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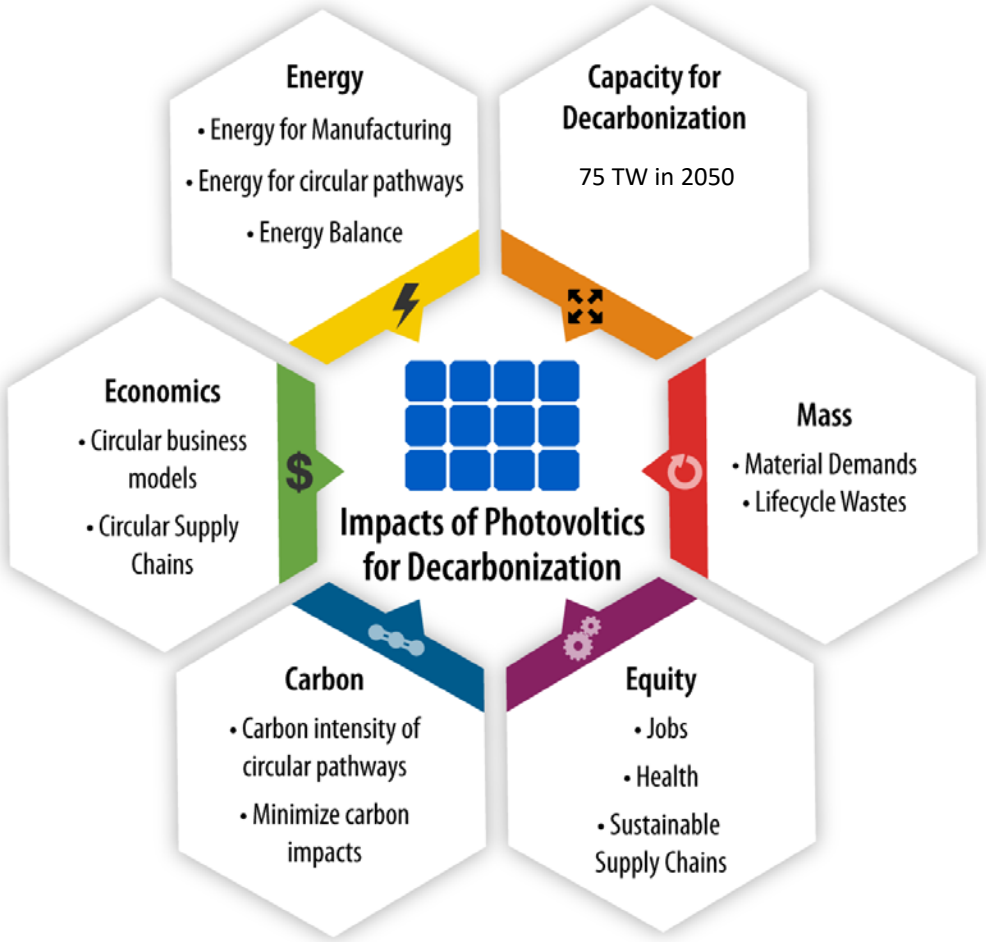

SIPS on "PV Repowering"

Quantifying the Impact of PV System Repowering and Module Reuse on PV Project Economics, Sustainability, & Equity

NREL: Silvana Ovaitt, Heather Mirletz, Brian Mirletz, Matt Prilliman & Teresa Barnes

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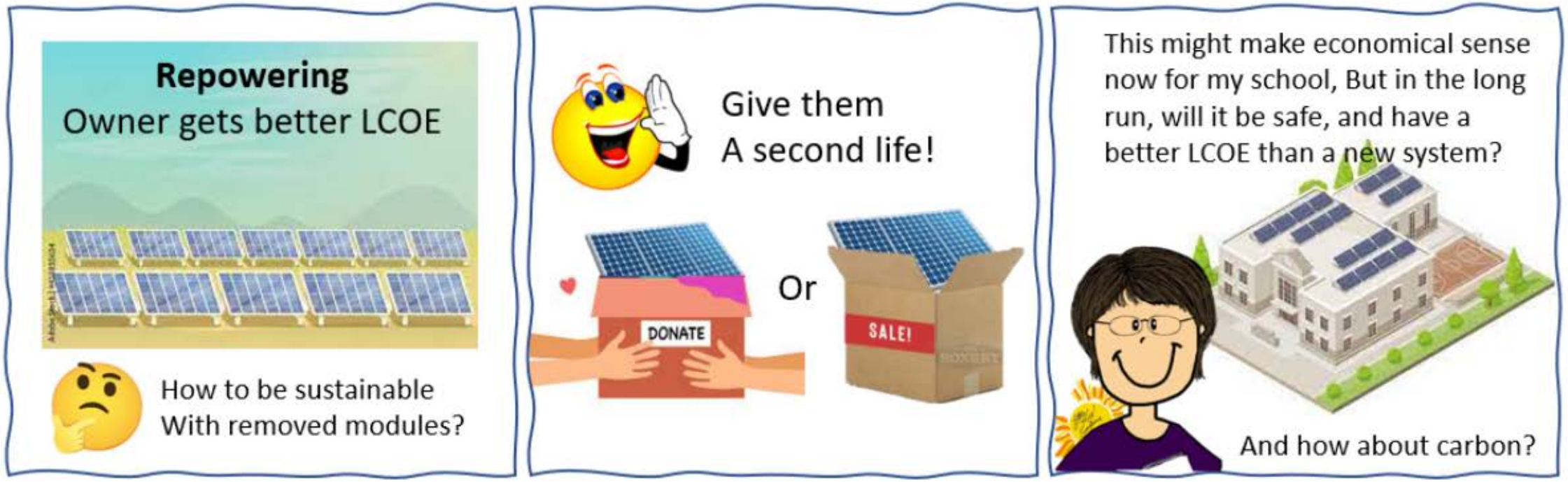
QUIP-SERIES Overview

(QUantifying the Impact of PV System Economics Repowering & Reuse with Integrated Equity and Sustainability)

Principal Investigator: **Silvana Ovaitt**, NREL, Golden, Colorado, 07/2024 – 07/2025

DOE Award Amount: $250,000

Project Summary: This project **quantifies the effects of repowering PV systems**, which is when outdated or damaged components are replaced with new ones. Underperformance of and minor damage to PV systems require a better understanding of the **resulting system energy yield, cost, sustainability impacts, remaining useful lifetime, and energy equity**. The team will use the System Advisor Model (**SAM**) and the PV in Circular Economy (**PV ICE**) tool to **guide repowering decisions**.



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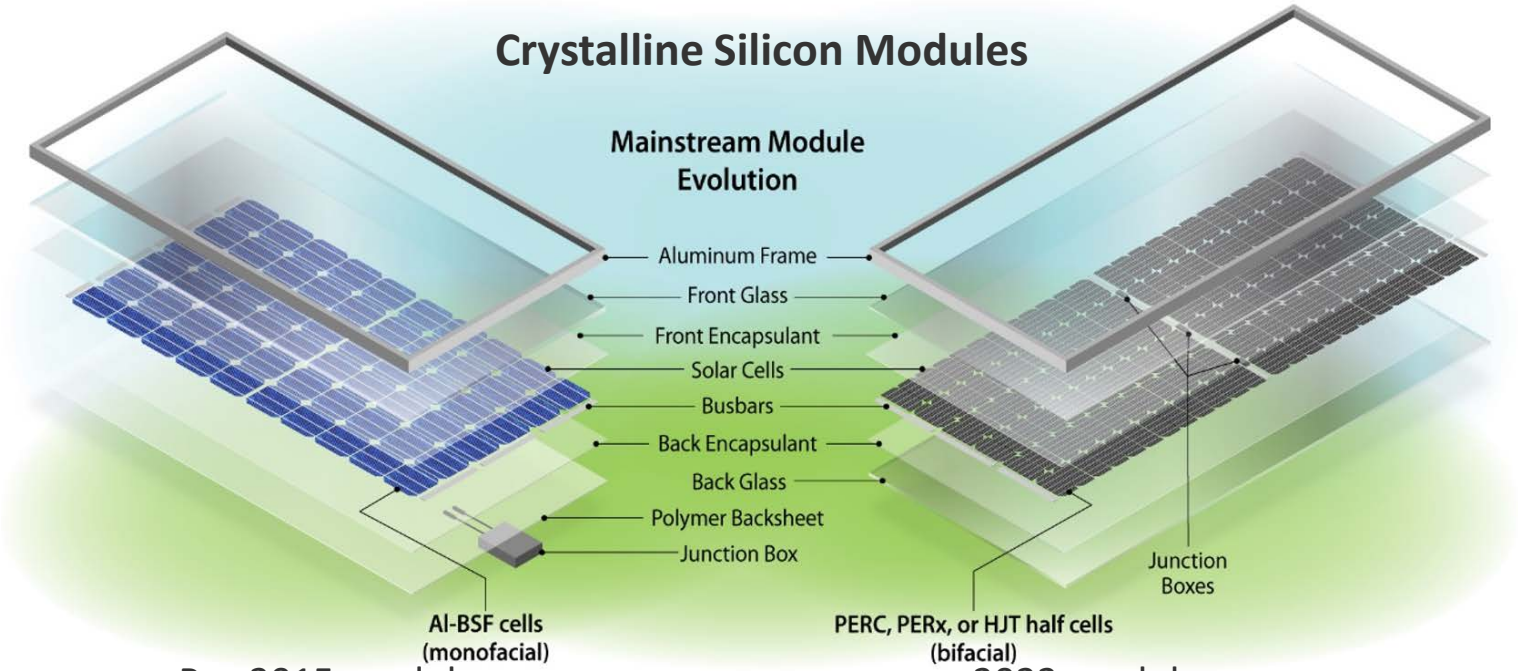
What is the status of repowering in the US?

Silicon PV module technology has evolved rapidly over the last decade, including significant increases in module efficiency, making module repowering attractive.



Pre-2015 module, 20-25 year life

2022 module, 35 year life

Data on US repowering is anecdotal; economics are a known important driver, and reliability issues are another motive. It is critical to understand which modules are viable for 2nd-life, technically, economically, and ethically.

Ovaitt & Mirletz et al, 2022. "PV in the Circular Economy, A Dynamic Framework Analyzing Technology Evolution and Reliability Impacts." *ISCIENCE* https://doi.org/10.1016/j.isci.2021.103488.

Analysis Methods

Gather Key Parameters

- Industry and User interviews, gleans insights into:
  - Drivers
  - Barriers
  - Key variables and metrics for decision making
- Literature Review
  - LCA of repowering, Herceg et al 2022
  - Re-use guidelines, van der Heide et al 2021
  - PV magazine, PVTech, SolarPowerWorld
  - Company websites, blogs

Model Case Studies

- SAM team collaboration
  - Capture complex economics
  - Identify thresholds of go/no-go on repowering decision financials

System Advisor Model

- PV ICE modeling
  - Mass, energy, carbon quantification of old and repowered system

Repowering Definitions

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- Replace multiple system components
- Modules not damaged, not subject to warranty claims
- Triggered by economic, W/area increase, or external events (inverter change, new roof on a house, etc).
- Entails “Re-engineering”, new set of stamped engineering drawings

PV Module reuse is often possible/desirable

revamping, restoring, repairing, …

- Repairs or Replacements due to Underperformance (module warranty claims, extreme weather damage, etc)
- Adding modules to match original capacity, expanding original capacity, or adding batteries
- Fixing a disconnected plant

No PV module reuse

Observations from Interviews

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Utility Scale

- Interviewees have only seen repowering due to failures, to avoid violating contract agreements/ppas.
- Otherwise, economically it hasn't yet made sense, but owners have been actively looking for evaluations.
  - **Re-engineering costs** are very high, compared to greenfield (above $1/Wp in some cases)
  - **Permitting** is another deterrent
  - **Physical barriers**: racking with changing module sizes, electrical changes that require recabling for higher power modules and inverter changes to go from 600V to 1000V and above systems, records.

Residential / Commercial Scale

- Systems of an average ~12 years in service, but some as early as 1-2 years
- Driven by newer system with better performance for the limited-area rooftops; and external events such as re-roof, remodel, building demolition

Both:

- Component failures is a driver (inverters)
- Financial incentives such as IRA and adders are interesting but unclear for repowering

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Stay Tuned!

Academic article examining modeling case studies

Energy news article for asset owners providing decision making considerations

Video for potential 2nd life module owners providing information

Feeding into knowledge gathering and methodology for PV RESOLVE

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If you have experience with repowering, we'd love to talk to you!

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nrel.gov/pv/pv-ice-tool.html

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