Overview of Analytical Approach

The analysis conducted for the TES leverages two distinct models

EV Adoption Model

- "Stock rollover" model
- Focus: Class 1-8 on-road vehicles
- Explores various policy / economic scenarios + sensitivities

"How many EVs do we expect over time? What types?"

EV Charging Needs Analysis

- Estimation of EVSE* required to charge given number of EVs
- Home, workplace, depot, public charging needs for diff. vehicles
- Based on local trip data

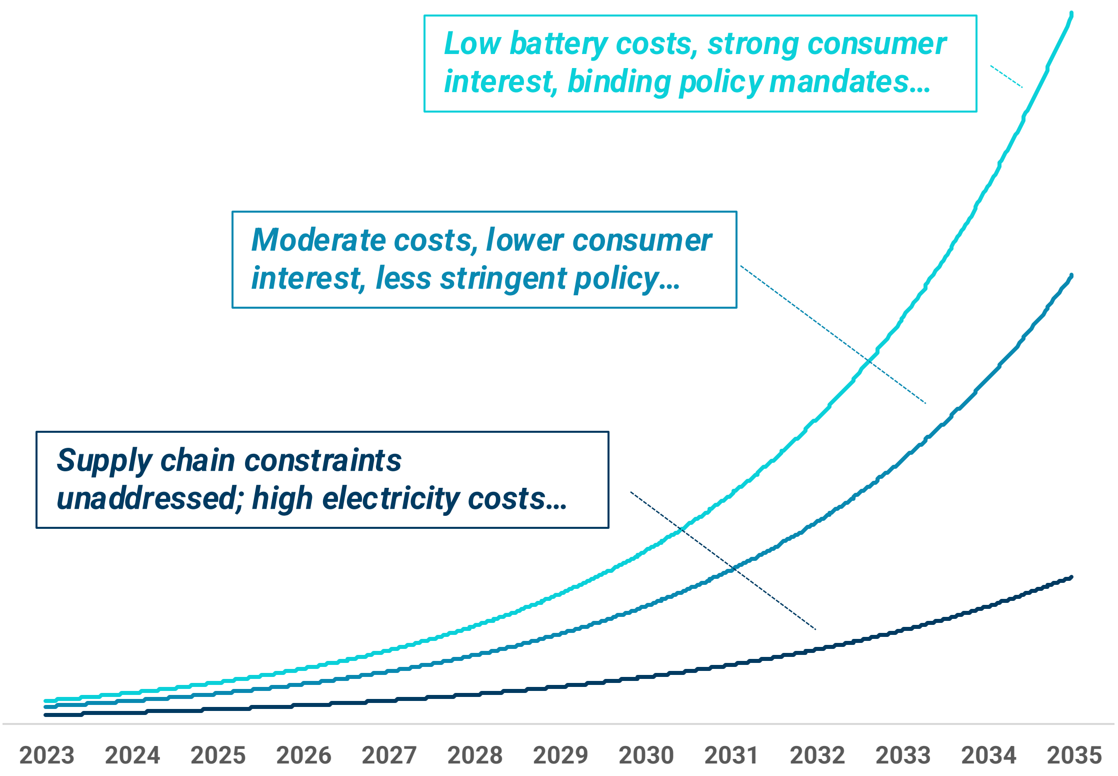
"How many chargers will we need for these EVs?"

*EVSE: Electric Vehicle Supply Equipment (i.e., EV chargers)

Analysis conducted using these models helps to frame TES policy needs and options

- **Scenarios highlight different outlooks on Washington's transportation sector**
  - *What would need to be true to make assumptions underlying desired scenario(s) a reality?*
- **Comparing *between* scenarios highlights policy and/or economic gaps to be filled to meet state targets**
  - *What types and magnitude of additional policy action may therefore be required?*

Illustrative comparison of EV growth over time under different scenario assumptions



EV adoption scenarios cover a range of potential market and policy dynamics

Baseline	Strong Electrification Technology	Strong Electrification Policy	Strong VMT Policy	Worst Case	Best Case Climate Aligned
• Current policy and baseline economics*	• EV, FCEV, electricity, hydrogen costs decline more quickly.	• Larger incentives for electrification; strong consumer demand for EVs.	• LDV VMTand vehicle stock reduction; bus VMT and stock increase; freight VMT and stock reduction.	• EV, FCEV, electricity, hydrogen costs decline more slowly; weak consumer demand for EVs.	• All policy and economic inputs move in ”climate-aligned” direction

*Baseline economics here indicates reasonable / middle-of-the-road outlooks on cost trajectories.

Sensitivity analysis helps illuminate the impact of key policy and/or economic factors

How much do ACCII* and ACT* influence outcomes?

How close does each modeled scenario get to the 2030 LDV target?

What additional benefits are achieved by reducing vehicle size and fleet size, beyond reducing VMT?

How do higher or lower petroleum prices affect the outcomes?

*Advanced Clean Cars II | **Advanced Clean Trucks

EV Adoption Model

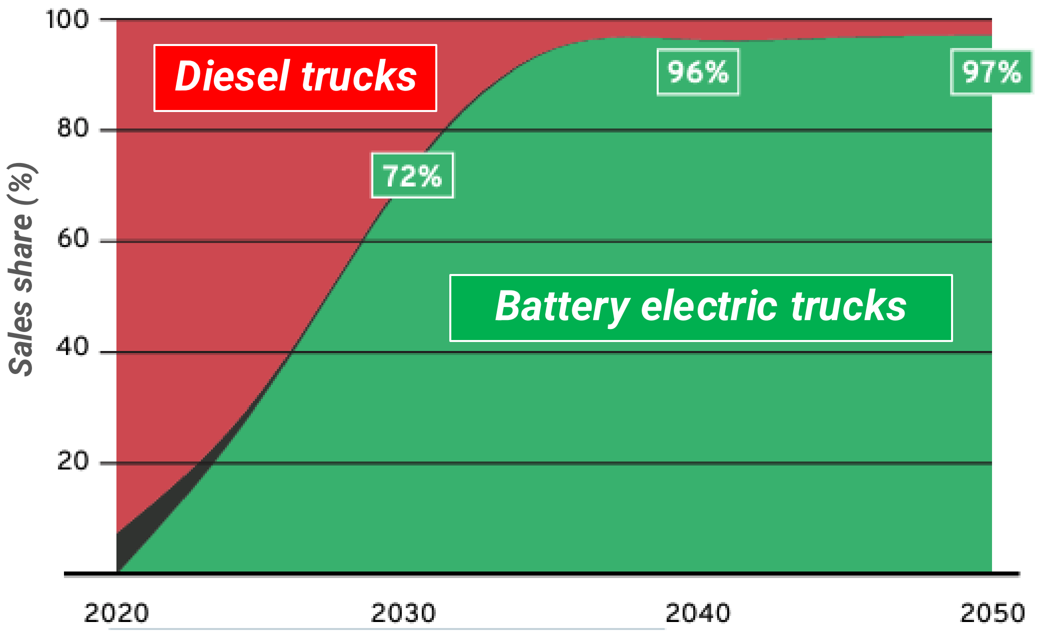
Adoption scenarios utilize a Python-based stock rollover model

- **Scope: Class 1-8, on-road vehicles**

- **Distinct scenarios and sensitivities drive differential adoption, e.g.,**
  - Economy (e.g., battery, gasoline costs)
  - Policy (e.g., ACC II, ACT*)
  - Mode choices (VMT impacts)

- **Builds upon past RMI modeling**
  - Mission Possible Partnership
  - Energy Policy Simulator
  - Inflation Reduction Act

Illustrative example, battery electric vehicle sales share over time.



RMI analysis, Mission Possible Partnership, Making Zero-Emissions Trucking Possible.

Graphic depicts representative "urban" duty cycle.

*Advanced Clean Cars II; Advanced Clean Trucks

Adoption modeling is influenced by both ‘bottoms-up’ and ‘top-down’ factors

Bottoms-up: *Economics*

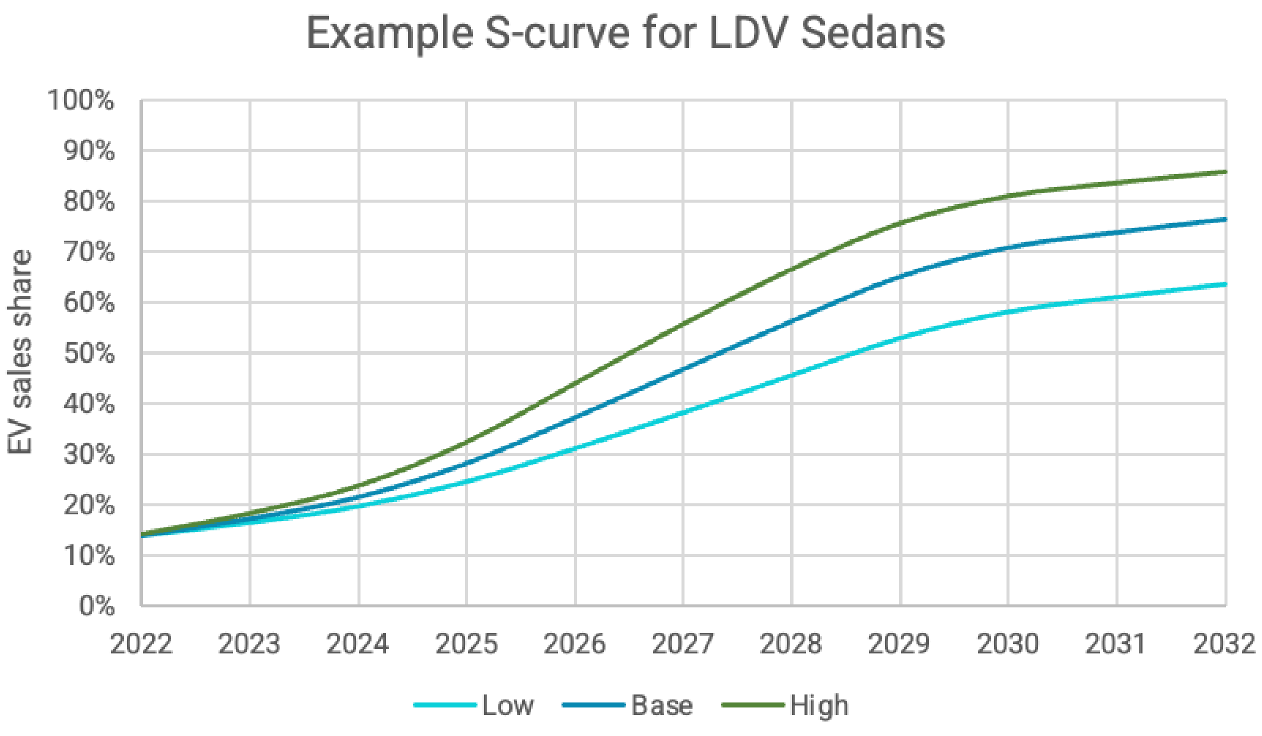
- **Mechanism**
  - Economic comparison (TCO) between vehicle options + assumed ‘S-curve’ population adoption profile over time determine annual sales share
- **Inputs**
  - Vehicle CapEx + OpEx
  - Incentives
  - S-curve shape (EV adoption demand rate / responsiveness)

Top-down: *Policy Mandates*

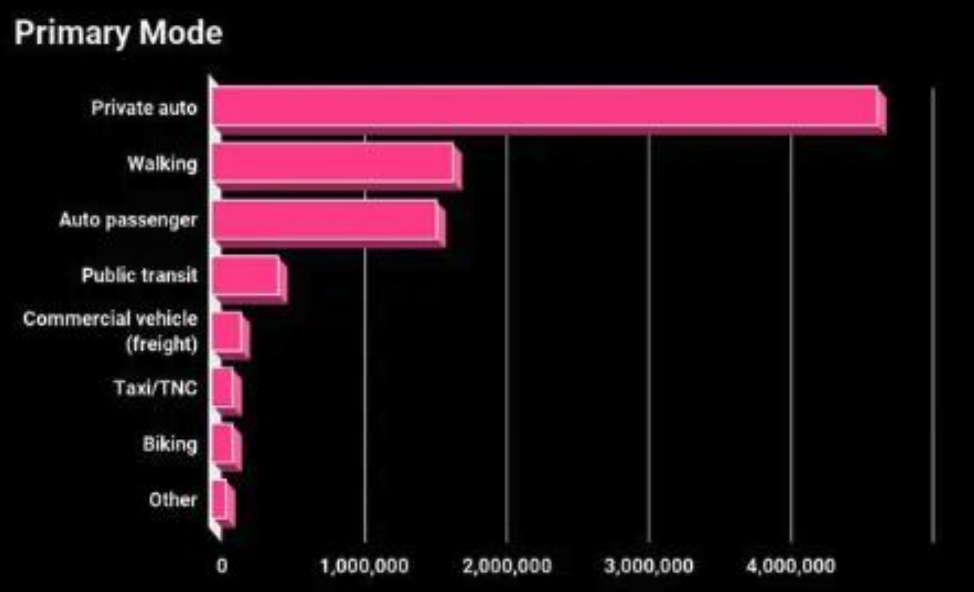
- **Mechanism**
  - ‘Binding’ policies ratchet up annual sales when bottoms-up economics fail to meet policy mandates
- **Inputs**
  - Annual sales requirements (ACCII, ACT, ACF)

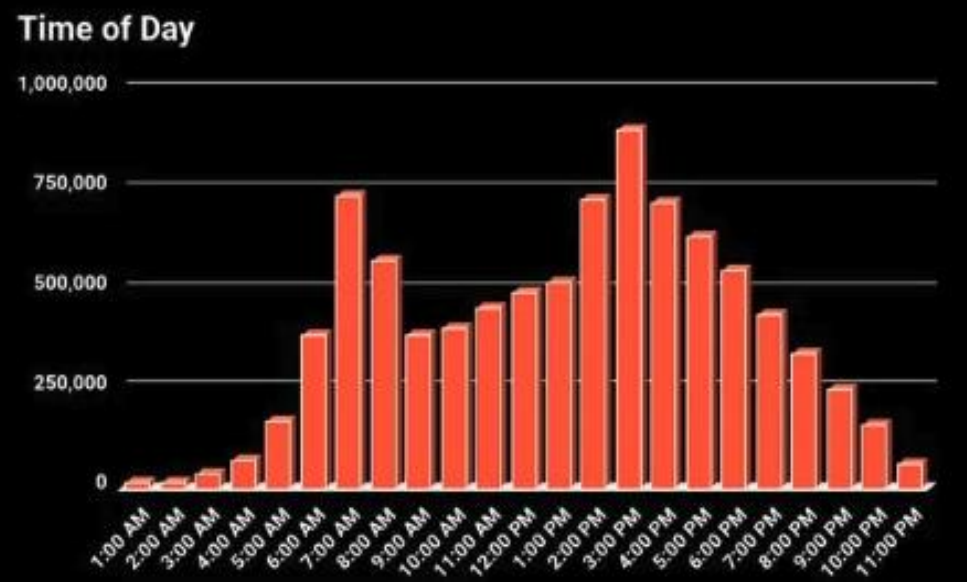
Determining the shape of the S-curve

- **Starting point: fitting curve to historic US EV sales**
  - Future shape = continued trend + assumed consumer responsiveness to economics
- **3 shapes for each vehicle segment**
  - Low / med / high responsiveness
  - Different shapes in different scenarios
- **Non-economic factors effectively embedded within S-curve**
  - Consumer responsiveness to positive economics
  - Assumed level of **public charging availability** and funding
  - Level of indirect supportive policies(e.g., education + awareness campaigns)



EV Charging Needs Analysis





EVSE needs assessment based on local trip data from "Replica"

- **Replica: granular, synthetic data set of local trips at census block group level**
  - Mode, trip purpose, time of day, demographics, etc.

- **RMI analytical pipeline developed specifically to convert to EVSE needs estimates**
  - Enables detailed assessment of anticipated EVSE needs
  - By vehicle segment, geography, year

Image source: Replica

Key Takeaways from TES Scenario Analyses

Key Takeaways

Light-duty Vehicles

- **ACCII is a very strong forcing mechanism for LD EV adoption**
  - 2030 100% ZEV sales target requires significant additional support; economics alone appear unlikely to spur sufficient adoption
- **Ensuring EV purchase prices are affordable is a key lever for reaching sales goals**
  - Making EVs cheaper earlier has large impact on total EV population
    - Tech and Policy improvements have biggest impact on LDV sales in early years, prior to stringency of ACCII
- **Targeting not only EV sales but also smaller vehicles + VMT reduction makes challenge easier**
  - Boost in early-year sales (shift to sedans -> best TCO advantage)
  - 6.7 vs. 6.2 million total LDVs in 2035
  - Significant reductions in greenhouse gas emissions relative to Baseline scenario
- **Policy support to close sales gaps must be sustained to have largest impact**
  - Compared w/ Strong Elec. Technology scenario, Strong Elec. Policy scenario produces smaller 2035 EV population
  - Policy incentives in model are largely time-limited; whereas tech cost declines reflect longer-term trends
- **LDVs considerably less sensitive to fossil fuel price sensitivities than MHDVs**
- **Ensuring available home (or neighborhood) charging meaningfully reduces need for public charging**

TCO: Total Cost of Ownership

Key Takeaways

Medium- and Heavy-duty Vehicles

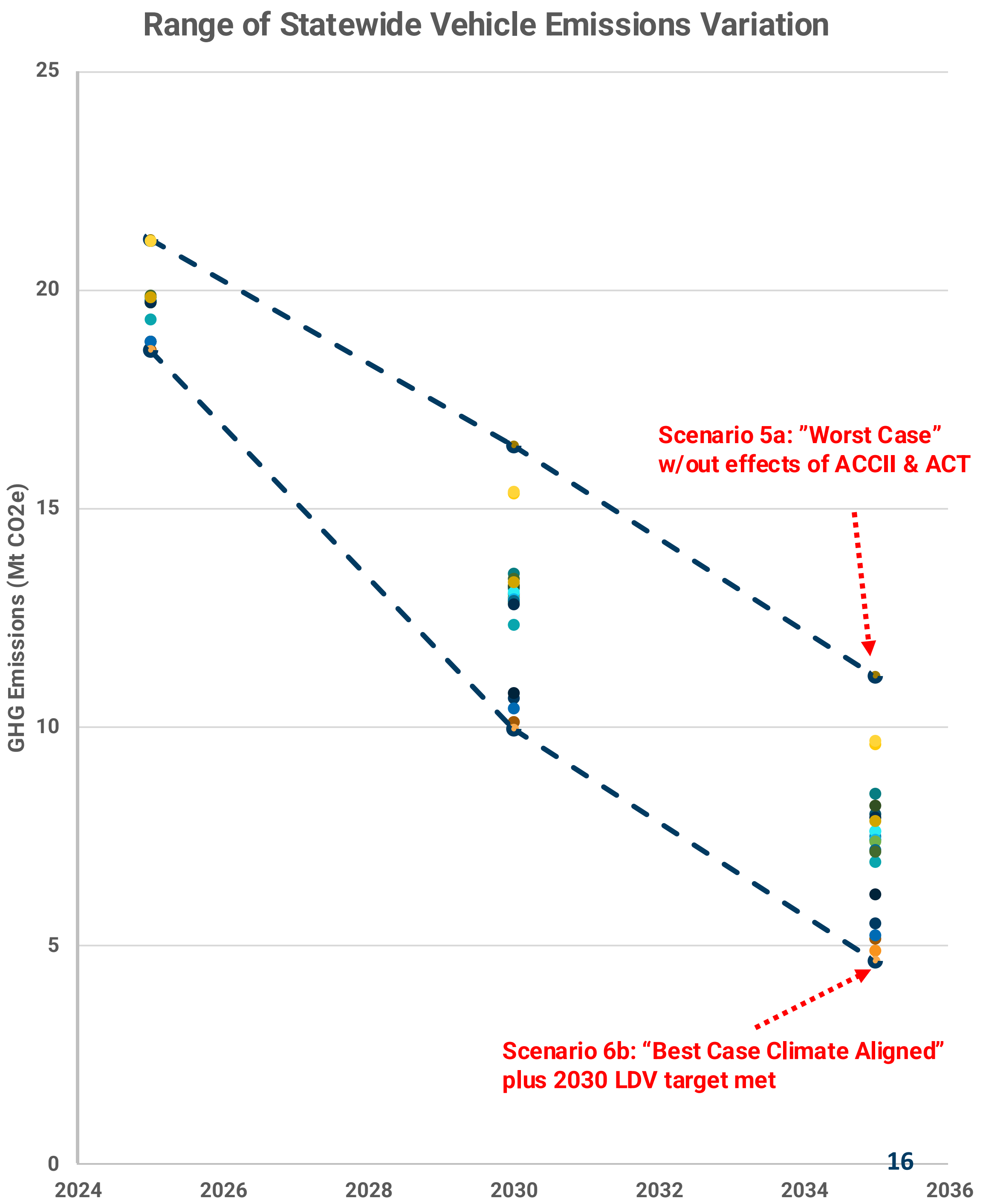
- **MHDVs more responsive to economics than LDVs**
  - Higher proportion of fuel + operating costs -> greater savings potential from electrification
- **Truck electrification is increasingly economic**
  - ACT serves as important policy, undergirded by strong baseline economics
  - Ensuring continued / growing economic advantage for electric trucks is key for enabling increased adoption
  - Inflation Reduction Act a true “game changer” for truck electrification
- **Advanced Clean Fleets has a huge impact – no LDV equivalent**
  - Very aggressive sales requirements, starting almost immediately
- **Bus electrification may remain largely dependent on grant funding**
- **Small number of MHD hydrogen FCEVs**
  - Heavy-duty trucks: role of EV vs. FCEV over time remains uncertain
  - Transit buses: FCEV buses likely to have small market share; dependent on H2 infrastructure

FCEV: Fuel Cell Electric Vehicle

On-road Transportation Emissions

On-road Transportation Emissions (GHG)

- **On-road greenhouse gas emissions range significantly across scenarios**
- **Spread of remaining emissions grows over time as scenario assumptions diverge**
  - 2030 range of 9.9 to 16.4 Mt CO2e
  - 2035 range of 4.7 to 11.2 Mt CO2e
- **Largest factors: strong VMT policy, "relaxing" ACCII constraint, and "requiring" 2030 target**
- **Tableau Dashboard also reports <u>local</u> air pollutants from tailpipes vs. electric grid**



GHG: Greenhouse Gas | **ACCII**: Advanced Clean Cars II | **ACT**: Advanced Clean Trucks

Effect of Scenarios and Sensitivities on 2035 On-road Transportation GHG Emissions

Percent Change relative to "Baseline, No Sensitivity" Scenario

		Major Sensitivities		Additional Sensitivities		
	No Sensitivities	Remove Effect of ACCII & ACT	2030 LDV Target Met	VMT Reduction w/out Stock Change	High Fossil Fuel Prices	Low Fossil Fuel Prices
1) Baseline		+11%	-1%		-5%	+4%
2) Strong Elec. Tech	-2%	+5%	-3%		-6%	+3%
3) Strong Elec. Policy	-3%	+8%	-4%			
4) Strong VMT Policy	-28%	-19%	-31%	-9%		
5) Worst Case	+16%	+36%	*[+13%]*			
6) Best Case	-36%	-32%	-39%			

ACCII: Advanced Clean Cars II

RMI

GridUp and Other Follow On Work

What problems are we trying to solve?

EV adoption growing rapidly.

↓

Electric grid unprepared, esp. for eMHDVs.

↓

Current grid planning / investment approach **too slow**.

↓

Real threat to EV adoption.

Why?

Root Cause

1. **Significant Uncertainty**
2. **Existing Regulatory Paradigm**
3. **Utility & Regulator Risk Aversion**

eMHDVs: Electric Medium- and Heavy-Duty Vehicles

Two RMI initiatives aim to highlight imminence of EV load growth and provide grid planning guidance.

Practical guidance for regulators and utilities to strategically plan for rapid EV load growth.

Recent insight brief, published October 2024. Developed based largely on input from ~a dozen expert interviews.

Promoting updates to utility and regulatory practices

GridUp
an RMI initiative

Geographic forecast of anticipated EV load and charging needs, available at detailed resolution nationwide.

User-friendly online tool, launched August 2024.

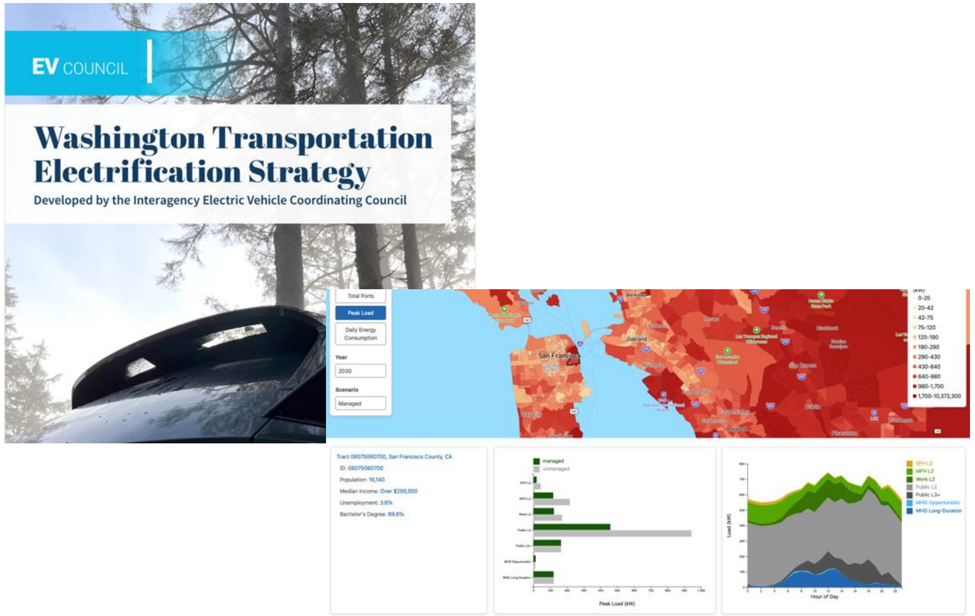
Providing analytical backing (need and urgency)

GridUp is RMI's method for constructing highly detailed EV demand forecasts.

GridUp, the model, is a core capability of the Carbon Free Transportation team…

GridUp
an RMI initiative

… which allows us to create insights and tools for a variety of audiences.



GridUp uses detailed vehicle travel data to project EV power and charging needs at the local level.

1

Aggregate and sample trip and population data

2

Assign charging availability and preferences

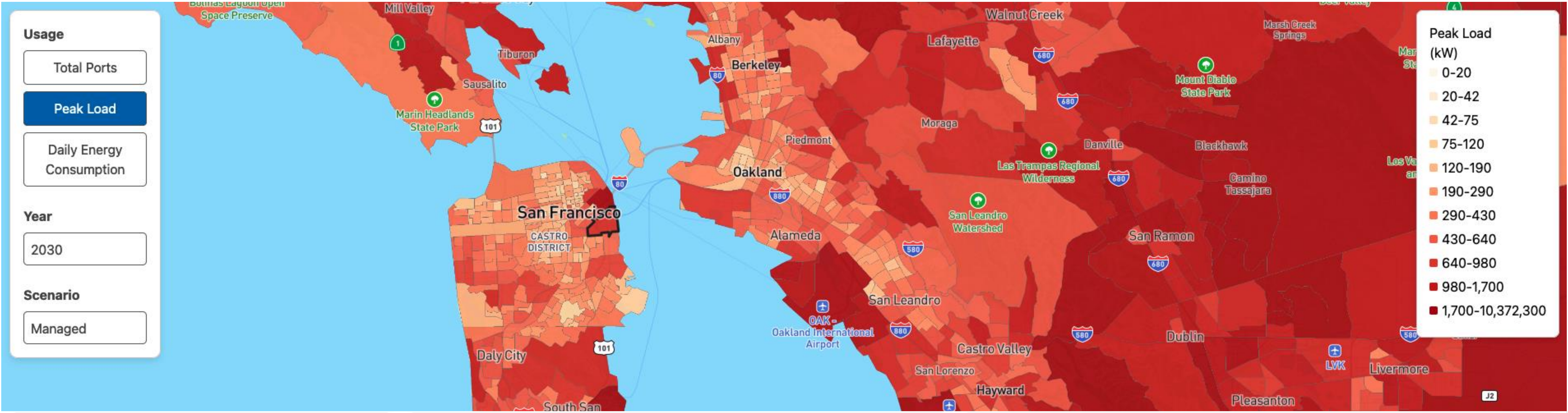
3

Simulate charging behavior based on energy needs, charger availability, stops

4

Summarize load curves and power needs by census block group

GridUp Example: Peak EV load estimates in San Francisco: 2030



Tract 06075060700, San Francisco County, CA

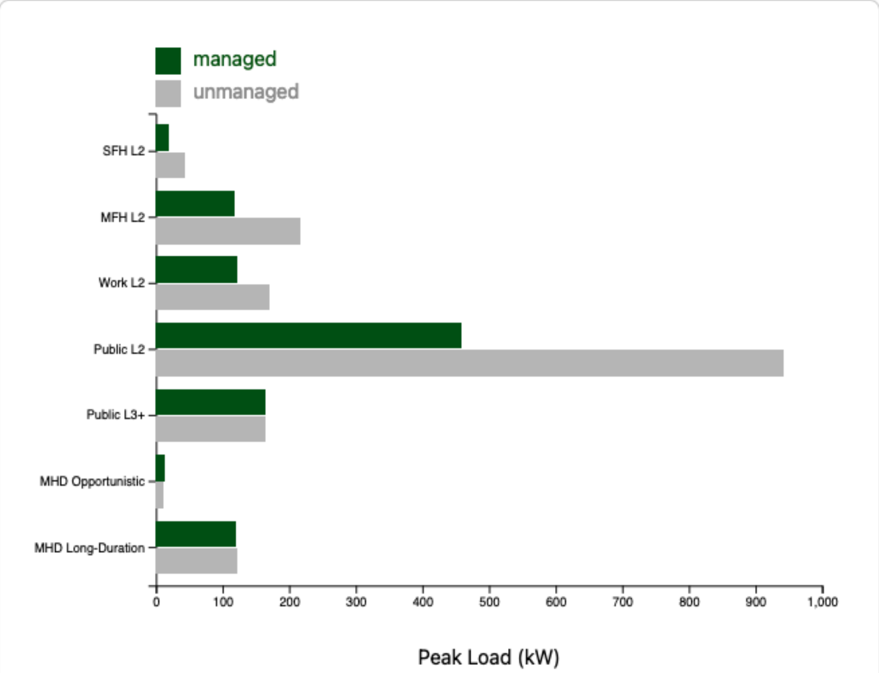
ID: 06075060700

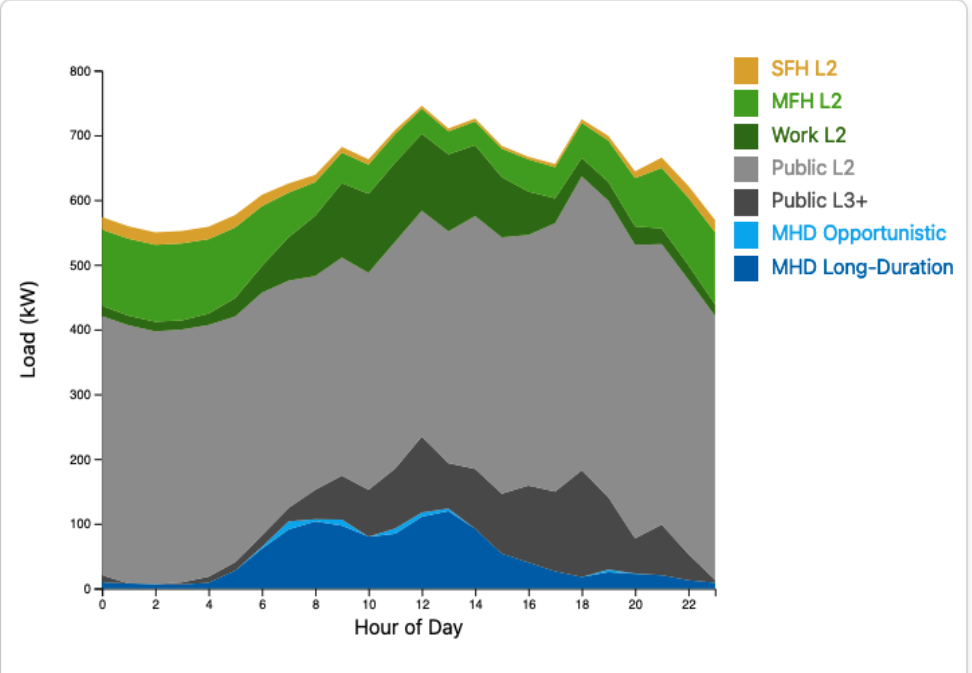
Population: 16,140

Median Income: Over $200,000

Unemployment: 3.6%

Bachelor's Degree: 69.8%





Regulators can support strong utility practices to plan for EV load growth.

Leveraging existing tools in targeted ways can enable forward-looking planning for EVs.

Set Grid Planning Guidance

- Updated utility practices; better data; consistent application across exercises

Establish and Track Desired Outcomes

- Performance metrics; clearly defined goals

Approve Appropriate Proactive Investment

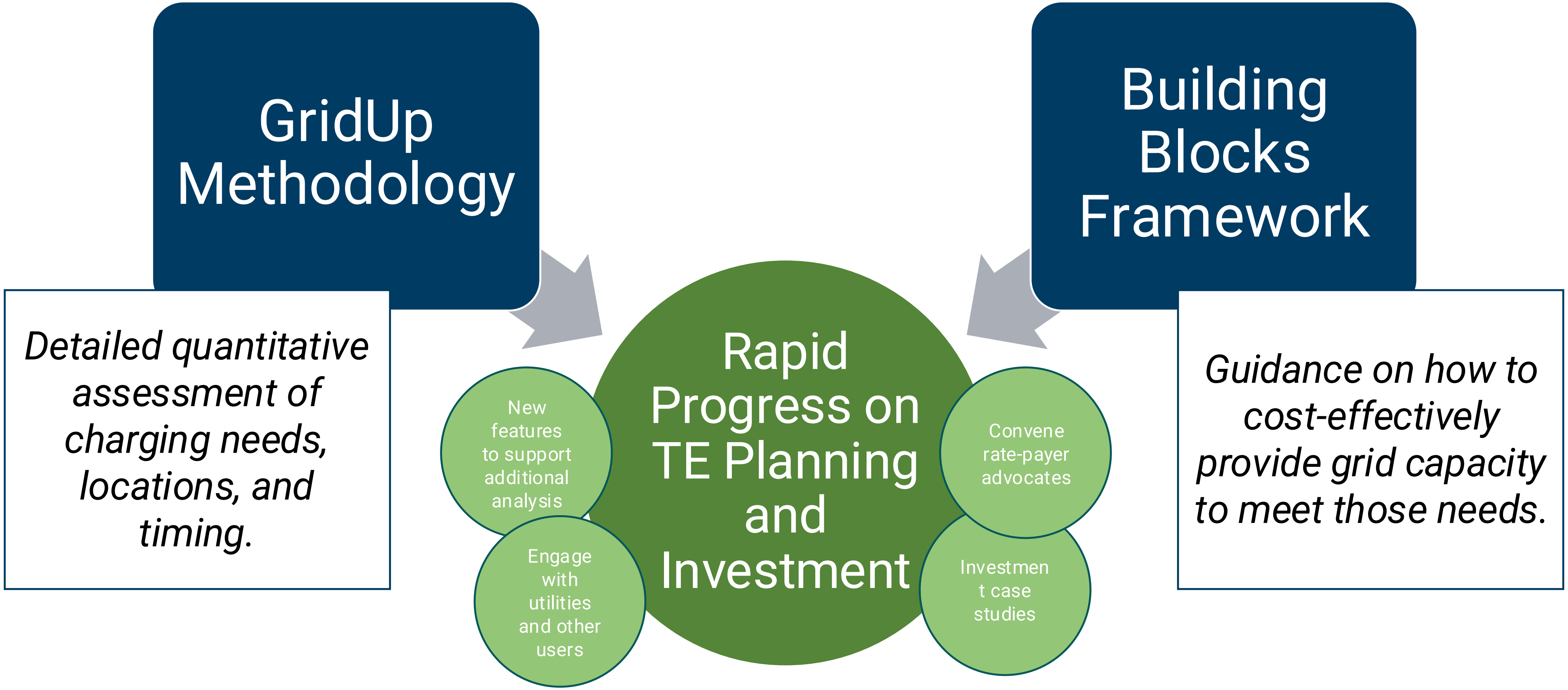
- Enabling needed investments when proposals adhere to guidance and embed accountability

Regulators and utilities can improve transportation electrification planning and investments using a series of core "building blocks."

	1		2	3		
Key Questions	**What do we need?** How much infrastructure and where?		**How can we efficiently meet that need?**	**How do we get there?** What changes are required to efficiently meet the need?		
Building Blocks	Plan against long-term EV market expectations	Improve load forecasting practices	Prioritize efficient, cost-effective use of distribution infrastructure	Align grid connection with customer needs	Improve risk sharing and mitigation	Enable accountable, longer-term utility capital investments

https://rmi.org/insight/transportation-electrification-building-blocks/

Our next steps: Combining the Building Blocks and GridUp workstreams.



Note: The GridUp methodology is much more flexible and robust than the limited scenarios and outputs shown on the GridUp user interface.

Thank you!

Learn more about this work:

Nick Pesta: npesta@rmi.org
GridUp Site: gridup.rmi.org