Oregon Energy Strategy Technical Report

January 31, 2025

Prepared for:

Oregon Department of Energy

EVOLVED ENERGY RESEARCH

Contents

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- **Agenda**
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    - Buildings

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Modeling Overview

How do we model energy pathways?

Overview of Modeling Approach

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Residential
Commercial
Industrial
Transportation

Model of Oregon's Economy

Overview of Modeling Approach

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Residential
Commercial
Industrial
Transportation

Model of Oregon's Economy

Model calculates energy needs

Oregon's Energy Needs

Electricity
Transportation fuels
Direct use fuels

Overview of Modeling Approach

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Model calculates energy supply

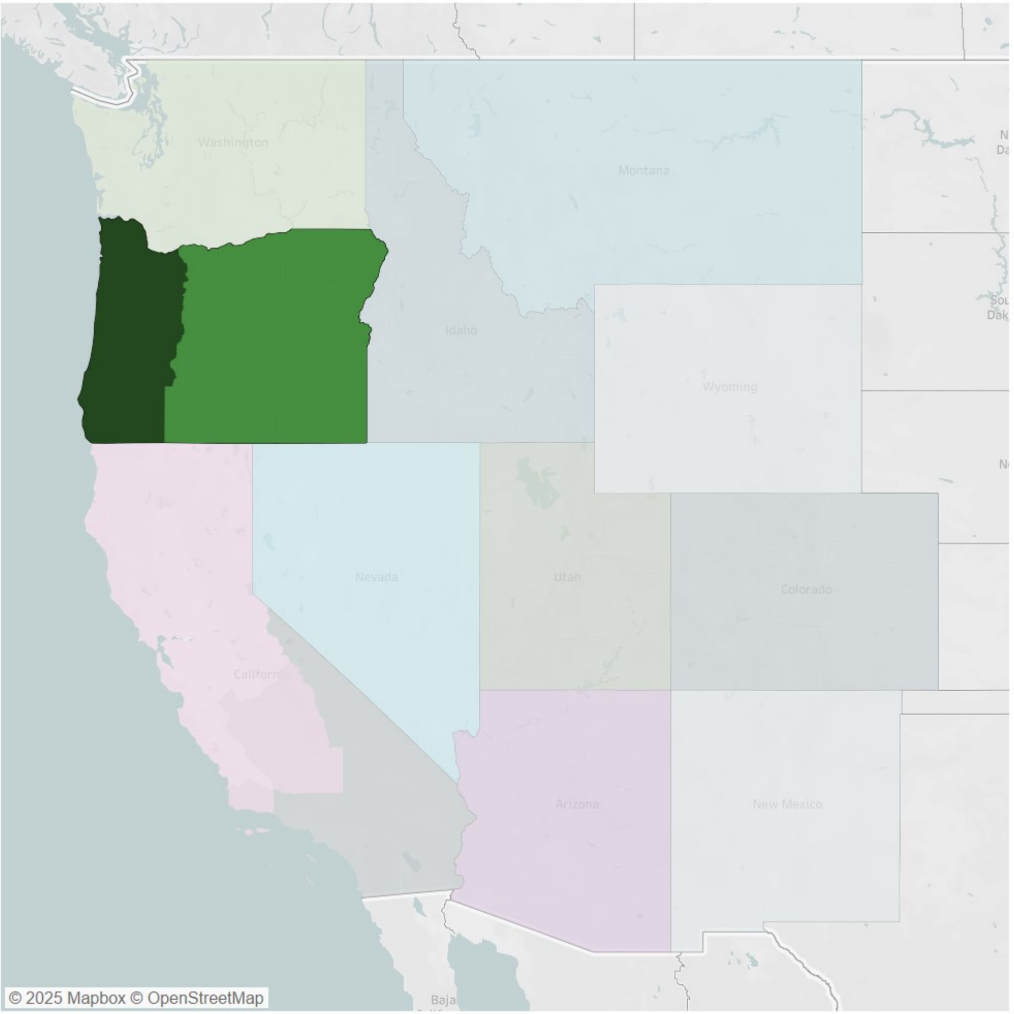
Least-Cost Energy Supply

Maintain reliability
Least-cost solutions
Meets energy policies

Must meet clean energy goals

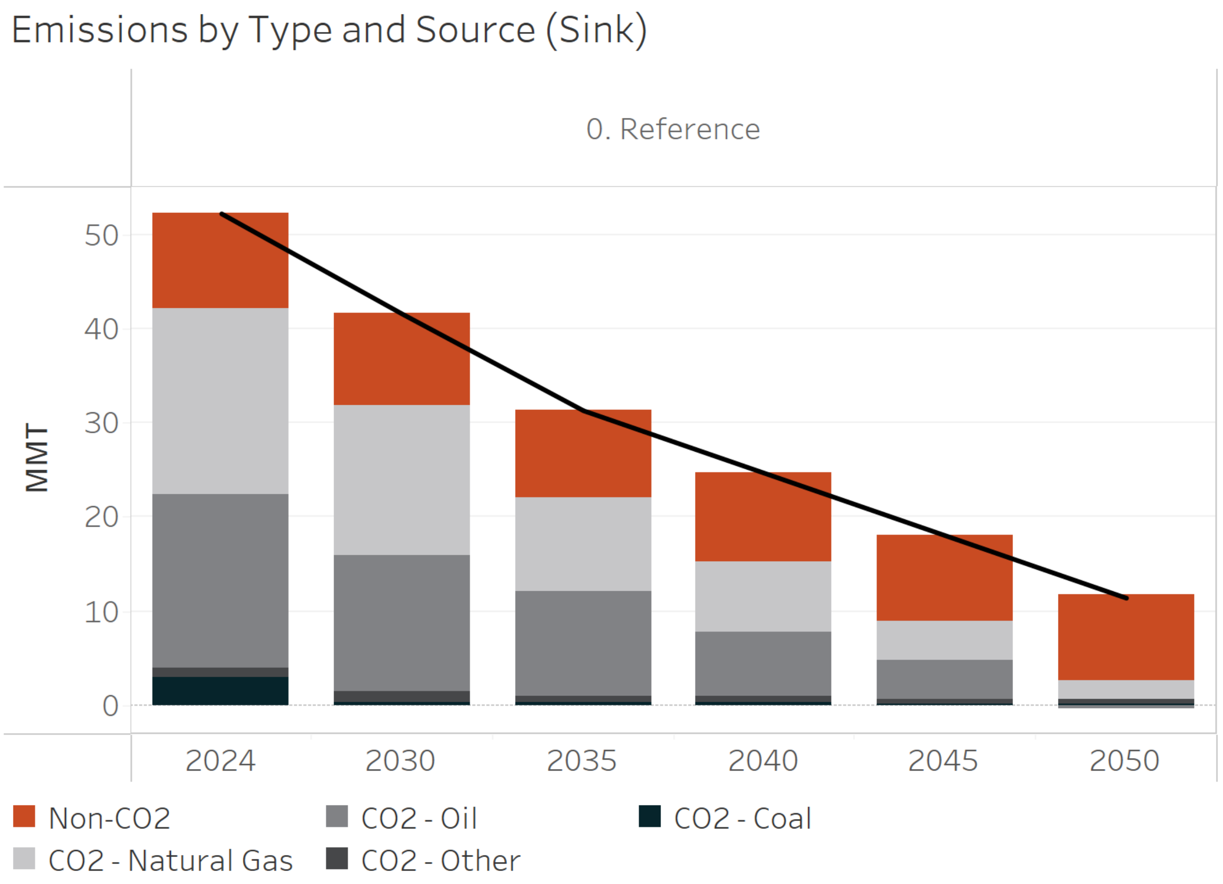
Model Geography: Oregon in Context of the West

- Oregon modeled as part of larger energy system
- All states in the West modeled with their specific energy policies
  - Resource and load diversity
  - Resource competition for Oregon
- Oregon modeled as two zones: East and West of the Cascades
- Transmission between zones modeled with existing transmission capability and the opportunity to expand with an associated cost



Modeling is Structured to Comply with Oregon Laws

- Oregon has aggressive climate policies and goals, including 80% reduction in greenhouse gas emissions economy-wide by 2050
- Each modeled scenario shows a pathway to achieving our goals
- Nearly all emission reductions come from energy sector

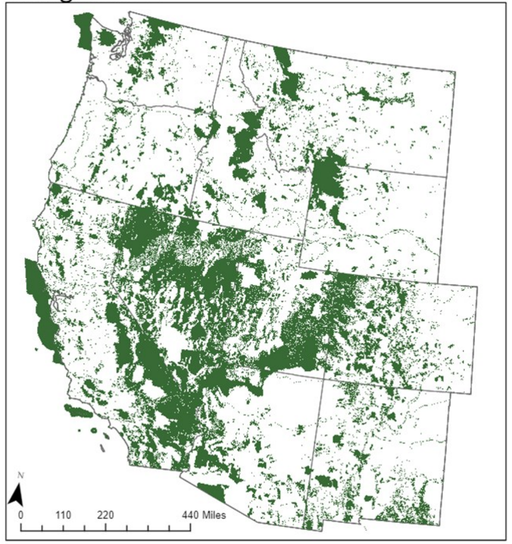


Note: Analysis was undertaken using the Climate Protection Program as proposed.

Modeling is Structured to Reflect Land Use and Natural Resource Constraints

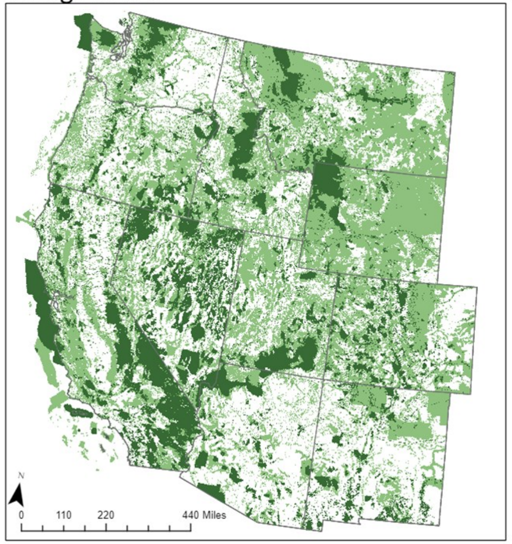
- Land use considerations are an input to the model through screening at a disaggregated level of where infrastructure projects could be located
- Every scenario complies with most restrictive land use constraints in The Nature Conservancy's *Power of Place-West* study: legally protected, administratively protected, and high conservation value lands (Levels 1 – 3)

Siting Level 1



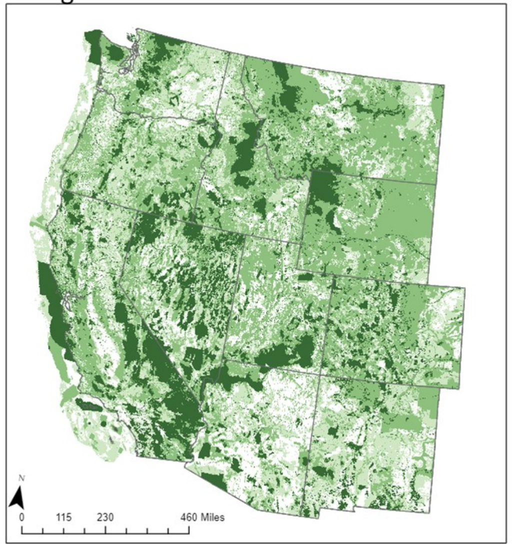
Excludes Category 1

Siting Level 2



Excludes Category 1, 2

Siting Level 3



Excludes Category 1, 2, 3

What If Scenarios and Assumptions

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Reference. Least-cost way to achieve goals. All other scenarios build on the Reference by changing a key area:

1. What if energy efficiency and building electrification is delayed by 10 years?
2. What if full transportation electrification of medium- and heavy-duty vehicles is delayed 10 years, from 2040 to 2050?
3. What if there is limited demand response participation?
4. What if there is limited utility-scale electricity generation in Oregon?
5. What if there are higher levels of rooftop solar and behind-the-meter storage and transmission is limited to reconductoring only (no new build)?
6. What might an alternative portfolio of flexible resources for electricity reliability look like?

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Key Findings

Introduction

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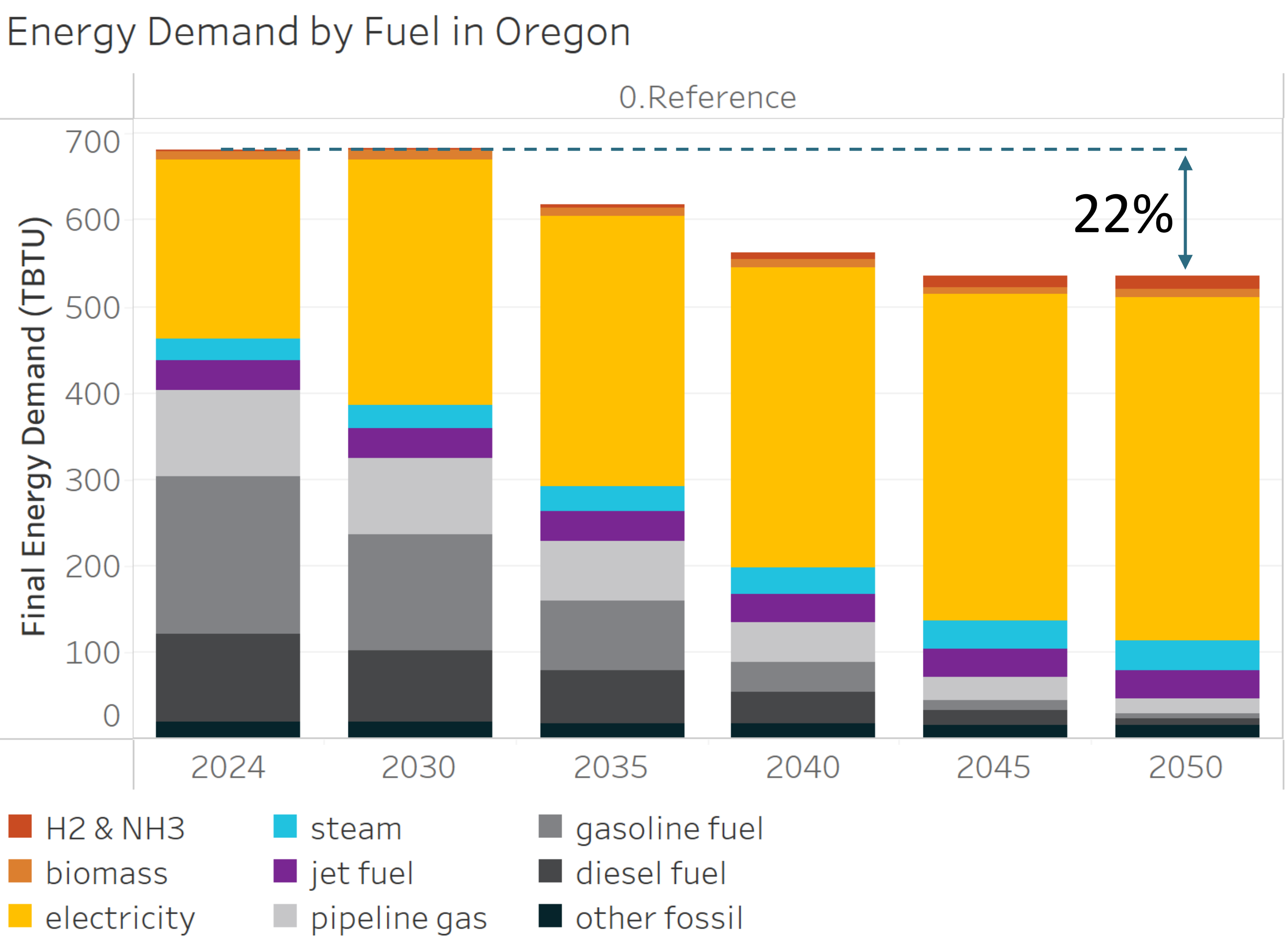
- The modeling results confirm that Oregon's existing policies are important to meet the state's goals
- Oregon's clean energy goals require more action than current policies will deliver
- The modeling explores some key options available to achieve the clean energy goals
- The modeling results give us information to consider the effects of different choices

Demand for Energy Decreases While Demand for Electricity Increases



Total energy demand decreases by 22%

Electricity demand doubles

Note: "other fossil" includes fuel oil, lpg, oil, coal, and petroleum coke. Steam is a heat input to many industrial processes. Like electricity, it can be generated from clean or dirty sources.

Data Centers Increase Demand; Transportation and Building Electrification and Efficiency Contain It

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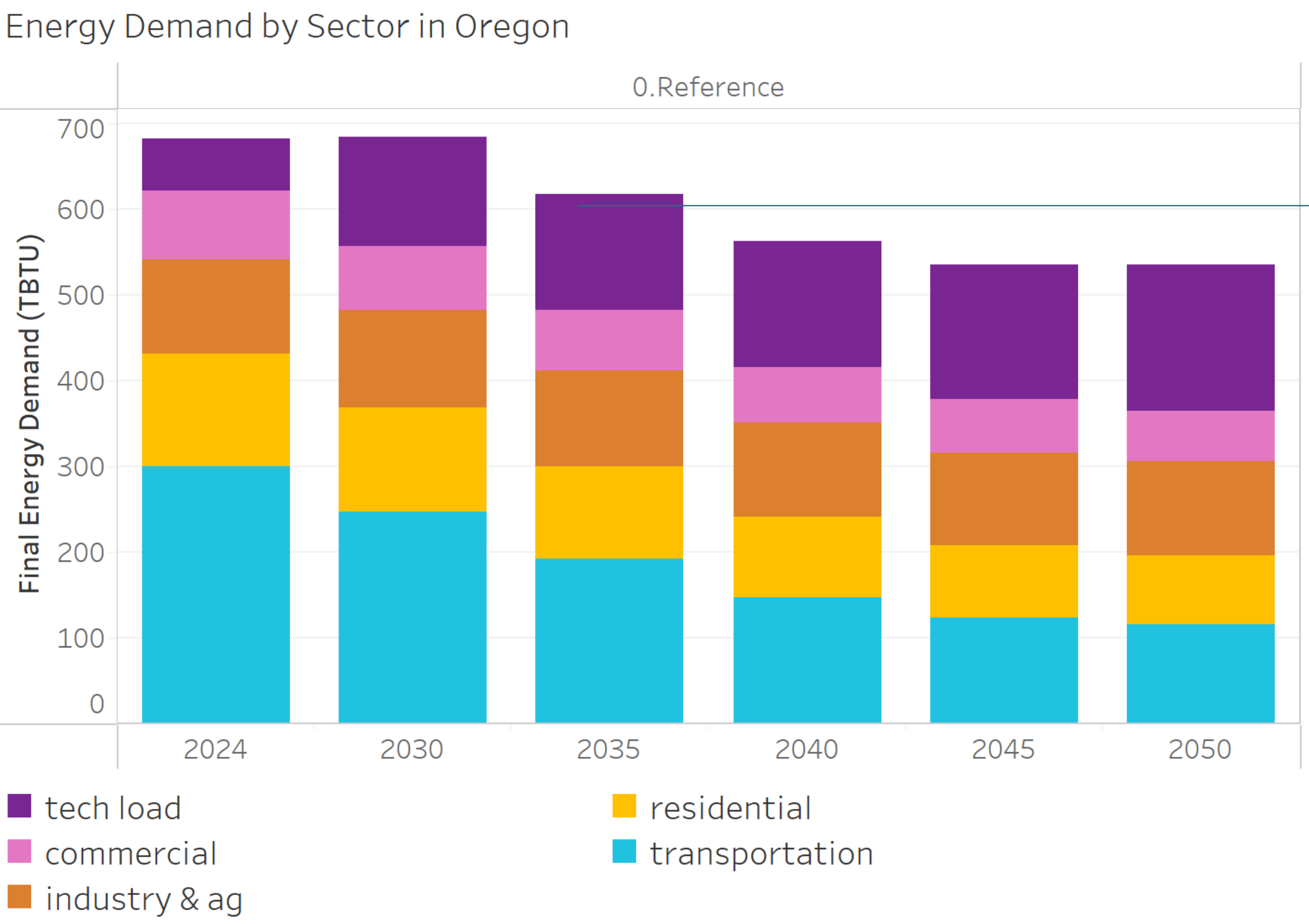
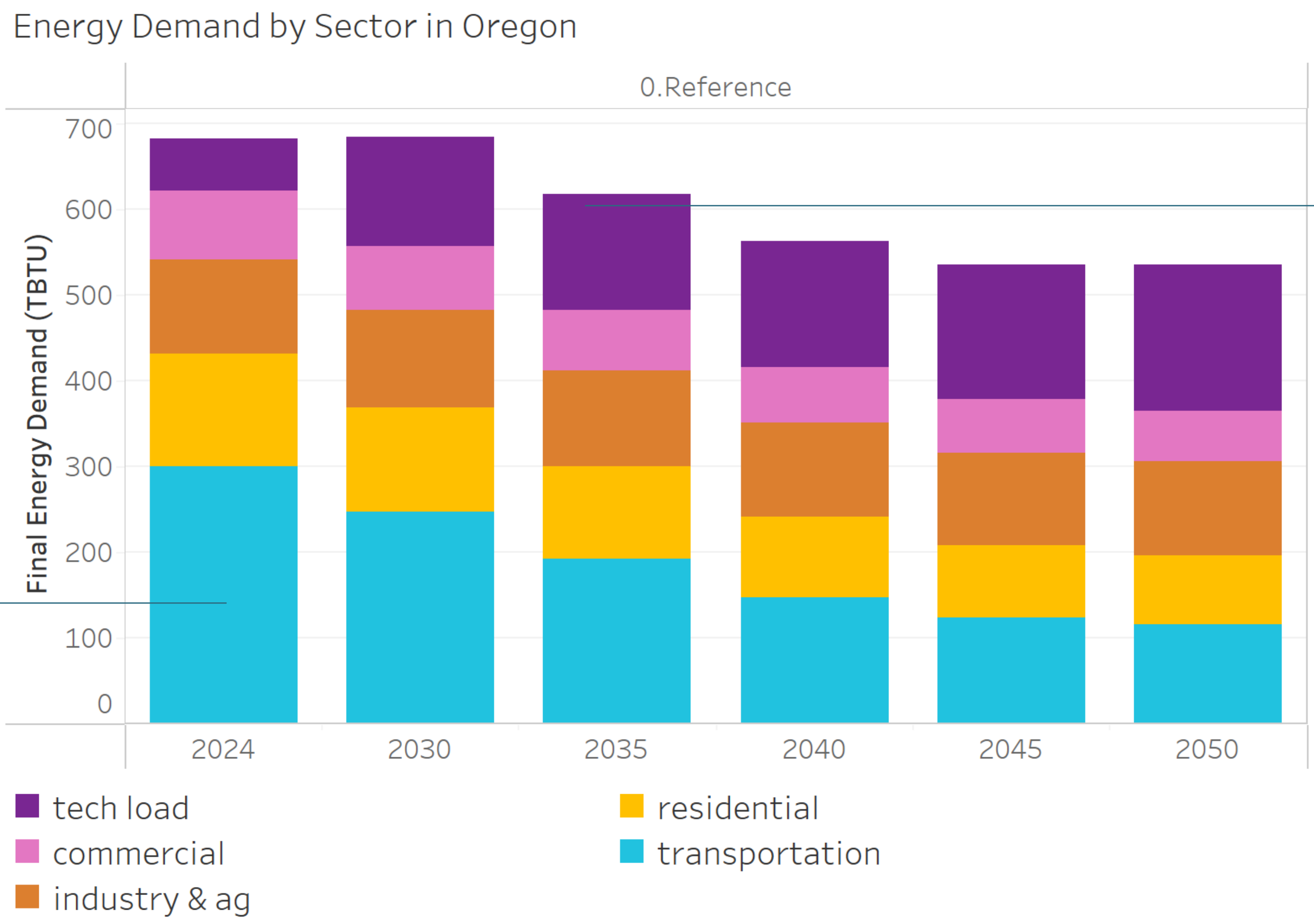


Data centers and chip fabrication facilities will likely add significant load to the system

Data Centers Increase Demand; Transportation and Building Electrification and Efficiency Contain It

Electrification of cars and trucks delivers the biggest efficiency gains, driving down overall demand



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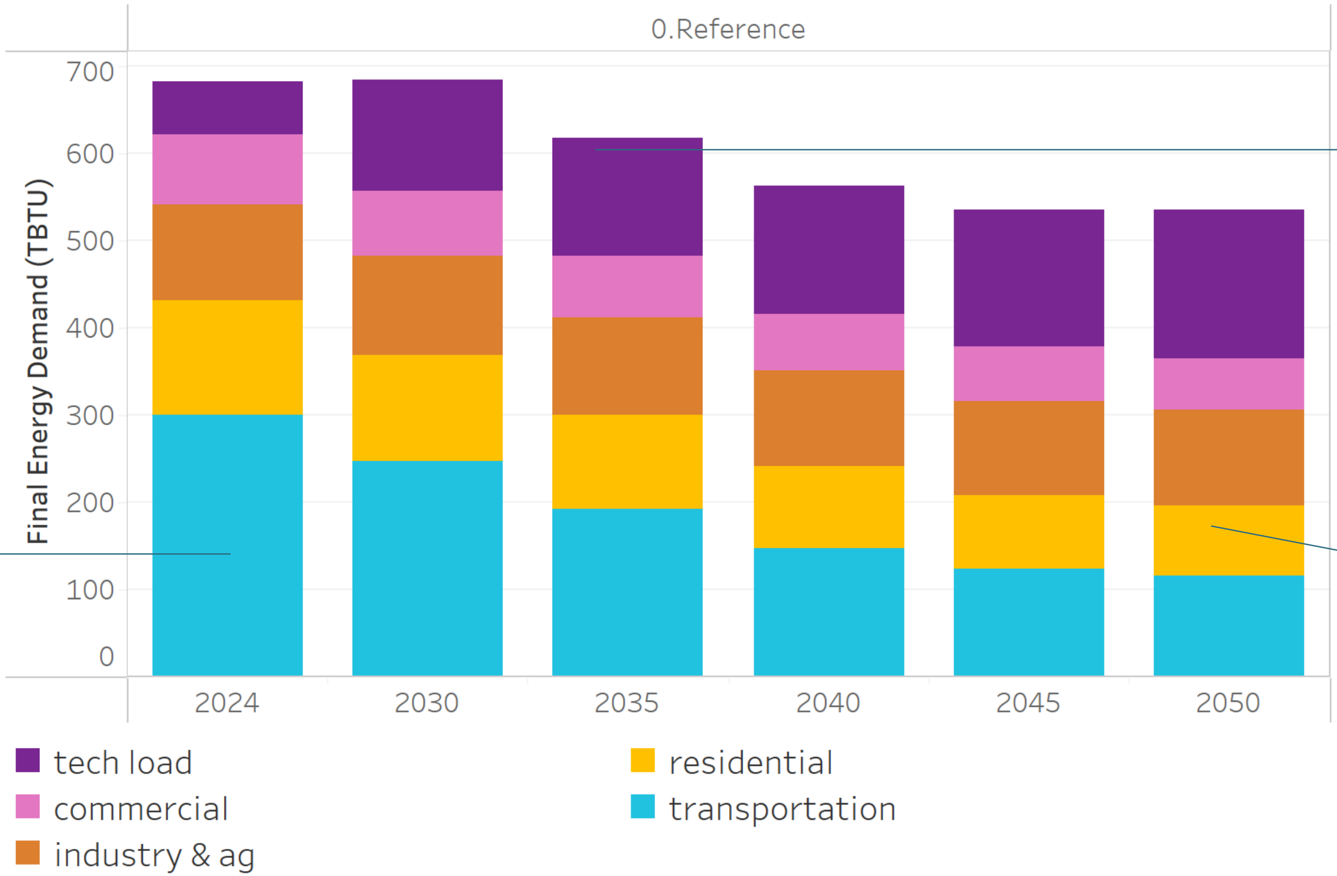
Data Centers Increase Demand; Transportation and Building Electrification and Efficiency Contain It

Energy Demand by Sector in Oregon



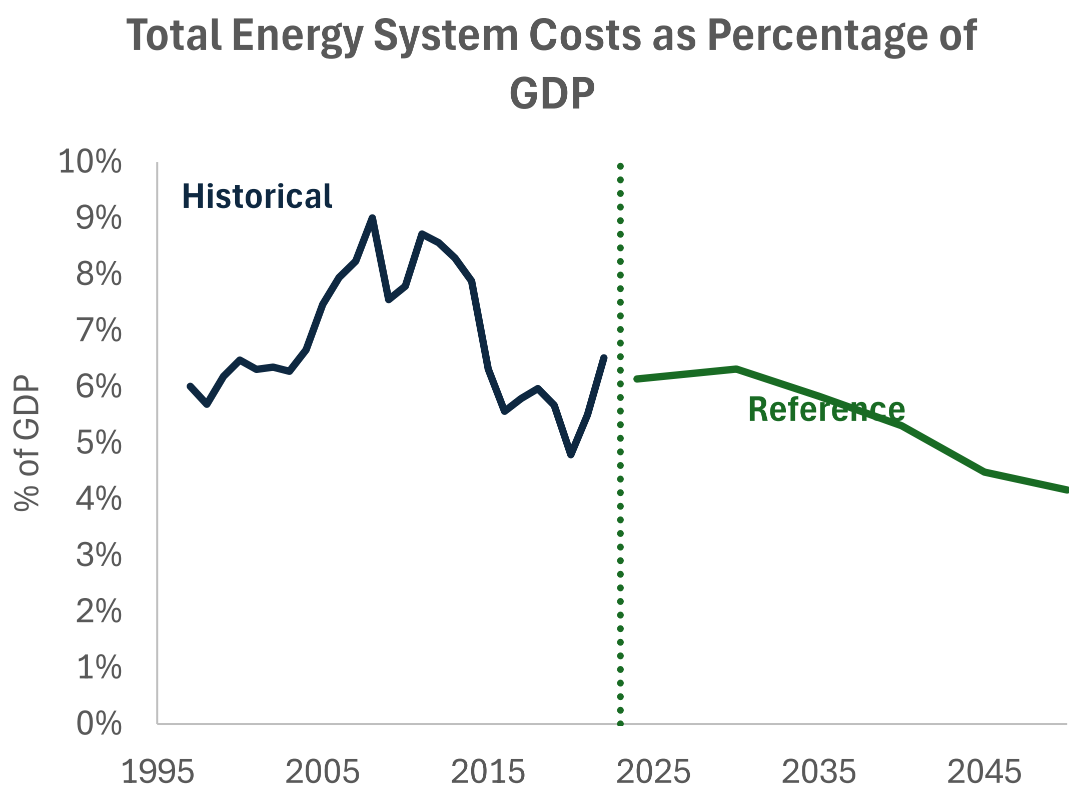
Data centers and chip fabrication facilities will likely add significant load to the system

Electrification of cars and trucks delivers the biggest efficiency gains, driving down overall demand

Building electrification and efficiency improvements reduce demand in homes

Level of Investment Needed is Not Unprecedented

- Declining costs with economic trends
- Trades global volatility in oil and gas markets for uncertainties about critical minerals, supply chains
- Keeping more money in-state and in-region
- Jobs study and follow-on workforce analysis will help identify how we meet workforce needs



Reference Scenario is the Least-Cost Pathway

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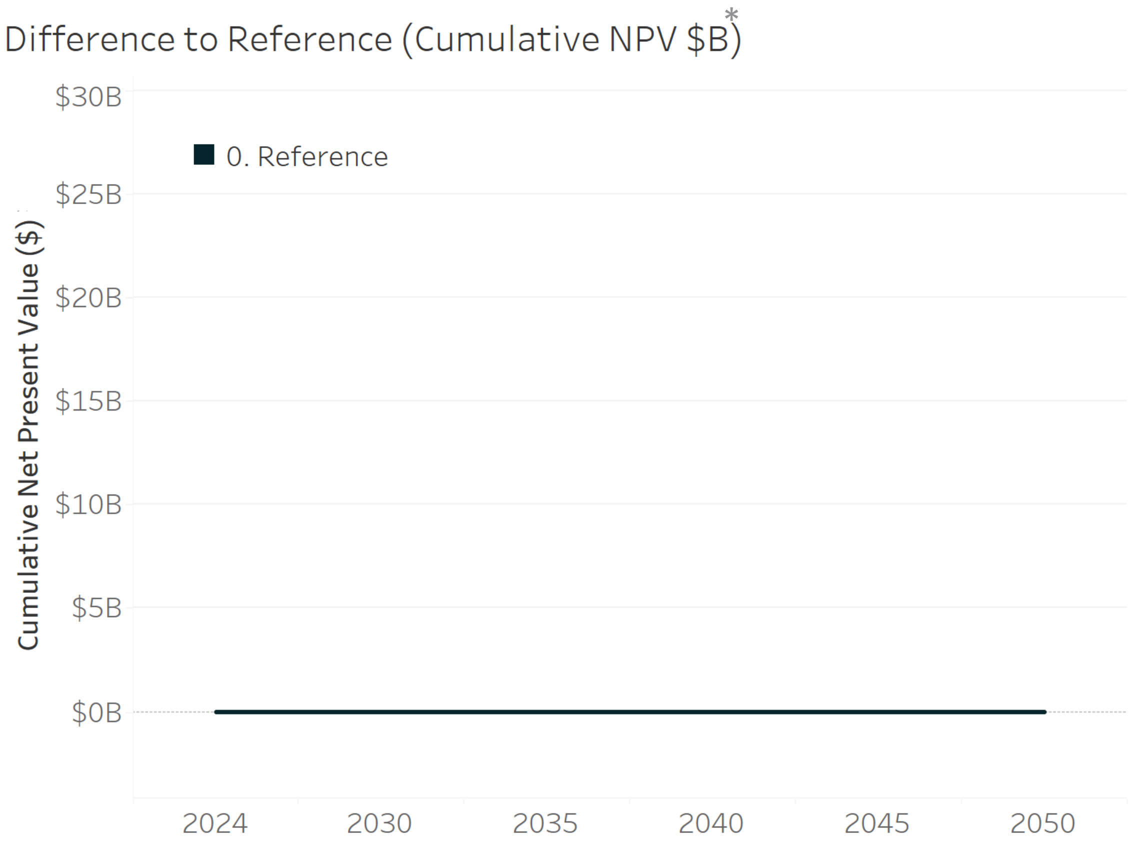
- All alternative scenarios lead to increase in costs relative to the Reference
- Existing transportation electrification policies are essential to ensure cost-effective transition
- Electrification and energy efficiency in buildings are key to cost containment



*Net present value costs calculated with a 3% societal discount rate

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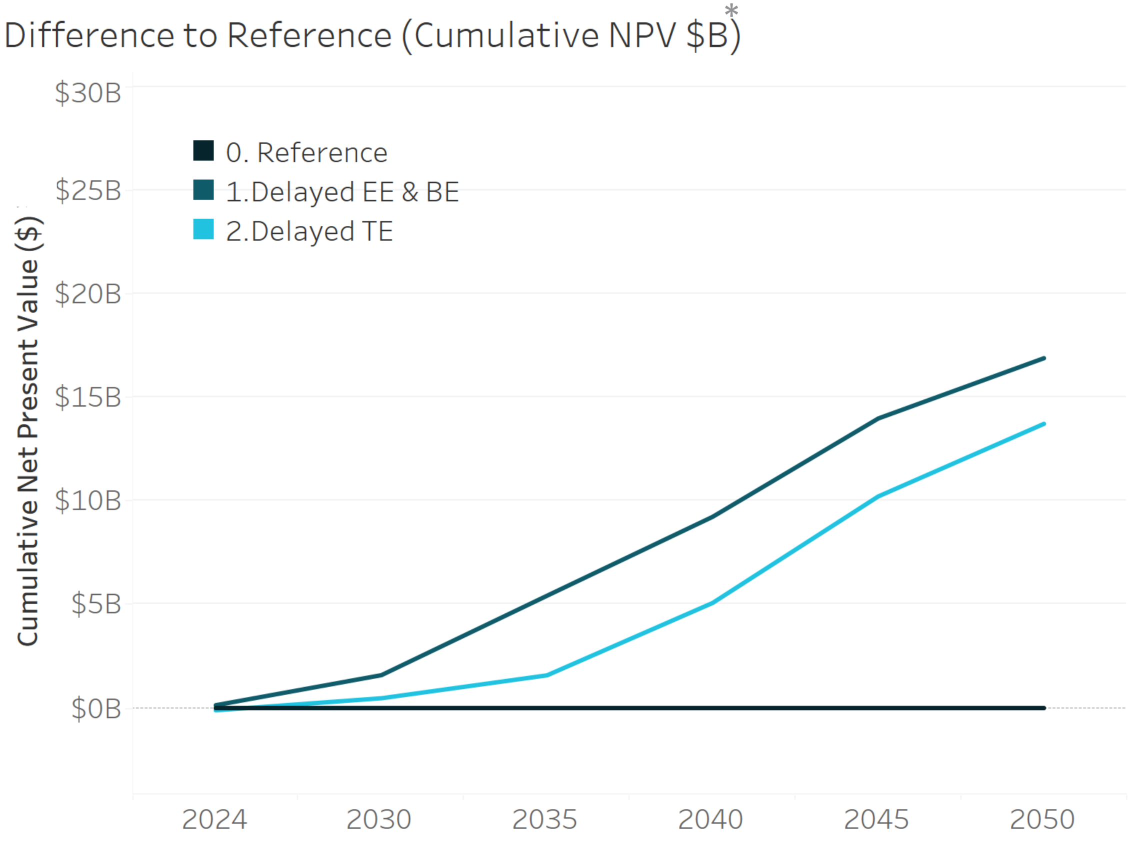

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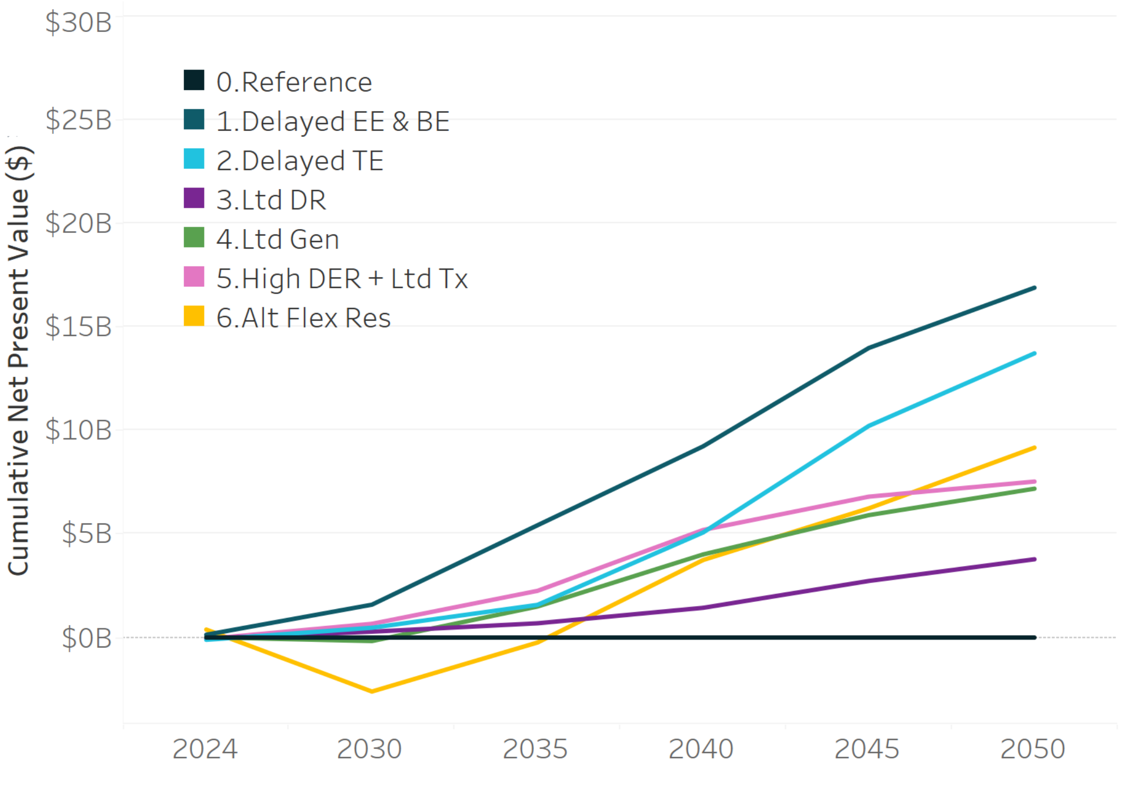
Difference to Reference (Cumulative NPV $B)*



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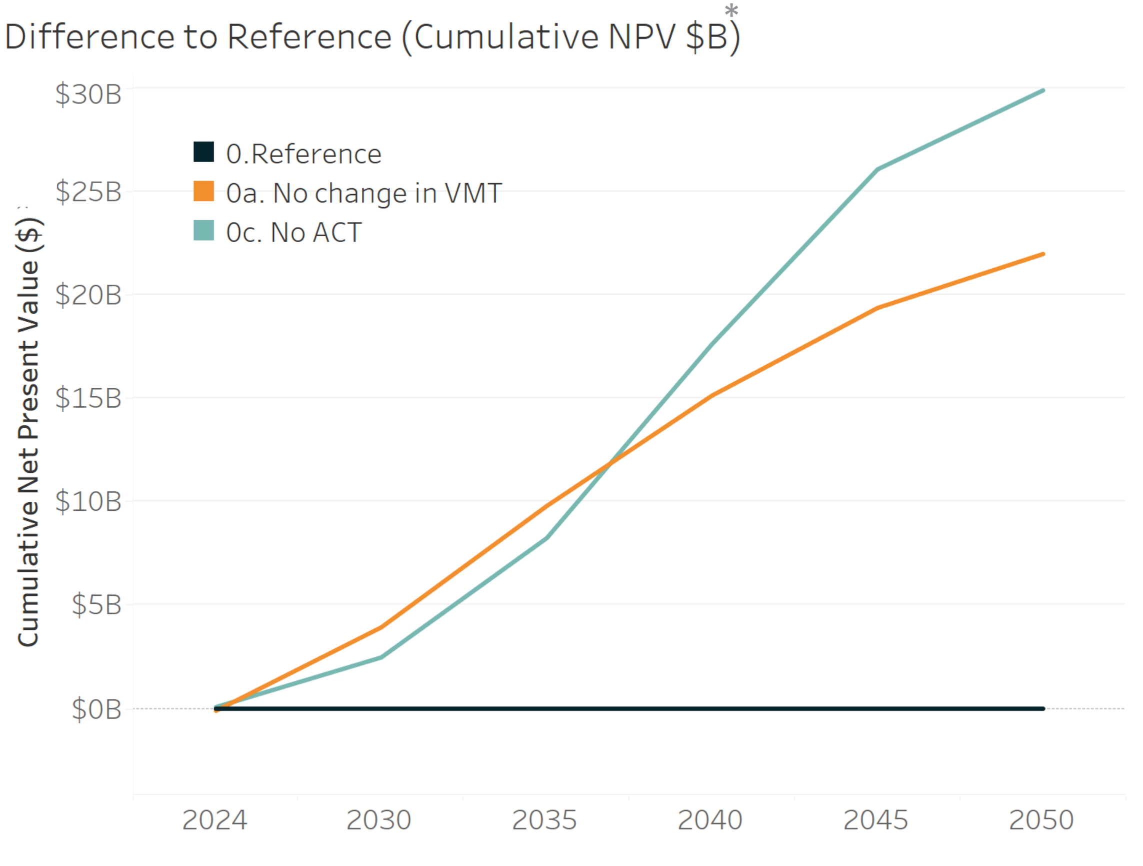

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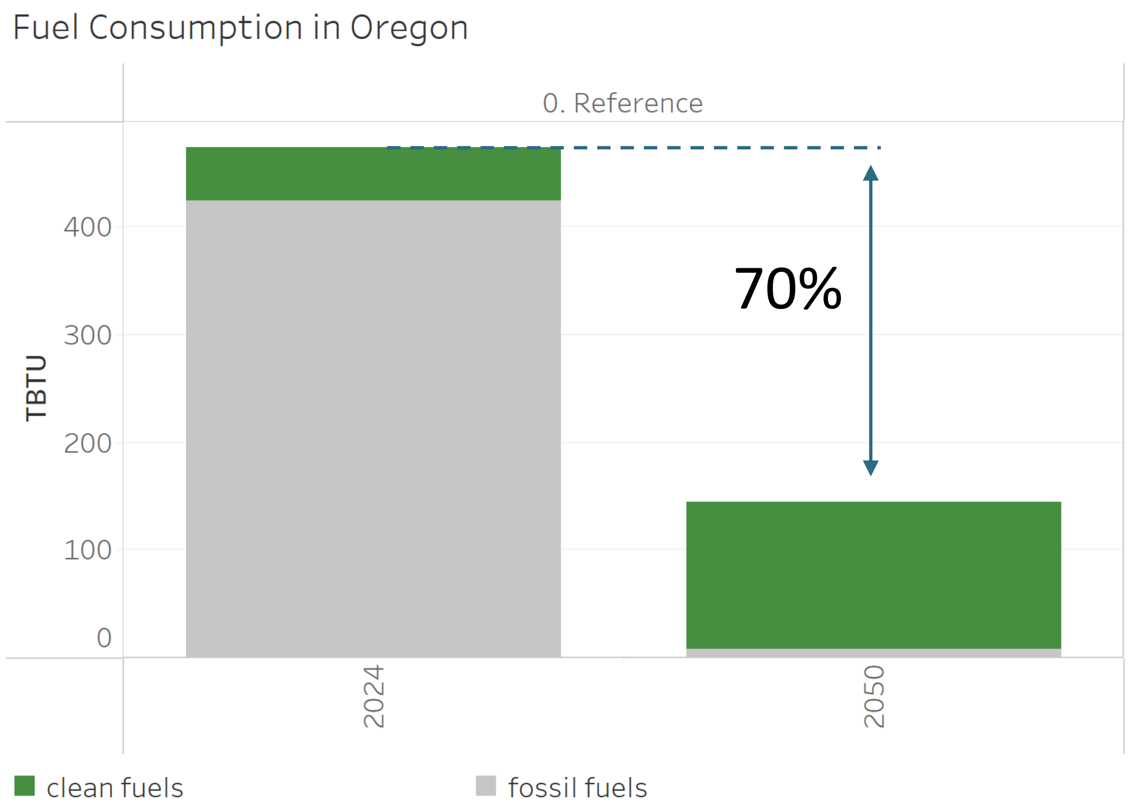
Clean Fuels are Needed to Meet Energy and Emissions Goals

- Fuel demands decrease over time but their importance does not
  - Hardest to decarbonize sectors
  - Resilience
  - Time for electric technologies to replace fossil
- Clean fuels include biogas, bio liquids, e-fuels, hydrogen, ammonia, and geothermal steam



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Electricity Sector Insights

Oregon Needs More Electricity Infrastructure

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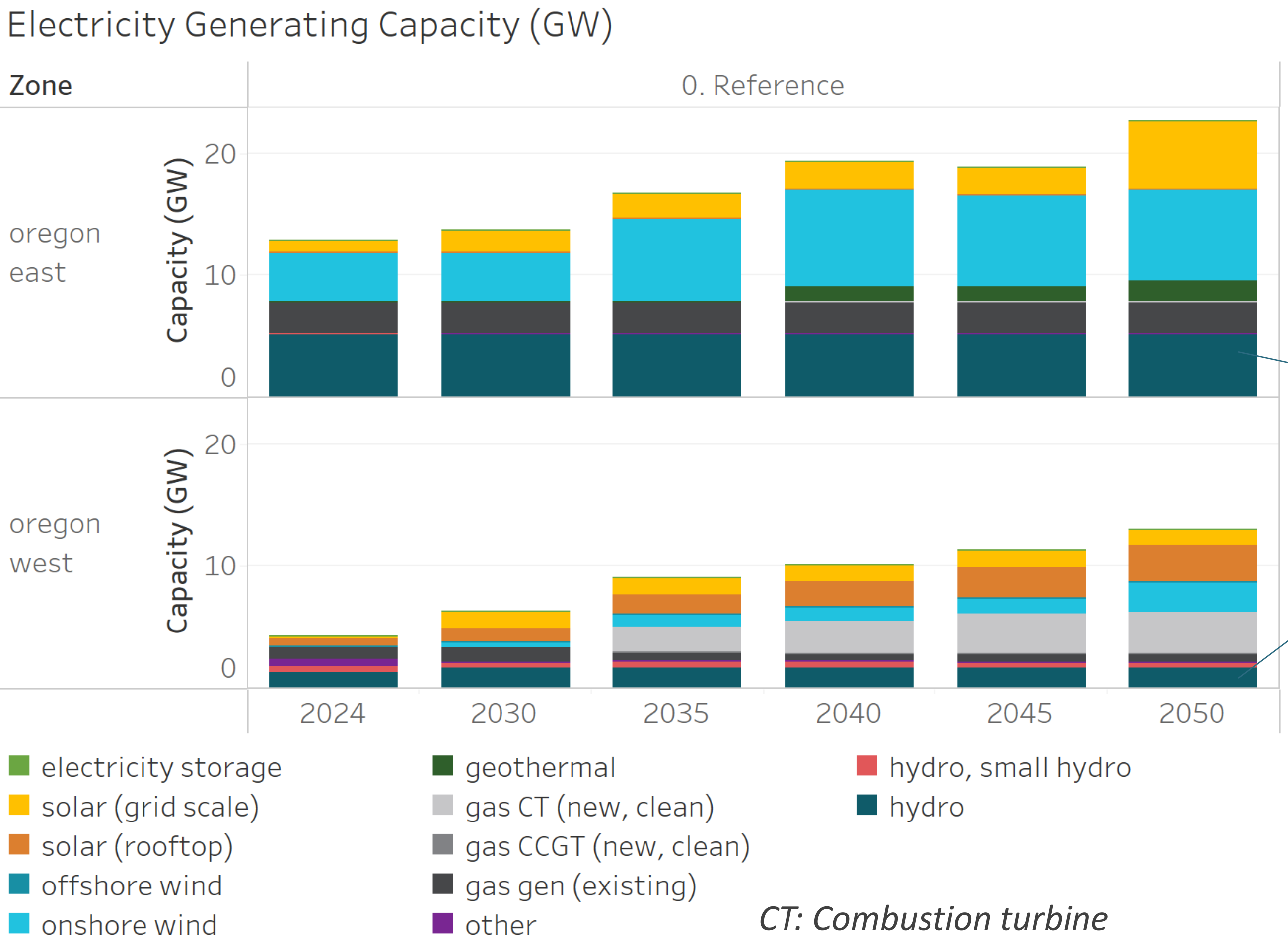
- Even with aggressive levels of energy efficiency, the electricity sector must expand significantly
- The model selects transmission expansion as part of a least-cost portfolio
- The model selects a diverse mix of generation technologies as part of a least-cost portfolio

Credit: Paulo Esteves https://stock.adobe.com/images/maintenance-in-a-high-voltage-electrical-substation/564704152

Oregon Needs More Generation Capacity



Hydropower remains a foundational resource

CT: Combustion turbine
CCGT: Combined-cycle gas turbine

Oregon Needs More Generation Capacity

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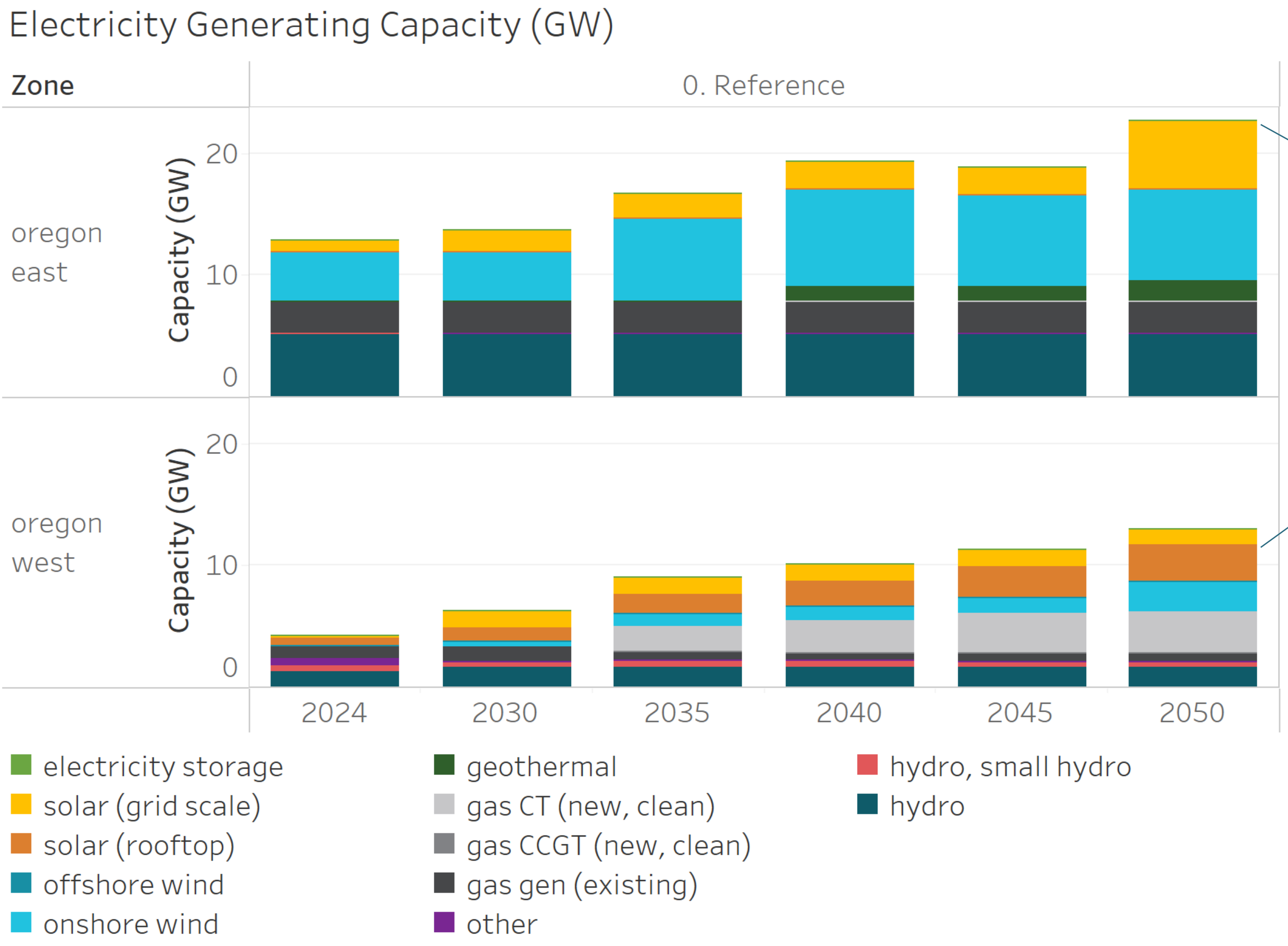

Solar grows, both grid-scale and rooftop

Oregon Needs More Generation Capacity

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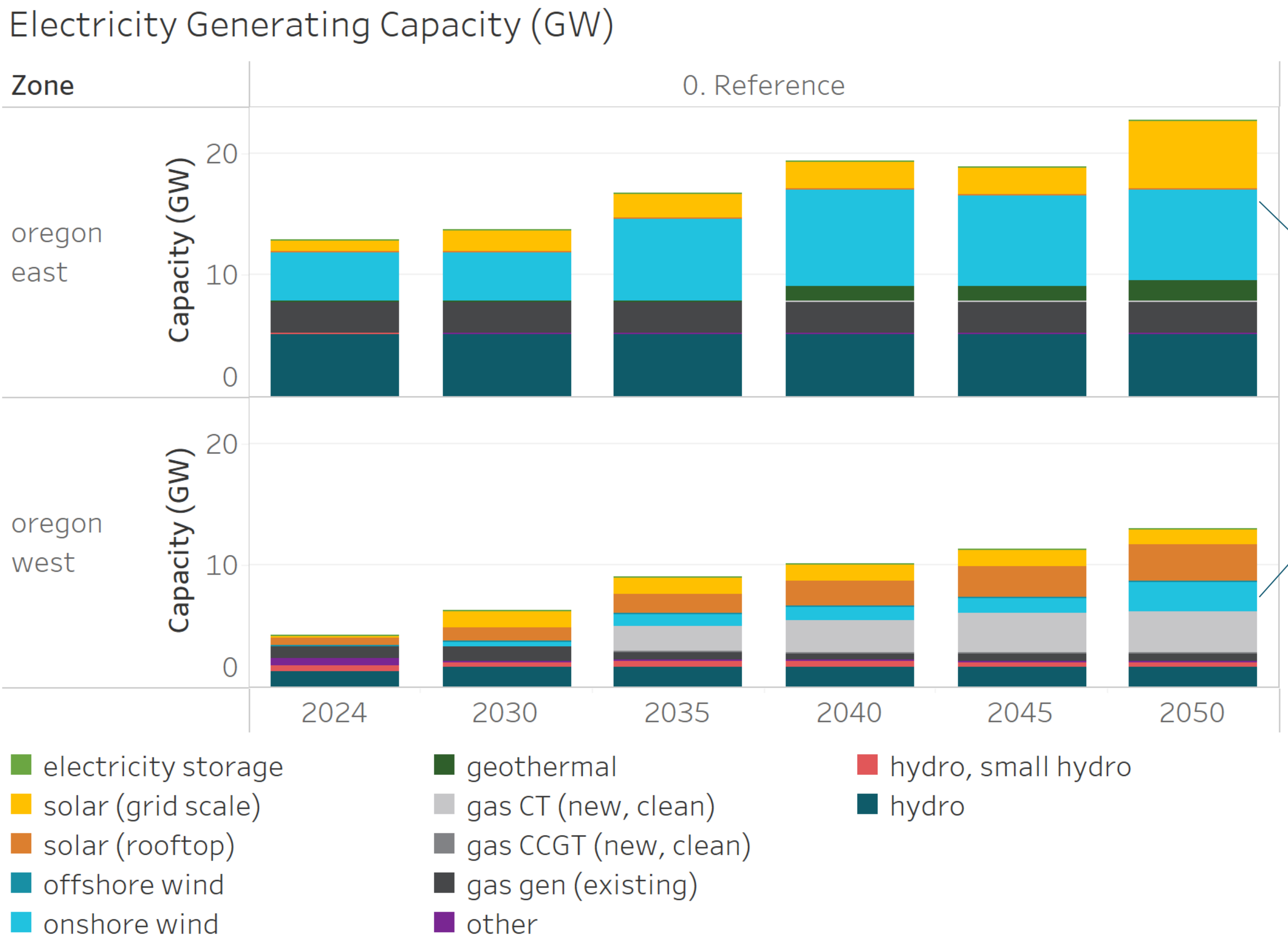

Onshore wind continues to be an important part of Oregon's resource mix

Oregon Needs More Generation Capacity

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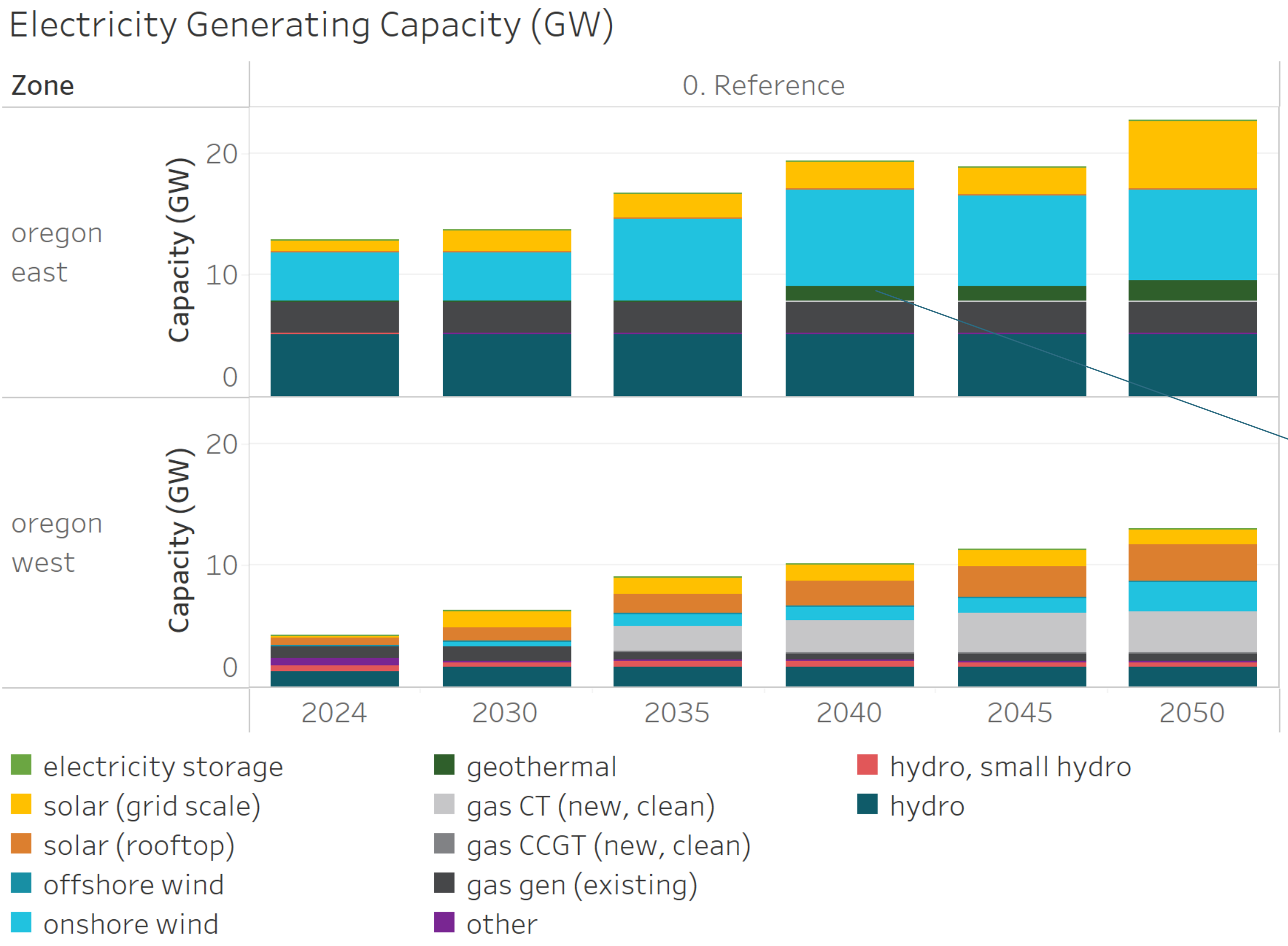
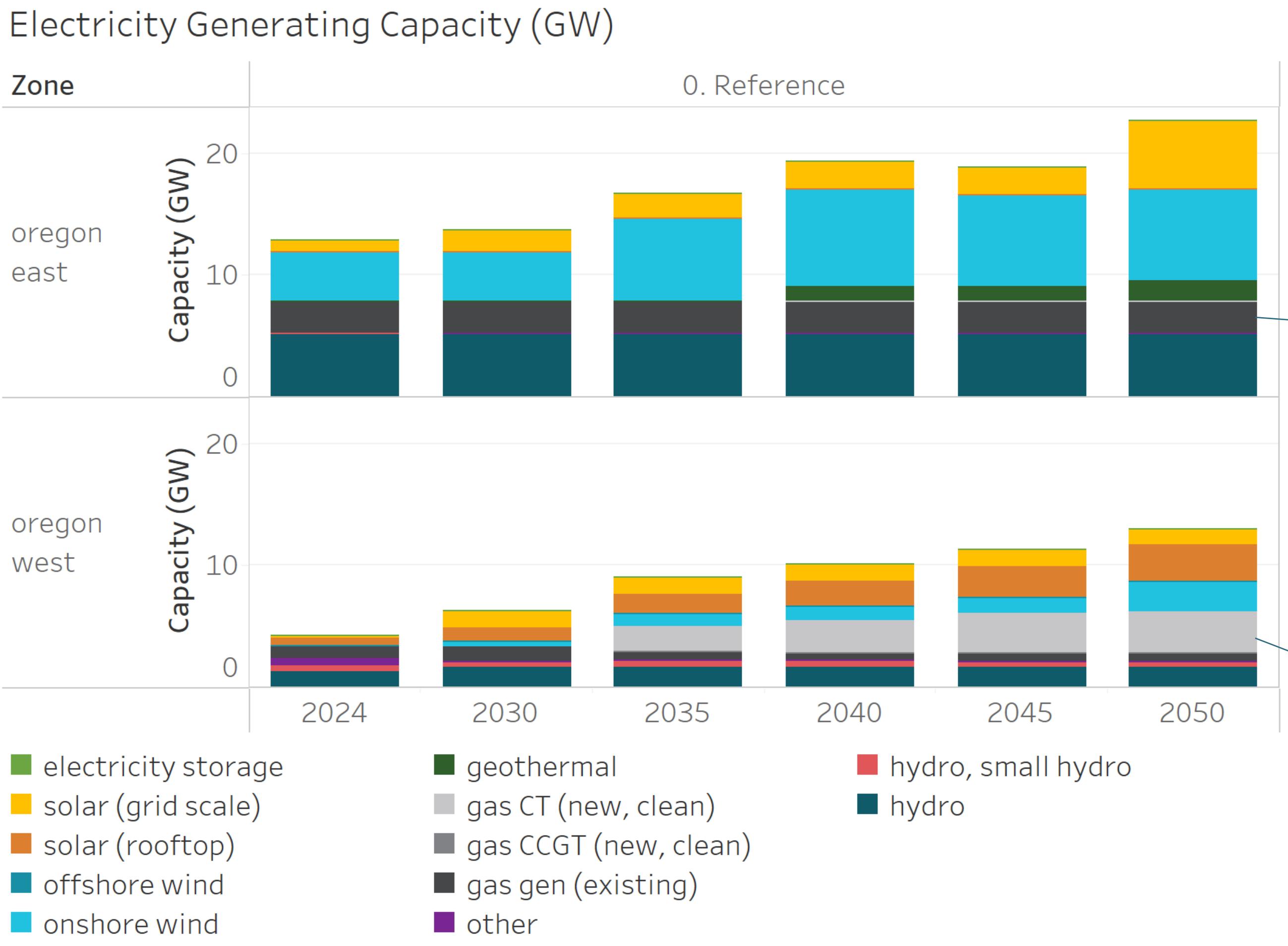


In 2040, enhanced geothermal comes onto the system

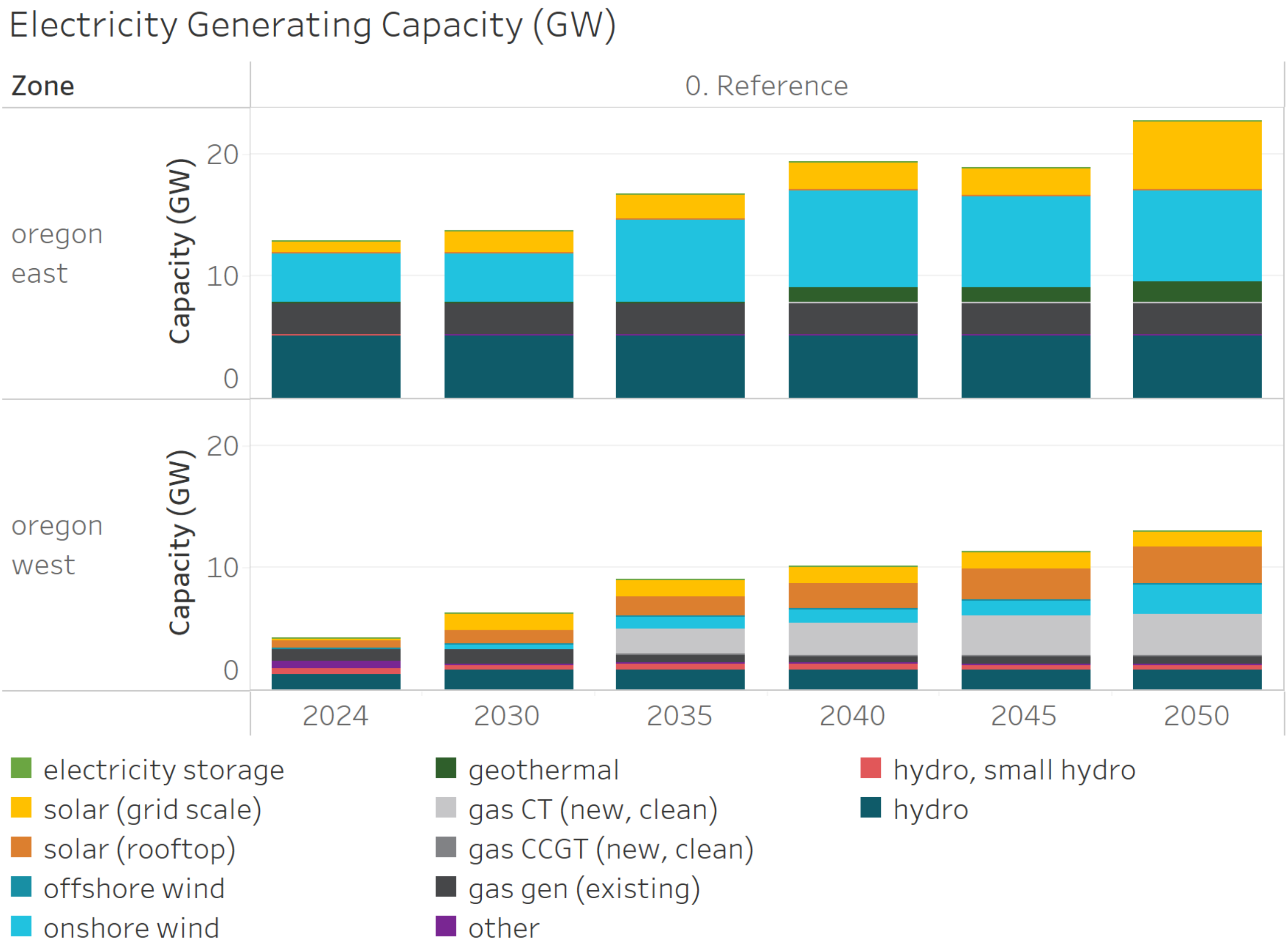
Oregon Needs More Generation Capacity



Model achieves HB 2021 emissions reductions but some existing gas remains in the statewide mix

And new, clean gas is built (but runs only rarely for reliability purposes)

Oregon Needs More Generation Capacity



This diverse mix of resources provide flexibility and reliability to a nearly non-emitting power system

More Clean Capacity = More Clean Electricity

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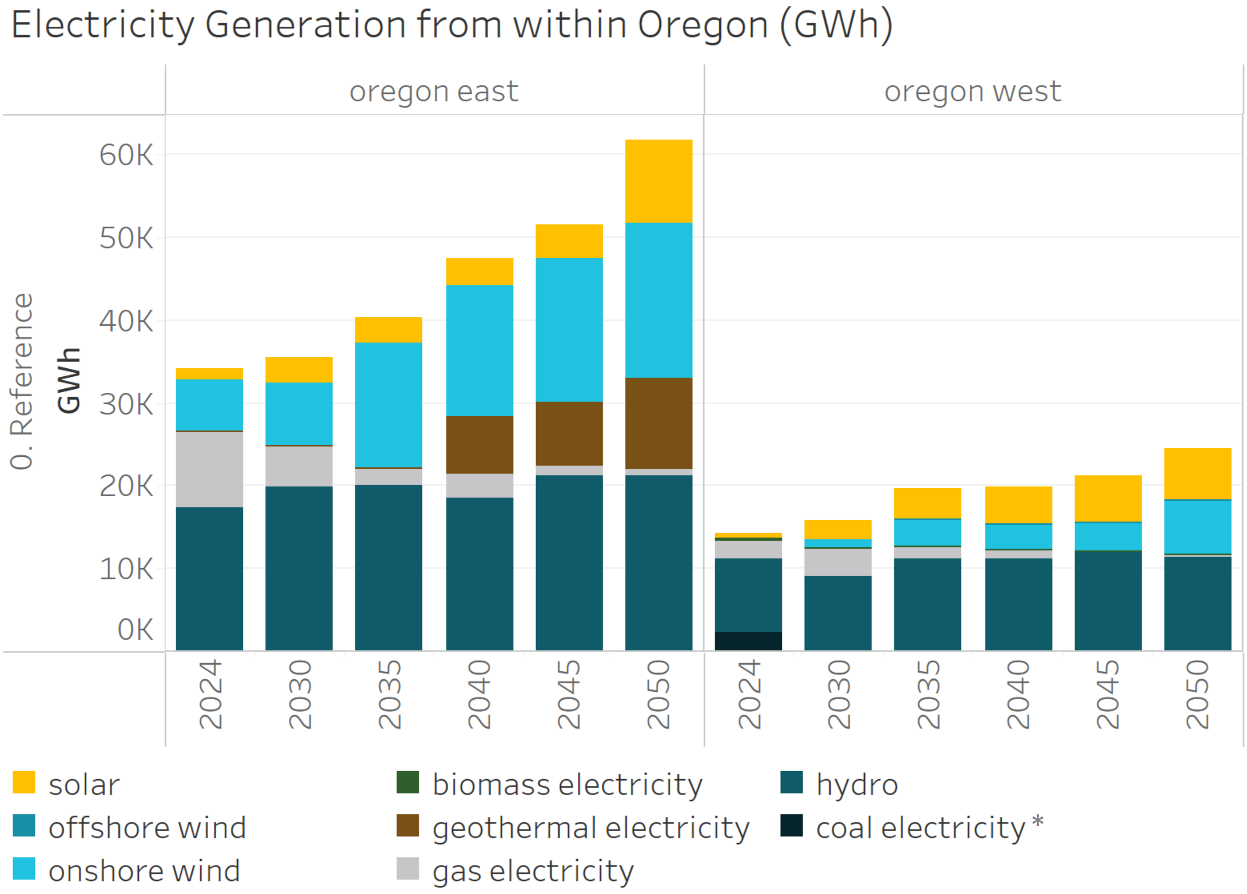
2030
Still have some gas; model built to hit HB2021 targets

2040
Enhanced geothermal emerges as key resource

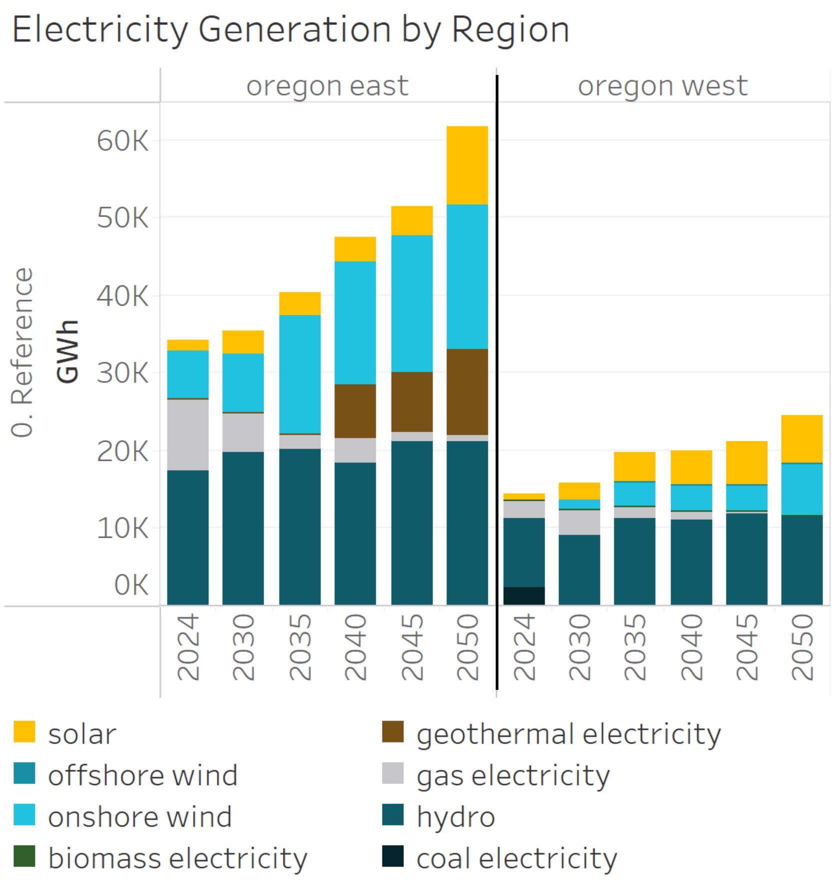


2050
Electricity generation is almost 100% non-emitting

*coal imported but represented as a contracted resource in modeling

Oregon Also Relies on Imported Electricity

- Oregon is part of a regional electricity system
- Even if we build more in-state resources like the model shows, we also need increasing levels of clean imported electricity
- Oregon exports power at times of surplus



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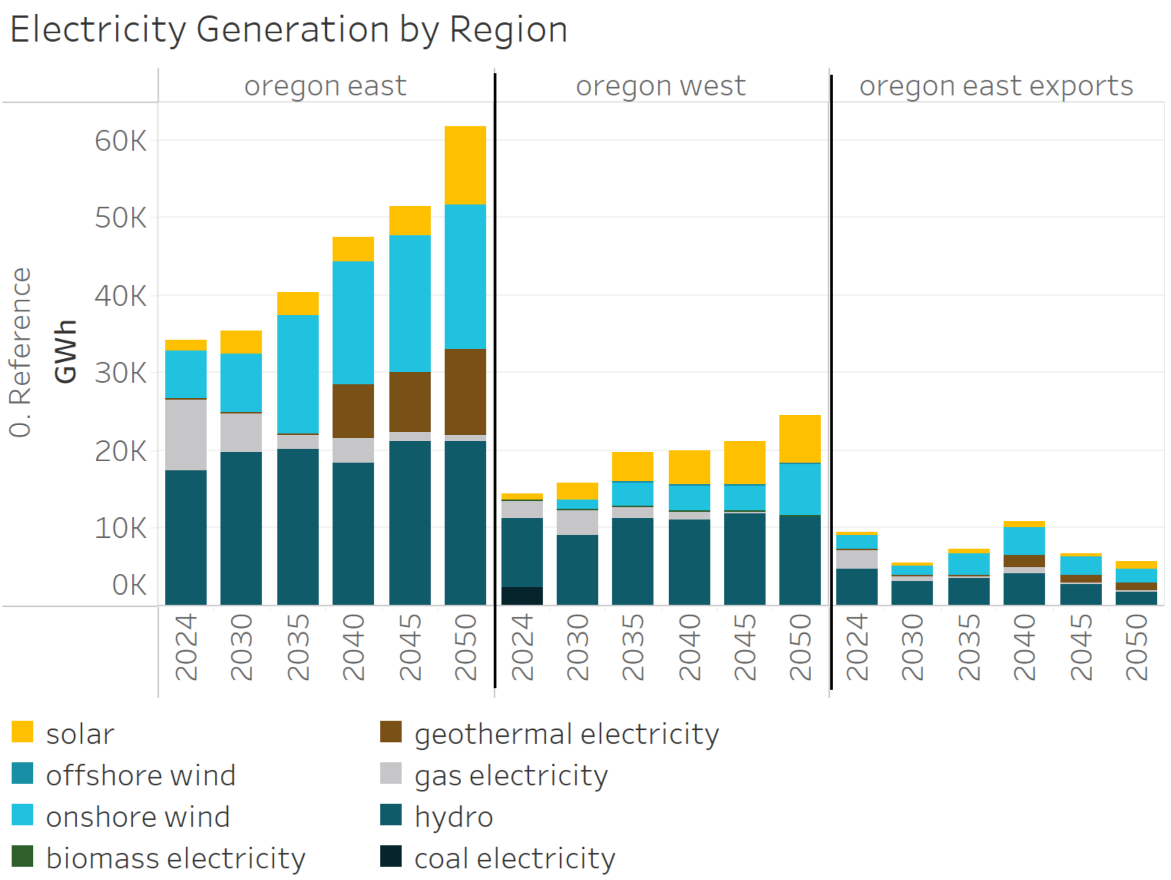

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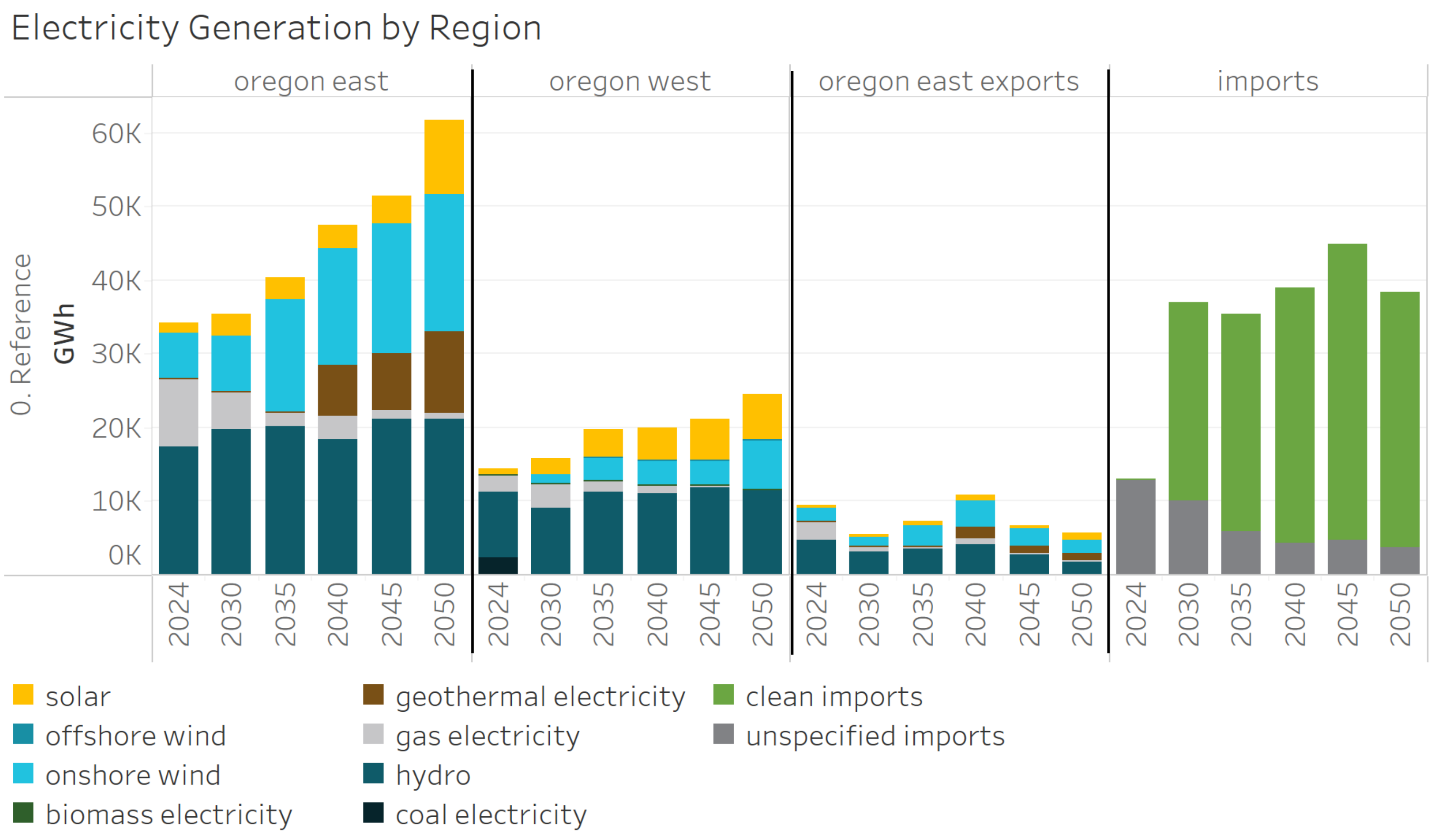
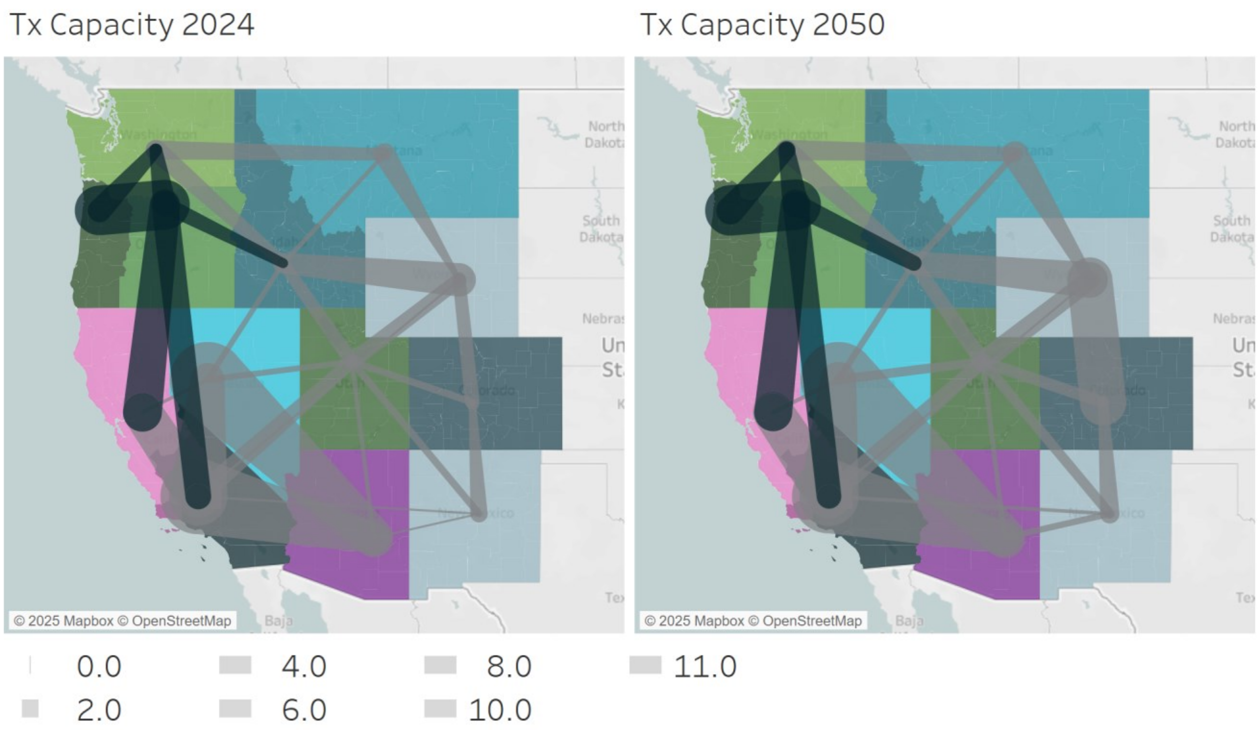


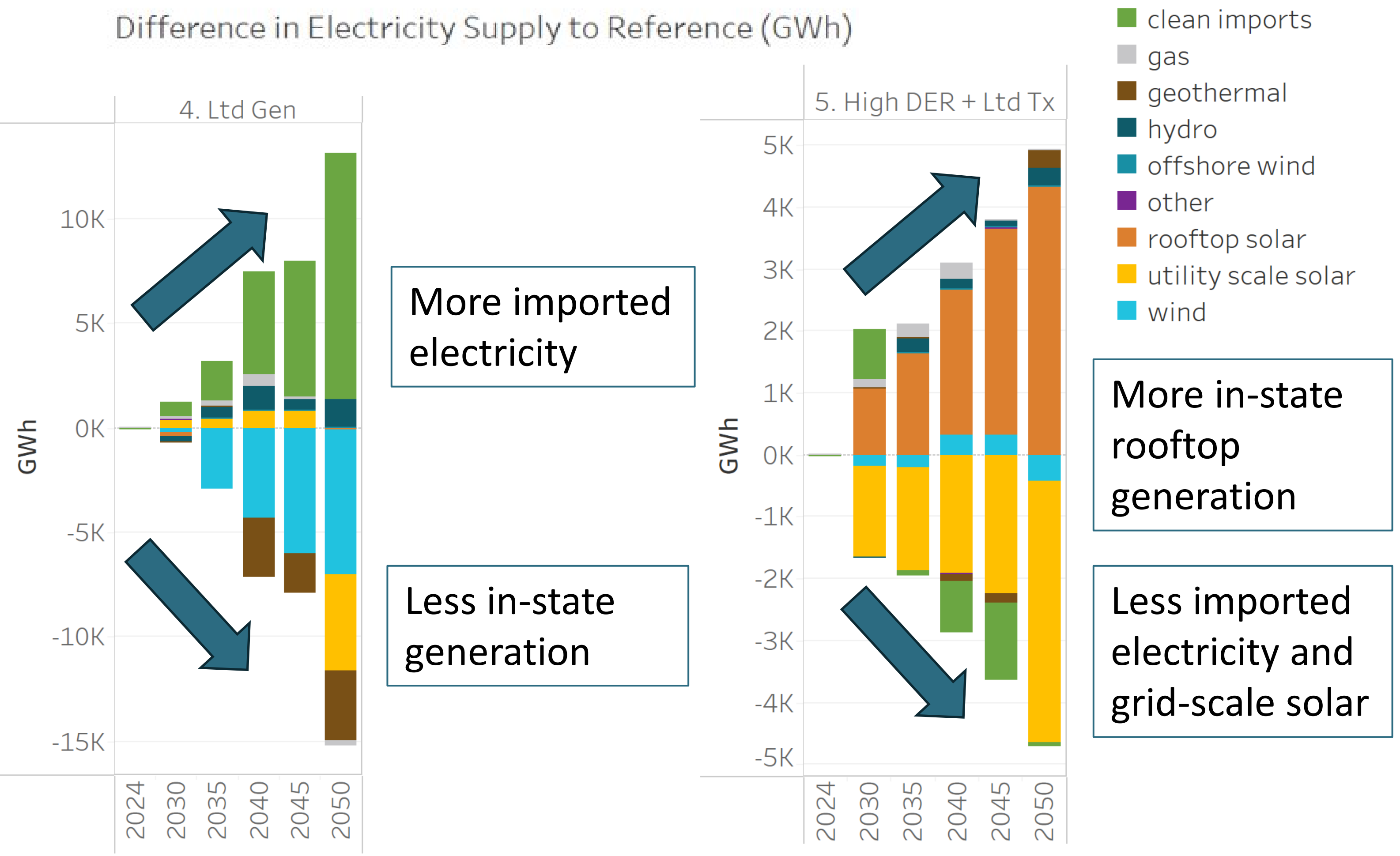
Oregon Needs More Transmission Capacity

- Transmission expansion focuses between zones:
  - Across the Cascades, and from Oregon to Idaho, Washington, and California
- The transmission model is linear, so investments can be made in fractions of new transmission lines
- These results are indicative of transmission need but do not replace detailed transmission planning
- Growth of transmission into Oregon West and Boardman to Hemingway transmission project into Oregon East
- If less clean gas capacity built in Oregon West or demand response is limited, more transmission is needed



The Balance of In-State vs. Imported Generation Can Change

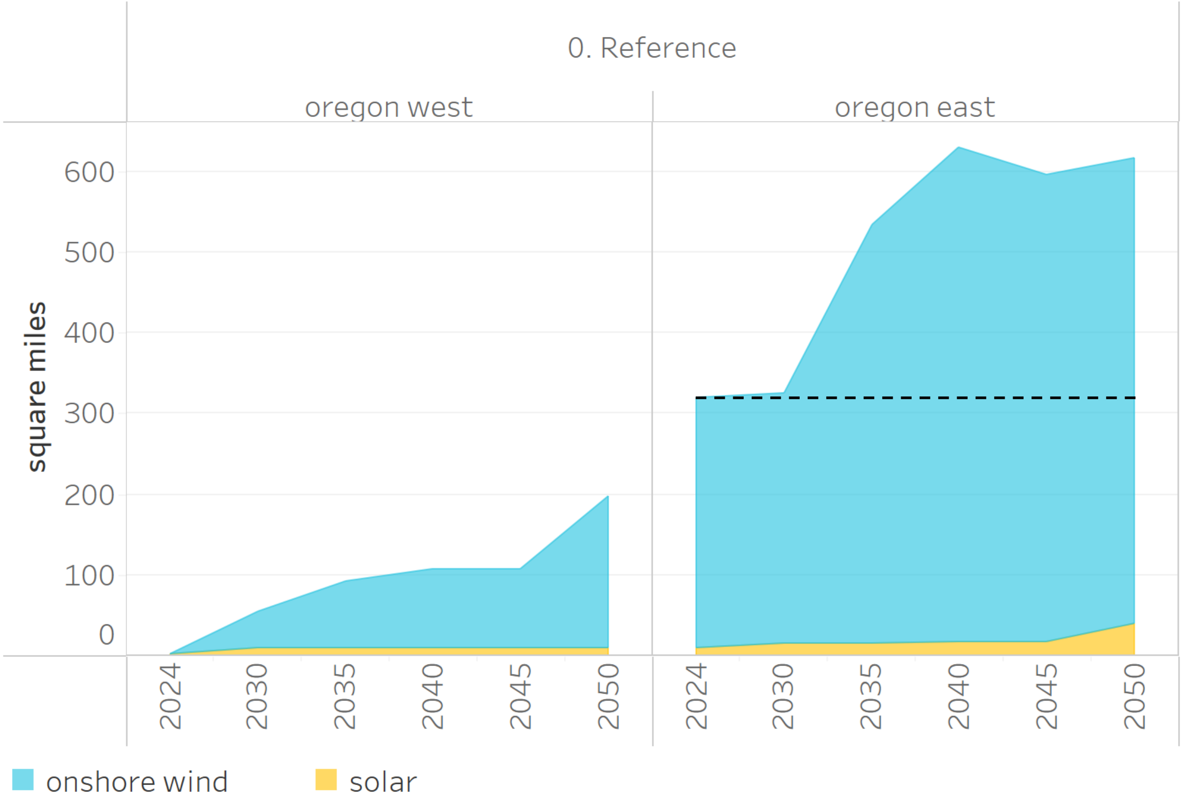
- If we cannot build more in-state generation, we need to import more (using more transmission capacity)
- If we cannot import more (due to lack of transmission capacity), we have to build more in-state
- Both alternatives cost more than the Reference Scenario



Wind and Solar Account for Largest Incremental Land Use Footprint

- Reference finds 620 square miles of development in OR East and 200 square miles in Oregon West by 2050
- Scenarios affect scale of land use and natural resource footprint
  - 31% reduction when limit development
  - 15% increase when take out clean gas as a reliability resource
- Other resources will have a footprint but wind and solar are the largest contributors

Land Use by Resource (square miles)



We use NREL estimates of wind and solar land use. Wind: 78 square miles/GW. Solar: 7 square miles/GW

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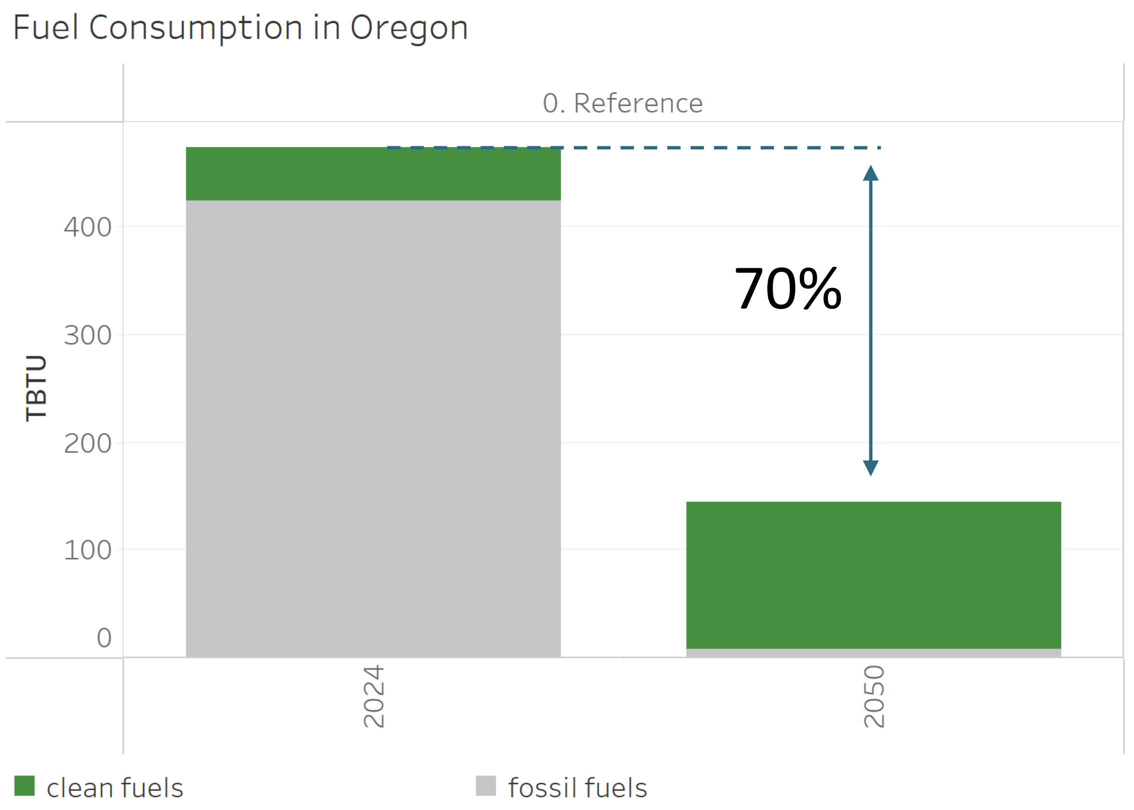
Fuels Sector Insights

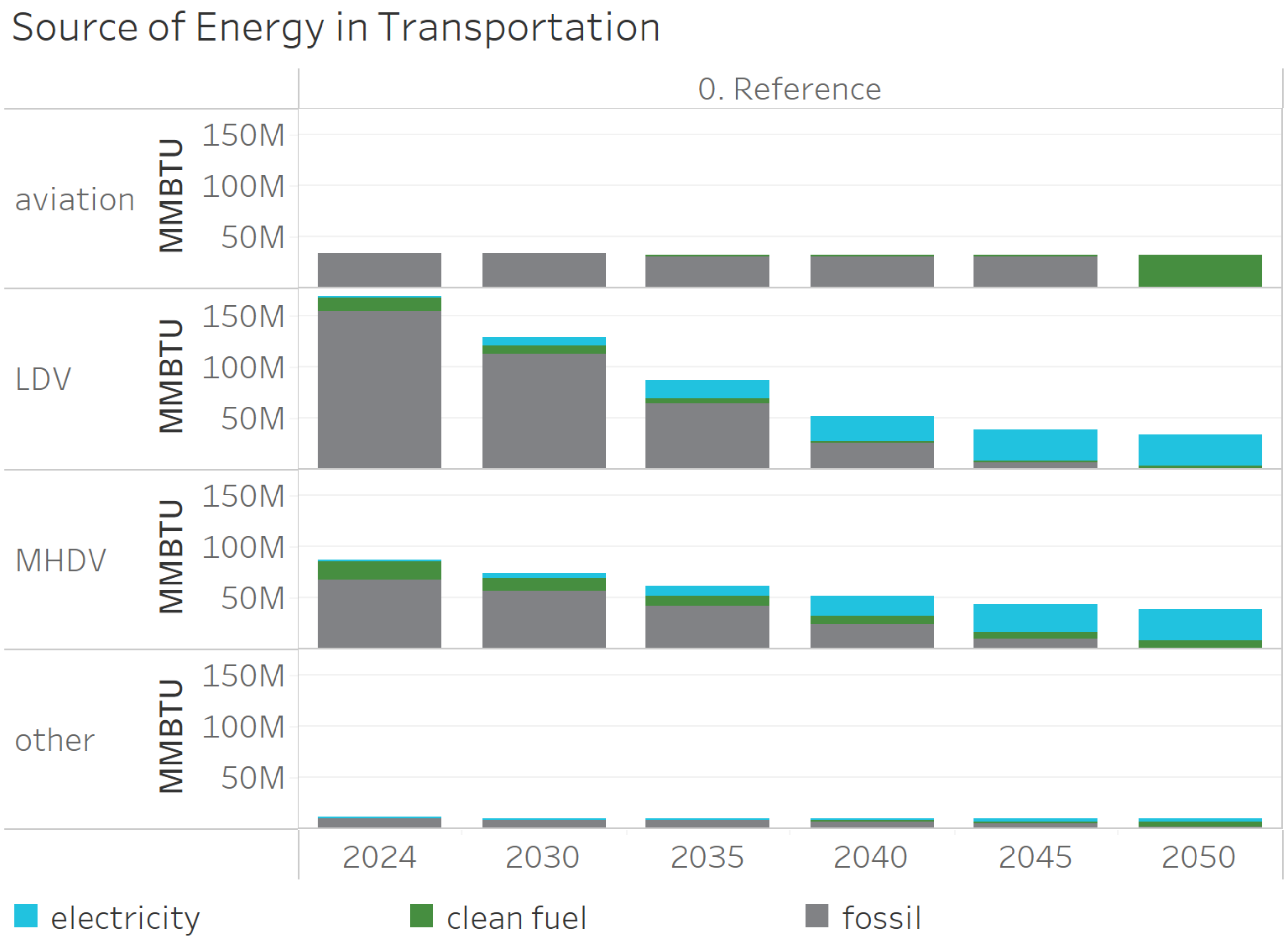
Clean Fuels are Needed to Meet Energy and Emissions Goals

- Fuel demands decrease over time but their importance does not
  - Hardest to decarbonize sectors
  - Resilience
  - Time for electric technologies to replace fossil
- Clean fuels include biogas, bio liquids, e-fuels, hydrogen, ammonia, and geothermal steam



Fuels in Transportation Decrease due to More Efficient Electric Drivetrains and Convert to Clean

- Electrification of light duty and medium duty vehicles
- Dependent on clean fuels
  - Aviation
  - Medium and Heavy-Duty Vehicles
  - Freight rail
  - Maritime



Direct Use Fuels Support Industrial Production and Mostly Phase Out in Buildings

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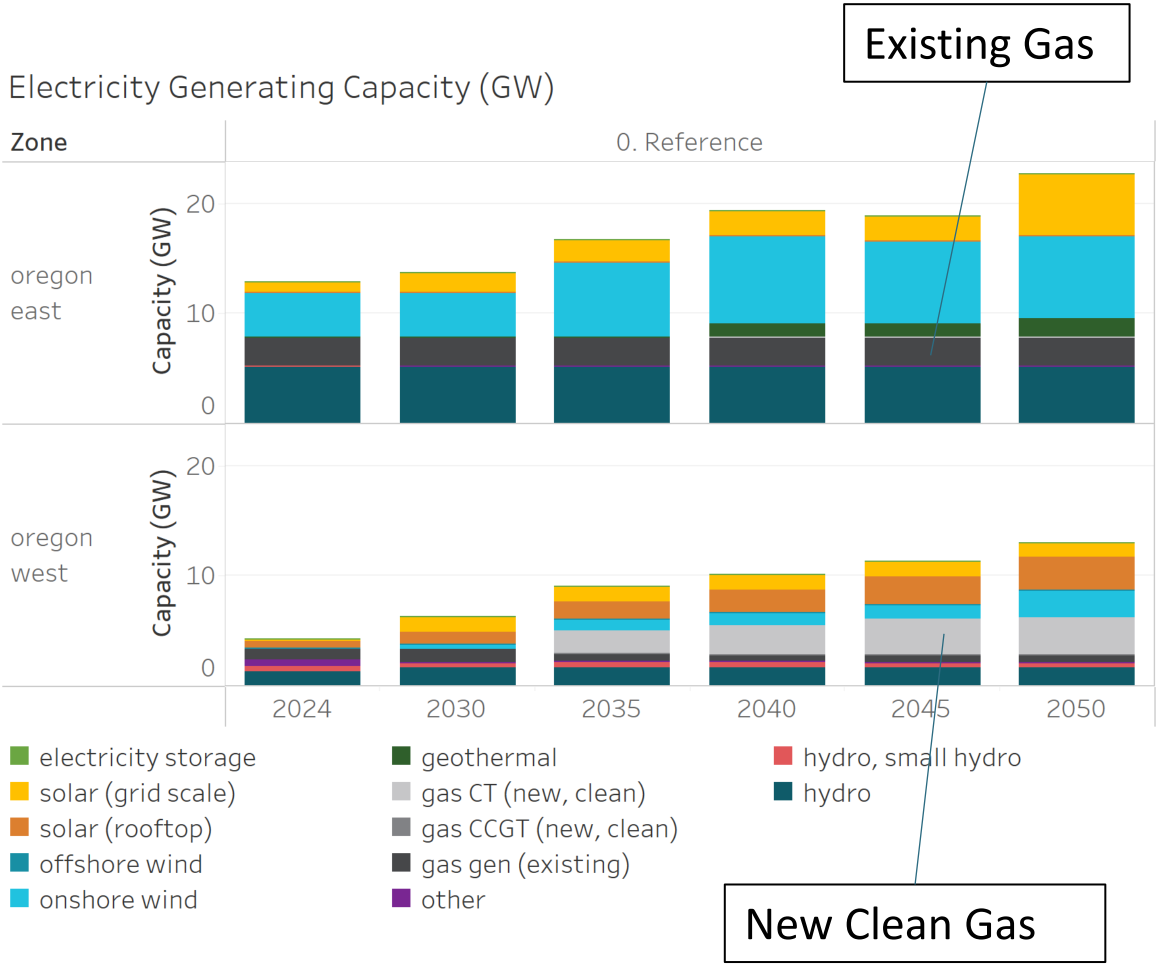
Direct Use Fuels in Industry & Ag, Commercial, and Residential Sectors

The Electricity System Relies on Installed Gas Capacity to Provide Flexibility and Reliability

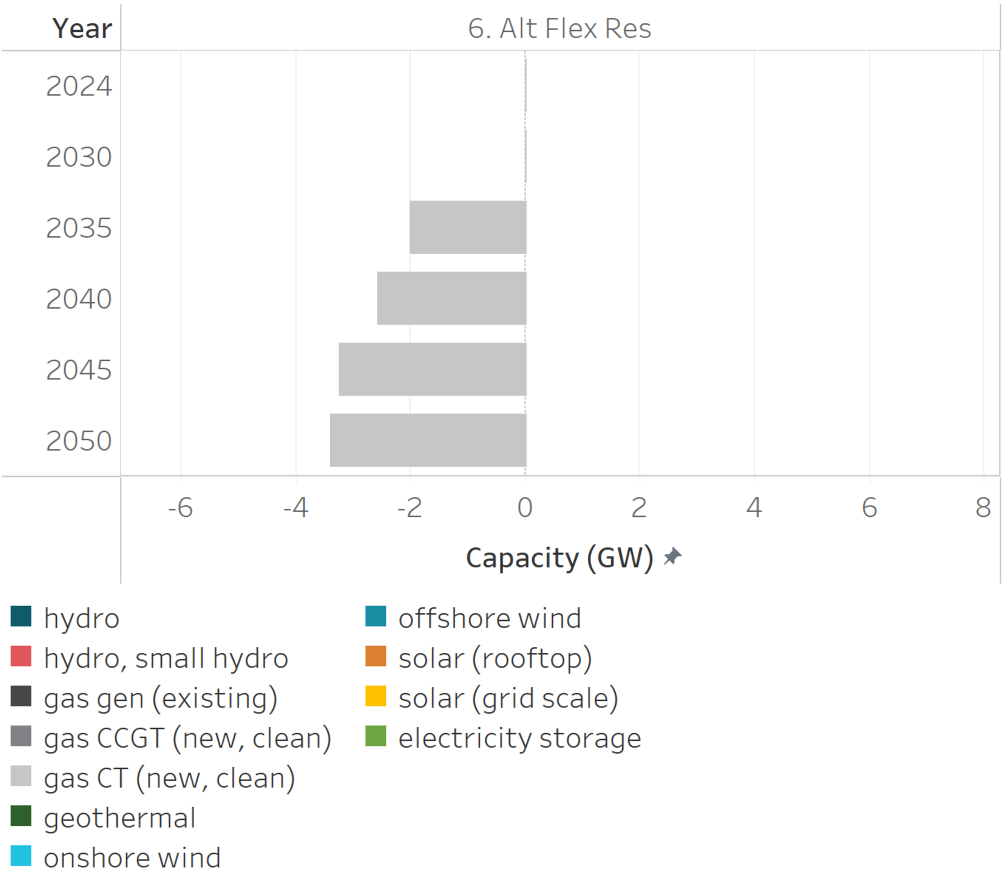
- Flexible capacity is needed to makes sure the system stays reliable
- New clean gas resources can only burn hydrogen or new sources of biogas
- New clean gas resources almost never operate
  - Expensive fuel but cheap capacity



What if We Couldn't Rely on Clean Gas Plants for Reliability?

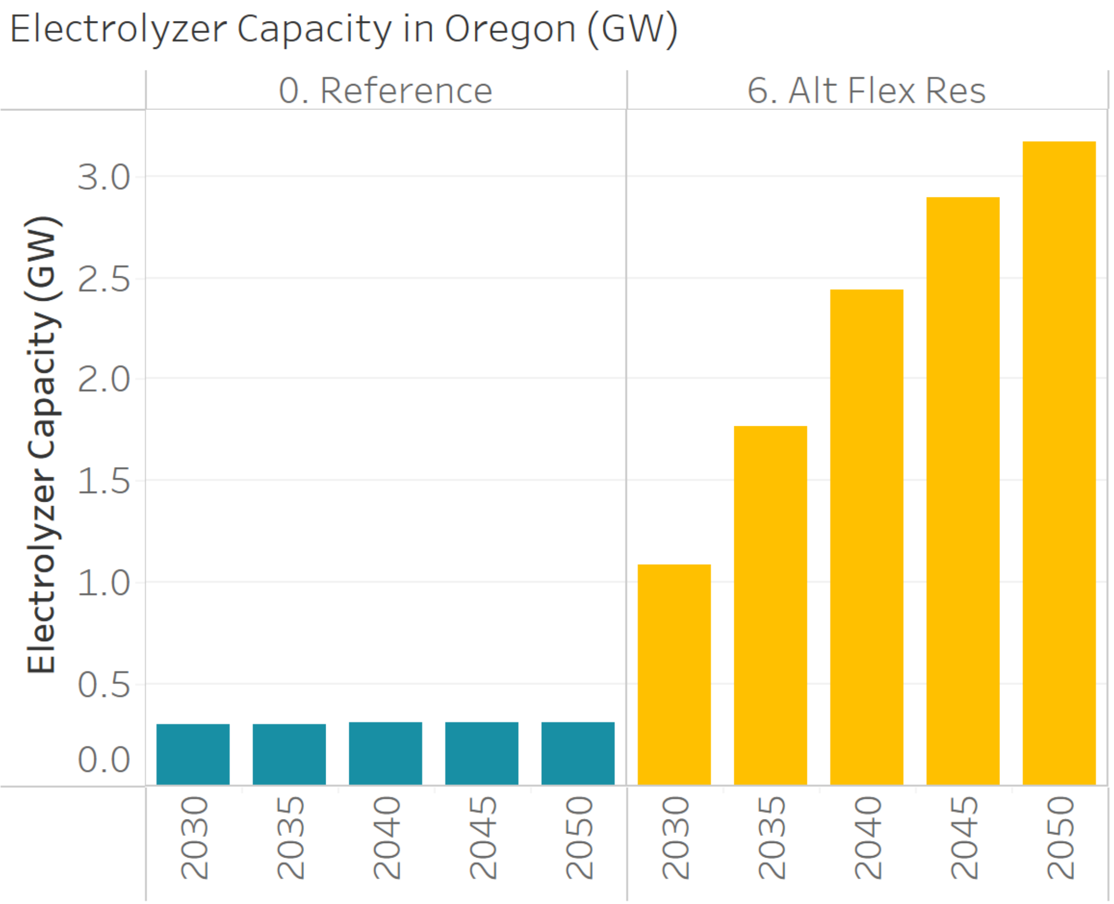
- The Alternative Flexible Resources scenario doesn't permit the build of new clean gas
- Doubling of electric end use loads and increasingly renewable electricity supply
  - What flexible resources are required to ensure reliability?
- Different options but the model takes a hydrogen and transmission path

Clean Gas Generating Capacity in 6.Alt Flex Res relative to Reference (GW)



What if We Couldn't Rely on Clean Gas Plants for Reliability?

- Clean fuels production from hydrogen occurs outside of Oregon in the Reference Scenario
- Large new flex load: electrolysis becomes valuable to Oregon West in Alt Flex Res
- Movement of electrolysis from out of state into Oregon West: Turn on loads when high renewable energy generation and turn off when low
  - Ammonia produced from H2 exported to Western ports



What if We Couldn't Rely on Clean Gas Plants for Reliability?

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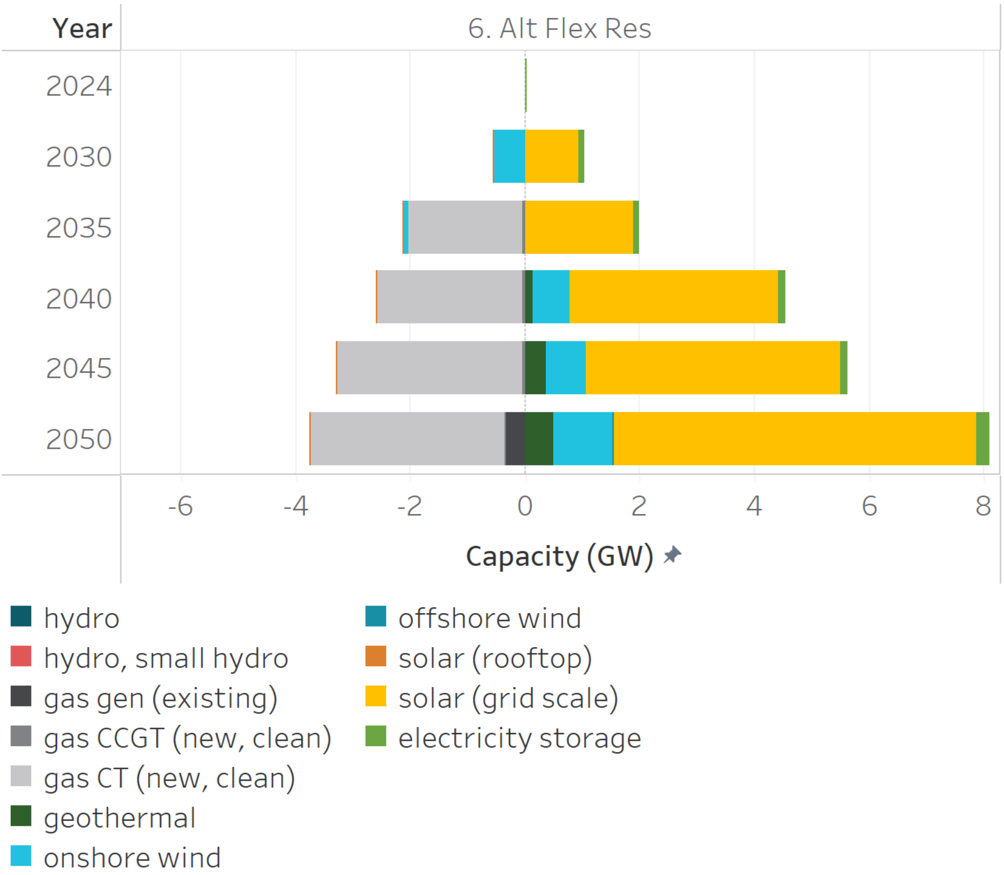
- Increased loads from electrolysis supported by increased renewables and transmission

Electricity Generating Capacity in 6.Alt Flex Res relative to Reference (GW)



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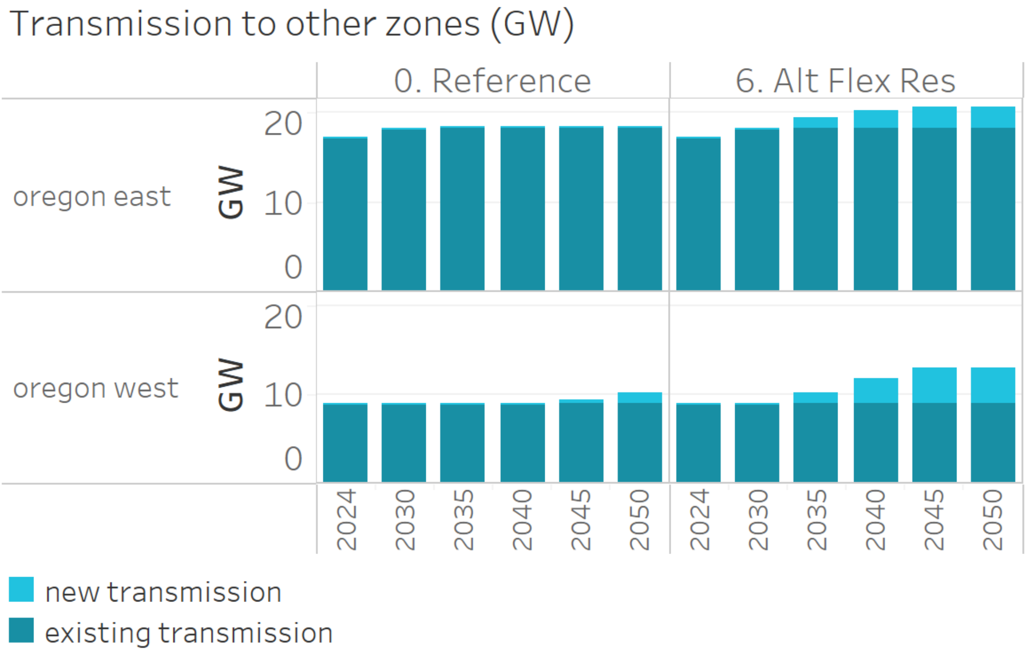

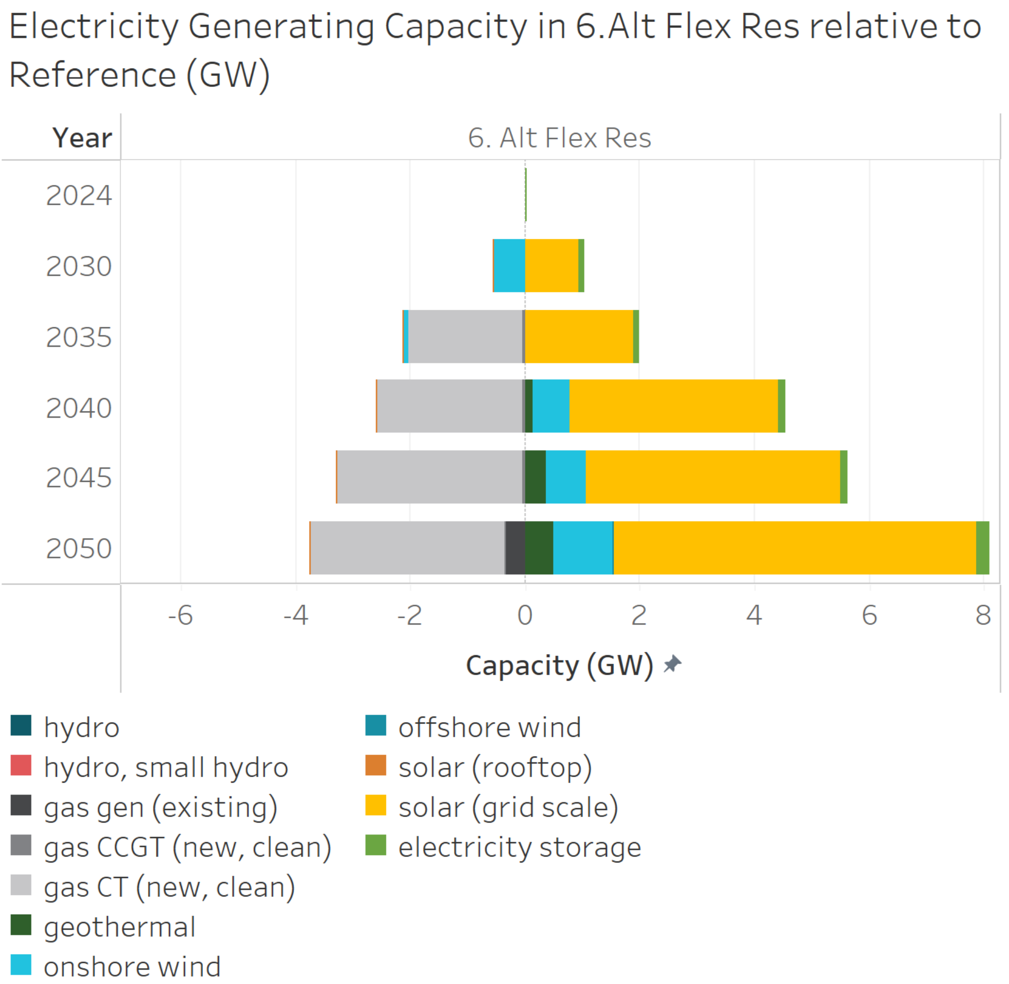

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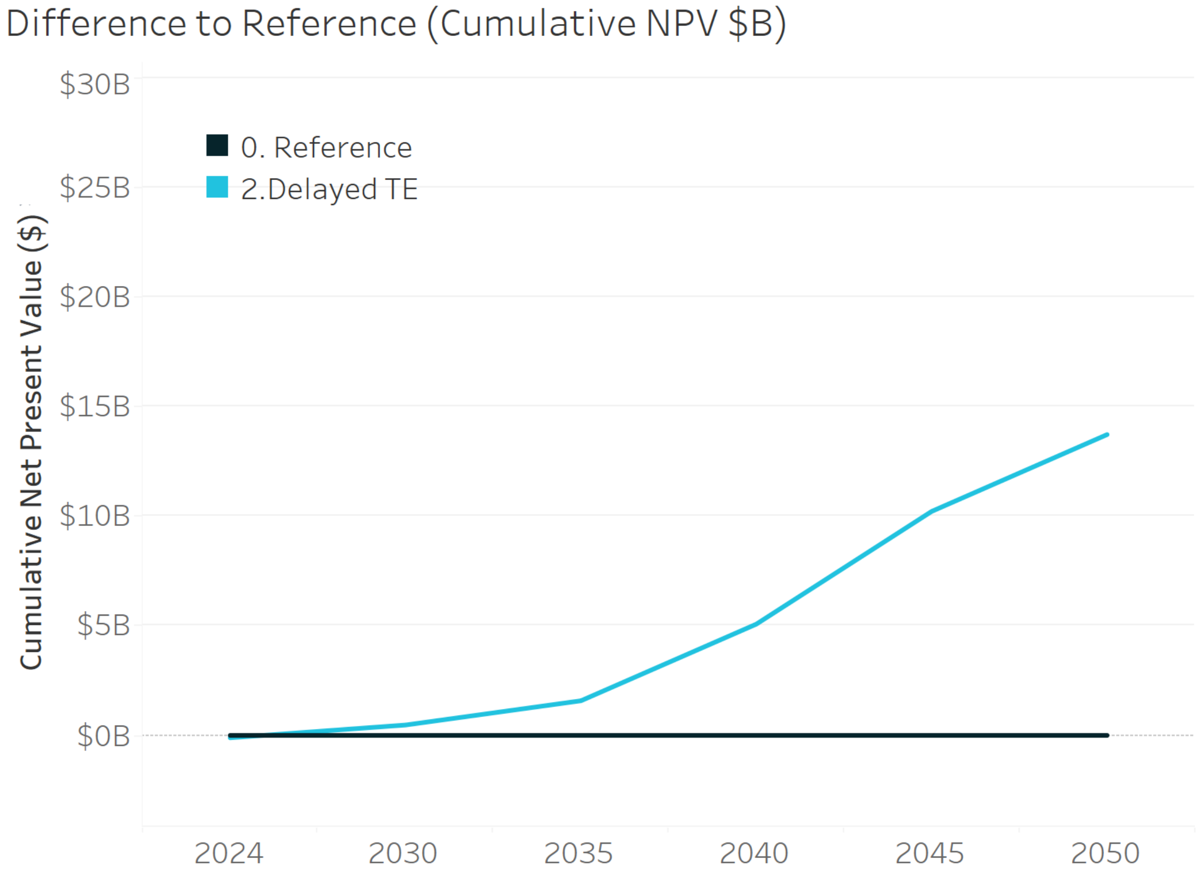
Transportation Sector Insights

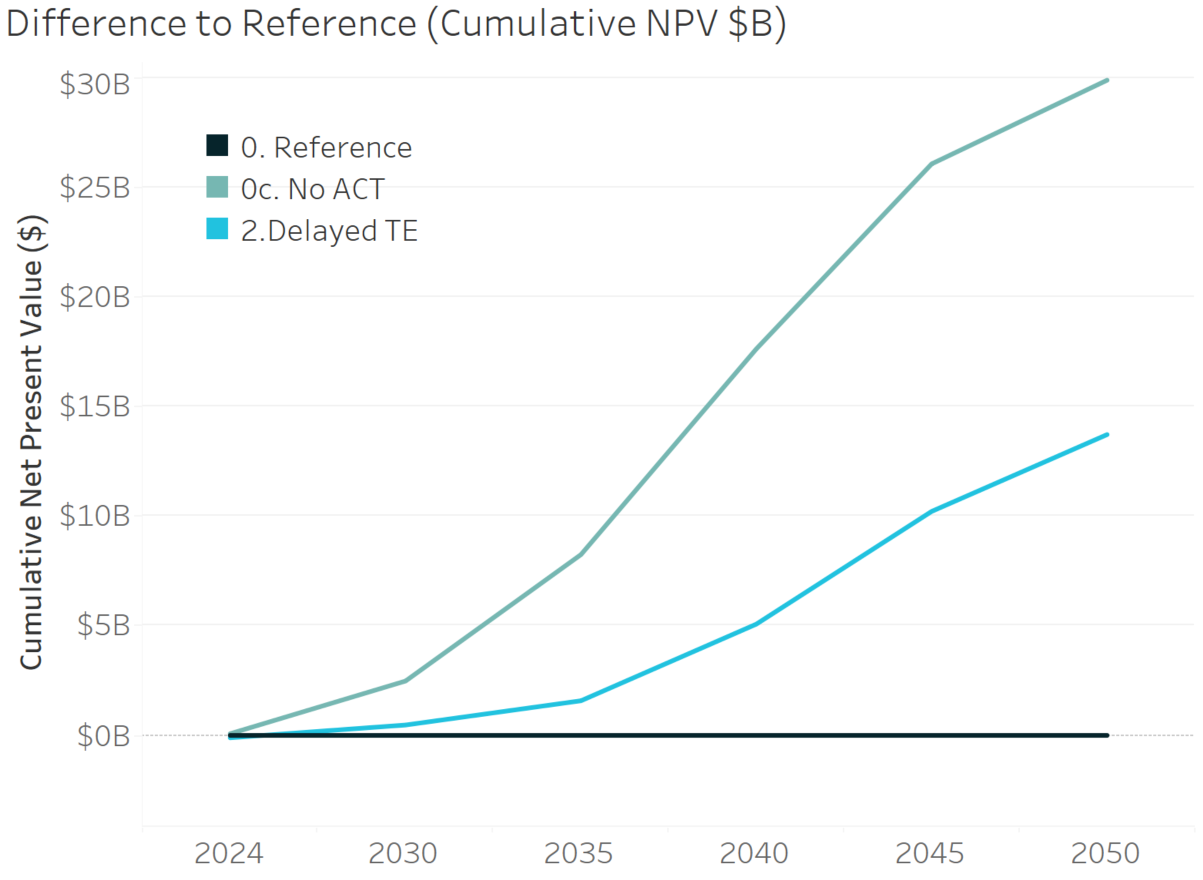
Delaying Electrification of Trucks beyond 2040 is More Costly

- Delaying when Oregon reaches 100% medium- and heavy-duty ZEV sales by 10 years increases costs
- Puts more pressure on clean fuels to meet targets
- Efficiency losses mean total demand 0.7% higher in 2040 and 0.9% higher in 2050
- To meet emissions target, **almost all vehicle fuel must be clean by 2050**



Delaying Electrification of Trucks beyond 2040 is More Costly

- Without the MHD ZEV targets required by the Advanced Clean Trucks rule, costs increase significantly
  - More than double Delayed TE
- Early adoption EVs, including MHD EVs, is critical for cost containment
- No ACT is $16B NPV higher over 25 years than Delayed TE



Electric Cars Are a Key Part of the Picture

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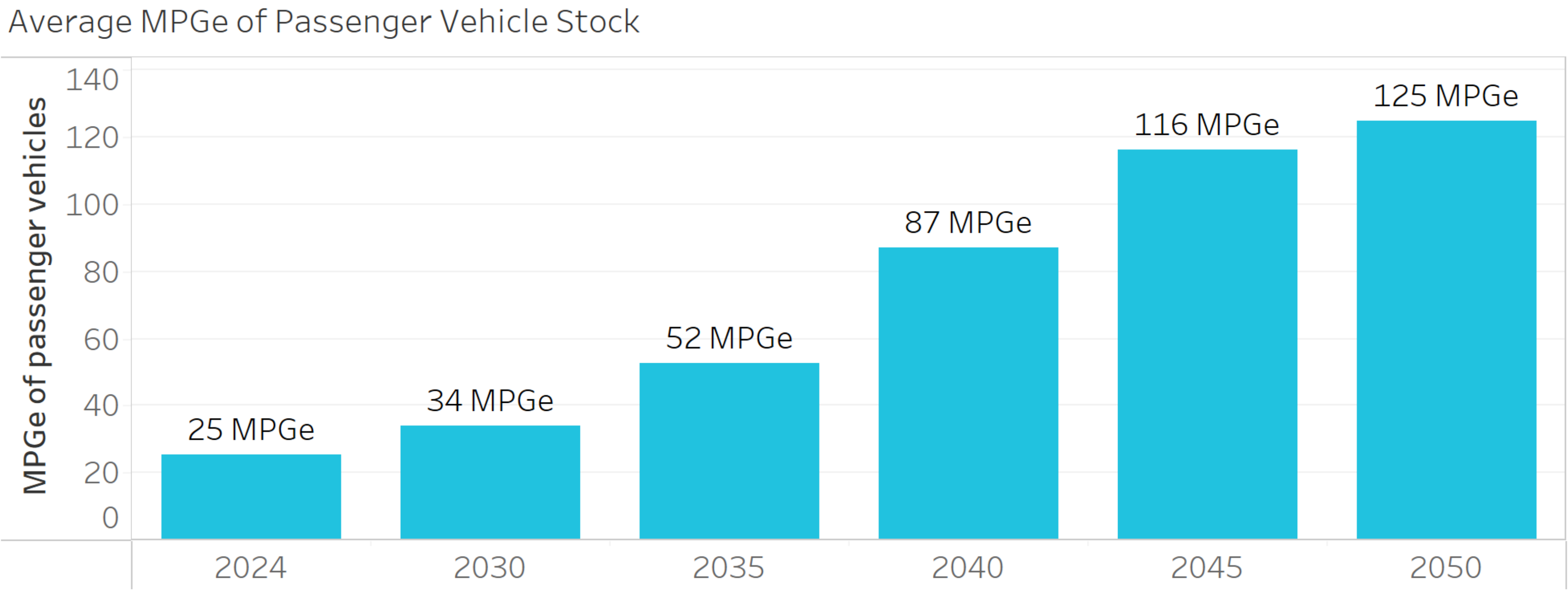
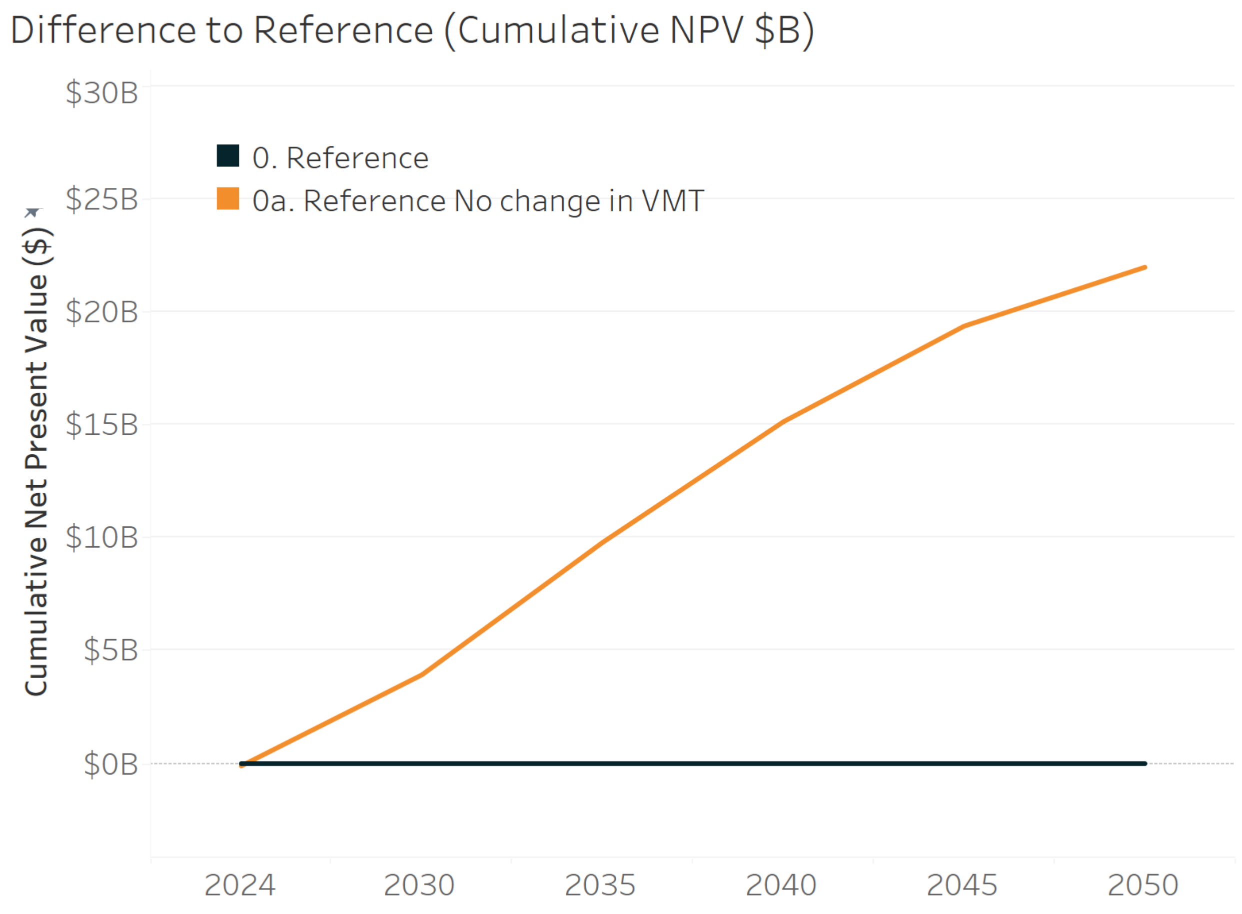


- Electric cars deliver huge efficiency gains
- Together with electrification of trucks, responsible for reducing the size of the whole energy sector by 27% over 2024 loads

Reducing Vehicle Miles Traveled Saves Money

- VMT reductions save $22B over 25 years
- The Reference Scenario incorporates Oregon's goal of a 20% reduction in VMT by 2050
- Removing improvements in VMT drives up costs by increasing the overall energy demand in the economy



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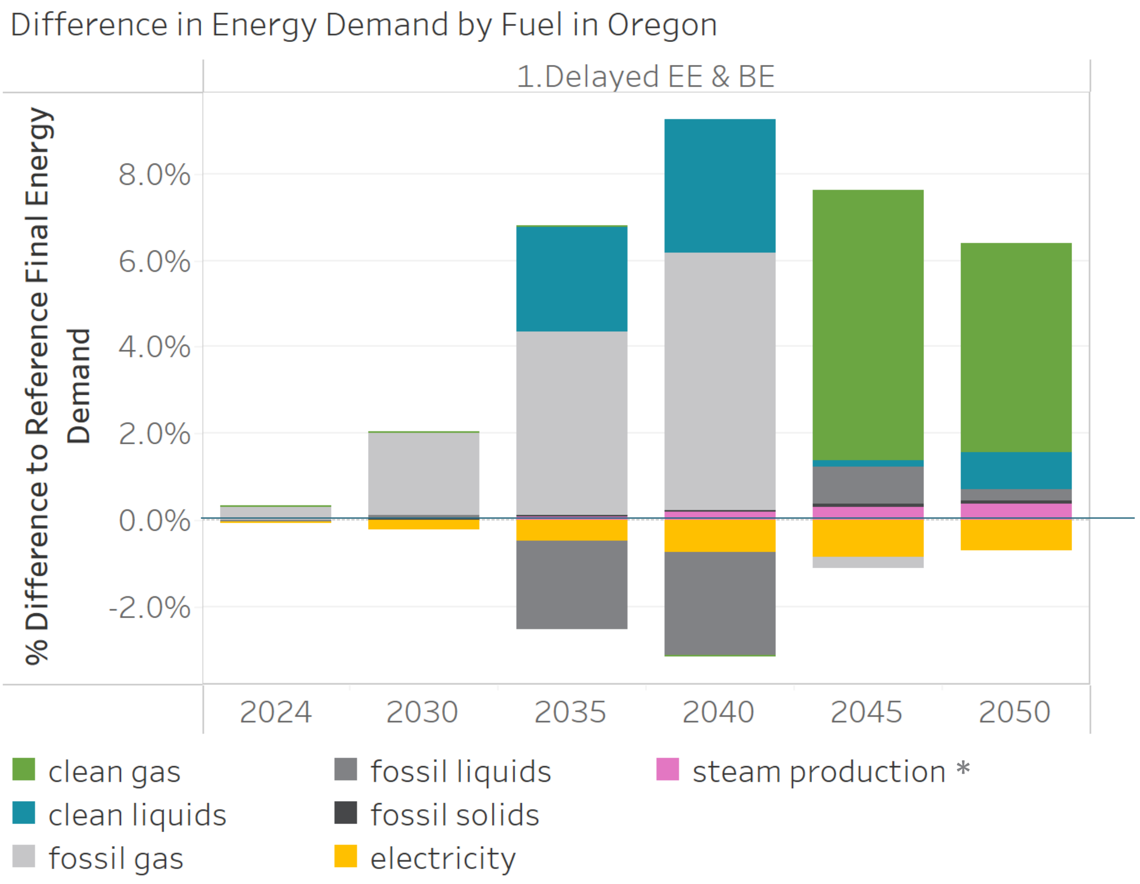
Buildings Sector Insights

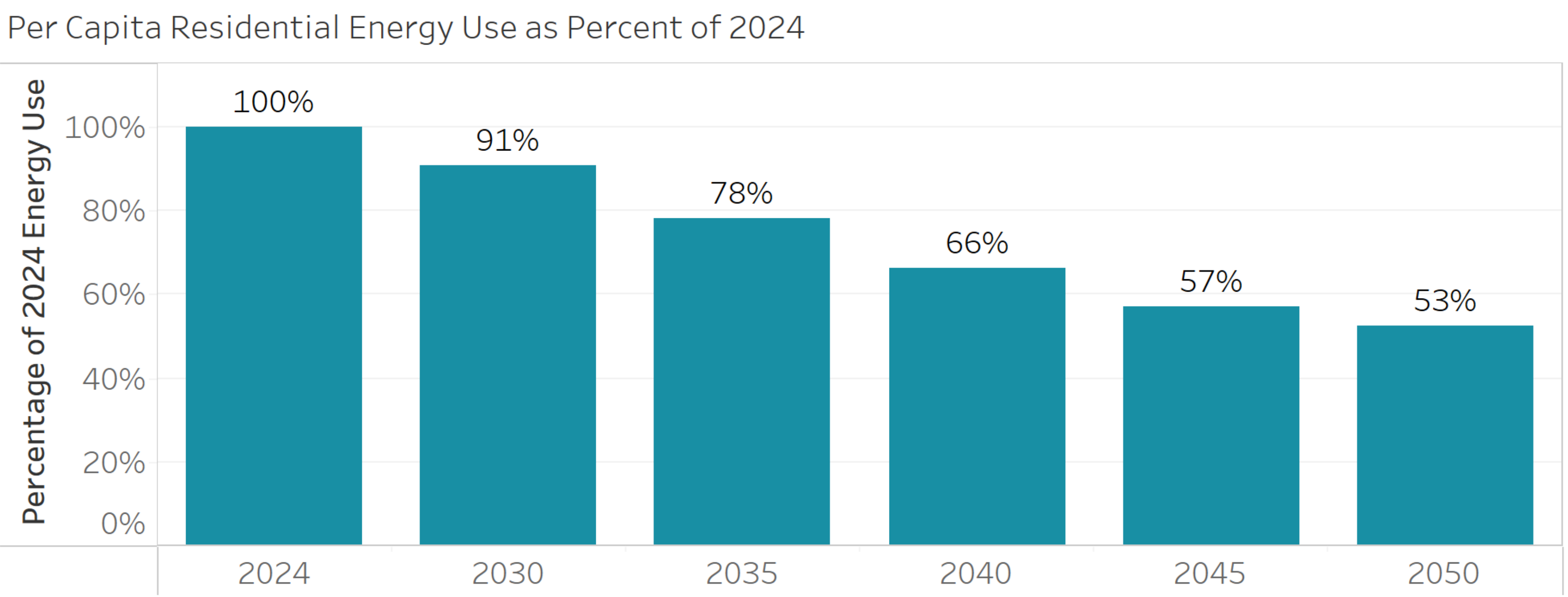
Delaying Energy Efficiency and Building Electrification Increases Fuels and Electricity Use

- Increased gas use
- Reduced electricity use
- Total energy demand 2% higher in 2030 and 6% higher in 2050
- Increases cost by $17B net present value
- Transition from fossil to clean may need to happen more gradually than shown



*Steam production is 55% geothermal and 35% biogas by 2050

Electrification and Energy Efficiency Mean a Lighter Lift to Meet Energy Demand



- Electrification of space and hot water heating are the biggest drivers of energy savings
- Other efficiency improvements from weatherization and other equipment (lighting, fridges…)
- Commercial and industrial efficiency improvements further drive down demand

As the Electricity Sector Grows, So Do Opportunities for Consumers

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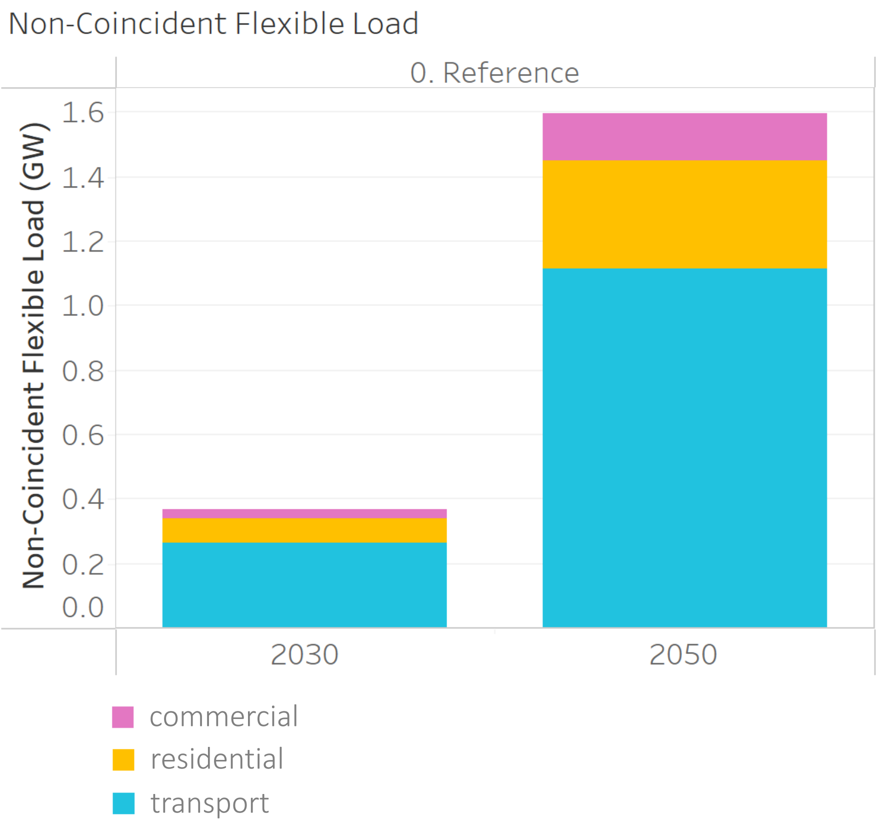
- Demand response programs reduce future capacity and transmission needs
  - Customers with smart thermostats, smart water heaters, battery storage systems and electric vehicles enroll in utility programs to shift loads to off-peak periods
  - Reducing peak demands on the grid displaces the most expensive future energy resources
  - Limiting demand response in the model results in more west side storage
- Rooftop solar reduces land use concerns in eastern Oregon



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Conclusions

Key Takeaways

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- Electrification and energy efficiency are key to reducing the size of the overall energy “pie” and to cost containment
- Fuels play a strategic role in the transition, with a shift toward clean fuel alternatives toward 2050
- All scenarios indicate a need to build infrastructure in Oregon
- Tech loads are the biggest driver of electricity demand growth but are also uncertain in when and where they could emerge

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Questions?

THANK YOU

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