

Benoit Delaveau, MS, BEAP, CEM (aka Prof. Ben)
benoit.delaveau@sjsu.edu
Office hours sign-up here: calendly.com/benoit-delaveau

ENVS 119 - Energy & the Environment

14 - Utility and Rooftop Solar Powerplant

Today

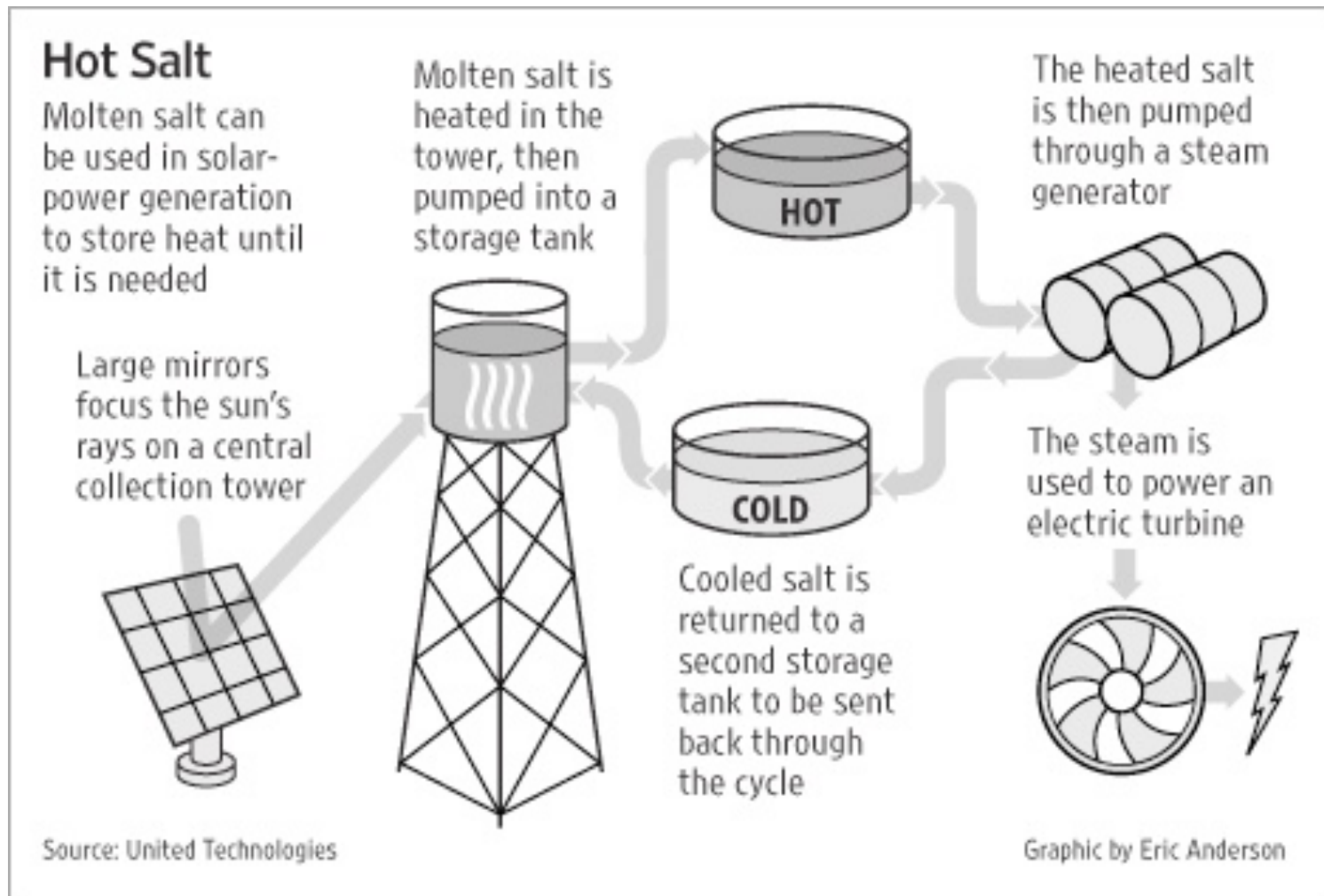
- Solarthermal Utility Plant
- SolarPV Utility Plant
- HCP Wright Solar workshop
- Price v. Market
- Intermittency (PV + Bat.)
- Demo + Sizing Examples



Photo: [Benoit Delaveau](#), Tesla Fremont.CA

Solar Thermal Powerplant

Sun + Mirrors + Steam + Turbine = Electricity

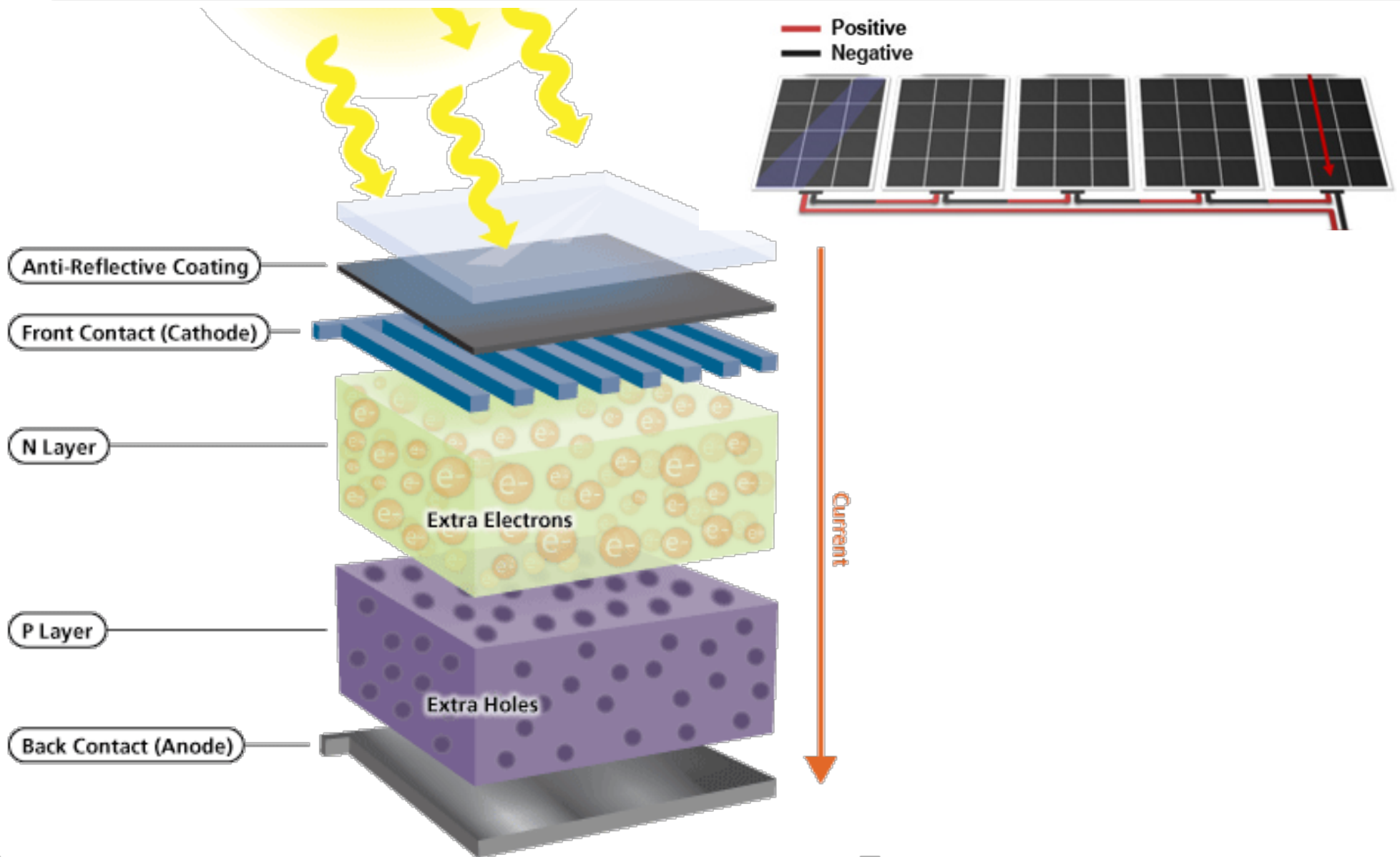


Solar Thermal Powerplant Ivanpah, CA



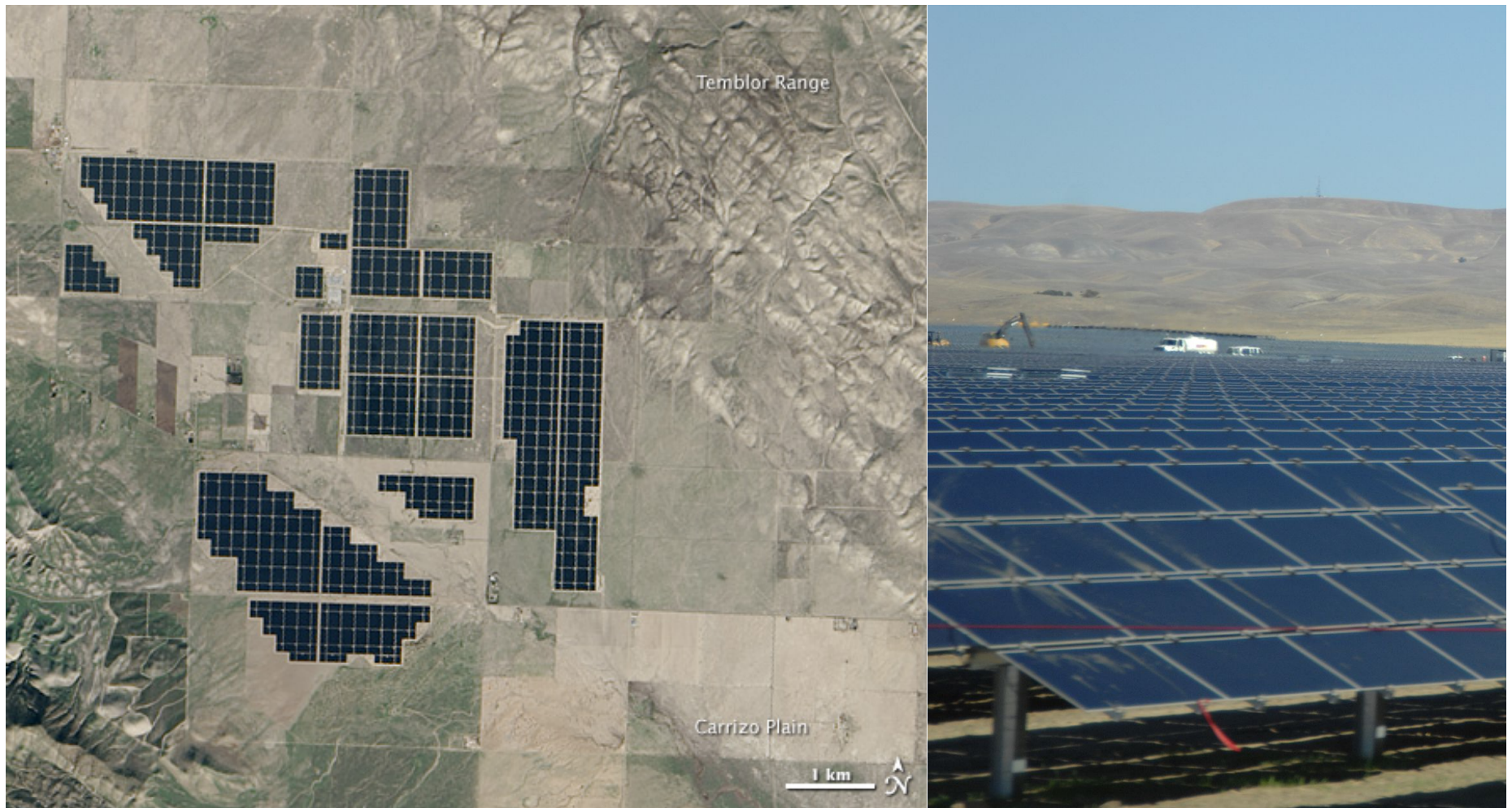
\$2.2B - 3,500 acres - 392MW - Hybrid Sun/Natural Gas - 2014

Solar PV (PhotoVoltaic panels)



Photovoltaic PV systems Solar farms

Topaz Solar Farm, San Luis Obispo, CA (PPA with PG&E)



\$2.4 B - 6,177 acres - 550 MW - 2012

Photovoltaic PV systems Solar farms

Wright Solar Park, Merced county (PCE PPA)



1,200 acres - 200 MW - 2018

What is the potential for US rooftop solar?

- Single family homes in U.S. = 25% (of electricity sales)
- Medium an large commercial roofs = 13.6%
- Total potential all buildings = 38.6%

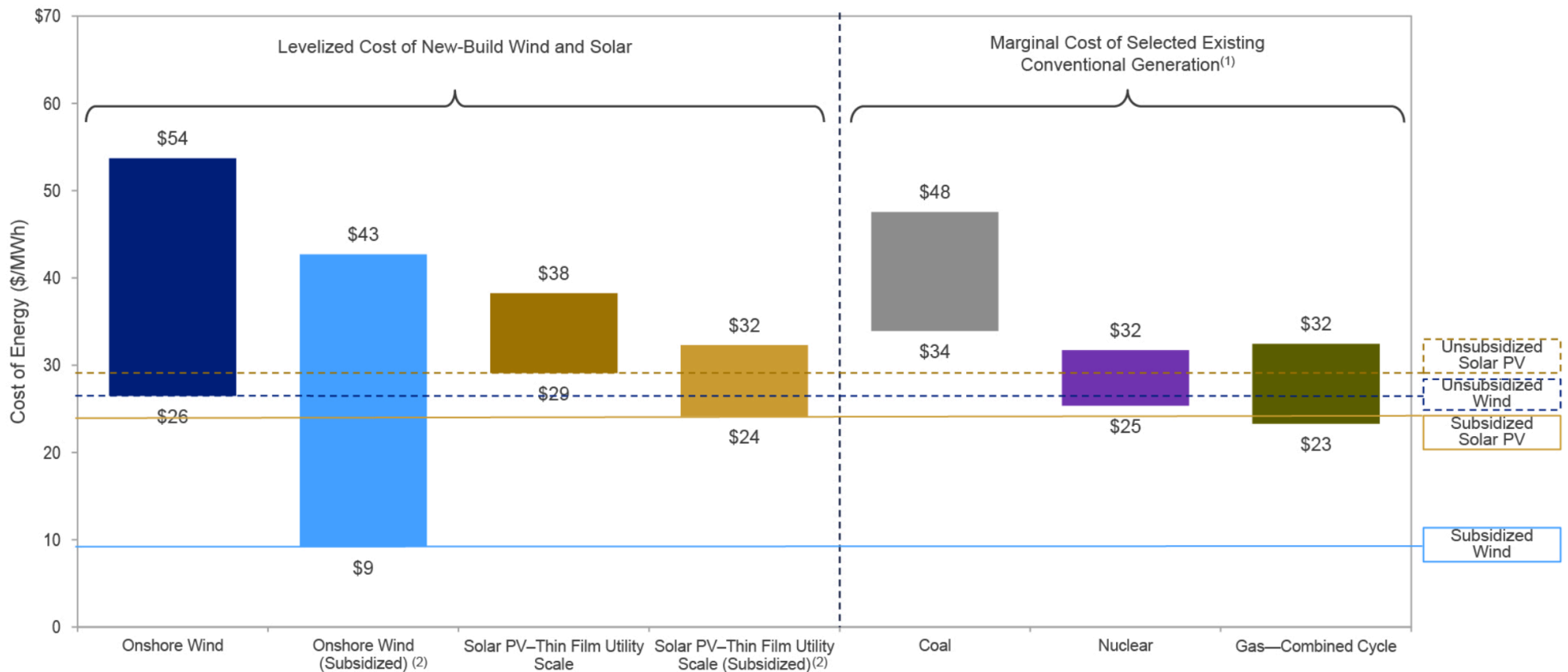
Updates to Randolph and Masters p451 - NREL, 2016 - <https://www.nrel.gov/docs/fy16osti/65298.pdf>



Solar PV panels - Price parity with other tech.

Levelized Cost of Energy Comparison—Renewable Energy versus Marginal Cost of Selected Existing Conventional Generation

Certain renewable energy generation technologies have an LCOE that is competitive with the marginal cost of existing conventional generation



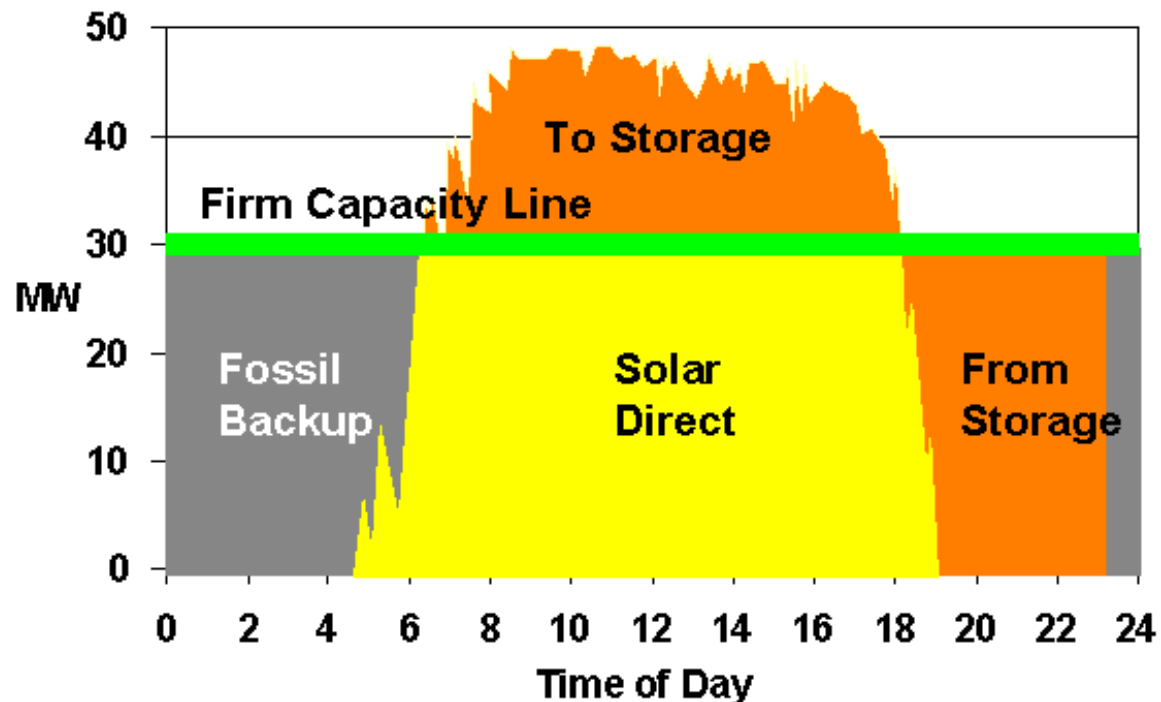
Lazard, 2020 - <https://www.lazard.com/media/451086/lazards-levelized-cost-of-energy-version-130-vf.pdf>

Source: Lazard estimates.

Note: Unless otherwise noted, the assumptions used in this sensitivity correspond to those used in the global, unsubsidized analysis as presented on the page titled "Levelized Cost of Energy Comparison—Unsubsidized Analysis".

- (1) Represents the marginal cost of operating fully depreciated gas combined cycle, coal and nuclear facilities, inclusive of decommissioning costs for nuclear facilities. Analysis assumes that the salvage value for a decommissioned gas combined cycle or coal asset is equivalent to its decommissioning and site restoration costs. Inputs are derived from a benchmark of operating gas combined cycle, coal and nuclear assets across the U.S. Capacity factors, fuel, variable and fixed operating expenses are based on upper and lower quartile estimates derived from Lazard's research.
- (2) The subsidized analysis includes sensitivities related to the TCJA and U.S. federal tax subsidies. Please see page titled "Levelized Cost of Energy Comparison—Sensitivity to U.S. Federal Tax Subsidies" for additional details.

Battery storage needed!



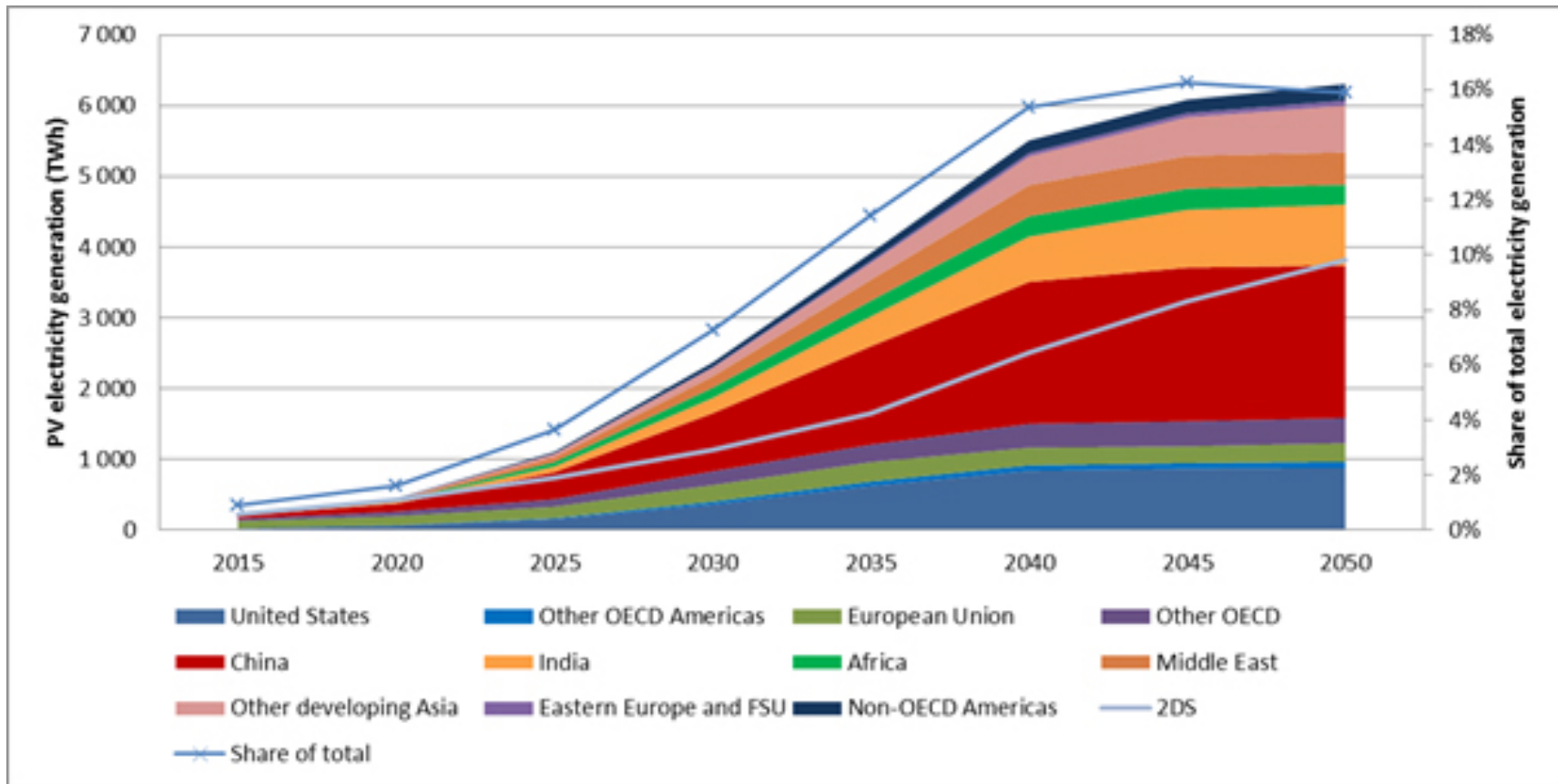
Solar PV electricity price is now at parity or lower the other competitive technologies, but day time excess MUST be stored for use at a later time of the day, driving cost up!

Demo - GoalZero Solar Van Project



- 100 Watt max. per folding panel (x5)
(50W max. x5 real)
- 1,000 Wh battery (x6)
- Full charge
 $6,000 \text{ Wh} / 250\text{W} = 24 \text{ hours}$
(2 to 4 very sunny days)
- 6,000 Wh = 6kWh
20 hours of mini fridge (50 W) - 1,000 Wh
50 hours of lighting (20 W) - 1,000 Wh
10 cups boiling water (300 W for 2 min.) - 100 Wh
10 charges for iPad, cameras, iPhones...
(15 Wh each) - 150 Wh
10 hours space heater (350 W) - 3,500 Wh
and more...

Solar PV panels - Market size



<https://www.iea.org/publications/freepublications/publication/technology-roadmap-solar-photovoltaic-energy---2014-edition.html>