

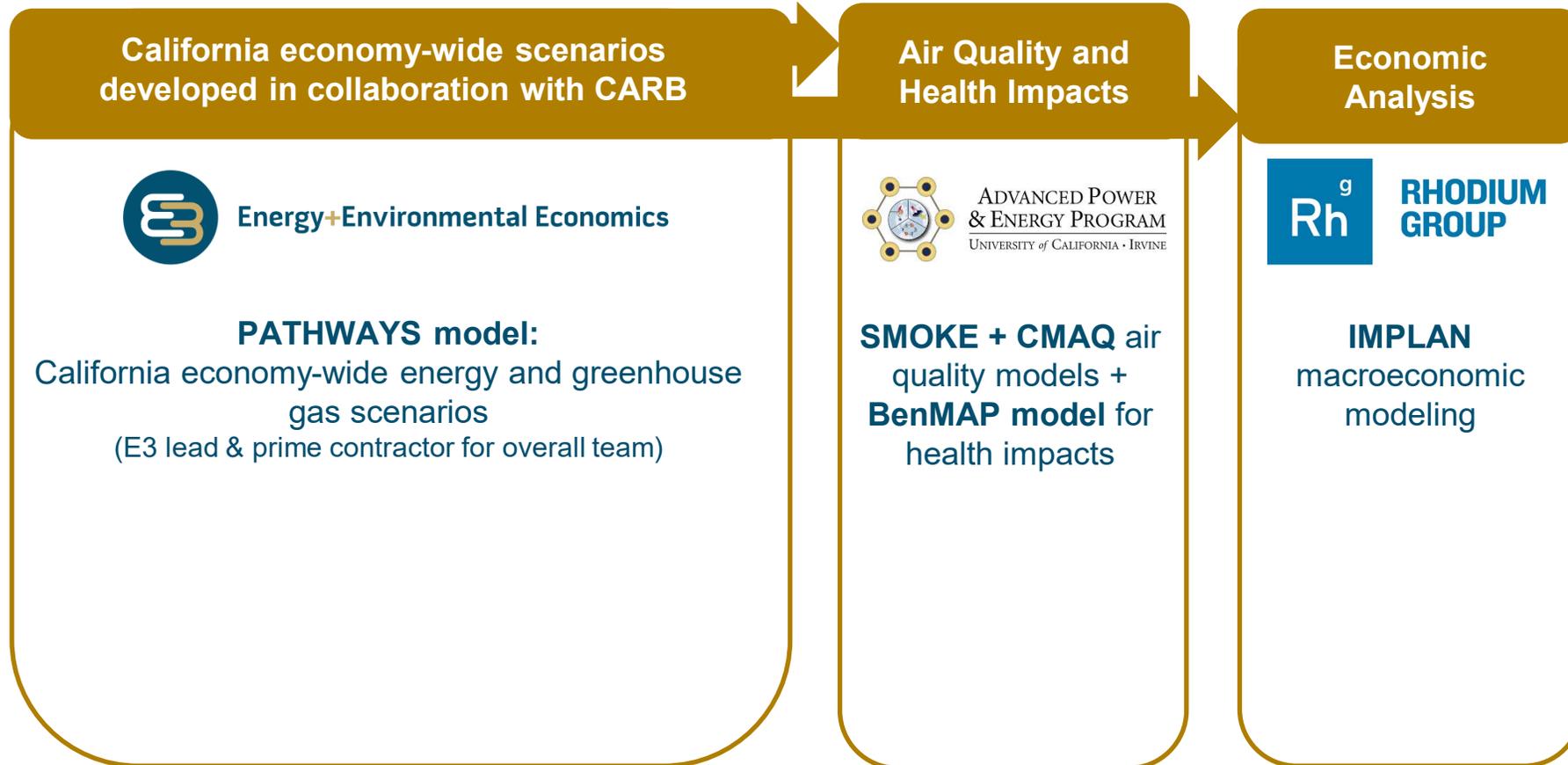
# **CARB Scoping Plan: AB32 Source Emissions Final Modeling Results**

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# Scoping Plan 2022



# Scenario Descriptions



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# Scenario Descriptions

**+ Scoping Plan Scenario (formerly Alternative 3):**  
Carbon neutral by 2045. Use of broad portfolio of existing and emerging fossil fuel alternatives and alignment with statutes and Executive Orders

| Sector   | Scoping Plan Scenario   |
|--|---|
| <b>Buildings</b>                                   | <p>100% res new construction electrified by <b>2026</b> and comm by <b>2029</b></p> <p>100% sales of electric appliances by <b>2035</b> (res) and <b>2045</b> (comm)</p> <p><i>Aligned with IEPR Energy Efficiency</i></p>  |
| <b>Transportation</b>                              | <p><b>VMT 25%</b> below 2019 by <b>2035</b> and <b>30%</b> below by <b>2045</b></p> <p>100% ZEV sales for LDV by <b>2035</b> &amp; MHDV by <b>2040</b> (inc HFCV)</p> <p>100% of passenger rail sales are ZEV by <b>2030</b>;<br/>100% of line haul sales are ZEV by <b>2035</b> (all primarily H2)</p> <p>100% OGV utilize shore power by <b>2030</b>. <b>25% OGVs</b> use H2 by <b>2045</b>. <b>100%</b> of cargo handling equipment is zero emission by <b>2037</b>; <b>100%</b> of drayage trucks are zero emission by <b>2035</b></p> <p>10% of aviation fuel demand is electric and 10% H2 by <b>2045</b>. Sustainable aviation fuel meets remaining demand</p> |
| <b>Industry &amp; Agriculture</b>                  | <p><b>6% energy efficiency</b> in industry and agriculture relative to 2019</p> <p>By <b>2035</b>:<br/>~<b>25% electrification</b>;<br/>Process Heat <b>25% H2</b>;<br/><b>CCS on 40%</b> cement~70% Pet Ref operations;<br/><b>CCS on ~70%</b> of petroleum refining<br/>OGE reduced with demand</p> <p>By <b>2045</b>:<br/><b>75-100% electrification</b>;<br/>Process Heat <b>100% H2</b>;<br/><b>CCS on 100%</b> cement</p>   |
| <b>Electricity</b>                                 | <p><b>38MMT</b> GHG target by 2030, <b>30MMT</b> by 2035, <b>SB100</b> by 2045</p> <p>20GW <b>OSW</b> by <b>2045</b>, <b>no new gas</b>, <b>CCS</b> to meet 85% economywide direct emissions reductions</p>   |
| <b>Low-Carbon Fuels</b>                            | <i>Align with LCFS through 2030 and biofuel feedstocks beyond</i>   |
| <b>High GWP &amp; Non-Combustion</b>               | <i>Align with CARB projections</i>  |
| <b>Carbon Dioxide Removal &amp; Carbon Capture</b> | <b>20MMT</b> by 2030 and <b>100MMT</b> by 2045  |

# Emissions



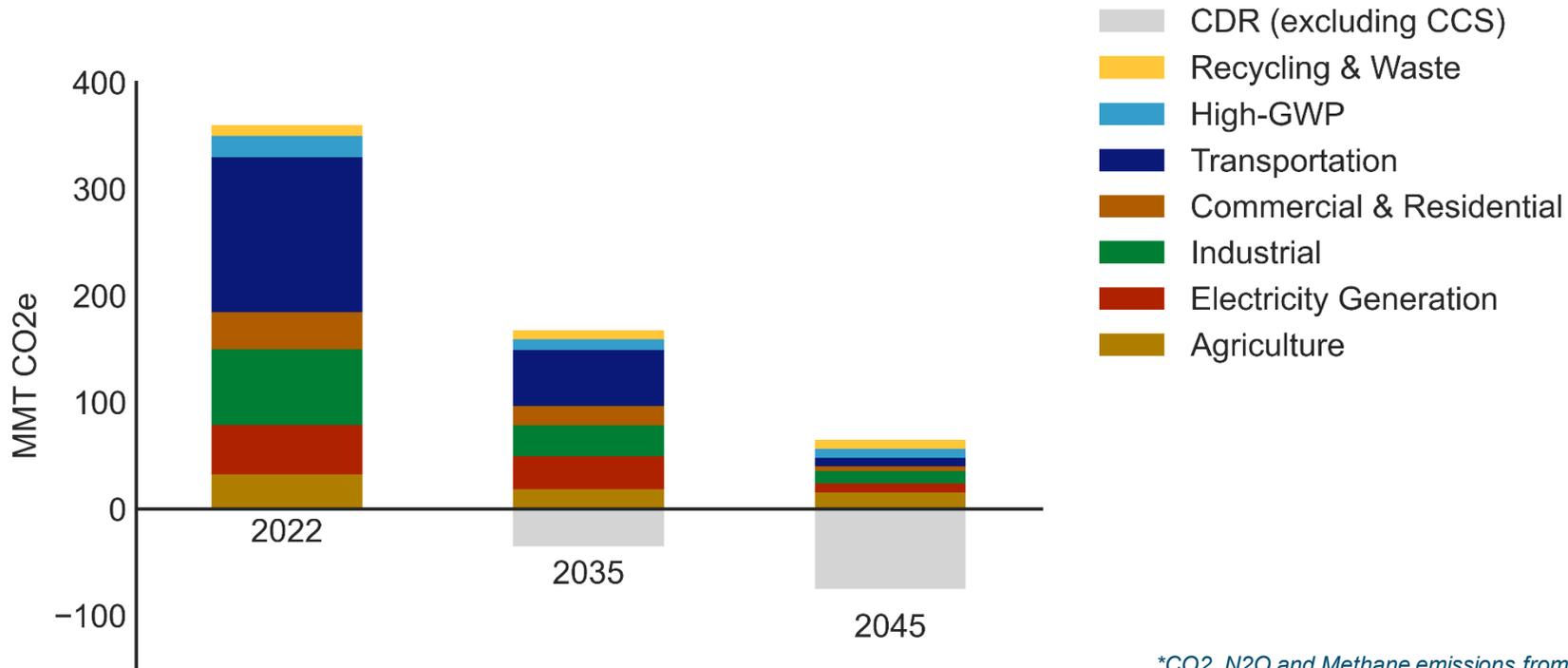
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# Total Emissions

- + **Agriculture\*** and **other** methane and fugitive emissions and **Recycling and Waste** are a persistent and large source of remaining emissions
- + **Industrial** and **high global warming potential (GWP)** emissions see proportionately large reductions but remain a large source of emissions in 2045
- + **Commercial & residential buildings, electricity generation** and **transportation** emissions have large reductions

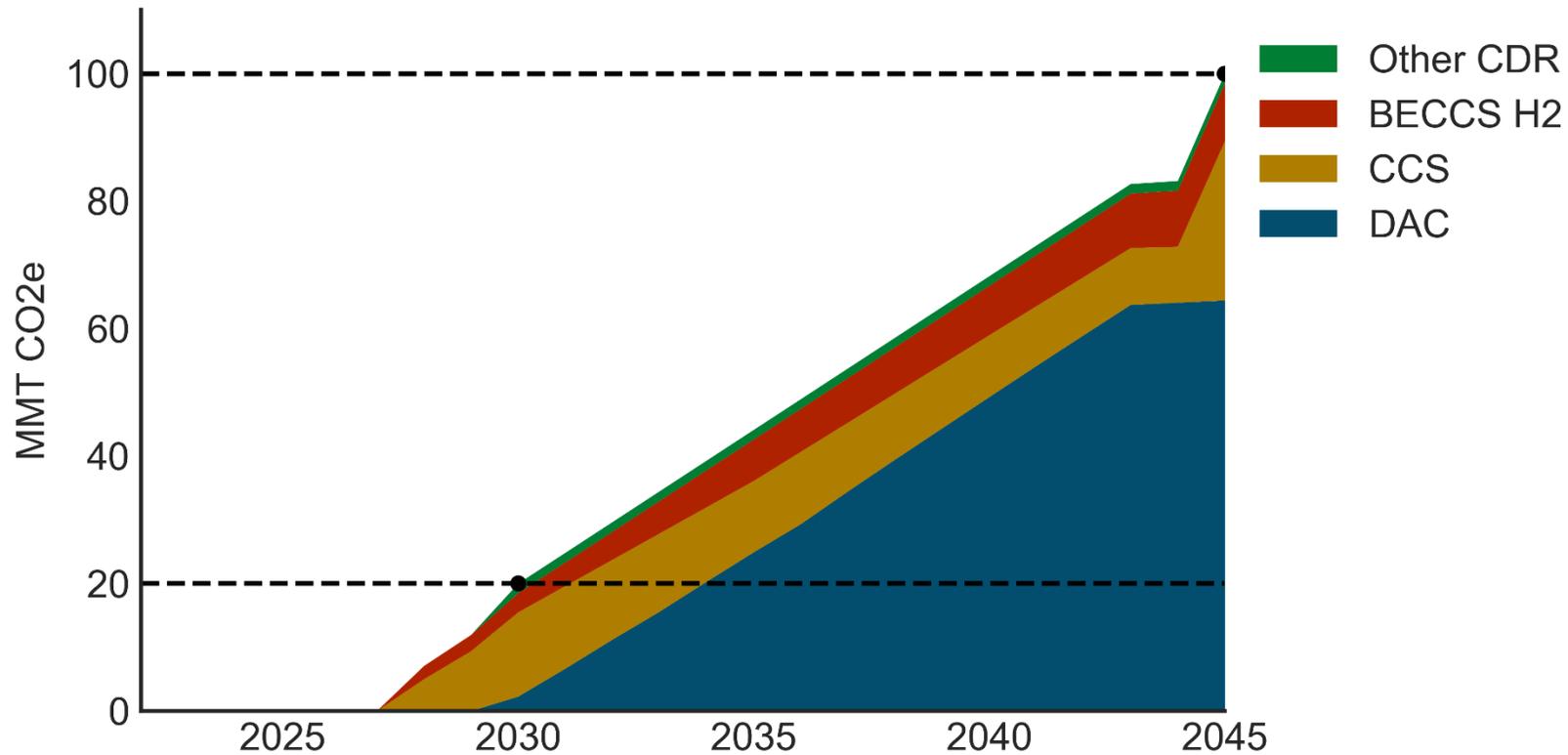


\*CO<sub>2</sub>, N<sub>2</sub>O and Methane emissions from livestock, dairies, fuel use, and crop burning



# Carbon Removal & Capture Targets

- + 20MMT by 3030 and 100MMT by 2045
- + Technologies that count towards this target include negative emissions from DAC, BECCS, and urban forestry, along with avoided emissions from CCS on industrial and electric sources

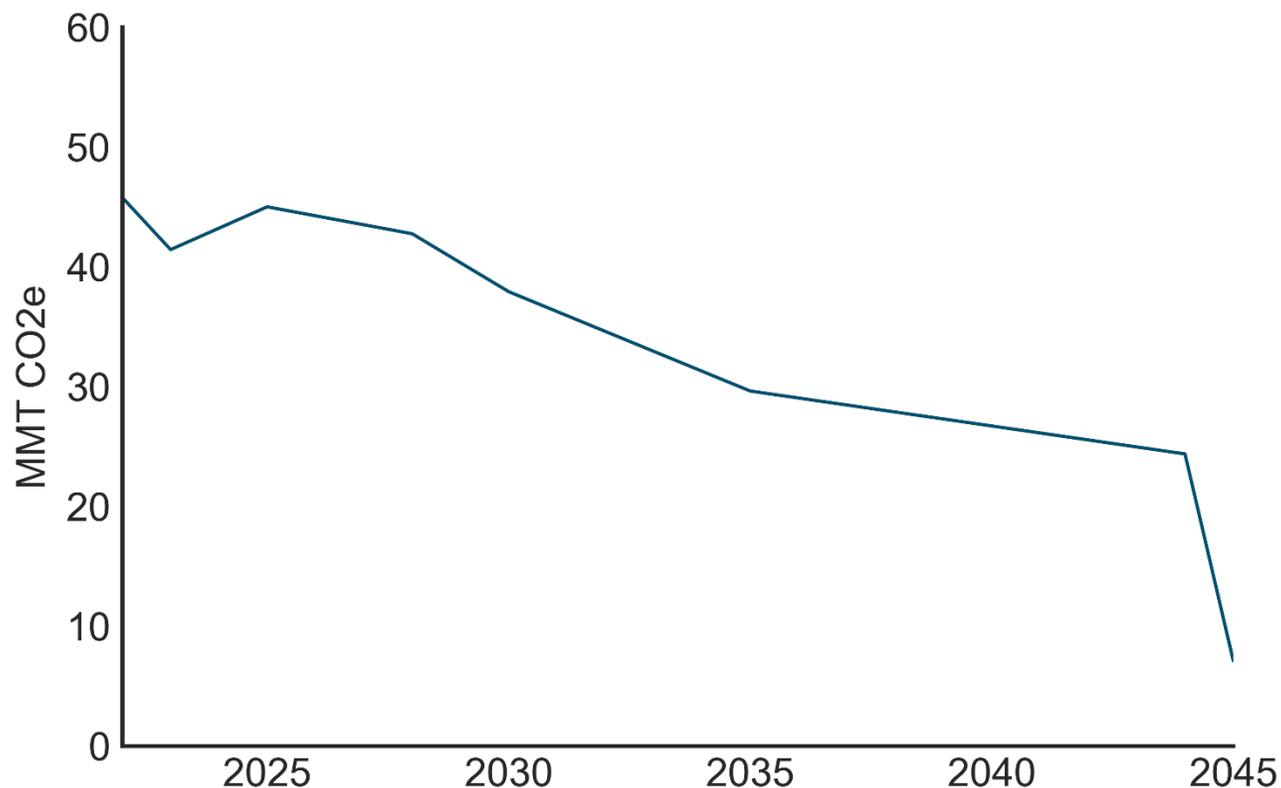




# Electric Sector Emissions

## + Scoping Plan targets:

- 38MMT by 2030
- 30MMT by 2035
- SB100 by 2045
- CCS on emissions to reach 85% economy-wide emissions reductions

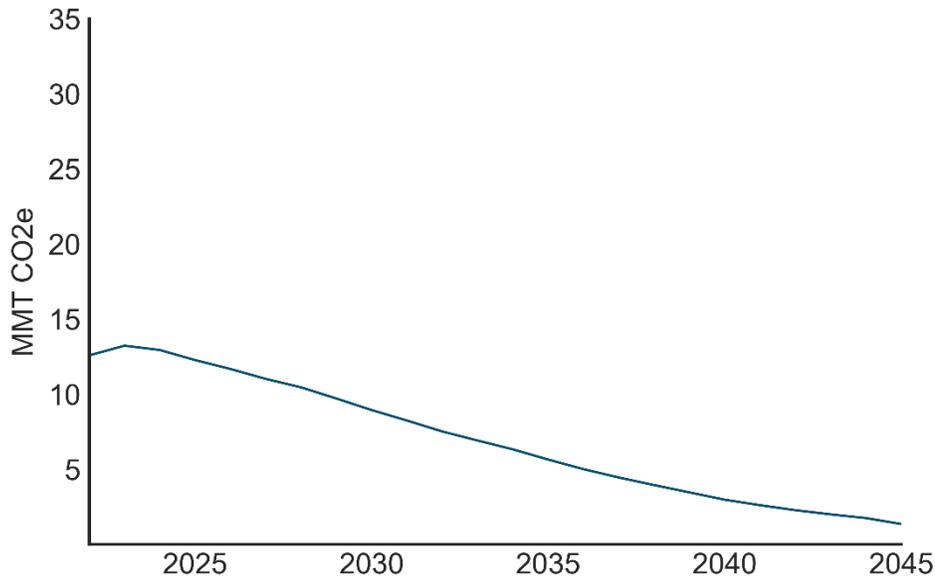




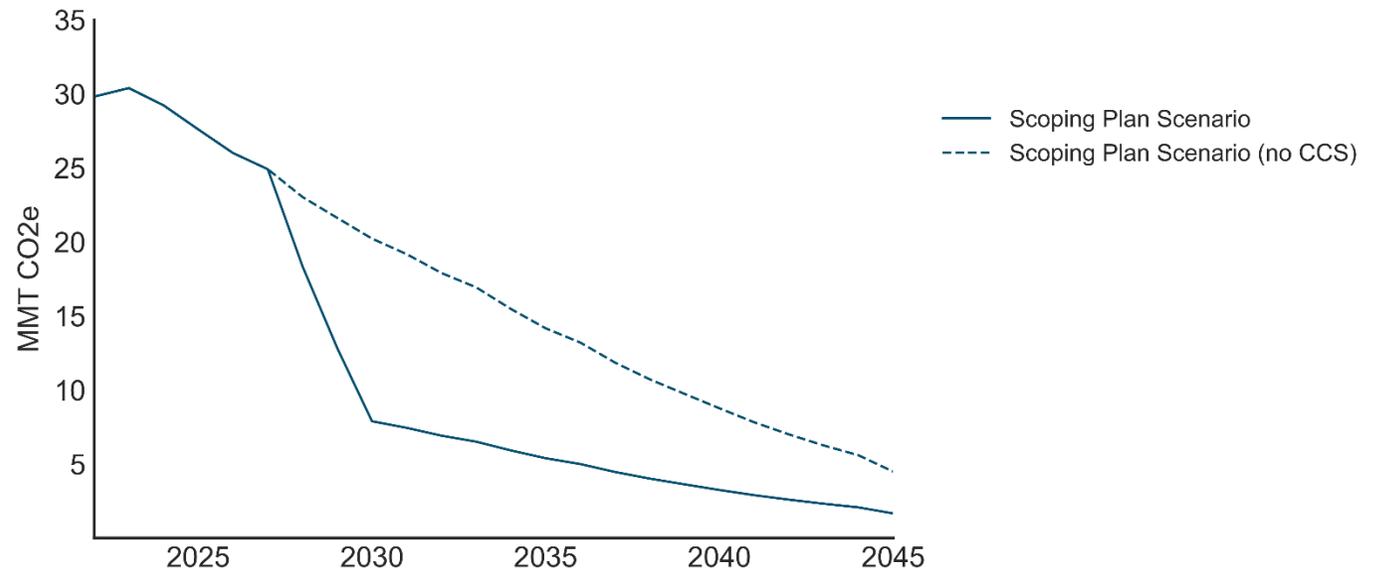
# Oil & Gas Extraction and Petroleum Refining Emissions

- + Oil & Gas Extraction tracks demand for petroleum
- + Petroleum Refining Emissions is shown with and without application of carbon capture & sequestration (CCS) with a 90% capture rate. Petroleum refining also tracks petroleum demand and applies CCS on ~70 of operations by 2030.

Oil & Gas Extraction Emissions

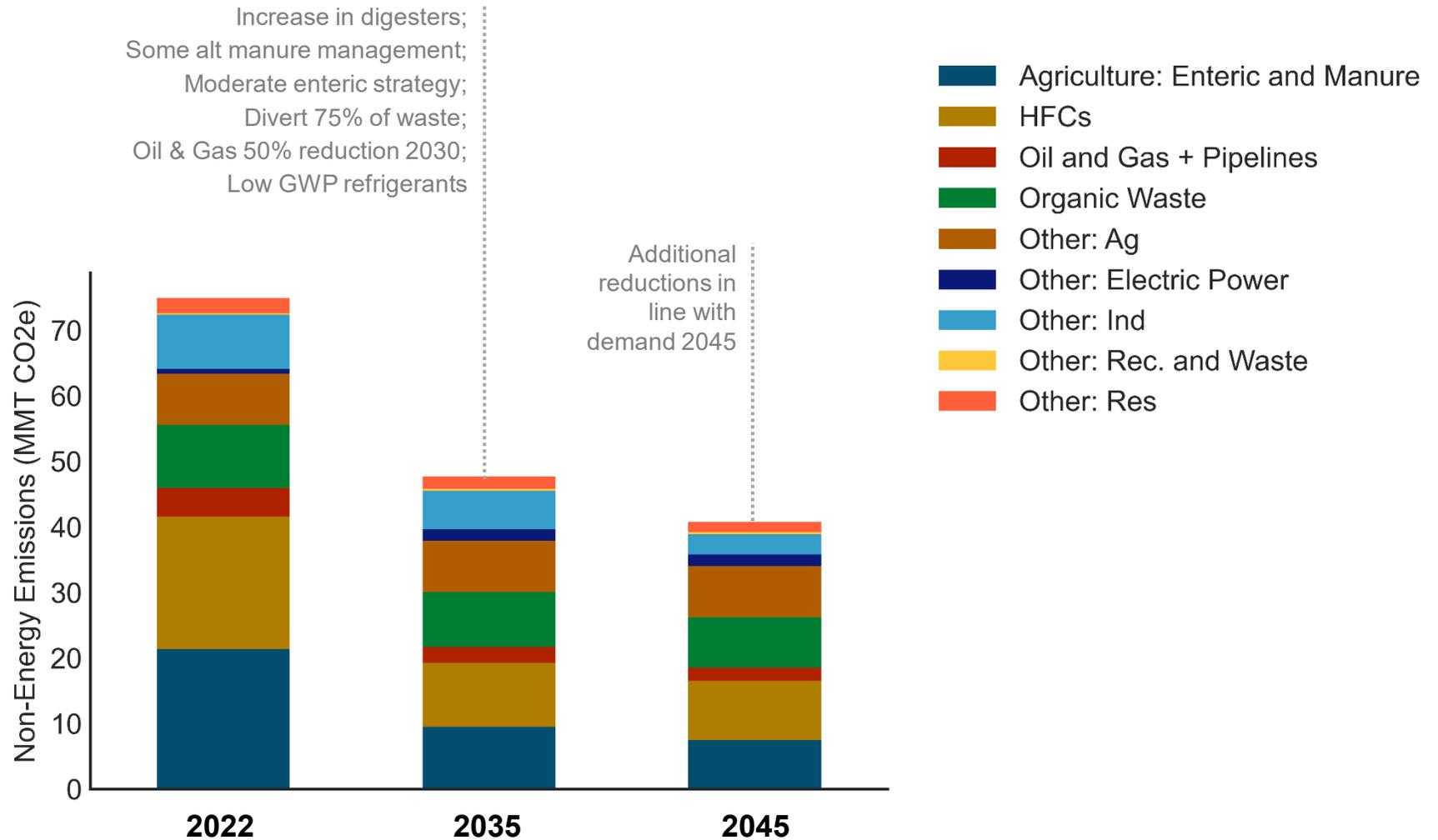


Petroleum Refining Emissions





# Non-Energy Emissions



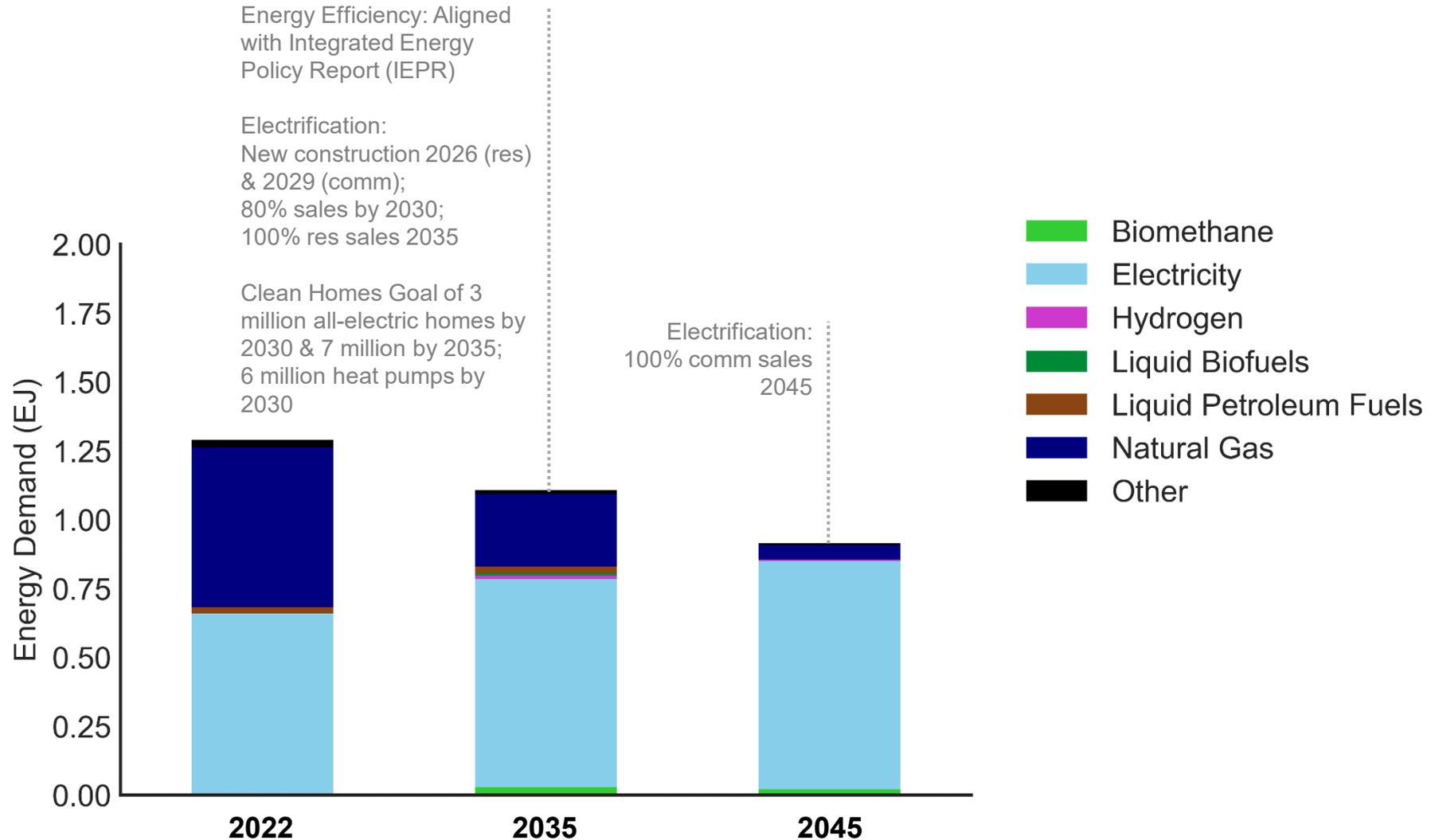
# Energy Demand



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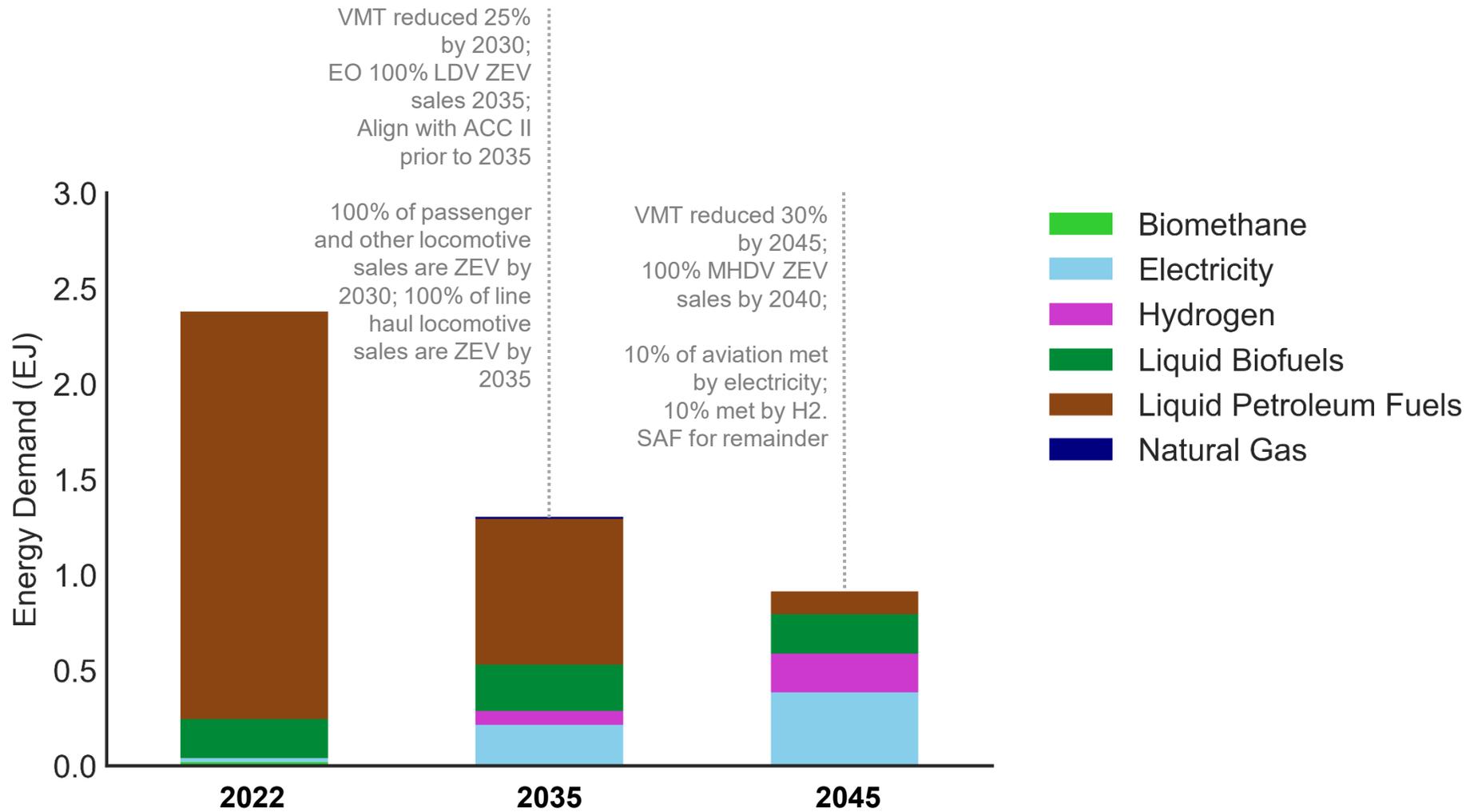


# Building Energy Demand



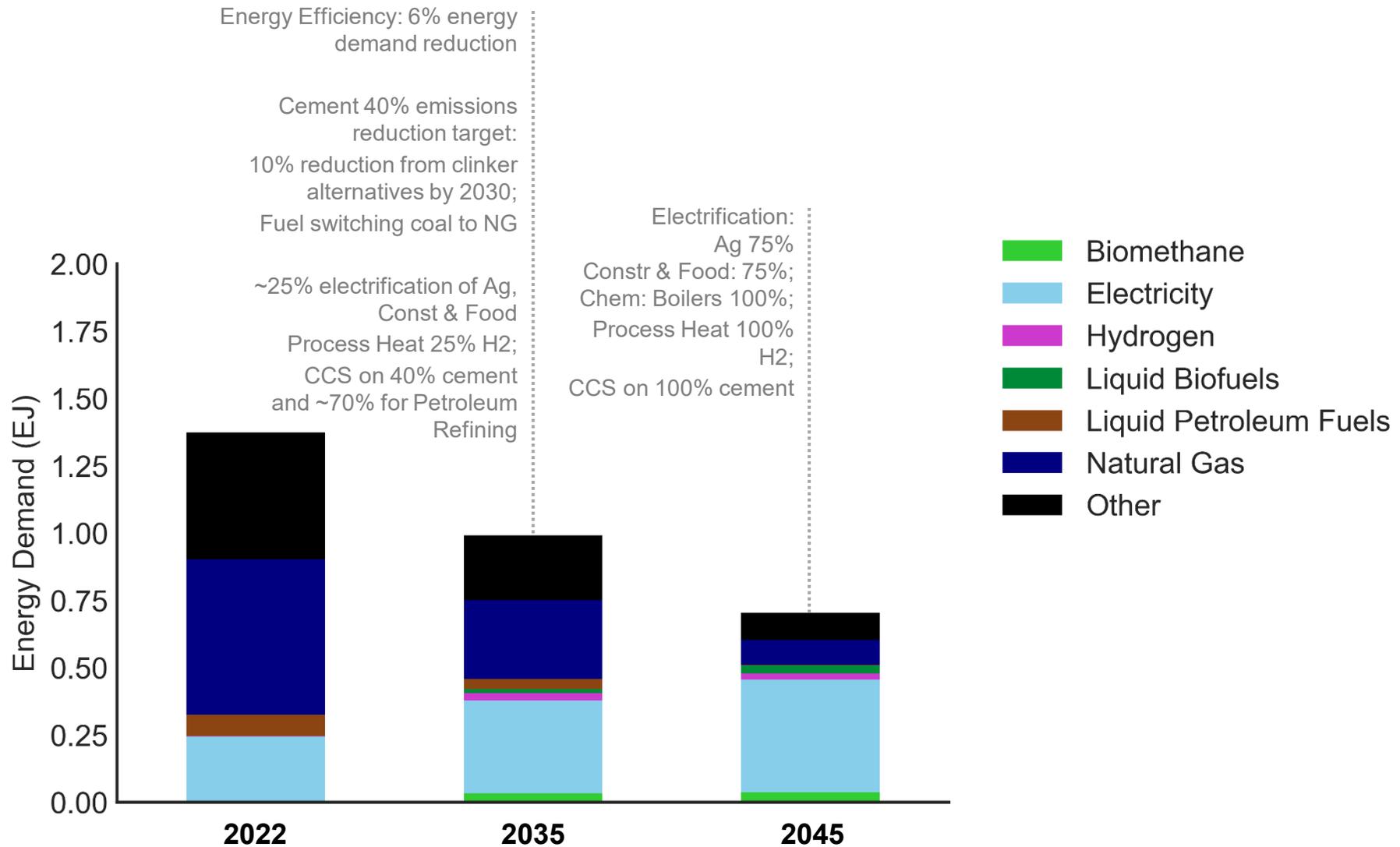


# Transportation Energy Demand





# Industry and Agriculture Energy Demand



# Fuel Transitions

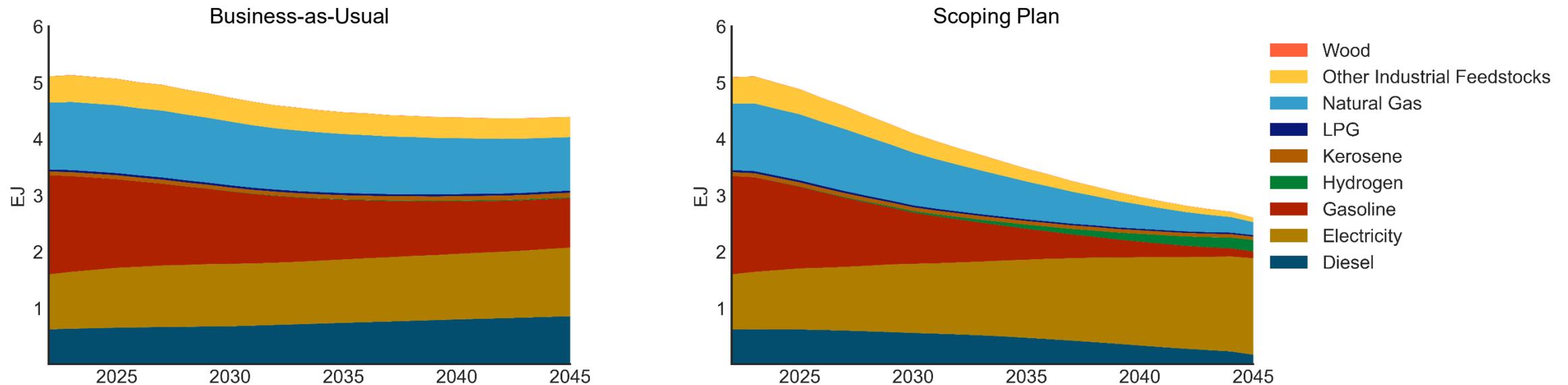


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# Energy Demand by Fuel

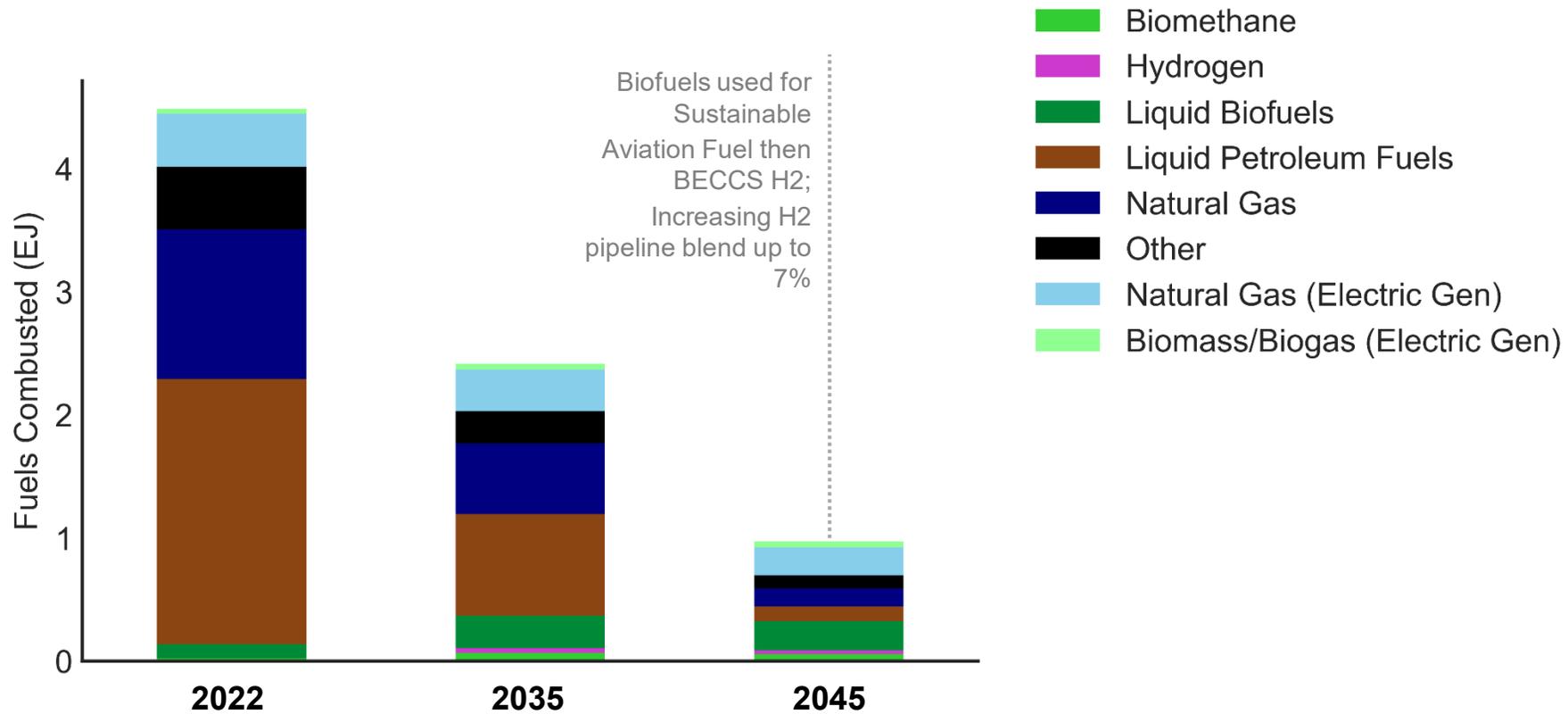
- + **Natural gas** phases down as electrification measures ramp up
- + **Hydrogen** is assumed to be biomass gasification with carbon capture and sequestration (CCS) and electrolysis and is heavily utilized in multiple sectors: 7% pipeline blend 2040; 25% OGVs 2045; HFCV trucks 2040; line haul/passenger rail 2035; 10% aviation by 2045
- + **Gasoline** ramps down in line with ZEV targets
- + **Electricity** ramps up in line with building and transportation electrification targets
- + **Diesel** ramps down in line with MHDV targets and industrial electrification



*Biofuels categorized in natural gas, kerosene, and diesel*



# Combustion Fuels Transition



# Electric Sector

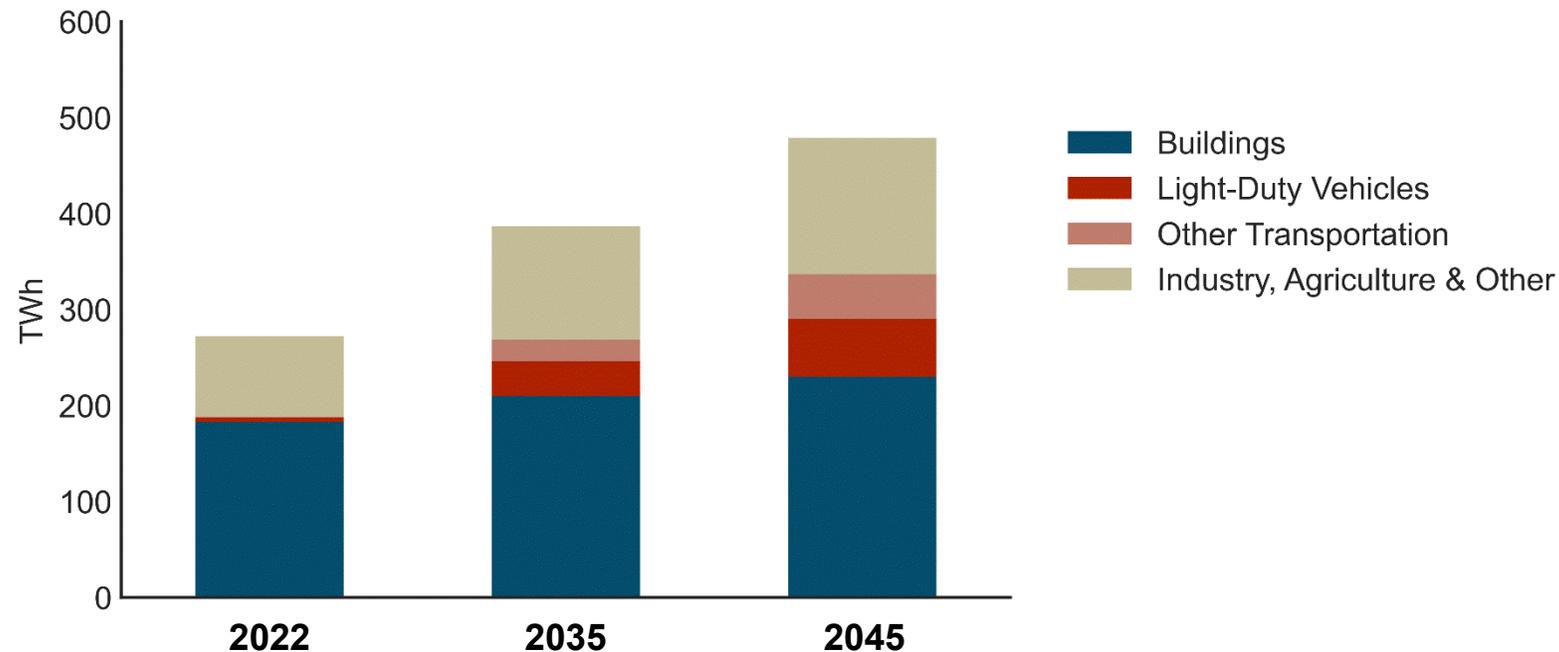


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# Scoping Plan Scenario Loads

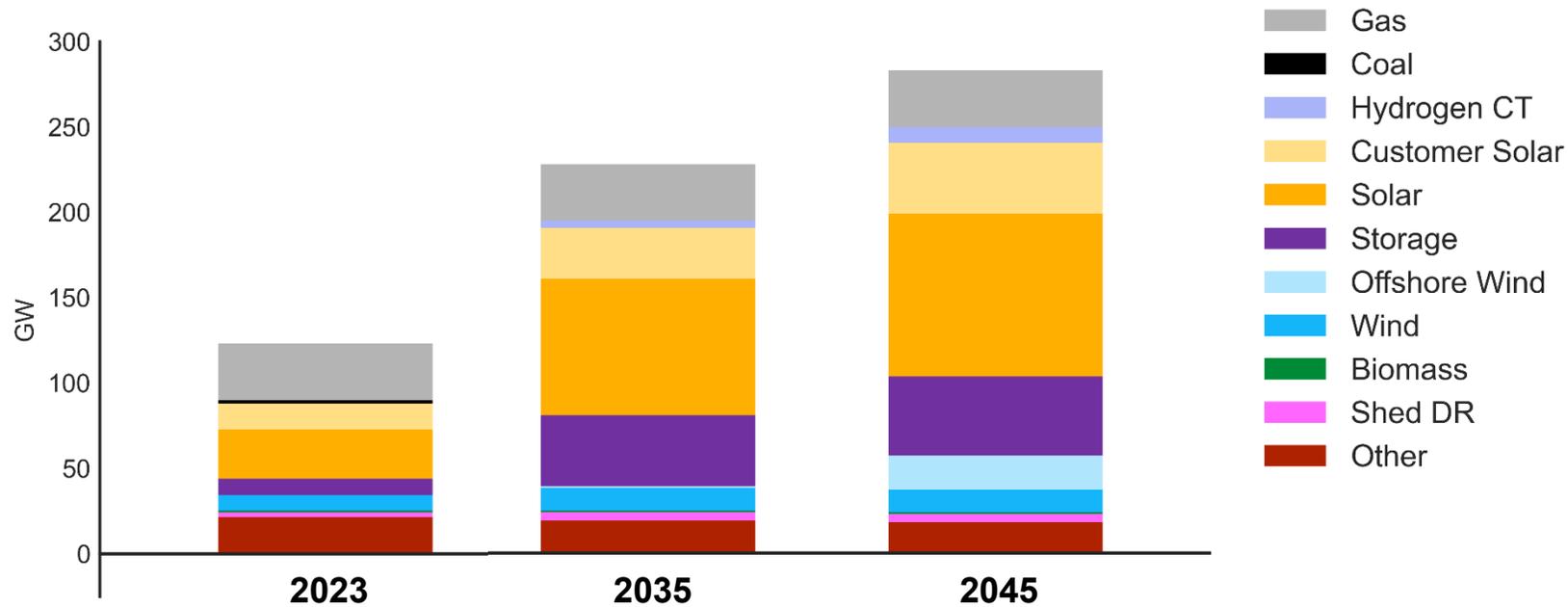
- + Electric loads increase by ~40% relative to today by 2035 and ~80% by 2045
- + Loads for direct air capture and hydrogen production are assumed to be provided by off-grid renewables, and are not included in this graphic
- + **Other transportation** includes all non-LDVs and reflects electrification of things like passenger and freight rail, aviation, and ocean-going vessels (OGVs)





# Cumulative Resource Capacity

- + **Solar**, **Wind** and **Batteries** make up the vast majority of new resource capacity build
- + 20GW of **Offshore Wind** is built by 2045 in line with the target
- + **Other** includes nuclear, CHP, hydro, geothermal, and pumped storage
- + Existing **Gas** capacity stays online but no new capacity is allowed to be built



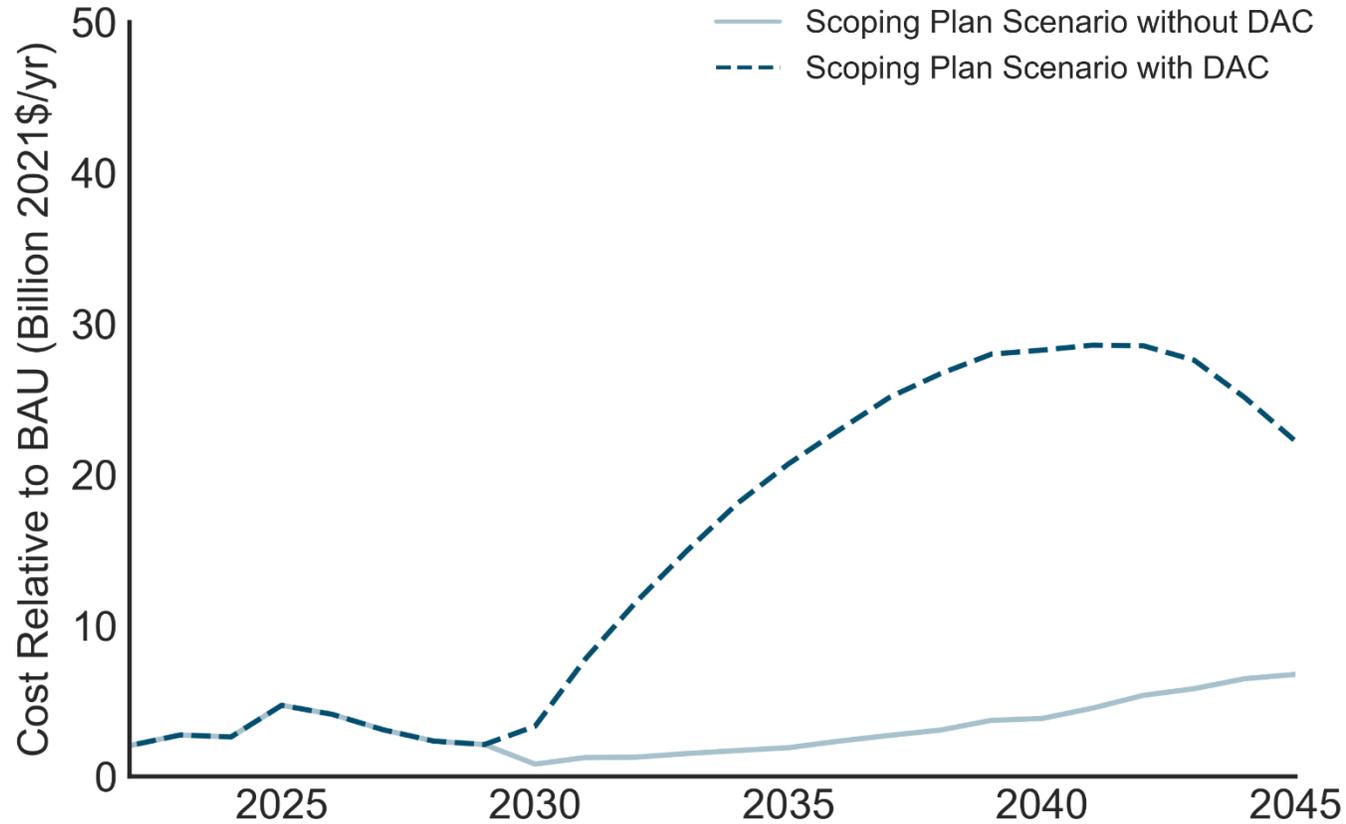
# Costs



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# Total Costs Relative to Business-as-Usual (BAU)



- + Direct Air Capture (DAC) ramps up starting in 2028 to meet carbon neutrality in 2045
- + Pre-DAC costs reflect the rate and scale of adoption of clean technologies
- + DAC needs increase in time, but DAC costs drop overtime so total cost increase is mitigated



# Sectoral Costs Relative to Business-as-Usual (BAU)

## + Transportation

- Cost savings reflective of fuel savings net of costs from ZEV stocks and electricity and hydrogen use

## + Commercial & Residential

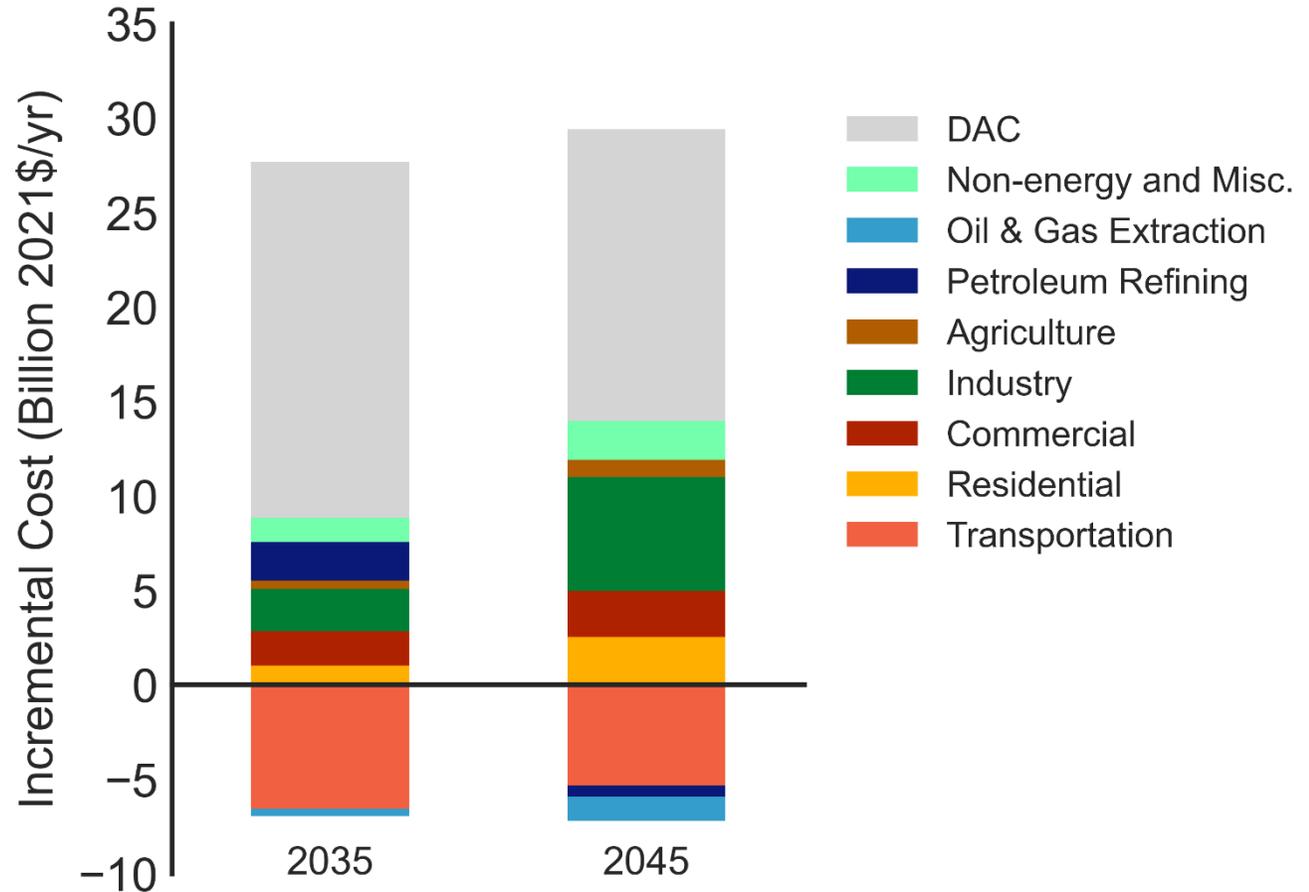
- Commercial electrification stock and energy costs comprise a large cost

## + Industry

- Reflects fuel cost savings due to electrification and increased costs for electricity from electrification and CCS
- Incremental industrial stock costs were not included and would significantly increase costs to achieve ambitious decarbonization measures

## + Petroleum Refining & Oil and Gas Extraction

- Cost savings relative to the BAU by 2045 as demand ramps down in line with ZEV targets



# Thank You

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