VGIC
VEHICLE-GRID INTEGRATION COUNCIL

State of Bidirectional Charging

April 7, 2026

Board Strategic Development Committee and Special SMUD Board of Directors Meeting

EVs represent **untapped potential** beyond mobility as distributed energy resources to support an affordable and reliable energy future

Vehicle-Grid Integration Council is focused on unlocking the value of managed charging, bidirectional charging, and DER-paired charging

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What is Vehicle-Grid Integration (VGI)?

VGI encompasses the suite of ways EVs can provide services to the grid and increase the value proposition of EVs:

Managed Charging	Grid-Isolated Bidirectional Charging	Grid-Parallel Bidirectional Charging	Flexible Service Connection	DER-Paired Charging
• Passive or active load shift	• Islanded configuration to power a home, or building	• Utility-interconnected to minimize customer bills and/or provide grid services	• Minimizing time and costs for infrastructure deployment using load management solutions and/or distributed energy resources (DER)	• Co-located or integrated with customer generators and/or stationary energy storage

Why VGI Now?

- Accelerate Transportation Electrification
- Support the Evolving Power Sector
- Increase Affordability of Electricity
- Improve Community Resilience
- Foster Economic Activity

Light-duty vehicle + charger pairings for **Home Backup Power**

Vehicle	Compatible Charger
Nissan LEAF	dcbel Ara
Volvo EX90	
Polestar 3	
Ford F-150 Lightning Electric	Ford Charge Station Pro
Chevrolet Bolt EV	GM Energy PowerShift
Chevrolet Silverado EV	
Chevrolet Blazer EV	
Chevrolet Equinox EV	
Cadillac Lyriq	
Cadillac Escalade	
Cadillac Optiq	
Cadillac Vistiq	
GMC Sierra	
GMC Hummer	
Kia EV9	Wallbox Quasar 2
Tesla Cybertruck	Tesla Universal Wall Connector

Additional product announcements: Toyota, Hyundai, Rivian, VW, Lucid, Chargepoint, Enphase, Emporia, Autel, and SolarEdge

Grid-Parallel Bidirectional Charging: Electric School Buses

- Due to predictable schedules and alignment with summer evening peaks, electric school buses are first to implement **grid-parallel** bidirectional charging
- Vehicles and chargers are *generally* interoperable, though implementations may still require addressing unexpected bugs:

Electric School Bus Manufacturers
BlueBird
BYD / RIDE
Thomas Built
IC Bus
MicroBird
Evolectric

Charger	Capacity
Tellus Power Green	20, 30, 40, or 60 kW
InCharge	22, 44, 66 kW
Heliox	44 kW

- Deployments in: Oakland (74 buses!), Fremont, Cajon Valley, Torrance, Ramona, and several outside of California

Grid-Parallel Bidirectional Charging: Passenger EVs

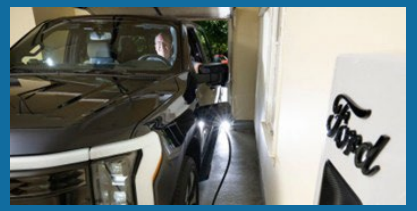
2008-2023

Testing and demonstrations

2024

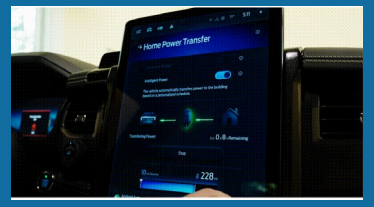
First customer grid-parallel deployment: Non-export with three Baltimore Gas & Electric (BG&E)

2025



BG&E expands three customers to **exporting**

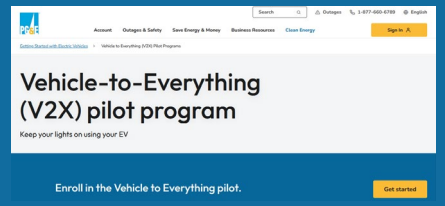
CEC funding launched seeking **~200 exporting** Kia EV9 (via Bidirectional Energy) and Nissan LEAF, Volvo EX90, and Polestar 3 (via dcbel)



Ford announces **additional non-exporting grid-parallel** tests in Vermont and Michigan

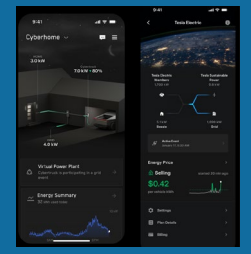
THE MOBILITY HOUSE

Massachusetts opens enrollment for **~50 fully subsidized exporting charger installations** (Ford, Nissan, Kia, Polestar, Volvo)



PG&E connects first two **grid-parallel customers** into V2X Pilot, which can support up to 1,000 customers

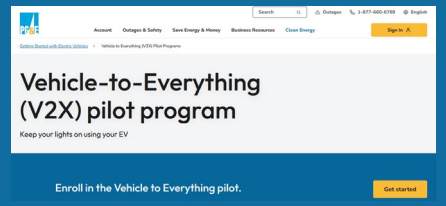
2026



Tesla announces **exporting pilot in Texas,** and upcoming launch for eligible PG&E, SCE, and SDG&E customers

PSE PUGET SOUND ENERGY ChargeScape

Ford, ChargeScape, and Kia announce **non-exporting** pilot with Puget Sound Energy



PG&E enrolls ~30 **grid-parallel customers** into V2X Pilot

What's it worth?

- The transition from one-off technology demonstrations to ~100 and ~1,000-customer deployment pilots will help **evaluate customer enrollment and behavior**
- The underlying **technical potential**, however, is immense:
  - The CEC estimates that California's current EVs house 18.5 GW of energy storage, more than all stationary energy storage in the state combined (~15 GW)

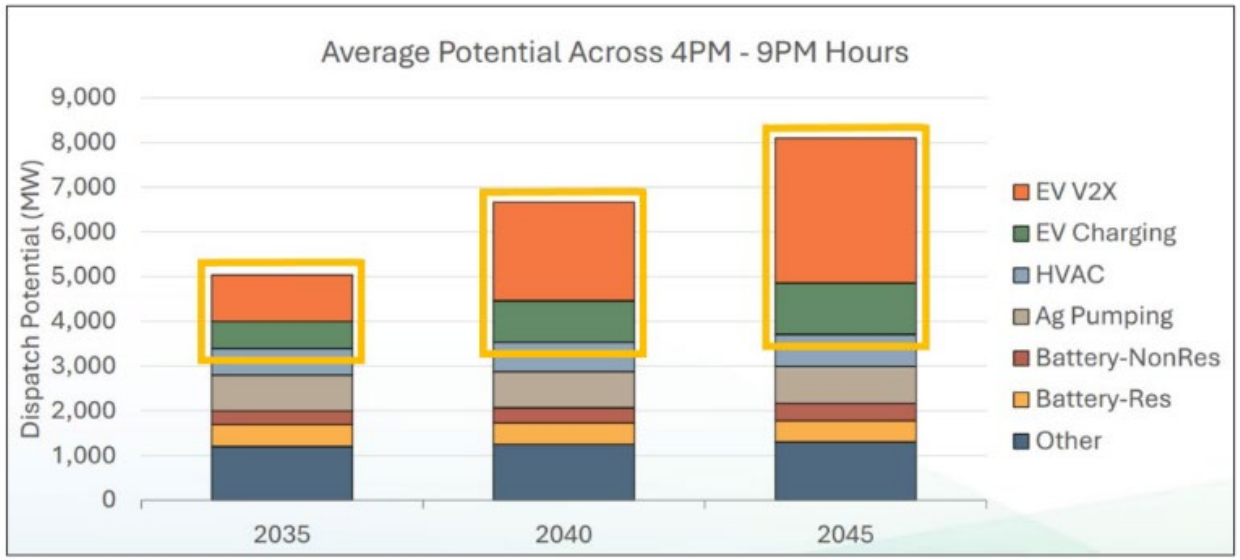
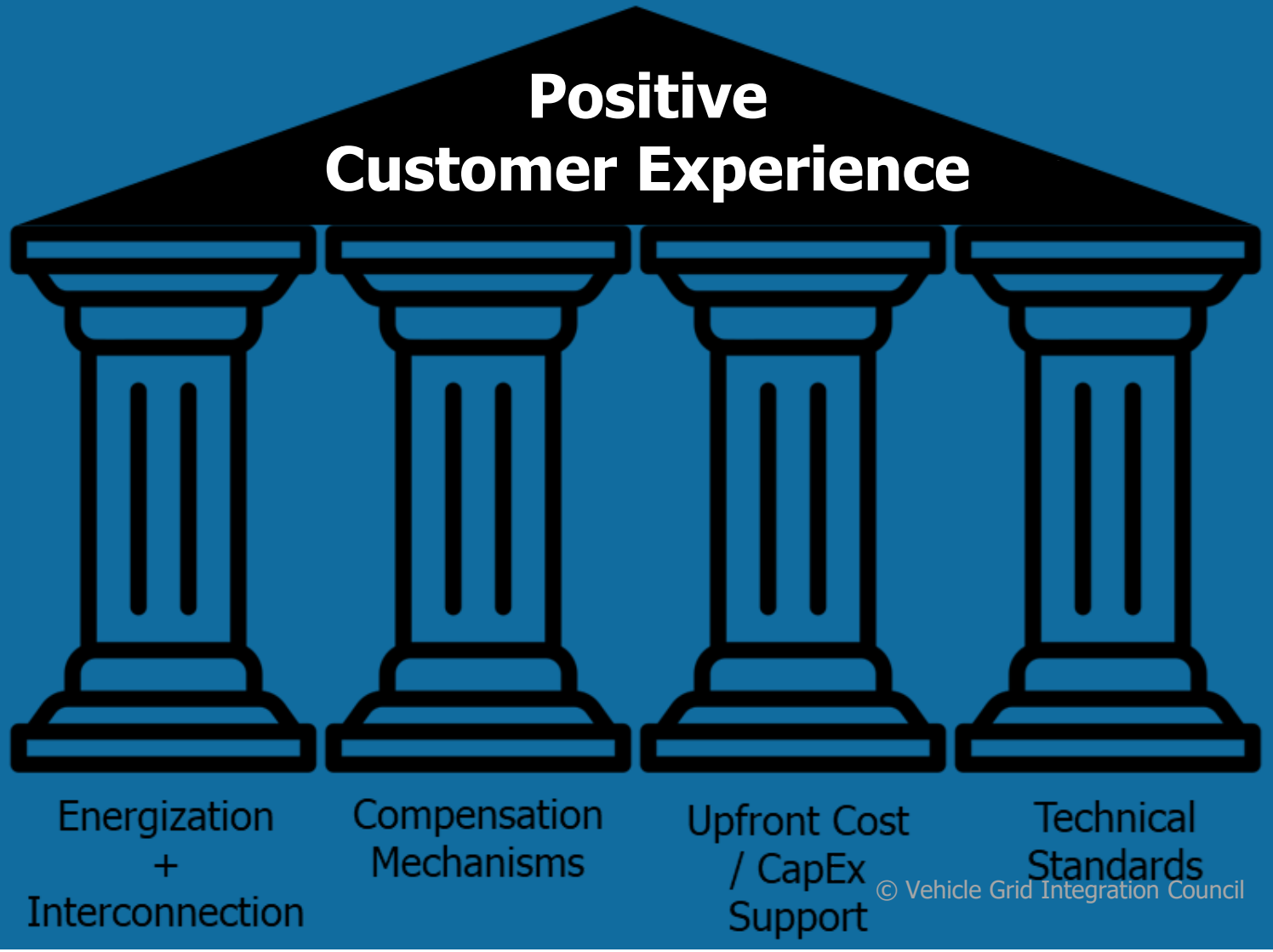


Figure 2: Demand flexibility potential of different resources

What's it worth? (continued)

Title	Organization	Findings
Roadmap to Unlocking the Benefits of Bidirectional Charging	California Energy Commission / National Lab of the Rockies	**Non-exporting** bidirectional charging could reduce California's peak residential demand by **5 GW in 2030**, yielding an average **annual savings of $321/vehicle**
Integrated Resource Planning Assumptions	California Public Utilities Commission / E3	**13.5 GW of additional capacity could be provided by bidirectional charging systems in 2045**
Residential vehicle-to-grid profits under dynamic pricing	Stanford University	EV owners can earn an annual *profit* of **$1,181 per EV** by exporting *only* when it is most beneficial to the grid.
Harnessing the Power of Electric Vehicles	Union of Concerned Scientists	In California, managed charging can save $4.2 billion in system costs by 2045, and bidirectional charging capability can unlock **an additional $3.5 billion at a modest 12.5% participation rate.**
The Utility Playbook: Turning EV Grid Risk into a $30 Billion Opportunity	EV.Energy / The Brattle Group	The study finds ~$5 billion of avoided costs from passive managed charging, ~$13 billion from active managed charging, and **~$12 billion from bidirectional charging by 2035 nationwide.**
Distribution System Constrained Vehicle-to-Grid Services for Improved Grid Stability and Reliability	Electric Power Research Institute (EPRI)	Maximum benefit to the grid of bidirectional charging ranging **between $450/year per vehicle to $1,850/year per vehicle in California.**
The Potential Electric Grid Benefits of Vehicle-to-Grid Technology in California	Lawrence Livermore National Laboratory	This study demonstrates that incremental benefits for California's grid equal **$337-$1,472 annually per EV for V2G vs V1G**.
The value of consumer acceptance of controlled electric vehicle charging in a decarbonizing grid: The case of California	UC Irvine	This California-specific study finds that the value of smart charging reaches $87 per vehicle-year, while that for **vehicle-to-grid can reach $2,850 per vehicle-year.**
Electrification Impact Study Part 2	PG&E / E3	**859 MW** of additional demand flexibility could be unlocked through bidirectional EV exports through 2040

How do we scale?



Interconnection Rules for Bidirectional Charging Systems – Case Studies

Clarifications and minor enhancements to existing DG/DER rules may be needed

Maryland
Pathway for both DC and AC equipment

California (IOUs)
Rule 21 pathway for DC equipment
Non-Rule 21 pathway for AC equipment

New York
Pathway for DC equipment

Massachusetts
Pathway for DC equipment

Pending: Nevada, Colorado, and Texas

Bidirectional Charging Compensation – Case Studies

New England utilities' Connected Solutions
~$250/kW-yr

Xcel Colorado Aggregator VPP
~$240/kW-yr

CEC Demand Side Grid Support
~$90/kW-yr

CA IOUs Emergency Load Reduction Program
~$60/kW-yr

New York Value of DER Tariff
Location-dependent export credit

Customer Bill Optimization
TOU optimization and/or demand charge management

Pending: Illinois and Maryland

Bidirectional Charging System Upfront Cost Support – Case Studies

Portland General Electric V2G School Bus
Up to $60,000 / charger

California Zero-Emission School Bus Adder
Up to $95,000 / charger

Massachusetts V2X Demonstration
$6 million in free installations across residential, commercial, and school bus

PG&E V2X Pilots
$2,500 – $5,000 / charger

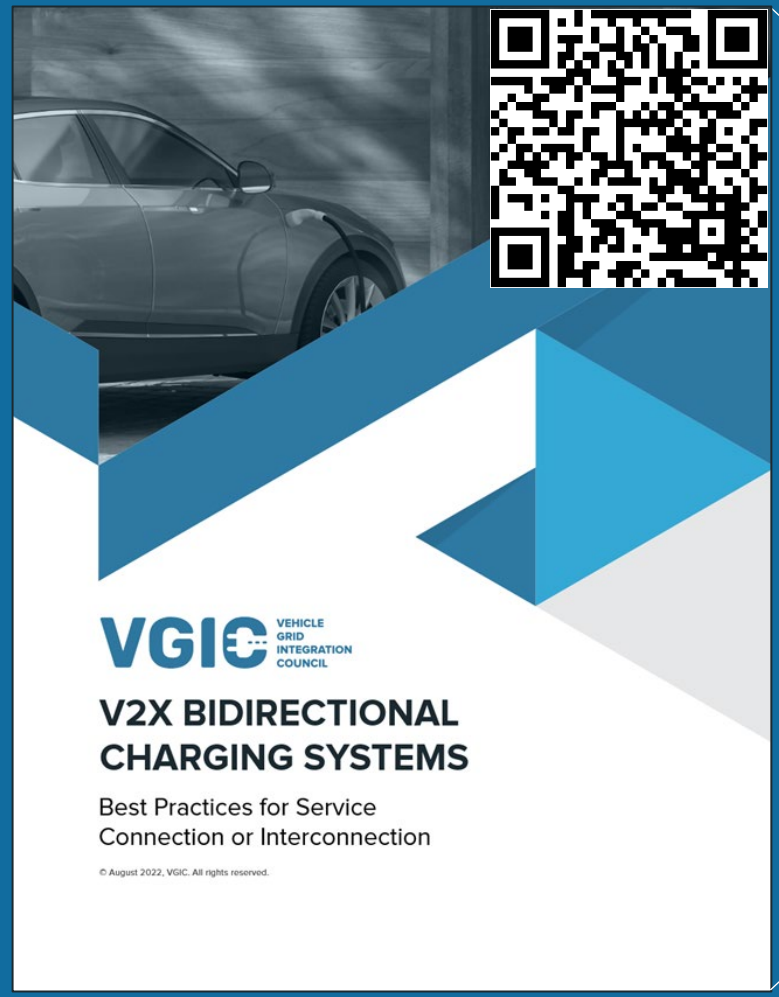
CEC REDWDS Funding
Up to $13,800 – Residential

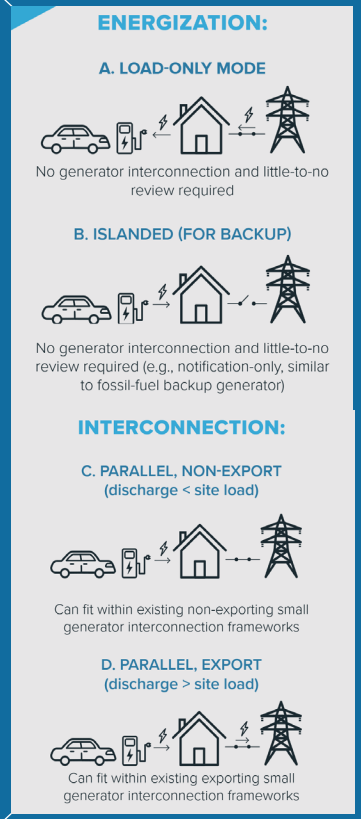
Connecticut Innovative Energy Solutions
Up to $10,000 – Residential

Pending: National Grid (Massachusetts) and Connecticut Energy Storage Program

Best Practices and Recommendations for Utilities and Regulators

- VGI Vision
- Pilot and Program Design
- Customer Engagement and Retention
- Vehicle-to-Everything (V2X) Bidirectional Charging Interconnection
- Vehicle Telematics and Embedded EV Supply Equipment (EVSE) Submetering





Thank you!

Vehicle Grid Integration Council (VGIC) is a national 501(c)(6) membership-based trade association committed to advancing the role of electric vehicles and vehicle-grid integration through policy development, education, outreach, and research.

VGIC VEHICLE GRID INTEGRATION COUNCIL

vgicouncil.org

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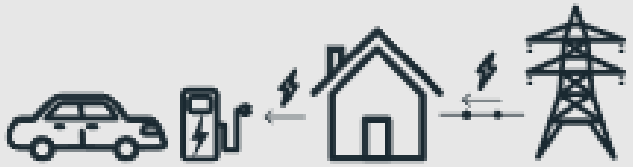
Appendix

Common V2X Bidirectional Charging System Configurations

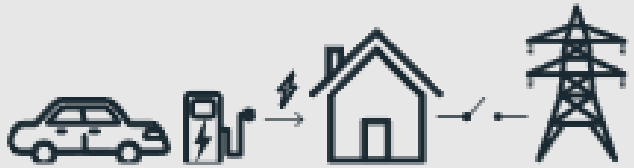
ENERGIZATION:

A. LOAD-ONLY MODE



No generator interconnection and little-to-no review required

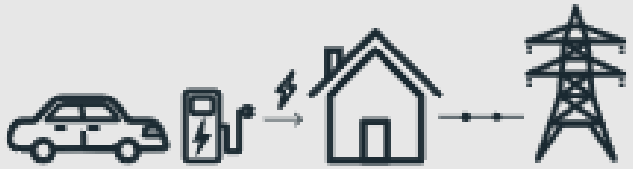
B. ISLANDED (FOR BACKUP)



No generator interconnection and little-to-no review required (e.g., notification-only, similar to fossil-fuel backup generator)

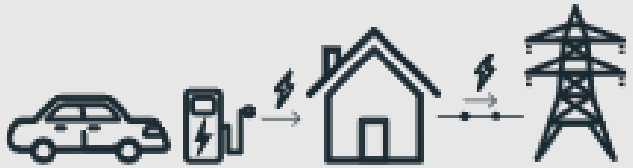
INTERCONNECTION:

C. PARALLEL, NON-EXPORT (discharge < site load)



Can fit within existing non-exporting small generator interconnection frameworks

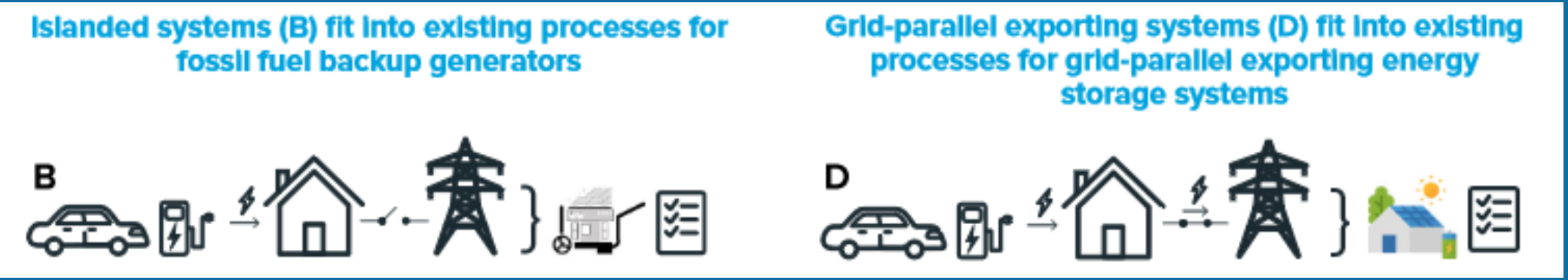
D. PARALLEL, EXPORT (discharge > site load)



Can fit within existing exporting small generator interconnection frameworks

Summary – Best practices for V2X Bidirectional Charging Connection/Interconnection

- **Avoid reinventing the wheel:** V2X systems can fit within existing processes



- **Minimize unnecessary review:** Load-only and islanded systems should require little–to-no interconnection review
- **Provide customers with flexible options:** Systems initially used in load-only or islanded modes should be permitted to seek grid-parallel interconnection at a later date