary technology learning. Total deployment cost amounts to USD 2.4 trillion over the period 2008 to 2030. The identified renewables options will be competitive thereafter with a financial CO_2 reduction incentive put in place to attract the necessary investments.

- Policy-makers will have to play a major role in setting the right framework to attract the needed investments in renewable energy technologies. This will imply moving towards a consistent combination framework of deployment and RD&D support schemes as a function of technology maturity level in order to foster a smooth transition towards massive uptake, progressively employing market forces.

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