Electricity, Energy and the Environment

Part A: Making the Connections

Parliamentary Commissioner for the Environment
Te Kaitiaki Taiao a Te Whare Pāremata

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Preface

Electricity is a pivotal part of life in the 21st century. Electricity and other forms of energy are essential for sustaining humans and our social and economic well-being.

Electricity in New Zealand has historically been, and continues to be, a major provider of energy services. In the residential and commercial sectors it is used to meet 72 per cent and 58 per cent of users' respective energy demands. Over the last two decades there has been a major government review of the electricity industry. This review has looked at business models for the generation, transportation and supply of electricity, with an emphasis on increasing the economic efficiency of the electricity sector. The resulting reforms have been conducted during a period of steadily rising electricity demand; an apparent decrease in the reliability of New Zealand's major generation source (hydro); and with an insufficient focus on improving the efficiency of electricity usage.

By 2001, rising concerns about the effectiveness of the electricity sector (in environmental, social and economic terms) led to the enactment of the Electricity Amendment Act 2001. This Act, in combination with the Environment Act 1986, empowered me to undertake ongoing environmental assessments of the sector. This is a daunting task, given that there is no existing methodology for examining the environmental sustainability of an entire country's electricity sector.

There are many major benefits that can potentially be gained. Since 1994, for example, a number of countries and businesses have committed to 'Factor Four' and 'Factor Ten' reductions in energy and material intensity (with reductions in resource use of 75 per cent and 90 per cent respectively). Such a focus on resource productivity does not only seek to continuously improve energy efficiency. It also aims to facilitate major leaps in design, in order to enhance productivity and quality of life while reducing resource demands. It makes sense for New Zealand to pursue strategies that increase the productive use of electricity resources. This is especially relevant given rising global energy prices; increasing demand; New Zealand's distance from many world markets; our significant renewable fuel endowments (water, wind, solar and biomass); and our propensity for innovation.

A revolution in resource productivity and efficiency is on the horizon. *Making the Connections* and the *Proposed Assessment Framework* represent the first contribution from my team and me towards supporting the electricity sector's part in this revolution. Both documents highlight how crucial it is to make the connections between how we use and provide electricity and how this impacts on sustainability. These connections will be essential for achieving significant social and economic gains, and for putting New Zealand's electricity sector onto an environmentally sustainable pathway.

Our desire is to contribute to this transition by working in collaboration with interested parties. We will ensure that the right questions are asked, that efficient use is made of all information, and that there are no surprises in the Commissioner's approaches or findings. We will also seek assistance from specialists within New Zealand and overseas, to help raise awareness of electricity and energy opportunities that will enhance environmental sustainability.

This overview and its partner document, the *Proposed Assessment Framework*, have been compiled after discussion with, and assistance from, key participants in the electricity sector. Before proceeding further we are seeking your views. I look forward to hearing them and thank you in anticipation.

J Morgan Williams
Parliamentary Commissioner for the Environment

Overview—Making the Connections

This discussion document is part of a framework the Parliamentary Commissioner for the Environment (PCE) is developing to assess the environmental performance of New Zealand's electricity sector. The purpose of the framework is:

> *to certify that energy services from electricity are provided in an environmentally sustainable manner through ongoing environmental performance assessments of New Zealand's electricity sector.*

There are two parts to this discussion document (*Electricity, Energy and the Environment*):

Part A: *Making the Connections* (this document)

This part should be used as a reference point (although readers are encouraged to read it in its entirety). It provides background information on the assessments of New Zealand's electricity sector and explains key concepts and terms. It also provides an overview of the existing electricity sector and its impacts on environmental sustainability. Importantly, it explains key features that New Zealand's electricity sector needs to have for it to develop in a sustainable direction.

Part B: *Proposed Assessment Framework* (a companion document)

The second part explains how the Commissioner proposes to assess the environmental performance of New Zealand's electricity sector. It sets out the proposed framework for the assessments and identifies quantitative and qualitative indicators and a variety of complementary approaches.

> The Commissioner would like to hear your thoughts and ideas about the proposed framework. Public submissions are invited until 30 September 2003. Guidelines for providing feedback are provided at the end of Part B.

Key points from Part A: *Making the Connections*

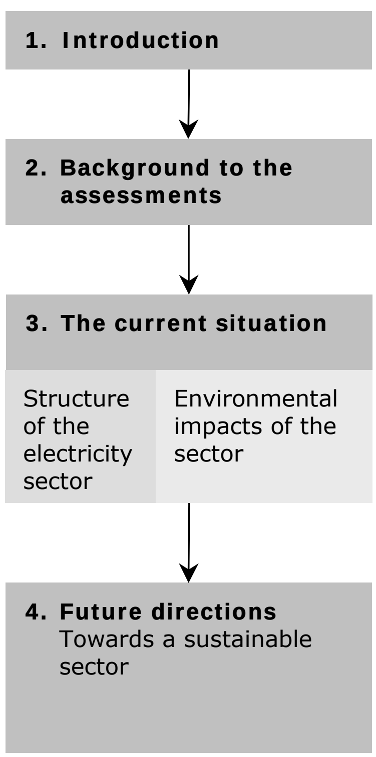
- Development of the assessment framework was prompted by an amendment to the Electricity Act 1992. This requires the Commissioner to examine the environmental performance of an Electricity Governance Organisation (EGO), which is currently being established (as an 'Electricity Commission').
- The Commissioner is also using his powers under the Environment Act 1986 to assess the environmental performance of the broader electricity sector.

- The PCE's framework will provide the foundation for all future environmental assessments. These will be conducted on an annual basis.
- There are some key features that the electricity sector needs to have for it to develop in a sustainable direction. Although the PCE has not specified what technologies should be used, all existing and future developments will need to be assessed against the criteria of environmental sustainability.
- Equal emphasis needs to be given to examining how electricity is **used** (the demand for energy services) and how it is **delivered** (the supply of electricity that is driven by the demand of users). This will be essential to develop a secure and sustainable electricity sector that promotes the environmental, social, cultural and economic well-being of New Zealanders.

Structure of *Electricity, Energy and the Environment*

There are two parts to this discussion document. This document is **Part A: *Making the Connections.***

Part A: Making the Connections



After a brief introduction, chapter 2 identifies the legislative basis for the Commissioner's assessments and discusses the methodology that has been pursued. It also explains what an assessment is and the scope of the PCE's environmental assessment framework.

For readers less familiar with the structure of the electricity sector, and/or its environmental impacts, chapter 3 provides an overview. It examines how the sector has developed over time into its current form. It also highlights how electricity is used in New Zealand, where it comes from, and key environmental impacts of electricity usage and provision.

Chapter 4 provides working definitions of environmental sustainability and sustainable development and applies these to the electricity sector. It then identifies key features that the electricity sector needs to have for it to develop in a sustainable direction.

Part B: Proposed Assessment Framework

1. Introduction

2. Scope and priorities
Scope, environmental priorities

Following an introduction, chapter 2 establishes the rationale for the proposed framework. It discusses the scope of the framework and proposes a set of environmental priorities.

3. Key institutions in the electricity sector
EGO | Broader sector

Chapter 3 discusses key institutions that affect the environmental performance of the electricity sector. It then examines how these institutions are related to the proposed environmental priorities.

4. Conceptual frameworks
Methodologies to measure progress towards sustainability

Chapter 4 identifies the conceptual basis and methodologies for the proposed framework. It introduces a set of environmental performance measures and discusses the suitability of targets in the assessment process.

5. Proposed assessment measures
EGO | Broader sector

Chapter 5 outlines the measures and procedures that the PCE is proposing to use for the assessments.

6. Process for the assessments

Chapter 6 discusses how the assessments can be applied. It includes a proposed timeline and discusses how the PCE can manage data and relationships with other agencies.

7. Providing feedback
What do you think?

Chapter 7 identifies how you can have your say about the proposed framework.

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1 Introduction

This document is part of a framework the Parliamentary Commissioner for the Environment (PCE) is developing to assess the environmental performance of New Zealand's electricity sector.

The purpose of this document is to provide background information on the framework and to explain key concepts and terms. It also provides an overview of the existing electricity sector and its impacts on environmental sustainability. Importantly, it identifies key characteristics that New Zealand's electricity sector needs to have for it to develop in a sustainable direction.

The actual framework that the PCE is proposing to use to conduct the assessments is explained in a separate document (see Part B: *Proposed Assessment Framework*).

1.1 Why is this project being done?

This project was prompted by an amendment to the Electricity Act 1992 (see chapter 2). This requires the PCE to examine the environmental performance of an Electricity Governance Organisation (EGO).

The Electricity Commission—an emerging EGO

The EGO is currently being established. As chapter 2 will highlight, the electricity industry was initially given the opportunity to establish and operate its own EGO. On 16 May 2003, industry participants rejected a self-governance model. The Government is therefore establishing an EGO called the 'Electricity Commission'.

In essence, the Commissioner needs to examine the degree to which the EGO is meeting the environmental objectives set by the Government Policy Statement (GPS) for electricity. This relationship is illustrated in figure 1.1 below. [1]

[1] Section 172ZQ(3) of the Electricity Act 1992 also specifies that this legislation does not limit any of the PCE's powers under the Environment Act 1986. Although the Commissioner is required to assess the EGO against the GPS, the Commissioner also maintains the power to review and critique the GPS if this is required.

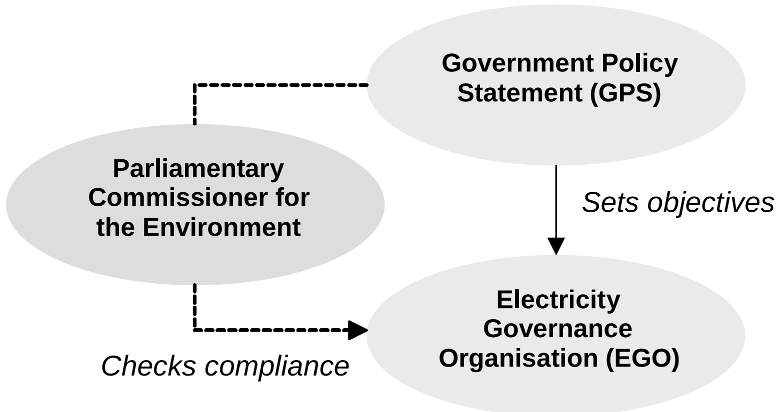

Figure 1.1: Relationship between the GPS, EGO and the Commissioner

The PCE also has an ongoing interest in the pivotal role of energy, including electricity, in New Zealand society. Although the Commissioner is required to examine the EGO under the Electricity Act 1992, he is also using his powers under the Environment Act 1986 to examine the environmental performance of the broader electricity sector. The justification for this decision can be found in chapter 2.

1.2 The importance of a sustainable electricity sector

Energy services provided by electricity have been fundamental to the social and economic development of New Zealand. An increasing supply of electricity has fostered industrial development and fuelled growth in every sphere of the economy. Towns and cities rely on a secure electricity system to maintain infrastructure for everything from water delivery to telecommunications. Electricity powers businesses and provides people with essential services like warmth and light. It has contributed to social and economic well-being for many people and become an integral part of the fabric of New Zealand society.

The natural environment has been the foundation for these developments. It has provided the resources for generating electricity and absorbed the impacts of electricity developments. At its point of use, electricity can be a relatively benign form of energy. Behind this use, however, there are always environmental impacts associated with the generation, transmission and distribution of electricity (see section 3.3). Any increasing use of electricity is therefore likely to place further pressure on the environment. To work towards a sustainable electricity sector, in which the benefits (or services) provided by electricity can be maintained far into the future, it will be necessary to sustain the environmental foundations on which the sector is based.

Many historical developments in the electricity sector have also contributed to debates and conflicts about impacts on the environment (Peat, 1995). These conflicts are often associated with the different values people hold with respect to the environment as a source for sustaining their social, cultural and spiritual well-being, as well as their economic welfare. If the electricity sector places additional pressures on the environment, ongoing tensions are likely to produce additional conflicts. Taking these aspects into consideration, it is therefore crucial to examine how electricity is used and provided in New Zealand and to ensure that the electricity sector is promoting environmental, social, cultural and economic well-being.

1.3 The purpose of the assessments

The purpose of the PCE's involvement in this area is:

> *to certify that energy services from electricity are provided in an environmentally sustainable manner through ongoing environmental performance assessments of New Zealand's electricity sector.*

To provide clarity and certainty to all stakeholders, and to ensure they understand his expectations, the Commissioner is developing an assessment framework. This will define the foundation for all future assessments (which will be conducted on an annual basis).

The key objectives for the assessment process are to:

1. meet the Commissioner's statutory obligations to assess the environmental performance of the EGO
2. provide information to decision makers in the electricity industry and government, to assist them in improving the environmental performance of New Zealand's electricity sector
3. raise awareness of the environmental aspects of the electricity sector, both among those working within the electricity industry and in the wider community
4. provide information on whether the electricity sector is assisting New Zealand to achieve its sustainable development objectives.

The PCE wishes to work with all participants in the electricity sector to assist them in the development of a secure and sustainable sector.

1.4 The structure of this document

There are three key sections in this document:

- Chapter 2 identifies the legislative basis for the assessments and discusses the methodology that has been used. It also explains what an assessment is and the scope of the PCE's environmental assessment framework.
- For readers less familiar with the structure of the electricity sector, and/or its environmental impacts, chapter 3 provides an overview. It examines how the sector has developed over time into its current form. It also highlights how electricity is used in New Zealand, where it comes from, and key environmental impacts of electricity usage and provision.
- Chapter 4 provides working definitions of environmental sustainability and sustainable development and applies these to the electricity sector. It then identifies key characteristics that the electricity sector needs to have for it to develop in a sustainable direction.

2 Background to the assessments

This chapter identifies the legislative basis for the assessments and discusses the methodology that has been used. It also explains what an assessment is and the scope of the PCE's environmental assessment framework.

2.1 Legislative basis for the assessments

The assessments of the electricity sector will be conducted pursuant to sections 172ZP(1) and 172ZQ of the Electricity Act 1992 (as amended by the Electricity Amendment Act 2001) and section 16 of the Environment Act 1986.

2.1.1 Electricity Act 1992

The initial impetus for the assessment framework came from the Electricity Amendment Act 2001. This amended the Electricity Act 1992 after more than a decade of reforms to New Zealand's electricity sector (see section 3.1). Key elements of this legislation that are relevant to the PCE's assessments are:

- The Commissioner is required to examine the environmental performance of an Electricity Governance Organisation (EGO) on an annual basis (section 172ZP(1)). The Commissioner must examine the extent to which the EGO is meeting the environmental objectives of the Government Policy Statement (GPS) for the electricity industry (see below).
- The Electricity Act 1992 does not provide the Commissioner with any specific powers to undertake the examinations. Instead, the Commissioner may exercise all of his or her powers under the Environment Act 1986 during the examination of the EGO (section 172ZQ(1)).
- The Commissioner's usual functions, duties and powers under the Environment Act 1986 are not limited in any way by the electricity legislation (section 172ZQ(3)).

The relevant sections of the Electricity Act 1992 are included in appendix 1.

The Electricity Act 1992 also requires the Auditor General to perform an assurance audit of the EGO. The Auditor General's investigation will have a different focus from that of the PCE. The Auditor General will examine the EGO's annual report to determine if it provides adequate and accurate information, and whether it gives an informed assessment of the EGO's performance against the GPS (or associated standards).

The Electricity Commission—an EGO under establishment

As noted in chapter 1, participants in the electricity industry were initially given the opportunity to establish and run their own EGO. Because the electricity industry was unable to reach agreement on a self-governing model, the Government is establishing an 'Electricity Commission' to act as a Crown EGO. The Electricity Commission will therefore be the focus of the PCE's assessments under the Electricity Act 1992.

Government Policy Statement

As noted previously, the Commissioner needs to examine the degree to which the EGO is meeting the environmental objectives of the GPS for electricity. This statement was released in 2000, after a Ministerial Inquiry into the electricity industry.[2] Its overall objective is "to ensure that electricity is delivered in an efficient, reliable and environmentally sustainable manner to all classes of consumer." Its guiding principle for the electricity industry is:

> *to ensure that electricity is delivered in an efficient, fair, reliable and environmentally sustainable manner to all classes of consumer. Industry arrangements should promote the satisfaction of consumers' electricity requirements in a manner which is least-cost to the economy as a whole and is consistent with sustainable development.*

The Government therefore expects electricity to be provided in an *environmentally sustainable* manner and in a way that is consistent with *sustainable development*. These two concepts are fundamental to this project and are examined in section 4.1.

Specific environmental objectives included in the GPS are:

- using energy resources efficiently and, in particular, minimising hydro spill
- facilitating and promoting active demand-side participation
- minimising greenhouse gas emissions
- being consistent with government policies on climate change and energy efficiency
- ensuring that the use of new electricity technologies and renewables, and distributed generation, is facilitated and that generators using these approaches do not face barriers.

2.1.2 Environment Act 1986

As highlighted above, the Electricity Act 1992 clearly specifies that the Commissioner's usual functions, duties and powers are not limited in any way by the electricity legislation. The scope of the Commissioner's usual investigative functions is prescribed in the Environment Act 1986 by the:

[2] The GPS was subsequently amended in February 2002.

- definition of environment
- role and powers of the Commissioner
- functions of the Commissioner.

Defining the environment

Section 2 of the Environment Act 1986 provides a very broad definition of environment. This includes:

- ecosystems and their constituent parts (including people and communities)
- all natural and physical resources
- those physical qualities and characteristics of an area that contribute to people's appreciation of its pleasantness, aesthetic coherence, and cultural and recreation attributes
- the social, economic, aesthetic, and cultural conditions that affect the matters listed above or which are affected by those matters.

Natural and physical resources are not defined in the Environment Act 1986. However, section 2 of the Resource Management Act 1991 defines these as including "land, water, air, soil, minerals, and **energy**, all forms of plants and animals (whether native to New Zealand or introduced), and all structures" (emphasis added).

The role and powers of the Commissioner

The primary objective of the PCE is to contribute to maintaining and improving the quality of the environment in New Zealand. The Commissioner is an independent Officer of Parliament. Independent means independent of the government of the day. The PCE has an important role to play in holding the government to account for its actions that affect the environment. This is achieved by providing independent scrutiny, advocacy and advice.

The Commissioner has wide powers to obtain information and to protect the confidentiality of that information where appropriate. The Commissioner also has the power to report any findings and to make recommendations. However, the Commissioner does not have the power to make any binding rulings and is unable to reverse decisions made by public authorities.

The functions of the Commissioner

The Commissioner's function are set out in section 16 of the Environment Act 1986. This empowers the Commissioner to investigate any matter where the environment has been, or could be, adversely affected. The functions most relevant to the electricity assessments are to:

- **review** the system of agencies and processes established by the Government to manage the allocation, use, and preservation of natural and physical resources
- **investigate** the effectiveness of environmental planning and environmental management carried out by public authorities

- **investigate** any matter in respect of which, in the Commissioner's opinion, the environment may be or has been adversely affected, whether through natural causes or as a result of the acts or omissions of any person or body
- **advise**, where necessary, the appropriate public authority and any other person or body the Commissioner thinks appropriate of the preventive measures or remedial action which the Commissioner considers should be taken.

The relevant sections of the Environment Act 1986 are included in appendix 1.

The Commissioner clearly has the discretion to use the provisions of both the Environment Act 1986 and the Electricity Act 1992 to assess the environmental performance of both the EGO and the broader electricity sector. This provides the possibility for the assessments to be very broad in scope and to go beyond those matters identified in the GPS. The approach that was used to determine the appropriate scope for the assessments is discussed in section 2.2.

2.2 Methodology

Scoping

The development of this project began in early 2002. From the outset, the PCE wanted to design an assessment framework that would be 'neutral' (in that it could apply to an EGO regardless of whether it was established by the electricity industry or by government).

To develop the scope for the assessment, the PCE enlisted the assistance of people with specific expertise in the electricity sector. This was an essential part of the process, as an assessment of this sort has never been undertaken for an electricity industry or sector before (either in New Zealand or elsewhere). There were therefore no other examples to draw upon and a new framework had to be developed.

The relationship of the EGO to the electricity industry and the wider electricity sector was examined in close detail. The mandates of the Electricity Act 1992, the GPS, and the Environment Act 1986 were considered, and core terms and concepts were defined. A broad range of institutions that could influence the scope and content of the assessment were then identified. These included the existing regulatory framework for the electricity industry, and government strategies, policies and programmes. Concepts of sustainability and relevant assessment techniques (from New Zealand and overseas) were also examined.

These institutions and initiatives were then analysed to develop a conceptual framework for the assessments. The product of this work is identified in Part B: *Proposed Assessment Framework*. Independent peer reviewers were also contracted to provide additional scrutiny.

Development of measures and targets

Key dimensions for the framework were then identified, drawing on the earlier analysis. The Commissioner and his team needed to develop appropriate measures (to assess the existing environmental performance of the sector) and targets (to identify where the sector should be heading in order for it to develop in a sustainable direction).

Firstly, relevant 'measures' were identified. These needed to be:

- capable of revealing environmental outcomes
- comprehensive
- measurable
- reliable
- timely
- cost-effective for both implementation and collection.

As a starting point it was decided to use existing data sets from government agencies and the electricity industry. However, as the assessment develops, the PCE may need to initiate additional data sets to allow a more comprehensive analysis.

It was a more complex task to determine appropriate targets. The intention of the PCE is to develop reasonable and achievable objectives for the sector to pursue. As Part B will illustrate, only a few targets have been identified for the early phases of the assessment. Nonetheless, as expertise in this area develops over time, it is expected that further targets for the sector will be introduced.

Implementation and feedback

Throughout this process, the Commissioner and his team have also engaged in an ongoing dialogue with members of the electricity industry, relevant government agencies, and other participants in the electricity sector. Several visits were conducted around the North and South Islands to talk with key players and to examine the physical structure of the industry. This dialogue (which is ongoing) is essential to inform the development and implementation of the assessment framework.

In addition, the PCE wishes to ensure that all participants in the electricity sector have the opportunity to comment on the proposed framework before the first assessment is conducted. All interested groups and individuals are therefore invited to comment by 30 September 2003 (following the guidelines provided in Part B, section 7).

It is important to note that the assessments will continue to evolve and develop over time. The framework will therefore be reviewed and refined on a regular basis. The first review will be conducted after at least two full assessment rounds have been completed.

2.3 What is an assessment?

Although the Electricity Act 1986 requires the Commissioner to undertake an 'examination' of the environmental performance of the EGO, this document uses the term 'assessment'.[3]

Similar to an audit, an assessment is an evaluation mechanism. It appraises and reports on the achievements of a management system against its stated goals and objectives. Environmental assessments are usually performed to check compliance with legislation or regulations, policies, programmes or other statements of desired outcomes.

An audit provides a practical way to demonstrate fulfilment of statutory requirements. The difference between an audit and an assessment (as used in this report) is that the latter is less retrospective. An assessment can provide a review of direction and examine the potential for future improvements. An assessment can also be used to raise awareness and to assist parties in developing solutions to problems.

The basic steps of an assessment are:

1. **Establish desired outcomes and criteria** against which overall performance will be evaluated. Maximum clarity is crucial to provide a clear direction.

2. **Set expectations** of performance for each institution being evaluated. These expectations are based on the desired outcomes. They should establish specific targets or outputs to be achieved during a specified period and need to be consistent with the purpose and the capacity of each institution being examined. Expectations can also be set for new institutions as they become established.

3. **Analyse performance** by determining any differences between the expected performance and the actual performance of each institution under examination. This requires judgements to be made. It will usually be necessary to question external parties and other stakeholders, as well as those involved in the institution itself.

4. **Provide feedback** to relevant agencies and stakeholders about the findings of the evaluation. This is necessary to assist ongoing improvement in the performance of the institution(s) towards the desired outcomes. Additional feedback from stakeholders is also needed to set further expectations.

Factors that may be critical for an assessment to be effective and meaningful include:

- agreement and commitment of the parties to participate
- clarity about the overall mission, goals, and responsibilities of the parties involved, and how the assessment contributes towards achieving these

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3 The PCE (2002b) has also discussed the concept of environmental-based assessment/audit frameworks in a recent report (in the context of the Treaty of Waitangi).

- commitment of the parties to an ethic and process of continuous improvement, so that constructive change happens as a result of the assessment
- clarity about the kinds of steps to be taken subsequent to the assessment to address or remedy any matters identified as deficient
- an agreed process for mediation of disputed findings.

2.4 What the PCE's assessments will cover

The electricity legislation was developed with a clear focus on the performance of the electricity industry and, more specifically, the EGO. Focusing an assessment on the EGO would meet the Commissioner's obligations under the Electricity Act 1992. However, such a focus may not be sufficient to ensure that energy services from electricity are being delivered in an environmentally sustainable manner.

It became apparent in the early phases of this work that the environmental performance of the EGO cannot be assessed in isolation. To adequately address the environmental objectives contained in the GPS, particularly the requirement for electricity to be delivered in an environmentally sustainable manner, the Commissioner needed to consider the ability of the EGO to influence environmental outcomes. As section 3.2 will highlight, the EGO is only one part of the electricity sector (which in turn operates within the constraints of society and its institutions). Many factors, both within and outside the sector, will therefore have an influence on the environmental performance of the EGO and the electricity sector.

It was therefore concluded that, for any assessment to be comprehensive and credible, it would be necessary to assess the EGO in a broader context. The Commissioner subsequently decided to use his mandate under the Environment Act 1986 to assess the environmental performance of the electricity industry. The electricity industry, as defined here, includes all institutions involved in the generation, transmission, distribution, and sale of electricity to users.

However, after further analysis it was determined that it would also be unfair to assess the performance of the industry without taking into consideration the wider regulatory and institutional framework that influences the environmental sustainability of the electricity industry. A decision was therefore made to increase the scope of the assessments to cover the entire electricity sector. This sector includes:

- the EGO
- the electricity industry
- government agencies that regulate the electricity industry
- electricity users
- providers of electrical equipment and infrastructure that use electricity
- demand management service providers.

The assessments will therefore consider the impacts that all institutions in the electricity sector could have on environmental sustainability. These institutions may be located within the supply side of the electricity market, they may be electricity users who demand energy services, or they may have regulatory functions. This coverage is important to ensure that equal emphasis is given to both supply-side and demand-side initiatives to promote sustainability.

The scope of the PCE's assessments is represented in figure 2.1. The assessments of the EGO are required under the Electricity Act 1992, while the Environment Act 1986 will be used to examine the broader electricity sector.

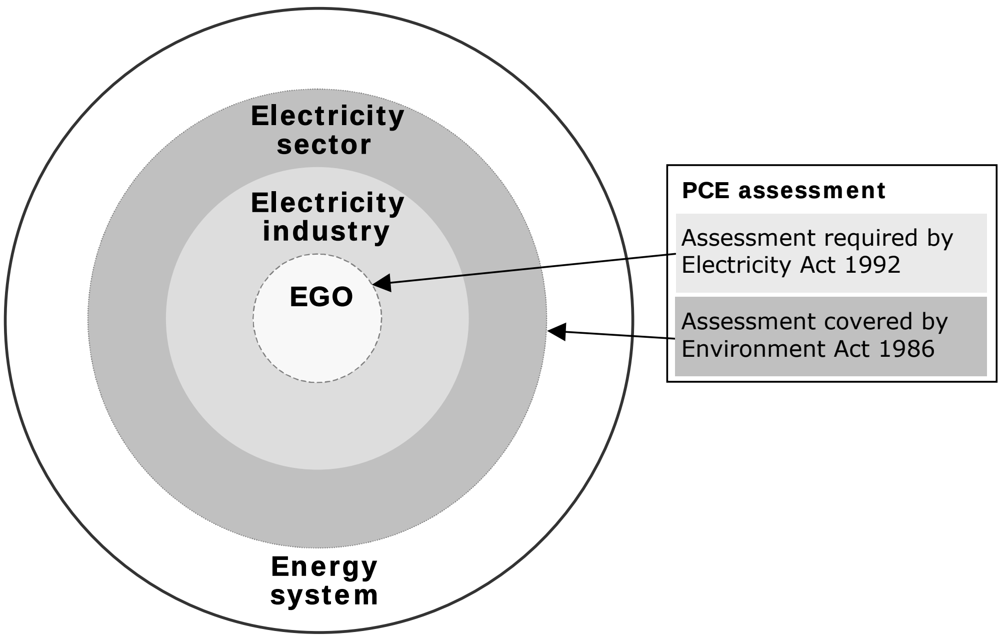

Figure 2.1: Scope of the assessments

The Commissioner also recognises that the electricity sector is placed within a much broader energy system. Other sectors within this system, particularly for gas and coal fuel sources, will also have an impact on environmental sustainability. However, these sectors will only be examined when it is possible to identify significant impacts on the environmental performance of New Zealand's electricity sector.

3 The existing electricity sector in New Zealand

This chapter provides an overview of the electricity sector and its environmental impacts. It examines how the sector has developed over time into its current form. It also highlights how electricity is used in New Zealand, where it comes from, and key environmental impacts of electricity usage and provision.

3.1 Historical developments

As noted in the introduction, electricity has been fundamental to the social and economic development of New Zealand. As the electricity sector has developed, it has greatly contributed to the well-being of many people's lives. Nonetheless, this development has also contributed to many adverse environmental impacts. Major electricity projects have even helped to forge the environmental movement in this country (Peat, 1995).

This section provides a very brief overview of how the electricity sector has developed. An historical perspective helps to illustrate how the current sector has been shaped into its present form. More in-depth coverage can be found in Martin (1991), McChesney (1991), Culy *et al.* (1995) and MED (2001).

Readers unfamiliar with the terminology in this section may wish to refer to the glossary. Figure 3.1 also provides a visual representation of how the current sector fits together.

From early sparks to an integrated system

Electricity first flowed in New Zealand in 1861 with the construction of a private electric telegraph line between Dunedin and Port Chalmers. In the 1870s, electricity was used for lighting, followed by some industrial uses in the early 1880s. Private companies and local authorities initiated early developments, which were small and concentrated on limited local areas.

By the beginning of the 20th century, local authorities had constructed a variety of small-scale hydroelectric and gas generating stations. Central government also looked at becoming actively involved in generating electricity at this time. From 1915 onwards, the Government investigated large-scale schemes, as more interconnected systems were developed overseas. Early thinking at this time provided the foundation for the system we have today (Martin, 1991).

As technologies developed, the Government began to actively encourage the generation and transmission of electricity. Large-scale public works were constructed in the pursuit of social and economic objectives. Increasing electricity capability and supply was regarded as essential for the development of New Zealand. As Martin (1991:286) notes:

in line with the government's goal of extending supply as far as possible, growth in demand was encouraged by keeping prices low, and additional capacity continued to be developed to match that growth. New projects were planned on the basis of unrestricted demand and declining real prices.

Like many other countries last century, government energy objectives were often targeted at the *supply* of electricity, with little attention given to the *demand* for electricity usage (Dobozi, 1987). Assumptions were made about unlimited supply potential and continuing economies of scale.

As the electricity sector developed, a significant cultural shift also began to occur. In the 1930s electricity and electrical appliances such as radios were regarded as 'newfangled' inventions. By the 1960s, however, electricity had become a dominant form of energy for machinery in workshops throughout the country. The all-electric home, with its television and full suite of electrical appliances, had also become the norm (a trend which has continued ever since, taking in a whole array of electronic applications). As a consequence, businesses and households throughout New Zealand became increasingly dependent on having a secure and uninterrupted supply of electricity.

Putting remote settlements throughout New Zealand on the national grid also emerged as a central goal of national development from the mid-1900s. Up until the 1970s, central government assumed a large responsibility for the development, control and financing of the electricity sector. Prices for electricity were determined by regulatory procedures instead of on the basis of cost recovery. Prior to the creation of the Electricity Corporation of New Zealand (ECNZ; see below), electricity generation and transmission were the responsibilities of the Ministry of Energy through its operational division, the New Zealand Electricity Department.

The significance of 2013

There are likely to be significant opportunities for more distributed generation and on-site generation in New Zealand as March 2013 approaches. After this date, there will be no requirement for electricity lines companies to service their customers. This is most likely to affect users in remote areas. As a consequence, the existing configuration of the physical electricity system is likely to change.

Commercialisation of the system

In the mid-1980s a major review of the Crown's role in the electricity sector commenced. This was conducted in the context of major social and economic reforms during this period. Consistent with the dominant thinking of the day, much less reliance was placed on government intervention in resource planning and a more market-oriented approach was pursued. State institutions were restructured and corporatised (i.e. redesigned to run like a model of a private business enterprise).[4]

In 1986, the Government announced its decision to reform trading activities for the generation and transmission of electricity. The Electricity Corporation of New Zealand (ECNZ) was set up as a commercial, profit-seeking State Owned Enterprise (SOE). ECNZ had responsibility for the generation and retailing of electricity and transmission via the national grid (through its subsidiary Transpower). At a local level, electricity was distributed through local electricity supply authorities.

In the early 1990s further reforms were conducted. Under the intention of improving economic efficiency, the Government advocated the need for promoting competition. The Electricity Act 1992 provided for the deregulation of the sector, with a form of competition introduced into the generation and retail sectors of the industry. Transpower, which retained responsibility for national transmission of electricity, became a stand-alone entity. ECNZ was split into two competing SOEs (called ECNZ and Contact Energy), and competitive wholesale electricity market arrangements (known as NZEM (New Zealand Electricity Market) and MARIA (the Metering and Reconciliation Information Agreement)) started operating. Contact Energy was subsequently privatised, and ECNZ was split again into three competing state-owned generators (Genesis, Mighty River Power and Meridian). The Act also stipulated that electricity lines businesses (involved in local distribution of electricity) would not be required to provide lines services to all existing customers from March 2013 onwards. Lines businesses were subsequently required to be under separate ownership from retail and generation businesses.

A shifting regime

Following the election of a new Government in 1999, there was another shift in direction. A Ministerial Inquiry was launched into the electricity industry. This focused on electricity distribution and retailing, the wholesale electricity market, and the national transmission grid. A key conclusion from this inquiry, which the Government supported, was that industry-derived solutions should be encouraged wherever possible.

The new regime is still under construction. A core component of this regime is the establishment of an Electricity Governance Organisation (EGO). Industry participants were initially given the opportunity to establish and run their own EGO to set rules for the industry. As noted in chapters 1 and 2, however, the electricity industry was unable to reach agreement on a proposed governance structure. The Government is therefore establishing a Crown entity instead. This has been labelled an 'Electricity Commission', which will have seven members tasked with governing the sector.

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[4] Although SOEs are structured like profit-seeking organisations, they are also required under the State Owned Enterprises Act 1986 to produce a statement of corporate intent. This mechanism (which still exists today) was developed to provide the Government with some control over SOEs and to encourage them to pursue objectives in the 'public good'.

Electricity in New Zealand's geography

The development of New Zealand's electricity sector has been very strongly influenced by both geography and climate. These factors continue to determine many of the strengths and weaknesses of the system for electricity usage and supply in this country.

New Zealand is remote from other sources of electricity supply. This means that electricity cannot be imported from other countries. The only way that energy can realistically be imported is in the form of fuels such as petroleum-based products, coal or possibly Liquefied Natural Gas (LNG).

New Zealand has a young and active geology. This has resulted in fast flowing rivers in steep narrow valleys. These valleys have limited capacity for large-scale hydro lakes. The capacity for new hydro storage is now extremely limited and our existing structures are closer to 'run-of-river' plants than the large hydro constructions seen elsewhere in the world. This increases the importance of demand side participation to manage the risks of water shortages.

The electricity system has also been influenced by the distribution of mountain ranges in New Zealand and the country's long shape. The mountainous South Island has provided many of the best hydro sites (around 66 per cent of all hydro) but the major population centres are located in the North Island (where about 60 per cent of the electricity is used—see figure 3.6). This has resulted in an electricity grid that is primarily designed to move electricity from South to North. As a consequence, the national grid is considered to be 'long and stringy' and there are limited cross connections for electricity. This means that if key lines fail, such as the High Voltage Direct Current (HVDC) link between the North and South Islands, there could be a critical failure of the system. The long transmission distances also mean that significant transmission losses occur (these are generally assumed to be around 10 per cent).

Another factor that has helped to define the current structure of the electricity sector is that all economic gas discoveries to date have been found in the Taranaki region. Transporting this energy source (either as gas or as electricity generated from this gas) to the major demand centres has added to the 'bottlenecks' on the infrastructure for energy transport (i.e. both gas pipelines and the electricity transmission grid).

New Zealand's climate is subject to El Nino weather variations and prevailing westerly winds. This also impacts on the electricity system, both in terms of supply and demand. The prevailing wind means that there are significant rain shadow areas in the east. This feature, in combination with an increased occurrence of El Nino dry year events, adversely affects the capacity of southern lakes for hydro generation. This occurs at the same time that there is increasing electricity demand for energy-intensive irrigation (see also section 3.3 on climate change).

On the other hand, New Zealand's location in the 'roaring 40s' provides a significant wind resource that is more economic than in most other parts of the world. Our wave power potential has also been rated as being in the top bracket worldwide.

3.2 Current shape of the electricity sector

3.2.1 Key institutions in the sector

The physical structure of the current electricity sector is illustrated in figure 3.1. Although this is a large simplification, it identifies the core components that collectively contribute to the physical structure of the sector. Connected with these, there are also many individuals and institutions involved in the regulation, provision and usage of electricity. Key institutions are summarised in table 3.1.

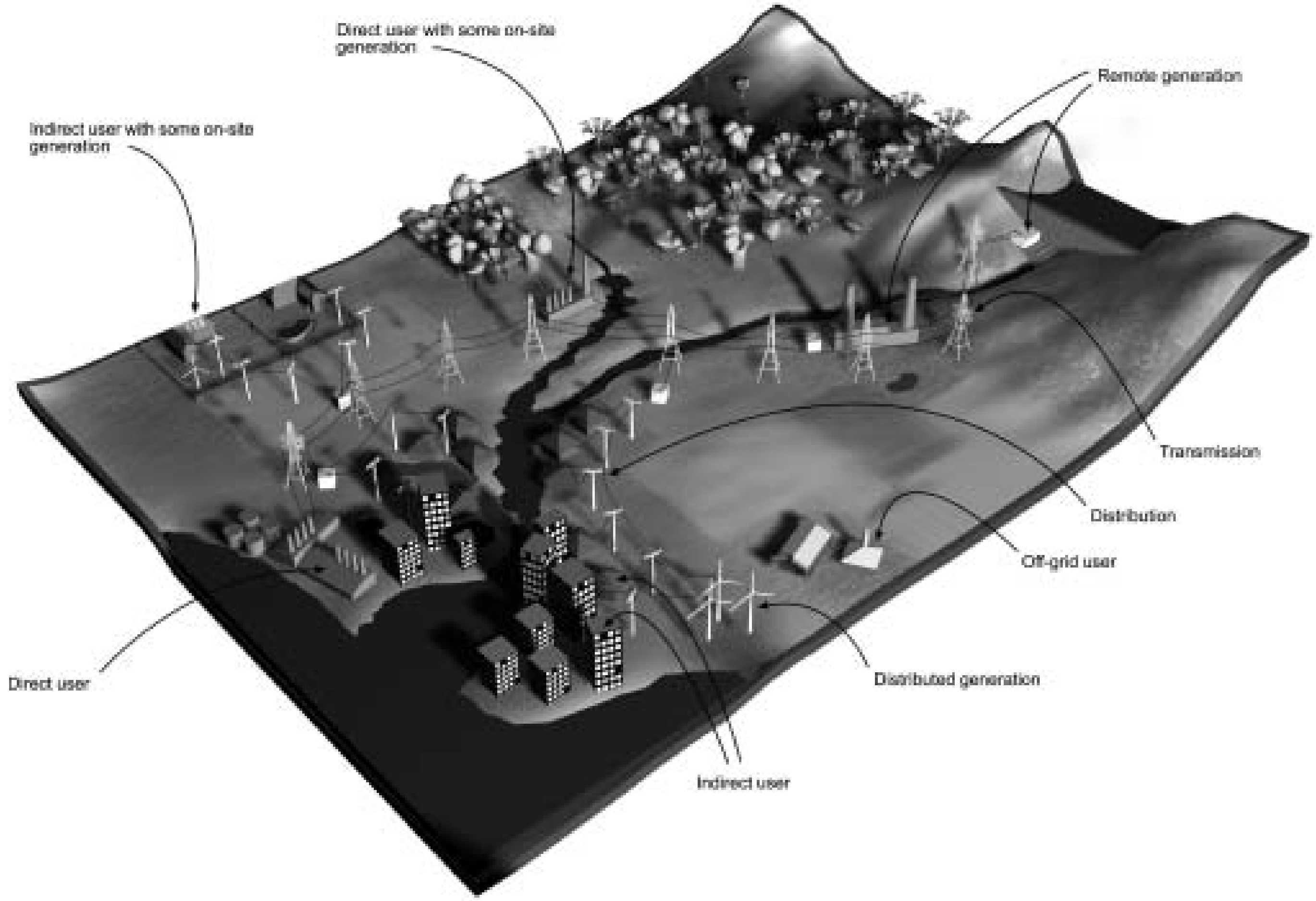


Figure 3.1: Physical structure of the electricity sector

Table 3.1: Key institutions in the electricity sector

<table>
<tr><th colspan="2">REGULATORS</th></tr>
<tr><td colspan="2">EGO—will be the primary regulator of the electricity industry, concentrating on the wholesale electricity market, and transmission and distribution pricing.</td></tr>
<tr><td colspan="2">Ministry of Economic Development—under the Electricity Act 1992, has regulatory oversight of the electricity sector and responsibility for policy formation.</td></tr>
<tr><td colspan="2">Commerce Commission—empowered by the Commerce Act 1986, aims to promote market efficiency, primarily by enforcing and fostering competition.</td></tr>
<tr><td colspan="2">Regional Councils—through the Resource Management Act 1991, allocate and control the use of natural resources such as land and water, and manage air quality.</td></tr>
<tr><td colspan="2">Local Councils—through the Resource Management Act 1991, control the use of land and emissions of noise.</td></tr>
<tr><th colspan="2">INDUSTRY PARTICIPANTS</th></tr>
<tr><th>Electricity usage</th><th>Electricity provision</th></tr>
<tr><td>Users—individuals, households or businesses that demand energy services provided by electricity. They include:
• Direct users—receive electricity directly from the national grid
• Indirect users—receive electricity via distribution networks
• Off-grid users—use electricity generated on-site.</td><td>Generators—organisations or individuals that generate electricity. They include:
• Remote generators—generate electricity in one area for use in another area (transported via the national grid)
• Distributed generators—generate electricity for use within a local network
• On-site generators—generate electricity on a user’s premises (ranging from domestic users through to large scale industrial users).</td></tr>
<tr><td>Energy management service providers—provide a range of services to users to assist them in making more efficient use of energy, including electricity.</td><td>Transmission—transport of electricity via the national grid through high voltage power cables. Currently the responsibility of Transpower.</td></tr>
<tr><td>Providers of electrical equipment—design and/or manufacture devices that are powered by electricity.</td><td>Distributors—transport electricity through a local network via low voltage power lines.</td></tr>
<tr><td>Providers of infrastructure—design and/or build major infrastructure (such as buildings) in which electricity is used.</td><td>Retailers—monitor the electricity usage of households and businesses and bill them accordingly. Many of these companies are also involved in generation.</td></tr>
<tr><th colspan="2">OTHER KEY INSTITUTIONS</th></tr>
<tr><td colspan="2">Treaty of Waitangi—particularly relevant to issues of ownership and access to energy related resources and impacts on taonga of tangata whenua.</td></tr>
<tr><td colspan="2">Market services—the various organisations or arrangements that allow the electricity sector to operate. These include:
• New Zealand Electricity Market (NZEM)—the current trading arrangement where most wholesale electricity is bought and sold on a half-hourly basis. It is a voluntary market that operates within a code of conduct (the rules of NZEM). It is currently administered by M-Co (the Marketplace Company).
• Market Surveillance Committee—an independent body charged with the surveillance and compliance of NZEM.</td></tr>
<tr><td colspan="2">EECA—responsible for the development and implementation of the National Energy Efficiency and Conservation Strategy.</td></tr>
<tr><td colspan="2">Climate Change Office—implementing the Government’s climate change policy package.</td></tr>
<tr><td colspan="2">Building Research Association of New Zealand—conducting the Household Energy End-Use Project to measure and model the way energy is used in NZ households.</td></tr>
<tr><td colspan="2">See also Part B, section 3.1 for key legislation and additional institutions relevant to the electricity sector</td></tr>
</table>

3.2.2 The electricity market and the EGO

In addition to the institutions identified in table 3.1, the electricity market is the segment of the electricity sector involved in buying and selling electricity and electricity related services. Traditionally the market has been grouped into the:

Wholesale market: where purchasers (industrial users and retailers) buy electricity off generators. It includes the half-hourly spot market, longer-term contract markets, and the security and reserve markets.

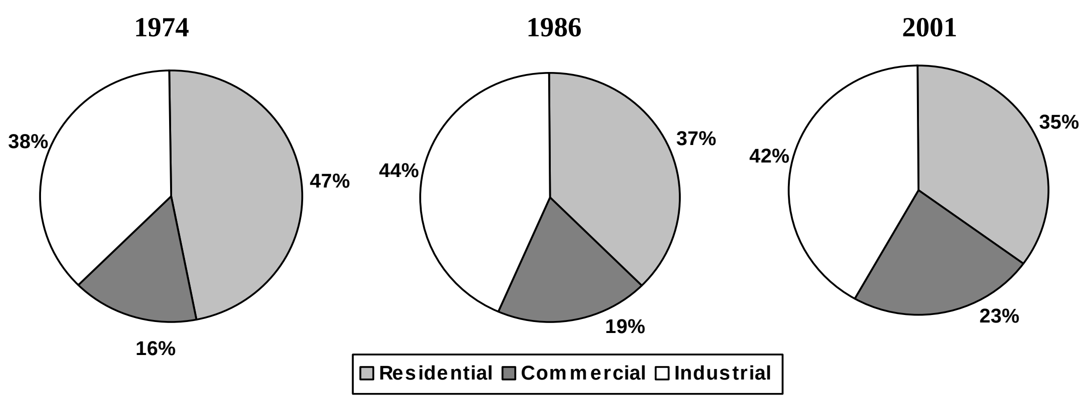
Transmission and distribution market: where generators and retailers purchase access to national and local grids.

Retail market: where users purchase electricity from electricity retailers.

Potentially, the electricity market could also include demand side participants. These participants can sell the value of reduced electricity demand into all of the markets identified above.

3.2.3 How is our electricity used?

Electricity is a major form of energy in the industrial, commercial and residential sectors of New Zealand.[5] As figure 3.2 highlights, the industrial sector[6] is currently the biggest user of electricity (using over 40 per cent of all electricity produced). The residential sector uses approximately a third of electricity, while the commercial sector uses just under a quarter.



Source: MED (2002)

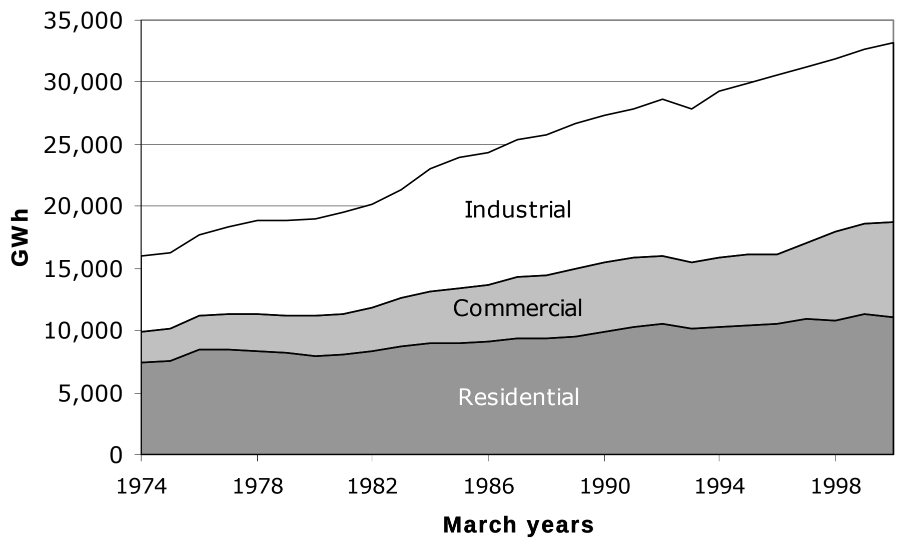
Figure 3.2: Share of electricity use by sector (1974–2001)[7]

The proportions of usage by the different sectors have changed significantly over time. Thus, in 1974 the residential sector used 47 per cent of all

5 The definitions for these sectors are taken from MED (2002).
6 As noted above, the 'industrial' sector includes the primary production sector, which used approximately 6.8 per cent of electricity in New Zealand in 2001.
7 NB: Some totals may not equal 100 per cent due to rounding.

electricity, the industrial sector used 38 per cent and the commercial sector used 16 per cent (MED, 2002). By 1986 (prior to the electricity reforms) the share of the industrial sector had climbed to 44 per cent, the commercial sector reached 19 per cent, and the residential sector's share of the total was 37 per cent.

As figure 3.3 illustrates, total usage of electricity has more than doubled over the last three decades. Trends within these sectors over the last thirty years are also discussed below.



Source: MED (2002)

Figure 3.3: Total electricity use by sector (1974–2001)

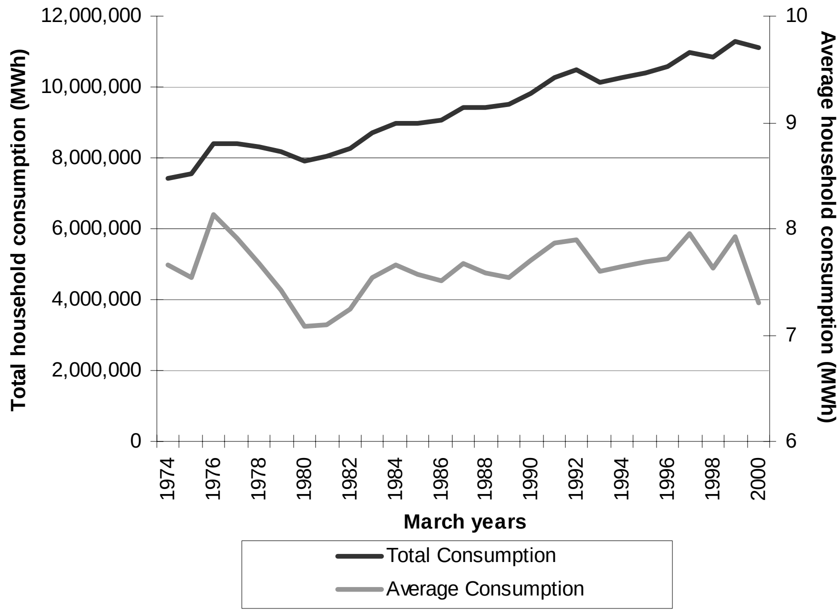
The residential sector

Electricity is the most significant form of energy in the residential sector[8] (providing 72 per cent of energy used in 2001). Approximately 45 per cent of this electricity is used for water heating, 20 per cent for space heating, 10 per cent for refrigeration, nearly seven per cent each for cooking, lighting, electronics and other electrical uses, and the remaining four per cent for laundry (EECA, forthcoming).

There are a variety of influences that are currently impacting on residential energy use (including electricity). These include: rising per capita incomes and lifestyle changes; bigger houses with fewer occupants and more heating and lighting; deregulation of the energy sector; growing environmental concerns; evolving fashions in building designs; energy efficiency regulations for new buildings; and growing recognition of the links between health and energy efficiency (*ibid.*).

[8] The residential sector includes all separately metered private houses, including unoccupied private holiday homes (but not commercial accommodation such as motels and hostels).

Between 1974 and 2000, total electricity use in the residential sector increased by 49 per cent (MED, 2002). This is illustrated in figure 3.4. This increase can largely be attributed to the increase in population during this period and a rise in the number of households. Average use per household decreased during this period by five per cent. This decrease may have been affected by improved energy efficiency (through, for example, the construction of better insulated houses). However, it is also likely to have been influenced by fuel switching (using alternative sources of energy such as gas, wood and coal). Although average electricity consumption has dropped slightly since 1990, average energy use per household has actually grown by about two per cent over this period (BRANZ, 2002).



Source: MED (2002)

Figure 3.4: Electricity use in the residential sector (1974–2000)[9]

The commercial sector

Electricity is also the most significant form of energy for the commercial sector[10] (providing 58 per cent of energy in 2001). Electricity use within this sector is generally dominated by services that provide a comfortable working environment within buildings. Approximately 27 per cent of the electricity used in this sector is for space heating and cooling, 22 per cent for lighting, 19 per cent for refrigeration, 12 per cent for motors, 10 per cent for electronic equipment, six per cent for water heating and four per cent for cooking (EECA, forthcoming).

9 The average consumption figure for 2000 is likely to have been higher than this graph indicates. This is because the number of residential customers for 2000 may have been overstated as a result of double-counting customers who switched from one retailer to another.

10 The commercial sector includes non-manufacturing businesses such as hotels, motels, restaurants, wholesale businesses, retail stores, and health, social and educational institutions. It also includes electricity used in public lighting, railway and urban traction.

Between 1974 and 2000, total electricity use in the commercial sector increased by 175 per cent (MED, 2002). More recently, electricity use increased by 27 per cent between 1996 and 2001. This may have been due to a relatively fast growth in electronic office equipment use during this period (EECA, forthcoming).

The industrial and primary production sectors

Between 1974 and 2000, total use of electricity in the industrial sector[11] increased by approximately 142 per cent (MED, 2002). This sector is extraordinarily diverse. It includes (according to the classification in the Energy Data File (MED, 2002)) the primary production sector. Separate data for this sub-sector has been identified below.

Approximately 30 per cent of the energy used by industry (excluding primary production) in 2001 was provided by electricity. This is still the major form of energy for the sector (MED, 2002). Electricity usage is dominated by a relatively small number of large industrial users. Thus, seven firms used approximately 52 per cent of electricity in the industrial sector in 2000 (or 23 per cent of New Zealand's total electricity supply) (MED, 2002).

The primary production sector used approximately seven per cent of total electricity in New Zealand in 2000 (MED, 2002). Electricity accounted for 24 per cent of total energy use in this sector in 2001 (the dominant form of energy for primary producers was oil) (MED, 2002).

Wasted opportunities in New Zealand's electricity usage

Over the last two decades, various commentators have highlighted considerable potential to improve energy efficiency in the electricity sector of New Zealand. For example, it has been estimated (EECA, 2000) that:

- the residential sector could cost-effectively reduce electricity usage by 19 per cent by giving priority to investing in energy efficient technologies, retrofitting houses (e.g. through increased insulation) and establishing behavioural changes (such as turning appliances off instead of placing them on standby)
- the commercial sector could achieve cost-effective savings in electricity usage of 30 per cent by giving priority to changes in technology, building designs and improved energy management
- the industrial sector could achieve cost-effective savings in electricity usage of 20 per cent, mostly through efficiency gains in electrical motor-drive systems.

[11] The MED (2002) definition of the industrial sector refers to everything beyond the residential and commercial sectors. The primary production sector, as defined here, includes agriculture, forestry and logging, hunting, commercial fishing, mining and exploration, and the processing of primary products such as dairy products processing, meat processing and other food processing.

Work undertaken by Bishop (2001) also suggests that there is considerable scope for cost-effective energy efficiency improvements in New Zealand. Bishop estimates that $75 billion worth of energy savings (including those in the electricity sector) could be achieved in the New Zealand economy over the next two decades at a cost of only $12 billion.

In spite of this potential, evidence from EECA (forthcoming) suggests that there is a very low uptake of energy efficiency improvements in the residential and commercial sectors. Between 1997 and 2001:

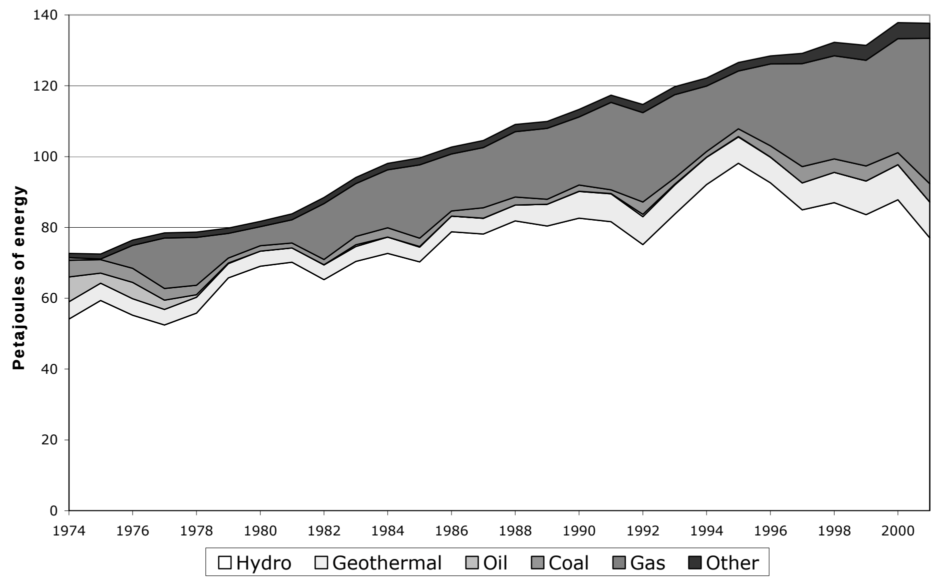
- energy efficiency in the residential sector showed negligible improvements, worsening over two years and improving only slightly over the other three years
- energy efficiency in the commercial sector worsened overall
- energy efficiency in the industrial sector improved by approximately 1.1 per cent per year.

In addition, EECA (2002) has estimated that 400MW of electricity could realistically be saved by increasing demand side participation of industrial users. These savings could avoid the need to build 400MW of further generation capacity (at a cost of approximately $340 million) and bring financial benefits of between $10 million and $100 million per year.

3.2.4 Where does our electricity come from?

To meet demand for electricity (which, as noted in section 3.1, has been encouraged by successive governments to meet their visions for national development), electricity generation has doubled over the last two decades. As figure 3.5 illustrates, electricity has been generated from a variety of different sources. Hydro facilities have consistently generated the main share of electricity (approximately 55 per cent in 2001). Hydrology changes over the years, with intermittent dry years, have contributed to the fluctuation in the proportion of hydro to other sources.

Figure 3.5 also highlights the increasing share of gas used to generate electricity in New Zealand since the mid 1970s (when the Maui gas field was developed).

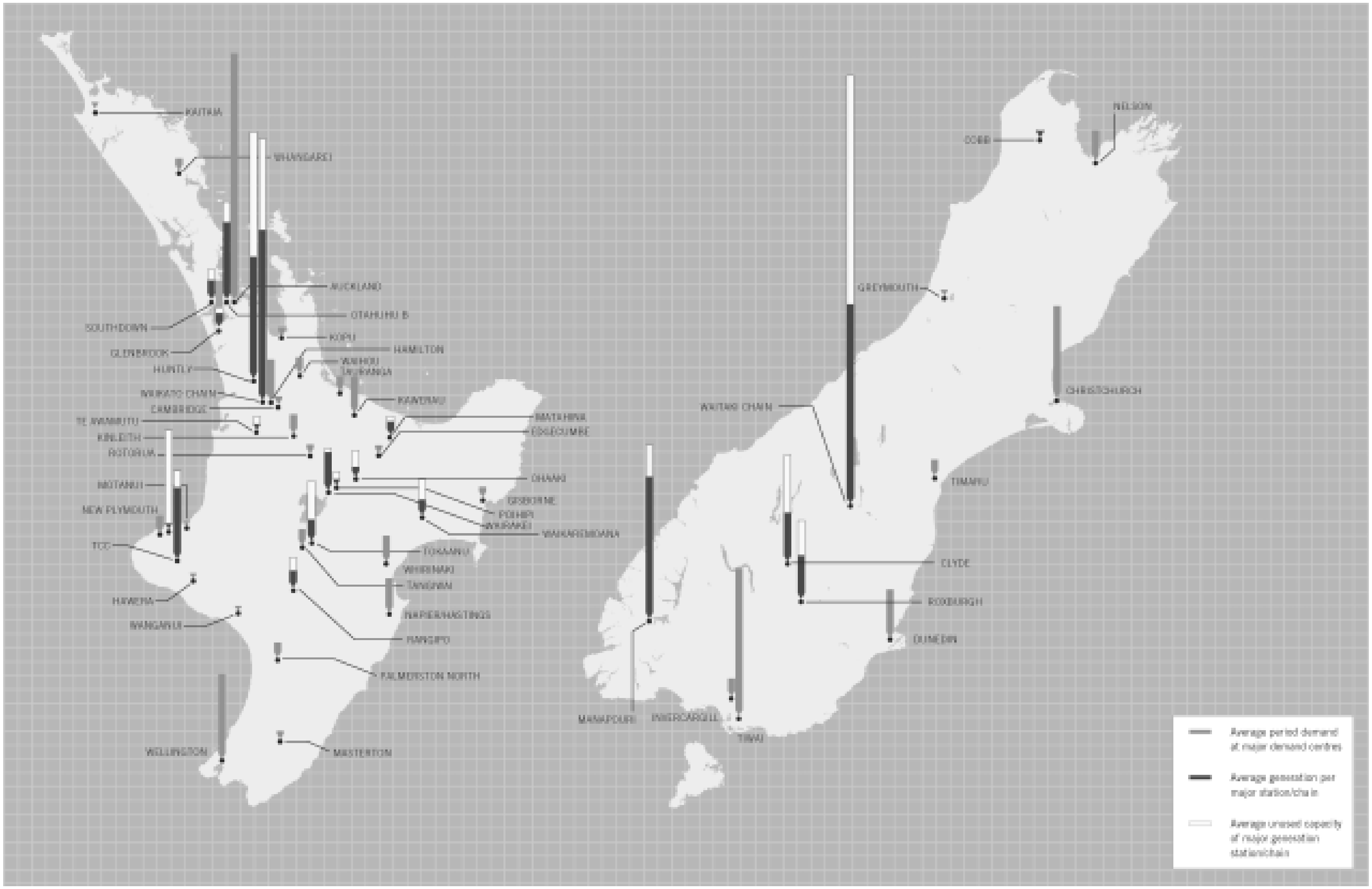


Source: MED (2002)

Figure 3.5: Annual electricity generation (1974–2001)

Figure 3.6 provides a useful indication of where the majority of electricity in New Zealand is generated and used. It highlights:

- the distances between where electricity is generated and where it is often used
- a significant dependence on hydro generation
- the large generation from the South Island hydro stations
- the major contribution of the Huntly, Otahuhu B, TCC and New Plymouth thermal (gas and coal) stations in the North Island
- the close match between generation from the Manapouri hydro station and demand from the Tiwai Point aluminium smelter.



Source: M-Co (2003)

Figure 3.6: Major electricity demand centres and production areas in New Zealand

3.3 Environmental impacts of the sector

There is a considerable body of literature on the environmental effects of energy use, including electricity.[12] Tables 3.2 and 3.3 provide a brief summary of key adverse impacts that are often associated with electricity usage, from generation to distribution.

Not surprisingly, the most significant impacts are associated with the generation of electricity and its transportation to the point of use (as well as during the transportation of fuel used for generation). Both tables highlight the fact that environmental impacts reverberate over long distances (as well as over time). Cumulatively, this means that initiatives at a local or regional level can have downstream consequences for the national environment and, in some cases, on the global environment. The fact that global environmental trends such as climate change can contribute to local impacts in New Zealand reinforces the need to neutralise any 'footprint' that the electricity sector may be having on the atmosphere.

Table 3.3 includes major generation technologies that are currently being used, or have been used recently, in New Zealand. It groups environmental impacts into two categories:

- impacts linked to the construction of facilities and the ongoing extraction of energy sources
- impacts associated with ongoing generation.

The environmental impacts from using fossil fuels for electricity generation are (as a general rule) much more significant than those of using renewable resources.[13] A full environmental analysis of any generation technology and fuel source should always take into account the full life cycle of electricity generation (from the extraction of raw materials through to the management of waste and decommissioning of any infrastructure).

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[12] For example, see East Harbour Management Services Limited (2002); IEA (1998), MfE (1997) and http://www.powerscorecard.org/technologies.cfm

[13] See for example http://www.appa.es/dch/artic/estudioimpactos_en.pdf

Table 3.2: Potential environmental impacts from the electricity sector

Context	Local	Regional	National	Global
Usage	***Drives all impacts from generation to distribution***			
Distribution	• Minor loss of habitat with temporary land disturbance. • Adverse visual impacts on urban scenery and rural landscapes. • Health concerns about low frequency electromagnetic fields.		• Indirect impacts from energy and resources used in making and transporting construction materials.	
Transmission	• Habitat loss from pylon sites and access roads. • Adverse visual impacts. • Effects on taonga of tangata whenua. • Health concerns about low frequency electromagnetic fields. • Safety concerns about high voltage overhead cables.		• Impacts on scenic and world heritage landscapes. • Indirect impacts from energy and resources used in making and transporting construction materials.	
Generation	***See table 3.3***			

Table 3.3: Potential environmental impacts from electricity generation

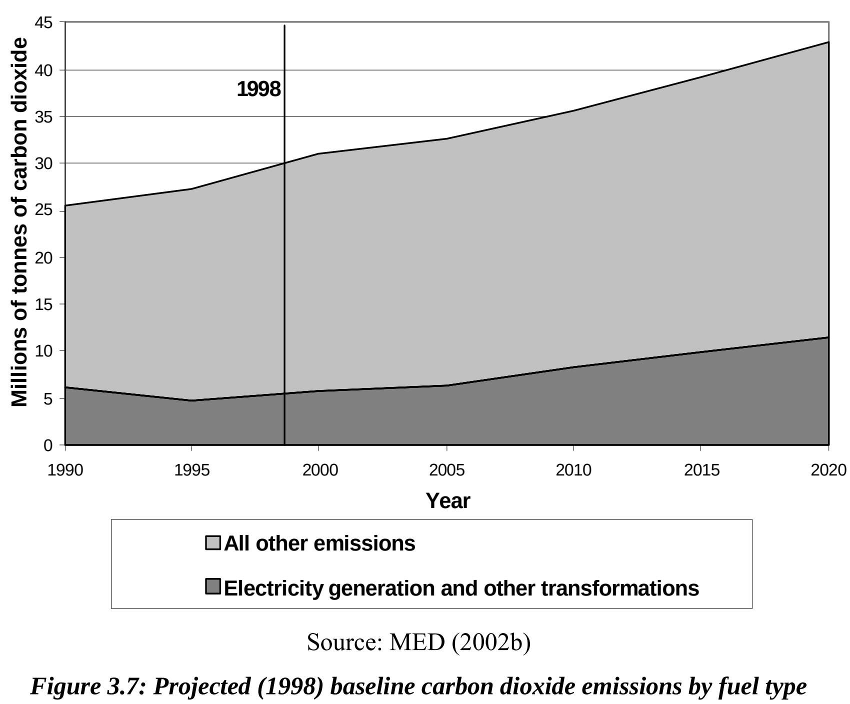
	Construction / Ongoing fuel extraction	Ongoing generation
Fossil fuels (coal, gas, oil)	**Local / Regional** • Impacts on habitat and biodiversity. • Contamination of soil and water. • Health effects from local pollution. • Disruption of aquatic ecosystems during offshore extraction (gas, oil). • Risk of spillage (oil). • Risk of fire/explosions from pipelines (gas, oil). • Impacts on environmental taonga of tangata whenua. • Adverse visual effects from open-cast mines (coal). • Construction noise. **Global** • Contribution to climate change from flaring (gas, oil).	**Local / Regional** • Discharge of contaminants (oxides of sulphur, oxides of nitrogen, carbon monoxide and particulates) into air. • Health effects from polluted air. • Discharge of contaminated coolant water at an elevated temperature with impacts on aquatic life. • Impacts on environmental taonga of tangata whenua. • Transportation noise (coal). • Flaring and fan noise (gas). **Global** • Depletion of ozone layer. • Contribution to climate change from CO_2 emissions.
Hydro	**Local / Regional** • Major changes to land forms. • Impacts on habitat and biodiversity. • Air and water pollution from construction activities. • Impacts on environmental taonga of tangata whenua. • Disruption of mauri of the river. • Impacts on recreational activities. • Construction noise. **Global** • One-off impacts from energy and materials used in making and transporting generation equipment.	**Local / Regional** • Artificial flow regimes. • Impeded fish passage. • Impeded sediment flows. • Impacts on environmental taonga of tangata whenua. • Disruption of mauri of the river. • Coastal erosion from reduced sediment flows. **Global** • Contribution to climate change from methane emissions (from decomposing vegetable matter under hydro lakes).
Geothermal	**Local / Regional** • Possible subsidence and hydrothermal eruption risk. • Contamination of drinking water supplies. • Impacts on habitat and biodiversity including specially adapted flora and fauna (e.g. heat resistant bacteria). • Possible adverse impacts on other users of the geothermal field (e.g. tourism and domestic interests). • Impacts on environmental taonga of tangata whenua. • Depletion of the geothermal field. **Global** • Contribution to climate change from CO2 emissions.	**Local / Regional** • Re-injection of cooled water. • Adverse impact on aquatic ecosystems and human health from the discharge of contaminated water (e.g. containing mercury and arsenic). • Visual effects and impacts on road safety of large foggy areas. • Venting noise. • Impacts on environmental taonga of tangata whenua. • Neighbouring undeveloped fields adversely affected.
Biomass	**Local / Regional** • Risks of erosion. • Impacts on water usage and water quality. • Impacts on habitats and biodiversity. • Degradation of soil structure and soil fertility from poor crop management. • Impacts on environmental taonga of tangata whenua. • Impacts from transportation of materials.	**Local / Regional** • Oxides of sulphur and oxides of nitrogen emissions. • Noise impacts.
Wind	**Local / Regional** • Small scale habitat disturbance. • Impacts on environmental taonga of tangata whenua. • Adverse visual impacts. • Construction noise. **Global** • One-off impacts from energy and materials used in making and transporting generation equipment.	**Local / Regional** • Habitat disturbance. • Bird strike. • Impacts on environmental taonga of tangata whenua. • Noise and visual impacts. • Impacts on bird brooding/roosting if inappropriately located.

Responding to climate change

The most significant impact that New Zealand's electricity sector has on the global environment is through its contribution to climate change. This impact has increased in recent years and is set to increase more rapidly (see figure 3.7).

Greenhouse gases (primarily carbon dioxide, methane and nitrous oxide) that exist in the atmosphere allow warmth from the sun to build up on the planet. This makes life on earth, as we know it, possible. However, international scientific consensus suggests that human activities are contributing to an increased level of these gases in the atmosphere. In particular, significant amounts of carbon dioxide (CO_2) are being released from the burning of fossil fuels like coal, petrol and gas, as well as from deforestation. These emissions are enhancing the greenhouse effect, an impact that is known as global warming or (more accurately) as climate change.

Electricity generation was responsible for about 23 per cent of the 29.8 million tonnes of CO_2 emitted from energy sources in New Zealand in 2001 (MED, 2002b). Approximately 76 per cent of these emissions came from natural gas combustion, 20 per cent from coal combustion and four per cent from geothermal generation. MED (2002) projections for the electricity sector suggest that, if there is 'business as usual', CO_2 emissions will increase by 89 per cent above 1990 levels by 2020. This trend, and the proportion of CO_2 emissions from the electricity sector relative to other sectors, is illustrated in figure 3.7.



Source: MED (2002b)

Figure 3.7: Projected (1998) baseline carbon dioxide emissions by fuel type

New Zealand is committed to reducing its greenhouse gas emissions to meet its obligations under the United Nations Framework Convention on Climate Change (UNFCCC). The Kyoto Protocol of the UNFCCC requires New Zealand to return its greenhouse gas emissions back to 1990 levels, on average, between 2008 and 2012. Alternatively, New Zealand needs to take responsibility for emissions above 1990 levels if this target cannot be met. The New Zealand Government ratified the Protocol in December 2002. The Protocol will only enter into force if:

- at least 55 countries ratify the Protocol, and
- the developed countries that ratify the Protocol are collectively responsible for at least 55 per cent of the carbon dioxide emissions that were produced by developed countries in 1990.

By April 2003, 106 countries had ratified the Protocol, representing 44 per cent of total emissions. It is likely that Russia will ratify the Protocol during 2003, thereby bringing it into force.

Adapting to climate change

Scientific projections indicate that climate change is likely to have a significant impact on New Zealand with the occurrence of more extreme weather patterns, including floods and droughts. Climate change is also associated with changes in the frequency and severity of natural events such as El Nino.[14] Changing weather patterns will impact on the electricity sector in two significant ways:

- increasing frequency of dry-year events will place pressures on the system by shifting demand for electricity (e.g. for additional irrigation in dry areas) while simultaneously reducing the capacity of hydro generation (especially from the southern hydro lakes)
- an increasing frequency of storm and flood events could damage generation and transmission assets (e.g. damage to hydro and wind turbines, and power lines).

Those managing the future of the electricity sector must consider how to adapt to climate change. It will be imperative to introduce more resilience into the system, primarily through:

- increasing the ability of the system to deal with short-term outages
- reducing reliance on dry-year affected assets
- reducing reliance on key transmission and distribution assets.

The commonly stated response to these risks (especially for dry-year risk) is to build more thermal generation close to centres of demand, thereby reducing reliance on hydro generation. However, reliance on this response is very unlikely to be consistent with the criteria of environmental sustainability. Other approaches will therefore need to be considered.

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[14] See www.climatechange.govt.nz/resources/resources_cc_impacts_region_alt.htm

4 Towards a sustainable electricity sector in New Zealand

This chapter provides working definitions of environmental sustainability and sustainable development and applies these to the electricity sector. It then identifies key characteristics that the electricity sector needs to have for it to develop in a sustainable direction.

4.1 What do we mean by sustainability?

4.1.1 Environmental sustainability and sustainable development

As noted in section 2.1, the Government Policy Statement (GPS; which establishes the Government's expectations for the electricity sector) requires electricity to be delivered in an environmentally sustainable manner and in a way that is consistent with sustainable development. Although a comprehensive discussion on these terms is beyond the scope of this document, it is necessary to provide an overview of these fundamental concepts. For further discussion, readers are encouraged to refer to previous investigations by the Parliamentary Commissioner for the Environment (PCE) including *Creating our future: sustainable development for New Zealand* (PCE, 2002), and *Getting more from less: a review of progress on energy efficiency and renewable energy initiatives in New Zealand* (PCE, 2000).

Environmental sustainability

In essence, environmental sustainability is concerned with the maintenance of processes on which all life depends. The Organisation for Economic Co-operation and Development (OECD; 2001) has identified four specific criteria that need to be met to ensure environmental sustainability. These are identified in table 4.1.

Table 4.1: Criteria for environmental sustainability

Regeneration	Using renewable resources efficiently and not permitting their use to exceed their long-term rates of natural regeneration.
Substitutability	Using non-renewable resources efficiently and limiting their use to levels that can be offset by substitution of renewable resources or other forms of capital.
Assimilation	Not allowing releases of hazardous or polluting substances to the environment to exceed the environment's assimilative capacity.
Avoiding irreversibility	Avoiding irreversible impacts of human activities on ecosystems.

The OECD criteria are particularly relevant to the PCE's assessments, as they can easily be related to the environmental aspects of the GPS (see section 4.2).

Beyond these physical and ecological factors, environmental sustainability also recognises the social values that humans place on the wider environment. Although these are more difficult to assess, and depend heavily on context, they can include any environmental qualities and characteristics that contribute to people's well-being. Societies (and the communities within them) need to determine which of these qualities they would like to sustain.

Sustainable development

As highlighted in prior investigations (PCE, 2000:16 and PCE, 2002:29), sustainable development is concerned with an unending quest to improve the quality of people's lives and surroundings, and to prosper without destroying resources and the life-supporting systems on which we, and future generations, depend.

The term 'sustainable development' was popularised by the World Commission on Environment and Development (WCED, also known as the 'Brundtland Commission') in 1987.[15] This defined sustainable development as:

> *development that meets the needs of the present without compromising the ability of future generations to meet their own needs (WCED, 1987).*

Since 1987 there has been ongoing debate about the meaning of sustainable development and over eighty official definitions have been spawned (Johnston *et al.*, 2000:812).[16] Nonetheless, the Brundtland definition of sustainable development is the definition most often referred to and has been adopted by the New Zealand Government.

At its core, sustainable development means recognising and thinking about the linkages between environmental, social and economic factors that influence the decisions people make (OECD, 2001b). It recognises the:

- finite reserves of non-renewable resources and the importance of using them wisely and, where possible, substituting them with renewable resources
- limits of natural life-supporting systems (ecosystems) to absorb the effects of human activities that produce pollution and waste
- linkages and interactions between environmental, social and economic factors when making decisions, emphasising that all three factors must be taken into consideration to achieve sustainable outcomes

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[15] The term was actually used in an official capacity for the first time in 1980 (IUCN, 1980:II). As a strand of thought in 'Western' thinking, it has also been traced back to the 1800s (Sachs, 1999:59) and early 1900s (Sachs, 1999:59; Johnston *et al.*, 2000:813).

[16] Some examples of definitions of sustainable development written between 1979 and 1997 can be found at http://www.sustainableliving.org/appen-a.htm

- well-being of current and future generations as a key consideration.

Conceptually, sustainable development can be represented in the form shown in figure 4.1.

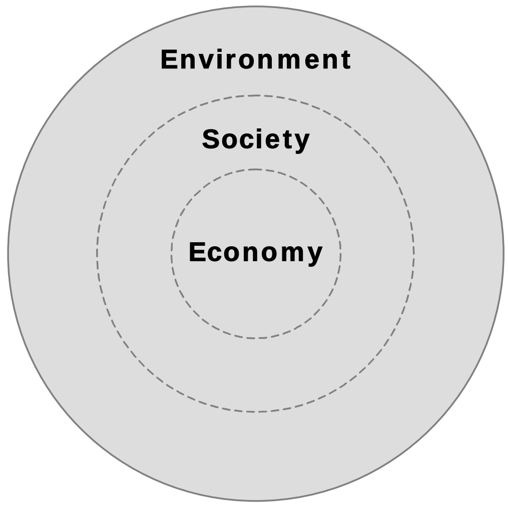

Figure 4.1: Strong sustainability

This diagram represents the concept of 'strong' sustainability.[17] It recognises that economic systems always exist within the context of a society (and many important social aspects do not involve economic activity). Similarly, human societies, and the economic activities that are conducted within them, are totally constrained by the natural systems of our planet. Economies may expand or contract, and societies' expectations and values may change over time, but to function in a sustainable way human societies must not exceed the capacity of the biosphere to absorb the effects of their activities.

Like the social aspects of environmental sustainability, the precise meaning of sustainable development also depends on the *context* in which it is used. The following section examines how these concepts can be applied to the electricity sector.

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[17] In contrast, 'weak' sustainability is characterised by a belief that the economy, society and the environment are competing interests. It suggests that environmental and social problems can always be solved by giving overriding priority to the health of the economy. It does not acknowledge the ecological constraints that human societies and their economic systems operate within (see PCE, 2002:34–35).

Sustainable development in legislation

The principles of sustainable development have been recognised in two key pieces of legislation that are likely to affect the electricity sector.

The Energy Efficiency and Conservation Act 2000 highlights the following sustainability principles that need to be taken into account:

- the health and safety of people and communities, and their social, economic, and cultural well-being
- the need to maintain and enhance the quality of the environment
- the reasonably foreseeable needs of future generations
- the principles of the Treaty of Waitangi.

The Local Government Act 2002 states that, in taking a sustainable development approach, local authorities should take into account:

- the social, economic and cultural well-being of people and communities
- the need to maintain and enhance the quality of the environment
- the reasonably foreseeable needs of future generations.

4.2 Sustainability and New Zealand's electricity sector

4.2.1 Core sustainability criteria

Table 4.2 summarises how the OECD definition of environmental sustainability can be applied to the electricity sector. These examples include all the environmental dimensions of the GPS.

Table 4.2: Core sustainability criteria applied to the electricity sector

Criteria	Example
Regeneration	• Using electricity generated from renewable resources (from the hydrological cycle, biomass, wind, sun, waves, and tidal action) efficiently. This includes ensuring that there are no avoidable hydro spills. Promoting and facilitating active demand side participation can significantly assist the achievement of this criterion. • Ensuring that the use of renewable resources (e.g. from biomass) does not exceed their long-term rates of natural regeneration.
Substitutability	• Using non-renewable resources (such as gas and coal) efficiently. Promoting and facilitating active demand side participation in the market can assist in the achievement of this criterion. • Facilitating the use of new, more efficient electricity technologies and renewables, and distributed generation.
Assimilation	• Minimising emissions of: - greenhouse gases - other contaminants to air (e.g. oxides of nitrogen and oxides of sulphur) - contaminants to water (including heat).
Avoiding irreversibility	• Avoiding irreversible impacts on: - ecosystems and the loss of biodiversity - significant cultural and historic landscapes or areas with wild and scenic attributes.

Cutting across the achievement of all of these criteria is a need to improve efficiency by promoting and facilitating active demand side participation in the electricity sector. As emphasised in an earlier PCE (2000) investigation, steps towards a sustainable sector must include managing how electricity is used. This is because (as discussed in section 3.3) even though the majority of environmental impacts are associated with the generation of electricity, these impacts are driven by demand for electricity usage. High priority therefore needs to be given to implementing demand management and energy efficiency initiatives to improve the environmental performance of the electricity sector. This is especially pertinent in New Zealand where there is considerable potential for improvement in this area (see section 3.2.3). Improving energy efficiency is also one of the most achievable aspects of sustainable development because it can contribute to lower economic costs and considerable social benefits (Johnston *et al*., 2000).

4.2.2 Broader sustainability issues

Looking through a sustainable development lens, the environmental sustainability of the electricity sector will have a significant impact on the social, cultural and economic well-being of people (both now and in the future).

In effect, all New Zealanders are likely to be affected, including:

- people directly affected by developments (including recreational users, tangata whenua exercising their kaitiaki responsibilities, and people whose health and well-being are affected by contaminants discharged into the air, water and soil)
- residential users affected by electricity prices and the need for provision of energy services such as warmth and lighting (especially those on low incomes and the elderly)
- isolated rural communities that may not be connected to the national grid, or those that may be disconnected after 2013 (see section 3.1)
- commercial users (mainly affected by shifting electricity prices and the provision of energy services)
- industrial users (mostly affected by shifting electricity prices impacting on their international competitiveness, and their significant demands for a secure supply of energy services)
- employees and owners of organisations associated with the sector.

Any impacts from the electricity sector on people within these groups will need to be carefully factored into decision making. In addition, it is important to acknowledge that electricity users are often very far removed from the locations where electricity is generated. As such, there are often inequitable impacts that need to be considered (i.e. individuals and organisations who demand electricity are often very dislocated from the people who experience the adverse impacts from local electricity developments).

The language and laws of energy sustainability

Throughout this document, reference is often made to the 'direction' the electricity sector needs to move in for it to 'shift towards sustainability'. This choice of language reflects the scientific basis for sustainability and the dynamics of energy systems.

Electricity is a form of energy, which is the capacity to do work. Strictly speaking, people do not actually 'use' the energy provided by electricity (although, for the purposes of simplicity, that word is used throughout this text). Instead, they use the *energy services* (such as heating and lighting) that electricity provides (IEA *et al.*, 1998). There are several key issues that need to be considered in any discussion on sustainability and energy, including electricity. Firstly, the laws of thermodynamics (the science of energy) highlight how human access to energy is ultimately constrained. The first two laws state that:

1. energy can neither be created nor destroyed; it can only be converted from one form to another
2. all conversions of energy from one form to another are less than 100 per cent efficient.

Applying these laws to the electricity sector, this means that electricity can never be 'created': it is merely 'generated' from converting other energy sources (such as the energy potential in falling water, or in fossil fuels) into electricity. However, as the second law emphasises, some potential energy from energy sources is always 'lost' (i.e. it becomes unavailable for useful work) during the conversion process. For example, a significant amount of energy from natural gas or other thermal fuels is 'lost' when it is converted into electricity. It is therefore much more efficient to access energy services directly from raw energy sources (instead of converting them into an intermediate form of energy before final 'use').

Because humans cannot create energy, societies throughout most of human history have largely been constrained by the amount of energy that they could access from energy flows (e.g. from solar energy and water flows). The exploitation of fossil fuels has enabled this constraint to be temporarily removed. Fossil fuels are accumulated stocks of previous solar flows (i.e. they are ancient plant matter, grown with energy from the sun, which has decomposed into a rich energy source). As these stocks become depleted, and as their usage increasingly contributes to climate change, human societies will need to adapt to an increasing dependence on energy flows.

The electricity sector is ultimately constrained by the natural systems within which it exists. To be sustainable, the sector needs to be capable of responding to physical constraints, as well as the social constraints constructed by society. That is, the sector will need to work with communities to determine what sorts of developments are (and are not) acceptable to sustain social, cultural and economic well-being.

A sustainable electricity sector, as part of a wider energy system, is therefore not a definitive 'destination' that can be reached. Instead, it is part of a *process* for ensuring that humans, both now and in the future, can gain as many benefits as possible from electricity, while minimising and preventing any negative impacts. In essence, movements towards a sustainable electricity sector will therefore be characterised by an ability to 'get more, from less, for longer'.

4.3 Key features for a sustainable electricity sector

Given the discussion above, it is possible to highlight some key features that the electricity sector needs to have for it to develop in a sustainable direction. In doing so, it is not possible to single out specific technologies from the outset. Otherwise, some emerging technologies, approaches or systems could be precluded (even though they may be capable of delivering desirable outcomes). In addition, specifying particular technologies may not take account of the differing needs of individuals, organisations and communities in different local contexts. Instead, all technologies, approaches, and systems should be evaluated against the criteria of environmental sustainability, as discussed in section 4.1.

4.3.1 Taking an integrated perspective

To develop in a sustainable direction, a key challenge for the electricity sector will be to take a balanced and integrated perspective. As indicated in section 3.1, the current sector has been shaped by the principles and technologies of the early 20th century. Although there have been many changes over the years, these have largely been incremental. The sector is still dominated by a focus on electricity supply, with relatively little attention given to managing electricity usage. It is therefore crucial to recognise that electricity demand and supply is not simply a linear process. This outdated way of thinking (represented in figure 4.2) narrowly assumes that demand can never be managed. Electricity is simply thought of as something that flows from generators to 'end-users.'

Instead, equal emphasis needs to be given to focusing on how electricity is **used** (the demand for energy services) as well as how it is **delivered** (the supply of electricity). Figure 4.3 represents a more integrated way of thinking. It recognises that:

- users need and want energy services (such as heat, light and motive power)
- the demand for energy services drives the demand for electricity (and different energy sources)
- energy management service providers, and providers of electrical equipment and infrastructure, can help determine the amount of electricity that users require to get their energy services[18]
- users can receive their electricity via different means—they may be connected to the local distribution networks and/or the national transmission grid, or they may not be connected to any external lines at all
- electricity may be generated in a remote area, it can be embedded in a local distribution area, or it can be located on a user's site—some users may even sell electricity that is surplus to their requirements back into their local distribution network or the national transmission grid.

There are therefore many different ways that energy services can be provided. In every circumstance, however, electricity demand and supply should be optimised to find the best approach. This means that a full range of demand side and supply side options need to be considered when providing energy services. The options that should be pursued are those that provide energy services with the least amount of energy overall (subject to other considerations such as price).

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[18] In some circumstances, energy management service providers may also be able to assist users to achieve energy services without any electricity (e.g. through making greater use of passive solar heating).

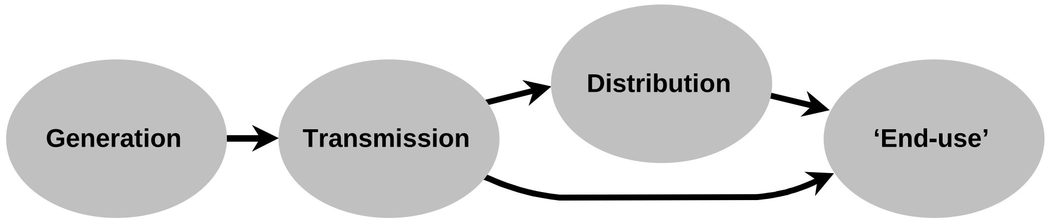

Figure 4.2: Old linear thinking

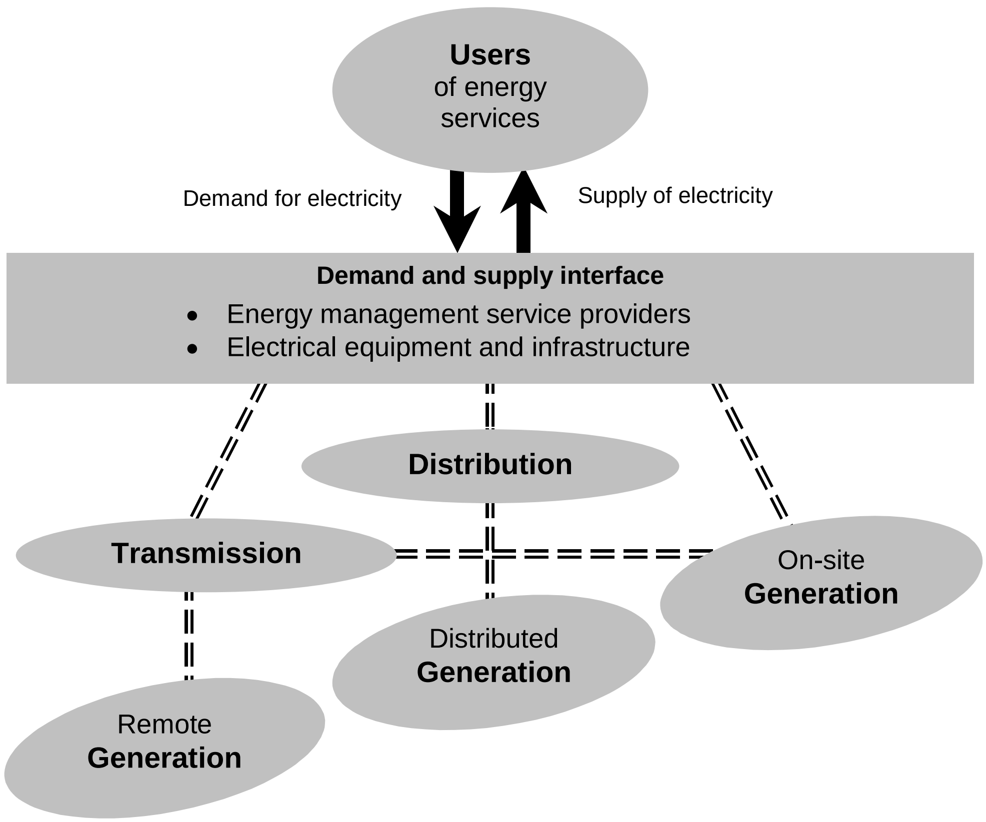

Figure 4.3: Integrated thinking

4.3.2 Core qualities to promote sustainability

In addition to taking an integrated approach, there are also some key qualities that the electricity sector will need to have to promote sustainability. These can be grouped into:

- those that address the underlying causes (or 'drivers') of environmental impacts
- those that address the environmental impacts (i.e. the 'symptoms').

Although all environmental impacts need to be carefully managed, highest priority should be given to managing underlying drivers (to avoid the need to manage any impacts in the first place). These drivers can be managed though the promotion and facilitation of:

- demand side participation
- efficiency across the full spectrum of electricity usage
- efficiency across the full spectrum of electricity supply.

It will also be important to:

- avoid and remove any barriers to the design and uptake of technologies that promote sustainability
- ensure that prices for electricity supply reflect all environmental and social costs
- manage any adverse impacts of new and existing developments.

In addition, a sustainable electricity sector (i.e. one that promotes environmental sustainability) will ultimately depend on the performance of its participants. It will therefore be important for these participants to take a proactive approach to promote sustainability.

These core qualities are summarised in figure 4.4.

Integration

Energy services are provided through optimising demand and supply

	Demand	**Supply**
	Managing electricity usage	*Matching electricity demand*
	Demand side participation is promoted and facilitated	
Managing drivers	• Users have a choice in their energy solutions and are encouraged to manage their demand. • The use of energy-efficient electrical equipment and devices is promoted and facilitated. • Infrastructure where electricity is used is designed and constructed to use electricity efficiently. • Retrofitting of existing inefficient infrastructure is promoted and facilitated.	• Prices for electricity supply reflect full environmental and social costs. • Electricity is generated as efficiently as possible, while avoiding any detrimental impacts on ecosystems. • Distributed generation is promoted and facilitated where appropriate. • Electricity losses through the national transmission grid and local distribution networks are minimised. • The design and uptake of renewable generation technologies (including new and emerging technologies) is promoted and facilitated.
Managing impacts		• Impacts of new and existing developments are managed by avoiding, remedying or mitigating adverse impacts on: - biodiversity - air, water and land - the atmosphere (climate). • Renewable resources used for generation are managed within their natural rates of replenishment.

Proactive participants

Users and providers of electricity will actively work towards a sustainable electricity sector. They will:

- understand how they can contribute to a sustainable sector
- have access to appropriate assistance and technologies
- be motivated to achieve improvements.

Figure 4.4: Key qualities for a sustainable electricity sector

4.3.3 Achieving security of energy services

Given the reliance that many individuals and organisations in New Zealand society now have on electricity, it will also be essential to achieve a system that promotes stability and security.

'Security of supply' (also known as 'keeping the lights on') is currently an issue of major concern to New Zealand's electricity sector, although this situation is neither new nor limited to this country. However, the term 'security of supply' immediately defines the problem as one of maintaining access to adequate generation capacity and fuels. This reflects a commonly held belief that electricity demand, both over the short- and longer-term, is something that can only be responded to (and that demand is not something than can be managed effectively). This suggests that electricity supply, and its supporting infrastructure, must be continuously expanded to accommodate an 'inevitable' growth in demand for electricity.

However, an increasingly accepted view is that demand can be managed and modified to match the available supply capacity (thereby reducing pressures to increase this capacity). Countries such as Denmark, for example, are proving that it is possible to achieve significant economic growth without an associated growth in energy supply (IEA, 1998b). In Denmark's case, these achievements have been made through consensus building and an integration of environmental, social and economic goals.

In the short term, a variety of demand side responses can be made to lower demand peaks or shift loads away from peak times (EECA, 2002). The desirability of having this flexibility in the sector is one reason the GPS includes an objective to increase demand side participation in the wholesale market.

Over the longer term, demand trends can be managed by building in 'baseload energy efficiency'. These are measures that can lighten loads on the national grid and local distribution networks, and are embedded into buildings, appliances, and industrial equipment (NARUC, 2002). Achieving this objective on an ongoing basis can delay or even remove the need to build new generation and transmission assets. In doing so, it can also contribute to increased reliability and better risk management. Demand side measures are therefore recognised as a critical component for boosting the security of electricity systems in an increasingly energy constrained future (European Communities, 2001). On the supply side, security can also be improved through the uptake of more distributed and embedded generation where appropriate (Swisher, 2002).

Energy security will therefore require a balancing of both supply *and* demand. It will be essential to take an integrated approach to achieve a system that provides security for energy services far into the future.

Glossary and acronyms

Advanced metering technology: Devices for recording or communicating the costs and use of electricity during specific time frames (such as minutes, hours, days or weeks). They can promote better load management by enabling users to alter their demand for electricity in response to changing prices. These prices may vary according to the time of day, during on-peak and off-peak periods of demand, and whether or not the supply of electricity is interruptible. They also provide opportunities for additional customer services, innovative rate structures, and automated meter readings, as well as for recording key indicators of availability and quality of electricity supply.

Bioenergy: Energy derived from the use of biomass. Bioenergy technologies can generate electricity by burning biomass in its solid form or by converting it to gas (biogas) and burning the gas.

Biological diversity (biodiversity): The variety of all life forms. It includes the different plants, animals and micro-organisms, the genes they contain and the ecosystems of which they are a part.

Biomass: Any organic matter that is available on a renewable or recurring basis (excluding old-growth timber), including: dedicated energy crops and trees; agricultural food and feed crop residues; wood and wood wastes and residues; aquatic plants; grasses; residues; fibres; and animal wastes, municipal wastes, and other 'waste' materials.

Cogeneration: The simultaneous generation of electricity and usable heat for industrial processes, or the use of 'waste' heat from electricity generation in an industrial process.

Demand side management: Methods used to manage electricity demand including energy efficiency, load management, and fuel substitution.

Demand management service providers: Individuals or organisations that assist electricity retailers and customers to reduce their electricity demand both in the short (interruptible load) and long term. Potential services include: the introduction of new energy efficient technologies, the development and management of financial management tools, and changing individual or institutional behaviours.

Demand side participation: The process whereby electricity retailers or users operating in the market can alter their demand for electricity according to varying prices.

Demand side: Of the electricity sector, refers to those who buy electricity and/or offer to alter their demand for electricity (according to price) in the wholesale market.

Distribution: The transport of electricity through a local network via low voltage power lines. Distribution networks connect users with the national grid. There are approximately 30 different distribution companies currently operating in New Zealand.

Economic efficiency: Economics defines three types of efficiency:

- *Allocative efficiency:* An economy is said to be allocatively efficient when it is not possible to improve total welfare further by re-allocating productive resources, i.e. any further reallocation will make someone worse off.
- *Dynamic efficiency:* Results from the socially optimal introduction of new goods and services over time.
- *Productive or technical efficiency:* A firm is productively efficient if it produces a level of output at the lowest possible average total cost.

EECA: Energy Efficiency and Conservation Authority.

EGO: Electricity Governance Organisation.

Electricity industry: The part of the electricity sector that undertakes to generate electricity, transport it through the national grid and local distribution networks, and sell it to users.

Electricity sector: Consists of people or organisations who use the energy services provided from electricity, providers of electrical equipment and infrastructure (such as buildings) that use electricity, demand management service providers, the electricity industry and the wholesale electricity market (including any secondary financial markets).

Embedded generation: Electricity generated by a plant that is connected to a distribution network instead of to the transmission grid.

Energy: The capacity to do work.

Energy efficiency: Any change in energy use that results in an increase in net benefits per unit of energy.

Energy management service providers: Individuals or organisations who assist users to use energy (including electricity) efficiently.

Energy services: Services such as heating and cooling, motive power and lighting that individuals and organisations can obtain through the provision of energy.

Environment: As defined in the Environment Act 1986, it includes:

1. Ecosystems and their constituent parts (including people and communities); and

2. All natural and physical resources; and

3. Those physical qualities and characteristics of an area that contribute to people's appreciation of its pleasantness, aesthetic coherence, and cultural and recreational attributes; and

4. The social, economic, aesthetic, and cultural conditions that affect, or are affected by, the matters stated in points (1) to (3) of this definition.

Environmental performance: Progress made by an organisation (or a group of organisations) in meeting the criteria of environmental sustainability that can be objectively verified through indicators and measures.

Environmental sustainability: In the context of this framework, there are four specific criteria for environmental sustainability (OECD, 2001):

- *Regeneration:* Using renewable resources efficiently and not permitting their use to exceed their long-term rates of natural regeneration.
- *Substitutability:* Using non-renewable resources efficiently and limiting their use to levels that can be offset by substitution of renewable resources or other forms of capital.
- *Assimilation:* Ensuring that releases of hazardous or polluting substances to the environment do not exceed the environment's assimilative capacity.
- *Avoiding irreversibility:* Avoiding irreversible impacts of human activities on ecosystems.

Fuel substitution: Using different energy sources or fuels to achieve the same energy services.

Generators: Organisations or individuals that generate electricity. They include remote generators (who generate electricity in one area for use in another area); distributed generators (who generate electricity for use within a local network); and on-site generators (who generate electricity on a user's premises).

GPS: Government Policy Statement. It describes the Government's guiding principles and objectives for the electricity industry.

Hapu: Family or district groups, communities.

HVDC: High Voltage Direct Current (transmission between the North and South Islands of New Zealand is via an HVDC line).

Hydro spill: The spillage of water that could potentially have been used for the purposes of electricity production but was released for other reasons.

Institution: Any set of rules and practices (either formal or informal) embodied in an organisation, regulation, policy, programme or convention constructed by society.

Interruptible load: Systems that, in accordance with contractual arrangements, can permit a supplier to interrupt a consumer's supply of electricity at times of peak load.

Iwi: Tribal groups.

Kaimoana: Food from the sea, shellfish.

Kaitiaki: Iwi, hapu or whanau group with the responsibilities of kaitiakitanga.

Kaitiakitanga: The responsibilities passed down from the ancestors, for tangata whenua to take care of the places, natural resources and other taonga in their rohe (geographical territory of an iwi or hapu), and the mauri of those places, resources and taonga.

Lines businesses: Organisations involved in the distribution of electricity.

Load: The amount of electric power delivered or required at any specific point or points on an electric system.

Load management: Steps taken to reduce power demand at peak load times or to shift some of it to off-peak times. This may be with reference to peak hours, peak days or peak seasons.

Load shifting: A demand response that involves users changing their behaviour to shift part or all of their demand from a peak period of a system (or a period of constrained supply) to some other period. This provides a key source of flexibility in an electricity system.

MACQS: (Multilateral Agreement on Common Quality Standards)—the agreement that deals with the security and quality of the electricity transported across the national grid.

MARIA: (Metering and Reconciliation Information Agreement)—outlines the rules that allow a retail buyer and seller to form a bilateral contract for the supply of electricity. This is achieved through a system that reconciles different quantities of electricity at different points of supply. It also enables consumers to switch suppliers regardless of their location.

Mauri: Essential life force, the spiritual power and distinctiveness that enable each thing to exist as itself.

M-Co: The Marketplace Company, which currently operates the New Zealand Electricity Market for trading wholesale electricity. It also administers both NZEM and MARIA.

MED: Ministry of Economic Development.

MfE: Ministry for the Environment.

National grid: The high voltage power cables that transport electricity from generators to distribution networks or direct users of electricity.

NEECS: National Energy Efficiency and Conservation Strategy.

NZEM: (New Zealand Electricity Market)—the current trading arrangement where most wholesale electricity is bought and sold on a half-hourly basis. It is a voluntary market that operates within a code of conduct (the rules of NZEM).

OECD: Organisation for Economic Co-operation and Development.

PCE: Parliamentary Commissioner for the Environment.

Peak load: High electricity demands experienced for short periods of time. During a normal day, demand peaks at around 8am and 6pm.

Renewable energy: Includes energy that comes from sources such as the sun, wind, waves, tides, ocean currents, the hydrological cycle, and biomass.

Retailers: Organisations that monitor the electricity usage of households and businesses and bill them accordingly. There are competing retailers in local distribution areas. Many retailers of electricity are also generators.

Supply capacity: The sustained maximum power output from an individual power station, or the sustained maximum throughput of an electricity supply system.

Supply side: Of the electricity sector, refers to those organisations that offer quantities of electricity into the wholesale electricity market.

Sustainable development: Commonly referred to as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987). It recognises:

- the finite reserves of non-renewable resources and the importance of using them wisely and, where possible, substituting them with renewable resources
- the limits of natural life-supporting systems (ecosystems) to absorb the effects of human activities that produce pollution and waste
- the linkages and interactions between environmental, social and economic factors when making decisions, emphasising that all three

factors must be taken into consideration if we are to achieve sustainable outcomes, particularly in the long term

- the well-being of current and future generations as a key consideration (PCE, 2002:6).

Tangata whenua: People of the land, Maori people.

Taonga: Valued resources, assets, prized possessions (both material and non-material) of tangata whenua.

Transmission: The transport of electricity via the national grid through high voltage power cables. The responsibility of Transpower.

Transmission losses: Electrical energy losses, incurred largely due to conductive resistance within the national grid (including the HVDC link between the North and South Islands).

Users: Individuals or organisations that demand energy services provided by electricity. They range from residential households to large industrial users. They may receive their electricity directly from the national grid (direct users); via distribution networks (indirect users); or they may generate electricity on their own site (off-grid users).

Wahi tapu: Special and sacred places.

Wholesale market: Where purchasers buy electricity off the generators. It includes the half-hourly spot market, longer-term contract markets, and the security and reserve markets.

Appendix 1: Legislation

This appendix provides extracts from the Electricity Act 1992 and the Environment Act 1986 that are relevant to the Parliamentary Commissioner for the Environment's assessments.

1: Electricity Act 1992

Section 172ZP(1)

Report by Parliamentary Commissioner for Environment—

(1) The Parliamentary Commissioner for the Environment must examine, in accordance with subsection (2), the extent to which an electricity governance organisation is meeting the GPS objectives and outcomes concerning the environment.

(2) The Parliamentary Commissioner for the Environment—

(a) must, as soon as practicable after each report date of an electricity governance organisation, carry out the examination in subsection (1) in respect of the last reporting period and report to the House of Representatives on the results of the examination:

(b) in addition, may carry out the examination in subsection (1) and report to the House of Representatives on the results of the examination at any other time.

(3) A report under subsection (2)(a) that states that an electricity governance organisation has failed significantly and overall to meet the GPS objectives and outcomes concerning the environment that are affected, or could be affected, by a wholesale market or a transmission matter contained in section 172D is a negative annual audit report for the purpose of section 5 of the Electricity Amendment Act 2001.

Section 172ZQ

Functions under this subpart—

(1) The Parliamentary Commissioner for the Environment may exercise all of the Commissioner's powers under the Environment Act 1986 in relation to the functions in this subpart, and that Act applies to those functions as if they were functions conferred under that Act.

(2) The Public Audit Act 2001 applies with respect to the assurance audit of an electricity governance organisation, as if it were a public entity as defined in section 4 of that Act.

(3) The functions conferred on the Auditor-General and the Parliamentary Commissioner for the Environment by this subpart are additional to, and do not limit, the Auditor-General's or the Commissioner's functions, duties, and powers under the Public Audit Act 2001 or the Environment Act 1986 (as the case may be).

2: Environment Act 1986

16. Functions of Commissioner—

(1) The functions of the Commissioner shall be—

- (a) With the objective of maintaining and improving the quality of the environment, to review from time to time the system of agencies and processes established by the Government to manage the allocation, use, and preservation of natural and physical resources, and to report the results of any such review to the House of Representatives and to such other bodies or persons as the Commissioner considers appropriate:
- (b) Where the Commissioner considers it necessary, to investigate the effectiveness of environmental planning and environmental management carried out by public authorities, and advise them on any remedial action the Commissioner considers desirable:
- (c) To—
  - (i) Investigate any matter in respect of which, in the Commissioner's opinion, the environment may be or has been adversely affected, whether through natural causes or as a result of the acts or omissions of any person or body, to an extent which the Commissioner considers warrants investigation; and
  - (ii) Advise, where necessary, the appropriate public authority and any other person or body the Commissioner thinks appropriate of the preventive measures or remedial action which the Commissioner considers should be taken; and
  - (iii) Report the results of the investigation to the House of Representatives:
- (d) At the request of the House of Representatives or any select committee of the House of Representatives, to report to the House or committee on any petition, Bill, or other matter before the House or committee the subject-matter of which may have a significant effect on the environment:
- (e) On the direction of the House of Representatives, to inquire into any matter that has had or may have a substantial and damaging effect on the environment, and to report the results of the inquiry to the House:
- (f) To undertake and encourage the collection and dissemination of information relating to the environment:
- (g) To encourage preventive measures and remedial actions for the protection of the environment.

(3) The Commissioner shall have, in relation to any such inquiry, and any report on the results of the inquiry, the same immunities and privileges as are possessed by a District Court Judge in the exercise of the Judge's civil jurisdiction.

18. Powers of Commissioner—

The Commissioner shall have such powers as may be necessary to enable the Commissioner to carry out the Commissioner's functions under this Act.

19. Power to obtain information—

(1) The Commissioner may from time to time require any person who in the Commissioner's opinion is able to give any information relating to any matter which is being investigated or inquired into by the Commissioner to furnish to the Commissioner any such information and to produce any documents or papers or things which in the Commissioner's opinion relate to any such matter and which may be in the possession or under the control of that person.

(2) The Commissioner may summon before the Commissioner and examine on oath any person who in the Commissioner's opinion is able to give any such information, and for that purpose may administer an oath. Every such examination by the Commissioner shall be deemed to be a judicial proceeding within the meaning of section 108 of the Crimes Act 1961 (which relates to perjury).

(3) Any person who is bound by the provisions of any enactment (other than the [State Sector Act 1988] and the Official Information Act 1982) to maintain secrecy in relation to any matter or not to disclose any matter shall not be required to—

(a) Supply any information to the Commissioner; or
(b) Answer any question put by the Commissioner; or
(c) Produce any document, paper, or thing to the Commissioner—

if compliance with the requirement would be in breach of the obligation of secrecy or non-disclosure.

(4) Every person shall have the same privileges in relation to the giving of information, the answering of questions, and the production of documents and papers and things in accordance with this section as witnesses have in any Court.

(5) Except on the trial of any person for perjury within the meaning of the Crimes Act 1961 in respect of his or her sworn testimony, no statement made or answer given by that or any other person in the course of any inquiry by or any proceedings before the Commissioner shall be admissible in evidence against any person in any Court or at any inquiry or in any other proceedings, and no evidence in respect of proceedings before the Commissioner shall be given against any person.

(6) No person shall be liable to prosecution for an offence against any enactment, other than this Act, by reason of compliance with any requirement of the Commissioner under this section.

(7) Where any person is required by the Commissioner to attend before the Commissioner for the purposes of this section, that person shall be entitled to the same fees, allowances, and expenses as if he or she were a witness in a Court, and the provision of any regulations in force under the Summary Proceedings Act 1957 shall apply accordingly. For the purposes of this subsection the Commissioner shall have the powers of a Court under any such regulations to fix or disallow, in whole or in part, or increase the amounts payable thereunder.

22. Proceedings privileged—

(4) Anything said or information supplied or any document or thing produced by any person in the course of any inquiry by or proceedings before the Commissioner under this Act shall be privileged in the same manner as if the inquiry or proceedings were proceedings in a court.

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