# Oregon Energy Strategy Technical Report

2/20/2025

**Prepared for:**

Oregon Department of Energy

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# Modeling framework

# Key Study Questions

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0. What are the key elements of a least-cost pathway to meeting Oregon's energy policy objectives?
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?

# Sensitivity Questions

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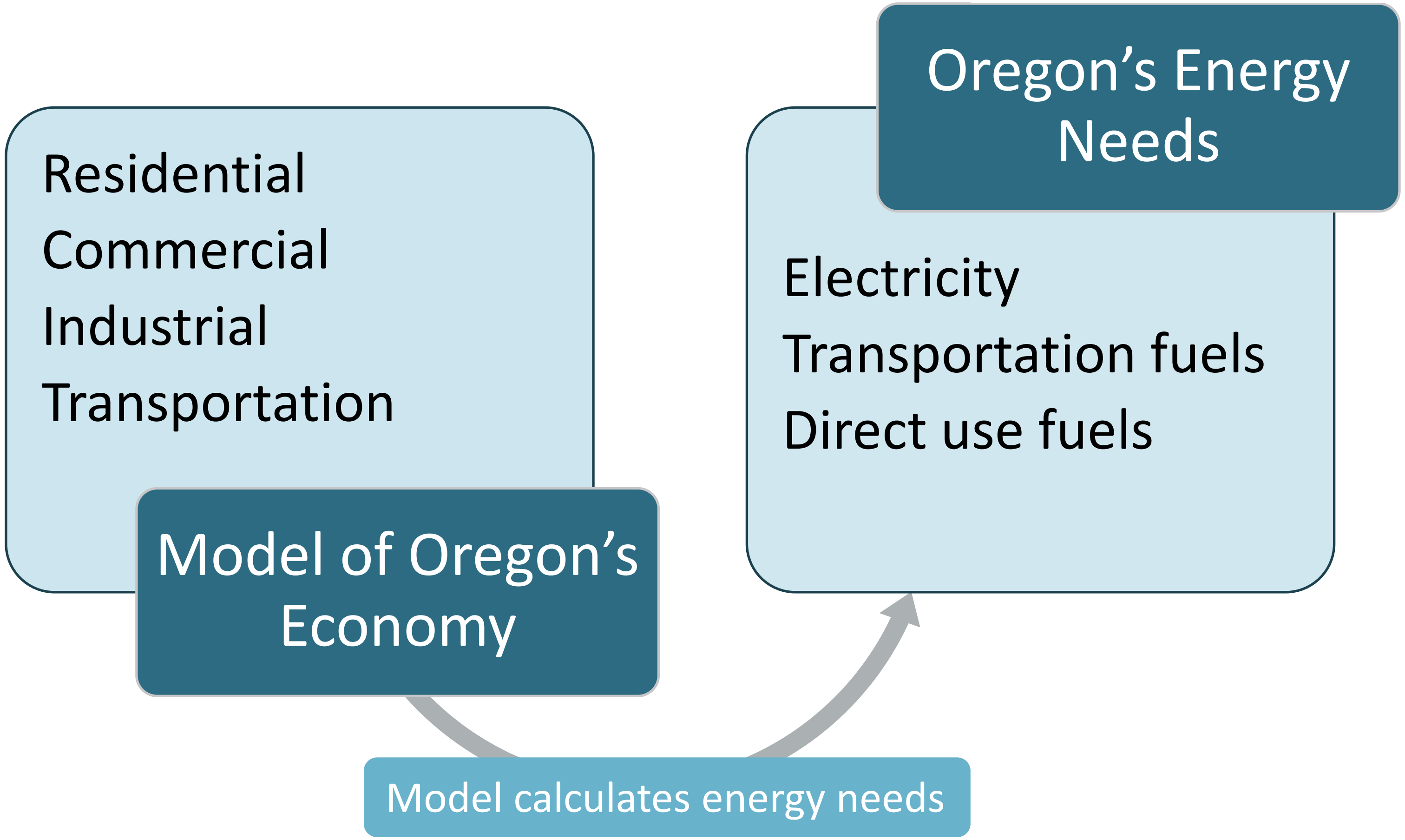
- **0a. No Change in VMT in Reference Scenario**
  - What if per capita vehicle miles traveled (VMT) remained the same from the present until 2050 instead of a 20% reduction in VMT per capita in light duty vehicles in the Reference Scenario?
- **0b. 50% Lower Tech Load Growth in Reference Scenario**
  - What if electricity demand supplied for data center and technology growth were 50% lower than the 2029 Northwest Power and Conservation Council's Power Supply Adequacy Assessment 2029 mid-higher forecast?
- **0c. No Advanced Clean Trucks Regulation in Delayed Transportation Electrification Alternative Scenario**
  - What if there were no electrification targets for medium-and heavy-duty vehicles through 2035 that deferred transportation electrification further than Scenario 2, Delayed TE?

# Overview of Modeling Approach

Residential
Commercial
Industrial
Transportation

Model of Oregon's Economy

# Overview of Modeling Approach



# Overview of Modeling Approach

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Residential
Commercial
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Transportation

**Model of Oregon's Economy**

Model calculates energy needs

**Oregon's Energy Needs**

Electricity
Transportation fuels
Direct use fuels

Model calculates energy supply

Maintain reliability
Least-cost solutions
Meets energy policies

**Least-Cost Energy Supply**

Must meet clean energy goals

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# Key Findings

# Top-Level Findings

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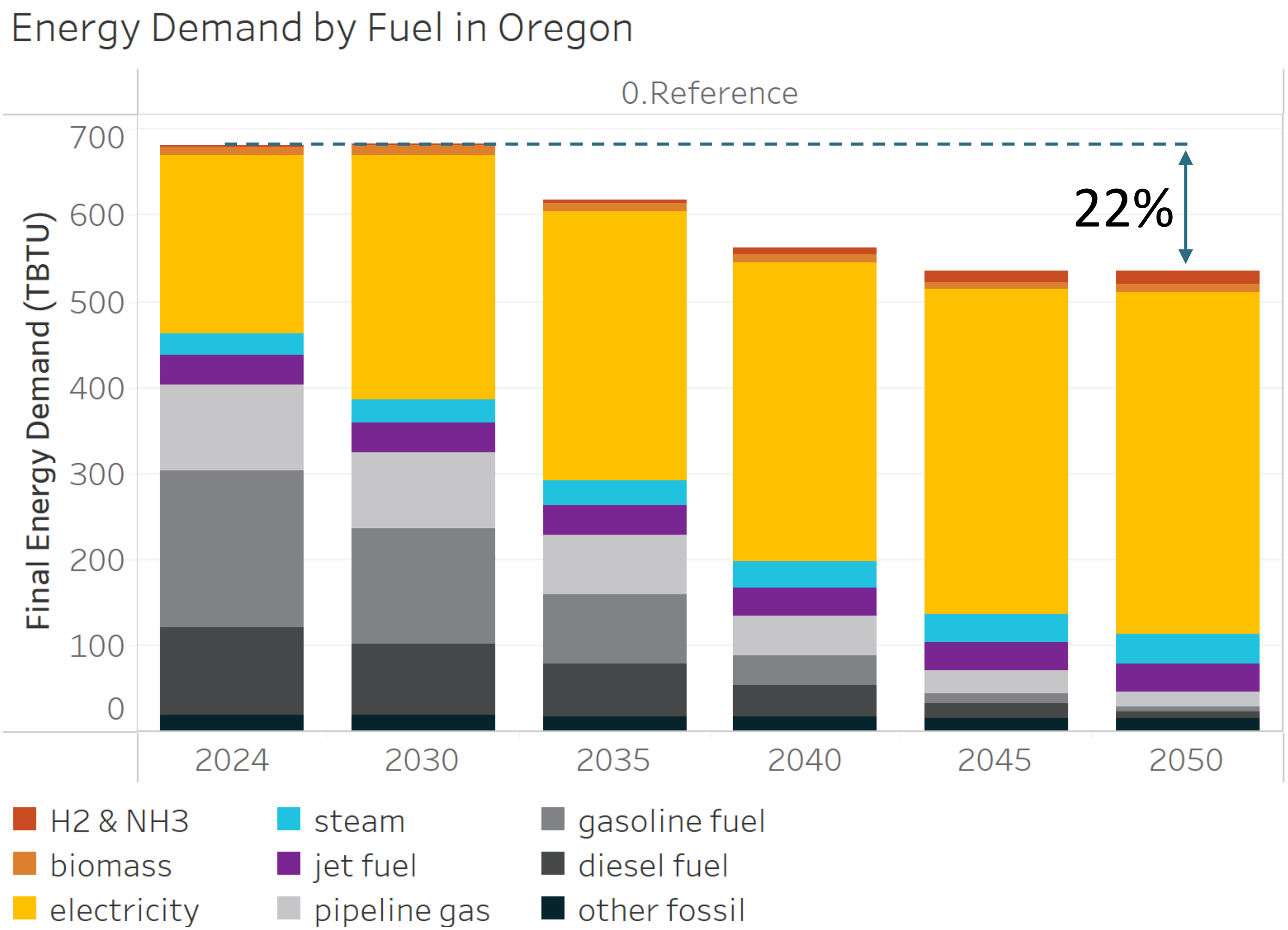
- The modeling results confirm that Oregon's existing policies are important to meet the state's goals
- Oregon's clean energy goals require more action than current policies will deliver
- The modeling explores some key options available to achieve the clean energy goals
- The modeling results give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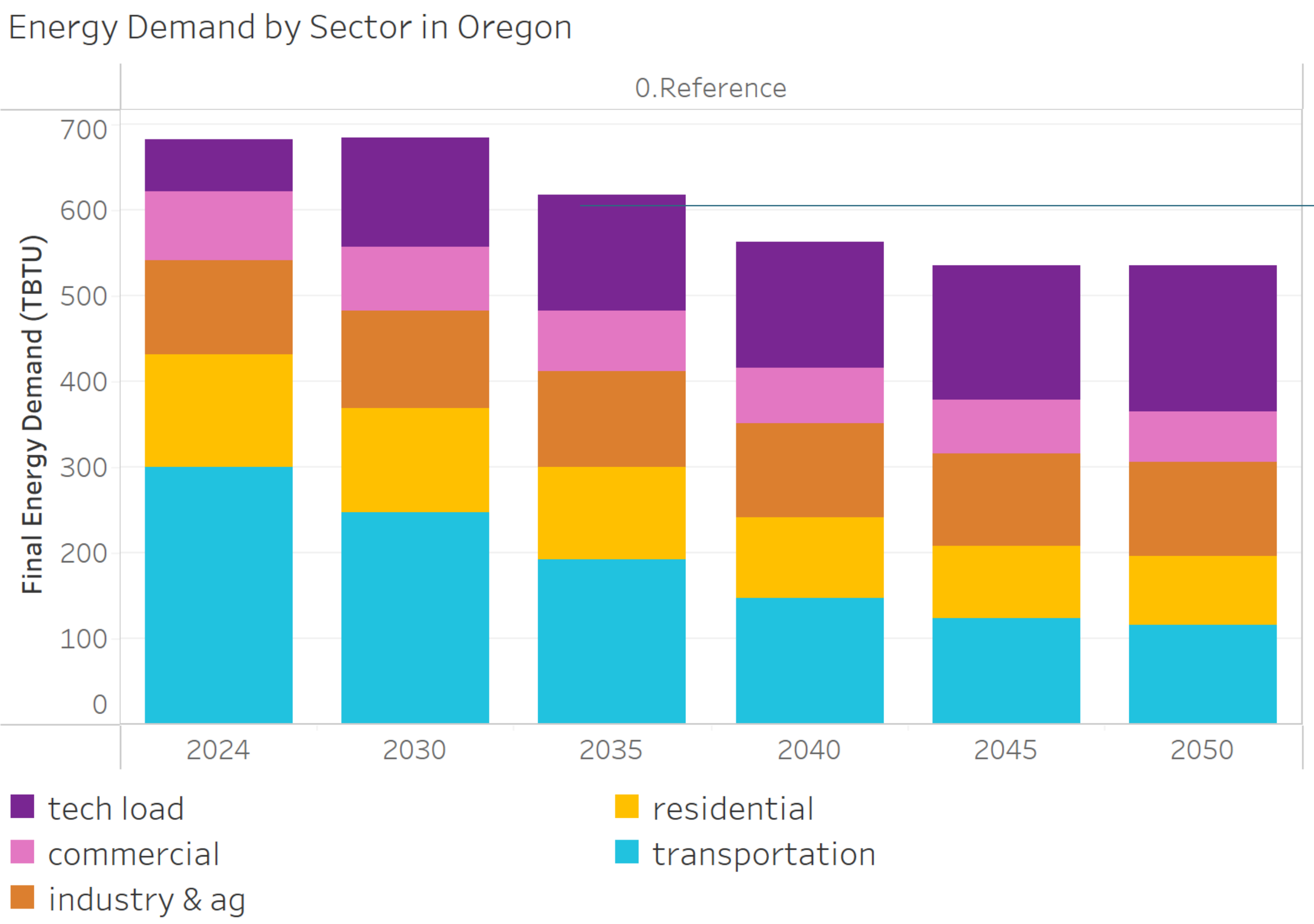


Data centers and chip fabrication facilities will likely add significant load to the system

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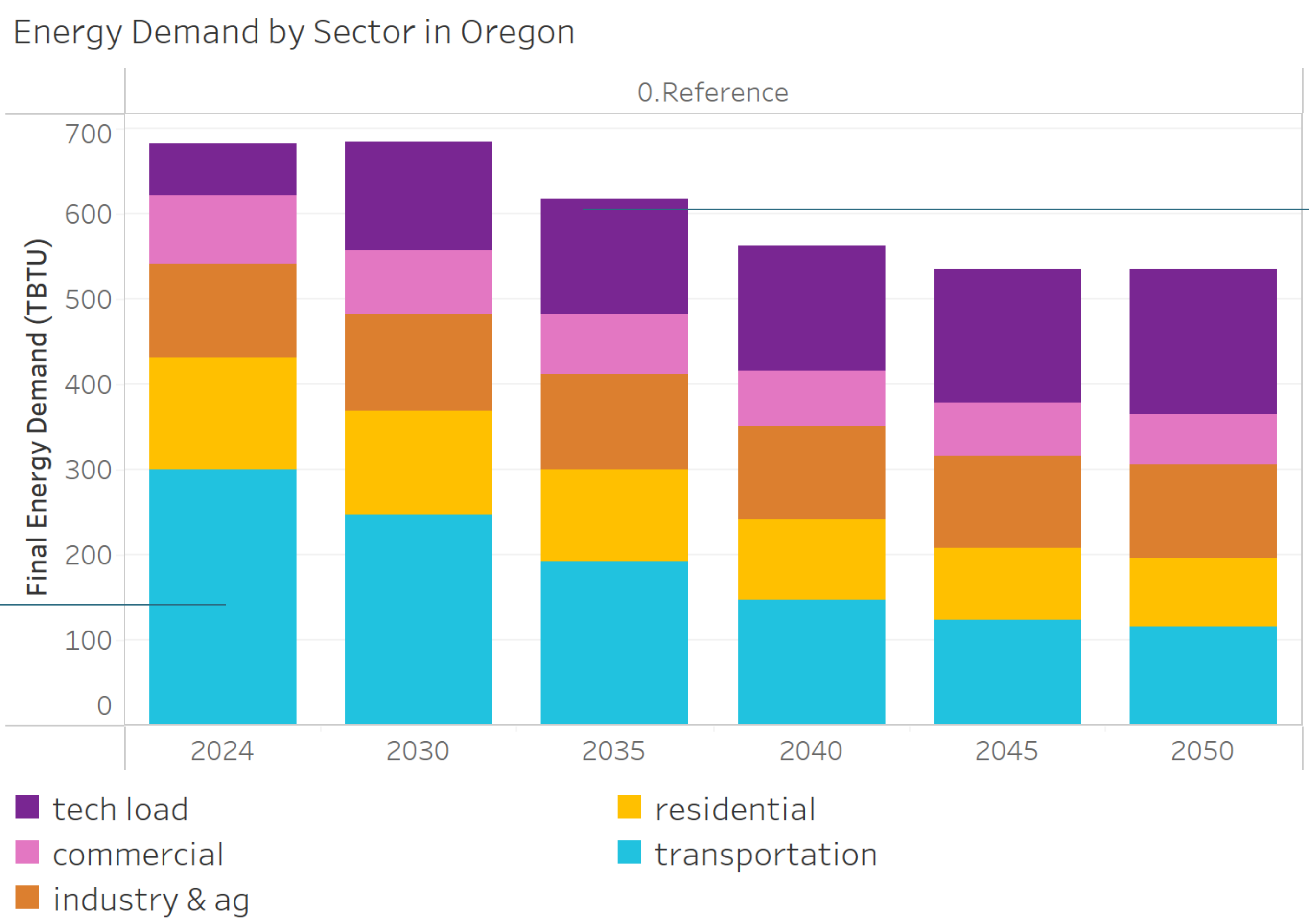


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Electrification of cars and trucks delivers the biggest efficiency gains, driving down overall demand

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

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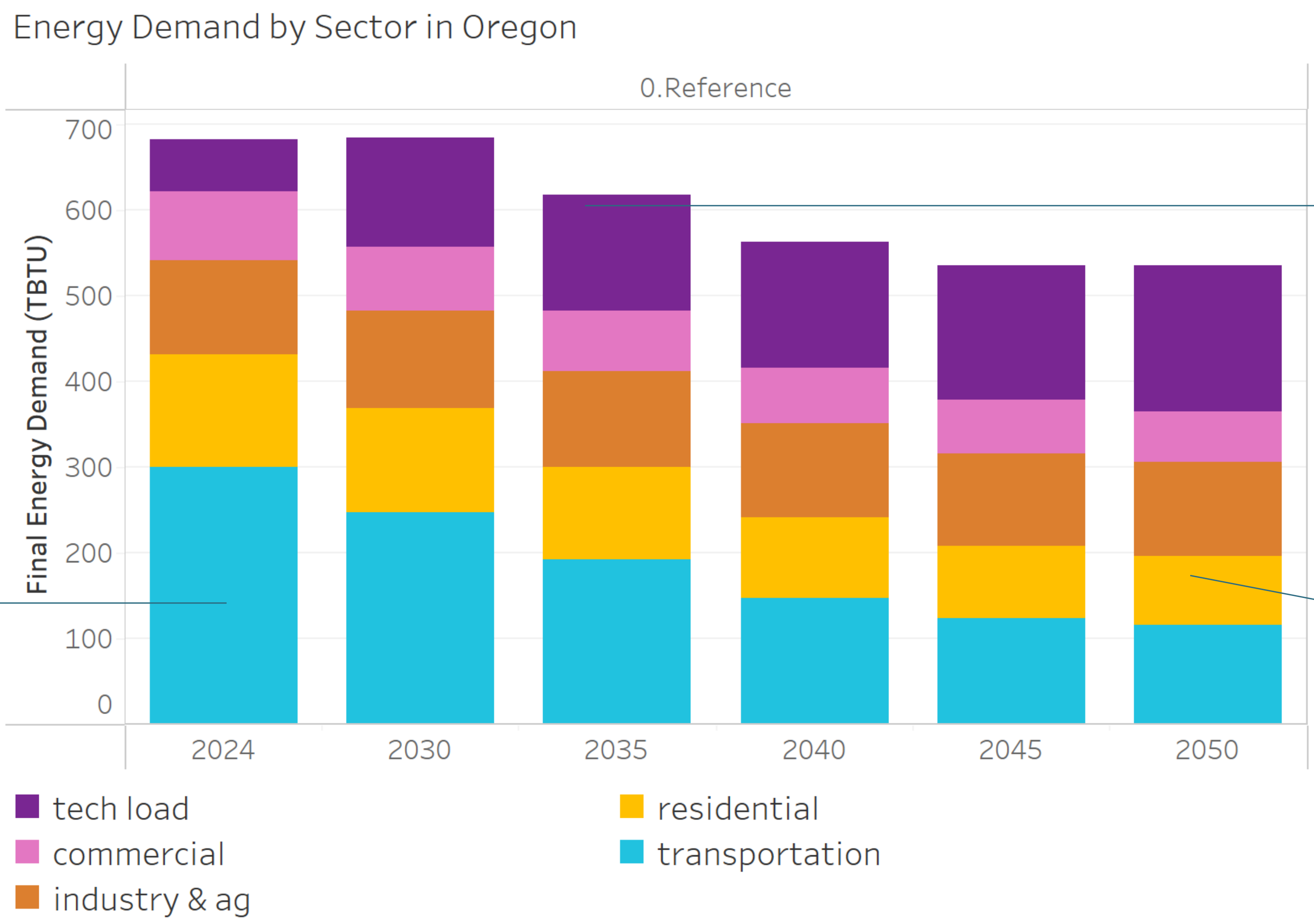
Electrification of cars and trucks delivers the biggest efficiency gains, driving down overall demand

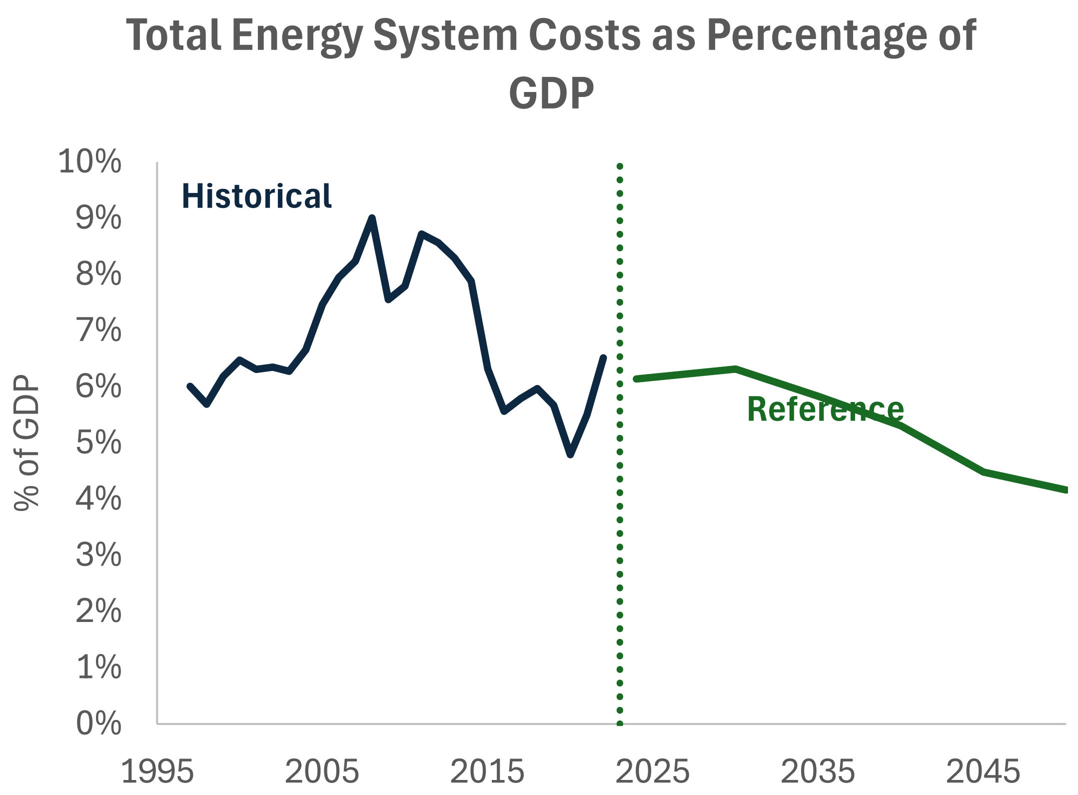



Data centers and chip fabrication facilities will likely add significant load to the system

Building electrification and efficiency improvements reduce demand in homes

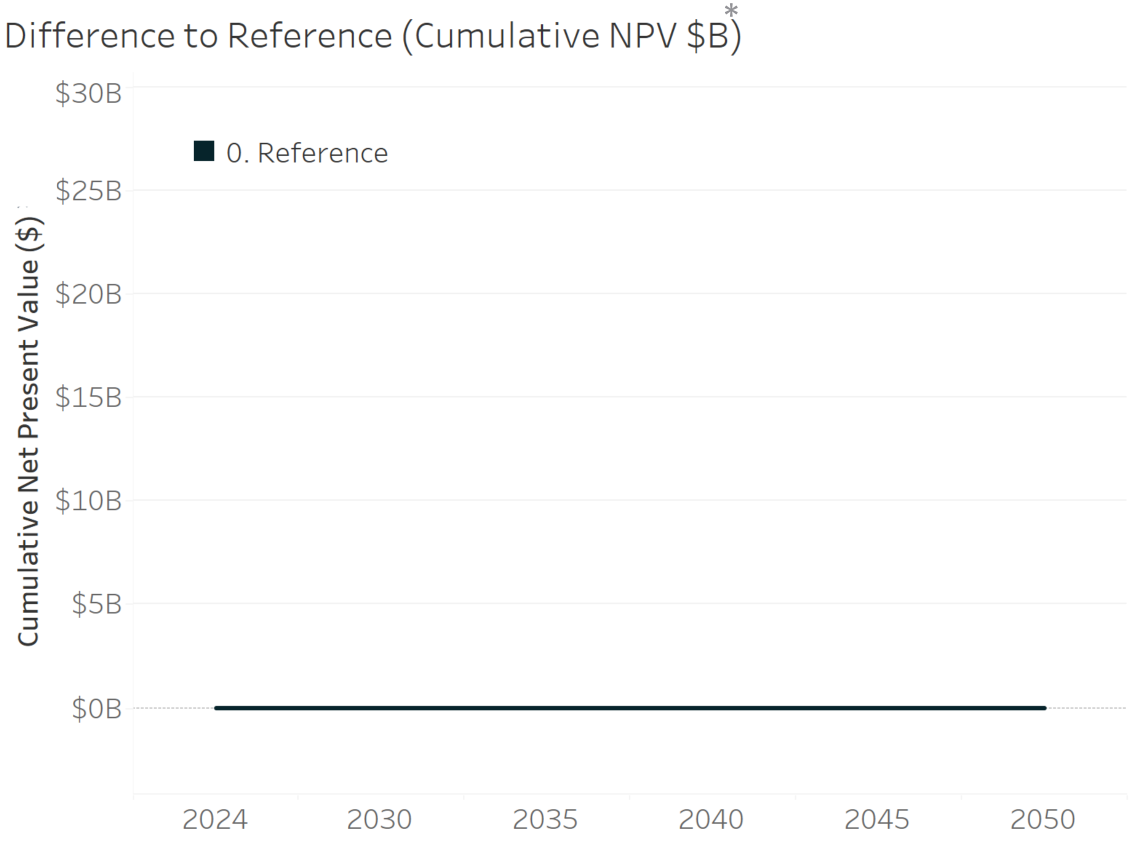
# Level of Investment Needed is Not Unprecedented

- 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

- 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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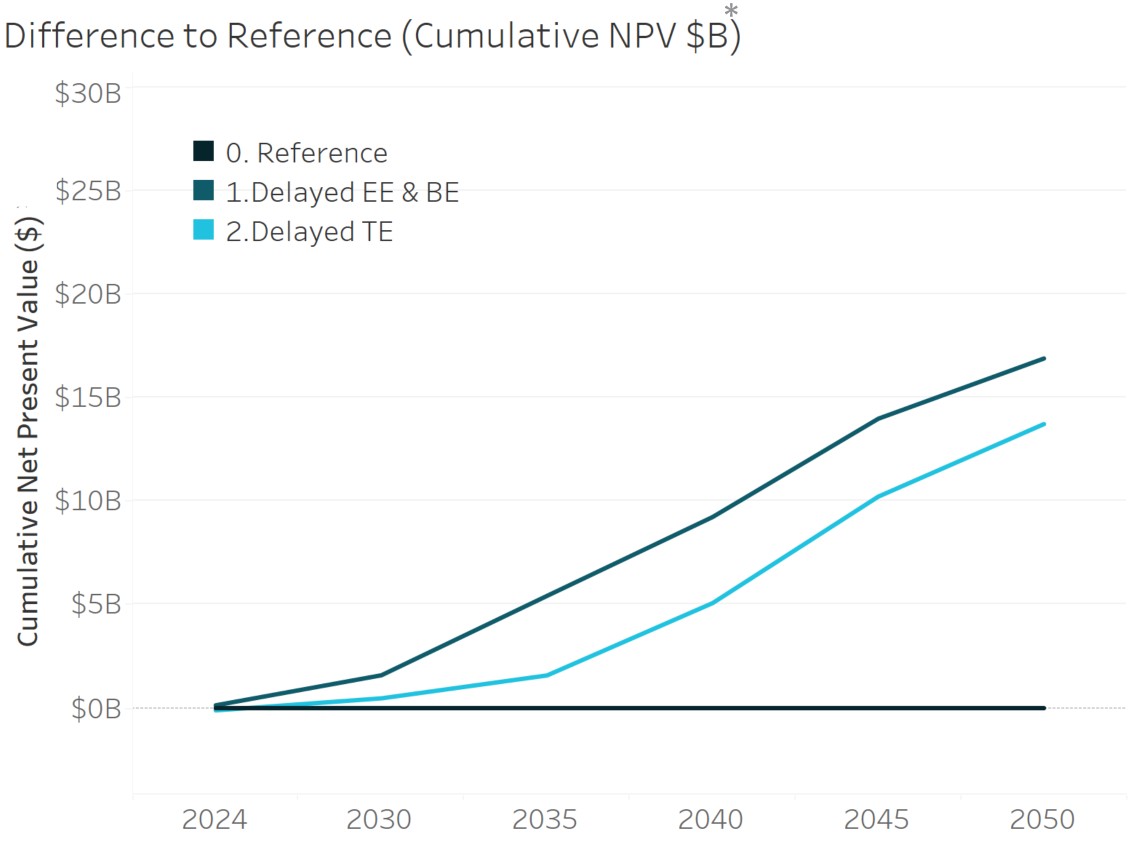


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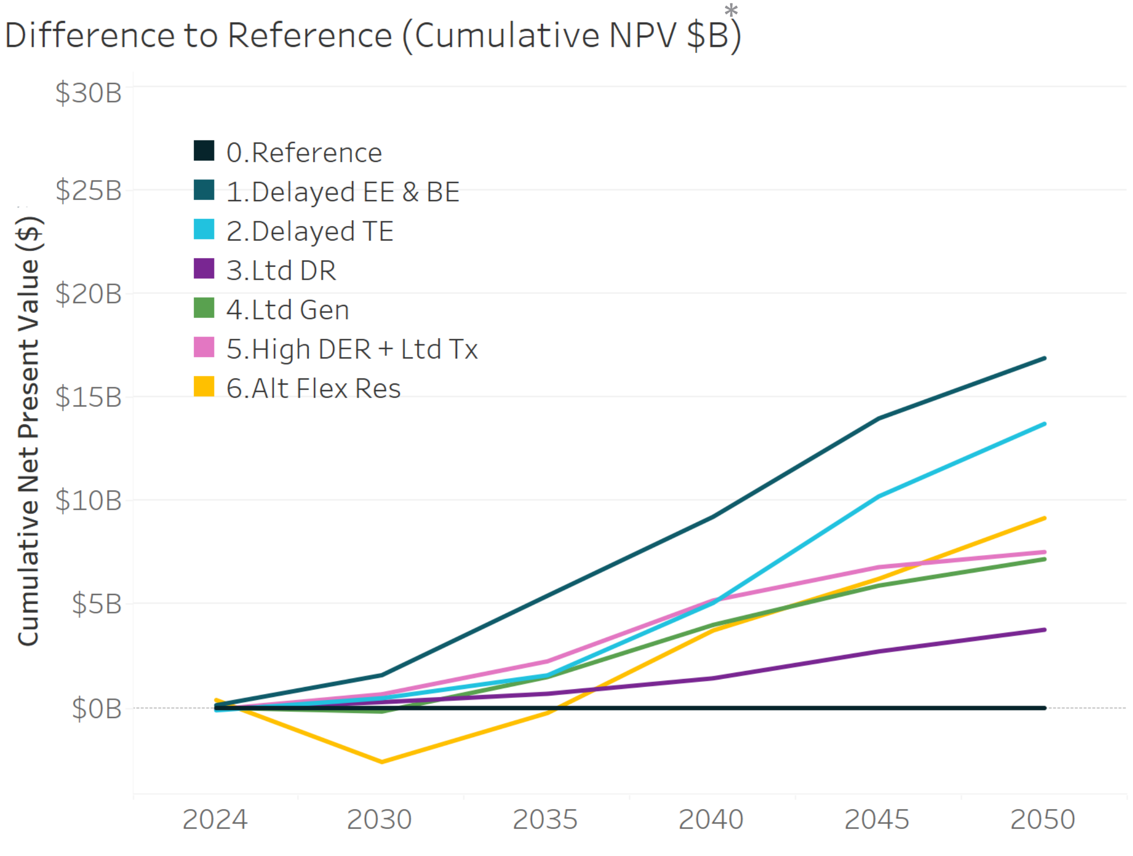


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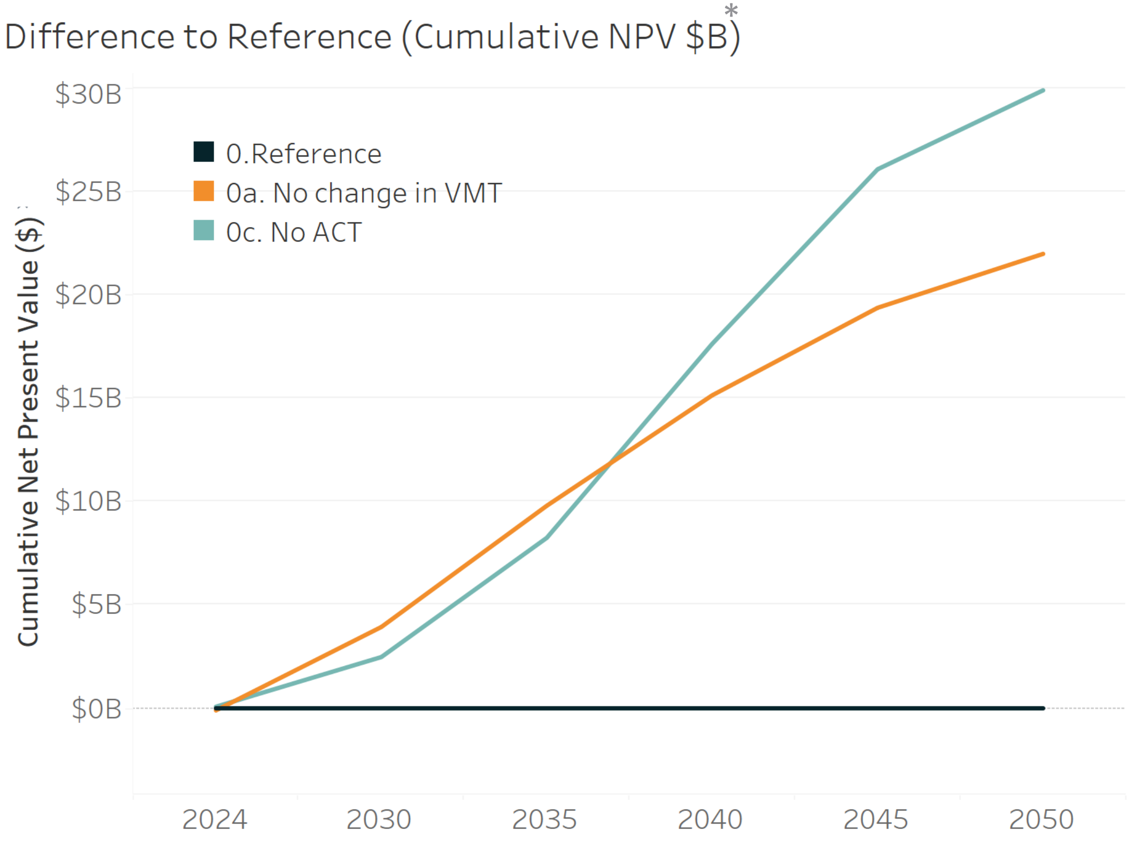


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# Sector Insights

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# Electricity Sector Insights

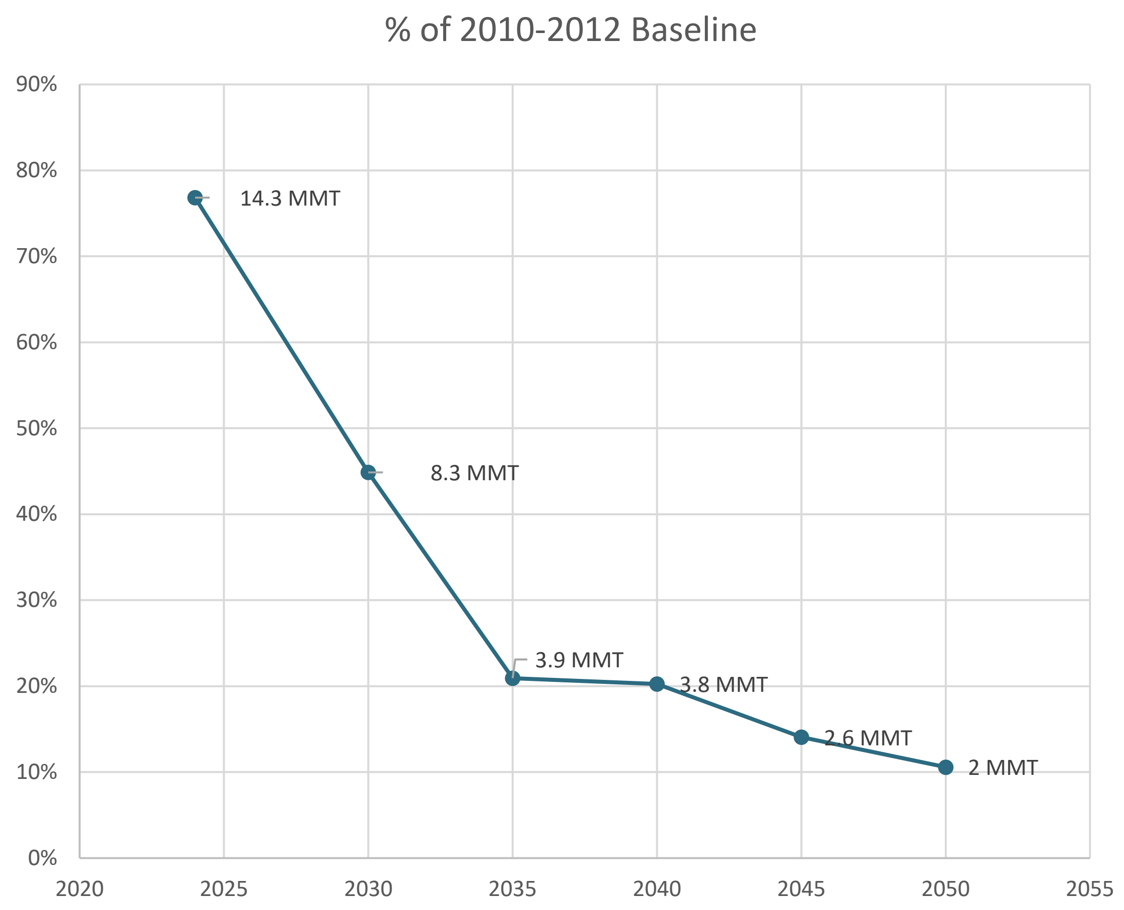
# Oregon Needs More Electricity Infrastructure

- Even with aggressive levels of energy efficiency, the electricity sector must expand significantly to remain reliable
- HB 2021 drives near-term decarbonization but EO 20-04 requires action beyond HB 2021
- There are competing priorities with in-state and out-of-state resource development, and a diverse mix of resources is likely the least risky approach

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

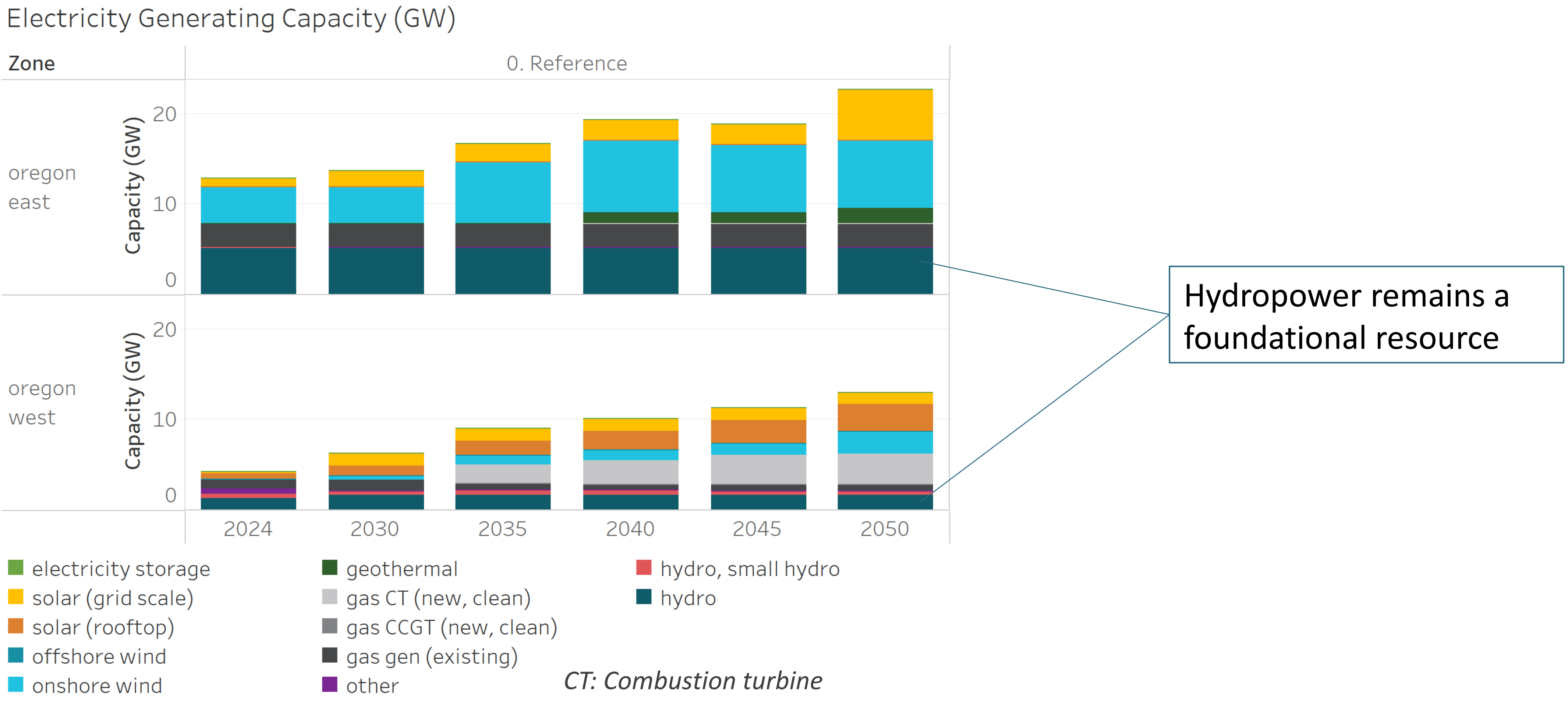
# Increasingly Clean Electricity Meets HB 2021 Targets and Helps Achieve EO20-04

- HB 2021 targets 80% emissions reductions by 2030, 90% by 2035, and 100% by 2040 below the baselines for PacifiCorp, Portland General Electric and ESSs (62.1% of load*)
- New tech loads otherwise allowed to consume emitting electricity
- EO 20-04 requires reductions beyond HB 2021 alone




*2023-Oregon-Utility-Statistics-Book.pdf

# Oregon Needs More Generation Capacity




*CT: Combustion turbine*
*CCGT: Combined-cycle gas turbine*

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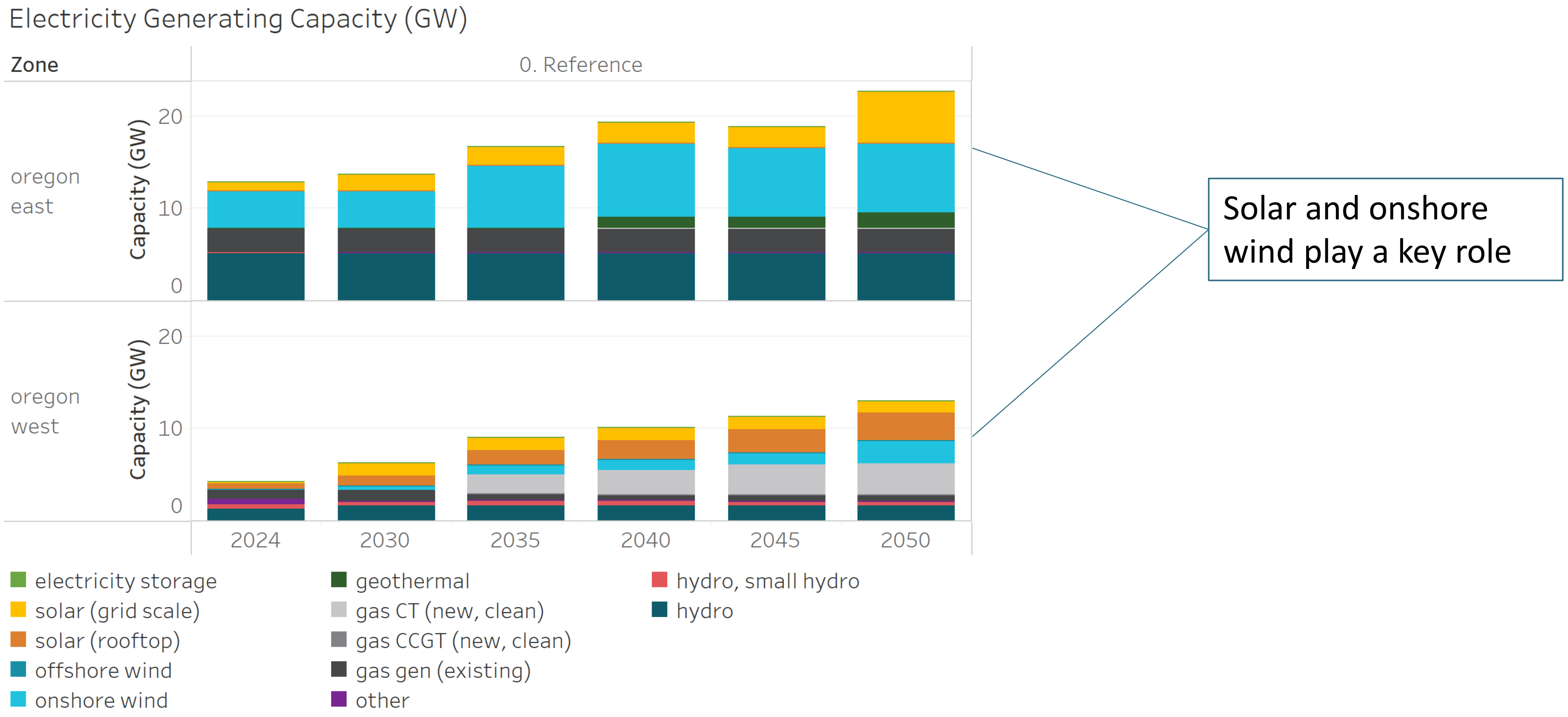

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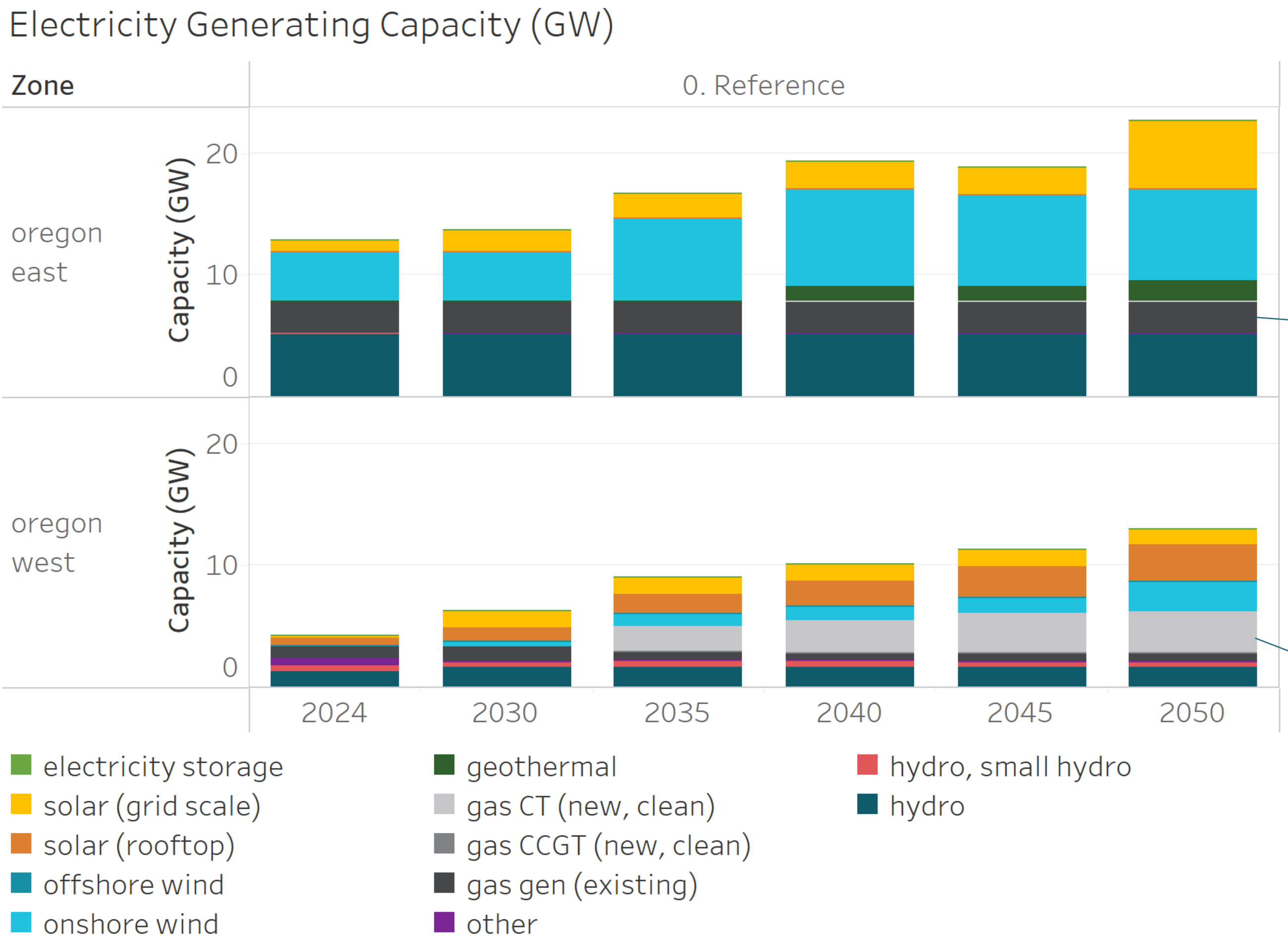


Model achieves HB 2021 emissions reductions but some existing gas remains in the statewide mix

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

# Oregon Needs More Generation Capacity

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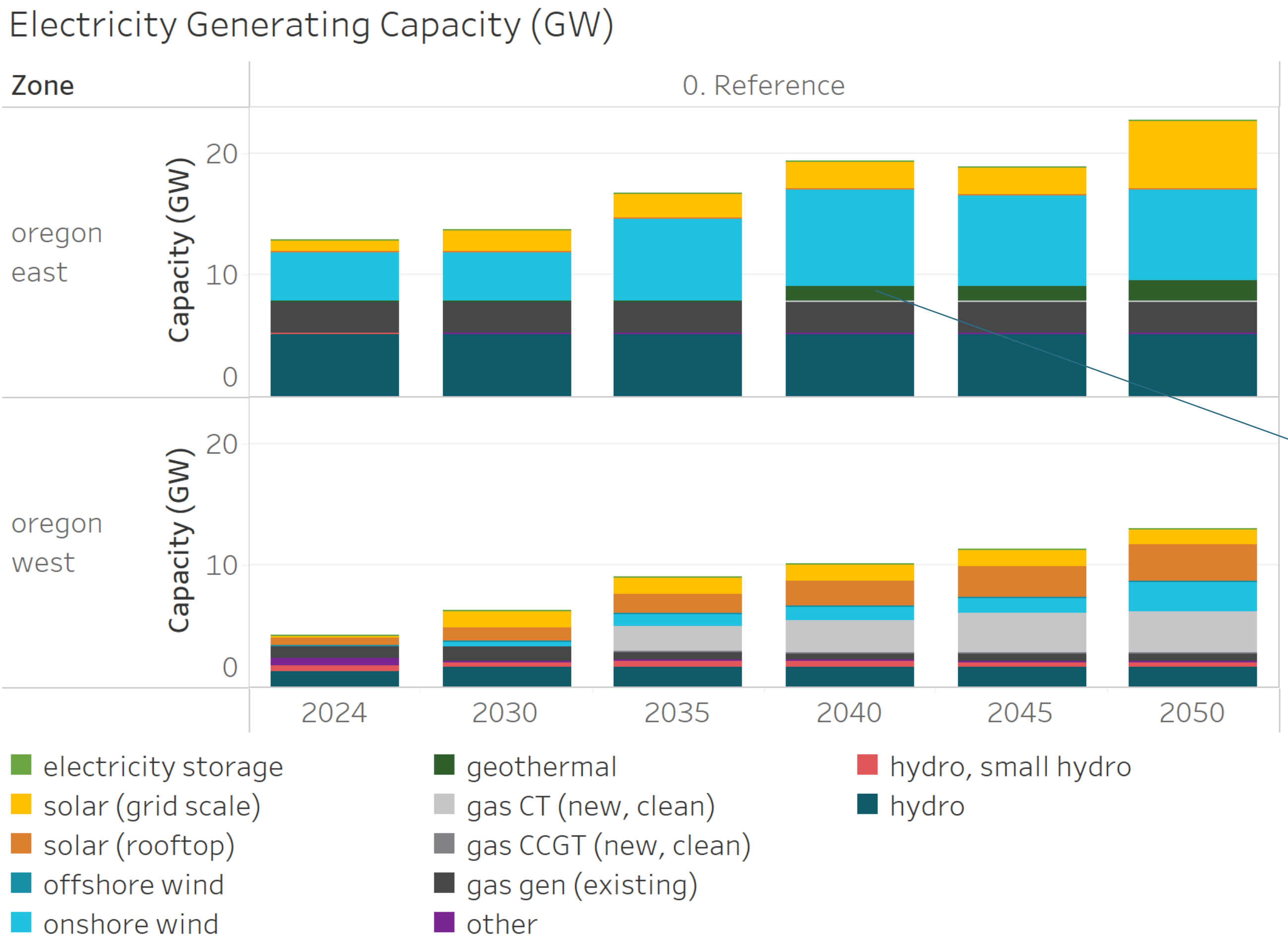
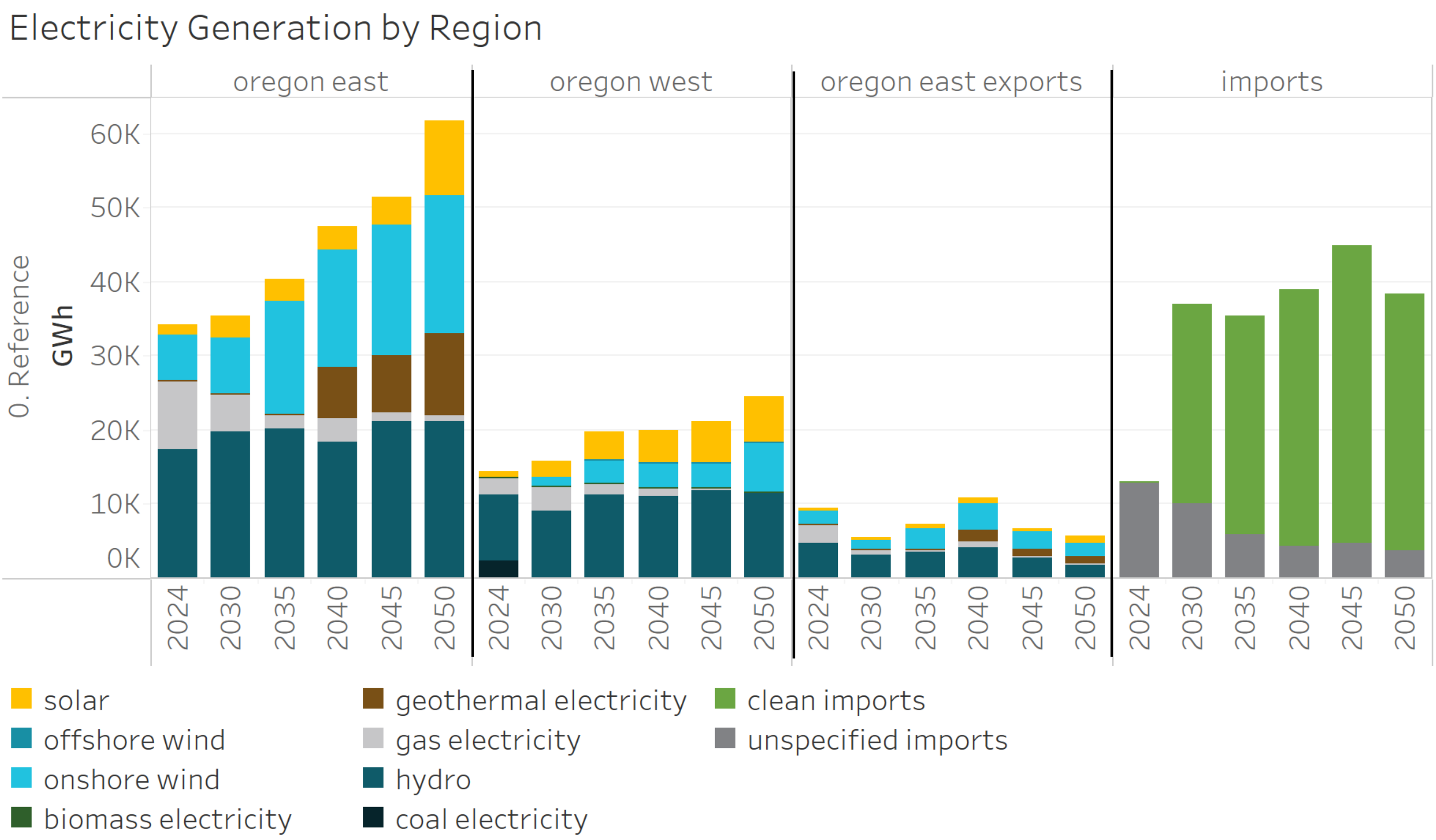



In 2040, enhanced geothermal comes onto the system

# Oregon imports and exports power

- 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



# Modeling is Structured to Reflect Land Use and Natural Resource Constraints

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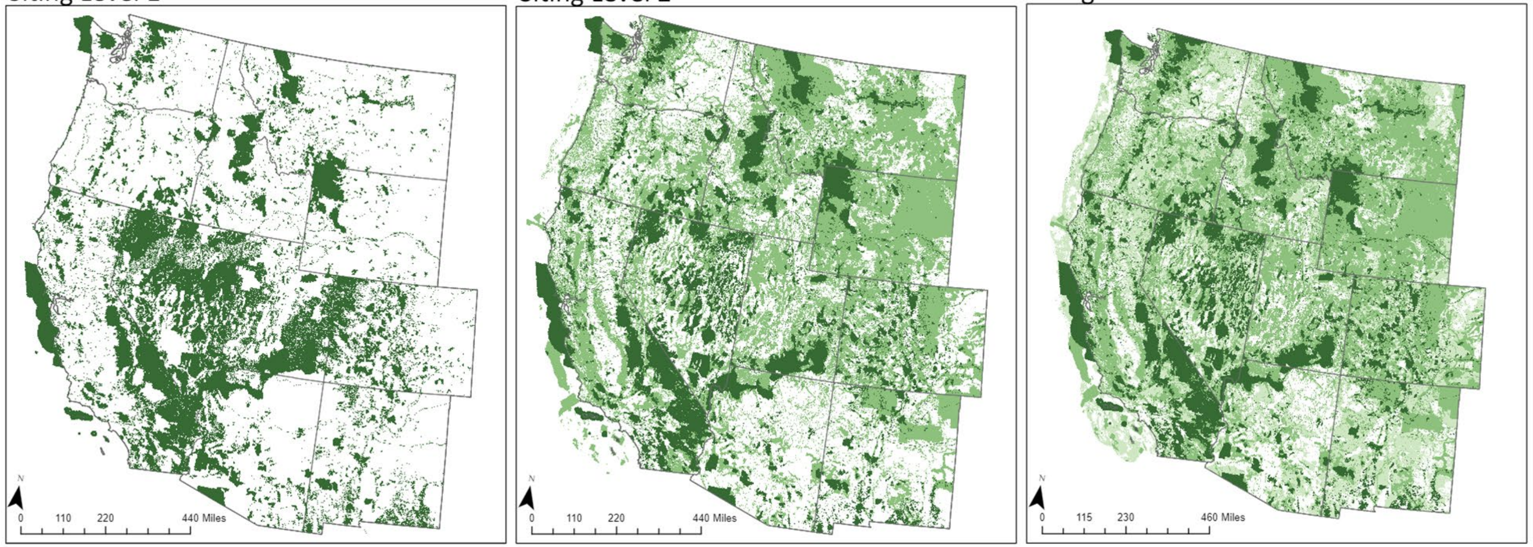
- Land use considerations are an input to the model through screening at a disaggregated level of where infrastructure projects could be located
- Every scenario complies with most restrictive land use constraints in The Nature Conservancy's *Power of Place-West* study: legally protected, administratively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

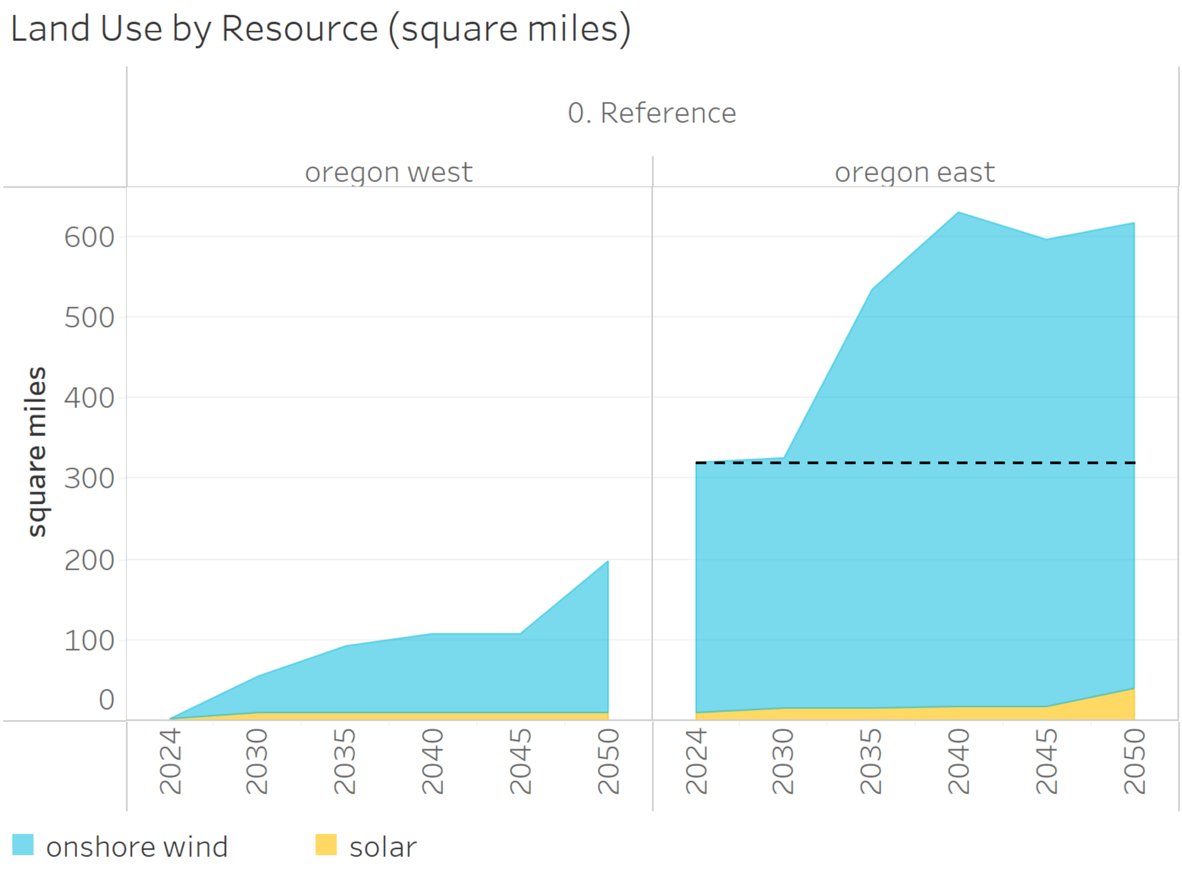
Siting Level 1 | Siting Level 2 | Siting Level 3




Excludes Category 1 | Excludes Category 1, 2 | Excludes Category 1, 2, 3

# 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




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

# Oregon Needs More Transmission Capacity

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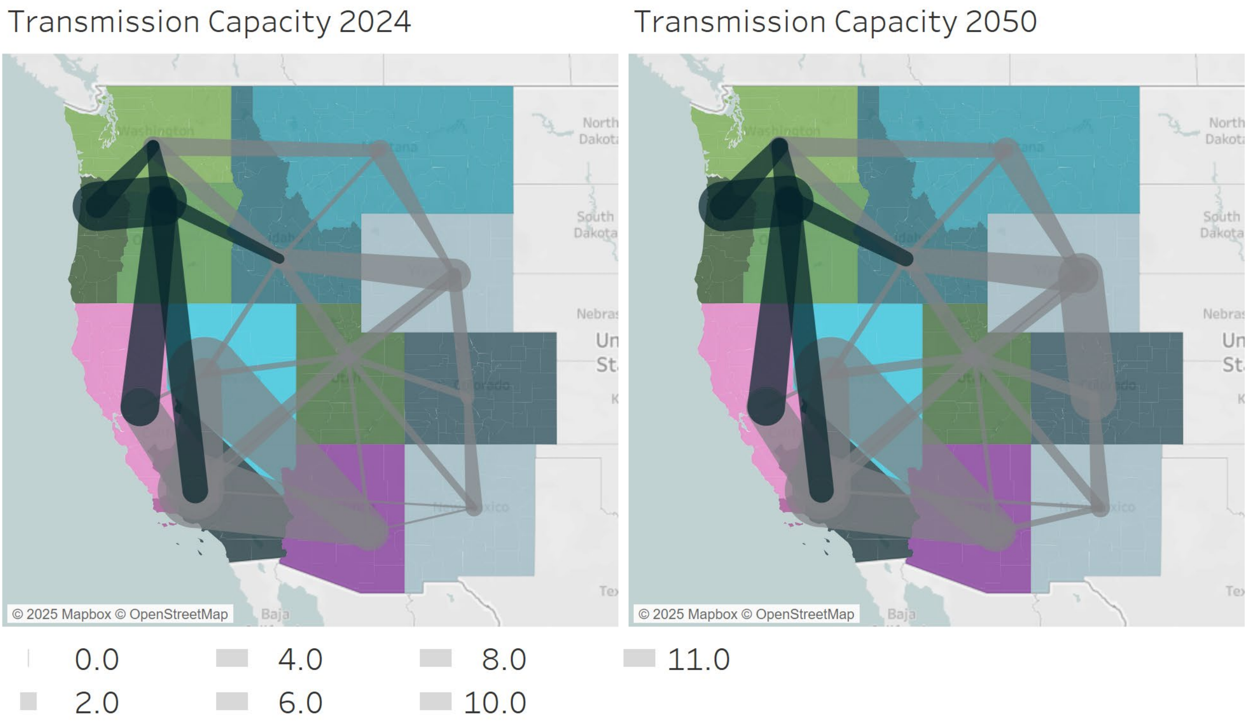
- Transmission expansion focuses between zones:
  - Across the Cascades, and from Oregon to Idaho, Washington, and California
- The transmission model is linear, so investments can be made in fractions of new transmission lines
- These results are indicative of transmission need but do not replace detailed 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



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# Fuels Sector Insights

# Clean Fuels are Needed to Meet Energy and Emissions Goals

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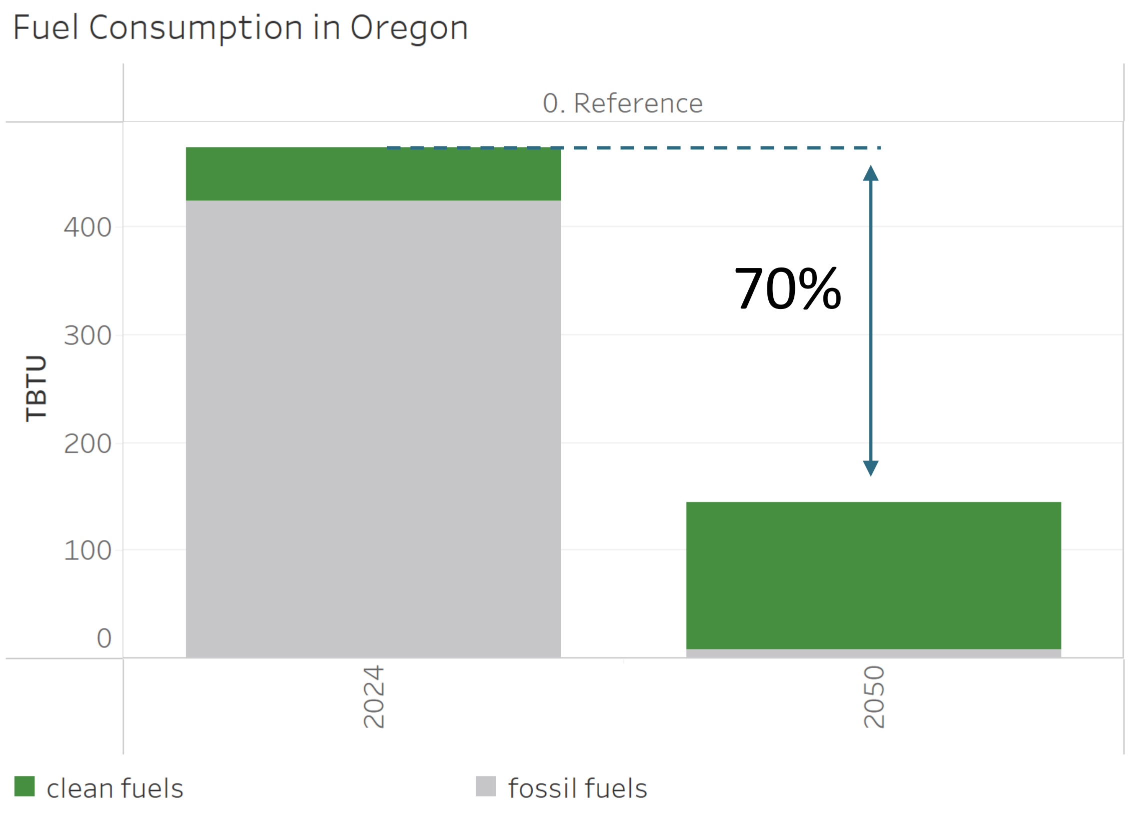
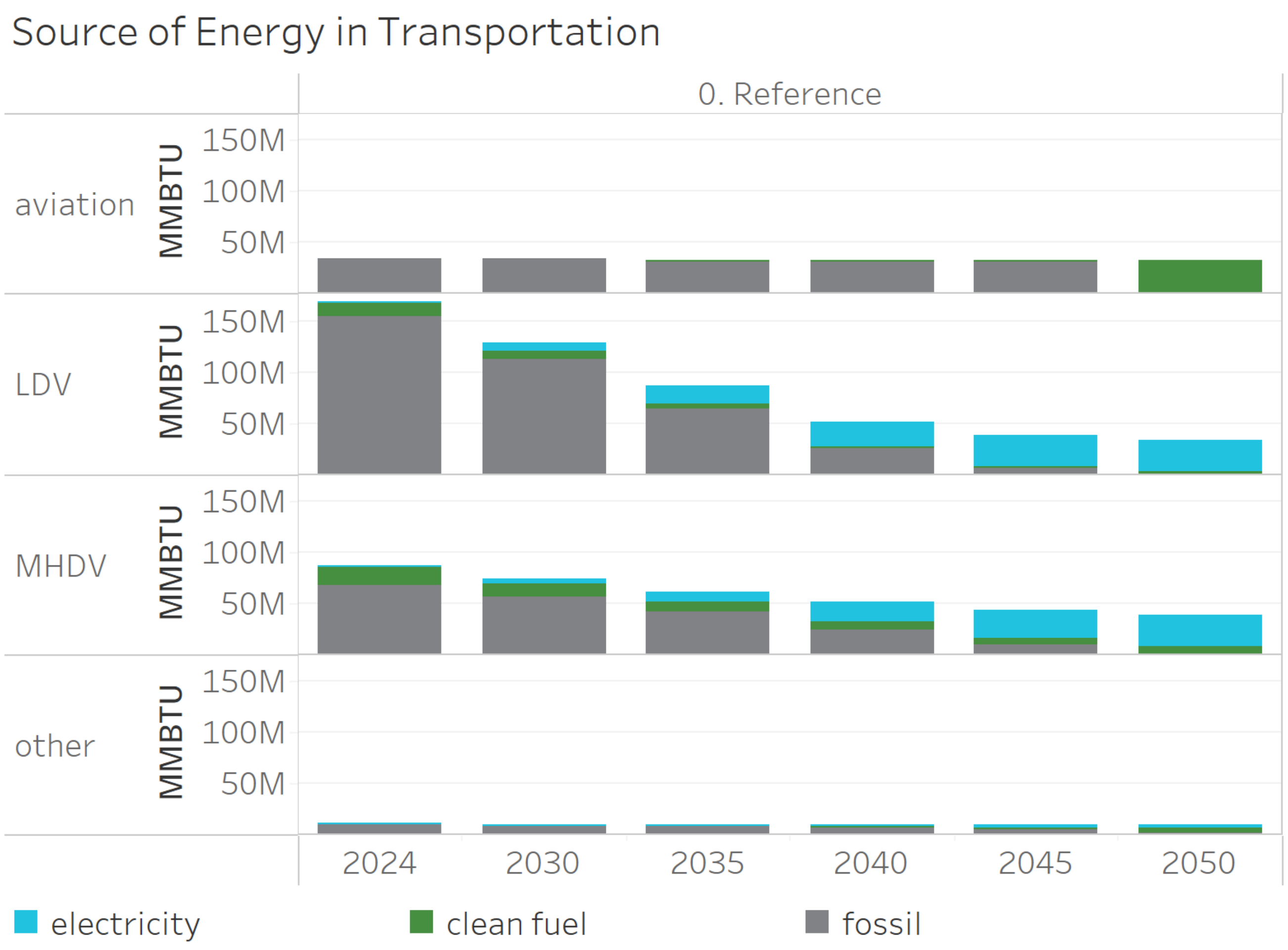
- Fuel demands decrease over time but their importance does not
  - Hardest to decarbonize sectors
  - Resilience
  - Time for electric technologies to replace fossil
- Clean fuels include biogas, bio liquids, e-fuels, hydrogen, ammonia, and geothermal steam



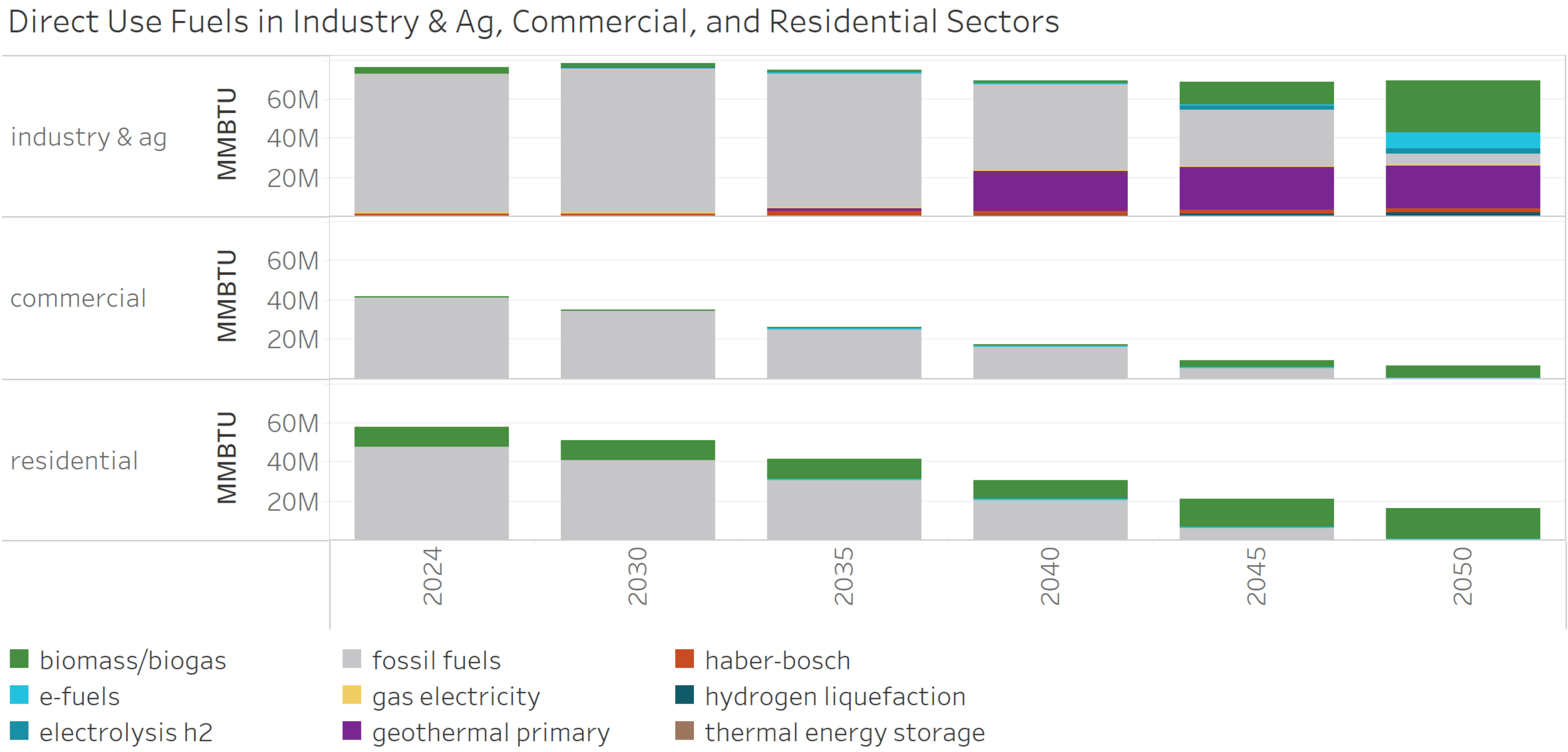
# Fuels in Transportation Decrease due to More Efficient Electric Drivetrains and Convert to Clean

- 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





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

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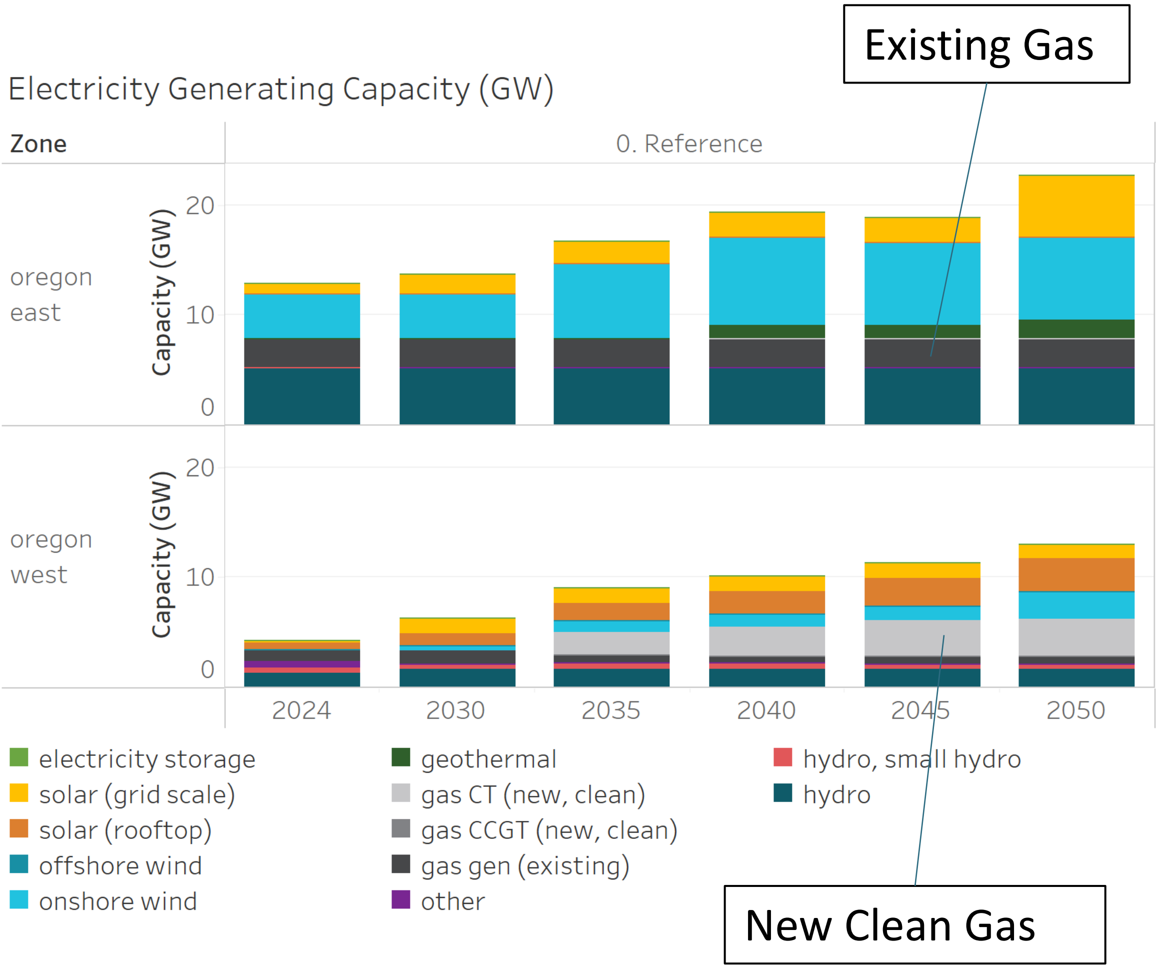
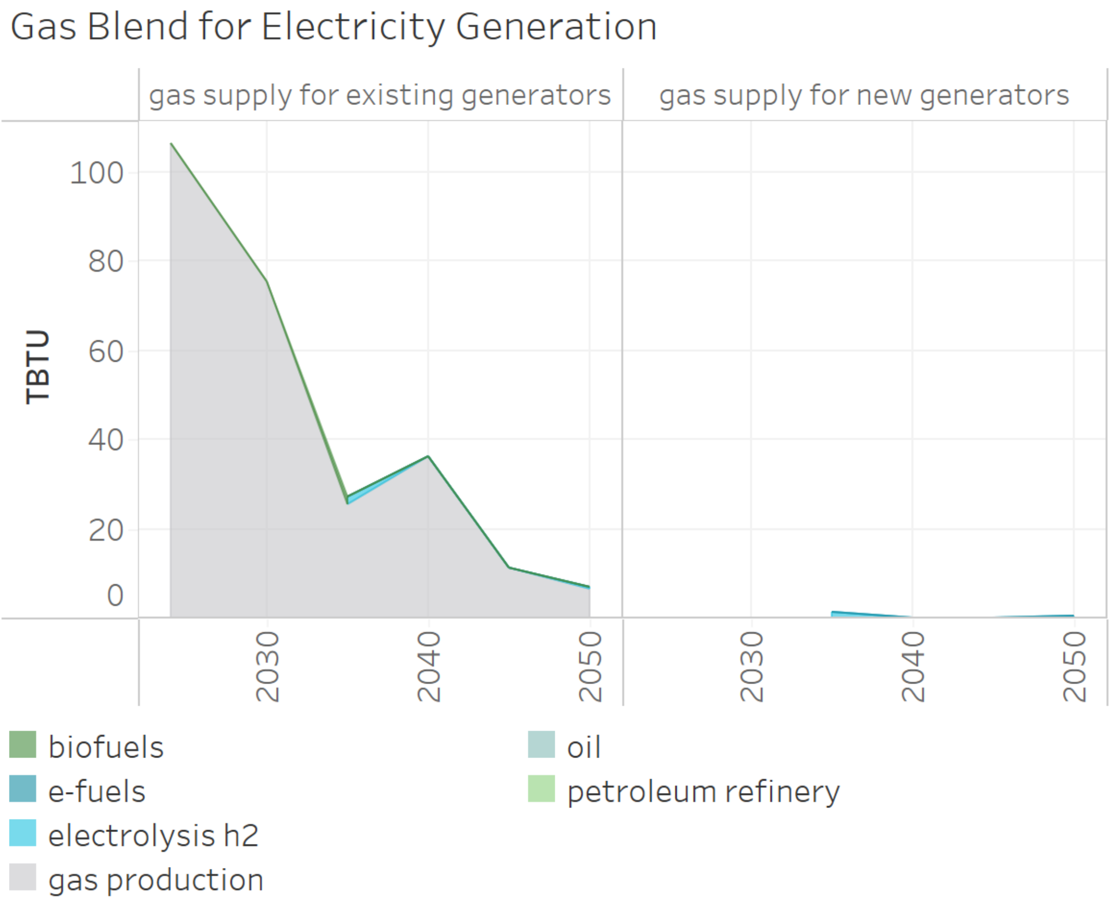
- Flexible capacity is needed to makes sure the system stays reliable
- New clean gas resources can only burn hydrogen or new sources of biogas
- New clean gas resources almost never operate
  - Expensive fuel but cheap capacity



# Gas Generators Use Very Little Fuel in the Future

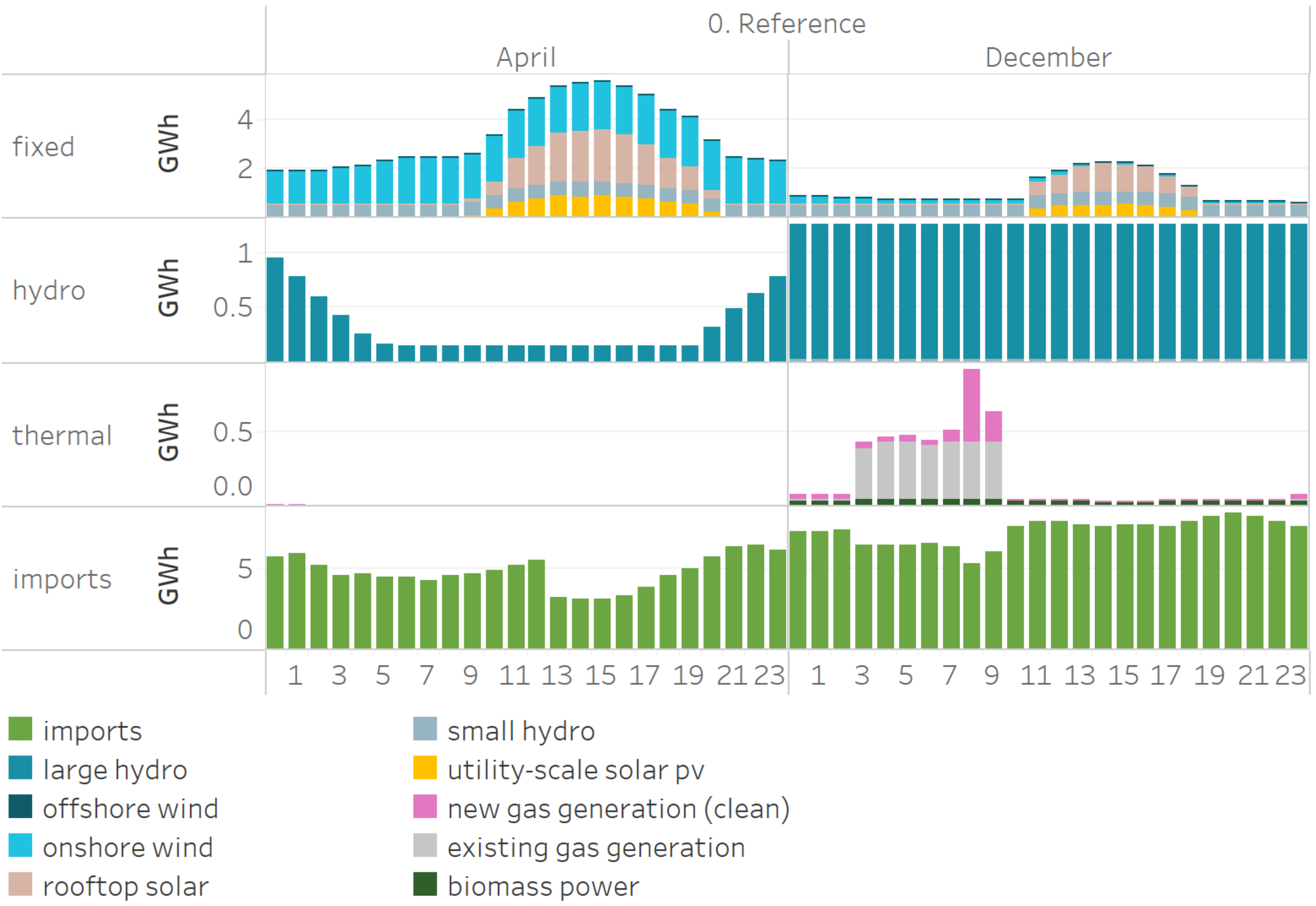
- High value flexibility role on the system
- Providing capacity during periods of low renewable output/high loads/low hydro conditions requires low volumes of fuel
- New clean gas resources use the most expensive fuel so use the lowest fuel volumes



# Example Hourly Operations in 2050 in Oregon West

- The December day shows limited renewable availability, and the April day shows renewable energy abundance
- Lack of wind in the December day drives need for hydro, imports, and gas, including new gas generation using electrolyzed hydrogen
  - New clean gas capacity is used infrequently, providing power during conditions where loads are hard to meet
- High renewable availability drives down hydro dispatch and imports, and gas generation is effectively zero on the April day with abundant renewables

High Renewable and Low Renewable Example Days in 2050



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# Transportation Sector Insights

# Transportation Key Findings

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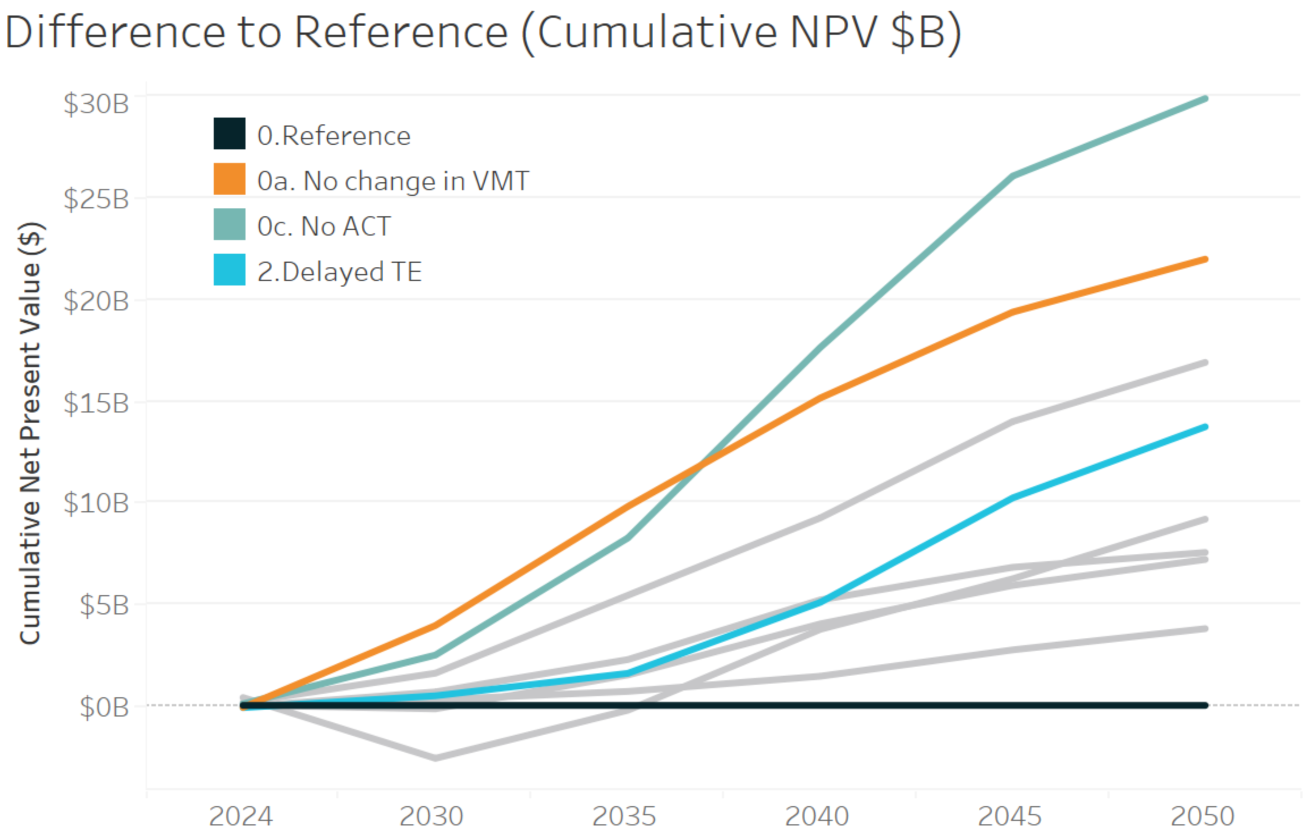
- Transportation electrification plays significant role in reducing system-wide energy demand across all scenarios, despite tech sector growth.
- Early adoption of electric vehicles, including MHDVs, reduces the costs of decarbonization.
- EVs are a significant driver of increased electric loads but can provide a net benefit to the grid if managed flexibly.
- Reducing VMT per capita provides significant value but will require investment.
- Low-carbon fuels play a strategic role in decarbonizing transportation and this role increases as pace of transportation electrification slows.

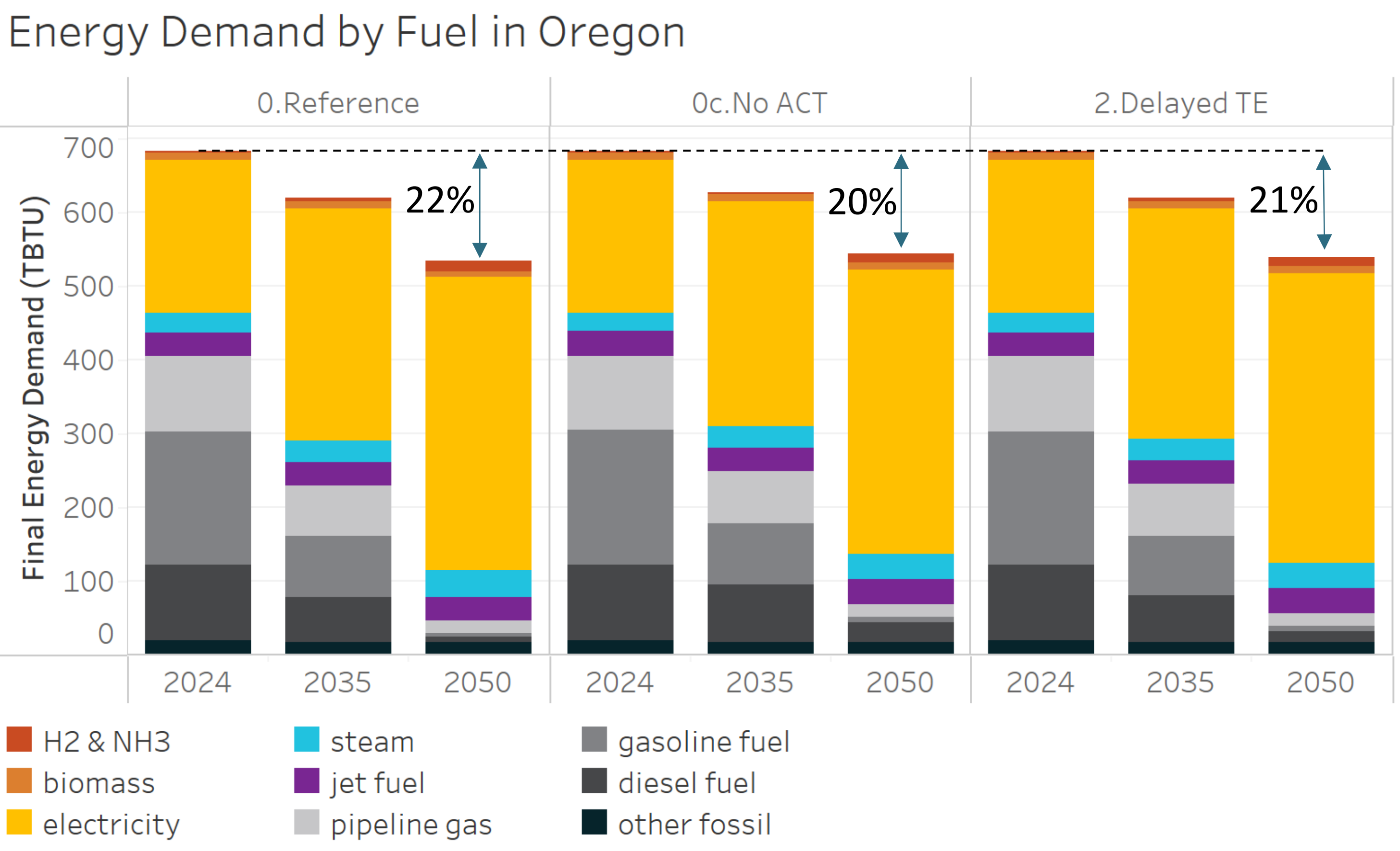
# Costs: TE Scenarios Difference to Reference

- 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
- Oregon’s goal of 20% VMT reductions save $22B NPV over 25 years
- No ACT is $16B NPV higher over 25 years than Delayed TE
  - Shows stock rollover of MHDVs in the 2030s is important for cost containment



# Impact on Economy-wide Energy Demand

- Overall energy demands are impacted by the level of MHDV electrification
- More significant is the impact on fuel use
  - No ACT: Diesel consumption is 25% higher in 2035 and 270% higher in 2050 than in the Reference Scenario
  - Delayed TE: Diesel consumption is 110% higher in 2050 than in the Reference Scenario
- Additional fuel use increases the volume of clean fuel needed in the long term



# Impact of Delays on Sales, Stocks, and Energy

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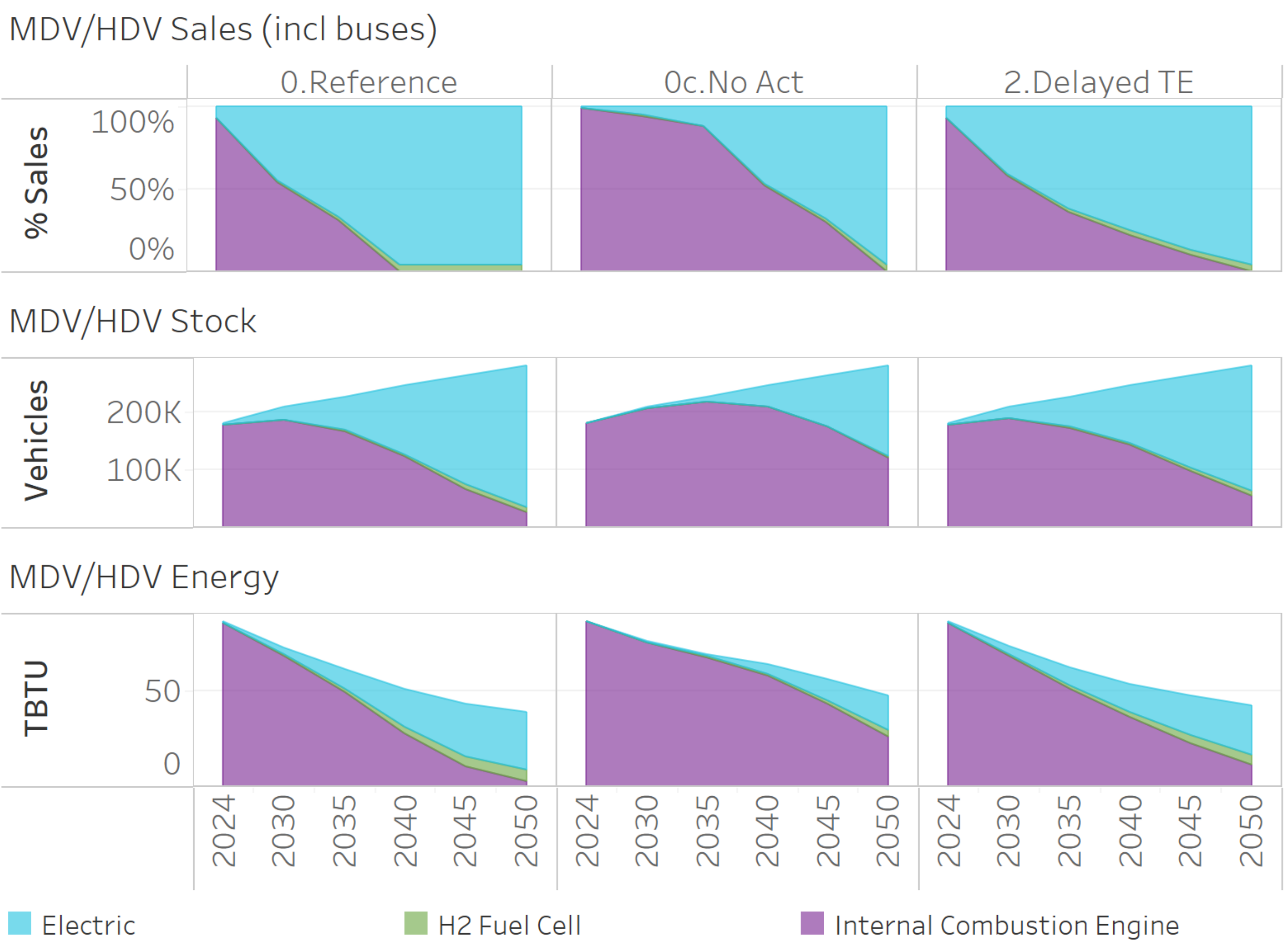
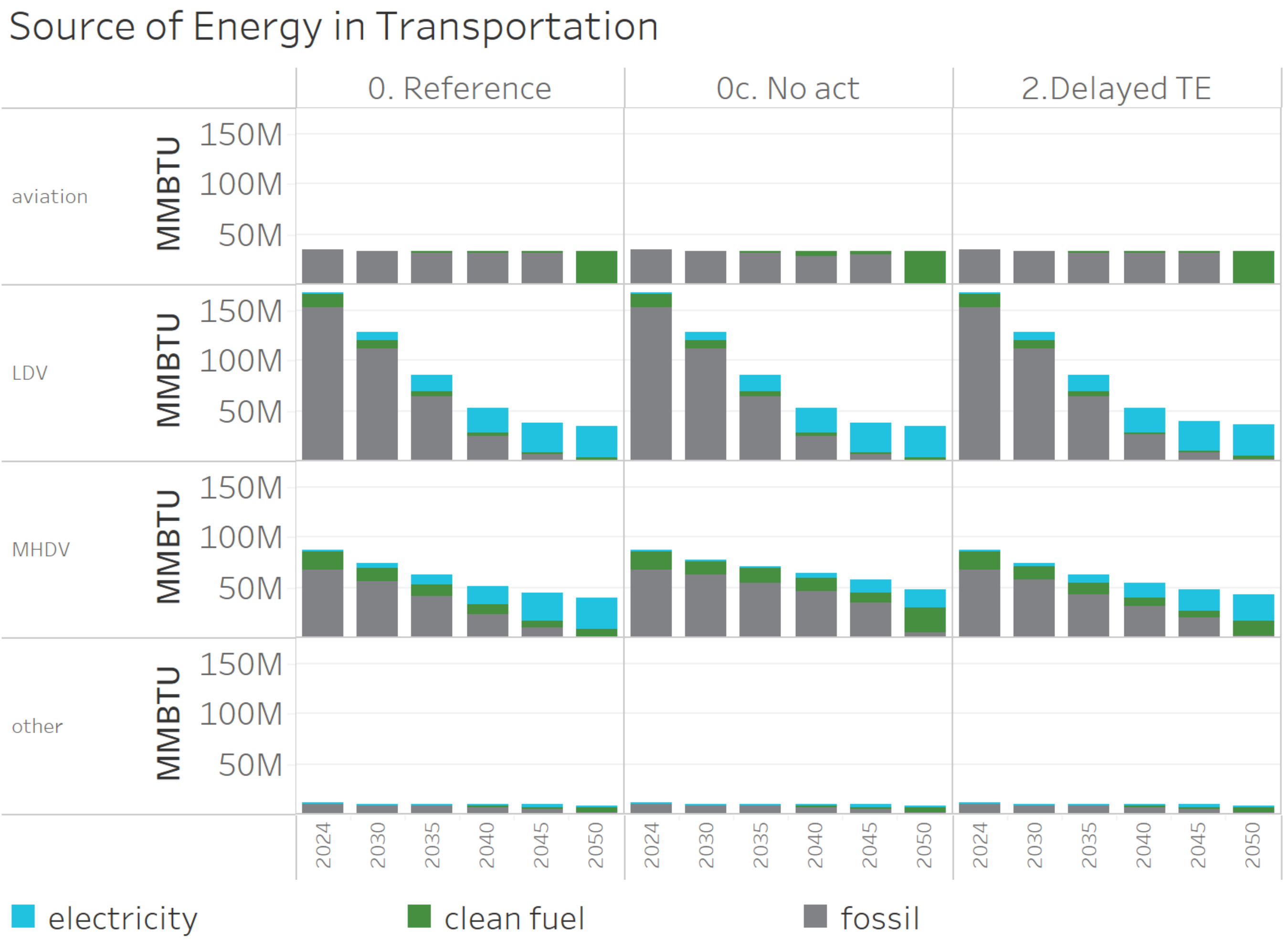
- Medium and heavy-duty vehicle sales are delayed in 0c. No ACT and 2. Delayed TE
  - No ACT has relatively few sales of electric vehicles through 2035, achieving 100% sales by 2050
  - Delayed TE has the same trajectory as Reference through 2035, delaying reaching 100% sales from 2040 to 2050
- The impact of the delays is to increase stocks of internal combustion engine vehicles, driving up energy demand



# Transportation Fuel Consumption Driven by the Pace of Electrification

- The transportation scenarios investigate differences in medium and heavy-duty vehicles
  - The transition to clean energy across other subsectors is similar across scenarios
- Delays in medium and heavy-duty vehicles drives greater need for clean fuels by 2050



# Electric Cars Are a Key Part of the Picture

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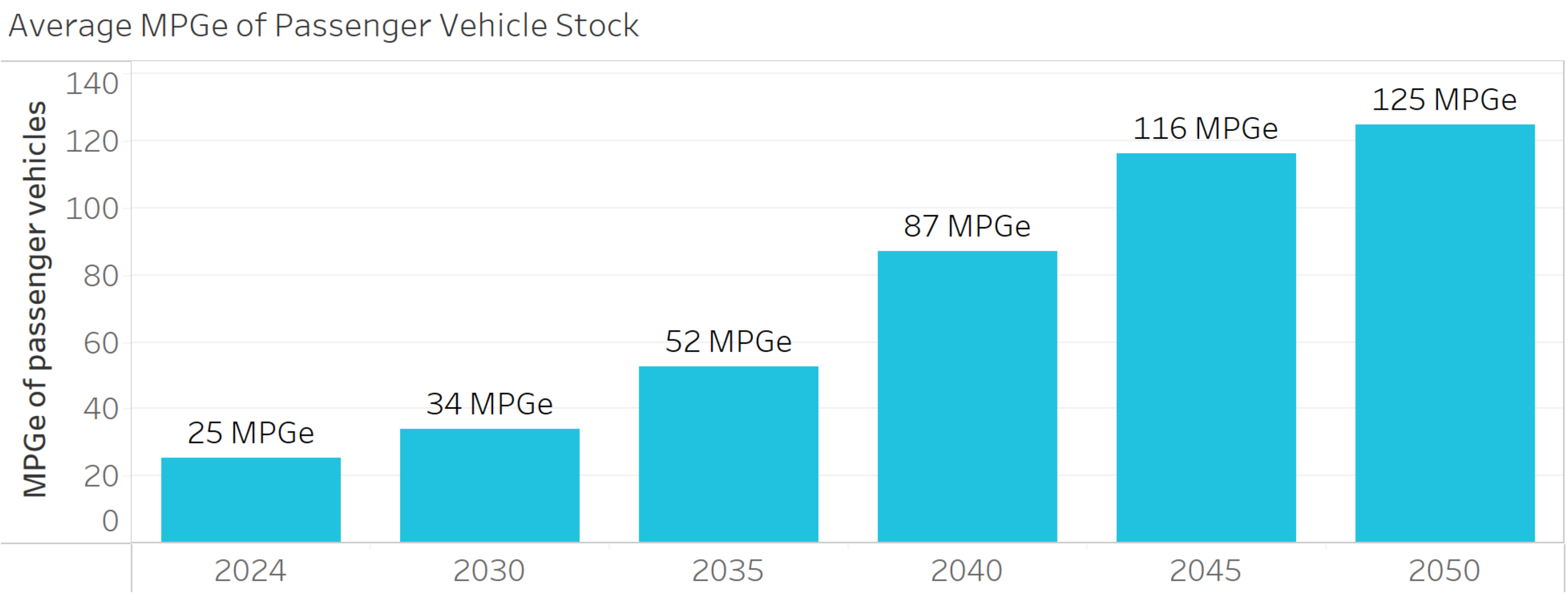


- Electric cars deliver huge efficiency gains
- Together with electrification of trucks, responsible for reducing the size of the whole energy sector by 27% over 2024 loads

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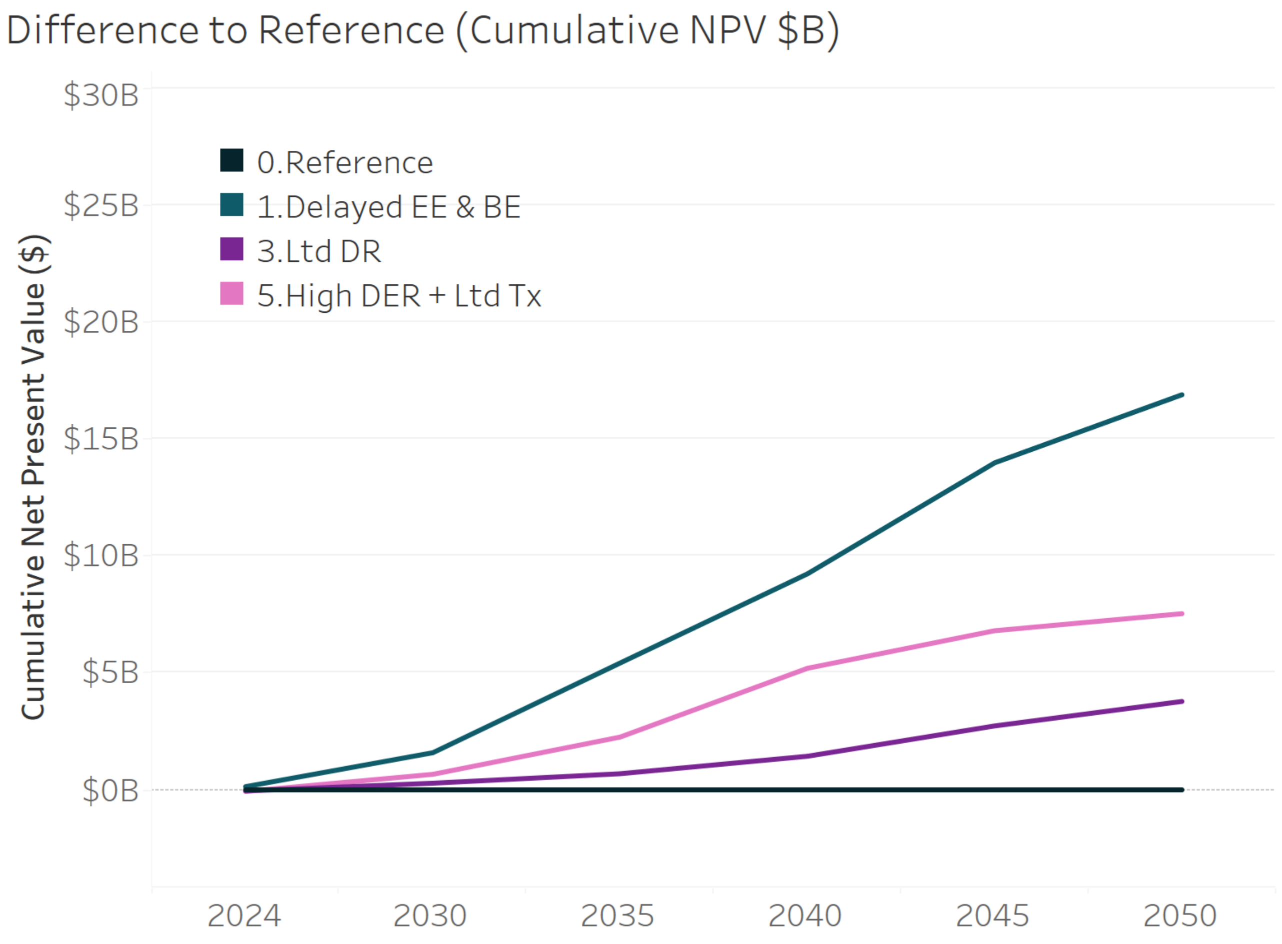
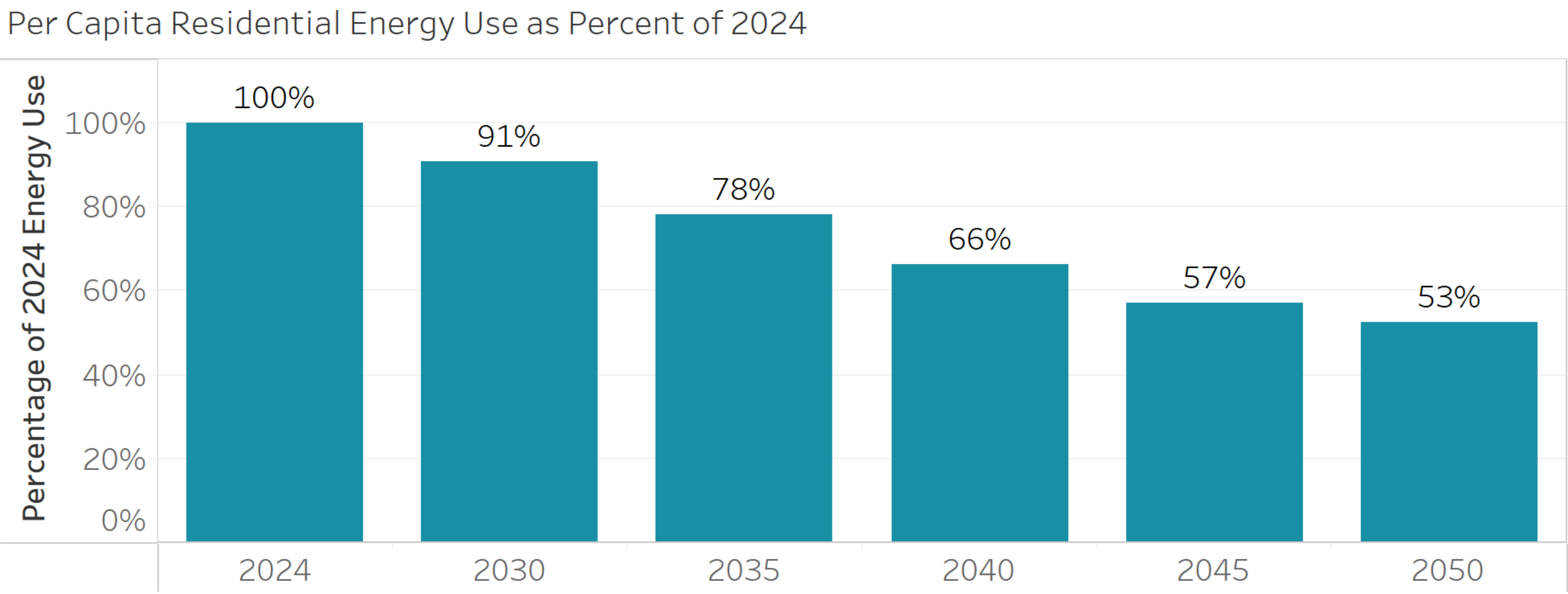
# Buildings Sector Insights

# Energy Efficiency, Building Electrification, PV, and DERs Are Important to a Least-Cost Pathway

- Delaying energy efficiency and building electrification drives up costs by $17B cumulative NPV over the next 25 years, showing the importance of these measures in buildings
- The higher DER scenario increases costs by $8B cumulative NPV, but reduces the need for grid scale renewables and T&D infrastructure investment, potentially easing siting and permitting challenges
- The Limited Demand Response scenario drives up costs by $4B cumulative NPV showing the value of customer participation with new electrified end uses



# Residential 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

# Delaying Energy Efficiency and Building Electrification Increases Fuels and Electricity Use

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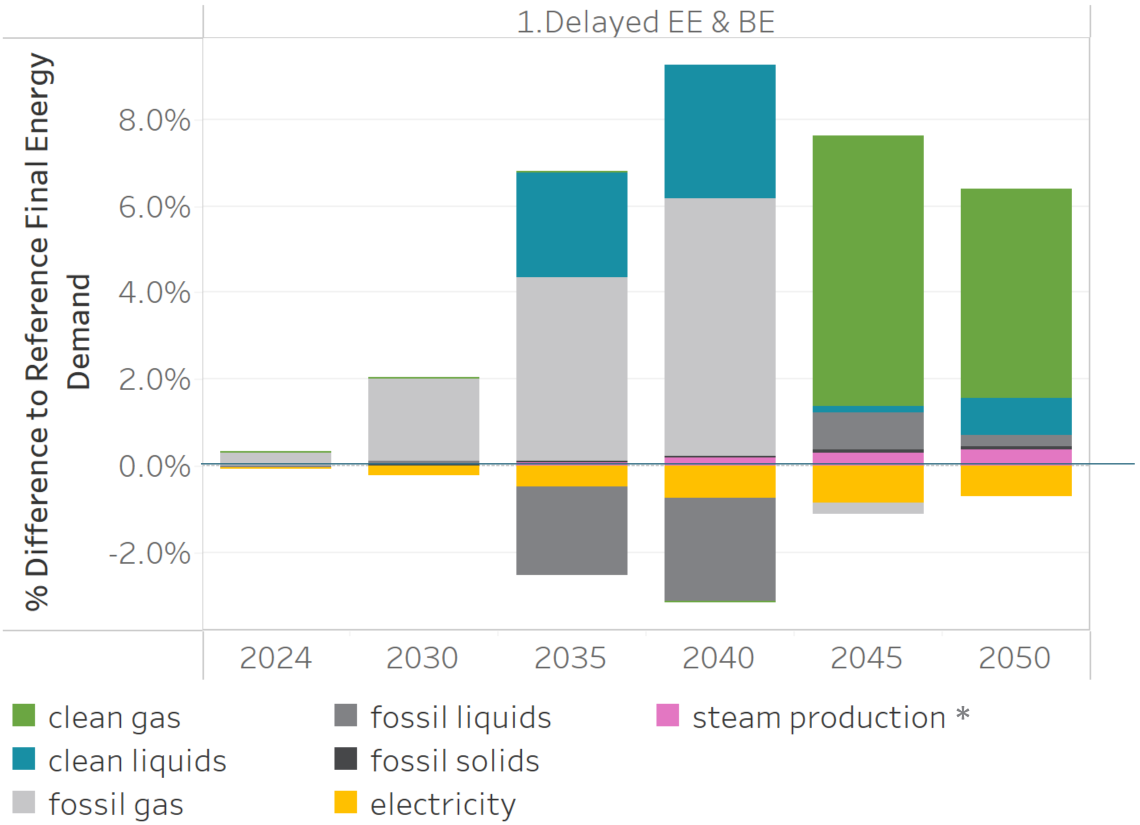
- Increased gas use
- Reduced electricity use
- Total energy demand 2% higher in 2030 and 6% higher in 2050
- Increases cost by $17B net present value
- Transition from fossil to clean may need to happen more gradually than shown

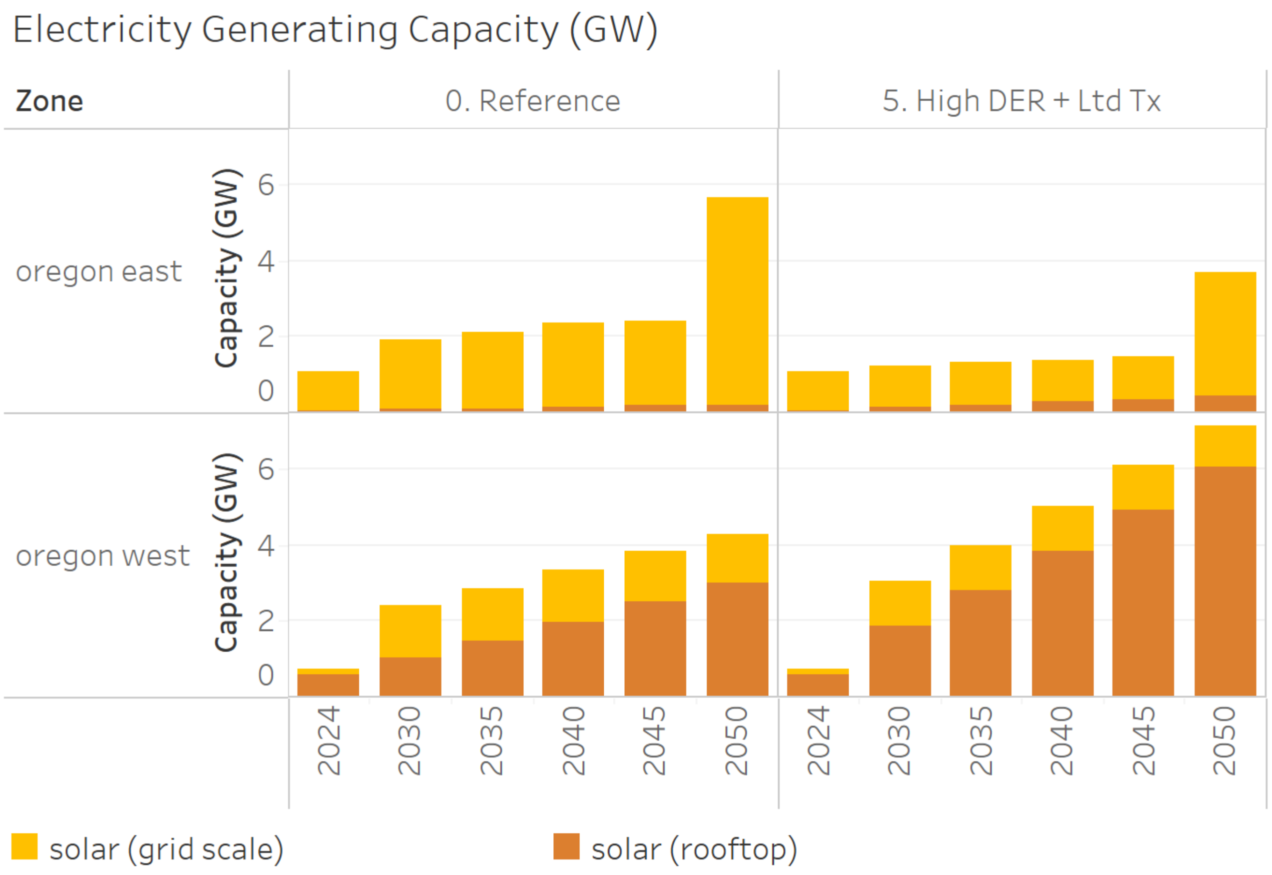
Difference in Energy Demand by Fuel in Oregon




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

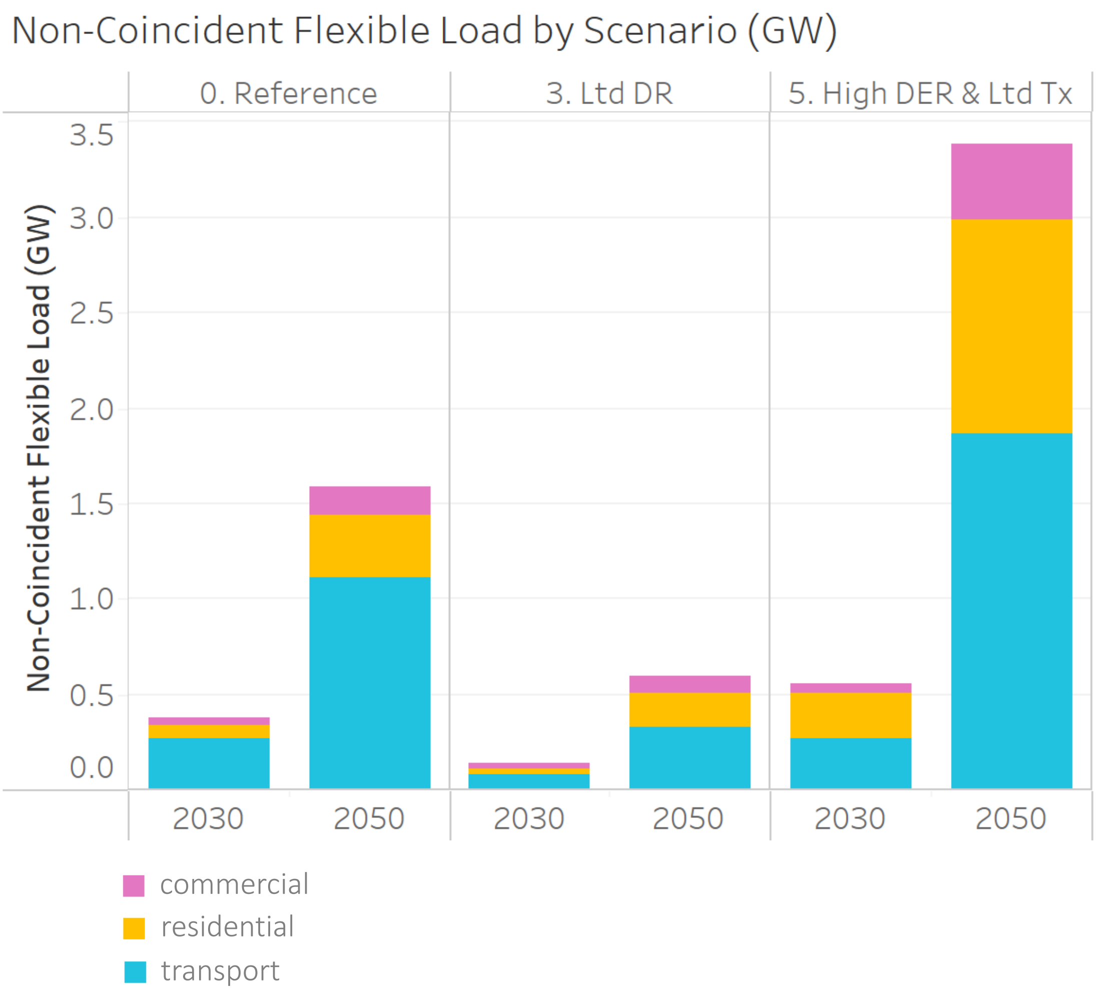
# Increasing Rooftop Solar Substitutes for Some Grid Scale Solar Builds

- Increasing rooftop solar to 7 GW across Oregon rather than the 3 GW in the Reference Scenario reduces both the overall need and the pace of grid scale solar build
- May mitigate challenges to siting and permitting large additions of grid scale renewables



# Flexible Loads Dependent on Participation in the Future

- The Reference Scenario assumes active participation of customers in demand response programs
- Managed charging in the transportation sector is the biggest source of flexible load
- Residential and commercial buildings contribute to demand response through participating water heating, space heating, and air conditioning systems
- Customer participation is key to results



# 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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# Thank you