Demand Forecast

July 12, 2022

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Safety Moment

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If you **want to type a question regarding the presentation,** insert **"Slide X followed by your question"** in the chat box!

If you **have a technical issue or a general question**, please type it in the chat box.

Please **keep yourself on mute** unless you are speaking.

If you want to **ask a question verbally,** click the 'Reaction' button and click on the **'Raise Hand'** option and we will call on you.

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Facilitator Requests

- Engage constructively and courteously towards all participants
- Respect the role of the facilitator to guide the group process
- "Take space and make space"
- Avoid use of acronyms and explain the technical questions

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Agenda

Time	Agenda Item	Presenter
1:00 – 1:10 p.m. *(10 min)*	Opening	Sophie Glass
1:10 – 1:15 p.m. *(5 min)*	Recap from June Delivery System Planning (DSP) IRP	Kara Durbin
1:15 – 1:25 p.m. *(10 min)*	Demand Forecast in the IRP	Elizabeth Hossner
1:25 – 1:35 p.m. *(10 min)*	Overview of Demand Forecast	Lorin Molander
1:35 – 2:05 p.m. *(30 min)*	Natural Gas Results	Allison Jacobs
2:05– 2:35 p.m. *(30 min)*	Electric Results	Stephanie Price
2:35 – 2:45 p.m. *(10 min)*	Break	All
2:45 – 3:10 p.m. *(25 min)*	Demand Forecast Assumptions	Allison Jacobs
3:10 – 3:55 p.m *(45 min)*	Electric Vehicle Forecast	Robin Maslowski Will Sierzchula Kajal Gaur Graham Malcolm
3:55- 4:00 p.m *(5 min)*	Next Steps	Sophie Glass
4:00 pm	Adjourn	Sophie Glass

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Today's Speaker

Kara Durbin
Director, Clean Energy Strategy, PSE

Lorin Molander
Manager, Load Forecasting and Analysis, PSE

Elizabeth Hossner
Manager, Resource Planning and Analysis, PSE

Allison Jacobs
Senior Economic Forecasting Analyst, PSE

Stephanie Price
Senior Economic Forecasting Analyst, PSE

Graham Marmion
Senior Marketing Analyst, PSE

Robin Maslowski
Director, Guidehouse

Will Sierzchula
Managing Consultant, Guidehouse

Kajal Gaur,
Managing Consultant, Guidehouse

Sophie Glass
Co-facilitator, Triangle Associates

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Recap from June Delivery System Planning (DSP) IRP

Kara Durbin
Director, Clean Energy Strategy, PSE

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How input from June meeting is shaping our work

Themes heard at June 6th meeting (DSP)	What we did with it
It is difficult to navigate the PSE website and find IRP materials.	Thank you for your feedback on the website. We developed the site with the intention of ease of access, this feedback is helpful to consider for incorporation the next time we can make website upgrades.
PSE actions and investments should match aspirations.	PSE is making strides to align our aspirational goals with our investments and long-term modeling process. There are legal, technological, and cost implications for our customers that must also be considered as we continue to make progress towards our clean energy goals.
Distributed Energy Resources (DERs) are too expensive.	DERs are evaluated with the portfolio model similar to other resource alternatives. The model evaluates the benefits of all types of resources that may not be limited to cost.
Concern about the lack of discussion around the lowest reasonable cost in the IRP process, and concern that IRP stakeholders are being excluded from the IRP process.	The focus of the June 6th meeting was on the delivery system planning. PSE plans to share resource and fuel costs in our September stakeholder meetings.
Explore additional methods of environmentally friendly energy storage outside of green hydrogen, including gravity storage.	This is included as part of the generic resources.
Improve the feedback loop between PSE and IRP stakeholders.	PSE will follow up with Triangle to better understand stakeholders concerns regarding the feedback loop.
Include stakeholders in future IRP scoring processes.	PSE will include advisory group input in future scoring processes.
PSE should commit to complete electrification.	PSE is committed to decarbonization and studying its effects on the delivery system.
Suggestion that batteries be located close to customers or near generation resources.	PSE agrees that there are benefits to locating batteries close to customers or generation resources.
Follow up on generic resource assumptions form March meeting	The 2022 National Renewable Energy Laboratory Annual Technology Baseline (NREL ATB) was released on June 16, 2022 and PSE is working to incorporated the updated data into the electric progress report.

More responses on unanswered questions from June 6th meeting and feedback form are addressed in Feedback Report.

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Demand Forecast in the IRP

Elizabeth Hossner
Manager, Resource Planning and Analysis

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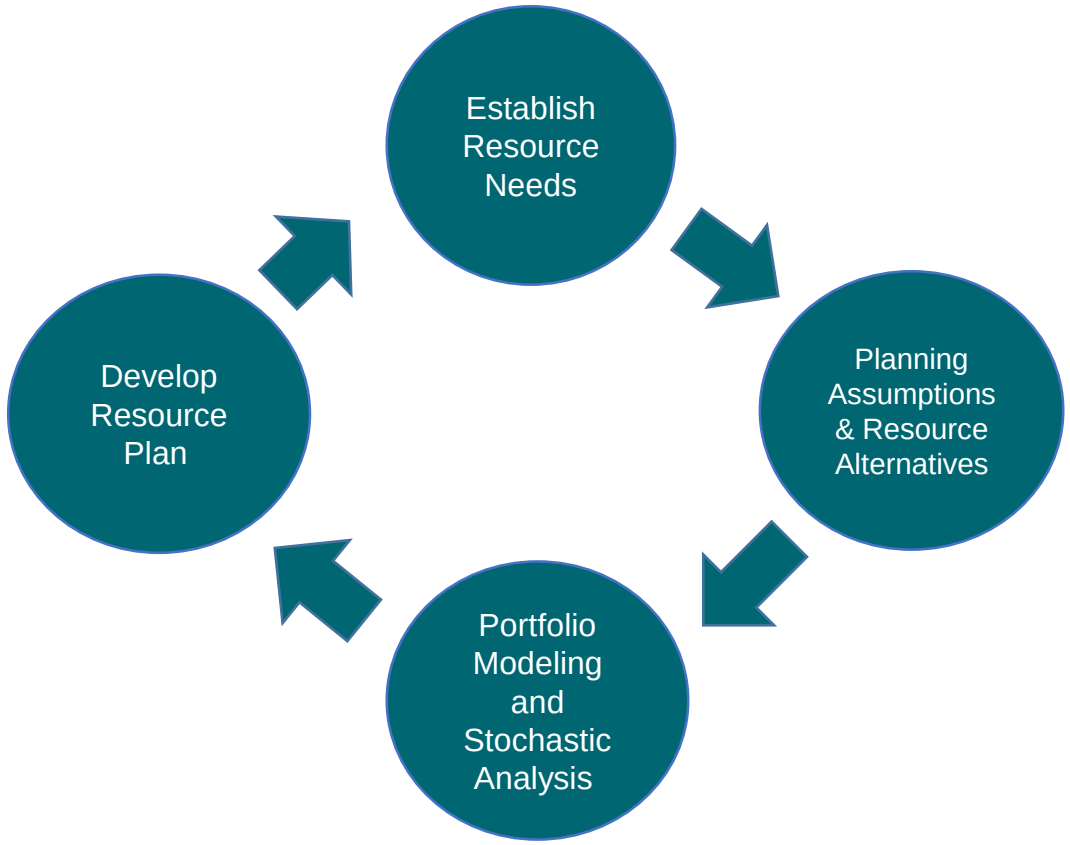
2023 Electric Progress Report & Gas Utility IRP modeling process

The 2023 Electric Progress Report will follow a 4-step process for analysis:

1. Analyze and establish resource need
    - Energy Need
    - Capacity Need
    - Renewable Need (electric only)
2. Determine planning assumptions and identify resource alternatives
3. Portfolio Modeling and Stochastic Analysis
4. Develop resource plan



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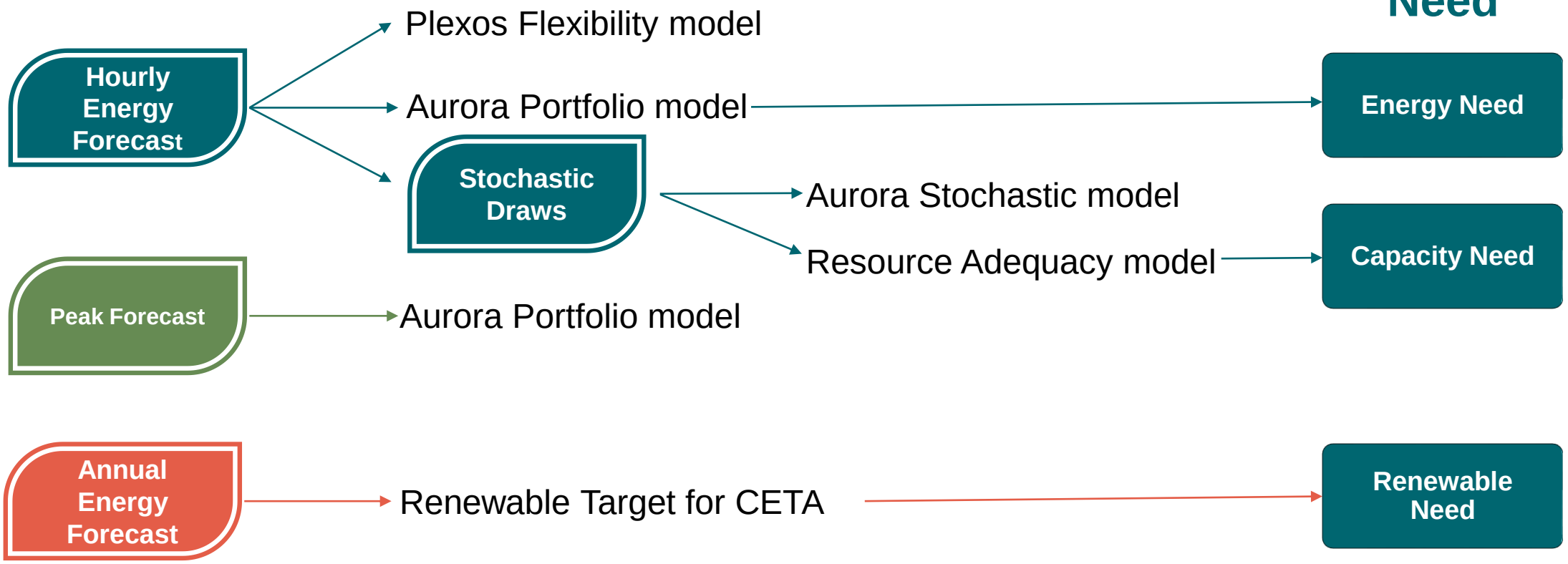
How the demand forecast is used in the Electric Progress Report

Establish Resource Need



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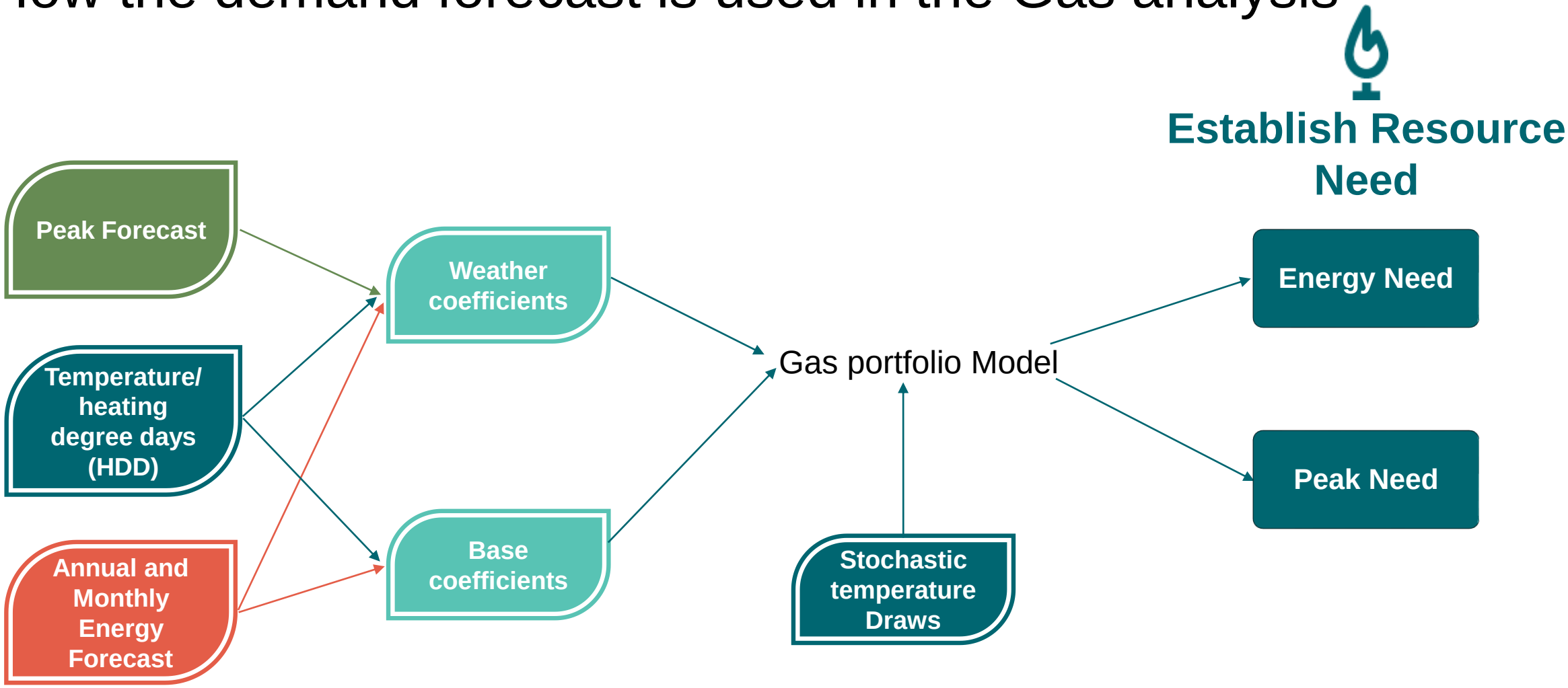
How the demand forecast is used in the Gas analysis



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Role of demand forecasts in the Integrated Resource Plan

- The 20+ year demand forecasts, before demand-side resources (DSR), are used as an input into the IRP.

- DSR is evaluated as a resource in the IRP analysis along with other resources.

- The IRP analysis determines resources including:
  - DSR (I.e., utility-sponsored conservation programs, distribution efficiency, and demand response).
  - Changes to codes and standards are developed in the conservation potential assessment and treated as no-cost, must-take conservation in the IRP analysis.
  - Distributed generation.
  - Potential demand impacts due to policies such as Clean Energy Transformation Act (CETA) and Climate Commitment Act (CCA).

- Therefore, the amount of resources that impact demand will be applied to the demand forecast when IRP analysis is complete.

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Overview of the Demand Forecast

Lorin Molander
Manager, Load Forecasting and Analysis, PSE

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Overview

- The forecast period is 2024 - 2045.
- The forecasts presented herein are for PSE's entire service area.
- The base/reference forecast is "business as usual."
- IRP analytics will determine the amount of future DSR.

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Prior feedback from stakeholders about the demand forecast

The demand forecast should use assumptions that reflect warming temperatures in the future due to climate change.

- PSE has developed a new methodology to develop future temperature assumptions that reflect climate change.
- The new methodology leverages climate model data selected and utilized by the Northwest Power and Conservation Council for the 8th Power Plan.
- The methodology and new temperature assumptions were presented at the January 20, 2022, public participation meeting.
- This presentation includes the impacts of the new climate change assumptions to the energy and peak demand forecast.

Include the summer peak demand forecast in addition to winter in presentation materials.

- The electric summer peak demand forecast is included in this presentation.

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Demand forecast updates and impacts

	UPDATE	GENERAL IMPACT
CLIMATE CHANGE	Updated normal temperature assumptions reflecting continued warming over time	Decreases energy and peaks for heating and increases energy and peaks for cooling
ELECTRIC VEHICLES (EVs)	Includes impact of recent legislation and forecast of medium and heavy duty EVs	Increases electric energy and peak forecasts
ECONOMY & COVID	More optimistic economic outlook than assumed for 2021 IRP	Increases energy and peak forecasts
OTHER	E.g., Incorporated recent actual customer counts and billed sales data, new major block loads	Increases energy and peak forecasts

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Natural Gas Results

Allison Jacobs
Senior Economic Forecasting Analyst, PSE

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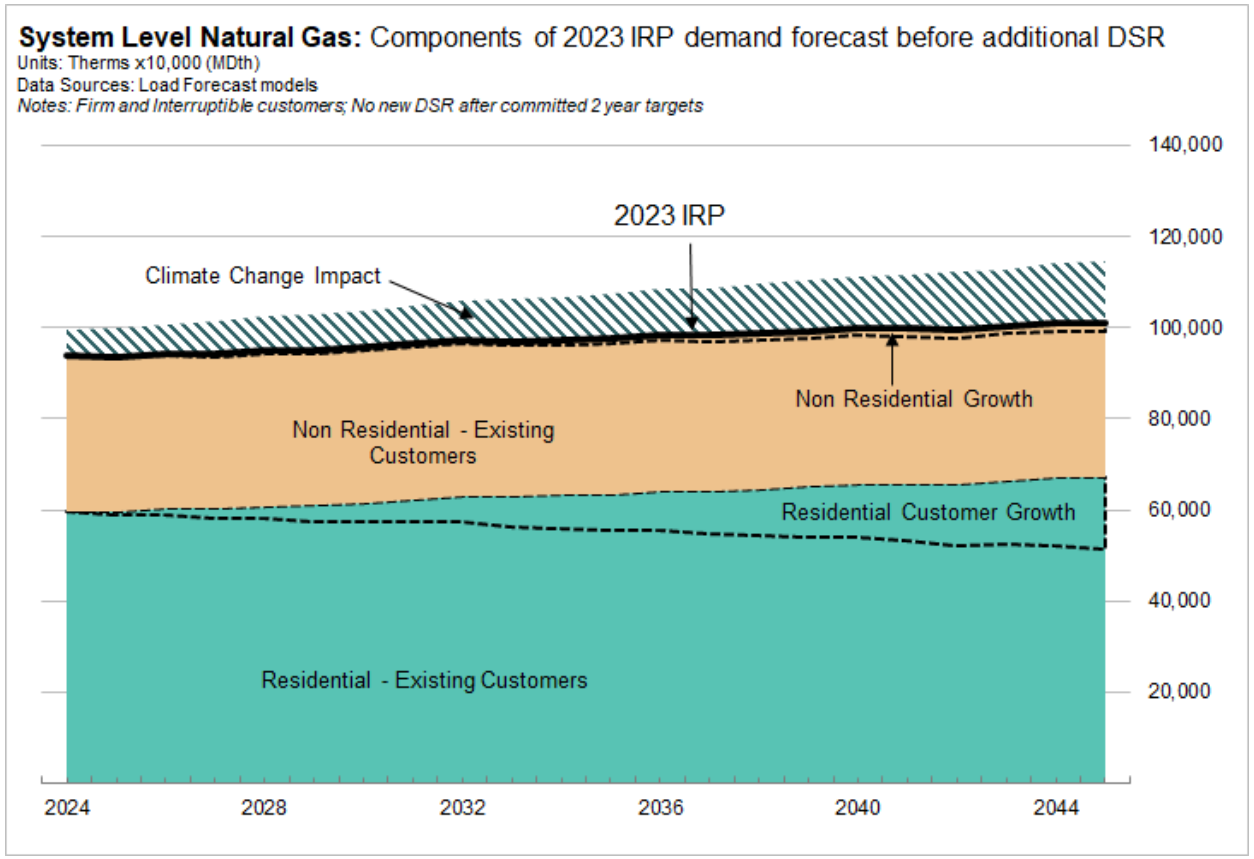
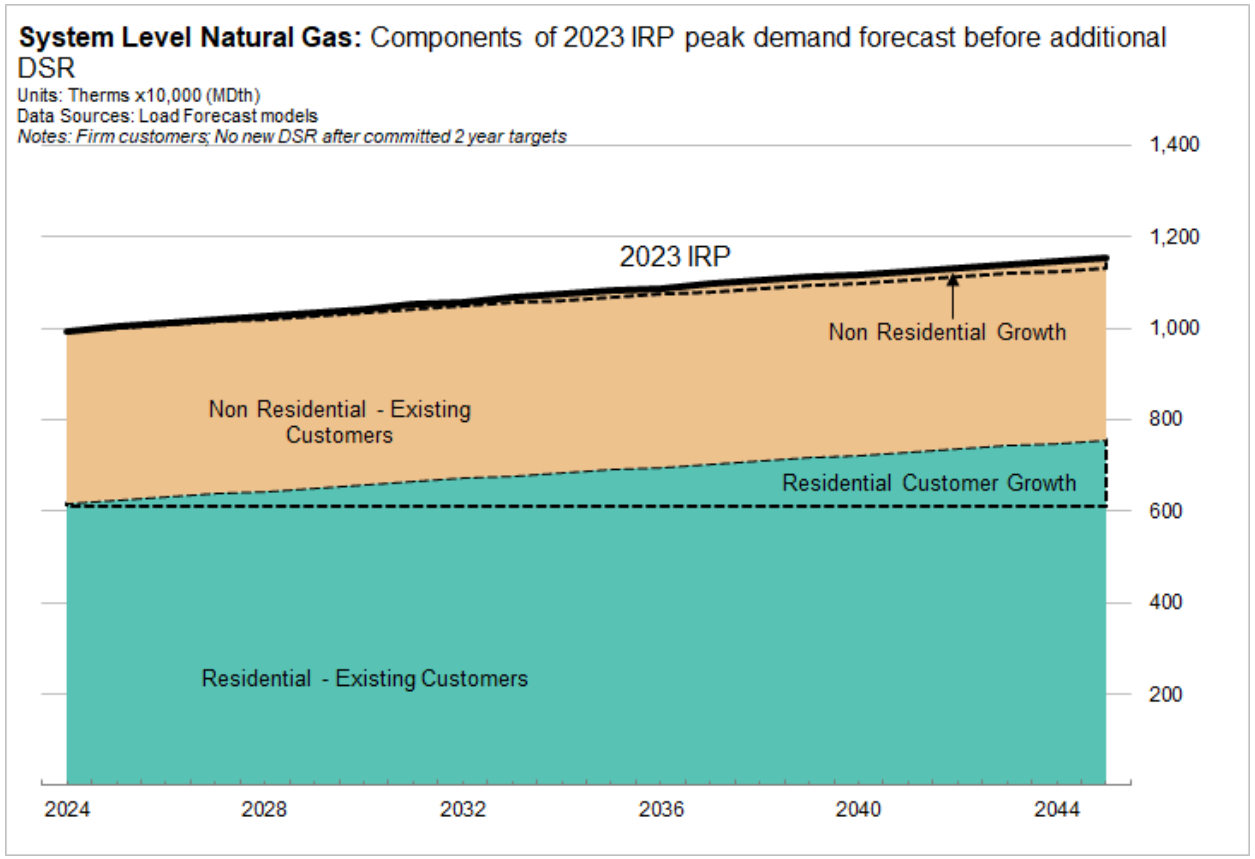
Natural Gas: Energy and peak demand forecast composition

Energy Demand

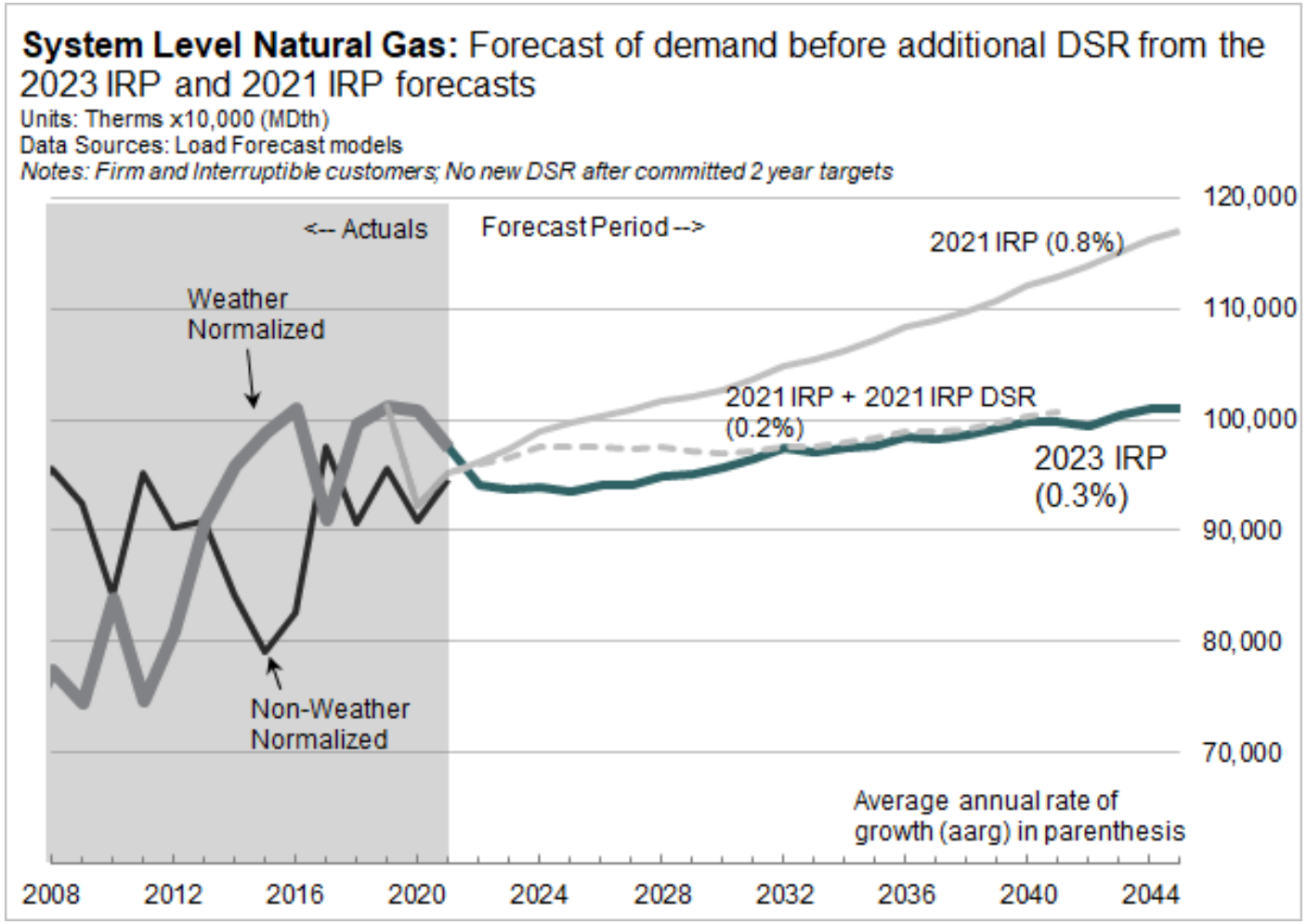


Peak Demand



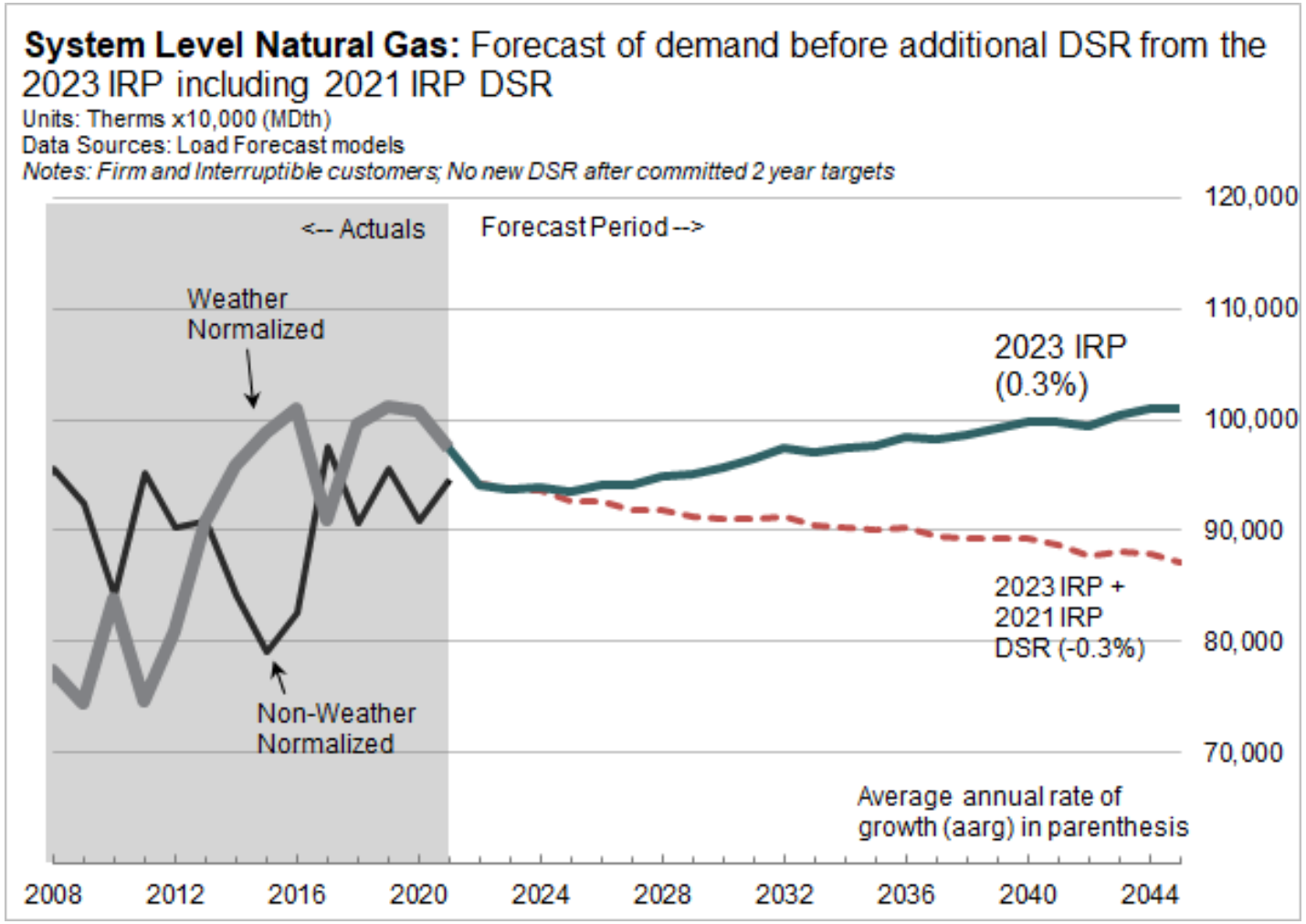
Natural Gas: Energy demand forecast compared to 2021 IRP

- Demand is down 14% in 2045.
- Climate change decreases forecasted demand.
- The 2023 IRP demand forecast after DSR will be available once final DSR determined.
  - Including changes from building codes, natural gas bans, conservation, and potential changes to demand due to the decarbonization policies.



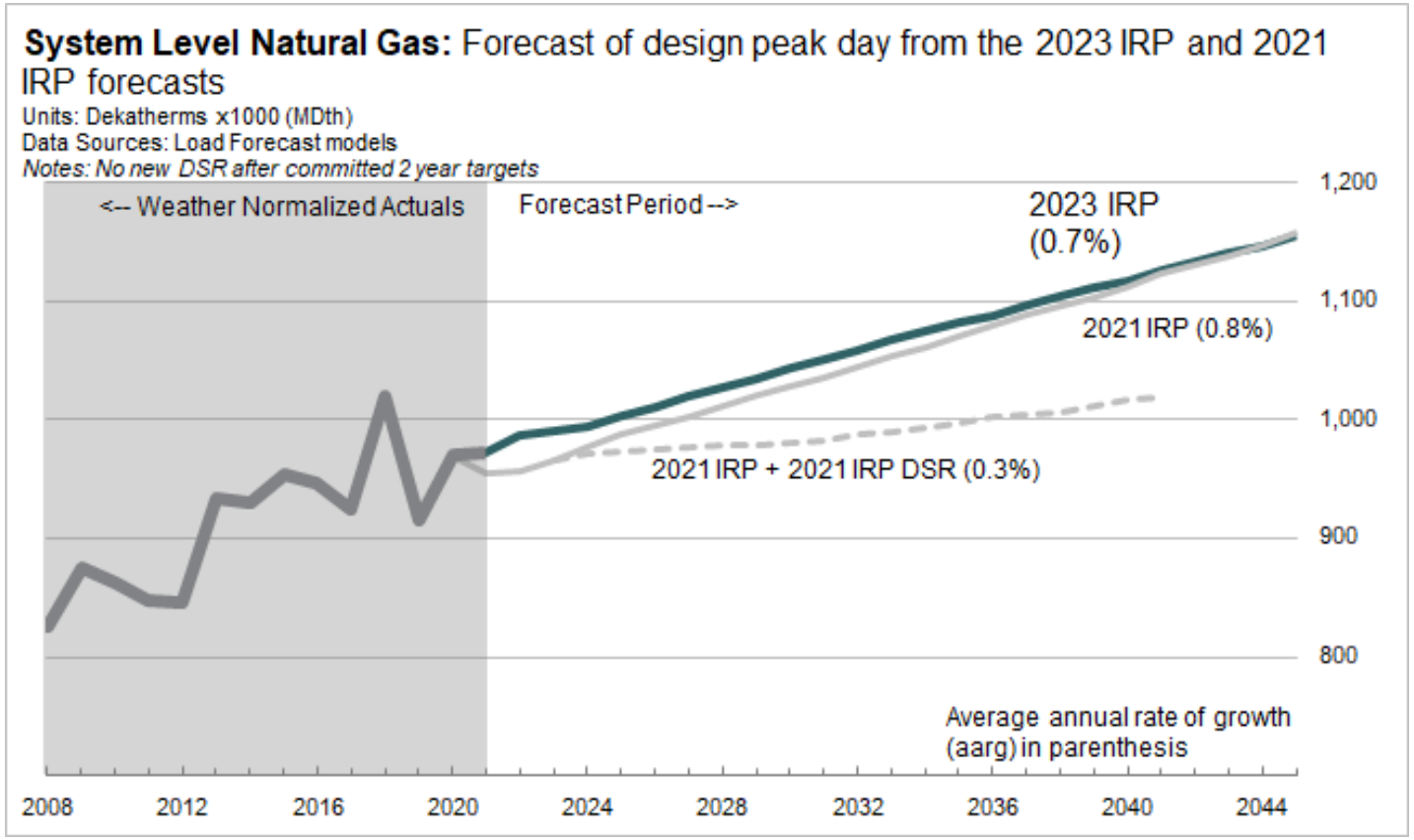
Natural Gas: Energy demand forecast after DSR

- *This graph is for illustrative purposes only.*
- Using the amount of DSR determined by the 2021 IRP, this graph illustrates an example of the 2023 IRP demand forecast after DSR.
  - In this example, gas energy demand is down 14% in 2045.
- The final DSR amount for 2023 IRP is still to be determined by the IRP analysis.



Natural Gas: Peak demand forecast compared to 2021 IRP

- Peak demand is slightly higher in near term.
- Long term growth drivers:
  - New customer growth.
- The 2023 IRP peak forecast after DSR will be available once final DSR is determined.
  - Including changes from building codes, natural gas bans, conservation, and potential changes to demand due to the decarbonization policies.



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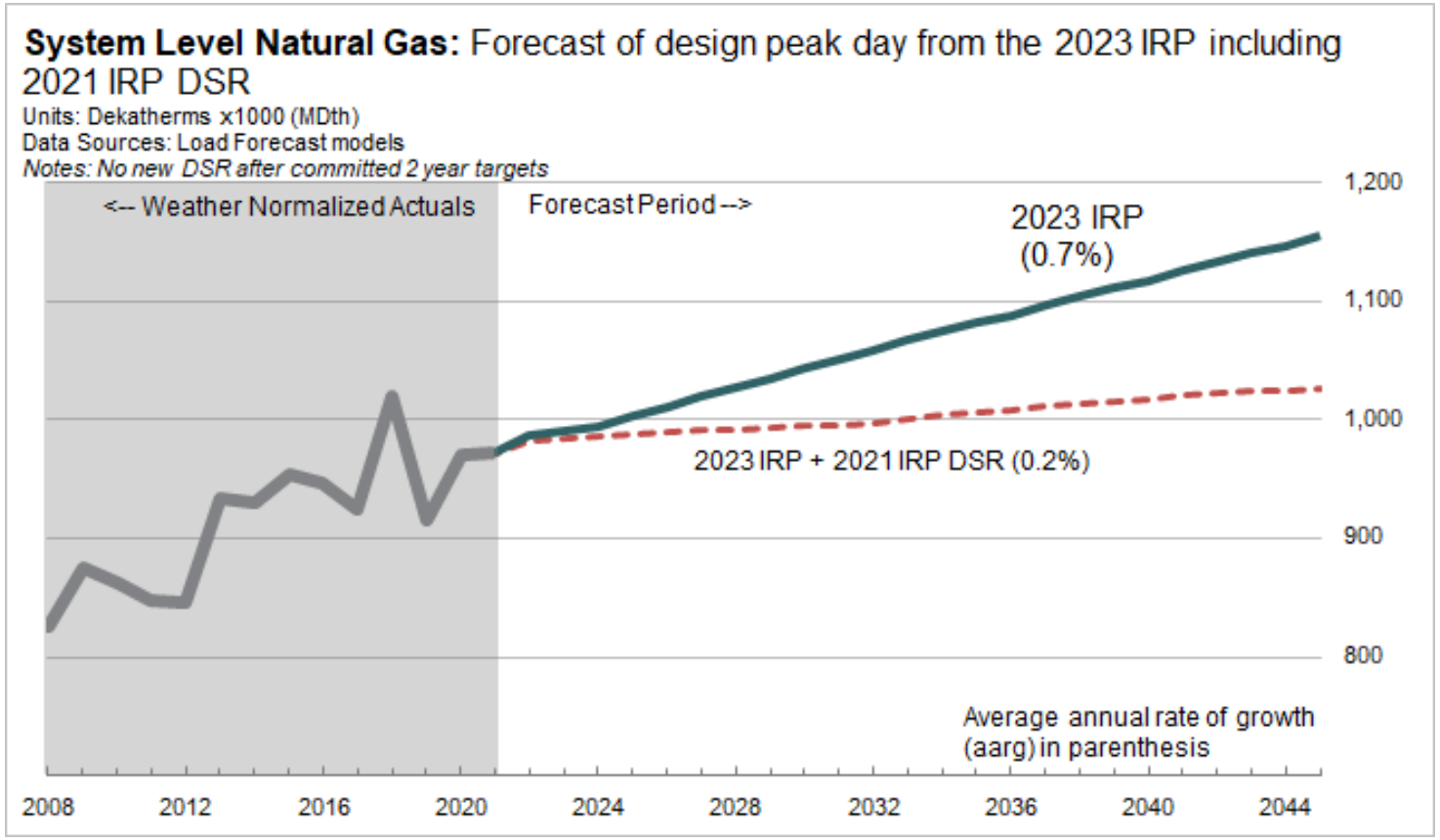
Natural Gas: Peak demand forecast after DSR

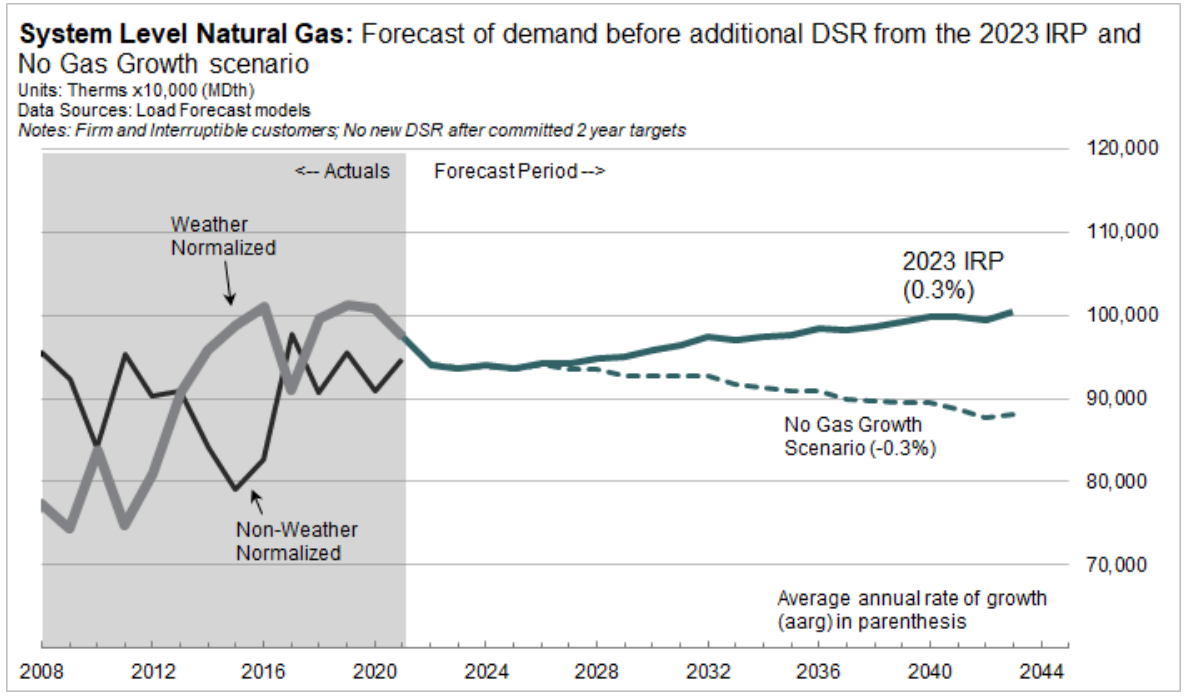
- *This graph is for illustrative purposes only.*
- Using the amount of DSR determined by the 2021 IRP, this graph illustrates an example of the 2023 IRP peak forecast after DSR.
- The 2023 IRP demand forecast after DSR will be available once final DSR is determined.



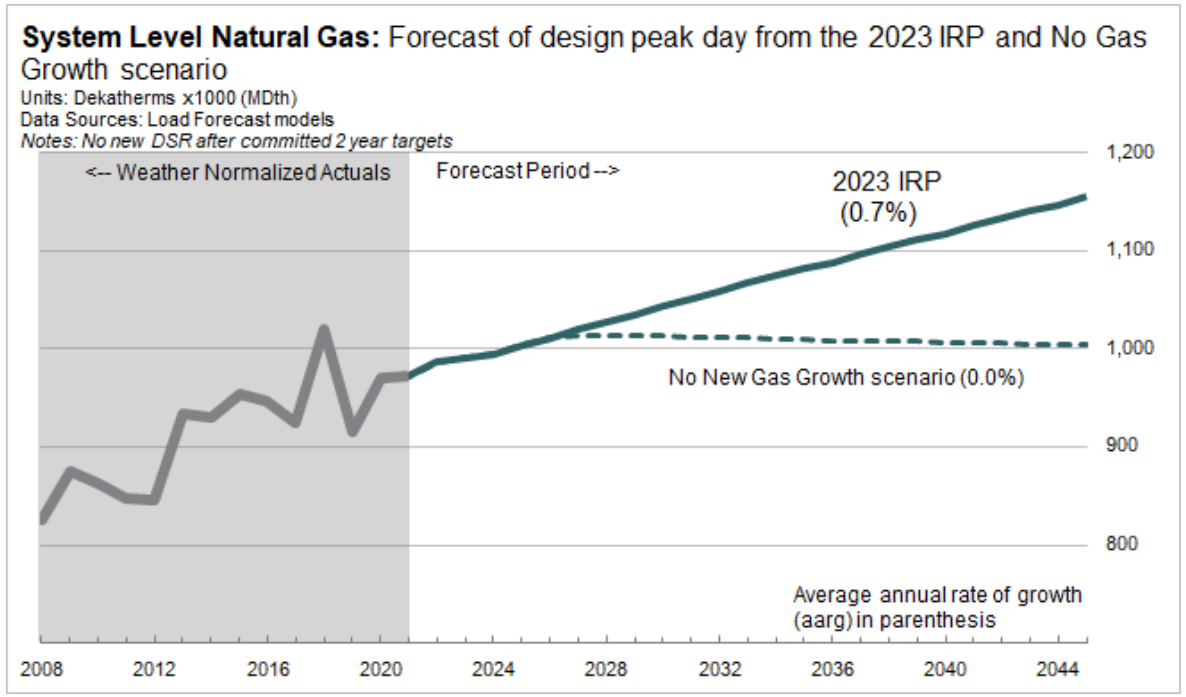
Natural Gas: No gas-growth scenario

- No gas-growth scenario assumes no new gas customers after 2026.
- These results are before DSR.

Energy Demand



Peak Demand



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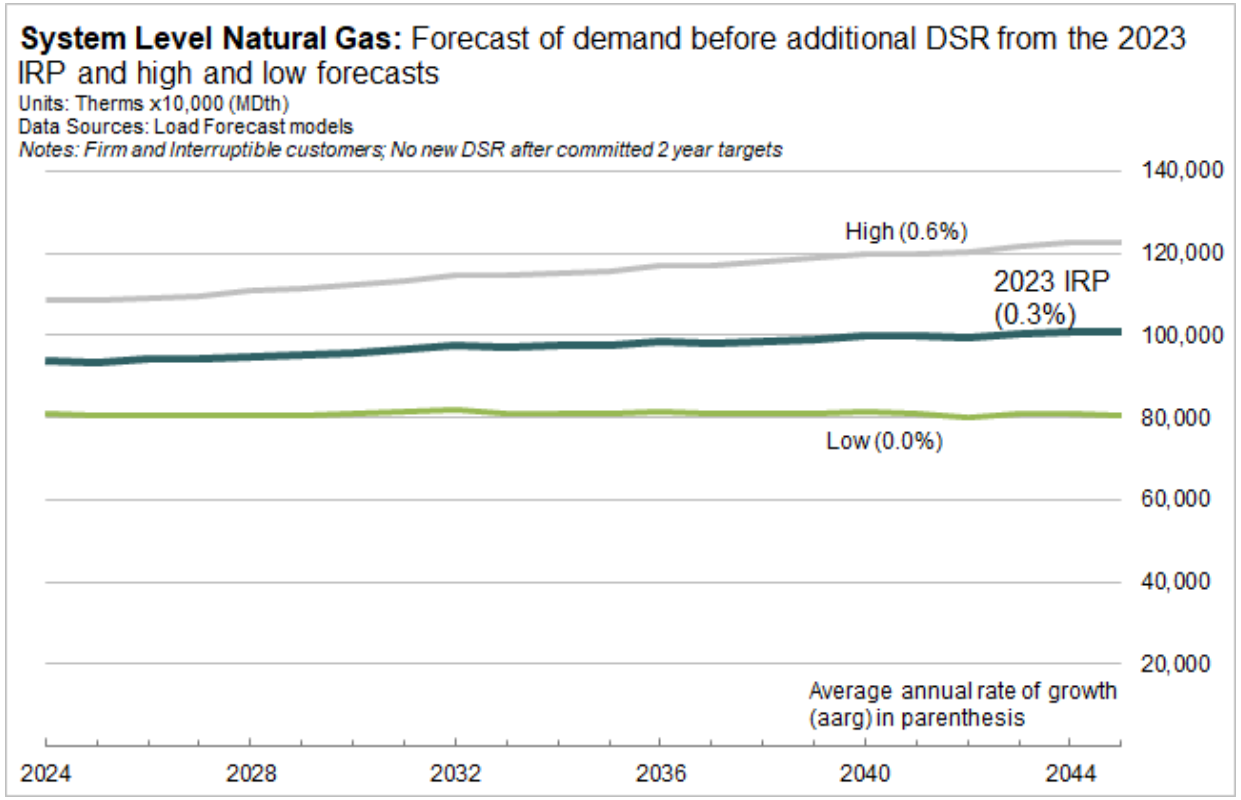
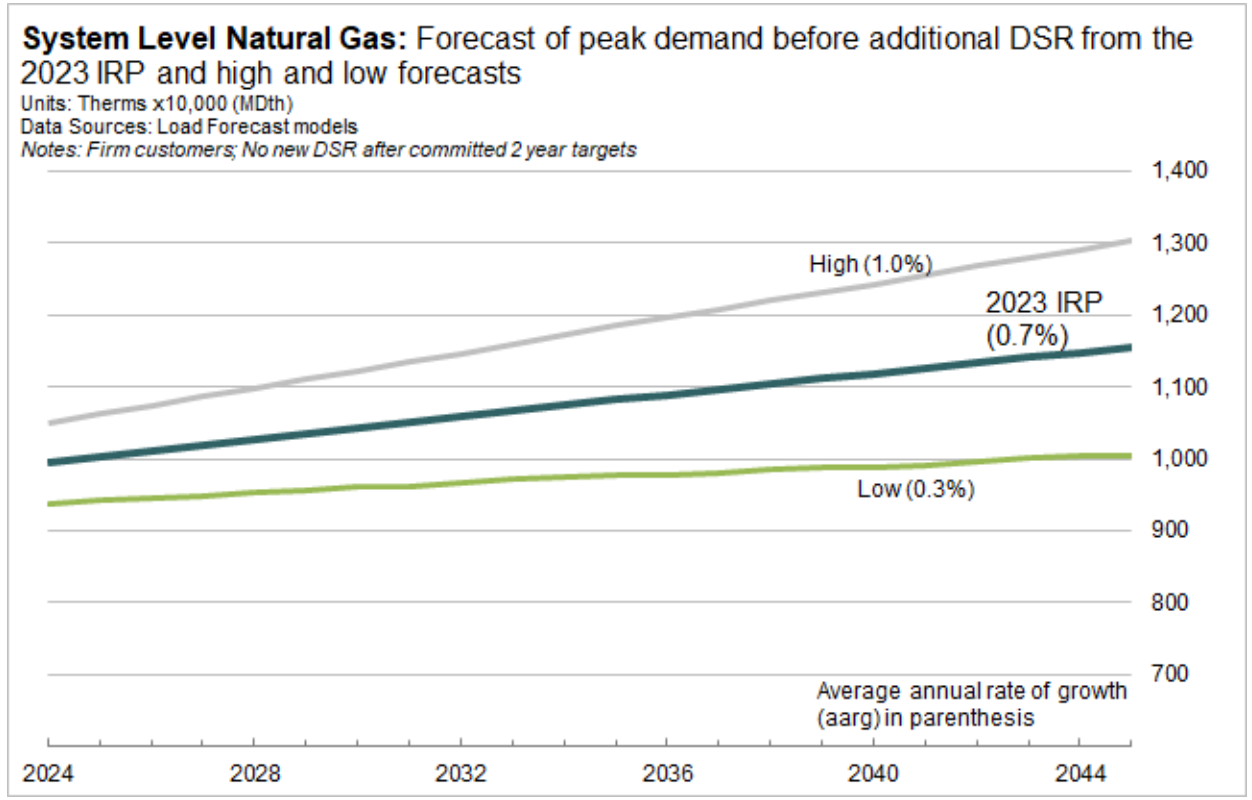
Natural Gas: High and low scenarios

Energy Demand



Peak Demand



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Electric Results

Stephanie Price
Senior Economic Forecasting Analyst, PSE

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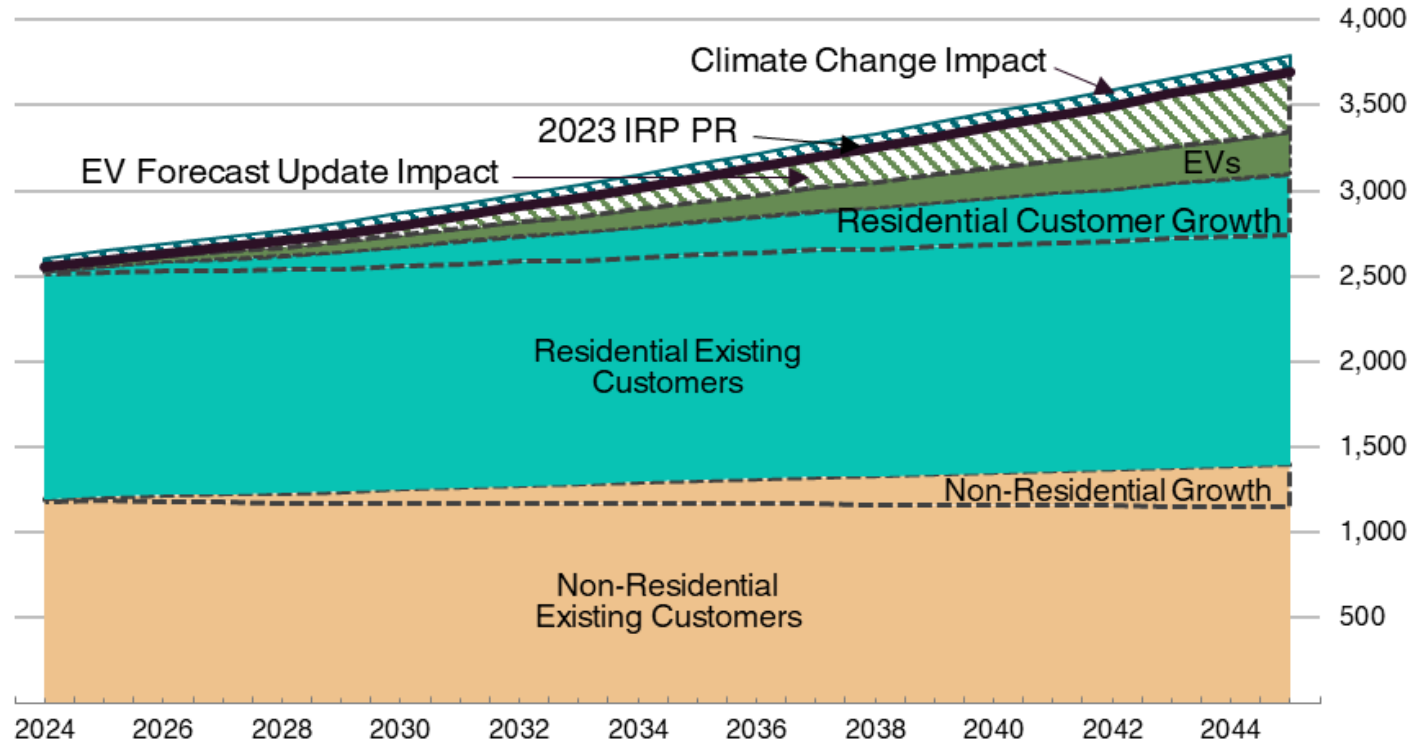
Electric: Energy demand forecast composition

System Level Electric: Forecast of demand before additional DSR from the 2023 IRP Progress Report ("IRP PR")

Units: aMW
Data Sources: Load Forecast models
Notes: No new DSR after committed 2 year targets



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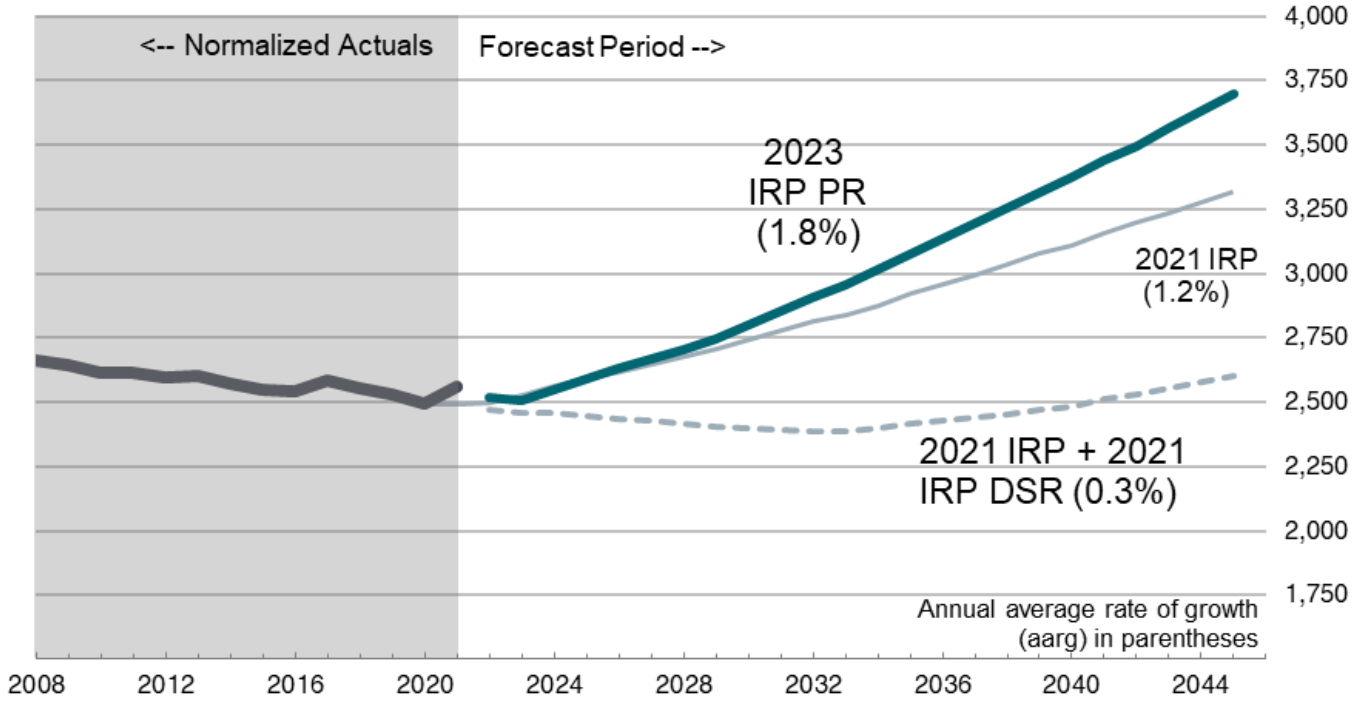
Electric: Energy demand forecast compared to 2021 IRP

- Demand lower by -0.4% in 2024 and higher by ~9% 2040.
- Positive customer growth, steady use per customer (UPC), and EV growth yield demand growth, before DSR.
  - Applying DSR will result in an “after DSR” forecast with lower growth than “before DSR.”
- Major updates: Normal Degree Days and EV forecast.
- The 2023 IRP Progress Report demand forecast after DSR will be available once final DSR is determined.

System Level Electric: Forecast of demand before additional DSR from the 2023 IRP Progress Report and 2021 IRP forecasts

Units: aMW
Data Sources: Load Forecast models
Notes: No new DSR after committed 2 year targets



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Electric: Energy demand forecast after DSR

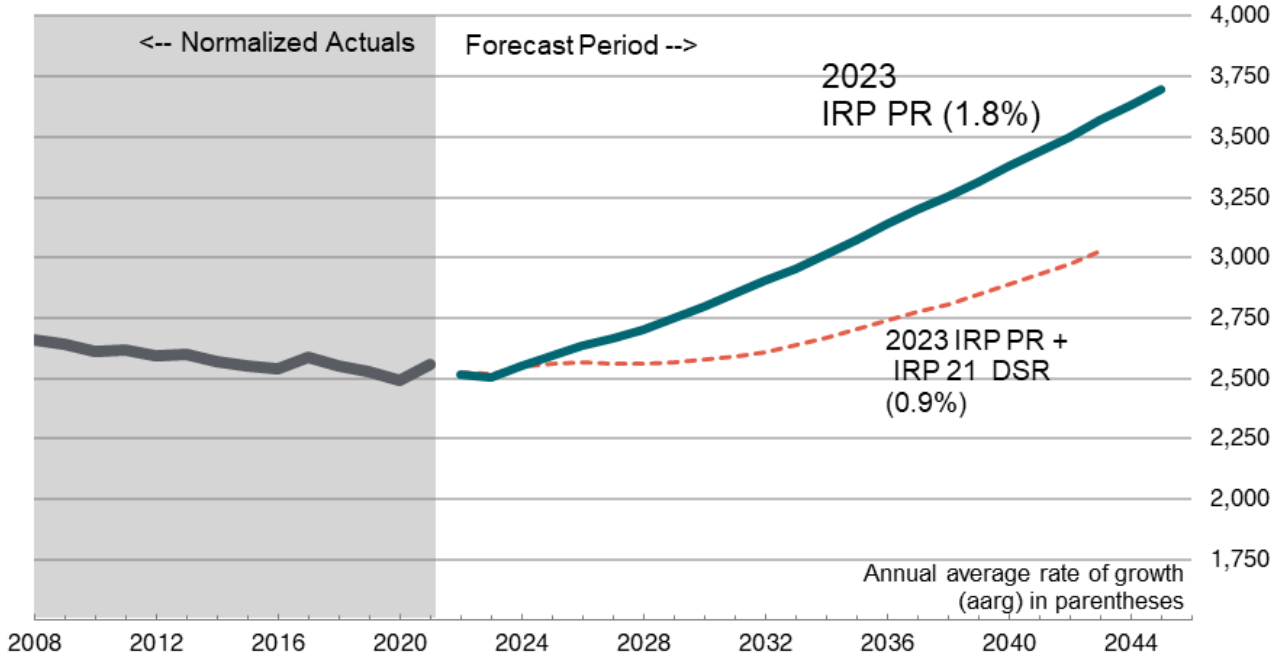
- *This graph is for illustrative purposes only.*

- Using the amount of DSR determined by the 2021 IRP, this graph illustrates an example of the 2023 IRP Progress Report demand forecast after DSR.

- The final DSR amount for 2023 IRP Progress Report is still to be determined by the IRP analysis.

System Level Electric: Forecast of demand before additional DSR from the 2023 IRP Progress Report including 2021 IRP DSR results

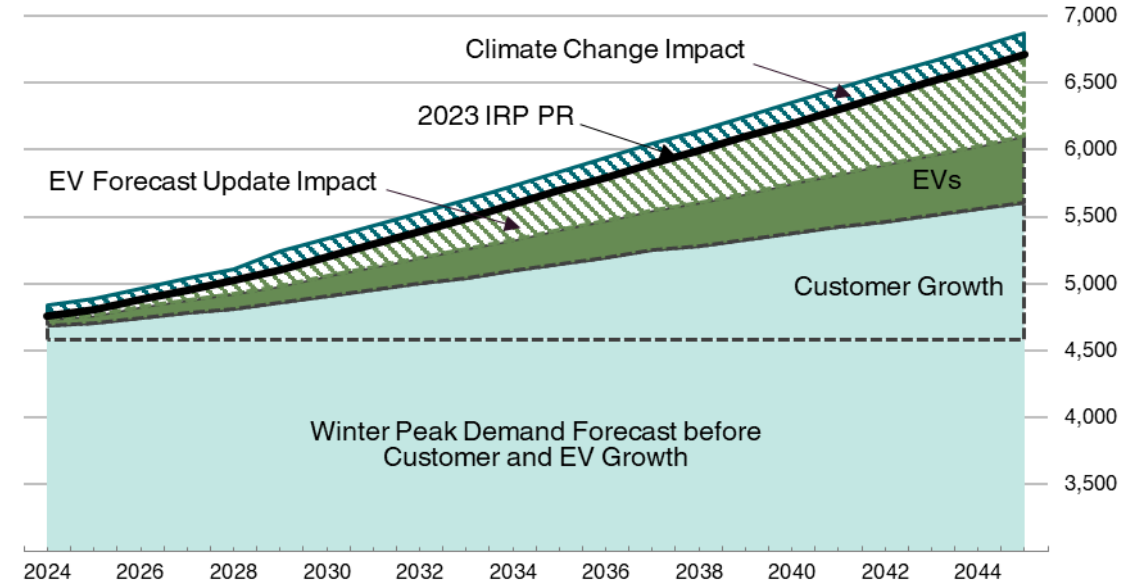
Units: aMW
Data Sources: Load Forecast models
Notes: No new DSR after committed 2 year targets



Electric: Winter and summer peak demand forecast composition

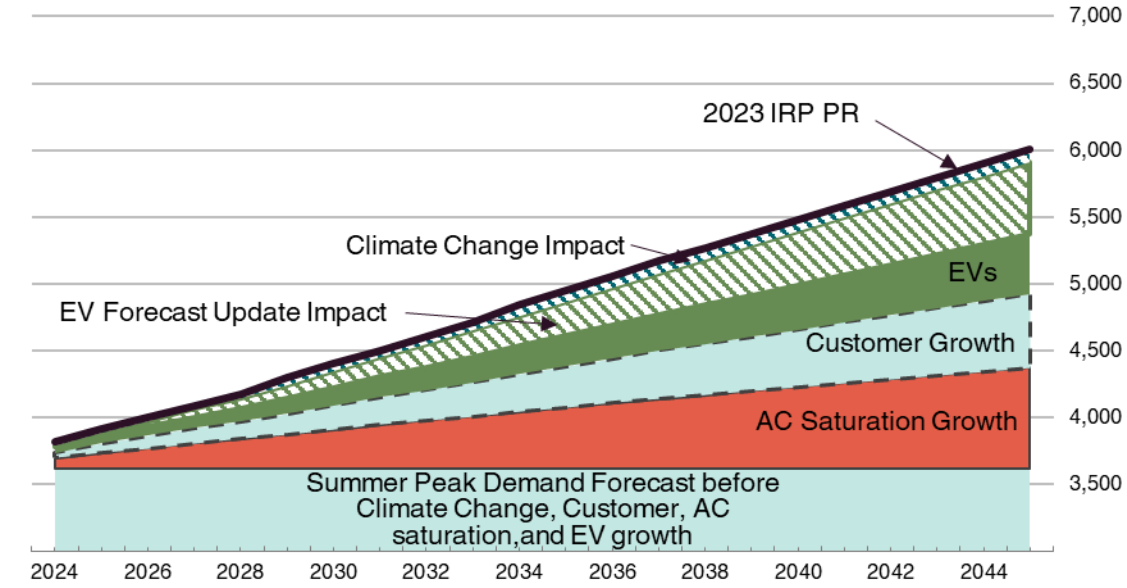
System Level Winter Electric: Forecast of peak demand before additional DSR from the 2023 IRP Progress Report

Units: MW
Data Sources: Load Forecast models
Notes: No new DSR after committed 2 year targets



System Level Summer Electric: Forecast of peak demand before additional DSR from the 2023 IRP Progress Report

Units: MW
Data Sources: Load Forecast models
Notes: No new DSR after committed 2 year targets



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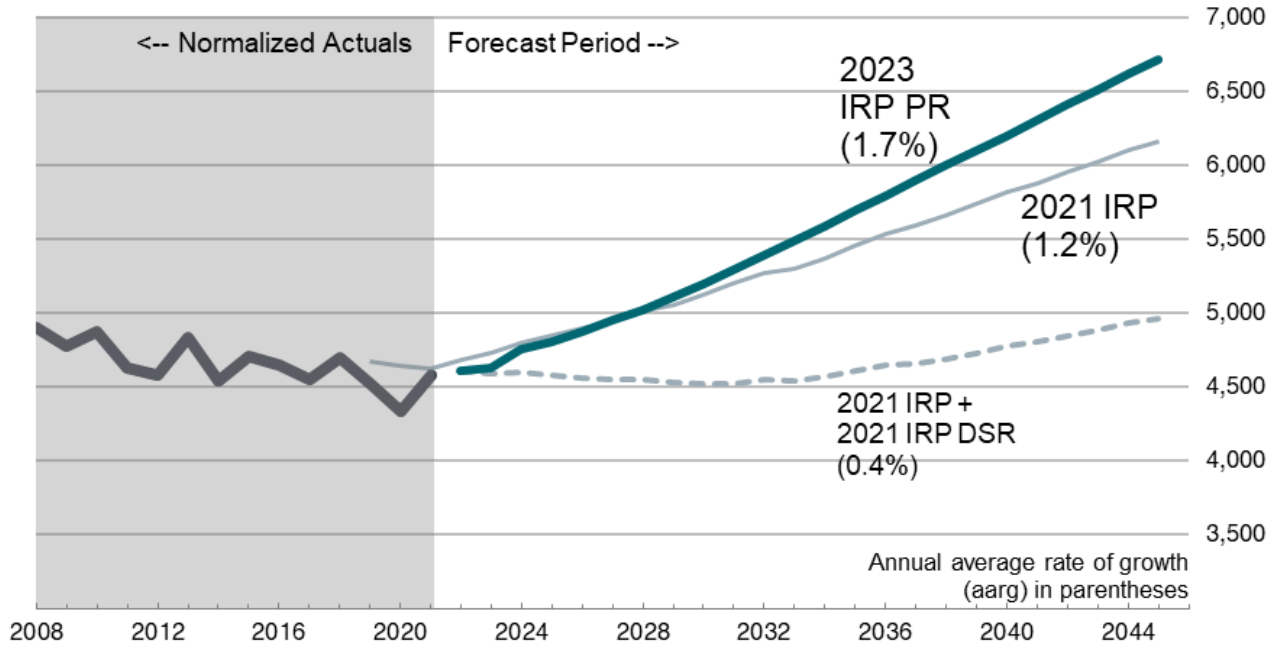
Electric: Winter peak demand forecast compared to 2021 IRP

- Winter peak demand lower by -1% in 2024 and higher by ~7% in 2040.
- Long-term growth drivers:
  - New customer growth.
  - Electric vehicles.
- The 2023 IRP Progress Report peak demand forecast after DSR will be available once final DSR is determined.

System Level Winter Electric: Forecast of peak demand from the 2023 IRP Progress Report and 2021 IRP forecasts

Units: MW
Data Sources: Load Forecast models
Notes: No new DSR after committed 2 year targets



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Electric: Summer peak demand forecast compared to 2021 IRP

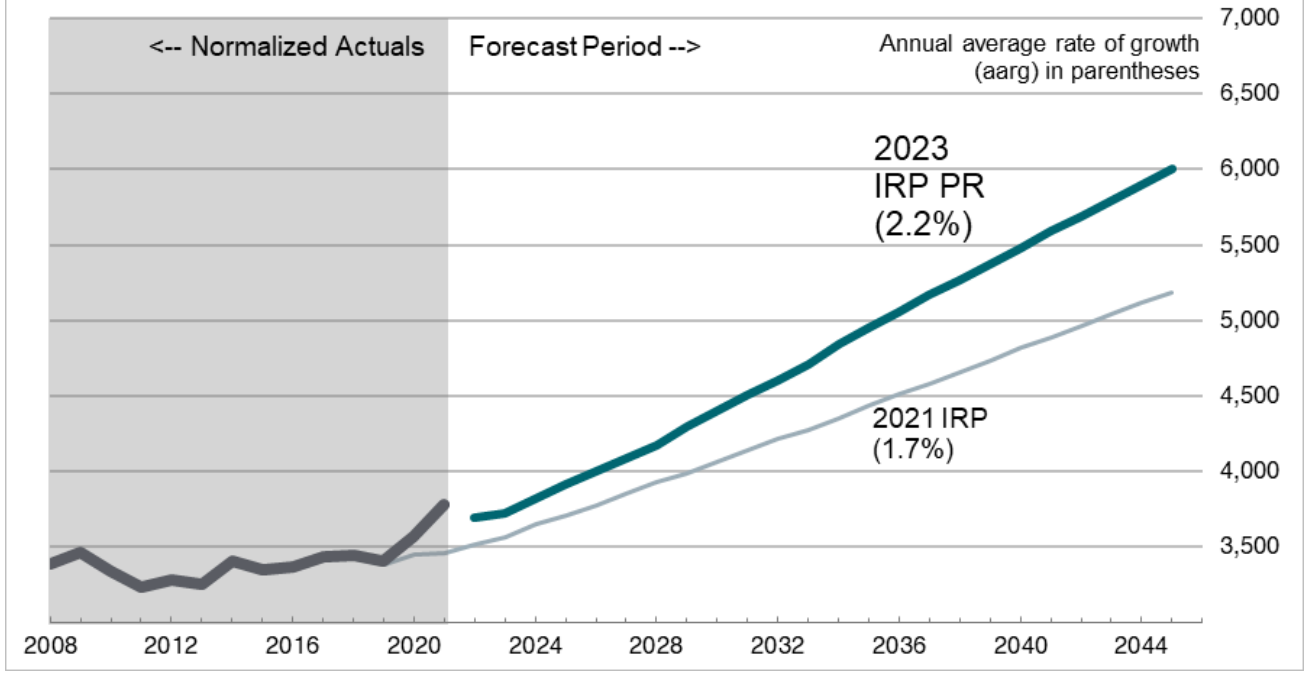
- Summer peak demand higher by ~5% in 2024 and 14% in 2040.

- Long-term growth drivers:
  - New customers/growth.
  - Electric vehicles.
  - Air conditioning saturation growth.

- The 2023 IRP Progress Report peak demand forecast after DSR will be available once final DSR is determined.

System Level Summer Electric: Forecast of peak demand from the 2023 IRP Progress Report and 2021 IRP forecasts

Units: MW
Data Sources: Load Forecast models
Notes: No new DSR after committed 2 year targets



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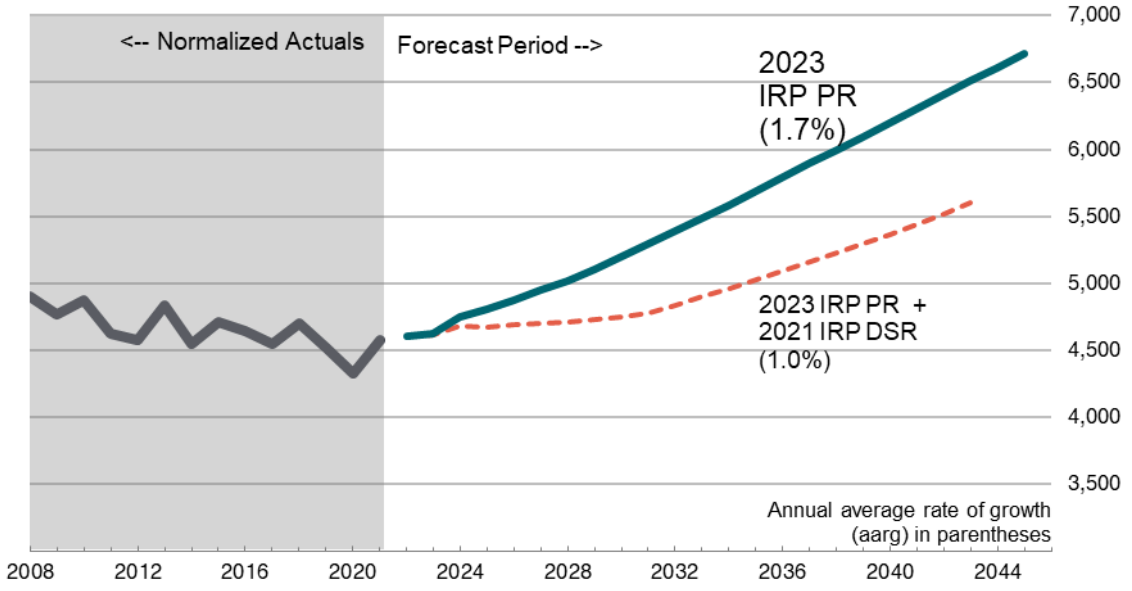
Electric: Winter and summer peak demand forecast after DSR

- *These graphs are for illustrative purposes only.*
- Using the amount of DSR determined by the 2021 IRP, these graphs illustrate an example of the 2023 IRP Progress Report winter and summer peak forecast after DSR.
- The final DSR amount for 2023 IRP Progress Report is still to be determined.

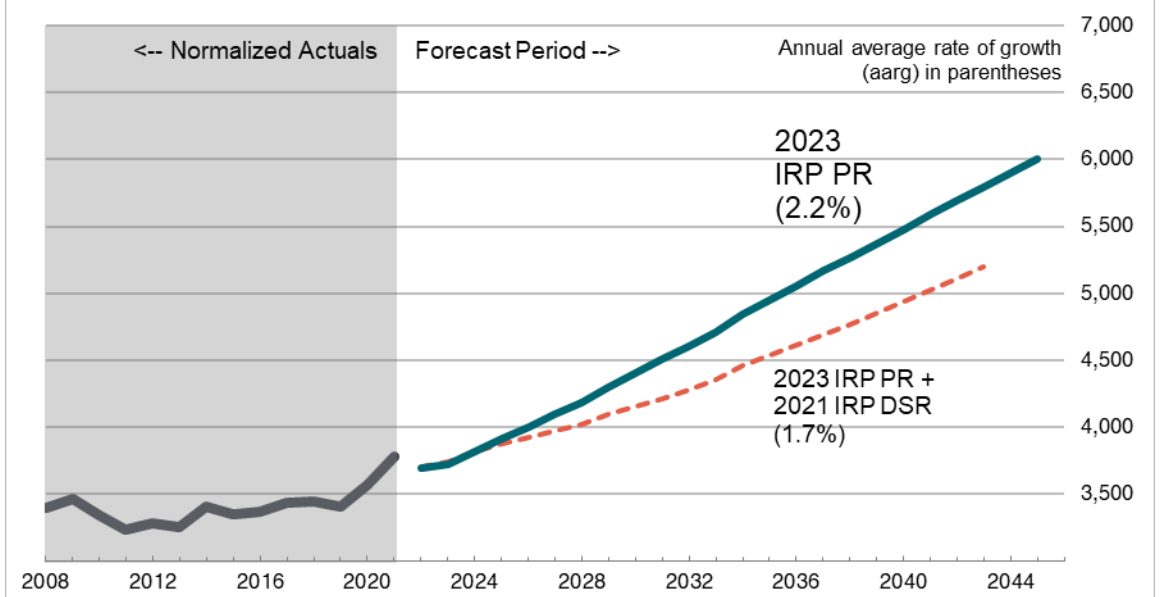
System Level Winter Electric: Forecast of peak demand from the 2023 IRP Progress Report and 2021 IRP DSR

Units: MW
Data Sources: Load Forecast models
Notes: No new DSR after committed 2 year targets



System Level Summer Electric: Forecast of peak demand from the 2023 IRP Progress Report and 2021 IRP DSR

Units: MW
Data Sources: Load Forecast models
Notes: No new DSR after committed 2 year targets



Break

Please return in 10 minutes

*Monet Wind" by Eric Jensen of Roslyn, WA

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Demand Forecast Assumptions

Allison Jacobs
Senior Economic Forecasting Analyst, PSE

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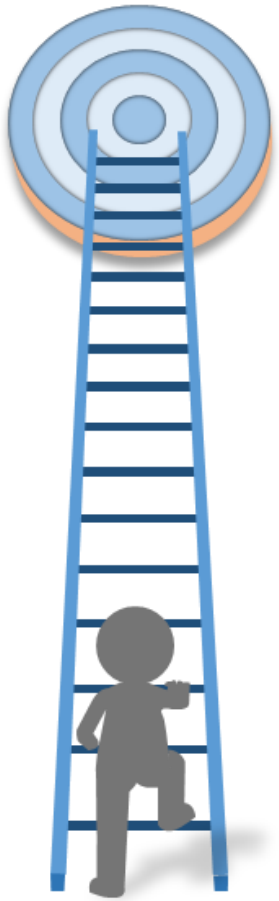
Climate change: New methodology using climate models to determine future temperature assumptions

- PSE's January 20, 2022, public participation meeting included a detailed presentation about the updated methodology using Northwest Power and Conservation Council's climate model temperature data (CanESM2, CCSM4, CNRM).

Model	Measurement	Calculation	Based on Time Period
Energy - Electric and Natural Gas	Degree Days	Average	15 years actual + 15 years forward
Peak – Electric Winter	Hourly Temperature	Median (1-in-2 chance)	15 years actual + 15 years forward
Peak – Electric Summer	Hourly Temperature	Median (1-in-2 chance)	15 years actual + 15 years forward
Peak – Natural Gas Utility	Daily Temperature	1-in-50 chance	2010 - 2049



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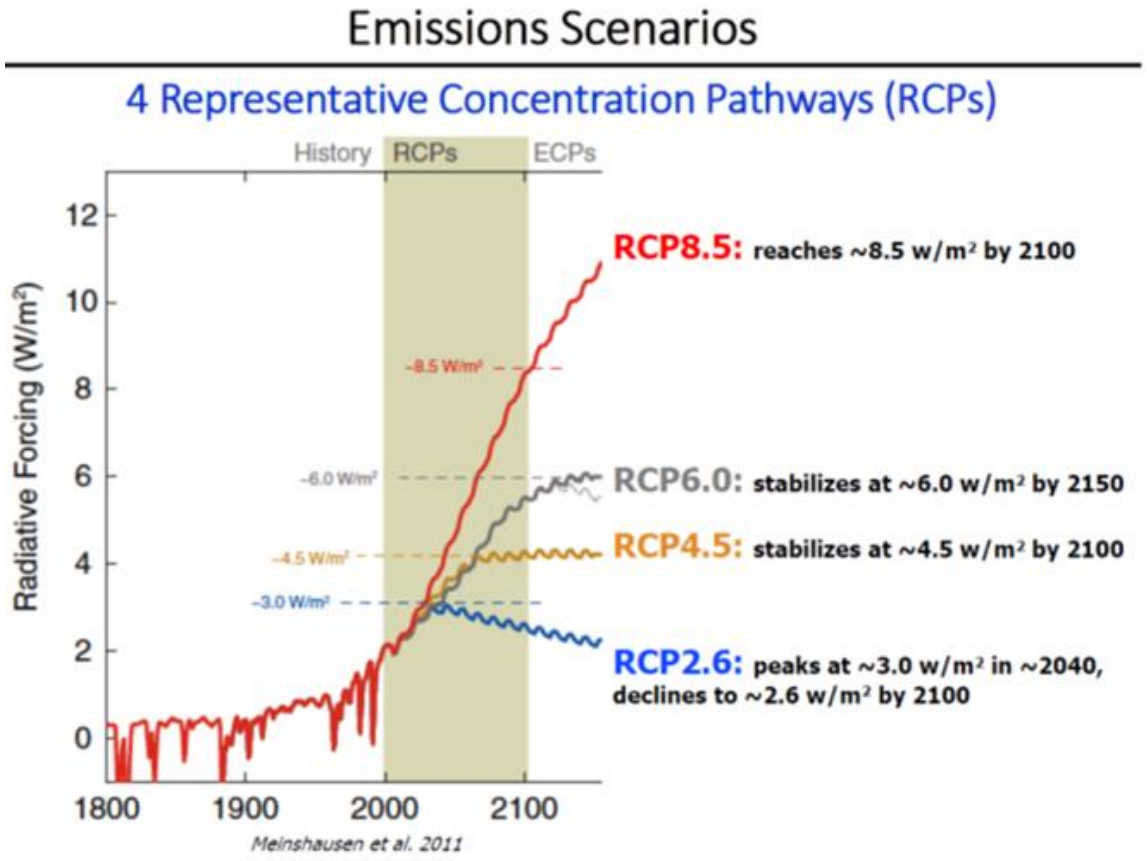
Climate change models for the region were developed

- A coalition including climate scientists, Bonneville Power Administration, US Army Corps of Engineers, and Bureau of Reclamation created climate models for the region.
  www.nwcouncil.org/2021powerplan_summary-climate-change-scenarios

- The Northwest Power and Conservation Council's draft 8th Power Plan was issued in September 2021.
  www.nwcouncil.org/2021-northwest-power-plan

- The Council uses temperature projections downscaled for the region from three different Global Circulation Models.



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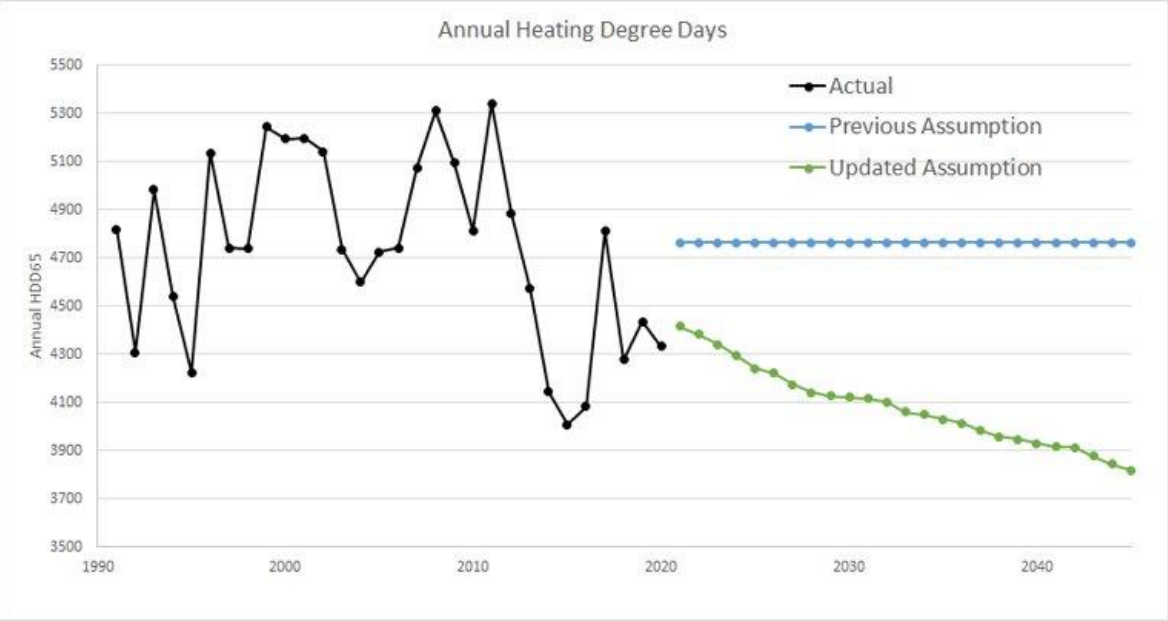
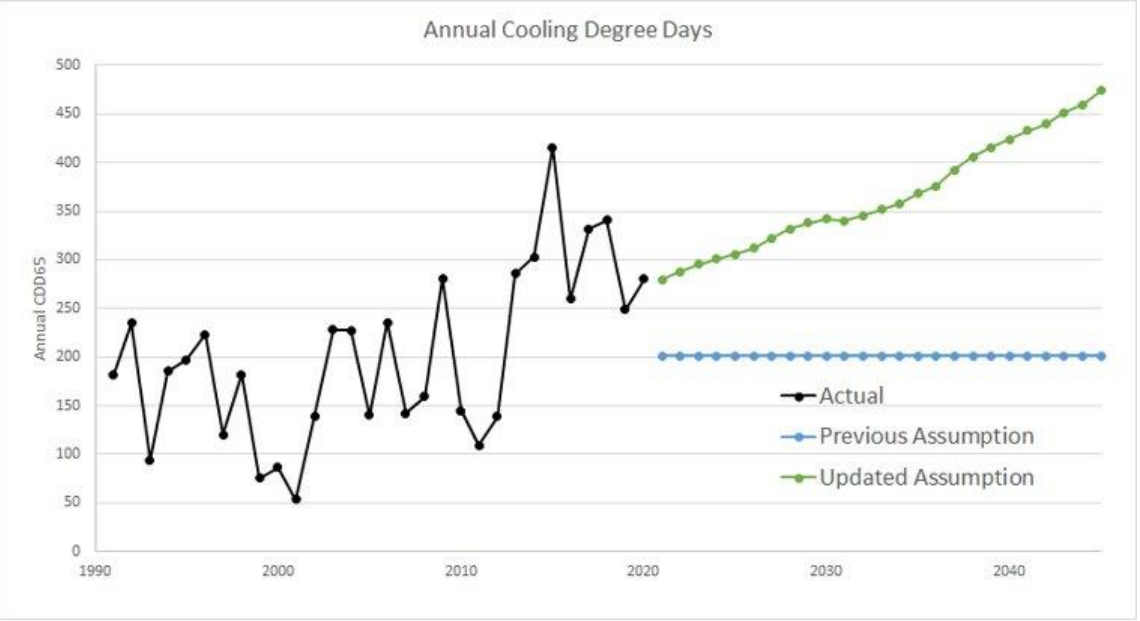
Energy demand forecast models use degree day assumptions





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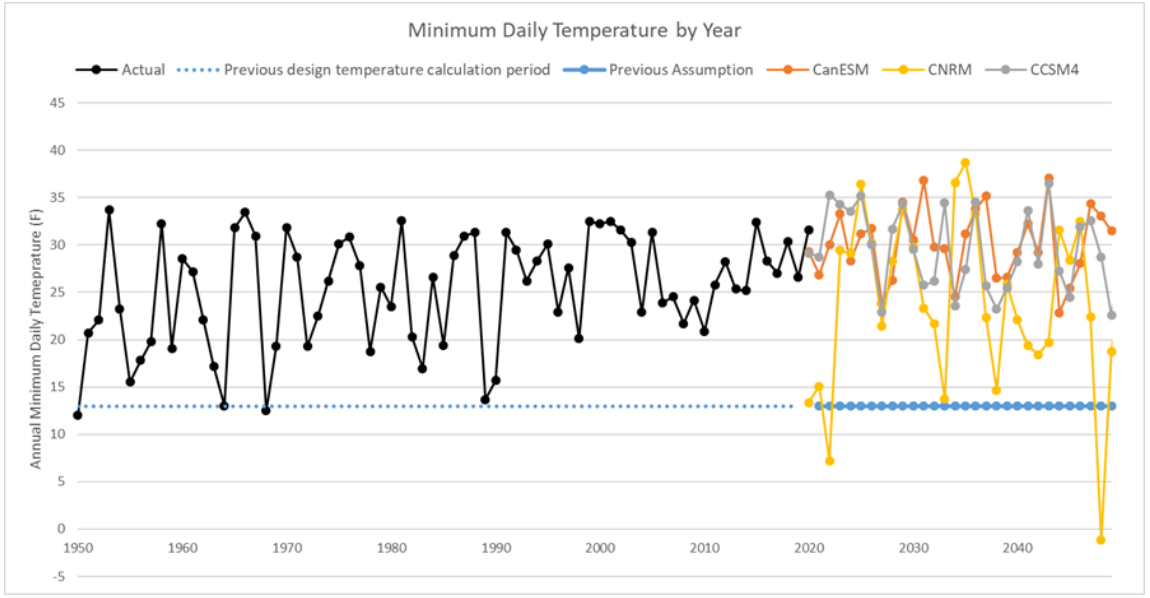
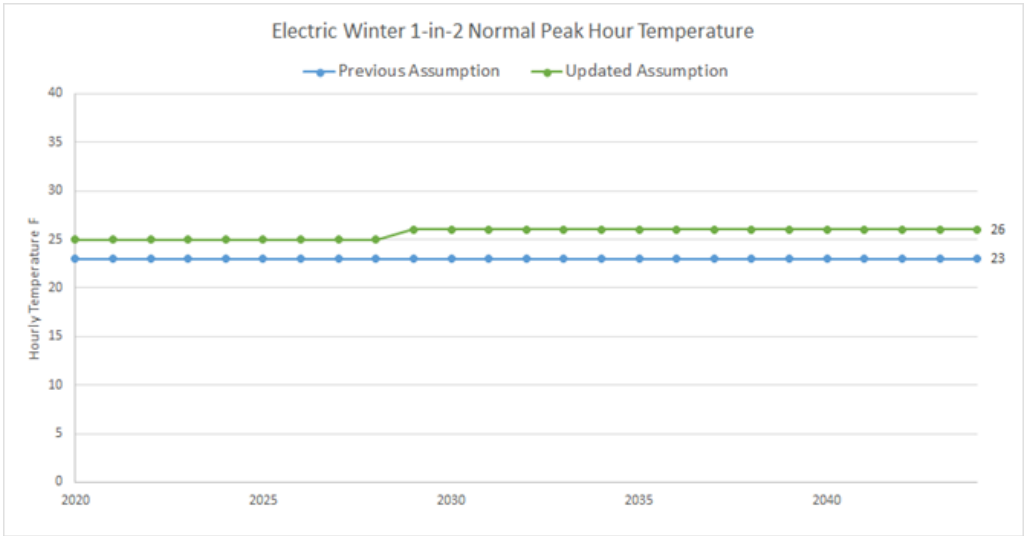
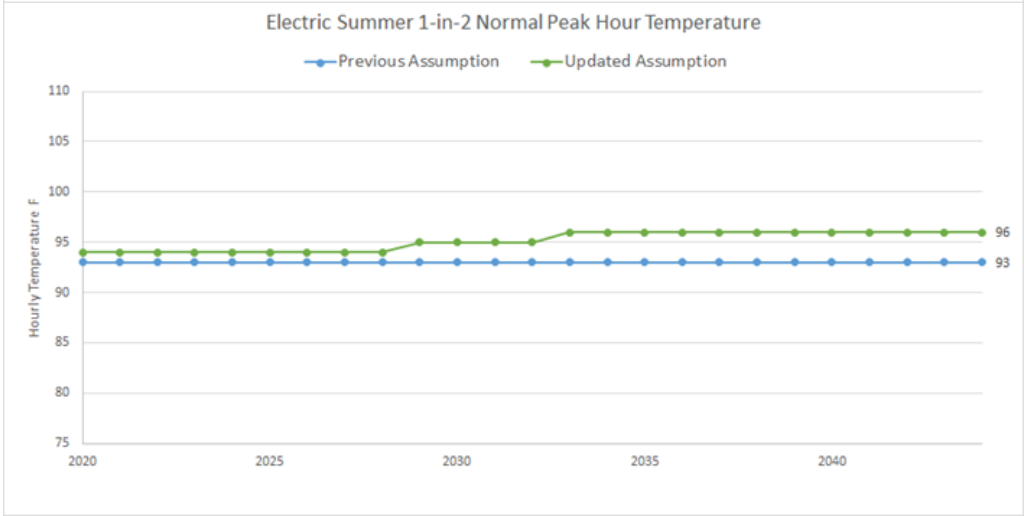
Peak demand forecast models use temperature assumptions

Natural Gas 1-in-50







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Economic forecasts include assumptions about COVID-19 and the continued re-opening of the economy

PSE subscribes to Moody's Analytics for **U.S.-level** macro-economic assumptions.

Moody's COVID-19 assumptions (November 2021):

- December 2021: Infections abate.
- Future waves of COVID-19 will have lessened economic effects because of vaccinations coming out for children.

Moody's cites risks to the forecast:

- A more contagious strain of the virus threatens to further worsen the already-severe health crisis.
- Disruption of global supply chains / tourism / business travel affecting global economy.

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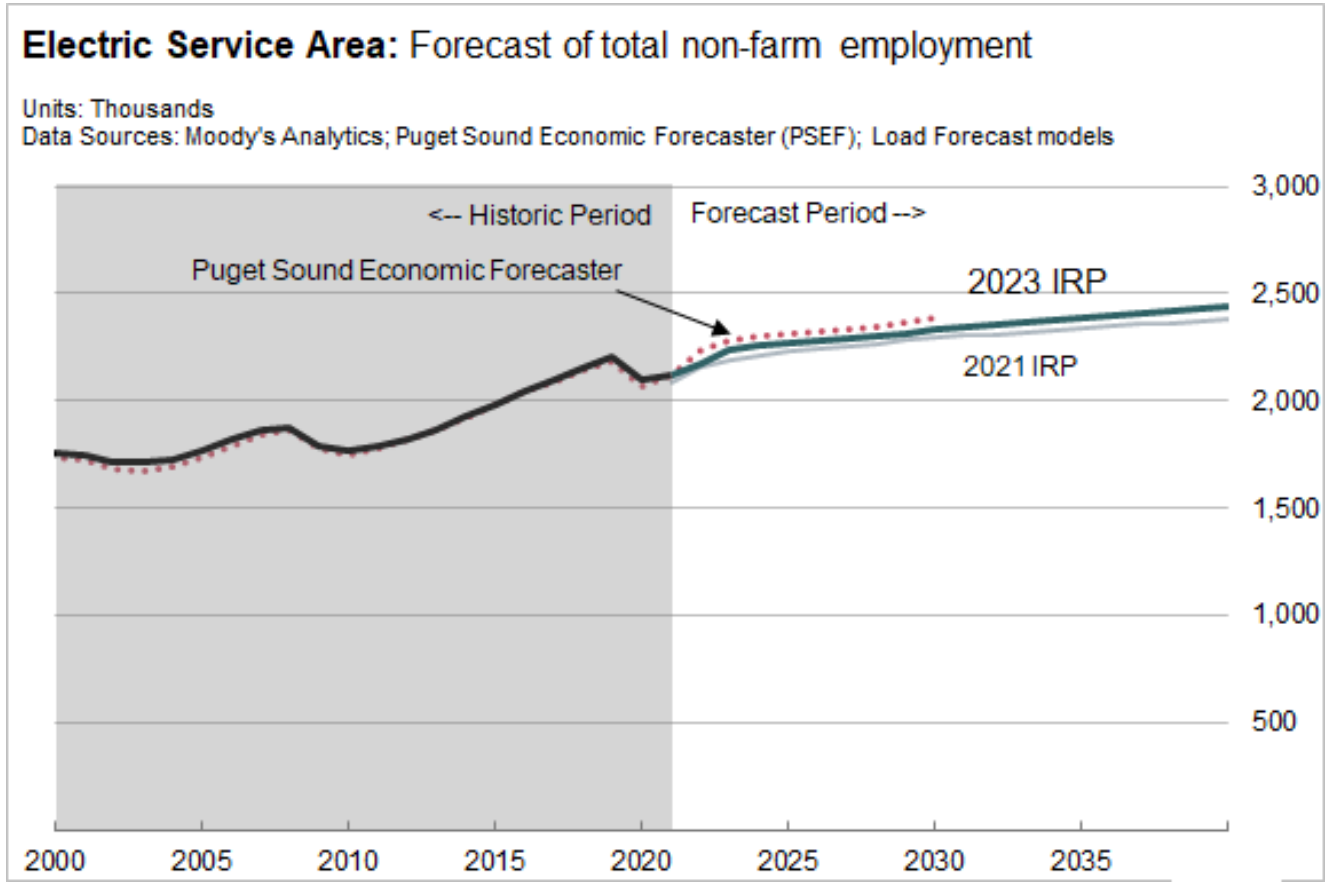
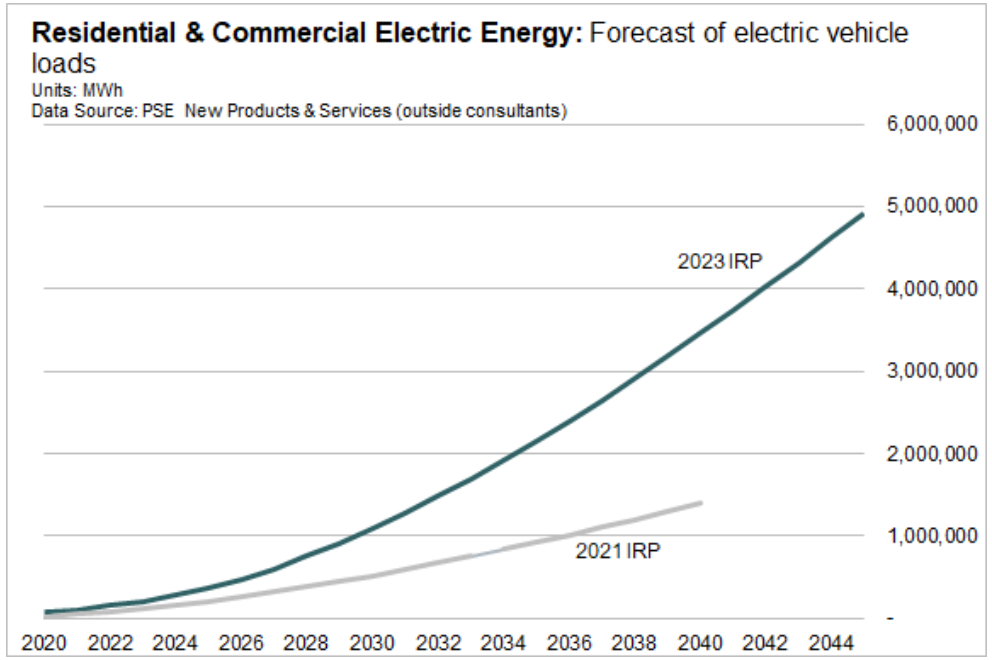
PSE's service area will return to pre-pandemic employment by 2024

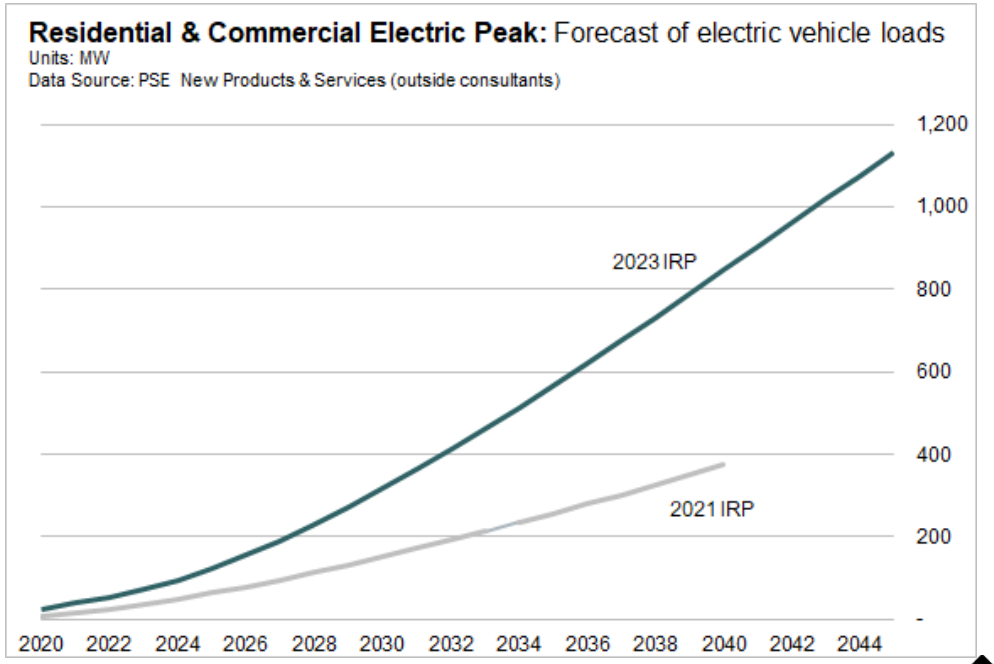
- PSE uses US-level assumptions combined with local economic data to develop economic forecasts for PSE's service area.
- PSE subscribes to Moody's Analytics for US-level macro-economic forecasts.
- Compared to the 2021 IRP, Moody's (November 2021) forecasts slightly higher employment rate.



Electric Vehicles: The 2023 IRP Progress Report EV forecast is higher than the 2021 IRP EV forecast

- The 2023 IRP Progress Report EV forecast includes:
  - Legislative updates -- Zero Emission Vehicle (2020) and Clean Fuel Standard (2021).
  - Forecast of medium and heavy-duty vehicles.
- The EV forecast is before DSR, and does not include impacts from managed charging programs or time varying rates.





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2022 Electric Vehicle Forecast

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Senior Marketing Analyst, PSE

Robin Maslowski
Director, Guidehouse

Will Sierzchula
Managing Consultant, Guidehouse

Kajal Gaur,
Managing Consultant, Guidehouse

Outline

#	Topic
1	Adoption Methodology
2	Clean Fuel Standard
3	Adoption Results
4	Load Forecasting Methodology
5	Load Forecasting Results

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

LDV = light-duty vehicles
MHDV = medium-heavy duty vehicles

Adoption Methodology

Vehicle Segmentation

Road Usage	Vehicle Duty		Vehicle Segment	Example Vehicle
On-Road	**Light Duty**		Class 1 Vehicles	• Sedan, small sport utility vehicle, small crossover, small pickup truck
			Class 2a-2b Vehicles	• Sport utility vehicle, pickup truck, small delivery van
	Medium & Heavy Duty		Class 3 Trucks	• Walk-in van, city delivery van
			Class 4-5 Trucks	• Box truck, city delivery van, step van
			Class 6 Trucks	• Beverage truck, rack truck
			Class 7-8 Trucks	• Short-haul truck, long-haul truck
			School Buses	• School bus
			Transit Buses	• Transit bus

Illustrative Class 2a Vehicles

Battery Electric Vehicles (BEV)

Tesla Model X

Audi e-tron

Plug-In Hybrid Electric Vehicles (PHEV)

Chrysler Pacifica PHEV

BMW X5 PHEV

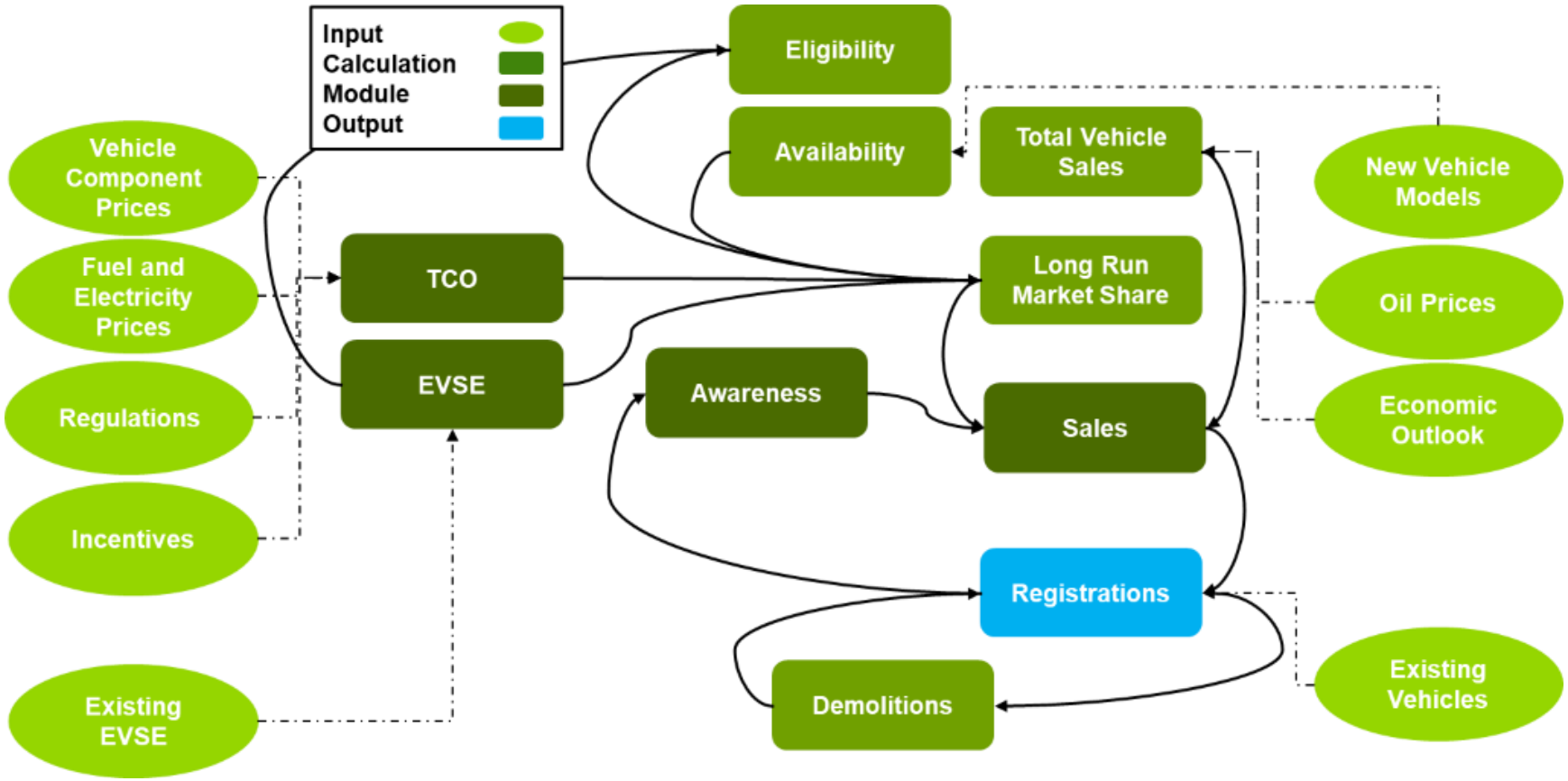
Porsche Cayenne PHEV

Mercedes GLE PHEV

Range Rover PHEV

Lincoln Aviator PHEV

Guidehouse's EV adoption model is based on multi-dimensional inputs to forecast vehicle penetration



TCO = Total Cost of Ownership
EVSE = Electric Vehicle Supply Equipment

Guidehouse

1. Guidehouse's **Vehicle Analytics & Simulation Tool™ (VAST) Suite** uses in-house datasets to provide market transparency that informs client lifecycle consulting needs, such as electric vehicle (EV) charging station location optimization analysis to develop an EV charging infrastructure plan.

EV adoption modeling inputs and outputs

Key Inputs		
Input	**Description**	**Source**
Registration Data	Washington vehicle registration by fuel type and zip	IHS Markit
Fuel Costs[1]	Electricity rates ($/kwh) and gasoline and diesel prices ($/gal)	Energy Information Administration (electricity) AAA (gasoline and diesel)
Vehicle Availability	Guidehouse research on future availability of EVs, including MHD vehicles in California	Guidehouse Insights
Vehicle Miles Traveled (VMT)	Forecasted annual vehicle miles traveled, Washington	Federal Highway Administration
Vehicle Efficiency	kWh/mile forecast	Argonne National Lab
PHEV e-Utilization	Proportion of plug-in hybrid electric vehicle (PHEV) miles using battery	
Battery electric vehicle (BEV) Range	Total miles increase forecast	Guidehouse Insights
Education and Income	Educational attainment and income levels, Washington, by ZCTA	US Census Bureau
Battery Cost	$/kWh cost decline forecast	Guidehouse Insights

Key Outputs	
Output	**Description**
EV Sales	Number of units per year
EV Population	Total units in operation in a given year, accounting for cumulative sales and scrappage
Year	2021-2050
Location	ZIP Code Tabulation Areas (ZCTA)
Duty	Light, Medium, and Heavy
Owner	Individual, Fleet
Powertrain[2]	BEV, PHEV

ZCTA: ZIP Code Tabulation Areas (ZCTAs) are generalized areal representations of United States Postal Service (USPS) ZIP Code service areas

Clean Fuel Standard

Clean Fuel Standard (CFS)

Levers used in VAST™ to model CFS

Higher Gasoline Prices

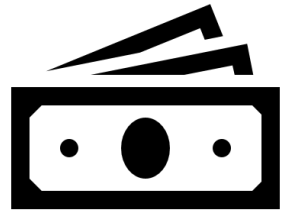
Raises ICEV TCO

Additional EVSE

Reduces Customer Barriers to EV Adoption

Greater Customer EV Awareness

Increases Pool of Potential EV Customers



Additional Incentives for EV customers

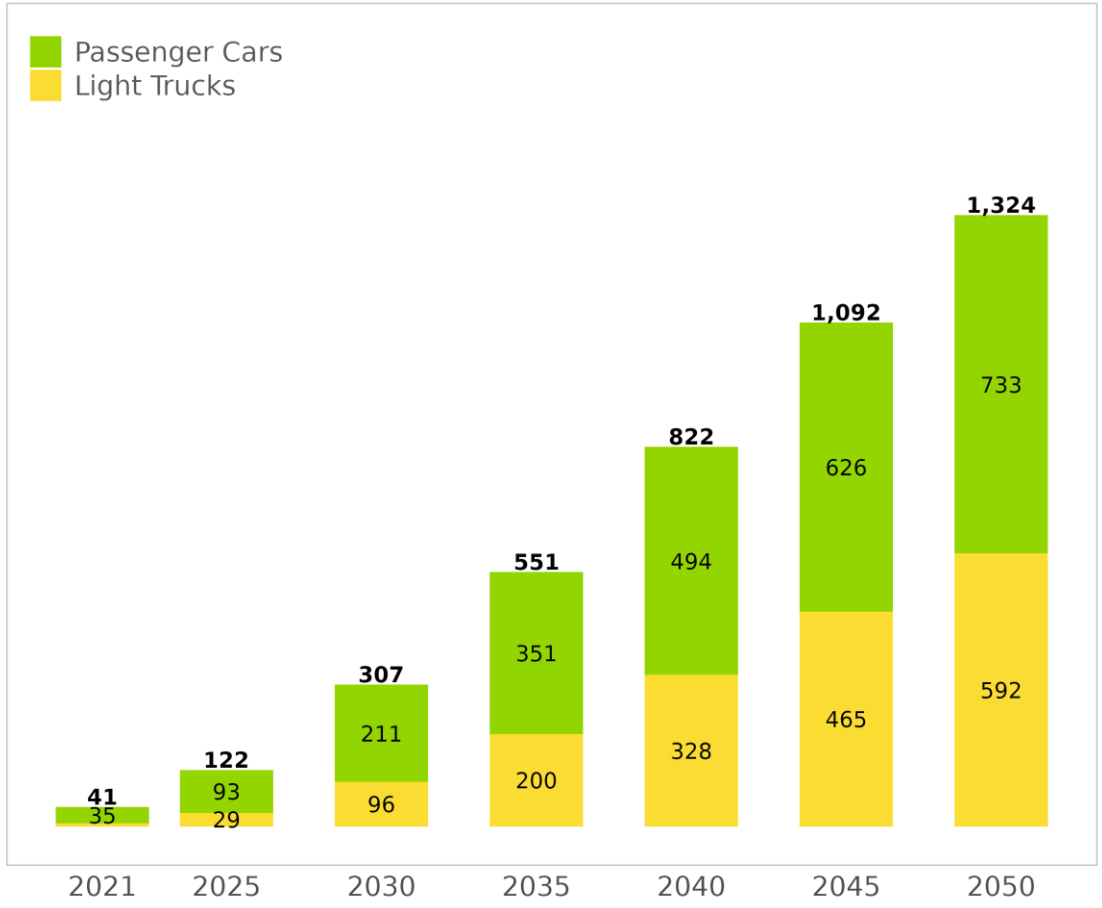
Decreases EV total Cost Ownership (TCO)

This forecast used Guidehouse's 2021 EV market forecast (with the ZEV standard) for PSE as the basis, then applied these CFS levers to understand the incremental impacts from the CFS.

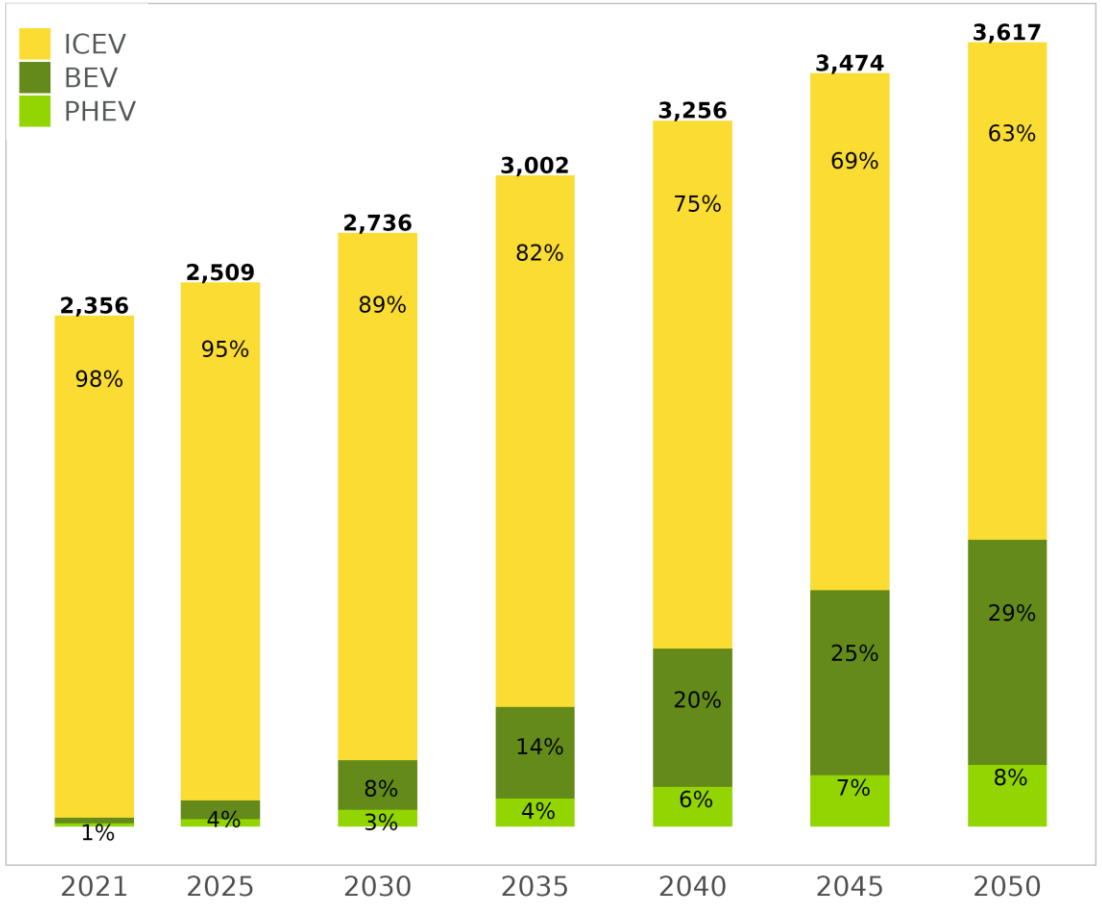
Adoption Results

Light Duty Vehicles: ~1.3M light duty EVs expected on the road in PSE service area by 2050 (37% penetration)

LDV EV Population by Class
'000 Vehicles, PSE Service Area, 2021-2050

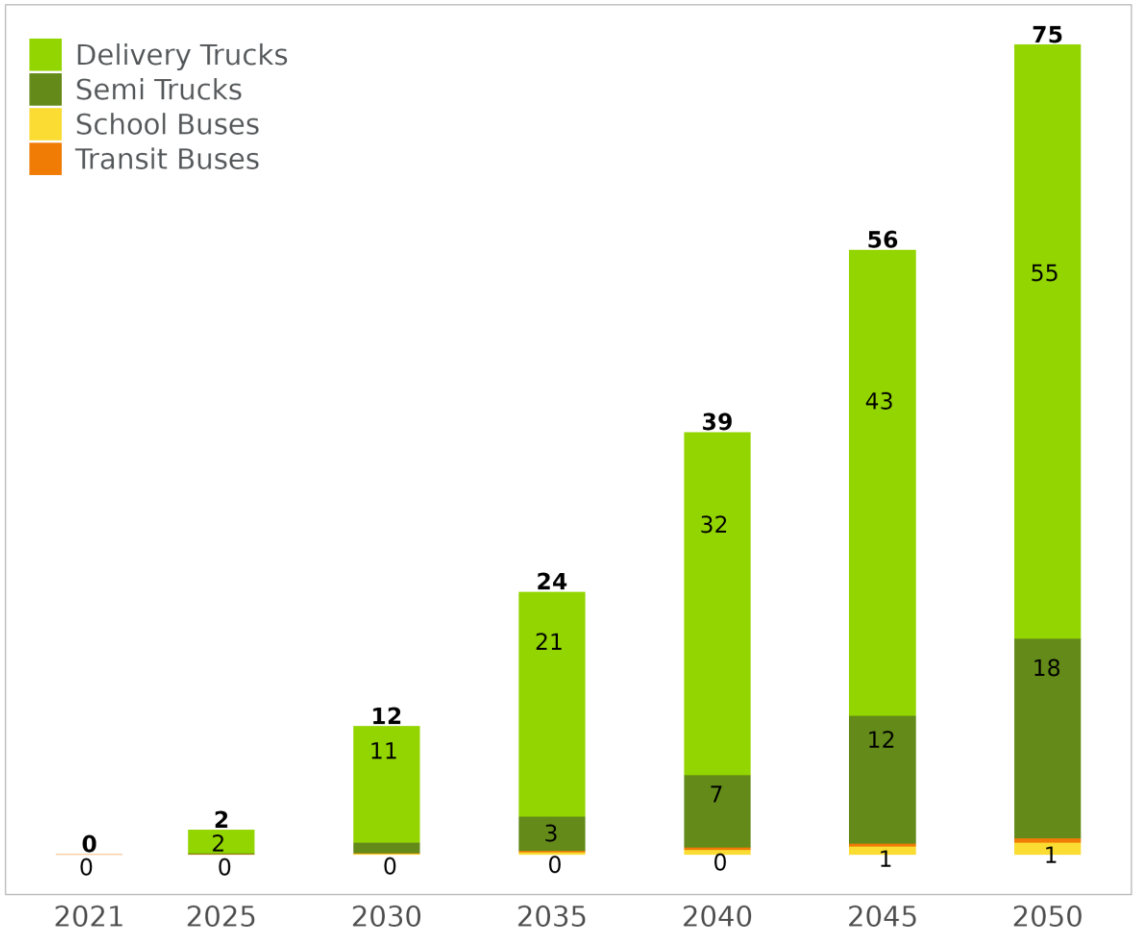


LDV Population by Powertrain
'000 Vehicles, PSE Service Area, 2021-2050

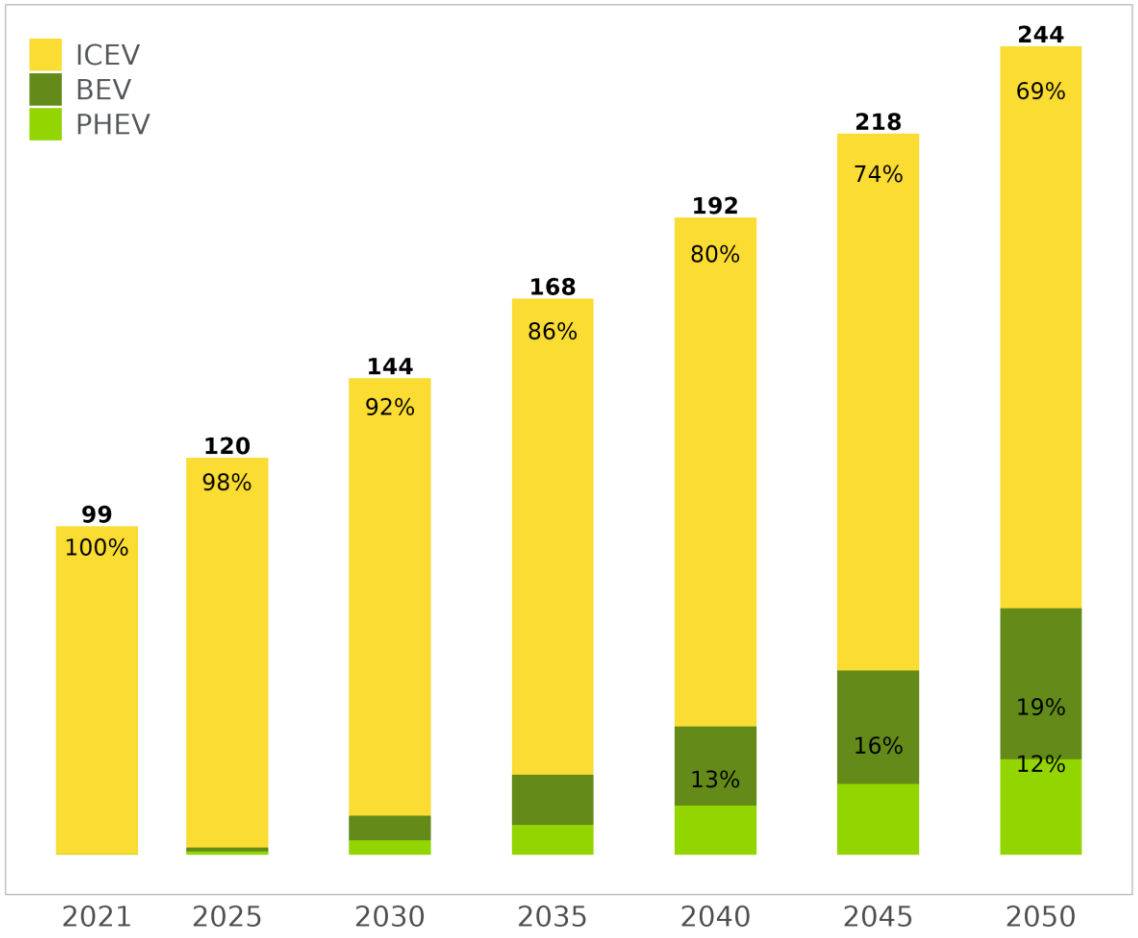


Medium and Heavy Duty Vehicles: ~75,000 non-light duty EVs expected on the road by 2050 (31% penetration)

MHDV EV Population by Class
'000 Vehicles, PSE Service Area, 2021-2050



MHDV Population by Powertrain
'000 Vehicles, PSE Service Area, 2021-2050



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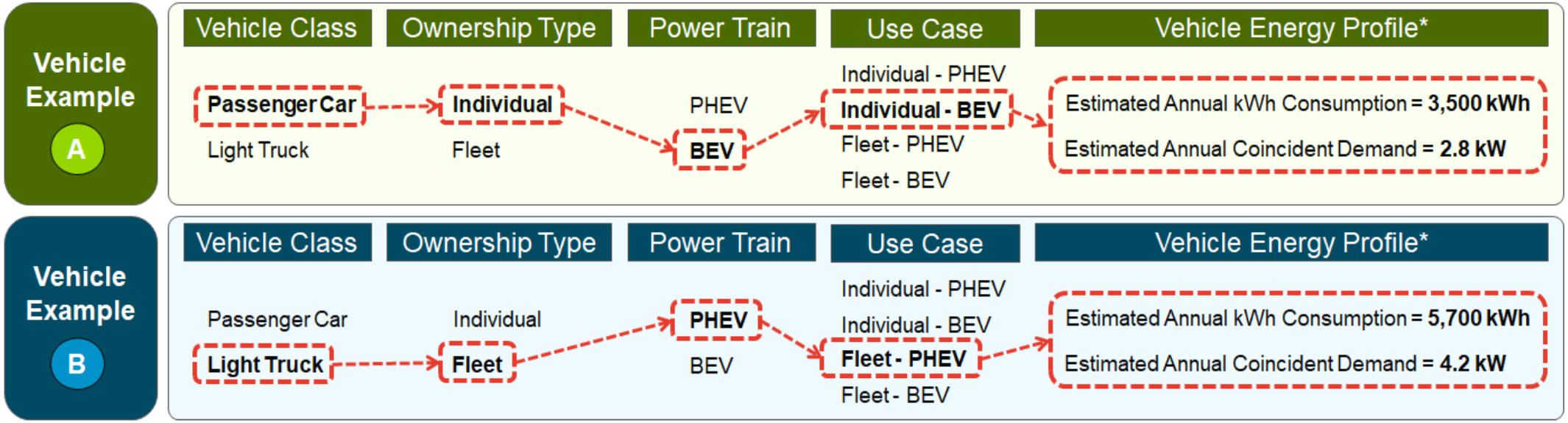
Load Forecasting Methodology

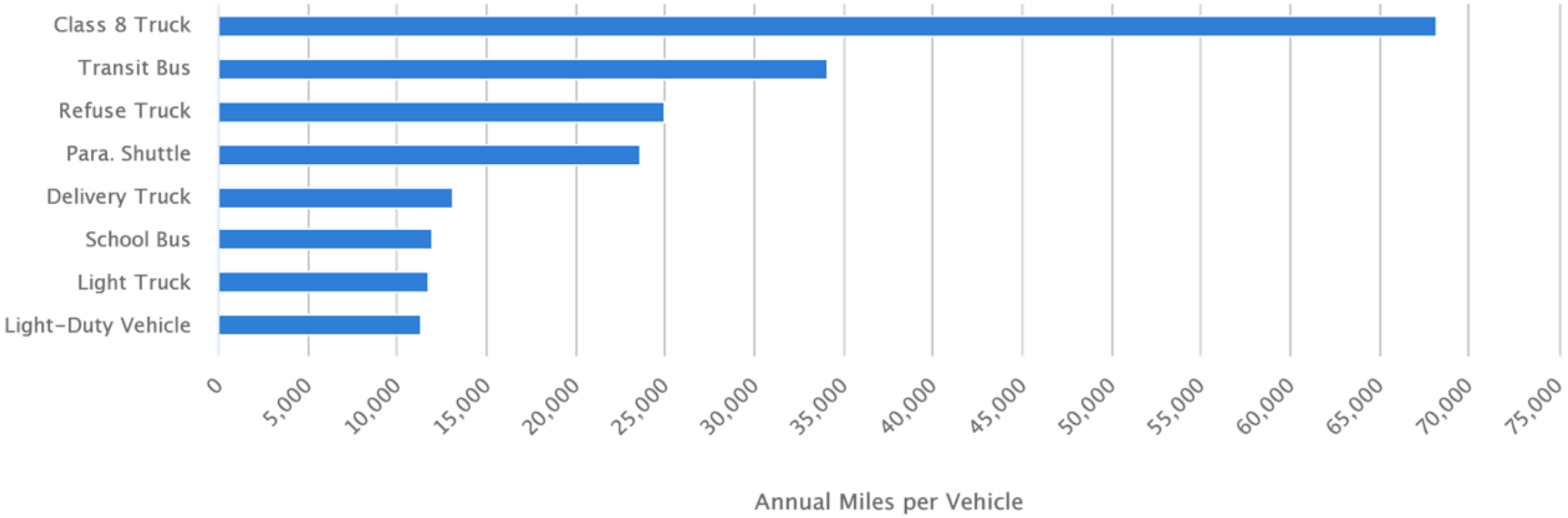
VAST™ Load Impacts Overview

The Load Impacts module calculates the kWh and kW impact of EV charging at EVSE locations, based on the driving need of the vehicles (VMT), efficiency of the vehicle, and capacity of the charger.



* Consumption = Vehicle Average Annual VMT x kWh/mile, and Coincident Demand = Vehicle Average Annual VMT x kW/mile

Average annual vehicle miles traveled



Source: Federal Highway Administration, Highway Statistics 2016, Table VM-1, updated December 2018

Load Forecasting modeling inputs and outputs

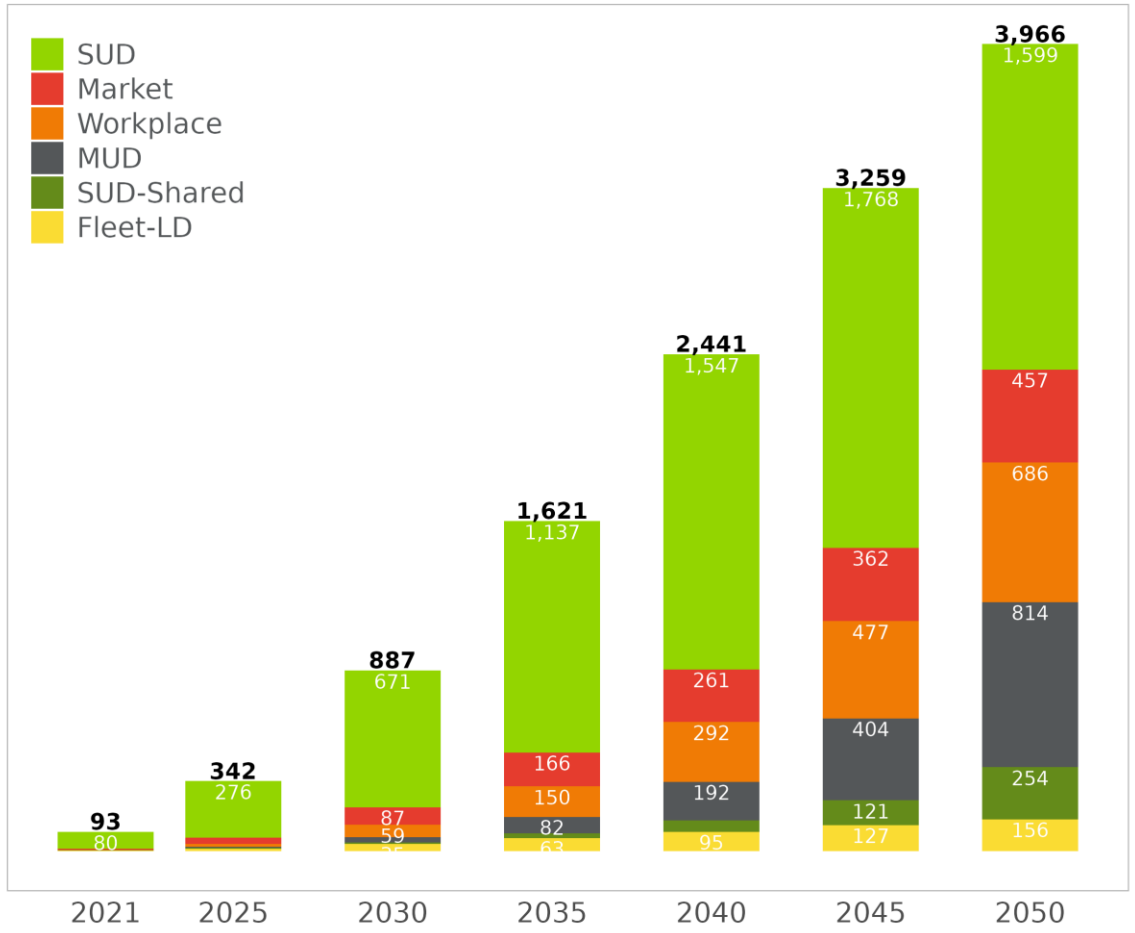
Key Inputs		
Input	**Description**	**Source**
EV Adoption Forecast	Number of BEVs and PHEVs by census tract by year	Guidehouse
EVSE Forecast	Number of chargers needed to support EV adoption	Guidehouse
VMT	VMT by segment, along with vehicle efficiency, determines total energy needs	Federal Highway Administration[1]
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
Rated kW	Average rated kW by use case, technology, and year
Year	2021-2050
Day of Week / Time of Day	Hourly, Weekend/Weekday
kWh	Hourly energy consumption

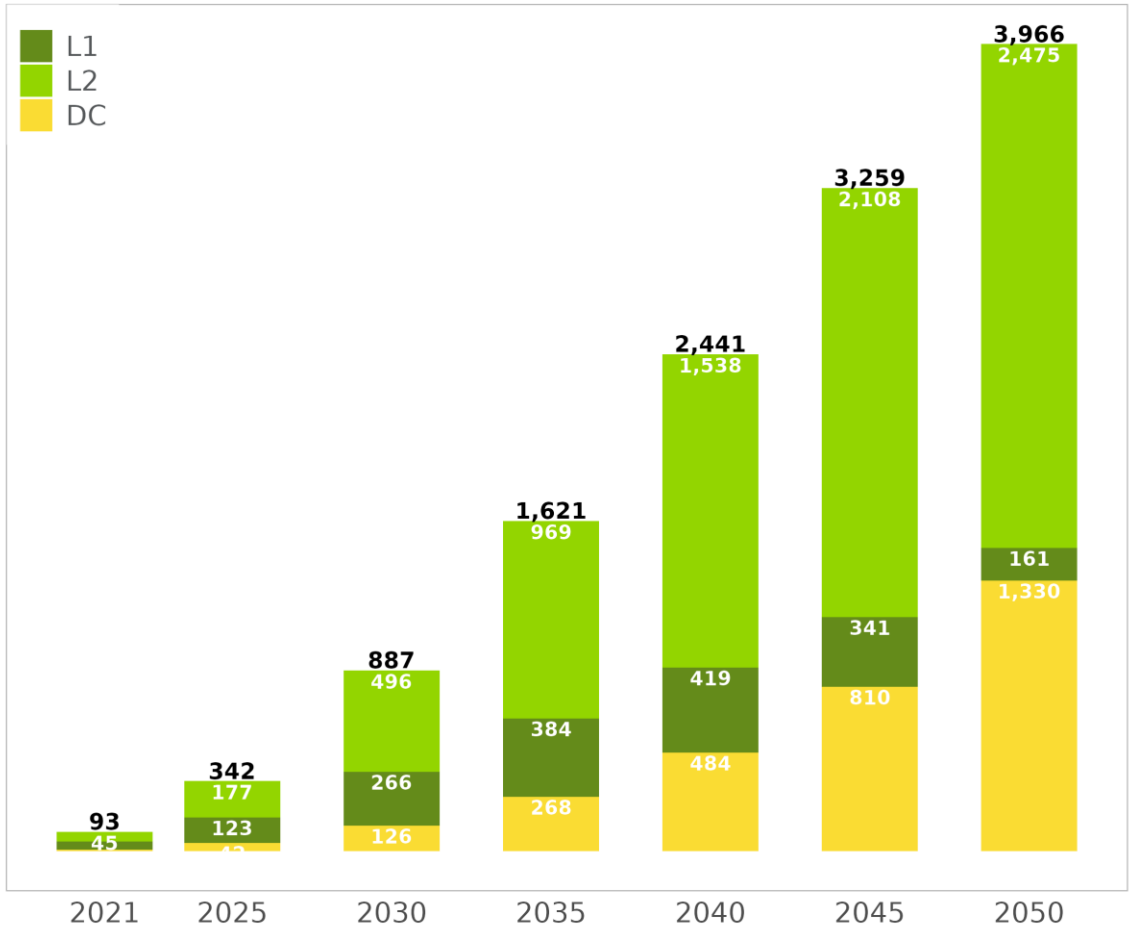
Load Forecasting Results

LDV impacts become more evenly distributed by use case and DC charging has fastest growth over study period.

LDV Impacts By Use Case
Impacts (GWh), PSE Service Area, 2021-2050



LDV Impacts By Technology
Impacts (GWh), PSE Service Area, 2021-2050



Strongest MHDV growth in HD fleets and hubs with most charging coming from DC stations.

MHDV Impacts By Use Case
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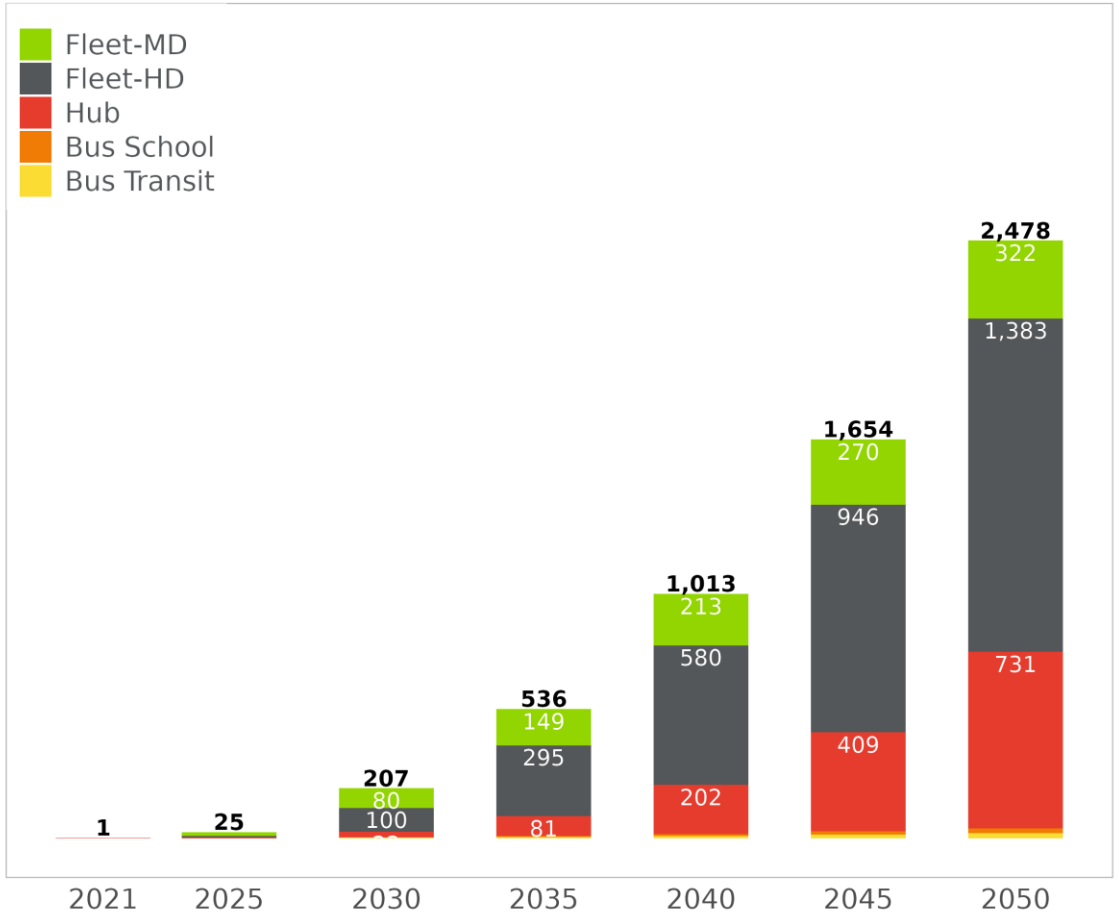
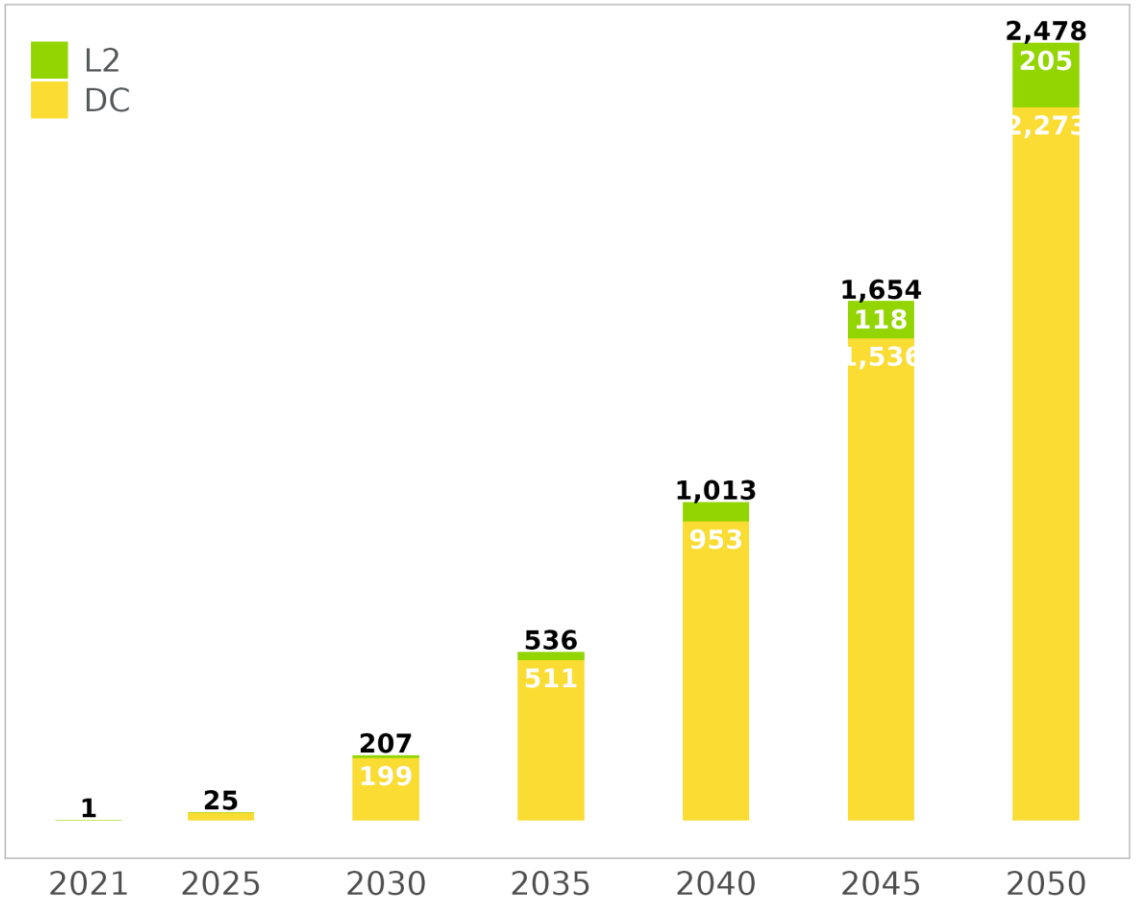
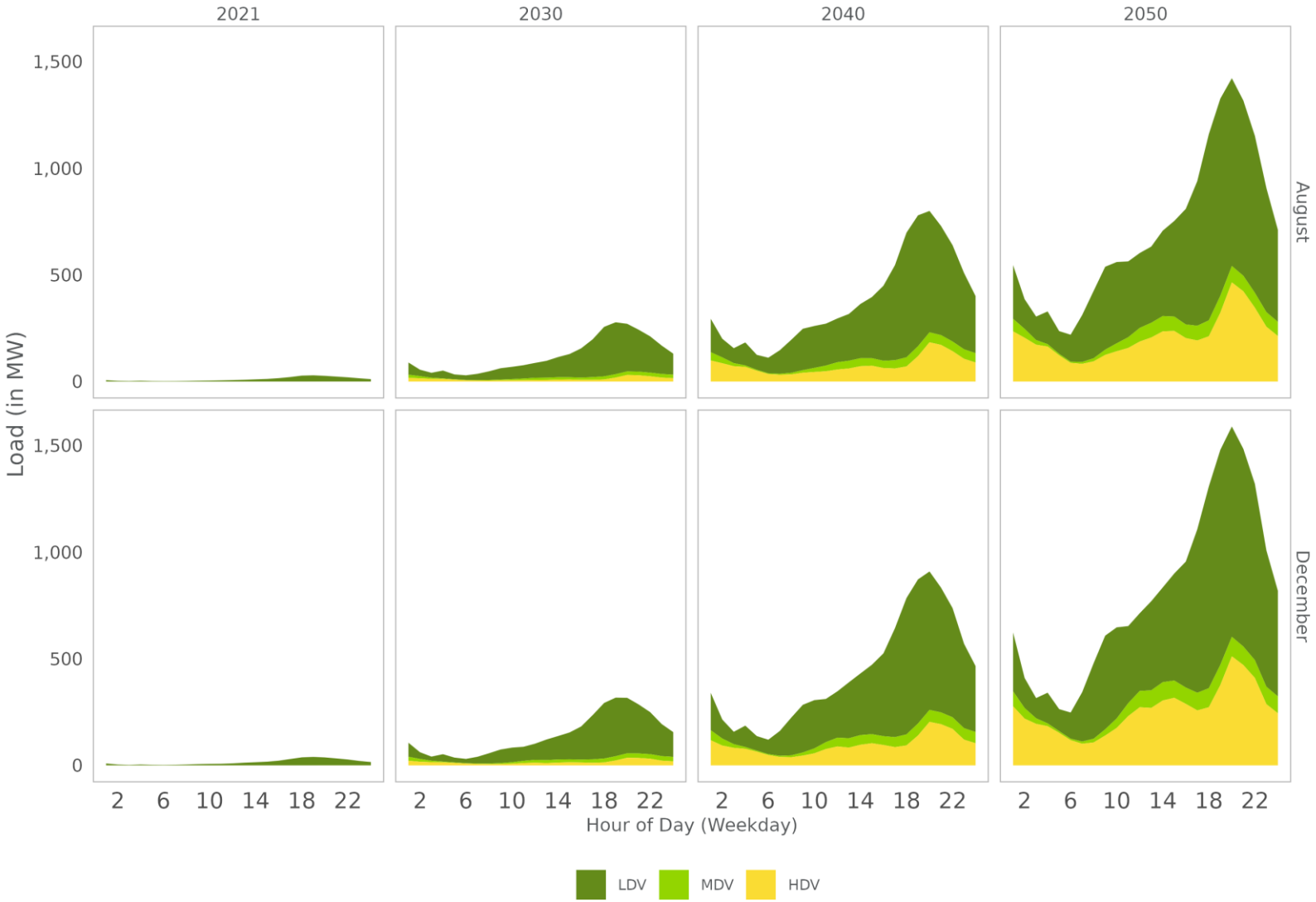


MHDV Impacts By Technology
Impacts (GWh), PSE Service Area, 2021-2050



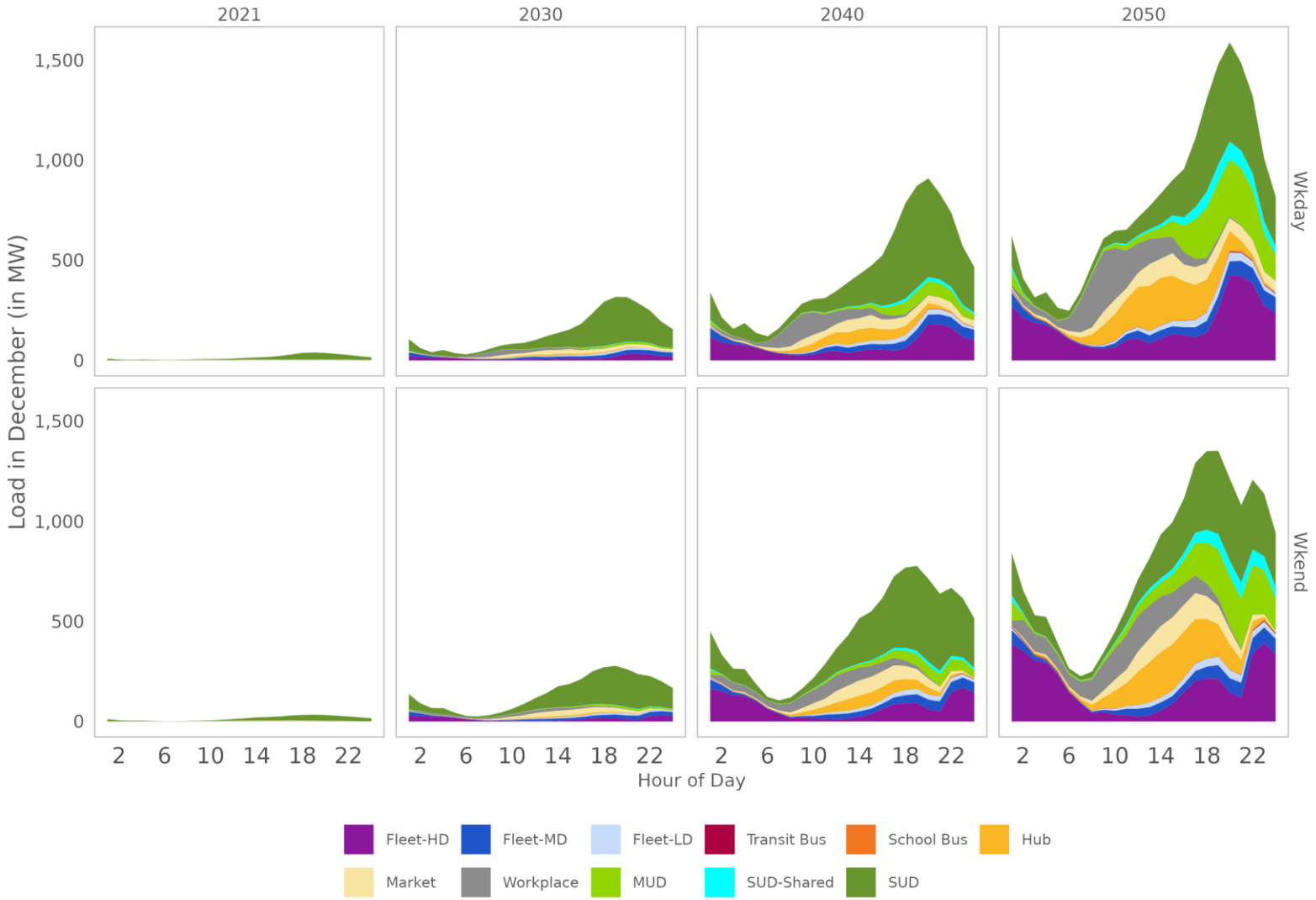
Guidehouse

Unmanaged Load Shapes: Totaled by duty (for Weekdays)



Notes: Load shapes based on currently available EV charging data and ICEV driving behavior data with limited assumptions about changes over time. Uncertainty in load shapes is greater for years further in the future and is expected to be refined over time. The load shapes do not account for any managed charging.

Unmanaged Load Shapes: Totaled by use case (in Dec)



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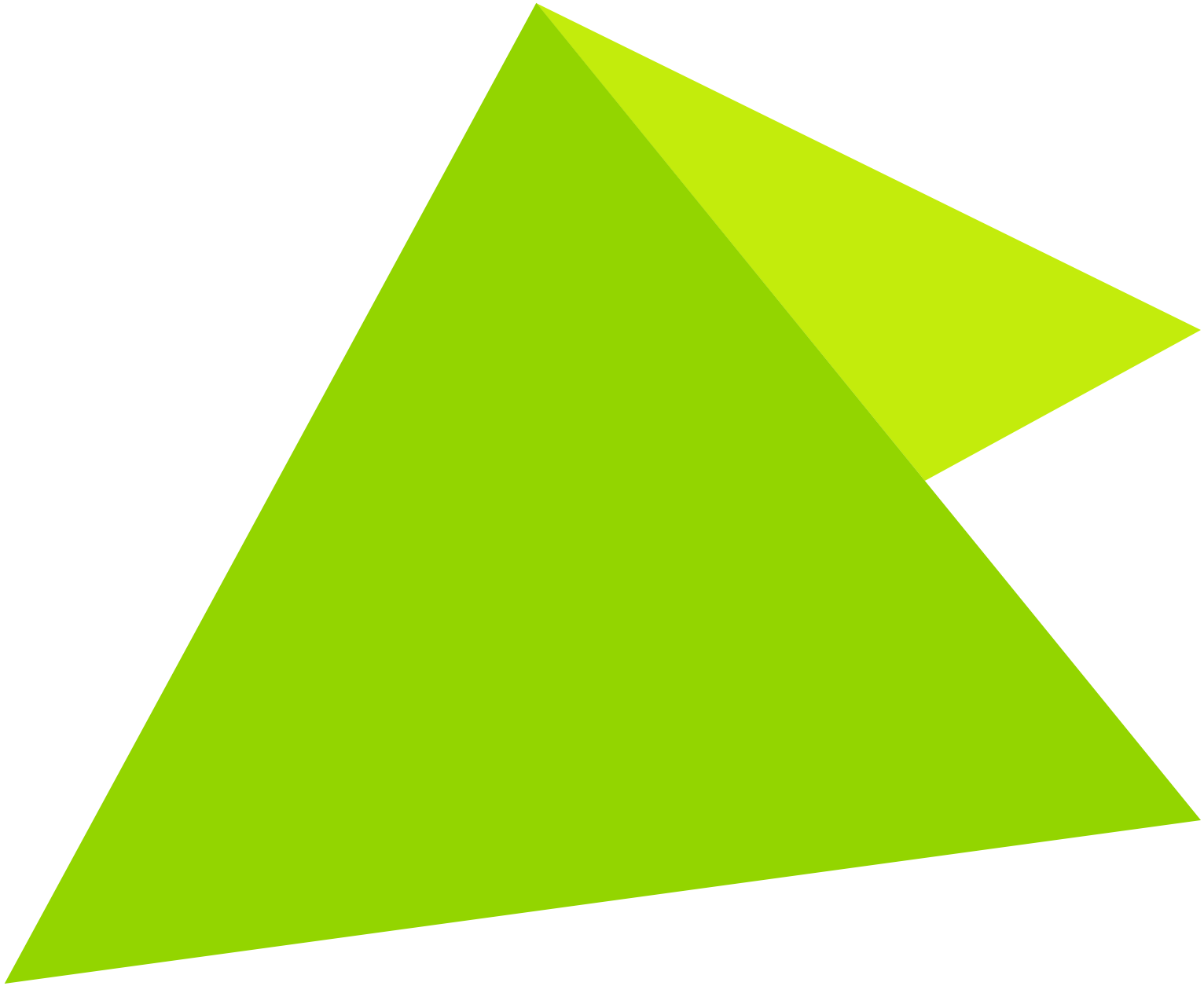

Next Steps

Sophie Glass, Co-facilitator, Triangle Associates

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IRP stakeholder feedback process

Feedback form: PSE IRP - Feedback Form

July 14	A recording of the webinar and the transcript of the chat will be posted to the IRP website so those who were unable to attend can review.
July 22	Feedback forms are due. Feedback should focus on topics related to demand forecast and EV vehicles.
August 12	A feedback report of comments collected from the feedback form, along with PSE's responses, and a meeting summary will be shared with stakeholders and posted to pse.com/irp

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Next steps and stay in touch

Next meetings with IRP stakeholders

- July 20, 2022 – Resource adequacy information session TO BE RESCHEDULED
- Sept. 13, 2022 – Electric Progress Report: final resource need and Conservation Potential Assessment (CPA) results

Irp@pse.com

Pse.com/irp

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Appendix

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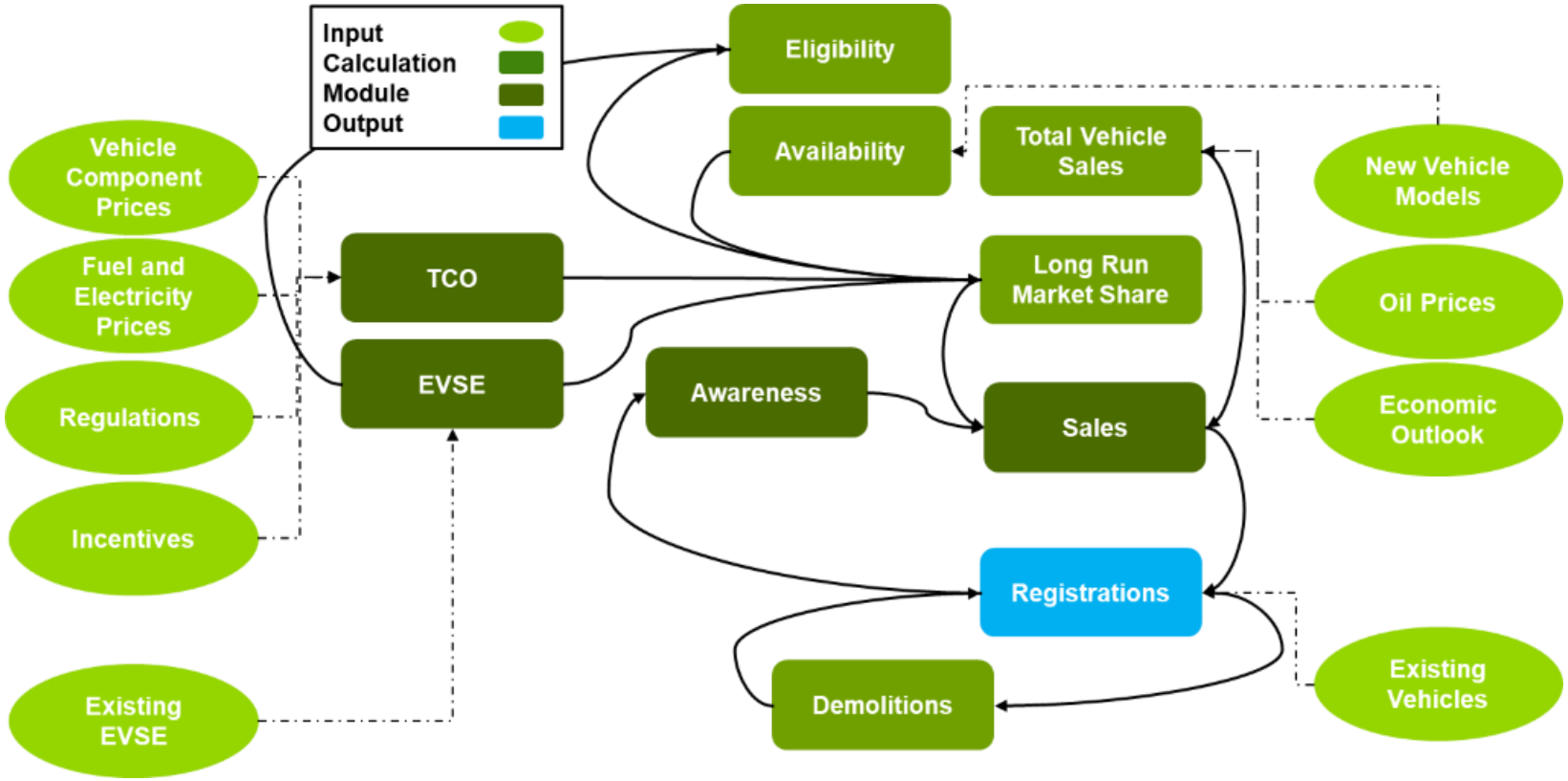
Guidehouse's EV adoption model is based on multi-dimensional inputs to forecast vehicle penetration



TCO = Total Cost of Ownership
EVSE = Electric Vehicle Supply Equipment

Scope

- Within Washington
- Including battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs)
- Including medium- and heavy-duty (MHD) vehicles
- Including individually- and fleet-owned vehicles

Methodology

- Leveraging VAST™ Suite[1], a proprietary model developed by Guidehouse to forecast geographic penetration and dispersion of electric vehicles
- Taking inputs at the census tract level, including:
  - Vehicle registrations by make and model
  - Expected gasoline and battery 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

Guidehouse

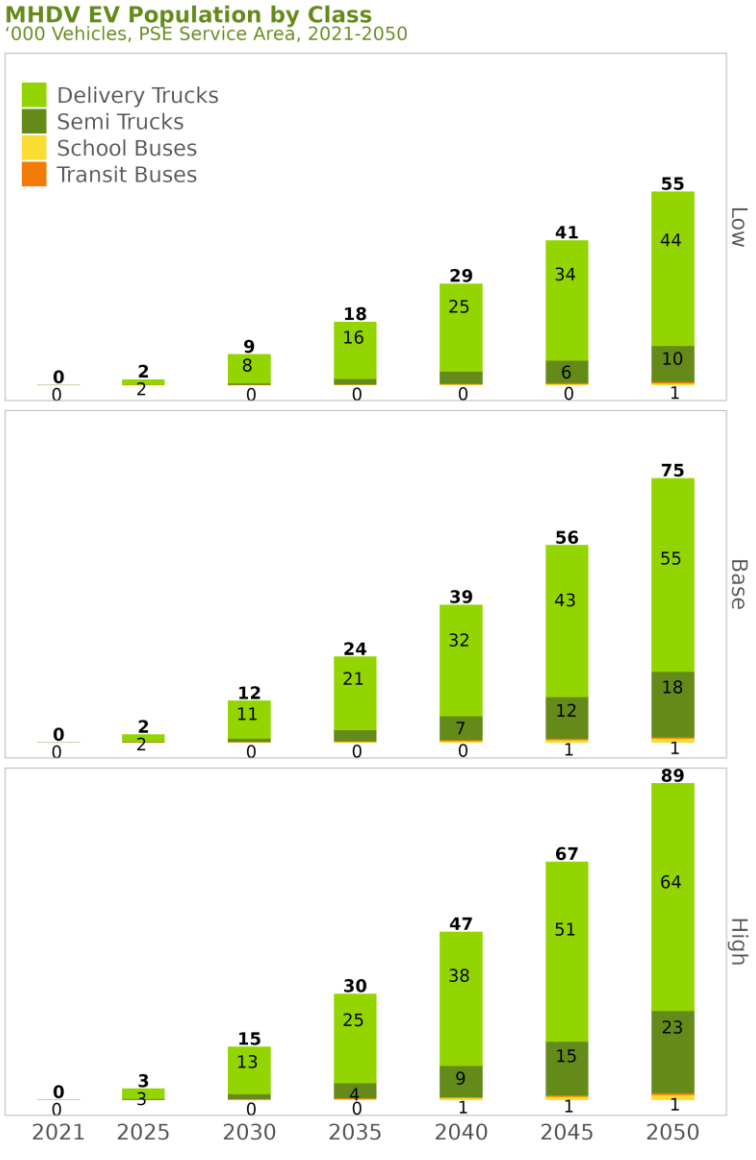
1. Guidehouse's **Vehicle Analytics & Simulation Tool™ (VAST) Suite** uses in-house datasets to provide market transparency that informs client lifecycle consulting needs, such as electric vehicle (EV) charging station location optimization analysis to develop an EV charging infrastructure plan.

MHDV Adoption Assumptions

- **MHDV adoption is still maturing relative to LDV**
  - Because the market is nascent, **historical sales values are still very low**
  - We apply **calibrated LDV fleet adoption curves** to MHDV
    - We identify ZCTAs with a more mature light-duty fleet EV market (as a proportion of all fleet vehicles). Then we determine the historical curve and identify where other tracts fit along that curve.
- **Unlike LDV, MHDV disaggregation is based on fleet location**
  - LDV uses demographic factors (income and education)
    - These are less important for MHDV
    - **MHDV adoption is driven** more **by economics**
    - **Economics, such as purchase price, do not vary greatly between tracts**
    - Uses proportional allocation of fleet vehicles by tract
    - **Higher fleet density means higher EV uptake**

Light Duty Vehicles: ~1.3M light duty EVs expected on the road in PSE service area by 2050 (37% penetration)

Medium and Heavy Duty Vehicles: ~75,000 non-light duty EVs expected on the road by 2050 (31% penetration)



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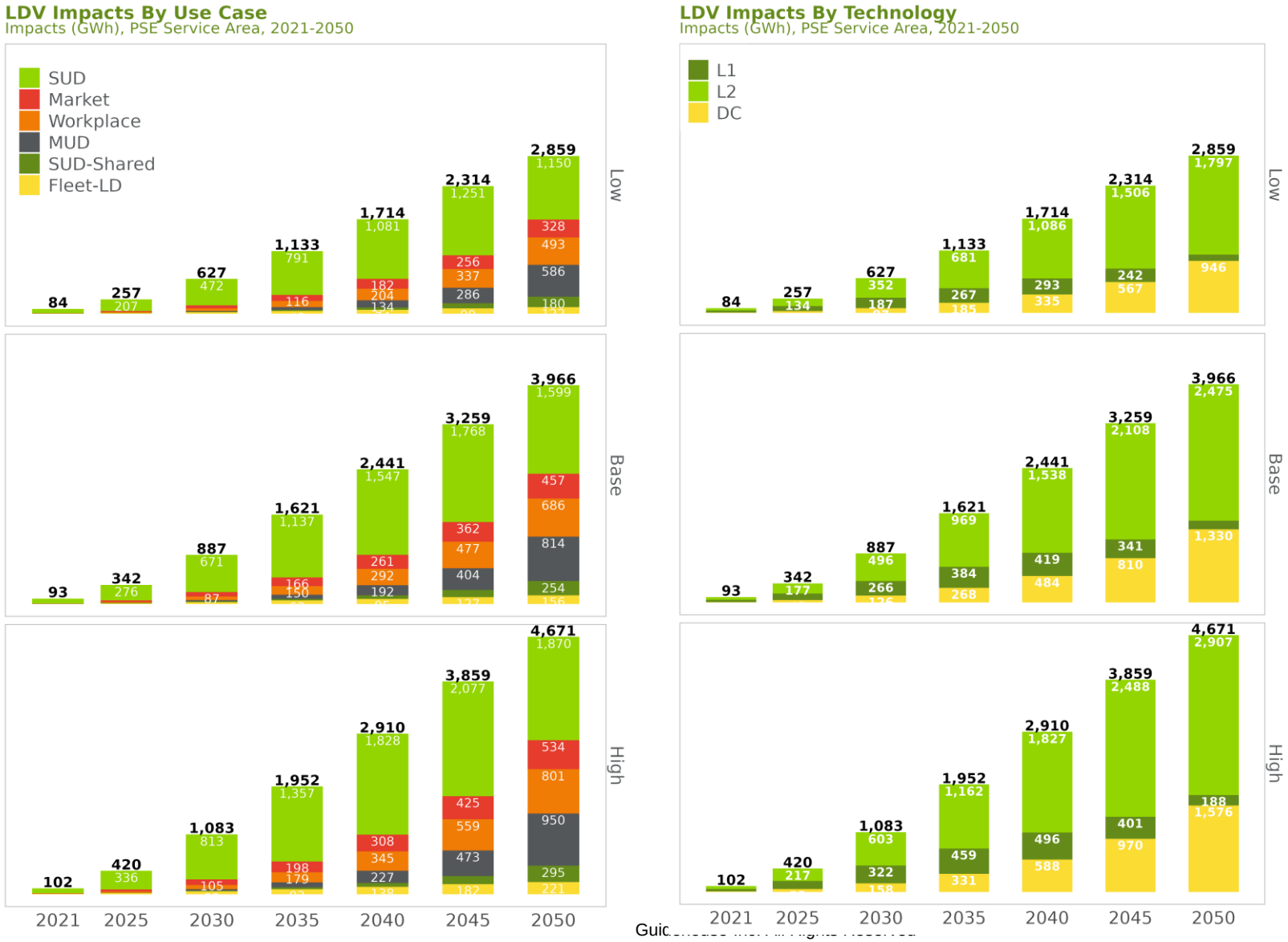
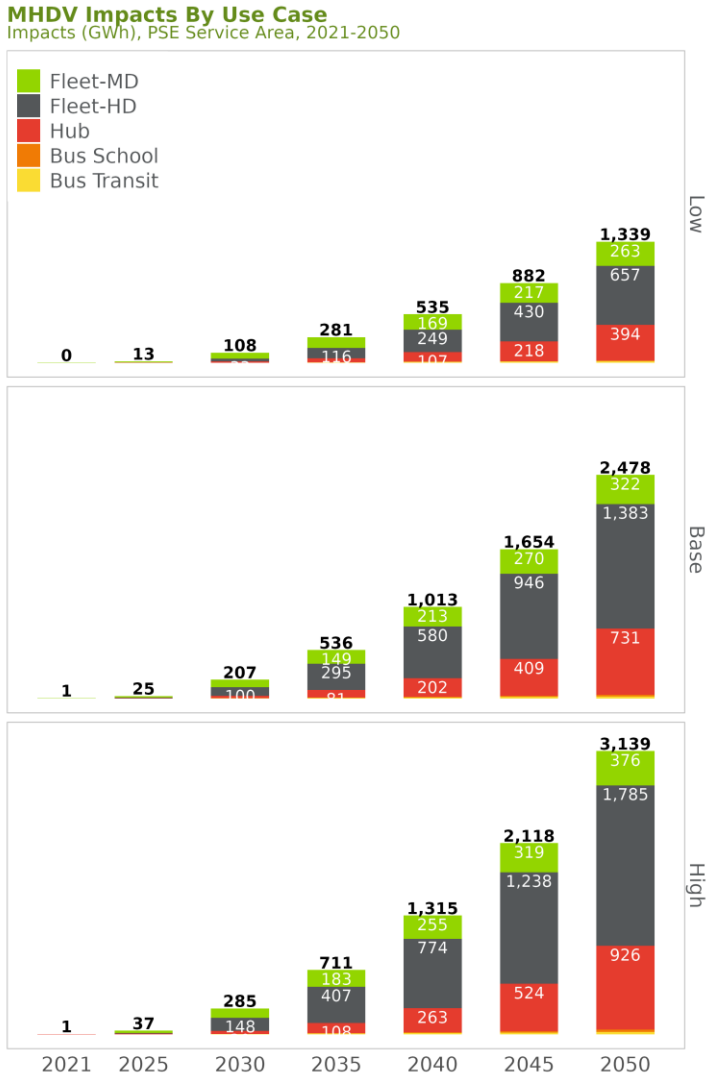
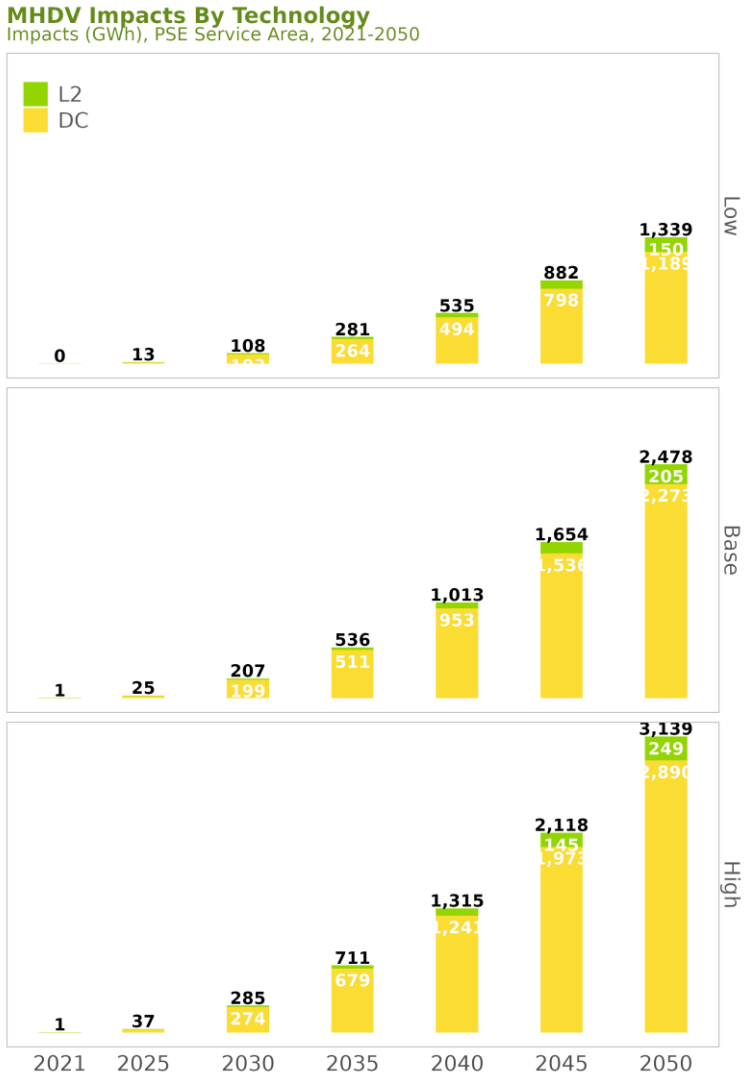


Strongest MHDV growth in HD fleets and hubs with most charging coming from DC stations.





Common Acronyms

Acronym	Meaning
AADT	Annual Average Daily Traffic
AFDC	Alternative Fuels Data Center
AARG	Average annual rate of growth
BEV	Battery Electric Vehicle
CAFE	Corporate Average Fuel Economy
CCA	Climate Commitment Act
CETA	Clean Energy Transformation Act
CFS	Clean Fuel Standard
DCFC	Direct Current Fast Charger
DERs	Distributed Energy Resources
DSR	Demand-Side Resources
DSP	Delivery System Planning
EVs	Electric Vehicles
EVSE	Electric Vehicle Supply Equipment
ICEV	Internal Combustion Engine Vehicle
IRP	Integrated Resource Plan
L1	Level 1 Charger
L2	Level 2 Charger
LDV	Light Duty Vehicle

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Common Acronyms

Acronym	Meaning
MHDV	Medium and Heavy-Duty Vehicle
NREL ATB	National Renewable Energy Laboratory Annual Technology Baseline
PHEV	Plug in Hybrid Electric Vehicle
TCO	Total Cost of Ownership
UPC	Use Per Customer
VAST™	Vehicle Analytics & Simulation Tool
VMT	Vehicle Miles Traveled
ZCTA	Zip Cost Tabulation Areas
ZCTAs	Generalized areal representations of United States Postal Service (USPS) ZIP Code service areas
ZEV	Zero-Emission Vehicle

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Terminology

- The terms “demand” and “load” are often used interchangeably, but in the IRP they actually refer to different concepts.
  - **Demand** refers to the amount of energy needed to meet the needs of customers, including energy to account for losses.
  - **Load** refers to demand plus the planning margin and operating reserves needed to ensure reliable and safe operation of the electric and gas systems.
  - The forecast results presented herein are demand forecasts and do not include planning margin and operating reserves.

- **Energy demand** refers to the total amount of electricity or natural gas needed to meet customer needs in a given year.

- **Peak demand** refers to the maximum energy needed to serve customer demand in a given hour (electric) or day (natural gas), typically occurring on the coldest hour/day of the year, since PSE is a winter-peaking utility.

- **Conservation** and **Demand-Side Resources (DSR)**. Used interchangeably in this presentation to represent optimal bundles of conservation programs, codes and standards, distribution efficiency, and demand response as developed by the Conservation Potential Assessment (CPA) and the Portfolio Model activities.

- **System-level** demand forecasts (both electric and gas) include residential, commercial, industrial, and interruptible customer classes; does not include transport or network loads.

- **Average annual rate of growth (aarg)** for the forecast period is provided in the results graphics.

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