# What will the Hawke's Bay look and feel like in 2050?

# Environmental Trends and Drivers

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# 1. About this report

## Title

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- Environmental Trends and Drivers

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# 3. Background

This report was commissioned by Hawkes Bay Regional Council (HBRC) and will inform the development of their Strategic Plan. This Strategic Plan will set out longer term strategies to inform future annual and ten year plans.

The analysis undertaken for this report identifying trends and drivers of change will ultimately assist in the formation and development of a set of future scenarios. Key research questions are:

- What will the Hawke's Bay look and feel like in 2050?
- What are the underlying forces?
- What are the implications?

A comprehensive 'STEEP' analysis will provide the necessary insight to reveal both current knowledge and future concepts. A STEEP analysis is a framework of macro-environmental factors used in the environmental scanning component of strategic management.

The elements of the STEEP analysis can be broadly summarised as follows:

- **S**ocial: changes in composition or attitudes of people, including trends in demographics, gender issues, consumer values
- **T**echnology: changes due to innovations and applications of science and technology
- **E**nvironment: changes in natural systems/ecology
- **E**conomy: changes in the system of material exchange
- **P**olitical: changes in government, related institutions, issues, and their constituents.

This report will contribute to the understanding of future scenarios and forms the '**Environment**' component of the STEEP analysis.

# 4. Introduction

We now live in a world which is experiencing shifting climates, soil loss and water scarcity. Along with these changes, environmental beliefs and values are also rapidly evolving.

In the past, society hasn't understood the interdependence of ecological and socio-economic systems, or their limits, until they have been breached. Recognition that ecosystems are all interconnected, that systems have natural limits to their equilibrium and that, in some areas, we have pushed some systems to or beyond their limits has only recently become widespread.

Now, in 2010, there is significantly more global interest in sustainable development issues and how these might impact on individuals, companies and communities. A 'perfect storm' of global change processes is approaching and many commentators are suggesting that there is increasingly little room to manoeuvre.

## 4.1 History of Environmental Movement

Environmentalism first appeared on the political landscape at the turn of the twentieth century. The modern environmental movement, however, is thought to have originated somewhere between Rachel Carson's *Silent Spring* (1962) and the global event 'Earth Day' in 1970.

Within the space of just ten years (1960-70), questions concerning the environment erupted on the political stage. Environmental issues began to shape public opinion, mobilised mass political protest and attracted media attention. In particular, between 1970 and 1972, environmental agencies were instituted in fourteen industrial nations, the United Nations Environment Programme was established, and a new type of political party - environmental parties - emerged on an electoral landscape that had remained relatively unchanged for over 100 years (Lovelock, 2006).

In 1979, James Lovelock put forward the Gaia Hypothesis, proposing that life on Earth can be understood as a single organism, in his book '*Gaia: A new look at life on Earth*'. This work became an important part of the 'Deep Green' ideology. Throughout the rest of the history of environmentalism there has been debate and argument between more radical followers of this 'Deep Green' ideology and more recent mainstream environmentalists (Doherty, 2002).

# 5. Recent Culture Shifts

Recently there has been a culture shift, with the concept of environmentalism becoming considerably more mainstream. Awareness of environmental issues has grown significantly during the past decade.

## 5.1 Culture Shift - Consumers

Changing consumer trends towards environmentally sustainable development are underpinned by rising incomes and urbanisation, which in turn have contributed to the growing 'supermarketisation' of the world. Some consumers, though, are becoming concerned not only about the food they buy, but the way in which and where it is produced.

This culture shift has produced New Zealand's newest consumer group, 'Solution Seekers'. A Solution Seeker is interested in sustainability, the environment and fair trade, and wish to 'do the right thing with their hard-earned cash' (Price, 2007).

Thirty two per cent of New Zealand consumers can be classified as belonging to this market segment, known internationally as LOHAS. LOHAS is an acronym for Lifestyles of Health and Sustainability, a market segment focused on health and fitness, the environment, personal development, sustainable living, and social justice (Moxie Design Group, 2008).

## 5.2 Culture Shift - Government and Business Leaders

Concerns about the environment and energy are moving towards the core of economic policy and business decision-making in many countries. Be it around energy security, climate change policies or how consumers are behaving, the trend is clear: governments in developed economies, leading corporations, significant segments of consumer markets and the investment community are all changing in an attempt to transition towards greater environmental sustainability and energy security.

Sustainability is becoming a business operating norm for many leading companies. Successful companies of the future will be, increasingly, those who can reconcile business and environmental sustainability objectives and who can move ahead of the game to seek competitive advantage.

# 6. Beyond Bright Green

## 6.1 Bright Greens - Moving on

Contemporary environmentalists have been described as being 'Bright Greens'.

The term bright green was first coined in 2003 by writer Alex Steffen. It refers to the fast-growing new wing of environmentalism, distinct from traditional forms (Steffen, 2004). Bright green environmentalism aims for a society that relies on new technology and improved design to achieve gains in ecological sustainability without reducing (indeed, increasing) the potential for economic growth and attending to human needs.

Bright green advocates understand that we need prosperity without planetary impact. In many circles this is no longer a controversial idea. Indeed, the conversation has moved onto discussing how we decouple better lives from ecological footprints (or even go beyond, and build a society that restores the ecosystems on which it depends).

Discussions have now even moved from 'sustainable/bright green' developments to 'regenerative' developments. Regenerative developments are a wider extension of William McDonough' s 'cradle to cradle' approach (where it is considered that waste from one process is a resource for another process) and sees humans as an inherent part of ecosystems. Regenerative development is a concept which is further explored in section 16 of this report.

## 6.2 Transdisciplinary Science

Science is getting to grips with understanding life cycle assessments, traceability and verifying the sustainability of products. This involves linking different aspects of science together to provide a coherent "story" for a product.

New concepts and approaches to environmental issues (such as cradle to cradle/regenerative development) are also demanding a paradigm shift in approaches to science. This shift is characterised by disciplines coming together in new ways to look at the systems of production and use.

We are moving towards a future where there will be a stronger linking of scientific disciplines, beyond multi-disciplinary or inter-disciplinary, into 'transdisciplinary'. Better ways of linking disciplines have been discussed for many years by the science community. Coming up with solutions to society's demands is likely to be a strong driver to deliver on the long-standing call for increased integration of disciplines towards 2050.

# 7. Pressure on Resources

## 7.1 Population Growth

The pressure on the world's natural resources from growing populations is likely to dramatically increase in the future (OECDa, 2008).

The world's population is moving inexorably towards the nine billion mark, and more and more people are aspiring to and achieving developed-economy lifestyles. The ecological footprint created by these two trends is currently distributed unevenly among regions (WWF, 2010). For example, the ecological footprint of the average Tanzanian or Indian is approximately a quarter of the ecological footprint of a European and a ninth of that of an American. Nevertheless, if the trend continues and the expected growth in carbon emissions is generated, humanity will need the equivalent of two planets to maintain those lifestyles by the 2030s.

## 7.2 Urbanisation

Our cities play a vital role in the quest to achieve global ecological sustainability. They are the largest contributors to greenhouse gases and climate change. The world's urban centres already account for close to 80 per cent of $CO_2$ emissions (WWF, 2010)

Contrary to previous thinking in the area, in the future the bulk of urban population growth will not occur in well-known and mature megacities like Beijing, London, Los Angeles, Mexico City and Mumbai. Instead, it will occur in smaller cities (fewer than 1 million), which already account for more than 60 per cent of urban dwellers globally (WWF, 2010).

This fact that growth is occurring fastest in small cities (that are still in the process of developing their infrastructure) creates a valuable opportunity to decouple the global urban future from expensive, high-carbon lifestyles. This also represents a major challenge as smaller cities typically have fewer resources available to support infrastructure planning and address climate change.

### New Zealand Context

New Zealand is one of the most urbanised nations in the world with almost 87% of our population living in towns and cities (MfE, 2005a). Most New Zealanders also live in urban areas within 50 kilometres of the coast and three out of four of us live in the North Island. While our overall population density is low, it is higher in major urban areas. New Zealand's demography and the way it is changing have implications for both the way we live and the impact of our lifestyles on the environment.

New Zealand's largest urban communities face increasing challenges over the sustainable production and consumption of energy, water and other resources (MfE, 2005b). In addition to this, the growing demand for lifestyle living (lifestyle blocks) in areas surrounding urban centres, places increasing pressure on the existing, and often already limited or highly-modified natural resources (Boothroyd and Drury, 2006).

Like the rest of New Zealand, the population of Hawke's Bay is largely urban dominant, with Napier and Hastings accounting for 80% of ratepayers. It is also one of the most urbanised regions in the country with only Auckland, Nelson and Wellington regions being more urbanised. The population of Hawke's

Bay is approx 147,783 people (Statistics, March 2009) covering Wairoa District 9,900, Napier City 53,463, Hastings District 66,279 and Central Hawke's Bay District 13,038.

# 8. Indicators of Sustainability

## 8.1 Ecological Footprint Analysis

The ecological footprint model has emerged as a primary indicator of environmental sustainability (Munier, 2007).

The ecological footprint provides a snapshot of a population's environmental requirements using current technology under prevailing management practices and social values. Even if the ecological footprint for a particular population is calculated at regular intervals, the results are always out of date – in this respect, the ecological footprint only tells us 'yesterday's news'.

The Ecological Footprint measures *'the amount of biologically productive land and water area required to produce the resources an individual, population or activity consumes and to absorb the waste it generates, given prevailing technology and resource management'* (BioRegional, 2009). The footprint area is expressed in global hectares. Footprint calculations use yield factors to take into account national differences in biological productivity (e.g. tonnes of wheat per UK hectare versus per Argentine hectare) and equivalence factors to take into account differences in world average productivity among land types (e.g. world average forest versus world average cropland).

The ecological footprint of the Hawkes Bay Region has been calculated by the Ministry for the Environment (MfE) for the 1997/1998 baseline year. This analysis showed that *'On a per capita basis, Hawke's Bay has the seventh lowest ecological footprint out of the 16 regions, at 2.63 ha per capita. This figure is relatively low compared with the national average, primarily because of the high productivity of agricultural land within the Hawke's Bay region. This means that less agricultural land per capita is required to produce agricultural products than in the nation. The highly fertile nature of the region's plains is a key influence'*. Within the same study MfE also determined that the region's ecological footprint (384,660 ha) is significantly less than the land embodied in overseas exports (941,110 ha). This means that the region is exporting most of its ecological capital overseas.

## 8.2 Ecological Credit Crunch?

Most of us are propping up our current lifestyles by drawing (increasingly overdrawing) on the ecological capital from other parts of the world. Globally more than three-quarters of the world's people now live in nations which are ecological debtors (where national consumption has outstripped a country's biological capacity). This *'reckless borrowing against Earth's exhausted bounty is driving the planet toward an ecological credit crunch'*, the World Wildlife Fund has warned (WWF, 2008).

The 'Living Planet Report' (2008), was prepared by the World Wildlife Fund and ranks countries according to their ecological footprints. New Zealand has the sixth-biggest ecological footprint in the world, on a per capita basis (first on the list is the United Arab Emirates, followed by the United States, Kuwait, Denmark and Australia).

The Global Footprint Network has stated that humanity uses the equivalent of 1.4 planets to provide the resources we use and absorb our waste. This means it now takes the Earth one year and five months to regenerate what we use in a year.

Moderate UN scenarios suggest that if current population and consumption trends continue, by the middle of the next decade we will need the equivalent of two planets to support us. Furthermore, if the entire planet currently lived like we do in New Zealand, we would need 3.5 planets to maintain our lifestyles (BioRegional, 2009).

## 8.3 State of the Environment Reporting

In recent years there has been agreement amongst practitioners that we can't measure what we don't manage (Schipper, 2009). Science provides much of the data, information and tools needed to manage the environment effectively. However, there has been a decline over the last ten to twelve years in environmental science capacity based in science institutions, which is largely because of funding shortages. For example, research staffing on freshwater science has declined by 35-40%.

In New Zealand, MfE co-ordinates monitoring and data collection to assess the state of our environment. The State of the Environment (SOE) Report identifies trends in, and selected pressures on, our natural resources. It introduces benchmark environmental indicators as well as specific measures to capture data which are then used to build up a clear picture of trends and pressures over time.

However, as reported in a New Zealand specific OECD report, *'National-level aggregates of data and indicators on the state of the environment and environmental pressures are scarce, thus impeding efforts to strengthen outcome-oriented environmental policy-making'* (OECD, 2007). An example of this is that the previous issue to the most recent SOE report (released in 2007), was ten years earlier in 1997.

State of the Environment reports are produced by Hawke's Bay Regional Council (HBRC) each year on the major aspects of our environment. Council staff also produce monthly monitoring reports. Every five years a comprehensive report on the state of the Region is given. Where available, results from the SOE reports are discussed when appropriate throughout the 'Environmental Impacts' section of this report.

# 9. Environmental Impacts

The availability and access to water, land and food will play a growing role towards 2050 as demand increases from growing populations and the impacts of climate change are increasingly felt.

Traditional energy supplies are likely to diminish (therefore increasing prices) within the next decade. Freshwater is going to become an increasingly valuable resource as climate change reduces rainfall in some critically important food production areas and as demand for food rises.

For New Zealand, the most significant issues are freshwater consumption and land use intensification in some regions, water quality in many catchments, and greenhouse gas emissions. The trends indicate that if we do not change current paths, we risk hitting environmental limits or effects that are irreversible or very costly to remedy (MfE, 2007a).

## 9.1 Land Use Change

Land use changes are intimately linked with the breadth and depth of environmental impacts for any given area. Land use is obviously constrained by environmental factors such as soil characteristics, climate, topography, and vegetation. But it also reflects the importance of land as a key and finite resource for most human activities including agriculture, industry, forestry, energy production, settlement, recreation, and water catchment and storage.

Many environmental, economic and social factors influence how we use our land. In turn, different land uses can affect the environment, economy and society in different ways.

### Land Use Change – Hawkes Bay Context

Livestock farming and horticulture have continued to be the main economic land uses throughout much of the1900's for the Hawke's Bay Region. Land use in the Hawke's Bay has, however, evolved. Vineyards were first established by the turn of the century, but remained a minor land use until the last 20 years. The area planted in grapes has grown significantly in recent years and is predicted to continue to expand, especially in river terrace areas. Forestry is also increasing at present, and dairying is being reintroduced, at the expense of meat and wool farming.

## 9.2 Water Shortage

More than half of all accessible freshwater is already being used, and a scarcity of water is becoming commonplace, even in the richest countries (NIWA, 2003).

### Water Shortage - Global Context

OECD water use projections to 2050 highlight a number of issues that policy makers need to address. These include an increase to 47% of the world's population living under severe water stress, mostly in developing countries, compared to 44% in 2005 (OECD, 2010).

Given the anticipated growth in demand for food and water, and increasing pressures from climate change, agriculture will be a key target for policy makers as it consumes about 70% of the world's freshwater withdrawals (45% in OECD countries). The level of charges for water supplied to farms has risen in OECD countries. Frequently, however, farmers are only paying the operation and maintenance costs for water supplied, with little or no recovery of agriculture's share of capital costs for water infrastructure. Water charges also rarely reflect scarcity and social values or environmental costs and benefits; this is likely to change in the future.

### Water Shortage - New Zealand Context

Each year 500,000 million cubic meters of water fall onto New Zealand as rain or snow, enough to fill Lake Taupo from empty eight times over. Despite this, key areas have major freshwater quality and quantity problems (NZBCSD, 2009).

New Zealand is becoming increasingly water stressed. Nationally, the per capita water extraction rate is two to three times higher than the average for OECD countries (OECD, 2007). Abstractions of water have outpaced growth in GDP due to increases in the use of irrigated agriculture, population growth and increasing affluence (affecting household consumption). The OECD 'Environmental Performance Review of New Zealand' recognised that there is a need to improve understanding of sustainable yield levels of key aquifers, and to rationalise allocation of water as an economic commodity (OECD, 2007).

In accordance with OECD findings it is fair to say the current water allocation system in New Zealand is fraught with inefficiencies. It has been widely published that by 2012 all of the available freshwater resources in our most economically significant regions will be fully allocated to users on what is essentially a first-in, first-served basis.

To compound the problem NIWA climate change modelling suggests that New Zealand will experience increases in the frequency of droughts, changes in rainfall patterns, and changes in evaporation rates. Eastern areas of New Zealand such as Hawke's Bay will become increasingly dry, aggravating existing problems of water availability.

It is hoped that the proposed recent National Policy Statement for Freshwater Management will help guide decision-making on freshwater management. The proposed national policy statement is intended to enhance management of New Zealand's freshwater resources so that, by 2035, these meet the needs and aspirations of all New Zealanders.

It will not be a piece of legislation, and will not in itself fix all New Zealand's water issues. Councils will still be responsible for setting local rules and standards for managing fresh water.

Four main matters of national significance for which the proposed NPS states objectives and policies can be inferred from the preamble as being:

- Challenges, of varying degrees and causes across regions, in ensuring there is sufficient water in lakes, rivers and aquifers
- Ensuring that society gains the greatest benefit from the allocation of available water
- Limiting and remediating degradation of water quality
- Improved integrated management of freshwater resources.

## Water Shortage – Hawke's Bay Context

Hawke's Bay has seven major river systems (mostly fast flowing, clean, gravel rivers) and four major lakes, as well as many minor rivers, streams, lakes and wetland systems. Droughts are common in Hawke's Bay and can have immense impacts. The demand for water is rising, particularly as a result of increasing crop and pasture irrigation.

In Hawke's Bay groundwater is increasingly relied upon as a dependable and safe water supply for domestic, irrigation and industrial purposes. The two known major groundwater systems in Hawke's Bay are under the Heretaunga Plains and Ruataniwha Plains. The Heretaunga Plains groundwater aquifer has been identified by the Ministry for the Environment as a national water body of highest economic value for existing and potential domestic and industrial use.

Climate change will compound problems for Hawke's Bay towards 2050 as the risk of drought will increase in areas that are already drought prone. Groundwater use is likely to rise in future, particularly during summer. It is also possible that there could be a reduction in flows from springs which could lead to conflict and water wars between users.

## Proactive approach of HBRC to water management in the Ruataniwha Plains

The Ruataniwha Plains in the Hawke's Bay is dominated by shallow, free draining and drought prone soils. The Plains have experienced three consecutive years of drought and this has provided increased interest in methods for irrigation.

The Plain's run-of-river surface water resources are fully allocated and the further allocation of shallow ground water has been put on hold until its relationship with surface water is better understood. In the meantime, alternative water management options such as the feasibility of a community water storage scheme are being investigated. A 'Prefeasibility Study of Water Augmentation Opportunities for the Rutaniwha Plains' was commissioned by HBRC and completed by Tonkin and Taylor Consultants in June 2009. Due to a number of environmental issues the identification of water storage opportunities has focussed on multiple dam sites located off-river or on minor tributaries.

As a next step it is recommended by Tonkin and Taylor that feasibility level investigations, including water resource studies, geotechnical site investigations, engineering design, environmental and cultural assessments, economic/governance studies, and community and stakeholder consultation are undertaken in order to confirm feasibility of the proposed scheme.

## 9.3 Water Degradation

### Water Degradation - New Zealand Context

Water quality is a significant national issue. It is now evident that water quality is declining nationally, despite most significant point source discharges now being well controlled. The primary cause is thought to be diffuse runoff associated with agricultural land use and land use intensification (increased stocking rates and increased fertiliser use). Contaminants of particular concern are nutrients (nitrogen and phosphorous), sediments and faecal coliforms.

Freshwater quality is declining, particularly in rural lowland rivers, streams and groundwater. One-third of our lakes have poor water quality, and 40% of monitored groundwater contains raised nitrate levels.

### Water Degradation - Hawke's Bay Context

Despite commonly held perceptions to the contrary, an independent review, commissioned in 2006 by the Regional Council, stated that *'it appears that with a few exceptions actual surface water quality within the Hawke's Bay region is good'*. However, it also reported that, there are a small number of rivers showing declining water quality and the reasons for that decline should be investigated and practical actions put in place to arrest that trend. This will be particularly important if the declining water quality in that small number of rivers was linked to land use intensification and change.

As part of the independent review, Council staff advised that although there had been a clearly identified pattern of long-term decline in the Heretaunga Plains aquifer, it was not considered to be an issue and wouldn't threaten existing water takes for the next 30-50 years at least. Council staff were said to be less certain about the Ruataniwha aquifer systems as those systems operate differently.

The region's 2007 SOE report also indicated that chloride concentrations in both the Wairoa and Mahia catchments are elevated. This is considered to be either from the dissolution of natural minerals or the intrusion of sea water.

SOE monitoring has also indicated that surface water quality has exceeded national guidelines for safe contact recreation after heavy rain where sewer systems can be flooded and animal waste washed from the land into the water.

## 9.4 Peak Soil – The Planet is Getting Skinned

Soil erosion by water, wind and tillage affects both agriculture and the natural environment. Soil loss, and its associated impacts, is one of the most important (yet probably the least well-known) of today's environmental problems (Radford, 2004). The planet is getting skinned.

David Pimentel, Professor of Ecology at Cornell University, reports that soil from the world's croplands is being swept and washed away 10 - 40 times faster than it is being replenished (Science Daily, 2006).

Knowledge gained about present-day soil erosion, and erosion in the past, is helpful in suggesting where and how future erosion is likely to be a problem. However, it is likely that there will be some important differences in erosion rates in the future. For example, climate change is likely to influence future rates of water and wind erosion, as is the change in land use. Rates of water erosion, for example, are likely to respond to increases in precipitation in a non-linear manner, with disproportionately greater increases occurring in wet years (Soil and Water Conservation Society, 2003).

The magnitude and range of increased rates of soil erosion and runoff that could occur under future precipitation regimes is large. In fact, the magnitude of observed trends in precipitation and the bias toward more extreme precipitation events are, in some cases, larger than simulated by global climate change models. Extrapolating those relationships to the changes in precipitation observed over the past century suggests increases in soil erosion ranging from 4% to 95% (Soil and Water Conservation Society, 2003).

Over the past century, the effects of long-term soil erosion were masked by bringing new land under cultivation and by developing fertilizers, pesticides and crop varieties to compensate for declining soil productivity (Montgomery, 2008). However, such 'agrotech' fixes become progressively more difficult to maintain because crop yields decline exponentially as soil depth thins. In the future, feeding a doubled human population (without further increasing crop yields) would require doubling the area presently under cultivation. Such vast tracts of land could only be found in tropical forests and subtropical grasslands, like the Amazon and the Sahel. Experience shows that farming such marginal lands produces an initial return, but the land quickly becomes degraded and has to be abandoned (assuming the residents have somewhere else to go). With the land best suited for agriculture already under cultivation, expansion into marginal areas is therefore not a long-term strategy (Montgomery, 2008).

### Peak Soil - New Zealand Context

In New Zealand, agricultural activities are responsible for about 34% of national soil loss (equating to 227 million tonnes per year). The remaining bulk of the erosion is due to natural ecological and geological conditions. Recent data, however, has suggested that the effects of soil compaction surpass that of natural soil erosion (Sparling, 2004). Wet soils and high stocking densities provide the conditions required for plugging and compaction. This damage leads to more run-off of topsoil and contaminants into waterways.

### Peak Soil – Hawke's Bay Context

Soils in the Hawke's Bay region, especially in the Heretaunga and Ruataniwha Plains, are fertile and versatile, enabling a wide range of agricultural activity. This includes traditional livestock farming, forestry, viticulture, horticulture, fruit growing and market gardening.

The Region's ten year plan reports that sixty four percent (approximately 900,000 ha) of the region's rural land is classed as erodible to highly erodible hill country. Of that approximately 300,000 ha is under a land use that is likely to exceed the sustainable capacity of the soil.

It follows that soil erosion is a key issue for Hawke's Bay. It can take many decades for topsoil to re-establish on slip scars; research shows that productivity rarely returns to more than 80% of the uneroded potential. The unstable nature of much of Hawke's Bay's hill country can be seen from the many lakes. Many of these have been formed as a result of large landslides, probably induced by earthquakes that caused hills to collapse into valleys blocking streams. Further indications of instability can be seen from the many landslide scars.

Hawke's Bay is also prone to wind erosion which proves a serious problem on the Ruataniwha Plains and parts of the Heretaunga Plains. Strong winds cause extensive soil loss from cultivated land. For land under pasture the problem is less severe, but land used for horticulture and cropping has intensified, increasing the potential for soil loss from wind erosion.

The likelihood of more intensive rain events and increased temperatures as a result of climate change, leading to increased risk of erosion and droughts, will increase towards 2050.

In 2006 the HBRC engaged Crop and Food Research to advise on a soil quality monitoring programme for the region. The regional monitoring programme commenced in 2007, focussing on the most intensive land uses. Soil quality sampling (for selected sites) has been completed for cropping, dairying and bull beef. Sampling of moderate intensity land uses (orchards, vineyards and mixed cropping) was scheduled for 2009-10, with more extensive land uses (hill country sheep, forestry and native cover) to follow.

## 9.5 Urban Air Quality

Without policy intervention it is predicted that air pollution will increase worldwide to 2030, with the number of premature deaths linked to ground-level ozone quadrupling and those linked to particulate matter more than doubling. Chemical production volumes in non-OECD countries are also rapidly increasing, and there is insufficient information to fully assess the risks of chemicals in the environment and in products (OECD, 2008a).

The focus of most air quality research and assessment has been on the three main anthropogenic sources: domestic, vehicle and industrial. Each of these is mainly derived from combustion of some sort, and each is amenable to mitigation policies (Fisher *et al.,* 2007). A particularly difficult issue that has to be dealt with is the effects of background, or natural, sources. This is especially relevant for New Zealand as we have high levels of air pollution from natural sources (such as geothermal activity).

### Urban Air Quality – New Zealand Context

New Zealand has relatively good air quality due to our low population density, close proximity to the sea, and remoteness from other continents and sources of pollution. However, there are some areas (mostly urban) where concentrations of air pollution are quite high, especially during low wind conditions where there is high traffic density and where home heating is mainly by open fires or wood burners. About 53% of New Zealanders live in these affected locations (MfE, 2007a).

For New Zealand, the main focus for improving air quality is to reduce emissions of PM10 particulates from home heating and transport. Regular monitoring of air quality has been put in place in managed airsheds through the national environmental standards. The focus has now shifted to monitoring how levels of PM10 particulates are tracking against the national environmental standard target set for 2013 (MfE, 2007a).

In the future as our population, standard of living and size of urban areas increase, air pollution could get worse.

### Urban Air Quality – Hawke's Bay Context

Air quality is measured regularly in the region and, apart from unusually high levels of dust following eruptions at Mt Ruapehu, dust levels are within national guidelines. There is some concern with both elevated levels of fine particles (PM10) (which is caused from domestic fires) and localized pollution incidences (such as spray drift and odour).

## 9.6 Biodiversity Loss

### Biodiversity Loss - Global Context

Globally, if no new policies are introduced, the conversion of natural land to agricultural use will continue to be a key driver of biodiversity loss into the future. Increasing the yield, or intensity, of agricultural and livestock production often requires energy-intensive farming methods associated with soil erosion and increased carbon and water footprints. High levels of fertilizer and pesticide use as well as irrigation can result in pollution with far-reaching downstream impacts ranging from loss of fisheries, human health impacts and biodiversity loss.

Under current policies, areas for biofuel crops are also projected to increase by 242% between 2005 and 2030 (OECD, 2008b). This may also be a key driver of biodiversity loss into the future.

### Biodiversity Loss - New Zealand and Hawke's Bay Context

Healthy functioning ecosystems, both natural and human-altered, underpin New Zealand's economy and are essential to social and cultural wellbeing. Our high levels of indigenous biodiversity are also a major element of the '100% Pure New Zealand' marketing campaign.

New Zealand has a responsibility to maintain our unique genetic and environmental resource. Since humans arrived in New Zealand, the country has experienced one of the highest species extinction rates in the world, due to the loss of habitats and the introduction of pest plants and animals (OECD, 2007).

In 2000, the New Zealand Biodiversity Strategy set an ambitious goal of halting the decline of indigenous biodiversity. Although progress has been made in some areas, the goal of 'halting the decline' is not being met. There have been serious declines in the status of many threatened species and ecosystems, continuing spread of pest fish and aquatic weeds, growing numbers of weed species, and ongoing loss of rare and threatened biodiversity on private lands. There has also been significant modification and pollution of harbours and estuaries.

Almost 2,500 of our native land-based and freshwater species are listed as threatened. Decreases in population sizes since the 1970's are largely caused by the impacts of introduced pest species, rather than habitat loss.

In the future plant and animal pest control will play an important part in maintaining biodiversity for Hawke's Bay Region. Although landholders have primary responsibility for pest and weed control on their land, regional councils control animals and weeds that have been identified as pests in their regions. Biodiversity is not treated as a separate 'topic' within HBRC hence it is difficult, if not impossible to gain insights of trends into the future on the matter.

Despite the lack of monitoring data it is likely that looking towards 2050, changing climate may further exacerbate pressures on our most endangered species.

# 10. Peak Oil

Oil is a finite, non-renewable resource that has powered phenomenal economic and population growth over the last 150 years.

As one would expect, there are hugely divergent opinions on the question of oil reserves, how much oil remains, and when we will reach the point when the oil begins to run out (the point at which oil production peaks). This 'peak oil' point is the topic of much heated debate and controversy (Middleton, 2007).

To quote from Kunstler (2005),

*'We are nearing the end of the cheap-oil age having invested wealth in living arrangements – which have no future'*

The energy sources that the world will consume in the future are difficult to predict due to the array of variables (supply, demand, technology, regulation and economics), which will all interact.

Generally speaking it is predicted that oil will remain as the world's largest source of energy for years to come even under the most optimistic of assumptions about the pace of development and deployment of alternative technology. However, the sources of oil, the cost of producing it and the prices that consumers will need to pay in the future are all uncertain (International Energy Agency, 2008).

## 10.1 Energy Demand – Global Context

A 2009 Annual State of the Future Report from the United Nations has stated that world energy demand could nearly double by 2030, with China and India accounting for over half of the increase.

It has been reported that China uses more coal than the U.S., EU, and Japan combined, and that it now has a policy to close an old coal plant for each new cleaner burning plant that turns coal into a gas before burning it.

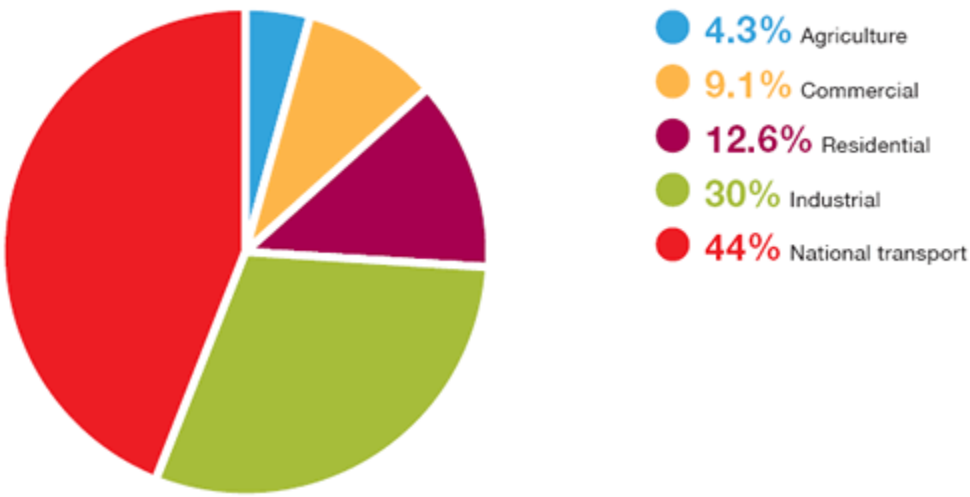
Without major policy and technological changes, fossil fuels could potentially meet 80% of primary energy demand by 2030. If so, the United Nations Annual State of the Future Report suggests that large-scale carbon capture, storage, and/or reuse should become a top priority to reduce global climate change. For the first time, during 2008 the majority of the increase in U.S. and EU electrical production came from renewable sources instead of fossil or nuclear sources. Japan has also claimed it will have a solar power satellite system wirelessly transmitting energy to its electric grids on Earth by 2030. Electricity was wirelessly transmitted 148 kilometers between two Hawaiian islands by a U.S. firm in 2008.

## 10.2 Energy Demand - New Zealand Context

New Zealand is energy hungry. Cheap electricity and cheap oil built and then nourished habits which created a wasteful use of both. Between 1974 and 2004 New Zealand's population rose from 3 million to 4 million, real Gross Domestic product (GDP) and electricity generation doubled, the total energy supply rose by 85% and oil consumption by 66% (OECD, 2007).

New Zealand energy use is dominated by electricity and transport. We currently rely on primary energy from oil, water, natural gas, coal and geothermal energy. New Zealand's energy prices have historically been low by international standards, and as such there has been relatively little investment in energy efficiency measures (MED, 2009). The sectors in which we use energy are shown in Figure 1 below.

Figure 1: Total Consumer Energy by Sector 2006




Source: Ministry of Economic Development

New Zealand, like many countries around the world, is facing two significant challenges:

- Finding the energy needed to power the economy; and
- Transitioning to a more sustainable energy future.

In October of 2004 the New Zealand Government released its own discussion paper on sustainable energy and summarised the New Zealand situation as:

- Innovation is modest
- Use of renewable fuels compared to world average is high but still reliant on fossil fuels
- Supply security is a growing concern
- The environment is under threat from climate change.

# 11. Global Heating

## 11.1 Climate Change – Global Context

It is now clear that the Earth's climate is changing rapidly. Scientists have concluded that these changes are a result of the accumulation of greenhouse gases (GHGs) in the atmosphere arising from human activity, principally carbon dioxide ($CO_2$) from the burning of fossil fuels.

Climate change is also no longer considered to be solely an environmental issue but one that will have serious economic and social repercussions. When Nicholas Stern, former chief economist at the World Bank, released his ground-breaking study 'The Stern Review of the Economics of Climate Change' he called for urgent international action (Stern, 2006).

The Stern Review received global attention by stating that *'scientific evidence is now overwhelming: climate change is a serious global threat, and it demands an urgent global response'*. The evidence gathered by the review led to a simple conclusion: *'the benefits of strong and early action far outweigh the economic costs of not acting'*.

Climate change will affect the basic elements of life for people around the world – access to water, food production, health and the environment. Hundreds of millions of people could suffer hunger, water shortages and coastal flooding as the world warms (Three Regions Climate Change Group, 2007).

The most comprehensive projections for global climate change are given in the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report, published in 2007 (IPCC, 2007). This gives strong warnings about the urgency and scale of the challenge we face in coming decades stating that:

- the frequency and intensity of storms are likely to increase
- there will be more areas affected by drought
- there will be more and hotter heat waves in temperate zones
- ecosystems will be affected and biodiversity will be hit
- certain diseases could become more common
- sea levels are likely to rise (between 18 and 59 cm by the end of the century), although the level of shoreline retreat will be much greater due to landscape morphology.

Under assumptions of rapid global economic growth and a shift to a balanced mix of energy sources, the Intergovernmental Panel on Climate Change projects that annual carbon emissions will more than double by 2050. Scenarios of future climate consider a range of possible emission scenarios – based on different levels of human activity and response. The IPCC emission scenarios give a range of global temperature change from about 1.5 °C to 6°C by 2100.

It is now believed that the risks of dangerous impacts rise sharply as planetary warming exceeds 2°C from preindustrial levels.

Many groups and countries have embraced the 2°C target, including the 2005 International Climate Change Taskforce, the European Union, and more than 200 of the world's leading climate scientists. The 2007 IPCC report concludes that the best estimate of '*equilibrium climate sensitivity*', which is *'the global average surface warming following a doubling of carbon dioxide concentrations'* is *'likely to be in* *the range 2°C to 4.5°C with a best estimate of about 3°C, and is very unlikely to be less than 1.5°C. Values substantially higher than 4.5°C cannot be excluded.'*

Under the IPCC's most stringent emissions reduction scenario, the world has a 50 per cent chance of limiting further temperature increases to 2° C. Achieving that would require a comprehensive global mitigation effort, including a further tightening of existing climate policies in developed countries and concurrent emissions reductions in developing nations. In other words, the world would need to see an emissions peak before 2020 and a 50 per cent reduction below 1990 levels by 2050. The impacts associated with such a scenario are serious but widely regarded as more manageable if a risk reduction approach is fully embraced. However, without action, there is overwhelming scientific evidence that climate change will threaten economic growth and survival of the world's most vulnerable populations.

Coastal communities in particular may experience forced migration of populations. This is of global importance as thirteen of the world's twenty current megacities are situated at sea level, and rises could result in catastrophic flooding (e.g. failure of London's flood protection walls or Thames Barrier), coastal erosion and salination of coastal freshwater aquifers. Storm water drainage and sewage disposal could also be disrupted with serious detrimental effects.

## 11.2 Climate Change – New Zealand Context

The IPCC fourth assessment report (2007) delivered a suite of documents including a working group report entitled 'Impacts, Adaptation and Vulnerability', which itself includes a chapter specific to Australia and New Zealand (Hennessy *et al*., 2007). In addition to this work there has been extensive documentation of observed changes to natural systems by others (such as NIWA in late 2008), major advances in understanding potential future climate changes and impacts, assessments of key risks and benefits and greater attention regarding the role of planned adaptation in reducing vulnerability.

The list below provides a summary of the findings of the IPCC report (referred to above) which are specific to New Zealand and this study.

1. **Regional climate change has occurred (very high confidence)**
Since 1950, there has been a 0.4 to 0.7°C warming, with more heatwaves, fewer frosts, more rain in south-west New Zealand, less rain in north-eastern New Zealand, and a rise in sea level of about 70mm (MfE, 2007).
2. **New Zealand is already experiencing impacts from recent climate change (high confidence)**
These are now evident in increasing stresses on water supply and agriculture, changed natural ecosystems, reduced seasonal snow cover, and glacier shrinkage.
3. **Some adaptation has already occurred in response to observed climate change (high confidence)**
Examples come from sectors such as water, natural ecosystems, agriculture, horticulture and coasts. However, ongoing vulnerability to extreme events is demonstrated by substantial economic losses caused by droughts, floods, fire, tropical cyclones and hail.
4. **The climate of the 21st century is virtually certain to be warmer, with changes in extreme events**

- Heatwaves and fires are virtually certain to increase in intensity and frequency (high confidence).
- Floods, landslides, droughts and storm surges are very likely to become more frequent and intense, and snow and frost are very likely to become less frequent (high confidence).

- Large areas of eastern New Zealand are likely to have less soil moisture, although western New Zealand is likely to receive more rain (medium confidence).

**5. Potential impacts of climate change are likely to be substantial without further adaptation**

- As a result of reduced precipitation and increased evaporation, water security problems are projected to intensify by 2030 in Northland and some eastern regions (high confidence).
- Ongoing coastal development and population growth, in Northland to Bay of Plenty (New Zealand), are projected to exacerbate risks from sea-level rise and increases in the severity and frequency of storms and coastal flooding by 2050 (high confidence).
- Significant loss of biodiversity is projected to occur by 2020 in some ecologically rich sites, including Sub- Antarctic islands and alpine areas (very high confidence).
- Risks to major infrastructure are likely to increase. By 2030, design criteria for extreme events are very likely to be exceeded more frequently. Risks include failure of floodplain protection and urban drainage/sewerage, increased storm and fire damage, and more heatwaves, causing more deaths and more blackouts (high confidence).
- Production from agriculture and forestry is projected to decline by 2030 over parts of eastern New Zealand, due to increased drought and fire. However, in New Zealand, initial benefits to agriculture and forestry are projected in western and southern areas and close to major rivers due to a longer growing season, less frost and increased rainfall (high confidence).

**6. Vulnerability is likely to increase in many sectors, but this depends on adaptive capacity**

- *Most human systems have considerable adaptive capacity:*
  New Zealand has well-developed economies, extensive scientific and technical capabilities, disaster mitigation strategies, and biosecurity measures. However, there are likely to be considerable costs and institutional constraints to the implementation of adaptation options
- Some Indigenous communities have low adaptive capacity. Water security and coastal communities are the most vulnerable sectors (high confidence).
- *Natural systems have limited adaptive capacity:* Projected rates of climate change are very likely to exceed rates of evolutionary adaptation in many species (high confidence). Habitat loss and fragmentation are very likely to limit species migration in response to shifting climatic zones (high confidence).
- *Vulnerability is likely to rise due to an increase in extreme events:* Economic damage from extreme weather is very likely to increase and provide major challenges for adaptation (high confidence).
- *Vulnerability is likely to be high by 2050 in a few identified hotspots:* In New Zealand, these include the Bay of Plenty, Northland, eastern regions and the Southern Alps (medium confidence).

## 11.3 Climate Change – Hawke's Bay Context

The climate of Hawke's Bay is heavily influenced by its position eastward of the mountain ranges. The ranges provide a sheltering effect from the predominant westerly weather pattern over New Zealand, resulting in a dry, sunny, temperate climate. Droughts are a regular feature of Hawke's Bay, particularly in association with the El Nino-Southern Oscillation phenomenon. However, Hawke's Bay has also experienced repeated flooding, owing to the variability in rainfall both across the region and over time. This has resulted in a significant investment by the HBRC in extensive flood protection works.

Some of the predicted impacts of climate change for Hawke's Bay include changes in average temperature, sea level rise and rainfall patterns. In general, Hawke's Bay (like much of the east coast of New Zealand) is likely to become warmer and drier.

NIWA climate scientists estimate that temperatures in Hawke's Bay and Gisborne could be up to 3°C warmer over the next 70-100 years. This compares to a temperature increase in New Zealand during the last century of about 0.7°C. To put this in perspective, the 1997/98 summer, which many New Zealanders remember as particularly long, hot and dry, was only about 0.9°C above New Zealand's average for the 1990s.

Hawke's Bay could be up to 20% drier, but with more varied rainfall patterns (dry periods interspersed with very heavy rainfall) flooding could become up to four times as frequent by 2070.

The effects of climate change may bring significant costs to the community. If extreme weather events become more frequent or severe, the costs and damages associated with them are also likely to increase. The cost of dealing with stock losses, replacing or repairing damaged roads, bridges, houses and stormwater drains, and dealing with increased soil erosion and loss of soil nutrients, can be formidable.

It is possible that there could also be benefits and opportunities from a change in climate. Farmers could benefit from better crop growing conditions and faster growth of pasture but greater fertiliser use would probably be needed. There could also be opportunities to grow new crops, with a longer growing season and fewer frosts.

However, if the rate and magnitude of climate change is not slowed, any beneficial effects of climate change are expected to diminish, and the adverse effects and long-term risks expected to increase.

### Increased Susceptibility to Coastal Erosion

A coastal hazards report was completed in February 2004 for the Hawke's Bay Regional Council by consultants Tonkin and Taylor Limited. It identified that the entire region's shoreline is prone to storm damage and the influence of cyclical erosion and accretion trends. The region is also prone to inundation due to storm surges. High sea swells or storm surges lead to coastal erosion and inundation of land adjacent to the coast as seawater is driven over the beach crest.

Properties in coastal hazard zones will be destroyed, unless communities can find a cost-effective and environmentally appropriate means of preventing beach erosion and inundation towards 2050.

For areas experiencing long-term shoreline recession and significant damage to property, retreat away from the coast may be the only viable long-term option for the future.

# 12. Future Emission Reduction Methods

In many parts of the world across a range of sectors it is clearly recognised by many people that a 'business as usual' approach to production and consumption patterns is no longer viable. Transitioning towards a more sustainable low emission future is now being seen as a priority.

The responses presently being planned or put in place seem to have an underlying assumption of an orderly transition towards a relatively clearly defined future. For instance, Shell's 'blueprints' and 'scramble' scenarios both assume that a healthy, sustainable future will eventuate. But the possibility exists that the future may be more unpredictable than is being planned for, partly because current economic models don't seem especially effective at predicting the consequences of the new kinds of global challenges that are emerging, and because finding technological solutions to the environmental sustainability problems (e.g. substitutes for fossil fuels) seem to be hard to develop.

There are two general ways to reduce emissions that could both have roles towards 2050:

1. Demand Side – reduce demand for emissions-intensive activities:
   a. Reduce "unnecessary" emissions (avoid wasting energy) and improve the efficiency of our energy use
   b. Change the structure of the economy to reduce the contribution of emissions-intensive sectors, or
   c. Reduce the size of our economy.

2. Supply Side – reduce the emissions intensity of direct and indirect productive activities:
   a. Reduce supply from emissions-intensive activities (fossil fuel use) and replace it with supply from non-emissions intensive sources (e.g. renewables)
   b. Continue the supply mix but use improved technology to increase efficiency of energy supply, or
   c. Continue the supply mix but capture and store greenhouse gas emissions.

## 12.1 The Role of Technology

Technology is expected to develop significantly over the period to 2050. Many of the technology and energy types required to generate a sustainable energy future in 2050 are not yet commercialised or widely available.

Partial solutions do exist. Many technologies available today (e.g. solar, wind, geothermal, carbon storage, natural sinks etc) can be scaled up to reduce emissions significantly by the middle of the century.

The impact and effectiveness of technological solutions depend on their being deployed on a global scale. The International Energy Agency estimates that, by 2020, 60 percent of greenhouse gas emissions will come from economies in transition and developing countries, underlining the fact that these countries will need to 'leapfrog' a technological generation or two if they are to avoid the fossil-fuel trap and move directly to environmentally-sound technologies.

The IPCC have found that it would be possible to stabilise atmospheric green-house gas concentrations at a level close to what is needed (to stay below the EU temperature target of 2°C). This assumes that appropriate and effective incentives are in place for the development, acquisition, deployment and diffusion of technologies and for addressing related barriers. The available technological options include:

- renewable energy sources, including solar photovoltaic, solar thermal, wind, hydro, geothermal, tidal, ocean thermal, and biomass;
- energy efficiency improvements, especially in building insulation and transportation;
- nuclear energy; and
- carbon capture and storage (CCS).

Looking toward 2050 it is possible that New Zealand will both have a higher percentage of electricity generated from renewable sources and that energy efficiency improvements in buildings and transport will be made. Questions still remain regarding the costs and environmental risks associated with nuclear energy and carbon capture and storage (the latter of these two options is discussed in section 14.3 of this report).

Climate change mitigation and adaptation options are also strongly influenced by urban form. At high densities, travel distances are minimised and community energy schemes become more viable, with obvious advantages for emissions reduction. However, higher densities can conflict with adaptation objectives by intensifying urban heat island effects and reducing urban drainage capacity.

An adapted and sustainable urban environment makes use of well designed green and blue spaces for cooling, water storage capacity, and infiltration of rainfall (McEvoy et al., 2006).

# 13. Geoengineering - The Silver Bullet?

Geoengineering is an umbrella term for large-scale actions intended to combat the climate-changing effects of greenhouse-gas emissions without actually curbing those emissions. Geoengineering is controversial and those who fear climate change would prefer to stop it by reducing greenhouse-gas emissions. Geoengineers argue that this may prove insufficient and that ways of tinkering directly with the atmosphere and the oceans need to be studied.

There are two broad approaches to geoengineering. One is to reduce the amount of incoming solar (shortwave) radiation that the planet absorbs. The other is to suck carbon dioxide out of the atmosphere and put it somewhere else (thus increasing outgoing longwave radiation).

A number of options have been considered including capturing carbon dioxide by artificial trees, underground storage or sequestering via powerstations, fertilizing the oceans with iron to promote algae growth (thus absorbing carbon dioxide), and even ‘solar radiation management’ which reduces the amount of incoming sunlight.

In 2009 a pair of climate researchers produced the first detailed examinations of geo-engineering schemes. The University of East Anglia's Tim Lenton, and N. E. Vaughan of the Tyndall Centre for Climate Change Research compare a long list of ideas in *Atmospheric Chemistry and Physics Discussions*. Lenton and Vaughan have reviewed both short-wave and long-wave geoengineering options and claim to have found several errors in previous efforts to calculate just how much radiative forcing can be offset by several schemes (producing a ranking of the relative, theoretical potential of each).

A summary of their key findings is reproduced below:

- Enhancing carbon sinks could bring $CO_2$ back to its pre-industrial level, but not before 2100 - and only when combined with strong mitigation of $CO_2$ emissions
- Stratospheric aerosol injections and sunshades in space have by far the greatest potential to cool the climate by 2050 - but also carry the greatest risk
- Surprisingly, existing activities that add phosphorous to the ocean may have greater long-term carbon sequestration potential than deliberately adding iron or nitrogen

- On land, sequestering carbon in new forests and as 'bio-char' (charcoal added back to the soil) have greater short-term cooling potential than ocean fertilisation
- Increasing the reflectivity of urban areas could reduce urban heat islands but will have minimal global effect
- Other globally ineffective schemes include ocean pipes and stimulating biologically-driven increases in cloud reflectivity
- The beneficial effects of some geo-engineering schemes have been exaggerated in the past.

Prior to the review, the pyrolysis (oxygen-free) burning of organic waste, which turns it into 'bio-char' that can then be buried, for example, had been considered one of the most promising proposals to sequester carbon. However, Lenton and Vaughan conclude that, at best, it will only bring down $CO_2$ levels by 34 ppm. Such a drop might make the difference between catastrophic and manageable change. As Lenton and Vaughan write, geoengineering really only makes sense as a part of a larger strategy that includes drastically cutting back on greenhouse gas emissions.

It has been concluded that by 2050, some land carbon cycle geoengineering options could be of comparable magnitude to mitigation 'wedges'. But only stratospheric aerosol injections, albedo enhancement of marine stratocumulus clouds, or sunshades in space have the potential to cool the climate back toward its pre-industrial state. Strong mitigation, combined with global-scale air capture and storage, afforestation, and bio-char production, i.e. enhanced $CO_2$ sinks, may be able to bring $CO_2$ back to its pre-industrial level by 2100, thus removing the need for further geoengineering options.

# 14. Renewable Energy and Carbon Capture Technologies

New Zealand is well placed to consider further development of renewable energy because it has large potential resources in wind, wave, and solar power and an economy that could adapt quickly to the use of hydrogen fuel cells (NIWA, 2003).

New Zealand increased the electricity generated from renewable sources in absolute terms from 1999 to 2005. But in percentage terms it fell from 70% in 1999 to 66% in 2005. The share generated from hydroelectric dams also dropped from 63% to 58%, because demand growth has been outstripping growth in renewable generation. Keeping up with demand (assuming no energy efficiency or demand reduction mechanisms are employed) will be a challenge if New Zealand wants to move to 100% renewable energy in the future (MED, 2008).

International energy policies have led to the development of a global market for renewable transport fuels and technologies. The uptake of these technologies is dependent on the suite of incentives/regulatory measures agreed by the newly elected national government.

Although increases to renewable electricity generation capacity are generally thought to be positive they can have environmental impacts that span local, regional and national scales. It is often the case with renewable energy that adverse effects manifest locally and positive effects manifest nationally. In some instances the benefits of renewable electricity generation can compete with areas of significant natural character, significant amenity values, historic heritage, outstanding natural features and landscapes, significant indigenous vegetation and significant habitats of indigenous fauna. For example, further generation of large scale hydro is limited because the pricing market has revealed it to be more expensive than many other generating options. This is in part because of competition for water resources and in part because of changing public attitudes to the environment and natural heritage. Meridian Energy's abandonment of *Project Aqua* illustrated the power of the latter two influences (Hood and James, 2007).

## 14.1 Renewable Energy Potential – Hawke's Bay Region

Hawke's Bay region is connected to the National Grid by two 220 kV circuits from Wairakei. The installed generation capacity in the region is 306 MW with a 'normally' available generation capacity of 146 MW.

Electricity demand on the Hawke's Bay is currently about 1,700GWh per annum and the maximum load or demand is 310 MW. By 2018, peak demand is expected to have increased to between 330 and 335 MW. The electricity demand is expected to increase to 2,200 GWh by 2050 as per the Electricity Commission's Demand Forecast Review.

In 2008 Sinclair Knight Merz (SKM) was commissioned to identify and assess the renewable energy potential in the Hawke's Bay region and provide advice to the HBRC on how to realise this potential.

A diversified portfolio of renewable energy supply can improve the resilience of the Hawke's Bay and New Zealand economy to future energy supply problems and price shocks. This is recognised as one of the main goals of the National Energy Efficiency and Conservation Strategy (NEECS).

The Hawke's Bay's renewable energy potential identified by SKM mainly comprises of 1,200 to 1,600 MW of wind power. It also comprises of 230 MW medium and small-scale hydroelectric schemes that are outside DOC lands and on rivers without Water Conservation Order.

Apart from wind and hydro, the region has limited renewable energy potential from other sources:

- About 6 GWh/year of electrical energy could be derived from municipal solid waste combustion. However, this is unlikely to be economical
- Marginal potential for commercial wave power but unlikely for early adoption of wave energy device trials
- No potential for power generation from geothermal sources
- Very limited tidal energy potential

In addition to the SKM report, HBRC has suggested that there are a number of issues, beyond the scope of the current report to consider including:

- Noting the potential for a substantial increase in power demand (e.g. from population and economic growth), the development of a more detailed understanding of demand projections.
- Evaluation of alternatives available to supply electricity to the communities after 31 March 2013
- Assessing the consequences of development of large-scale renewable projects and the role of renewables in security of energy supply
- Understanding the role of small scale distributed renewable resources such as solar in the context of energy supply and demand scenario and developing a more detailed understanding

of smaller scale energy measures (including demand side, energy efficiency, small-scale renewables) at the domestic and community scale and within commercial and industrial sites.

- Involving all key stakeholders in the region and develop future renewable energy action plans and integrate the national renewable energy policy statements into the regional plans

## 14.2 Biofuels – Future Uptake

Biofuels are energy crops that have been grown either for biomass burning (to produce heat and energy) or for transport fuel. Their supporters argue that they produce less greenhouse gases than oil and any emissions they produce when burned are not necessarily additional because the plants have absorbed the carbon dioxide while growing. A close look at the life cycle of biofuels, however, reveals potential for considerable greenhouse gas emissions (Rockwood *et al.,* 2008). These come from the processes of refining and distilling as well as from transport, the use in farm machinery, and fertiliser production. Further emissions are generated right at the beginning of the biofuel life cycle. This is because the key growing regions for biofuels (such as oil palms and soya) are Indonesia, Malaysia and the Amazon. Here vast forests that act as vital carbon sinks and provide habitats for a range of species are being felled in order to clear land for the biofuel crops (Mastny, 2007).

The overall climate impacts of biofuels will depend on several factors, the most important of which is associated with land use changes, choice of feedstock and how it is managed and the refining process Liquid biofuels are another possibility for transport. Growing scarcity of oil and advances in biotechnologies could bring a smooth transition but some estimates suggest that up to one-sixth of the world's agricultural land would need to be utilised if biofuels are to play a major part in offsetting growing global emissions from transport (Office of Science and Technology, 2005).

## 14.3 A Future Hydrogen Economy?

The development and deployment of fuel cells are considered to be an integral part of a sustainable 'hydrogen economy', in which hydrogen gas is produced using renewable sources of energy. Such an approach could offer abundant energy with negligible emissions as when fuel cells are supplied with pure hydrogen the only by-product is water vapour. Where renewable energy is used to produce hydrogen, overall emissions are very low but many futurists question whether it is better for those renewables to be used to produce electricity directly rather than first being used to produce hydrogen. Obtaining hydrogen from the electrolysis of water using renewable energy sources would require the construction of new power plants and improvements to existing plant designs if they are to be able to compete with fossil fuels on economic terms (Drennen and Rosthal, 2007).

## 14.4 Realities of Carbon Dioxide Capture and Storage (CCS)

Carbon dioxide capture and storage (CCS) involves capturing carbon dioxide and transporting it by tanker or pipeline to be stored underground in depleted oil reservoirs, depleted natural gas fields or deep saline aquifers. This is already happening in the Sleipnner gas field in the Norwegian North Sea, where carbon dioxide is removed from the gas and pumped into highly permeable sandstone. The IPCC has said there is considerable potential for CCS, particularly if supplied to the electricity sector, suggesting that such systems could provide between 15 and 55 % of the cumulative mitigation efforts until 2100 (IPCC, 2007). But many questions still remain about the environmental risk safety and costs of CCS systems. The International Energy Agency (2008) said that costs are so great that the technology will not be applied without strong government support.

# 15. Alternative Models for Energy Supply Management

Most of New Zealand's electricity is currently generated in large, centralised power stations a long way from where the electricity is used. The electricity is inefficiently transported around the country through transmission lines, and then carried through local distribution networks to where it is needed.

There are preferable alternatives to this model which include the use and development of decentralised energy/distributed generation, Transition Towns, bioenergy, combined heat and power and Smart Grids.

## 15.1 Distributed Generation

Distributed generation is also sometimes known as small-scale (household-sized through to community-sized) electricity generation. The electricity generated is used on site or nearby. Distributed generation projects are hooked up to the local distribution network which are connected the national grid. This means that when there is not enough electricity being generated by the local project users can still get electricity from the network. It also means that if excess electricity is being generated, the excess can be exported into the network.

Electricity from distributed generation projects can be generated using different systems such as wind turbines, solar panels, hydro turbines, geothermal heat, bio-energy (for example biogas, or biomass), or diesel or gas turbines. In some cases, known as 'cogeneration', heat is produced as well as electricity.

Distributed generation can contribute to an efficient and renewable electricity future for New Zealand by potentially:

- Increasing the use of renewable sources of energy
- Improving the efficiency of our electricity system by reducing transmission and distribution losses
- Improving the security of our electricity supply through increased diversity and reduced vulnerability to simultaneous system failures (the impact of simultaneous failure may be less with a high number of small generation projects than a few large power stations)
- Deferring need for lines upgrades where it is more cost effective to invest in localised energy generation projects.

### Microgeneration

Looking to the future, a major trend for New Zealand towards 2050 could be the generation, management, and storage of electricity and/or heat close to where it is to be used.

Micro generation technologies are at the heart of local energy systems and could be considered by the Hawke's Bay Region in the future.

Adopting microgeneration technologies should be supported by various other technologies and measures. These include:

- Enabling technologies that provide control and monitoring
- Building design and performance measures that can significantly improve energy- efficiency for heating, cooling, and lighting
- Efficient management of energy services, as the management of peak loads is critical, particularly for off-grid systems
- Changes in people's attitudes and behaviour that result in more effective use of energy (this helps local energy systems perform up to their full potential)
- Whether systems will be able to link to form micro grids (small local networks) that permit micro generators to share smart control and energy storage equipment, and thereby have increased security of supply.

## 15.2 Transition Towns

Transition towns are local communities who are seeking to manage the transition to a lower energy future by increasing local resilience in the face of diminished oil supplies, and mitigating the effects of climate change by reducing its carbon emissions. For example, Transition Towns grow more of their own food, generate their own power, encourage local trade and local currencies, and build their own houses using local materials. They encourage alternative forms of transport and the creation of vibrant, creative communities. Transition Towns are relevant to New Zealand have had rapid uptake here (Millar and Puckey, 2008).

## 15.3 Bioenergy in New Zealand

Wood biomass currently provides about 5% of New Zealand's main energy supply (MED, 2008). Wood biomass is mainly used by the timber industry, which burns residue wood to provide heat energy.

There are opportunities to significantly increase our use of biomass as an energy source. EECA is administering the Wood Energy Grant Scheme (WEGS), which aims to increase the use of wood residues as an energy source.

## 15.4 Smart Grids

Smart Grids help achieve a more efficient transmission grid and improve opportunities for renewable energy supply and distributed energy. Electricity grids of the future are 'smart' in several ways. Firstly, they allow the customer to take an active role in the supply of electricity. Demand management becomes an indirect source of generation and savings are rewarded. Secondly, the new system offers greater efficiency as links are set up to draw on available resources and enable an efficient exchange of energy. In addition, environmental concerns will be addressed, thanks to the exploitation of sustainable energy sources. Distribution grids (a Smart Grid) will become active in the future and will have to accommodate bi-directional power flows (European Commission, 2006).

In essence a 'Smart Grid' means that your home or building could generate clean power and sell the surplus to the grid at peak prices for you during the day and buy any excess energy you need during the evening when prices are low. You could plug your hybrid car into an integrated system and, depending on the time of day, it would either sell surplus energy from its battery to the grid or charge itself up ready for use the next morning. Extra energy produced from solar and wind production systems could be linked to the batteries in our cars with Smart Grids. These energy linking systems could help buildings and transportation power each other (Steffen, 2008).

## 15.5 Combined Heat and Power (CHP)

Just over 8% of world electricity generating capacity uses cogeneration, also known as combined heat and power (European Commission, 2006). Combined heat and power captures waste heat as electricity is produced and recycles it to provide another energy service. This is unlike conventional systems in which heat is simply exhausted into the environment and additional fuel must be used to provide the same amount of heat to industry or buildings. Another form of cogeneration captures waste energy from industrial processes and recycles it into useful electricity and thermal power.

According to the International Energy Agency, CHP could reduce global greenhouse emissions by at least 4% in 2015 and 10% in 2030. Historically there has been a lack of awareness about the technology. Recent developments have, however, signalled heightened interest in CHP.

# 16. Beyond Eco-efficiency - Regenerative Development

In their 2009 report 'Towards a Sustainable Future', the Ministry for the Environment state that *'In regenerative development, the built environment becomes a conduit for producing resources and energy, improving physical and psychological health, remedying past pollution, and transforming and filtering waste into new resources'.*

Regenerative development represents a fundamental rethinking of architectural and urban design and:

- Is a positive contributor to the living systems (human and biotic) in which it occurs
- Is a means of achieving sustainability. By regenerating and integrating with living systems it enables the possibility for continual adaptation and growth
- Leads to a source of deeper meaning and significance for all involved

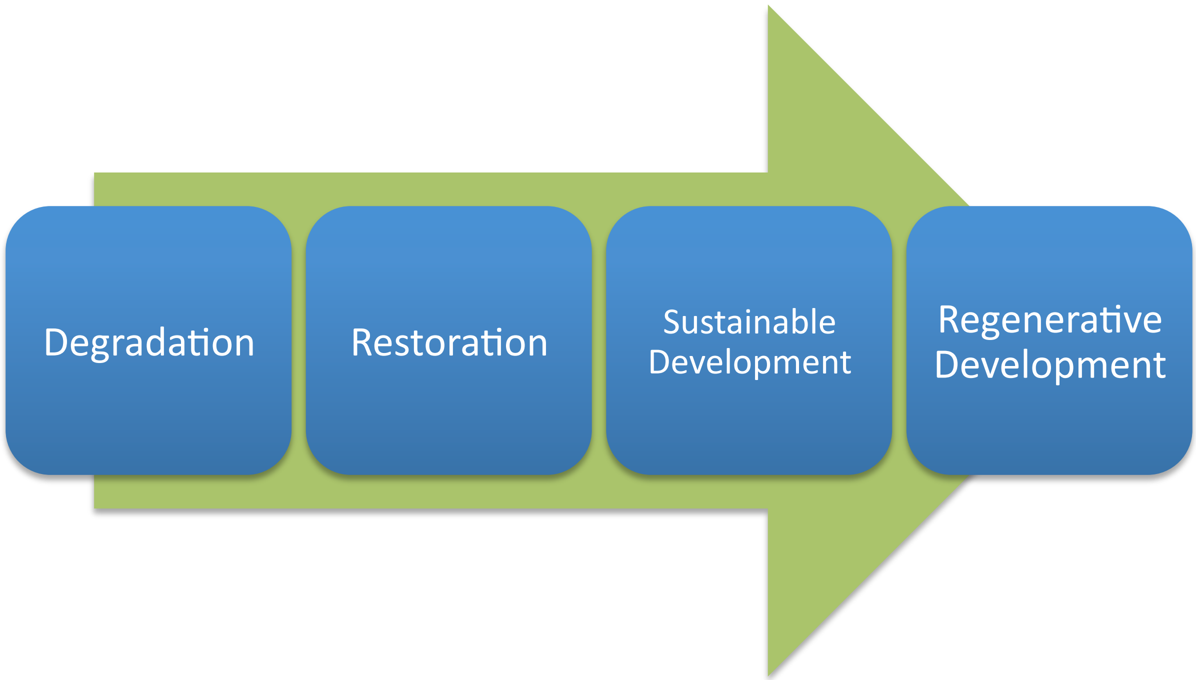



Figure 2: The Pathway to Regenerative Development

Regenerative Development moves beyond traditional sustainable development to address negative impacts such as the contribution to climate change, reduced air quality, high water and energy use, high materials use and waste.

The challenge we face is that this requires an expanded notion of our goals for ecological performance. It also requires greater understanding of the relationships between the living and built environments.

Buildings are not considered as individual objects, but rather are designed to become parts of larger systems, allowing complex and mutually beneficial interactions to occur between the built environment, the living world and human inhabitants.  This ensures constantly dynamic, responsive and resilient developments evolve over time, and is a key difference between regenerative and eco-efficient development.

Regenerative development leaves behind the idea that the best a building can be is neutral in relation to the living world.  It acknowledges humans, our developments, social structures and cultural concerns are an inherent and indivisible part of ecosystems.

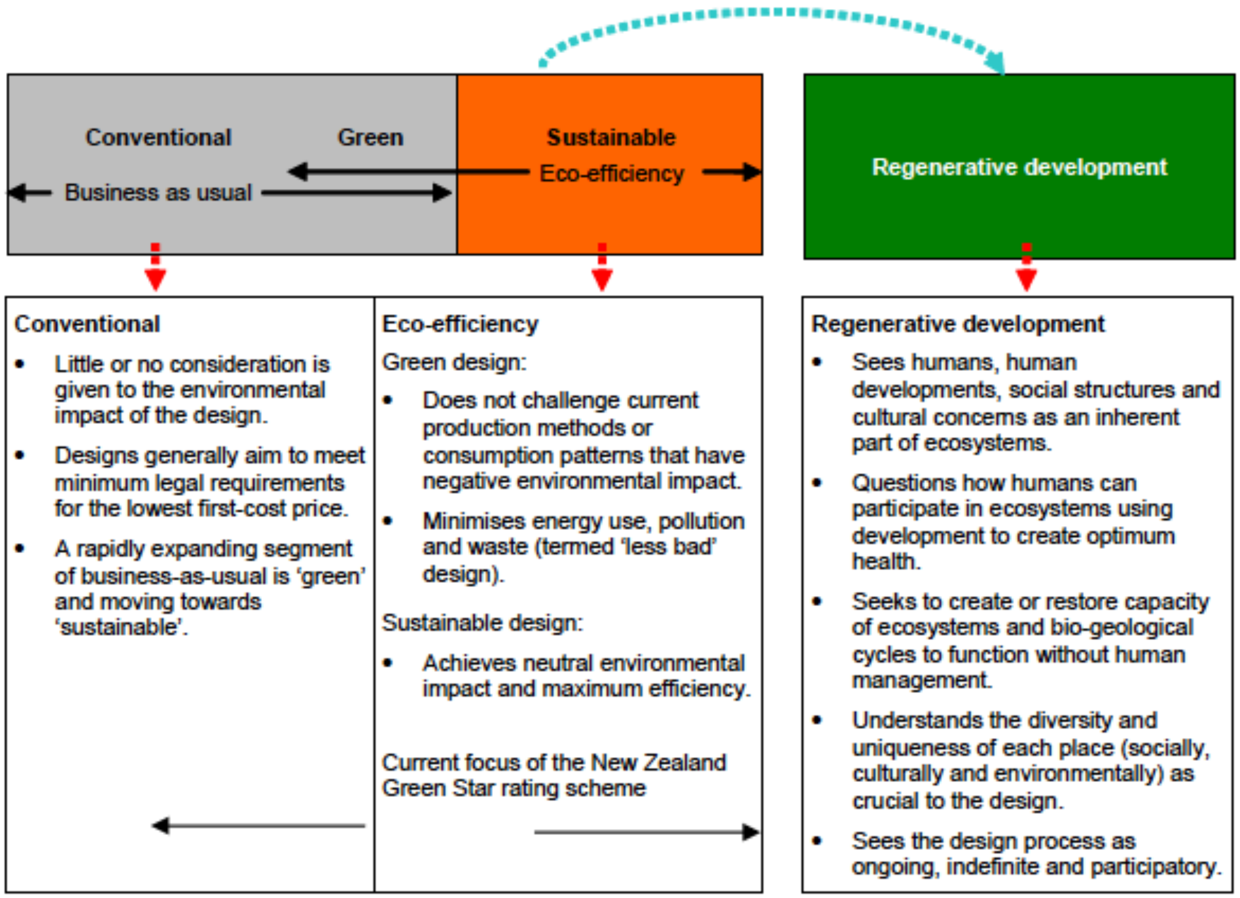



Figure 3: From Conventional to Regenerative Development (Source MfE, 2009b)

MfE have identified a number of challenges are associated with implementing regenerative development. Primarily, these are the '*current lack of an integrated approach to government development, and few real-life examples to provide quantifiable evidence of its benefits*'. In addition, because regenerative development looks at the built environment as a holistic system, it poses challenges to our current methods for dividing land into discrete parcels that do not relate to each other. Examples of shared holistic services that will become increasingly necessary to provide for towards 2050 challenge traditional boundaries and include methods for generating renewable energy and restoring ecological features.

# 17. Glossary

| | |
|---|---|
| CCS | Carbon Capture Storage |
| CHP | Combined Heat and Power |
| Consumer | The end user of a product or service |
| EECA | Energy Efficiency and Conservation Authority |
| Gaia Hypothesis | an ecological hypothesis proposing that the biosphere and the physical components of the Earth (atmosphere, cryosphere, hydrosphere and lithosphere) are closely integrated to form a complex interacting system that maintains the climatic and biogeochemical conditions on Earth in a preferred homeostasis |
| GDP | Gross Domestic Product |
| Green Star | New Zealand's first comprehensive environmental rating system for buildings |
| IEA | International Energy Agency |
| IPCC | Intergovernmental Panel on Climate Change |
| Kyoto Protocol | This international agreement was established in 1997 as a means of setting binding emission reduction targets for greenhouse gases. It entered into force in 2005 meaning that New Zealand has agreed to return its net greenhouse gas emissions over the 2008-12 commitment period to 1990 levels. It allows the opportunity for international initiatives to reduce emissions cost effectively through the use of its flexible mechanisms based on the trading of $CO_2$ equivalent emission allowances. |
| Mfe | Ministry for the environment |
| NES | National Energy Strategy |
| NZBCSD | New Zealand Business Council for Sustainable Development |
| OECD | Organisation for Economic Co-operation and Development |
| RMA | Resource Management Act |
| Solution Seekers | A market of a growing number of people concerned about global issues and lifestyle pressures. |
| STEEP | Framework of macro-environmental factors used in the environmental scanning component of strategic management |
| SOE | State of the environment report |
| Urban Design Protocol | A voluntary commitment to specific urban design initiatives by signatory organisations in New Zealand, which include central and local government, the property sector, design professionals, professional institutes and other groups |
| Urbanisation | The physical growth of rural or natural land into urban areas as a result of population immigration to an existing urban area |
| UK | United Kingdom |
| US | United States of America |
| WWF | World Wildlife Fund |
| WEGS | Wood Energy Grant Scheme |

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