From threat to opportunity:

moving to a sustainable energy pathway

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Executive summary

Introduction

Over the next decade New Zealand must make important decisions that will strongly determine its future energy development pathway. Two strategic issues are of vital importance:

- the need for the energy sector to respond to the Government's policy of reducing CO_2 emissions,
- the need to develop a viable energy strategy to take the country beyond the depletion of the Maui gas field.

Recent energy forecasts have detailed a business-as-usual approach to New Zealands energy future. The business-as-usual pathway follows the trend of recent years, indicating continued rising energy consumption over the next two decades. The pathway emphasises the need to develop new energy supplies from conventional energy sources - coal, oil, gas and hydro-electricity - to meet anticipated demands. However, this pathway seems to exacerbate problems that New Zealand needs to deal with over the coming decades. Instead of reducing CO_2 emissions towards the Government's target of a 20% cut in CO_2 by 2000, emissions would increase by 40% by 2010. Instead of moderating energy demand in anticipation of the rundown of the Maui gas field, growth in demand would continue, requiring new sources of energy to be discovered and developed. Instead of contributing in a positive way to the needs of a sustainable global energy system a business-as-usual approach contributes little. It will fail to bring CO_2 emissions under control, let alone achieve cuts. It will fail to contribute to the necessary technology transformation required to develop and deploy environmentally-benign energy technologies (those that minimise the environmental harms from energy use) to both the developed and developing world. It is the contention of this study that such a pathway is **unsustainable.**

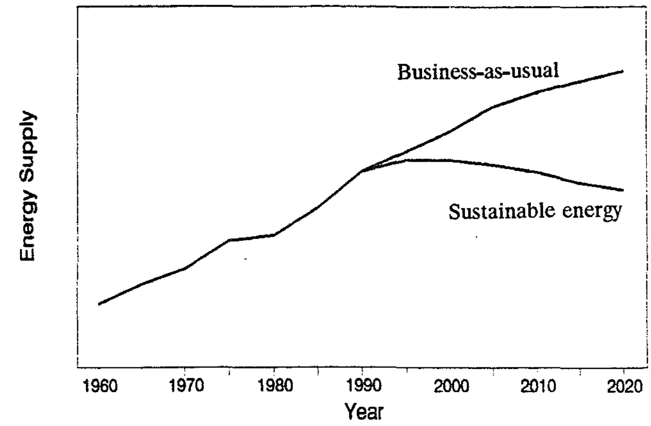
A new pathway

Trend need not be destiny. There is a need to focus on a vision of a different pathway for New Zealands energy future - to create an "alternative future". A new pathway would be based on two key strategies:

- progressively improving energy efficiency i.e. using less energy to deliver the same level of service,
- gradually introducing renewable energy technologies, based on the current advances in new-technology solar systems.

This strategy would not only provide long term environmental benefits, it promises to offer the potential for considerable economic benefit as well. It is a pathway of opportunity. It is a pathway that needs a full and immediate evaluation.

This pathway does **not mean a sacrifice in the level of energy services** compared with business-as-usual. An alternative "sustainable energy" pathway outlined in this study indicates that by 2020, the same level of energy services could be delivered to consumers by using only two-thirds of the primary energy that a business-as-usual pathway would require.



Energy requirements for a sustainable energy compared to a business-as-usual pathway.

The sustainable energy pathway would require the following outcomes to be achieved:

- end-use efficiency needs to improve at an average of one percent per year compared to business-as-usual. This is considered to be readily achievable given some purposeful goals within the appropriate institutional setting. Attention must be given to pricing and the creation of efficiency markets, and to equity issues,
- energy transformation losses (energy wasted in transforming one type of energy to another e.g. gas to electricity) need to be systematically reduced over the next two decades,
- renewable energy sources, in particular new-technology solar-based systems need to be progressively deployed from about 2005 onwards, to take over from declining indigenous gas and oil production. By 2010, about 5%, and by 2020, about 20% of primary energy would come from these technologies.

Introduce new insights and innovations

Optimism over the feasibility of such a pathway comes mainly from developments and innovations overseas, and the belief that these developments can be readily transferred to the New Zealand setting. Systematic improvements in end-use efficiency are occurring under purposeful institutional settings, including pricing policies, and with the advent of new technology. The past decade has also seen systematic cost reductions in new-technology solar systems, in particular wind generation and photovoltaics. Both manufacturers and energy suppliers are confident that further significant cost reductions will occur, and that many of these technologies will be fully cost-competitive with some conventional energy sources within a decade.

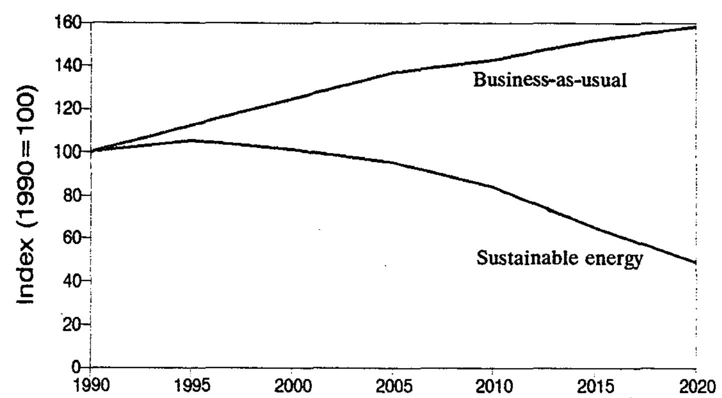
New Zealand is ideally placed to bring new-technology systems on-stream in a systematic way early next decade. Energy supply over the next decade is projected to be relatively secure, and thus it provides a stable base to investigate, and phase in, new energy systems. The next few years provide a unique opportunity for New Zealand to move quickly onto the technological learning curve. But a move towards solar-based energy systems also offers another big benefit for New Zealand. These systems are low risk in that they do not entail high, upfront capital expenditure, and they do not require long lead times for construction. They can be deployed as incremental chunks of capacity when needed. They get around one of the major problems that has plagued energy development in New Zealand over the last two decades - the focus on large energy developments that have overstretched the relatively small New Zealand economy, and created alternative "shortages" and "surpluses" prior to, and after, the development.

An early move towards renewable energy sources also creates the opportunity to establish a competitive industry base around renewable technologies. The international market for environmentally-benign energy technologies is likely to continue its current growth path well into the future.

Producing renewable energy technologies could also provide a positive contribution to the needed technology transfer to developing countries. Up until now New Zealand's stance on CO_2 emission reductions has been based on moral suasion - symbolically important but unlikely on its own to have much effect. If New Zealand is really serious about reducing CO_2 emissions globally, then it needs to be rather more positive in its approach. The ability to provide solar-based technologies and technological expertise would be one of the more positive approaches New Zealand could take.

A permanent solution to CO_2 emissions

A sustainable energy path addresses the CO_2 problem in a permanent manner. Whereas the business-as-usual approach regards CO_2 emissions targets as a "threat" to the economy, this study suggests that we should be turning such threats into opportunities. The sustainable energy pathway outlined here achieves major and permanent cuts in CO_2 emissions in the medium to long-term. It does not achieve the Government's target of 20% reduction by 2000, rather, emissions are stabilised by 2000, and progressively cut from then on. By 2020, CO_2 emissions are 50% of today's levels.



Index of CO_2 emissions for the sustainable energy and business-as-usual pathway (Base year 1990 = 100).

New Zealand is one of a handful of countries taking an activist role in setting a CO_2 emission reduction target. That New Zealand's effort, on its own, will bring about an insignificant reduction in emissions in relation to the global total is a well recognised fact. The policy is, however, acknowledgement that developed countries in particular, have a moral responsibility to act, despite uncertainties. The New Zealand Government is looking to meet its greenhouse targets by utilising "win-win" strategies, where CO_2 reductions provide more than solely environmental benefits. An early move towards a sustainable energy pathway offers hope for considerably better than that:

WIN - confront the looming supply "gap" and move towards a permanently sustainable energy system

WIN - bring CO_2 emissions under control and rapidly reduce them after the turn of the century

WIN - create an industry base built on genuine competitive advantage, with a captive world market

WIN - develop and deploy the technology to allow developing countries to leap-frog the fossil fuel development phase.

Getting started

While there are some encouraging signs that moves are being made in this direction, it seems unlikely that this pathway can self-start simply under the incentives of the free market. There are many road blocks in the path. These include the parlous state of the New Zealand economy, the propensity for New Zealand to undervalue and underprice its energy, the predominance of business-as-usual thinking in energy decision making, the lack of wider participation in energy matters, and the lack of purposeful direction to energy policy. There is also a lack of belief that an alternative pathway to business-as-usual could be viable.

The sustainable energy approach outlined here is not fanciful - the more one looks into it the more logical and compelling it becomes. To move on to the pathway will require an evolving transformation in our approach to energy. It will require a national commitment to energy policy, a purposeful approach to meeting energy objectives, and an encouragement of technological innovation. What needs to be given urgent attention is the required "nudge" to get this process underway. But once on that pathway, there is reason to believe that the evolutionary process of change will provide mutual reinforcement for the required transformation. New technologies will reinforce new institutions, which will reinforce new values, and vice versa.

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Introduction

The notion of sustainable development has parachuted into our modern idiom. The World Commission on Environment and Development[1] (hereafter referred to as the Brundtland Commission) can take much of the credit for "commercialising" the concept, although they certainly did not invent it. Nevertheless, the Commission's definition of sustainable development, "development that meets the needs of the present without compromising the ability of future generations to meet their needs", has become a widely used point of reference.

In New Zealand, "the sustainability of natural and physical resources" is part of the long title of the Environment Act 1986. Now, the Resource Management Act 1991 has as its purpose the promotion of "the sustainable management of natural and physical resources".

Be it under the guise of "sustainable development" (as used by the Brundtland Commission), "sustainable management", "sustainable growth"[2], or just sustainability, it is nevertheless generally accepted that if something is sustainable it "is a good thing". That, at least, is a promising start.

The difficulty, it seems, is in operationalising the concept. The question invariably turns to what should be sustained? In what quantity and quality? Who should decide and how? New Zealand is not alone in grappling with this challenge. Prominent US environmental analyst Richard Norgaard has observed that:

> *"the call for sustainable development in the latter 1980s appears pretty vague...environmentalists want environmental systems sustained. Consumers want consumption sustained. Workers want jobs sustained...All are threatened. Thus sustainability is called to and being called by many. With the term meaning something different to everyone, the quest for sustainable development is off to a cacophonous start.*[3]

This reaction should come as no surprise. The dictionary definition of "to sustain" means essentially to keep going continuously; as such it implies a non-changing state. Yet "sustainable development" is explicitly recognised as a "process of change"[4]. Notions of change that challenge the status quo, challenge the considerable vested interests that wish to see the status quo maintained. The resulting tensions produce conflicts and contradictions. The conflicts, at least in the short term, are unavoidable. The contradictions are avoidable, but some have not been avoided.

For instance, energy is at the core of the sustainable development concept. Energy is ubiquitous, driving all processes both natural and human-made. The impacts of its production and use are everywhere. Sustainable development could not have meaning as a national goal unless it were also a goal of energy policy[5]. In New Zealand we now have a Resource Management Act that has as its primary purpose the sustainable management of resources. But we lack any corresponding energy policy that explicitly supports this purpose. Can we manage our resource base sustainably without also addressing the unsustainable use of our energy resources? Such apparent ambiguities seem typical of the New Zealand response to sustainable development so far[6].

Nevertheless the Government has signalled its clear intention to reduce the environmental impact of our energy use by setting a CO_2 reduction target. An interim goal of a 20% reduction in CO_2 emissions by the year 2000 (cf. 1990 levels) has been set, one of the more stringent in the world. Meanwhile, other strategic energy issues are looming for New Zealand, the most important being the replacement for Maui gas. Maui gas currently provides one-third of the primary energy supply of the country and is expected to be depleted by about 2005.

This publication seeks to give meaning to the sustainable development concept as it applies to energy supply in New Zealand. It is a broad attempt at outlining a vision of a pathway consistent with sustainable development over the next three decades. The publication is presented in three sections:

- Section A outlines and summarises principles of sustainable energy development, and presents the emerging international consensus.
- Section B outlines energy supply, past and present in New Zealand, and reviews the "business-as-usual" pathway to the future.
- Section C proposes, and expands on, an alternative "sustainability" pathway, in which the principles of sustainable development underpin the strategic direction for energy supply and use. The barriers and opportunities to this pathway are examined.

This study has been produced as part of the Centre for Resource Management's research programme funded by the Ministry for the Environment. However, it does not necessarily represent the views of the Ministry for the Environment. Neither is it written with the expressed aim of supporting specific environmental objectives such as the CO_2 emissions target. Rather, it is hoped that this publication can serve as a stimulus for wider public discussion and future action.

Notes and references

1. World Commission on Environment and Development (WCED), 1987. *Our Common Future.* Oxford University Press, Oxford. 400p.

2. Daly, H. 1990. Toward some operational principles of sustainable development. *Ecological Economics 2:* 1-6 has argued that the term sustainable growth should be rejected as a bad oxymoron, since in a finite global ecosystem growth cannot be sustainable over long periods of time.

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6. A broader analysis of the way sustainable development has been addressed in New Zealand is contained in McChesney, I.G. 1991. The Brundtland Report and sustainable development in New Zealand. *Information Paper No. 25.* Centre for Resource Management, Lincoln University. 72p.

SECTION A

Sustainable development

This section discusses the concept of sustainable development in an international setting, and looks at the requirements of an energy strategy from this perspective. The section discusses the principles and strategic imperatives of a sustainable energy pathway.

CHAPTER 1

Overview

"Many present development trends leave increasing numbers of people poor and vulnerable, while at the same time degrading the environment. How can such development serve next century's world of twice as many people relying on the same environment?" (Brundtland Commission, 1987)[1]

1.1 We have a problem

During the 1980s three interrelated global crises have emerged in ways that have made their impacts impossible to ignore: poverty, environmental breakdown, and social violence. They all represent a **failure of development**[2]. These failures demonstrate that the systems by which we manage our relationships with one another and with our natural environment are not working. Our present path of development is damaging to both people and the earth.

It is not just a minority lobby that is coming to this conclusion. The Brundtland Commission, which comprised 22 elite politicians and functionaries, came to the same conclusion. In April 1987, after three years of extensive investigations and deliberations into the state of the global environment, they reported their findings to the world. The Commissioners came to a blunt assessment about the impact of most of humankind's current development trends. They are **unsustainable** - that is if people continue with current patterns of development, and continue to reproduce at present rates, then they will narrow the chances of prosperity, or even of safe and secure livelihoods, for the next and subsequent generations[3]. The Commission urgently called on all countries of the world to reverse these trends and to adopt policies consistent with the theme of "sustainable development".

The Brundtland Report was presented to the United Nations General Assembly in October 1987 and a resolution of approval was passed. Meanwhile the Report had been presented to the governments or leaders of over 100 nations and met with no serious objections or disagreements.

Yet in the four years since the Brundtland Report was issued little apparent change is obvious. The environment is still largely regarded as being outside of economic affairs. As the Worldwatch Institute Director Lester Brown recently pointed out global economic indicators continue to paint a rosy view of the future. Yet every major indicator of the environment shows a deterioration in natural systems[4]. The issues of unsustainable development outlined by the Brundtland Commission have not gone away in the last four years. Rather, they have intensified. The predominant response has been a continuation of the typical reaction throughout most of the 1980s -to deny that anything was fundamentally wrong. The United Nations has referred to the 1980s as the "lost decade". It has been alternatively described as the "decade of denial"[5].

1.2 Confronting the "new realities"

Setting the context for any appropriate response to unsustainable development is an understanding of what can be described as the "new realities" - that must be recognised and managed.

Foremost is the rapid and accelerating process of "globalisation". This has pervaded most aspects of life including technology and production; employment and work; trade and finance; information;

militarization; pollution and resource depletion; consumption patterns and culture; and leisure and recreation[6]. These activities are interactive, and the processes are accelerating and irreversible. The result is that the international interdependence between individuals, communities and nations and the natural environment is being continually strengthened.

A second reality is the changing nature of change. Business consultant Charles Handy has recently pointed out that "change is not what it used to be"[7]. Only 30 years ago we thought change meant more of the same, only better. This no longer holds true. No longer is change secure and predictable. We are entering an era of what he describes as "discontinuous change" - where old ideas and means of organisation are being overturned. It is a confusing, disturbing and unstable time.

A third reality is that our now well-recognised environmental problems lie rooted in the development process itself[8]. For decades prophetic voices have warned of the problems we were creating for ourselves and future generations by our apparently insatiable demands on nature's goods and services. As time goes by two conclusions appear inescapable; first, the problems appear to be more serious than first indicated; and second, the longer we delay action on problem solving the more intractable these problems become[9]. Many people are now caught in a downward and self-reinforcing spiral of poverty and environmental degradation. The Brundtland Commission stressed that much of what was unsustainable in the world today was a result of the unevenness of development and a product of the relative neglect of economic and social justice within and amongst nations:

> *"Poverty is a major cause and effect of global environmental problems. It is therefore futile to attempt to deal with environmental problems without a broader perspective that encompasses the factors underlying world poverty and international inequality"*[10].

According to the Commission, the sustainable development agenda must have as its "overriding priority" the fulfilment of basic needs of all people in the world. But the Commission also explicitly recognised that development must be bounded by ecological constraints and considered that "at a minimum, sustainable development must not endanger the natural systems that support life on earth: the atmosphere, the waters, the soils and the living beings"[11].

1.3 Sustainability - old ideas for new?

The sense that modern development is unsustainable, that it is heading down a dangerous and destructive pathway has prompted people to look to the past to rediscover "new" or forgotten insights.

Despite its contemporary "rebirth", sustainability is consistent with old traditions of stewardship, kaitiakitanga, and others. It reflects much of what is regarded as traditional wisdom. Sustainability was the original economy of our species[12]. To a greater or lesser extent, the sustainability of our forebears' way of life was maintained by a particular consciousness of nature. There was a spiritual connection between people and the animals and plants on which they subsisted. People were a part of nature, not set apart as masters.

People are also looking to the past, or to non-western cultures, to rediscover a new sense of values and social cohesion. The teachings and traditional wisdom of many traditional cultures and religions has stressed what can be called "voluntary simplicity" - the rejection of riches and personal wealth in favour of a simpler, more spiritually-based existence[13] [14]. In essence, it is a search for quality, rather then quantity.

1.4 Sustainable development as new ways of thinking and acting

Lessons of history serve as a valuable guidepost to the future. But the past cannot be recreated.

> *"To resolve the global crisis we must achieve basic changes in the way we think and act"*[15].

David Korten has argued that **transformation** defines the essential sustainable development priority for the 1990s. This involves transforming our values, our institutions, and our technologies[16].

In addressing the question of values, former head of the EPA in the US (and one of the Brundtland Commissioners) William Ruckelshaus has stated that the new world view needs a new consciousness. He has proposed these fundamental beliefs:

- the human species is part of nature. Its existence depends on its ability to draw sustenance from a finite natural world; its continuance depends on its ability to abstain from destroying the natural systems that regenerate this world,
- economic activity must be organised to account for the environmental costs of production,
- maintenance of a livable global environment depends on the sustainable development of the entire human family[17].

Another way of viewing this new consciousness is to frame it within the context of our **responsibilities** to future generations and the question of inter-generational equity. Jan Wright has proposed a "hierarchy of responsibilities" in the way in which we manage resources[18]. These are outlined in Box 1.1.

Box 1.1: Our responsibilities to future generations

1. Our greatest responsibility is not to inflict "unallowable harms",

2. Slightly lower down the hierarchy is the responsibility to preserve the "renewability" of renewable resources,

3. The responsibility to slow the depletion of non-renewable resources in order to share them with other generations is of lower priority. The real responsibility in the use of non-renewable resources lies in the easing of transitions to substitutes.

On the question of "unallowable harms", Wright suggests three questions that might be a starting point for determining the "allowability" of environmental harms: first, is the impact of human activity potentially reversible? second, what is the scale and distribution of the impact? and third, what is the quality of our knowledge about the impact?

These provide at least the starting point to developing a set of principles to guide the new ways of acting.

The Brundtland Commission also pointed out that our concern for the welfare of future people must also logically extend to include concern for the welfare of current peoples who are disadvantaged or caught in the downward spiral of poverty/environmental degradation. Hence, sustainable development must concern itself with equity, both between generations and within generations.

Sustainable development is not just about developing a new ethic between people and nature. It is also about developing a new ethic between all peoples.

This ethic must spread to the institutions we construct to organise political, social and economic activity. The nature of the economic process dictates much of the way people relate to nature and to each other. Hence, transformation towards a new economics that is consistent with new values and the new realities is considered crucial[19].

Third, the transformation must extend to the nature of technology: technologies must become efficient in their use of resources, minimise pollution by employing pollution prevention techniques, utilise and re-utilise recycled materials, minimise environmental impact, and enhance human well being[20].

1.5 Sustainable development as a process of change

Although it is often portrayed as such, sustainability is not an end-state. It is impossible to define future end-states when the global economy is undergoing such rapid change in both its natural and human-built environment. Sustainable development, therefore, is a process of change along a new pathway of development: a pathway in which "the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are made consistent with future as well as present needs"[21].

The idea that humanity is at some kind of historic watershed has been around for the last decade or so. To some, the fact that it has been talked about for years and has not yet happened is evidence enough that it will not happen.

If development is to be sustainable a major change in direction is inevitable. But the nature of this turnaround is full of complexity. Two perspectives are given below:

> *"Our species is now at its most important turning point since the agricultural revolution. For the first time humanity has the knowledge to destroy itself quickly, and for the first time humanity also has the knowledge to take its own evolution into its hands and change now"*[22].
>
> *"The conventional image is that of a crossroads: a forced choice of one direction or another that determines the future for some appreciable period. But this does not at all capture the complexity of the current situation. A more appropriate image would be that of a canoeist shooting the rapids: survival depends on continually responding to information by correct steering"*[23].

These perspectives highlight several central principles of the sustainable development path. First, all future options entail uncertainties and risks. Second, the application of knowledge and information is of prime importance. But that knowledge must be of "high quality". Third, new development strategies must **anticipate and prevent** negative environmental and social outcomes. Fourth, strategies must also be **adaptive** to rapidly changing circumstances. Underpinning this is the necessity for a process to allow this to happen, and for just and equitable outcomes to be achieved. This will rely on broad ranging participatory processes.

1.6 Summary

The global environment is at present in the process of vast and unprecedented change, much of it having a negative impact on the earth's vital life support functions and on human welfare. It represents a failure of development.

At its broadest, "sustainable development" is the embodiment of an emerging new paradigm - a new world view, a new way of thinking and acting. Sustainable development is based on the interdependence of economic and social activity and environmental quality - without a healthy environment, social and economic activity is threatened. Its core philosophy is the promotion of harmony amongst human beings and between humanity and nature. The sustainable development pathway calls for a **transformation** in values, perceptions, institutions and technology. It requires a development process that does not destroy the natural resources and environmental systems on which it depends.

It is clear that sustainable development is not about sustaining all activities. The finiteness of the biosphere sets priorities. It is about sustaining the basic life support mechanisms as a priority. It is about sustaining levels of natural capital. And it is about sustaining the basic needs of all the world's peoples.

There are road signs, but there is no road map for sustainable development. Sustainable development is not an end-state that we can picture from where we currently stand. Sustainable development principles must be applied to influence future directions. But the process of sustainable development must also be adaptive to a world of uncertainty.

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10. WCED, *Our common future,* op. cit.

11. *Ibid.*

12. Ruckelshaus, W.D. 1989. Toward a sustainable world. *Scientific American 261(3):* 114-120b.

13. One of the most widely known contemporary exponents of alternative approaches based on non-western thought was E.F. Schumacher with his exposition of Buddhist Economics in *Small is beautiful* (Schumacher, E.F. 1974. *Small is beautiful.* Abacus, London. 255p.). For a useful recent summary addressing the question of what are needs, and what are extravagant wants, see: Durning, A. 1991. Asking how much is enough. *In:* Brown, L.R. *et. al. State of the world 1991, op. cit. pp.153-169.*

14. It also needs to be recognised that such teachings often had an ulterior motive - to retain the power of the religious order.

15. Korten, *Getting to the 21st century,* op. cit.

16. *Ibid.,* p.133.

17. Ruckelshaus, *Toward a sustainable world,* op. cit.

18. Wright, J. 1988. Future generations and the environment. *Studies in Resource Management No. 6.* Centre for Resource Management, Lincoln College. 100p. This publication provides an extensive review of the moral and philosophical arguments behind our current regard for the welfare of future people.

19. For the most penetrating analyses see: Robertson, J. 1989. Future wealth. Cassell, London. 178p; Daly, H.E. and Cobb, J.B. Jr. 1989. *For the common good.* Beacon Press, Boston. 482p; Henderson, H. 1988. *The politics of the solar age: alternatives to economics.* Knowledge Systems, Indianapolis. 433p. (2nd edition). A more reformist approach is given by: Pearce, D., Markandya, A. and Barbier, E.B. 1989. *Blueprint for a green economy.* Earthscan Publications, London. 192p.

20. See: Heaton, G., Repetto, R. and Sobin, R. 1991. *Transforming technology: an agenda for environmentally sustainable growth in the 21st century.* World Resources Institute, Washington. 50p; Davis, J. 1991. *Greening business: managing for sustainable development.* Basil Blackwell, Oxford. 215p.

21. WCED, *Our common future,* op. cit.

22. Ornstein, R. and Ehrlich, P. 1990. *New world new mind.* Touchstone, NY. 302p.

23. Ruckelshaus, *Toward a sustainable world,* op. cit.

CHAPTER 2

The issue of unsustainable energy development

"Present energy systems based largely on the burning of fossil fuels are the most obviously unsustainable of human activities. Present levels of use of fossil fuels are warming the planet; yet population growth and any conceivable form of "development" for the three-quarters of humankind who live in the South will require more energy". (Holmberg *et al.*, 1991)[1]

It is often more straightforward to approach the sustainable energy agenda by focusing on the unsustainable aspects of our energy supply and use. This unsustainability has two distinct (although inter-related) aspects: adverse impacts on the physical environment, and impacts on people's livelihoods and social systems.

2.1 Environmental harms

The most obviously unsustainable aspect of energy use is the level of environmental harms caused by energy production and consumption. These harms are essentially of two types. First they are caused by waste discharges exceeding the capacity of the environment to absorb them without producing adverse effects. The specific harms can be characterised as (1) release of sulphur dioxide and nitrogen oxide during the combustion of fossil fuels causing localised and regional air pollution and acidification of the environment; (2) release of CO_2 into the atmosphere through the combustion and use of fossil fuels, creating the potential for climate change (this also applies to nitrogen oxides); (3) release of methane into the atmosphere through leakage from natural gas production, distribution and storage facilities (and from coal mines), again creating the potential for climate change; (4) release into the environment of long-lived radioactive wastes; and (5) toxic discharges through energy production activities (e.g. mining activities, energy transformation activities, oil spills). The impacts span an enormous range - from minor, localised and reversible (i.e. low level waste heat emissions at power stations), through to global in scale with major and irreversible impacts (i.e. the threat of climate change through the release of greenhouse gases).

Over the last five years the threat of climate change has emerged as the dominant environmental concern. According to calculations carried out by the World Resources Institute, energy sector emissions comprise 49% of the contribution to greenhouse gas buildup from human activity. Seventy percent of this comprises CO_2 from the combustion of fossil fuels[2]. The atmospheric lifetime of CO_2 is over 100 years, and the estimated time for atmospheric CO_2 to adjust to changes in sources or sinks is 50-200 years because of the slow exchange of carbon between surface waters and deep layers of the ocean[3]. In late 1990, Working Group 1 of the Intergovernmental Panel on Climate Change (IPCC) reported **with certainty** that emissions resulting from human activities are substantially increasing the atmospheric concentrations of greenhouse gases, and that these increases will enhance the greenhouse effect, resulting on average in an additional warming of the earth's surface. It was the IPCC's **judgement** that temperatures had increased by 0.3-0.6°C over the last 100 years, and while this was consistent with the predictions of climate models it was not absolute proof of human-induced warming[4].

A second category of environmental harm is that associated with the loss of other amenity values caused by energy production activities. In many developing countries deforestation and desertification caused by the demand for fuelwood is one of the major causes of widespread and irreversible environmental degradation[5]. On a lesser scale, hydro electric dams flood river valleys and productive farmland, and may lead to ongoing riverbank erosion. Surface coal mining may lead to permanent loss of productive land. Lesser still (although not unimportant) are such things as the visual impacts of energy production e.g. power pylons or wind turbines may diminish the amenity value of particular landscapes.

2.2 Reliance on non renewable resources

Our current reliance on non renewable (fossil) energy resources carries a triple punch - not only is it these energy types that contribute most to environmental degradation, but the more accessible and desirable energy forms are being depleted, while increased use of the most abundant form of fossil energy for the future (coal) entails even greater environmental impact.

From a strict interpretation of sustainability it is obvious that reliance on non renewable resources cannot be continued indefinitely i.e. that it is unsustainable. But as was discussed in the previous chapter, the moral argument for preserving these resources for future generations is not as strong as other obligations to future generations. The unsustainability of our current heavy reliance on non renewable resources is related more to questions about the **resilience** of social, economic and political structures that have been sustained by cheap energy than it is about the imminent prospects of absolute shortages. In the short term at least, it is more a question of relative shortage and distribution, rather than absolute shortage.

Indeed, at a global level the proven reserves of fossil energy have increased between 1970 and 1990 from 35 to 43 years for oil (at current rates of consumption), and from 45 to 58 years for gas[6]. This lends some superficial credibility to the argument that we will never "run out" of these resources as the functioning of markets and new technologies will allow new reserves to be continually discovered and exploited.

However, this is not really the point. The reserves figures above are averages that disguise a growing imbalance in distribution between regions of the world. In 1980 the Persian Gulf region had 55% of proven global oil reserves; by 1989 this had risen to 65%[7]. At current extraction rates, reserves remaining in the Middle East are estimated at 110 years compared with less than 20 years worth now in Europe, North America and the Soviet Union[8]. The global distribution of natural gas reserves also shows major regional imbalances, with diminishing reserves in the US in particular.[9]

Increasing reliance on energy imports from what have in the past been politically unstable regions is more an issue of the unsustainability of political, economic and social systems that have been built on cheap oil. The danger, as Christopher Flavin from the Worldwatch Institute sees it, is that "not only is the world addicted to cheap oil, but the largest liquor store is in a very dangerous neighbourhood"[10].

2.3 Inefficient utilisation

The problems of environmental degradation and depletion of stocks of high quality energy are exacerbated by our inefficient utilisation of energy. Many energy activities are highly inefficient. The internal combustion engine, the heart of the global transport system, operates typically at about 20-35% efficiency[11]. Other losses inherent in vehicles brings overall efficiency down even lower. Thermal power stations operate at efficiencies of typically 30-35%, while further losses occur in the transmission and conversion of electricity to provide a useful service. All these efficiencies are **device** dependent. If instead we were to look at efficiency in terms of **task** then efficiencies (called second law efficiencies) become much lower still[12].

While our demand for energy today translates into a demand for particular energy sources, what we really want is energy services. Energy demand is not a demand directly for energy, but rather for the services that energy provides. People do not want electricity, oil or coal as such, but rather comfortable rooms, light, vehicular motion, hot water and other tangible things[13].

Providing energy services in general requires transforming primary energy sources into a useful form, and then converting this energy to provide functional services (i.e. to provide work, heat etc.). Much of what is environmentally unsustainable about energy use is a **mismatch between source and service**. For example, adherents of second law efficiency concepts maintain that "the use of a high quality flame ... to provide low quality, low-temperature heat is a fundamental abuse"[14].

2.4 Inequitable distribution of the costs and benefits of energy

The basic needs of a large number of the world's people are not being met, and this includes their basic needs for energy. There exists a large disparity in energy consumption between different nations of the world. The 24% of the population living in the richest countries use 77% of the energy, while the 76% living in the poorest countries use just 23% of the energy. Per capita consumption averaged just 0.4 kW for those living in "low income" countries, 1.1 kW for middle income countries and 6.7 kW for high income countries[15].

Yet even these figures fail to illustrate the true picture concerning the lack of **energy services** available to many people. In rural areas of many third world countries for instance most of the energy is supplied from fuelwood. Yet fuelwood is in increasingly short supply[16]. And despite the enormous technological advances in energy systems in the developed world (and in some parts of the developing world) the energy system most essential to most people on earth is the bonfire[17]. As a source of heat it is enormously inefficient. Thus, the per capita energy consumption figures given above grossly overstate the level of energy service available for many people living in the developing world. Intrinsically linked to the lack of energy to provide basic needs is therefore a lack of basic, efficient energy conversion devices.

There is also inequity in terms of the allocation of costs of energy use. In most countries energy prices fail to include social and environmental costs. Most of the benefits of fossil fuel use have accrued to the world's "wealthy" (most of whom live in developed countries). However, the costs of climate warming, if it occurs as anticipated, will fall on future generations, and is likely to have an impact on people in developing countries more so than in developed countries. This is not just a question of the geographic location of developing countries. Developing countries will have less resources with which to adapt to change. In addition their economies will be less resilient to climate changes because they are more closely tied to agriculture[18].

2.5 The implications of business-as-usual

Total global energy consumption is on a steadily rising pathway that has been disrupted only briefly by the two oil shocks in the early 1970s and early 1980s. A continuation of energy growth through to the turn of the century and beyond is assumed in "consensus" or business-as-usual forecasts[19]. The World Energy Conference, meeting in late 1989 for instance, concluded that by 2020 the world would be using 75% more energy, and that most of it would be supplied by coal, oil and nuclear power[20].

It is not difficult to see the reasoning for such an outcome. Population growth is expected to lift global population levels to 7.8 billion people in 2020 compared with 5.3 billion in 1990 (a 47% increase)[21]. This increase, when combined with a doubling in the energy use per capita for people living in developing countries, and maintenance of existing per capita levels in developed countries, leads to such an answer. This is just one scenario, yet many other scenarios can be constructed using "reasonable" assumptions that lead to even greater energy needs. For instance, if the notion of equity is taken to one extreme by assuming that all people in the world in 2020 enjoy a per capita energy consumption equal to that of developed nations today, then total primary energy supply would increase four-fold.

What are the implications of such energy growth for the global environment if today's level of energy use, and mix of energy sources, is unsustainable? What are the implications for security if a substantial shift in the balance of world oil reserves occurs over the next two decades as a result of energy growth continuing at present rates?

The Brundtland Commission and its Advisory Panel on energy concluded that the continuation of current growth trends will likely produce several disturbing environmental outcomes. They will:

- increase greenhouse gases and enhance the likelihood of causing climate change,
- aggravate urban-industrial air pollution,
- further acidify the environment by increasing combustion of fossil fuels,
- increase the environmental and health risks that would accompany a rapid expansion in nuclear energy[22].

The IPCC has added weight to these fears. Working Group 1 of the IPCC concluded that under a "business as usual" scenario, emissions of greenhouse gases would continue to increase, resulting in an estimated increase in global mean temperature during the next century of about 0.3°C per decade (with an uncertainty range of 0.2-0.5°C per decade). This emission rate would result in a likely increase in global mean temperature by 2025 of about 1°C above the current mean, and increasingly rapid increases beyond then[23].

Such climate changes, if they came about, would put the world into a new zone of "unknowability" -that is we will pass beyond the sphere of human experience and hence beyond what is reasonably knowable about ecosystem reaction to the rapid rate of temperature change, and the absolute temperature rise[24]. Such a state would undoubtedly greatly increase the risks of unpredictable and irreversible outcomes.

2.6 Conclusions

The energy issue is fundamental to sustainable development. At a global level our current patterns of energy supply and use are unsustainable.

Because of uncertainty, sustainability of energy is a relative, rather than an absolute, concept. Many of the issues described above, are not, on their own, a description of absolute unsustainability. What is now unsustainable is the **scale** of many of these activities. The global ecosystem has limits, and the scale of energy activities is now pressing on those limits.

This situation can only worsen if a business-as-usual pathway to the future is followed. The business as usual path seems likely to exacerbate **all** aspects of our current unsustainable energy activities. Unsustainable energy use threatens the economic and political security of nations and the global environment. The future needs a new energy agenda.

Notes and references

1. Holmberg, J., Bass, S. and Timberlake, L. 1991. *Defending the future - a guide to sustainable development.* Earthscan, London. 40p.

2. World Resources Institute, 1990. *World resources 1990-91.* Oxford University Press, New York. 383p.

3. Wratt, D.S., Mullan, A.B., Clarkson, T.S., Salinger, M.J., von Dadelszen, J. and Plume, H. 1991. Climate change - the consensus and the debate. New Zealand Meteorological Service and the Ministry for the Environment, Wellington. 48p.

4. *Ibid.*

5. With typical vision the Worldwatch Institute's first publication in their ongoing series of Worldwatch Papers addressed the energy and environmental implications of the firewood "crisis". They have continued to provide critical commentary on this issue. See: Eckholm, E.P. 1975. The other energy crisis: firewood. *Worldwatch Paper 1.* Worldwatch Institute. 22p.; Postel, S. and Heise, L. 1988; Reforesting the earth. *In:* Brown, L.R. *et al. State of the World 1988.* Worldwatch Institute, Washington. pp.83-100.

6. Cairncross, F. 1991. A survey of energy and the environment. *The Economist,* 31 August.

7. Flavin, C. and Lenssen, N. 1991. Designing a sustainable energy system. *In:* Brown, L.R. *et al. State of the World 1991.* Worldwatch Institute, Washington. pp.21-38.

8. *Ibid.*

9. Based on data given in Fulkerson, W., Judkins, R.R. and Sanghvi, M.K. 1990. Energy from fossil fuels. *Scientific American 263(3):* 83-89.

10. Flavin and Lenssen, Designing a sustainable energy system. op. cit.

11. About 20-25% efficiency for petrol engines, and 30-35% efficiency for diesel engines.

12. The common means of describing efficiency is "first law efficiency", which is based on the principles of the first law of thermodynamics i.e. the conservation of energy. It is a measure of the efficiency of conversion of the device based on the heat of combustion. Physicists in the US in the early 1970s developed the concept of "second law efficiency" (based on the second law of thermodynamics), which is defined as the "ratio of the least available work that could perform the task to the available work actually consumed in doing the job with a given device or system". It is a true measure of the room for improvement if the "ideal device" was available. See: Carnahan, W., Ford, K.W., Prosperetti, A., Rochlin, G.I., Rosenfeld, A.H., Ross, M., Rothberg, J., Seidel, G. and Socolow, R.H. 1974. Efficient use of energy Part 1: a physics perspective. Energy and Environment Division, Lawrence Berkeley Laboratory, University of California.

13. Lovins, A.B. 1977. *Soft energy paths: toward a durable peace.* Friends of the Earth, Ballinger. 231p.

14. Carnahan *et al.* Efficient use of energy, op. cit.

15. WCED, 1987. *Our common future.* Oxford University Press, Oxford. 400p. Note that data relates to the early 1980s (per capita consumption levels have risen since then), and that 1 kW means 1kW year per year (i.e. equivalent to using 1kW continually for one year).

16. Ibid.

17. Patterson, W.C. 1990. *The energy alternative.* Macdonald Optima, London. 186p.

18. Holmberg *et al.,* Defending the future, op. cit.

19. See for instance Davis, G.R. 1990. Energy for planet earth. *Scientific American 263(3):* 21-27. World Resources Institute, *World Resources 1990-91,* op. cit.

20. Flavin and Lenssen, Designing a sustainable energy system, op. cit.

21. Based on Holdren, J.P. 1991. Population and the energy problem. *Population and Environment 12(3):* 231-255.

22. WCED, *Our common future,* op. cit; World Commission on Environment and Development Panel on Energy. 1987. *Energy 2000 - a global strategy for sustainable development.* Zed Books, London. 76p.

23. Wratt *et al.* Climate change, op. cit. see also: IPCC, 1990. Scientific assessment of climate change. The policymaker's summary of the report of Working Group 1 to the Intergovernmental Panel on Climate Change. WMO/UNEP Intergovernmental Panel on Climate Change, Geneva.

24. See the discussion in Pearce, D. 1991. The global commons. *In:* Pearce, D. (Ed.). *Blueprint 2.* Earthscan, London. pp.11-30.

CHAPTER 3

The energy agenda - a low energy path

"The period ahead must be regarded as transitional from an era in which energy has been used in an unsustainable manner". (Brundtland Report, 1987)[1]

3.1 The only "realistic option"

According to the Brundtland Commission, the key elements of sustainability that have to be reconciled are:

- sufficient growth of energy supplies to meet human needs,
- energy efficiency and conservation measures, such that waste of primary resources is minimised,
- public health, recognising the problems of risks to safety inherent in energy sources,
- protection of the biosphere and prevention of more localised forms of pollution.

The Commission's investigation into a business-as-usual pathway, led them to the conclusion that such a pathway was simply not viable. It entailed too many risks, with the increased likelihood of widespread, and potentially irreversible environmental change. Greatly expanded use of nuclear power was rejected because it was considered there were not "solid solutions to the presently unsolved problems to which it gives rise"[2].

The Commission then investigated the feasibility and implications of lower energy paths. Such paths are neither new in concept, nor are they in the Commission's word "fanciful"[3]. While considered technically feasible, such paths would require "fundamental political and institutional shifts"[4]. But the Commission concluded that:

"there is no other realistic option open to the world for the 21st century...it is clear that a low energy path is the best way towards a sustainable future"[5].

This conclusion has been perhaps the most far-reaching of all the recommendations made by the Brundtland Commission. Indeed, they were under no illusions as to its implications; it would require "profound structural changes in socio-economic and institutional arrangements and is an important challenge to global society". But they were also well aware of the significance of energy in the sustainable development agenda: choose an energy strategy they said, and you choose an environmental strategy.

What are the implications of a low energy path? The Brundtland Commission pointed out that developed countries at present use about 70% of global primary energy production, with a per capita consumption some 10 times higher than in developing countries. The low energy scenario discussed in the report allows for increased energy use overall compared with present consumption, based on a 30% increase in primary energy consumption in developing countries, but a 50% fall in industrial countries[6].

These are scenarios, not predictions. But the message seems unmistakable. In order to respect environmental limits and achieve a more equitable distribution of the costs and benefits of energy use, energy systems within developed countries in particular must change substantially.

The strategy of a low energy path contains two essential priorities:

1. emphasis on efficiency (both end-use and transformation),
2. investment in, and deployment of, renewable energy technologies (the future energy base).

3.2 Efficiency - the "cutting edge" of national energy policies[7]

There seems little doubt that from a technical standpoint, major improvements in efficiency in energy use worldwide can be made. Pioneering advocate of end-use efficiency Amory Lovins was making this point 15 years ago. Since then he has been joined by many others in outlining the enormous potential for efficiency improvements[8].

The benefits from improving energy efficiency are wide-ranging. Improved efficiency allows the same energy service to be achieved from a reduced primary energy supply. This outcome offers economic benefits as well as environmental benefits[9]. Greater efficiency will also extend the life of existing fuel stocks and "buy time" for the necessary transition to renewable energy sources.

In addition it has been argued that end-use planning based on energy efficiency is the key for meeting the basic energy needs of the world's poor. "Basic needs and much more" could be met with an energy requirement of about 1 kW per capita provided up-to-date energy efficient end-use technologies were used[10]. This level of energy use is approximately the same as the average per capita energy consumption of the world's 4.1 million poor in 1990[11], but clearly the energy services provided would be far in excess of today's levels.

An emphasis on efficiency refocuses attention on the nature of energy demand. It calls for a much closer matching between end-use (the task or service), the energy conversion technology (the device), and the energy source[12]. In order to benefit from efficiency, appropriate technologies and conversion devices have to be more than just "available". They have to be deployed and used by energy consumers. But making substantial progress on energy efficiency is not only about technologies; perhaps most importantly it is about changing individual and collective behaviour, and reshaping institutional rigidities[13]. The energy efficiency challenge therefore encompasses all aspects of the needed transformation - values, institutions and technologies.

3.3 "The cinderella options" - renewable energy

> *"...renewable energy...should form the foundation of the global energy structure during the 21st century".* (Brundtland Report, 1987)[14]

At present about 17% of energy consumed worldwide is from renewables (six percent hydropower and 11% comprising fuelwood, crop wastes and dung)[15], although much of the fuelwood can no longer be thought of as a renewable resource because consumption rates have overtaken sustainable yields. The potential for renewable energy though is very much larger. Solar energy hugely in excess of current demands is available for utilisation throughout the world. Solar is the ultimate **sustainable** energy source, with the virtues of continuous supply, wide geographical distribution, and low environmental impacts.

Yet, as energy analyst Michael Grubb has observed in coining the "cinderella" tag, everyone is in favour of renewable energy but few take it seriously. The reasons for the low status include inadequate data, scepticism born of past disappointments, a failure to transfer knowledge to the policy community, and institutional and attitudinal barriers[16]. There is no doubt that some renewable technologies have given disappointing results, with early promise failing to be realised. Solar energy also suffers from being expensive to collect and store. Yet it is clear that despite very small R & D budgets in relation to other energy sources, some dramatic improvements have been made in renewable technologies in the last decade. Costs of electricity produced by wind power, photo-voltaics and solar thermal are all on a downward trajectory, and further significant improvements are confidently expected[17]. Already, some of these technologies are approaching cost competitiveness with traditional energy sources. The "solar age" may be ready to dawn somewhat earlier than many analysts were picking just four or five years ago.

> *"The speed and extent to which the large potential for renewables can be realised will depend on how rapidly the resulting dismissive attitudes change, and upon policy developments in response to this. Removing existing market obstacles, increasing R & D expenditures, and various forms of support including institutional reforms can all be clearly justified, and they could make a large impact on renewable energy developments"*[18].

3.4 The future of fossil fuels

The Brundtland Commission described the nature of fossil fuel use in the future as the "continuing dilemma". Fossil fuels are at the heart of the global energy system, yet it is the combustion of fossil fuels that is producing many of the "unallowable harms". Despite this general understanding, traditional opinion still appears to be overwhelmingly of the view that conventional oil and gas resources (and a large part of the coal reserves) would be consumed before a major shift away from fossil fuels would occur.

The climate change issue is forcing that assumption to be challenged. Recent analyses suggest that climate stabilisation requires keeping significant portions of even the world's conventional resources in the ground[19]. Environmental Editor of *The Economist* Frances Cairncross has come to a similar conclusion, noting that if global warming is to be limited then "the world simply cannot afford to burn all the fossil fuel now known to be economically recoverable - let alone the greater quantity that might become so"[20].

Already, worldwide there is a clear move away from coal towards gas, largely because of its versatility and clean-burning characteristics. Of all the fossil fuels coal undoubtedly has the largest environmental impact. More than half of the SO_2 and 30% of NO_2 released into the atmosphere comes from the combustion of coal[21]. Emissions of CO_2 per unit of heat produced by coal is some 60% higher than for natural gas, and 30% higher than for oil products, although one has to be wary of comparisons based on combustion alone[22].

Nevertheless, Michael Grubb has argued that natural gas makes up one of the three legs of a triad of responses (the other two being efficiency and renewables) that will form the pathway out of the current energy/environment impasse[23].

3.5 Summary

The strategic imperatives for a sustainable energy path are clear. A sustainable energy path will be a low energy path. This pathway requires an orientation away from simply "supplying" energy to achieving a much closer matching of end-use services with energy sources. There are three strategic imperatives. First, a large and ongoing effort is needed to improve efficiency - both at the point of supply (transformation), and end-use (conversion). Second, as a transitionary measure there should be a move towards lower carbon, and lower polluting fossil fuels. Third, there must be a sustained effort at developing and deploying renewable energy technologies.

Notes and references

1. WCED, 1987. *Our common future.* Oxford University Press, Oxford. 400p.

2. *Ibid.*

3. The Commission was (probably deliberately) vague about just what a low energy path meant; how low is "low"? Essentially it means that it has to be low in relation to the high growth continuation path, especially in the next few decades given that the future mix of energy sources will be much the same as today.

4. WCED, *Our common future,* op. cit.

5. The Brundtland Commission (and its Advisory Panel on Energy) was heavily influenced by a low energy path study carried out by the End Use Global Energy Project (EUGEP) led by Jose Goldemberg in 1985. This study adopted a "technological improvement" approach, asking what energy is needed for and how those needs can be most efficiently met. Based on the rapid deployment and uptake of efficient technology this study painted an optimistic view of the possibility of maintaining economic growth, meeting energy needs in developing countries, and maintaining energy demand at close to today's levels (thus moderating potential climate change effects). See: Goldemberg, J., Johansson, T.B., Reddy, A.K.N. and Williams, R.H. 1987. *Energy for a sustainable world.* World Resources Institute, Washington D.C. 119p.

6. Note that this particular scenario was not necessarily endorsed by the Commission, rather it illustrated the direction required.

7. WCED, *Our common future,* op. cit.

8. Lovins, A.B. 1977. *Soft energy paths: toward a durable peace.* Friends of the Earth/Ballinger. 231p; Goldemberg *et al., Energy for a sustainable world,* op. cit.; Flavin, C. and Durning, A. 1988. Raising energy efficiency. *In: Brown, L.R. et al. State of the world 1988.* Worldwatch Institute, Washington. pp.41-61; Ficket, A.P., Gellings, C.W. and Lovins, A.B. 1990. Efficient use of electricity. *Scientific American 263(3):* 28-37.

9. The environmental benefit will depend on the current environmental impact of the marginal energy supply. Improving the efficiency of electricity use in New Zealand for instance will yield disproportionately large CO_2 emission reduction benefits, because most of the electricity generation displaced at the margin is from fossil-fueled thermal stations operating at 30-35% efficiency.

10. This analysis was undertaken as part of the EUGEP study discussed above. It set out to establish a basic energy requirement in a warm climate, developing country using up-to-date energy efficient end-use technologies. These needs included all energy for household requirements, transport, as well as the energy indirectly sequestered in other goods and services consumed. The energy services provided were far in excess of current levels, approaching that of many European countries in the mid-1970s. See: Goldemberg, J., Johansson, T.B., Reddy, A.K.N. and Williams, R.H. 1985. Basic needs and much more with one kilowatt per capita. *Ambio 14(4-5):* 190-200.

11. Holdren, J.P. 1991. Population and the energy problem. *Population and Environment 12(3):* 231-255.

12. *Ibid.* and see discussion on second law concepts in Chapter 2.

13. I thank John Blundell for bringing to my attention a recent important contribution to this debate: Robinson, J.B. 1991. The proof of the pudding - making energy efficiency work. *Energy Policy (Sept):* 631-645. See also Fitzsimmons, J. 1990. Energy efficiency: ten reasons why the market will not deliver. *New Zealand Engineering (November):* 28-31.

14. WCED, *Our common future,* op. cit.

15. Holdren, *Population and the energy problem,* op. cit.

16. Grubb, M.J. 1990. The cinderella options - a study of modernised renewable energy technologies. Part 1-A technical assessment. *Energy Policy (July/August):* 525-542.

17. *Ibid.:* Weinberg, C.J. and Williams, R.H. 1990. Energy from the sun. *Scientific American 263(3):* 99-106; Flavin, C. and Lenssen, N. 1991. *Here comes the sun. World Watch 4(5):* 10-18.

18. Grubb, M.J. 1990. The cinderella options - a study of modernised renewable energy technologies. Part 2 - political and policy analysis. *Energy Policy (October):* 711-725.

19. Krause, F., Bach, W. and Koomey, J. 1990. *Energy policy in the greenhouse: from warming fate to warming limit.* Earthscan, London.

20. Cairncross, F. 1991. A survey of energy and the environment. *The Economist (31 August 1991).* 28p.

21. Fulkerson, W., Judkins, R.D. and Sanghvi, M.K. 1990. Energy from fossil fuels. *Scientific American 263(3):* 82-89.

22. Many gas fields also contain a significant proportion of CO_2 that is released upon processing or when the gas is used. Also, methane is a strong greenhouse gas, and any leakage of natural gas during production or distribution will add to atmospheric greenhouse gases. Overall, this may diminish any actual CO_2 advantage gained by the gas in combustion.

23. Grubb, The cinderella options (Part 2), op. cit.

CHAPTER 4

Some guidelines

4.1 Introduction

Times of change call for new ways of thinking and acting. The underlying issues of sustainable development and the reality of the process of globalisation are compelling people to seek new solutions to what are now widely perceived to be common problems. The implications of current and future energy supply and demand has become a key focus for these concerns. Indirectly, the issue is now being driven by concern at the prospect of global climate change. Emissions from our current energy use patterns are a major contributor.

Since early 1991 representatives from most countries in the world have been involved in negotiations towards a climate change convention, expected to be signed at UNCED (United Nations Conference on Environment and Development), to be held in Brazil during June 1992. The form and content of this convention remain somewhat problematic however. First-world concern for climate change is neither unanimous, nor is it echoed by third-world countries who perceive such a convention to be a brake on their development ambitions.

The climate change issue presents us with a classic individual versus commons problem. Action by individual countries alone will have little impact on greenhouse gas emissions and hence will do little to reduce the risk of climate change. This is especially true for small or less developed countries. Justifiably, all countries are concerned with the costs to their economies of taking unilateral action, when the benefits are both uncertain in scale and in time. Also, only a small proportion of the benefit will accrue to those bearing the cost.

Co-operative action at an international level then is widely agreed to be essential to limit and control greenhouse gases. Nevertheless, any realistic assessment of the hope for such co-operation, at least in the short term, would have to be somewhat qualified. The UNCED convention may be signed, but true international agreement is some way off.

Given this dilemma, how should countries be approaching the strategic imperatives for sustainable energy development? The following points are offered as some guidelines to approach the issues - they are not exhaustive, and need further debate and refinement.

4.2 Clarifying what needs to be sustained

We need to be clear about what it is we are trying to sustain. Sustainable energy development for instance does not mean sustaining the energy industry in its present form. Rather, it means:

- sustaining the environment, by reducing the harms from energy use to within allowable limits,
- sustaining essential and desirable energy services for all people now and in the future.

Three principles should guide decision making concerning environmental sustainability:

- waste disposal rates should not exceed the rate of (natural or managed) assimilation by the counterpart ecosystems,
- resource harvest rates should not exceed managed or natural regeneration rates (for renewable resources)[1],
- the use of high quality non-renewable stocks should be depleted at rates that allow for an orderly transition to renewables[2].

These principles recognise that development needs to occur within environmental limits. Within these limits lies the priorities of meeting people's needs by sustaining energy services. The factors that are important in sustaining these services include:

- equity in access to energy and energy conversion technologies,
- affordability of energy and energy conversion technologies,
- continuity of energy supply.

4.3 Develop a pathway approach

Sustainable development is not well served by a focus on end states. End-state thinking, which relies on images of future technologies, is not particularly helpful because it does not help define societal goals and decision criteria regarding technological change, it does not facilitate and nurture the process of consensus formation, and (not unimportantly!) it is usually inaccurate[3]. What is most important is how to get from here to there i.e. the process. In other words it is a question of pathways.

Thinking about sustainable energy development means we should be thinking in terms of pathways. Fundamental to pathway analysis is that they are organised around a consistent set of values and beliefs[4]. These values and beliefs set the framework and the boundaries - they do not prejudge outcomes (in particular, specific technologies). In other words, rejection of end-state thinking is not a rejection of vision - quite the contrary.

> *"... energy planners should not strive to solve the energy problem for all time, but, rather, they should pursue an evolutionary energy strategy consistent with the achievement of a sustainable world"*[5].

Energy planning needs to be carried out within a broad strategic framework that is underpinned by sustainability principles.

4.4 Adopt a precautionary approach to risk and uncertainty

There is both scientific uncertainty about the nature of global warming, and there is also economic uncertainty, because we cannot be sure what the impacts will be, or how people will respond[6]. The IPCC report painted a fairly black and white picture of the prospects for global warming, although acknowledging the scientific gaps. Recent scientific findings concerning the correlation of temperature with sunspot activity, and the role of sulphur dioxide in contributing to increased cloudiness may well lend support to those who have argued that the case for global warming is far from proven[7]. Yet it does little to change the underlying concerns. Human activities are changing the atmosphere in ways that as yet we are unable to anticipate. Induced warming of the globe, if it occurs, will be irreversible, and failure to take action now will mean a bigger loss in opportunities for future generations. Loading costs on to future generations is inconsistent with the requirements of sustainable development[8].

Sustainable development requires us to **anticipate and prevent** environmental damages. We should be seeking to minimise the prospects for climate change, rather than let it happen and incur the cost. This is the precautionary approach.

4.5 Developed nations to give the lead

It is widely acknowledged that developed nations must take the lead in moving the global energy system towards sustainability[9]. There is a strong moral argument for this - up until now, developed nations have been the main beneficiaries of fossil energy use and the main contributors to greenhouse gas emissions. Yet developed nations, because of their wealth and technological expertise, have the means to bring about change.

To some extent this is happening already. The "activist" countries on the issue of CO_2 emission reductions (e.g. Denmark, New Zealand, Germany, Australia, the Netherlands, Austria and Sweden) are all developed countries, while Norway has already offered to contribute one percent of GDP to a fund to support technology transfer to developing countries, if other developed countries would do the same. However, at present many of the most "developed" countries feel unable, or unwilling to act[10].

The maldistribution in available energy services between peoples of the developed and developing world is clearly going to have to be faced up to. Whether we should be aiming for "equal" per capita energy use between the developed and developing world is fairly dubious[11]. Rather there needs to be an awareness and commitment to closing the gap. Individual countries can no longer ignore the reality of the impact of their energy use on the global environment. Policies must consider whether the country's energy demand and level of emissions are **"generalisable"** to other countries of the world i.e. countries must consider whether what applies to them, should, on equity grounds, be applicable to other countries as well. It is especially important to address this question within a longer time perspective and to consider future energy demand and emissions, not just the present.

4.6 Minimise the transference of problems

It is self defeating if policies to reduce CO_2 emissions are enacted in one country, but they result in CO_2 emissions simply being transferred elsewhere. For instance, industries with high fossil fuel use may relocate offshore if too punative a carbon tax were to be imposed on them. Responses to transboundary pollution problems require a transboundary perspective.

Of course, there may be other reasons, apart from minimising CO_2 emissions, for countries to employ high fossil fuel taxes. And, if the net result is that industries do relocate offshore, there may still be a net reduction in emissions if more efficient energy conversion equipment is installed. However, the potential for transferring emissions from developed to developing countries is high, especially through the global linkages of transnational corporations. This problem needs to be recognised.

4.7 Look to pricing strategies

> *"There is general agreement that the efficiency gains achieved by some industrialised countries over the past 13 years were driven largely by higher energy prices....it is doubtful whether such steady improvements can be maintained and extended if energy prices are held below the level needed to encourage the design and adoption of more energy-efficient homes, industrial processes, and transportation vehicles".* (Brundtland Commission, 1987)[12]

Environmental degradation is often portrayed as the result of market "failure" - where the cost of environmental externalities has not been "internalised" into the economic calculus. The environmental externalities of energy use are a case in point. The calls for carbon taxes are essentially calls for the environmental costs of energy use to become internalised in the price consumers pay for fossil fuels. According to theory, once energy prices reflect true environmental and social costs of production and use[13], rational consumer choice will produce "optimum" outcomes.

Already many countries impose taxes that elevate energy prices well above free market levels, and presumably prices energy closer to true costs. But in many countries, particularly so in developing countries, energy has been (and still is) regarded as an essential social service and, accordingly, energy supplies are subsidised. Effectively, this has isolated real cost signals from both energy producers and energy consumers.

The further integration of environmental and social costs into energy pricing needs to be viewed as a key mechanism in purposefully working towards sustainable outcomes. This not only includes the level of price, but also the structure of prices (in particular for electricity). Higher energy prices of course have major equity implications. The raising of energy prices would need to occur in tandem with ensuring basic levels of income, and by providing more flexibility and cost-effectiveness in the provision of energy services (rather than the promotion and expansion of particular energy forms).

Also, as discussed in the previous chapter, intrinsically associated with the question of energy price is that of technology change. The twin sustainable development imperatives of (1) energy efficiency and (2) developing a renewable energy base rest to a large degree on technology - discarding wasteful technologies, improving existing ones, and developing new ones. The whole question of pricing for energy must also address the necessary "technological transformation"[14].

4.8 Recognise the requirement for active participation in energy

Changing the path of energy development can only be achieved by the actions of people. Raising awareness of the issues, building commitment to change, and seeking participation of people is the basic starting point from which any action will stem.

The Brundtland Commission argued that giving people an effective say over the use of resources was an essential element to achieving sustainable outcomes[15]. A decade earlier, David Orr made the case for participation in energy, putting forward four main propositions that participation:

- alters the outlook and behaviour of the participant and encourages awareness of the wider public interest,
- promotes greater equity in the distribution of costs and benefits of energy policy and thereby enhances social stability,
- is essential as a countervailing influence to offset elite biases, ensure accountability, and to prevent domination of energy policy by special interests,

- leads to greater societal resilience, defined as the capacity to withstand disturbances[16].

As Orr has noted, however, a fundamental pre-requisite is that the quality of public knowledge would have to be raised somewhat above present levels of understanding.

Another role for participation is in technology change. The participation of end users in the successful innovation and adoption of energy technology has been shown to be very important, but has so far been given little recognition[17].

4.9 Conclusions

Times of change call for new ways of thinking. The important challenge for all countries is to translate the global imperatives of sustainable development into policies and actions that support and reinforce the national interest. Perhaps the most important thing that needs to be done in this respect is to broaden the meaning of "the national interest". The reality of the accelerating global interdependence means that old concepts of "the national interest" must change and be broadened to include new concepts such as the security implications of unsustainable global development. Just as countries in the past have invested in indigenous energy sources, partly as an insurance against global energy security problems, so the energy issues of today need to encompass ideas of national and international security. New "insurance policies" are required.

Moving decisively on energy and climate issues has been popularly portrayed as imposing huge costs on the economies of countries. Yet Professor David Pearce asserts that "the economic cost burdens (of climate control) are manageable provided policy is addressed **in an imaginative way**"[18]. Seeking innovative and imaginative "win-win" solutions is a key to making progress. International climate conventions may be a useful lever to enable issues to be addressed that might otherwise have been left, but they will tend to reflect a desire for action, rather than initiate it. In the end it will come down to the will of individual governments to pursue:

> *"... sensible energy policies in individual countries, with sound pricing and determined efforts to make energy markets work as efficiently as possible. It will be through the energy-saving technological developments that such pricing policies will encourage in the industrial countries. And it may be through the development of ways to draw energy from the sun that are cheaper and easier to apply, even in the third world, than a coal-fired power station"*[19].

Governments have a clear responsibility to work towards these ends. In particular they must focus on assisting the necessary technological transformation, and facilitating institutional change. They must help create the conditions so that "the right choice is the easy choice"[20].

Notes and references

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9. United Nations Economic Commission for Europe, 1989. Energy and environment - sustainable energy use. Velen Workshop report to the 1990 Bergen Conference "Action for a common future". 88p.

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11. John Holdren has recently argued that an "optimistic" energy scenario for the world would see a convergence from the current energy use per person (7.5 kW/capita in rich countries and 1 kW/capita in poor countries) to 3 kW/capita across all countries by 2050. While this may take one perspective of "equity" to its extreme, it is neither practical nor is it necessarily "equitable" in that it does not recognise cultural or geographic variation. See: Holdren, J.P. 1991. Population and the energy problem. *Population and Environment 12(3):* 231-255.

12. WCED, 1987. *Our common future.* Oxford University Press, Oxford. 400p.

13. David Pearce *et al.* gives the "proper" pricing of natural resources as the "marginal opportunity cost" (MOC) where:

$$MOC = MC + MEC + MUC$$

where MC is the marginal cost of extracting or harvesting the resource, MEC is the marginal external cost of any damage done by the resource, and MUC the marginal user cost (essentially an opportunity cost that reflects the unavailability to future generations of resources used today). *In:* Pearce, D., Markandya, A. and Barbier, E.B. 1989. *Blueprint for a green economy.* Earthscan, London. 192p.

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16. Orr, D.W. 1979. U.S. energy policy and the political economy of participation. *The Journal of Politics 41:* 1027-1056.

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SECTION B

The New Zealand energy scene

This section provides a brief journey through the New Zealand energy scene - the evolution of energy policy over the last two decades, the characteristics of energy supply, and a description of the business-as-usual energy future that has recently been outlined by the energy industry.

CHAPTER 5

The policy: three identifiable phases

Contemporary energy policy in New Zealand has evolved through three phases in the last two decades. These phases can be described thus:

Phase 1	up to mid-1970s	Government control and responsibility, ad-hoc planning
Phase 2	mid-1970s to mid-1980s	Government control with deliberate "planning" approach
Phase 3	mid-1980s onwards	Diminished Government responsibility and a progressive move to market-based strategies

5.1 Phase 1

Until the early-1970s, the widely perceived "problem" (if indeed a problem was widely perceived) with energy was how to ensure continued, increasing energy supply in order to accommodate demands that were increasing at four to five percent per annum.

In New Zealand, we dammed our abundant rivers to produce electricity, dug coal from our extensive coal mines, and drilled hundreds of holes in the ground in a (largely fruitless) search to find oil - but we found gas instead. Our inability to find oil was an inconvenience, but we were still able to increase our meat, wool and butter production to pay for increasing quantities of oil imported from the Middle East and elsewhere. Apart from the odd hiccup, it seemed to be a comfortable, non-threatening existence.

For successive governments, increasing energy capability and supply was regarded as an essential part of the development of New Zealand and accordingly regarded as a "public good". Central government assumed a large responsibility for the development and control of the energy business. The Crown of course was the owner of New Zealand's energy resources, but Crown involvement extended into a dominating role in the commercial exploitation of these resources, and in the development of the energy supply infrastructure. The energy business was also heavily regulated by government, with energy prices being government determined.

State involvement was organised around a few departments that had specific responsibility for developing the supply of specific energy forms. The New Zealand Electricity Department supplied electricity and the State Coal Department supplied coal. Government became a partner in the development of the Maui gas field, and the State-owned Petrocorp was formed as a monopoly distributer of natural gas.

Four events, all related to the demands for increased energy supply, can be identified as bringing Phase 1 to a close, and ending the widespread perception that the energy issue was simply one of supply. These were:

- the decision to raise the level of Lake Manapouri to provide electricity generation capacity, most of which was to be fed to a proposed aluminium smelter at Tiwai Point. The decision raised a storm of public protest, and provided the first major conflict between energy supply and the environment,

- the discovery of, and agreement to develop, the Maui gas field. The terms of the agreement committed the Government to purchase gas under a "take or pay" agreement for 30 years up to 2008,
- the first "oil shock" in 1973 when OPEC raised the price of oil almost overnight, highlighting the dependency of the New Zealand economy on imported oil,
- the Electricity Plan of 1975, which included for the first time the intention to commission in 1988 two 600 MW nuclear power plants in order to meet the expected exponential increase in electricity demand. The subsequent public debate through the Burns Fact Finding Group, and the Royal Commission on Nuclear Power substantially altered the energy planning processes of the time, and exposed the fallacious basis on which electricity forecasting decisions were being made.

These events propelled debate on energy and energy futures into the public arena. Already in official circles there was some explicit recognition that the complexity of energy issues would require new types of response, and the fledgling Ministry of Energy Resources was formed in 1972. The end of Phase 1 laid the foundation for a new era in energy policy making and formulation based on central planning.

5.2 Phase 2

By 1978, the growing awareness of energy issues had seen Government responding to the need to clarify New Zealand's energy future. *Goals and guidelines - an energy strategy for New Zealand*[1] was issued by the Minister of Energy as a public discussion document that sought to clarify goals for the energy sector, within a consistent framework of principles.

The goals were to meet energy needs, promote efficient use, reduce imported oil and balance environmental with economic benefits. Eleven guidelines were proposed to apply to all energy decision making. These were:

- promote international co-operation in energy,
- promote public understanding of the issues,
- ensure efficient organisation of the energy sector,
- establish a broad social and economic context for energy,
- take a long-term view in evaluating energy projects,
- ensure effective environmental impact procedures,
- ensure high quality information is available,
- ensure energy R&D is carried out,
- develop pricing structures that promote energy conservation,
- replace oil and electricity with indigenous energy (gas and coal),
- reduce the country's dependence on oil.

While *Goals and guidelines* touched a broad base of concern it nevertheless was criticised from both ends of the energy spectrum, especially for its generalised and at times contradictory positions. Nevertheless the public discussion process generated by the report was widely appreciated and provided a welcome catalyst for public debate on energy futures[2].

By late 1979, with a new Minister of Energy and a changed oil supply situation brought on by the second oil shock, the time for public debate was largely considered over - it was a time for action. The Minister declared firmly that "five goals have been adopted for New Zealand's energy strategy"[3]. These goals are listed in Box 5.1:

Box 5.1 New Zealand's energy strategy goals 1979[4]

1. reduce New Zealand's dependence on imported oil,

2. increase diversity in New Zealand's energy supply system,

3. ensure that energy is used efficiently through the reduction of waste and by using appropriate energy types,

4. transfer energy supplies from non-renewables to renewable sources in the long term,

5. establish a framework for energy planning which provides for changing social and economic circumstances.

These goals provided the springboard for a series of major energy decisions and investments. But in fact it was only the first goal that dominated the energy agenda. Expansion of the Marsden Point refinery, including the installation of a hydrocracker, was approved and the decision was made to construct a plant to produce synthetic petrol using Maui gas as the feedstock - the first such plant in the world. Expanded use of Maui gas became the means to achieve the drive for increased self-sufficiency. Government accepted a major part of the investment and risk associated with these developments. This phase also saw the introduction by the Government of the National Development Act - an act designed to "fast-track" the consents procedures necessary for these developments to occur.

Government involvement in energy became centralised around a much enlarged Ministry of Energy, encompassing operating divisions (electricity, coal, gas) and a planning division (policy and regulation).

During Phase 2 energy research and development reached its peak. Again this was mainly government sponsored, through the New Zealand Energy Research and Development Committee (NZERDC), which was set up in 1974, and the Liquid Fuels Trust Board (LFTB), which was established in 1978 and funded by a small levy on petrol sales.

5.3 Phase 3

The election of the Labour Government in 1984 heralded the third phase of energy policy. This phase has been characterised by a fundamental change in philosophy about the role of government in the economy and its involvement in commercial enterprises.

For the energy sector and energy policy it has meant:

- a separation of the State's commercial and policy arms of energy,
- a scaling down of State responsibilities for energy planning, information disclosure, participatory mechanisms, R & D, and investigatory work,
- the formation of commercially-driven State Owned Enterprises for electricity and coal (Electricorp and Coalcorp), and the privatisation of most other government-held energy production assets (such as Petrocorp),
- progressive moves to deregulate the energy industry,

- disbandment of the Ministry of Energy, with the incorporation of regulatory functions and energy management advice under the Ministry of Commerce,
- sale of the Crown's entitlements to the remaining reserves of Maui gas in 1990 (57.2% was allocated to Fletcher Challenge, and 42.8% to Electricorp).

One of the factors that drove these changes was the turnaround in world oil prices in the mid-1980s. The rapid decline in prices turned what was supposed to have been risk-averse energy investments by the Government into enormous financial liabilities. This reinforced in many people's minds the unsuitability of Government involving itself in the risky business of commercial energy production and energy planning.

But reform of the energy sector has also been based on the assertion that there is "nothing special about energy".[5] Treasury officials, in advocating the disbandment of the Ministry of Energy and Energy Management Group of the Ministry in 1988, advised the Minister of Finance that:

> *"We consider that although energy is both essential and strategically important it is not unique in these attributes. For example, water, steel and plastic are all essential commodities and like energy utilised both as inputs and in their own right. Similarly butter access to the EEC and other trade issues are of great strategic importance"*[6].

The general thrust of this policy has continued through to the present day. Government policy remains focused on achieving "efficiency" and cost reductions in the energy sector. Much of the current debate concerns issues associated with structure, regulation, and privatisation of the electricity industry, based on the recommendations of the Electricity Task Force in 1989[7].

5.4 Summary

Some features stand out in this brief journey through the energy policy environment of the last two decades. Successive governments have traditionally played a central role in the energy sector. Increased energy supply has been equated with increased social good, and governments took responsibility for the provision of this social good. This reached a peak during the middle of Phase 2, with Government dictating almost every aspect of energy supply decisions. Since then there has been an enormous reversal in thinking about the role of government in all matters related to energy. During Phase 3, energy lost its "social good" aspect, and began to be treated as just another commercial product. Associated with this has been the loss of some public aspects of the energy infrastructure - research and development, information, and participatory mechanisms.

Nevertheless, Government still plays a pivotal role in the sector, and many decisions related to ownership and regulation still await Government decisions.

Throughout all phases of energy policy, the main emphasis has continued to be dominated by questions of supply.

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CHAPTER 6

The results: energy supply and demand

6.1 Trends in supply and demand

Demand for energy in New Zealand has continued more or less on a steady growth trajectory through to the present day. Although there was a levelling out (and slight decline) in energy use during the late 1970s and early 1980s, there has been a rapid increase again since then. Total primary energy supply (TPES) has grown at an average of 0.35 million tonnes of oil equivalents (Mtoe)[1] per annum from 1960 to 1989 (representing an average growth of 5.5% per annum through to 1974, and three percent from 1975 through to 1989) (Figure 6.1).

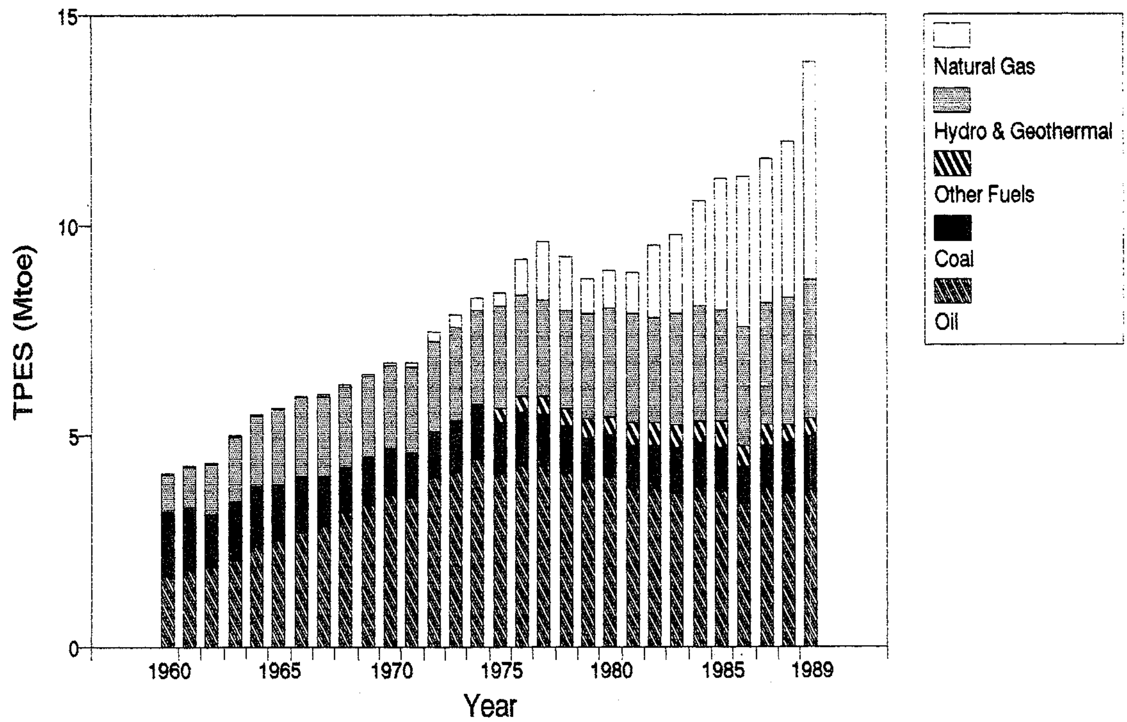

Figure 6.1 New Zealand primary energy requirement by energy form, 1960-89 (Mtoe)[2].

The rise in TPES over the last two decades has reflected increases in both transformation losses and total final energy consumption TFEC[3] (Figure 6.2). Losses have more than doubled over the last two decades due to increased thermal generation of electricity (both fossil fuel and geothermal), and the production of synthetic petrol. For electricity, these losses accounted for 51% of the energy value of primary inputs in 1988, mostly due to losses at thermal power stations. For liquid fuels, losses accounted for 34% of the energy value of the primary energy inputs due to losses at the Marsden Point oil refinery (transforming crude oil into fuels) and the Motonui synthetic petrol plant (transforming natural gas to methanol and then petrol). Providing coal and gas in final consumer form entails low losses of typically one to five percent (Figure 6.3). In 1989, losses accounted for 25% of TPES.

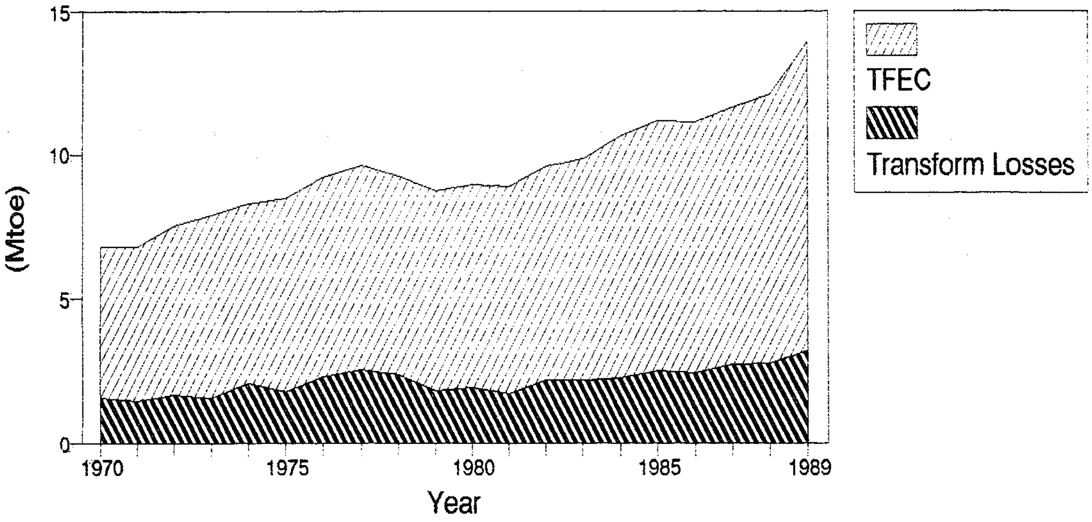

Figure 6.2 **Breakdown of TPES into energy transformation losses and TFEC 1970-89 (1989 data provisional)**[4].

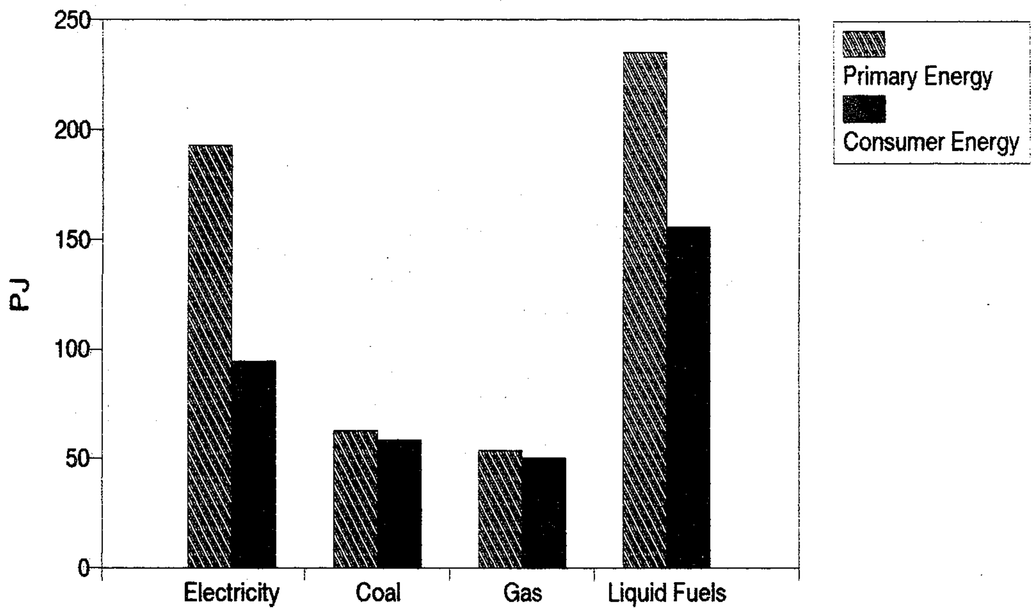

Figure 6.3 **Primary energy supply compared with final energy consumption for the four major energy forms (1988 calender year)**[5].

What has been driving the steady increase in final energy consumption? Figure 6.4 shows the trends for the last two decades broken down into various sectoral categories. The main sectors of growth have been industry (150% increase in demand), and transport (75% increase in demand). These two sectors alone now account for 75% of TFEC.

Demand growth has been driven by an increasing population (42% increase in population in the three decades since 1960), and increased per capita energy demand. Indeed, per capita final energy consumption has shown a consistent, rising trend over the last three decades, and has doubled since 1960 (Figure 6.5). These trends reflect a general shift towards a higher energy intensiveness of our industrial base and our transport system.

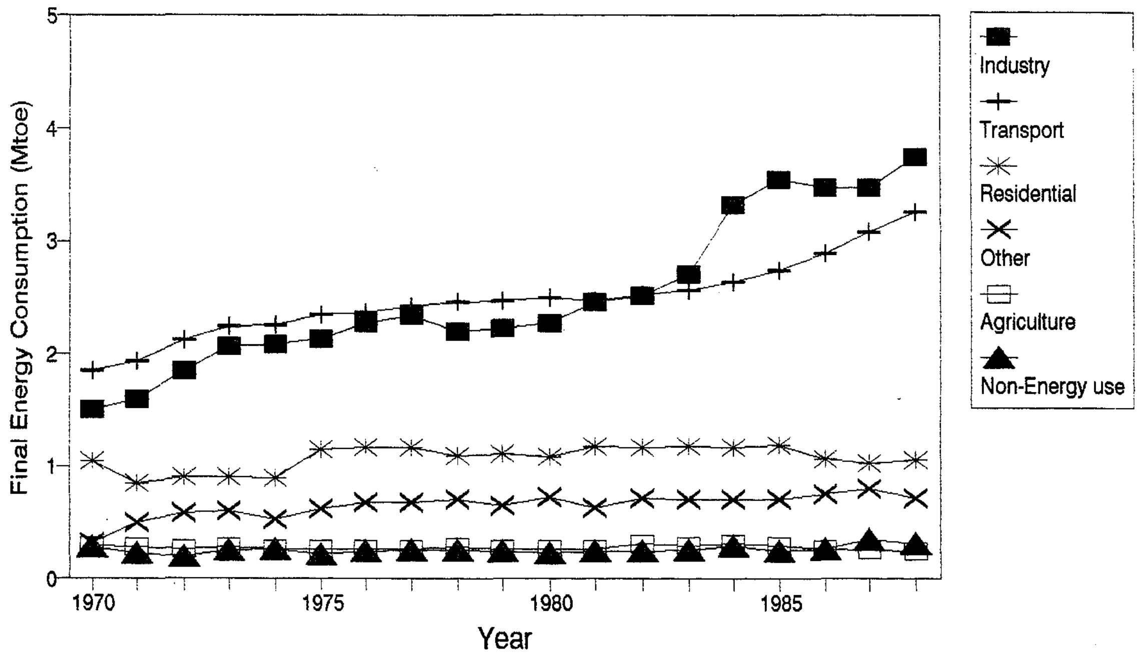

Figure 6.4 **Allocation of TFEC to sectors 1970-89[6].**

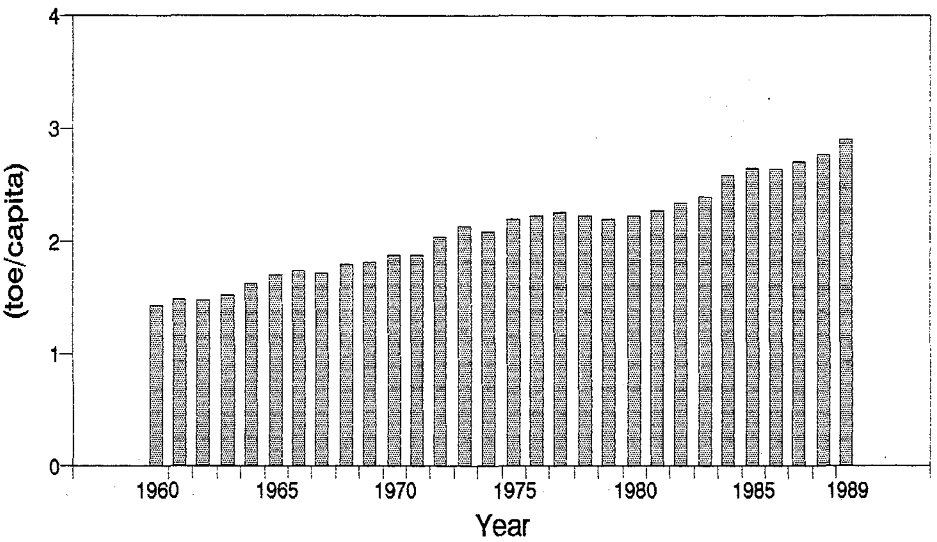

Figure 6.5 **Final energy consumption per capita 1960-89[7].**

Over this period there has been a change in the mix of energy sources. The relative importance of coal has declined consistently, while natural gas has increased market share considerably since first becoming available in the late 1960s. The availability of natural gas (and indigenous oil) has also brought about a decline in the relative importance of imported oil. In 1974, 58% of primary energy was supplied by imported oil, while by the late 1980s this contribution had declined to about 20% (indicating that New Zealand had achieved some 80% self sufficiency in energy). Nevertheless, the proportion of energy supplied by fossil fuels (oil, coal and natural gas) has remained consistent at about 80-85% throughout the last three decades.

6.2 Greenhouse gas impact

Recent calculations indicate energy production and use contribute approximately 36% of New Zealand's greenhouse gas impact[8]. Ninety percent of this is from carbon dioxide and 10% from methane and nitrous oxides. This contribution from energy to total greenhouse emissions is a somewhat lower proportion than most other developed countries, largely because New Zealand's livestock systems are believed to be major contributers to greenhouse gas emissions through methane and nitrous oxides.

Figure 6.6 shows the energy-related CO_2 emissions by energy source. The CO_2 emissions are a function of the primary supply of fossil fuels, and so reflect end-use consumption characteristics and transformation losses. Emissions have been increasing at an average of three percent per annum since 1960. From 1980 to 1988, CO_2 emissions increased by over 50% i.e. an average increase of over five percent per annum.

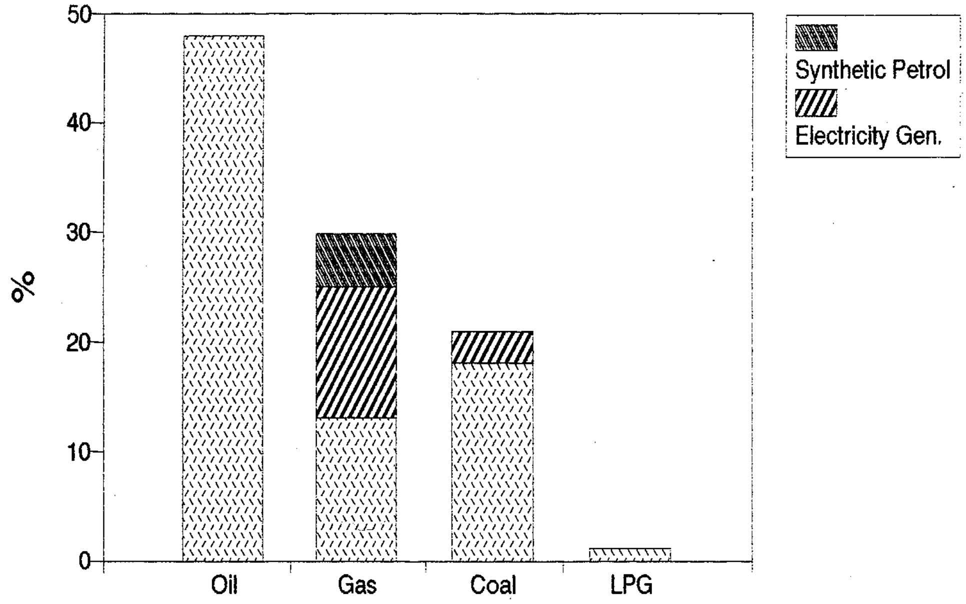

Figure 6.6 **Distribution of energy-related carbon dioxide emissions by energy source (showing also the proportion of CO_2 emissions from synthetic petrol and electricity generation)[9].**

6.3 Summary

Over the last three decades a number of dominant trends in energy supply, demand and CO_2 impact have emerged. These are:

- energy demand increasing at a steady rate due mainly to increased industrial demand and transport,
- energy demand increasing as a result of both increasing population size and increasing per capita consumption,
- a steady increase in energy transformation losses,
- a steady rising trend in CO_2 emissions,
- a continued heavy reliance on fossil fuels.

Are these trends our destiny? How will these trends translate into future energy demands and impacts? The implications of following a "business-as-usual" trend to the future are discussed in the following chapter.

Notes and references

1. The International Energy Agency (IEA) uses these units as a standard in order to derive some equivalence in the treatment of energy sources between countries. Note however that the IEA has recently modified its energy balance methodology to represent more accurately a physical energy supply and to align the treatment of hydro and geothermal electricity with conventions used elsewhere. Hydro-electricity is now converted to oil equivalents based on the energy content of the electricity generated (i.e. 100% efficiency assumed), while electricity generated from geothermal plant is now converted to oil equivalents based on an assumed 10% transformation efficiency. For New Zealand this has had the effect of substantially reducing the "losses" component of TPES, since hydro electricity was formerly given the equivalence of fossil-fuelled thermal generation plant and ranked at only 33% efficiency. Source: IEA, 1991. *Quarterly oil statistics and energy balances - first quarter 1991.* IEA, Paris.

2. Source: Bertram, G. 1990. Energy intensity in New Zealand: a working paper. Victoria University, Wellington. 37p; modified to account for revised energy transformation losses discussed above in Endnote 1.

3. TPES can be considered as the gross energy supply and TFEC the net energy consumption: the difference between the two measures is accounted for by transformation losses, which are the losses incurred in transforming primary energy into a final consumer form (e.g. gas to electricity).

4. Derived from: Bertram, Energy intensity, op. cit.; Electricity Corporation of New Zealand, 1991. Annual Report 31 March 1991. Wellington.

5. Derived from Dang, H.D.T. and Ling, A.K.C. 1989. Energy data file June 1989. Ministry of Energy, Wellington. 77p.

6. Source: Bertram, Energy intensity, op. cit.

7. Source: *Ibid.,* and population data from Department of Statistics information.

8. From data given in Turbott, C., Pool, F. and Vickers, G. 1991. *Energy management and the greenhouse effect.* Ministry of Commerce, Wellington. 69p.

9. *Ibid.*

CHAPTER 7

The future: business as usual?

7.1 Introduction

New Zealand's energy future used to be forecast by the Ministry of Energy and published in the annual Energy Plan[1]. These documents reported on forecasting exercises of energy demand and supply for periods up to 20 years. Energy Plans were abandoned during the early part of Phase 3, and since then industry-wide forecasts of future demand and supply have been irregular. *Energy 88* was the last effort carried out by the Ministry of Energy before it was disbanded, and represented an heroic effort on the part of the author in the face of declining Government interest[2]. As the Minister of Energy clearly indicated in the Foreward to *Energy 88,* its purpose was simply as an information source to guide the players in the energy market[3].

Energy 88 represented the last word on energy planning and forecasting from Government until August 1991. The Ministry of Commerce (with the New Zealand Institute of Economic Research) then published an energy forecast based on econometric modelling through to the year 2000, based essentially on "business-as-usual" assumptions[4].

In September 1991, The Energy Foundation (comprising the major players in the energy supply industry) published its first forecast of supply and demand from 1991 through to 2010[5]. This forecast was based on a Delphi survey of representatives of the established energy industry, again assuming a "business-as-usual" environment.

For this study, a business-as-usual pathway was developed through to the year 2020. It was carried out prior to the release of the Energy Foundation study, and so contains some different assumptions concerning sources of energy supply. Nevertheless, the energy demand outcomes of the two forecasts are very similar.

7.2 The business-as-usual path

The business-as-usual pathway follows current energy supply trends, using projections of demand through to the year 2000 published by the IEA[6] (growing at an average of two percent per annum), with an assumption of slower rates of energy growth through to 2020 (averaging 1.1% per annum) (Figure 7.1).

Maui gas production peaks between 1995 and 2000, and then declines, with production from known new reserves of gas providing continued, but diminishing, supply from then on. Declining indigenous oil supplies from the mid 1990s, coupled with a steadily increasing demand for oil products of about 1.5% per annum will require steadily increasing oil imports.

The business-as-usual pathway is based on a large increase in the use of coal (and lignite) in the post-Maui era. Coal again becomes a major energy source in the economy, being utilised particularly for a range of energy transformation processes - conversions through to methanol or petrol, and electricity. Coal production would increase fourfold by 2020.

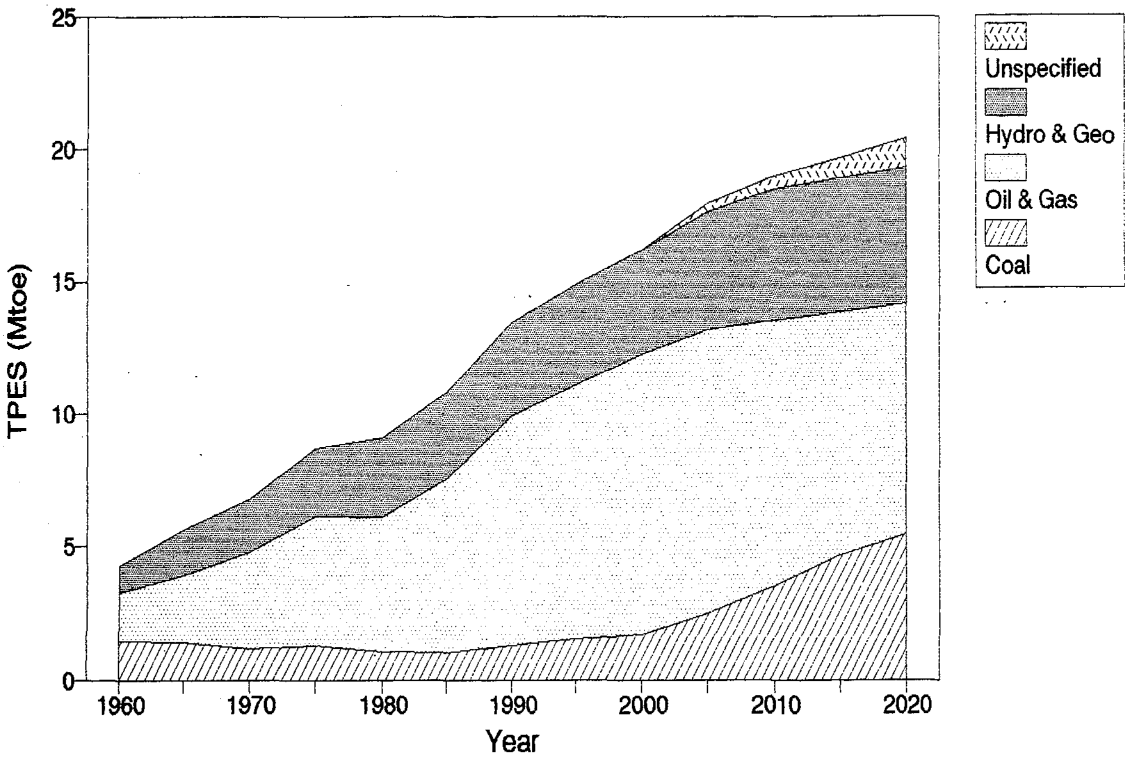

Figure 7.1 Business-as-usual pathway of total primary energy supply (TPES).

Meanwhile, hydro and geothermal electricity production would increase by about 45%. This would necessitate investment in several major hydro-electric projects such as the Lower and Upper Clutha schemes, and the Lower Waitaki scheme, as well as local schemes on smaller rivers and catchments.

Even with these developments, further energy sources will be required from about 2005 onwards to fill a small, but growing, energy "gap". This may mean more oil and gas (e.g. LNG could be imported), renewables (solar, biomass) or nuclear power.

The other features of this pathway are:

- TPES would increase by 53% over the next three decades, with the increase in TFEC (48%) being slightly lower because of higher transformation losses in the energy system,
- population growth is assumed to increase by 17% through to 2020, based on a series of "medium" population projections[7]. Therefore, per capita final energy consumption would increase by just 26% over the period. Most of this growth would be in the first 20 years (following the current trajectory of increasing per capita consumption), with per capita consumption levelling out from about 2010 onwards,
- much of the increase would reflect the continued growth in energy-intensive forestry industries (but no major expansion of the metals industry), as well as other increased economic activity such as tourism that entails high demands for transport fuel. Indeed, it is anticipated that the business-as-usual pathway would entail a modest level of efficiency measures being adopted.

However, the environmental implications of the business-as-usual path would be considerable. The greatly increased coal production implies large land and water impacts due to mining activities. Meanwhile, CO_2 emissions would increase markedly. Instead of heading towards the government target of a 20% decrease in CO_2 emissions by the year 2000, emissions would increase by about 25%. By the year 2020, they would be 58% above 1990 levels.

7.3 Discussion

The business-as-usual pathway is consistent with many of the predictions being made by players in the energy industry, in particular it is consistent with predictions made for the post-Maui era. Indeed it is somewhat more conservative than many. For instance, Barry Leay from the Electricity Supply Association of New Zealand is reported as suggesting that electricity demand will increase from the present 30,000 kWh to 51,000 kWh by 2006 (68% increase), and that coal-fired power stations would provide a substantial base for that[8]. Similar sentiments have been expressed by the coal industry. Industry personnel have recently outlined a coal-based future for the post-Maui era that will provide replacement feedstock for thermal power stations and for the Motonui synfuels plant[9]. On the question of future transport fuels, much investigatory work was undertaken in the early 1980s by the Liquid Fuels Trust Board (LFTB) into the use of lignite as the raw energy source to provide indigenous transport fuels[10]. As has recently been pointed out, lignite is still very much sitting waiting "on the back burner"[11]. So while the pathway cannot account for the almost certain occurrence of the unexpected, it seems a reasonable interpretation of one particular perspective of the future.

Clearly there is much speculation involved here because there is considerable uncertainty about sources of supply in the post-Maui era. But despite some different assumptions about sources of supply[12], the business-as-usual pathway is consistent in direction with the Energy Foundation's forecast of energy demand, and matches the prediction of CO_2 emissions very closely. For instance, the Energy Foundation forecasts a 23% increase in CO_2 levels by 2000, and an approximately 40% increase by 2010 - almost exactly the same as this study.

7.4 Conclusions

The business-as-usual pathway outlined here is consistent in direction with other recent "business-as-usual" forecasts of future energy demand. Yet, given the principles of sustainable development outlined in Section A, this pathway seems to be taking us in very much the wrong direction. Energy demand continues to increase, and the reliance on fossil fuels continues at much the same level as today.

There is much uncertainty about the supply of fossil fuels in the post-Maui era. But in the absence of finding a substantial oil field in the next decade, the options are to greatly increase imports of oil, or to embark upon another indigenous liquid fuels programme, possibly based on lignite as feedstock.

Either way, CO_2 emissions continue to increase and become increasingly out of control. A large penalty is paid for the high transformation losses incurred in converting less preferable types of fossil fuels into electricity and liquid fuels. In the words used in Chapter 4, such a policy becomes increasingly "non-generalisable". In short, the business-as-usual pathway becomes increasingly **unsustainable**. We need a different pathway.

Notes and references

1. The first Energy Plan was published in 1980. See: Ministry of Energy. 1980. *1980 Energy Plan.* Government Printer, Wellington. 75p.

2. Wyatt, N.S. (Ed.) 1988. *Energy 88.* Ministry of Energy, Wellington. 48p.

3. *Ibid.*

4. Ellis, J., Howard, A., Mayes, K., Otang, B., Tan, L., Clough, P., Culy, J. and Gale, S. 1991. Energy demand forecasts - some initial results. Ministry of Commerce and the New Zealand Institute of Economic Research, Wellington. 77p.

5. The Energy Foundation, 1991. *New Zealand energy supply and demand forecast.* Wellington. 16p. Note that the Energy Foundation was formed in large part to fill the gap caused by the demise of the energy planning and information function of Government.

6. IEA, 1990. *Review of IEA country energy policies.* International Energy Agency, Paris.

7. This is based on the Department of Statistics' population projection known as "Series 8", which assumes "medium" fertility, "medium" mortality rate, and a long term net annual migration of zero.

8. Reported in: Environment and Conservation Organisations. 1991. *Eco newsletter (June 1991):* 8-9.

9. Whitney, R. 1991. Thermal power for the future. *Coal Research Newsletter (No.2, 1991).* p.3. See also: Third, J. 1991. Coal in the gas hole. *Terra Nova 10:* 44-45.

10. Liquid Fuels Trust Board, 1981. Annual Report to Parliament, 1980-81. Wellington.

11. Wright, J. and Baines, J. 1990. Transport fuels in New Zealand after Maui - lignite on the back burner. *Information Paper No. 19.* Centre for Resource Management, Lincoln University and University of Canterbury. 28p.

12. The Energy Foundation study presented several alternative generation options to fill the future electricity "gap". Using coal in thermal stations was presented as the most likely option. They also assumed that there would be no new indigenous synthetic fuel production facility taking over from Motonui, and that imported oil would make up the shortfall. This is arguable. It is highly probable that a strong case would be made on political and security grounds to continue with a reasonable level of indigenous transport fuel production. Regardless of these assumptions though, the CO_2 implications are very similar.

SECTION C

Moving to a sustainable energy pathway

This section brings the strategic imperatives of sustainable development to bear on New Zealand's energy future. It is an exploration of the options, road blocks, and opportunities for developing our energy system along an alternative route to business-as-usual - to develop it along a sustainable energy pathway.

CHAPTER 8

Envisioning a different direction ... sustainability

8.1 Introduction

An alternative "sustainable energy"[1] path is outlined in this chapter. The purpose of this exercise is illustrative, not predictive. It is to illustrate options and possibilities for energy supply, assuming that a process of transformation evolves in the way energy is supplied and used. It is also to illustrate the contrasting outcomes between the business-as-usual and sustainability pathways.

An important basic premise of this comparison is that the level of **energy end-use services** provided by each pathway is comparable. In other words the sustainable energy pathway does not limit economic opportunities by placing restrictions on energy supply, although this does not mean that the structure of the economy would be the same for each path. Rather, the potential for carrying out the same level of activities from the energy system would be similar.

8.2 Sustainable energy path

The sustainable energy path presented here represents one view of the way in which a low energy path could develop. The pathway is underpinned by two fundamental principles - a commitment to progressively improve energy efficiency (both in the supply and consumption of energy), and a commitment to invest in, and deploy, renewable energy sources. Under this pathway TPES would peak at around the year 2000, and gradually decline after that (Figure 8.1). By 2020, TPES would be only two-thirds of the level required by business-as-usual.

Fossil fuel use would peak around 1995 and decline rapidly from 2010 onwards. On-going efforts to improve end-use efficiency would extend the life of existing gas reserves and provide a longer "bridging" period for the uptake of renewables.

Hydro electricity production would increase only modestly, while geothermal production would increase depending on field capabilities. It is anticipated that coal would continue to play an important although declining role as a source of relatively cheap energy for bulk heating.

The pathway requires energy suppliers to begin orientating themselves towards new-technology solar-based energy sources during the 1990s. Investment in R&D, but more particularly investment in gaining operational experience with the technologies, would start to pay dividends from about 2005 onwards, with solar energy taking over from declining supplies of oil and gas.

The other features of this pathway are that:

- there would be a phased, but substantial, reduction in energy transformation and distribution losses, due to the gradual phase out of fossil fuel thermal electricity generation, the synfuels plant, and an emphasis on improving distribution efficiency,
- primary energy supply per capita would decline by 23% over the period but, because of improved transformation efficiency, per capita final energy consumption would actually rise slightly over the next few years as the economy expanded, dropping away gradually as end-use efficiency measures become more widely adopted and as future economic growth becomes less energy intensive,

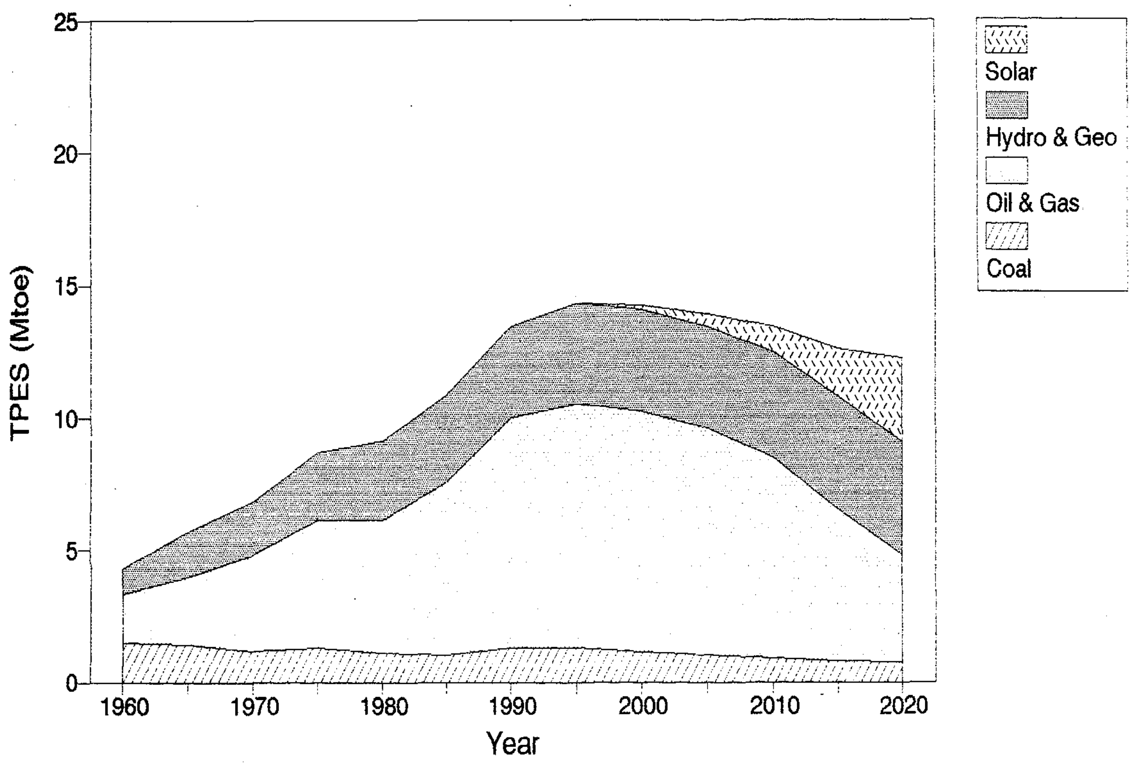

Figure 8.1 **"Sustainable energy" pathway of TPES (based on actual demand up to 1990 and author's calculations through to 2020).**

- end-use efficiency would need to improve at an average of approximately **one percent per year** compared to the business-as-usual pathway. This would seem to be an achievable target given the potential for efficiency improvements that have been claimed by some recent studies[2],
- the breakdown of end-use demands are somewhat speculative, but comparisons of the two pathways are shown in Figures 8.2 and 8.3. Transport demands continue to increase in the sustainable energy path through until near the end of this decade before levelling off. It is assumed that it will be particularly difficult to stabilise energy use in the transport sector in the short term, as there appears to be significant momentum behind increasing transport demands in the short term. Nevertheless, there would be a concerted effort to utilise fuels such as CNG.

8.3 Impact of sustainable energy pathway on carbon dioxide reduction targets

And what of the CO_2 implications? Emissions of CO_2 in the year 2000 would be on a par with existing levels, but would have stabilised and started on a declining trend. By 2005, there would be a five percent reduction (14% per capita), by 2010 a 16% reduction, and by 2020 a 51% reduction (Figure 8.4). The key to the rapid decline in CO_2 emissions after 2010 is the availability and uptake of appropriate, renewable technologies.

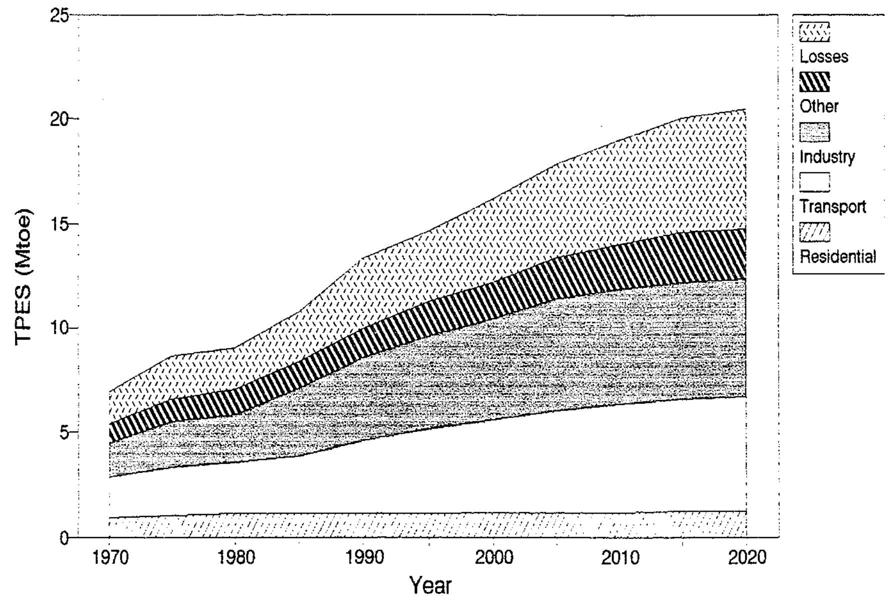

Figure 8.2 **End-use breakdown of TPES for business-as-usual path.**

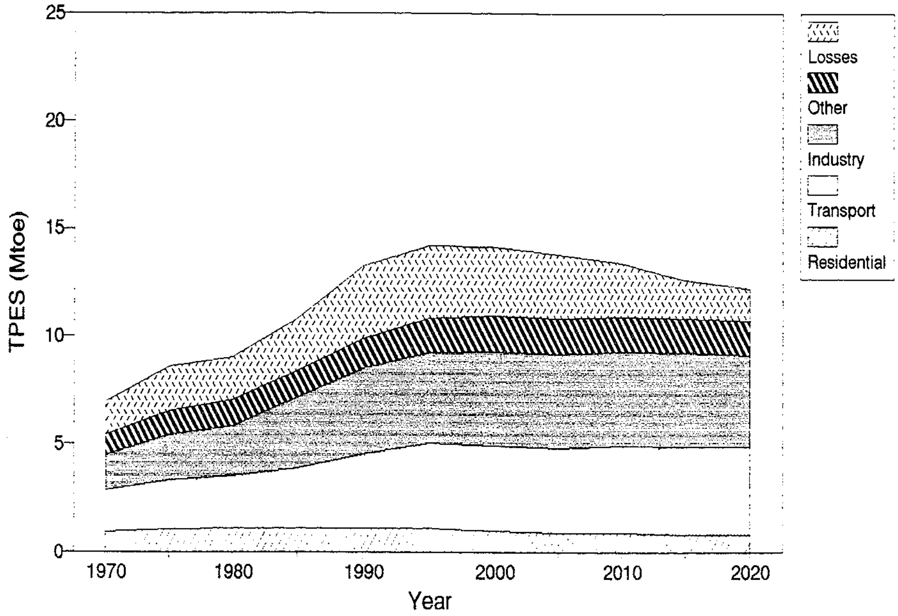

Figure 8.3 **End-use breakdown of TPES for sustainable energy path.**

Thus, under the assumptions used in this pathway, the country would not achieve the Government's target of a 20% CO_2 cut by 2000. While it could be argued that the assumptions used here have been somewhat conservative, the pathway contains an essential message. Perhaps it is less important to achieve this specific target than it is to be well on the pathway to achieving significant and permanent cuts in CO_2 emissions early next century. As Figure 8.4 shows, the real gains from this particular pathway occur after the year 2000. By 2020, both total CO_2 emissions and emissions per capita would be less than one-half of current CO_2 levels, and less than one-third of those for the continuation path.

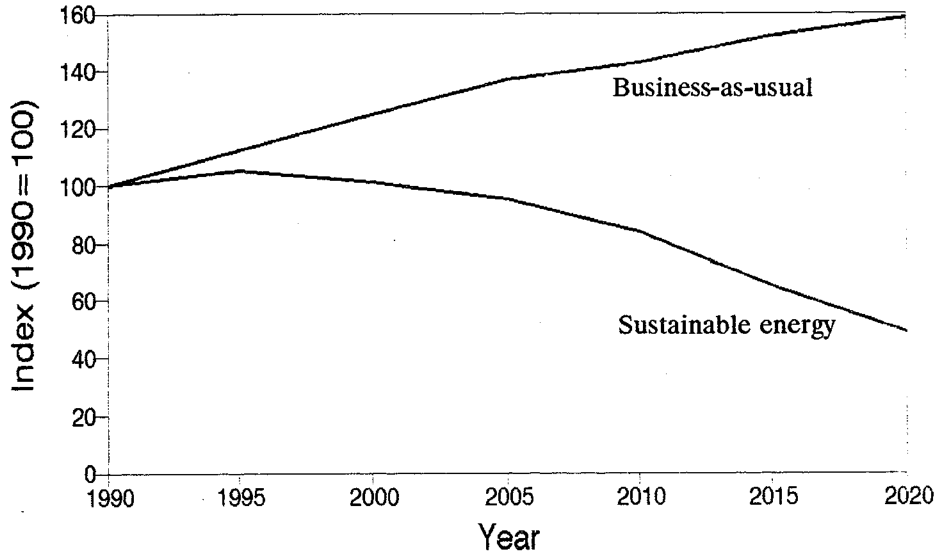

Figure 8.4 **Index of total CO_2 emissions from the continuation and the sustainable energy pathways.**

8.4 Conclusions

A pathway based on applying the principles of sustainability produces a similar level of energy services to business-as-usual, but is vastly different in terms of the level and sources of energy supply, and the environmental impact. The sustainable energy pathway developed here provides a different route to a different future. The pathway reduces dependence on fossil fuels, brings CO_2 emissions under control, and provides for significant and accelerating reductions from 2005 onwards.

Nevertheless, it is important not to get caught up in end-state thinking. This is just one particular interpretation of "sustainability" within which to frame present actions. We must concentrate on the process. We need to address many questions about feasibility, and means. A key aspect is the presumption that new-technology solar-based energy sources could provide a rapidly increasing proportion of New Zealand's primary energy supply early next century. Is such an assumption fanciful? The prospects are discussed further in the following chapter and in Chapter 12.

Notes and references

1. There is some difficulty in giving any pathway a "sustainability" label. What is sustainable? No doubt some people will find some of the assumptions built into this pathway to be "unsustainable", especially because end-uses have not been scrutinised with respect to sources of supply, and end-use demands are forecast to increase. This is a valid criticism. More work is needed. However, it is important to note that the pathway is indicative only and, because of the terms of reference of the study, is "supply" oriented.

2. The Energy Management Group from the Ministry of Commerce recently concluded that the feasible energy savings due to efficiency improvements across the commercial, domestic and industrial sectors up to the year 2005 was typically 25-30%. A reduction in car fuel use of 45% by 2005 was considered technically feasible mainly through improved energy efficiency of new vehicles (Turbott, C., Pool, F. and Vickers, G. 1991. *Energy management and the greenhouse effect.* Ministry of Commerce, Wellington. 69p.). An analysis carried out by Electricorp indicated the technical feasibility of saving 57% of total electricity consumption by end-use efficiency, although they considered that a 20% saving would be more realistic in practice (Cameron, L. 1989. Potential savings in electricity consumption through increased electricity efficiency in New Zealand. Electricorp, Wellington).

CHAPTER 9

A solar future: fiction or reality?

9.1 Introduction

The presumption that renewable energy would provide the future energy base is not new. As was discussed in Chapter 5 the move to a renewable energy base in the "long term" was acknowledged by Government as a major policy goal back in the late 1970s. Initially, Maui gas was seen as the "bridge" to a more sustainable energy future based on renewable energy[1]. More recently the Coal Corporation has acknowledged that renewable energy is the logical long-term energy source[2].

Therefore it seems to be not so much a question of "if", but "when". For those with a vested interest in maintaining the status quo, the role of renewables continues to be cast in the long-term - they are always somewhere beyond the short-term horizon. But the available evidence is beginning to show otherwise. Several renewable energy technologies are beginning to bridge this long-term barrier, and are becoming viable.

9.2 What is the state of solar technologies?

It is the solar to electricity conversion technologies where the rate of advance in solar technologies during the 1980s has been most impressive. A combination of research and development, field experience and mass production of componentry has led to both an improvement in efficiency, and two to threefold reductions in real costs per kWh during the last decade. Wind energy and photovoltaics systems (PV) are both on development pathways that suggest further significant cost reductions over the coming decades.

For instance, during the 1980s the cost of wind energy in the US was reduced by 70% and is now 6-8 c/kWh (cf. electricity from coal-fired plants at about 6 c/kWh)[3]. Carl Weinberg and Robert Williams, writing in Scientific American last year, noted that most of the cost reduction seen in the last decade has come from "organisational learning", such as learned techniques of mass-production, more effective machine siting and more rigorous maintenance schedules, rather than technology breakthroughs[4]. Incremental technology improvements have centred on lightweight composite-material blades, and microprocessor-controlled turbines. Further cost reductions are confidently predicted. For instance projections made by the US Department of Energy estimate that costs could fall to 3.5 c/kWh during the next 20 years[5].

Advances in photovoltaics have been even more spectacular. But, unlike wind, this progress has been due almost entirely to technological breakthroughs as a result of ongoing R&D effort[6]. Most of the effort has concentrated on improving energy conversion efficiencies, which are now around 10% for commercially available PV systems, and over 30% for laboratory prototypes[7]. Costs that were around $60 per kWh in 1970 have declined to 20-30 c/kWh today[8]. Cost reductions to 10 c/kWh (US) by the end of the decade seem possible, with further reductions likely[9].

The costs of another new technology, solar thermal electricity, has rapidly declined throughout the 1980s, although its application has been more confined to deserts and other areas of high solar radiation flux. Solar-thermal systems are now operating at up to 22% conversion efficiency[10].

The actual and projected cost reductions in electricity from solar technologies are summarised in Box 9.1. Such progress provides grounds for optimism that solar technologies could provide economically competitive supplies of energy early next decade, or even before then. Indeed, the senior Vice President of California's Pacific Gas and Electric Company (the largest utility in the US) is quoted as saying:

> *"many renewable-generation options are technically feasible today, and with encouragement can prove to be fully cost competitive...within 10 years"*[11].

Box 9.1 Actual and predicted costs of solar-based electricity 1980 - 2030

Technology	1980	1988	2000	2030
	(US c per kilowatt-hour)			
Wind	32	8	5	3
Photovoltaic	339	30	10	4
Solar thermal	24	8	6	-

Source: Flavin and Lenssen, 1991, see Endnote 11.

9.3 Where are the initiatives coming from?

The solar industry overseas has developed through government assistance programmes that have supported R&D and assisted with the deployment of technologies into the existing energy supply system. At present a handful of countries are leading the technological and commercial advances of solar energy for electricity, but the list is growing. The current state of play for wind and PV technologies is summarised briefly below:

Wind

In the US, most initiatives have been in California. Several wind farms were established during the 1980s with the assistance of Federal and State tax credits. This programme not only boosted a local manufacturing industry, but also provided a market for British and Danish manufacturers who set up wind farms. Federal government assistance for R&D programmes has also been a factor. New development has slowed since the incentives have been discontinued, but R&D programmes are continuing.

In Britain, the wind industry has several manufacturers providing a range of turbine sizes and configurations. Government supports an ongoing R&D programme.

The Netherlands Government provided a major assistance package to the Dutch wind turbine industry in 1986 for both technology development, and market subsidies to encourage deployment. The aim was to develop the Dutch industry and enhance its ability to penetrate the market for large wind turbines both in the Netherlands and abroad[12]. The Netherlands plans to have 150 MW capacity by 1992 and 1000 MW by the year 2000[13].

In Denmark, the official goal is that wind power should contribute 10% of electricity by the year 2000. The industry enjoys a level of direct government support, as well as a programme that obliges utility companies to build 100 MW of wind power before 1991[14]. The Danish industry is also widely supported by private investors - indeed six percent of Danes now own shares in wind turbines[15]. Danish wind turbines have been exported to both the US and India.

Many other countries are also embarking on wind energy programmes, including West Germany, China and India - the Indian programme is particularly ambitious.

Photovoltaics
Until the mid-1980s the US was the dominant player in the PV business. The Federal Government has continued to support the industry through the National Photovoltaic Program, an R&D effort that collaborates closely with industry[16].

Now, the Japanese, German and Italian Governments are strong supporters of R&D in PV, and US firms have lost a large part of their previous dominant market share as these countries have invested in manufacturing capacity. Australia is also at the forefront of silicon solar cell research, and also has a substantial manufacturing capacity. The federal government has recently established the Centre for Photovoltaic Devices and Systems at the University of New South Wales in order to enhance Australia's leading position[17]. State electricity utilities are also involved in this programme.

9.4 Watching the way the world is going

The discussion above emphasises technologies that provide direct conversion of solar energy to electricity. It is a reflection of international trends. In most countries, electricity consumption as a proportion of total final energy consumption has continued to increase over the last few decades. In the future, increased requirements for electricity seem likely, especially if the direction of technology change in energy systems for transport continues on its present path. In some countries, hydrogen is being looked upon as the fuel of the future because it produces no CO_2 during combustion, and has very low levels of harmful emissions. However, hydrogen production requires electricity to split the water molecule, so without a cheap source of electricity the process is expensive. Germany currently leads the effort to develop solar-hydrogen systems, using electricity from photovoltaic cells[18]. Meanwhile electric vehicle development and production is now a priority for several major vehicle manufacturers. Much of this activity is being driven by the regulatory requirement passed in California last year specifying two percent of car sales by 1998, and 10% by 2003, be "zero emission" vehicles. With California being such an important vehicle market, the effect on the auto industry will likely be ground-breaking. Already some commercial models are available, and these are certain to increase as further progress with battery storage systems occurs.

In New Zealand we have tended to look towards biomass as the major renewable (solar-based) energy resource for the future. Early work focused on alcohol production from crops but the net energy yield was never very high, while the land requirements were high. More recently wood has been considered for a range of applications: direct combustion, transformation to electricity, gasification and alcohol production. New Zealand, with its favourable climate and land-based heritage seems to be particularly well placed to utilise biomass, but apart from the use of wood wastes, prospects are still uncertain. At an international level, widespread use of biomass for liquid fuel production is no longer considered feasible because of competing demands for wood and land. There are also considerable environmental impacts from intensive energy cropping. And despite some advantages (such as energy storage ability), biological systems are stuck with the reality of low conversion efficiencies in turning sunlight energy into biomass - typically about one percent. Direct conversion systems are now achieving considerably better than this.

Direct conversion systems are likely to be dominant solar technologies of the future. But electricity generation represents just one application. Typically about one-third of the energy required in developed countries is for low-grade heat, and solar energy is especially well suited to supplying this through either passive or active heating systems.

9.5 Summary

Despite very low R&D expenditures in relation to other energy sources, several solar-based renewable technologies have advanced over the last decade to the point that they are approaching cost competitiveness with conventional energy sources. The most important advances are with direct solar to electricity systems.

Several countries have recognised the opportunity that these energy technologies present, not only to supply energy to meet local needs, but to capitalise on the strong expectation of a rapidly growing international market in solar technologies. These countries vary markedly in terms of size and state of development, but they all have one thing in common - a programme of targeted government investment in the industry through R&D and/or market-based deployment assistance.

Notes and references

1. See the discussion in Birch, W.F. 1979. *Energy strategy '79.* Government Printer, Wellington. 96p; Ministry of Energy. 1980. *1980 Energy Plan.* Government Printer, Wellington. 75p. Fitzsimmons, J. 1981. *Synthetic petrol or sustainable fuel.* Energywatch Special Publication (August). 27p.

2. Third, J. 1991. Coal in the gas hole. *Terra Nova 10:* 44-45.

3. Weinberg, C.J. and Williams, R.H. 1990. Energy from the sun. *Scientific American 263(3):* 98-106. Flavin, C. and Lenssen, N. 1991. Here comes the sun. *Worldwatch 4(5):* 10-18.

4. *Ibid.*

5. Cited in Weinberg and Williams. Energy from the sun, op. cit.

6. Hubbard, H.M. 1989. Photovoltaics today and tomorrow. *Science 244:* 297-304.

7. *Ibid.;* The Economist. 1990. *Waiting for the sunrise (19 May):* 103-106.

8. Weinberg and Williams, Energy from the sun, op. cit.; Flavin and Lenssen, Here comes the sun, op. cit.

9. *Ibid.*

10. Flavin and Lenssen, Here comes the sun, op. cit.

11. Quoted in Flavin and Lenssen, Here comes the sun, op. cit.

12. Laughton, M.A. (Ed.) 1990. Renewable energy sources. *Report No 22.* The Watt Committee on Energy. Elsevier, London. 168p.

13. Global Tomorrow Coalition, 1990. *The global ecology handbook.* Beacon Press, Boston. 414p.

14. Meyer, N.I. and Norgard, J.S. 1989. Planning implications of electricity conservation: the case of Denmark. *In:* Johansson, T.B., Bodlund, B. and Williams, R.H. (Eds). *Electricity: efficient end-use and new generation technologies, and their planning implications.* pp.787-810.

15. Milne, R. 1991. Renewable energy: Britain's untapped resource. *New Scientist 132(1790):* 12-13.

16. Hubbard. Photovoltaics today and tomorrow, op. cit.

17. Milne, A., Taoul, M. and Sproul, A. 1990. What's happening in photovoltaics? *In:* Bansal, Raine and White, Living in the greenhouse. Proc. Australian and New Zealand Solar Energy Society Conference, Auckland. pp.487-494.

18. Flavin and Lenssen, Here comes the sun, op. cit.

CHAPTER 10

Setting out on the pathway: lessons from the past

10.1 Introduction

To the casual observer it might appear that we have started down the sustainable energy pathway before. Indeed, it is remarkable to look back at the energy goals and guidelines developed in the late 1970s, and to see the striking similarity with the concepts and principles being discussed now under the guise of sustainability[1]. The two key strategic imperatives of a sustainability path (efficiency and renewables) were both recognised as two of the five goals for New Zealand's energy strategy in 1979. Other important principles such as having in place an energy planning framework, participatory processes, and pricing structures that encourage efficiency were all recognised.

Yet by many measures, New Zealand's energy system is less sustainable now than it was during the late 1970s. Primary energy consumption is over 50% higher, and the environmental impacts of our energy use have increased similarly. Our reliance on non-renewable energy resources has increased while, according to some analysts, New Zealand's energy efficiency has declined over the last decade. All of these are reversals of what were set out as goals and guidelines in the late 1970s. So what happened to derail these good intentions?

The outcomes have to be seen within the context of the time. The late 1970s and early 1980s represented the peak of Phase 2 energy policy making, and the peak of government involvement. Two issues drove the decision-making process: the debate about what to do with Maui gas, and the events following the second oil shock in early 1979.

10.2 How to use the gas up "fast enough"

Initially it had been planned to use Maui gas for electricity generation, but when electricity demand forecasts in the mid 1970s were shown to be wildly over-estimated, new uses for the gas were sought with some urgency. In November 1978 the then Minister of Energy (Mr Gair) set up the Liquid Fuels Trust Board (LFTB), who were given until September the following year to come up with recommendations on the best ways to use natural gas to reduce New Zealand's dependence on imported oil for transport fuels. These recommendations needed to be integrated with the expansion plans for the Marsden Point refinery. Decisions on the expansion had been delayed for many years but were now considered a high priority[2]. The specific details of the expansion depended on decisions taken on the indigenous fuels programme. The two initiatives were locked together.

The first delivery of Maui gas was due in 1978, and the "take-or-pay" contract meant that the Government would be paying for increasing quantities of Maui gas, regardless of whether there was a use. The take or pay agreement was not the only pressure however. In addition, the Joint Venture Agreement set an obligation for the joint venturers to act "for the maximum commercial advantage of the joint venture"[3]. Since condensate was the most valuable product from the Maui field, and condensate volumes were proportional to gas draw-off volumes, maintaining high condensate flows was central to fulfilling this obligation. Overall, the effect of the take or pay agreement, in concert with the agreement to maximise commercial gain, was to create, in the words of one analyst, a "depletion mentality"[4]. According to the Chairman of the LFTB, Dr Colin Maiden, there was an imperative to find options that could use the gas "fast enough"[5].

10.3 The second oil shock

The second oil shock in early 1979 threw New Zealand into something of a panic. Almost overnight, oil production from Iran was cut by half. At that time Iran supplied 40% of New Zealand's crude oil. By June, physical restrictions on the consumption of avgas and diesel were being enforced and quota systems were introduced. Carless days followed, and petrol sales during weekends were prohibited. Throughout this time there was the definite air of a seige mentality.

It soon became a dominant belief that the world oil market would become terminally unstable, and that oil prices were on a permanent upward climb. Delphi surveys of "experts" were carried out by the Ministry of Energy to forecast future oil prices, and from mid 1979 to early 1981 these people were forecasting steadily rising prices through to 1995-96[6]. Substantial actual price rises over that time also added to this view. The public's mind was thus reinforced and this dominant belief drove the energy decision-making process. Oil prices would continue onwards and upwards!

The second oil shock also put pressure on the country's balance of payments. Wheras prior to the first oil shock, oil imports were equivalent to about six percent of agricultural export earnings, by 1980 this proportion had risen to 27%[7].

The coincidence of all these events led to rapid action. Decisions on several major energy projects were made within a short time period. The oil refinery expansion was approved in November 1979, and a memorandum of understanding was signed in April 1980 between the Government and Mobil Oil for the joint development of the synfuels plant at Motonui[8]. Meanwhile the National Development Act had been passed through Parliament in late 1979 in order to streamline the planning procedures, and reduce delays in obtaining consents and approvals for the projects.

10.4 Goals become guidelines .... and guidelines disappear

The goals and guidelines exercise established a participatory, multi-objective path for an energy strategy. But within the space of a few months, most of these goals had been subsumed by just a single objective. In proceeding with the liquid fuels "package", several of the goals set only months earlier by the *Energy Strategy '79* exercise were contravened. In particular, the goal "to ensure that energy is used efficiently" was seriously compromised by the decision to transform gas into petrol with a 50% energy loss[9].

Subsequently, once the substantive decisions on the liquid fuels programme had been made, subtle (and not so subtle) changes in New Zealand's energy goals began to appear. Several new, or changed, energy goals appeared in the 1980 Energy Plan, only months after the goal-setting strategy of *Energy Strategy '79*. Goal 1 (to reduce dependence on imported oil) was expanded to include "...by the progressive implementation of substitution measures selected to minimise increases in the cost of energy supply". Wording on Goal 2 had been changed so that rather than the specific objective of increasing diversity of supply, it would now just be encouraged. Reference to using appropriate energy types to ensure efficiency (Goal 3) was dropped in preference to "employment of appropriate energy utilisation systems". Goal 4 was changed from a purposeful objective of transferring energy supply from non renewables to renewables to read: "to promote the preferential use of renewable rather than non renewable resources in energy supply where this can be achieved without significantly increasing the cost of supply". Goal 5 (establishing an energy planning framework) emerged unscathed. Two new goals were also outlined: (1) "to promote the formulation and implementation of a stable energy pricing policy"; and (2) "to promote the effective and economic utilisation of indigenous energy resources which contribute to energy supply, assist economic growth, and benefit export receipts"[10].

The 1981 Energy Plan signalled further significant changes of emphasis. Policy "goals" became narrowed down to just two. The previous year's other goals became either "guidelines", or were dropped altogether[11]. The two over-riding goals were to:

- promote the development of indigenous energy resources, both to contribute to national energy supply and to produce export-led economic growth,
- reduce New Zealand's dependence on imported oil by the progressive implementation of substitution measures selected to minimise increases in the cost of energy supply and use.

Policy objectives reported in the *1982 Energy Plan* were unchanged from the previous year, and were considerably downplayed. By the following year there was no reference to goals or guidelines at all[12].

10.5 Discussion

What can we take from this brief period in New Zealand history, when an exercise in public goal-setting for energy was carried out, but was quickly subsumed by the single-minded objective of reducing dependence on oil? Is it full justification for the view that now dominates Phase 3 thinking, and that was summed up flatly by the previous Minister of Energy thus: "Government-sponsored energy planning...is incapable of leading to sensible decision-making"[13]? There is no doubt that the energy process during that time was driven by Government, and that the decisions taken were driven by a central planning process rather than by commercial market decisions. Once a political commitment had been made to these decisions, they proved impossible to reverse even although strong cases against them were made on economic grounds[14].

But what might have happened had the "market" dictated decisions? First, it is worth asking whether the Maui gas field would have been discovered as early as it was without exploration subsidies[15]. The answer is "possibly not". But it needs to be remembered that subsidies were in place essentially for oil exploration. Had oil been found and not gas the subsequent decision-making convolutions would not have occurred. Second, given the discovery of the field, how would Maui gas have been used under a full market-based response? Again it is somewhat difficult to speculate. However, there must be a strong likelihood that a large quantity of gas would have been flared to waste because the owners would have maximised condensate flows and treated the gas as incidental, especially if there was no established market for it.

So while the obvious shortcomings of the Maui decisions have tended to be used to justify a "hands off" approach by Government to our energy future, the "evidence" (for what it is) is hardly conclusive. Private enterprise is equally capable of turning "tough decisions" (decisions filled with ambiguity, uncertainty and conflict) into debacles[16]. Indeed the explanation for the outcomes we have are perhaps more to be found in the process of decision making that was undertaken, and in the small-country characteristics of New Zealand.

Energy decision making quickly became dominated by a technological elite. The LFTB began to hold enormous influence in the energy thinking and energy decisions of the time. LFTB thinking was directed almost entirely towards supplying conventional indigenous liquid fuels through large scale technologies. This thinking soon became the main driving force behind the major energy decisions taken in Phase 2.

This inability to accommodate a wider range of viewpoints was also notable in the views portrayed on oil prices. The spectre of ever-increasing oil prices that served as the backdrop for the energy decisions was not a view shared by everyone. A minority of economists at the time predicted that continued high oil prices would be unsustainable because of demand-supply imbalance, and accurately predicted the slump in oil prices. But contrary opinions were largely ignored[17].

But there are also two important qualifications. First, it was often suggested that actually paying for gas not taken so that it could be kept in the ground for future use was a viable option[18]. But under the rationale of a 10% discount rate, modest annual costs would accumulate rapidly over the 30-year contract period. Also, the legal situation concerning access to gas not taken after 2008 was also unclear[19]. The Maui agreement set in place a strong imperative to use the gas quickly.

Second, by choosing to utilise gas as a major source of transport fuel, New Zealand was stepping outside the mainstream. The options New Zealand faced were to transform the gas into a fuel compatible with the vehicle fleet, or to change the vehicle fleet fuel systems (and supply infrastructure) to suit the gas (or a less transformed product of the gas). In the event, by choosing both synthetic petrol and CNG, the Government tried to do both, although CNG was somewhat incidental to producing synthetic petrol. In effect the government decided that the "disadvantages of producing a more costly, lower octane, and dirtier fuel was preferable to having to modify the nation's vehicle fleet and fuel distribution infrastructure"[20]. It was a decision to transform the energy source to suit the available end-use technology i.e. it was determined by end-use technology.

How limited were New Zealand's options in this choice? The size of New Zealand's vehicle market was very small in relation to the international marketplace - there was clearly limited leverage in convincing the multinational automobile manufacturing companies to produce cars just for New Zealand fuel specifications[21]. How much would consumer choice have been restricted in vehicle types? How far ahead of the international marketplace could New Zealand afford to move? What would the economic and political consequences have been? Even with the benefit of hindsight these questions are difficult to answer, but they do emphasise one essential truth. Changing the energy system, because of the enormous investment (and vested interest) in infrastructure and reliance on overseas technologies is extremely difficult. The best intentions in the world face many real constraints. These have to be realistically addressed.

10.6 Conclusions

In attempting to move down a sustainability pathway it is always useful to see whether we can learn from the past. It is easy to identify Government decision making and involvement as a primary cause of unsustainable outcomes, and that the Government position as risk taker, particularly in the case of the indigenous liquid fuels programme, was inappropriate. It is less easy to assert, as the dominant view of Phase 3 thinking asserts, that the "market", left to its own devices would have produced a superior outcome. As much as anything we need to acknowledge the real constraints that the situation at the time imposed, and to focus on the issues of technology change, and shortcomings of the decision making process. Situations of "panic" will inevitably lead to poor decision-making. It is a lesson that needs to be applied to today's energy debate.

Energy goal setting after 1980 essentially became a hollow exercise in justifying the major energy decisions. Today the legacy of past energy decisions continues to cast a long shadow over the energy scene. The critical issue of energy pricing is discussed in the next chapter.

Notes and references

1. The one major difference since 1978 has been the emergence of the issue of CO_2 emissions and the potential for climate change, with the associated implications for a more globally-oriented energy strategy. Even so, Guideline 1 from *Goals and guidelines* recognised that energy issues required an international response.

2. For an interesting discussion on the background and events surrounding the decision making see: Paterson, M. 1991. *The point at issue - petroleum energy politics in New Zealand 1955-90.* Collins, Auckland. 243p.

3. Fisher, D.E. 1986. Maui gas depletion law and policy. *New Zealand Law Journal (February):* 52-56.

4. Smellie, P. 1990. Maui gas sale latest event in sorry saga. The Press (June).

5. Quoted in: Fitzsimmons, J. 1981. *Synthetic petrol or sustainable fuels.* Energywatch Special Publication (August). 27p. See also Paterson, *The point at issue,* op. cit.

6. Several such surveys were carried out, each successive survey forecasting higher future oil prices. See: Boshier, 1980. Prospects for world oil price. *Technical Publication No. 5.* Ministry of Energy, Wellington; Ministry of Energy, 1980. *1980 Energy Plan.* Government Printer, Wellington. 75p. Ministry of Energy, 1981. *1981 Energy Plan.* Government Printer, Wellington. 86p.

7. McChesney, I.G., Sharp, B.M.H. and Hayward, J.A. 1982. Energy in New Zealand agriculture: current use and future trends. *Energy in Agriculture 1:* 141-153.

8. Ministry of Energy. 1980. *1980 Energy Plan.* Government Printer, Wellington. 75p.

9. Fitzsimmons, *Synthetic petrol or sustainable fuels,* op. cit.

10. Ministry of Energy, *1980 Energy Plan,* op. cit.

11. Ministry of Energy. *1981 Energy Plan,* op. cit.

12. Ministry of Energy, 1982. *1982 Energy Plan.* Government Printer, Wellington. 96p; Ministry of Energy, 1983. *1983 Energy Plan.* Government Printer, Wellington. 94p.

13. Butcher, D. 1990. Letter to The Dominion, (14 September).

14. See Fitzsimmons, *Synthetic petrol or sustainable fuels,* op. cit.

15. I thank Peter Farley for raising this point.

16. Nutt, P.C. 1990. Preventing decision debacles. *Technological Forecasting and Social Change 38:* 159-174.

17. Interestingly, the 1981 Energy Plan, released before the final decision to proceed with the synfuels plant, pointed out the looming supply-demand imbalance, suggesting that oil prices would likely fall. However, the 1981 Plan persisted with forecasting still higher oil prices in the future. See: Ministry of Energy, *1981 Energy Plan,* op. cit. p.23.

18. The Gas Contract stipulated the Government would pay the Consortium 37 cents per million BTU of gas ($0.39/GJ), with increases after April 1976 based on one half of the movement of a modified wholesale price index. Since Government was a 50% shareholder in the Consortium, payments are effectively halved.

19. Fisher, Maui gas depletion law and policy, op. cit.

20. Sperling, D. 1988. *New transportation fuels - a strategic approach to technological change.* University of California Press, Berkeley. 532p.

21. *Ibid.*

CHAPTER 11

Cheap energy - necessary for competitive advantage?

11.1 Energy pricing

The legacy of Government involvement in the energy sector is also one of underpricing indigenous energy. That legacy remains today, and is an important determinant of current and future energy demand.

Throughout Phase 1 of policy development, prices for electricity and coal continually failed to cover costs. Government made up the shortfall with subsidies. During the late 1960s and early 1970s, for instance, electricity prices overall fell short of direct costs by 15%. Taking interest charges on capital into account, the shortfall was 36%[1]. A similar situation applied to coal. In 1968 the losses incurred by State Coal were equivalent to 30% of revenue[2]. Petroleum products, on the other hand, most of which were imported, attracted taxes that were used to fund the road network.

When the Maui gas contract was being negotiated from 1971 to 1973 one of the key issues under discussion was the gas price. Since electricity generation was being seen as the main use for Maui gas, the rationale behind an appropriate gas price was that it should be set at about the equivalent price of fuels used by the New Zealand Electricity Department for its thermally-generated electricity[3]. In effect this meant pricing at somewhere between the price of coal and that of oil. Thus was the reasoning behind the gas price of 37 cents per million BTU. But a condition of this price was the take-or-pay agreement[4].

Thus, Maui gas was priced on the basis of being competitive mainly with coal (which was already subsidised by Government), burnt in thermal power plants at 25-30% efficiency, and sold as electricity (the price of which was further subsidised by Government). Clearly, from the start, Maui gas was undervalued. Also, by a quirk of timing, the Maui agreement was signed only a few months before the first oil shock[5].

Major energy-related decisions have been taken in the last decade predicated on the availability of large amounts of cheap energy. But at the same time the New Zealand economy has been opened up to competitive pressures. Lowering energy prices became an active objective in the government's policy to increase the competitiveness of New Zealand business and to reduce inflation. In addition, local business and farm organisations applied considerable pressure on the government to reduce what they regarded as discriminatory taxes on diesel so that they were able to compete on a fairer basis with Australian imports (and the Australian home market) under CER. The Minister of Energy stated in 1990 that "because it is so central to the wider economic performance, energy is seen as a key sector for achievement of cost reductions"[6].

The net result is that energy prices have consistently declined in real terms for all energy sources over the last five years (the exception being petrol over the last 12 months). In part this has been due to efficiency gains from within the industry. For petrol and diesel, taxes have been reduced.

In 1990, industrial electricity prices in New Zealand were the lowest of 19 developed countries. Domestic prices were the second lowest[7]. Petrol and diesel prices are amongst the lowest in the OECD, essentially because of a low tax regime. A sample analysis carried out by the Ministry of Commerce in 1990 showed that petrol prices in New Zealand were third lowest of nine countries, despite having the second highest cost of supply (after Japan)[8]. Prices for diesel were the lowest of the sample (12 c/litre lower than Australia) and have been reduced further by approximately 8 c/litre with the elimination of excise duty in January 1991)[9]. Natural gas is still subject to price control. One recent analysis has concluded that compared to other OECD countries New Zealand consumers face "moderate natural gas prices with a tendency towards becoming a cheap-gas country in the 1980s"[10]. Of course, the gas price through negotiated contracts with bulk users such as Electricorp, is very cheap. And last, coal prices have been on a par with many other countries.

Many of these low prices have been aided by what has been described in a Ministry of Energy analysis as a "patchwork, unsystematic regime" of resource royalties[11]. Currently no royalties apply to hydro-electricity or geothermal electricity, while various resource rentals apply to oil, gas and coal. Coal in particular attracts a very low rental in relation to other fossil fuels.

11.2 Rising energy intensity

Cheap energy produces a number of outcomes that are entirely predictable under "economic rationality". It encourages use. It raises the economic threshold for which efficiency potential can be implemented. It encourages energy-intensive activities. And it sets in place patterns of energy use and investment that are likely to persist over time.

It is not surprising therefore that New Zealand has experienced a rising trend of energy intensity (i.e. energy use per $ of GDP) over the last three decades. This has occurred while most other OECD countries have achieved a substantial decline in energy/GDP ratios[12]. Several reasons have been offered including the establishment of energy intensive industries, in particular those associated with the "think big" era, transport deregulation, labour substitution and declining efficiency of use. Indeed, it is interesting to note that the rise in energy per GDP that occurred during the 1980s was predicted quite precisely by the Ministry of Energy in the *1981 Energy Plan,* based on the anticipated changing structure of the New Zealand economy, and in particular the impact of think big[13]. Thus, the rising trend throughout the 1980s has been very consistent with expectations of a decade ago.

Energy intensity trends should not be looked upon solely as indicators of energy trends, though Energy/GDP ratios are also the product of GDP trends. In understanding what the trend in these ratios implies it is also necessary to look at changes in GDP. For example, there would be much less difference in energy/GDP ratios between Japan and New Zealand today if GDP in New Zealand had increased at the same rate as that in Japan over the last three decades[14].

While many commentators have looked upon the rising trend of energy/GDP as mainly an indication of poor and declining energy efficiency vis à vis other countries, there is little evidence available to show that the energy used per (physical) unit of product produced in New Zealand is significantly higher than comparable products made in other countries. Rather, the energy/GDP trend should be regarded as a broader indication of unsustainable energy-economic trends.

11.3 Weak economic structure

As the recent Porter project highlighted, many New Zealand exports are in structurally unattractive businesses - facing high competition and low barriers to entry by competing products[15]. They are consequently often caught up in the classic cost-price squeeze. Many products are sold in a bulk or semi-processed state, with limited value added. There have been consistent declines in real returns from many products over the last few decades as low cost competing countries have entered the market to apply downward pressure on prices. In addition of course, the discriminatory nature of protection and subsidies particularly in the EC countries provides another reason for diminished export returns. Further, New Zealand now operates an open economy with tariff barriers being eliminated or reduced.

As a result of all this, cheap energy has, over the years, become an essential element of the economy, in particular for the export sector but now also for domestic market businesses competing against imports. In the past, low energy prices have been an incentive for some energy-intensive industries to set up in New Zealand. Now, continued low energy prices are being seen as a survival mechanism - as a means of retaining competitiveness in the face of adversity. There are many examples - low priced coal for export, for the steel industry and the dairy and meat industries; low priced electricity for aluminium and pulp and paper; low priced gas for methanol and urea (and synthetic petrol, some of which is exported); and low priced oil products to retain competitiveness in transport.

The difficulty of course is that this syndrome, once in place, becomes very difficult to break out of in an orderly, planned way. Once industries set up to take advantage of cheap energy, there is an overwhelming imperative to keep energy cheap, especially when the economy lacks other more structurally viable business opportunities. Cheap energy may encourage further energy-intensive industries, lock-in inefficiencies and reinforce the status quo.

11.4 Breaking out of the cycle

A series of interlocking issues are driving, and reinforcing, an unsustainable energy path in New Zealand. This country's economic vulnerability in the 1970s, allied with the search for a use for Maui gas, drove a quest for energy self-sufficiency. But to achieve this has required large government subsidies, especially after world oil prices dropped in the mid 1980s. The economic vulnerability of the country in the 1970s has now been translated into widely acknowledged economic weakness in the 1990s, and cheap energy is now regarded by many as a necessity because of the weakness of the New Zealand economy.

Cheap energy is a two-edged sword. Access to genuinely sustainable low priced energy offers considerable long-term economic advantages, although only if that energy is used efficiently. If the low price derives from **unsustainable** supply conditions then it is creating the pre-conditions for economic instability. In New Zealand hydro electricity offers a genuinely sustainable, low cost supply of high grade energy (although as we have recently witnessed it is subject to seasonal limitations). Geothermal heat offers cheap, long-term energy supplies subject to flowrate restrictions. Coal offers cheapness and reasonably large reserves, but that cheapness derives from pricing which delivers low resource rentals and takes no account of external costs. Gas offers cheapness because of the extremely low prices set through long-term contracts. At current use rates reserves amount to only about 15 years. And petrol and diesel are relatively cheap because of the low rates of taxation levied in relation to most other developed countries. By and large, energy is relatively cheap because New Zealand chooses to underprice its energy compared with many other countries.

Cheap energy is again being actively promoted by some players in the energy sector as a form of "competitive advantage" for New Zealand businesses[16]. Yet it is a fundamental misinterpretation of what competitive advantage is all about. As Professor Porter has painstakingly pointed out, **factor advantages** such as cheap energy may be an ingredient for competitive advantage, but the essential ingredients are the application of skills - training, marketing, and innovation[17]. Cheap energy is not a substitute for these skills - in fact New Zealand's abundance of relatively cheap energy in the past has probably contributed to the false expectations many people have had about the economy in the last two decades.

New Zealand needs to break out of the cycle of underpricing energy to retain competitiveness. The reality of the post-Maui energy hole, coming upon us early next decade through continuing with a business-a-usual approach, should be reason enough for a fundamental re-appraisal.

Moving to a sustainable pathway will not be costless. It will require a commitment to the task. But if we can broaden our vision, then a new pathway becomes a pathway of enormous potential.

Notes and references

1. Sources: Department of Statistics, 1970. New Zealand Official Yearbook 1970. Wellington; Department of Statistics, 1973. *New Zealand Official Yearbook 1973.* Wellington. 1118p.

2. *Ibid.*

3. Paterson, M. 1991. *The point at issue: petroleum energy politics in New Zealand, 1955-90.* Collins, Auckland. 243p.

4. *Ibid.*

5. From the point of view of the country though this was clearly beneficial since the negotiated price for both the Government's 50% share in the field, and the gas, would have been substantially higher.

6. Butcher, D. 1990. Speech given to the Gas Association of New Zealand Conference, Lower Hutt, 19 February. 19p.

7. Electricity Corporation of New Zealand, 1991. Annual Report 31 March 1991. 64p.

8. Ministry of Commerce, 1990. Oil Market Newsletter, May 1990. Market Analysis Unit, Wellington. 10p.

9. Diesel users face Road User Charges in lieu of a direct tax on the fuel, and is charged on a per kilometre of travel basis.

10. Bertram, G. 1990. Energy intensity in New Zealand: a working paper. Victoria University, Wellington. 37p.

11. Ministry of Energy, 1989. *From generation to generation - a New Zealand Heritage Fund and a new pricing regime for energy and mineral resources.* Ministry of Energy, Wellington. 42p.

12. Patterson, M.G. 1988. An explanation of recent trends in New Zealand's energy:GDP ratio. Market Analysis Unit, Ministry of Energy, Wellington. 5p; Patterson, M.G. 1989. Productivity trends in the New Zealand economy from an energy perspective. Market Analysis Unit, Ministry of Energy. 8p; Bertram, Energy intensity in New Zealand, op. cit.

13. See page 22 of the Plan for a graph predicting the rising trend in energy intensity through to 1990: Ministry of Energy, 1981. *1981 Energy Plan.* Government Printer, Wellington. 86p.

14. In 1987 the energy intensity of the Japanese economy was 0.26 Toe/$(000)US versus 0.62 for New Zealand. But between 1965 and 1987, per capita GDP grew at 4.2% per annum in Japan, and 0.9% per annum in New Zealand (5.1% versus 1.1% allowing for different rates of population growth). Thus, New Zealand's energy intensity in 1987 would have been 0.32 Toe/$(000)US if GDP had grown at the same rate as Japan. Calculated from: Bertram. Energy intensity in New Zealand. op.cit.: New Zealand Trade Development Board, 1990. Ten by 2010 - a goal for New Zealand. Wellington. 32p.

15. Crocombe, G.T., Enright, M.J. and Porter, M.E. 1991. *Upgrading New Zealand's competitive advantage.* Oxford University Press, Auckland. 235p.

16. The Chairman of the Energy Foundation recently stated that New Zealand's cheap energy provided opportunities for business expansion (Speech to the 1991 Transport Outlook Forum, Christchurch 22 August). The Coal Corporation claim that low price coal is a form of competitive advantage for New Zealand, and should be exploited as such - see: Third, J. 1991. Coal in the gas hole. *Terra Nova 10:* 44-45.

17. Porter, M.E. 1990. *The competitive advantage of nations.* The Free Press, New York. 855p.

CHAPTER 12

Creating an alternative future

12.1 Introduction

The thrust of the arguments developed throughout the preceeding 11 chapters have led inexorably to one conclusion - there is a need to focus on a vision of a different pathway for New Zealand's energy future: to create, in Hazel Henderson's words an "alternative future"[1].

This chapter pulls together the various strands that have been discussed. The purpose is to outline some of the changes that might be required to provide the "nudge" our energy pathway needs to change trajectory towards a sustainable system. It is not a detailed agenda for change. That requires much further work and analysis. Nevertheless, the required direction seems clear - it is not business-as-usual.

Over the last 18 months, spokepeople for major energy interests have issued dire warnings about the consequences of changes to our energy system, and in particular the impact of CO_2 targets. "CO_2 emissions target threatens New Zealand economy" stated the Director of the Coal Research Association. "To achieve such a reduction (in CO_2 emissions) would require major regulation including carless days and power blackouts" said the General Manager of Electricorp[2]. The Treasury and the Ministry of Commerce have recently echoed these warnings.

These warnings should not be disregarded. Depending on the way New Zealand chooses to tackle its energy future, large additional costs may be imposed. But the problem is that these statements are intrinsically tied up with the general approach of the energy industry to the future - that "there is no alternative" to business-as-usual.

The business-as-usual path has been outlined by the Energy Foundation. Criticism of business-as-usual is not a criticsim of the Foundation's work (indeed it has been a valuable exercise), since the Foundation has invited comment and debate. Rather, it is a criticism of:

- the dominance of major interests, with a vested interest in maintaining the status quo,
- the lack of participatory structures that would allow for a broader range of interests to be represented,
- the dominant focus on short-term issues (i.e. CO_2 target, deregulation), and a lack of longer-term strategic thinking,
- the lack of imagination in energy thinking,
- the recourse to yesterday's solutions to tomorrow's challenges.

The strategic imperative for New Zealand energy policy over the next decade is to link the requirements for CO_2 limitations and reductions with a viable energy demand and supply strategy for the post-Maui era. A pathway based on the principles of sustainability would seek to:

- improve end-use efficiency and reduce energy transformation losses by a closer matching of energy source with energy service. The objective would be to reduce growth in demand, provide economic benefit, and extend the lifetime of gas reserves,
- begin an immediate programme to deploy "non conventional" renewable technologies on a small scale, as a prelude to larger scale deployment early next century.

12.2 Moving towards the end of Maui

A key plank of the sustainable energy pathway is the desirability of slowing the depletion rate of the Maui gas field. Slowing the depletion of Maui gas offers environmental benefits and, perhaps more importantly, it offers considerable strategic benefits. It would **buy further time** for the transition to renewable energy systems to take place.

But how realistic is it to expect a slowing in the depletion rate of Maui? The issue is clouded somewhat now by claims from the Maui field operators that slowing the depletion rate will cause gas to be bound in the field under the action of water pressure drive - claims that are by no means accepted by all but difficult to counter. The limited life of the Maui platform has also been raised as a reason why a longer depletion period is not advisable. Yet it is difficult to separate these technical claims from the purely commercial imperative of the gas owners of maximising short-term profitability.

There still remains the constraints imposed by the Maui agreement. The terms of the contract have set in place strong incentives to use the gas quickly. It has been suggested that the contracts be renegotiated to slow down the depletion rate[3]. This will undoubtably cost the Government a significant amount in compensation, and one has to ask whether this would be money well spent i.e. what is the opportunity cost of spending money this way? Instead of looking at altering the terms of supply, might it not be better to indirectly influence depletion by creating pressure on gas users through pricing strategies, and strategies that encourage (and achieve) end-use efficiency. It is sobering to reflect on the fact that we are currently depleting our largest reserve of primary fuel at a wastage rate of about 75%[4]. A large part of this wastage is from transformation losses in converting gas to electricity and synthetic petrol. Creating strong disincentives against high transformation losses by creating a specific tax is suggested in Section 12.4. This would have the effect of shifting gas towards higher value uses, with the aim of providing more profitable, but lower volume, sales for the present gas owners (Fletcher Challenge and Electricorp). This added profitability would also compensate for gas paid for under the "take or pay" agreement but not immediately used.

It is interesting to note that Fletcher Challenge has recently set a target of reversing the declining fortunes of CNG and of having 15% of the light vehicle fleet converted to run on CNG over the next three to five years[5]. This represents a long-term commitment to direct use of gas as a transport fuel, and is a step along the sustainable energy pathway. A developing market for CNG provides many incentives for gas to be depleted at a slower rate, so that the market can be expanded and satisfied during the first two decades of next century. It may even provide sufficient incentive for the synfuels plant to be closed before the expected date of 2003. And does expanded use of CNG provide a potential alternative to using gas for electricity generation, and an opportunity for Electricorp to enter the direct use market?[6]

Electricorp holds the balance of entitlements to the remaining Maui gas (currently about 1200 PJ). Approximately 30% of this gas has been paid for in advance. At present about 50-70 PJ of gas is used per year to generate 5000-6500 GWh, approximately one-fifth of electricity end-use demand. The marginal cost of generating electricity from gas is currently very low - between two and three cents per kilowatt-hour depending on the generation station, and simply reflects the extremely low contract price paid for Maui gas. Much of the electricity generated is to meet North Island base-load demand. Under the business-as-usual scenario, gas use for electricity would increase throughout the next decade (apart from a two-three year period following commissioning of the Clyde Dam), and a substantial "hole" of about 8000 GWh would have to be filled starting about 2005. Just how a gradual reduction in gas use for electricity under the assumption of continued growth in end-use services would occur needs further consideration.

One proposal has recently been outlined by the author[7]. It is based on an alternative way of approaching the electricity "hole". It is assumed that demand for electricity end-use services will continue to grow from the present demand of about 31000 GWh to the equivalent of 39000 GWh by 2010. The approach would:

- achieve a progressive improvement in end-use efficiency (an average of one percent per year over the next two decades would reduce the total generation requirement to about 32000 GWh in 2010),
- develop the potential for small geothermal generating plants in the North Island,
- tap the potential for co-generation[8],
- assume some contribution from new-technology solar sources, in particular from wind generation (each 100 MW of wind turbine capacity should produce about 300 GWh[9]).

By 2010 therefore there is a clear potential to move away from an increasing reliance on fossil fuels for generating electricity, and to extend the life of the Maui reserves. Indeed, many of the assumptions that underpin the business-as-usual approach come into question under an alternative vision. For instance, Electricorp are currently basing their long-run marginal costs on the assumption that the electricity will be generated by coal-fired thermal stations at a cost of 7-8 cents/kWh. Yet, based on overseas costs, wind energy is likely to match this by the turn of the century. If coal attracts a carbon tax (or, as suggested here, a transformation tax), then wind energy starts to look "economic" almost immediately (Figure 12.1).

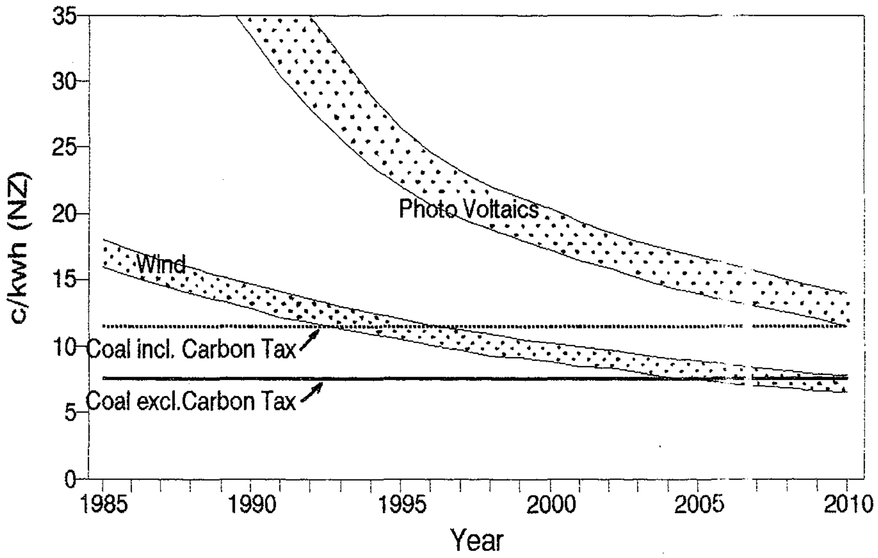

Figure 12.1 **Projected electricity costs from wind and photovoltaics versus coal (coal costs based on Electricorp long-run marginal cost; wind and photovoltaic costs taken from Box 9.1 and converted to NZ$).**

There are other strategic benefits to be considered also. Small scale renewable systems are low risk in that they do not entail high, upfront capital expenditure, and they do not require long lead times for construction. They can be deployed as incremental chunks of capacity when needed. They get around one of the major problems that has plagued energy development in New Zealand over the last two decades - the focus on large energy developments that have overstretched the relatively small New Zealand economy, and created alternative "shortages" and "surpluses" prior to, and after, the development.

The sustainable energy approach outlined above is not fanciful - the more one looks into it the more logical and compelling it becomes.

12.3 Creating a market for energy efficiency

Last year both the Electricity Supply Association and Electricorp displayed some public enthusiasm for energy efficiency. Renowned efficiency advocate Amory Lovins was brought to New Zealand, and the scope for bringing about large savings through end-use efficiency was given a wide hearing. Since then, enthuisiasm has waned as it has become apparent that the large technical efficiency improvements that are possible are not going to be achieved overnight[10]. In some circles, Lovins' star has definitely been on the wane. Is this fair, both to Lovins and to efficiency? It is not, and it highlights an ongoing weakness that seems to plague some thinking in the energy sector - to look for, and expect, large, quick-fix solutions to energy problems.

The sustainable energy pathway outlined in Chapter 8 was based on achieving an average of one percent per annum improvement in end-use efficiency over business-as-usual. While this may seem to be a conveniently rounded and arbitrary figure, it is not. It is a realistic assessment of what is readily **achievable** given some purposeful goals within the right institutional setting. It is based on the experience gained by overseas organisations, in particular electricity utilities in the US, that are now investing in end-use efficiency. For instance the Con Edison utility from New York has instigated a demand-side efficiency programme called "Enlightenment", utilising least-cost solutions in order to moderate an expected future growth of 1.3% per annum over the next 18 years. Under this programme they expect growth in demand to be reduced to 0.4% per annum[11]. In other words, improvement in end-use efficiency will substitute for an equivalent growth in electricity supply of 0.9% per annum.

Presenting efficiency gains as a certain percentage gain per year is also a more accurate means of representing reality. One percent per year, for instance, equates to 10% savings by 10% of consumers per year: this more accurately reflects the actual way efficiency savings come about. Indeed, as Frances Cairncross has recently noted, "conservation is more complicated than supplying new power. It involves many small investments rather than a few giant ones"[12]. She goes on "... that is why it is ultimately important to find ways to release the force of the market".

Overseas experience is showing that a combination of regulation and market forces is required to achieve the "optimum" level of energy efficiency. Purposeful regulation (changing investment criteria and financial incentives) was required to bring about the now growing market in end-use efficiency in the United States. In New Zealand the creation of end-use efficiency markets has recently been proposed[13]. The deregulation of electricity franchise areas proposed under the Energy Sector Reform Bill is seen by the Electricity Distribution Reform Unit (EDRU) as opening up this market potential[14]. If this occurs then the opportunity will surely exist for potentially large electricity savings. But there are many potential roadblocks that could thwart this potential e.g. if line and energy costs are charged separately to consumers, and the possible disincentives offered by Electricorp in their pricing strategies.[15]

A market-based approach to efficiency also raises equity questions. Many of the benefits gained from efficiency remain unavailable to lower income people because of lack of access to new technologies, poor information etc. If efficiency improvements are also driven by higher energy prices, there is the real danger of exacerbating an energy poverty trap - people unable to afford the more efficient technologies, who are forced to both use more energy and to pay a higher price for it. Community-based efficiency schemes need to be considered alongside market-based initiatives[16].

12.4 Pricing energy

The pricing debate cannot be done justice in this one section. Nevertheless, as was discussed in the previous chapter, pricing is an essential component of policy if progress towards a sustainable energy pathway is to be made. In the short term, pricing policy needs to recognise the need to ensure industry viability and fairness to consumers, while encouraging the shift to a sustainable pathway. Therefore, preserving the relative cheapness of New Zealand's genuinely sustainable energy supplies, while creating strong disincentives at the margin for energy waste and increased consumption of energy sources, would seem to be an important principle. The following points need to be considered.

- Pricing is not only about quantity, it is also about structure. Recent suggestions to allow electricity fixed costs to become fixed charges for consumers is both contrary to wise resource use and to normal pricing procedures[17]. It will unquestionably be a major disincentive to encourage efficient electricity use. It is interesting to note that in Germany the response to CO_2 emission targets is eliciting the opposite response - a move to reduce their current high fixed charges, and a loading of costs back on to energy charges[18].
- Alternative pricing structures, such as the "progressive tariff" proposal[19] need to be investigated thoroughly.
- The ramifications of revenue-neutral energy price increases (where increased energy taxes are compensated for by tax reductions in other areas), through such mechanisms as a carbon tax, need to be examined in detail. The fact that extra revenue is fed back into the economy in other ways is often overlooked in discussions on the effect of a carbon tax.
- A variation on an across-the-board carbon tax is a **transformation tax** where the tax is specifically applied to fossil energy that is transformed to other energy types (e.g. gas and coal to electricity, gas to petrol). This would not affect the cost of energy where the transformation losses for energy are low or non-existent (i.e. coal used for basic heating applications), but it would steeply increase costs at the margin for activities such as thermal generation. It would be a relatively painless way of adjusting the market distortions caused by the very cheap gas contract price, although for electricity, a transformation tax would probably need to be associated with a progressive block tariff to ensure that hydro and geothermal prices were not simply ratcheted upwards in line with increased gas costs, as occurs at present.[20]
- One way around the current impasse over energy price increases and the need to retain competitiveness would be to signal phased price increases in the long term. In that way, businesses do not have to bear higher energy costs in the short term, but do have the right signals for investment decisions in the longer term.

The basic principle of requiring least-cost energy supply (where investment in efficiency is equated to a form of "supply") is appealing but has the following qualifications. First, it will only be truly successful if there is a "level playing field" where all energy sources are priced to include true social and environmental costs. Second, there may be national strategic reasons for making some anticipatory investments that are not in the short term the least cost option. For instance, some early investment in renewables can be justified for the strategic benefits that may accrue in the longer term, even although that investment today is not necessarily the cheapest option. As a basic principle this "early" investment in renewables should be funded by taxes on fossil fuels i.e. a **transition tax.**

12.5 Investing in solar

If solar technologies are to fill the energy gap early next century, and provide a progressively increasing proportion of energy supply, New Zealand has three options: (1) import most of the required hardware, (2) create a local industry base to produce the hardware, or (3) a mix of both.

At present, to all intents and purposes, New Zealand does not have a solar industry. Given this current situation the option to import seems logical. We would be able to buy-in to the latest technologies, and take advantage of two to three decades of R&D, the cost of which has been borne by other countries. This would seem to be the simple solution. But does it make the most of the potential opportunities that solar technologies could provide? What would be the potential benefits from New Zealand developing a solar industry base?

The rationale for moving to solar energy is the advantage it offers both environmentally and economically (in the future). The rationale for creating a major solar energy industry in New Zealand would have to be economically determined, but it offers two potential benefits:

- the prospect of an internationally competitive industry,
- a positive contribution to technology transfer to developing countries.

What is the prospect for creating a competitive industry base? Robert Reich, writing recently in Scientific American on the decline of US technological competitiveness, argued that the first step towards technological pre-eminence was to **"scan the globe for new insights"**[21]. One particular insight seems clear and unmistakable. There is a quietly developing global market for renewable technologies that within a decade or two could become huge[22].

Should New Zealand undertake the risky strategy of setting up an industry where there is no existing home base? There is no question that New Zealand needs new types of business that will enhance international competitiveness. It is unlikely that our current stock of existing industries can, on their own, evolve sufficiently to maintain economic welfare. New industries are required that are responsive to new market opportunities. But, interestingly, while there is no solar industry as such in the country, we would not necessarily be starting off from scratch. The Porter project gave us some useful insights into the value of industry "clusters" that enhance and reinforce competitive advantage[23]. A solar technology industry for instance would not just rely on devices to turn solar energy into some other energy form. Just as important will be control and management systems, possibly storage systems, materials suppliers, plus other types of infrastructure support, as well as downstream utilisation technologies. Arguably, some aspects of the necessary cluster around a solar-based industry already exist. For instance, New Zealand has an internationally competitive software industry, and an emerging electronics industry, both of which conceivably would have an important role in control systems. Turbine construction for wind generators can make use of New Zealand's leading edge boat building technologies[24]. Recent battery technology breakthroughs have come from a New Zealand inventor. And we should not forget of course the considerable expertise that has been built up by New Zealanders in conventional hydro and geothermal technology. The integration of new-technology solar systems with conventional renewable technologies into grid systems will be important. And as well as having the technical ability New Zealand also has the other necessary ingredient for establishing a competitive industry base - the factor advantage of strong fluxes of natural solar energy.

The second point is technology transfer. The importance of achieving technology transfer to developing countries was stressed earlier in Section A. Unsurprisingly, it is becoming a central issue in the negotiations leading up to UNCED next year in Brazil. The World Bank has recently indicated that support of renewable energy sources will be a priority under its Environmental Action Program[25]. Recently, External Relations Minister Mr McKinnon indicated that New Zealand's level of aid-giving to developing countries was inadequate and needed to increase. Clearly there is the potential for targeted assistance in solar technologies (the technologies themselves, or expertise, joint ventures etc.).

Up until now New Zealand's stance on CO_2 emission reductions has been based on moral suasion - symbolically important but unlikely on its own to have much effect. If New Zealand is really serious about reducing CO_2 emissions globally, then it needs to be rather more positive in its approach. The ability to provide solar-based technologies and technological expertise would be one of the more positive approaches New Zealand could take.

12.6 Expanding our horizons

According to Charles Handy, times of discontinuous change require discontinuous, or "upside-down thinking"[26]. We need to look at things in a new way. We need to look for new opportunities in the face of adverse times. Upside-down thinking changes nothing "but the way we think". It is part of the process of breaking out of business-as-usual (Box 12.1).

Box 12.1 Some upside-down energy thinking

- Upside-down thinking suggests that instead of building megawatts of new capacity, we look for opportunities to invest in "negawatts" of saved energy through efficiency,
- Upside-down thinking asks why our current electricity suppliers do not become broad-based suppliers in energy services?
- Upside-down thinking asks why Coalcorp does not fundamentally reorganise itself to become "Solcorp", providing a diversified range of leading edge solar technologies (as well as coal). It would mean that no longer was the organisation reliant solely on a polluting energy form from the past,
- Upside-down thinking asks why our current energy using artifacts cannot, in the future, be suppliers of energy and energy services, incorporating direct solar conversion technologies as an integral part of their design,
- Upside-down thinking suggests that we need to move the burden of taxation away from useful work that adds value, to activities that impose costs on society, such as our use of environmentally harmful energy resources,
- Upside-down thinking suggests that when we have discovered the benefits of moving down a sustainable energy path, we will wonder why we did not make the transition sooner.

Of course, these are not ideas of the future, they are ideas of the present. Amory Lovins has come up with the "negawatt" concept, a number of US utilities are re-orientating to become energy service providers, oil companies are investing in photovoltaics, one Japanese company is now producing photovoltaic roof tiles, to mention just a few. The future is with us now.

It is important that we are in a position to evolve into the opportunities and challenges as they unfold over the next two to three decades. We should not be waiting a decade until the energy gap appears before considering renewables. That process should begin now. Wind energy probably offers the most promising immediate prospect for utilisation. Overseas, wind energy is becoming economic now in countries that are less windy than New Zealand. For a country with the wind energy potential of New Zealand, its lack of development so far is disappointing. The proposal put forward by Electricorp for a single wind turbine to be installed near Wellington is welcome but hardly sufficient to gain the necessary field experience. As a high priority we need to investigate mechanisms to ensure an immediate investment in wind energy, so that the country can move quickly onto the technological learning curve. Overseas, wind energy has been established through government subsidies, and compulsory obligation-to-buy schemes. It defies all overseas experience to expect "the market" on its own, to deliver this outcome.

At the very least, the prospects for making a transition into renewables over the next two decades demands an immediate enquiry sponsored by Government, and involving a broad range of interest groups. It is interesting that in the UK a Parliamentary Select Committee, and a Department of Energy Special Advisory Group are both examining with some urgency why Britain is lagging behind some European countries in its utilisation of renewables[27].

The sustainable energy pathway requires that we define some direction for energy supply (and demand) at a national level. We need, in other words an energy strategy. In order to do this we must reject some of the more extreme notions of Phase 3 thinking. The view that there is "nothing special about energy", and that energy decisions can be handled by private "competitive markets" under light-handed regulation is appealing, but in the words of Fletcher Challenge "there is no evidence that market forces in isolation will produce rational solutions to New Zealand's energy problems"[28]. Nevertheless, all interest groups have their own agendas, and the sorts of interventions being sought by various players are not necessarily designed to meet sustainability objectives. We urgently need to develop new participatory mechanisms that will allow a broader participation into the energy policy process, and avoid the dominant business-as-usual thinking that is clearly a feature at present. It is a Government responsibility to facilitate this process.

A sustainable energy pathway requires us to adopt a new vision, and a positive approach to change. New technologies are changing the world, and they are changing the way in which we can approach our energy future. Wheras a decade ago New Zealand faced some real technological constraints that limited the decision-making options, current technology development looks set to broaden our options in the future. Supply and end-use technologies are starting down a transformation pathway. The information revolution is spinning off benefits to the energy industry through such devices as "smart" meters and computerised control systems. Even relatively simple changes, such as using new time-of-use electricity meters, have the potential to alter completely the interaction between electricity supplier and customers, and patterns of energy use. New technology, brought on by new needs, will reinforce new approaches by energy suppliers and vica versa. A new energy pathway that substitutes information for energy, that encourages technological innovation, and that is dedicated to providing energy services in an economical and environmentally benign manner is not only a pathway of opportunity but also a pathway of "fun and excitment"[29].

Notes and references

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3. Campaign: Climate for Change. 1991. A national strategy to reduce greenhouse emissions. *Briefing Paper No. 5.* Auckland.

4. Calculated on the use of Maui for energy, with the following assumptions regarding transformation and conversion efficiencies (first law only): 37% Maui transformed to electricity at 33% efficiency, and with end-use conversion efficiency of 65%; 37% of Maui transformed to synthetic petrol at 50% efficiency, and used in internal combustion

engines at 20% efficiency; 25% of Maui used directly for industry, commerce and domestic at 60% efficiency. The overall efficiency calculated is 26.5%.

5. Blackburn, A. 1991. Can CNG make a comeback? *Marketing Magazine 10(9):* 38-39.

6. A shift from using gas in thermal power stations at 33% efficiency to using gas in vehicles at around 20% efficiency raises some valid objections. It could be argued that a more viable alternative would be to build a modern combined cycle generation plant operating at about 45% efficiency, and use the electricity to run electric vehicles at 70-80% efficiency. No pathway is free from contradictions!

7. McChesney, I. 1991. A bridge to nowhere? *Terra Nova 12:* 6,7.

8. An annual potential of 676 GWh has been given by Jamieson, R.E. and Pool, F. 1991. Cogeneration in New Zealand - existing capacity, future potential and the need for a cogeneration association. Paper presented to the Inaugural Cogeneration Association Seminar, Wellington, March. 11p. In another study, 1024 GWh potential was identified. See: Zoellner, S. 1991. Cogeneration in New Zealand. Reports 1-3. Gas Development Centre/Ministry of Commerce, Wellington.

9. Based on an annual utilisation factor of 35% for a moderately windy site. See: Cherry, N. 1987. Wind energy resource survey of New Zealand - national resource assessment - summary and final report. *Report No. 140.* NZERDC, Auckland.

10. Even then this has to be qualified since the large technical improvements claimed can be achieved relatively quickly for individual developments, especially if they are incorporated into designs from the start. For instance, energy savings of 50% are expected for a new hospital built in the UK that incorporates a range of energy conservation and recovery schemes. It also has its own windmill - expected to raise the level of energy savings to 60%. See: Webb, J. 1991. New hospitals save lives - and energy. *New Scientist 132(1796):* 19.

11. Con Edison. 1990. *Enlightened energy.* Con Edison, New York. 21p.

12. Cairncross, F. 1991. *Costing the earth.* The Economist Books/Business Books, London. 256p.

13. Terry, S. 1991. *Creating a market for energy efficiency.* New Zealand Planning Council, Wellington. 70p.

14. The EDRU sees the selling of end-use efficiency by the competing "wheelers" of electricity (who in effect will mostly be various supply authorities) as a potentially attractive means of gaining profitable market share - pers. com. Peter Farley, EDRU, Wellington.

15. At present Electricorp has no strong short-term incentive to promote energy efficiency. This is mainly because of current over capacity in generating plant, and the relatively short run marginal cost of supply caused by the very low gas contract price and the fact that 30% of the gas has been prepaid so is essentially a fixed cost. In Electricorp's view, it is more profitable to seek additional sales than it is to conserve electricity. Pricing strategies have also been put in place to actively prevent entry by new generators. This has been achieved by (at least) two strategies; first Electricorp's dominant position in the market place and its ability to lever down both gas and coal prices for its thermal stations, and second, its ability to load overall corporate profitability back on to the hydro stations and accept minimal returns from thermal stations operating at the margin. See: Bertram, G. 1991. Power industry reform, sustainability, and energy efficiency: some conflicts. Paper for Conference on Power Electricity Reform, Wellington, 26-27 August. 13p; Spicer, B., Bowman, R., Emanuel, D. and Hunt, A. 1991. *The power to manage.* Oxford University Press, Auckland. 188p.

16. For a discussion on these schemes see the very useful review by Sheldrick, B. and Macgill, S. 1988. Local energy conservation initiatives in the UK. *Energy Policy (December):* 562-578.

17. This argument seems to arise because of the high fixed costs of supplying electricity, and the fact that these assets are both highly visible and fixed. Yet all businesses face fixed costs to some extent - very few have the luxury of being able to pass on these fixed costs as fixed charges, and to eliminate a large part of their business risk. Why should electricity be treated differently?

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24. Pers. comm. Geoff Henderson, Wind Torque Ltd, Christchurch.

25. The World Bank, 1991.

26. Handy, C. 1990. *The age of unreason.* Arrow Books, London. 216p.

27. Milne, R. 1991. Renewable energy: Britains untapped resource. *New Scientist 132(1790):* 12-13.

28. Fletcher Challenge Limited, Energy in New Zealand, op. cit.

29. Pers. comm. Roger Sutton, Project Development Manager, Southpower, Christchurch.

CHAPTER 13

From threat .... to opportunity

The global energy system is in bad shape. Emissions from the burning of fossil fuels, the world's main energy source, is threatening the global environment. Emissions of CO_2 and other greenhouse gases are increasing steadily, enhancing the likelihood of widespread climatic change early next century. Meanwhile, oil reserves will become progressively maldistributed over the next two decades as many country's reserves are depleted, and this will likely exacerbate economic and political tensions. In short, the global energy system is unsustainable.

New Zealand is one of a handful of countries taking an activist role in setting a CO_2 emission reduction target. That New Zealand's effort, on its own, will bring about an insignificant reduction in emissions in relation to the global total is a well recognised fact. The policy is however, acknowledgement that developed countries in particular, have a moral responsibility to act, despite uncertainties.

However, some of the largest players in the energy industry in New Zealand see the target as a "threat". Electricorp and Coalcorp have both argued that such a target will impose large costs on the economy, at a time when the country can least afford it. What should we make of such claims?

We should note that these claims are assertions, and that they come from two large energy players who have an interest in maintaining the status quo. But we should not dismiss these claims lightly because they may well be correct **if we continue to take a conventional approach** to the problem.

The conventional, or business-as-usual, approach may well become increasingly costly to break out of. Business-as-usual undervalues energy, encourages energy waste, and encourages a self-reinforcing cycle of underpricing energy to maintain competitiveness. Business-as-usual looks to yesterday's technologies to meet tomorrow's challenges. It fails to provide the environmentally-benign technologies that will be needed by developing countries if they are to avoid the potentially environmentally catastrophic fossil fuel industrialisation phase that many of these countries are heading into. Business-as-usual will fail completely to bring CO_2 emissions under control.

New Zealand desperately needs to break out of its business-as-usual approach to energy. New Zealand needs a vision of a new energy pathway. Fortunately, the principles of sustainability provides one. The combination of efficiency (transformation and end-use) and renewable energy technologies seems irresistible.

An early move towards developing new-technology solar systems appears to be an opportunity of considerable promise. It demands immediate and thorough analysis. The next few years provide a unique opportunity for New Zealand to move quickly onto the technological learning curve. The anticipated secure energy supply situation for the next decade provides a stable base to phase in a new energy era.

The New Zealand Government is looking to meet its greenhouse targets by utilising "win-win" strategies. An early move towards a sustainable energy pathway offers hope for considerably better than that:

WIN - confront the looming supply "gap" and move towards a permanently sustainable energy system

WIN - bring CO_2 emissions under control and rapidly reduce them after the turn of the century

WIN - create an industry base built on genuine competitive advantage, with a captive world market

WIN - develop and deploy the technology to allow developing countries to leap-frog the fossil fuel development phase.

It will however, require an evolving transformation in our approach to energy. It will require a national commitment to energy policy, and a purposeful commitment towards meeting energy objectives. What needs to be given urgent attention is the required "nudge" to get this process underway. But once on that pathway, there is reason to believe that the evolutionary process of change will provide mutual reinforcement for the required transformation. New technologies will reinforce new institutions, which will reinforce new values, and vice versa.

And perhaps, as Amory Lovins argued 15 years ago:

> *"If we get our energy policy right many other kinds of policy will tend to fall into place too"*[1].

Now that would be too good an opportunity to pass up.

Notes and references

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