WWF

PowerSwitch! FACTSHEET

FROM COAL TO CLEAN

LOW CARBON ELECTRICITY SYSTEMS IN THE EUROPEAN UNION

EXECUTIVE SUMMARY

The 'Power Switch' Vision

Climate change is arguably humankind's greatest threat. It threatens disruption on an unprecedented scale for ecosystems, human health and animal species. While the Kyoto Protocol to limit greenhouse gases was an important step, it was only the first in what needs to be a major shift to a carbon neutral energy future. This will be necessary to meet the European Union objective of keeping global temperature increases below 2 degrees Celsius since pre-industrial times.

The power sector, which produces 37% of global carbon dioxide emissions, is crucial in making deep carbon dioxide cuts over the next two decades. This study shows that the sector offers a huge potential for emission reduction.

Key elements of the WWF 'Power Switch!' vision are:

- Improving the end-use efficiency of appliances, buildings and industrial motors
- Increasing the efficiency of power plants such as through combined heat and power (CHP)
- Expanding the role of renewable energy such as wind power, biomass and solar power

WWF invites power companies to become partners in the 'Power Switch!" vision and to:

- Improve the energy efficiency of both power plants and of how consumers use electricity by shifting to co-generation of heat and power and investing in consumer's use of highly efficient residential and office appliances and industrial production equipment
- Increase their share of "new" renewables[i], such as wind, biomass and solar, to at least 20 percent within the next 10 years
- Support strong policies in their countries to cut CO_2 emissions and increase the share of renewable energy
- Stop investing in new coal plants and coal mining

INTRODUCTION

WWF has launched 'Power Switch!' - a climate change initiative focused on the power sector. This is in acknowledgement that the sector produces 37% of global CO_2 emissions - the biggest single source of emissions. Encouraging electric utilities to adopt lower carbon investment and technological strategies and shift away from fossil fuels is a key part of 'Power Switch!'

How quickly can carbon reductions be made in the power sector? WWF commissioned Ecofys to assess realistic potentials for greenhouse gas emission reductions in the European Union. Other regions of the world are also being analysed for WWF.

METHODOLOGY

The study adopts a 'bottom-up' approach which essentially looks at the opportunities to reduce energy demand by improving energy efficiency in all sectors, and to meet these reduced energy demand levels through lower carbon fuels such as gas and renewable energy. It builds upon extensive data broken down into end-use sectors such as households, industry and services, and sub-sectors of these such as the aluminium industry. A long list of technical reduction options was evaluated, both on the demand side through energy efficiency, and on the supply side through power plant options and lower carbon fuels. Table 1 below summarises the main options assessed.

Table 1 - The main CO_2 reduction options analysed

Additional demand-side reductions	Additional supply-side reductions
Best practice appliances and cooling equipment in the household sector.	Increase the amount of CHP production
Appliances with low stand-by losses (< 1W) in the household sector.	Additional fuel switching from coal (and oil) to gas
Energy efficiency office equipment, lighting and cooling.	Co-firing of biomass in existing coal-fired plants, especially lignite plants
Increasing the amount of recycled aluminium to 90%.	Increased use of wind and biomass for electricity production
Introduction of energy efficient motors in industry.	CO_2 storage in old oil and gas wells [1]

Previous Ecofys studies and a host of other analyses have shown that the technical potential for CO_2 reductions through energy efficiency improvements, fuel switching and renewables is very large. We live in an imperfect world however, and not all of the technical or economic options for reducing CO_2 emissions will necessarily be adopted. Hence the study makes a number of assumptions to produce what is termed a 'realistic' emission reduction potential. While this is a subjective term, in this study it was assumed that:

- The additional reduction options would start to be implemented in 2004
- Power plants, appliances and other technologies would not be replaced earlier than their economic lifetime

[1] While WWF does not support the full introduction of storage as a mitigation option, it believes that pilot projects and research are valid in order to address unresolved issues. CO_2 removal or storage is therefore included in this study as a back-up option.

- The rate of introduction of more energy efficient appliances was based on 'real life' past experiences in progressive countries where a strong policy effort to stimulate the market for these appliances was made
- The rate of introduction of renewable energy sources was based again mainly on 'real life' experience in countries where progressive policies to stimulate the renewable energy market was used. The exception was in the biomass sector, where higher growth rates than previously seen were assumed.

Overall, the assumptions of the study are challenging, but based on reality by mainly assuming the widespread adoption of rates of energy efficiency and renewable energy already achieved in a number of countries.

BUILDING ENERGY SCENARIOS

To contrast what is likely to happen in the absence of new policy initiatives, the study first developed a 'Business-As-Usual' (BAU) scenario. This utilised results from other studies including the World Energy Outlook (WEO) by the International Energy Agency and the European Energy Outlook by the European Commission. These studies show quite high CO_2 emission increases, while including all currently adopted climate and energy policies up to mid-2000. For the European Union, a 23% CO_2 increase was predicted for 2020 compared to 1995.

From this BAU scenario, realistic CO_2 reduction potentials were then assessed for the years 2010 and 2020, the so-called 'Power Switch' scenario.

THE MAIN CO_2 REDUCTION TECHNOLOGY OPTIONS

Supply Side Options

- Combined heat and power (CHP). These efficient plants can be utilised at a wide range of sizes from individual households (micro-CHP) right up to very large power plants.
- Fuel switching to low-carbon fuels. This can include switching from coal and oil to natural gas – a trend already well underway in Europe – and the use of biomass in coal plants in a co-firing mode. Most fuel switching will occur through new power plants being gas fuelled rather than fuel switching in current power plants.
- More efficient new power plants. The main improvement here will come through combined cycle technologies and gasification. For the period 2004-2010 it was assumed that a new gas plant could reach efficiencies of 58% and 60% between 2010 to 2020.
- Retrofitting power plants. This includes a range of options with relatively low investment to reduce CO_2 emissions for the same electricity output. An assumption of a 5% improvement was made, even though there is a potential for 10%.
- Wind power. The big renewable energy success over the past decade, it has a massive potential worldwide. Europe is currently the global leader. Wind can penetrate up to 20% of the total electrical capacity in a country without major technical problems. It was assumed that growth rates of 30% per annum could be sustained until 2010 and then slowed after that date.[2]
- Biomass energy. A range of technologies including the gasification, pyrolysis and anaerobic digestion of organic wastes and wood are in use across Europe, but direct combustion is currently

[2] WWF proposes a series of criteria for wind development, especially in the case of offshore wind, in order to avoid any potential negative ecological impacts from wind.

the most attractive option. Up to 10% of the energy input of a coal plant can be switched easily to biomass without major investment. Coal plants could even be completely converted to run on biomass. For co-firing with other fuels such as gas, biomass would have to be gasified first, and the first large scale developments are currently being developed.[3]

- Solar Photovoltaics (PV) and solar thermal power. High growth rates can be sustained for PV, but starting from a small base the technology will likely only make a significant impact post 2010. After good progress in the early 1990s, solar thermal power development slowed, but several planned developments should move the technology forward.
- Hydro-power. It was assumed that retrofitting larger hydro plants could improve the efficiency by 5-12%[4]. For small-scale hydro-power growth rates of 2.5-5% were assumed.
- CO_2-removal. Storage of CO_2 in old oil and gas fields is a prospective option with a world wide potential estimated at 500-1800 GtC. The costs and technology have yet to be proven, but it may have a role post 2010.[5]
- No new nuclear power capacity was assumed, though the scenarios contain existing nuclear capacity which over the period to 2020 has substantially reduced.

Demand-side reductions

- Households. The options include reducing stand-by losses in appliances (such as TVs and videos), more efficient appliances, efficient cooling (refrigerators, freezers and air-conditioning equipment) and efficient lighting.
- Other sectors. Improved appliances and cooling equipment.
- Enhanced aluminium recycling. This can reduce energy needs for this very energy-intensive sector significantly. Recycling rates can be increased by up to 90%
- Reducing electricity use in the chlorine industry.
- Efficient industrial motor technologies. These use the largest amount of electricity in industry and savings using currently available technologies can reduce demand by 10-18%.

THE STUDY RESULTS

Past trends show that in the European Union there has been a growing use of electricity per person, while the carbon intensity of electricity production has fallen due to the lower use of coal as a fuel.

Business-As-Usual scenario – The main results for electricity production are shown in Table 2 and Figure 1 and 2. Highlights are:

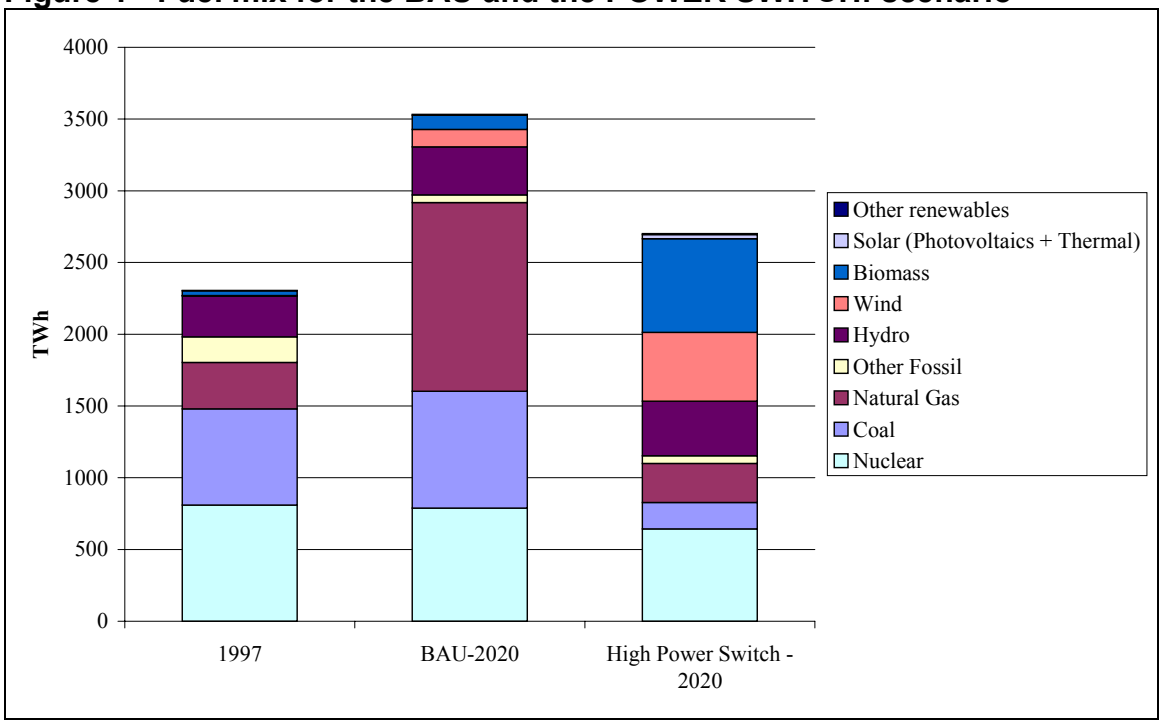
- Under the BAU scenario, CO_2 emissions increase from 1149 Mt CO_2 today to 1190 Mt CO_2 by 2010 and then to 1411 Mt CO_2 by 2020. This is a 23% increase on 1995 levels.
- Electricity production continues to grow, from 2306 TWh to 3024 TWh in 2010 and 3531 TWh in 2020. That's a 54% increase in two decades
- Generating capacity and output remains dominated by fossil fuels and nuclear. 68% of the generating capacity is based on fossil fuels in 2020, and 84% of the electricity output comes from either fossil fuels or nuclear power.

[3] WWF proposes a series of criteria for "sustainable" biomass to differentiate between ecologically sound biomass development and unsustainable biomass.
[4] WWF does not support new large hydro developments in view of their significant ecological impacts.
[5] While WWF does not, at this point, fully support the use of carbon storage due to a number of uncertainties that still exist, it does support pilot projects and research into the issue. For this reason, storage is included as an option in this analysis, but only one to show the future reductions that could be possible if the issues surrounding carbon storage are resolved and if meaningful deep targets are undertaken by industrialised countries.

The 'Power Switch!' scenario

- Demand reduction is the key difference with the BAU scenario. In the "high" demand reduction assumption scenario this brings demand down by 9% in 2010 and a further 27% in 2020
- On the supply side, renewable energy options such as wind power, hydro, fuel switching from coal to natural gas, CHP and especially co-firing of biomass are the big CO_2 reduction options
- The share of renewable energy in the fuel mix increases to between 50-60% of the total.
- European wind capacity reaches 60 GWe in 2010, and 150 GWe in 2020. This is equivalent to the total UK generating capacity in 2010 and that for the UK, Germany and Belgium combined in 2020.
- Under the high levels of energy efficiency and main renewable measures assumed, CO_2 emissions fall from 1190mt CO_2 in 2010 under BAU to 956mt, and 548mt in 2020. This is a 20% fall in CO_2 emissions by 2010 and 61% by 2020 compared to the BAU scenario. These measures will set the EU well on its way for achievement of a carbon neutral power sector by 2040.

Figure 1 - Fuel mix for the BAU and the POWER SWITCH! scenario



COSTS OF THE 'POWER SWITCH!' TRANSFORMATION

While a full economic assessment has not been carried out for this study, some initial conclusions on the costs have been made. These show that:

- The lifetime economic benefits to consumers of the demand reduction options are likely to be negligible or positive
- On the supply side, costs will likely be higher than natural gas plants. Specific costs for the supply side options may be in the range of 10 – 60 Euros per tonne of CO_2 avoided (at social discount rates). This will tend to be at the higher end in 2010 and the lower end in 2020 as technology improves and costs fall. This may lead to additional costs of the order of 10 Euros per capita per year in 2010 and 30 Euros per year in 2020

- An important synergistic effect is that strong efforts to improve energy efficiency on the demand side will have a downward pressure on the electricity prices in the European Union. Hence – despite higher average production costs in a low-carbon future – it might well be that the total costs of the electricity production/consumption system remain the same or even decrease.

CONCLUSIONS

The study shows that with an effective demand reduction programme and the aggressive adoption of policies stimulating renewable energy investment, carbon neutrality for new and retrofitted power production capacity in the European Union can almost be achieved by 2020. Only where demand reduction efforts are less successful would additional measures such as carbon storage be considered, assuming that the outstanding issues regarding storage have been addressed.

The major challenge for policymakers will be in designing and stimulating an effective market and implementation programmes for energy efficiency and renewable energy technologies. Europe is not currently on a carbon reduction curve which would allow carbon-neutrality in 2020. Indeed some countries are struggling to meet their commitments under the Kyoto Protocol. Substantial changes to energy policies, energy taxes and market incentives will be required to meet the challenging targets indicated in this study.

Figure 2 - Development of CO_2 emissions in BAU and POWER SWITCH! Scenario