

Solar Photovoltaic (PV) Recycling and Reuse Program

Established in 1984, the Illinois Sustainable Technology Center (ISTC), a unit of the Prairie Research Institute at the University of Illinois at Urbana Champaign, sits at the forefront of pollution prevention research, outreach, and technical assistance to solve environmental problems and conserve natural resources since its creation.

In 2017, ISTC leveraged this experience to mobilize a team of diverse experts to address the recovery challenges and opportunities presented by aging solar PV modules and ensure that they are re-purposed or recycled properly in Illinois when they reach end-of-life (EoL).

ILLINOIS PV END-OF-LIFE (EOL) MATERIAL MANAGEMENT FORECASTS

Solar power is now the fastest growing renewable energy source in the world. As of the end of 2019, over 76 gigawatts (GW) of solar capacity has been installed in the U.S.¹ The International Renewable Energy Agency projects a substantial increase in solar modules reaching EoL as early as the 2020s and 2030s.²

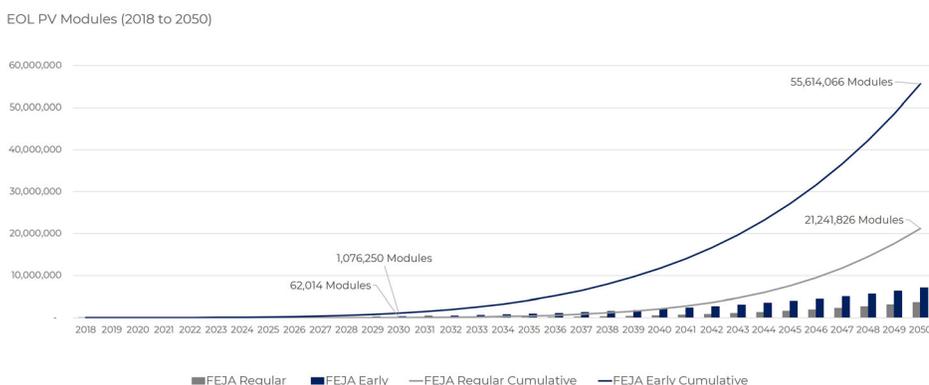
Illinois passed the Future Energy Jobs Act (FEJA) in 2016. The law requires the state to significantly increase renewable energy capacity. Because of this requirement, solar capacity is estimated to reach around 2,600 megawatts (MW) by 2030. This is a huge increase from the 87 MW of solar capacity that was installed in the state when FEJA passed in 2016.

Through this project, ISTC found that:

- ▶ By the end of 2019, Illinois had approximately 212 MW of PV, equaling more than 636,000 PV modules currently installed in the state.³
- ▶ With FEJA's 25% Renewable Energy Portfolio requirements, Illinois is expected to add an additional ~7 million PV modules by 2025. These modules weigh an estimated 120 thousand metric tons (MT) based on current equipment and technology estimates.
- ▶ By 2030 Illinois will have between ~100 thousand to ~600 thousand modules reaching their end-of-life. This will result in an estimated 2,000 to 12,000 MT of material that that must be managed through recovery, recycling, & reuse or landfill disposal.

END OF LIFE PV PROJECTIONS

Based on FEJA goals to reach 2600 MW by 2030 and projected out to 2050



Preliminary EOL PV projection modeling for the state of Illinois based on FEJA goals and IRENA and IEA's waste model in End-of-Life Management: Solar Photovoltaic Panels - Pai, 2019, ISTC

As is common with fast-growing markets, little thought has been given until recently to end-of-life disposal considerations for solar modules.

Currently, solar disposal makes up only a small percentage of the number being installed, and the majority of disposal presently in the U.S. is due to damage to the panels during transportation and installation or from severe weather events.

The design life of a solar module is 30 years. In the next 5-10 years, states will begin to see a sharp spike in the number of modules that will need to be reused or recycled.

SOLUTIONS INCLUDE:

- ▶ Early engagement on module takeback models with national, state, and local stakeholders
- ▶ Feedback loops with public utilities and contractors for resource and system planning
- ▶ Consideration for impacts on landfills, collection and transportation for reuse, recycling, and secondary material markets
- ▶ Education and outreach to businesses & communities

- ▶ In Illinois, ~2 million PV modules will reach EoL by 2050. This will result in an estimated 40,000 MT of material that must be managed.
- ▶ EoL PV module waste can include regulated materials such as silver, copper, lead, arsenic, cadmium, and selenium. They may be classified as regulated hazardous wastes, depending on the size of the modules and volumes of the regulated materials.
- ▶ Recycling EoL PV modules can prevent toxic compounds from entering the environment and lead to the recovery of high-value materials such as indium, silver, tellurium, and copper.

Through FEJA, Illinois has emerged as a leading state for solar job growth. The sector has grown nearly 48% since 2016. Statewide reuse and recycling requirements will divert millions of EoL PV modules from landfills, recover high value materials, and strengthen job opportunities for a new and diverse workforce.

PV EOL WORKING GROUP

As part of this initiative, ISTC partnered with the Illinois Environmental Protection Agency (IEPA) to form a PV EoL Management Stakeholder Working Group in the spring of 2018.

The group includes a diverse set of stakeholders with over 30 active members. Their objectives are to identify existing barriers to integrating PV into the circular economy and to develop technical, economic, and environmentally sustainable solutions to overcome them.



Damaged solar modules

Next steps include:

- ▶ a staged strategy plan for the state;
- ▶ solutions for reuse/redeployment, refurbishment, and recycling; and
- ▶ an assessment of policy options that can help to drive PV EoL requirements in Illinois and be used as a model by other states.

¹ Solar Energy Industries Association, *U.S. Solar Market Insight Executive Summary 2019 Year in Review, 2020*

² International Renewable Energy Agency & the International Energy Agency, *Photovoltaic Power Systems End-of-Life Management: Solar Photovoltaic Panels, 2016*

³ Solar Energy Industries Association, *Illinois Solar – Data Current Through: Q4 2019, 2020*

⁴ The Solar Foundation, *Illinois Solar Job Census 2019, 2020*

STAKEHOLDERS INCLUDE:

- ▶ IL EPA
- ▶ U.S. EPA
- ▶ Solar Energy Industries Association
- ▶ Illinois Solar Energy Association
- ▶ Illinois Department of Commerce and Economic Opportunity
- ▶ Representatives from Illinois counties
- ▶ U.S. Department of Energy's National Renewable Energy Laboratory (NREL)
- ▶ Product Stewardship Institute
- ▶ PV module manufacturers
- ▶ Midwest and Illinois solar PV and e-waste recyclers
- ▶ Illinois PV installers, developers & distributors
- ▶ Illinois PV training organizations
- ▶ Illinois solar energy market experts
- ▶ National, state, and local environmental advocacy groups



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ABOUT ISTC

The Illinois Sustainable Technology Center is a division of the Prairie Research Institute at the University of Illinois at Urbana-Champaign. ISTC's mission is to encourage and assist citizens, businesses, and government agencies to prevent pollution, conserve natural resources, and reduce waste to protect human health and the environment of Illinois and beyond.