Meeting the Challenge of Our Time

Pathways to a Clean Energy Future for the Northwest

An Economy Wide Deep Decarbonization Pathways Study • November 2019

Clean Energy Transition Institute

Energy Leadership Conference Agenda

- Clean Energy Transition Institute
- Pacific Northwest National Lab
- Deep Decarbonization Pathways Study
- Key Findings
- Implementation Opportunities and Challenges
  - Building Integration with the Grid
  - Grid-Scale Storage
  - Transportation Electrification
  - Jet Fuel & Marine Fuel

Clean Energy Transition Institute

Independent, nonpartisan Northwest research and analysis nonprofit organization with a mission to accelerate the transition to a clean energy economy

- Identify deep decarbonization strategies
- Provide analytics, data, best practices
- Offer information clearinghouse
- Convene stakeholders to facilitate solutions

The Challenge: Achieving Deep Decarbonization in the Northwest

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

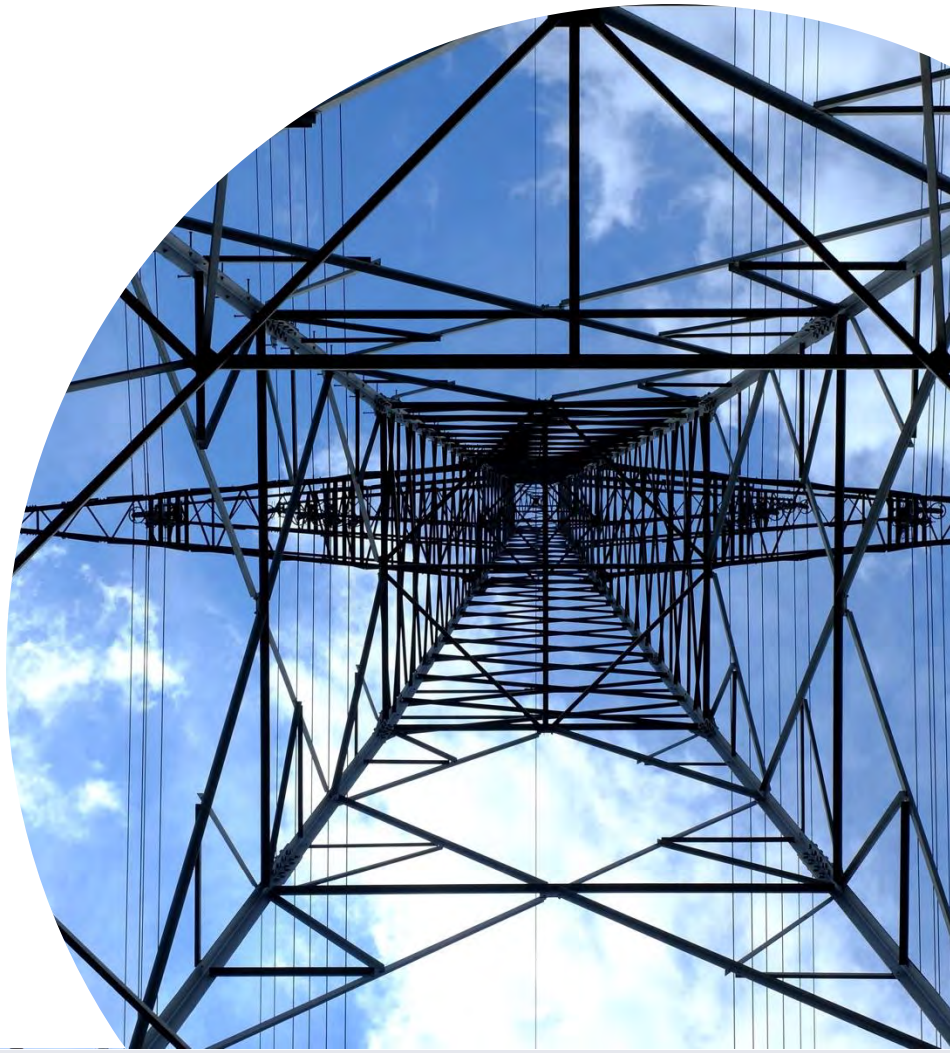
- Unbiased, analytical baseline for the region
- Variety of pathways to lower carbon emissions
- Surface trade-offs, challenges, and practical implications of achieving mid-century targets
- Broaden conversations about actions needed

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?

Approach to Decarbonizing Energy Supply

- Uses **conservative** assumptions about existing technology from public sources
- **Explores** how four NW states can achieve deep decarbonization in all energy sectors
- **Modeling determines optimal investment** in resources with least-cost
- **Decarbonizing energy supply**—electricity, pipeline gas, liquid fuels
- Accounts for **California systems** impact on the region



Scope: Northwest Regional Energy Sector

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

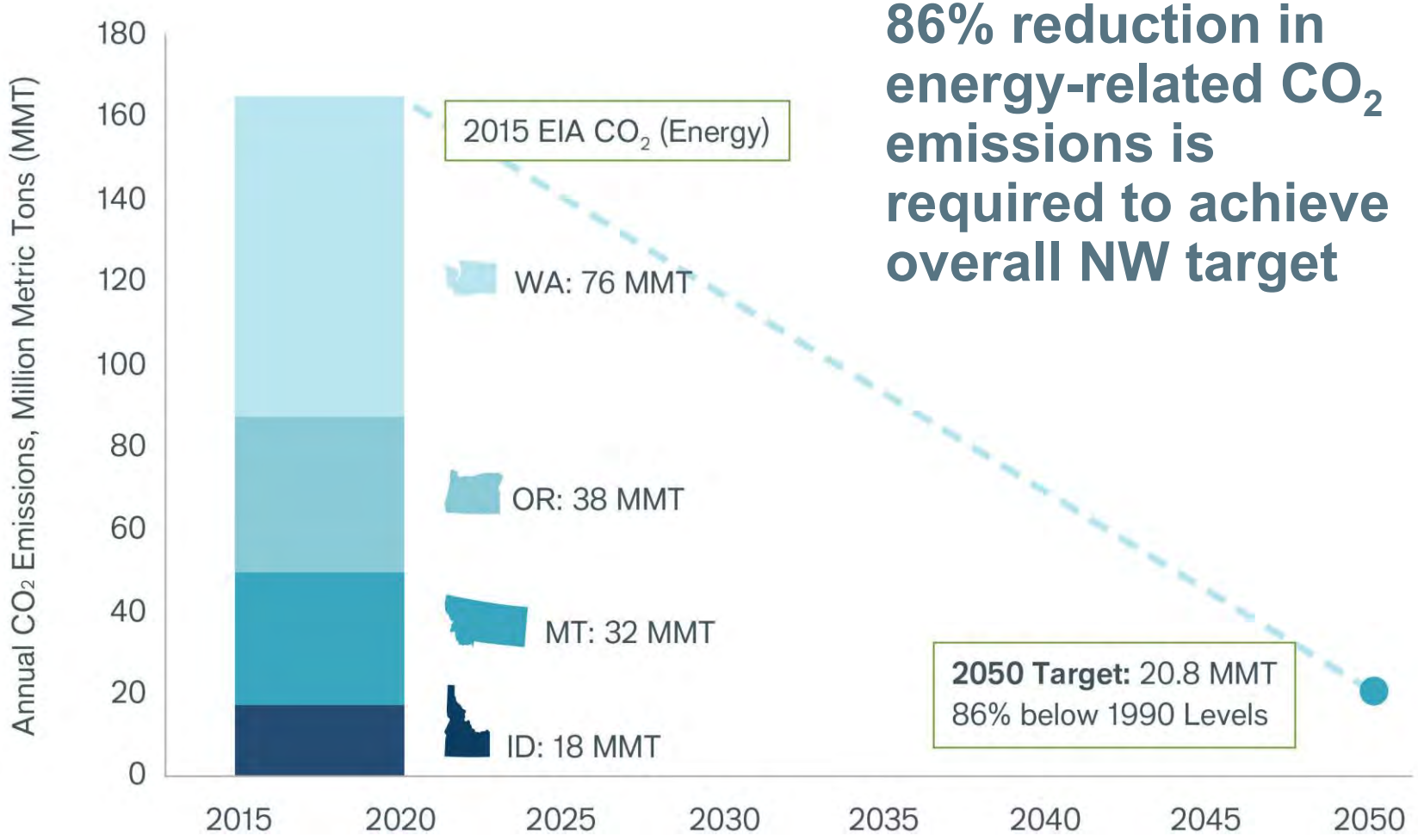
Evaluating holistically provides an understanding of cross-sectoral impacts and trade-offs

Study Emissions Target

86% reduction in energy-related CO_2 below 1990 levels by 2050

- Applied to each Northwest state independently
- Consistent with economy-wide reduction of 80% below 1990 levels by 2050
- Allows for reductions below 80% for non-energy CO_2 and non-CO_2 GHG emissions, where mitigation feasibility is less understood relative to energy

Northwest Deep Decarbonization Target



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

Energy Sector Transformation

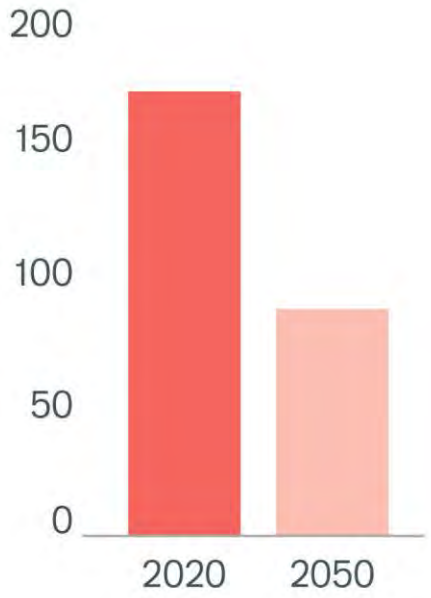
Key Findings: Deep Decarbonization Achievable

- **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

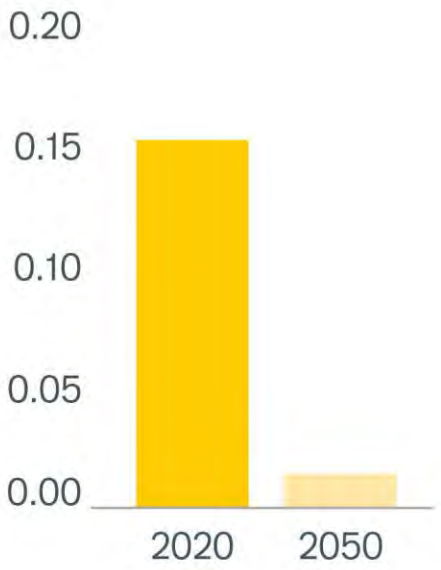
Efficiency

Per capita decreases 50%



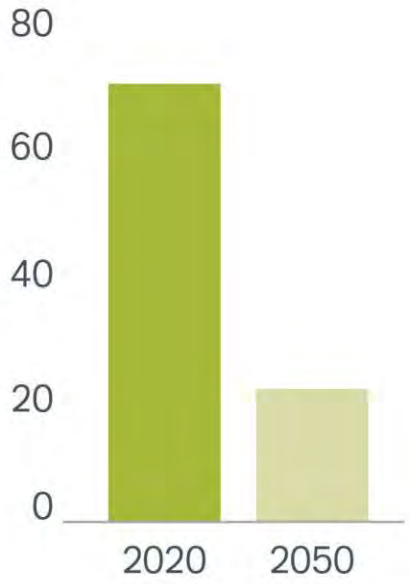
Clean Electricity

96% Clean by 2050



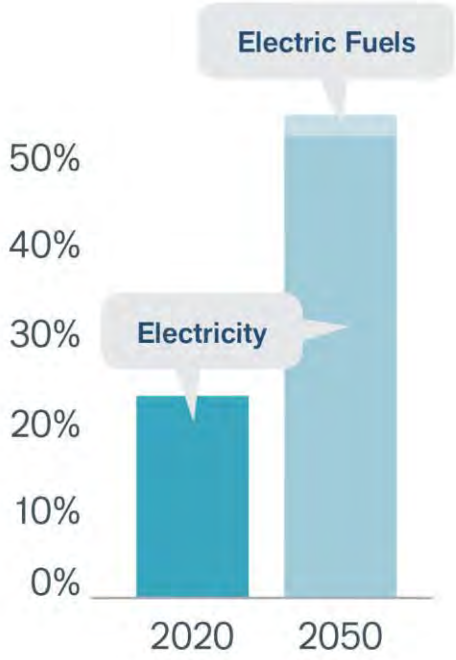
Clean Fuels

70% decrease



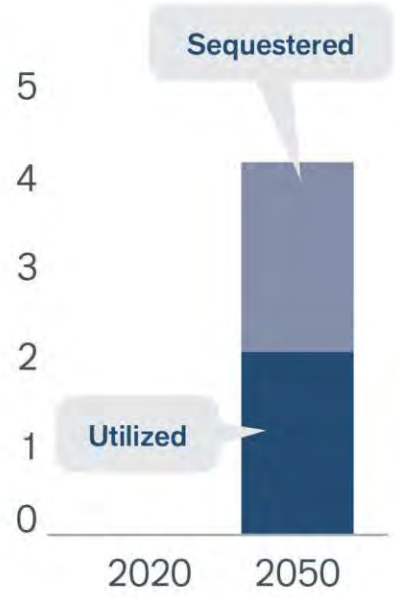
Electrification

Doubles from 23% to 55%



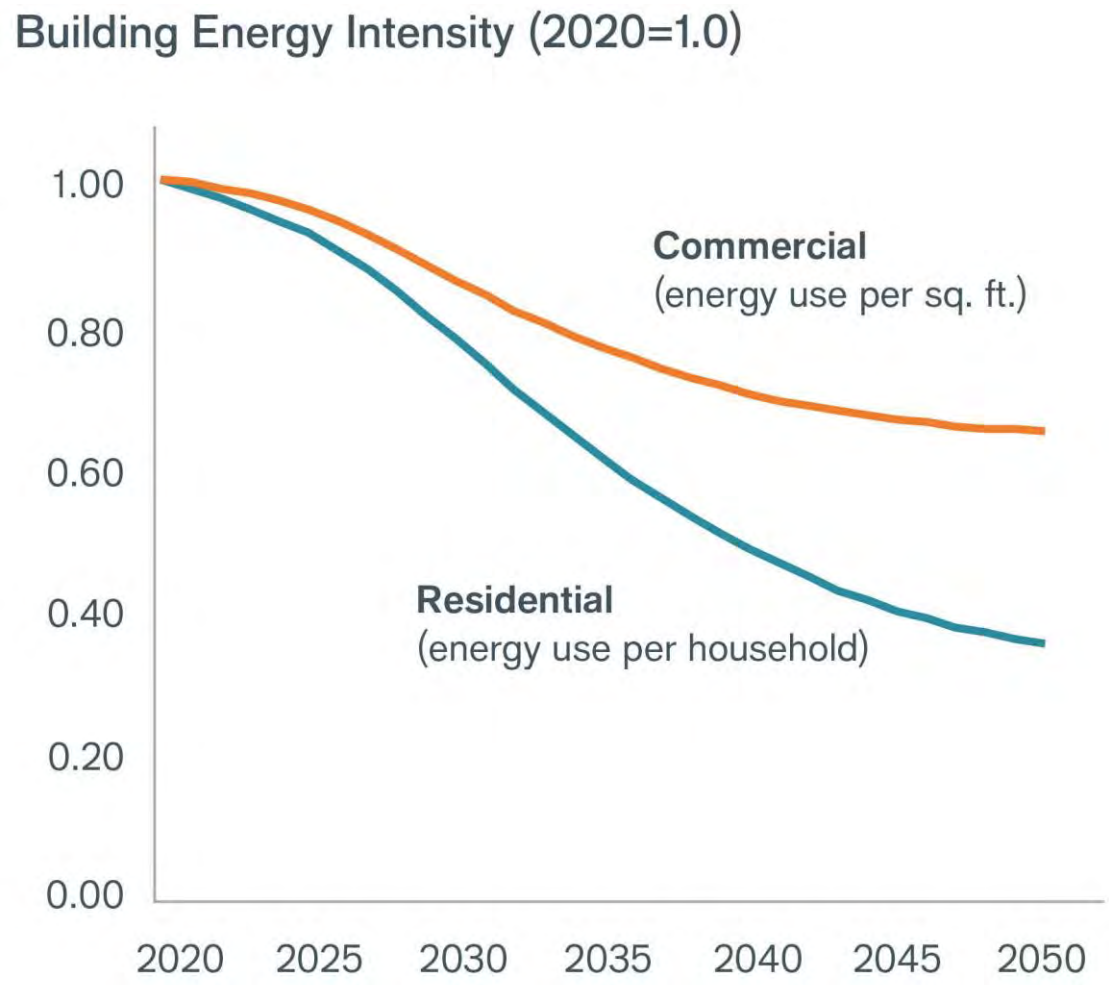
Carbon Capture

1/2 fuel; 1/2 sequestered



Buildings: Deep Efficiency & Electrification

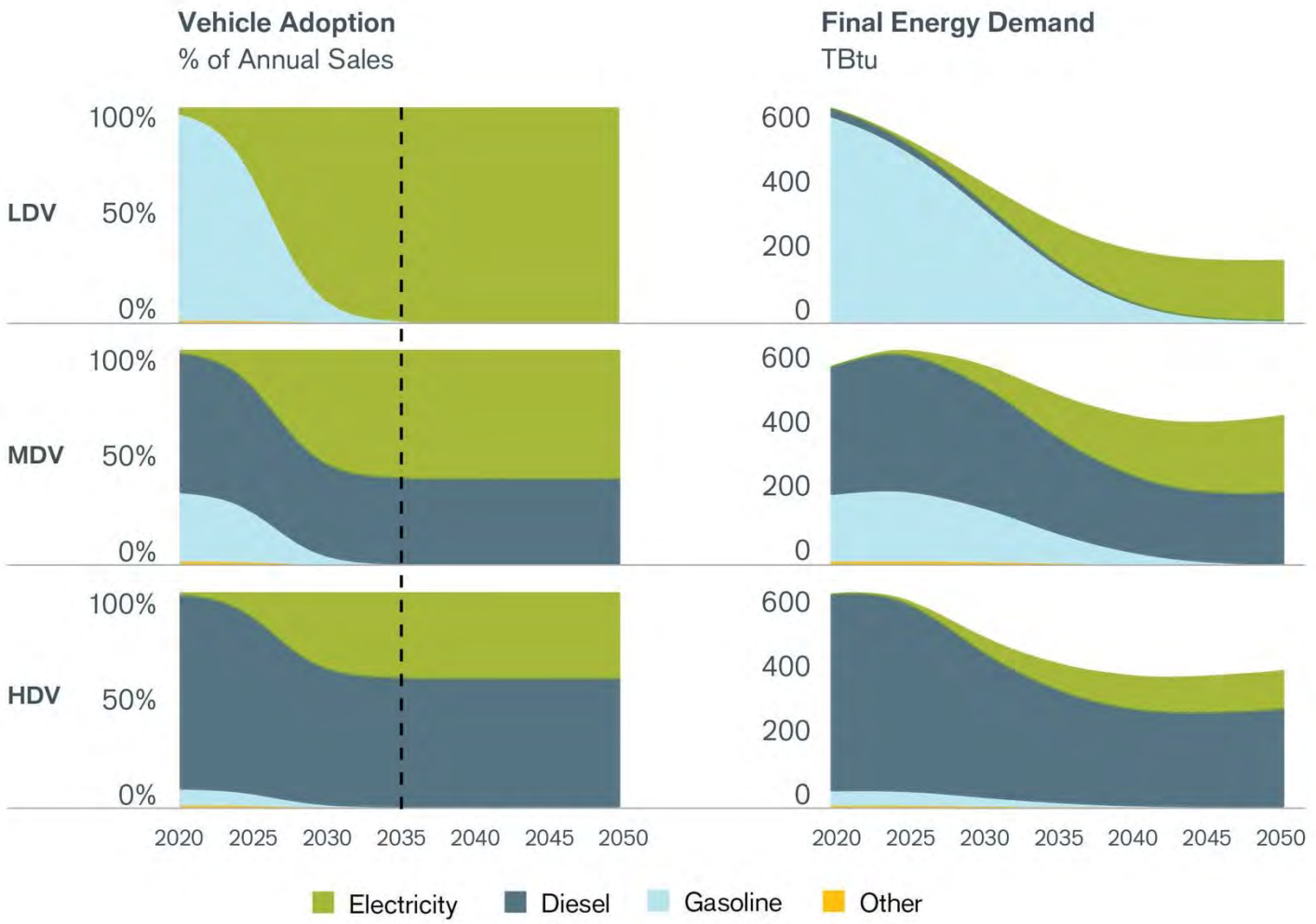
- **Building energy intensity declines by 30% for commercial and 60% for residential sector from 2020 to 2050**



Transportation: Massive Shift to Electric Vehicles

By 2050:

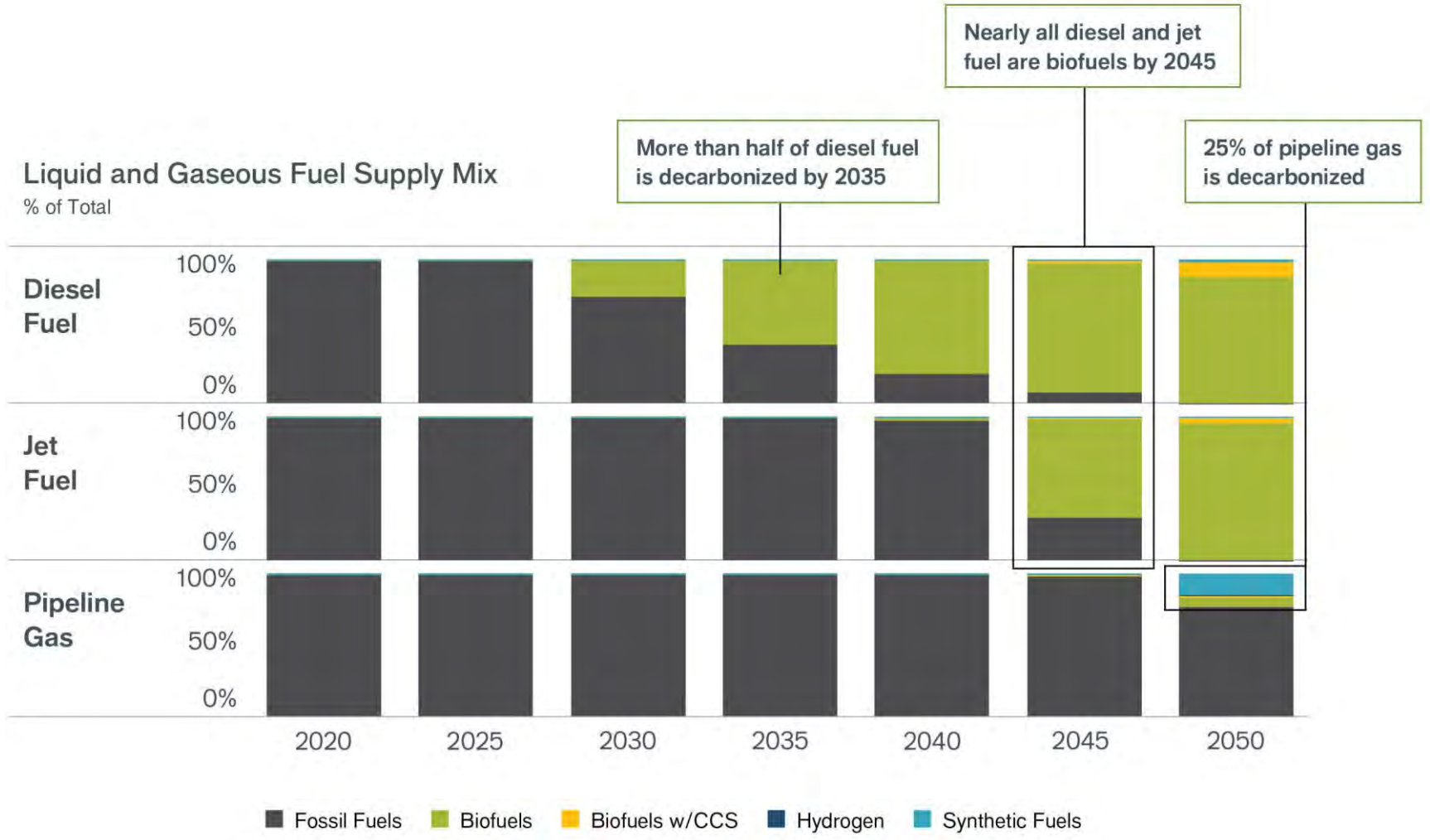
- Cars, SUVs, and light trucks fully electrified
- Medium and heavy-duty trucks partially electrified
- Results in a 60% reduction in final transportation sector energy demand from light, medium, and heavy-duty vehicles



Fuels: Decarbonized Diesel, Jet, and Pipeline Gas

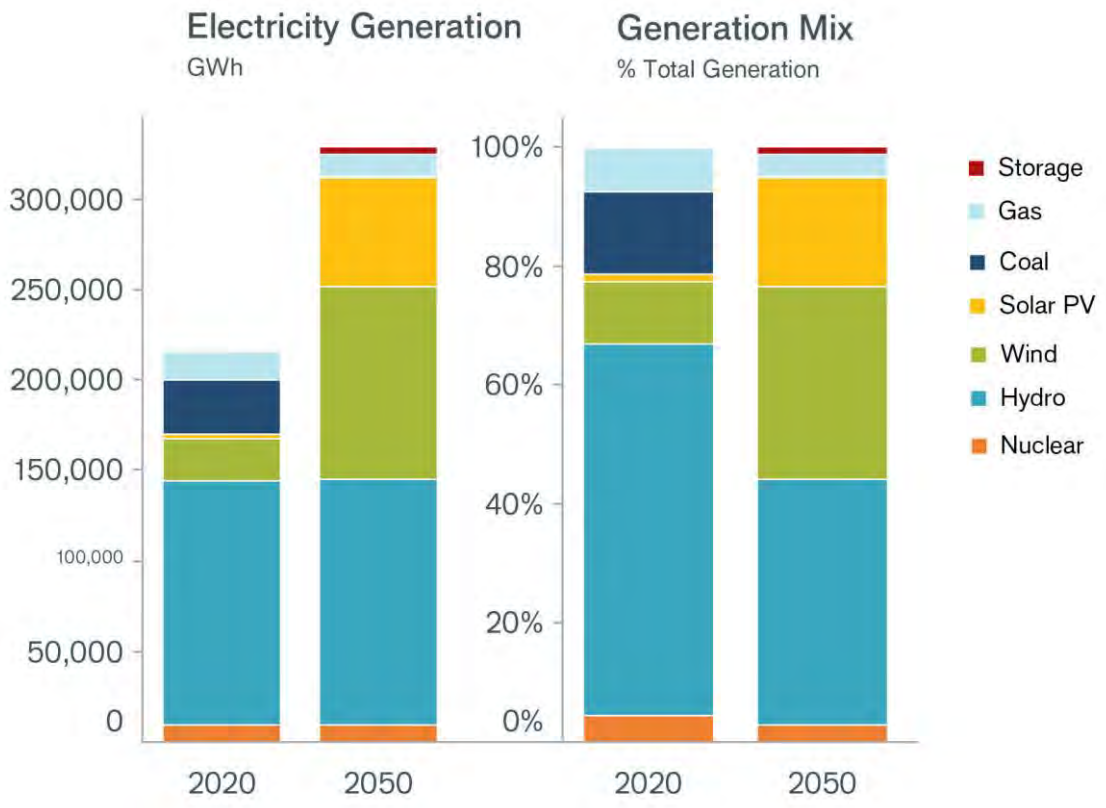
By 2050:

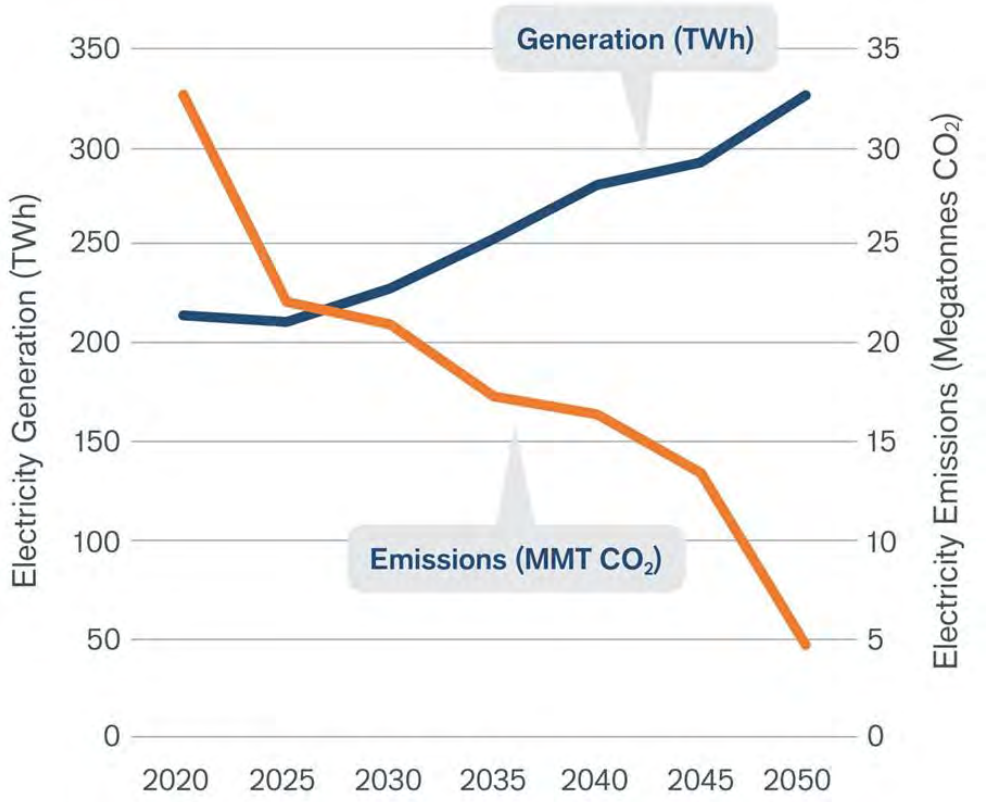
- Diesel and jet fuel fully decarbonized, primarily using biofuels
- 25% of pipeline fuels partially decarbonized
- Synthetic fuels play a key role



Electricity: 96% Carbon Free

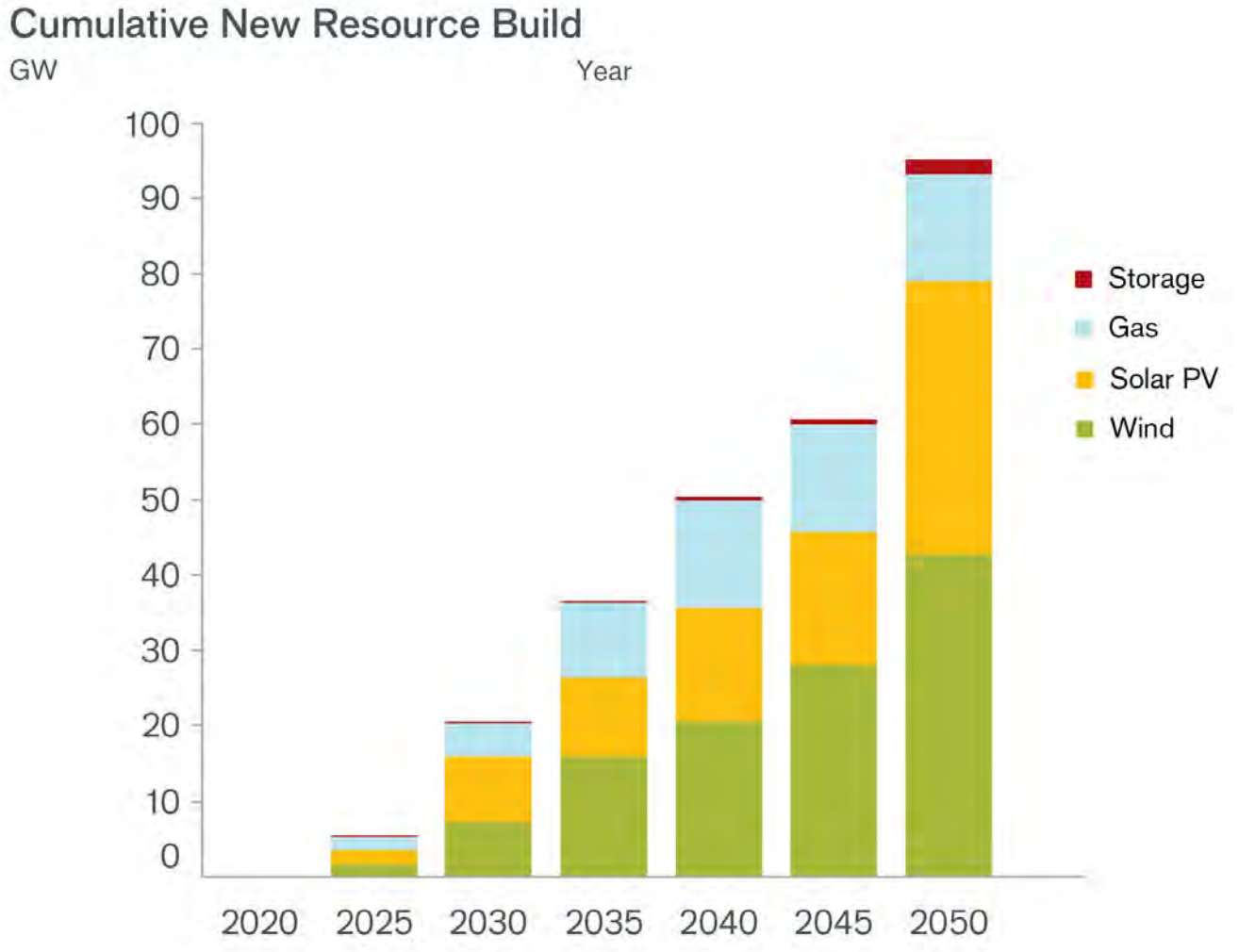
Generation increases 53%, with fossil fuel use at 4%, emissions decline by 86%.





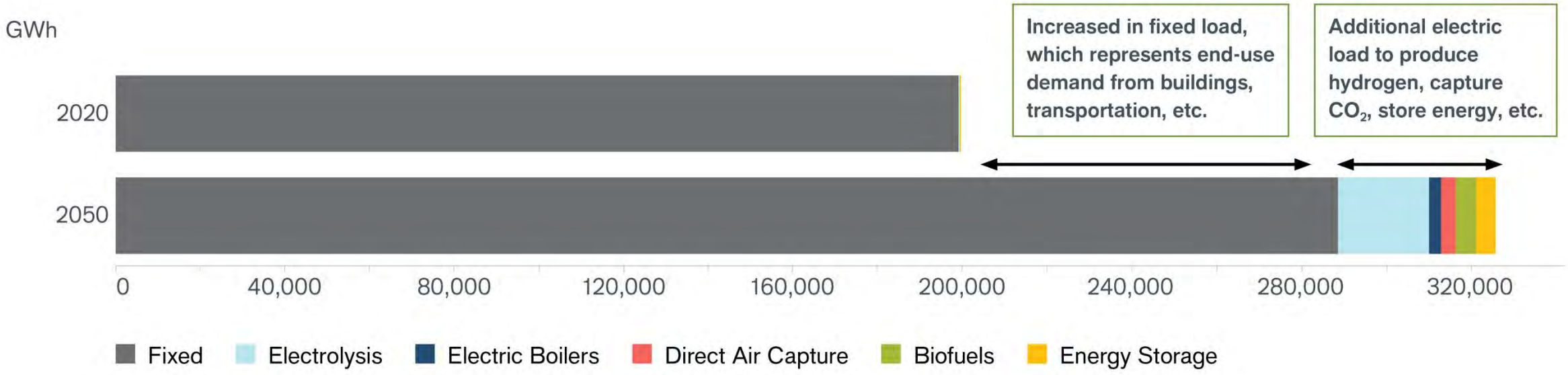
Electricity: Expands to Serve 55% of Energy Demand

- 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



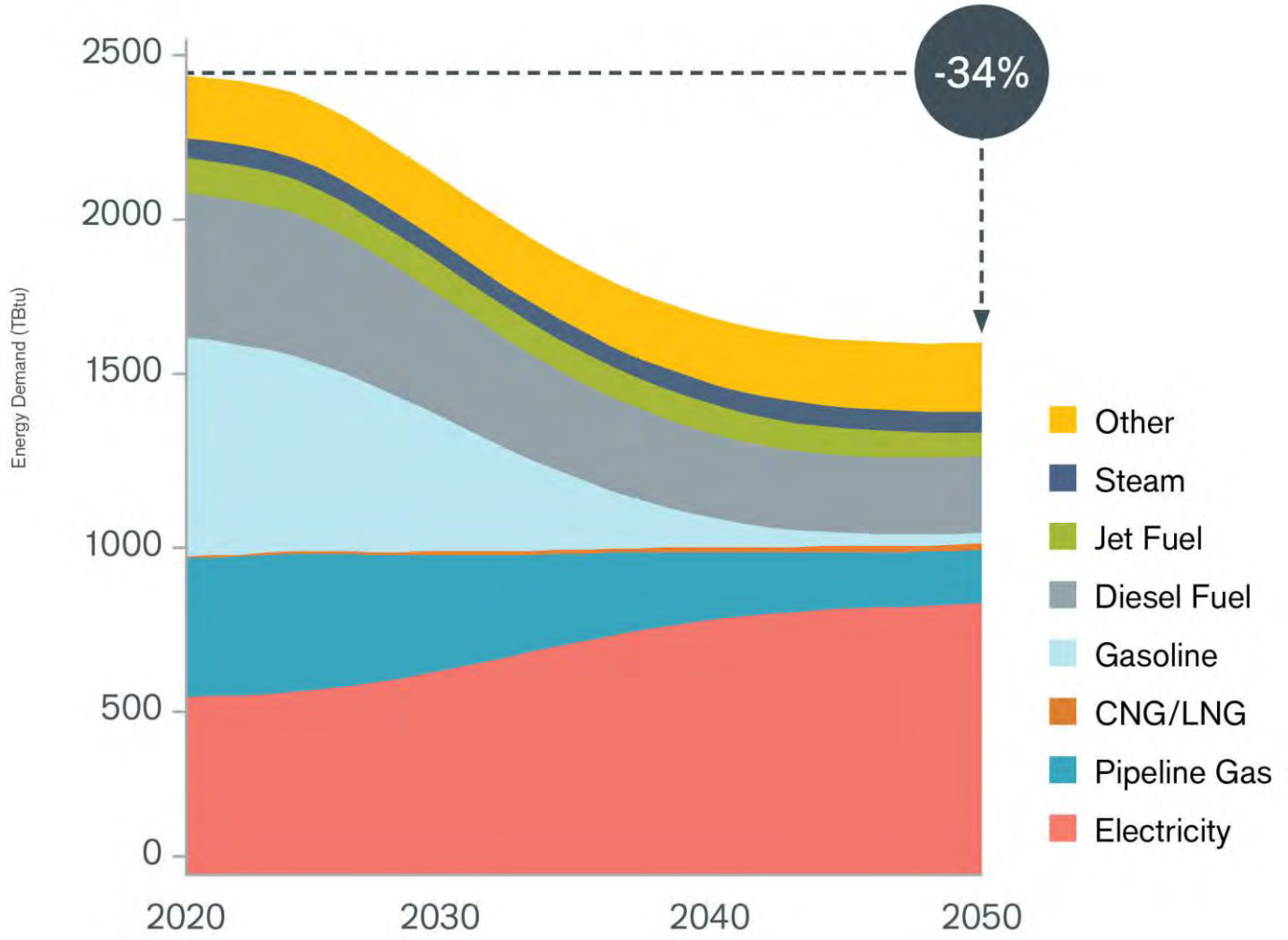
Electricity Sector: Serves Increasing Fixed Load, Produces New Sources of Decarbonized Energy

- **Load increases by more than 60%** between 2020 and 2050
- **A large portion of the net increase is from higher "fixed" loads**, such as transportation electrification
- Load also increases to produce hydrogen, capture carbon, store energy, etc.



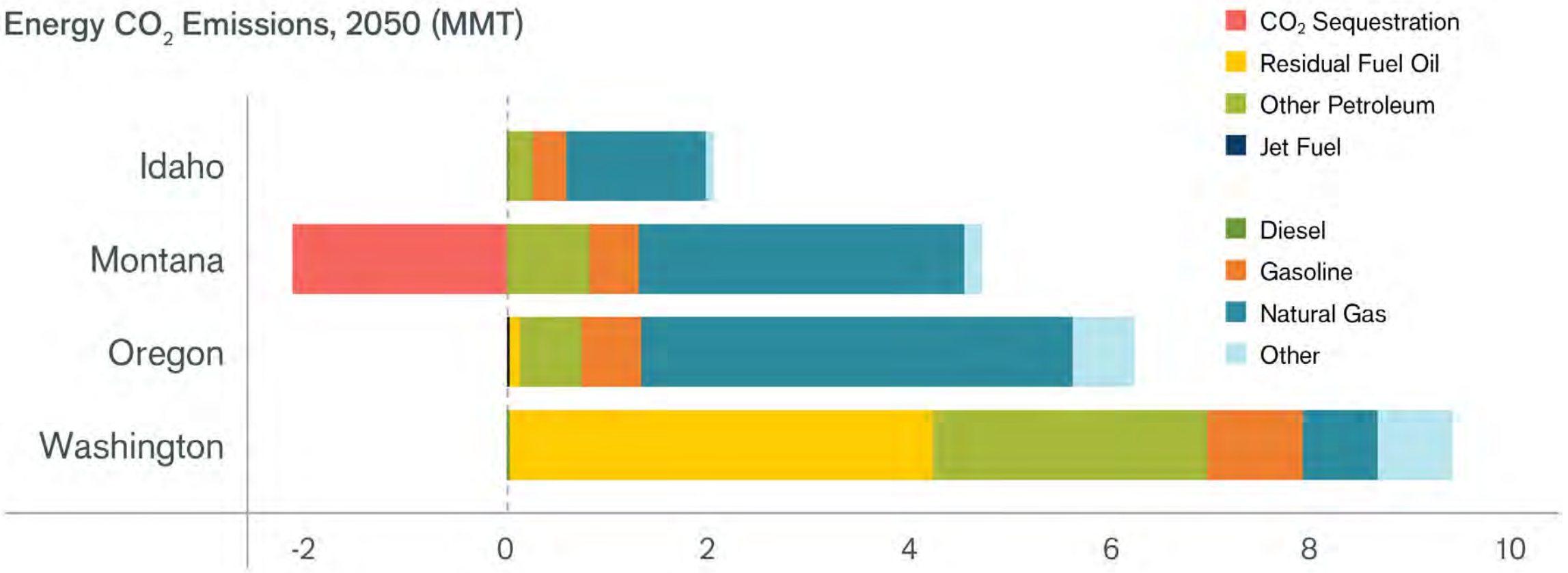
Final Energy Demand Declines, Even as Region Grows

- 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 grows



State-Level Energy CO_2 Emissions in 2050

In three of four states, majority of remaining emissions in the Central Case in 2050 are from natural gas combustion.



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
- Does not include benefits from avoiding climate change, reducing air pollution, improved health

Insights from Alternative Pathways

Alternative Pathway Results

100% Clean Electricity Grid

Limited Electrification & Efficiency

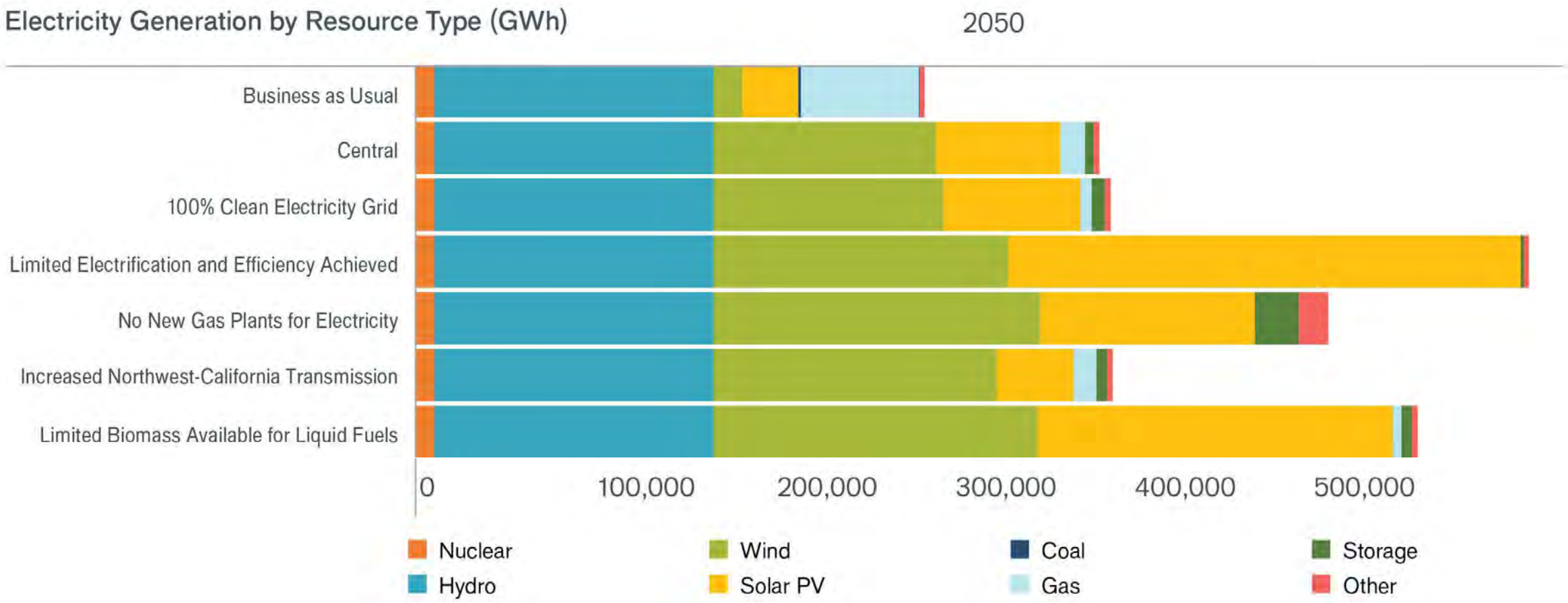
No New Gas Plants for Electricity

Limited Biomass for Liquid Fuels

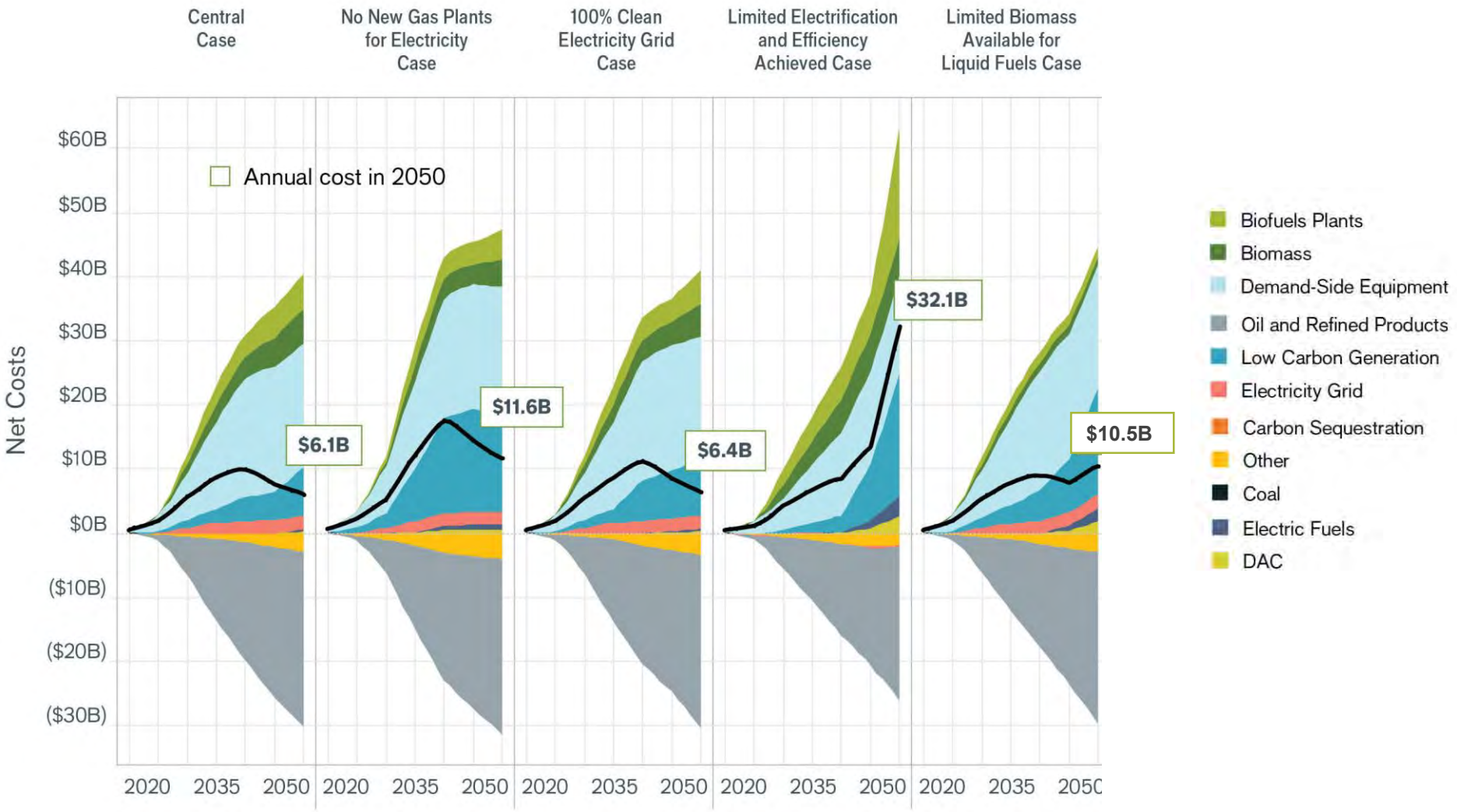
Increased NW-CA Transmission

- 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



Annual Net Energy System Costs, Six Cases



Study Implications

Equity and Implementation

- Equity implications must be explored and addressed
- Implementation Challenges:
  - Implementing widespread transportation electrification
  - Limiting natural gas in buildings, transport, and the grid
  - Achieving deep energy efficiency
  - Grid storage, grid readiness
  - Improving/expanding Northwest-California grid integration
  - Assessing actual biomass in the Northwest
  - Determining the role power-to-X, electrolysis, direct air capture in the Northwest

Institute Next Steps

- **Develop Policy, Innovation, & Investment Frameworks** to Accelerate Deep Decarbonization
  - Role of Natural Gas in Buildings, Transport, Grid
  - Transportation Electrification
  - Northwest-California Grid Integration
- **Potential Additional Runs** of the Model
  - Change assumptions about hydroelectricity, nuclear availability, coal plant retirements, natural gas pricing and carbon intensity.
- **Project:** Building Decarbonization with an Equity Focus

Thank you

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