Solar PV Paybacks + Paradoxes

Lucy Marsland | 2023 CIBSE ANZ Seminar Series

Whole of life carbon estimates of building scale solar photovoltaics
Whole of life carbon estimates of building scale solar PV

- Life cycle inventory
- Design context
- Purpose of assessment

Inspiration for this study came from Chris Worboy’s article, *The rapid fall of solar’s embodied carbon* https://www.linkedin.com/pulse/rapid-fall-solars-embodied-carbon-chris-worboys/
Life cycle stages

CO2
CH4
H2O
N2O

Global warming potential (GWP100) in kgCO2-e
Life cycle stages

Operational carbon

Upfront carbon

A1, A2, A3, A4, A5, B1-B5, C1-C2, C3-C4, D

CO2, CH4, H2O, N2O
Life cycle of a solar panel

- **Silica, copper, aluminium, sodium silicate (glass), polymer, acetate**

- **PV cell etching/diffusion, grooving, printing and sintering**
  - Half cut
  - Soldering
  - Lay-up and lamination
  - Edge cutting and framing
  - Cleaning, testing and packaging

- **Installation with inverters, framing, cables, sub-station, structure and transformer**

- **Product phase occurs in various Chinese provinces – transport to site will be specific to project**

- **30y service life for solar PV systems is typical as reported in EPDs**

- **Disposal treatment dependent on project location – may include combination of re-use, recycling, landfill and incineration**

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Sourcing and interpreting data

Emissions reporting at product scale, including EPDs:

- Functional unit – panel, kWp, kWh generated…
- Service life – 30 years
- Transportation, construction and end of life scenarios vary by project location

As an industry we all need to upskill, develop ‘carbon-literacy’ to read and interpret product emissions data
Review of solar PV data

Review of product carbon (A1-A3) taken from third-party certified EPDs for 9 suppliers over last 5 years.

- Imerys Toiture
- Systovi
- JA Solar
- Voltec Solar
- DualSun
- SunPower
- Trina
- First Solar
- Jinko

\[\text{GWP (A1-A3) [kgCO2-e/kWp]}\]

\[\text{~670 kgCO2-e/kWp}\]

or \[\text{~235 kgCO2-e for a 350W panel}\]
A solar panel’s contributions to emissions are largely governed by the upfront stages

- Based on EPD data (Jinko, 2021)
The VIC grid has been decarbonizing ~4% annually over the last 10 years.

Nationally, renewables have steadily increased in the grid mix with rooftop solar contributing ~7% in 2021.

Assuming a linear decarbonization path (unlikely), this rate of decarbonization would hit zero emissions ~2050.
It is very typical to undertake return on investment (ROI) analysis for a solar PV system on building projects.

- Capital cost
- Avoided electricity bills

**Payback - financial**

89kW rooftop solar PV in Victorian school

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<th>Year since installation</th>
<th>Asset payback</th>
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We can similarly analyze the emissions ‘payback’ of a solar PV system.

- A1-A3 upfront emissions ‘paid back’ by avoided B6 emissions
- Emissions avoided assuming linear grid decarbonization
Upfront and operational ‘payback’

89kW rooftop solar PV in Victorian school

Lower embodied carbon panel (A1-A3 ~670kgCO2-e/kWp)

Best case (north tilted roof-mounted)

High embodied carbon panel (A1-A3 ~2,500kgCO2-e/kWp)

Best case (north tilted roof-mounted)
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Worst case (southern façade)
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Does it still make sense to install solar?

YES, if….

- We thoughtfully design solar system location/orientation to maximize energy generation
- We review the location specific grid mix
- We also design for peak electricity demand reduction to stabilize supply/demand
- We engage in early, design-integrated, comprehensive cradle to grave LCA
- We introduce a carbon performance specification and system efficiency specification to the procurement strategy