Edison Electric INSTITUTE

The Customer-Centered Clean Energy Transformation:

Balancing Technology, People & the Planet







Emily Sanford Fisher
General Counsel, Corporate Secretary & SVP, Clean Energy
March 1, 2022

Leading on Clean Energy



Changing U.S. Energy Mix

40%

CARBON-FREE



↓CO_2

Carbon Emissions from Power Sector at

LOWEST LEVEL IN 40+ YEARS AND CONTINUE TO FALL



Increasing Investments

$120 Billion+

Per Year on Average

TO MAKE THE ENERGY GRID SMARTER, CLEANER, STRONGER



>1/2

Over the Past 10 Years, More Than Half of New Electricity Generation Capacity Was

WIND AND SOLAR



Providing

67%

of the

SOLAR ENERGY

in the Country



Investing Nearly

$3 Billion

to Deploy

EV CHARGING INFRASTRUCTURE



Using

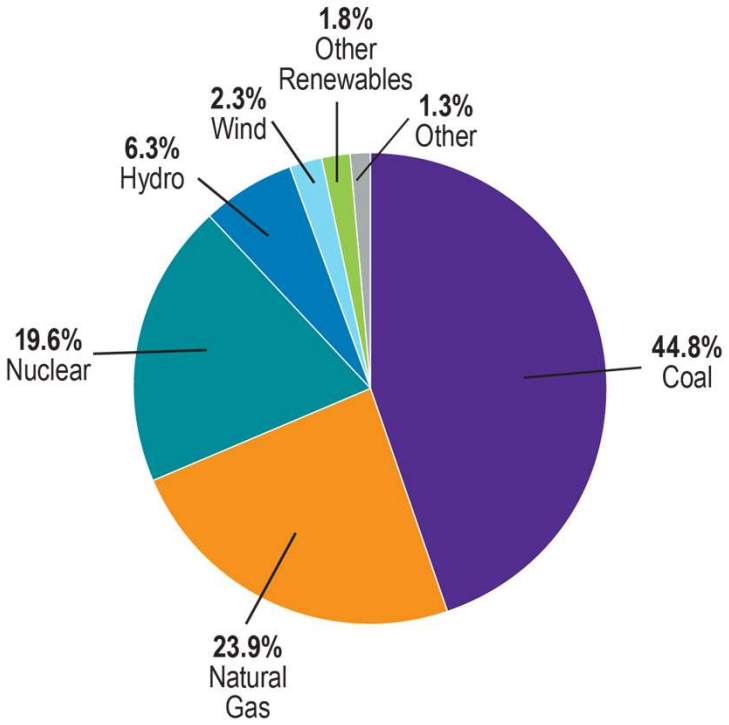
90%+

of all

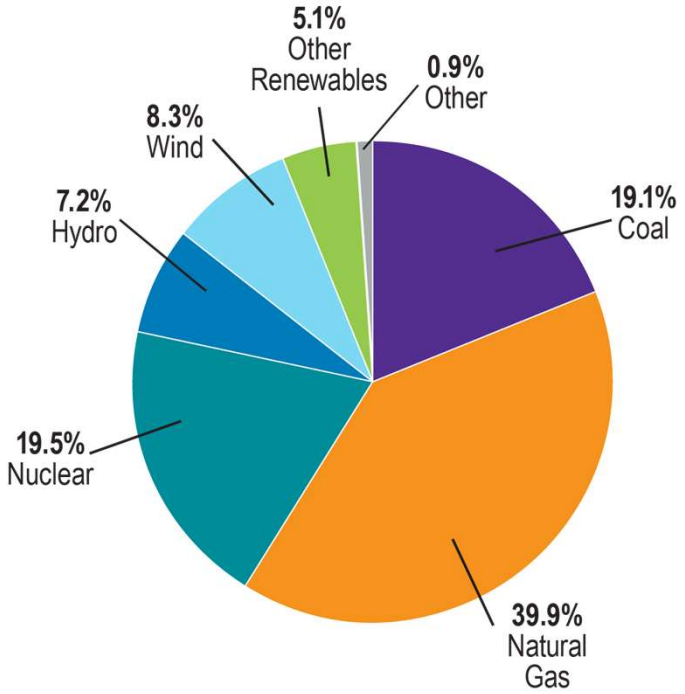
U.S. ENERGY STORAGE

Transforming the Energy Mix

2010 National Energy Resource Mix

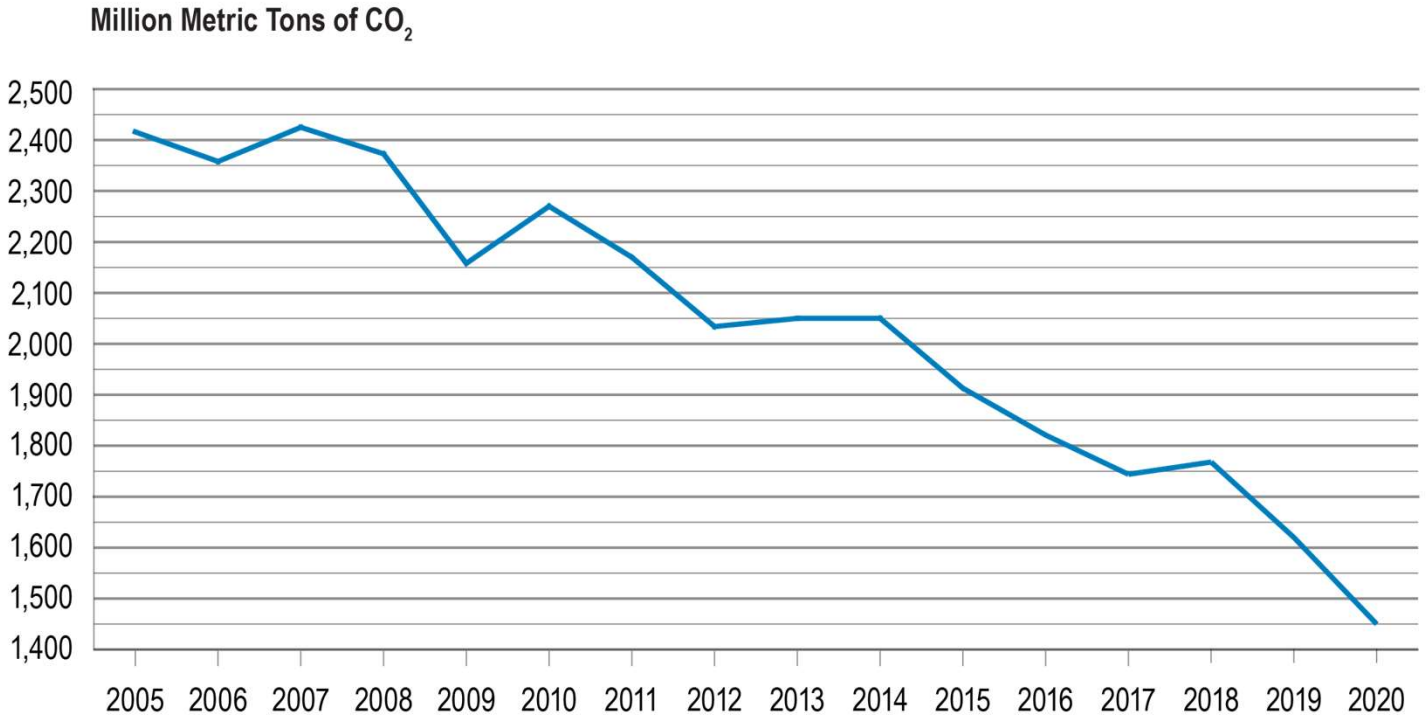


2020 National Energy Resource Mix



Source: U.S. Department of Energy, Energy Information Administration.

Reducing Carbon Emissions

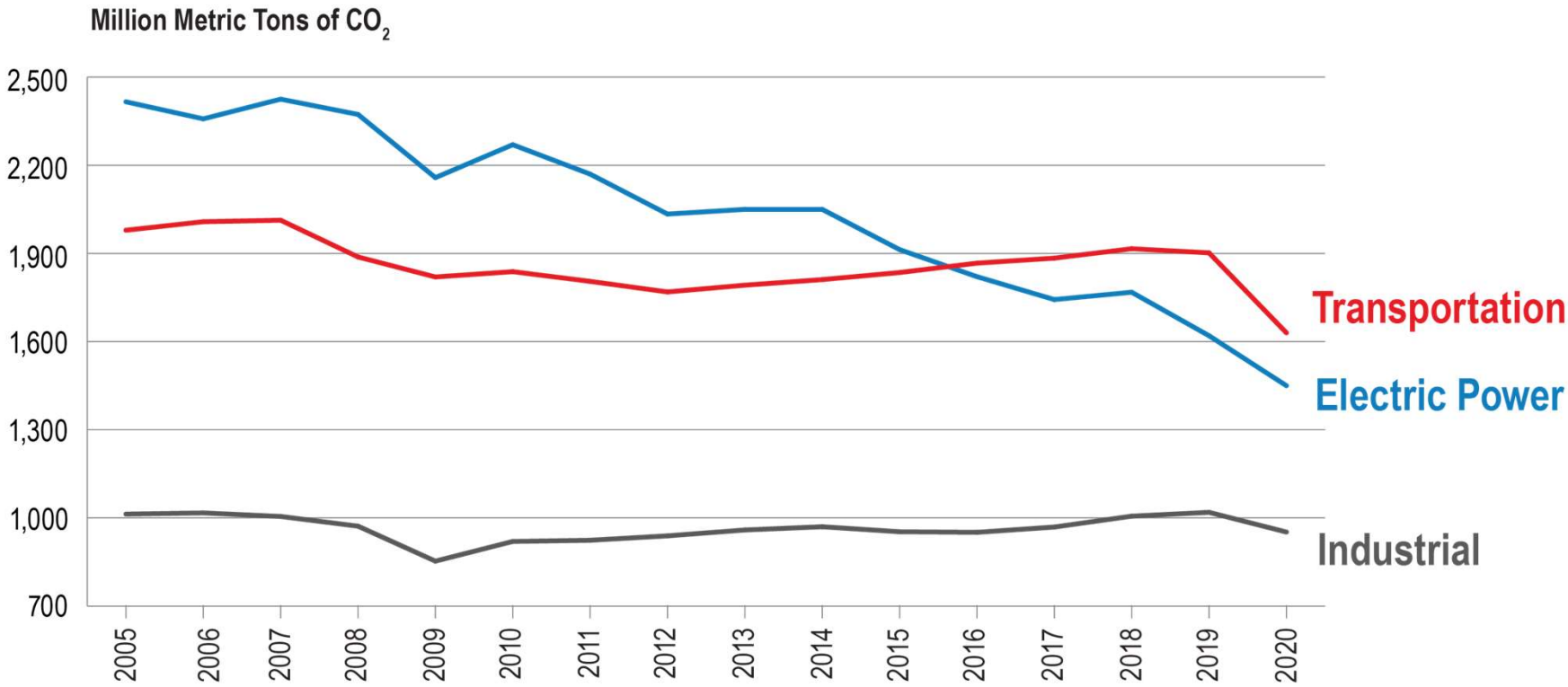


- Today, 40 percent of U.S. electricity comes from carbon-free sources
- As of 2020, electric power industry CO_2 emissions are 40 percent below 2005 levels
- Overall trajectory is expected to continue based on current trends

Source: U.S. Department of Energy, Energy Information Administration, *Monthly Energy Review*, March 2021.

Comparing CO_2 Emissions

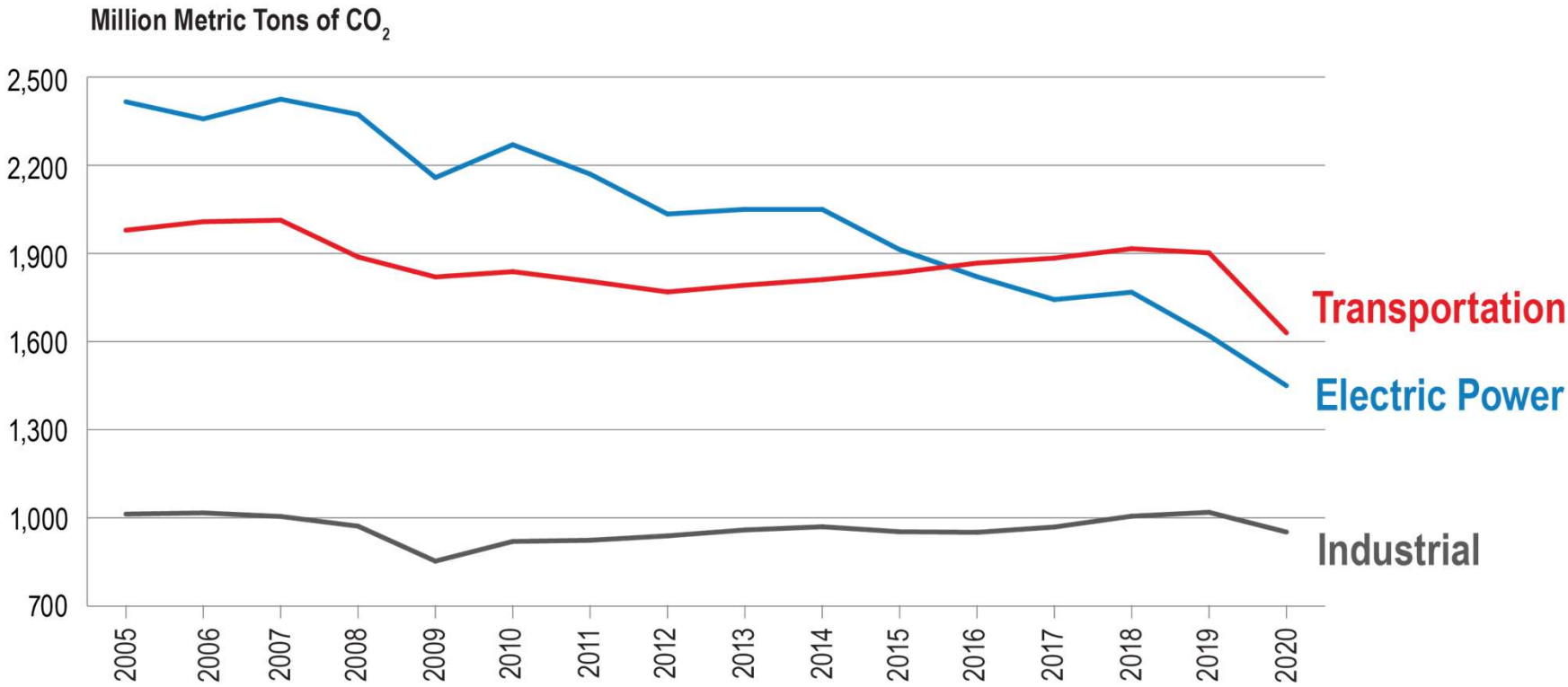
Electric Power, Transportation, and Industrial Sectors



Source: U.S. Department of Energy, Energy Information Administration, *Monthly Energy Review*, March 2021.

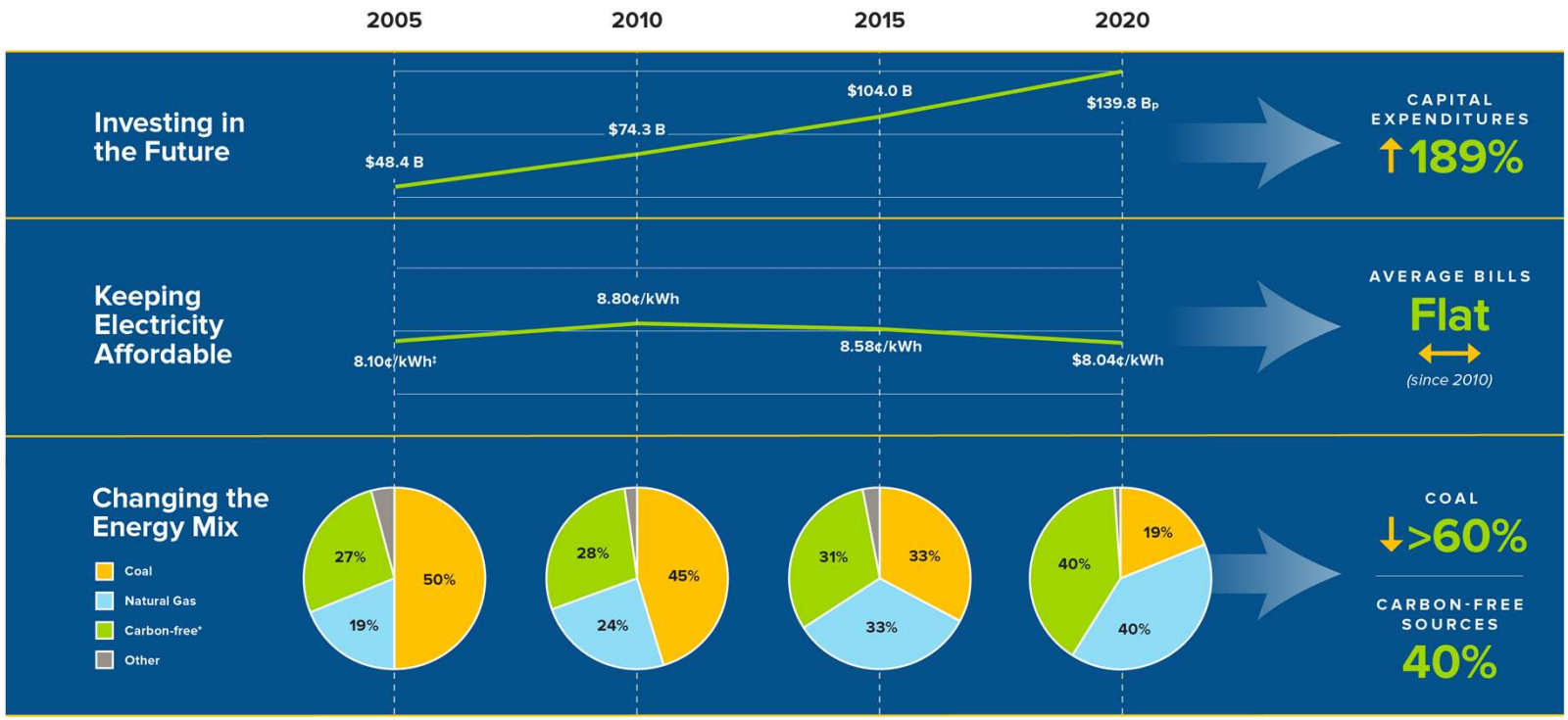
Comparing CO_2 Emissions

Electric Power, Transportation, and Industrial Sectors



Source: U.S. Department of Energy, Energy Information Administration, *Monthly Energy Review*, March 2021.

Our Clean Energy Journey



From 2005 Levels | Electric Power Industry Carbon Emissions** ↓40%

Sources and Notes: ‡Average Annual U.S. Retail Electricity Rates 2005–2020 (real 2005 $) | *Carbon-free = nuclear and hydropower and other renewables | **U.S. Department of Energy, Energy Information Administration, *Monthly Energy Review*, March 2021

EEI Member Company GHG Reduction Goals

(02-04-22)

COMPANY	GOAL
AEP (February 2021)	• 80% below 2000 levels by 2030 • Net-zero carbon emissions by 2050
AES (November 2018)	• Reduce carbon intensity 50% from 2016 levels by 2022 • Reduce carbon intensity 70% from 2016 levels by 2030
Algonquin (October 2021)	• Net-zero carbon emissions by 2050
Allete (January 2021)	• 80% below 2005 levels by 2035 • 100% carbon-free energy by 2050
Alliant (July 2020)	• 50% below 2005 levels by 2030 • Net-zero CO_2 emissions by 2050*
Ameren (September 2020)	• 50% below 2005 levels by 2030 • 85% below 2005 levels by 2040 • Net-zero carbon emissions by 2050
AVANGRID (2021)	• 35% below 2015 levels by 2025 • 100% carbon neutral by 2035
Avista (April 2019)	• Carbon-neutral electricity by 2027 • 100% clean electricity by 2045
BHE (November 2021)	• 50% below 2005 levels by 2030
Black Hills (November 2020)	• Reduce GHG intensity 40% below 2005 levels by 2030 • Reduce GHG intensity 70% below 2005 levels by 2040 • Reduce GHG intensity 50% below 2005 levels by 2035[8]
CenterPoint (September 2021)	• Net-zero Scope 1 and Scope 2 emissions by 2035 • Reduce Scope 3 emissions 20-30% by 2035[5]
CMS Energy (February 2020)	• Net-zero CO_2 emissions by 2040 • Net-zero methane emissions by 2030
Con Ed (November 2021)	• 100% clean power to Con Ed facilities by 2030 • Net-zero Scope 1 CO_2 emissions by 2040

COMPANY	GOAL
Dominion[1] (February 2020)	• 65% below 2010 by 2030 (methane) • 80% below 2010 by 2040 (methane) • Net-zero CO_2 and methane emissions by 2050
DTE Energy (September 2019)	• At least 50% below 2005 levels by 2030 • 80% below 2005 levels by 2040 • Net-zero carbon emissions by 2050* (DTE Gas, 06/20)
Duke Energy (September 2019)	• At least 50% below 2005 levels by 2030 • Net-zero CO_2 emissions by 2050*
El Paso Electric (August 2018)	• Reduce carbon footprint 25% below 2015 levels by 2025 • Reduce carbon footprint 40% below 2015 levels by 2035
Emera (February 2021)	• 55% below 2005 levels by 2025 • 80% below 2005 levels by 2040 • Net-zero carbon emissions by 2050
Entergy (September 2020)	• Reduce emissions intensity 50% below 2000 levels by 2030 • Net-zero CO_2 emissions by 2050
Evergy[7] (November 2019)	• 80% below 2005 levels by 2050
Eversource[3] (December 2019)	• Carbon neutral by 2030
Exelon[2] (August 2021)	• Reduce emissions 50% below 2015 levels by 2030 • Net-zero operations by 2050
FirstEnergy (November 2020)	• 30% below 2019 levels by 2030 • Carbon neutral by 2050
Green Mountain Power (April 2019)	• 100% carbon-free electricity by 2025 • 100% renewable energy by 2030
Hawaiian Electric (May 2019)	• 100% renewable energy by 2045

Note: See reverse for more

EEI Member Company GHG Reduction Goals (2)

(02-04-22)

COMPANY	GOAL
Idaho Power (March 2019)	• Provide 100% clean energy by 2045
Madison Gas & Electric (May 2019)	• 65% below 2005 levels by 2030 • Net-zero carbon electricity by 2050*
Montana-Dakota Utilities (2017)	• Reduce GHG intensity 45% below 2005 levels by 2030
National Grid# (June 2020)	• 80% below 1990 levels by 2030 • Net zero emissions by 2050
NextEra (June 2019)	• Reduce CO_2 emissions rate 67% below 2005 levels by 2025
NiSource (May 2017)	• 50% below 2005 levels by 2025 • Reduce CO_2 emissions >90% by 2028 (NIPSCO, 11/18)
Northwestern[4] (December 2019)	• Reduce carbon intensity 90% below 2010 levels by 2045
OG&E (December 2018)	• 50% below 2005 levels by 2030
Otter Tail Power (2021)	• 50% below 2005 levels by 2025 • 97% below 2005 levels by 2050
PG&E (July 2018)	• 40% below 1990 levels by 2030 • 80% below 1990 levels by 2050
Pinnacle West (September 2020)	• 65% clean energy by 2030 • 100% carbon-free electricity by 2050
PNM Resources (April 2019)	• 60% below 2012 levels by 2030 • 100% carbon-free electricity by 2040
Portland General Electric (November 2020)	• Net zero GHG emissions by 2040 • 80% below 2010 levels by 2030
PPL# (August 2021)	• 70% below 2010 levels by 2035 • Net zero emissions by 2050

COMPANY	GOAL
PSEG (June 2021)	• Net-zero carbon emissions by 2030 (Scope 1 & 2)[8] • 100% carbon-free generation by 2030
Puget Sound Energy (January 2020)	• Net zero electric supply (including gas) by 2030 • 100% carbon free electric supply by 2045 • Net zero carbon emissions for NG sales by 2045*
Sempra (May 2020)	• Deliver 100% renewable/zero-carbon energy to customers by 2045 (SDG&E)
Southern California Edison (November 2019)	• 40% below 1990 levels by 2030 • Carbon neutrality by 2045
Southern Company (May 2020)	• 50% below 2007 levels by 2030 • Net-zero GHG emissions by 2050
Tucson Electric Power (June 2020)	• 80% below 2005 levels by 2035
TVA (May 2021)	• 70% below 2005 levels by 2030 • ~80% below 2005 levels by 2035 • Net-zero GHG emissions by 2050*
UGI Utilities (June 2020)	• >8 MMT below 2012 levels by 2030 (GHG emissions) • 92% below 1999 levels by 2030 (methane emissions) • 95% below 1999 levels by 2040 (methane emissions)
Unitil (June 2021)	• At least 50% below 2019 levels by 2030 • Net-zero emissions by 2050
WEC Energy Group (May 2021)	• 60% below 2005 levels by 2025 • 80% below 2005 levels by 2030 • Net-zero methane emissions by 2030 • Net-zero carbon emissions by 2050
Xcel Energy (December 2018)	• 80% below 2005 levels by 2030 • Carbon-free electricity by 2050*

1 – Taking actions to support the objectives of the Paris climate agreement; 2 – Applies to operations-driven emissions; 3 – Applies to corporate emissions across all departments and operations; 4 – Applies to electric energy portfolio for Montana; 5 – Applies to carbon emissions from natural gas customers' usage; 6 – Includes GHG emissions from DTE Gas from procurement to delivery; 7 – Working on IRP for 2021 with potentially updated goals; 8 – Applies to natural gas utilities; * – Aspirational and/or dependent on advancements in technology and public policy; # - Includes 2040 reduction goal

Carbon-Free Technology Initiative

Achieving deep carbon reductions while maintaining affordability and reliability will require new, affordable, 24/7 carbon-free technologies.

5 Key Technology Areas of Focus:

- Advanced, dispatchable renewables (e.g., superhot deep geothermal) and advanced power electronics
- Zero-carbon fuels, such as hydrogen or ammonia, produced from a variety of sources
- Advanced nuclear energy (both fission and fusion)
- Carbon capture, utilization, and sequestration, especially for natural gas facilities
- Advanced demand efficiency and long-duration storage

Clean Energy Policy Priorities

To meet long-term clean energy and climate goals, we need policies that:

- **Advance** carbon-free technologies through appropriations, authorizations, and tax policy.
- **Recognize** industry's clean energy leadership in reducing carbon emissions and support rapid investment in clean energy resources and the infrastructure needed to integrate it.
- **Support** investments in the electric transmission system to integrate more renewables, more clean energy, and new technologies into the energy grid affordably and reliably.
- **Promote** electric transportation and facilitate build-out of EV infrastructure.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Power by Association℠

The Energy Transformation

Merging the Vision with Reality & Reliability

Neva Espinoza
Vice President
Energy Supply and Low-Carbon Resources

Critical Consumers Issues Forum
March 1, 2022



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EPRI

Leading Collaborative Energy R&D Around the World

EPRI advances energy technologies and informs decision-making through ~$420M in collaborative annual research involving nearly 400 entities in ~40 countries - spanning the generation, delivery, and use of electricity.



ENGAGING

- Utilities
- Academia
- OEMs
- Regulators



LISTENING

- Financial Community
- Policy Makers
- Consumer Advocates
- Media

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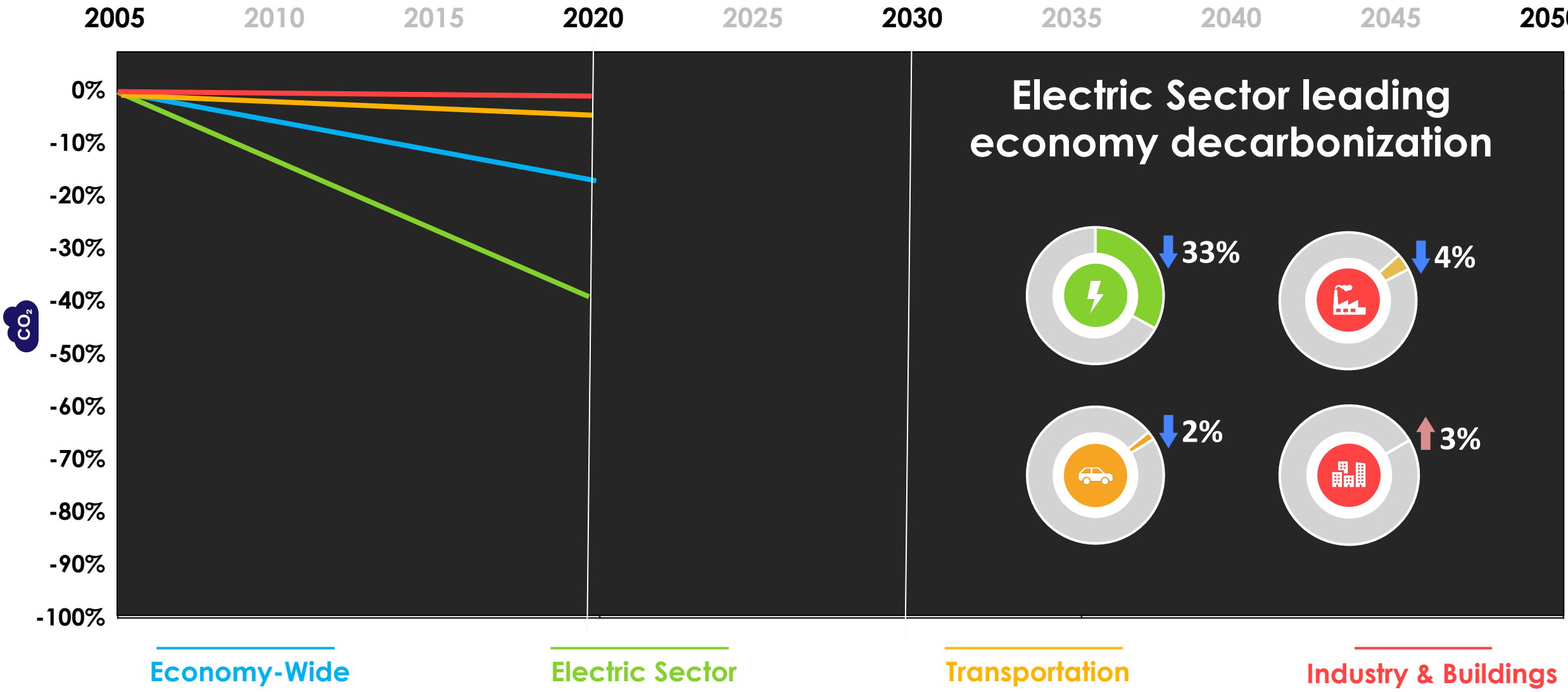
PAST 15 YEARS

Electric Sector Leading
maintaining affordability & reliability



https://www.youtube.com/watch?v=42UqxqCCYs4

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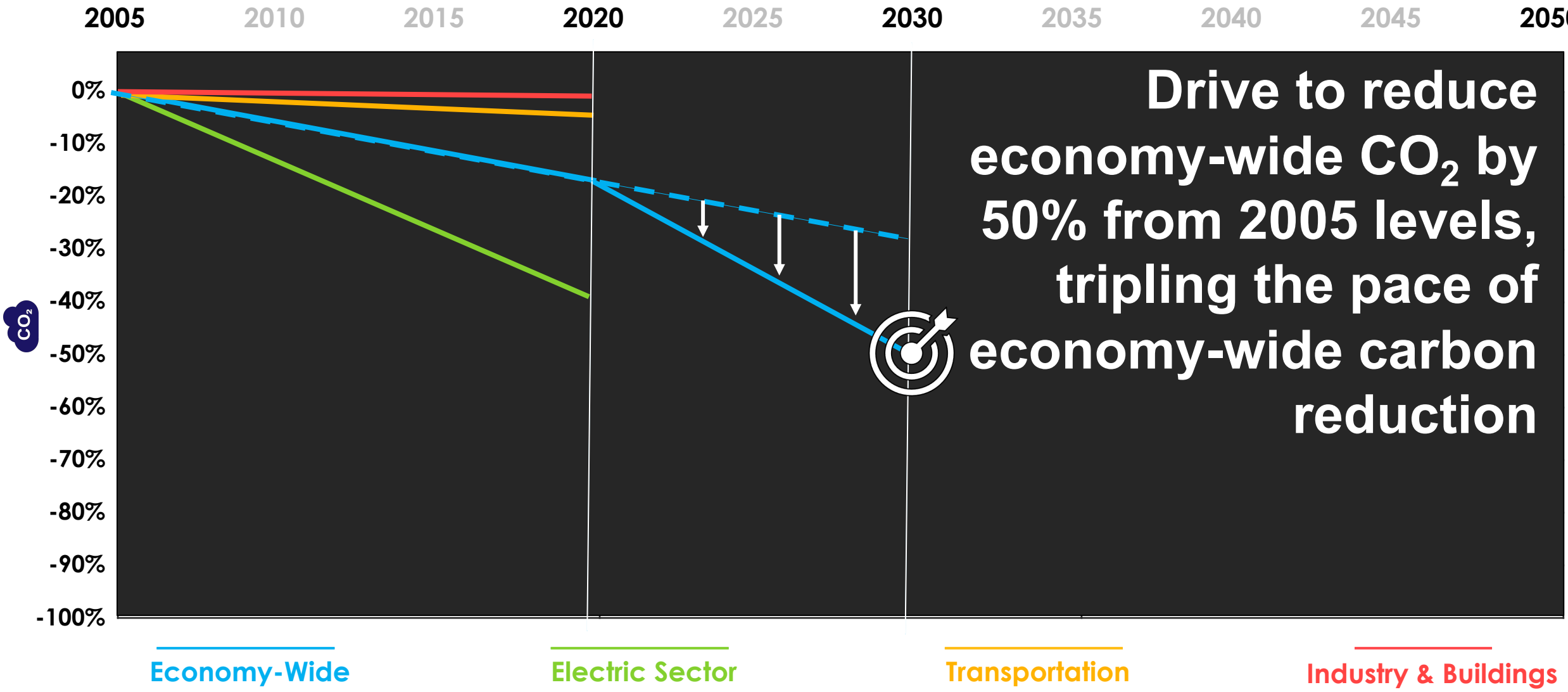
THIS DECADE

Pathway to 50%
electric sector continues to lead



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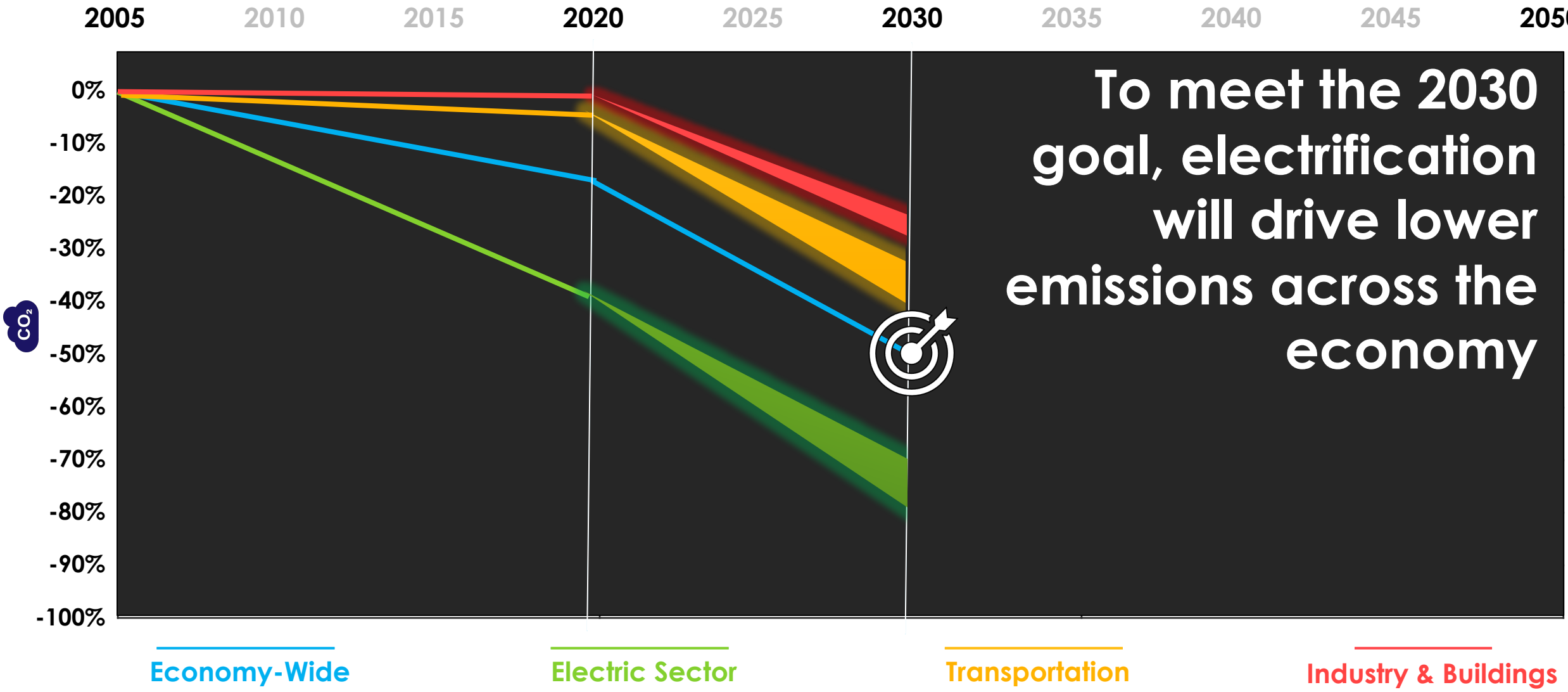

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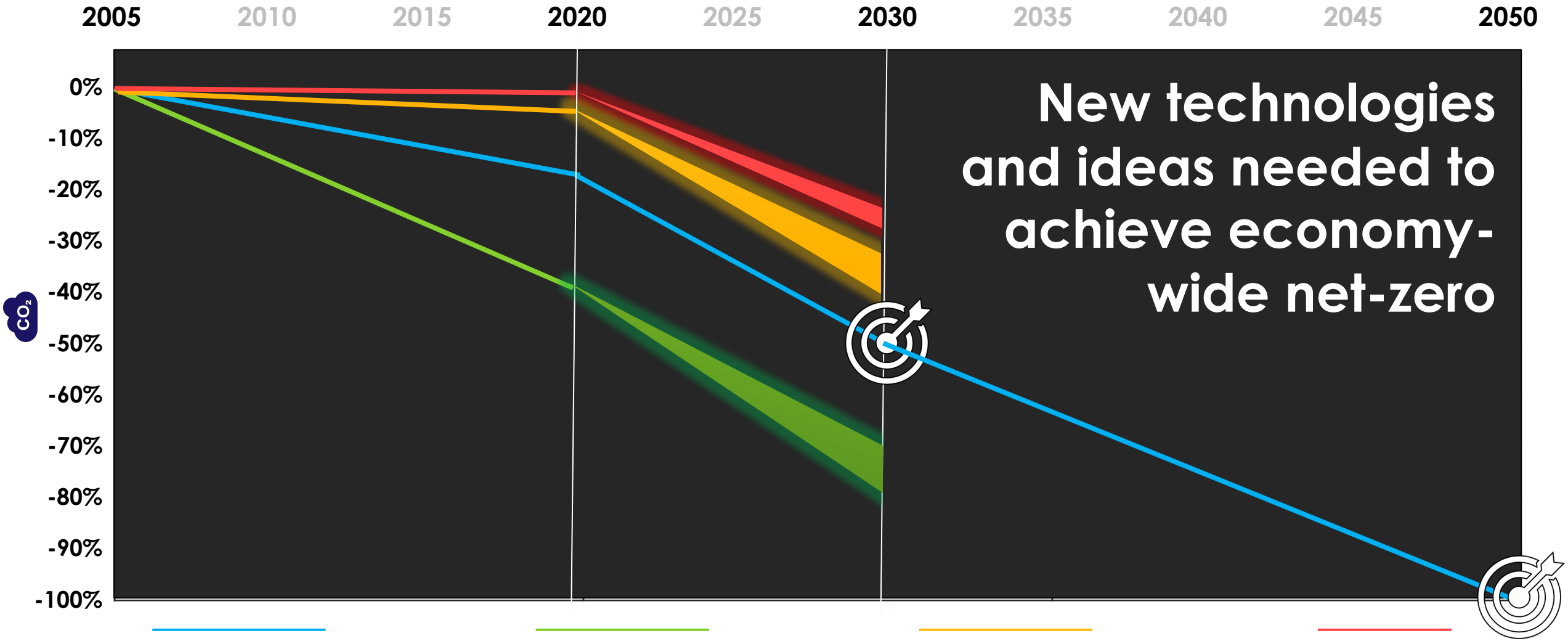
BEYOND THIS DECADE

Pathway to Net-Zero
more technology needed



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WHAT WILL 2050 LOOK LIKE?



- What are the technologies?
- What value do they provide?
- What will they cost?
- How will they perform?
- What are the barriers to overcome?

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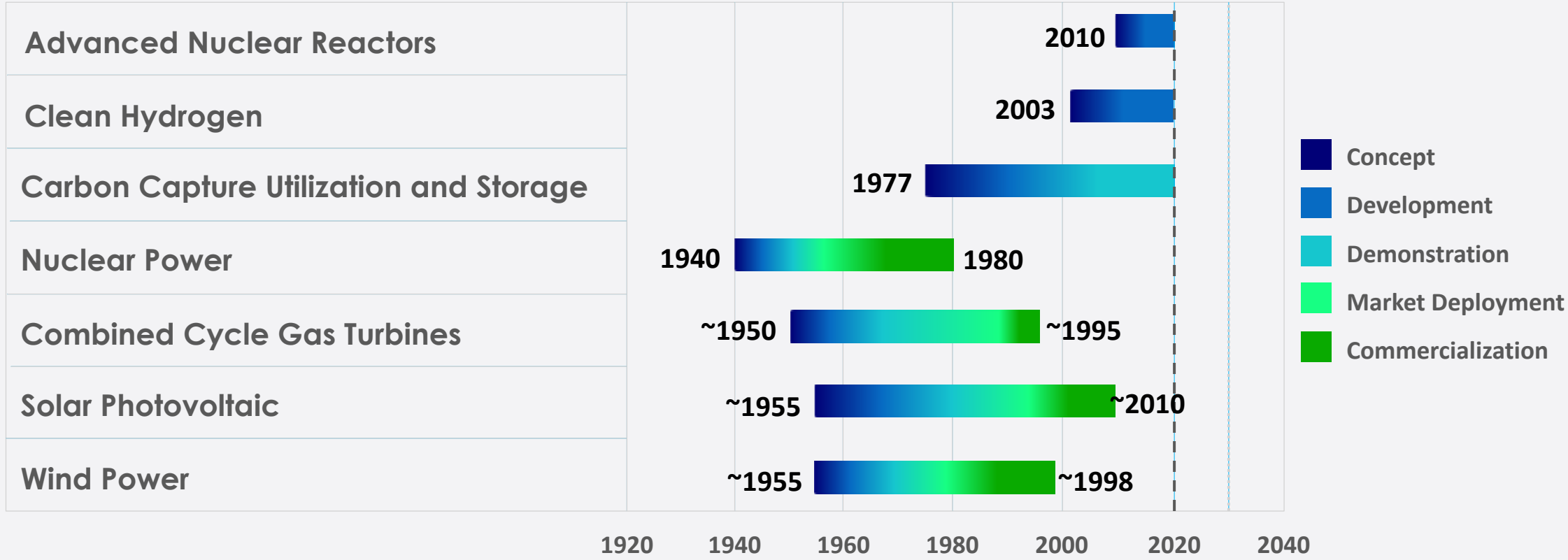
TECHNOLOGY

Decades of Effort
from concept to commercialization



Notional timelines

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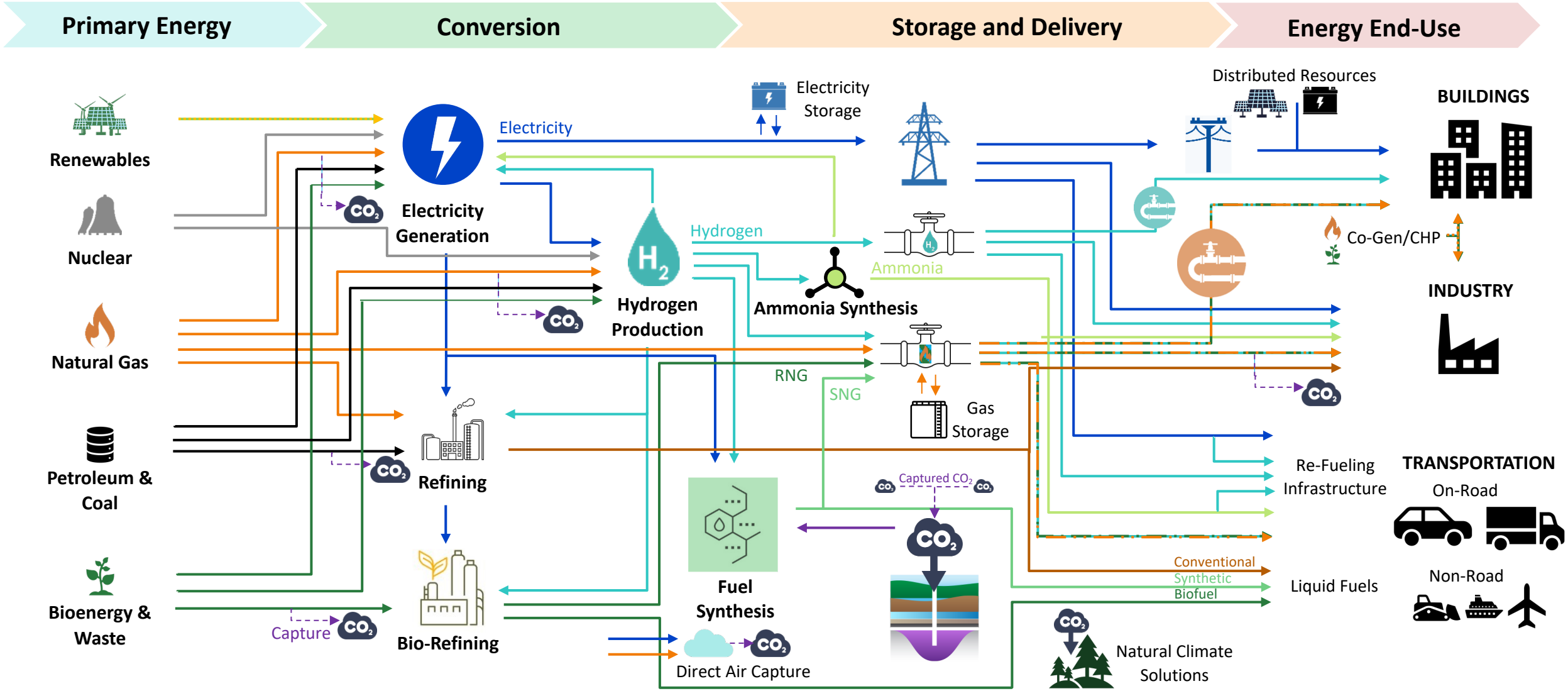
COMPLEXITY

New Resources and Players
how will they fit and transition?



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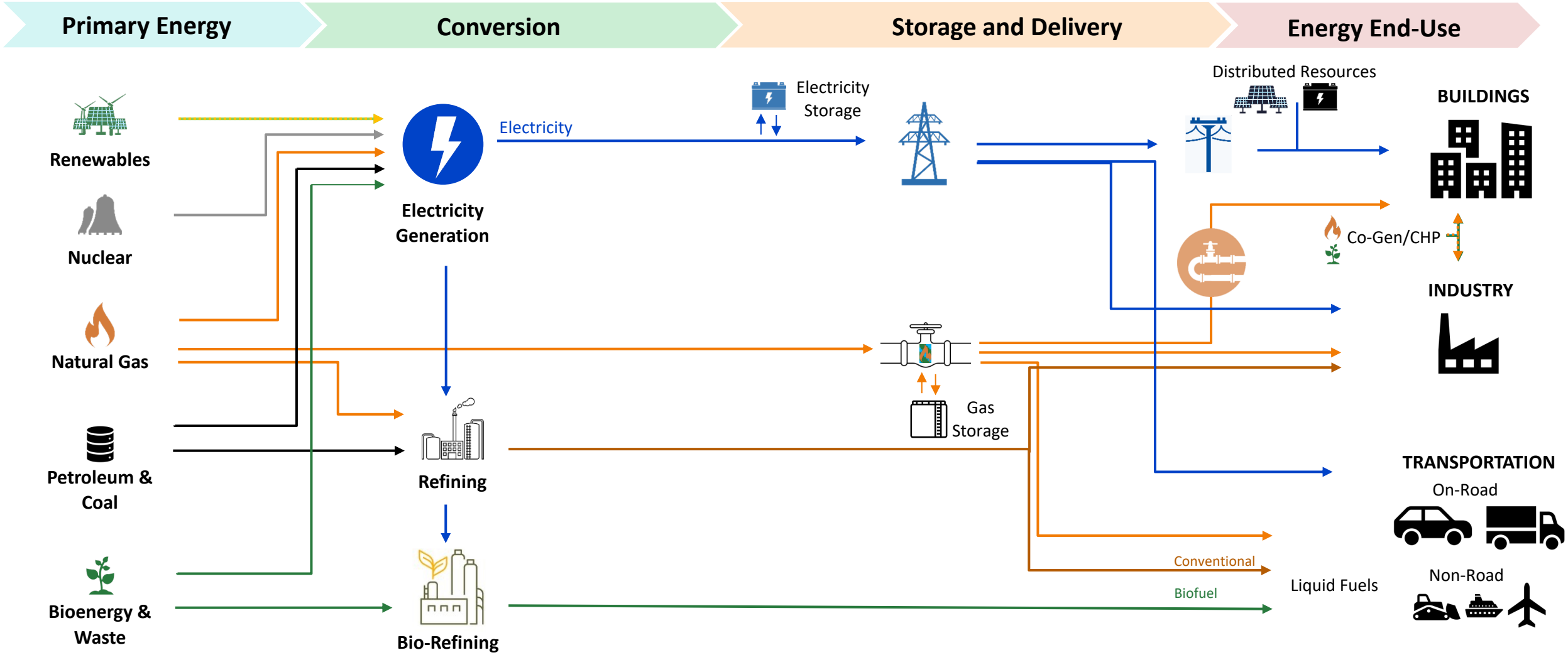
TECHNOLOGY+++

Energy System won't be as 'simple' as today



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Pathway to Net-Zero
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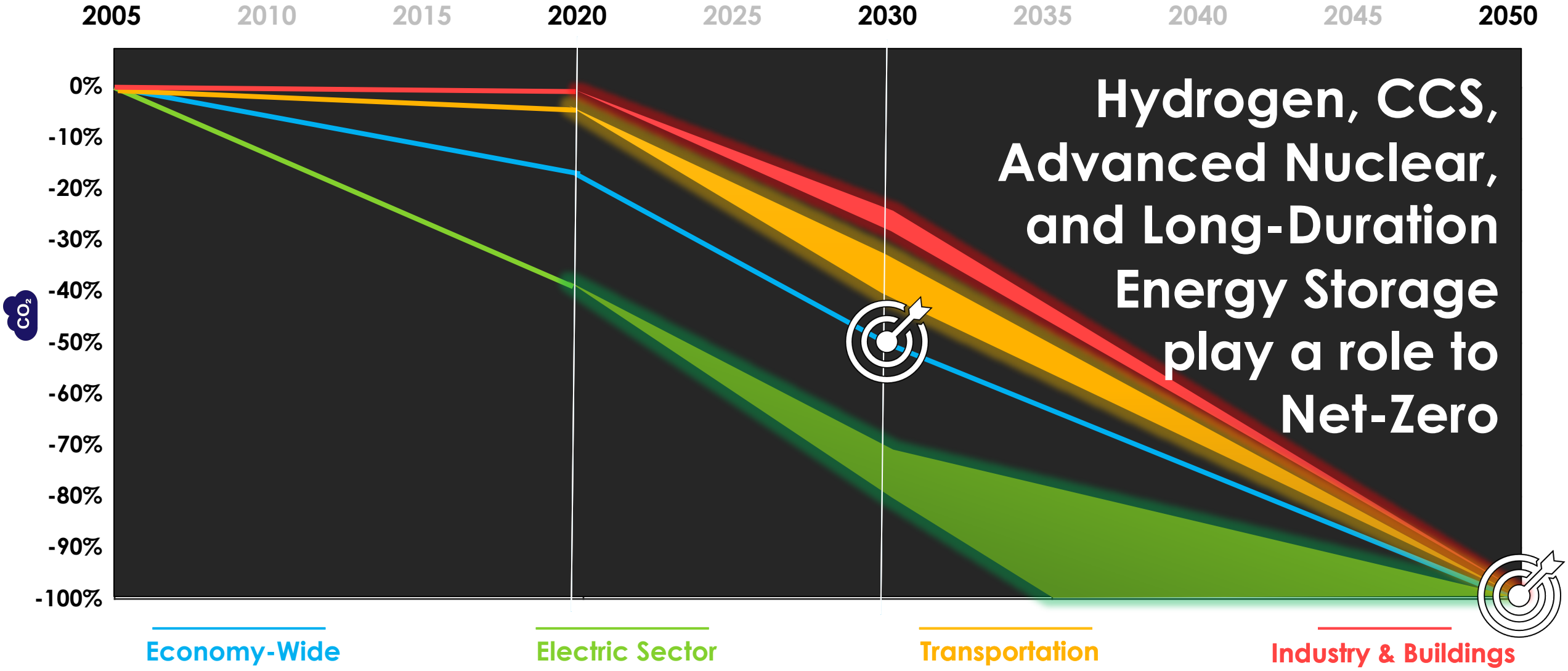

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Decarbonization

~10-15 years

Accelerate economy-wide, low-carbon solutions

- Electric sector decarbonization
- Transmission and grid flexibility: storage, demand, EVs
- Efficient electrification

~15-30 years

Achieve a net-zero clean energy system

- Ubiquitous clean electricity: renewables, advanced nuclear, CCUS
- Negative-emission technologies
- Low-carbon resources: hydrogen and related, low-carbon fuels, biofuels, and biogas



Transformation

Drive affordability of a clean and resilient energy system through digital transformation

- Power system modernization: pervasive sensors, monitoring, advanced analytics using AI
- Upgraded and expanded communications infrastructure and control systems

Resiliency

~10-15 years

Mitigate climate impacts and cyber/physical risks

- System and asset hardening
- Improved response
- Faster recovery
- Cybersecurity

~15-30 years

Future proof energy system design basis

- Resilient power system design
- Advanced asset design and strategic undergrounding
- Smart integration of energy carriers

Making Energy More

Clean | **Affordable** | **Reliable**

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HYDROGEN

Expanding the Energy Economy
the role of alternate energy carriers

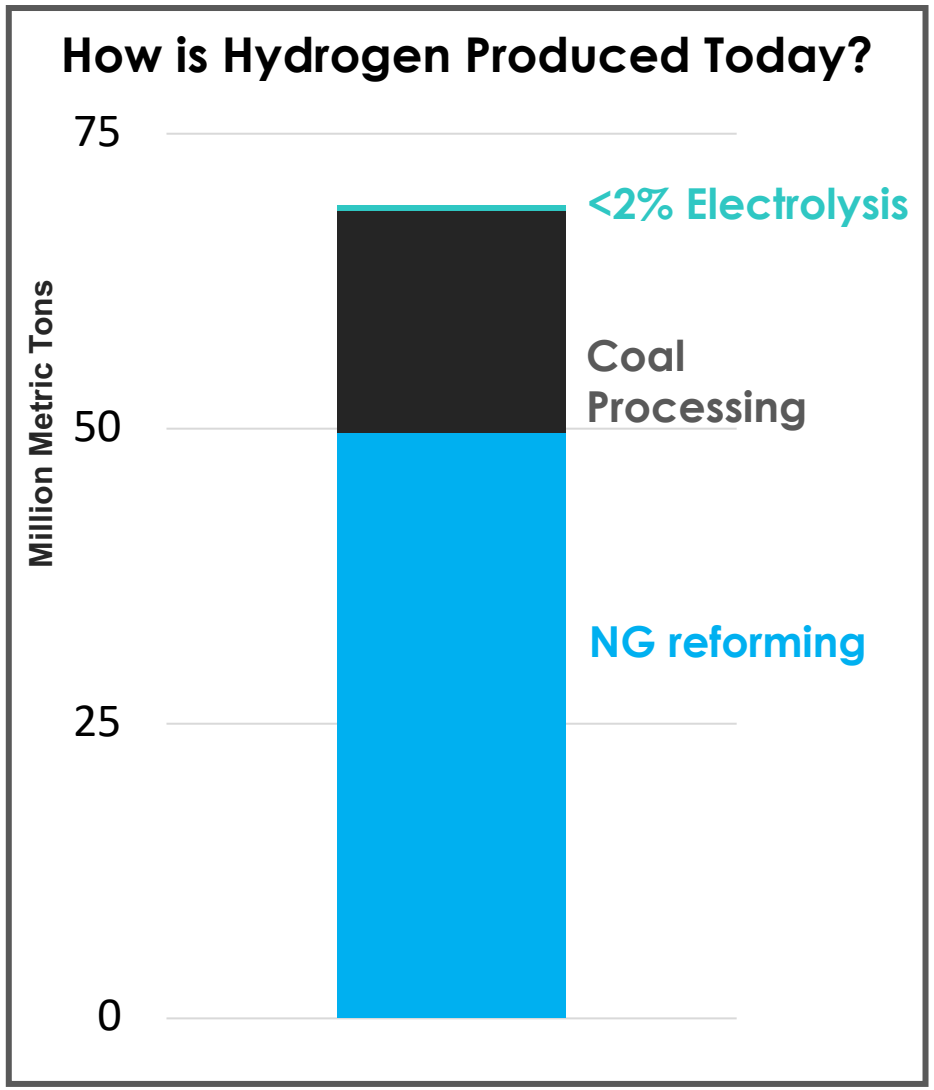
WHAT IF...

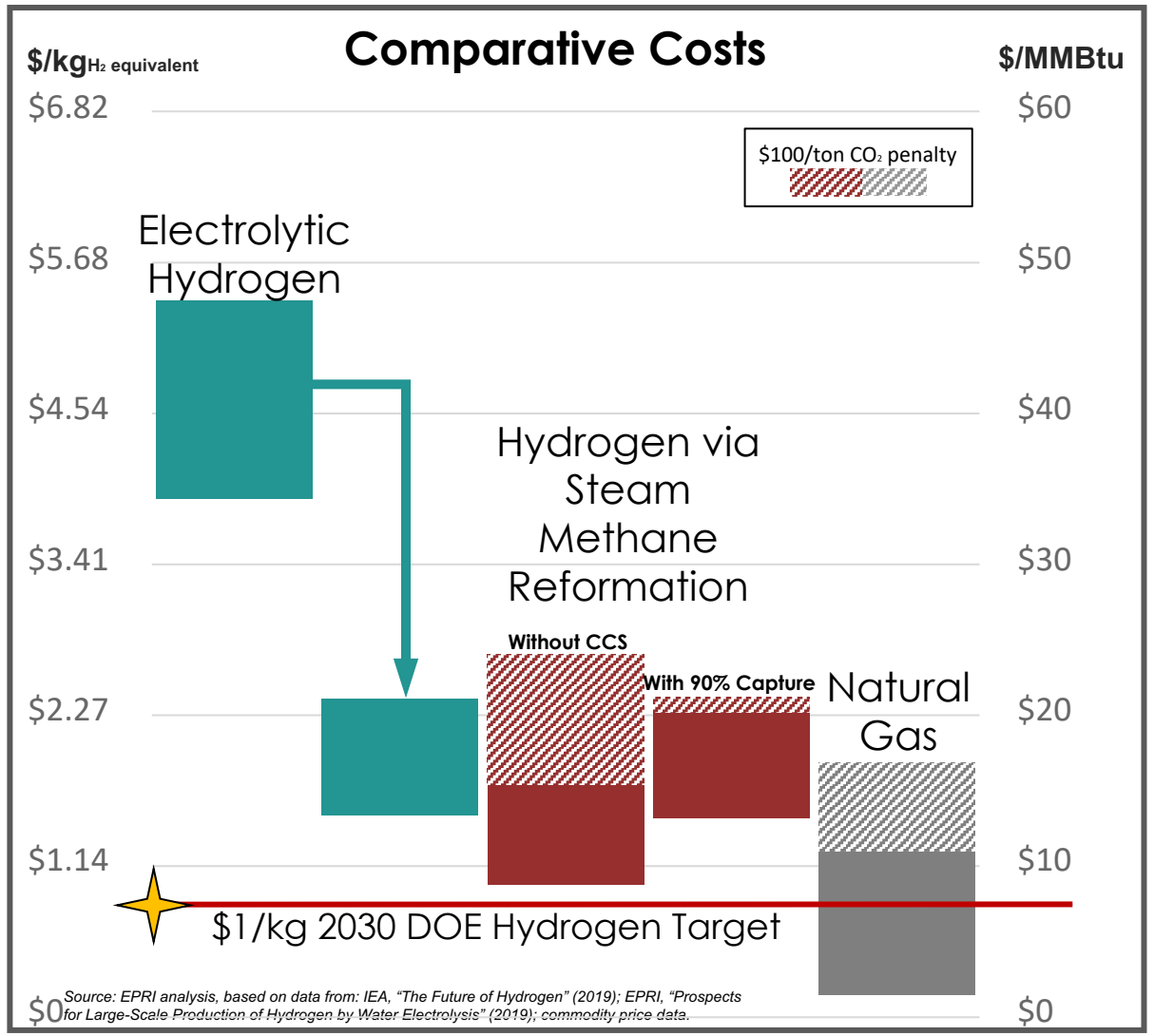
All of the hydrogen used globally today was produced from electricity?

The amount of **electricity consumed** would be equal to

88% of the electricity generation in the **United States** today

nearly **14%** of electricity consumption **worldwide**





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CCUS

Demonstration to Deployment
acceleration and collaboration needed today

Capture

"Capture dominates the cost of CCUS."

Abhoyjit Bhown, EPRI

Utilization

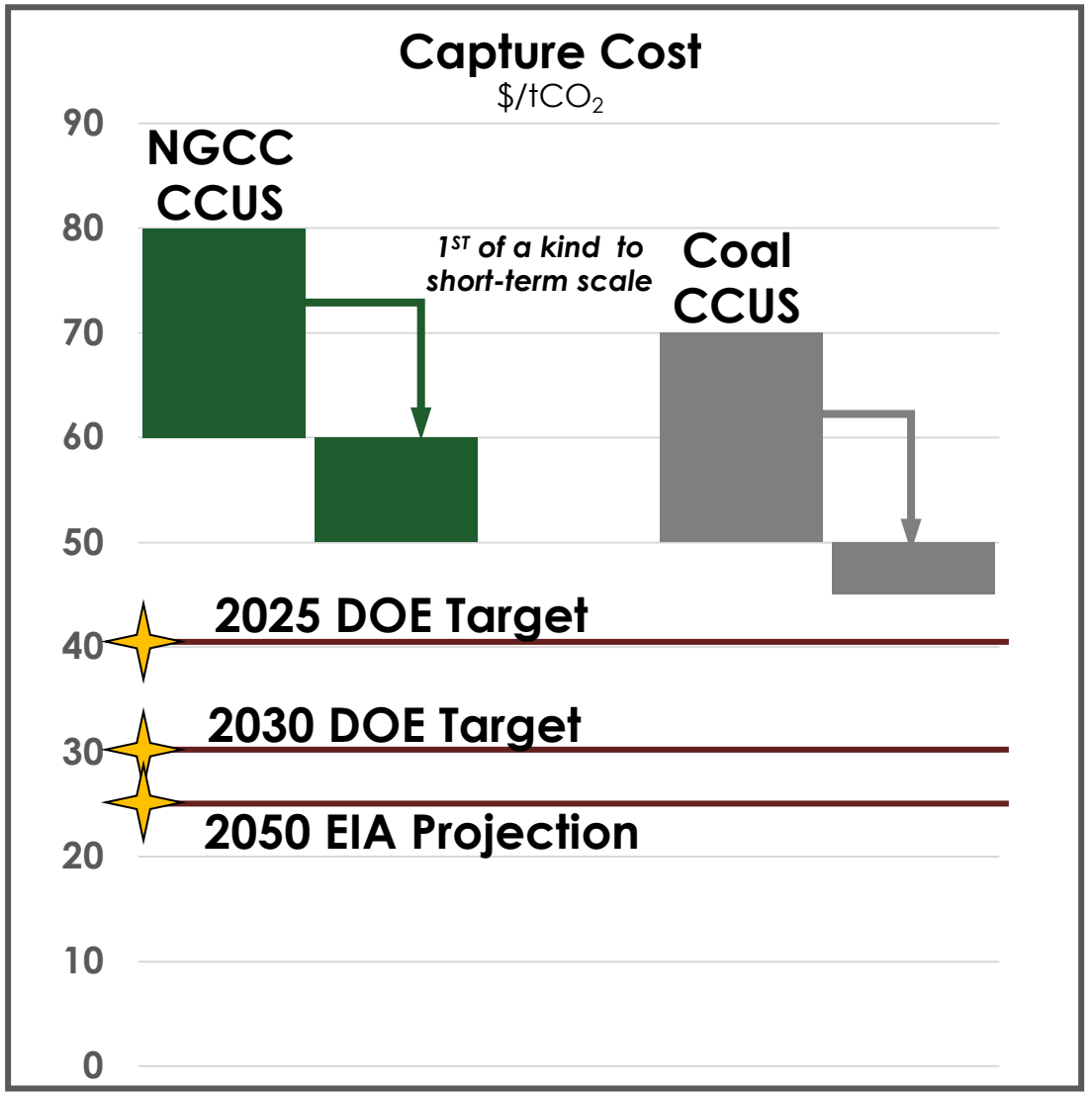
"CO_2 use can complement CO_2 storage but is not an alternative."

International Energy Agency

Storage

"Risk comparable to risks of current activities such as natural gas storage, EOR, and deep underground disposal of acid gas"

The Intergovernmental Panel on Climate Change



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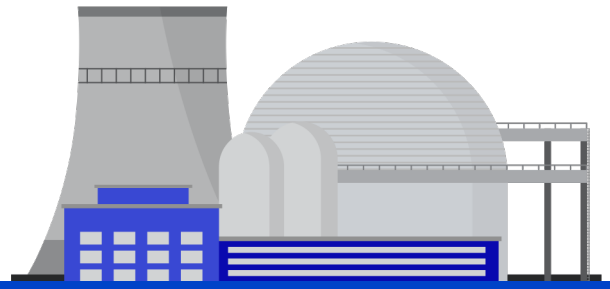
ADVANCED NUCLEAR

Global Experience
US deployment this decade

- Increased flexibility
- Higher availability and longer operating life – typically 60 years
- Most current US plants have about $5x10^{-5}$ core damage frequency; modern plants are about ten times better than this
- Ability to reach unique communities
- New reactor designs can load-follow closer, faster, and more flexibly than current designs
- With the needed infrastructure, some ARs can convert up to 95% of fuel energy to usable electricity vs. traditional conversion of ~5%)
- More conducive to decarbonization goals
- Many new designs are small – at or below 300 MWe



(Source: Resources for the Future, Advanced Nuclear Reactors 101, March 2021)

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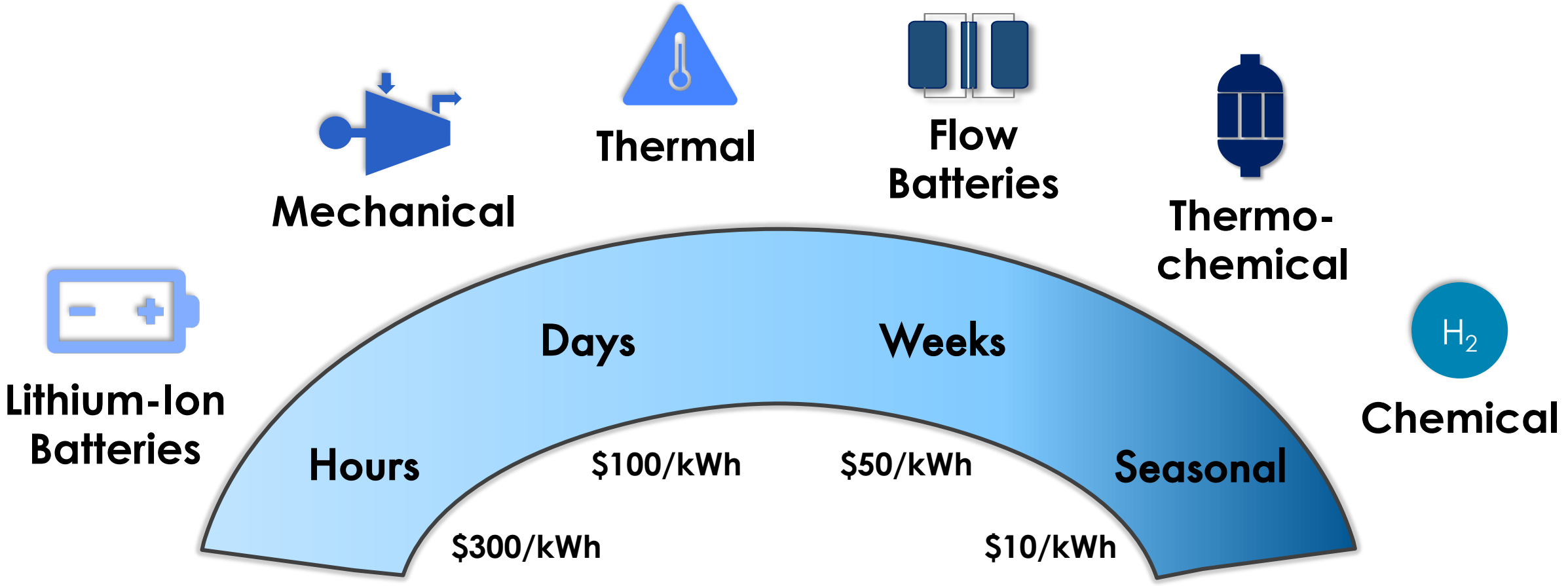
ENERGY STORAGE

Batteries and Beyond
storage to drive resiliency



Technologies may need to play a role in multiple time segments

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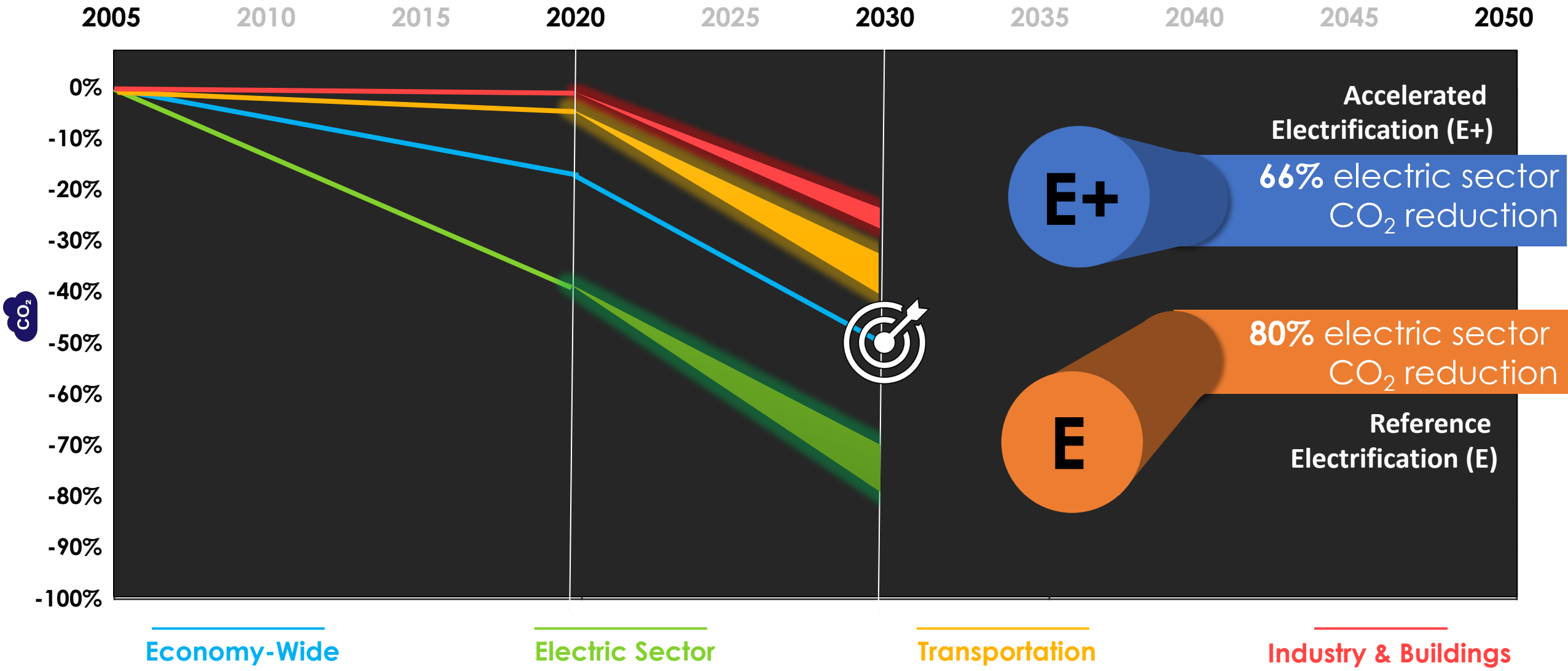
THIS DECADE

Pathway to 50%
electric sector continues to lead



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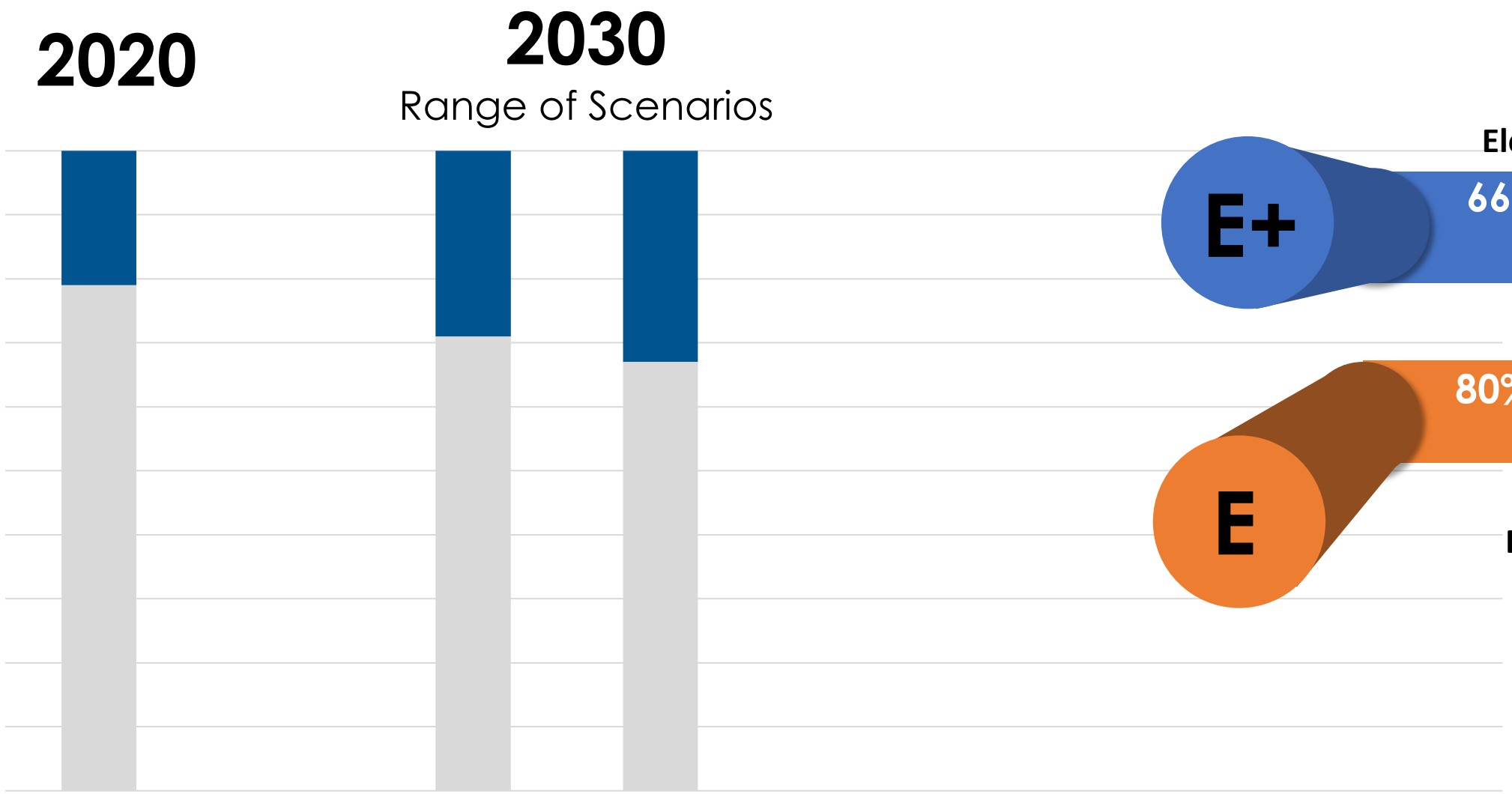
ELECTRICITY

Critical to Decarbonization
share of final energy rises



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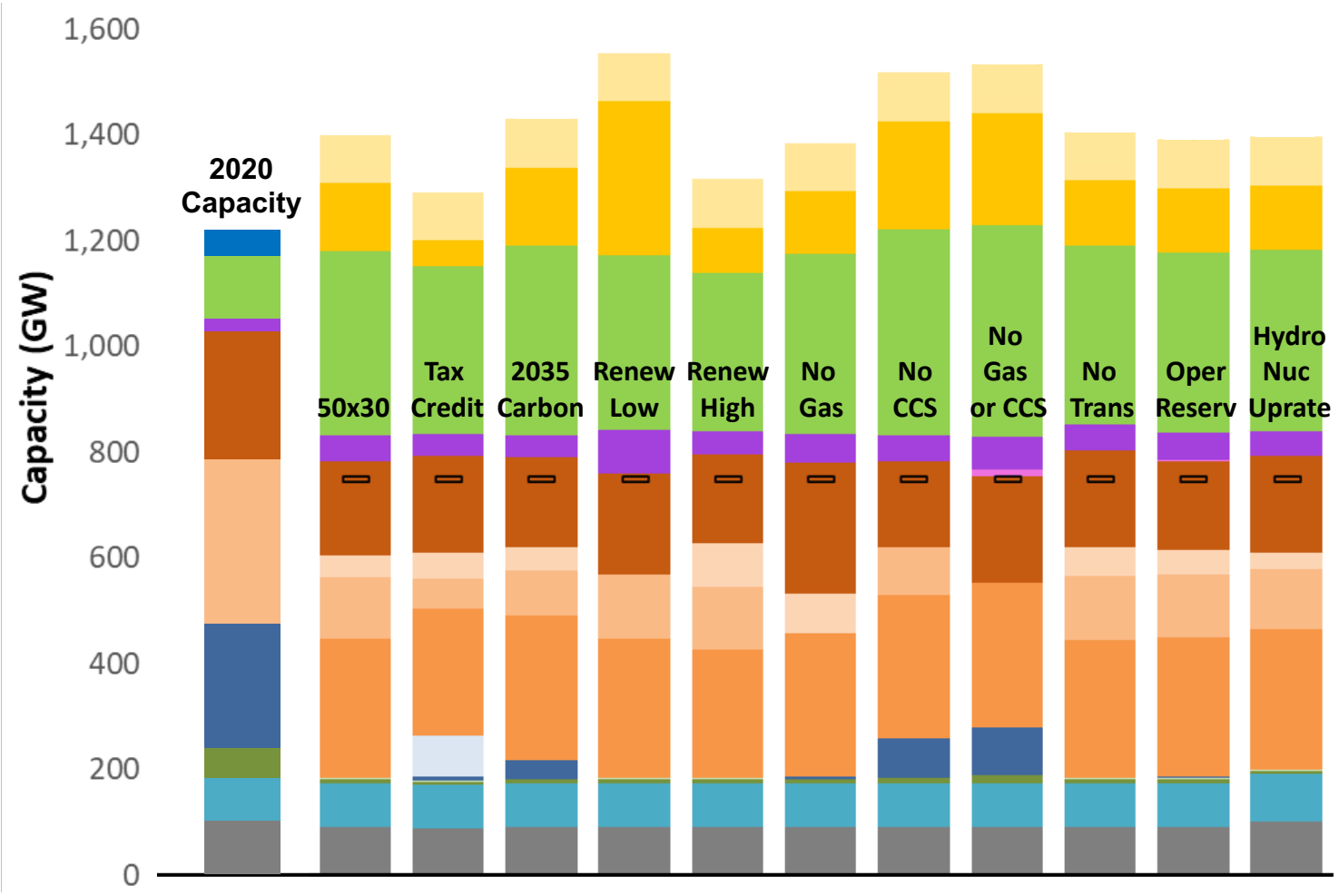
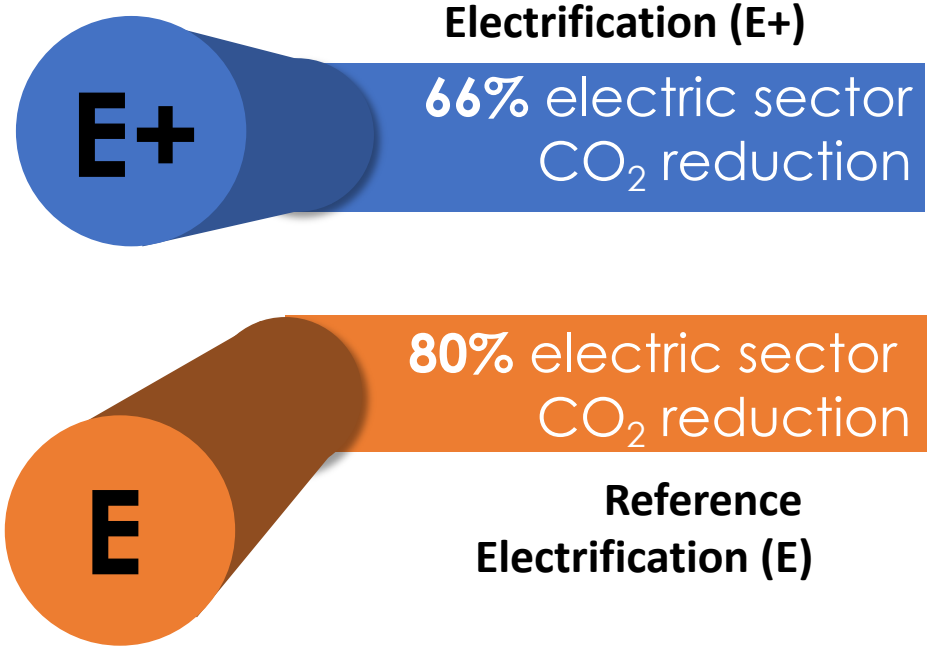
POSSIBILTIES

Diverse Asset Mix with various R&D needs





Solar Distributed | Solar Utility | Wind | Storage | Hydrogen | NGGT | NGCC CCS | NGCC New | NGCC Existing | Coal CCS | Coal | BECCS | Bio/Other | Hydro | Nuclear

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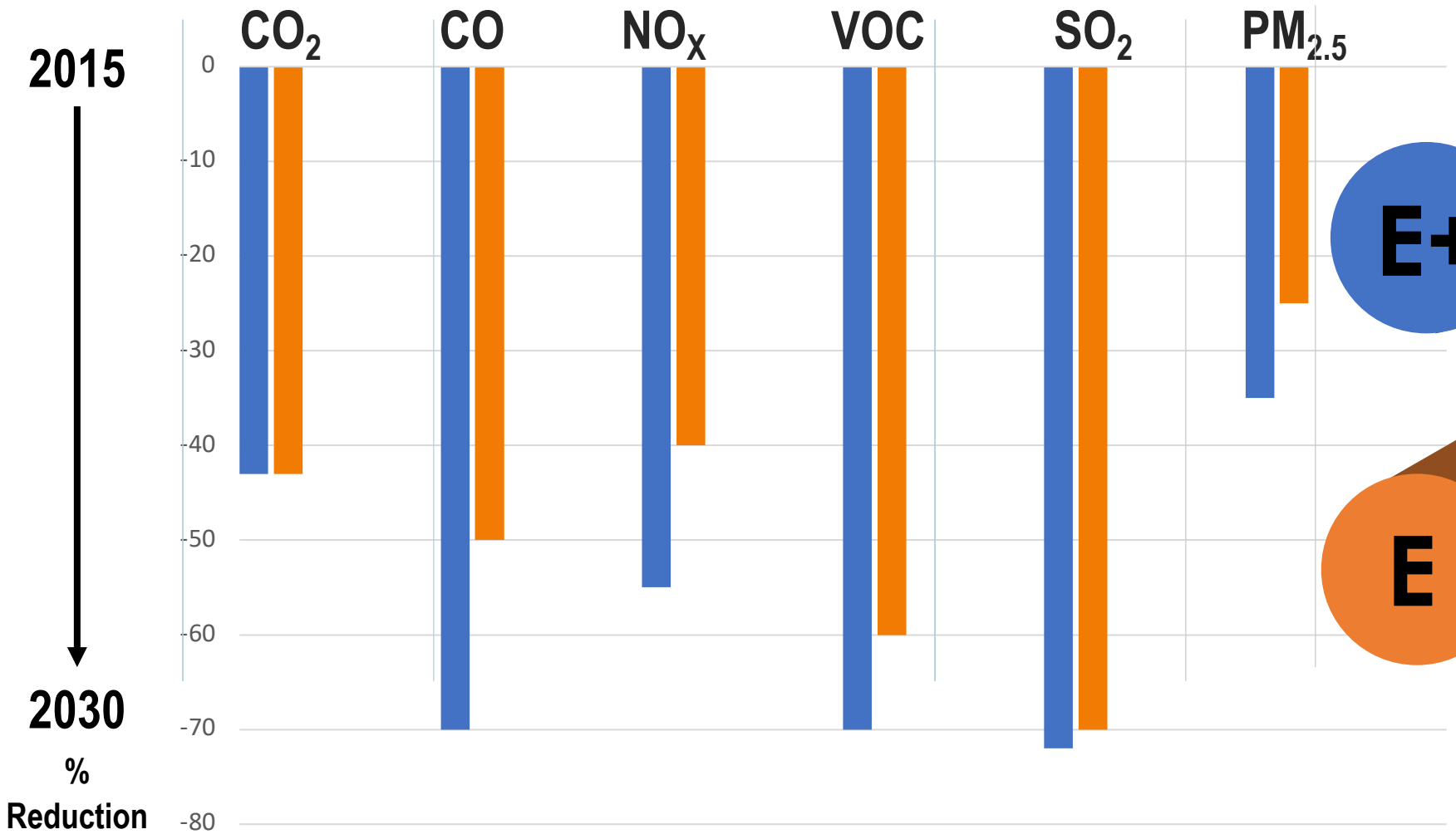
AIR BENEFITS

Beyond CO_2
electrification…improved air quality



Accelerated Electrification (E+)

E+

66% electric sector CO_2 reduction

80% electric sector CO_2 reduction

E

Reference Electrification (E)

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EPRI

Strategies and Actions for Achieving a 50% Reduction in U.S. Greenhouse Gas Emissions by 2030



Pathways to Achieve 50% Reduction

Accelerated Electrification (E+)

E+

66% electric sector CO_2 reduction

80% electric sector CO_2 reduction

E

Reference Electrification (E)

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