



ENERGY FUTURES GROUP

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Analysis of Buildings/ Thermal Energy Sector Emissions Reduction Policies for Vermont

Baseline Scenario Updates and Results

June 15, 2023



Today's Discussion

1. Presentation to Thermal Task Group and X-Sector Sub-committee on Updates and Results to LEAP model
2. Summary of major updates to Baseline scenario in model version 3.08
3. Selected input assumptions (with additional detail shown by request in model)
4. Focus on Building and Transportation Sector Updates Reflecting Inflation Reduction Act, and Advanced Clean Cars and Trucks
5. Aggregate results (emissions, energy consumption)

Baseline Update Objectives

1. Latest adoption levels – information from EEU’s and other sources
2. Consider impacts of new policies and programs
 - Federal Inflation Reduction Act
 - Federal Infrastructure and Jobs Act
 - Vermont Weatherization Act 185
 - Multi-State Advanced Clean Cars II adoption
 - Multi-State Advanced Clean Trucks
3. Major changes in economic/demographic drivers
4. Fuel prices, calibration, and model streamlining

Residential Sector Change Log

Reduce cost of single-headed residential mini-split heat pumps to 2/3 that of double-headed units	Increased share of household heating needs met by advanced pellet boilers to meet all of a home's heating requirements
Ensure that costs of wood stoves, pellet stoves and pellet boilers aligns with Tier III planning tool: Residential Wood Stoves - Measure cost \$3,319; Measure life = 18 years Residential Pellet stoves - Measure cost \$4,400; Measure life = 18 years Residential Pellet boilers or furnaces - Measure cost \$20,000; life = 20 years	Add air-to-water heat pumps (a new technology not in previous model) into baseline
Updated number of projected residential retrofits to include forecasts provided by EVT and OEO through 2030 and 2033, respectively, after which the annual number of retrofits is held constant. In addition, IRA-attributable retrofits from 2050-2030 are included.	Adjust wood and pellet stove penetrations to gradually increase to 0.25% of rural single family housing stock per year.
Update projected heat pump shares based on impacts of EVT rebate program and IRA. Heat pumps expected to meet 44% of existing household heating needs (16% in urban multi-family households) by 2050. In newly constructed homes, heat pumps to meet 85% of heating needs by 2050.	Add advanced pellet boilers into baseline (previously reserved only for mitigation scenario), distributing 100 units/year among single- and multi-family homes.
Update projected heat pump shares based on impacts of EVT rebate program and IRA. Heat pumps expected to meet 44% of existing household heating needs (16% in urban multi-family households) by 2050. In newly constructed homes, heat pumps to meet 85% of heating needs by 2050.	In rural single-family homes only, additional wood and pellet stoves are added, eventually converting 0.25%/year (by 2030) to wood and pellet stoves. In addition, displacement rules for heat pumps were refactored so that heat pumps do not affect wood and pellet stoves in rural single-family homes.
Adjusted share of heating load met by single and double-headed heat pumps. Single headed heat pumps meet 30% of household heating needs, while double-head meet 55% (formerly 40% and 66%, respectively).	Incorporated historical retrofits completed in 2020 and 2021 from all weatherization programs.
Increased share of household heating needs met by central ducted heat pumps to meet all of a home's heating requirements	Updated historical space heating technology shares spanning all household types. Major changes included generally reducing heating provided by oil and propane furnaces in favor of oil and propane boilers, increasing the share of natural gas-heated homes, and updating shares of household heat supplied by heat pumps.
Update household number projection to align with change in total residential customer account forecasts through 2040, provided by Cadmus, mirroring those used for 2022 Energy Efficiency Potential Study. Values were converted to an multiplicative index relative to 2019, and then applied to previously-estimated 2019 statewide commercial floorspace. After 2040, the index grows at the average annual growth rate calculated from index values 2030-2040. Overall, households grow from 340 thousand in 2020 to 348 thousand in 2050.	Updated historical water heating technology shares
Introduce heat pump water heaters in baseline, reaching 47% of water heating needs in single-family households by 2050.	Calibrate residential energy use, including energy consumption through 2019 from SEDS.

Transportation Sector Change Log

Include \$1,500 200A service panel upgrade costs for 70% of newly sold passenger car or light truck EVs.

Added Advanced Clean Cars II rule sales targets for passenger cars, previously only obeyed in mitigation scenario. Sales of model category "Passenger Cars" reach 100% EVs by 2035.

Added Advanced Clean Trucks rule for sales of vehicle classes 2b-3, 4-8 and 7-8, with intermediate sales targets inscribed in VT DEC's Advanced Clean Trucks Fact Sheet. Imperfect overlap of model categories with ACT rule categories means that sales of the entire model category "Light Trucks" reaches 90% ZEV by 2035, "Medium Duty" sales reach 75% ZEVs by 2035, and "Heavy Duty" sales reach 40% ZEVs by 2035. Vermont DEC.

Removed medium-duty PHEVs and FCVs from forecast

Calibrate transport energy use, including energy consumption through 2021 from SEDS.

Updated fleet-wide vehicle-miles travelled estimates using Office of Highway Policy Information VM-2 data for 2020 and 2021, recalibrating model's total VMT forecast.

Update current numbers of EVs and PHEVs on road at beginning of 2023

Cross Cutting, Commercial, and Industrial Change Log

Cross Cutting: Update fuel costs using AEO 2023

Updated the baseline scenario to include a biofuel blending target for heating oil in line with New York Senate Bill S3321A relating to bioheating fuel requirements (<https://www.nysenate.gov/legislation/bills/2021/s3321>). Heating oil consumed in the residential and commercial sectors now reaches 5% in 2022, 10% in 2025, and 20% in 2030 (all percentages measured by volume).

Commercial:

Update commercial floorspace projection to align with change in total commercial customer account forecasts through 2040, provided by Cadmus, mirroring those used for 2022 Energy Efficiency Potential Study. Values were converted to an multiplicative index relative to 2019, and then applied to previously-estimated 2019 statewide commercial floorspace. After 2040, the index grows at the average annual growth rate calculated from index values 2030-2040. Overall, floorspace grows from 139 million sqft in 2020 to 227 million sqft in 2050.

Change ASHP efficiency (reduce ASHP COP for the most efficient devices from 3.3 to 2.6)

Update number of projected heat pumps

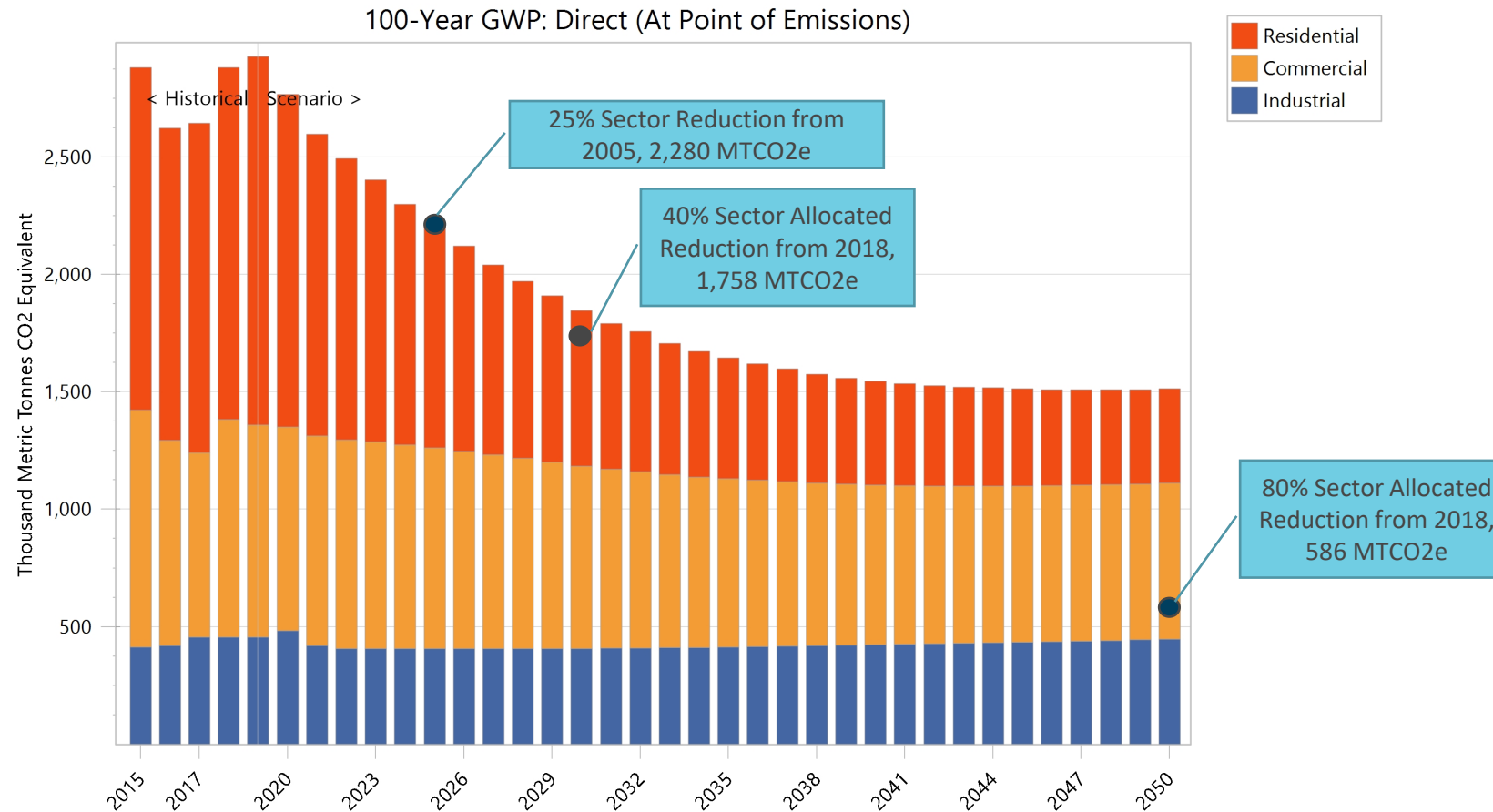
Update recent 2021 technology shares for space heating and lighting end-uses, based on 2021 Vermont Business Sector Market Characterization and Assessment Study

Calibrate commercial energy use, including energy consumption through 2021 from SEDS.

Industrial:

Calibrate industrial energy use, including energy consumption through 2021 from SEDS.

Revised Baseline Emissions Thermal Sector

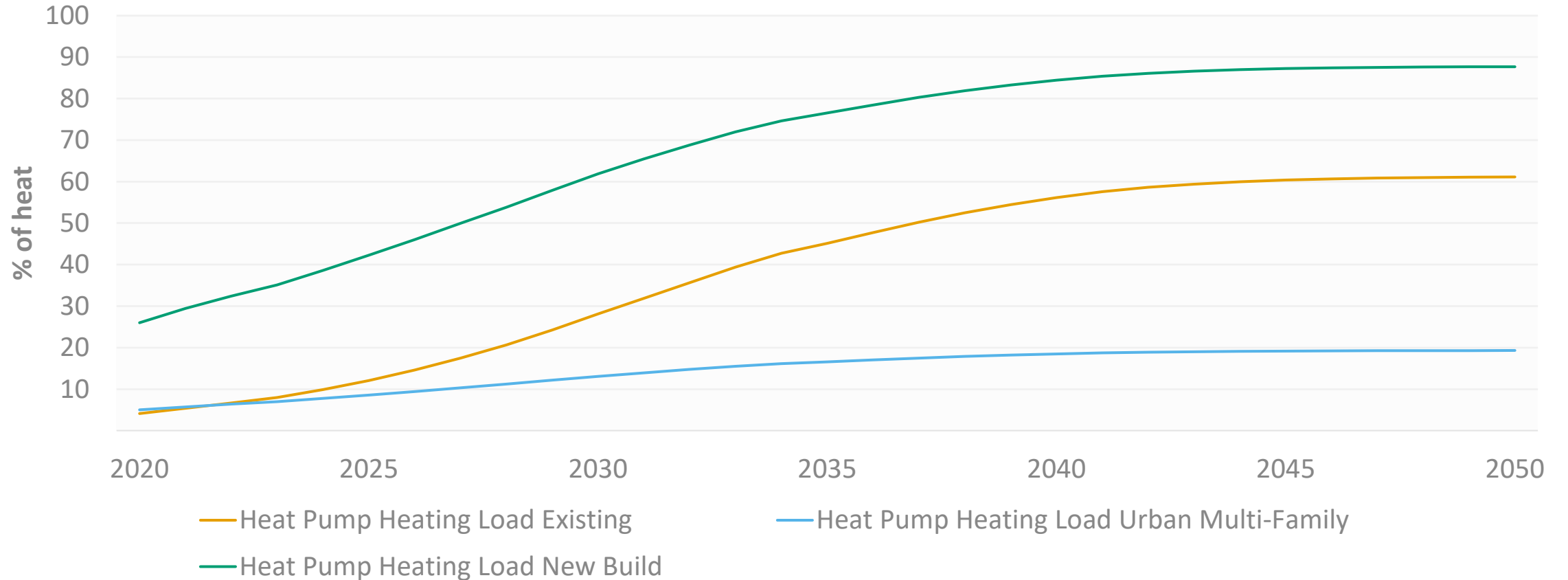


Revised Baseline Update Input: Heat Pump Forecast

- Incorporated EEU forecast of heat pumps pre-IRA
 - Based on EVT and BED Demand Resource Plans and recent market data
- Included heat pump projections as a result of IRA funding on top of this forecast (manufacturer estimate of 6% increase in estimated annual market activity)
- Single-head/double-head/central air-source heat pumps provide 25%/45%/100% of household heating needs, respectively

Revised Baseline Update Input: Heat Pump Forecast

Residential Heat Pump Load

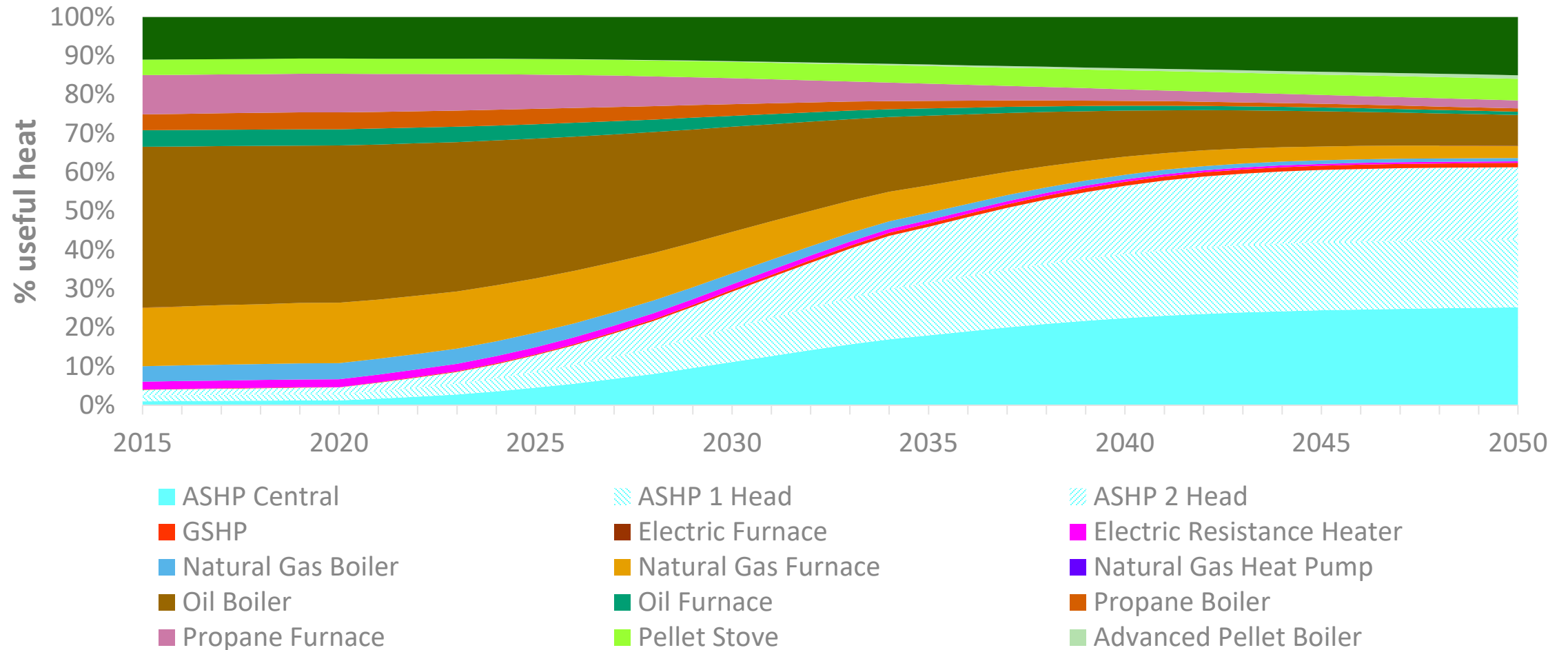


Revised Baseline Update Input: Wood and Pellet Stoves

- Small number of advanced pellet boilers introduced among single- and multi-family homes
- By 2030, 0.25% of rural single-family homes each year converted to wood or pellet stoves; heat pumps do not displace them

Revised Baseline Update Input: Wood and Pellet Stoves

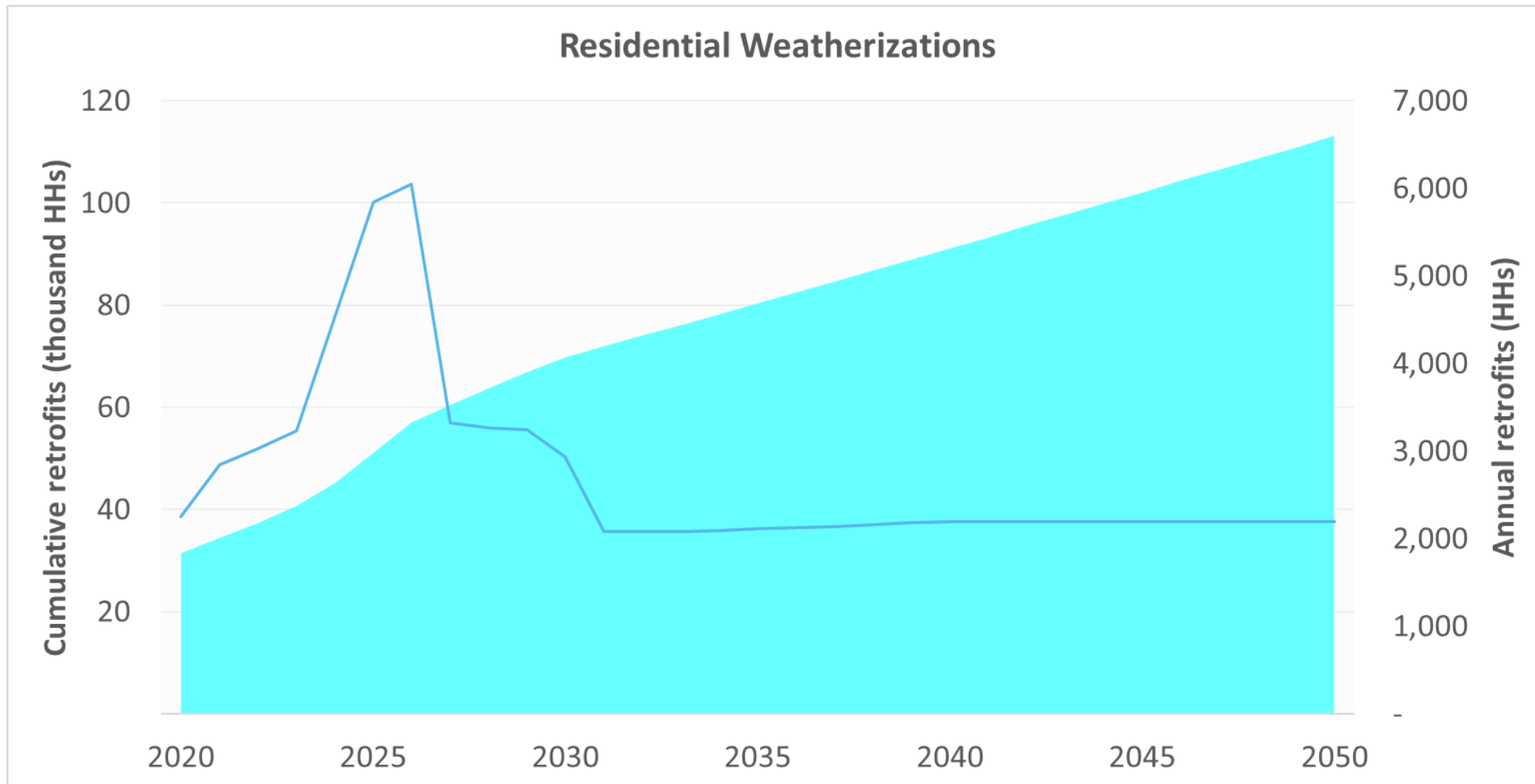
Rural Single-Family Detached Home Heating Technologies, BAU



Revised Baseline Update Input: Weatherization Forecast

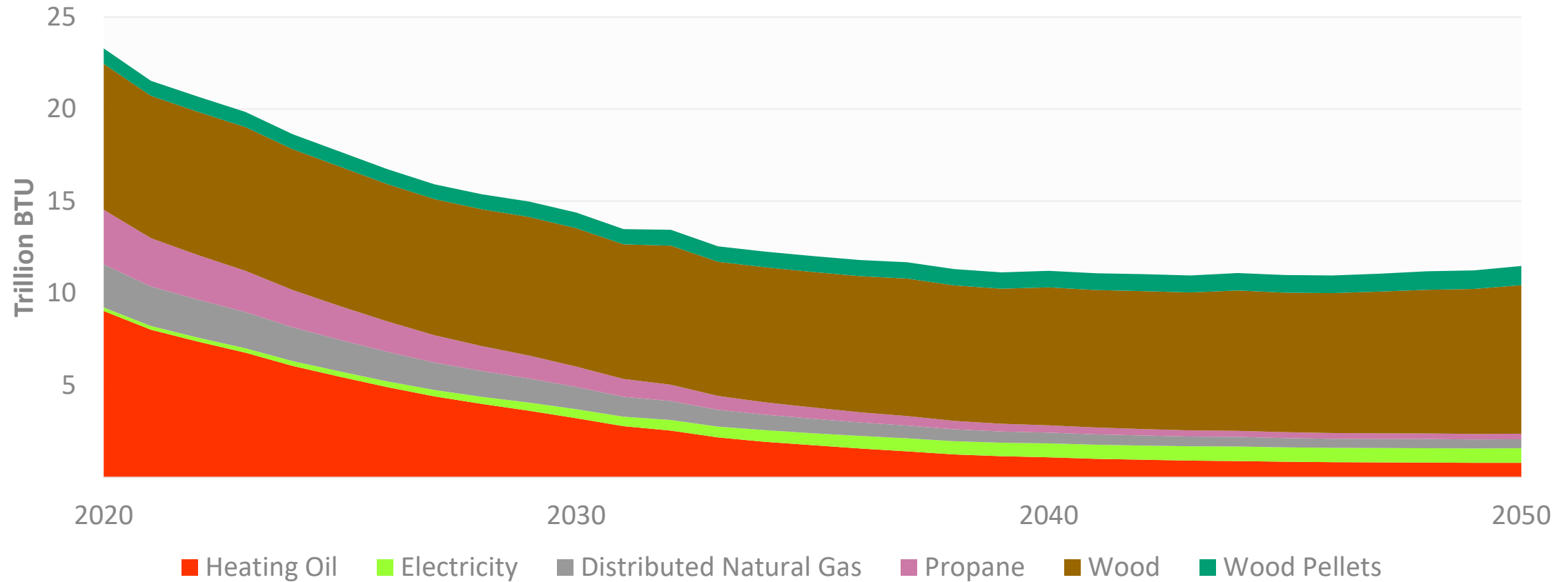
- Baseline annual retrofit forecasts from OEO (2023-2033), VEIC (2023-2030), and existing (from 2021) forecasts from VGS and BED
- Revision: Additional retrofits added as a result of IRA and Clean Heat Homes funding
 - \$30 million from HOMES program of the IRA and \$8.5 million from Clean Heat Homes
 - Translated this into number of retrofits based on average cost of retrofit
 - Adds 3,286 single-family, 1,486 multi-family retrofits 2025-2030
- Following forecasts, annual retrofits held constant through 2050

Revised Baseline Update Input: Weatherization Forecast



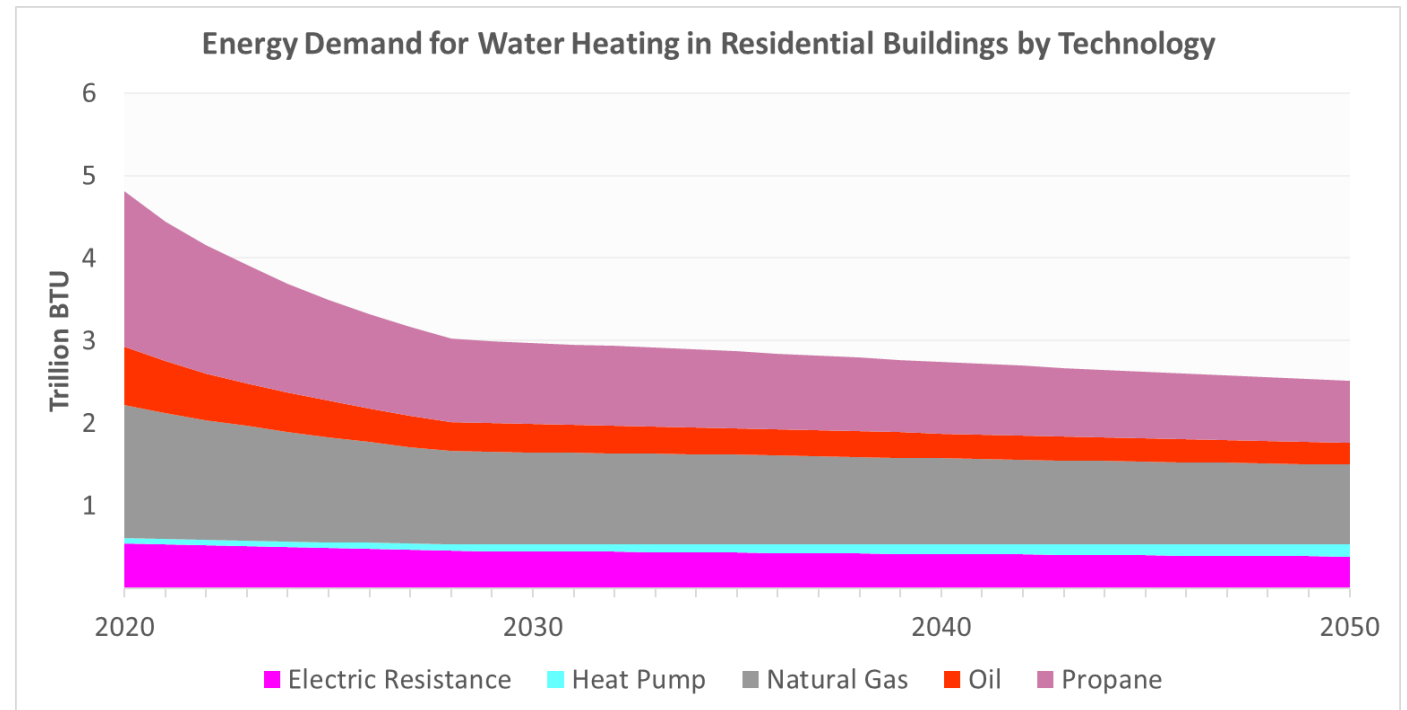
Revised Baseline Update Input: Residential Heating Fuels

Energy Demand for Space Heating in Residential Buildings by Fuel



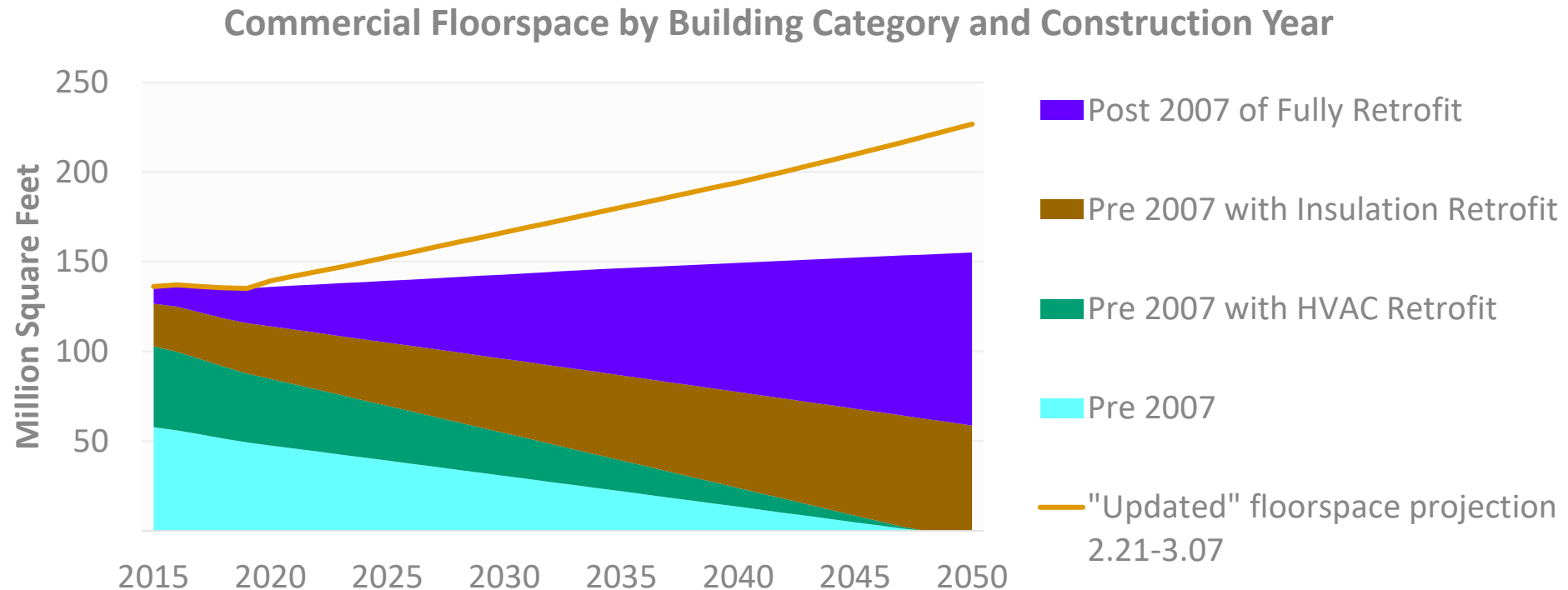
Revised Baseline Update Input: Residential Water Heating

- By 2050, nearly 50% of single-family water heating is provided through heat pumps
- Outside of single-family households, technology mix remains constant
- Fossil water heating efficiency increases



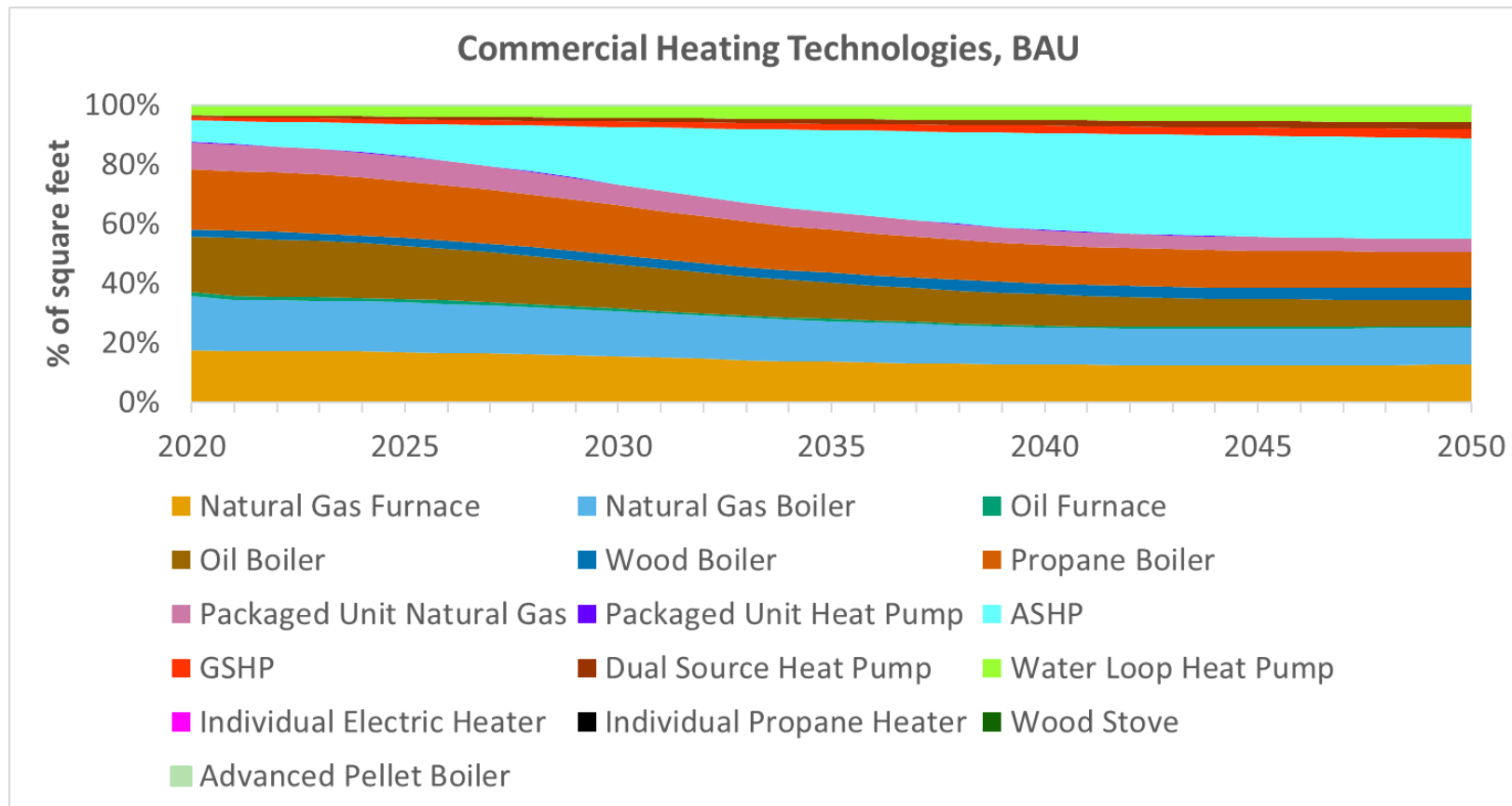
Revised Baseline Update Input: Commercial Floor Space

- After indexing to forecasted number of customer accounts through 2040 (used in 2022 Energy Efficiency Study), commercial floor space reverted to floor space projection in the original CAP analysis.

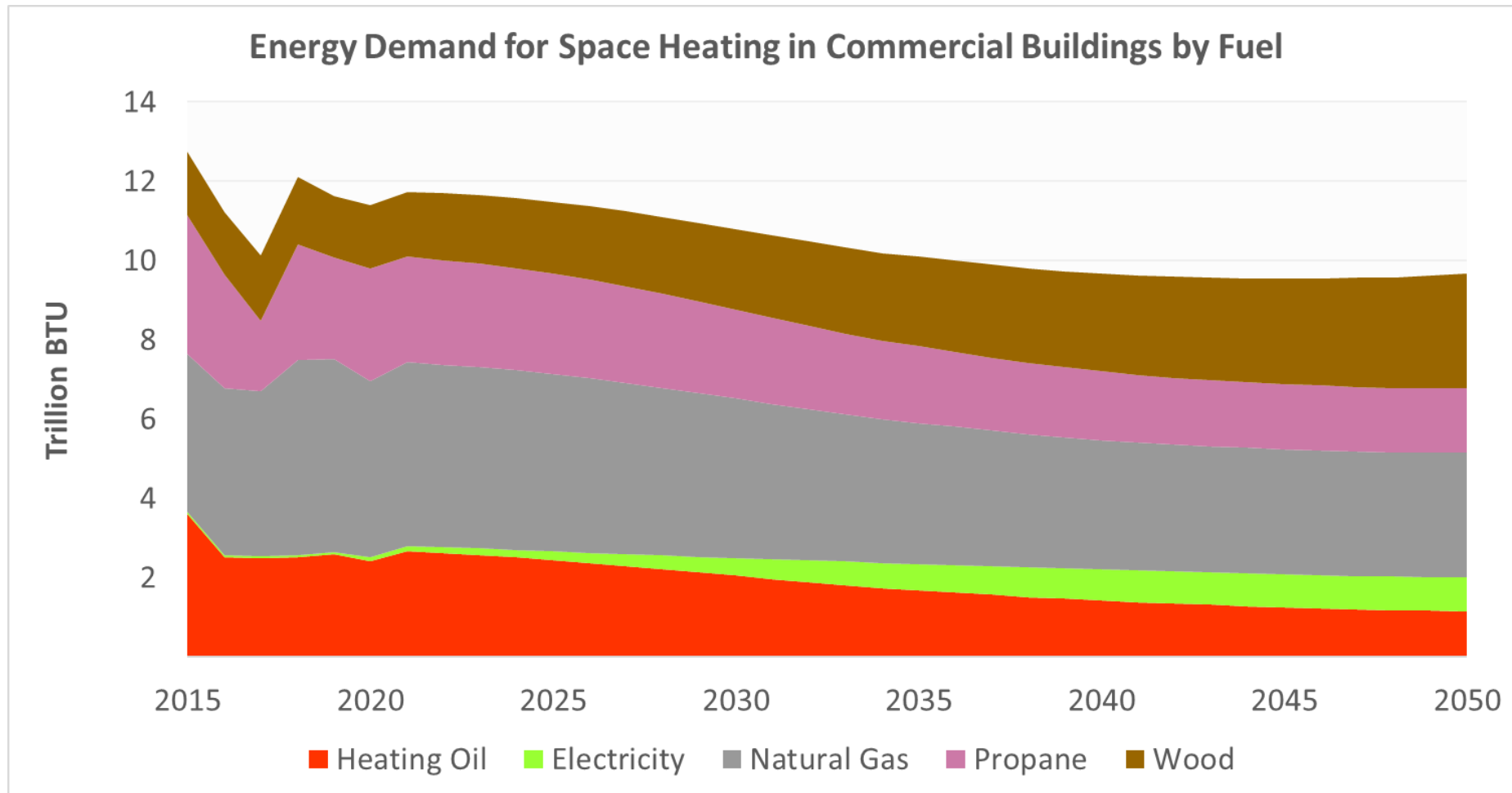


Revised Baseline Update Input: Commercial Heat Pump Forecast

- Commercial heat pump forecast tied to residential forecast, preserving same (90%R/10%C) relationship as earlier CAP work



Revised Baseline Update Input: Commercial Heating Fuels



Revised Baseline Update Input: Road Transport

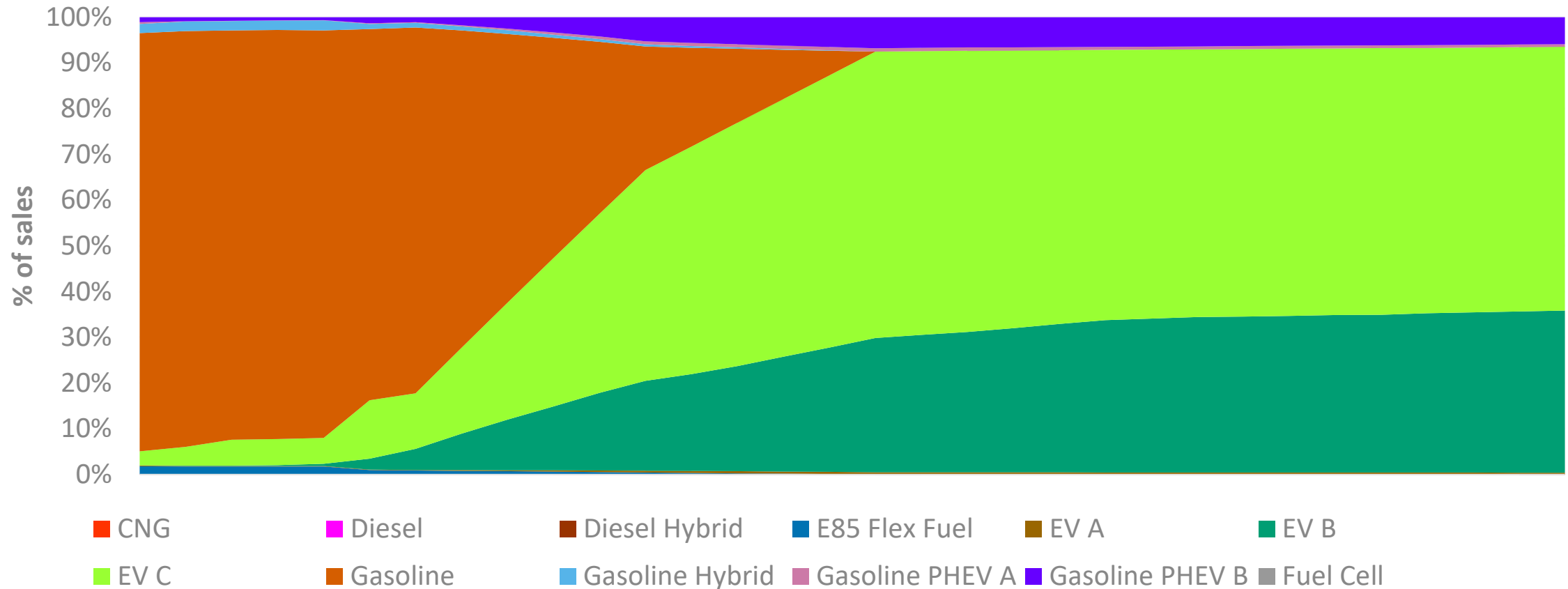
- ACCII for Passenger Cars (100% sales BEVs and PHEVs by 2035)
- ACCII/ACT for Light Trucks (90% sales BEVs and PHEVs by 2035)
- ACT for Medium-Duty Vehicles (75% sales BEVs by 2035)
- ACT for Heavy-Duty Vehicles (40% sales BEVs by 2035)

Additional modifications discussed, but not included to date:

- Limit PHEVs to be no more than 20% of all light-duty EV sales, using newly-created 70-mile range PHEV
- Migrate all heavy-duty PHEVs to a newly created BEV technology
- Limit heavy-duty fuel cell vehicle sales to 10% of total

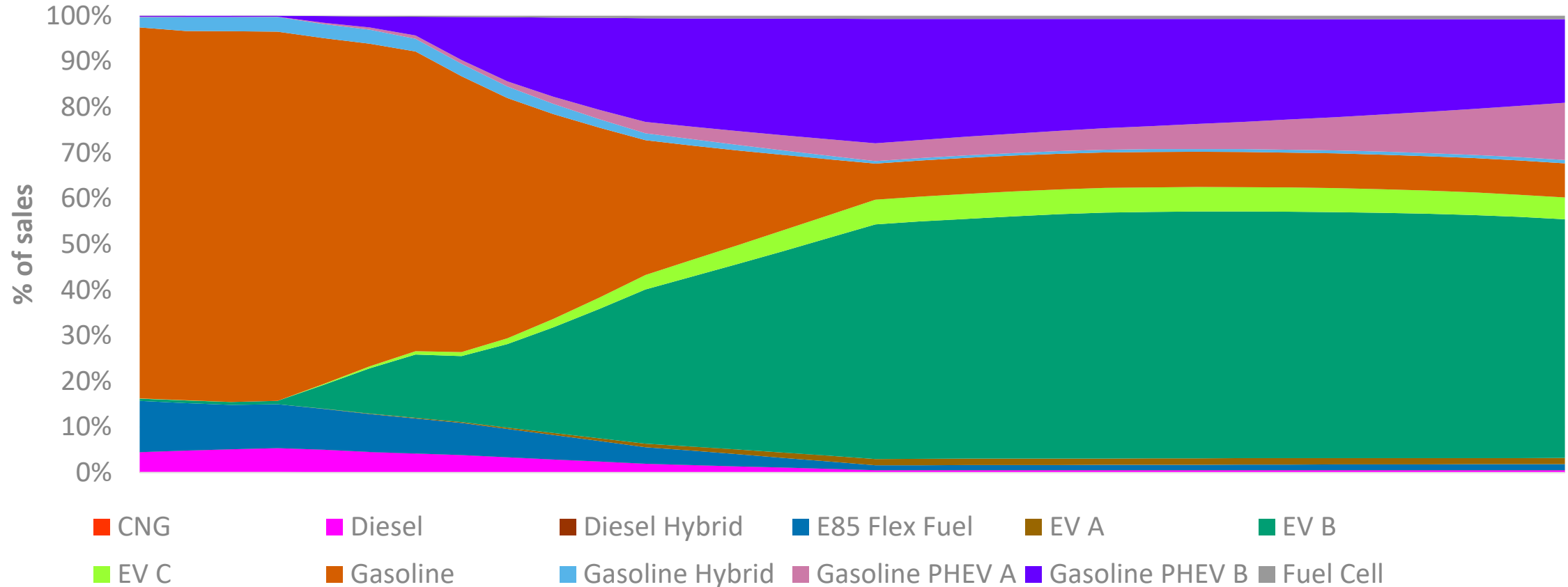
Revised Baseline Update Input: Road Transport

Passenger Car Sales Shares by Technology



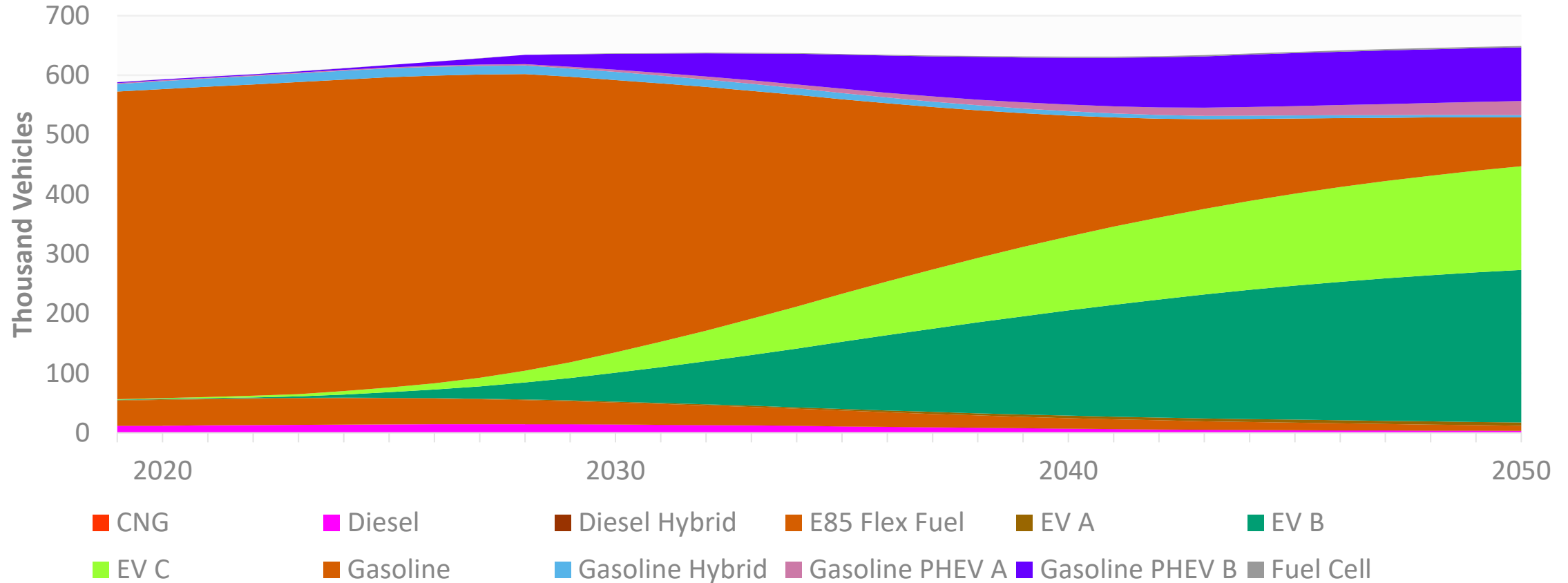
Revised Baseline Update Input: Road Transport

Light Truck Sales Shares by Technology



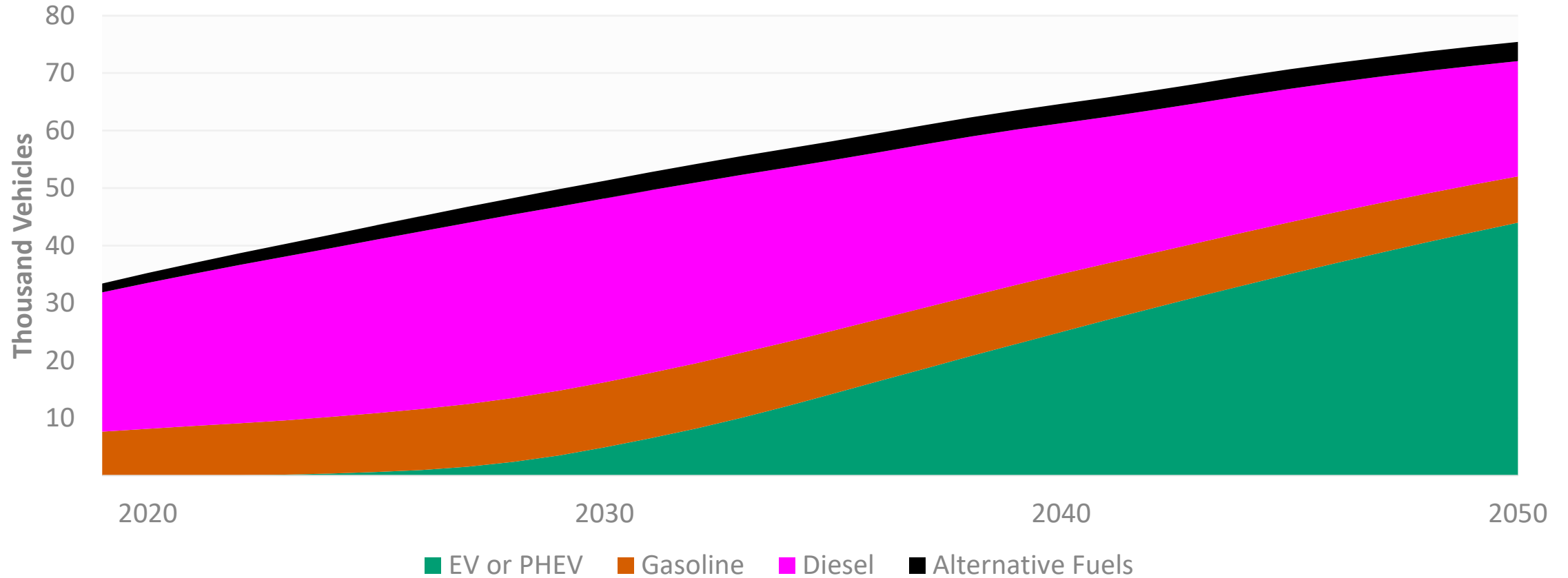
Revised Baseline Update Input: Road Transport

LDVs by Technology, BAU

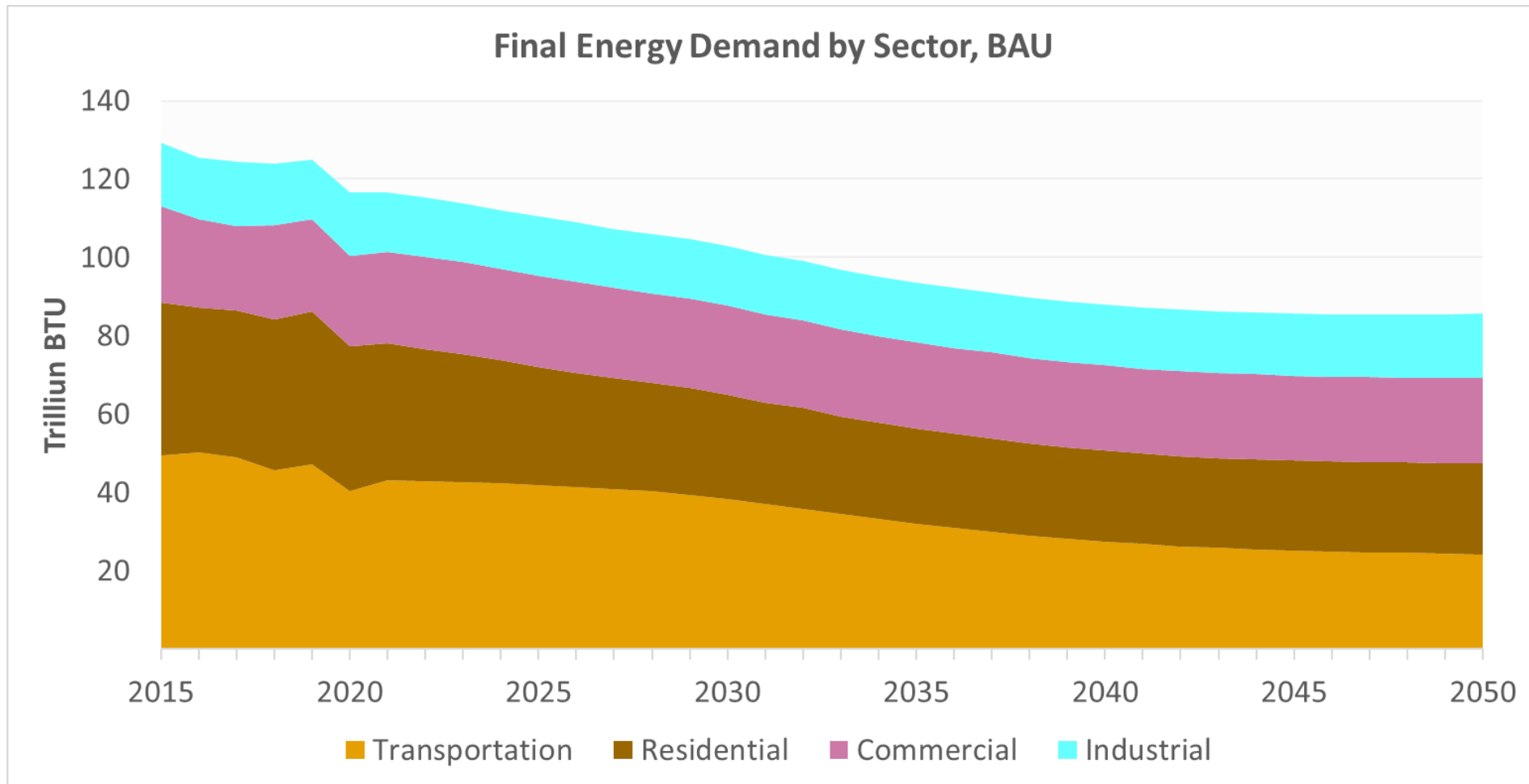


Revised Baseline Update Input: Road Transport

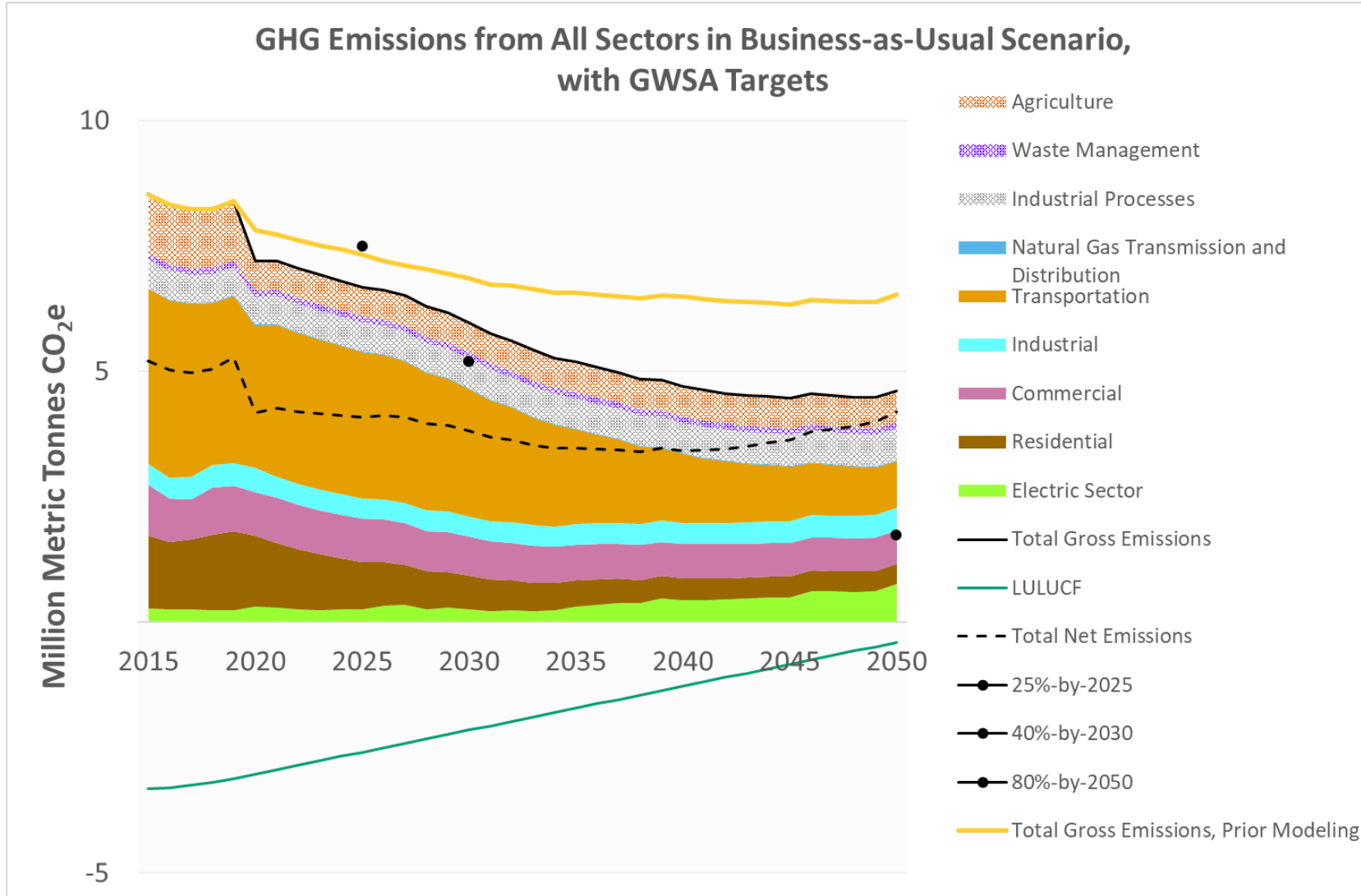
MDV/HDVs by Technology, BAU



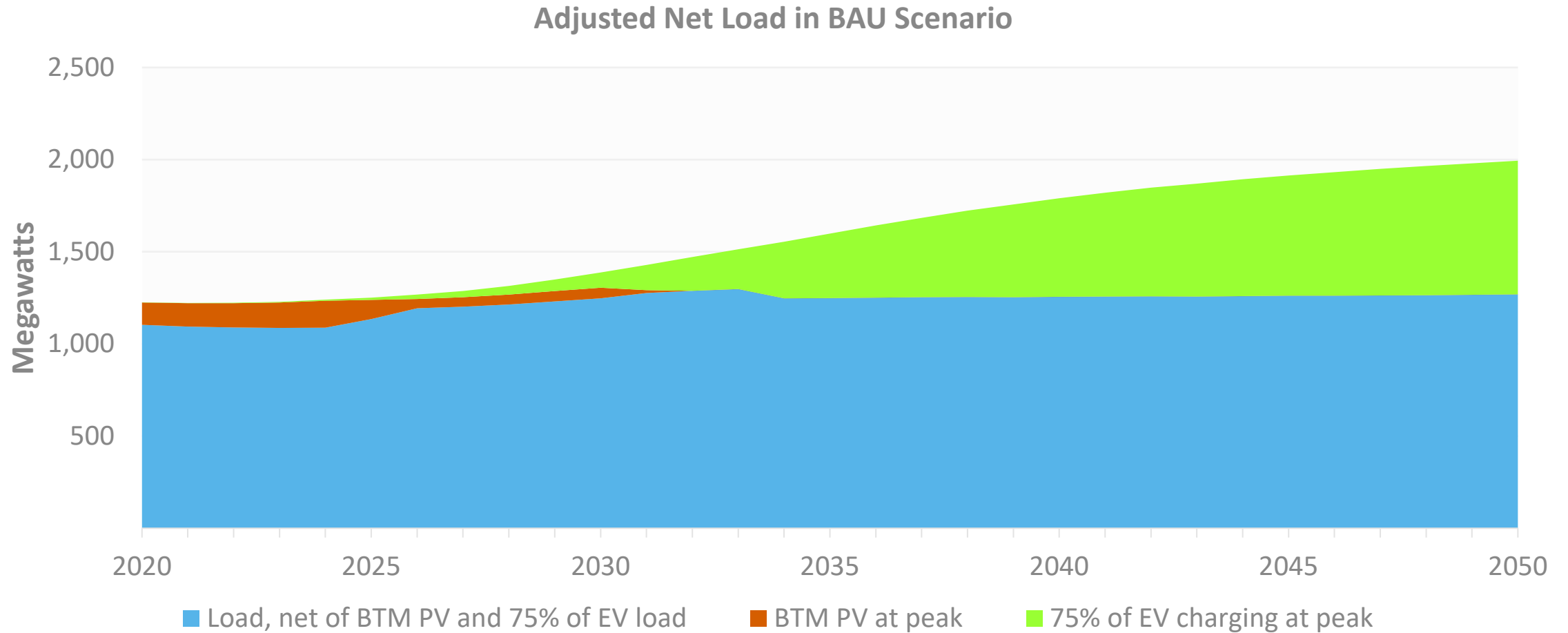
Revised Baseline Update Results



Revised Baseline Update GHG Results



Revised Baseline Update Results





Questions and Discussion

