A review of the environmental performance of the Electricity Commission

1 July 2006 – 30 June 2007

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

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PO Box 10-241, Wellington, Aotearoa New Zealand
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Preface

This report is a review of the "environmental performance" of the Electricity Commission (EC) for the year 1 July 2006 to 30 June 2007. The approach used is to focus on five particular areas of work that are relevant to the year under review, rather than undertaking a systematic audit.

The five work areas are:

- electricity efficiency programmes, such as subsidising the sale of energy efficient light bulbs
- the monitoring of "hydro spill", that is, water flowing past a power station that is not being used to generate electricity
- the introduction of more sophisticated electricity meters – meters which could help households and businesses better manage their electricity use
- the incorporation of wind power into the electricity grid
- the issue of who pays for transmission lines and the consequent impact on investment in renewable forms of electricity generation.

The EC has carried out a considerable amount of work developing programmes to improve efficiency of electricity use by households, businesses and industry, and is to be commended for this.

There is, however, a significant issue that needs examination when considering the EC's role in improving electricity efficiency. Focusing solely on electricity may not give the best environmental result. In some instances switching from electricity to gas or wood may give greater environmental (and economic) benefits than improving end-use electricity efficiency. In particular, residential space heating is a key driver of winter peak demand, and what some have called the "electrification of space heating" may well increase the height and duration of those peaks. Peak power is largely generated by burning fossil fuels.

This in turn raises the wider issue of the scope of the EC's functions. What may be best from an environmental perspective for electricity may not be best across the whole energy sector. In short, is there a case for the Electricity Commission to evolve into an Energy Commission? In other jurisdictions, energy governance agencies are usually responsible for both electricity and gas. Looking further ahead, if electricity becomes a major transportation fuel, should there be some kind of joint governance of electricity and biofuels?

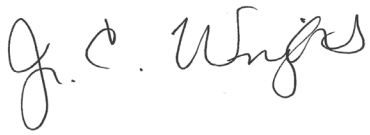
The EC is also unusual in international terms with respect to its powers. Despite many years of effort, New Zealand struggles to make real gains in improving energy efficiency. The energy governing body in the United Kingdom sets mandatory energy-

saving targets for electricity and gas suppliers. The EC, of course, has no such powers, but this "light hand" is not the norm for energy governance in other countries. The development of advanced metering systems is another example of where the EC can only guide, but other jurisdictions mandate.

Due to the intermittent nature of wind generation, there are challenges in integrating a significant increase in wind generation capacity into the system. Through the Wind Generation Integration Project, the EC is removing technical barriers to integrating wind into the grid, and is to be commended for this.

There is, however, an active debate over whether the Transmission Pricing Methodology that the EC has recommended to the Minister for approval discourages investment in renewable generation. The EC's position is that the debate is irrelevant because the preferential treatment of renewables is not required in the Government Policy Statement (GPS) on Electricity Governance, and that what is required is the adoption of efficient pricing.

This seems to be a case where goals in the GPS are in conflict; that is, the goal of economic efficiency is in conflict with the goal of reducing greenhouse gases. Ideally, such conflicts should be explicitly acknowledged and the GPS be amended to provide guidance to the EC on the relative importance of different goals.



Dr Jan Wright
Parliamentary Commissioner for the Environment

1 Introduction

This report fulfils the Parliamentary Commissioner for the Environment's (PCE) function under the Electricity Act 1992. Section 172ZP of the Electricity Act requires the PCE to "examine the extent to which the [Electricity] Commission is meeting the Government Policy Statement objectives and outcomes concerning the environment." The Office of the PCE was established under the Environment Act 1986, with various functions including investigating, where it is deemed necessary, the environmental planning and management carried out by public authorities, and advising on any remedial actions considered desirable.[1]

This review covers the period 1 July 2006 to 30 June 2007 and is based on both the Government Policy Statement on Electricity Governance (GPS) dated October 2004 which was in place at the commencement of this review period, and the amended (October 2006) GPS which is currently in place.[2]

1.1 The Electricity Commission

The Electricity Commission (EC) is a Crown entity set up under the Electricity Act to oversee New Zealand's electricity industry and markets. The EC was established following concerns from the government that the existing industry arrangements did not provide for the effective management of the sector and that the existing governance arrangements did not ensure security of supply in dry years.

Section 172(1) of the Electricity Act 1992 sets out the following *principal objectives* for the EC:

a. to ensure that electricity is produced and delivered to all classes of consumers in an efficient, fair, reliable and environmentally sustainable manner; and

b. to promote and facilitate the efficient use of electricity.

Section 172N(2) of the Act requests that, consistent with the principal objectives, the EC must seek to achieve, in relation to electricity, the following specific outcomes:

a. energy and other resources are used efficiently

b. risks (including price risks) relating to security of supply are properly and efficiently managed

c. barriers to competition in the electricity industry are minimised for the long-term benefit of end-users

d. incentives for investment in generation, transmission, lines, energy efficiency, and demand-side management are maintained or enhanced and do not discriminate between public and private investment

e. the full costs of producing and transporting each additional unit of electricity are signalled

f. delivered electricity costs and prices are subject to sustained downward pressure

g. the electricity sector contributes to the Government's climate change objectives by minimising hydro spill, efficiently managing transmission and distribution losses and constraints, promoting demand-side management and energy efficiency and removing barriers to investment in new generation technologies, renewables and distributed generation.

The EC has multiple roles, including:

- policy advice
- regulation
- enforcement
- arbitration
- market administrator
- managing contracts for the provision of services to allow market operation and providing for operation of the electricity system
- managing contracts for the provision of reserve energy
- overseeing transmission investment, transmission pricing methodology and grid reliability standards
- promoting energy efficiency.

1.2 Approach of this review

Many of the objectives contained in the 2006 GPS that relate to the environment are defined at a high level and measuring performance is challenging. With this in mind, the approach taken here is to:

- Review relevant work carried out by the EC during the period 1 July 2006 – 30 June 2007
- Analyse and assess the resulting environmental impact of the work, in a quantifiable way where possible
- Identify areas for improvement and additional issues the EC and the Minister of Energy should consider, while giving regard to the extent of the EC's influence.

The approach used in this report is to look at particular issues, relevant to the year under review, rather than undertaking a systematic audit of the EC's environmental performance.

The report begins with the Commissioner's recommendations from the 2005/06 review and the EC's response to those recommendations. The next section contains a brief summary of the EC's activities during the timeframe of this review. The report then focuses on five significant areas of work:

1. Electricity efficiency programmes
2. Monitoring of hydro spill
3. Work to encourage demand management and metering technology
4. Integration of wind into power systems
5. Transmission pricing and renewable generation.

These areas are discussed and assessed, and the Commissioner recommends some actions to the EC and to the Minister of Energy. As this is an annual review, issues that are not considered in-depth in this report may be considered in later reviews. Information for the assessment is primarily based on documents and material published by the EC, as well as discussions with the EC staff and others within the energy sector.

Finally, there is a summary of the recommendations from the Commissioner made in the report.

This review is aimed primarily at the EC and the Minister of Energy. It is written with the assumption that the reader has a basic understanding of the electricity sector.

2 2005/06 recommendations and the Electricity Commission's response

This section lists the six recommendations made by the PCE in the 2005/06[3] review (in bold). The EC's responses to the recommendations (in quotations) are recorded without comment in this section.[4] However, the issues that led to recommendations one, three, and four in the 2005/06 report are explored further in Section 5 of this report.

1. **That the Electricity Commission quantifies the hydro spill from the 'cost', 'economic', and 'other' hydro spill categories, to establish a basis for considering whether the potential loss from "unnecessary hydro spill" is significant.**

   EC response:

   "The Commission is charged with minimising hydro spill in part of section 127N(2)(g) of the Electricity Act 1992.

   Para 39 of the Government Policy Statement on Electricity Governance (GPS) requires the Commission to:

   > "ensure that public information is provided on: … hydro spill …"

   In line with paragraphs 3 and 4 of the GPS, the Commission has worked with generators to achieve the objective of providing information on hydro spill and generators agreed to publish the information voluntarily, which they do on their own web sites.

   Draft Rules released by MED for consultation in July 2003 for the purpose of consultation did contain a hydro reporting requirement, but this was not retained within the finalised Rules. The reporting is voluntary and the Commission has no powers of compulsion in this respect in the Rules as they are now. Generators do not report spill information to the Commission.

   Hydro spill data was voluntarily provided by the industry, collated and assessed for the Market Design Review Issues Paper released by the Commission in May 2007. This was prepared as a one-off analysis, with the cooperation of generators. The relevant extract from the Market Design Project Issues Paper is provided as appendix 1. However, assessment of 'unnecessary' spill from the available data was considered to be problematic.

   The Commission will give consideration to this suggestion as part of its work on options for market design in relation to ongoing information requirements. However, it should be noted that the suggested analysis would be time consuming and costly and the analysis undertaken as part of developing the Market Design Issues Paper did not give rise to a significant concern in this area at this stage. The potential value from the recommended analysis is currently considered marginal.

When assessing transmission investment proposals that focus on addressing generation constraint, the Commission takes potential wind and hydro spill into consideration as part of its analysis for the Grid Investment Test (GIT). This technical analysis addresses the economic costs associated with potential constraints on the transmission network. To support this process, modelling is taking place on existing hydro data."

2. **That the Electricity Commission establishes a publicly accessible database that records the tariff classes provided by each retailer, their pricing characteristics (e.g. fixed or variable, price differentials), and the degree to which they are being used in the market, to provide a basis for assessing the degree to which tariffs incentivise efficient use of electricity and offer consumer choice.**

   EC response:

   "Tariff information is already publicly available through a number of sources. These include:

   - All retailers place tariff information on their web sites, including line and energy costs. The Commission has encouraged this approach in line with paragraph 4 of the GPS.
   - The MED collate and publish information on tariffs. See:

     http://www.med.govt.nz/templates/MultipageDocumentTOC____32769.aspx
   - Consumer.org.nz publishes information in a user-friendly format designed specifically to assist consumers in making choices about electricity and gas options. See:

     http://www.consumer.org.nz/powerswitch.Default.asp?bhcp=1

   The Commission is considering potential issues and options for market design through its Market Design Project. The suggestion of a database of retailer tariffs over and above those mentioned above is being considered as part of this wider consideration of market and competition matters. Consideration is also being given to the issue of analysing the relationship between tariffs and other factors in consumer choices of retailer and energy use."

3. **That the Electricity Commission develops a set of minimum performance criteria for smart meters, which include real-time information for retail customers.**

   EC response:

   "The Commission agrees with the recommendation and is already progressing the work which is detailed on pages 41-42 of the 2007/2010 Statement of Intent. The

Commission has consulted extensively on the principles for advanced metering and guidelines are currently in preparation."

4. **That the Electricity Commission works with the electricity industry to develop a plan for the roll out of smart meters to all consumers in New Zealand.**

   EC response:

   "As noted above, the Commission is producing guidelines for advanced meters. This is part of a substantial suite of related projects addressing load management, technology and metering innovation. These are being given the Commission's highest priority.

   The Commission will monitor the development and introduction of advanced meters and will advise the Government should there be a strong case for regulating the introduction of smart meters using the guidelines."

5. **That the Electricity Commission works with the Commerce Commission to consider how lines companies can be involved in cost-effective demand-side or distributed generation options as alternatives to new investment in lines.**

   EC response:

   "The Ministry of Economic Development (MED) is undertaking work on legislation to relax the rules restricting cross-involvement between electricity lines business and supply businesses, which will facilitate increased investment in distributed generation. See:

   http://www.med.govt.nz/ContentTopicSummary____4145.aspx

   Discussion is also taking place with the Commerce Commission on thresholds for investment in load management and loss optimisation.

   The Commission is responsible for monitoring the Electricity Governance (Connection of Distributed Generation) Regulations 2007, which came into force on 30 August 2007 (see pages 44-45 of the 2007/2010 SOI).

   The Commission's load management project will enable improved demand-side options in particular the third phase, which has recently commenced, will address facilitating introduction of innovative load control technology."

6. **That the Electricity Commission examines the grid investment test with respect to the environmental objectives set out in relevant legislation and the Government Policy Statement on Electricity Governance.**

   EC response:

   "The Commission considers that environmental objectives are fully covered by existing legislation and processes.

The overall principal objectives (section 172N(1) of the Act), which include environmental sustainability, are considered in all Board decisions. The Grid Investment Test (GIT) is an additional requirement under the Rules for grid investment proposals from Transpower. There is also a requirement to assess transmission alternatives as part of grid investment decision-making on a project-by-project basis. This includes consideration that the GIT is effective in ensuring that grid investments are justified, and thus avoiding unnecessary environmental impact from over-development of the national grid.

It should also be noted that further consideration of environmental issues in relation to grid investments is carried out as part of the resource consent process under the Resource Management Act 1991 (RMA)."

3 Overview of the Electricity Commission's activities 2006/07

The EC has focused on four main areas in relation to its environmental outcomes and objectives: improving electricity efficiency, demand management, facilitating renewable energy and facilitating distributed generation.[5] This section contains a summary of the work carried out in the 2006/07 year, as reported by the EC, but does not include any assessment of the EC's work. Some work that occurred outside of the 2006/07 period has also been referenced in the summary so as to provide a balanced picture of the EC's ongoing efforts.

3.1 End-use electricity efficiency

A key environmental goal of the EC is to manage increases in electricity demand by promoting end-use energy efficiency.[6] The EC's work in this area focuses on researching ways to improve end-use electricity efficiency, and promoting and facilitating the efficient use of electricity. This includes funding programmes that provide incentives for improving electricity efficiency.

During the 2006/07 financial year, the EC has:

- conducted research into potential electricity efficiencies (the Electricity Efficiency Potentials project, due for completion in 2007/08)
- conducted a number of electricity efficiency pilot projects
- conducted a national compact fluorescent lamp (CFL) programme, resulting in 2.4 million CFLs sold to 30 June 2007, and
- developed working relationships with other agencies, relevant industry sectors and electricity efficiency programme providers.

The pilot projects aimed to identify when intervention by the EC would be worthwhile. These projects tested possible intervention methods, determining whether they would result in cost-effective improvements in electricity efficiency. The pilots resulted in the launch of a national light bulb (CFL) replacement project in 2006/07 and the design of ongoing programmes (commencing in 2007/08) covering efficient lighting, electricity use in commercial buildings, compressed air systems and industrial motors. These are reviewed briefly in Section 5.1.

During 2006/07, the EC and the Energy Efficiency and Conservation Authority (EECA) have continued to work together in accordance with their Memorandum of Understanding. The memorandum includes a schedule that clarifies each organisation's role relating to electricity efficiency programmes.

3.2 Demand management and metering technology

When aiming for an electricity sector that is reasonably secure but has less adverse environmental impacts, it is easy to focus on generation alone. However, it is also important to consider also how electricity is used. Reducing electricity demand, especially at peak times, should play a significant role in reducing environmental impacts.

The EC has a major work programme aiding the electricity sector to better manage demand and adopt new technology. As part of this, the EC is:

- investigating how to achieve optimal load management. Load management can be used to reduce load at peak times and in emergency situations, and also as a way to reduce energy costs in the wholesale market.
- developing rule changes to improve the bidding process in the wholesale market auction and to improve forecasting demand. An objective of this project is to improve the accuracy of price forecasts, which by providing greater certainty may improve the level of demand response in the market.
- developing a programme for data collection, compilation, and assessment of specific indicators related to metering and switching issues, which may effect the uptake of advanced metering.

3.3 Facilitating renewable energy

A major environmental aim of the Government, outlined in the New Zealand Energy Strategy, is to generate 90% of electricity from renewable sources by 2025. Renewable-energy generation technologies present an opportunity to decrease New Zealand's reliance on fossil fuels. Different technologies have varying characteristics and perform different roles within the generation mix. For example, power from wind generation is intermittent whereas power from thermal generation is relatively continuous. The issue of how these technologies can be integrated efficiently into the existing system is a concern.

To meet the challenge of integrating large-scale wind generation, the EC has undertaken two initiatives: the Tactical Wind Project and the Wind Generation Investigation Project (WGIP). In December 2006, two changes were made to the Electricity Governance Rules 2003 as a result of the Tactical Wind Project. These rule-changes were designed to allow for easier integration of wind energy into the existing national grid. The WGIP is discussed in more detail in section 5.4.

A review of market design is currently underway. This review includes an assessment of market issues that affect renewable generation. For example, consideration is given to whether the reform of the electricity market has caused generators to increase the amount of hydro spill. The conclusions from this review relating to hydro spill are discussed in 5.2.

3.4 Distributed generation

The efficiency and security of the electricity system may be assisted by distributed generation, i.e., small generation capacity that is located close to the end-user. Such generation may reduce environmental impacts by reducing lines losses, avoiding upgrades to transmission and distribution networks, and increasing flexibility in the system.[7]

The 2006 Government Policy Statement on Electricity Governance (GPS) requires the EC to reduce barriers to the development of distributed generation installations. Also, the EC is responsible for monitoring compliance with the Electricity Governance (Connection of Distributed Generation) Regulations 2007, which came into force on 30 August 2007.

The EC has established model contracts for retailers to offer to providers of distributed generation, which include provisions for purchase of surplus generation from consumers. Retailers were advised that the EC expected them to offer these terms to consumers from 1 February 2006. The EC is monitoring this and a review of the contracts is planned for 2008/09. The EC is also developing a distribution pricing methodology, which is to be completed in 2008/09.

4 Assessment of the Electricity Commission's activities in 2006/07

In this section, five aspects of the EC's work are assessed and recommendations made to the EC and the Minister of Energy. The work areas assessed are:

- end-use electricity efficiency,
- hydro spill,
- demand management and metering technology,
- integration of wind generation into power systems, and
- transmission pricing and renewable generation.

While this section is primarily focused on work that occurred during 2006/07, related work that occurred outside of the period has also been included for completeness.

4.1 End-use electricity efficiency

The Government aims to reduce forecast non-transport energy consumption by 8,300,000 MWh/annum by 2025 through improving energy efficiency.[8] This is approximately equivalent to the amount of energy used by one million New Zealand households in 2006.[9]

The EC is positioned to play an important role in addressing the market issues that discourage electricity efficiency improvements. According to the GPS, the EC has as a key goal the efficient provision and use of electricity. Efficient electricity use helps reduce demand for electricity, thereby reducing pressure on prices, scarce resources and the environment. In order to accomplish this, the EC is expected to promote and facilitate the efficient use of electricity by end-users, "providing financial incentives for investment in electricity efficiency where it is cost-effective to do so and in response to market failures and barriers."[10]

As part of satisfying this requirement, in the period from 2004 to 2007 the EC has:

- undertaken research on electricity efficiency
- implemented pilot trials for a range of electricity efficiency initiatives
- refined electricity efficiency programmes on the basis of this work, and
- expanded programmes it deemed successful regionally and nationally.[11]

The EC commissioned a number of initiatives focused on understanding opportunities

for improving electricity efficiency. These projects included: three residential pilot projects in Auckland, Waikato, and Canterbury, an industrial motors efficiency project, and a compressed air pilot project.[12]

The Auckland residential project sought to improve energy efficiency in homes mainly through installing hot water cylinder wraps. The Waikato project sought to improve refrigeration efficiency by providing a rebate on the cost of a new refrigerator when an old refrigerator was traded in. There is little published documentation about these projects[13] making it difficult to assess how well the pilot projects were conducted. However, the documentation does show that public response was low. In the Auckland pilot, only seven percent of the subsidised hot water cylinder wraps were actually installed.[14] In the Waikato pilot, low participation meant that only 25 percent of expected energy savings were actually achieved.[15]

Based partly on the low public response to these pilots, the EC decided not to launch nationwide programmes for hot water system improvements and residential refrigeration upgrading.[16] Another factor that contributed to this decision was that a similar programme conducted previously had a low benefit:cost ratio (equal to about one). Eventually, the EC decided that efficiency improvements in the residential sector would be better made through an integrated household approach, an area in which EECA is currently active.

For the third residential pilot, the EC worked with Orion and Meridian Energy to launch an $800,000 campaign selling 200,000 Compact Fluorescent Lamps in Christchurch and central Canterbury in November 2005.[17] Based on encouraging results from this pilot and another promotion in Auckland, the EC decided to launch a national programme.

Over the three years to June 2007, the EC had spent around $4.22 million on the national programme (from 2004/05 - 2006/07) and had subsidised a total of 2.4 million bulbs.[18] The cost was estimated to be one cent/kWh of energy saved.[19] By June 2007, the EC estimated electricity savings at about 200,000 MWh/annum, nearly two percent of residential electricity consumption in 2006.[20, 21]

The EC spent around $1 million on the Industrial Motors Efficiency Pilot Project between 2004/05 and 2006/07[22 23] to identify and trial a range of practical strategies across the lifecycle of electric motor systems.[24] This project involved a series of surveys and case studies to identify potential savings through motor replacement. The study identified a potential savings of 500,000 MWh/annum, three percent of industrial electricity consumption in 2006.[25] This could be achieved through replacement of old motors at a cost of between two to four cents/kWh. Resulting from this study, the EC is introducing an incentives scheme to permanently remove low efficiency three-phase electric motors from New Zealand industry. The EC has initiated a pilot phase with nine companies, and intends to extend it nationally.[26]

Finally, the EC spent $1 million between 2004/05 and 2006/07[27] [28] on work aimed at identifying potential electricity savings from improving compressed air systems, and establishing how this potential is best captured.[29] The work was based on data from a pilot study including three Fonterra factories that involved installing new, high-efficiency air compressors, improving performance of existing systems, and improving metering to enable users to quantify savings. From the studies, the EC estimated a nation-wide potential savings of 300,000 MWh/annum, two percent of industrial electricity consumption in 2006.[30] The expected cost is one cent/kWh. As a result of this study, the EC decided to carry out a nationwide programme aimed at capturing some of this potential.

By reducing electricity demand, these national programmes will decrease the amount of fossil-fuelled thermal generation, and the associated greenhouse gas emissions. These national programmes could result in carbon dioxide equivalent savings of roughly 40,000 tonnes/annum from the CFLs campaign, 60,000 tonnes/annum from the Compressed Air project, and 100,000 tonnes/annum from the Motor Systems project.[31] In aggregate, the resulting savings could be about 2.4 percent of the 2006 emissions from thermal electricity generation.[32]

Commentary

The pilot projects have been a very successful start along the path to improving electricity efficiency and the EC's work to date is to be commended. There are two points for future consideration, relating to the extent of the EC's involvement in improving residential energy efficiency. These relate to:

- the relationship between the EC and EECA, and
- the scope of the electricity efficiency projects.

The EC and EECA signed a Memorandum of Understanding in 2005, as required by the GPS, to ensure future work would be complementary and not overlap.[33] According to the memorandum, EECA is "primarily concerned with encouraging, supporting, and promoting efficiency and conservation of all forms of energy, as well as increasing the use of renewable sources of energy", and the EC has responsibility for "governance and regulation of the electricity industry".

Schedule Two of the memorandum designated that the EC should lead the pilot residential electricity efficiency programmes, with cooperation from EECA. Based on the experience gained as a result of these programmes, it appears the EC considers it is better placed to focus on improving electricity efficiency in the industrial and commercial sectors, as well as certain technologies that are used the residential sector. Alternatively, EECA should focus on the residential sector.[34] This is one reason the EC decided not to extend the residential refrigeration and hot water system wrap programmes nationally.

However, it is important that residential projects that are more cost-effective than transmission and generation investment are provided with sufficient funding to proceed. As EECA has different goals, expertise, and funding, it may not always be in a position to justify funding and running all projects that fit this criteria. Further, the EC has a mandate under the GPS to ensure such projects proceed and has funding available for this purpose. Therefore, the EC should maintain a shared responsibility for residential projects with EECA, and ensure that beneficial projects in this sector are not overlooked.

Another point is that the EC has been focused on increasing end-use efficiency. Potentially, significant gains could be made by reducing electricity losses that occur during the delivery of electricity, which account for a considerable amount of wasted energy. The EC should widen its scope to improving the efficiency of delivery, as well as end-use efficiency.

The projects so far have been very targeted.[35] As well as specific projects, a more general approach to encouraging across the board efficiency increases may be beneficial. The United Kingdom (UK) has introduced such a policy. The Office of Gas and Electricity Markets (Ofgem), the energy governing body in the UK, administers a programme that requires certain gas and electricity suppliers to meet energy saving targets. Suppliers are required to promote and deliver energy efficiency measures to customers, but are able to choose from a range of measures relating to lighting, insulation, heating or appliances. Measures include insulating homes and distributing CFLs. In the first commitment period (2002–2005) suppliers delivered energy savings equal to about one percent[36] of total electricity and gas consumption in the UK.[37]

A similar programme in New Zealand may be an effective way to deliver energy efficiency improvements. However, the EC does not have the power to compel suppliers to improve energy efficiency. Without this power, such a programme would be voluntary, and this would be likely to reduce its effectiveness.

Commissioner's recommendations

I recommend that:

1. the Electricity Commission continues to carry out residential end-use electricity efficiency projects, and does this in conjunction with the Energy Efficiency and Conservation Authority.
2. the Electricity Commission undertakes a study assessing the programmes used by energy governance agencies in other jurisdictions to encourage or require energy suppliers to meet end-use energy efficiency targets.

4.2 Hydro spill

Hydro spill is defined as "water flowing past a power station that is not being used to generate electricity".[38] With a view to meeting greenhouse gas emission targets in accordance with the government's Climate Change policy, hydro spill should be avoided whenever possible.[39] This is because it represents a potential lost opportunity for generating emissions-free electricity. However, there may be circumstances where the market structure creates an incentive to spill water. This might not be optimal from an environmental perspective if electricity is instead generated from fossil-fuelled plant, resulting in more carbon dioxide emissions. As a consequence, the EC is charged under 172N(2)(g) of the Electricity Act with minimising hydro spill, as part of contributing to the government's climate change objectives.

Quantifying hydro spill in 2005 and 2006

Generators voluntarily report spill information on their websites. The quantity spilled is reported and assigned to one of 11 categories defined by the cause (Table 1). In the 2005/06 EC review conducted by the PCE, the suggestion was made that although many events caused by physical or legal situations are beyond the control of the generator (1-6,9,10), events occurring for 'cost', 'economic' or 'other' reasons are potentially avoidable (7,8,11).

Table 1 Classification of hydro spill events (from PCE 2005/06 review)

	Category	Comment
1	Plant	Hydro spill was due to a plant malfunction including plant owned by a third party, or from plant testing, or from planned or unplanned outages.
2	Obstruction	Hydro spill was due to physical obstructions preventing normal operation of generating plant. Such obstructions include weed, logs, silt, public, etc.
3	High flow	Hydro spill was due to high inflow events. This code applies when the flows exceed the ability of the generation scheme to generate at that level. This code only applies when the operator has no discretion over avoiding the release.
4	Regulatory	Hydro spill was due to regulatory obligations. It includes statutes, resource consents, use permits, bylaws, etc. This code only applies when the operator has no discretion over avoiding the release.
5	Contractual	Hydro spill was due to contractual obligations. This code only applies when the operator has no discretion over avoiding the release.
6	Recreational	Hydro spill was for recreational use. That is where recreational, social or cultural interests have negotiated hydraulic profiles, and hydro release has occurred as a result.

7	Cost	Hydro spill was due to the cost of generation exceeding the spot price.
8	Economic	Hydro spill was for other commercial reasons such as price support in the market.
9	Transmission constraint	Hydro spill was due to transmission or distribution constraints.
10	Hydraulic constraint	Hydro spill was due to capacity differences within some hydraulically coupled schemes, requiring additional water bypass to maintain output.
11	Other	Hydro spill was due to any other reason. When this code is used, an appropriate description and explanation must also be included.

NB Different generators describe these categories slightly differently, but the above short definitions are consistent with those in use by the generators.

At the time of this report, hydro spill data covering January 2005 to December 2007 was available on every generator's website. It appears that several "potentially avoidable" events occurred, with one event significantly larger than the rest. For illustrative purposes, this section examines the conditions that led to the large spill in January 2005.

In January 2005, enough water to produce 24,100MWh of electricity was allowed to spill though the Clyde and Roxburgh dams due to "cost" reasons. This event represents about half of Contact's total hydro spill for the year and is equal to about one percent of the total energy from Contact's hydro generation.[40] Although hydro spill does not necessarily lead to increased carbon dioxide emissions, to generate this amount of "lost" energy in a gas-powered plant would produce between approximately 9,000-14,000 tonnes of carbon dioxide and in a coal-powered plant, around 22,000 tonnes of carbon dioxide.[41]

According to Contact, the event occurred because the final spot price was below its offer price.[42] As a result, its offer was not fully dispatched by the system operator. As there were high inflows at the time and no storage capacity, Contact generated its allowance and had to spill the remainder of the water. This spill event was therefore defined as "cost" because Contact's offer price, which was higher than the spot price, is determined by its short-run marginal cost of generation.[43]

Contact's explanation is consistent with the EC's analysis of the event.[44] Electricity demand at that time of year and day is usually low. At the time, most of the major hydro lakes were near full, with at least three major rain events in the region between late December and early February. Wholesale spot prices were very low, less than one cent/kWh for significant periods in the early part of January. On the basis of the above, the EC concluded that spill events were likely to occur for "cost" reasons.

Commentary

At the time of Contact's hydro spill event, a fossil fuelled plant was generating electricity. Thus, fossil-fuelled thermally generated electricity was dispatched in preference to Contact's hydro generation. On the face of it, this suggests the spill (and carbon dioxide emissions) might have been avoided. In this case, it is possible that system design led to "unnecessary" hydro spill and carbon dioxide emissions.

The system operator will dispatch fossil-fuelled thermal in preference to hydro mainly because the thermal price offered is lower than hydro, but also for security reasons such as frequency keeping, and voltage support.

In general, fossil-fuelled thermal generation will be offered at a higher price than hydro, since the short-run cost of generation is higher. However, in many instances some thermal generation plant will be offered at close to or zero price[45] due to the shutdown, restart and ramp characteristics of thermal plant.

The Electricity Governance Rules allow this behaviour in order to meet the least cost dispatch objectives. Further, there are supply security benefits from dispatching some thermal generation in the early hours of the morning – it means thermal plant will be running and available for the morning peak demand. Therefore, this spill event appears to be an example of different EC outcomes coming into conflict: in this case the specific outcome of minimising hydro spill was at odds with the specific outcome of putting downward pressure on prices and the principal objective of maintaining security of supply.

In the 2005/06 review, the PCE recommended that the EC quantify hydro spill that has occurred for cost, economic or other reasons, to establish a basis for considering whether the level of "unnecessary" hydro spill is significant. However, it is worth acknowledging that the fundamental reasons behind spillage may not be always easy to observe and may be subject to hindsight bias. For example, a generator may store water in expectation of higher prices later. If a large rainfall event then precipitates spillage, one might classify it as a "high flow" event that on the face of it seems unavoidable, but could arguably have been avoided.

The EC considered hydro spill in its recent Market Design Review paper.[46] To avoid the difficulties of defining unnecessary spill the EC looked for trends or patterns over a long time period as an indicator for potential market issues. Based on this data, the EC concluded that there was no indication that the reformed electricity market had caused an increase in the levels of spill.

Although the EC's analysis indicates that spill has not become more frequent or greater in quantity, the increasing amount of renewable generation may well result in greater spill in the future (from hydro and wind). Some of this may be justifiable. Nevertheless, any spill that occurs while thermal power plant is generating electricity means carbon dioxide may be emitted unnecessarily. It is important that events of this type are

monitored and analysed to find out if the spill is optimal from the national perspective, and – when it is not – to identify any system causes that need to be addressed.

Commissioner's recommendation

I recommend that:

3. the Electricity Commission collate the hydro spill data published by generators and investigate the causes of hydro spill events where the event is classified by the generator as 'cost', 'economic', or 'other', and that have occurred when thermal plant has been generating.

4.3 Demand management and metering technology

Based on recent media releases, retailers plan to install around 1.6 million advanced meters in New Zealand homes over the next few years.[47] New Zealand appears to be the only country in the world where such deployment is being driven solely by the market.[48] With market driven deployment, there is a risk that many meters will not have the functionality required to gain optimal environmental benefit.

In the 2006 GPS, the EC was charged with considering whether the introduction of advanced meters should be mandated. The EC is also required to encourage demand-side participation in the wholesale and retail market. To meet these requirements the EC is involved in a considerable amount of work focused on demand management and metering.

The EC's project plan relating to load management and metering includes work on advanced meter deployment. During 2006/07, the EC identified investment barriers associated with load-management related metering and concluded that it needed to intervene for the benefits to be realised.[49] This intervention will involve providing guidelines by June 2008 that include minimum recommended standards for advanced meters. However, these guidelines will be non-binding.

At the same time, retailers are already planning their residential deployment strategies. Table 2 shows deployment plans released in the media over the last year. Meridian and Mercury have already rolled-out 73,000 advanced meters, but they do not yet have the IT systems in place to enable real-time pricing. This means their customers will be reliant on pricing structures offered by retailers that will average out the real-time costs of electricity generation. In particular, consumers will not face a higher price for using electricity at peak times that is generated by carbon dioxide emitting, fossil-fuelled plant. If consumers do not pay prices that better reflect the real-time cost, they are unlikely to change their behaviour to use electricity more efficiently. Consequently, any potential environmental benefits from using advanced metering may not be realised.

Table 2 Planned Advanced Meter Roll-out (number of meters) [50] [51]

Roll-out completion date	Contact	Genesis	Mercury	Meridian	Total
2008			5,000	68,000	73,000
2009	35,000			67,000	175,000
2011			335,000		510,000
2013	465,000	575,000			1,550,000

Commentary

There are three main areas where action by the EC could help realise the potential environmental benefit from advanced meters. These relate to installation of in-home displays, removal of barriers to price signals, and the use of passive demand response.

Advanced meters have been deployed in a number of jurisdictions overseas including the UK, Italy, and some states in the US and Australia.[52] The UK energy governance body, Ofgem, has evidence that simply installing a meter with in-home display will lead to approximately a 2.8% reduction in total energy consumption. Ofgem is currently conducting a pilot study in 50,000 homes to confirm these findings.[53]

An even greater demand response should occur if consumers with advanced meters were charged higher prices during periods of high demand and tight supply. Examples of such pricing plans include time-of-use plans (e.g., peak and off-peak rates) and critical peak pricing (e.g., where an additional high rate is used on occasion with short notice at critical times). However, the pricing structures offered by retailers will not necessarily provide the maximum national environmental or economic benefit.

Finally, the demand response will almost certainly be greater if the advanced meter is integrated with other technology within each household, enabling an automated demand response. This would open the door for centrally controlled, remote load management. For example, a household could have dedicated circuits or appliances, such as refrigerators, that can be turned off for a short time when the spot price is high and the system is under pressure. For this to be acceptable, consumers would need to receive some financial reward.

Market-led deployment of advanced meters is unique to New Zealand and, as outlined above, the risk exists that significant environmental benefits may not be fully realised. For this reason, the EC must monitor, and to some extent guide and encourage, this process carefully.

In the past, ripple control has provided some automated demand response. Ripple control refers to a system where lines companies can directly switch on and off specific load in a residence, such as water heaters and night storage heaters.[54] There are approximately 1.4 million ripple control receivers in New Zealand.

Based on surveys of the ripple control owners, the EC estimate that approximately 880MW is controlled.[55] This is roughly 10% of the total installed generation capacity in New Zealand. However, the total load available for ripple control at any one time is less than this because not all water heaters would be switched on at any given time. The EC recently attempted to physically test how much load could be controlled using ripple technology, but was unable to proceed at that time.[56]

The infrastructure enabling ripple control is ageing and it appears to be gradually falling into disuse. This disuse is probably associated with obsolete technology and unreliable performance, as about one third of ripple control assets are over 30 years old.

The usefulness of the installed ripple control infrastructure appears to be diminishing due to ageing receivers and changes in the patterns of energy use. Instead of upgrading the current ripple control infrastructure, it may be sensible to develop a remote load control system based on the emerging advanced meters infrastructure.

Advanced meters may more than fill the gap left by ripple control. However, the transition to advanced meters could result in less control over load. This might happen if advanced meters are deployed without optimal functionality and the ageing ripple control infrastructure continues to decline. Therefore, this transition may need oversight from the EC. This should include coordinating testing of the evolving load control system, which may require encouraging greater cooperation among electricity sector participants such as lines companies.

Commissioner's recommendation

I recommend that:

4. the Minister of Energy requests that lines companies assist the Electricity Commission in testing of the total load able to be shed from load control arrangements, such as the installed ripple control infrastructure and the newly installed advanced meters.

4.4 Wind Generation Integration Project

The GPS requires the EC to contribute to the Government's climate change objectives by, among other things, removing barriers to investment in renewable generation, such as wind. As wind generation is intermittent, increasing it as a proportion of the electricity supplied to the national grid will challenge the security of the supply system. Additionally, the existing system operation and market arrangements rely on accurate generation forecasts in advance of delivery, which is difficult in the case of wind.[57] The Wind Generation Investigation Project (WGIP) is one initiative underway to help address these issues and smooth the way for more wind integration.

The main objective of the WGIP is to identify and quantify the technical and electricity market impacts of wind generation upon the New Zealand power system over the

next five to ten years.[58] In June 2007, the EC released its evaluation of impacts on the system arising from increasing wind generation. Following this, it developed options to address the issues. It identified the high priority tasks as follows:

- reviewing how the costs associated with increasing wind generation are allocated
- investigating methods for improving wind forecasting
- investigating specific methods to address some frequency and voltage issues.

The EC has and is undertaking significant work on reducing barriers to wind generation and this work is proceeding well.

4.5 Transmission pricing and renewable generation

The GPS requires that the EC develop a sound framework for transmission pricing as a method for Transpower to recover full costs for its services; this is referred to as the Transmission Pricing Methodology (TPM).[59] In June 2007, the EC recommended the TPM to the Minister of Energy for approval. The proposed TPM allocates existing and future upgrade costs of the High Voltage Direct Current (HVDC) transmission link solely to South Island generators.[60] The EC based its recommendation on the reasoning that the South Island generators were the major beneficiaries from the link, as most of the flow is south to north, providing them with a market for their generated power.[61]

The South Island generators Meridian, Contact and Trustpower have heavily criticised the proposed TPM.[62] Meridian's main argument is that there are wider private and public benefits resulting from upgrading the HVDC link, for example security of supply, and therefore private South Island generators should not have to pay the full cost.[63] They also contend that as a result of this inequitable distribution of costs, the TPM discriminates against renewable generation. This is because virtually all hydro and much potential wind generation is situated in the South Island and virtually all thermal is situated in the North Island. In its 2007 submission to the EC, Trustpower suggested that new North Island wind sites would struggle to compete against thermal generation, whereas new South Island sites would be economically competitive as long as there were no transmission penalties relating to the HVDC link.[64]

The TPM with respect to the HVDC link may impose a significant economic cost on generators. Meridian and Trustpower estimate long-run penalties ranging from $3-10 per MWh.[65] This is about 5-15% of the average wholesale price that generators receive and is a cost that the renewable generators would not be able to pass on to consumers.[66]

However, work by the EC questions the contention that there is limited economic potential for new wind sites in the North Island. EC modelling work suggests that there is currently 9,000MW potential for new wind generation currently feasible in terms of cost in the North Island alone. Indeed, 12 new North Island wind farms, with a combined capacity of 1,106MW, either have been, or are, in the process of being granted resource consent – although not all of these may be built. Additionally, results

from scenarios run on its Generation Expansion Model (GEM) suggest that the TPM makes little difference to the development of renewable generation.[67] Based on this work, the EC concludes that there is not a significant problem.

Both the GEM and the related analysis have not been formally peer reviewed.[68] Also, in a 2007 report the EC indicates that the treatment of the HVDC charge in the GEM needs refinement.[69] Therefore, as it is not certain whether or not the TPM creates a barrier to investment in new renewable generation, the EC's conclusion appears premature and should be qualified as 'draft' or 'initial'.

The EC has stated that there is no requirement in the GPS for it to "preferentially treat renewables, but rather to adopt efficient pricing so that undue barriers are reduced or removed".[70] The EC has therefore concluded that the TPM "does not present an undue barrier to investment in renewables overall, and does not detract from the Government's climate change objective".[71] However, it is worth noting that the EC's conclusion only holds if the electricity sector faces the full environmental costs of supply-side options, which it currently does not. The introduction of a carbon price on electricity, through the Emissions Trading Scheme, is one step in this direction.

As the full environmental costs are not included in electricity prices, the most economically efficient option often will not achieve the best result for the environment. Under these circumstances it is probable that there will be times when the GPS goals will conflict with environmental objectives. This trade-off should be explicitly acknowledged and the GPS should be amended to provide guidance on how to weigh up conflicting objectives.

Finally, it should also be recognised that if the TPM were changed so that South Island generators did not carry the full cost of the HVDC, it would not necessarily result in a better environmental result. Although most generation in the South Island is renewable, this could change. For example, altering the TPM might result in South Island coal generation becoming economic. Changes to HVDC charges shift the economic viability of all generation projects, not just that of renewable generation. Another consequence of removing the HVDC charge from South Island generators could be that they displace North Island renewable development, which may increase system losses and potentially be both economically and environmentally inefficient.

Commissioner's recommendations

I recommend that:

5. the Electricity Commission undertakes a formal independent peer review of the Generation Expansion Model, and the relevant modelling work, to check the validity of its conclusions regarding the impact of the Transmission Pricing Methodology on future renewable generation.
6. the Minister of Energy amends the Government Policy Statement to provide guidance on how to reconcile environmental and economic objectives when they come into conflict.

5 Summary of the Commissioner's recommendations

As a result of this review, the Commissioner has made four recommendations to the Electricity Commission and two recommendations to the Minister of Energy. The Commissioner has also commended the Electricity Commission for its considerable work in two areas. These are summarised below.

End-use Electricity Efficiency

The Electricity Commission has carried out a considerable amount of work developing programmes to improve electricity efficiency in the residential, commercial, and industrial sectors. I commend the Electricity Commission for its work on improving electricity efficiency.

It is important that residential projects, when more cost-effective than transmission and generation investment, are provided with sufficient funding to proceed. The Electricity Commission has signaled that work in the residential sector may be better carried out by the Energy Efficiency and Conservation Authority. However, because the Energy Efficiency and Conservation Authority has limited funding, it may not always be able to justify funding and running all worthwhile residential projects. Therefore, I recommend that:

1. **the Electricity Commission continues to carry out residential end-use electricity efficiency projects, and does this in conjunction with the Energy Efficiency and Conservation Authority.**

The methods used by the Electricity Commission to improve energy efficiency have been very targeted to date. A broad energy efficiency programme, where the onus is on retailers to encourage electricity efficiency improvements, might potentially provide great electricity efficiency benefits at low cost. The energy governing body in the UK administers a programme that requires certain gas and electricity suppliers to meet energy saving targets but allows them to choose how they do it. A similar programme in New Zealand may be an effective way to encourage energy efficiency improvements. Therefore, I recommend that:

2. **the Electricity Commission undertakes a study assessing the programmes used by energy governance agencies in other jurisdictions to encourage or require energy suppliers to meet end-use energy efficiency targets.**

Hydro spill

The Electricity Commission's analysis indicates that hydro spill has not become more problematic over time. Nevertheless, any spill that occurs while thermal power plant is generating means carbon dioxide may have been emitted unnecessarily. It is important

that events of this type are monitored and analysed to find out if the spill is optimal from the national perspective, and when it is not to identify any systemic causes that may need to be addressed. I therefore recommend that:

3. **the Electricity Commission collate the hydro spill data published by generators and investigate the causes of hydro spill events where the event is classified by the generator as 'cost', 'economic', or 'other', and that have occurred when thermal plant has been generating.**

Demand management and metering technology

Various market factors prevent optimal investment in both energy efficiency and demand side management. Advanced meters, in conjunction with other measures such as time-of-use tariffs, may enable some of these issues to be solved and lead to significant reductions in consumption. However, deployment of advanced meters that is solely led by the market is unusual. For this reason, the Electricity Commission must monitor and, where necessary, guide this process carefully.

In the past, the ripple control infrastructure has enabled significant automated demand response in times of tight supply and high demand. However, the total load available for ripple control at any one time is unknown. The Electricity Commission recently attempted to physically test how much load was available, but was unable to proceed at that time. Therefore, I recommend that:

4. **the Minister of Energy requests that lines companies assist the Electricity Commission in the testing of the total load able to be shed from load control arrangements, such as the installed ripple control infrastructure and the newly installed advanced meters.**

Wind Generation Integration Project

Through the Wind Generation Integration Project, the Electricity Commission has made removing barriers to wind integration a high priority. This work is proceeding well and I commend the Electricity Commission for its work in the Wind Generation Integration Project.

Transmission Pricing and Renewable Generation

The Electricity Commission has recommended a Transmission Pricing Methodology that allocates to South Island generators both existing and future upgrade costs for the current High Voltage Direct Current North Island-South Island transmission link. South Island generators state that this methodology will deter renewable generation development in the North Island thereby contravening the Electricity Commission's goal of encouraging renewable generation development. Work by the Electricity Commission brings those claims into question: model results suggest that the methodology does not significantly impact the development of renewable generation.

However, because both the model used (the Generation Expansion Model) and the related analysis have not been formally peer reviewed, this conclusion appears premature. I therefore recommend that:

5. **the Electricity Commission undertakes a formal independent peer review of the Generation Expansion Model, and the relevant modelling work, to check the validity of its conclusions regarding the impact of the Transmission Pricing Methodology on future renewable generation.**

As the full environmental costs are not included in electricity prices the most economically efficient option will, at times, not achieve the best outcome for the environment. Under these circumstances it is probable that there will be times when goals outlined in the Government Policy Statement will conflict with environmental objectives. This trade-off should be explicitly acknowledged and the Government Policy Statement should be amended to provide guidance on how to weigh up conflicting objectives. Therefore, I recommend that:

6. **the Minister of Energy amends the Government Policy Statement to provide guidance on how to reconcile environmental and economic objectives when they come into conflict.**

Glossary

CFL	Compact fluorescent lamp
EC	Electricity Commission
EECA	Energy Efficiency and Conservation Authority
GEM	General Expansion Model
GPS	Government Policy Statement on Electricity Governance (October 2006 update unless otherwise stated)
GIT	Grid Investment Test
GWh	Gigawatt hour
HVDC	High voltage direct current
MoU	Memorandum of Understanding
MW	Megawatt
MWh	Megawatt hour
NZES	New Zealand Energy Strategy
PCE	Parliamentary Commissioner for the Environment
SOI	Statement of Intent
Transpower	Transpower New Zealand Limited
TPM	Transmission Pricing Methodology
WGIP	Wind Generation Investigation Project

Endnotes

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23 $280,000 was spent in the 2006/07 financial year.

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27 Electricity Commission. November 2006. "Proposed Request for Appropriation for the Electricity Efficiency Function for the financial years ending 2008-2010 and outyears". *Consultation Paper for the Electricity Commission.* Available online at http://www.electricitycommission.govt.nz/pdfs/opdev/elec-efficiency/consult/request-for-appropriation-06.pdf.

28 $480,000 was spent in the 2006/07 financial year.

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