Northwest **Power** and
Conservation Council

August 5, 2025

MEMORANDUM

TO: **Council Members**

FROM: **Kevin Smit, Manager of Power Planning Resources**

SUBJECT: **Emerging Technology in Ninth Plan Energy Efficiency Supply Curves**

BACKGROUND:

Presenters: Kevin Smit, Christian Douglass

Summary: Conservation, or energy efficiency, is defined as a resource and given priority by the Northwest Power Act when compared with generating resources. This presentation will cover the emerging energy efficiency technologies that will be considered in the Ninth Power Plan. In similar fashion to generating resources, staff have developed proxy energy efficiency emerging technologies. The measures include deep retrofits in commercial buildings, passive home construction, electric vehicle efficiency, next generation motor efficiency, distribution system improvements (loss reduction), and heat pump dryers for the commercial sector. These emerging technology measures will be included in the energy efficiency supply curves and are intended to fill gaps in the outer years of the plan forecast period. They will be treated consistent with the generating technologies in the scenario modeling, including sensitivities that will explore price and availability uncertainty of these proxy resources.

Relevance: Over the past year, the power division has been preparing for the Council's next power plan by conducting research, enhancing tools, and building spreadsheets that contain our energy efficiency measure definitions. The resource definitions are key parameters for conducting the optimization modeling for the Ninth Power Plan. A robust public process is an integral part of the supply curve development.

Workplan: B.4. Develop demand side supply curves and related assumptions for plan analysis.

More info: Staff held a Conservation Resources Advisory Committee meeting on June 25, 2025, and presented the draft EE ET proxies:

- Draft Emerging EE Techology Proxies

Staff also presented a Primer on EE for the Ninth Plan in July of 2024, and Parts 1, 2 and 3 of the proposed conservation resources in the first half of 2025:

- Supply Curve Primer for EE in the Ninth Plan (July 2024)
- Proposed Conservation Resources for the Ninth Plan (Part 1) (March 2025)
- Proposed Conservation Resources for the Ninth Plan (Part 2) (May 2025)
- Proposed Conservation Resources for the Ninth Plan (Part 3) – Draft Supply Curves (June 2025)

Energy Efficiency Emerging Technologies for the 9th Power Plan

August 2025 Council Meeting

Kevin Smit, Christian Douglass

Northwest Power and Conservation Council

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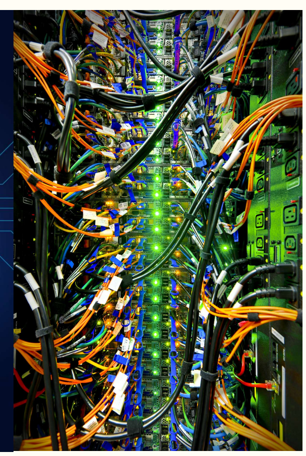
Agenda

- Background
- Emerging Technology (ET) Proxies
  - Passive House
  - Commercial Deep Retrofits
  - Commercial Heat Pump Dryers
  - Industrial Motors
  - Distribution Efficiency
  - Electric Vehicles



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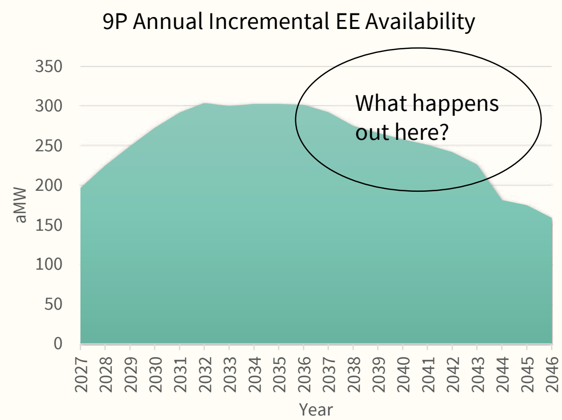
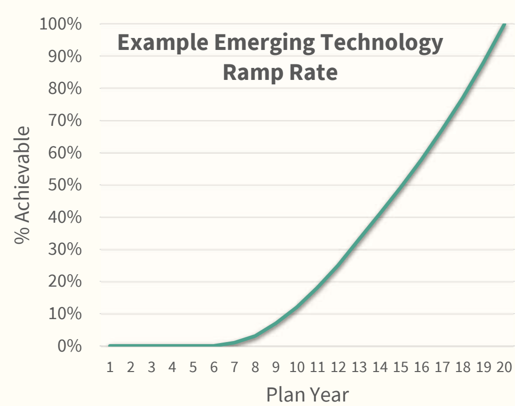
Background

- In most prior plans, the Council has considered emerging power generation technologies in the mix along with standard power plants, but have not done this in a similar fashion for energy efficiency (EE)
- We have historically included some emerging EE technologies, but they have always met the "reliable and available" standard for cost-effectiveness:
  - Able to quantify savings, cost, and lifetime
  - Commercially available by at least one manufacturer
- For the 9th Plan we are developing emerging technology EE measures that represent a significant advancement in each sector, end-use, or technology
- These proxies represent real and measurable savings but may not be common or reliable at this point
- The proxies represent chunks of conservation that may not be readily available now (or too costly), but could happen in the future (i.e., primarily during the last half of the planning period)



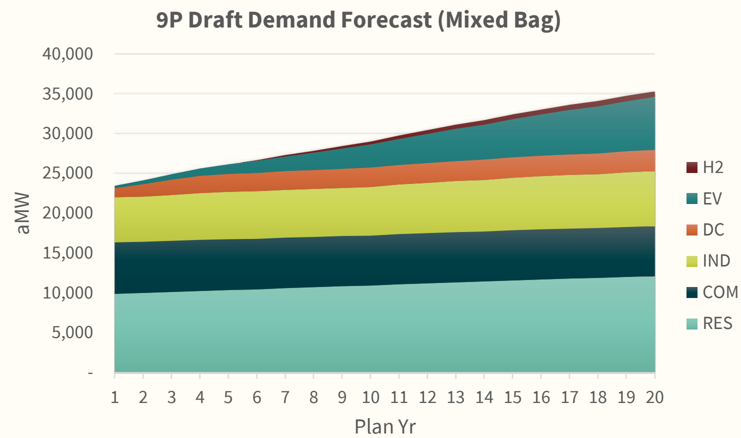
How will EE ET Proxies Be Used?

- The ET proxies will be built into our supply curves
- These measures will be clearly tagged as "ET" to allow for us to
  - Conduct scenario analysis consistent with the generating resources where we change cost assumptions and limit availability in certain sensitivities
  - Be mindful when developing the power plan recommendations to ensure we are prioritizing cost-effective resources over any recommendations on these ET options



Context: Load Forecast and EE

- Our EE potential estimates are always tied to the demand forecast
- Typically, the relative shares of potential by sector are proportional to the demand by sector
- The residential sector has the largest demand in 2027, followed by commercial and industrial:
  - Residential = 10,000 aMW
  - Commercial = 6,500 aMW
  - Industrial (including Ag) = 5,700 aMW



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Residential Sector

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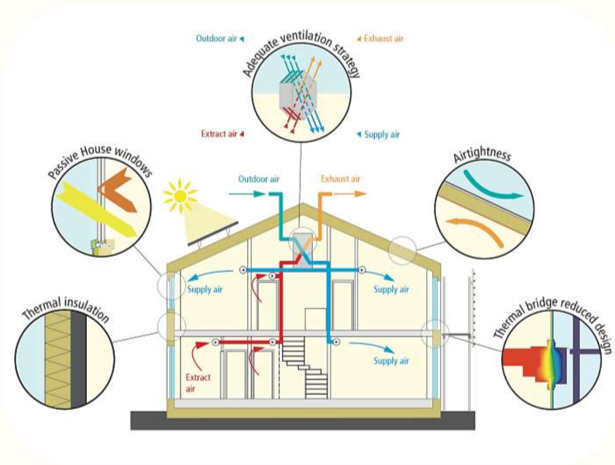
Residential Sector Emerging Tech Proxy Resource: Passive House Construction

- Passive House (or "Passivhaus") is a voluntary energy efficiency standard that originated in Sweden and Germany
- The standard is based on super-insulated, high-performance envelopes, and requires both minimal HVAC and total home energy usage
- Passive House is a convenient basis for a proxy resource:
  - well-established standard
  - deep energy savings potential
  - readily available real world project data (including projects in the US and Northwest)



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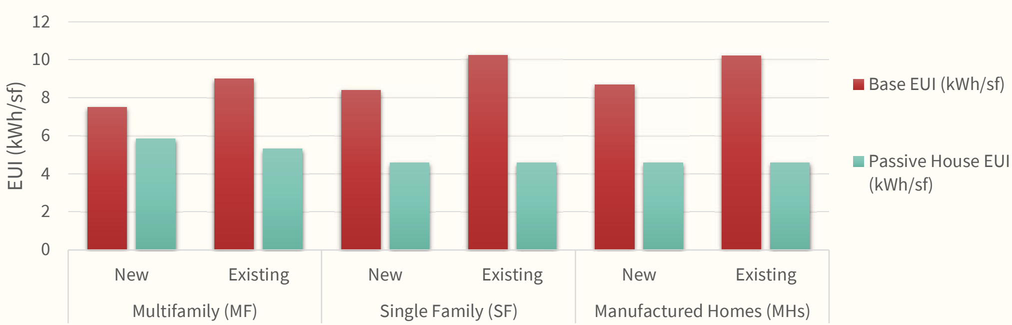
Estimated Energy Usage Intensity (EUI) Reductions of Passive House Construction

Passive Houses can use 75-90% less HVAC energy[1] and 20-50% less total energy[2] compared to conventional construction practices



[1] https://passivehouse.com/02_informations/01_whatisapassivehouse/01_whatisapassivehouse.htm

[2] Based on Council staff analysis using EUI estimates from NEEA building stock assessments, Seattle building benchmarking data, and the Passive House Institute US database

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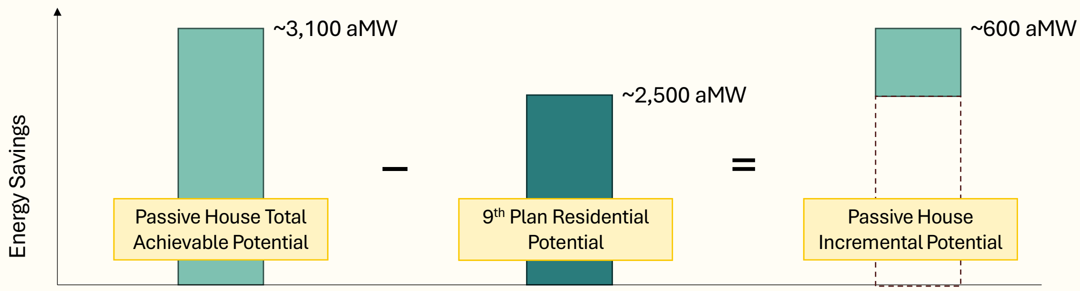
Estimating Incremental Potential of Passive House Standard



1. Estimate total achievable potential of converting all NW homes to Passive House using top-down approach

2. Subtract the total 9th Plan conservation supply curve potential, derived from bottom-up approach

3. The remainder is the incremental potential of converting NW homes to Passive House

Estimated Costs of Passive House Construction

Building Type	Vintage	Estimated Cost Adder Relative to Standard Practice, %	Estimated Cost Adder Relative to Standard Practice, $ per SF	Estimated Levelized Cost ($ per MWh)
Multifamily	New	3.5%	$7	$174
	Existing	25.0%	$38	$433
Single Family	New	10.0%	$20	$219
	Existing	40.0%	$60	$451
Manufactured Homes	New	10.0%	$15	$150
	Existing	40.0%	$40	$299

Notes: Costs based on estimates from Passive House case studies (on new multifamily buildings, in particular), regional builders, and professional judgment of the Council's Conservation Resources Advisory Committee and central staff

Commercial Sector

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Commercial Deep Retrofits – Background

- The commercial building sector has an electricity demand of 6,000 aMW in 2025 and is expected to grow to 10,000 by 2046
- The bottom-up EE potential we are showing thus far is about 1480 aMW, or about 15% of the 2046 load
- CRAC members and others have suggested there could be more potential in the commercial sector than we get with the bottom-up approach (measure by measure)
- The RTF has developed a white paper and presentation – "Commercial Deep-Savings Baseline Framework"
  - https://nwcouncil.box.com/v/20230321CommWBUpdate
  - https://nwcouncil.box.com/s/vh1w1q7gcd3coypwjsdcl80srdav2izm
- Council staff worked with Energy350 to develop an EUI data set for the PNW base largely on Building Performance Standards data
  - https://nwcouncil.box.com/s/ktv2rtar381ix4z7zmw6qj8w5s7s4rfn

What is EUI?

EUI = Energy Use Intensity, typically in kBtu/sf, or kWh/sf

For a commercial building, take the total annual energy consumption (kBtu or kWh) and divide by the total floor area (sf)

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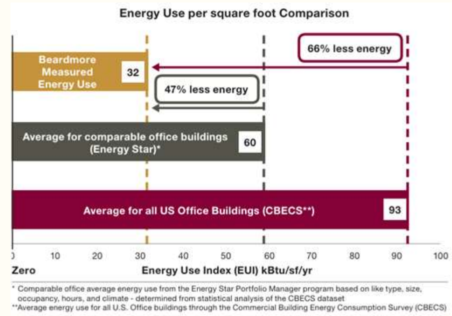
Whole Building Electric EUI

- Building Performance Standards in Washington and Oregon have been established to encourage commercial building owners to reduce their consumption over time
- These BPSs us an energy use intensity (EUI) approach for comparing an existing building with the average, and set EUI goals for all buildings by segment
  - Most data and BPS programs use total energy intensity (kBtu/sf)
  - For the plan, we focus on the electricity intensity (kWh/sf)
- The Energy350 tool enables us to look at our current regional EUI level and compare that to various lower levels of EUI
- We considered two options for estimating potential:
  - Current average EUI ➔ 25th percentile (lower quartile)
  - Current average EUI ➔ 50% improvement

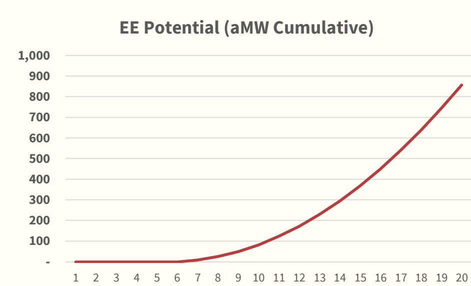
EXAMPLE:



- Beardmore Building
  - Priest River, ID
  - Office/mixed use
  - 28,800 SF
  - Completed in 2009
- Renovations:
  - High efficiency rooftop HP
  - Economizers
  - DCV with CO2 sensors
  - Modulating outside air dampers
  - Triple pane windows
  - Added insulation; R50 in roof
  - Daylighting
  - Commissioning
  - Monitoring
  - Solar-ready

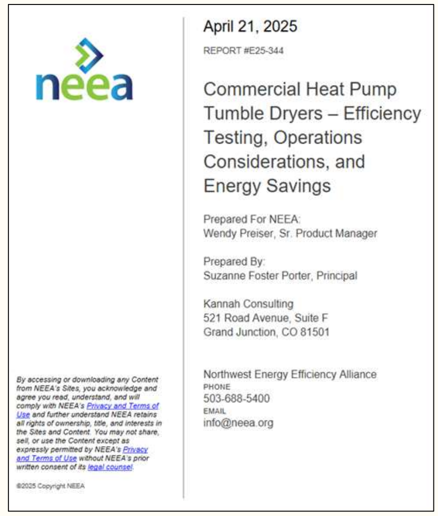
Commercial Deep Retrofit Potential

- Current ➔ 25th Percentile = 2,311 aMW
- Current ➔ 50% Improvement = 2,371 aMW
- Current ➔ Lowest Level = 3,805 aMW
- However, need to net out our current bottom-up potential of around 1500 aMW
- **Resulting potential is 857 aMW**
- Cost is based on the high end of VHE-DOAS retrofit costs (ranged from $10/sf to over $27/sf) – Selected $27/sf.
- The resulting levelized cost is $344/MWh



Commercial Heat Pump Dryers

- NEEA report on Commercial Heat Pump Tumble Dryers (CTDs)
  - CTDs are beginning to be imported from Europe
  - NEEA developed a research project to test one of the products (12.7 cubic feet drum size)
  - The HP CTD can save up to 60% of site energy with an increase of 15-25 minutes of drying time
  - Works well on towels, but not as well on bedding
  - Developed a hotel laundry model for a 100-room hotel
- Overall, a very promising technology but not yet commercially available in the US


neea

April 21, 2025

REPORT #E25-344

Commercial Heat Pump Tumble Dryers – Efficiency Testing, Operations Considerations, and Energy Savings

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Commercial HP Dryer Assumptions

- Calculated savings on a per room basis:
  - **487 kWh per year per room savings**
- Incremental cost:
  - Heat Pump Dryer - $25,000
  - Baseline Electric Dryer – $12,000
  - $13,000 incremental cost per unit
  - **$260 incremental cost per room**
- Measure life: 12 years

Baseline Consumption	0.347	kWh/lb - Electric Resistance Dryer
HP Dryer Consumption	0.125	kWh/lb - Heat pump dryer
Savings	0.22	kWh/lb savings
Savings Per Room Per day	1.31	kWh/day/ room savings
Savings Per Year	478.6	kWh per year per room

Potential Estimate:
- 180 million sf of lodging in the region
- 25% of this has electric dryers (per CBSA2019)
- Total potential is 4 aMW
- Levelized cost: $52.21/MWh

Industrial Sector

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Industrial Motors ET

- What is next for motor efficiency?
- Research is ongoing into numerous concepts for improving the efficiency of motors
- The industrial sector electricity demand in the Northwest is about 70% from motors and motor systems (pumps, fans, compressors, conveyors, etc.)
- If there is a breakthrough in motor efficiency it could have a significant impact on both commercial and industrial demand

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Motor Research

- Superconducting motors – use superconducting wires which enable larger currents with minimal resistance
- Soft Magnetic Composite (SMC) motors – SMC materials allow for 3D magnetic flux distribution resulting in more compact designs and improved performance
- Nanomaterials in Motor Construction – Graphene and carbon nanotubes are being explored for their potential to enhance thermal management and electrical conductivity
- Magnet-Free motors, Trapezoidal Radial Flux motors, Hyper-Efficiency motors, Advance cooling options

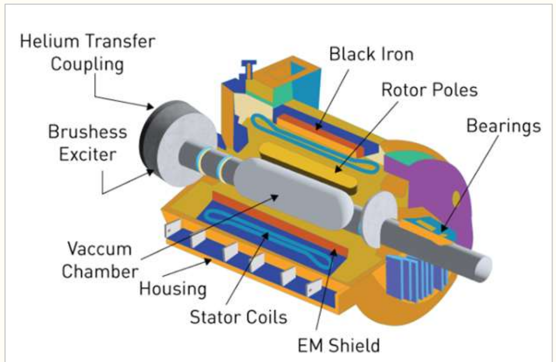

Figure 3: Example Construction of a Superconducting Motor

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Motor ET Assumptions and Potential

- Assume a 10 percent improvement (10% reduction of motor end-use consumption)
  - By each industrial segment
- Cost – assume 5x more expensive than current motors (comparison of copper wire cost to superconducting wire cost)
- Life – 21 years
- Total EE Max potential is about 300 aMW, but when turnover rates apply, this is reduced to about 150 aMW.
- Levelized cost is ~$344/MWh

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Distribution System

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Distribution Efficiency – Beyond CVR

- Our main supply curves include voltage control (CVR)
- However, there are a variety of other areas where distribution system losses can be reduced (and therefore, and efficiency gain). These include:
  - Transformer right sizing
  - Phase balancing
  - Adding capacitors
  - Adding regulators
  - Feeder balancing
  - Reconductoring (this is included elsewhere in the plan)
- We lack specific savings and cost data for any one of these

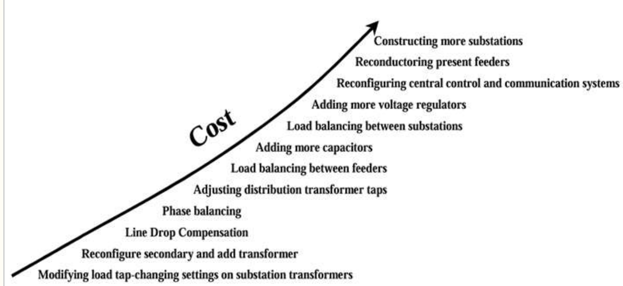

Figure 3-5
Methods of Systematic Voltage Reduction, Ordered by Cost

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Distribution Efficiency ET

- We have limited data:
  - NEEA Distribution Efficiency Initiative: https://neea.org/wp-content/uploads/2025/03/distribution-efficiency-initiative-e05-139.pdf
  - Recent effort by City of Burbank found 0.5% savings from transformer right sizing (Jim Lazar)
- For this ET we are assuming a 1.0% savings (reduction in losses) can be achieved through a combination of measures listed on previous slide
- Assume three levels of cost:
  - Low Cost - $1.00/kWh (first year); 25% savings (0.25% of load)
  - Medium Cost - $1.50/kWh (first year); 35% of the savings (0.35% of load)
  - High Cost - $2.00/kWh (first year); 40% of the savings (0.40% of load)

Potential Results:

- Regional load forecast for 2046 = 35,000 aMW
- One percent of load = 350 aMW
  - 0.25% - 87.5 aMW
  - 0.35% - 122.5 aMW
  - 0.40% - 140 aMW
- Levelized costs
  - $65/MWh
  - $96/MWh
  - $129/MWh

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Electric Vehicles

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Electric Vehicle Efficiency

- The RTF commissioned a market study for EV efficiency
- The study concluded that there are numerous technologies, features, driving conditions, etc., that could result in a more efficient EV
- However, it is currently difficult to identify baselines and corresponding efficient cases for EVs
  - Primarily due to lack of useable EE data
  - Due also to significantly varying vehicle class definitions, trims, etc.
- We believe with more vehicles coming into the market and more data availability going forward, that there will be a way to define some specific efficiency measures for EVs

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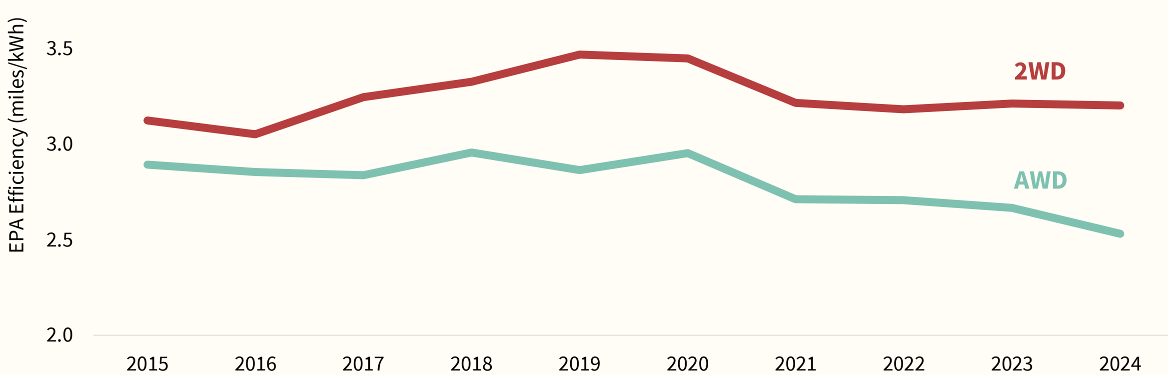
Example: Would be great if the EE community could use EPA Efficiency Ratings

EPA Class isn't perfect: ALL EPA vehicle classes should Have an EV drive type. Drive type (single vs dual motor) impacts EV efficiency – same EV model efficiency can vary 10-25%. Currently only trucks and SUVs receive drive type designation. Also, real-word usage differs from EPA-rated efficiency values.



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EV EE ET Proxy

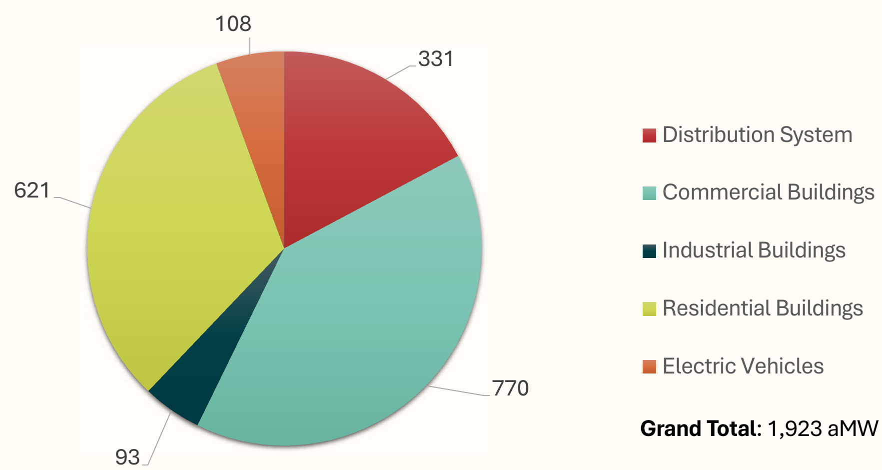
- We don't have data or information for how much specific technologies/components can save if implemented
- Therefore, we chose to make broad assumptions based on the load forecast (for savings) and the price of a vehicle (for EE cost)
- Ten percent of EV load
- Two cost levels:
  - Fifteen percent of a $40,000 vehicle - $6,000
  - Fifteen percent of a $70,000 vehicle - $10,500
- Life: 10 years

Potential Estimate:

- EV load in 2046 (per load forecast) = 6621 aMW
- EE Potential estimate 662 aMW (331 aMW for each measure)
- Two Cost Tiers:
  - $1.20/kWh (first-year savings)
  - $2.10/kWh (first-year savings)
- Levelized cost
  - Low-cost measure - $129/MWh
  - High-cost measure – 227/MWh

Combined ET Potential: Summary Charts

Total Emerging Tech Potential, By Sector (aMW)



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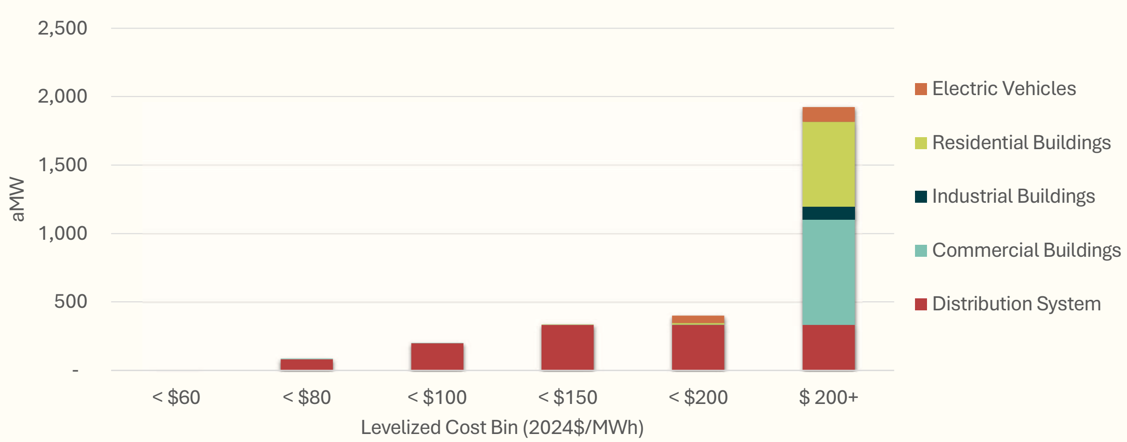
Supply Curve, 20-yr Potential, Emerging Tech Only, by Sector



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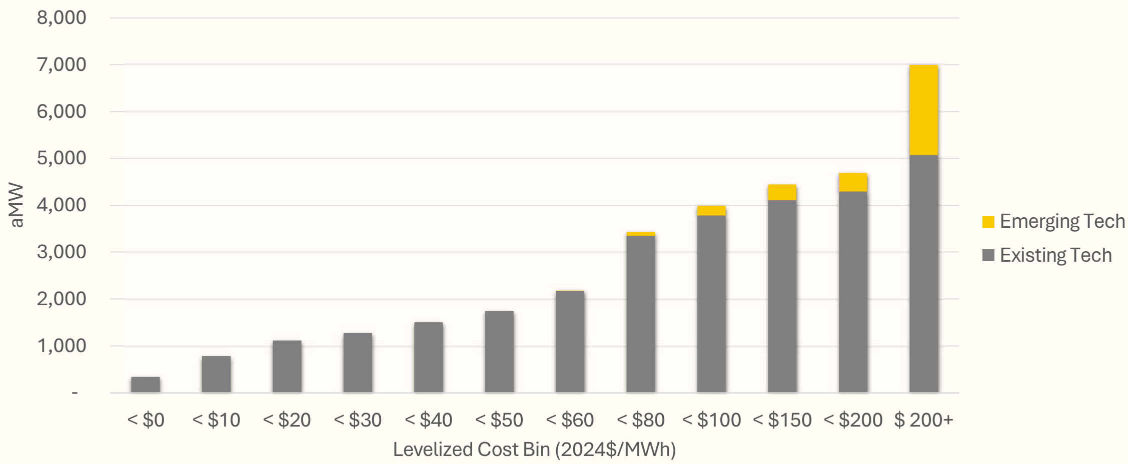
Supply Curve, 20-yr Potential, Existing vs. Emerging Tech



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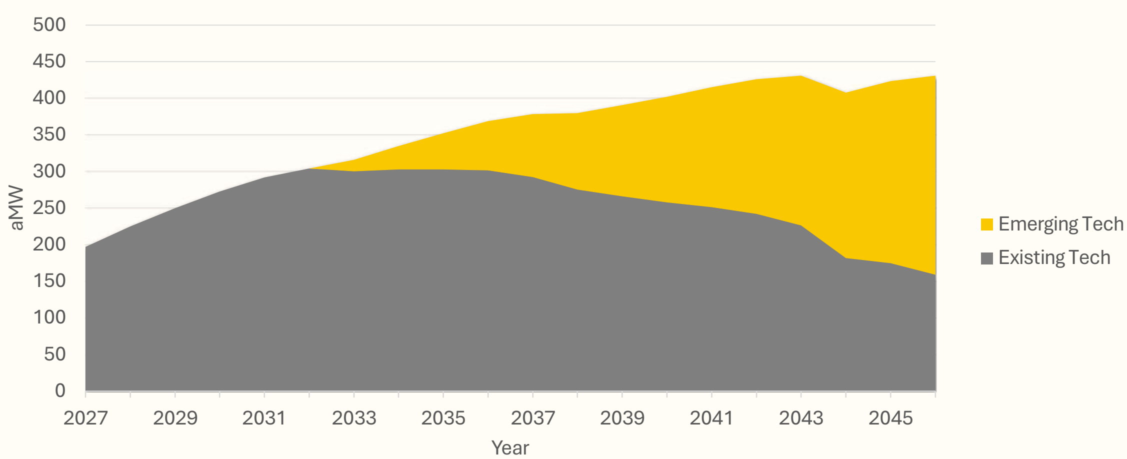
20-yr Incremental Potential Over Time: Existing vs. Emerging Tech



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Final Draft 9th Plan EE Supply Curves

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Updates and Changes Since "Draft" Supply Curves Presented in June 2025

- Finished the review of nearly 500 individual comments received from supply curve reviewers (primarily BPA, BPA contractors, NEEA, and Energy Trust of Oregon)
- Made hundreds of edits and changes based on reviewer comments
  - Many edits do not change numerical results, but are rather reviewer requests for additional details on data sourcing and/or methodology
  - Some individual measures changed significantly (+/- 50%), however, overall supply curve potential changed very little (~1%)
- Some noteworthy changes since June
  - Removed data center loads from industrial loads driving industrial supply curve potential
  - Updated to latest 2023 EIA sales data (from 2022) to allocate energy savings to modeling zones
  - Commercial HRV measure revised assumptions (reduced potential)
  - Changed peak hour definition from historical to future (consistent with gen res)
  - Added more residential multifamily measures/applications

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Final Draft Supply Curves (20-Yr Potential)