Transportation electrification building blocks

Practical guidance for regulators and utilities to strategically plan for rapid electric vehicle load growth

OCTOBER 2024

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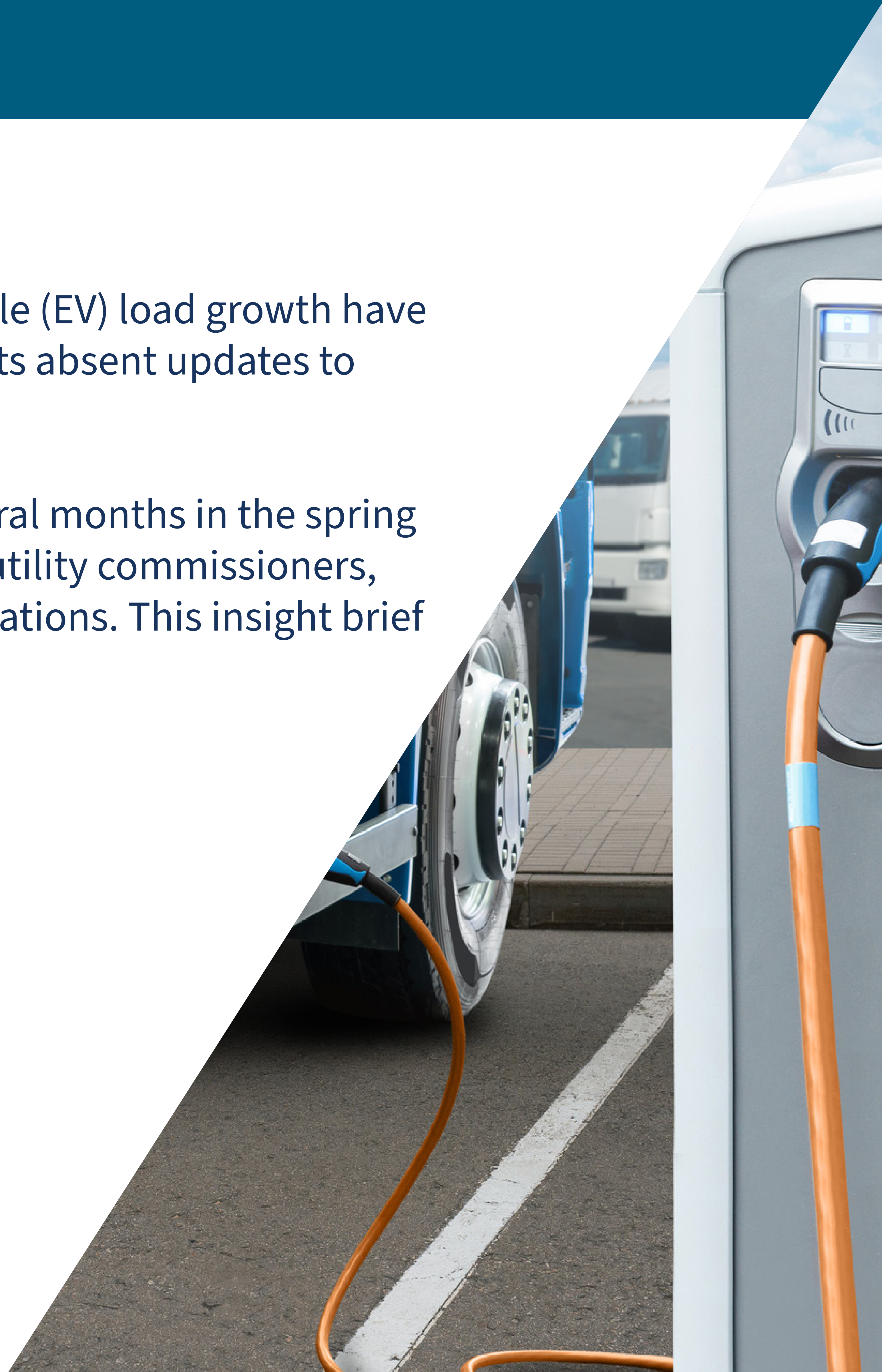
Executive summary

Project background

Discussions of the need for proactive grid investment to support electric vehicle (EV) load growth have increased in recent years, in recognition of the challenge this new load presents absent updates to traditional grid planning and investment approaches.

To help regulators and utilities make effective decisions in this area, over several months in the spring of 2024 RMI interviewed engaged stakeholders, including current and former utility commissioners, utility representatives, research organizations, and non-governmental organizations. This insight brief is informed by their contributions.



EV load growth presents challenges for utilities and regulators

The current rate of grid infrastructure deployment based on reactive and incremental investments is **too slow to provide electric service based on market expectations of EV load growth**.

This poses risks of utilities not meeting their core obligation to provide electric service — constraining customer choice — inefficient use of ratepayer funds, and policy non-compliance.

What are the root causes of this issue?

Significant Uncertainty (many forms)

Existing Regulatory Paradigm

Utility and Regulator Risk Aversion

How do these dimensions contribute to the problem? What are the implications for regulators and utilities?

ROOT CAUSE	ASPECTS	IMPLICATIONS
1. Significant Uncertainty	• Load (when, where, size, profile, flexibility) • Timelines (connection, regulatory approval, construction) — especially for medium- and heavy-duty fleets and public fast charging • Potential cost for/value of EV resources	We must reduce uncertainty to **increase confidence** and improve decision-making.
2. Existing Regulatory Paradigm	• Reactive and incrementalist • Primarily predicated on historical data • Too slow for rapid load growth • Fragmented (limited coordination between utilities, ISOs/RTOs*, third parties)	We must move to a more **targeted, coordinated approach** to prepare the grid for electrification.
3. Utility and Regulator Risk Aversion	• Strong utility preference for assured cost recovery • Little to no reward for utility proactivity • Few tested options for sharing risk • Challenging to capture and trust full benefits of EVs as a grid resource	We must find ways to **mitigate** and **appropriately share risk** across parties.

How regulators can support strong utility practices to plan for EV load growth

Leveraging existing tools in targeted ways can enable forward-looking planning for EVs.

Set Grid Planning Guidance

Work with utilities to update grid planning practices and requirements to incorporate best available data on future loads — including but not limited to EV loads — and ensure these are consistently applied across all planning exercises.

Establish and Track Desired Outcomes

Identify desired EV and related outcomes; establish and track performance metrics to assess progress.

Approve Appropriate Proactive Investment

Accommodate utility investments that appropriately account for EV load growth by adhering to planning and investment guidance. Consider cost recovery and performance mechanisms to ensure accountability to desired outcomes, including ratepayer protections.

This framework uses a sequential set of "building blocks" to help regulators and utilities answer three critical questions and plan for EV load growth

Key Questions

1. **What do we need?**
How much infrastructure and where?

2. **How can we efficiently meet that need**

3. **How do we get there?**
What changes are required to efficiently meet the need?

Building Blocks

- Plan against long-term EV market expectations
- Improve load forecasting practices
- Prioritize efficient, cost-effective use of distribution infrastructure
- Align grid connection with customer needs
- Improve risk sharing and mitigation
- Enable accountable, longer-term utility capital investments

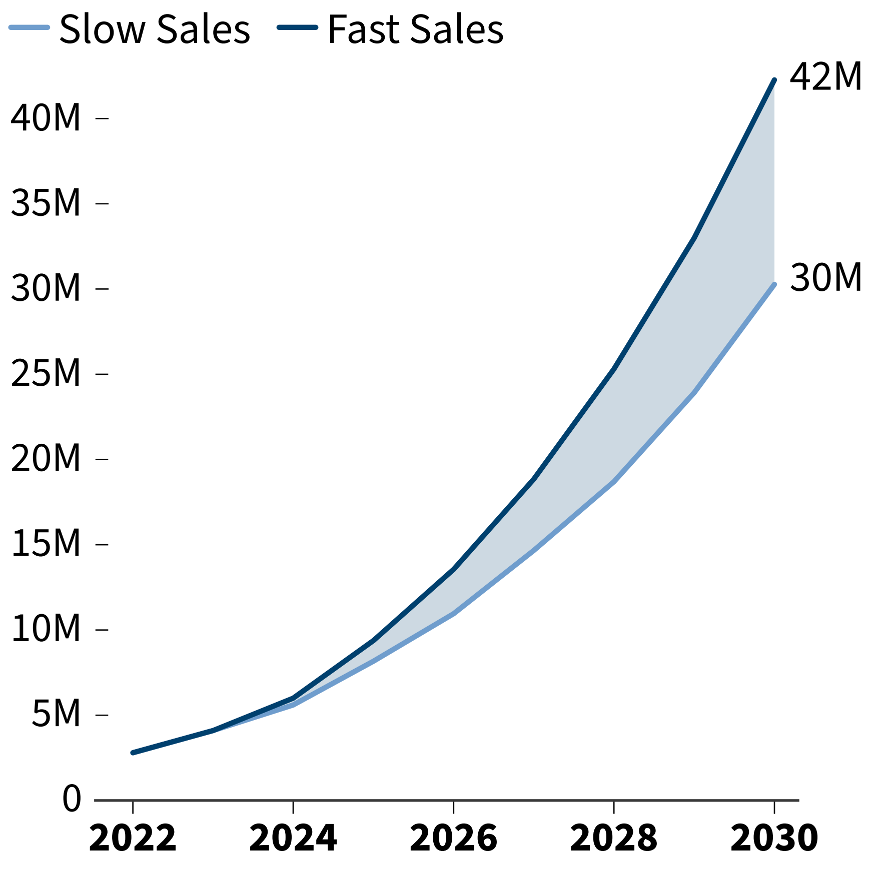
Understanding the challenge

All signs point to rapid EV load growth

The number of both light-duty and medium-/heavy-duty EVs in the US will rise exponentially in the coming years. Even lower-end estimates of EVs on the road signal dramatic growth, with commensurate needs for a rapid buildout of charging infrastructure.

These EVs will be fueled by a surge in demand for electricity. Even relatively conservative scenarios like the IEA forecast shown below anticipate that by 2035 EV charging will consume about 15% of current electricity production, with sharp growth beginning today.

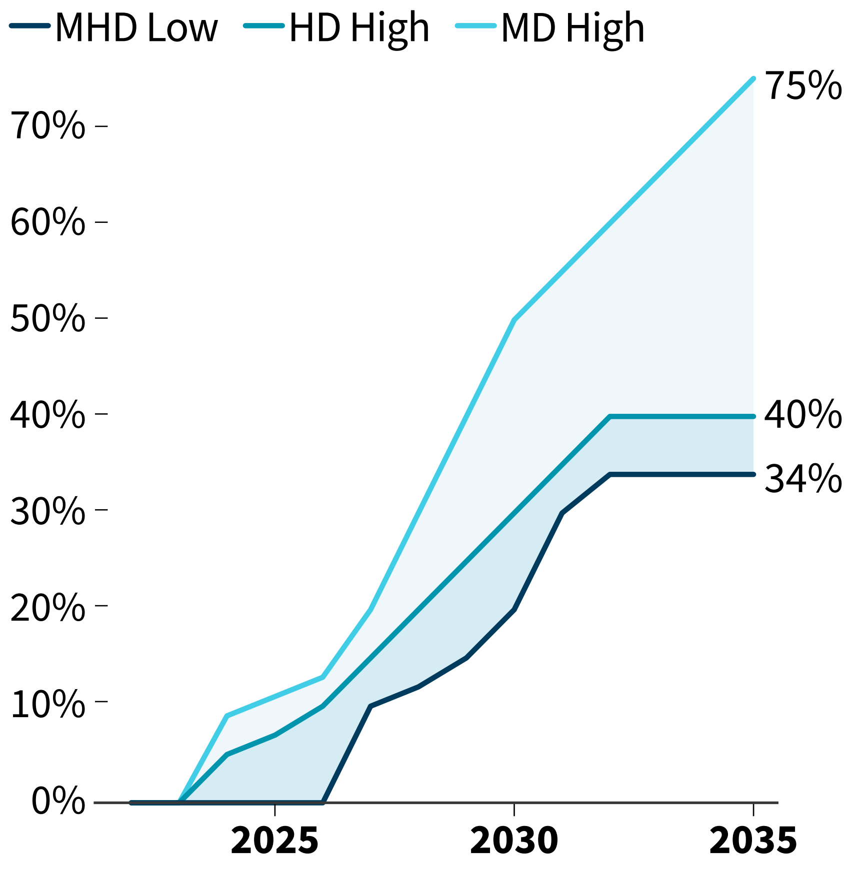
Outlook for Light-Duty EVs on US Roads



Includes Battery Electric and Plug-in Hybrid Electric Vehicles

Source: NREL: "The 2030 National Charging Network"

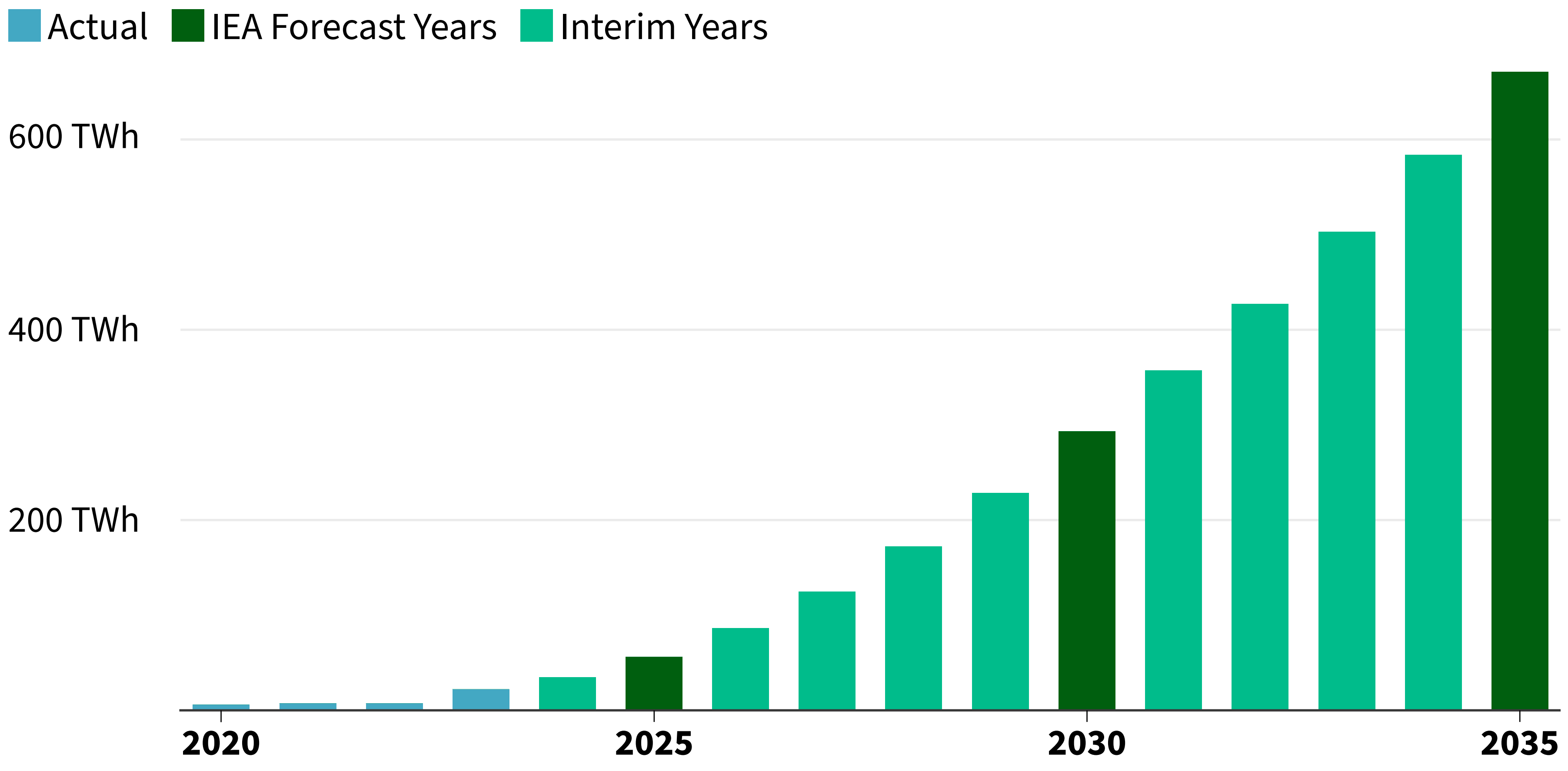
Zero Emission Truck Sales in the US



Medium-/heavy-duty (MHD) Low sales share from EPA GHG rule; Medium-duty (MD) and Heavy-duty (HD) High sales share from Advanced Clean Truck (ACT) rule, a regulation adopted by several states which sets sales targets for zero emission trucks.

Source: RMI analysis

Electricity Demand for On Road EV Charging in the US



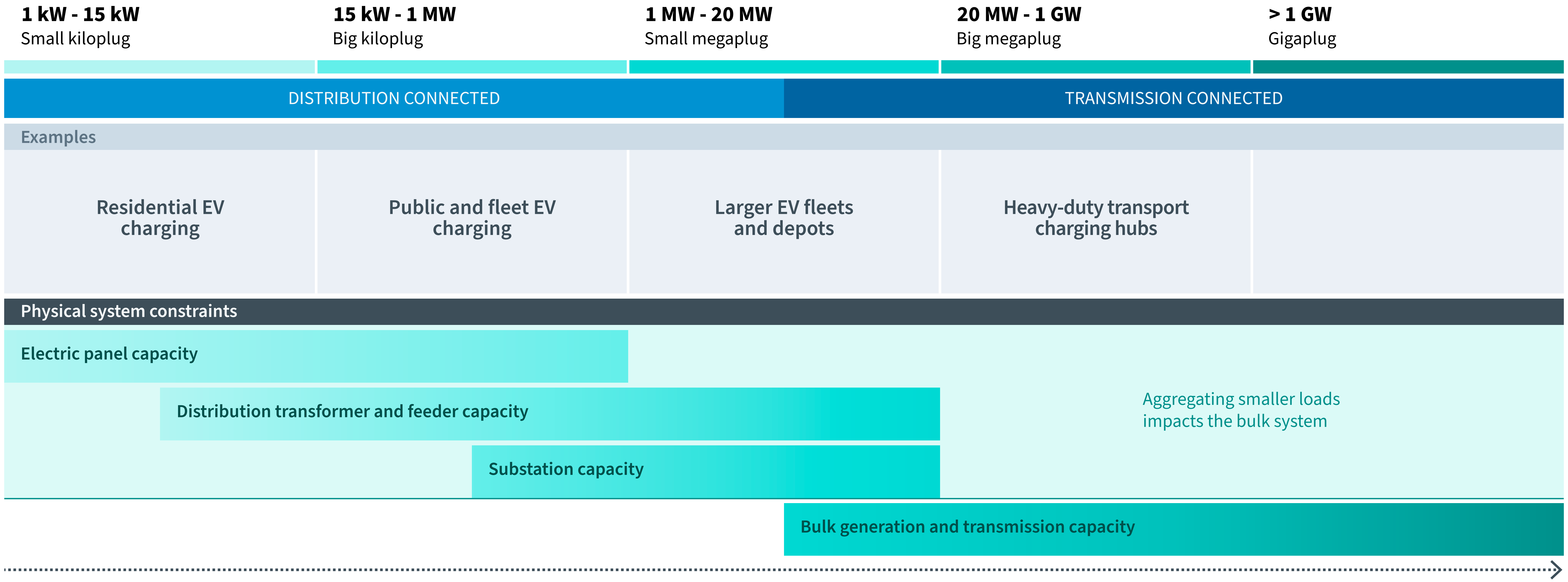
Data is from the International Energy Agency (IEA) Announced Policies Scenario

Source: IEA Global EV Data Explorer

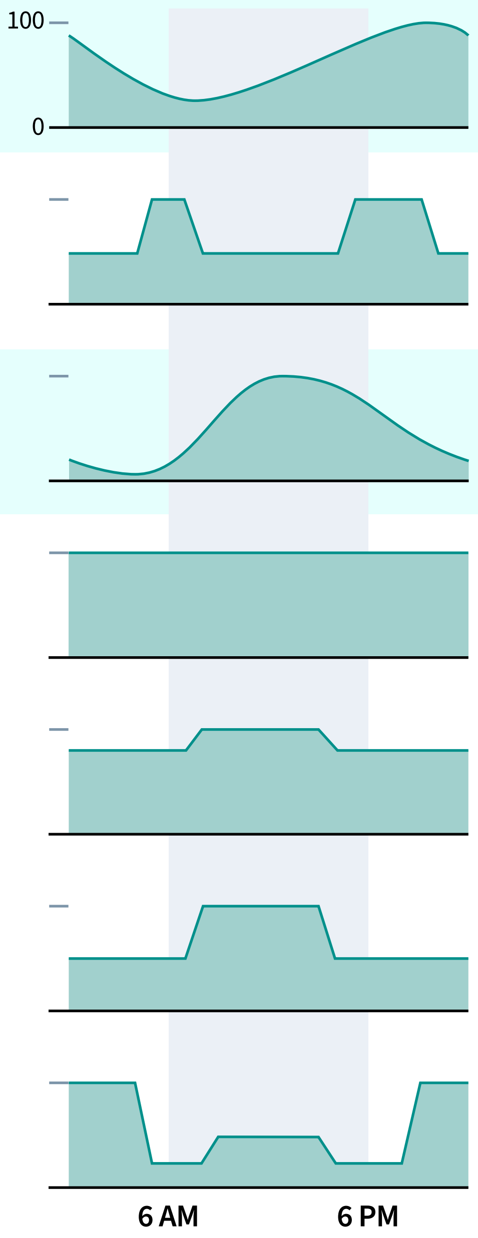
EV load growth will impact all levels of grid infrastructure

The equipment providing this charging will require a range of power availability, from the low kilowatt-scale power supplied by Level 1 and 2 chargers in residences to 25+ megawatts at truck charging depots that are currently being developed. This range of power demand corresponds to a variety of impacted grid equipment. Utilities will need to manage investment and upgrades to all types of equipment on their system as EV loads grow.

Load growth impacts all levels of the grid



EV load is different than other types of expected load growth



	Load shape Illustrative depiction of load shape across the day (May vary seasonally)	**Forecast uncertainty** Measure of confidence that projections of future load will match reality	**Flexibility potential** Price sensitivity of load and willingness/ability of customers to change consumption patterns based on signal	**Flight risk** Likelihood that the load may shift to a different location if grid or economic conditions are not favorable
Residential or commercial EV charger (overnight charging)		Medium	★ ★ ☆ Somewhat flexible	Very Low
Residential or commercial heat pump		Medium	★ ★ ☆ Somewhat flexible	Very Low
Public EV fast charger		High	★ ☆ ☆ Somewhat inflexible	Medium
Data centers		Very High	★ ☆ ☆ Somewhat inflexible (AI); ★ ★ ☆ Somewhat flexible (crypto)	High
Manufacturing facilities		High	★ ★ ☆ Somewhat flexible	Medium
Conventional C&I loads		Medium	★ ★ ☆ Somewhat flexible	Medium
Hydrogen electrolysis		Very High	★ ★ ★ Very flexible	High

Transportation electrification will occur alongside growth in electricity demand in several other sectors of the economy — notably data centers and building electrification. While these loads should all be considered when utilities plan investments, EV loads have distinct characteristics that must be taken into account. They will peak at different times, with large overnight peaks for most home and depot-based charging and day-time peaks for fast chargers. They have some potential for flexibility and can serve as distributed resources in virtual power plant (VPP) or vehicle-to-everything (V2X) programs. It is notable that, even within the EV charging category, different types of vehicles and charging equipment will likely present different load characteristics that must be considered in utility planning.

Why does this present a challenge?

The current rate of grid infrastructure deployment based on reactive and incremental investments is **too slow to provide electric service based on market expectations of EV load growth**.

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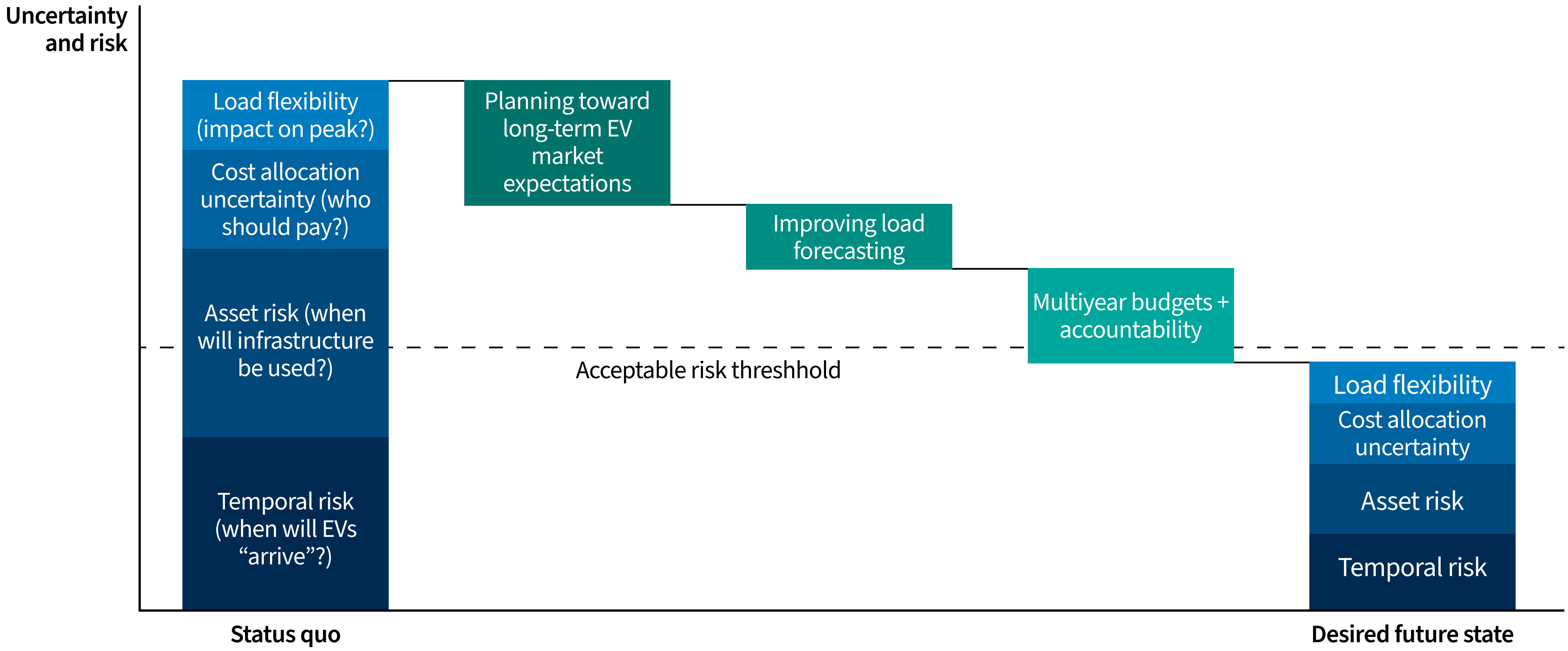
3. Utility and Regulator Risk Aversion	• Strong utility preference for assured cost recovery • Little to no reward for utility proactivity • Few tested options for sharing risk • Challenging to capture and trust full benefits of EVs as a grid resource	We must find ways to **mitigate** and **appropriately share risk** across parties.

To enable needed grid investments, risk and uncertainty can be reduced to acceptable levels through various mechanisms

Illustrative example of reducing uncertainty and risk through a combination of practices



New approaches to risk allocation

In addition to risk **mitigation**, new approaches to risk **allocation** across parties — by expanding markets and protecting fairness — also hold promise for unlocking a more efficient and equitable system for rapid grid investment.

EXPANDING MARKETS

Third-Party Solutions

Embracing the potential value provided by third-party technologies and private capital will help to reduce total grid upgrade costs and provide more customer choice.

Data Sharing

Establishing clear utility data sharing and usage guidelines is a key enabler for third-party participation and solution deployment.

PROTECTING FAIRNESS

Cost Allocation

New approaches to risk sharing and cost allocation can play an important role in providing affordable electric service on timelines that meet customer needs.

Prioritizing Equity

Attention must be paid to sharing the benefits of electrification with all ratepayers, including through grid planning and investment processes.

Transportation electrification building blocks

Regulators and utilities can improve transportation electrification planning and investments using a series of core "building blocks."

The following slides lay out six concepts, or **building blocks, that collectively create a strong foundation to appropriately plan for and invest in upgrades needed to support EV load growth**, while also protecting ratepayers.

Utility regulators and utilities are the primary actors for incorporating these building blocks into their processes. However, to ensure their implementation is successful, equitable, and efficient, it is critical that other stakeholders are engaged throughout, including ratepayer advocates, fleets, automakers, EV charging providers, and community organizations, among others. **Ratepayer advocates, in particular, will need additional resources and technical support** to meaningfully engage with the recommendations in this brief. Legislators may also play an important role in enabling and encouraging regulatory action, in some cases by providing resources to expand regulator and advocate capacities.

While this insight brief focuses on strategic planning for electric vehicle load, **EV load growth is not taking place in a vacuum**. Many other forms of electricity usage are also growing, such as data centers and building end-uses. It is critical for regulators, utilities, and other stakeholders to **consider overall needs from the electric grid**, and plan holistically for efficient, cost-effective ways to meet them.

Transportation electrification building blocks

This framework can help regulators and utilities answer three critical questions to plan for EV load growth, using a sequential set of "building blocks"

Key Questions	1 What do we need? How much infrastructure and where?	2 How can we efficiently meet that need	3 How do we get there? What changes are required to efficiently meet the need?			
Building Blocks	Plan against long-term EV market expectations	Improve load forecasting practices	Prioritize efficient, cost-effective use of distribution infrastructure	Align grid connection with customer needs	Improve risk sharing and mitigation	Enable accountable, longer-term utility capital investments

RMI

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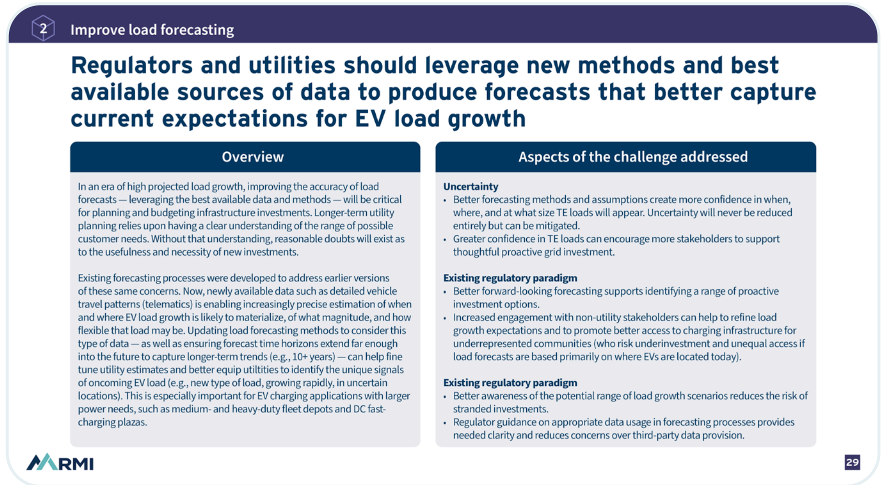
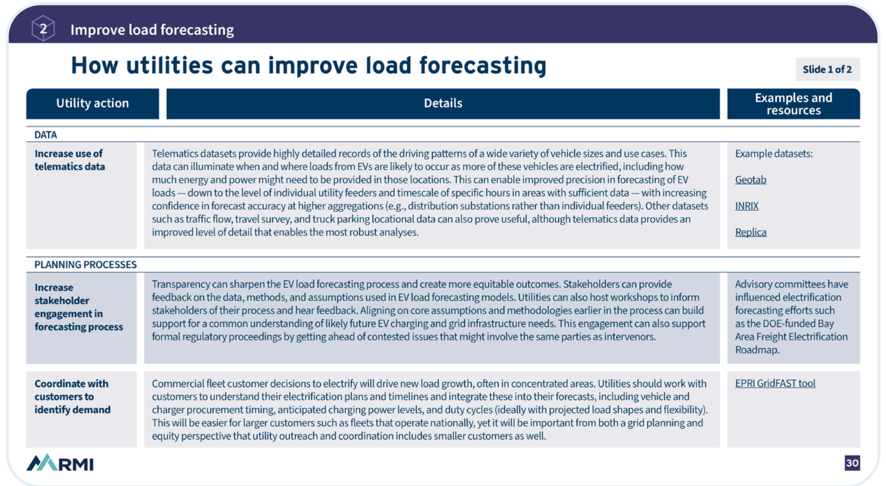
Components of the building blocks

How to read the following slides on each of the six building blocks.



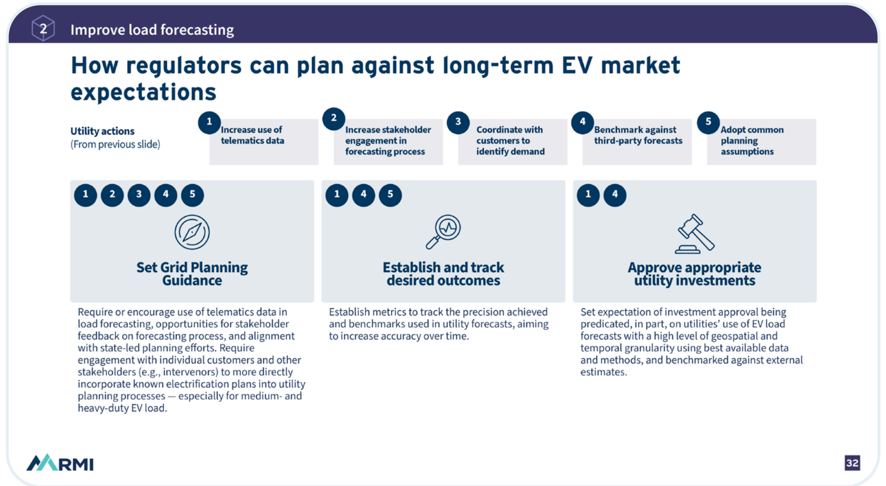
1. Overview

The first slide provides an overview of the building block, including discussion of how implementing it helps to address parts of the core, underlying challenge presented by the pace of EV load growth.



2. Utility Actions

The next slide (or two) presents utility actions that can be taken to achieve that building block, along with examples and/or resources. Examples are not always directly tied to planning for EV load growth, specifically.



3. Regulator Options

The final slide provides regulatory options to support development of each building block by enabling or incentivizing the utility actions.

Building block 1

Plan against long-term EV market expectations

Regulators can provide needed clarity by designating explicit targets for utilities to plan against

Overview

Strategic investment in the electric grid to support transportation electrification first requires an understanding of how many EVs will be operating in the future. Regulators can help make this future state less uncertain by requiring or encouraging utility plans be tied to specific targets, informed by market expectations of future EV growth and customer demands. These targets should be incorporated into core or central scenarios to ensure utility planning is directly linked to long-term expected needs. To help with utility capital and operational planning, regulatory guidance should include expectations for how EVs will be deployed **over time**, for light-, medium-, and heavy-duty vehicles, and require periodic updates (e.g., every 2–5 years).

These targets and expectations of deployment pace provide essential clarity for utilities and other stakeholders, targeting forward-looking, economically efficient development of the grid to support EVs. Incorporating these longer-term targets into the core scenario(s) **across planning and investment exercises** within a utility (e.g., IRPs and DSPs* as well as rate cases) is critical for encouraging consistency and cost-effective investments.

*Integrated Resource Plans and Distribution System Plans

Aspects of the challenge addressed

Uncertainty

- Market-driven and/or policy targets create a common expectation for future levels of vehicle electrification for regulators and utilities, increasing confidence in a shared vision of what the future state may entail. This also presents an opportunity to build broad stakeholder alignment around future EV growth trajectory and associated needs.
- Clarifying shared expectations for EV adoption over time — even if still a forecast — provides utilities more certainty to proactively plan for the associated new load.

Utility and regulator risk aversion

- Planning against long-term market expectations should include consideration of additional funding opportunities, such as federal programs, which can help to de-risk needed investments for both utilities and ratepayers.
- External market expectations and/or policy goals spur other investments that make future demand from electric vehicles more likely to materialize.
- Investments made relatively early in the EV adoption trajectory are unlikely to be unused, given both EV market growth expectations and ongoing load growth from other sources.

How utilities can plan against long-term EV market expectations

Utility action	Details	Examples and resources
DEMAND FORECASTING		
Identify appropriate EV adoption forecasts	Various EV adoption forecasts are available for consideration and potential inclusion in transportation electrification plans (TE plans) and other utility planning exercises. Some utilities conduct their own internal EV adoption forecasts, while others use external projections. In either case, the most appropriate forecasts will reflect the local market conditions for each utility, including commitments made by policymakers and the relative cost of vehicles. Utilities can leverage the growing body of research that articulates expectations for future EV growth based on a combination of technoeconomic, policy, consumer preference, and other factors. Utilities can develop or identify scenarios that align with the appropriate long-term targets designated by regulators, for use across planning initiatives. Demonstrating meaningful engagement on this topic with external parties and/or intervenors in relevant proceedings can help to bolster regulators' confidence in the use of utilities' proposed EV adoption forecasts.	NREL IEA Bloomberg NEF RMI
PLANNING		
Develop transportation electrification plans	Dedicated TE plans can create explicit links between expected transportation electrification growth rates and the new load utilities will need to meet. Utilities can use these plans to incorporate external targets into their planning (load growth, asset needs, etc.), whether based around market expectations of EV growth or driven by specific policies. Importantly, these plans should be explicitly tied to investment plans (e.g., through general rate cases) and other utility planning exercises (e.g., IRP and DSP processes). As with the EV adoption forecasts above, utility engagement with other stakeholders on TE plan development prior to regulatory review can increase the value of these planning exercises.	The ACEEE State TE Scorecard provides many examples of utility (and other) TE plans.

How regulators can plan against long-term EV market expectations

Utility actions
(From previous slide)

1 **Identify appropriate EV adoption forecasts**

2 **Develop transportation electrification plans**

1 Set grid planning guidance

Issue guidance clarifying which vehicle electrification targets should be included in utility plans. Work with utilities and other stakeholders to align on both the long-term vehicle forecast (number of EVs, by vehicle segment) **and** the pace of market growth (shape of adoption curve).

2 Establish and track desired outcomes

Require that utility TE planning link to the appropriate external targets, in turn based on market growth expectations. TE planning should also be explicitly tied to investment plans in rate cases and other utility planning processes.

1 2 Approve appropriate utility investments

Require utility proposals to include monitoring and reporting progress of new asset deployment to support EV load growth, potentially tied to carefully designed performance incentive mechanisms.

Establish metrics for EV service connections to track progress against TE plans.

Building block 2

Improve load forecasting

Regulators and utilities should leverage new methods and best available sources of data to produce forecasts that better capture current expectations for EV load growth

Overview

In an era of high projected load growth, improving the accuracy of load forecasts — leveraging the best available data and methods — will be critical for planning and budgeting infrastructure investments. Longer-term utility planning relies upon having a clear understanding of the range of possible customer needs. Without that understanding, reasonable doubts will exist as to the usefulness and necessity of new investments.

Existing forecasting processes were developed to address earlier versions of these same concerns. Now, newly available data such as detailed vehicle travel patterns (telematics) is enabling increasingly precise estimation of when and where EV load growth is likely to materialize, of what magnitude, and how flexible that load may be. Updating load forecasting methods to consider this type of data — as well as ensuring forecast time horizons extend far enough into the future to capture longer-term trends (e.g., 10+ years) — can help fine tune utility estimates and better equip utiltities to identify the unique signals of oncoming EV load (e.g., new type of load, growing rapidly, in uncertain locations). This is especially important for EV charging applications with larger power needs, such as medium- and heavy-duty fleet depots and DC fast-charging plazas.

Aspects of the challenge addressed

Uncertainty

- Better forecasting methods and assumptions create more confidence in when, where, and at what size TE loads will appear. Uncertainty will never be reduced entirely but can be mitigated.
- Greater confidence in TE loads can encourage more stakeholders to support thoughtful proactive grid investment.

Existing regulatory paradigm

- Better forward-looking forecasting supports identifying a range of proactive investment options.
- Increased engagement with non-utility stakeholders can help to refine load growth expectations and to promote better access to charging infrastructure for underrepresented communities (who risk underinvestment and unequal access if load forecasts are based primarily on where EVs are located today).

Existing regulatory paradigm

- Better awareness of the potential range of load growth scenarios reduces the risk of stranded investments.
- Regulator guidance on appropriate data usage in forecasting processes provides needed clarity and reduces concerns over third-party data provision.

How utilities can improve load forecasting

Utility action	Details	Examples and resources
DATA		
Increase use of telematics data	Telematics datasets provide highly detailed records of the driving patterns of a wide variety of vehicle sizes and use cases. This data can illuminate when and where loads from EVs are likely to occur as more of these vehicles are electrified, including how much energy and power might need to be provided in those locations. This can enable improved precision in forecasting of EV loads — down to the level of individual utility feeders and timescale of specific hours in areas with sufficient data — with increasing confidence in forecast accuracy at higher aggregations (e.g., distribution substations rather than individual feeders). Other datasets such as traffic flow, travel survey, and truck parking locational data can also prove useful, although telematics data provides an improved level of detail that enables the most robust analyses.	Example datasets: Geotab INRIX Replica
PLANNING PROCESSES		
Increase stakeholder engagement in forecasting process	Transparency can sharpen the EV load forecasting process and create more equitable outcomes. Stakeholders can provide feedback on the data, methods, and assumptions used in EV load forecasting models. Utilities can also host workshops to inform stakeholders of their process and hear feedback. Aligning on core assumptions and methodologies earlier in the process can build support for a common understanding of likely future EV charging and grid infrastructure needs. This engagement can also support formal regulatory proceedings by getting ahead of contested issues that might involve the same parties as intervenors.	Advisory committees have influenced electrification forecasting efforts such as the DOE-funded Bay Area Freight Electrification Roadmap.
Coordinate with customers to identify demand	Commercial fleet customer decisions to electrify will drive new load growth, often in concentrated areas. Utilities should work with customers to understand their electrification plans and timelines and integrate these into their forecasts, including vehicle and charger procurement timing, anticipated charging power levels, and duty cycles (ideally with projected load shapes and flexibility). This will be easier for larger customers such as fleets that operate nationally, yet it will be important from both a grid planning and equity perspective that utility outreach and coordination includes smaller customers as well.	EPRI GridFAST tool

How utilities can improve load forecasting

Utility action	Details	Examples and resources
MODELING METHODS		
Benchmark against third-party forecasts	Telematics and other rich datasets are increasingly being deployed by research organizations to better understand the anticipated geospatial distribution of EV charging needs, largely in recognition of the need for this level of detail to inform utility planning. In addition to directly using this data and/or tools developed specifically for EV load forecasting, utilities should benchmark their forecasts against those from third parties. These comparisons can help utility forecasters understand (and potentially resolve) any areas of noteworthy deviation. These third-party forecasts can also demonstrate how managed charging and other demand response programs can shift. Additionally, benchmarking against relevant state (or federal) forecasting or EV adoption planning exercises presents an opportunity to better align individual utility expectations of EV load growth — and associated charging needs — with expectations from key public agencies, such as state energy offices and departments of transportation. This can help prioritize efficient planning and deployment of grid infrastructure to support vehicle electrification.	RMI, GridUp EPRI, eRoadMAP NREL, 2030 Charging Network LBNL, HEVI-LOAD
Adopt common planning assumptions	Many assumptions (such as charger utilization, vehicle characteristics, and charging management) go into forecasting TE load growth. Regulators, utilities, and other stakeholders should align on common assumptions to be used in TE modeling efforts to avoid lengthy iteration on these inputs and potential mistrust in the outputs. This alignment can ensure forecasts are capturing the most up-to-date information on EV characteristics, driving patterns, charger specifications, and other related inputs. These assumptions should also incorporate the benefit EVs can provide to the grid as flexible assets that can serve as distributed energy resources. As EVs are mobile, utilities should also coordinate with adjacent utilities to align on load forecasts, sharing modeling assumptions to encourage a more consistent and efficient deployment of needed grid infrastructure.	DOE/JOET-led EV Load Forecasting Guide initiative (ongoing) RMI, Understanding Utility Projections for Load Growth (forthcoming)

How regulators can plan against long-term EV market expectations

Utility actions
(From previous slides)

1. **Increase use of telematics data**
2. **Increase stakeholder engagement in forecasting process**
3. **Coordinate with customers to identify demand**
4. **Benchmark against third-party forecasts**
5. **Adopt common planning assumptions**

Set grid planning guidance

1 2 3 4 5

Require or encourage use of telematics data in load forecasting, opportunities for stakeholder feedback on forecasting process, and alignment with state-led planning efforts. Require engagement with individual customers and other stakeholders (e.g., intervenors) to more directly incorporate known electrification plans into utility planning processes — especially for medium- and heavy-duty EV load.

Establish and track desired outcomes

1 4 5

Establish metrics to track the precision achieved and benchmarks used in utility forecasts, aiming to increase accuracy over time.

Approve appropriate utility investments

1 4

Set expectation of investment approval being predicated, in part, on utilities' use of EV load forecasts with a high level of geospatial and temporal granularity using best available data and methods, and benchmarked against external estimates.

Building block 3

Prioritize efficient, cost-effective use of distribution infrastructure

Utility plans should prioritize the most efficient way to meet new demand

Overview

Attempting to meet all new EV demand through traditional distribution capacity upgrades will make the challenge much more difficult, slower, and expensive to address. In areas with higher penetration of EVs — especially medium- and heavy-duty vehicles — grid connection and upgrade timelines and costs are already hindering deployment and energization of chargers, such as at truck depots and DC fast-charging plazas.

Regulators and utilities should structure their approach to planning in a way that improves the efficiency of existing and new infrastructure. These plans should take a whole system view of assets available on the distribution network and consider how they can best be utilized, including enabling **customer and third party-owned resources** to be useful grid assets in exchange for appropriate compensation. Inviting customers and utilities to work together can accelerate service provision and potentially make it more affordable, in exchange for supporting the active management of loads.
Like the familiar "reduce, reuse, recycle" adage on waste handling, this approach can be broken into three steps:

1. **Reduce (peak) demand** — utilities can work with customers to manage the amount and timing of energy or power they will need from the grid.
2. **Use existing distribution infrastructure efficiently** — improvements can be made to both manage load and speed up existing grid connection processes.
3. **Identify the remaining need** that must be met with new investments in grid capacity.

This approach takes advantage of existing distribution infrastructure, making the challenge of building out new grid capacity more tractable, faster, and less expensive.

Aspects of the challenge addressed

Uncertainty

- Longer term, more holistic planning will create more clarity for customers on capacity availability, grid connection process, and alternative connection or technology options.
- Scenario planning helps identify "least-regrets" investments.
- Limiting the size and number of traditional grid upgrades should shorten the time to connect new load that does require new infrastructure.
- Building clarity on review standards that must be met for regulatory approval will provide needed certainty to utilities.

Existing regulatory paradigm

- Reducing the need for new grid infrastructure presents promising cost-savings opportunities, reducing potential rate impacts for all customers and diminishing the size of capital investment approvals.

Utility and regulator risk aversion

- Working through non-infrastructure build options reduces the overall size of the proactive investment needed to meet TE loads, reducing concerns around overbuilding and associated ratepayer impacts.
- Leveraging private capital is a key opportunity for both achieving scale and de-risking utility investments.
- Studies have shown that a focus on managed charging and load flexibility increases anticipated net benefits for ratepayers from utility investments to support transportation electrification.

How utilities can prioritize efficient, cost-effective use of distribution infrastructure

Utility action	Details	Examples and resources
TECHNOLOGY		
Adopt technology solutions / non-wires alternatives	New technologies are creating alternative pathways to serve new loads. Flexible interconnection options, non-wires alternatives like distributed energy resource deployments, automated load management, and managed charging programs are only some of the variety of tools that utilities can utilize to support larger loads instead of defaulting toward investments in traditional poles-and-wires infrastructure without considering alternative approaches. Many of these technology solutions can also effectively leverage third-party capital, de-risking what would otherwise be traditional utility investments financed through electricity rates.	RMI, Virtual Power Plant Flipbook ComEd (IL) is working with intervenors to develop a flexible interconnection plan. EPRI, Interim Service Solutions and Timely Grid Connections for Large Transportation Electrification Projects
Identify digitalization needs to support planning	"Digitalizing" the grid is a process of installing data capture and communication technology in grid infrastructure and making much of that information available to customers, EV service providers, and other stakeholders who interact with grid services. This allows for deeper insights into the utilization of grid infrastructure and can expose reliability issues further in advance. This data is critical to inform the decisions that utility planners and other stakeholders would make using the three-step process described on this building block's overview slide (reducing demand, efficiently using existing infrastructure, identifying remaining needs). Ensuring this data is available to third-party developers will help to identify a broader range of cost-effective solutions than relying only on utility infrastructure investments.	NARUC, Grid Data Sharing Playbook NYSERDA, Integrated Energy Data Resource Deloitte, Digital Technology Solutions for Utilities
ENABLER		
Stakeholder engagement	Holistic planning will require utilities to more closely consider the priorities of stakeholders like local governments, customers, and marginalized groups such as low-income and disadvantaged communities. These stakeholders can be engaged in setting the objectives for a planning process, determining the metrics for successfully achieving those objectives, and bringing data to the process — including around where, when, and how much EV charging is likely to be needed.	Oregon PUC, DSP Work Group HECO, Electrification of Transportation Strategic Roadmap 2.0 HECO Integrated Grid Planning Stakeholder and Community Engagement

How regulators can prioritize efficient, cost-effective use of distribution infrastructure

Utility actions
(From previous slide)

1. **Implement IDSP and comprehensive planning**
2. **Expand the distribution planning time horizon and future-proof equipment**
3. **Adopt technology solutions / non-wires alternatives**
4. **Identify digitalization needs to support planning**
5. **Stakeholder engagement**

Set grid planning guidance

(1, 2)

Require that utilities demonstrate having prioritized solutions that increase efficiency of grid infrastructure in their planning processes (e.g., EV load flexibility).

Require longer-term planning outlook to maximize efficient use of capacity.

Establish and track desired outcomes

(3, 5)

Create metrics and incentives that encourage adoption of cost-effective and time-saving technological solutions, including working with stakeholders to identify appropriate options and processes for deploying them.

Set clear standards for review and approval of utility investments, which, depending on the justification, could be a prudency, least cost, best fit review or benefit-cost analysis.

Approve appropriate utility investments

(1, 3, 4)

Prioritize approving plans that make clear efforts to mitigate new EV load impacts on the grid and invest in systems to more efficiently and cost-effectively utilize existing infrastructure where possible.

Building block 4

Align grid connection with customer needs

Grid connection timelines must be aligned with customer EV charging project needs to ensure that utilities can meet their core obligation to provide electric service

Overview

Even where sufficient grid capacity exists, many utilities today cannot provide adequate electric service for EV charging commensurate with customer project timelines — especially for medium- and heavy-duty vehicles. Better aligning grid connection processes with EV charging project needs is a key component of ensuring existing distribution infrastructure is used efficiently, reducing the overall need for new infrastructure investments (building block #3). This will help enable the growing volume of new loads to be served on reasonable timelines, as required by utilities' core obligation to provide electric service.

Additionally, more rapid grid connections result in earlier utility revenue collection, increases in utility infrastructure utilization, and reduced concerns over stranded asset risk.

Aspects of the challenge addressed

Uncertainty

- Improved grid connection practices and reducing queue backlogs provide needed certainty for project developers on timeline, costs, and overall process.
- Transparency in utility hosting capacity helps to streamline project developer decision-making.

Existing regulatory paradigm

- Emphasizing grid connection improvements as a priority provides clarity for utilities that their core obligation to serve requires more responsive and efficient processes, including reducing timelines.

Utility and regulator risk aversion

- More rapid grid connection when and where there is sufficient capacity enables earlier utility revenue collection from new EV load, lowering the risk of stranded assets.
- Improved grid connection processes increase transparency between customer and utility plans, supporting improved load forecasting and increasing confidence in utility planning.

How utilities can improve load forecasting

Utility action	Details	Examples and resources
DATA		
Publish hosting capacity maps	Providing clear and frequently-updated utility hosting capacity data enables customers and developers to consider potential capacity upgrade needs and timelines along with other siting criteria. This presents a pathway for more rapid grid connections to customers with flexibility on specific location, as well as reducing overall service connection application volume by enabling customers to more strategically target their planned projects. While focused on distribution system capacity, ideally utilities should coordinate with their transmission planning processes to flag any specific areas of transmission constraint (see discussion of IDSP and comprehensive planning as part of building block #3, Prioritize Efficient, Cost-Effective Use of Distribution Infrastructure).	US DOE, Atlas of Electric Distribution System Hosting Capacity Maps EPRI Brief: The Value of Grid Capacity Maps NREL and IREC, Data Validation for Hosting Capacity Analyses Atlas Public Policy, Best Practices in Hosting Capacity Maps (forthcoming)
Digitalization and data sharing	As discussed in the preceding building block, digitalization of utility assets — such as advanced metering infrastructure (AMI) and other digital communication and monitoring technologies — acts as an enabler of better data tracking and sharing. Similar to hosting capacity maps, this can help to provide customers and developers with needed transparency and help to speed grid connection processes.	NARUC, Grid Data Sharing Playbook NYSERDA, Integrated Energy Data Resource Deloitte, Digital Technology Solutions for Utilities

How utilities can improve load forecasting

Utility action	Details	Examples and resources
PROCESS		
Streamline connection processes	Grid connection processes — including internal utility data sharing and workflow alignment — should be updated to prepare for an increase in service requests.	Con Edison, Straw Proposal for Streamlined Queue Management DOE, EV Service Connection Streamlining Project (ongoing)
Standardize connection options and develop flexible interconnection offerings	Developing a menu of standardized grid connection choices provides valuable optionality to customers and developers. Options can include traditional service connections, various forms of flexible connections (e.g., ramped service over time, static vs. dynamic load limits), and forms of hybrid (inter)connection with distributed energy resources that can affect net load, such as on-site solar and/or storage.	AVANGRID is piloting flexible interconnection options. In the United Kingdom, National Grid provides several standardized, flexible grid connection options.
Increase utility staff capacity	Utilities will need to staff up to accommodate a growing volume of service connection requests. This must be paired with a focus on improving process efficiency to limit the total required staffing increase.	RMI, The People Element: Positioning PUCs for 21st-Century Success
ENABLER		
Develop equipment stockpiles	Supply chain constraints have become a significant barrier to grid and service upgrades. Utilities and regulators can mitigate timeline risk and reduce costs by proactively developing stockpiles of common equipment such as service transformers and switchgear, taking advantage of economies of scale through bulk procurement.	Colorado's Modernize Energy Distribution Systems legislation (SB 218, 2024)

How regulators can align grid connection with customer needs

Utility actions
(From previous slides)

1. **Publish hosting capacity maps**
2. **Digitalization and data sharing**
3. **Streamline connection processes**
4. **Standardize connection options and develop flexible interconnection offerings**
5. **Increase utility staff capacity**
6. **Develop equipment stockpiles**

Set grid planning guidance

1 2 3 4

Require publication and regular updating of high quality hosting capacity maps.

Encourage increased use of detailed utility asset and operational data in planning exercises.

Direct utilities to develop standard grid connection and flexible interconnection options.

Establish and track desired outcomes

3 4

Establish maximum timelines for grid connections, potentially tied to carefully designed performance incentives.

Approve appropriate utility investments

2 3 4 5 6

Review utility proposals to ensure practices are in place to improve grid connection processes and timelines, including use of alternatives such as flexible interconnection.

Enable reasonable utility stockpiling of critical electrical equipment to reduce grid upgrade timelines, based on best available load forecasts (building block #2).

Building block 5

Improve risk sharing and mitigation

Stakeholders should explore new approaches for how the overall risk in investing in grid infrastructure ahead of firm load commitments can be reduced and shared in different ways

Overview

Both real and perceived risks limit more rapid grid upgrades to support electrification. Examples of relevant risk, by primary risk-holder, include:

- **Utility:** overbuilding (disallowed cost recovery); underbuilding (failing obligation to serve)
- **Ratepayer:** overbuilding (increased costs); underbuilding (unrealized rate impact benefits)
- **EV customers:** underbuilding (insufficient grid capacity; inability to operate vehicles; unrealized fuel savings; policy non-compliance); cost allocation (excessive payment for grid upgrades that will also benefit many other customers)

As uncertainty is reduced through better planning and forecasting practices, these risks will diminish. However, additional risk sharing and mitigation — such as through new partnerships between utilities and customers or third parties — will likely be important to enable the scale of grid investment required to support anticipated levels of EV load growth. Doing so likely requires new approaches such as those discussed as part of this building block, although most remain nascent and require further exploration and testing.

Aspects of the challenge addressed

Uncertainty

- Clarity on how risks will be shared across stakeholders eases risk management concerns for utilities.

Existing regulatory paradigm

- Alternative approaches to risk sharing can help to evolve regulator (and utility) perspectives on acceptable risks.

Utility and regulator risk aversion

- Better sharing risks between parties diversifies exposure and reduces risk to any single entity. This can help utilities and/or regulators become more comfortable with investments that might otherwise be deemed too risky yet are still likely needed to support load growth.

How utilities can improve risk sharing and mitigation

Utility action	Details	Examples and resources
NON-TRADITIONAL PARTIES		
Explore opportunities through federal programs, green banks, and other funding sources	Non-ratepayer programs may be able to help overcome uncertainty by backstopping investments. The US Department of Energy's Loan Programs Office leverages significant federal funding to backstop or guarantee loans. There may be opportunity to leverage these programs to backstop grid investments that might otherwise be perceived as too risky from a ratepayer perspective, with loans repaid based on anticipated (yet not entirely certain) revenue collection from new electric load enabled by the grid upgrades. Green banks provide low-cost capital and other forms of financial support, generally with the aim of supporting clean energy development or emissions reductions. These institutions may be able to support proactive investment in utility infrastructure through loan guarantees or other backstop mechanisms that help to reduce the risk that EVs and other new load will take longer to materialize than anticipated.	The Loan Program Office's Energy Infrastructure Reinvestment program could provide loan guarantees for qualifying infrastructure investments, backstopping risk of underused or stranded assets with federal rather than ratepayer funding.
Explore opportunity to work with "anchor tenants"	Many areas that will require distribution system upgrades to support EV load will need to be upgraded to support multiple customers, such as a port or warehouse districts where many medium- and heavy-duty vehicle fleets operate. As some customers — such as certain large, national fleets — are pursuing electrification of their vehicles relatively quickly, there is opportunity to leverage their electrification needs and plans as "anchor tenants" who will use a certain amount of needed grid capacity. For example, if 10 MW of new capacity is estimated to be needed in an area, a specific customer with electrification plans who is willing to commit to 2.5 MW by a certain date can potentially serve as a helpful de-risking mechanism for the larger need in that area — especially if the customer is willing to commit to a certain level of capacity or asset utilization.	This area remains nascent yet holds promise.

How utilities can improve risk sharing and mitigation

Utility action	Details	Examples and resources
IMPROVED PLANNING		
Mitigate risk through holistic planning	Load growth is coming not only from EVs, but also from other end-uses such as building and industrial electrification, and data centers. Ensuring that upgrades to the electric grid consider this diversity of end-use loads can de-risk investments by mitigating the risk of overbuilding (even if some end-use load doesn't materialize or takes longer to arrive than anticipated, other end-use loads will be able to use the deployed grid capacity). Aligning utility- and state-led planning exercises can help to develop a more holistic view.	See examples included with building block #3, Prioritize Efficient, Cost-Effective Use of Distribution Infrastructure.
COST ALLOCATION		
Develop new tariff options with different approaches to cost allocation	Cost allocation for utility-side grid upgrades varies across jurisdictions and customer classes. Regulators, utilities, and — in some jurisdictions — state legislatures, are considering alternative approaches that either socialize larger portions of this cost or enable alternative, more granular cost allocations for certain customer types, which can de-risk utility investments for both utilities and customers (who might otherwise pay an unfair share). While this remains an active area of exploration, well-designed new tariff options — which must consider equity implications — present an opportunity for a novel approach to risk mitigation through different cost allocation methods.	RMI report on Electrification Cost Allocation options (forthcoming) RAP's Electric Cost Allocation for a New Era provides useful discussion and examples.

How regulators can improve risk sharing and mitigation

Utility actions
(From previous slides)

1. **Explore opportunities through federal programs and green banks**
2. **Explore opportunity to work with "anchor tenants"**
3. **Mitigate risk through holistic planning**
4. **Develop new tariff options with different approaches to cost allocation**

Set grid planning guidance

1 3 4

Require planning efforts to holistically consider load growth from both EVs and other end-uses, and to align with state-led planning exercises.

Encourage exploration of federal programs to serve as investment backstop.

Direct utilities to explore new tariff options for alternative cost allocation approaches.

Establish and track desired outcomes

1 3 4

Establish standardized approaches to valuation to support cost allocation and assess which risks participants, utility shareholders, all ratepayers, and other parties are taking on.

Establish metrics to track costs and cost allocation against desired outcomes, such as faster grid connections for EV charging projects or rate impacts from any socialized costs.

Approve appropriate utility investments

1 2 3 4

Evaluate proposed investments based on utility exploration and inclusion of alternative risk-sharing and mitigation opportunities focused on protecting ratepayers (see building block #6, Enable Accountable, Longer-Term Utility Capital Investments).

Building block 6

Enable accountable, longer-term utility capital investments

Enable longer-term utility capital investment with reasonable flexibility to account for uncertainty, balanced by appropriate accountability measures

Overview

To efficiently and rapidly upgrade our electric grid in preparation for EV (and other) load growth, we must ensure needed infrastructure investments are made far enough in advance to avoid becoming a bottleneck. This requires providing flexibility in exactly how and when that capital will be deployed — in recognition of remaining forecast uncertainty — while also designing this structure to hold utilities accountable for the appropriateness of expenditures. This can be enabled through existing methods, and in many ways is an extension of traditional practices (utilities always need to build at least somewhat in advance of needs).

While several discrete actions are detailed on the following slide, it is critical that these be viewed as a cohesive package of regulatory and utility mechanisms rather than standalone approaches, as they collectively work to unlock needed grid investments to meet rapid load growth while also mitigating risks.

Additionally, while engagement from stakeholders has been identified as a recommended action for all building blocks, it is especially worth highlighting here. The package of mechanisms to ensure accountability must be well designed to be effective. Ratepayer advocates should be included in the process of designing and deploying these mechanisms to avoid unintended outcomes.

Aspects of the challenge addressed

Uncertainty

- Balances risk of inaccuracy in longer-term load forecasts with flexibility to proactively allocate capital as EV adoption progresses and uncertainty is reduced.

Existing regulatory paradigm

- Evolves planning and budgeting practices in recognition of fundamental shift from recent past into the current, high load growth era.

Utility and regulator risk aversion

- Provides regulatory guidance to utilities that they are expected to take a longer-term view on grid infrastructure needs to ensure they can provide reliable electric service in a timely fashion.

How utilities can enable accountable, longer-term utility capital investments

Utility action*	Details	Examples and resources
COHESIVE PACKAGE OF OPTIONS		
Work with regulators to adopt multi-year rate plans	A) Multi-year rate plans (MRPs) set utility revenues for multiple years in advance (typically 3–5 years). Although a main focus is on cost containment — providing opportunities for utility savings by reducing costs without reducing revenues — these rate plans also offer utilities more flexibility in resource and system planning. This is a critical component of more rapidly deploying infrastructure to support EV charging as these loads materialize, or new data indicates where they are most likely to materialize soon. However, **good design is key** — if an MRP is poorly designed, it can de-risk earnings, inflate profits, and fail to share efficiency gains with customers.	A) The Hawaii PUC adopted MRPs as part of a larger regulatory strategy to support clean energy goals and contain costs (see RMI report How To Restructure Utility Incentives: The "Four Pillars" of Comprehensive Performance-Based Regulation).
Propose cost trackers for proactive grid investments — with appropriate safeguards	B) Cost trackers enable utilities to recover specific categories of costs on an ongoing basis. They are generally used to enable prompt recovery of costs considered to be outside the utility's control (e.g., the cost of purchased power) as well as to reduce the financial risk to the utility of engaging in certain desired activities (e.g., energy efficiency programs). Though expenditures are generally subject to a prudence review prior to being approved for recovery through a cost tracker, in practice this review is often less rigorous than costs considered in the context of a rate case. As a result, though cost trackers can encourage the utility to spend the money necessary to achieve desired outcomes, they also tend to reduce the utility's incentive to spend money cost efficiently. **Adopting cost-containment strategies alongside trackers is important** for addressing this problem (e.g., shared-savings mechanisms, additional transparency measures). Cost trackers paired with appropriate cost-containment measures can be used to support distribution upgrades incurred to enable rapid electrification while discouraging wasteful spending.	B) Colorado's Grid Modernization Adjustment Clause included in the recently-passed SB 218.
Propose performance-based mechanisms	C) Utility cost recovery can be tied, in part, to various performance metrics around desired outcomes such as interconnection/energization timelines, use of non-wires alternatives, and load management practices to reduce the total need for new grid infrastructure. **Any performance incentive mechanisms must be carefully designed to ensure incentive payouts are directly rewarding progress toward desired outcomes and produce net benefits.**	C) See Hawaii example noted above.

*These actions should be viewed as a cohesive package rather than discrete activities independent of one another.

How regulators can enable accountable, longer-term utility capital investment

Utility actions*
(From previous slide)

A **Work with regulators to adopt multi-year rate plans**

B **Propose cost trackers for proactive grid investments — with appropriate safeguards**

C **Propose performance-based mechanisms**

A

Set Grid planning guidance

Adopt multi-year budgeting, through multi-year rate cases or other budgeting venues. Ensure that budgeting is connected to planning outputs and use forward rather than historical test years to capture anticipated EV growth.

Require use of latest load forecasts and other prospective (vs. historical) estimates to establish anticipated costs and revenues.

A **B** **C**

Establish and track desired outcomes

Evaluate and help design cost trackers and performance-based mechanisms that appropriately balance utility flexibility and accountability while aligning with state goals and desired regulatory outcomes.

A **B** **C**

Approve appropriate utility investments

Approve traditional and non-traditional investments proposed by utilities when they are well justified, sufficiently account for anticipated EV load growth (timing, location, load shapes), and adhere to accountability measures.

*Note that utility actions for this building block are denoted with letters rather than numbers, to indicate that these actions should be viewed as a cohesive package rather than discrete activities independent of one another.

Conclusion

Next steps

Thank you for reading this insight brief. We welcome all feedback, including that related to the proposed building blocks, innovative examples and case studies, and/or parallel and related efforts. Please send your feedback to Ben Shapiro or Nick Pesta.

RMI is currently planning our next phase of this work, which will include:

- Developing case studies that explore how following the recommendations in these building blocks can reduce the total cost of grid infrastructure; and
- Further investigating cost-sharing mechanisms and other ratepayer considerations.

THANK YOU!

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Authors:
E.J Klock-McCook
Ben Shapiro
Nick Pesta
Rachel Gold
Kaja Reban

If you have any questions or suggestions regarding the Transportation Electrification Building Blocks, feel free to reach out to:

Ben Shapiro, bshapiro@rmi.org
Nick Pesta, npesta@rmi.org