POLICY APPROACHES TO HEAVY-DUTY EV CHARGING IN THE EUROPEAN UNION

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Abstract
The electrification of heavy-duty road transport has become an increasingly important component of decarbonisation policy in the European Union. A central challenge in this transition is the deployment of charging infrastructure capable of supporting freight operations, which differ substantially from passenger transport in terms of energy demand, operational requirements, and infrastructure needs. In response, European policy has increasingly combined emissions regulation, corridor-based infrastructure planning, and financial support mechanisms to accelerate the development of heavy-duty EV charging networks.
This paper provides an overview of policy approaches supporting heavy-duty EV charging deployment in the European Union. It reviews the broader policy context shaped by European regulatory initiatives, examines key policy instruments including regulatory measures, incentives, and energy-system integration approaches, and discusses differences in implementation readiness across selected Member States. Particular attention is given to the relationship between infrastructure deployment plans, freight transport demand, and emerging challenges related to grid readiness, interoperability, and charging network adequacy.
The analysis indicates that significant progress has been made in establishing a policy framework for heavy-duty transport electrification, although infrastructure deployment remains uneven and implementation challenges persist. The paper argues that the effectiveness of current approaches will depend not only on meeting deployment targets, but on aligning charging infrastructure development with logistics system requirements and broader freight decarbonisation strategies.
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INTRODUCTION

Road freight transport plays a central role in the economy of the European Union, enabling the movement of goods across increasingly complex supply chains and supporting a substantial share of inland freight transport demand [1,2]. At the same time, growing trade volumes and freight activity have intensified concerns regarding greenhouse gas emissions, energy dependence, and the sustainability of freight transport systems [3]. As the transport sector remains a major contributor to emissions, the decarbonization of heavy-duty road transport has become an important policy priority, reinforced by European climate objectives and regulatory initiatives such as the European Green Deal, the Fit-for-55 package, and strengthened CO_2 standards for heavy-duty vehicles [4–6].

Recent developments in European freight transport further reinforce the importance of addressing heavy-duty vehicle decarbonization. Road freight transport in the EU reached approximately 1.87 trillion tonne-kilometres in 2024, showing continued resilience and slight growth despite economic uncertainty. Road transport also remains a major freight mode in Europe, accounting for roughly one quarter of freight transport performed in tonne-kilometres, while its modal share has increased over the past decade. At the same time, freight activity is increasingly concentrated along major international corridors and logistics hubs, intensifying pressure on transport infrastructure and reinforcing the strategic relevance of the Trans-European Transport Network (TEN-T) for future charging deployment. These trends suggest that decarbonization policies must address not only emissions reduction, but also growing freight demand and evolving logistics patterns.

Although heavy-duty vehicles represent only a small share of vehicles on European roads, they account for roughly one quarter of road transport CO_2 emissions, highlighting their disproportionate environmental impact.

Among emerging decarbonization pathways, battery-electric heavy-duty vehicles have gained increasing attention due to technological advances in vehicle performance, battery systems, and charging technologies [7,8]. However, large-scale electrification of freight transport depends not only on vehicle adoption but also on the timely deployment of suitable charging infrastructure [8,9]. Compared to passenger electric mobility, heavy-duty charging presents additional challenges related to higher power requirements, depot and corridor charging needs, grid capacity constraints, interoperability, and significant infrastructure investment requirements [9–11]. Consequently, charging infrastructure development has emerged not merely as a technical issue, but as a broader policy and planning challenge involving coordinated action across transport, energy, and industrial policy domains [10,11].

Recognizing these challenges, the European policy framework has increasingly emphasized infrastructure deployment through corridor-oriented approaches linked to the Trans-European Transport Network and the Alternative Fuels Infrastructure Regulation [12,13]. These initiatives seek to support the rollout of charging infrastructure along strategic freight corridors while promoting interoperability and coordinated implementation across member states [12,13]. At the same time, differences in national strategies, funding approaches, grid readiness, and market structures contribute to a diverse and evolving policy landscape, raising questions about the effectiveness and coherence of alternative policy approaches [14,15].

While existing research has largely focused on charging technologies, infrastructure planning, and vehicle deployment [8–11], comparatively less attention has been given to synthesizing policy approaches supporting heavy-duty EV charging deployment in the European Union [15, 7].

In response, this paper provides an overview of key policy approaches in this area, focusing on regulatory frameworks, economic support instruments, implementation challenges, and emerging directions for policy development.

1. POLICY CONTEXT FOR HEAVY-DUTY ELECTRIFICATION

The electrification of heavy-duty road transport in the European Union is shaped by a broader policy framework linking climate objectives, transport regulation, industrial strategy, and energy transition policies. Unlike passenger electromobility, heavy-duty vehicle electrification has emerged more recently as a strategic policy focus, driven by the need to reduce emissions in freight transport while maintaining competitiveness and resilience in logistics systems [7,16].

A major policy driver has been the progressive tightening of emissions reduction targets for heavy-duty vehicles through European CO_2 performance standards, which establish increasingly ambitious requirements for manufacturers and support the market uptake of zero-emission freight vehicles [6]. These measures are reinforced by broader initiatives under the European Green Deal and Fit-for-55 policy package, which frame freight electrification as part of a wider transition toward sustainable mobility and climate neutrality [5,12].

Infrastructure deployment has become a parallel policy priority, particularly through the Alternative Fuels Infrastructure Regulation, which introduces requirements for the rollout of charging infrastructure along major transport corridors [12]. In the heavy-duty segment, this reflects a shift from primarily vehicle-focused policy toward integrated approaches that recognize infrastructure availability as a prerequisite for market adoption. In this context, the Trans-European Transport Network provides an important spatial planning framework, linking charging deployment to strategic freight corridors, logistics hubs, and cross-border transport connectivity [13].

Beyond regulatory mandates, the policy context is also influenced by supporting measures related to infrastructure funding, electricity market design, permitting, and grid development. Public support programs at European and national levels, including instruments such as the Connecting Europe Facility and various national subsidy schemes, seek to reduce investment barriers associated with high-power charging infrastructure [17,18]. At the same time, increasing attention is being given to interoperability standards, smart charging, and emerging technologies such as megawatt charging systems, which may further shape future policy development [11].

Despite increasing policy support, the framework for heavy-duty electrification remains characterized by challenges related to implementation coordination. Differences in member state readiness, infrastructure planning approaches, and grid capacity conditions contribute to uneven deployment conditions across Europe [15]. As a result, current policy development increasingly emphasizes coordinated approaches that integrate transport, energy, and industrial policy perspectives rather than addressing charging infrastructure solely as a transport-sector issue.

2. POLICY APPROACHES TO HEAVY-DUTY EV CHARGING

Policy approaches supporting heavy-duty EV charging deployment in the European Union can generally be grouped into regulatory approaches, financial support mechanisms, market and operational measures, and energy-system integration policies. While these categories overlap in practice, they reflect different mechanisms through which public policy seeks to accelerate infrastructure deployment and support market uptake.

2.1. REGULATORY APPROACHES

Regulatory approaches primarily seek to establish framework conditions and minimum infrastructure requirements. A central example is the Alternative Fuels Infrastructure Regulation, which defines deployment targets for charging infrastructure along major freight corridors and contributes to greater predictability for infrastructure investments [11].

Closely linked are policies associated with the Trans-European Transport Network, where corridor-based planning supports coordinated charging infrastructure rollout at strategic transport routes and logistics nodes [13].

Additional regulatory approaches include permitting simplification, grid connection procedures, technical standards, and interoperability requirements intended to reduce non-financial barriers to deployment [8]. Such measures are particularly important in the heavy-duty segment, where infrastructure projects often face longer lead times and higher complexity than passenger charging installations.

2.2 FINANCIAL SUPPORT AND INCENTIVE MECHANISMS

Given high upfront costs associated with heavy-duty charging infrastructure, many policy approaches rely on financial support instruments. These include direct investment subsidies, grants for depot and public charging installations, tax incentives, and co-financing mechanisms designed to reduce capital risk [19].

At the European level, support instruments such as the Connecting Europe Facility have played a role in financing strategic infrastructure deployment, while member states have introduced complementary national programs [17]. In addition, electricity tariff design and incentives aimed at lowering operational charging costs are increasingly considered part of the policy toolbox [20].

2.3. MARKET AND OPERATIONAL POLICY MEASURES

A third category includes policies aimed at enabling market functionality and operational effectiveness. These approaches include interoperability requirements, open-access charging policies, pricing transparency measures, and support for standardized payment and service models [8].

Operational policies also increasingly address freight-specific charging concepts, including support for depot charging strategies, public corridor charging, and emerging megawatt charging system deployment [12]. In this context, policy is not only concerned with infrastructure quantity, but with ensuring that charging systems align with freight operational requirements.

2.4. ENERGY-SYSTEM INTEGRATION POLICIES

Because heavy-duty charging creates substantial electricity demand, policy approaches increasingly extend beyond transport into energy-system integration. This includes support for grid reinforcement, smart charging, demand management, renewable energy integration, and in some cases vehicle-grid flexibility services [10].

Such approaches recognize that large-scale charging deployment may depend as much on electricity system readiness as on transport policy. Consequently, policy discussions increasingly emphasize integrated planning between transport infrastructure deployment and energy network development [9].

Taken together, these approaches reflect a gradual shift from narrowly supporting charging deployment toward more systemic policy frameworks that combine regulation, market support, infrastructure planning, and energy integration. Their relative emphasis varies across jurisdictions, but collectively they shape the emerging policy landscape for heavy-duty EV charging in Europe. An overview of policies is given in Table 1.

Table 1: Policy overview (source, compiled from [10, 12, 13, 15])

Policy category	**Typical policy instruments**	**Primary objective**	**Example EU framework / sources**
Regulatory approaches	Infrastructure deployment mandates; corridor coverage requirements; technical standards; permitting simplification; interoperability rules	Provide legal framework and reduce deployment barriers	AFIR (EU 2023/1804) TEN-T Regulation (EU 2024/1679)
Financial support mechanisms	Investment subsidies; grants; tax incentives; co-financing; tariff support	Reduce capital costs and improve investment viability	Connecting Europe Facility national incentive programs
Market and operational measures	Open-access requirements; pricing transparency; roaming/interoperability; support for depot and corridor charging	Improve market functioning and operational usability	AFIR interoperability
Energy-system integration policies	Grid reinforcement support; smart charging; demand response; renewable integration; flexibility incentives	Align charging deployment with electricity system readiness	Grid integration studies EU energy policy sources
Strategic planning and coordination approaches *(optional extra category — I would include it)*	Corridor planning; logistics hub targeting; public-private coordination; integrated transport-energy planning	Improve long-term system-level deployment effectiveness	TEN-T; corridor planning CEF

The implementation of heavy-duty EV charging policy in the European Union depends not only on regulatory targets, but also on the availability of incentives that reduce investment risks for vehicle operators, charging infrastructure providers, and logistics companies. At EU level, the Alternative Fuels Infrastructure Regulation establishes mandatory infrastructure requirements, including distance-based charging deployment along the TEN-T network and provisions for interoperability, payment access, price transparency, and smart recharging. The regulation has applied since 13 April 2024 and requires Member States to ensure minimum infrastructure coverage for both light- and heavy-duty vehicles.

However, AFIR creates the regulatory baseline rather than fully financing deployment. Practical implementation therefore depends on complementary support mechanisms, including grants, co-financing, tax benefits, vehicle purchase incentives, charging infrastructure subsidies, toll differentiation, and grid-connection support. ACEA's 2025 overview indicates that fiscal support remains uneven: over one third of EU Member States do not offer acquisition incentives for zero-emission commercial vehicles, and only 12 countries offer incentives for charging or hydrogen refueling infrastructure. The overview of the readiness level is given in Table 2.

Table 2: Readiness assessment across EU countries

Country / group	Incentive and implementation profile	Current readiness assessment
Sweden	Purchase incentives, charging infrastructure grants, and relatively advanced public charging deployment. Programs such as Klimatklivet and Ladda bilen support vehicle and infrastructure uptake.	Among the more advanced countries; strong progress toward AFIR 2030 targets, but future challenges remain in grid capacity and load-capacity mapping.
Germany	Strong policy attention to zero-emission freight, charging infrastructure, and vehicle taxation benefits.	Important market due to freight volume and TEN-T relevance; progress depends strongly on grid connection speed and high-power corridor deployment.
France	National support for transport decarbonization and infrastructure deployment; important role in corridor charging due to central EU geography.	Relatively important early market, but implementation depends on coordination between national programs, grid operators, and freight corridors.
Netherlands / Belgium	High freight and logistics intensity, major port and corridor relevance.	AFIR targets may cover only a lower share of expected public charging needs in dense logistics markets; additional market-led and national support may be needed. ICCT notes that targets cover only 30–50% of expected public charging needs in about half of Member States, including the Netherlands and Belgium.
Spain	Offers tax exemptions and infrastructure subsidies, but charging deployment remains geographically dispersed.	Progress visible, but current deployment still falls short of AFIR requirements in the cited assessment.
Poland	Charging infrastructure for electric trucks remains at an early stage, but a forthcoming €480 million subsidy program for zero-emission trucks and charging infrastructure could significantly improve readiness.	Currently behind leading countries, but policy momentum is increasing.
Central and Eastern EU countries	Generally lower zero-emission truck uptake and less mature charging infrastructure.	Deployment may depend more strongly on EU funds, TEN-T corridor obligations, and national recovery or infrastructure programs.
EU-wide baseline	AFIR sets minimum coverage requirements along TEN-T and in urban nodes, while CEF and other instruments can support infrastructure deployment.	Provides a common regulatory floor, but Member State implementation remains uneven.

CONCLUSION

The policy framework for heavy-duty transport electrification in the European Union has moved beyond pilot-stage initiatives toward a more structured deployment strategy centred on vehicle uptake targets, corridor charging requirements, and integration of charging infrastructure within the Trans-European Transport Network. Current plans, particularly under the Alternative Fuels Infrastructure Regulation and related national initiatives, indicate a transition from fragmented infrastructure expansion toward a coordinated European charging network intended to support long-distance freight electrification. This represents an important shift, as policy increasingly addresses not only the promotion of electric trucks but also the system conditions required for their operation.

With regard to implementation progress, available evidence suggests that infrastructure development is advancing, although not uniformly at the pace implied by long-term electrification ambitions. Several Member States have made substantial progress in corridor planning, depot charging deployment, and incentive support, while others remain at earlier stages of readiness. Current developments indicate that the planned infrastructure network can provide an important foundation for early large-scale deployment of electric heavy-duty vehicles, though uncertainties remain regarding whether charging rollout, grid reinforcement, and logistics node integration will keep pace with accelerated vehicle adoption. It may therefore be expected that policy attention will increasingly shift from establishing deployment targets toward resolving implementation bottlenecks related to power availability, interoperability, and corridor-level operational adequacy.

From a decarbonization perspective, the expansion of electric heavy-duty road transport may provide substantial emissions reduction potential, particularly where charging is increasingly supported by low-carbon electricity generation. While rail freight generally remains among the most energy-efficient and lowest-emission freight transport modes, electric trucks may contribute significantly in transport segments where modal shift to rail is constrained by geography, network access, service flexibility, or first- and last-mile requirements. In this sense, heavy-duty electrification should not necessarily be viewed as competing with rail, but rather as complementing broader freight decarbonization strategies in which modal shift and vehicle electrification play parallel roles.

Looking ahead, the effectiveness of European policy approaches will depend not only on meeting infrastructure deployment plans, but on whether those plans translate into charging networks capable of supporting real freight transport demand. If current policy momentum is maintained and infrastructure rollout continues to expand in line with projected needs, electric heavy-duty transport may become a significant contributor to freight decarbonization alongside rail and other low-carbon transport solutions. The broader expectation is therefore not the replacement of one mode by another, but the emergence of a more diversified low-emission freight system in which electrified road freight assumes an increasingly important role.

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