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Asset value of water and other renewables for electricity generation: 2007–15

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Contents

List of tables and figures

List of tables

List of figures

Purpose and key findings

This environmental account presents the estimated asset values of water and other renewable resources in New Zealand that are used to generate electricity. An asset value is the market price of an asset if it was sold. A renewable resource, or renewable, is a resource that after being used, can return to previous stock levels by natural processes of growth.

Water is an important source of energy that contributes to New Zealand's energy supply and economy. It is the main renewable resource in New Zealand and generates income for hydroelectricity operators.

In New Zealand, the entire electricity and gas supply industry accounted for $6 billion, or 2.5 percent, of gross domestic product (GDP) in 2015. In 2015, 6,710 filled jobs were in the electricity supply industry – 2,350 in electricity generation and transmission, and 4,360 in electricity distribution and on-selling and electricity market operation. Thirty-eight hydro-generation plants in New Zealand had an operating capacity of 10 megawatts or greater. Of these, 19 were in the North Island, seven of which were in the Waikato region. In the South Island, generating plants were concentrated in the Canterbury, Otago, and Southland regions.

New Zealand is making more use of its natural resources for generating electricity. This use is called 'renewable electricity generation' or electricity generation that uses water, geothermal (steam), wind, sun, wood, or biogas. This report provides estimates of the asset values of all renewable resources used for electricity generation.

About environmental accounting

Environmental accounting is the measurement of environmental assets in monetary terms. It focuses on the value of an environmental resource and the changes in that value over time. One aim of environmental-asset accounting is to assess whether patterns of economic activity are depleting or degrading our resources.

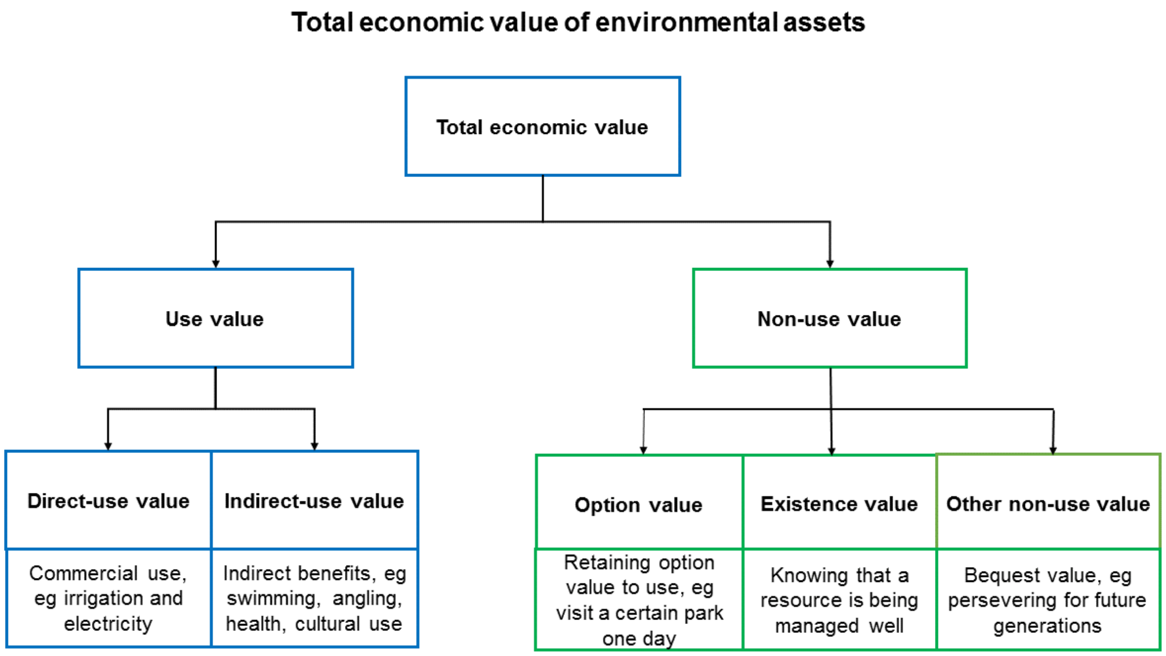
Information from an environmental-asset account can be used to manage the resource. The valuation of a natural resource, such as water, can be combined with valuations of other physical or financial assets (eg machinery or equity and investment fund shares) to provide estimates of national wealth.

Use and non-use values

Where available, an asset value can be combined with those for alternative uses of a resource to indicate whether the resource is being used efficiently. Figure 1 shows how the total economic value of an environmental asset consists of its use and non-use values. Resource rents (revenue generated from a resource less all costs incurred in its extraction) and asset values measure the direct-use value of environmental assets. Direct-use values are easy to measure because market values are available. Non-use values are harder to measure.

A natural resource may retain an option value for future production, even if its current use value is close to zero (eg coal could have a future value as cost-effective carbon-capture technologies are being developed).

Figure 1



Source: Kaye-Blake et al, 2014

Economic benefits compared with environmental impacts

The economic benefits of hydroelectricity can be compared with its environmental impacts to highlight what is being traded off in return. Where available, the asset value of water can be combined with information on river flow to fully understand whether the economic benefits outweigh the effects on the environment. Changes in the value of water may also be affected by climate change. While the economic benefits of using water can be viewed in the national context, environmental and cultural impacts are more evident by region.

Evaluating trade-offs for developing renewable energy resources

Developing renewable energy resources often involves trading off one aspect (or opportunity) for another. For example, hydroelectricity generation does not directly result in carbon dioxide emissions; it is also a means of transitioning towards a low-carbon economy. On the other hand, damming river systems can result in the loss of wildlife habitat and natural character, which compromises ecological function and amenity values (Parliamentary Commissioner for the Environment, 2012).

Similar trade-offs also apply when other renewable energy resources are developed. For example, a common barrier to wind farms is the perception that turbines are incompatible with the amenity and landscape values of the surrounding area (Parliamentary Commissioner for the Environment, 2006). When considering trade-offs, decisions must balance the values from undeveloped rivers and landscapes against the benefits provided by renewable energy.

Key findings

In the year ended March 2015:

- The asset value of all renewables used to generate electricity was $13.8 billion.
- The asset value of water resources used to generate hydroelectricity was $9.8 billion.
- Returns to electricity operators from the use of all renewables (resource rent) was $829 million.
- Returns to hydroelectricity operators from the use of water (resource rent) was $586 million.
- Hydroelectric generation accounted for 56 percent of New Zealand's electricity generation (23,728 of 42,362 gigawatt hours).
- Electricity generated from renewables accounted for 79 percent of total electricity generation.
- After hydroelectricity, the second-largest source of renewable electricity generation was geothermal, at 17 percent of total net generation (7,091 of 42,362 gigawatt hours).

From 2007 to 2015 (March years):

- The proportion of resource rent generated from renewables compared to total resource rent increased steadily from 68 percent in 2007 to 79 percent in 2015.
- This increase was mainly due to geothermal, which increased from 3,210 gigawatt hours to 7,091 gigawatt hours (8 percent to 17 percent of net generation) over the period.
- The resource rent from geothermal increased from $76 million in 2007 to $175 million in 2015 – a growth rate of 11 percent a year.
- The resource rent from wind was $14 million in 2007, up to $53 million (6.4 percent of resource rent from renewables) in 2015. Previous estimates in the *Energy monetary stock account 1987–2001* did not include wind-generated electricity as it was then considered insignificant.
- Total net generation remained reasonably steady, at an average of 42,487 gigawatt hours a year, increasing only 1 percent over the period.

About this report

For this report we used the concepts, methods, and definitions from the *System of Environmental-Economic Accounting 2012 – Central Framework* (SEEA Central Framework) (United Nations, 2014). SEEA is the internationally accepted approach for measuring the stocks and flows of environmental assets in physical and monetary terms, using principles consistent with the System of National Accounts (the basis for measuring economic statistics). All data in this report was checked for confidentiality.

Measuring asset value

The monetary asset value is calculated by discounting the resource rent of the environmental asset using the net present value (NPV) approach. Resource rents reflect the surplus value accruing to the user of an environmental asset calculated after all costs and normal returns are taken into account (United Nations, 2014, p152). It is the current market value after accounting for both supply and demand factors and, therefore, reflects the immediate impacts of resource use on the economy. The asset value represents the discounted future income stream from natural resources used for electricity generation, and therefore the benefits to accrue to future, as well as current, generations. The estimate is not a measure, for example, of the value of the stock of water in dams at that particular point in time. In fact, a hydro dam may be dry at the time of the balance date used, but is still valued on the basis of the expected future availability of water.

An asset account records the opening and closing stocks of, and stock changes in, an environmental asset, and can be presented in physical or monetary terms. This account is based on March years for consistency with the national accounts, and is measured in monetary units. All values are in current prices.

Results in the energy monetary stock account are best analysed with physical stock, and the monetary and physical flow accounts. An energy asset valuation can be compared with an energy physical stock account that shows the quantity of energy contained in an economic reserve, and the potential resources that might be used in the future. We aim to compile energy physical stock and flow accounts in the future.

See our environment page for more information on Stats NZ's wider environmental statistics framework.

Electricity generation in New Zealand

In New Zealand, electricity is generated by five major companies. Three operate under a mixed-ownership model in which the government holds a majority stake; two are private-sector companies. The five companies account for 94 percent of electricity generation, with the remaining 6 percent made up of smaller companies (Ministry of Business, Innovation and Employment (MBIE), 2015). (See Electricity generation for more information about electricity generation in New Zealand.)

We used national accounts benchmarks for electricity generators (units engaged in on-selling electricity and electricity market operation are excluded) to calculate the monetary estimates in this report. The primary source for the benchmarks is the Annual Enterprise Survey (AES). AES fully covers the electricity industry, meaning all economically significant units in this industry are included.

We calculated the resource rent from electricity generation using renewable resources by applying the proportion of total net generation (in gigawatt hours) from MBIE to the national accounts data.

More than 200 generation plants supply electricity to the national grid. Some smaller-scale generation is 'embedded' and feeds directly into local distribution networks (MBIE, 2016). MBIE production data covers units supplying both the national grid and local networks. The Electricity Authority maintains a list of generating plants and those producing electricity from renewable sources are mapped in figure 2.

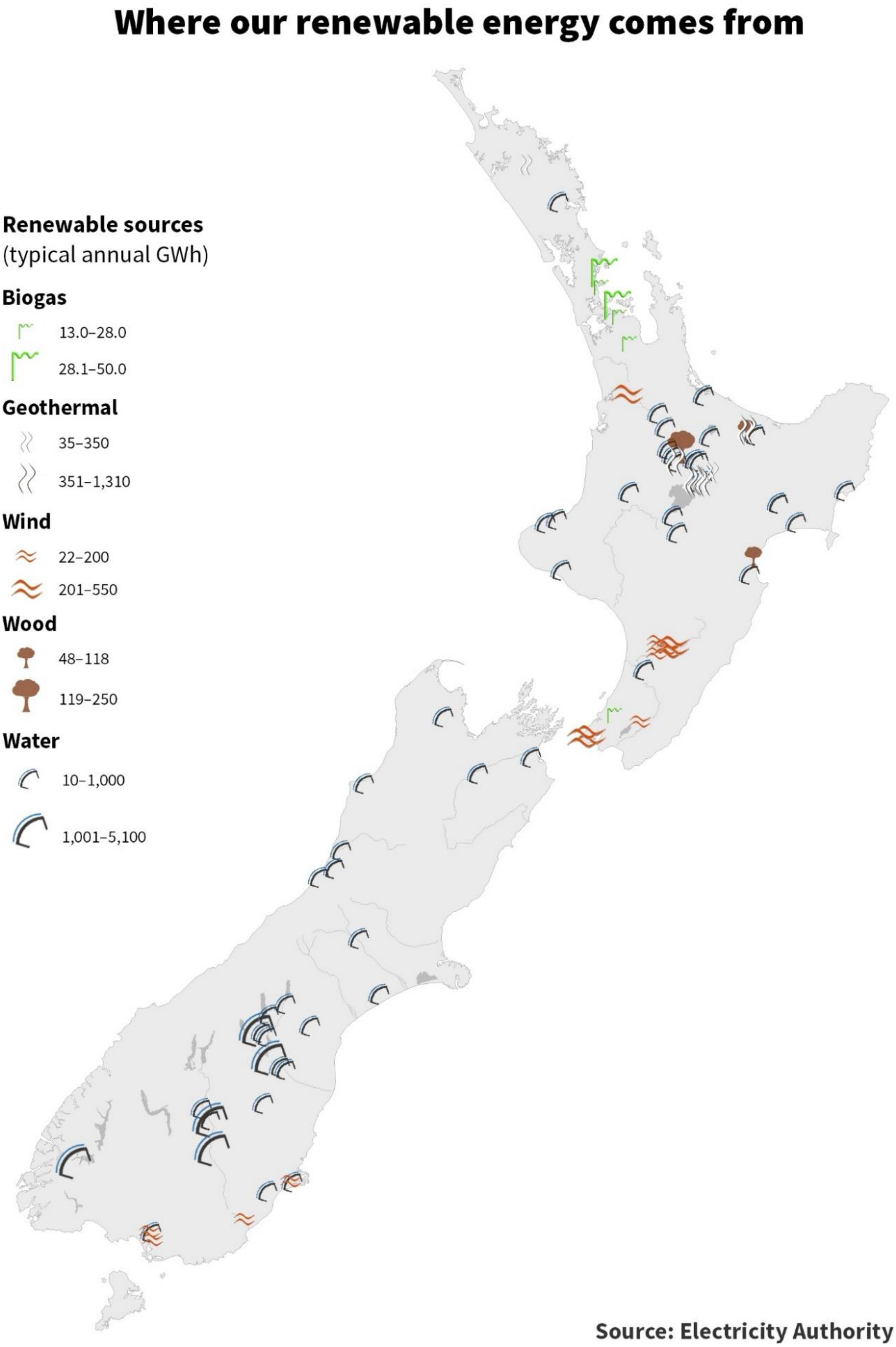
Future improvements

Energy physical stock and flow accounts can be analysed alongside energy asset valuations to show the quantity of energy in economic reserves, and how potential resources might be used in the future. Physical stock and flow accounts are an area for future development.

Estimates for the asset value of non-renewable forms of electricity generation (oil, coal, and gas) are not presented in this report. This is because we lack information on the lifespan of these assets, which we require to calculate their values. Estimates of the resource rent from non-renewables, however, are included.

This report used the Australian and New Zealand Standard Industrial Classification 2006 (ANZSIC06) to classify industries. *Energy Monetary Stock Account: 1987–2001* used the 1996 version. Due to this updated classification, low-level ANZSIC-class information from AES is available only from 2007. Depending on user need and feedback, we may be able to backcast the current ANZSIC06 estimates if sufficient demand is identified.

Figure 2



Note: Locations given are for generating stations' network supply points. Only generating stations with typical annual gigawatt hours (GWh) greater than 10 were used.

Results

Value of renewable energy assets was $13.8 billion in 2015

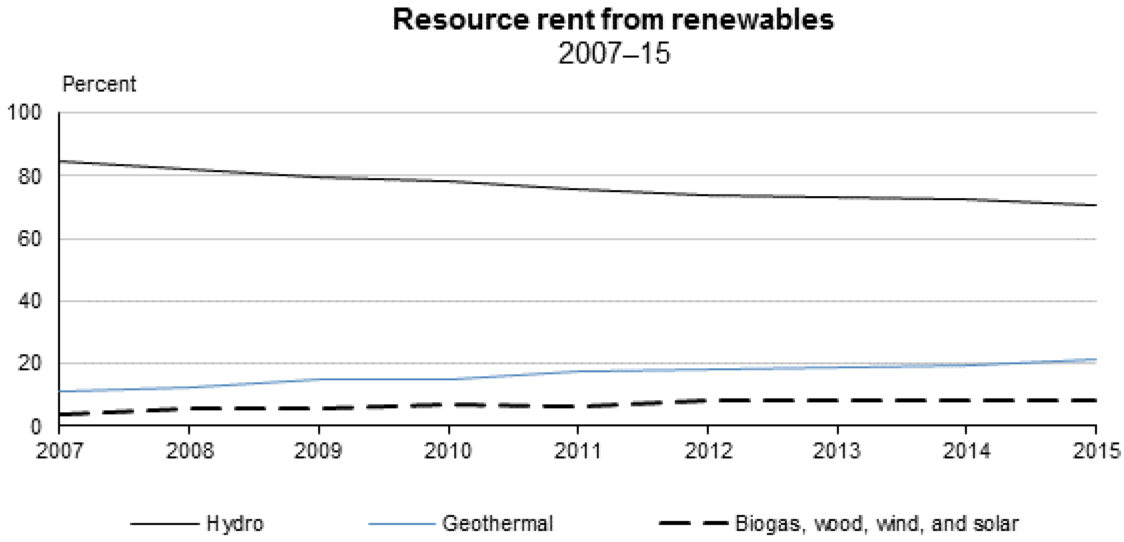
The asset value of all renewables used to generate electricity was $13.8 billion in 2015. Resource rents totalled $829 million (79 percent of total resource rents from electricity generation), up from $677 million (68 percent) in 2007 (see table 1).

Table 1

Resource rent from electricity generation 2007–15									
	2007	2008	2009	2010	2011	2012	2013	2014	2015
	$(million)								
Total electricity generation	997	1,039	1,030	1,046	1,037	1,086	1,081	1,121	1,046
Total renewables	677	675	692	761	787	817	787	861	829
	Renewables – percent of total								
Renewables	68	65	67	73	76	75	73	77	79
	$(million)								
Hydroelectricity	574	553	549	593	596	604	575	622	586
Geothermal	76	84	103	115	138	147	147	168	175
Wind	14	25	27	39	39	51	51	55	53
Wood	7	8	8	9	8	9	9	10	9
Biogas	5	5	5	5	5	6	6	6	6
Solar	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.5
Source: Stats NZ									

The percentage of resource rent from hydro-generation decreased over the period 2007–15 (as a percentage of electricity generated by all renewables). In contrast, the percentage of resource rent from both geothermal and wind increased (see figure 3).

Figure 3



Source: Stats NZ

Water resources contribute over half the total electricity generation resource rent

Hydropower generates energy from turbines being spun from the force of water moving downstream. The potential energy created is captured by damming rivers and diverting the flows through pipes and turbines, which extract kinetic energy.

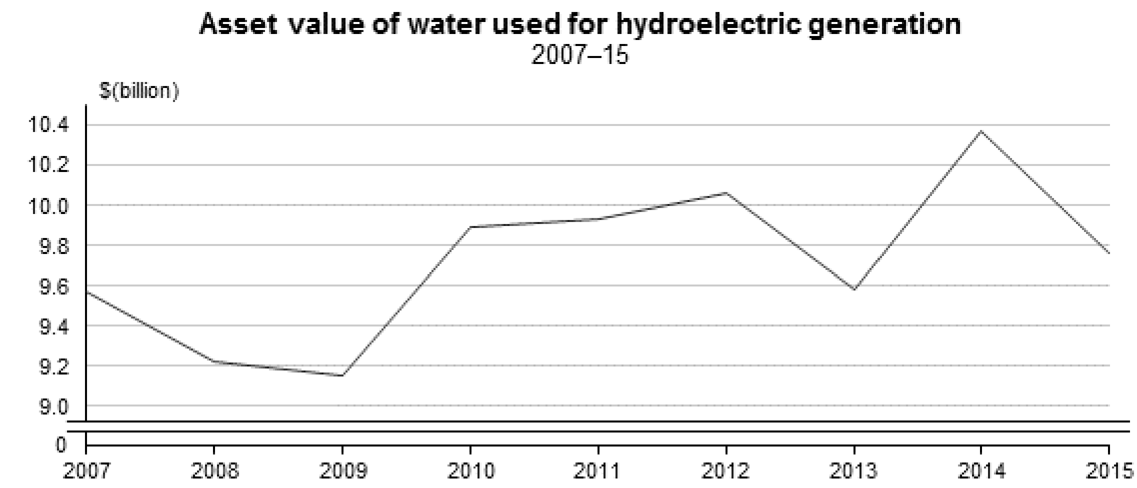
In 2015, 38 hydro-generation plants had an operating capacity of 10 megawatts or greater, with these stations accounting for over 95 percent of operating capacity. Of these, 19 were in the North Island, seven of which were in the Waikato region. In the South Island, generation plants were concentrated in the Canterbury, Otago, and Southland regions.

The resource rent from hydroelectricity generation was estimated at $586 million in 2015, up from $574 million in 2007. The latest figure accounted for over half the total resource rent from electricity generation (which includes non-renewables), which was estimated at $1 billion in 2015 (see table 1).

The asset value of water for electricity generation was estimated at $9.8 billion in 2015, up 2 percent from $9.6 billion in 2007. The higher asset value in 2015 reflects the increase in resource rent associated with hydro resources. The asset value and resource rent fluctuated over this period. The asset value fell to a low of $9.2 billion in 2008 and 2009, but peaked in 2014 at $10.4 billion. Resource rents showed the same variation, with a low of $549 million in 2009 and a high of $622 million in 2014 (see figure 4).

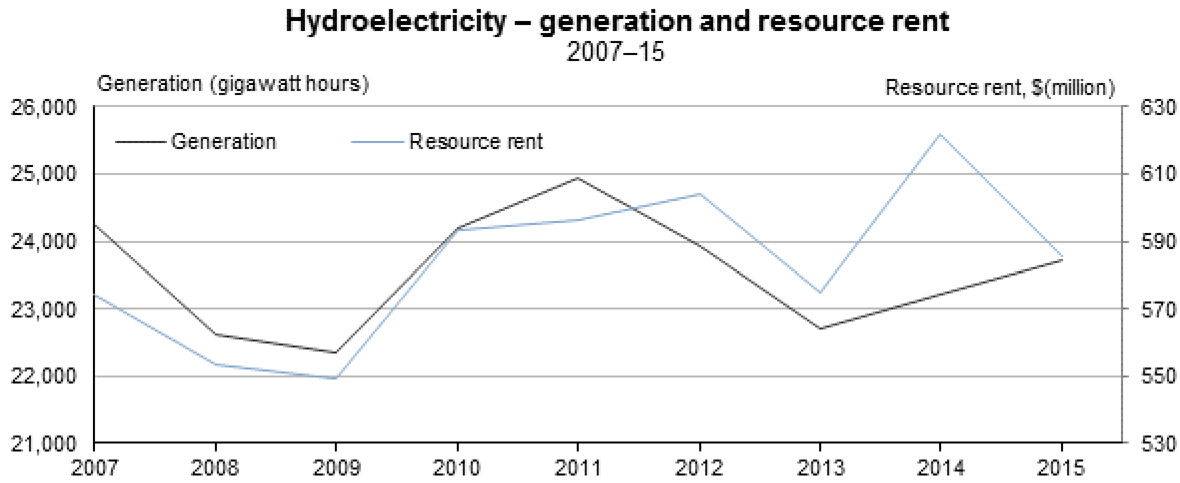
Hydroelectric generation accounted for 56 percent of New Zealand's electricity generation (23,728 of 42,362 gigawatt hours) in the year ended March 2015. From 2007 to 2015, resource rent fluctuated due to the variability in total hydroelectricity production, which peaked at 24,950 gigawatt hours in 2011 (see figure 5).

Figure 4



Source: Stats NZ

Figure 5



Source: Stats NZ; Ministry of Business, Innovation and Employment

Historically, developing New Zealand's hydroelectricity resource was an integral part of national economic development. However, many sites best suited for hydroelectricity generation have already been dammed. Further generation is limited by development costs, environmental concerns, and the need to manage competing demands between in-stream values and out-of-stream-uses (De Vos et al, 2009; Parliamentary Commissioner for the Environment, 2012). Between 2007 and 2015, the proportion of net generation attributable to hydroelectricity decreased from 58 percent to 56 percent. Over this period, development of hydro resources was limited, with only small generating schemes commissioned.

Value of geothermal assets doubles

New Zealand's geothermal resources are derived from groundwater heated naturally within the earth's crust. Groundwater heats when water seeps into the crust and comes into contact with a hot body of rock. Geothermal plants are in areas of past and present activity, with most geothermal-generating capacity in the Taupo Volcanic Zone.

The resource rent from geothermal electricity generation was estimated at $175 million in 2015, up from $76 million in 2007. The latest figure accounted for 21 percent of the total resource rent from electricity generation from renewables, which was estimated to be $829 million in 2015 (see table 1).

The asset value of steam used in geothermal generation was an estimated $2.9 billion in 2015, up from $1.3 billion in 2007 as seen in figure 6. The higher asset value (and resource rent) in 2015 reflects the increased share of geothermal electricity generation. Over the period, the resource rent and asset value increased steadily in line with the increase in both the amount of geothermal electricity generated and its share of all electricity generation.

Geothermal generation accounted for 17 percent of New Zealand's electricity generation (7,091of 42,362 gigawatt hours) in the year ended March 2015. From 2007 to 2015, the resource rent increased steadily in line with total geothermal electricity production, which peaked at 7,091 gigawatt hours in 2015 (see figure 7).

Figure 6

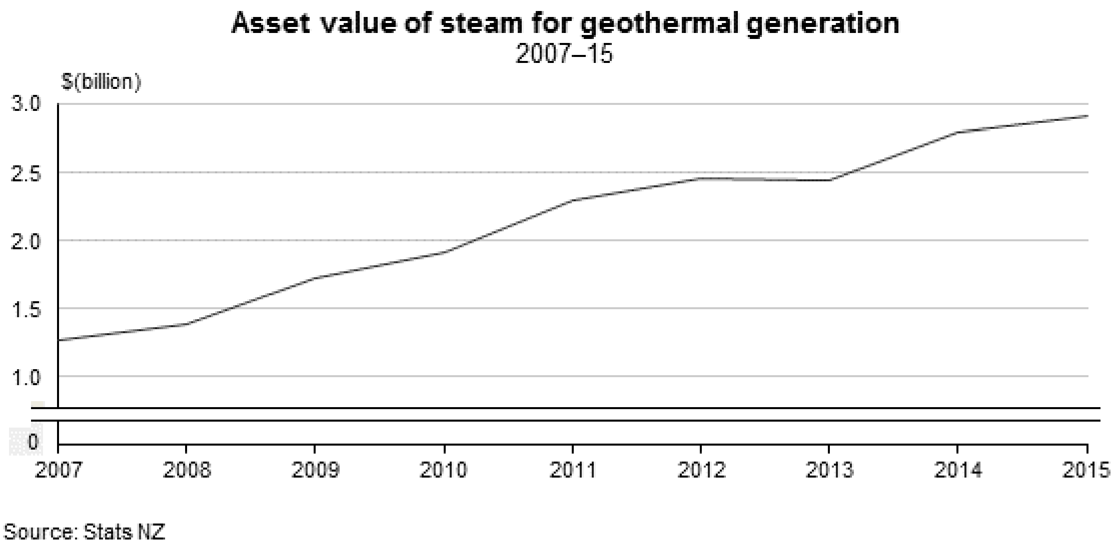
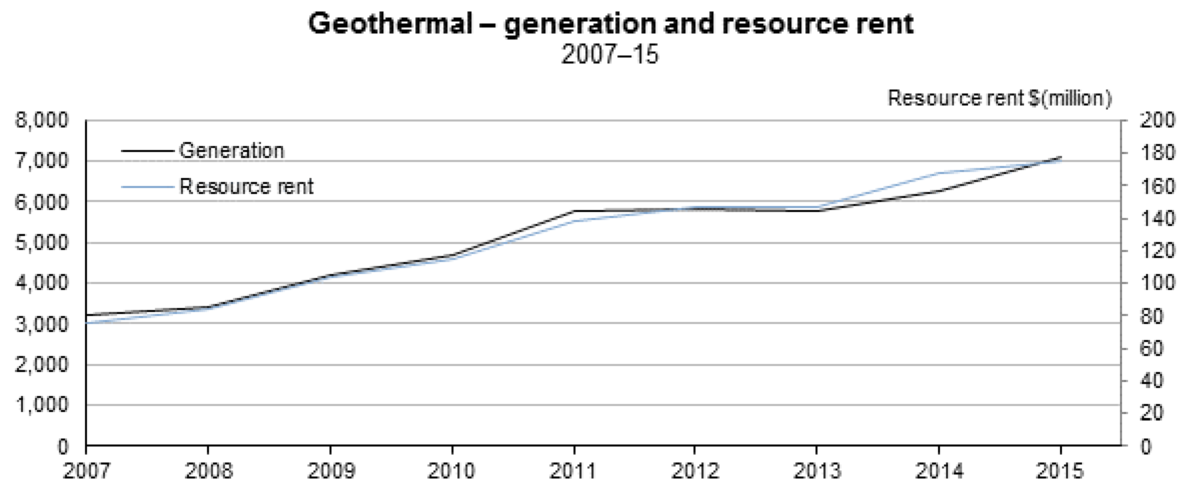


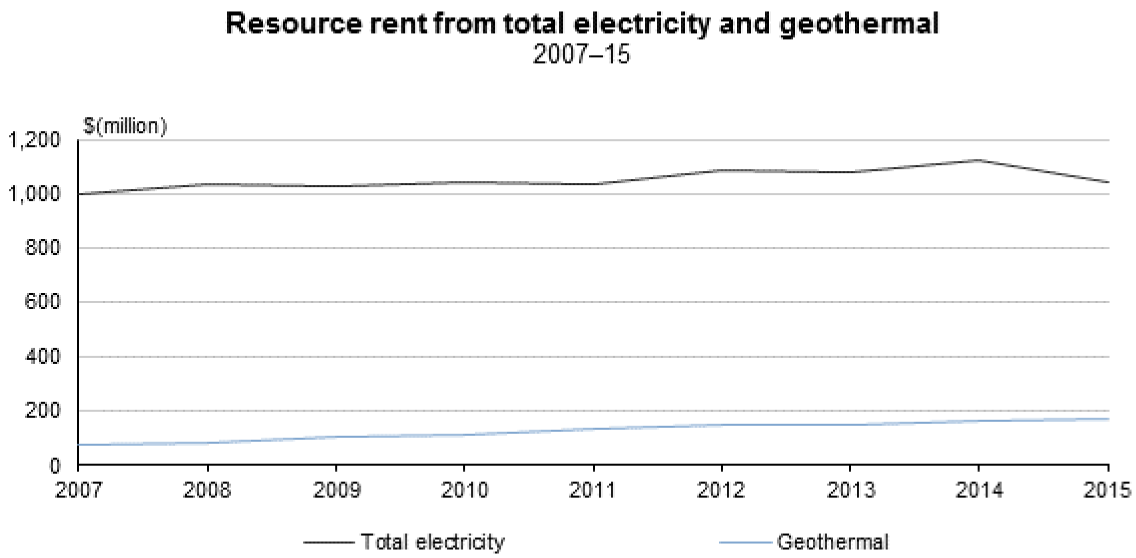
Figure 7



Source: Stats NZ; Ministry of Business, Innovation and Employment

The resource rent from total electricity generation and how that compares with geothermal generation is shown in figure 8.

Figure 8



Source: Stats NZ

The increase in electricity generation from geothermal energy between 2007 and 2015 was a result of the ongoing development of geothermal resources. New Zealand's geothermal resources are a reliable, secure, and cost-effective source of renewable energy. Concerns about New Zealand's dependence on hydro resources and the Maui gas field in the early 2000s prompted additional geothermal development (De Vos et al, 2010). Since 2007, eight geothermal schemes with a generating capacity of 10 megawatts or greater were commissioned (these were new schemes or upgrades to existing generating capacity) (MBIE, 2016).

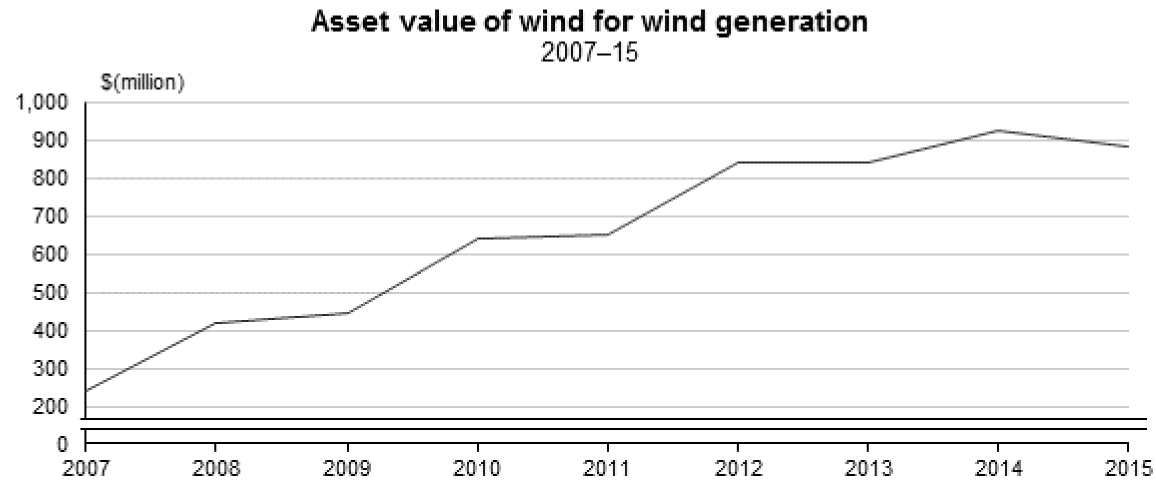
Wind power emerges as significant environmental asset

Wind energy is the process of exploiting the kinetic energy of wind. Wind turbines convert this kinetic energy into mechanical power, which can be used to generate electricity. New Zealand has a relatively abundant supply of wind due to its physical geography – the country is exposed to strong, consistent westerly winds. In 2015, eight wind farms (mostly in the North Island) had a generating capacity of 10 megawatts or greater.

The resource rent from wind generation was an estimated $53 million in 2015, up from $14 million in 2007.The asset value of wind was estimated at $884 million in 2015, up from $238 million in 2007 (see figure 9). The increase in asset value between 2007 and 2015 was a result of the growing contribution of electricity from wind generation.

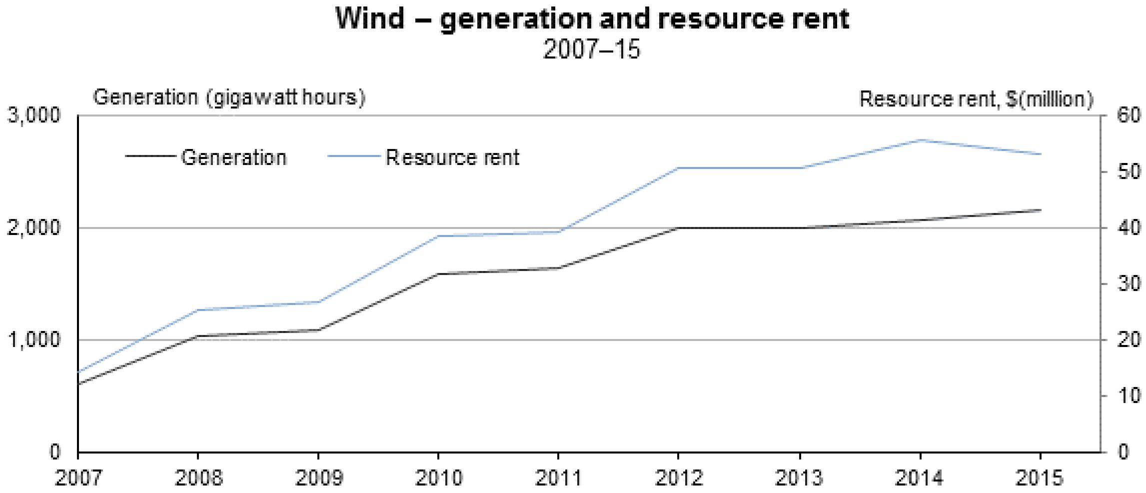
Wind generation supplied 5.1 percent of New Zealand's electricity (2,149 of 42,362 gigawatt hours) in the year ended March 2015. From 2007 to 2015, the resource rent fluctuated with the variability in total wind generation, which peaked at 2,149 gigawatt hours in 2015 (see figure 10).

Figure 9



Source: Stats NZ

Figure 10



Source: Stats NZ; Ministry of Business, Innovation and Employment

Solar, biogas, and wood provide small contributions to renewable asset values

Solar photovoltaic (PV) systems directly convert solar energy into electricity. Light energy hits the solar panels and excites the electrons in the atoms of semi-conducting material –the movement of these electrons results in an electric current. Installed generating capacity of solar PV is currently limited but has experienced strong growth in recent years.

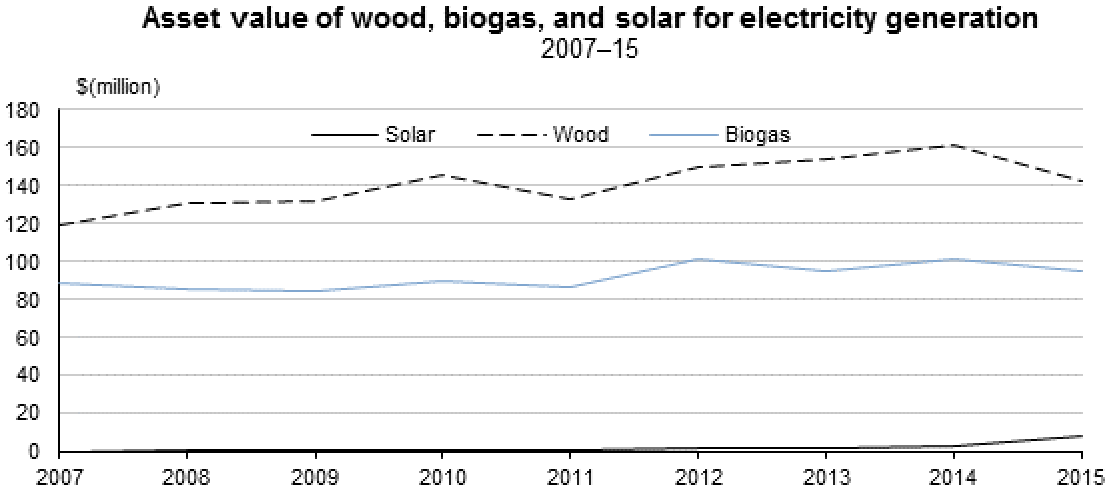
MBIE data on electricity generation includes estimates for distributed solar photovoltaics (PV) generation, which has been estimated using Electricity Authority data on the total installed capacity of grid-connected solar PV installations. This is converted to output using an assumed capacity factor of 14 percent (ie the solar panels produce their full output 14 percent of the time) (MBIE, 2016).

Biogas (mostly methane) is generated by the anaerobic digestion of organic matter by bacteria. Sufficient quantities of methane can be generated from landfills and wastewater treatment sites to provide a valuable source of energy. Biogas can be burnt to produce heat, or can be used in specialised combustion engines to create electrical energy.

Trees and plants use solar energy to convert water, carbon dioxide, and nitrogen into hydrocarbons. This energy is stored in plants and can be replaced by burning plant biomass. Burning plants produces heat, which can be used to create electricity.

Solar, biogas, and wood accounted for 1.8 percent of the total value of renewable energy assets in 2015. The resource rents from fuelwood, biogas, and solar were estimated at $8.6 million, $5.7 million, and $0.5 million, respectively, in 2015. For the March 2015 year, fuelwood supplied 0.8 percent of New Zealand’s electricity (348 of 42,362 gigawatt hours). Asset values for fuelwood, biogas, and solar were $143 million, $95.3 million, and $8.5 million, respectively (see figure 11). The asset value for solar showed the strongest growth from 2007 to 2015, with most of this occurring in the March 2015 year.

Figure 11



Source: Stats NZ

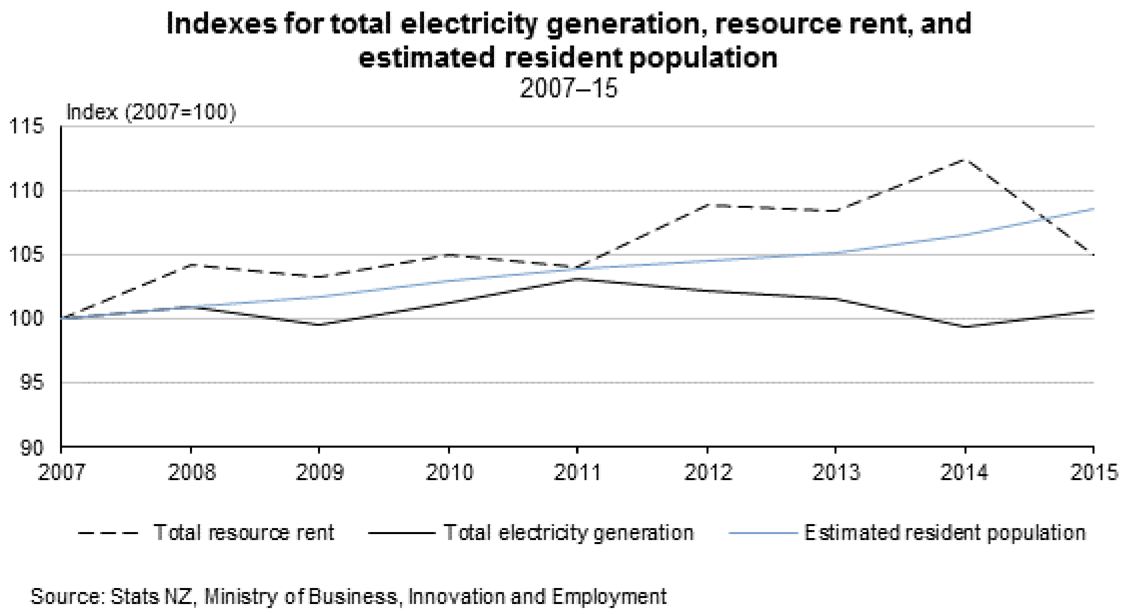
Further analysis and decoupling indicators

Decoupling indicators track the relationship between the use of resources and growth in production and consumption or population. We derive the indicators by comparing population growth with a relative physical flow (eg electricity generation). The focus of these indicators is to identify any divergence between environmental and economic or population aggregates (United Nations, 2014).

From 2007 to 2015, the total level of electricity generation decoupled from population growth (see figure 12), with the divergence in electricity generation compared to population becoming more apparent after 2011. This means that fewer energy resources in the form of electricity were being demanded per person, implying greater efficiency in energy resource use, which may be driven by economic considerations.

At March 2007 the estimated resident population of New Zealand was 4,219,400 (Stats NZ, nd). In 2015 this had increased by 9 percent to 4,580,000. Over the same period, total net electricity generation increased less than 1 percent (0.6) or 270 GWh (gigawatt hours). However, net generation had been declining since 2011 and increased slightly only in 2015. This increase in demand may be associated with improving economic performance and increased migration (Electricity Authority, nd). Gross domestic product (GDP) is New Zealand's official measure of economic growth. GDP statistics show that economic growth was 3.4 percent in the March 2015 year. Information on international travel and migration shows permanent and long-term migration counts for 2014, 2015, and 2016 (February years) were higher than the 2007–17 average.

Figure 12



Hydroelectricity generation and precipitation

Higher annual levels of precipitation (mostly rainfall) will generally result in higher levels of abstraction for hydro-generation. This is evident when we look at a regional breakdown (see table 2). Most hydro-generation schemes are located in four regions. Where precipitation is lower than average, hydro-generation as a percentage of total generation will be lower and wholesale prices will be generally higher (see 2009–13, table 2). An exception to this was seen in 2009 when wholesale pricing was higher than usual but precipitation was also higher. This is partially explained by the precipitation data being in June years where a water year runs 1 July–30 June and the other components of table two being in years ending March 31. A further explanation is the effect of seasonality in rainfall – a very dry winter in 2008 resulted in high electricity prices (Electricity Authority, 2011) and this is visible in higher average prices and lower hydro-generation in the year ended March 2009.

Table 2

Hydroelectricity generation and precipitation by selected regions 2007–15									
	2007	2008	2009	2010	2011	2012	2013	2014	2015
Precipitation (million m³)									
Waikato	31,527	34,652	40,014	36,481	44,127	34,720	34,127	30,056	…
Canterbury	60,841	54,429	77,535	66,417	66,885	54,007	69,822	65,159	…
Otago	38,358	37,262	43,671	40,772	43,930	34,439	43,463	41,955	…
Southland	77,011	68,004	70,812	79,221	70,642	57,946	68,650	77,846	…
Total	522,435	500,540	594,342	556,322	603,393	473,474	506,337	526,936	…
Precipitation as a percent of average precipitation 1995–2014 (%)									
Waikato	85	93	107	98	118	93	91	81	…
Canterbury	95	85	121	104	104	84	109	102	…
Otago	95	92	108	101	109	85	108	104	…
Southland	103	91	95	106	95	78	92	104	…
Total	95	91	108	101	110	86	92	96	…
Abstraction for hydro-generation (million m³)									
Waikato	51,512	46,852	56,740	49,634	57,743	55,517	51,041	44,988	…
Canterbury	60,658	56,547	57,469	62,212	63,621	53,713	57,779	62,960	…
Otago	28,667	27,510	27,826	30,054	30,787	22,457	28,336	32,570	…
Southland	11,978	10,822	11,214	12,244	11,340	9,420	10,890	11,936	…
Other regions	1,665	1,558	1,589	2,042	1,971	1,762	1,088	1,535	…
Total	154,480	143,289	154,838	156,186	165,462	142,869	149,134	153,989	…
Mean price $ per MWh	60	70	105	52	52	75	81	69	74
Net generation(GWh)	42,091	42,467	41,870	42,642	43,407	42,998	42,714	41,835	42,362
Hydro-generation(GWh)	24,249	22,616	22,341	24,194	24,950	23,918	22,719	23,209	23,728
Hydro-generation as % of net generation	58	53	53	57	57	56	53	55	56

Note: Water components are for June years; electricity generation and prices are for March years.
Symbol: … not applicable
Source: Stats NZ; NIWA; MBIE

NIWA produces the annual estimates for 11 components of the physical water stocks available in New Zealand. The data comes from a combination of direct measurement and modelled data (TopNet model). The model estimates how much water is gained through precipitation and lost through evapotranspiration, and summarises the surface component of water stocks in New Zealand. This information was presented in the form of a water physical stock account (see Water Physical Stock Account: 1995–2010) in 2011. This data was updated in 2015 for the July 1994 to June 2014 years. The latest version of the tables are available from *Environmental indicators Te taiao Aotearoa* – Water physical stocks: precipitation and evapotranspiration.

Information on water used for hydroelectric generation is supplied directly (to NIWA) by recording authorities. Abstraction for hydro-generation is equal to discharge by hydro-generation, as water used in hydroelectricity generation is returned to the hydrological system, meaning that net abstraction is generally zero. However, one hydroelectric power station in Southland returns water directly to the sea. The information is provided in June years (a year runs from 1 July to 30 June).

The volume of water abstracted for hydro-generation should not be compared with the volume of inflows because inflows is abstracted several times as power stations are often built in chains along rivers (Henderson et al, 2011).

We compiled wholesale prices from Electric Market Information's final prices, which are available in monthly increments from October 1996. For this report we converted the data to annual (March year) mean values in dollars per megawatt hour ($/MWh).

Concepts

This chapter presents the definitions of renewables used in this report. It explains what asset accounts are, including the concepts of resource rent and net present value which are essential to monetary asset valuation.

Definition of renewables

A renewable resource, or 'renewable', is a resource that after being used, can return to previous stock levels by natural processes of growth.

The SEEA Central Framework (United Nations, 2014, p45) recognises the following renewable sources of energy.

- solar
- hydro
- wind
- wave and tidal
- geothermal
- other electricity and heat.

The United Nations is developing the SEEA-Energy, an SEEA 'sub-system', to provide compilers and analysts with agreed concepts, definitions, classifications, tables, and accounts for energy and energy-related air-emission accounts. SEEA-Energy elaborates and expands the guidance on accounting included in the International Recommendations for Energy Statistics (IRES) and is fully coherent with the broader SEEA. According to IRES, heat from renewable resources is considered renewable but heat from chemical processes is considered non-renewable. Electricity data supplied by MBIE includes electricity generated from waste heat, which includes heat from chemical processes (eg the fertiliser industry). For this reason, we excluded electricity generated from waste heat in this report.

Energy monetary asset account

An energy monetary asset account is a balance sheet for an energy resource. The balance sheet shows a resource's opening stocks at the beginning of a year, changes in its stock over a year, and closing stocks at the end of a year.

The opening and closing stocks are calculated as the net present value (NPV) of anticipated resource rent. The difference between opening and closing stocks is a residual that implicitly accounts for other changes affecting asset levels and values, including changes in the capacity to use renewable energy resources.

Resource rent

Asset value is calculated by discounting the resource rent from the environmental asset using the net present value (NPV) approach. The resource rent from an environmental asset is based on the concept of economic rent. Resource rent reflects the surplus value accruing to the extractor or user of an environmental asset calculated after all costs and normal returns are taken into account (United Nations, 2014, p140). It is the current value after accounting for both supply and demand factors. The amount of resource rent is always derived relative to the returns earned by other firms on average over time (ie normal returns) and may be positive or negative. Economics suggest that a resource rent should be positive in the long term. It reflects the gross return attributable to the environmental asset, or income generated by the use of such assets. The resource rent therefore, reflects the impacts of resource use on the economy. It provides the basis for computing the asset value using the NPV approach (see Net present value approach).

SEEA valuation of an environmental asset focuses on the benefits that accrue to the economic owners of the asset. This focus aligns with the measurement of economic assets in the System of National Accounts. Using consistent definitions and concepts, such as exchange value, makes comparison easier.

Natural resources (such as water) and managed fisheries are examples of extractable renewable resources that can generate resource rent. Water abstracted for hydroelectricity generation is discharged back into the hydrological system. However, one hydroelectricity power station in Southland returns water direct to the sea, which prevents others from reusing the fresh water. This could be defined as consumptive use. However, SEEA treats all discharges from hydroelectricity generation as non-consumptive abstraction, regardless of where in the environment or economy the water is discharged.

Net present value approach

NPV is the method used to estimate the 'market value' of natural resources that enable electricity production. SEEA recommends this approach, which is used internationally for valuating non-renewable energy resources.

The logic of the NPV approach requires estimating the stream of resource rents that are expected to be earned in the future, and then discounting these resource rents back to the present accounting period. This provides an estimate of the value of the asset at that point in time. The asset value represents the discounted future income stream of water resources used for hydroelectric generation, and therefore the benefits to accrue to future, as well as current, generations.

An asset valuation calculated using the NPV approach values only the natural resource currently being used for economic gain.

Under the NPV approach, renewable monetary assets are estimates of the net discounted income stream from the resource. The estimate is not a measure, for example, of the value of the stock of water in dams at that particular point in time. In fact, a hydro dam may be dry at the time of the balance date, but is still valued on the basis of the expected future availability of water.

The NPV approach requires:

- output and user cost of produced capital to estimate resource rent
- user costs of produced capital
- a rate of return on produced capital
- lifespan of the resource
- a discount rate.

Method

This chapter outlines how we calculated resource rents and asset values, which industries we covered, time-series considerations, comparisons with previously published energy monetary asset accounts, and data quality.

How resource rent is calculated

The resource rent from the electricity generation industry is first calculated: gross operating surplus less user cost of produced capital, all sourced from the national accounts (see Industry coverage for the subgroups under the electricity generation industry). No appropriate taxes or subsidies on extraction are applicable to this industry, so nothing is added back to gross operating surplus. Table 3 shows the process for deriving resource rent.

Table 3

Deriving the resource rent from environmental assets
Output
- operating costs
= gross operating surplus (SNA basis)
- specific subsidies on extraction
+ specific taxes on extraction
= gross operating surplus (for resource rent derivation)
- user cost of produced assets
= resource rent

Operating cost consists of intermediate consumption, compensation of employees, and other taxes and subsidies on production. The user cost of a produced asset includes consumption of fixed capital and a return to produced assets.

The resource rent from electricity generation using renewables is then calculated by applying the proportion of total electricity production from MBIE to the national accounts data. Quarterly MBIE data is converted to March years for consistency with the economic data.

User cost and rate of return of produced capital

User cost is derived using the method used in productivity statistics. This is computed as the price index of the asset multiplied by the sum of the rate of economic depreciation and rate of return, all multiplied by the productive capital stock (derived using the perpetual inventory method). Stats NZ adopted a 4 percent real rate of return for capital assets in the compilation of productive capital stock and productivity estimates for all industries and all years. See MacGibbon (2010) for more information on this approach to user cost.

Asset lifespan

For the asset value computations to work, we assume that the lifespan of the resource is infinite (ie there will always be a minimum sufficient flow). The longevity of the fixed asset used to generate electricity (ie the dams) are accounted for in calculating user cost.

Discount rate

The asset value for natural capital assets used for generating electricity is calculated as resource rent divided by the discount rate (due to the assumption of infinite lifespan). The discount rate is 6 percent to be consistent with Treasury recommendations for undertaking cost-benefit analyses for water and energy assets (see current discount rates).

In setting the discount rate, we first considered the purpose for which it is needed. When considering the value of water for hydroelectric plants, a commercial rate is more appropriate than a lower social rate of time preference to ensure that the valuation is aligned to the general concept of market prices. For national accounting purposes, the focus is on average value to production in current uses rather than marginal value of choices between uses. It is necessary to assume that consenting conditions on hydro-generation internalise the externalities (including environmental) – although in practice that may be inconsistently done.

The NPV approach invokes assumptions on the real rate of return and real discount rate (assumed to be constant at 4 percent and 6 percent, respectively). Annual distortions from these rates may lead to some bias in the trend, while systematic differences will affect the confidence in the level.

Coverage

Industry coverage

The Australian and New Zealand Standard Industrial Classification 2006 (ANZSIC06) groups firms based on similar production functions (see table 4 for the structure of the electricity, gas, water, and waste services industry).

The starting point for estimating the asset value of renewables used for electricity generation was the national accounts benchmarks for electricity generation and on-selling industries. To estimate resource rents from electricity generation, we excluded units engaged in on-selling electricity and electricity market operation. We used data from the Annual Enterprise Survey (AES) to exclude these units from the national accounts totals. This provides the baseline for computing the resource rent from electricity generation. Units engaged in electricity transmission, electricity distribution, water supply, sewerage, and drainage services are included in the electricity, gas, water, and waste services industry but are not included in the asset values in this report.

The resource rents for electricity generators used national accounts data at the working-industry level (electricity generation and on-selling combined). This level of information is considered to be robust. AES had complete coverage of firms in the electricity and gas supply industry (division level) for the years 2007–15. This means sample errors are zero.

The top-down approach we used involves using national accounting aggregates and supplementary information to estimate the resource rent from renewables. This contrasts with a bottom-up approach, which would be based on firm-level data.

We explored a bottom-up approach using firm-level data from the AES, but classification issues at the ANZSIC level mean the validity of this approach could not be ensured. The top-down approach is also not subject to confidentiality issues – aside from excluding on-selling electricity and electricity market operation, it is based on publicly available data. However, using national aggregates affects the potential to produce disaggregated estimates, for example, by region.

The use of supplementary information, in this case electricity production by generation type from MBIE, results in an assumption that resource rents will be similar for all electricity producers. This may not be the case for all producers, but due to the small number of large companies involved and their structure (ie where a company may operate stations using several types of fuel) this assumption is necessary in order to present information for all types of renewables used in electricity generation.

Table 4

Industrial classification structure of the electricity, gas, water, and waste services industry
ANZSIC 2006

Subdivision	Group	Class
Electricity supply		
	Electricity generation	
		Fossil fuel electricity generation
		Hydroelectricity generation
		Other electricity generation
	Electricity transmission	
	Electricity distribution	
	On-selling electricity and electricity market operation	
Gas supply		
Water supply, sewerage, and drainage services		
	Water supply, sewerage, and drainage services	
		Water supply
		Sewerage and drainage services
Waste collection, treatment, and disposal services		
	Waste collection services	
		Solid waste collection services
		Other waste collection services
	Waste treatment, disposal, and remediation services	
		Waste treatment and disposal services
		Waste remediation and materials recovery services

Asset coverage

The asset value of and resource rent from electricity generation reflects the role of land form in generating electricity. For example, the land's slope under a river and the land used for operating a dam are essential to production. However, the role of land in generating hydroelectricity cannot be readily extracted from these estimates. Similarly, land that generates gross operating surplus may also be attributed to other renewable energy assets, such as an exposed or sunny position for wind and solar generation, respectively. Although we cannot separate the contribution from land form we expect its influence to be small.

Some gross mixed income may be captured in the resource rent, but this is likely to be small given that the electricity, gas, water, and waste services industry is a strongly capital-intensive industry.

Time-series consistency

Data is available from 2007. National accounts data is available from 1987, but for user costs there is greater uncertainty in the earlier part of the time series given the use of constant price rather chain volume productive capital stock in the calculations. For future work we will endeavour to estimate values back to 1996 to enable comparability with the water physical stock account, and to balance these values against data quality.

The resource rent and asset values are based on March years, so we recommend caution when comparing these with other environmental information, such as river flow or rainfall which may be in June or calendar years.

Timeliness

This report covers data until March 2015, consistent with the latest period available from the annual national accounts at the time we compiled this report.

National accounts data is provisional for 2015. Future updates of this report will incorporate 2015 revisions and any national accounts revisions to any year in the series.

Comparison with previous methods

The methods used in this report improve on those used in Energy Monetary Stock Account: 1987–2001 (Statistics NZ, 2005). Because of the differences, comparisons with the 2005 publication are not valid.

Key improvements include:

- Estimates of user costs are fully incorporated rather than approximated by consumption of fixed capital and a rate of return. The user-cost method is aligned with international best practice as outlined in *Measuring capital* (OECD, 2009). The rate of return used in calculating user costs is now consistent with that used for producing economic statistics. The previous report used a rate of return of 8 percent.
- The new industrial classification and AES data allowed firms in the electricity supply industry to be more easily identified, which replaced the use of fixed proportions (from the 1996 inter-industry study). The input-output proportions were only available for one year and therefore invoked an assumption of constant proportions which may not hold. We removed this limitation and potential uncertainty in the estimates.
- The discount rate is consistent with domestic guidance, as opposed to international recommendations, thereby better reflecting the New Zealand situation. The previous report used a discount rate of 4 percent.

- We included the asset value of wind and solar resources used for electricity generation. The previous energy account did not attempt to value these resources as they then accounted for a very small amount of electricity generation. However, the contribution of electricity derived from wind resources has steadily increased. Between 2000 and 2015, eight generating schemes that had a generating capacity of 10 megawatts or greater were commissioned. As a result of the increase in installed generating capacity, this report now includes estimates of the asset value of wind resources. Solar-generated electricity supplied by the electricity generation industry is still very small, but these estimates are available so are presented in this report.

Given these differences, comparisons between these estimates and those in Statistics NZ (2005) are not valid.

Quality declaration

Stats NZ has taken all possible reasonable steps to ensure the quality of the data. An assessment against the six data-quality criteria for official statistics is presented below.

Relevance

The estimates include all significant natural capitals used in generating electricity at the national level.

Accuracy

Key sources of uncertainty are the use of a fixed discount rate and rate of return on produced assets. The use of generation proportions may not capture the relative value of carbon to non-carbon using assets. Resource rents may in fact be higher for renewable assets given they are substantially carbon free.

Timeliness

Data is consistent with the latest available national accounts release.

Coherence/consistency

The methodology used here is consistent with guidance in the SEEA. Time-series consistency has been ensured.

Accessibility

All assumptions and explanations of the impact of these assumptions have been made. Data is available in CSV format with this report.

Interpretability

This report contains the appropriate information to interpret these estimates. Interpretability can be enhanced by comparing these estimates with river flow and climate data. However, the lack of regional estimates affects the ability for these comparisons to be made. Renewable assets should be placed in context with non-renewable and other environmental assets to fully understand their relative value.

References

De Vos, R, Fortuin, S, Nichol, S, Franz, P, Jamieson, D, Smith, M, & Stevens, C (2009). New Zealand's Energyscape: Renewable resources (PDF, 6.35MB). Retrieved from www.niwa.co.nz.

De Vos, R, Heubeck, S, Harvey, C, King, P, Edbrooke, S, Stagpoole, V, … Hooper, G (2010). New Zealand's EnergyScape: Earth resources (PDF, 11.2MB). Retrieved from www.niwa.co.nz.

Electricity Authority (nd). Electricity Market Performance 2015. Retrieved 8 December 2016 from www.ea.govt.nz.

Electricity Authority (2011). Wholesale electricity prices: December 2010. Retrieved 2 March 2017 from www.ea.govt.nz.

Henderson, R, Woods, R, Singh, S, & Zammit, C (2011). Surface water components of New Zealand's National Water Accounts, 1995-2010 (PDF, 1MB). Prepared for Statistics NZ, NIWA client report CHC 2011-051 (PDF, 0.97MB). Retrieved from www.stats.govt.nz.

Kaye-Blake, B, Schilling, C, Nixon, C, & Destremau, K (2014). Water management in New Zealand: A road map for understanding water value. NZIER public discussion paper 2014/01. Retrieved from http://nzier.org.nz.

MacGibbon, N (2010). Exogenous versus endogenous rates of return: The user cost of capital in statistics New Zealand's multifactor productivity measures (Statistics NZ Working Paper No 10-03). Retrieved from www.stats.govt.nz.

Ministry of Business, Innovation and Employment (MBIE) (2015). Electricity generation. Retrieved from www.mbie.govt.nz.

Ministry of Business, Innovation and Employment (MBIE) (2016). Energy in New Zealand 2015. Retrieved from www.mbie.govt.nz.

Organisation for Economic Co-operation and Development (OECD) (2009). Measuring capital 2009. Retrieved from www.oecd.org.

Parliamentary Commissioner for the Environment (2006). Wind power, people, and place (PDF, 0.67MB). Retrieved from www.pce.parliament.nz.

Parliamentary Commissioner for the Environment (2012). Hydroelectricity or wild rivers? Climate change versus natural heritage (PDF, 3.33MB). Retrieved from www.pce.parliament.nz.

Statistics NZ (2005). Energy Monetary Stock Account: 1987–2001. Retrieved from www.stats.govt.nz.

Stats NZ (nd). Estimated resident population by age and sex, total all ages (1991+) (Annual-Mar). [Population, Population Estimates – DPE]. Retrieved 14 February 2017 from www.stats.govt.nz/infoshare.

United Nations (2014) System of Environmental-Economic Accounting 2012 – Central framework (PDF, 4.40MB). Retrieved from https://unstats.un.org.

Glossary

Asset value. The asset value of a natural resource is conceptually the market value of the asset if it was sold. However, in practice market values will not always be available. Where market prices do not exist the asset value is estimated as the net present value of discounted resource rent.

Discount rate. Annual percentage by which future income is discounted to give an equivalent value in the present period. The discount rate expresses a time preference for money now rather than in the future. A social discount rate or social rate of time preference reflects the time and risk preferences of society as a whole. It reflects the value that society attaches to present, as opposed to future consumption. A social discount rate will usually be applied by government in relation to its decision-making on behalf of a society.

Environmental assets. Naturally occurring living and non-living components of Earth, together constituting the biophysical environment, which may provide benefits to humanity.

Gigawatt hour (GWh). Unit of energy representing one billion (1,000,000,000) watt hours and is equivalent to one million kilowatt hours. Gigawatt hours are often used as a measure of the output of large electricity power stations. One GWh equals 0.0036 petajoules.

Gross operating surplus. Surplus generated by operating activities after the labour input has been compensated.

Lifespan. Estimated time for which an asset will continue to be in use and produce revenue.

Megawatt. Unit for measuring power that is equivalent to one million watts. A megawatt hour (MWh) is equal to 1,000 kilowatt hours (KWh). It is equal to 1,000 kilowatts of electricity used continuously for one hour.

Net generation. Generation that excludes that used on-site for auxiliary services (eg lighting, coal grinders) and internal losses. Net generation does not include transmission/distribution losses.

Net operating surplus (NOS). Gross operating surplus, less consumption of fixed capital.

Net present value (NPV). Value of an asset based on the summed value of discounted future earnings from the use of the asset.

Non-renewable energy. Exhaustible energy source that cannot be regenerated after exploitation.

Rate of return. Measures the 'profitability' of an asset. Often calculated by dividing the operating surplus by the capital stock. Stats NZ adopted a 4 percent real rate of return for capital assets in the compilation of productive capital stock and productivity estimates for all industries and all years.

Renewable energy. Energy source that after exploitation can return to previous stock levels by natural processes of growth or replenishment, as long as the resource is managed adequately.

Resource rent. The revenue generated from a resource, less all costs incurred in its extraction.

System of Environmental-Economic Accounting (SEEA). System developed jointly by the United Nations, European Commission, International Monetary Fund, Organisation for Economic Co-operation and Development, and World Bank. SEEA is the international standard for measuring the links between the environment and the economy.

System of National Accounts (SNA). Developed jointly by the United Nations, European Commission, International Monetary Fund, Organisation for Economic Co-operation and Development, and World Bank. The SNA is the international standard for measuring economic statistics. For this report we used the 2008 version.

User cost of produced capital. Cost of using produced capital assets in a year. It accounts for the price change of the asset, an exogenous rate of return, depreciation, and the sum of all taxes-less-subsidies that the government levies on owning certain assets.