

Meeting the Challenge of Our Time: Pathways to a Clean Energy Future for the Northwest

An Economy-Wide Deep Decarbonization Pathways Study • June 2019



Agenda

- Clean Energy Transition Institute
- Deep Decarbonization Pathways
- Key Findings
- Perspectives from the Northeast
- Issues Utilities Face
- Discussion



Clean Energy Transition Institute

Independent, nonpartisan Northwest research and analysis nonprofit
organization with a mission to accelerate the transition to a clean energy economy.
Provide information and convene stakeholders.

- Identifying deep decarbonization strategies
- Analytics, data, best practices
- Nonpartisan information clearinghouse
- Convenings to facilitate solutions



The Challenge: Meeting Science-Based Emissions Reduction Targets

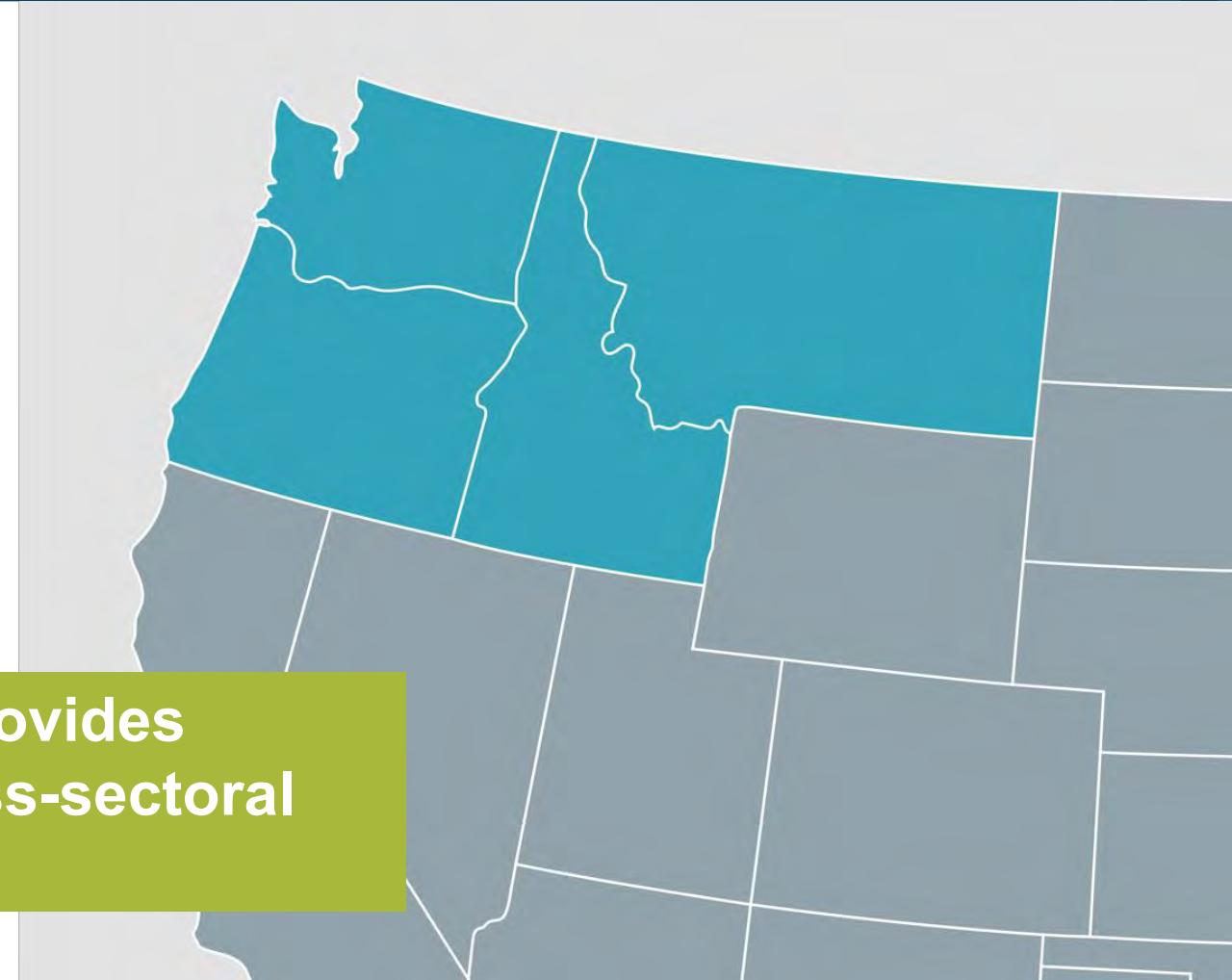
Key Study Questions Posed

- **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?



Scope: Northwest Regional Energy Sector

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



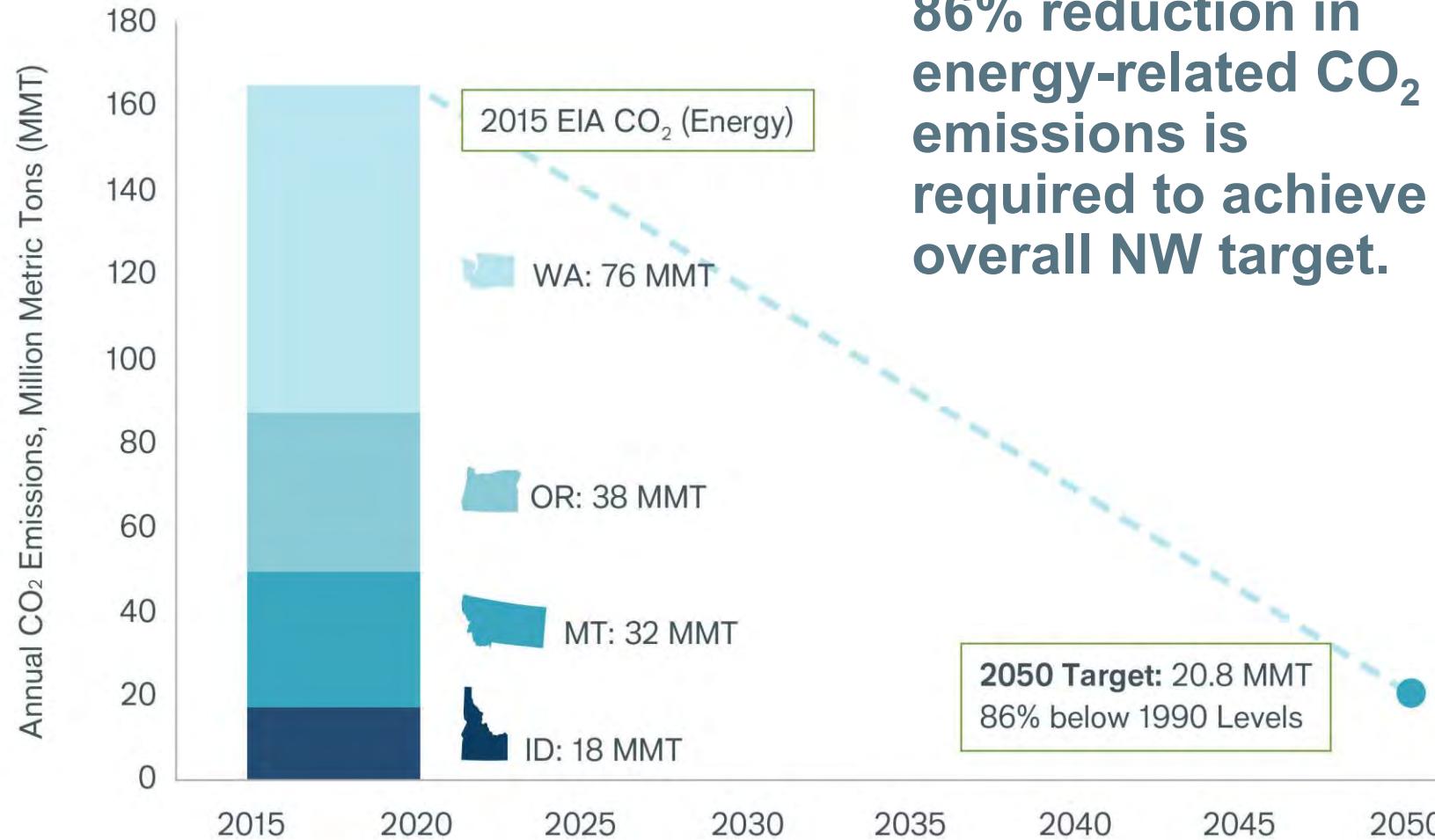
Evaluating holistically provides
an understanding of cross-sectoral
impacts and trade-offs

Pathways Model Methodology

- **Models** eight cases to achieve least-cost energy supply to meet Northwest energy needs
- Determines **fuel and supply-side infrastructure** decisions simultaneously considering constraints
- Uses **conservative assumptions** about existing technology from public sources
- Deploys a **stock-rollover approach** on the demand side and optimizes for cost on the supply side
- Incorporates **new electric loads**
- Accounts for **California policy** impact on the region

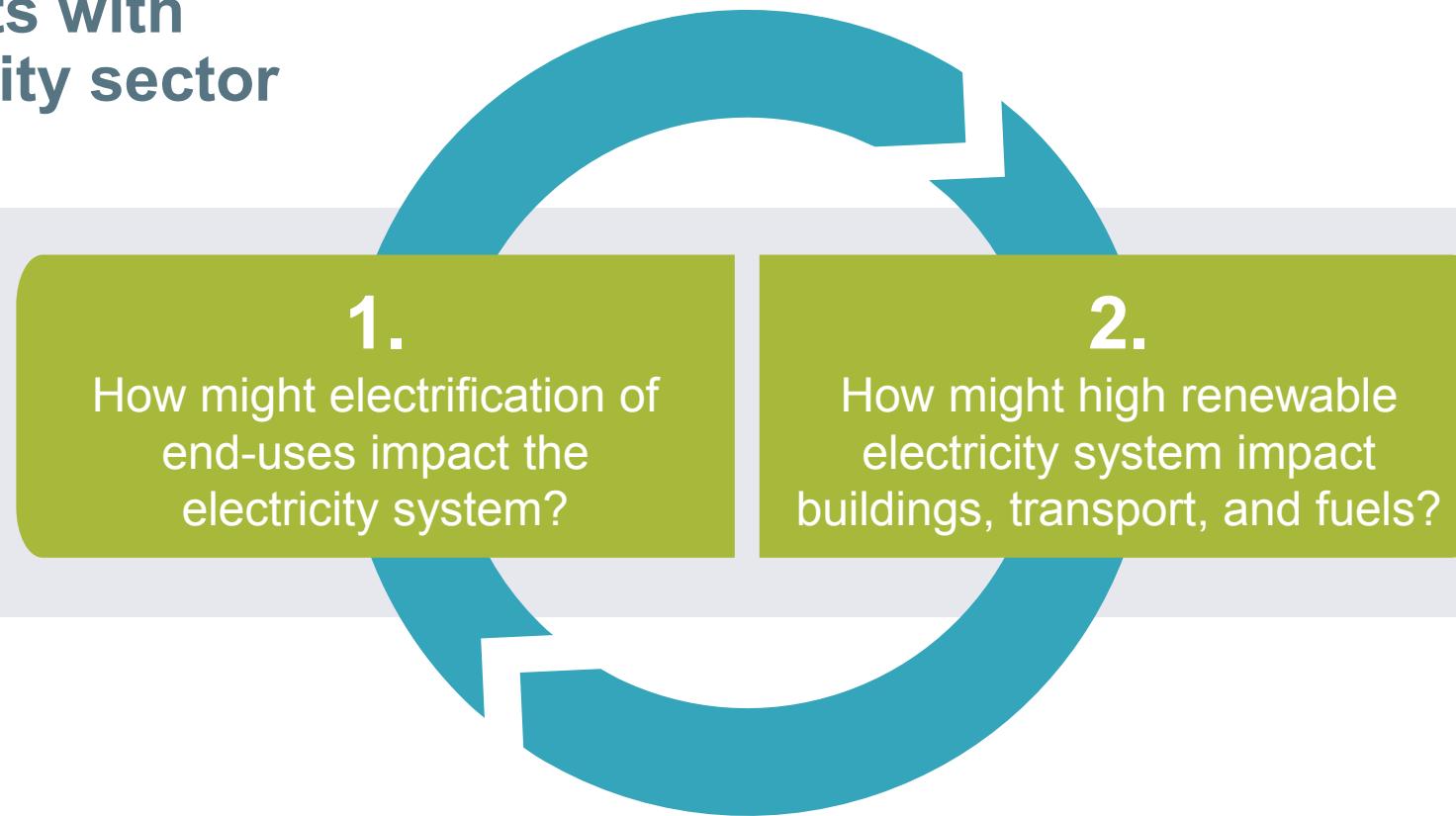


Northwest Deep Decarbonization Target



Relevancy to Power Planning

Economy-wide
decarbonization
interacts with
electricity sector



Deep Decarbonization is achievable

- Requires Demand & Supply Side Transformations
- Utilities can/will/must play a central role



Key Findings: Deep Decarbonization Achievable

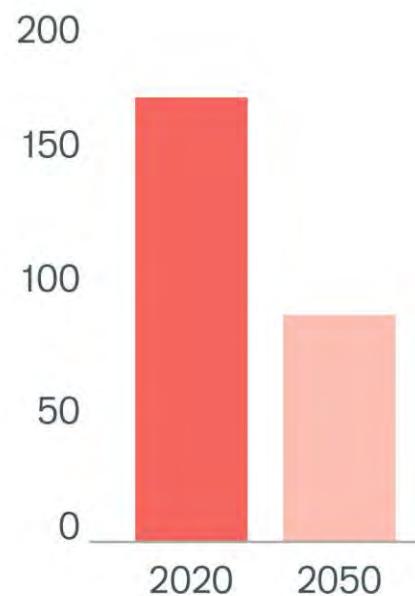
- **Electricity** generation must be ~96% clean
- **A highly efficient built environment** powered by clean electricity
- **Aggressive vehicle electrification** powered largely by clean electricity
- **Thermal generation (natural gas) important for reliability** but operates at low capacity factor in 2050
- **Significant cost savings** if the Northwest and California grids are better integrated
- **Biomass** allocated to replace jet and diesel fuel
- **Electric fuels** play an important role



Five Decarbonization Strategies Deployed

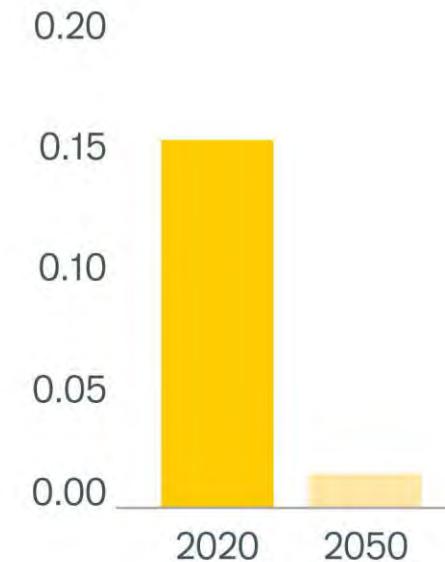
Efficiency

Per capita decreases 50%



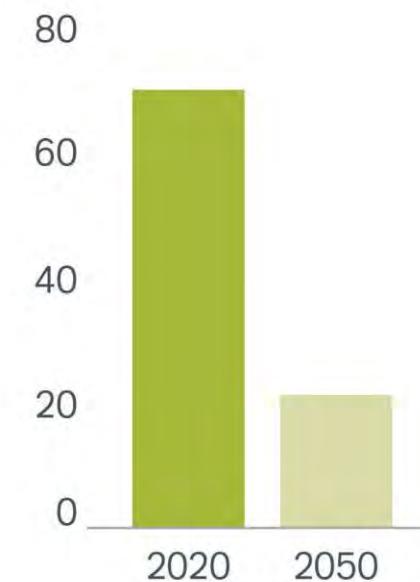
Clean Electricity

96% Clean by 2050



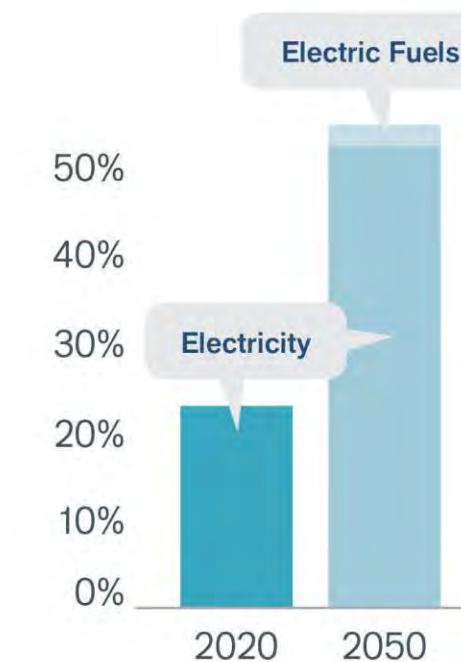
Clean Fuels

70% decrease



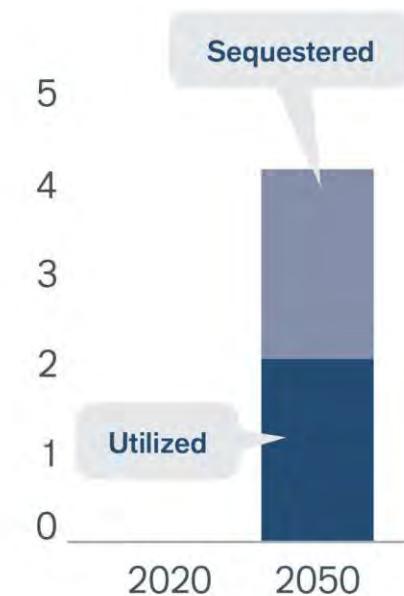
Electrification

Doubles from 23% to 55%



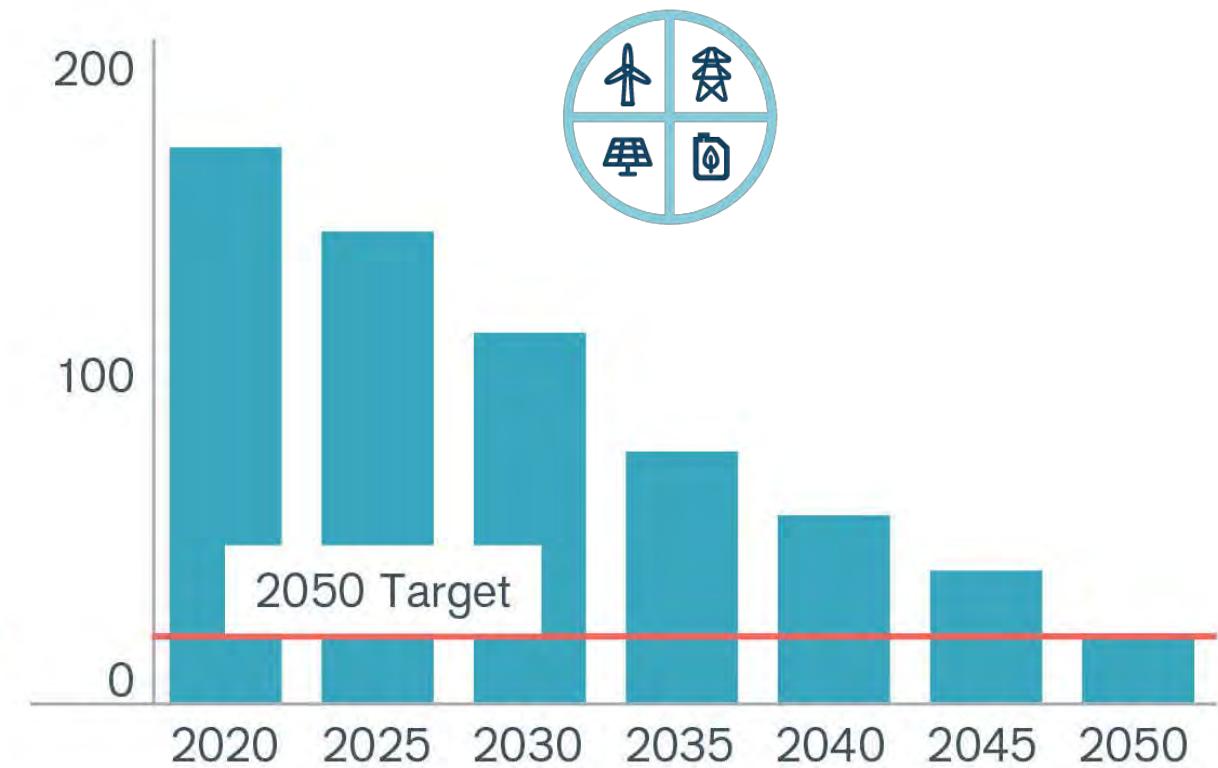
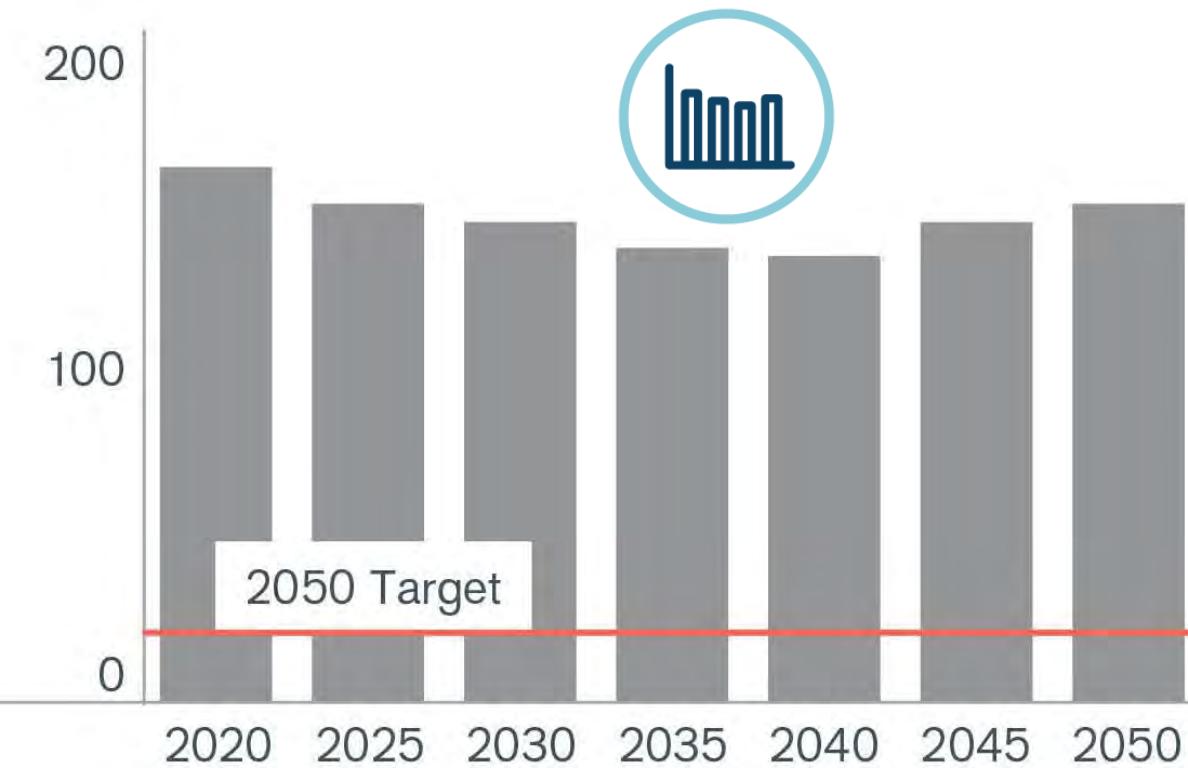
Carbon Capture

1/2 fuel; 1/2 sequestered



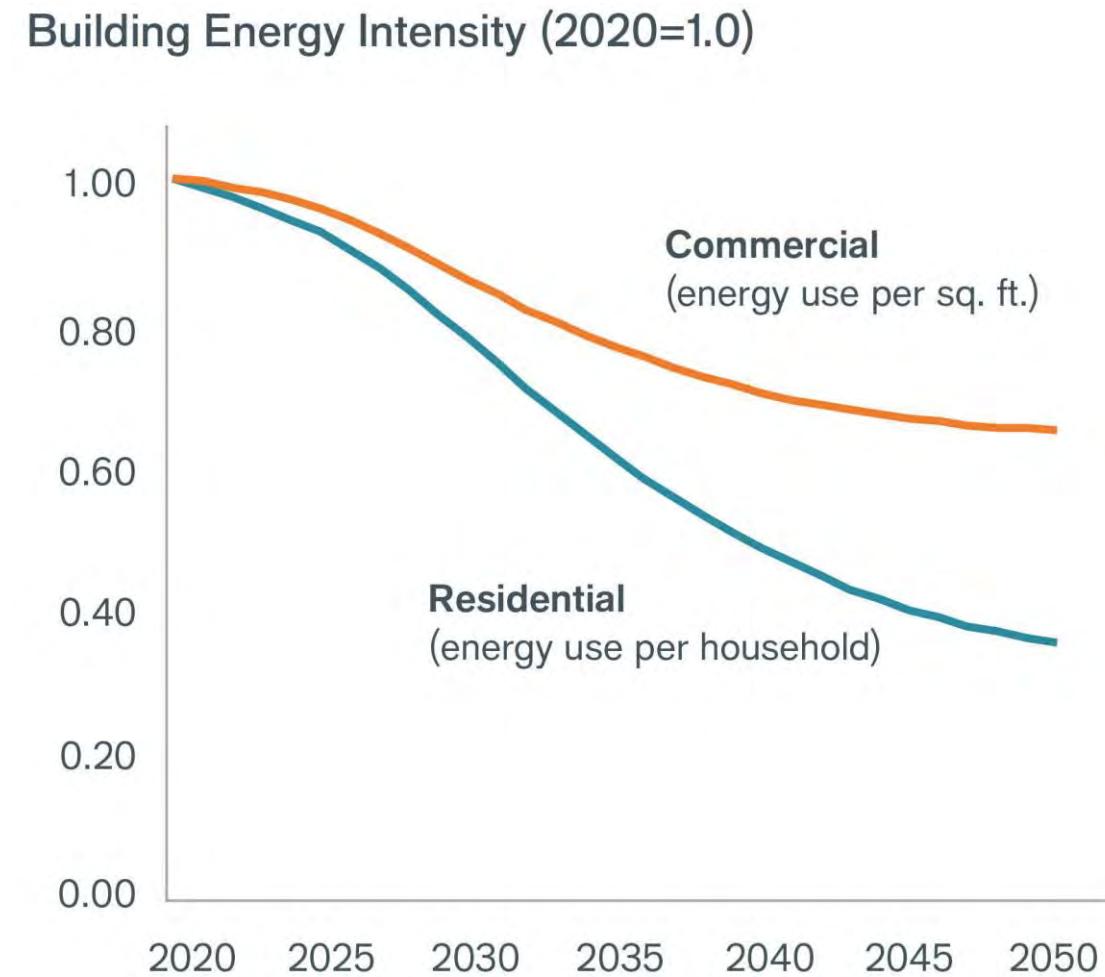
Business as Usual vs. Central Case

In the Business as Usual Case emissions trajectory falls far short of the 2050 reduction goal, while the Central Case meets the mid-century energy CO₂ emission target of 86% below 1990 levels.



Buildings: Deep Efficiency & Electrification

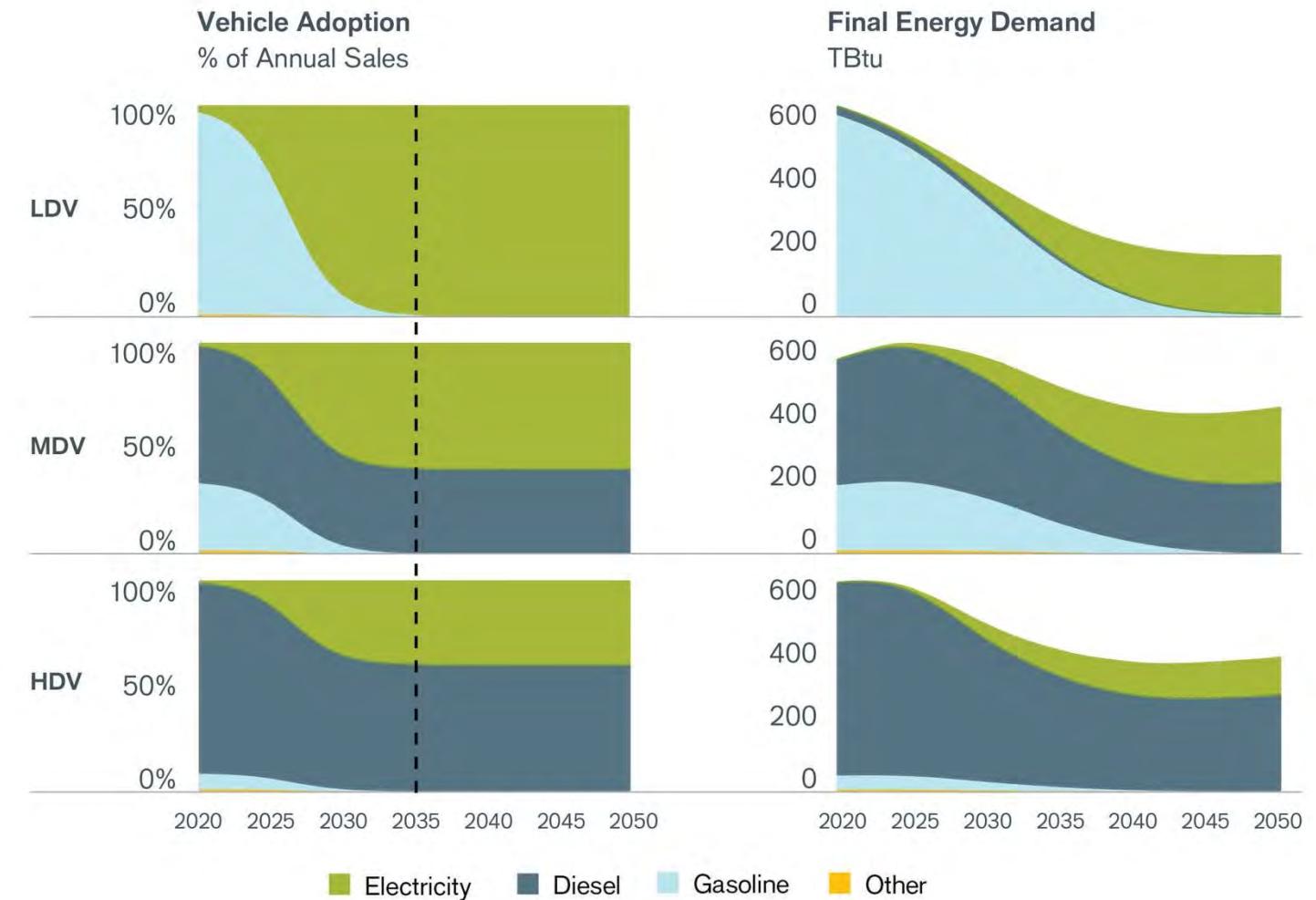
- Building energy intensity declines by 30% for commercial and 60% for residential sector from 2020 to 2050.



Transportation: Massive Shift to Electric Vehicles

By 2050:

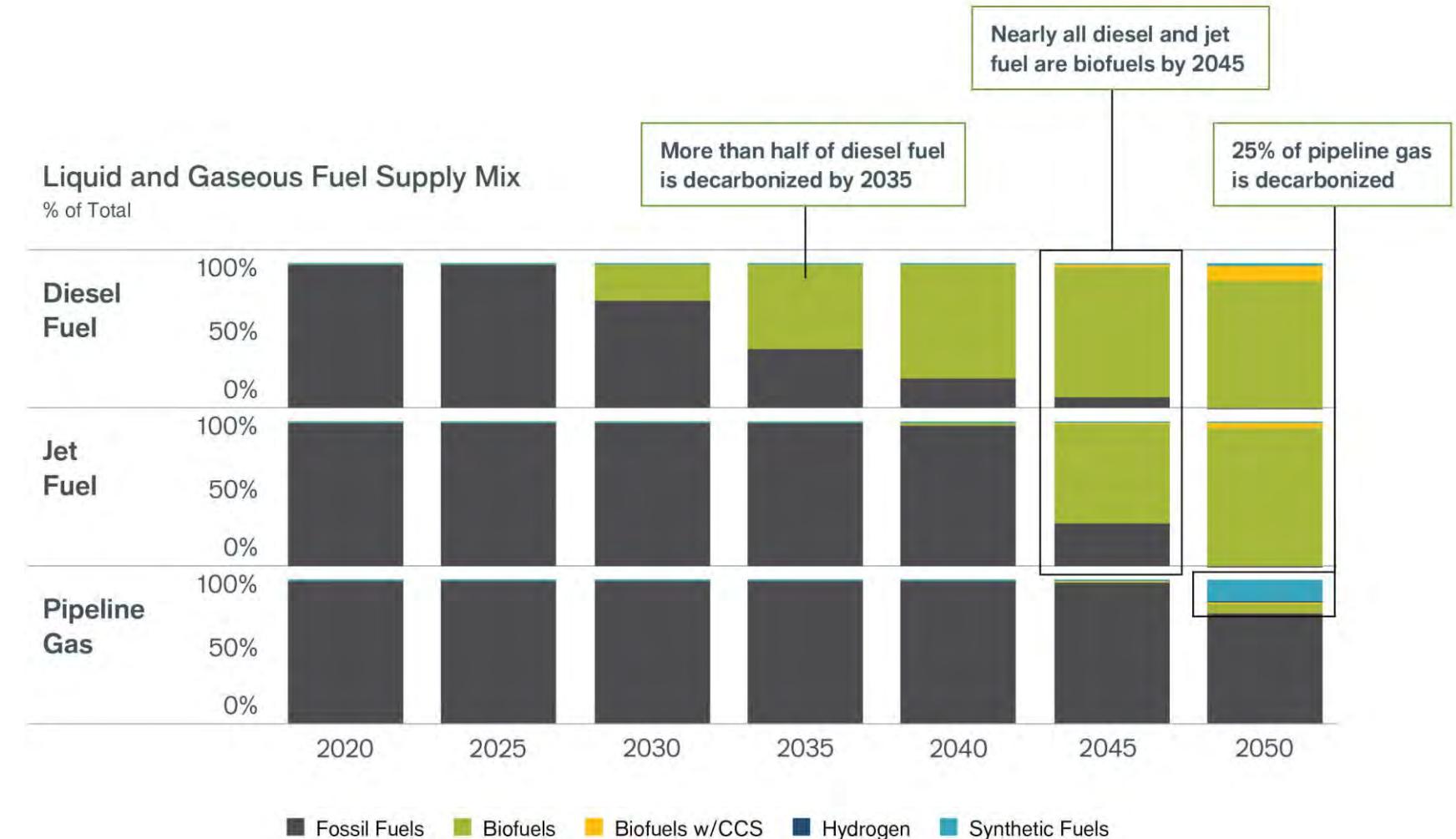
- Cars, SUVs, and light trucks fully electrified
- Medium and heavy duty trucks partially electrified
- Results in a 60% reduction in final transportation sector energy demand from light, medium, and heavy duty vehicles



Fuels: Decarbonized Diesel, Jet, and Pipeline Gas

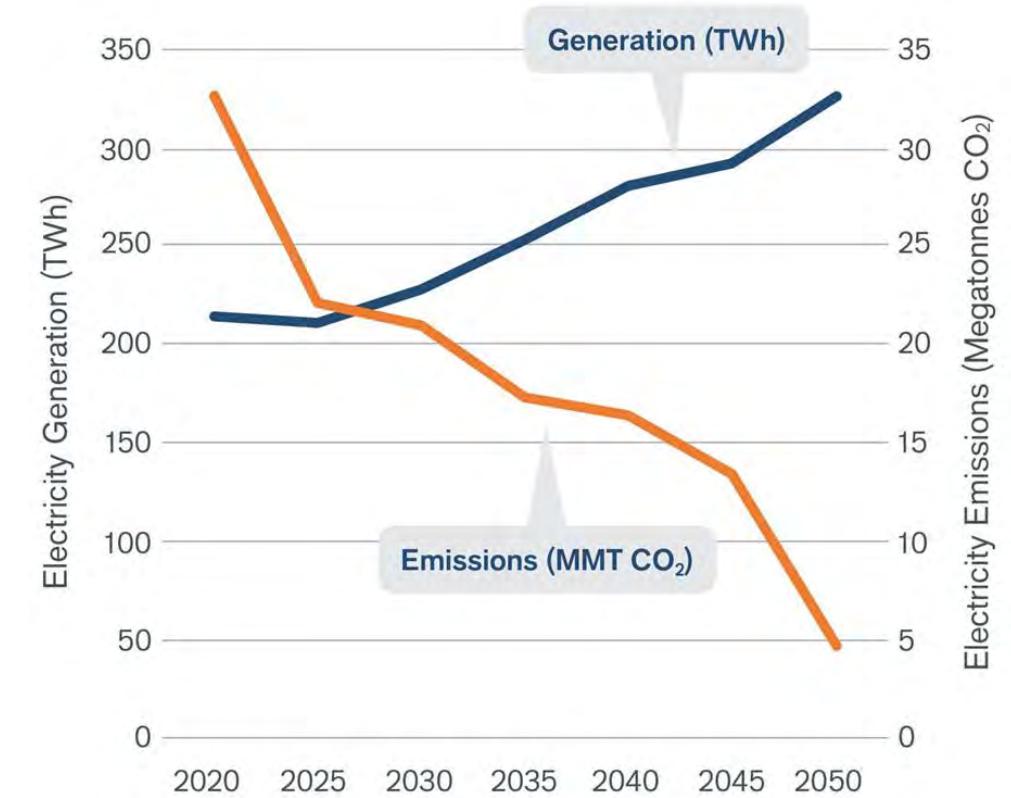
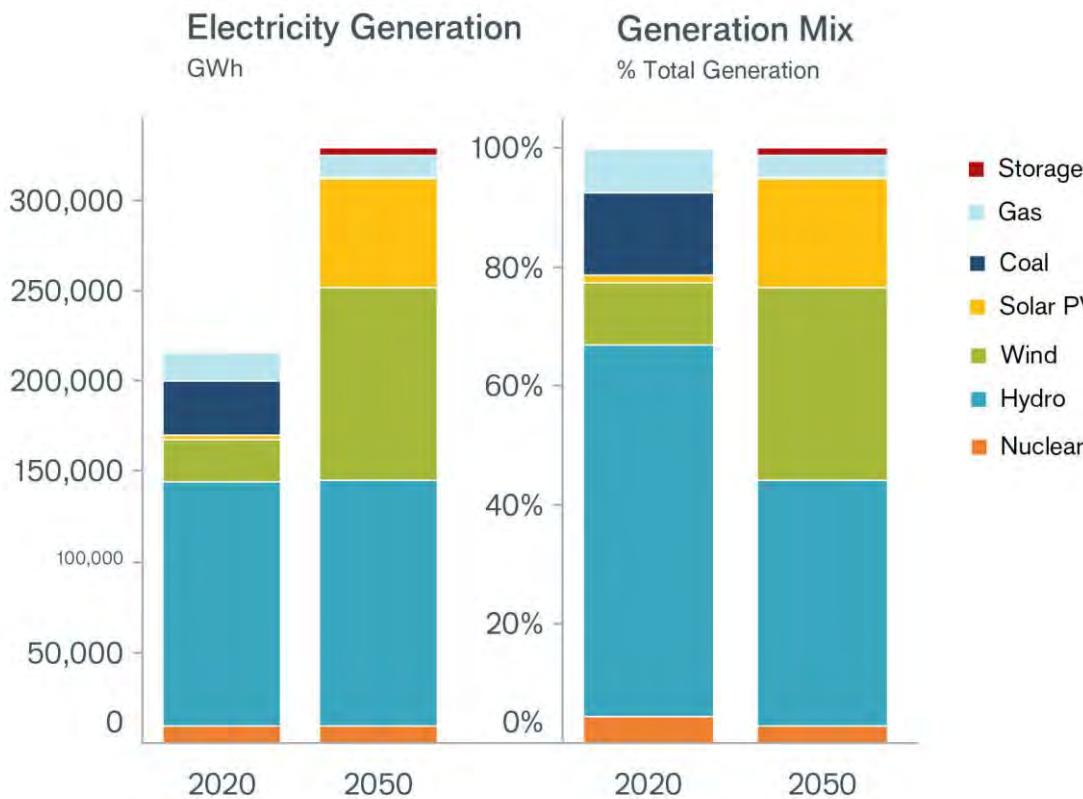
By 2050:

- Diesel and jet fuel fully decarbonized, primarily using biofuels.
- 25% of pipeline fuels partially decarbonized
- Synthetic fuels play a key role



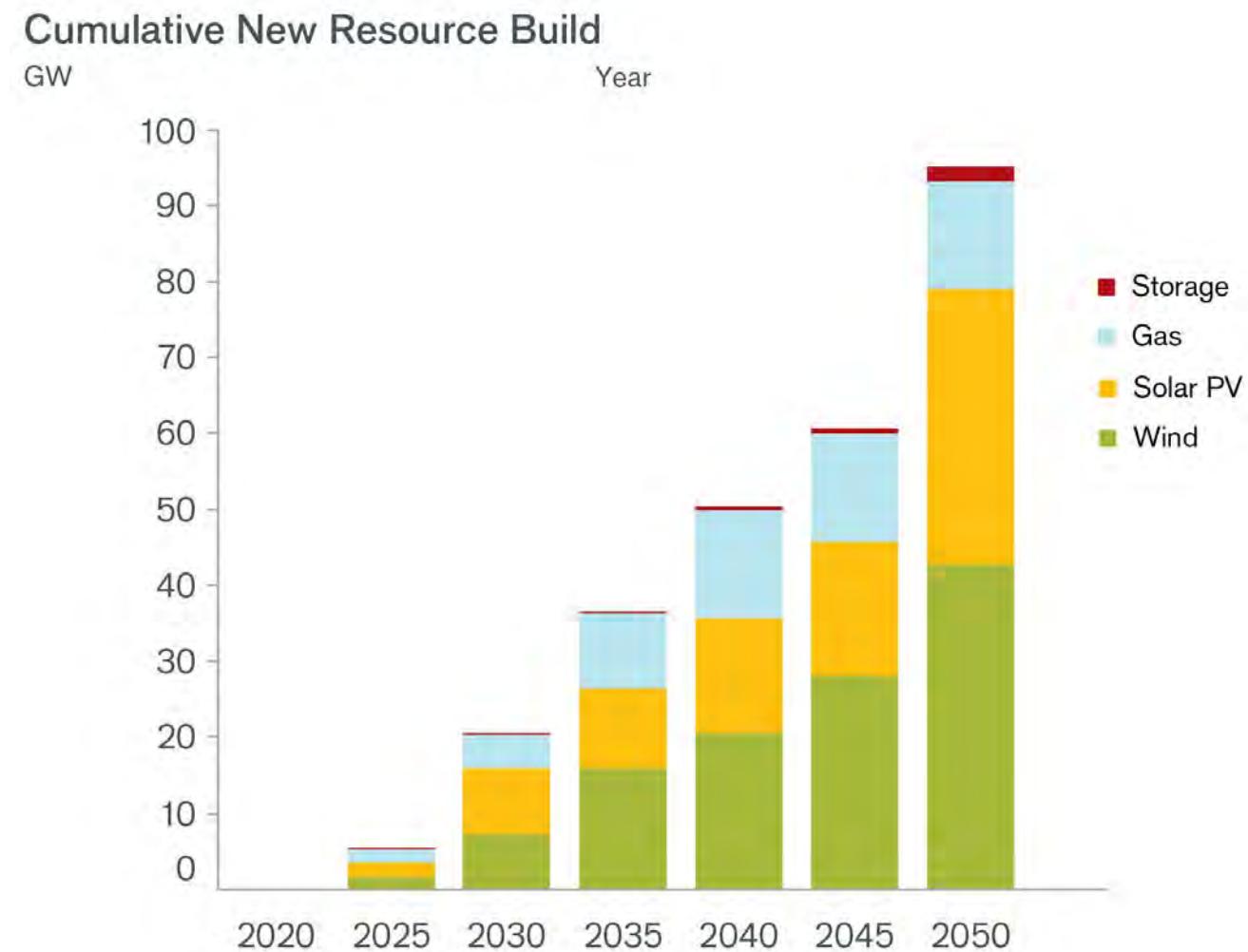
Electricity: 96% Carbon Free

Generation increases 53%, with fossil fuel use at 4%, emissions decline by 86%.



Electricity: Serves 55% of Final Energy Demand

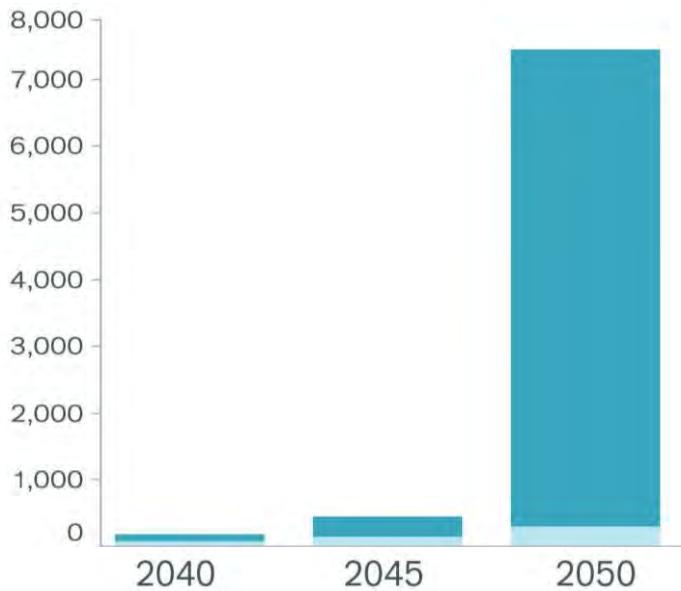
- By 2050, 95 GW of generation capacity added.
- 44 GW wind, 35 GW solar
- 14 GW gas, primarily for reliability, capacity value in times of low hydro, wind, solar combined with high demand
- 2 GW storage



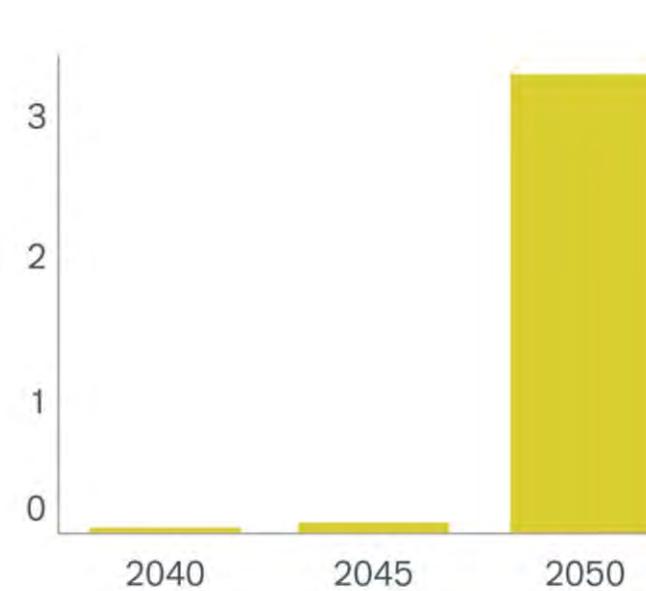
Electricity: New Technologies Reduce Curtailment & Meet Demand for Decarbonized Liquid Fuels

19

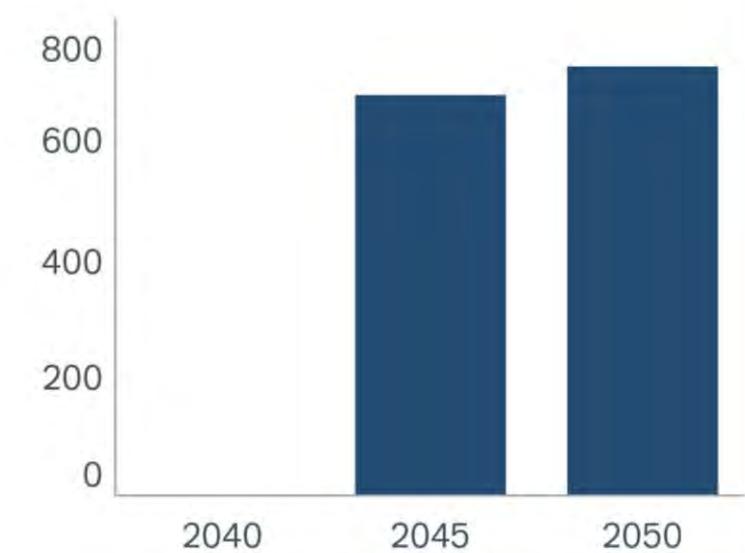
Electrolysis Capacity (MW)



DAC Total Capture Capacity (MMT)

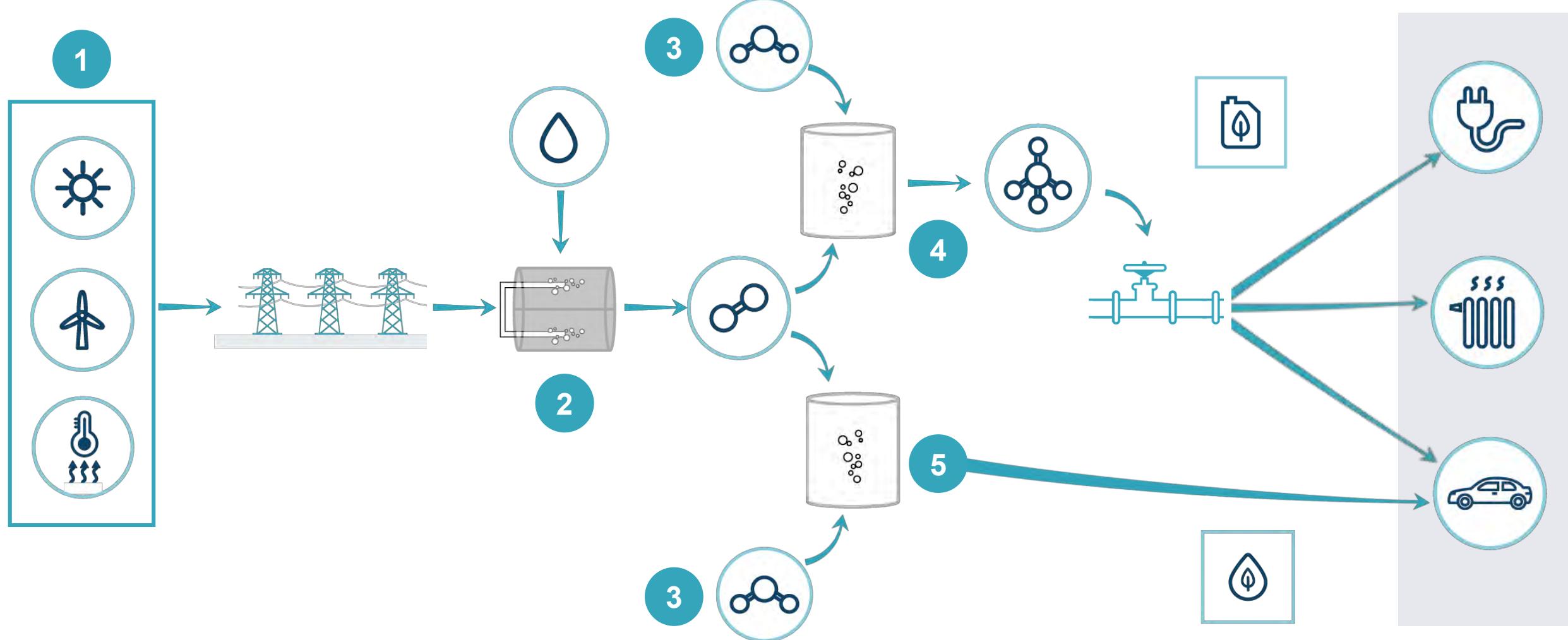


Electric Boiler Capacity (MW)



- **Electrolysis uses 21,400 GWh; DAC uses 3,340 GWh; and Electric Boiler uses 2,950 GWh**

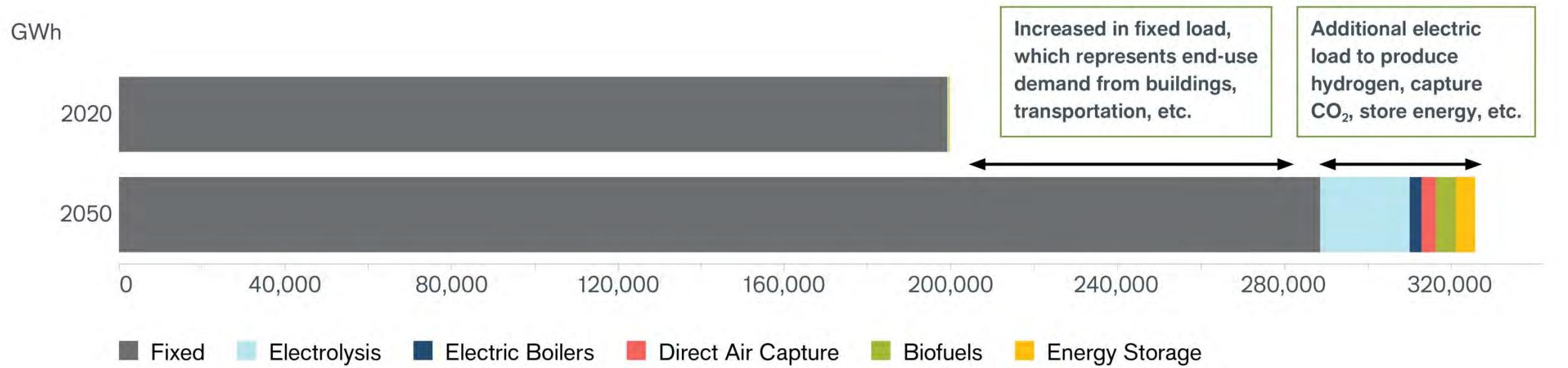
Illustration of Power-to-Gas



Electricity Sector: Serves Increasing Fixed Load, Produces New Sources of Decarbonized Energy

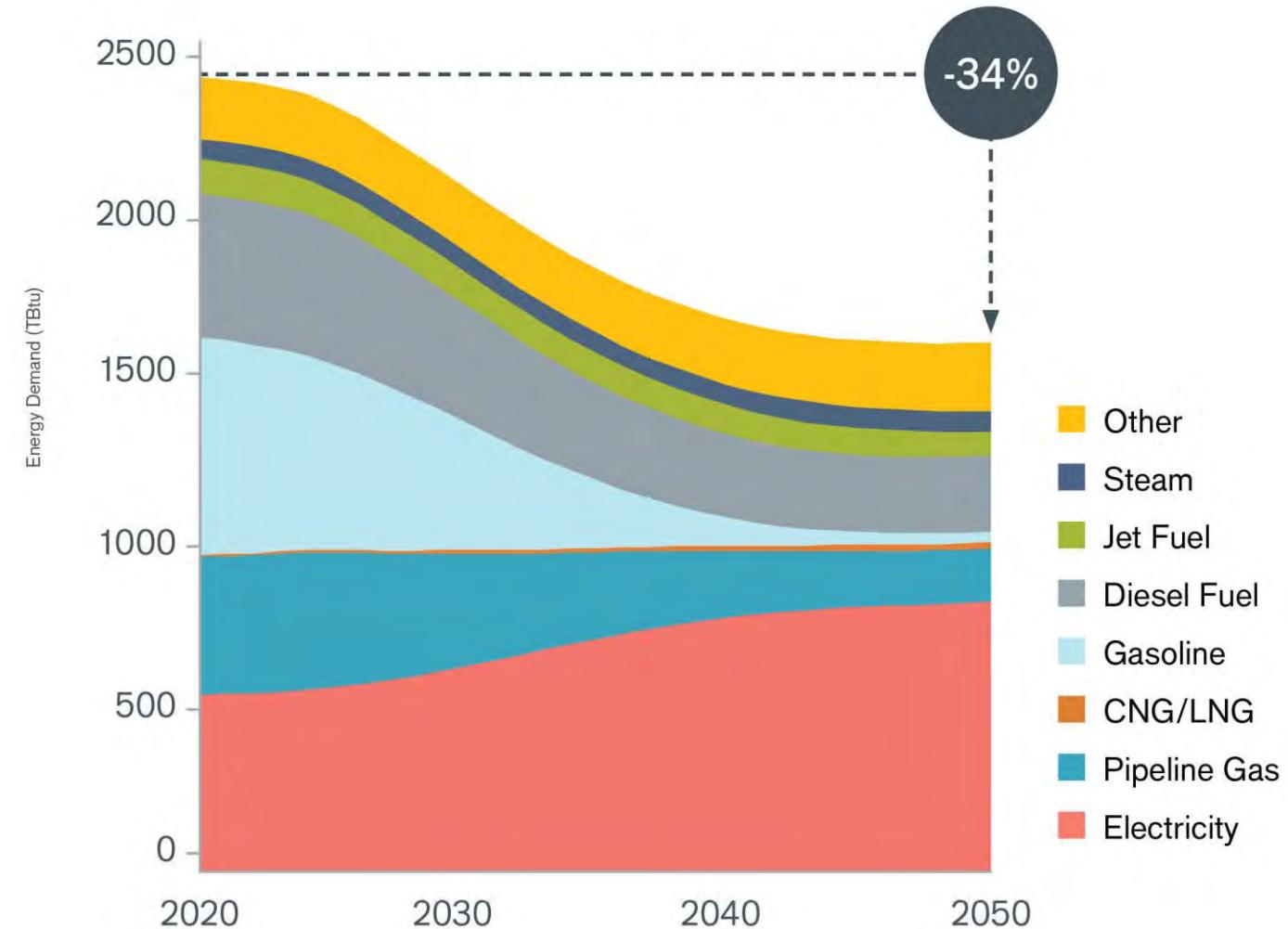
21

- Load increases by more than 60 percent between 2020 and 2050
- A large portion of the net increase is from higher “fixed” loads, such as transportation electrification
- Significant portion is from other demand sources



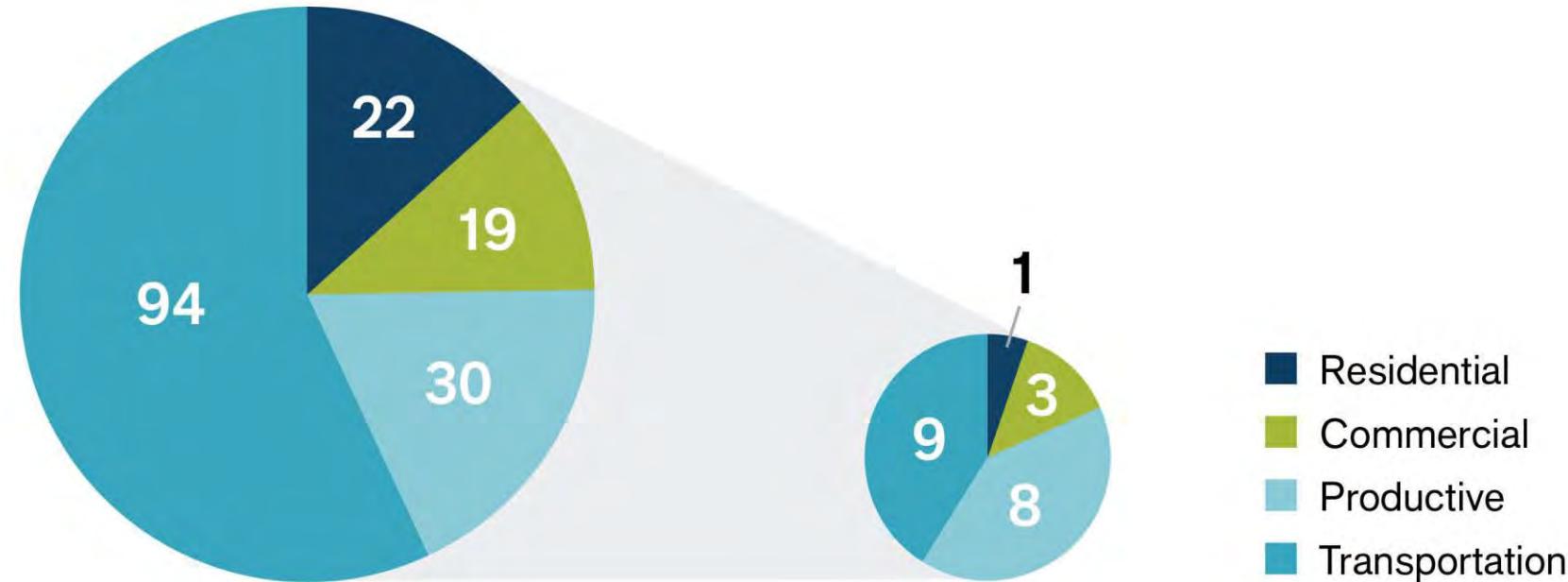
Final Energy Demand Declines, Even as Region Grows

- In the Central Case energy demand is down 34% and electricity consumption is up more than 50% in 2050.
- Even as population increases from 14.7 million people in 2020 to 19 million in 2050 and economy grow



NW CO₂ Emissions Decrease by Sector

All sectors contribute to reduction in Northwest CO₂ emissions, with decreases ranging from 95 to 73%.



2020: 165 MMT CO₂

2050: 21 MMT CO₂

Costs

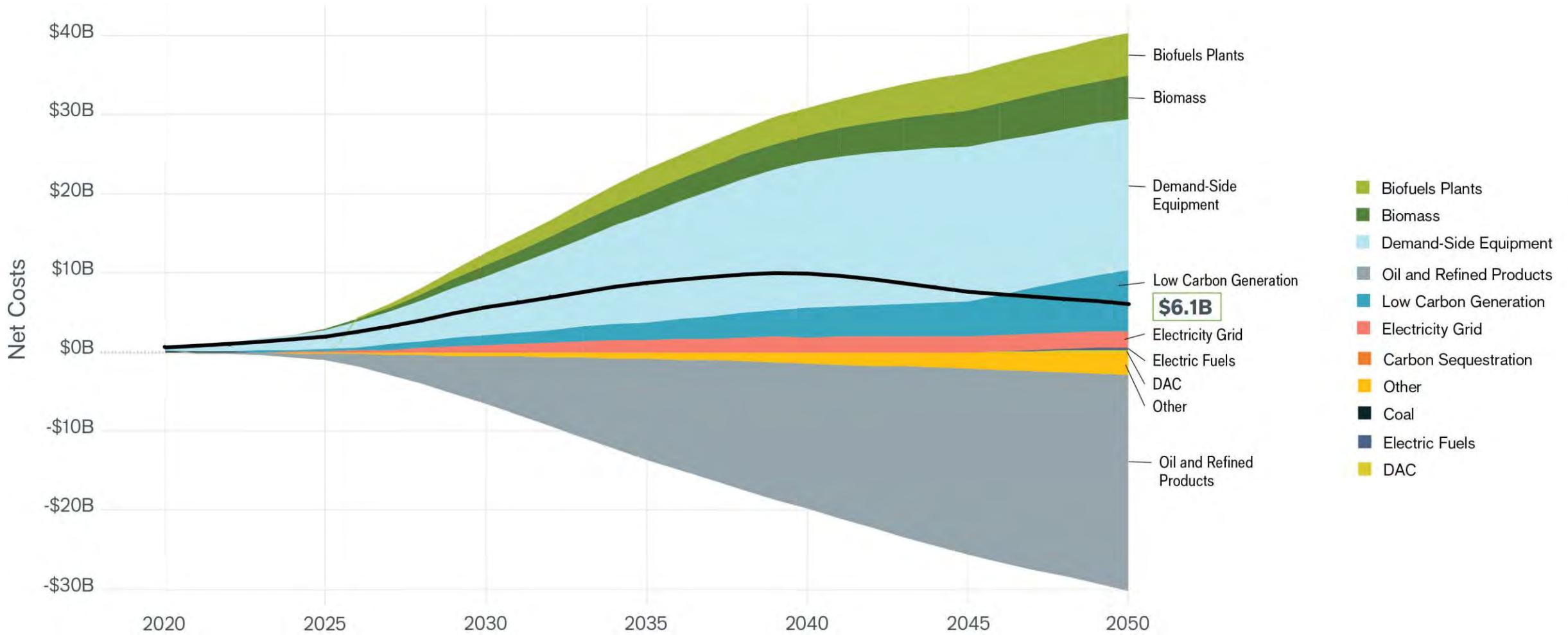


Estimated Net Cost to Achieve Target Roughly 1% of GDP

- Cumulative costs of decarbonizing the energy system in the Central Case are 9.5% higher than the capital and operating expenses of the Business as Usual energy system
 - Represents roughly 1% of region's GDP
- \$48/avoided ton of carbon
- Does not include benefits from avoiding climate change, reducing air pollution, improved health

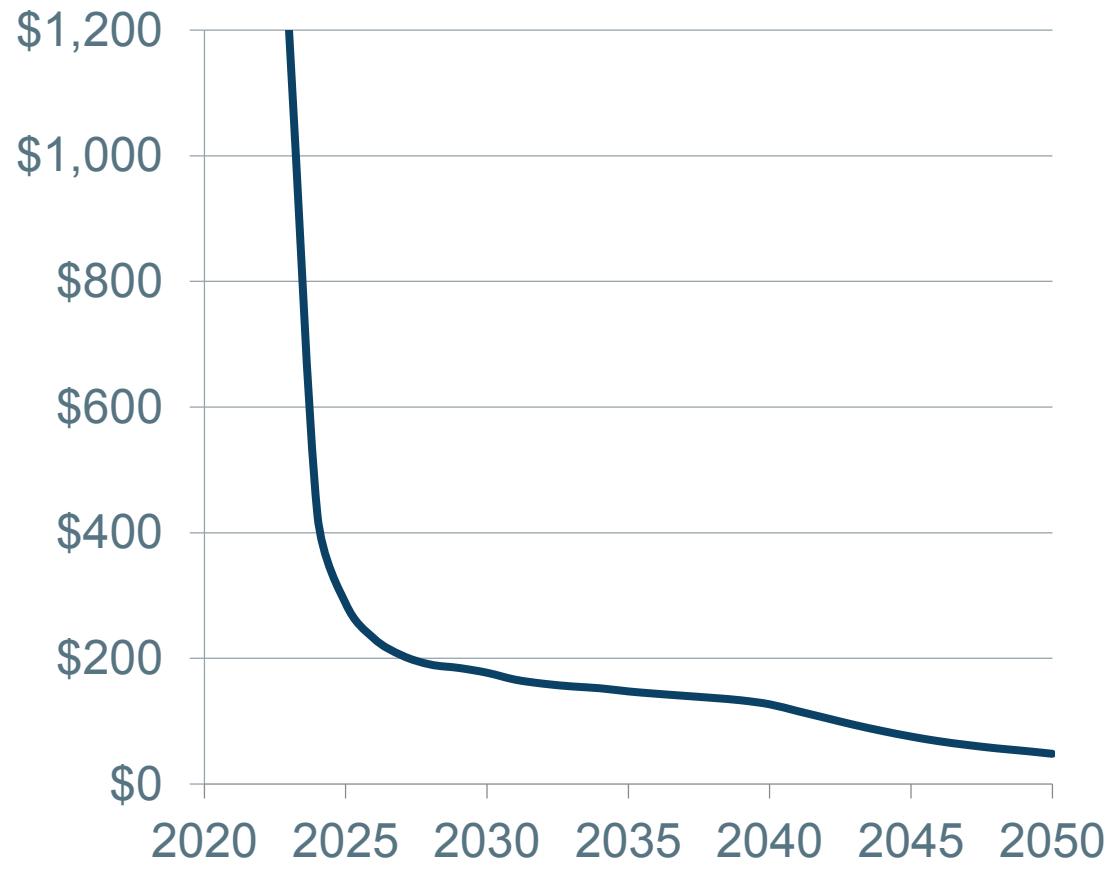


Net Annual Energy Costs



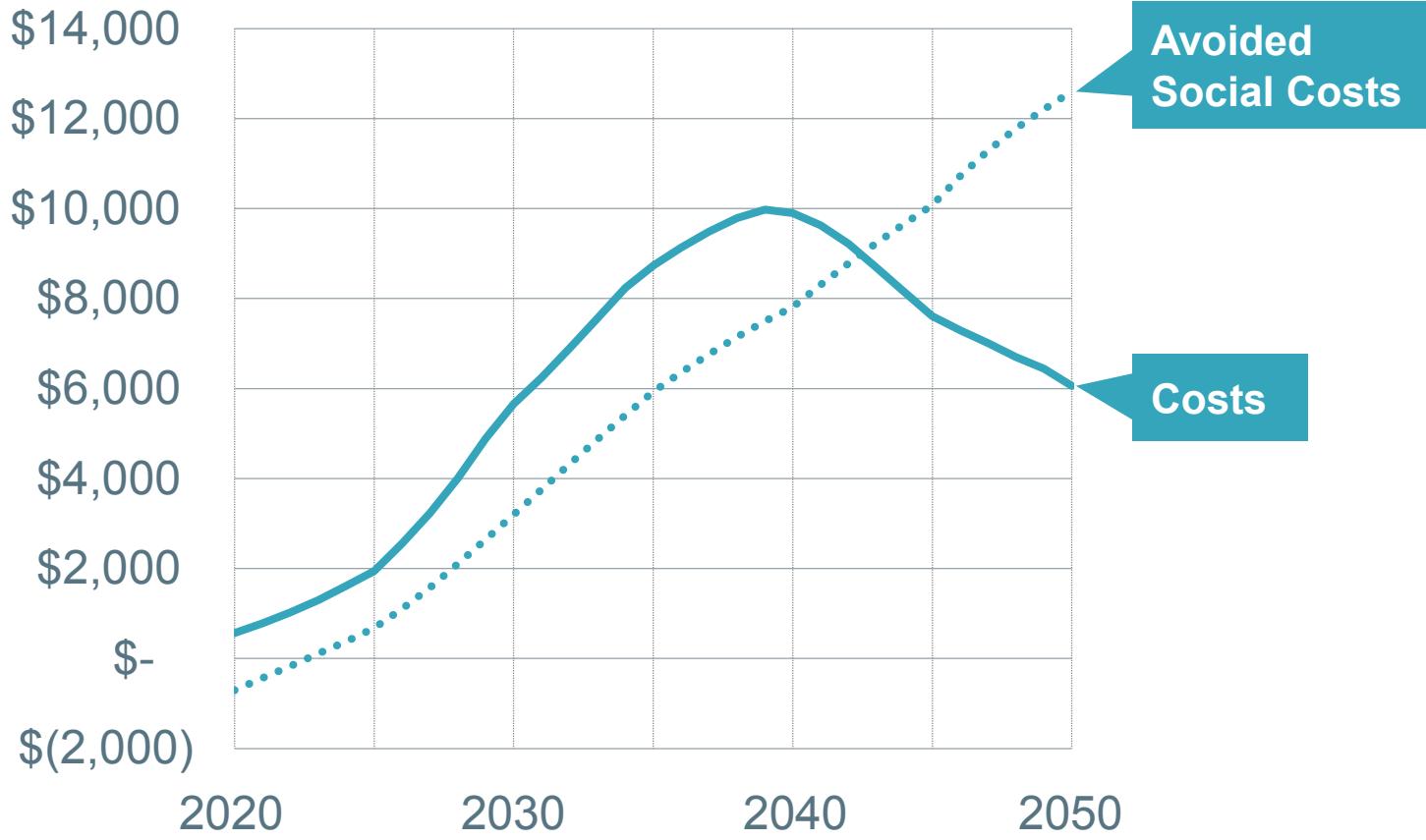
Annual Net Energy System Costs

Average Annual System Cost of Avoided CO₂ (\$)



Annual Net Energy System Costs

Annual Central Case System Costs and Avoided CO₂ Social Costs vs BAU Case (\$)



Insights from Alternative Pathways



Alternative Pathways



100% Clean Electricity Grid



Limited Electrification & Efficiency



No New Gas Plants for Electricity



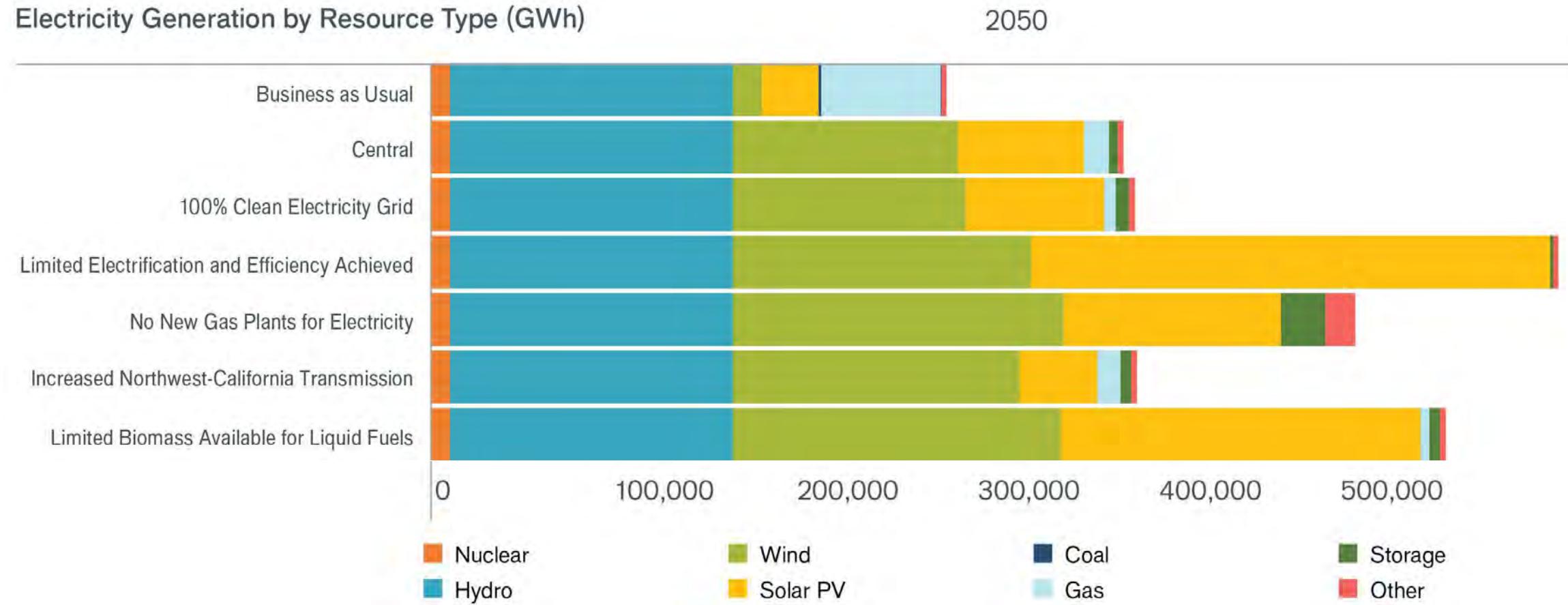
Limited Biomass for Liquid Fuels



Increased NW-CA Transmission

- Easier with economy-wide approach; electric fuels achieves additional 4%
- Enormous supply/cost implications; scale of facilities prohibitive; imports likely
- More energy storage & renewables for reliability; approximately double the cost
- Similar energy system impacts to the No New Gas, though not as costly
- Saves \$11.1B; avoid development of low-quality renewables in CA & in NW

Electricity Resources All Cases in 2050



Bottom Line: Deep Decarbonization Achievable

Deep decarbonization is achievable but will require:

- Energy System Transformation
- Deployment of Multiple Strategies
- Investment and R & D
- Technology, Business Model, and Policy Innovation



Policy, Investment, and Innovation Implications

- Implementing widespread, regional transportation electrification
- Severely limiting natural gas in buildings, transport, and the grid
- Achieving better grid integration between the Northwest and California
- Assessing actual biomass in the Northwest for jet and diesel biofuels
- Determining the role power-to-X, electrolysis, direct air capture in the Northwest



Discussion



Issues Utilities Face

- Maintaining **reliability & affordability**
- Planning & investing in the face of **increased uncertainty**
- Responding to the “**No New Gas**” movement
- Maintaining hydro capacity
- Achieving **regional grid integration**
- Siting new **generation & transmission** facilities
- Creating **new flexible loads using new technologies**
- Developing and deploying new **business models and regulatory approaches**



Thank you



Eileen V. Quigley
Executive Director
Clean Energy Transition Institute
eileen@cleanenergytransition.org

Marc Daudon
President
The Caspian Group
marc@caspiangroup.com