CRITERION 5

Maintenance of forest contribution to global carbon cycles

Forests are renewable and one of the largest terrestrial reservoirs of biomass and soil carbon. They have an important role in global carbon cycles as sinks and sources of carbon. Carbon stocks in forests include above ground biomass, below ground biomass, dead and decaying organic matter and soil carbon. Carbon is also stored in wood products.

The biosphere has a significant influence on the chemical composition of the atmosphere. Vegetation draws CO_2 from the atmosphere, through photosynthesis and returns it through respiration and the decay of organic matter. The interchange between the biosphere and atmosphere is large; approximately a seventh of total atmospheric CO_2 passes into vegetation each year.

Global climate change could have significant impacts on the structure, distribution, productivity, and health of temperate and boreal forests as well as impacts on forest carbon stocks and fluxes, and the prevalence of forest fires, disease and insect outbreaks, and storm damages.

Forest management practices also affect the carbon cycle and fluxes. Deforestation has a negative impact, but management activities that maintain and enhance the carbon stored in forests and forest products over the medium to long-term can make a positive contribution to mitigating atmospheric carbon dioxide levels. In addition, biomass from forests can be used as a substitute for fossil fuels thereby reducing greenhouse gas emissions.

Change in the global carbon cycle and associated climate change will have major impacts on human wellbeing, especially rural communities and indigenous peoples dependent directly on the natural environment.

TABLE 5.1: INDICATORS FOR CRITERION 5, QUALITY OF INFORMATION AND TRENDS

CRITERION 5: MAINTENANCE OF FOREST CONTRIBUTION TO GLOBAL CARBON CYCLES		QUALITY OF INFORMATION	TREND
5.a	Total forest ecosystem carbon pools and fluxes	M	▲
5.b	Total forest product carbon pools and fluxes	H	▲
5.c	Avoided fossil fuel carbon emissions by using forest biomass for energy	M	▲



KEY

L = low
M = medium
H = high

Neutral ▶
Positive ▲
Negative ▼
Insufficient data ?

NEW ZEALAND OVERVIEW

New Zealand has established a Land Use and Carbon Analysis System for reporting carbon pools and fluxes. Carbon stocks in forests are estimated based on the definitions of the four biomass pools as defined in the Good Practice Guidance for Land Use, Land-Use Change and Forestry (GPG-LULUCF) brought out by the Intergovernmental Panel on Climate Change (IPCC). These carbon pools are: above-ground biomass, below-ground biomass, coarse woody debris, and fine woody debris and litter.

A first LUCAS plot-based assessment of indigenous forests was completed from 2002 to 2007, although the current carbon estimates for plantation forests are based on information from the *National Exotic Forest Description.* The mid-point (2005) analysis estimated a total of 1271 million tonnes of carbon in indigenous forests and 189 million tonnes in plantation forests.

Harvested wood products (HWP) store carbon, and the stock of these products has significance in national carbon reporting. This pool has increased over time.

Forest biomass accounts for about 7 percent (35.4 petajoule, PJ) of New Zealand's total primary energy supply, and about 25 percent of the renewable energy supply. If it was assumed that all biomass was replacing coal, then the avoided emissions would be about three million tonnes of CO_2-equivalent.

Pinus radiata plantations, Wairau Valley, Marlborough. Photo: Ian Platt.

Indicator 5.a Total forest ecosystem carbon pools and fluxes

New Zealand has established a Land Use and Carbon Analysis System (LUCAS) for reporting carbon pools and fluxes. A first LUCAS plot-based assessment of indigenous and plantation forests was completed between 2002 and 2007, although the current carbon estimates for plantation forests are based on information from the *National Exotic Forest Description*. The mid-point (2005) analysis estimated a total of 1271 million tonnes of carbon in indigenous forests and 189 million tonnes in plantation forests.

Quality of information: M **Progress against indicator: ▲**

RATIONALE

This indicator provides information about the total amount of carbon stored in forest ecosystems. It also describes changes, fluxes or flows in carbon between forests and the atmosphere. A better understanding of these processes will aid the development of appropriate responses to the effects of climate change.

2008 COUNTRY REPORT

Carbon stocks in New Zealand forests are estimated based on the definitions of the four biomass pools defined in the Good Practice Guidance for Land Use, Land-Use Change and Forestry (IPCC, 2000). These pools are: above ground biomass, below ground biomass, coarse woody debris, and fine woody debris and litter.

The New Zealand data are being collected through the Land Use and Carbon Analysis System (LUCAS). The aim of LUCAS is to develop a robust and comprehensive data gathering, management, analysis and reporting system appropriate for reporting on the LULUCF sector under the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol. LUCAS will also support and underpin New Zealand climate change policy development through to 2012 and beyond. Data collection methodologies have been designed to provide unbiased carbon estimates at the national scale, with methods supported by relevant scientific research. Analysis of the data will provide nationally applicable values for carbon stock and stock change for the four carbon pools.

The forest carbon inventory involves the use of plots located on a systematic grid across New Zealand (8 km grid for indigenous forest and 4 km grid for plantation forest). Historic plots for soil carbon measurement have been established in different land uses.

Indigenous forest carbon estimates were based on data collected from 2002 to 2007 through the New Zealand's Carbon Accounting System inventory and analysed by Beets et al (2009). The results of this analysis were assumed to be an average for 2005. The reported estimates for carbon in indigenous forests are preliminary.

Plantation forests carbon stocks for these pools are quantified every year for the national greenhouse gas inventory (Wakelin, 2008). These are currently based on *National Exotic Forest Description* data. Plantation forests data for all the pools have been collected through New Zealand's Carbon Accounting System inventory and will replace NEFD-based estimates in the future.

TABLE 5.2: TOTAL CARBON IN PLANTATION AND INDIGENOUS FORESTS IN 2005

BIOMASS POOL	CARBON (MILLION TONNES)		
	INDIGENOUS FOREST	PLANTATION FOREST	TOTAL
Carbon in above-ground biomass	893	121	1 014
Carbon in below-ground biomass	223	26	249
SUB-TOTAL: LIVING BIOMASS	1 116	147	1 263
Carbon in coarse woody debris	119	24	143
Carbon in fine woody debris and litter	36	18	55
SUB-TOTAL: DEAD WOOD AND LITTER	155	42	198
Total	**1 271**	**189**	**1 461**

Source
Beets et al (2009) – Indigenous forest.
Wakelin (2008) – Plantation forest.

SOURCES OF INFORMATION

Intergovernmental Panel on Climate Change (IPCC) (2000) *Good practice guidance and uncertainty management in national greenhouse gas inventories*. Penman J; Kruger D; Galbally I; Hiraishi T; Nyenzi B; Emmanuel S; Buendia L; Hoppaus R; Martinsen T; Meijer J; Miwa K; Tanabe K (eds). IPCC/OECD/IEA/IGES, Hayama, Japan.

Beets, PN; Kimberley, MO; Goulding, CJ; Garrett, LG; Oliver, GR; Paul, TSH (2009) *Natural forest plot data analysis: carbon stock analyses and re-measurement strategy*. Scion Research contract for the Ministry for the Environment; Wellington.

Wakelin, SJ (2008) *Carbon inventory of New Zealand's planted forests – calculations revised in October 2008 for New Zealand's 2007 greenhouse gas inventory*. Scion; Rotorua. Contract report for the Ministry of Agriculture and Forestry; Wellington.

FURTHER READING

LUCAS project. http://www.mfe.govt.nz/issues/climate/lucas/

New Zealand's UNFCCC reporting. http://maindb.unfccc.int/public/country.pl?country=NZ

New Zealand 2009 National greenhouse gas inventory submission (2008 inventory). http://unfccc.int/files/national_reports/annex_i_ghg_inventories/national_inventories_submissions/application/zip/nzl_2009_nir_15apr.zip

Indicator 5.b Total forest product carbon pools and fluxes

Harvested wood products store carbon, and the stock of these products has significance in national carbon reporting. The Intergovernmental Panel on Climate Change has developed different methods for calculating HWP contribution. As the HWP pool is increasing, including it in national reporting would demonstrate increased net removals of carbon dioxide by the forestry sector.

Quality of information: H **Progress against indicator:** ▲

RATIONALE

This indicator provides information on the role that forest products play in storing, cycling and releasing carbon. Forest products delay the release of carbon into the atmosphere and are more sustainable than products with manufacturing processes that have significant carbon footprints.

2008 COUNTRY REPORT

The carbon stocks in New Zealand's harvested wood products have been estimated using a New Zealand HWP model developed by Wakelin et al (2008). The estimated carbon stocks use statistics from the *United Nations Food and Agriculture Organization for production, export and import of forest products in New Zealand* (FAO, 2009). The model is based on Chapter 4 of the *Agriculture, Forestry and Other Land Uses* (AFOLU) volume of the revised *2006 IPCC guidelines for greenhouse gas inventories* (IPCC, 2006). The Conference of the Parties to the United Nations Framework Convention on Climate Change accept the 2006 IPCC guidelines for the preparation of national greenhouse gas inventories. However, they provide more detailed methodologies to account for HWP when compared with the currently used inventory guidelines (IPCC, 1996, 2000, 2003).

The lifespan of carbon in wood products is divided by the lifespan in-use (accounted as HWP) and after the product is discarded (accounted in the waste sector). IPCC default values for half-life in-use for different HWP were used, since there are no country-specific values available. Some of the default values applied to New Zealand's HWP are[1]:

- Sawn wood 35 years
- Veneer, plywood and structural panels 30 years
- Non-structural panels 20 years
- Paper 2 years

The 2006 guidelines present four approaches for HWP reporting. The first three are as defined by Brown et al (1999):

Stock change approach – Estimates net changes in carbon stocks in the forests and the wood products pools within national boundaries. Changes in carbon stock in forests are reported in the country in which the wood is grown (producing country). Changes in the products pool are reported in the country where the products are used (consuming country). These stock changes are reported within national boundaries, where and when they occur.

Atmospheric flow approach – Reports net emissions or removals of carbon to/from the atmosphere within national boundaries, where and when emissions and removals occur. Removals of carbon from the atmosphere due to forest growth are reported in the producing country, while emissions of carbon to the atmosphere from oxidation of harvested wood products are reported in the consuming country.

1 Table 3a.1.3 in *Good Practice Guidance for Land Use, Land Use Change and Forestry* (IPCC, 2003).

Production approach – Estimates the net changes in carbon stocks in the forests and the wood products pools, but attributes both to the producing country. This approach inventories domestically produced stocks only and does not provide a complete inventory of national stocks. Stock changes are reported when, but not where they occur if wood products are traded.

The fourth methodology defined in similar terms by Ward (2004):

Simple decay approach – Estimates the net emissions or removals of carbon to/from the atmosphere when, but not where they occur if wood products are traded. Removals of carbon from the atmosphere due to forest growth, and emissions resulting from forest harvesting are accounted for in the producing country.

The New Zealand HWP model uses default conversion factors from product units to carbon[2] and a carbon fraction of 0.5.

2 Table 12.4 in *2006 IPCC Guidelines for National Greenhouse Gas Inventories* (IPCC, 2006).

Mahinapua Scenic Reserve, West Coast, South Island.

TABLE 5.3: ESTIMATION OF HWP CONTRIBUTION BY EACH IPCC APPROACH, IN MILLION TONNES (MT) CO_2-EQUIVALENT (CO_2-E) PER YEAR

APPROACH FOR HWP REPORTING	CHANGE IN HWP STOCK (MT CO_2-E/YR)		
	1990	2003	2008
Stock change approach	1.08	2.65	2.45
Atmospheric flow approach	5.31	13.62	13.65
Production approach	2.29	6.96	7.35
Simple decay approach	6.04	10.84	7.73

The results presented in Table 5.3 presents the HWP contribution estimated for each approach (total CO_2 removals). These results indicate that overall the HWP pool is growing (Table 5.4). This trend is consistent with the information reported in 2003, with all reporting methods indicating an increase in carbon stored in HWP since 1990. In 2008, it was estimated that HWP stored between 2.5 (stock change approach) to 13.7 (atmospheric flow approach) million tonnes of carbon dioxide. The atmospheric flow approach represents the highest HWP contribution, favourable for a country like New Zealand which exports more than half of the forest products it produces and has relatively low imports.

SOURCES OF INFORMATION

Brown, S; Lim, B; Schlamadinger, C (1999) *Evaluating approaches for estimating net emissions of carbon dioxide for forest harvesting and wood products*. Report from IPCC Expert workshop, Dakar, May 1998. IPCC/OECD/IEA. OECD; Paris; France; 20 p.

Wakelin, SJ (2008) *Carbon inventory of New Zealand's planted forests–calculations revised in October 2008 for New Zealand's 2007 greenhouse gas inventory*. Scion; Rotorua. Contract report for the Ministry of Agriculture and Forestry; Wellington.

TABLE 5.4: TOTAL NET REMOVALS WITHOUT AND WITH HWP CONTRIBUTION, IN MILLION TONNES (MT) CO_2-EQUIVALENT PER YEAR

NET FOREST REMOVALS WITHOUT AND WITH HWP CONTRIBUTION	NET FOREST REMOVALS (MT CO_2-E/YR)		
	1990	2003	2008
NET PLANTATION FORESTS REMOVALS WITHOUT HWP CONTRIBUTION (WAKELIN, 2008)	18.17	24.07	23.97
NET REMOVALS WITH HWP CONTRIBUTION			
Stock change approach	19.25	26.73	26.42
Atmospheric flow approach	23.47	37.69	37.62
Production approach	20.46	31.03	31.32
Simple decay approach	24.21	34.91	31.69

Food and Agriculture Organisation (FAO) (2009) *FAOStat: FAO statistical databases*. Food and Agriculture Organisation of the United Nations, Rome. http://faostat.fao.org/site/626/default.aspx#ancor

Intergovernmental Panel on Climate Change (IPCC) (2006) *2006 IPCC guidelines for national greenhouse gas inventories*. Prepared by the National Greenhouse Gas Inventories Programme, Eggleston, HS; Buendia, I; Miwa, K; Ngara, T; Tanabe, K (eds). IGES; Japan.

Intergovernmental Panel on Climate Change (IPCC) (2003) *Good practice guidance for land use, land use change and forestry*. Penman, J; Gytarsky, M; Hiraishi, T; Krug, T; Kruger, D; Pipatti, R; Buendia, L; Miwa, K; Ngara, T; Tanabe, K; Wagner, F (eds). IPCC/OECD/IEA/IGES; Hayama; Japan.

Ward, M (2004) *Harvested wood products – a beginning guide to key issues*. http://homepages.paradise.net.nz/murrayw3/documents/pdf/HWP%20article.pdf

Wakelin, SJ; Turner, JA; Love, S; Nebel, B (2008) *New Zealand's harvested wood products carbon accounts*. Scion; Rotorua. Contract report for the Ministry of Agriculture and Forestry; Wellington.

FURTHER READING

Intergovernmental Panel on Climate Change (IPCC) (1997) *Revised 1996 IPCC guidelines for national greenhouse inventories*. Houghton JT; Meira Filho, LG; Lim, B; Treanton, K; Mamaty, I; Bonduki, Y; Griggs, DJ; Callander, BA (eds). IPCC/OECD/IEA; Paris; France.

Intergovernmental Panel on Climate Change (IPCC) (2000) *Good practice guidance and uncertainty management in national greenhouse gas inventories*. Penman, J; Kruger, D; Galbally, I; Hiraishi, T; Nyenzi, B; Emmanuel, S; Buendia, L; Hoppaus, R; Martinsen, T; Meijer, J; Miwa, K; Tanabe, K (eds). IPCC/OECD/IEA/IGES; Hayama; Japan.

Indicator 5.c Avoided fossil fuel carbon emissions by using forest biomass for energy

New Zealand forest industries use about 250 000 tonnes of forest biomass per year as a source of energy. There is potential for this to increase considerably in the future. About 7 percent of the country's primary energy comes from forest biomass. The degree of fossil fuel carbon emission avoidance depends on which type of energy source the forest biomass replaces.

Quality of information: M **Progress against indicator:** ▲

RATIONALE

This indicator provides information about the amount of energy produced from forest biomass and the extent to which it offsets the need to burn fossil fuels, thereby benefiting the global carbon budget and lowering carbon emissions.

2008 COUNTRY REPORT

New Zealand has about 1.8 million hectares of plantation forests throughout the country. Residues from harvesting operations offer a significant source of biomass that has a potential to be used for energy. Harvest residues currently yield about 250 000 tonnes per annum, largely used in the wood processing industry. The volume of residues potentially available from forest harvesting is significant and will increase over the time, estimated to peak at 5 million tonnes by 2030.

Forest biomass plays a small role in New Zealand's consumer energy supply. Its share has been around 7 percent of the total primary energy supply and 25 percent of the renewable energy supply. In 2007, 6.9 percent (35.4 petajoules) of New Zealand's total consumer energy of 508.2 PJ came from biomass. Biomass residues could provide another 60 PJ per annum. The contribution from residues could theoretically rise to 90 PJ in the future. The potential also exists to substantially increase the nation's biomass contribution to energy from dedicated energy forests.

Figure 5.1 illustrates the contribution of biomass and other renewables to the New Zealand's total primary and renewable energy supply since 2000. In 2007, biomass was the second largest source of renewable consumer energy in the country. Figure 5.2 illustrates the breakdown of the New Zealand's renewable consumer energy supply in 2007.

The use of biomass for energy has not been increasing in New Zealand because there are cheaper indigenous sources of other renewable and fossil energy available: hydro, wind and coal. However, there is a potential of a step-change if bioethanol from biomass becomes competitive in price with fossil fuels.

The use of biomass in New Zealand involves mainly combusting wood residues to provide process heat in the wood processing industry, and to a lesser extent for co-generation and residential space heating. In the forestry industry, heat plants fuelled by biomass are common. Biomass, usually wood waste, is also supplemented by fossil fuels such as coal and gas. The use of biomass for process heat and electricity generation also has the advantage of reducing waste disposal costs while utilising a renewable resource. Co-firing is used to improve boiler performance when using low-quality primary fuels.

FIGURE 5.1: PRIMARY, RENEWABLE AND BIOMASS ENERGY SUPPLY IN NEW ZEALAND 2000–2007

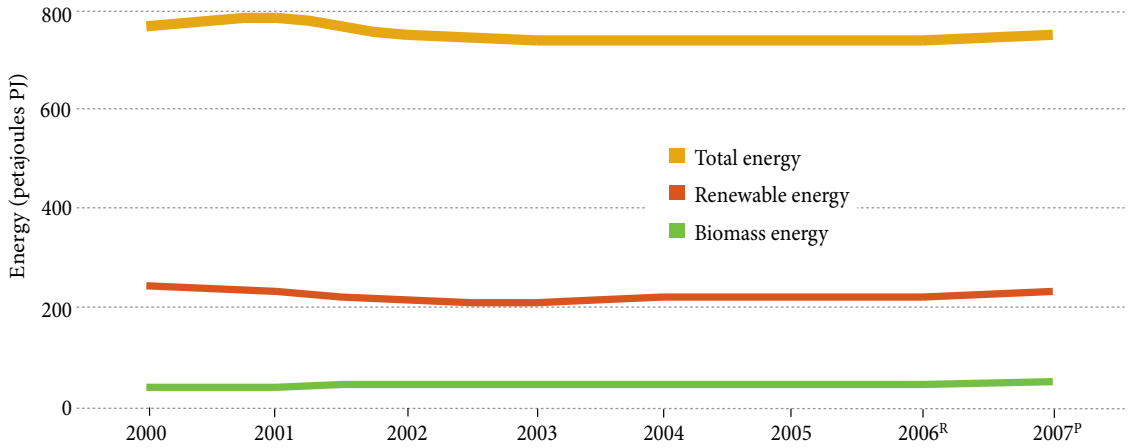
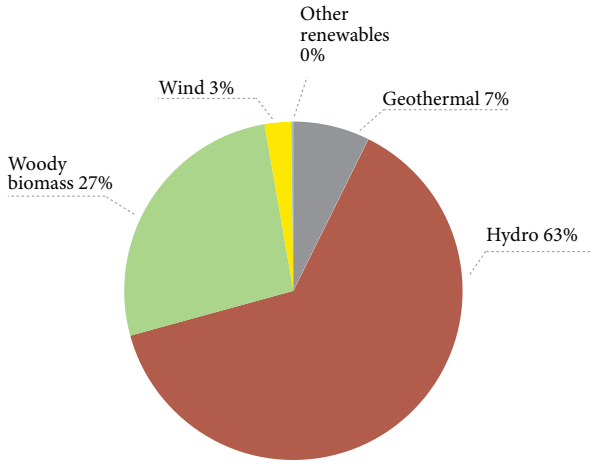


FIGURE 5.2: RENEWABLE CONSUMER ENERGY IN NEW ZEALAND



Source
Ministry of Economic Development (2008).

The use of biomass can be considered as avoiding use of fossil fuels, thereby benefiting the national carbon budget and lowering carbon emissions. However, there are some complexities in calculating avoided emissions. The biomass energy could be replaced by renewable sources (geothermal, wind and hydro) or fossil fuels, hence avoided emission depend upon the choice of the energy source.

If it is considered that all the current biomass energy (35 PJ in 2007) was replacing coal, the avoided emission would be about three million tonnes of CO_2-e using an average emission factor of 89.4 kilo tonnes of CO_2-e per PJ.

SOURCES OF INFORMATION

Ministry of Economic Development (2008) *New Zealand energy data file*. Available at: http://www.med.govt.nz/templates/StandardSummary____15169.aspx

SCION (2007) *Bioenergy options for New Zealand: situation analysis – biomass resources and conversion technologies*. Scion; Rotorua.