Decarbonizing the Northwest

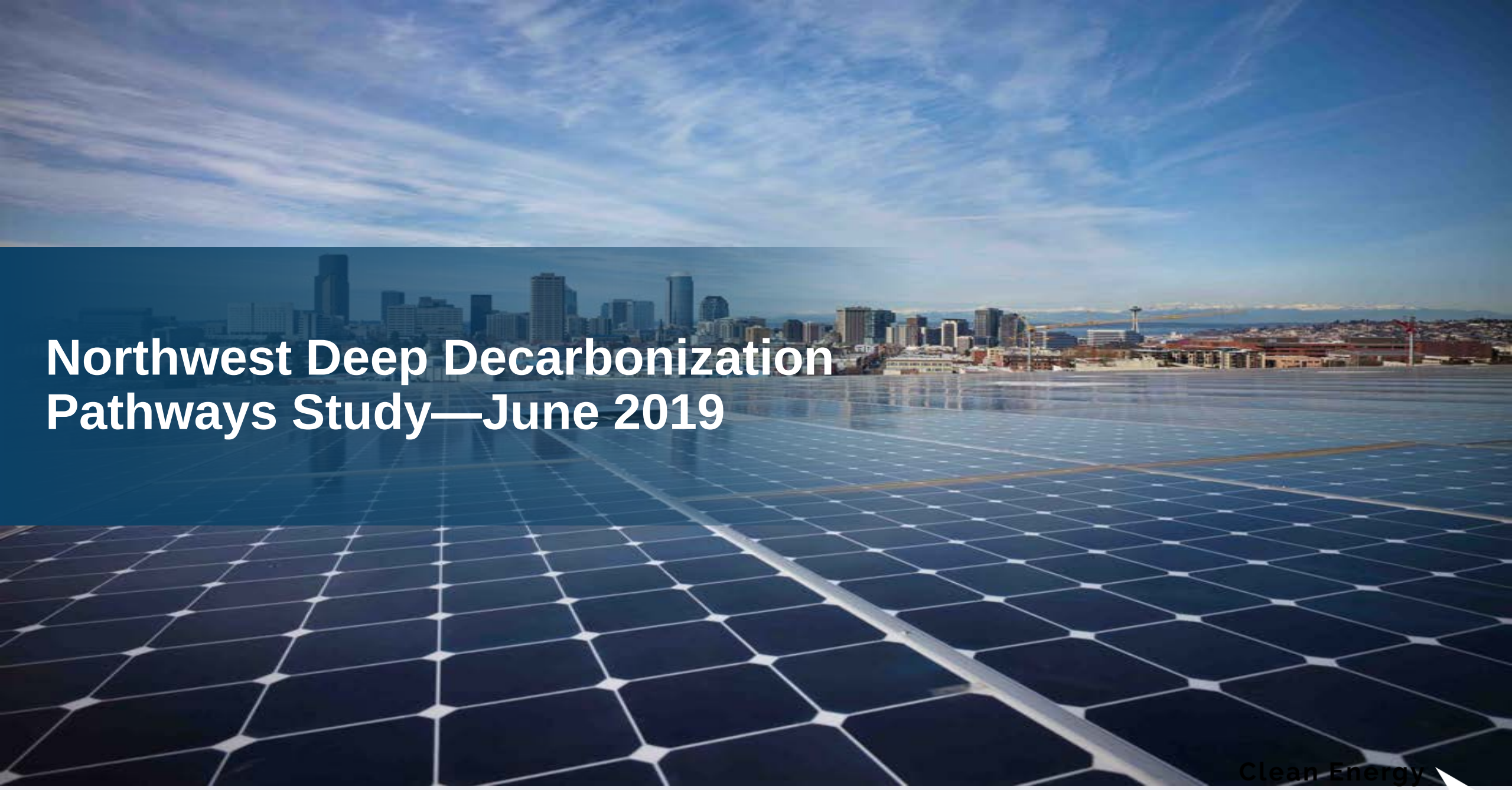
- Eileen V. Quigley—EPA Region 10—April 15, 2021

Agenda

- Clean Energy Transition Institute
- Northwest Deep Decarbonization Pathways
- Washington 2021 State Energy Strategy
- Montana Climate Solutions Council
- Oregon Clean Energy Pathways
- Questions and Answers

Clean Energy Transition Institute

- **What We Are:** Independent, nonpartisan Northwest research and analysis nonprofit organization
- **Our Vision:** Accelerate the transition to a clean energy economy in the Northwest
- **Our Role**:
  - Provide unbiased research and analytics on the pathways to a clean energy economy
  - Offer an information clearinghouse of fact-based analysis for policymakers
  - Convene diverse stakeholders to address the opportunities, risks, and trade-offs of carbon emission-reduction approaches



Northwest Deep Decarbonization Pathways Study—June 2019

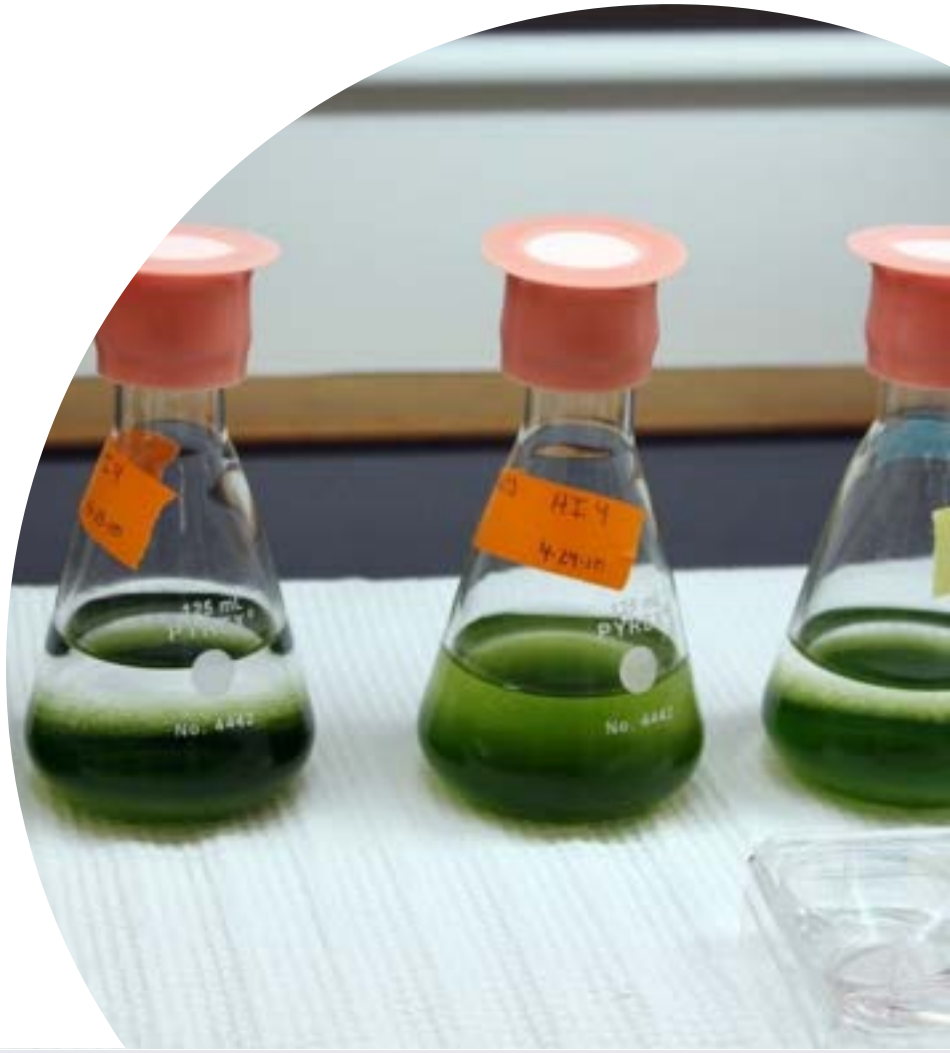
Why a Northwest Deep Decarbonization Study?

Common set of assumptions to inform decisions about how the clean energy transition could unfold over the coming decades

- Unbiased, analytical baseline for the region
- Variety of pathways to lower carbon emissions
- Surface trade-offs, challenges, and practical implications of achieving mid-century targets
- Broaden conversations about actions needed

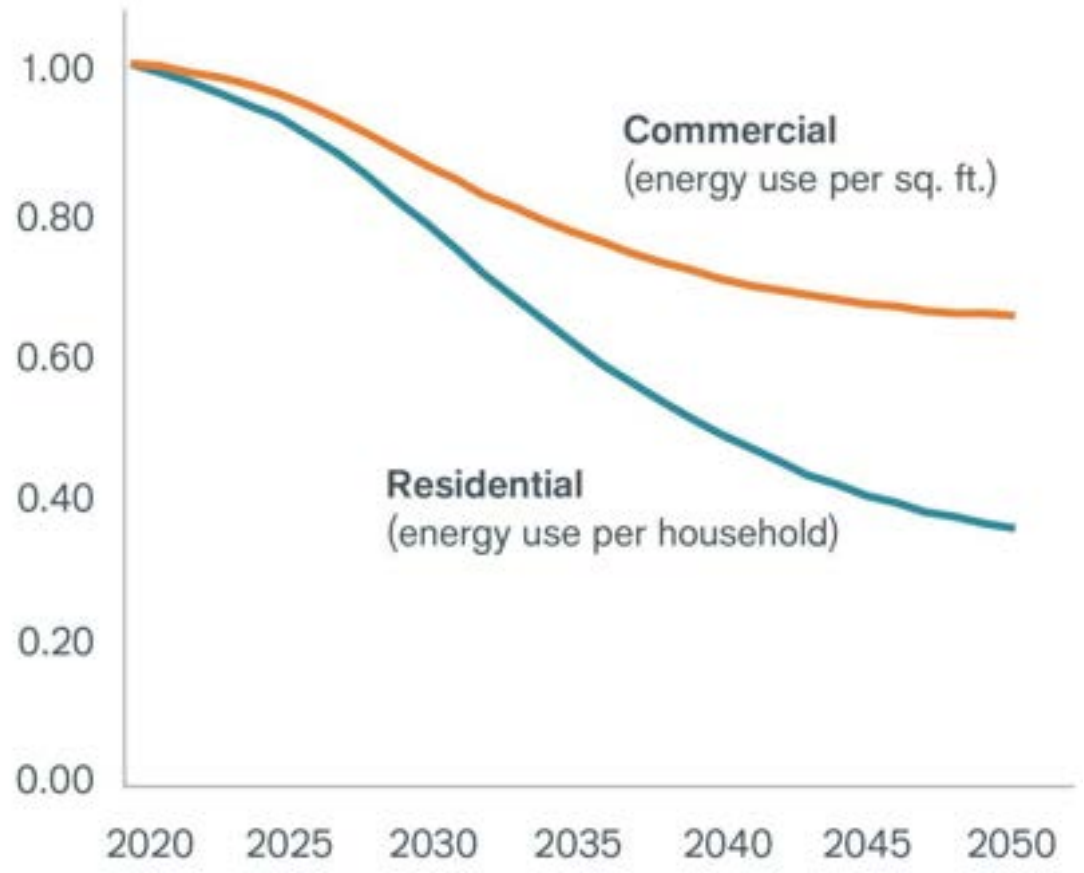
NWDDP Study Questions

- **How does the energy sector need to transform** in the most technologically and economically efficient way?
- **How does electricity generation need to be decarbonized** to achieve economy-wide carbon reduction goals?
- **What if we can't** achieve high electrification rates?
- **What is the most cost-effective use** for biomass? What if biomass estimates are wrong?
- **What would increased electricity grid transmission** between the NW and CA yield?

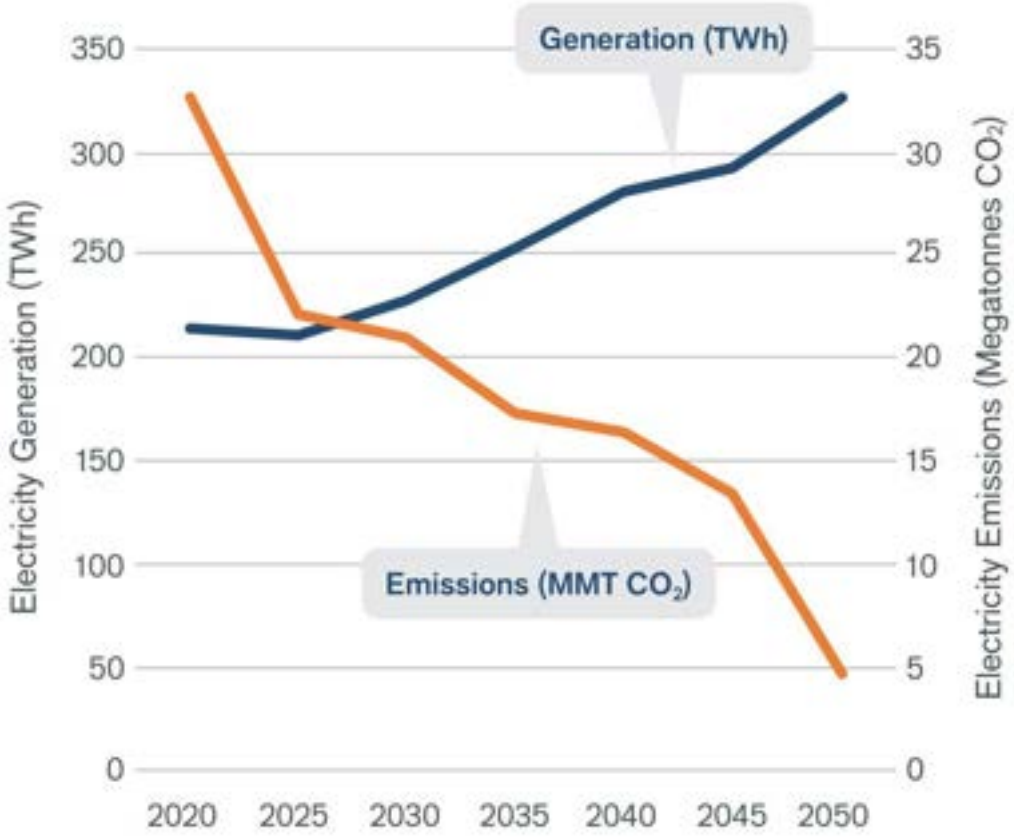


Deep Efficiency & Clean Electricity Fundamental Pillars

Building Energy Intensity (2020=1.0)

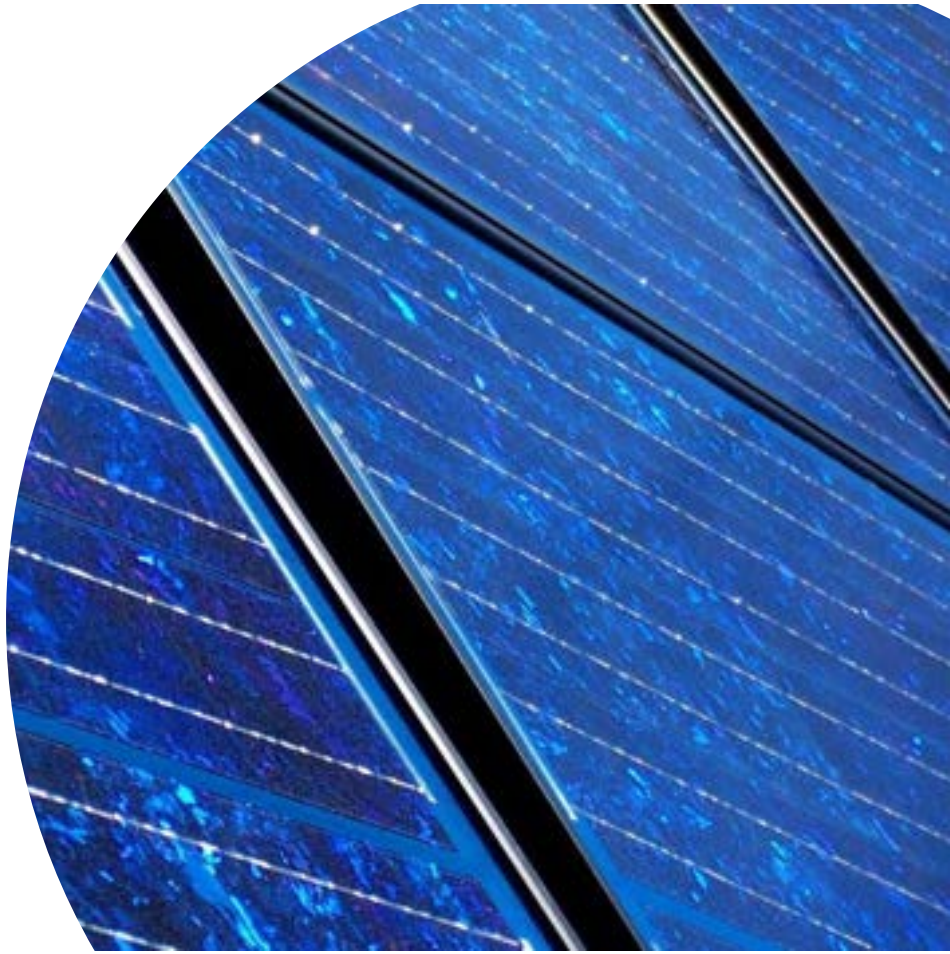


Generation increases 53%, emissions decline by 86%.



No One Solution to Economy-Wide Decarbonization

- **Electricity** generation must be **~96% clean**
- **A highly efficient built environment** powered by clean electricity
- **Aggressive electrification** powered largely by clean electricity for vehicles where possible
- **Thermal generation (natural gas) important for reliability and transition** but operates at low-capacity factor in 2050
- **Improved regional transmission** and integration
- **Biomass** allocated to replace jet and diesel fuel
- **Electric fuels** play an important role



Key Issues and Challenges the NWDDP Highlighted

- **100% Clean Grid**: How to deploy required renewables, transmission, storage, gas?
- **Reliability, Capacity & Resource Adequacy**: How to avoid outages with intermittent supply and variable demand?
- **Electrification**: How much, how fast? What happens to demand and how to manage it?
- **Affordability**: How to manage the cost impacts, overall and for different customer groups?
- **Business/Regulatory Models/Markets**: What is needed for the transition?

Equity and Workforce Implications

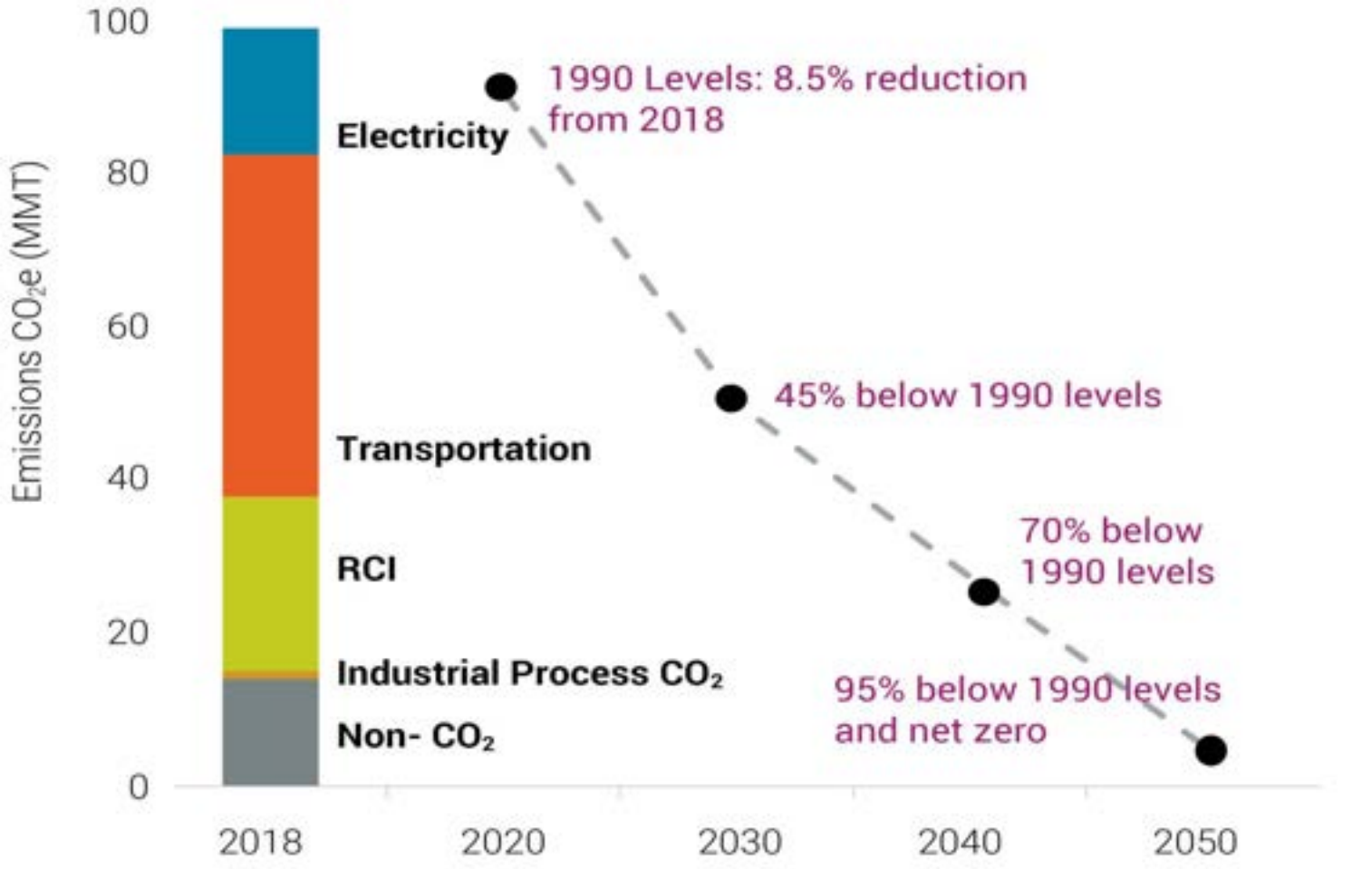
- Regional equity (rural vs. urban)
- Addressing existing environmental/racial justice inequities
- Who makes the decisions about cost distribution and who benefits?
- What jobs are gained, and which are lost?
- How are people compensated for loss?

Washington 2021 State Energy Strategy—December 2020

Washington State Legislature Direction

- Maintaining reasonable and **fair prices** and **sufficient supply** of energy
- Promoting a **competitive clean energy economy** and workforce development
- Understanding and addressing the needs of **low-income and vulnerable populations**
- Reaching and responding to both **urban and rural** communities

Transforming Washington's Energy System



Source: Washington State Department of Ecology and Washington State.
Appendix A –Deep Decarbonization Pathways Modeling Technical Report, December 11, 2020 (p. 15).

Washington State's 2030 Challenge:

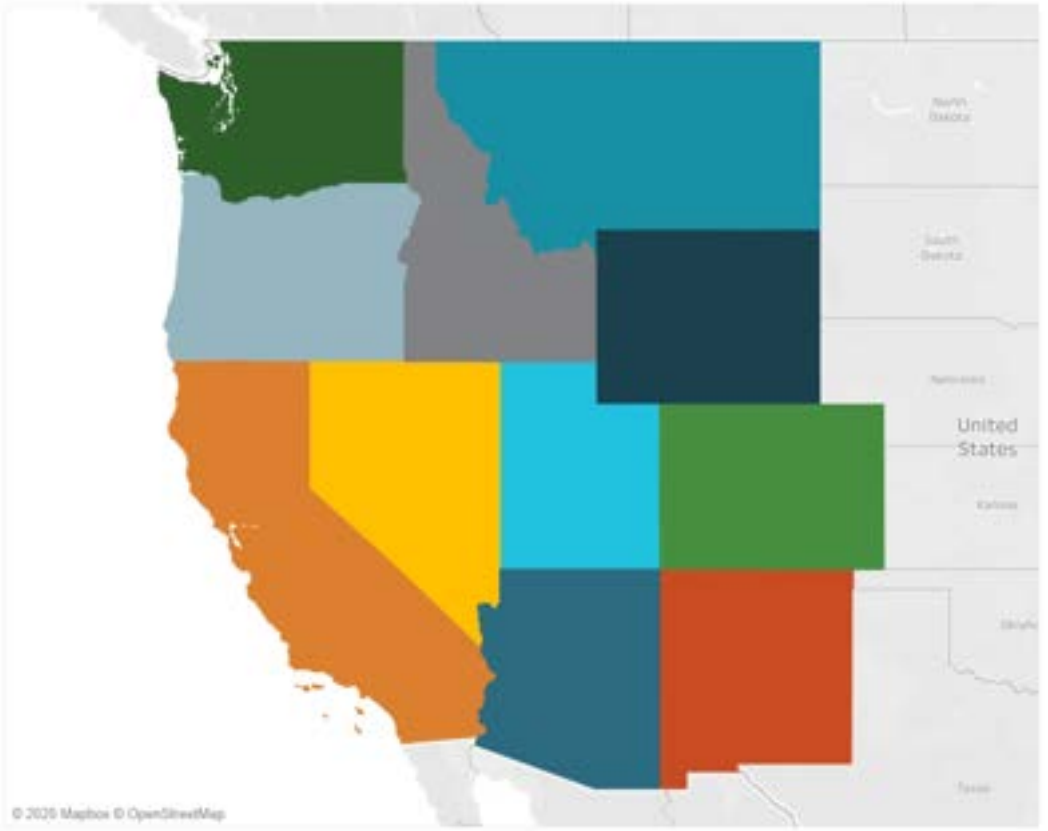
- ***53% Reduction in Emissions in less than a decade***

Washington 2021 State Energy Strategy Modeling Questions

- **What is the impact of rapid and aggressive electrification** of energy systems, assuming no technical constraints?
- **What if we don't** electrify transportation as quickly as in the aggressive electrification case?
- **What happens if we retain gas in** buildings instead of electrifying them?
- **What if transmission expansion is limited** due to siting or permitting challenges?
- **What if policies or behavior change** (i.e., more telecommuting after Covid) lowered demand?

Washington in the Context of a Western Grid

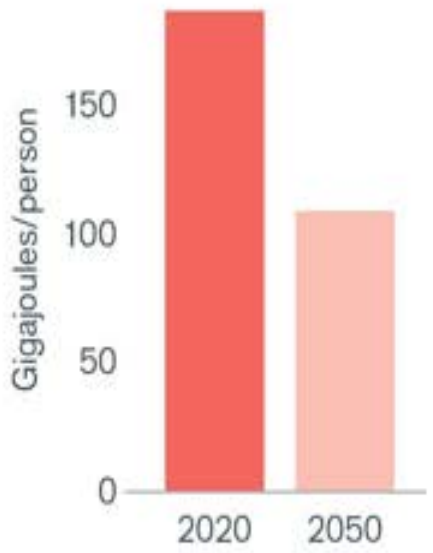
- Wholistic Approach
  - Integrated across geographies and economic sectors
- Regional Representation
  - Other state's actions impact the availability and cost of solutions
  - 11 Western states
- Remainder of the U.S. also modeled



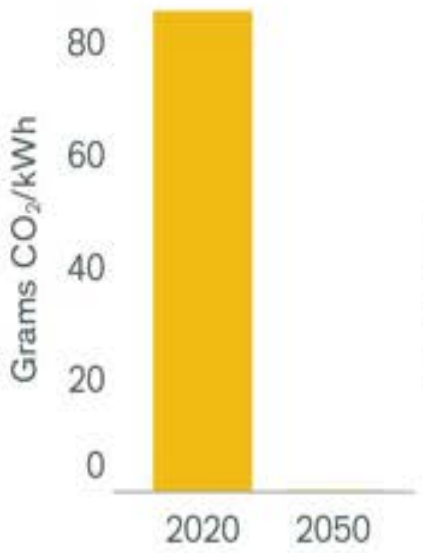
Sector Results and Strategies

Five Pillars of Deep Decarbonization-Washington State

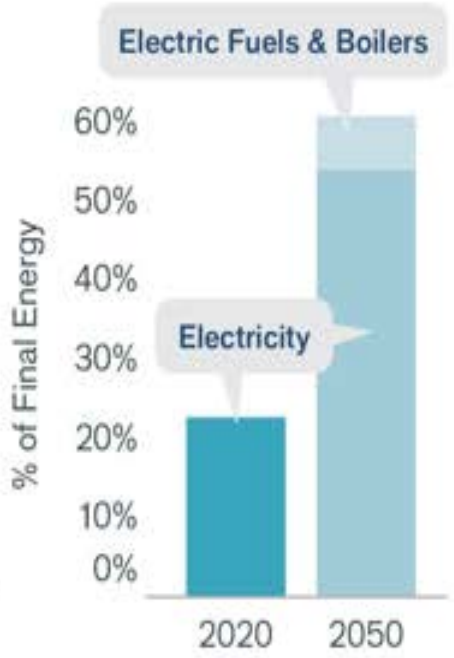
Energy Efficiency
Energy Consumption
(Gigajoules/person)



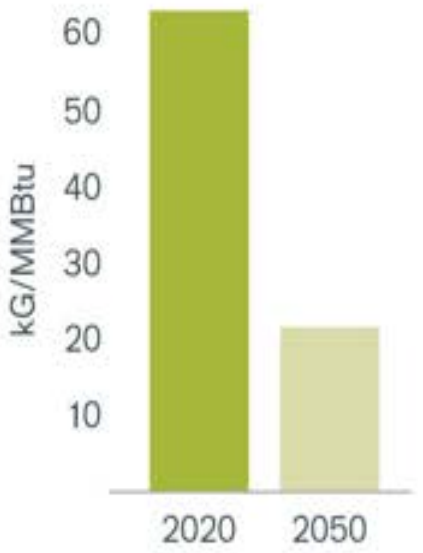
Clean Electricity
Electricity Carbon Intensity
(Grams CO_2 per kWh)



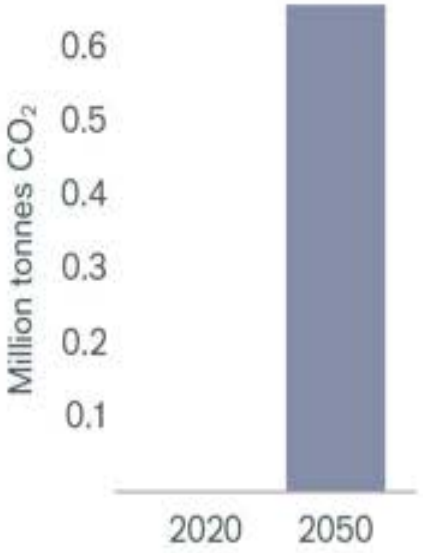
Electrification
Electricity Share of Total Energy
(% of Final Energy)



Clean Fuels
Fuels Carbon Intensity
(kG/MMBtu)



Carbon Sequestration
(Million tonnes CO_2)



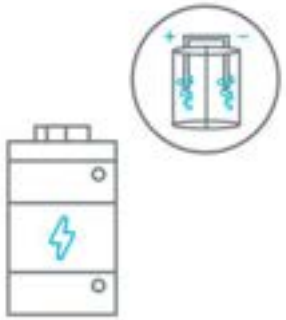
Clean Electricity

97%
growth in electricity end use demand over 2020 levels by 2050

43%
of electricity imported by 2050

36%
from WY & MT wind

100%
renewable/non-emitting electricity by 2045



19%
of total electricity demand from electric boilers and electrolysis by 2050

Clean Transportation

43%
improved vehicle efficiency by 2050

100%
electric vehicle sales by 2035

HEAVY DUTY VEHICLE STOCKS
majority electric and hydrogen by 2050

NEARLY 100%
electric vehicle stock by 2050

All transportation fuels
100%
decarbonized by 2050

Clean Buildings

NEARLY **100%** building stock electrified by 2050

84% less pipeline gas used for residential heating in 2050

ENERGY EFFICIENCY reduces building energy load by 26% in 2050

64% electric water heating in **2030**

100% electric water heating in **2050**

64% electric space heating in **2030**

82% electric space heating in **2050**

26%

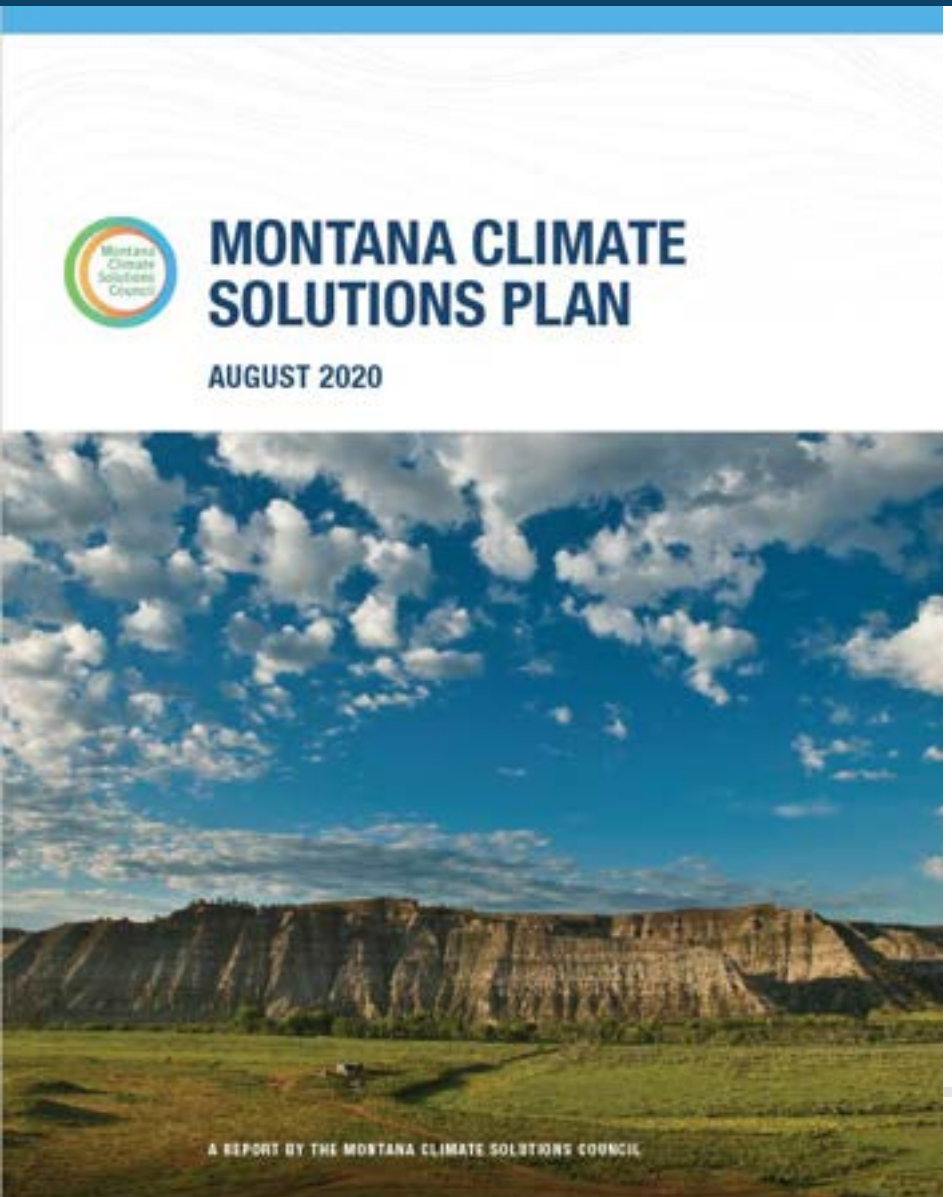
Low-Carbon Industry Sector

Implications for Washington State

- **To Meet the State's 2030 GHG Targets**
  - Deep energy efficiency to reduce energy use
  - Clean electricity grid by 2030
  - Electrifying as many energy end uses as practical
  - Accelerating clean fuels industry critical
  - Regional approach required

Montana Climate Solutions Council
September 2020

Montana Deep Decarbonization Modeling



- Presented NWDDP results to MT. Gov. Bullock's Climate Solutions Council
- Worked with Governor's team to model Montana-specific results
- Incorporated into the Montana Solutions Plan
- Announced September 9, 2020

Oregon Clean Energy Pathways January-May 2021

Oregon Clean Energy Pathways Study Purpose

- Study to examine technical and economic implications of accelerating decarbonization in Oregon
- Study not aimed at determining specific policies
- Results intended to inform development of policies

EVOLVED ENERGY RESEARCH

RENEWABLE NORTHWEST

GridLAB

Questions for Consideration

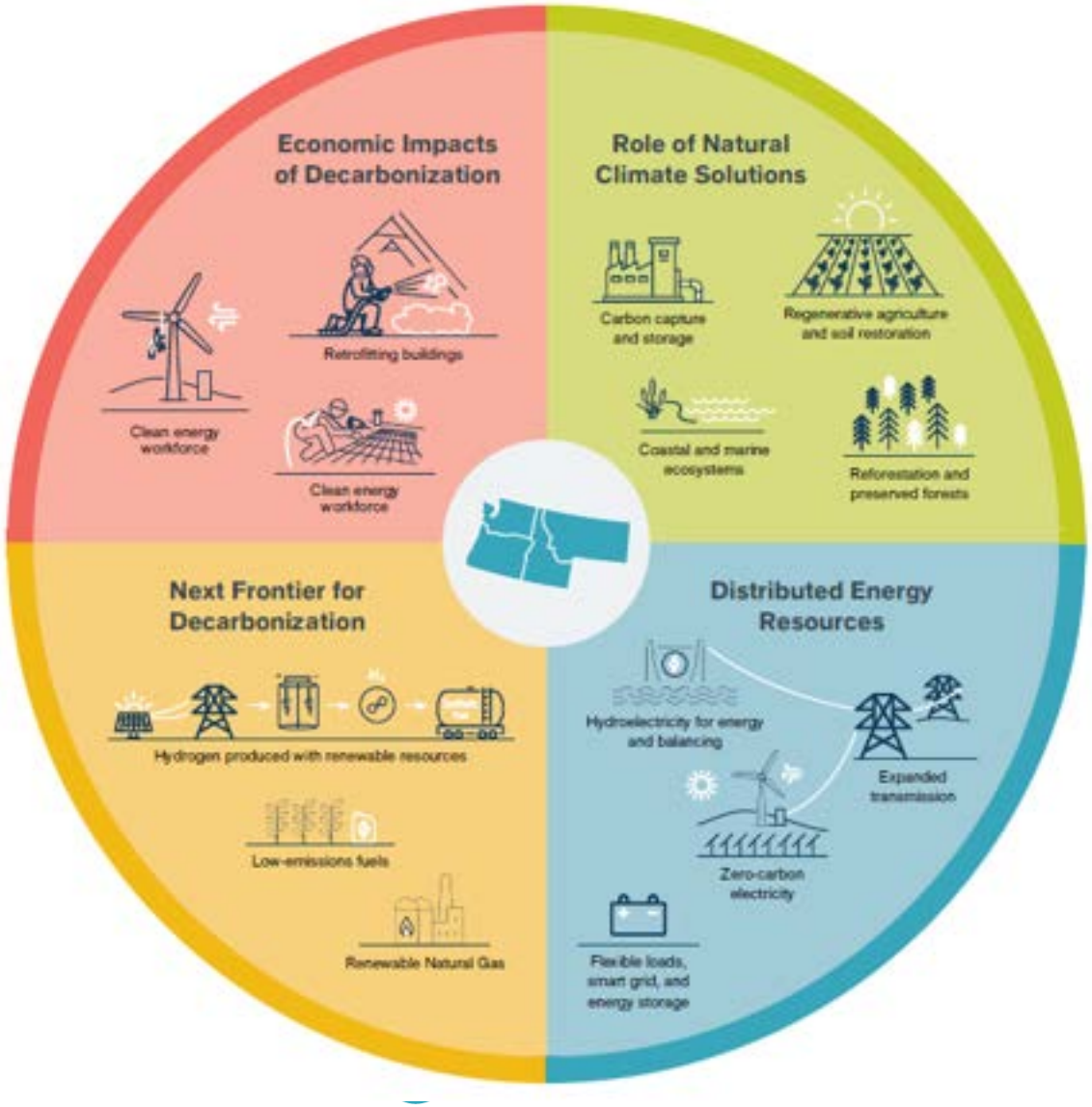
- What if Oregon had an **economy-wide net-zero emissions** target?
- What if **siting/permitting constraints** limit grid-scale renewables?
- What if existing **transmission networks can't be expanded** in the West?
- What if Oregon had to meet its emissions and clean electricity targets **only with in-state resources**?
- What emissions target could be set to achieve Oregon's climate policy goals **while minimizing economic impact**?

Clean Energy Transition Institute 2021 Programs

2021 Current Programs

- **Oregon Clean Energy Pathways Modeling**
  - NWDDP model test clean energy standards and emissions reduction targets for Oregon
- **Decarbonizing Buildings with Equity Focus**
  - Research and pilot project equitable rural building decarbonization (Seattle Foundation/Bullitt Foundation)
- **Northwest Clean Energy Atlas**
  - Data visualization software to create interactive dashboard of decarbonization solutions in the Northwest (Tableau Foundation)
- **WA Department of Commerce**
  - Industrial emissions analysis, modeling, comms

Areas for Investigation



- Economic Impacts
  - ✓ Decarbonization impacts on employment and on low- and moderate-income people
- Role of Natural Climate Solutions
  - ✓ Sequestration potential of agriculture, soil, forests, marine/wetland habitats
- Distributed Energy Resources
  - Evaluating role of community-based energy
- Next Frontier for Decarbonization
  - Solutions for industrial process emissions and natural gas

Discussion

- Questions & Answers

Thank you very much!

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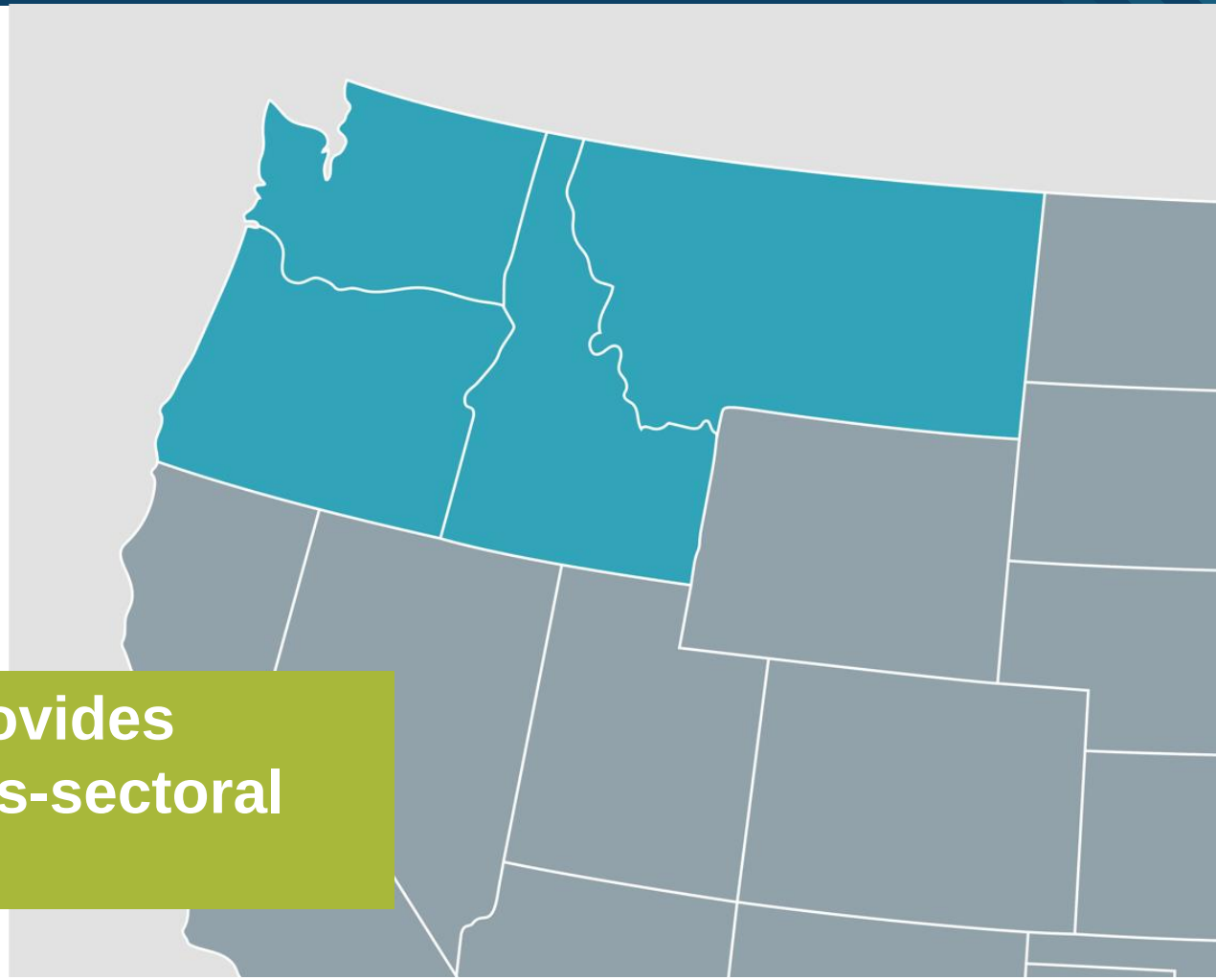
Appendix

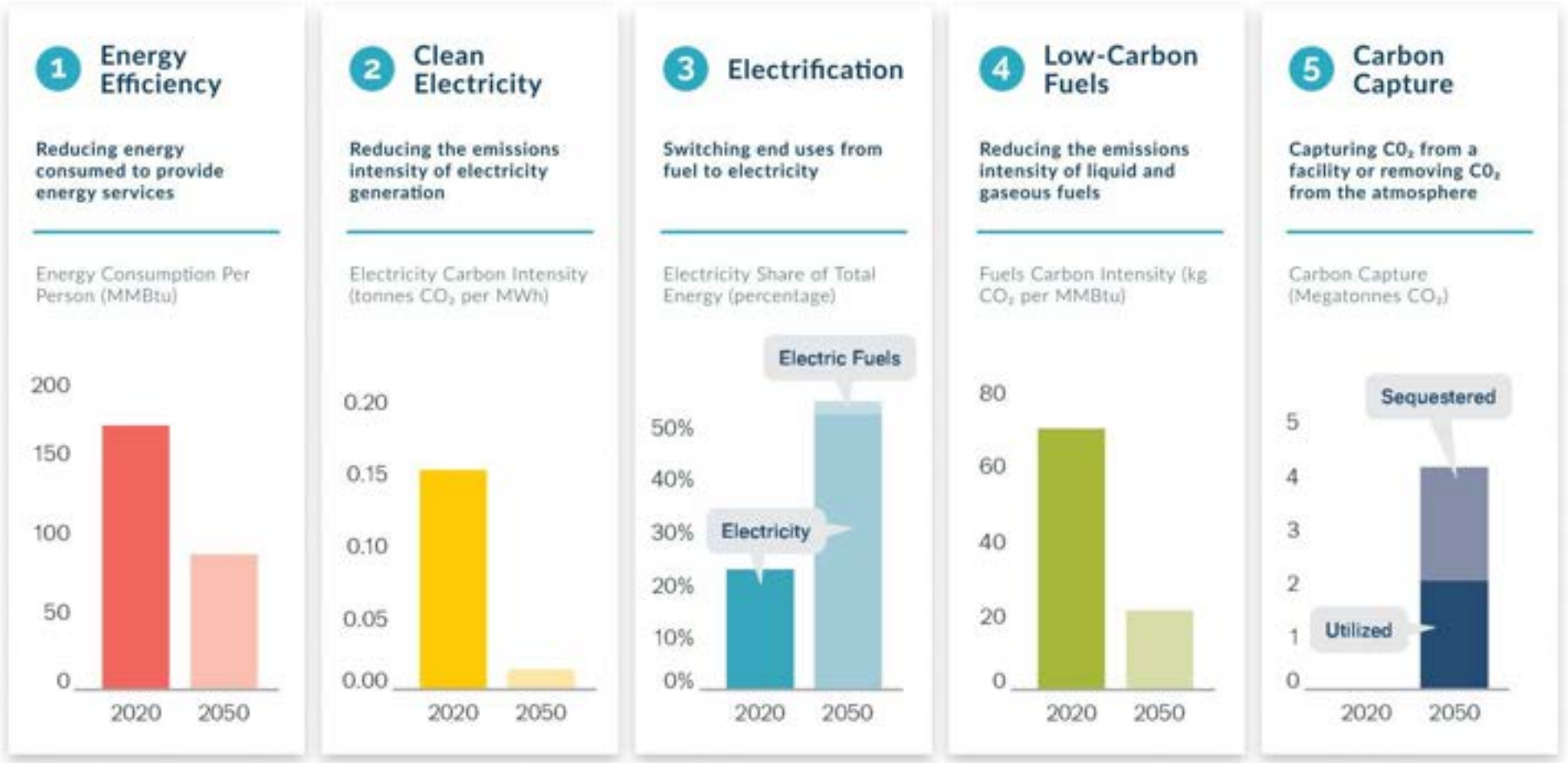
Northwest Deep Decarbonization Pathways (NWDDP) Scope

- **Scope:** WA, OR, ID, MT
- **All Energy Sectors Represented:**
  - Residential and commercial buildings
  - Industry
  - Transportation
  - Electricity generation

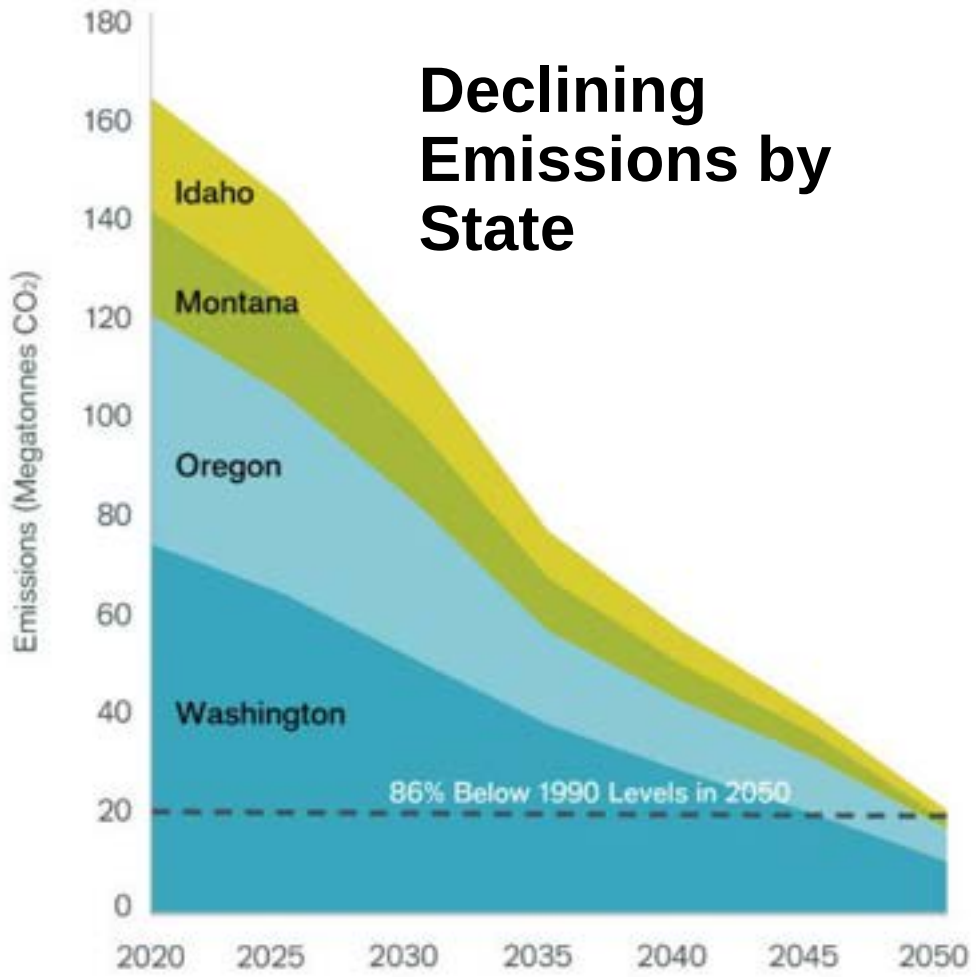


Evaluating holistically provides an understanding of cross-sectoral impacts and trade-offs

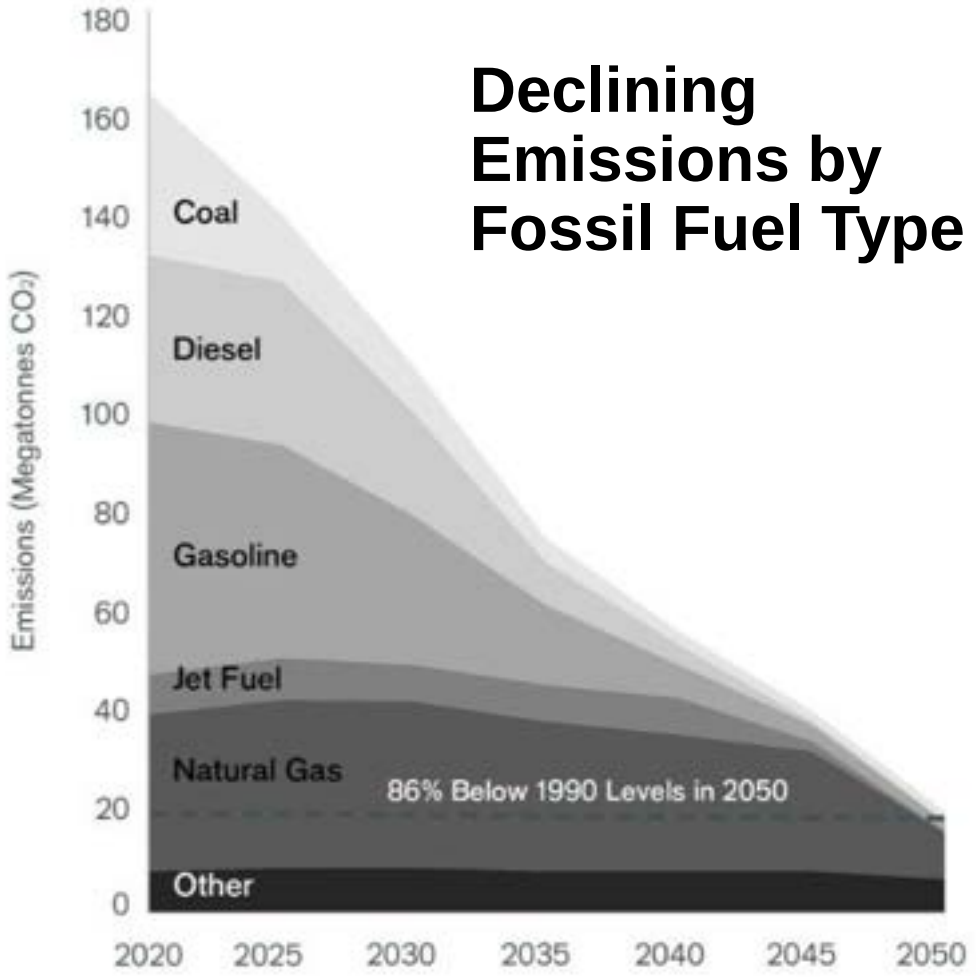
NWDDP Five Pillars of Deep Decarbonization



NWDDP: CO_2 Emissions Decrease by State & Fossil Fuel Type



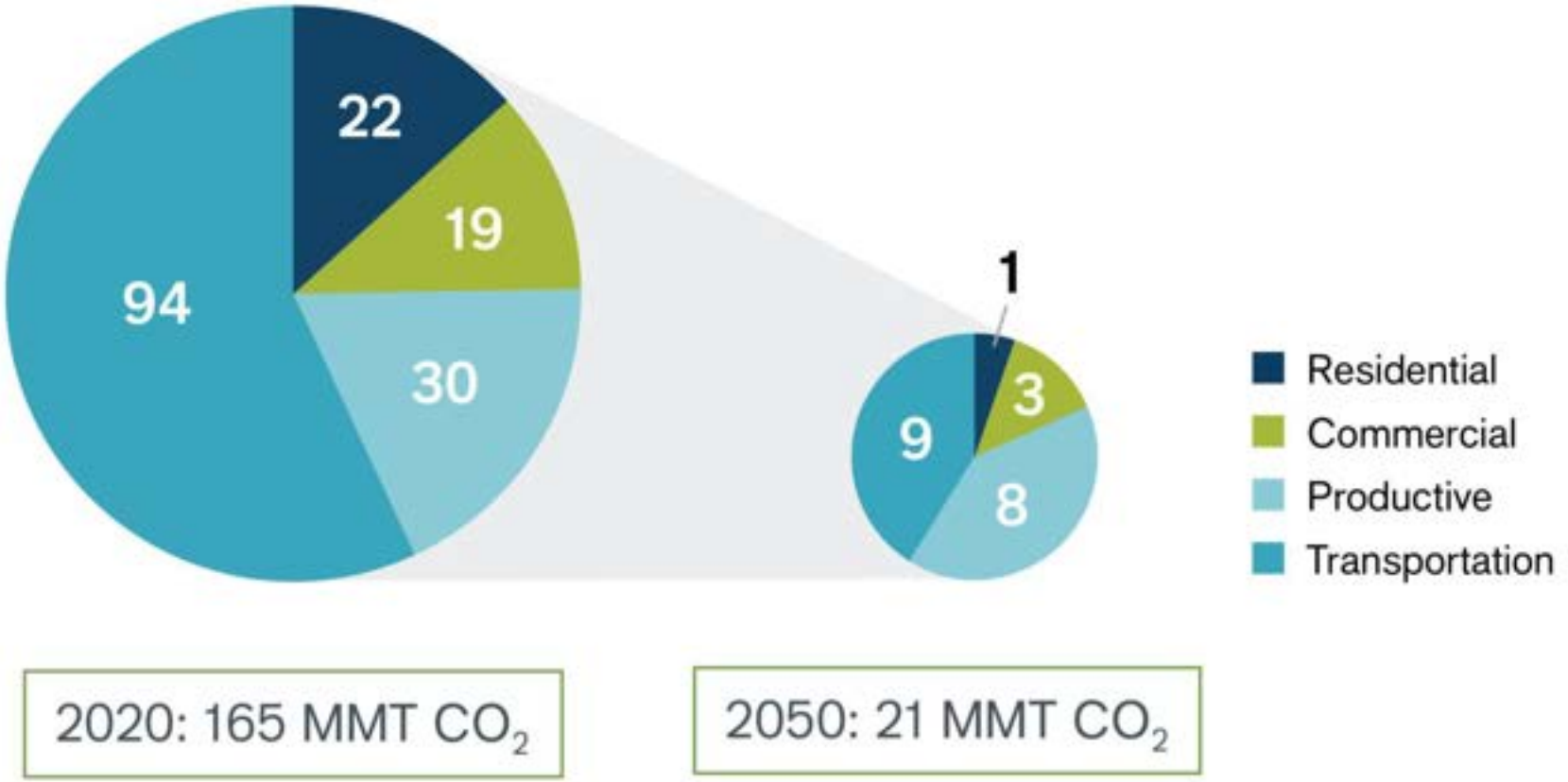
Declining Emissions by State



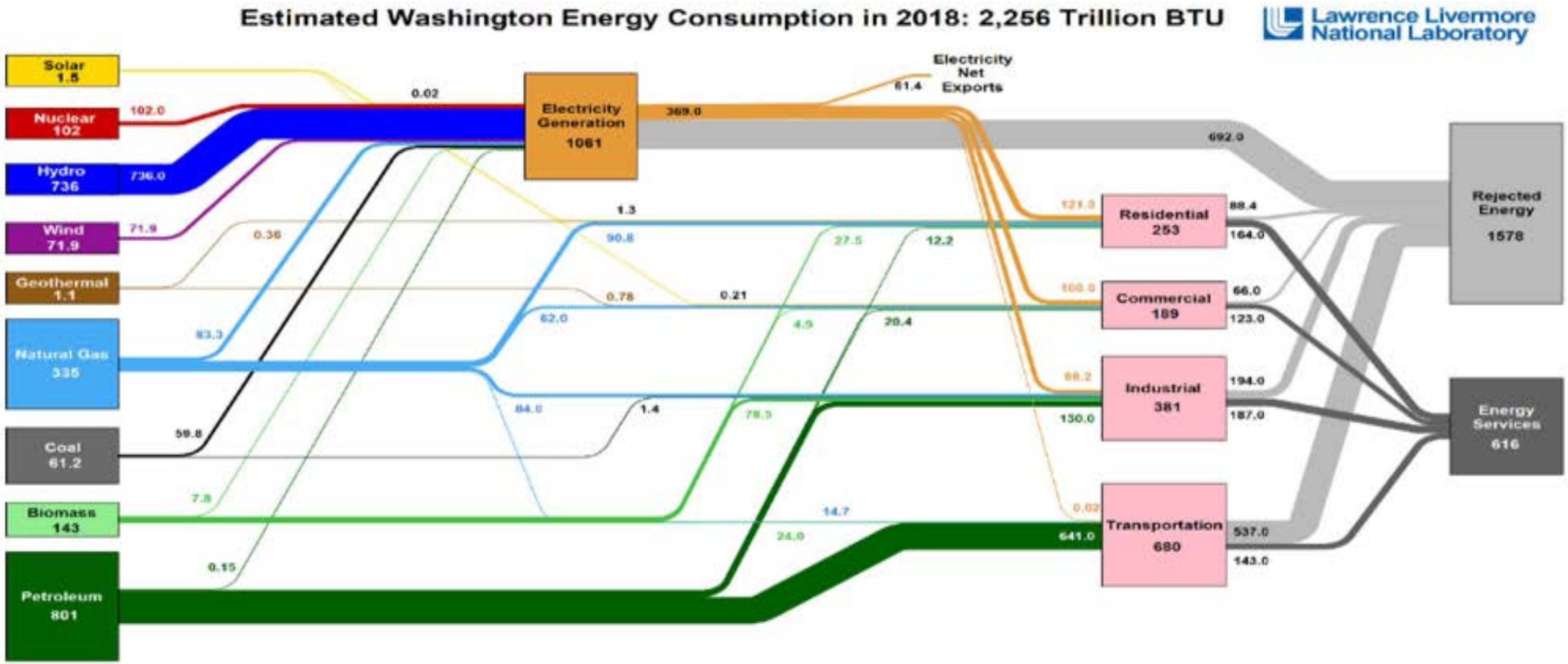
Declining Emissions by Fossil Fuel Type

NWDDP CO_2 Emissions Decrease by Sector

Comparison by sector of Northwest CO_2 emissions decrease from 2020 to 2050 in the Central Case



ESTIMATED WASHINGTON ENERGY CONSUMPTION IN 2018



Source: LLNL June, 2020. Data is based on DOE/EIA SEDS (2019). Lawrence Livermore National Laboratory and the Department of Energy, under whose auspices the work was performed. Distributed electricity represents only retail electricity sales and does not include self-generation. EIA reports consumption of renewable resources i.e., hydro, wind, geothermal and solar) for electricity in BTU-equivalent values by assuming a typical fossil fuel plant heat rate. The efficiency of electricity production is calculated as the total retail electricity delivered divided by the primary energy input into electricity generation. End use efficiency is the estimated as 65% for the residential sector, 65% for the commercial sector, 49% for the industrial sector, and 21% for the transportation sector. Totals may not equal sum of components due to independent Rounding. LLNL-MI-410527. https://flowcharts.llnl.gov/commodities/energy

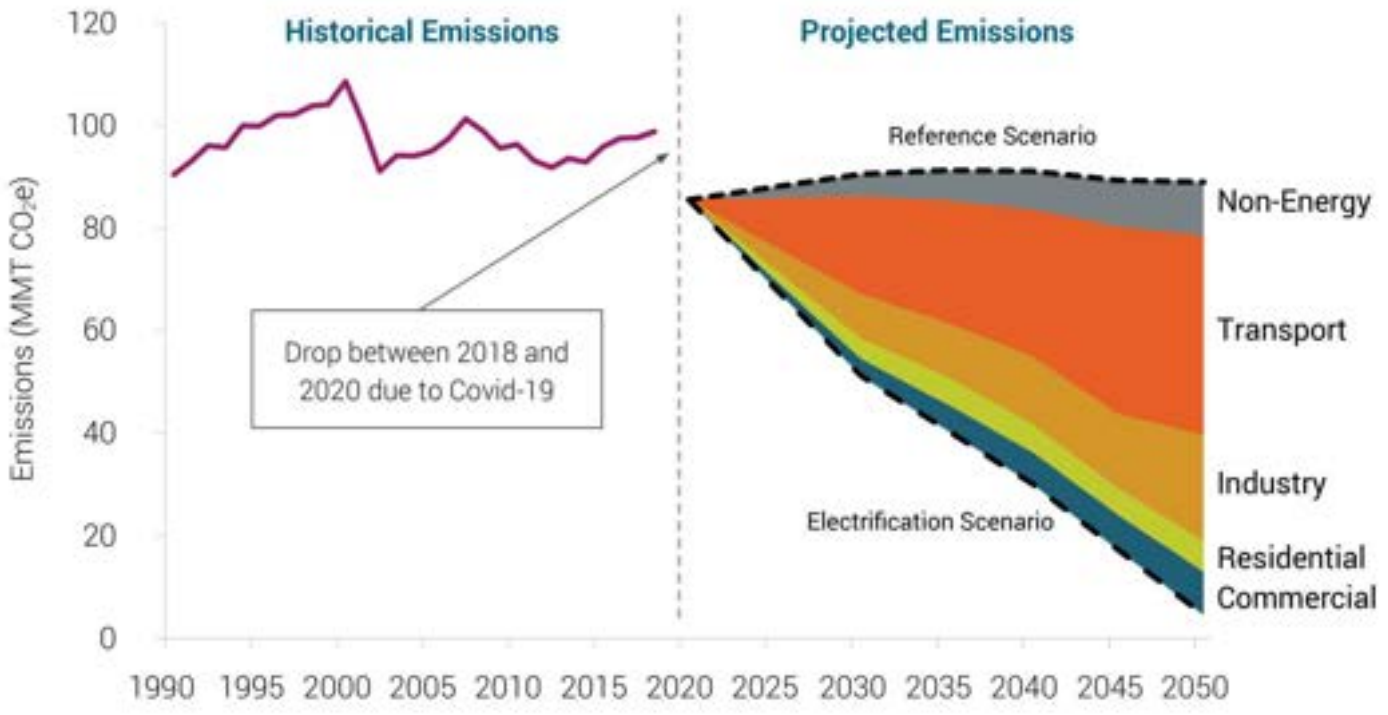
Washington State Energy Strategy

- **Process**
  - 14-member team; March-December
  - Over 700 sources
  - Approximately 180 interviews with experts, agency staff, Advisory Committee members
- **Technical Analysis Deliverables**
  - Deep decarbonization pathways analysis
  - Compendium of all Washington State clean energy policies
  - Economic impacts analysis
  - Technical advisory process: buildings, transportation, industry, electricity

https://www.cleanenergytransition.org/projects/washington-state-energy-technical-advisory-process

Washington's Historical and Projected GHG Emissions

HISTORICAL AND PROJECTED GROSS GREENHOUSE GAS EMISSIONS IN WASHINGTON STATE



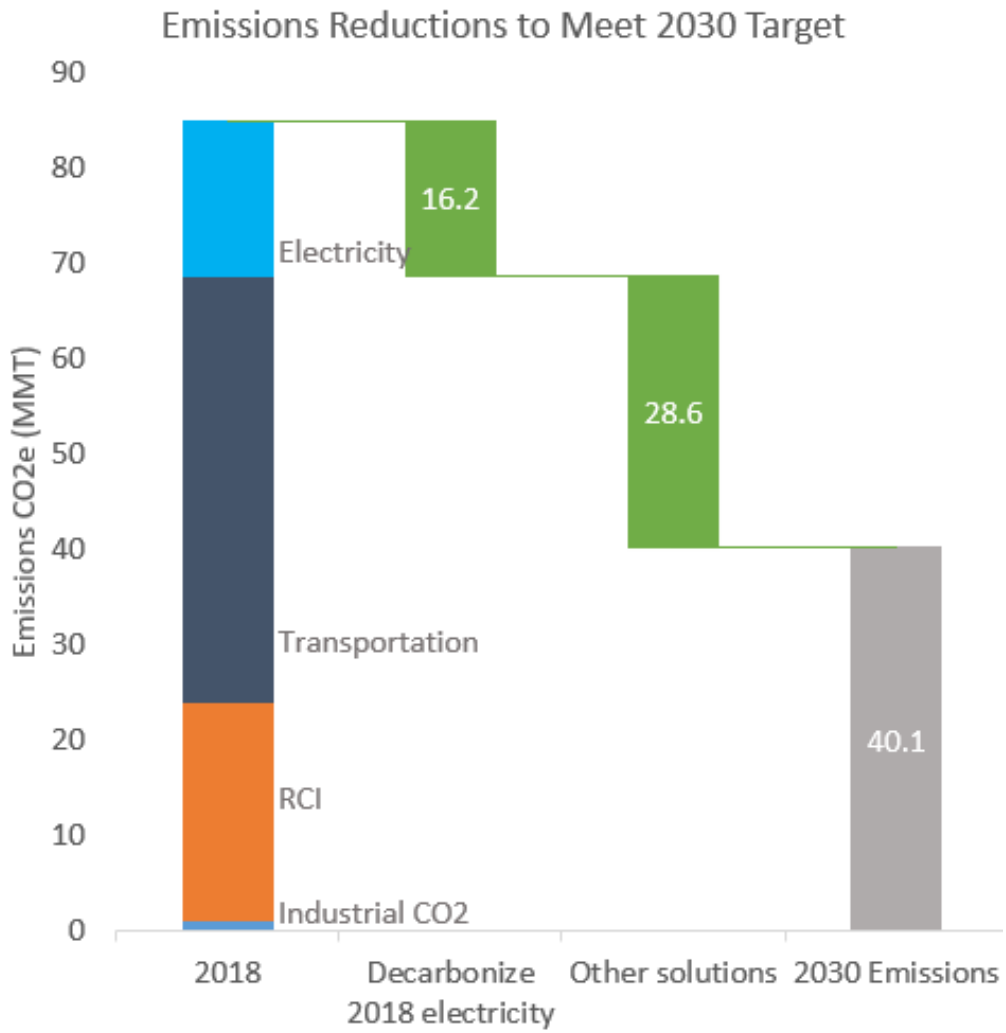
Source: Washington State Department of Ecology for historical emissions (2018 value is preliminary).
Appendix A – Deep Decarbonization Pathways Modeling Technical Report, December 11, 2020 (p. 26).

Approach to Modeling Decarbonized Energy Supply

- Deep decarbonization across **all energy sectors** to meet the emissions targets
- **Conservative** assumptions existing technologies, cost projections
- **Optimal investment** in resources with least-cost approach
- **Decarbonizing energy supply** of electricity, pipeline gas, liquid fuels
- Electricity and fuels systems that extend beyond Washington's borders to **capture regional opportunities and challenges**

Options and Obstacles to Reaching 2030 Targets

- Decarbonizing all electricity generation from 2018 leaves 28.6 MMT to decarbonize (40% of remaining emissions)
- Options:
  - **Energy Efficiency**: Reduce energy use through more efficient appliances, processes, and vehicles
  - **Electrification**: Electrify end uses and supply with clean electricity
  - **Decarbonize fuels**: Displace primary fossil fuel use with clean fuel
- Obstacles
  - Depends on customers replacing inefficient technologies
  - Stock rollover issues
  - Bio or synthetic fuels technologies not deployed at scale yet



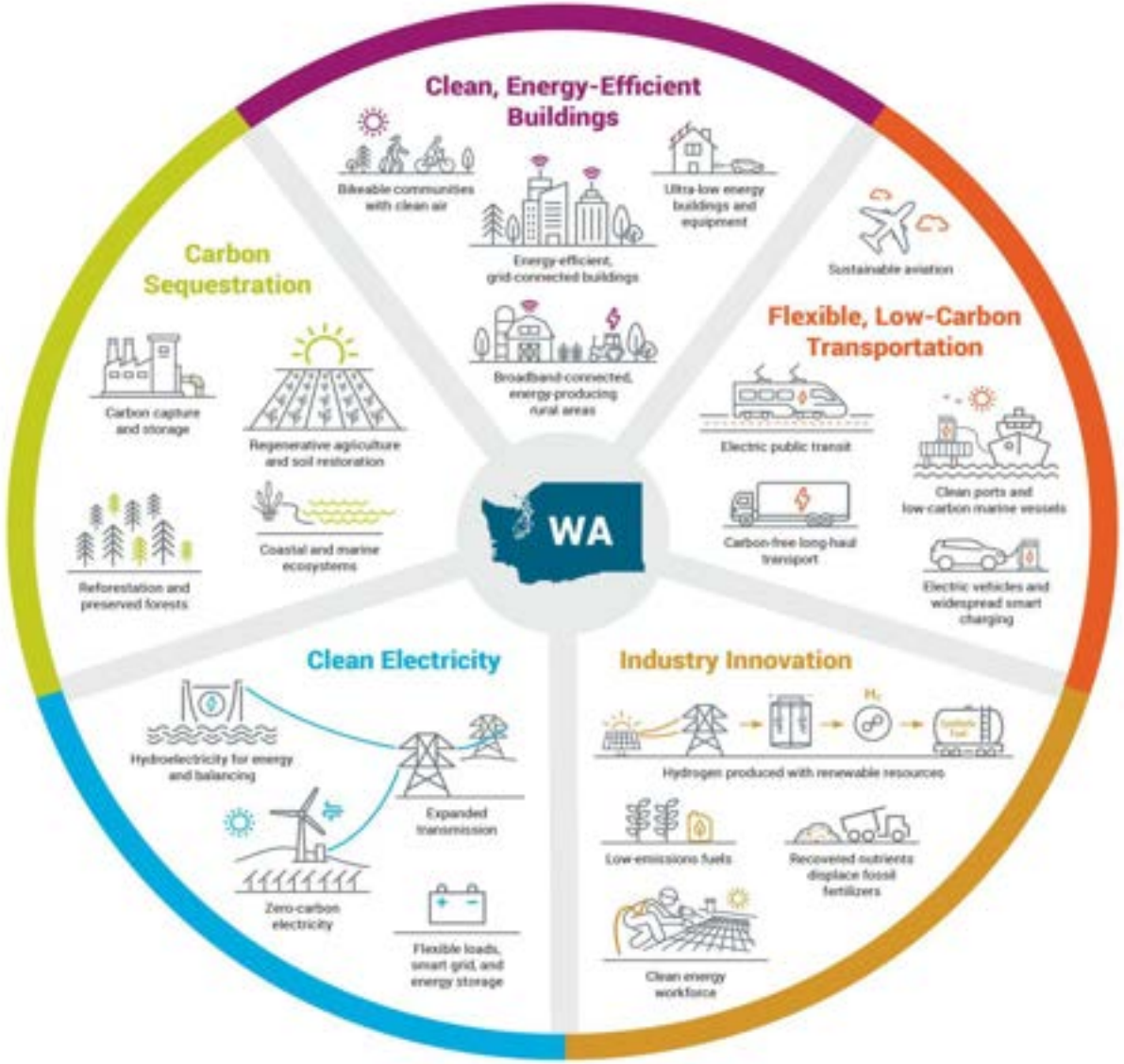
REFERENCE AND FIVE DECARBONIZATION SCENARIOS ANALYZED

Scenario	Summary	Key Questions	Policy Mandates
Reference 	Business as usual	Assumes no emissions target and that current policy is implemented	No constraints on emissions
Electrification 	Investigates a rapid shift to electrified end uses	What if energy systems achieve aggressive electrification and aggressive efficiency, and relatively unconstrained in-state and out-of-state technology were available?	Meets 2050 net zero emissions target
Transport Fuels 	Investigates reaching decarbonization targets with reduced transportation electrification	What alternative investments are needed when larger quantities of primary fuels remain in the economy?	
Gas in Buildings 	Investigates reaching decarbonization targets by retaining gas use in buildings	What is the difference in the cost of decarbonization if gas appliances are retained in buildings?	
Constrained Resources 	Investigates a future that limits potential for transmission expansion into Washington	What alternative investments in in-state resources would Washington make if transmission expansion is limited due to siting/permitting challenges?	
Behavior Changes 	Investigates how lower service demands could impact decarbonization	What if policy-driven or natural behavior changes (i.e., more telecommuting post COVID-19) lower service demands?	

Source: Appendix A – Deep Decarbonization Pathways Modeling Report, December 11, 2020 (p. 21).

Washington's 2050 Net-Zero Vision

A blueprint for how Washington can meet its climate goals to nearly eliminate the use of climate-threatening fossil fuels by 2050, while growing a prosperous economy and maintaining affordable and reliable energy supplies.



Ensure Equitable Transition for Communities

Source: Washington State Department of Commerce

- Apply explicit equity principles
- Ensure impacted communities design solutions
- Invest in equitable and inclusive transition
- Support workers in transition
- Universal broadband access as foundation for transition

Transformational Change Required

- Transformational ***not*** incremental change
  - Must transition to an energy system that does not exist today
- Aggressive action needed across all energy sectors
- Must address equity, affordability, reliability, competitiveness
- Many options to get there

Final Results of Five Decarbonization Scenarios

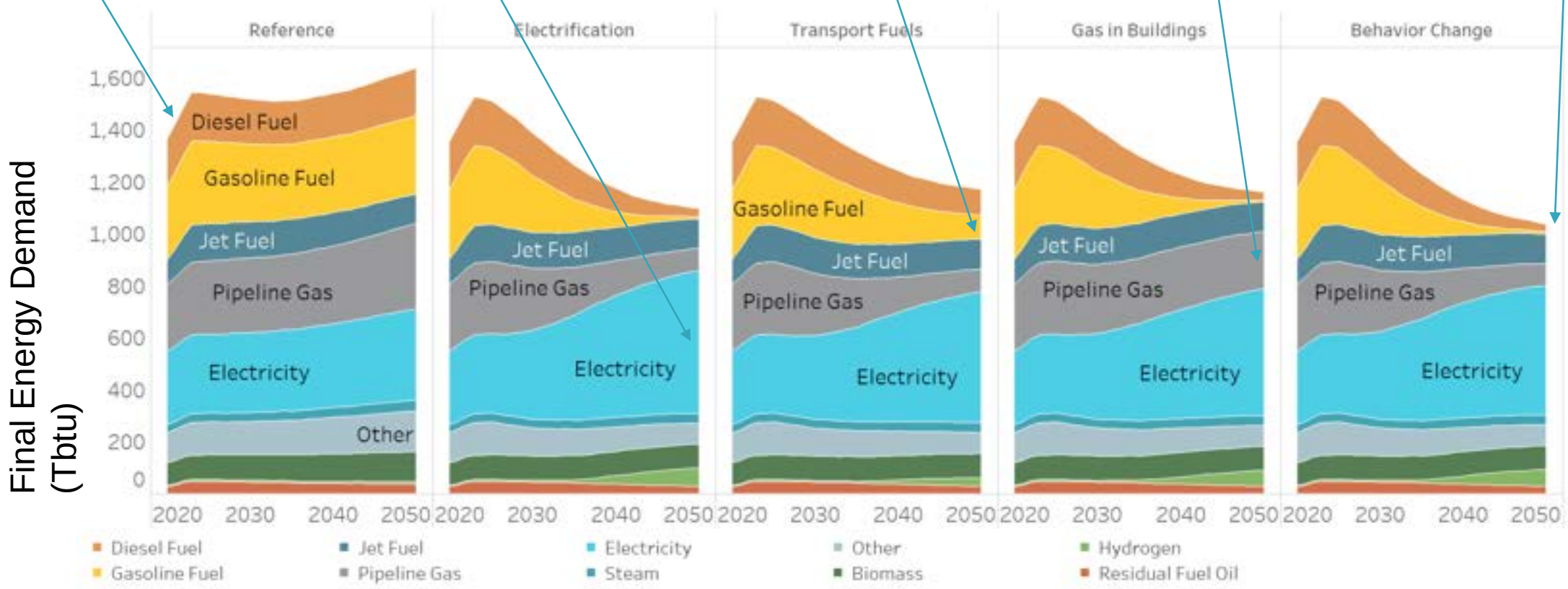
COVID: **10% drop in demand in 2020** due to COVID impact

Electrification**: 90% growth in electricity sector** over 2020 levels, displacing fuels

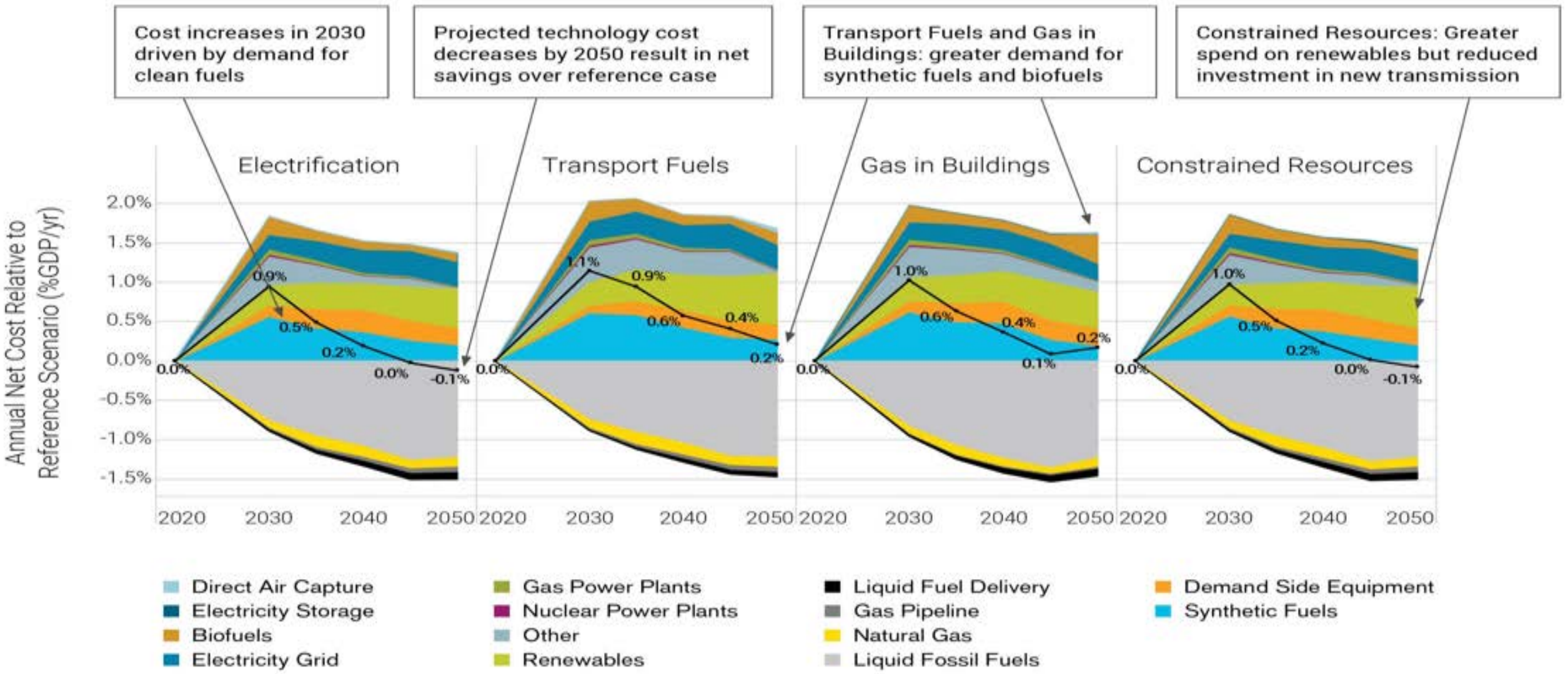
Transport Fuels: Demand for **fuels remains in 2050**

Buildings: **Higher demand for gas** due to less electrification

Behavior: Fewer energy services **drive demand lower**



Costs Compared to the Reference Scenario



Source: Appendix A – Deep Decarbonization Pathways Modeling Report, December 11, 2020 (p. 54).

Common Findings across Decarbonization Scenarios

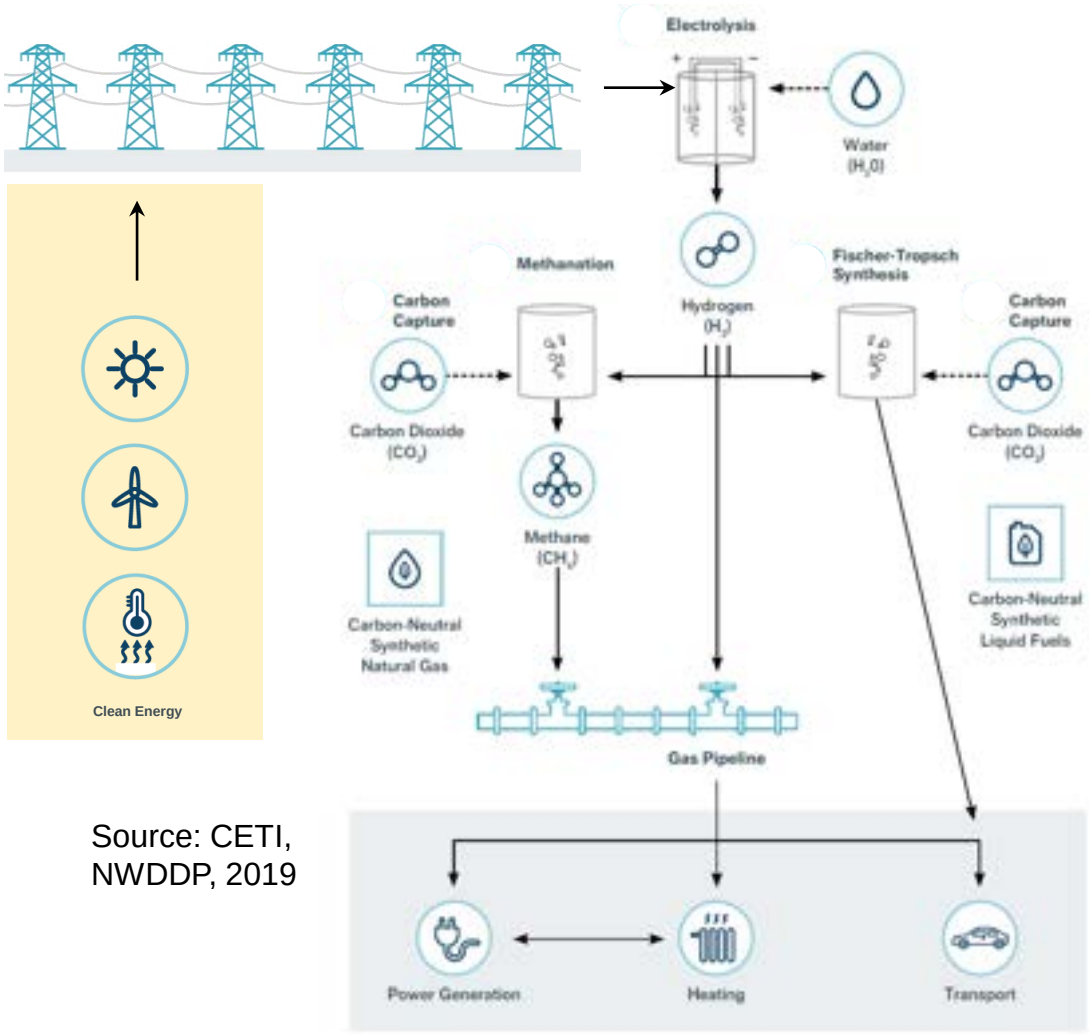
- Strengthened/expanded Western grid needed to take advantage of resource and geographic diversity
  - Large build of solar in the Southwest and wind in the inland states (MT, WY)
- A large clean fuels industry developed based on biofuels and hydrogen from electrolysis

Clean Fuels are Required to Reach Decarbonization

- All liquid fuels fully decarbonized by 2050
- Decreasing fuel consumption over time with electrification and efficiency
- Liquid fuels (gasoline, diesel, jet fuel, others) significantly decarbonized by 2030 with synthetic and biofuels
  - Significant growth in clean fuels industries with few current commercial operations; major challenge
- Emerging opportunities for hydrogen solutions

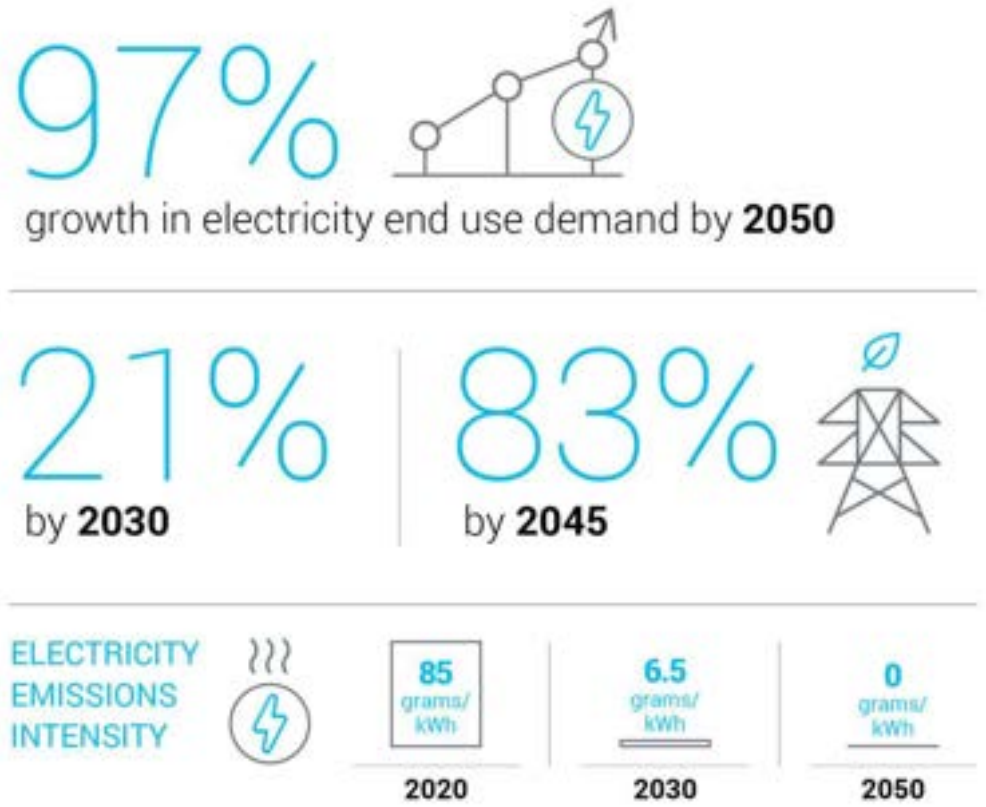
Emerging Role for Electric Fuels

- Conventional means of “balancing” may not be the most economic or meet clean energy goals
- New opportunities: Storage and flexible loads
- Fuels are another form of energy storage
- Large flexible loads from producing decarbonized fuels:
  - Electrolysis, synthetic fuels production



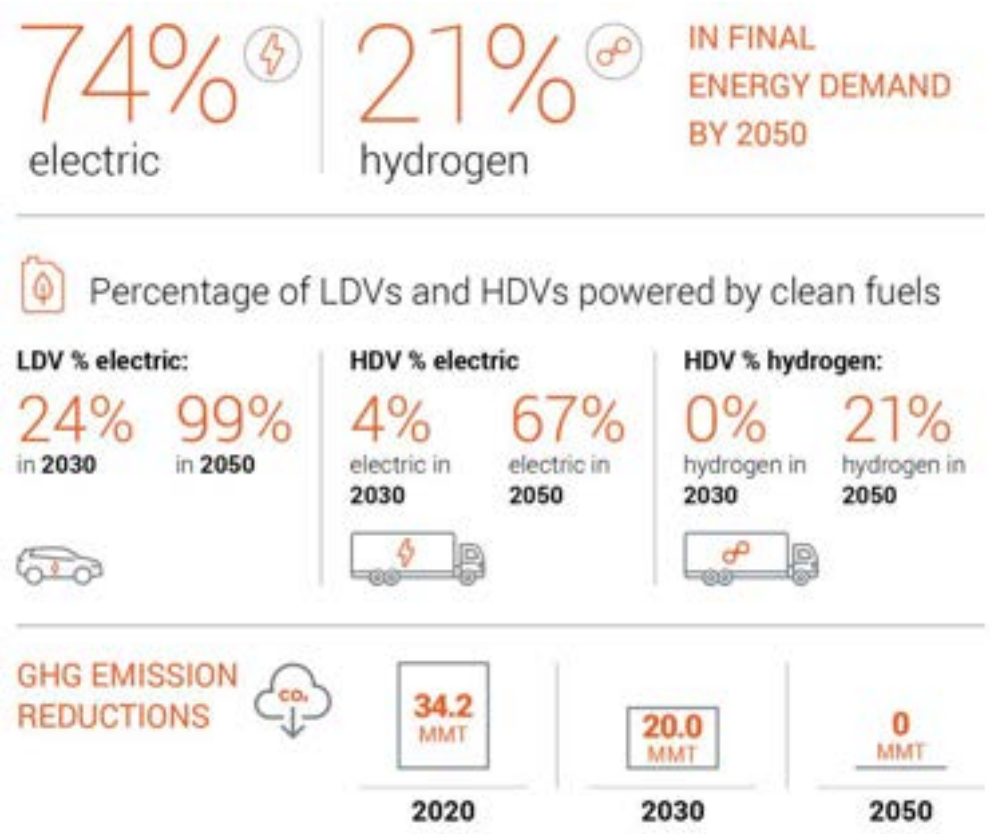
Source: CETI, NWDDP, 2019

Decarbonizing the Electricity Sector



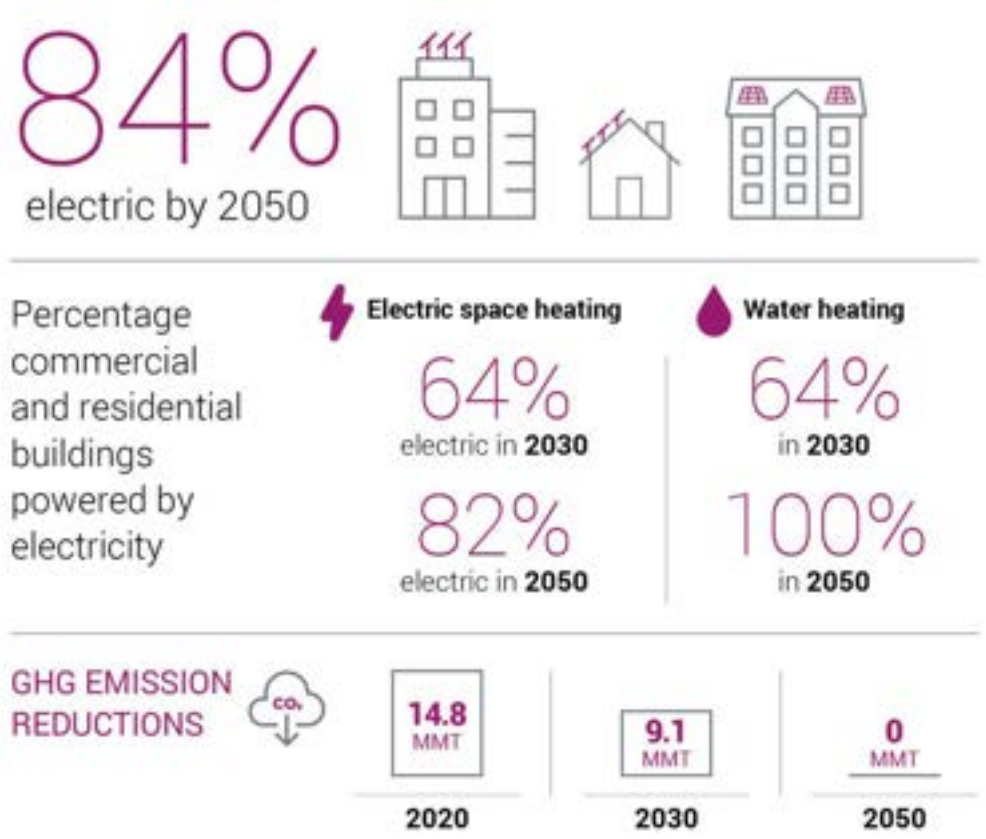
- Doubling of 2020 end use electricity load by 2050, plus additional flexible load from electrolysis and boilers
  - Growth in electricity sector displaces fuels by 2050
- Larger integrated electricity system in West
  - Regional coordination key to decarbonization
- All coal-fired electricity from state portfolios eliminated by 2025
  - Carbon-neutral electricity by 2030
- Gas capacity added for reliability
  - Used only for rate reliability events

Decarbonizing the Transportation Sector



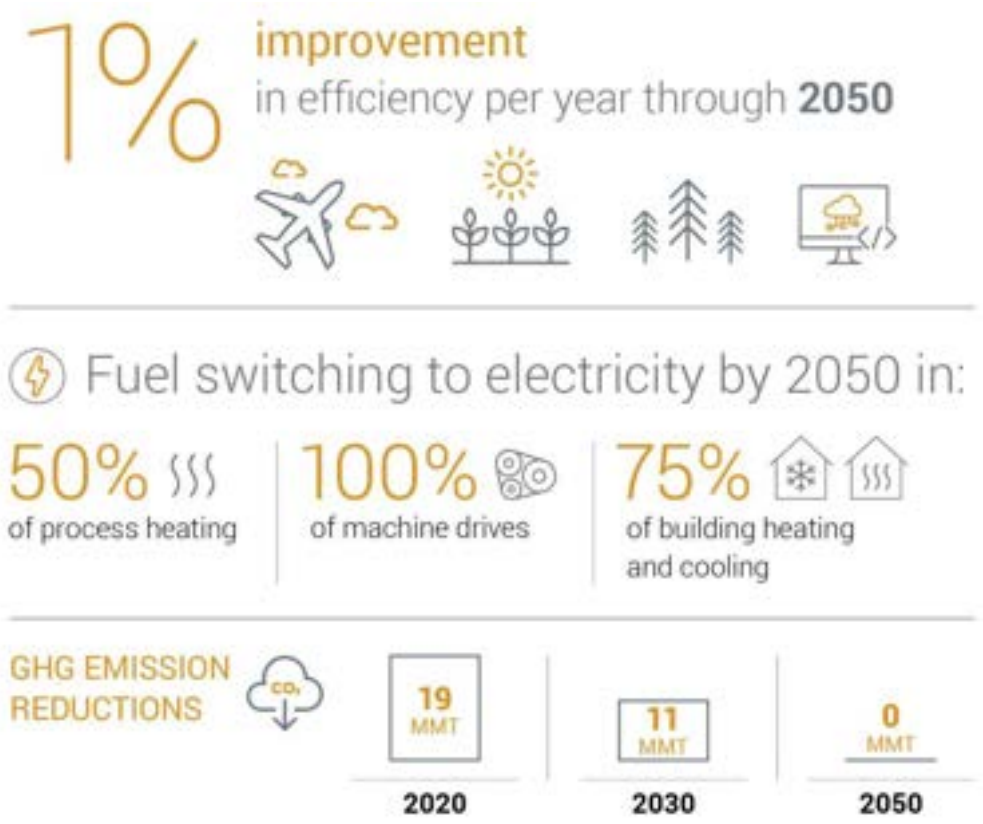
- Transportation electrification key to cost-effectively decarbonizing Washington economy
  - Dramatically reduces use of diesel and gasoline
- Gasoline, diesel, jet fuel significantly decarbonized by 2030
  - Synthetic fuels and biofuels
- Peak in clean fuel demand in 2030 due to large number of ICEs still on the road
- Heavy-duty trucking drives demand for hydrogen fuel cells

Decarbonizing the Building Sector



- Greater efficiency & electrification in buildings in 2020s short- & long-term benefits
  - Avoids the need for clean fuel investments
- Significant reductions in energy
- Pipeline gas largely eliminated from heating buildings by 2050

Decarbonizing the Industrial Sector



- Washington's significant demand for clean fuel requires an investment in clean fuels industry
- Large quantities of synthetic fuels required in 2030 to reach the target of 45% below 1990 emissions by 2045
  - New industrial flexible loads major emerging industry for producing hydrogen through electrolysis
- Significant fraction of carbon stream used to produce synthetic fuels comes from industrial carbon capture

100% Clean Electricity, Smart Grid Power Transition

- Enhance reliability and resource adequacy of the electricity grid
- Accelerate new renewables and transmission expansion
- Deploy flexible solutions and smart grid technology to manage load
- Develop market mechanisms for clean power
- Ensure effective implementation of the Clean Energy Transformation Act

Efficient, Equitable Mobility and Clean Fuels

- Move people and goods more efficiently and equitably
- Reduce the need for travel
- Improve fuel economy for all vehicles, planes, ships
- Shift to clean fuels and electrify where possible
- Enact a low-carbon fuel standard

Clean Electricity Fueling High-Efficiency Buildings

- Shift from fossil fuels to electricity to power commercial and residential buildings
- Accelerate the path to zero-energy buildings
- Weatherize and retrofit existing building stock
- Reform existing programs, codes, and standards

Excel in Building a Clean Energy Economy

- Develop and implement clean energy industrial policy
- Accelerate research and development
- Develop a clean energy workforce
- Produce clean fuels and hydrogen
- Improve data and analytical capabilities