Recycling of Photovoltaic Modules in Australia: An Analysis of Viability and Potential Value

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Solar panels have a limited lifespan and will eventually turn into waste. Worldwide, the number of photovoltaic panels at the end of life (EoL) is increasing exponentially (Weckend et al., 2016). As evident from Figure 1, the first great influx of waste modules will happen as early as 2020, with a cumulative 850,000 tons of waste (Weckend et al., 2016). This is a 5% annual growth rate up till 2020, which is expected to continue further at greater than 3% annually, reaching 78 million tonnes of photovoltaic waste by 2050, as shown in Figure 1 (Weckend et al., 2016).

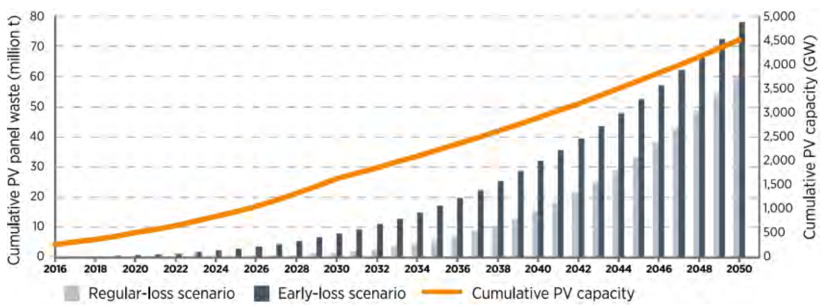

Figure 1. Estimated cumulative global waste volumes (million tonnes) of end-of-life PV panels (Weckend et al., 2016)

For solar energy to remain sustainable, it is inevitable that innovative methods to efficiently deal with EoL waste are investigated. Hence, the goal of this study is to examine the viability of recycling PV modules as a potential solution from the environmental point of view. Specifically, this study aims to examine whether the environmental benefits attained through the recycling of multi-crystalline silicon (multi-Si) panels outweigh the potential environmental burden of the recycling process. The LCA methodology will be used to quantify the environmental impacts, taking into consideration the influence that recycling has on the production of new panels. The open-source software, OpenLCA, was used to conduct this LCA, along with the ecoinvent database.

This paper focuses on a case study based on the Moree Solar Farm, whereby assuming that at the end of its lifetime, the PV modules will be recycled in a facility near the solar farm. The materials and energy recovered from the recycling process are fed back into the production of new panels, being manufactured in the same facility, that are to be re-installed at the Moree Solar Farm. This hypothetical scenario was chosen to keep transport impacts outside the scope of the study.

The state of the art technology, ‘Full Recovery End Life Photovoltaic’ (FRELP) recycling process was chosen as the recycling technology to be analysed, due to the availability of life cycle inventory data.

All analysis was conducted with respect to five impact categories, that are frequently used for solar energy production (Stolz and Frischknecht, 2017) and for the recycling of multi-Si panels (Latunussa et al., 2016, Müller et al., 2011). These include climate change potential, abiotic resources depletion potential, photochemical ozone creation (oxidation) potential, human toxicity potential (carcinogenic effects), and freshwater ecotoxicity.

In order to make comparisons and determine the net environmental benefits, three scenarios were analysed:

- Scenario 1: this is the base case scenario, which considers no recycling. The impacts were calculated only considering the production and transportation of the panels installed at the Moree Solar Farm.
- Scenario 2: it was assumed that 50% of the total number of panels installed at the Moree Solar Farm will be recycled and that the materials and energy recovered from this process will be reused for producing new panels for the solar farm.
- Scenario 3: it was assumed that 100% of the panels installed at the Moree Solar Farm will be recycled.

For all cases, the panels not being recycled are assumed to be disposed into a landfill, at the end of their lifetime. The net impacts obtained in the 50% and 100% recycling cases were compared to the base case. Hence, net reductions represent the potential benefits that can be obtained from recycling PV panels.

The LCA results show that in both the 50% and 100% recycling cases, there was a net benefit to the environment (see Figure 2). The highest reduction was observed for the abiotic resources depletion potential, with a decrease of 6.6% for scenario 2 and of 13.3% scenario 3, due to the reuse of the materials and energy recovered from the recycling process. The measure with the lowest reduction, or least environmental improvement, was that of the Photochemical ozone creation (oxidation) potential, with a 4.9% reduction for scenario 2 and a 9.8% reduction for Scenario 3.

From this study, it is evident that recycling provides an important environmental benefit, for all the analysed impact categories and scenarios. Therefore, it is concluded that recycling of photovoltaic panels can, in fact, be a very viable and valuable solution to combat the increasing photovoltaic waste crisis, in terms of environmental impacts.

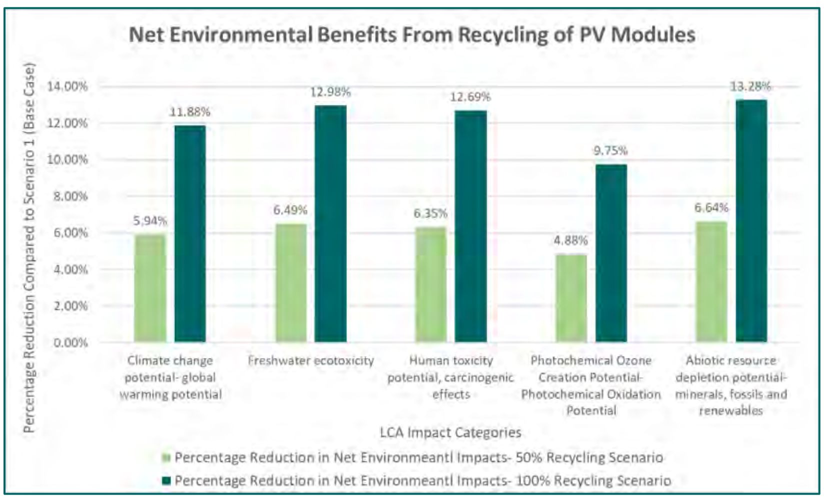

Figure 2. Net environmental benefits from the recycling of PV modules

References

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