Friday, 9 October 2020

Committee Secretary
Standing Committee on Industry, Innovation, Science & Resources
Department of the House of Representatives
Canberra ACT 2600
iisr.reps@aph.gov.au
CC: Peter.Richardson.Reps@aph.gov.au

Dear Sir or Madam

RE: Public Hearing Invitation - Inquiry into Waste Management and Recycling

The Clean Energy Council (**CEC**) welcomes the opportunity to provide a response to the inquiry of waste management and recycling of wind turbines and solar PV panels, conducted by the House of Representatives Standing Committee on Industry, Innovation, Science and Resources.

The Clean Energy Council is the peak body for the clean energy industry in Australia. We represent and work with Australia's leading renewable energy and energy storage businesses, as well as rooftop solar installers, to further the development of clean energy in Australia. We are committed to accelerating the transformation of Australia's energy system to one that is smarter and cleaner. This includes engaging with the industry, CEC accredited installers and members to lead a positive impact on the environment by responsible waste management and recycling.

This submission explores the end-of-life and disposal processes for both the solar PV industry and the wind industry in Australia. We identify key barriers to the recyclability of relevant components, outline current recycling studies and offer suggestions on how the Government can assist in addressing these issues.

Solar PV panels

The average lifetime of a solar PV module is around 20 to 25 years. The earliest set of solar panels have now started being decommissioned and, as we approach 2050, the projected amount of waste from retired solar panels in Australia is over 1,500 kilo-tonnes. There is a very small return from the recycling of constitute materials, and therefore there is currently a relatively low incentive for recycling of solar PV panels to occur.

Solar PV components

The main contributor to the total weight of a typical crystalline silicon PV module is about 75 per cent glass, followed by 10 per cent polymer, eight per cent aluminium, five per cent silicon, one per cent

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copper and small amounts of silver, tin, lead, and other metals and components. Currently only the aluminium plates surrounding the solar panels and glass are recyclable within Australia.

The main barrier to recycling solar PV panels is the difficulty in dissolving the glue which holds the components together within the solar PV panels. If the glue holding the components of the solar PV panels can be dissolved efficiently, then most of the components within solar PV panels, such as different types of metals, glass and silicon, can be recycled within Australia today.

Another issue is that households often remove rooftop solar PV panel prematurely around the 10-12-year mark, instead of the intended 20-25 years. The common reason is, if some part of the solar PV panel system gets damaged it requires the whole system to be replaced. Increasing the recyclability and the recycling rates of PV panels is important for reducing waste to landfill and maximising resources efficiency.

Potential solutions to recycling barriers

One partial solution for reducing solar PV panels going into landfill is to develop a secondary market to extend the life of the existing stock. In such as scheme, the performance of older modules would be tested, and properly functioning panels could be resold.

Another solution is to establish a new product stewardship scheme for solar PV panels. Such a scheme should start by having multiple collection points for old solar panels around Australia which stop old PV panels from reaching landfill. The CEC suggests that e-waste is banned from landfill in each jurisdiction, as is the case in Victoria. Having a single collection point in different regions would increase the value of recycling solar PV panels (as bulk recycling increases the economic returns from recycling solar PV panels).

The CEC is working across the industry and currently providing in-kind contributions in the form of technical advice and accredited installer data and analysis for organisations around Australia to build a solution to reuse and recycle solar PV panels. The CEC is involved in several proposed solar PV recycling projects across Australia, which are anticipated to commence over the next three years. Below is a brief description of these proposed projects:

1. **Integrating Circular Economy into Photovoltaic Product Stewardship Design - Griffith University (Status: Commencement subject to funding)**

   This project is working to develop a managerial toolbox that will assist planning and investment of existing and potential industry-led photovoltaic product stewardship schemes to expand their operational scope and capabilities. Key project activities and outcomes include development of evidence-based strategies to promote industry-led PV recycling schemes, a tool for prediction of spatial distribution of photovoltaic waste and collection rates, an interactive simulation tool to evaluate industry operational costs and benefits and a strategic planning tool for repurposing used solar panels. This work will support our industry in the on-going photovoltaic product stewardship options assessment by understanding industry drivers and operational feasibility.

2. **Product Stewardship options for Solar PV panels - University of South Australia (Status: Commencement subject to funding)**

   This project intends to inform the detailed design of a product stewardship scheme for solar PV panels to complement the National Project agenda and provide the development and uptake of related recycling technologies guidance to satisfy stakeholder expectations. The project aims to establish end-of-life measures for solar PV panels which are endorsed by the project stakeholders.

In addition, the project will accelerate the implementation steps of end-of-life management processes of solar PV panels.

3. **NSW EPA Circular Solar Trials potential - PV Industries, ReSource and MRI e-cycles solutions (Status: Commencement subject to funding)**

This potential project plans to collect data on solar PV panels and batteries that are being decommissioned to gain a greater understanding of decommissioning, waste management and disposal practices. This project would implement a small-scale collection and logistics network in strategically significant regions in NSW, as well as trial different methods for aggregation, collection and processing. The project also plans to explore potential end-markets for reuse of second-hand PV panels and batteries.

The CEC has also worked with the Gippsland Climate Change Network on a Statement of Opportunity in relation to the reuse of solar panels and is planning to collaborate with Task Group 15 of the PV Quality Assurance Taskforce to explore more options on the reuse/repair and recycling of solar PV panels.

The CEC is also aware of the following national solar PV recycling research projects/funding taking place:

- The NSW Government has committed $10M to boost solar panel recycling.[1]
- Researchers at Deakin University are working to develop a solar panel recycling solution to recycle silicon.[2]
- A total of $15.14 million has been awarded through the Australian Renewable Energy Agency (ARENA) to support research teams at six Australian universities.[3] The two-year R&D projects will support solar PV in the following areas:
  - Improvements to cost-effectiveness of silicon-based panels
  - Increasing cost-effectiveness of silicon-based solar PV through use of tandem materials
  - Development of new materials for cost-efficiency purposes or new deployment applications
  - New solutions, including upfront solar PV panel designs and end of life processing, that increase the cost-effectiveness of sustainable end-of-life management of solar PV panels.

As part of the CEC's role in building knowledge and awareness of responsible practices in the industry, we will also be hosting a free webinar on sustainable and responsible solar recycling and disposal of batteries for CEC solar installers and retailers on 14 October at the All-Energy Conference this year.

Wind turbines

The standard lifetime of a wind turbine is approximately 20-25 years. With a complete mechanical re-service, it is possible to have a half-life refurbishment or increase the life span by at least another 10 years. The CEC has spoken with some members who now anticipate the life span of their turbines to be 30 years.

At the end of their life, wind farms are either fully decommissioned or 'repowered', with both processes requiring the retirement of the current turbines. There are currently 101 wind farms built across Australia. The CEC understands that around 15 per cent of these farms are over 15 years old, with only two farms being 20 years or older. The CEC is not aware of any utility-scale wind farms in Australia that have

[1] https://wastemanagementreview.com.au/nsw-commits-10m-to-boost-solar-panel-recycling/
[2] https://www.deakin.edu.au/about-deakin/media-releases/articles/deakin-researchers-find-key-solution-to-recycling-solar-panels
[3] https://arena.gov.au/news/research-boost-for-solar-panel-efficiency-and-cost-reduction/

decommissioned their turbines to date. However, as preparation for the repowering or decommissioning of wind farms typically begins a few years prior to planned end-of-life, owners of wind farms built during the first wave of investment in the early 2000s are now beginning preliminary investigations into recycling and waste management of their turbines. Some international companies are able to draw on experience from the decommissioning of wind farms in Europe.

Wind turbine components and recycling capabilities

A wind turbine is generally comprised of a foundation, a tower, a nacelle (which contains several mechanical components including the gear box), and three blades. A key principle in recycling wind turbines is separating the different materials that make up these different components.

Dismantling a turbine is as almost as complex as its construction, with an estimated cost of approximately $150,000 to dismantle a turbine, not including the cost associated with recycling labour.

Foundation

The foundation of the turbine is made of reinforced concrete. Some turbine foundations will remain in situ in adherence with the planning permit as it may be more environmentally disruptive to remove the entire foundation. If removed, the concrete can be recycled, crushed and used within fresh cement. It may also be possible to remove the foundation using hydro demolition technologies.

Tower and nacelle

The tower and the nacelle contain a large amount of steel or steel derivatives which have an easy and well-established recycling process in Australia. However, in order to recycle the steel, the paint on the turbine must first be removed. This can be achieved through techniques such as sand blasting however the volume of marine grade paint presents a challenge and labour-intensive removal process.

Internally, the tower and nacelle contain electrical materials, such as copper cabling and aluminium, which can also be recycled. The electrical components also integrate a large volume of plastics (eg. insulating the cables) which, particularly in the earlier wind turbines, are not easily recycled due to their age.

The CEC notes recycling facilities for steel and copper are typically located in or near major population centres, and as such the dismantled components would be unlikely to be handled or processed by the regional and rural communities in which the wind farms are located.

Blades

Due to the composite materials contained in the current generation of turbine blades, they currently present a challenge to recycling. First generation blades were made from fibreglass, while the current generation (the past decade) is made from carbon-fibre. While it may be possible to reuse the blades in some circumstances, there is currently no clear end-of-life pathway for blades in Australia.

This is a global issue in a range of industries, not just the wind energy sector. The recycling of fibreglass is becoming the focus of intensive work in Europe in particular, which has had a strong focus on product circularity and recyclability. The main technology for recycling composite waste in Europe is through cement co-processing which is commercially available in some European countries.[4] Through this process, the glass fibre is recycled as a component of cement mixes, while the polymer matrix is burned to fuel the process which reduces the carbon emissions of cement production. However, this process is

[4] https://windeurope.org/wp-content/uploads/files/about-wind/reports/WindEurope-Accelerating-wind-turbine-blade-circularity.pdf

so far only suitable for glass-reinforced composites. There is currently no clear large scale recycling option for carbon-fibre, which is an imminent global research topic in composite engineering.[5] WindEurope, the peak body for the wind energy industry in Europe, has also indicated that the following alternative methods may be used to recycle composite materials, [6] although these are available at different levels of maturity and scale, and vary in their effect on fibre quality:

- Mechanical grinding
- Pyrolysis
- High voltage pulse fragmentation
- Solvolysis
- Fluidised bed

The CEC notes that as part of the effort to accelerate wind turbine circularity, a French consortium is currently working to develop blades that have increased longevity and are able to be recycled at the end of their life.[7] As many wind farms in Australia source their equipment from overseas, it is possible that these blades will enter the Australian market in the coming years.

Potential solutions to recycling barriers

It is clear that the biggest challenge in recycling wind turbines is the blades. As mentioned above, it is possible to recycle the composite material through cement-co-processing. There are a small number of participants in the chemical and recycling industry that are investigating the commercial feasibility of recycling blades. However, any such market requires a large volume of material, unable to be provided by the wind industry alone, and incentives to become viable.

Fortunately, the recycling of composite material is a cross-sector issue, with industries within the construction, electronics, transportation, and marine sectors all producing composite waste.[8] The CEC sees a role for the Government in facilitating a business-case investigation into the size of this potential market of recycling composite waste, creating a new aspect of the recycling industry and new jobs. The CEC also recommends creating incentives for industry players to participate in composite recycling such a cement co-processing, as well as funding research into new and alternative methods of composite recycling.

Repurposing of wind turbine blades

There are a few instances in which projects have found a different application for some old wind turbine blades. For example, in Europe, blades have been reused for playgrounds, street furniture, bicycle shelters and walkways[9] (see the image below from the Netherlands).

These re-purposing options could also play a small role over time in reducing the need for blade recycling solutions.

[5] Hao, Siqi; Wong, Kok H; Liu, Xiaoling and Rudd, Chris D. Importance of chemical pretreatment for carbon fibre recycled from composite by pyrolysis [online]. In: ICCM22 2019. Melbourne, VIC: Engineers Australia, 2019: 4169-417.
[6] https://windeurope.org/wp-content/uploads/files/about-wind/reports/WindEurope-Accelerating-wind-turbine-blade-circularity.pdf
[7] https://reneweconomy.com.au/french-consortium-developing-first-completely-recyclable-wind-turbine-blades-31940/
[8] https://etipwind.eu/files/reports/ETIPWind-How-wind-is-going-circular-blade-recycling.pdf
[9] https://windeurope.org/wp-content/uploads/files/about-wind/reports/WindEurope-Accelerating-wind-turbine-blade-circularity.pdf

Playground in Rotterdam, the Netherlands built from decommissioned wind turbine blades.[10]

Conclusion

Thank you for the opportunity to contribute an update on the current status of waste management and recycling within the renewable energy sector.

Respect for the environment is a core value of the renewable energy sector and we are committed to working collaboratively with our members, the broader supply chain, research institutions, the recycling and waste management sector, and government to find sustainable solutions for end of life management of renewable energy equipment.

Yours sincerely,

Anna Freeman
Director Energy Generation

[10] https://www.amusingplanet.com/2017/01/the-second-life-of-wind-turbine-blades.html