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From Oslo to the EU:

The journey towards clean construction

BELLONA REPORT

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These experts do not necessarily endorse the findings of this report, nor does their organisation. Bellona Europa is solely responsible for the content of this report.

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Table of Contents

List of Acronyms

Acronym	Breakdown
BVP	Best Value Procurement
CAPEX	Capital Expenditures
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide equivalent
DSO	Distribution System Operator
EPBD	Energy Performance for Buildings Directive
EPD	Environmental Performance Declaration
EU	European Union
EUR	Euros
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GWP	Global Warming Potential
LCA	Life Cycle Assessment
LCC	Life Cycle Costing
LEZ	Low-Emission Zone
MEAT	Most Economically Advantageous Tender
NOK	Norwegian crowns
NO_x	Nitrogen Oxides
NRMM	Non-Road Mobile Machinery
OPEX	Operational Expenditures
SME	Small & Medium Enterprises
TCO	Total Cost of Ownership
TSO	Transmission System Operator
PM	Particulate Matter
PMC	Preliminary Market Consultations
USD	United States Dollars
WLC	Whole-life Carbon
ZECS	Zero-Emission Construction Sites

Executive summary

The construction sector is a major, yet often overlooked, source of greenhouse gas (GHG) emissions and local air pollution in Europe. Non-road mobile machinery (NRMM) used on construction sites contributes significantly to emissions of CO_2, NO, particulate matter (PM), and noise pollution. Transitioning to Zero-Emission Construction Sites (ZECS), where construction activities are powered by electric machinery, presents a unique opportunity to improve urban air quality, protect public health, and advance climate neutrality goals.

Oslo has led the way globally in operationalising ZECS at scale, as part of a winder effort to reduce 95% of direct GHG emissions by 2030. Since 2015, the city has implemented a step-by-step strategy to eliminate fossil fuels from construction, beginning with fossil-free requirements (biodiesel) and progressing towards fully zero-emission sites. The city mandated that, from 2025, all public construction projects must be zero-emission, with a goal of achieving 100% ZECS citywide, including private developments, by 2030.

Key lessons from Oslo's journey include:

- Long-term vision and political leadership were essential to steer the market towards clean technologies.
- Strategic use of public procurement—embedding environmental criteria into tenders, not just lowest price—created strong demand signals.
- Early and continuous market dialogue with contractors, suppliers, and grid operators helped overcome technological and logistical barriers.
- Energy systems planning and collaboration with grid operators were critical to ensure adequate power supply for ZECS operations.
- Pilot projects such as Olav Vs Gate allowed the city to de-risk innovation, build contractor confidence, and refine technical specifications.
- Data-driven approaches using life-cycle assessments and emissions reporting helped measure progress and improve future project designs.

At the European level, several frontrunner cities (for example Amsterdam, Utrecht, Eindhoven, Rotterdam, London, Barcelona, Copenhagen and Stockholm) have begun integrating ZECS into policy frameworks and pilot projects, though gaps remain in mainstream procurement practices and regulatory support.

To replicate Oslo's success across Europe, the report recommends that public purchasing authorities:

- Set clear ZECS targets linked to national and EU climate goals (e.g., EPBD).
- Leverage procurement strategically, prioritising life-cycle cost and environmental impact in tender evaluations.
- Mandate environmental award criteria, using shadow pricing or minimum standards where appropriate.
- Launch pilot projects to build local capacity and collect real-world data.
- Foster early market dialogue to de-risk innovation and prepare suppliers.
- Coordinate energy planning alongside construction projects to ensure grid readiness.
- Invest in procurement training and peer-learning platforms.
- Offer transitional financial support to close cost gaps and incentivise early adopters.
- Standardise data collection to track ZECS performance and inform future policy.

The Oslo model demonstrates that ZECS are feasible and scalable when political will, strategic procurement, technical planning, and collaborative approaches align. With upcoming EU climate and building regulations, now is the time to make zero-emission construction the new normal across Europe.

This report first sets the scene by explaining why ZECS are crucial for the European construction sector, European manufacturers and the green transition. It then dives into the lessons learned from Oslo's pioneering approach and finally explores the current landscape and future opportunities for ZECS uptake across Europe.

SECTION 1

Introduction

Why zero-emission construction sites?

The European Union (EU) is increasingly looking at products' life cycle emissions, with ongoing efforts to reduce embodied carbon in buildings and constructions. Thus far, however, much of the focus of researchers and EU policymakers alike has fallen on the product, use, and end-of-life stages of the product life cycle. The construction stage is still largely overlooked.

However, this is not the case for some major European cities that, in recent years, embarked on a silent revolution, characterised by the growing deployment of Zero Emission Construction Sites (ZECS). In these cities, construction and transport activities are carried out using zero-emission construction machinery and equipment. This entails using machinery that does not produce emissions on-site, mostly electric-powered machinery[1], to perform operations and move people and goods within, and to and from construction sites. The definitions used by Oslo can be found in Annex I.

The benefit of upscaling the diffusion of ZECS across more EU cities would be considerable.

In the EU, the non-road mobile machinery (NRMM) sector (i.e. construction machinery, inland waterway transport, railcars and locomotives, and agriculture machinery) emits about 108 million tonnes of carbon dioxide equivalent (Mt CO_2e) per annum. It accounts for 3.1% of EU greenhouse gas (GHG) emissions. Approximately two-thirds of these emissions arise from only two sub-sectors: industry and construction, and agriculture and forestry[2].

These are also the only sub-sectors where, over the past thirty years, emissions related to NRMM have not declined, but actually increased. GHG emissions, however, are not the only source of concern when it comes to fossil fuel-powered NRMM. NRMM constitute a significant source of air pollutants, including particulate matter (PM), carbon monoxide (CO), and nitrogen oxides (NOx) emissions[3].

Construction workers and individuals residing near construction sites face significant exposure to air pollutants due to exhaust fumes from construction machinery. This makes them more vulnerable to cardiovascular, respiratory, and cerebrovascular diseases. Construction workers and nearby residents are also subjected to prolonged noise pollution. For construction workers, in particular, this entails critical health hazards, as repeated exposure over time can lead to hearing loss, hypertension, sleep disturbances and other mental and physical health risks.[4]

The widespread use of zero emission construction machinery would effectively enhance the quality of life of EU inhabitants and workers while also advancing climate neutrality. Even with today's current average EU grid, where only 45% of electricity is renewable[5], using electric machinery would halve emissions per operating hour against the emission baseline of diesel-powered construction machinery. Air pollution from exhaust fumes would be reduced to zero, as would noise pollution caused by

1 Technically, hydrogen-powered machinery could also be classified as ZECS. However, both from the point of view of logistics and predictability of supply and cost of hydrogen, this type of machinery is not commonly used in ZECS projects.

2 T&E (2024). Reducing emissions from non-road mobile machinery.

3 EEA (2023). Harm to human health from air pollution in Europe: burden of disease 2023

4 Bellona (2019). Zero-emission construction sites: Status 2019.

5 T&E (2024). Reducing emissions from non-road mobile machinery

engines. With projections estimating a full decarbonisation of the power sector by 2040[6], the emission savings compared to diesel-powered machinery would be enormous.

In addition to their environmental benefits, zero-emission construction machines offer economic and technical advantages that can enhance contractors' productivity. In fact, due to technical features such as fewer moving parts, maintenance and repair costs for electric machinery are generally lower, with cost reductions up to 50%. At the same time, due to less mechanical wear, they tend to display a longer operational lifetime than that of diesel-powered machinery. Adopting electric construction machinery also means that diesel-engine-related service costs (such as oil and filter changes), are lowered to zero. Energy prices also play a huge role: for prices of USD 2 per litter of diesel and USD 0.30 per kWh of electricity, a large electric machine would save USD 12,620 per year over its diesel counterpart. As a result, operating expenses for construction projects would be significantly reduced, and total cost of ownership (TCO) would be lower for electric machinery[7],[8].

What is needed for zero-emission sites to become the norm?

Despite the opportunities and benefits that a transition to ZECS would bring, at least two key barriers hinder their large-scale diffusion and the uptake of zero-emission machinery in the European market.

First, zero-emission construction machinery is currently more expensive to purchase. As with all new technologies, higher production costs translate into what is known as "green premium". As a result, purchasing zero emission construction machinery can cost twice as much as their diesel counterparts, as highlighted by the head of public affairs at Volvo Construction Equipment, Tora Leifland[9]. This situation is exacerbated by a vicious cycle of low demand and supply. Higher prices discourage the uptake of demand, while the lack of demand keeps supply volumes low. This in turn hinders the capacity of developing economies of scale which are key to rapidly reducing the green premium. It is important to note that this assessment refers to the purchasing price of the machine, and not to the TCO, which is already positive compared to diesel-powered machines for some models, and which highly depends on use profile, energy intensity of the works, energy infrastructure on site and diesel and electricity prices[10].

The second barrier arises from the need to ensure that enabling conditions for deploying ZECS are in place. Turning construction sites into zero-emission areas requires careful energy systems planning. This means ensuring a continuous energy supply by installing charging and refuelling stations, estimating grid capacity needs, using electricity efficiently, and considering buffering services that batteries can provide to the grid. Moreover, conducting operations in ZECS requires new skills and work process planning and optimisation that entail identifying new job roles and training workers to operate zero emission construction machinery effectively.

The involvement of the public sector, with its large purchasing power and the ability to create long-term demand signals and to foster the development of key infrastructure is, therefore, critical to encourage the expansion of these technologies beyond the market's niche segments. As major buyers of construction goods and services, public authorities are well-positioned to promote lead markets creation for zero-emission construction machinery. Incorporating climate and sustainability requirement in public procurement is critical to overcome the barriers outlined above, with significant long-term benefits on key aspects such as public health and economic profitability. Large and predictable demand can tilt production levels towards economies of scale, thereby bringing

6 European Commission (2024). Recommendation for 2040 emissions reduction target

7 IDTechEx (2024). Total Cost of Ownership Will Fuel the EV Construction Industry.

8 Liebherr (2024). Australia's first electric excavator: The R 9400 E with Fortescue | Liebherr

9 Niranjan, A. (2025). Sites without sound: Oslo leads in quiet, low-emission electric construction. *The Guardian.*

10 Construction Briefing (March 2025) *When will the total cost of owning electric construction equipment go positive? - construction briefing.*

down costs.

Further cost reduction can be achieved also through learning-by-doing effects arising from a broader diffusion of ZECS, both in terms of technology performance and project implementation. Furthermore, public procurement alone accounts for around 25% of emissions from the EU construction sector[11], which makes the case for a shift in public consumption practices not only strategic but also essential from an environmental standpoint.

EU-level policy developments related to NRMM have been limited and fragmented. While existing regulations could, in principle, support the uptake of zero-emission non-road mobile machinery (NRMM), these vehicles are often exempted from key decarbonisation targets. This creates a policy gap that places clean technologies at a disadvantage compared to their diesel-powered counterparts.

This omission is problematic given that NRMM, particularly in construction, represents a significant and growing share of emissions. At the same time, these applications offer relatively low-hanging fruit in the broader climate mitigation effort. Unlike sectors such as long-haul road freight, shipping, or aviation, many NRMM applications operate in confined areas with predictable duty cycles and minimal range requirements. This makes them ideal candidates for electrification.

Electric alternatives—such as electric excavators, loaders, and compressors—are increasingly commercially viable, especially for urban or semi-stationary operations. In markets like China, electric wheel loaders have already moved from pilot projects to widespread use, driven largely by cost-effectiveness rather than policy mandates. With limited additional regulatory support and targeted public procurement, similar transitions could take place across Europe.

11 Mähönen et al. 2023. *Public Procurement for Climate Neutrality: a transformative policy instrument?* D4.2: 4i-TRACTION case study report. University of Eastern Finland & Ecologic Institute

Comparison: Diesel vs. Electric Wheel Loader (20-tonne class)

Based on Leach & Co.'s operational data and EECA modeling

Category	Diesel Loader	Electric Loader (XCMG XC968EV)
Purchase Price	Approx. NZD $245,000	NZD $429,295
Annual Fuel/Energy Cost	Approx. NZD $50,000	Approx. NZD $30,000
Maintenance Costs	Higher (more frequent servicing)	Lower (fewer moving parts)
Operational Lifespan	~10,000 hours	~16,000 hours
Total Cost of Ownership	Baseline	~5% lower over full utilisation

Key Findings:

☑ Fuel Savings: The electric loader rduced diesel consumption by approximately 25,000 litres annually, leading to significant cost savings.

☑ Maintenance Efficiency: Servicing time decreased from half a day for the diesel loader to just 1.5 hours for the electric model, due to fewer moving parts and no need for oil changes.

☑ Performance: Operators reported the electric loader to be more powerful, faster, and more responsive than its diesel counterpart, enhancing productivity.

☑ Environmental Impact: The transition contributed to a 7% reduction in the company's total carbon footprint.

This case study demonstrates that, despite a higher upfront cost, the electric wheel loader offers lower total cost of ownership over its lifespan, along with operational and environmental benefits.

Source: EECA Case Study: Electric loader outperforms diesel

To support this transition, the EU should consider integrating construction-related NRMM into its core climate policy instruments, aligning them with the ambitions of the revised Energy Performance of Buildings Directive, national decarbonisation targets, and forthcoming zero-emission regulations for vehicles.

Already in 2019, Bellona emphasised how being early movers would have provided EU suppliers a competitive edge over a green market that was still at its very inception[12]. The situation has changed today, with more economies supplying zero emission NRMM. EU suppliers are still well-suited to retain their competitiveness. However, decisive guidance from EU policymakers must occur now, otherwise, the EU NRMM industry will not be able to face competitive pressures in the future.

Several procurement authorities at different levels of governance have already made huge advances. In the Netherlands, the national government, provinces, municipalities, and water authorities have jointly committed to making all construction activities clean and emission-free by 2035 (with some equipment already zero-emission by 2030). Through the program *Op Weg naar Schoon en Emissieloos Bouwen* ("On the Way to Clean and Emission-Free Construction"), public clients across various governance levels have aligned on a phased roadmap that incorporates zero-emission requirements into procurement processes. This coordinated effort includes stimulating innovation, harmonising tender criteria, and collaborating with the construction sector to scale the use of zero-emission machinery[13].

Oslo, the pioneering city in zero-emission construction, has achieved 85% zero-emission construction sites in all public works commissioned by the city in 2024. From January 1st 2025, all public construction sites in the city are zero-emissions.

12 E. Barbiroglio (2020). Construction Sector Calls On The EU To Delay Regulation On Engines' Emission Limits Due To COVID-19 - But Climate Action Can't Wait Forbes.

13 Schoon en Emissieloos Bouwen (SEB) (2023). English | Zero Emission Construction Equipment | Schoon en Emissieloos Bouwen

Scope of the report

This report examines how cities can accelerate the decarbonisation of construction through public procurement, using the City of Oslo as a detailed case study. By focusing on the experience of Oslo, this report showcases the role of public procurement policies in encouraging the adoption of zero emission construction machinery and fostering the uptake of ZECS beyond Norwegian borders.

The primary objective is to understand the policy tools, implementation strategies, and infrastructure planning that allowed Oslo to become the first city to operationalise ZECS at scale. The report traces Oslo's step-by-step journey—from setting a climate roadmap, piloting fossil-free construction[14], and raising procurement standards, to launching the world's first zero-emission site and embedding zero-emission criteria into construction tenders.

Through this multi-dimensional analysis, the report aims to provide a practical blueprint for cities and policymakers interested in leveraging procurement as a strategic climate tool, showcasing how zero-emission construction can shift from a niche innovation to a systemic urban standard.

The report is structured to deliver:

- A critical assessment of Oslo's policy design, governance, and procurement architecture;
- An analysis of technical and infrastructure challenges, especially grid capacity, charging infrastructure, and energy planning;
- Insights into the industry response, highlighting how contractors adapted to new standards and what barriers remain;
- A forward-looking review of key enablers and lessons learned, transferable to other urban contexts;
- A broader European perspective on ZECS deployment, identifying current gaps, replicability potential, and policy recommendations to support EU cities in their

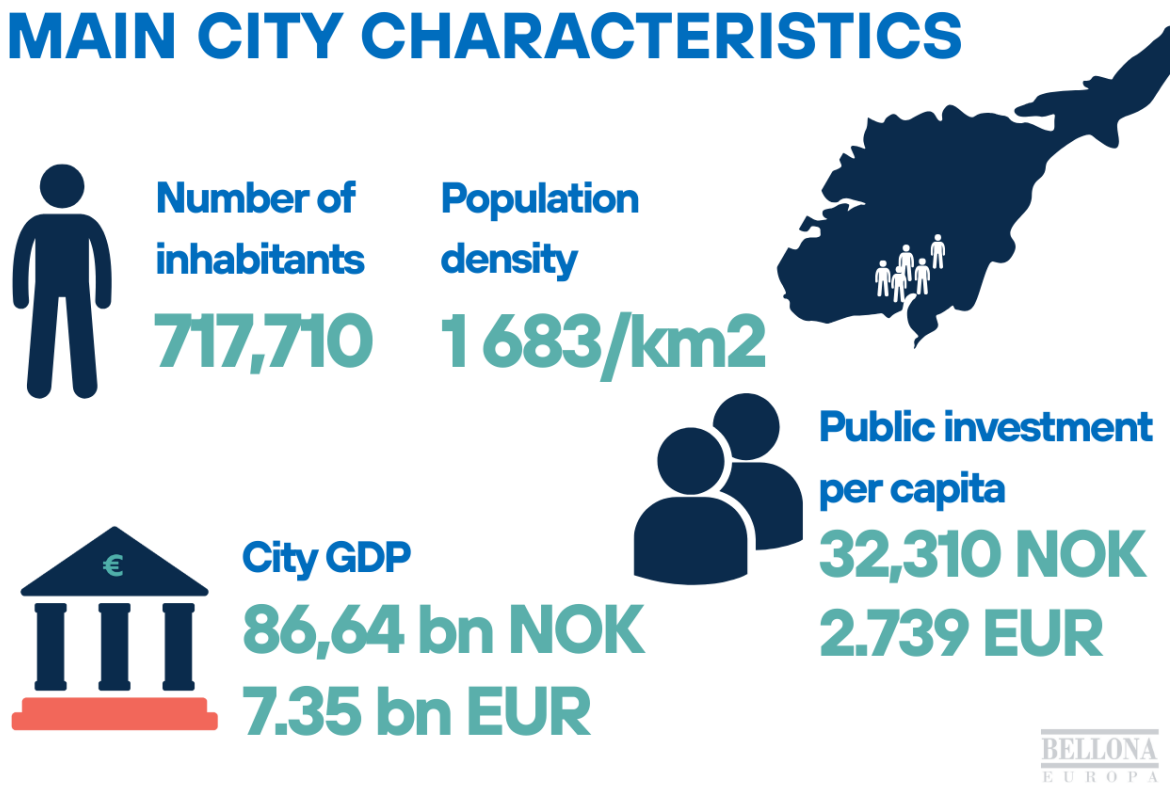
14 Fossil free construction site is a construction site that does not use any fossil fuels in any of its on-site construction activities. Fossil fuels (i.e. diesel or propane) are often replaced with bioenergy and biofuels (i.e.HVO or wood pellets) or alternative renewable energy resources such as electricity or hydrogen. Source: Selamawit Mamo Fufa *et al* 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **352** 012021

SECTION 2

Lessons Learned in Oslo's Journey

Following the Paris Agreement, Oslo set the ambitious goal to cut its GHG emissions by 95% by 2030. A key part of the city's strategy involved making public construction projects emission-free. In 2019, the city launched the world's first fully zero-emission construction site and, as of January 2025, all public construction works are ZECS. Contractors in Oslo are gaining experience with electric machinery, while workers and residents already experience the benefits of reduced noise pollution and improved air quality. Nevertheless, key challenges such as high upfront investment costs, and insufficient charging and grid infrastructure, and limited workforce expertise still constitute major barriers to a broader diffusion of ZECS.

Context, targets & plans



15 All figures refer to the year 2024.

16 Statistics Norway (2025). Population per 1.1. (persons), 0301 Oslo municipality.

17 Statistics Norway (2025). Population per km² land area, 0301 Oslo municipality.

18 Statistics Norway (2025). Gross operating revenues, 0301 Oslo municipality.

19 An exchange rate of EUR 1 = NOK 11.7950 was applied. Cfr. ECB (2024). Euro Foreign Exchange Reference Rates, 31st dec. 2024.

20 . Oslo municipality's gross investment expenditure for 2024 was NOK 23,188,929,000. This figure refers to the consolidated accounts (i.e., the broader municipal entity) rather than the ordinary accounts (i.e., core municipality). The per capita value was calculated by the author, as it was not provided in the original source. Cfr. Statistics Norway (2025). Gross investment expenditures, municipality/county authorities consolidated accounts, 0301 Oslo municipality.

21 An exchange rate of EUR 1 = NOK 11.7950 was applied. Cfr. ECB (2024). Euro Foreign Exchange Reference Rates, 31st dec. 2024.

Governance and procurement capacity:

Governance structure: The City of Oslo follows a parliamentary governance model. The City Government is elected by, and accountable to, the City Council, which holds the authority to dismiss it through a vote of no confidence. The City Council is responsible for setting municipal policies, managing the city's budget, and overseeing the activities of both the City Government and its administration. Oslo administration is decentralised and organised into 15 districts, each granted decision-making authority to the extent delegated by the City Council. The Council allocates funding to the districts, while districts may also generate additional revenue through service fees, which are determined and regulated by the City of Oslo.

Total procurement budget: EUR 3 billion/year

- *Of which dedicated to civil works/construction procurement*: EUR 1-2 billion/year[22]

Procurement autonomy: While much of Oslo's municipal activity is guided by national legislation and mandates, particularly in sectors like education and healthcare, the city enjoys a high degree of autonomy when it comes to the design and implementation of procurement requirements. Although the overall budget is subject to approval by the City council and influenced by national transfers and service-related revenues, individual project-level decisions, including technical specifications and environmental criteria, are primarily within the city's discretion.

Number of active municipal developers or agencies involved in construction: In total, 5 different city agencies account for the bulk of the projects in the investment portfolio, providing new purpose buildings such as schools and sports facilities, water supply infrastructure, metro extension and development and maintenance of the harbour recreational parks and public spaces.

22 For 2024 and 2025, the investment budget has been approximately EUR 2 billion each year, due to large investments in a metro system extension and a new main water supply infrastructure project.

Step 1: A clear Roadmap for Oslo

The City of Oslo, after the Paris Agreement in 2015, decided to put together a roadmap to transition the city towards zero-emission. While the transition period and the 2030 goal of reducing 95% of direct greenhouse gas (GHG) emissions by 2030 were set in 2015, the climate strategy of the city was officially approved in May 2020. The strategy was set with the goal of making the city climate-resilient, reducing emissions (direct and indirect), reduce energy consumption and conserve carbon storage.

The City identified the key emissions sources per sector: the mobility (47%), waste (27%) and off-road machinery (14%) sectors were identified as crucial. Buildings and construction were selected as one of the 16 priority areas[23].

Procurement was soon identified as a strategic tool to achieve Oslo's goal of becoming a zero-emission city. Oslo procures goods, services and works with a budget of 3 billion EUR per year. In terms of awards criteria, while price is considered in the tender, they include quality and environment criteria.

Step 2: Fossil-free construction sites

The journey began in 2016, whenOslobygg (former Omsorgsbygg Oslo KF), Oslo's municipal developer, responsible for public buildings like kindergartens and care homes—partnered with Bellona to set a new procurement standard requiring fossil-free construction sites. Contractors were asked to switch from diesel to biodiesel—a relatively simple but effective change that helped kick-start market transformation. This kick-started piloting activities that will continue until 2018.

Step 3: Making fossil-free the minimum

Thanks to the success of the fossil-free procurement standard, fossil-free projects became the minimum requirement for all public works taking place in the city from 2017.

Step 4: Raising the bar to zero-emission

The success of the standard also prompted conversations to move to zero-emission machinery. Oslobygg set a new criterion for public tenders, requiring that electric machinery was used whenever there was the option to. This action, while having limited immediate uptake due to the lack of product availability, sent a strong demand signal to the industry.

Step 5: Preparation through market dialogue

Through continuous dialogue with industry stakeholders in 2017 and 2018, Oslo prepared suppliers for the shift to zero-emission construction, gradually building capacity and awareness across the sector. The city also planned for the procurement of a zero-emission construction site.

23 Climate Strategy for Oslo towards 2030 - Klimaetaten

World's First Zero-Emission Construction Site: Olav V Gate

In September 2019, Oslo launched the world's first fully zero-emission construction site for the pedestrianization of Olav V Gate. The project, managed by the Agency for Urban Development, required electric-powered machinery, despite limited availability at the time. Market engagement before tendering enabled suppliers to develop and provide suitable equipment, including electric excavators and loaders.

To mitigate uncertainty, the City covered energy costs and ensured electricity availability, collecting vital data for future projects. This approach accelerated industry adaptation and demonstrated the feasibility of zero-emission construction, setting a precedent for future large-scale implementation.

Step 6: Revising procurement policy

In October 2019, less than 5 years after setting the targets and since the journey towards zero-emission construction began, Oslo municipality introduced standard climate and environment requirements for public procurement of construction sites, based on the experience from the pilot, and the market dialogues undertaken in the previous years. This revised procurement framework outlined that, for construction projects, a share of at least 30% environmental criteria would be the only mandatory requirement. The weighting of price and quality is provided for illustrative purposes and may vary depending on the project. A common example applied in past tenders allocated 30% to price, 40% to quality, and 30% to environmental performance.

Within the environmental performance criteria, typical subdivisions included:

- 7% for emissions from construction machinery,
- 5% for the transport of bulk materials,
- 3% for other transport to/from the site,
- 15% for other environmental considerations (e.g., energy use, material choices, biodiversity).

It is important to note that the framework is adaptable, with project-specific tailoring and evolving requirements. As of January 1st, 2025, Oslo entered a new phase of implementation, where Zero-Emission Construction Sites (ZECS) have become a minimum requirement in all publicly procured construction works. This marks a transition from using environmental performance primarily as an award criterion to embedding it as a baseline contractual condition, raising the ambition for environmental procurement standards citywide.

The city awards a premium on low or zero-emission solutions in construction contracts.

Oslo planned a 15 year transition period: from 2015, with no zero-emission sites in the city, to 2030, date by when all construction sites in the city must be zero-emission.

The new requirements are outlined below.

Climate and environmental requirements for construction sites

The City of Oslo has introduced a comprehensive framework to drive fossil-free and ultimately zero-emission construction across all publicly procured building and infrastructure projects. This policy document sets minimum requirements, award criteria, and contractual obligations that apply depending on the value of the procurement[24].

24 City_of_Oslo_-_Requirements_Zero_Emission_Construction_Sites.pdf

Table 1: Requirements for construction sites in Oslo based on the project procurement value.

Procurement value	> NOK 500,000 (~ EUR 43,500[25])	> NOK 5 million (~ EUR 435,000)	> NOK 51 million (~ EUR 4,435,000)
Contractual requirements	• All equipment must be fossil-free, CE-marked, and registered in the Machine Registry. • From January 1st, 2025, all public construction machinery and transport to/from sites must be zero-emission or biogas-based. • The Supplier is obliged to make use of the machine and vehicle technologies and/or fuel types specified in the tender • Suppliers must provide detailed documentation on fuel use, and emissions reduction strategies must be embedded in contracts. • Idle running of engines is strictly prohibited. Breach of environmental terms can lead to daily fines or termination of contract.		
Award criteria	A simplified version could be required by the contractor. The documentation requirements would be limited to listing the equipment and a short description.	Environmental criteria are weighted (recommended at 30% of total evaluation score), broken down as: • 50%: Ratio of zero-emission or biogas-powered construction machinery to be used. • 30%: Ratio of zero-emission or biogas vehicles for transporting bulk materials to be used. Points also awarded for reduced transport of bulk materials. • 20%: Other transport and environmental measures (e.g., reduce ue of fossil vehicles for waste transport, staff mobility,etc to/from the building/construction site). Points are awarded according to estimated reduction in emissions. Documentation required: Annex to be filled in for machinery and vehicles & short description for "other transport and environmental measures).	
Minimum re-quirements	N/A	N/A	Zero-emission heating and drying must be used throughout the construction period. Exemptions are allowed if infrastructure is not yet available.

This framework positions Oslo as a leader in sustainable construction by mandating zero-emission solutions through procurement. The document ensures environmental accountability through clear standards, rigorous documentation, and enforceable contractual clauses—laying the groundwork for a zero-emission construction sector by 2025.

25 To convert from NOK to EUR value, a rounded exchange rate of 1 EUR ≈ 11.5 NOK was used.

Oslo's electrification context: setting the stage for ZECS

Oslo is rapidly becoming a model city for electrification, building an integrated strategy that spans private mobility, freight, public transport, and construction[26]. These efforts lay the groundwork for Oslo's pioneering push toward Zero Emission Construction Sites (ZECS).

Transport electrification: the electrification of Oslo's vehicle fleet is well underway. As of 2024, 40% of all private cars in Oslo are electric, and 90% of new private car sales are zero-emission. In the commercial sector, electric cargo vans now represent 20% of the fleet, while 15% of trucks are electric or biogas-powered—rising to 33% for new truck sales. These changes are supported by an extensive charging network, including 2,400 municipal AC chargers and 95 DC fast chargers, with special infrastructure prepared for the city's electric taxi mandate effective November 2024.

Public and freight transport: Oslo's public transport system is already largely electrified, with trams, metro, and ferries running on electricity, and 70% of city buses already electric—a figure expected to reach 99% by 2026. The city also supports shore power installations for ships, which significantly reduce emissions from large passenger and cargo vessels while docked.

Infrastructure and policy: The toll road system continues to play a key role in supporting electrification. Incentives such as toll exemptions for zero-emission trucks and vans until 2030, combined with higher tolls for fossil-fuel vehicles, are driving change. In 2023, 98% of toll revenue was reinvested into public transport and active mobility infrastructure.

Behavioural shifts and urban planning: Beyond technology, Oslo is reshaping urban travel patterns. Between 2019 and 2024, car use declined from 26% to 18%, while walking increased from 31% to 39%. Cycling also saw a modest rise, supported by a 64% expansion of cycling infrastructure since 2016. Car-sharing is also growing, with nearly 1,000 dedicated parking spaces for shared vehicles expected by end-2024. Overall climate friendly travel modes (walking, cycling or public transport) within the city stands at 73%, beating Copenhagen and trailing world leader Amsterdam.

Oslo's strong commitment to electrification across sectors creates an enabling ecosystem for ZECS. The electrified vehicle fleet, maturing charging infrastructure, and progressive policy environment provide critical synergies for scaling up zero-emission construction. However, it also underscores the urgency of ensuring adequate energy planning and grid capacity to support the cumulative demand from transport, construction, and logistics simultaneously.

The role of national level policies and instruments

The efforts to electrify construction in Oslo is supported by national level goals and economic instruments. An economy-wide CO_2-tax at roughly 100 Euro per ton will be increased gradually up to 200 Euro per ton by 2030. This core policy element enjoys political support across most political parties. Enova, which is a company owned by the Climate & Environment Ministry of Norway, provides financial support in technology investments, covering up to 40% of the additional up-front costs when buying new heavy-duty construction equipment and complementary fast-charging infrastructure.

Several policy initiatives are currently being considered, for example standardised ZECS requirements for all public procurement of construction services in Norway. Recently the Norwegian government provided Norwegian municipalities with a legal mandate to make local regulations requiring ZECS also from private real estate developers. This brings credibility to Oslo's long-standing ambitions to introduce such regulations locally, and provides for increased predictability for the industry, reducing financial risks when investing in ZECS. The Norwegian government has also initiated an impact assessment on banning fossil fuels in construction works from 2035, providing a

26 European Green Capital Report Oslo - Oslo's five-year report - European Commission

strong signal to the market on what policies might be introduced further down the road.

Oslo's early successes and challenges – key lessons

Oslo's journey, like that of any pioneer, has been marked by both great successes and inevitable challenges. As the first city to systematically pursue zero-emission construction, Oslo had to test new technologies, adapt procurement frameworks, and rethink the role of energy infrastructure in urban development. Thanks to this, the city gathered a wealth of practical insights that now offer valuable guidance to other cities looking to follow suit, helping them avoid common pitfalls and accelerate their own transitions with greater confidence and clarity. This section aims to provide an overview of the key lessons learned by Oslo that are common for any zero-emission construction project.

Emissions reductions and co-benefits

In Oslo, citizens have already noticed how zero-emission construction sites make their city more liveable. In the Grünerløkka neighborhood, where a former hospital is being converted into a new district administration and a kindergarten, locals reported that the construction site was much quieter than conventional ones, a change appreciated by residents and businesses alike[27]. In the pilot project on Olav Vs Street, workers also noticed the benefits of reduced noise pollution, with communication onsite and safety conditions enhanced[28].

Air quality in Oslo has also improved in recent years. While it is difficult to quantify how much of this improvement is directly attributable to zero-emission construction sites, the positive trend is encouraging. Although air pollution levels still exceed the limits recommended by the World Health Organization, the municipality is effectively responding by installing new monitoring stations and updating its air quality action plan[29].

Better air quality and less noise pollution are among the main benefits of zero-emission construction sites. In Europe, prolonged noise exposure is linked to around 12,000 premature deaths and 48,000 new cases of heart disease every year[30]. In 2021 alone, air pollution caused 327,000 premature deaths in the EU, making it a leading environmental health risk[31]. These figures show how urgent the need for policies protecting the health of citizens and workers is. Given these alarming numbers and the growing technical feasibility of deploying zero-emission construction sites, it is difficult to understand why there is still no decisive action at the European level. Finally, climate benefits are also already measurable. The community center project in Grünerløkka, for example, has avoided 207 tons of CO_2 emissions by using zero-emission machinery[32].

Early & in-depth planning

One of the key lessons Oslo has learned in its transition toward zero-emission construction is the critical importance of dedicating sufficient time and resources to the early planning phase of a project. Successful implementation of zero-emission requirements, especially at the start of the transition, is rarely the result of standard procedures being followed; instead, it stems from a deliberate and collaborative process of defining ambitions, anticipating challenges, and adapting workflows accordingly.

Early and structured collaboration between

27 Omland, E. (2024). The sound of Zero emissions. Klimaoslo. Link to source here

28 Eurocities. (2020). Quiet, clean and green: Discover Oslo's Zero-emissions construction site. Link to source here

29 Klimaoslo (2025). European Green Capital Report Oslo.

30 European Court of Auditors (2025). Special report 02/2025: Urban pollution in the EU – Cities have cleaner air but are still too noisy.

31 European Environment Agency (2023). Harm to human health from air pollution in Europe: burden of disease 2023

32 Omland, E. (2024). The sound of Zero emissions. Klimaoslo. Link to source here

municipal agencies, contractors, suppliers, and other stakeholders enables more effective alignment on climate goals and operational constraints. In several pioneering projects, Oslo facilitated a series of clarification meetings at the outset, which proved instrumental in setting shared expectations and identifying enablers for fossil-free and zero-emission operations. These early engagements also created space for discussing the availability of suitable machinery and equipment, reviewing lessons from past projects, and tailoring solutions to project-specific constraints[33].

The City has also learned that producing a draft construction plan during the early design phase—and actively seeking feedback on it—can significantly improve workflow efficiency and clarity of responsibilities. Furthermore, early-phase planning allows for better anticipation of site-specific conditions that may affect construction operations, such as safety requirements, traffic restrictions, or urban mobility conflicts.

This includes the very crucial step of providing definitions for fossil-free machinery and zero-emission machinery, including specifying the systems boundaries for assessing. These definitions could start in a simplified way in pilot projects (e.g. including only on-site emissions) and progressively expand the boundary overtime (e.g. including the emissions of transport of people and goods to and from the site), once the initial experience has been gained by all stakeholders involved. Annex I provides an overview of the definitions used by Oslo, as a point of reference.

Stakeholder involvement

Looking beyond the first pilot project, taking a long-term vision, is another very important aspect of the planning phase. Oslo anticipated future needs (such as the need for data) and involved stakeholders beyond those in charge of project implementation. The main stakeholders involved in ZECS, aside from the city government, are:

- ☑ Procurement officials: These are the public employees responsible for designing and managing the tendering process for construction projects. In Oslo, they played a crucial role in embedding climate and environmental goals into public procurement documents, setting requirements for fossil-free and later zero-emission machinery. Their work shaped the market through demand signals, structured award criteria, and enforcement mechanisms in contracts.

- ☑ Contractors: Contractors are the actors who deliver the construction projects on the ground. Their role in Oslo's ZECS transition was twofold: adapting operational practices to comply with new procurement requirements, and offering feedback on feasibility, risks, and innovation potential. Contractors were early adopters of electric machinery and tested new workflows, often taking part in pilot projects that demonstrated the viability of ZECS.

- ☑ Suppliers & dealers: These stakeholders provided the technical solutions—electric machinery, batteries, and charging systems—needed to enable ZECS. Their ability to respond to public procurement requirements shaped the speed and success of technology uptake, particularly when it came to retrofitting diesel machinery. In Oslo, suppliers worked closely with the City and contractors through market dialogue processes, adjusting their offerings and timelines to meet new demands.

- ☑ Grid operators/public developers:

  - Grid operators like Elvia (DSO) were essential for planning and delivering the electrical infrastructure needed for ZECS, as they would incur in an estimated 1-2% increase in electricity demand. They provided insight into grid capacity, connection timelines, and technical constraints. When it comes to the role of transmission system operators (TSOs),

33 Selamawit Mamo Fufa *et al* 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **352** 012021. Link to source here

it is important to note that while there is a risk of significant long-term grid increase, it is not directly relevant at early stages of the process, as challenges are mostly on the distributing end of the grid. Very local issues of congestions might arise from ZECS demand locally, for example initiating need for local capacity increase (i.e. new transformation station).

- Public developers (such as Oslobygg and Bymiljøetaten) ensured that ZECS requirements were included in projects and facilitated coordination between actors. Together, they helped secure power supply for construction sites and shaped Oslo's broader energy planning.
- Researchers: such as research institute SINTEF, who has undertaken scientific research of the main open questions and developments throughout the journey, providing technical analysis and highlighting the data gaps.
- ☑ Civil society representatives: such as non-profit organisation Bellona, who from early on supported exchanges with relevant industry and policymakers at national and EU level.

Energy, infrastructure deployment & grid load management

One of the most critical lessons learned from Oslo's experience is the substantial increase in power demand associated with zero-emission construction sites. The power requirements of individual projects are considerable, and when multiple zero-emission projects operate simultaneously, local grid capacity challenges might arise. The findings of the report Electrification of heavy-duty transport and the construction sector in Oslo towards 2030 from the City of Oslo highlight the need to explore options for energy flexibility and careful planning of operations to limit grid load during peak hours.

Therefore, it is crucial to integrate energy planning early in the project lifecycle. Early-phase collaboration between public authorities, contractors, and suppliers allows for a shared understanding of available energy sources—such as electricity and sustainable fuels—as well as site-specific constraints related to local energy infrastructure. This early alignment makes it possible to identify feasible low-emission solutions and to adjust construction methods, such as using prefabricated elements, to reduce on-site energy demand.

It is also essential to understand how the use of zero-emission machinery will affect power peaks in the grid. In terms of power peaks. Oslo quickly found that the largest power surges on zero-emission sites are caused by direct cable electric use and fast charging of heavy electric machinery. Without coordinated charging or energy management, unnecessary peak loads occur—especially at the end of workdays when machines are charged rapidly despite being unused for hours. Introducing battery storage, staggered charging schedules, or user-defined charging windows can flatten peaks and reduce strain on the grid. Smart power cabinets and mobile battery containers were highlighted as promising solutions already entering the market.

A related key takeaway is the need for extensive investment in public fast-charging infrastructure tailored to the needs of the construction and heavy-duty transport sectors. It was found that the city needs to deploy at least 32 high-power fast chargers (up to 1 MW) along major transport routes leading into the city, in order to decarbonise heavy-duty vehicles and construction. Moreover, improvements in grid capacity and distribution infrastructure are critical, requiring proactive collaboration between the municipality, distribution grid operators (Elvia), and the transmission system operator (Statnett)[34].

To accelerate investments, the City deployed its Energy and Climate Fund with targeted financial support instruments. The City of Oslo covers up to 80 percent of the installation costs for publicly accessible fast chargers for heavy-duty vehicles[35]. Earlier the City also of-

34 City of Oslo, 2022 - Electrification of heavy-duty transport and the construction sector

35 City of Oslo, 2025 - Offentlig tilgjengelige hurtigladere for tunge kjøretøy

fered support for investments in mobile battery containers to support energy supply at construction sites, but this has now been replaced by a similar support mechanism from the national fund Enova[36].

In terms of grid load management, Oslo also found that, when it comes to managing grid access, public developers should take responsibility for coordinating grid capacity and clearly communicating the available power in tender documents, to properly inform the contractor[37].

For subsequent projects beyond the first pilot, collecting energy data from the construction site is a priority. At the beginning of the journey, obtaining high-resolution energy data from construction sites is not easy. Most sites rely on utility company smart meters, which only provide hourly readings. These do not capture short-term power peaks, such as fast charging of electric machinery. In practice, this means actual power demand is likely underestimated, making it harder to plan effectively. Circuit-level data with 10-minute resolution is far more useful for understanding real-time power dynamics. The earlier this type of data is collected in zero-emission projects, the easier it will be to plan the energy demand accurately.

To tackle this issue, Oslo has signed a contract with Fremby, a software company, which provides the City with a digital platform to monitor real time energy use across projects and equipment. While it is still in an early stage, it will gradually be introduced in all projects and provide the municipality with high-resolution energy data.

Regulatory and financial mechanisms

One of the clearest lessons regarding regulatory and financial mechanisms is that Green Public Procurement (GPP) can effectively drive market transformation when environmental goals are embedded across all stages of the procurement process—from qualification and technical requirements to award criteria and contractual obligations.

A central success factor has been Oslo's willingness to set ambitious, clear, and evolving environmental requirements. By including emissions-related criteria such as life cycle assessments (LCA), Environmental Product Declarations (EPDs), and fossil-free construction mandates, the City has influenced both upstream materials choices and downstream construction practices. The experience from specific projects showed that real-world pilots help refine future procurement strategies, supporting the wider weighting of environmental performance and broader use of emissions-based award criteria in subsequent tenders[38].
Oslo has also demonstrated the value of flexibility and innovation in procurement models. The use of Best Value Procurement (BVP) in several projects has empowered contractors to propose optimised, low-emission solutions while fostering trust-based collaboration. This model shifts the emphasis from lowest price to overall project performance, allowing for greater innovation, especially when combined with early contractor involvement.

However, the City has also learned that clear legal frameworks and early planning are prerequisites for success. The national policy enabling environmental criteria to be used in public tenders, as provided by the Norwegian government, has made it easier for the City to deploy green public procurement practices. Furthermore, the importance of setting GHG targets and defining them early in the design phase has become apparent, as it is in these early stages that the greatest emission reductions can be achieved

Finally, market engagement has been key. Oslo has invested in dialogue conferences, supplier interviews, and pre-tender consultations to create predictability for suppliers and lower the risks of compliance. These efforts have helped

36 Enova, 2025 - Mobile ladestasjoner for elektriske anleggsmaskiner | Enova | Enova

37 SWECO, 2024 - Report: Current power demand at construction sites

38 Marianne Kjendseth Wiik *et al* 2020 *IOP Conf. Ser.: Earth Environ. Sci.* **588** 022017. Lessons learnt from green public procurement in the Norwegian construction sector - IOPscience

address initial resistance and build capacity within the construction sector. Yet, challenges remain—such as aligning procurement across building and infrastructure projects, bridging knowledge gaps, and ensuring sufficient technical and financial support for contractors.

Oslo's experience highlights both the challenges and solutions in transitioning to zero-emission construction while maintaining grid stability. Strategic energy planning, infrastructure investment, and policy support are critical to overcoming these obstacles.

The experience of contractors

Contractors in Oslo are increasingly gaining experience with electric construction machinery, with over 70% having completed at least one project using 76–100% electric equipment. This demonstrates a growing willingness in the sector to adapt and build competence in zero-emission operations. 32 active contractors with experience in zero-emission projects report in Hafslund's 2024 survey that this early involvement has accelerated internal learning and improved their readiness to meet stricter environmental requirements[39]. The use of both normal and fast chargers is now widespread, and tailored energy solutions—like battery systems and provisional grid stations—are being deployed to match project-specific needs.

However, most projects undertaken by the contractors (in other parts of Norway or by private real estate developers) still have low overall electrification levels, and many contractors remain cautious about fully electrifying their fleets by 2030. Only 28% of contractors currently plan their own electrical infrastructure, reflecting a continued reliance on external expertise. In addition, access to grid capacity and charging infrastructure remains a challenge. Projects often begin before grid connection approvals are finalised, leading to limited or no electricity access during early phases. Most contractors operate with less power than they consider optimal, and tender documents rarely include information on available grid capacity—creating uncertainty and added pressure on grid operators.

Contractors face several persistent barriers: limited availability of electric machinery, high investment costs, and charging-related disruptions. Technical challenges, such as reduced operating time due to faults or insufficient infrastructure, also impact efficiency. Financially, contractors note low willingness from developers to cover additional electrification costs, and many point to the lack of economic incentives or clear guidance as limiting factors. Despite this, the momentum in the sector is clear: early adopters are gaining valuable experience, contributing to a maturing market, and helping lay the groundwork for a more robust and scalable zero-emission construction ecosystem.

Guidelines for operators for buildings and infrastructure projects

Hafslund has developed guidelines to facilitate energy planning for contractors. The purpose is to inform contractors who are planning and designing infrastructure for electrical construction projects, with a particular focus on charging infrastructure for construction machinery. They are intended to be useful tools in the process of sizing electrical installations and serve as a supplement to existing procedures and knowledge on project planning among contractors. There are two set of documents, depending on the type of construction project:

- ☑ Guideline for Zero Emission Construction Sites – Building Construction
- ☑ Guideline for Zero Emission Construction Sites – Infrastructure and Road Construction

The guides are divided into six main sections, based on the phases contractors must go through when planning electrical projects. They are adapted to the Norwegian context but its approach can be easily replicated depending on the local context[40].

39 Oslo (2024). Entreprenører deler erfaringer fra utslippsfrie anleggsplasser

40 Hafslund (2025). Two guidelines for Zero Emission Construction Sites

SECTION 3

ZECS across Europe

Interest in ZECS is growing across Europe, with Nordic capitals and Dutch cities leading the way by setting ambitious targets for clean construction. The strategic use of public procurement guided by ambitious emission reduction targets and effective energy-planning has proven essential for supporting decision-makers and industry deploying ZECS. At the EU level, local and national authorities can leverage existing provisions in EU procurement directives and introduce mandatory environmental criteria. Oslo's experience demonstrates that successful progress also depends on fostering early market dialogue, coordinating energy infrastructure, strengthening internal procurement capacity, and offering transitional support to help the market grow. Finally, participating in collaborative networks such as NetZeroCities, Big Buyers, C40, and Eurocities is vital to building trust, facilitating knowledge exchange, and identifying systemic barriers.

Building on the success and lessons learned from Oslo, a number of strategic recommendations can be offered to local, regional, and national public purchasing authorities across Europe. These are aimed at enabling the replication—and scaling—of zero-emission construction sites (ZECS), while accounting for differences in governance models, procurement capacities, and market maturity.

Where EU Public Buyers stand today

European interest in ZECS is growing, with early adopters in many regions. Several Nordic capitals and Dutch cities have already embedded ZECS targets into their policy frameworks and procurement practices. In the Netherlands, for example, the "On the Way to Clean and Emission-Free Construction" initiative brings together national and local authorities to phase in emission-free requirements in public tenders[41]. In other cities like Barcelona and Paris, ZECS pilots have emerged, but full integration into procurement frameworks is still in development[42],[43]. London has also set its sights on NRMM: current plans are that by January 2040, only zero-emission machinery will be allowed to operate within London's NRMM LEZ[44].

At EU level, initiatives like the Big Buyers Working Together platform (led by DG GROW) and city networks like NetZeroCities,C40 and Eurocities are fostering collaboration and knowledge exchange on sustainable procurement. Yet, significant disparities remain across regions in the uptake and implementation of ZECS.

Success factors and replicability

European public procurement authorities share a number of common objectives—delivering infrastructure cost-effectively, ensur-

41 Schoon en Emissieloos Bouwen (SEB) (2023). English | Zero Emission Construction Equipment | Schoon en Emissieloos Bouwen

42 M. Latorre (2024). Barcelona ejecuta la primera obra municipal con maquinaria eléctrica: reduce el ruido, las emisiones de CO2 y el coste energético 20minutos

43 EODev (2023). Zero emission roadworks in the center of Paris

44 London City Hall (2025). Non-Road Mobile Machinery (NRMM) | London City Hall

ing compliance with environmental and social standards, and contributing to broader policy goals such as climate neutrality. However, their starting points, capacities, and institutional arrangements vary considerably, which affects their ability to replicate Oslo's ZECS approach without adaptation.

Some of the most notable differences include:

- ☑ **Governance structures**: Centralised systems (e.g., France, Italy) often set procurement policy at national level, whereas cities in countries like Norway or the Netherlands enjoy greater autonomy in setting environmental standards in tenders.
- ☑ **Procurement maturity and innovation culture**: Nordic and Dutch cities have a longer history of using public procurement strategically for climate action, while others may still treat it as a compliance exercise with limited integration of environmental objectives.
- ☑ **Market readiness and supply chains**: In some regions, the availability of electric construction machinery, skilled contractors, or grid capacity is limited, which can constrain the feasibility of ZECS in the short term.
- ☑ **Legal and regulatory environments**: Not all national frameworks currently allow for strong environmental award criteria or require life cycle emissions to be considered in tenders.

Despite these differences, a shared opportunity exists: EU directives and guidance on green public procurement, EU climate goals, and a renewed political attention to the role of lead markets to help decarbonise and retain competitiveness in Europe's industrial sectors, in addition to widespread methodologies like life cycle costing[45], provide a common legal and policy backbone. Most EU cities have access to cohesion funds, EU technical support instruments, and international city networks that enable learning and capacity building.

With this in mind, replicating ZECS effectively across Europe will depend on both recognising these contextual differences and leveraging the enablers of success that have been identified in pioneering projects such as the one in Oslo.

Key success factors & transition enablers

Based on Oslo's experience and comparative developments in Europe, the following conditions are critical to enabling effective ZECS deployment across local contexts:

1. Strong political mandate and clear targets

Establishing an overarching climate target at the city level is fundamental, as it provides the framework within which more specific goals, such as requiring zero-emission construction machinery by 2025 or 2030, can be effectively implemented. These targets must be supported by cross-departmental commitment (e.g., climate, procurement, transport, urban planning) and written into city climate strategies and investment plans. When political direction is clear, procurement authorities are empowered to act more ambitiously and consistently.

There are currently plenty of opportunities at the national and European level. There is a large focus in industrial decarbonisation and on resilience and competitiveness in Europe, which is intimately related to decreasing dependencies on fossil fuels. EU Member States also need to provide Whole-life carbon (WLC) roadmaps by 2027, limit values for whole life-cycle global warming potential (GWP) for new buildings and set targets from 2030, with a downward trend, according to the Energy Performance for Buildings Directive (EPBD)[46]. The emissions from the construction phase (i.e. including construction machinery emissions) are also accounted for under the WLC

45 European Commission, Green Forum - Life-cycle costing - European Commission

46 Viegand Maagøe, COWI and exergia (2024). Home - Whole Life-Cycle greenhouse gas emission reporting for buildings (website available until end of 2025)

methodology, providing a clear political opportunity to set ambitious targets at national level.

Plenty of cities and regions are also looking to reduce emissions and pollutants. Therefore, at the local level, it is possible to build on existing initiatives like low-emission zones (LEZs), which are considered to be the most effective measure to improve air pollution, reducing emissions of fine particles, nitrogen dioxide and (indirectly) ozone.[47]

LEZs are increasingly used in European cities. For example, since 2019, mandatory LEZs have been in place in Paris, Grenoble, Lyon, Strasbourg, Marseille and several other French metropolises with notably poor air quality[48]. Spain went from 10 municipalities with LEZs in January 2023, to LEZs being in place in 49 cities, and are expected to triplicate by the end of 2025[49]. Therefore, measures targeting the use of zero-emission machinery in construction works taking part inside already designated LEZs would be a logical place to start. Although LEZs are more typically used in the context of road transport, these could also be extended or designed specifically for non-road applications, such as construction machinery or diesel generators, as is the case in London.

A clear market signal, such as a climate target or a LEZ, offers regulatory certainty towards market participants looking to shift towards zero emission machinery and can effectively provide a clear timeline as to when this shift needs to happen.

2. Strategic use of public procurement as a market driver

Public procurement is one of the most powerful levers available to public authorities to accelerate the market uptake of zero-emission construction technologies. As demonstrated by Oslo's approach, aligning procurement strategies with long-term climate goals can effectively steer supply chains, stimulate innovation, and build a competitive advantage for clean technology providers. Yet, across Europe, the potential of procurement to serve as a climate policy tool remains significantly underused.

The legal framework for this strategy already exists. The EU Public Procurement Directive (Directive 2014/24/EU) provides a solid foundation for integrating environmental criteria into public tenders. It allows public authorities to award contracts not solely on the basis of lowest cost but on the basis of the "most economically advantageous tender (MEAT)", taking into account a best price–quality ratio. This includes evaluation criteria such as life cycle costs, technical quality, environmental performance, and social considerations.

However, despite these enabling provisions, the default practice across many Member States still heavily favours lowest-price awards. According to the European Commission, 55% of all public tenders in the EU continue to use lowest price as the sole criterion, missing the opportunity to reward sustainable innovation or consider broader societal value.

The lack of mandatory requirements to include environmental or social criteria, despite Article 67(2)'s strong encouragement[50], limits the strategic use of procurement for climate or other environmental objectives. This is particularly relevant in the construction sector, where public buyers account for a significant share of total market demand for works such as hospitals, schools, public housing, and administrative buildings—all of which fall under the scope of the directive.

From a ZECS perspective, the current situation offers both a challenge and an opportunity. On one hand, public procurement procedures remain under-leveraged in many

47 Urban Access Regulations (2025). Low Emission Zones

48 POLITICO (2025). Living Cities: Amsterdam's success in tackling HIV – POLITICO

49 POLITICO (2025). Living Cities: Mr. Mayor goes to Brussels – POLITICO

50 Article 67(2) of the Public Procurement Directive allows public buyers to award contracts based on more than just the lowest price. They can also consider quality, environmental and social aspects linked to the project. Member States can even require that tenders are judged on a mix of cost and quality, not just price alone.

regions. On the other, the legal basis is already in place to do more. If Member States and local authorities begin to consistently apply the MEAT approach, prioritizing emission reduction and climate alignment in award criteria, this could unlock significant demand for electric construction machinery, clean energy infrastructure, and low-emission logistics solutions, by providing preferential market access to cleaner bids.

Ultimately, strategic procurement must be supported by adequate training, guidance, and capacity-building. The Directive requires Member States to ensure that support structures are in place for public buyers to effectively plan and carry out environmentally responsible procurement. These support systems—combined with political will, dedicated climate targets, and clear award mechanisms—are essential to transform procurement from a compliance tool into a catalyst for zero-emission construction across Europe.

The ideal context for the effective uptake of ZECS entails clear and ambitious targets on the one hand (which can be understood as the 'stick'), while integrating these targets into public procurement criteria such that a lead market is created for greener bids (which can be understood as the 'carrot), therefore unlocking significant revenue potential for projects preferring to use zero emission machinery.

Annex II showcases a summary of potential measures for accelerating ZECS adoption through public procurement.

3. Early and continuous market dialogue

In first-time procurement of ZECS projects, many suppliers and contractors will be unfamiliar with ZECS requirements. Oslo's use of early dialogue—years before binding standards were introduced—helped prepare the market and mitigate resistance. Engaging contractors, suppliers, and energy providers early helps build trust, identify barriers, and stimulate innovation.

Preliminary market consultations (PMC) are allowed in the EU, as stated in Article 40 of the Directive 2014/24 on Public Procurement, "*with a view to preparing the procurement and informing economic operators of their procurement plans and requirements*", as long as the process remains transparent, competitive, and non-discriminatory[51].

In the context of ZECS, market dialogue has proven critical for several reasons:

- ☑ It helps public buyers assess technological readiness, particularly for rapidly evolving solutions such as electric or hydrogen-powered construction machinery and smart charging infrastructure.
- ☑ It allows the contracting authority to signal future demand to suppliers, giving them time to prepare and innovate in response.
- ☑ It promotes trust and collaboration, especially for complex or first-of-a-kind projects, by giving industry actors a platform to raise concerns, propose solutions, and flag practical limitations.

While voluntary, this provision is recommended when ZECS projects are being tendered for the first time, as it helps authorities to prepare the market and identify any potential challenges. This dialogue should continue throughout the process and could include dedicated workshops, one-on-one supplier meetings, and guidance documents, with the objective of:

- ☑ Validating whether environmental criteria under consideration are technically and commercially feasible.
- ☑ Understanding which alternative fuels or charging solutions are realistically available in the region.
- ☑ Testing how contractual performance criteria or bonus schemes could work in practice.

51 Directive 2014/24/EU of the European Parliament and of the Council of 26 February 2014 on public procurement and repealing Directive 2004/18/EC. CL2014L0024EN0020010.0001_cp 1..1

- ☑ Establishing a baseline of data availability and gaps (e.g. energy demand, emissions factors, costs).

The experience from Oslo and other frontrunner cities highlights that early and structured market dialogue can significantly de-risk innovation-oriented procurement. It provides a platform to prepare the supply side for higher environmental requirements while ensuring contracting authorities receive high-quality, compliant bids. As ZECS become more widely adopted, formalising PMC processes within public procurement cycles will be critical to replicating and scaling these outcomes across Europe.

The European Commission's Guidance on Innovation Procurement (Section 4.1.2) outlines key steps when undertaking preliminary market consultations and can be overall a useful guide for innovative procurement[52].

Annexx II of this report provides an overview of suggested potential measures to accelerate ZECS adoption through public procurement.

4. Technical planning and energy coordination

A key constraint in scaling ZECS is power availability. Energy planning must happen in parallel with procurement planning to ensure grid capacity is in place. Oslo worked closely with distribution (Elvia) and transmission (Statnett) grid operators to anticipate future needs and allocate power accordingly.

Cities must also consider on-site charging logistics, smart load management, battery use, and off-site depot charging. Technical guidance should be developed in collaboration with contractors and grid operators.

5. Data-driven approach and quantifiable metrics

The success of ZECS depends on clear definitions and measurable targets. Oslo's experience highlights the importance of performance-based specifications (e.g., "what can be electric, shall be electric"), early-phase GHG calculations, and mandatory emissions reporting throughout implementation. This makes tools such as life cycle assessment (LCA), energy modelling, and machine-specific data collection essential for benchmarking and continuous improvement.

6. Start with a pilot project

Launching a pilot project allows public buyers to test ZECS requirements in a controlled setting before scaling up. Oslo's first pilot at Olav V Gate served as a crucial learning opportunity, helping identify technical, logistical, and regulatory challenges while building internal capacity and supplier confidence. Pilots also provide necessary data for future procurement decision-making, such as real-world energy use, emissions savings, and equipment performance.

Critically, pilot projects can de-risk innovation by allowing for greater flexibility in contract terms—such as the public authority covering energy costs, supplying key equipment or extending the project timeline if needed. This helps lower the barrier to entry for suppliers and contractors new to ZECS technologies, while fostering collaboration and mutual learning between public buyers and industry actors. A successful pilot strengthens political and stakeholder support, validates procurement strategies, and lays the groundwork for future standard-setting.

52 European Commission (2021). Guidance on Innovation Procurement (Section 4.1.2)

7. Enabling ecosystems and learning platforms

Peer learning and access to practical tools are essential for scaling ZECS. Creating repositories of model tender documents, success stories, and training materials empowers less experienced authorities to replicate best practices. The Big Buyers initiative and city networks such as NetZeroCities, C40, ICLEI, and Eurocities play a critical role in facilitating this exchange.

National platforms and ministries can also support local action through capacity-building programmes and technical assistance.

For contractors, in addition to market dialogues, the preparation and dissemination of practical guidelines, such as those developed in Oslo by Hafslund, are key. When tailored to specific geographies, project types, and market maturity levels, these resources can prepare industry actors for a successful transition to ZECS.

8. Transitional support for market readiness

To ensure long-term economic competitiveness, ZECS will require transitional support mechanisms even as their adoption becomes more widespread.

These may include:

- ☑ Investment in enabling framework conditions (e.g., infrastructure and workforce training)
- ☑ Risk-sharing models (e.g., public ownership of charging infrastructure or shared use of zero-emission machinery)
- ☑ Grants, subsidies or temporary schemes to support the early adoption of zero-emission construction machinery and equipment

Tailored financial and regulatory support is not only essential to foster the uptake of ZECS but is also justified by the presence of market failures that hinder market entry for smaller industrial players, such as SMEs. While no one-size-fits-all approach exists, a mix of political will, strategic procurement, collaborative planning, and capacity-building can make ZECS replicable across diverse EU contexts.

Recommendations for EU cities

Based on the Oslo experience and progress across other leading European cities, the following recommendations are designed to support the replication and scaling of Zero-Emission Construction Sites (ZECS) across the EU. These actions target both local and national public procurement authorities, acknowledging the diversity in administrative structures, regulatory environments, and market maturity across Member States.

Recommendation Area	Key Actions	Actors
Set clear climate and ZECS targets	- Include ZECS in municipal and national climate action plans - Link to EPBD whole-life carbon targets - Align targets with local air quality and noise pollution goals	Local governments, Ministries
Use procurement strategically	- Apply MEAT (Most Economically Advantageous Tender) in all construction-related tenders - Make CO_2 emissions and environmental criteria mandatory in evaluation	Procurement authorities
Mandate environmental award criteria	- Include lifecycle emissions, energy use, and equipment electrification as standard criteria - Provide shadow prices for emissions or social/environmental co-benefits	National procurement agencies
Launch pilot projects	- Start with smaller, controlled ZECS pilots - Use results to inform guidelines and standardise requirements	Local governments, developers
Enable early market dialogue	- Conduct preliminary market consultations (PMC) - Involve grid operators, SMEs, suppliers and contractors early to de-risk innovation	Contracting authorities

Coordinate energy planning	- Collaborate with DSOs/TSOs to assess grid availability and plan upgrades - Provide guidance on temporary power supply, depot charging and energy-efficient site logistics	City utilities, grid operators
Build procurement capacity	- Develop training on sustainable procurement, life cycle costing and innovation procurement - Support cities with tools and helpdesks	Ministries, EU/national platforms
Provide transitional financial support	- Set up subsidies for ZE equipment and charging solutions - Support shared infrastructure models and contractor training	Ministries, EU programmes (LIFE, Cohesion funds)
Standardise data collection and metrics	- Require energy and emissions monitoring on ZECS - Develop KPIs for project evaluation	Local governments, regulators
Leverage networks and peer learning	- Use platforms like NetZeroCities, Big Buyers, C40, ICLEI and Eurocities - Share templates for tender documents, guidelines, and training materials	Cities, city networks, EU bodies

These actions should be adapted based on local context, but collectively, they offer a roadmap to shift public construction procurement from a cost-driven model to a strategic climate policy tool. As the public sector often represents the largest construction client in many countries, these measures can have a powerful market-shaping effect, driving demand for clean technologies and accelerating supply chain transformation.

SECTION 4

Conclusion

Oslo's pioneering journey demonstrates that zero-emission construction sites are not only feasible but also scalable—when supported by the right mix of political ambition, technical planning, stakeholder engagement, and strategic use of public procurement.

The key lessons learned include:

1. **A long-term vision and strong political mandate** are essential to guide procurement strategies, align departments, and mobilise industry change.
2. **Data-driven planning and performance monitoring** enable cities to measure impact, refine approaches, and build trust in ZECS outcomes.
3. **Structured collaboration and early dialogue** with contractors, suppliers, grid operators, and research bodies allow for shared learning, technical feasibility assessments, and greater market readiness..
4. **Procurement as a policy lever**—when used beyond lowest-price models—can create sustained demand for zero-emission technologies and help mainstream new practices across construction sectors.

These insights are timely. With the implementation of the Energy Performance of Buildings Directive (EPBD), together with the current political focus on industrial decarbonisation and EU competitiveness, there is a strategic opening for local, regional and national governments to make ZECS the new standard.

By embedding ZECS requirements into public procurement frameworks—and supporting them with technical tools, financial incentives, and peer learning—EU public authorities can accelerate the green transition in the construction sector while improving air quality, noise levels, and public health.

These findings also lay the groundwork for future deliverables focused on exploring in depth the current political opportunities at EU level, and how to ensure that the European policy framework contributes to the deployment of ZECS across the globe.

Annex I

Definitions used by the Department of Finance of the City of Oslo in the "Standard Climate And Environmental Requirements For Transport For The City Of Oslo's Goods And Services Procurements" City Government proposition 1123/19. Translation provided for reference only.

Definitions

Fossil-free	Fuel that does not emit new CO2 to the atmosphere in use. Fossil-free fuels in this context are biodiesel, bioethanol, biogas, electricity and hydrogen.
Zero-emission	Fuel that does not produce any form of emissions in use, neither CO2 nor other gases that affect local air quality (such as particulate emissions and airborne dust). Zero-emission fuels are electricity and hydrogen. Zero-emission vehicles include battery-electric vehicles and vehicles that run on hydrogen.
European emissions standard	Type approval of all new vehicles and new engines for vehicles. The Euro requirements specify the maximum emissions from new vehicle engines in order to be approved for sale in EU member states. European emissions standards only set requirements for emissions that primarily affect local air pollution (such as particulate emissions and airborne dust). No requirements are set for CO2 emissions. Incorporated in chapter 25 of the Norwegian Vehicle Regulations.
Minimum requirement	Description of the properties required of the product/service to be procured.
Award criteria	The properties in the tenders that must be considered to determine which tender will win the competition.
Contractual clauses	The general and special terms and conditions that apply to the contract.

Annex II

Potential measures for accelerating ZECS adoption through public procurement

Public procurement is a powerful tool for transforming markets and scaling zero-emission construction sites (ZECS). Oslo's journey illustrates how strategic procurement measures—when deployed coherently—can stimulate demand, build supply-side readiness, and create systemic change. For other EU cities and public authorities aiming to replicate this success, the following procurement-related measures can play a pivotal role:

Measure	Description	Impact / Benefit
A. Shadow pricing of emissions	Apply a carbon price (e.g. €200/ton CO_2e) to evaluate bids on environmental cost, not just upfront price.	Internalises climate externalities; rewards low-carbon solutions; bridges cost gap for zero-emission bids.
B. Bonus or penalty clauses	Include financial rewards for using ZE machinery (e.g. per hour) or penalties for non-compliance (e.g. idle running).	Motivates over-compliance; derisks innovation; improves monitoring and enforcement.
C. Co-investment in charging infrastructure	Public entities finance grid upgrades or shared chargers near sites, reducing burden on contractors.	Speeds infrastructure roll-out; levels playing field for SMEs; supports first movers.
D. Targeted financial incentives	Provide subsidies, grants, or guarantees for ZE machinery, batteries, or depot chargers.	Closes cost gap; stimulates supplier investment; supports SME participation.
E. Lifecycle-based procurement	Use Life Cycle Costing (LCC) to compare bids based on whole-life impacts.	Encourages sustainable choices; justifies higher CAPEX through lower OPEX and emissions.
F. Procurement officer training	Offer training and guidance on Green Public Procurement (GPP), innovation procurement, and ZECS-specific strategies.	Builds internal capacity; improves consistency across tenders; supports replication.

The Netherlands' MEAT Model

Overview:

The Netherlands has developed a targeted model to use the MEAT principle to accelerate the uptake of clean and zero-emission construction machinery through public procurement. This model is part of the SEB (Schoon en Emissieloos Bouwen) support programme and aligns with national climate and clean air policies.

Objectives:

- Stimulate market adoption of zero-emission (ZE) and clean construction equipment.
- Support contractors in deploying ZE equipment in infrastructure-limited areas.
- Promote temporary on-site charging solutions and battery systems.
- Facilitate climate-aligned public procurement through clear, quantifiable incentives.

Key Features of the SEB Model:

Component	Description
Part 1: Equipment Scoring	Scores based on emission levels, power type, and share of ZE equipment.
Part 2: ZE Bonus Mechanism	Additional fictitious discount awarded for surpassing ZE deployment threshold, incentivising on-site energy solutions.
Threshold Range	A "sweet spot" is defined (e.g. 20–50% ZE) for optimal scoring benefits.
Infrastructure Awareness	Projects in areas with low charging access receive additional support.
Customisable Tool	An Excel-based scoring form tailored per project and energy context.

Implementation Support:

- Pre-tender energy scan to assess infrastructure.
- Custom EMVI forms and scoring thresholds.
- Free advisory support via SEB Helpdesk.

SEB Helpdesk: bastiaan.dupre@infram.nl
More info: www.opwegnaarseb.nl & Gunningsmethodiek SEB (EMVI-model) - SEB Kennisbank

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