Resource Planning Advisory Group meeting

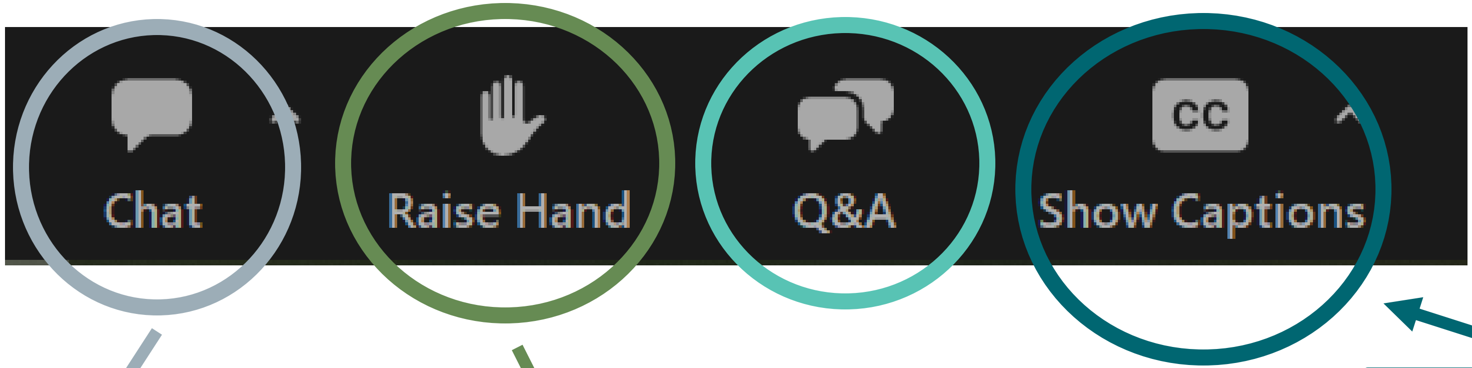
2025 Integrated Resource Plan

April 17, 2024

PUGET SOUND ENERGY

Welcome to the meeting!

The Q&A tool will be turned off during the meeting



Click to see real-time closed captioning

RPAG members and PSE staff are welcome to use the chat feature

During the public comment period, raise your hand if you would like to make a verbal comment

Safety moment

April is Distracted Driving Awareness Month

- Cell phone use is the most common distraction to drivers
- Pull over and park or use a “designated texter” if you need to send a message
- WA state law requires drivers to use hands-free devices (like Bluetooth)
- Cell phone violations are reported to insurance and tickets are hefty!

Facilitator requests

- Engage constructively and courteously towards all participants
- Take space and make space
- Respect the role of the facilitator to guide the group process
- Avoid use of acronyms and explain technical questions
- Use the Feedback Form for additional input to PSE
- Aim to focus on the meeting topic
- Public comments will occur after PSE's presentations

Today's speakers

Sophie Glass

Facilitator, Triangle Associates

Phillip Popoff

Director, Resource Planning Analytics, PSE

Lorin Molander

Manager, Load Forecasting and Analysis, PSE

Gavin Aiello

Guidehouse

Jeff Tripp

Manager, Strategic Program Initiatives, PSE

Tom Smith

Product Development Manager, Residential Demand Response

Aquila Velonis

Cadmus Group

PUGET SOUND ENERGY

Agenda

Time	Agenda Item	Presenter / Facilitator
12:00 p.m. – 12:05 p.m.	Introduction and agenda review	Sophie Glass, Triangle Associates
12:05 p.m. – 12:10 p.m.	Feedback summary	Phillip Popoff, PSE
12:10 p.m. – 12:55 p.m.	Electric vehicle forecast	Lorin Molander, PSE Gavin Aiello, Guidehouse
12:55 p.m. - 1:25 p.m.	Demand response programs	Jeff Tripp, PSE Tom Smith, PSE
1:25 p.m. - 1:30 p.m.	Break	All
1:30 p.m. - 2:50 p.m.	Conservation potential assessment results	Aquila Velonis, Cadmus Group
2:50 p.m. - 3:00 p.m.	Next steps and public comment opportunity	Sophie Glass, Triangle Associates
3:00 p.m.	Adjourn	All

Feedback summary

Phillip Popoff, PSE

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March 12 RPAG meeting feedback summary

Public feedback included:

- How PSE should reflect social cost of greenhouse gas (SCGHG) in the 2025 IRP
- Model ELCCs for hybrid systems

RPAG feedback included:

- Addressing transmission constraints in 2025 IRP
- Request for additional information about expiration of PG&E exchange
- Clarification from Commission staff regarding modeling approaches for SCGHG

PSE PUGET SOUND ENERGY

Electric vehicle forecast

Lorin Molander, PSE

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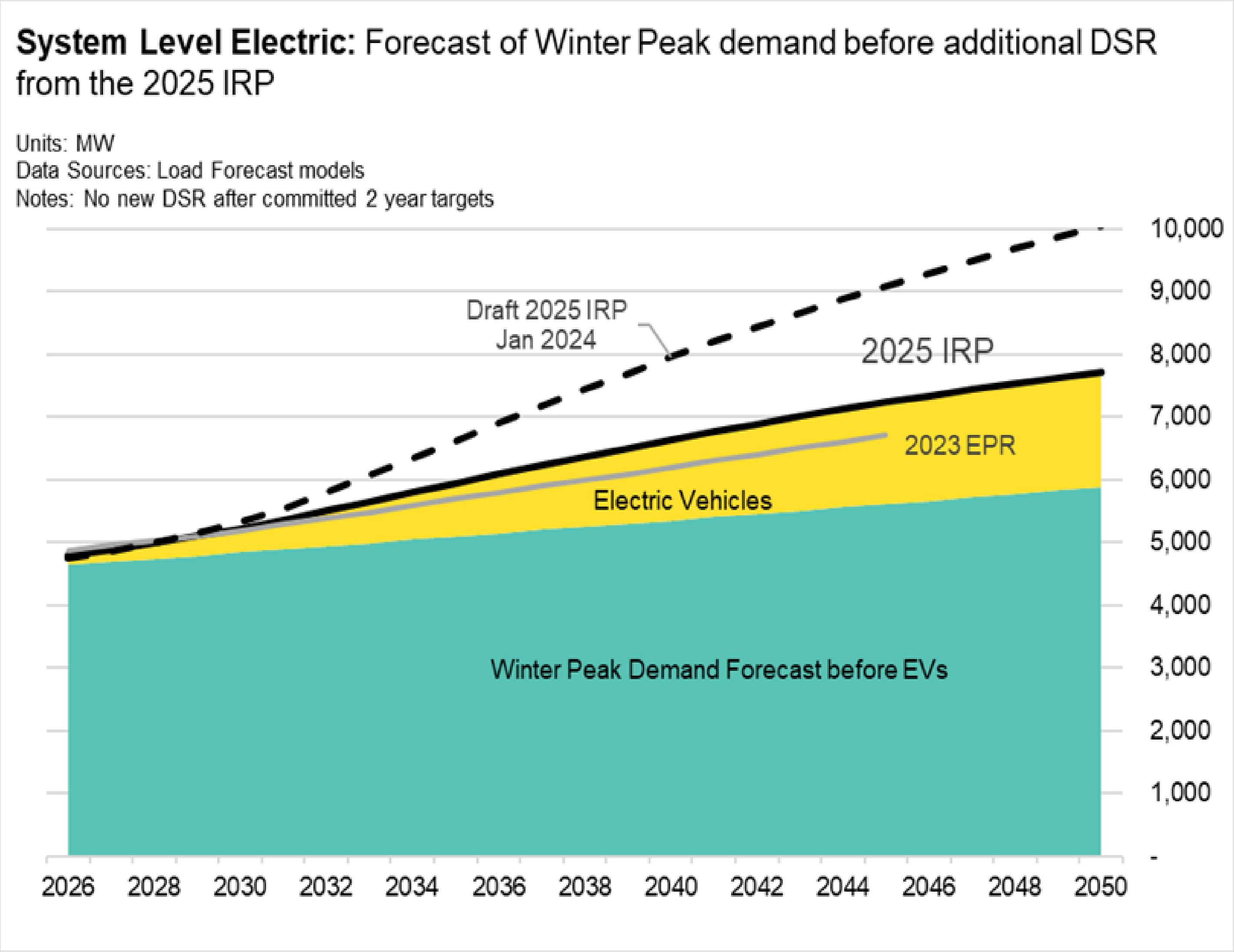
Background


System Level Electric: Forecast of Winter Peak demand before additional DSR from the 2025 IRP
Units: MW
Data Sources: Load Forecast models
Notes: No new DSR after committed 2 year targets
Draft 2025 IRP
Jan 2024
2025 IRP
2023 EPR
Electric Vehicles
Winter Peak Demand Forecast before EVs
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
-
2026
2028
2030
2032
2034
2036
2038
2040
2042
2044
2046
2048
2050

IAP2 Spectrum

	INFORM	CONSULT	INVOLVE	COLLABORATE	EMPOWER
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INCREASING IMPACT ON THE DECISION →

PSE PUGET SOUND ENERGY

Guidehouse
Outwit Complexity

PSE PUGET SOUND ENERGY

PSE F24 EV Forecast

RPAG - Results Presentation

April 17, 2024

Prepared for Puget Sound Energy

Agenda

Guidehouse Outwit Complexity

Executive Summary

PSE F24 EV Forecast Overview

Guidehouse forecasted EV adoption, their associated EVSE need and load impacts within PSE’s Service Area through 2050 across 3 adoption scenarios and 3 managed charging scenarios.

EV Adoption	Charging Needs	Load Impacts	Managed Charging
Forecast battery-electric (BEV) and plug-in hybrid (PHEV) EV adoption for Light-, Medium- and Heavy-Duty Vehicles	Forecast charging infrastructure needs associated with EV adoption across charging use case and technology	Forecast monthly energy requirements to support EV adoption within PSE’s service area	Develop average daily weekday and weekend load shapes associated with different levels of managed charging uptake

Background

Guidehouse has supported PSE in EV forecasting since 2019

2019
- Initial light-duty vehicle (LDV) forecast, with preliminary medium-/heavy-duty vehicle (MHDV) assessment

2020
- Updated LDV forecast with 2019 year-end registration data

2021
- Updated LDV and MHDV forecasts with Washington's Zero Emissions Vehicle (ZEV) policy

2022
- Updated LDV and MHDV forecasts with Clean Fuel Standard (CFS) assumptions

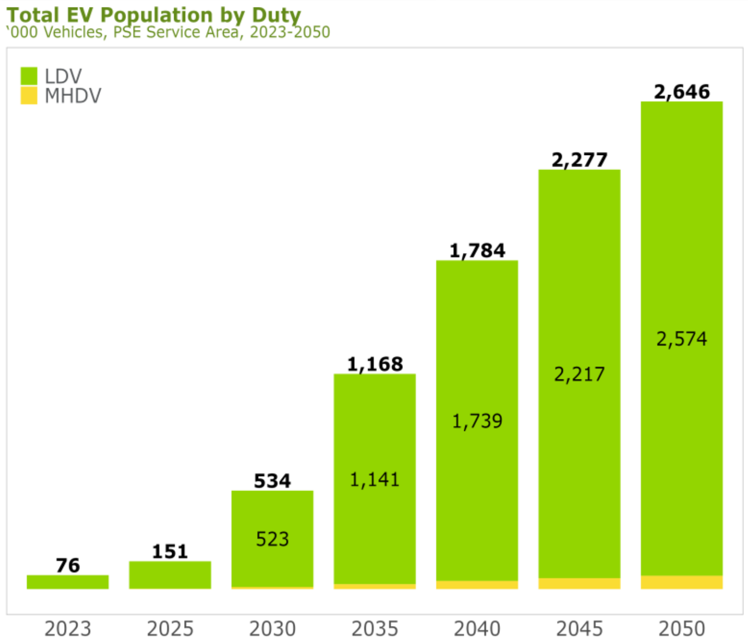
2023
- Updated LDV and MHDV forecasts with CFS, IRA, ICE Ban, IIJA and ACT assumptions

2024
- Updated LDV and MHDV forecasts with new MHDV classes

Base Scenario EV Adoption & Load Impacts

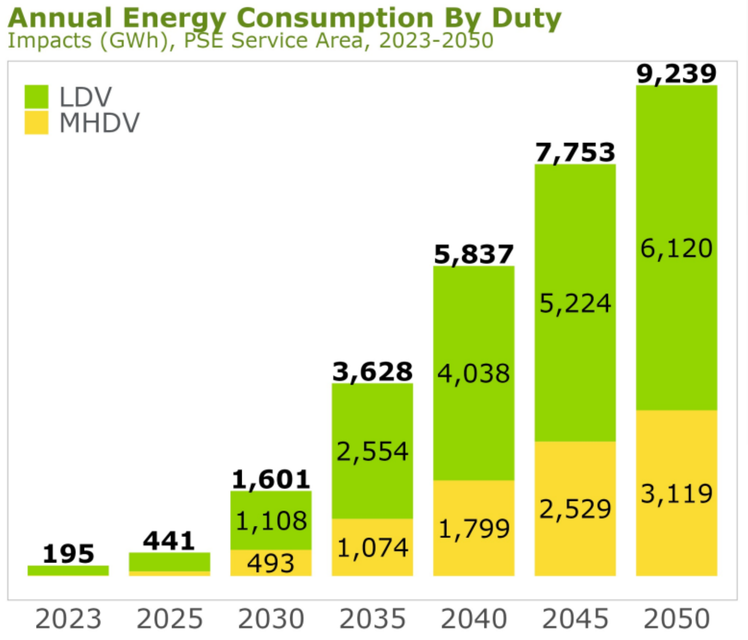
By 2050, 2.6 million EVs are forecasted in PSE's Service Area (71% of the total vehicle population), requiring 9.2k GWh of energy with an annual EV peak before losses forecasted to hit 1,800 MWs

EV Population



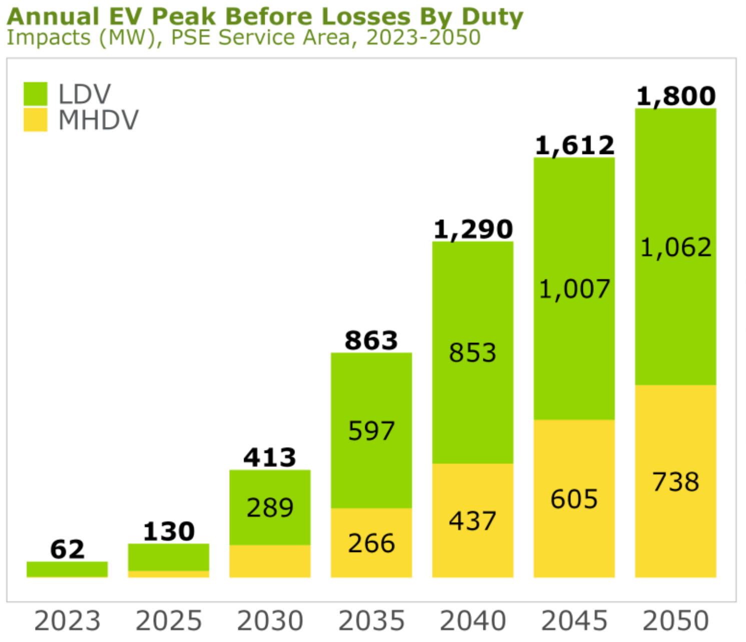
- By 2050, **Light-duty (LD) EVs represent 97%** of the total EV population
- The Base Scenario forecast is **heavily impacted by policy** assumptions, specifically that sales targets under the **Advanced Clean Cars II and Advanced Clean Trucks** are achieved

Energy Need



- **MHDVs**, while only 3% of the total number of EVs, are forecasted to **represent 34% of the required energy needs** due to larger batteries, lower efficiencies and more demanding duty-cycles

EV Peak Before Losses*



- The **peak load** associated with EV charging occurs between **7:00 and 8:00 PM** for most years
- The peak is driven by **residential charging for LDVs** and **depot charging for MHDVs**

* The Annual EV Peak Before Losses is not coincident with PSE's system peak and occurs at the customer's meter.

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Market Trend: EV Sales in 2023 Up 50% Compared to 2022 but Lingering Uncertainty Led to Slower Sales in Q4 2023

EV Market tailwinds driven by federal and state policy and OEM announcements saw EV sales for Q1, Q2 and Q3 of 2023 up by ~60% YoY compared to 2022 EV sales

Favorable Federal and State Policies

- Infrastructure Investment and Jobs Act (IIJA)
- Inflation Reduction Act (IRA)
- EPA limits on tailpipe emissions
- WA Advanced Clean Cars II
- WA Advanced Clean Trucks
- WA Clean Fuel Standard

OEM EV Investment and Goals

- By the end of 2022, OEMs, including Toyota, Nissan and Volkswagen, had announced over $1.2 trillion in investments for EVs
- GM, Ford and Hyundai set EV sales targets of 50% of new vehicles sold by 2030

EV Market headwinds driven by concerns over industry job loss, infrastructure and lower customer demand has led to monthly YoY EV sales growth falling to approximately 30% for the last quarter of 2023

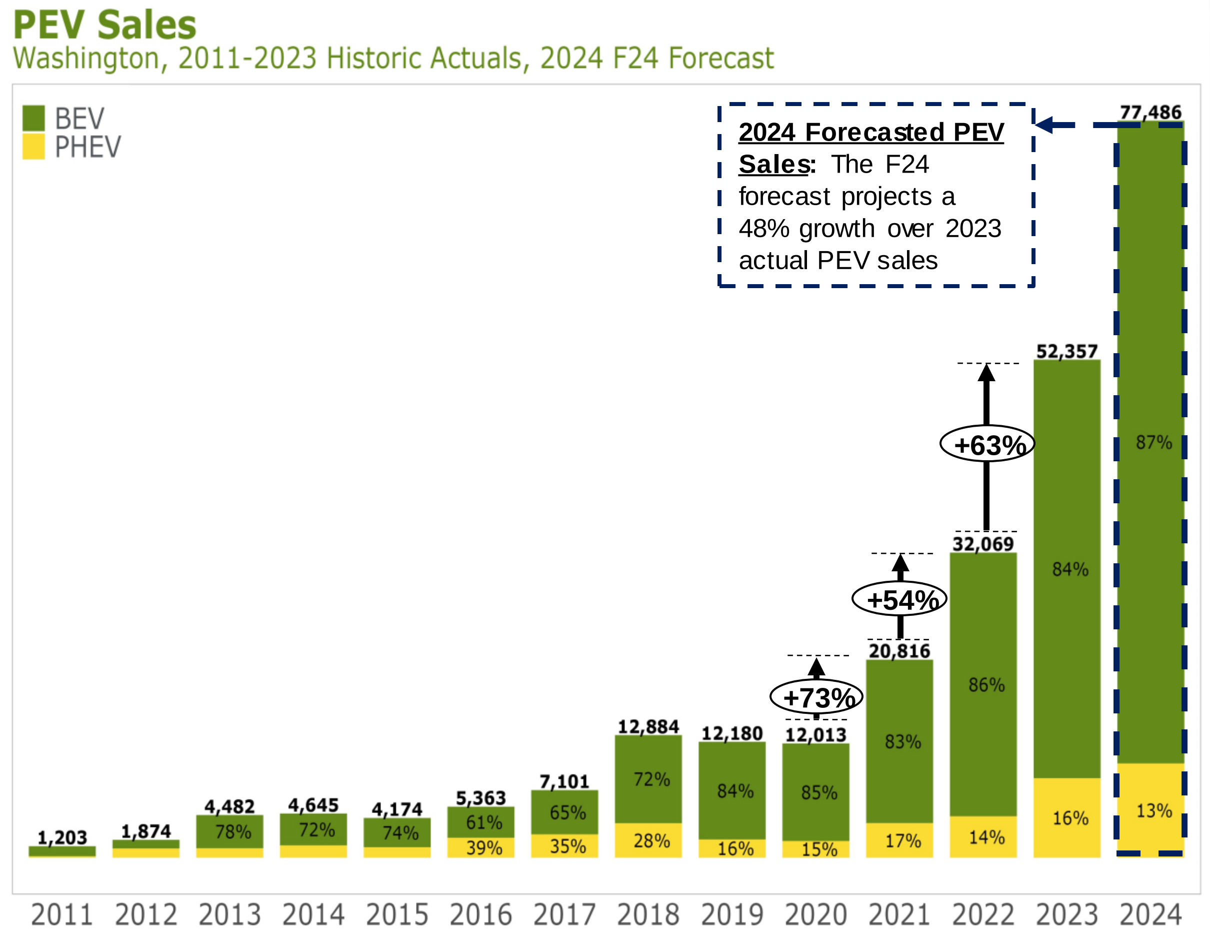
Pushback and Slowdown on Policies

- United Auto Workers and auto dealers have petitioned President Biden to slow down EV transition over concerns of job loss and readiness
- Some ZEV states, such as CT, have reversed position on sales mandates

OEM Delays in EV Transition

- Ford postponed building of $12B EV battery plant in Kentucky
- Rivian paused building of $5B factory in Georgia
- GM delayed construction of EV drive plant in Ohio and reduced 2024 EV production targets

Historic Sales and National/State EV Forecast Benchmarks



Forecast Source	Forecast Metric	Forecast Results	F24 Forecast Results
S&P Global[1] - National	National Light-Duty BEV Sales	13% in 2024	22% in 2024
International Energy Agency (IEA)[2] - National	National Light-Duty BEV + PHEV Sales	22% in 2025 50% in 2030	38% in 2025 67% in 2030
National Renewable Energy Lab (NREL)[3] - Washington	Washington Light-Duty BEV + PHEV Population	352k in 2025 1,336k in 2030	346k in 2025 1,255k in 2030
WA Department of Ecology[4] - Washington	Washington Light-Duty BEV + PHEV Sales under Base Scenario	70% in 2030 100% in 2035	67% in 2030 96% in 2035
WA Department of Ecology[4] - Washington	Washington Medium- and Heavy-Duty BEV Sales under Base Scenario	48% in 2030 72% in 2035	42% in 2030 66% in 2035

[1]S&P Global - https://www.spglobal.com/mobility/en/research-analysis/sp-global-mobility-forecasts-883m-auto-sales-in-2024.html
[2]IEA - https://www.iea.org/data-and-statistics/data-tools/global-ev-data-explorer
[3]NREL - https://data.nrel.gov/submissions/214
[4]WA DoE - https://public.tableau.com/app/profile/waevcouncil/viz/WashingtonTransportationElectrificationStrategy/Story_Published

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Key Takeaways

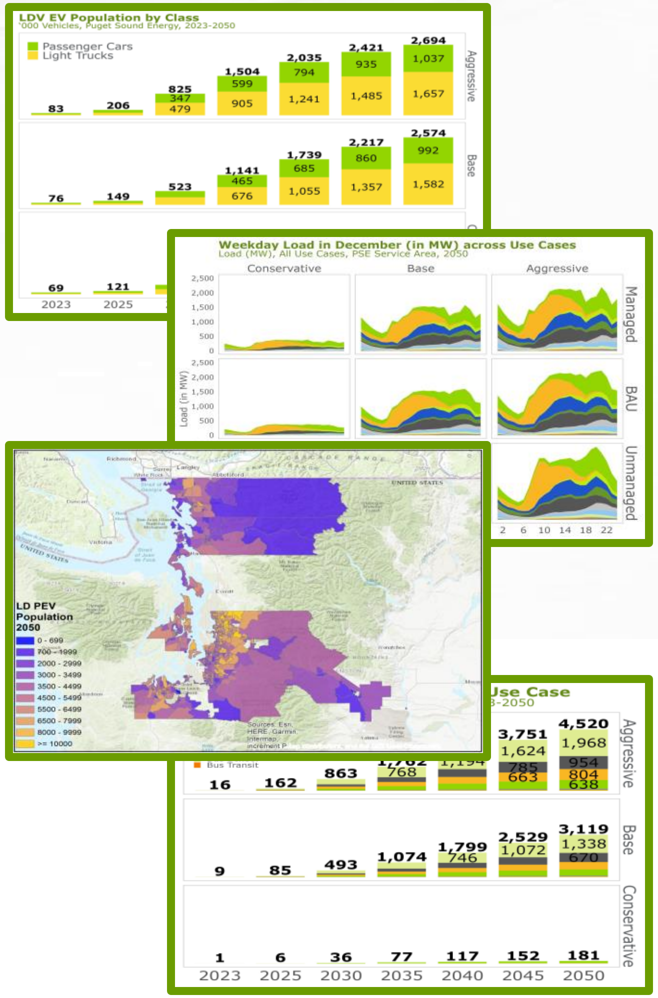
EV adoption and associated energy requirements in PSE's service area are expected to grow significantly: An average of **330 GWh per year** of load is estimated to be added to the PSE system (2024-2050) due to EV adoption.

Policy-defined sales targets have greatest impact: The assumption that WA will hit sales targets established under the ACC and ACT drives very high EV adoption, but it is not certain whether these targets will be achieved.

The magnitude of the energy requirements associated with EVs may vary: While EVs will introduce a substantial amount of energy to the PSE system, uncertainty regarding the success of sales targets, VMT associated with EVs, and fuel efficiency lead to a wide range of how much energy will be needed.

Uncertainty in LDV forecasts related to home charging: As more individuals without access to home charging adopt EVs, dependence on workplace and public market charging will likely grow.

Uncertainty in MHDV forecasts related to unknown market behavior: As a nascent market, it is still unclear what the charging needs and behavior may be for large vehicles (e.g., Long-Haul trucks) as duty-cycle, battery efficiency, and use of in depot vs en route charging are not yet well-established.



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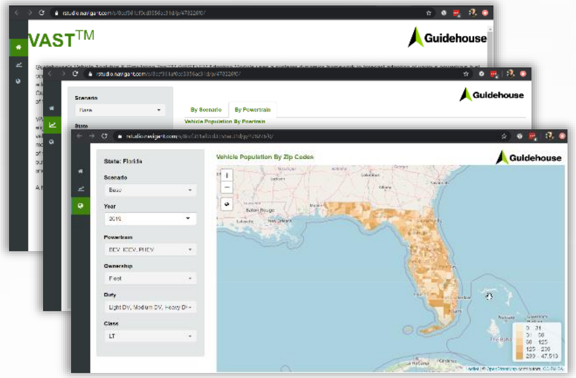
VAST Overview

VAST Suite Overview

Guidehouse's Vehicle Analytics & Simulation Tool (VAST) Suite uses in-house datasets and industry insights to provide market transparency as a single / repeatable source of truth for EV analysis needs.

EV Adoption



EV Market Assessment
How many vehicles are on the road by type and location?

EV Charging Needs

EV Charging Infrastructure Plan
What charging infrastructure is required to support these vehicles?

EV Load Impacts

EV Load Impacts
What are the energy impacts (kWh, kW) at the distribution system levels, including managed charging?

Key Business Use Cases for VAST Solution Outputs

- Clean Transportation Electrification Roadmap Development
- Integrated Resource Planning
- Distribution Planning

- Load Forecasting
- Charging Infrastructure Planning
- Infrastructure Siting Analysis
- Customer Program Design

- Benefit-Cost Analysis
- Regulatory Filing & Rate Design
- Stakeholder Engagement
- Economic Development Impacts

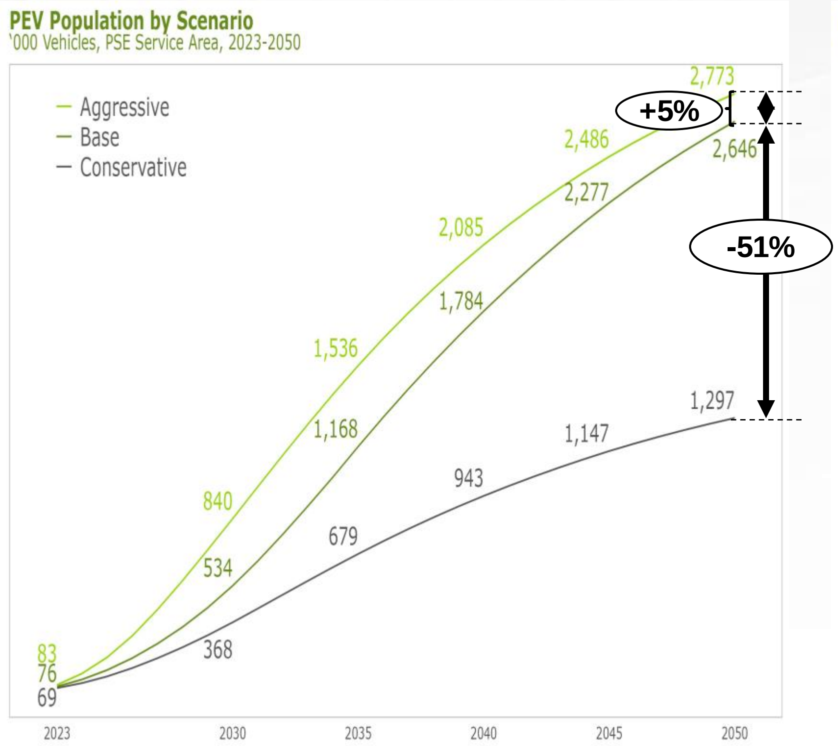
Guidehouse Outwit *Complexity*

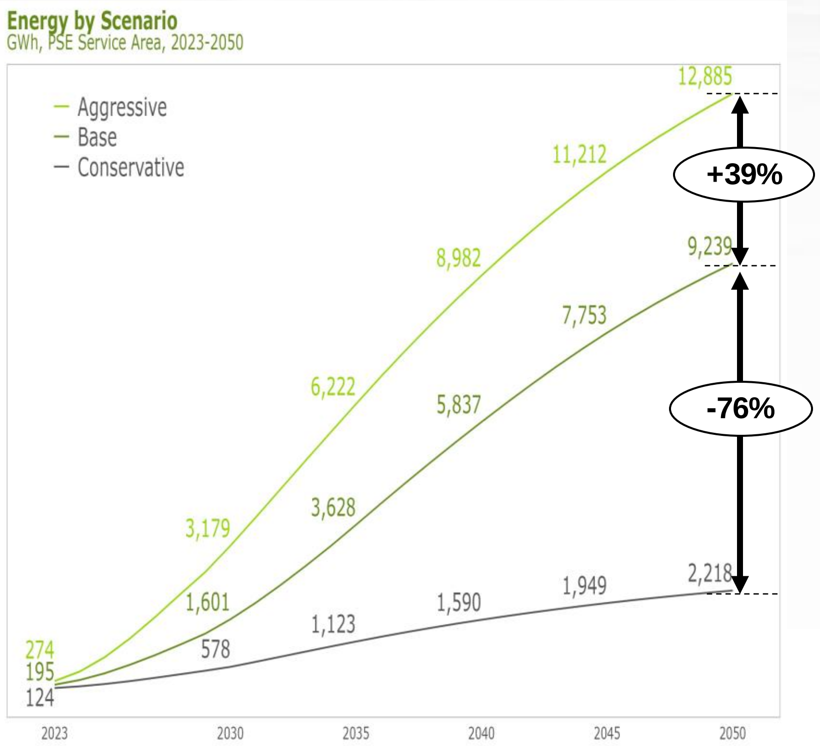
Scenario Analysis

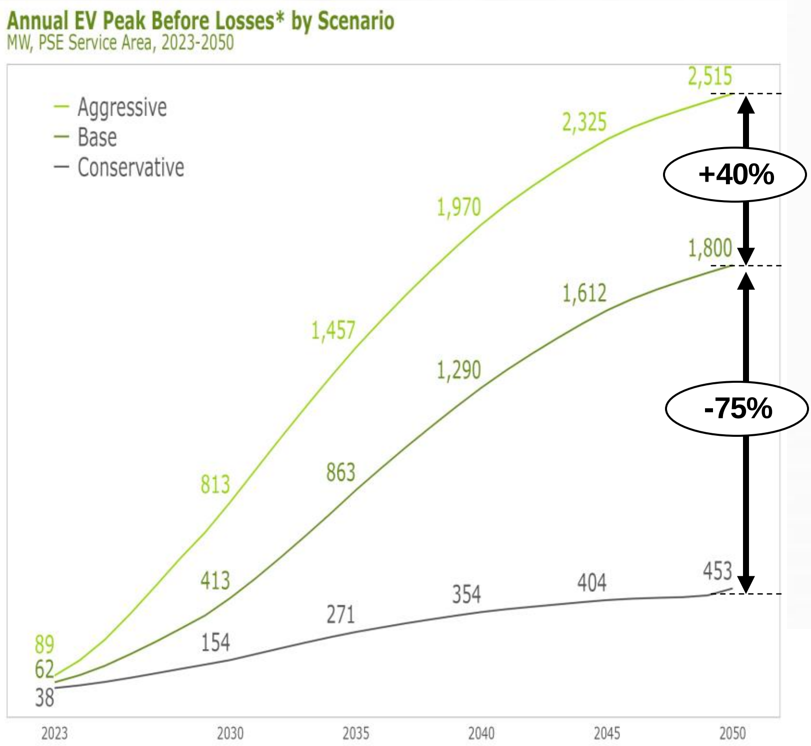
Scenario Definitions

Drivers	Description	Conservative Scenario	Base Scenario	Aggressive Scenario
Incentives	Dollar per EV tax incentive ($)	Any existing and planned **incentives discontinued**	**Currently existing and planned** incentive policies	**Additional "cash on the hood" incentive** per vehicle covering 50% of incremental cost of EV over ICEV
Vehicle Cost	EV MSRP ($)	**15% higher EV MSRP** vs. base forecast (leading to increased EV operating costs)	**Base EV MSRP** forecast - GHI	**15% lower EV MSRP** vs. base forecast (leading to decreased EV operating costs)
Fuel Prices	Gasoline and diesel prices ($ per gallon)	**25% lower gasoline and diesel prices** vs. base (leading to decreased operating ICEV costs)	**AAA average base** assumption, adjusted for inflation	**75% higher gasoline and diesel prices** vs. base (leading to increased operating ICEV costs)
Consumer Awareness & Acceptance	Marketing & outreach impacting customer familiarity (i.e., awareness, acceptance)	**1/3 lower consumer awareness and acceptance** vs. base (leading to decreased EV adoption)	**Base assumption** calibrated to Washington's historical consumer awareness metrics - GHI	**1/3 higher consumer awareness and acceptance** vs. base (leading to increased EV adoption)
Regulations	Policies regulating ICEVs and EVs	**Policy overturned or not met**	**Adoption consistent with Advanced Clean Cars II 2035 Targets**	**Adoption consistent with Department of Ecology's 2030 Targets**
MHD Trucks	Assumptions on MHD Truck electrification	**No HD Trucks and 40% Capped Market Share for MD Trucks**	**Adoption consistent with Advanced Clean Trucks 2035 Targets**	**Adoption consistent with Advanced Clean Trucks 2035 Targets**
Vehicle Miles Traveled	Annual VMT by vehicle class and powertrain	**30% lower VMT** vs. base (leading to decreased energy requirement)	**Base assumption** from FHWA, EMFAC, EDF and AFDC	**30% higher VMT** vs. base (leading to increased energy requirement)

Scenario Comparison – PEV Population & Load Impacts







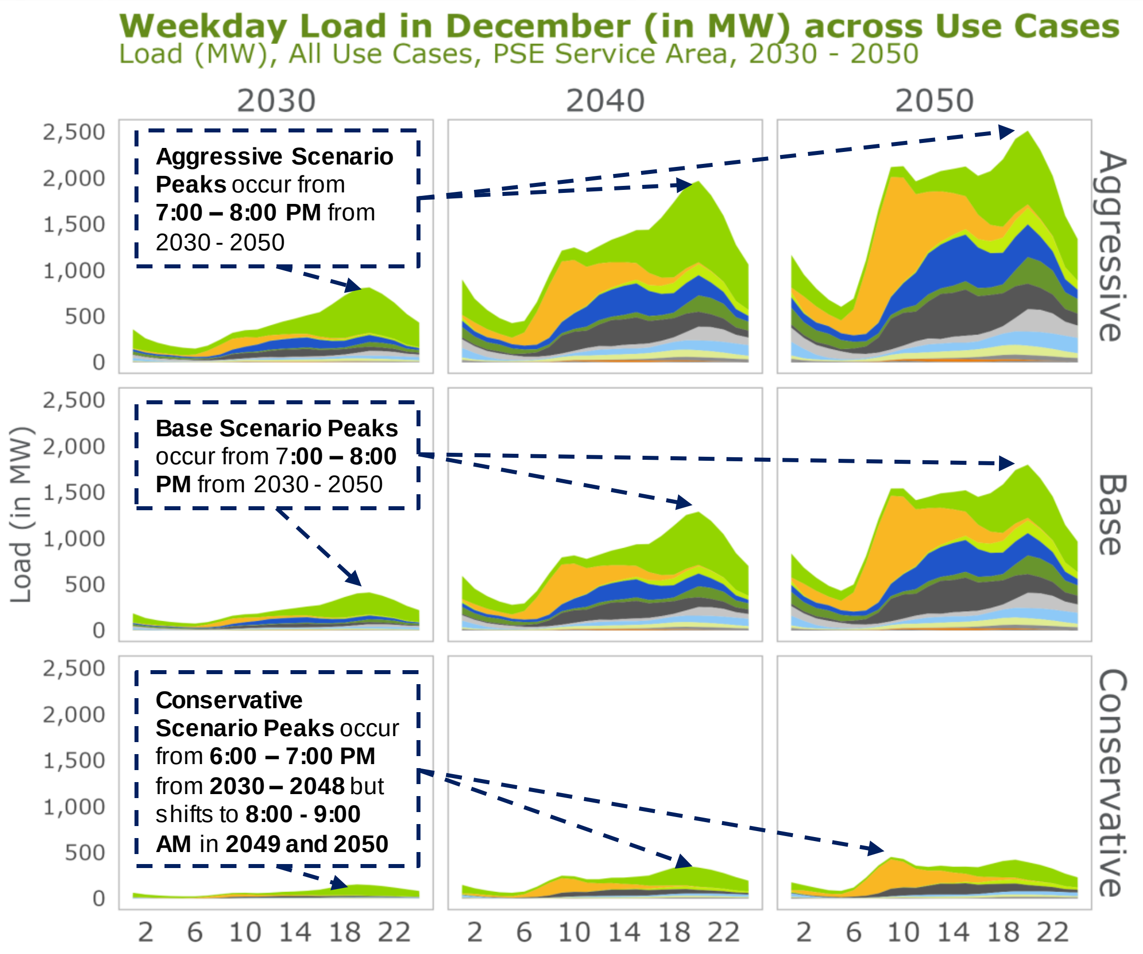
- Under the **Base and Aggressive**, the ACC and ACT are similarly implemented, and the scenarios **differ by only 5% in 2050**
- The **Conservative Scenario decreased by 51% from the Base Scenario in 2050**, driven primarily by the removal of the ACC and the elimination of HDV adoption

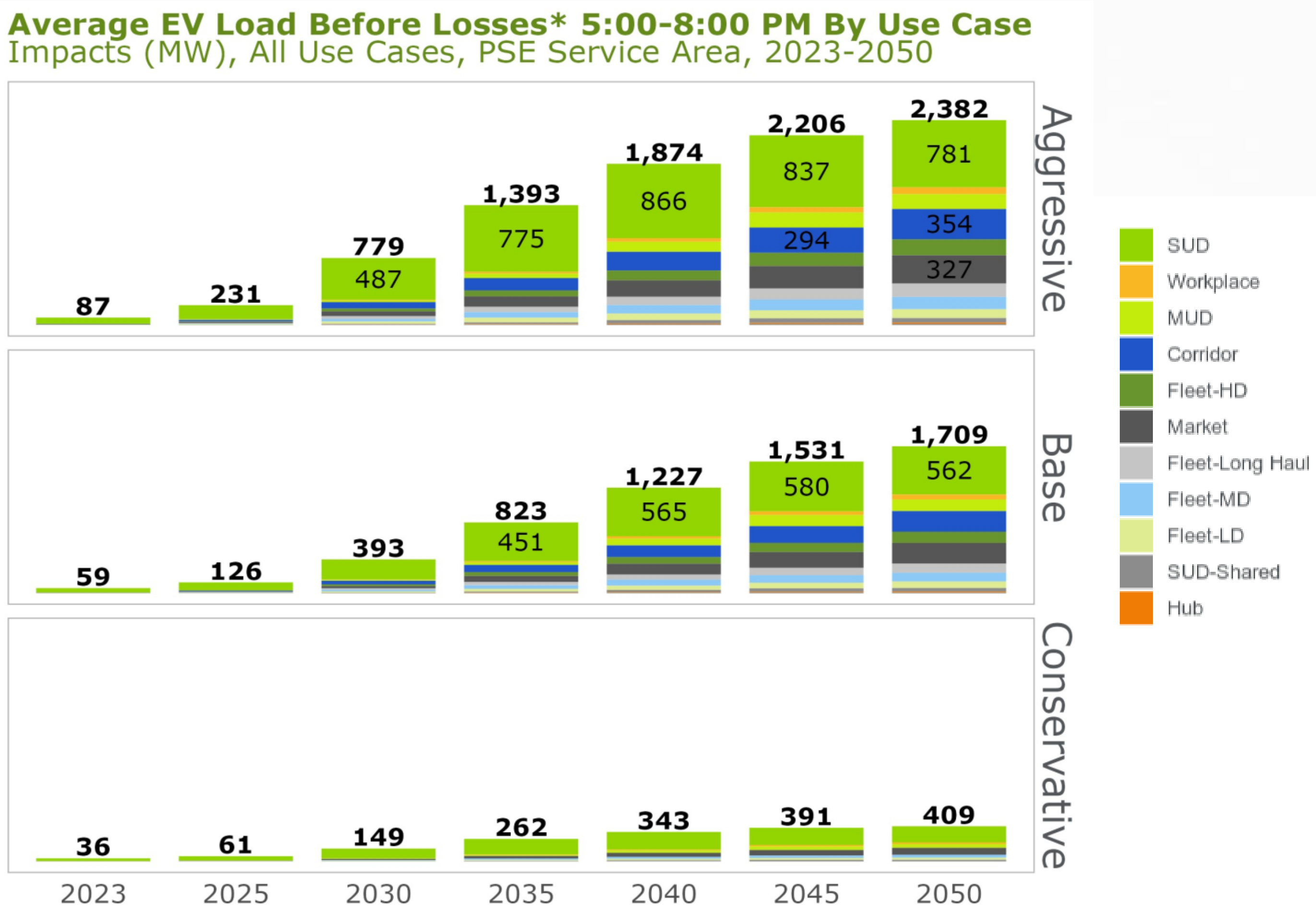
- The Energy Requirement under the **Aggressive Scenario increased by 39% Base Scenario in 2050** driven primarily by a 30% increase in VMT
- The Energy Requirement **Conservative Scenario decreased by 76% the Base Scenario in 2050** driven by substantial decreases in PEV population and the 30% decrease in VMT

- Similarly to the Energy Requirement, Annual EV Peak Before Losses* is impacted by the **30% VMT adjustment and the decrease in PEV population**, leading to a **40% increase in 2050 under the Aggressive Scenario** and a **75% decrease in 2050 under the Conservative Scenario**

Average of EV Load before Losses* from 5:00 to 8:00 PM for Adoption Scenarios

By 2050, the average of EV Load before Losses* from 5:00 to 8:00 PM is forecasted to range from 409 MWs under the Conservative Scenario to 2,382 MWs under the Aggressive Scenario





* The Annual EV Peak Before Losses is not coincident with PSE's system peak and occurs at the customer's meter.

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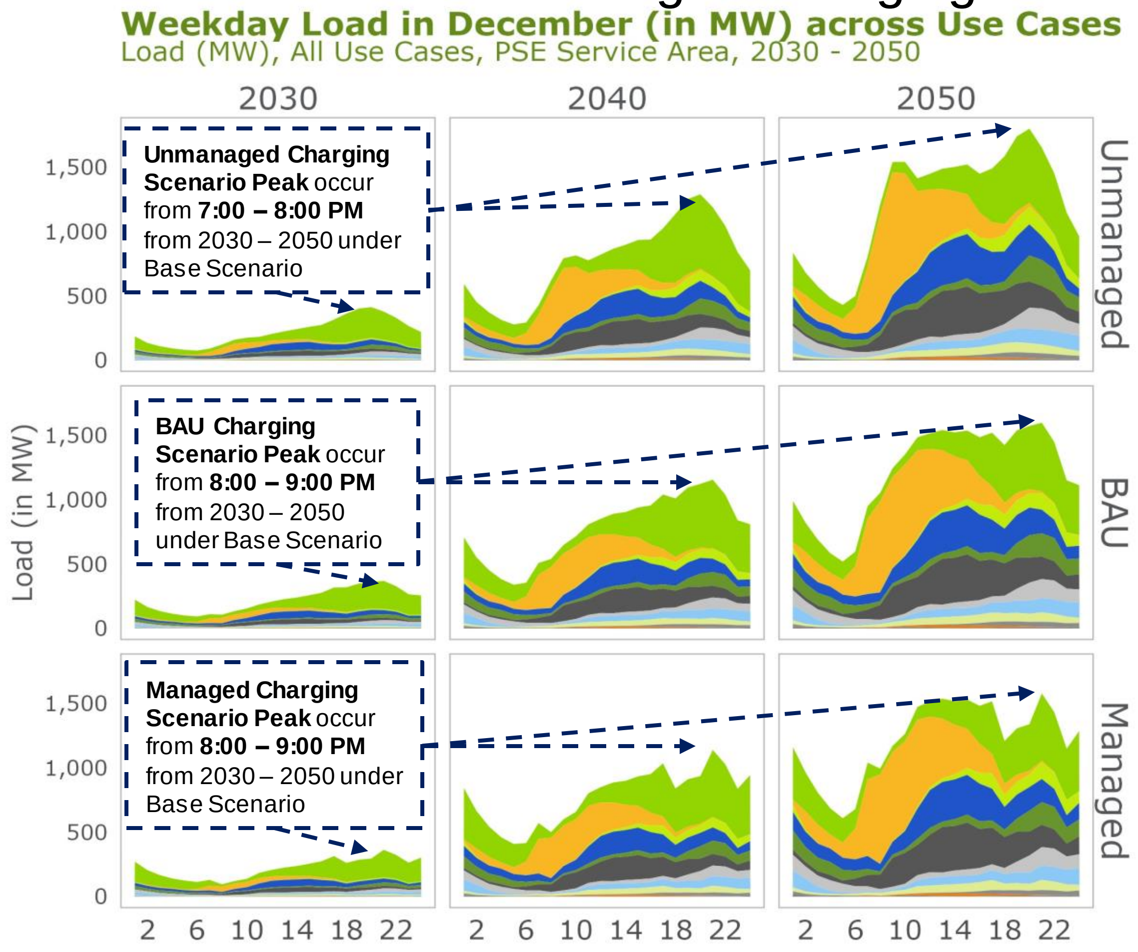
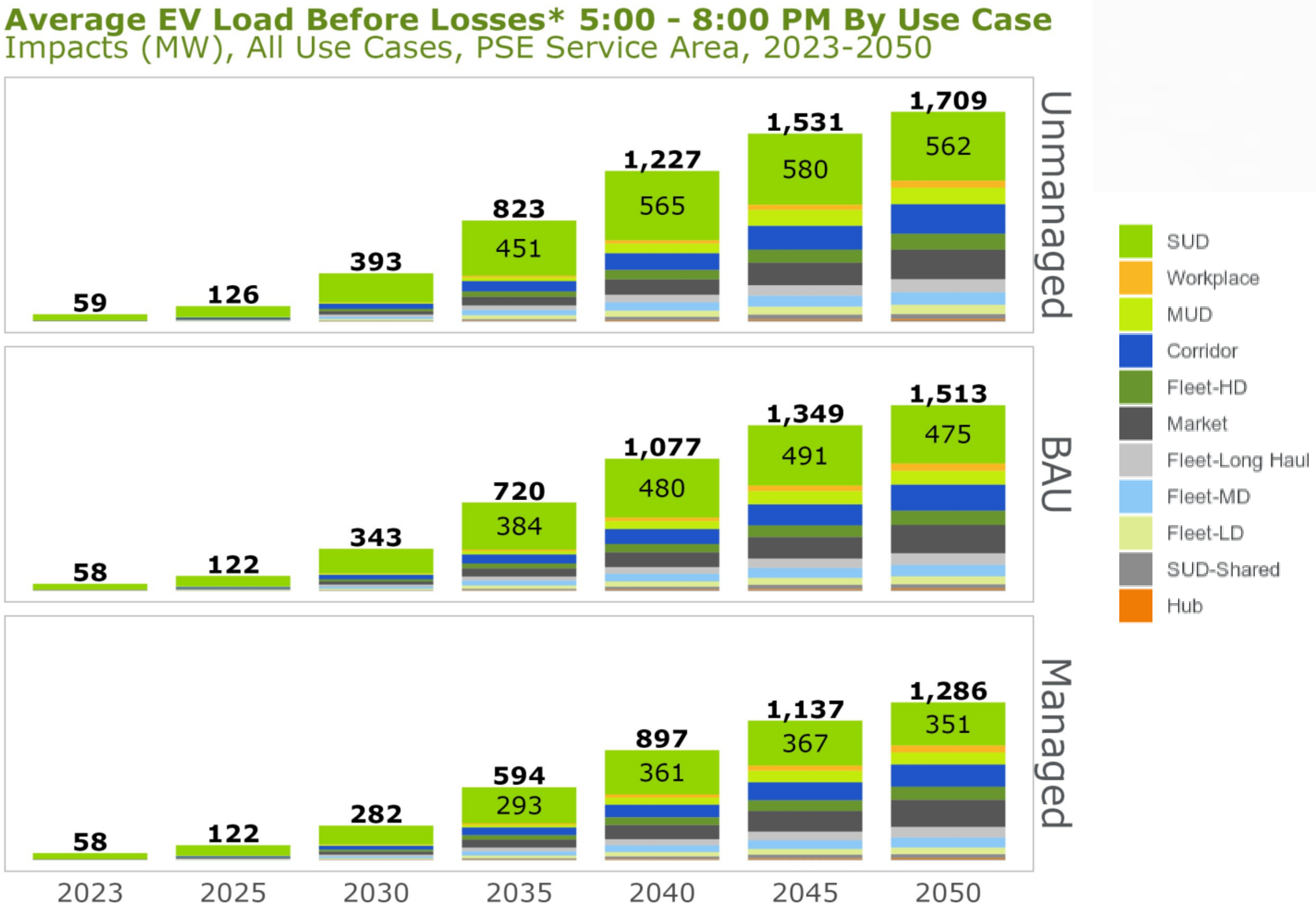
Average of EV Load before Losses* from 5:00 to 8:00 PM for Managed Charging Scenarios

By 2050, under the Base adoption scenario, the average of EV Load before Losses* from 5:00 to 8:00 PM is forecasted to range from 1,286 MWs under the Managed Charging Scenario to 1,709 MWs under the Unmanaged Charging Scenario





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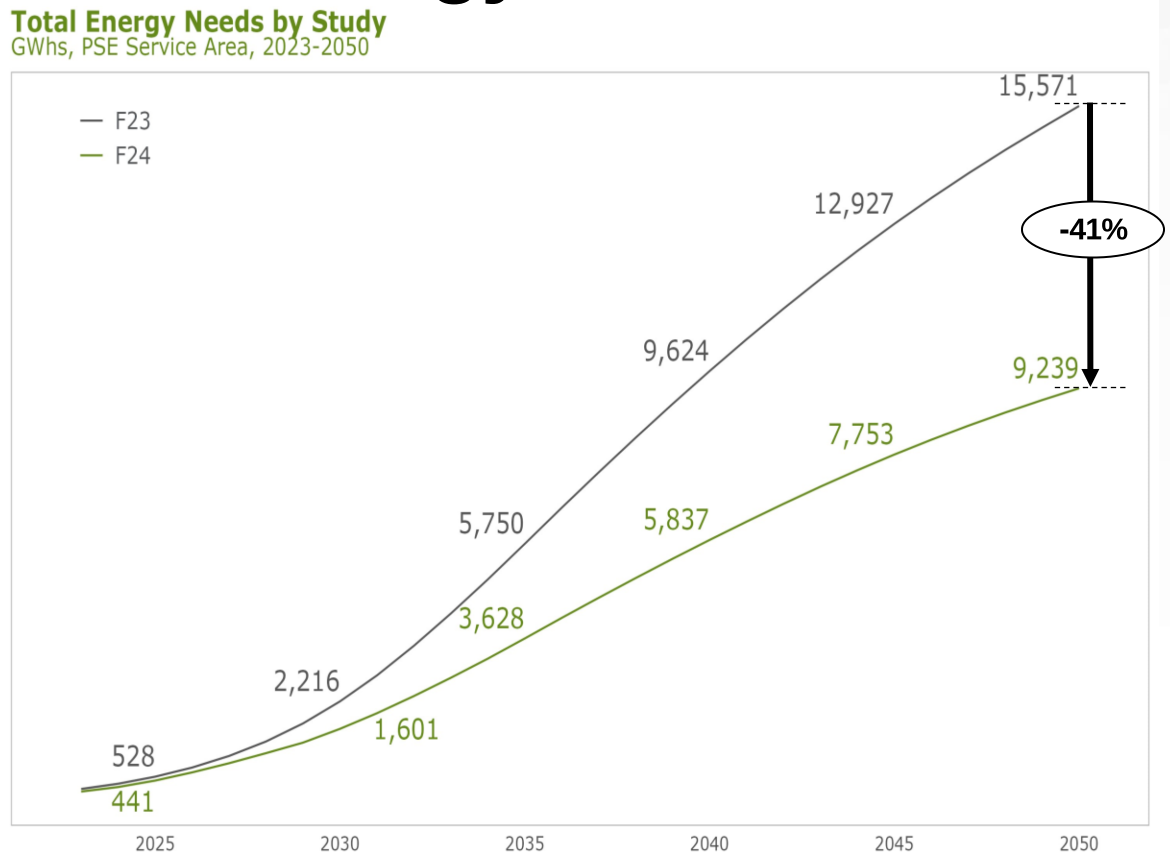
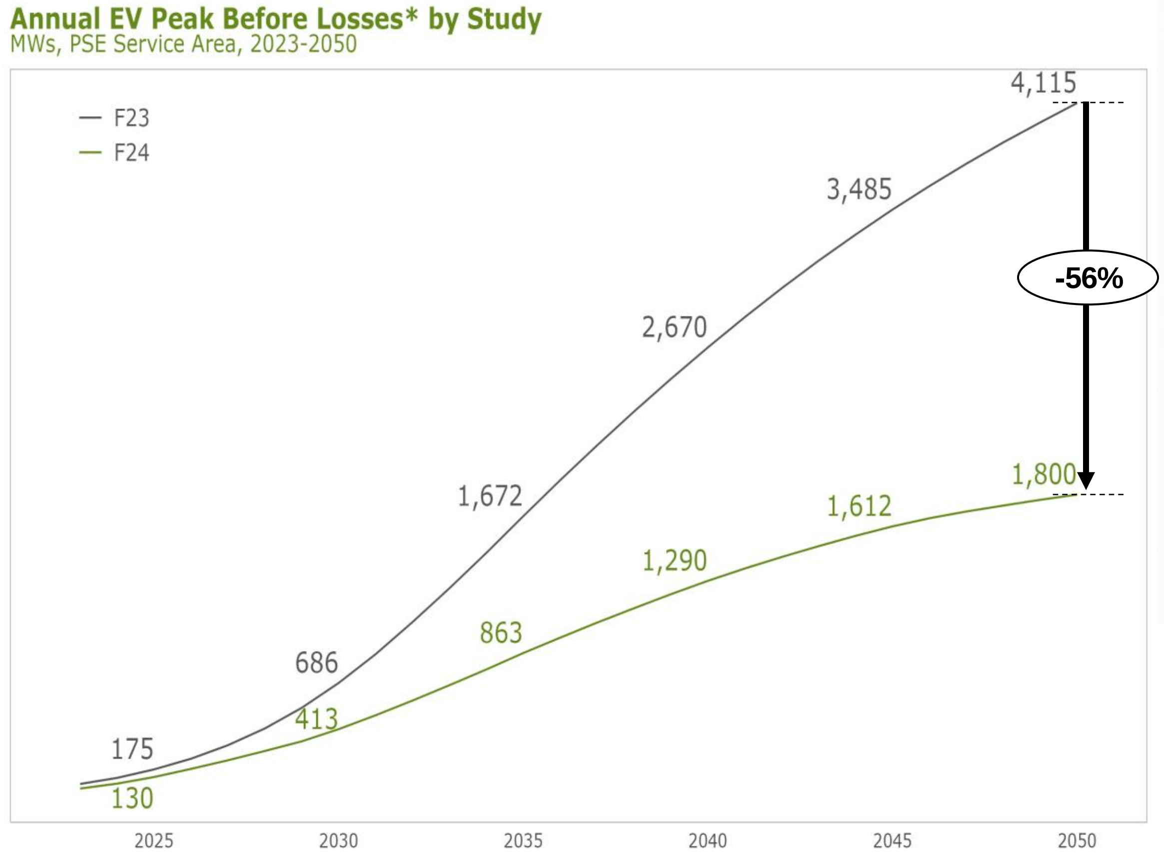
F23 vs F24 EV Forecast –
Total Energy & Annual EV Peak Before Losses





- F24 EV Forecast incorporated refinements to the vehicle miles traveled assumptions, specifically with relation to the Semi Truck and Delivery Truck classes
- F24 EV Forecast introduced the Long Haul and Short Haul classes, implemented to address variations of the Semi Truck driving needs and duty cycle

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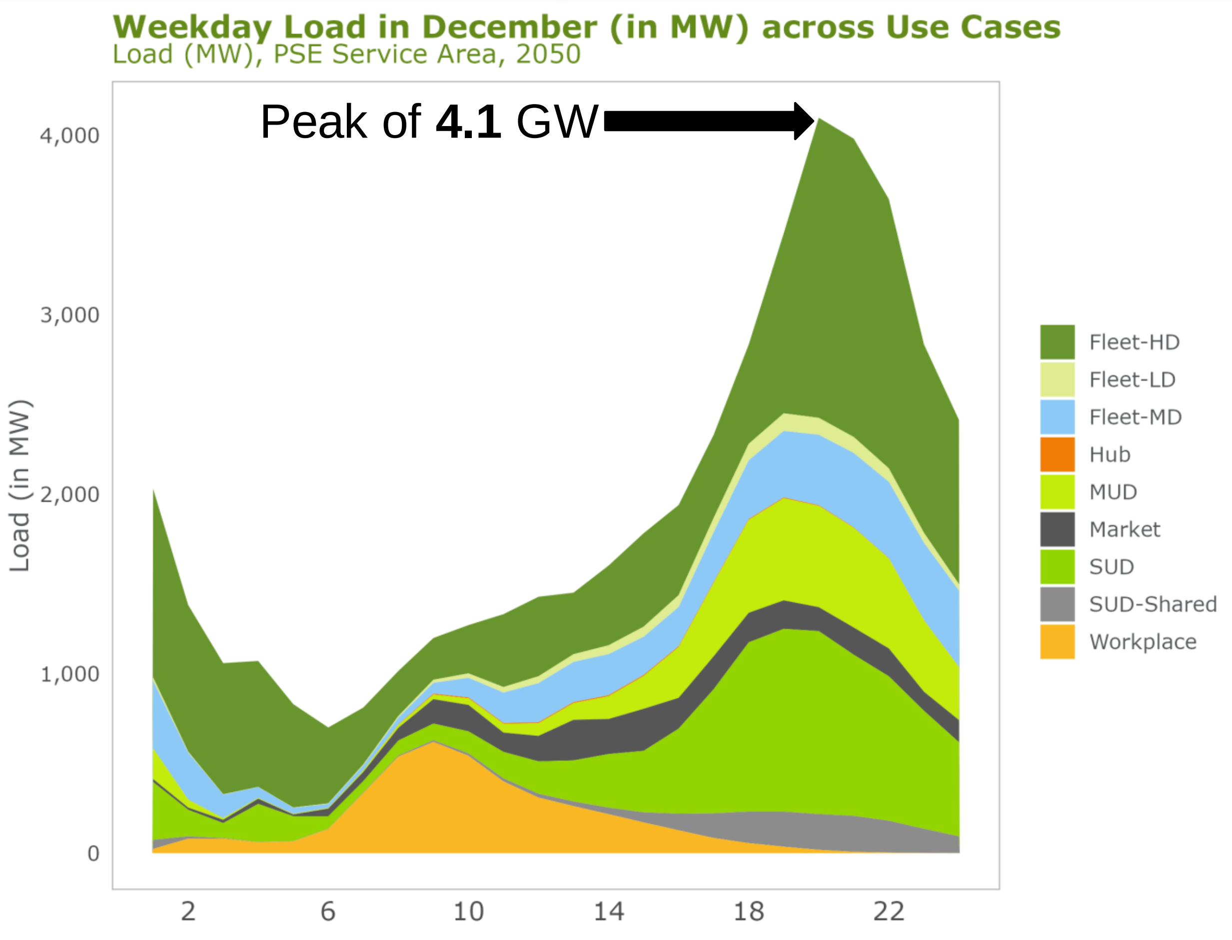
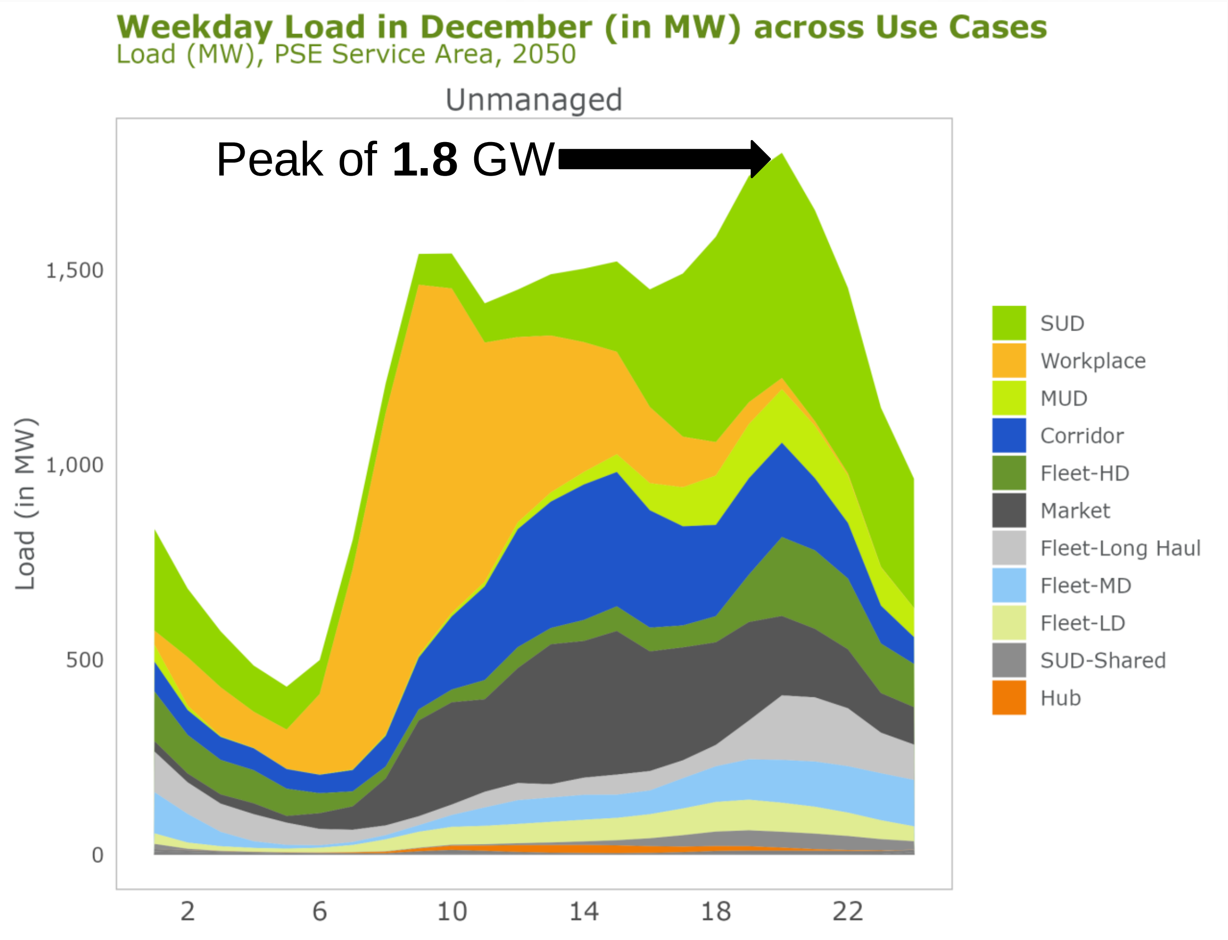
Study load shape comparison

Corridor and charging access flattened the load shape

F23 analysis



F24 analysis



Demand response programs

Jeff Tripp, PSE
Tom Smith, PSE

IAP2 Spectrum

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INCREASING IMPACT ON THE DECISION

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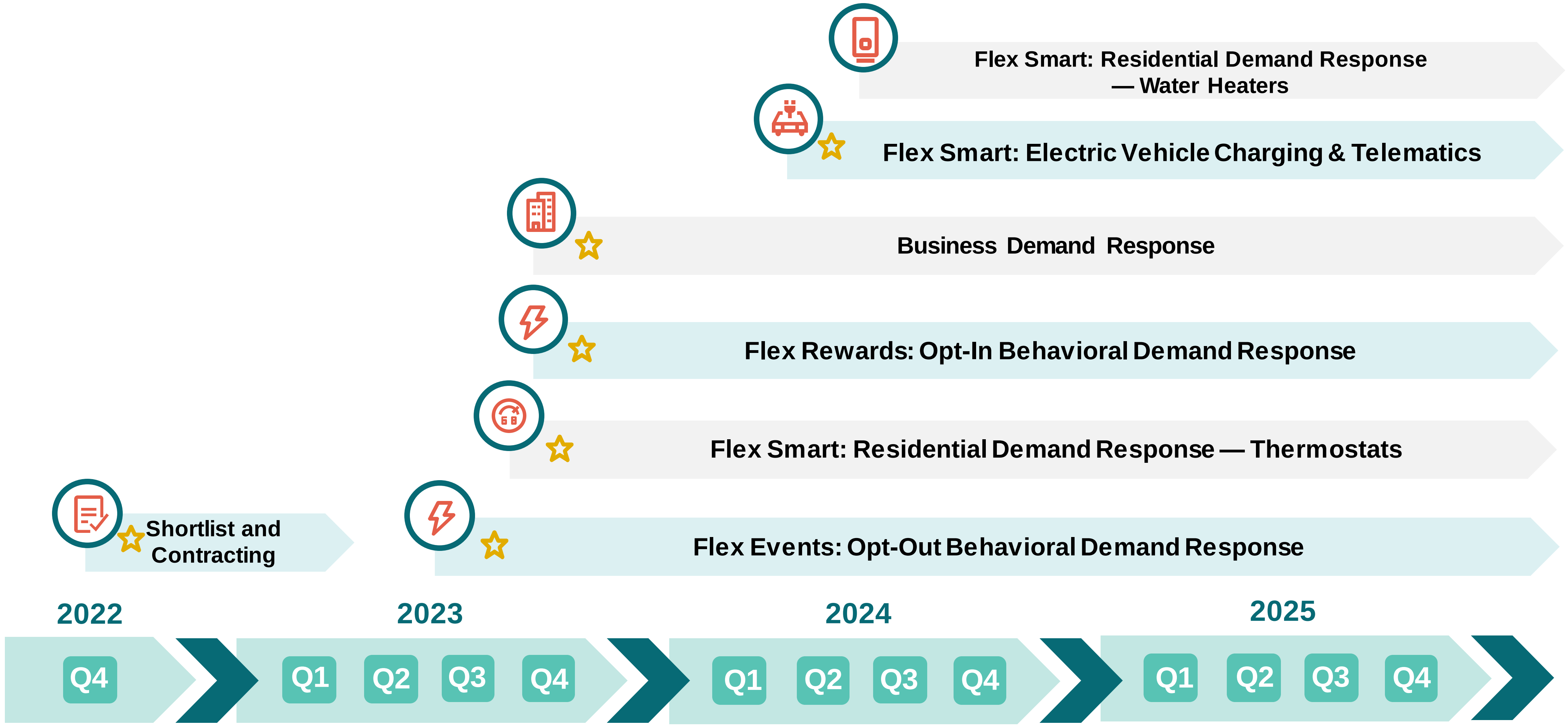
Demand response update

Timeline:

- 2021 CPA/IRP identified a DR capacity need of 23.66 MWs by 2025
- 2021 CEIP filed a target of 23.7 MWs by 2025
- 2022 DER RFP issued for 24 MWs of DR by 2025
- 2022 General Rate Case established a performance incentive mechanism (PIM) and threshold starting at 40 MWs by 2024
- 2022 PSE selected all cost-effective DR proposals
- 2023 CPA/IRP Electric Update identified additional DR capacity needs
- 2023 PSE contracted with their DR vendors from 2022 RFP proposals
- 2023 Started implementing DR programs
- 2023 CEIP update amended DR target to 86 MWs by 2025

PUGET SOUND ENERGY

Demand response program rollout timeline



What flex programs are there?

FLEX SMART
~19 MW

- Adds ~12k customers/year
- Customers receive rewards for ***enrolling smart devices*** in automatic energy reduction such as
  - Thermostats
  - EVs
  - EV Chargers
  - Water Heaters
  - Residential Batteries

FLEX REWARDS
~5 MW

- Adds ~16k customers/year
- No smart device required
- Customers receive rewards for ***manually reducing*** their energy usage

FLEX EVENTS
~5 MW

- Up to 500k customers
- Customers notified and given tips on how to **reduce their energy usage**
- Minimum 30% Named Community penetration

BUSINESS DR
~3 MW

- Adds ~50 customers/year
- Businesses receive payments for participating in ***personalized energy reduction plans***

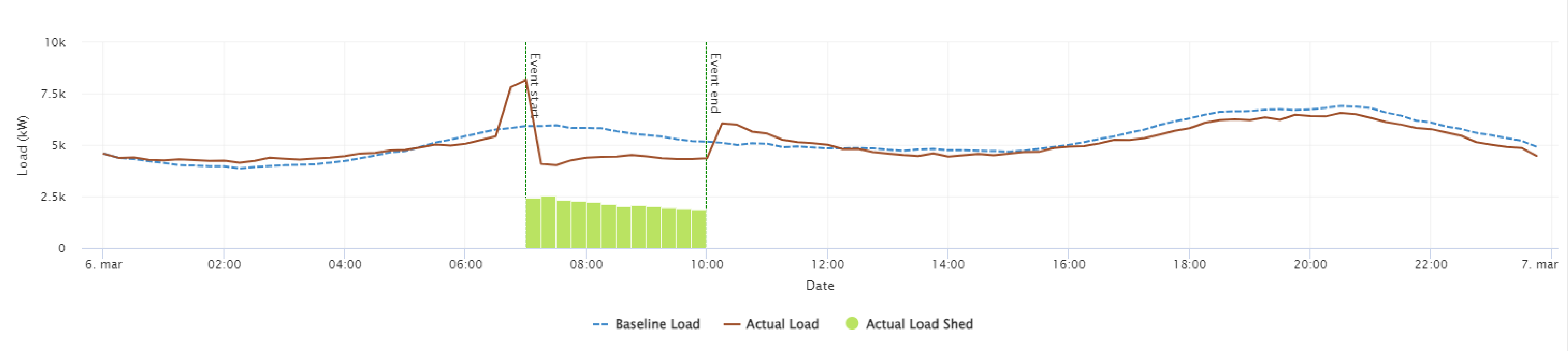
Note: *Nameplate capacities per program are as of 3/7/24.*

Virtual power plant demand response events dispatched

Event Date	Forecast Shed (kW)	Avg Net Load Shed (kW)	% of Forecast	Programs Dispatched
12/22/2023	18,024	24,171	134%	Flex Smart, Flex Events, Flex Rewards
1/12/2024	24,170	22,748	94%	Flex Smart, Flex Events, Flex Rewards, Business Demand Response
1/17/2024	24,539	29,298	119%	Flex Smart, Flex Events, Flex Rewards
2/8/2024	19,918	25,335	127%	Flex Smart, Flex Events, Flex Rewards, Business Demand Response, Peak Time Rebates
2/16/2024	17,119	21,105	123%	Flex Smart, Flex Rewards, Peak Time Rebates
2/27/2024	28,876	28,695	99%	Flex Smart, Flex Events, Flex Rewards, Peak Time Rebates
3/6/2024	32,729	32,623	100%	Flex Smart, Flex Events, Flex Rewards, Business Demand Response, Peak Time Rebates

Ecobee flex event load curve

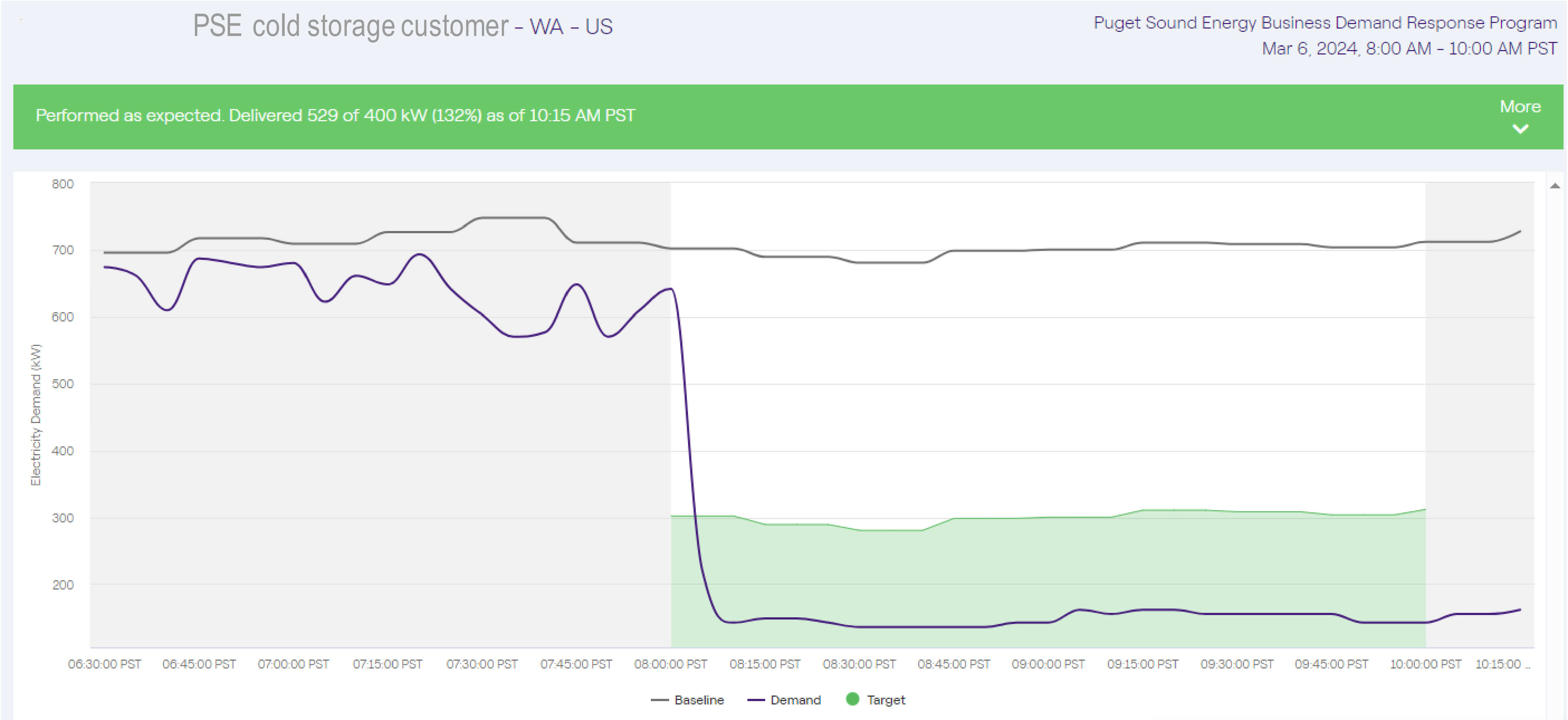
Back



Event Info	pse-20240305-27-1R2BWY
Event Date	Mar 6, 2024
Start Time	07:00 AM
End Time	10:00 AM
Duration	3 h
Notification Time	
Targeted Devices	5476

Event Results	
Actual Load Shed (kW)	2160.24
Total Energy Reduction (kWh)	6480.70
Actual Load Shed (%)	38.60%
Actual Load Shed Per Meter (kW)	0.82
Actual Meter Count	2644
Opted Out Resources	0

Cold storage customer flex event load curve



Business demand response

EVSE and EV telematics went live March 7

- 69 chargepoint
- 28 wallbox
- 30 JuiceBox
- 1 EVOCHARGE
- 540 EVs

Ford

TESLA

LEXUS

PORSCHE

HYUNDAI

KIA

NISSAN

BMW

JAGUAR

PSE PUGET SOUND ENERGY

CADMUS

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2025 IRP: Conservation Potential Assessment

April 17, 2024

IAP2 Spectrum

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PUBLIC PARTICIPATION GOAL	To provide the public with balanced and objective information to assist them in understanding the problem, alternatives and/or solutions.	To obtain public feedback on analysis, alternatives and/or decision.	To work directly with the public throughout the process to ensure that public concerns and aspirations are consistently understood and considered.	To partner with the public in each aspect of the decision including the development of alternatives and the identification of the preferred solution.	To place final decision-making in the hands of the public.
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INCREASING IMPACT ON THE DECISION

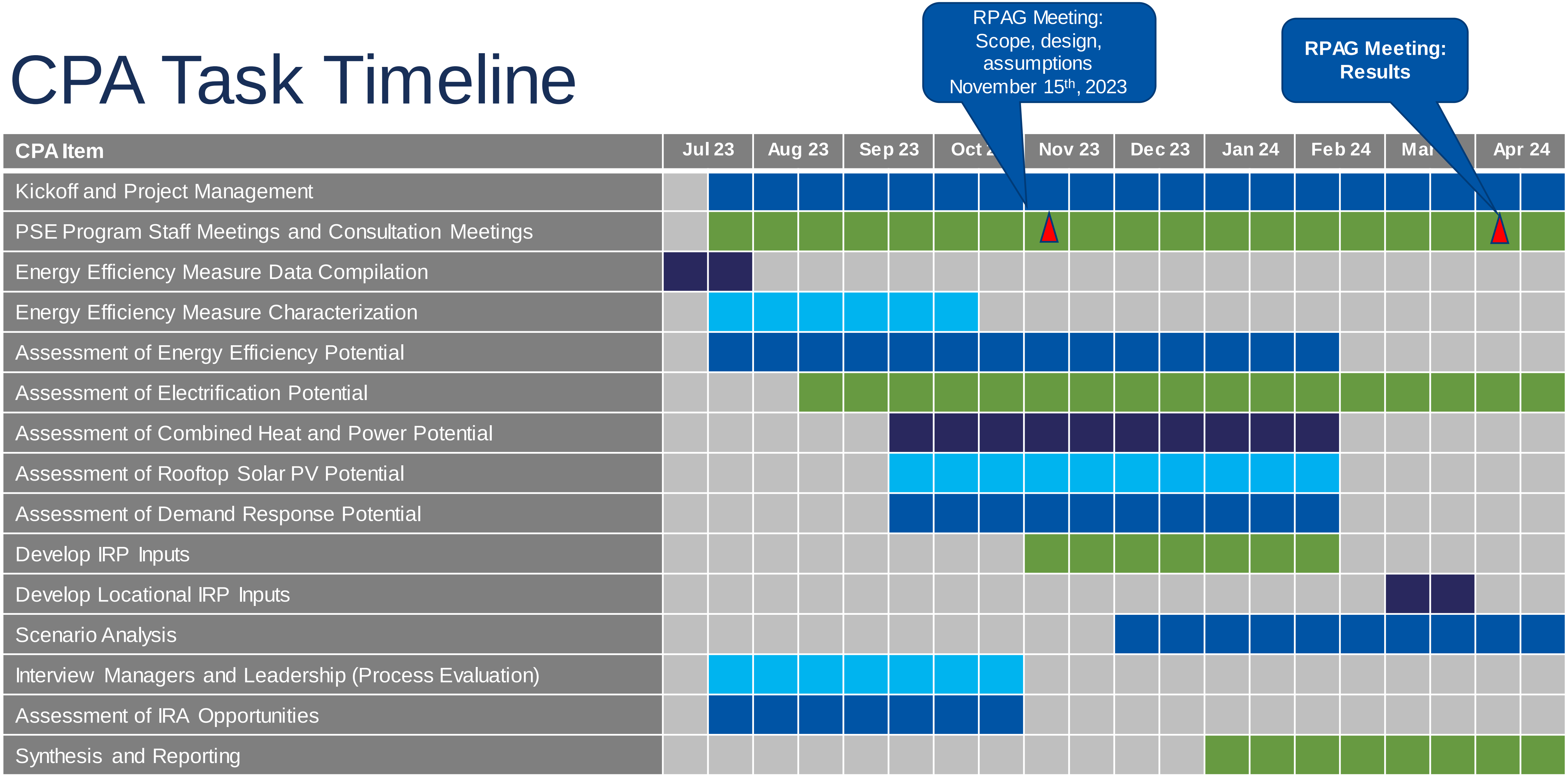
PUGET SOUND ENERGY

Agenda

- CPA Task Timeline
- Overview of the CPA – Main Themes
- Energy Efficiency Methodology Overview
- Electric Energy Efficiency Potential
- Natural Gas Energy Efficiency Potential
- Demand Response Potential
- Rooftop Solar PV Potential

CADMUS

CPA Task Timeline



PSE PUGET SOUND ENERGY

CADMUS

Overview of the CPA – Main Themes

Resources	Energy Efficiency (EE) Demand Response (DR) Solar PV Combined Heat and Power (CHP) Distribution Efficiency
Fuels	**Electric** – EE, Solar PV, DR, CHP, Gas to Electric **Natural Gas** – EE, Gas to Electric

Underserved Communities	Climate Change	IRA Research and Impacts
Codes and Standards / Non-Energy Impacts	Scenario Analysis, Locational Analysis & IRP Bundles	Program Research

Blue = consistent with the prior CPA

Green = new to this CPA

PUGET SOUND ENERGY

CADMUS

Results Expectations Today

Presentation contains **Reference Case Potential Only**

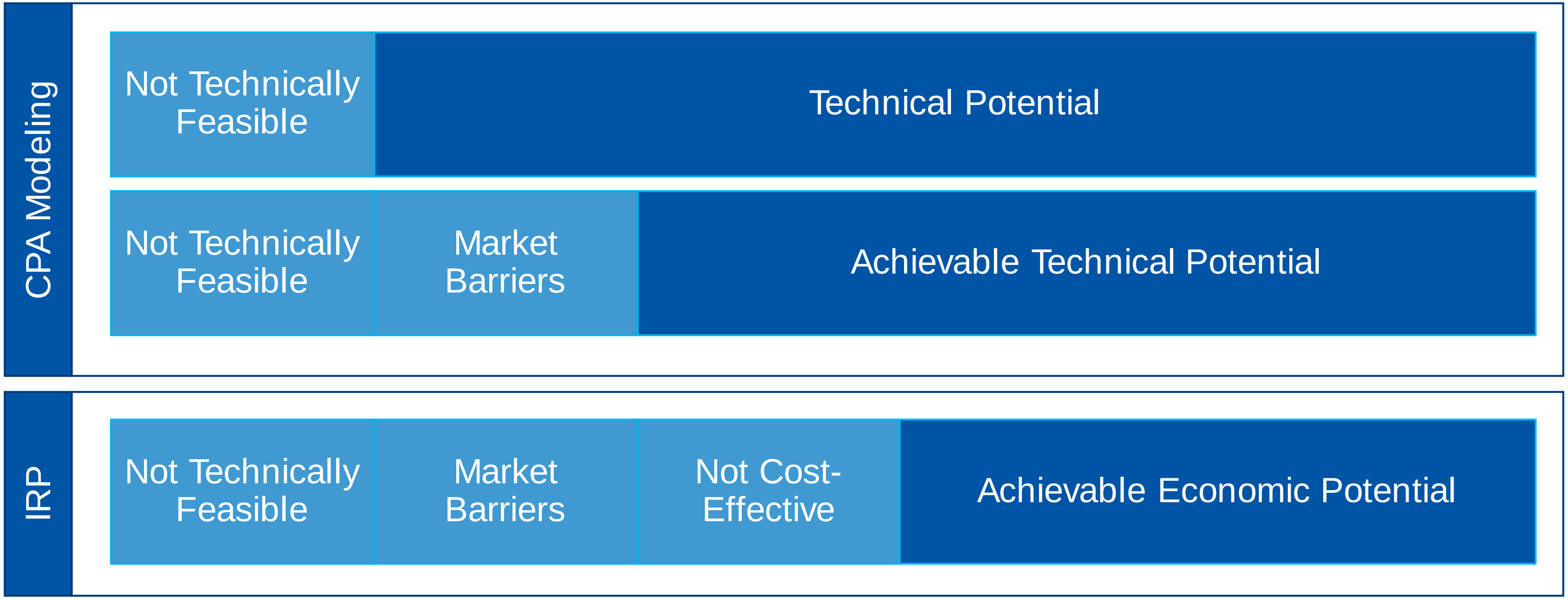
That means…

- Potential relative to PSE's base case forecast
- Energy efficiency potential results without electrification impacts
- Electrification modeling in progress
- Potential results represents achievable technical potential (not economic)
- All results shown at the generator (unless specified)

Energy Efficiency Methodology Overview

CADMUS

Types of Energy Efficiency Potential



PUGET SOUND ENERGY

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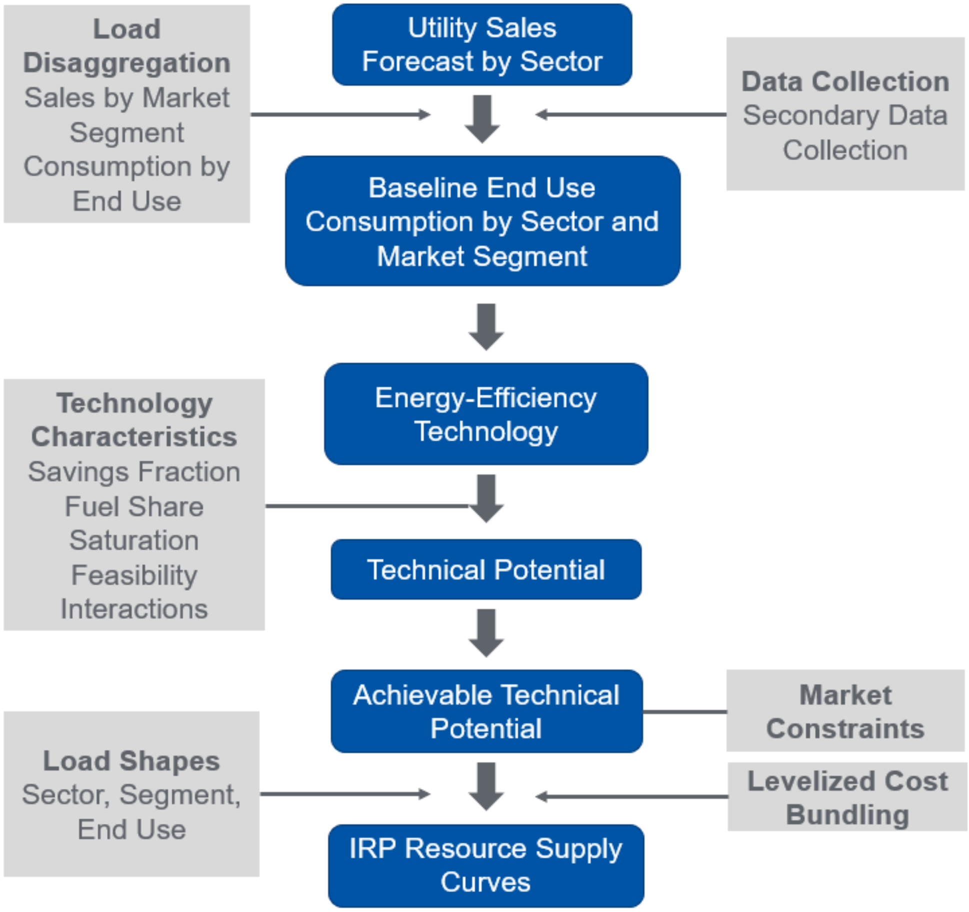
Energy Efficiency – Methodology Overview

Steps for estimating conservation potential

1. Compile Measure Data
2. Develop End-Use Forecast
3. Calculate Technical Potential
4. Calculate Achievable Technical Potential
5. Calculate Levelized Costs
6. Develop Supply Curves for IRP Modeling



PSE PUGET SOUND ENERGY

CADMUS

Energy Efficiency - Electric & Natural Gas

Estimating technical and achievable electric and natural gas 2026-2050 energy efficiency potential for PSE's residential, commercial, and industrial sectors (including streetlighting and indoor agriculture)

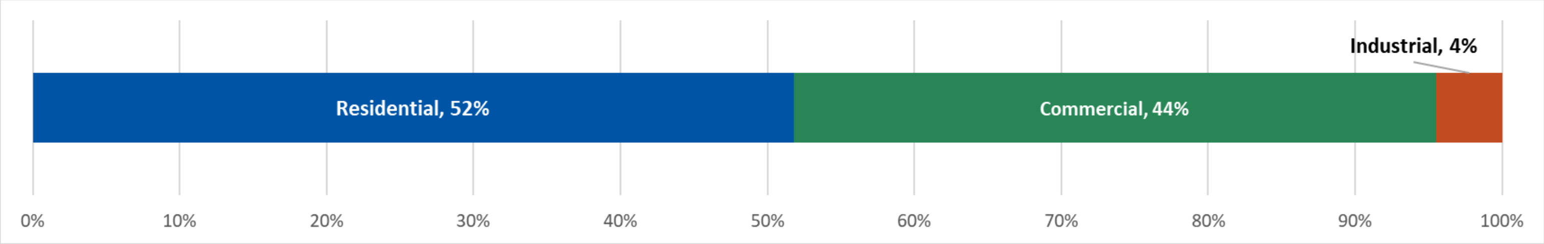
- **Federal, state, and local codes and standards** – On-the-books state codes WSEC 2021 and RCW; on the-books federal standards and the 2029 gas furnace standard
- **All electric new construction** – No natural gas load or potential in new construction in residential
- **Climate change** – Impacts weather-sensitive measures
- **Non-energy impacts** – A range of NEIs (e.g. health & safety, comfort, productivity, etc.); based on 2023/2024 Business Cases
- **Underserved Communities & Equity** – Based on vulnerable population data
- **Ramp rate** – Revised based on program research, PSE discussions, and IRA impacts
- **IRA impacts** – Incentives and adoption rates based on IRA research
- **Shared Potential Across Efficiency Tiers** – Assume share between tiers (e.g. 50% CCHP, 50% ASHP upgrade) for select technologies

Electric Energy Efficiency Potential

Electric Energy Efficiency Potential

Achievable Technical Potential

Sector	2-year (2026-2027)	4-year (2026 -2029)	10-year (2026-2035)	25-year (2026-2050)
Cumulative Achievable Technical Potential (aMW)				
Residential	18	37	115	266
Commercial	26	54	149	223
Industrial	5	9	23	23
Total	**49**	**100**	**288**	**512**



- Represents the cumulative achievable technical potential, not economic potential
- Less short-term retrofit measures available for residential than in the commercial sector

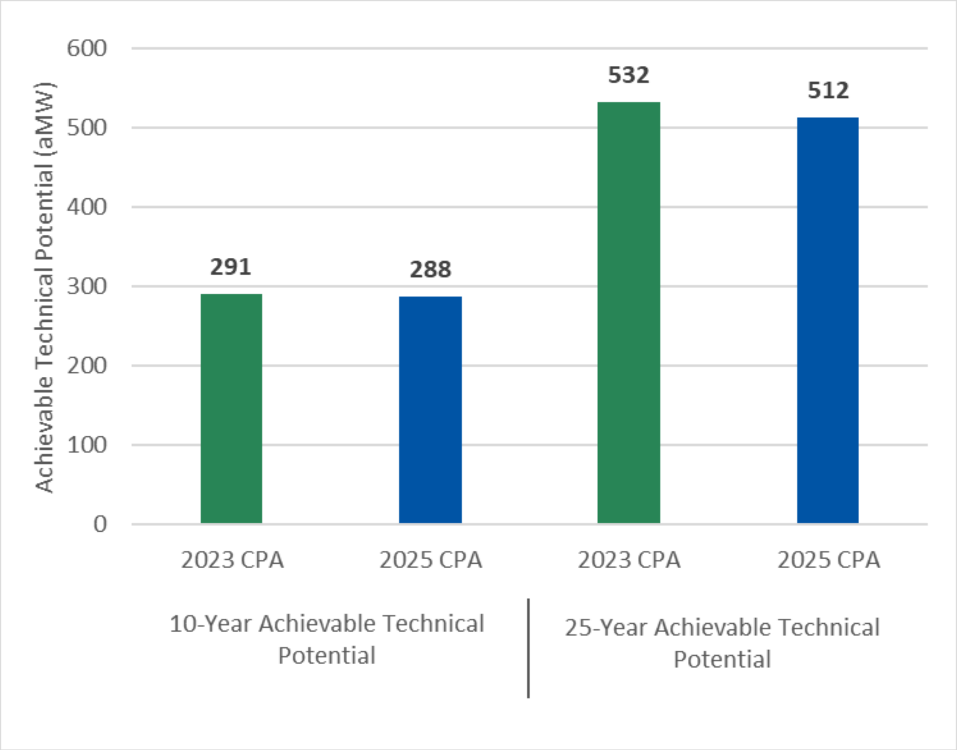
Comparison to 2023 CPA

10-year and 25-year Cumulative Electric Achievable Technical Potential (at generator)

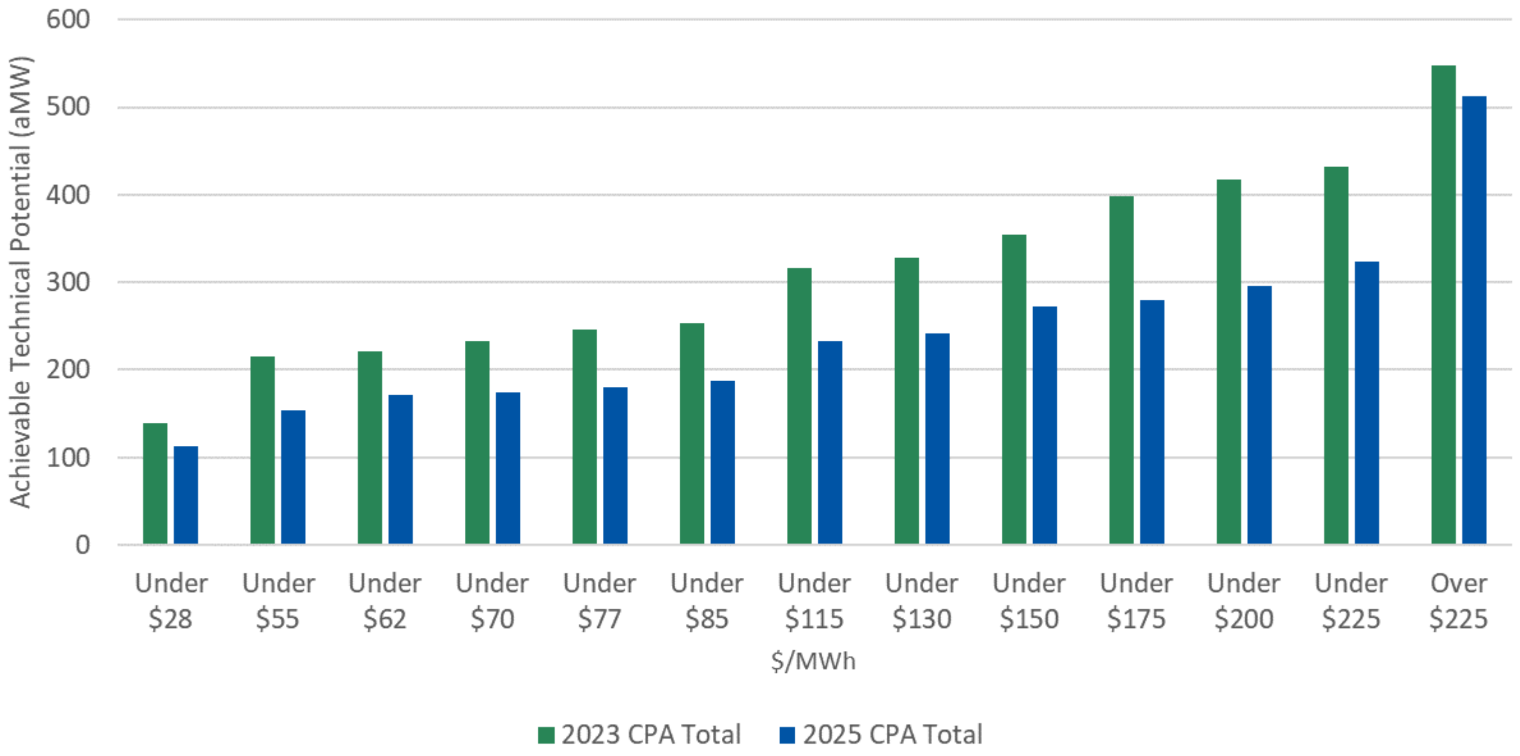
1% decrease in 10-year total potential; 4% decrease in 25-year total potential

Sector	10-Year Technical Achievable EE Potential (aMW)		25-Year Technical Achievable EE Potential (aMW)	
	2023 CPA	2025 CPA	2023 CPA	2025 CPA
Residential	103	115	287	266
Commercial	169	149	226	223
Industrial	18	23	18	23
Total	**291**	**288**	**532**	**512**

The 2023 CPA study period covers 27 years. This table shows only the first 25 years for comparison purposes.



Comparison to 2023 CPA – Levelized Cost Bundles

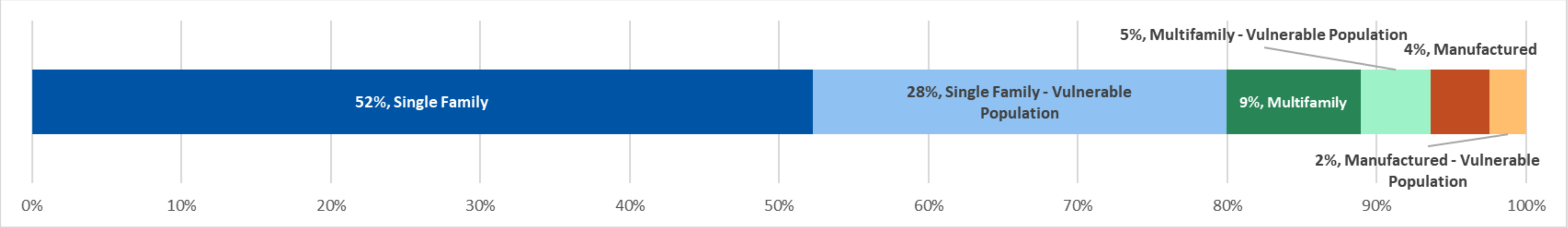


Changes from 2023 CPA

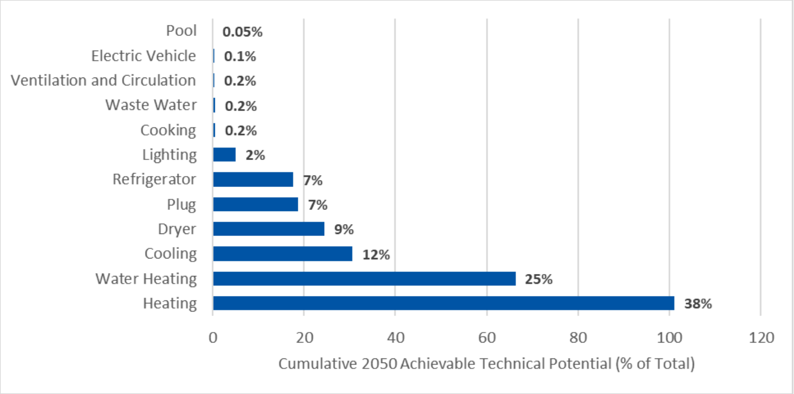
- Added more expensive energy efficiency compared to the prior CPA (e.g., cold-climate heat pumps)
- Updates in line loss and global cost inputs (avoided T&D, discount rate, $2026)

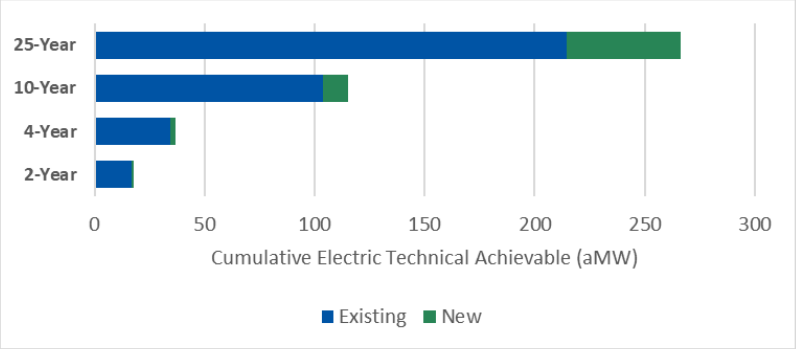
Residential Electric Energy Efficiency Potential

By Segment, End Use and Vintage



- Potential for vulnerable populations is 35% of the total residential achievable technical potential (92 aMW)
- Space and water heating end uses make 63% (167 aMW) of total residential achievable technical potential.
- New construction potential accelerates over time due to all-electric codes where heat pump equipment is required where there are upgrade opportunities to ccHP and heat pump water heaters





Top Electric Residential Measures

Cumulative Achievable Technical Potential (aMW)

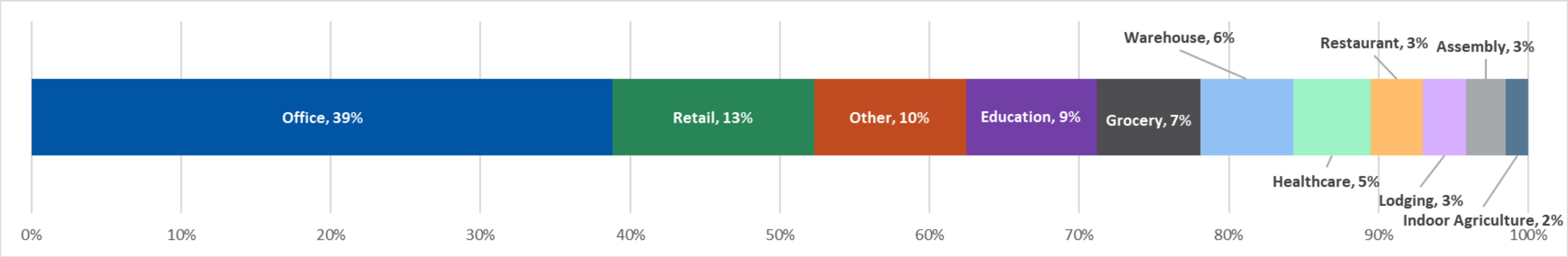
Measure Name	10-Year	25-Year
Heat Pump Water Heater - Tier 4 - No Resistance, Split System	10.8	32.3
Cold Climate Ductless Heat Pump Heat Room Electric	8.0	25.0
Heat Pump Water Heater - Tier 3	7.8	22.8
Heat Pump Dryer	2.1	20.0
Cold Climate Ducted Heat Pump	2.9	14.7
Central Air Conditioner - Enhanced	3.4	11.5
Refrigerator - ENERGY STAR 2022 Most Efficient	3.8	10.2
Central Air Conditioner - ENERGY STAR 2022 Most Efficient	2.6	8.7
Set Top Box - ENERGY STAR	4.5	7.2
Zonal to Ductless Heat Pump	3.1	6.9
Window - Film	4.4	6.5
Cold Climate Ductless Heat Pump Heat Central Electric	2.1	5.7
Behavioral - Home Energy Reports	4.3	5.6
Window - Storm Window	4.0	4.8
Insulation - Attic	3.8	4.6

Changes from the 2023 CPA

- PSE Business Case updates
- RTF updates for selected measures (lighting, water heaters, weatherization)
- Added cold climate heat pump measures
- Accounted for recent PSE program accomplishments and projected through 2025
- Updates to reflect WSEC 2021 and latest RCW
  - All electric new construction
  - Circulator pump controls required in SF new construction
- Updated ramp rates to better align with PSE programs
- Accounted for IRA incentives and their impact on measure adoption
- Shared potential across efficiency tiers assuming an even split (e.g., 50% CCHP, 50% ASHP upgrade)
- Updates in line loss and global cost inputs (avoided T&D, discount rate, $2026)

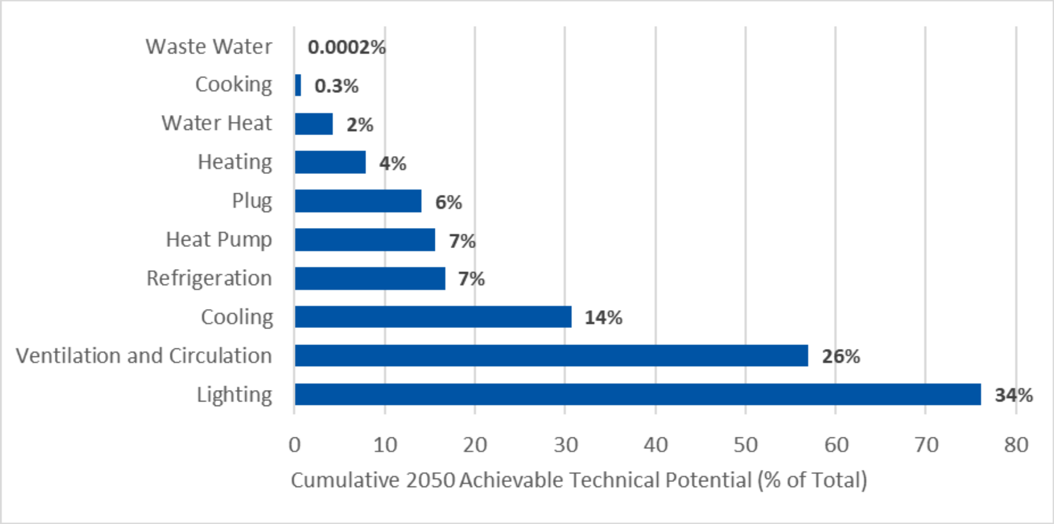
Commercial Electric Energy Efficiency Potential

By Building Type and End Use



Lighting and Ventilation Circulation end uses make 60% (133 aMW) of total commercial achievable technical potential.

Heat pump potential is significantly higher (4x) than in the prior study, driven by WSEC requiring heat pumps for most Commercial new construction.



Top Electric Commercial Measures

Cumulative Achievable Technical Potential (aMW)

Measure Name	10-Year	25-Year
Lighting - Interior - Control	37.4	42.7
Lighting - Interior - LED	16.2	16.3
Fan - VSD	3.3	15.2
Window - Upgrade	12.7	12.7
Cooling DX	2.6	12.0
Very High Efficiency Dedicated Outside Air System (DOAS)	1.3	10.4
Exit Sign	8.2	8.2
Rooftop HVAC Controls - Advanced	3.8	7.8
Heat Pump	1.9	7.8
Pump - Efficient	3.7	7.3
Fan - Efficient	2.6	6.5
Server - Efficient	5.5	6.2
Lighting - Exterior - LED	5.2	5.8
Re-Commissioning	4.0	4.9
Energy Management System	3.9	4.4

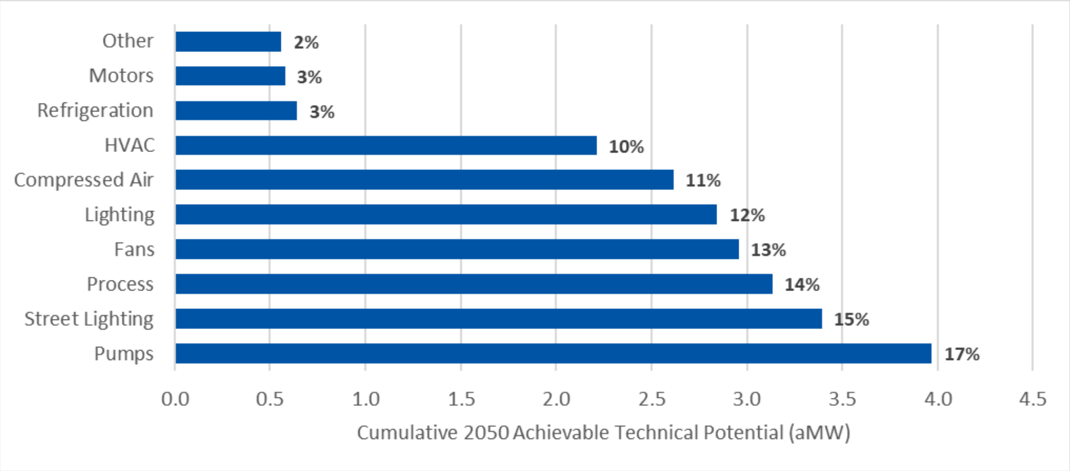
Changes from 2023 CPA

- PSE Business Case updates
- RTF updates for selected measures (pumps, fans, water heaters, weatherization, display case lighting)
- Updates to reflect WSEC 2021 and latest RCW
- Accounted for recent PSE program accomplishments and projected through 2025
- Updated ramp rates to better align with PSE programs
- Updates in line loss and global cost inputs (avoided T&D, discount rate, $2026)

Top Electric Industrial Measures

Cumulative Achievable Technical Potential (aMW)

Measure Name	10-Year	25-Year
Wastewater	3.3	3.3
Energy Management	2.8	2.8
HVAC	1.6	1.6
Lighting Controls	1.6	1.6
Streetlight - HPS 100W - Group Relamp - to LED 38W - Retro	1.4	1.4
Energy Management2	1.3	1.3
Streetlight - HPS 100W - Group Relamp - to LED 53W - Retro	1.1	1.1
Air Compressor Equipment	1.0	1.0
Pump Optimization	0.9	0.9
Advanced Motors - Material Processing	0.9	0.9
Fan Equipment Upgrade	0.8	0.8
WaterSupply	0.7	0.7
Air Compressor Variable Speed	0.6	0.6
Advanced Motors - Material Handling	0.5	0.5
Streetlight - HPS 250W - Group Relamp - to LED 159W - Retro	0.5	0.5



Measure Changes from the 2023 CPA

- Added streetlighting network control measure
- Updates in line loss and global cost inputs (avoided T&D, discount rate, $2026)

"Energy Management" represents the standard SEM in mostly large industrial facilities. "Energy Management2" represents a more difficult share of SEM potential likely found in smaller facilities, and therefore more difficult and expensive to achieve.

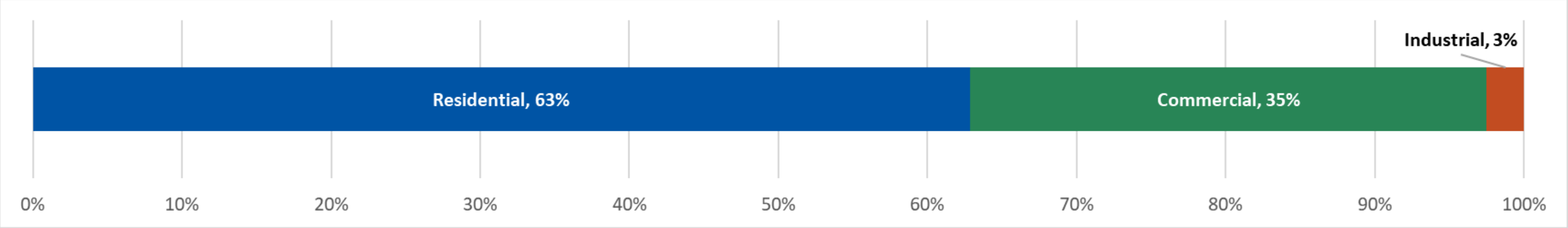
Natural Gas Energy Efficiency Potential

Natural Gas Energy Efficiency Potential

Achievable Technical Potential

Sector	2-year (2026-2027)	4-year (2026 -2029)	10-year (2026-2035)	25-year (2026-2050)
Cumulative Achievable Technical Potential (MMTherm)				
Residential	4	8	32	78
Commercial	5	12	31	43
Industrial	0.6	1.2	3.1	3.1
Total	**10**	**21**	**66**	**124**

Represents the cumulative achievable technical potential, not economic potential



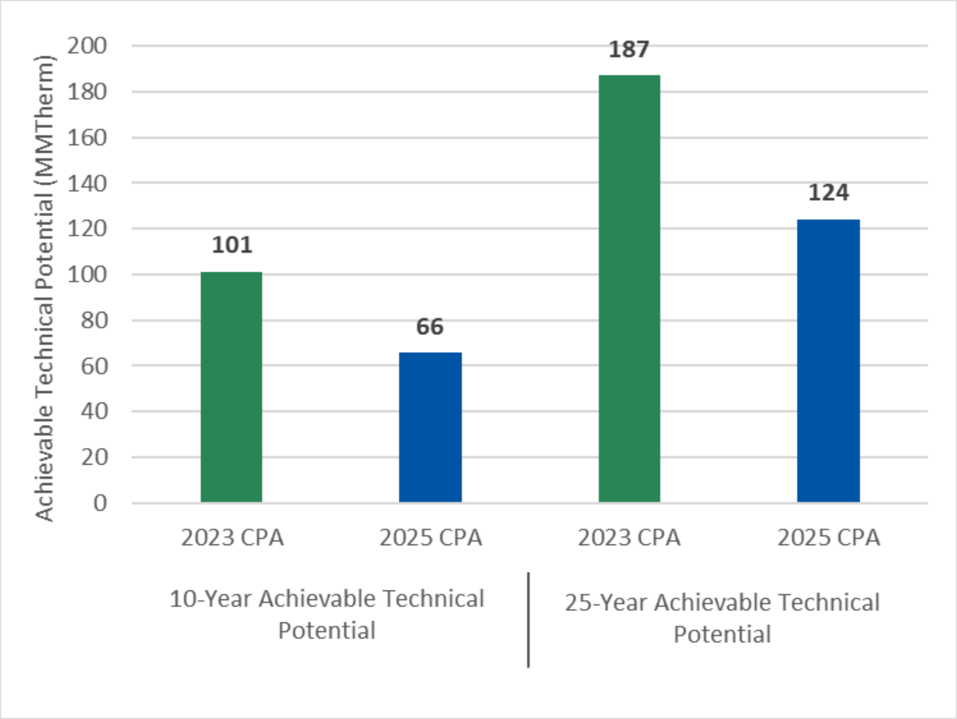
Comparison to 2023 CPA

10-year and 25-year Cumulative Natural Gas Achievable Technical Potential (at generator)

35% decrease in 10-year total potential; 34% decrease in 25-year total potential

Sector	10-Year Technical Achievable EE Potential (MMTherm)		25-Year Technical Achievable EE Potential (MMTherm)	
	2023 CPA	2025 CPA	2023 CPA	2025 CPA
Residential	59	32	107	78
Commercial	39	31	50	43
Industrial	3	3	3	3
Total	**101**	**66**	**187**	**124**

The 2023 CPA study period was 27 years. This table shows only the first 25 years for comparison purposes.



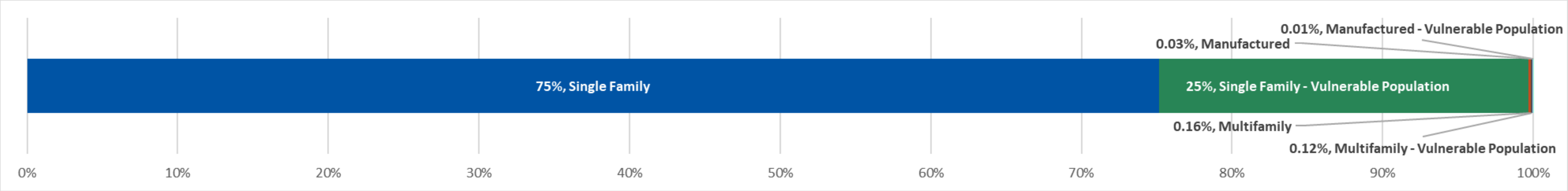
Comparison to 2023 CPA – Levelized Cost Bundles

Changes from 2023 CPA

- Similar lower cost potential but less overall potential due to furnace standard (2029) impacting the more expensive bins with equipment measures
- Updates in line loss and global cost inputs (avoided T&D, discount rate, $2026)

Residential Natural Gas Energy Efficiency Potential

By Segment, Construction Vintage, and End Use

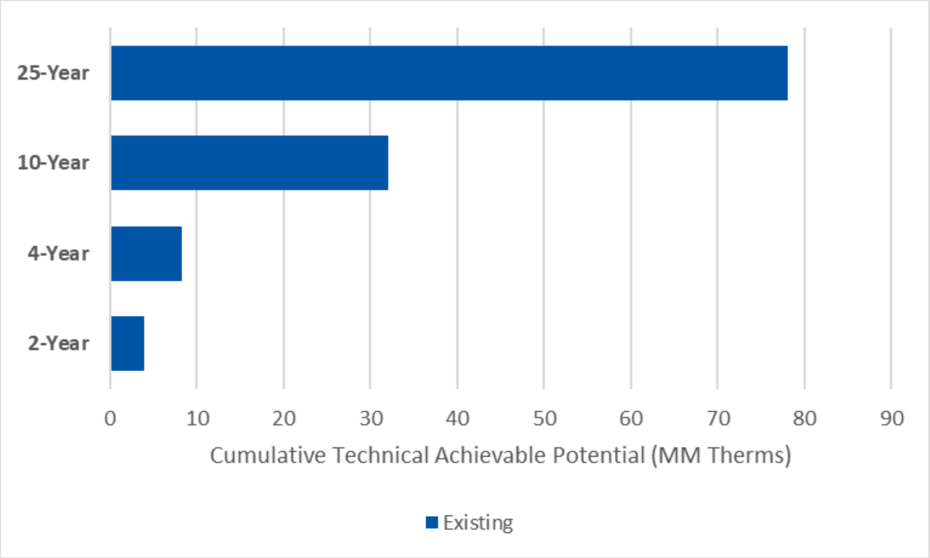


Potential for vulnerable populations is 25% of the total residential achievable technical potential (19 MM Therms)

Almost all residential potential is within single family homes

No new construction potential

End Use	25-Year Achievable Technical Potential (MM Therm)
Heating	47
Water Heating	31
Dryer	0.3
Cooking	0.3
Pool	0.2
Total	**78**



Top Natural Gas Residential Measures

Cumulative Achievable Technical Potential (MM Therm)

Measure Name	10-Year	25-Year
Water Heater - ENERGY STAR Tankless	2.4	19.3
Smart Thermostat	2.7	7.8
Furnace - Premium Efficiency	0.6	7.6
Integrated Space and Water Heating	1.4	7.2
Duct Sealing	2.1	6.3
Window - Storm Window	4.3	5.2
Insulation – Attic	4.1	4.9
Insulation – Wall	4.0	4.8
Windows	2.1	2.5
Duct Insulation	1.6	1.9
HVAC Tune-up	0.6	1.2
Behavioral - Home Energy Reports	1.0	1.0
Insulation – Floor	0.8	1.0
Water Heater - Tank Wrap	0.6	1.0
Tub Spout	0.3	1.0

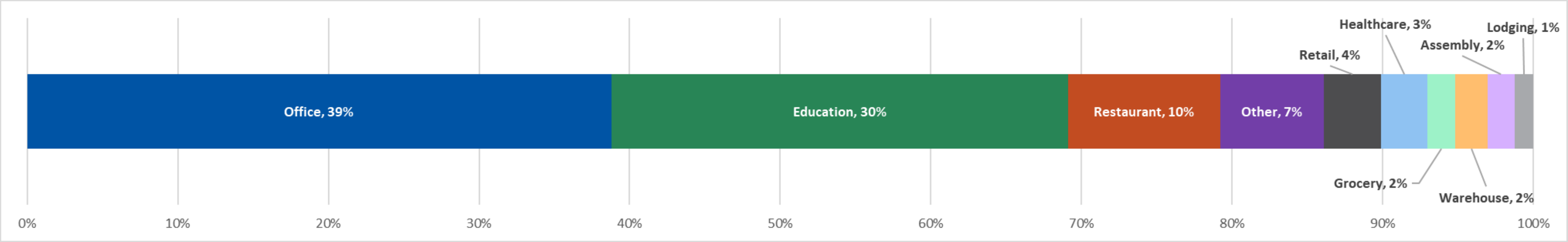
Changes from the 2023 CPA

- Less overall potential due to no-growth load forecast and updated measures
  - No new construction potential
  - Less potential for gas furnaces - incorporating 2029 furnace standard; lower unit energy savings due to aligning with PSE evaluation;
  - PSE Business Case updates
  - RTF updates for selected measures (water heaters, weatherization)
- Ramp rate updates
- Updates in line loss and global cost inputs (avoided T&D, discount rate, $2026)

C&I Natural Gas Energy Efficiency Potential

By Building Type and End Use

Commercial



Commercial

End Use	25-Year Achievable Technical Potential (MM Therm)
Heating	34
Cooking	5
Water Heat	4
Pool	0.01
Total	**43**

Industrial

End Use	25-Year Achievable Technical Potential (MM Therm)
Process	2
Boiler	1
HVAC	0.40
Other	0.03
Total	**3**

Top Natural Gas C&I Measures

Cumulative Achievable Technical Potential (MM Therm)

Commercial Measure Name	10-Year	25-Year
Re-Commissioning	6.5	7.8
Energy Management System	5.0	5.6
Window - Secondary Glazing	4.4	4.4
Weatherization - Attic/Roof Insulation	1.7	3.3
Pipe Insulation - Space Heat	2.6	2.9
Water Heat LE 55 Gal	0.3	2.9
Fryer	0.7	2.2
Space Heat - Gas Boiler	1.1	1.9
Kitchen Hood - Demand Controlled Ventilation	1.1	1.8
Strategic Energy Management	1.5	1.5

Industrial Measure Name	10-Year	25-Year
Waste Heat From Hot Flue Gases To Preheat	0.48	0.48
Process Improvements To Reduce Energy Requirements	0.44	0.44
Heat Recovery And Waste Heat For Process	0.42	0.42
Thermal Systems Reduce Infiltration; Isolate Hot Or Cold Equipment	0.27	0.27
Improve Combustion Control Capability And Air Flow	0.20	0.20
Equipment Upgrade - Boiler Replacement	0.15	0.15
Equipment Upgrade - Replace Existing HVAC Unit With High Efficiency Model	0.15	0.15
HVAC Equipment Scheduling Improvements - HVAC Controls, Timers Or Thermostats	0.10	0.10
Analyze Flue Gas For Proper Air/Fuel Ratio	0.09	0.09
Thermal Systems Add Insulation To Equipment	0.09	0.09

Commercial Changes from the 2023 CPA

- Less overall potential due to limited-growth load forecast and updated measures
  - Much less new construction potential
  - 2029 furnace standard (impacts small commercial)
  - Updates to reflect WSEC 2021 and latest RCW (notably cooking equipment)
- PSE Business Case updates
- RTF updates for selected measures (weatherization)
- Ramp rate updates
- Program accomplishments through 2025
- Updates to global cost inputs

Demand Response Potential

Demand Response

Estimated the technical and achievable potential for the **demand response options of reducing peak load in both winter and summer.**

Residential	Commercial and Industrial
• Direct load control (DLC) for space heating / central cooling - smart thermostats • DLC for electric resistance water heating (grid-connected and grid-enabled) • DLC for heat pump water heating (grid-connected and grid-enabled) • Electric vehicle (EV) supply equipment DLC ***NEW IN 2025 CPA*** • ***EV managed charging*** • ***Time of use (TOU)*** • ***Peak time rebates*** • ***Behavioral DR***	• Small commercial DLC for space heating / central cooling - smart thermostats • Commercial curtailment • Industrial curtailment • Commercial critical peak pricing (CPP) • Industrial CPP ***NEW IN 2025 CPA*** • ***Commercial TOU*** • ***Medium/Heavy duty EV DLC*** • ***EV fleet managed charging***

Changes from the 2023 CPA

- Updated residential EV forecast - Current 2025 CPA forecast estimates roughly doubles EVs in 2050 as compared to 2023 CPA forecast which was roughly 660,000 EVs in 2050
- New nonresidential EV forecast of light-duty, medium-duty, and heavy-duty of commercial fleet, transit, long-haul trucks, etc.
- Updated fuel share and saturations for HVAC and water heating equipment - 2025 CPA more accurately tied EE end use forecast to calculate weighted average of existing and new construction annually. 2023 CPA largely used existing construction values only.
- Updated T&D Deferral Value ($109.36/$87.49 per kW-Year summer/winter in 2025 CPA vs $74.70 per kW-Year in 2023 CPA)
- Updated line loss (8.14% in 2025 CPA vs 7.80% in 2023 CPA)

2025 Modeled Peak Definition:
Winter: December Weekdays
HE 8 to HE 10 (7:01 – 10 am)
HE 18 to HE 20 (5:01 – 8 pm)
Summer: July through August Weekdays
HE 17 to HE 20 (4:01 – 8 pm)

2023 Modeled Peak Definition:
Winter: December Weekdays
HE 8 to HE 10 (7:01 – 10 am)
HE 18 to HE 19 (5:01 – 7 pm)
Summer: July through August Weekdays
HE 17 to HE 18 (4:01 – 6 pm)

DR Potential Details for Selected Products

Developed Hourly Results (8760s for 2026-2050) for six EV and TOU Products

Residential	Commercial and Industrial
Residential EV Managed Charging Residential EV DLC Residential TOU	Commercial EV Managed Charging Commercial MDV/HDV EV DLC Commercial TOU

EV Analysis

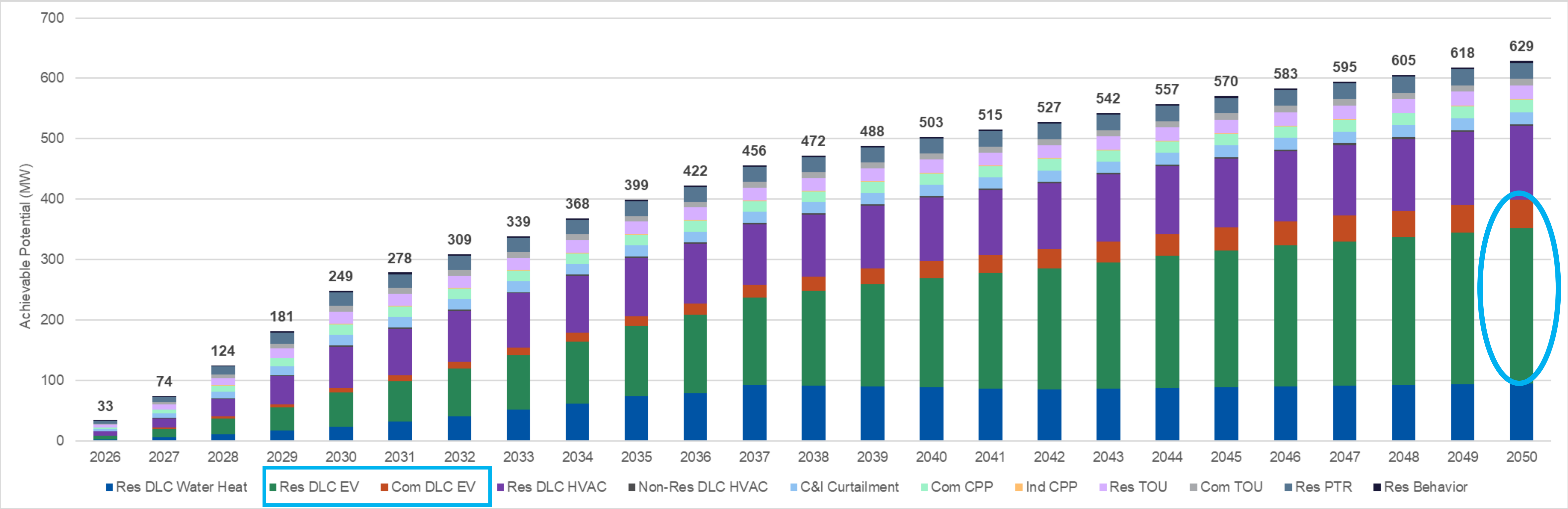
- Analysis follows estimated percent shift by use case, duty, ownership type and charger type using FY24 forecasts of unmanaged and managed load (developed by Guidehouse for PSE)
- Cadmus applies new participation assumptions to reflect program design opt-in scenario (ranging from 15%-25%), and 5-year ramp (aligns with Council assumptions)
- DLC assumes 10 events per season (winter/summer) to be controlled by PSE
- Managed EV assumes daily shifts (TOU/telematics)

TOU Analysis

- TOU follows PSE TOU peak hours for residential and commercial, and uses % reduction based on benchmarked data (Council and PGE TOU evaluation)
- Applied TOU reduction to projected annual loads, shaped by historical PSE hourly data (2021)
- 0.5% total energy savings assumed for residential and 0.2% assumed for commercial

Overview of Winter Results

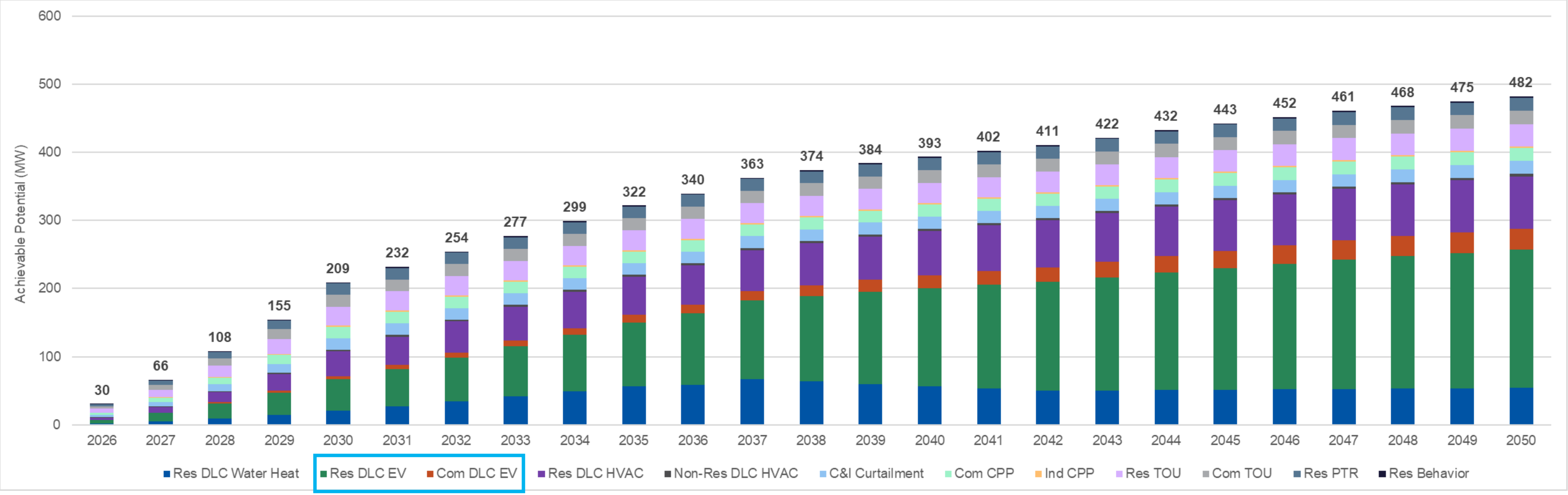
Total 25-Year Demand Response Potential, by Year and Product Group



EV DR from DLC switch and managed charging represents 48% of the total winter DR potential

Overview of Summer Results

Total 25-Year Demand Response Potential, by Year and Product Group



EV DR from DLC switch and managed charging represents 48% of the total summer DR potential

Comparison to the 2023 CPA

Product Option	Winter				Summer			
	2023 DRPA Achievable Potential in 2050		2025 DRPA Achievable Potential in 2050		2023 DRPA Achievable Potential in 2050		2025 DRPA Achievable Potential in 2050	
	Achievable Potential (MW)	Levelized Cost ($/kW-year)	Achievable Potential (MW)	Levelized Cost ($/kW-year)	Achievable Potential (MW)	Levelized Cost ($/kW-year)	Achievable Potential (MW)	Levelized Cost ($/kW-year)
Res HVAC Switch DLC	97.4	-$24	Not modeled		49.5	$52	Not modeled	
Res Smart Thermostat DLC	108.0	-$56	122.3	-$71	99.8	-$40	76.8	-$75
Res ERWH Switch DLC	0.0	$24	Not modeled		0.0	$74	Not modeled	
Res ERWH DLC Grid-Enabled	32.3	-$28	3.7	-$21	21.5	-$4	3.7	-$43
Res ERWH DLC Grid-Connected	Not modeled		10.5	-$30	Not modeled		10.5	-$52
Res HPWH Switch DLC	0.0	$203	Not modeled		0.0	$481	Not modeled	
Res HPWH DLC Grid-Enabled	58.3	$91	20.9	$50	29.1	$257	10.5	$166
Res HPWH DLC Grid-Connected	Not modeled		59.5	$31	Not modeled		29.8	$128
Res EV Switch DLC	41.6	$105	82.4	$22	41.6	$105	65.3	$26
Res EV Managed Charging	Not modeled		174.9	$11	Not modeled		137.1	$14
Res Peak Time Rebate Pricing	Not modeled		26.6	-$14	Not modeled		18.9	-$10
Res Time of Use Pricing	Not modeled		23.1	-$21	Not modeled		32.3	-$62
Res Behavioral	Not modeled		2.9	$3	Not modeled		2.1	-$18
Res Critical Peak Pricing	33.4	-$56	Not modeled		74.3	-$66	Not modeled	
Small Comm Smart Thermostat DLC	3.0	-$36	2.8	-$54	3.8	-$3	3.7	-$54
Small Comm HVAC Switch DLC	2.7	$0	Not modeled		5.3	$64	Not modeled	
Medium Comm HVAC Switch DLC	18.4	-$33	Not modeled		77.2	-$42	Not modeled	
Comm EV Fleet Load Management	Not modeled		34.4	$51	Not modeled		22.7	$97
Comm EV Heavy Duty	Not modeled		12.9	-$13	Not modeled		8.7	$1
Comm Critical Peak Pricing	21.3	-$57	20.0	-$70	26.4	-$61	19.2	-$91
Ind Critical Peak Pricing	1.5	-$34	1.1	-$32	1.6	-$35	2.3	-$82
Comm Curtailment	16.3	-$28	15.9	-$52	20.0	-$28	14.4	-$74
Ind Curtailment	4.8	-$37	4.0	-$59	4.9	-$37	4.1	-$81
Comm Time of Use Pricing	Not modeled		10.8	-$64	Not modeled		20.3	-$97

Rooftop Solar PV Potential

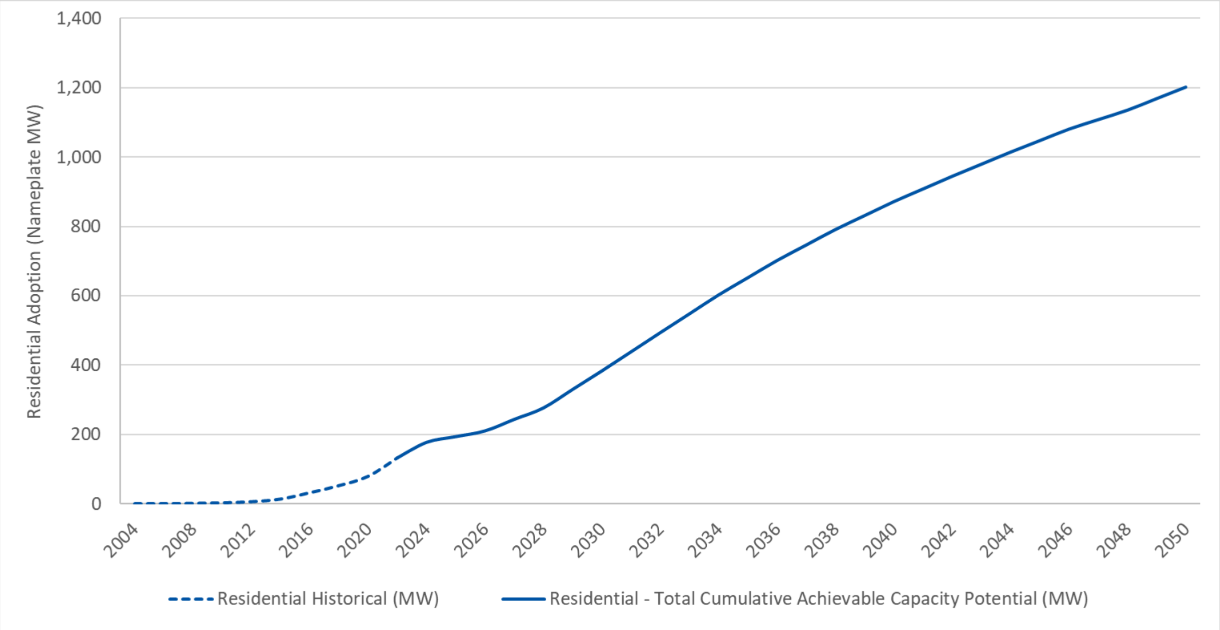
CADMUS

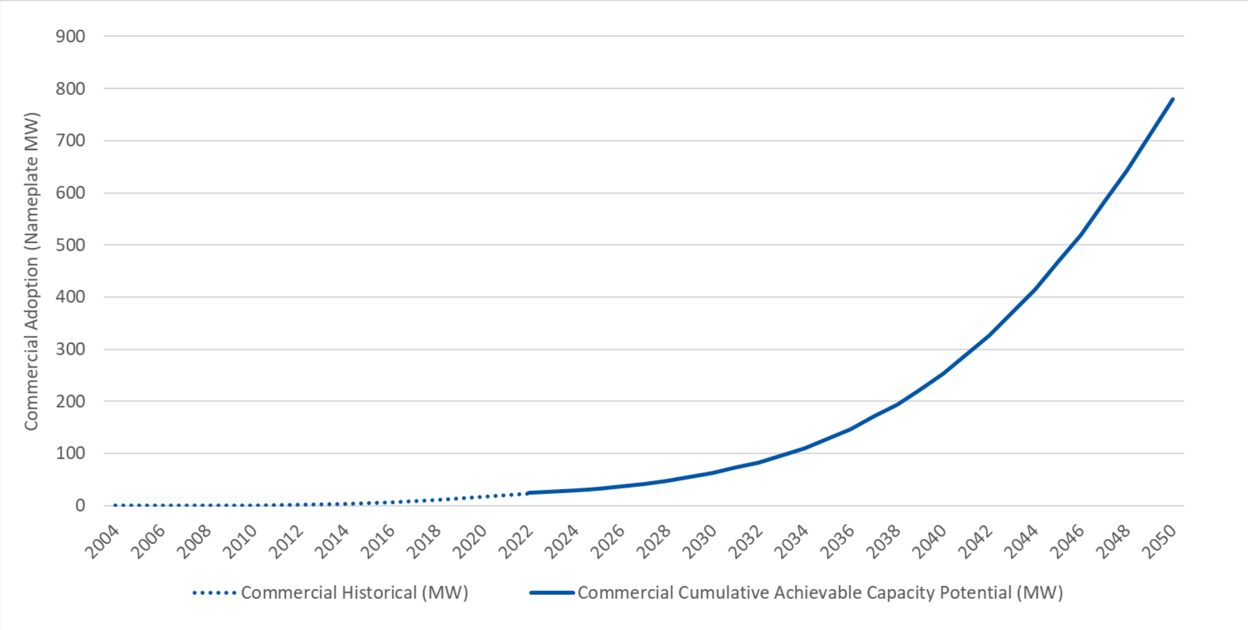
Rooftop Solar PV Potential Methodology

- Used **NREL's Distributed Generation Market Demand (dGen) model** to simulate customer adoption of rooftop solar PV technology and determine solar PV achievable market potential
- To enable bottom-up analysis, **Google Project Sunroof** data is reviewed to establish solar PV potential at the zip code level
- Calibrating the model to align with PSE historical installations
- Assessing solar potential for the Residential Vulnerable Population
- Cost forecasts based NREL Annual Technology Baseline data

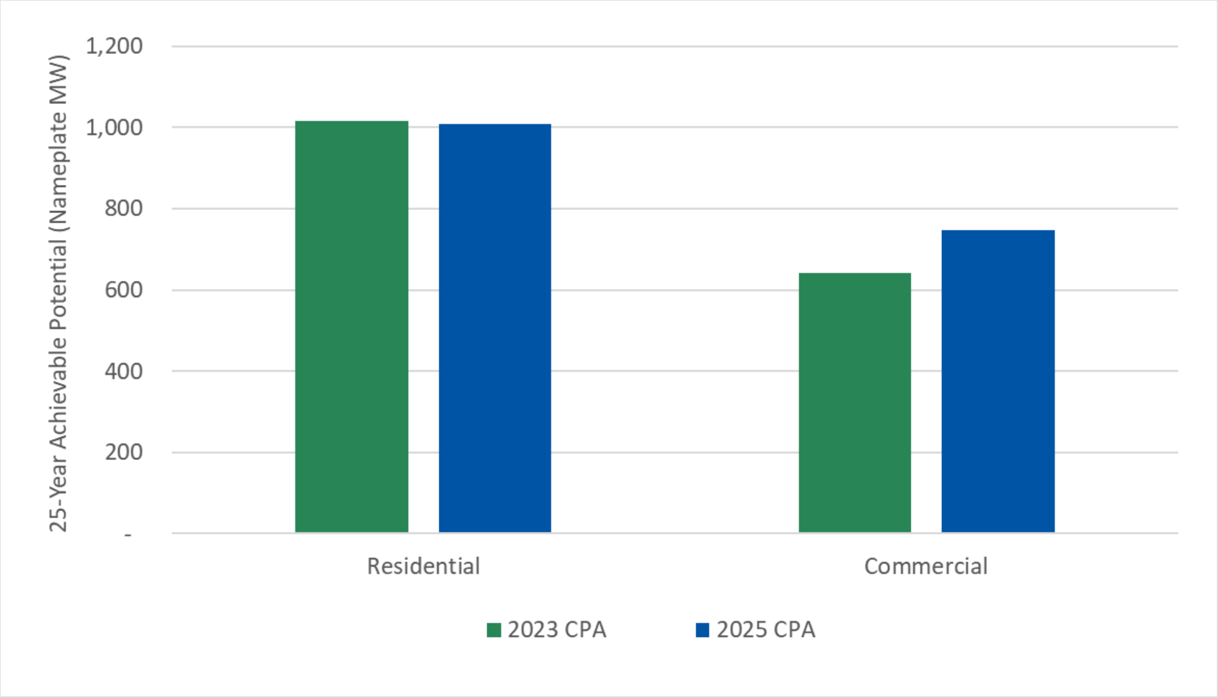
Rooftop Solar PV Achievable Potential

Sector	2050 Cumulative Achievable Nameplate MW	2050 Cumulative Achievable aMW
Residential	983	112
Residential Vulnerable Population	25	3
Commercial	747	93
Total	**1,755**	**207**





Comparison to 2023 CPA



Key Changes

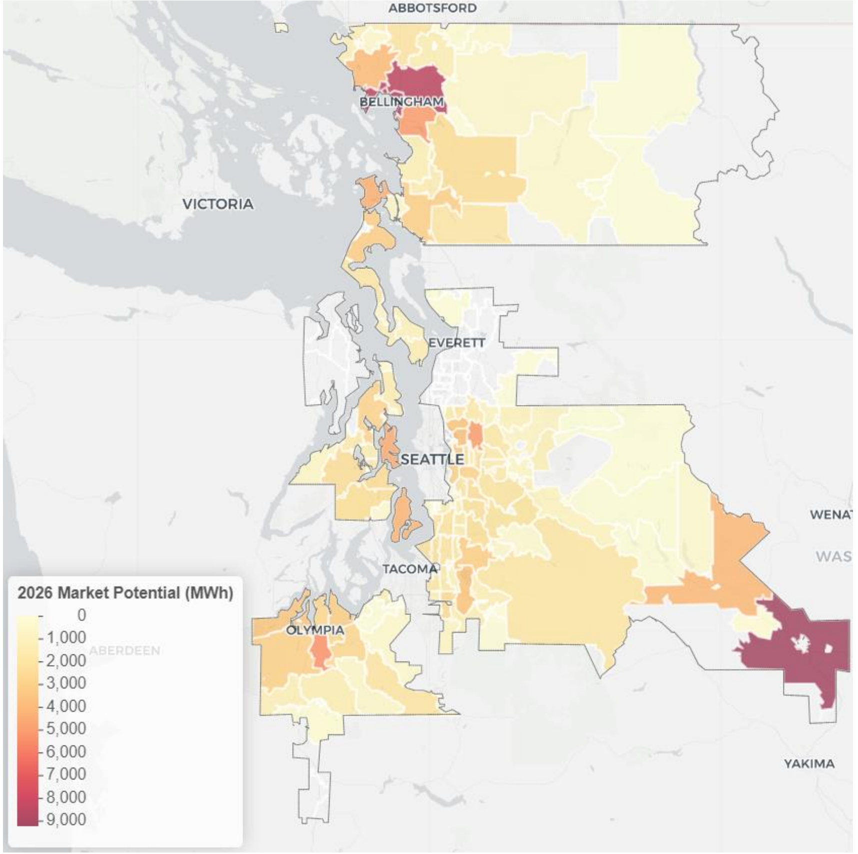
Most analytical updates unrelated to adoption methodology, which still leveraged dGen modeling and with consistent policy drivers. Updates that drive changes:

- Historical adoption
- Solar **system costs** and price forecasts

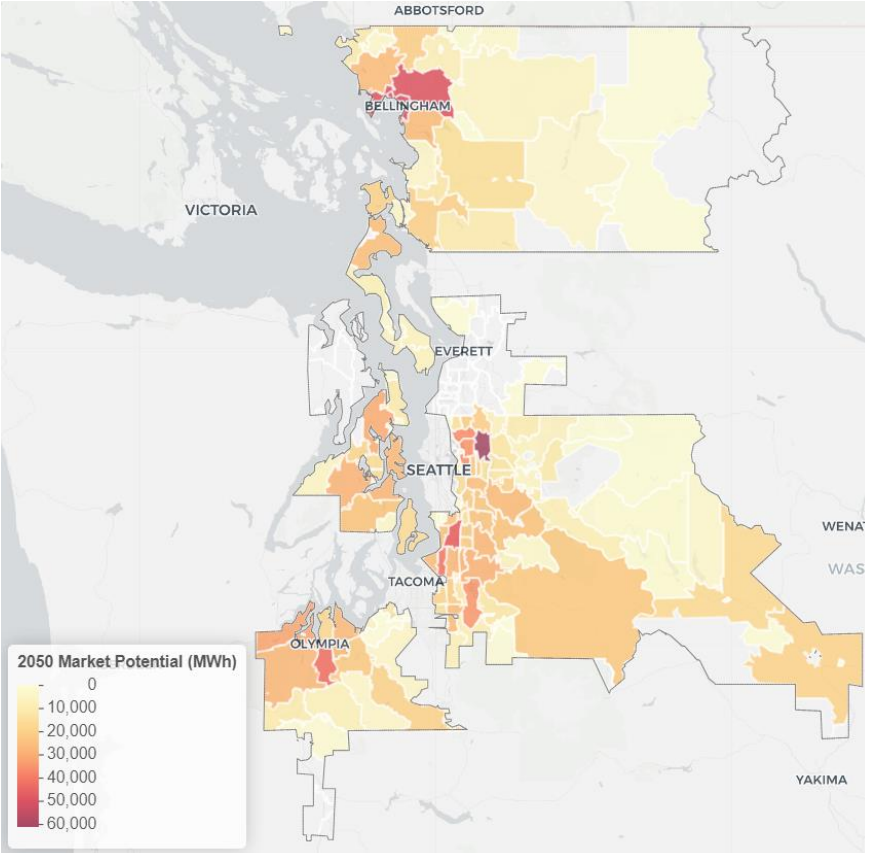
The new set of historical data contributed to a slight decrease in residential potential and an increase in commercial compared to 2023 CPA

2026 and 2050 Rooftop Solar PV Achievable Potential MWh Heat Map by Zip Code

2026



2050



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PSE PUGET SOUND ENERGY

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Thank You

Next steps

Sophie Glass, Triangle Associates

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Upcoming activities

Date	Activity
April 23, 2024	Public webinar: Resource alternatives for energy storage
April 24, 2024	Feedback form for April 17 RPAG meeting closes

Email us at irp@pse.com

Register for email updates

Visit our website at pse.com/irp

Leave a voice message at 425-818-2051

Public comment opportunity

Please raise your “hand” if you would like to provide comment.

Thanks for joining us!

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Appendix

Acronyms

Acronym	Meaning
BDR	Business demand response
BEV	Battery-electric vehicle
CCA	Climate Commitment Act
CEIP	Clean Energy Implementation Plan
CETA	Clean Energy Transformation Act
CFS	Clean fuel standard
CPA	Conservation potential assessment
DLC	Direct load control
DR	Demand response
DSR	Demand-side resources
ELCC	Effective load carrying capacity
EV	Electric vehicle
EVSE	Electric vehicle supply equipment
GRC	General Rate Case

Acronyms

Acronym	Meaning
GWh	Gigawatt hour
IAP2	International Association of Public Participation
ICE	Internal combustion engine
IIJA	Infrastructure Investment and Jobs Act
IRA	Inflation Reduction Act
IRP	Integrated resource plan
KWh	Kilowatt hour
LDV	Light duty vehicle
MHDV	Medium-/heavy-duty vehicle
MSRP	Manufacturer’s suggested retail price
MW	Megawatt
NEI	Non energy impacts
NREL	National Renewable Energy Laboratory
OEM	Original equipment manufacturer

Acronyms

Acronym	Meaning
PHEV	Plug-in hybrid electric vehicle
PV	Photovoltaics
RFP	Request for proposal
SCGHG	Social cost of greenhouse gas
T&D	Transmission and distribution
TOU	Time of use
VMT	Vehicle miles traveled
VPP	Virtual power plant
WSEC	Washington State Energy Code
ZEV	Zero emissions vehicle

Appendices

Appendix A – Inputs and Outputs

Load Forecasting Modeling Inputs and Outputs

Key Inputs		
Input	**Description**	**Source**
EV Adoption Forecast	Number of BEVs and PHEVs by census tract by year	Guidehouse
Charger-to-Vehicle Ratios[1]	Current, long-run, and interpolated ratios of chargers needed to support number of EVs, by Tech, EVSE Owner (Public/Private), Use Case	Alternative Fuel Data Center (current) NREL's EVI-Pro (long-run)
Existing Charging Infrastructure	Locations of existing charging stations by tech, owner, and use case	Alternative Fuels Data Center
EVSE Forecast	Number of chargers needed to support EV adoption	Guidehouse
VMT	VMT by segment, along with vehicle efficiency, determines total energy needs	FHWA, EDF, EMFAC, AFDC
Vehicle Efficiency	kWh/mile forecast	Argonne National Lab
PHEV e-Utilization	Proportion of PHEV miles using battery	
Stock Vehicle Charging Profile	Typical hourly charging behavior by vehicle type and use case	Guidehouse

Key Outputs	
Output	**Description**
Site Location	Census tract
Use Case	Charging use case, examples include Public Market and Private Depot
Technology	L1, L2, DC
Year	2023-2050
Day of Week / Time of Day	Hourly, Weekend/Weekday
kWh	Monthly energy consumption
kW	Hourly load

EVSE Modeling Inputs and Outputs

Key Inputs		
Input	**Description**	**Source**
Vehicle adoption forecast	Vehicle population by powertrain, duty, class, and owner for each census tract	VAST adoption module
Charger-to-Vehicle Ratios[1]	Current, long-run, and interpolated ratios of chargers needed to support number of EVs, by Tech, EVSE Owner (Public/Private), Use Case	Alternative Fuel Data Center (current) NREL's EVI-Pro (long-run)
Charger Rated kW	Current and long-run charger kW values by owner, technology, and use case	NREL
Existing Charging Infrastructure	Locations of existing charging stations by tech, owner, and use case	Alternative Fuels Data Center
Expected Home Charging Access	The percent of PEV owners that will have access to home charging	NREL VAST adoption module US Census Bureau
Workplace Employee Counts	The volume of employees within each census tract	US Census Bureau

1. Vehicle-per-charger ratio assumptions are based on the best publicly-available data (even if LD only) along with substantiated refinements calibrated to Guidehouse synthetic vehicle load shapes by use case.

Key Outputs	
Output	**Description**
Site Location	Census tract
Use Case	Charging use case, examples include Public Market and Private Depot
Technology	L1, L2, DC
Rated kW	Average rated kW by use case, technology, and year
Year	2023-2050
Number of Ports	Number of ports forecasted for each census tract

Appendix B – Vehicle Segmentation

Vehicle Segmentation with VAST Vehicle Segments

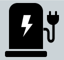
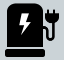
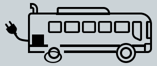
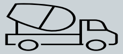
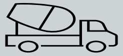
Road Usage	Vehicle Duty		Vehicle Segment[1]	VAST™ Vehicle Class	Example Vehicle
On-Road	Light Duty		Class 1 Vehicles	Passenger Class	• Sedan, small sport utility vehicle, small crossover, small pickup truck
			Class 2a Vehicles	Light Truck	• Sport utility vehicle, small pickup truck
			Class 2b Vehicles	Light Truck	• Pickup truck, small delivery van
	Medium and Heavy Duty		Class 3 Trucks	Delivery Truck	• Walk-in van, city delivery van
			Class 4-5 Trucks	Delivery Truck	• Box truck, city delivery van, step van
			Class 6 Trucks	Delivery Truck, Semi Truck, Short-Haul	• Beverage truck, rack truck
			Class 7-8 Trucks	Delivery Truck, Semi Truck Long-Haul, Short-Haul	• Short-haul tractor-trailer truck, long-haul tractor-trailer truck, dump truck
			School Buses	School Bus	• School bus
			Transit Buses	Transit Bus	• Transit bus
			On-Road Specialty Vehicles	Delivery Truck	• Fire truck, ambulance, recreational vehicle, refuse truck, drayage truck
			Transport Refrigeration Units	N/A	• Refrigeration unit (excluding tractor trailer) for warehouses, distribution centers, grocery stores
Off-Road			Airport Ground Support Equipment	N/A	• Aircraft refueler, aircraft pushback tractor
			Seaport Cargo Handling Equipment	N/A	• Hostler truck, rubber-tired gantry crane, container handler
			Other Forklifts	N/A	• Counterbalance / telescopic handler forklift for warehouses, lumberyards, and construction sites

1. Vehicle Segments are defined based on recognized vehicle classifications by the US Federal Highway Administration, US Energy Information Administration, and state-of-the-art vehicle registration data vendors such as IHS Markit and Hedges.

Outside of current scope

Appendix C – Policy Details

Policy Included in Base Case

Policy	Timeline	Technology Impacted	Implementation in VAST
Washington Advanced Clean Cars (ACC)	2023 - 2050		PEV availability adjusted to match targets
Clean Vehicle Credit (IRA)	2023 – 2032		TCO for PEVs reduced by incentive
Alternative Fuels Fueling Credit (IRA)	2023 – 2032		EVSE Rollout & Non-residential Charging Eligibility
NEVI Program	2022 – 2026		Captured in EVSE Rollout of Market Chargers
Charging & Infrastructure Program (Community Charging)	2022 – 2026		Captured in EVSE Rollout of Market and SSUD Chargers
Charging & Infrastructure Program (Corridor Charging)	2022 – 2026		Captured in EVSE Rollout of Market Chargers
No and Low Emissions (Bus) Grant Program	2022 – 2026		TCO for PEV transit buses reduced by incentive
EPA Clean School Bus Program	2022 – 2026		TCO for PEV school buses reduced by incentive
Washington Advanced Clean Trucks (ACT)	2023 – 2050		PEV availability adjusted to match targets
Washington Clean Fuel Standard	2023 – 2038		Credits applied towards EVSE rollout & EV incentives
Washington State EV Sales Tax Exemption	2023 – 2025		TCO for LD PEVs reduced by tax credit
Washington State Zero Emissions School Bus Grant Program	2023 – 2025		TCO for PEV School Buses reduced by incentive
Diesel Emissions Reduction Act National Competitive Grants	2023 – 2025		TCO for PEV Refuse Trucks reduced by incentive
Charger Where You Are	2024 – 2025		Captured in EVSE Rollout of MUD, Market, Workplace and Fleet Chargers
EV Charging Program (Department of Commerce)	2024 – 2025		Captured in EVSE Rollout of MUD, Market, Workplace and Fleet Chargers

ACC and ACT Targets

Vehicle Segments can consist of different classes of vehicles, leading to differing policy targets

Vehicle Segment	Class	2035 ACC Target	2035 ACT Target
Passenger Car	1	100% of New Sales	NA
Light Truck	2	100% of New Sales	NA
Delivery Truck	2b-3	NA	55% of New Sales
Delivery Truck	4-8	NA	75% of New Sales
Semi Truck	6-8	NA	75% of New Sales
Semi Truck	7-8 Tractor	NA	40% of New Sales (2032 forward)
Short Haul Truck	6	NA	75% of New Sales
Short Haul Truck	7-8 Tractor	NA	40% of New Sales (2032 forward)
Long Haul Truck	7-8 Tractor	NA	40% of New Sales (2032 forward)

Appendix D – Assumptions Detail

Home Charging Access

NREL's 2021 study on EV charging at homes suggests home charging access may be more limited than previously believed

The F24 study base scenario assumes **58% of PEVs will have access to Home Charging in the long-run**

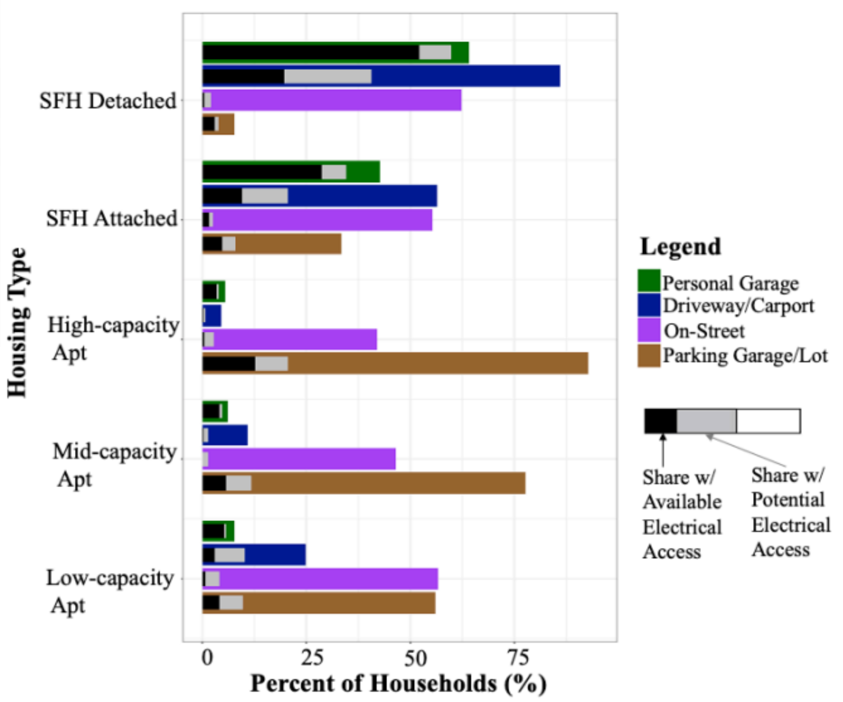


Figure 7. Existing and potential electrical access by residence type and parking option

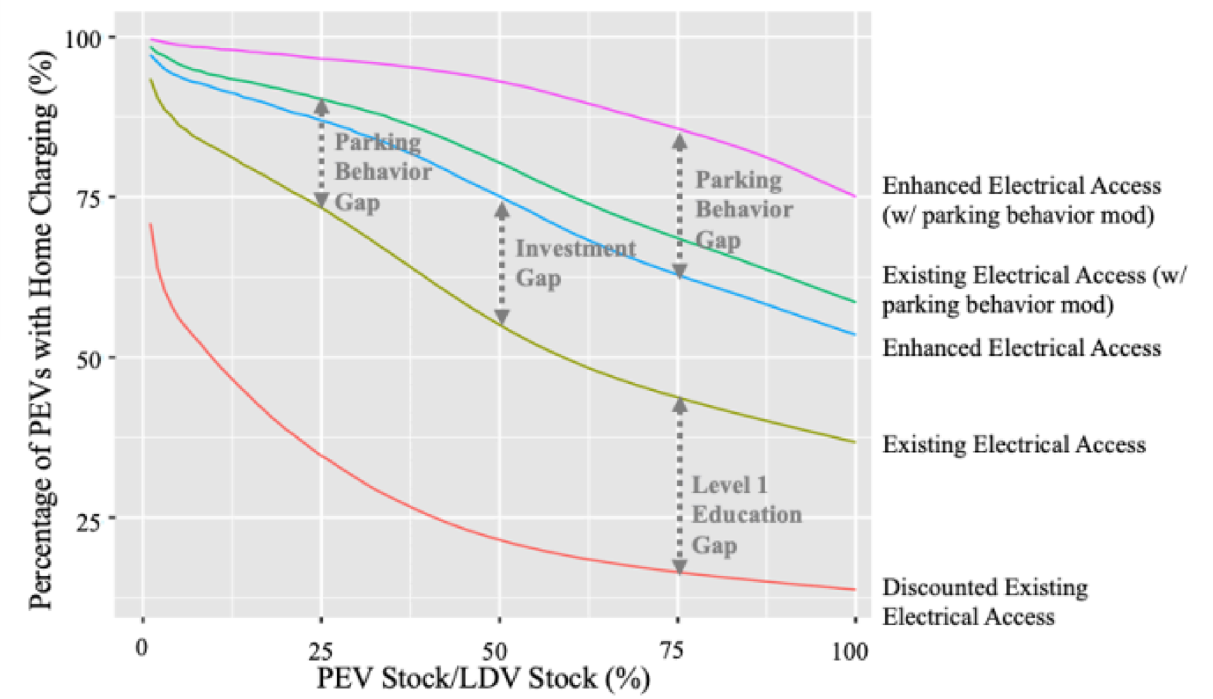


Figure 11. Residential charging accessibility projection with the change of PEV stock share

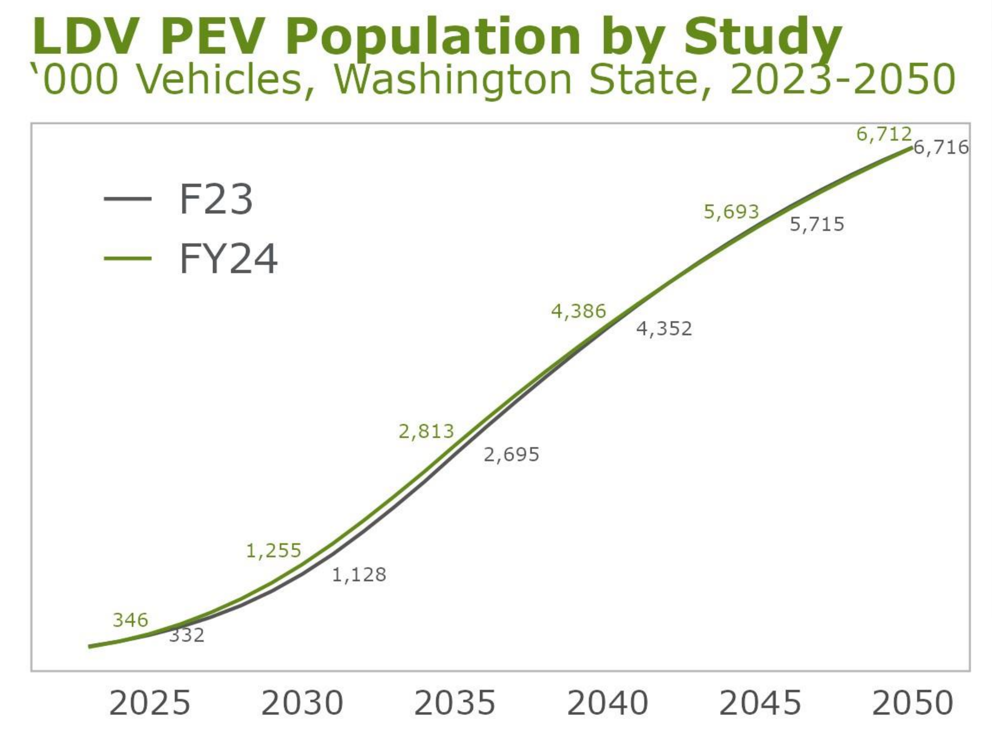
Figure 7 and 11: Ge, Yanbo, Christina Simeone, Andrew Duvall, and Eric Wood. 2021. There's No Place Like Home: Residential Parking, Electrical Access, and Implications for the Future of Electric Vehicle Charging Infrastructure. Golden, CO: National Renewable Energy Laboratory. NREL/TP-5400-81065. https://www.nrel.gov/docs/fy22osti/81065.pdf.

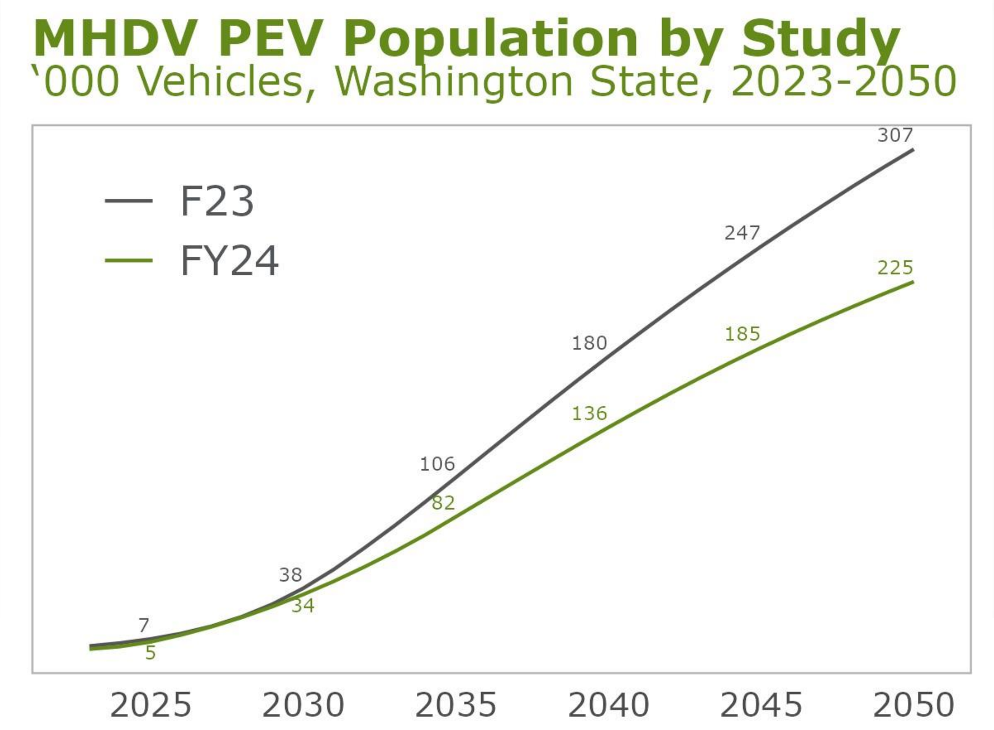
F23 vs F24 EV Forecast – VMT Update

VMT Update				
Duty	**Class**	**2023 VMT**	**2024 VMT**	**% Change**
HDV	D. Truck	78,000	25,000	-67.95%
HDV	Long Haul	-	100,060	
HDV	S. BUS	12,000	12,000	0.00%
HDV	S. Truck	78,000	30,000	-61.54%
HDV	Short Haul	-	40,000	
HDV	T. BUS	78,000	44,000	-43.59%
LDV	LT	9,946	10,038	0.93%
LDV	PC	13,026	9,734	-25.27%
MDV	D. Truck	48,000	12,000	-75.00%
MDV	S. BUS	12,000	12,000	0.00%
MDV	S. Truck	48,000	20,000	-58.33%
MDV	Short Haul	-	30,000	
MDV	T. BUS	48,000	44,000	-8.33%

Appendix E – F23 vs F24

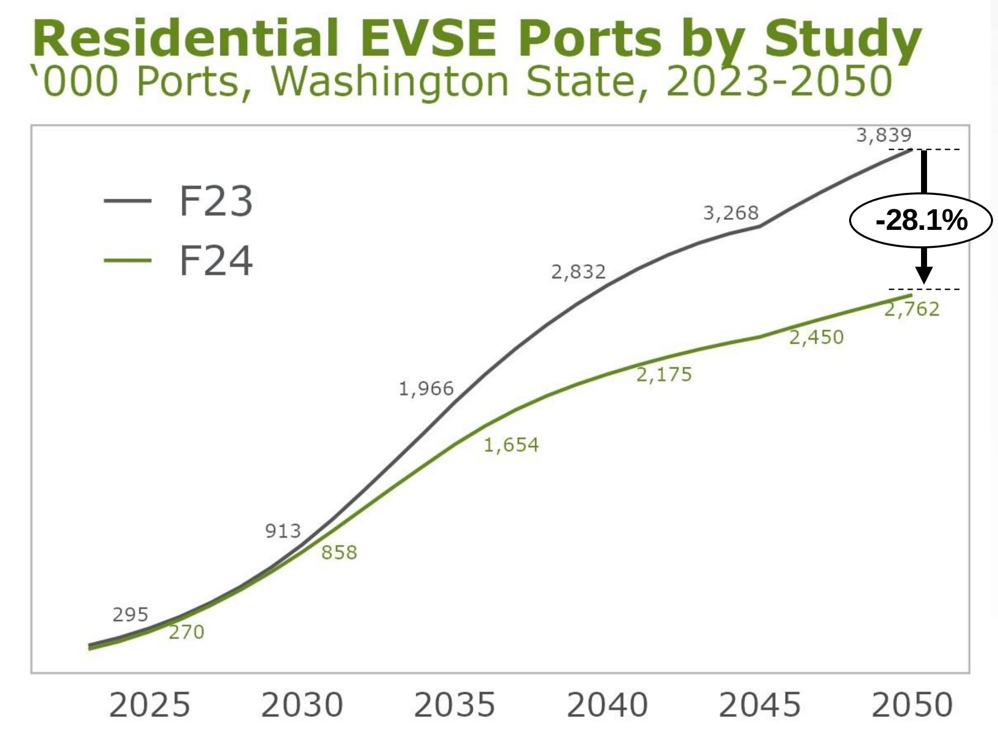
F23 vs F24 EV Forecast – Washington State

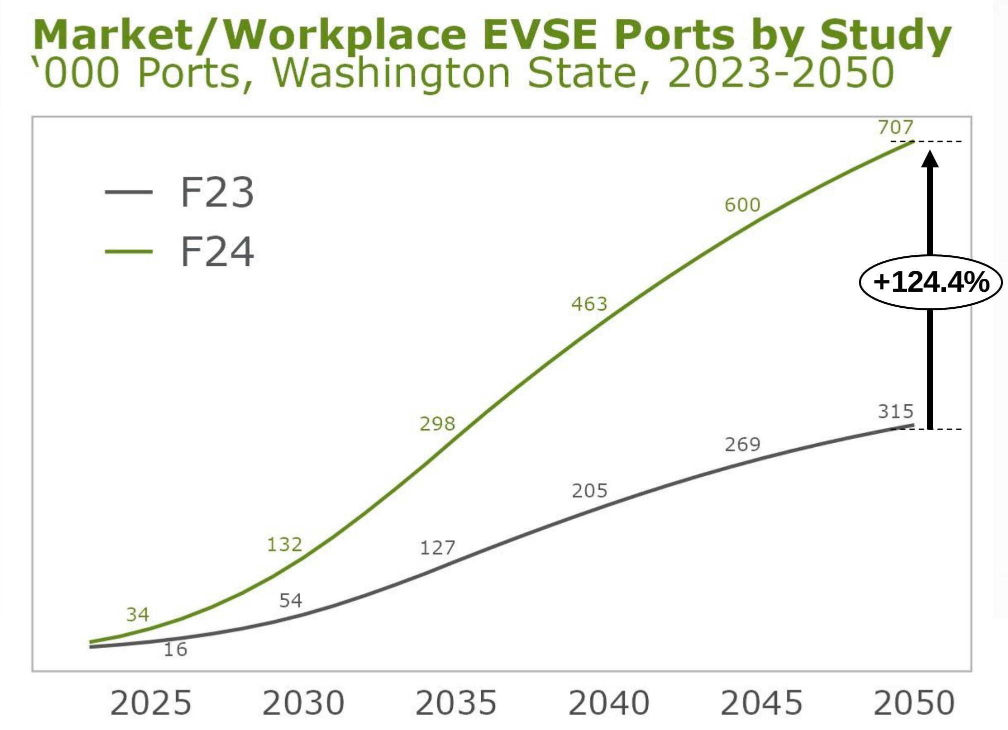




- F24 forecasts reflect general updates to modeling inputs, including vehicle MSRP, fuel prices, policies, vehicle registrations, and state sales
- For LDVs, the adoption trajectory increased to reflect actual YoY growth from 2021 to 2023 leading to more aggressive adoption between 2024 and 2029 than F23, but F23 and F24 reach similar levels of sales from 2030 forward
- For MHDVs, market share for non-buses has increased in F24 to reflect the ACT, however overall state sales for MHDVs has been realigned with historic YoY actual sales data leading to absolute MHDV sales decreasing between F23 and F24

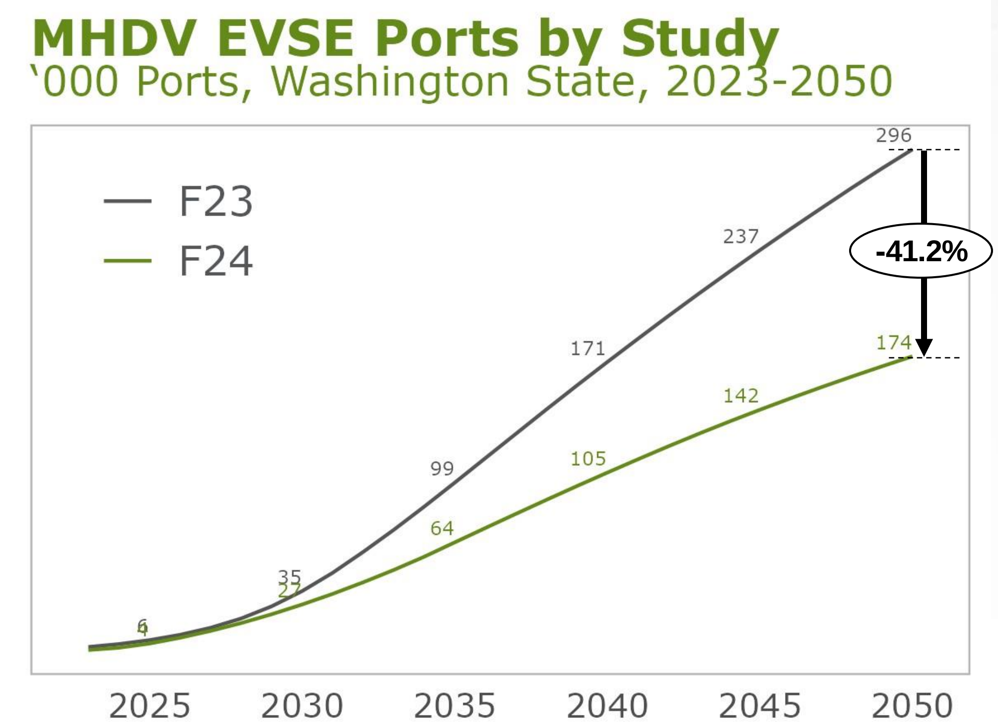
F23 vs F24 EV Forecast – Home Charging Access

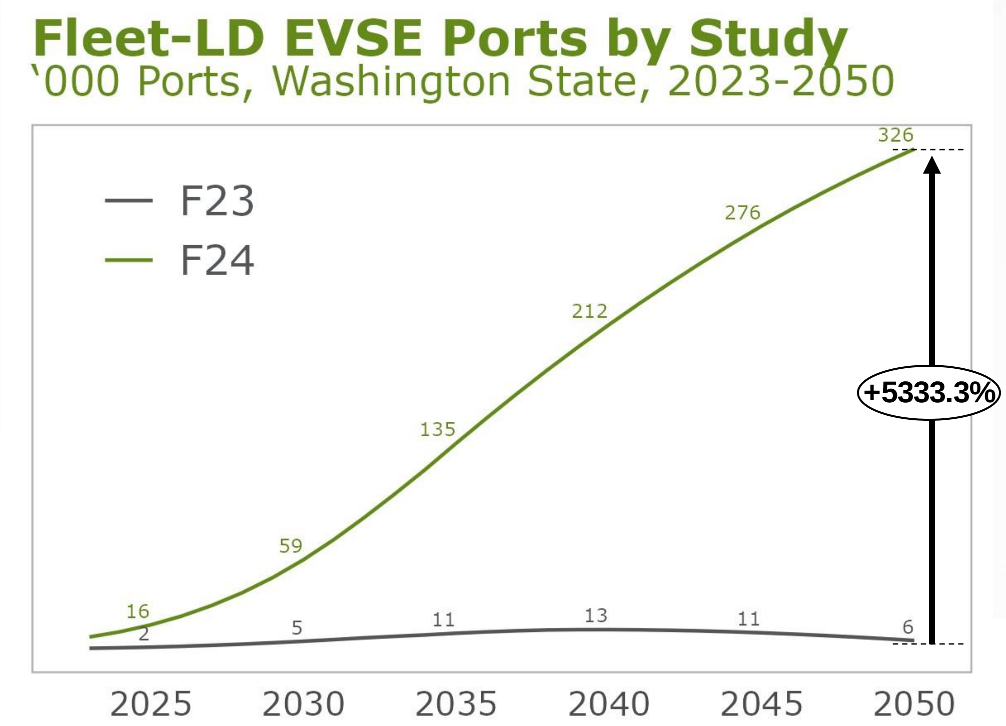




- VAST modeling assumptions on access to home charging has been updated from assuming 100% accessibility in the long-run to a value based on census data and NREL research
- The F24 EV Forecast assumes 57.6% of individually-owned LD PEVs in Washington State will have access to home charging, leading to **28.1% less residential ports in 2050** compared to F23
- The gap in charging need due to fewer residential chargers is made up via market and workplace charging, leading to **124.4% more market and workplace ports in 2050** in the F24 forecast compared to the F23 forecast

F23 vs F24 EV Forecast – MHD & Fleet-LD Charging

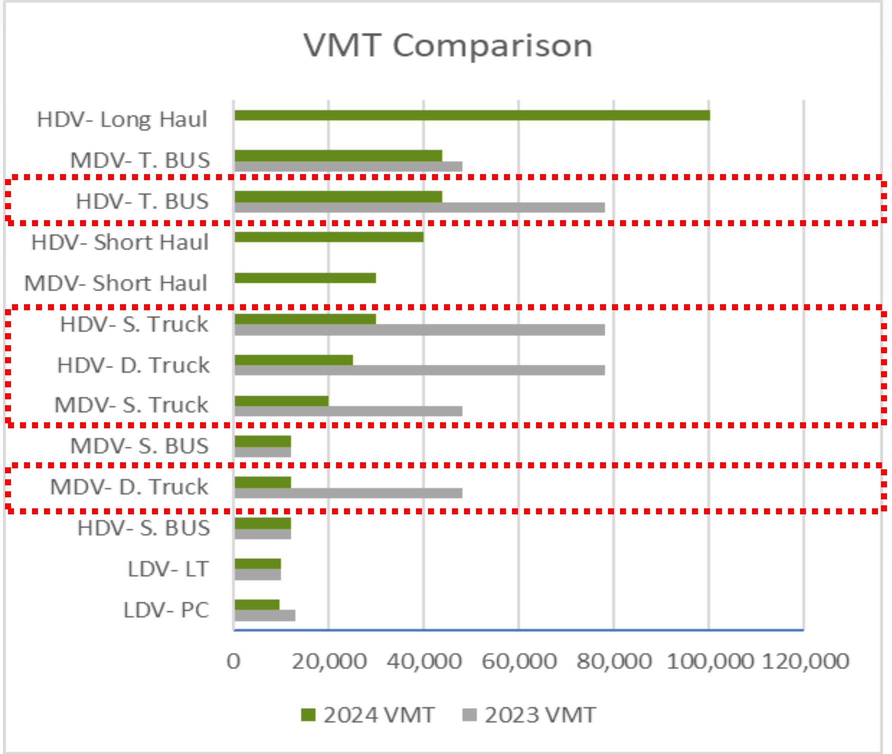


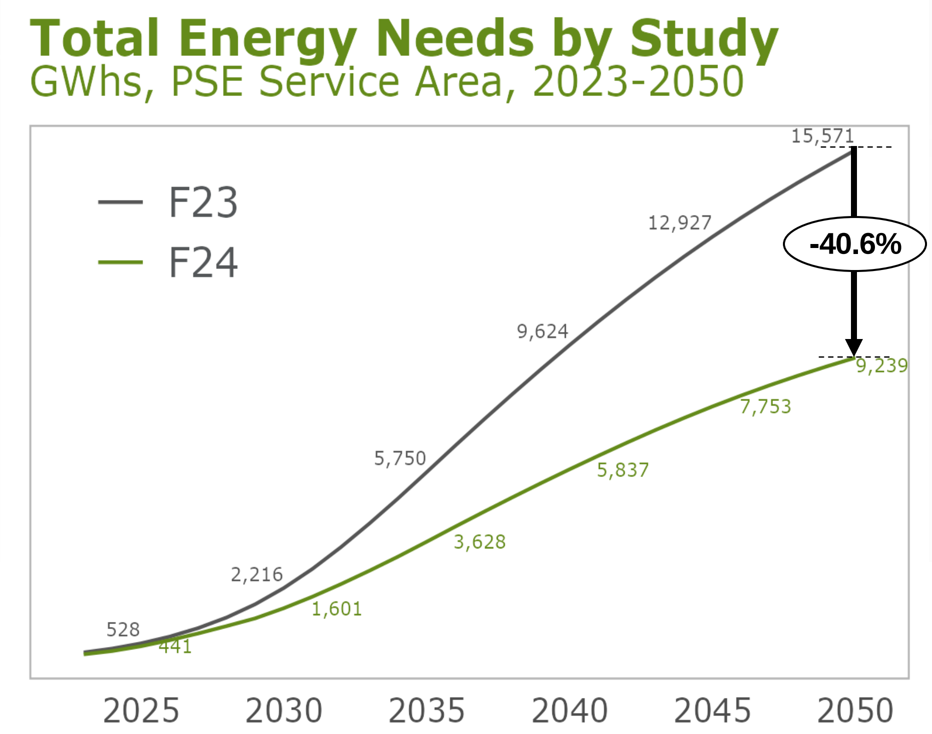


- Variation in the MHDV charging use case port counts between the F24 and F23 forecasts are driven primarily by differences in forecasted MHD PEV population
- Based on LD fleet vehicle cycle and annual VMT, and supported through interviews with fleet owners, the F24 EV forecast assumes the **Fleet-LD charging use case will be primarily comprised of L2 chargers as opposed to DC**
- The assumed preference to L2s combined with a higher port-to-vehicle ratio than DC chargers leads **to over 5000% increase in Fleet-LD ports in 2050** in the F24 study compared to the F23 study

F23 vs F24 EV Forecast – Total Energy Needs

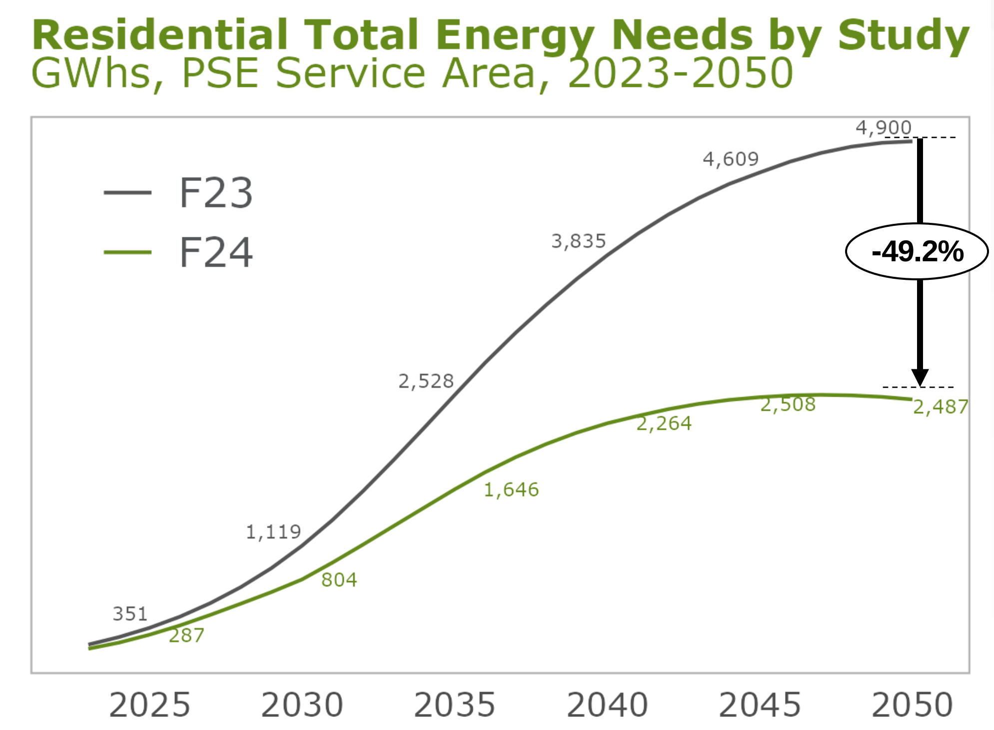
Updates to VMT lead to ~40.6% decline in total energy need from F23 to F24 in 2050

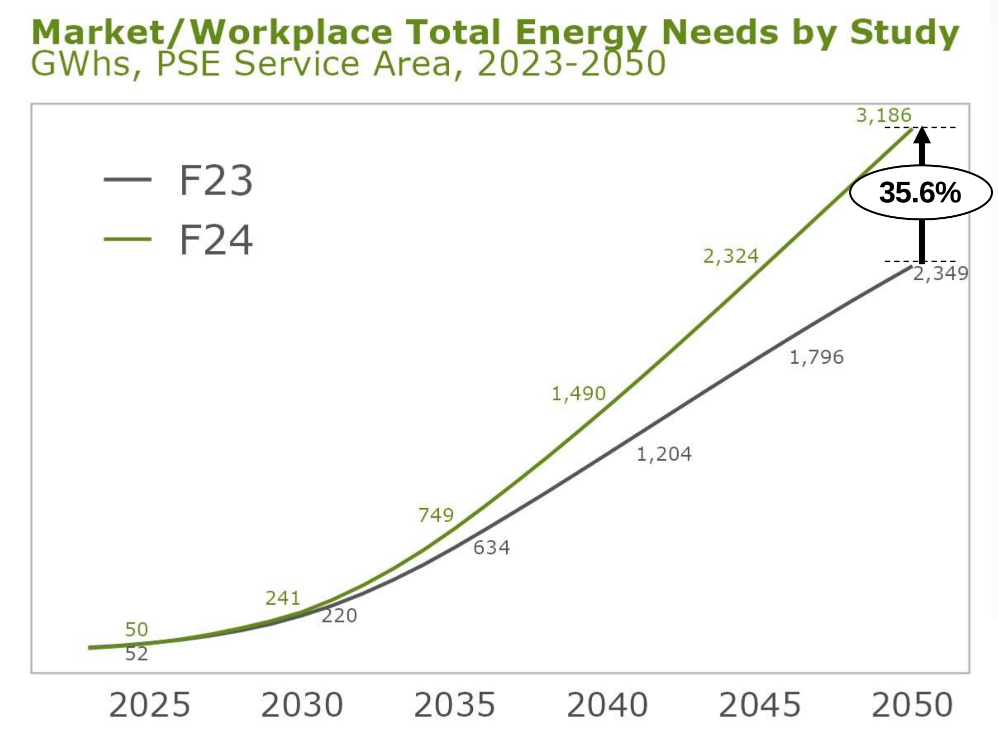




- VMT updates were informed by the FHWA, California's Emissions Factor model (EMFAC), the Environmental Defense Fund (EDF), and AFDC
- Significant reductions in S. Truck and D. Truck VMT reflect both VMT updates **and** the introduction of the Long Haul and Short Haul classes, implemented in VAST to address variations of the S. Truck duty driving needs and duty cycle

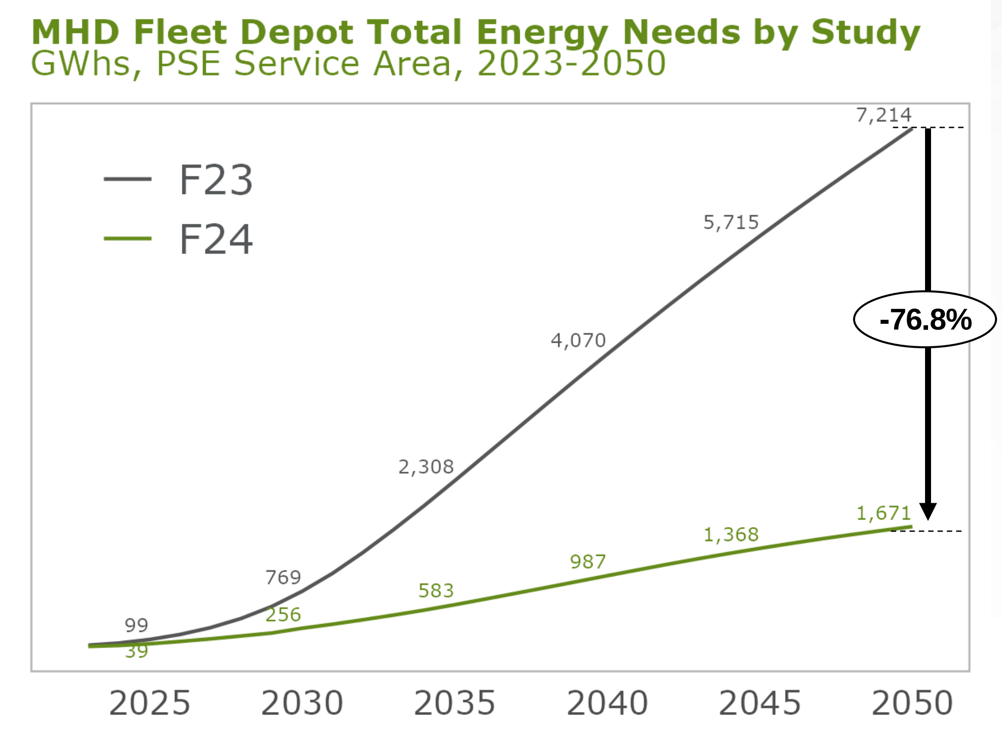
F23 vs F24 EV Forecast – Home Charging Access

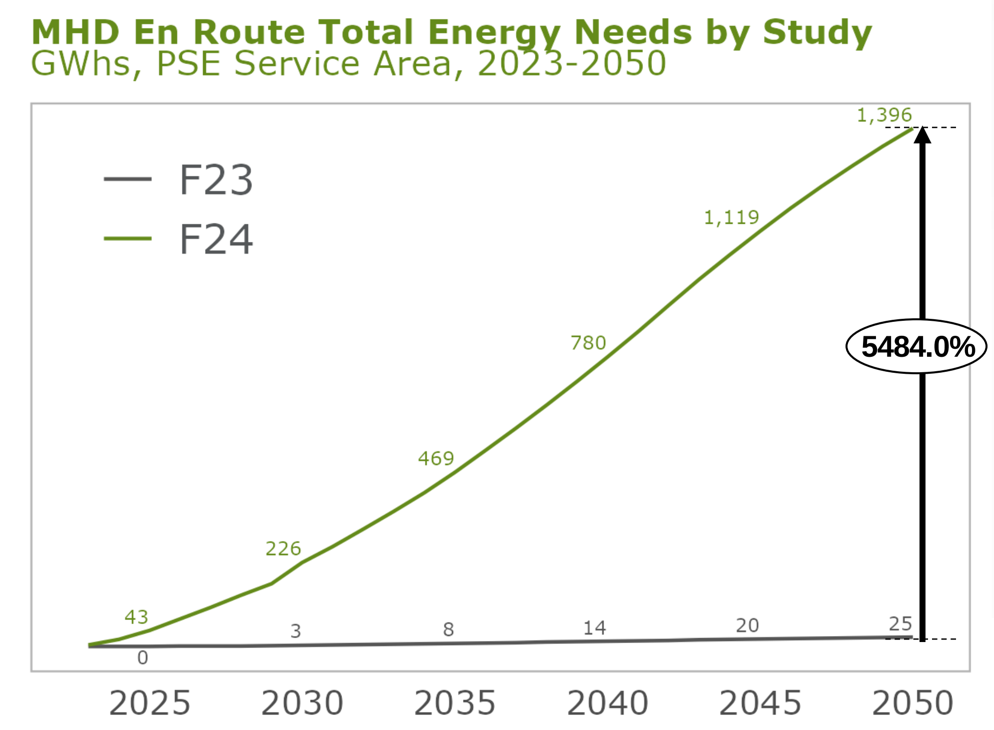




- The decrease in Residential charging needs and increase in Market/Workplace charging needs reflects the VAST modeling assumptions on access to home charging, which assumes that **Market and Workplace charging will support the majority of individually-owned LD PEV charging in the long-run**
- The F24 EV Forecast projects **~45.0% of charging energy from individually-owned LD PEVs occur at residences** (SUD, MUD, or SUD-Shared), **and ~35.9% of charging energy from individually-owned LD PEVs will occur at SUDs**

F23 vs F24 EV Forecast – MHDV Depot vs En Route Charging



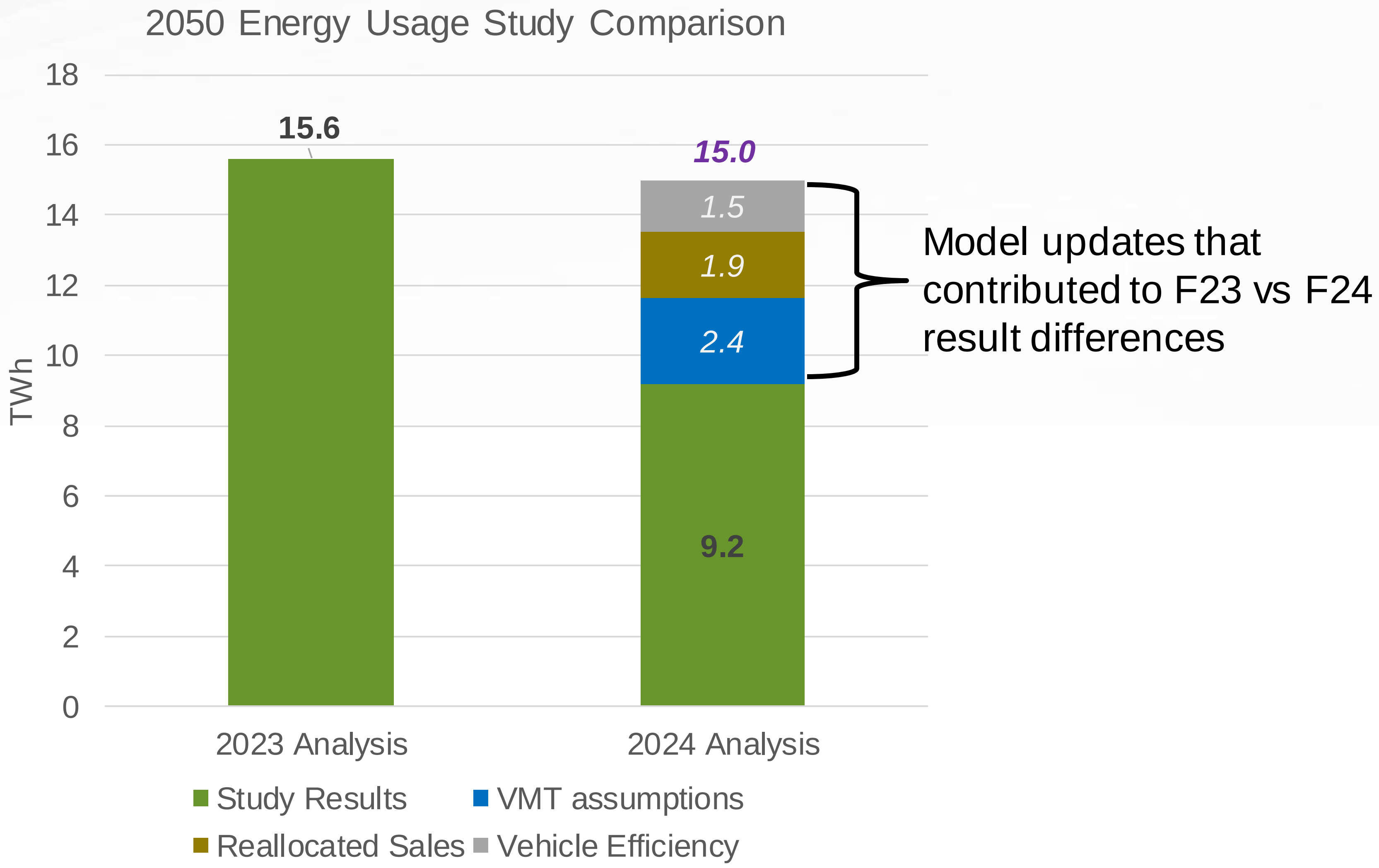


- For the F24 EV Forecast, VAST has introduced the **Long-Haul Truck class, which represents the largest source of charging need of all the MHDVs**
- **Long-Haul trucks are expected to primarily use en route charging**, specifically the Corridor use case, which **leads to an increase of over 5000% in en route total energy** compared to the F23 EV Forecast

Energy difference breakdown

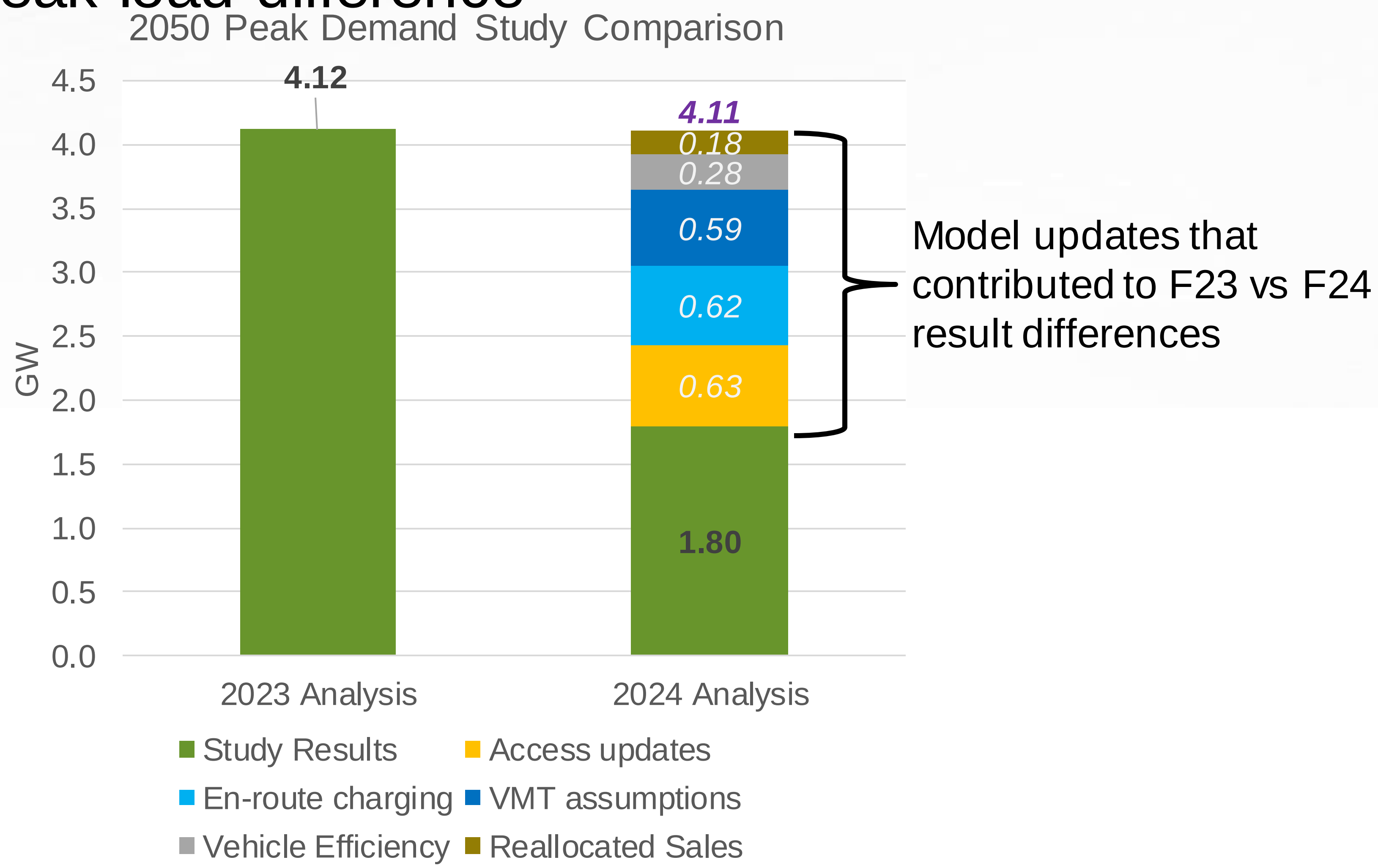
Vehicle efficiency was biggest contributor to energy differences

From a peak demand perspective, this reduction in overall energy pushed down the load shape



Peak Demand

Corridor charging, electricity access, and VMT assumptions were biggest drivers in peak load difference



Sales and VMT updates

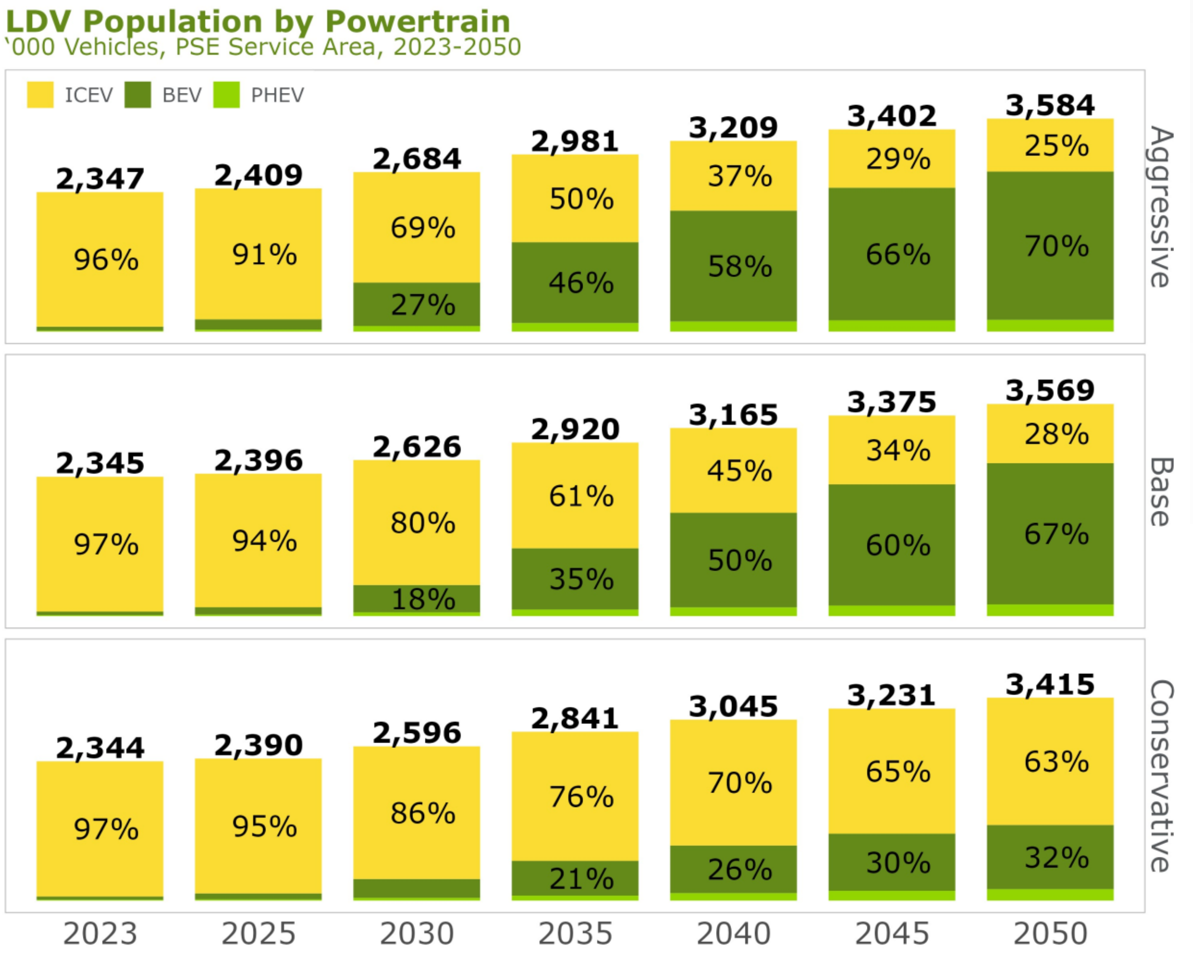
F24 Model Update	Impact	Sources	Uncertainty	Urgency
Reallocated US vehicle sales to individual states based on updated IHS registration data. Registrations during Covid threw off sales estimates.	25% reduction in 2050 WA MHDV population (with minimal impact on 2050 WA LDV population).	S&P Global (registration data provider) MarkLines (vehicle sales data provider)	**Medium** level of certainty regarding WA sales in near years, which decreases over time	Not urgent
Updated VMT assumptions from disaggregating semi-truck vehicle class to include short-haul, long-haul, and "others". Updated VMT for other vehicle classes as well	The previous analysis assumed all HDV Semi-Trucks had VMT of 78K. In this analysis, we assigned more appropriate values by use case: Short-Haul = 40k Long-Haul = 100k Semi-Truck ("others") = 30k Reduced VMT assumptions resulted in lower energy usage.	FHWA Statistics Series GHI Fuel Institute report EMFAC EDF AFDC	**Medium** level of certainty regarding VMT in near years, which decreases over time	Not urgent

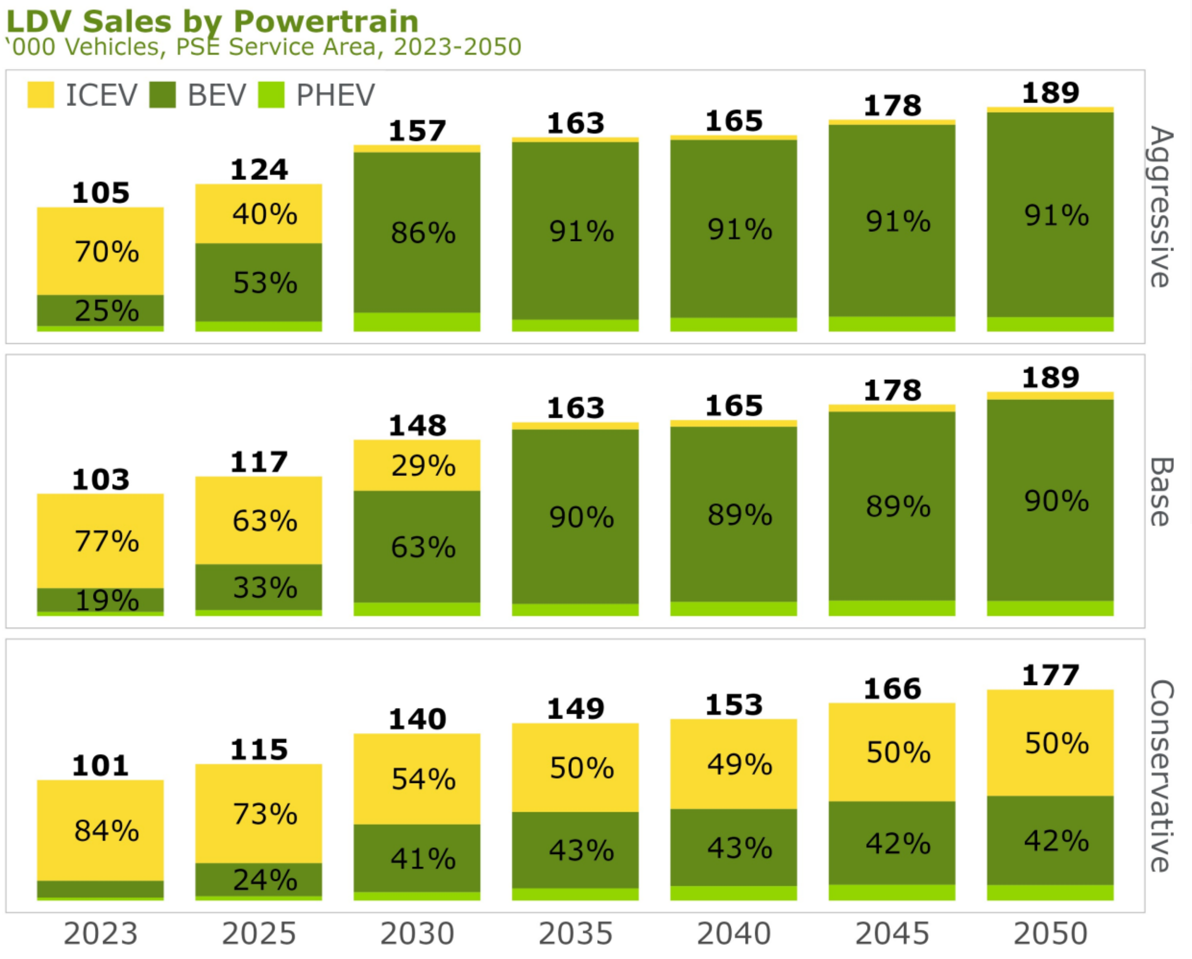
Efficiency, access, and corridor charging updates

F24 Model Update	Impact	Sources	Uncertainty	Urgency
Vehicle efficiency updates.	Increased vehicle efficiency led to lower energy use.	2023 Fuel Economy Guide ICCT Purchase Cost of Zero-Emissions Truck Working Paper AFDC Advanced Vehicle Search for S. Bus AFDC Advanced Vehicle Search for T. Bus	**Medium** level of certainty regarding vehicle efficiency in near years, which decreases over time	Not urgent
The F24 EV Forecast uses **updated assumptions** about housing stock and **electricity access**	Long run home charging access decreased from 70% to 57%. This reduced evening peak demand as charging shifted from early evening at residences to the middle of the day at workplaces or public (market) stations.	https://www.nrel.gov/docs/fy22osti/81065.pdf Census info source	**Low** level of certainty	This becomes an **urgent** issue in **2040-2050** time-range
Added en-route charging use case for long-haul trucks	Updated assumptions to indicate long-haul trucks will meet 71% of their charging needs from en-route charging, which occurs during the day as opposed to in-depot, which happens in the evening. Previously the model assumed all semi-truck charging occurred at depots.	National Household Travel Survey Bureau of Transportation Statics, Freight Analysis Framework Version 5	**Low** level of certainty	This becomes an **urgent** issue in **2040-2050** time-range

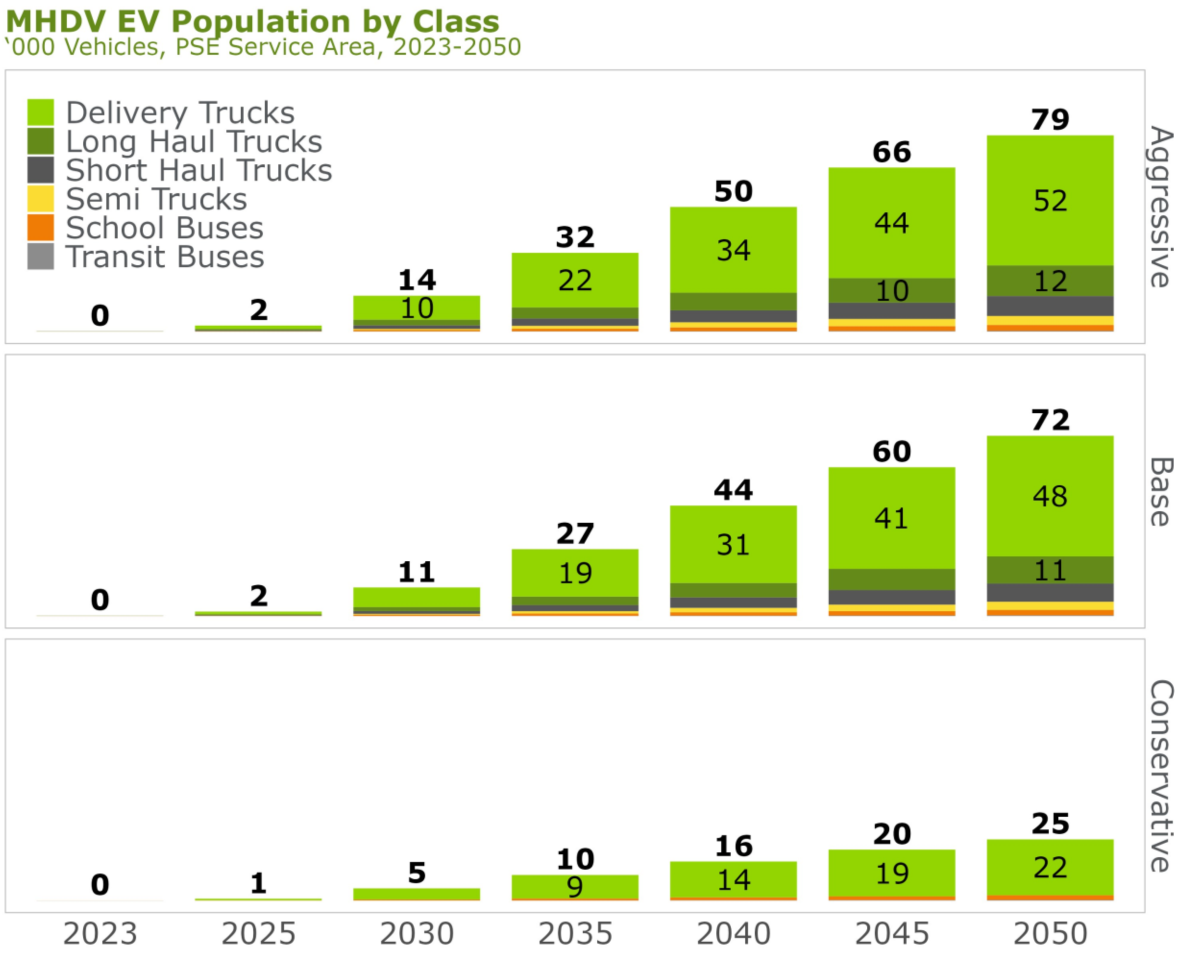
Appendix F – PSE Service Area EV Adoption Scenario Results

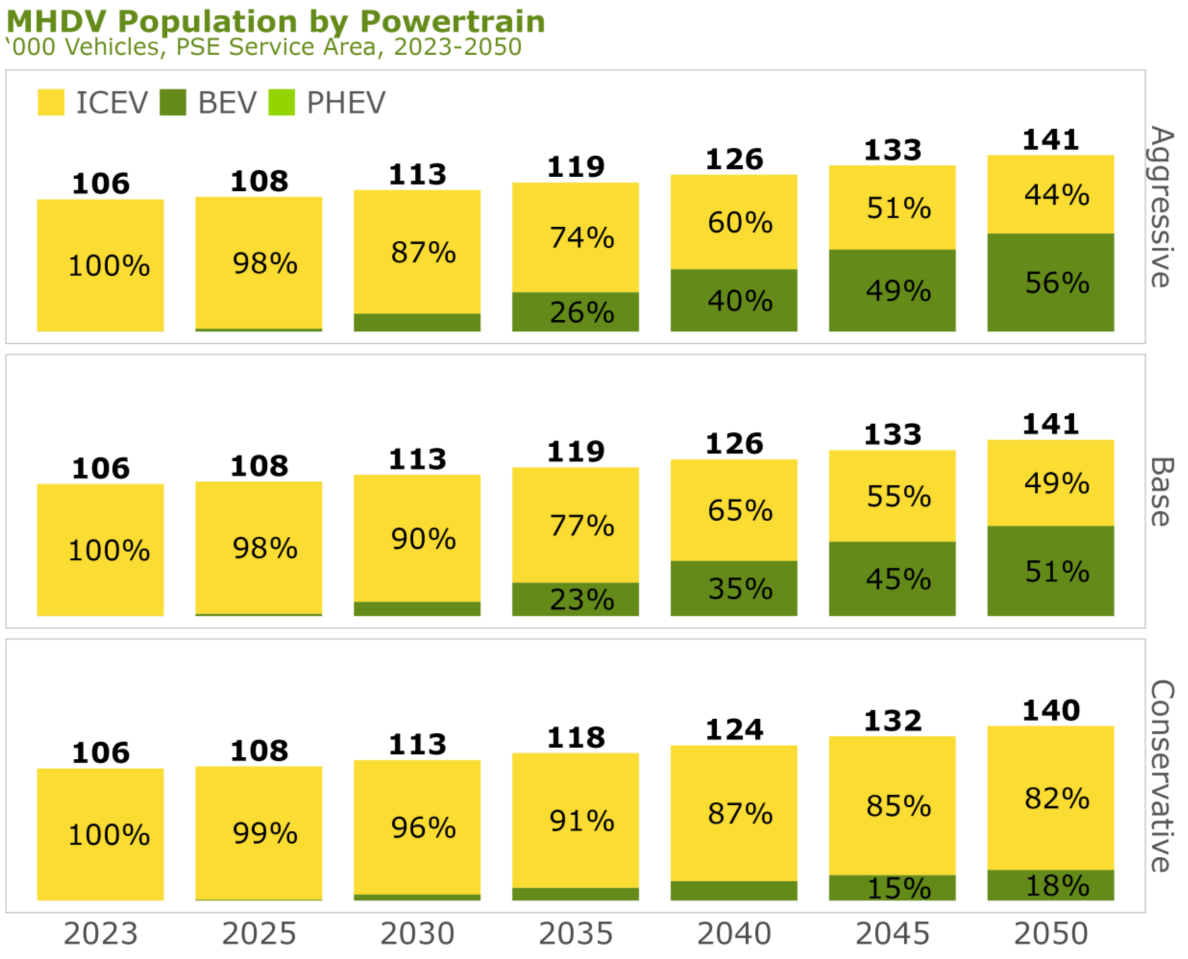
In PSE's Service Area in 2050, LD PEV Population is forecasted to range from 1,273k vehicles to 2,694k, with sales ranging from 88k PEVs to 184k





In PSE's Service Area in 2050, MHD PEV Population is forecasted to range from 25k vehicles to 79k, with penetration ranging from 18% up to 56%





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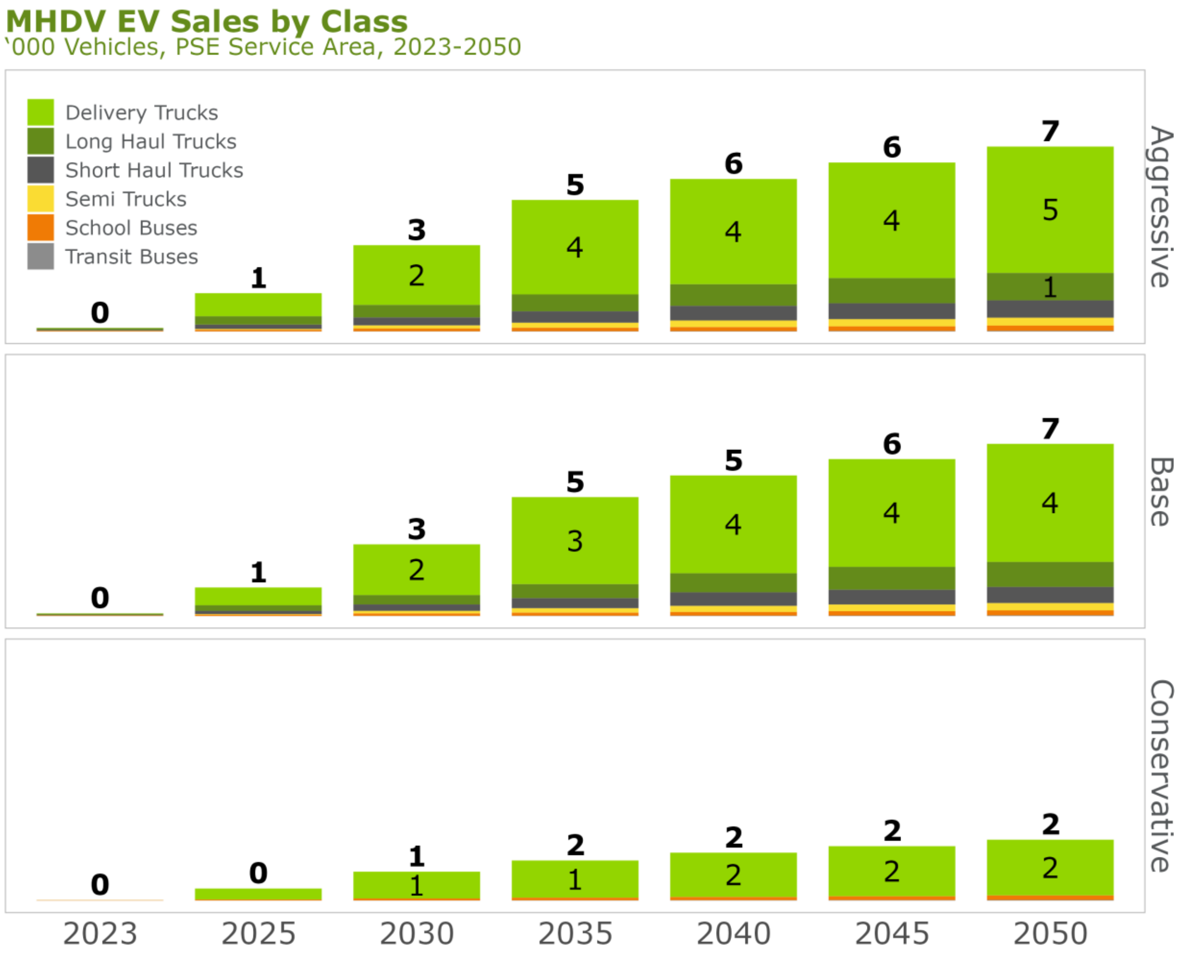
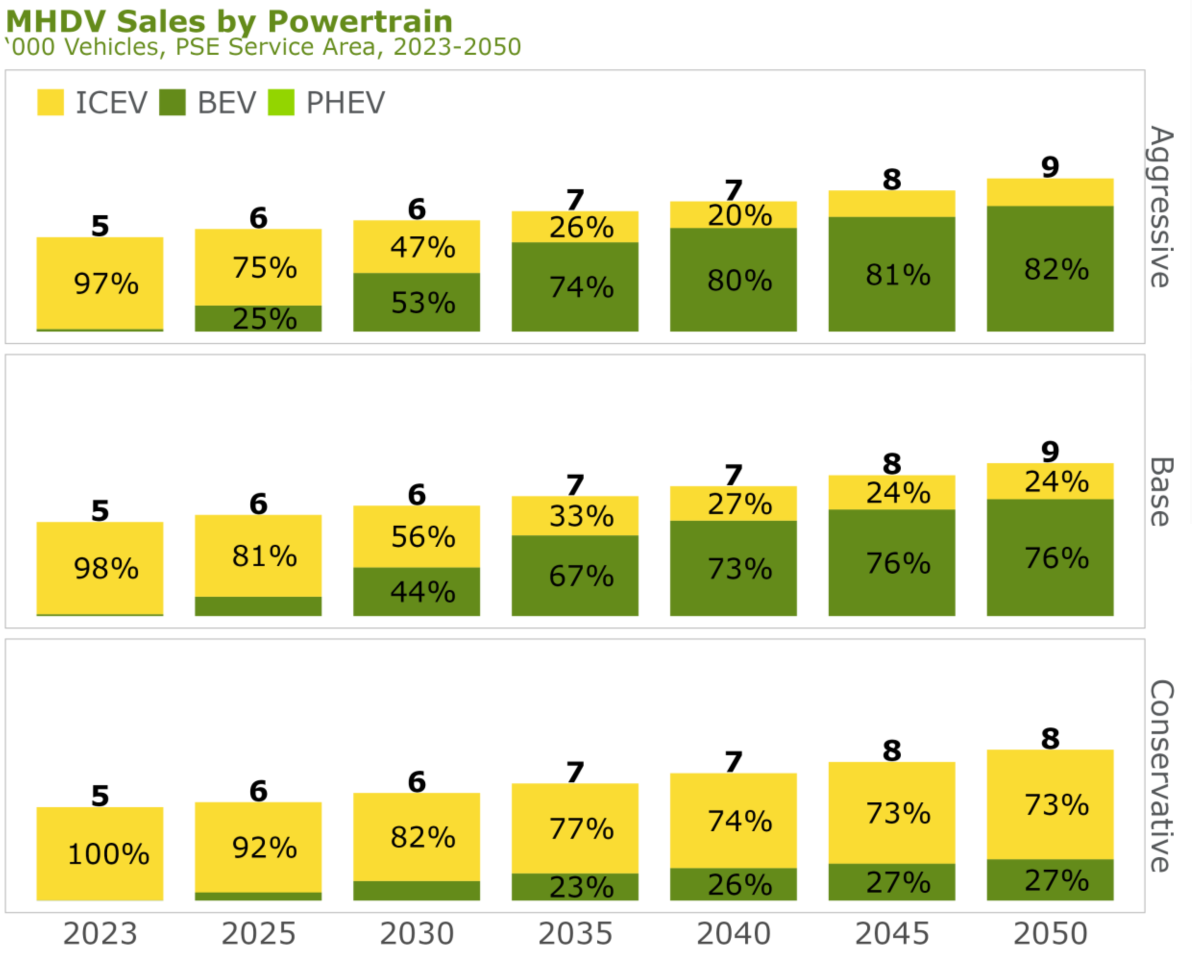
In PSE's Service Area in 2050, MHD PEV Sales is forecasted to range from 2k vehicles to 7k, with market share ranging from 27% up to 82%





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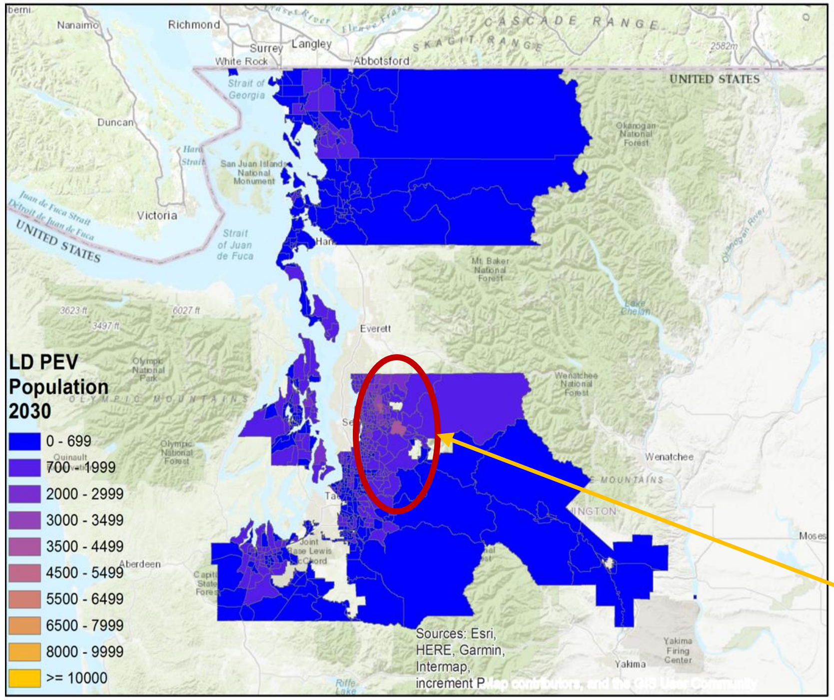
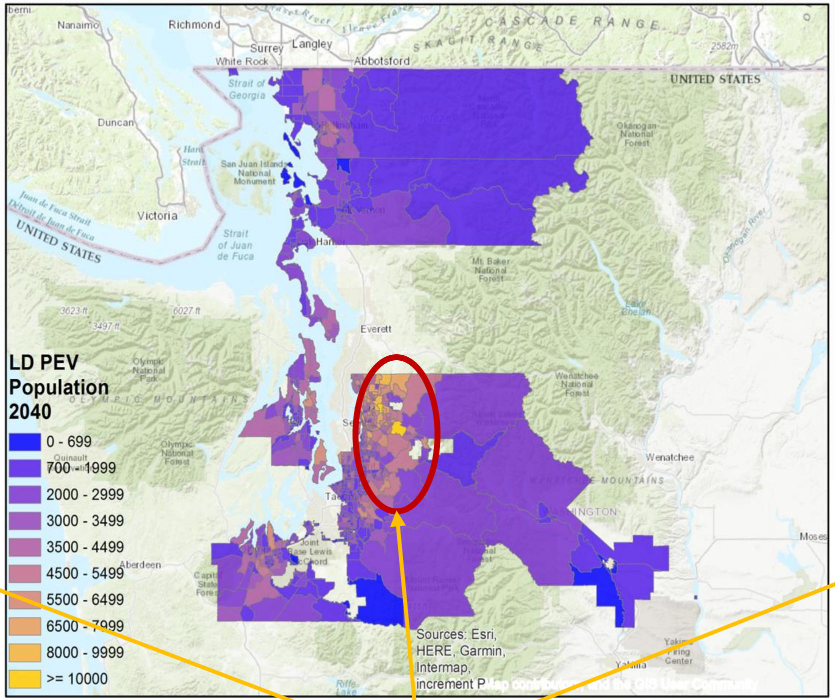
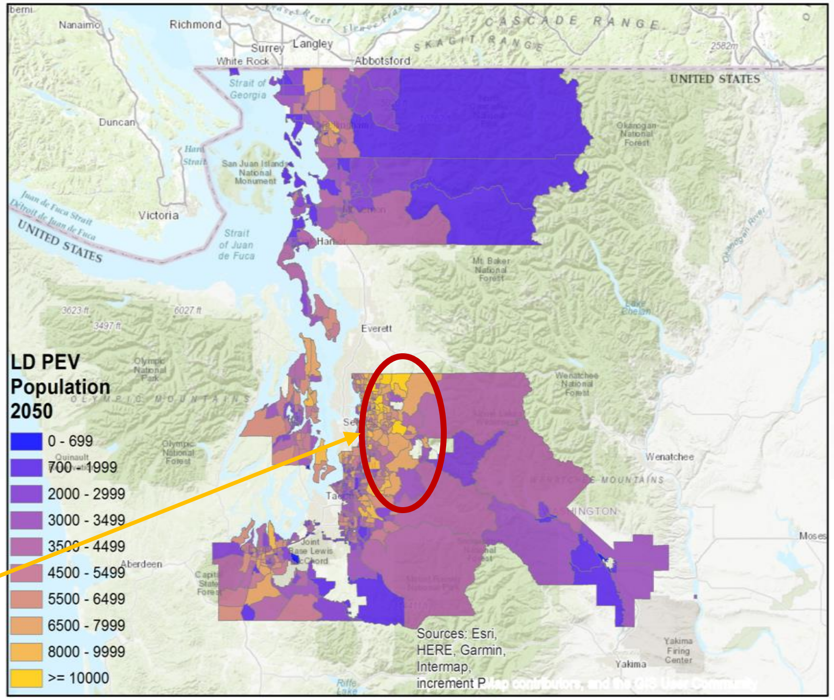
LD PEV registrations concentrated around major areas such as suburban Seattle, Tacoma, and Kent

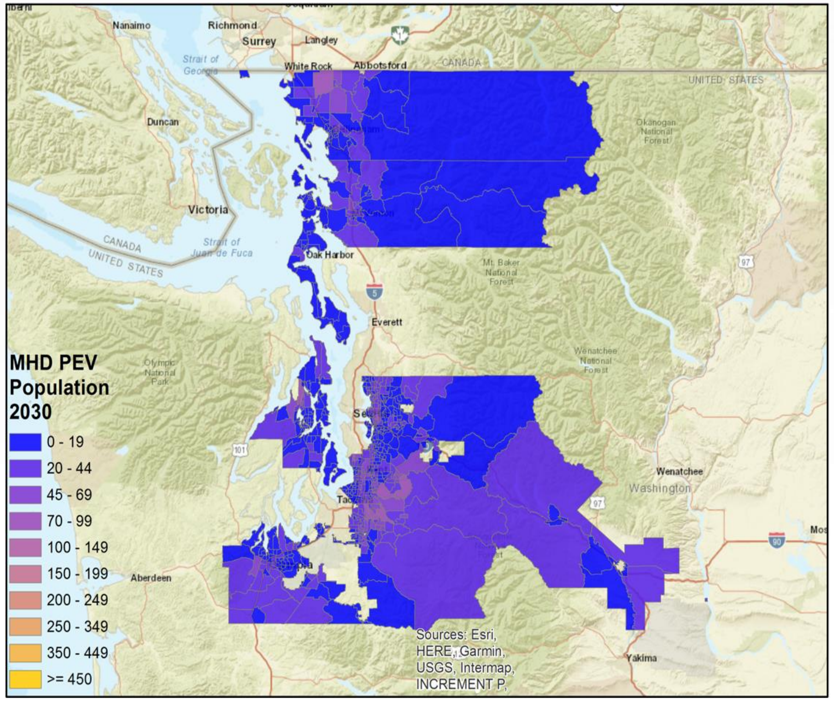


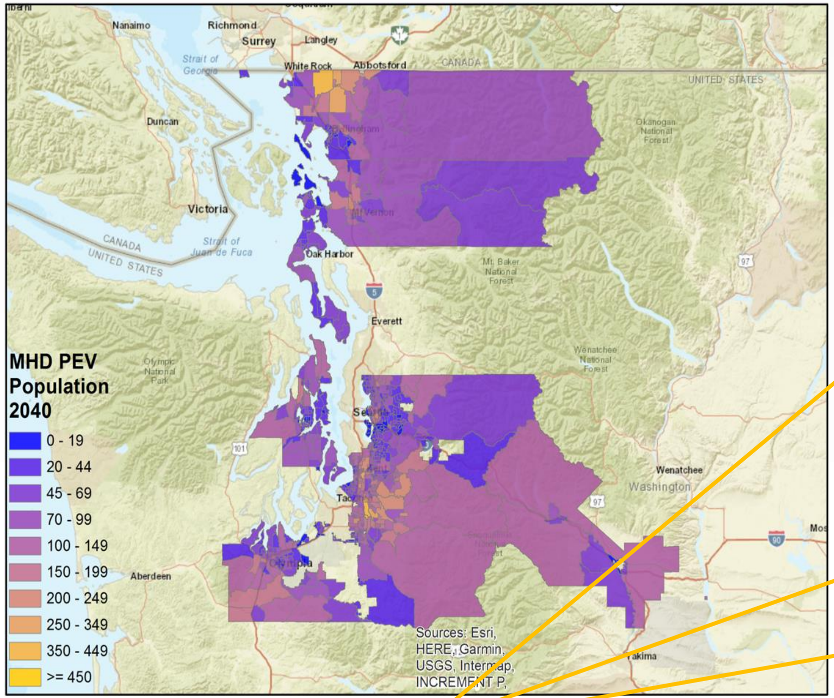


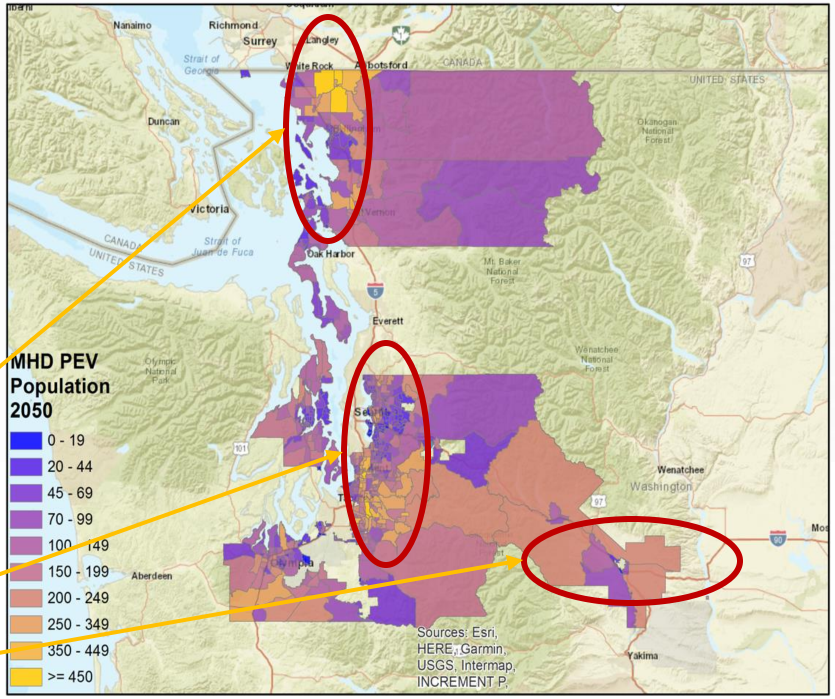


LDV adoption aligns with suburban Seattle, Tacoma and Kent

MHD PEV registrations concentrated around Interstate 5 – a major shipping artery



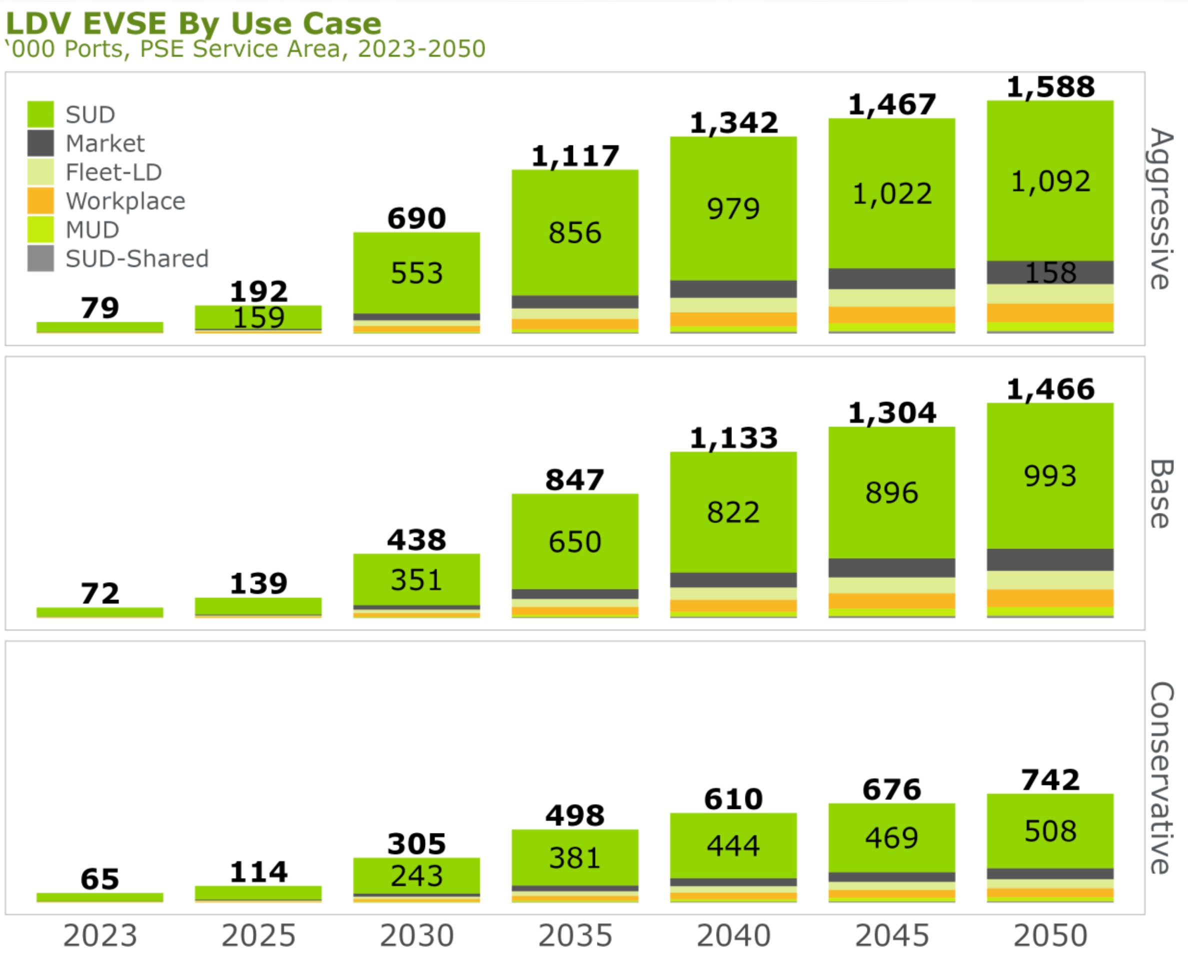


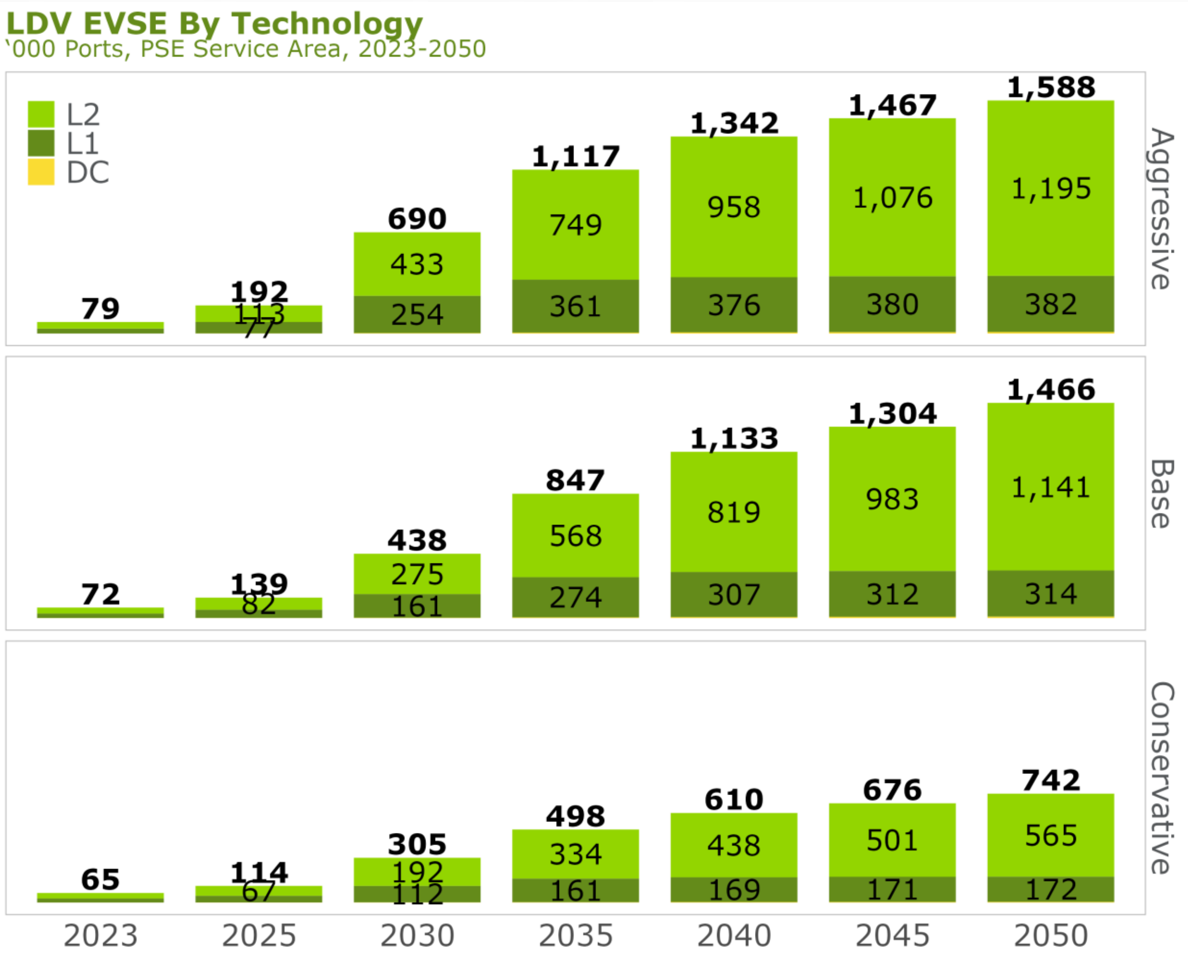


MHDV adoption focused around major shipping arteries such as I5 and I90

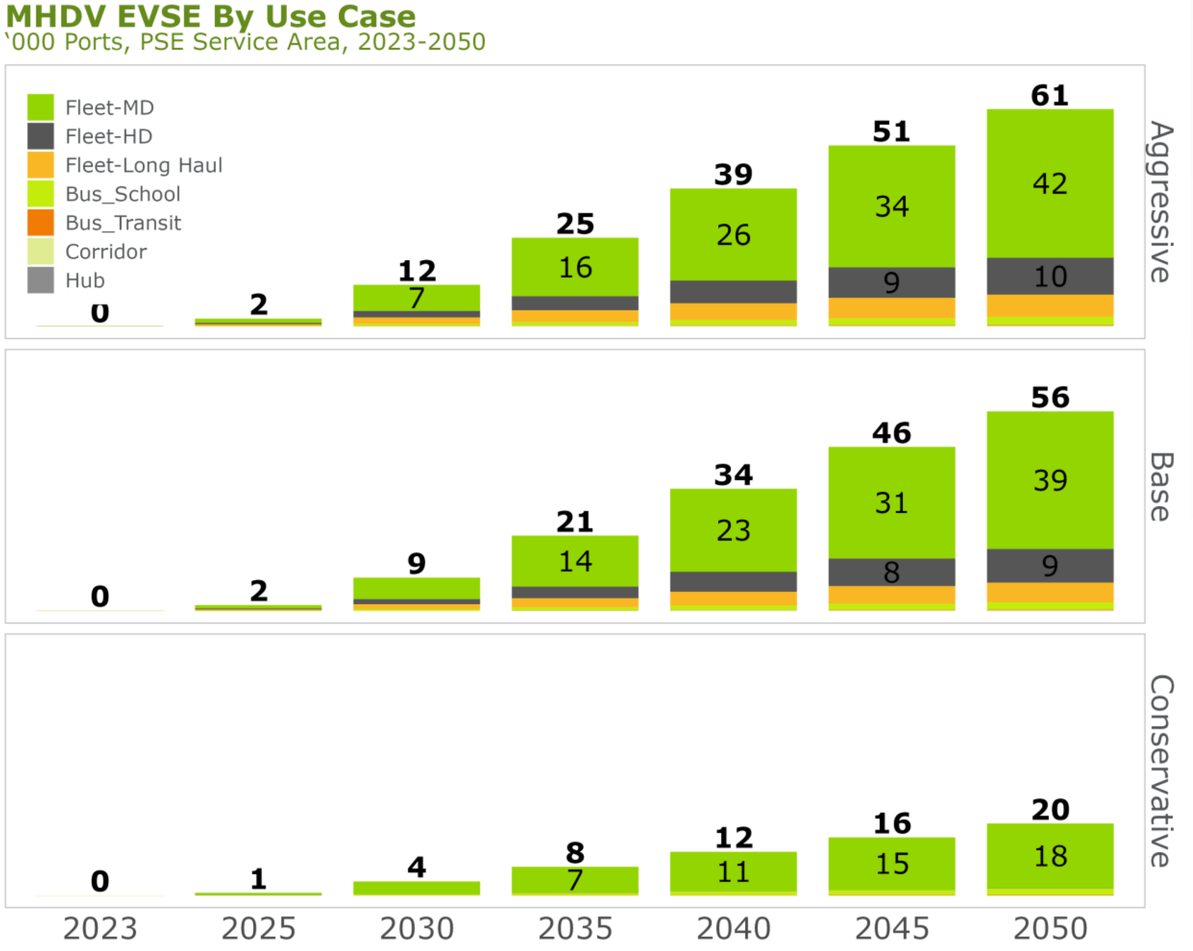
Appendix G – PSE Service Area EVSE Needs Scenario Results

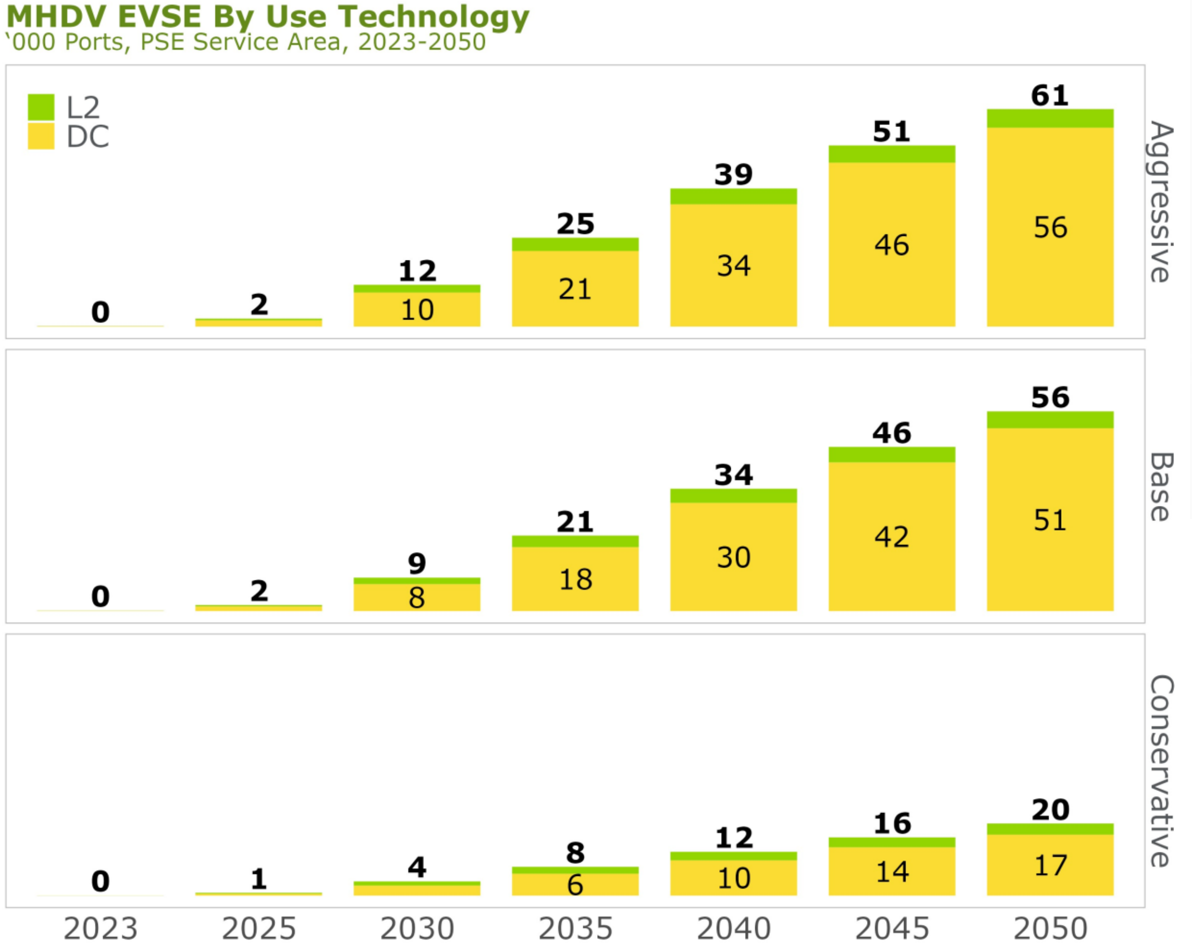
In PSE’s Service Area in 2050, EVSE for LDVs is forecasted to range from 742k ports to 1,588k





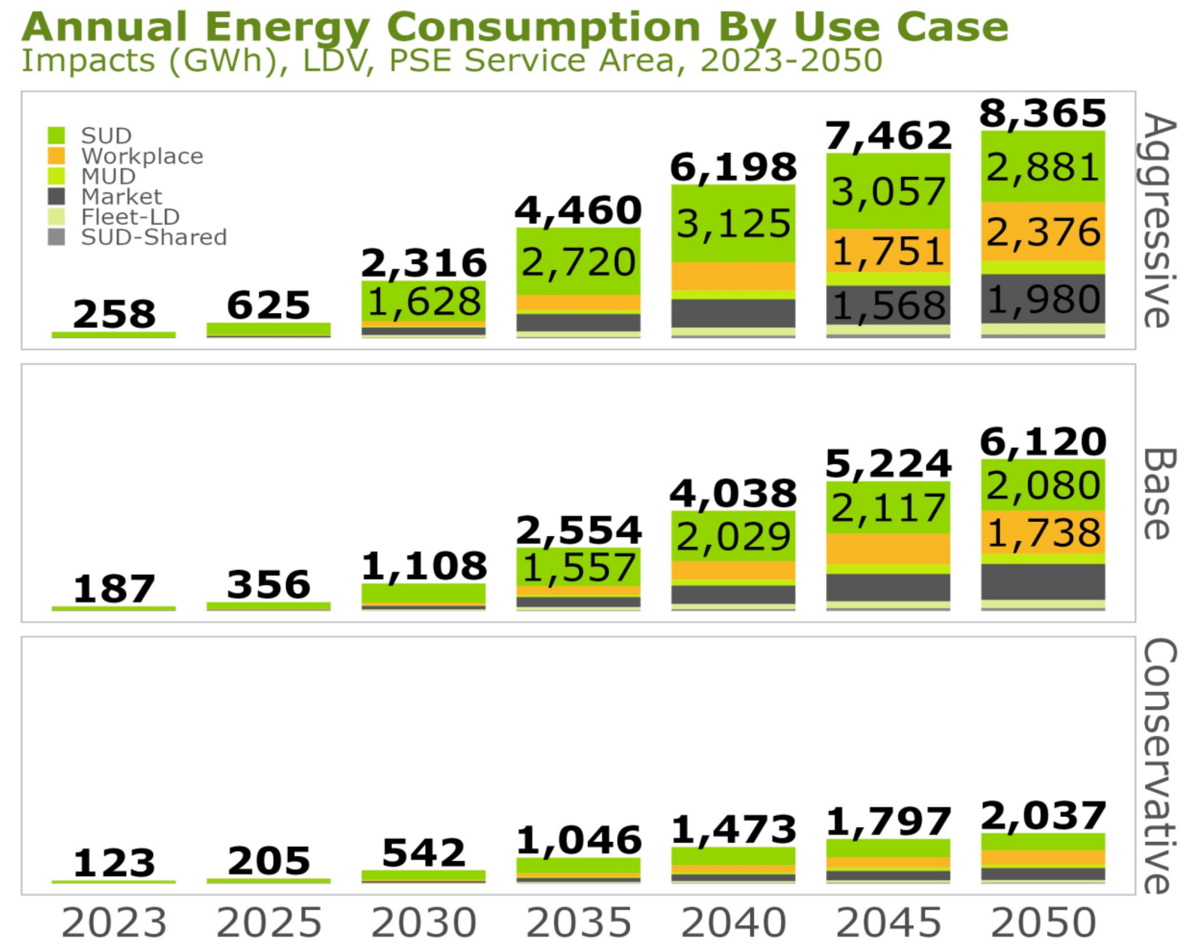
In PSE's Service Area in 2050, EVSE for MHDVs is forecasted to range from 20k ports to 61k

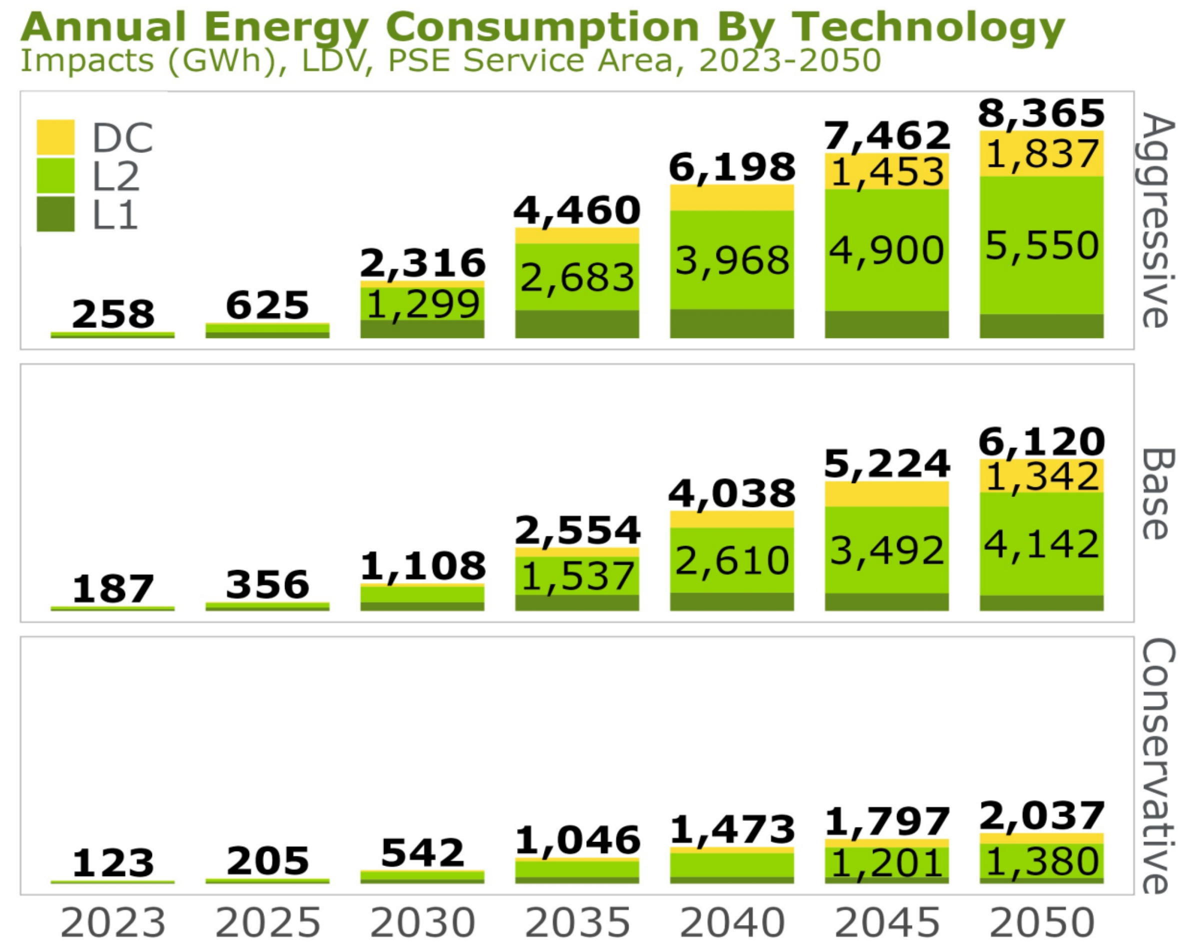




Appendix H – PSE Service Area Load Impacts Scenario Results

In PSE's Service Area in 2050, Energy Required for LDVs is forecasted to range from 2,037 GWhs to 8,365 GWhs

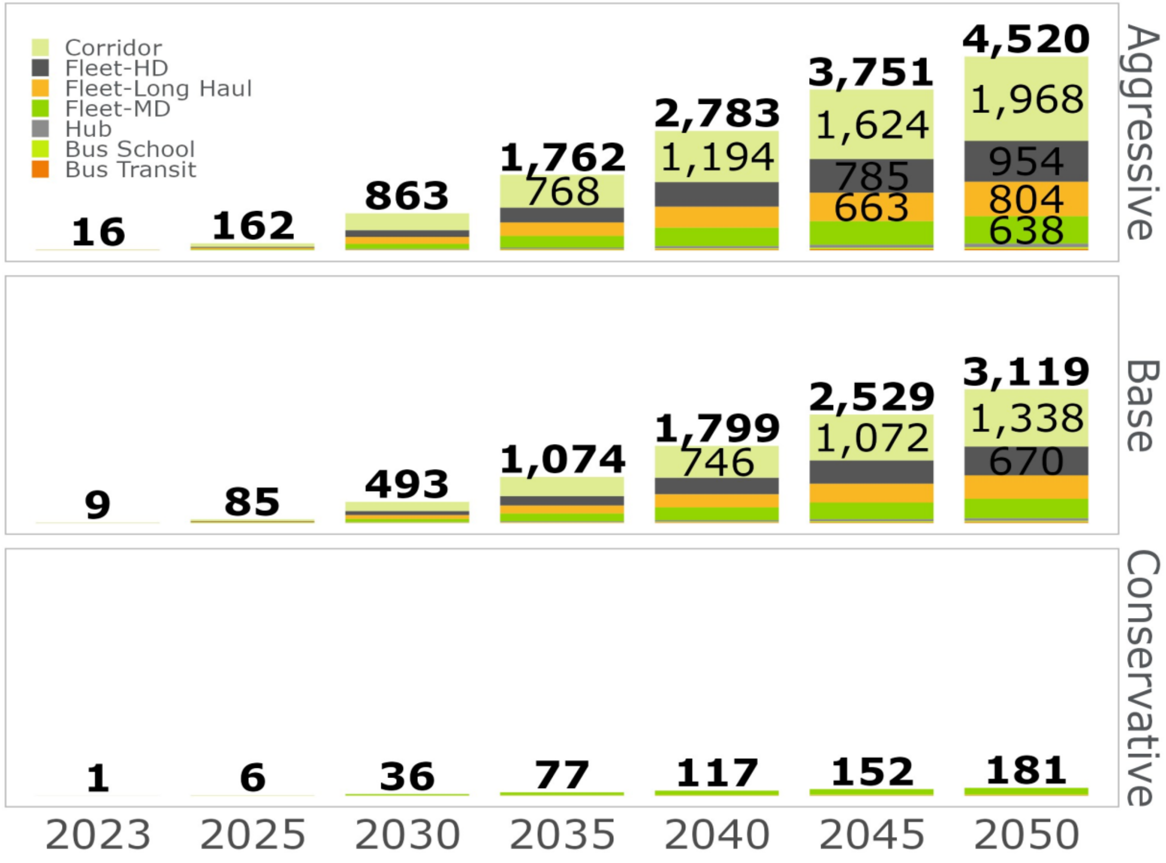




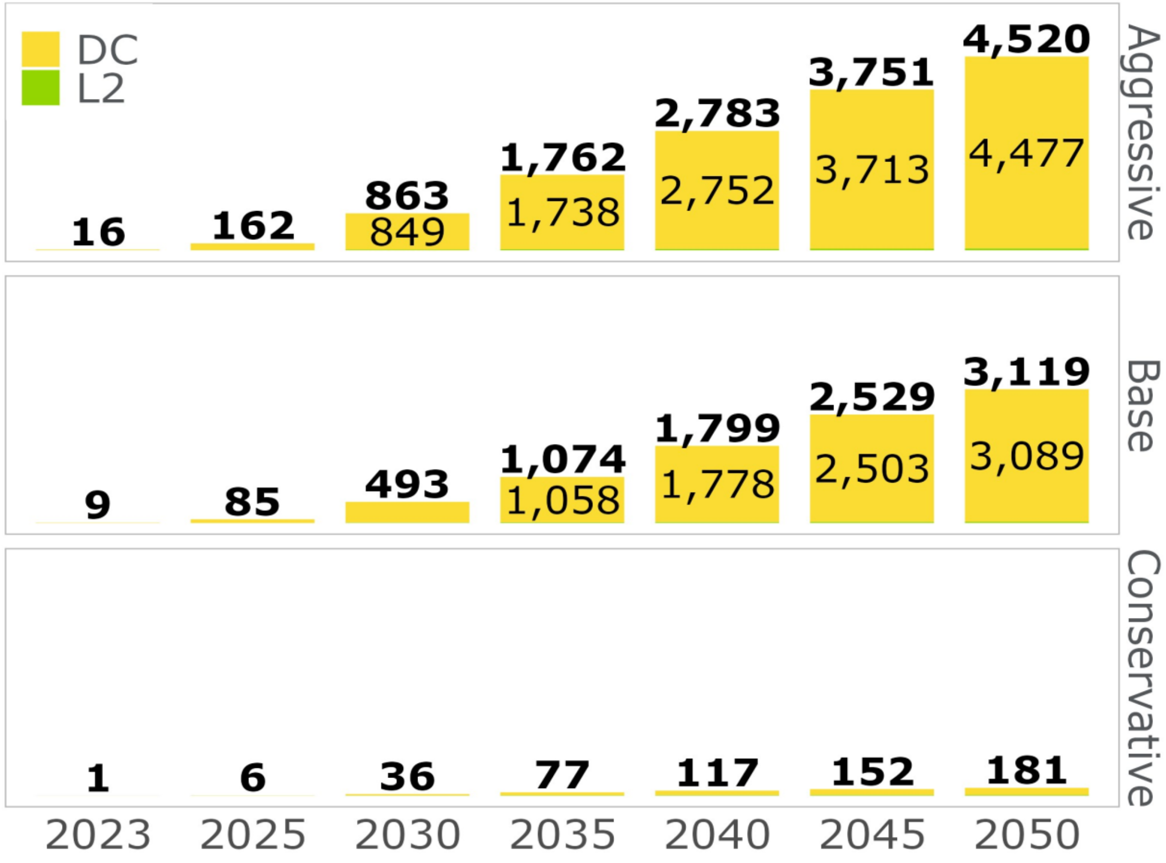
In PSE's Service Area in 2050, Energy Required for MHDVs is forecasted to range from 181 GWhs to 4,520 GWhs

The assumption that no HDV adoption in the Conservative scenario significantly impacts the MHDV energy requirement

Annual Energy Consumption By Use Case
Impacts (GWh), MHDV, PSE Service Area, 2023-2050



Annual Energy Consumption By Technology
Impacts (GWh), MHDV, PSE Service Area, 2023-2050

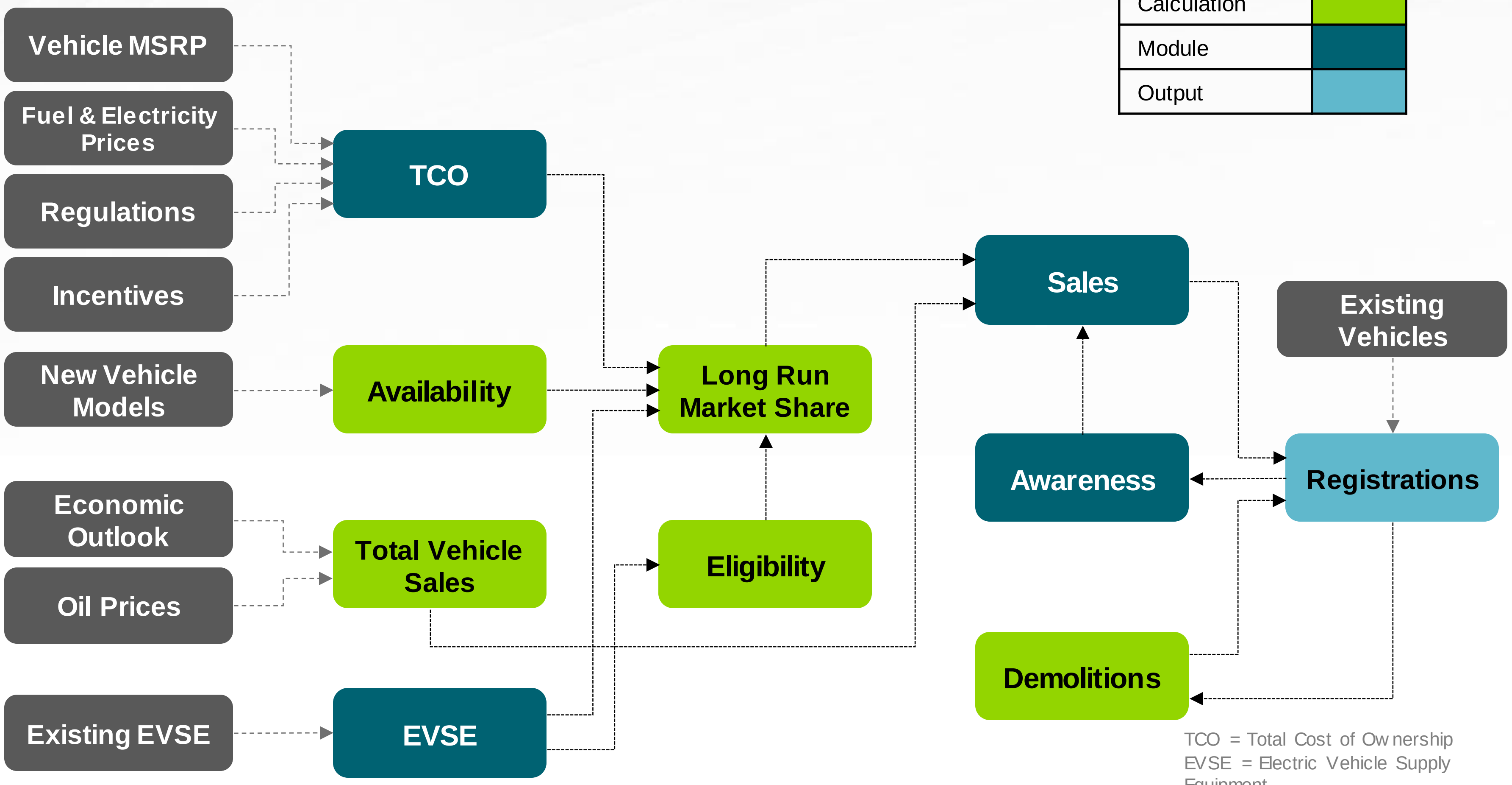


Guidehouse Outwit Complexity

Appendix I –Overview of Methodology

VAST EV Adoption Overview

Input	
Calculation	
Module	
Output	



TCO = Total Cost of Ownership
EVSE = Electric Vehicle Supply Equipment
Source: Guidehouse Analytics

Methodology

- Using a **systems dynamics model** of stocks (vehicle registrations) and flows (vehicle sales, scrappage) that uses **Enhanced Bass Diffusion**, VAST is able to forecast EV
- Forecasts EV adoption by **explicitly accounting for key dynamics** of technology adoption such as incentives, regulations, availability, awareness and total cost of ownership
- Taking inputs at the census tract level, including:
  - Vehicle registrations by make and model
  - Vehicle MSRP
  - Expected gasoline and electricity prices
  - Vehicle lifetime
  - Incentives
  - Annually collected survey data on vehicle owners
  - Demographic data, e.g., population, income, units in housing structure, vehicle ownership, household counts, educational attainment

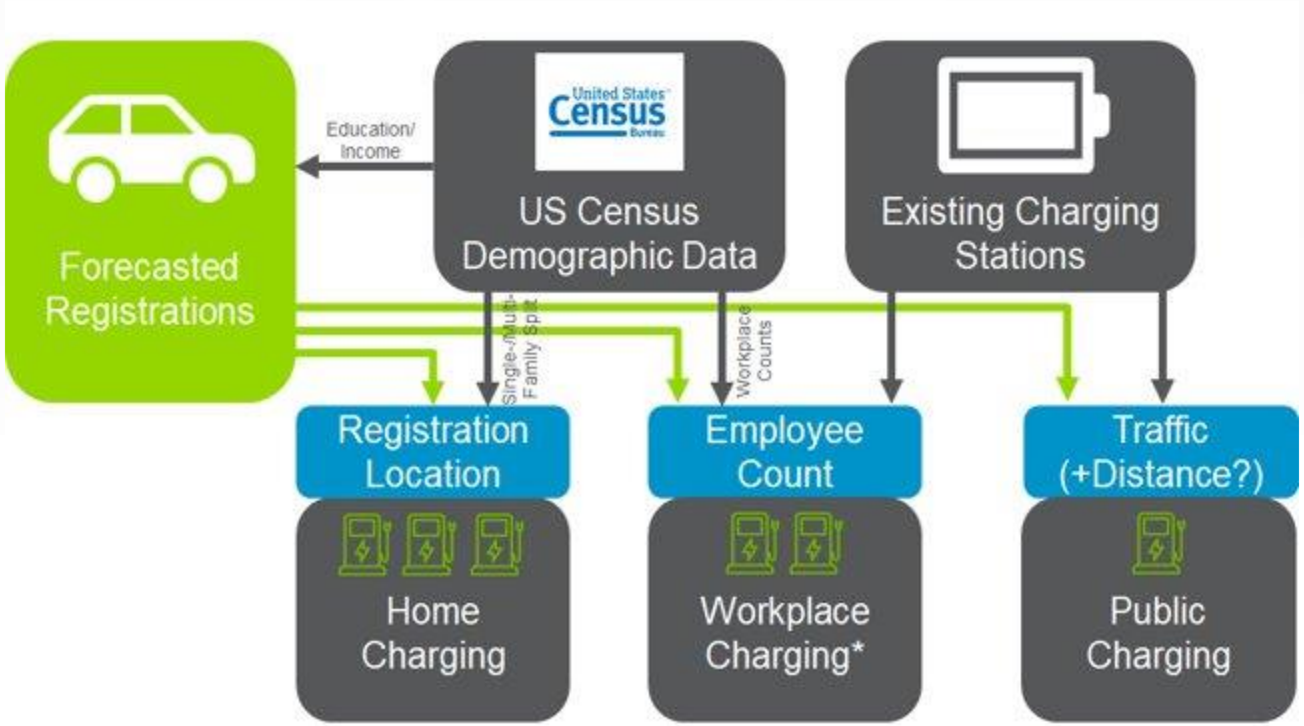
EV adoption modeling inputs and outputs

Key Inputs

Input	Description	Source
Registration Data	Vehicle registration by fuel type and zip	IHS Markit
Fuel Costs	Electricity rates ($/kwh) and gasoline and diesel prices ($/gal)	U.S. EIA (electricity) AAA (gasoline and diesel)
Vehicle Availability	Guidehouse research on future availability of EVs, including MHD vehicles in California	Guidehouse Insights
VMT	Forecasted annual vehicle miles traveled, California	Federal Highway Administration
Vehicle Efficiency	kWh/mile forecast	Argonne National Lab
PHEV e-Utilization	Proportion of PHEV miles using battery	
BEV Range	Total miles increase forecast	Guidehouse Insights
Education and Income	Educational attainment and income levels, by census tract	US Census Bureau
Vehicle MSRP	Cost of vehicle in $'s	Guidehouse Insights, Kelly Blue Book

Charging Methodology

Guidehouse's EV Charging module determines the volume and location of EVSE required to support adopted EVs, specific to use-cases and technology charging levels



EV Adoption

↓

Pr (Charges at Use Case | EV Class, Duty, Powertrain)

↓

Pr (Charger Technology | Use Case ∩ EV Class, Duty, Powertrain)

↓

Applicable Vehicles * Ports per Vehicle

↓

Port Volume

**Pr = Probability*

Vehicle Classes Served by Charger Site Types

Site Ownership	Use Case	Vehicle Classes Served
Private	**Residential** • *Single-Family (SUD)* • *Multi-Family (MUD)*	• Passenger Cars • Light Trucks
	Workplace	• Passenger Cars • Light Trucks
	Fleet Depot • *Fleet-LD* • *Fleet-MD* • *Fleet-HD* • *Fleet-Long Haul*	• Passenger Cars • Light Trucks • Delivery Trucks • Semi Trucks • Short Haul Trucks • Long Haul Trucks
	Bus Depot • *School Bus* • *Transit Bus*	• School Buses • Transit Buses
Public	**Curbside Residential** • *Single-Family Shared (SUD-Shared)*	• Passenger Cars • Light Trucks
	Market	• Passenger Cars • Light Trucks
	Corridor	• Long Haul Trucks
	Hub	• Delivery Trucks • Semi Trucks • Short Haul Trucks

- Charger **use cases** are specific to the needs of different **vehicle classes**, as listed in the table to the left.
- Light-duty vehicles (LDV) typically share **all public** charging infrastructure and **some private** charging infrastructure, including MUD, SUD-Shared, and Fleet-LD use cases.
- Medium- and heavy-duty vehicles (MHDV) rely on **separate** charging infrastructure from LDVs.

VAST Load Impacts Calculation by Use Case

The VAST Load Impacts module calculates the kWh and kW impact of EV charging at EVSE locations. Key variables include the driving need of the vehicles (VMT), vehicle class and duty, vehicle power train and efficiency, and the capacity of the charger.

Vehicle Example A

Class (a)	Duty (b)	Powertrain (c)	Annual VMT# (d)	Fuel Efficiency # (e)	Use Case # (f)	Energy* (kWh = d*e*f)
Long-Haul	Heavy	BEV	100,000 miles	2 kWh/mile	Corridor (71%)	142,000 kWh

Vehicle Example B

Class (a)	Duty (b)	Powertrain (c)	Annual VMT # (d)	Fuel Efficiency # (e)	Use Case # (f)	Energy* (kWh = d*e*f)
Passenger Car	Light	BEV	10,000 miles	0.3 kWh/mile	Residential (80%)	2,400 kWh

Vehicle Example A

Vehicle Composite Charging Profile	
Private – Home – Urban/Suburban/Rural	0%
Private – Workplace – Urban/Suburban/Rural	0%
Private – Depot – Urban/Suburban/**Rural**	**29%**
Public – Corridor – Urban/Suburban/**Rural**	**71%**
Public – Market – Urban/Suburban/Rural	0%

Vehicle Example B

Vehicle Composite Charging Profile	
Private – Home – Urban/**Suburban**/Rural	**80%**
Private – Workplace – Urban/Suburban/Rural	**10%**
Private – Home – Urban/Suburban/Rural	0%
Public – Corridor – Urban/Suburban/Rural	0%
Public – Market – Urban/Suburban/Rural	**10%**

**Consumption = Vehicle Average Annual VMT * efficiency (kWh per mile) * proportion of charging by use case*
 # Values presented here are for illustrative purposes only

Appendix

Model Inputs & Key Assumptions

Model Input	Value
Reporting Level (Generator or Meter)	Generator
Study Period	2026-2050
Cost Year	2026
Line loss	**Electric:** 8.14% , **Natural Gas:** 1.12%
Avoided T&D ($/kW-Year)	**Electric:** $98.42 (avg. of summer and winter), **Natural Gas:** $0.00
Conservation Credit	10%
Admin Adder	21%
Discount Rate	6.62%
Vulnerable Population Levelized Cost Adjustment	0.667
Peak Definition	January, February, November, December Weekdays (HE8-HE10, HE18-HE20)
Includes non-energy impacts (NEIs)	Yes

Energy Efficiency- Measures

General CPA Input Assumptions

CPA Energy Efficiency Measures

Secondary Sources
-Industrial Assessment Center Database
-TRMs (gas measures)

Council's 2021 Power Plan
Includes future climate change impacts + adjust to PSE climate assumptions

Regional Technical Forum (RTF)
Climate change adjustments

PSE Business Cases
Climate change adjustments +NEI

Saturation and Measure Input Data

PSE 2021 Residential Characteristics Study (RCS)
Provides residential equipment saturation data

NEEA 2017 RSBA II
Includes PSE oversample and provides detailed residential equipment saturation data

NEEA 2019 CBSA IV
Includes PSE oversample and provides commercial equipment saturation data

Codes and Standards Forecast

Federal Appliance Standards

- Accounting for all on-the-books federal standards
- Including the new residential gas furnace standard (finalized on September 29th, 2023)

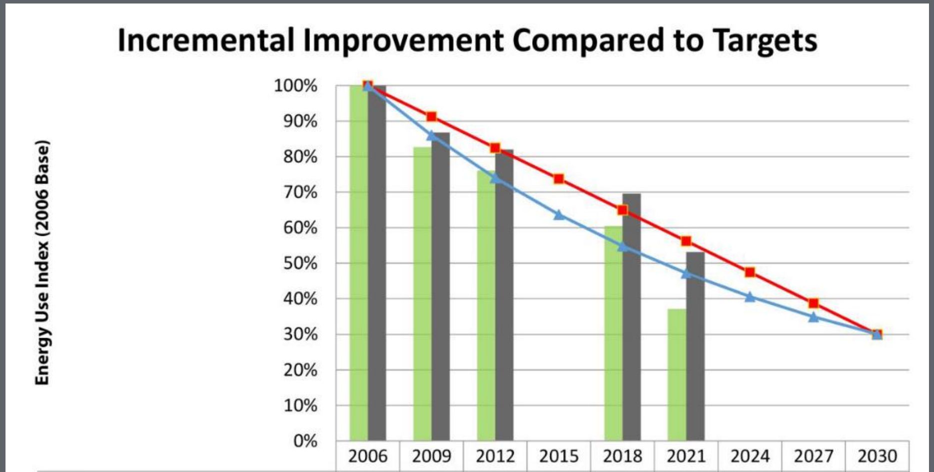
Washington State Energy Codes (2021 WAC)

- No gas or electric resistance for space and water heating
  - New construction only
  - Single-family, multifamily, and commercial
  - Impacts: Increase in electric EE potential and reduction in natural gas EE potential
- New requirements for commercial cooking

City of Seattle Building Emissions Performance Standard (BEPS) policy

- Existing commercial and multifamily buildings larger than 20,000 square feet
- Reducing building emissions 27% by 2050 by improving energy efficiency

Modeling RCW 19.27A future code that require 70% reduction in **net annual energy** consumption by 2031, compared to the 2006 WSEC.



	2006	2009	2012	2015	2018	2021	2024	2027	2030
Residential	100%	82.7%	76.1%		60.5%	37.2%			
Commercial	100%	86.8%	82.0%		69.6%	53.0%			
Target: 8.75 % savings compared to the 2006 WSEC	100%	91%	83%	74%	65%	56%	48%	39%	30%
Target: 14% savings compared to each previous code	100%	86%	74%	64%	55%	47%	41%	35%	30%

Source: Draft Washington Progress of the Residential and Commercial Energy Codes Towards RCW 19.27A (PNNL), 2023

2025 CPA Approach

- Planned approach assume future code cycles (2027 and 2030) will reduce commercial sector consumption by 10% each for all gas and electric end-uses
- No planned adjustment for residential sector

Climate Change Adjustments

2023 CPA Approach

Accounted for climate change on weather-sensitive measures based on the Council's 2021 Power Plan data and collaboration with PSE's load forecasting team

Adjustment factors applied to weather-sensitive RTF and PSE Business Case measures

Residential air conditioning saturations increased to align with PSE load forecast projections

Council Modeled Ratios	HVAC Ratio FMY/TMY
All Residential Heating - HZ1	80%
All Residential Cooling - HZ1	200%
All Residential Combined - HZ1	105%

2025 CPA Approach

Similar to 2023 CPA approach, with **updated PSE climate change data**

~ 21% decrease in heating load by 2050

~ 197% increase in cooling load by 2050

Expected impact on potential similar to prior CPA (compared to base year)

- Higher cooling savings (from ACs and retrofits with cooling savings)
- Lower heating savings from gas furnaces and boilers

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Non-Energy Impacts and Underserved Communities & Equity

Non-Energy Impacts	Underserved Communities & Equity
In 2023 CPA, added additional non-energy impacts. • Some RTF/Council measures have NEI already (water savings, O&M, lifetime replacement) • PSE has conducted NEI evaluation (e.g., DNV study) to expand NEIs • PSE incorporating these NEIs into some Business Cases	In 2023 CPA, Cadmus used CETA and CEIP as a starting point aligned with geographic areas to inform the potential for Highly Impacted Communities and Vulnerable Populations • The ***Vulnerable Population*** data best aligned with CPA geographic areas (e.g., county level built up from block groups) and therefore, selected as the primary identifier • Segmented PSE residential accounts for vulnerable populations by county (SF, MH, and MF) • Used PSE 2021 RCS data to inform equipment saturations and fuel shares for vulnerable population (based on income)
2025 CPA Assumptions • Following the same NEI approach as the prior CPA • Using updated PSE Business Cases with the latest NEI data	**2025 CPA Assumptions** • "Vulnerable populations" is still the preferred primary identifier. • Using the same VPs data set as 2023 CPA. • Using PSE 2021 RCS low-income data to inform equipment saturations and fuel shares for VPs.

Adoption Ramp Rates

2023 CPA Approach

- Applied 10-year flat ramp for discretionary measures (electric and natural gas based on PSE historic precedent)
- Created disconnect between natural gas programs and potential study near-term savings

Updated ramp rate process for 2025 CPA

- Updated **natural gas** discretionary measure 10-year ramp rates to align Council discretionary ramp rates.
- Conducted in-depth interviews with the PSE personnel for four measure categories which showed the most divergence between planned potential in last CPA and actual (evaluated) savings and gathered **recommendations on updating the ramp rates of selected gas and electric measures.**

Water Heating | Weatherization | Smart Thermostats | Furnaces

- Solicited feedback from PSE program staff on the draft results and made further gas and electric measure ramp rate updates to better align with PSE programs.

IRA Funding Opportunities Research

Interviewed two Washington State Department of Commerce staff, the lead IRA state funding agency on direction of IRA funding and opportunities to leverage existing PSE programs

CONCLUSIONS

1	Commerce prioritizes a comprehensive strategy for IRA program implementation, focusing on collaborative, proactive engagement, and a Summer 2024 rollout. This reflects a commitment to high-impact initiatives, particularly in whole-home efficiency and electrification rebates.
2	Allocated funds for new programs are substantial but may only meet a fraction of the overall need, highlighting the ongoing need for funding support.
3	Navigating the initial design phase can be challenging for planning alignment. Varied motivations between utility and state programs, targeting different populations, and eligibility criteria, may pose challenges.
4	Interviewees acknowledge the challenges in integrating IRA programs with existing incentives, particularly to low-income households, due to the limited coverage of project costs with existing incentives, non-seamless processes, and delays in rebate processing.
5	There is a chance for collaboration with the state and utilities to standardize programs, use diverse funding sources, and align contractor networks.
6	Utilities have a valuable messaging platform that can be leveraged to effectively distribute information about IRA-related opportunities.

IRA Modeling Considerations

2025 CPA Assumptions:

- PSE IRA HOMES/HEAHRA funding based on PSE allocations and for 25C based on the proportion of housing units in PSE service area compared to US
- 25C only applies to homeowners (primary residence)
- HOMES/HEEHRA + 25C tax credits to be combine
- Hard to model EE measures with HOMES rebate (apply to weatherization mainly)
- Assuming similar measures as HEEHRA, and increase HEEHRA funding by HOMES budget
- HEEHRA program contributes 70% funds for electrification measures and 10% EE funds (remaining 20% for non-EE funds)
- HOMES program indirectly funds 20% for electrification and 60% EE funds (remaining 20% for non-EE funds)
- 25C program contributes 45% to EE, 45% to electrification, and 10% to other (biomass, audits, etc.)

HEEHRA and 25C

Rebate and Tax Credit Summary for Specific Measures

Measure	High-Efficiency Electric Home Rebate		25C Tax Credit	
	Requirements	Rebate Amount	Requirement	Credit Caps
Overall incentive amount and limit	Household <150% AMI	80-150% AMI: 50% of installation cost <80% AMI: 100% of costs for households Total cap of $14,000	Sufficient tax liability to claim credit	30% of installation cost up to $2,000 per year for heat pumps and biomass; 30% of installation cost up to $1,200 per year for all other measures combined
Appliances				
Heat pumps	ENERGY STAR electric	$8,000	Highest CEE non-advanced Tier	$2,000
Heat pump water heaters	ENERGY STAR electric	$1,750	Highest CEE non-advanced Tier	$2,000
Central air conditioner, water heater, furnace, or boiler	N/A	N/A	Highest CEE non-advanced Tier	$600
Stove, cooktop, range, or oven	N/A	$840	N/A	N/A
Heat pump clothes dryer	ENERGY STAR electric	$840	N/A	N/A
Biomass (wood) stove or boiler	N/A	N/A	>75% thermal efficiency (by HHV)	$2,000
Components				
Insulation and air sealing [a]	ENERGY STAR	$1,600	IECC (of two years before)	$1,200
Windows and skylights	N/A	N/A	ENERGY STAR Most Efficient	$600 (total)
Doors	N/A	N/A	ENERGY STAR	$500 ($250 max per door)
Electric panels/load service centers	N/A	$4,000	Enables qualifying equipment, at least 200 amps	$600
Electric wiring	N/A	$2,500	N/A	N/A
Measures	N/A	N/A	N/A	N/A
Energy audit	N/A	N/A	IRS to specify	$150

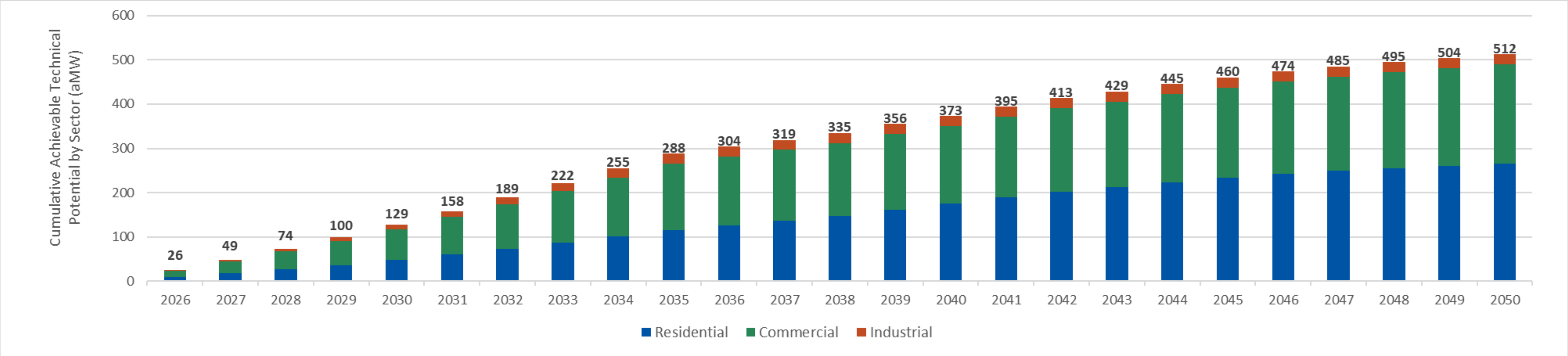
HOMES Rebate

Rebate and Tax Deduction Summary for Whole-Building Retrofits

HOMES Rebate		
	Modeled Savings Approach	**Measured Savings**
Minimum energy savings	20%	15%
Energy metric	Savings calibrated to historical energy usage based on BPI 2400 standard	Weather-normalized energy usage of building pre- and post-retrofit using open-source software
Percentage of project cost	≥80% AMI: 50%, <80% AMI[c]: 80%	≥80% AMI: 50%, <80% AMI: 80%
Incentive amount/cap at minimum savings level	At 20+% energy savings: • ≥80% AMI: 50% of project cost up to $2,000/home or dwelling unit, up to $200,000 per multifamily building • <80% AMI: 80% of project cost up to $4,000/home or dwelling unit, up to $400,000 per multifamily building At 35+% energy savings: • ≥80% AMI: 50% up to $4,000/home or dwelling unit, up to $400,000 per building • <80% AMI: 80% up to $8,000/home or dwelling unit, up to $800,000 per multifamily building	Payment per kilowatt-hour-equivalent saved relative to the average home/dwelling unit in the state. $2,000 incentive earned for 20% energy savings, can increase or decrease based on actual savings realized (no cap)
Contractor rebate	$200 for each home in a disadvantaged community	

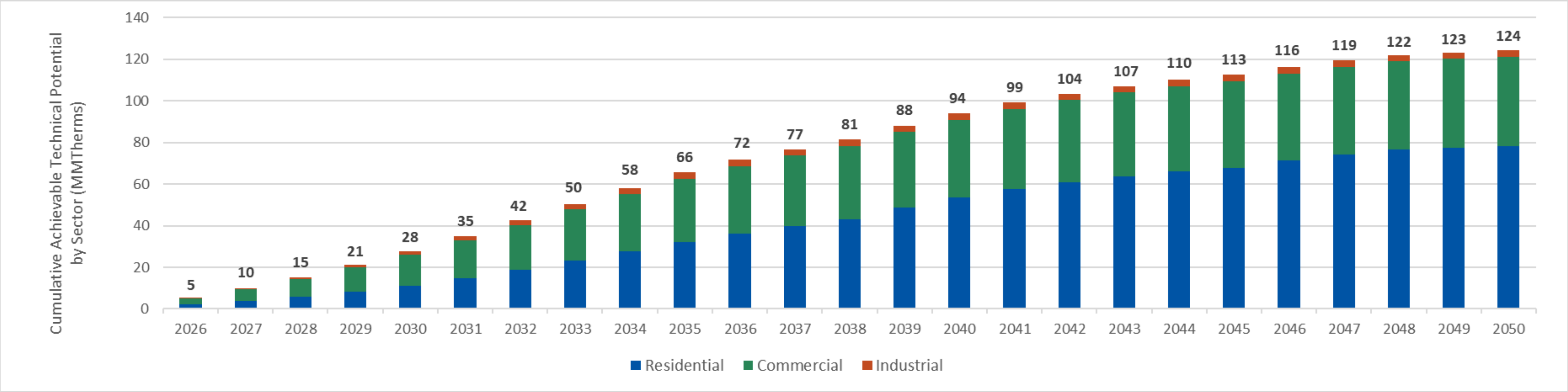
Electric Energy Efficiency Potential Forecast

Cumulative Achievable Technical Potential (2026-2050)



Natural Gas Energy Efficiency Potential Forecast

Cumulative Achievable Technical Potential (2026-2050)



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Solar PV Cost Forecast

Residential and Commercial Installed Cost

Residential costs:

$2,123 per kW (in $2026)

Based on historical PSE data

Commercial costs:

$1,252 per kW (in $2026)
Based on historical PSE data

Costs decline according to NREL 2021 ATB "moderate" estimates