HOW UTILITY-OWNED VPPS CAN REDUCE EVERYONE'S COSTS

LEVERAGING EMERGING TECHNOLOGIES TO UNLOCK REAL SAVINGS

PREPARED BY

Tom Chapman

PREPARED FOR

Smart Grid Canada

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Brattle

Disclaimer and Acknowledgements

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Economic Opportunity

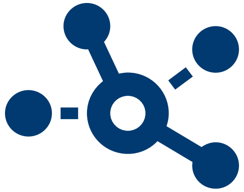
$$$

Assessment of EV based VPP potential

VPP Use Cases

Recent Use Cases developed by Brattle

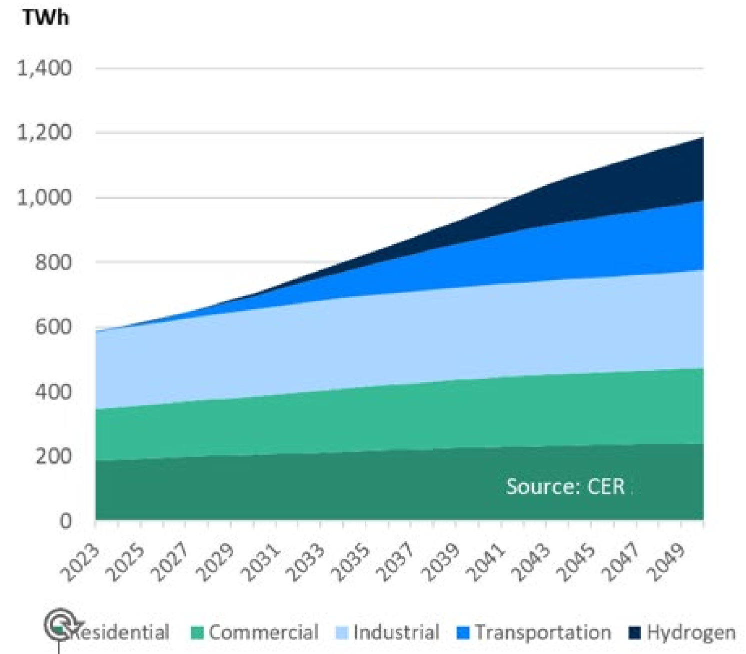
Unlocking Benefits

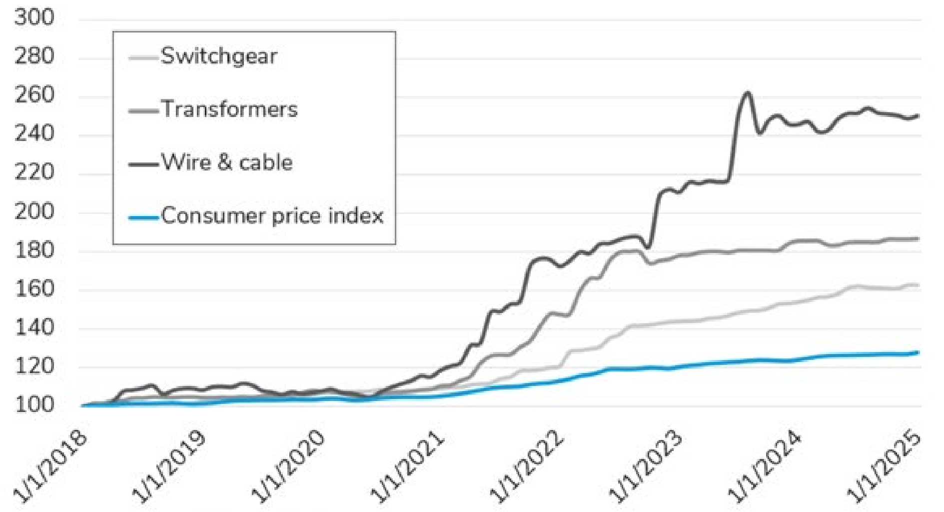


Key findings and observations

Economic Opportunity

Electricity is a growth industry……but surging input costs highlight affordability concerns and need to leverage all available assets





Source: Andy Lubershane, Steel for Fuel, 2025. Data from St. Louis Federal Reserve FRED databased, Producer Price Indices Accessed April 29, 2025.

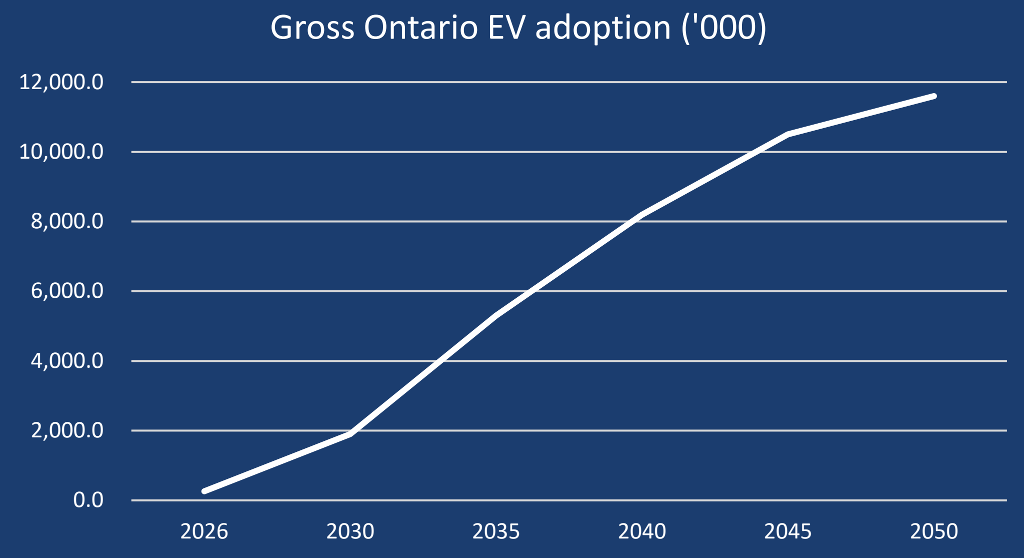
Could EVs be part of the solution, to what extent and how?

Case Study: Estimating EV Capacity Potential in Ontario

Gross GW based on policy goals

5.2GW in 2026
232 GW in 2050

Based on Level 2 limits (19.2kW)



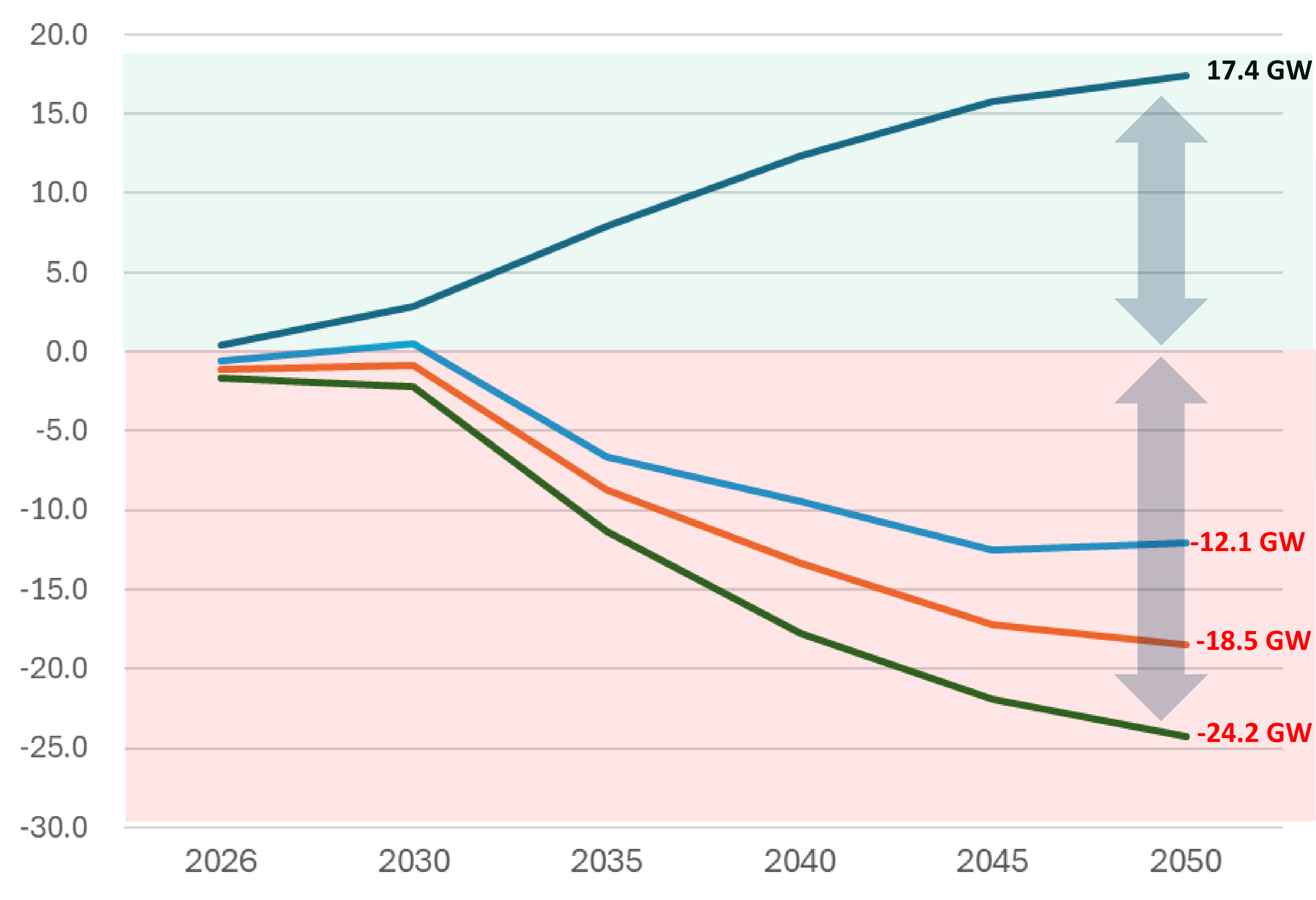
Adjusted GW assuming slower adoption (50%)

Cautious participation (30%)

Battery constraints (50%)

How could utilizing just 7.5% of installed EV charging capacity benefit Ontario's grid?

Comparing EV Capacity Potential to IESO Projected Shortfalls



EV Charging Capacity Potential

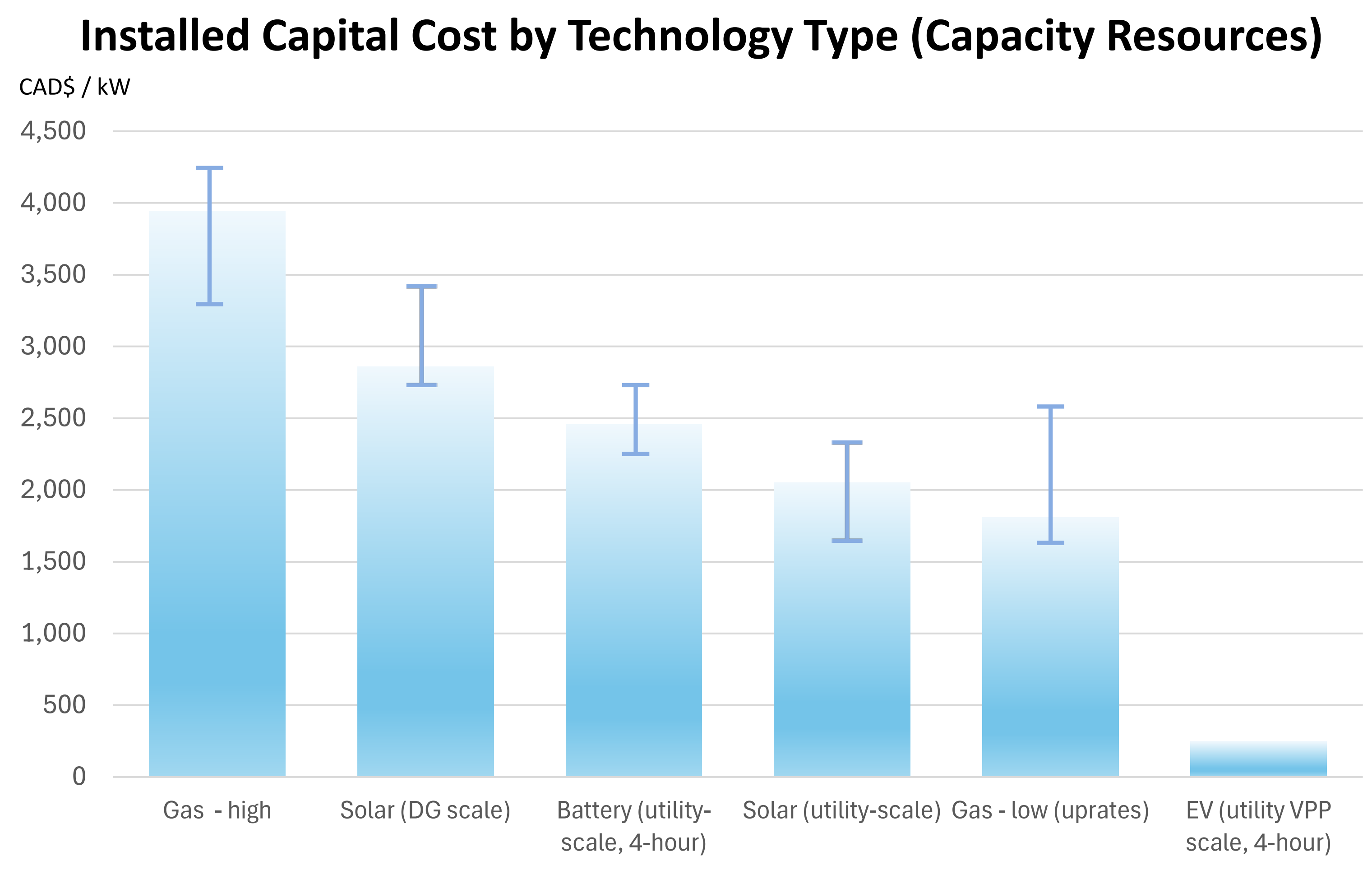
The looming capacity supply shortfall is significant and will require many resource additions - but the energy potential from an expanding EV fleet is also significant…

IESO 2026 Low -demand scenario

IESO 2026 Reference Scenario

IESO 2026 High-demand scenario

Economic Opportunity (Ontario)



EV are being bought and deployed as transportation vehicles and do not incur the same upfront capital investment compared to traditional source of power

If an EV VPP was able to displace some conventional capacity resource the savings could be considerable

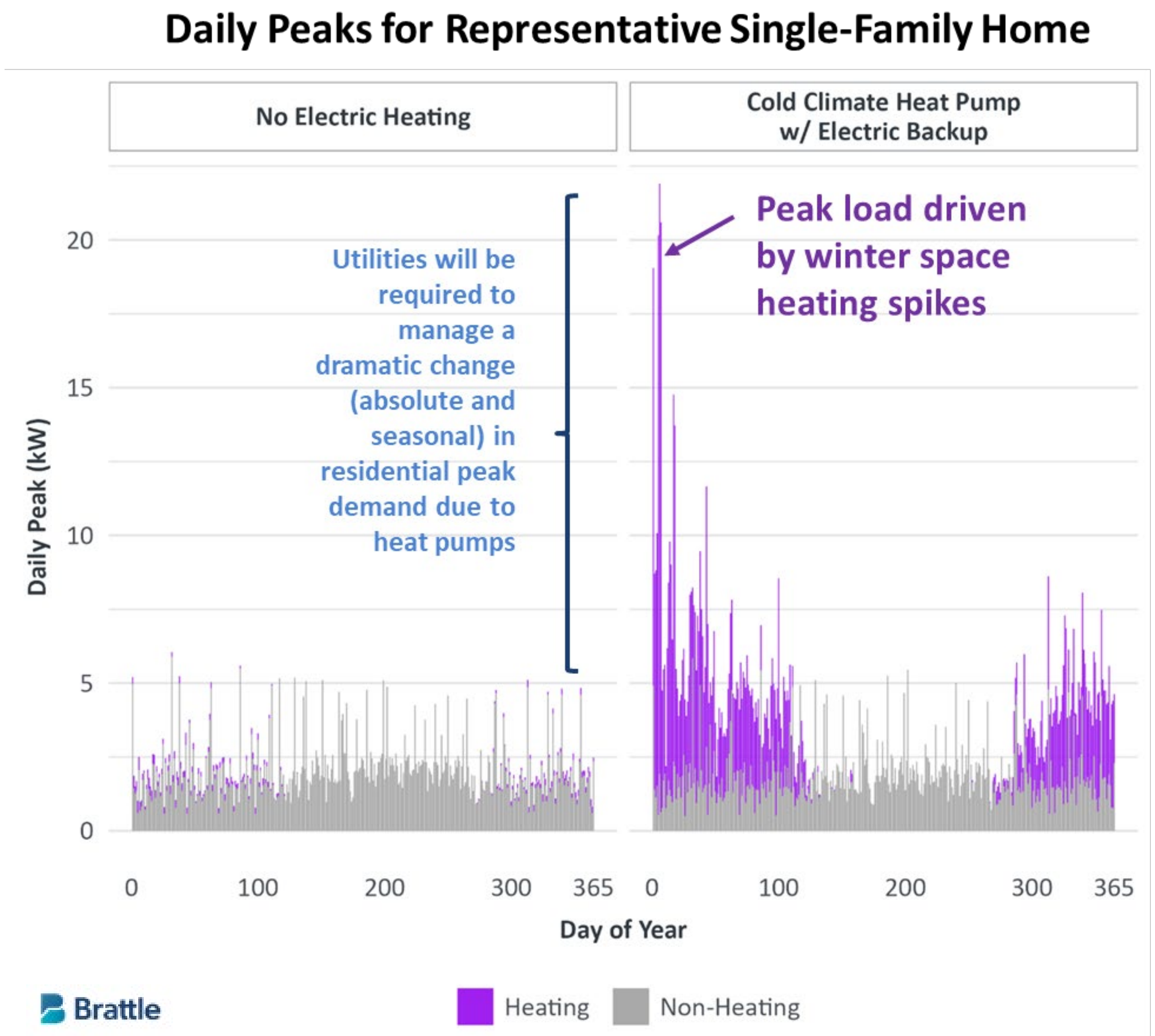
1 GW	**$2.4 billion**
17 GW	**$40 billion**

Notes: IESO APO cost assumptions and Brattle estimates. Costs do not include baseload resources or ongoing O&M and sustaining Capex

Use Cases

- Wholesale grid service
- Network benefits
- Resiliency / emergency (not today!)

Use Case 1: Addressing Heat Pump Driven System Peaks



Ontario VPP Assessed

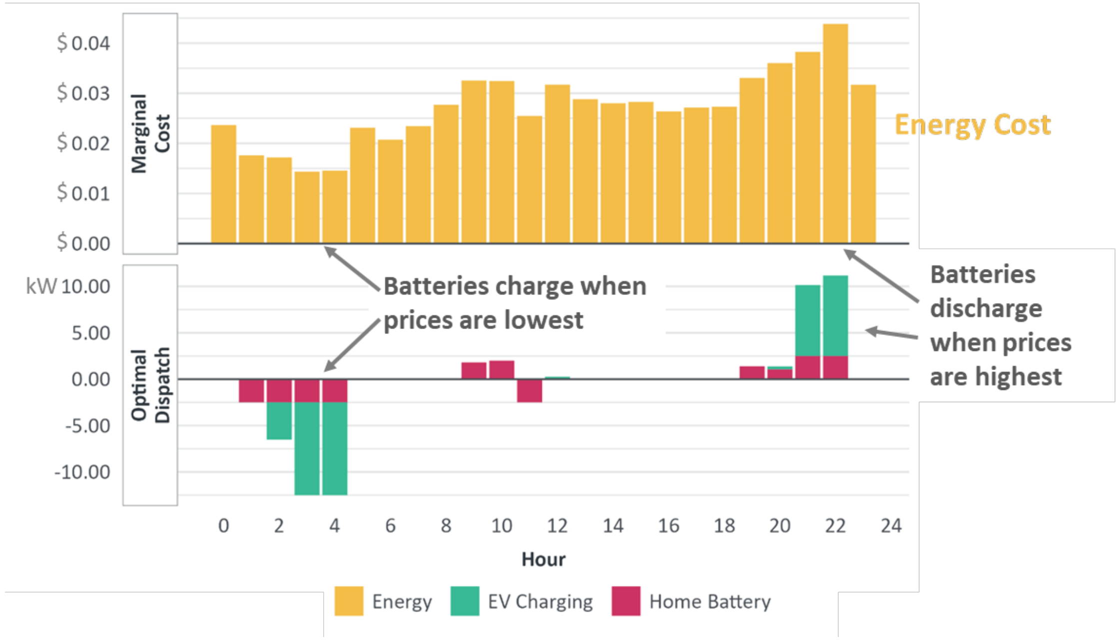
Electric Vehicle (EV) with 60 kWh battery, 10 kW (Level 2) bidirectional charging

10 kWh 4-hour home battery
Cold climate heat pump w/ electric resistance backup for space heating

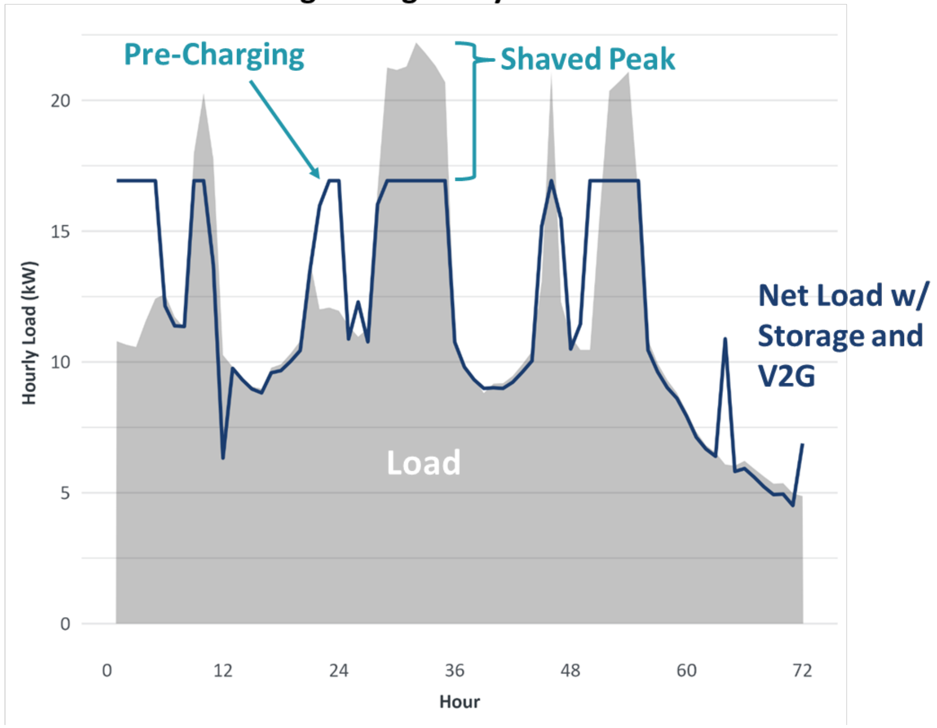
We assume the Local Distribution Company installs, owns and operates the VPP

How Can a VPP Deliver Savings?

System Marginal Cost, System-Optimal Battery Dispatch, and Battery Dispatch in Response to RPP Prices (July 11, 2023)



Peak Shaving During 3-Day Winter Period



VPP earns revenue and ………..

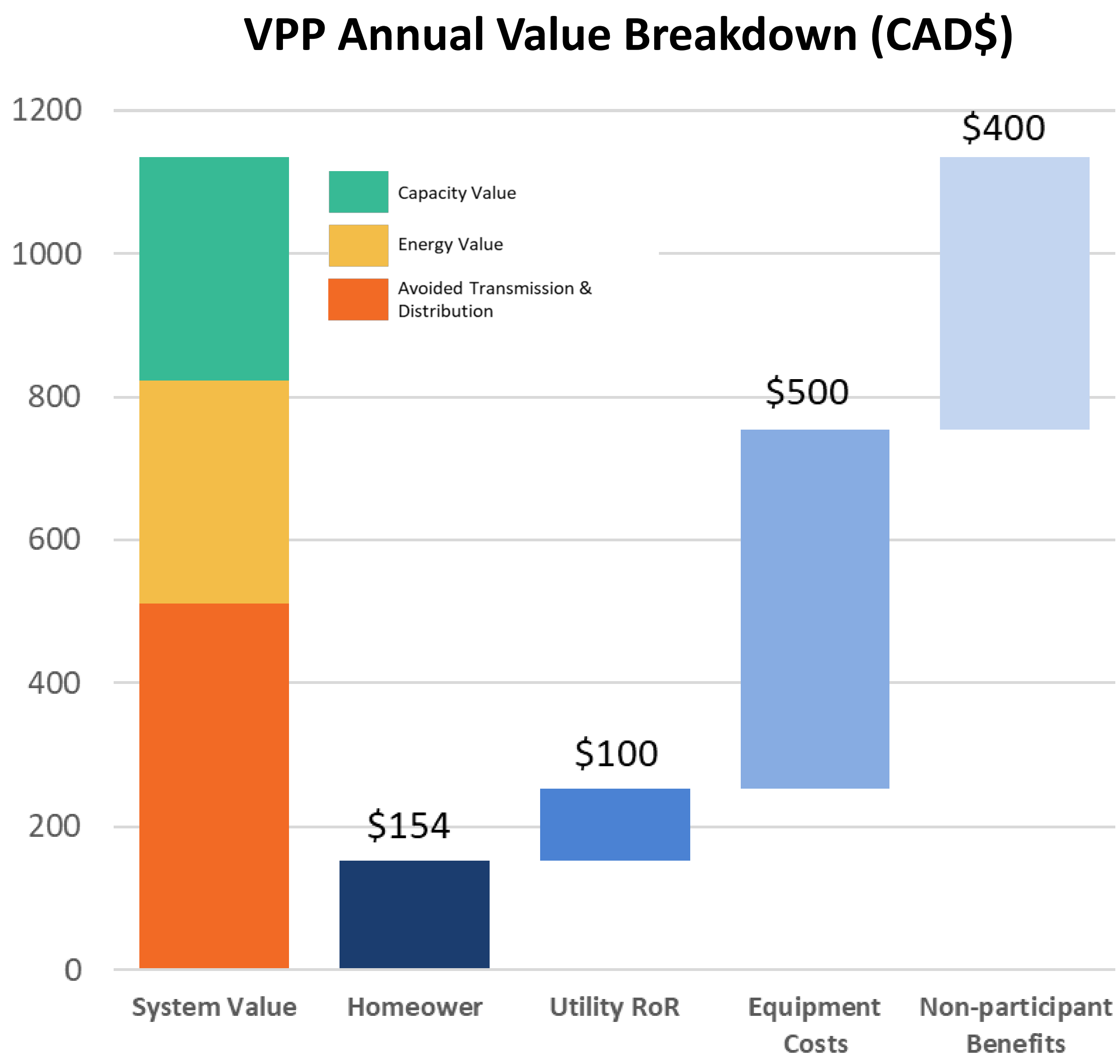
- Energy arbitrage from wholesale market
- Capacity revenue from Ontario's Capacity Auction

VPP avoids costs

- Supply loads behind-the-meter reducing bills
- Shaving the peak winter load served by the utility avoiding future costs

Breakdown of Savings and Benefits

- **Homeowners** - reduced electricity bill (assume Time of Use rates)
- **All other consumers** benefit from reduced system costs
- **Utilities** can earn **at least** what they would have earned on conventional T&D investments - to fairly compensate them for the additional risk
- **Equipment costs** include a utility installed stand-alone battery and smart EV charger



Key Findings

System wide savings

up to $1,150 annually

Smart charging flattens homeowners load profile reducing system wide costs

Reduces distribution system peaks by

25%

Managed charging can provides significant benefits to utilities and their customers

Meaningful grid wide economic benefits

$115 million

100,000 EV as part of a managed EV network VPP could unlock sizeable benefits.

Utility financial incentive is critical

>ROI

Utilities should be compensated for the additional risk and uncertainly from adopting and operationalizing EV based VPPs

Widespread deployment increases benefits

up to $500 million annually

Benefits are scalable as EV adoption accelerate

Does not compromise EV driver needs

100%

of EVs that plugged in with sufficient time to charge reached their desired target state of charge by the end of the optimization window.

Use Case 2: EV Managed Charging Strategies

Brattle team evaluated two active managed charging strategies for reducing electric system costs of EVs and compares them against two baseline strategies commonly used today.

BASELINE CHARGING STRATEGIES

- **Unmanaged Charging**
- **Passive TOU Rate**

ACTIVE MANAGED CHARGING STRATEGIES

- **TOU + Load Limit**
- **Wholesale + Load Limit**

New Report Shows Active Managed EV Charging Can Double the Distribution Grid's EV Hosting Capacity - Brattle

Value stacking: Optimizes and stacks multiple value streams, including distribution protection, wholesale and transmission cost reduction, rate-based bill savings, and incentive/dispatch participation.

Multi-level distribution optimization: Maps each vehicle to substation, feeder, feeder section, and transformer assets, and enforces charging limits across all levels.

How it works: Runs a charging schedule optimization that recalculates in real time for plug-ins, early departures, and overrides to meet state of charge targets while managing for grid constraints and minimizing wholesale or TOU rate costs.

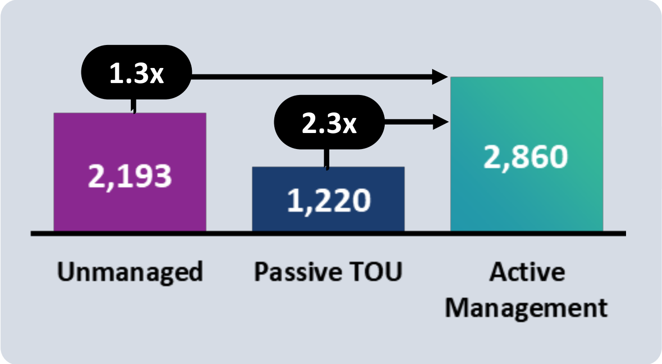
OEM integrations: Built on API-based integrations with EV manufacturers.

Distribution System EV Hosting Capacity Benefits

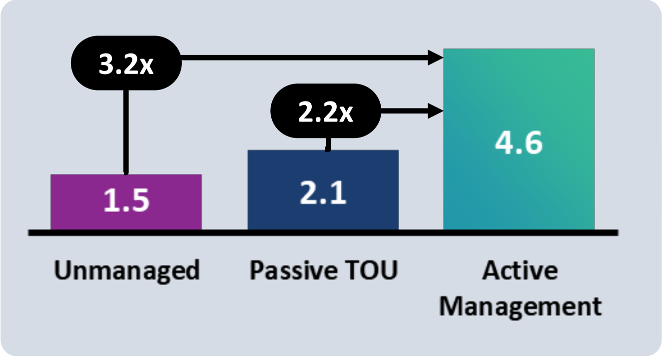
EV HOSTING CAPACITY
Number of EVs

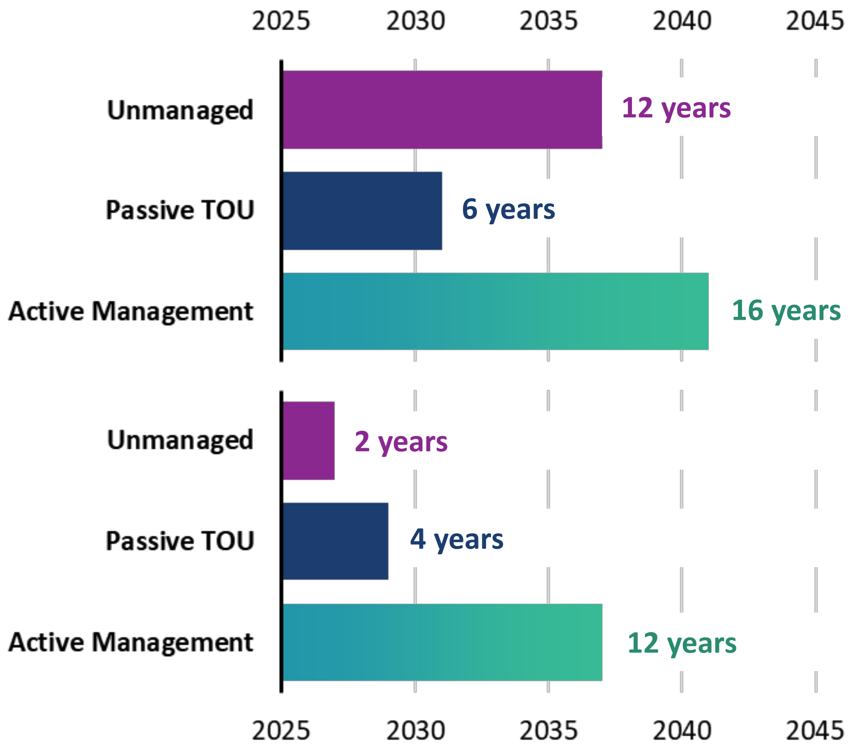
YEARS TILL GRID UPGRADE
In a scenario where 25% of annual vehicle sales are EVs

Primary Distribution System
5,000 customers served by a 13 MVA feeder loaded to 75% of capacity without EVs



Secondary Distribution System
11 customers served by a 37.5 kVA transformer loaded to 75% of capacity without EVs

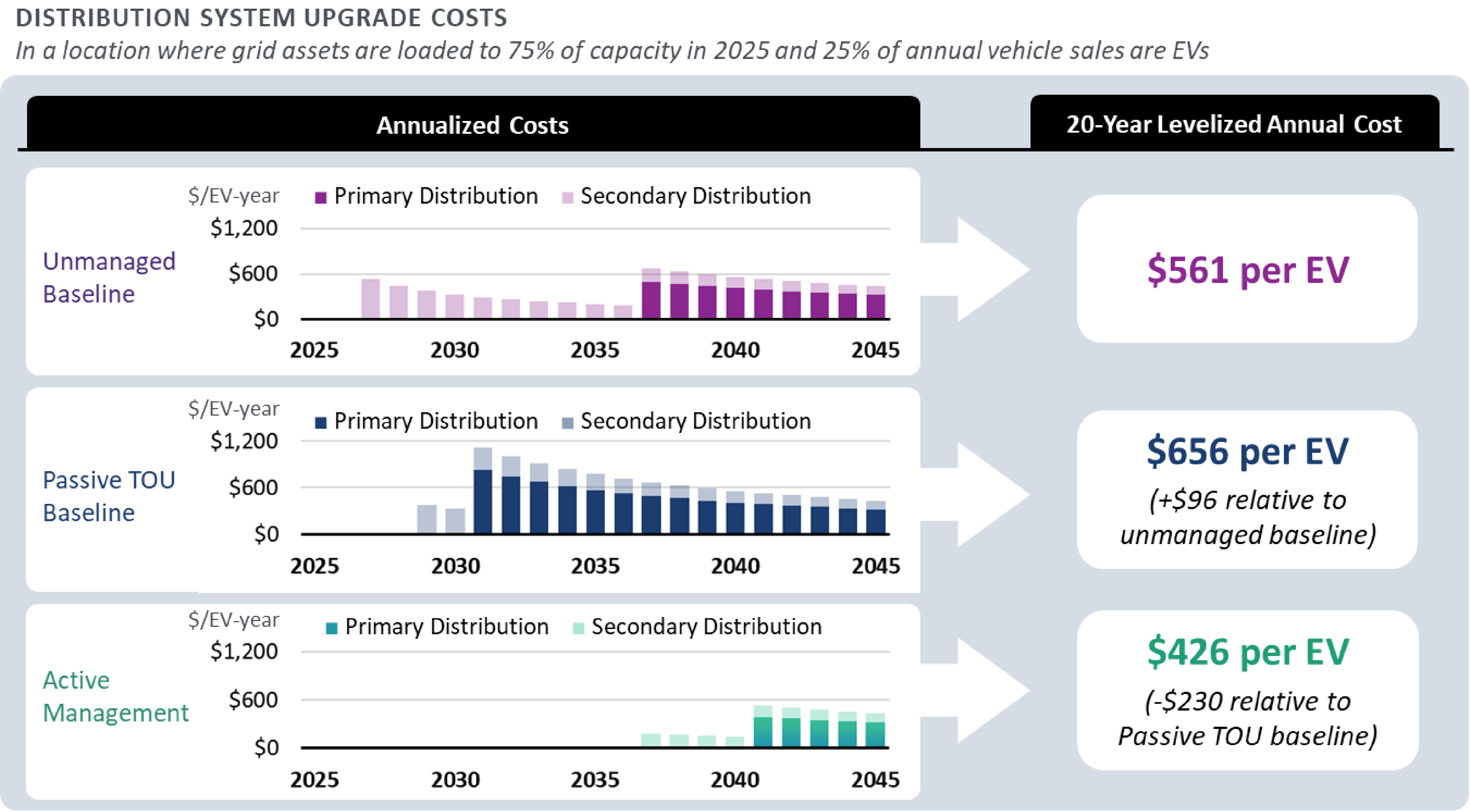




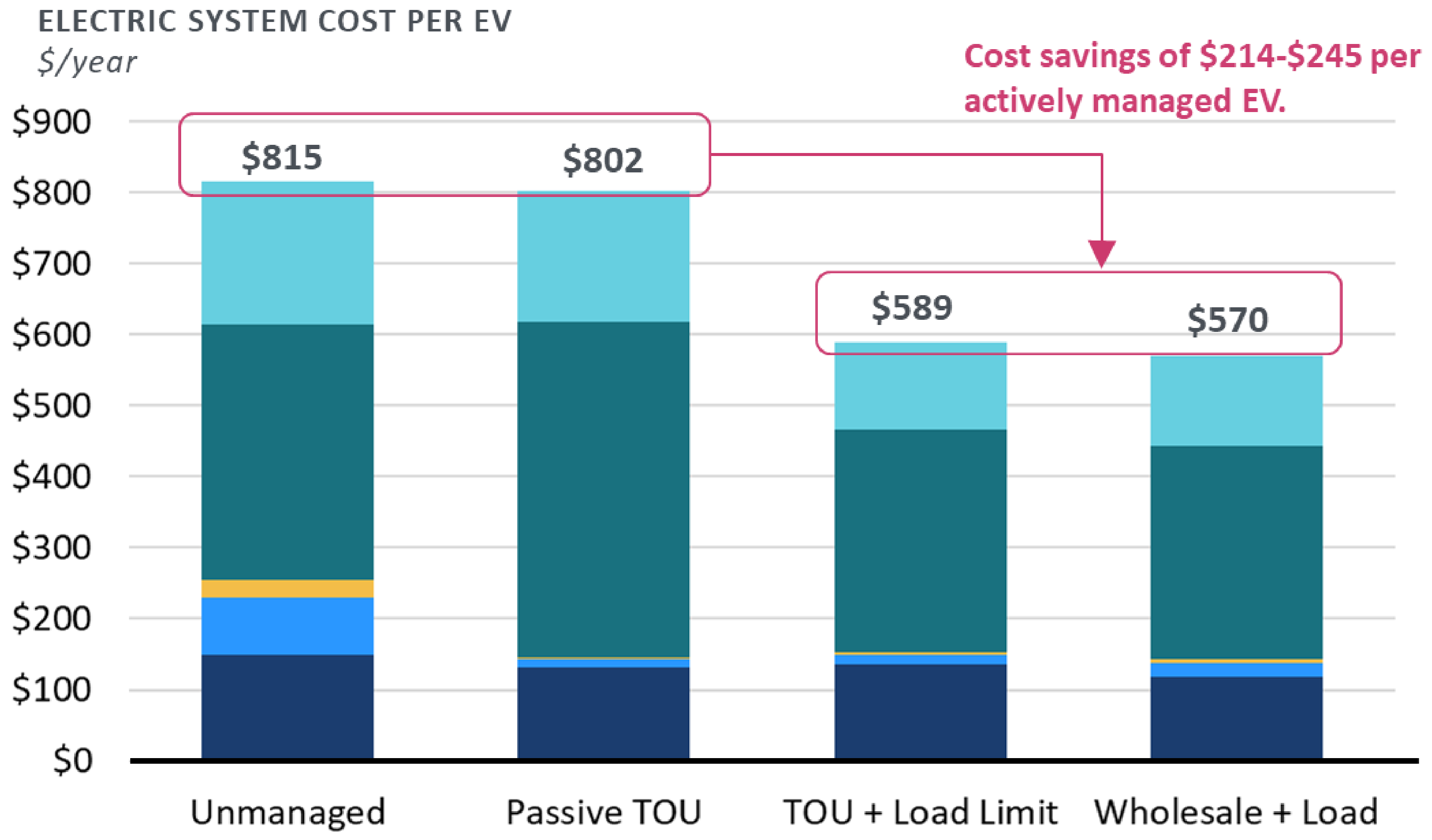
Value of Deferring Distribution System Capex

Benefits

1. **Delaying rate impacts**
2. **Reducing rate impacts**
3. **Providing utilities more flexibility**



Illustrative Value Stack in a Relatively High-Cost Location



Note: This modeled case does not correspond to a specific region. It is based on a hypothetical distribution network scenario and bulk system costs from CA and NY.

Key Findings

Reduces EV charging peaks by

up to 55%

Active management smooths EV load at the service transformer and feeder levels, reducing distribution grid congestion.

Reduces distribution grid costs by roughly

$200/year per EV

Managed charging provides significant benefits to utility ratepayers.

Increases the distribution grid's EV hosting capacity by

up to 3.2x

Optimizing charging allows service transformers to support roughly 3.2 times more EVs before requiring upgrades.

Provides reliable performance with only

2.3 session opt-outs per month

Drivers overrode control signals 2.3 sessions per month, on average.

Could defer distribution grid upgrades by

up to 10 years

Utilities can substantially delay costly investments while maintaining service quality in EV adoption hotspots.

Does not compromise EV driver needs

100%

of EVs that plugged in with sufficient time to charge reached their desired target state of charge by the end of the optimization window.

Unlocking Benefits

Takeaways from Recent Studies

EV based VPPs have incredible potential to meet future needs	• Utilities, system operators and regulators should prioritize EV solutions given their inherent capability and cost advantage
Value stacking is critical to ensure cost-effectiveness.	• New tools are needed to model the grid holistically and dynamically Data availability is key to assessing benefits to help key decision makers
New regulatory models are needed	• A one size fits all approach to network upgrades, non-wires alternative, EV based VPP deployment is not an accurate refection of business risk – utilities need the right incentives to modify their business model
Utility investments essential to unlock EV potential -discipline needed to prioritize upgrades.	• DERMs investment is foundational to unlocking full value • Benefits are locational specific and high value opportunities should be prioritized
Roles and responsibilities for coordination of DERs	• It will take an industry team effort to unlock the full potential benefits • Greater coordination, industry planning, sharing of best practice and ideas

Specific Insights for Managed EV Program/Tariff Rollout

Brattle recommends a proactive approach to managing EV grid impacts by deploying both TOU tariffs and active managed charging programs now, without waiting for grid needs to become imminent.

Near-Term Strategy
Under 5% EV penetration

- Deploy TOU rates, which are beneficial for managing non-EV loads and for managing EV loads at lower penetration levels.
- Design active management programs and deploy on an opt-in basis across the service territory.
- For customers in active management programs, phase in optimized charging for distribution grid needs on a locational basis, as needs arise.
- Account for managed EV charging in integrated system planning to reduce bulk system costs.

Mid-Term Strategy
5%–20% EV penetration

- Begin incentivizing customers to transition EVs off TOU rates and onto the active management programs, while maintaining TOU rates for non-EV loads.
- Market programs through OEM channels (in-app experiences, dealership partnerships, email) to drive scale.1

Long-Term Strategy
Over 20% EV penetration

- Consider default enrollment of EVs in active managed charging programs.
- Grow program capabilities, including through grid-aware approaches that can further optimize charging based on real-time data from local grid assets.
- Continue to allow customers opt-in/out choice

1: Refer to Distributed Energy, Utility Scale: 30 Proven Strategies to Increase VPP Enrollment for a detailed set of program design and enrollment strategies.

Doing Things Differently Requires New Tools

Brattle has developed a state of the art toolset to evaluate how emerging technologies can unlock value from the grid and assess new business models and utility solutions

DEEFER has been used to assess five residential DER technologies:

- Smart thermostats
- EV managed charging
- Grid-interactive water heaters
- BTM batteries
- BTM solar

Overview of DEFER Model

Inputs

Feeder Load Forecast
Forecasts of hourly load on grid asset

Feeder & Upgrade Parameters
Current asset limits, cost and additional capacity of upgrade

Financial & Scenario Inputs
Discount rate, study time horizon

DER Cost & Operational Params
Net DER cost (utility incentive payment minus lifetime benefits); technology-specific constraints

DER Deployment Limits
Total DER potential in the location and max. annual rate of deployment

Optimization Engine

Objective:
Minimize NPV of Net DER Cost + Grid Upgrade Cost

MILP Optimization

Decision Variables:
- ❑ DER deployment & dispatch
- ❑ Number of deferral years

Constraints:
- ✓ Load limit of asset
- ✓ DER operational constraints (events per year, SOC, load-building, etc.)
- ✓ DER deployment limits

Outputs

Optimal Deferral Length
Determines the year to upgrade that minimizes total net cost; Builds upgrade in first overload year if no cost-effective NWS exists

Cost-Effective DER Deployment
Annual deployment of each DER required for NWS; deploys ahead of need as necessary

Optimized DER Dispatch
Detailed dispatch of each DER technology to ensure load constraints are met in each hour, while respecting operational constraints of each technology

Thank You!

Tom Chapman
PRINCIPAL | TORONTO
Tom.Chapman@brattle.com

And thanks to Brattle's Distributed Energy Experts:

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- Ryan Hledik, Principal | San Francisco

- Akhilesh Ramakrishnan | Managing Energy Associate | Toronto

- J. Michael Hagerty, Principal | Washington DC

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- Cost of Capital
- Energy Risk Management
- Forecasting
- Incentive Regulation
- Retail Rates

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- Electric Transmission
- Energy Storage
- Environmental Policy, Planning, and Compliance
- Large Loads
- Market Design
- Market Modelling
- Nuclear
- Renewables & Alternative Energy
- Resource Planning

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- Expert Testimony (Regulatory & Court)
- Damages Estimation for Energy & Utility Contracts
- Litigation Support & Strategy
- Settlement Negotiation Assistance
- Discovery, Depositions & Cross-Examination Support
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