ESIG Forecasting and Markets Workshop

ESIG
ENERGY SYSTEMS INTEGRATION GROUP

Salt Lake City, Utah

June 11-13, 2024

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Workshop Agenda Overview

Tuesday am

- Tutorial : Weather Datasets for Power System Planning

Tuesday pm

- Introduction and Keynote Comments
- Opening Plenary Session: AI Applications to Forecasting and Markets
- Networking Reception 6:30 – 8:00 pm

Wednesday am

- Session 2a: Improving DER Participation in Organized Markets
- Session 2b: Growth of Large Loads
- Session 3a: Considerations for 100% Zero Marginal Cost Markets
- Session 3b: Advances in Wind and Solar Forecasting

Workshop Agenda Overview

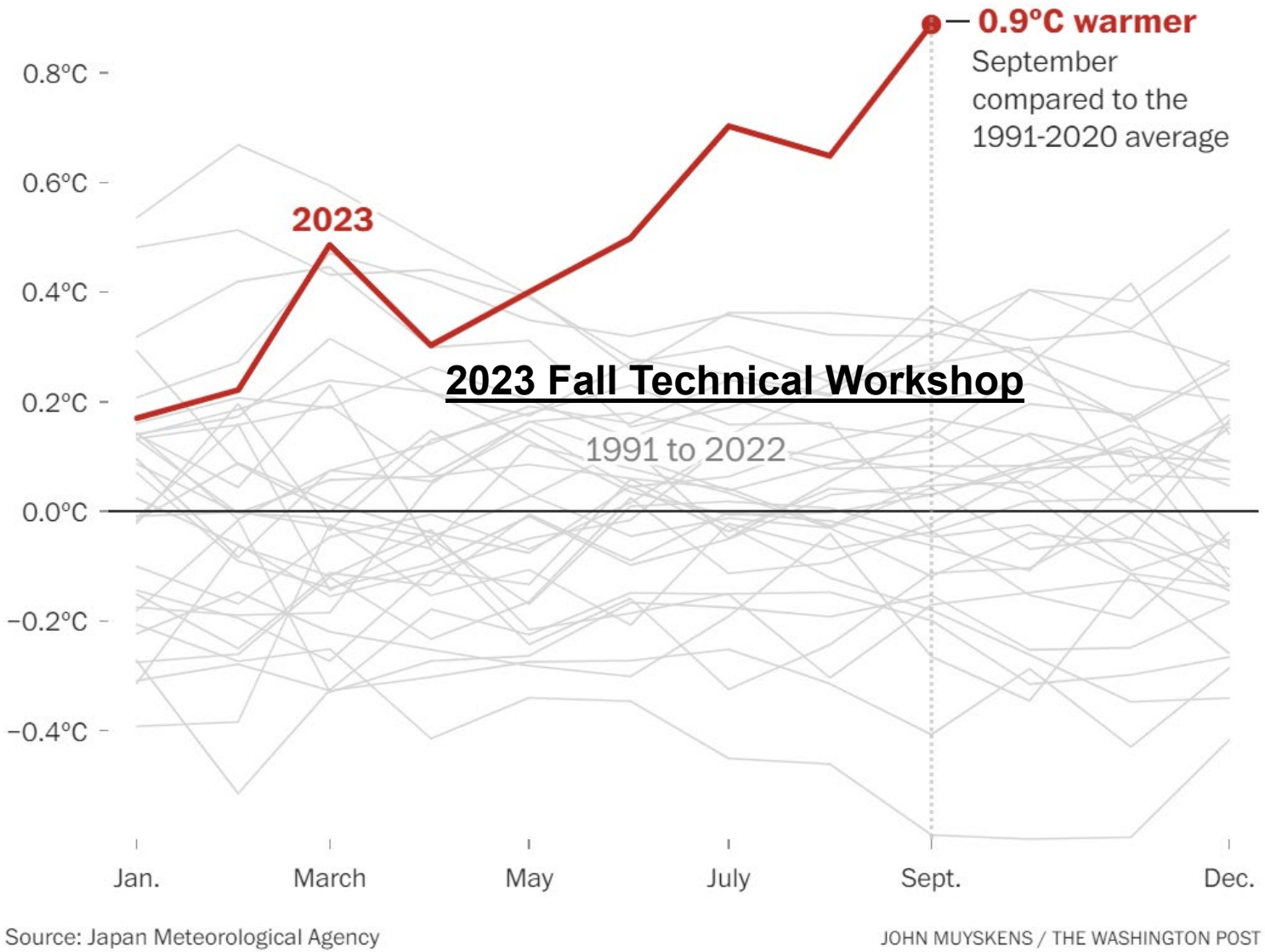
Wednesday pm

- Session 4a: Retail Pricing
- Session 4b: Power System Impacts of Rapid Electrification
- Session 5a: Forecasting & Markets
- Session 5b: Utility and ISO Probabilistic Forecasting Developments

Thursday am

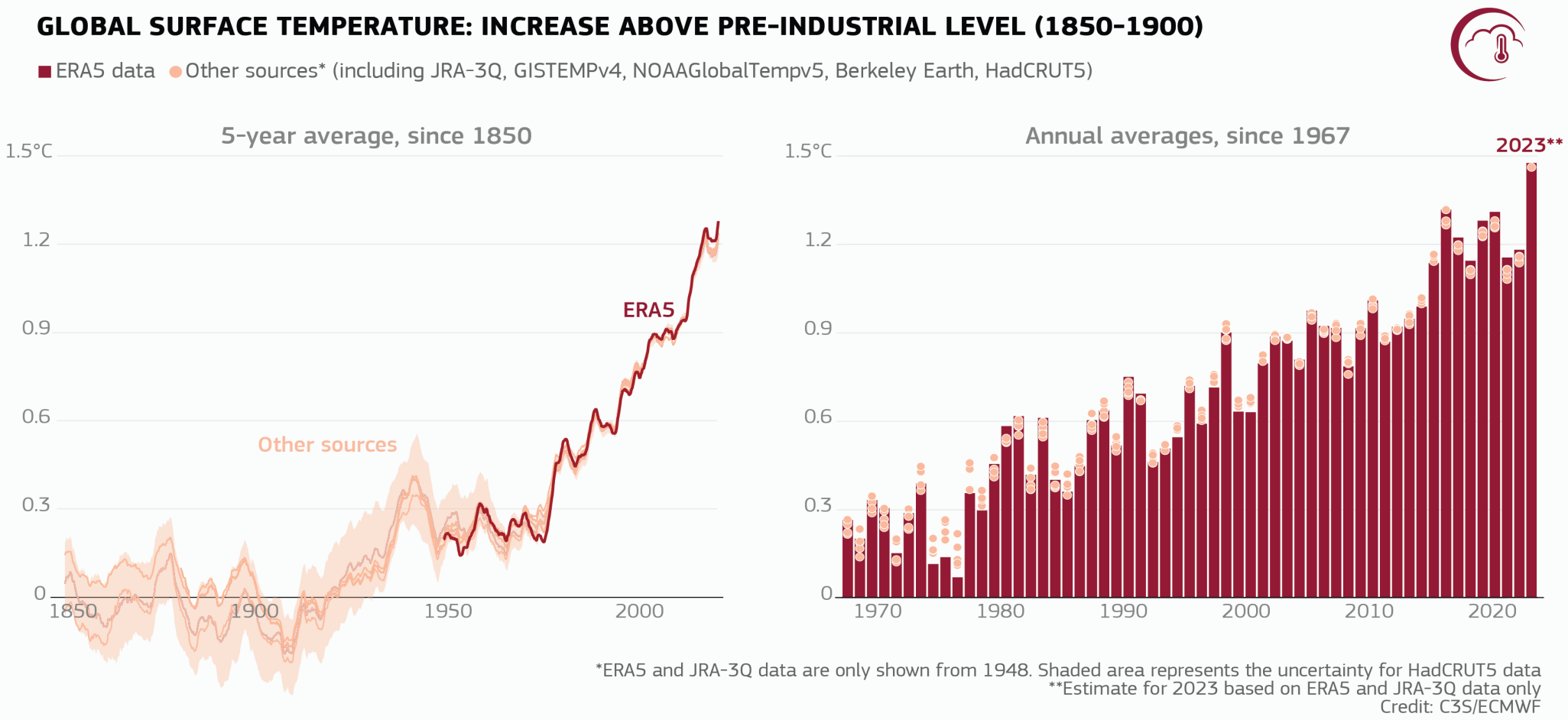
- Session 10: Bridging the Gap between Atmospheric Science and Grid Modeling – cosponsored with the Renewable Energy Committee of the American Meteorological Society (AMS)
- Session 11: Closing Plenary Session - Panel Discussion of the Issues and Challenges in the Energy Transition
- Adjourn: noon

“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



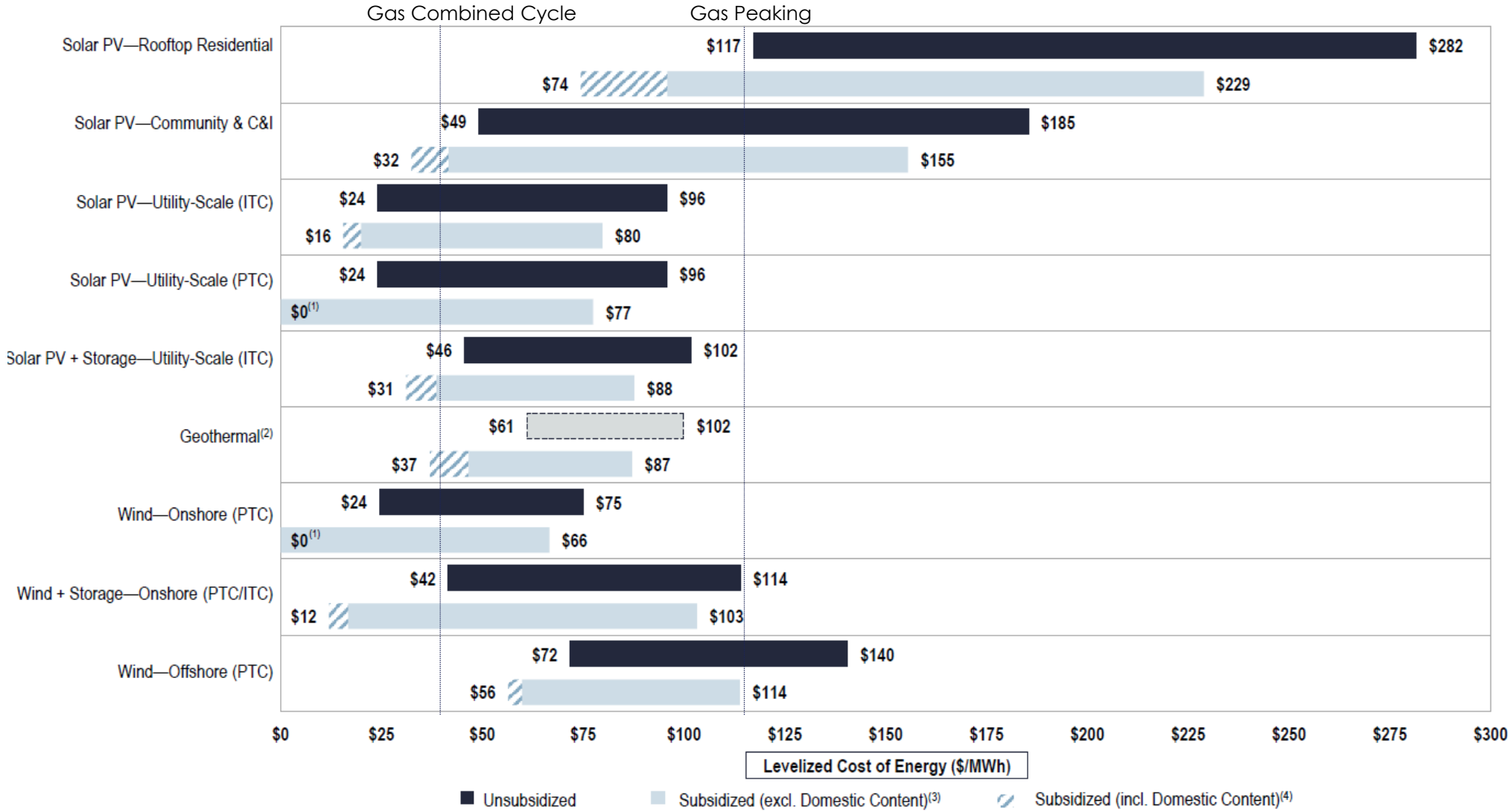
Source: Copernicus Climate Change Service 2024

Do You Ever Have That Feeling?

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

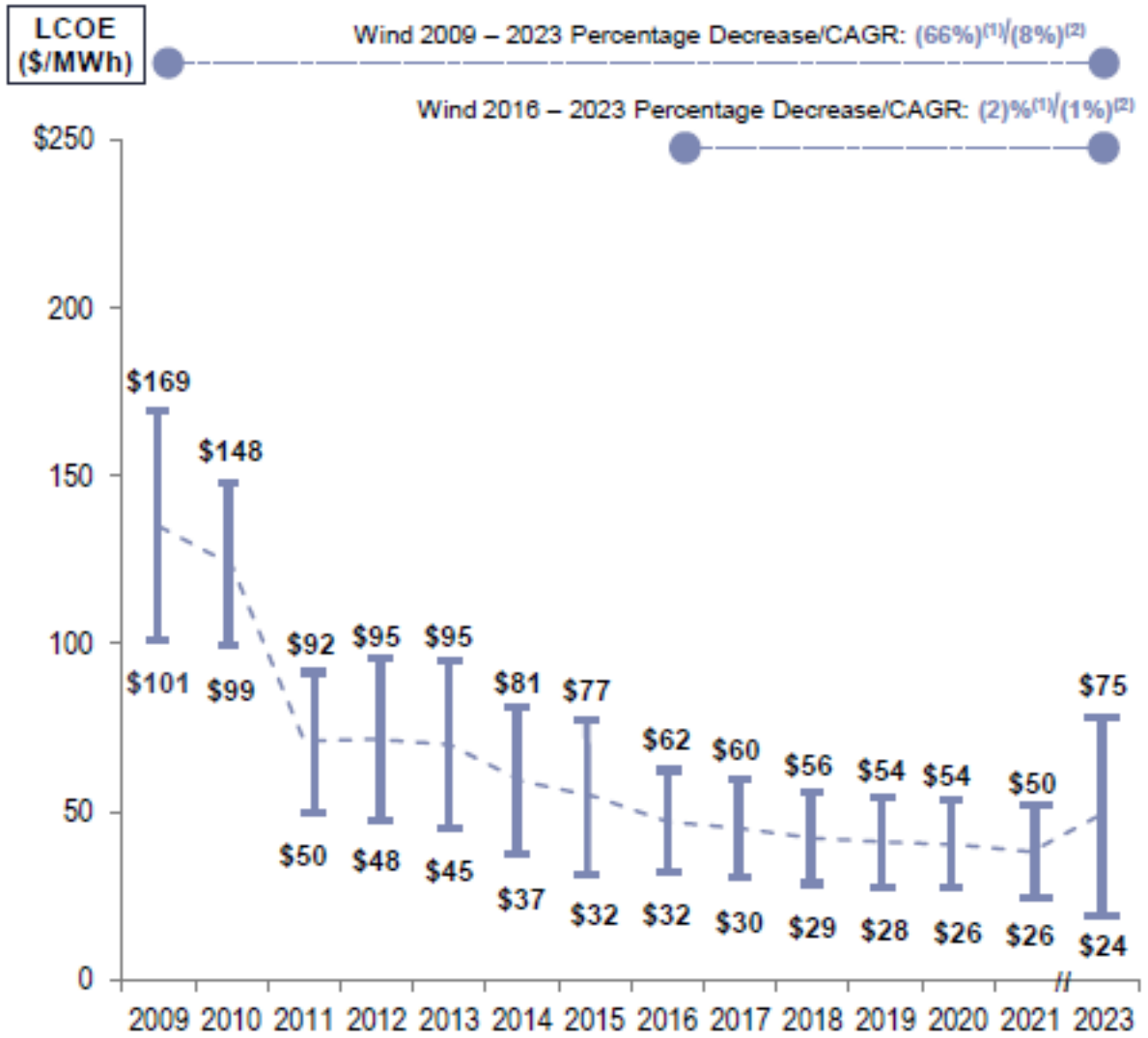
CartoonStock.com

LCOE Comparison – Sensitivity to Tax Credits



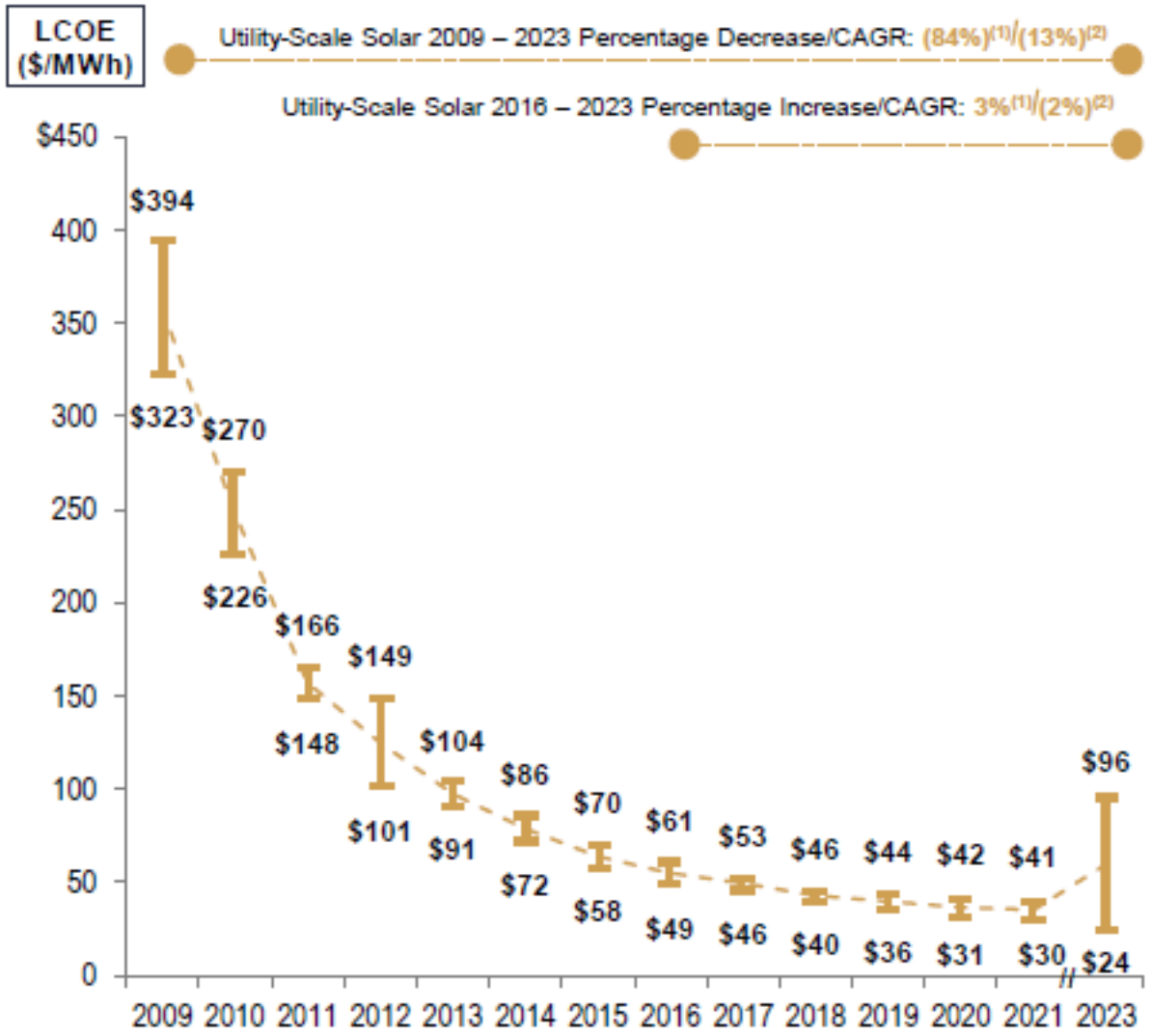
Source: Lazard

Unsubsidized Wind LCOE Over Time



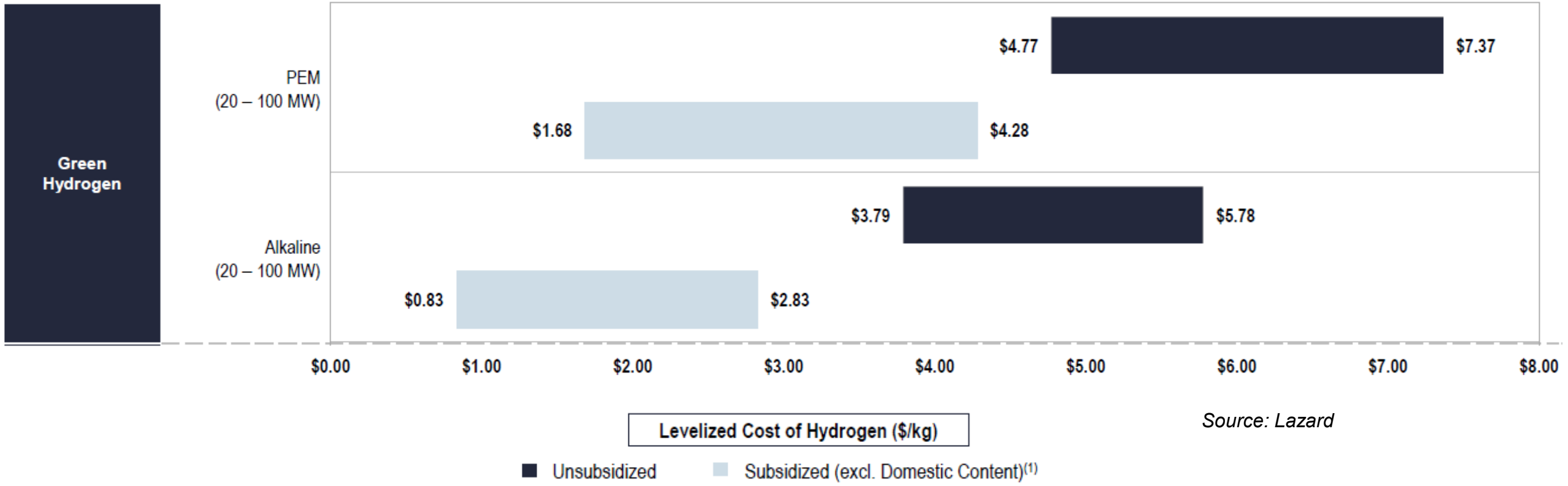
Source: Lazard

Unsubsidized Solar LCOE Over Time



Source: Lazard

LCOE of Hydrogen – Illustrative Results



Source: Lazard

- 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.

Nextera Energy Projections

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**

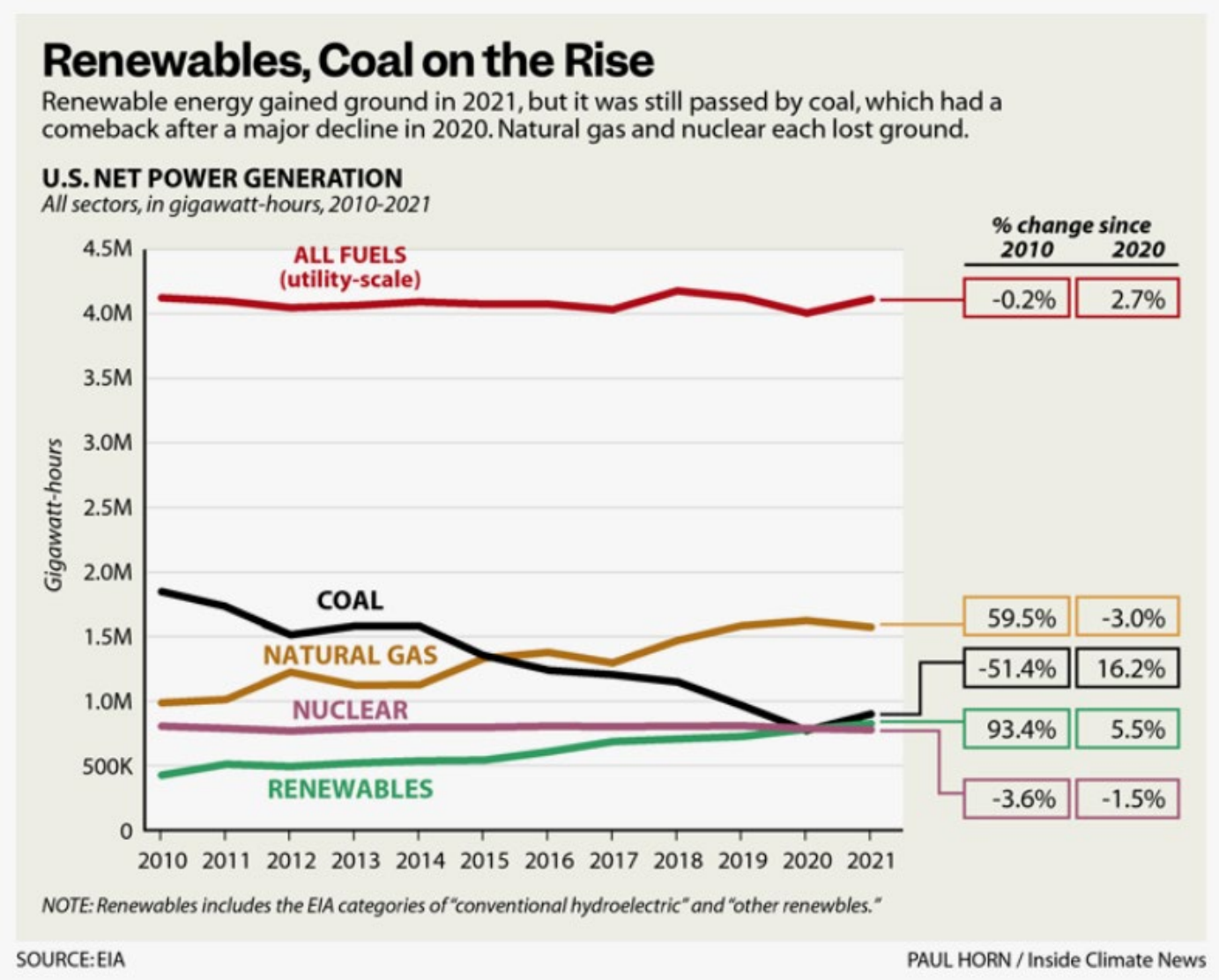
From March 2024

- 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

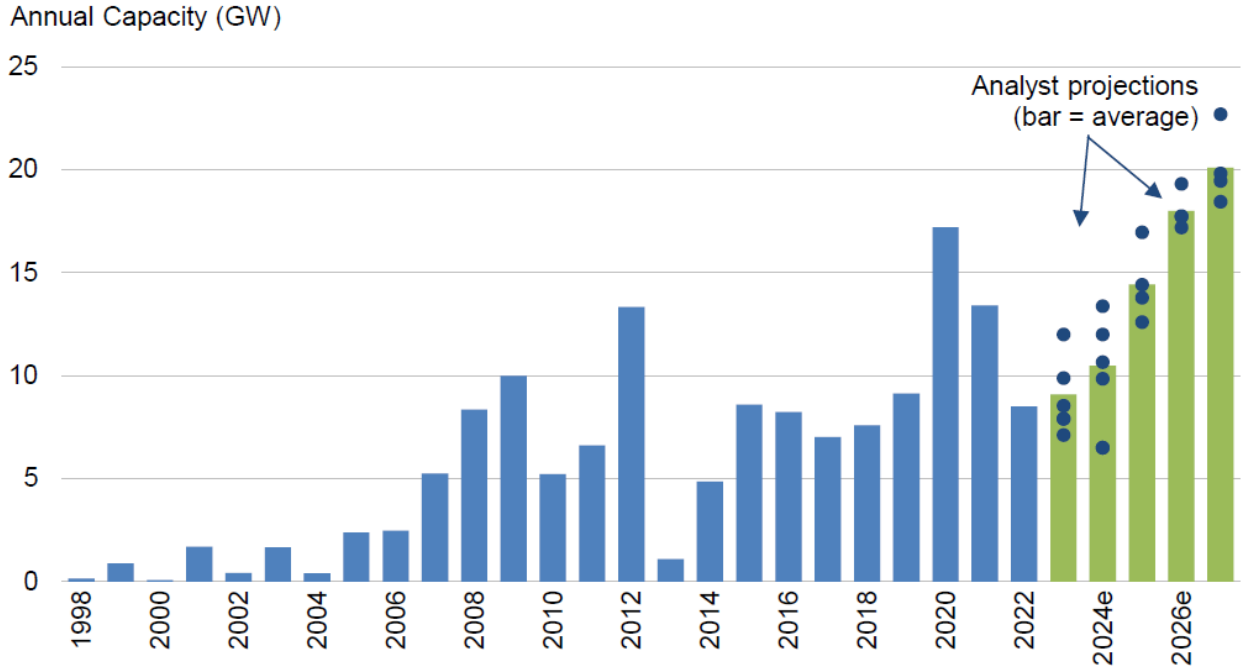
Still a Ways to Go in the US



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

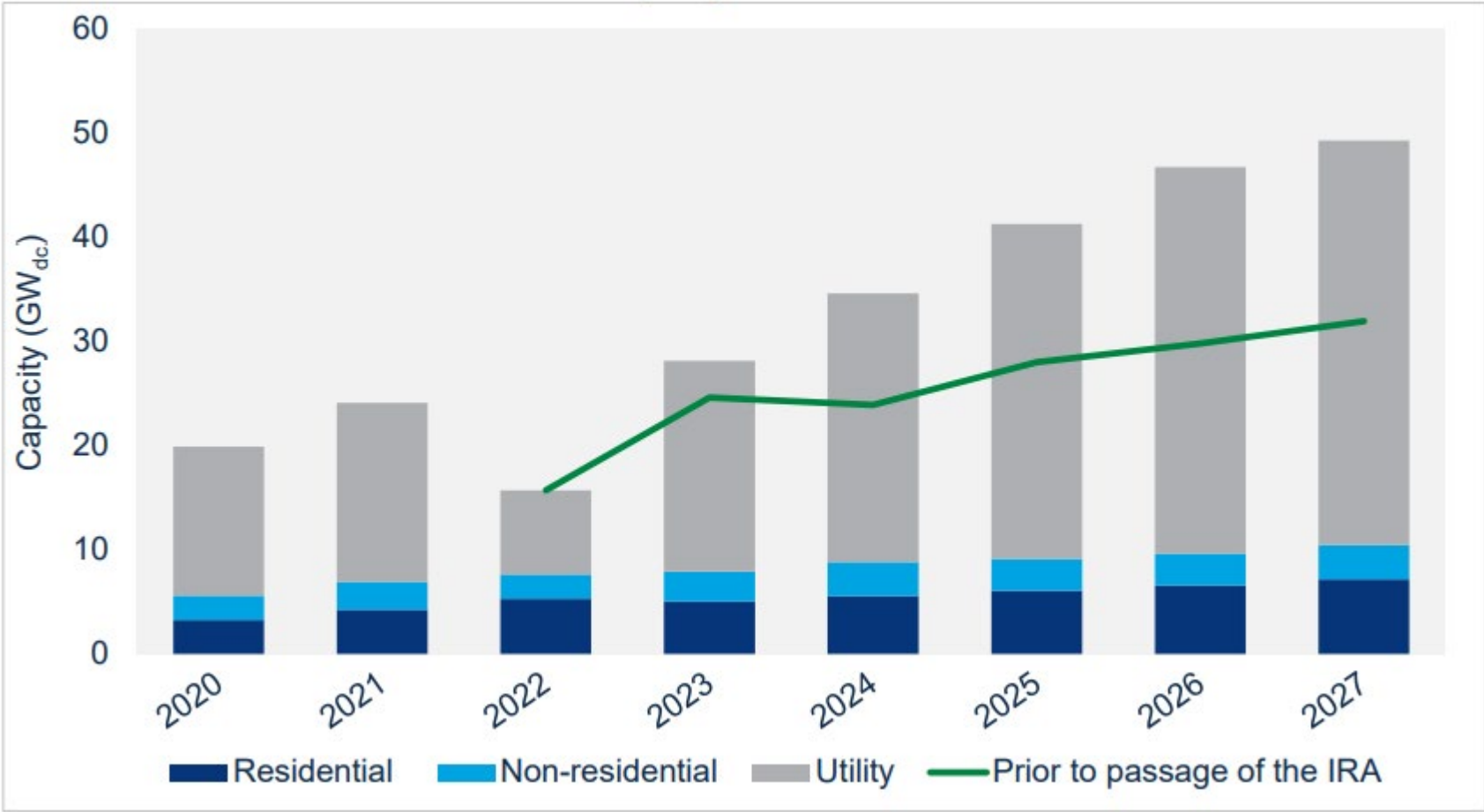


Sources: ACP, independent analyst projections

- 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

Outlook for Future US Solar PV Installations

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

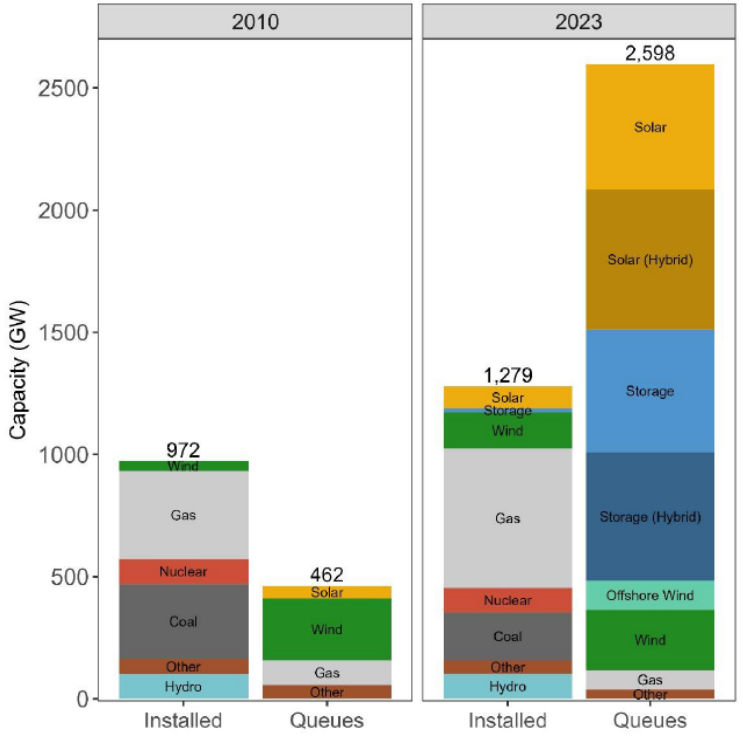


(Source: pv magazine - SEIA/Wood Mackenzie)

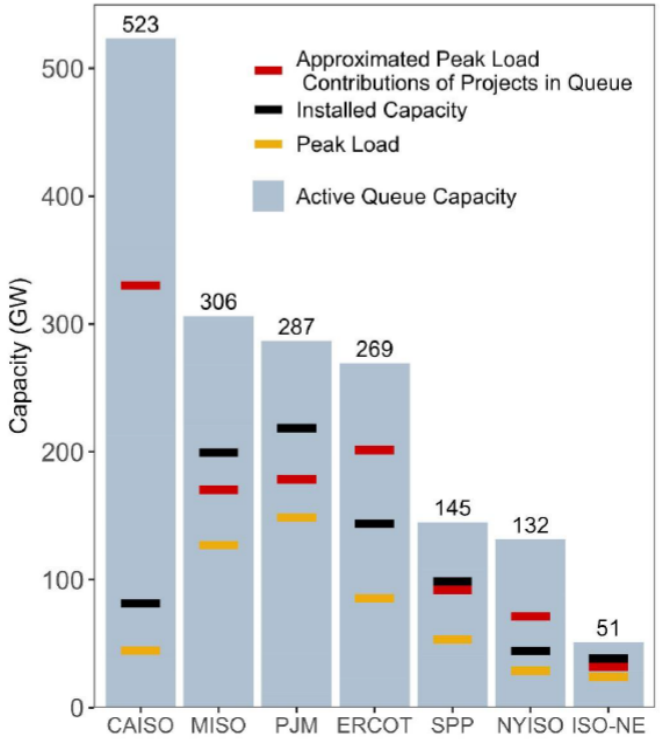
Installed Capacity and Active Queues

Active capacity in queues (~2,600 GW) is twice the installed capacity of U.S. power plant fleet (~1,280 GW); greater than peak load and installed capacity in all ISOs

Entire U.S. Installed Capacity vs. Active Queues



RTO Installed Capacity & Peak Load vs. Active Queues



Comparisons of queue capacity to installed capacity or peak load should also consider generators' contributions to resource adequacy, for example their "effective load carrying capability" (ELCC). As variable resources, solar and wind contribute a smaller percentage of their nameplate capacity to resource adequacy and peak load compared to dispatchable generation like natural gas. The red lines in the chart are a simplified estimate of the peak load contribution of projects in the queue.

Decarbonizing the electric sector requires higher levels of *installed* solar and wind capacity to achieve the same resource adequacy contributions. High levels of storage can offset this need to some degree. Electrification of buildings and transport will also result in load growth.

Source: LBNL

Notes: (1) Hybrid storage in queues is estimated for some projects. (2) Total and RTO installed capacity from EIA-860, December 2023. (3) Peak load data from RTO websites. (4) Peak load contributions by region relies on NERC 2023 reliability assessments for standalone solar, onshore wind, and hydro. Storage, gas, coal, and nuclear are approximated with a peak load contribution of 100%, even though in practice their contributions will be smaller. Offshore wind contributions are based on recent reliability studies.

DOE Preliminary Map of National Interest Electric Transmission Corridors

Map is a rough approximation for illustrative purposes only.

Source: DOE

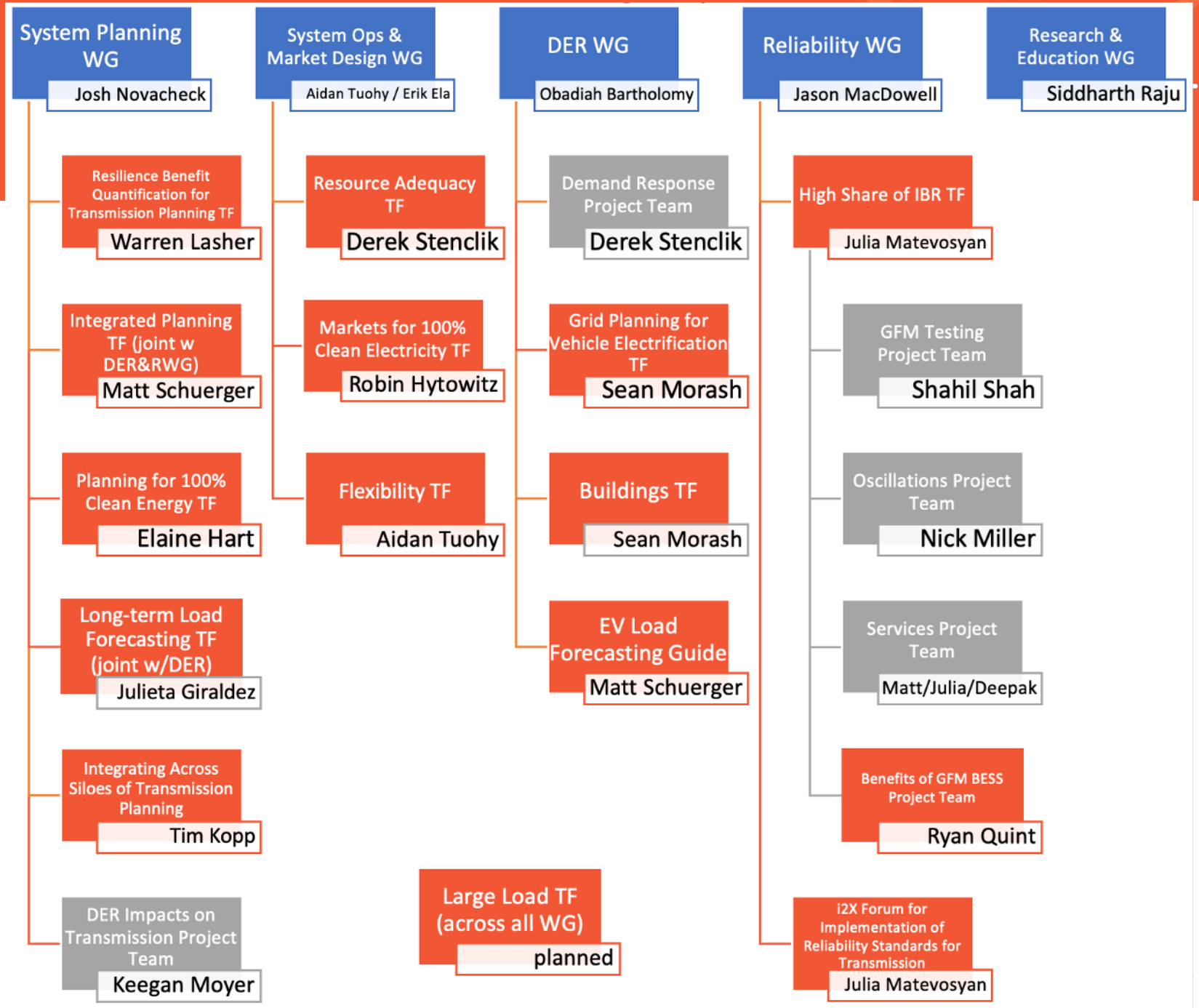
What's the Buzz This Past Year?

- 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.

Other Items in the News

- Aspiration hits reality - Scotland abandons 2030 climate goal (reducing GHG emissions 75% by 2030) citing credibility concerns - 'Bitterly disappointing'. Scotland was the first government globally to declare a climate emergency.
- AI's voracious need for computing power is threatening to overwhelm energy sources, requiring the industry to change its approach to the technology. By 2030, the world's data centers are on course to use more electricity than India, the world's most populous country. (Bloomberg)
- AEP testifies to 108 GW of load seeking to connect to their 11-state system
- Maryland is first US state to pass vehicle-to-grid legislation, VPP tariff
- EU Adopts Rules Requiring All New Buildings to Be Zero Emissions by 2030
- FERC issues Order 1920 on Interregional Transmission Planning in May '24

Working Groups and Task Forces Structure



Users Groups Structure

Operations & Maintenance

Ninochska Bosworth & Stanton Peterson

Probabilistic Forecasts in Planning & Operations

Nitika Mago

GETs

Ken Donohoo

Upcoming ESIG Meetings

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

2025 Forecasting and Markets Workshop
June 17 – 19, 2025
Nashville, TN

Onward and Upward

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

Australia	**Mexico**
Canada	**Saudi Arabia**
Germany	**South Korea**
Japan	**Texas**

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

THANK YOU

Charlie Smith

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