

ESIG Spring Technical Workshop and Annual Meeting



Tucson, AZ
March 25-28, 2024

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Workshop Agenda Overview



Monday am

- Tutorial : Electromagnetic Transient Analysis Simulation Tools

Monday pm

- Introduction and Keynote Comments
- Opening Plenary Session: Grid Forming Technology Applications
- Board Meeting & Dinner 6:00 – 8:30 pm

Tuesday am

- Session 2: Markets for Transmission
- Session 3a: Transmission Expansion Studies
- Session 3b: Grid Forming Technology Developments
- Annual Meeting 12:00 – 12:20 pm

Workshop Agenda Overview



Tuesday pm

- Session 4a: Resilience
- Session 4b: Virtual Power Plants
- Session 5a: Transmission Interconnection Process
- Session 5b: Resource Adequacy
- Annual Awards/Networking Reception 6:30 – 8:00 pm

Wednesday am

- Session 6: Price-based Demand Flexibility
- Session 7a: System Planning
- Session 7b: DER

Workshop Agenda Overview



Wednesday pm

- Session 8a: System Oscillations
- Session 8b: EV Impacts on Electrification
- Closing Plenary: Plant Retirement Planning – A Panel Discussion

▪ Thursday – Working Groups and Task Forces – Members Only

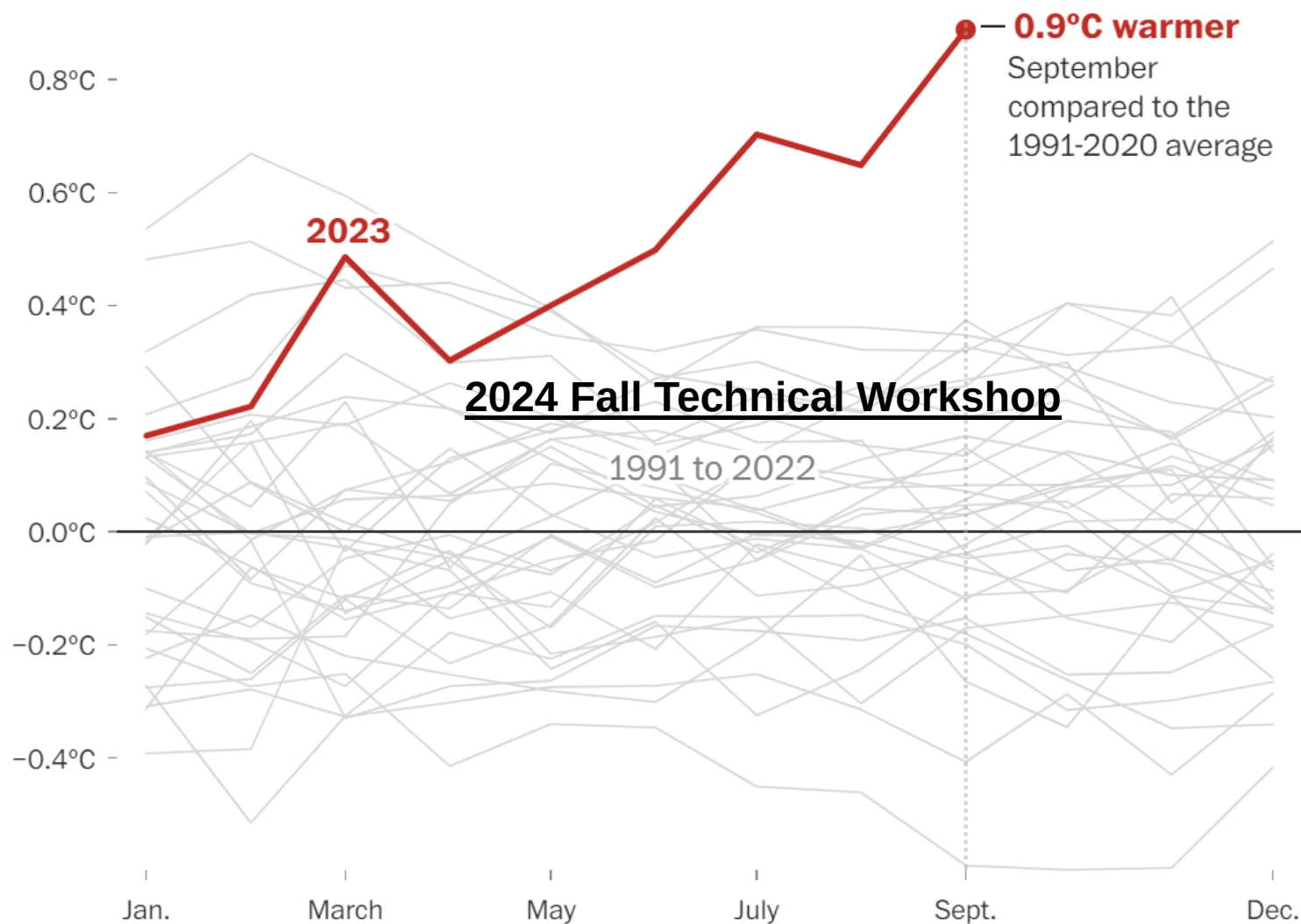
- Thursday am
 - System Operation & Market Design Working Group
 - DER Working Group

Workshop Agenda Overview



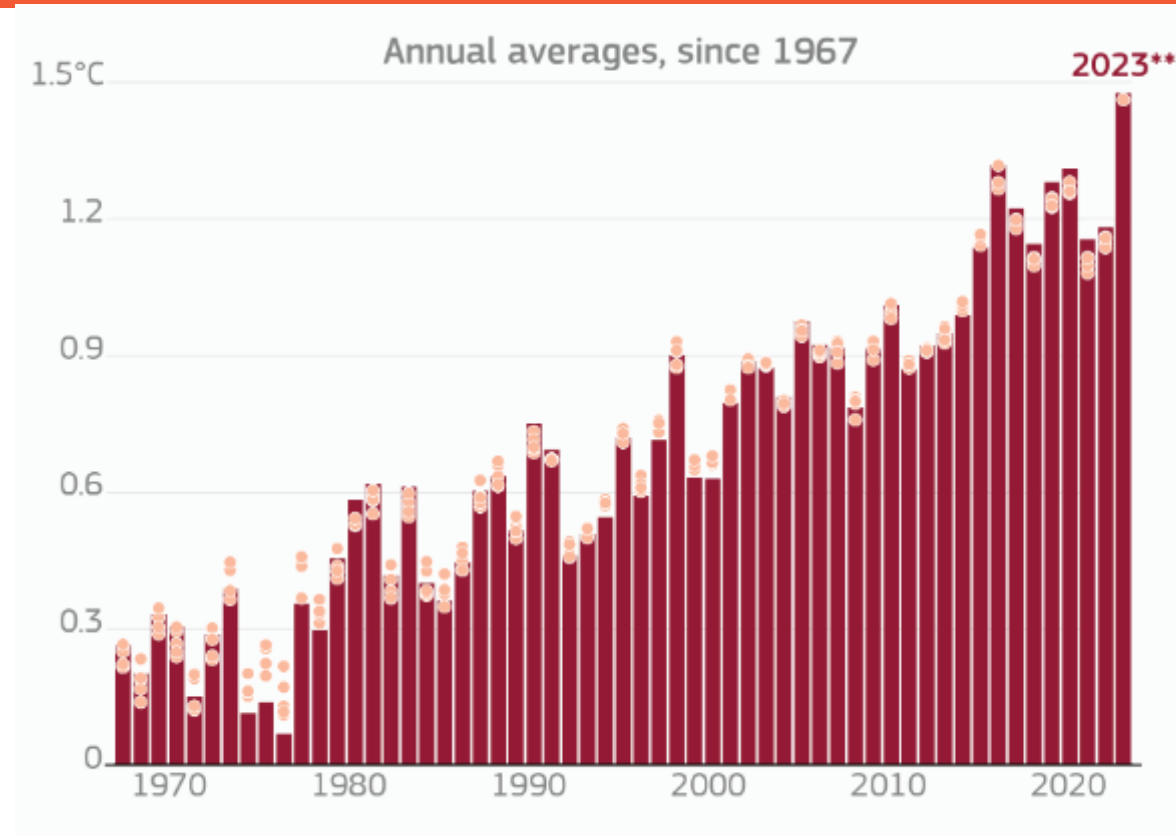
- Thursday pm
 - Research & Education Working Group
 - System Planning Working Group
- Thursday (all day):
 - Joint Reliability Working Group / GPST Special Topic Workshop on System Oscillations

“September Shattered Global Heat Record”



- “Absolutely gobsmackingly bananas”
- “Extraordinary”
- “We’ve never seen a record smashed by anything close to this margin.”
- “Copernicus estimates annual average temperatures this year are expected to end up about 1.4 degrees Celsius (2.5 degrees Fahrenheit) above preindustrial levels.”

Global Surface Temperature: Increase Above Pre-Industrial Level



Source: C3S/ECMWF

- 2023 is confirmed as the warmest calendar year in global temperature data records going back to 1850
- 2023 was 1.48°C warmer than the 1850-1900 pre-industrial level

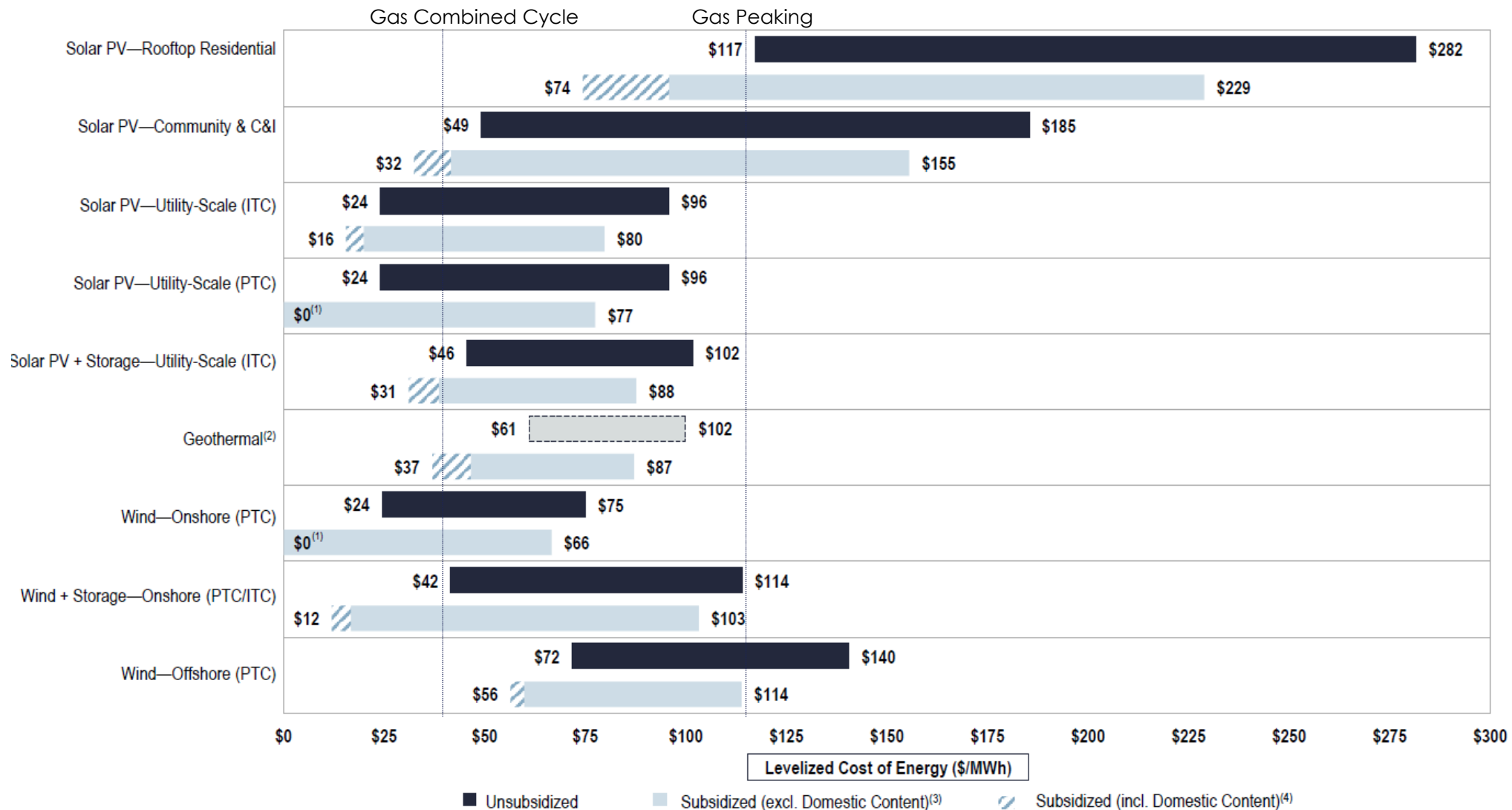
Do You Ever Have That Feeling?



"Maybe if I unplug it and plug it in again, it'll fix this mess."

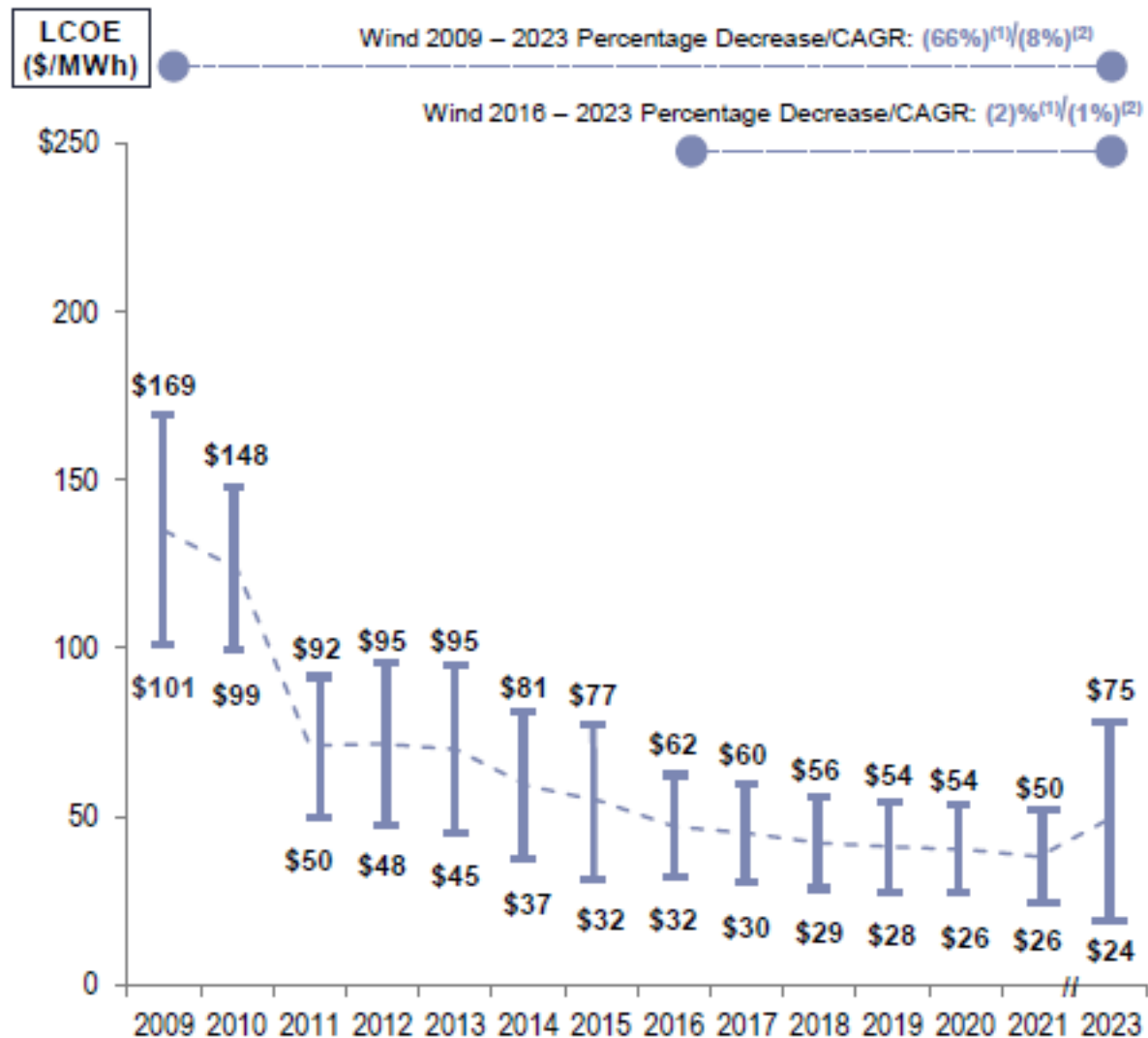
CartoonStock.com

LCOE Comparison – Sensitivity to Tax Credits



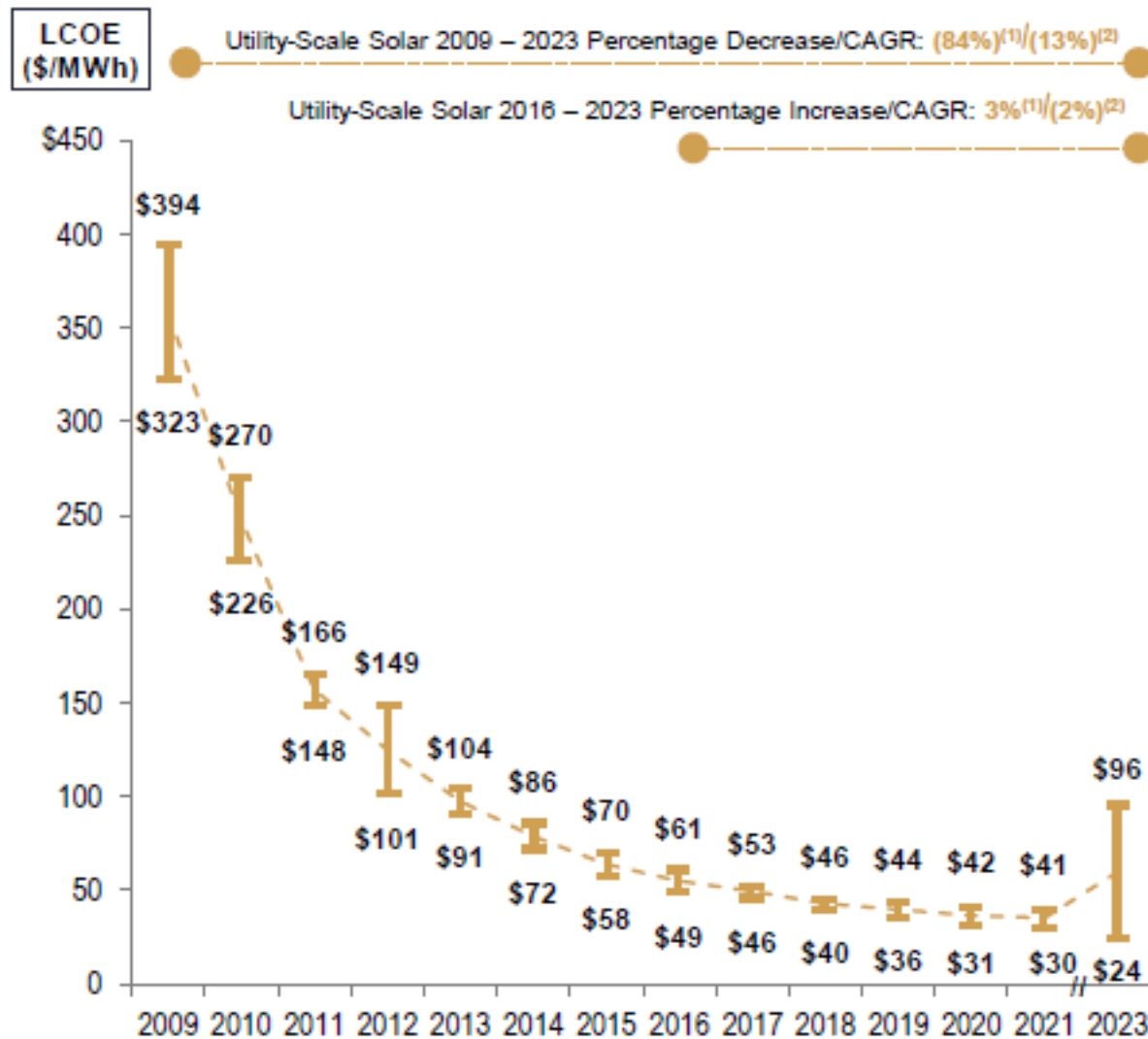
Source: Lazard

Unsubsidized Wind LCOE Over Time



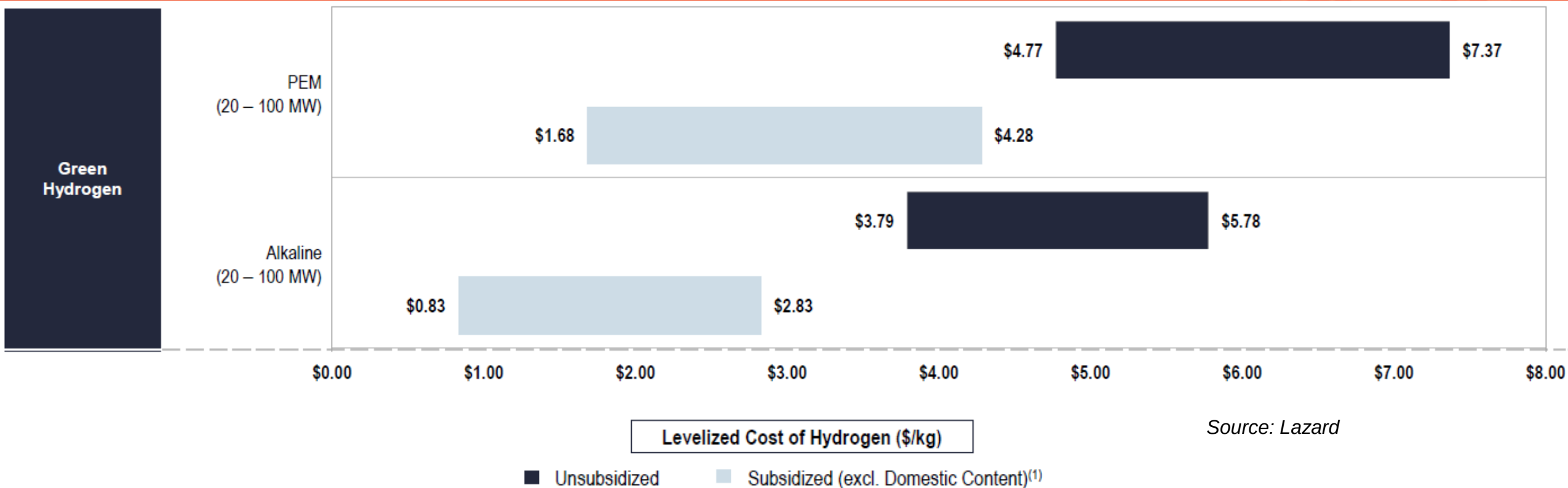
Source: Lazard

Unsubsidized Solar LCOE Over Time



Source: Lazard

LCOE of Hydrogen – Illustrative Results



- Reminder: DOE Hydrogen Shot seeks to reduce the cost of green hydrogen from \$5 to \$1 per kilogram (\$8/MMBTU) by 2030, competitive with fossil fuel sources of H₂.

From late 2022

- Wind and solar paired with battery storage is in the \$20/MWh to \$30/MWh range, making them competitive with natural gas-fired generation
- **Later this decade, with the IRA, NextEra expects wind coupled with a 4-hour battery system will cost \$14/MWh to \$21/MWh**
- **NextEra expects Solar with batteries will cost \$17/MWh to \$24/MWh**
- **An existing natural gas-fired power plant will cost \$35/MWh to \$47/MWh to operate, assuming gas is in the \$4/million British thermal units to \$5/MMBtu range**

From March 2024

- Florida-based Nextera, the largest renewable energy developer in the U.S., plans to double its operating fleet to 64 GW by the end of 2026

An Industry Maturing – Globally



- Global wind capacity end of 2023 (various): 1075 GW
- Global PV capacity end of 2023 (various): 1475 GW
- US Renewable capacity end of 2023
 - Wind 150 GW
 - PV 160 GW
- Variously Estimated Global VG installations in 2024
 - Wind 100 – 125 GW
 - PV 250 - 300 GW

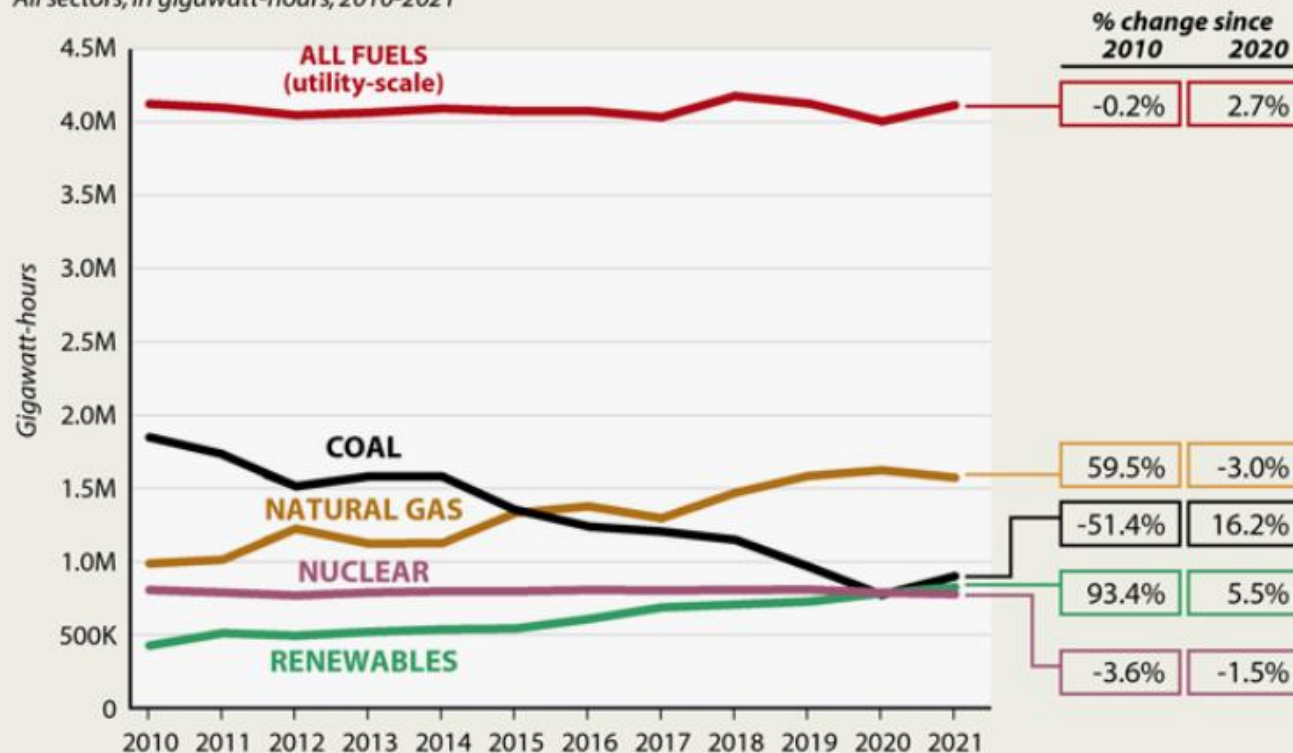
Still a Ways to Go in the US

Renewables, Coal on the Rise

Renewable energy gained ground in 2021, but it was still passed by coal, which had a comeback after a major decline in 2020. Natural gas and nuclear each lost ground.

U.S. NET POWER GENERATION

All sectors, in gigawatt-hours, 2010-2021



NOTE: Renewables includes the EIA categories of "conventional hydroelectric" and "other renewables."

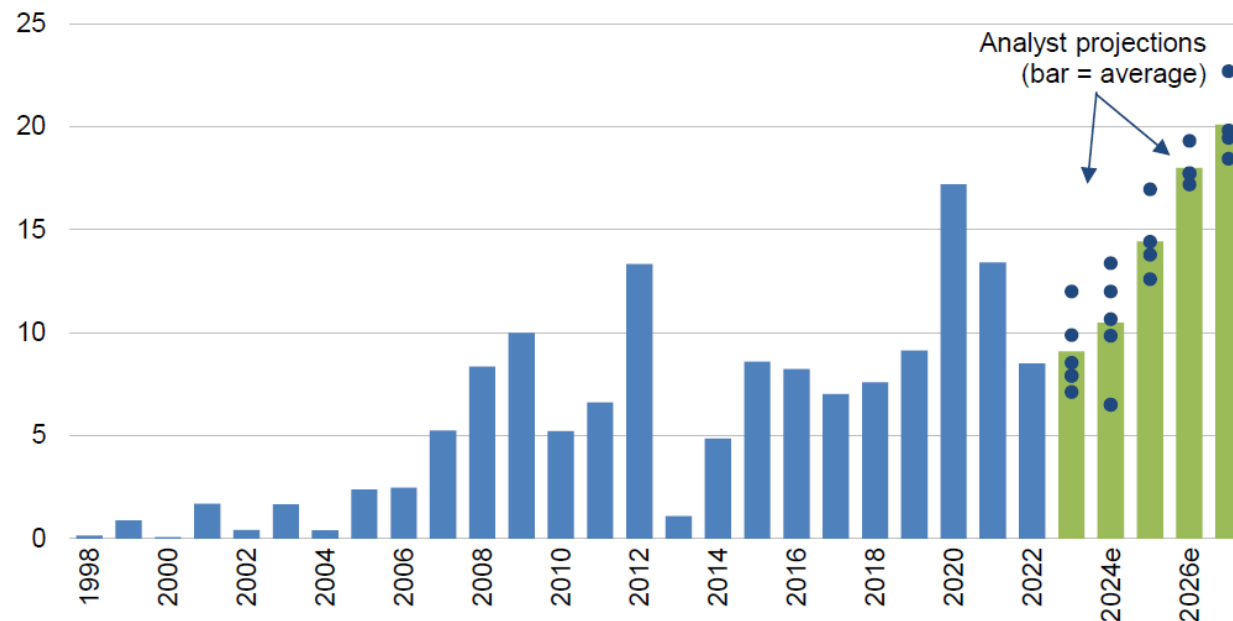
Outlook for Future US Wind Plant Installations



Analysts project growing wind deployment, spurred by incentives in the Inflation Reduction Act (IRA)

- IRA extends PTC at full value for at least ten years for projects that meet wage & apprenticeship requirements
- Two 10% bonuses on top of PTC, for meeting domestic content requirements or for location in energy community
- Additional tax credits for domestic clean energy manufacturing, including for nacelles, blades & towers

Annual Capacity (GW)

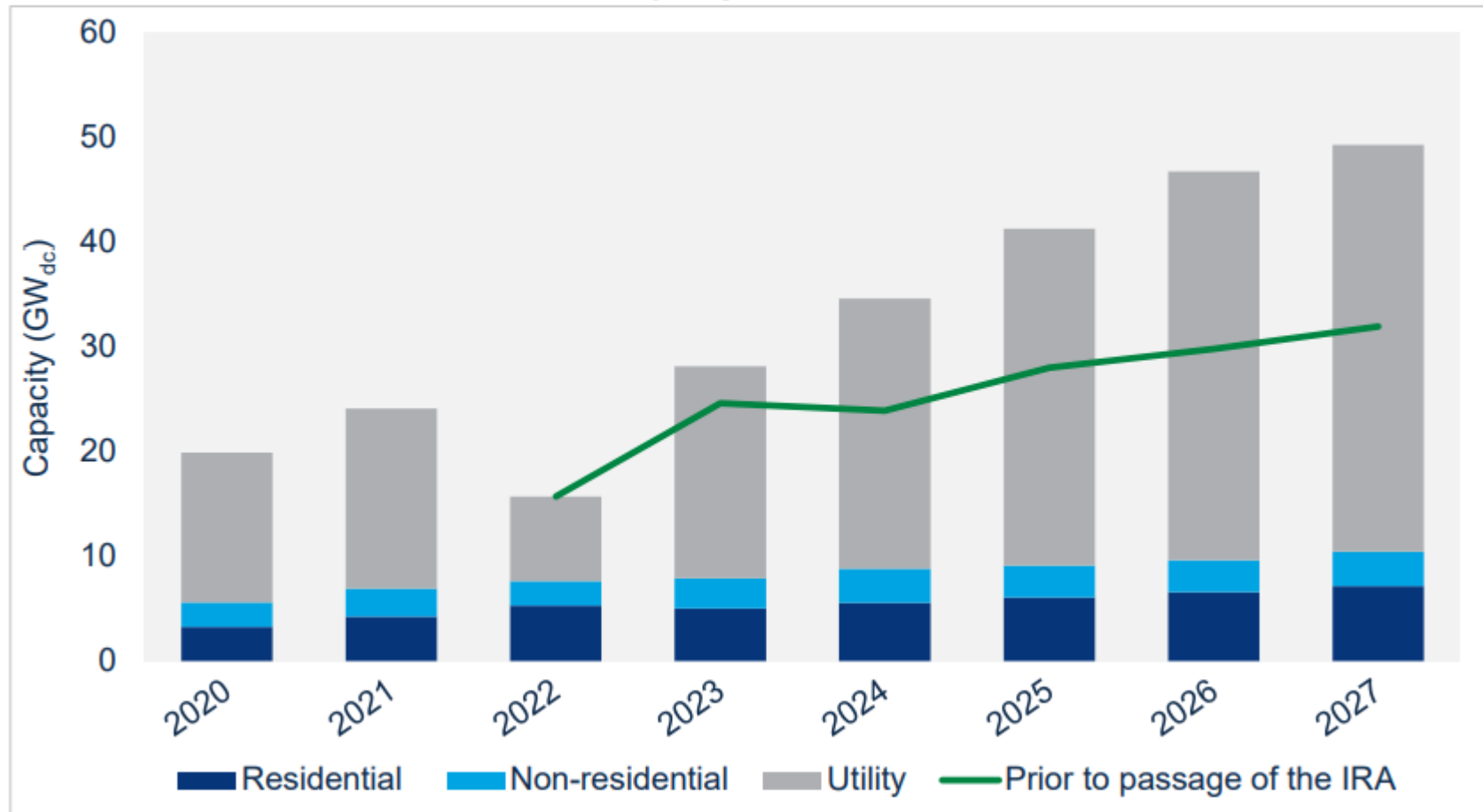


- Has resulted in both higher expectations for future capacity growth and a growing number of announcements for new, expanded, and re-opened manufacturing facilities
- Limited transmission, interconnection costs and timeframes, siting and permitting challenges, inflation and interest rates, and competition from solar may dampen growth

Sources: ACP, independent analyst projections

Outlook for Future US Solar PV Installations

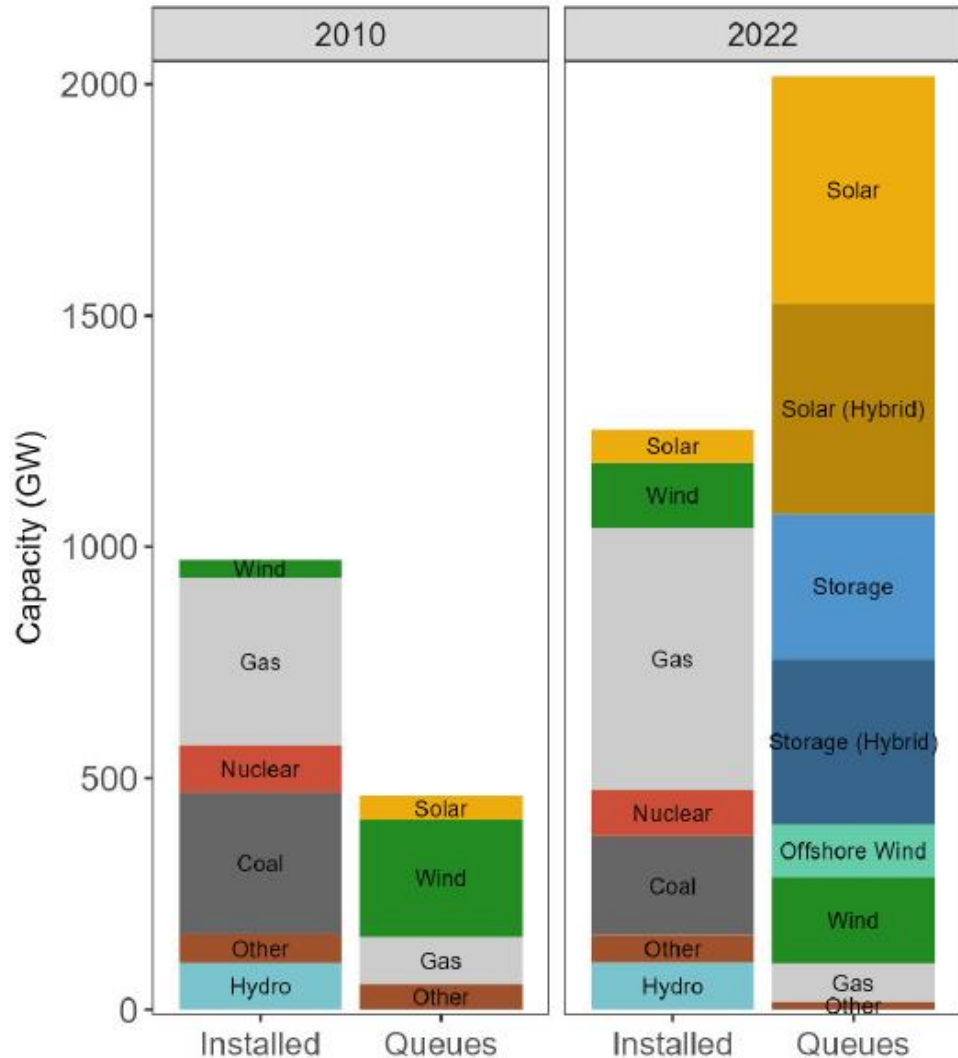
US solar PV installations and forecasts by segment, 2020-2027



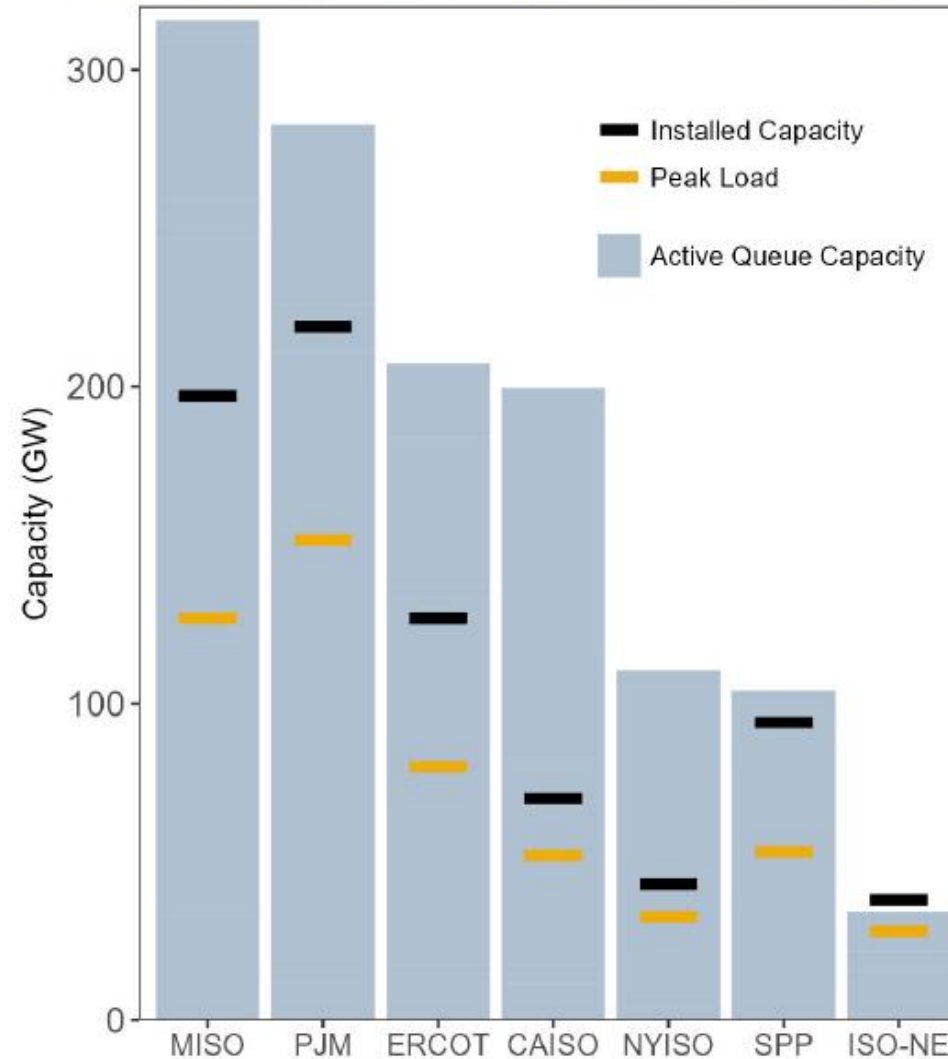
(Source: pv magazine - SEIA/Wood Mackenzie)

Generating Capacity and Queues – Then and Now

Entire U.S. Installed Capacity vs. Active Queues



RTO Installed Capacity & Peak Load vs. Active Queues



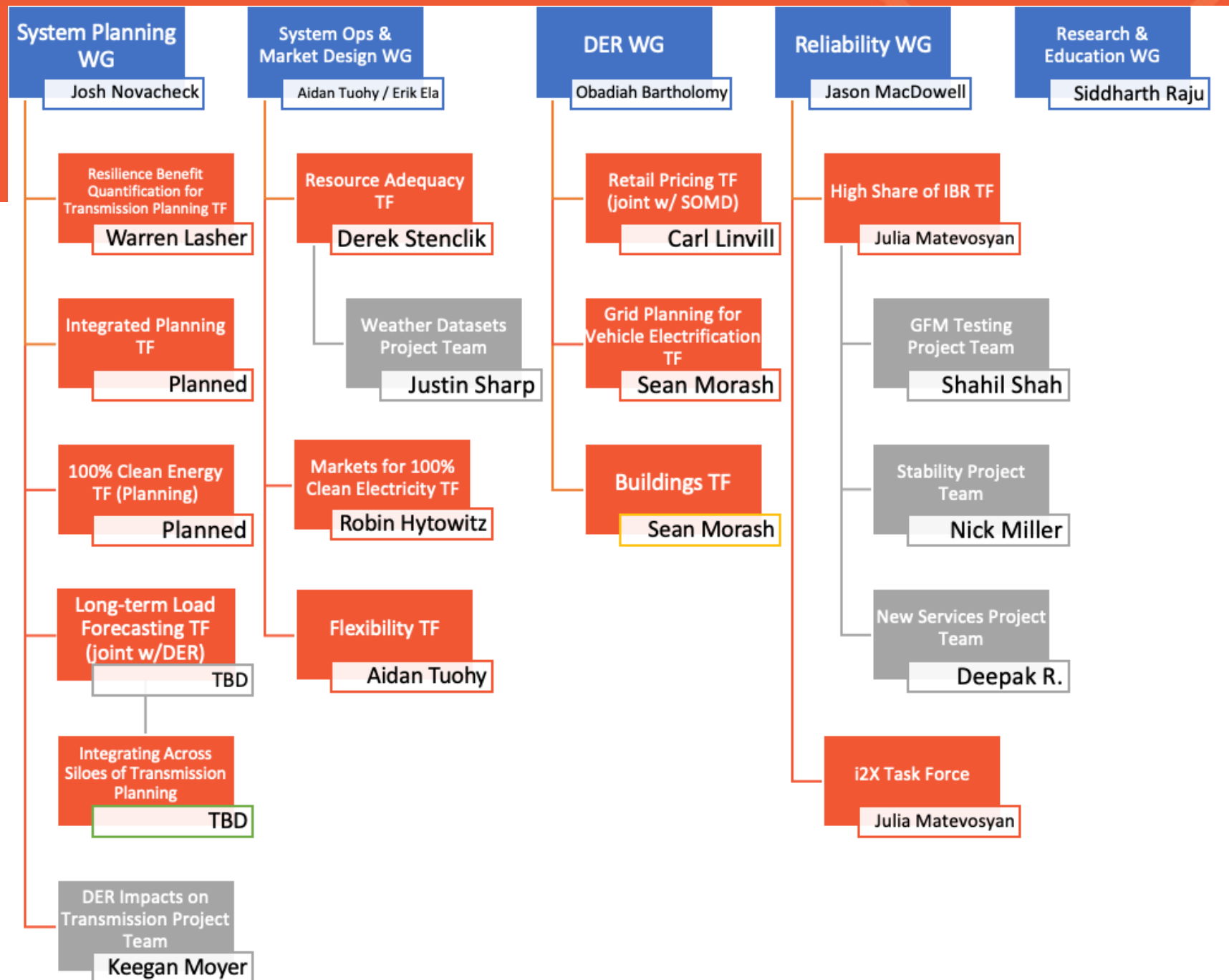
Source: Lawrence Berkeley National Laboratory

What's the Buzz This Past Year?



- Rhodium Group finds \$239 billion invested in clean tech in 2023, with every dollar from the IRA matched by \$5.47 from the private sector
- Global energy transition investment must quadruple to \$5T/yr to meet climate targets
- AI and the boom in clean tech manufacturing are pushing America's power grid to the brink. Utilities can't keep up. (Wash Post, March 2024)
- 4 heat pump manufacturers develop successful sub-zero prototypes in the US (DOE Residential Cold Climate Heat Pump Challenge) (Lennox, Carrier, Trane, Rheem)
- Energy storage developer Plus Power began operating its 185 MW/565 MWh grid forming battery facility on Oahu, Hawaii, using Tesla Megapack lithium iron phosphate batteries
- 2 Tesla VPPs cleared to provide energy to ERCOT
- DOE awards \$7B for 7 hydrogen hubs and \$750 M for clean hydrogen R&D
- EV Impacts: Preliminary results from CPUC Part 1 Study estimate approximately \$50 billion for distribution grid investments by 2035 to accommodate an unconstrained EV scenario if measures are not taken to reduce costs and manage load. Part 2 study should consider real-time dynamic rates and flexible load management strategies.

Working Groups and Task Forces Structure



Users Groups Structure



Operations &
Maintenance

Ninotchka Bosworth & Stanton Peterson

Probabilistic Forecasts in
Planning & Operations

Nitika Mago

GETs

Ken Donohoo

Upcoming ESIG Meetings



2024 Forecasting and Markets Workshop

June 11 – 13, 2024

Salt Lake City, UT

2024 Fall O&M User Group Meeting

September 24 - September 26

Boston, MA

2024 Fall Technical Workshop

October 21 - 24, 2024

Providence, Rhode Island

2025 Spring Technical Workshop

March 17 - 20, 2025

Austin, TX

Onward and Upward

- Latest IEEE P&E magazine integration issue published March/April 2024
- A warm welcome to visitors from afar:

Australia	Ireland
Belgium	Japan
Canada	South Korea
Chile	United Kingdom
Denmark	Texas
Germany	



- Take the time to make some new friends!
- Looking forward to another great meeting!



THANK YOU

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