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Powering the Future of Logistics: A Comprehensive Implementation Strategy for Heavy-Duty Charging Infrastructure in the Netherlands.

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Executive Summary

This paper presents the Dutch approach for stimulating the development of charging infrastructure for the logistics sector through the National Charging Infrastructure (NAL) Agenda. Based on three recent case studies, (i) a thorough grid capacity analysis, (ii) corridor location strategy development, and (iii) stress testing in real world (living lab) conditions, we demonstrate an integrated approach combining data-driven analysis with stakeholder engagement. We reflect on the effect of the programmed approach within the NAL and identify 5 factors that may facilitate the required conditions for developing sufficient charging infrastructure for the logistics sector. This model provide insights that may provide replicability potential for international heavy-duty charging infrastructure development.

Keywords: heavy duty electric vehicles, fast and megawatt charging infrastructure, optimal charging locations, public policy & promotion

1 Introduction

The transition to zero-emission logistics transport represents a crucial component in achieving climate goals and improving urban air quality. While the Total Cost of Ownership (TCO) of electric vehicles is approaching parity with fossil fuel vehicles, partly due to purchase subsidies for vehicles and charging infrastructure, the availability and accessibility of charging infrastructure remain potential barriers to adoption. This paper presents the Dutch approach to facilitating the development of charging infrastructure for logistics, coordinated through the National Charging Infrastructure Agenda (NAL), focusing on both public and private charging solutions.

The study addresses three primary implementation challenges that drives the approach that is integrated in the Dutch National Charging Infrastructure Agenda (NAL) [1]. First, grid capacity limitations threaten to constrain fleet electrification, particularly for medium and large logistics operations, requiring data-driven analysis to identify specific constraints and optimization opportunities. Second, optimal infrastructure placement must integrate technical demand forecasting with stakeholder engagement across diverse location types, from industrial estates to transport corridors, ensuring both technical feasibility and operational acceptance. Third, effective coordination between multiple stakeholders—including grid operators, municipalities, logistics companies, and charging point operators—requires institutionalized collaboration platforms that align diverse interests while translating practical insights into policy frameworks and industry standards.

2 National agenda for facilitating charging infrastructure

The Netherlands' transition to zero-emission transport is anchored in the National Charging Infrastructure Agenda (“NAL”) [1], a multi-year policy framework established as part of the National Climate Agreement [2]. The NAL represents an ambitious national program designed to ensure that charging infrastructure does not limit the deployment of electric vehicles across all transport modes. The program's mission is to create conditions where everyone can charge their vehicles easily, everywhere, and smartly by 2030, supporting the national goal of achieving nearly 2 million electric passenger cars and substantial growth in electric commercial vehicles.

The NAL operates through a dual organizational structure combining (i) knowledge development and (ii) practical implementation. Firstly theme-based working groups conduct research and develop tools to address specific sectoral challenges, while six regional NAL regions concentrate on implementing charging infrastructure across different geographical zones. Among these working groups, the Logistics working group focuses on freight transport electrification, serving as the focal point for addressing commercial vehicle charging requirements. This working group has emerged as a productive public-private partnership that has generated more than 20 reports and tools since 2020, bringing together logistics companies, grid operators, government agencies, and research institutions to collaboratively address infrastructure deployment challenges. The NAL is financed by the Dutch Ministry of Infrastructure and Water Management.

The NAL working group on Logistics [3] specifically focuses on enabling the prerequisites for realizing logistics charging infrastructure, recognizing the distinct requirements of commercial vehicle charging compared to passenger transport. The group addresses two primary infrastructure categories: (i) charging infrastructure at industrial estates where logistics companies are based, and (ii) charging infrastructure along transport corridors for long-distance freight operations. Through its public-private partnership model, the working group ensures that industry needs drive infrastructure planning and policy development, creating actionable guidance for municipalities, businesses, and other stakeholders navigating the charging infrastructure transition.

The drive toward zero-emission trucks is propelled by both European and national regulatory frameworks. At the European level, the Alternative Fuels Infrastructure Regulation (AFIR) creates legally binding targets for heavy-duty charging infrastructure, amongst others requiring charging stations every 60 kilometers along major highways by 2030 [4]. More urgent for companies are the zero-emission zones (ZE zones) being implemented in close to 30 cities in the Netherlands between 2025 and 2030 [5]. This will progressively restrict access for conventional diesel vehicles and ultimately require all new commercial vehicles entering these zones to be emission-free. The Netherlands has set ambitious electrification targets of having 10% of trucks and 25% of delivery vans electric by 2030. By mid-2025, the country has approximately 1,400 electric trucks (roughly 1% of the total fleet) and 41,000 electric delivery vans (approximately 4% of the total) [6] [7] [8].

A relevant practical component of the NAL’s activities on logistics charging is its affiliation with the Living Lab Heavy Duty Charging Plazas, operated by Rijkswaterstaat (Dutch Ministry of Infrastructure and Water Management [9]. This initiative conducts testing across six different real-world charging plaza configurations, examining technical infrastructure, grid integration, logistics processes, and business case development through partnerships with vehicle manufacturers, charging operators, and logistics companies.

The remainder of this paper presents three practical results from this comprehensive national program, demonstrating how systematic data integration, collaborative research and practice-oriented development can provide actionable insights for removing barriers to zero-emission logistics transformation. One of these case studies specifically examines findings from the Living Lab Heavy Duty Charging Plazas, illustrating how practical experimentation generates empirical insights for infrastructure optimization.

3 Key findings of 3 initiatives

3.1 Data-based analysis of grid limitations for Zero Emission Logistics companies

The transition to zero-emission logistics faces significant infrastructure challenges, particularly regarding electricity grid capacity for commercial vehicle charging. While many logistics companies are beginning to electrify their fleets, a critical question remains: how many vehicles can be charged using existing grid connections before requiring costly grid reinforcement? This study [10] addresses this knowledge gap by analysing the available capacity on current electricity connections of Dutch logistics companies, providing essential insights for removing barriers to fleet electrification.

Data Collection and Methodology

This research combined two comprehensive Dutch databases to create an unprecedented view of grid capacity constraints. The Central Connection Register (CAR) provides detailed information on contracted power capacity, physical capacity, and actual energy consumption for electricity connections, while the Vehicle

Emission Shipment Data Interface (VESDI) contains fleet composition data including vehicle types, mileage, and logistics sector classifications. The study successfully linked 34,782 unique electricity connections to companies operating significant commercial vehicle fleets, covering 327,529 delivery vans (32% of the Dutch total) and 119,375 trucks and tractors (81% of the national fleet). This linkage enabled analysis of current grid utilization patterns and remaining capacity for vehicle charging across different company sizes and logistics sectors. For this study a "baseline" electrification scenario was considered in which by 2030 25% of the delivery vans and 10% of all trucks in the Netherlands are electrified and require charging on their own premises (in line with national ambitions). These percentages were assumed to account across all logistics companies in the sample, allowing to analyse possible limitations in grid capacity per company.

Key Findings

The analysis reveals that 75% of logistics companies operate on small-scale electricity connections (≤55 kW), yet these connections do not necessarily constitute a limiting factor for electrification. Most of the companies in this category have relatively small fleet sizes and as a result a limited additional charging demand. Examining available capacity, 76% of all connections have less than 25 kW of spare capacity based on contracted capacity, with 17% having only 10 kW or less remaining. However, the impact varies significantly by fleet size. Small fleets demonstrate considerable electrification potential, with 90% of locations having sufficient capacity under the 2030 baseline scenario and 41% able to achieve complete electrification. Conversely, medium and large fleets face substantial challenges across all electrification scenarios, representing approximately 5,000 connections despite comprising only 10-15% of the total population. The study also demonstrates that smart charging strategies can significantly reduce the proportion of companies facing capacity constraints, highlighting the importance of load management technologies.

Implications and Policy Recommendations

These findings have important implications for both national government policy and grid operators' investment strategies. For policymakers, the results suggest that while small-scale logistics operations can largely electrify within existing grid constraints, targeted support programs may be necessary for larger fleet operators who face systematic capacity limitations. The research indicates that smart charging infrastructure should be prioritized in policy frameworks, as it substantially reduces grid reinforcement requirements. For grid operators, the study provides a data-driven foundation for strategic capacity planning, identifying specific geographic regions and company types most likely to require grid upgrades. These insights enable more efficient allocation of resources and better coordination between electrification timelines and grid development planning.

3.2 Location Strategy for Heavy-Duty Charging Infrastructure: A Multi-Stakeholder Approach

A second case relates to significant infrastructure barriers for Zero Emission logistics, particularly regarding the strategic placement of charging facilities for heavy-duty electric vehicles along transport corridors. A comprehensive study [11] carried out by Buck Consultants in assignment of the NAL working group Logistics addresses this challenge by developing a systematic methodology for identifying optimal charging locations through collaborative stakeholder engagement.

Study Context and Methodology

The research was motivated by the growing adoption of electric trucks and the European Alternative Fuel Infrastructure Regulation (AFIR), which mandates charging points every 60 kilometres along major transport routes by 2030. The study developed a location selection tool that integrates multiple data sources including traffic flow data from the Dutch Road Authority, existing service station locations, truck parking facilities, business parks, grid capacity information, and charging demand forecasts through 2040.

The methodology centres on a collaborative approach where national, regional, and local authorities use the tool to systematically evaluate potential locations across nine selected corridor segments in the Netherlands. The tool incorporates a location preference hierarchy that prioritizes proximity to corridors, existing charging infrastructure, appropriate zoning, truck parking availability, sufficient space, adequate road infrastructure, and electrical grid capacity.

Key Findings

The analysis reveals three primary location types for heavy-duty charging infrastructure: (i) existing service stations along highways, (ii) truck parking facilities, and (iii) business parks. The study demonstrates that while existing service stations can accommodate short-duration fast charging, they often lack capacity for overnight charging due to current (Dutch) policies restricting extended truck parking. For long-duration charging, dedicated truck parking facilities prove most suitable, as they naturally align with driver rest requirements.

The research identifies significant capacity gaps, particularly for overnight charging locations. More than half of the analysed corridors show insufficient truck parking capacity for projected charging demands, highlighting the critical need for coordinated infrastructure planning. The study emphasizes that combining short and fast charging capabilities at single locations creates better business cases and more efficient land use.

Implications and Transferability

This systematic approach offers significant potential for application beyond the Netherlands. The methodology's strength lies in its integration of quantitative demand forecasting with qualitative stakeholder input, creating a balanced framework for infrastructure planning. The tool's modular design allows adaptation to different regulatory environments and geographic contexts while maintaining its core principle of multi-stakeholder collaboration.

The study demonstrates that successful zero-emission logistics infrastructure requires coordinated planning across governmental levels, with clear division of responsibilities and shared commitment to strategic objectives. This collaborative framework could prove particularly valuable for other European countries facing similar AFIR compliance requirements and for regions worldwide developing heavy-duty electrification strategies. The methodology's emphasis on combining technical analysis with stakeholder engagement provides a replicable model for addressing infrastructure barriers in the transition to sustainable freight transport.

3.3 Living Lab Heavy Duty Charging Plazas: Real-World Stress Testing

The Living Lab Heavy Duty Charging (LLHDL) represents a collaborative research initiative led by Rijkswaterstaat (part of the Ministry of Infrastructure and Water Management) in partnership with businesses, government bodies, and research organizations including TNO, National Knowledge Platform for Charging Infrastructure (NKL), and ElaadNL. The initiative addresses the central research question: "What constitutes a functional, affordable, and scalable design for (semi-)publicly accessible charging infrastructure for heavy-duty logistics toward 2025 and 2030?"

The living lab methodology enables real-world testing and validation of charging infrastructure concepts through systematic collaboration between public and private stakeholders. This approach facilitates knowledge sharing while examining critical aspects including spatial planning, electrical grid integration, logistical processes, and economic viability across diverse operational contexts.

Location Characteristics and Typology

The research encompasses six strategically selected charging locations across the Netherlands, representing different infrastructure typologies and operational models. These sites include dedicated truck parking facilities that serve as overnight charging hubs for long-haul operations, semi-public locations integrated with logistics centers and distribution facilities, and publicly accessible charging plazas positioned along major transport corridors.

Each location type presents distinct challenges and opportunities for charging infrastructure design. Truck parking facilities offer extended dwell times but face space constraints and grid capacity limitations. Semi-public locations provide controlled access and predictable usage patterns but require coordination with facility operations. Public charging plazas offer strategic positioning along transport routes but must accommodate diverse vehicle types and unpredictable demand patterns. This typological diversity enables comprehensive evaluation of infrastructure performance across different operational contexts and user requirements.

Experimental Design and Implementation

In November 2024, the Living Lab conducted its first comprehensive stress test—an intensive one-week field study across all six locations using trucks from various manufacturers [12]. The experiment facilitated intensive utilization of charging infrastructure by multiple vehicles simultaneously to assess performance under high-demand conditions and identify operational bottlenecks.

The methodology incorporated both quantitative measurements and qualitative observations. Technical data collection focused on charging speeds, power distribution effects during concurrent charging sessions, and electrical grid impact assessments. Behavioural observations documented driver interactions with infrastructure, navigation challenges, and operational workflow efficiency across different plaza configurations.

Key Findings

The stress test revealed several critical insights:

- **Charging time constraints**: The mandatory 45-minute rest period proved insufficient for charging batteries from below 30% to above 80%, highlighting needs for faster charging solutions

- **Infrastructure preferences**: Drivers demonstrated clear preference for drive-through charging configurations over parking bay designs, significantly reducing manoeuvring time and operational complexity

- **Payment system fragmentation**: While individual transactions proceeded smoothly, lack of standardization across locations creates operational inefficiencies for fleet operators

- **Navigation and wayfinding challenges**: Navigation systems frequently directed trucks via inappropriate access routes, while on-site signage inadequately indicated charging point locations and power specifications

- **Physical infrastructure limitations**: During peak usage periods, suboptimal charging point availability led to situations where cable lengths were insufficient for truck charging port configurations

- **Underutilized reservation systems**: Advanced booking systems saw minimal usage due to sufficient capacity, though these may become critical as demand increases

Discussion and Implications

This practical testing approach demonstrates significant value in identifying concrete operational challenges and bottlenecks that cannot be adequately captured through theoretical modelling or laboratory testing alone. The living lab methodology enables systematic documentation of real-world performance limitations while generating actionable insights for infrastructure optimization.

The project's findings generate new research questions regarding optimal charging plaza design, grid integration strategies, and operational workflow optimization. These insights position the research community to develop evidence-based solutions that address practical implementation challenges facing the heavy-duty electrification sector.

The living lab approach is largely complementary to the more research- and tool-focused approach by the NAL, while the results of the living lab experiments in turn provide input for new research in the NAL. This integrated approach between empirical testing and policy development represents a model that could provide valuable guidance for international heavy-duty charging infrastructure development, particularly as European markets face similar electrification challenges and regulatory requirements.

4. General Implications and Key Success Factors

This paper describes the Dutch approach to providing sufficient charging infrastructure for the logistics sector. It consists of multi-stakeholder engagement, developing a coordinated (applied) research agenda, leading to practical research results and tools that support both governments as well as logistics companies to realize (public and private) charging infrastructure for the logistics sector. Practical experimentation through initiatives like the Living Lab Heavy Duty Charging, can effectively address several of the more complex challenges of heavy-duty electrification. This integrated model of research, policy development, and real-world testing reveals several success factors.

4.1 Systematic Multi-Stakeholder Collaboration

Effective infrastructure implementation requires institutionalized collaboration platforms that align diverse stakeholder interests over extended timeframes. The NAL working group' Logistics has a public-private partnership model that creates sustainable engagement mechanisms where logistics companies, grid operators, government agencies, and research institutions can collectively shape a research agenda that facilitates sufficient infrastructure development. This collaborative framework ensures that policy decisions reflect practical operational requirements rather than theoretical assumptions, while taking along all relevant stakes and interests related to the entire logistics ecosystem.

4.2 Comprehensive Data Integration for Strategic Planning

Strategic infrastructure planning depends on systematically linking multiple data sources to create actionable insights that would be impossible to achieve through isolated analysis. The integration of grid capacity databases with fleet composition data exemplifies how comprehensive data analysis can reveal specific implementation opportunities and constraints. This data-driven foundation enables targeted policy interventions and strategic coordination between electrification timelines and infrastructure development planning, optimizing resource allocation across different operational contexts.

4.3 Methodological Innovation Combining Analysis with Engagement

Successful infrastructure planning requires methodologies that integrate rigorous quantitative analysis with meaningful stakeholder engagement to address both technical requirements and practical operational needs. The combination of demand forecasting models with collaborative stakeholder workshops provided a promising approach to overcome the complexities of identifying charging locations along corridors. It can contribute to a balanced framework that can adapt to different regulatory environments while maintaining stakeholder buy-in.

4.4 Real-World Experimentation for Implementation Optimization

Practical testing under actual operating conditions provides irreplaceable insights into implementation challenges that cannot be anticipated through theoretical modelling alone. Real-world experimentation reveals the accumulation of small but significant operational issues that can create substantial adoption barriers. Systematic documentation of performance limitations under actual usage conditions generates actionable insights for infrastructure optimization that inform both technical design and policy development.

4.5 Regional Coordination

Effective national infrastructure deployment requires coordinated regional planning that prevents infrastructure gaps while optimizing resource allocation across different geographic contexts. This is particularly so for establishing charging infrastructure locations conforming to AFIR regulation, both on regional/national level, as well as in cross-border development of charging infrastructure.

The development of standardized methodologies that combine current operational data with future demand projections enables regions to develop multiple deployment scenarios while maintaining national coordination. This multi-layered approach ensures efficient infrastructure deployment while preventing conflicting requirements between different administrative levels.

Conclusion

In this paper we present a structured approach applied in the Netherlands to stimulate the development of sufficient charging infrastructure for the logistics sector. It describes how a public-private collaboration (NAL) drives the development of new knowledge, tools and manuals relevant for both public and private stakeholders. Furthermore it describes how real world experiences and observations are extracted from the Living Lab Heavy Duty Charging. It is argued that the transition to zero-emission logistics requires comprehensive national programs that systematically integrate collaborative stakeholder engagement, data-driven analysis, methodological innovation, real-world testing, and regional coordination. The NAL working group model, enhanced by practical experimentation through initiatives like the Living Lab, provides a replicable framework for other countries developing heavy-duty electrification strategies. This integrated approach between empirical testing and policy development represents a model that could provide valuable guidance for international heavy-duty charging infrastructure development, particularly as European markets face similar electrification challenges and regulatory requirements under frameworks like AFIR.

Acknowledgments

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Biography

Robert van den Hoed is affiliated to NKL Netherlands since January 2021, a knowledge platform for the development and roll-out of charging infrastructure. Within NKL he acts as programme manager for charging infrastructure for the logistics sector for which he has authored several reports and developed a number of practice-oriented manuals and tools, largely related to the Dutch National Agenda on Charging Infrastructure (NAL). Prior to NKL, he worked as professor in Energy and Innovation at the Amsterdam University of Applied Sciences from 2011-2020.

Suzanne Riezebos is affiliated tot NKL Netherlands since October 2024, a knowledge platform for the development and roll-out of charging infrastructure. She is the chair of the working group Logistics within the National Agenda Charging Infrastructure (NAL), on behalf of NKL. Prior to joining NKL she worked for the Province of Gelderland, where she established NAL-region East, one of six regions that concentrate on implementing charging infrastructure in The Netherlands.

Frank ten Wolde is project manager and EV expert at APPM Management Consultants. He has a vast experience in the field of electric vehicles, charging infrastructure and policy development. Currently Ten Wolde is research manager within the working group Logistics within the National Agenda Charging infrastructure (NAL), setting a yearly applied research agenda and prioiritizing and supervising projects. Prior to APPM Ten Wolde worked at Rijkswaterstaat (part of Ministry of Infrastructure and Water Management), responsible for the early phases of fast charging networks in the Netherlands.