

Evaluating solar water heating:  
Sun, renewable energy and climate change

July 2012



Parliamentary Commissioner  
for the **Environment**

Te Kaitiaki Taiao a Te Whare Pāremata

## **Acknowledgements**

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## Commissioner's overview

*Two roads diverged in a wood, and I —  
I took the one less travelled by.  
And that has made all the difference.*

– Robert Frost

So began one of the influential pieces of energy writing from the 1970s, entitled *Energy strategy: The road not taken* by Amory Lovins, American physicist and environmental scientist. I was a student at the time and this was part of the brave new world of renewable energy. The idea of this 'road less travelled' influenced the thinking of a generation.

This was the time of the oil price shocks, with the Organisation of Petroleum Exporting Countries (OPEC) flexing its muscles. In response to the 'energy crisis', New Zealand, like many other countries at that time, developed a policy of being self-sufficient in energy. On the one hand there was the more travelled road leading to Think Big projects like the Motunui synthetic petrol plant and the Clyde dam. On the other hand, there was increasing interest in the less travelled path of energy efficiency and small scale energy technologies like solar water heaters distributed in their thousands across the country.

Using the sun's energy to heat water feels instinctively right. It is certainly renewable; we will not run out of sunlight. Nearly 12% of all the electricity generated in New Zealand is used to heat water in our homes, and replacing much of this electricity with sunlight has great appeal.

In the late 1970s, central government began to promote solar water heating by providing financial support in the form of interest-free loans. Subsidies for solar water heaters continued right through until June 2012 as this investigation was coming to a close. There is now, however, increasing interest from local government. Thirty local authorities have become involved in promoting solar water heating or are considering doing so.

In looking at the merits of solar water heaters, my focus is on the environmental benefits. Of particular importance is how much solar water heaters can help us in the fight against climate change – the greatest environmental challenge we face. Because solar water heaters save electricity, every solar water heater that is put on a roof will contribute to reducing carbon dioxide (the major greenhouse gas) which comes from the electricity generated by burning fossil fuels. But this investigation has taken us on a journey into the electricity sector that has led to some unexpected conclusions.

Instinct and reason both tell us that solar water heaters perform at their best in summer when days are long and sunshine is often bright. But winter is the time when use of electricity rises to its highest levels driven by chilly temperatures and early darkness. At these times, virtually every power plant in the country will be generating electricity and carbon dioxide emissions will be at their highest. And as these winter peaks rise, more power plants must be built.

Meeting the very top of peaks on cold days in winter is done using the relatively inefficient open cycle gas power plants known as 'gas peakers'. Last year a new gas peaker was built in Taranaki, one is under construction, and the plan for another has just been announced. Every new fossil fuel plant that is constructed 'locks in' carbon dioxide emissions for decades. Unfortunately, solar water heaters are at their least effective when saving electricity benefits the environment most.

Successive Governments have committed to a 90 percent renewable electricity generation target by 2025. The 'peakier' electricity demand becomes, the harder it will be to meet this target.

A major conclusion of this investigation is that flattening the high peaks in electricity demand that occur in winter has great environmental value. Most forms of renewable energy cannot be stored – geothermal, wind, and run-of-river hydro are all "use it or lose it". New Zealand is an island country and cannot import electricity, so supplying peak demand in winter must be done through using stored energy – either by burning fossil fuels or by using water from large hydroelectricity reservoirs such as Lake Pūkaki.

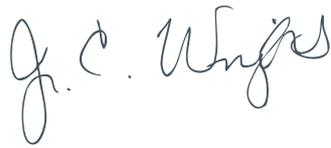
Controlling the electricity used for water heating in order to flatten peaks in demand – load management as it is known within the industry – has a long history in New Zealand. About sixty years ago Kiwi ingenuity developed ripple control – the ability to turn water heaters on and off remotely by sending a high frequency signal down the power lines.

One use of ripple control is to turn off water heaters during the day so that all water heating is done at night when demand for electricity is low. Householders who opt for night-only water heating are, unbeknown to them, delivering a really significant environmental benefit. Heating water only at night flattens peaks. This in turn reduces the need to build new fossil fuel power plants and lock in carbon dioxide emissions into the future. Night-only water heating will not work for everyone, but in one part of the country at least 30% of households have opted for night-only water heating at half the cost of 'anytime' water heating.

Of course, there are other options for managing demand including the introduction of smart meters that support the development of a smart grid. These too have the potential to change the way we use electricity to the betterment of the environment.

This investigation, more than most that take place in my office, has taken us on an interesting journey. It began by asking questions about one technology – solar water heaters. Answering these initial questions led to looking at the whole electricity sector in New Zealand – how supply meets demand, how the sector is structured and how it is regulated.

Using sunlight to heat water is an idea that holds great appeal. But in this country, making electricity use more consistent over time is the key to achieving the 90 percent renewable electricity target and reducing the impact of electricity on the environment. We should not underestimate the significant challenges that lie before us in our fight against climate change.



Dr Jan Wright

**Parliamentary Commissioner for the Environment**





# 1

## Introduction

Harnessing the power of the sun has inspired people across cultures for millennia. From deity to practical application, solar energy has been entwined with human history. In ancient Greece, legend has it that Archimedes focused the sun's rays using highly polished shields to destroy enemy ships, and in sixth century Rome the Justinian code established that all people had 'sun rights' ensuring that buildings had access to the sun.<sup>1</sup>

We continue to use the power of the sun in the world of the twenty-first century. Solar energy has the potential to help provide solutions to the great challenge of a changing climate, whether it be through electricity generated by photovoltaic cells, or by the design of passive solar buildings, or by technologies yet to be developed.

Solar water heating in homes is the focus of this report. It is generally thought of as relatively new technology, yet the first commercial solar water heater was advertised in 1891.<sup>2</sup>

The oil price shocks of the 1970s stimulated interest in, and the development of, renewable sources of energy including wind, geothermal, and biofuels, as well as sunlight. In New Zealand, the Government has set a target of 90 percent of the country's electricity to be generated from renewable sources by 2025. Most electricity in New Zealand is already renewable – 77 percent of New Zealand's electricity came from renewable sources in 2011.<sup>3</sup>

It is now clear that the world is not short of fossil fuels. New Zealand, for instance, has huge quantities of the low quality coal called lignite, but all large scale uses of lignite would be accompanied by very high emissions of carbon dioxide. Climate change, rather than renewability *per se* is now the issue.

In March 2011, the Government established a target for a 50 percent reduction in the country's greenhouse gas emissions from 1990 levels by 2050. And both the New Zealand Energy Strategy 2011–2021 and the New Zealand Energy Efficiency and Conservation Strategy 2011–2016 emphasise the importance of reducing greenhouse gas emissions. The great value that solar energy promises is helping the transition to a low-carbon economy.

Within New Zealand, solar water heating has been actively promoted as part of this approach. According to the Energywise website: *“Many homes in New Zealand are well-placed to harness the sun’s free, renewable energy with solar water heating.”*<sup>4</sup>

## 1.1 The purpose of this report

The Parliamentary Commissioner for the Environment is an independent Officer of Parliament, with functions and powers granted through the Environment Act 1986. Her role allows a unique opportunity to provide Members of Parliament with independent advice in their consideration of matters that may impact on the environment.

It is generally assumed that solar water heating is ‘good’ for the environment. Household water heating currently uses nearly 12 percent of all of New Zealand’s electricity; using the sun instead could significantly reduce this demand. The purpose of this investigation is to examine the potential environmental benefits of solar water heating in New Zealand.

Solar water heating is promoted at both central and local government level. For example, it is being promoted in the rebuild of Christchurch, with design guides provided by the Christchurch City Council. And in Auckland, a pilot programme is underway which aims to have more than 250 solar water heating systems installed in homes and businesses across the region in the next 12 months.<sup>5</sup>

At central government level, grants which had been available for solar water heating and heat pump water heating were stopped in Budget 2012 and are to be replaced by an information programme for efficient water heating.<sup>6</sup> The agency responsible for this will be the Energy Efficiency and Conservation Authority (EECA).

The merits of government intervention at both local and central level are also assessed in this report. While householders can choose to install solar water heaters, the question remains whether government should promote and subsidise them.

This report is not limited to an examination of solar water heating. ‘Joining the dots’ led the investigation into a much wider area – the nature of the electricity system in New Zealand, how supply meets demand, how the sector is structured, and how it is regulated.

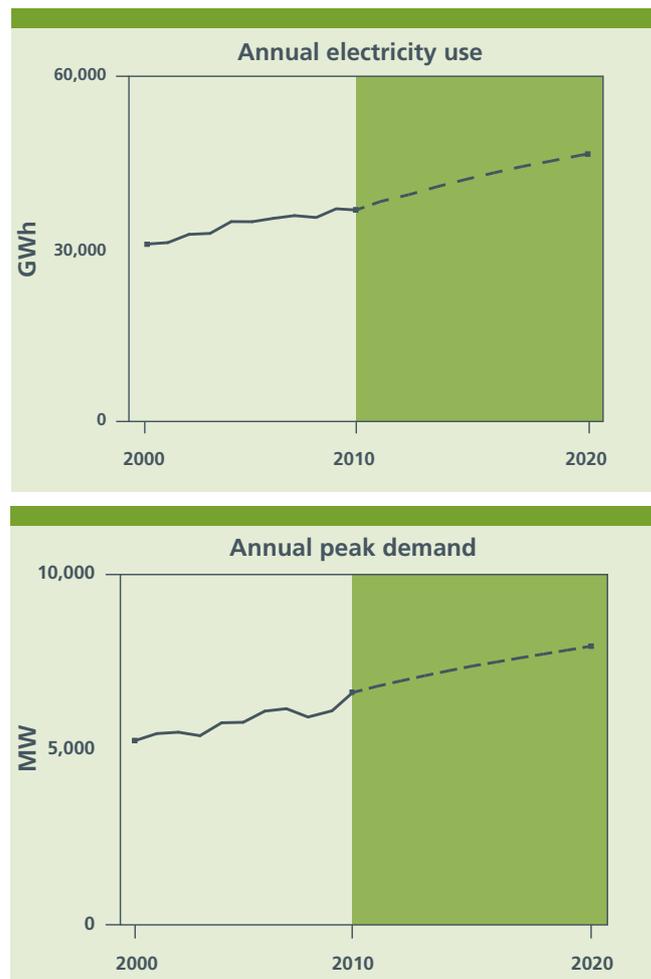
## 1.2 The environmental impacts of electricity

In order to consider the environmental benefits of solar water heaters, the environmental impacts of the electricity system must be considered.

Around a quarter of the country's electricity is generated by power plants burning coal, natural gas and diesel. This generation produces about 20 percent of New Zealand's carbon dioxide emissions, the main greenhouse gas.<sup>7</sup> While most of New Zealand's electricity is renewable, all forms of generation have environmental impacts. For example, hydro dams can drown landscapes, affect fish passage, and trap sediment.

The need to build more generation and power line infrastructure is largely driven by the high peaks in demand that occur in winter. While static in recent times, current predictions are that New Zealand's total electricity use and peak electricity use will both increase substantially (see Figure 1.1).

A major theme of this report is that peak power is the most costly electricity both from an environmental perspective and from an economic perspective.



**Figure 1.1 Electricity consumption and peak power demand are both expected to continue increasing.<sup>8</sup>**

## 1.3 Structure of the report

The remainder of the report is structured as follows:

Chapter 2 is a history of water heating in New Zealand and the role that solar water heating plays within that broader context.

Chapter 3 provides an introduction to the promotion of solar water heating and the main institutions involved.

Chapter 4 summarises a survey of all New Zealand councils which was done to understand their involvement in solar water heating.

Chapter 5 provides an analytic framework for evaluating the environmental benefits of saving electricity.

Chapter 6 assesses the environmental performance of solar water heaters. Some practical and economic issues are also discussed.

Chapter 7 looks at some alternatives to solar water heating and their environmental performance.

Chapter 8 discusses the implications of the investigation for government policy, both at central and local level.

Chapter 9 contains a brief conclusion and three recommendations from the Commissioner.

An Appendix is available on our website at [www.pce.parliament.nz](http://www.pce.parliament.nz)

## 1.4 What the report does not cover

This report does not cover:

- detailed analysis of other alternatives such as gas water heating, heat pump water heaters, wetback, and solar water heaters that are backed up by gas or wetback
- other solar energy technologies such as photovoltaic cells
- solar water heaters for commercial and industrial use
- carbon dioxide emissions associated with manufacturing water heaters or the building of supply side infrastructure ('embodied' carbon dioxide)
- detailed economic analysis of water heating options
- security of electricity supply
- advice to the public on different water heating options.

Finally, the findings in this report are specific to New Zealand and should not be taken to apply to other countries.



# 2

## The story of water heating in New Zealand

As part of modern life, it is taken for granted that hot water will be available. Yet as recently as the 1940s, one in four homes did not have hot water at the turn of a tap.

Methods that have been used to heat water in New Zealand have changed over time. Solar water heating has been a minor and recent player. Electricity has been, and remains the dominant player in water heating, although natural gas is common in parts of the North Island. Indeed, by the 1970s New Zealand's water heating was probably the most electrified in world.<sup>9</sup>

This chapter describes how domestic water heating has evolved hand-in-hand with the electricity system and how water is heated in New Zealand households today.

### 2.1 The early days

It was not until the early 1900s that piping water into houses became widespread. Prior to this, water was carried into the house in containers and heated over the fire or coal range. Wetbacks – pipes carrying water passing through the firebox of a coal range or the back of a fireplace – also provided hot water. Dedicated stoves called chip heaters (as they burned chips of wood) heated water for bathing and for kitchen use. Another device, a 'copper', was commonly used to heat water for washing clothes.

Coal gas, produced in gasworks during the 1800s and into the 1900s, also became a fuel for heating water. Instantaneous water heaters called 'califonts' and 'geysers' became popular. These heated water as people needed it but their spread was limited to areas with reticulated gas. From the 1930s the use of coal gas declined and by the 1960s it was being phased out.<sup>10</sup>



Source: Boiling the copper, Wilton Bush, Wellington. Hislop, Harold Stevens, d 1933 :Photograph albums. Ref: PA1-o-229-28-1. Alexander Turnbull Library, Wellington, New Zealand. <http://beta.natlib.govt.nz/records/23150199>

**Figure 2.1 A boy heats water with a 'copper' in Wilton, 1907.**

## 2.2 The introduction of electric water heating

New Zealand's first electric water heater – a resistance element submerged in a cylinder of water – was developed around 1915. By the 1920s electricity use was widespread. In the 1930s, when companies began heavily promoting kitchen stoves running on 'white coal' (electricity), electric water heaters became more common. Electric stoves needed heavier wiring to carry the greater load and this also allowed for electric water heaters to be installed.

The electric water heater replaced wetbacks, califonts and chip heaters. But its success created problems. The amount of power that lines could carry, and power plants could produce, was being outstripped by households' appetite for electricity.

Unsurprisingly, electricity demand was greatest in the evenings when lights and electric stoves were switched on. And until 1944, when thermostats were made compulsory, most electric water heaters were adding to this load as they were not temperature-controlled.<sup>11</sup> By the 1950s, just over three decades after they were introduced, electric water heaters used one-third of the country's electricity.



Source: McClary electric oven. Burt, Gordon Onslow Hilbury, 1893-1968 :Negatives. Ref: 1/1-015786-G. Alexander Turnbull Library, Wellington, New Zealand. <http://beta.natlib.govt.nz/records/22331643>

**Figure 2.2 Electric kitchen ranges running on ‘white coal’ (electricity) became common from the 1920s. The heavier wiring they required into households also allowed water heating to be electrified.**

### 2.3 Introducing control into the system

To cope with increasing peak use in the 1920s, local electric power boards had installed ‘changeover switches’ so that either the electric stove or electric water heater could be turned on, but not both at the same time. In the 1930s, timers were also installed, as were pilot wires – separate wires that allowed the power board to remotely turn cylinders on and off. However, timers were unreliable and pilot wires were not economic to install in many cases.

Supply struggled to match increasing demand and through the 1940s there were numerous power cuts. In 1947 the Auckland Electric Power Board prohibited the use of standard electric water heaters at peak times. If caught taking a bath outside of allotted times the penalty was a £200 fine or a year in prison. Within a few days electricity demand dropped 22 percent at peak.<sup>12</sup>

A reliable technology that could remotely turn water heaters on and off was needed. In 1949 the Waitemata Electric Power Board experimented with sending a high frequency signal down the power line itself. A switch at the household’s switchboard detected the signal and turned the hot water cylinder on or off. The ‘ripple control’ system was born.

Water heaters can be ripple controlled so that they are only turned on at night when demand is lower and electricity is cheaper. The other main way in which ripple control is used is to turn water heaters off for short periods of time when demand is very high, usually on winter evenings.<sup>13</sup>

## 2.4 The growing demand for power

Ripple control quickly spread around the country during the 1950s. However, electricity demand continued to rise due to the post-war economic boom, especially at peak times.

More hydro stations were built in the mid 1950s but growing demand eroded these gains and by the late 1950s there were more power cuts. Larger hydro stations which stored water for times of peak demand were built. New power plants burning coal were the other way of meeting peaks in demand because they could be ramped up quickly.

There were times, however, when supply 'dropped off', mainly due to low lake levels affecting hydroelectricity generation. This vulnerability continues today. In dry years when the storage in hydro dams is very low, the country can still struggle to meet the winter peak. As recently as 2008 an advertising campaign encouraged people to take shorter showers and switch off lights and appliances due to the effects of drought on the hydro lakes.

The story of water heating in New Zealand has largely been one of electrification, though gas may play a bigger role in the future. Today, nearly 12 percent of all the electricity in the country is used to heat water in people's houses.<sup>14</sup>

Around three-quarters of households currently heat their water with electricity.<sup>15</sup> Today, the use of ripple control varies across the country. Several years ago the Electricity Commission estimated that perhaps ten percent of load is interruptible, mostly water heating.<sup>16</sup> However, the extent to which it is functional is not well known. Where ripple control is used by lines companies, it is mainly to reduce peak loads on local distribution networks.<sup>17</sup>

The modern way of controlling peak loads is through smart meters. New electronic meters have been installed in many households in New Zealand, but while often called smart meters, they lack the functionality needed to 'talk to' appliances and water heaters in a more sophisticated way than ripple control.<sup>18</sup>

## 2.5 Other ways of heating water

### *Heating water with the sun*

The origins of solar water heating can be traced back to Switzerland. In the 1760s naturalist Horace-Bénédict de Saussure built 'hot boxes' – prototypes of solar water heaters. The bottom was painted black and above it were several layers of glass. When oriented perpendicular to the sun, Bénédict de Saussure recorded air temperatures over 100 degrees Celsius. He hoped that "someday some usefulness might be drawn from this device."<sup>19</sup>

It was not until the late 1800s that the concept was applied to heating water. American Clarence Kemp, a plumbing and heating manufacturer, built a solar water heater based on this design. Designs continued to evolve but the essential principles remain the same. The technology took hold in California and Florida and spread to Israel and Cyprus and elsewhere. Today the giant in solar water heating is China with over 30 million households using the sun to heat water.

**Climax Solar-Water Heater**  
UTILIZING ONE OF NATURE'S GENEROUS FORCES

**THE SUN'S HEAT** { Stored up in Hot Water for Baths, Domestic and other Purposes.

GIVES HOT WATER at all HOURS OF THE DAY AND NIGHT.  
NO DELAY.  
FLOWS INSTANTLY.  
NO CARE. NO WORRY.  
ALWAYS CHARGED. ALWAYS READY.  
THE WATER AT TIMES ALMOST BOILS.

**Price, No. 1, \$25.00**  
This Size will Supply sufficient for 3 to 5 Baths.

CLARENCE M. KEMP, BALTIMORE, MD.

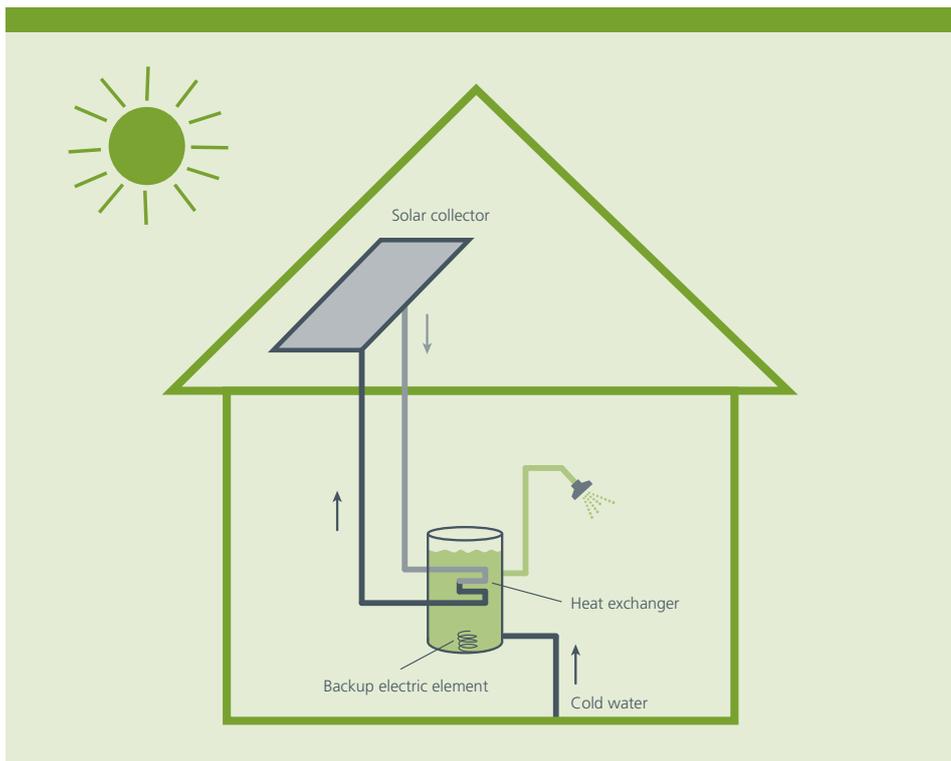
Price Of No. 1 Heater for 1892 Reduced to \$15 Net

OUTLET

Source: Climax Solar Water Heater Advertisement – 1891

**Figure 2.3 Advertisement for the Climax Solar-Water Heater, the world's first commercial solar water heater, patented in 1891.**

In 1978, the New Zealand Government began to support solar water heaters through the then Ministry of Energy Resources. The aims were to save energy and promote the viability of the solar water heating industry. Interest-free loans were made available for the purchase and installation of approved solar water heating systems. By 1982 an estimated 6,500 solar water heaters had been installed, with over half funded by the loan scheme. The scheme was not deemed a success, due to low uptake rates and poor electricity savings of the systems, but it continued without increased funding until 2000.<sup>20</sup>



**Figure 2.4** Solar water heaters work by heating panels filled with fluid which circulates to heat water through a heat exchanger. When the sun does not provide enough energy, a backup system is used to boost the heating. In most cases the backup is electricity, but gas or wood (via a wetback fitted to a log burner) may also be used. A solar water heating system must be designed to match a household's hot water needs and climate to work well.

From 2002 a subsidy of \$300 was available through the EECA. This later increased to \$500 and then \$1,000 for the best performing systems.<sup>21</sup> The subsidy was reviewed in 2011 and it was announced in the 2012 Budget that it would cease.

Between 2006 and 2011 over 11,000 solar water heaters were subsidised under this scheme.<sup>22</sup> It is difficult to say with any degree of certainty how many households currently use solar water heating, but it is probably about 30,000 to 40,000.<sup>23</sup>

### *Heat pump water heaters*

People are familiar with heat pumps for heating rooms. What is not nearly so well known is how the same technology can be used to heat water.<sup>24</sup> Heat pump water heaters draw heat out of air that has been warmed by the sun and use this to heat water in a cylinder. In 2011 heat pump water heaters also became eligible for the EECA subsidy and about 200 grants were made before the subsidy was ended by the 2012 Budget. It is not known how many households have a heat pump water heater.

### *Gas*

About 8 percent of households heat water using gas.<sup>25</sup> These are mostly in the North Island where reticulated gas is available. Water can also be heated using cylinders of LPG. Instantaneous gas hot water systems heat only the water required and are particularly efficient because they do not store heated water, thereby avoiding 'standby loss'. Gas water heating is likely to become more common if the price of gas falls relative to electricity.

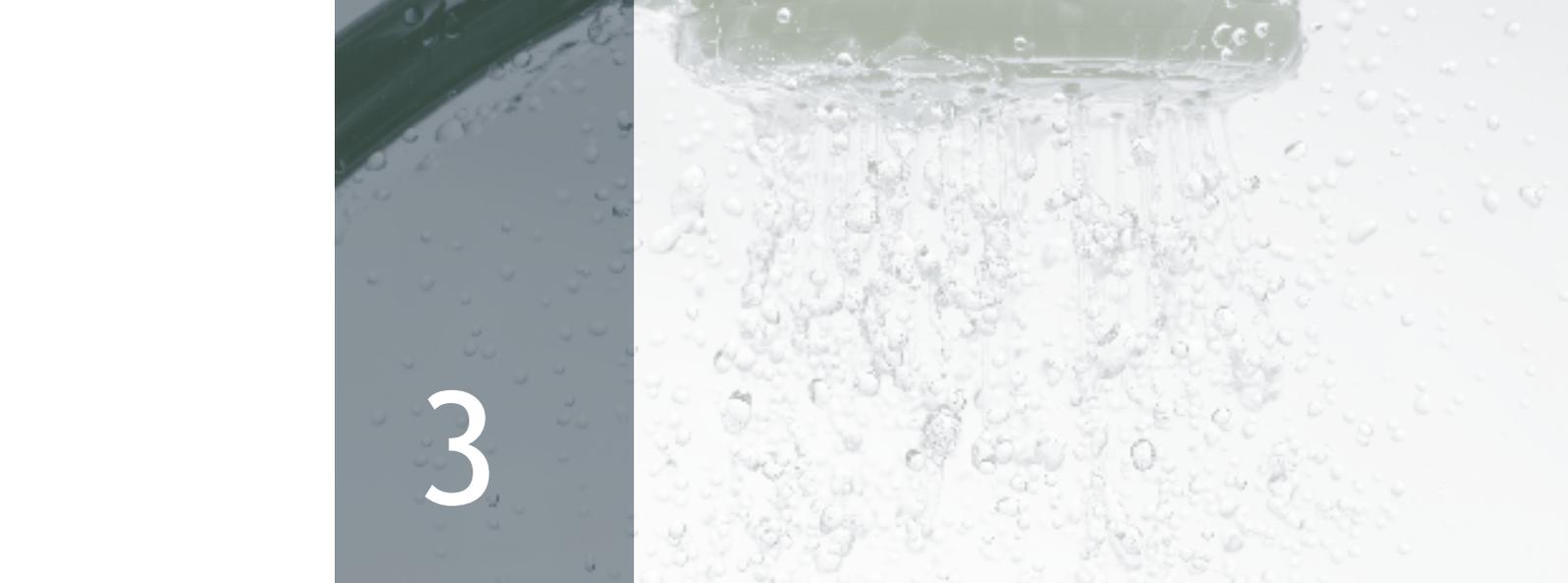
### *Wetbacks*

A traditional way of heating water is still used in about 5 percent of New Zealand's houses.<sup>26</sup> Wetbacks are more common in rural areas and colder parts of the country where log burners are used for space heating over winter. They are most commonly used to supplement electric water heating, but are also used in houses not connected to the national electricity grid where they can complement solar water heaters.

## **2.6 In conclusion**

As most households currently use electric water heaters, the most likely scenario for an installation of a solar water heater will be a case where it is backed up by electricity. The next chapter looks at how using the sun to heat water has been supported in New Zealand over time, and the main agencies involved.





# 3

## Support and promotion of solar water heaters

The idea of using the sun to heat water has steadily grown in popularity in New Zealand over the last three decades. 'Free' hot water, independence from the grid, and 'treading lightly on the earth' are understandably appealing concepts.

Support and promotion of solar water heating has been led by central and local government. At central government level, EECA is the agency responsible for the support and promotion of energy efficiency and renewable energy. At the local government level, a number of councils are active or planning to become active in supporting and promoting solar water heating. Some electricity companies are also involved in solar water heating.

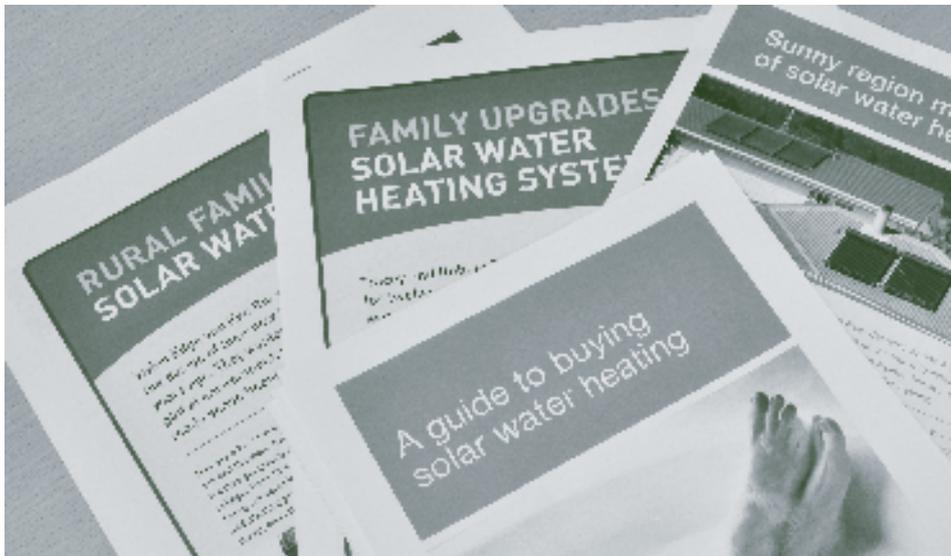
### 3.1 Central government support for solar water heating

#### *The role of EECA*

In 1992, the Resources Monitoring and Conservation Authority was established within the Ministry of Commerce, with a broad role that included policy and strategic planning functions.<sup>27</sup> In 2000, the Energy Efficiency and Conservation Act 2000 established EECA as a stand-alone Crown entity with the role of promoting energy efficiency, energy conservation, and renewable energy across all sectors of the economy.

EECA has a broad mandate under its legislation and engages in a range of activities from setting energy efficiency standards, to building the capability of energy specialists, and managing the Government's home insulation programme. One area of operational focus of EECA is the promotion of solar water heaters. This has been through providing information and a subsidy of \$500 or \$1000 for the best performing systems. This subsidy is no longer available. Its removal was largely based on an analysis of the costs and benefits of solar and heat pump water heating.<sup>28</sup>

EECA's long-term strategy is driven by the Energy Efficiency and Conservation Strategy, a companion document to the New Zealand Energy Strategy. In this strategy the Government has reaffirmed the 2025 target of 90 percent renewable electricity by, among other things, "*ensuring the electricity sector has an appropriate focus on electricity demand management tools.*"<sup>29</sup>



**Figure 3.1** EECA has published information on the benefits of solar water heating.

### *Other government agencies*

Other central government agencies are involved in policy and regulation related to the support and promotion of solar water heating.

The **Ministry of Economic Development** (recently merged into the Ministry of Business Innovation and Employment) is the main policy agency. In addition to providing oversight of the relevant regulation, the Ministry of Economic Development must also *“monitor the Energy Efficiency and Conservation Authority’s energy efficiency programmes and ensure these programmes are well-targeted and are delivering value for money.”*<sup>30</sup>

The Ministry of Economic Development has also been the lead agency for the development of the New Zealand Energy Strategy which sets the strategic direction for the energy sector.<sup>31</sup>

The **Electricity Authority** is an independent Crown entity with an objective *“to promote competition in, reliable supply by, and the efficient operation of, the electricity industry for the long-term benefit of consumers.”*<sup>32</sup>

The Electricity Authority replaced the Electricity Commission in 2010. The Commission had very broad functions as the regulator of the electricity industry, including the promotion of demand-side management and energy efficiency, and ensuring that electricity was produced in an environmentally sustainable manner.<sup>33</sup> The Authority has no responsibilities with regard to the environment, and is largely focused on increasing the competitiveness of the electricity sector. The Authority does set technical standards for the industry, including those for electricity meters.

The **Commerce Commission** is responsible for regulation of Transpower and the 29 electricity lines companies (including price control of the 17 companies not wholly controlled by consumer or community interests). These companies are by their very nature natural monopolies, so there is no competitive pressure on the prices they charge.

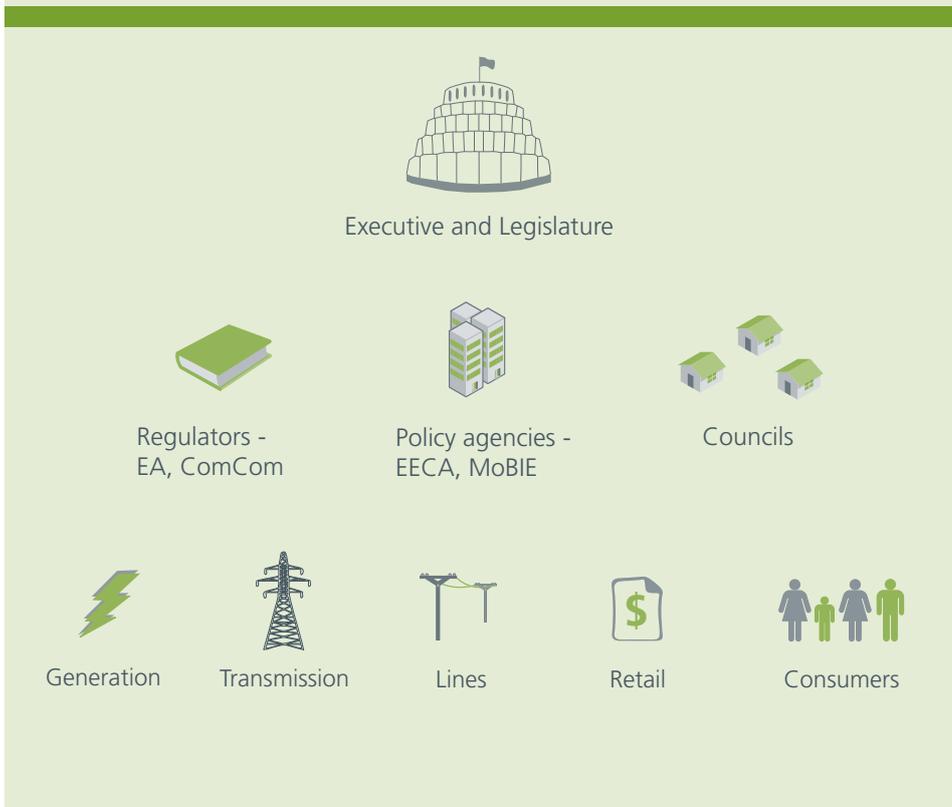
### Box 3.1: Regulating the electricity system

The Government influences the electricity system through policies it sets via agencies such as EECA and the Ministry of Business, Innovation and Employment (MoBIE).

It also determines how the electricity system is regulated through the Electricity Authority (EA). The Commerce Commission (ComCom) regulates the pricing of Transpower and 17 lines companies, and information disclosure for all 29 lines companies. Councils have also begun to play a part through their energy policies.

Generators build new power plants. Transpower is a state owned enterprise responsible for the big transmission power lines, including the Cook Strait cable, that take power from the power plants to different parts of the country. Lines companies are responsible for the web of power lines that take electricity from Transpower’s transmission lines to households and businesses. Retailers have a direct billing relationship with consumers – they incorporate the costs of electricity transmission and distribution into the prices they charge consumers.

Figure 3.2 shows how central and local government interact with the electricity sector.



### 3.2 Local government support for solar water heating

The Local Government Act of 2002 encourages councils to focus on promoting the social, economic, environmental, and cultural well-being of their communities, consistent with the principles of sustainable development. As a result, some councils promote solar water heating.

However, central government intends to narrow the role of local government to focus on providing local infrastructure such as roads.<sup>34</sup> If these changes are made, local government will be restricted in its promotion of sustainable development. Councils will still have a role in promoting energy efficiency and renewable energy through the Building Act 2004 and the Resource Management Act 1991.<sup>35</sup> For example, the Building Act requires local government to take into account *“the need to facilitate the efficient use of energy and energy conservation and the use of renewable sources of energy in buildings.”*<sup>36</sup>



Source: Griffiths, Mervyn, fl 1978. State houses with solar panels - Photograph taken by Merv Griffiths. Dominion post (Newspaper) :Photographic negatives and prints of the Evening Post and Dominion newspapers. Ref: EP-Industry-Housing-State-01. Alexander Turnbull Library, Wellington, New Zealand. <http://beta.natlib.govt.nz/records/23226302>

**Figure 3.2 In the late 1970s central government provided a subsidy for solar water heaters. These two state houses in Wellington have solar water heaters on their roofs.**

In 2009, Nelson City Council was the first to promote solar water heating on a significant scale. The council saw solar promotion as a way to market Nelson as New Zealand’s sunniest city. It was also seen as an opportunity to stimulate the local economy and consistent with the principles of sustainable development in the Local Government Act. The council provided financing to home owners to help them with the capital cost of buying solar water heaters, with both capital and interest paid back through rates. This scheme was reviewed and discontinued in 2012 when a review showed that the scheme was not achieving the outcomes it was set up to achieve.<sup>37</sup>

In July 2011, a nationwide campaign called 'The Solar Promise' was launched in Wellington by nine mayors and solar water heater distributor SolarCity.<sup>38</sup>

*"We're calling for councils, the Government, individuals, organisations and businesses throughout the country to do what they can to make solar more affordable, to help New Zealanders save money and combat climate change."*<sup>39</sup> [Solar Promise]

### 3.3 Electricity company promotion of solar water heating

At least four electricity companies are, or have been, involved in promoting and providing finance for solar water heaters.

Meridian Energy has teamed up with solar water heater distributor SolarCity to offer solar water heaters to Meridian customers. Customers must remain with Meridian for two years, and pay half the full cost upfront and the other half six months after installation.

*"Energy from the sun is 100 percent renewable, so it's better in the long term. And seeing as we're all here for the long term, let's create a better energy future. Starting today."*<sup>40</sup> [Meridian Energy]

Nova Energy offers solar water heaters which are paid off through a higher monthly energy bill.

*"Solar power uses the natural energy of the sun, is free, and lowers energy costs as well as your home or businesses carbon footprint."*<sup>41</sup> [Nova Energy]

Genesis Energy offers a \$500 credit for a solar water heater.<sup>42</sup>

*"The sun pumps out a piping hot 400 million, million, million, million watts of energy per second – which makes it pretty good at heating water, even in winter."*<sup>43</sup> [Genesis Energy]

WEL Networks, a lines company in the Waikato, began a trial of solar water heaters in 2011. Participants had to pay an upfront cost of \$2,500 and were given an interest-free loan for the balance, paying it off over 10 years. Motivated by energy efficiency, WEL wanted to explore whether the technology had the potential to reduce electricity demand on parts of their network and understand both the benefits and issues that might surface as a result of a full scale commercial project. The trial was completed and shelved due to other projects being given priority.<sup>44</sup>

In the next chapter the results of a survey of council involvement in the support and promotion of solar water heating are presented.

A close-up photograph of water splashing into a glass, creating numerous bubbles and droplets. The water is clear and the background is a light, neutral color. The number '4' is overlaid on the left side of the image.

# 4

## Council involvement in solar water heating

Growing interest by councils in promoting solar water heating raised the following questions:

- How widespread was local authority involvement in solar water heating?
- What form did this take?

In March 2012, as part of the investigation leading to this report all New Zealand local authorities were surveyed. The aim was to determine the involvement of councils in solar water heating. All 78 councils replied to the survey.

Forty-eight councils had no involvement in solar water heating and had no future plans in this area. Thirty councils had some involvement or had plans to get involved.

### 4.1 Types of council involvement

There are three main areas of council involvement (summarised in Table 4.1):

- Financing (either currently in place or is under consideration)<sup>45</sup>
- Subsidising building consent fees
- Pilot schemes and council demonstrations.

Councils with existing subsidy for building consent fees <sup>46</sup>	Councils considering financing scheme	Councils with pilot scheme	Councils with demonstration installations
Ashburton District	Chatham Islands	Auckland	Ashburton District
Hauraki District	Dunedin City	Hawke's Bay Regional (proposed)	Auckland
Hutt City	Gore District	South Waikato District <sup>47</sup>	Christchurch City
Kapiti Coast District (considering)	Hamilton City	Venture Southland <sup>48</sup>	Dunedin City
Nelson City	Hastings District		Kapiti Coast District
Porirua City	Hawke's Bay Regional		Tauranga City
South Waikato District	Hutt City		
Stratford District	Kapiti Coast District		
Tasman District	Marlborough District		
Taupō District	Napier City		
Tauranga City	New Plymouth District		
Waimakariri District	Palmerston North City (existing financing scheme)		
Western Bay of Plenty District	Southland District		
Westland District	Wairoa District		
Whakatāne District (considering)	Wellington City		

**Table 4.1 Council involvement with solar water heaters.**

### *Financing – paying it back through rates*

Palmerston North City Council is the only council that currently has a financing scheme for solar water heaters. However, fourteen councils are considering schemes where councils initially pay for the solar water heaters and that particular ratepayer repays the investment through a higher rates bill. These would be similar to Nelson City Council's scheme which was launched in 2009 and which was discontinued in mid-2012.<sup>49</sup>

### *Subsidising building consent fees*

Fourteen councils waive or discount building consent fees for solar water heaters and two were considering such a subsidy.<sup>50</sup> For example, Christchurch City Council subsidises building consent fees by \$240 per consent.

### *Pilot schemes and demonstrations*

In 2012 Auckland Council launched a solar pilot scheme of 225 homes and 25 businesses. The scheme was one of the Mayor of Auckland's '100 projects in 100 days' initiatives. The pilot scheme project is being managed for council by Solar Group Ltd.

*"Auckland Council wishes to provide locally generated renewable energy to ensure greater resilience and efficiency of energy supply."<sup>51</sup>*

In Auckland the council is also focusing on improving the consenting process for high standard solar water heaters.

Hawke's Bay Regional Council is currently consulting on a proposed pilot scheme in its Long Term Plan.

*"Hawke's Bay Regional Council proposes to provide the funding for the scheme, with borrowings of \$6 million over five years."<sup>52</sup>*

This proposal would see 1,200 solar water heaters installed.

A smaller pilot scheme of 25 solar water heaters is occurring in Southland.

Six councils also promote solar water heating through demonstrations of the technology.<sup>53</sup> For example, the Christchurch City Council also has solar water heaters installed in some of its council housing units and has installed solar water heaters on the roof of the Council's new Civic Offices building.

### *Reasons for involvement*

The reasons for councils being involved in promoting solar technologies are varied. The most common reasons given were healthier homes and a desire for reduced energy costs along with economic reasons such as supporting local industry. In communities that are off the grid solar water heating was seen as an alternative energy source.

Half of councils with some involvement in solar water heating cited environmental reasons alongside economic ones. An example is Auckland Council which has a “*proposed target of 40% reduction in greenhouse gas emissions from 1990 levels by 2040 in the Long Term Plan*”. Similarly the Hawke’s Bay Regional Council’s proposed involvement demonstrated “*regional leadership, strategic partnerships, and responding to climate change.*”<sup>54</sup>

Policies supporting solar water heaters appear in consultation documents such as Long Term Plans and also in existing council planning documents. Councils also look for alignment with central government policies. Christchurch City Council’s policies link to its Sustainable Energy Strategy 2008–2018:

*“A greater uptake of domestic solar water heating would be a major step forward on the road to a sustainable energy future. The Council wishes Christchurch to become a solar-friendly city. Central government also intends to achieve a major increase in the number of solar water heaters installed...”*<sup>55</sup>



Source: mk2010

**Figure 4.1 An evacuated tube solar water heater.**

## 4.2 Scale of investments

Most councils have not committed much in actual funding to solar water heating. For example, while Auckland Council is involved in a pilot scheme it has only allocated \$5,000 for marketing. However, with hundreds of thousands of ratepayers the potential ramifications of any expansion would be significant.

If councils are involved in financing schemes they loan money to households which must be paid back with interest. Nelson, for example, originally allocated \$9 million for this purpose over four years. Palmerston North City Council is currently the only council running a financing scheme but there is the potential for more councils to run similar schemes.

Collectively, councils considering financing represent hundreds of thousands of households. If significant numbers of ratepayers opted to purchase solar water heaters and pay councils back through a higher rates bill, then millions of dollars would be invested.

While these schemes may appear cost-neutral to councils, there are administration costs. In this respect, it is useful to look at the Nelson City Council experience, as they are the only New Zealand council to run such a scheme at any scale.

A 2012 review by Nelson City Council staff found that “the total cost in the 2010/2011 year was approximately \$1,540 per agreement signed.”

Eighty thousand dollars per annum was also being set aside by Nelson City Council to cover the costs of zero building consent fees for solar water heaters but the actual cost was likely to be lower as uptake rates did not meet expectations (240 solar water heaters were installed under the scheme).

The Nelson City Council review summed up its assessment of the costs versus benefits of the scheme as follows:

*“It is also questionable whether providing support to such small numbers of customers is providing more public good, or more private good for the individual homeowners.”<sup>56</sup>*

### 4.3 In conclusion

In conclusion, most councils do not promote solar water heaters in New Zealand. In cases where councils are involved, this is mostly at a relatively small scale, and of a trial or pilot nature.

However, there are councils such as those in Hawke's Bay with larger proposals. Pilot schemes such as Auckland Council's have the potential to be scaled up. Councils are likely to look to EECA for further guidance, and also at the experience of other councils such as Nelson, to guide them in their future plans.<sup>57</sup>

A close-up photograph of water splashing from a showerhead, with numerous water droplets and bubbles captured in mid-air. The background is a soft, out-of-focus light color.

# 5

## Electricity and the environment

Saving electricity, or at least curbing growth in its use, has long been accepted as being 'good' for the environment. In general this is true – lower electricity use is associated with lower impacts on the environment. But it is not always this simple. *When* those savings occur also matters, especially in New Zealand with its large proportion of renewable generation.

In this chapter an analytic framework for evaluating the environmental benefits of saving electricity is developed. These environmental benefits come from reducing the impacts of the electricity sector on the environment.

The impacts of electricity on the environment are of two kinds.

The first is the emission of carbon dioxide from existing power plants that burn gas, coal and diesel. Carbon dioxide is the main greenhouse gas causing global climate change.<sup>58</sup>

The second is the range of impacts that occur when new electricity infrastructure is built (e.g. power plants and transmission lines). In the context of climate change, the concern is the building of new power plants that burn gas or coal because this locks in carbon dioxide emissions for decades to come. But all new power plants have environmental impacts. Large hydroelectricity schemes that inundate landscapes to store water for times of high demand can be especially damaging.

This chapter has three sections explaining how:

- electricity use varies over time
- carbon dioxide emissions vary over time
- electricity use is expected to grow and what type of infrastructure must be built as a consequence.

The chapter concludes with two questions that can be used to evaluate the environmental benefits of saving electricity.

## 5.1 How electricity use varies over time

Electricity use is not constant; it varies throughout the day and year. Therefore the environmental impacts (of greenhouse gas emissions) will also change over time. It is important to understand the nature of this variation in order to be able to assess the environmental benefits of saving electricity at different times. Daily variation in the demand for power is shown in Figure 5.1.

34

At night, electricity use is low – few people are working and most are sleeping.

In the morning, electricity use starts to rise around breakfast time as lights, kettles and toasters are switched on, showers are used and people arrive at work. Electricity use levels off but stays high throughout the day. The daily peak occurs in the early evening when people begin to arrive home from work, and tapers off around nine o'clock.



Source data: Energy Markets Services

**Figure 5.1** The demand for electricity over an average day.<sup>59</sup>

The demand for power also varies with the seasons. In winter, electricity use is high because of colder temperatures and shorter daylight hours leading to more heating and lighting.

Typically, electricity use reaches its highest level in the early evening of the coldest day of the year. Many remember Monday 15 August in 2011, when snow covered much of the country. Even Aucklanders reported seeing a few flakes of snow fall. On that day peak power demand rose to over 7000 MW.

Because generation must instantaneously match electricity use, sufficient generation, transmission, and distribution capacity must be built to meet the winter peak.<sup>60</sup>

## 5.2 How carbon dioxide emissions vary over time

The amount of carbon dioxide emitted from fossil fuelled power plants follows a similar pattern to electricity use, varying throughout the day and year. Figure 5.2 shows that on an average day the amount of carbon dioxide emitted during an hour in the early evening is about 70 percent higher than the lowest amount emitted during the wee small hours of the night.<sup>61</sup>



Source data: Energy Markets Services

**Figure 5.2 The carbon dioxide emitted from fossil fuelled power plants over an average day.**<sup>62</sup>

At night when the demand for power is low, there is a large surplus of generating capacity in the electricity system, and there is less need to burn gas and coal to generate electricity. Rivers continue to run, geothermal fluids continue to percolate to the surface of the earth, and wind continues to blow even when these flows of renewable energy exceed the demand for electricity. Especially in the early hours of the morning, the price of generated electricity often falls to zero, indicating there is a risk of renewable energy being 'wasted'.<sup>63</sup>

As the day begins, fossil fuelled power plants are ramped up to meet the higher demand.

The amount of carbon dioxide emitted over the year also follows the same pattern as the demand for electricity. On a winter day, carbon dioxide emitted from fossil fuelled power plants is about 50 percent higher than the carbon dioxide emitted on a summer day. This pattern becomes more exaggerated in dry years (such as 2001 and 2008) when water in hydro storage lakes is low and more gas and coal is burned.



Source: Rui Vale De Sousa

**Figure 5.3 'Use it or lose it' wind energy. There is a risk of some renewable energy being wasted at night.**

In the early evening on very cold days, virtually every power plant will be generating to meet the high demand, and carbon dioxide emissions will be at their maximum.

Not all thermal generation is equal – thermal power plants vary considerably in the carbon dioxide they produce as they generate electricity. This is known as carbon intensity (see Box 5.1).<sup>64</sup>

#### Box 5.1: Different fuels – different carbon intensity

The carbon intensity of electricity generated by different thermal power plants in New Zealand varies widely.<sup>65</sup>

	<i>kg carbon dioxide per MWh electricity</i>
Coal	930
Diesel	710
Gas - Open cycle	570
Gas - Combined cycle	370
Gas - Cogeneration	250
Geothermal	100

Source data: Concept Consulting, 2003, New Zealand Geothermal Association.

The most carbon-intensive electricity is generated by the Huntly power plant burning coal.

Diesel, burned to spin turbines, has the second highest emissions but relatively little is used.

There are two types of gas power plants. Combined cycle gas plants are considerably more energy efficient than the open cycle gas plants used for meeting peak demand, and so are less carbon-intensive. But they cannot respond quickly to fluctuating demand and they are much more expensive to construct. This means that combined cycle gas plants are not built to meet very 'peaky' demand because they will not be run often enough to recoup the capital costs.

Cogeneration is from simultaneously generating both electricity and heat for drying milk powder and timber by burning gas. A smaller amount of carbon-neutral electricity is cogenerated by burning wood.

Geothermal steam has carbon dioxide dissolved in it. The concentration of carbon dioxide varies widely across geothermal fields.

### 5.3 Pressure to build new electricity infrastructure

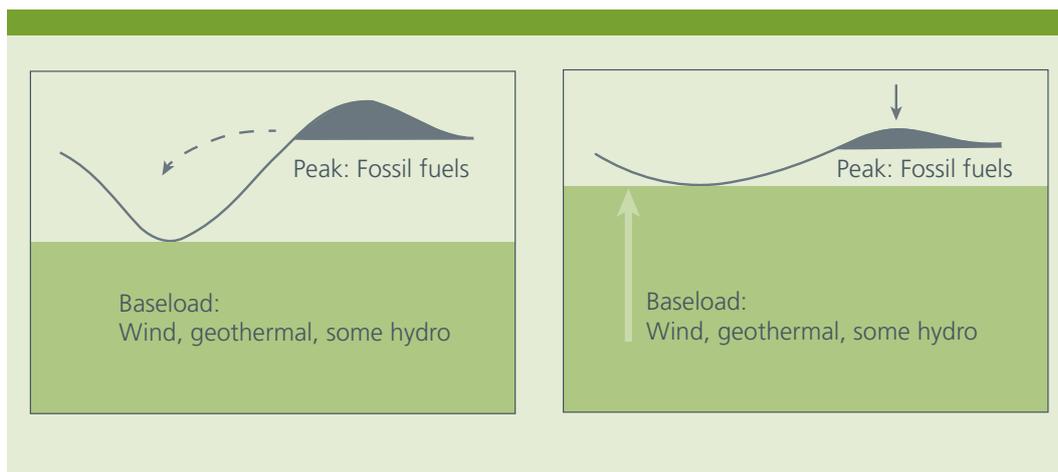
New Zealand's electricity use is projected to grow, especially at peak times. The nature of the growth in demand largely determines the types of new power plants that are required.

Growth in demand that is fairly consistent over the day and year is met by new **baseload** power plants designed to be run most of the time. Geothermal power plants and wind farms are baseload since the heat in the geothermal steam/fluid and the energy in the wind cannot be stored. They provide 'use it or lose it' renewable electricity – if the energy is not used it is lost.

When growth in demand leads to the winter peak rising faster than demand at other times (the peak becomes 'peakier'), new **peakload** power plants must be built. These are cheap to build and are designed to operate for short periods of time.<sup>66</sup> These usually run on gas, coal or diesel.

Hydroelectricity is, of course, New Zealand's major type of electricity and contributes to both baseload and to peakload. Run-of-river hydro schemes are 'use it or lose it' baseload. But water stored in hydro lakes or behind dams can also be released when needed to assist with meeting peakload. This is why low levels in the southern hydro storage lakes of Tekapo and Pūkaki in autumn are of such concern.<sup>67</sup>

Without flattening peaks in demand, increasing the proportion of renewable electricity to 90 percent (as is the Government's aim) will be extremely difficult, if not impossible.



**Figure 5.4 Flattening peaks in the demand for electricity reduces carbon dioxide emissions and allows for more renewable generation (see online Appendix for more information).**

Different types of generation can thus be classified into two groups as shown in Table 5.1. Generation that is ‘use it or lose it’ (e.g. wind, geothermal) is only practical for baseload. Generation that has storage can be used for peakload, such as power plants burning fossil fuels, or hydro dams with storage.<sup>68</sup>

Use it or lose it	Can be stored
Wind	Coal
Geothermal	Gas
Cogeneration	Diesel
Some hydro	Some hydro

**Table 5.1 Some power plants can store energy to deal with daily and seasonal variation in the demand for electricity and some cannot.**<sup>69</sup>

It follows that the greater the ‘peak’ demand is, the more coal, gas and diesel must be burned, and/or the more hydro storage must be created. The former means the emission of more carbon dioxide. The latter can be environmentally damaging – indeed the proposed Manapōuri hydro scheme which would have merged Lake Manapōuri with Lake Te Anau and flooded tens of thousands of hectares of beech forest is often described as the genesis of the modern conservation movement in New Zealand.<sup>70</sup>



Source: Contact Energy

**Figure 5.5 Gas ‘peaker’ in Stratford, Taranaki.**

Meeting peaks is not only costly from an environmental perspective, but also from an economic perspective. Building new power plants that are needed for only a few weeks a year means that the electricity they generate is very expensive. Growth in the annual peak also means more transmission and distribution infrastructure must be built and the cost of carrying peak electricity is very high.<sup>71</sup>



Source: GNS Science

**Figure 5.6 Lake Pūkaki is New Zealand's biggest hydroelectricity storage lake.**

## 5.4 How to assess the environmental benefits of solar water heaters

The environmental benefits of solar water heaters come from reducing the amount of electricity used to heat water.<sup>72</sup> Traditionally it has been assumed that the environmental benefits of solar water heaters are represented by the electricity they save. But *when* they save electricity matters a great deal. This is because New Zealand's electricity system operates on a high proportion of renewable energy with little storage capability.

Reducing electricity use when demand is high is more valuable from an environmental perspective (and from an economic perspective) than reducing demand at other times.<sup>73</sup>

Reducing electricity demand in the day is more valuable than reducing it at night. This is because fossil fuelled power plants are run more in the day than at night and carbon dioxide emissions are higher. And at night, there is plenty of 'use it or lose it' low-carbon electricity generation.

Reducing electricity demand in winter is better for the environment than reducing it in summer because fossil fuelled power plants are run more in winter than in summer.

The electricity system must have the capacity to meet the annual peak which occurs in winter. If that peak rises, more generation, transmission, and distribution capacity must be built.

Low-carbon options (e.g. wind, geothermal) can be built to meet baseload growth, but the only options to meet peak growth are either fossil fuelled power plants or large hydro storage. It is especially important to avoid building new fossil fuelled power plants because their long lifetime means future carbon dioxide emissions would be locked in for several decades. And hydro storage, whether from damming a river or raising lake levels, can be damaging to the environment.

In summary, two questions can be used to guide the assessment of the environmental benefits of solar water heaters in the next chapter.

- *How much do solar water heaters reduce the carbon dioxide emitted from existing power plants?*

and more importantly, in the long term:

- *How much do solar water heaters reduce the pressure to build new electricity infrastructure?*





# 6

## How much do solar water heaters benefit the environment?

Solar water heaters are generally acknowledged to be good for the environment. But just how good are they?

The last chapter showed how the environmental benefits of saving electricity in New Zealand depend on not just how much electricity is saved but also on *when* it is saved. This chapter uses this approach to assess the environmental performance of solar water heaters. Assessing solar water heaters in this way lays the foundation for understanding how significant a role this technology might play in meeting climate change targets. Practical and economic issues, which also become important in this context, are discussed at the end of this chapter.

### 6.1 How much sun and how much electricity?

Heating water using the sun saves electricity. But the sun does not always shine brightly. When there is not enough sun to heat the water sufficiently, an electric element in the cylinder switches on as 'backup'.<sup>74</sup> Consequently, a solar water heater system uses two kinds of energy – sunlight and electricity.

For this investigation, the performance of a solar collector was modelled using a software program commonly used by the Solar Industries Association and EECA.<sup>75</sup>

The model results show that on average 70 percent of the energy used to heat water comes from the sun and the remaining 30 percent is electricity.<sup>76</sup> But these percentages vary considerably throughout the year.

Solar water heaters perform better in summer than winter. In summer, daylight hours are longer and skies are generally sunnier, so over a day more sunlight falls on solar collectors.

There is another difference between winter and summer that is much less obvious, but is revealed by the modelling. Much more energy is required to heat water in winter than in summer. There are two reasons for this.

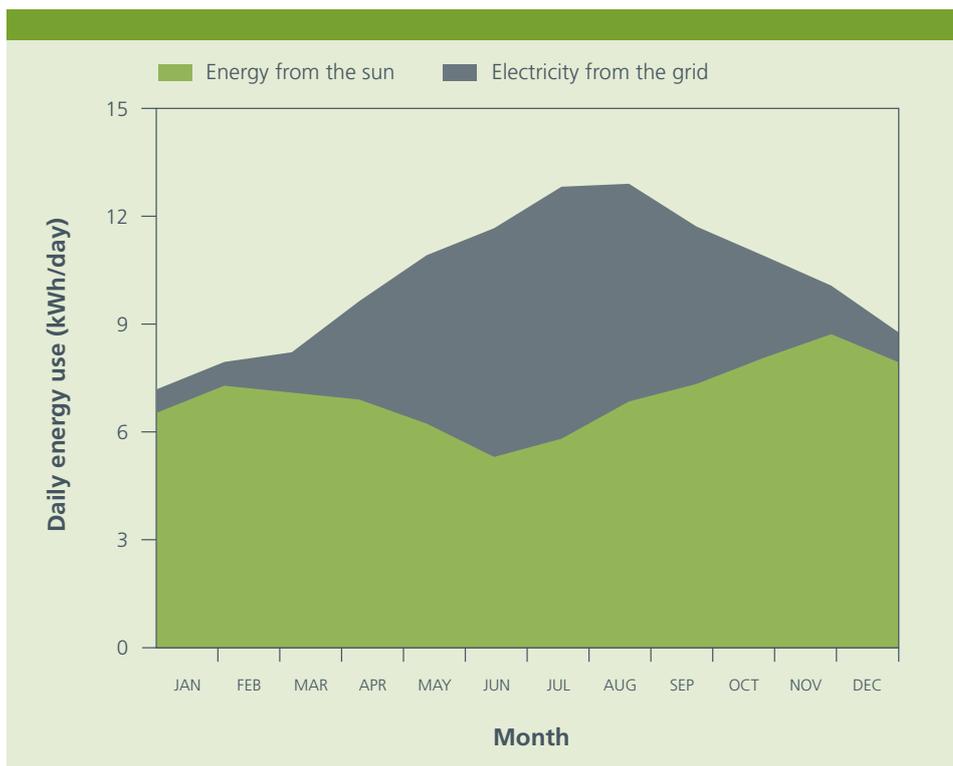
In winter, water coming into the cylinder is colder. Therefore, raising the water temperature to the required level takes more energy.

Most hot water is mixed with cold water and used for showering and bathing (about 80 percent). In winter, water coming out of the cold tap is colder and so more hot water must be mixed with it to get warm water.

The relative amounts of solar energy and electricity used for heating water vary throughout the year as shown in Figure 6.1. The green areas show the solar energy used in heating water and the grey areas show the electricity used when there is not enough sunshine.<sup>77</sup>

Figure 6.1 is based on a household that uses a 'medium' amount of hot water averaged across the modelling results for six cities – Auckland, Tauranga, Wellington, Nelson, Christchurch, and Invercargill. As expected, it shows that the amount of solar energy used for heating water is highest in summer and lowest in winter.<sup>78</sup>

The size of the seasonal difference is less in the warmer, sunnier cities. However, the modelling results show higher electricity use in winter than in summer for all six cities.<sup>79</sup>



**Figure 6.1** The performance of a solar water heater varies throughout the year. The green area is the amount of energy provided by the sun. The grey area is backup electricity provided by the electricity grid.<sup>80</sup>

## 6.2 Assessing the environmental performance of solar water heaters

In this section the following two questions presented at the end of Chapter 5 are used to assess how much solar water heaters could reduce the environmental impacts of the electricity system in New Zealand.<sup>81</sup>

- How much do solar water heaters reduce the carbon dioxide emitted from existing power plants?

and the question that is more important for the long term:

- How much do solar water heaters reduce the pressure to build new electricity infrastructure?

### *Reducing the carbon dioxide emissions from existing power plants*

Figure 5.2 in the previous chapter shows how the emissions of carbon dioxide from power plants vary over the day and night. Consequently, reducing electricity use in the daytime is more valuable from an environmental perspective than reducing it at night, and daytime is when solar water heaters reduce electricity consumption because that is when the sun shines.<sup>82</sup> On a daily basis, solar water heaters are winners when it comes to reducing carbon dioxide emissions.

However, on a yearly basis, solar water heaters are less impressive. Figure 6.1 shows that on a summer day solar water heaters use on average about 1 kWh of backup electricity, but on a winter day they use about 7 kWh of electricity. Thermal power plants are run much more in winter than in summer, so when carbon dioxide emissions are greatest, the performance of solar water heaters is at its lowest.

**Reducing electricity use during winter is more valuable**

### *Reducing the pressure to build new electricity infrastructure*

Solar water heaters do reduce the pressure to build new baseload generation because in effect they supply 'use it or lose it' baseload electricity. However, they do little to reduce the 'peakiness' of the annual demand for electricity, and therefore do not reduce the pressure to build new peaking power plants and power lines.<sup>83</sup>

Pressure to build new peaking power plants and power lines occurs when the winter peak rises. It is in winter when solar water heaters use the greatest amount of electricity and the least amount of sunlight to heat water. But because they still supply some baseload electricity, this would surely help meet the winter peak. Unfortunately, the reality is more complicated.

The amount of sunlight varies from day to day within a season as well as from season to season. There are dull cloudy days in summer and bright sunny days in winter. On the coldest, stormiest days in winter, when there is little sunshine, a solar water heater's backup electric element heats the water with very little assistance from the sun. These are often the days which have the highest electricity demand. On the days when reducing peak electricity is needed the most, solar water heaters perform at their worst.<sup>84</sup>

Another way to look at this is to compare solar water heaters with wind farms. Both supply baseload renewable energy. The wind farms supply electricity through large-scale centralised generation. Each solar water heater 'supplies' a small amount of electricity by substituting sunlight for it at the household level.

**Solar water heaters save electricity but very little when it's needed most**

Both wind and sun are intermittent forms of energy – some days are windier than others and some days are sunnier than others. But while a windless day in winter may or may not be a high demand day, a gloomy sunless day is more likely to be a cold day when electricity demand is high.<sup>85</sup> On the worst day in winter, a solar water heater will only get about 10 percent of the energy needed to heat water from the sun.<sup>86</sup>

### 6.3 Other issues

Householders install solar water heaters for a variety of reasons. One motivation is self-sufficiency and independence from the grid. Another is wanting to do the right thing by the environment. And another is the prospect of lower electricity bills and future-proofing against price rises.

Whether or not solar water heaters are economic is especially important if public money is to be invested in their support and promotion. At least three economic analyses of solar water heating in New Zealand have been done, none of which have shown it to be a high value spend of public money.<sup>87</sup>

Solar water heaters have the same effect as feeding baseload electricity into the grid. However, as discussed at the end of Section 5.3, displacing baseload electricity is less valuable from an environmental perspective than displacing peak electricity. Displacing baseload electricity with solar is also considerably more expensive per kWh than generating more baseload electricity from new wind farms.<sup>88</sup>

There will be many houses where it is not practical to install solar water heaters because of orientation and shading. The modelling results in this chapter are based on the assumption that solar water heaters are installed and perform optimally.<sup>89</sup> As the bearing and angle of the solar collectors move away from the optimum, the efficiency of the system will suffer. If a house was not designed with a solar water heater in mind, it is unlikely the roof will have been built so as to align the collector to the optimum position.

Another assumption in the model is that the size of the collectors and cylinder match well with household demand. In reality this is unlikely to always be the case. For instance, a household with children may greatly increase its hot water use when the children become teenagers and fall again when they leave home.

The modelling of an optimal installation gave the result that on average 70 percent of the energy used to heat water comes from the sun and the remaining 30 percent is electricity. In real installations, the percentage of energy provided by the sun is lower. Based on a number of sources, it is reasonable to assume that solar water heaters will provide 50 percent to 65 percent of the energy required for water heating on average over the year.<sup>90</sup>

Solar systems require a building consent to install. They have to be plumbed into the house and sometimes a frame is built on the roof to better align the collectors.<sup>91</sup>

Solar water heaters do provide a valuable way of heating water if the house is not connected to the grid. In colder months when solar is less effective, water can be heated using a logburner with a 'wetback'. For example, a north-facing house in a high sunshine area with a wetback will have low carbon dioxide emissions – however this will not be a practical option for most households.

## 6.4 In conclusion

In summer most of the energy a solar water heating system uses comes from the sun. In winter a considerable amount of electricity is needed to supplement the energy from the sun. On the coldest, cloudiest days in winter the performance of solar water heaters is at its lowest. Yet it is on very cold winter days that the demand for electricity is at its highest.

When it comes to considering the environmental benefits of solar water heaters, they do reduce carbon dioxide emissions from power plants by, in effect, replacing baseload electricity. But the most valuable type of electricity to save, from both an environmental and economic perspective, is peak electricity. Solar water heaters do little to reduce peak demand in winter and therefore do little to reduce the pressure to build new peaking power plants or power lines.

**Cold winter days are when demand for electricity is at its highest and the environmental cost is at its greatest**

There are ways of reducing the environmental impacts of heating water that are more cost-effective than solar water heaters.





# 7

## If not solar water heating, then what?

In New Zealand the electricity that must be supplied at peak times is particularly costly from an environmental perspective and from an economic perspective. It follows that flattening peaks is an especially valuable thing to do.

Using the sun to heat water has long carried the appeal of 'living lightly on the earth'. Unfortunately, as shown in Chapter 6, solar water heaters – even in very large numbers – would do little to flatten the winter peaks in New Zealand. Yet nearly 12 percent of all the electricity used in the country is used to heat water in households – reducing this demand carries the promise of a substantial environmental and economic win.

There are two sections in this chapter, each dealing with a different way of changing water heating that flattens peak demand.

- Controlling water heating at certain times using ripple control and, potentially, smart meters.
- Alternative ways of heating water – heat pump water heaters, gas, and wetbacks.

## 7.1 Controlling water heating at critical times

### *The technology*

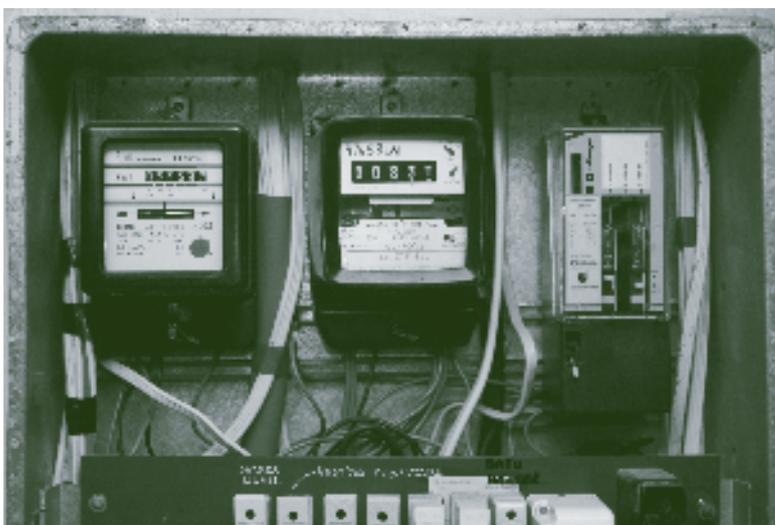
Water heating can be controlled at critical times in many households using ripple control. This technology was pioneered in New Zealand in the 1950s, so has been around for a long time.

Another approach is to use the new electronic meters already installed in many households. This would require the meters to be able to 'talk to' both water heaters and other appliances. Unfortunately, the opportunity to make many of these new meters really smart has yet to be taken up.<sup>92</sup> However, an alliance of electricity lines companies called SmartCo is planning to install proper smart meters.

Ripple control can be used to switch water heaters on and off. Smart meters have the potential for finer control (e.g. turning the water temperature down a few degrees when demand is high) as well as having the ability to communicate with other appliances.<sup>93</sup>

Ripple control is heavily used in the upper South Island to manage peaks on power lines. Eight distribution companies and Transpower have invested in enhancements to their load management systems to enable coordinated load management.<sup>94</sup> During the 1990s, the lines company Orion invested in replacement of ripple receivers in Christchurch. In recent times, most of the Christchurch meters (approximately 110,000) and ripple receivers have been replaced with modern meters with a ripple receiver integrated within the meter.

The state of the technology elsewhere is difficult to ascertain. There is no requirement for the separate wiring of water heaters needed for ripple control in new houses, and there are anecdotal accounts of ripple receivers being disconnected by electricians.<sup>95</sup>



Source: Parliamentary Commissioner for the Environment archives

**Figure 7.1: This meter box has two meters and a ripple control receiver. The local lines company use the ripple control receiver on the right to turn the power to the water cylinder on and off.**

## Heating water only at night

Heating water only at night is a very effective way to flatten both daily and annual peaks by shifting electricity from high demand in the daytime to low demand at night.

Householders with functional ripple control in their meters can allow their water heaters to be turned off during the day by choosing to pay an *interruptible* electricity tariff.

Switching from an *anytime* tariff to a *night-only* tariff will significantly:

- reduce carbon dioxide emissions from existing power plants
- reduce the pressure for new peaking power plants
- defer the need for investment in power lines.

Restricting water heating to the night will only be suitable for some households. For many, hot water use will be too high and/or the cylinder too small to store enough hot water to last throughout the day.<sup>96</sup> However, in the greater Christchurch area, at least 30 percent of households are on a night-only tariff due to the active encouragement by the lines company Orion.

The simple act of switching to a night-only tariff will benefit the environment more than installing a solar water heater. Heating water only at night will not work for all households, but the same applies to solar water heating. Both work best with a large cylinder. Moreover, rather than paying thousands of dollars for a solar water heater, switching to night-only water heating will save the household money. In Christchurch, for instance, the *night-only* tariff is about half the *anytime* tariff.

For households that already have a solar water heater, switching to a night-only tariff will be beneficial – both in terms of their power bills and will deliver better results for the environment. This is because electricity is cheaper at night and it is most important to reduce demand when electricity use is at its peak. Conversely, for a household that is already signed up to a night-only tariff, switching to a solar water heater gives limited environmental benefits and is also likely to be expensive. At the higher level, the electricity system would gain more from investments in baseload generation such as wind.

**For those with solar water heating switching to a night-only tariff would be beneficial**

### *Switching off water heaters at critical times*

Households with functional ripple control in their meters can allow their water heaters to be turned off at peak times by choosing to pay an *interruptible* electricity tariff. This enables lines companies to shift some electricity from the peak to shoulder periods of the day to avoid excessive loads. Most lines companies only do this regularly over the coldest winter months – around 30 days of the year when peak load approaches network limits.<sup>97</sup>

An interruptible water heater will do little to reduce carbon dioxide emissions in existing power plants. For around a month in winter, it will flatten the peak. Switching to an interruptible tariff does little to reduce carbon dioxide emissions from existing power plants. This is because the load is shifted from peak periods to shoulder periods. Shoulder periods and peak periods have essentially the same carbon dioxide emissions.

On the other hand, a night rate water heater will reduce the pressure to build new power plants and power lines because it will do more to lower critical annual peaks in winter. Thus it will reduce the need to build new gas peakers which lock in ongoing carbon dioxide emissions into the future, and delay the need to invest in upgrading power lines.

The majority of households with electric water heating have opted for an interruptible tariff.

## **7.2 Alternative ways of heating water**

### *Heating water with a heat pump*

New Zealanders are familiar with heat pumps being used to heat indoor air, but few know that heat pumps are now available for heating water.

A heat pump water heater is more efficient than a standard resistance water heater.<sup>98</sup> Importantly, heat pump water heaters save more electricity in winter than in summer.<sup>99</sup>

In marked contrast with solar water heaters, heat pump water heaters save most electricity when it is most valuable from both an environmental and economic perspective. And since their performance is not dependent on weather, they reliably lower the winter peak.<sup>100</sup> They are however over twice as expensive as a resistance water heater.

### *Heating water with gas*

Many households already heat water with gas. Switching to gas and avoiding the use of electricity altogether will most certainly flatten electricity peaks. But the impact on emissions is much more complex because burning gas produces carbon dioxide as well as heat.

The net change in carbon dioxide from switching a water heater from electricity to gas depends on what type of electricity is saved. Electricity that has been generated from burning coal is more carbon-intensive than electricity generated from burning gas, and much more carbon-intensive than electricity generated from geothermal steam. The greater the peaks in demand for electricity, the better gas water heaters appear from an environmental perspective.<sup>101</sup>

Instantaneous gas water heaters (califonts) are more efficient, and therefore emit less carbon dioxide, than gas water heaters with storage cylinders because there is no standby loss.



Source: Robert Lyon

**Figure 7.2** A califont is an instantaneous gas water heater.

### *Heating water with a wetback*

Heating water with wood using a wetback in a logburner is another way of helping reduce winter peaks. Moreover, wood is carbon-neutral so the net emissions of carbon dioxide are zero. There are now logburners available with a wetback that are relatively clean burning that have low particulate emissions. A wetback can work well in conjunction with solar water heaters because the wetback heats water in winter and the solar in summer.

## 7.3 In conclusion

Chapter 6 showed that solar water heating is not a ‘magic bullet’. While a solar water heater does reduce emissions of carbon dioxide, it does not flatten the winter electricity peak. The flatter electricity demand can become, the more renewable energy can be incorporated into New Zealand’s electricity system.

In contrast, turning off water heating at critical times, and especially heating water only at night, does help flatten peak demand. This requires either ripple control or smart meters to be available. Heating water only at night is about half the cost of uncontrolled water heating, although it will not suit all households and a bigger cylinder may be required.

Heat pump water heaters flatten electricity demand and have some other significant advantages over solar water heaters. Switching from heating water with electricity to heating it with gas will flatten demand, but the net effect on carbon dioxide emissions over time is what really matters. Heating water with wood helps flatten peaks and reduce carbon dioxide emissions.



# 8

## Policy that delivers for the environment

The previous chapters have shown how important the timing of electricity use can be in terms of reducing its environmental impacts. Indeed, solar water heating is least effective when it is needed most. Although installing solar water heaters on a large number of New Zealand roofs would benefit the environment, there are cheaper ways to achieve greater environmental benefits. Policies which seek to deliver outcomes for the environment at both the local and central government level should recognise this.

This chapter discusses the implications for government (at the local level as well as the central level) of the findings of this investigation.

### 8.1 It's mostly about the carbon

The distinction between energy that is renewable and energy that is nonrenewable became widespread after the oil price shocks in the 1970s. At its simplest, the concept is that fossil fuels are finite and that humans need to switch from nonrenewable fossil fuels to renewable sources of energy. Discussions about energy are often still framed in the language of (good) renewable energy and (bad) nonrenewable energy.

Solar energy is certainly renewable – the sun will keep shining. But this investigation has found that the environmental benefits of one solar technology (household water heating) in one country (New Zealand) are not as great as they are commonly perceived to be. Other options that are less obviously 'green' are better.

The Government has a target of 90 percent of the country's electricity coming from renewable sources by 2025. But the reason this target exists is because renewable energy is often (but not always) low-carbon energy. Renewability is no longer the primary issue, climate change is.

The world is far from running out of fossil fuels. New Zealand, for instance, has plenty of lignite. But because lignite is such low quality coal, its large-scale use would hugely increase the country's carbon dioxide emissions.<sup>102</sup> Again, climate change is the issue.

Yet renewable energy is embedded not just in public discourse in New Zealand but in policy and law, most notably in the New Zealand Energy Strategy and the Resource Management Act.

A related belief is that what is known as 'distributed generation' is always better than large centralised generation. Solar water heaters can be seen as distributed generation. However, for every dollar invested, new wind farms save more carbon dioxide than solar water heaters.<sup>103</sup>

**New wind farms are better for the environment than solar water heaters in terms of dollars spent**

## 8.2 The implications for councils

Thirty councils, representing hundreds of thousands of households, are promoting solar water heating, or are considering doing so. Promotions include subsidising the cost of obtaining building consents, pilot trials, demonstrations, and helping with financing.

Auckland and Christchurch are two cities where it is particularly important to consider the promotion of solar water heating that is taking place. Many new houses are expected to be built in both cities – Auckland because of continued growth and Christchurch because of the earthquake rebuild.

Solar water heaters will do little to help with the winter peak. However, in both Auckland and Christchurch, there is concern about a future summer peak developing because of space heating heat pumps being used for *cooling* in summer.<sup>104</sup>

Certainly solar water heaters would help curb growth in summer peaks because it is in summer that they are most effective. But night-only water heating would do as well, if not better, cost less and save money. Using ripple control to switch off water heating at peak times would also help.

In Christchurch, there is an intent strongly endorsed by the community to take the opportunity to build a greener city – an intent that is both sensible and laudable. One large subdivision proposal is expected to include solar water heaters as well as photovoltaic panels on roofs.<sup>105</sup>

**Heating water at night is a smart use of electricity and will save households money**

The Christchurch City Council's energy strategy states that *"the Council does want to encourage and assist in the installation of solar water heating systems in both new dwellings and as a retrofit in existing properties."* To this end, the Council currently subsidises building consent fees as part of encouraging a *"solar friendly city."*<sup>106</sup>

Councils that are subsidising solar water heaters for environmental reasons should consider whether other assistance would yield greater environmental benefits at a lesser cost. This is especially important in Christchurch with the burgeoning cost of the rebuild. This report has shown, for instance, that increasing the uptake of night-only water heating would save householders money. And if more efficient water heating systems are to be put in new houses, heat pump water heaters, instant gas, or possibly wetbacks would possibly be better ways to go than solar water heaters.

More generally, money spent promoting solar water heating is money that cannot be invested in other environmental initiatives. For example, councils wishing to promote sustainable development might instead invest in efficient street lighting, insulating council housing, improving public transport, or providing personalised advice to householders on how to save energy.



Source: Russell Lyon

**Figure 8.1 A wetback is a heat exchanger fitted to a log burner.**

### 8.3 Guidance from EECA

EECA is the central government agency with the role of promoting and supporting energy efficiency and renewable energy.

EECA's grant scheme for solar and heat pump water heaters was removed in 2012, with funding being reprioritised into other programmes.<sup>107</sup> It is to be replaced by an information-based programme for efficient water heating.

EECA already provides guidance for householders on water heating on its website. This guidance covers opportunities for making water heating more efficient as well as advice on choosing solar water heaters and heat pump water heaters. Recommendations include switching water cylinders to night rates.

While EECA's EnergyWise advice on its website is accessible and reader-friendly, there are a number of problems with it. Most importantly, not all opportunities for saving energy or switching to renewables are equal. These opportunities vary in the environmental and economic benefits they deliver, but the website gives little guidance on priorities for action.

The small section titled 'Environmental impacts' states:

*Choosing a hot water system that uses renewable energy sources like the sun (i.e. solar hot water or heat pump) or wood (a wetback or wood boiler) or electricity (about 75% renewable) will limit the environmental impacts into the future.<sup>108</sup>*

The statement rests on the yardstick of 'renewable is good; nonrenewable is bad'. The analysis in the previous chapters has demonstrated that this yardstick is far from adequate.

Other advice on the website says that a solar water heater "produces fewer greenhouse gas emissions than straight electric water heating".<sup>109</sup> However, heating water only at night is about as effective as a solar water heater (with electricity backup) in reducing carbon dioxide emissions.

**Heating water at night is the simplest way to reduce the winter peak**

More importantly, solar water heaters do very little to help reduce the need to build new fossil fuelled 'peaking' plants which lock in carbon dioxide emissions for decades to come. But heating water only at night, a modest and invisible change, is the simplest way for many to reduce the winter peak, and also save money.

Clear guidance on the relative environmental and economic merits of different water heating options is important for the general public, and is vital for local councils looking to make wise investments on behalf of their constituents.

## 8.4 Technology for load control

This investigation has shown that while solar water heating saves electricity, it does not perform well at the times when saving electricity is most valuable. In particular, solar water heating has little effect on winter peaks, which are especially costly from an environmental perspective and from an economic perspective. And the 'peakier' the demand for electricity is, the more difficult it is to meet that demand with low carbon renewable generation.<sup>110</sup> It follows that the ability to reduce peak loads – load control – is very beneficial.

In New Zealand, ripple control has been a way of controlling the water heating load for about 60 years.

The lines company Orion has invested in upgrading ripple injecting infrastructure and uses it frequently to control water heating load in the greater Christchurch area.<sup>111</sup> Furthermore, Orion and seven other distributors along with Transpower have worked together to develop a coordinated upper South Island load management system. As a result, peak growth has been substantially curtailed in the upper South Island.<sup>112</sup> Around 1.3 million households have access to some form of ripple control, however the extent to which it is operational is unclear because companies do not always know whether the ripple control is actually working. In addition, the extent to which ripple control is used varies around the country.<sup>113</sup>

The modern approach to load control around the world is through the new electronic meters that are replacing the old analog meters. Unfortunately, most of these so-called smart meters currently being rolled out in large numbers in New Zealand lack the ability to 'talk to' water heaters and other appliances in a more sophisticated way than ripple control. As a result, lines companies are prevented from making full use of load control. This is because electricity retailers who own many of these meters are not concerned with the benefits they could bring to lines companies, households, and the environment.<sup>114</sup>

**Smart meters have lots of potential to manage demand better**

Smart meters have greater potential to reduce peaks than ripple control because the technology is not restricted to water heating. Some lines companies are reportedly installing the types of smart meters that do have this broad ability to control load.<sup>115</sup>

The Electricity Authority has the power to set standard regulations for load control technology, be it ripple control or smart meters. However, like its predecessor the Electricity Commission, the Authority prefers to use market tools.

One consequence of the failure to set communication standards for smart meters is currently unfolding in the Waikato. Almost 60,000 Waikato consumers will soon have two smart meters – one installed by the retailer Genesis Energy and one installed by the lines company WEL Networks.<sup>116</sup>

## 8.5 Incentives for load control

Having in place the technology for reducing peak loads is one thing; having the incentives for load control is another. The fragmented nature of New Zealand's electricity system has resulted in different kinds of companies facing different incentives. Of particular relevance to controlling peak loads are the different incentives faced by lines companies and retail companies.

The Electricity Reform Act 1998 made it illegal for local power companies to both distribute power and to sell it. While this prohibition has since been watered down, the resulting splitting of local power companies into separate lines companies and retail companies has diluted and confused the motivation for load control.

**Our fragmented electricity system makes managing demand difficult**

Controlling peak loads has great value for lines companies when peaks approach the capacity of their lines because it can defer the need for investment in new infrastructure.

Retailers have little such incentive and in fact those owned by generators may sometimes benefit from high peak prices.<sup>117</sup> And because lines companies do not normally bill consumers directly, householders may only see a small difference between 'anytime' and 'controlled' tariffs.<sup>118</sup>

Lines companies are natural monopolies and are regulated by the Commerce Commission to prevent them from making excessive profits.<sup>119</sup> The Commission is also required to avoid disincentives for lines companies to invest in load control and energy efficiency.<sup>120</sup>

Rising peak electricity drives up the costs of lines companies, by forcing them to invest in new infrastructure like substations. This gives them a strong incentive to reduce peak demand. However, in certain circumstances this incentive is negated by the regulations set by the Commerce Commission that are designed to prevent lines companies from making monopoly profits. Under these regulations, the lines companies subject to price regulation are financially penalised if the total amount of energy carried by their lines over the year falls.

**Regulations make it difficult for lines companies to invest in energy efficiency**

The Commerce Commission has established a mechanism for resolving this conflict. It requires lines companies to apply for a 'customised price path', but the process appears complex and burdensome.<sup>121</sup> The Commission is also required to promote incentives to invest in load control and energy efficiency.<sup>122</sup> However, the only way the Commission can do this for all lines companies is by requiring certain information to be disclosed, which is a very weak instrument.<sup>123</sup>

## 8.6 In conclusion

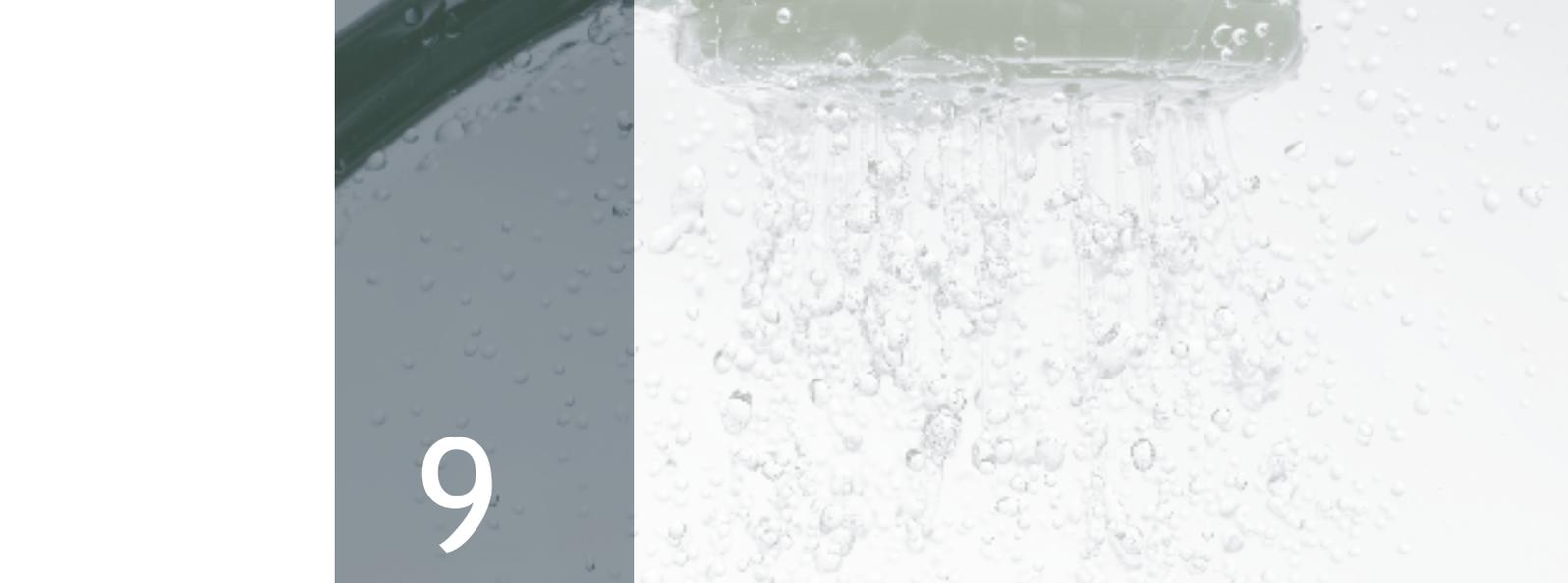
Policy makers need to take into account the importance of reducing peak electricity use as a way of achieving climate change targets.

If we are smarter about how and when we use electricity we can reduce the pressure to build more fossil fuelled power plants and power lines – it is this peak demand that drives the need for these fossil fuel plants. Having electricity demand spread more evenly over time, either during the day, or across the year, means we can use our renewable energy sources like wind and run-of-river hydro to meet most of our needs, and that is better for the environment.

On current trends our electricity use is growing more uneven in some areas – the highs are getting higher, caused by peak demand. If this trend continues we will need to build more fossil fuel power plants and the likelihood of meeting the target of 90% renewable electricity generation by 2025 fades considerably.

The following chapter contains three recommendations to the Minister of Energy and Resources.





# 9

## Conclusions and recommendations

Nearly 12 percent of all the electricity generated in New Zealand is used for heating water in households. Solar water heaters carry the promise of replacing much of this electricity with energy from the sun and reducing the environmental impacts of the electricity sector. This is where this investigation began, but it is not where it ended.

What might be called the ‘small’ conclusion of this report is that there are ways of heating water that give greater environmental benefits than solar water heaters, and are considerably more cost-effective. While solar water heaters do reduce carbon dioxide emissions from existing power plants, they do little to reduce the pressure to build new peak generation. This is because solar water heaters are least effective on winter days when saving electricity would be most beneficial from both an environmental and economic perspective.

This conclusion about solar water heaters is specific to New Zealand, an island country that must supply all its own electricity, has a relatively high proportion of renewable electricity, and has the annual demand for electricity peaking in winter.

The ‘big’ conclusion of this report is that reducing peaks in electricity demand is valuable for a number of reasons. In particular, carbon dioxide emissions from power plants are generally greatest at peak times. And when a new fossil fuelled power plant is built, a new source of carbon dioxide is locked in for decades.

This chapter contains three recommendations covering the following issues:

1. Carbon dioxide is what matters, not renewability
2. Improving information and advice from EECA
3. Enabling load control and demand management.

## 9.1 Carbon dioxide is what matters, not renewability

The Government's priorities for the electricity sector are set out in the New Zealand Energy Strategy. The strategy recognises the international importance of reducing greenhouse gas emissions, and that New Zealand has extensive opportunities to develop renewable sources of energy. But while considerable attention is paid to renewable energy, there is little discussion on carbon dioxide emissions and climate change. The same emphasis on renewable energy is present both in society at large and in other policy and legislation.

The concept of renewable energy has its origin (or at least gained its impetus) last century when it was seen as the answer to Peak Oil. But there is no shortage of fossil fuel that could be burned to generate electricity. The big issue now is climate change. Using renewable energy sources helps slow climate change because they are usually (but not always) low-carbon sources of energy.

*I recommend that:*

- 1. The Minister of Energy and Resources directs officials to recognise that the main reason for encouraging renewable energy is not renewability *per se* but climate change, and to incorporate this understanding into policy and advice.**

## 9.2 Improving information and advice from EECA

The added dimension of timing makes assessing the environmental benefit of demand side technologies more complicated. When it comes to saving electricity, *when* a technology saves electricity can be very important.

EECA has a valuable role to play in providing guidance to consumers, including guidance on water heating. There is a need for this guidance to be reassessed and updated. Specifically, the information provided needs to enable consumers to be able to compare the environmental benefits and cost-effectiveness of different energy efficiency and renewable options.

EECA also has a key role in providing guidance to local government. This is especially pertinent in the case of solar water heating given that 30 local councils are either promoting, or considering promoting, solar water heaters.

It is important that councils seek to make wise investments of public money on behalf of their ratepayers. There is much that can and hopefully will be done to make New Zealand's cities greener. EECA has a particular responsibility to give clear advice about environmental benefits and cost-effectiveness to help councils invest in energy initiatives.

*I recommend that:*

- 2. The Minister of Energy and Resources directs the Energy Efficiency and Conservation Authority to provide better information on electricity efficiency and renewable options (including solar water heating), so that the environmental benefits and cost-effectiveness of different options are clear.**

## 9.3 Enabling load control and demand management

For over 60 years New Zealand has had an effective way of managing load using ripple control of water heating. Heating water only at night and switching off water heaters at critical times flattens peaks. Originally, ripple control was used as a means to balance the rapid growth in electricity use with available electricity generation and transmission. However, now there are good environmental reasons – and still good economic reasons – for flattening peaks as well.

This investigation revealed three industry issues that appear to be constraining the ability to manage electricity loads and flatten peaks. These are:

- In many parts of the country it seems that ripple control infrastructure is being eroded, but no one can provide an assessment of its state at the national level.
- Neither the Electricity Authority, nor the Electricity Commission before it, has set communication standards for the hundreds of thousands of new electronic meters that are being rolled out across the country.
- The way in which the Commerce Commission regulates the lines companies to prevent them profiting from their monopoly status appears to make it very difficult for them to make a strong economic case for investing in load control and energy efficiency.

*I recommend that:*

- 3. The Minister of Energy and Resources directs officials to investigate how current electricity regulations (or lack of regulation) are constraining the potential for load control and demand management to deliver environmental and economic benefits.**

## Endnotes

- 1 *'The history of solar power'* [library.thinkquest.org/17658/sol/solhistoryht.html](http://library.thinkquest.org/17658/sol/solhistoryht.html) [accessed July 2012].
- 2 *'Solar evolution'* [www.californiasolarcenter.org/history\\_solarthermal.html](http://www.californiasolarcenter.org/history_solarthermal.html) [accessed July 2012].
- 3 Minister of Energy and Resources, Hon Phil Heatley, press release 15 June 2012. The percentage varies from year to year mainly depending on hydro lake inflows – for instance, in the dry year of 2008, it was 65%. The Government also has a National Policy Statement on renewable electricity generation which requires councils to provide for renewable electricity generation in their policies and plans.
- 4 *'Solar water heating'* [www.energywise.govt.nz/how-to-be-energy-efficient/your-house/hot-water/solar-water-heating](http://www.energywise.govt.nz/how-to-be-energy-efficient/your-house/hot-water/solar-water-heating) [accessed July 2012].
- 5 Auckland Council, 27 April 2012, press release *'Launch of Auckland solar water heating project'*
- 6 Hon Phil Heatley, Minister of Energy and Resources, 24 May 2012, press release, *'Thousands more NZ homes to be insulated'*.
- 7 The agricultural gases methane and nitrous oxide make up about half of New Zealand's greenhouse gas emissions, so 20% of the country's carbon dioxide emissions accounts for around 10% of the total greenhouse gas emissions.
- 8 Data from Electricity Commission, 2010, *'Statement of opportunities – September 2010'*, and the Electricity Authority, *'Centralised data set'* [www.ea.govt.nz/industry/monitoring/cds/](http://www.ea.govt.nz/industry/monitoring/cds/) [accessed July 2012].
- 9 Isaacs, N. et al., 2008, *'Hot water over time – the NZ experience'* [www.branz.co.nz](http://www.branz.co.nz) [accessed July 2012].
- 10 Isaacs, N. et al., 2010, *'Energy use in New Zealand households – final report on the Household Energy End-use Project [HEEP]'*. [www.branz.co.nz](http://www.branz.co.nz) [accessed July 2012]. Page 141 cites the 1966 census when over 95% of households used electricity for water heating.
- 11 Prior to the Electric Water Heating Order of 1943, water heating in the North Island was charged at a flat rate determined by the installed capacity of the heater. From then on all new and repaired water heaters had to be fitted with thermostats and supply was metered and charged for at an hourly rate. In 1944 the metering of water heating was made compulsory.
- 12 Reilly, H. 2008, *'Connecting the country – New Zealand's national grid 1886–2007'*. Wellington: Steele Roberts: p. 113.
- 13 Until 1967 local electricity companies paid for their bulk supply solely on the basis of peak demand, which provided a powerful economic incentive to shift as much demand to off-peak hours as possible.
- 14 Heating water uses 34% of household total electricity. Isaacs, N. et al., 2010, *'Energy use in New Zealand households – final report on the Household Energy End-use Project [HEEP]'*. In 2010 household electricity use was 34% of total electricity use. 2011. *'NZ energy data File'* [www.med.govt.nz](http://www.med.govt.nz) [accessed July 2012].

- 15 Isaacs, N. et al., 2010, *'Energy use in New Zealand households – final report on the Household Energy End-use Project [HEEP]'*, p. 141. About 77% of all New Zealand households heat water with electricity.
- 16 Electricity Commission, 2006, *'Load management, final report of the ECWP'*, RMAG papers.
- 17 This reduces the transmission charges lines companies must pay Transpower and reduces the need to invest in distribution infrastructure. Some lines companies also bid it into the Interruptible Load market which reduces the need for spinning reserves. Another option is to sell the load control to an electricity retailer who can then use it to shed demand in cases where they would otherwise have to purchase electricity at high prices on the wholesale market.
- 18 See Parliamentary Commissioner for the Environment, 2009, *'Smart electricity meters: how households and the environment can benefit'*.
- 19 Sun Belt Solar website <http://www.sunbelt-solar.com/history.html> [accessed July 2012].
- 20 Roulleau, T. and Lloyd, C.R. 'International policy issues regarding solar water heating, with a focus on New Zealand'. *Energy Policy* 36 (2008): 1843–1857. [www.sustainablecities.org.nz/](http://www.sustainablecities.org.nz/) [accessed July 2012].
- 21 EECA, *'Increasing the uptake of solar water heating – a government discussion document'*, September 2006, p. 35.
- 22 EECA information – yearly breakdown appears in a table in the Appendix. Available on our website [www.pce.parliament.nz](http://www.pce.parliament.nz)
- 23 Currently, there are probably around 30,000–40,000 solar water heaters in New Zealand – in 2005 there were 25,000. Pollard, A.R. et al, 2005, *'How are solar water heaters used in New Zealand?'* [www.branz.co.nz](http://www.branz.co.nz) [accessed July 2012].
- 24 While heat pumps for space heating have moved into the mainstream in the last decade, heat pumps for water heating are still an emergent technology, and as such are more expensive than their counterparts. The average cost is around \$4,500. Heat pump water heaters can use up to 70% less electricity than standard electric water heaters.
- 25 Isaacs, N. et al., 2007, 'HEEPs of hot water', *Build*, April/May 2007, p. 58. [www.branz.co.nz](http://www.branz.co.nz) [accessed July 2012].
- 26 Isaacs, N. et al., 2007, 'HEEPs of hot water', *Build*, April/May 2007, p. 58. [www.branz.co.nz](http://www.branz.co.nz) [accessed July 2012].
- 27 Archive version of Directory of Official Information, *'Energy Efficiency and Conservation Authority'*. Available online at: <http://www.justice.govt.nz/>
- 28 PA Consulting Group, *'Evaluation study of the EECA Water Heating Programme'*, 2012.
- 29 Ministry of Economic Development, 2011, *'New Zealand Energy Efficiency and Conservation Strategy 2011–2016'*, p. 26.
- 30 Ministry of Economic Development, *'Statement of Intent 2012–2015'*.
- 31 Ministry of Economic Development, *'New Zealand Energy Strategy 2011–2021'*.
- 32 Electricity Industry Act 2010, s 15.

- 33 Electricity Act 1992, s 172N.
- 34 The amendments proposed to the Local Government Act in 2012 would remove the 'sustainable development' clause in the Purpose but leave the 'sustainable development' clause in the 'Principles relating to local authorities performing their role'.
- 35 RMA ((s 61(1), s 66(1) and s 74(1)) requires local authorities to consider the sustainable management provisions in Part 2 when developing Policy and Plans.
- 36 Building Act 2004, s 4(2)(m) and s 49. A building consent can only be granted if the building consent authority is satisfied that the building constructed achieves "an adequate degree of energy efficiency" (Clause H1.2 - New Zealand Building Code).
- 37 A 2012 review by Nelson City Council staff concluded that the "Solar Saver scheme is not effectively or efficiently achieving the outcomes it was set up to achieve, and recommend that the scheme be discontinued as of 30 June 2012". Letter from Nelson City Council, 19 April 2012.
- 38 SolarCity website: <http://www.solarcity.co.nz/vision> [accessed July 2012].
- 39 Solar promise website: <http://www.solarpromise.org.nz/about> [accessed July 2012]
- 40 Meridan Energy website: <http://www.meridianenergy.co.nz/for-home/products/solar-power/> [accessed July 2012]
- 41 Nova Energy website: <http://www.novaenergy.co.nz/solar> [accessed July 2012].
- 42 'Apricus solar hot water offer', Genesis website: <http://www.genesisenergy.co.nz> [accessed July 2012].
- 43 Genesis Energy website: [http://www.genesisenergy.co.nz/genesis/energy-efficiency/apricus-solar-hot-water-offer/apricus-solar-hot-water-offer\\_home.cfm](http://www.genesisenergy.co.nz/genesis/energy-efficiency/apricus-solar-hot-water-offer/apricus-solar-hot-water-offer_home.cfm) [accessed July 2012]
- 44 Personal Communication Brendon Moloney, Customer Services Manager, WEL Networks Ltd. Email 16 July 2012.
- 45 A financing arrangement where the householder does not pay the upfront cost of the solar water heater but rather pays it back through a higher rates bill (plus interest), usually over a ten-year period.
- 46 The following councils have installation of solar water heaters as a permitted activity so there are no resource consent fees (Hutt City Council, Hamilton City Council, Rotorua District Council, Ruapehu District Council, Stratford District Council, and Wellington City Council).
- 47 South Waikato District Council was involved in a 2009 project "seeking to install solar into 20 homes in localised cluster groups".
- 48 Venture Southland is a Joint Committee of Councils under the Local Government Act. "*Southland District Council, Gore District Council, and Invercargill City Council have all endorsed a solar water heating pilot being run by Venture Southland in conjunction with SolarCity.*" Letter from Southland District Council, 18 April 2012.
- 49 A 2012 review by Nelson City Council staff concluded that the "Solar Saver scheme is not effectively or efficiently achieving the outcomes that it was set up to achieve, and recommended that the scheme be discontinued as of 30 June 2012". Letter from Nelson City Council 19 April 2012.

- 50 Whakatāne District Council and Kapiti Coast District Council are currently consulting on whether to remove building consent fees. Letter from Whakatāne District Council, 5 April 2012. Letter, from Kapiti Coast District Council, 13 April 2012. Wellington City Council has discontinued its discounting of building consent fees from 2012. Letter from Wellington District Council, 20 April 2012
- 51 AucklandSOLAR<sup>o</sup> website <http://aucklandsolar.co.nz/> [accessed July 2012].
- 52 Letter from Hawke's Bay Regional Council, 12 April 2012.
- 53 Councils involved in demonstrations (Tauranga City Council, Ashburton District Council, Auckland Council, Christchurch City Council, Dunedin City Council and Kapiti Coast District Council).
- 54 Letter from Auckland Council, 12 April 2012. *Solar hot water – joint business case for a voluntary targeted rate proposal*. Solar Saver Scheme. October 2011. p.21
- 55 'Christchurch City Council Sustainable Energy Strategy 2008–2018', section E10. [resources.ccc.govt.nz/files/EnergyStrategy-docs.pdf](http://resources.ccc.govt.nz/files/EnergyStrategy-docs.pdf)
- 56 Solar Saver Review p.6.
- 57 Nelson City Council has ceased its voluntary targeted rate but retains its zero building consent fees and is consulting on whether the voluntary targeted rate should instead be used for funding photovoltaics. Solar Saver Review p.6. Letter from Nelson City Council, 19 April 2012.
- 58 The carbon dioxide emissions from electricity generation are greater than those from manufacturing industries but considerably less than those from transport. See 'New Zealand energy – greenhouse gas emissions 2011', <http://www.med.govt.nz>
- 59 The data for this plot is based on five years of SCADA data from 2007 to 2011. For each hour period the total megawatts are summed and then divided by 1825.
- 60 While the winter peak places the most strain on the electricity system as a whole, rising summer peaks can also cause problems. For example, concern has been expressed about increasing use of heat pumps as air conditioners in summer in Auckland and Christchurch.
- 61 More specifically, the amount of carbon dioxide emitted per kWh generated at night is lower than the amount of carbon dioxide emitted per kWh generated during the day. This is because the highest emitting generation is mostly used at peak, whereas low carbon renewables run day and night.
- 62 Data for this figure is based on five years of SCADA data from 2007 to 2011. The different types of generation are summed separately and then multiplied by the values given in Box 1 and then divided by 1825.
- 63 For instance, at the Haywards node in Lower Hutt where the Cook Strait cable links to the North Island grid, the price was effectively zero (less than 1 cent per kWh) between 3 am and 5 am for 120 days in 2011. See Figure A.1 in the Appendix available on our website [www.pce.parliament.nz](http://www.pce.parliament.nz)
- 64 While some fossil fuelled power plants are still run at low capacity overnight, these tend to be the less carbon-intensive power plants – such as combined cycle gas and cogeneration gas. Diesel and open cycle gas power plants operate mainly at peak.
- 65 Data from 'An electricity emission factor', Concept Consulting, 2003.

- 66 Contact Energy built a 200 MW gas peaker near Stratford in Taranaki, in early 2011. Trustpower commissioned a new 9 MW diesel peaker at Bream Bay near Marsden Point in July 2011. Todd Corporation plans to build a new 100 MW gas peaker in Taranaki (*'New Plymouth to get power station'*, [www.stuff.co.nz](http://www.stuff.co.nz), 12/07/2012).
- 67 Some hydroelectric power plants that can store water behind dams also contribute to baseload. Some do this because they store relatively little of the inflow water. Others (such as the Karapiro Power Station on the Waikato River) must let a certain amount of water through the turbines to maintain a minimum flow downstream.
- 68 See Figure A.2 in the Appendix on our website at [www.pce.parliament.nz](http://www.pce.parliament.nz) for more detail.
- 69 Natural gas is not as easily stored as coal and diesel. New Zealand's hydro system has a relatively small amount of storage capacity – about six weeks.
- 70 Proposals to construct more hydro storage capacity are politically fraught because they engender so much concern from the public, although their environmental impacts vary. There is also greater uncertainty about their costs compared with fossil fuelled power plants.
- 71 Power lines and transformers must have enough capacity to carry the load – if the load gets higher, investments must be made. And again if this new infrastructure is only required for a few hours a year, the cost of carrying peak kWh is very high.
- 72 Although this is covered in Chapter 1, note that the scope of the assessment does not include solar water heaters backed up by gas, or the carbon dioxide 'embodied' in the solar water heaters themselves.
- 73 In the interests of clarity the explanation that follows is necessarily simplistic, but the implications stand. See Chapter 9. More detail in an Appendix available on our website [www.pce.parliament.nz](http://www.pce.parliament.nz)
- 74 The best cylinders for backing up solar water heaters have two electric elements – one near the top and one at the bottom. Heated water is drawn off near the top, so the top element switches on first. The lower element will not switch on if it is not needed. Gas and wood (using a wetback) can also be used as backup for a solar water heater, but electricity is most commonly used. Some may choose to just rely on the solar water heater and adjust lifestyle accordingly.
- 75 The modelling is described in detail in *'Comparison of solar and heat pump water heaters in New Zealand'* and is available at [www.pce.parliament.nz](http://www.pce.parliament.nz). All the graphs in this chapter are based on this modelling. The model used local hourly records for temperature, humidity, wind speed, and solar radiation for a typical meteorological year for Auckland, Tauranga, Wellington, Nelson, Christchurch, and Invercargill. Low, medium, and high levels of household hot water use were modelled for each city, each with an appropriate collector area and cylinder size. The results for Invercargill were based on a larger collector area and a larger cylinder as required by the Australian New Zealand standard because it is in a different climate zone from the other cities.
- 76 The electricity savings for solar water heaters increase as the collector area increases. Theoretically, a solar water heater could save up to 95% with a sufficiently large collector area. But in practice, if a solar water heater system is sized to produce annual average savings much greater than 70%, there is a risk of overheating. On sunny days, the water could boil and damage the pipes, collector, and cylinder.
- 77 Even on the hottest day in summer a solar water heating system will use a small amount of electricity for pumping water through the system. The model always shows some electricity being used because of the need for pumping.

- 78 The peak in November is not intuitive. In November, water temperatures are still low from winter, so more energy is required to heat water than in summer. But because the summer solstice is approaching and daylight hours are long, and because there are more sunny days, more solar energy is available.
- 79 Graphs for a medium user household in each of the six cities are available at [www.pce.parliament.nz](http://www.pce.parliament.nz)
- 80 Data for this graph comes from '*Comparison of solar and heat pump water heaters in New Zealand*' and is available at [www.pce.parliament.nz](http://www.pce.parliament.nz).
- 81 Note again that the carbon dioxide emissions associated with the energy 'embodied' in solar water heaters are not considered in this analysis and that this analysis is unique to New Zealand.
- 82 To be more specific, it is the marginal plant that is important. Based on a static analysis, at times when the marginal plant is fossil fuelled, reducing demand in the short run will reduce carbon dioxide emissions. Thermal generation is more likely to be marginal during the day, and renewable generation is more likely to be marginal during the night. It becomes more complex when dynamics are taken into account as a consequence of hydro storage but in the long run what matters from an environmental point of view is the type of plant that will need to be built.
- 83 The number of hours that the power plant is expected to run over its lifetime determines what the most economic type of generation is to build. For example, an open cycle gas peaking plant is relatively cheaper to build, but has higher running costs. In contrast, a geothermal baseload plant is relatively expensive to build, but has lower running costs.
- 84 See Figure A.3 in the Appendix for more detail on how the performance of a solar water heater can vary during winter. Available on our website [www.pce.parliament.nz](http://www.pce.parliament.nz)
- 85 There will be still, cold days in winter when the demand will be high, but it is unlikely to be as highly correlated as lack of bright sunshine and high demand.
- 86 While Figure 6.1 shows average energy provided at a monthly scale, there is considerable variation within months. See Appendix available on our website [www.pce.parliament.nz](http://www.pce.parliament.nz)
- 87 See the KEMA Efficiency Potential Study prepared for the Electricity Commission in 2007, an economic analysis prepared for EECA in 2007, and the January 2012 analysis prepared by PA Consulting Group for the Ministry of Economic Development.
- 88 A kWh of electricity generated from wind farms and transmitted and distributed is currently about half of the cost of a kWh of electricity 'generated' by a solar water heater. Electricity LRMC model [www.med.govt.nz](http://www.med.govt.nz) [accessed July 2012]. This spreadsheet lists 17 wind farms that are either under construction, in the consent process, or have been proposed. The estimated cost of generating electricity from these wind farms is between 9 and 15 cents per kWh. The cost of delivering this electricity to households would add perhaps 4 cents per kWh. The KEMA Efficiency Potential Study in 2007 estimated costs for solar water heaters expressed as an electricity price as being 30 cents per kWh for new builds and 37 cents per kWh for retrofits.
- 89 The model assumes that the solar collectors were installed facing due north and sloping with the angle of elevation equal to the angle of latitude.

- 90 [http://www.solarassociation.co.nz/system/files/Chapter1\\_SWH%20Overview.pdf](http://www.solarassociation.co.nz/system/files/Chapter1_SWH%20Overview.pdf) p.11 [accessed July 2012].
- 91 Some homeowners do not like the look of the panels mounted to frame and have had the collector mounted directly to the roof, thus reducing the efficiency of the system.
- 92 The majority of advanced meters have been installed by electricity retail companies who are much less concerned than lines companies about peak power. See Parliamentary Commissioner for the Environment, 2009, *'Smart electricity meters: how households and the environment can benefit'*.
- 93 Smart meters can only talk to appliances that are also smart. For example, a smart dishwasher might delay heating water until demand has fallen from its peak.
- 94 These are Orion, Mainpower, Network Tasman, Electricity Ashburton, Alpine Energy, Buller Electricity, Marlborough Lines, and Westpower.
- 95 The incentive for load control is much stronger for lines companies than it is for retail companies. The splitting of local power companies into separate lines companies and retail companies by the Electricity Industry Reform Act 1998 meant the end of the direct relationship between lines companies and consumers. Before this the local power companies set conditions of supply that included separate wiring of water heaters.
- 96 One way in which night-only water heating can be made more manageable is to have a separate small water heater under the kitchen sink (or boil the jug).
- 97 There may also be control done at other times – if the water heating load is offered into the instantaneous reserves market or if Transpower has a grid emergency.
- 98 The coefficient of performance (COP) of a heat pump is the measure of its efficiency. If, for instance, the COP is 3, then the heat pump will use only a third of the energy to heat water than a standard resistance water heater does.
- 99 The online Appendix on our website [www.pce.parliament.nz](http://www.pce.parliament.nz) contains a graph showing how much electricity a heat pump water heater uses and how much electricity it saves over a year. This graph should be compared with Figure 6.1 which shows how much electricity a solar water heater uses and how much energy is provided by the sun over a year.
- 100 Heat pump water heaters have other significant advantages over solar water heaters. They are considerably cheaper (though probably not as long-lived), and a mature market may bring the price down further as it has done for the heat pumps used to heat rooms. They can be retrofitted into almost all houses and do not require a large cylinder.
- 101 One report on different water heating options concluded that the option with the lowest carbon intensity was 'instant gas' – gas continuous flow water heaters. However, this analysis assumed that switching to using gas substituted for the most carbon-intensive electricity – that generated by burning coal at Huntly. It also did not consider the option of heating water with electricity only at night. Concept Consulting, 2009, *'Cost: benefit analysis for increasing the direct use of gas in New Zealand: a report prepared for the Gas Industry Company'*.
- 102 See Parliamentary Commissioner for the Environment, 2010, *'Lignite and climate change: the high cost of low grade coal'*.

- 103 A kWh of electricity generated from wind farms is considerably cheaper than a kWh of electricity 'generated' by a solar water heater (see Section 6.3). For the same dollar investment a wind farm would generate more electricity and thus save more carbon than a large investment in solar water heating.
- 104 An increasing summer peak makes it more difficult to take lines out during summer for maintenance. 'Heat pumps putting load on grid', *New Zealand Herald*, 3 April 2009. See also Building Research Association of New Zealand (BRANZ), 2008, 'Peak load and total energy use forecasting for heat pumps', pp. 5–6. Available on Transpower's website: <http://www.transpower.co.nz/>
- 105 A recent large subdivision proposal called Highfield (2,200 homes) in Christchurch includes photovoltaic cells and solar water heaters being installed as part of the finished house package.
- 106 Christchurch City Council, 'Sustainable Energy Strategy for Christchurch 2008–2018', Section E10. Letter from Christchurch City Council, 28 March 2012.
- 107 Phil Heatley, Minister of Energy and Resources, 24 May 2012, press release, 'Thousands more NZ homes to be insulated'.
- 108 <http://www.energywise.govt.nz/how-to-be-energy-efficient/your-house/hot-water/choosing-the-right-water-heating-system> [accessed July 2012].
- 109 EECA published pamphlets, 'A guide to buying solar water heating' and 'Get more from your hot water'.
- 110 See the Appendix on our website [www.pce.parliament.nz](http://www.pce.parliament.nz) for more discussion of demand growth.
- 111 Orion has been very active in a number of ways of controlling load. For instance, it provides an optional 'interruptibility rebate' paid to irrigation customers who agree to have a ripple relay installed to switch off irrigation pumps during emergencies.
- 112 'Upper South Island cuts peak power demand', *Scoop*, 29 October 2009.
- 113 In 2009 Powerco, the country's second largest lines company, ordered six large ripple control injectors. 'Powerco opts for ripple control renewal' <http://www.landisgyr.eu> [accessed July 2012]. As part of this investigation, PCE surveyed all distributors in New Zealand regarding ripple control. 1,120,000 installation control points were on interruptible metering. 250,000 installation control points were on night only metering.
- 114 Parliamentary Commissioner for the Environment, 2009, 'Smart electricity meters: how households and the environment can benefit'.
- 115 SmartCo is a group of fourteen lines companies who are reportedly planning to install meters that have a 'home area network' chip.
- 116 Edward White, Energy News, 16 July 2012, 'WEL-Genesis smart meter duplication 'ridiculous' – Consumer NZ'.
- 117 Retailers are sometimes incentivised to reduce sales to manage their risk on the spot market.

- 118 In a submission on load management to the Electricity Authority, one lines company (Network Tasman Limited) explained *“The retailers bundle these unit rates into their offerings for domestic consumers. Unfortunately in the process, the pricing incentive for having water heater cylinders controlled as opposed to uncontrolled is often significantly diluted.”* Electricity Authority Model Use of Systems Agreements (MUoSA) Submission on Load Management. [www.ea.govt.nz](http://www.ea.govt.nz) [accessed July 2012].
- 119 Concern about anticompetitive behaviour by lines companies was the rationale given for the splitting of power companies into separate lines and retail companies.
- 120 Commerce Act 1986 s 54Q *“The Commission must promote incentives, and must avoid imposing disincentives, for suppliers of electricity lines services to invest in energy efficiency and demand side management, and to reduce energy losses...”*.
- 121 Lines companies had their first opportunity to apply for a ‘customised price path’ during 2–9 July 2012 and no companies applied. Pers comm., Calum Gunn, Commerce Commission. See also EECA’s 2009 submission to the Commerce Commission’s discussion paper on *‘EECA submission on the reset of default price-quality path for electricity distribution businesses discussion paper’*. [www.comcom.govt.nz](http://www.comcom.govt.nz) [accessed July 2012].
- 122 Commerce Act 1986 s 54Q *“The Commission must promote incentives, and must avoid imposing disincentives, for suppliers of electricity lines services to invest in energy efficiency and demand side management, and to reduce energy losses...”*.
- 123 Information disclosure regulation applies to all 29 lines companies. Price-quality regulation is another potential instrument for promoting energy efficiency and demand side management but this regulation only applies to Transpower and 17 of the lines companies.