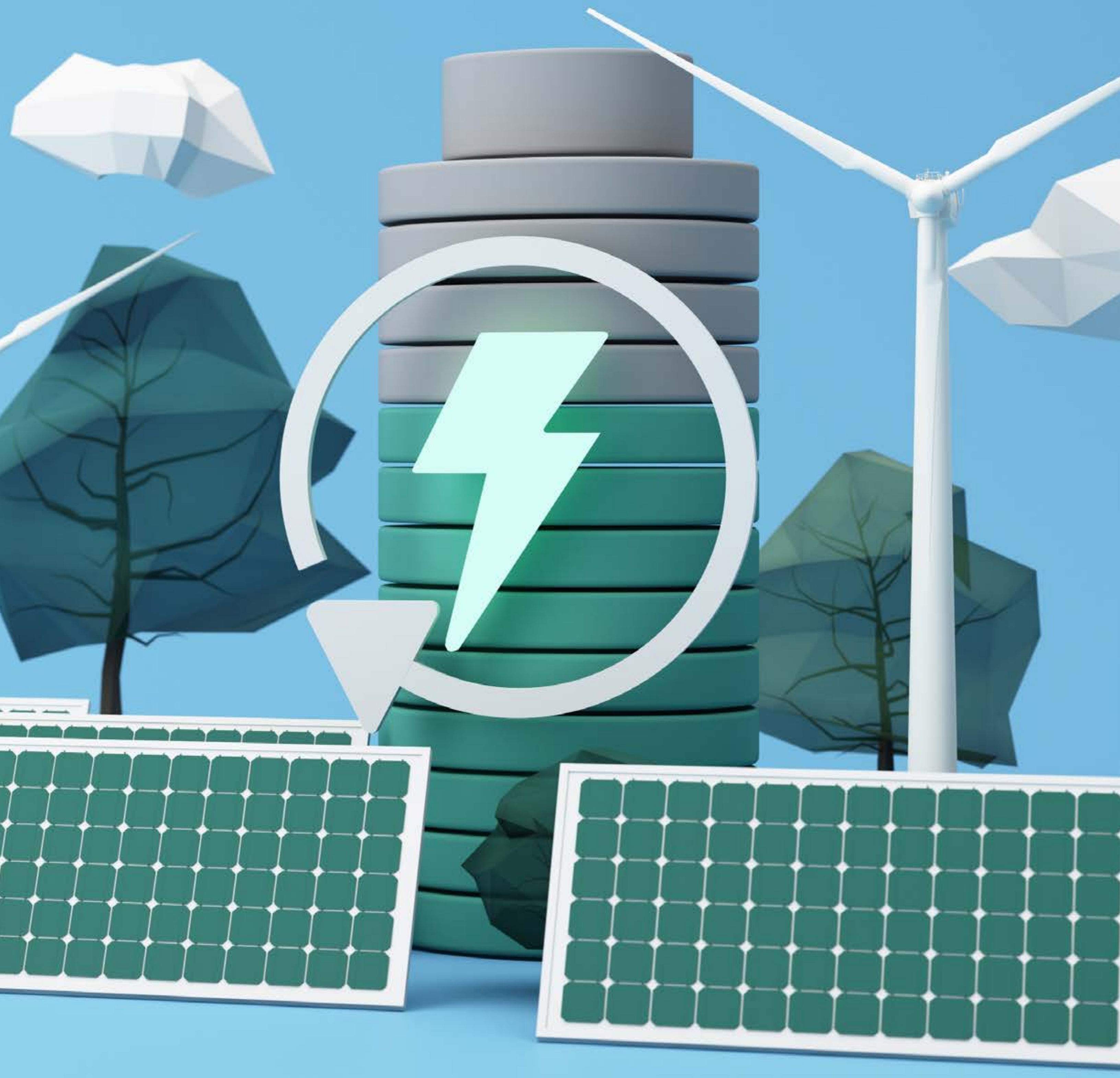
# THE SHADES OF GREEN – ADDRESSING THE UNINTENDED CONSEQUENCES OF CLEAN ENERGY PRODUCTION



ESTIMATED READ TIME: 7 MINUTES

ON THE GREEN AGENDA

# KEY TAKEAWAYS

*There are tradeoffs and externalities of clean energy value chains that we need to address before they evolve into problems, including waste and environmental impacts associated with production processes and deployment of clean energy technologies.*

*Early identification of risks and challenges allows us to find pre-emptive solutions and create commercial opportunities in the process.*

At the close of the 19th century, the city of New York was grappling with an urban crisis. With thousands of horses pulling carriages and cabs through its streets every day, millions of pounds of manure were being produced and deposited along its thoroughfares. Mechanisms for collecting and disposing of this waste could not keep pace, leading to a host of mobility, health and sanitation issues.

So it was that when Henry Ford's affordable automobile was introduced some years later, the innovation was hailed as a solution for cleaning up the transportation sector. Cars replaced horses, and manure became a problem of the past. At the time, however, it was not foreseen that within a century, that solution would contribute to a world-scale climate crisis.

This story is worth remembering as we enter a new age of energy. Today, we are looking to harness renewable forms of energy to help halt and reverse climate change. However, just as the automobile replaced old challenges with new ones, there are tradeoffs and externalities of clean energy value chains that we need to address before they evolve into problems. Early identification of risks and challenges allows us to find pre-emptive solutions and create commercial opportunities in the process.

## THE CHALLENGE OF **WASTE**

By definition, renewable energy is inexhaustible in supply – any sunlight, wind, wave energy and geothermal heat we use are replenished through natural processes. However, the infrastructure with which we capture and convert those forms of energy has a finite lifespan.

Solar panels, wind and water turbines, pumps and generators are built using materials and mechanical parts that inevitably deteriorate and lose efficiency. The narratives around renewable power seldom speak of the waste generated when those parts or entire systems are replaced or decommissioned, or the emissions produced during their manufacture.

*Recycling waste from damaged or decommissioned solar arrays presents both challenges and opportunities.*

Consider solar arrays as an example.

THE AVERAGE LIFESPAN OF A SOLAR PANEL IS AROUND **30 YEARS.**

On paper, this seems to be a long enough timeframe to make waste from the industry manageable. However, as with many other appliances and devices we use today, consumers do not always run solar systems through their full lifespan. Technology and innovation are making panels more efficient, affordable and accessible, and tax incentives are encouraging greater uptake. Not only are more consumers entering the market, but existing users are seeing practical benefit and economic merit in replacing their older systems earlier than necessary.

IN 2016, THE INTERNATIONAL RENEWABLE ENERGY AGENCY (IRENA) HAD PROJECTED THAT GLOBAL WASTE FROM SOLAR PV PANELS COULD TOP

**78Mn tonnes**

BY 2050[1]

HOWEVER, BASED ON THE RATE OF TURNOVER AND ADOPTION WE SEE TODAY, OTHER RESEARCHERS SUGGEST WE WILL GENERATE THAT VOLUME MUCH SOONER.[2]

One challenge with that waste is that most solar PV modules are comprised of glass which often cannot be recycled because of impurities.[3] Moreover, when dumped into landfills, toxic chemicals such as lead and cadmium can be leached out of the modules into soil and groundwater sources.

To the extent that they can be recycled, there are additional challenges that make the process burdensome. For instance, the fact that most panels have long lifespans and are composed of low-value glass has disincentivised investment in recycling infrastructure.[4] There are consequently few facilities that provide that service, making the cost of recycling high. In the US, it costs around US$25 to recycle a solar PV panel, while it costs US$1-2 to transport it to a landfill.[5]

That said, the challenge of solar waste management presents a lucrative opportunity for investors and innovators.

---

[1] https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2016/IRENA_IEAPVPS_End-of-Life_Solar_PV_Panels_2016.pdf?rev=49a75178e38c46288a18753346fb0b09
[2] https://hbr.org/2021/06/the-dark-side-of-solar-power
[3] https://www.forbes.com/sites/michaelshellenberger/2018/05/23/if-solar-panels-are-so-clean-why-do-they-produce-so-much-toxic-waste/?sh=65f37933121c
[4] https://hbr.org/2021/06/the-dark-side-of-solar-power
[5] https://www.wired.com/story/solar-panels-are-starting-to-die-leaving-behind-toxic-trash/

# 82%

OF THE WORLD'S MINING AREAS TARGET MATERIALS THAT ARE CRITICAL FOR RENEWABLE ENERGY PRODUCTION.[9]

*Rystad Energy has predicted that recyclable materials from PV panels at the end of their lifespan will be worth more than US$2.7 billion in 2030 - up from only US$170 million in 2022 - and approach US$80 billion by 2050.*[6]

This is because of increasing demand for panels and higher demand for their mineral and material inputs. Entrepreneurship in end-of-life management of solar panels can therefore generate significant economic returns and employment opportunities.

The same holds true for other renewable energy technologies. Researchers estimate the US will have more than 720,000 tonnes of wind turbine blade material to dispose of over the next 20 years.[7] These blades, usually made from a mix of resin and fiberglass, have little resale value, and are difficult and expensive to transport to landfills. There are, therefore, valuable commercial opportunities for startup companies exploring options for recycling these blades.[8]

## IMPACT ON THE **BIOSPHERE**

While the problem of waste occurs at the end of the clean energy value chain, there are also threats at the top. Production of renewable energy infrastructure depends heavily on mineral inputs such as lithium, cobalt, copper and neodymium, and there are environmental concerns around mining these minerals.

However, ironically, the mining industry is notorious for its environmental footprint. In China - where most of the world's neodymium is mined for creation of the magnets used in wind turbines, electric motors and electronics – the high environmental cost of extraction of the mineral can be seen in the Baotou Lake. Toxic sludge from the mining process - including radioactive clay – are dumped into the lake, with unquantified but irrefutable impacts on surrounding communities and landscapes.[10]

To treat with this issue, stricter regulations will be needed in mining jurisdictions to ensure companies treat and properly dispose of their waste and remediate the environment around mining sites. Mining can also affect endangered species, as a percentage of the world's mining sites overlaps with areas that are protected for their biodiversity.[11] As demand for renewables increases, so too will the footprint and intensity of mining, and the possibility of greater encroachment on sensitive habitats.

[6] https://www.rystadenergy.com/news/reduce-reuse-solar-pv-recycling-market-to-be-worth-2-7-billion-by-2030
[7] https://www.npr.org/2019/09/10/759376113/unfurling-the-waste-problem-caused-by-wind-energy
[8] Ibid
[9] https://www.nature.com/articles/s41467-020-17928-5
[10] https://www.bbc.com/future/article/20150402-the-worst-place-on-earth
[11] Ibid

*Hydro-dams can present risks for fish.*

Governments and permitting agencies will need to look carefully at protected areas to ensure mining is minimally disruptive - if not prohibited altogether – in such spaces.

Wildlife can also be impacted when renewable technologies are actually deployed. For example, generating power using watercourses involves construction of large hydro-dams. These dams sometimes obstruct migratory routes of fish, and the passageways around their turbine blades can be piscine death traps.[12] The same is true of wind farms, where spinning blades can disrupt avian flight paths and improper siting of offshore infrastructure could lead to infringement on aquatic ecosystems.

Prefeasibility studies of potential deployment sites, as well as research and innovation, are critical to reducing these unintended consequences. For example, one engineering company in the US has already pioneered a blunt-edged water turbine that is fish-friendly, and is working on developing a distributed system of smaller dams - based on biomimicry of beaver structures - to replace larger and more disruptive hydropower facilities.[13]

## MANAGING **IMPACT**

*There is no question that we need to continue investing in and expanding renewable energy technologies - no other solution addresses the climate crisis quite as effectively as the clean energy transition.*

At the same time, we cannot ignore that it is not a perfect solution, and there are many actual and potential environmental ills associated with these technologies.

Fortunately, early identification of these problems can allow sufficient investment and research attention to be paid to those areas, so that the negative externalities can be properly managed before they spiral out of control. The invention of new components that do not require as many mineral inputs; innovations designed to reduce the footprint and invasiveness of clean energy structures; and the creation of circular economies around renewables to reduce, reuse and recycle materials; are just a few examples of strategies currently being used to minimise the impact of the clean energy transition. For the prescient and savvy entrepreneur, these strategies can also lead to profitable economic opportunities. Ultimately, in whatever approach we take to clean up our energy production, we must strive to find balance and ensure we do not attempt to solve one problem with another. ■

---

[12] https://www.bbc.com/future/article/20200713-the-most-powerful-renewable-energy
[13] Ibid