Sustainable Energy in New Zealand

One of a number of discussion papers produced by the IPENZ Presidential Task Committee on Sustainability during 2003 and 2004.

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1. Summary

Energy plays a crucial role in the economic and social development of all people and New Zealanders are more dependent on energy than many people in the world. Visionary energy policies are essential to facilitate sustainable, affordable economic and social development.

Engineers need to be in the forefront of efforts to mitigate and prevent adverse local and global impacts from energy generation, transmission and use on human health and all living things in the environment. The climate change implications of increased atmospheric concentrations of greenhouse gases are of particular significance to all people in the world. This paper does not include specific information on transport energy as that is the topic of another paper in this series.

The objective of this paper is to present an action framework to assist engineers to:

1. Promote sustainable energy initiatives that will help ensure the survival of living species and support positive economic and social developments;
2. Encourage and prioritise the rational use of energy, energy efficiency and renewable, clean, safe and sustainable energy technologies;
3. Encourage relevant research, development and commercialisation of innovative technologies, information exchange, training, consultancy, monitoring, planning and by bringing adequate financial resources to sustainable energy issues;
4. Support action that ensures sustainable energy services are available in quantities that are sufficient for all human beings to satisfy their survival and development needs.

2. International Perspectives on Sustainable Energy & Climate Change

In 1999, a report "Ethics of Energy" by a sub-committee of the UNESCO World Commission on the Ethics of Scientific Knowledge & Technology[1] defined sustainable development as:

"Sustainable development, meaning the use of our planetary resources for the well-being of all its present and future inhabitants, has become the concept which must guide both individual and collective action at every level and national and international policies."

[1] World Commission on the Ethics of Scientific Knowledge and Technology (COMEST) Sub-Commission on "The Ethics of Energy" (2000), UNESCO Headquarters, *Report,* 2-3 November 2000.

The report's conclusion was that access to adequate sources of energy is no longer a matter of maximising supplies for more and more people, it is also a matter of social, environmental and future equity. Discoveries of new supplies of traditional commercial energy resources – mainly fossil fuels – have peaked, and future fossil fuel supplies will become scarce and more expensive. There is now a widely accepted awareness of the atmospheric, climatic and environmental consequences from the burning of fossil fuels.

Renewable energy resources are those that can be utilised at a rate which allows for their replenishment, through natural processes, within reasonable time-scales. Fortunately, the underlying sources of most renewable energy are the sun, the action of gravity, the earth's rotational forces and internal temperature. The growth of plant material, or biomass – from photosynthesis of sunlight – is another renewable source. These resources are not in short supply, although there may be a restriction of the rate at which they may be harvested. These resources are the basis for a sustainable energy future for humanity on the Earth.

However a significant and courageous effort by political and community leaders will be required to redirect our direction toward a sustainable energy future. New Zealand, like the rest of world, will need to adopt new ways of thinking about energy for this shift in direction to occur.

Studies over the past decade have confirmed that the climate warming trend is continuing. The ten warmest years in recorded weather history have taken place since 1987. The world is experiencing what the global warming models predict. The physical evidence includes retreating glaciers, melting permafrost in Alaska, and many more severe weather events. Even the Pentagon has issued a warning that global warming, if it takes place abruptly, could result in a catastrophic breakdown in international security. They suggest that wars over access to food, water, and energy would be likely to break out between states.

Even if climate change impacts happen more gradually, recent studies have argued that as many as one million plant and animal species could be rendered extinct due to the effects of global warming by 2050. A recent report by the world's largest reinsurance company, Swiss Re, predicted that in 10 years the economic cost of disasters like floods, frosts, and famines caused by global warming could reach $150 billion annually. Accelerating the development of a portfolio of new technologies could stabilize greenhouse gas concentrations, enhance global energy security, and eradicate energy poverty.

We urgently need the technical expertise, political will and international cooperation to make sustainable energy a reality. Engineers need to be leading the discussion and action on this issue.

3. The New Zealand Context

Around 29% of commercial consumer energy used in New Zealand is supplied from renewable energy sources, but the efficiency of use of energy in New Zealand is poor.

In 2000, the Government published an overall energy policy framework that committed NZ to achieving a sustainable and efficient energy future. This policy commitment also included an

objective of ensuring that the delivery of energy services to all classes of consumer was done in an efficient, fair, reliable, and sustainable manner. [2]

This overall policy framework declares that energy services must aim to achieve:

- environmental sustainability,
- a continuing improvement in our energy efficiency, and
- a progressive transition to renewable sources of energy,
- costs and prices to consumers to be as low as possible,
- prices to reflect the full costs of supply including environmental costs,
- reliable and secure supplies of essential energy services, and
- fairness in pricing, so that the least advantaged in the community have access to energy services at reasonable prices.

In 2001 the Government's Energy Efficiency and Conservation Authority (EECA) published a National Energy Efficiency & Conservation Strategy (NEECS) for moving New Zealand toward a more sustainable energy future. [3] This strategy established two targets as a mechanism to measure progress and confirm that New Zealand was heading in the right directions. The first target was for a 20% improvement in energy efficiency and the second target was to increase the contribution of renewable energy by 30 Petajoules. These targets will need to further tightened if the overall goal is to be achieved.

The Government's Climate Change Goal is *"..that New Zealand should have made significant greenhouse gas reductions on business as usual and be set towards a permanent downward path for total gross emissions by 2012."* [4]

Government has also ratified the Kyoto Protocol and is committed to reducing New Zealand's greenhouse gas emissions back to below 1990 levels. To help reflect the full environmental costs, Government is implementing programmes to help change the direction on our energy future. The imposition of a carbon tax from 2007, and the distribution of carbon credits to developers of new renewable energy has already started. Whilst these Government policy positions are a good beginning, there will need to be concerted action by everyone, particularly engineers, if the country is to move significantly toward the overall goal of a sustainable energy future.

Unfortunately projections about the current energy future for New Zealand - from the Ministry of Economic Development (MED) [5] - show an ever-increasing demand for more fossil fuels. The current reliance on global energy markets to meet the demand for energy in New Zealand is inherently unsustainable.

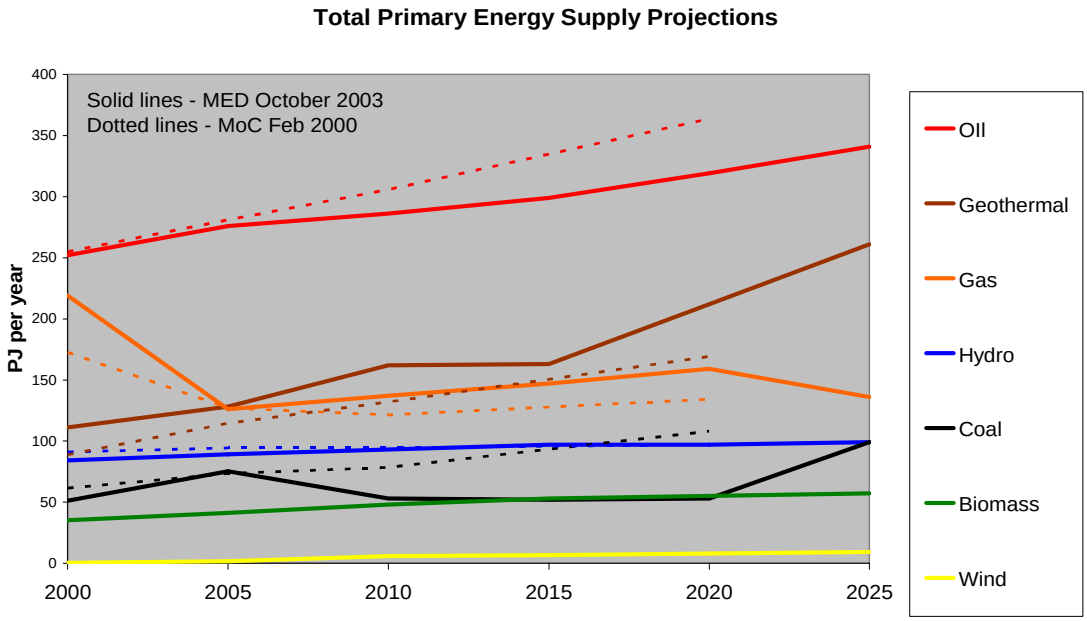
Future primary energy requirements for New Zealand - from the MED model - are shown below. The solid lines show the Reference Scenario from the 2003 Energy Outlook report. The dotted lines show the corresponding projections from the 2000 Energy Outlook report.

[2] New Zealand Energy Policy Framework, http://www.med.govt.nz/ers/electric/package2000/epf.html

[3] National Energy Efficiency & Conservation Strategy, http://www.eeca.govt.nz/default2.asp

[4] Climate Change Policy in New Zealand, http://www.climatechange.govt.nz/policy-initiatives/

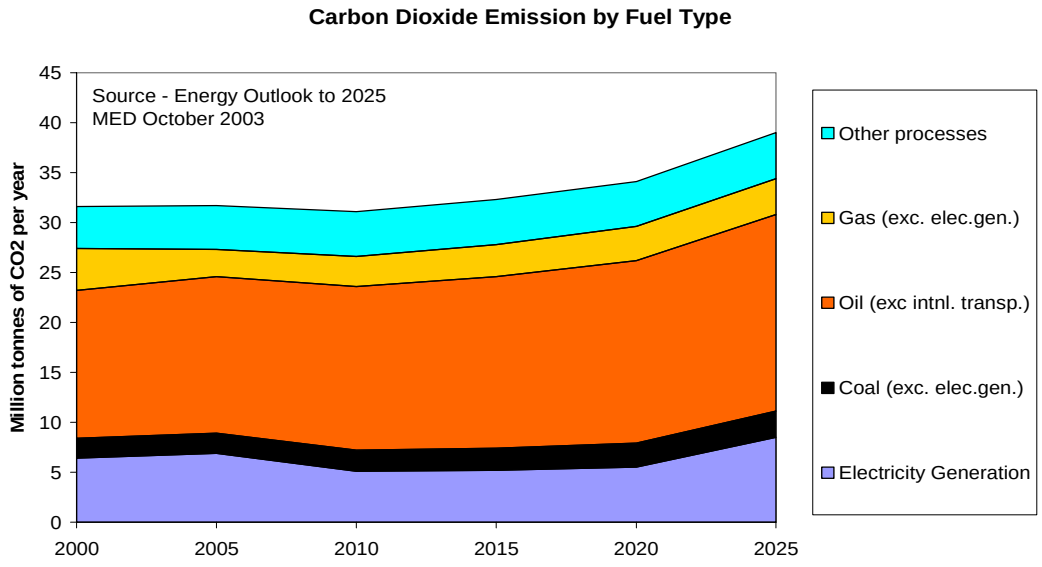
[5] New Zealand Energy Outlook to 2025, Ministry for Economic Development; Nov 2003, http://www.med.govt.nz/ers/en_stats/outlook/index.html



This MED graph shows a steady continuous rise in oil demand (primarily due to increasing demands of the transport sector). The natural gas primary energy resource line reflects the early depletion of the Maui gas field followed by a steady increase in gas use as Pohokura, Kupe and new gas discoveries are exploited. Beyond 2020 the MED economic model projection assumes an increase in gas price towards that of imported LNG and its replacement by coal as a fuel for electricity generation.

There are no stated assumptions in the 2003 Energy Outlook about the uptake of renewable energy. Their output is projected by economic analysis using MED assumptions on the costs of new generation. The increase in wind generation is projected to be about 10% pa over the outlook period. This outlook does not specifically address the impact of policy changes or the introduction of new and emerging energy technologies, although the effect of the carbon charge in 2007 is included.

These fossil fuel use projections in the MED 2003 Reference Scenario would result in CO_2 emissions of 39 million tonnes by 2025, as shown in the graph below.



The upward trend in CO_2 emissions, is dominated by the use of oil in the transport sector. This figure shows that CO_2 emissions in 2010 are a minimum with steady increases thereafter. The MED economic assessment model takes account of the impact of a carbon charge on the basis of $15 per tonne of CO_2. However, no assumptions are made about other measures that might be required to address climate change beyond the First Kyoto Protocol Commitment Period.

To change direction from the pathway set out in MED's 'Energy Outlook to 2025' to a more sustainable energy future, New Zealand will require widespread adoption of a changed way of thinking about energy. A recent commentator, Steve Goldthorpe [6] stated "Instead of being considered only as a tradable commodity, energy supply and its infrastructure need to be considered a privilege available to our generation that must be handed down in good shape to future generations. A practical energy strategy to take New Zealand forward to a sustainable energy future needs to be developed and then the policies and prices needed to facilitate the change to that regime need to be defined. The energy markets need to become the servants of the energy industry not its master."

4. An Energy End-use Focus

To achieve a sustainable energy future, New Zealand needs to find ways to control the demand for energy in a way that energy pricing alone demonstrably cannot deliver.

Suggested principles for minimisation of the impact of end-use demand on energy supply: -

- Match the application to its primary energy source (Take a holistic view of the path from end use to energy supply);
- Understand where energy is used via energy audits (Defining the problem is the first step towards solving it);
- Avoid use of energy where possible (It is ten times better to avoid a journey than to make that journey in a vehicle that is 10% more efficient);
- Locate renewable electricity generation as close as possible to the end-use of energy services (Dispersed energy resources are well suited to distributed generation);
- Where the end use requires low-grade energy for heating or drying then a low temperature energy source should be used (e.g. Solar water heating, recycling waste water heat to a cold water inlet, passive solar space heating);
- Only convert energy from one form to another where that conversion improves the usefulness of the output energy (e.g. direct use of gas for heating is preferable to the use of electricity generated from gas);
- With fossil fuel combustion use high temperature energy for a high temperature duty and residual low temperature part for a low temperature duty (e.g. combined heat and power schemes);

[6] "2025 - Then What? - Can NZ achieve a Sustainable Energy Future?" Steve Goldthorpe – Energy Analyst, Presentation to the Sustainable Energy Forum Conference, UNITEC - Auckland - 15th November 2003.

- Consider combinations of energy sources (e.g. a low grade energy source for water heating, topped up by a high quality energy source);
- Provide high quality reliable electricity and power conditioning locally (isolate critical services for the general purpose electricity grid);
- Minimise the number of energy conversion steps (each time energy is converted from one form to another some of it is lost and losses compound together); and
- Value energy in proportion to its usefulness.

Implementing these ideas will help New Zealand move along the way to a sustainable energy future.

5. Implications for IPENZ Members and Engineers in General

IPENZ President's Sustainability Group recommends that the Sustainable Energy concepts and ideas, presented in this paper, are adopted by engineers for works and projects in which they are involved, and that IPENZ promotes these principles at every appropriate opportunity.

There a number of ways in which engineers and the engineering community can move New Zealand towards sustainability. The following checklist provides some guidance.

Sustainable Energy Actions Checklist

1. Have you supported the establishment of targets, programmes and other actions to reduce energy-related atmospheric emissions? ☐
2. Have you encouraged and used energy performance standards and labelling for energy using equipment and systems, based on international best practice? ☐
3. Establish of guidelines and methods of evaluation for determining the external effects and lifecycle costs and risks for energy systems, taking into account the environmental, health and other damage caused by energy-related activities. Make decisions based on these methods. ☐
4. Have you developed programmes for improvements in energy efficiency, safety controls, waste management and emissions reductions in the production, storage, transportation and consumption of all types of energy, and implemented them? ☐
5. Encourage the substitution of non-renewable energy resources by environmentally benign sustainable energy sources? ☐
6. Have you promoted the development of new financial instruments and investment mechanisms, including full life-cycle costing assessments, to encourage private and public sectors to invest in sustainable energy developments? ☐
7. Have you supported and promoted cooperation and exchange of technology, expertise, education, training programmes, information and statistics on the best sustainable energy technologies? ☐
8. Can you encourage performance monitoring as a vital element to achieve long term success? ☐
9. Can you support the re-introduction of “community service obligations” for utilities to ensure financing for enhanced research, development and demonstration of renewable energy technologies? ☐
10. Can you support sustainability linked tax incentives and subsidies to foster renewable energy utilisation? ☐
11. Support regulation of access to electricity networks to increase community interest in the decentralisation of power supply? ☐