VALUING USES OF GEOTHERMAL RESOURCES IN THE WAIKATO REGION

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ABSTRACT

In 2002 Waikato Regional Council surveyed the numbers of visitors to geothermal attractions in the Waikato Region. A repeat survey was recently undertaken, involving all 50 geothermal tourism sites, divided into six categories of attraction, in the Waikato Region. The overall number of visits by domestic and overseas tourists to has increased from 2 million in 2002 to 2.6 million in 2010.

The survey also assessed the regional direct use of geothermal energy, and employment numbers. Multiplier analysis was used on figures from this survey and other sources such as Tourism NZ and Statistics NZ to estimate the value of electricity production, geothermal tourism and direct uses to the regional economy. More than 1200 people are estimated to be employed in geothermal tourism and direct uses in the Waikato Region, while 189 are employed in geothermal electricity production. Preliminary results suggest that geothermal electricity production is worth $134 million to the regional economy, while geothermal tourism is worth somewhere between $84 and $162 million. Indirect and induced economic values are also calculated.

1. INTRODUCTION

This report provides the results of a survey conducted between April 2011 and June 2011, and the results of multiplier analysis to estimate the value of geothermal resources to the Waikato region. The survey investigated a) the numbers of visitors from domestic and international sources visiting geothermal attractions in the Waikato Region; b) the numbers of staff employed in tourism and direct heat facilities in the Waikato Region; and c) the amount of geothermal energy used in commercial and domestic direct heat applications in the Waikato Region.

The survey updates and expands on the results of a survey conducted in the period from December 2001 to February 2002 (Luketina, 2002) which investigated the numbers of visitors from domestic and international sources visiting geothermal attractions in the Waikato Region.

The 2002 survey identified that more than two million tourists visited geothermal attractions in the Waikato Region each year. Bathing was the greatest attraction, but nature tourism and technology-related sites were also important.

The visitor numbers collected in the survey support assumptions used in multiplier analysis to estimate the value and employment effects of geothermal tourism to the regional economy in 2009. Multiplier analysis is also used to estimate the value of geothermal generation for the regional economy. Projections of future contributions for each sector to the regional economy are made.

2. DEFINITIONS

2.1 Geothermal Attraction

This report defines a geothermal attraction as a publicly accessible site where geothermal characteristics are a primary recreational or tourist attraction. Enjoyment of most of these sites involves either experiencing geothermal activity such as geysers and fumaroles, or bathing in geothermal water.

A smaller group of sites is the technology-related group, where people experience highly modified characteristic of geothermal technology. Currently this group contains three sites: Wairakei Terraces, a tourist attraction mainly comprising artificial geothermal features, the Wairakei Power Station borefield and the Prawn Park, where prawns are grown in geothermally-heated ponds for consumption in an on-site café.

Public sites where geothermal heat is used to heat fresh water for recreational bathing are included where it is likely that the facility would not exist without the geothermal heat source. The exception is bathing facilities that are not primarily tourism and leisure-oriented. Sites where geothermal heat is used for space heating and domestic water heating only are not included as geothermal attractions. Also excluded are sites where geothermal water is used in a domestic environment, such as homes, rest-homes, and marae, and natural hot springs that are used almost exclusively by local residents.

2.2 Direct Heat Application

A geothermal direct heat application is one that uses geothermal heat directly for primary production, space and water heating, or an industrial application.

2.3 Geothermal electricity generation

Geothermal electricity generation involves converting the energy contained within geothermal resources into electrical energy.

3. TOURISM

Tourism is a vital component of New Zealand's economy, with international and domestic tourists spending $22.4bn in the year to March 2010 and contributing directly $6.5bn (3.8 %) to New Zealand's GDP in 2010. The indirect value-added contribution to GDP through industries supporting tourism contributed a further $8.8 billion, totalling of 8.7 % of GDP (Statistics New Zealand, 2010a).

3.1 Geothermal tourism

Geothermal attractions were particularly popular with international tourists in 2008, with 500,000 (22.5 %) visiting geothermal sites (Figure 1). Similarly, visiting thermally heated pools was a popular activity, particularly for international tourists.

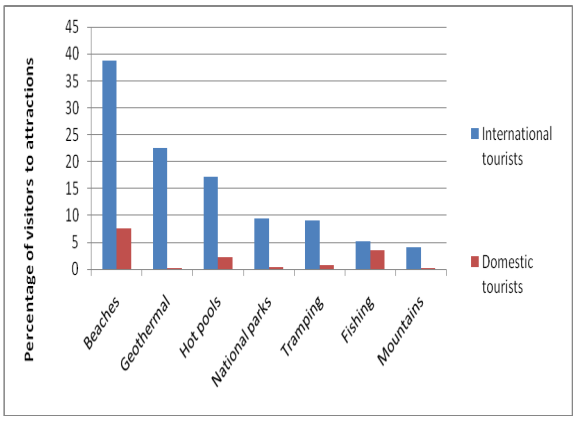


Figure 1: Percentage of international and domestic tourists taking part in selected activities

Source: (Ministry of Economic Development, 2009).

3.2 Geothermal tourism in the Waikato region

About 70 % of New Zealand's geothermal resources are in the Waikato region, making the region an attractive place for both domestic and international tourists. In identifying visitor numbers, this report defines geothermal attractions in six categories: Bathing as part of travel accommodation facilities: (23 sites); Pay bathing: (9 sites); Free informal bathing: (10 sites); Pay nature tourism: (4 sites); Free nature tourism: (1 site); Technology-related sites: (3 sites).

The annual visitor number estimates are determined from surveys of proprietors and users.

3.3 Bathing as part of tourist accommodation (23 sites)

Visitor numbers in the 2010-2011 year were similar to those in the 2001-2002 year for motels. There was a significant increase in business for motor-camps. International visitor numbers have fallen by 9 percent (Table 3).

3.4 Pay Bathing (9 sites)

Most sites reported a drop in numbers. All of the decrease came from domestic visitors, probably due to the economic recession. International visitor numbers remained stable (Table 3).

3.5 Free informal bathing: (10 sites)

At various sites around the region, there are geothermal springs that are largely undeveloped, have no entry price, and are used by the public for bathing. Some are on public land, while others are on private land, but are accessible to the public.

The total number of visitors is more than five times bigger than in 2002, at 831,300, an increase of 421 percent (Table 3). Much of this increase is probably due to a more accurate sampling method. The 2002 result was based on about 100 observations, whereas the current estimate was based on 180. In addition there may have been a real increase in use since the last survey due to an increase in overseas free independent travelers and bus tourists using the facilities, and in New Zealanders preferring to holiday within New Zealand and undertake low-cost leisure activities.

3.6 Nature tourism (5 sites)

Nature tourism covers developed facilities that charge visitors to look at geothermal attractions such as geysers, boiling mud pools, sinter terraces, fumaroles, and hot springs, as well as sites for which there is no entry fee.

3.7 Technology-related tourism (3 sites)

This category covers free unguided views of the Wairakei Power Station borefield, and paying visitors to The Prawn Park and the artificial Wairakei Terraces. Wairakei Terraces has started up since the 2002 survey, so the category has gone from two sites to three. Data came from a range of sources including the current and 2002 surveys, and news media. We have no data for a fourth site, guided tours of the Wairakei borefield by NETCOR, so that is excluded from the survey.

3.8 Summary of visitor results

Overall numbers of visitors to geothermal attractions have increased by more than half a million, to almost 2.6 million, made up of a 25 percent increase in both domestic and international visitors (Table 3). For both visitor types, a large part of the increase is due to more accurate counting in the free informal bathing category. There has been a decrease in the number of domestic visitors to pay bathing sites, but this is largely because a redefinition of the category now excludes Matamata Sports Centre. Overall, more New Zealanders are visiting geothermal attractions than in 2002. The decrease in international visitors to motels and motor camps is more than offset in the accommodation category by an increase in domestic holiday-makers. There has been a significant decrease in international visitors to technology-related tourism sites, which is more than offset in by an increase in numbers to nature tourism sites.

3.9 Geothermal tourism's contribution to the regional economy

Tourism operators participating in the survey were asked how useful geothermal resources were to their operation (Table 1). Among the 30 % who found it essential, one estimated that they actually had no energy saving from its use because of pumping costs. Nevertheless, the tourism value of the water made it an essential part of the business. Several others found it somewhat useful despite high pumping and maintenance costs. In the Pay Bathing, Nature Tourism and Technology-related tourism categories, all respondents considered the geothermal resource essential to their business.

Table 1: Usefulness of geothermal water and energy

Direct Users	Not useful (%)	Useful (%)	Essential (%)
Tourist accomm. bathing	0	70	30
Tourist pay bathing	0	0	100
All other geothermal tourism sites	0	0	100

To estimate the value of geothermal tourism to the Waikato region it is necessary to assess how many of the tourists visiting geothermal attractions stay in the Waikato region

because of the presence of geothermal attractions.[1] Information from Tourism New Zealand on current and forecast levels of international and domestic tourism, patterns of spending and visits to geothermal attractions have been used. Multipliers have been calculated for the direct and flow-on impacts of tourism within the regional economy.

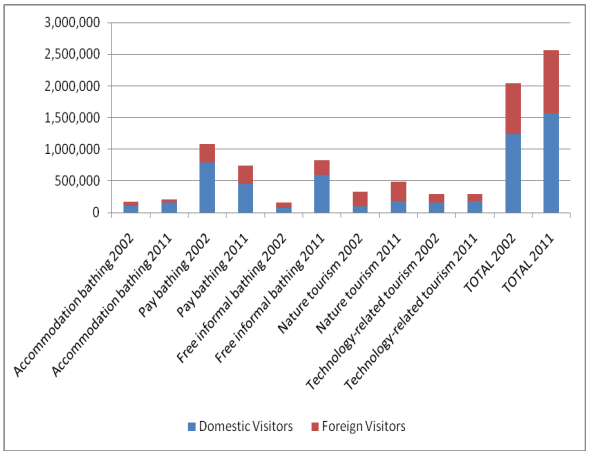


Figure 2: Visitor numbers to geothermal attractions

To estimate volcanic/geothermal tourism for the Waikato region (excluding other regions where geothermal attractions exist - such as the neighboring Bay of Plenty) it is assumed that 45-55 % of geothermal tourists (both domestic and international) visit attractions in the Waikato region. This equates to 732,000 to 896,000 visitors. These figures are a good fit with independently collected survey data (Table 3).

To complete the estimation of the value of geothermal tourism to the Waikato region, value added multipliers have been calculated. Output is the quantity of goods supplied multiplied by the price of each unit. Direct value-added is the output multiplied by the output to value-added ratio, so calculated to remove double-counting. The indirect effects are the impact from the tourism sector activity on other businesses (including those supplying goods and services to the sector). The induced effects are the flow-on effects from wages and salaries now available in the economy. The multiplication of the direct value-added effects with the Type I multiplier determines the direct and indirect effects. The multiplication of the direct value-added effects with the Type II multiplier determines the direct, indirect and induced effects.

The multipliers used here are based on 2006/07 regional input-output tables. It is assumed that the inter-industry relationships and relative price of goods have remained constant since that time.

[1] It is important to note that the following assessment of value to the region relies on the assumption that without the geothermal attractions, the time and money spent in the region for the purpose of visiting geothermal attractions would not be spent in the region. Where this assumption does not hold (i.e. visitors continue to visit the region, but visit other attractions instead of geothermal), the assessment will result in an overestimation of the tourism value of geothermal.

Based on the data and assumptions, geothermal tourism has a significant impact on the regional economy (Table 4), contributing directly $63.0m to $121.5m in the year to March 2010. Direct and indirect effects were $93.9m to $181.0. With the addition of induced effects, this contribution increased to $141.2m to $272.1m.

Tourism forecasts estimate that in 2016, New Zealand is forecast to host 3.1 million international tourists, and 56.1 million domestic tourist visits. Of the domestic visits, 36.7 million will be day trips, and 19.4 million will be overnight trips (Ministry of Economic Development, 2010a).

Assuming the same patterns as in 2010, 873,000 (28 %) international tourists in 2016 will visit volcanic/geothermal attractions. Of domestic travelers, 1.2 million visits will be to geothermal sites: 403,000 visits will be day trips and 758,000 will involve overnight trips. Daily spending for international, domestic day trips and domestic overnights is forecast to be $141, $94 and $115 respectively, with international tourists staying in New Zealand for 19 nights on average, and domestic overnight trips being three nights on average.

Using the forecast data, the 2010 assumptions regarding length of stay and the 2010 value-added multipliers (which assumes that the structure and linkages within the tourism sector remain the same over this period), in 2016 the direct contribution of geothermal tourism to the Waikato regional economy is estimated to be from $87.7m to $162.2m (Table 4). Adding indirect and induced effects lifts this contribution to $189.7m to $363.3m.

3.10 Geothermal tourism – employment survey results

All tourism sites where visitor numbers are counted, and all large-scale direct heat users were surveyed for employment numbers. Employment figures were not surveyed in the 2002 survey, so no comparison can be made.

The categories are: Tourist accommodation bathing (23 sites), Tourist pay bathing (9 sites), All other geothermal tourism sites, including pay nature tourism and technology-related tourism sites (5 sites). Wairakei Terraces and Netcor are not included as no data was available for these sites

Table 2: Employment by geothermal tourism

Employment by geothermal tourism	Total Staff	EFTS
Tourist accommodation bathing	407	242
Tourist pay bathing	182	124
All other geothermal tourism sites	80	46
TOTAL	**669**	**412**

The output (number of tourists multiplied by daily spend and number of days) of the Waikato regional tourism sector (Table 7) was used to estimate employment for the Waikato regional economy. The value-added multipliers for tourism employment are calculated to be 1.27 (Type I) and 1.66 (Type II), and the employment to output ratio is 11.5 marginal employment count (MEC) per $m (Market Economics Limited, July 2011a).

Direct employment within the Waikato region as a result of geothermal tourism is estimated at 1298 - 2501 MECs (Table 10). Adding the indirect and induced effects increases the MEC to 2154 – 4152 jobs.

These figures are considerably higher than the survey results (Table 2). This is expected because of the broader range of tourism-based businesses included in the multiplier analysis, such as accommodation and restaurants. For this reason, the multiplier analysis is a more accurate estimation of geothermal-related employment in the region.

Looking forward to 2016, (assuming the value-added employment multipliers and the employment to output ratio remain unchanged), geothermal tourism will contribute an estimated 1744 to 3339 directly to employment (MEC). Adding indirect and induced effects increases the range to 2895 – 5543 MECs (Table 5).

Table 3: Visitor numbers to geothermal attractions

Category	Domestic visitors (000)			International visitors (000)			Total visitors (000)		
	2002	2011	Δ%	2002	2011	Δ%	2002	2011	Δ%
Accommodation-related bathing	111.5	154.0	+38	63.8	58.0	-9	175.3	212.0	+21
Pay bathing	795.8	450.0	-43	287.2	290.0	+1	1,083.0	740.0	-32
Free informal bathing	79.2	592.7	+65	80.5	238.6	+196	159.7	831.3	+42
Nature tourism	99.7	186.4	+87	230.5	304.6	+32	330.2	491.0	+49
Technology-related tourism	160.0	183.0	+14	137.8	109.0	-21	297.8	292.0	-2
TOTALS	**1,246.2**	**1,566.1**	**+26**	**799.8**	**1,000.2**	**+25**	**2,046.0**	**2,566.3**	**25**

Table 4: Geothermal tourism contribution to the regional economy (based on 2009/10 data)

Year	Type of geo-thermal tourist	Geo-thermal tourists (000)	Avg. daily spend per person$	Days in the Waikato region (est.)	Multipliers (Waikato region)		Output to value-added ratio ($m/$m)	Contribution to the regional economy $m		
					Type I	Type II		Direct value added	Direct and indirect	Direct, indirect and induced
2009	Dom. (day)	286-350	$100	1	1.49	2.24	0.51	7.4 – 9.1	11.1 – 13.5	16.7 – 20.4
	Dom. (o/n)	161-197	$115	1-2				17.1 – 41.8	25.5 – 62.4	38.4 – 93.8
	Int'l	285-349	$133	2-3				38.5 – 70.5	57.3 – 105.1	86.2 – 157.9
	TOTALS							**63.0 – 121.5**	**93.9 – 181.0**	**141.2 – 272.1**
2016	Dom. (day)	247-423	$94	1	1.49	2.24	0.51	8.7 – 10.6	13.0 – 15.8	19.4 – 23.7
	Dom. (o/n)	184-225	$115	1-2				19.9 – 48.8	29.7 – 72.6	44.7 – 109.2
	Int'l	393-480	$141	2-3				56.1 – 102.8	83.6 – 153.2	125.6 – 230.4
	TOTALS							**84.7 – 162.2**	**126.2 – 241.7**	**189.7 – 363.3**

Table 5: Geothermal tourism contribution to regional employment

Year	Type of tourist	Geothermal tourism output $m	Multipliers Waikato region		Output to value-added ratio (MEC per $m)	Estimated contribution to employment regional employment (MEC)		
			Type I	Type II		Direct impacts	Direct and indirect	Direct, indirect and induced
2009	Dom. (day)	14.6 – 17.9	1.27	1.66	11.5	153 – 187	197 – 238	254 – 311
	Dom. (o/n)	33.7 – 82.4				353 – 862	448 – 1095	586 – 1432
	Int'l	75.7 – 138.7				792 – 1452	1006 – 1843	1314 – 2410
	TOTALS					**1298 – 2501**	**1648 – 3176**	**2154 – 4152**
2016	Dom. (day)	17.1 – 20.9	1.27	1.66	11.5	179 – 218	227 – 277	296 – 362
	Dom. (o/n)	39.2 – 95.9				411 – 1004	521 – 1275	682 – 1666
	Int'l	110.4 – 202.3				1155 – 2117	1467 – 2689	1917 – 3514
	TOTALS					**1744 – 3339**	**2215 – 4240**	**2895 – 5543**

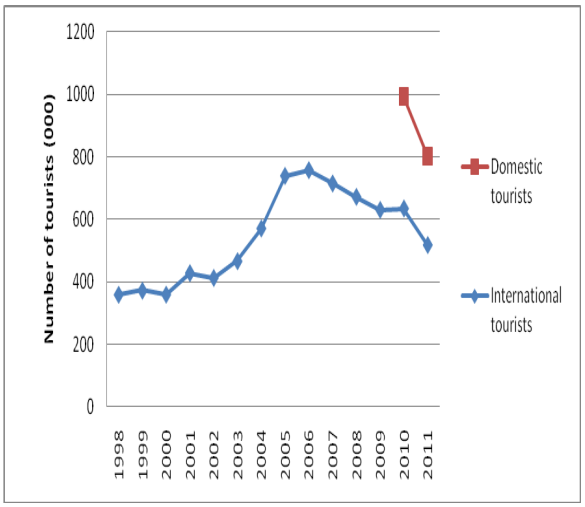


Figure 3: New Zealand geothermal tourism 1998 to 2010. Source: (Ministry of Economic Development, 2011a; 2011b)

3.11 The future of geothermal tourism

The number of international tourists visiting geothermal attractions in New Zealand increased sharply in the early to mid 2000s, and then steadily declined (Figure 3). From 2010 to 2011, the number of international tourists visiting geothermal attractions fell steeply, likely reflective of recessionary conditions in the world economy, and the high value of the New Zealand dollar. Domestic travel also fell steeply from 2010 to 2011, in line with economic conditions in New Zealand.

All of these outcomes are relevant for geothermal tourism, and given its attractiveness to international and domestic visitors, it has an important role in achieving the vision articulated in New Zealand's Tourism Strategy.

6 GEOTHERMAL ELECTRICITY GENERATION

6.1 Air discharges

In 2002, the life cycle emissions of key pollutant gases (CO2, SO2 and NOX) for electricity generation from renewable and non-renewable sources was explored based on data reported by International Energy Agency (IEA) in 1998. Life cycle analysis takes into account both the emissions associated with energy generation and also with construction of plant and manufacture and transport of machinery and components. This analysis revealed that pollutant gas emissions can be greater for renewable than for non-renewable electricity generation because the renewables generally harness energy sources that are more 'dispersed' or 'dilute', as opposed to the more 'concentrated' energy represented by coal or oil (Heath, 2002). While the information showed that geothermal energy provided benefits in terms of lower greenhouse gases relative to fossil fuel energy, when geothermal was compared with other renewable sources it did not fare so well, particularly with carbon dioxide and nitrous oxide emissions (Tables 6 and 7).

6.2 Value of geothermal generation in the Waikato region

Multiplier analysis has been used to calculate the contribution of geothermal generation to the regional economy. This method takes into account the backward linkages of electricity generation – that is, the value-added and employment generated within the electricity sector and in the industries that support the sector through supply of inputs. What is not included in the analysis is the contribution that generation of electricity from geothermal makes to the rest of the economy – the forward linkages (ie to dairying, manufacturing, retailing and other industries).

In 2009, Waikato geothermal generation was estimated at 3478 GW h, making up 76 % of national geothermal production (Ministry of Economic Development, 2010b). The estimated production from power stations added in 2010 increased production to 4747 GW h, with planned and consented plants increasing productive output to 8197 GW h (assuming average productive output is 90 % of installed capacity). Calculating the contribution of geothermal generation to the regional economy has been based on the electricity consumer price for 2009 of $48.15/MW h (Energy News, 2011). The value-added multipliers have been calculated as 2.69 and 2.73 for Type I and Type II for the Waikato region. The output to value-added ratio has been estimated at 0.34 (Market Economics Limited, July 2011b). Based on these figures, the direct contribution of the geothermal generation sector to GRP in 2009 was $56.9m. Adding the indirect and induced effects lifts the contribution to an estimated $155.4m. Inclusion of the power stations installed in 2010 lifts the regional estimates to $77.7m, $209.0m and $212.1m (based on 2009 figures), and with the implementation of currently consented stations, the value-added contribution of geothermal generation to the regional economy is estimated to be $134.2m, $361.0m and $366.3m (Table 8).

Table 6: Life cycle emissions (g/kW h) of key pollutant gases for selected fossil fuels and geothermal energy

Source: (Heath 2002; adapted from IEA, 1998).

	Energy crops	Hydro (small)	Hydro (large)	Solar (photo-voltaic)	Solar (thermal)	Wind	Geothermal
CO_2	17-27	9	3.6-11.6	98-167	26-38	7-9	79
SO_2	0.07-0.16	0.03	0.009-0.0024	0.20-0.34	0.13-0.27	0.02-0.09	0.02
NO_X	1.1-2.5	0.07	0.003-0.006	0.18-0.30	0.06-0.13	0.02-0.06	0.28

Table 7: Life cycle emissions (g/kWh) of key pollutant gases for renewable energy sources

Source: (Heath, 2002; adapted from IEA, 1998)

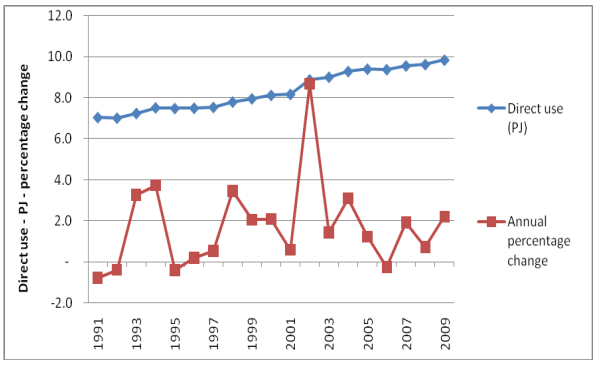
	Coal (best practice)	Coal (FGD and low NO_X)	Oil (best practice)	Gas (CCGT)	Geothermal
CO_2	995	987	818	430	79
SO_2	11.8	1.5	14.2	-	0.02
NO_X	4.3	2.9	4.0	0.5	0.28

6.4 Geothermal generation – employment

Nationally in 2009, 5,850 people were employed in the electricity sector, and of those, 880 (15 %) were in the Waikato region (Statistics New Zealand 2010b). Using the assumption that the national employment-output ratio for the electricity industry is applicable for Waikato geothermal, Type I and Type II multipliers for the Waikato region have been estimated at 8.48 and 8.84 (Market Economics Limited, July 2011b). Based on these multipliers, the MEC estimate for the Waikato region in 2009 is 80. Adding the indirect and induced effects lifts the estimate to 709 (Table 9). Inclusion of the 2010 commissioned plants increases the MEC to 109, 928 and 968, and with plants consented by not commissioned, the MEC increases to 189, 1603 and 1671 (Table 9).

7 DIRECT USE OF GEOTHERMAL ENERGY

Direct use of geothermal resources (by petajoule) has risen by 39 % over the past 20 years by (Figure 4).



Source: (Ministry of Economic Development, 2010b)

Figure 4: Direct use of geothermal energy (PJ) and annual percentage change (1991 – 2009)

New Zealand direct use by sector (2009) is recorded in Figure 5.

7.1 Direct use in the Waikato region

Geothermal resources in the Waikato region include those in the Hauraki and the Rotorua-Taupo areas. Direct use of geothermal resources across the Waikato region is shown in Figure 6. As with New Zealand data (not shown), wide differences between supply and use are obvious, with use an average of 41 % of supply. However, the variation between different uses is interesting: Space heating, water heating, greenhouse heating and bathing and swimming each hover around 50 % efficiency, whereas fish and animal farming use just 18 % of supply. This may have implications for future policy as demand increases relative to supply.

In addition to the above uses of direct geothermal, an estimated 520 domestic consumers in the region use 6.1m tonnes of geothermal water or 1724 TJ of geothermal energy per annum. This equates to 30 % of geothermal water used, and 17 % of geothermal energy. Domestic use is mostly covered by a Permitted Activity Rule, so a resource consent is not required.

7.2 Value to the Waikato region

The value of direct use of geothermal resources has not been assessed. It would be possible to estimate the value by separating out use categories, surveying users and developing multipliers. As commercial use increases this may to be useful for policy decision-making. It will be important to differentiate between commercial uses that exist because geothermal is available (eg prawn farming) and those uses where geothermal is an input with viable substitutes (eg irrigation and frost protection).

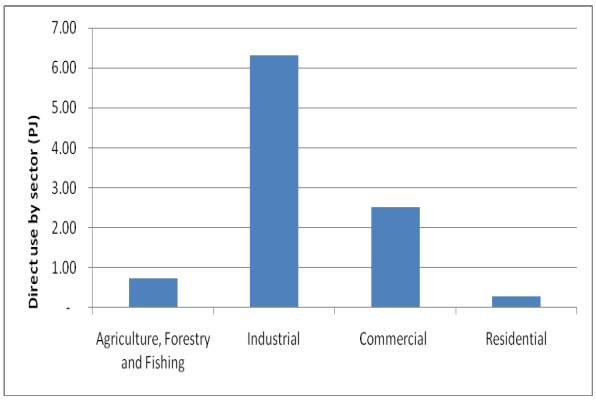
Direct users surveyed were asked how useful geothermal resources were to their operation (Table 10). The one glasshouse owner considered it to have no overall benefit. They cited problems with corrosive fluids leading to higher maintenance cost, and with having to buy carbon dioxide for the glasshouse atmosphere, whereas if they were obtaining heat from the burning of natural gas, this would provide sufficient carbon dioxide for free.

Table 8: Geothermal generation contribution to the regional economy (based on 2009 prices and production)

	Energy supplied MWh (000)	Price per MWh 2009 $	Value-Added Multipliers		Output to value-added ratio ($m/$m)	Contribution to Waikato economy ($m)		
			Type I	Type II		Direct value-added	Direct and indirect	Direct, indirect and induced
2009 (est.)	3,478	48.15	2.69	2.73	0.34	56.9	153.2	155.4
With 2010 plants included	4,747					77.7	209.0	212.1
With additional consented plants	8,197					134.2	361.0	366.3

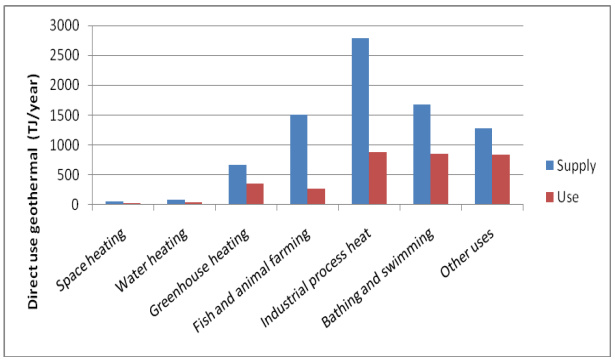
Table 9: Geothermal generation contribution to regional employment

Year / generating plants	Geothermal generation output $m	Employment Multipliers Waikato region		Output to value-added ratio (MEC/$m)	Estimated contribution to regional employment (MEC)		
		Type I	Type II		Direct impacts	Direct and indirect	Direct, indirect and induced
2009	167.5	8.48	8.84	0.57	80	680	709
With 2010 plants included	228.6				109	928	968
With additional consented plants	394.7				189	1603	1671



Source: (Ministry of Economic Development 2010b).

Figure 5: Geothermal direct use by sector 2009 (NZ) (PJ)



Source: (White, 2009).

Figure 6: Assessed primary energy supply and direct use for geothermal for the Waikato region (TJ/year)

The process heat and commercial space heating users found the resource somewhat useful.

Table 10: Usefulness of geothermal water and energy

Direct Users	Not useful (%)	Useful (%)	Essential (%)
Glass houses	100	0	0
Primary and industrial processes	0	100	0
Commercial heating	0	100	0

7.3 Direct use – employment

In the Waikato Region geothermal direct use includes space and water heating, tourism, primary production and industrial uses. The tourism employment numbers are dealt with elsewhere in this report so are not counted here. Because the geothermal source of space heating and non-tourism bathing are not key drivers of employment they are not accounted for here.

There are four glasshouse complexes in the region that use geothermal heating, and three primary and industrial sites processing wood products and honey using geothermal resources. The Prawn Park is included in the tourism figures so is not counted here.

The employment count (EC) is reported to be 184 for glasshouse and 366 respectively (Table 11). Employment figures were not surveyed in the 2002 survey, so no comparison can be made.

Table 11: Employment by geothermal direct use

Employment by geothermal direct use	Total staff	EFTS
Glass houses	184	166
Primary and industrial processes	366	366
TOTAL	**450**	**532**

Multipliers for employment in these sectors have not been developed, given the current levels and diversity of resource use. It may be beneficial to do this in the future to provide additional information to policy makers.

8 ALLOCATION OF GEOTHERMAL WATER AND ENERGY

All known direct uses of geothermal water and energy in the Waikato Region are assessed in this section. This has not been reported before in detail so no comparison is made with previous years.

Where a site has a resource consent to take geothermal water, the consented amount of water is used in the calculation. For small takes, where there is no resource consent, the maximum allowable take under Permitted Activity Rules. In most cases this is 30 tonnes per day for takes of water. Most sites will not take the full allocated amount, and therefore our results will be higher than those by other agencies that assess actual use. However, for resource management purposes it is important to assess the allocated amount so that over-allocation does not occur.

Some larger takes obtain water from Contact Energy and therefore do not have their own consents. In these cases most of the figures are taken from White (2009).

This report continues the practice followed by White (2009) of assessing all heat takes relative to 0 °C, as is the convention with other fuels.

Table 12: Allocation of geothermal water and energy

Direct Users	Geothermal water allocated p.a. (Tonnes)	Geothermal energy allocated (TJ)
Tourist accommodation bathing	834,000	271
Tourist pay bathing	3,592,000	1231
All other geothermal tourism sites	5,581,900	2800
Tourism subtotal	**10,007,900**	**4302**
Glass houses	55,780	1014
Primary and industrial processes	2,606,750	2800
Irrigation and frost protection	584,000	86
Commercial heating	1,252,000	320
Domestic heating	6,132,000	1724
Direct use subtotal	**10,630,530**	**5944**
TOTAL	**20,638,430**	**10,246**

11 CONCLUSION

Geothermal resources are important to the people of the Waikato region. They contribute to economic, social, cultural and environmental wellbeing through a broad range

of values. Demand for the resource is growing and supply is limited.

In 2009/10, geothermal generation and geothermal tourism each contributed to the regional economy both in terms of GRP and employment. The direct effects from these two uses are in terms of contribution to GRP and on a par, with generation contributing an estimated $56m, and tourism contributing within a range of 38.5 – 70.5m. The differences are more pronounced when indirect effects are taken into account. From tourism, these impacts are relatively modest, increasing the contribution by 50 %. For generation, the increase is 173 % – indicating greater flow-on effects in the sectors directly connected to generation than those connected to tourism.

With employment, the differences between the two sectors in terms of direct effects are large – the MEC for tourism is 1298 – 2501, where for generation the MEC is just 80. Part-time work in the tourism sector may explain some of this difference. The difference lessens when indirect and induced effects are considered. The survey of tourism employment revealed considerably lower numbers than those estimated through the multiplier analysis – this is likely because of the wider range of tourism services included in the multiplier analysis.

While the operation of geothermal plants produces low levels of greenhouse gas emissions, the lifecycle emissions are high relative to other renewable energy sources. Counting emissions only in terms of production ignores critical information required for sound decisions regarding future generation.

While geothermal generation and tourism are not mutually exclusive, generation use has the capacity to impact on the value of the tourism, and spatial increases in tourism may affect generation development. Both uses produce negative externalities that can affect the wider values held by the community at local, national and international levels.

The small but growing direct use by industrial and domestic users also contributes to the regional economy. Direct uses of geothermal water and energy are a small but important economic factor for the Waikato Region in terms of employment and a low-carbon energy source. While the value of these uses has not been assessed, the survey found that 544 people were employed through direct use. Monitoring direct uses will enable analysis of trends which could provide useful information to policy makers.

Twenty million tonnes of geothermal water and ten thousand terajoules of geothermal energy are used in geothermal tourism, primary production, industry, and space heating.

The challenge for policy makers is in determining what combination of uses will achieve the highest level of net benefits, while avoiding irreversible effects that will impact negatively on the short- and long-term wellbeing of communities.

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