ZERO EMISSION CONSTRUCTION SITES: THE POSSIBILITIES AND BARRIERS OF ELECTRIC CONSTRUCTION MACHINERY

June 2018
Table of Contents

Executive Summary .................................................... 3

The Impact of Construction Machinery .......... 4
  Disruption ...................................................... 4
  Noise .............................................................. 4
  Air Quality ..................................................... 4
  Greenhouse Gases ............................................... 5

Benefits of Electric Construction Machinery .... 5
  Economic Benefits ............................................... 5
  Environmental Benefits ........................................ 5

The Barriers to Zero Emission Construction .... 5

Limited Policy Intervention .................................... 6

Current Policy Advances ........................................ 6
  Oslo ................................................................. 6
  London ............................................................. 7

Current Market Advances ...................................... 7

The Way Forward ................................................... 7

The Clean Vehicles Directive .............................. 8

Financial Support Measures ............................... 8

Infrastructure ...................................................... 8

Sustainable Batteries ....................................... 9

Conclusion .......................................................... 10

Authors:
Mark Preston Aragonès: mark@bellona.org
Teodora Serafimova: teodora@bellona.org

Disclaimer: Bellona endeavours to ensure that the information disclosed in this report is correct and free from copyrights but does not warrant or assume any legal liability or responsibility for the accuracy, completeness, interpretation or usefulness of the information which may result from the use of this report.

© 2018 by the Bellona Foundation. All rights reserved. This copy is for personal, non-commercial use only. Users may download, print or copy extracts of content from this publication for their own and non-commercial use. No part of this work may be reproduced without quoting the Bellona Foundation or the source used in this report. Commercial use of this publication requires prior consent from the Bellona Foundation.
Construction is a fundamental component of human civilisation. It lies at the heart of economic and social development. In fact, the construction industry generates roughly 9% of European GDP and accounts for 18 million jobs. In spite of this, construction sites are also a major source of environmental and human health damage throughout all aspects of the construction process. While it is well known that construction sites are the source of different forms of pollution – including material waste, visible dust, noise, and vibration – construction and demolition sites also produce less obvious pollutants which are of serious concern for human health, namely NO, and particulate matter. Combined with increasing urbanisation trends and a fast-growing global population, it goes without saying that construction is here to stay. This calls for the adoption of timely policies and measures at the local, national- and EU levels to encourage the transition to zero emission technologies and processes across the full construction supply chain.

A number of different pathways and tools exist to enable efficiency gains and emission cuts from construction site machinery, ranging from engine and machine component improvements; process optimisation; dedicated training of machine operators to reduce fuel use; to the deployment of alternative technological solutions such as electrification of the machinery. This paper only explores one of these, namely the potential of electrification, given that it holds the largest CO2 mitigation potential, while delivering significant environmental, human health and economic benefits. Here we take a closer look into the solutions which exist today, the current policy and market advances in this regard, and goes on to provide some forward looking policy recommendations, drawing on EU legislation that is undergoing reform, and pending transposition at national levels.

Executive Summary

Government expenditure on works, goods and services represents around 14% of EU GDP, accounting for roughly €1.8 trillion annually. This makes cities powerful actors in boosting demand for sustainable zero emission construction sites while building trust among consumers and creating certainty for industry to invest in low- and zero-emission products and processes. European and national policy must seek to capitalise on this potential through the following recommendations:

Incorporating Construction Site Machinery in EU ‘Green Public Procurement’ Legislation

The ongoing recast of the EU’s Clean Vehicles Directive (CVD) offers a unique opportunity to mandate the procurement of clean and zero emission construction site machinery by public authorities. Amending the CVD’s scope to include construction site machinery has already been acknowledged by members of the European Parliament and needs to be further supported by EU Member States as negotiations go ahead.

Bellona welcomes greater ambition level in the recast CVD reflected in a definition of ‘clean vehicles’ that is confined to ‘zero emission’ vehicles only. On this basis, the procurement targets set by the CVD need to be forward-looking, necessitating that all new vehicles procured by public authorities be zero emission by 2030.

Retrofitting plays a large role in electrifying construction machinery today and helps reduce capital expenditure. Therefore, the CVD review should also envisage the inclusion of retrofitted vehicles within its scope and count these towards the achievement of procurement targets.

Putting in place a coherent EU policy framework governing the procurement of construction machinery is key to lowering costs, and creating scale and demand for zero emission products.

Financial Support Measures

EU financial support will be crucial in supporting public authorities, contractors and companies in making necessary vehicle, infrastructure, and staff training investments. In order to help public authorities to achieve their procurement targets, Bellona supports the establishment of an EU platform for cross-border and joint procurement of zero emission vehicles and machinery covered within the scope of the CVD. By providing economies of scale, this helps to bring down compliance costs while helping smaller cities reap the benefits of electrified machinery.

Ensuring Environmental and Social Sustainability Across the Full Battery Supply Chain

The reform of the EU Batteries Directive if properly designed could provide the necessary impetus for the implementation of an effective battery collection and recycling system. This in turn will have to be accompanied by adequate incentives, and the deployment of a comprehensive network of collection points, transport- and recycling facilities.

Need for Targeted Investments in Infrastructure

Similarly to electric vehicles on the road, the electrification of construction site machinery necessitates investments into the deployment of suitably positioned recharging infrastructure. The Energy Performance of Buildings Directive offers synergies since it mandates the pre-equipping of new and renovated buildings with pre-tubing for EV charge points. The use of electric construction machinery supports the compliance of this directive in ensuring the installation of charging facilities during the construction process. All charging infrastructure installed should be capable of modulating the charging process in reaction to price and grid signals.
The Impact of Conventional Construction Machinery

Disruption

Building and construction activities today are mainly diesel-powered, whether it comes to digging, loading, moulding or sheet piling. As a result, they cause disruption, increased traffic jams and related exhaust emissions, particularly in densely populated city centres. Large public works also have a tendency to be around for extended amounts of time. The city of Brussels, for instance, currently has 7 public construction sites underway (as of 4/5/2018) lasting between 6 weeks for minor reconstruction to over 2 years for reconstruction of a large section of roads and pavements. These can be delayed by weather events, such as heavy rain or strong winds, and technical issues, such as machinery downtime. There is also a possibility that construction machinery in the Brussels Low-Emission Zone would have to grind to a halt when air pollution reaches a level deemed as dangerous. The extent and duration of the inevitable disruption caused by construction sites clearly calls for measures to minimise noise and air pollution stemming from them. The fact of the matter is that disruption caused by construction machinery is inevitable, but the emissions produced by them are not.

Noise

Conventional construction machinery is notoriously loud and produces vast amounts of emissions, negatively affecting the wellbeing of both the neighbourhood and that of the workers on site. Even though much of the noise relates to ‘impact equipment’, a significant amount of noise can be attributed to ‘non-impact equipment’, from pumps, generators, compressors, and engines. This may come from activities such as generating electricity through diesel pumps, heating or drying of materials, and traffic to and from the site. The human health impact of noise can provoke restlessness, headaches, inadequate sleep, and nervous and cardiovascular diseases. According to the European Environment Agency, exposure to environmental noise contributes to at least 900,000 additional cases of hypertension, 43,000 additional hospital admissions and up to 10,000 premature deaths, each year. A recent study suggests that noise pollution in Barcelona is responsible for more deaths than other forms of pollution.

The harm to human health also has a subsequent effect on labour productivity and economic growth. For example, GDP losses in Czechia resulting from this are estimated to be between 1.7% and 2% of GDP. This diverts significant financial resources away from health care, education and not least environmental and climate protection.

Air Quality

A significant side-effect of construction is the emission of exhaust fumes from machinery. In London, construction sites are responsible for around 7.5% of the city’s NOx emissions, 8% of large particle matter PM_{10} and 14.5% of fine particle matter PM_{2.5}.

It must be noted that PM_{2.5} fine particles are especially dangerous due to their ability to deeply penetrate the human body, causing increased mortality from respiratory and cardiovascular diseases and from lung cancer. The elderly and children are particularly vulnerable to develop the aforementioned health issues. This is particularly alarming in light of recent findings that children in London schools are being exposed to higher levels of health-damaging air pollution than inside the classroom than outside, as a result of outdoor air pollutants penetrating buildings.

Furthermore, the WHO warns that there is no evidence of the existence of a ‘safe level’ of exposure at which no adverse health effects occur. This demonstrates the need to push for ‘zero emissions’ as opposed to simply ‘low emissions’. Meanwhile, air pollution is already a major problem in European countries, where around 500,000 people die prematurely every year because of dangerous air quality. Both the cost to human life and the cost to productivity should already provide a large incentive for rapid and deep improvements in the current policy framework in the EU, which is both lacklustre and improperly enforced.

ZERO EMISSION CONSTRUCTION SITES: THE POSSIBILITIES AND BARRIERS OF ELECTRIC CONSTRUCTION MACHINERY
Greenhouse Gas emissions

In light of anthropogenic climate change and the widely agreed target to decarbonise all economic sectors by mid-century, addressing the greenhouse gas emissions of construction sites is key to mitigating the human impact on the climate. Nonetheless, the primary source of greenhouse gas emissions on construction sites is the exhaust fumes of machinery.

In Oslo alone, 18% of its total greenhouse gas emissions originate from construction sites, accounting for approximately 30% of traffic emissions. This is greater than the entirety of the city’s emissions from passenger cars and light duty vehicles, while also emitting an extra 5.1 tonnes of NOx. In Germany, emissions from construction machinery exceed those derived from domestic rail and air transport combined (Figure 1).

![Figure 1. German CO2e emissions from construction machinery (in yellow) are higher than those from domestic air and rail travel (red and blue respectively). Source: UNFCCC 2015](image)

Benefits of Electric Construction Machinery

There are multiple benefits and co-benefits to electrifying construction site machinery, both at the societal level and at the consumer level.

Economic Benefits

Firstly, investing in electric engines makes economic sense, as these result in much lower operational costs. Fuel, being one of the highest input costs in construction processes, means that manufacturers have an important incentive to come up with innovative solutions that reduce fuel consumption while ensuring a high performance of the machines as well as compliance with ever stricter exhaust emission limits at the same time. Improving fuel economy has been, and will continue to be, one of the main drivers for innovation. Electrification offers a promising solution here.

Volvo, for instance, estimates that its prototype electric excavator will be 10 times more energy efficient than a conventionally powered one. Moreover, a test of the prototype excavator showed that over the course of 10 weeks of operation, a 25% reduction in costs and a 95% reduction in CO2 emissions were observed. A Hitachi report, on the other hand, states that the “proportion of useful energy available for performing work [with a conventional hydraulic excavator] is less than 10% of the energy in the fuel”. The use of electricity thus reduces energy costs and the dependence on a volatile fossil fuel price. Moreover, Hitachi also claims that the electric motor provides efficiency gains compared to the hydraulic motor, because of the high level of control responsiveness and high drive and transmission efficiencies. Associated to this point, the fact that there are less moving parts in electrically powered machinery also results in less wear and tear and a subsequent reduction in downtime, thereby further improving productivity. This may also help alleviate disruption in cities since machinery is less likely to break down and delay works.

Environmental Benefits

Electric machinery also does not produce waste, such as engine oil or filters, which makes them an important component of the EU’s circular economy and sustainable construction strategy, seeking to reduce waste from the construction industry. The lack of an exhaust means machinery can be used indoors, which is more convenient for workers and increases the productivity of the construction site. Last but not least, electrifying NRMMs significantly reduces noise levels. This is of great benefit for works undertaken next to sensitive areas, such as schools and hospitals, and allows contractors to work after normal hours in urban streets without disturbing residents. UK-based heavy equipment manufacturer JCB, for instance, claims that its first electric excavator, the 19C-1 E-Tec mini-excavator, is roughly 5 times quieter than its diesel-powered counterpart –with external noise 7 dBA lower. It is demonstrable that the development of zero emission construction sites presents a net benefit to both society and the operators of the machinery.

Last but not least, similarly to electric vehicles, electrically powered construction site machinery has the potential to become a source of flexibility for the electricity grid through smart charging and demand response services. This will help promote the wider integration of renewable energies in the grid, thus contributing towards the attainment of EU climate objectives, while further improving the environmental performance of electric construction machinery vis-à-vis fossil counterparts.

The Barriers

There are still some issues which need to be overcome before electric construction machinery can become the norm. There are also commonly used arguments against the wider adoption of electro-mobility which may resurface when promoting the electrification of machinery and equipment.

Capital Expenditure

Firstly, the high capital cost of electric machinery makes it near-prohibitively expensive for small to medium sized companies and contractors. The cost of developing new technologies and building the infrastructure cannot feasibly be borne by small and medium sized companies. The higher upfront cost of purchasing electric machinery will require financial assistance or schemes. Furthermore, despite the certainty that operating costs are lower and purchase costs are higher, a recent Volvo statement stipulates that while the Total Cost of Ownership of electric machinery will...
undoubtedly be lower, the complexity of calculating these will be just as great, if not more so. This is due to operational changes, since operators will have to account for charging requirements, the highly variable cost of electricity, battery life and replacements costs, as well as the maintenance of electric motors.

**Lack of Policy**

Secondly, the current gap in policy regarding construction emissions means contractors and manufacturers lack the clarity and guidance necessary to encourage rapid innovation towards sustainable solutions. The efforts in the City of Oslo, detailed below, show that making clear and decisive political decisions foster innovation and can allow industry to transition to zero emissions with certainty. However, no EU city currently encourages the procurement of zero emission construction machinery, which helps explain why no manufacturer provides electric machinery for the European market, other than the Nordic NASTA, PON, Volvo, and Wacker Neuson, who have significant presence in Norway. As such, a major barrier to the deployment of electric machinery is the lack of political drive and certainty in the development of the solutions to poor air quality and emissions from construction sites.

**Battery Technology**

Thirdly, the technology for providing fully electric and battery powered heavy duty machinery will require further technological improvements and is yet to meet parity with conventional powertrains. This question also exists regarding buses. Nonetheless, significant advancements have happened thanks to political support and city initiatives to trial the use of electric buses, such as the ZeEUS Project which successfully demonstrated that electric buses can operate with very little disruption to the service. It is clear that such partnerships between broad sets of stakeholders can help identify problems and solutions in electrification.

**Economies of Scale**

Fourthly, as is the case with almost all new technologies, there is a challenge relating to the economies of scale. The production cost per unit is highly dependent on the ability to mass produce, which makes it difficult to break into a new market and compete with already existing and cheaper technologies. Varying requirements according to different local authorities may complicate the possibility of making zero emission construction sites affordable. This will need to be addressed through standardisation and interoperability.

**LIMITED POLICY INTERVENTION**

Despite the overwhelming evidence exposing the numerous environmental and human health impacts of conventional construction machinery, there is very little policy regulating it to date. In some cases this type of machinery is specifically exempted from blanket regulations, such as in London’s ‘Ultra Low Emission Zone’. While sustainable construction is becoming an increasingly salient issue, policy mostly relates to the environmental footprint of buildings and their materials, thus regulations specifically tackling emissions from construction site machinery are lacking. This was concurred by a representative from the European Commission during who participated in our event.

As of January 1st 2017, the EU’s 2016/1628 Regulation, imposes emission limits and type-approval requirements for engines used in Non-Road Mobile Machinery (NRMM) with the intention of “stimulating innovation, improving air quality, reducing health costs and increasing life expectancy.” The regulation progressively reduces air pollutant emissions, thus phasing out equipment with the most polluting engines over time. Among the broad range of machinery covered in this regulation are construction machinery such as excavators, loaders, and bulldozers, among others.

Nonetheless, despite the value of emission standards in improving air quality, the ideal quantity of emissions is to have none. Therefore, in combination with stricter standards, there is also a need to incentivise and push the market towards adopting the use of zero emission NRMMs through more direct measures such as public procurement, which will create a market for industry actors to seize.

Local governments have often taken the lead on this issue, but more must be done at the national and European levels for policy to be successful and progress coherent Europe-wide. For example, despite the City of Oslo being at the forefront of zero emission construction sites via public procurement standards, the local municipality has limited agency in setting environmental requirements, since it must also follow national policy. Thus, the interaction between local, national, and European policy needs to be considered. However, the current lack of national policy on construction site emissions risks undermining the climate impact of cities’ efforts at a national level. Since cities have different requirements, expecting local administrations to regulate construction site emissions could force contractors and manufacturers to comply with a plethora of different requirements within the same country, which is less cost effective than a standardised national or European rule.

**CURRENT POLICY ADVANCES**

**Oslo**

The City of Oslo has taken ambitious steps towards achieving zero emissions in most of its economic sectors. The city’s operator of kindergartens and sport arenas, Omsorgsbygg, currently has a public procurement standard for its tenders which aims for fossil-free construction sites. As a result, four kindergartens and two sports arenas are currently under
construction using fossil-free machinery when possible. This project has proven that electric machinery exists on the market and can be used for the construction of large projects such as public venues. As such, during Bellona’s EU Greenweek partner event, Lene Lad Johansen, project manager for Smart Oslo and a knowledgeable voice on the topic of zero emission construction sites, concluded her presentation on Oslo’s policy developments with the inspiring words ‘We have stopped walking and have started to run’.

Bellona has partnered with manufacturers and the Oslo City Council within the so-called pilot-e projects for the production of zero emission diggers, concrete mixers, and pumps. The use of electric diggers in Oslo is expected to save around 100 tons of CO₂ every year. There is a complementary project for zero emission transport of cement from the production facility to the refining facility. As such, collaboration between local policy-makers, industrial actors, and civil society, is helping to develop innovative technologies to comply with Oslo’s procurement standards.

London

The Greater London Authority is another pioneer when it comes to tackling construction site emissions. While construction machinery is exempted from the ULEZ, emissions and dust guidelines were published to inform local councils on how to regulate it. The ‘Supplementary Planning Guidance’ sets several recommended mitigation measures and values their expected effect. However, only one measure encouraged zero emissions; avoiding the use of diesel or petrol powered generators and use mains or battery powered equipment where possible. This is a strong and valuable recommendation, despite the fact that councils have the option to ignore the advice. Other recommendations simply offered incremental efficiency gains and emission standards which offer ways to reduce environmental damage without actually solving the issue. More must be done in order to meaningfully push towards emission-free construction sites.

CURRENT MARKET ADVANCES

Several manufacturers have anticipated an evolution in construction requirements, with Volvo, Wacker Neuson, and PON all explicitly mentioning that the likely advent of ever-stricter LEZs and green public procurement requirements in most major cities as a reason to develop electric machinery. As such, a handful of companies already have electric construction machinery available on the market. Wacker Neuson, which provided the equipment for the maintenance of Munich’s indoor Olympic swimming pool with the world’s first electrically-powered rammer, has a line of so-called ‘ECO’ products which are either hybrid or fully electric. Its own financial reports state that revenue from this line of products increased by 50% in the past year. A Wacker Neuson representative at our event in May 2018 mentioned that while their ECO line were not yet best sellers, the market was gaining momentum in the Benelux, Germany, Austria, Switzerland and the Scandinavian countries.

PON, the Nordic distributor of Caterpillar products and a partner in the Pilot-e project, now produces a battery powered excavator and has developed a kit to retrofit other models. NASTA, a Scandinavian distributor for Hitachi, has also developed a model of electric excavators, as well as an electric salvage machine which primarily operates indoors, thus not requiring a battery. The company also produces a large hybrid dump truck, using a pantograph to go uphill faster than it would running on diesel, presenting productivity gains. Recently, JCB developed its own electric excavator, citing advantages for the rail industry which can now use electric diggers instead of installing ‘costly exhaust extraction equipment’ when working in tunnels or underground.

Another interesting development, is the use of cabled machinery for processes which do not require much flexibility. Some mining machinery uses a pantograph to power the engine on the way up, which then does not need much power on the way down. Additionally, the indoor salvage machinery is an example of a cabled system which eliminates the need for batteries, thus substantially reducing the capital cost of electric equipment.

Clearly, the market is already producing electric machinery due to its economic and practical benefits and in anticipation of the likely tightening of green public procurement standards and emission limits. While the industry is demonstrating a clear interest in developing this technology, which is still quite niche, EU and national policy needs to provide clear signals to the industry that pollution from construction machinery should be an issue of the past.

WHAT IS THE WAY FORWARD? BELLONA POLICY RECOMMENDATIONS AT EU AND NATIONAL LEVELS:

The introduction of an overarching EU policy and financial support framework is crucial to addressing the aforementioned barriers relating to cost, technology maturity and scale.

Government expenditure on works, goods and services represents around 14% of EU GDP, accounting for roughly €1.8 trillion annually (figure 2). This makes cities powerful actors in boosting demand for sustainable zero emission construction sites while building trust among consumers and creating certainty for industry to invest in low- and zero-emission products and processes.
Incorporating construction site machinery in EU ‘green public procurement’ legislation

The ongoing recast of the EU’s Clean Vehicles Directive (CVD) offers a unique opportunity to mandate the procurement of clean and zero emission construction site machinery by public authorities. While the scope of the existing legislation has to date been limited to light- and heavy-duty road vehicles, there is a clear rationale to expand its provisions to non-road vehicles in order to further reduce urban dwellers’ exposure to health damaging levels of air and noise pollution. The extension of the CVD’s provisions to construction site machinery has already been acknowledged by members of the European Parliament and needs to be further supported by EU Member States as negotiations go ahead.

In general, Bellona welcomes the European Commission’s legislative proposal for the revised CVD and sees it as offering a number of improvements, in terms of general simplification and enhanced ‘user friendliness’ of the directive; inclusion of a definition for ‘clean vehicles’; introduction of minimum procurement targets; and extension of its scope to include a wider range of vehicle categories.

Furthermore, procurement targets need to be underpinned by fair tendering procedures which take into account not only TCO, but also other machinery characteristics, such as accessibility, insertion in urban landscape, noise levels, energy efficiency as well as recyclability of batteries and components, using the most economically advantageous tender (MEAT) criterion. The city of Oslo has already successfully demonstrated the benefits of applying the MEAT criterion in its procurement practices aimed at promoting clean construction. To stimulate clean construction of social buildings, such as schools and kindergartens, Oslo’s procurement criteria allowed for lower emissions to be weighted 17.5% in the tender scoring and price was a maximum of 30%. This procurement strategy included a risk management approach that placed more risk on the building owner, which encouraged the appetite of the market to innovate. This example shows that using the MEAT principles in procurement can drive value for money, while delivering significant environmental benefits.

Given the fact that provisions under the CVD would only apply to newly procured vehicles, as opposed to all existing fleets, and in light of rapid advancements in EV and battery technologies in terms of cost and performance, Bellona welcomes greater ambition level in the recast CVD reflected in a definition of ‘clean vehicles’ that is confined to ‘zero emission’ vehicles only. This is furthermore justified by the fact that public authorities across the EU would only have to take measures to come into compliance with procurement targets as of 2025 and 2030.

As elaborated in the previous sections, electrification is rapidly becoming a viable decarbonisation option for the heavier transport modes too, with key actors in the construction industry following suit.

Moreover, the recast CVD should also envisage the inclusion of retrofitted vehicles and machinery within its scope and therefore allow these to count towards the achievement of the 2025 procurement targets. Retrofitting plays an important role in the electrification of construction site machinery today, in enabling a shift towards cleaner technologies, while securing significant savings in capital expenditure. Some equipment importers operating in Europe such as PON Equipment – importers of Caterpillar – retrofit conventional machinery into electric. Retrofitting such machinery thus enables an accelerated introduction of cleaner solutions. While not easily regulated at the EU level, national and city governments should put in place ‘scrapage schemes’ to incentivise the retirement of the most polluting machinery.

What is more, there is a growing tendency towards hiring as opposed to purchasing. As the machinery is becoming more specific in terms of functions and uses, it has also become more expensive. As such, contractors avoid purchasing machinery which will remain unused for periods of time. Machinery that is hired is generally used for more hours in a year than purchased machinery. This means that since fleet renewal of construction machinery is becoming faster, there are more opportunities to regulate and push for greater ambition.

Putting in place a coherent EU policy framework governing the procurement of construction machinery is key to lowering costs, and creating scale and demand for zero emission products.

Financial support measures

In addition to bold procurement targets, EU financial support will be crucial in supporting public authorities, contractors and companies in making necessary vehicle and infrastructure investments as well as re-training staff involved in the operation and maintenance of zero emission machinery and vehicles. In order to support public authorities in the attainment of their procurement targets, Bellona furthermore supports the establishment of an EU platform for cross-border and joint procurement of zero emission and energy-efficient vehicles and machinery covered within
the scope of the CVD. This platform shall be publicly accessible and bring together all actors interested in pooling their resources and creating economies of scale. Moreover, and very importantly, such a platform shall promote multi-stakeholder collaboration and ensure minimum requirements are put in place to prevent the exclusion of SMEs from tendering processes.

**Need for targeted investments in smart and future-proof recharging infrastructure**

Similarly to electric vehicles on the road, the electrification of construction site machinery necessitates investments into the deployment of suitably positioned recharging infrastructure. This of course, will entail better planning to factor in the recharging needs of the electric machinery. To facilitate this, the provision of electricity and district heating (which will eventually be entering the building) to the designated construction site prior to the works kicking off will be key.

New EU buildings legislation is already anticipating the needs of an ever growing electric vehicle fleet. Late last year, EU policy makers struck a deal on the new Energy Performance of Buildings Directive (EPBD) which mandates that buildings be pre-equipped with a minimum level of electric vehicle charge points or mere conduits for their later installation. This provides greater rationale for builders to consider electric options for the construction machinery and exploit synergies, given that newly built- and substantially renovated -buildings shall have to comply with charging infrastructure requirements as soon as the directive enters into force.

In order to ensure electric construction machinery works in harmony with the grid all charging infrastructure installed should be capable of modulating the charging process in reaction to price and grid signals. The introduction of dynamic electricity pricing to stimulate demand response as well as ‘vehicle to grid’ mechanisms in the longer run will be key to mitigating the burden on the grid during peak hours, while further reducing operational costs (via reduced electricity bills) of electric construction machinery. Consequently, future EU funding instruments such as the Connecting Europe Facility (CEF) and Structural and Investment Funds should ensure that electrification projects of construction machinery are eligible for support.

**Ensuring environmental and social sustainability across the full battery industry value chain**

Continuous technological advancements coupled with over 79% drop in battery prices since 2010 have placed electrification as a viable solution for light duty vehicle segment. The electrification of heavier transport modes, including trucks and construction site machinery, will require us to look beyond the conventional lithium ion battery technology. And Bellona is already part of this in Norway, where Bellona Holding’s BEBA company has teamed up with industrial actors and academia to research and further develop next-generation lithium-sulphur batteries with graphene. These hold great potential in terms of doubling today’s battery capacity, prolonging battery lifetime, lowering cost and very importantly reducing negative impacts on the environment as the raw materials used to produce these, namely graphene and sulphur, are present in high abundance locally in Norway (which in turn helps in overcoming issues of reliance on critical raw materials like cobalt). The combination of these characteristics makes sulphur-based li-ion batteries particularly suitable for applications in heavier construction site machinery. While these hold enormous promise, their commercial application requires EU policy and financial support. This should be reflected in the ongoing work streams of the EU battery initiative.

As this paper makes clear, electrifying construction machinery and equipment will result in significant environmental and human health benefits, as well as economic gains for the industry itself. Nonetheless, a shift towards battery electric solutions in the construction industry will inevitably also entail higher demand for lithium and other critical raw materials. This calls for the introduction of minimum standards to ensure that lithium extraction worldwide is both socially and environmentally sustainable. The Initiative for Responsible Mining Assurance (IRMA) is a good initiative in this regard which should be further supported.

The battery accounts for roughly 35-55% of the total electric vehicle production costs, and thus is the determining factor in their still higher initial purchase price as compared to conventional vehicles. To reduce costs of electrified construction machinery, Wacker Neuson manufactures standardised batteries which can be fitted into both its electric rammer and vibratory plate products. Encouraging the wider standardisation of batteries could enable the lowering of the purchase price of electric machinery and subsequently aid the deployment of large-scale battery recycling facilities.

On this note, while in the short- to mid-term used batteries from the construction and automotive industries may have useful secondary applications for stationary energy storage, recycling will have a growing role to play in recovering critical raw materials. Today recycling of lithium is expensive, facilities underdeveloped, and recovery rates low. In fact, as little as 5% of lithium-ion batteries are recycled in the EU today, the majority being dumped in landfill or incinerated instead.

The existing EU Batteries Directive design does not provide an adequate impetus to overcome these hurdles. Its upcoming revision should take into account developments relating to traction batteries used in the automotive and construction industries by introducing dedicated and ambitious collection and recycling targets per raw material. This is paramount to increasing the recovery and re-use of critical raw materials, and reducing Europe’s dependence on imports from vulnerable regions. The implementation of an effective battery collection and recycling system will have to be accompanied by adequate incentives, and the deployment of a comprehensive network of collection points, transport- and recycling facilities.

As outlined above, the construction industry carries a heavy toll on the health of people and our planet. This heavy external cost is unaccounted for in the highly biased diesel taxation regimes throughout Europe and thus does not
provide a sufficient incentive to switch to electricity. The upcoming reform of the EU Energy Taxation Directive is an opportunity to rectify these imbalances by reducing electricity taxes, and thereby helping to overcome competition from duty-free diesel, and conversely introducing higher taxes for diesel.

CONCLUSION

The electrification of construction machinery can help the EU to deal with multiple challenges. The need to decarbonise all economic sectors by 2050 to stay below the agreed 2°C target and reduce the human impact on the climate; the need to address a growing public health crisis which is heavily linked to rising ambient air and noise pollution; and the need to tackle ever-growing emissions from the transport sector. The impact of conventional construction machinery has been established, as well as the benefits of electrifying these to reduce noise, air pollution, and greenhouse gas emissions.

Industry actors have confirmed both the technological feasibility as well as their appetite in transitioning towards zero emission construction machinery. A key pre-condition to enabling the shift from niche to norm is the provision of an adequate EU regulatory framework, composed of both push and pull factors, as well as sufficient financial support measures. As such, the EU must use the available mechanisms and tools to encourage the development of a new, disruptive technology in electric construction machinery.
The Bellona Foundation is a multidisciplinary international environmental NGO based in Oslo, Norway. Founded in 1986 as a direct-action protest group, it has since blossomed into one of the world’s most recognized technology and solution-oriented environmental champions with offices on two continents. There are altogether some 40 ecologists, nuclear physicists, engineers, economists, lawyers, advisors and journalists working at Bellona.

The Bellona Foundation is financed by industry, business and individuals as well as through project-orientated grants from philanthropic organisations and the Norwegian government.

Throughout our offices, located in Brussels, Murmansk, Oslo, St. Petersburg, Bellona works with relevant governments, experts and other NGOs in achieving sustainable solutions to the world’s most pressing environmental problems. These include fighting global warming, the clean-up after the Cold War legacy in Russia and the safety of the oil and the gas industry in Europe. The work is carried out through information dissemination, lobbying and campaigns directed at local and governmental levels. Bellona publishes its findings on the Bellona web site in order to inform and educate the public about the environment in which it lives.

Contact

Jonas Helseth, Director, Bellona Europa
jonas@bellona.org

Teodora Serafimova, Policy Manager
teodora@bellona.org

Mark Preston Aragonès, Policy Assistant
mark@bellona.org

Bellona Europa,
15 Rue d’Egmont
Brussels 1000
Belgium

bellona.org @Bellona_EU