EPRI/IEA Workshop: Renewables and Clean Energy for Industries
US National Perspective and Enabling Policies

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

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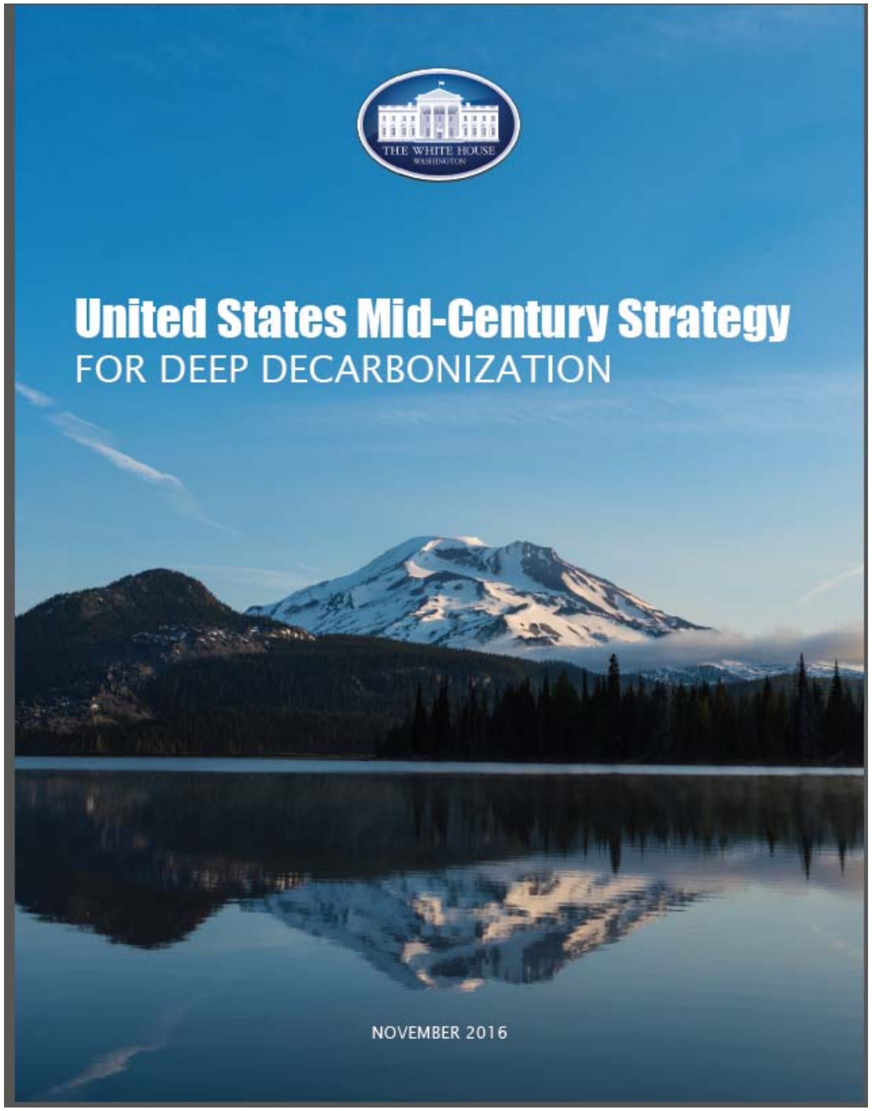
Outline

- Recent US Government Developments
- Short term drivers of renewable energy
- The challenge of clean energy deployment in the industrial sector

Recent US Government Developments

First ever Federal Government report laying out how to achieve economy-wide 80% emissions reductions



- The MCS is not a political strategy or a new target – it's a technical document illustrating pathways to achieve 80% economy-wide emission reductions
- Consistent both with the 2025 target in the U.S. NDC and the global ambition needed to meet the long-term Paris Agreement aim to limit increases in global average temperatures to well below 2°C above pre-industrial levels

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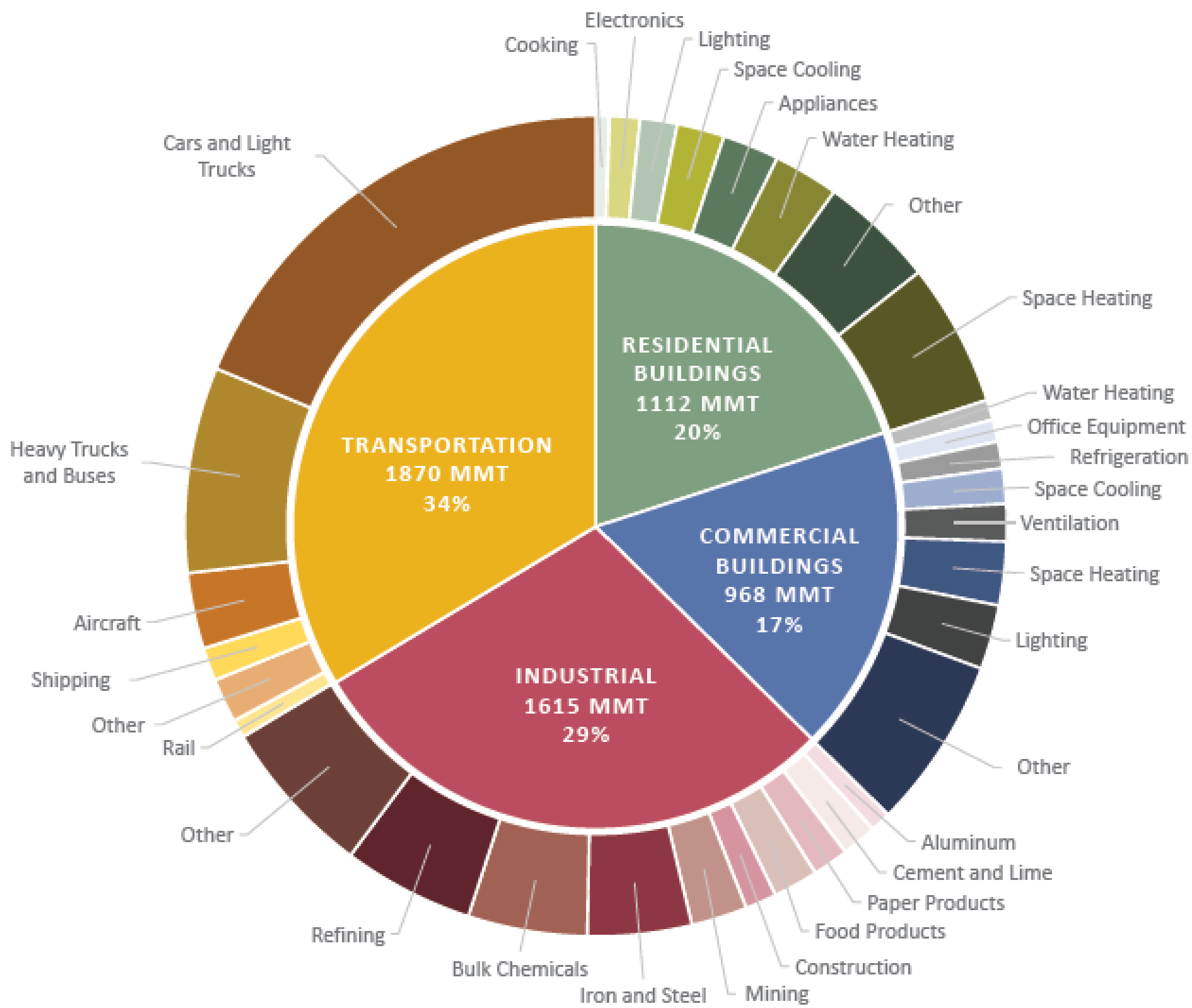
Energy related emissions come from many different sources



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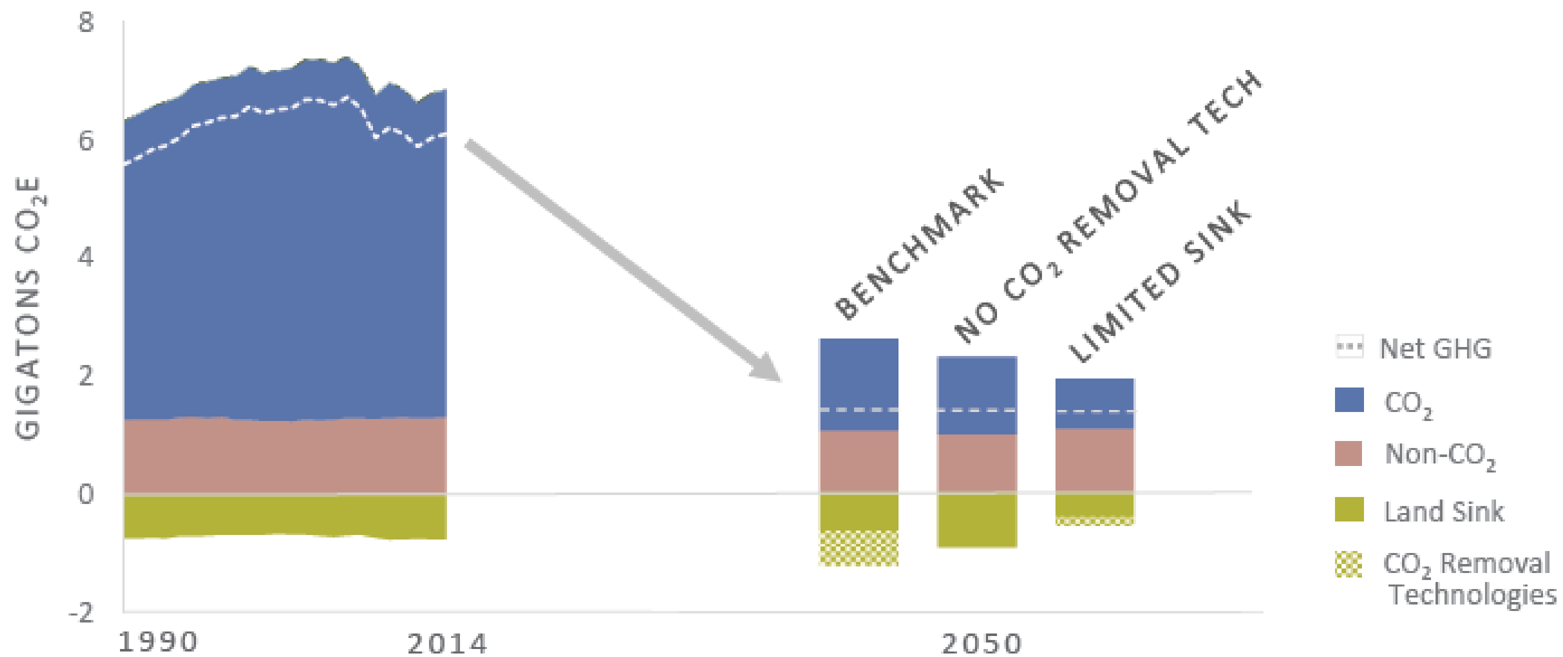
MCS lays out multiple pathways to achieve deep decarbonization

FIGURE E1: U.S. NET GHG EMISSIONS UNDER THREE MCS SCENARIOS



Multiple pathways to 80 percent GHG reductions by 2050 are achievable through large reductions in energy CO_2 emissions, smaller reductions in non-CO_2 emissions, and delivering negative emissions from land and CO_2 removal technologies. Note: "No CO_2 removal tech" assumes no availability of negative emissions technologies like BECCS.

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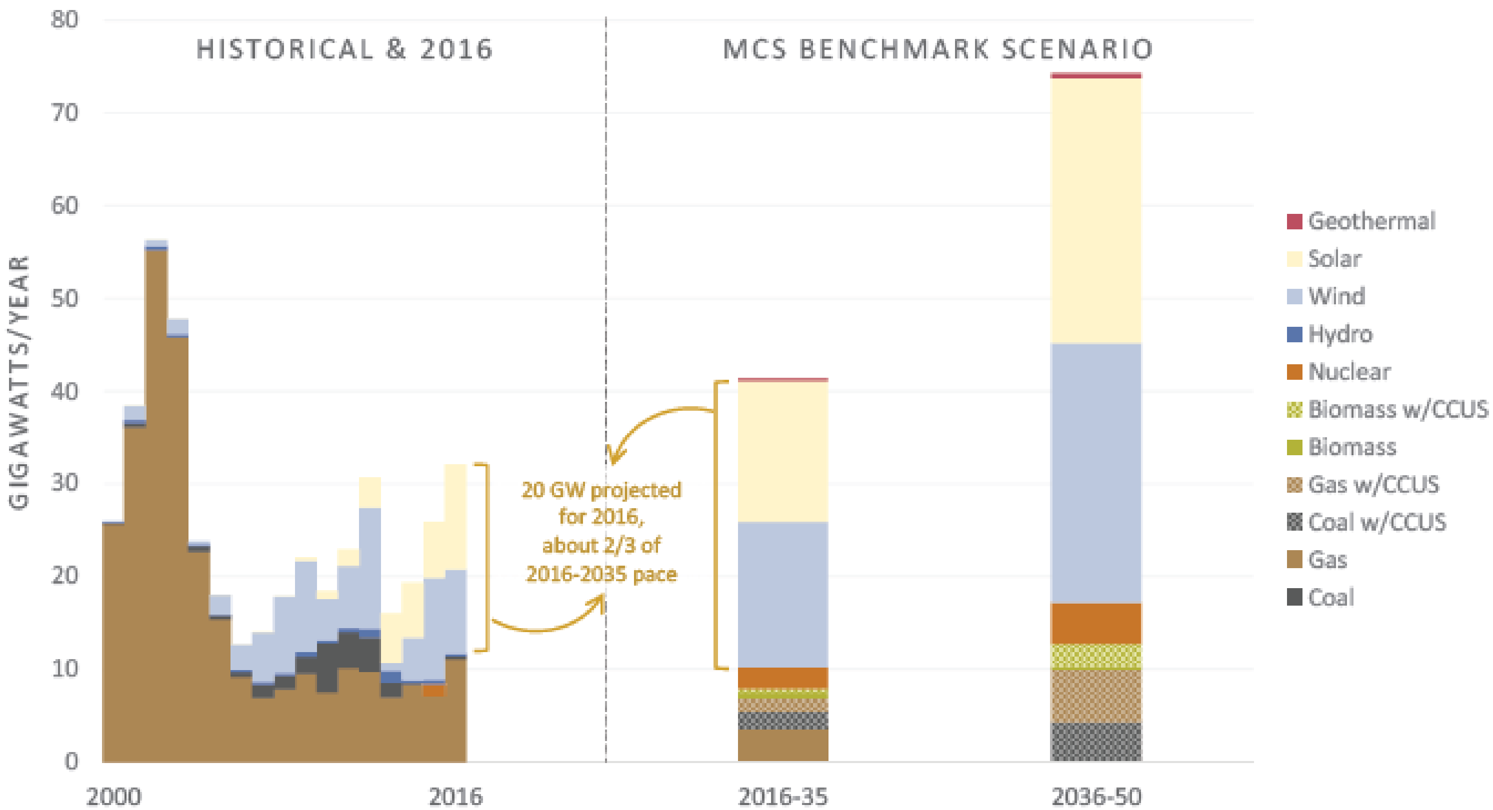
Achieving these goals will require dramatic increases in the deployment of clean energy

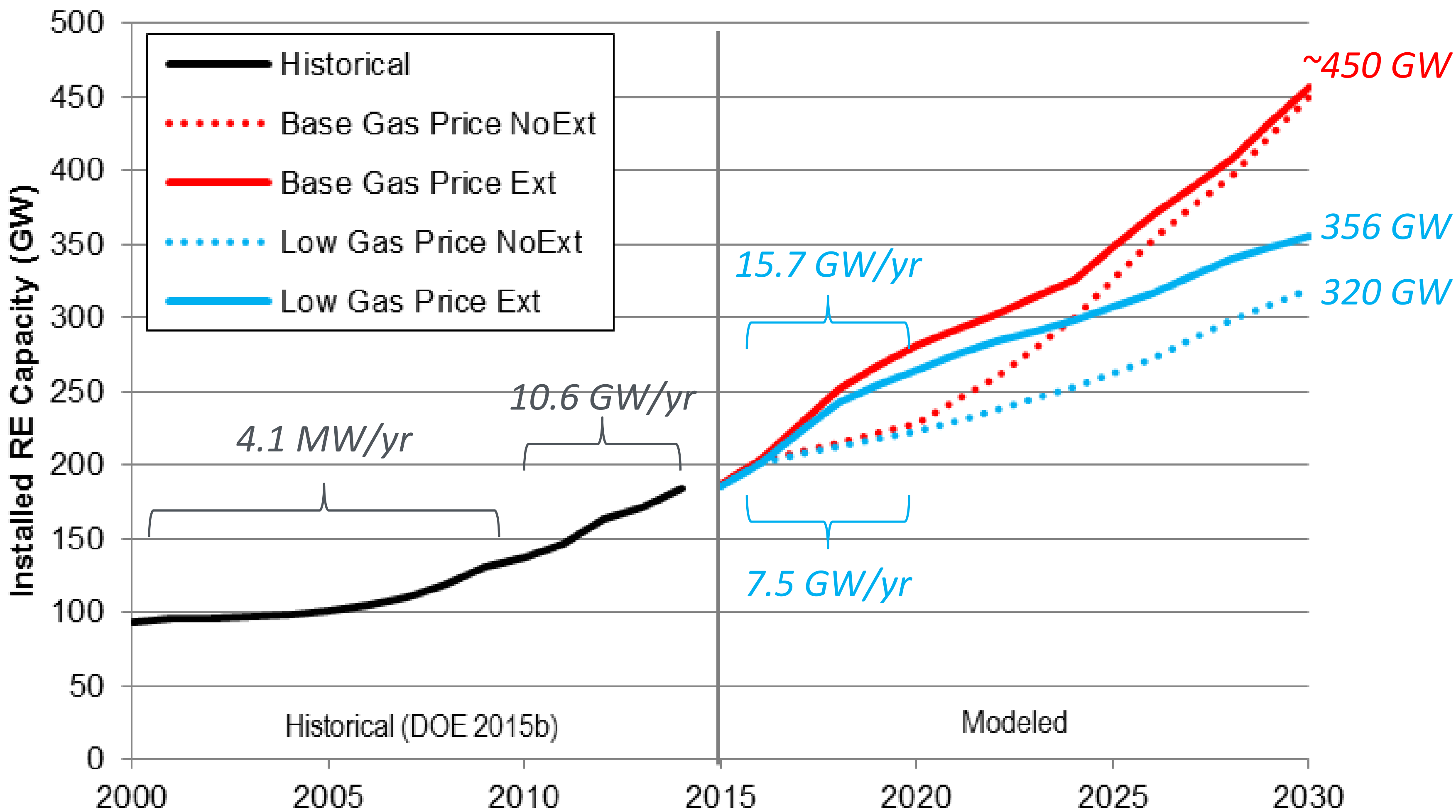
FIGURE E2: AVERAGE ANNUAL CAPACITY ADDITIONS BY FUEL, HISTORICAL AND MCS BENCHMARK SCENARIO



Note: 2016 data are AEO 2016 reference case projections (EIA 2016a; MCS analysis).

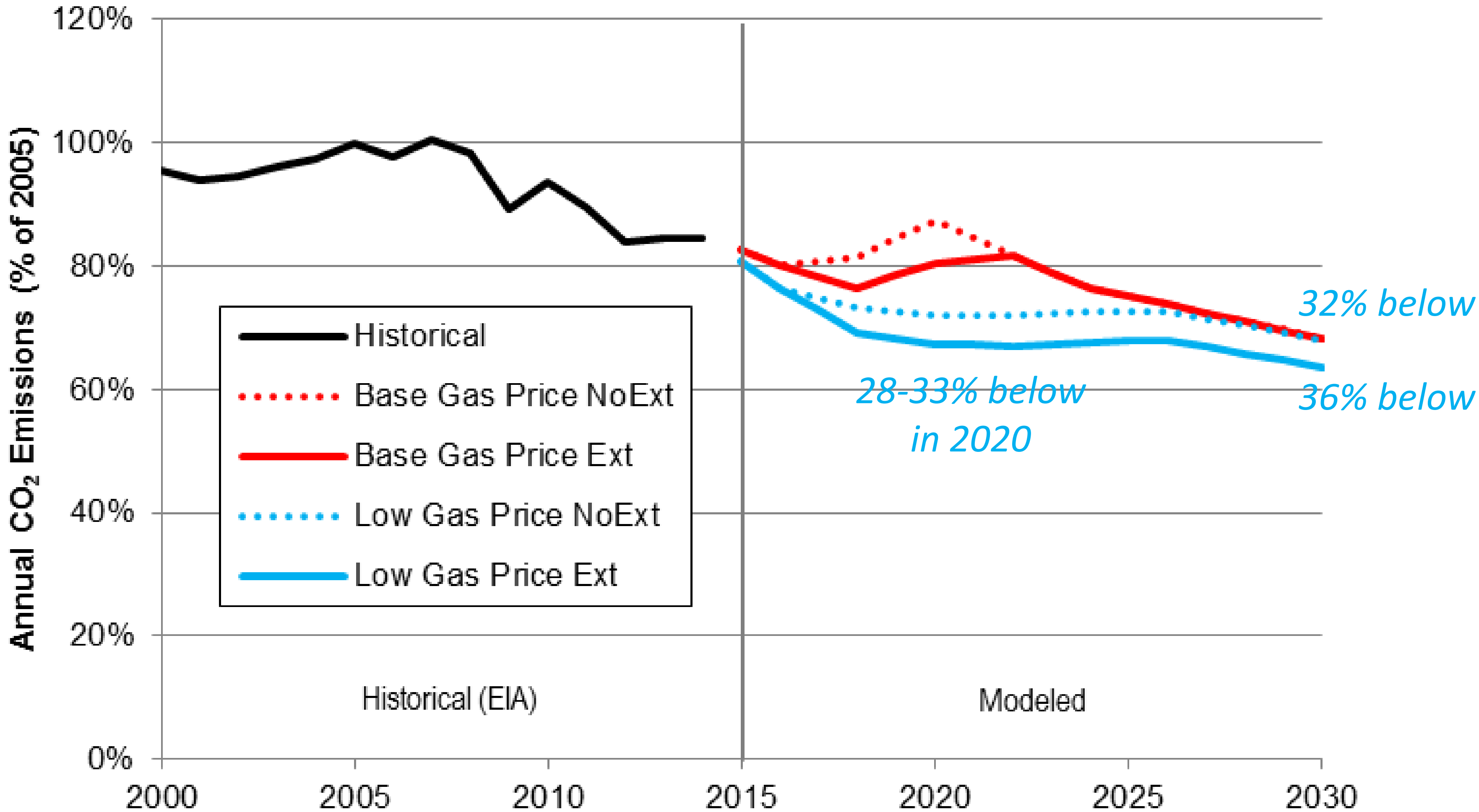
Short-Term Drivers of Renewable Energy

The multi-year extension of the PTC and ITC for RE in December 2015 changed the short-term RE deployment trajectory



Source: Mai et al, NREL, 2016

Low natural gas prices and RE tax extensions can lead to medium-term power sector emissions below CPP requirements



RE tax credit extensions help drive even lower emissions and with longer lasting avoided emissions

Source: Mai et al, NREL, 2016

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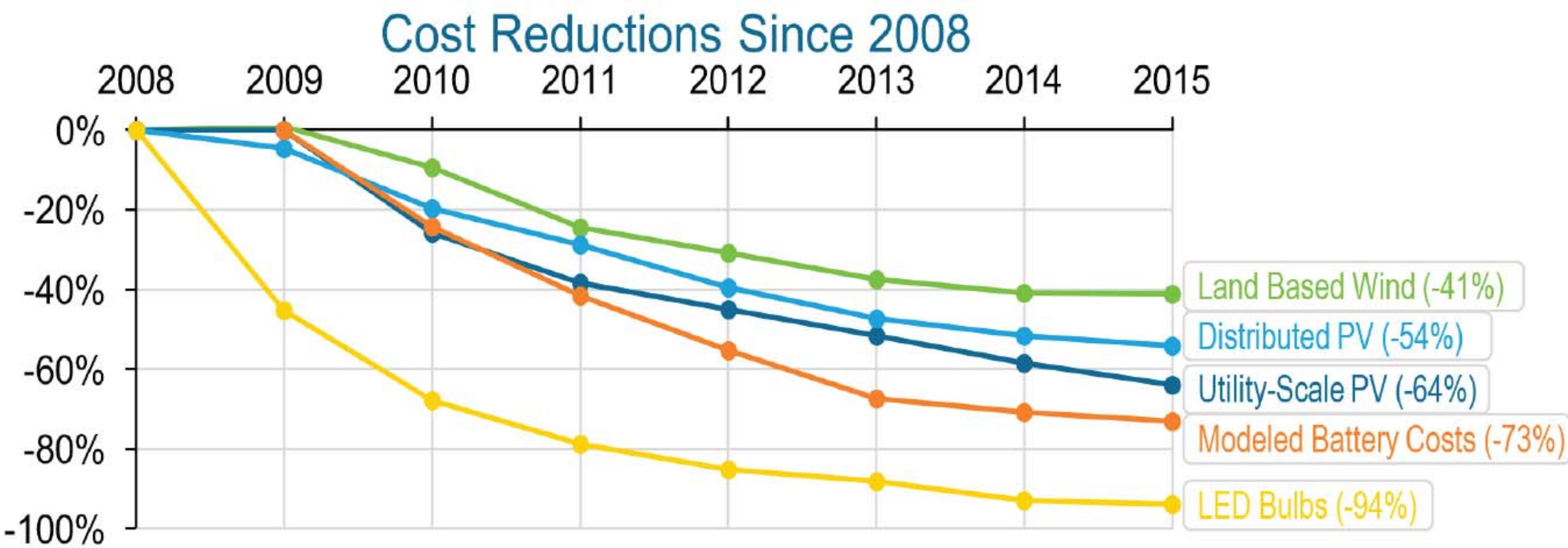
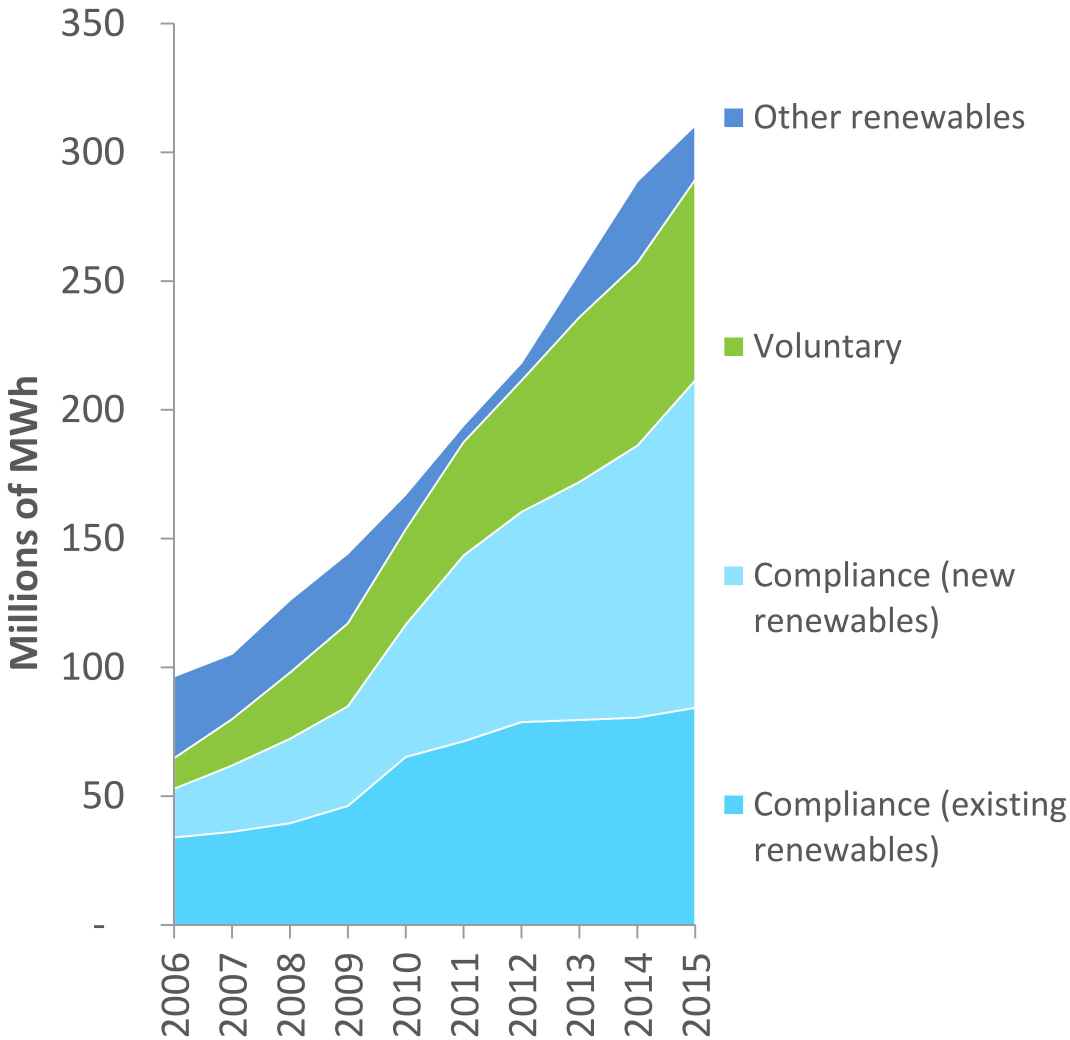
Continued deployment of clean energy is also enabled by enormous cost reductions over recent years



Notes: Land based wind costs are derived from levelized cost of energy from representative wind sites. Distributed PV cost is average residential installed cost. Utility-Scale PV cost is the median installed cost. Modeled battery costs are at high-volume production of battery systems, derived from DOE/UIS Advanced Battery Consortium PHEV Battery development projects. LED bulb costs are cost per lumen for A-type bulbs. See full report for full citations and details.

Source: *Revolution…Now,* DOE, 2016 Update

…As well as by increasing demand for voluntary renewable energy purchases



- Voluntary REC market grew ~10% from 2014-2015, and represented 25% of non-hydro renewables in 2015
- Other renewables – those built for purely economic reasons, represented 11% of non-hydro RE in 2015

Sources: EIA (2016), Barbose (2016), O'Shaughnessy et al. (2016), as cited in Heeter, "Status and Trends in the Voluntary Market" (2016)

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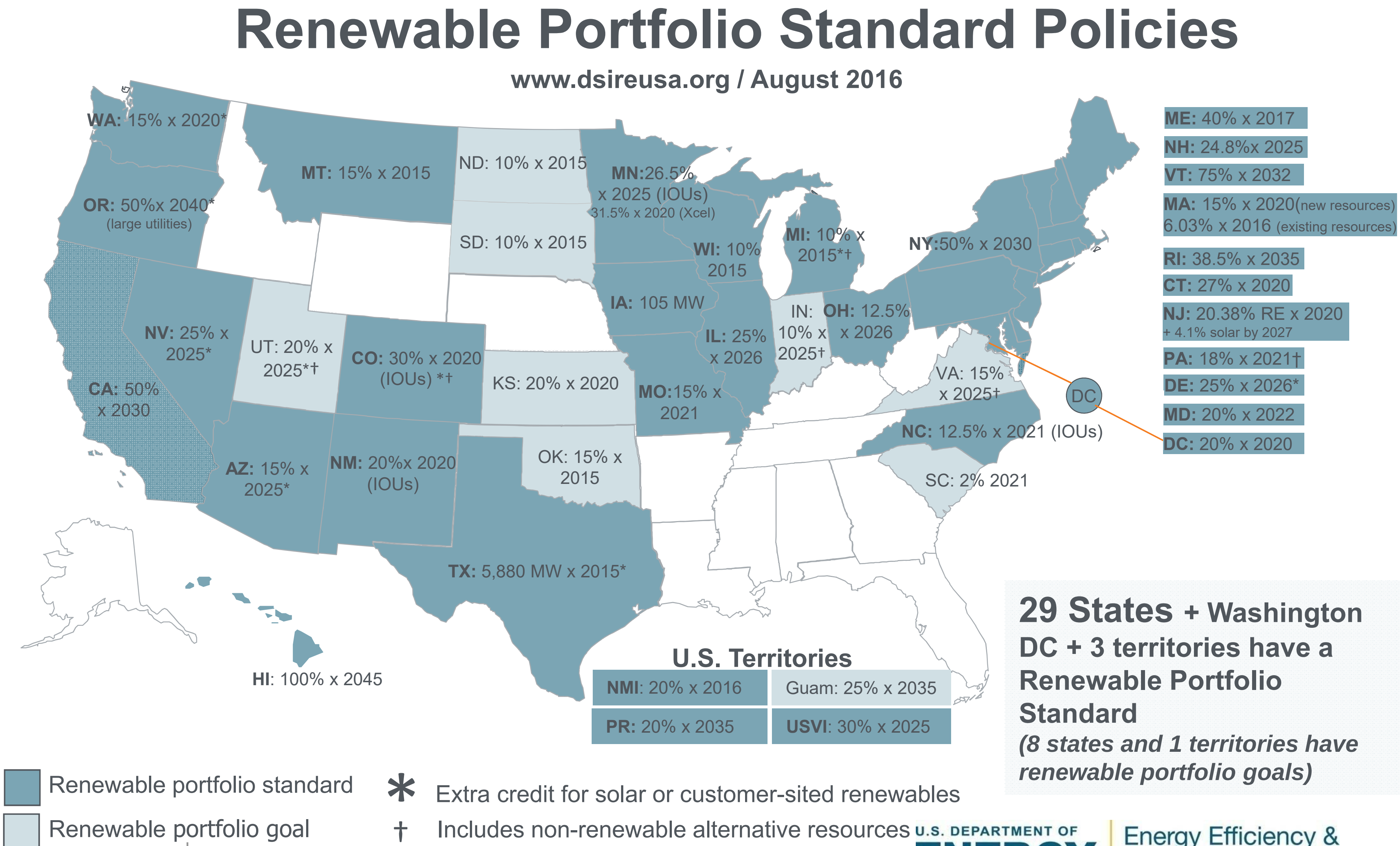
State Policy has also been essential to increased RE deployment



29 States + Washington DC + 3 territories have a Renewable Portfolio Standard

(8 states and 1 territories have renewable portfolio goals)

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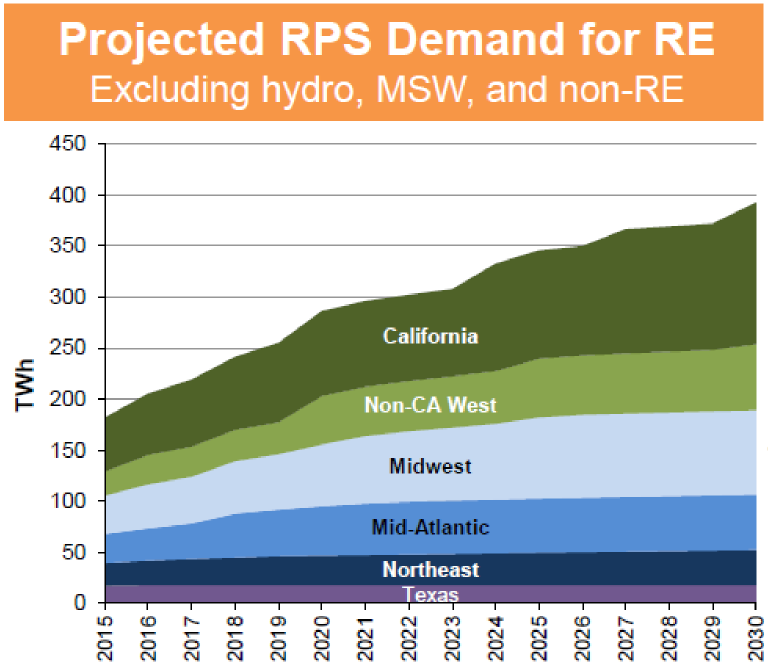
There is substantial remaining growth in existing RPS demand

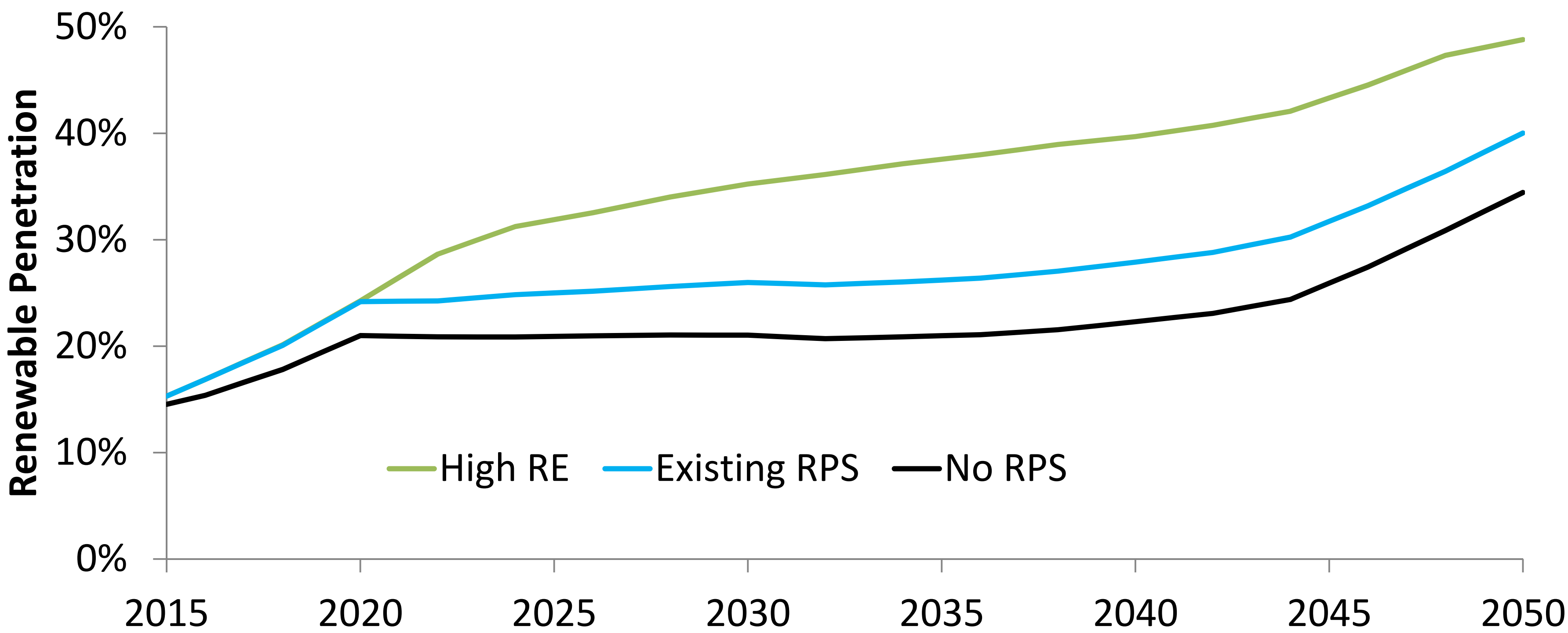


Notes: Projected RPS demand is estimated based on current targets, accounting for exempt load, likely use of credit multipliers, offsets, and other state-specific provisions. Likely contributions by hydro, municipal solid waste (MSW), and non-RE technologies are deducted from the totals for consistency across states. Underlying retail electricity sales forecasts are based on regional growth rates from the most-recent EIA Annual Energy Outlook reference case.

- Under current state targets, total U.S. RPS demand will increase from 215 TWh in 2015 to 431 TWh in 2030 (though RE-portion in figure is slightly lower: 393 TWh in 2030)
- California represents roughly 40% of that growth; most of the remainder associated with relatively large states

Source: Barbose, “U.S. Renewables Portfolio Standards, 2016 Annual Status Report,” 2016

More aggressive RPS targets could drive significant growth in RE deployment



- **No RPS**: no further growth in RPS requirements beyond 2015 and limited economic growth in RE
- **Existing RPS**: RPS requirements continue to grow based on existing state RPS policies as of July 2016
- **High RE:** nearly all states adopt an RPS with relatively aggressive targets.

Source: **Preliminary Report**, LBNL & NREL, *A Prospective Analysis of the Costs, Benefits, and Impacts of U.S. Renewable Portfolio Standards*, 2016 (forthcoming)

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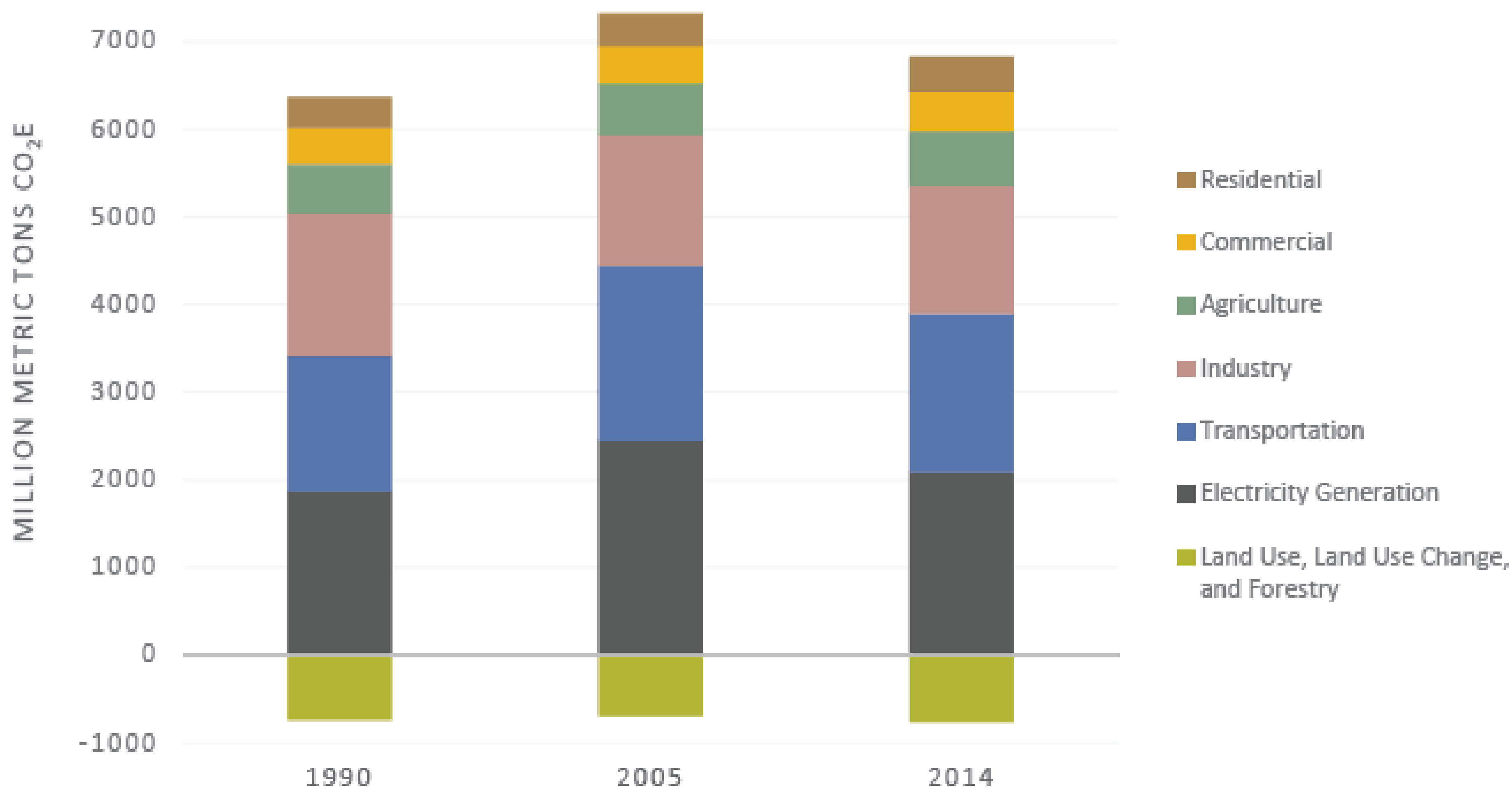
The challenge of clean energy deployment in the industrial sector

Deep energy transformation must include industry

White House Mid-century Strategy for Deep Decarbonization, 2016



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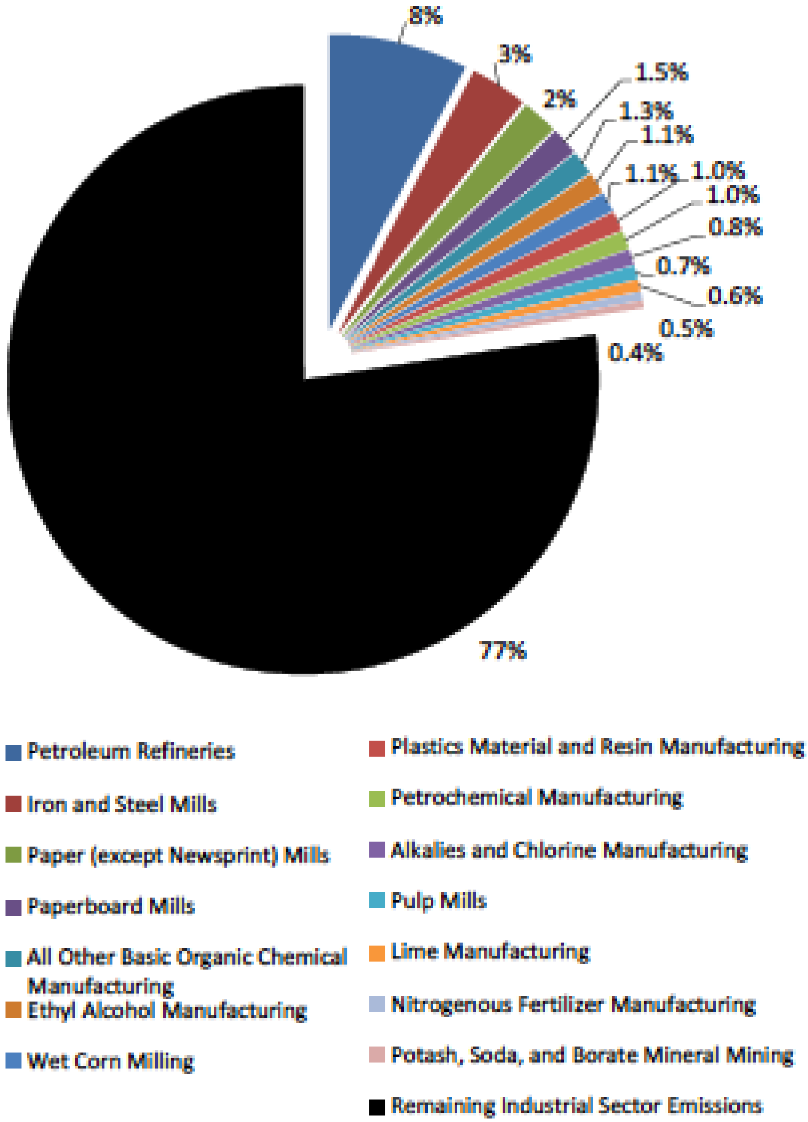
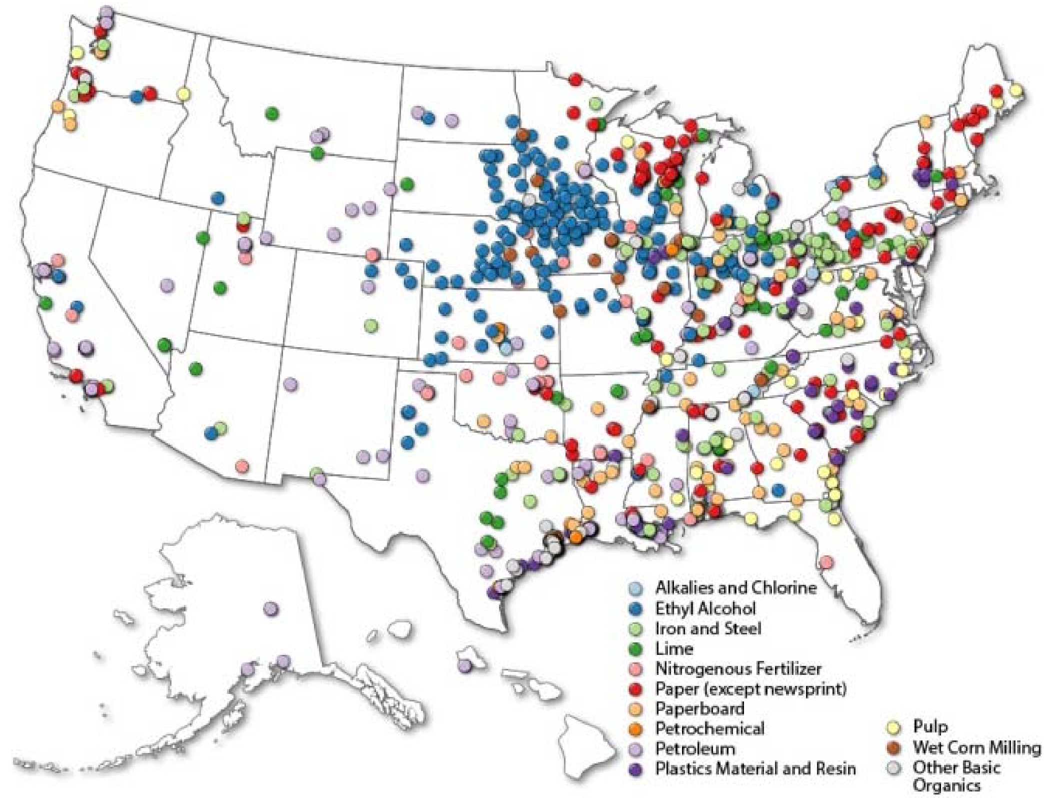
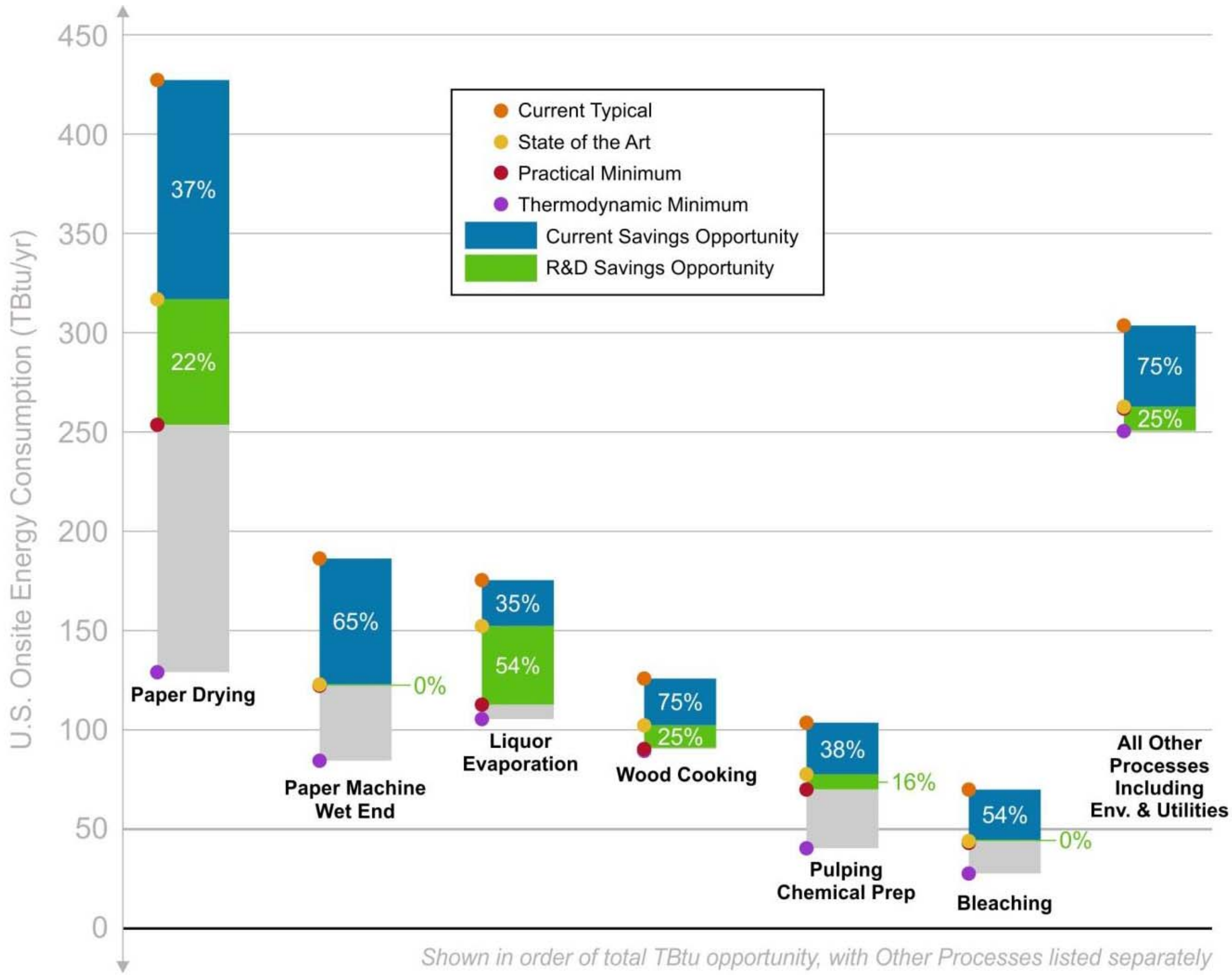
Diversity of industrial energy use makes this sector especially challenging





Generation and Use of Thermal Energy in the U.S. Industrial Sector and Opportunities to Remove its Carbon Emissions (McMillan, Boardman et al. INL-NREL, forthcoming)

Pulp & Paper: Current and R&D Energy Savings Bandwidths



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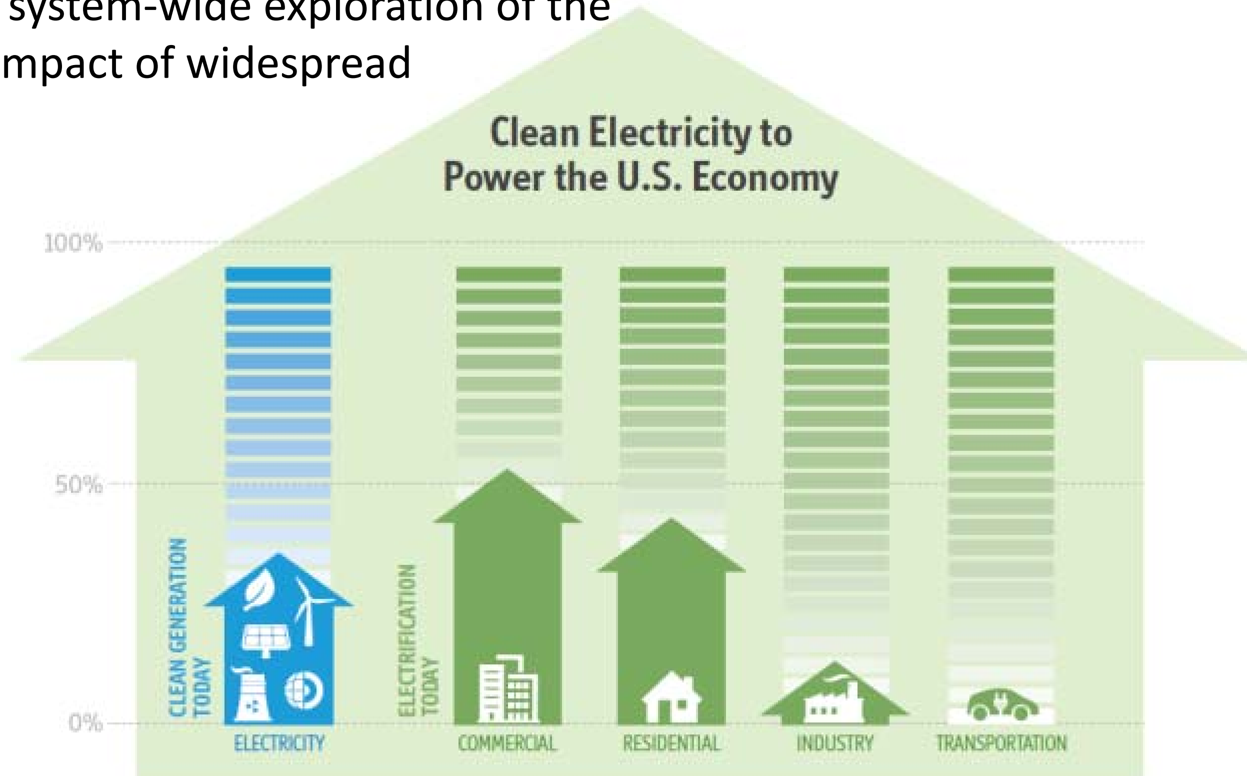
Forthcoming project: Potential for Widespread Electrification to Reduce Unwanted Pollution (POWER-UP) Study – www.nrel.gov/analysis/power-up.html

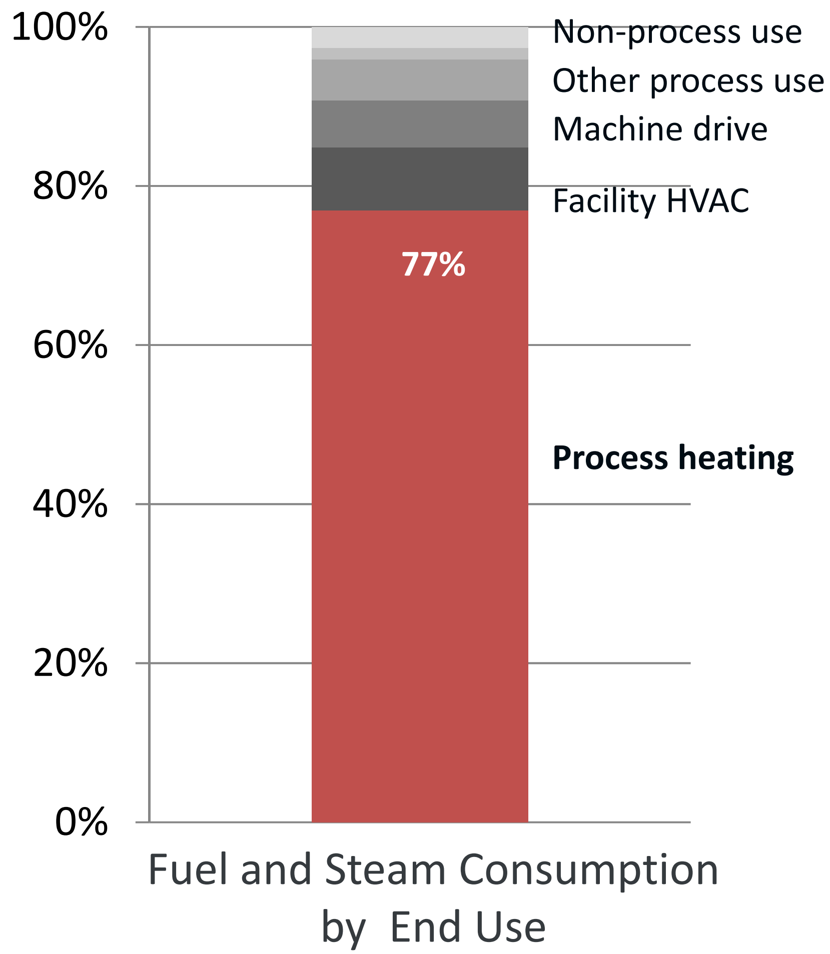
Goal: Detailed system-wide exploration of the potential and impact of widespread electrification



1. What **end-use services** are the best candidates for **electrification** and how might adoption barriers be overcome?
2. How might mass electrification impact national and regional **electricity consumption and consumption patterns**?
3. How would the U.S. **electricity system transform** to meet the growing consumption needs from mass electrification and, at the same time, decarbonize?
4. How would a decarbonized grid operate to serve an electrified economy and what role might **demand-side flexibility** play to support reliable operations?
5. What impacts would this pathway have for GHG emissions, consumer costs, and other environmental, public health, and social implications?

But many industrial resources are hard to electrify

The largest source of industry GHGs is associated with fossil fuel combustion for process heating



Alternative heat supplies could include:

- Geothermal
- Solar industry process heat
- Small nuclear reactors
- Biomass
- Hydrogen

Data source: U.S. DOE. 2015. "Manufacturing Energy and Carbon Footprints (2010 MECS)"

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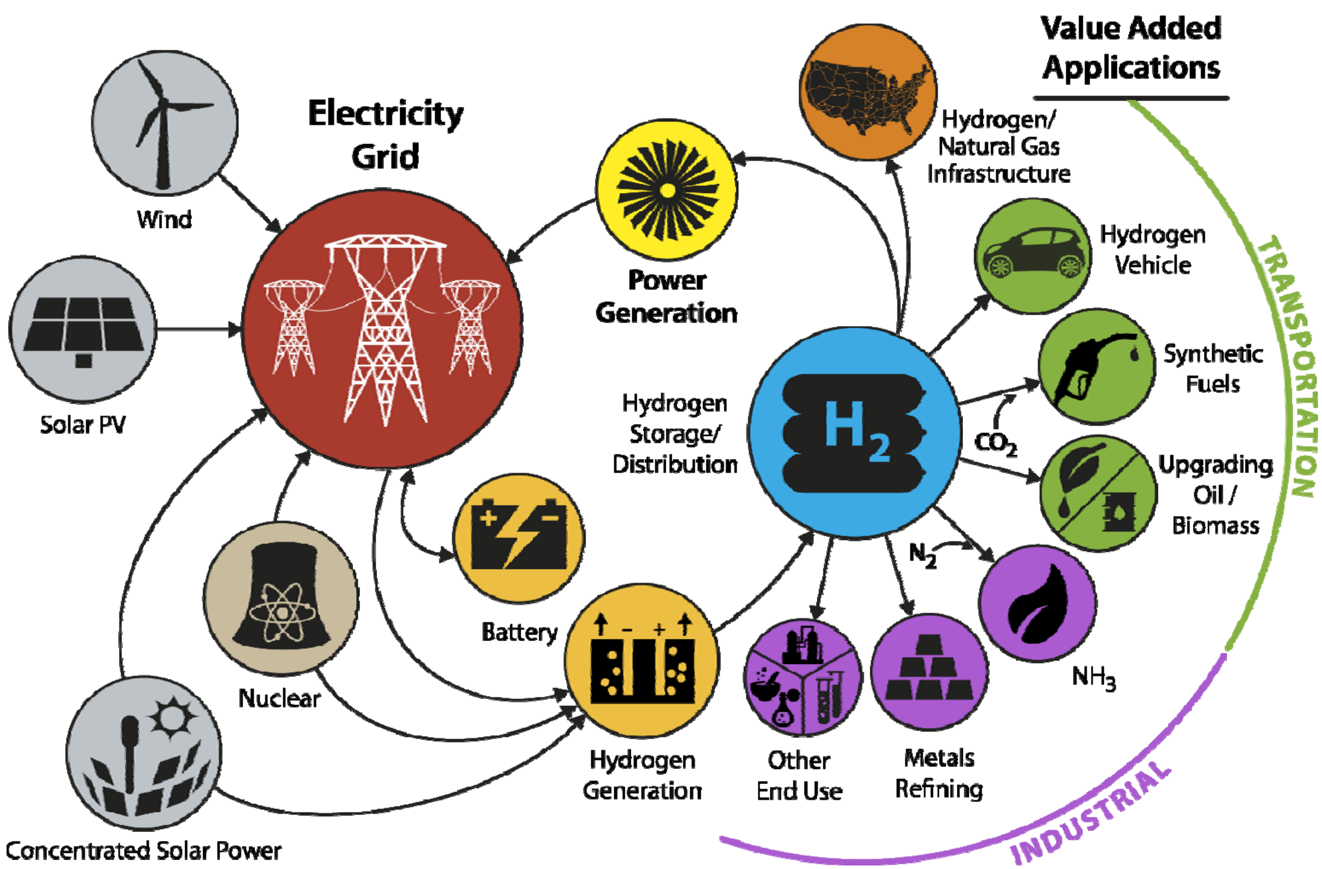
Conceptual H_2 at Scale Energy System

RE Grid plus battery storage



*Illustrative example, not comprehensive

Thank You!

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