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TECHNOLOGY OPTIONS FOR CLIMATE CHANGE MITIGATION

EFNZ Seminar, Wellington 18 October 2006

SUMMARY OF PROCEEDINGS

EFNZ Chairman Dr Rob Whitney introduced the programme by referring to the shift towards technology solutions in the climate change debate in recent years. He said the theme for the day was to consider the questions of what are the energy technology climate change solutions and what are the policies we need to make the technology solutions happen. The focus would be on a technology push rather than a market pull.

He referred to the Energy Research Investment Strategy (ERIS) (made available to seminar participants) that had been prepared by EFNZ with wide industry and research involvement and in close consultation with FRST and MoRST. Its aim is to develop a sustainable energy future for New Zealand, to support economic growth, environmental and social sustainability. Overarching themes include global trends in demand and supply, the best NZ options to utilise indigenous energy sources, the role of markets, energy infrastructure, climate change and meeting our international obligations, education and behaviour. The immediate research priority issues arising from the process include changing energy use patterns, modelling to aid transformation to a more efficient and distributed energy infrastructure, proving NZ energy resources and investigating high efficiency/low impact conversion technologies, including bio-energy and carbon capture and storage.

"Climate Change: The Scientific Basis"
Dr David Wratt, National Institute of Water and Atmospheric Research

Dr Wratt summarised the findings of the IPCC's 2001 Third Assessment Report. He described global warming as being unusually rapid over the past few decades and more substantial changes are likely over coming decades. Climate models could explain warming around the 1940s based on solar changes and less volcanic activity than the 19th century but to explain warming since 1960 requires the influence of greenhouse gases. The effect of greenhouse gas changes (vs. 1750) is estimated to be 5 times that of solar changes. Model predictions of global cooling after the Pinatubo eruption matched observations very well and this is considered to validate the climate models.

Further observations include:

- the corrected satellite data (previously showing minimal warming since 1979) are now considered to confirm expected warming of the lowest few kilometres of atmosphere and stratosphere cooling;
- massive retreat of mountain glaciers during 20th Century;
- Arctic sea ice extent and thickness decreased during latter part of 20th Century;
- the measured increase in heat stored in the upper 500m of oceans matches modelled changes;
- there is new and stronger evidence that most of the warming observed over the past fifty years is due to human activities.

Developments since 2001 include the observations of more weather extremes and possible changes in deep ocean circulation. The European 2003 summer heat wave was seen as extremely unusual. There has also been an increase in the number and proportion of hurricanes reaching categories 4 and 5 over the past 35 years and the "potential destructiveness" of hurricanes has increased markedly since the mid-1970s. One research group has concluded a 30% decrease in deep ocean circulation transport from 1957 to 2004, but this is disputed by some others because there is considerable decade-to-decade variability. Most coupled climate models predict weakening, but not complete shutdown before 2100 with projected local cooling for the North Atlantic and Europe being outweighed by "global warming".

There is also the potential for release of substantial amounts of CO_2 and methane from the permafrost for a 2 to 4°C warming. Dr. Wratt concluded the science on some of these major/abrupt change issues is still uncertain and cloud feedbacks are still a substantial source of uncertainty in models. He noted that a target of no more than 2°C global temperature rise above pre-industrial, suggested by some for minimising risk of "dangerous interference", would require deep emissions cuts (~70%).

Dr. Wratt responded to one question about the Pinatubo eruption by adding that the models' validation is based on the water vapour feedback being shown to be responsible for half of the observed global cooling. Another question related to modelling of regional impacts for New Zealand – the variability is much higher for such modelling but his colleagues are at an early stage of running regional models. Other audience members asked questions about the highly variable global methane emissions trend and about the recent European summer (no data yet).

"Studies Related to Technology & Climate"
Dr. Bob Schock - Director of Studies, World Energy Council

WEC is in the middle of its 2004-2007 Studies Cycle that will be reported at the end of 2007 at the World Energy Congress. WEC's goal is to understand possible energy futures to 2050 identifying the role that policy actions could play to help or hinder the achievement of the WEC 3As:

- ***Accessibility*** to affordable modern energy services for all;
- ***Availability*** of reliable and secure energy supplies;
- ***Acceptability*** of energy services and supplies with minimal environmental damage and without compromising future welfare.

The uniqueness of the WEC approach is to attempt to build bottom up energy studies from the participation of its 100 Member Committees in developed and developing countries. This has never been attempted before and the gathering of base data is likely to change all top-down scenarios and consequently the views of decision makers. The result will not be perfect on the first attempt but limited

modelling will be performed to provide consistency of treatment. The richness of regional views (with all the differences) is viewed as a very valuable product of the study.

Individual country situations and government policies have been assessed along a more to less government engagement continuum and a more to less integration/cooperation continuum. His preliminary (personal) assessment of the regional findings was summarised with regard to the relative priorities for the WEC criteria.

The goal of the Energy & Climate Change Study is to understand how effective climate change policies might shape sustainable energy development. It is looking at individual country CO_2 trends and energy related responses to date, and assessing policy approaches against the 3As. Charts of energy use (and CO_2 emissions) per capita against energy intensity (and CO_2 intensity i.e. per GDP unit) for OECD vs. non-OECD countries suggest there is no automatic link between economic growth and energy use or between energy use and emissions - thus decoupling emissions from economic development is not in principle inconceivable. There is some evidence that emissions growth tends to slow down as economies mature - but there are other factors involved, some more susceptible (economic structure, demand saturation) to policy than others (geography, resources). Areas deserving policy focus are energy intensity and carbon intensity - but they are not strongly correlated (nor are energy intensity with energy use). Policy intervention is more difficult in transport than in the electricity sector.

Prof. Ralph Sims asked how difficult the bottom-up data gathering had been – the IEA had been trying this for a long time but found great difficulty and highly variable quality for a number of countries. Dr. Schock responded that many member committees were very active (even in places like North and West Africa) in "twisting arms" to improve the data quality. He did not expect they would get every country and every sector the first time but later studies could improve the coverage. Ms. Jane Desbarats (MfE) asked what form of policy intervention he saw as appropriate if not the Kyoto Protocol and he replied he was thinking instead of policies post-2012. Prof. Kahn-Ribeiro commented that she and her colleagues had been criticised for an apparent bias towards cars instead of focusing on mobility solutions. Mr Schock responded that he was surprised the previous WEC study did not include the car manufacturers and he did not want to scare them away from the current study – they are also getting some airline industry involvement and are hoping for something on rail freight. When asked about examples of decoupling energy/emissions growth, he quoted work from the Oxford Energy Institute that suggested there was not an automatic link (although some would consider this may be too optimistic a view). It would be a major challenge to keep energy consumption increasing while carbon intensity was decreasing (not just flat or stabilising).

Dr. Schock was asked if the study report would consist of broad recommendations or examples of good practice and he replied that he hoped it would include both to demonstrate the very different regional views. It was pointed out to another question that Oceania is included in WEC's Asia region. One participant asked how the system boundary was set around the transport sector where it was part of say a manufacturer's business. Dr. Schock said this study would just say that the manufacturing sector would mainly depend on technology implementation and such issues would have to be resolved in future studies. Mr. Murray Ward (GCCC) commented on the current US "coal rush" with plans for about 150 new coal fired power plants and asked how WEC proposed to deal with such issues. Dr. Schock responded that he had no specific answer but the study's aim was to provide firm policy recommendations to decision makers.

"International Economics of Climate Change"
Dr. Michael Grubb, Chief Economist, The Carbon Trust, Visiting Professor of Climate Change and Energy Policy, Imperial College, London, & Senior Research Associate, Faculty of Economics, Cambridge University

Dr. Grubb presented his understanding of climate change science and highlighted the nature of the problem is already evident, probably implicated in some "extreme events", but unevenly distributed and (usually) difficult to isolate from other factors. The most important potential impacts were inherently unpredictable but they would be cumulative over huge time horizons with a lot of inertia and irreversibility. The evidence provides a clear and compelling case for action and suggests aiming to stabilise atmospheric concentrations in a range of 450-500ppm for CO_2 equivalent (requiring major emissions reduction).

He presented a number of charts to demonstrate that climate change impacts are best expressed in terms of risk categories, including risks of large scale singularities (such as breakdown of deep ocean circulation and disintegration of the West Antarctica Ice Sheet), frequency and intensity of tropical storms/floods/drought, risks to unique and threatened systems (coral reefs, mangrove forests, glaciers), monetary or economic welfare losses by region.

He described the quantifying of impacts in global economic terms as fraught with difficulty. Discounting is critical process used to apply a weighting factor to impacts on the welfare of future generations and is subject to basic ethical principles. Aggregation is the weighting factor accorded to impacts on different peoples and countries and it similarly has to reflect fundamental ethical principles e.g. he considered there is no practical basis for substitution between foreign aid and mitigation expenditure because this would confuse the willingness to help others with the responsibility not to inflict damage. In summary he believes that if the economic analysis is done properly, the costs of climate change left unchecked probably equate to 10-30% of current consumption-equivalent.

Economic analysis suggests the mitigation cost of atmospheric stabilisation at around 500ppm CO_2 equivalent is manageable (about 1% of global GDP by 2050) if action is swift and broad based. He pointed to the UK example of how a low carbon economy will need both much cleaner energy and big reductions in energy demand through technology innovation and a stable policy framework.

He gave an overview of the EU emissions trading scheme and the reasons for the major allowance price fluctuations (driven by allocations, relative coal-gas pricing and the emerging nature of market participation). His presentation slides included detailed consideration of the economic impacts on the power generation sector and on some industries. He concluded the major problems were not with market design, but with the allocation process. He believes the logical solution to most of these problems is to work towards greater auctioning over time because the current free allocation can only work if there is a central authority empowered to accept or reject allocation plans according to agreed criteria (to neutralise profit impacts rather than a host of other pressures).

He described the Carbon Trust's support for innovation and its commercialisation. Accelerating innovation requires combining 'push' and 'pull' to drive investment in technologies and systems that traverse the entire innovation chain. This chain starts with the generation of low carbon technology intellectual property (IP) and concepts, capturing the relevant IP and then commercialising it. He illustrated this with the examples of innovation awards and the launch of fuel cell companies (a £75M investment fund offering was launched this month). He showed how power sector profits (about €5000M

during 2005) from the EU ETS could help fund technology investment and demonstrated encouraging examples of action from energy suppliers.

He considers that after a long hiatus, the international process is slowly gearing up for the next negotiation round, built upon the emerging experience from Kyoto and other mechanisms. His view is that conditions are changing and 2007-8 will see a number of forces combining for breakthroughs on the basis of the seriousness of problem and the feasibility of solutions. Established carbon markets and investment flows through the Kyoto mechanisms will embed these as a 'reality'. Growing business concern about risks of inaction and costs of an unstable and fragmented international regime will help convergence. He concluded that there is growing appreciation that energy efficiency, carbon markets and technology innovation are not alternatives, but complements appropriate to different parts of the problem.

Dr. Grubb was asked a question about different discount rates and he repeated that public policy requires quite a different treatment from the private sector and there are a lot of studies suggesting that public policy rates should decrease with time and perhaps even be zero (to highlight the importance of future generations). Prof. Jonathon Boston (VUW) commented that if civilisations or ecology is threatened, where was the justification for applying a discount rate greater than zero and Dr. Grubb responded that this is fundamentally because it is assumed that people will be wealthier in the future.

Mr. Tim Jones (Sustainable Energy Forum) asked how the EU ETS distortions could be fixed and Prof. Grubb repeated that free allocation (grandparenting) had not worked well on a national basis but reality dictated that moving away from this situation would be slow – it would still be fairly bad in Phase 2 (2008-12) and somewhat better by Phase 3 (2013-17). Dr. Rob Whitney (EFNZ) asked how stranded assets could be dealt with and he answered it was not unreasonable to provide protection to some degree but that argument has less strength as time goes by. Mr. Brett Longley (MfE) asked if it would prove cheaper to spend funds on cleaning up companies in developing countries if developed country marginal abatement costs are relatively high. Dr. Grubb responded by referring to Steven Hatfield-Dodds (CSIRO) work on consumption based carbon accounting as having intriguing possibilities even though it would be problematic.

Mr. Murray Ward (GCCC) asked whether the electricity sector would have created a Carbon Trust or whether it was better for government to establish it on a business model. Dr. Grubb responded that either could work – the UK trust was set up between government and industry 5 years ago with government funding and an independent board. Otherwise it would have been subject to political pressure on the projects selected. Something entirely private might look like the US Electric Power Research Institute – to help industry rather than the planet.

In answer to a question about public education, he suggested to make the problem real would mean informing people about the costs and benefits now (not in the future). He applied the journalism principle of never underestimating people's intelligence but never overestimating their knowledge. There has been an amazing lack of knowledge but he is encouraged that there is now a much greater awareness of carbon emissions embodied in various products.

Ms. Jane Desbarats (MfE) asked how the EU ETS quantified emissions and he explained how it had been designed for large industrial facilities that were used to verification systems for pollution control. The scheme coverage could be extended, but only very marginally and could not be expected to include widely distributed emissions from the transport or agriculture sectors.

Mr. Jim Sinner (Ecologic) asked whether sectoral agreements had much promise of offering a solution – for instance all the cement firms in the world could combine part of their revenues to create a fund. Dr. Grubb said that a major cement producer had suggested exactly that measure because of competitiveness issues but there were serious questions about whether sector associations would have jurisdiction over their individual member companies.

'Reducing Emissions from Transport – Brazilian Case Studies"
Professor Suzana Kahn-Ribeiro, Engineering Transport Programme, Federal University of Rio de Janeiro

Professor Kahn-Ribeiro used IEA figures to demonstrate the relevance of the transport sector in terms of global and Brazilian energy consumption and summarised the results of her transport research programmes. A Vehicle Labelling Programme for new light vehicles (assuming a labelling system proposed for the EU) could have avoided the consumption of 141 million litres of gasoline in São Paulo from 2000 to 2004. An Inspection/Maintenance Programme for 1.6M existing light vehicles in Rio de Janeiro in 2002 could have avoided the consumption of 73 -126M litres of gasoline. A similar programme for heavy duty vehicles throughout the whole of Brazil would avoid 320M litres/year of diesel.

The results of Brazil's advanced biofuels programmes were of particular interest to the audience. Flex-fuel (high ethanol mixes with gasoline) for light vehicles in Southeast and South Regions had avoided 8300 – 9900M litres of gasoline consumption between 2003 and 2006. The National Biodiesel Programme (a 2% blend derived from soybeans) in heavy duty vehicles avoided 1.2M litres of diesel use from 2005 to 2006. She quoted a study showing the area needed to supply biodiesel (a 5% blend) would be minor compared with about 90 M hectares available for agricultural expansion without contributing to deforestation.

She concluded that biofuels might have an important role in diversifying the transport energy matrix, depending on the characteristics of the country or region. Technological alternatives are important for reducing emissions from increasing transport energy demand but so are non-technological issues such as urban planning and mobility management.

Prof. Kahn-Ribeiro was asked how she could determine the baseline for say the inspection programme if other programmes were happening at the same time and she answered that the inspection was separate from others and no behaviour change assumptions were made. Mr. Murray Ward (GCCC) commented that the labelling results looked impressive and they were dependent on only voluntary uptake. Dr. David Wratt had seen at first hand the major increase in private car ownership in China and India and asked if there was any work on ways to discourage this trend but she knew of no answer to this problem. Mr. Cito Gazo (EFNZ) asked whether the shift from planting for food to planting for biofuels would result in significant farmer unemployment. She responded that she could not see problems with land availability or food supply for Brazil – just with distribution (to alleviate poverty). She conceded this would not provide the answer for many countries with less land availability.

"The Potential of Energy Management and Efficiency to Reduce Emissions"
Dr Diana Ürge-Vorsatz, Central European University

Dr. Michael Grubb presented this paper on behalf of the author. There are many technologies that can save significant amounts of energy compared to currently widely used technologies including advanced lighting technologies, superwindows, advanced motors, hypercar, and passive solar design. While some

technologies have enjoyed remarkable improvements in their energy efficiency, adaptation and wide diffusion of other advanced technologies (even cost effective ones) have often been limited or moderate, especially in the residential, commercial and transport sectors. Improved energy efficiency is associated with major co-benefits including social welfare, (fuel) poverty alleviation, increased energy security, improved competitiveness, air pollution reduction, comfort, etc. Those co-benefits are estimated to have a value greater than the energy savings. Thus they offer major opportunities for policy integration for delivering greenhouse gas mitigation goals without having climate change high on political agendas. A consumption based emissions trading scheme was suggested as a cost effective way to target rapidly rising emissions associated with large non-energy-intensives. Non-technological options for GHG emission mitigation include good management and improved planning, behavioural and cultural changes, and many other scattered options such as urban planning, integrated building design, telecommuting, and modal shift in transport. Whereas some of these are covered well in the literature at an individual project level, they are typically not integrated into national and global assessments on GHG mitigation potentials.

The author concluded that improving energy efficiency is a key priority for strategies to combat climate change. There has been much progress in technological innovation but more progress is needed in the broad adoption of these technologies (through policy innovation) and innovation on the final to useful energy conversion, as well as useful to energy service conversion. She considered this would require a quantum leap in our understanding of non-technological opportunities for reducing energy demand while providing equal (or better) energy services.

Low Carbon Electricity Supply Options
Professor Ralph Sims, Massey University and currently with International Energy Agency

Together with Dr. Bob Schock, Professor Sims is coordinating the lead authors of the forthcoming IPCC Fourth Assessment Report "Energy Supply" chapter. He highlighted the importance of the energy sector by saying that it currently accounts for around 70% of global GHG emissions. Since the IPCC 2001 report, in spite of all the available technologies, all the supporting government policies, and recent higher energy prices, GHG emissions from the use of fossil fuels continue to increase. Mitigation has therefore become more challenging and total investment by 2030 in energy infrastructure will exceed US$17 trillion. To continue to extract and combust the world's rich resources of oil, coal, peat and natural gas without carbon capture and storage (CCS) is no longer environmentally sustainable.

His presentation slides included a useful comparison chart of the different supply scenarios (with energy source breakdown) from IEA's World Energy Outlook, the IPCC and the more recent ABARE study (including CCS). The IPCC has assessed the global mitigation potential by 2030 for <US$20 per tonne CO_2 and US$20-50/t. The total potential by 2030 for <US$50/t is projected to be 4700 M tonnes CO_2 equivalent per year, composed of 500Mt from fuel switching and efficiency, 2100Mt from bioenergy, 1000Mt from other renewables, 1000Mt from nuclear power and 100Mt from CCS (with potential for rapid growth after 2030).

Other charts showed the huge increase in annual investment funding in renewable energy R&D from 1995 to 2005 and the growth in the number of countries with electricity feed-in policies to encourage renewable generation. Electricity generation emissions projections were illustrated with low potential mitigation and high potential (including CCS). There is growing potential for biofuels to mitigate transport sector emissions (assessed to range from 250-450MtCO_2 by 2030) but this will be partly offset by

increased CO_2 emissions from unconventional oils (oil shales, tar sands, gas and coal to liquids) reaching the market.

Prof. Sims summarised by saying the world is rapidly changing with threats including rising energy prices, energy supply security, and climate change. Energy efficiency, nuclear and renewable energy and CCS will all have key role to play in mitigation. He considered we are on the cusp of decarbonising the power sector but the transport sector will be more challenging. Communicating the links between climate change, sustainable energy, security of supply and potential co-benefits has not yet been successfully achieved.

"Carbon Capture and Storage"
Mr. Chris Baker and Dr Trevor Matheson (Coal Association of NZ)

Mr. Chris Baker quoted the IEA estimate that coal will still provide 38% of the world's electricity in 2030 (39% currently) in its Reference Scenario. CCS is one of several carbon management paths to achieve large reductions in CO_2 emissions and it has the major advantage of being the only approach that does not require countries to overhaul their energy infrastructures and continue to use fossil fuels. It also has the potential to remove enough CO_2 to stabilise the atmospheric concentration and could be the lowest cost carbon management option. Post-combustion capture has been demonstrated at some small power plants and could be retrofitted to existing plants. However, solvents are degraded by oxygen and impurities, the energy penalty for capture is relatively high (5% to 30%) and retrofitting old, inefficient plants is unlikely to be viable. Pre-combustion capture has the advantages that higher CO_2 concentrations allow the use of more compact equipment; physical solvent scrubbing for CO_2 separation is commercially proven and can take advantage of improvements in gas turbines. However, a key disadvantage is that partial oxidation or gasification of fuel is required and this leads to greater plant complexity. Power generators are also unfamiliar with gasification and plant reliability for power generation has been relatively poor so far.

Estimates for existing capture technologies are that capital costs would increase 30% to 100%, resulting in a 25% to 100% increase in the cost of electricity. The US-led FutureGen project has a target of reducing costs to US$10 per tonne of CO_2 by 2015, although this may be viewed as very optimistic with current costs ranging US$30-50. Reducing the cost of separation is the main technical issue for CO_2 capture, related to the CO_2 quality issue requiring greater capture of other pollutants. The main regulatory and legal issues relate to CO_2 transport and storage: technologies must be safe and secure (including key factors of the integrity of overlying caprock, regional geology/faulting, monitoring for verification).

The global storage capacity is recognised as huge so there is considerable international funding to demonstrate various storage projects and NZ is linked with a number of these programmes. Research priorities here are seen to be identifying the best geological storage options (location, capacity, security) in relation to CO_2 emission sources and identifying appropriate capture and separation technologies for CO_2 capture/separation/cleanup/transport/injection. Legal, policy and Maori issues (and overall public acceptance) around geological storage would depend partly on technical issues of monitoring to verify the integrity of the storage.

Panel Q&A session

In response to a question from a renewable energy advocate, Mr Baker said that with about 150 conventional coal fired plants planned in the US and similar numbers in China, if CCS is not part of the

solution in the next few years, there will be a big problem to find mitigation technologies. Prof. Ralph Sims pointed to the apparent Greenpeace High Court victory on coal fired Marsden B emissions, suggesting that many of the US plants may be challenged in their courts and state legislatures. Dr. Bob Schock agreed that some US states are starting to legislate on CO_2 issues and he noted a saying in the US: "all politics is local".

Mr. Murray Ward (GCCC) argued there was a need to match the technology push with the pull of market prices including a CO_2 price. He said he did not suggest that coal's role is not important but questioned why CCS should be picked for a technology with major potential when marine technology had similar potential both here and globally. It was pointed out that there had been a presentation on marine technologies at a previous EFNZ seminar and Prof. Ralph Sims noted that AWATEA (the NZ association) would soon be joining the well funded IEA marine technology task group. He added that with the first commercial demonstration in Portugal, marine energy was at the stage wind energy was 30 years ago and it remained to be seen how the costs would compare with CCS. Dr. Michael Grubb said he had been assessing long run engineering costs and the Carbon Trust aimed to be part of the global marine energy business. Dr. David Wratt noted that NIWA was involved in monitoring wind and marine resources and Liquid Fuels Trust Board research from 20 years ago was proving useful for assessing potential wind projects.

Ms. Jane Desbarats (MfE) pointed out there are different camps on the view as to whether CO_2 pricing should be used as a driver to fund research investment. Mr. Chris Baker responded that the issue was really one of timing: pricing would be a factor at some but the big driver for many technologies is investment funding. Many technologies (not just CCS) were a long way off in terms of commercialisation. So for these technologies, there would not be a high enough price without huge disruption to the energy and economic infrastructure – government investment was needed to bring forward their commercialisation. Australian central and state governments together with industry had committed about $2 billion towards low emission technologies with a major focus on CCS.

Prof. Ralph Sims countered that the IPCC's 2001 assessment concluded that there were hundreds of technologies waiting to be implemented that needed no more R&D. He added that the AP6 group was partly focusing on high risk (in terms of success) technologies like nuclear fusion that could not be implemented early enough for effective climate change mitigation. Instead what was needed was a renewable energy technology deployment task force to get implementation going with local bodies, industry etc. Dr. Michael Grubb commented that some had labelled AP6 as an alternative to Kyoto but this had driven some countries away from participation when it would actually be a very valuable means of encouraging technology cooperation.

Mr. Eric Pyle (MoRST) asked if CCS was considered just in terms of fossil fuels and what was the NGO reaction to CCS. Prof. Ralph Sims responded that the IPCC Special Report on CCS had a biological sequestration section that would result in net CO_2 removal from the atmosphere but there were no projects under way yet. He added that he considered soil sequestration to be a useful technique that had been ignored so far (and Japan had been adding char to soil for centuries). Dr. Rob Whitney commented that bio-energy projects tended to be smaller scale than fossil fuel ones so capture costs would be higher.

Ms. Catherine Beard (Greenhouse Policy Coalition representing large industries) asked if competitiveness issues have been thought through when NZ trades largely with Pacific countries that have not committed to Kyoto targets. Dr. Michael Grubb responded that he had done a lot of work on competitiveness issues and he did not consider the EU allowance price levels had caused problems – industries were now

factoring the CO_2 price into their business and this was helping provide the solution to emissions mitigation. With regard to wind generation, he did not consider the variability of 20% wind in the generation mix to be a problem anywhere. Ralph Sims added that unlike the EU, NZ had the benefit of renewable hydro rather than fossil fuel stations as the backup to wind.

In assorted comments, Ms. Carole Glynn of FRENZ said she was jointly funded by the European Commission and MoRST to make contact with researchers in the whole range of environmental issues. Mr. Jerome Morris-Jarrett of the French Trade Commission asked Dr. Grubb about the UK suggestion of individual carbon accounting. He responded that this was not a Carbon Trust initiative and suggested that UK officials had been alarmed by their Minister's suggestion that it might be a good idea. It would be very difficult to administer at an individual level and in the EU trading system, there is an argument that even the 20MW threshold may be too low (rather than too high) because of high management costs.

In summary, Energy efficiency, nuclear and renewable energy and CCS will all have key role to play in mitigation. Communicating the links between climate change, sustainable energy, security of supply and the costs and potential co-benefits of mitigation has not yet been successfully achieved. There were initiatives in place to ensure mitigation technologies would be available at affordable costs, but we need policies and financial signals provide the market pull to complement this technology push.

The Seminar was sponsored by The Royal Society of New Zealand, Coal Association of New Zealand and NIWA CRL National Centre for Climate-Energy Solutions, and the Institute for Policy Studies-Victoria University of Wellington. It attracted 78 participants from various companies and organisations.

The Energy Research Investment Strategy and the seminar proceedings can be found on the Energy Federation of New Zealand Website (www.energyfed.org.nz).