ADDRESSING GRID CONSTRAINTS THROUGH RATE DESIGN

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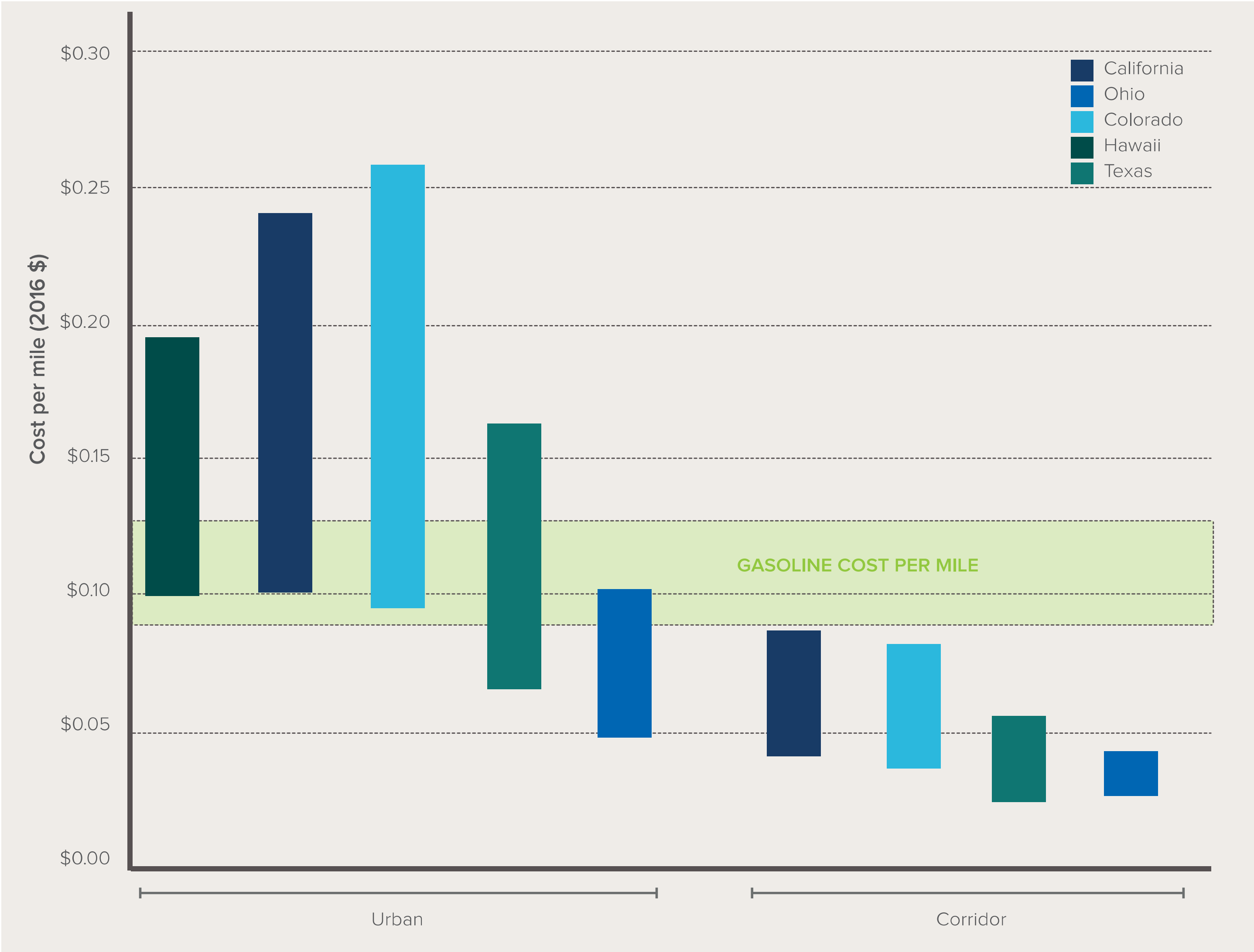
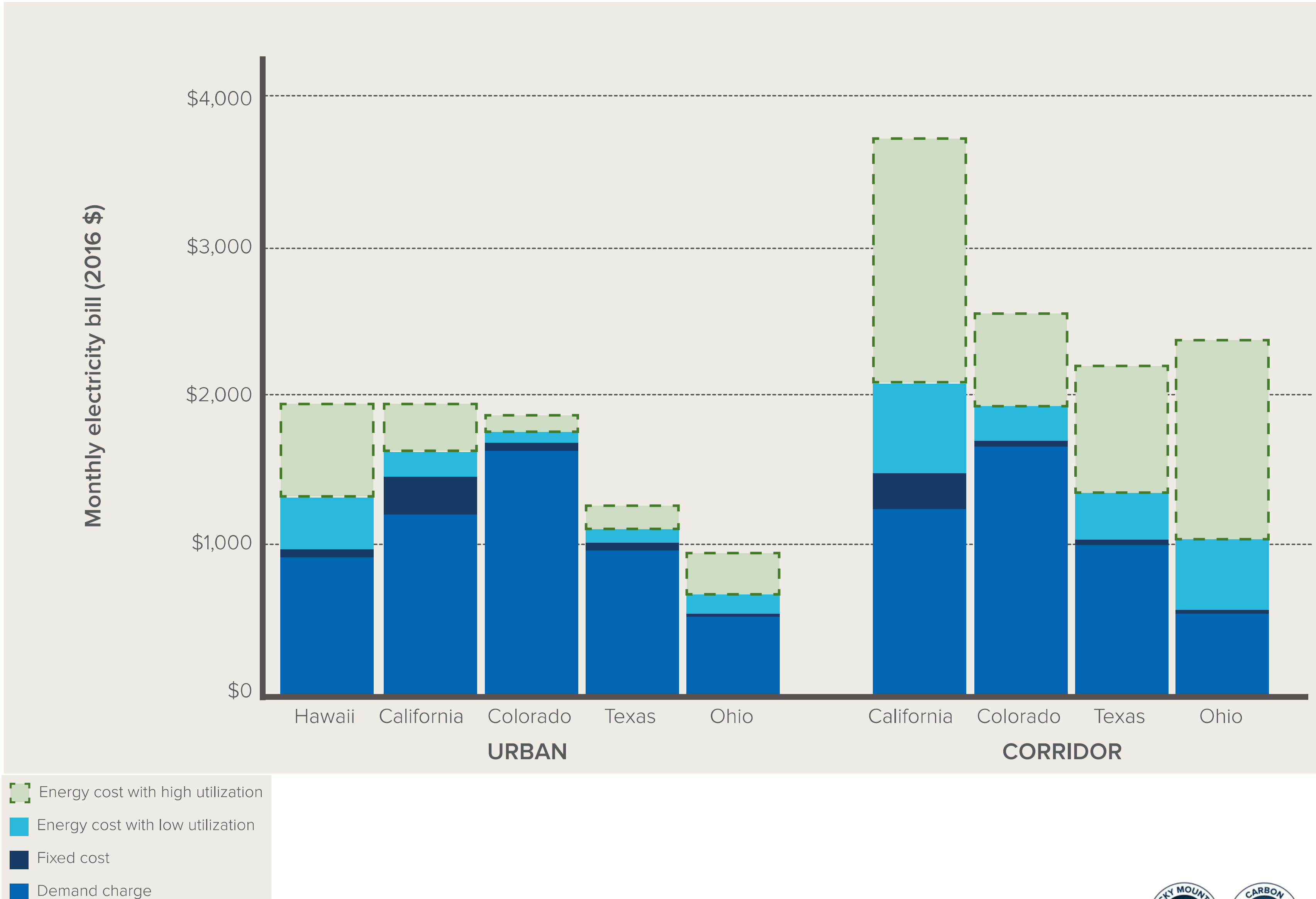
CORRIDOR DCFC PENCIL OUT; URBAN DCFC, NOT SO MUCH



DEMAND CHARGES KILL AT LOW UTILIZATION



EVGO STUDY: DEMAND CHARGES

Demand charges can make up a very high percentage of the charger's monthly bill if utilization rates are low.

Tariff	Host Type A	Host Type B	Host Type C	Host Type D
SCE ToU EV 4 (actual)	70%	75%	77%	81%
SCE ToU EV 8 (proposed)	0	0	0	0
SDG&E AL-ToU Commercial (actual)	88%	91%	92%	94%
SDG&E Public Charging GIR (proposed)	0	0	0	0
PGE A-6 ToU with Option R (actual)	0	0	0	0
PG&E A-10 (actual)	67%	73%	76%	81%

EVGO STUDY: DEMAND CHARGES

- Tariffs with high demand charges are problematic for public DCFC with low utilization rates. Tariffs that de-emphasize demand charges are more favorable to DCFC operators.

Category	Host Type A	Host Type B	Host Type C	Host Type D
Utilization	15%	8%	8%	4%
SCE ToU EV 4 (actual)	$1,933	$1,817	$1,762	$1,682
SCE ToU EV 8 (proposed)	$808	$648	$569	$461
SDG&E AL-ToU Commercial (actual)	$3,313	$3,219	$3,178	$3,114
SDG&E Public Charging GIR (proposed)	$501	$329	$255	$138
PGE A-6 ToU (actual)	$484	$322	$260	$150
PG&E A-10 (actual)	$1,318	$1,197	$1,147	$1,065

Monthly utility bill by rate and host type

EVGO STUDY: DEMAND CHARGES

Tariffs that de-emphasize demand charges are more favorable to DCFC operators.

SCE	Fixed	Energy	Demand	Total
TOU EV4	$220	$278	$1,362	$1,938
TOU EV 8 without demand charges	$330	$478	$0	$808
TOU EV 8 with demand charges in year 11	$330	$368	$792	$1,490

SDG&E	Fixed	Energy	Demand/Dynamic	Total
AL-TOU	$116	$279	$2,545	$2,941
Public GIR	$0	$452	$115	$567

EVGO STUDY: ICE PARITY

PUBLIC DCFC RATE DESIGN ISSUES

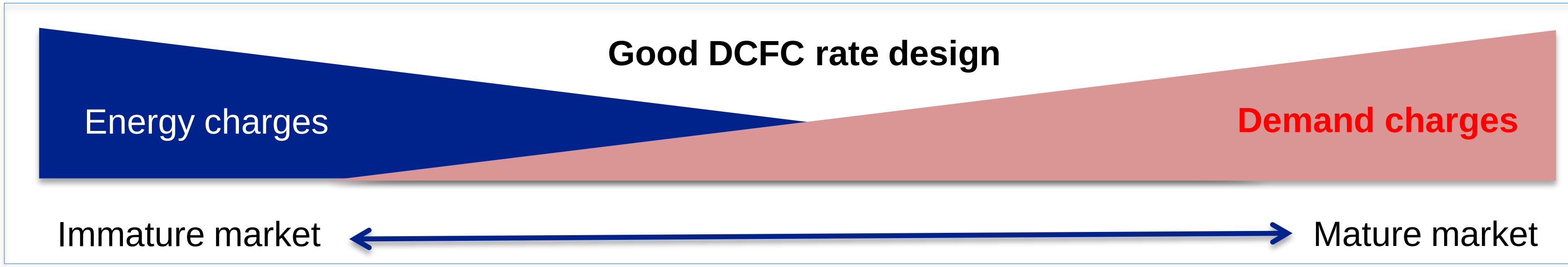
- It is critical that tariffs support public charging infrastructure.
- Most existing tariffs are not designed for DCFC operators and are not suitable:
  - Do not accurately reflect the true cost of service
  - Are not consistent across utilities
  - Lack appropriate price signals for effective integration of EVs onto the grid
- DCFC utilization varies by host type, and increasing utilization eases issues with demand charges.

We need tariffs that create a better business case for DCFC owners & operators

RATE DESIGN GOALS

- 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 should be considerably **cheaper than DCFC**.
- 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.
- Ideally, utilities could leverage DERMS and offer rates that vary by location to **promote a more efficient use** of existing grid infrastructure.

BEST PRACTICES FOR RATE DESIGN



- Tariffs should be **time-varying**, and preferably dynamic, while recovering most utility costs.
- Tariffs should have **low fixed charges** which primarily reflect routine costs for things like maintenance and billing.
- Tariffs should reflect the actual cost of providing service, and should charge more for **coincident peak demand.**
- Tariffs for DCFC should de-emphasize demand charges and **shift more cost to volumetric charges until market matures** and utilization rates climb, then scale up demand charges and scale down volumetric charges.
- If demand charges are necessary, they should be designed to recover **only location-specific costs of connection to the grid, not upstream costs**, so that customers sharing capacity share costs, and continuous-capacity customers are not subsidized by spiky loads.

MANAGED CHARGING

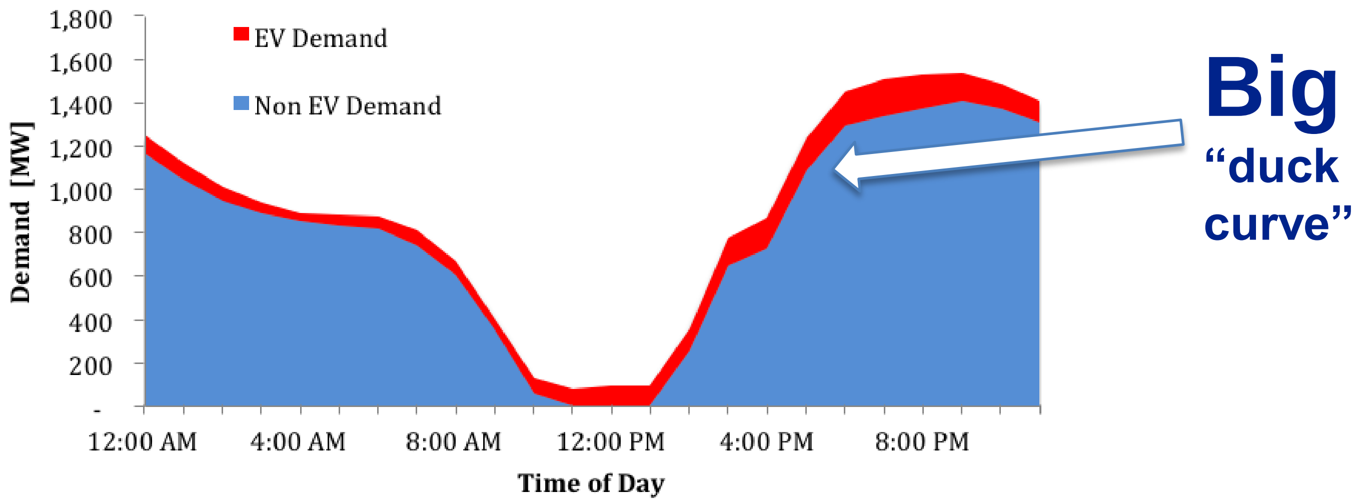
Managed charging of electric vehicles (G2V not V2G) can deliver many benefits *

- Optimize existing grid assets and extend their useful life
- Avoid new investment in grid infrastructure
- Supply ancillary services, such as frequency regulation and power factor correction.
- Absorb excess wind and solar generation
- Reduce emissions
- Reduce electricity and transportation costs
- Reduce petroleum consumption

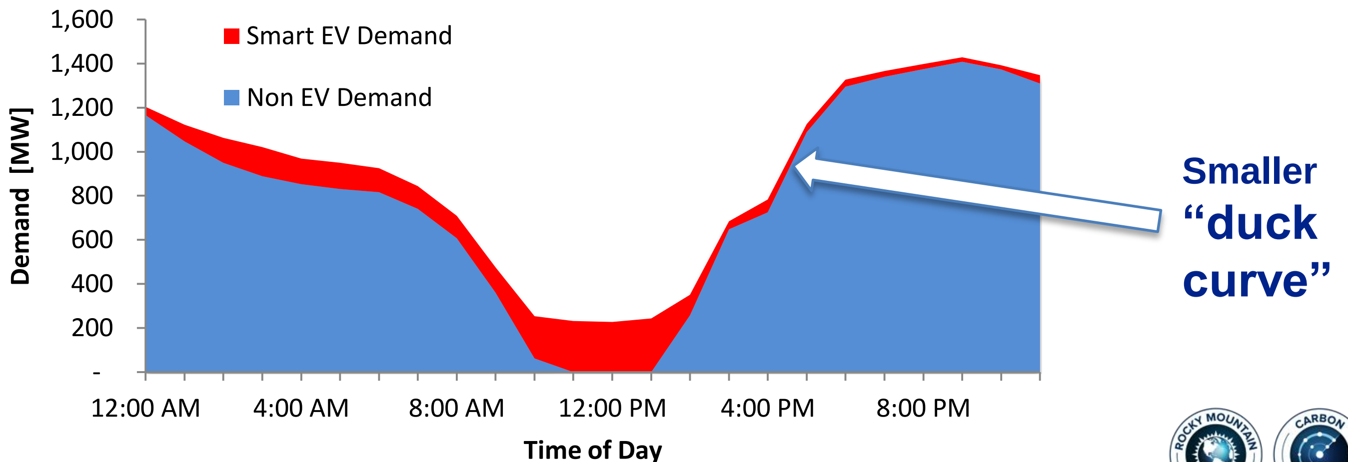
* But: Managed charging is difficult and costly with DCFC depots

MANAGED CHARGING - PRESSED DUCK

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



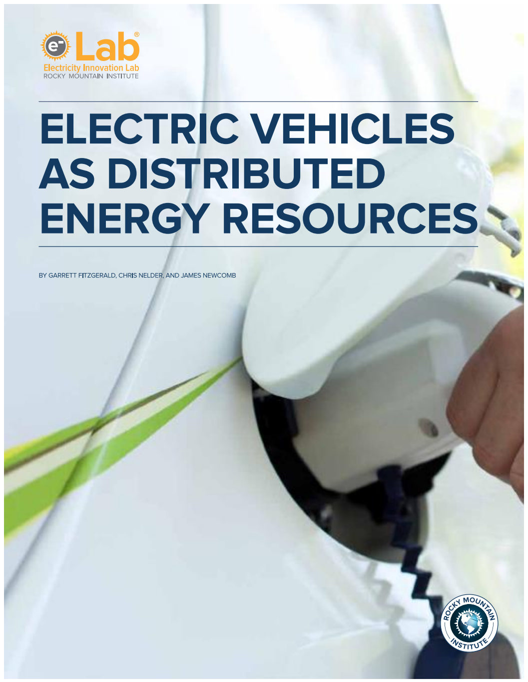
- Projected HECO demand with 23% EV penetration with managed EV charging



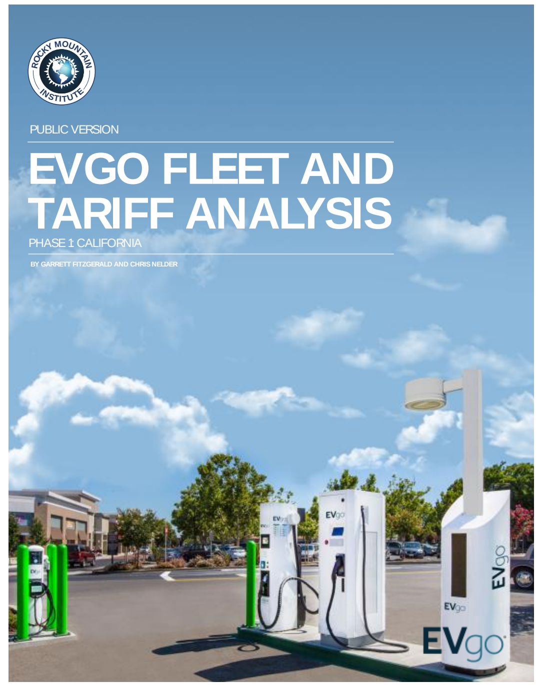
KEY ISSUES

1. **DCFC is a market failure** we will have to correct to achieve our transportation electrification aims.
2. **Demand charges are problematic with low utilization, spiky loads.** If needed at all, demand charges should scale with utilization rates, and only recover location-specific costs of connection to the grid, not upstream costs.
3. **Utility tariffs should encourage managed charging.**
4. Charging infrastructure paid for with ratepayer money should **support managed charging.**
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.

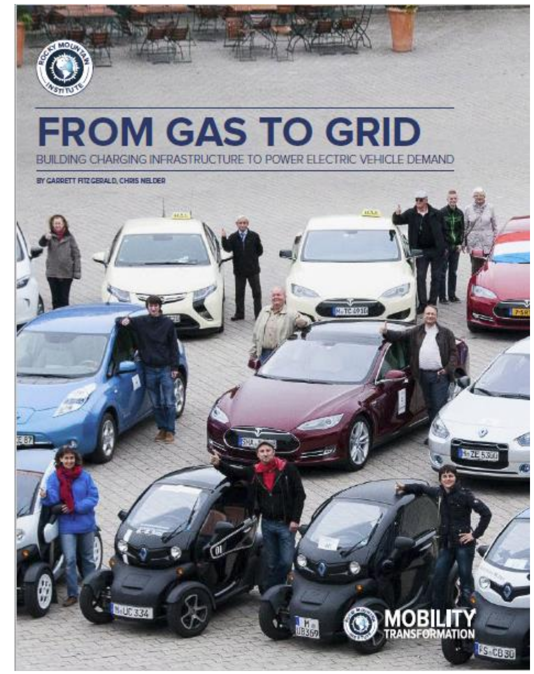
RMI EV-GRID REPORTS



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



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



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

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Chris Nelder is a Manager in the Mobility practice at the Rocky Mountain Institute in Boulder, Colorado, where he heads the EV-grid Integration team. Chris has written about energy and investing for more than a decade. He is the author two books on energy and investing, as well as more than 200 articles on energy in publications such as *Nature*, *Scientific American*, *Slate*, *The Atlantic*, *Quartz*, *Financial Times*, *Greentech Media*, *SmartPlanet*, and *the Economist Intelligence Unit*. In his spare time, he hosts the Energy Transition Show podcast. He enjoys bantering with other energy geeks on Twitter at @chrisnelder.