ACEEE HWF 4D

Deep Decarbonization in the Pacific Northwest

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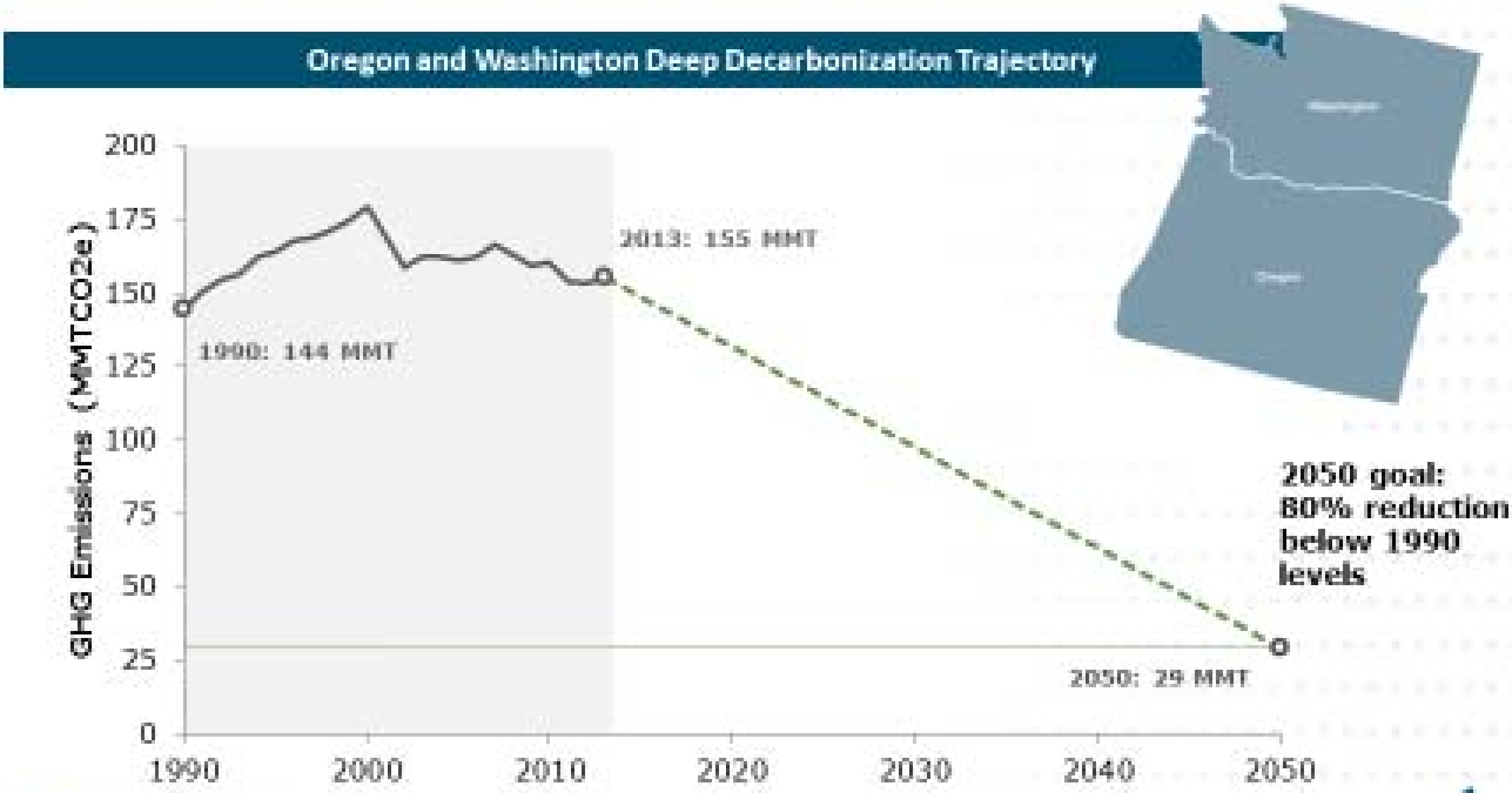
NW Natural®

NW Natural asked E3 to evaluate scenarios to achieve deep decarbonization in PNW

- **Oregon and Washington are taking steps reduce emissions, but exactly how deep decarbonization will be achieved remains uncertain. This study evaluates different strategies to achieve an 80% reduction in greenhouse gases (GHGs), aka deep decarbonization by 2050.**



OUR WHY

We believe there is a climate imperative

NW Natural has an important role to play in a smart and affordable Northwest climate strategy

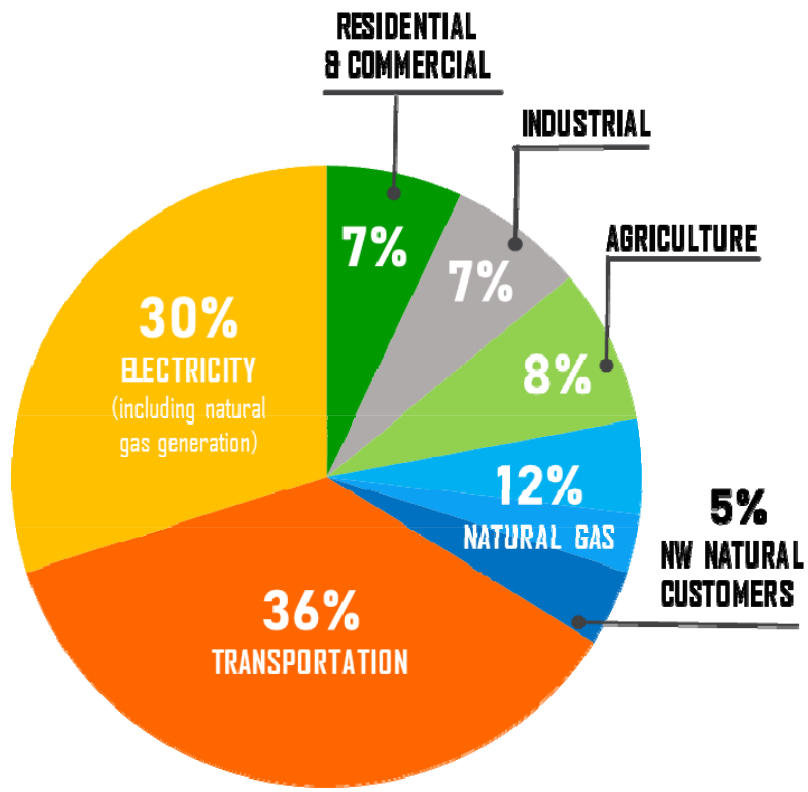
OUR OBJECTIVES:

1. Long-term goal of deep decarbonizati on that leaves no one behind.
2. Reduction opportunities take advantage of the infrastructure in place.
3. Lead the way on natural gas innovations and share broadly for larger impact.

WHAT IS OUR STARTING POINT?

NW Natural's system is highly efficient.

- Our system is one of the most modern in the U.S., thanks to aggressive pipe replacement
- On the coldest mornings of the year, natural gas meets 90% of our customers' household energy needs
- The gas used by our residential and commercial customers accounts for 5% of the state's annual GHG emissions



OREGON 2015 DEQ
IN-BOUNDARY GHG INVENTORY

LOW CARBON PATHWAY
HELPING REGION ACHIEVE CLIMATE GOALS

OUR PRODUCT	OUR CUSTOMERS	TRANSPORTATION
REDUCE CARBON INTENSITY	REDUCE AND OFFSET CONSUMPTION	REPLACE MORE CARBON INTENSIVE FUELS
NW NATURAL OPERATIONS UPSTREAM METHANE REDUCTION RENEWABLE NATURAL GAS POWER TO GAS (hydrogen pathway)	ENERGY EFFICIENCY SMART ENERGY (voluntary offsets) GAS + RENEWABLE HYBRID EQUIPMENT (solar thermal)	CNG AND RNG SERVE TRASH TRUCKS AND RETURN-TO-BASE FLEETS

NW NATURAL STUDY

Study Completed by Energy+Environmental Economics

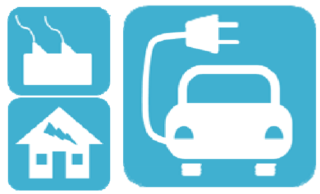
To achieve deep decarbonization, broad changes will be required across the economy	✓ Vehicle Electrification ✓ Aggressive Energy Efficiency ✓ Technological Innovation ✓ Development of biofuels
Builds upon recent similar studies	✓ Examines energy needs on the coldest days of the years, especially critical for utility system planning ✓ The role the direct use of gas plays in our region's energy portfolio
All pathway scenarios use natural gas	✓ The key difference is how gas is utilized (peaker plants vs. direct use)

Significant mitigation efforts are required across all sectors in all scenarios

- **All scenarios include some measures from each pillar**

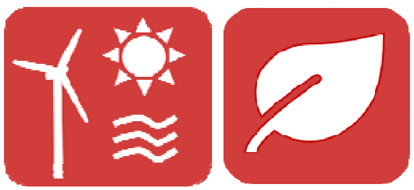
Energy efficiency & conservation

- ✓ Smart-growth driven VMT reductions
- ✓ Whole-home retrofits & new construction codes
- ✓ Electric heat pumps displacing resistance heat



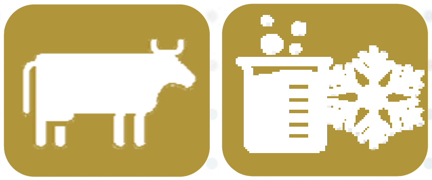
Electrification

- ✓ Electrification of industry OR buildings
- ✓ Electrification of passenger vehicles
- ✓ Electrification of trucks and freight transportation



Low-Carbon Energy

- ✓ Low-carbon electricity
- ✓ Low-carbon biofuels
- ✓ Potentially renewably produced hydrogen



Reduce non-combustion GHGs

- ✓ Methane reductions
- ✓ Replacement of high global warming potential gases
- ✓ Industry process emissions reductions

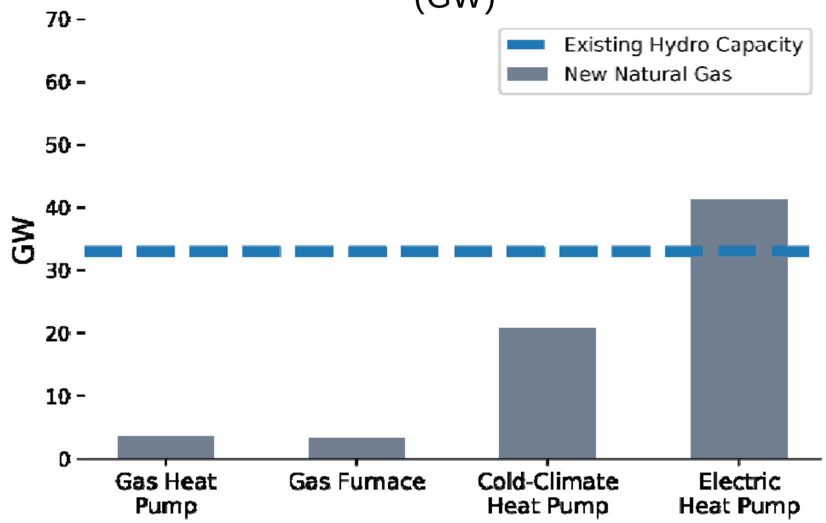
Scenarios vary based on level of electrification, low-carbon fuels & renewable electricity

2050 metrics	Gas Furnaces Scenario	Natural Gas Heat Pumps Scenario	Electric Heat Pumps Scenario	Cold Climate Heat Pumps Scenario
	Gas in Buildings Scenarios		Electrification in Buildings Scenarios	
Share of natural gas space- and water heating electrified	0%	0%	96%	96%
Industry electrification (fuel-switching % of total industrial energy)	30%	30%	5%	5%
Zero-carbon electricity	97%	97%	95%	95%
Share of available biofuels used	100%	97%	73%	73%
Hydrogen mix in pipeline	7%	0%	0%	0%

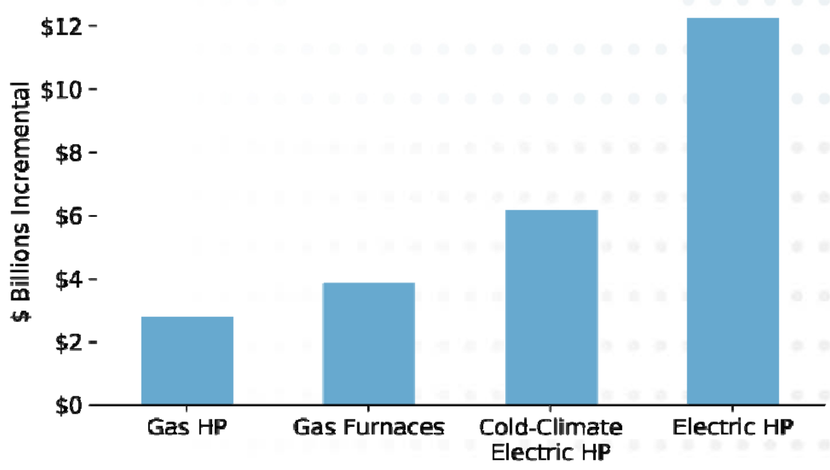
By 2050, incremental gas capacity is 5-10 times higher in electric heat pump scenarios compared to gas scenarios

- Electric scenarios include 17 – 37 GW of new gas capacity by 2050 to serve winter space heating peaks (at 1-in-10 winter temperatures)
- Additional electric sector costs are $3B - $9.5B in 2050 in electric heat pump scenarios, relative to gas heat pump scenario
- Energy storage could display some of this new gas capacity, but more detailed reliability analysis of storage as a winter peak solution is needed

2050 incremental gas capacity
(GW)



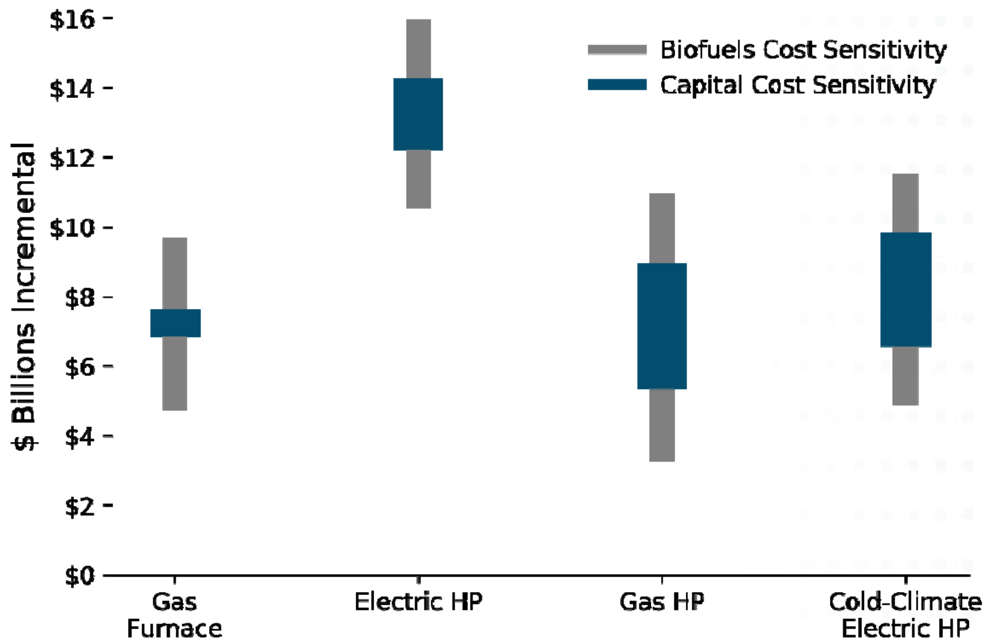
2050 electricity sector cost
relative to Reference ($ Billions)



Economy-wide scenario costs in 2050 are similar for three scenarios, electric heat pump scenario is highest cost due to winter peak capacity need

- **The 2050 economy-wide scenario costs range from $3 - $16 billion / year in 2050, relative to Reference scenario**
  - Equivalent to ~1% of projected 2050 regional Gross Domestic Product
- **Cost forecasts are uncertain and sensitive to assumptions about technology costs for building heat equipment and biofuel prices**

Total Annual Scenario Cost in 2050
($ Billions, incremental to Reference)

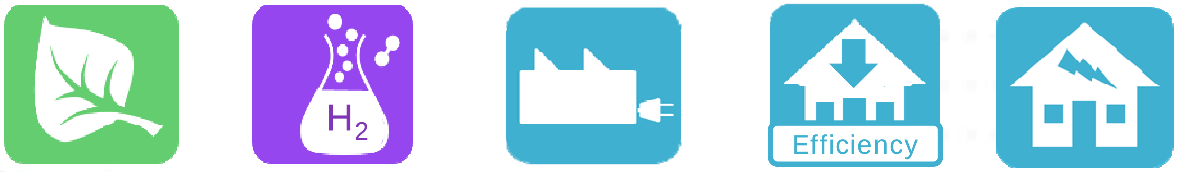


Study findings (1 of 2)

- **There are multiple pathways in the Pacific Northwest to achieve deep decarbonization with different strategies in buildings; Each faces significant challenges and risks**

- **Maintaining gas heat in buildings requires:**
  - RD&D and commercialization of advanced renewable natural gas (also used in the electrification scenarios but RNG is less pivotal in those cases)
  - Either natural gas heat pumps or hydrogen blended into the pipeline
  - Additional sources of GHG mitigation in other sectors (e.g. industrial electrification)

- **Retrofitting to electric heat in buildings requires:**
  - Rapid consumer adoption, major building retrofits, and market transformation of cold climate electric heat pumps
  - Expansion of the electricity system to accommodate winter peak demand, e.g. new gas peaking power plants and/or storage. Ensuring winter peak reliability is a key challenge



Study findings (2 of 2)

- **Northwest electric demands are already at their highest in the winter; this means that new electric space heating loads require additional peak capacity**
- **Winter peak needs continue to be met mostly with gas in all of the decarbonization scenarios through 2050, with:**
  - Gas-fired electric generation (could be partly displaced by energy storage, though reliability of storage is less certain), or
  - Direct use of gas
- **Widespread deployment of electric heat pumps leads to 5 – 10 times increase (17,000 – 37,000 MW) in winter peak electricity demands, relative to gas scenarios**
  - This increase is compared to the entire hydroelectric system of ~33,000 MW
- **Total economy-wide scenario costs in 2050 are similar between scenarios given uncertainties, with the exception of the non-cold climate electric heat pump scenario. That scenario is the most expensive due to the cost of serving winter peak demand.**

RESOURCES

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Pacific Northwest Pathways to 2050
Pathways summary
www.lesswecan.com

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