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Zero-Emission Construction Sites:

Turning Europe's Silent Revolution into Policy

The EU has the tools. Now it must use them.

POLICY BRIEF
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DISCLAIMER

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

NET ZERO CITIES
EU MISSION PLATFORM | CLIMATE NEUTRAL AND SMART CITIES

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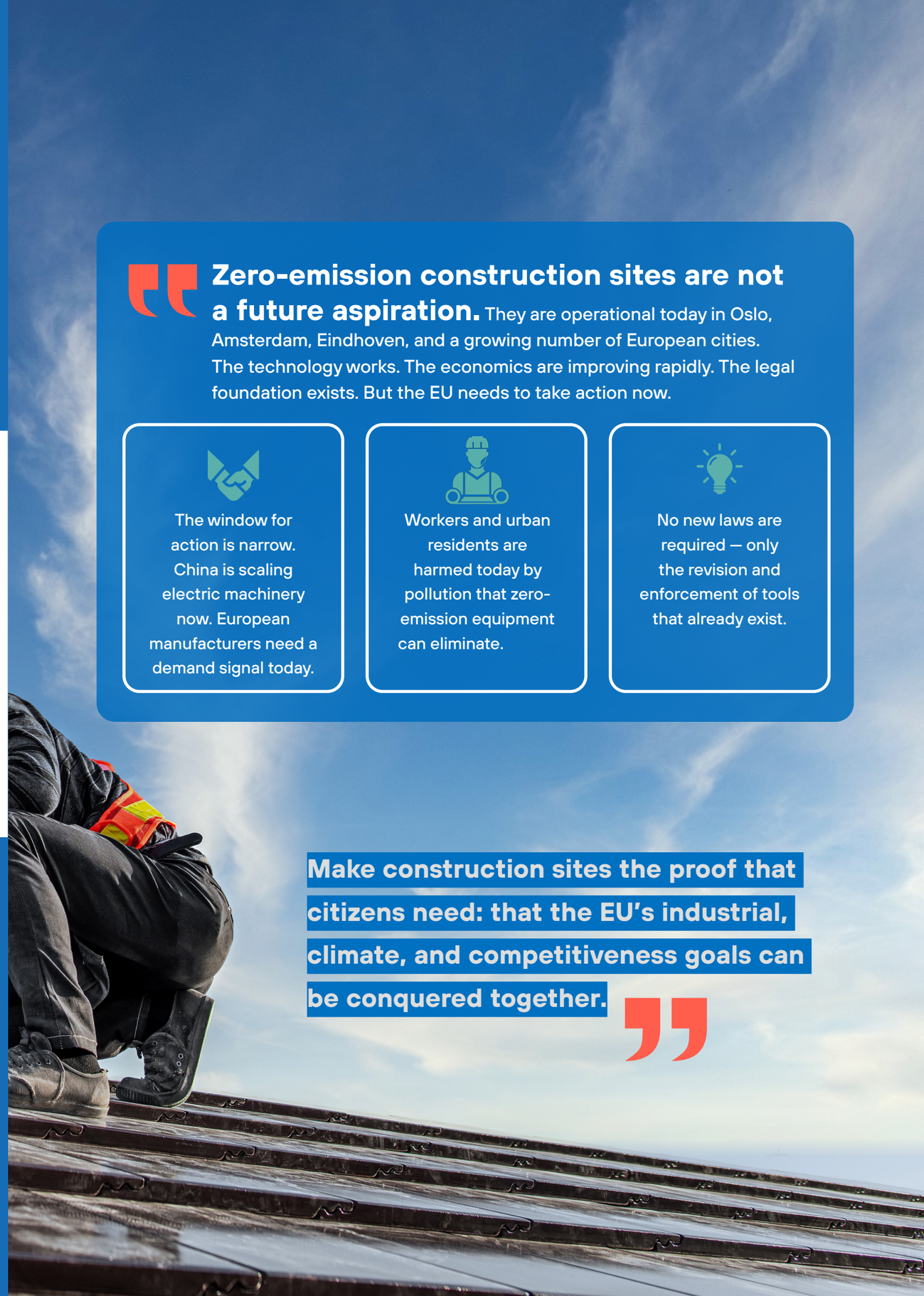


Zero-emission construction sites are not a future aspiration. They are operational today in Oslo, Amsterdam, Eindhoven, and a growing number of European cities. The technology works. The economics are improving rapidly. The legal foundation exists. But the EU needs to take action now.

The window for action is narrow. China is scaling electric machinery now. European manufacturers need a demand signal today.

Workers and urban residents are harmed today by pollution that zero-emission equipment can eliminate.

No new laws are required — only the revision and enforcement of tools that already exist.

Make construction sites the proof that citizens need: that the EU's industrial, climate, and competitiveness goals can be conquered together.

~3%

of EU GHG emissions from off-road machinery

Climate gap: Electrification of Non-Road Mobile Machinery (NRMM) in Europe could reduce ~3% of EU greenhouse gas emissions per year, equivalent to 55 million fossil-powered cars. Construction machinery accounts for a third of these. Climate emissions from this sector remain mostly unregulated at EU level.

40%

higher lung cancer risk for diesel exhaust exposed workers

Public health: Transitioning to zero-emission construction equipment could dramatically improve health outcomes for workers and urban residents alike. Eliminating diesel exhaust on construction sites would reduce workers' significantly elevated risk of lung cancer and other occupational diseases, while cutting the NOx and PM2.5 emissions that contribute to tens of thousands of premature deaths across Europe every year. Zero-emission equipment is the only technology that eliminates these harms at source.

1% → 17%

increase of electric loader market share in China, Q1 2023 to Q1 2025

Competitiveness: Europe has the industrial base to lead the global market for zero-emission construction machinery, but will only seize the chance if it acts now. China is already scaling production rapidly, and without a clear EU demand signal, European manufacturers risk ceding first-mover advantage in a fast-growing sector. Total cost of ownership parity with diesel is already achievable for several equipment categories and is improving quickly.

239k

EU deaths/year linked to PM2.5 exposure (EEA 2024)

No new laws needed: The EU already has the legislative tools to act. Existing directives – covering non-road mobile machinery, public procurement, clean vehicles, energy performance of buildings, ambient air quality, environmental noise, and worker safety – provide a solid legal foundation. These must be revised, strengthened, and consistently enforced, as well as be accompanies by targeted financial support, which is also required to bridge upfront cost gaps during the transition

Bellona's Recommendations

1. Level the playing field and provide transitional financial support

Key Policy Actions:
- Phase out diesel tax exemptions
- Reaffirm timely ETS2 implementation,
- Introduce EU financial support measures under the next MFF

2. Mandate environmental criteria in public procurement

Key Policy Actions:
- Make environmental and life-cycle cost criteria mandatory under the Public Procurement Directive revision
- Extend the scope of the Clean Vehicles Directive in the 2027 revision to cover off-road construction machinery

3. Revise the NRMM Regulation to introduce a zero-emission pathway

Key Policy Actions:
- Introduce a zero-emission supply roadmap in the revision of the NRMM Regulation, with a full diesel phase-out by 2040 at the latest

4. Leverage air quality and noise directives to require zero-emission equipment

Key Policy Actions
- Issue EU guidance for Member States to address construction-site emissions

5. Member States should include all lifecycles stages in the WLC limits under the EPBD

Key Policy Actions:
- Member States' WLC roadmaps should include the construction phase as a mandatory component

6. Develop and publish an EU-level "Zero-emission Machinery Action Plan"

Problem: A Critical Gap In EU Climate And Health Policy

Zero-Emission Construction Sites (ZECS) are worksites where only zero-emission machinery and transport i.e. those without exhaust pipe emissions, are permitted to operate. They differ fundamentally from fossil-free sites in that biofuel-powered equipment is *not* permitted: biofuels do not eliminate local air or noise pollution. This distinction matters for health, for regulation, and for industrial strategy.

Construction machinery is a critically overlooked source of climate emissions and urban pollution. Despite off-road machinery accounting for approximately 3.1% of EU greenhouse gas emissions (GHG) – two-thirds of which originates from construction and agricultural equipment – CO_2 **emissions from this sector remain largely unregulated at EU level**. There is no CO_2 standard for non-road mobile machinery (NRMM). **This is a critical gap** in EU climate law.

Climate

Globally, non-road mobile machinery emits approximately 2 billion tonnes of CO_2e annually; construction machinery accounts for roughly one third. In Europe, the picture is similar. While most off-road emission segments have declined, emissions from construction machinery have not. Construction activities are also a significant source of embodied carbon in buildings and infrastructure: a Swedish study estimated that the construction phase accounts for 17% of embodied emissions in the national new buildings stock, with approximately 95% driven by energy use for on-site machinery and transport.

Air and Noise Pollution

Diesel construction machinery is a leading source of nitrogen oxides (NO_x), fine particulate matter ($PM_{2.5}$), and engine noise, particularly in urban areas. An impact assessment undertaken by Hafslund and Bellona Europa (2026) estimates that in 12 major European economies[1], construction non-road machinery emitted 56,860 tonnes of NO_x and 2,380 tonnes of $PM_{2.5}$ in a single year. In cities with strong clean-air policies for traffic, construction machinery can account for a disproportionately large share of remaining local pollutant emissions. The European Environment Agency (EEA) estimates that **239,000 deaths in the EU-27 in 2022 were attributable to long-term $PM_{2.5}$ exposure, and 48,000 to NO_2 exposure**. The EU is currently off track to meet its 2030 Zero Pollution Action Plan targets: nitrogen

1 Germany, Italy, France, Spain, Netherlands, Belgium, Sweden, Austria, Norway, Finland, Denmark, and Hungary.

deposition will reach at best a 19% reduction against a 25% target, and noise reduction a maximum of 23% against a 30% target. Strikingly, the mid-term review of the Zero Pollution Action Plan contains no mention of the role zero-emission construction machinery could play in meeting these goals.

Occupational Health

Workers systematically exposed to diesel exhaust emissions (DEE) face a **40% higher risk of developing lung cancer**, as well as elevated risks of bladder cancer, cardiovascular disease, stroke, and asthma. Construction workers also face **dangerous noise exposure**: an estimated 23% of US construction workers suffer hearing loss, higher than any other sector studied. These are not marginal risks: **they represent a systematic failure to protect workers**, which existing EU directives already require public authorities to address. Zero-emission machinery is currently the only technology capable of eliminating these risks at source.

SPOTLIGHT

How the Netherlands is using existing law to require zero-emission machinery

Directive 2004/37/EC on carcinogens and mutagens requires employers to eliminate DEE exposure at source whenever technically feasible. The Dutch Labour Inspectorate has operationalised a four-tier enforcement hierarchy:

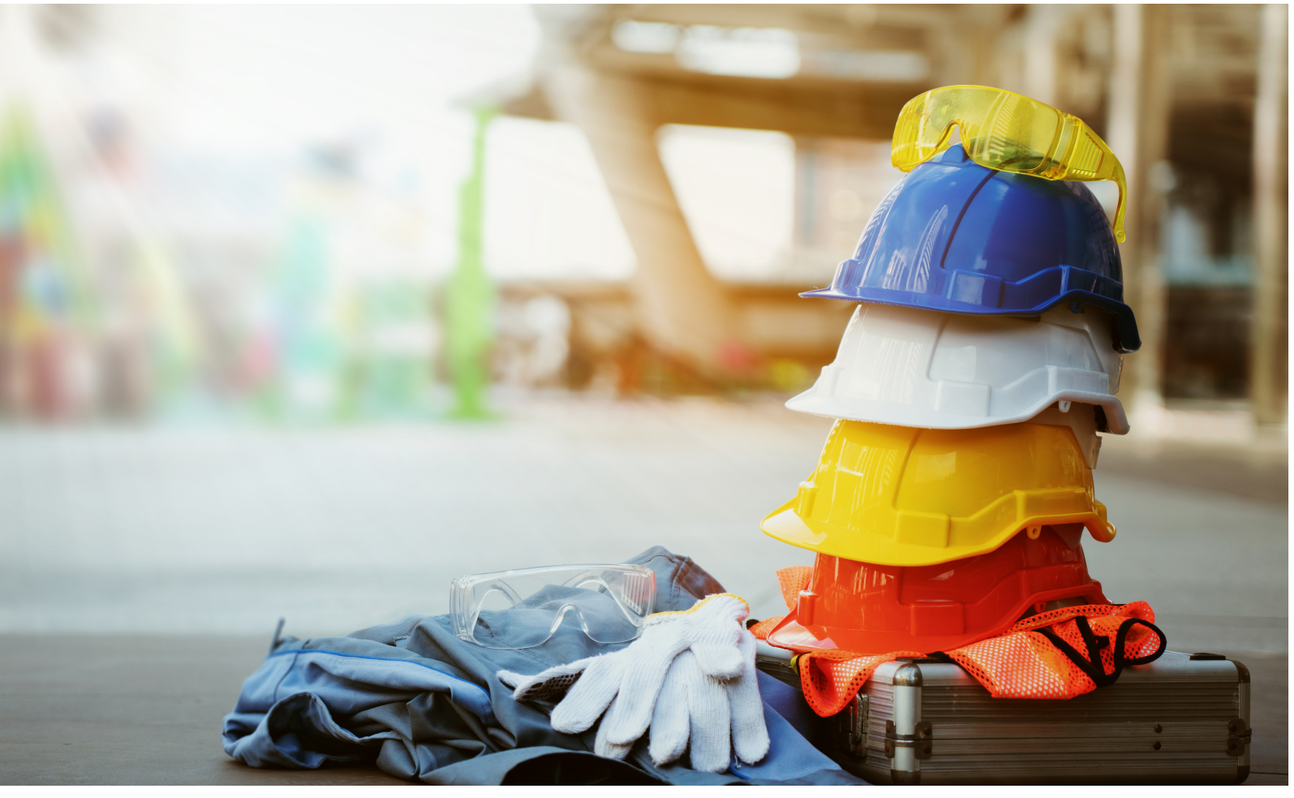
- **Level 1 – Replace:** The employer must replace diesel equipment with zero-emission machinery. Failure to do so without documented justification is a breach of law.
- **Level 2 – Technical mitigation:** If replacement is genuinely infeasible, the employer must minimise DEE exposure through technical means (e.g. particle filters).
- **Level 3 – Organisational measures:** Limit worker access to high-exposure zones.
- **Level 4 – Personal protective equipment:** A last resort, with mandatory time-limits on use.

The Netherlands is the first country to formally consider requiring the deployment of zero-emission equipment under Directive 2004/37/EC. The technical feasibility of ZECS has already been demonstrated across multiple European cities.

Competitiveness

European construction machinery manufacturing represents a market value of approximately €50.9 billion. However, Chinese manufacturers have doubled their output since 2010 and, facing a contracting domestic construction market, are aggressively expanding into international markets. China now offers over 200 electric construction machinery models, with rapid market penetration in key segments. Electric loaders reached 17% of total Chinese sales in Q1 2025, up from just 1% in Q1 2023.

European manufacturers are capable of competing as they already produce a range of zero-emission models, but the absence of EU-level regulation and demand signals leaves zero-emission solutions at a structural disadvantage versus conventional diesel equipment. Green premiums range from 100–200% for medium- and heavy-duty equipment, and 0–20% for lighter machinery. However, when total cost of ownership (TCO) is considered, accounting for energy efficiency, lower fuel costs, reduced maintenance, and learning-by-doing effects, parity is already achievable for many equipment categories and favourable in some. **The key constraint is scale**: without a consistent demand signal, manufacturers cannot drive down unit costs through serial production.



2. The Transition Is Already Underway – But Scale Is Insufficient

The journey toward ZECS began in Oslo in 2016. By 2019, **Oslo** had launched the world's first fully zero-emission construction site. As of January 2025, all public construction works in Oslo are required to be zero-emission. This development has been driven by strategic use of public procurement. Oslo is now developing regulations to require emission-free energy use across local construction sites, including private construction projects. Momentum is growing across Europe. In the **Netherlands**, over 150 stakeholders, including public authorities and industry, have signed a voluntary agreement committing to phasing out fossil-based construction equipment by 2040. **Sweden**, **Finland**, **Norway**, and **Iceland** are developing national programmes. **Copenhagen** will require equipment under 8 tonnes to be emission-free from mid-2027. **Barcelona** is piloting ZECS with a target for 50% zero-emission procurement by 2030. **London**'s NRMM low-emission zones will require zero-emission equipment from 2040.

International demand signals are also strengthening: the **Big Buyers Working Together** Joint Declaration, the **C40/ICCT/CCAC Strategic Partnership** launched at COP30, and the **Leap to Zero Conference** collectively represent a growing coalition of public authorities committed to shifting procurement and production norms.

Why voluntary action alone is not enough

Scattered national and municipal action has sparked innovation and local transformation. A more focused and coordinated effort would generate the consistent demand signal that manufacturers need to shift to serial production and reduce unit costs. Individual cities cannot carry the market on their own. The ZEMCON impact assessment demonstrates that non-binding instruments, such as voluntary agreements, plans, and roadmaps, have low impact in isolation. High-impact tools are binding regulations, mandatory environmental criteria in procurement, and direct financial support. **Only EU-level action can unlock the market at the necessary scale.**

Policy Recommendations

> **The EU already has the regulatory backbone to deliver zero-emission construction - but it needs to be updated and consistently enforced.**

Recommendation 1: Level the playing field and provide transitional financial support

Diesel used in construction currently benefits from tax exemptions or below-minimum rates under the Energy Taxation Directive (ETD, 2003/96/EC), artificially disadvantaging zero-emission alternatives. The revision of the ETD should phase out these exemptions on a clear timeline aligned with the NRMM roadmap. The delayed rollout of ETS2 has weakened the economic signal that frontrunners relied on to justify early investment; its timely implementation should be reaffirmed. In parallel, the EU should establish targeted financial support mechanisms under the next Multiannual Financial Framework (2028–2034): purchase subsidies and voucher schemes for electric NRMM, grants for charging and grid infrastructure, battery leasing programmes for SME contractors, and innovation grants for pilot ZECS deployments.

Recommendation 2: Mandate environmental criteria in public procurement

The revision of Public Procurement Directive 2014/24/EU should make the Most Economically Advantageous Tender (MEAT) principle mandatory for construction-related contracts, requiring environmental, climate, and occupational health criteria to be included as award criteria. Life-cycle costing – including carbon shadow pricing at €200/tCO_2e – should become standard in evaluating bids. This would replicate at EU scale what Oslo, Eindhoven, and the Netherlands have already demonstrated: that procurement criteria are the single most effective driver of early market transformation. The Clean Vehicles Directive (2019/1161/EU) should also be revised to extend its scope to include off-road construction machinery, sending a direct market signal to manufacturers and procurement authorities across Member States.

Recommendation 3: Revise the NRMM Regulation to introduce a zero-emission pathway

The Non-Road Mobile Machinery Regulation 2016/1628/EU sets Stage V emission standards but contains no CO_2 targets and will not deliver the 2050 climate goals. The Commission should introduce a zero-emission supply roadmap, phased by equipment category and power class, beginning with lighter machinery and progressively covering heavier categories. The Dutch roadmap provides a proven model. Full phase-out of diesel-powered construction equipment should be scheduled for 2040 at the latest. This would give European Manufacturers the long-term certainty they need to invest in zero-emission production lines and reduce costs through serial manufacturing.

Recommendation 4: Leverage air quality and noise directives to require zero-emission equipment

The Ambient Air Quality Directive (AAQD, 2024/2881/EU) requires competent authorities in EU Member States to drastically reduce air pollutant emissions through action plans and roadmaps. Currently, construction machinery is largely overlooked by EU national and local authorities as a means to meet ever more stringent EU targets. The Commission should issue formal guidance to Member States requiring that air quality plans and roadmaps under the AAQD explicitly address construction-site emissions and consider mandatory ZECS requirements as a compliance measure.
The Commission should also support Member States in applying Directive 2004/37/EC (carcinogens and mutagens) to require zero-emission equipment wherever technically feasible, as the Netherlands has already initiated. Similar rules are found in Directive 2003/10/EC, on workers' noise exposure, and include provisions to minimise their harmful effects, including substitution.

Recommendation 5: Member States should include all lifecycles stages in the WLC limits under the EPBD

The Energy Performance of Buildings Directive 2024/1275/EU now requires Member States to develop whole-life carbon (WLC) roadmaps by 2027. Member States should include all life-cycle stages, including the construction phase, in the WLC limits under their national plans. Even though the Commission guidelines allow for cherry-picking of life-cycle stages, all Member States should make the construction stage a mandatory component of their WLC roadmaps, set ambitious thresholds, and align with the objectives of the Zero Pollution Action Plan.

Recommendation 6: Develop and publish an EU-level "Zero-emission Machinery Action Plan"equipment

Recommendations 1 to 5 each address a specific legislative or fiscal instrument. Their impact, however, will only be fully realised if they are pursued in a coordinated, sequenced, and mutually reinforcing way. The European Commission should develop and publish an EU Action Plan for Zero-emission Machinery, serving as the overarching delivery framework that integrates the preceding recommendations into a single, coherent programme with clear milestones. This Act would give industry, procurement authorities, and Member States the long-term certainty they need to plan, invest, and act.

4. Enabling Conditions: What Makes It Work

Legislative action alone is insufficient. Oslo's experience, and that of frontrunner cities across Europe, demonstrates that policy ambition must be matched by enabling conditions:

Grid capacity and energy planning: Power availability is the primary technical constraint. Grid upgrades must be planned in parallel with procurement requirements. Oslo worked closely with distribution and transmission operators to anticipate future demand. The EU Electrification Action Plan, European Grids Package, and the Alternative Fuels Infrastructure Regulation should explicitly address future NRMM power demand.

Market dialogue: Early, structured consultation with suppliers allows public buyers to assess technical feasibility, understand infrastructure constraints, and signal future demand. This de-risks innovation and improves bid quality. Preliminary market consultations are already supported under EU procurement guidance.

Data and measurement: Effective ZECS require clear definitions and measurable performance targets. The EU should support standardisation of data collection on construction-site emissions, energy use, and total cost of ownership, enabling evidence-based procurement and policy review.

Workforce skills: Electrification requires new competencies for operators, site managers, and procurement officers. Capacity-building programmes, peer-learning platforms (e.g. Big Buyers, NetZeroCities, Eurocities), and standardised training materials are essential, particularly for smaller municipalities and SME contractors.

Conclusion

The construction site can become a visible milestone of Europe's industrial and environmental ambitions. The five recommendations in this brief require no new laws: only the revision, strengthening, and consistent enforcement of tools that already exist, backed by targeted financial support. **The time to act is now.**

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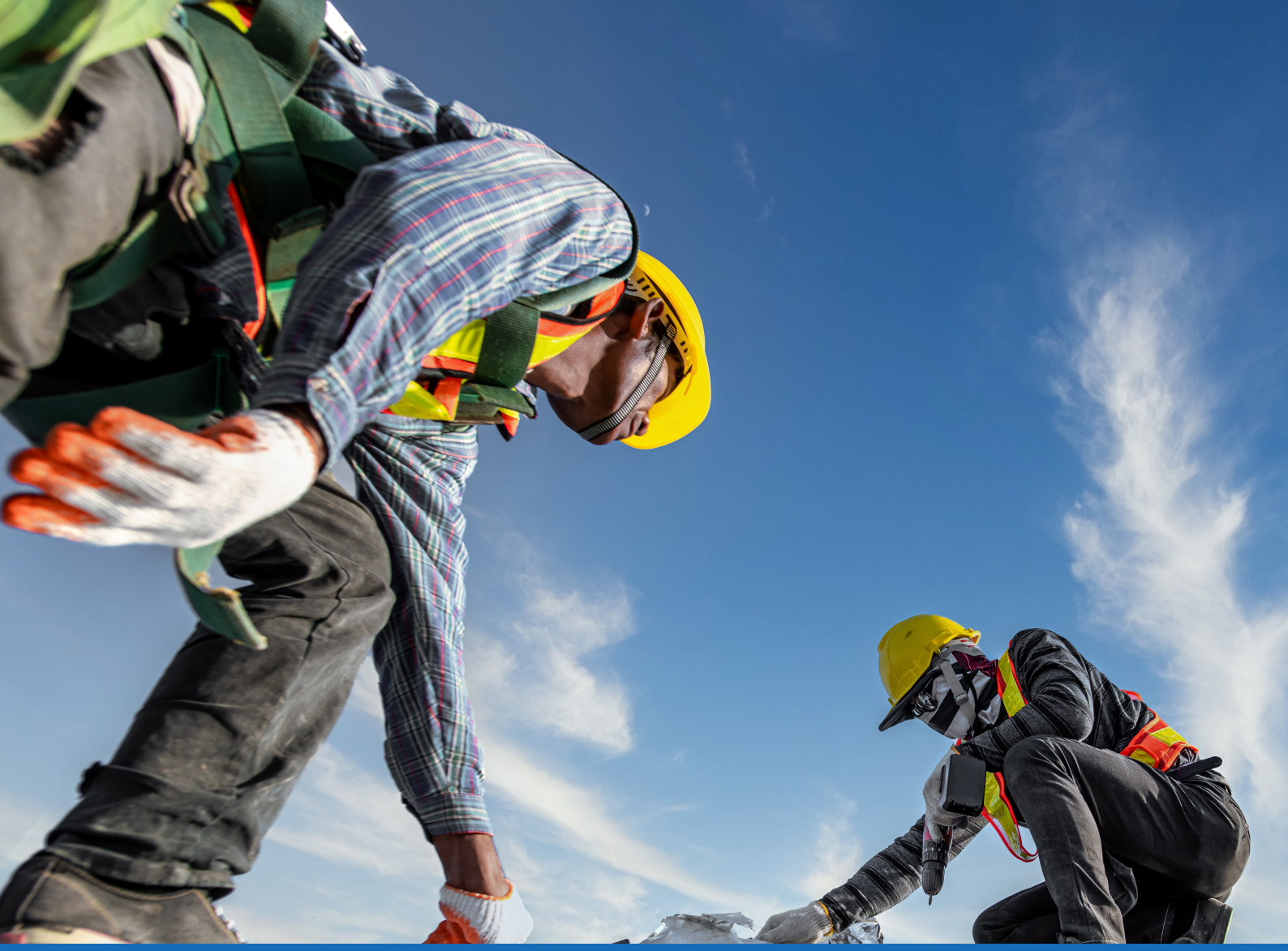

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