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

An Economy-Wide Deep Decarbonization Pathways Study • June 2019

Yale Environmental Sustainability Summit | 11.02.2019

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- Deep Decarbonization Pathways
- Key Findings
- Perspectives from the Northeast
- Issues Utilities Face
- Discussion

YALE ENVIRONMENTAL SUSTAINABILITY SUMMIT

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

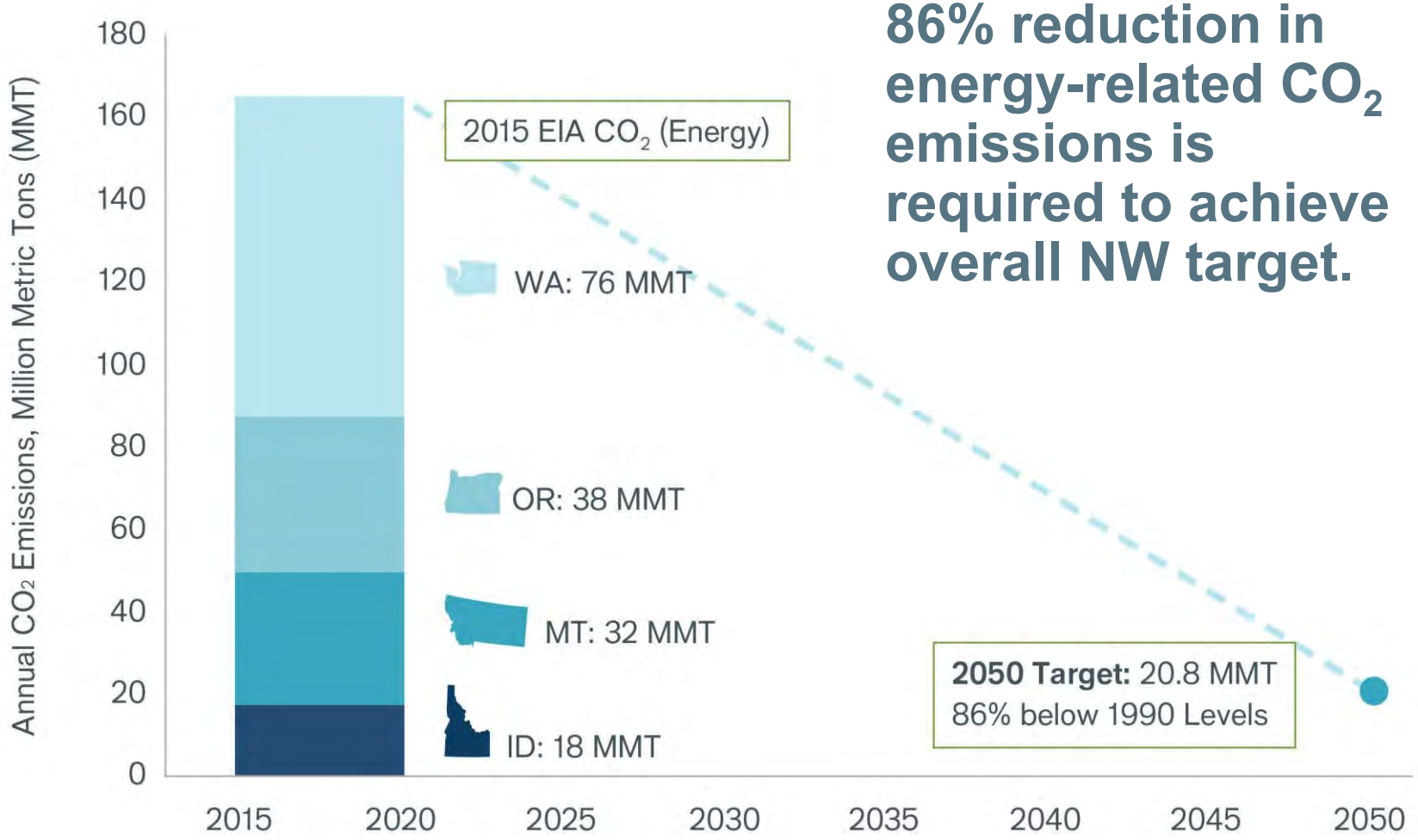
- **Scope:** WA, OR, ID, MT
- **All Energy Sectors Represented:**
  - Residential and commercial buildings
  - Industry
  - Transportation
  - Electricity generation

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

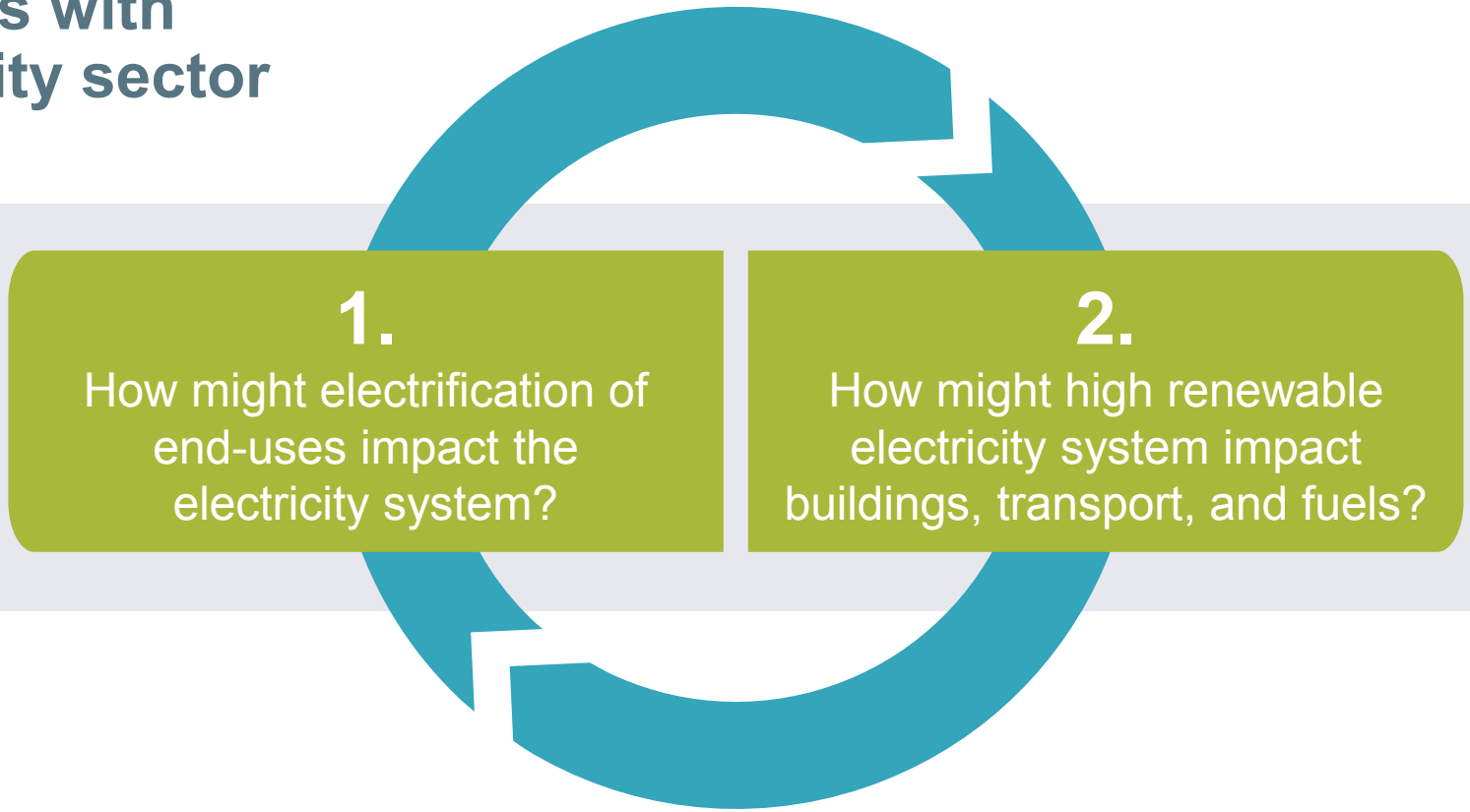
Northwest Deep Decarbonization Target



86% reduction in energy-related CO_2 emissions is required to achieve overall NW 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

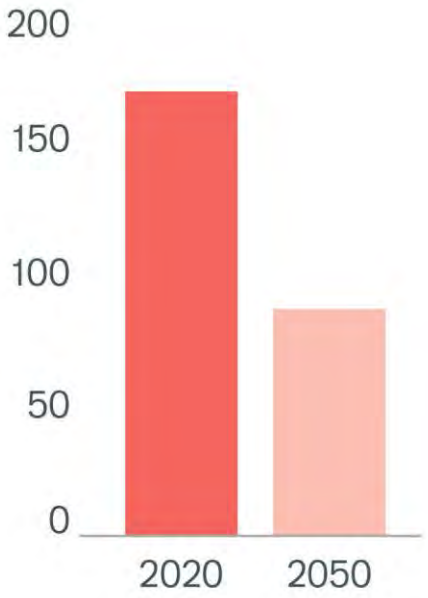
Key Findings: Deep Decarbonization Achievable

- **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

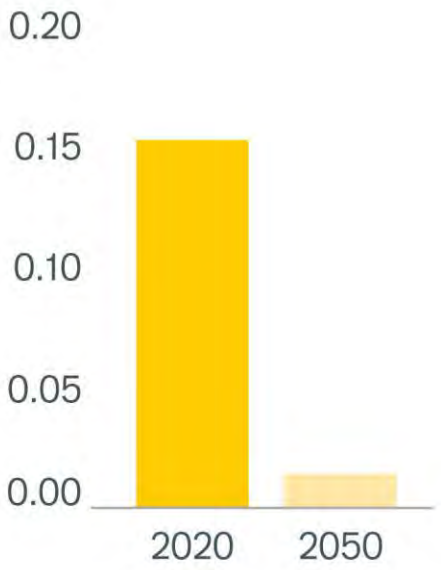
Efficiency

Per capita decreases 50%



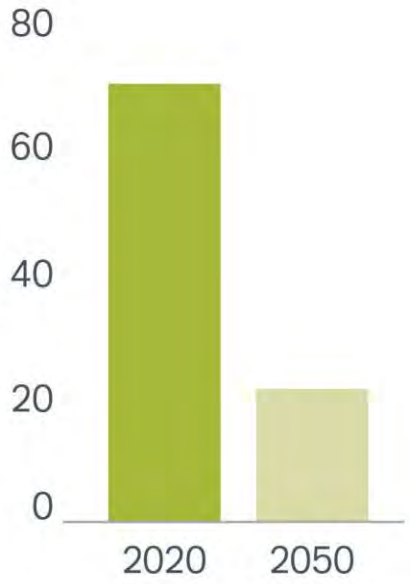
Clean Electricity

96% Clean by 2050



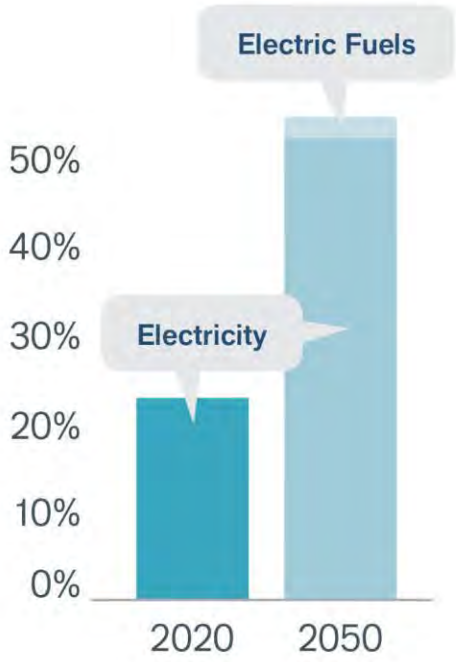
Clean Fuels

70% decrease



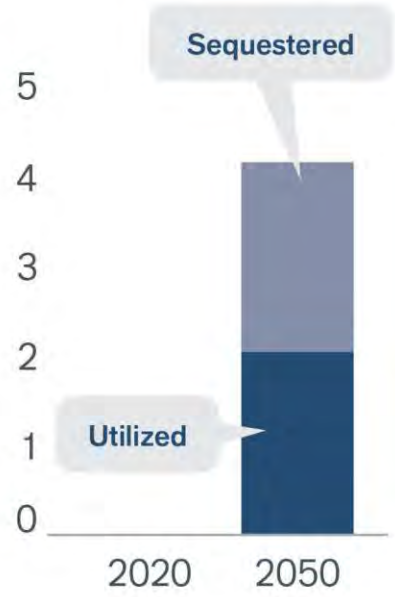
Electrification

Doubles from 23% to 55%



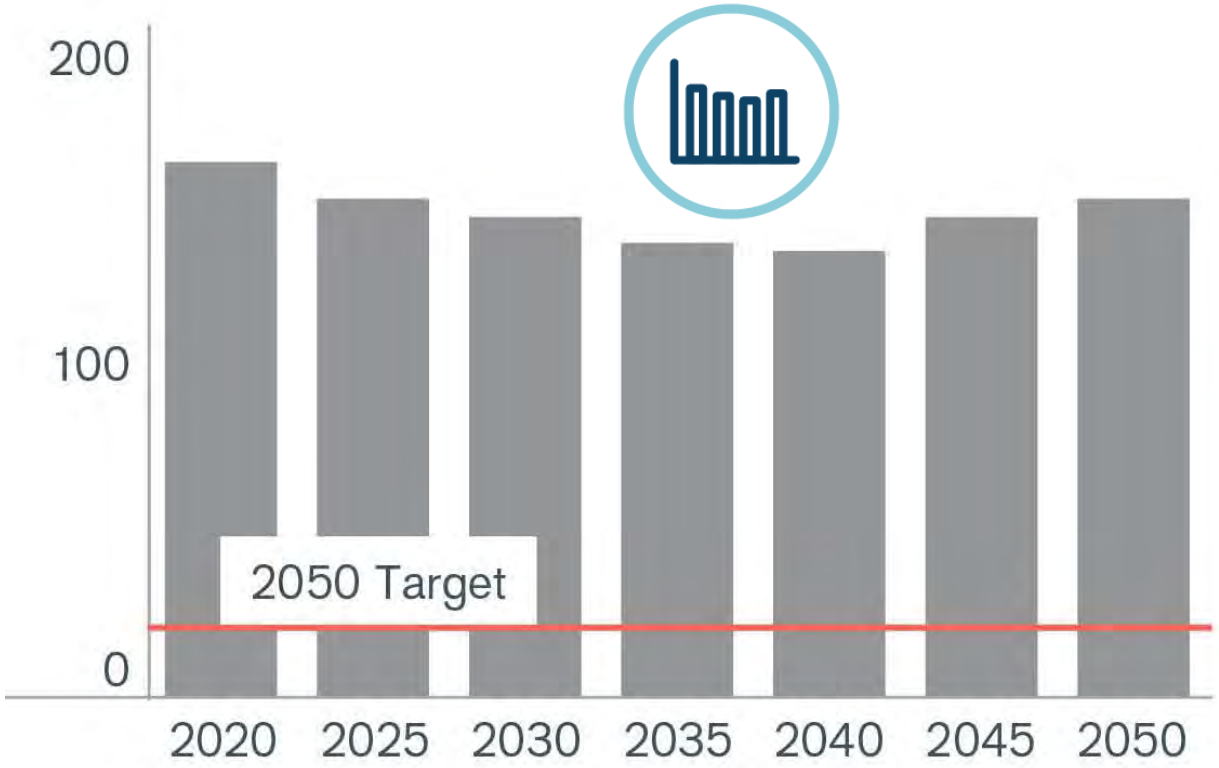
Carbon Capture

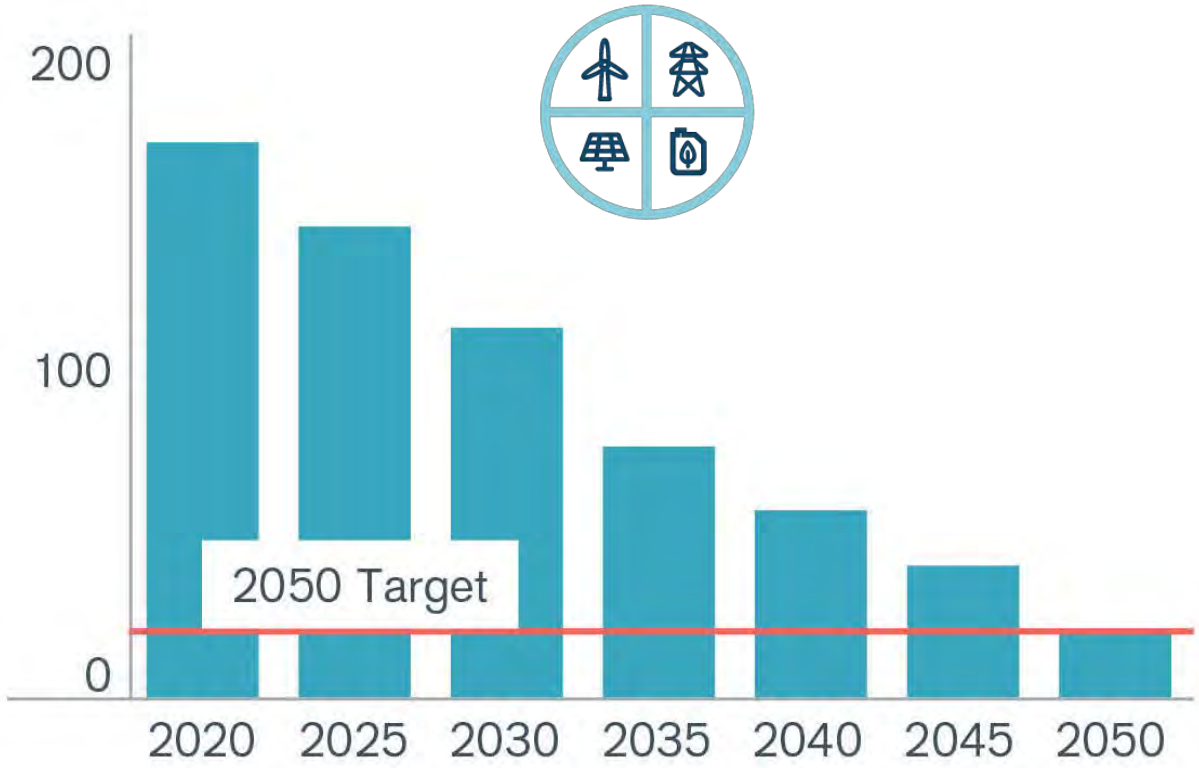
1/2 fuel; 1/2 sequestered



Business as Usual vs. Central Case

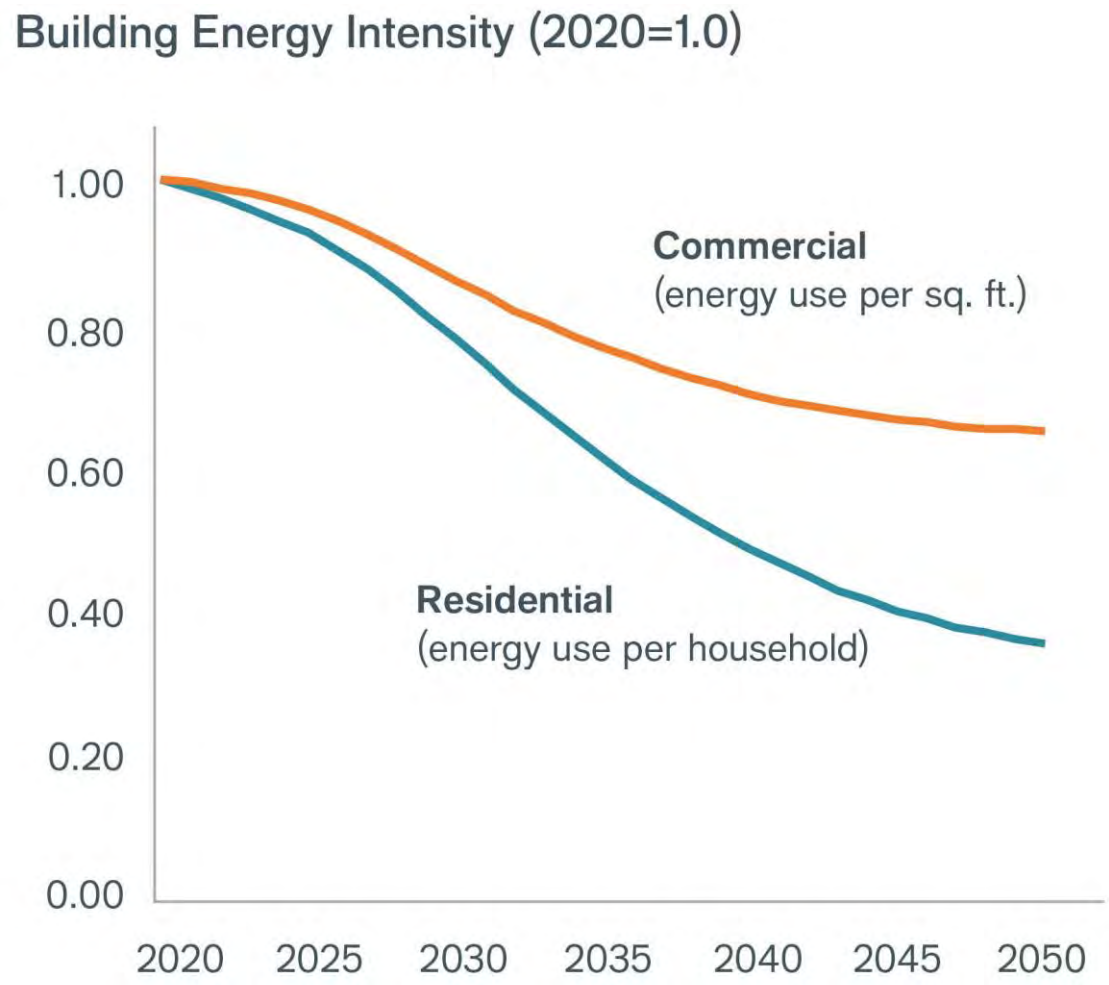
In the Business as Usual Case emissions trajectory falls far short of the 2050 reduction goal, while the Central Case meets the mid-century energy CO_2 emission target of 86% below 1990 levels.





Buildings: Deep Efficiency & Electrification

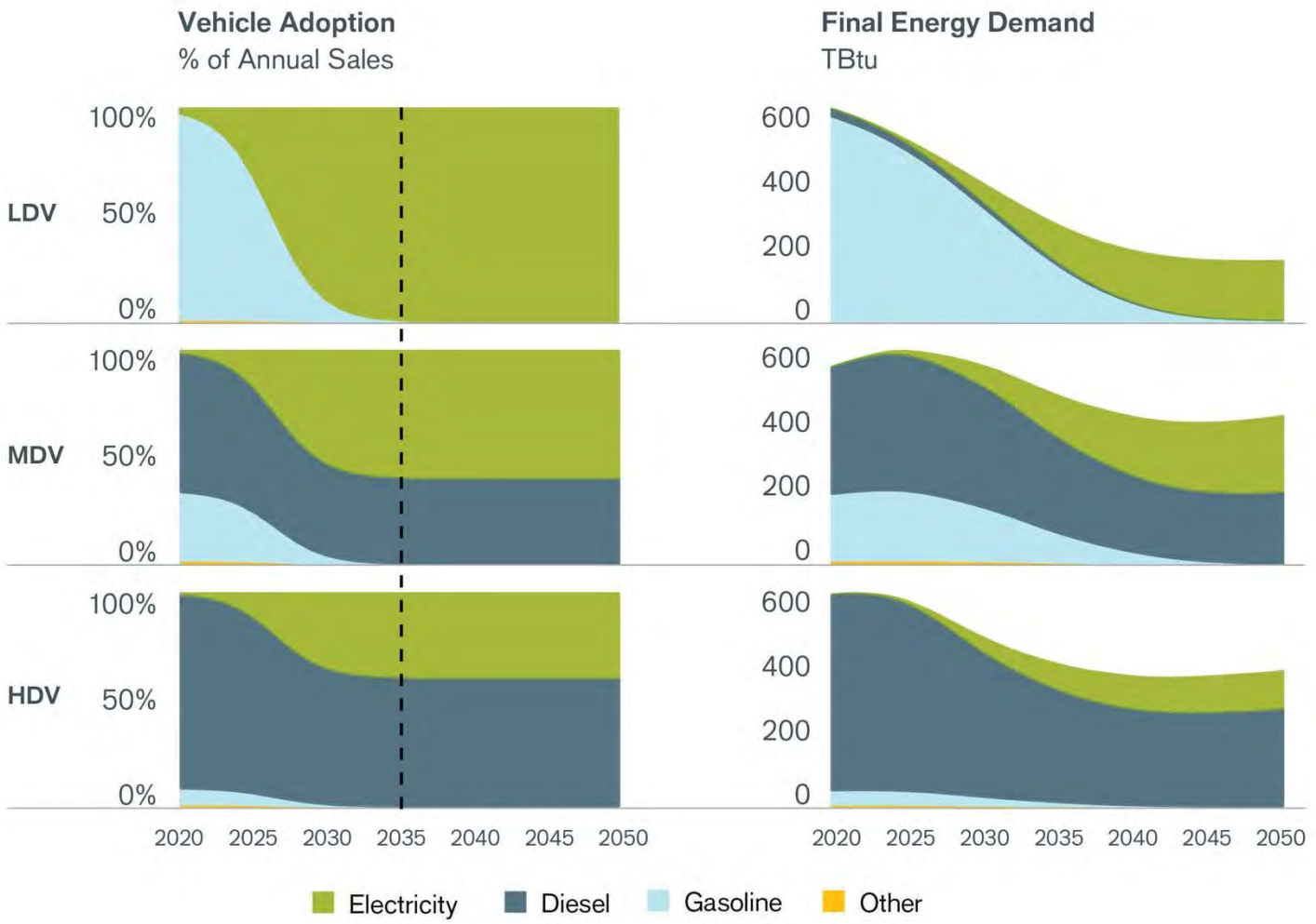
- **Building energy intensity declines by 30% for commercial and 60% for residential sector from 2020 to 2050.**



Transportation: Massive Shift to Electric Vehicles

By 2050:

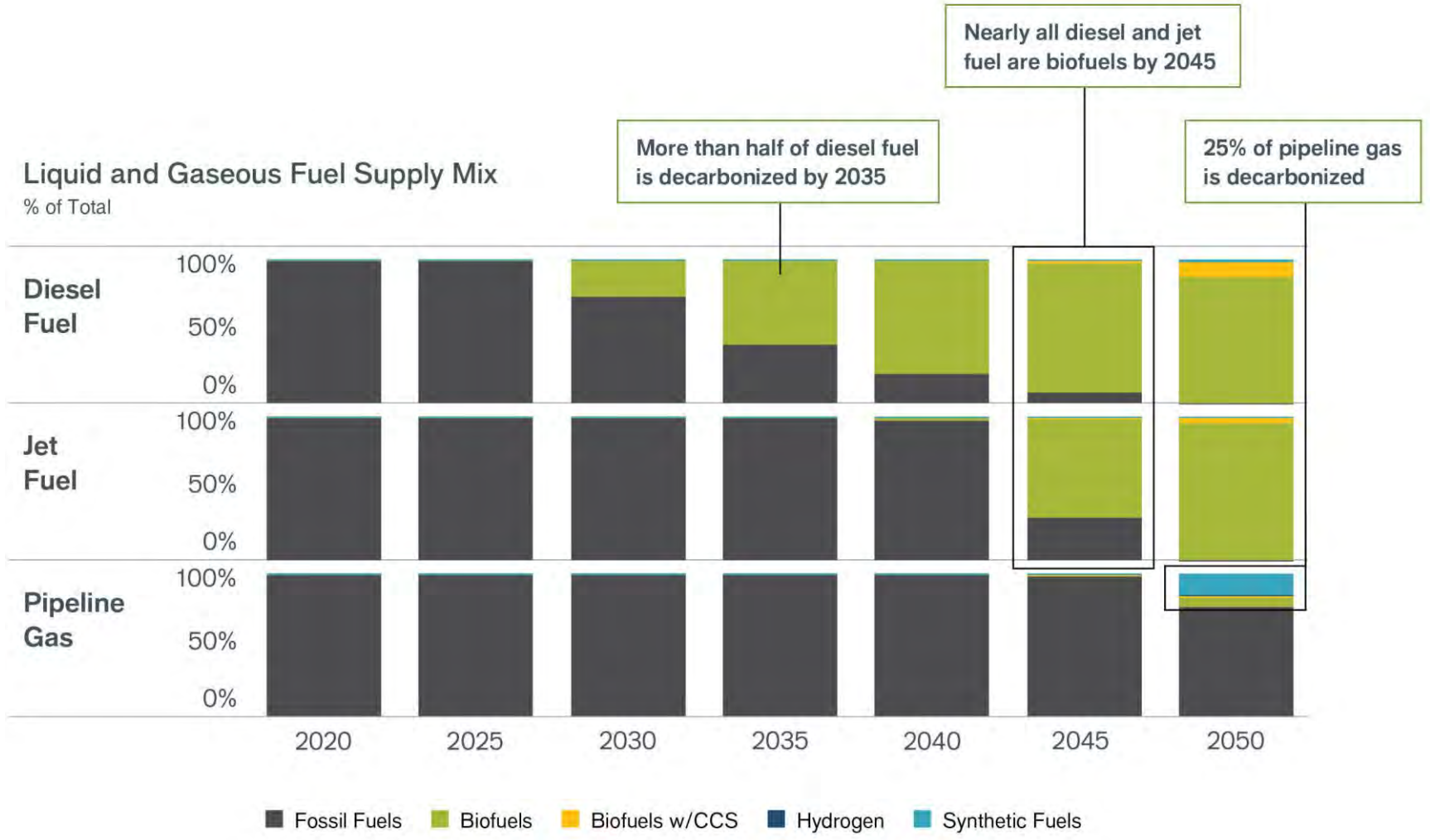
- Cars, SUVs, and light trucks fully electrified
- Medium and heavy duty trucks partially electrified
- Results in a 60% reduction in final transportation sector energy demand from light, medium, and heavy duty vehicles



Fuels: Decarbonized Diesel, Jet, and Pipeline Gas

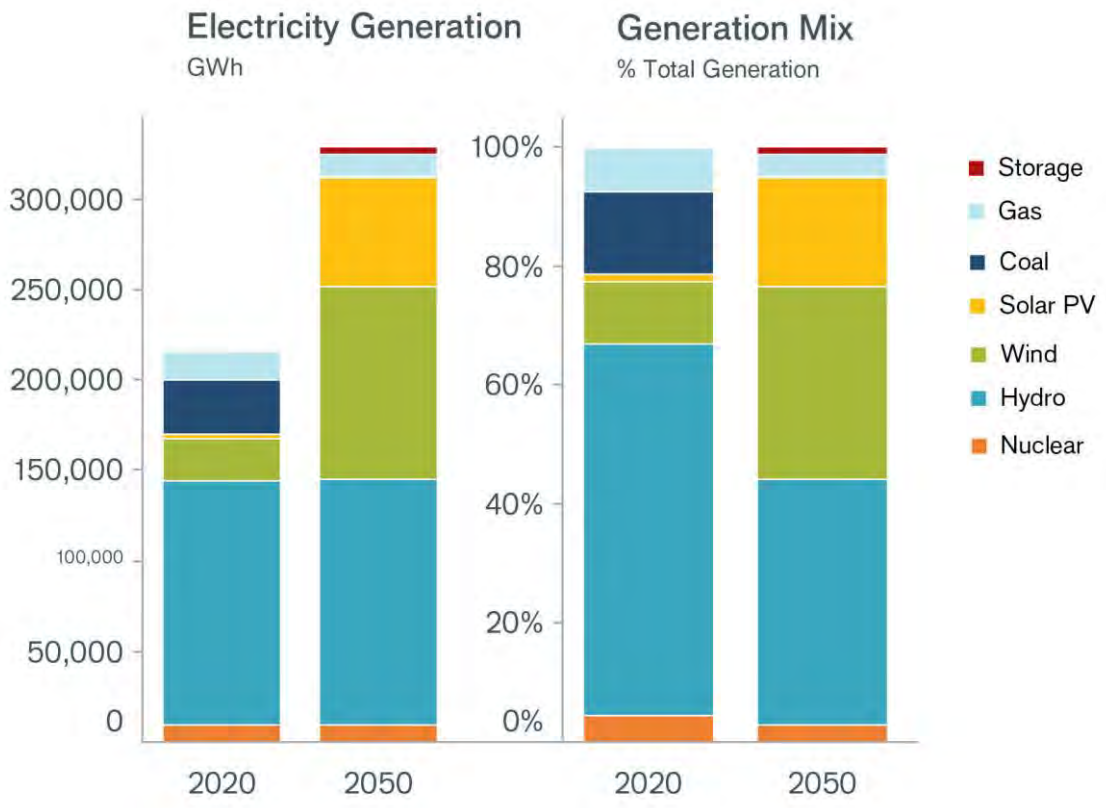
By 2050:

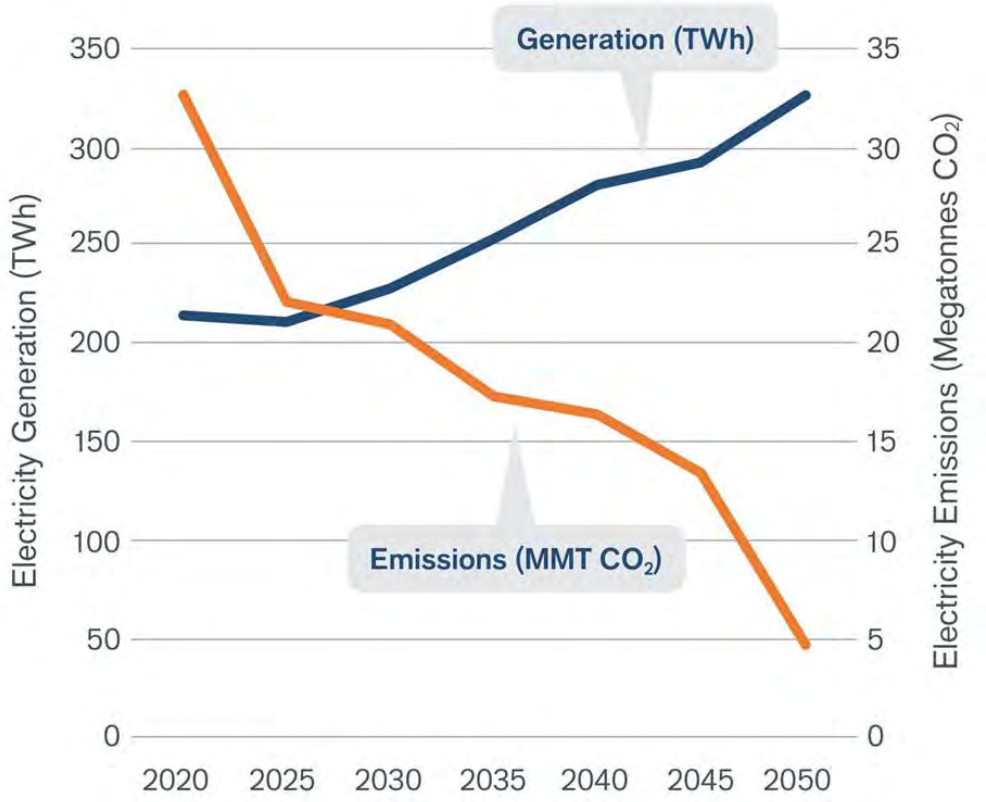
- Diesel and jet fuel fully decarbonized, primarily using biofuels.
- 25% of pipeline fuels partially decarbonized
- Synthetic fuels play a key role



Electricity: 96% Carbon Free

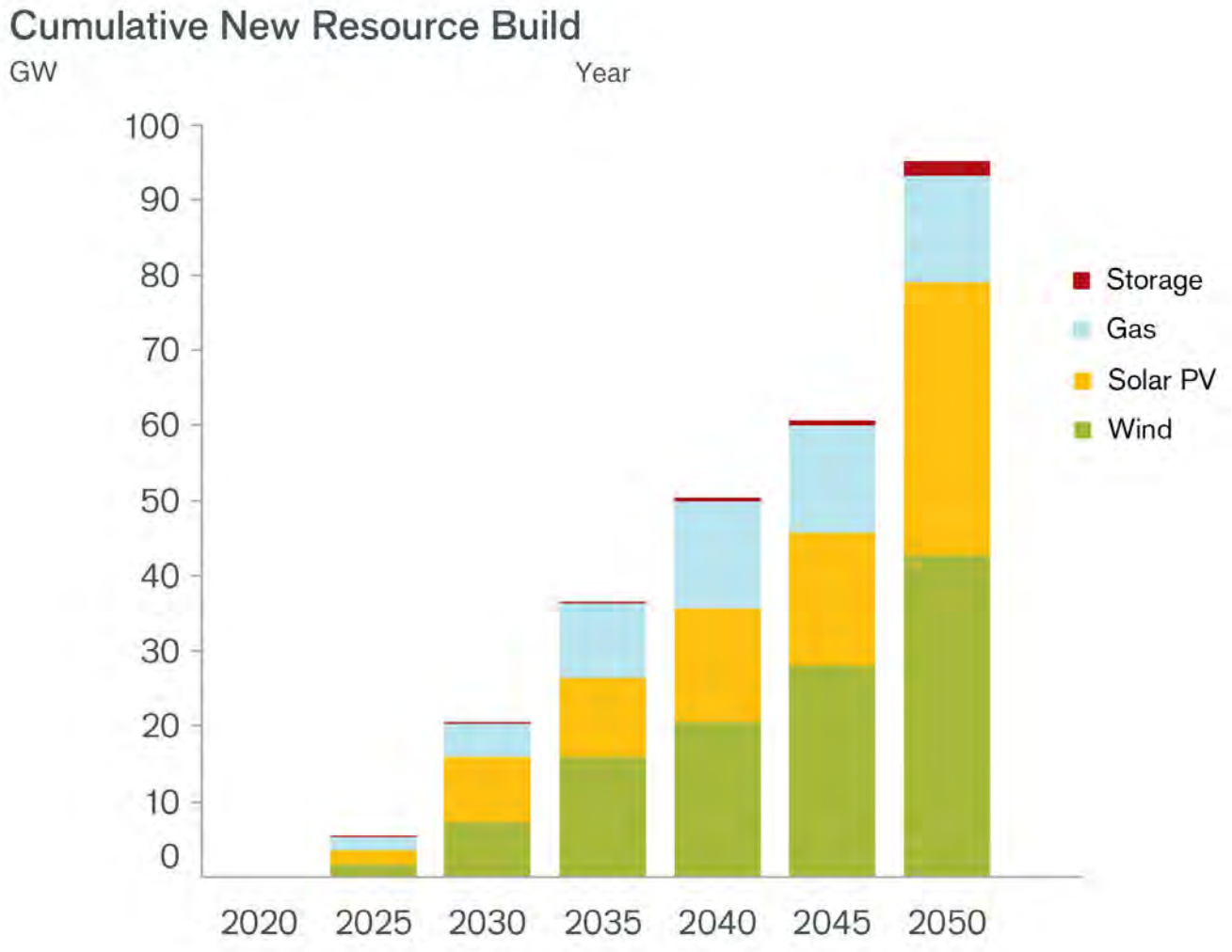
Generation increases 53%, with fossil fuel use at 4%, emissions decline by 86%.





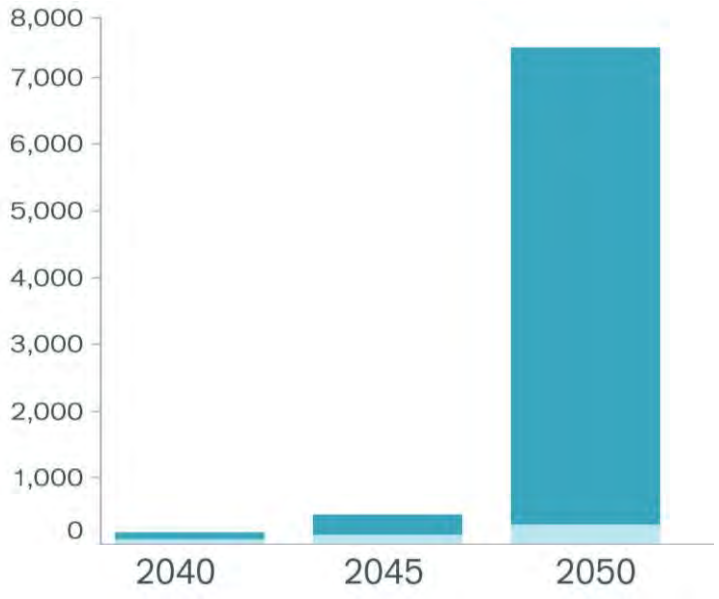
Electricity: Serves 55% of Final Energy Demand

- 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

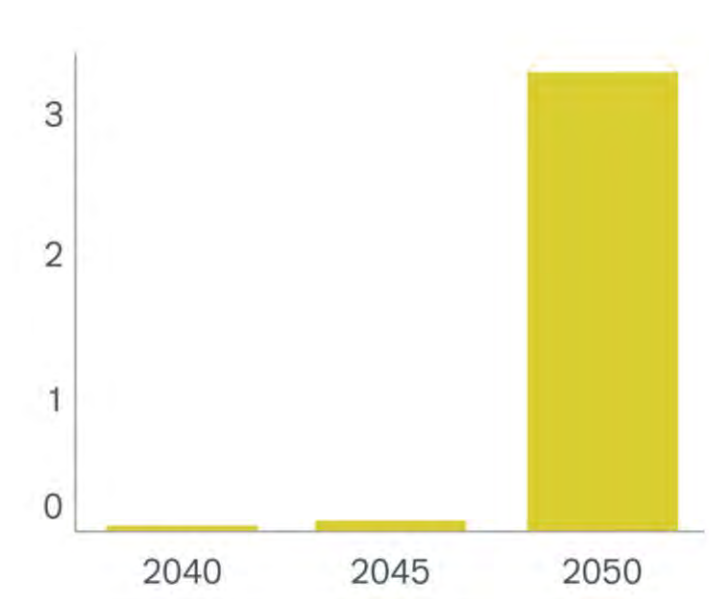


Electricity: New Technologies Reduce Curtailment & Meet Demand for Decarbonized Liquid Fuels

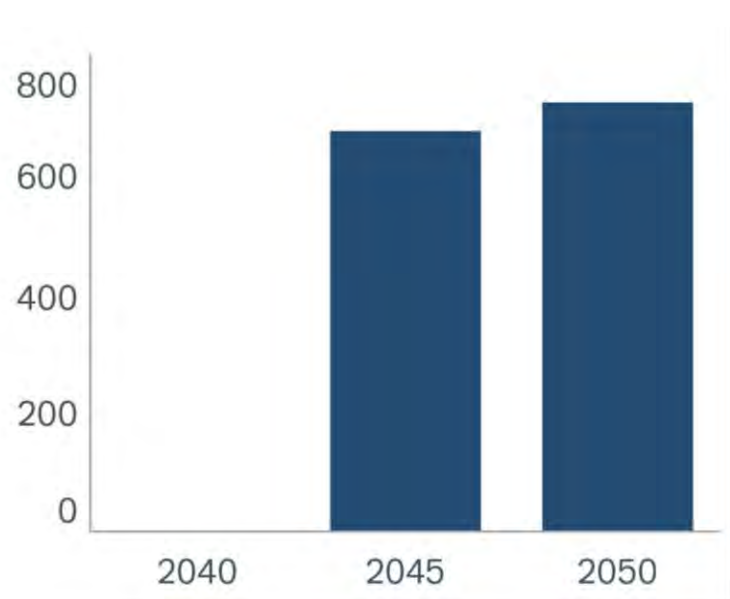
Electrolysis Capacity (MW)



DAC Total Capture Capacity (MMT)

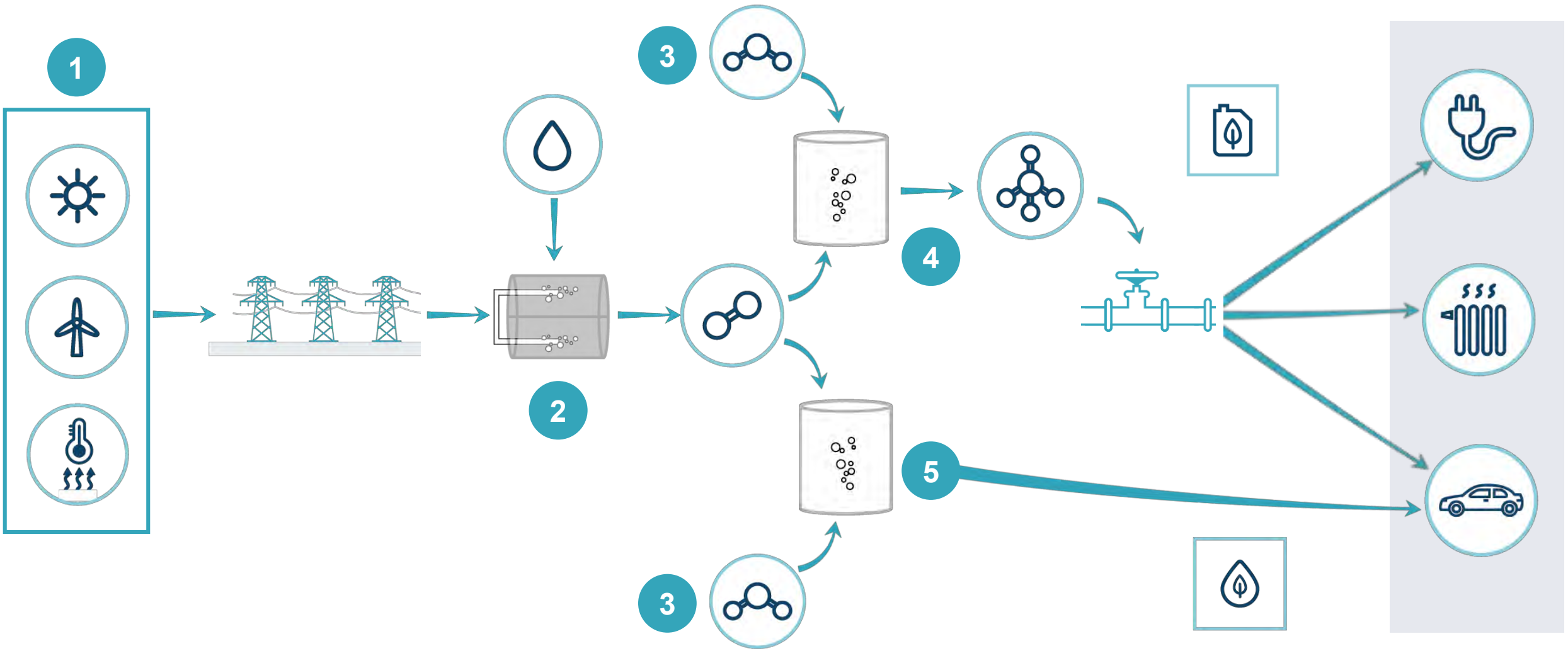


Electric Boiler Capacity (MW)



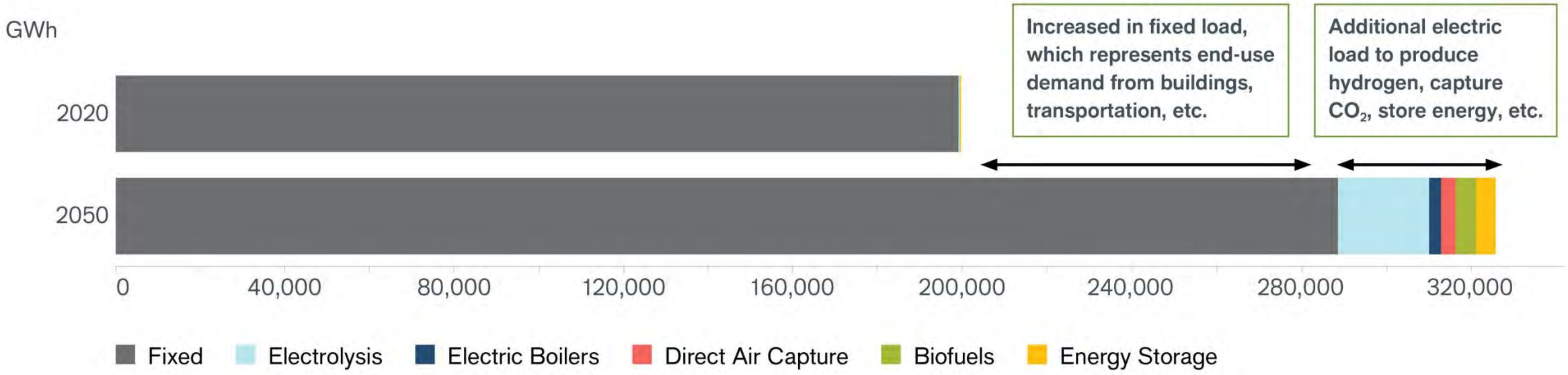
- Electrolysis uses 21,400 GWh; DAC uses 3,340 GWh; and Electric Boiler uses 2,950 GWh

Illustration of Power-to-Gas



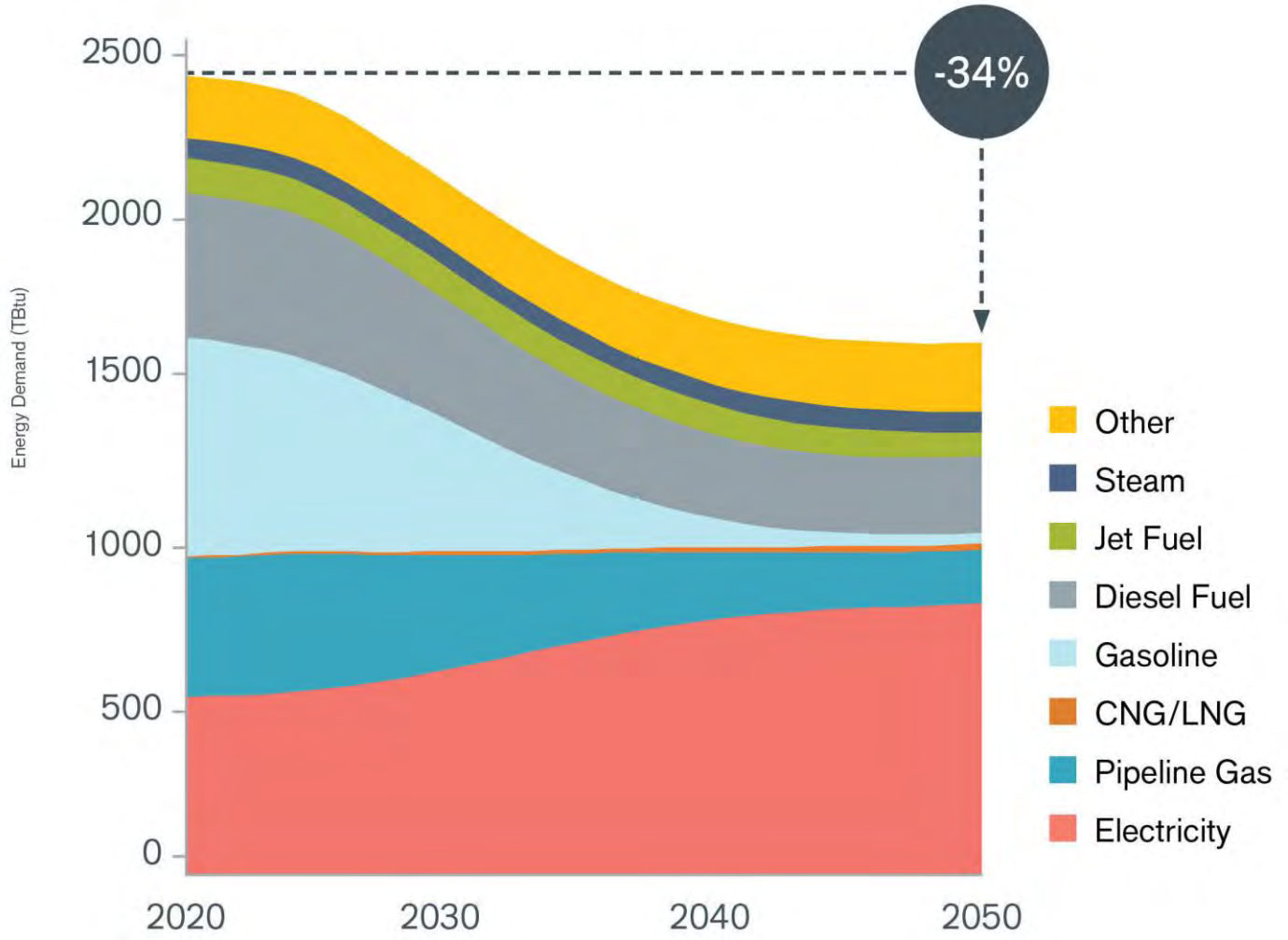
Electricity Sector: Serves Increasing Fixed Load, Produces New Sources of Decarbonized Energy

- **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**



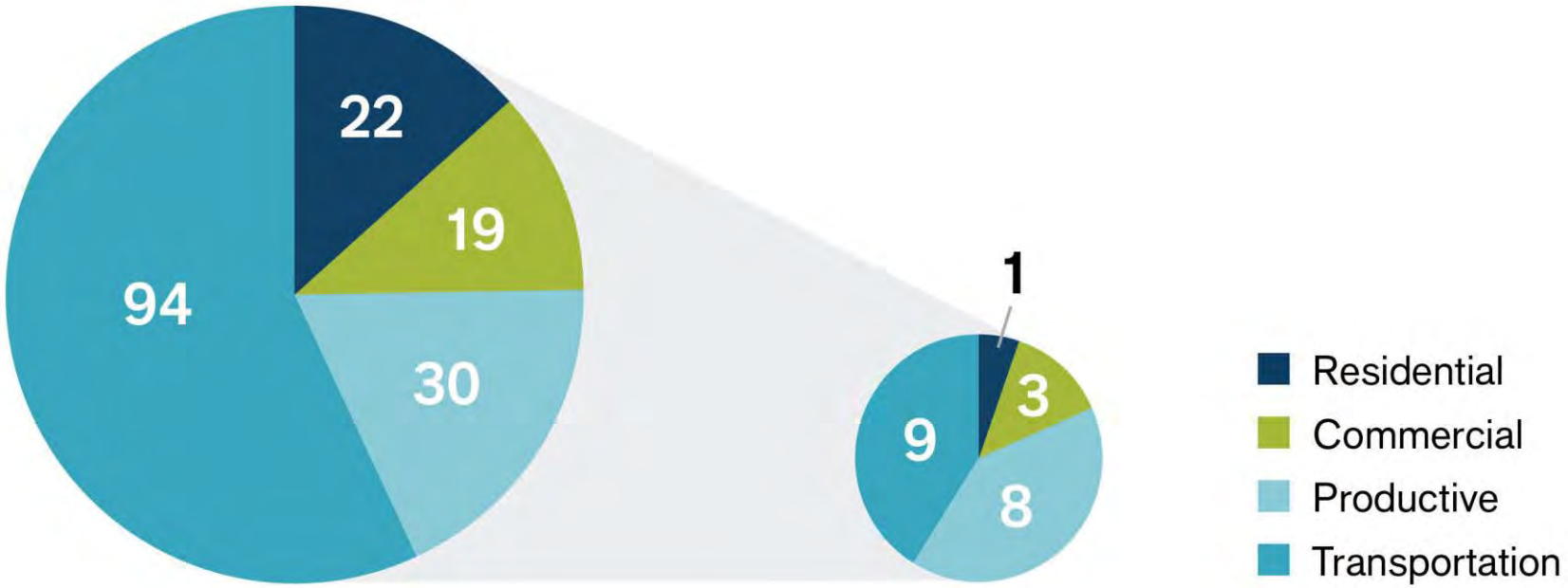
Final Energy Demand Declines, Even as Region Grows

- 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 CO_2 Emissions Decrease by Sector

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

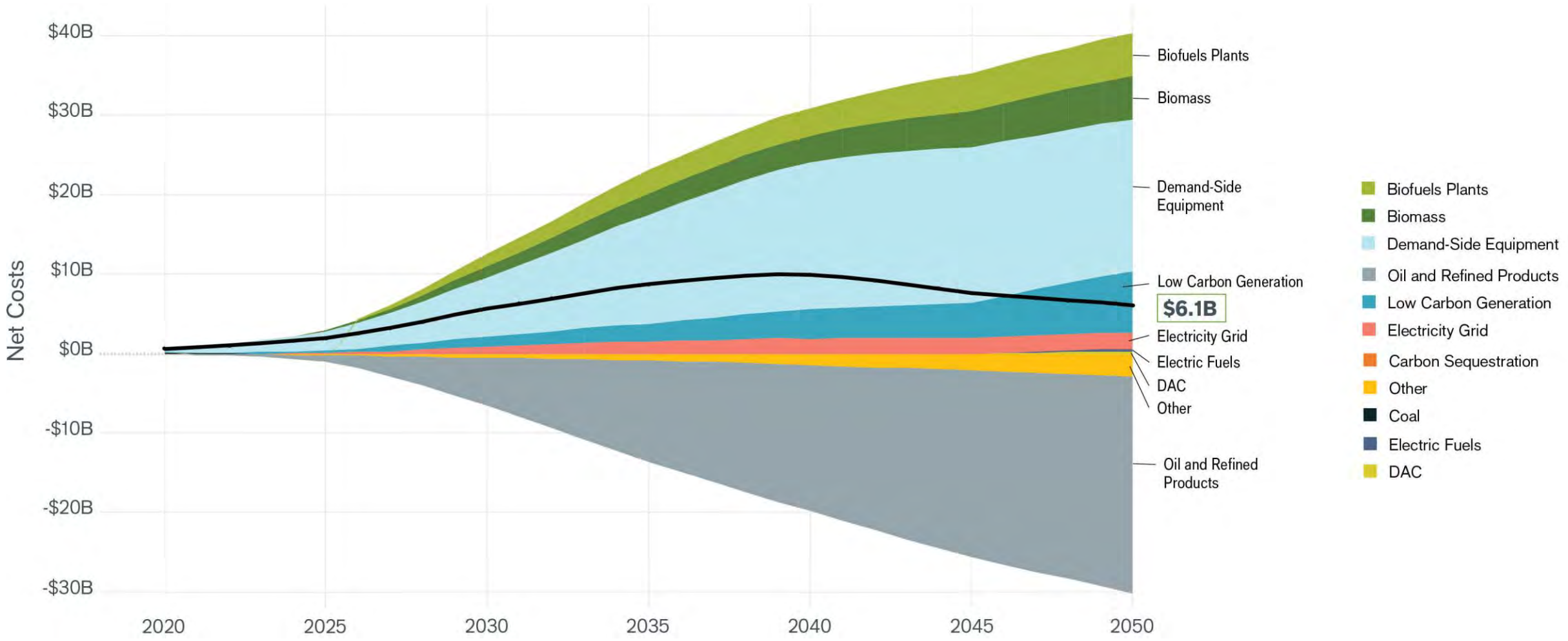


Costs

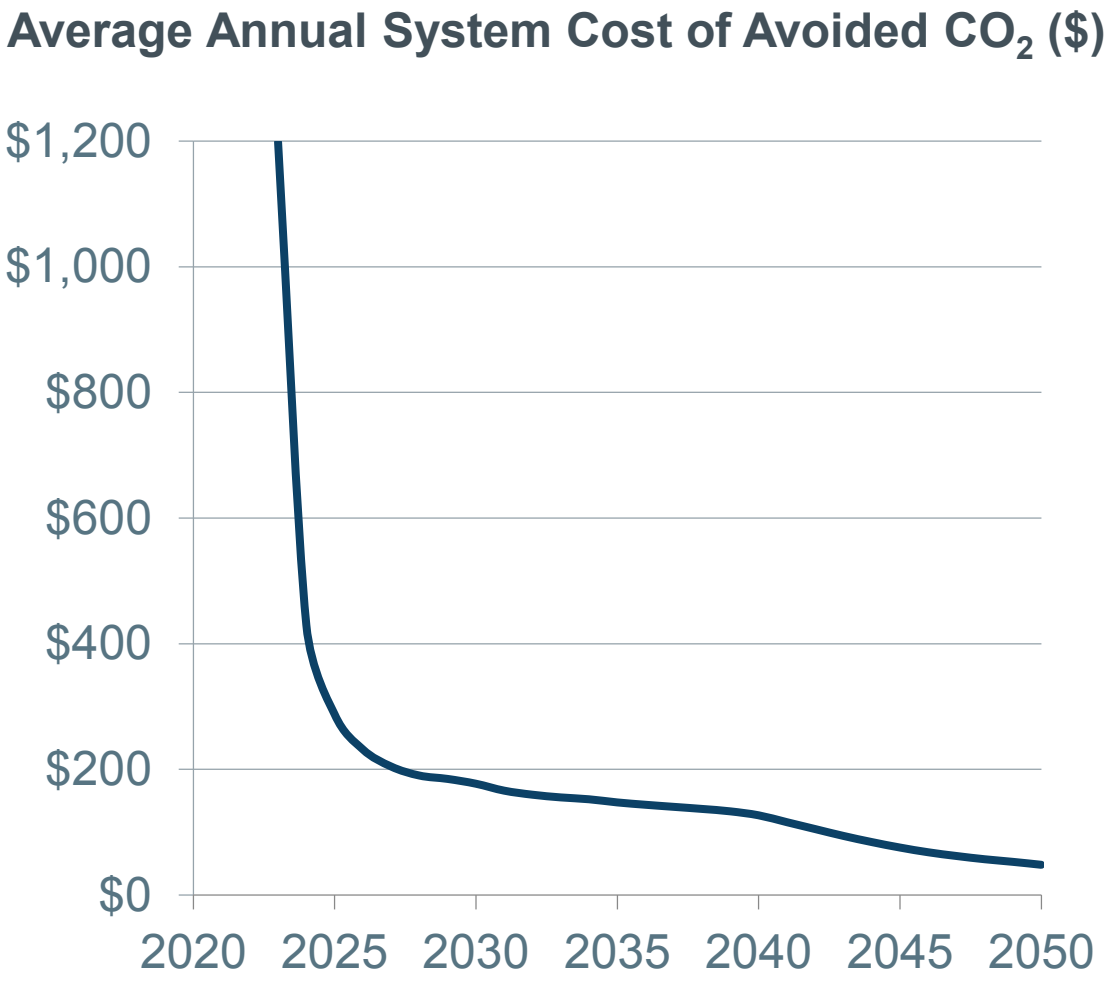
Estimated Net Cost to Achieve Target Roughly 1% of GDP

- 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

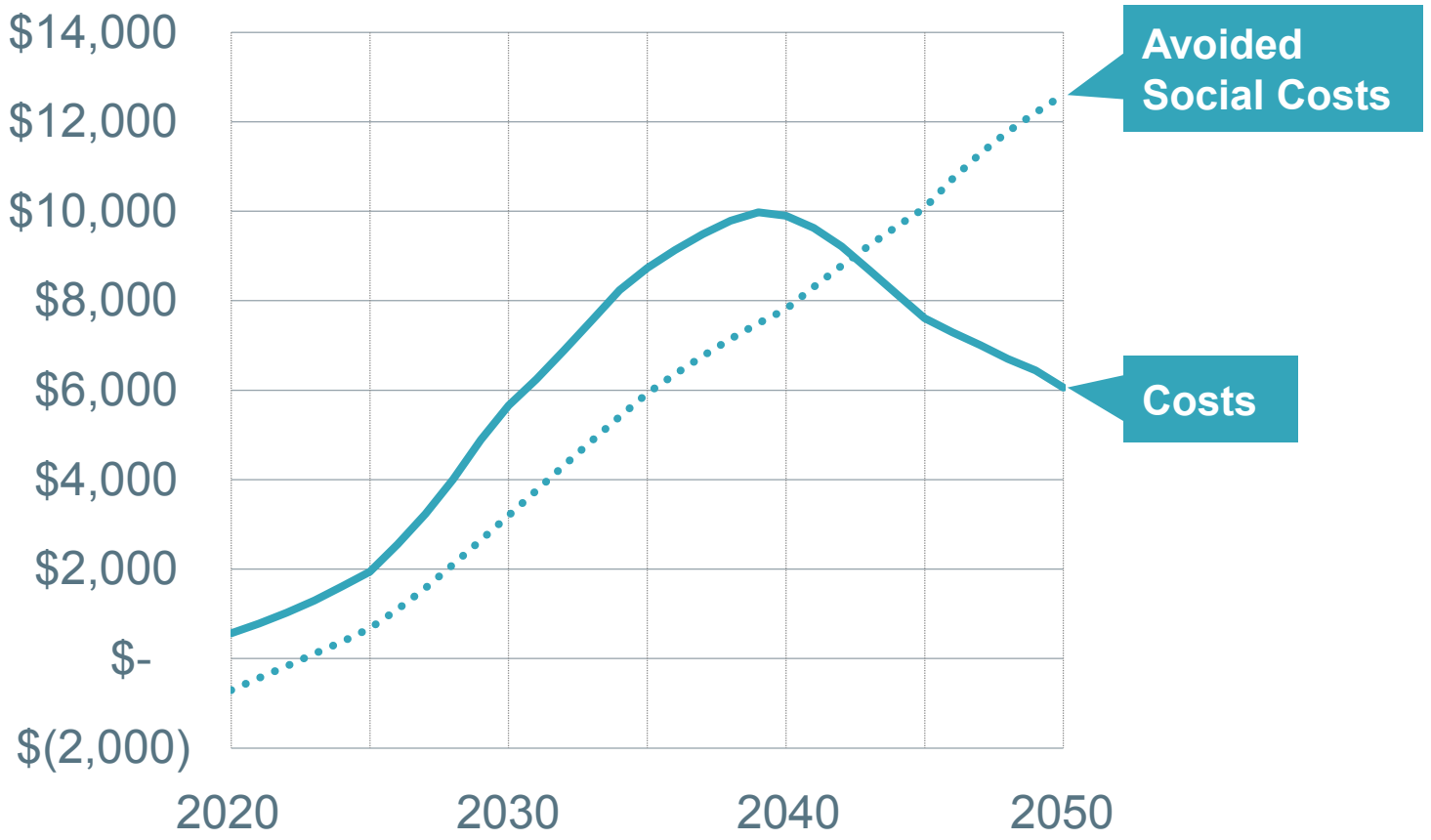


Annual Net Energy System Costs



Annual Net Energy System Costs

Annual Central Case System Costs and Avoided CO_2 Social Costs vs BAU Case ($)



Insights from Alternative Pathways

Alternative Pathways

100% Clean Electricity Grid

Limited Electrification & Efficiency

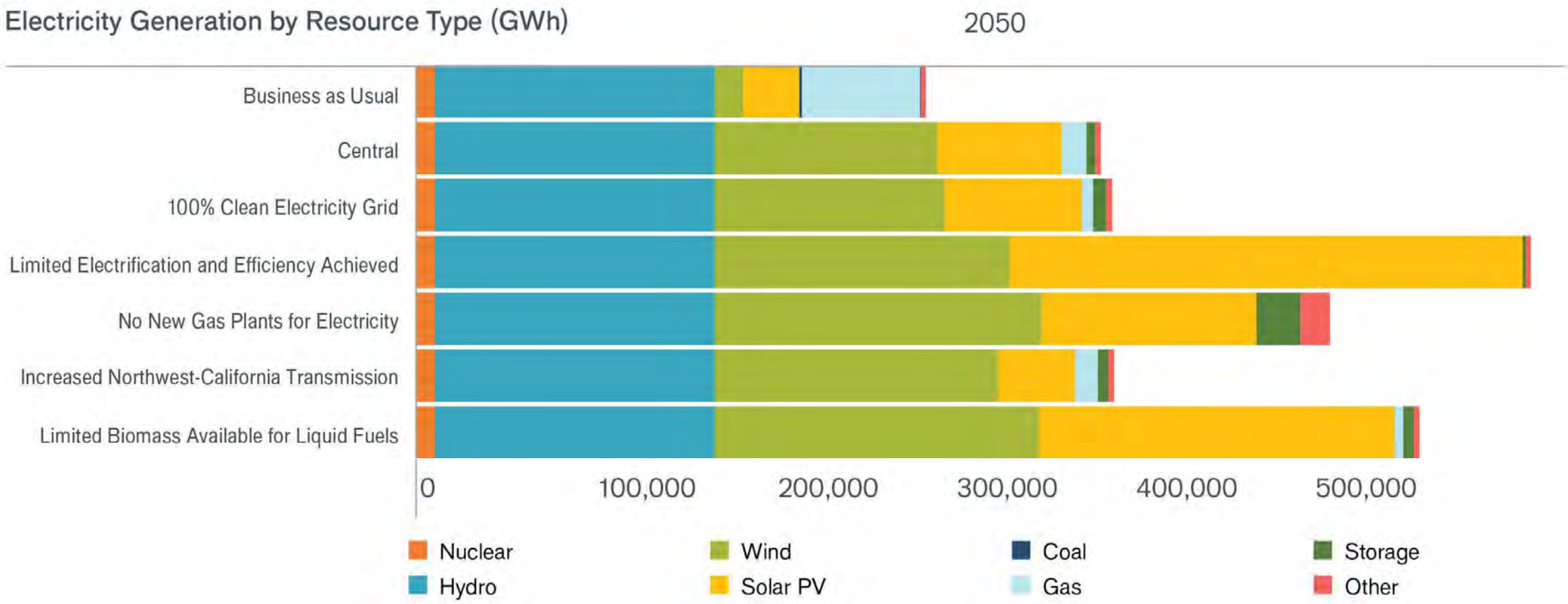
No New Gas Plants for Electricity

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

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