13. Comparison with other 'deep cuts' studies

This chapter reviews briefly some of the other scenario studies of 'deep cuts' in CO_2 emissions from Australia and overseas.

13.1. ABARE's MENSA model, Australia

MENSA was developed from the International Energy Agency's MARKAL model by the Australian Bureau of Agricultural and Resource Economics (ABARE). It is the principal 'bottom-up' model of the Australian energy system. 'Bottom-up' or 'engineering' models start with a large database on the performances and costs of all conceivable energy supply and energy using technologies. Then, given scenarios for future growth in the demand for energy services, these models calculate the combination of technologies that gives the least cost within the energy sector. By its very nature MENSA cannot examine the impact of changes in the energy sector upon the rest of the economy.

However, a strength of MENSA is that, unlike 'general equilibrium' models, it does not assume that the present energy system or future business-as-usual energy scenarios are necessarily least-cost. As a result, MENSA and similar models generally find that some reductions in greenhouse gas emissions can be achieved with economic savings.

In the early 1990s, within the Ecologically Sustainable Development (ESD) Energy Production Working Group, MENSA was used to answer the question:

"If the government imposed a 20% reduction on greenhouse gas emissions from the electricity industry within a certain period and if the non-technical barriers to efficient energy use and renewable energy were removed, what would happen to the existing array of energy technologies and what would those changes cost?"

At the time of doing this study, Australia's proposed greenhouse gas reduction target was the Toronto Target, a 20% reduction in CO_2 emissions below the 1990 level by 2005. Applying this target as a constraint gave the result that by 2005 all brown coal power stations had been phased out and generation from black coal decreased by 80-90%. Their places were taken by natural gas and the cheaper renewable sources of energy. The cost of this transition was found to be about 2% of the total annual cost of the energy sector.

This rapid (15 year) phase-out scenario entailed that most coal-fired power stations had to be shut down before the ends of their operating lives. As a result, costs were higher than they would have been under scenarios that allowed them to retire at the ends of their lifetimes (30-40 years) and then replaced them with a combination of efficient energy use, natural gas generation and renewable energy sources.

This early work with MENSA also suffered because of the gaps in the database on technologies for efficient energy use. Subsequently, this part of MENSA's database was improved and it was found that some scenarios for greenhouse gas reductions in the residential sector led to substantial net cost savings.

References: ESD (1991); Naughten et al. (1994).

13.2. 'Deep cuts' study by the Australia Institute

The 'deep cuts' study by the Australia Institute (TAI) was one of the inspirations for the present study (see Turton et al., 2002).

TAI considers a 60% cut in greenhouse gas emissions from the energy sector (including transport) by 2050. It requires that technologies used be already proven, although not necessarily currently commercial. Unlike the MENSA model, it does not attempt an economic optimization and indeed argues that that would be inappropriate for such a large step into the future. However, it requires that the costs of energy production in 2050 must be no greater than current average energy prices in Western Europe, which are 50-100% higher than current energy costs in Australia. Having stated that, it does not present the actual costs of its 2050 scenario.

The basic assumption of the study is that the economy drives greenhouse gas emissions. So the study develops projections for the growth or decline of each sector of the economy. It then provides an analysis of opportunities for reducing emissions in each sector by implementing efficient energy use and fuel switching. The study covers the whole energy sector, including transport, and also all of the non-energy sources of greenhouse gas emissions. These are the main strengths of the study.

The study finds that, using available technologies, Australia could feasibly cut its greenhouse gas emissions by 60% by 2050. To achieve this would entail significant trade-offs: for example allocation of a significant fraction of Australia's arable land to biomass crops and plantations.

However, the study was conducted without external funding and this has inevitably resulted in several limitations:

- The description of the electricity supply system is very general and incomplete. We are told that grid-connected wind power will provide 50% of electricity, but it is unclear how much electricity and heat will come from natural gas and biomass.

- The reader is given the impression that most of the electricity supply system will actually be in the form of local cogeneration, which is presumably either entirely separate from the transmission grid or at best involved in small transfers in each direction between the grid and the cogeneration plant. If so, how will the large fluctuations in wind electric power be stabilised? Hydro-electricity will not be sufficient. An electricity grid with 50% windpower will require much long-term storage, which is not specifically described in the study.

- There are some inconsistencies in the treatment of population growth. For instance, a statement in the Summary assumes that a 60% decrease in greenhouse gas emissions by 2050 is equal to a 60% decrease in *per capita* emissions over the same period, which is incorrect when there is population growth.

- The study's principal scenario is one with a significant growth in aluminium production, in other energy intensive extractive and process industries, and in beef production (a major source of methane emissions). Sensitivity analyses of alternative economic structures, with a stronger shift towards elaborately transformed manufacturing and services, would probably have demonstrated that the same emission reductions could be achieved at lower cost (or greater reductions at the same cost).

13.3. Ecofys study on the EU

This study (Harmelink et al., 2003) focuses on the electricity industry and achieves a 60% reduction in CO2 emissions between 1997 and 2020, based mostly upon existing technology. Although such a rapid change in the industry would be technically possible, it would inevitably result in the premature retirement of many fossil-fuelled power stations. The cost of these ‘stranded assets’ would be substantial. However, it could be argued that, after internalising external costs, there would be net benefits, and the costs of ‘inaction’ would be much higher. However, this study does not attempt to evaluate costs apart from roughly estimating that this package costs 10- to 30 Euro per capita per year.

On the demand side, the EU has the advantage over Australia that the former’s population growth is much less. Therefore, over the 23 year period considered, efficient energy use can readily compensate for the effect of GDP growth.Even so, the reader is left with the feeling that the full potential of efficient energy use has not been achieved. The study focuses on ways of using *electricity* more efficiently and so misses out on opportunities to reduce electricity use by switching from electricity to solar for space heating and water heating.

On the supply side it is surprising that the study does not increase the use of natural gas, but rather assumes that biomass can rapidly fill the gap left by coal. Indeed, the report seems to assume that retired coal-fired power stations can readily be transformed into biomass power stations, which is doubtful. The most cost-effective biomass-burning power stations are smaller, situated near the biofuel sources and so are less centralised than coal-fired power stations, as discussed in Chapter 7.

In the Ecofys study wind power is a distant second in substituting for coal. This is surprising, considering Europe’s huge off-shore wind energy potential. In this study it appears that nuclear energy maintains most of its existing contribution.

13.4. Royal Commission on Environmental Pollution on the UK

The aim of the study by the UK Royal Commission on Environmental Pollution is to develop scenarios that achieve a 60% reduction in CO2 emissions from the energy sector by 2050 compared with the 1998 level (RCEP, 2000). The study disaggregates energy uses into the forms of electricity, high-temperature heat, low-temperature heat and transport.

It develops four scenarios with different levels of energy demand and different supply mixes in 2050. All scenarios have substantial implementation of efficient energy use, with the least efficient having the same energy use in 2050 as in 1998. This is more readily achievable in the UK, which has a much lower rate of population growth than

Australia. All scenarios have substantial contributions from renewable sources of energy. Two of the scenarios also have large contributions from fossil fuels with CO2 capture or and equivalent amount of nuclear power. The other two scenarios have neither of these conventional technologies.

Features of this study are:

- the careful calculation of available energy resources as a function of cost;
- a conclusion that energy demand must be curbed substantially or renewable energy and fossil or nuclear energy would be very intrusive environmentally;
- an observation of the need for a culture change within government;
- a recommendation for challenging national targets for improving energy efficiency and developing new energy sources;
- the strong recommendation for the introduction of a carbon levy, where the amount raised is spent to reduce fuel poverty in low-income homes and to assist the development of efficient energy use and renewable energy technologies.

13.5. Department of Trade & Industry on the UK

This study for the UK Department of Trade & Industry (DTI) focuses on the potential contribution of new and renewable energy sources to the reduction of greenhouse gas emissions in the UK. A valuable component is a consultancy by Future Energy Solutions from AEA Technology plc (Marsh et al., 2003) which builds on the earlier UK studies (RCEP, 2000). Like RCEP, the study considers both stationary energy and transport, and uses the IEA's 'bottom-up' MARKAL model of the energy sector. It finds that annual abatement costs in reaching the 60-70% greenhouse reduction target are generally less than 0.5% GDP. Annual GDP growth is only reduced by about 0.01% p.a. over the 50-year period. Achieving high levels of energy efficiency is a key factor in keeping down abatement costs. Reductions in CO_2 emissions are achieved through approximately equal contributions from the demand and supply sides.

13.6. Pew Center study on the USA

The Pew Center (Mintzer et al., 2003) considers three 'base-case' US energy scenarios to 2035. An economic model drives the increase in consumption. The study then applies carbon constraint policies to each of the base cases in order to reduce emissions in 2035 to 38% below the year 2000 level.

Across the three scenarios, efficient energy use and different mixes of supply technologies, existing and new, achieve the target. Coal use declines, but still is important, and natural gas use increases greatly, both for centralised and distributed generation. It is assumed that geosequestration locks up the CO_2, despite the high costs and limited contribution of this technology (see Chapter 8). Hydrogen is assumed to be important in all scenarios, but it is generated from coal in one and natural gas in another, not renewables. In all three scenarios renewable energy sources are only allowed to make modest contributions: wind contributing only 6-12.5% of electricity generation and biomass less than half of wind.

In summary, in this study the ‘new’ technologies are mixed up with the existing, but the only innovations occur in the use of fossil fuels.

13.7. US Interlaboratory studies

The first report (Interlaboratory Working Group, 1997) presents the results of a study conducted by five U.S. Department of Energy laboratories on the U.S. potential to reduce greenhouse gas emissions using energy-efficient and low-carbon technologies. Like the UK studies outlined above, the US study uses a ‘bottom-up’ engineering-economic model and places strong emphasis on efficient energy use. It focuses on four energy sectors: buildings, industry, transportation and utilities. The calculations show that numerous cost-effective energy-efficient technologies remain under-utilised in each sector. The report quantifies the reductions in CO2 emissions that could be attained by 2010. It also describes a wide array of advanced technology options that could be cost-competitive by the year 2020, given a strong and sustained national commitment to energy research and development.

For the assessment of potential carbon reductions by 2010, the study defines a Business-as-Usual (BAU) forecast as well three alternative scenarios. The BAU scenario, based on the Energy Information Administration’s Annual Energy Outlook, 1997, projects an increase of 390 million tonnes of carbon (MtC) per year (from 1340 to 1730 MtC) between 1990 and 2010. In the ‘efficiency’ scenario, the nation actively pursues policies and programs to promote market acceptance of energy efficiency while expanding commitments to research and development. In the two high-efficiency/low-carbon scenarios, under a carbon cap and trading system, permits for carbon sell for either US$25 or US$50/tonne C. The study concludes that, along with utility sector investments, a vigorous national commitment to develop and deploy energy-efficient and low-carbon technologies could cost-effectively reduce U.S. carbon emissions by approximately 390 MtC per year.

The second report (Interlaboratory Working Group, 2000) builds on the first report by extending the quantitative analysis from 2010 to 2020 and qualitative analysis out to 2050. Unlike the first report, the second identifies specific policies and programs needed to motivate consumers and business to purchase the energy efficient and renewable energy technologies that make up its scenario.

13.8. Study for WWF (USA)

A study conducted by the Tellus Institute and the Center for Energy and Climate Solutions develops policies for the *PowerSwitch!* Program of World Wildlife Fund in the USA (Bailie et al., 2003). The study is similar in several ways to the present Clean Energy Scenario study for Australia, also considering the effect of small improvements to existing technologies. But the US study focuses on the electricity sector, rather than the whole of stationary energy, and takes a shorter time horizon than ours, 2020. Within this domain it explores the ways and means, and costs and benefits, of reducing CO_2 emissions by 60% relative to the 2000 level by 2020.

The study takes its baseline energy scenario from the US Department of Energy's Energy Information Administration (DoE/EIA). Then, by drawing upon the work of the American Council for an Energy Efficient Economy, it develops its energy efficient scenario.

To overcome the diverse market barriers, the study considers and proposes a portfolio of diverse policies. To foster efficient energy use, there are building codes, minimum energy performance standards for equipment and appliances, tax incentives and a National Public Benefits Fund that is obtained from a small surcharge on electricity prices and is used to foster efficient energy use. On the supply side, there is a Renewable Portfolio Standard (similar in some ways to Australia's MRET), which fosters bioenergy, wind power and heat pumps based on geothermal energy; and tradeable emission permits that place caps on CO_2 and oxides of sulphur and nitrogen, and mercury. There are also specific strategies to foster cogeneration.

The proposed policies are applied to the National Energy Modeling System of DoE/EIA. This yields a 60% reduction in CO_2 emissions from the US electricity generation, with economic savings to households and businesses that total US$80 billion per year. Electricity prices increase, but demand decreases, with the net effect that electricity bills are lower. It is unclear whether the study considers the cost of premature retirement of coal-fired power stations.

13.9. Discussion

Almost all the studies reviewed here achieve large reductions in CO_2 emissions by a combination of strong energy efficiency and decarbonisation of supply. All regard energy efficiency as offering a wide range of cost-effective measures, however they find that energy efficiency alone is insufficient for large reductions.

There are big differences in the treatments of the supply side. The two UK studies and the study by the Australia Institute make substantial use of several renewable sources of energy. However, the two US studies use much smaller proportions, with the Pew Center focusing on cleaning up fossil fuels and the Interlaboratory Working Groups focusing on the demand side.