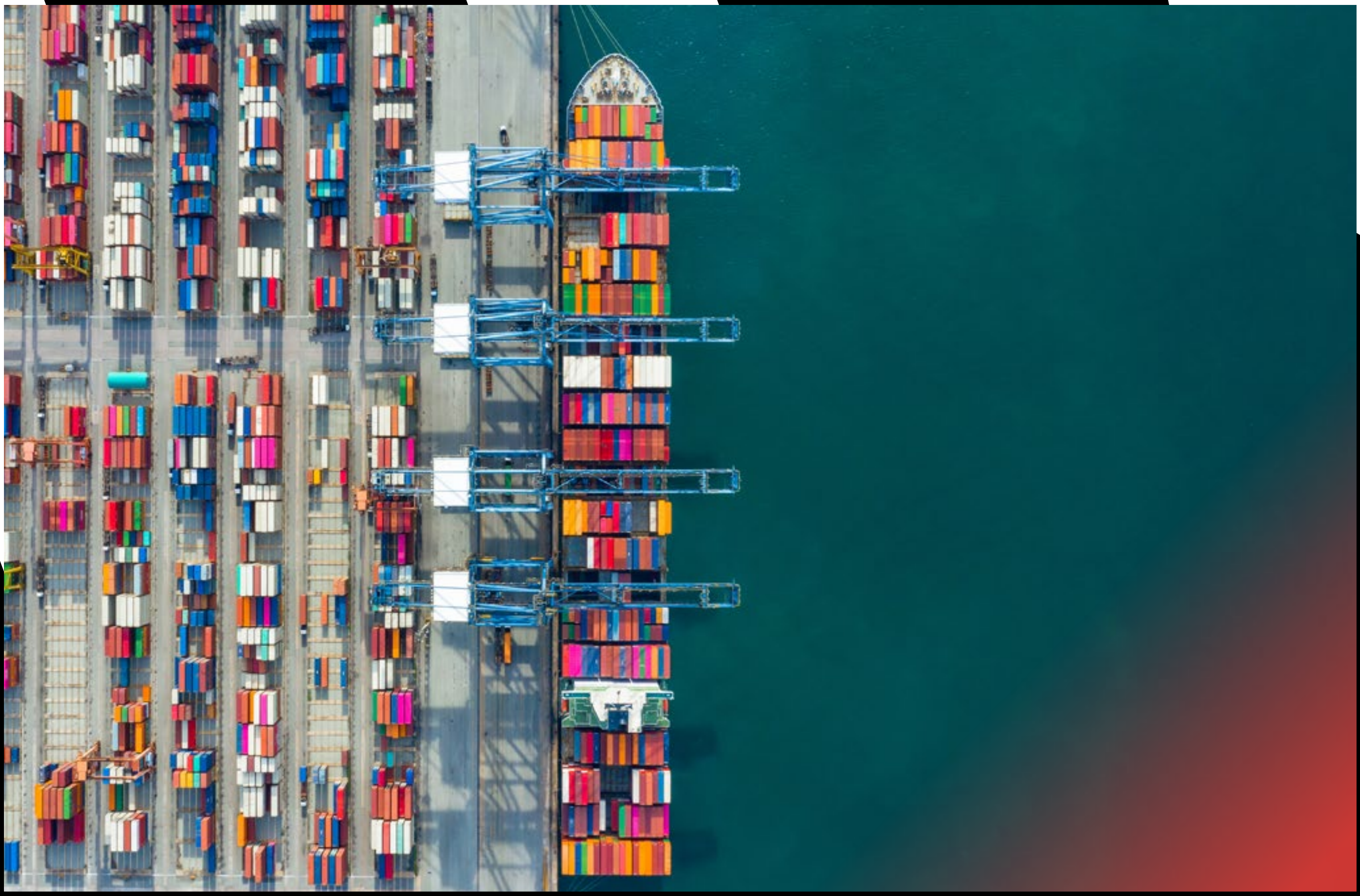

PORT ELECTRIFICATION FOR CONTAINER OPERATIONS AND VESSELS

Key considerations to scale up decarbonization efforts

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Electrical power is essential in the shift to a more modern, efficient and sustainable shipping industry. Dry and liquid bulk operations have been running on electrified equipment for decades, and the same applies to the naval defense sector with regards to providing vessels with shore power. More recently, port electrification has increasingly involved container terminals; this process entails converting all existing operations that rely on fossil fuels to an electric-powered operation—in other words, shifting from the traditional pool of diesel-powered container handling equipment, commonly used for moving and storing the containers in the port, to modern electric equipment.

Ports can take this concept to the next level, to provide shore power to vessels at a much larger scale than previously done, such as to container vessels that may contain thousands of refrigerated containers or cruise vessels that have an electrical consumption on the same scale as a small city. In this scenario, vessels connect to an electrical power source on the landside, enabling them to turn off their diesel-powered engines while berthed at the port.

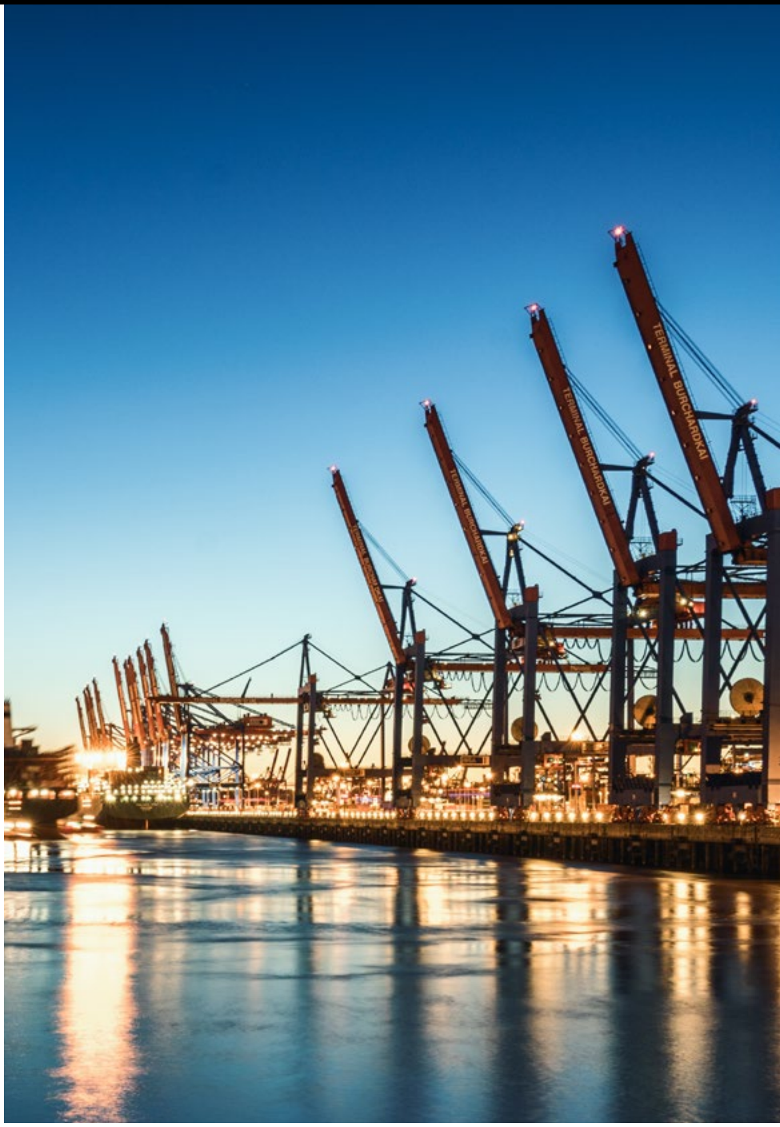
This article focuses on factors for scaling up electrical power at container terminals and explores how naval defense infrastructure experience can inform the process.

Backdrop

The port industry, in addition to many other industries and governments, is following the global trend of taking responsibility for the consequences of their activities and aiming to reduce or offset the carbon footprint involved with the cargo handling at the ports.

Normally by electrifying operations, port-related emissions tend to be reduced, depending on the source of electricity of the country or region where the site is located; also, on many occasions, electrification allows ports and terminals to choose a more sustainable, or renewable, source of energy to be used for its operations. This might come at a cost, but it is a cost that many terminal operators are willing to bear to be able to achieve zero emissions.

Another factor that raises the importance of reducing greenhouse gas (GHG) emissions is the fact that ports are often inside the city or close to it; this port-city proximity potentially presents the issue of localized emissions, in addition to other issues such as noise. This location near populated areas, in tandem with the drive toward global sustainability, weighs on the industry and pushes for more ambitious targets in relation to corporate social responsibility and environmental concerns—so, electrification also becomes a tool to reach those goals.



Key Factors

Stakeholder Buy-in

A combination of factors is usually required to enable the implementation of electrified solutions; the top areas are stakeholder buy in, upfront investment or long-term vision that enables electrification, and stakeholder collaboration.

Port stakeholders, mainly terminal operators and port authorities, need to truly believe that electrification is the way forward to achieve the desired results—be it carbon emissions reduction, efficiency gains, reduction of operational costs, automation, as well as other outcomes, either individually or altogether.

Electrifying container port equipment is sometimes directly linked with automation as a combination of electrical equipment and automated operations at ports can bring multiple benefits, such as a decrease in the risk of accidents, and thus increased safety, as well as the reduction of air and noise pollution; these positive outcomes complement the broader worldwide goal of GHG emissions reduction toward net zero.

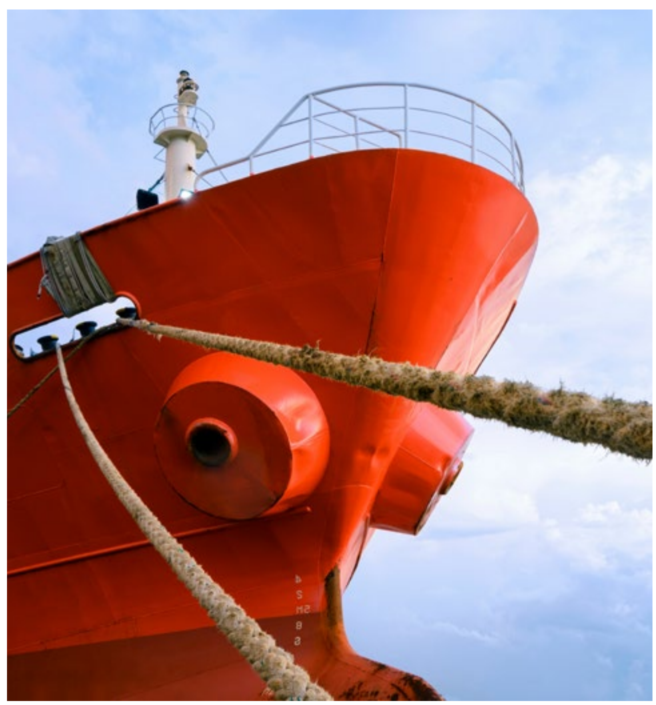
Once electrification is part of the stakeholders' strategy, implementation can begin with well-established equipment options, such as electric rubber-tired gantry cranes (eRTGs), which are increasingly being adopted worldwide; at the same time, newer options should be considered to support broad electrification solutions. However, for the parts of the industry that are still being tested such as horizontal transport—terminal tractors, straddle carriers and shuttle carriers—there is more resistance from terminal operators; they have a risk aversion to committing to an equipment option that may still require a considerable amount of development and learning. Therefore, terminal operators must be open to include, as part of their strategic plans, pilot tests on specific sites to help develop these new equipment alternatives and enhance existing ones toward greater reliability.

Collaboration

Collaboration between port stakeholders and those outside of the port—including equipment manufacturers, energy providers and government agencies—also plays an important role for some aspects of port electrification. In the case of providing shore power to the vessels (also called cold ironing), for example, this collaboration is essential to ensure that the infrastructure and technology required are developed, deployed and operated in a coordinated manner, satisfying regulatory frameworks that apply to all parties involved.

Upfront investment, Long-term vision

Another factor, and also the main challenge, for port electrification is the financial barrier due to high upfront costs. An alternative is to have a long-term vision for developing new infrastructure; if not possible to commit to this investment early on, ports and terminals should make conscious planning decisions to allow for eventual electrification. This can be done in different ways, such as allowing sufficient space in the layout for specific electrified equipment or reserving areas for future electrical infrastructure. The goal is to develop plans that do not prevent a conversion—in other words, those that enable Future Ready®[1] solutions.



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1 Future Ready® is WSP's global innovation program that seeks to better understand the key trends in climate change, society, technology, and resources and how they are impacting our world, locally and globally. Future Ready® is a registered trademark of WSP Global Inc. in Canada and New Zealand. WSP Future Ready (logo)® is a registered trademark of WSP Global Inc. in Europe, Australia and in the United Kingdom.

Challenges

Investment, Standards, Guidelines

Running an electric terminal and providing cold ironing to multiple vessels simultaneously can strain the electrical capacity of the port, requiring high investment to provide a robust electrical system. Besides the high upfront investment required to bring electrified solutions, another key challenge is lack of standards and guidelines to support the ongoing development of new equipment. For example, with cold ironing, there might be compatibility issues where the electrical power supply systems have different requirements, voltage levels and frequencies, and positions to connect the vessel to the shore power plug; these challenges may require significant modifications on the landside.

Stakeholder Engagement

Supportive regulatory frameworks are needed to stimulate the implementation of electrified solutions. Given the large number of stakeholders involved to develop these frameworks, the public nature of stakeholder engagement and the planning required to implement solutions, progress might not occur at a pace that satisfies many operators. In turn, this slow process brings an additional challenge relative to mapping and controlling aspects that are outside the port operators' reach. Such uncertainty can stand in the way of adopting new technologies during the planning stages of new port projects.

Infrastructure

Regarding the infrastructure aspect, many ports are brownfield and therefore already have an existing infrastructure that was designed for diesel-powered operations; adapting this infrastructure to serve an electric operation also calls for considerable modifications. As an example relative to vessels, in the US state of Washington, traditionally diesel-powered automobile ferries are slated to be replaced with electric-powered vessels to promote decarbonization. Work is underway to design and construct the necessary infrastructure to allow for charging vessel batteries when at berth. In many ports, highly congested subsurface pathways add a challenge to the installation of new infrastructure due to many decades of development along waterfront properties.

Solutions

Leverage Technical Experience

Providing shore power for large vessels is not new. The US Navy has been successfully providing shore power for vessels for decades, including the infrastructure, hardware and connections needed for low- and medium-voltage shore power. WSP has been involved in shore power designs and has supported construction of associated Navy projects since the 1970s. Vessels at these berths include submarines, aircraft carriers and many other large surface vessels. Such projects have entailed multiple challenges, which have been met, among them maintaining connections in areas of the world where high tidal exchanges occur. The commercial maritime industry stands to benefit from lessons learned over the years from naval defense projects as well as current technology use shoreside by the US Navy in the move to change over commercial vessels from diesel to electrical power while at berth.

Informed Decision-Making

When considering port electrification projects, the port authorities and terminal operators should develop programs that include appropriate port and terminal master planning. Planning should go beyond a flexible layout to encompass suitable equipment and technologies that best fit the project needs; an integrated decision-making process would enable prioritizing the reduction of both operational carbon emissions and embodied carbon when comparing options.

Furthermore, ports and terminals should observe industry developments and maintain an open channel of communication with suppliers, consultants and others who are well versed in the latest technologies and solutions, with experience developing projects and running pilot programs before full implementation on-site.

Training Programs

Switching to electric equipment also requires specialized training and maintenance programs that are different from those used for diesel-powered equipment. Port operators must be willing to invest in training and maintenance programs to ensure that their staff are prepared to work with electric equipment.

Digital Tools

To illustrate container operation electrification, WSP developed a case study using PRIME,[2] our proprietary port planning tool, where a container terminal had a regular operation with mainly diesel-powered equipment, such as terminal tractors, RTGs, reach stackers and empty container handlers. With a long-term vision for developing a brownfield site, to not only expand the terminal capacity but also to futureproof this terminal for decades to come, WSP developed a master plan after considering different layout options and equipment types. The plan adopted an approach to design that could accommodate changes in terms of equipment selection, allowing the terminal to be developed using equipment options that already exist or those that are still being developed and that might come in the future—without impacting the overall plan.

After assessing the options, a preferred solution was defined, where the stacking equipment switched from mainly diesel RTGs, reach stackers and empty handlers to automated stacking cranes, and the horizontal transport switched from diesel terminal tractors to future battery-powered shuttle carriers. Furthermore, WSP compared the operational carbon emissions for all the options taking into account the carbon-emissions factors from the country/region energy grid and indicated a carbon reduction of over 30 percent per twenty-foot equivalent unit (TEU) container box handled at the terminal.

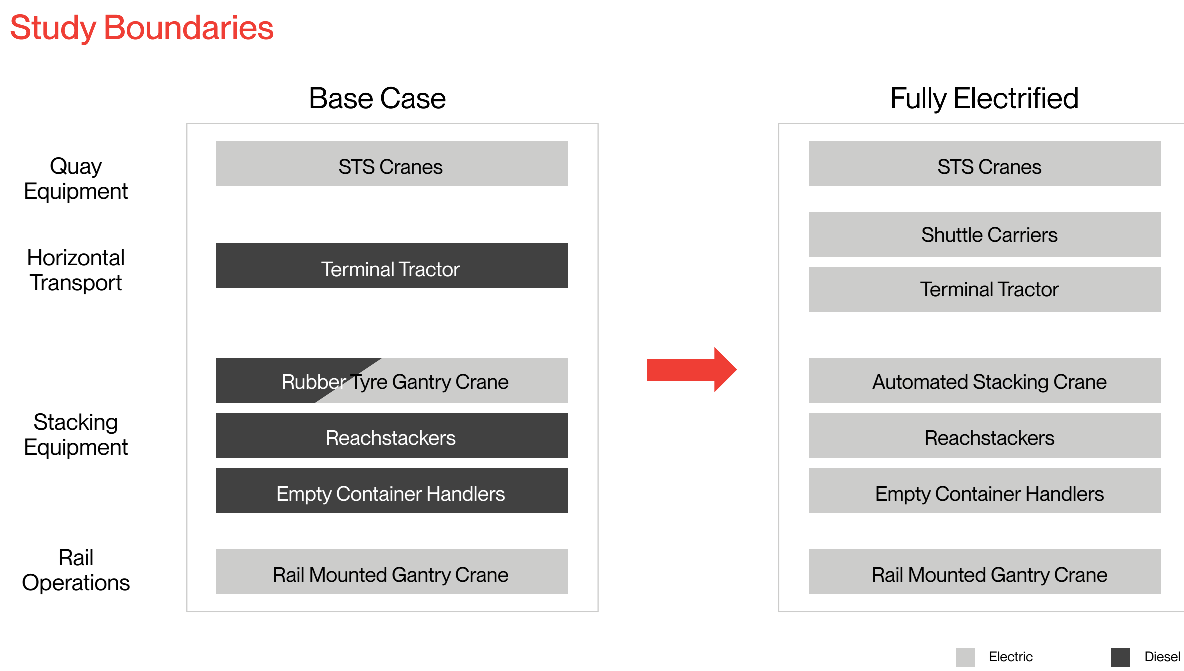

Figure 1 - A typical transition for existing ports from diesel-fuelled equipment to fully electrified equipment in the container handling sector.

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2 WSP's in-house proprietary suite of port planning tools, referred to as Port, Rail, Intermodal Modelling Engine (PRIME), allows us to configure terminal plans, estimate their capacities and operational carbon emissions, and forecast capital and operating costs efficiently. PRIME integrates physical planning, operational analysis, economic assessment, and environmental impact estimation into a single platform, allowing coherent analysis of all key drivers and variables.

While this drop, depends on the emissions factor of the electrical grid of each country, the gains are nevertheless significant; the next step, based on this scenario, is to make use of renewable energy within the terminal, be it through renewable energy production at the port or through the purchase of energy attribute certificates,3 allowing the terminal to neutralize their scope 2 carbon emissions.4

Many terminals are investigating the production of renewable energy on-site or nearby, sometimes by taking advantage of unused areas or the coastal environmental conditions. The production of renewable energy on-site represents one of the potential ways to reduce scope 2 emissions and obtain economic benefit in the medium/long term.

GHG Emissions (in kg of CO_2) per TEU

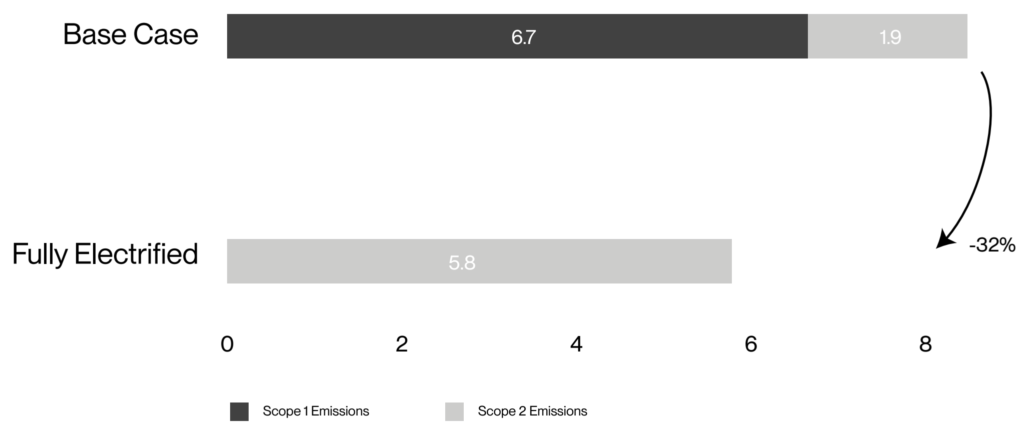

Figure 2 – GHG emissions per TEU in a case study where the container terminal had about 80 percent of the emissions related to diesel-fuelled equipment and planned to switch to fully electric operations.

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3 Energy attribute certificates (EACs) are a type of environmental attribute certificate that represent the environmental benefits of generating electricity from renewable energy sources; they are used to track and verify the generation and use of renewable energy. There are various types of EACs, including renewable energy certificates (RECs) in the United States, guarantees of origin (GOs) in Europe, and international renewable energy certificates (I-RECs) for international use. These certificates are often traded and bought and sold in renewable energy markets.

4 Carbon Trust: Scope 1 covers direct emissions from owned or controlled sources; scope 2 covers indirect emissions from the purchase and use of electricity, steam, heating and cooling; scope 3 includes all other indirect emissions that occur in the upstream and downstream activities of an organisation.

There are a range of options to have renewable energy production on-site: solar power (photovoltaic); wind power, which is gaining significant traction in many places in the world with the expansion of wind farms; and newer technology such as ocean energy:

Solar Power

The installation of photovoltaic panels can take advantage of unused rooftops of offices, warehouses, car and truck sheds, or unexploited open fields in the port area. The geographical location also influences the annual solar irradiation and consequently the level of energy that the technology is able to harvest.

Wind Power

Both onshore and offshore wind turbines located in a maritime port area represent an important source of energy, taking advantage of areas with high average wind speeds. It is common to see breakwaters being used to install wind turbines.

Ocean Energy

Tidal energy converters – Stream generators, horizontal or vertical axis turbines, tidal barrages and other devices can capture the water streams movement to produce energy. Not ideal for areas with low tide variations.

Wave energy converters – These small devices can accumulate a large quantity of energy. Advantages include the possibility of installing this technology close to the port edge, making use of breakwaters for example.

Conclusion

Implementing electrified solutions in ports and increasing electrification in the port industry requires a comprehensive and integrated approach that addresses the political, financial, technological, and logistical challenges involved.

By putting the necessary elements in place, ports can reap the benefits of electrification while reducing their environmental impact and advancing a sustainable maritime sector.

Accelerating the shift away from fossil-fuel-based power to reach net zero means considering solutions in the broad context of alternative energy solutions for communities. This approach should include supply-chain understanding and considerations relative to hydrogen and offshore wind, and other technologies that can support a sustainable future.

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