GREEN Grid

Future Proofing New Zealand's Electricity Supply

Environmental Aspects of Photovoltaic Solar Power: The New Zealand Context

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This study was carried out to provide some clarity of the environmental impact of photovoltaic (PV) panels for New Zealand. It involved qualitative analysis of the environmental impacts, and used quantitative information from foreign life cycle analyses to firm the magnitude of the findings. This poster summarizes some of the results.

PV Panel Types

PV panels are the dominant contributor to a PV system's environmental impact. Table 1 below compares the different types.

Table 1: Energy usage of manufacturing as a percentage of mono-crystalline panels

Generation	Description	Technology Type	Top Cell Efficiency (2014)	Best Industrial Panel Efficiency (2012)	Market Share (2013)
1st	Mature technology, mass produced for at least 20 years	c-Si Mono	25.0%	20.5%	Approximately 90%
		c-Si Multi	20.8%		
2nd	Recently entered large scale production	CdTe	21.5%	12.1%	Approximately 10%
		CIS/CIGS	21.7%	14.5%	

Crystalline Silicon (c-Si), Cadmium Telluride (CdTe), Copper Indium Gallium Selenide (CIGS)

Manufacturing

The majority of the impact is from the manufacture of the panel. The two major components are to the climate (climate change) and to soil and waterways through acidification. The two aspects to keep in mind when assessing PV panel impact are (1) the manufacturing location and (2) the technology type.

The electricity grid of the manufacturing country supplies the large amount energy to produce the panels. An example is China, which in 2012 generated 77% of its electricity from fossil fuels and it is a dominant producer of PV panels. Many other PV panel producing countries rely on fossil fuel generation, which results in the emissions of greenhouse gases or GHGs (CO_2, CH_4, etc.) and acidification gases (SO_2, NO_X).

All the panel types have different energy requirements due to the different manufacturing processes. This means that not all panels have the same environmental impact. Table 2 below shows the energy input differences between panel types.

Table 2: Energy usage of manufacturing as a percentage of mono-crystalline panels

Mono-crystalline	Multi-crystalline	CIGS	CdTe
100%	58.6%	40%	22.9%

Figure 1 illustrates the GHG payback period depending on the place of manufacture and technology type. It is based on a life cycle analysis where the panels were manufactured in Europe and China, and installed in Southern Europe. The results of the life cycle analysis were altered to be more representative of New Zealand.

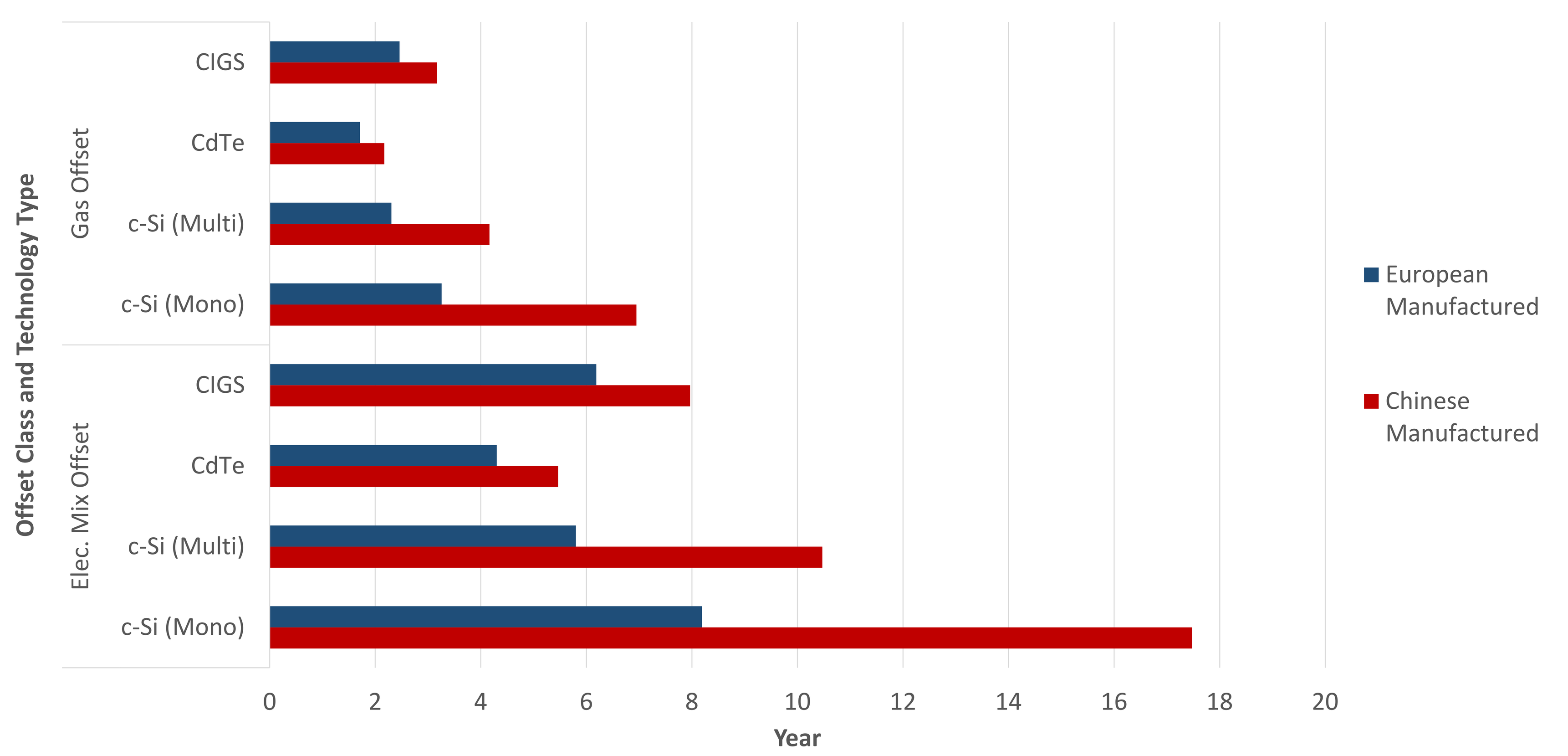

Figure 1: GHG Payback Period

PV in New Zealand

The major environmental benefit that PV can offer to a country is through the reduction of GHG emissions. To understand the benefit that PV can have in New Zealand, how the generated energy interacts with the grid needs to be understood. The generated energy from a PV system can be considered a negative load. Geothermal and coal generation is relatively constant during sunlight hours (i.e. when the PV system is producing electricity). Wind is not going to be curtailed in reaction to solar generation, leaving gas or hydro to be offset. Offsetting gas directly is ideal, but offsetting hydro is, at first glance, detrimental. However, if hydro is offset by solar generation, a small amount of water is conserved which is likely to offset gas in the future. The means gas is indirectly offset.

The common way avoided GHG emissions are calculated is by using the overall emissions factor of the grid. For New Zealand, this reduces PV's perceived benefit. The overall emissions factor for New Zealand's electricity grid was 171 g CO_2-e/kWh, whereas gas generation's factor is 430 g CO_2-e/kWh (2013 values). From the explanation above, gas generation will be offset, meaning the calculated avoided emissions is a factor of 2.5 times higher.

PV can aid New Zealand in two ways: (1) to reduce the electricity emissions in order to achieve the GHG emissions targets and (2) to help reach the target of 90% of electricity demand provided by renewable energy sources by 2025.

The avoided emissions due to PV in 2014 was 5.4 Gg CO_2-e/kWh. Compared to the electricity sector's total emissions of 5476 Gg CO_2-e/kWh, as seen of Figure 2. This will increase with expanding installed capacity of PV but there are better methods to reduce GHGs, such as electric vehicles.

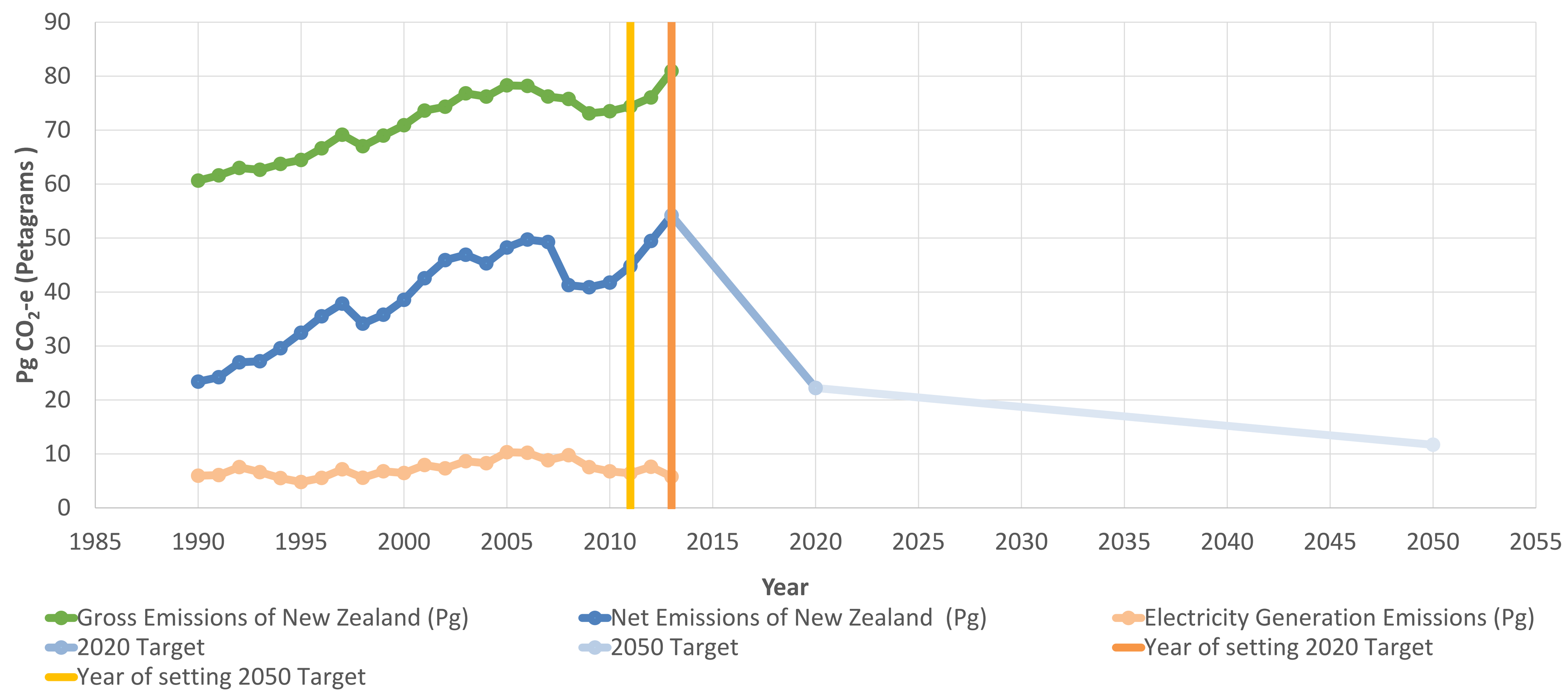

Figure 2: New Zealand's Historical GHG Emissions

Figure 3 shows recent increase in renewable proportion has been due to an increase geothermal generation and the reduction from coal. PV does contribute to the renewable energy proportion. However, with such low capacity factors across New Zealand, this is unlikely to be significant, at least in the near term.

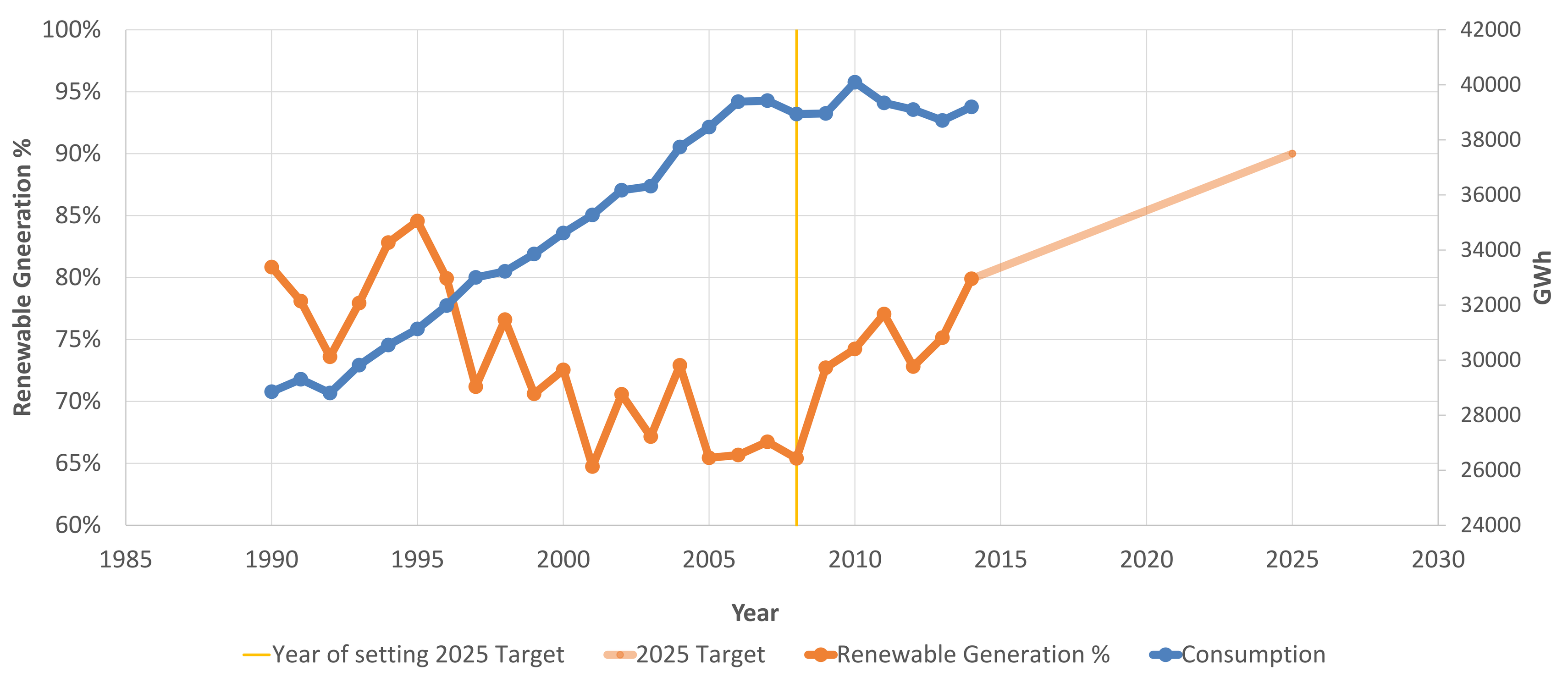

Figure 3: New Zealand's Renewable Generation % and Demand

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