Renewable Energy in New Zealand: The Reluctance for Resilience

Hugh Byrd and Steve Matthewman

Abstract This chapter explores renewable energy governance in the context of New Zealand's "energy culture". New Zealand enjoys an international reputation as being a clean and green country. Yet surface appearances can be deceptive. Image frequently trumps reality. The green label is largely an exercise in branding (the country is the latest recipient of the "Fossil Award"), although energy is one of the areas where this might not hold. New Zealand's energy supply mix is impressive, the majority of it being drawn from renewable sources. However, global warming will severely impact upon our ability to generate adequate amounts of electrical power in a sustainable manner, and our centralised corporate-dominated supply system is poorly placed to deal with the challenges that lie ahead. These issues are compounded by various political problems such as ownership of resources and access to the grid. Numerous questions arise: can water be commodified or is it held in common? Does it properly belong to the indigenous people of this country? Why is there no feed-in tariff and why are smart meters not being installed? To explore the topic of renewable energy governance we examine various components of the national energy culture, energy policies and resources. We then look at the likely impacts of climate change, the current state of the deregulated electricity supply industry and why the "business as usual" model is set to prevail. This is illustrated by reference to two case studies—of the potential for distributed generation to contribute towards future electricity demands in Auckland and the proposed district energy system in Christchurch—in both cases we identify a worrying reluctance for resilience.

H. Byrd (✉)
Faculty of Art Architecture and Design, University of Lincoln, Lincoln, UK
e-mail: hbyrd@lincoln.ac.uk

S. Matthewman
Faculty of Arts, University of Auckland, Grafton, New Zealand
e-mail: s.matthewman@auckland.ac.nz

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1 Introduction

New Zealand has an international reputation as being 'clean and green' as well as '100 % pure'. For the most part these brand images are empty signifiers (Grinlinton 2009; Pearce 2009), they do, however, have some basis of truth in terms of renewable energy. New Zealand's electricity supply is largely generated by renewable sources such as hydro, geothermal and wind. The proportions vary from year to year but they typically supply about 75 % of total electricity demand. This is an enviable energy supply mix that many other countries would covet. However, what at first sight may appear to be a fuel's paradise, disguises unsettled issues of the governance of energy supply and the maintenance of adequate renewable resources in the face of climate change.

Harnessing energy from the wind, rain and sun raises key governance issues regarding ownership of these resources and the distribution of the energy gained from them. For example, some of the key energy questions in 2013 in New Zealand are: who owns the water in the rivers (in anticipation of selling off the country's rivers, see Bosselmann and Round 2012), why is there no feed-in tariff, why has the subsidy for solar hot water heating been removed and why are authentic smart meters not being installed? These questions increase in significance as the price of electricity rises. To understand such questions, and related ones, we begin by outlining the contours of New Zealand's energy culture. This will provide the context for the subsequent discussion.

2 The Forming of New Zealand's Energy Culture

New Zealand's energy policies and resources form an energy culture that differs significantly from other OECD countries. The concept of an 'energy culture' in New Zealand has been previously proposed as a micro-sociological conceptual framework to trace interactions between household energy technologies, energy norms and behaviours (Stephenson et al. 2009). However, this paper will look at the pragmatics of the national culture, its implications on governance and its consequences on renewable energy.

At the heart of the nation's energy culture is the pioneering settler spirit. Dakin (2007) portrays the immigrants to New Zealand throughout its history as being people that were *escaping* both church and state in Europe to a place where they were free from a class structured society and where the pioneering spirit was unhindered by regulation (see also Phillips 1987). This individualistic spirit has endured and manifests as a resistance to being told what to do by an interfering "nanny state". A recent example of this, discussed further below, was when a political leader was obliged to apologise to an outraged public for attempting to regulate for energy efficient light bulbs in 2008.

This energy culture is also a culture of complacency in as much as it adheres to the notion of 'infinite energy' (Fanning 2012); a mind-set that assumes that demand will always be satisfied by supply. This mind-set was formed by the historical low price of electricity and the seemingly endless supply of natural resources to generate it. In consequence, the energy culture is one that fixates on the present, paying little attention to future energy security. We discuss the implications of this reluctance for resilience in the following section.

The energy culture is also linked to politics in two important senses: grassroots politics concerning public protest and government politics concerning privatization. Let us briefly discuss each in turn. 'Green politics' are an important part of the country's political landscape. One of the world's first green parties was in New Zealand. The 'Values Party' was set up in 1972, almost a decade before European green parties, and was spawned from protests against the destruction of the environment caused by hydroelectric development (Rainbow 1992). These types of protests have carried on through anti-nuclear protests in the mid-1970s (Priestly 2010) to the present day and are currently focussed on wind farms. For example, the successful campaign, from the protestor's point of view, against a large wind farm in Turitea (New Zealand Board of Enquiry 2011).

The nation's energy culture has been decisively shaped by the privatisation of the electrical supply industry. This industry has a vested interest in a centralised supply of energy and a financial disincentive to practice energy conservation. This state of affairs is best described by the chairperson of the Australian Photovoltaics (PVs) Association, Muriel Watt: "They don't want you to use less (power) because they make less money when you use less. The retailers make money so they don't want you to use less. The generators make money (by selling more)… and the networks make money from every kilowatt hour that goes through their network, so they don't want you to use less either" (Fanning 2011).

It has also been suggested that the electrical supply industry has presented barriers to the integration of distributed energy generation. A report on these barriers concluded that a major barrier was the unwillingness of the electrical supply industry to change the 'status quo' of centralised power generation (Stevenson 2010).

3 Energy Policies and Resources

These characteristics of the energy culture lead to vulnerability and a lack of energy security for the end-users economically, with precious little control of energy prices. Additionally, they face the risk of power failure that may be caused by both natural events or by inadequate supply systems, including generation and infrastructure capacity (Matthewman and Byrd 2011). As Nair and Zhang (2009, p. 3419) write: 'One current challenge facing the New Zealand power system infrastructure is the transmission capability of the national grid system. The current backbone of the national grid was built in the 1950s and 1960s, and there is a need for upgrading capacity to meet future requirements. The electricity demand in NZ is estimated to grow at around 1.3 % per annum which puts stress on both transmission grid and distribution networks'. These systems lack resilience. In this section, we explain the sequence of changes in energy supply policy that have taken place over the last half a century and *have led to the governance failure which we identify as a reluctance for resilience*.

3.1 Hydroelectricity: The Backbone of New Zealand's Electricity Supply

Hydroelectricity has long been the backbone of the energy supply mix in New Zealand. Small scale private power stations started in the late nineteenth century but it was not until 1896 that the state gained control over the water supply for hydroelectricity (Martin 2011). Power stations were gradually developed on both the North and South Islands but by the onset of the Second World War there were serious power shortages. New dams and power stations were rapidly developed in the 1950–1960s, but by the late 1960s a strong environmental movement had been mobilised that was to impact on the development of power industry to the present day.

3.2 Strong Opposition to Nuclear Power

Such were the electricity shortages in the 1950s that alternative means of generation were considered and nuclear power was seen as the viable means of overcoming New Zealand's power problems. The first governmental report on nuclear power was produced in 1957 but it was not until 1968 that the Planning Committee on Electric Power Development in New Zealand recommended a reactor turbine to be in operation by 1977 with three others to follow on soon after (Priestly 2010). Plans were drawn up and sites north of Auckland were selected.

New Zealand could so easily have introduced nuclear power into its generation mix and, although the New Zealand Nuclear Free Zone, Disarmament and Arms Control Act 1987 prohibits nuclear power for military purposes, it is entirely possible that the country could once again consider nuclear power for its electricity generation.

Public opinion against nuclear power grew during the mid-1970s and the Royal Commission Enquiry into Nuclear Power Generation, set up in 1975, was confronted with strong opinion against its implementation on the basis of environmental safety. It also met with criticism that the total electricity consumption of New Zealand could be reduced rather than supply increased. The Royal Commission eventually concluded that, "nuclear power is not justified for New Zealand until about the turn of the century, or even perhaps later" (Priestly 2010).

3.3 The Rise and Fall of Natural Gas

However, there was another reason behind the decision to delay the adoption of nuclear power. By 1970, it had been firmly established that there were substantial quantities of natural gas in the offshore Maui gas field that could be economically recovered. Gas-fired electricity generation stations are substantially less expensive than nuclear powered and with relatively less public opinion against their construction, they proliferated. Annual production of gas increased rapidly over the 30 years, peaked in 2002 and has been in decline in the decade since. With few new significant finds, the economic extraction of natural gas is predicted to dramatically fall by the end of this decade.

3.4 Coal: Focus of Strong Public Opinion

The Huntley power station is central to the story of gas-fired electricity generation. Constructed in stages between 1973 and 1985 and further upgraded in 2004, it produces about 17 % of the country's total power demand. In the 1990s, with the realisation that gas reserves were dwindling, coal partially substituted gas and now the power station contributes about 50 % of the total greenhouse gases produced by electricity generation in New Zealand (Gluckman 2009). The power station has been the focus of strong public opinion and protests (New Zealand Herald 2007) and has come to symbolise the ire of environmentalists. In response to this, a government report suggested that the plant may be closed down in 2015. However, following a change in government, the station has been given consent to operate for another 25 years (Genesis Energy 2012).

3.5 Focus on Price Rather than Efficient Use of Resources

The Maui gas field successfully halted nuclear power in New Zealand and gave about 30 years of energy to New Zealand. The gas field is now nearly depleted. The search for more gas fields continues, even into 'deep-water'. However, in November 2012, one of the largest international oil companies, Petrobras, withdrew its search on the grounds that there were insufficient signs of gas and oil to justify further exploration (Energy News 2012). During those 30 years, there has been some growth in geothermal power generation and, more recently, wind power with each contributing about 20 and 7 %, respectively, to total electricity demand (Ministry of Economic Development 2012). But these forms of power generation are unlikely to fill the energy gap that is emerging unless demand is reduced. An adequate supply of resources to generate energy is, once again, facing the country as the demand for electricity increases and fossil fuels deplete. Only this time the country is also faced by the impacts of climate change that conspire to both increase electricity demand and reduce the supply from hydro. It also faces the problem of the impacts of ‘peak oil’. While New Zealand has a relatively ‘clean’ electricity supply, about half the country’s total energy demand comes from oil that is used principally for transport, leaving New Zealand the obvious choice to adopt electric vehicles.

The depletion of fossil fuels, the assumption of ‘infinite energy’ and climate change challenge the energy culture of New Zealand. The deregulated electricity supply industry has shaped public opinion to focus on price as opposed to the efficient use of resources. The following sections analyse how these factors will impact on New Zealand.

4 The Heavy Impact of Climate Change

Climate change will impact on energy supply and demand in several ways in New Zealand. One of the biggest problems with New Zealand’s existing hydro schemes is the lack of water storage capacity. New Zealand’s hydro schemes do not benefit from large reservoir capacity; most have just a few months of storage capacity (International Waterpower 2006). They are therefore more vulnerable to annual or even seasonal fluctuations in precipitation and snow melt. New Zealand Glaciers have an estimated volume of about 53 Km^3 and have been exponentially decreasing in volume (World Glacier Monitoring Service 2009).More than half the water entering hydroelectric lakes and rivers comes from glacial water (Fitzharris and Hay 1989). However, global warming will have an impact on this. Predictions of a 3 °C temperature rise and 15 % increase in precipitation indicated a significant decrease in snow accumulation resulting in increased flows of 40 % in the winter and a 13 % decrease in the summer (NIWA 2012). Other recent research has shown that snow accumulation, at 1,000 m elevation, may reduce by up to 44 % by 2040, and 79 % by 2090 (Poyck et al. 2011).

Short periods of dry weather have significant consequences on water storage for hydro in NZ. For example, in 2012 the South Island experienced several weeks without rain with the result that large hydro lakes were some 64 % below levels usual for that time of year. Retail prices increased fourfold (Evans 2012). Dry years such as this combined with reduced glacial melt will have an even greater impact.

Also of relevance, although still inadequately researched, is the energy-water nexus in New Zealand. With increased temperatures, the peak demand for electricity will shift towards summer rather than winter. There will also be an increased demand for water for irrigation during the summer. This will reduce the ability of the hydroelectric power sector to provide an unfluctuating supply and could result in significant reduction in the hydroelectricity supply in the future.

A further impact that climate change will have on energy security is the risk of infrastructure failure. An extreme, though sobering, example is that of the cable failures that fed the Central Business District of Auckland in 1998. High summer temperatures increased the air-conditioning load as well as ground temperatures until cables melted. After several attempts to mend the cables, the CBD eventually went back to work after 2 weeks of closure costing billions of dollars (BBC 1998).

The importance of this example for New Zealand is that while many blackouts are caused by systems failures, there is an increasing risk of failures due to inadequate energy; whether due to depletion of resources such as oil and gas or due to the vagaries of the climate in the supply of renewable energy. As we enter the period of peak oil, peak gas and climate change the security of energy supply for electricity generation is under threat. Understanding the nature of blackouts is more than just a record of past systems failures; blackouts are dress rehearsals for the future in which they will appear with greater severity and frequency (Matthewman and Byrd 2011).

5 Cheap Electricity by Ignoring External Costs

The New Zealand Government's monopoly on generation was removed by the State Owned Enterprises Act (1986). Over the following 10 years, various legal changes took place in the structure and ownership of the generation and transmission of the electrical supply industry until in 1996 the wholesale electricity market was in full operation and consumers could choose their suppliers. The deregulation of the New Zealand electricity supply was a copy of that in the UK, driven by the need to reduce government budget deficits rather than a concern about electricity prices (Evans and Mead 2005).

Ownership and management of the electricity supply industry is a key issue for renewable energy as it dictates policy, investment, prices and the stewardship of resources. In general, monopolies are not good at controlling prices but can be good at protecting resources while a competitive market does the reverse. The purpose of those in a competitive market is to sell as much of a product as possible at a rate that will eliminate the competition. While resources are abundant, the consumer may benefit from this; the problem arises when resources are constrained. Policies that encourage consumers to use electricity efficiently or use an alternative source are not in the interests of a competitive electrical supply industry. Hence, energy efficiency or self-supply of electricity is a potential economic threat to be resisted. As a consequence of this, the energy culture in New Zealand focuses on the price of electricity. The success of the electricity industry is measured in 'power switches', the number of people who change back and forth between companies. The media reinforce this agenda set by the electricity supply industry (on this see Jones 2012).

Reducing electricity costs of consumers by reducing demand or the introduction of requirements that aim to conserve resources is a sensitive topic. It was an important factor in the 2008 general election. The government of the time proposed that shower heads should be 'low-flow' and that light bulbs should be 'energy efficient'. There was public outrage at this and accusations of the government becoming a "nanny state" (New Zealand Herald 2008). Consequently, the party leader apologised (South 2008) and the party subsequently lost the election. While the loss of the election may have been due to several factors, the issue of trying to impose energy efficiency requirements on a public accustomed to an unfettered electricity supply should be acknowledged.

While cheap electricity is desirable it should not be at the cost of appropriate investment in the supply industry in response to forthcoming resource constraints. To respond to the issues of climate change, depletion of natural gas or maintenance of fragile infrastructure requires mitigation strategies that come at a price. Investment for preparedness combined with public awareness would justify additional expenditure and consequent price rises. However, the supply industry and its governance have set the agenda and everyone else is dancing to their tune, inadvertently strengthening a very unhelpful energy culture; that energy should be cheap, or at least not pay for its true external costs.

The problem of not accounting for externalities is that low prices eventually come back and hit in some form or another. Eventually they are paid for. This was the basis of the 'boomerang paradox' in the electricity industry in Australia (Simshauser et al. 2010). Years of cheap electricity had lured customers into habits and appliances that consumed electricity excessively. Most of the electricity in Australia is generated by burning coal. As coal prices escalated and the price of carbon increased, electricity bills also rose. The growth in air-conditioning also accelerated and burdened the capacity of the electrical infrastructure. In order to respond to this demand, new cables and new power generation had to be installed. It was estimated that for every AUD$1,000 spent on air-conditioning, AUD$7,000 had to be spent on upgrading the infrastructure (Fanning 2011). Ultimately the consumer has to pay for this. While the same externalities may not apply to New Zealand, climate change and resource depletion demand an energy policy that looks beyond 'power switches' as a measure of the electrical supply industry's effectiveness. Clearly the status quo needs to be changed. We need an energy culture based on resilience and sustainability. In the next section, we look at reasons why the barriers to distributed generation of electricity remain.

6 Distributed Generation

6.1 Disincentive for Distributed Generation

Distributed generation (DG), in particular by PVs, has been victim of cheap energy. Unlike almost every country in the OECD and in many developing countries, New Zealand has not introduced a subsidised feed-in tariff. *There is no obligation for the New Zealand Government to commit to either reducing carbon emissions or increasing renewable energy generation as there is in Europe.*

Indeed, New Zealand recently had the dubious distinction of being given 2012's "Fossil Award" by the UN's civil society conference for the worst performance on climate change (New Zealand Celsias 2012). There is also no financial incentive for the electricity supply industry to engage with DG and this has created obstacles to this area of the renewable energy sector. In 2010, a report was produced (Stevenson 2010) for the Government's Energy Efficiency and Conservation Authority (EECA) entitled "Analysis of Barriers to Distributed Generation". The primary obstacle in the report was described as 'the electricity industry status quo prevails'. *The industry is based on central generation and is unwilling to move from this model.* As previously noted, they have no financial incentive to do so.

In response to this report a 'Retail Advisory Group' was set up by the Electricity Authority to examine whether there were any obstacles to DG (Retail Advisory Group 2012). The report found that there were no obstacles of any significance. However, of greater significance was the proportion of the Group with a vested interest in centralised generation and the overwhelming submissions to the report by the centralised electricity supply industry. The recommendation of the group was that electricity retailers should not be required to purchase electricity from small scale DG or offer any rate for exported electricity to the grid. In other words, there is no incentive for small scale renewable energy to be connected to the grid in New Zealand.

Due to electricity price increases in New Zealand combined with the reduced capital cost of photovoltaics, DG electricity produced by PVs has now reached grid-parity (Byrd and Ho 2012). Distributed generation has the potential to reduce transmission losses from centralised generation plants, to be able to offset electricity demand from the grid and to be able to share surplus electricity with the grid. In so doing, it necessarily alters the energy markets that it enters, for this reason it is often perceived negatively as a 'disruptive technology' (Sustainable Electricity Association New Zealand 2012). Significant changes have been observed in countries where feed-in tariffs have been introduced, for example Germany and Japan.

6.2 Solar Hot Water Heating Subsidy Removed: An Even Greater Dependency on the Grid

A further issue that has raised concern in New Zealand is the removal in 2012 of a government subsidy for solar hot water heating. The cheap price of electricity has historically made investment in solar water heating unattractive. With the majority of houses in the country using electricity for water heating, which accounts for about 30 % of household electricity use (Isaacs et al. 2010), the removal of the subsidy was a surprise on energy efficiency grounds.

A report by the Parliamentary Commissioner for the Environment put forward the case that the problem in New Zealand is not so much adequate energy but more the problem of peak demand (Parliamentary Commissioner for the Environment 2012) and that solar energy is not available during times of peak hot water demand. While this is true, it is a curious argument because there are simple and proven technologies that can delay the electric heating of hot water until times outside peak demand. 'Ripple control' has been in operation since the 1950s in New Zealand. Even more curious was the recommendation in the report that heat pumps should be used to heat hot water rather than solar hot water heaters. Such a recommendation results in an even greater dependence on the grid for electricity and, even though heat pumps are more efficient than electrical resistant heaters, solar water heating in New Zealand is estimated to provide up to 75 % of household hot water needs (EECA 2012).

6.3 Increased Demand Due to Buildings and Vehicles

Elsewhere in the world countries have attempted to reduce energy demand by introducing requirements that increase the energy efficiency of buildings and appliances. With the risk of being called a nanny state, politicians in New Zealand have steered clear of using legislation for reducing energy demand. For example, the first Building Code (minimum legal standards) requiring houses to be insulated were implemented in 1978. It remained unchanged for 30 years and even then required only a modest change in standards in 2008 (Byrd 2012).Energy performance standards for commercial buildings are also low compared to other OECD countries. Large areas of unshaded single glazing and a lack of control of artificial lighting are not only common but also compliant with Code. The New Zealand Green Building Council has introduced a 'green' accreditation scheme for voluntary improvements above Code compliance. However, 'best practice' (4-star) accreditation can be achieved by buildings that meet, but do not have to exceed, Building Code standard for energy use. In other words, 'best practice' can be achieved even when a building is on the threshold of breaking the law (Byrd and Leardini 2011).

Apart from a general increase in energy use as the built environment grows, there are two areas of growth that are predicted to rapidly increase. The first is the increase in electricity use by domestic heat pumps for both cooling and heating. The Government has been offering a subsidy for heat pumps with the original intention of reducing the amount of heating by electrical resistance. The subsidy has had several unintended consequences that have resulted in an increase in energy consumption (Byrd and Matthewman 2012). The most significant of these consequences has been the extent that the heat pumps have been used for cooling. New Zealand is a temperate climate and cooling is not necessary in appropriately designed buildings. However, aggressive marketing, subsidies and a perceived improvement in lifestyles have led to a rapid increase in the uptake of heat pumps for cooling in New Zealand, a relatively new pattern of energy consumption to New Zealand. Research has indicated that, in Auckland, energy consumption of houses could increase by 180–250 % in real terms by the year 2041 due to increased cooling loads (Page 2009).

The second significant anticipated area of growth in electricity demand is electric vehicles. Almost half the total energy use in New Zealand is for transportation and the majority of this is imported oil which makes New Zealand very vulnerable to the global oil market and the consequences of 'peak oil'. A logical response to this would be to shift to electric vehicle use, not only because the electricity produced is from renewable sources but also because about 85 % of the population are urbanised and 90 % of daily travel by private vehicles is less than 60 km; which is well within the capabilities of electric vehicles. The electricity Authority (Hemery and Smith 2008) has predicted an exponential increase in the use of electric vehicles into the next decade. And although the additional energy required could be provided from the proposed wind power developments (assuming they will obtain consent to be constructed) (Duke et al. 2009) the problem with electric vehicles is not their average energy use but their impact on peak electricity demand in the evenings when vehicles return home and recharge. As one electricity market commentator has observed (Scott 2012): "the cables will melt".

6.4 Slow Movement Towards Smart Meters and a Smart Grid

Prior to the report on solar water heating, the Parliamentary Commissioner for the Environment produced a report on smart metering (Wright 2011). It was a strongly worded report, targeting the electricity supply industry that challenged their interpretation of 'smart'. Electricity meters were being installed that were intended only for remote reading and not for 'home area network' (HAN) functionality. Therefore, the meters were 'smart' for the supplier but not for the customer and, for only a few dollars more could have included HAN technology. This technology is required for DG so that electricity can be directed from the home to the grid and would allow DG, such as photovoltaics, to feed into the grid.

A report on smart grids (Strbac et al. 2012) in New Zealand was commissioned by a company within the electricity supply industry. The report anticipated the growth in electricity demand due to electric vehicles and heat pumps and identified that managing peak loads was of greater importance than overall energy demand. It concluded that investment in a smart grid on a national level would become feasible in about 2030. However, of greater interest was what was omitted from the report. No mention was made of the potential impact of distributed generation and its impacts on a smart grid. The smart technology that is required to make the maximum potential of distributed electricity generation is in the hands of an industry that will not significantly benefit from it financially. The status quo of the electrical industry and its focus on its own bottom line is at odds with a resilient electricity network.

6.5 Case Studies: Opportunities Coming from Disasters and Depletion

The analysis above has outlined the conflict that exists within New Zealand's energy culture. The desire not to be controlled by the state has resulted in a country where there has been little regulation to reduce energy demand. One would expect that the same culture would embrace distributed generation of electricity as a means of self-determination and resilience. However, the state has sold much of its control of the electricity sector to private industry that now controls the network and pricing to the extent that distributed generation, with the exception of remote areas, can be effectively excluded from contributing to the network. It is in the interests of the electricity supply industry to centralise rather than decentralise and this conflicts with the idea of resilience.

These centralised systems lack resilience which, within the context of energy, is defined as *the ability to respond to a disturbance by resisting damage and recovering quickly* (Folke et al. 2002). Resilience of the electricity supply in New Zealand is of increasing importance as changes take place both suddenly and gradually. Sudden changes in New Zealand include such things as earthquakes and dry weather. Gradual changes include climate change and the shift towards greater electricity use for transport as a response to oil insecurity.

To illustrate these conflicts, two case studies will be briefly described. Both are recent proposals that have not been implemented. The first concerns the potential for using distributed generation to contribute towards the future electricity demands for transport in Auckland. The second concerns the proposals for a DES in Christchurch.

6.5.1 Powering Electric Vehicles in Auckland

While the historical focus of the 'green' movement in New Zealand has been on the environmental and aesthetic implications of electricity generation by hydro and wind, the internal combustion engine vehicle, with all its negative environmental implications, has been embraced by society. Auckland is a car-dependent city with an average of one car for every 1.5 people. Only 5.5 % of those travelling to work use public transport (Huang et al. 2010). As a consequence, New Zealand also depends on imported oil with almost half of its total energy consumption being for transport. A report by the consultancy firm ARUPs (Auckland Council 2011) showed that the single largest contribution to reducing carbon in Auckland would be by a transition to electric vehicles (EVs).

One of the main problems of transitioning to EVs in Auckland is the fragility of the electrical distribution system. Without a smart grid, the only means of attempting to control the electrical demand for recharging in the evening would be by increased pricing. An alternative to this is to charge electric vehicle by PVs on residential roofs. Research was carried out into the feasibility of this (Byrd and Ho 2012) and it was found that the electricity generated on household roofs could potentially supply an all-electric vehicle fleet and also generate excess electricity that could offset other forms of generation. EVs and PVs have a synergy that could significantly reduce carbon outputs but could also reduce electricity demand and peak demand on the grid as well as reducing the need to upgrade electrical infrastructure.

6.5.2 Energy for Buildings in Christchurch

The devastation caused by the earthquakes that hit Christchurch in February and June 2011 is such that much of the city needs to be rebuilt. This gives an opportunity to review the best methods of generating and transmitting energy in a resilient manner so that there is greater preparedness should there be similar events in the future. Such a system would not only need to be robust but also be able to operate so that there was some form of energy-autonomy in the event of infrastructure failure.

An early decision was made to use a DES that would pump hot and chilled water around a circuit in the City (BECA 2011). The circuit is made up of large underground pipelines that are heated by boilers that can use a mixture of fuels such as agricultural waste or timber; both in abundance in the area. The chilled water is to be derived from tri-generation plants.

It is not clear what the main motivation is behind decision for a centralised DES; the feasibility study appears to have been drawn up after the decision was made and there is little evidence of any alternatives being considered.

The questions that arise from this decision are: why place heavyweight pipes below ground in an earthquake prone area where liquefaction of the ground is an historical problem? Furthermore, if the system fails in one place it is all likely to fail leaving the City without this energy system. The other issue that never appeared in the feasibility study is the question of reducing demand. The opportunity to design new buildings with low energy usage has not been adequately considered. Indeed, there is no need for cooling in buildings in Christchurch if they are appropriately designed (with perhaps the exception of a hospital). Energy demands could be brought near to zero and those that remain produced by distributed generation through smart meters.

7 Discussion of Case Studies

The two case studies described illustrate the dichotomy in the energy culture of New Zealand. Both studies propose systems that are based on renewable energy but their governance, ownership and control are at opposite ends of the energy-system spectrum. On the one hand, we have a system for Auckland that responds to the need for reducing carbon emissions and gives building occupants both autonomy and choice. On the other hand, we have a system in Christchurch that is centralised and has little resilience in the event of breakdown. The former has all the issues of the supply industry, discussed above, to overcome (such as an inadequate feed-in tariff and lack of smart meters), were it to be adopted. The latter is likely to proceed as it is centralised in both its decision making and its technology. The lack of governance to support the distributed generation of renewable energy for transport, in the former case study, and the apparent support for centralised generation, in the latter case study, might be judged the wrong one if the ultimate goal is to create a resilient and sustainable energy culture.

8 Conclusions

While the shift away from fossil fuels to renewable energy is unquestionably a positive step towards resilience, it introduces its own set of issues relating to the governance of energy supply. New Zealand claims to be 'clean and green' and much of this claim is based on a high proportion of renewable energy in the electricity supply mix. However, RE has brought with it a conflict within the energy-culture of the country that has been masked by an historical abundance of energy resources that has allowed prices to remain cheap. This has created the illusion that we possess 'infinite energy'. As these resources deplete, in particular in the case of gas, or become less dependable because of climate change, in particular in the case of hydro, the ownership and management of these resources becomes significantly more important (and arguably more politicised).

In addition to being informed by the beliefs that we have infinite energy and that we are clean and green, the energy culture has also been framed by consumers who are adverse to regulation and by government who are committed to deregulation. The consequence of this is a non-resilient electrical supply industry based on centralised generation. It is actively antagonistic towards more flexible practices of distributed generation. It will take a significant political turnaround to change this energy culture, including legislation aimed at reducing electrical demand (new building codes, energy efficient lighting and solar hot water heating subsidies). Unfortunately, as our two case studies demonstrated, we seem to be heading in the wrong direction. Our earnest hope is that New Zealand does not continue to win the Fossil Award in the future.

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