# PHASING IN U.S. CHARGING INFRASTRUCTURE

A Roadmap for Zero-Emission Medium- and Heavy-Duty Infrastructure Buildout

The market for zero-emission medium- and heavy-duty vehicles (ZE-MHDVs) is taking off, and with it, the need for **reliable** and **accessible charging infrastructure.**

AUGUST 2023

**CALSTART has developed a model and roadmap for how the U.S. can implement a national buildout of infrastructure at the scale and speed needed to support rapid adoption of ZE-MHDVs by targeting priority areas first.**

In this roadmap, infrastructure buildout meets the pace and volume of ZE-MHDV market growth set by the **Global Memorandum of Understanding on Zero-Emission Medium- and Heavy-Duty Vehicles (Global MOU)**, which the U.S. signed in 2022. The Global MOU, co-led by the Government of The Netherlands and CALSTART's Global Commercial Vehicle Drive to Zero campaign and program (Drive to Zero), calls for 30 percent new commercial vehicle sales being zero-emission by 2030 and 100 percent being zero-emission by 2040.[1] This adoption rate is 45 percent deeper than the vehicle penetration rates assumed by EPA's proposed Phase 3 Greenhouse Gas Emissions Standards for Heavy-Duty Vehicles.

This roadmap requires that industry targets favorable areas—or priority launch areas—then extends investment in **phases**. Priority launch areas are those where:

1. Industry concentrates and demand on the grid can cluster and aggregate.
2. Industry and government have prioritized investment.
3. Supportive policy actively takes measures to incentivize the ZE-MHDV transition and/or maximize social and equity co-benefits.
4. Energy will cost less and capacity is favorable near-term.

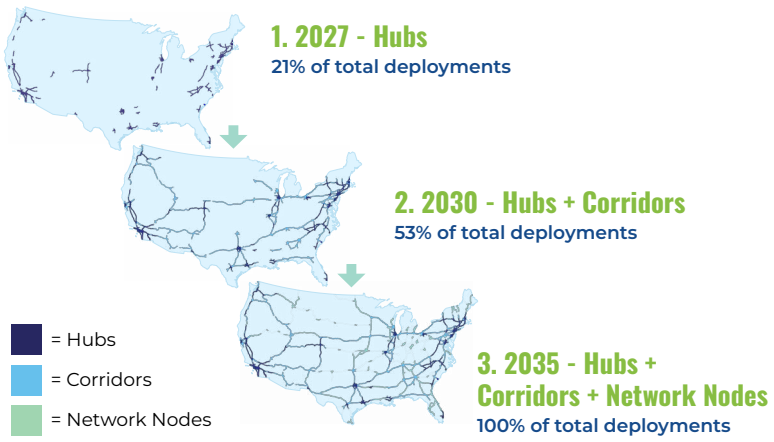
By prioritizing these four factors, the resulting scenario shows buildout through 2035 occurring in three phases (Figure 1):

1. **Hubs** in key industry clusters
2. **Corridors** for regional travel
3. **Nodes** in a national, ubiquitous zero-emission network

Ultimately, this **phase-in strategy** to infrastructure buildout **meets rapid adoption scenarios** by enabling:

- Faster deployment through priority launch areas.
- Utilities, government, and investors to target their actions.
- Focused, cost-effective implementation, leading to greater utilization and reduced per-vehicle infrastructure costs.
- Grid modernization planning that unleashes private investment.

## Figure 1. Phase-in Strategy Through 2035



## GROWTH IN ENERGY NEEDS

CALSTART calculated commercial vehicle activity on the National Highway Freight Network to show the impact of ZE-MHDV adoption. This network makes up the critical backbone of U.S. truck travel.[2] Energy needs were determined by calculating what proportions of existing traffic could be made up of new ZE-MHDVs over time.[3]

Figure 2 shows a snapshot of the average rate of increase in yearly consumption of power per network segment needed to get the network to 2035 Global MOU adoption levels. In general, power consumption increases range from up to 0.3 megawatt-hours (MWh) per day to, at the high end, 5.5 MWh per day in certain areas. Negotiating these energy needs will require industry to prioritize launch areas and pursue strategies that make the most of capacity, store more energy onsite, and maximize infrastructure utilization while the grid is built out to support this transition.

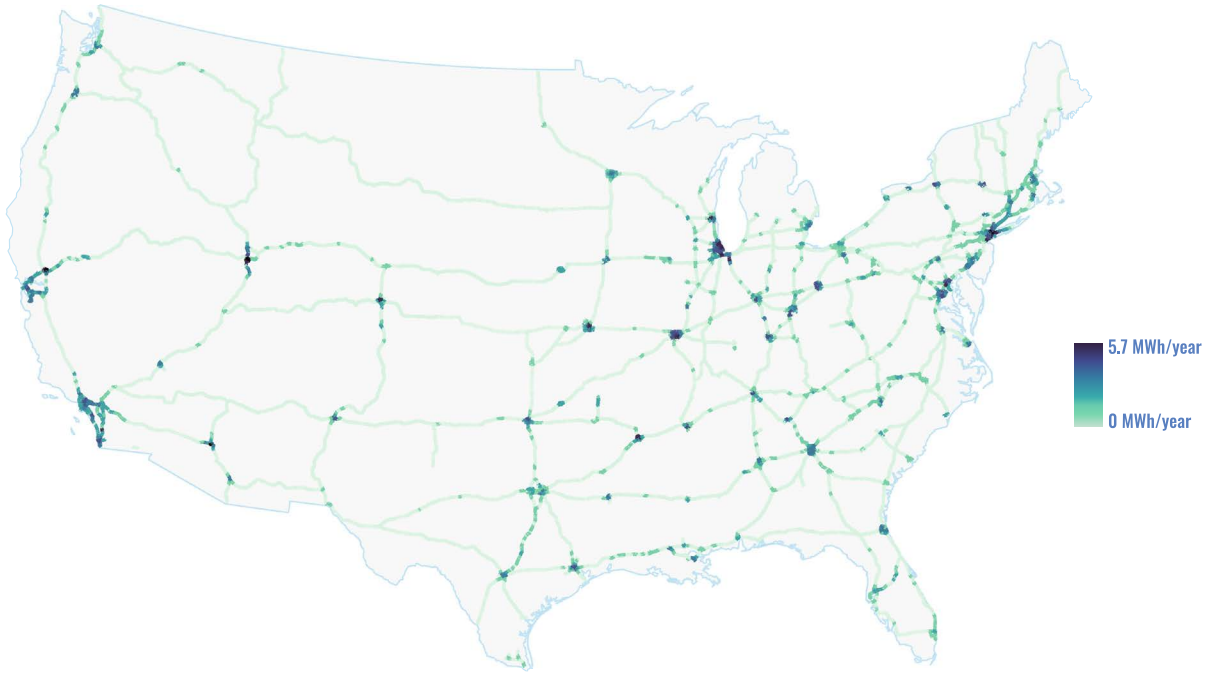
The key is **phasing in the ZE-MHDV transition** by targeting 1) several kinds of favorable areas and 2) different site configurations within these areas, which will integrate the grid with U.S. transportation systems.

## PRIORITY LAUNCH AREAS

The intersection of the four priorities[4] below makes areas favorable for meeting Global MOU adoption rates in this scenario:

- **Industry clustering:** There is a concentration of sectoral activity (i.e., fleet location and growth) in ZE-MHDV transportation services, such as warehouses, logistics, or other sectors.
- **Industry and government investment zones:** An area has been announced as a priority for infrastructure companies or by supportive federal planning grants.
- **Favorable policy environments:** Policy prioritizes climate and equity benefits of zero-emission vehicles through adoption of the Advanced Clean Trucks rule, grid modernization measures, and/or commitments to the Global MOU.
- **Potential for energy system improvements and energy cost reduction:** An area has low future-levelized cost of energy and strong growth in distributed energy resources.

**Figure 2. Average Annual Increase in Daily Energy Consumption from New ZE-MHDV Sales, 2023-2035**



## PRIORITY CONFIGURATIONS

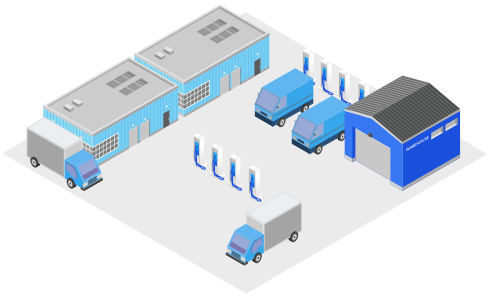
This scenario also assumes that several kinds of site configurations will accompany the buildout from these priority launch areas, as well as an expanding range of vehicle applications (Figure 3).

- **Hubs** will be depot-style home bases in industry clusters for out-and-back operations. As buildout occurs, many of these hubs can also form by two or more firms entering into agreements to share infrastructure, or where infrastructure providers at key locations provide a multi-use site. Demand for energy at these sites can be concentrated in a predictable manner which utilities can target, and fleets can utilize charge management systems to keep growth underneath capacity during buildout.
- **Corridor connectors** may be a mix of 1) depots or shared and multi-use sites with clear connections to corridors, or alternatively, 2) pull-through charging sites along these key routes. As transportation volumes grow, targeted private and public investment in these configurations will enable point-to-point operations and provide redundancies that continue to catalyze hub development. Sites can store energy in onsite battery storage systems, especially in areas where it is cheap and can be supplemented.
- **National network nodes** will enable full regional and inter-regional point-to-point travel and provide ubiquitous access. These sites can be made with public investment and support public applications, as well as linkages in the network with key facilities critical to the surface transportation goods movement system (like ports).

Eventually, all configurations will be present across the country, but buildout will sequence the development of **hubs** in **industry clusters**, then **connections** along key **corridors**, and finally **nodes** to create the **full zero-emission network**.

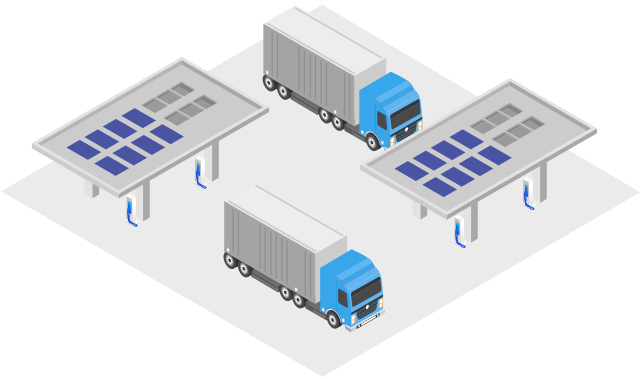
**Figure 3. Site Configurations Within Priority Launch Areas**

### Hubs



### Connectors

### Nodes



## PRIORITY MAP

Figure 4 details important findings regarding the priority launch areas and sequence of the buildout:

- The East and West Coasts, where favorable policy environments and industry clusters are prominent, are advantageous for hubs, along with the Texas Triangle and major industry clusters and urban centers in the West, Midwest, and East.
- Corridor connections between these areas selected for investment by industry and government, as well as growth in renewables and low levelized cost of energy, make the Southwest, Southeast, and areas of the Midwest key for the second phase of buildout.
- Finally, major nodes in the national network fill out remaining connections to critical goods movement regions by 2035.

In this scenario, the entire National Highway Freight Network, which moves most of the goods in the U.S., is accommodated. These results are deeply aligned with recent work by organizations like the International Council on Clean Transportation in its geographic emphasis and results,[5] as well as research institutes, government agencies, and labs in emphasizing that prioritizing key areas will be a core component of integrating the transportation network into the energy system.

**Why the Phase-in Strategy Works**

- In industry hubs in urban centers, near ports, or at distribution centers, fleets can manage charging with favorable rates and available onsite storage, or can take advantage of shared or multi-use charging centers.
- Along important corridors, connector sites between hubs can drive up infrastructure utilization to mitigate near-term capacity constraints.
- Nationally, utilities and regulatory bodies can focus on supportive policies to target deployment in priority nodes, linking up the hubs and corridors to make a national zero-emission freight network.

### Figure 4. Priority Launch Areas for Phase-in of Infrastructure To Meet Rapid ZE-MHDV Adoption

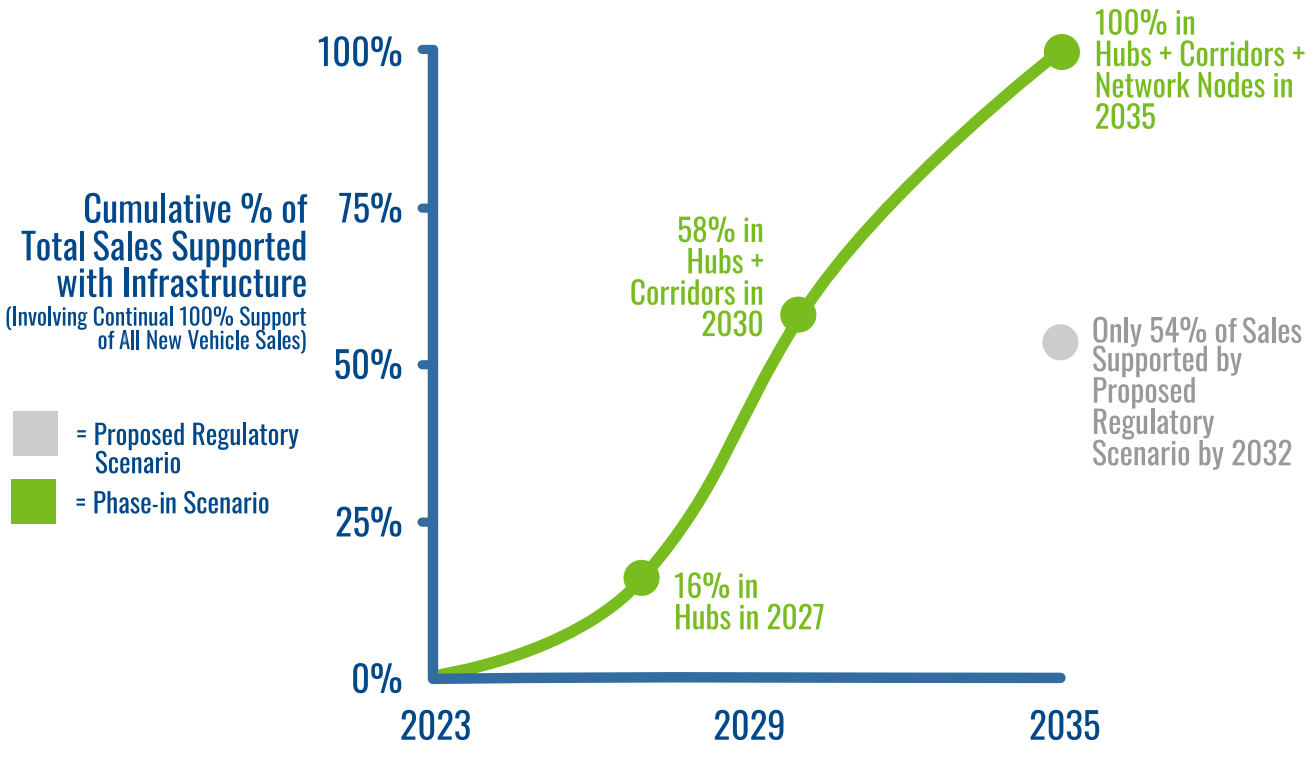
## FINDINGS AND BENEFITS

CALSTART's model also shows the pace and extent of buildout compared to an unphased strategy. Figure 5 below contrasts the phase-in scenario with a scenario that reflects an untargeted, uniform approach to buildout[6] and the adoption rates currently proposed by EPA regulators.[7]

The advantages and benefits regarding pace and timing of the phase-in strategy are clear:

- At each stage of phase-in buildout, 100 percent of demand can be supported by more targeted investment.
- It accommodates an overall higher demand and deeper percentage of market penetration while encouraging achievable grid modernizing and strengthening. Forty-five percent more vehicles are electrified at the same or faster rate, a total of over 3 million vehicles.
- Early stages of investment can accommodate the same demand as those assumed by less aggressive regulatory scenarios by targeting areas where maximizing charging utilization or management is possible.
- In key areas with industry clustering, supportive policies, supportive investments, and/or cheap energy, the utilization of infrastructure can increase; the cost of buildout can be reduced; and capacity constraints can be mitigated by a wider range of management strategies, shared by utilities and fleets.
- It provides clear signals to coordinating bodies, utilities, government, and investors about **where and when deep integration of the energy and transportation systems is needed most** to tackle climate challenges, identifying where private capital and public funds can be leveraged most.

**Figure 5. Rapid, Extensive Market Penetration Supported by Phased Buildout of Infrastructure**



## NOTES AND REFERENCES

[1] See the Drive to Zero Global Roadmap at: **https://calstart.org/global-roadmap-for-reaching-100-zero-emission-medium-and-heavy-duty-vehicles-by-2040/.**

[2] See the National Highway Freight Network Visualization Tool at: **https://fpcb.ops.fhwa.dot.gov/tools_nhfn.aspx.**

[3] The analysis distributed new sales by relating these to vehicle miles traveled (VMT) by commercial vehicles (Classes 3–8) on relevant segments of the ZE-MHDV road network, which CALSTART defined as the National Highway Freight Network (NHFN) within the lower 48 U.S. states. VMT was calculated for travel on the road segments through these areas, which was then used this as a basis for determining new ZE-MHDV introductions in these areas by way of a scaling factor. The energy used by travel through the area vis-à-vis all travel on NHFN was related to the energy of potentially introduced ZE-MHDVs in that area to the total of ZE-MHDVs forecasted by the Global MOU scenario, given their energy usage, typical range, and other factors. See the full report for more information at: **https://calstart.org/zev-infrastructure-phase-in.**

[4] Data on factors came from the following sources: 1) Industry clusters: County NAICS code categories of "Transportation and Logistics," "Distribution and Electronic Commerce," and "Local Logistical Services." 2) Industry investments: industry announcements and federal announcements. 3) Policy alignment: state adoption of and support for Advanced Clean Trucks rule and statewide high potential regions identified by the North American Council for Freight Efficiency (NACFE). NACFE (2018). "Electric Trucks Where They Make Sense: High Potential Regions for Electric Trucks." Retrieved from: **https://nacfe.org/research/electric-trucks/#electric-trucks-where-they-make-sensehigh-potential-regions-for-electric-truck-deployments.** 4) National Renewable Energy Laboratory's data on Levelized Cost of Energy for renewables from 2020–2040: "Levelized Cost of Energy" in "SLOPE: State and Local Planning for Energy Data Viewer." View this data at: **https://maps.nrel.gov/slope**. 5) See the full report for more information at: **https://calstart.org/zev-infrastructure-phase-in.**

[5] International Council on Clean Transportation (2023). "Near-Term Infrastructure Deployment to Support Zero-Emission Medium- and Heavy-Duty Vehicles in the United States." Retrieved from: **https://theicct.org/wp-content/uploads/2023/05/infrastructure-deployment-mhdv-may23.pdf.**

[6] The contrast between the phase-in vs. unphased scenarios shows that 1) a linear mentality and universal, untargeted approach to infrastructure buildout will not lead to rapid or sustained growth, and 2) rapid growth will arise only by focusing first on areas primed for success. See the full report for more information at: **https://calstart.org/zev-infrastructure-phase-in.**

[7] EPA's Proposed "Greenhouse Gas Emissions Standards for Heavy-Duty Vehicles: Phase 3: Draft Regulatory Impact Analysis" can be found at: **https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P10178RN.pdf.**

### QUESTIONS ABOUT ZE-MHDV INFRASTRUCTURE?

**Reach out to Michael Joseph, MJoseph@calstart.org.**

For more information, please visit: **https://calstart.org/zev-infrastructure-phase-in**