EV State Working Group - Heavy Duty Truck Charging

NARUC 2021

EDF Core Staff on Charging

Timothy O’Connor	Senior Director, Energy Transition
Pamela MacDougall	Lead on Charging and Infrastructure Strategy
Larissa Koehler	Lead on Electric Vehicle Policy
Elizabeth B. Stein	Lead Counsel, Energy Transition Strategy

Presentation Roadmap

- Part 1 - *Discussion of recent study on* ***heavy duty charging*** – Tim O’Connor (15 min)

- Part 2 – *Discussion of studies, research and observations on* ***electric vehicles as a grid asset*** - Pamela MacDougall (15 min)

- Part 3 – *Principles and recommendations for utility commissions engaging in* ***transportation electrification planning*** - Pamela MacDougall and Elizabeth Stein (15 min)

- Part 4 – Discussion and Q&A (15 min)

Heavy Duty Fleet Electrification - Charging Analysis

NARUC 2021

Tim O’Connor

Senior Director, Energy Transition

EDF ENVIRONMENTAL DEFENSE FUND®

Finding the ways that work

Goals of Study

- ***Fleet needs*****:** How effective will electrification be at meeting fleet operational needs without modification of routes and timetables?

- ***Electric load:*** What is the aggregate and peak facility electrical load for a combination of charging strategies, charger sizes, and traction battery capacities needed to accommodate a 40-50 heavy-duty battery electric truck deployment project?

- ***Charging rates and scenarios:*** Under what charging scenarios can a target facility maximize the fraction of trips successfully charged while minimizing power demands and expected infrastructure costs? Also, how are the costs of charging and peak load impacted by managed charging under different electric rate variants?

- ***Distributed energy resources:*** What role do distributed energy resources (DERs), including on-site solar photovoltaic (PV) generation and battery energy storage systems (BESS), have on the charging infrastructure costs and emissions reductions profiles of each deployment? Also, how do DER scenarios affect the aggregate facility load profile under various utility rates?

gna CLEAN TRANSPORTATION & ENERGY CONSULTANTS

NFI

SCHNEIDER

Assumptions

- Using Existing Rates (TOU, Demand Holiday, Subscription) in California
- Infrastructure
  - Charging Station Power (50, 150, 350, 800 kW)
  - Traction Battery Capacity (300, 500, 750, and 1000 kWh)
  - Solar Sizing: 80% of annual energy consumption
- Infrastructure programs:
  - Low Carbon Fuel Standard (LCFS)
  - Investment Tax Credit (ITC)
  - Self Generation Incentive Program (SGIP)
- Fleets: Based on 2019 & 2020 Driving Data

Fleet	Annual VMT	Number of Trucks	Location
NFI	40,000	50	Chino
Schneider	67,000	42	Stockton

Finding: Electric Trucks Can Meet Most of the Duty Cycle Needs

Fleet	Schneider	NFI	NFI
Scenario Name	Baseline	Current Technology	Advanced Technology
DCFC Power Level (kW)	150	150	800
Truck Battery Capacity (kWh)	1,000	500	1,000
% of Successful Trips	88%	71%	93%
Maximum Number of Chargers In Use	25	40	40

Influencing Factors

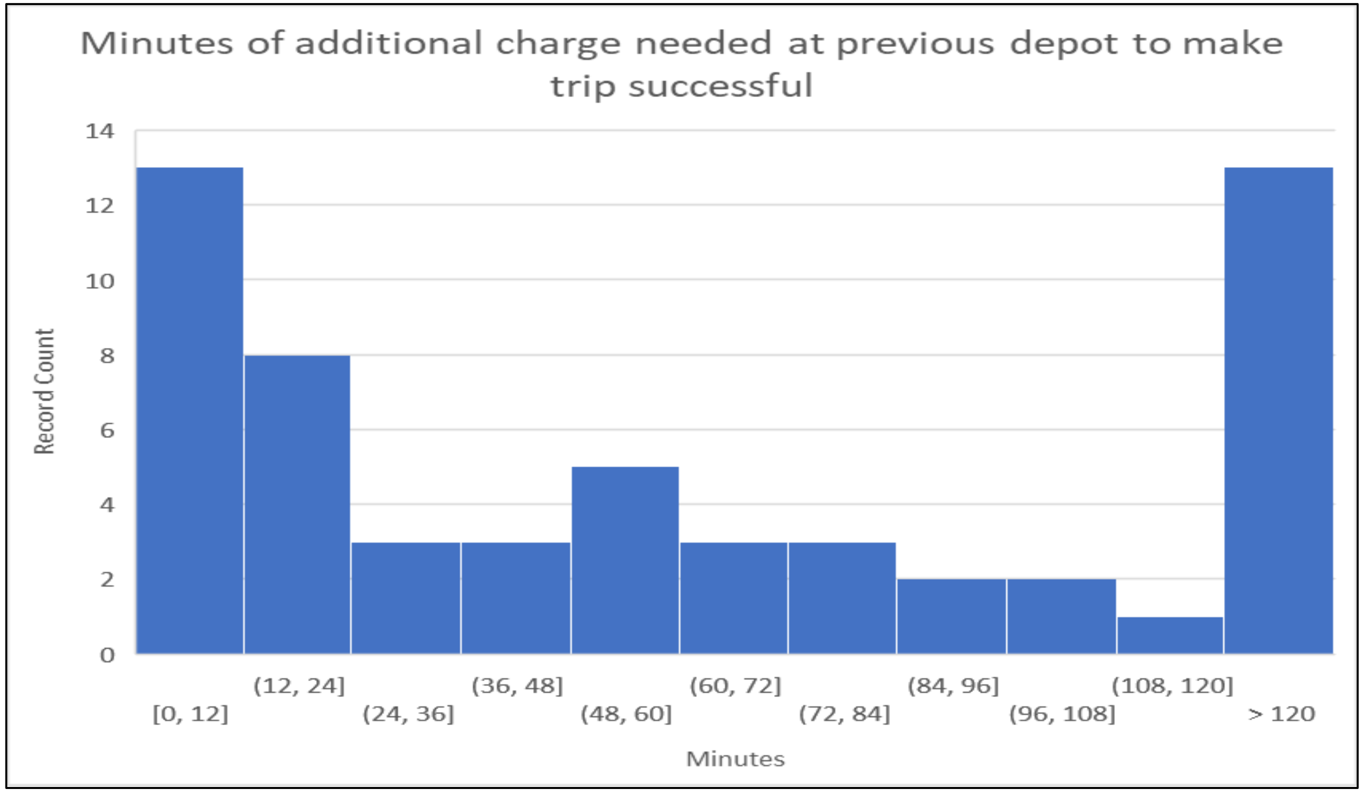
Charging Window

Schneider fleet has an average charging window of 110% longer than NFI, and median charging window 550% longer than NFI

Driving Distance

Schneider fleet has an average trip distance 65% higher than NFI Chino, and a median trip distance 134% higher than NFI Chino

Finding: A small amount of on-route charging can unlock even more potential



Most failed trips could be completed successfully with the addition of minimal on-route charging -- 70 minutes for NFI's failed trips, and 30 minutes for Schneider's

Shared Charging has potential to help meet business needs

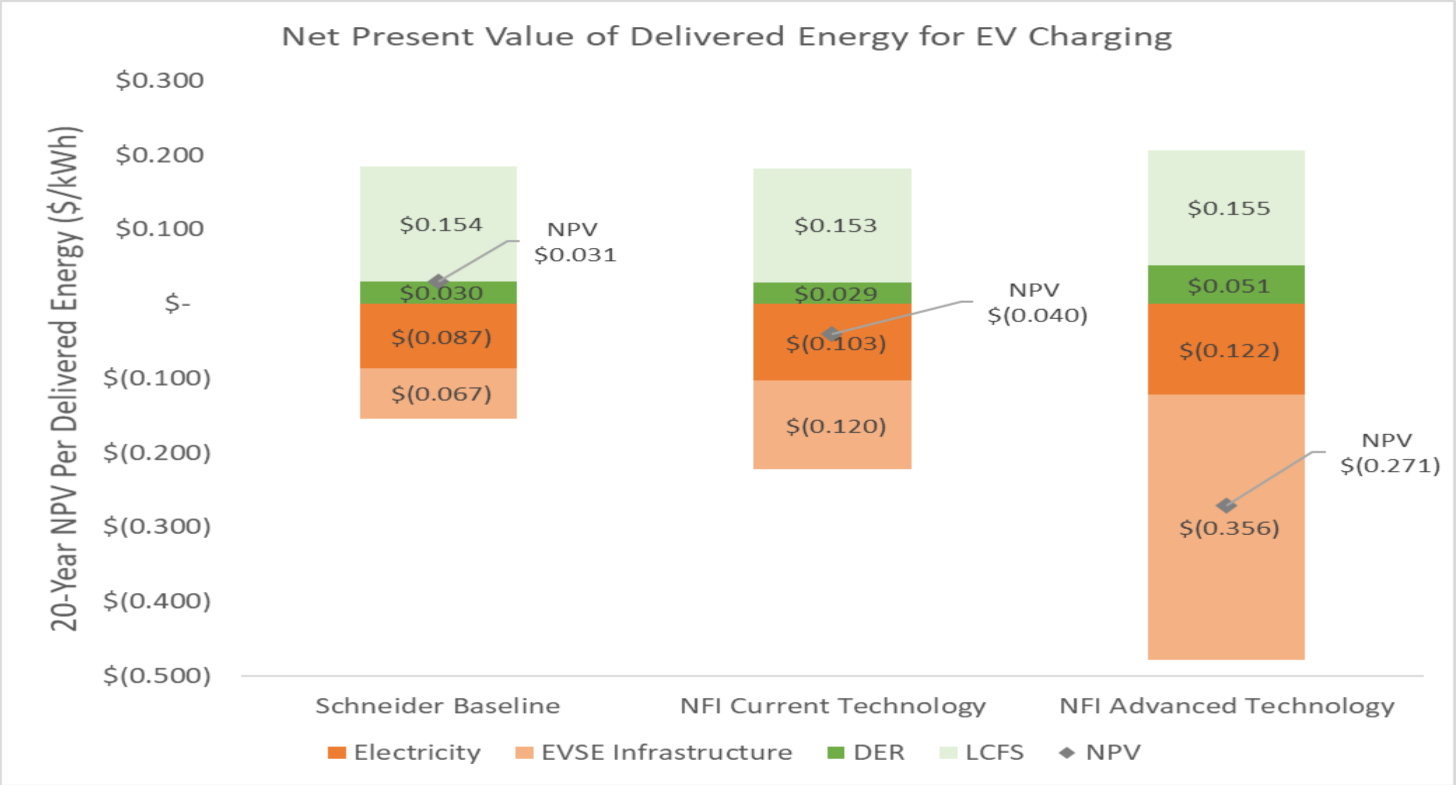
Finding: Infrastructure Is Costly

NFI Charging Infrastructure Scenario	Current Technology Managed	Advanced Technology Managed	Advanced Technology Unmanaged
Charger Rating	150 kW	800 kW	800 kW
EVSE Capital Costs			
Power Cabinet + Dispenser	$107,000	$375,000	$375,000
Warranty (Increase from 2-5 years)	$15,500	$65,250	$65,250
Cable Management	$1,500	$1,500	$1,500
Sales Tax (8.5%)	$10,540	$37,549	$37,549
Commissioning/Activation Fees	$2,000	$2,000	$2,000
Equipment Subtotal	$136,540	$481,299	$481,299
EVSE Installation	$35,000	$175,000	$175,000
Total Installed Cost (per Charger)	$171,540	$656,299	$656,299
Total Site Work Cost	$551,000	$1,586,000	$1,053,900
Subtotal Scenario Cost	$7,412,600	$27,837,950	$18,117,668
Design, Permitting, Management Fees	$2,223,780	$8,351,385	$5,435,300
Contingency	$741,260	$2,783,795	$1,811,767
Total Scenario Cost	$10,377,640	$38,973,130	$25,364,735

Total Scenario Cost	$8,979,810

← Schneider Charging Infrastructure Scenario

Finding: Value of electrification projects (NPV) only positive with LCFS, ITC and SGIP incentives



LCFS Revenues

EV Carbon Intensity Basis	Smart Charging	Grid Average	Renewable/ Zero CI
Current Technology	$1,198,583	$1,196,396	$1,495,495
Advanced Technology	$1,502,603	$1,511,064	$1,888,829

ITC + SGIP Incentive

~ $3.4 Million

Finding: Electrification Results in Annual Fuel and Emissions Savings

Electrification Does Result in Fuel Savings

	Diesel	Electricity	Savings
Schneider Annual Fuel Cost	$1,536,656	$981,843	$554,813
NFI Annual Fuel Cost	$1,387,735	$639,424	$748,311

Emission Reductions are Significant

NFI tailpipe reductions annually:

- 5,295 MT CO2e/year,

- 6,240 kg NOx

- 69 kg PM2.5

Finding: Charging Costs go down with managed charging

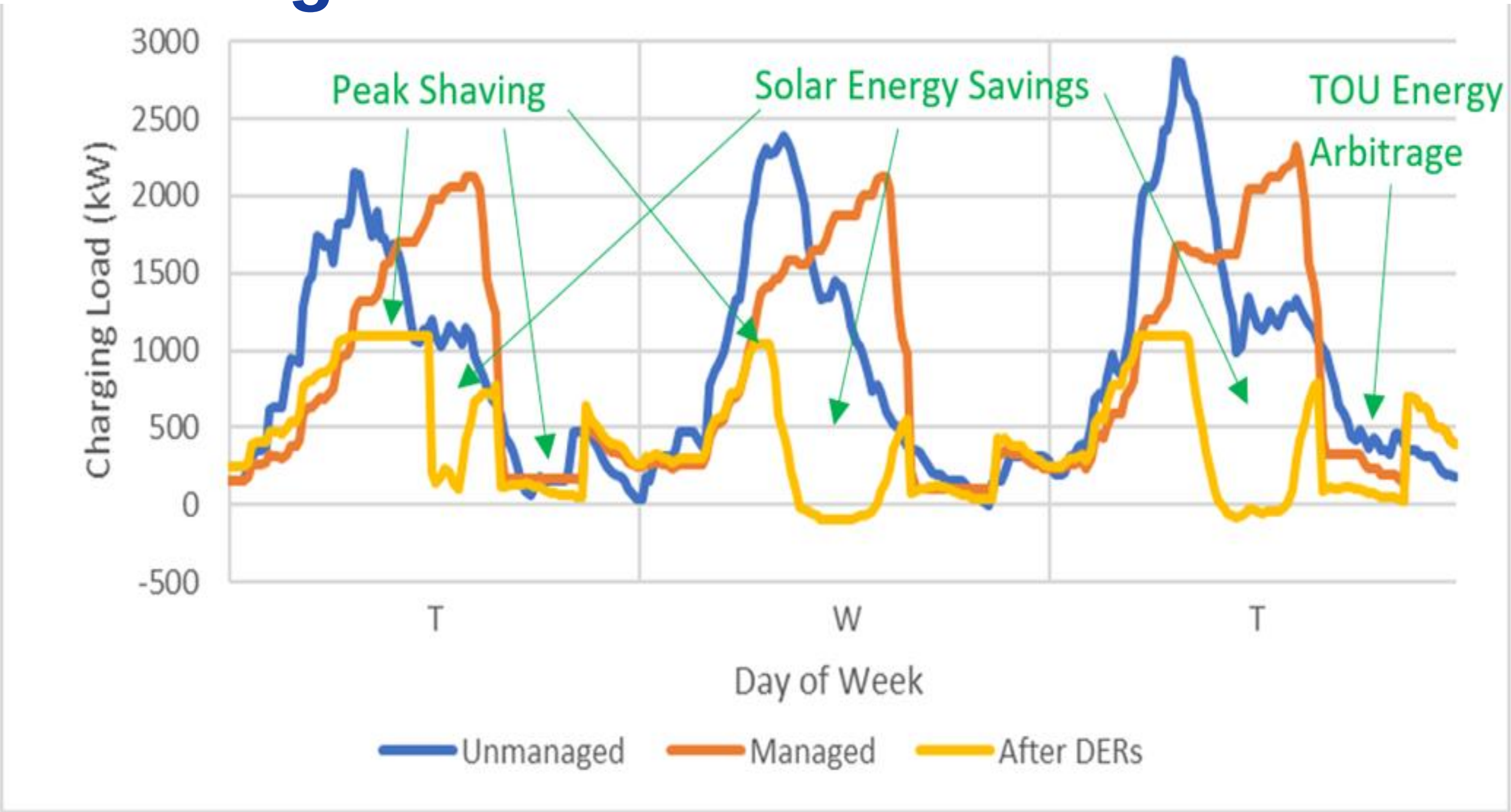
Unmanaged Charging

Energy	Demand	Fixed	Total Bill	Rate Type
$636,364	$0	$3,061	$639,424	Demand Holiday
$525,505	$437,338	$3,061	$965,904	Demand Holiday*
$350,796	$883,764	$3,061	$1,237,621	TOU
$725,817	$70,964	$0	$796,781	Demand Subscription

Managed Charging

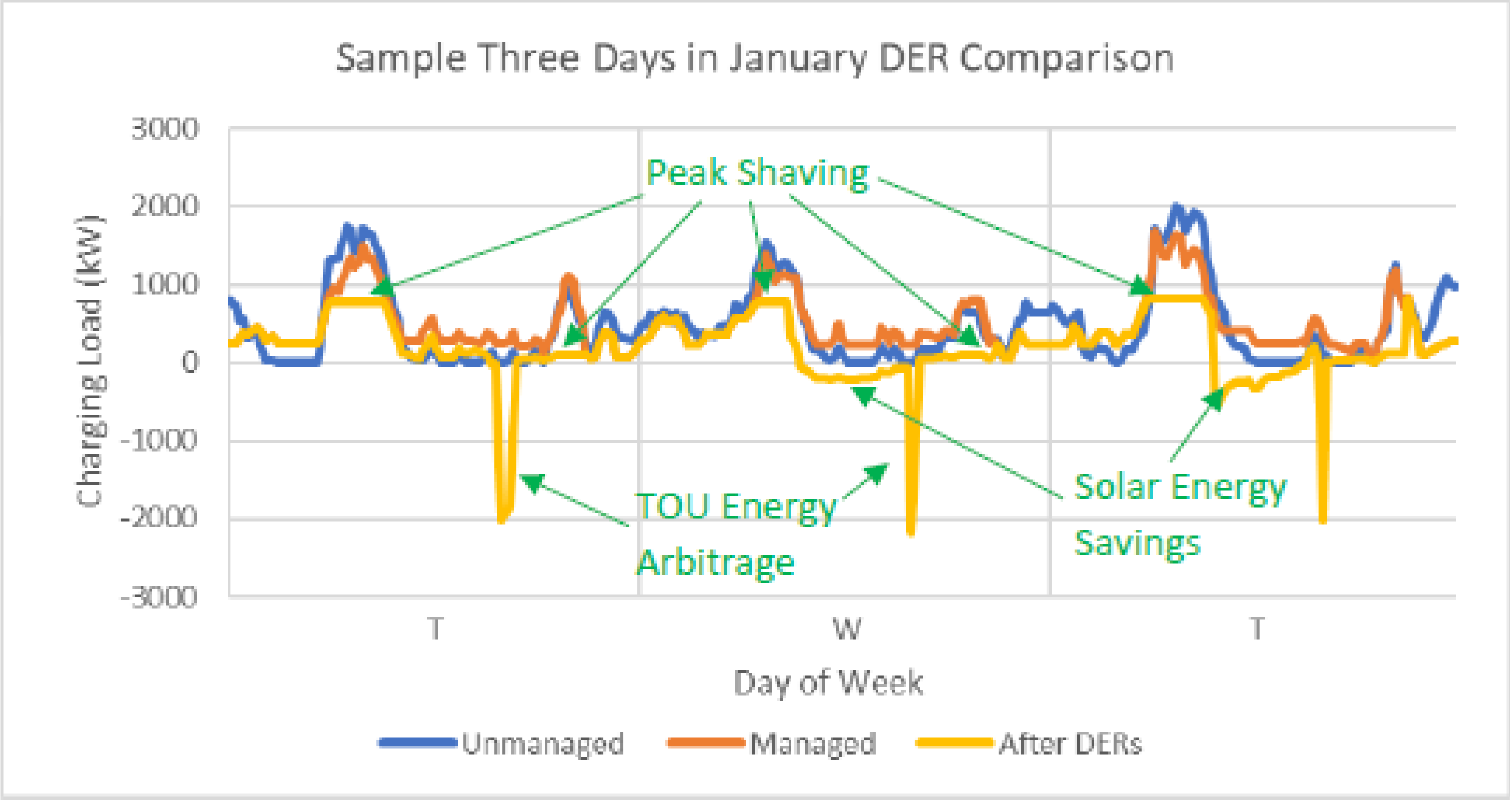
Energy	Demand	Fixed	Total Bill	Rate Type
$578,549	$0	$3,061	$581,609	Demand Holiday
$470,269	$400,565	$3,061	$873,895	Demand Holiday*
$342,364	$760,266	$3,061	$1,105,691	TOU
$685,175	$64,997	$0	$750,173	Demand Subscription

Finding: Pairing managed charging with DERs saves money by further reducing and shifting demand



Scenario	Energy	Demand	Fixed	Total Bill	Total DER Savings
Current Technology DER $2/W	$42,521	$174,190	$3,061	$219,771	$433,648
Current Technology DER $5/W	$167,902	$239,441	$3,061	$410,404	$624,281
Advanced DER $2/W	$57,286	$256,206	$3,061	$316,552	$1,016,746

Finding: Managed charging and DERs reduce peak energy use.



Scenario	Peak Load Reduction (kW)
NFI Current Technology w/DER	1278
NFI Advanced Technology w/DER	4151
Schneider Baseline w/DER	611

Four Key Takeaways

1. Existing and upcoming electric Class 8 truck models, paired with commercially available charging equipment, can meet the technical requirements of the vast majority of truck-trips analyzed with on-site (depot) charging – though operational challenges remain.
2. Charging infrastructure investments required for Class 8 fleets are significant and can vary dramatically.
3. Policies and programs that reduce the infrastructure costs required for fleet electrification will be essential to accelerate the transition of Class 8 trucks.
4. Managed charging and on-site distributed energy resources (DERs) like batteries or solar will be critical to making infrastructure costs affordable.

Plug-in Vehicles for the Greener Grid

NARUC 2021

Pamela MacDougall, PhD

Senior Manager, Grid Modernization

ENVIRONMENTAL DEFENSE FUND®

Finding the ways that work

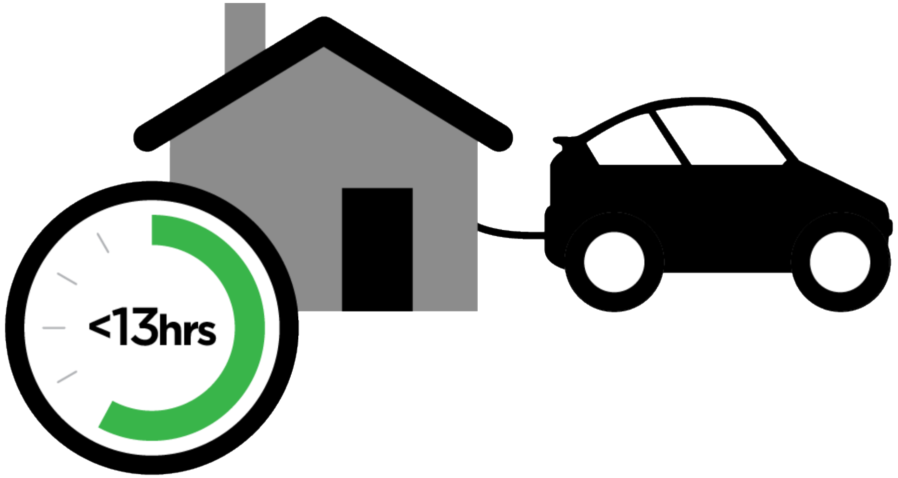
EVs can do more than just drive

The goals of VGI are to:

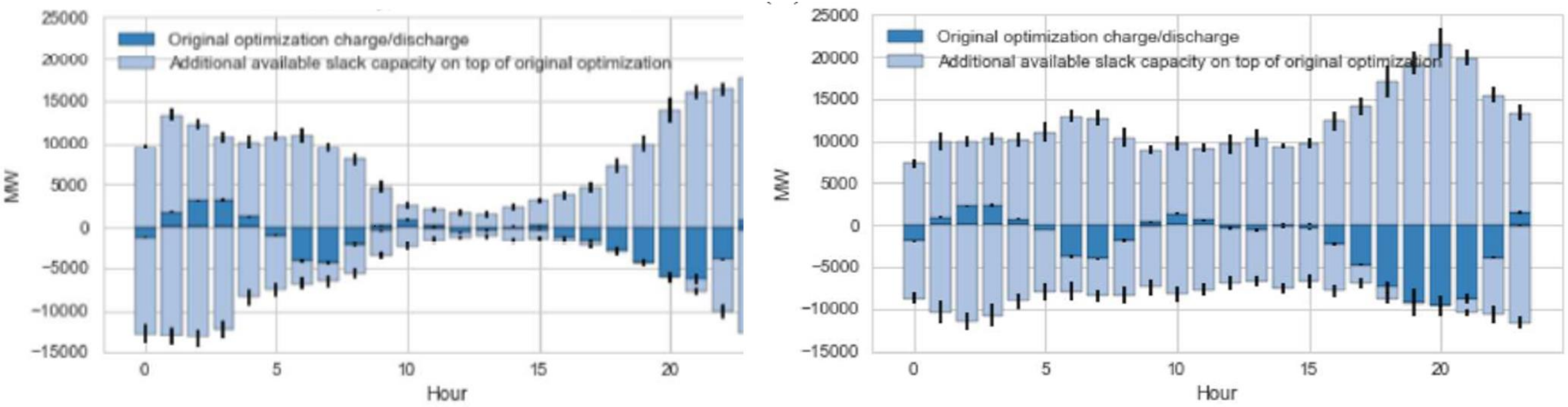
- Assist with **renewable integration** and reduce peak demand
- **Scale up EV deployment**, and reduce cost of ownership
- Help to **mitigate grid upgrades**, lowering ratepayer costs

Plug-in EVs (PEVs) can enable this via a combination of:

1. Thoughtful placement of EVSE
2. V1G = Managed charging
3. V2G = Bi-directional smart charging
4. V2B = Vehicle to Building Charging



What is the Flexibility Potential?



Study by MISO showed expected future EVs in aggregate can have 10 GW of upward and downward ramp capacity at any time of the day.

Source: Greenblatt, Jeff and Margaret McCall. "Exploring enhanced load flexibility from grid-connected electric vehicles on the Midcontinent Independent System Operator grid" Available at: https://cdn.misoenergy.org/Exploring%20enhanced%20load%20flexibility%20from%20grid%20connected%20EVs%20on%20MISO%20grid543291.

Example: VGI and Distribution Grid
What happens when every house has an EV?

Study done to evaluate impact on grid feeders at 100% residential EV penetration.

Measurements: Voltage Stability and Available Capacity (Overloading).

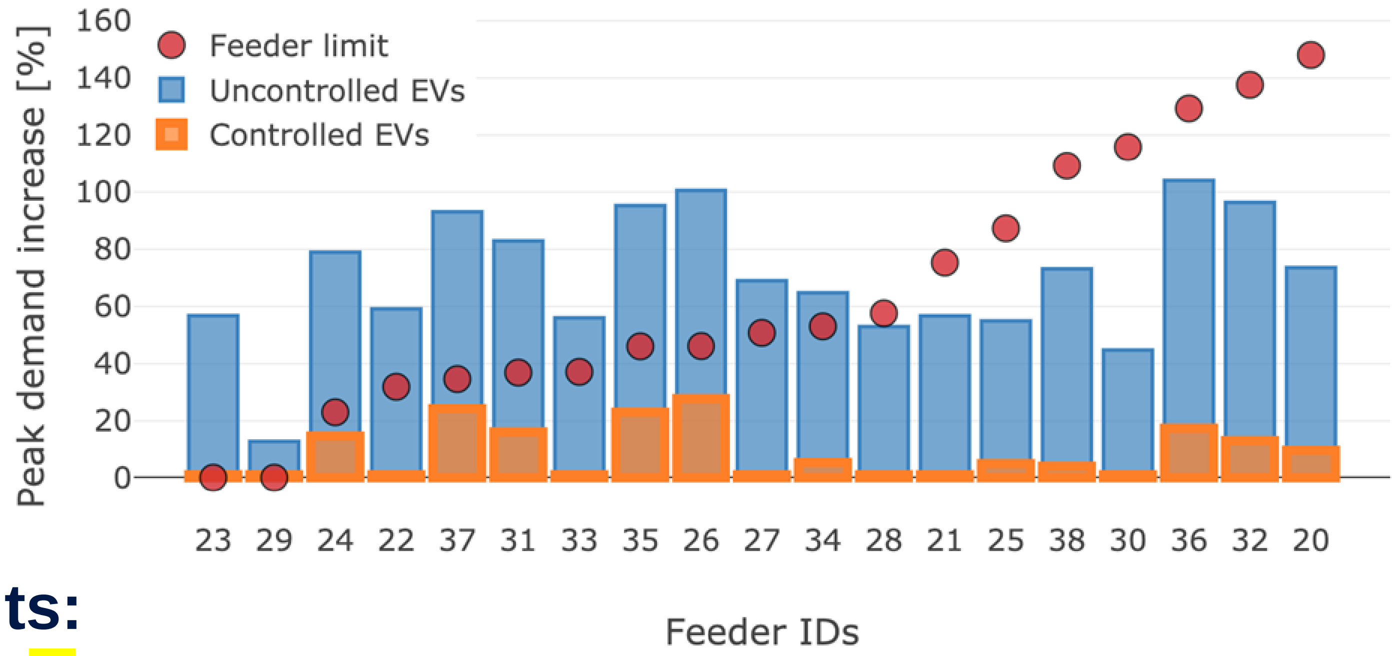
Data:
- 50 feeders from PG&E
- Charging data from ChargePoint

EV and Grid models validated with real data.

Expanded Results to all 3000 PG&E Feeders

Source: Coignard, J., MacDougall, P., Stadtmueller, F. and Vrettos, E., 2019. Will electric vehicles drive distribution grid upgrades?: The case of California. *IEEE Electrification Magazine*

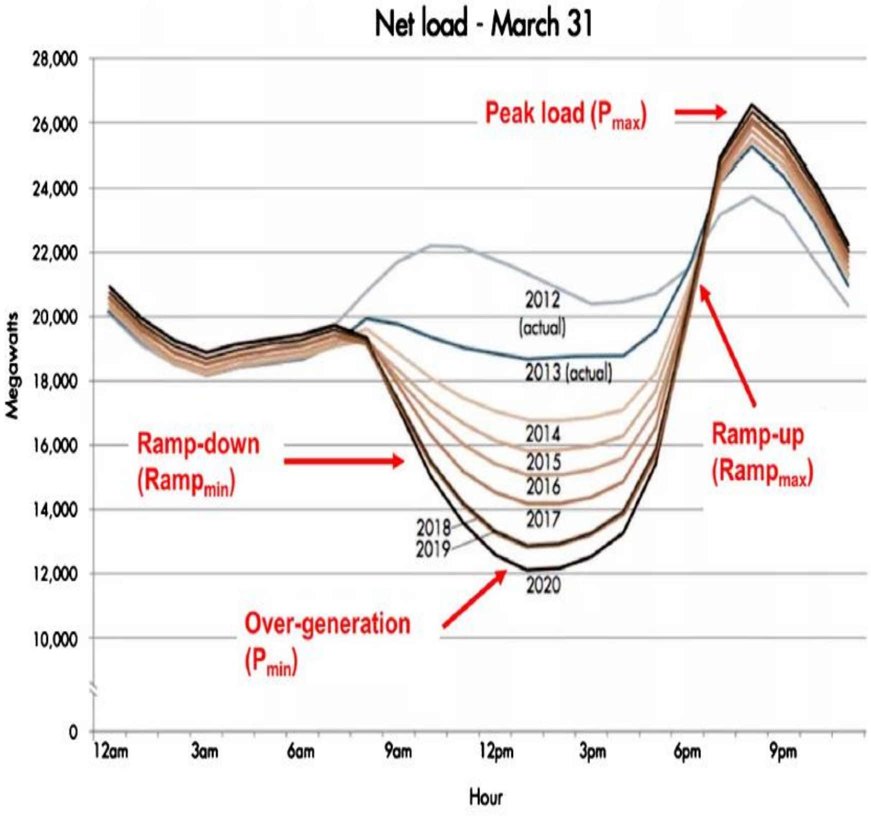
VGI can Mitigate Build-out



Main Results:

- *If charging is unmanaged, utilities will face large problems with voltage stability and overloading.*
- If 28% of the EVs are smart charging off-peak on TOU rates, almost all grid issues can be addressed.
- ***We need to get EV customers on time-variant rates.***

VGI as Storage is Cost-Effective



How Much Storage?

- V1G ~ 1 GW of storage
- V1G and V2G ~5 GW of storage.

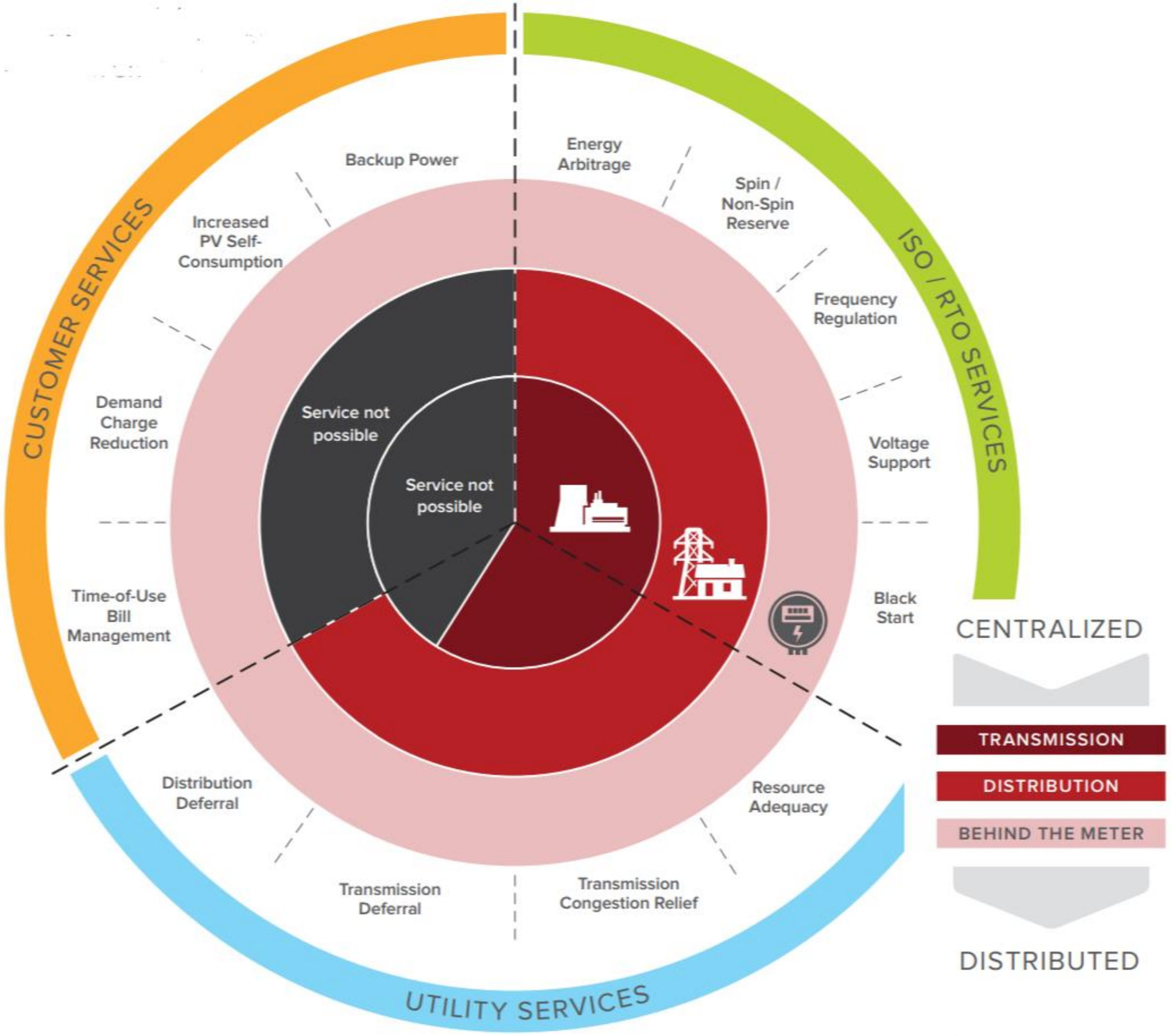
How Much Savings?

- V1G system-wide investment of ~$150 million, compared to $1.45-$1.75 billion for stationary (non-EV) storage.
- V2G is worth $12.8 to $15.4 billion in equivalent stationary storage.

LBNL Study shows without impacting driving V1G and V2G can provide storage….at a much lower cost.

Source: "Clean vehicles as an enabler for a clean electricity grid", Jonathan Coignard et al 2018 Environ. Res. Lett. 13 054031, 16 May 2018

VGI can provide a range of benefits



Source of image: Rocky Mountain Institute

Appropriate monetization & policy constructs

State/City
- Meeting renewable and EV goals

ISO
- Reduced cost and aid with balancing and transmission issues
- Integration of renewables

Utility
- Reduced cost of grid management
- Reduced grid upgrade costs.
- Integration of renewables and EVs

EVSE (charging station) operator
- Improved business case

3rd party
- Entry to market

EV owner / clean energy owner
- Reduced cost of ownership

Solutions to unlock the potential that VGI holds…

Need to Create Business Opportunities

Achieve Favorable Economics:

- Access to Wholesale Market Prices
- Storage Mandates: Allow V1G to participate
- Bring Your Own Device Programs
- Effective, actionable price signals for the full spectrum of EV owners

Need to Align Utility Business Model and Societal Interests

Utilities making large headway with:
- Time-Variant Rates
- Billions in Infrastructure Programs

Don’t have comparable progress for VGI

Not necessarily in utilities’ interest to invest in non-wires solutions.

For example, a **Utility Performance Incentive Mechanisms** that reward achievement of specified outcomes can help.

Ensuring use of proper communication standards

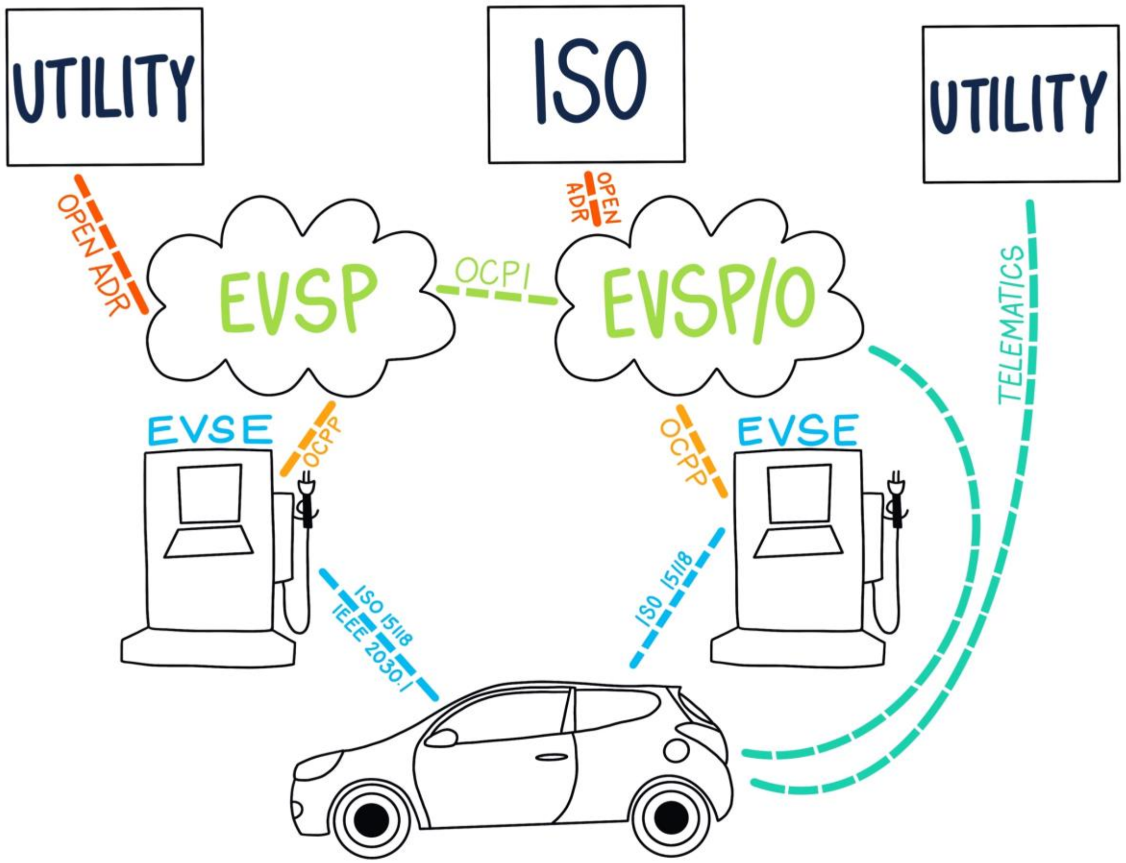
Demand Response (Open ADR)

Get Price Signals to Customers
(OpenADR, OCPP, and ISO 15118)

Customer Service Choice (OCPP)

Roaming Billing (OCPI)

Avoid Stranded Assets (OCPP)



Communication standards allow a more seamless experience

Pursue beneficial metering and telemetry programs

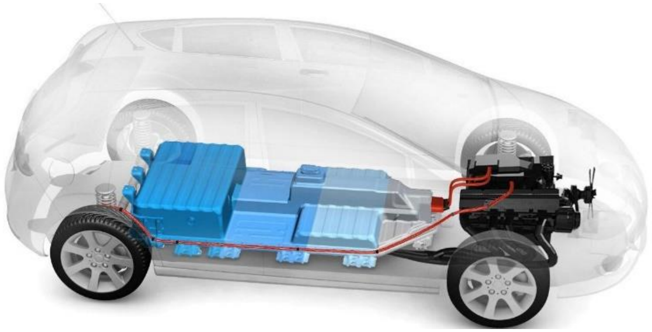
Solutions:

- Set Metering Requirements that Match the VGI Service
  - e.g., 4 second telemetry is not needed for an hourly TOU rate.
- Define Sub-metering Requirements
- Allow 3rd party metering
  - e.g., CAISO Allows 3rd party metering for DER wholesale participation

Pilot Programs:

Electric Vehicle Sub-Metering Pilot

- e.g., Minnesota Xcel Energy



Get the Grid Ready: It's Time to Modernize

Enhanced Visibility

- Wide Area Monitoring and Control
- Information Communication Technology Integration

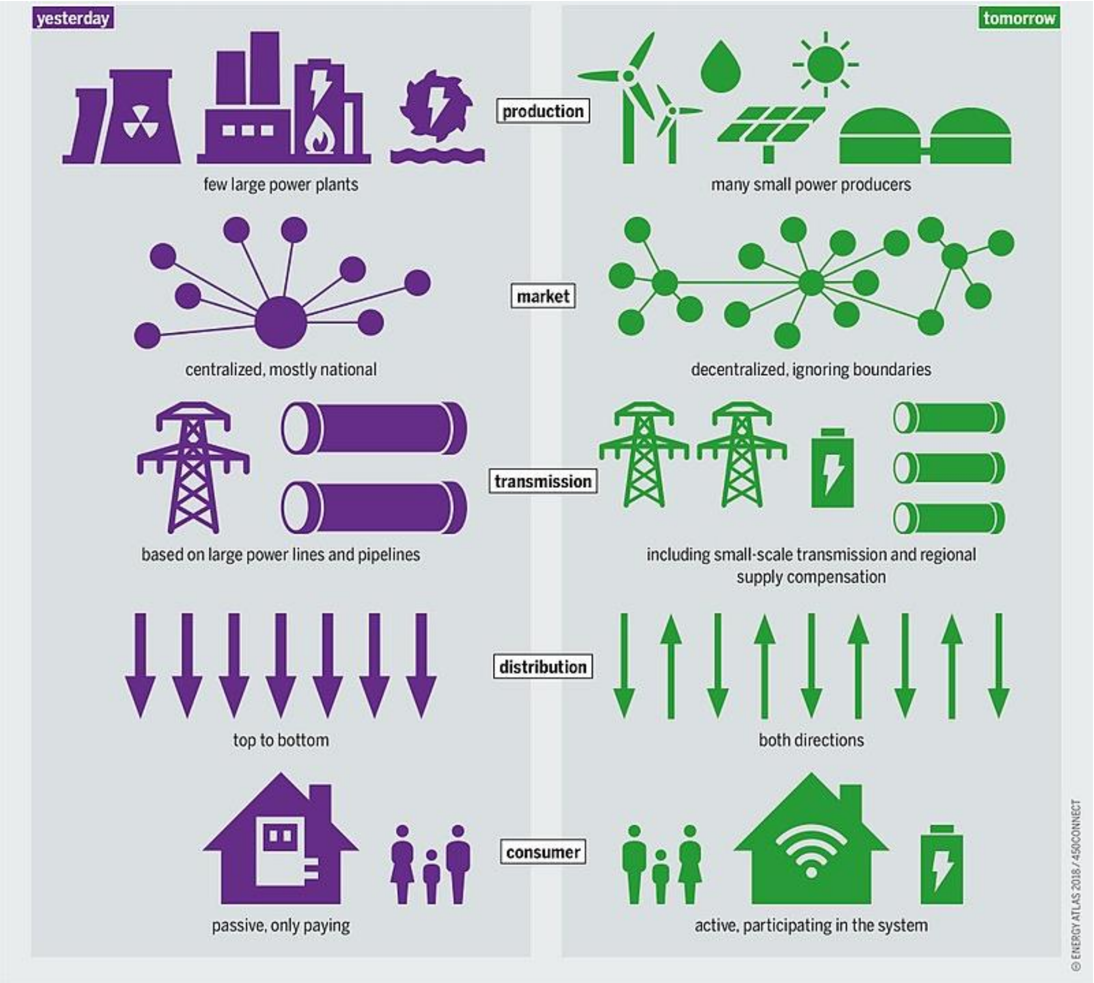
Smart Technology

- Advanced metering infrastructure
- Grid Automation

Advanced Billing Systems

- Subtractive Billing

Holistic and Streamlined Interconnection Practices



Recommendations for Successful Infrastructure Programs and Policies

Upcoming White Paper by Larissa Koehler & Pamela MacDougall

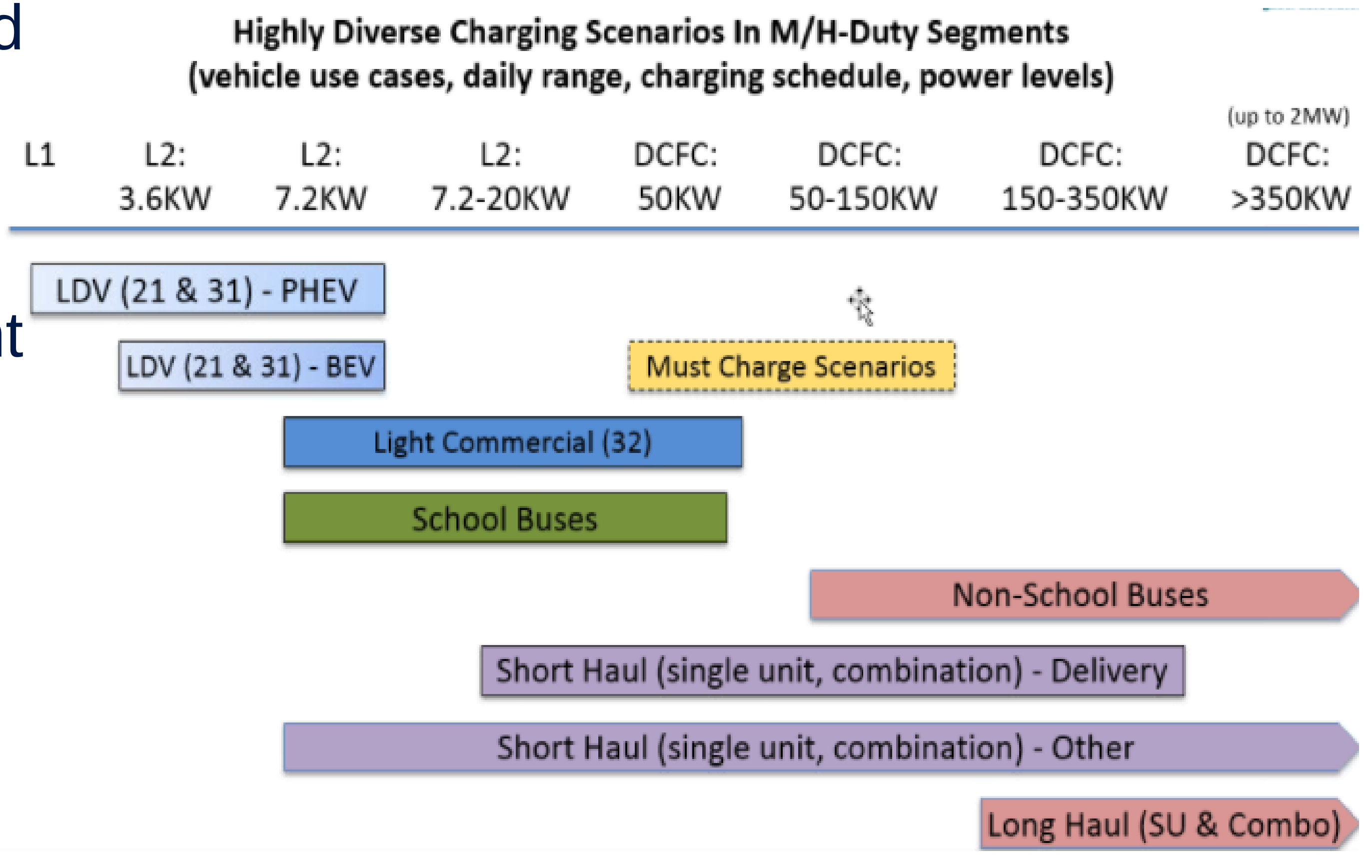
High-level applicability of recommendations

These recommendations are meant to apply to utility commissions that are already embarking on EV infrastructure planning and deployment.

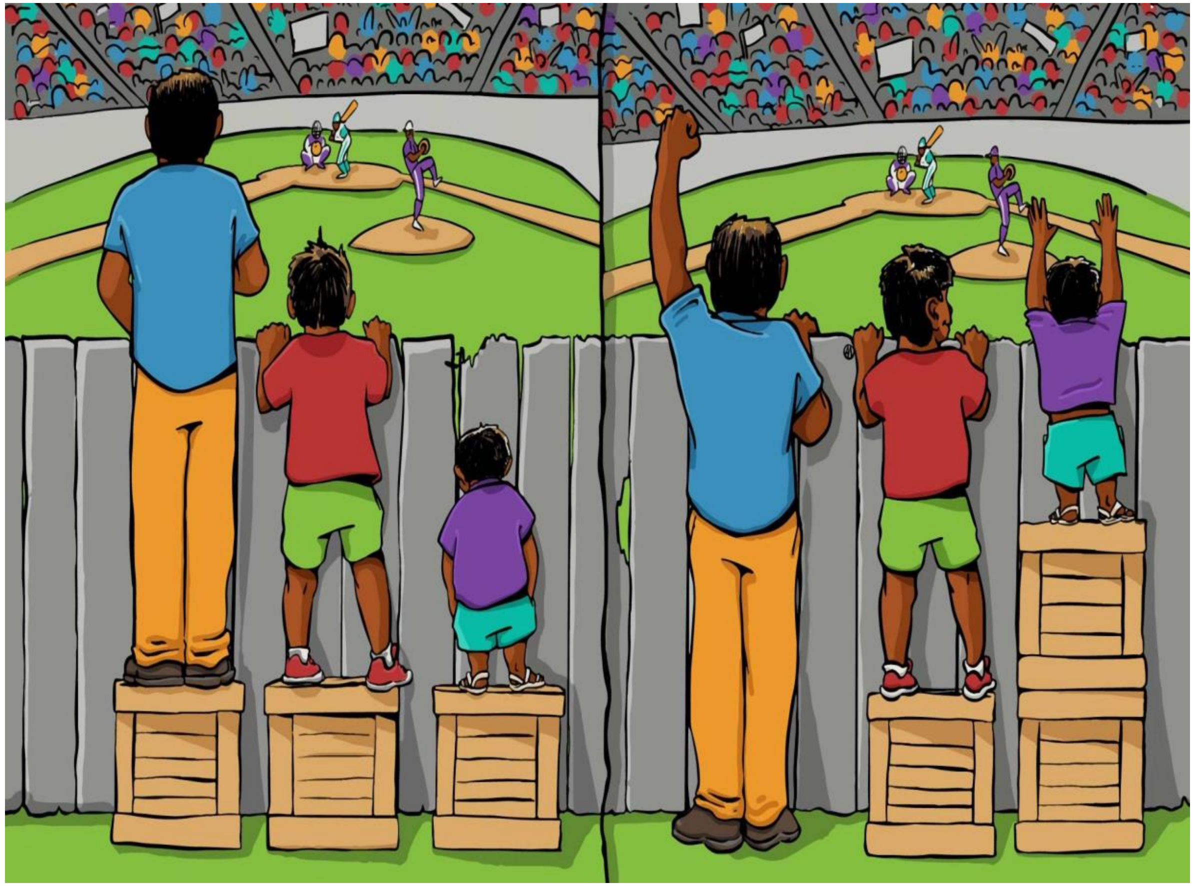
- Prior to getting to this point, states and utility commissions should observe that vehicle electrification is here, and utility participation in the transition is a key component of meeting long-term climate goals. Short-, medium-, and long-term utility planning therefore needs to become aligned with these goals.

Recommendation 1: Differentiate policy approaches between LDVs and MHDVS

Utility regulators and utilities should create policies and programs that account for the differences between, and therefore lend more tailored support for, the deployment of infrastructure necessary to support the electrification of both medium- and heavy-duty vehicles (MHDVs) and light-duty vehicles (LDVs).



Recommendation 2: Equity Should Come First



State policymakers and utilities should prioritize charging station deployment in:

- Low-Income Communities
- Areas with Disproportionate Air Quality and Environmental Impact
- Emphasis on MHDVs in these areas

Programs should ensure deployment barriers for all stakeholders are identified and overcome. Particularly:

- small and women/minority-owned businesses

Recommendation 3: Targeted Marketing, Education, and Outreach is Necessary

Utilities, in collaboration with various local organizations and businesses, should develop targeted marketing, education, and outreach (ME&O) materials to help disseminate information to potential EV purchasers, recognizing that different communities and market segments will need nuanced approaches to how information is provided and presented.

- e.g., LDVs and MHDVs have wildly different infrastructure barriers and needs

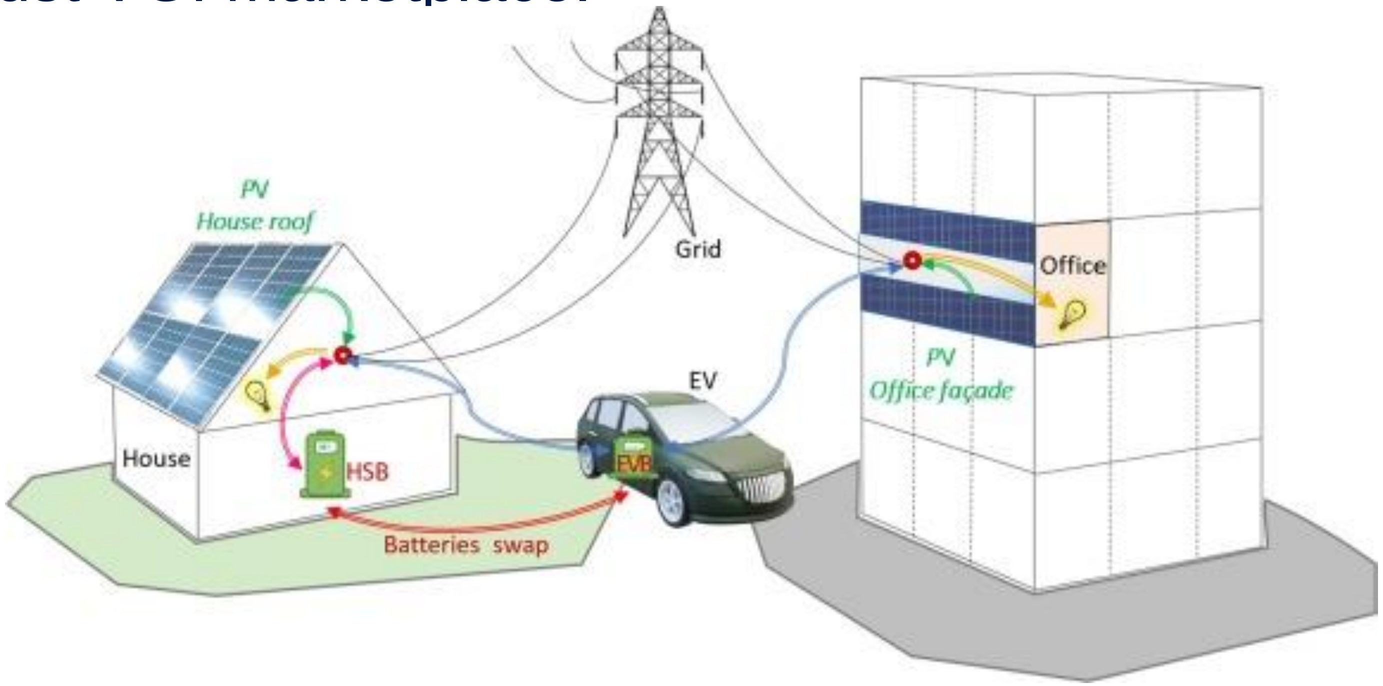
Recommendation 4: Fostering Accountability Drives Results

Utilities should be required to collect and monitor data to show the extent to which EVs are being effectively integrated into the grid, ensure prudent expenditure of ratepayer funds, and demonstrate achievement of pre-determined metrics and goals.

- *Conduct Grid Impact and Market Potential Analyses*
- *Develop, and Update Hosting Capacity Maps*
- *Publish Frequent Reports*

Recommendation 5: Develop Robust Vehicle-Grid Integration Strategies

1. Seek to Mitigate Fleet Charging Infrastructure Cost
2. Seek to Mitigate Grid Build-Out and Integrate More Renewables
3. Leverage EVs to Boost Resiliency and Reliability
4. Use price signals, communications protocols, and supporting technologies to foster a robust VGI marketplace.



Recommendation 6: Safeguard EV Charging Infrastructure

To better harness the benefits of EVs and provide a better customer experience, state and utility policymakers must establish infrastructure, communication, and safety standards to help harmonize transportation electrification efforts.

Recommendation 7: Broaden Infrastructure Programs to include Low-Cost Solutions

Key Finding of GNA Study was clear benefits of managed charging and DERs, such as solar and storage. These include:

- *Lower total cost of ownership for fleets*
- *More adaptive response to grid conditions*
- *Reducing grid impact, including peak load*

Designing Effective Electricity Rates for EVs

Elizabeth Stein, *Lead Counsel, Energy Transition Strategy*

Electric Pricing for Charging MHDVs

- Keep bills manageable (preferably competitive with diesel) while moderating costly grid impacts.
- Evaluate the impact of existing rates in various fleet scenarios – and consider new approaches to improve the electrification business case for fleets and/or the system impact.
- Expect to need a suite of options for diverse MHDV customers.

Electric service pricing can help optimize VGI

Price signals can provide incentives for EV operators…

- to charge during off-peak times or when there is a surplus of renewables
- to charge in a manner that avoids unwanted demand spikes, and even provide ancillary services or improve system reliability
- to charge in places where capacity exists
- to deploy clean energy DERs such as distributed solar and storage

and

- to discharge when beneficial to the grid for reliability and other purposes

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