Compensating Nuclear Power

NARUC-DOE Nuclear Energy Partnership

FRIDAY, OCTOBER 8, 2021

2:00 – 3:00PM ET

WELCOME

- **Commissioner Anthony O’Donnell**, Maryland Public Service Commission, Partnership Co-Chair
- **Commissioner Mary-Anna Holden**, New Jersey Board of Public Utilities

NARUC-DOE NUCLEAR ENERGY PARTNERSHIP

- Launched in March 2021 with support from the U.S. Department of Energy Office of Nuclear Energy
- An educational partnership that provides opportunities for state public service commissioners and commission staff to better understand barriers and possibilities related to the U.S. nuclear fleet, the nation's largest source of zero-carbon power
- Includes commissions and commission staff representing 20 states and territories
- Associate members from the Coalition for Advanced Reactor Solutions, University of Michigan Nuclear Engineering and Radiological Sciences

PANELISTS

- **Dr. David Gattie**, Associate Professor of Engineering, University of Georgia
- **Steve Swilley**, Senior Director and Deputy Chief Nuclear Officer, Electric Power Research Institute
- **Lori Bird**, U.S. Energy Program and Polsky Chair for Renewable Energy, World Resources Institute

NARUC

Nuclear Energy Partnership Webinar

Steve Swilley
Senior Director and Deputy Chief Nuclear Officer
Electric Power Research Institute

October 8, 2021

VISION

To be a world leader in advancing science and technology solutions for a clean energy future

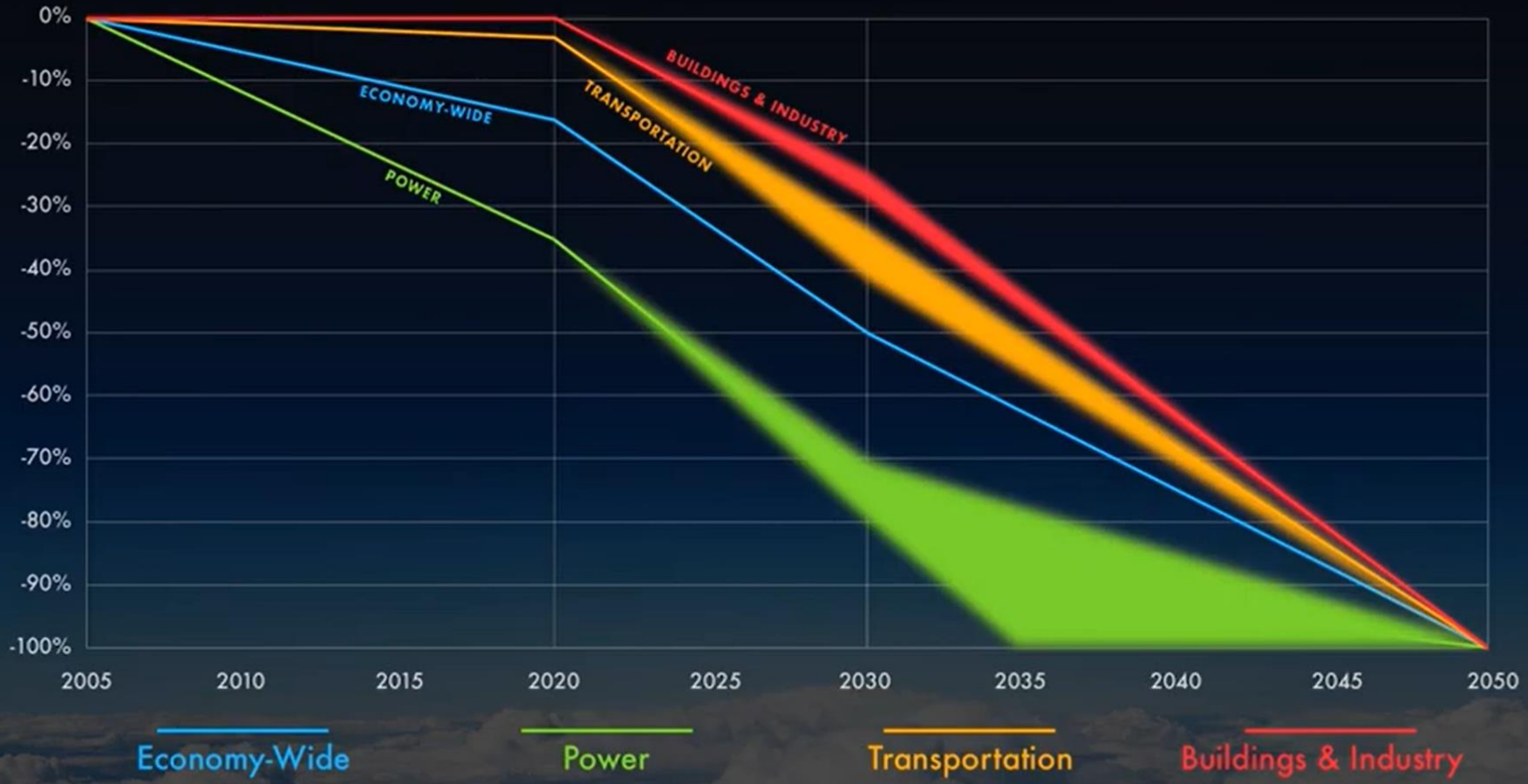
MISSION

Advancing safe, reliable, affordable, and clean energy for society through global collaboration, science and technology innovation, and applied research

Together…Shaping the Future of Energy

EXAMINING THE PACE OF U.S. CARBON REDUCTION BASED ON 2030 GOALS

Collaborative innovation essential to an affordable and reliable energy future



The trends shown here are illustrative of possible U.S. sector-level decarbonization trajectories.

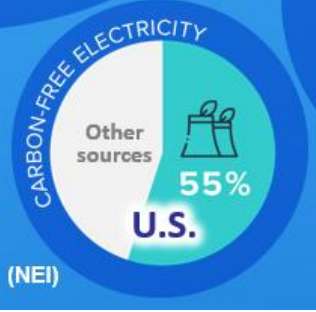
Nuclear's Role in the Clean Energy Transition

ADVANCE EXISTING & NEW TECHNOLOGIES

Beyond the Initial License

Operate and extend life of the existing nuclear fleet safely, reliably and affordably; and support development of new plants globally

10% of the world's electricity is generated by 440 nuclear power reactors. 50 are under construction, equivalent to about 15% of existing capacity. (World Nuclear Association)



REIMAGINE PLANT FLEXIBILITY

Beyond Electricity

Hydrogen generation, water de-salinization, thermal storage, electrical storage, medical isotopes, etc.

DEPLOY ADVANCED REACTORS

Beyond Advanced Light Water Reactors

Safer, modular, flexible, fabricated instead of constructed

Today's plants: Preparing for the long-term

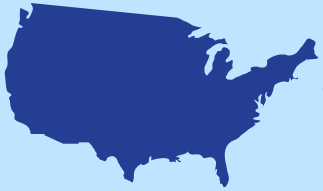
World Nuclear Generation

2,560,05

GWH

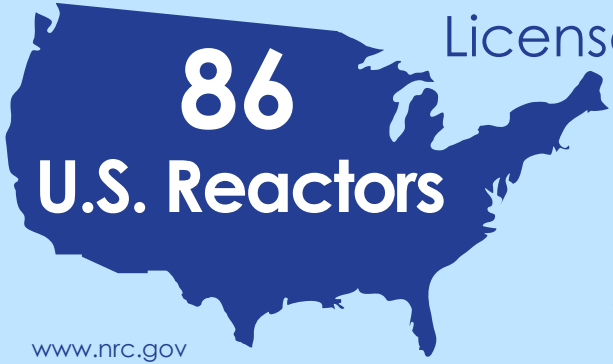
March 2020, NEI

Emissions AVOIDED



in the U.S.

= Emissions from 100 million passenger vehicles

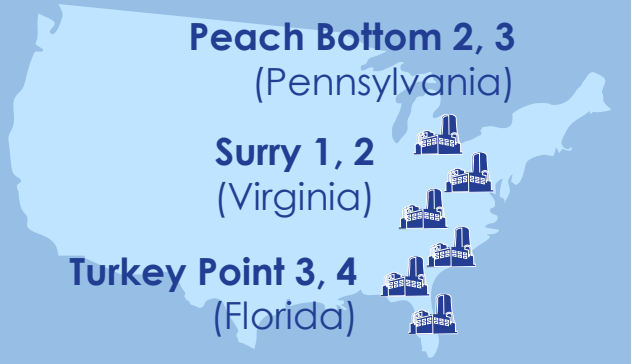


86 U.S. Reactors

www.nrc.gov

License Renewals for 40-60 years

License Renewals for 80 years



Peach Bottom 2, 3 (Pennsylvania)

Surry 1, 2 (Virginia)

Turkey Point 3, 4 (Florida)

PLANT MODERNIZATION

Industry

Vision

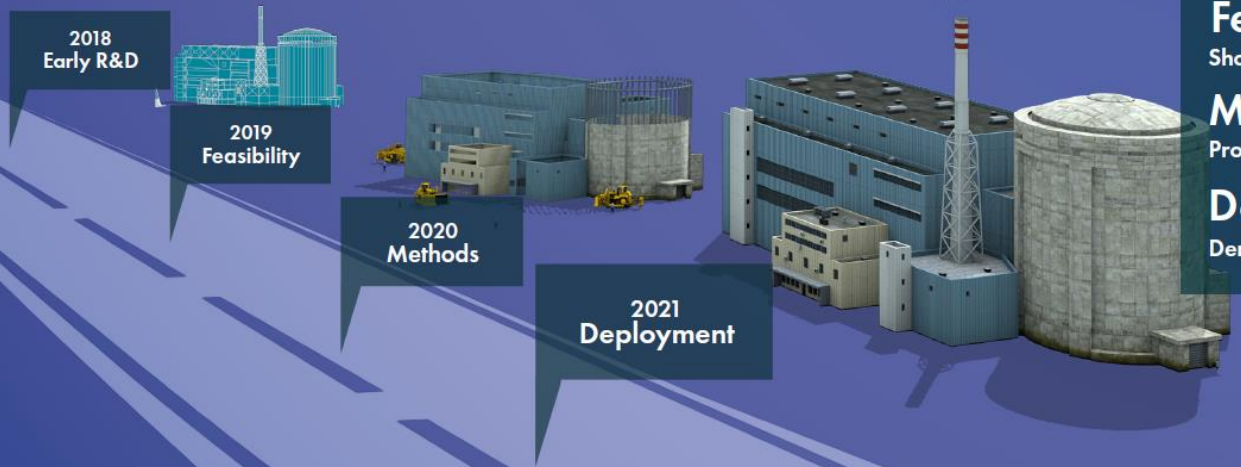
To preserve nuclear power as a carbon-free, safe, and reliable energy resource.

Mission

Achieve nuclear power plant economic viability through transformative technology and innovation that optimizes operations & maintenance while ensuring safety and reliability.

Collaborators

- Utilities
- Institute of Nuclear Power Operations (INPO)
- Nuclear Energy Institute (NEI)
- Owners, groups, other R&D organizations, vendors
- U.S. Department of Energy (DOE) and National Labs



Strategic Goals

Feasibility

Show that modernization effort can be successful

Methods

Provide the tools to implement modernization ideas

Deployment

Demonstrate modernization can be implemented

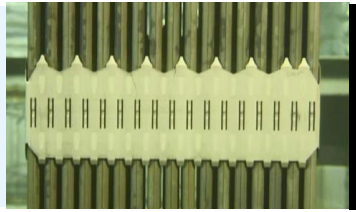
EPRI ELECTRIC POWER RESEARCH INSTITUTE

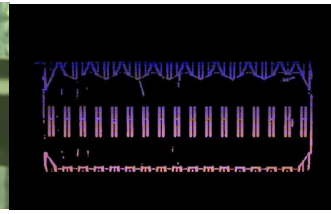
Flexible Power Operations

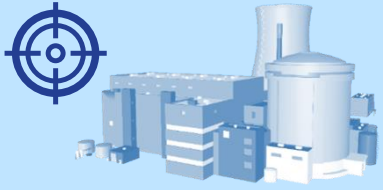
Tech tools to support existing fleet and new builds

Machine Learning

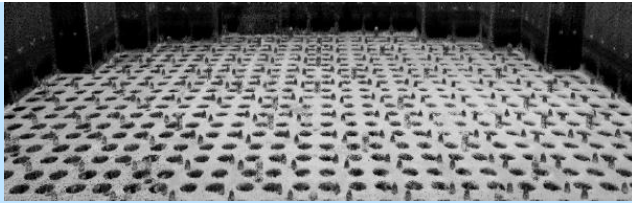
Automated, Enhanced Evaluation of Fuel Inspections







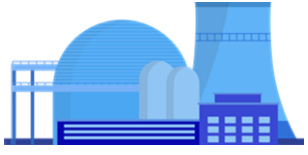
Light Detection and Ranging (LiDAR)



Digital Twin Technology

Better informing decisions, and enhancing analytics

Drones



Growing challenge: Knowledge transfer

WORLD RESOURCES INSTITUTE

Advanced Clean Energy Purchasing Practices and The Role of Nuclear

Lori Bird, World Resources Institute

October 8, 2021

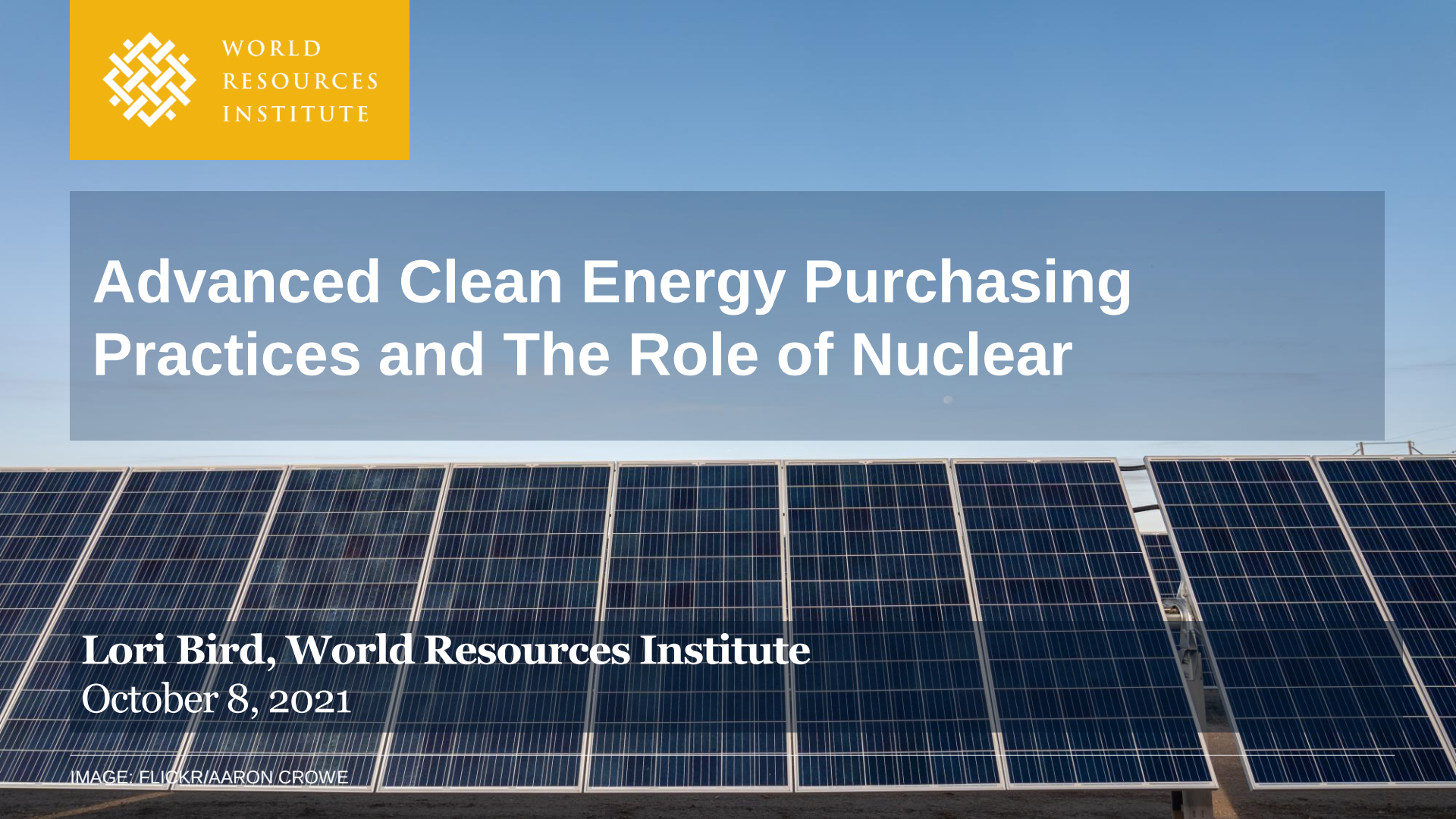


IMAGE: FLICKR/AARON CROWE

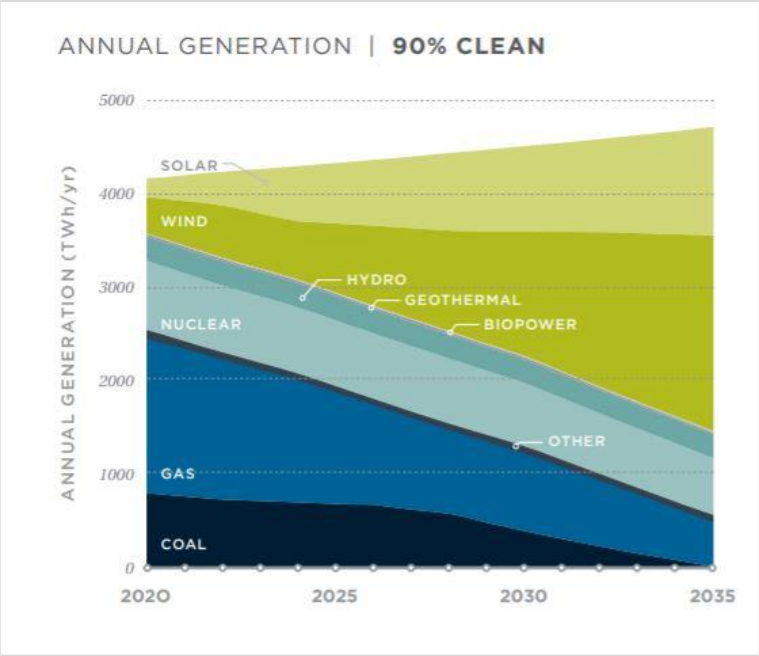
LARGE ENERGY BUYERS HAVE BEEN DRIVING SUBSTANTIAL CLEAN ENERGY DEPLOYMENT

- Between 2011 and 2020, corporate buyers purchased 76 GW of renewable energy PPAs globally
- Wood Mackenzie estimates 85 GW of corporate renewable energy demand in U.S. by 2030

Source: BloombergNEF (January 2021)

TRANSITIONING TO A CARBON-FREE GRID REQUIRES RAPID CHANGE AND NEW CUSTOMER ROLES

Transition Needed in U.S. Over Next Decade+



Source: UC Berkeley 2035 Report (90% Clean Energy)

Grid transition needed for net-zero by 2050

- 10s-100s of GW per year of new renewables
- 3-5x today's transmission
- Large flexible loads: 50-180 GW of six-hour batteries
- 240 new 1 GW nuclear reactors
- 300+ natural gas combined cycle-carbon capture & storage plants
- Carbon capture at ~1000+ facilities

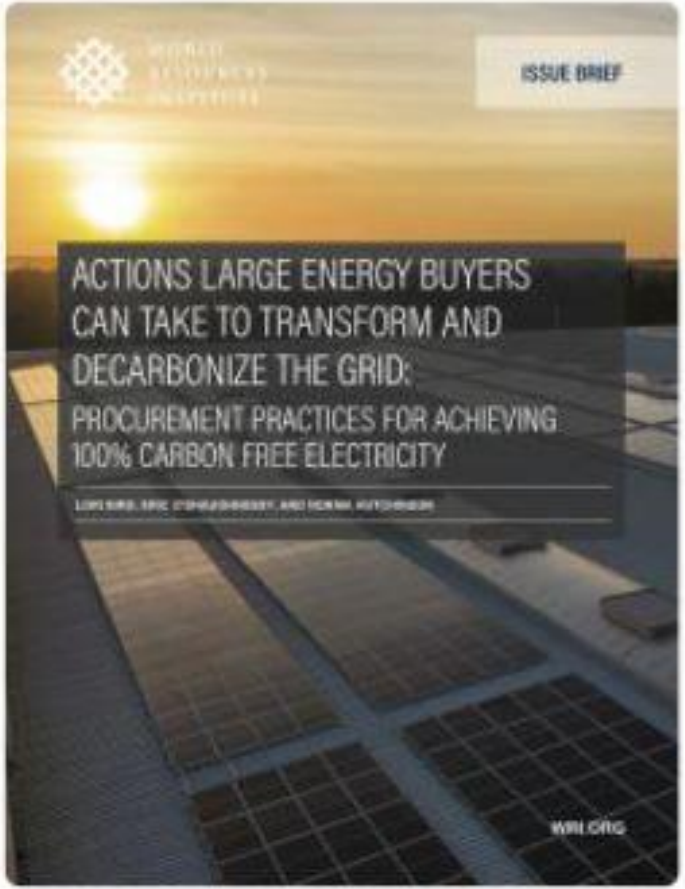
Source: Princeton Net Zero America Study

WRI PAPER OVERVIEW

Actions Large Energy Buyers Can Take to Transform and Decarbonize the Grid

Project overview:

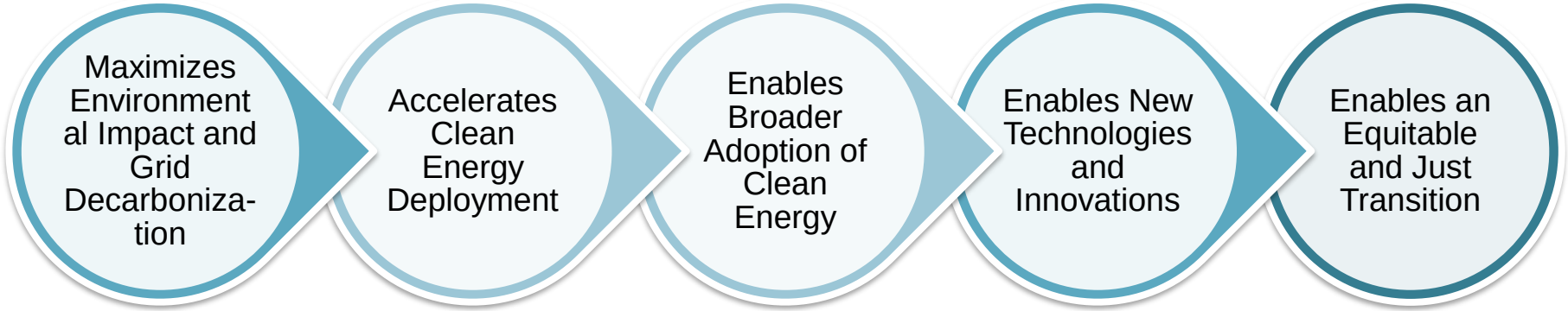
- Examine new approaches large energy buyers can take to drive grid decarbonization
- Identify barriers to broader adoption
- We define “**transformative procurement”** as approaches that aim to decarbonize grids
- Covers case studies, and the path forward for enabling new approaches
- Webinar held August 24, 2021



https://www.wri.org/research/actions-large-energy-buyers-can-take-transform-and-decarbonize-grid

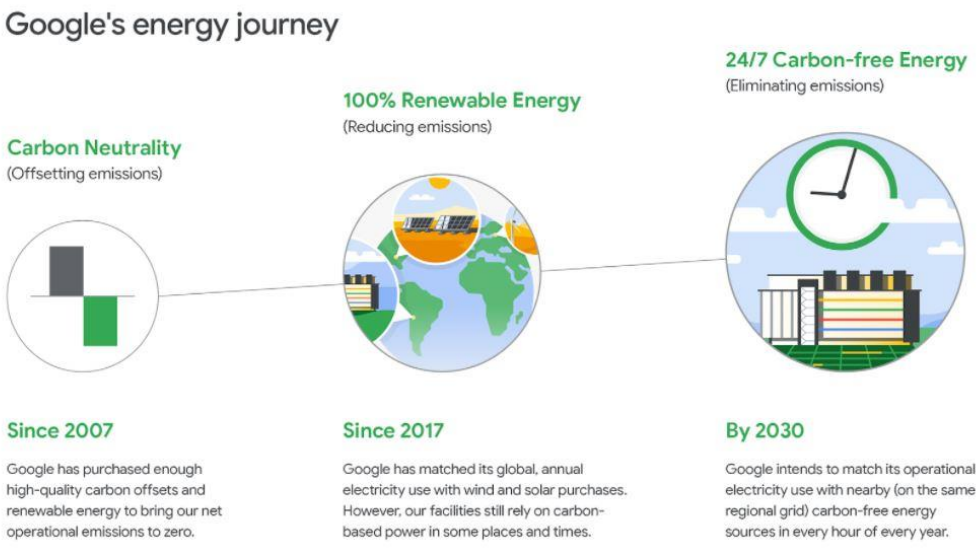
CUSTOMER ROLES NEED TO EVOLVE TO SUPPORT GRID TRANSFORMATION NEEDED

Characteristics of Transformative Clean Energy Procurement



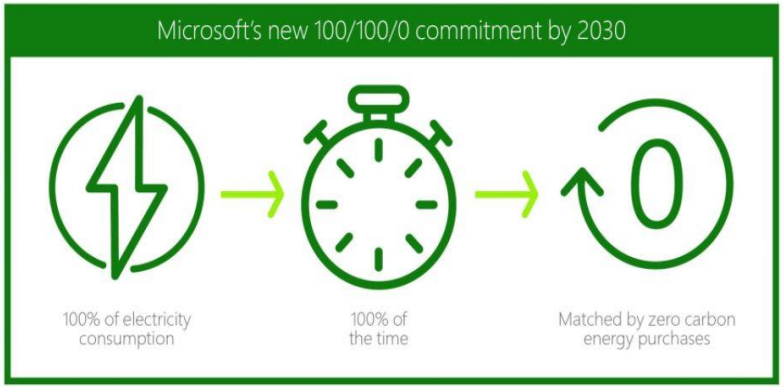
Buyers can do more to help with the transition to a carbon free grid; advanced procurement practices are needed

HOURLY CLEAN ENERGY PURCHASING COMMITMENTS



Following Google's footsteps, Des Moines pledges 24/7 clean electricity by 2035

(2016). "Des Moines, Iowa". Retrieved from Pixabay.



Biden administration goal in American Jobs Plan for federal agencies to purchase 24/7 clean energy

TRANSFORMATIVE CLEAN ENERGY PROCUREMENT PRACTICES

Time-Coincident Purchasing	*24/7 carbon-free goals or other load matching (e.g., Google, Des Moines)*
Procurement that Incorporates Demand Flexibility	*Load shifting to accommodate clean energy (e.g., EV smart charging)*
Using Firm, Dispatchable Clean Energy Technologies	*Use of dispatchable clean energy (e.g., hydro, geothermal)*
Incorporating Decarbonization-Enabling Technologies	*New technologies such as storage, electrification, carbon capture*
Maximizing Emissions Reductions	*Selecting, operating, and siting projects to maximize emissions reductions*
Ensuring Equitable Transition	*Ensuring equity co-benefits (e.g., Apple's workforce investments)*

ADDRESSING TIMING OF CLEAN ENERGY USE

Matching Purchases to Load Hourly

- Today, most customer clean energy purchases match demand annually
- Customers can buy clean energy that aligns with their loads on an hourly basis
- Benefits are enabling more clean energy, reducing curtailment, reducing fossil reliance
  - 24/7 matching is most ambitious form, could also be for a fraction of customer demand
  - Buyers could target specific time periods that pose challenges for grid operators
  - Examples: Google 24/7; Microsoft 100/100/0; Des Moines, Iowa 24/7 goals

Shifting Loads and Increasing Demand Flexibility

- Customers can shift demand to use clean energy, temporarily curtail load to integrate clean energy, or provide grid services
- Benefits grids by adding flexibility to manage more variable wind/solar
  - Shifting timing of loads
  - Shifting loads across locations
  - Expanding demand response
  - Managing electric vehicle charging
  - Aggregating distributed energy resources for grid services

USING DISPATCHABLE CLEAN ENERGY AND NEW DECARBONIZATION-ENABLING TECHNOLOGIES

Using New Dispatchable Clean Energy

- Firm, dispatchable technologies can provide power on demand
- More dispatchable clean energy will be needed to supplement variable wind/solar in deep decarbonization
  - e.g., hydro and geothermal
  - Some buyers support use of nuclear and fossil with carbon capture & storage for 24/7 purchasing goals
- Possible customer roles:
  - Development of new projects
  - Pilot projects for emerging technologies
  - Alternative contracts for firm power

Using Storage and Decarbonization-Enabling Technologies

- Grid transformation will require new technologies, more storage, electrification
- New models can be developed for utility-scale storage that benefits customers
- Buyers can incorporate enabling technologies into clean energy portfolios
  - Customer-sited storage
  - Utility-scale storage
  - Electrification, efficiency
  - Carbon capture (e.g., Microsoft use of CCS for negative emissions)

ROLE OF NUCLEAR IN MEETING CUSTOMER CARBON FREE ENERGY GOALS

Market Context

- Some buyers support use of nuclear and fossil with carbon capture & storage for 24/7 purchasing goals
- Not universally supported by buyers; most focused on driving new renewables
- Voluntary markets have strong focus on driving new clean energy projects, with least environmental impact
- Most recognition programs for corporations and cities focus on renewable energy and identify eligible technologies
- State policies (e.g., CES, incentives) increasingly focused on supporting nuclear energy
  - Policies are complementary to voluntary market demand for clean energy

CONCLUDING REMARKS

- Limited product offerings today that enable purchases of hourly carbon free energy
  - Other challenges are it can be more difficult to implement and involve increased costs
- Options and product offerings will vary among buyers and across grids
  - Grids rely on different mix of resources, resource potential, and face different challenges in achieving decarbonization
  - Customers have different load profiles, flexibility of loads, staff and resources to implement practices
- Evaluation frameworks would need to evolve to enable hourly purchasing practices and broader resource portfolios

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THANK YOU

www.wri.org/energy

IMAGE: FLICKR/AARON CROWE

UPCOMING PARTNERSHIP WEBINARS

- November 7-10, 2021 – NARUC Annual Meeting in Louisville, KY and online
  - November 7, 1:30-2:30 p.m. (ET) – Subcommittee / Staff Subcommittee on Nuclear Issues – Waste Disposal
- December 10, 2021, 2:00-3:00 p.m. (ET) – Quarterly partnership meeting

naruc.org/cpi-1/energy-infrastructure-modernization/nuclear-energy

THANK YOU

Chair Tim Echols, Georgia

Chair Anthony O'Donnell, Maryland

NARUC staff supporting the Partnership:

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