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CEC Demand Scenarios: Economy-Wide PATHWAYS Results

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Energy+Environmental Economics

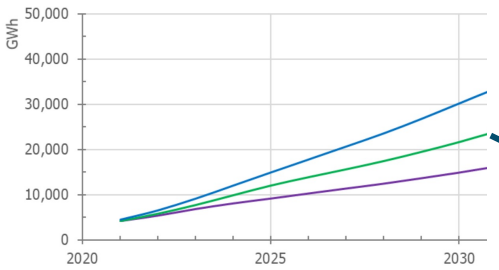
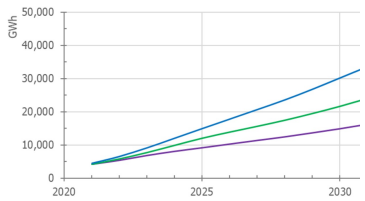
Agenda

+ Motivation and context
+ PATHWAYS overview
+ Scenario description
+ Scenario results

Motivation and context: why are we using PATHWAYS?

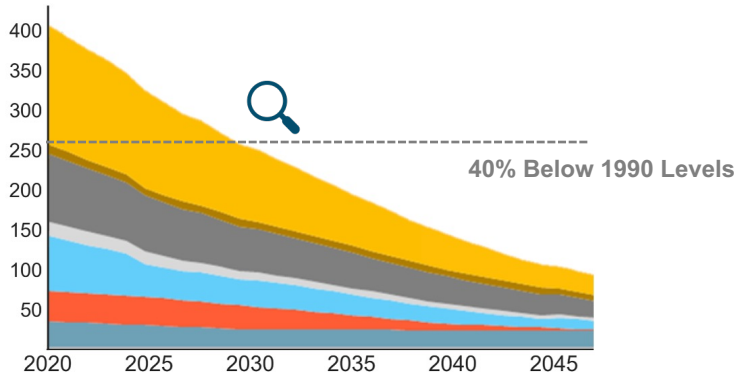
+ PATHWAYS adds energy demands from sectors not modeled by CEC, and adds emission factors, to arrive at an economy-wide picture of energy demand and emissions
+ These economy-wide results allow us to determine compliance with emission reduction targets

Scope of IEPR Demand Scenarios

Sector	Energy Demand
Residential	
Commercial	
Transportation	
Industry, Agriculture, Other	

Calculate energy demand across all sectors, then calculate emission factors via assumptions on biofuels and electric generation

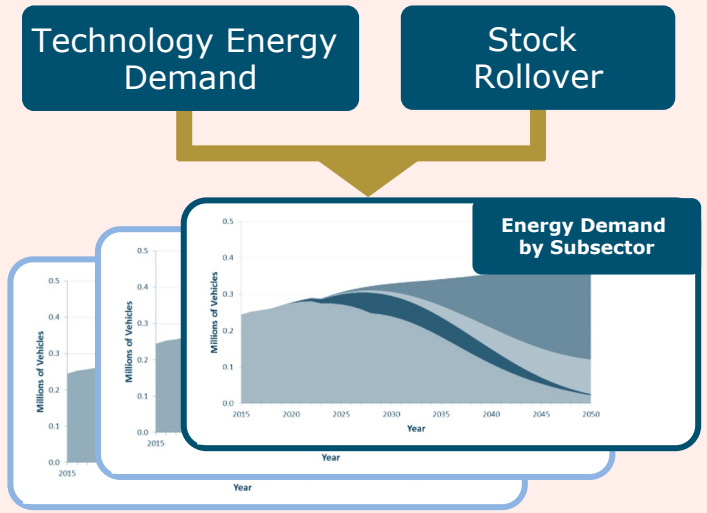
Emissions



What is PATHWAYS?

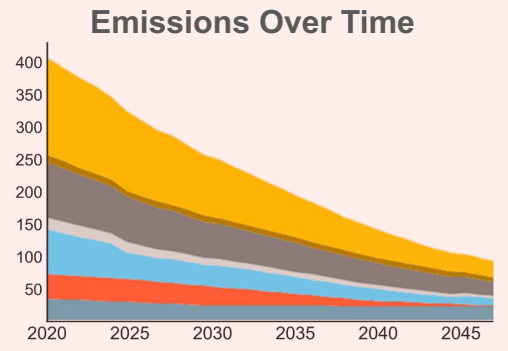
+ PATHWAYS is an economy-wide, bottom-up model of energy demand and emissions, that evaluates emissions and cost implications of user-defined technology transformation scenarios
+ PATHWAYS is used by the CEC, CPUC, and CARB to evaluate the emissions implications of various infrastructure transformation trajectories, and to evaluate tradeoffs between different decarbonization strategies
+ For this project, we are using CEC inputs for residential, commercial, and transportation energy demand

Energy demand module



Energy supply module

Results



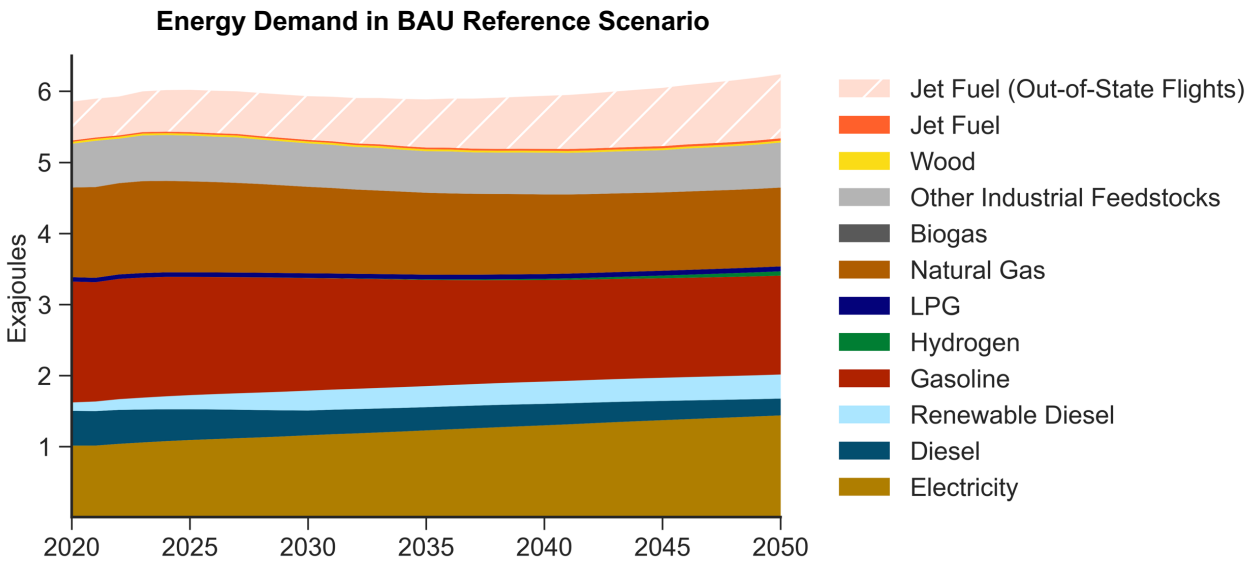
Scenario assumptions

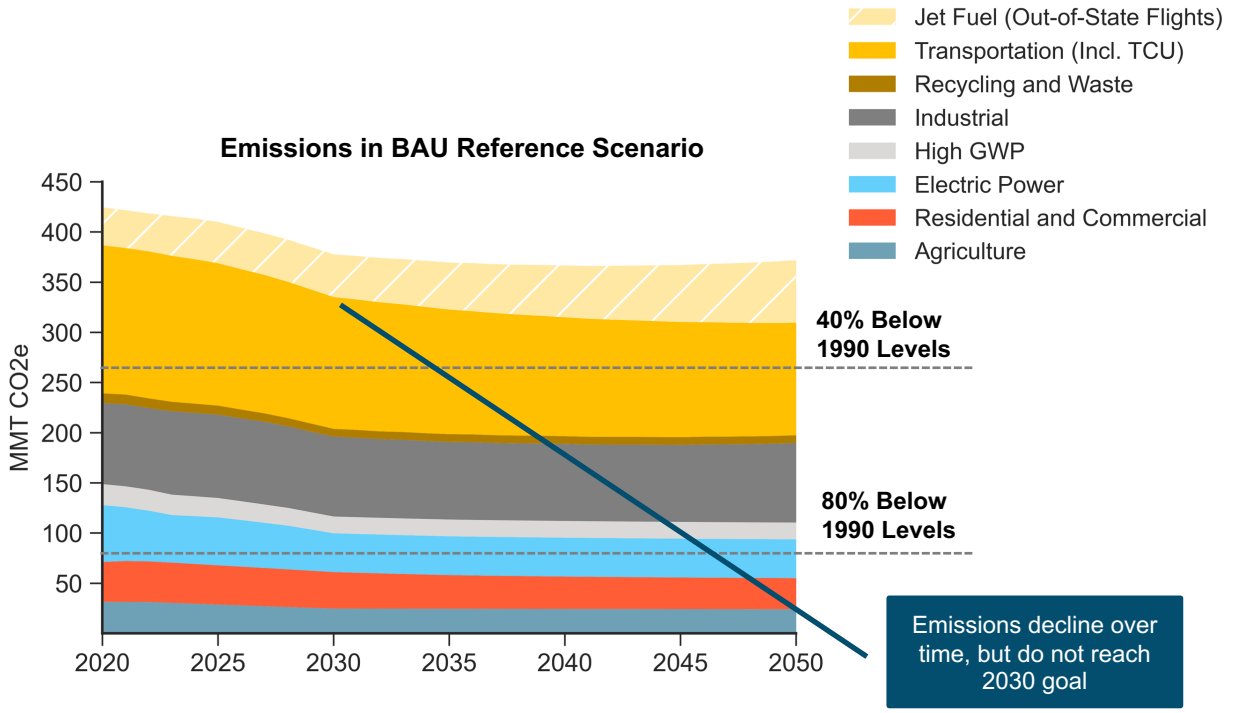
+ In this project, we evaluate three scenarios: Reference, High Electrification Policy Compliance, and High Electrification Mitigation

	Assumptions Category	Reference	High Electrification Policy Compliance	High Electrification Mitigation
Energy demand provided by CEC modeling	Residential	Align with CEC modeling	Align with CEC modeling	Align with CEC modeling
	Commercial			
	Transportation			
Energy demand provided by PATHWAYS	Industry	No industry decarbonization	No industry decarbonization	Industry nearly decarbonized by 2050 through CCS, hydrogen, and electrification
	Agriculture	No agriculture decarbonization	No agriculture decarbonization	No agriculture decarbonization
Energy supply and non-combustion emissions modeled in PATHWAYS	Electric Generation	Align with current policy: 38 MMT by 2030, 60% RPS	Align with current policy: 38 MMT by 2030, 60% RPS	Accelerated policy: 30 MMT by 2030, 100% clean electricity by 2045 (SB 100)
	Low Carbon Fuels	LCFS: 20% CI reduction by 2030	LCFS: 20% CI reduction by 2030	LCFS through 2030, increased use of advanced biofuels afterwards
	Non-Combustion Emissions	Align with current trends (some progress on refrigerants and manure, minimal elsewhere)	SB 1383: 40% reduction by 2030	SB 1383: 40% reduction by 2030. Continuing reductions after 2030.

Scenario results: Reference

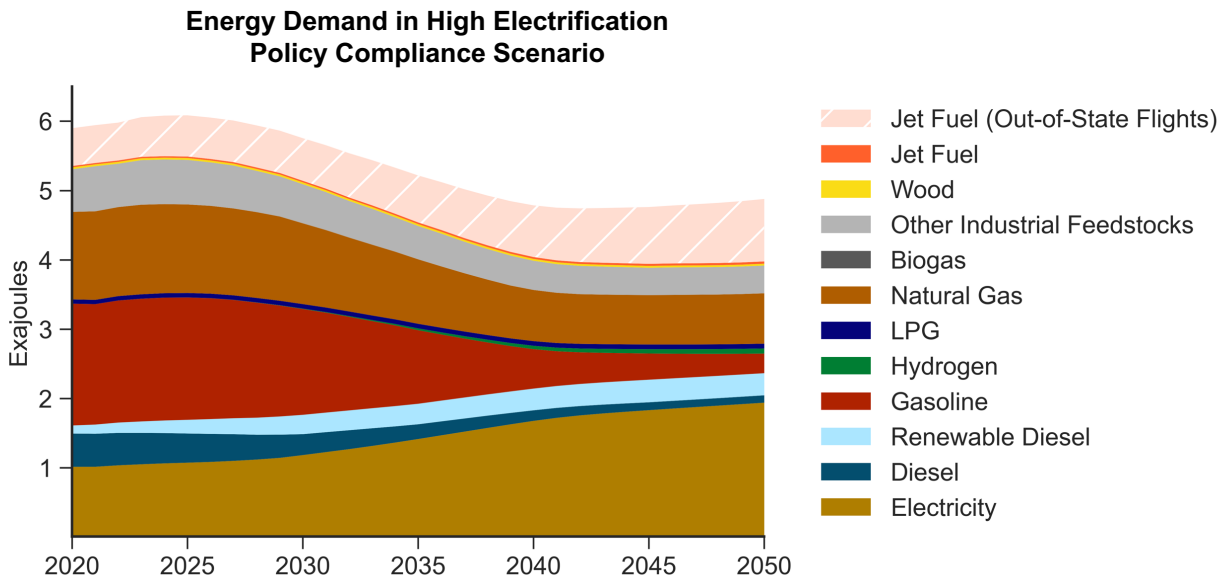
- Energy demand results in Reference scenario show gradually increasing electric load, and gradual increase in Renewable Diesel blending due to LCFS
- Emissions decline over time, but do not come close to GHG reduction goal of 40% below 1990 levels by 2030
- Note jet fuel demand for out of state flights is not included in CARB GHG inventory, nor is it accounted for in our GHG goals, but it is included here for reference

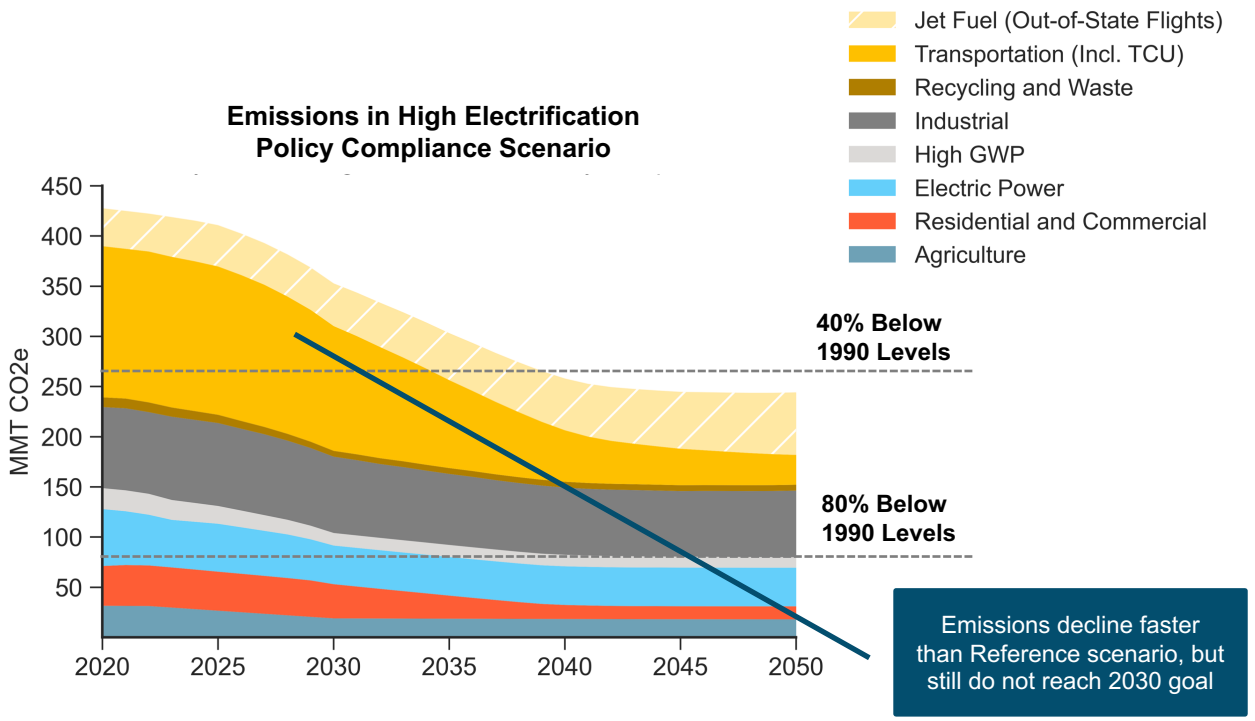




Scenario results: High Electrification Policy Compliance

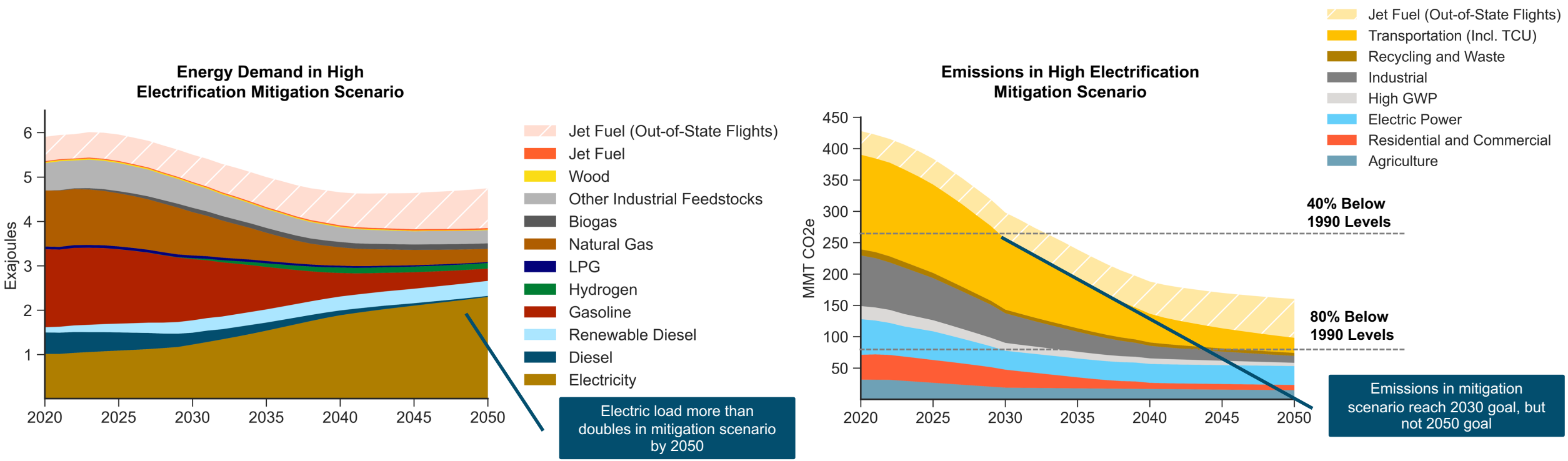
- Energy demand results in High Electrification Policy Compliance scenario show a near-doubling of electric load by 2050, and a corresponding efficiency benefit
- Emissions decline faster than Reference scenario, but still do not reach 40% by 2030 GHG reduction goal





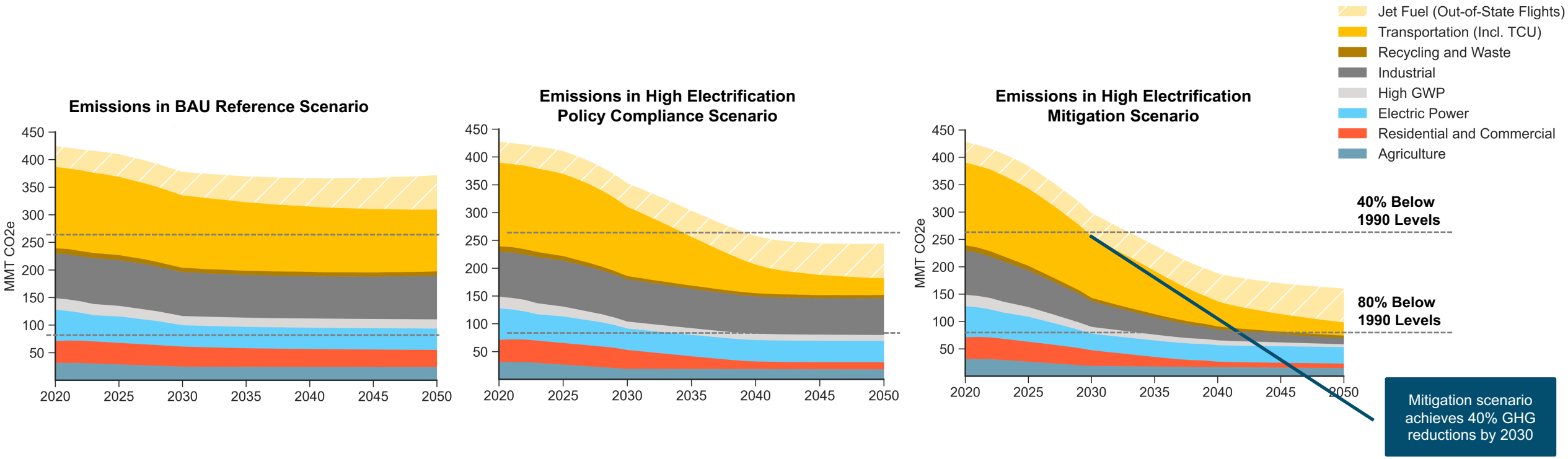
Scenario results: High Electrification Mitigation

- Energy demand results in High Electrification Mitigation scenario show electric load more than doubling by 2030
- Emissions reach 2030 GHG reduction goal of 40% below 1990 levels, but do not reach 2050 goal of 80% below 1990 levels



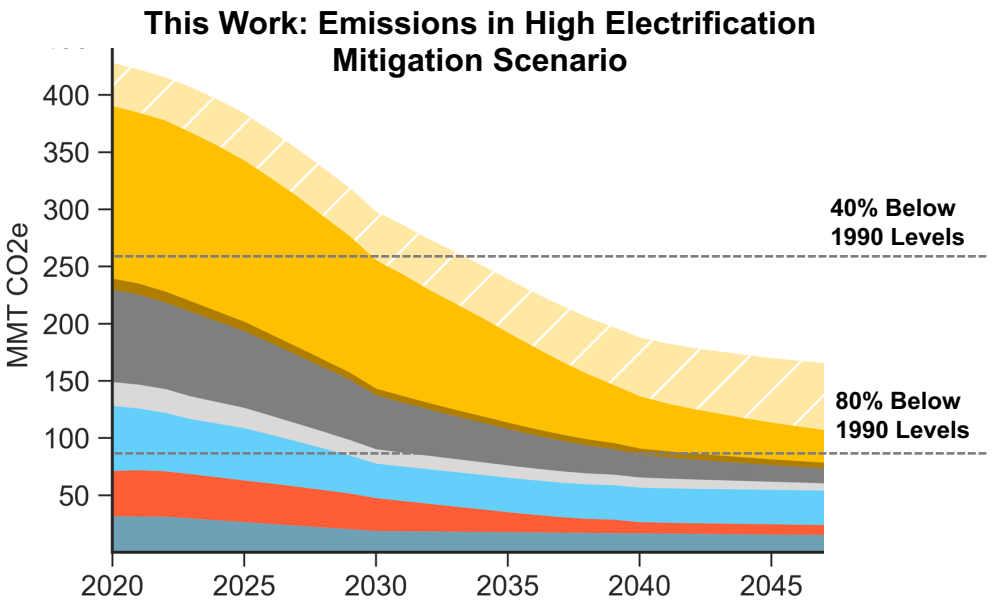
Scenario results summary: emissions

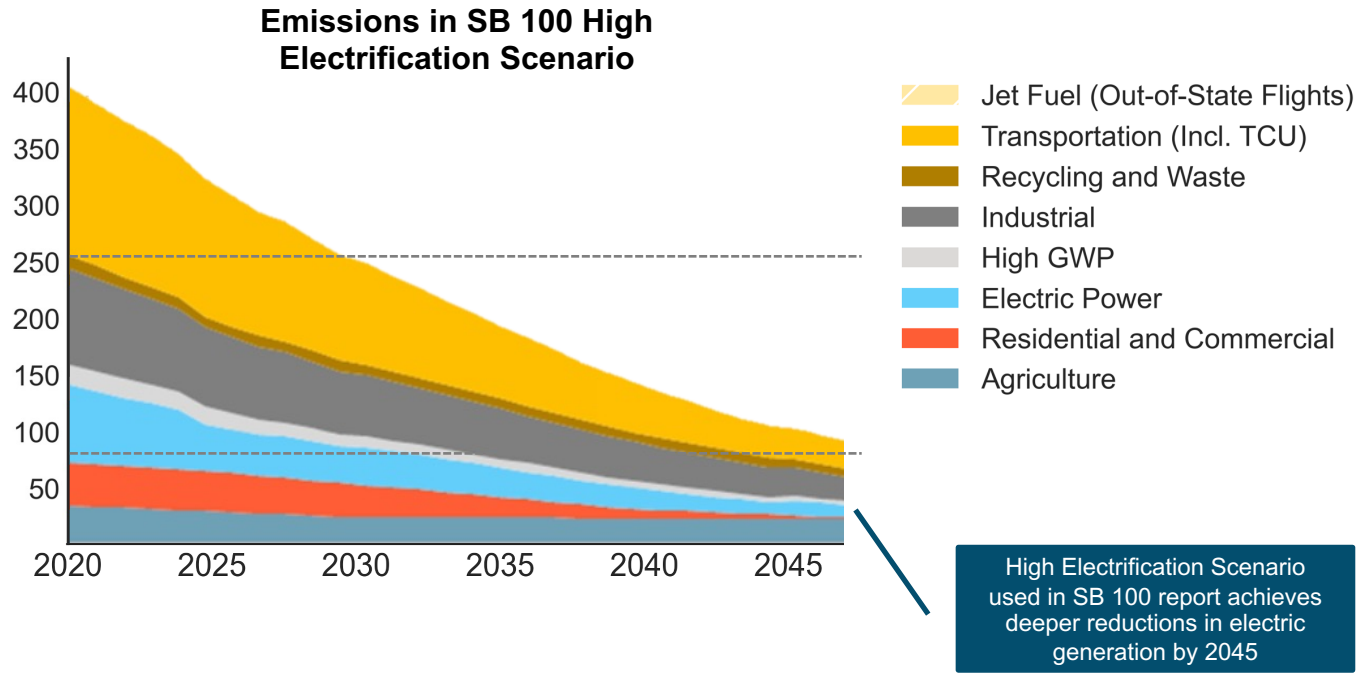
+ **Reference and Policy Compliance scenarios do not achieve California's GHG goals of 40% reductions below 1990 levels by 2030 or 80% reductions by 2050**
+ **Mitigation scenario achieves 2030 goal, but does not achieve 2050 goal**



Scenario results in context: comparison to SB 100 High Electrification scenario

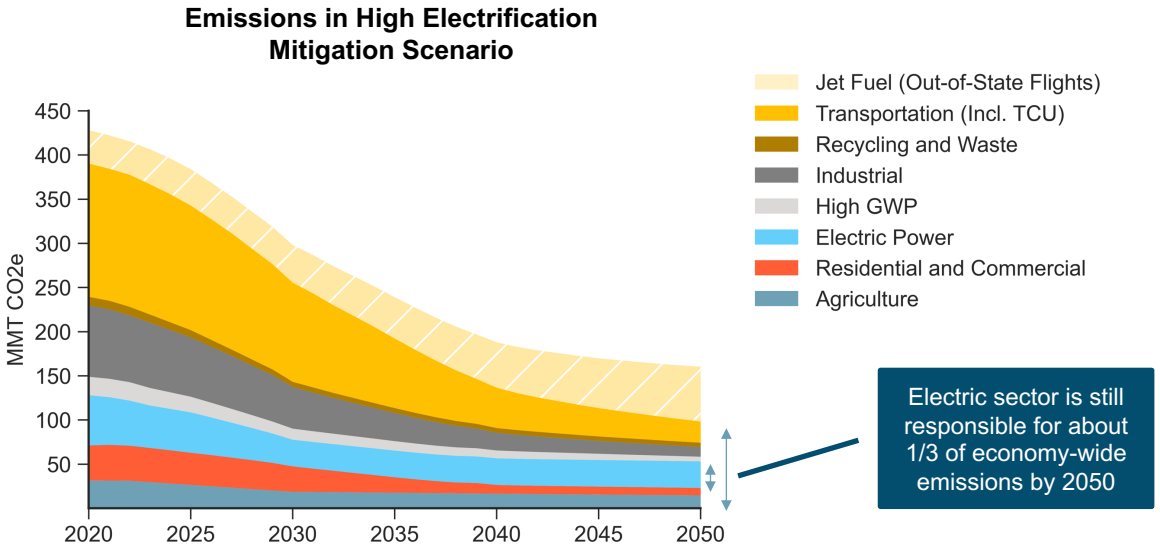
- Mitigation scenario in this work is similar to SB 100 High Electrification scenario, which is based on an E3 2018 PATHWAYS study
- Main difference is that SB 100 High Electrification scenario achieves deeper GHG reductions post-2030, particularly in Electric Generation
- Previous PATHWAYS scenarios also have not included jet fuel demand for out-of-state flights

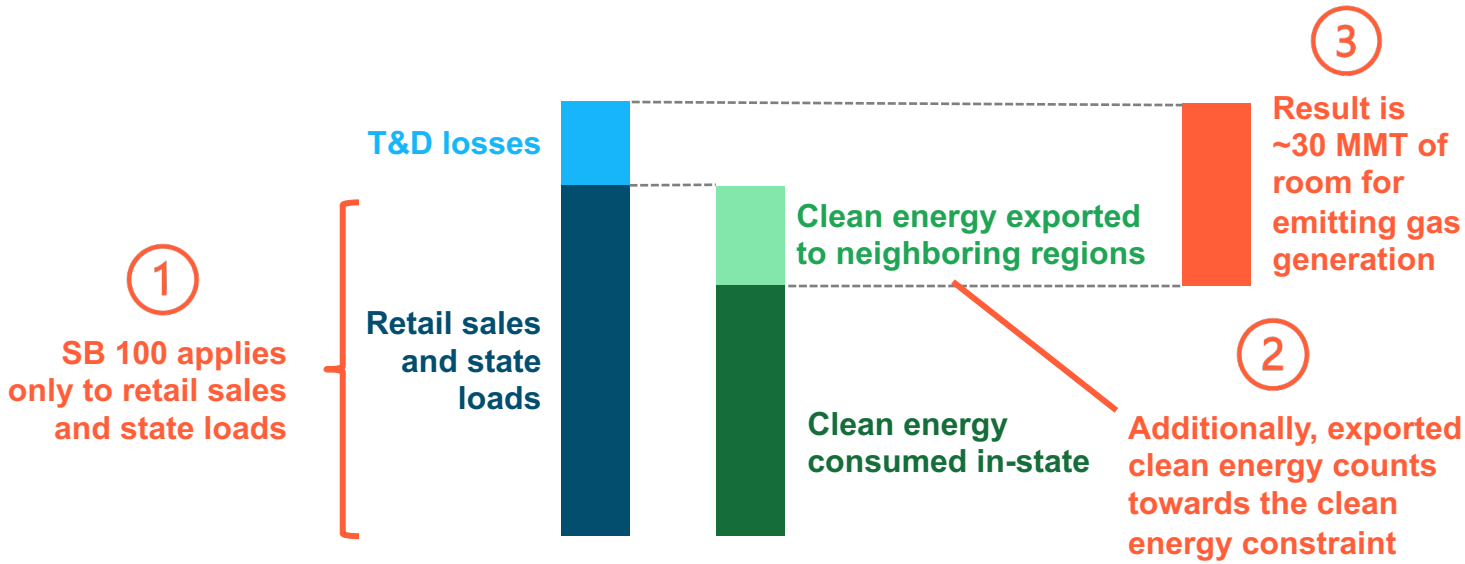




How does electric sector emissions accounting work under SB 100?

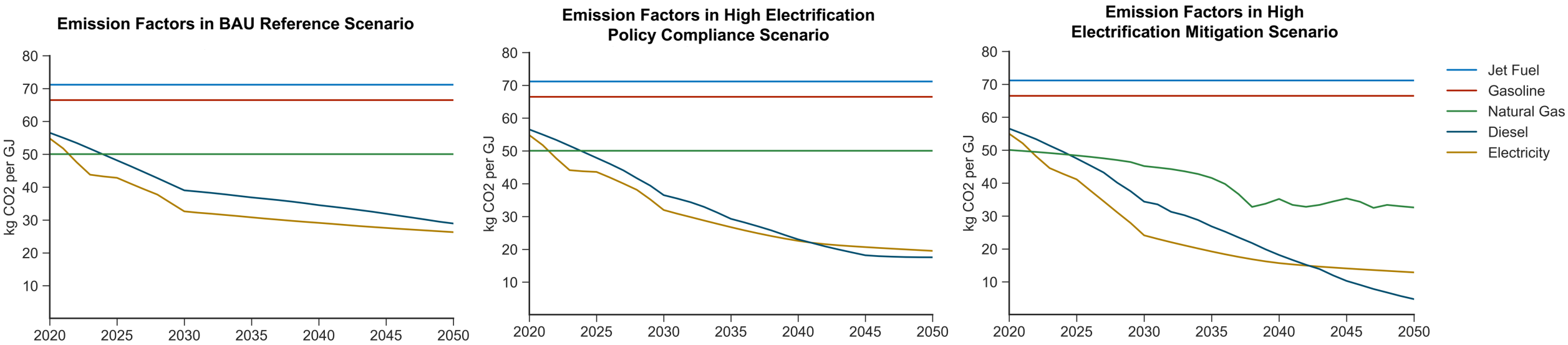
- **In mitigation scenario, despite SB 100 constraint for 100% clean energy, electric sector emissions still represent about one third of remaining economy-wide emissions by 2050**
- **This is happening for two primary reasons:**
  1. SB 100 stipulates that 100% of **retail sales and state load**, not total load, should be served by clean energy. This means that, since the accounting is done on an annual basis, emitting generation can be used to "cover" transmission and distribution losses.
  2. Clean energy that is **exported** counts towards SB 100. These exports reduce GHGs in neighboring regions but do not reduce GHGs in CA.





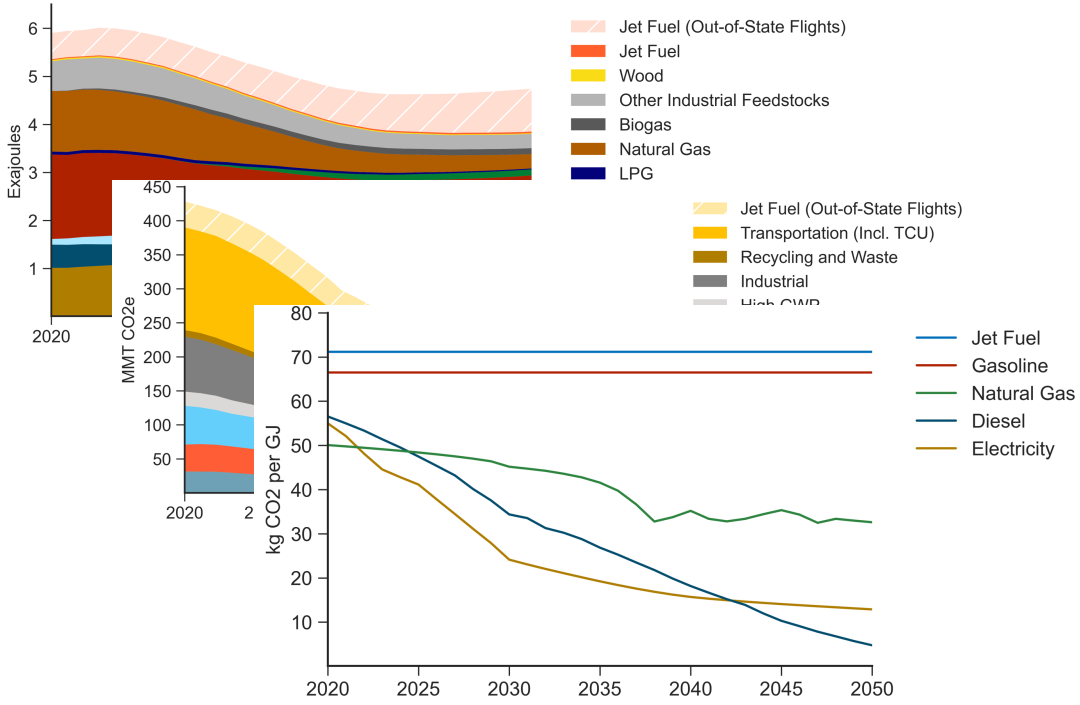
Scenario results: emission factors

- Emission factors for diesel and electricity decline in all scenarios due to renewable fuels and electricity, but especially so in mitigation scenario
- Natural gas emission factor also declines in mitigation scenario, due to addition of renewable natural gas
- Note these are direct emissions, as measured by CARB GHG inventory, and not lifecycle emissions



Key takeaways

- Reference scenario shows that current policies are insufficient to take us to our GHG goals
- Policy compliance scenario shows that, even with expected new policies, we are still likely to fall short of our 2030 GHG goal
- Mitigation scenario shows the level of effort that would be necessary to reach our 2030 GHG goals– but even this scenario falls short of our 2050 goal



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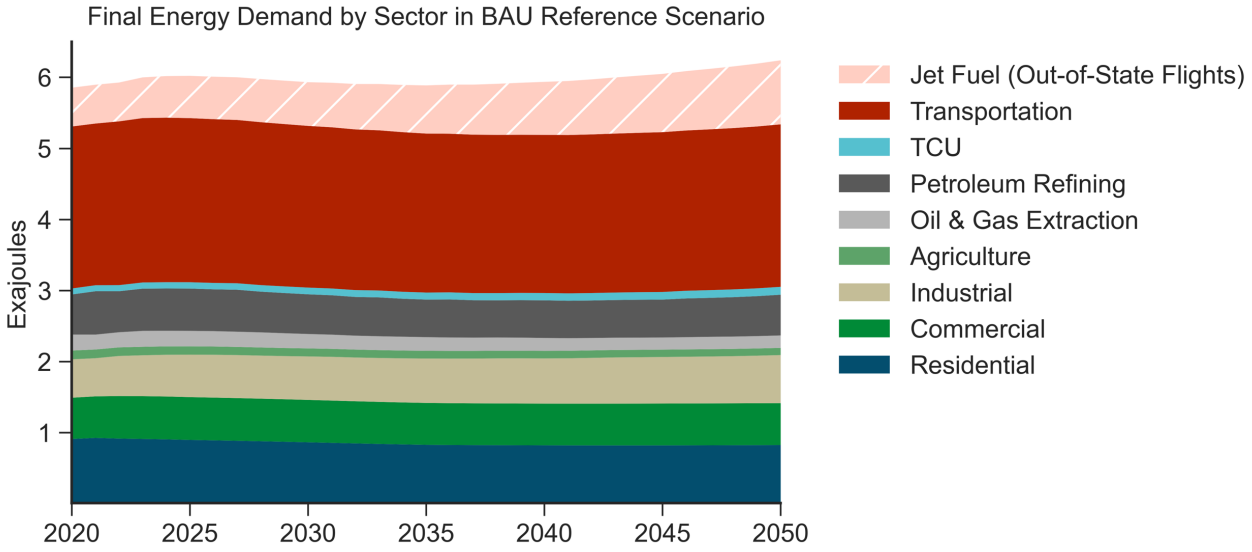
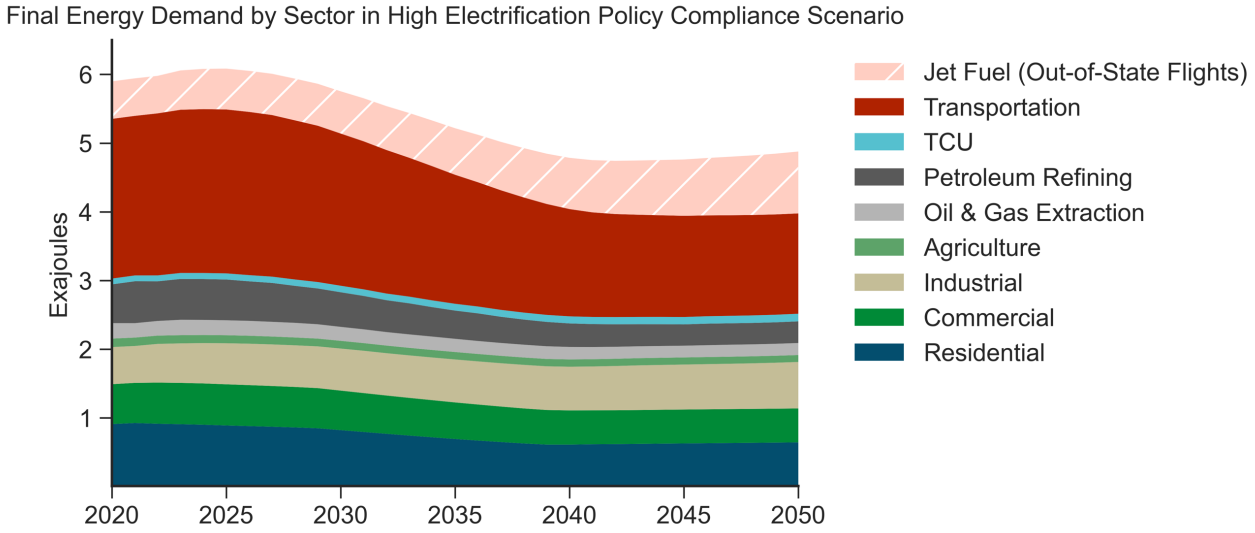
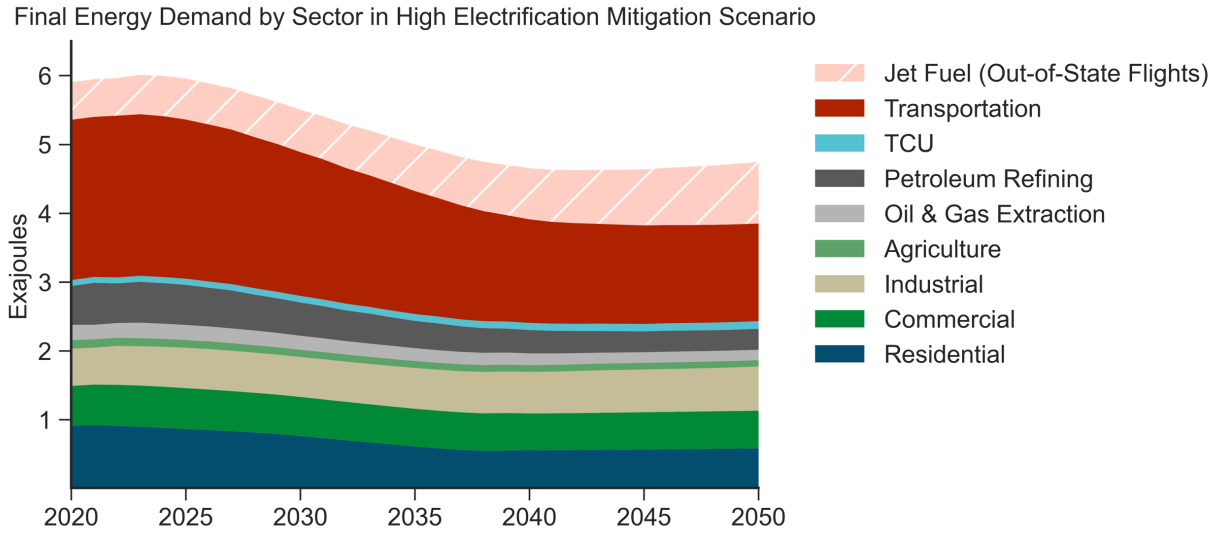
Appendix

Energy demand by sector







Emissions by economic sector