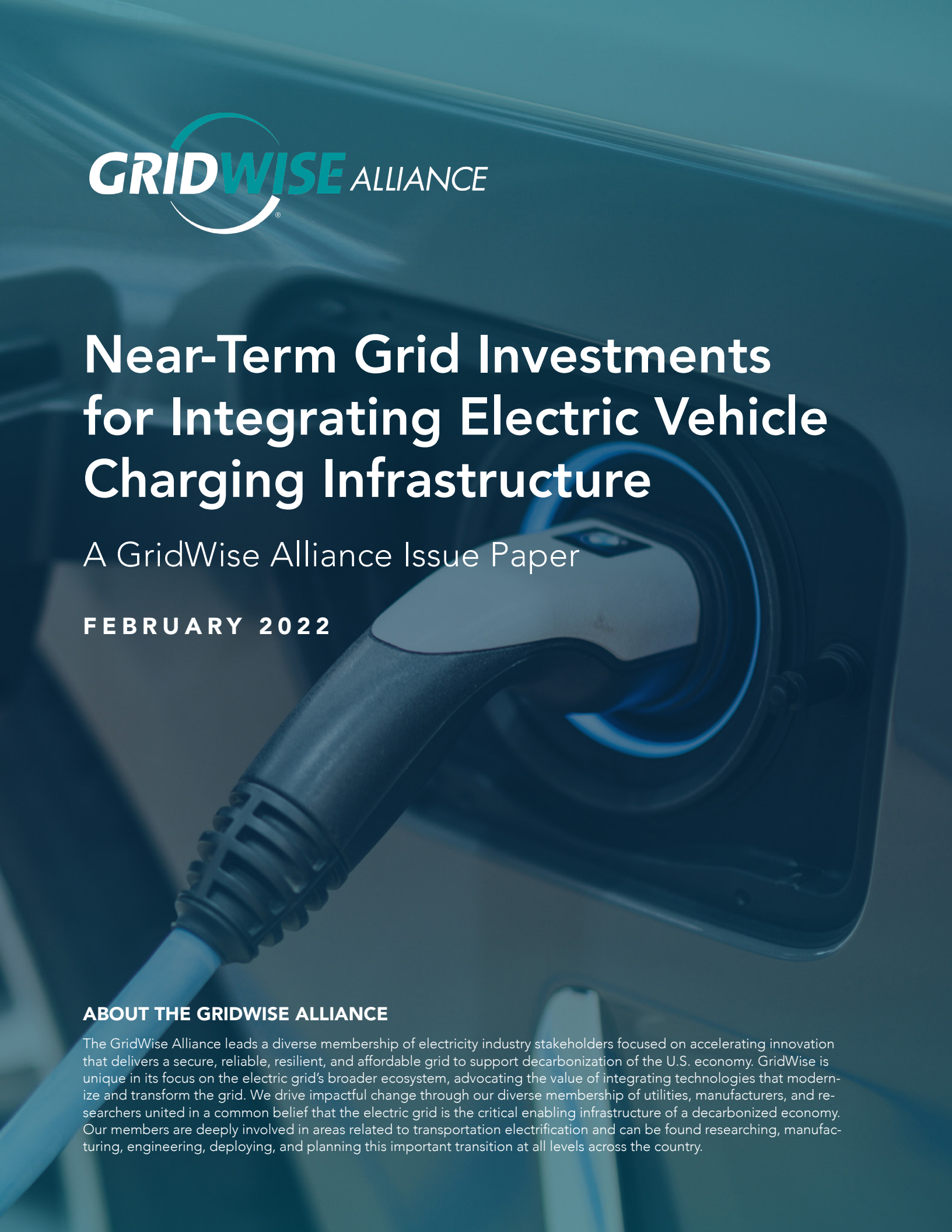


Near-Term Grid Investments for Integrating Electric Vehicle Charging Infrastructure

A GridWise Alliance Issue Paper

FEBRUARY 2022

ABOUT THE GRIDWISE ALLIANCE

The GridWise Alliance leads a diverse membership of electricity industry stakeholders focused on accelerating innovation that delivers a secure, reliable, resilient, and affordable grid to support decarbonization of the U.S. economy. GridWise is unique in its focus on the electric grid's broader ecosystem, advocating the value of integrating technologies that modernize and transform the grid. We drive impactful change through our diverse membership of utilities, manufacturers, and researchers united in a common belief that the electric grid is the critical enabling infrastructure of a decarbonized economy. Our members are deeply involved in areas related to transportation electrification and can be found researching, manufacturing, engineering, deploying, and planning this important transition at all levels across the country.

WHERE WE ARE TODAY:

INFRASTRUCTURE BILL FUNDING

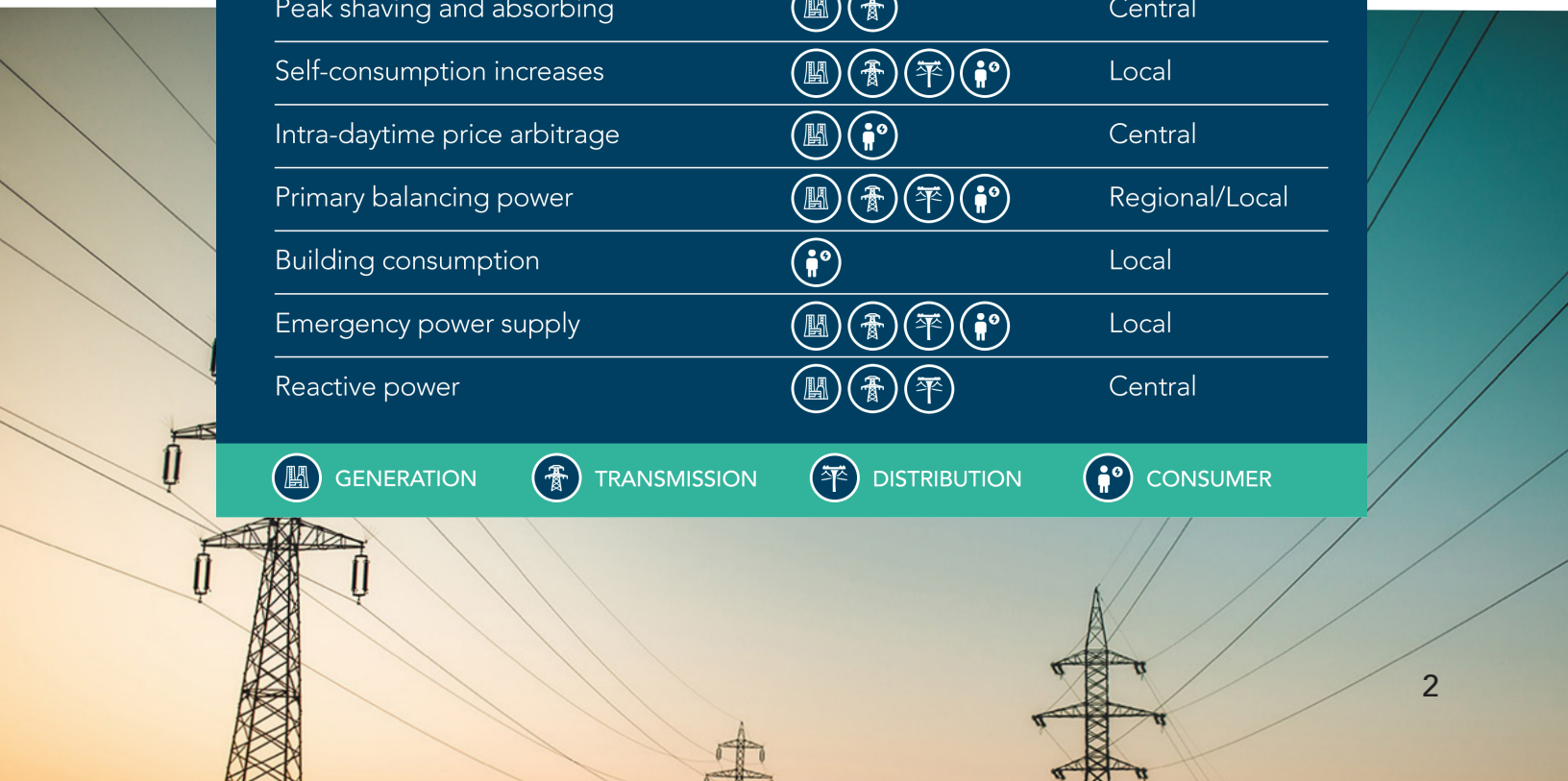
Both public and industry leaders have planned investments to support the rapid expansion of transportation electrification. The Infrastructure Investment and Jobs Act (IIJA), signed by President Biden in November 2021, authorizes $1.2 trillion in infrastructure spending over the next five years. Electric vehicles (EVs) and charging infrastructure are eligible for $30.7 billion of IIJA funding. Many states have explicit transportation electrification goals and action plans, EV highway coalitions are working to bridge federal and individual state and utility activities, and private automobile makers are investing billions of dollars to develop electric vehicle lines and a domestic EV manufacturing presence.

The GridWise Alliance welcomes the opportunities that transportation electrification represents for the benefit of both the environment and American communities. Our members are deeply invested in this transition, and are eager to support it to meet consumer needs, minimize costs, and add functionality for other grid benefits, some of which are represented in Table 1.

Table 1. Grid use cases supported by transportation electrification (Source: Dell Technologies)

USE CASE	BENEFICIARY	CONTROL
Peak shaving and absorbing	GEN, TRANS	Central
Self-consumption increases	GEN, TRANS, DIST, CONS	Local
Intra-daytime price arbitrage	GEN, CONS	Central
Primary balancing power	GEN, TRANS, DIST, CONS	Regional/Local
Building consumption	CONS	Local
Emergency power supply	GEN, TRANS, DIST, CONS	Local
Reactive power	GEN, TRANS, DIST	Central

GENERATION TRANSMISSION DISTRIBUTION CONSUMER



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IIJA Funding for EV and Charging Infrastructure

$30.7 BILLION+

GENERAL FUNDING BY CATEGORY

- Deployment of EVs and related infrastructure | **$7.5 BILLION**
- Deployment of clean vehicles and fueling infrastructure | **$12.7 BILLION**
- Grid and battery-related investments | **$10.3 BILLION**

MAJOR PROGRAM FUNDING

- National Electric Vehicle Infrastructure Formula Program | **$5 BILLION**
- National Electric Vehicle Infrastructure Grant Program | **$2.5 BILLION**
- Clean School Bus Program | **$5 BILLION**
- Low- and No-Emission Transit Bus Program | **$5.6 BILLION**
- Electric or Low-Emitting Ferry Pilot Program | **$250 MILLION**

OTHER RELATED PROGRAMS

- Surface Transportation Block Grant Program: includes EV charging and vehicle-to-grid infrastructure | **$72 BILLION**
- Congestion Mitigation and Air Quality Improvement Program: can be spent on medium- or heavy-duty zero emission vehicles and infrastructure | **$13.2 BILLION**
- Reducing Truck Emissions at Ports: Evaluates emissions benefits due to truck electrification and emerging technologies | **$250 MILLION**

Source: M. Moaz Uddin. Electric Vehicle Programs in the Bipartisan Infrastructure Bill. Great Plains Institute. December 2021.

To enable these additional benefits, investments in hardening, upgrading, and modernizing the grid will be needed to ensure a safe, secure, reliable, and affordable electricity system. In this brief, we focus on investments that would be necessary to accommodate an initial exponential EV share increase. While we expect these near-term investments to include those that support managed charging and time-of-use pricing programs, they may not yet enable EVs to support aggregated grid services. It is important that any near-term grid-side investments are "no-regrets" investments that allow for and support the increasing integration of EVs.

NEAR-TERM GRID INVESTMENT NEEDS

The following near-term investments will be foundational to supporting the widespread uptake of EVs. These investment priorities are organized by a set of five functional areas, areas GridWise developed in late 2021 to describe the fundamental capabilities of a modern grid.[1]

Integrated Planning

BACKGROUND

Every state and utility has planning processes to determine operational and capital expenditures required to meet near- and long-term grid needs. Transportation electrification will increase electric loads across the system and modify traditional demand profiles. It will also lead to significant spot loads from both the fleet electrification of medium- and heavy-duty vehicles and fast charging along transportation corridors, resulting in the need for coordinated and revised planning processes.

NEAR-TERM INVESTMENT NEED	REASONING
Early and frequent utility, state, and federal energy and transportation office coordination	Enable those with current knowledge of grid policy, planning, and operations to be leveraged to share information and shape the transition efficiently.
Hosting capacity studies from both the top-down and bottom-up	Evaluate existing hosting capacity of the grid along interregional highway routes, while also evaluating the ability of transmission and distribution lines to serve increased electricity demand from EVs.
Coordination of load forecasting assumptions and methodologies that are inclusive of anticipating consumer electricity demands	Planning EV infrastructure deployment is dependent upon consistent assumptions across multiple states, making the coordination of load forecasting methodologies and inputs important. Concurrently, anticipating consumer demands—in particular large new demands like those required for charging medium- and heavy-duty vehicle fleets—makes it important to plan grid upgrades for long-term electricity needs.

[1] See the GridWise Alliance Technology Portfolio for more information on the five functional areas. https://gridwise.org/technologyportfoliowhitepaper/

System Visibility

BACKGROUND

System operators need to "see" power flows on the grid to support planning efforts and system operation. This includes identifying where electricity is entering and leaving the system, when it is being used and generated, and how power is flowing through distribution and transmission lines. Extending visibility and control throughout the grid and up to the grid edge through communication and data sharing systems allows system operators to manage the grid at a granularity required for intermittent loads caused by EVs.[2] Most electric utilities today would benefit from extended real-time situational awareness to both support increased EV charging infrastructure and maintain customer reliability and power quality.

NEAR-TERM INVESTMENT NEED	REASONING
Broadband infrastructure	A communication network capable of rapid data sharing supports situational awareness of EVs on the grid.
Advanced metering infrastructure (AMI)	AMI is one way to facilitate EV adoption because it provides greater visibility into granular usage and power data by both the utility and the customer. This visibility and understanding of customer usage patterns can make it easier to incentivize optimal charging for both utilities and customers.
Dynamic line rating (DLR)	Installing DLR technologies along both transmission and distribution wires enables system operators to understand how much power is being sent across various parts of the system in real-time. This type of visibility into the system can help unlock additional capacity in the existing grid.

[2] NREL. Multi-Lab EV Smart Grid Integration Requirements Study. https://www.nrel.gov/docs/fy15osti/63963.pdf

Real-time Operation

BACKGROUND

At both the transmission and distribution level, the grid needs systems and technologies that can act automatically on system data and deliver the increased load associated with growing EV adoption. Electric vehicles will be a source of two-way power flow on the grid once vehicle-to-grid functionality is implemented and upgrades will need to occur at the substation level and throughout the system to prepare the grid for this reverse power flow. Several technologies available today can monitor and respond to grid conditions, especially important as EVs continually connect and disconnect from the grid, and are capable of immediately correcting operational problems related to voltage, current, frequency, and outages.

NEAR-TERM INVESTMENT NEED	REASONING
Voltage regulation technologies	Voltage regulation technologies offer greater visibility and control into real-time, localized usage of electric load. Electric load and quality fluctuate during EV charging or when vehicle-based stored energy is passed back to the grid. Proper siting of this technology allows the utility insights into the behaviors and patterns of an EV charging station while managing power quality. Smart inverters are one example of a voltage regulation technology, though they also provide other services including frequency regulation and DC-AC current conversion. Another type of voltage regulation technology is volt-VAR regulation, which regulates and optimizes power flow on the distribution system.
Energy storage systems	Energy storage, when co-located with EV charging infrastructure, could play a role in mitigating peak electricity demand of highway charging stations and ultimately lower the cost of charging for consumers. It may not be necessary to have storage at all charging sites however, so supporting early planning efforts around charging infrastructure and technology needs is important.
Distributed energy resource management systems (DERMS)	DERMS can both monitor and control DERs placed throughout the distribution system, such as EVs. At minimum, DERMS provide a way to make the load from EVs visible to the broader system. Fully implemented DERMS will be a key component to supporting advanced vehicle-to-grid functionality.

Consumer & Energy Services Engagement

BACKGROUND

Electric vehicles present an opportunity for consumers and third-parties to increase their interaction with the grid. Engagement may be driven by potential cost-savings, potential profits, environmental reasons, or reliability purposes, yet leveraging consumer demand and supply can benefit the grid. EV infrastructure should be planned and developed such that widescale transportation electrification improves and facilitates interactions between itself, consumers, and third parties to realize and maximize potential resilience and economic co-benefits.

NEAR-TERM INVESTMENT NEED	REASONING
Communication and coordination with consumers, especially those requiring significant capacity upgrades	Electricity consumers, particularly those who have fleet electrification plans, and utilities should communicate and coordinate about their transportation electrification goals. In particular, fleet electrification of medium- and heavy-duty vehicles will increase electric demands and necessitate new grid infrastructure. Discussions with utilities will allow for system upgrades and other make-ready work (discussed below) to proceed further in advance and be coordinated among other nearby fleet operators.
Low-cost grid disconnects	To enable customers to island from the grid during outages and take advantage of a vehicle capable of providing power to a home.

Emerging Grid Architecture

BACKGROUND

Current grid infrastructure, market rules, and business models were built over the last century to support one-way electricity flow and passive end-uses. An electrified transportation sector will require a transformation in grid operation. Grid stakeholders can take this as an opportunity to consider emerging designs and architecture that helps manage the trends of system decentralization, increasing renewable energy, and widespread EV deployment.

NEAR-TERM INVESTMENT NEED	REASONING
EV charging infrastructure interoperability standards	Public chargers should be interoperable with different charging networks such that EV users can charge their vehicle at any location. This includes charging hardware and software. Enabling charging interoperability will support EV charging infrastructure safety, scalability, savings, security, and simplicity for consumers.
Make-ready EV charging infrastructure sites	Make-ready work produces a nearly-complete site that can be quickly interconnected with a charging station, streamlining the charger interconnection process. By identifying prime locations for make-ready work, the utility can anticipate expansions to the EV charging network, can help provide opportunities for a wider base of customers to have access to chargers, can look to avoid areas with immediate grid constraints, and can prepare the distribution system to accommodate increased EV charging demands.

CONCLUSION

The electric grid is the foundational backbone supporting the electrification of transportation and its subsequent enhancement of the American economy. We are excited by the opportunity the historic Infrastructure Investment and Jobs Act provides, and the concurrent Federal and state political momentum for this transition. Underlying this transformation, however, is the need for the grid to continue to be safe, secure, reliable, and affordable. This brief issue paper provides direction for near-term grid investments for integrating electric vehicles to do just that.