

## The Potential Role of PortCDM in Cold Ironing

by

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### Abstract

Sustainable development to combat climate change is arguably one of our biggest global challenges. Across Europe, all types of stakeholders are looking for cost-effective ways to reduce CO<sub>2</sub>, as well as curbing local emissions, such as noise, NO<sub>x</sub>, SO<sub>2</sub> and particle emissions to create a healthier environment especially in cities, where thousands die every year due to respiratory diseases. The general anxiety in the population is reflected in a recent article in the Guardian: "*I don't want ships to kill me: Marseille fights cruise liner pollution*".<sup>1</sup>

One possible major game changer, which could dramatically reduce both global greenhouse effects and local pollution, is to use electric shore powering for ships when they are at berth. This is often referred to as 'cold ironing' or 'shore side electricity'. We contend that there are real benefits in using the digital data sharing concepts of Port Collaborative Decision Making (PortCDM), which is one of the enablers of the Sea Traffic Management (STM) concept, as part of the future implementation of cold ironing. The digital data sharing under PortCDM, which is further explained below, can support the coordination and synchronization of cold ironing by ensuring the synchronization of the requirements of both the shore and ship infrastructure and power availability. The term '*eBerthing*', defined as cold ironing supported by digital data sharing as suggested in this concept note, may be considered in future.

Today, cold ironing is technically feasible.<sup>2</sup> All ships use electricity for communications, lighting, ventilation, cooking, heating, operation of pneumatic/hydraulic/electrical systems and other on-board equipment. Currently, most ships use boilers or generators burning conventional fuel (marine diesel oil) to provide this electricity, though some new cruise ships are being built to use LNG, which is less polluting. At the same time, many, if not most ships have facilities to receive electricity from shore, but cold ironing for most commercial ships is still very much in its infancy. As we shall discuss later, this is in large part due

<sup>1</sup> <https://www.theguardian.com/world/2018/jul/06/i-dont-want-ships-to-kill-me-marseille-fights-cruise-liner-pollution>

<sup>2</sup> <https://www.portauthoritynsw.com.au/sustainability-and-environment/air-and-noise-emissions/shore-power-study/> AND [https://www.lighthouse.nu/sites/www.lighthouse.nu/files/elektrifiering\\_webb.pdf](https://www.lighthouse.nu/sites/www.lighthouse.nu/files/elektrifiering_webb.pdf)



to the relatively high cost of electricity (typically taxed heavily) and the relatively low cost of diesel fuel (not taxed).

Some RoRo ships have been cold ironing for nearly two decades, for instance in Gothenburg (Cobelfret RoRos)<sup>3</sup> since 2000, but it is only in the last few years that we see more widespread adoption and diffusion. Especially in the cruise ship industry, which is responsible for the largest emissions/pollution, we have seen a number of initiatives - particularly in ports in California and Alaska. Furthermore, new port development plans, such as those for Singapore, now include cold ironing as part of the planned infrastructure. In addition to cruise ships, cold ironing seems especially well suited for ships with fixed routes and designated berths, such as RoRo ships and ferries<sup>4</sup>.

However, there are many barriers hindering adoption of cold ironing – particularly when it comes to costs related to retro-fitting ships, providing global interoperable connections and powering standards, and the sheer expenses of putting the infrastructure in place. Cold ironing could contribute to societal gains by reducing noise, reducing air pollution and reducing the greenhouse effect. In comparison, in the airline industry, electric powering of parked aircrafts is the norm. Why would the same not be possible within shipping?

Establishing shore-powering facilities is costly, particularly if only a small proportion of the ships visiting a port use shore power. Accordingly, cold ironing needs to be made as efficient and as widely used as possible in order for the business case to be acceptable. As cold ironing involves many stakeholders, including, for example, ship owners, ports, power suppliers, grid managers, electricity suppliers, environmental protection authorities, ship electrical equipment manufacturers, and naval architects, there is a call for collaboration among different stakeholder.

Once shore power facilities are available in a port, any ship's cold ironing requirements could be synchronized and optimized through PortCDM data sharing, simply by including the operational planning requirements for the supply of electricity for the ship to be part of the wider PortCDM data sharing that occurs. From a PortCDM perspective, shore-based electrical power is simply another resource to be planned for and managed as part of a port call. While PortCDM is not a driver for cold ironing, it nevertheless can address one of the key barriers to a general adoption of cold ironing, which is ensuring the optimal use of the shore powering facilities that exist and the planning of power demand.

This concept note highlights a number of the issues around cold ironing and highlights how any cold ironing infrastructure that takes advantage of PortCDM could help reduce the economic barriers for the effective cold ironing of ships by ensuring the most efficient and effective use of shore power facilities.

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<sup>3</sup> <http://www.gp.se/nyheter/g%C3%B6teborg/hamnen-vill-klimatsatsa-1.117933>

<sup>4</sup> <https://www.ecofys.com/files/files/ecofys-2014-potential-for-shore-side-electricity-in-europe.pdf>

**Motivation**

We have argued above that the burning of fossil fuels by ships while berthed has two major types of non-sustainable implications, 1) an increased emission of CO<sub>2</sub> (leading to an increasing greenhouse effect and global warming) and 2) an emission of a large number of pollutants (especially noise, NO<sub>x</sub>, SO<sub>2</sub> and particle emissions). The reason for the pollution is that fossil fuels to a varying degree contain sulphur, nitrogen, heavy metals and other particles. When the fuel burns, these are released into the atmosphere causing health issues.

As the table below shows, other than fuelling ships’ generators with hydrogen or using solar or wind power, shore supplied electricity is the only other viable source of electricity, which ideally would come from renewable sources like solar or windpower.

Type	Method	SOx	NOx	PM	CO2
<b>Electric</b>	Shore power	100%	100%	100%	100%
	Battery power	100%	100%	100%	100%
<b>Compliant and alternative fuels</b>	Hydrogen	100%	100%	100%	100%
	LNG	100%	90%	100%	20%
	Bio fuel	100%	10%	?	100%
<b>Exhaust cleaning</b>	SOx scrubbing	80%	5%	30%	0%
	NOx scrubbing	0%	85%	0%	0%
	Diesel particulate filters	0%	0%	50%	0%
<b>Combustion improvement</b>	Slide valves	0%	25%	0%	0%
	Direct water injection	0%	15%	20%	0%
	Exhaust gas recirculation	0%	80%	0%	0%
	NOx rating				

Global warming is an existential threat, and many nations, cities and organizations are acting to reduce greenhouse gas emissions across the globe. Cold ironing is an initiative that will help the shipping industry contribute to this goal. It will dramatically eliminate the noise from generators while at berth, it will dramatically reduce the different types of local emissions (NO<sub>x</sub>, SO<sub>x</sub>, particles, etc.), and it would

**Figure 1 Comparison table showing percentage reduction according to technology or fuel used - Source: DNV-GI**

potentially reduce operational costs because large-scale electricity generation is typically cheaper than running diesel generators. There is also the possibility to use renewables for supplying electricity, depending on the options available to the electrical supply company, and reduce the global impact from CO<sub>2</sub> as well. Additionally, cold ironing could reduce the need to have engineers on watch, since the ships would not be running heavy machinery such as diesel generators. Adopting cold ironing, a ship-owner will see less operating hours a year on auxiliary engines, which means that maintenance intervals can be extended.

Cold ironing promises to provide a significant contribution towards achieving several of the goals in the UN’s 2030 Sustainable Development Agenda as well as the International Maritime Organization (IMO) goal to reduce shipping’s CO<sub>2</sub> emissions by 50% by 2050<sup>5</sup>.

<sup>5</sup> <http://www.imo.org/en/MediaCentre/PressBriefings/Pages/06GHGinitialstrategy.aspx>



Shipping currently accounts for 2-3% of global greenhouse gas emissions. A 2014 IMO study warns that increasing trade could raise the sector's carbon footprint by as much as 250% by mid-century<sup>6</sup>.

An illustrative example of the pollution challenge is that the daily emissions from cruise ships alone are equivalent to one million cars. At times, the air quality on the deck of a cruise ship can be as bad as the world's most polluted cities. When in port, an average cruise ship can emit as much NO<sub>x</sub> as 10,000 cars driving from Paris to Berlin.<sup>7</sup>

The efficient, coordinated and synchronized use of cold ironing offers the potential to mitigate 800,000 tons of CO<sub>2</sub> emissions annually, while the total electricity demand would be 3,543 GWh, around 0.1% of electricity consumption in Europe.<sup>8</sup> Since the carbon content of electricity produced onboard is higher than from electricity delivered from shore, this is an environmental plus. In some ports, it is already possible to obtain electricity from 100% renewable energy resources, primarily wind and water power. Even using land-based fossil fuels, cold ironing 'moves the pollutants (emissions from ships) from densely populated areas to more remote regions, where larger power plants are typically located and where emissions are less (because of legislation/cleaner fuels) and explicit health damages (e.g., NO<sub>x</sub>, particles, noise) are less severe<sup>9</sup>.

Today, all cruise ships arriving at ports in California and Alaska must run on shore power while at their berth<sup>10</sup>. This means that all new cruise ships are equipped with the necessary facilities to move to cold ironing, and those that are likely to operate in US ports have the necessary equipment already installed.

When in harbor, ships add to a city's pollution, which is now prompting a political response, especially among environmentally sensitive populations. Accordingly, a large number of cities such as Bergen plan to be fossil fuel free by 2030. This will inevitably lead to stricter requirements on ships than just using light fuel when berthed.

Already in 2006, the EU approved Recommendation 2006/339/EC: "*Member States should consider the installation of shore-side electricity for the use by ships at berth in ports, particularly where air quality limit values are exceeded or where public concern is expressed about high levels of noise nuisance, and more*

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<sup>6</sup> Third IMO GHG Study 2014, IMO

<sup>7</sup> Rob Winkel, Ulf Weddige, Doris Johnsen, Vincent Hoen, Georgios Papaefthymiou: Potential for Shore Side Electricity in Europe, 2015. ECOFYS Netherlands B.V. | Kanaalweg 15G | 3526 KL Utrecht

<sup>8</sup> Rob Winkel, Ulf Weddige, Doris Johnsen, Vincent Hoen, Georgios Papaefthymiou: Potential for Shore Side Electricity in Europe, 2015. ECOFYS Netherlands B.V. | Kanaalweg 15G | 3526 KL Utrecht

<sup>9</sup> Ibid

<sup>10</sup> RISE and SSPA: Elektrifisering af sjöfarten, [www.lighthouse.nu](http://www.lighthouse.nu) AND 'Klima og environment plan', Bergen municipality 2017-2020. [https://www.tankershipping.com/news/view,steel-cutting-has-begun-on-teekay-offshores-eshuttle-tankers\\_53786.htm](https://www.tankershipping.com/news/view,steel-cutting-has-begun-on-teekay-offshores-eshuttle-tankers_53786.htm)

*especially in berths situated near residential areas.”<sup>11</sup>*

So far, the development has not been rapid. However, from a slow start, we are now witnessing an increasing level and rate of interest spreading, as governments and communities become more concerned about carbon pollution, and we see a mix of incentives and punitive measures being considered and implemented to reduce emissions from fossil fuels. The introduction of carbon-tax offsets for cold ironing as part of an incentive scheme is conceivable.

As far as the US are concerned, California is leading the way in terms of CO<sub>2</sub> emissions reduction. According to California's state mandate, already by 2014, at least half of all container ships had to run on shore-side electricity when at the berth. Furthermore, carriers were subject to an additional requirement: each fleet had to reduce its total emissions by 50%. As of today, the requirements have been raised further to 70% and by 2020 80% of fleet calls must use shore power and 80% of fleet emissions must be cut.

### **Moving the focus to electric power supply from shore**

While the number of implementations has been modest since the EU recommendation was passed in 2006, ports, cities, cruise ship operators and others are now increasingly active in addressing the challenges. In the Lighthouse report<sup>12</sup> of April 2018, the situation regarding electrification of the maritime area is summarized in the following way:

*“The pace of development within the area of maritime electrification is high, and new, innovative projects are continually being started... There are many examples of electrification within the passenger vessel segment, especially in Norway. There are also a few examples in Sweden. These passenger vessels operate on a defined route over shorter distances. In Sweden, there are examples of fully electric cable road ferries operating over very short distances. Other vessel segments adopting electrification are offshore industry vessels and special vessels such as tugs. In these segments, battery hybrid solutions result in higher efficiency for operations such as dynamic positioning. There are a number of ongoing projects, for example RoPax ferries, inland waterways vessels, and container vessels, that are broadening the scope of application of maritime electrification.*

*A number of different actors are involved in maritime electrification - users (ports, shipping companies), suppliers (energy storage, vessel design, shipyards, shore power, system and components), regulatory authorities, class societies, and research organizations (institutes and universities). There are incentives for electrification of vessels that are related to climate and*

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<sup>11</sup> COMMISSION RECOMMENDATION of 8 May 2006 on the promotion of shore-side electricity for use by ships at berth in Community ports (2006/339/EC)

<sup>12</sup> RISE and SSPA: 'Elektrifiering af sjöfarten', [www.lighthouse.nu](http://www.lighthouse.nu)



*environment, economy, market and safety.*

*Existing Swedish electrification initiatives are within the short-range ferry traffic segment, as well as a RoPax project (Gothenburg-Frederikshavn). Today, there is a big economic risk with electrification projects, and funding from governmental players is often necessary. Technical challenges identified include ensuring enough battery power and charging speed can be obtained, and implementation of a reliable charging method. The safety of battery usage was also identified as a challenge, where there is limited practical experience on how different safety systems perform in hazardous situations. A well-functioning charging infrastructure is necessary and there is a need for clarifying the requirements for such infrastructure, based on different applications of maritime electrification”.*

While the Lighthouse report considers the possibilities of electric powering throughout a voyage, this concept note has focussed on the specific issue of providing electricity to ships while at berth and how PortCDM and its data sharing philosophy will help to ensure that cold ironing is optimized.

In order to enable ships to obtain electric power while in port requires both facilities on board and ashore. On board it is clear that almost all ships use electricity for a wide variety of purposes. Thus, the costs of changing from electricity supplied from the current onboard diesel burning generator to using a shore connection while at berth are relatively low, although of course not trivial. The cost of the equipment per vessel is between USD 150k to USD 1M (without taking into consideration the loss of revenue for a vessel while retrofitting works in the case of an existing ship).<sup>13</sup>

Ashore is a different matter. The costs to augment existing port installations to provide electrical power to ships is much higher. The costs of establishing a power installation with connections, 50 and 60 Hz power compatibility, the necessary grid connection powerful enough to handle a peak load, etc., are substantial. In the port of Stavanger, the harbour master Trond Andersen estimate that *“for offshore vessels they calculate from USD1M, but for cruise ships (needing up to 20MW) we calculate a cost at USD10M for a single connection point”*. Furthermore, it is not trivial that a USD5M dedicated site might require a piece of land of maybe 120 m<sup>14</sup>.

Furthermore, as the Lighthouse report (ibid.) states: *“Cyclical or irregular peaks in ship traffic creates a lumpy demand problem that can raise demand for electricity appreciably for a period. This might require additional investment in spare generating capacity. Due to the amount of electrical energy required, an upgrade of the existing capacity of the local grid may be necessary”*.

It follows that, if cold ironing facilities are established, it is essential to assure a high utilization to cover the cost of the investment and achieve pollution reduction goals. This is where the PortCDM concepts,

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<sup>13</sup> California Air Resource Board, TECHNOLOGY ASSESSMENT: OCEAN-GOING VESSELS (Draft, May 2018)

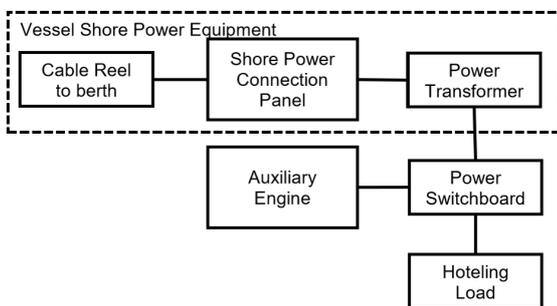
<sup>14</sup> Information provided on 5 October from PowerCon, who established the first 15 MW power converter for cruise ships in Kristianssand in 2018. Just the power converter with necessary installations was approximately USD 4 million.

structures, platforms, and systems could provide value through their contribution to the synchronization and optimization of the use of those facilities. PortCDM can primarily contribute to maximizing the use of existing cold ironing facilities through the information systems and digital collaboration already developed on PortCDM foundations. The PortCDM data recording capability could also allow for third parties to provide better forecasting and planning of possible new electricity generating systems and any grid upgrades required to handle additional demand and fluctuations in demand.

As part of a port visit, PortCDM shared data could easily be used to plan for the power needs of a ship. PortCDM already provides data such as a ship’s ETA and ETD to support resource planning for a visit. These data can be used to ensure the appropriate electrical connection equipment is reserved and in place, and that the additional load on the grid for the berthing period can be estimated.

**Examples of cold ironing implementations**

According to the California Air Resource Board, container vessels connect at 6.6 kilovolts (kV) and generally draw less than 3 MW of power while at berth. Cruise vessels connect at either 6.6 kV or 11 kV, and can draw upwards of 10 MW of power while at berth. The scheme of a typical set-up for a shore to ship connection is represented below.<sup>15</sup>



The most spectacular example of shore based electric power supply in the Nordic countries is the 16 Megawatt power supply in Kristiansand for cruise ships.<sup>16</sup> PowerCon, the company that supplied the shore facilities, has also delivered smaller installations of shore power to several other ports, including the Norwegian ports of Bergen and Stavanger. Together, these can support cold ironing for up to 30 supply ships.

A smaller 10 Megawatt shore installation entered service at the German port of Cuxhaven, in the North Sea, west of Hamburg, on 25 May 2018.<sup>17</sup> The ShoreCONNECT in Cuxhaven will mainly be used by vessels transporting Siemens Gamesa’s wind turbine parts to off-shore windfarms in the North Sea.

Other installations are also under consideration or under way in ports in Northern Europe including the ports of Antwerp, Amsterdam, Bremen, Gothenburg<sup>18</sup>, the Hamburg Port Authority, Port of Le Havre, Stadtwerke Lübeck, port of Kiel, and the port of Copenhagen/Malmö.

<sup>15</sup> Source: California Air Resource Board, TECHNOLOGY ASSESSMENT: OCEAN-GOING VESSELS (Draft, May 2018)

<sup>16</sup> <http://www.powercon.dk/index.php/shorepower>

<sup>17</sup> <https://safety4sea.com/shore-power-facility-installed-in-port-of-cuxhaven/>

<sup>18</sup> <https://www.goteborgshamn.se/om-hamnen/gronare-transporter/elanslutning-av-fartyg/>

Sweden has taken significant steps for traffic in fixed routes and tonnage: RoRo in the Port of Gothenburg since year 2000<sup>19</sup> and Trelleborg, ferries in Stockholm, HH ferries has become fully electrical with 4,2MWh battery onboard and shore power of 11MW on the route Helsingborg/Helsingør, and lately Stena added to its shore power investment with trials for hybridization by mounting a 1MWh battery onboard Stena Jutlantica. Färjerederiet has ordered a new large fully electrical car ferry Tellus, where the charging infrastructure is not yet in place. There are no solutions for charging car ferries available on the market that meets the Swedish conditions. This development is initiated by Färjerederiet.

While the most compelling business models for cold ironing are not yet clear, many cities and governments have started to see cold ironing as a necessary investment in the light of the environmental and public pressures. They have come to realize that in line with providing facilities for ships to unload their sewage and provide optimal transport facilities for passengers to get on and off the passenger ship, it is an environmental necessity to provide shore power for as many ships as possible, especially for ports in or near major cities or in vulnerable environments.

An example of cold ironing implementation being driven primarily by environmental concerns is in the port of Long Beach, California, which has completed more than USD185 million worth of dockside power hookups and other infrastructure to facilitate shore power. This commitment is fully in line with California's mandate, mentioned previously.

### **Barriers and drivers for the diffusion and adoption of cold ironing**

In spite of the many initiatives, the idea of shore powering has achieved limited adoption, and the scale and range of adoption in terms of ports and types of ship remains relatively low. Cruise ship lines like Carnival, which now has 43% of its fleet equipped with shore powering capability are getting impatient.<sup>20</sup> Ships want to recoup their cold ironing investment by connecting in every port they visit. What is needed now is that the world's major 200 ports and most of its ships adopt cold ironing to make an environmental difference.

We see that the cruise ship industry and other sectors are steadily moving towards cold ironing. At the same time, the IMO's subcommittee on Ships Systems and Equipment (SSE) is developing mandatory and non-mandatory safety provisions for the cold ironing of ships and guidance on safe operation of on-shore power supply service in port. It is due to finalize this work in 2020.

Thus, it is important to identify what factors continue to limit a higher rate of adoption of cold ironing, and what needs to be done to remove the barriers and raise the rate of implementation. Those who can answer these questions and develop supportive business models that accelerate adoption will have an opportunity to create a global market for their professional advice at the same time as addressing an

<sup>19</sup> <http://www.gp.se/nyheter/g%C3%B6teborg/hamnen-vill-klimatsatsa-1.1179338>

<sup>20</sup> <http://carnivalsustainability.com/commitment/energy-emissions/>



18<sup>th</sup> of October 2018

(Concept Note #20)

important global issue – CO<sub>2</sub> emissions and airborne particulate pollution.

It is our belief that PortCDM in support of the IMO vision for e-Navigation and as part of the EU STM project has an important part to play in the operational success of cold ironing. PortCDM addresses the need to ensure the continuous flow of real-time data using the standardized, internationally recognized (IALA S-211 standard) Port Call Message Format (PCMF) among different actors concerning port call intentions, outcomes, and possible disruptions. The PCMF can be used to transfer information from a ship's onboard system to a port hub regarding movements and service provision thereby keeping all those involved in the berth-to-berth maritime transport planning process informed. This can easily include cold ironing requirements.

The optimization of port calls requires that relevant data are shared in advance. This enables better planning of resource utilization, including berth occupation. This includes securing the availability of equipment, labor resources, stowage space, etc. as well as enabling planning and the subsequent distribution and delivery arrangements for goods. The provision of electric shore power is 'just' another port service that can be added to the PCMF standard and in that way be made more efficient with PortCDM.

The creation of a sustainable society needs well-informed decision making by many players to raise efficiency, reduce carbon emissions and reduce emissions of toxic pollutants killing thousands of people every year in big cities around the world. PortCDM can only address a minor part of that problem related to port operations. However, PortCDM was conceived to take advantage of information systems to drive port visit efficiency and in that way indirectly advance sustainability. Now, as this concept note illustrates, PortCDM has the potential to directly support sustainability and pollution reduction through the role that it can play in cold ironing. And as mentioned in the introduction, the term '*eBerthing*' may be a way to express this concept of cold ironing supported by digital data sharing.

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