The emergence of a circular PV economy

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The End-of-life (EOL) management of PV panels has been discussed for over a decade, with many reports, strategies, policies, and industries created to minimise their waste impact. As the cohesiveness of the European and USA PV value chain evolves, so too does access to new thinking and ways of designing, manufacturing, and operating to move from recycling to circularity, where we stop waste being produced in the first place. This is potentially a big shift in thinking and redesign of componentry and manufacturing processes for solar PV.

Since 2018, Circle Economy has been producing the Circularity Gap Report, to help understand how circular economy strategies can contribute to achieving the goals of the Paris Agreement. It also helps give clarity on where we stand today in achieving these goals and how material extraction and GHG emissions are linked.

The 2022 Circularity Gap Report highlights that our world is only 8.6% circular. To put this in context, in 2019 global use of materials exceeded 100 billion tonnes, with over 90% of all the materials extracted and used, wasted; currently only 8.6% of the materials make it back into the economy.[1]

The 2022 report states that 'Between the COP25 in Paris in 2015, where the Paris Agreement was formed, and COP26 in

Glasgow in 2021, 70% more virgin materials were extracted than what the earth can safely replenish.' There is a growing urgency to step away from the take, make, waste linear, economic model. See Figure 1 on following page.

According to the Ellen MacArthur Foundation, a circular economy is based on three principles, which is driven by design to eliminate waste and pollution, circulate products and materials at their highest value and regenerate nature. Using these principles enables companies to identify additional, circular value from their products and materials, and mitigate risks from material price volatility and supply.

The circular economy has critical importance in supporting the development of new industries and employment, while cutting greenhouse gas emissions and making more efficient use of finite natural resources.

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The solar PV industry now has the opportunity to learn what actions other sectors are taking to embed circularity into their organisations.

Car manufacturer Volvo, with its long-term goal of becoming a circular business by 2040, is aiming to save nearly €1B and reduce GHG 2.5 million tonnes annually.

To become a circular business in less than two decades, Volvo believes that every part in its cars should be designed, developed, and manufactured to be used and reused, either by the company or its suppliers.

It anticipates that optimising its use of materials and eliminating waste throughout the process will lead to reduced costs and positive environmental impact, whilst unlocking new revenue streams.

Currently, Volvo remanufactures parts such as gearboxes and engines to make better use of material and reduce emissions. In 2020, around 40,000 parts were remanufactured, saving nearly 3,000 tonnes of CO_2 emissions.[2]

New business models such as giving electric vehicle batteries a second life are important from a circular business perspective. By using batteries in energy storage applications outside of cars, new revenue streams and cost savings can be realised, while also extending the batteries' lifecycles.

We are seeing several collaborations across the globe, for such creative solutions as refrigeration, water purification and emergency response systems being built for EV batteries which have four life cycles in place.[3]

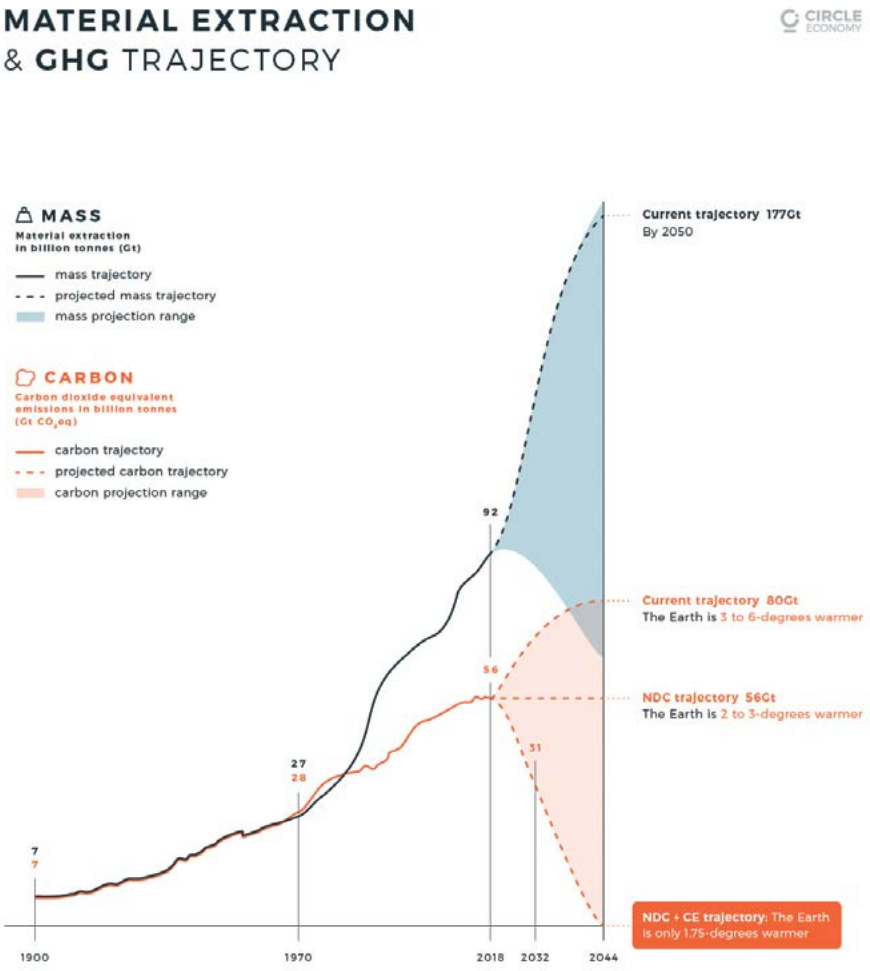
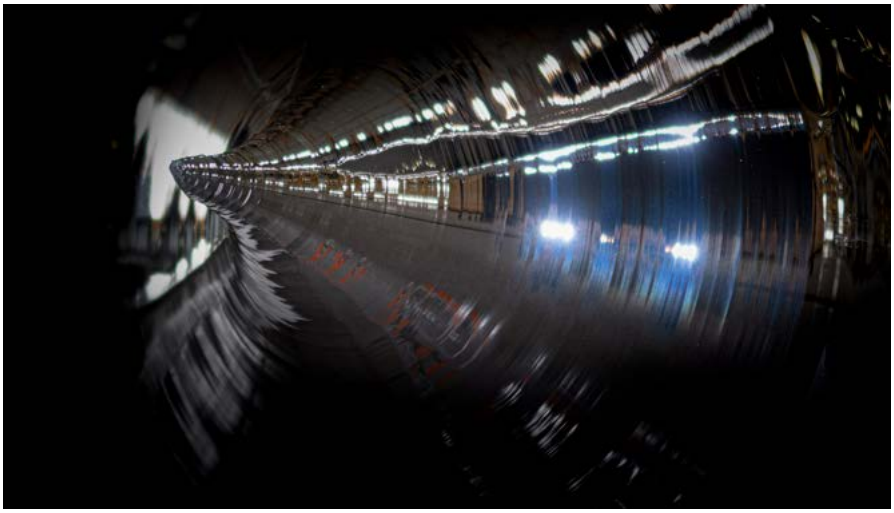


Figure 1

Tesla's EOL process saw the avoidance of mining nearly 1,300 tons of nickel recycled, 80 tons of cobalt and some 400 tons of copper due to a closed recycling process.[4]

Material handling has a large impact on global greenhouse gas emissions of 70%. Therefore, to continue even further in making a meaningful contribution to emission reductions the solar PV sector has an important role in transforming and embedding circularity across the value chain. According to Circle Economy, unless we transform 'how we use materials to satisfy our needs, we cannot meaningfully cut emissions.'

Circularity in the design process across the PV value chain is essential to reducing the global footprint. So, what is the solar PV industry doing to make this shift from linear to circular manufacturing?



According to the Circular PV Alliance (CPVA), much of the great work being undertaken is in isolation. They believe this work will benefit from a 'central, coordinated platform to bring together all the pieces of the puzzle required to establish a thriving solar energy circular economy'.[5]

Norwegian Crystals believes that industry coordination to both revitalize the PV industry in Europe and execute the development of a circular manufacturing ecosystem is critical to achieving Scope 3 gHg ambitions and securing a better future.

It appears that to date, much of the investment, expenditure and employment opportunities have focused on recycling and energy recovery in the form of processed engineered fuel.

The International Energy Agency (IEA) forecast that Australia will have one of the most significant accumulated PV waste streams in the world. One scoping study looking at how to deal with this waste stream found battery recycling is likely to be more feasible in the short term as, they can be

processed in facilities with diverse capabilities and capacity to scale up rapidly.

With little to no manufacturing of its own PV panels and its physical distance from its suppliers, Australia is an example of how the lack of regulatory and producer and reseller responsibility schemes drive action for disposal as until recently, this has been cheaper than any diversion strategies.

CPVA's focus is to work with its network of industry stakeholders and member-base to remedy perceived (or actual) barriers to the circular PV economy and create a thriving commercial ecosystem. We recently spoke to Megan Jones, a co-founder of Circular PV Alliance (CPVA). In May 2022, CPVA in conjunction with The University of Queensland published a research report identifying multiple solutions and opportunities to drive a sustainable solar energy industry through developing a circular PV economy. With the report receiving widespread positive attention across the world, CPVA plans to expand on findings as part of further research in the coming months.

ARUP in their Circular Photovoltaics report[6] suggest the circulatory in this sector will involve rethinking the design to improve the maintenance, repair, upgrade, refurbishment and/or manufacturing process.

One of the key recommendations in the ARUP report for the PV value chain, is the need for standardisation, coordination, and collaboration of business models. This includes establishing an extended producer responsibility scheme and creating and expand partnerships between players along the value chain, especially public-private partnerships. It also covers standardising panel design and data management processes, including labelling and materials passports.

Norwegian Crystals is a manufacturer of low carbon monocrystalline silicon ingots and is working to advance the circularity agenda in this sector. There is much to do, however we are excited to continue to execute our strategy to lower our manufacturing footprint even further. Here is an overview of our circular manufacturing activities we are currently both undertaking and researching.

Reusing heated water

The naturally cool cooling water from local glacier Svartisen cools down the crystal-growing furnace. The temperature of the furnace's exterior is controlled by closed water-cooling loops which heat the water from 20C° to about 40C°. NCR directs the warm water to a local salmon hatchery who, once the salmon are big enough, releases the fish into the ocean. This process lowers the hatchery's energy demand for water tempering.

Polysilicon reuse and recycle

The manufacturing of monocrystalline silicon ingots which are shaped into bricks, leads to offcuts, which in the past was considered a waste stream. Today, 98% of the silicon material 'waste' that is generated as the process of ingot and brick production is reused as feedstock.

Argon gas and CO_2 emissions & recovery

The liquification of air and separating out the 1% argon it contains is a very energy intensive process. NCR use Argon for as an essential part of the crystal growing process. If Argon gas is vented after use it has a negative environmental impact with an increase in CO_2 emission.

Recycling argon makes environmental and, with the growing demand and price for argon gas, economic sense. NCR is currently exploring a closed loop system for gas recovery, which allows for reuse and recycling.

Hot zone waste

Whilst heating our furnaces up to temperatures ranging around 1,450 degrees utilises hydro energy, the furnace uses graphite which is an important but non-renewable resource. NCR ensures that its graphite, is responsibly sourced and is looking at ways for the graphite materials to be successfully recycled if it can be segregated from other materials and contamination is not an issue.

Reducing resource extraction cuts can dramatically cut greenhouse gas emissions. Now more than ever, it is time to move away

from the focus of end-of-life management to beginning-of-life re-design for circularity.

At Norwegian Crystals we are at the beginning of the circular economy journey, with much to discover, test and expand upon. We continue to explore what other industries are doing and look forward to working across the Solar PV value chain to incorporate further opportunities to reduce our material flows at the manufacturing level and reduce our GHG emissions even further.

www.crystals.no

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