Embracing Change

Affordably and Reliably

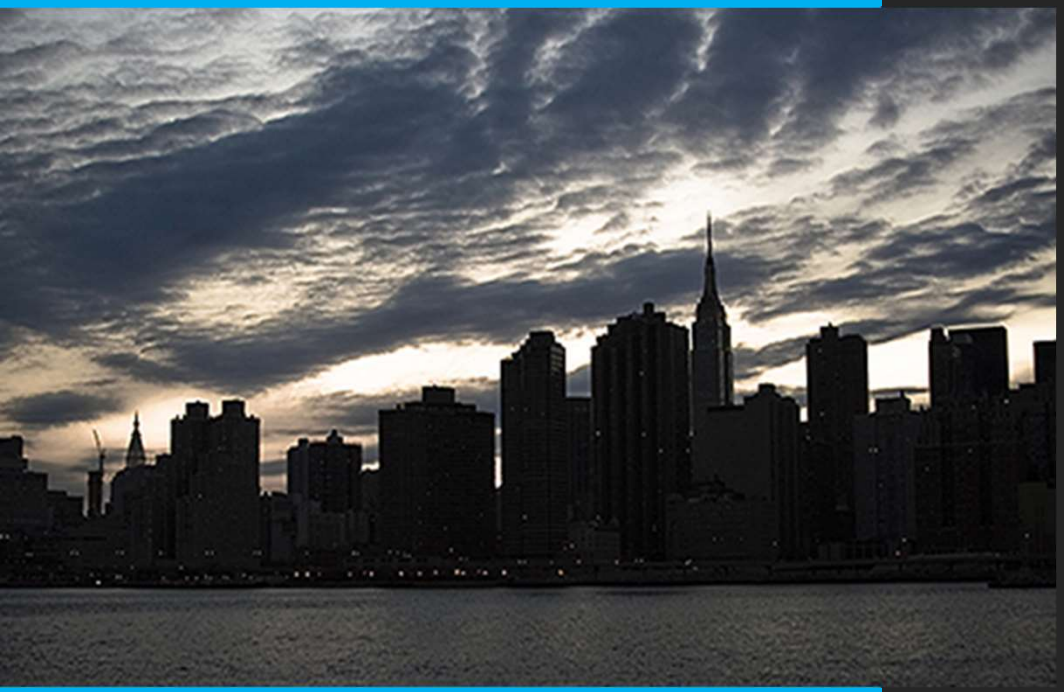
Austin Energy

Arshad Mansoor
President & CEO, EPRI

May 16th, 2024

EPRI Born in a Blackout

Independent, non-profit, center for public interest research



New York City: The Great Northeast Blackout, 1965

Mission

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

Vision

Together…Shaping the Future of Clean Energy

Power of Collaboration

Leveraging Research Funds (~460M/year), industry expertise, academia and National Labs, state and federal dollars

Global Presence

Over 40 countries participate in EPRI overall research, development, and demonstration activities.

DECADE OF CHANGE

WHAT 2030 COULD LOOK LIKE

2020 — 2030

Extreme Weather

1-in-100-year events are now 1-in-10

Renewables

3X to 4X growth by 2030

Electric Transportation

~1/2 of new car and fleet sales electric

Critical Minerals

transitioning from fuel to material dependent system

Grid Hardening & Community Resilience

Resource Adequacy Flexibility

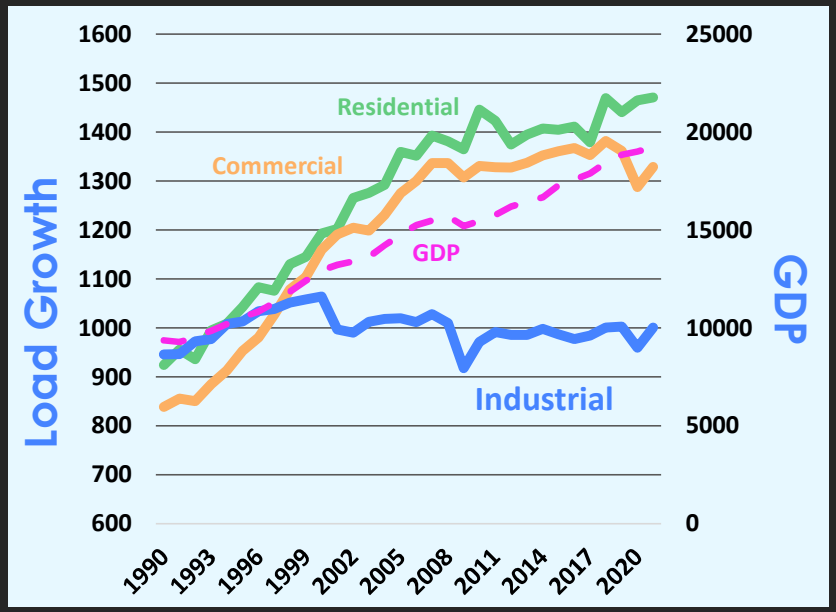
Societal Dependance Reliable Electricity

Critical Mineral Supply Chain

FORWARD RADAR:

Emerging Opportunities and Challenges

Regional Reindustrialization: Long Term Planning



Generative AI/NLP

Physical Security

Energy Security:
Moving from a Fuel Rich Energy System to Material Rich Energy System

Bypassing the Grid:
Behind the Meter Hydrogen, Liquid Fuel, Data Center, etc.

Unprecedented Electricity Demand Growth

AI Bonanza

Data Center Operation is one of the fastest growing industries worldwide.

Other growing demand includes EV and heat pump adoption, Battery manufacturing

Data Center demand is challenging to project.

Generative AI models are more energy intensive than the data retrieval, streaming, and communications that drove previous data center growth.

Growth is geographically concentrated.

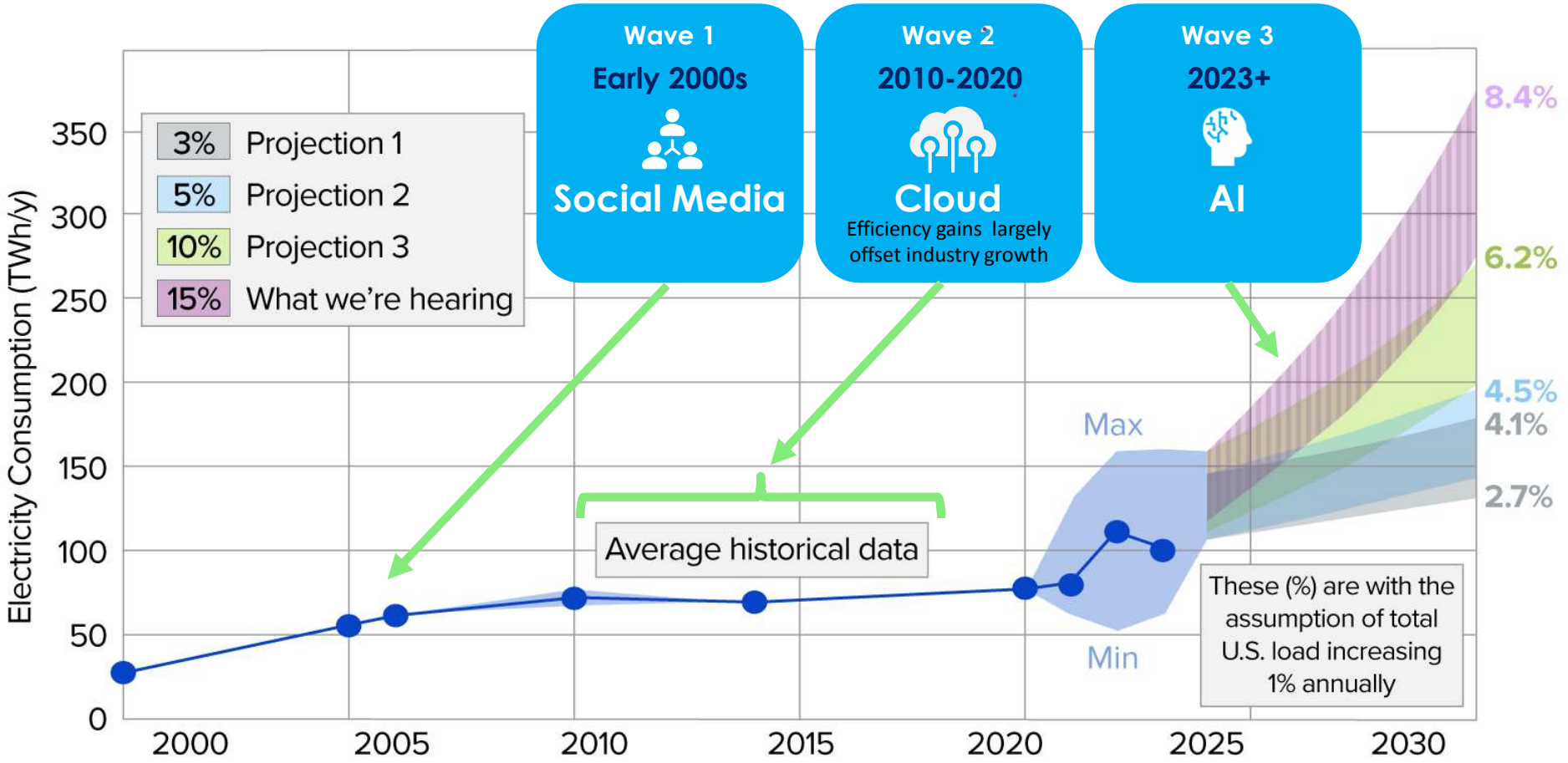
Seven “point demand” states in the US account for ~75% of national data center load. This trend is evident internationally as well.

New Data Centers represent large point load.

Capacities range from 100-1000 megawatts.

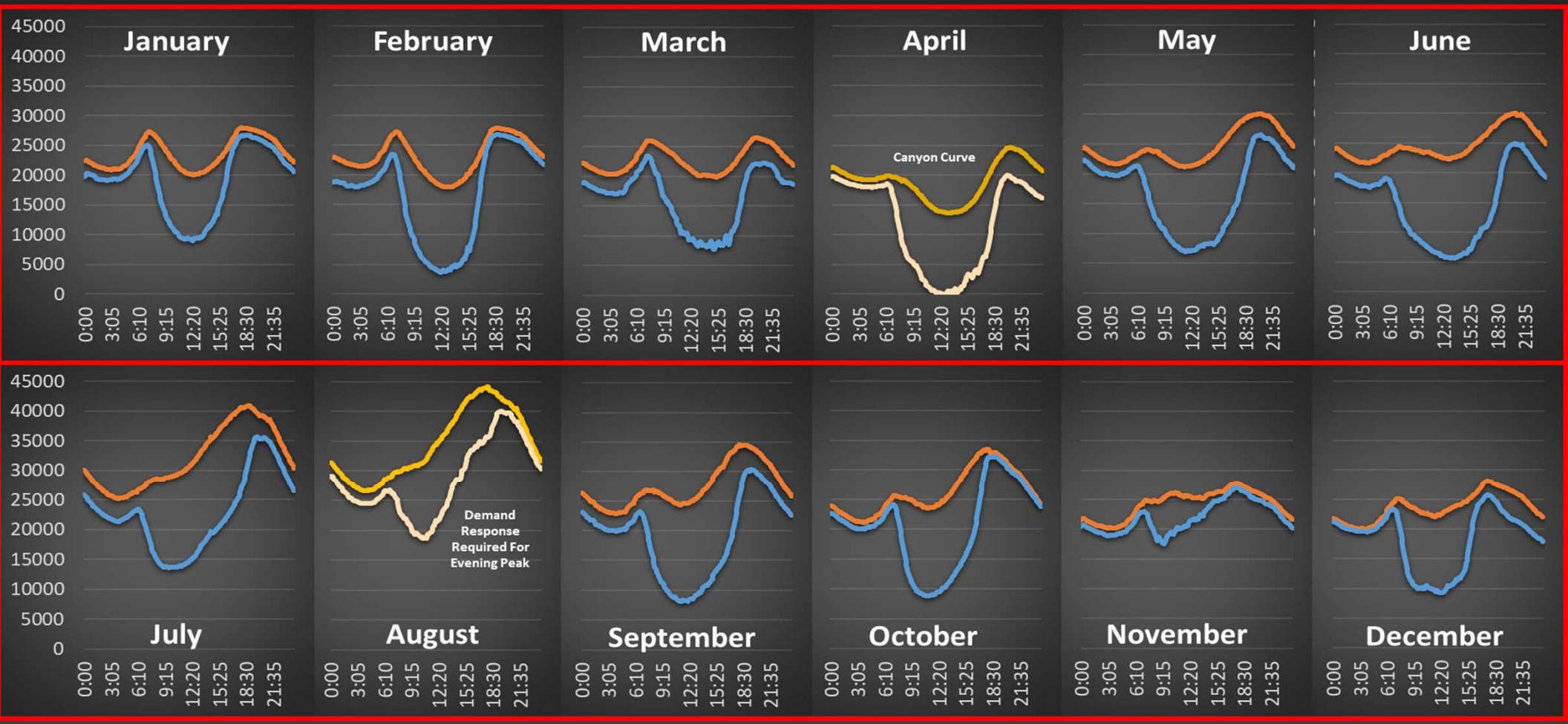
EPRI has developed a Roadmap to Support Rapid Data Center Expansion

AI is Driving a Third Wave of Data Center Growth



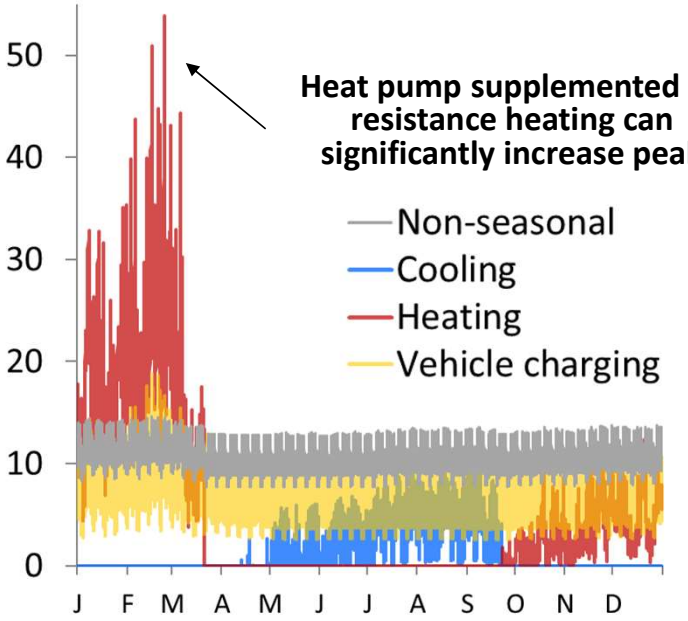
Duck, Duck, Goose, CAISO 2023

CAISO Net Demand (PV Effect) 2023 Representative Days for each Month



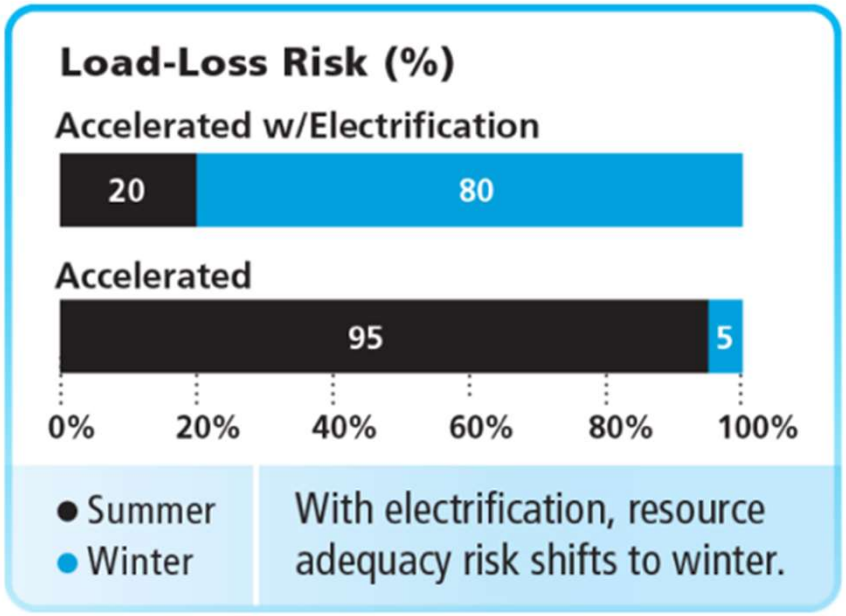
Electrification: Significant Winter Peak & Load Loss Risk

Transformation (2050)



Source: EPRI Study NY Electrification, 2022

Transformation (2035)

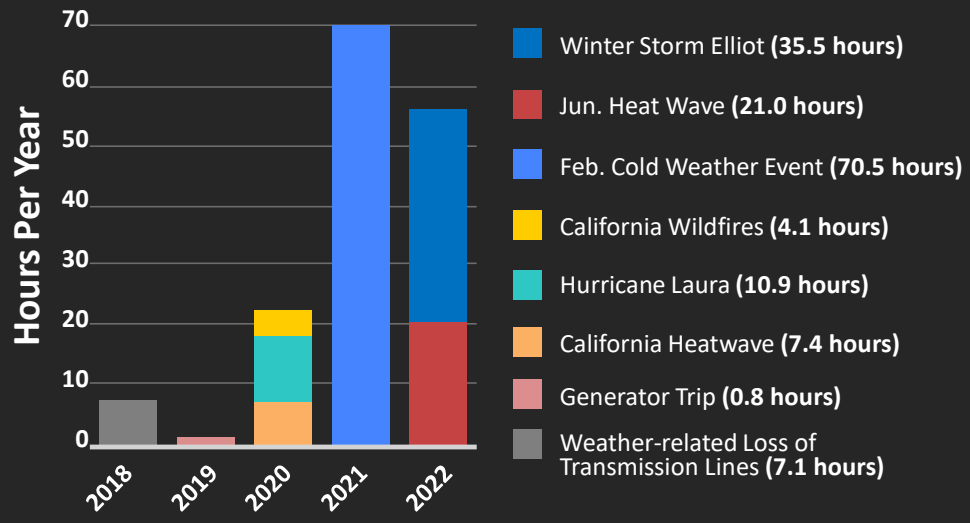


Source: Energy Transition in PJM, 2022

Early Signs of Reliability Challenges

Operator-Initiated Firm Load Shed

Source: NERC

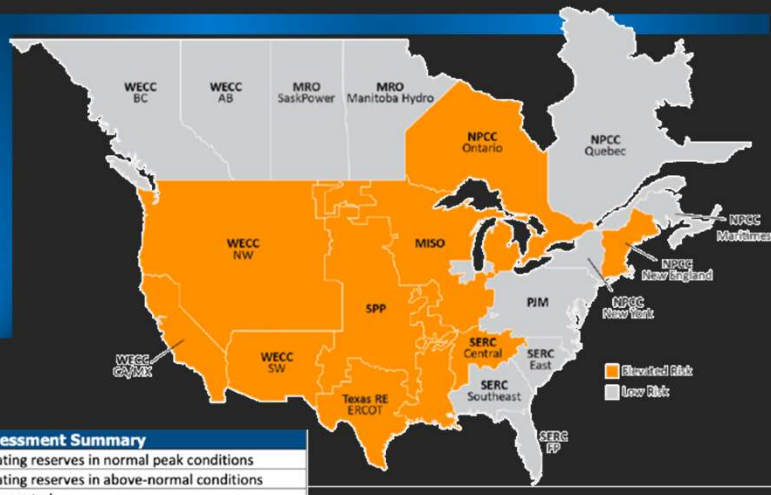


Federal Emergency Power Act Use

Past 2 Decades:	2000	2002	2003	2005	2005	2017	2017	2020	2020	9
Past 2 Years:	2021	2021	2022	2022	2022	2022	2022	2022	2022	9
Location:	CA	TX	NY	PJM	Other					

2023 NERC Summer Reliability Assessment

50% of the US elevated seasonal risk

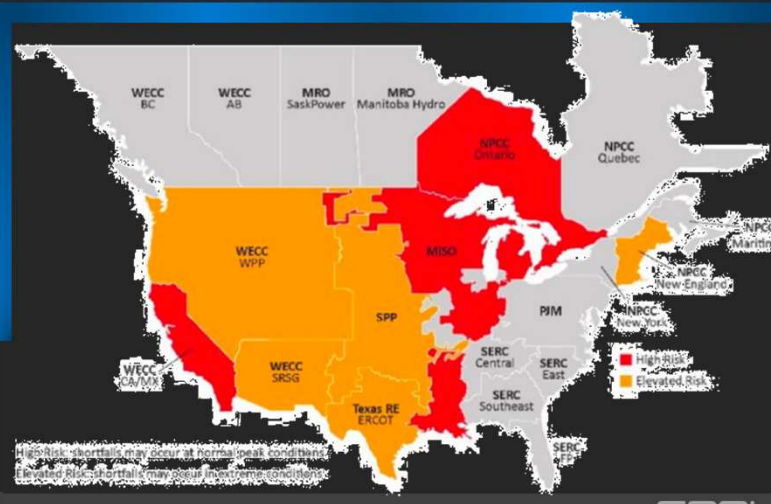


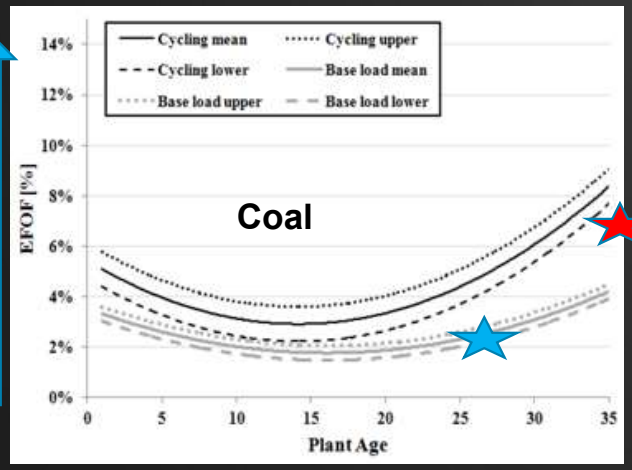
Seasonal Risk Assessment Summary	
High	Potential for insufficient operating reserves in normal peak conditions
Elevated	Potential for insufficient operating reserves in above-normal conditions
Low	Sufficient operating reserves expected

2022 NERC Long-Term Reliability Assessment

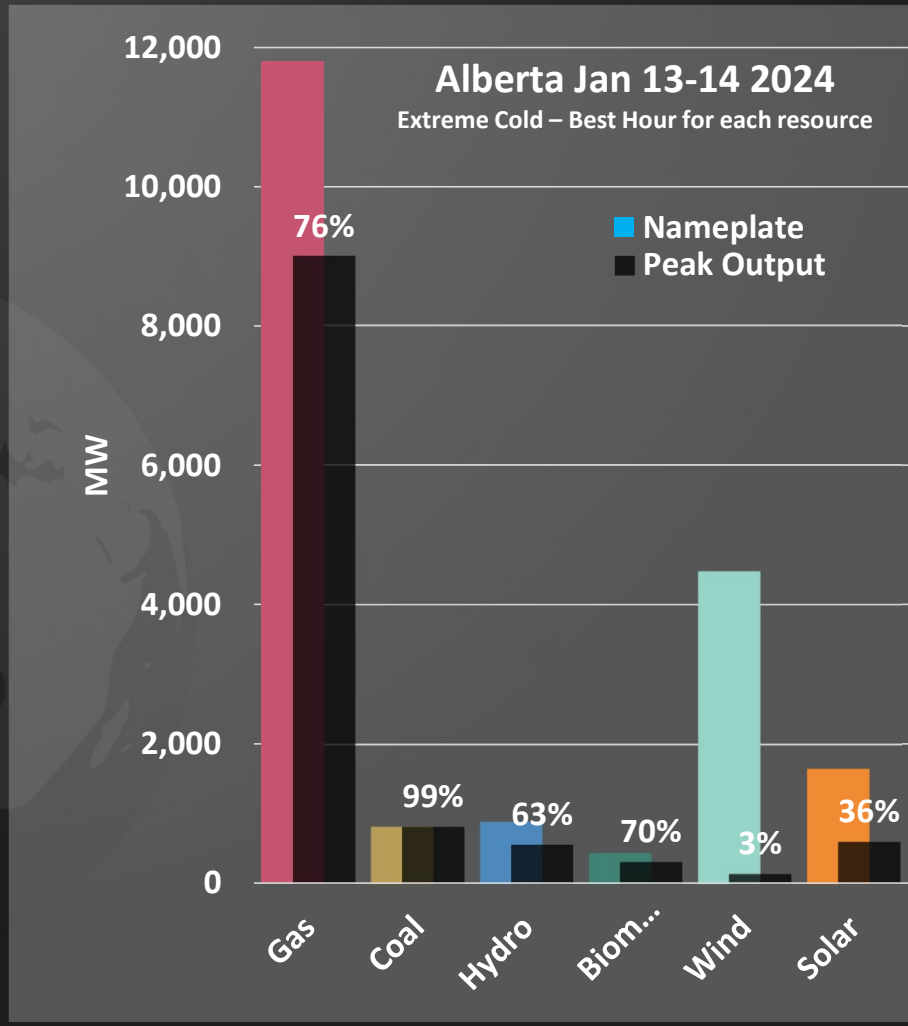
3 regions high risk

5 regions elevated risk





1. Continued Reliance on Dispatchable Generation to meet Peaks
2. Most new Capacity is Variable
3. Aging and Increasing Flexible Operation of Dispatchable Capacity
4. Significant Seasonality to Variable Generation



For today and the foreseeable future we need reliable dispatchable generation to fill in energy gaps that occur over daily, weekly, and seasonal periods

2030 STRATEGIC IMPERATIVES

NEW THINKING, NEW APPROACHES

Maximize Existing Resource Utilization

Enhance Grid Climate Adaptability and Resilience

Double Down on Energy Innovation

FAST FORWARD TO 2030

WHAT IF…

In this future, each customer brings

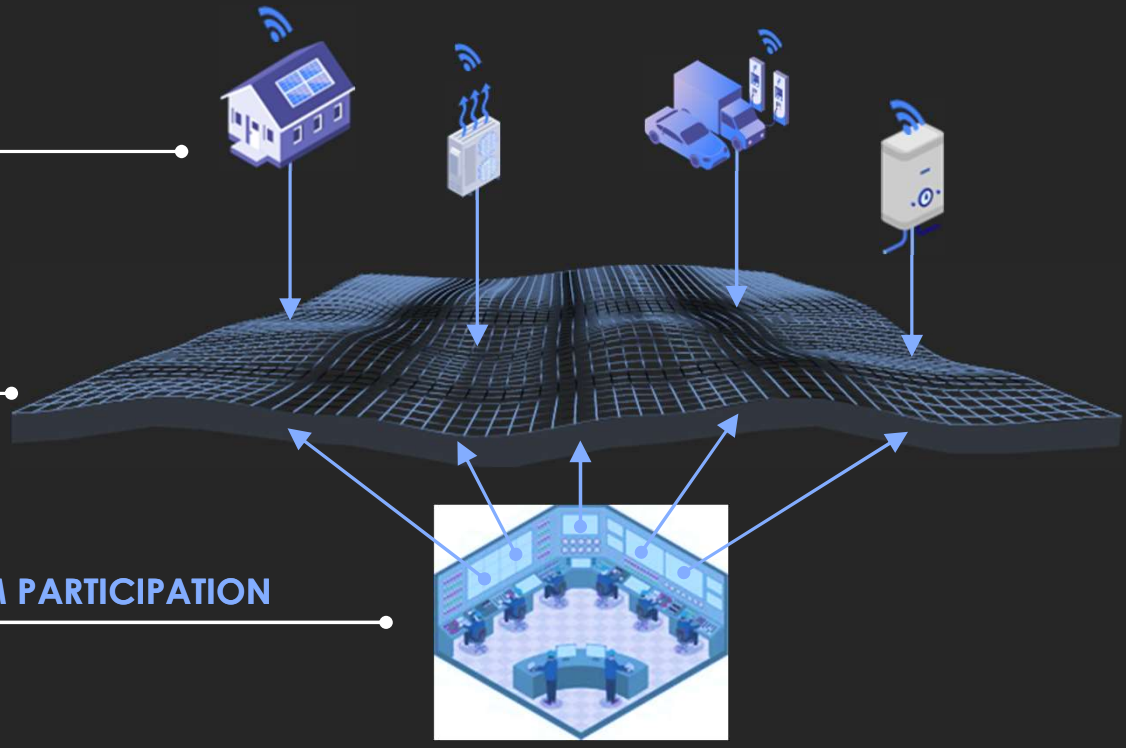
2-11 kW

of controllable load.

CUSTOMER-OWNED APPLIANCES ARRIVE GRID-CONNECTED

EV CHARGERS ARE CONTROLLABLE FROM DAY ONE

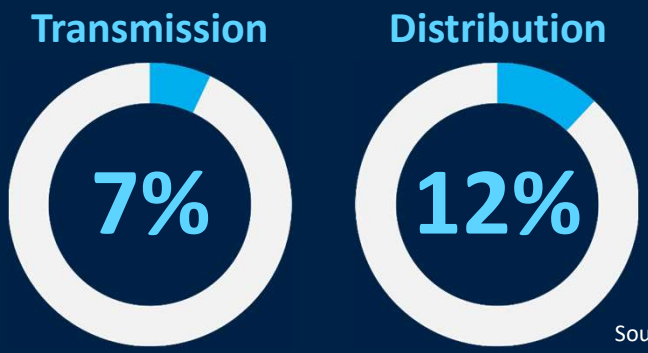
EVERY NEW WATER HEATER AND A/C INCENTIVIZES DEMAND-RESPONSE PROGRAM PARTICIPATION



REALIZING THIS VISION BY 2030 REQUIRES A COMPREHENSIVE STRATEGY NOW

Transmission Grid Enhancing Technologies (GETs)

Today's T&D Investments



Source: EEI Business Analytics 2022 surveys.

Advanced technologies will have a much greater portion of tomorrow's T&D Investments

GETs:

Advanced Conductors/DLR
(Dynamic line rating)

Power Flow Controllers, Topology- Optimization

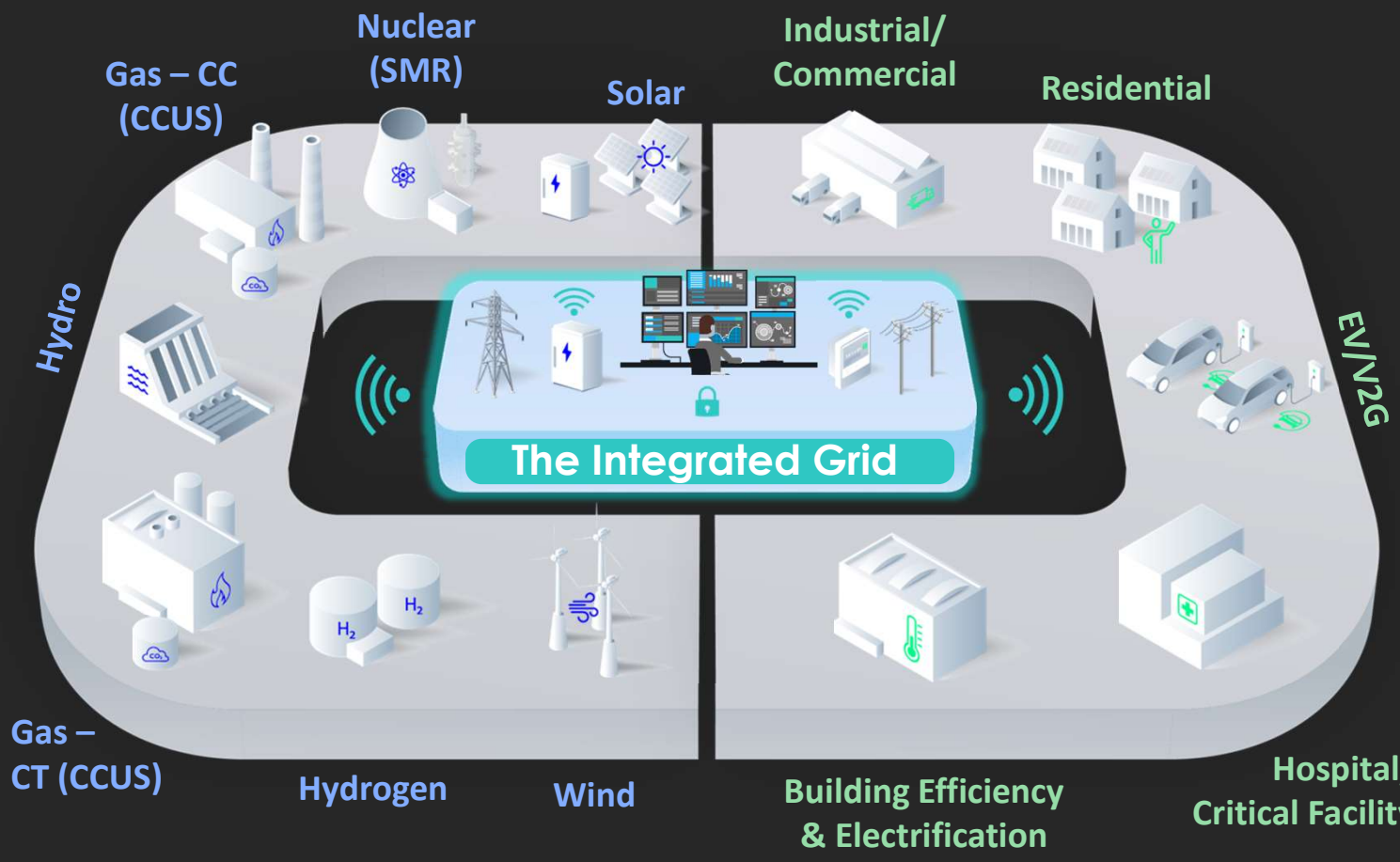
Bulk Energy Storage

Virtual Power Plant

Ubiquitous Comms Systems & Cyber Underpin GETs

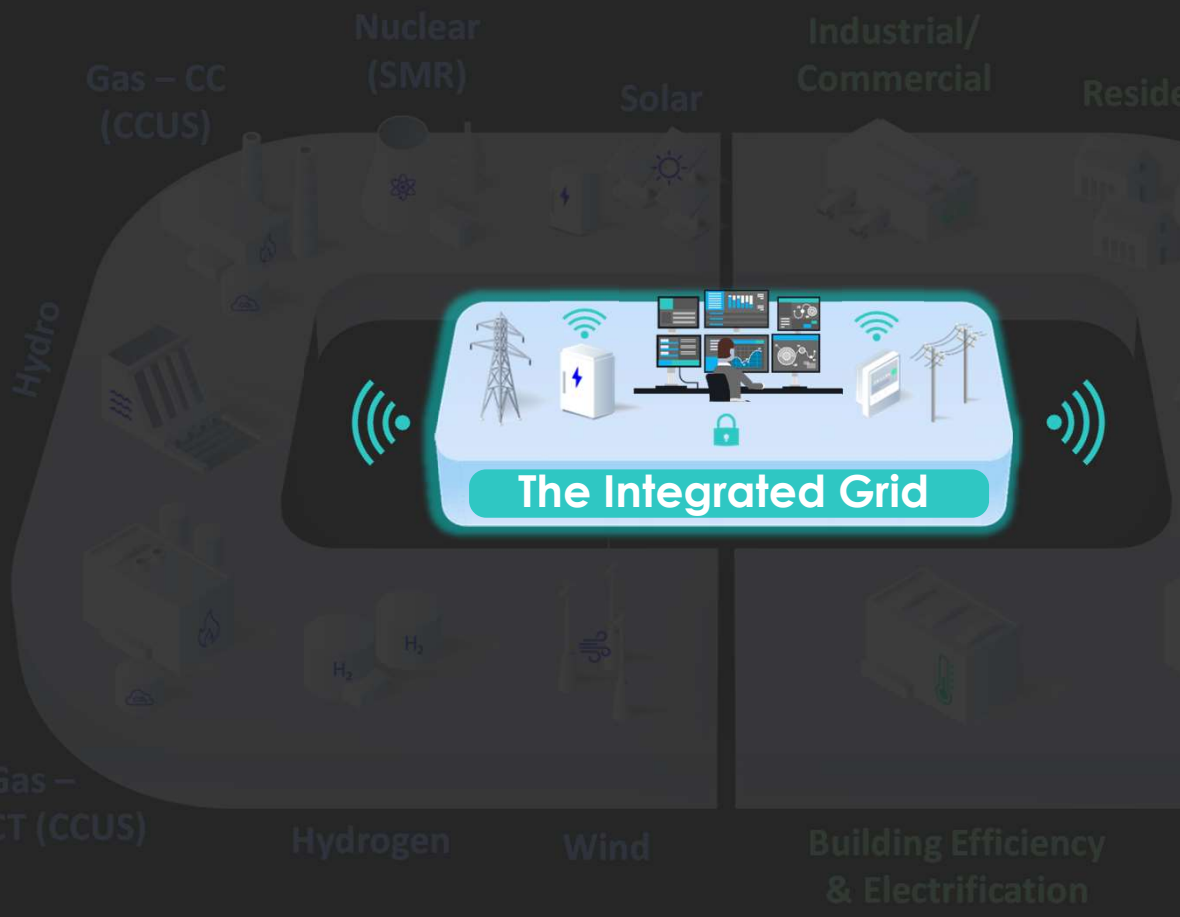
Challenges Need to Overcome to Realize Longer Term Benefits

Shared Integrated Grid (IG) . . .



. . . Enabling the Shared Energy Economy

Communication and Digital Technologies are the Foundation for the Shared Energy Economy



DIGITAL TECHNOLOGY

- Communication technology
- Smart meter technology
- Distributed energy resource management
- Digital data platform and advanced analytics
- Cloud, mobility and edge computing
- Cybersecurity

ENABLING A SHARED ENERGY ECONOMY

Innovation Needs:

Regulatory
Investments in shared customer resources benefit all

Grid Operations & Planning
Integrated, system-level approach

Customer Engagement
Greater choice, comfort, convenience, control

Affinity Partnership
From tech companies to the environmental justice community

Integrated Grid
Ubiquitous communication and DERMS integration

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Maximize Existing Resource Utilization

Enhance Grid Climate Adaptability and Resilience

Double Down on Energy Innovation

Grid of the Future Prepared for Weather of the Future

Climate change requires updating the technical basis for designing, planning, and operating the grid.

Labs Ground our Research

EPRI Labs at Lenox, MA (pictured), Charlotte, NC, Knoxville, TN

Labs Ground our Research

EPRI Labs at Lenox, MA (pictured), Charlotte, NC, Knoxville, TN

2030 STRATEGIC IMPERATIVES

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Emerging Low-Carbon Dispatch Technology Critical to the Clean Energy Transition

Geothermal
Hot rock

Carbon Capture, Usage and Storage

Hydrogen

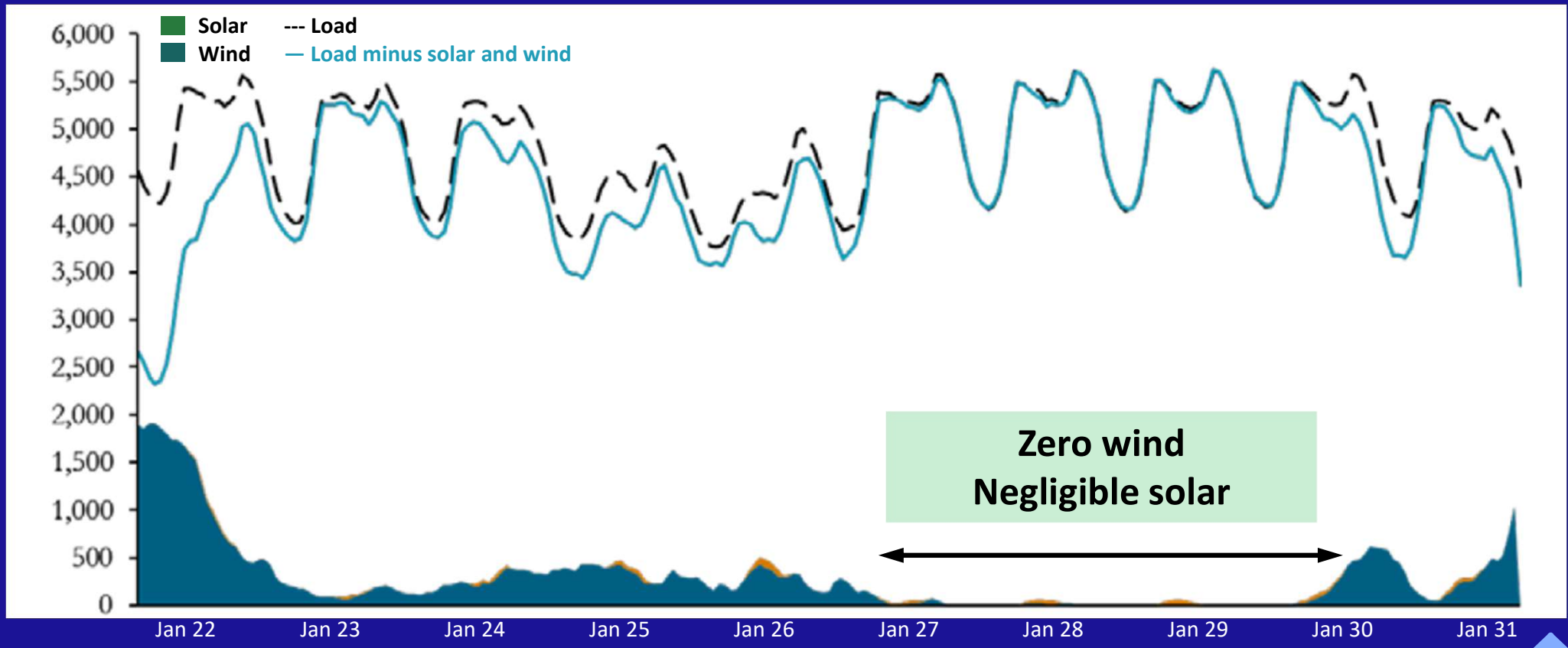
Advanced Nuclear

Long Duration Energy Storage

Load Flexibility/ Virtual Powerplant

MID-LONG DURATION

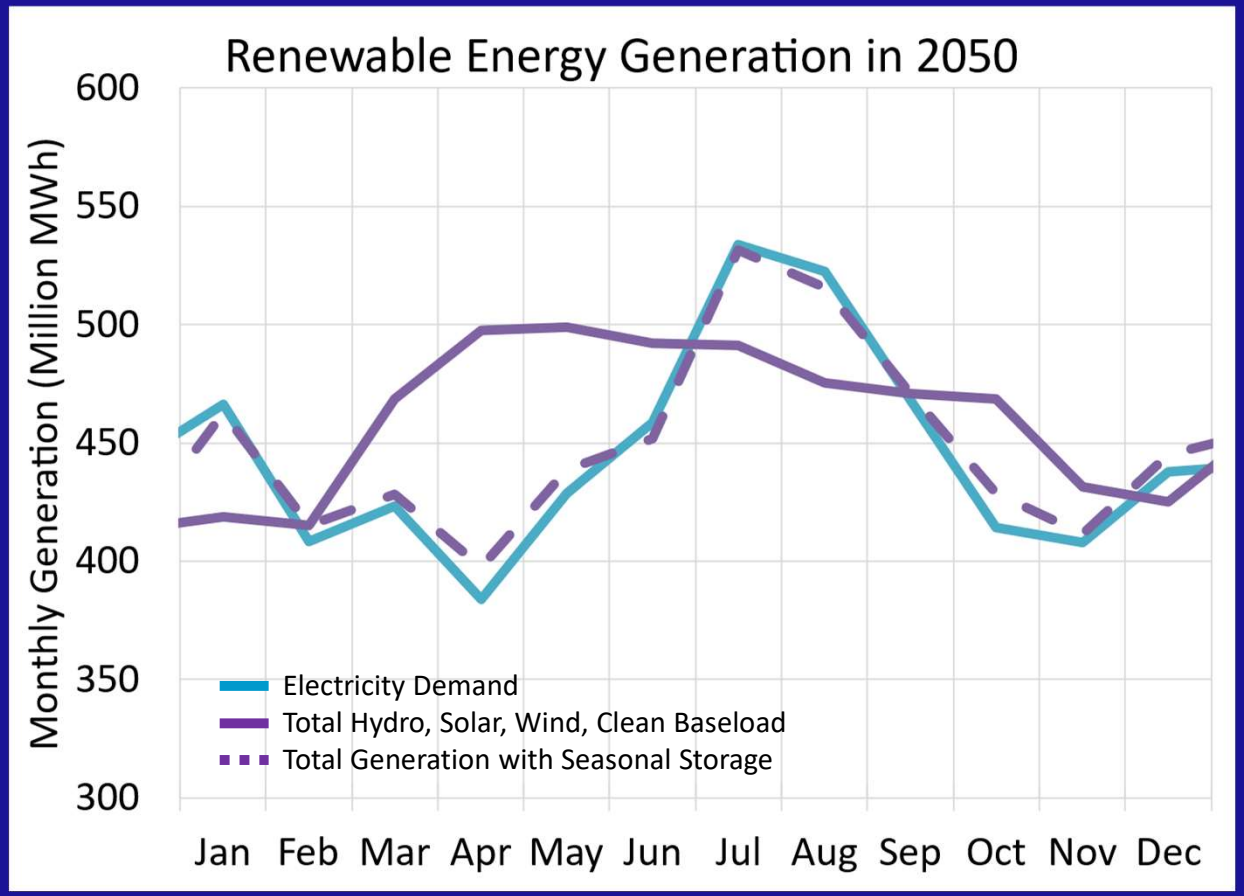
Weekly Use Case
multi-day renewables gap



Source: Upper Midwest Integrated Resource Plan, Xcel Energy, 2020.

LONG DURATION

Seasonal Use Case
designing to meet load profile



Renewables overgeneration in certain seasons and shortfall in others.

Adding in seasonal energy storage allows matching generation profile to load.

Energy Storage Spectrum

Storage should have a duration that fits the need

Short

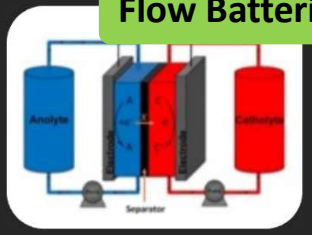
Mid

Long

Mechanical

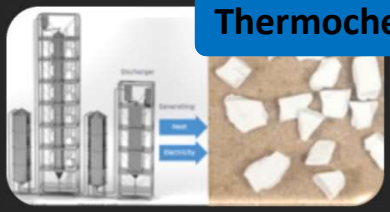
Thermal

Flow Batteries

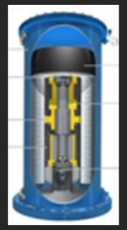


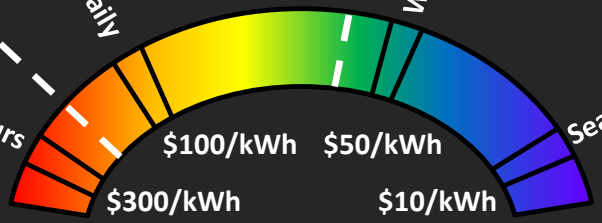
Lithium-ion Batteries

Thermochemical

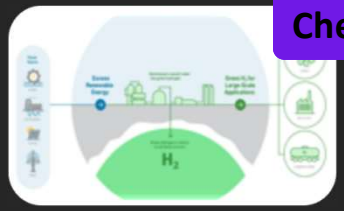


Flywheels





Chemical

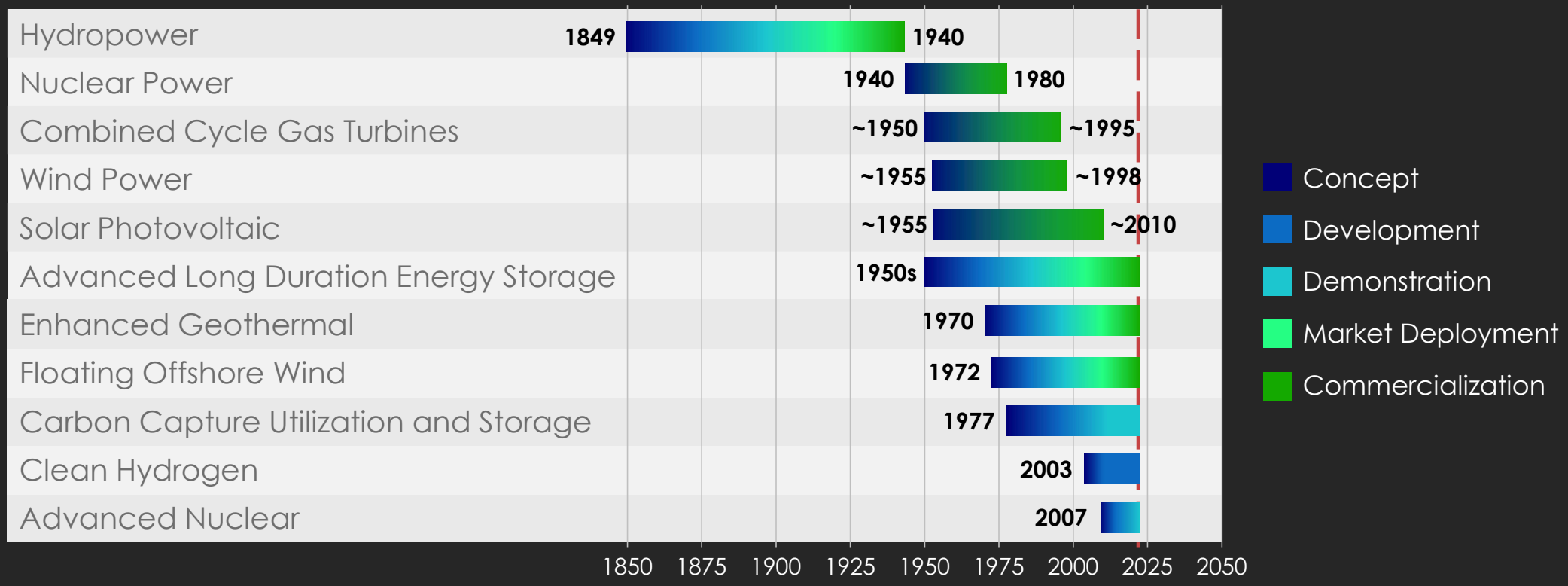


Different technologies are best suited for each duration type

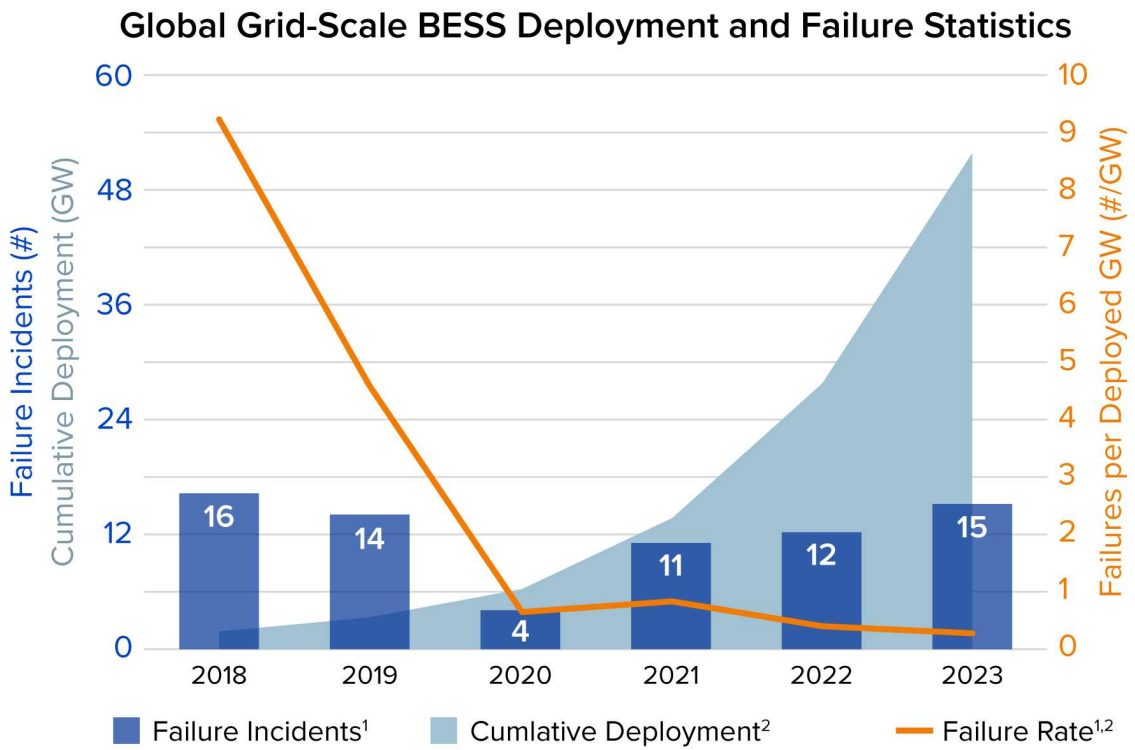
TRANSITION TIMING

Nascent Technologies demand Deliberate Deployment

Accelerating the energy transition before emerging technologies are ready to scale can amplify already notable reliability challenges.



Grid Scale Battery Safety: The Big Picture



- Figure shows utility and C&I failure incidents
- Only verified incidents with public data

Sources: (1) EPRI Failure Incident Database, (2) Wood Mackenzie. Data as of 12/31/23.

*Between 2018-2023, **97% reduction** in failure rate*

"Energy Wallet"

Leveraging the Energy Transition to Improve Affordability

Done Right…the Clean Energy Transition will Reduce Customers Energy Wallet

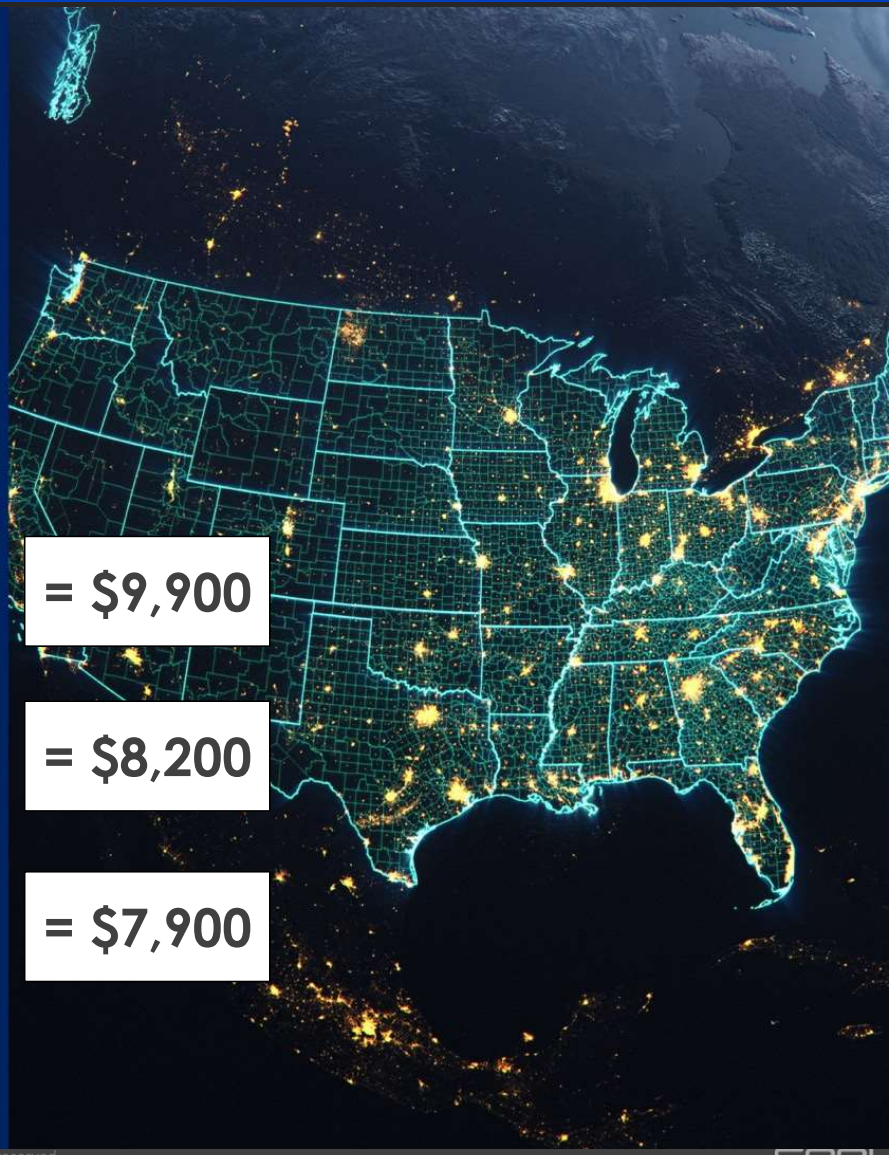
Energy Transition Reduces Average Household Energy Bills with Greater Savings Over Time

Home Electrification, EV, and Maintenance Savings:

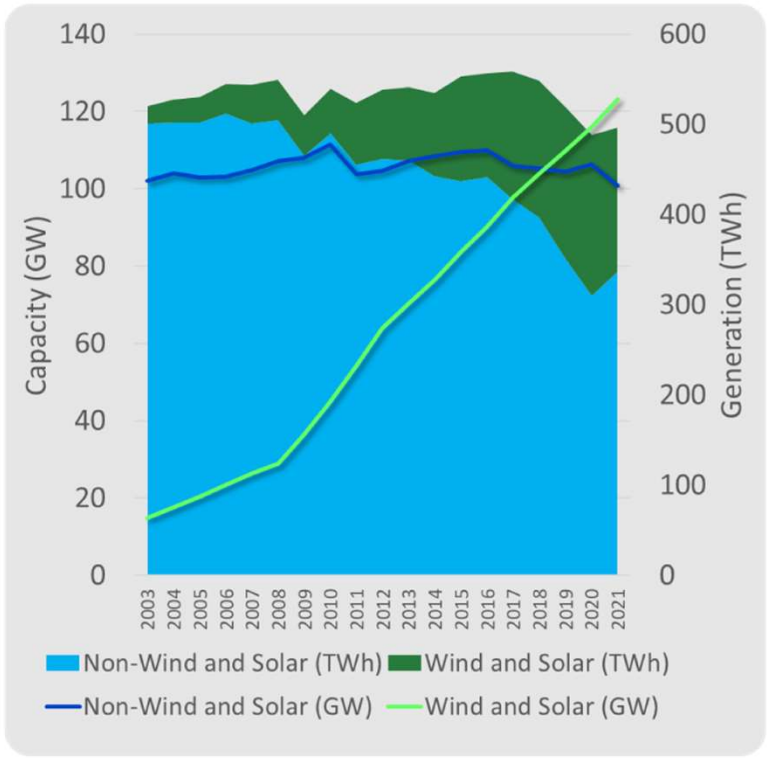
Virtual Power Plant Savings:

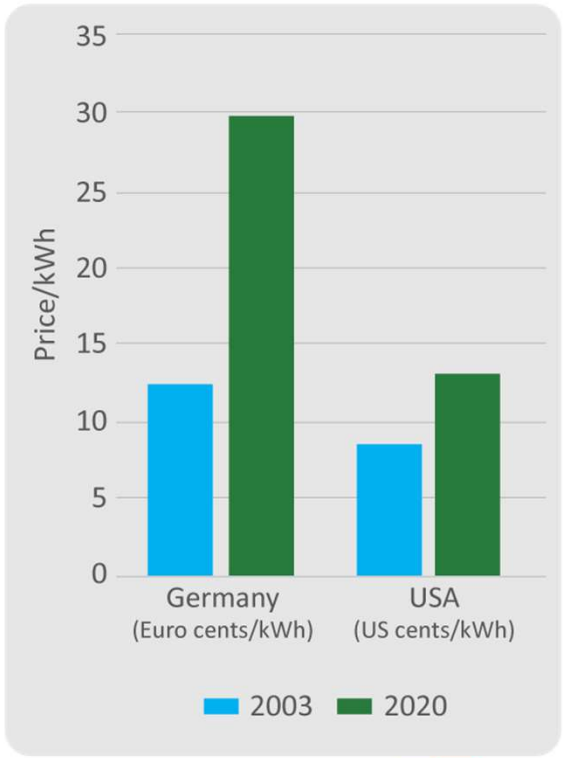
Example only- results vary across US Regions

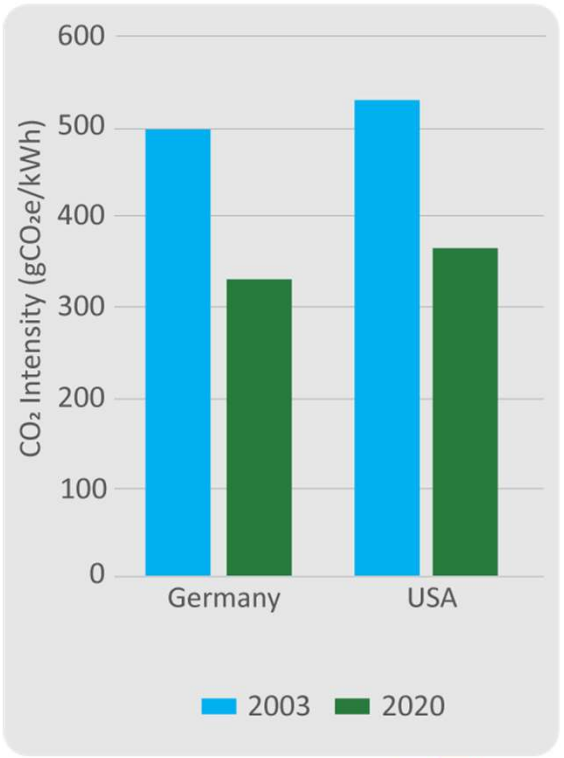
Source: Department of Commerce, 2021 Consumer Expenditure Survey.



Decisions made 20 years ago are impacting today







Decisions made today will impact the clean energy transition in 2050