DEMAND ANALYSIS WORKING GROUP (DAWG)

Draft Results: AAEE & AAFS 2024 IEPR Update

October 21, 2024

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Acronyms and Initialisms

AAEE – Additional Achievable Energy Efficiency
AAFS – Additional Achievable Fuel Substitution
AC – Air Conditioner
AQMD – Air Quality Management Districts
Btu – British Thermal Unit
CARB – California Air Resources Board
CEC – California Energy Commission
CED/CEDF – California Energy Demand Forecast
Comm. – Commercial Sector
DAWG – Demand Analysis Working Group
FSSAT – Fuel Substitution Scenario Analysis Tool
FSSAT-ZEAS AAFS - FSSAT-ZEAS modeling
GT – Gradual Transformation (scenario)
IEPR – Integrated Energy Policy Report
LI – Low Income
MF - Multifamily
MM – Million
NC – New Construction
NOx – Nitrogen Oxides
Prog. AAEE - Programmatic AAEE
Prog. AAFS – Programmatic AAFS
Regs – Regulation
Res. – Residential Sector
RASS – Residential Appliance Saturation Study
ROB – Replace on Burnout
SF – Single Family
UEC – Unit Energy Consumption
ZEAS – Zero-Emission Appliance Standards

Presentation Outline

1. Recap of AAFS and AAEE Scenario Inputs and Assumptions
2. Draft AAEE/AAFS Results
    1. Annual energy impacts, including increased electric A/C loads
    2. Electric appliance stock projections
    3. Hourly impacts

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Recap of AAFS and AAEE Scenario Inputs and Assumptions

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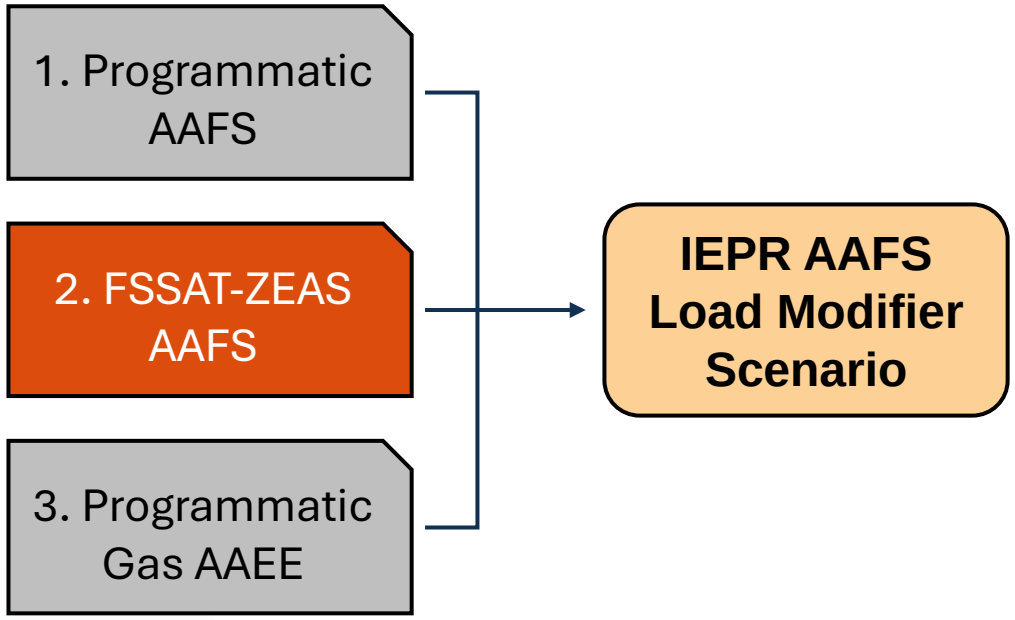
CEC's AAEE-AAFS Nomenclature:

- FSSAT creates IEPR AAFS Load Modifier Scenarios using different input scenarios
  1. Programmatic AAFS
  2. **FSSAT-ZEAS AAFS**
  3. Programmatic gas AAEE
- Must run FSSAT instead of plug-and-play different scenarios (ingredients)
- Programmatic AAEE **does not** imply "efficient electrification"
- The 2024 IEPR Update only updates the **FSSAT-ZEAS AAFS** scenario



RECAP: CARB's updated ZEAS compliance schedule (Board vote expected in 2025)

Effective Date	Equipment Type	Capacity/Size Limits
2027	Boilers and water heaters	< 75,000 Btu/hr
2029	~~Central~~ Furnaces	< 175,000 Btu/hr
2029	Boilers and water heaters	≤ 400,000 Btu/hr
2029	Instantaneous water heaters	≤ 200,000 Btu/hr
2029 ~~TBD~~	~~Central~~ Furnaces	≤ 2MM Btu/hr
2031	Boilers and water heaters	≤ 2MM Btu/hr
2031	Instantaneous water heaters	≤ 2MM Btu/hr
2031	Pool heaters	≤ ~~400,000~~ 2MM Btu/hr
2033	High temperature (>180°F) boilers and water heaters	≤ 2MM Btu/hr

CARB

Source: CARB Public Workshop on Zero-Emission Space and Water Heater Standards (May 29, 2024; Slide 13)

Summary of Draft 2024 AAFS Scenarios

AAFS Scenario	Programmatic Scenarios	FSSAT/ Statewide	FSSAT / Local AQMDs Zero-NOx Regulations
AAFS 2	AAFS 2 AAEE 2	Gradual Transformation	Bay Area AQMD Rules 9-4 & 9-6 South Coast AQMD Rule 1146.2
AAFS 3 (Planning Scenario)	AAFS 3 AAEE 3	CARB ZEAS	Bay Area AQMD Rules 9-4 & 9-6 South Coast AQMD Rule 1146.2
AAFS 4 (Local Reliability Scenario)	AAFS 4 AAEE 2	CARB ZEAS	Bay Area AQMD Rules 9-4 & 9-6 South Coast AQMD Rule 1146.2 *South Coast AQMD Rules 1111 & 1121*

- Updates to three AAFS scenarios
  - 2023 Programmatic AAEE/AAFS Impacts (not updated)
  - AAFS 2 includes a gradual transformation statewide ZE adoption
  - AAFS 3 & 4 include CARB ZEAS with a staggered statewide compliance schedule
- Simplified assumptions for ZEAS and zero-NOx regulations to fit FSSAT
  - Many regulations varied by the appliance's heat capacity size
  - Public Hearing for South Coast AQMD's amendments to Rules 1111 and 1121 expected December 6, 2024

Statewide AAFS Characterization

Programmatic Scenario	AAFS 2	Planning Forecast (AAFS 3)	Local Reliability (AAFS 4)
Programmatic AAFS	Scenario 2 (2023 IEPR)	Scenario 3 (2023 IEPR)	Scenario 4 (2023 IEPR)
Programmatic AAEE	Scenario 2 (2023 IEPR)	Scenario 3 (2023 IEPR)	Scenario 2 (2023 IEPR)

Scenario(s)	Replacement Type	Sector	End Use	Interpreted FSSAT Scenario Description
AAFS 2, 3, 4	NC	Res/Comm	Space and Water Heating	100% adoption beginning in **2029**
AAFS 2 (Gradual Transformation)	ROB	Res/Comm	Space and Water Heating	A 6.67% linear annual growth adoption rate reaching 100% in 2040
AAFS 3, 4 (CARB ZEAS)	ROB	Res/Comm	Space Heating	Ramp up to a **2029** compliance date
AAFS 3, 4 (CARB ZEAS)	ROB	Res	Water Heating	Ramp up to a **2027** compliance date
AAFS 3, 4 (CARB ZEAS)	ROB	Comm	Water Heating	Ramp up to a **2031** Compliance Date

AAFS CARB FSSAT-ZEAS ROB Adoption Rates Comparisons (2023 IEPR versus 2024 IEPR)

IEPR	Scenario(s)	End use	2024-2025	2026	2027	2028	2029	2030	2031-2040
2023*	AAFS 3 (Initial CARB ZEAS)	Res/Comm Space and Water Heating	0%	10%	30%	50%	70%	**100%**	100%
2023*	AAFS 4 (Initial CARB ZEAS)	Res/Comm Space and Water Heating	0%	20%	40%	60%	80%	**100%**	100%
2024^	AAFS 3 & AAFS 4 (Updated CARB ZEAS)	Res/Comm Space Heating	0%	**25%**	**50%**	**75%**	**100%**	100%	100%
2024^	AAFS 3 & AAFS 4 (Updated CARB ZEAS)	Residential Water Heating	0%	**50%**	**100%**	**100%**	**100%**	100%	100%
2024^	AAFS 3 & AAFS 4 (Updated CARB ZEAS)	Commercial Water Heating	0%	16.7%	33.3%	50%	66.7%	83.3%	**100%**

* The initial CARB ZEAS proposal used in the 2023 IEPR had a 2030 compliance date.
^ These are CEC staff's FSSAT-interpreted modeling assumptions. See Slide 6 for CARB's updated ZEAS compliance schedule.

AAFS Characterization of Local Zero-NOx Standards

Measure^ (✓ – included in scenario)	Amendments Adoption Date	Zero-NOx Standard Compliance Date and CEC-Interpreted FSSAT Impacted Sector	AAFS 2	Planning Scenario (AAFS 3)	Local Reliability (AAFS 4)
Statewide characterization		*See slide 12 for proposed ZEAS and electrification adoption schedule*	GT AAFS	CARB ZEAS	CARB ZEAS
Bay Area AQMD (Rule 9-4)	3/15/2023	**2029**: NC/ROB Res. & Comm. Space Heating	✓	✓ *	✓ *
Bay Area AQMD (Rule 9-6)	3/15/2023	**2027**: NC/ROB Res. Water Heating; **2031**: ROB Comm. Water Heating	✓	✓ *	✓ *
South Coast AQMD (Rule 1146.2)	6/7/2024	**2028:** NC Comm. Water Heating; **2031**: ROB Comm. Water Heating	✓	✓	✓
South Coast AQMD (Rule 1111)	**Expected:** 12/6/2024	**2026:** NC Res. and Comm. Space Heating; **2028**: ROB Res. and Comm. Space Heating			✓
South Coast AQMD (Rule 1121)	**Expected:** 12/6/2024	**2026:** NC Res. Water Heating **2027**: ROB Res. Water Heating			✓

* Indicates non-binding for a given scenario (i.e., CARB's ZEAS aligns with local zero-NOx standard).

^ Please see links for regulations specifics such as sector, compliance dates, appliance energy capacity, etc.

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2024 IEPR Update: AAFS Annual and Hourly Draft Results

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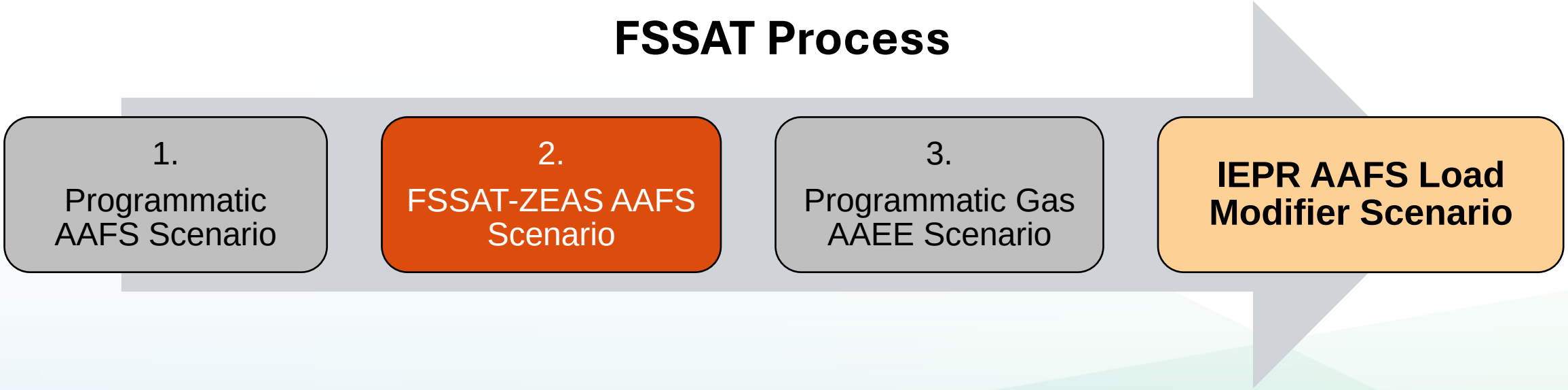
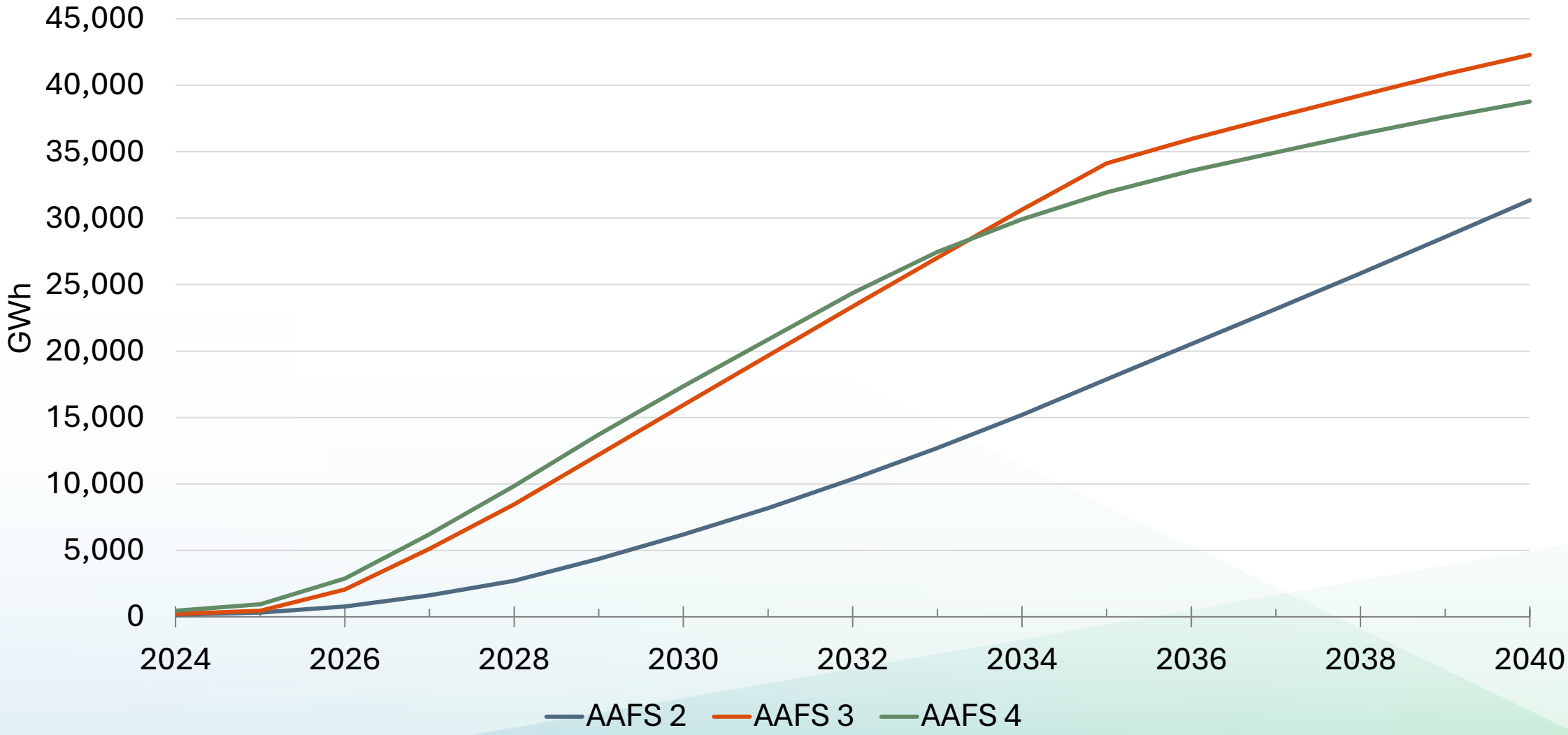
AAEE and AAFS Load Modifiers Characterization

- Naming conventions for AAEE and AAFS load modifiers:
  1. Programmatic AAFS impacts – **Prog. AAFS**
  2. FSSAT-ZEAS modeling impacts – **FSSAT-ZEAS AAFS**
  3. Programmatic AAEE impacts – **Prog. AAEE**



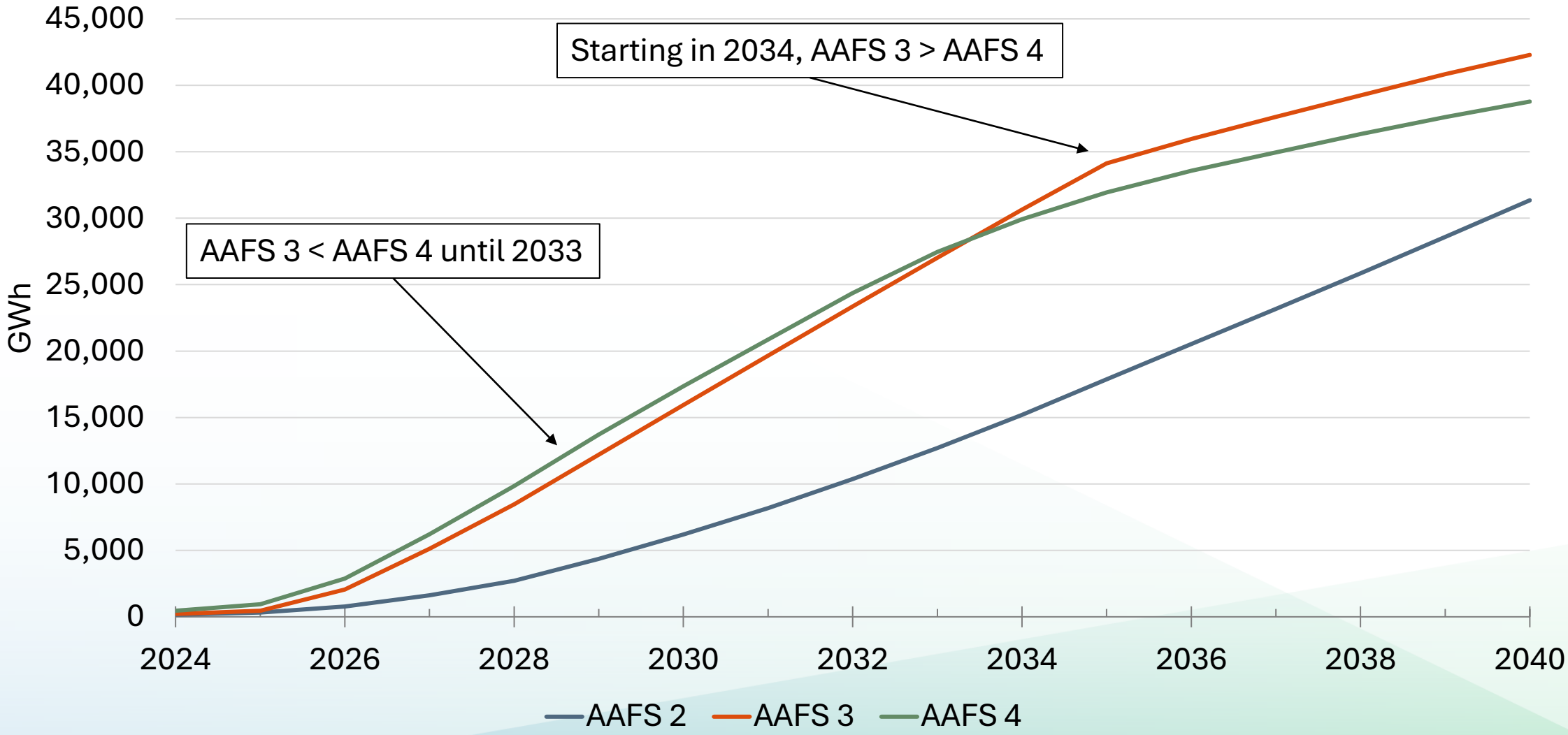
Electricity Impact Results

Added Electric Demand for AAFS 2-4 - 2024 IEPR Update



Source: CEC Staff

Added Electric Demand for AAFS 2-4 - 2024 IEPR Update (Highlights)



Source: CEC Staff

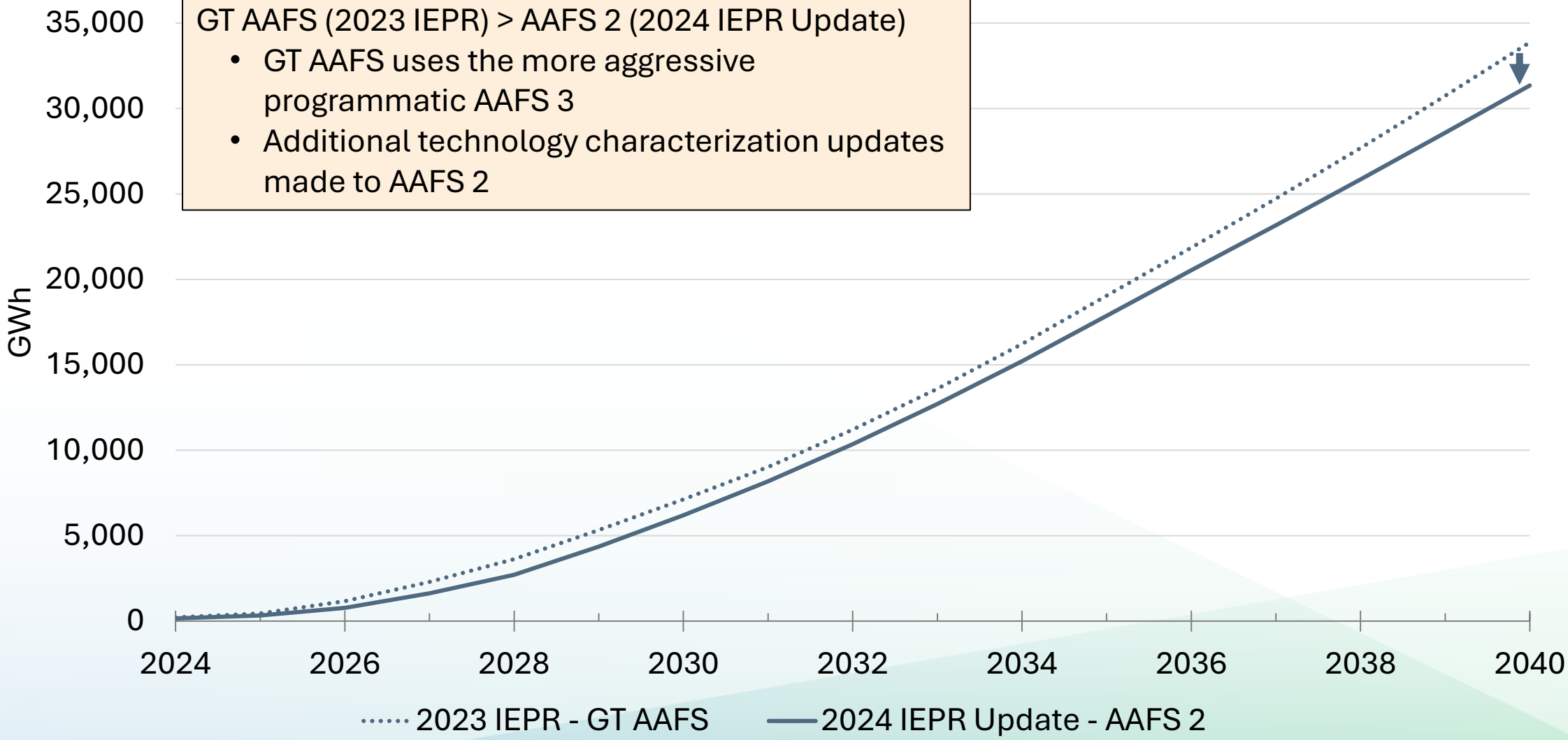
Why are AAFS 4 Impacts Lower than AAFS 3?

#	Reasons	FSSAT model accounting
1	More aggressive programmatic AAFS scenario savings leave less gas eligible for fuel substitution in FSSAT	FSSAT accounts for programmatic AAFS savings impacts before calculating technology-based fuel substitution
2	FSSAT-ZEAS AAFS scenarios allow for the adoption of less-efficient appliances (i.e., electric resistance) in FSSAT	A wide range of electric technologies are available for FSSAT modeling, while programmatic AAFS assumes the most efficient appliances
3	Savings decay is more apparent in programmatic AAFS 4, which is most noticeable after 2033	All programmatic AAFS results include decay. Decay is removed in our FSSAT accounting to avoid double counting.

Added Electric Demand for AAFS 2 vs GT AAFS - Forecast Vintage Comparison

GT AAFS (2023 IEPR) > AAFS 2 (2024 IEPR Update)

- GT AAFS uses the more aggressive programmatic AAFS 3
- Additional technology characterization updates made to AAFS 2

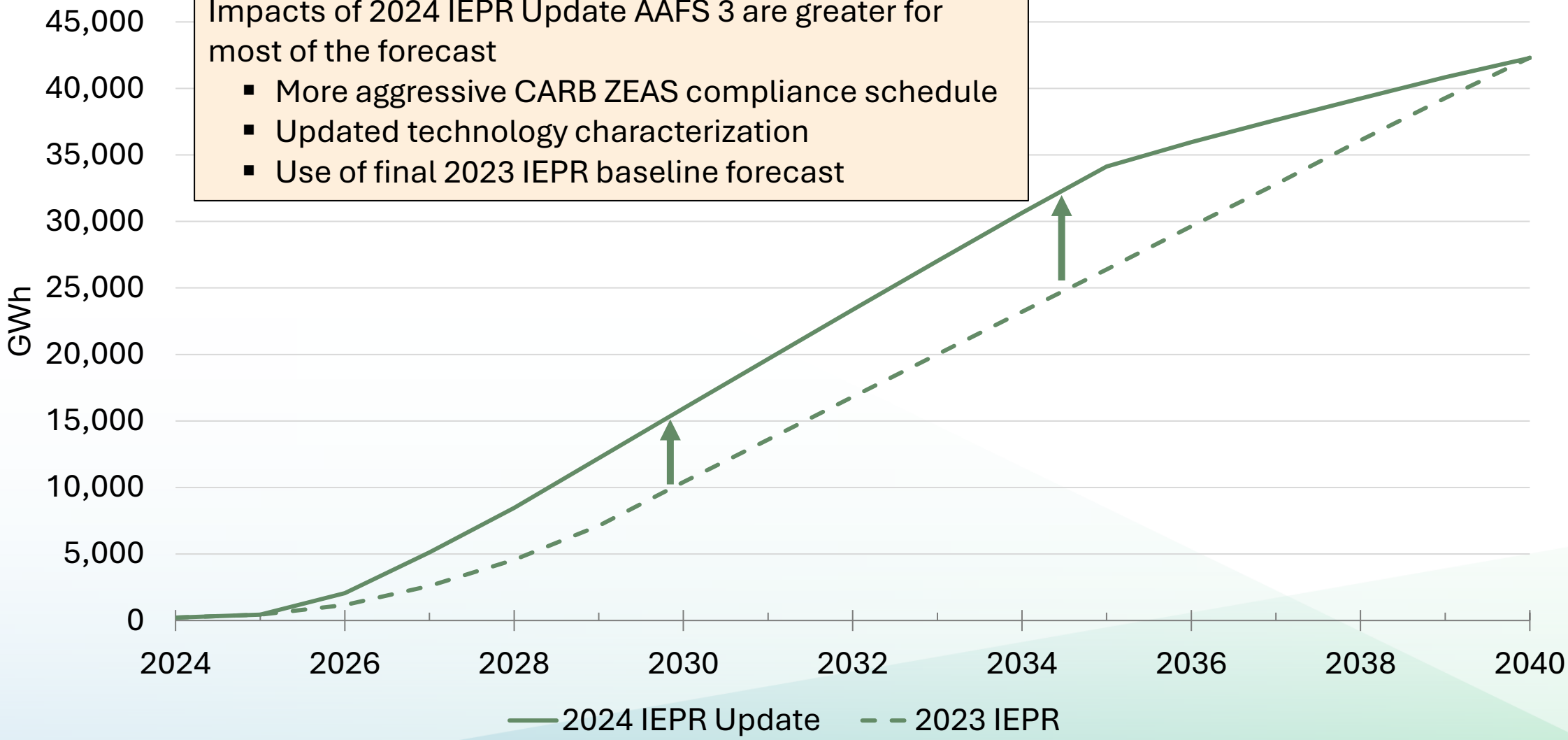


Source: CEC Staff

Added Electric Demand for AAFS 3 - Forecast Vintage Comparison

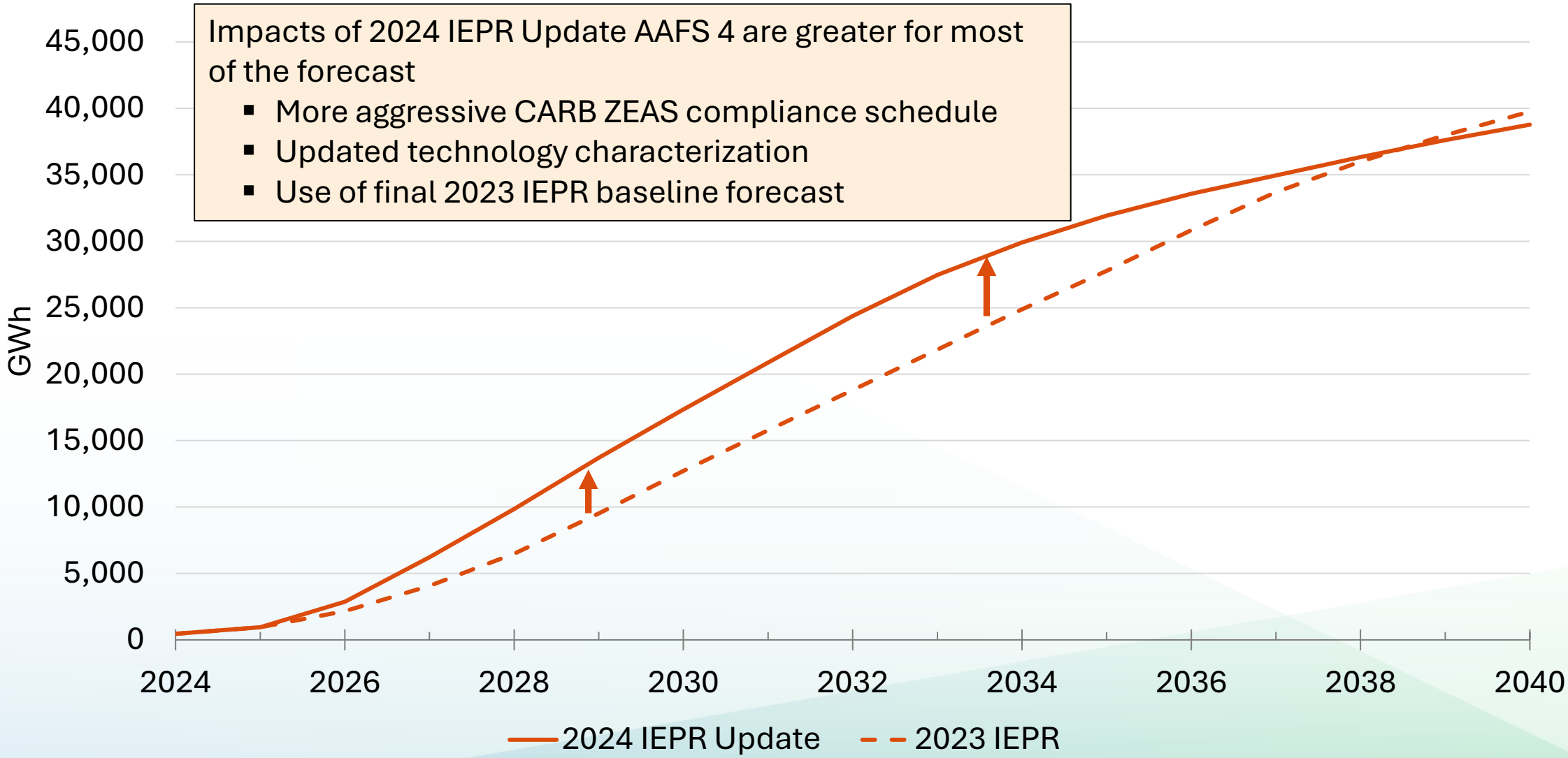
Impacts of 2024 IEPR Update AAFS 3 are greater for most of the forecast

- More aggressive CARB ZEAS compliance schedule
- Updated technology characterization
- Use of final 2023 IEPR baseline forecast



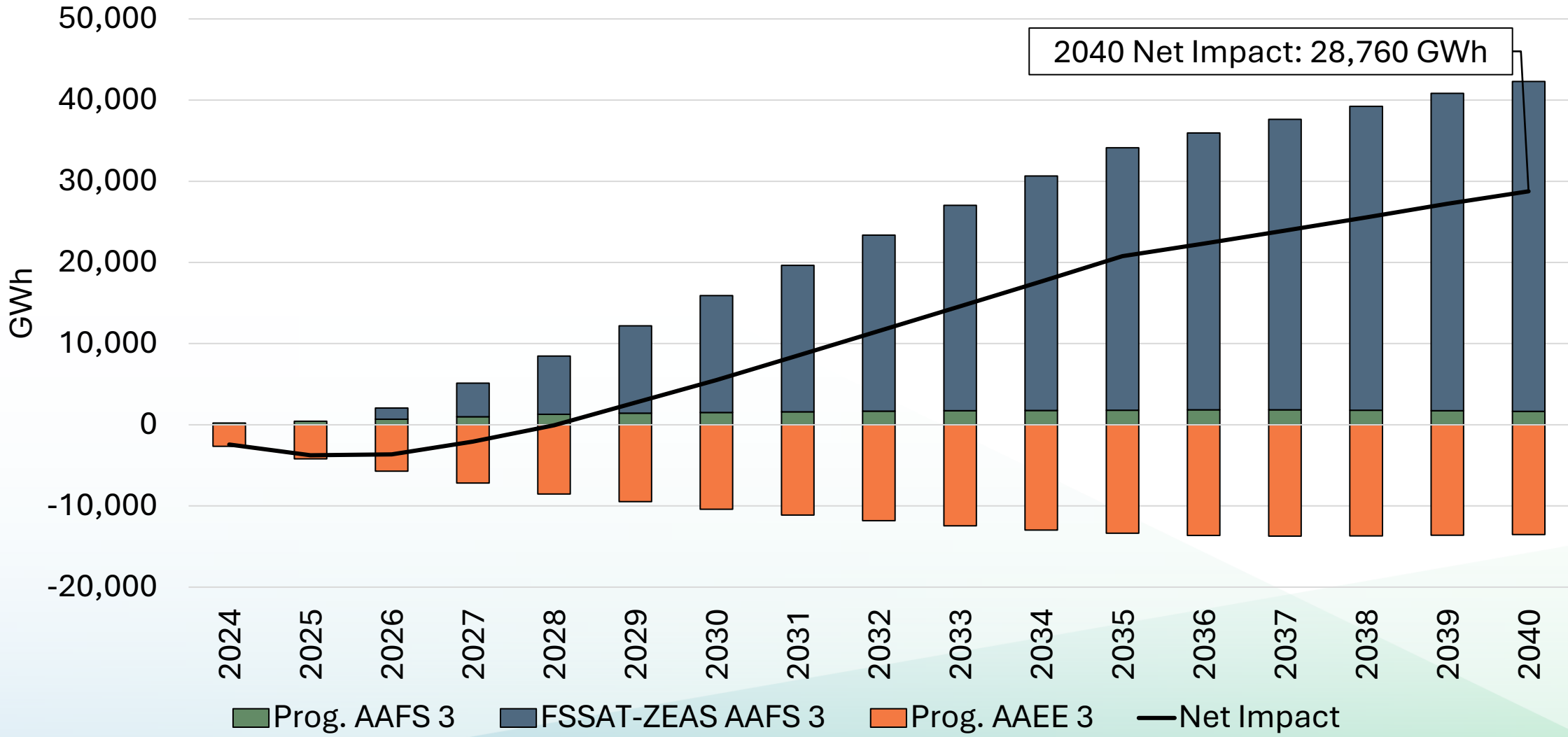
Source: CEC Staff

Added Electric Demand for AAFS 4 - Forecast Vintage Comparison



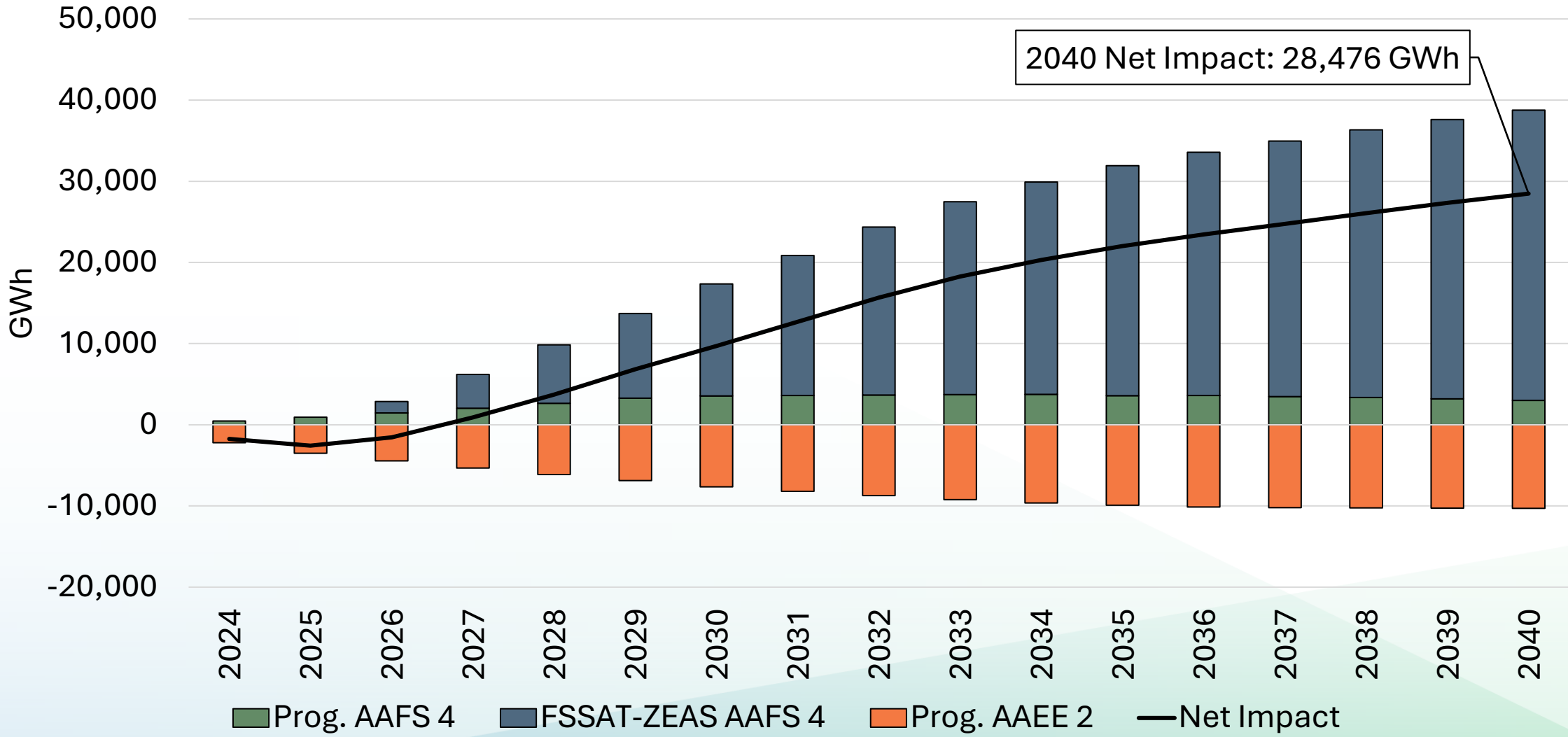
Source: CEC Staff

Combined Electricity Impacts for AAEE/AAFS 3 – Planning Forecast



Source: CEC Staff

Combined Electricity Impacts for AAEE 2 and AAFS 4 – Local Reliability Scenario



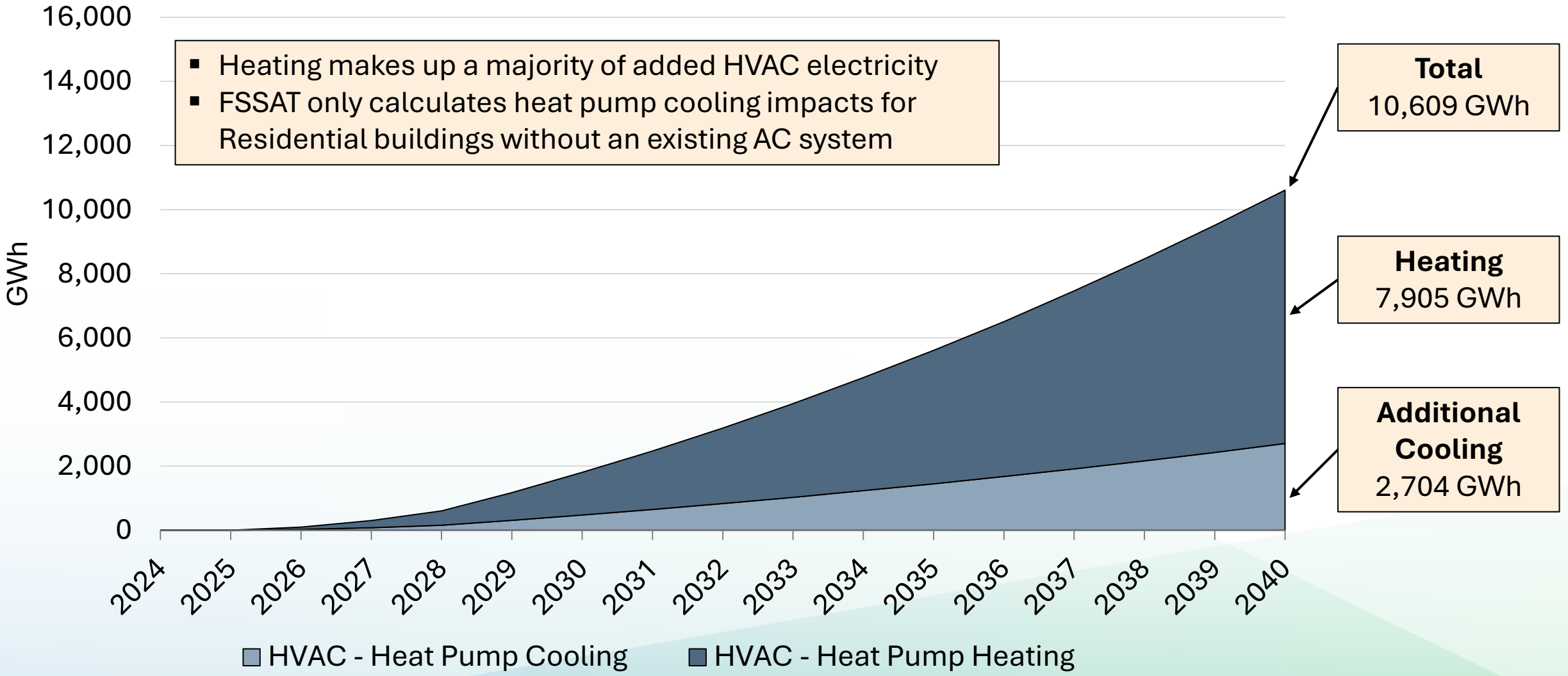
Source: CEC Staff

FSSAT Modeling Assumptions: Percentages of Residential Buildings with AC

Gas Utility	Climate Zone	Building Type (SF/MF)	Sector (Res/LI)	% of Buildings with AC
PG&E	CZ01 - Arcata	Res - Single Family	Residential	8.0%
PG&E	CZ02 - Santa Rosa	Res - Single Family	Residential	35.3%
PG&E	CZ03 - Oakland	Res - Single Family	Residential	11.1%
PG&E	CZ04 - Sunnyvale	Res - Single Family	Residential	47.9%
PG&E	CZ05 - Santa Maria	Res - Single Family	Residential	62.8%
PG&E	CZ11 - Red Bluff	Res - Single Family	Residential	90.5%
PG&E	CZ12 - Sacramento	Res - Single Family	Residential	79.4%
PG&E	CZ13 - Fresno	Res - Single Family	Residential	95.0%
PG&E	CZ14 - China Lake	Res - Single Family	Residential	62.8%
PG&E	CZ16 - Mount Shasta	Res - Single Family	Residential	57.4%

The table shows selected FSSAT input data of percentages of residential buildings with AC. FSSAT models the additional residential cooling from fuel-substituted homes without AC by gas utility, climate zone, residential building type, and sector (residential or low income).

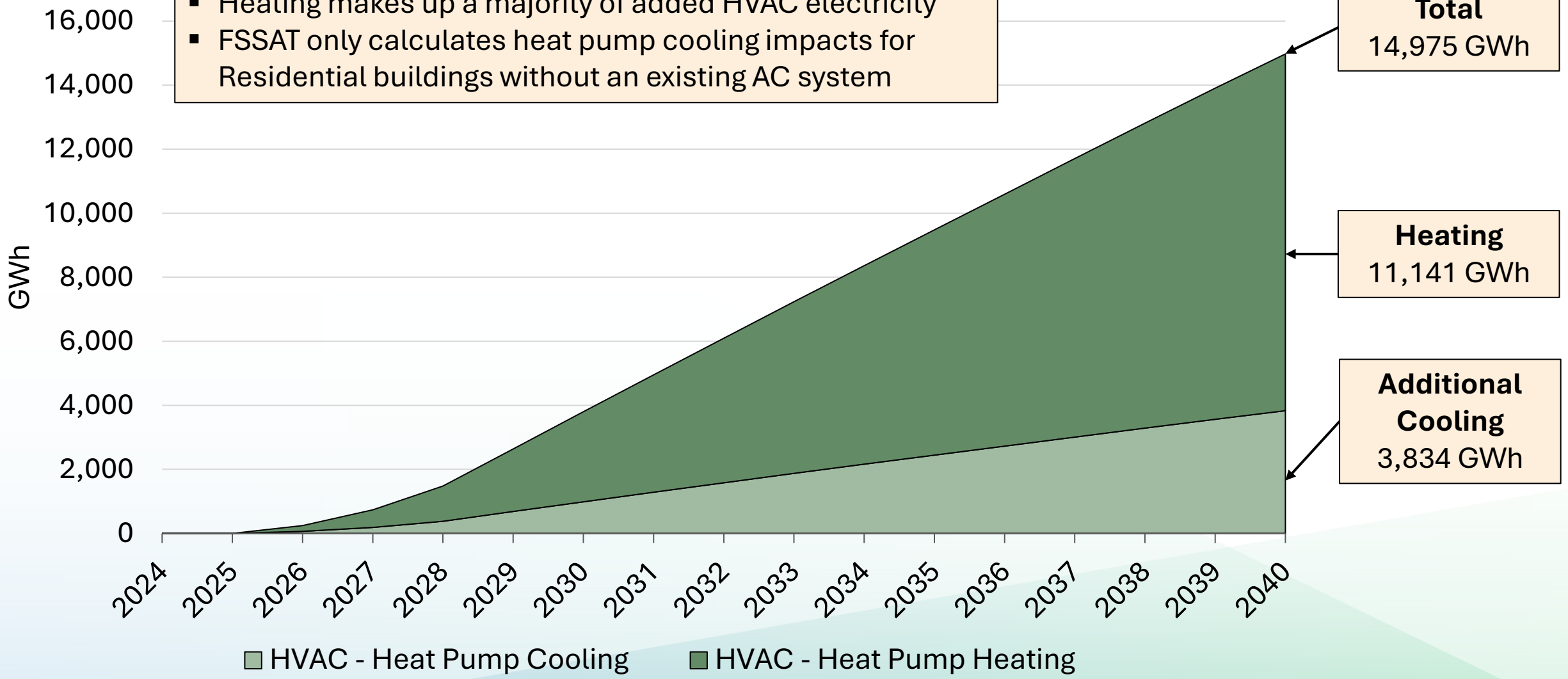
Added Electric Demand – FSSAT-ZEAS AAFS 2 Heating vs Cooling



Source: CEC Staff

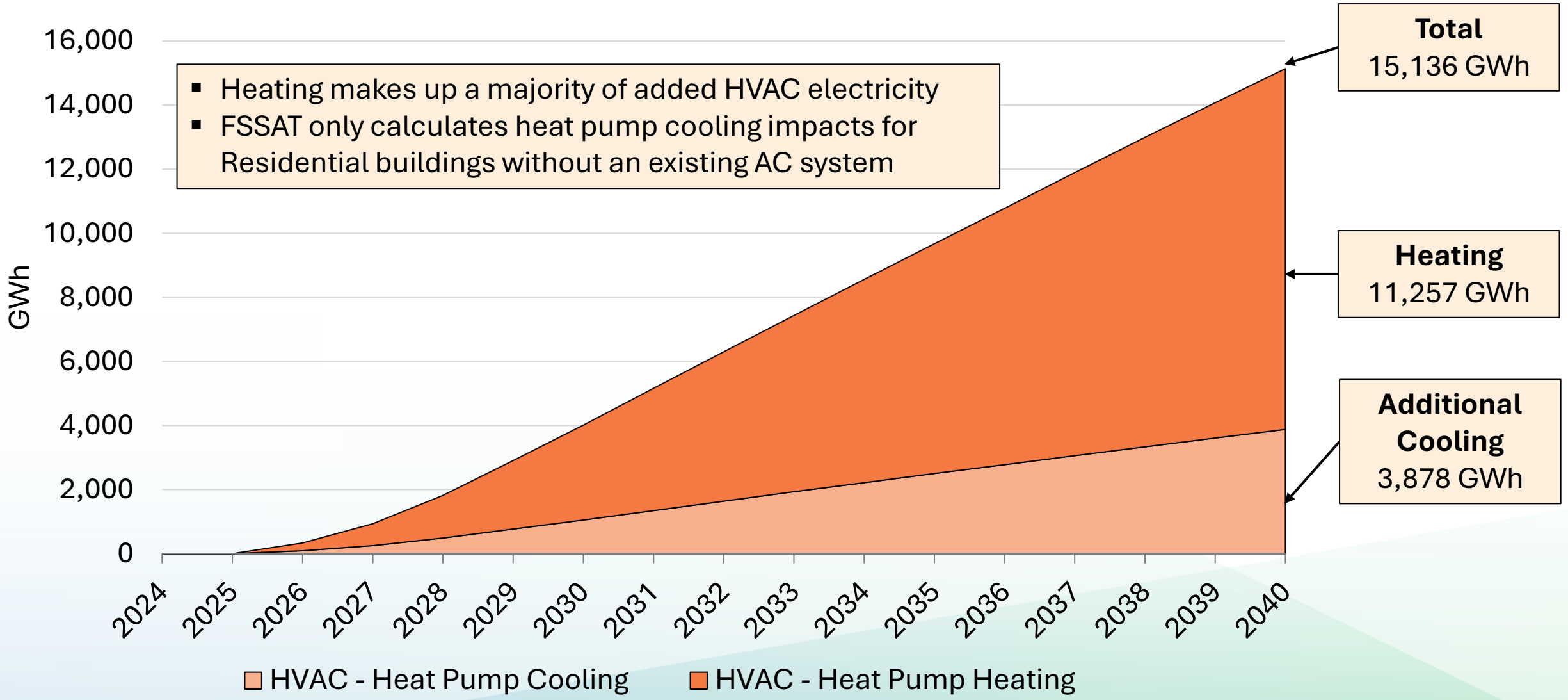
Added Electric Demand – FSSAT-ZEAS AAFS 3 Heating vs Cooling

- Heating makes up a majority of added HVAC electricity
- FSSAT only calculates heat pump cooling impacts for Residential buildings without an existing AC system



Source: CEC Staff

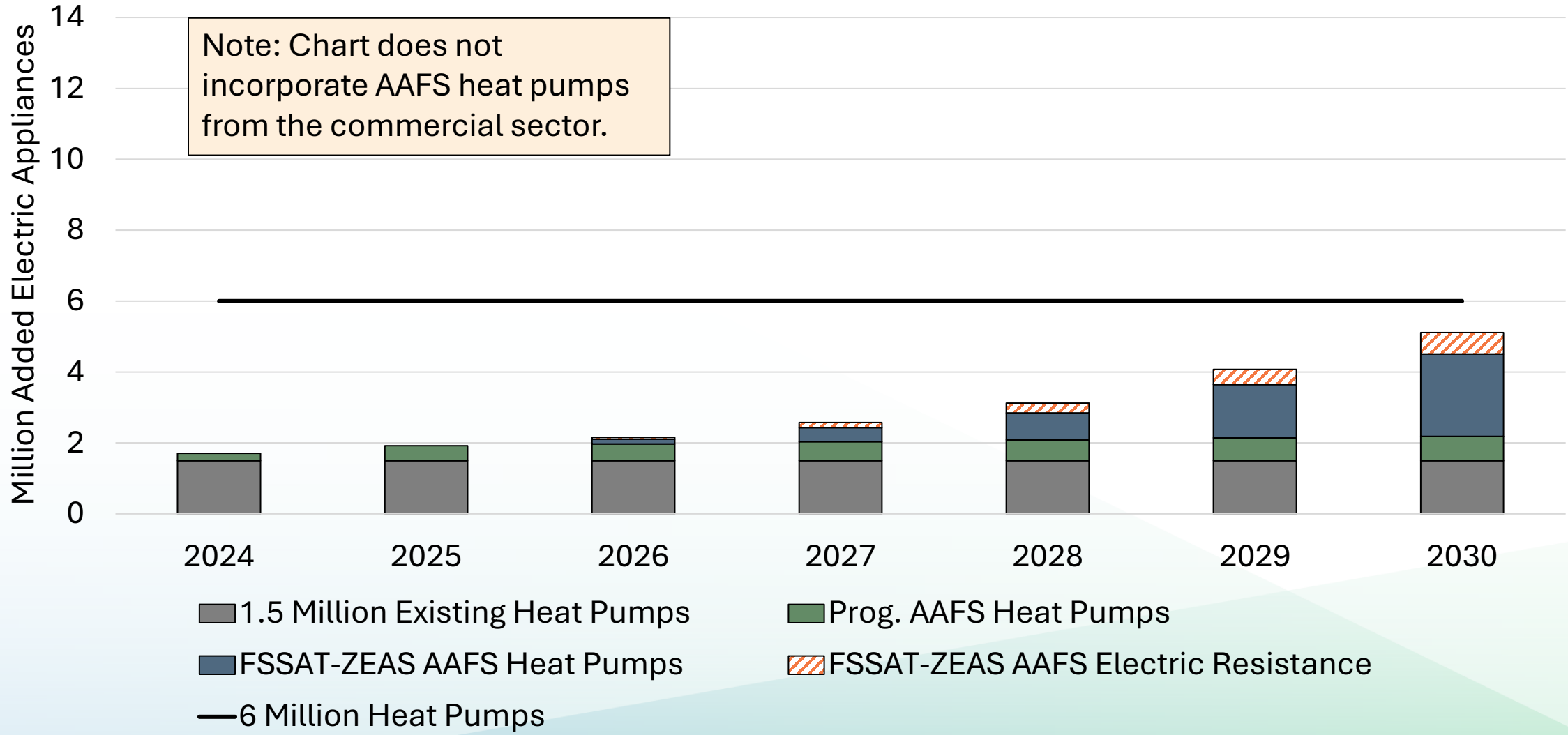
Added Electric Demand – FSSAT-ZEAS AAFS 4 Heating vs Cooling



Source: CEC Staff

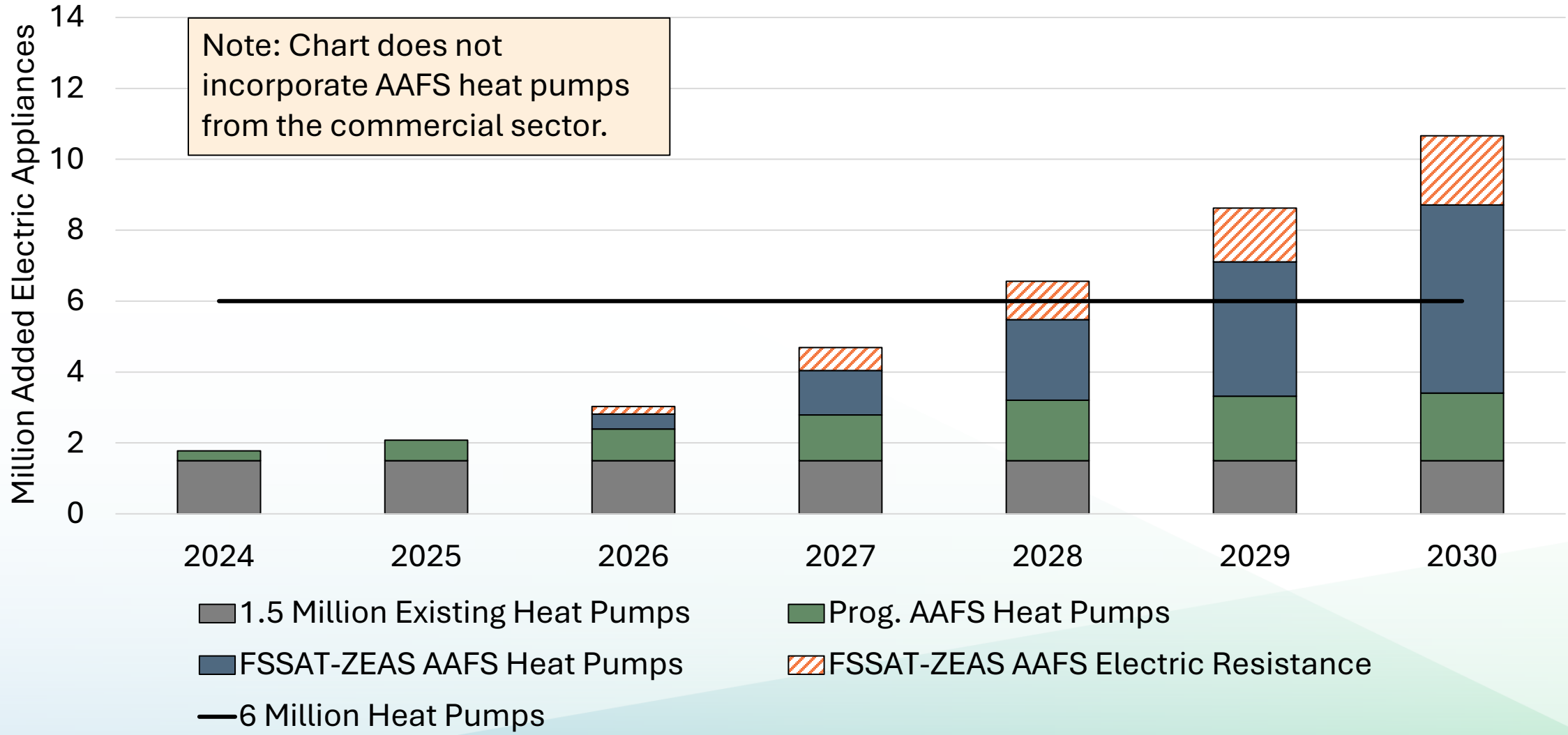
Electric Stock Results

Estimated Cumulative Electric Appliances – AAFS 2



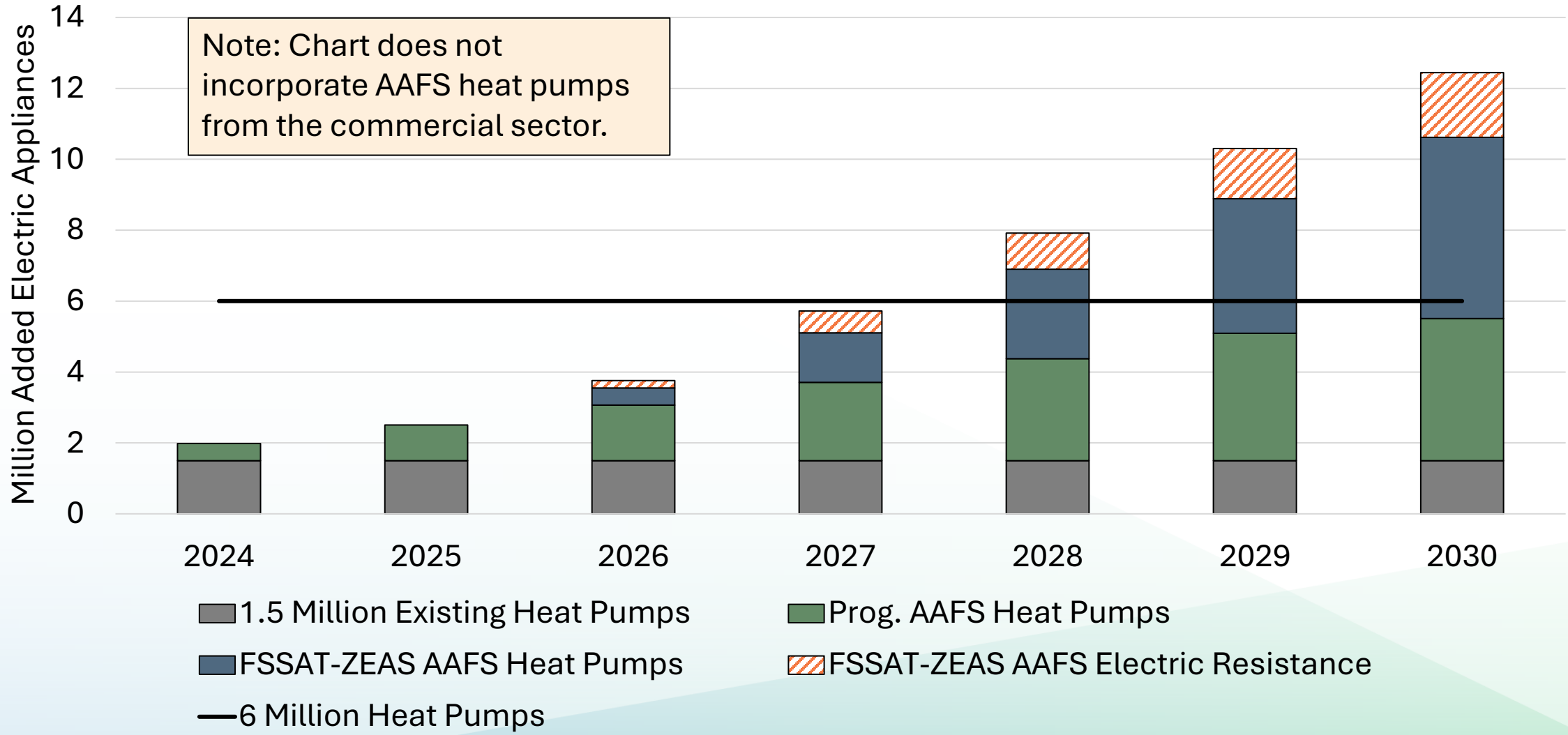
Source: CEC Staff

Estimated Cumulative Electric Appliances – AAFS 3



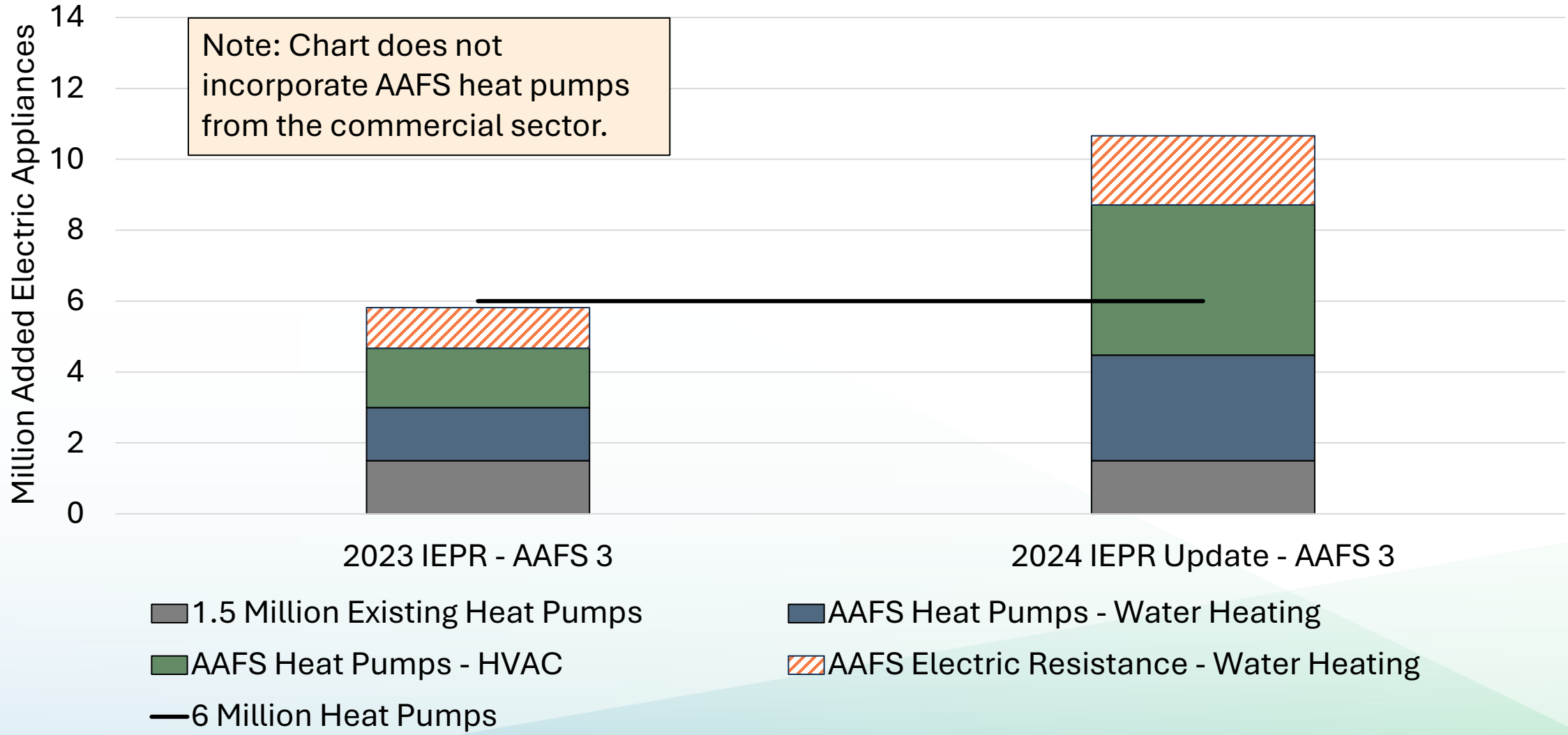
Source: CEC Staff

Estimated Cumulative Electric Appliances – AAFS 4



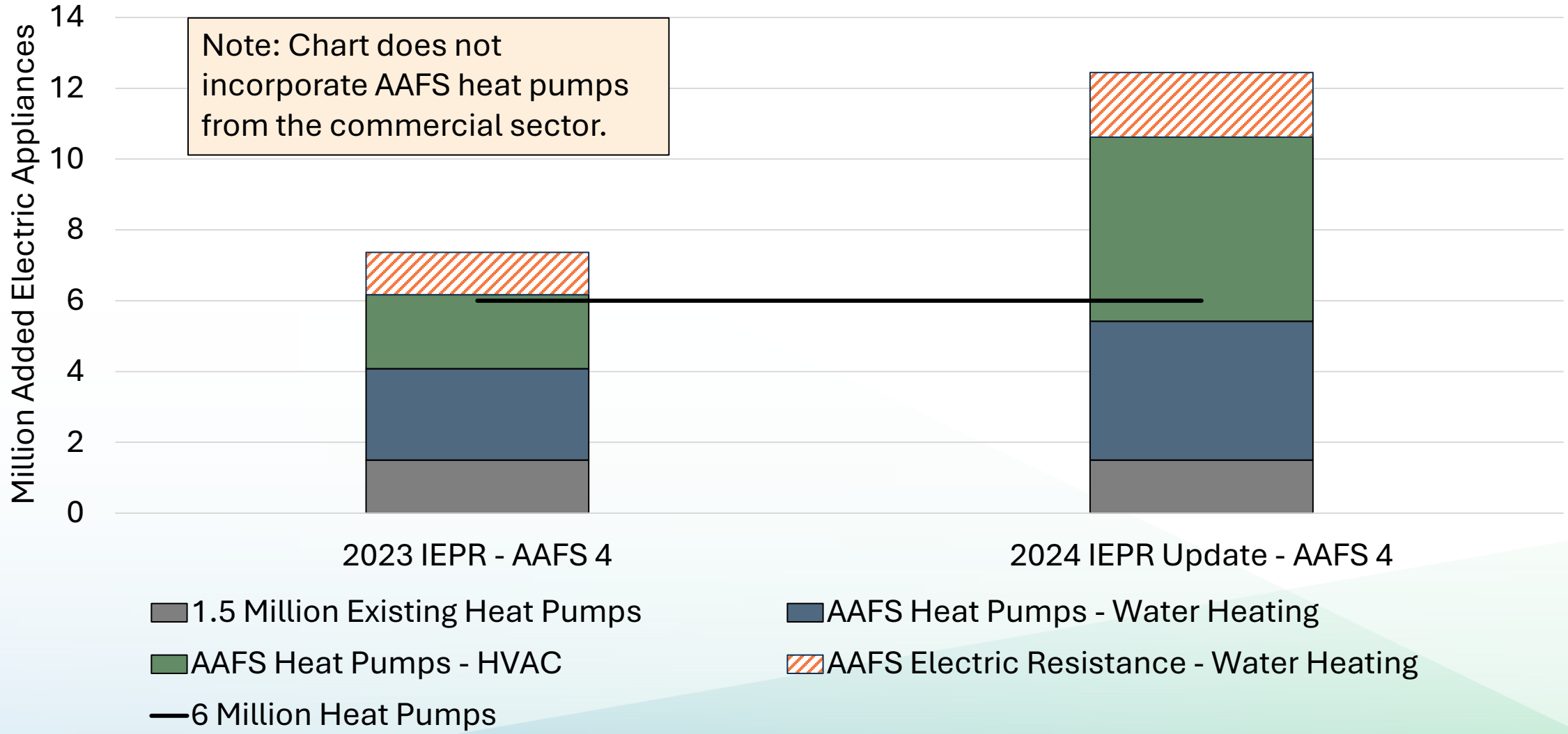
Source: CEC Staff

Cumulative Electric Appliances in 2030 – AAFS 3 Forecast Vintage Comparison



Source: CEC Staff

Cumulative Electric Appliances in 2030 – AAFS 4 Forecast Vintage Comparison



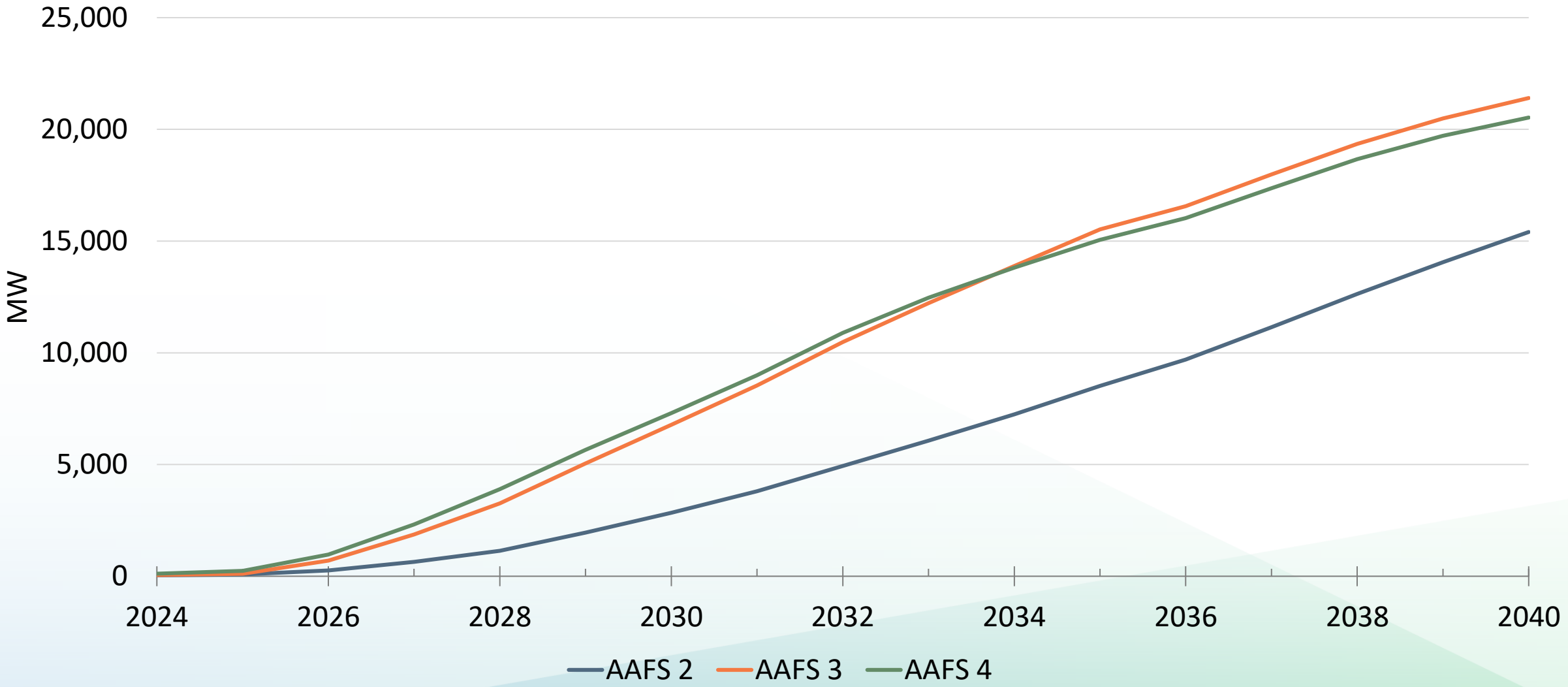
Source: CEC Staff

Explanation of Electric Appliance Stock Projections

#	Reasons	FSSAT model accounting
1	Updated technology characterization inputs with RASS 2019	FSSAT now has new or revised unit energy consumption (UEC) values and technology choices for gas appliances
2	Instances of lower UEC values for certain gas appliances when using RASS 2019	Having lower UEC values applied to the baseline gas forecast in FSSAT causes the baseline and removed gas appliance stock to increase
3	Removed gas stock = added electric stock for FSSAT based fuel substitution	With more gas appliances being removed in the 2024 IEPR update, this consequently led to an increase in added electric appliances for AAFS

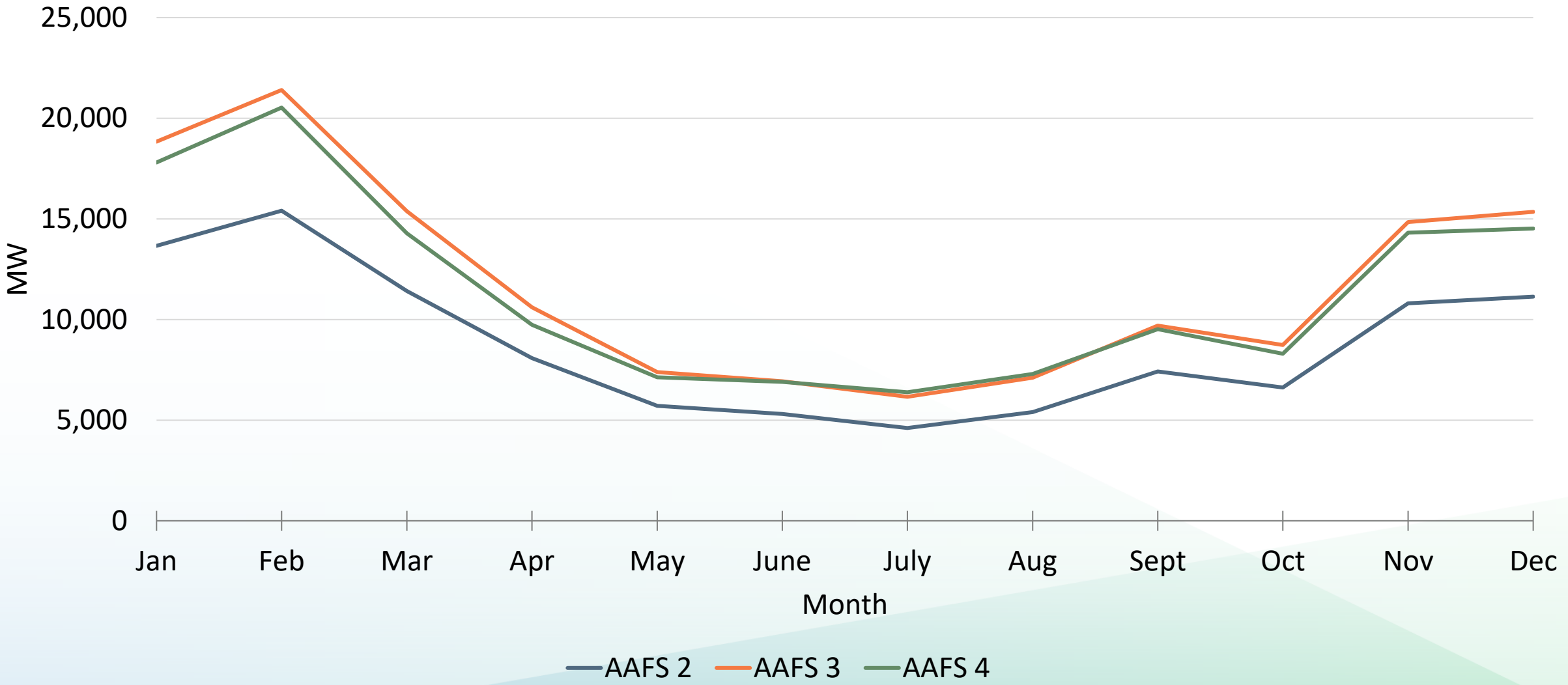
Hourly Results

CAISO System AAFS Annual Maximum Load



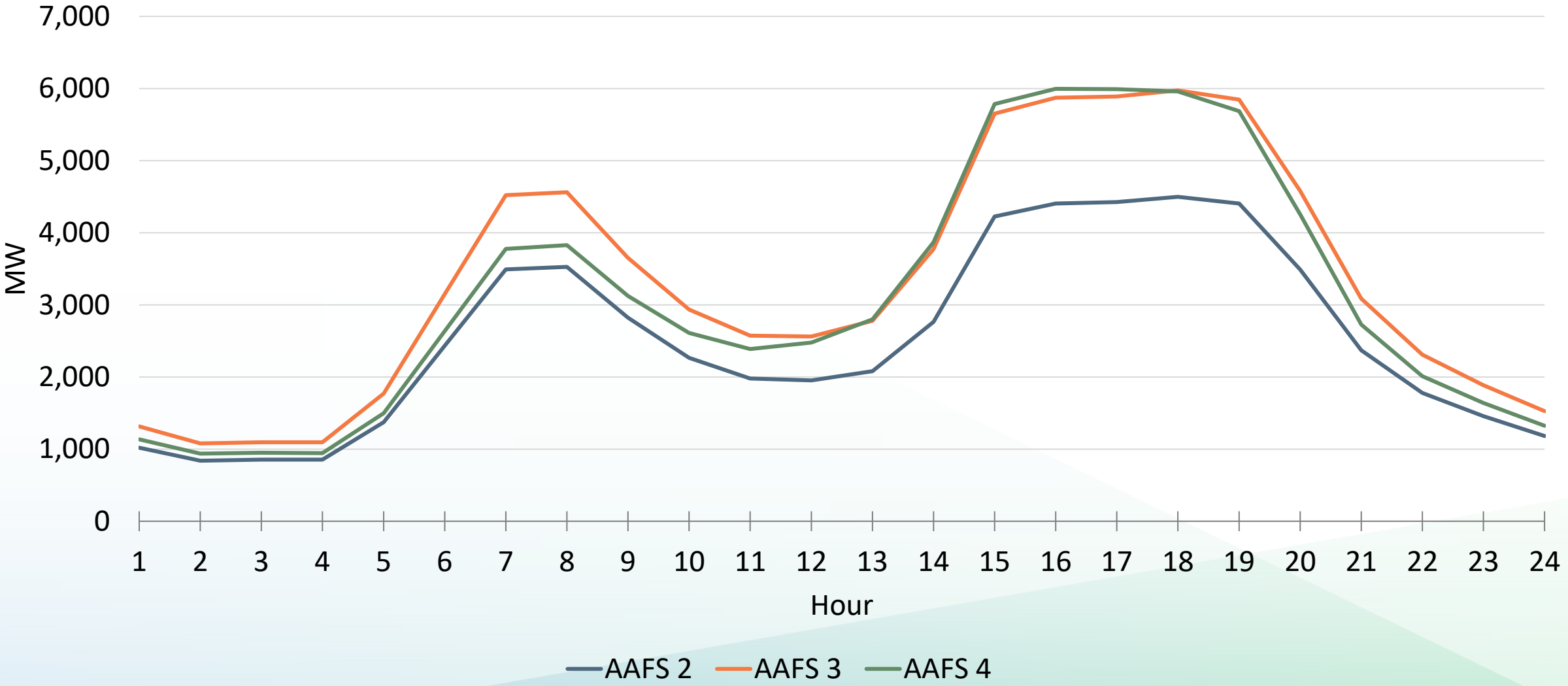
Source: CEC Staff

CAISO System AAFS Monthly Maximum Load - 2040



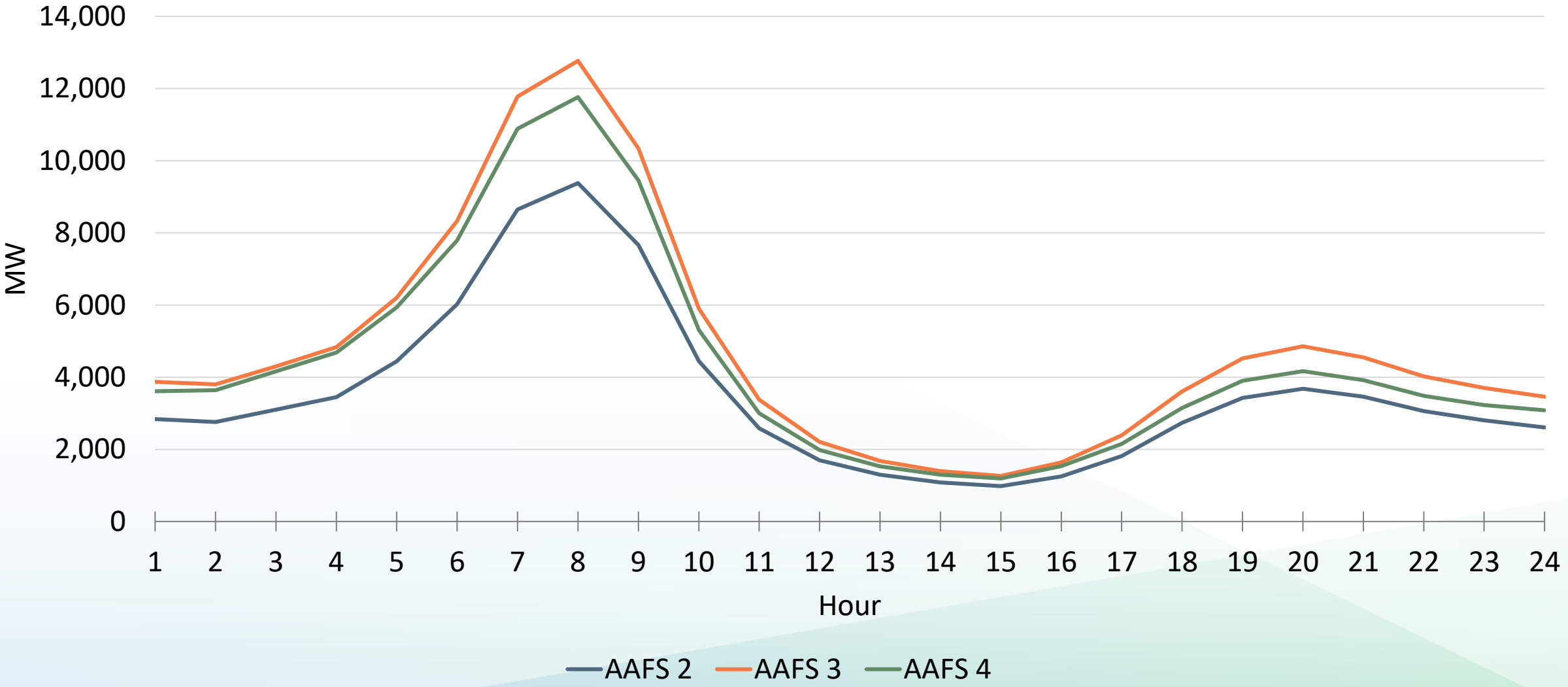
Source: CEC Staff

CAISO System AAFS Load Profile for Average September Weekday - 2040



Source: CEC Staff

CAISO System AAFS Load Profile for Average February Weekday - 2040



Source: CEC Staff

Thank you

Please send any written comments or questions to:
Nicholas Janusch (nicholas.janusch@energy.ca.gov),
Ethan Cooper (ethan.cooper@energy.ca.gov)

Note: CEC staff will post the FSSAT-ZEAS FSSAT input assumptions to the 2024 IEPR Docket

Highlights from Draft Results

Topic	Highlights
AAFS Characterizations	• The updated CARB ZEAS compliance schedules occur earlier than what was used in the 2023 IEPR
Annual Electric Impacts	• Annual AAFS 3 & 4 impacts are larger for most of the 2024 IEPR Update forecast (when compared to the 2023 IEPR) • The 2040 electric impact for AAFS 2, AAFS 3, and AAFS 4 are 31,349 GWh, 42,288 GWh, and 38,777 GWh, respectively • The added electric demand from the additional cooling for existing homes that did not have AC contributed to roughly 25 percent of the total increased HVAC electric demand for FSSAT-ZEAS AAFS
Hourly Impacts	• By 2040, the largest hourly impact for AAFS 2-4 will occur in February • Added load in February largely occurs during the early morning from water and space heating
Heat Pump Stock Projections	• Added electric appliance estimates are greater for the 2024 IEPR Update AAFS scenarios • Existing and forecasted heat pumps exceed 6 million by 2030 for AAFS 3 & 4

Summary: "Commercial" ROB Water Heaters (> 75k Btu/hr)

	Board Vote or Amendments Adoption Date	Equipment Size	Compliance Date
Statewide CARB ZEAS	Expected 2025	Boilers and water heaters (≤ 400k BTU/hr)	**2029**
Statewide CARB ZEAS	Expected 2025	Instantaneous water heaters (≤ 200k Btu/hr)	**2029**
Statewide CARB ZEAS	Expected 2025	Boilers, water heaters, and instantaneous water heaters (≤ 2MM Btu/hr)	**2031**
Bay Area AQMD (Rule 9-6)	March 15, 2023	Water Heaters (75,000 – 2MM Btu/hr)	**2031**
South Coast AQMD (Rule 1146.2)	June 7, 2024	**Phase I:** Smaller units (≤ 400k Btu/hr)	NC: 2026; Existing: **2029**
South Coast AQMD (Rule 1146.2)	June 7, 2024	**Phase II:** Larger units and pool heaters (> 400k Btu/hr)	NC: 2028; Existing: **2031**
South Coast AQMD (Rule 1146.2)	June 7, 2024	**Phase III:** High temperature units (> 180 degrees F)	NC: 2029; Existing: **2033**

Summary: "Residential and Commercial" ROB Furnaces

	Board Vote or Amendments Adoption Date	Equipment Size	Compliance Date
Statewide CARB ZEAS	Expected 2025	Furnaces (< 175k Btu/hr & 2MM ≤ Btu/hr)	**2029**
Bay Area AQMD (Rule 9-4)	March 15, 2023	Furnaces (< 175k Btu/hr)	**2029**
South Coast AQMD (Rule 1111)	Expected 12/6/2024	Residential Fan-type central furnace (< 175k Btu/hr)	NC: 2026; Existing: **2028**
South Coast AQMD (Rule 1111)	Expected 12/6/2024	Commercial Fan-type central furnace (175k-2MM Btu/hr)	NC: 2026; Existing: **2028**
South Coast AQMD (Rule 1111)	Expected 12/6/2024	Mobile home furnace	NC: 2026; Existing: **2028**
South Coast AQMD (Rule 1111)	Expected 12/6/2024	Wall furnaces, floor furnaces, and others	NC: 2026; Existing: **2028**

→ **South Coast AQMD's proposed amendment to Rule 1111** is more aggressive than CARB's proposed ZEAS and Bay Area's AQMD's Amended Rule 9-4.