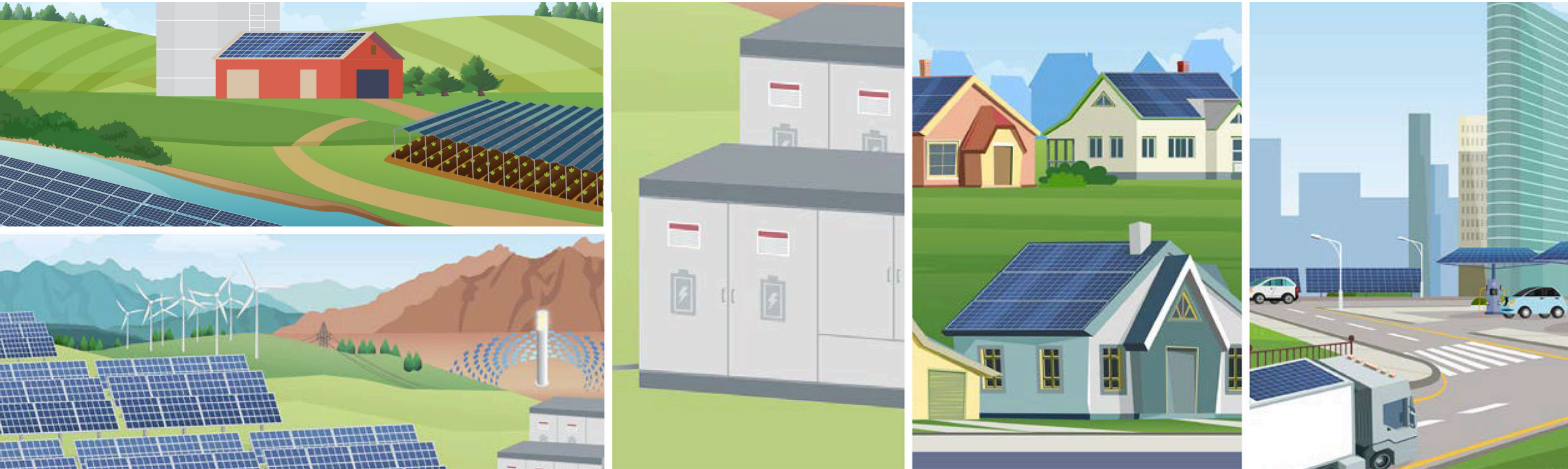
U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

US Solar Futures

Garrett Nilsen, Acting Director
U.S. Department of Energy Solar Technologies Office
November 9, 2021



Solar Energy Technologies Office (SETO) Overview

MISSION

We accelerate the advancement and deployment of solar technology in support of an equitable transition to a decarbonized economy no later than 2050, starting with a decarbonized power sector by 2035.

WHAT WE DO

Drive innovation in technology and soft cost reduction to make solar affordable and accessible for all Americans

Enable solar to support the reliability, resilience, and security of the grid

Support job growth, manufacturing, and the circular economy in a wide range of applications

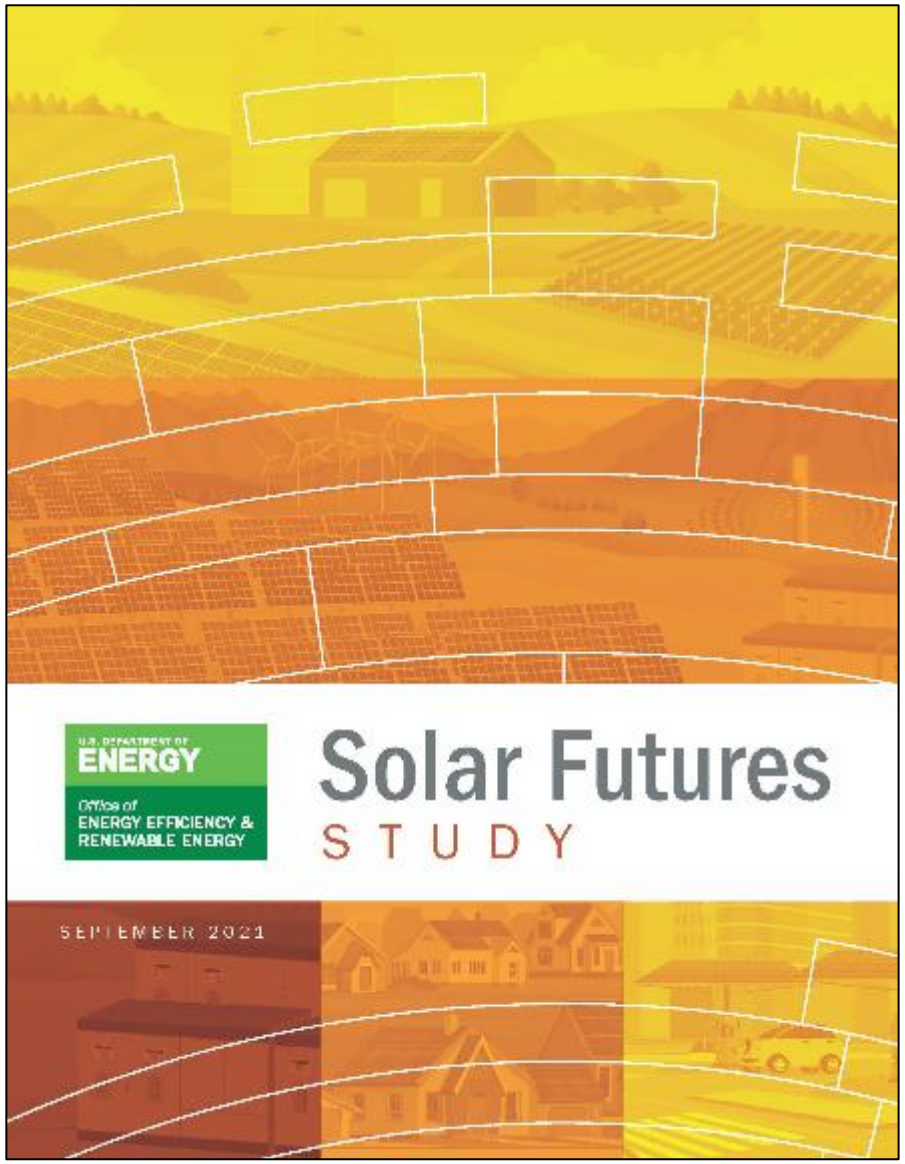
Solar Futures Study Overview

PURPOSE

- Comprehensive review of the potential role of *solar* in decarbonizing the electricity grid by 2035 and the energy system by 2050.
  - Addresses other large trends and activities across the U.S. economy that are necessary to achieve a zero-carbon energy system.
  - Builds analytical foundations to guide the next decade of solar research.

SCOPE

- Chapters cover future scenarios, technology advances, equity, grid integration, cross-sector interactions, supply chain, and environmental impacts.



Solar Futures Study: Key Results

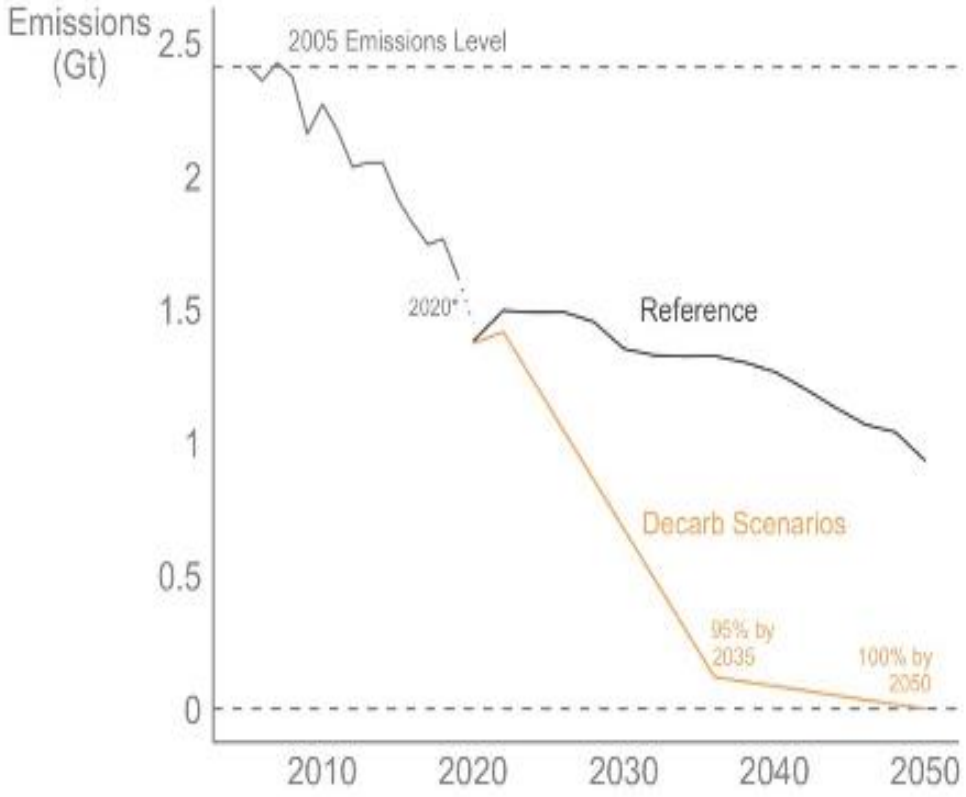
1. **Deploy, deploy, deploy.** We must install an average of 30 GW of solar capacity per year between now and 2025 and 60 GW per year from 2025-2030. (In 2020 the U.S. installed 15 GW.)
   - 1,000 GW of solar meets 40% of electric demand in 2035, 1,600 GW meets 45% in 2050.
   - We must reshape workforce development, supply chains, siting and permitting, and regulation.
   - Major growth in wind and storage are also required.
2. **With continued technological advances, electricity prices do not increase through 2035.** This includes solar, wind, energy storage, and other technologies.
3. **The grid will be reliable and resilient.** Storage, transmission, and flexibility in load and generation are key.
4. **Expanding clean electricity supply yields deeper decarbonization.** Electrifying buildings, transportation, and industry reduces carbon emissions.
5. **Policy changes are necessary**. Limits on carbon emissions and/or clean energy incentives.

Three Core Scenarios

Solar Futures Study models three core scenarios for the evolution of the U.S. grid:

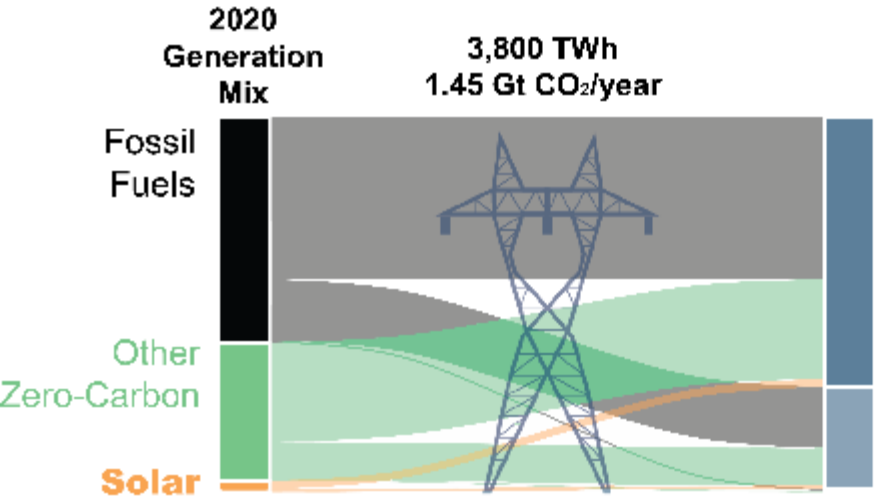
- **Reference:** business-as-usual costs, policies, electricity demand
- **Decarb:** carbon constraint, BAU electricity demand, advanced technology improvements
- **Decarb + E:** same as Decarb but with enhanced electrification and demand flexibility

Scenario Name	Renewable Energy & Storage Technologies	Electricity Demand	Policies
Reference	Moderate cost reductions	U.S. Energy Information Administration Reference	Existing policies as of June 2020
Decarbonization (Decarb)	Advanced cost reductions		95% reduction in CO_2 emissions from 2005 levels by 2035, 100% by 2050
Decarbonization with Electrification (Decarb+E)		Electrification Futures Study: High Electrification with Enhanced Flexibility	



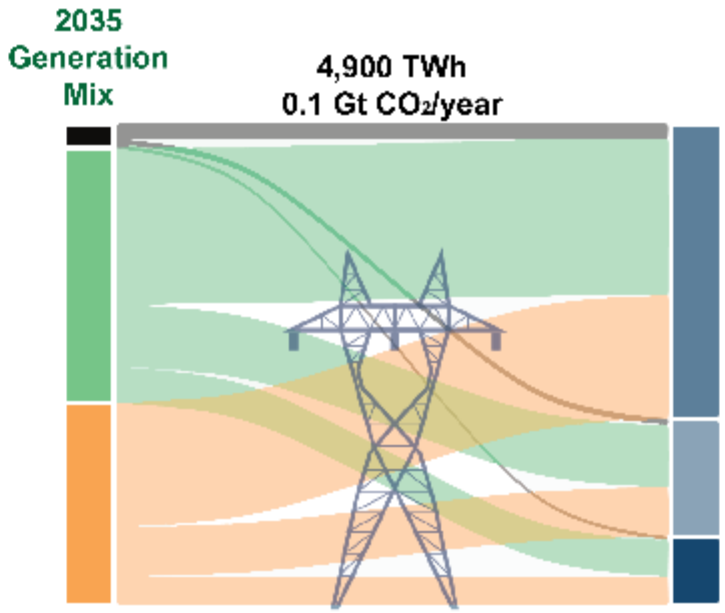
U.S. Energy Mix 2020-2050

The U.S. Electric Grid in 2020



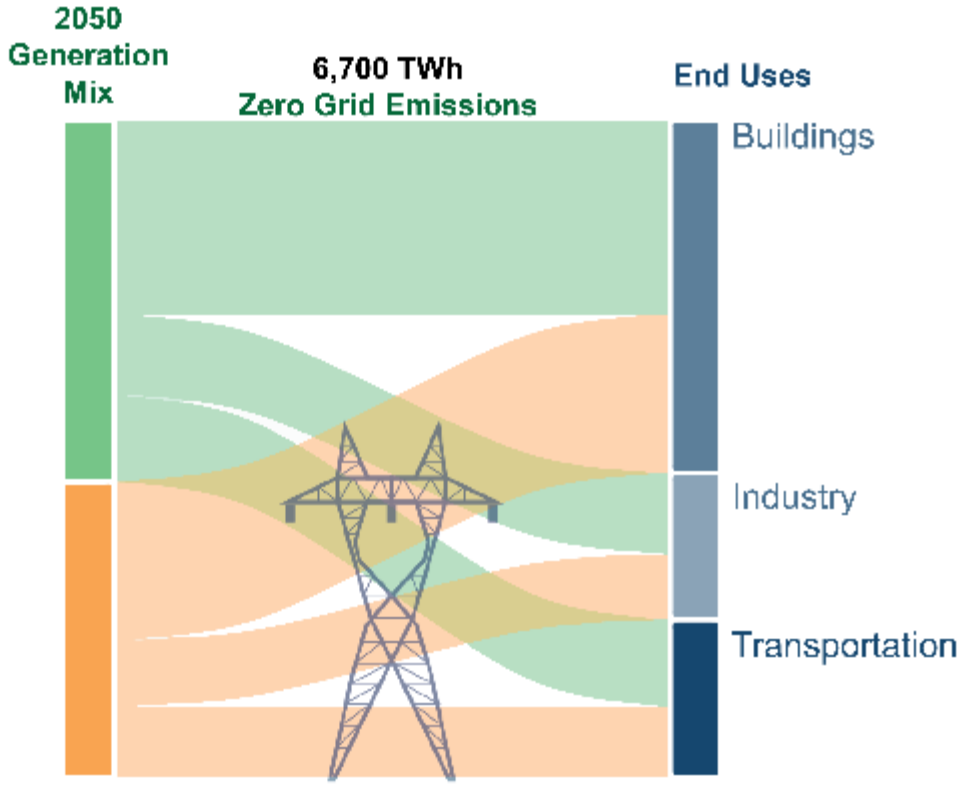
Solar: 3% of electricity demand, 80 gigawatts AC installed

95% Decarbonized Grid in 2035



Solar: 40% of electricity demand, 1,000 gigawatts installed

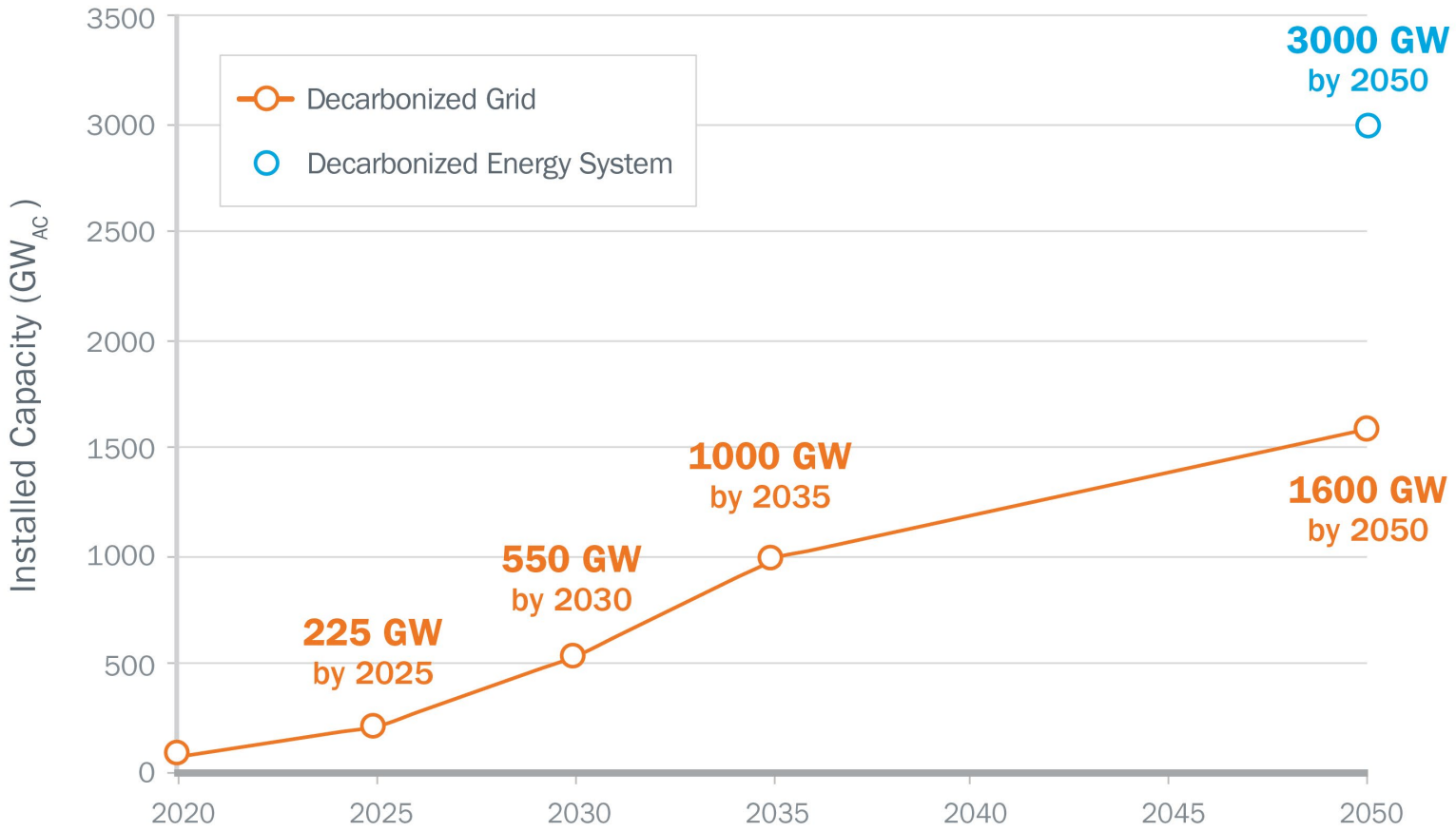
Decarbonized Grid in 2050



Solar: 45% of electricity demand, 1,600 gigawatts installed
3,000 GW in decarbonized energy system

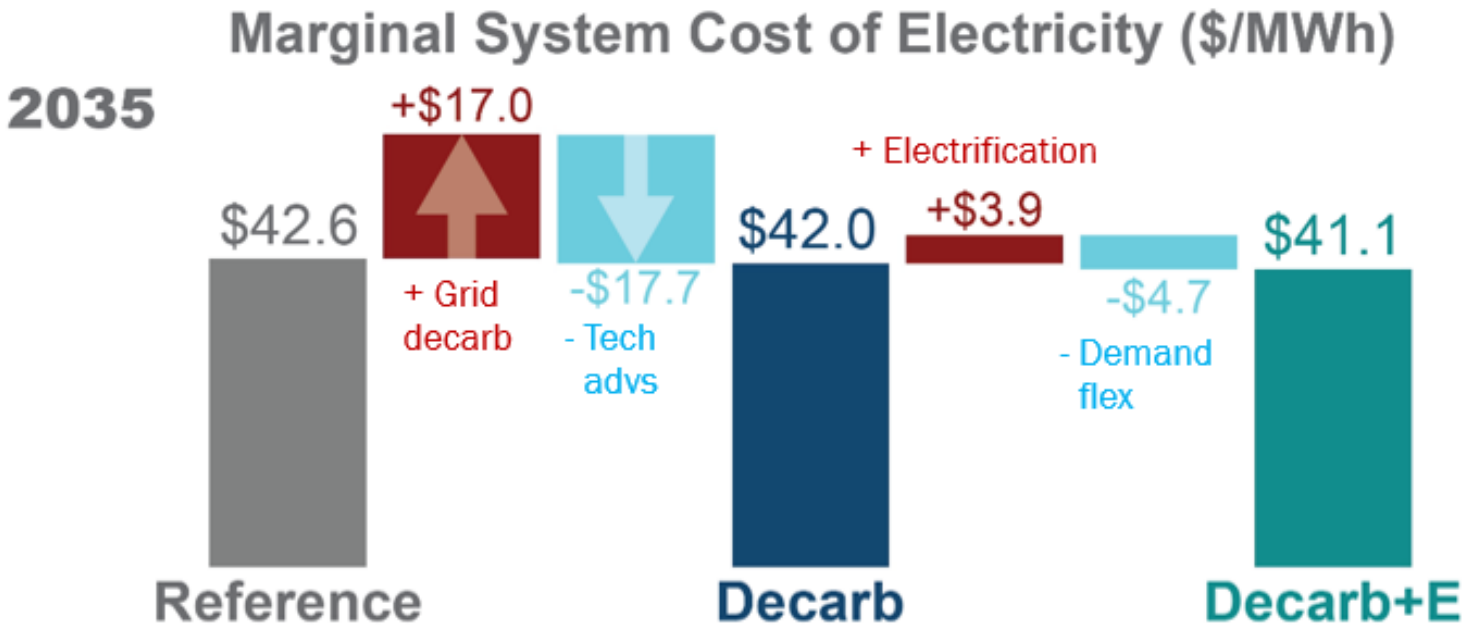
Solar Deployment by 2050

- Need rapid, sustained growth over next decade+.
- Simplified analysis of 100% energy decarbonization shows solar capacity reaching 3,000 GW by 2050.



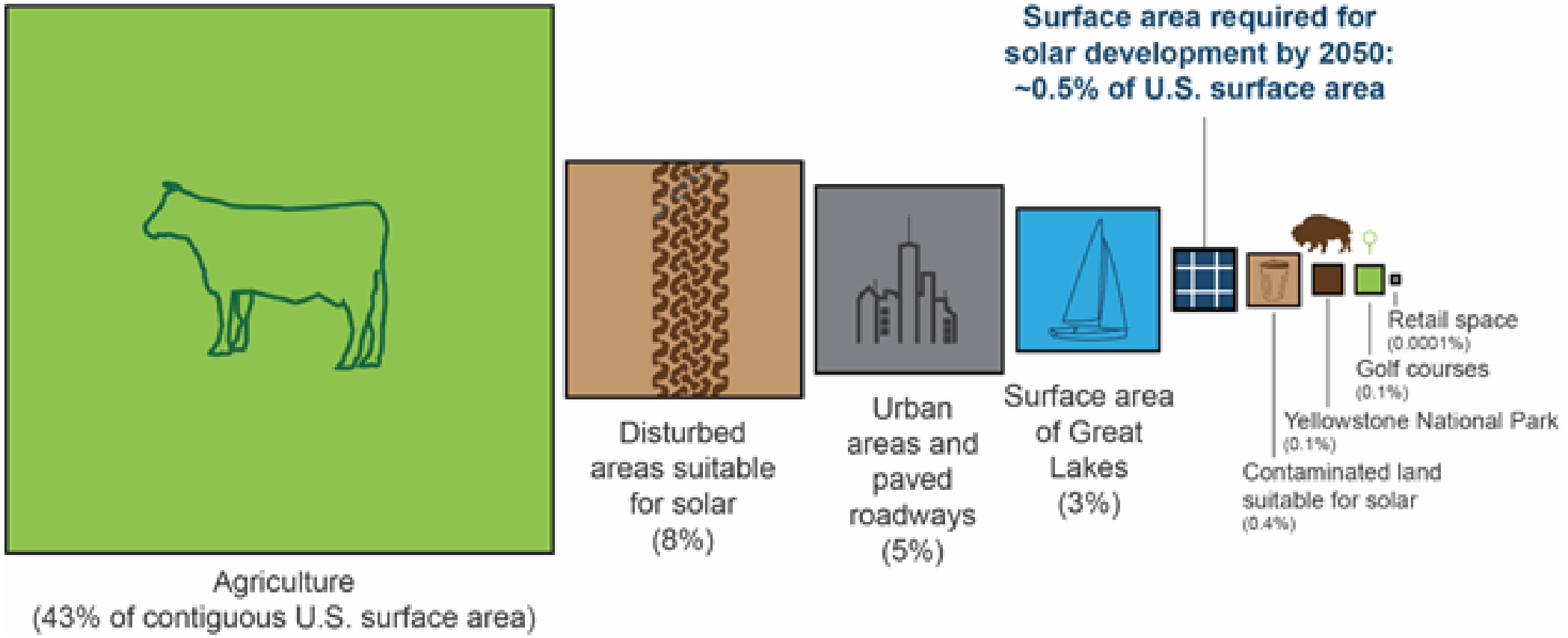
Note: The Solar Futures Study modeled the deployment of solar necessary for a decarbonized grid. Preliminary modeling shows that decarbonizing the entire energy system could result in as much as 3,000 GW of solar due to increased electrification across the energy system.

Will achieving the Solar Futures Scenarios be costly?



- Solar facilitates deep decarbonization of U.S. grid by 2035 without increasing projected 2035 electricity prices if targeted technological advances are achieved.
- Cumulative system costs 2020-2050 higher in the Decarb (10%) and Decarb+E (25%) scenarios but avoided climate damages and improved air quality more than offset those additional costs.
  - Resulting net savings of $1.1 trillion (Decarb) and $1.7 trillion (Decarb+E)

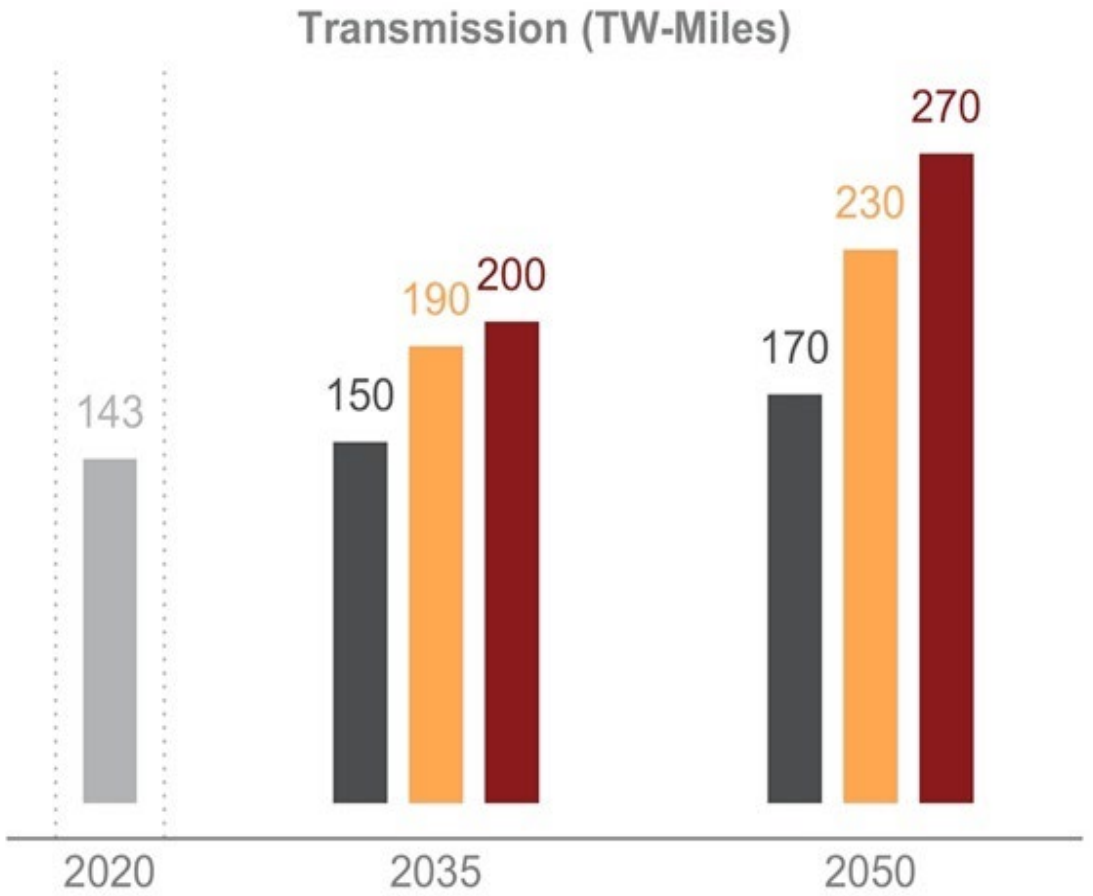
How much land will be required to achieve the scenarios?



Is new transmission needed to achieve the scenarios?

From 2020 to 2050, interregional transmission expansion increases by:

- 60% (86 TW-miles) Decarb
- 90% (129 TW-miles) Decarb+E



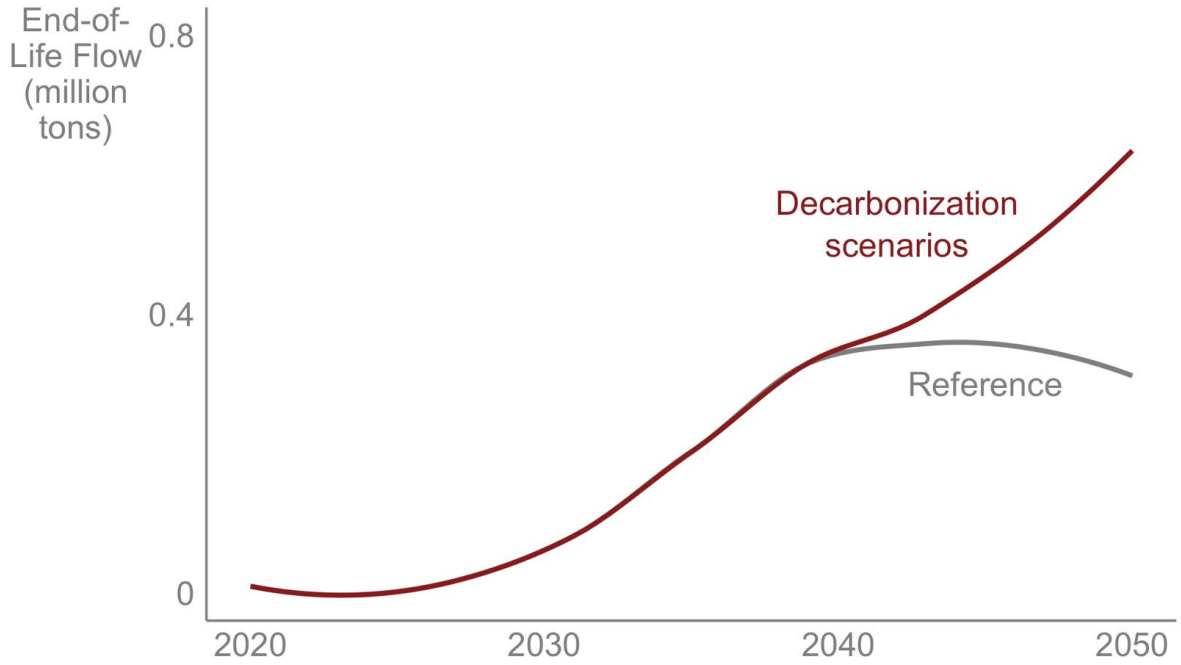
Will achieving the Solar Futures scenarios create a lot of waste?

Waste volumes increase as PV panels reach the end of their useful lives (typically 30 years), but can be reduced through sustainable end of life practices e.g.

- Recycling, re-use, re-manufacturing

Governments, industry, and associated stakeholders can begin preparing now for higher end-of-life solar volumes through various measures e.g.

- Development of low-cost recycling approaches
- Maximizing value from recovered materials
- Matching recovered materials with markets
- New policies and incentives for sustainable end-of-life practices



End of life material mass (million tons), Decarbonization scenarios vs. Reference Scenario

Thank you for listening!

SETO Newsletter – Stay in Touch!

SIGN UP NOW:
energy.gov/solar-newsletter

The SETO newsletter highlights the key activities, events, funding opportunities, and publications that the solar program has funded.