EV-GRID INTEGRATION CHALLENGES AND BEST PRACTICES

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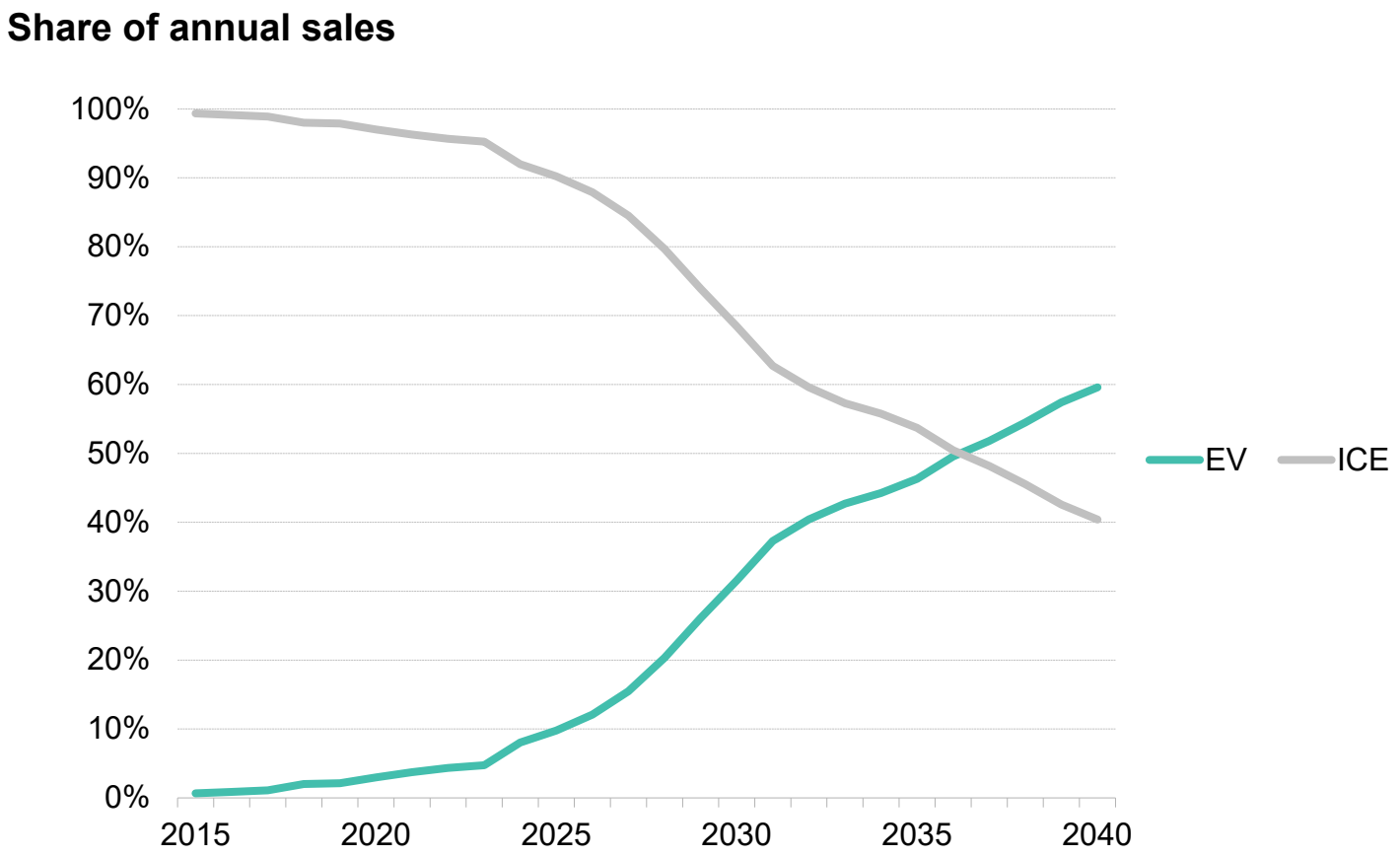
ARE YOU READY FOR THIS?

- Rapid EV adoption is expected around 3 years from now
- EVs overtake ICE by 2037



MOST COMMUNITIES AREN'T…

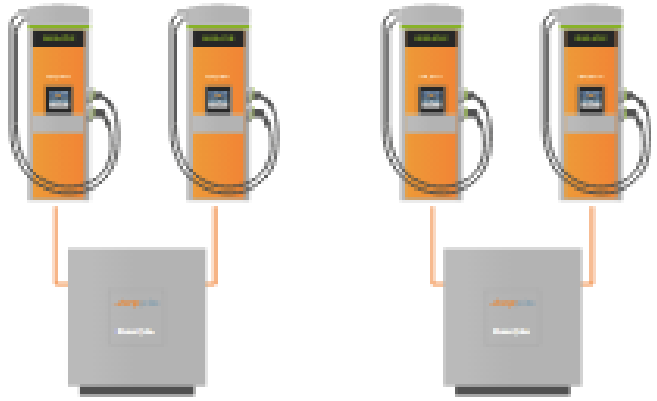
Bloomberg New Energy Finance warns the U.S. will hit an **"infrastructure cap"** in the mid-2030s due to a lack of charging stations.

The questions we should be grappling with now are:

- **what kind** of EV chargers we need
- **where** to build EV chargers
- **who** should own them
- **whether** utilities should be able to recover costs via the rate base
- **how** to make fast charging a profitable (sustainable) business – role of utility vs. private sector operators
- **should** the cost of infrastructure be broadly (i.e. federally) socialized?

DIFFERENT RATES FOR DIFFERENT USE-CASES

For Level 2 chargers, which are mainly used for residential and workplace charging (8 hours or more), a conventional Time of Use (ToU) rate design to encourage **managed charging is appropriate**.

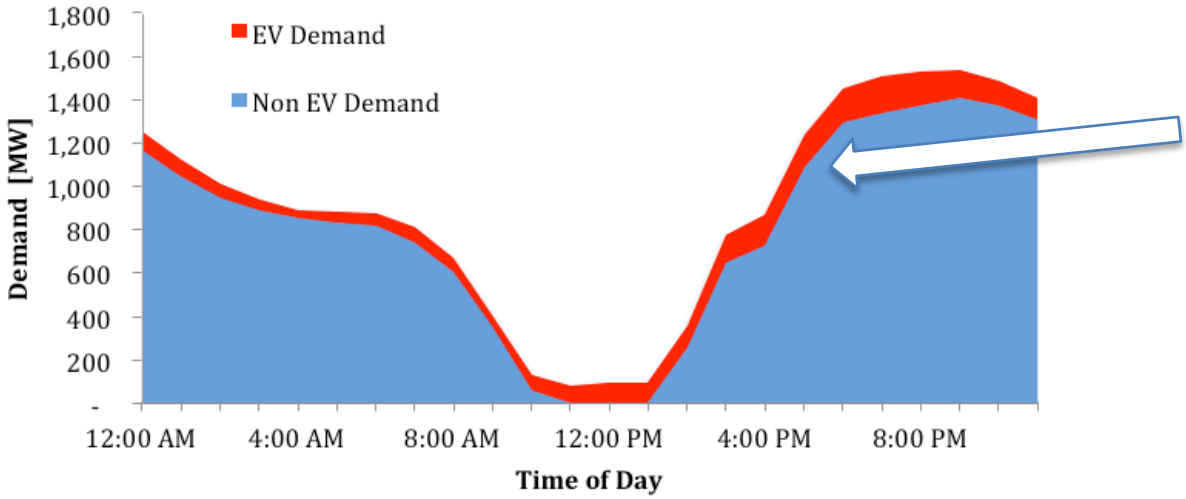


For DCFC (50-350+ kW), a more sophisticated rate design is needed, which minimizes the role of demand charges until the market matures.

- The load is “spiky” and unpredictable.
- The DCFC use-case is **not conducive to managed charging**.

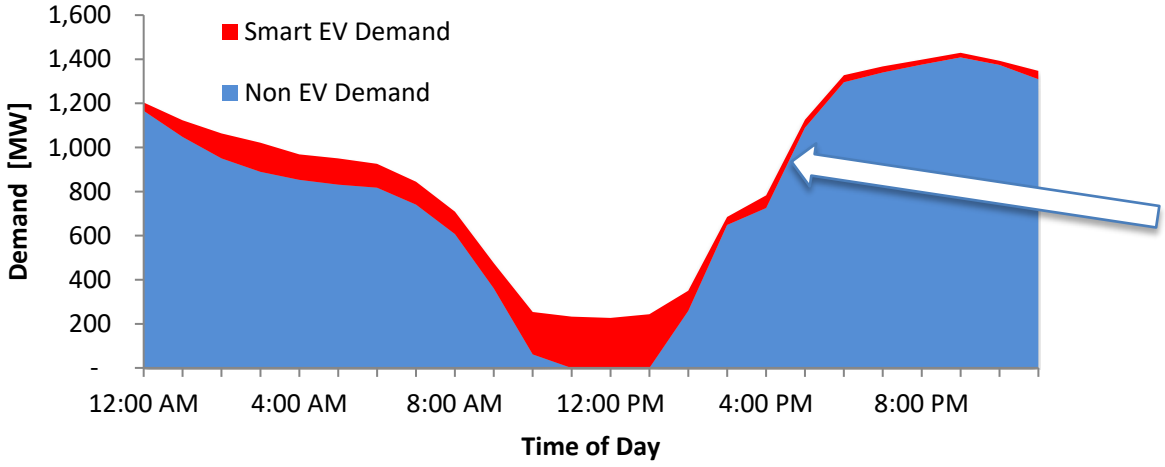
MANAGED CHARGING

- Projected HECO demand with 23% EV penetration with uncontrolled EV charging



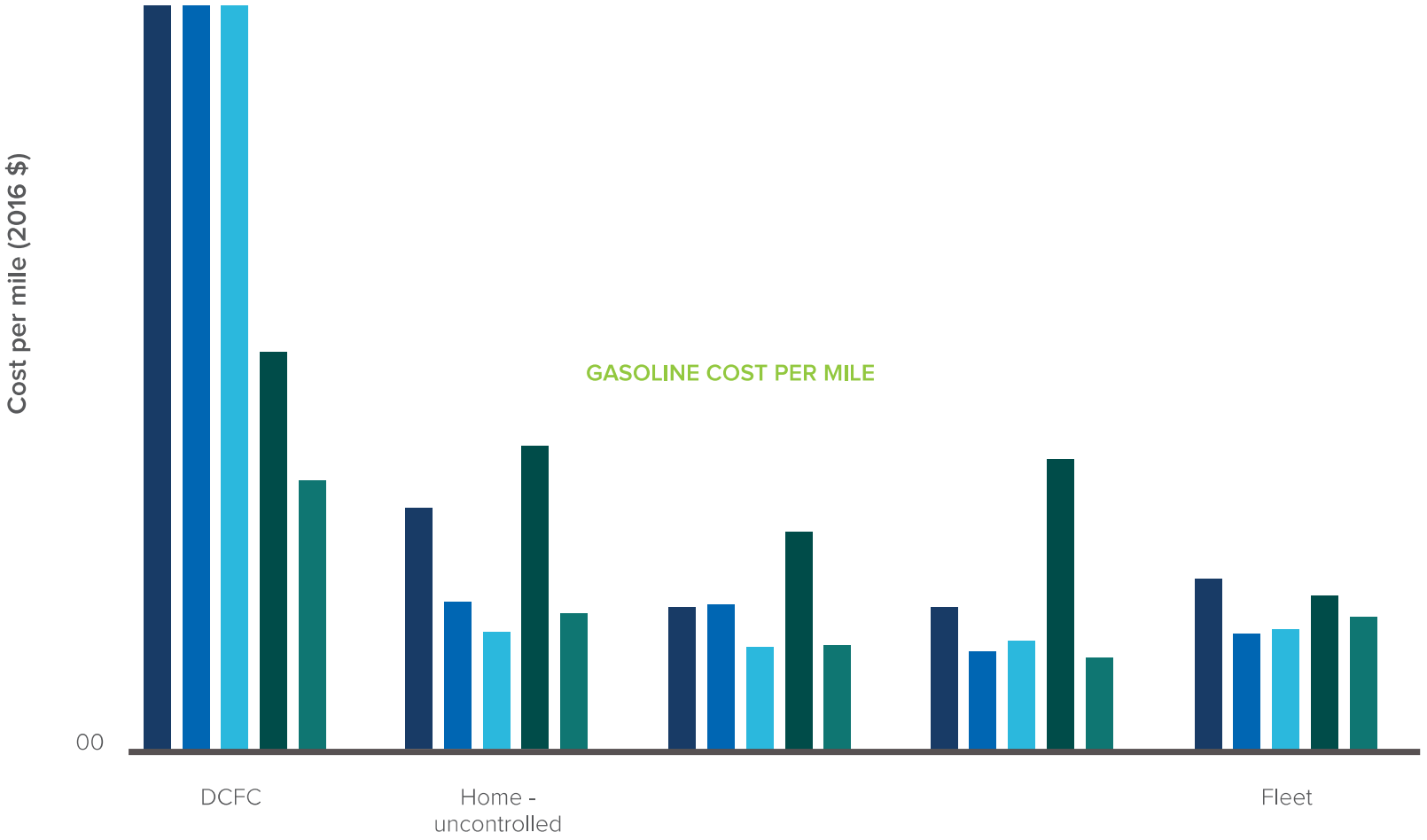
Big "duck curve"

- Projected HECO demand with 23% EV penetration with managed EV charging



Smaller "duck curve"

LEVEL 2 IS COMPETITIVE WITH GASOLINE; DCFC ISN'T



RATE DESIGN OBJECTIVES

- Charging should be **profitable** so that it is sustainable.
- Charging should always be **cheaper than gasoline** (typically **$0.29/kWh, or ~$0.09/mile, or less**).
- Level 2 charging should be considerably **cheaper than DC fast charging.**
- EV chargers should be on **dedicated tariffs** and on **separate meters**, preferably the meter built into the charging station.
- Tariffs should offer an opportunity to **earn credit for providing grid services** through **managed charging**.

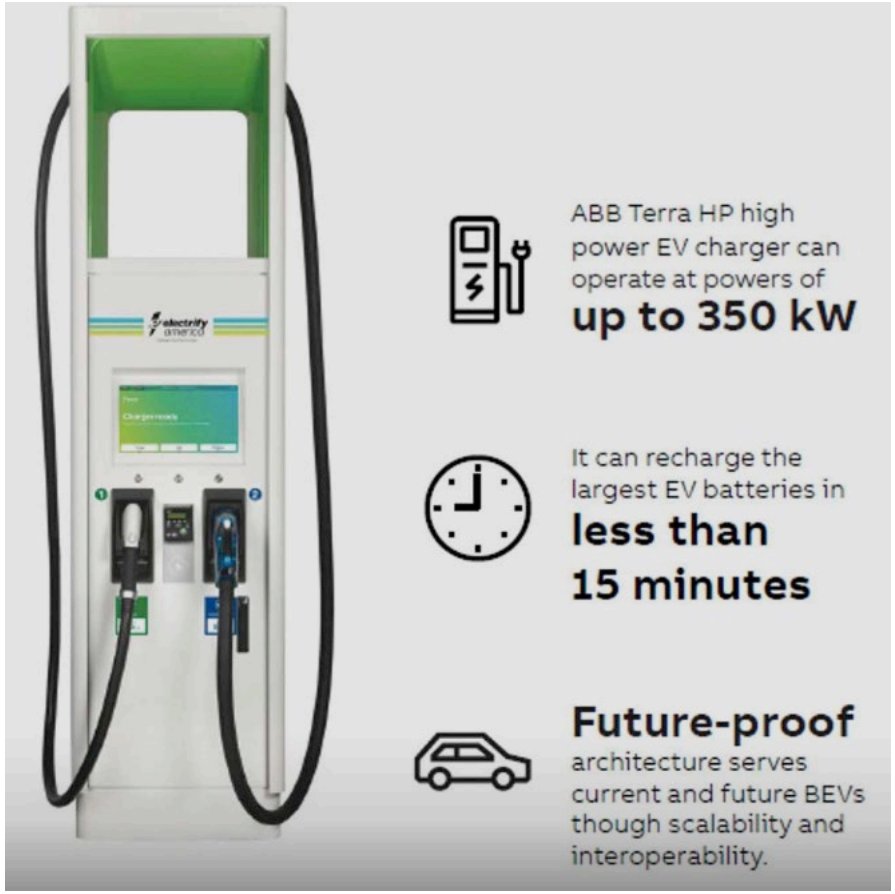
KEY ISSUES WITH DCFC RATE DESIGN

1. **DC fast charging is mostly a market failure.**
2. Public **DCFC are critical** parts of the network. We cannot achieve our transportation electrification aims without widespread public DCFC.
3. Conventional utility rates with **demand charges can kill the business case** and are not suitable. On public DCFC with low utilization rates, demand charges can be as much as **80-90%** of a monthly bill.
4. New, **DCFC-specific rates are needed** while the market is young and charger utilization rates are low.
5. **Charging depot loads will be significant.** In addition to today's 50-150 kW DCFC loads, let's have a view toward funding & recovering costs for 2 MW loads at public charging depots and 20 MW loads at truck stops.

CHARGING INFRASTRUCTURE: TODAY AND TOMORROW

Everything is changing…

- Yesterday: **1** kW home charging, **50** kW fast chargers
- Today: **7** kW Level 2 home and workplace charging, **150 - 350** kW fast chargers
- Public fast-chargers site with retail, not gas stations
- 1.8 MW “mega-chargers” at truck stops
- Electrify America installing 150 DCFC network. Charging power levels up to 350kW will be available at every station
- Home charging is dominant now, but will not be as EV range grows and adoption moves to apartment dwellers



WATCH OUT FOR…

Large new loads	Can require
Residential Level 2 chargers (2.9 – 7.7 kW) • **Each EV is like adding a new house**	• Distribution transformer upgrades
Workplace Level 2 chargers (7.7 – 16.9 kW) • Up to ~1 MW	• Distribution transformer upgrades • Feeders • Service panel upgrades
Public high-speed (DCFC) charging depots • 50 kW – 2 MW • Most new public DCFC are 150 kW	• Distribution transformer upgrades • Feeders • Service panel upgrades • Make-ready
Transit bus barns, fleet vehicle yards • 5 – 30+ MW	• Distribution transformer upgrades • Feeders • Service panel upgrades • Make-ready
Interstate truck stops • 20 – 40 MW	

DISTRIBUTION GRID UPGRADES WILL BE REQUIRED

- Vehicle range is increasing (200+ mi), demanding more DCFC charging (150+ kW)
- Use-cases more general (Class 1-6, all-purpose)
- Clusters of Level 2 chargers in residential neighborhoods may require distribution transformer upgrades
- Multi-unit dwellings and workplaces will need dozens of Level 2 chargers
- Charging at home could become secondary
- On-peak/daytime charging could increase
- Sites with multiple chargers will have large power requirements (1+ MW)
- Private charging companies seek high utilization rates (8 hours/day) to chargers more profitable

MEDIUM- AND HEAVY-DUTY VEHICLES REQUIRE EARLY PLANNING FOR UTILITIES AND THE ELECTRIC GRID

Electric buses, delivery trucks and vans are *here today*

By 2025, depots for MD/bus fleets will be here, drawing 4-30 MW per site

- Early planning helps with site selection and planning, avoid or minimize large grid upgrade costs
- These loads could cause grid constraints. We recommended that Seattle City Light engage with fleet customers and begin support planning *now*.

FedEx chanje

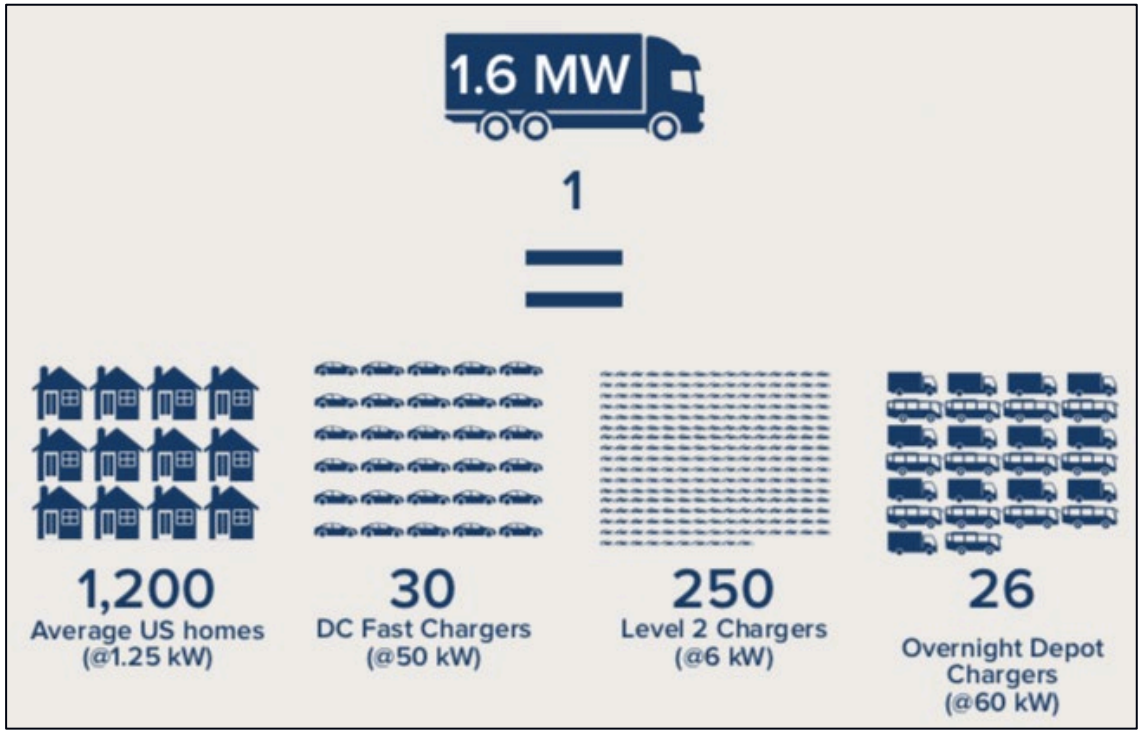
FedEx orders 1000 Chanje electric delivery vehicles

amazon RIVIAN

Amazon orders 100,000 electric delivery vans from startup Rivian

UPS WORKHORSE

UPS buys 1000 electric vans from Workhorse



SPECIAL CONSIDERATIONS FOR MEDIUM- AND HEAVY-DUTY VEHICLES

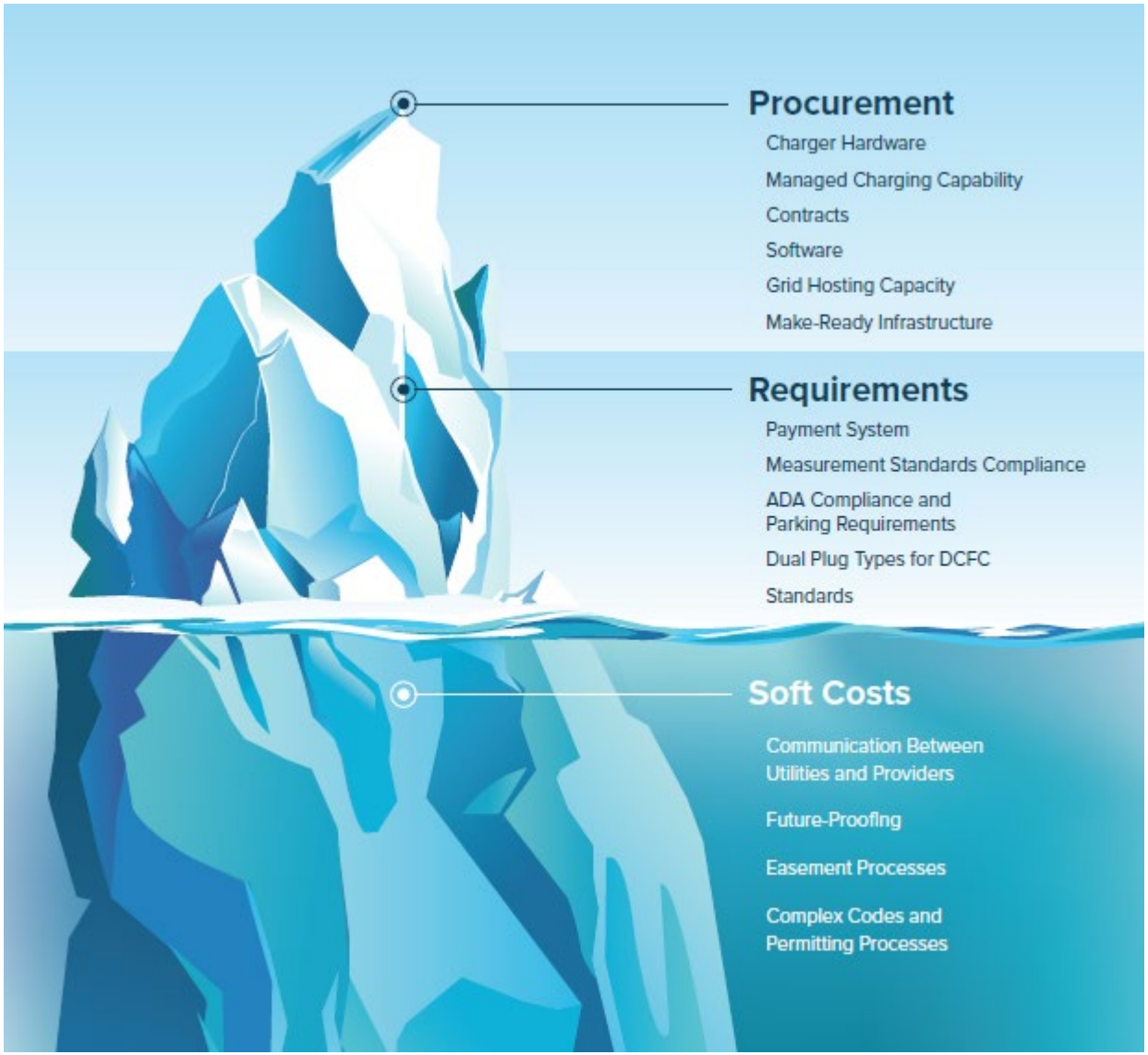
Fleet managers need help

- A steep and treacherous learning curve.
- Most fleet managers are unfamiliar with charging equipment, operational aspects of managing charging, financial impacts of charging and maintaining electric fleets, etc.
- Horror stories abound.
- **Utility outreach is essential** to sense future MHD loads, and to help fleet managers plan infrastructure.

Long-haul HD trucks will be the last to electrify:

- Technology at prototype stage, with 12 manufacturers targeting 2020/21 for first models
- Will require build-out of national network of "mega"-chargers
- **Significant grid upgrades will be required to handle ~40 MW loads in small rural communities.**
- Possible disparate impact in rural communities along freight routes.

PROCUREMENT CONSIDERATIONS



- Procurement should require open standards
- Future-proofing isn't easy
- Utility engagement is critical
- Soft costs and other process issues incur unnecessary expenses

UTILITY OWNERSHIP OF CHARGING INFRASTRUCTURE

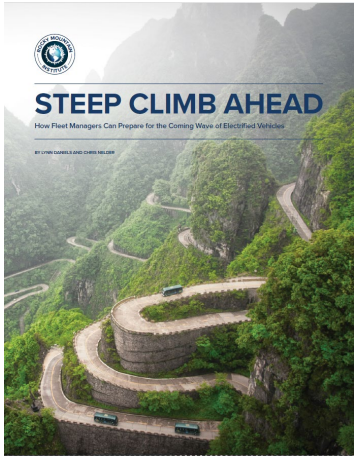
Jurisdictions vary in their views on utility ownership of charging infrastructure.

- Utility investment in **"make-ready"** infrastructure is probably okay everywhere, BUT…
- Utility incentives to invest in make-ready should be **performance-based**
- Utility investment in charging stations (not just make-ready) should focus on installations that are **unlikely to interest private sector** companies, like low-income multi-unit dwellings
- While the sector is young, test multiple models via **pilot projects**.

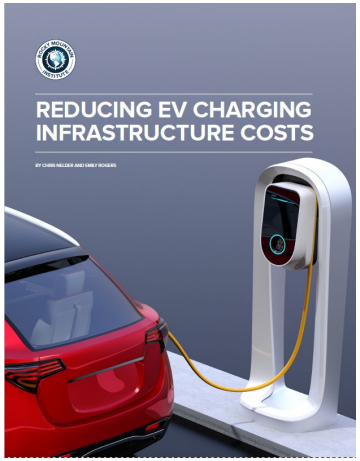
MOVE FAST AND FIX THINGS

- Transportation electrification is a rapidly changing space, full of uncertainty
- Potentially large loads on the way, plan ahead to minimize capital expenditures
- Model early and often, challenge assumptions and be ready to abandon them
- Work to cut red tape in deploying charging infrastructure
- Develop programs/rates for EV customers today
- Be ready for accelerated adoption tomorrow
- Help fleets prepare for the “steep climb ahead”

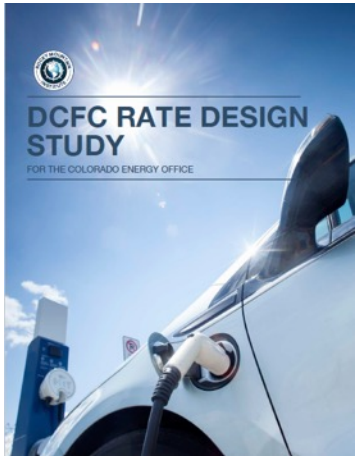
RMI EV-GRID REPORTS



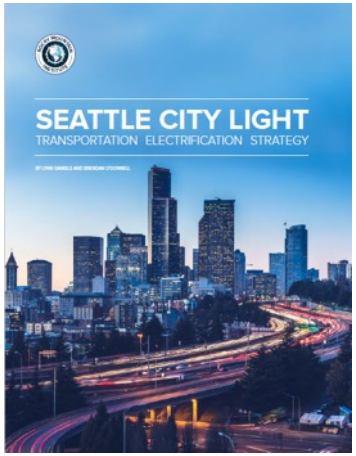
Steep Climb Ahead **(January 2021)**



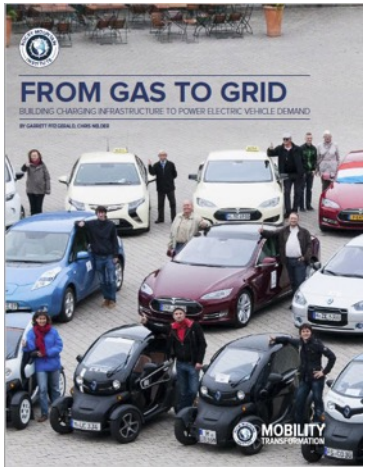
Reducing EV Charging Infrastructure Costs **(January 2020)**



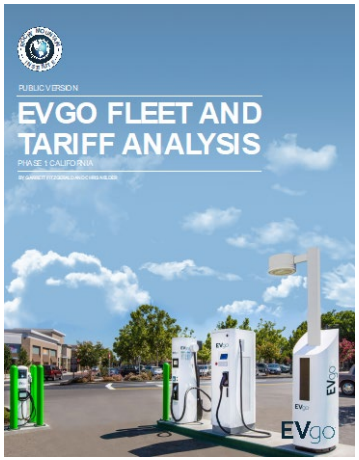
DCFC Rate Design Study **(Sept 2019)**



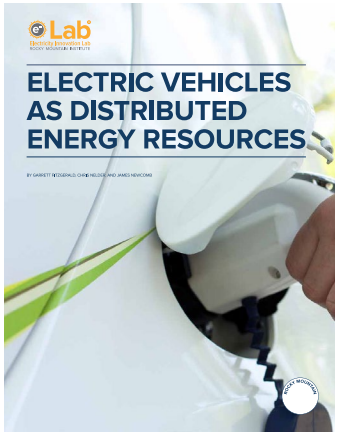
Seattle City Light TE Strategy **(Aug 2019)**



From Gas to Grid **(October 2017)**



EVgo Fleet and Tariff Analysis **(March 2017)**



Electric Vehicles as Distributed Energy Resources **(June 2016)**

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