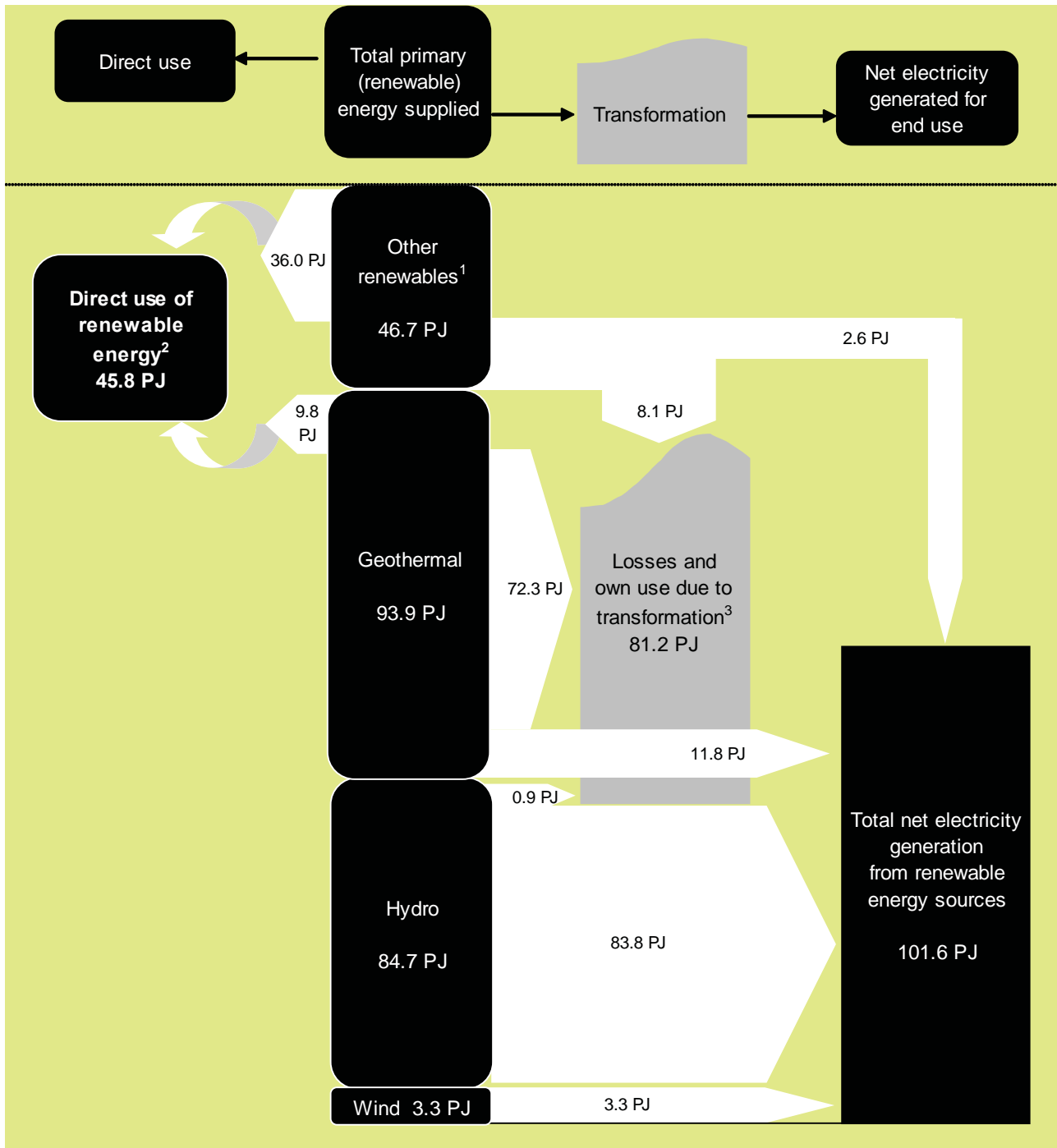


F. Renewables

Figure F.1a: Renewable Energy Flows for 2007

Petajoules (to approximate vertical scale)



Note:

- ¹ "Other renewables" includes solar, biogas and landfill gas.
- ² Direct use of renewables energy covers mainly heat and biofuel for commercial and industrial applications.
- ³ Energy efficiency for geothermal is assumed to be 15%, for biogas 30% and for wood 25%. Generation from wind is assumed to be 100% efficient.

F.1 Primary Renewable Energy¹

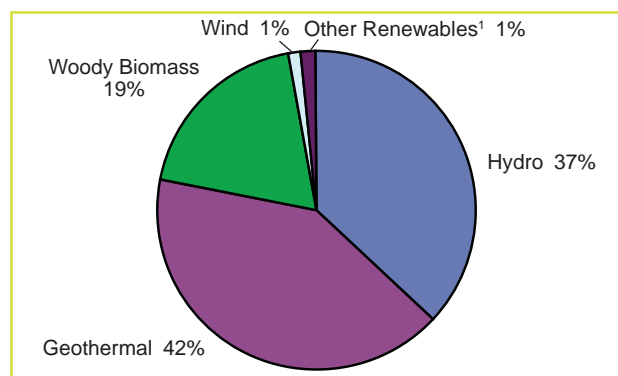
Renewable energy plays a significant role in New Zealand's primary energy supply. Approximately 30% of New Zealand's total primary energy supply comes from renewable sources. The latest international comparisons show New Zealand has the third highest percentage of renewable primary energy supply of all OECD² countries, behind only Norway and Iceland³.

New Zealand's historically high level of renewable primary energy is largely due to plentiful hydro and geothermal resources. In recent times, there has also been considerable interest in and uptake of the use of biofuels, wind and solar resources. Most of New Zealand's renewable primary energy is used for electricity generation.

Figure F.1b presents the breakdown of renewable primary energy supply for the 2007 calendar year. This covers renewables used for electricity generation (including geothermal and bioenergy cogeneration) and also direct use of renewable energy.

Wind has been included in the breakdown for the first time in this edition of the *Energy Data File* as it is becoming an increasingly significant source of renewable primary energy.

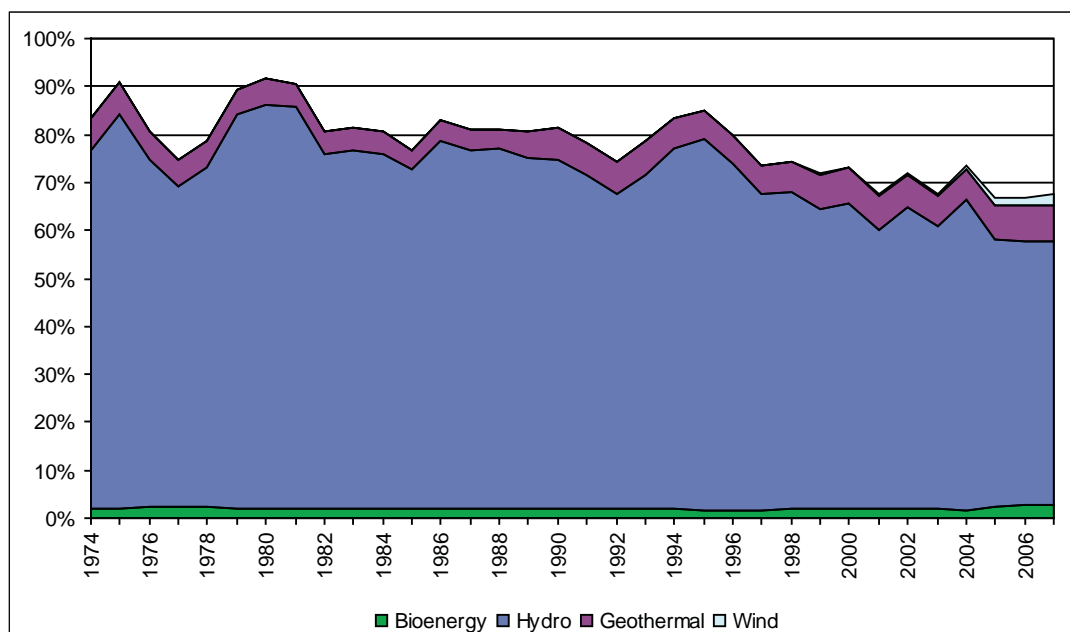
Figure F.1b: Renewable Primary Energy for 2007



Note:

¹ "Other Renewables" includes solar, biogas and landfill gas.

Figure F.2a: Percentage of New Zealand Electricity Generation from Renewable Sources



¹ Since the *New Zealand Energy Data File September 2006*, industrial waste heat has been excluded from this chapter to better align reporting of renewables with international convention. Industrial waste, which prior to 2006 was categorised under Biomass & Wastes in Table F.3, is now classified under the primary energy source from where the industrial waste heat was derived. The Energy Balances and Electricity chapters also reflect this change.

² Organisation for Economic Cooperation and Development.

³ Source: IEA *Renewables Information 2007*.

F.2 Renewable Electricity Generation

Around 67% of New Zealand's total electricity generation in 2007 was from renewable sources. Figure F.2a shows electricity generation from renewable sources over time. In 2007 total renewable generation increased from 66% in 2006 to 67%, which is in part due to a 50% increase in wind generation.

Table F.2 shows generation by renewable energy source and the percentage change from 2006 to 2007. Further information on electricity generation can be found in the electricity chapter.

Renewable electricity generation capacity at the end of 2007 was 6,253 MW out of a total 9,133 MW (including cogeneration). This equates to 68% of New Zealand's generation capacity and is up from 6,058 MW in 2006. Figure F.2b shows that most of the increase in renewable capacity can be attributed to the near doubling of wind capacity in 2007.

The transformation of geothermal energy into electricity is much less efficient than that of hydro and wind energy. The net efficiency of geothermal is around 15%, compared with the 100% assumed for hydro and wind. Biogas and wood also have low net efficiencies of approximately 30% and 25% respectively⁴.

Table F.2: Net Renewable Electricity Generation by Calendar Year (GWh)

	2005	2006 ^R	2007 ^P	Δ2006/2007
Hydro	23,099	23,124	23,283	0.7%
Geothermal	3,007	3,200	3,272	2.2%
Wind	609	617	928	50.4%
Biogas	165	199	198	-0.6%
Wood	484	502	528	5.3%
Total	27,365	27,642	28,209	2.1%

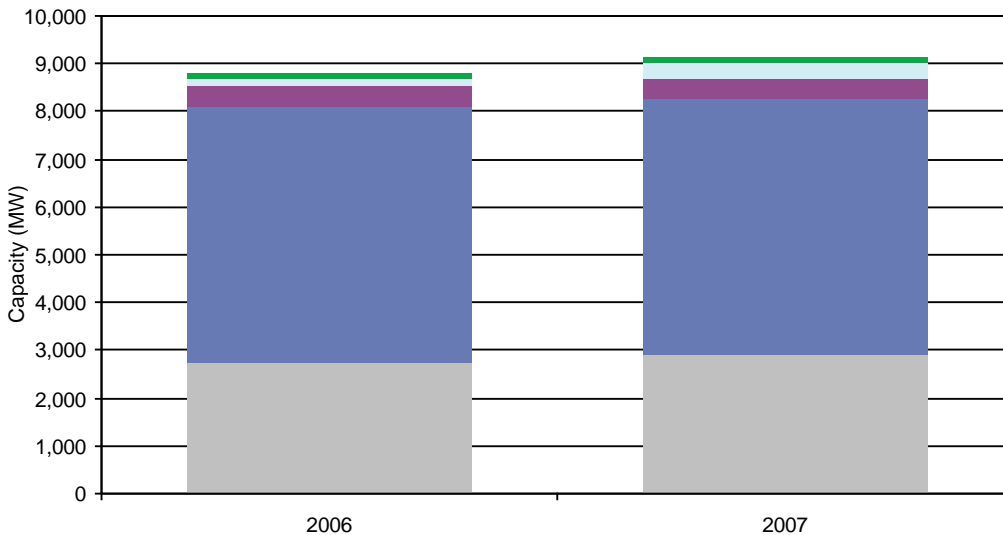
Notes:
^R = Revised.
^P = Provisional.

Hydro generation

Electricity from hydro generation has been a part of New Zealand's energy system for over 100 years and continues to provide the majority of our electricity needs. Early schemes such as the Waipori scheme commissioned in 1903 and the Coleridge plant commissioned in 1914 established New Zealand's use of renewable hydro energy.

By the early 1950s over 1,000 MW of installed capacity was from hydro energy. In 1965 the high voltage direct current transmission line between Benmore in the South Island and Haywards in the North Island

Figure F.2b: Electricity Generation Capacity by Fuel Type



	2006	2007
Non Renewable	31.3%	31.5%
Hydro	60.7%	58.8%
Geothermal	4.9%	4.9%
Wind	1.9%	3.5%
Biogas and Biomass	1.2%	1.3%

⁴ Actual plant efficiencies can vary, these are best estimates.



was commissioned. From this point onwards hydro capacity in the South Island increased rapidly with developments including the 540 MW Benmore power station in 1966, the 700 MW⁵ Manapouri power station in 1971 and the 432 MW Clyde dam which was commissioned in 1992. By the mid 1990s hydro capacity had reached over 5,000 MW, and remains around this level today.

Most new hydro developments currently under consideration are less than 100 MW. Meridian Energy is currently considering the North Bank Tunnel Project on the Waitaki River in South Canterbury, which would have a capacity of around 200 MW. Other smaller proposals are TrustPower's 72 MW Wairau scheme in Marlborough and Meridian Energy's 65-85 MW Mokihinui station on the West Coast of the South Island. Contact Energy is also considering more large scale hydro on the Clutha River.

Wind generation

Wind generation is playing an increasing role in New Zealand. The first grid connected, large scale, wind turbine with a capacity of 225 kW was opened in Wellington in 1993. By mid-2008 New Zealand had a total capacity of over 320 MW, of which 151 MW came online during 2007.

The first wind farm in New Zealand, Hau Nui, was commissioned in 1997. Today it has a total capacity of 8.65 MW and is owned by Genesis Energy.

Today the largest wind farm in New Zealand is TrustPower's Tararua wind farm. Stage 3 of the project was commissioned with the addition of 31 wind turbines each rated at 3 MW, which has brought the combined capacity of the Tararua wind farm to 161 MW.

Meridian's Te Apiti wind farm began supplying electricity to the grid in August 2004, with a total generating capacity of 91 MW.

In March 2005, Energy3 commissioned a 100 kW pilot project in Southbridge, Canterbury.

The first stage of Te Rere Hau wind farm was commissioned in September 2006. The Te Rere Hau wind farm is the first wind farm in New Zealand to be built using New Zealand designed and manufactured turbines developed by WindFlow Technology. It currently comprises five turbines with a total generating

capacity of 2.5 MW, which is expected to increase to 30 MW by the end of 2009.

In June 2007 Meridian Energy opened the first South Island wind farm with a total capacity of 58 MW. Meridian Energy hopes to have its 143 MW West Wind project, near Wellington completed by the end of 2009.

In 2007 Vector began trials of micro wind turbines developed by Swift Turbines Limited, each with a rated capacity of 1.5 kW, in urban sites around Auckland and Wellington.

Geothermal generation

Geothermal generation has for a long time been an integral part of New Zealand's electricity landscape, and continues to play a significant role in 2007 with a net increase of around 16 MW.

New Zealand's first geothermal power station, Wairakei, was opened in 1958 with a capacity of 162 MW. In 2005 a binary plant was added at the Wairakei site which increased the total site capacity to over 176 MW. Today Wairakei is owned by Contact Energy and remains New Zealand's largest geothermal power station. Wairakei is due to be replaced by the planned Te Mihi plant, with stage 1 to be completed around 2011. This will increase total site capacity to around 230 MW with the original Wairakei plant still producing around 75 MW. By 2016 Wairakei will be completely replaced by the new Te Mihi plant with the site capacity remaining at around 230 MW.

Ohaaki, with an installed capacity of 104 MW, was built in 1989 and is now owned by Contact Energy. Due to geothermal steam limitations, the field's capacity has been progressively derated from 104 MW to around 50 MW.

In 1997 the Poihipi and Rotokawa geothermal power stations were commissioned, adding 55 MW and 35 MW respectively. Poihipi is owned by Contact Energy and Rotokawa is owned by Mighty River Power in a joint venture with the Tauhara No. 2 Trust⁶.

Ngawha was commissioned in 1998 with a capacity of 10 MW which is currently being increased to over 25MW by its owner, Top Energy⁷. Ngawha will be the largest generation plant in New Zealand owned by a distribution company⁸.

⁵ Manapouri has never operated at full capacity due to tail race consent and safety limits. Although Manapouri's 1971 maximum rated capacity was 700 MW its dependable capacity was 585 MW. Between 2002 and 2008 its rated capacity was increased to around 850 MW however it can only operate safely at less than 730 MW.

⁶ Mighty River Power owns 100% of the Generation plant and 50% of the Steam field, with the other 50% of the steam field owned by the Tauhara No.2 Trust.

⁷ Top Energy Limited is owned by a power consumer trust the Top Energy Consumer Trust, on behalf of the electricity consumers of the north-land area serviced by Top Energy.

⁸ An exemption under the Electricity Industry Reform Act 1998 was granted to Top Energy as under the act electricity distribution businesses must be separate from generation and retail. See the Commerce Commission for further information.

In 2000 the Tuaropaki Power Company commissioned the Mokai geothermal field with a capacity of 55 MW. This was increased in 2005 to 94 MW and again in 2007 to bring the total capacity to around 112 MW.

There are several other geothermal projects currently being planned, built or upgraded as of mid-2008. These include the Poihipi Road (25 MW) and Centennial Drive (20 MW) developments, which are due to be commissioned in the next two years, and the 80 MW Nga Tamariki and 132 MW Nga Awa Puroa (Rotokawa 2) geothermal plants.

Biomass, landfill and sewage gas

The main use of biomass (mainly black liquor and wood residues from the timber, pulp and paper industries) in New Zealand involves combusting wood residues to provide process heat in the wood processing industry and for residential space heating.

Landfill gas from sites in Auckland and Wellington has been successfully used for electricity generation for some time. More recently, sites in and around Rotorua, Hamilton, Christchurch and Palmerston North have been commissioned, bringing the combined landfill gas generation capacity to well over 20 MW nationwide. A government standard to control landfill gas is now in operation, which requires all operative landfills with total capacity of over 1 million tonnes of refuse to collect the landfill gas.

Biogas (mainly methane) from sewage treatment plants, farm wastes and the food processing industry has been used on-site for decades to produce electricity and heat for local consumption or for vehicle fuel. Electricity and heat for the digestion of sewage waste is currently produced in Auckland, Hamilton, Christchurch and Invercargill. Biogas from animal waste and green crop can be used as a feedstock, and there are several successful biogas plants operating on farms.

Solar

Solar energy in New Zealand is used mainly for hot water systems and passive solar heating in buildings using architectural features to collect, store and distribute heat. The solar water heating industry has continued to grow in recent years with establishment of a network of accredited suppliers and a quality assurance programme to ensure new entrants are properly trained to install appropriate systems.

Solar Photovoltaic technology is widely used in New Zealand to recharge batteries for power supply systems at remote sites, for example: in parks and reserves, by harbour companies for light beacons, by telecommunication companies for site monitoring and by farmers for remote electric fences.

Marine Energy

Marine energy has been identified as a promising source of electricity generation. In May 2008, the government announced a \$1.85 million grant to Crest Energy for a project to generate electricity from the tides in Kaipara Harbour. Neptune Energy has been granted resource consent for the installation of a 1 MW marine turbine off Wellington's south coast.

F.3 Renewable Energy Supply and Consumption

Some geothermal, wood and biogas energy is used directly for heating and as biofuel for commercial and industrial applications.

Total renewable consumer energy, excluding electricity generation, was 46 PJ in 2007, up from 45 PJ consumed in 2006.

Table F.3 details renewable consumption and energy transformation as a component of total primary energy supply.

Table F.3: Renewable Energy¹ Supply and Consumption (PJ)

Calendar Year	1985	1990	1995	2000	2001	2002	2003	2004	2005	2006R	2007P
Total Primary Energy Supply	178.48	208.67	225.94	240.71	231.00	212.96	205.22	221.56	220.44	220.65	228.59
Hydro	70.24	82.63	98.13	88.67	81.41	90.79	85.28	97.92	83.99	84.08	84.66
Geothermal ²	78.93	92.65	93.30	114.25	111.40	81.49	78.77	79.85	89.07	88.78	93.86
Solar ³	-	-	-	-	-	0.17	0.18	0.21	0.24	0.27	0.30
Wind	-	-	0.00	0.43	0.50	0.56	0.53	1.31	2.22	2.24	3.37
Biogas and landfill gas	1.30	1.62	2.13	1.47	1.48	1.73	1.87	1.57	2.34	2.82	2.83
Woody biomass and animal products ⁴	28.02	31.77	32.37	35.88	36.21	38.22	38.58	40.70	42.58	42.45	43.57
Energy Transformation (including losses)	143.97	170.32	184.82	202.11	190.63	171.02	162.42	177.21	175.18	175.67	182.80
Hydro	70.24	82.63	98.13	88.67	81.41	90.79	85.28	97.92	83.99	84.08	84.66
Geothermal ²	67.63	81.27	79.77	104.80	101.86	71.78	69.19	70.31	79.40	79.06	84.08
Wind	-	-	0.00	0.43	0.50	0.56	0.53	1.31	2.22	2.24	3.37
Biogas and landfill gas	1.26	1.57	2.07	1.32	1.30	1.54	1.69	1.46	2.12	2.56	2.55
Woody biomass and animal products ⁴	4.84	4.84	4.84	6.88	5.56	6.35	5.73	6.21	7.46	7.73	8.14
Direct Use (Consumer Energy)	34.51	38.35	41.12	38.60	40.36	41.95	42.80	44.35	45.26	44.98	45.80
Geothermal ⁵	11.30	11.38	13.53	9.45	9.54	9.72	9.58	9.54	9.67	9.73	9.78
Solar ³	-	-	-	-	-	0.17	0.18	0.21	0.24	0.27	0.30
Biogas and landfill gas	0.04	0.05	0.06	0.15	0.18	0.19	0.18	0.11	0.22	0.26	0.28
Woody biomass and animal products ^{4,6}	23.18	26.93	27.52	29.00	30.64	31.87	32.86	34.49	35.13	34.72	35.43

Notes:

- Sources of data include the Ministry of Economic Development's electricity annual questionnaires (MED-E) and Statistics New Zealand.
- Efficiency of geothermal plants for electricity generation had been assumed to be 10% prior to 2000. From 2000, it is assumed to be 15%.
- Solar values have been revised slightly due to improved data in this EDF. This is estimated from solar water heating sales.
- In previous editions of the *Energy Data File* the figure for residential firewood use was based on an average use of 4.3 GJ per household. BRANZ recently released their findings (Report No. SR 141 (2005)) on the "Household Energy End-use Project" (HEEP), which monitored energy end use in the home including firewood use. For firewood, their studies found that the average annual use was 13.7 GJ per household and we have adopted this figure in our calculations from 2004 onwards.
- Revised figures from 2000 based on report: "An Assessment of Geothermal Direct Heat Use in New Zealand" prepared by Brian White, Executive Officer of the New Zealand Geothermal Association.
- An estimated 0.6 PJ of woody biomass comes from wood pellets. From "Assessment of Possible Renewable Energy Targets – Direct Use: Woody Biomass", by East Harbour Management Services and SCION (data from 2005).

R = Revised.
P = Provisional.