British Ports Association

Reducing Emissions from Shipping in Ports: Examining the Barriers to Shore Power

May 2020

Contents

Acknowledgements

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Arkevista provided analysis and modelling of AIS data for vessels in UK ports in 2019. This work will be analysed in detail in follow-on pieces of work Arkvevista deliver bespoke market, competitor and customer intelligence, leveraging global maritime data (including AIS) and research to analyse markets and distribution networks, prioritise sales leads, study vessel and port activity and map markets.

Arup provided advice and insight from their experiences in the maritime sector. Arup are an independent firm of designers, planners, engineers, consultants and technical specialists offering a broad range of professional services. Through our work we make a positive difference in the world.

Schneider Electric contributed specialist advice, insight and expertise from their experience in providing shore power systems in the UK and around the world. Schneider Electric provides energy and automation digital solutions for efficiency and sustainability and is a leading shore power connections systems and electrical distribution systems supplier.

TT Club provided their insight into potential emerging risks around the provision of shore power. TT Club is the leading provider of insurance and related risk management services to the international transport and logistics industry.

UK Power Networks Services provided technical expertise and guidance. UK Power Networks Services provides solutions to global energy challenges that enable clients to take advantage of the energy transition and decentralisation.

Overview: Key Points

- The BPA is technology neutral when it comes to emissions reduction, but it is likely that shore power will be part of a mix of emissions reductions solutions for ships at berth in UK ports in future.
- There are significant barriers to implementation of shore power in the UK, with uncertainty and risks bourne by ports and benefits accruing elsewhere
- The primary barrier is **capital costs**: no shore power project anywhere in the world has been undertaken without public support. A green maritime fund to support shore power in the UK is clearly needed to help meet prohibitive costs, particularly around energy networks and generation
- The **price of electricity** in the UK is much higher than in countries where shore power is provided. Most ports with shore power provision have support to help make electricity as a marine fuel more competitive and that needs to be replicated in the UK
- There is a **lack of consistent demand** from vessels calling in the UK for shore power. Government needs to address this. The BPA is putting forward a zero emission berth standard for discussion with industry and Government which would drive up demand for emissions abatement technology and provide certainty for investors. We are keen to discuss this or realistic alternatives that spread the costs of decarbonisation and emissions abatement fairly
- There are a number of other barriers that Government and industry should address and areas of potential further research and analysis. The BPA is ready to participate wherever we can be of value.


SEABOURN OVATION

Summary

The UK ports industry is critical to the UK economy, handling the overwhelming majority of the UK's trade. UK ports also facilitate the provision of offshore energy and support leisure and tourism and the fishing industry, contributing £29 billion in business turnover and £9.7 billion in GVA annually to the UK economy as well as 115,000 jobs. Each year ports contribute approximately £2 billion to the Exchequer and invest round £600 million in infrastructure.

Shipping is by far the most energy and carbon efficient way to move freight and the British Ports Association has long argued that when it comes to climate change, ports and shipping are part of the solution, not part of the problem.

We all recognise that action is needed to reduce emissions from ports and ships. Whilst emissions from port operations are typically very small, most ports are taking action to reduce their impact. Many ports in the UK provide low-voltage shore power connections for leisure boats, smaller fishing vessels and smaller port craft. High capacity connections for large vessels or cruise ships present significant technical and funding challenges for ports, however. As of April 2020, there are no large-scale commercial shore power connections available in the UK. This report sets out the reasons why.

We have examined the primary barriers to investment in the provision of shore power in the UK. These are examined in detail but three stand out: (1) high capital costs, (2) expensive electricity, and (3) a lack of consistent demand. Our research indicates that there are no existing shore power projects on any significant scale anywhere in the world, with the exception of those that have received substantial public funding. Whilst we celebrate smaller scale projects that have been undertaken, large scale shore power is currently almost always not commercially viable.

As a critical part of logistics and supply chains, ports will have a wider role to play in facilitating the decarbonisation and wider emissions abatements efforts of the freight industry. We recognise that, subject to the source of the electricity, shore power has the potential to be a viable tool for meeting public policy aims such as the UK and Scottish Governments' net zero targets[1,2] and some of the goals set

[1] (UK Government, 2019)
[2] (Scottish Government, 2019)

out in the Clean Maritime Plan[3] [4] as well as Government clean air policies[5]. Whilst the British Ports Association is technology-neutral when it comes to meeting these goals, we recognise that shore power is likely to play a role in reducing emissions at berth. It is clear that it is not feasible to install shore power at every berth in the UK or accommodate every vessel. We think it is likely that shore power will be part of a mix of future solutions to reducing emissions from ships in ports.

The core contention of this paper is that this cannot be done without public investment in four key areas: (1) pre-project planning and feasibility studies; (2) network upgrades or off-grid generation; (3) shoreside infrastructure; and (4) on-board electrical systems.

This is not something we propose lightly – the British Ports Association has traditionally argued that Government should not intervene directly in a competitive market. Decarbonisation is a serious and unprecedented challenge and the ports industry is serious about playing its part.

We also set out a case for a tax exemption for electricity when it is being used to power vessels at berth to bring it into line with marine fuel, which is exempt from tax.

Finally, we believe that a goal-based regulatory approach is needed to drive up demand for emissions reductions at berth. We propose a zero-emission berth standard that would help create more certainty around investments in emissions reductions technologies and solutions and help with some of the technical barriers. This would need buy-in and support from the wider maritime industry and real collaboration between Government and industry: we are ready to play our part in that and we are open to alternative solutions.

Our research has found that a ‘build it and they will come’ approach is not likely to work on its own, particularly given the price of electricity in the UK. Even where electricity prices have been low, vessels have not always used the infrastructure available to them.

[3] (Department for Transport, 2019a)
[4] (Department for Transport, 2019b)
[5] (Department for Environment, Food and Rural Affairs, 2019)

Mandatory regulation of shore power would disincentivise other emissions reductions solutions and be an inefficient and expensive policy. A zero-emission berth standard is a technology-neutral, goal-based policy approach that will allow industry to tackle the issue in the manner best suited to their specific circumstances. It recognises that some technologies will be complementary rather than competing with each other. Where vessels choose or are unable to comply, they will still contribute to 'greening' UK port infrastructure. This approach is flexible and gives Government a 'green' shoreside policy lever for the first time.

We believe that a technology neutral, goal-based approach is the most sensible way to reducing emissions from ships in ports. Over time, funds collected from a levy could fund innovative new green projects in the UK maritime industry. Such a scheme would need to be carefully designed to ensure that it would not affect the competitiveness of particular sectors or trades whilst also ensuring that it drives behavioural change and private investment.

The British Ports Association presents these proposals as a holistic package. The barriers to shore power are complex and intertwined and the solutions must also be multi-faceted. Whilst funding or reductions in electricity prices would be welcome, there is a need to incentivise vessels to use the infrastructure. Similarly, supply-side support and collaboration will be needed to provide the infrastructure.

This document is offered as policy proposal and discussion document on how to drive demand for low emission technologies for vessels berthing in the UK.

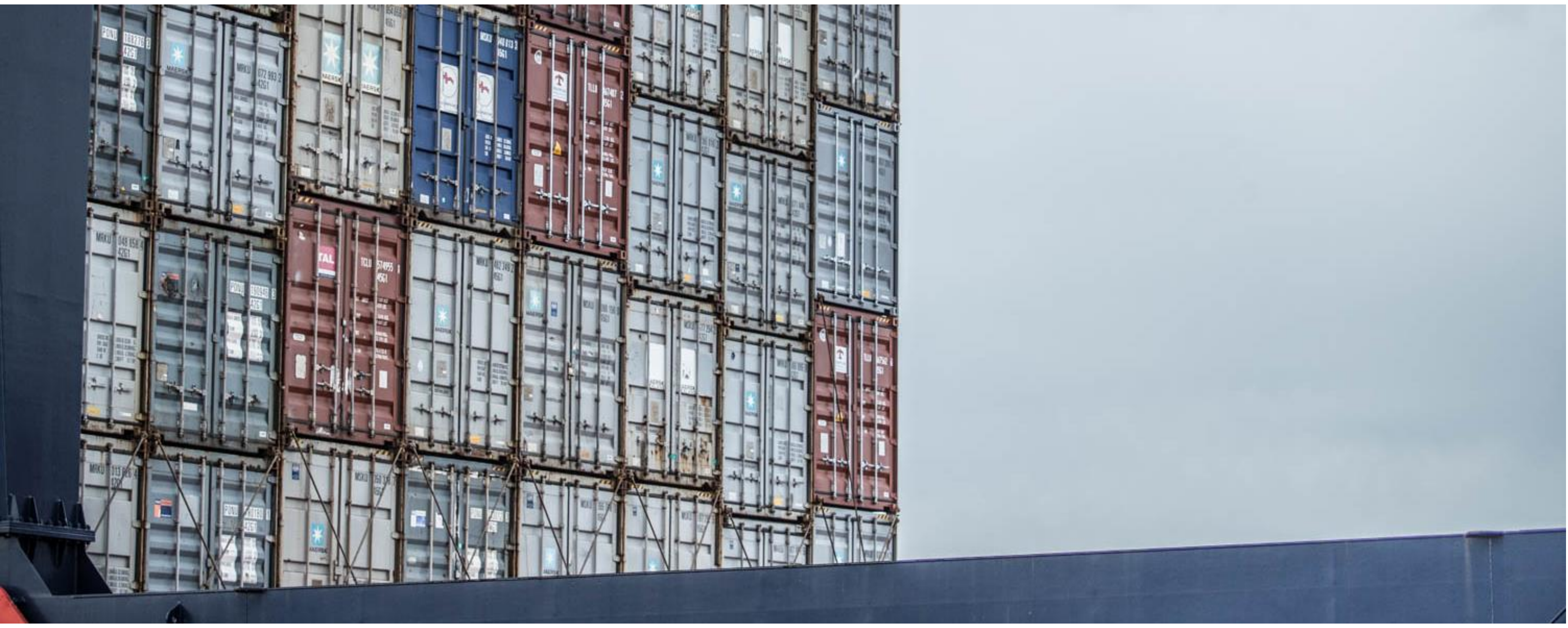


Table of Recommendations

	Recommendation	Responsibility
Primary Recommendations		
1	A **Clean Maritime Fund** to support emissions reductions in the maritime sector Barrier: High Capital Costs	Department for Transport
2	**Removing taxes on shoreside electricity** to bring it in line with marine fuel Barrier: High Electricity prices	HM Treasury
3	Goal-based measures to increase demand, such as a **zero-emission berth standard** Barrier: Lack of consistent demand	Industry to develop; Government to introduce and administer
Secondary Recommendations & Next Steps		
4	Regulatory advice and support for maritime industries for emissions abatement	Department for Transport
5	Exploring power as a service as a potential alternative model of shore power provision	Industry; Government
6	Continued national and international engagement on developments to support shore power and wider emissions abatement options including exploring collaborative programmes and information sharing	BPA; industry; Government
7	Research into quantifying the costs and benefits of shore power and other emissions abatement options, including the development of an emissions calculator	Government-led; BPA
8	A review of the energy planning system and how it supports maritime emissions reductions	Government-led; Industry
9	Further analysis and research into demand and modelled demand scenarios in future	BPA and partners

Introduction

What is shore power?

Shore power is the provision of electricity to ships berthed alongside in port. When at berth, ships will turn off their main engines, which are used for propulsion. Vessels connecting to shore power are also able to turn off their auxiliary engines, which are used to generate power needed for accommodation and other electrical needs for crew and passengers as well as cargo systems in some cases. Shore power is often sourced from the grid but could be from an off-grid source, such as a wind turbine or LNG or renewable barge.

Shore power is also known as 'cold ironing', a historical term referring to when ships with coal-fired engines would cool whilst at berth. As well as cold ironing, it is also known as 'onshore power supply', 'shoreside electricity', 'alternative maritime power', and several other terms.

Certain types of vessels will have other power demands whilst at berth. Containerships or other vessels with refrigerated cargo, for instance, need to power cargo units and tankers will have safety systems such as inert gas scrubbers that also need power. Cruise ships will have large hotel loads at berth due to the number of passengers and crew on board.

The provision of shore power to small vessels such as most leisure craft and small fishing vessels is relatively straightforward and increasingly common in the UK. These types of vessels need low voltage and low capacity. Bigger vessels have higher power demands and will need high-voltage connections with transformers either shoreside or on-board to transform voltage, with cruise ships typically having particularly large electrical loads, and frequency conversion requirements. Most vessels operate at a different frequency to the UK grid. The Royal Navy has commonly used shore power for its vessels for many years, recently installing a 13.5MW off-grid power plant to provide shore power to new carriers in Portsmouth[6].

Off-grid solutions are also possible, with power being generated on-site or locally. On-site renewable generation could also be used to generate zero-emission fuels such as hydrogen, which could be delivered directly to a vessel or effectively used as storage and then delivered by barge as clean electricity.

[6] (Royal Navy, 2019)

Table 1: Typical Power Requirements of Different Vessel Types

Vessel Type	Typical maximum power requirements
RORO/Ferry	6.5 MVA
Container Vessel	7.5 MVA
Cruise	16/20 MVA
LNG / Tanker / FSU / FPSO	10 MVA

Source: ABB[7]

Table 2: Typical system specs for the different power requirements

Power Capacity	Typical specification
<100kW	230/400/440V – 50/60hz
100 – 500kW	400/440/690V – 50/60hz
500-1000kW	690V/6.6/11kV – 50/60hz
>1MW	6.6/11kV – 50/60hz

Source: GloMEEP[8]

The UK's electricity network operates at a frequency of 50Hz. There is no frequency standard for vessels – the global fleet is divided between 50Hz and 60Hz systems. To accommodate both kinds, shore power systems usually need frequency converters at the shore side, significantly increasing costs.[9]

Table 3: Estimated Frequency of Global Fleet, Selected Vessel Types

Frequency on board	50 Hz	60 Hz
Container (<140m)	63%	37%
Container (>140m)	6%	94%
Container total	26%	74%
Ferry / RORO	30%	70%
Oil Tanker	20%	80%
Cruise (<200m)	36%	64%
Cruise (>200m)	-	100%
Cruise total	17%	83%

Source: ABB

[7] (ABB, 2017)
[8] (GloMEEP, 2020) GloMEEP is a project aimed at supporting the uptake and implementation of energy efficiency measures for shipping, thereby reducing greenhouse gas emissions from shipping.
[9] Industry experts we spoke to told us that in all but the biggest projects, frequency conversion would make up 20-40% of project costs (of work inside the port, so excluding any network upgrades). For a very large project this might fall to 10%.

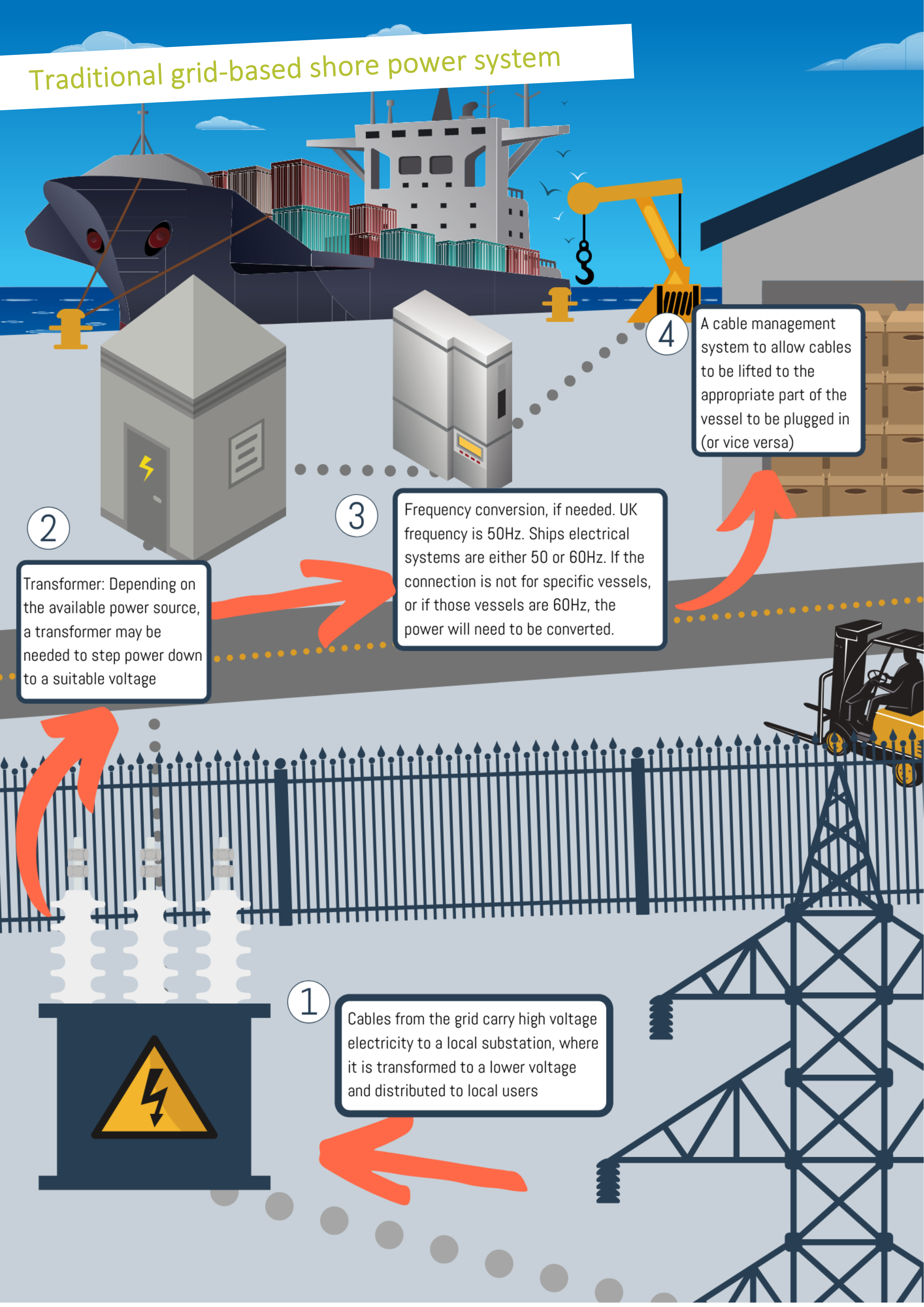

Traditional grid-based shore power system
1
Cables from the grid carry high voltage electricity to a local substation, where it is transformed to a lower voltage and distributed to local users
2
Transformer: Depending on the available power source, a transformer may be needed to step power down to a suitable voltage
3
Frequency conversion, if needed. UK frequency is 50Hz. Ships electrical systems are either 50 or 60Hz. If the connection is not for specific vessels, or if those vessels are 60Hz, the power will need to be converted.
4
A cable management system to allow cables to be lifted to the appropriate part of the vessel to be plugged in (or vice versa)

Table 4: Typical system requirements for different ship types and sizes. All vessels either 50Hz or 60Hz

Vessel types	Gross Tonnage						
	<= 1k	1 – 5k	5 – 10k	10 – 25k	25 – 50k	50 – 100k	100k+
Oil tankers	230/400/440V	400/440/690V	690V/6.6/11kV	690V/6.6/11kV	690V/6.6/11kV	6.6/11kV	6.6/11kV
Chemical/product	400/440/690V	400/440/690V	690V/6.6/11kV	6.6/11kV	6.6/11kV		
Gas tankers	400/440/690V	400/440/690V	6.6/11kV	6.6/11kV	6.6/11kV	6.6/11kV	6.6/11kV
Bulk carriers	230/400/440V	400/440/690V	400/440/690V	400/440/690V	400/440/690V	690V/6.6/11kV	
General cargo	230/400/440V	400/440/690	400/440/690V	400/440/690V	690V/6.6/11kV		
Container vessels		400/440/690V	400/440/690V	690V/6.6/11kV	6.6/11kV	6.6/11kV	6.6/11kV
RoRo vessels	230/400/440V	400/440/690V	400/440/690V	690V/6.6/11kV	690V/6.6/11kV	6.6/11kV	
Passenger vessels	230/400/440V	400/440/690V	400/440/690V	690V/6.6/11kV	6.6/11kV	6.6/11kV	6.6/11kV
Offshore supply	230/400/440V	400/440/690V	6.6/11kV				
Fishing vessels	230/400/440V	400/440/690V	6.6/11kV				

Source: GloMEEP[10]

[10] (GloMEEP, 2020)

Table 5: Estimated cost for implementing shore power on board vessels (US Dollars, thousands)

Vessel types	Gross Tonnage					
	10 – 25k	10 – 25k	10 – 25k	10 – 25k	10 – 25k	10 – 25k
Crude tankers	50 – 350	100 – 400	100 – 400	100 – 400	300 – 750	300 –750
Chemical/product tankers	50 – 350	100 – 400	300 – 750	300 – 750		
Gas tankers	50 – 350	300 – 750	300 – 750	300 – 750	300 – 750	300 – 750
Bulk carriers	50 – 350	50 – 350	500 – 3,000	500 – 3,000	100 – 400	
General cargo	50 – 350	50 – 350	500 – 3,000	100 – 400		
Container vessels	50 – 350	50 – 350	100 – 400	300 – 750	300 – 750	300 – 750
RoRo vessels	50 – 350	50 – 350	100 – 400	100 – 400	300 – 750	
Passenger ship	50 – 350	50 – 350	100 – 400	300 – 750	300 – 750	300 – 750
Fishing vessels	50 – 350	100 – 400				

Note: These figures are indicative and are the costs for installing equipment on existing vessels. The cost of adapting a vessel for shore connection depends on the plant design and the possibility of varying the voltage and frequency range when needed.

Source: The IMO GloMEEP Project[11]

[11] (GloMEEP, 2020)

The Benefits of Shore Power

Emissions at berth account for approximately 16% of ships' carbon emissions, 13% of NOx and 11% of PM10.[12] Connecting to shore power results in significant reductions in at-berth air emissions. Whilst it is important to contextualise emissions from both ports themselves and vessels within ports (see Table 6), lowering emissions of both greenhouse gases and other air pollutants is a priority for the industry.

Table 6: Source Apportionment of Nitrogen Oxides emissions in six UK ports

Location*	Predicted NO2 concentration (µg/m3)	NOx Source Apportionment (µg/m3)							
		Main background	Industrial	Rail	Port rail	Port machinery	Shipping	Roads	Total NOx
1	36.7	23.9	0.2	<0.1	<0.1	0.2	1.5	36.8	62.8
2	30.5	17.4	0.1	<0.1	<0.1	0.1	0.7	31.6	49.9
3	42	32.6	0.3	<0.1	0.2	0.1	4.4	42	78.3
4	41.3	24.3	0.4	0.2	0.1	0.2	1.4	45.9	72.6
5	40.4	23.8	0.2	<0.1	<0.1	0.2	1.4	44.9	70.6
6	47.3	24.8	0.4	0.2	0.4	0.2	1.5	60.3	87.9

Source: Arup for UK Major Ports Group[13]

**Location numbers correspond to ports participating in the research*

The provision of shore power is often presented as a solution for improving air quality, but its potential for helping reduce greenhouse gas emissions should not be overlooked. Connecting to shore power only reduces greenhouse gas emissions if the source of the energy is 'green', of course. Whilst UK energy generation is made up of around 40% renewables, that is likely to continue to grow. Many ports have invested significantly in on site renewable energy or are otherwise closer to energy generation sites. Combined with the growing greenhouse gas intensity of the UK Grid, this means that the contribution of shore power to decarbonisation is increasingly recognised.

[12] Schneider Electric
[13] (Arup for UK Major Ports Group, 2018)

According to a study by Entec[14], shore power can result in on-site emissions reductions of 97% for NOx, and 89% for particulates. It should be noted that the ultimate source of the electricity may be fossil fuel which effectively moves emissions elsewhere. However, in the UK this is increasingly from cleaner sources.

Shore power also eliminates vibrations and noise from auxiliary engines at berth, which has been measured at 90-120 dB in close proximity and improve maintenance conditions for the ships' engineers.[15] Emissions during manoeuvring, which can be significant, are not affected.

Shore power is not the only zero emission berth solution. Some hybrid batteries charge whilst on a voyage allowing vessels to be zero emission at berth, for example, and other options are being developed.

[14] (Entec, 2018)
[15] (European Commission, 2006)

EMISSIONS BY TRANSPORT MODE

grams of CO2 /tonne-km ▼

AIR

Boeing 747 — 435

Ilyushin IL 76T — 1,100

ROAD

Truck (40+ tonnes) — 80

RAIL

Intermodal (container) train — 35

Diesel locomotive — 49

SHIPPING

By far the most efficient way to move freight

Large bulk carrier — 2.5

Large container ship — 12.5

The UK ports industry

This section offers background information on the ports industry that is helpful background to later sections where we set out some barriers to the installation of shore power and potential solutions to overcoming those barriers.

As a relatively small island with a large population and advanced economy, it is no surprise that the UK boasts a large number of commercial harbours. There are approximately 125 cargo-handling ports around the UK, with 445 ISPS certified UK terminals registered by the International Maritime Organisation (IMO).

The UK ports industry is diverse, independent and competitive. It is the second largest in Europe, handling 95% of UK trade, almost 500 million tonnes of freight and over 60 million international and domestic passenger journeys each year.

The industry contributes £29.0 billion in business turnover and £9.7 billion in GVA to the UK economy annually as well as 115,000 jobs. Each year the industry contributes approximately £2 billion to the Exchequer and invests around £600 million in infrastructure. The aggregate impacts are much higher: it is estimated that the ports industry helped to support a total of £70.0 billion in turnover, 822,000 jobs and £10.8 billion through the compensation of employees in 2017.[16]

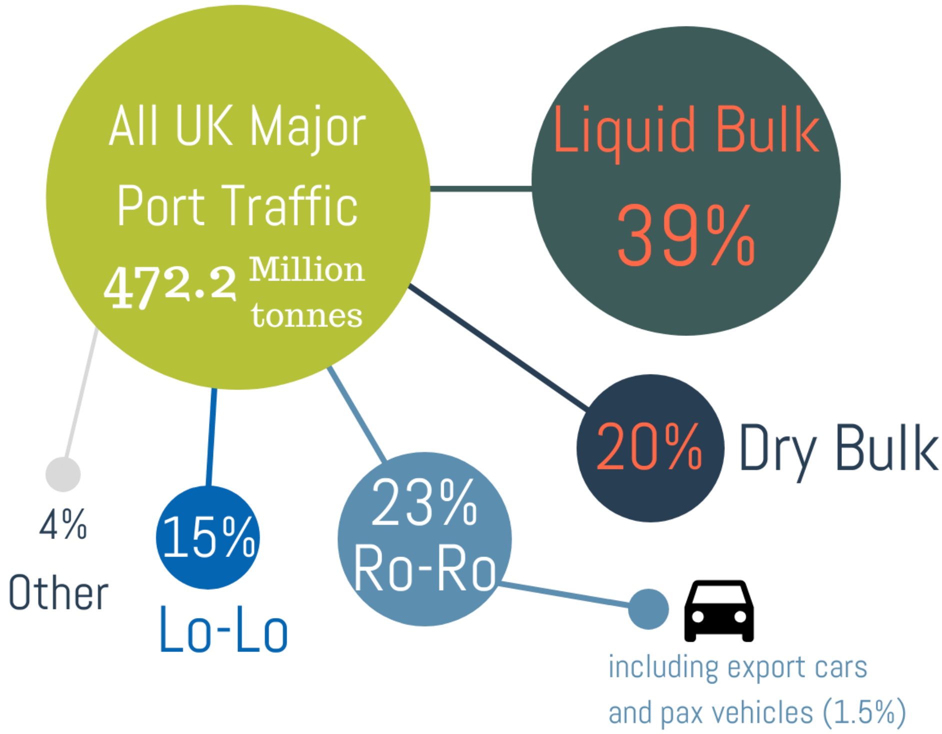
Each UK harbour authority is a unique statutory entity established with its own primary legislation. UK ports are required by law to operate their harbours commercially for the benefit of its users.

Ports are diverse in the type of cargoes they handle – many have become specialised in particular markets or trades although there are still a large number of multi-purpose ports that cater to a range of vessels and cargoes. There is also diversity in the degrees of vertical and horizontal integration: some ports are owned by shipping or logistics organisations, notably in the ferry sector, for example. There are different levels of vertical integration: some port authorities will also be port operators, others are more of a continental landlord model, with separate private operators handling cargo and passenger operations. This diversity is the sector’s strength but can make developing policy challenging.

Just as the markets they serve vary, so too do ports themselves. The ports sector in the UK has changed substantially over the last thirty years. A process of privatisation and deregulation has created a unique ports industry.

[16] (CEBR for Maritime UK, 2019)

Ports in the UK fall into one of three[17] ownership categories: Private, Municipal, and Trust. All three models are open to market forces, and are run independently as stand-alone, self-financing enterprises, free from systematic Government support or subsidy.



Source: Department for Transport Port Freight Statistics[18]

A mature industry, (ports in the UK have been operating in the UK for over two millennia[19] and Britain's oldest continual business is Aberdeen Harbour[20]), annual cargo throughput tends to rise and fall with GDP. As well as handling cargo, many ports have diversified to cater to wider maritime industries, such as shipbuilding and repair, bunkering, fishing, leisure and tourism (including cruise), and offshore energy. Ports have responsibilities for maintaining their harbours for the benefit of its users and have powers to charge those users accordingly for the maintenance of the port and where applicable, pilotage. Maintaining a port incurs significant costs and harbour dues must be set at an appropriate level and can be challenged if users do not feel they are fair.

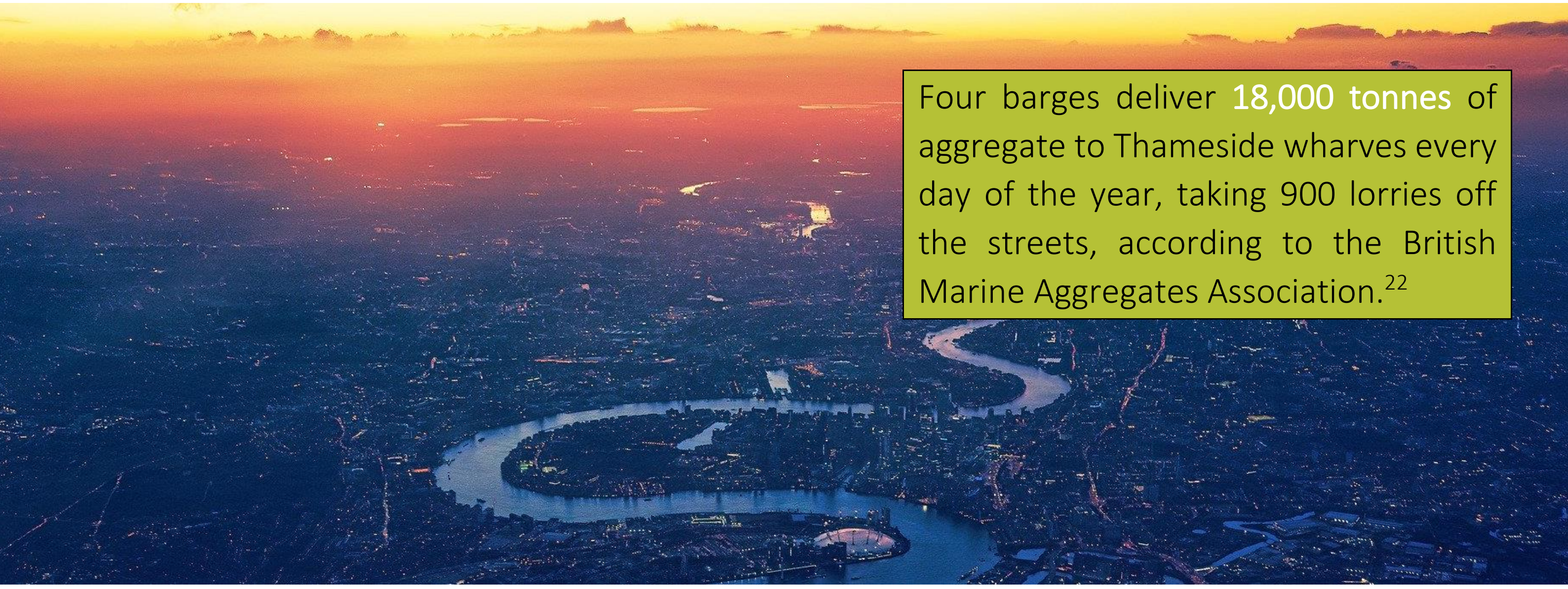
[17] In Scotland, port and ferry operator Caledonian MacBrayne is a company owned by the Scottish Government. Caledonian Maritime Assets, the Harbour Authority for 24 ports in Scotland, is also wholly-owned by Scottish Government.
[18] (Department for Transport, 2019c)
[19] (BBC News, 2002). In 2002 archaeologists identified harbour works in Poole dating back to 250 BC.
[20] (Aberdeen Harbour, 2020)

The competitive nature of the UK ports industry is the result of Government policy designed to deliver private investment and an efficient logistics industry. Ports compete with others in the UK and Europe on the quality of their infrastructure and quality of service, as well as other areas largely outside of their control such as location and hinterland connectivity.

The National Ports Policy Statement says that the Government welcomes and encourages such competition.[21] It has delivered an industry that is efficient and invests hundreds of millions of pounds in capital investment every year.

Government policy has successfully delivered an efficient and investing ports industry. Challenges such as climate change which necessitate rapid decarbonisation were not part of this design and whilst the industry is used to adapting to new environmental regulations on a regular basis, tackling both climate change and improving air quality will need greater collaboration and partnership between industry and Government.

When developing or implementing climate change policy, Government and others must be mindful of the fact that moving freight by water is by far the most efficient mode of transport. A holistic approach to emissions reduction is critical and indeed electrification in general can be cross-modal. Ports are very much part of the solution to lowering emissions and in many cases, there are no realistic alternatives. It is therefore important that shipping is not put at any unnecessary competitive disadvantage that may disincentivise modal shift towards shipping.



Four barges deliver 18,000 tonnes of aggregate to Thameside wharves every day of the year, taking 900 lorries off the streets, according to the British Marine Aggregates Association.[22]

[21] (Department for Transport, 2012)

[22] (British Marine Aggregates Association, 2020)

What are the barriers to shore power in the UK?

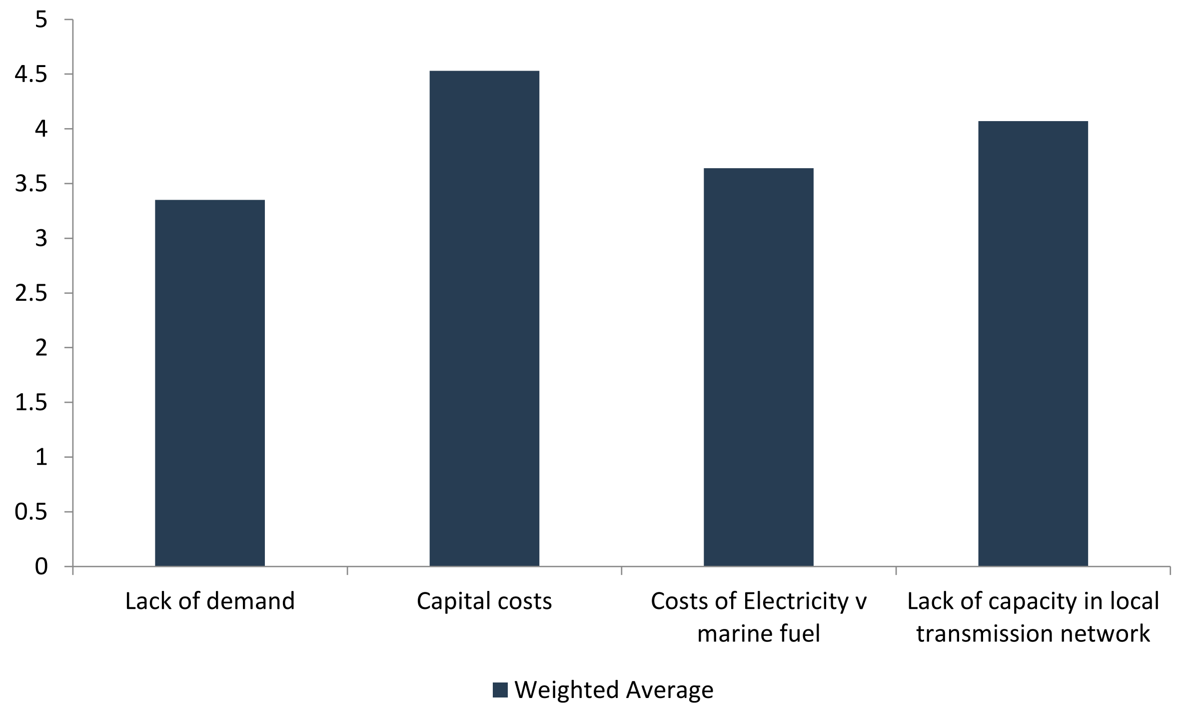
The British Ports Association conducted a survey in February and March 2020 of its members on their attitudes towards shore power and barriers they perceived as preventing them from installing it in their ports or terminals. We also undertook in-depth phone interviews with several ports in the UK to understand some of the challenges in more detail. In the course of our research we also spoke to several European ports on their experiences with shore power.

A summary of the responses to our survey is attached at Annex A.

We found that capital costs were the most commonly identified barrier, followed by the related challenge of energy network capacity (which typically comes at a large cost to remedy), the cost of electricity and a lack of demand.

We have examined these barriers in detail in the following sections, as well as summarised some of the wider challenges that were raised with us.

To what extent are the following a barrier to shore power in your port? (5 is 'Prohibitive barrier'; 1 is 'Not a barrier')



Source: BPA Member Survey

High capital costs

UK ports operate on a commercial basis and investment and spending therefore must have a viable business case. Our survey and qualitative phone interviews found that the high capital costs were the biggest barrier to the installation of shore power. This is not a surprising finding for most people who are familiar with this issue. We have found that this barrier can be split between (1) high capital costs for installing infrastructure inside the port and (2) high costs and charges for any remedial work that will be needed on the local distribution network, including providing additional capacity, building new substations and any network reinforcement that may be necessary.

We have not spoken or heard from any ports who have said that this is not a barrier, although clearly some ports have overcome it and do provide power – albeit none so far at a large scale. One port we spoke to who has been considering a large capacity shore connection said that if the project went ahead it would be despite the costs and lack of business case; the project would be undertaken on its environmental merits alone.

This barrier is not unique to UK ports; it is consistently raised in discussions, interviews and meetings with port authorities and operators that we speak to around the world.

The overall cost for shore power projects varies significantly depending on location, the capacity of the connection the and characteristics of the local energy networks.

Table 7: Selected examples of reported shore power project costs from around the world

Port	Country	Date first operational	Total Cost	Maximum Capacity (MW)
Juneau	USA	2002	USD 5.5m	11
Gothenburg	Sweden	2010	SEK 7m	2.5
New York	USA	2011	USD 21m	20
Oslo	Norway	2011	NOK 7.8m	4.5
Oakland	USA	2013	USD 70m	8
Kristiansand	Norway	2014	NOK 4.2m	0.5
Bergen	Norway	2015	NOK 7.5m	0.5
Livorno	Italy	2015	EUR 3.5m	12
Vancouver	Canada	2017	CAD 12m	7.5
Dunkirk	France	2019	EUR 2.2m	8
Vancouver	Canada	2019	CAD 6.8m	7.5
Genoa	Italy	2020	EUR 4.5m	40
Kiel	Germany	2020	EUR 15m	12.8
Hamburg	Germany	2022	EUR 76m	33.5
Note: currencies not adjusted for inflation For reference, April 2020 currency rates are roughly 1 USD 0.81 GBP; 1 CAD 0.58 GBP; 1 SEK 0.08 GBP; 1 NOK 0.08 GBP; 1 EUR 0.88 GBP				

Source: BPA research

Table 7 shows the wide variance in reported project costs from a range of shore power projects. The uncertainty is compounded by the fact that some projects include the cost of network upgrades – usually the bulk of the cost – whereas others do not or they were not necessary.

The costs of potentially having to upgrade local energy networks were cited by most people we spoke to and respondents to our survey identified it as the biggest barrier. The second highest barrier identified was lack of capacity in the local energy network, which is related to the capital costs barrier.

Large vessels will require in the order of 5MW per connection which could be a quarter or half the typical demand for a small to medium port. This connection will inevitably put stress on local energy networks, which requires either significant capital expenditure on reinforcement to remedy or energy storage

A feasibility study into network upgrades could cost around £60,000 and there are additional costs associated with investigating shore power technical viability. For many ports we spoke to, even relatively small upfront costs are can be dissuasive given the other barriers identified below, but the system of charges is punitive for ports looking to lower emissions for their customers. The costs for studies inside the port tend to be much smaller – usually around £5,000 according to suppliers we spoke to.

Table 8: Estimated costs of shore power project elements

Project Element	Estimated Cost ranges
Feasibility Studies; Surveys, Pre-Project work etc	£5 to £70k
Network capacity upgrades, reinforcement etc	£2m to £25m for a 16MW connection
Off-grid generation	Up to £6m
Infrastructure inside port or terminal, including groundwork etc.	£0.3m to £10m
Retrofitting Vessels	Up to £1m

Source: BPA research

The necessity for network upgrades will be a major factor in any shore power business case. We looked at National Grid's network capacity map in an effort to understand how many ports energy constraints would affect. Of the top ten largest ports in England and Wales by throughput, seven were in areas where the nearest substation was at or near full capacity.[23] [24] Even where there is additional available capacity, there may not be enough to meet the requirements of shore connections. We would be interested to see more in-depth research and analysis of network capacity specifically in regards to shore power and wider port electrification.

Off-grid generation

On-site generation offers a potential alternative to connecting to electricity grids. In some locations where the capital costs associated with network remedies are particularly high, off-grid solutions might be (relatively) more financially viable. Ports are often in good locations for the generation of renewable energy such and many UK ports have installed solar panels and wind turbines, as well as other

[23](Department for Transport, 2018)

[24] (National Grid, 2020)

technologies. Submarine energy cables from offshore wind farms often come ashore near ports, too. Most renewable energy sources are intermittent generators however and so may need associated large, and costly, energy storage options alongside it as well as transformers and other equipment.

Table 9: Cost Estimates of Terrestrial Wind Turbine Project

Maximum Power Output	Project Cost
Single 100kW turbine	£345k
Single 800kW turbine	£1.03m
Single 1MW turbine	£1.25m
Single 3MW turbine	£2.33m
Single 3.5MW turbine	£3.13m
Note: If the turbine is connected to the grid to export energy, then there will be related costs that could significantly increase overall project costs	

Source: Renewables First[25]

[25] (Renewables First, 2015)

The Price of Electricity

The price of electricity compared to marine diesel is consistently raised as a barrier to the take-up of shore power. UK electricity prices are the second highest in Europe, before taxes.[26] From our participation in European ports forums, this is not specific to the UK, although as shown in the table below it is a bigger barrier given the costs.

When building a business case, a port must be confident that their product – the electricity – will be able to compete against marine fuel and any potential alternatives that might appear in the longer term. Ports will usually also need to add their own margins to the electricity to recover their investment costs.

Table 10: Price of Business Electricity (High Usage Industries), Selected Countries Supporting Shore Power, before tax

Nation	Pence per kWh
UK	10.96
Spain	7.83
Germany	7.75
Norway	7.35
Belgium	6.48
USA	5.69
France	5.67
Netherlands	5.31
Sweden	4.62

Both the prices of electricity and the price of marine diesel fluctuate and different shipping owners and operators (and indeed ports) will have differing buying power when it comes to negotiating prices. This makes direct comparisons more difficult.

Shipping is an extremely competitive industry and it is clear to us from our conversations with ports that shipowners – like most commercial organisations – will in most cases take the cheapest viable option on energy. Therefore whilst using auxiliary engines is the cheaper option and with no regulation in place to

[26] BPA Research

prevent it (notwithstanding IMO and emissions control area rules), it will be difficult for shore power to compete.

Consumer facing sections of the shipping industry such as cruise may opt for shore power for their reputation or because customers demand it. Pressure may also begin to fall on carriers from investors which may change behaviour but our view is that for the majority of shipping, cost will remain the primary driver of choice between using auxiliary engines and plugging in, where available.

Figure 1: Rotterdam Bunker Prices, MGO

Source: shipandbunker.com[27]

Our understanding is that a large shipping line buying marine fuel in large quantities might expect to pay around \$0.08 (£0.06) per kWh. During our research we were told that smaller organisations in the UK might currently expect to pay around £0.13 per kWh.

[27] (Ship and Bunker, 2020). Values as of 20 May 2020.

Lack of demand

UK ports are market-led and provide their infrastructure and services based on anticipated or actual demand from port users. A lack of consistent demand from port users was identified as a major barrier for UK ports in the provision of shore power. It is not as big a challenge as capital costs, local network capacity or even the price of electricity, but it is nevertheless seen by many as a prohibitive barrier.

Only a minority (11%) of ports responding to our survey had had “a lot” of inquiries about the availability of shore power at berths. Phone interviews revealed that cruise and container lines tended to be the main segments that enquired about shore power. Some members also noted that these sectors are often demanding, reflecting the extremely competitive nature of those sectors.

Ferries are another sector that are often mooted as suitable for shore power, given the predicable vessel calls and berthing times, relatively lower power demands and high degree of vertical integration between vessels and ports. Ferries in the UK are also highly competitive. Many ferries have a short turnaround time which we were told could make plugging in unfeasible[28] but that many ferry companies are exploring a wide range of options to lower air emissions, including the use of exhaust gas cleaning systems and hybrid systems.

Offshore support vessels (OSVs) are also sometimes suggested as an appropriate segment for showcasing shore power given that these vessels are at berth for longer periods of time and usually work out of a single port. Phone interviews suggested that there had not been a significant demand from this sector in this regard.

Demand from shipping more widely

There are over 96,000 vessels in the world as of April 2020.[29] Around 50,000 are internationally trading merchant vessels, according to the International Chamber of Shipping.[30]

[28] Although new technologies such as contact charging may help resolve this particular issue
[29] (UNCTD Data Centre, 2019)
[30] (International Chamber of Shipping, 2020)

Table 11: World merchant fleet by type of ship

Total fleet	96,295
Oil tankers	10,766
Bulk carriers	11,373
General cargo	18,993
Container ships	5,269
Other types of ships	49,894

Source: UNCTAD[31]

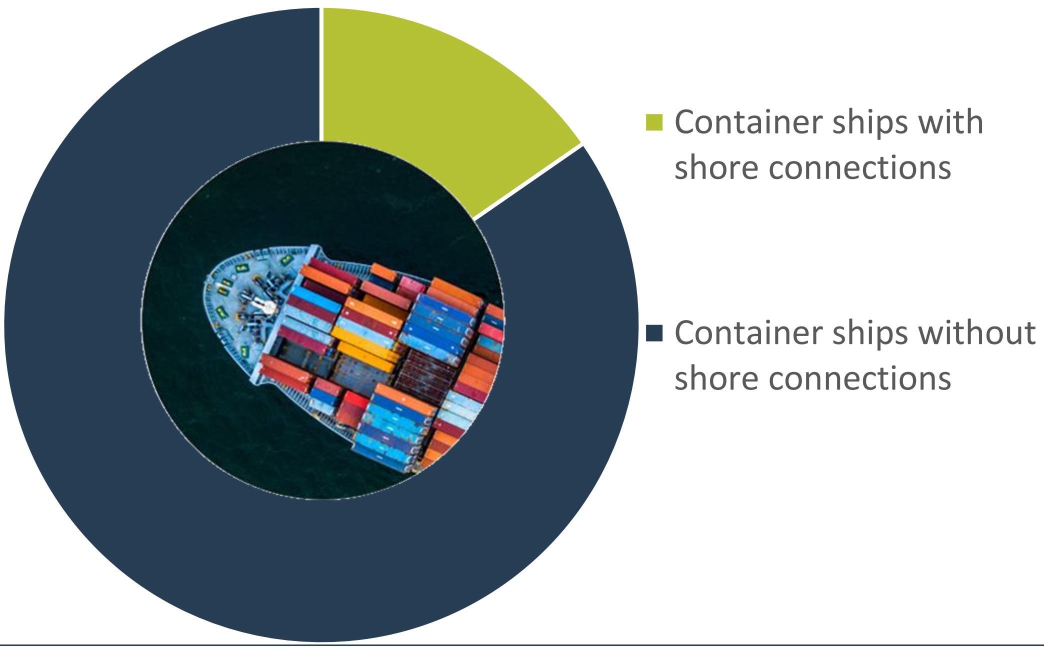
There is little reliable evidence as to the number of vessels in the global fleet that are able to connect to shore power. Clarksons Research suggests there are 525 vessels with shore connections.[32] However data shared with us by the Environmental Ship Index[33] shows that there are approximately 1500 vessels that have the ability to connect to shore, with container ships standing out with 809 of them having shore connections.[34] This accounts for approximately 15% of all container vessels.[35]

[31] (UNCTD Data Centre, 2019)
[32] (Clarksons, 2020)
[33] (Environmental Ship Index, 2020). The Environmental Ship Index is a voluntary scheme that allows ships to register particulars about their vessels in order to quality for port tariff discounts at participating ports. The Port of London Authority is the only UK port that participates as of May 2020.
[34] This data includes vessels who have capacity to connect to shore power although it is not guaranteed that it is in working order, but it is the most reliable indicator we have found so far. The large discrepancy between the figures may be due to the fact that Clarksons' data is vessels with 'High Voltage Shore Connections' whereas many vessels' connections will not be high voltage. The data may also just simply be incomplete.
[35] It is worth noting that many of the ports offering ESI scheme incentives are container ports.

Table 12: Vessels registered with the Environmental Ship Index (ESI) as having shore power capability

Type of vessel	Number
Bulker	85
Chemical tanker	81
Container ship	809
Dredger	3
Ferry	2
Fishing	4
Gas tanker	2
Multipurpose ship	247
Other vessel	127
Passenger vessel	36
RoRo-Ship	25
Sailing vessel	1
Tanker	27
Tug	51
Total	1500

Source: Environmental Ship Index as shared with BPA[36]



Source: UNCTAD; data provided to the BPA[1]

[36] (Environmental Ship Index, 2020)

Whilst we recognise that our data may be incomplete, it is clear that at present only a minority of ships overall are able to connect to shore power.

Data for cruise ships is also patchy, but the cruise industry is likely the most shore-power ready of all shipping segments. Cruise Lines International Association (CLIA) report that as of 2019 55 (27% of total cruise ships) cruise ships are equipped for shore power.[37]

Whilst we think it likely that the number of vessels with shore connections will grow, data from Clarksons Research shows that just 1.5% (56) of the current vessels on order will have shore connections.[38] Even accounting for some possible underreporting, that is concerning. Despite this, and considering the costs for retrofitting vessels with shore connections is substantially higher than costs of installing them during their build, it does not seem likely that there is to be a significant growth in demand in the near future across the board, given the 20-30 year lifespan of vessels.

Demand by sector

There are other factors affecting the demand for shore power from different types of vessels calling at UK ports that we have not considered. This includes potentially different types and different lifespans of vessels typically calling at UK ports. The points above may not be comprehensive; they are however illustrative of an issue picked up in our survey, in our interviews and in conversations and discussions over many years: there is currently not enough demand to make shore power a commercially viable option in the overwhelming majority of UK ports.

The higher prevalence of shore power installations on certain types of vessels does offer some hope however. During the course of our research we spoke to the Port of Hamburg, which is currently expanding its shoe power availability, including off-grid and mobile solutions. Hamburg estimate that shore connections are concentrated in larger container vessels and cruise ships and predict this will grow. The table below shows estimates of the number of vessels that will be ready to connect to shore power at the Port of Hamburg within five years.

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[37] (Cruise Lines International Association, 2019)
[38] (Clarksons, 2020)

Table 13: Port of Hamburg's Estimates of Vessels' Shore Power Readiness by 2025

Vessel Type	Sub-Class	Estimated Shore Power Readiness by 2025 (of vessels calling at Port of Hamburg)
Container	1-ULCS Future > 20k TEU	80%
	2-ULCS 405*63	75%
	3-ULCS 400*60	42%
	4-New Postpanamax	44%
	5-New Panamax	30%
	6-Old Panamax	2%
	7-Feeder/NOKmax	5%
Cruise	1-CRUISE>2500 pax	82%
	2-CRUISE<2500 pax	27%
	3-CRUISE<1000 pax	51%
Gas/Oil/Chemical Tanker	1-Suezmax/VLCC	
	2-Aframax	
	3-Panamax	
	4-NOKmax	
	5-LNG	
Bulker	1-Capesize	
	2-Postpanamax	
	3-Panamax	
	4-NOKmax	3%
Multipurpose	1-Large General Cargo 1	
	2-Large General Cargo 2	
	3-NOKmax	11%

Source: Hamburg Port Authority estimates shared with BPA

This is an interesting view of the situation in one major European port. We would welcome more robust insight into the prevalence of shore connections in different segments of the world fleet and credible projections on how this is likely to change in future.

It is not a coincidence that the prevalence of shore power installations in Europe, where its use is currently voluntary, are to support vessels that call regularly or where a consistent demand can be expected and that these vessels are ahead in installing connection equipment on board.

Our research and experience from talking to port professionals in Europe is that successful shore power projects are usually undertaken as a collaborative effort. A "build it and they will come" approach is not sensible. In New York's Brooklyn cruise terminal, we found that cruise vessels had declined to plug in for various reasons including the cost of electricity[39]. Interviews with European ports suggested that many projects (both complete and planned) are undertaken on a partnership basis with agreements and involvement of vessels and occasionally with other ports on established liner or ferry routes.

Cost Recovery

The primary issue with a lack of demand for shore power is the missed revenue opportunities from selling power to vessels. This would be the only method of recovering costs for shore power installations for ports and terminals.[40] Therefore a lack of consistent usage of available shore power would mean that the port or terminal is unable to recover the capital costs. In addition to this risk, there are a number of fixed costs associated with shore connections that must be considered.

As a supplier of energy to tenants or customers, ports incur charges for more than the actual electricity that is used. Distribution Network Operators (DNOs) and the operators of the transmission network charge for the use of their transmission and distribution networks. Included in these costs will be capacity or availability charges, which covers costs incurred by the DNOs for ensuring that the agreed power capacity is always available to the customer. Volume management charges will also be levied if the customer uses *more* than the agreed power capacity. These charges are designed to help network operators manage the balancing of supply and demand across the network.

This means that if a port installs shore power in anticipation of supplying significant amount of power to vessels at berth and it is not used, they will be incurring costs for that power anyway, on top of the capital investment. We have estimated availability charges to be approximately £1.50 per kVA[41] of available capacity per month. This would equate to approximately £180,000 a year in use

[39] (Collins, 2019)

[40] Vertically integrated logistics/freight companies who own terminals and vessels can potentially recover costs from fuel savings – obviously depending on what they pay for fuel and electricity, both of which vary. Even here, for the most part it will be difficult or take a long time to recover costs.

[41] This figure was supplied by a BPA member port

of system charges for an 8MW/10MVA shore connection. Some larger ports may be able to negotiate lower charges, but the fact remains that there are ongoing and significant charges for ports for installing shore power if it is not used.

In addition to use of system charges, there are also fixed costs incurred by ports and terminals supplying shore power for maintenance and for any additional staff hours that may be needed to operate equipment. We have covered the challenges around other electricity charges – where power *is* used – in a later section of this report.

As we have established, the cost of building shore connections in ports and terminals can run into many millions of pounds and are built on the expectation that they will be used. The cost of installing shore connection equipment on a vessel are usually considerably smaller – especially when included at construction phase. In short, ports installing shore power equipment bear significant costs and must do so in the expectation of reasonable usage, whereas vessels installing or retrofitting shore power connections have relatively smaller costs and there are also few ongoing costs or concerns.

Given the above, we conclude that when it comes to the tired ‘chicken and egg’ debate on shore power, there are substantially higher risks for ports and terminals in providing a supply without demand than there are for vessels requesting demand without a supply. Even where there are shore power enabled vessels calling regularly at a port (or particular berth), there remains uncertainty for the port in that vessels and routes can change.

Therefore, any Government that wants to see shore power play a significant role in emissions reduction – as seems reasonable for certain sectors at least – must make tackling the lack of demand a central pillar in any policy considerations. Tackling lack of demand might focus on certain sectors but must not do so in a way that confers a competitive advantage on any particular one of them.

Table 14: Number and selected characteristics of vessels arriving in UK and world ports, 2018

		Number of arrivals	Median time in port (days)	Average age of vessels	Average size (GT) of vessels	Maximum size (GT) of vessels
World	**All ships**	**4,112,944**	**1.00**	**18**	**15,066**	**234,006**
	Passenger ship	2,227,407	N/A	21	8,928	228,081
	Wet bulk	494,120	0.90	13	15,543	234,006
	Container ship	454,016	0.70	13	38,520	217,673
	Dry breakbulk	430,344	1.10	19	5,438	91,784
	Dry bulk	259,551	2.00	13	31,940	203,483
	Roll-on/ roll-off ship	187,532	N/A	17	25,368	100,430
UK	**All ships**	**193,462**	**1.10**	**17**	**13,667**	**217,673**
	Passenger ship	135,259	N/A	18	12,278	171,598
	Wet bulk	12,329	1.10	13	12,485	170,004
	Container ship	8,355	0.70	13	37,344	217,673
	Dry breakbulk	17,646	1.50	18	3,323	71,543
	Dry bulk	1,800	2.70	13	25,699	99,195
	Roll-on/ roll-off ship	15,870	N/A	15	24,483	100,430

Notes: Figures supplied to UNCTAD from the fusion of automatic identification system (AIS) information with port mapping intelligence by MarineTraffic (http://marinetraffic.com), covering ships of 1000 GT. Passenger ships and RO/RO ships are excluded from time at port calculations.

Source: UNCTAD Data Centre[42]

[42] (UNCTD Data Centre, 2019)

Table 15: Size and Selected Types of Vessels Calling in UK ports

	Vessel size (DWT)	Number of vessel arrivals (2018)	Percentage of total
Tankers (total: 15,448)			
	1 - 4,999	5446	35%
	5,000 - 19,999	7072	46%
	20,000 - 99,999	1738	11%
	100,000+	1192	8%
Ro-Ro vessels (total: 57,792)			
	1 - 4,999	16457	28%
	5,000 - 19,999	40635	70%
	20,000+	508	1%
Fully cellular container vessels (total: 8698)			
	1 - 4,999	590	7%
	5,000 - 19,999	4897	56%
	20,000+	3211	37%
Other dry cargo vessels (total: 23,984)			
	1 - 4,999	16194	68%
	5,000 - 19,999	5220	22%
	20,000 - 99,999	2348	10%
	100,000+	99	0%
Other vessels (total: 12,588)			
	1 - 4,999	9438	75%
	5,000 - 19,999	2881	23%
	20,000+	0	0%
Passenger Vessels (total: 1,935)*			
	1 - 4,999	903	47%
	5,000 - 19,999	979	51%
	Unknown	53	3%
* Deadweight tonnage is not a particularly useful indicator of cruise ship size as it measures cargo and passenger weight.			

Secondary Barriers & Considerations

In addition to the primary prohibitive barriers discussed in the previous section, ports have raised a variety of other concerns and considerations with us around the provision of shore power.

The issues discussed below vary in significance. Some will be prohibitive barriers stopping projects from going ahead whereas others will be lesser considerations. Some can be overcome, others might need some assistance from Government. We have included these in a separate section as they are of a different magnitude to those listed above, which are raised by almost every port in every conversation about shore power. These issues have been raised by one or more ports during our research.

Complexity

The sheer complexity of what needs to be done to get a shore connection in place was mentioned by numerous ports in our discussions.

"I don't know why anybody would be against [shore power], but there are so many nagging issues that add up to big barriers and when this isn't your primary business it can be very off putting"

BPA Member during phone interview

A ports primary business is ensuring the safe navigation of users through the provision of suitable infrastructure and in many cases, pilotage. Cargo terminals are logistics specialists whose business is the efficient movement of cargo through the terminal. The energy system is complicated and even preliterary investigations can be expensive and time consuming.

Whilst the provision of shore power may in years or decades to come offer ports a competitive advantage – especially in sectors such as cruise, for now it is a difficult and costly activity that immediately seems fraught with risk with little or no reward for the port.

Many ports are not in areas with significant spare power capacity and the energy planning and upgrade system seems designed to punish the operator who tips local energy demand over the limit with significant charges for extra power with little guarantee it will be used. A feasibility study alone will cost a port £60,000.

In short, even a cursory look into providing shore power is enough for many of the ports we interviewed to decide that it is too complicated with little or no reward – at least not as things stand.

Other Opportunities

Several ports we spoke to said they had explored wider electrification possibilities in their port or terminal. Emissions from vessels in port and/or at berth are 'Scope 3' emissions.[43] Many ports are already putting significant thought into how they can reduce their own 'scope 1' emissions – of both greenhouse gases and other pollutant air emissions. As commercial entities, ports do not have endless resources to spend on emissions reductions and must decide where best to spend their time and money. In some locations, power availability may also be at a premium.

Many ports have already invested in electric plant, equipment and vehicles. Others are planning to. Others have found it not feasible for their particular circumstances.

For many ports, therefore, shore power may be competing with other investments that offer the port itself more immediate and guaranteed emissions reductions options. Investing in electrification of port infrastructure or plant and equipment may offer benefits directly to the port instead of its customers. This has perhaps been made more urgent by the Government's announcement in the 2020 budget to remove tax relief on diesel for non-road mobile machinery (NRMM), which will have a significant impact on many cargo-handling ports. The Government's stated intention is to incentivise electrification of NRMM. If this succeeds then it may reduce the resource (cash, time and power capacity) for shore power in some ports. If, as many of our members report, it fails as the alternatives are too expensive or not suitable (for example we are told that many battery-powered forklifts cannot complete a full-days' work between lengthy charges) then many ports will have to bear additional costs, potentially reducing investment available for shore power and indeed other operational efficiencies competing for investment.

[43] (Greenhouse Gas Protocol, 2020). The GHG Protocol Corporate Standard classifies a company's GHG emissions into three 'scopes'. Scope 1 emissions are direct emissions from owned or controlled sources. Scope 2 emissions are indirect emissions from the generation of purchased energy. Scope 3 emissions are all indirect emissions (not included in scope 2) that occur in the value chain of the reporting company, including both upstream and downstream emissions.

Emerging Liabilities

Port authorities each have enabling legislation that set out their powers and duties. Common to most harbour authorities is a responsibility for ensuring navigational safety and conservancy. Many also have pilotage duties. Terminals do not have specific statutory duties related to their business as a port.[44]

Beyond the provision of infrastructure and pilotage, ports often offer ancillary services, either directly or by leasing out land to terminals and third parties. These services include cargo and passenger operations, layup, vessel maintenance and repair, bunkering, and the provision of freshwater and goods. The provision of power to a vessel at berth is and always has been the responsibility of the vessel's charterer. The provision of power for a vessel is relatively new service for ports and could introduce significant new liabilities on ports, transferring responsibility for the provision of power from the vessel to the port in the longer term.

Vessels at berth depend on power, not just to keep the lights on but often for cargo operations such as pumping cargo to or from shore, keeping cargo refrigerated, or running critical computer systems. This is not a theoretical problem.

There will be a shift in liability as the provision of power will become a port responsibility rather than being under the control of the vessel. In the event that critical systems are lost on the vessel the costs could rapidly escalate. The commercial risk to the port of defending and paying out for claims could be significant. Such amounts will either have to be costed into financial predictions or mitigated by the provision of (expensive) backup systems, further denting any commercial case.

[44] Those handling vessels over 300 GT will have security obligations from the IMO and those that are critical national infrastructure or in scope of certain regulations, like the Network & Information Systems Regulations.

TT Club: Shore Power Claims

In one of the first claims related to a shore connection, a medium-sized European port authority with significant ro-pax traffic and TT Club member experienced an outage due to a transformer failure.

The port had originally installed shore power facilities partly in response to complaints from local residents over noise and emissions. It was the largest high voltage shore connection anywhere in the world when it was originally installed.

The shore power equipment was installed by a reputable service provider and the transformer plant was supplied by major manufacturer. A transformer failure put the shore connection out of service. The port found that there was a long wait for spare parts and so the facility was permanently connected to the local power grid.

Repairs, loss of profit and increased cost of working (main loss heading) ended up costing the port approximately 1.5% of its annual turnover.

<u>Lessons learned:</u>

- The importance of regular and correct maintenance
- Consider availability of spare parts
- Contingency planning
- Manage communications and messaging

TT CLUB
50 years of established expertise

Disincentivising Modal Shift

The British Ports Association is a champion for coastal shipping – moving more freight by water around the coast and using inland waterways. Shipping is the most carbon-efficient mode to move freight. Moving freight by water helps takes traffic off the road and lowers emissions overall. Our industry would be wary of anything that makes shipping less competitive against other modes of freight transport – particularly in the name of emissions reductions as the overall effect of encouraging more freight onto other modes could actually increase emissions.

Whilst the provision of shore power would not affect this, concerns have been raised by industry colleagues in the UK and beyond that steps to mandate its use in Europe could impact the competitiveness of shipping.

Quay Space

For many ports and terminals, quay space is at a premium. Land at the coast is expensive, especially in the south of England. Whilst some ports will have a lot of spare land, most will not, especially in a terminal and at operational berths. This must be factored into shore power plans. Disrupting operations to dig trenches, where needed, is also something no port will relish. Whilst the equipment needed for shore connections has a small footprint, it still takes up space in a terminal and at the berth and this must be factored into construction plans.

Safety

Several ports raised potential safety issues around installing shore power. Whilst we are unaware of any safety incidents related to shore connections it was noted that handling cables (where that is necessary) and additional 'quay furniture' such as transformers and cable management systems will not be welcome.

Electrical equipment add additional obstacles in an operational environment which could create cargo-handling issues for some or electrical hazards.

UK multifunctional port model

Many medium and large sized UK ports are multifunctional with many berths used to handle a variety of different types of vessels and cargoes. Whilst certain types of vessel, such as ferries, may need specialist equipment and dedicated berths, most vessels do not. In many multifunctional ports it would not be feasible to install shore power at every berth. Most shore power projects we have seen in our research involve installing equipment at a handful of berths.

Terminals and vessels both seek to minimise the time spent at berth loading or discharging cargo. Shore connections are usually fixed – although mobile solutions do exist. It would therefore be difficult to charge most vessels unless the 'shore power' berth was able to be used for the particular cargo operations that vessel required. Moving a vessel before or after cargo operations would not be feasible as the time at berth outside of those operations would be minimal. It would also undermine the financial and environmental case (vessel manoeuvring is a significant source of emissions and the auxiliary engines would be in use during cargo operations).

Many of the shore power projects we have looked at in North America and Europe are at berths used by specific vessels and designed in partnership or agreement with a shipping line. Having a 'shore power berth' at a multifunctional port may therefore not make much sense without a good idea of which vessels would use it and when.

Electricity charges

In the previous section we discussed availability charges, also known as capacity charges. These are essentially standing charges the energy users pay to cover the costs of having the power they need available to them. Amongst the other charges that ports pay for as part of their energy bills are volume management charges and transmission charges (TNUoS charges – Transmission Network Use of Service).

'Spikey' or unpredictable demand means higher electricity charges for a port, as of course does higher energy consumption. The provision of shore connections results in both higher energy use and significant spikes in demand. As significant energy users, most ports will pay Transmission Network Use of System (TNUoS) charges. These are paid to cover the cost of the transmission network operator. TNUoS charges are currently forecast by estimating demand during three peak half-hourly periods between November and February – known as triads. The amount of energy used during these periods can significantly affect the energy charges paid by a user and many organisations that use a lot of power will attempt to manage their load during these peak times, despite not being known in advance. Having a large vessel drawing a significant load – which may be equivalent to a port's entire power consumption - during a triad period is therefore a potential risk for a port.

We understand that there are proposals to change this system of charging, this uncertainty means that ports (and other energy users) will find it difficult to understand what their costs might be in the long term.

Volume management charges are also levied on ports that use more than their agreed capacity and ports connected directly to the transmission network will also incur balancing services use of system (BSUoS) charges.

Whilst these costs can be passed on, they could be significant and therefore lower demand and/or weaken the business case.

Stranded Assets

Another barrier to building a viable business case for shore power is uncertainty around the future of marine fuels or other emissions reduction or abatement technologies. At berth emissions account for just 16% of a ship's carbon emissions on average (although this will differ by vessel type). Most cargo vessels seek to minimise their time at berth for commercial reasons. Shipping is under pressure to cut emissions at sea as well as at berth and whilst there are lots of exciting technologies and innovations that make ships more efficient and thereby cut emissions, ultimately the holy grail for shipping is a zero emission fuel.

Some ports told us that they saw a risk of shore connections becoming 'stranded assets' – assets that do not see out their design life because they are no longer needed or rendered obsolete.

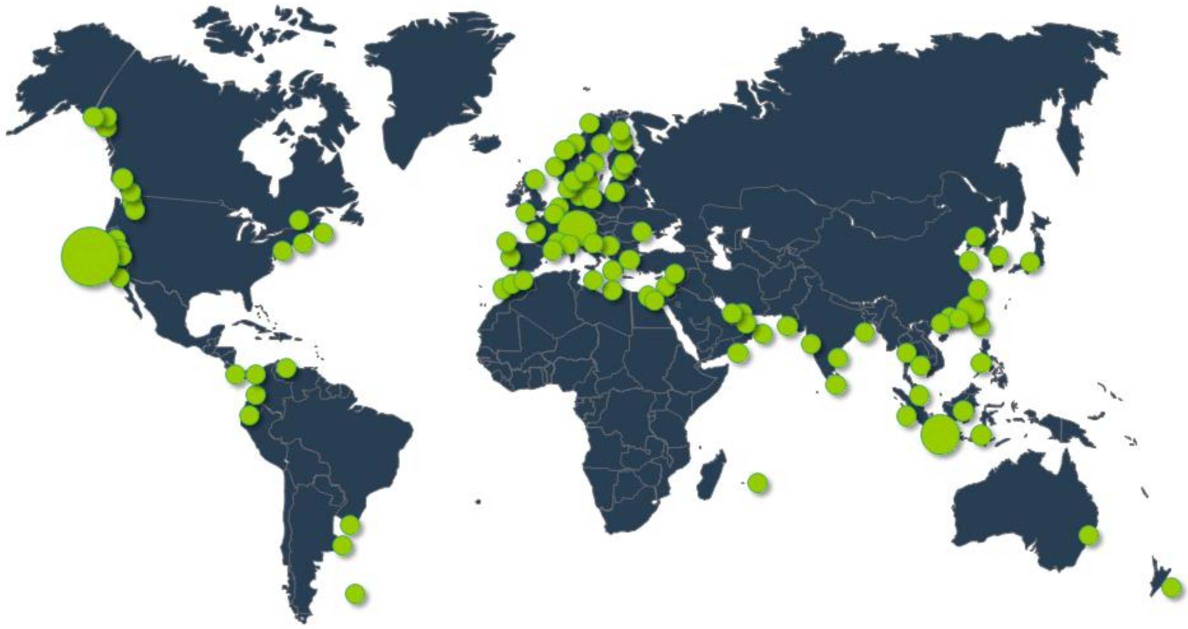
We heard from one port with shore power connections in North America that there is some interest in shore connections from some shipping lines, but that 'green' investments compete with other targets such as the IMO 2020 sulphur cap that drove investment in LNG, scrubber technology and low-sulphur fuel.

Others have argued that shore power would not necessarily be rendered obsolete by low or zero emission technology or fuel as – depending on the costs – shore power could be a complementary technology.

How have other countries overcome barriers?

There is no definitive list of ports or berths with shore power, although we understand the work is underway by several separate organisations on building databases. We believe that there are approximately 150 berths around the world with shore power available.[45]

Ports and berths with shore power



Source: Schneider Electric

We have analysed dozens of shore power schemes from around the world and looked at mechanisms used to support shore power projects. Our research did not find any current examples of any significant shore power projects anywhere in the world that have proceeded without some level of public funding, with one exception. If there are any large-capacity, commercially-financed projects, we have not been able to find them and they are in a small minority.

Whilst most port authorities outside of the UK are public entities with varying degrees of political influence, most are expected to operate on a commercial basis and be at least cost-neutral, although many will make a profit. In the USA, dredging in commercial harbours is undertaken by the army and in Europe there has been significant investment of EU funds in ports.

[45] Source: Schneider Electric. This figure includes shipyards, naval bases and connections for commercial fishing and leisure, including superyachts.

The UK's ports industry model is therefore somewhat unusual in that the sector is entirely independent of Government and generally operates commercially with very little public funding or Government support. This is something the industry has always proudly supported. The UK is also somewhat unusual in the high level of centralisation of policy and public spending. The combination of these factors means that ports are not tools or 'levers' that the Government can use in policy making. In short, UK ports function effectively at their primary purpose: private investment in infrastructure and the efficient handling of cargo and passengers and oversight of navigational safety.

In Gothenburg, for example, the port is owned by the city government and is responsible for tackling emissions from road traffic as well as emissions from vessels.

The necessity of public funding

Regardless of how efficient ports are in each of the countries and projects we looked at, public investment was deemed necessary for shore power projects to go ahead. We have not examined countries where there is no available large-scale shore power provision.

We have sought information across a wide range of ports and countries. We have found only one example of a shore power project being funded entirely from private sources: Princess Cruises' own berth in Juneau, Alaska. For every other project where we have been able to find information on the funding of the project, there has been some level of public subsidy. We believe it unlikely that the projects for which we could not find funding data would have been funded solely through commercial means given the available data and our experience. This echoes findings from our survey and interviews with UK ports where we were told that investigations into shore power has usually found that it is not financially viable in commercial timescales.

Several countries, such as Norway, Germany, France, Canada and the United States have national or regional funding schemes (or elements of wider schemes) that are dedicated to specifically supporting shore power projects. A summary of different types of support available is described in the next section.

Data limitations

We have gathered data from mostly public sources, which are listed in the annexes to this report. In some cases we have contacted ports to clarify information. Often the data that is publicly available is contradictory or imprecise, or missing key details. Some ports have initiated multiple, sometimes overlapping projects and at least one port we spoke to had dismantled one of their shore power systems after it became obsolete. Some countries and ports are more open about funding and project costs than others, and sometimes projects have changed between announcement and completion (in terms of costs and specification, in one case never proceeding at all). The most complete data we have is for Europe and North America, where the majority of large-scale shore power availability seems to be concentrated (for now). We have tried to use the latest reports where we are not sure or information is conflicting. Different ports or authorities also have different definitions of what costs are included in a project – in particular grid upgrades are sometimes included and sometimes not. Occasionally vessel upgrades are included as well.

Despite this, we believe the information we have gathered represents the most comprehensive and up to date dataset on the availability of shore power that is currently available. We are pleased to learn that other organisations are gathering robust data directly from ports and we hope that some of this information will be made public in some form.


NO SMOKING

Table 16: Characteristics and Funding of Selected Shore Power Projects

Port	Terminal	Vessel types	Date	Cost (millions)	Capacity (MW)	Funding
Bergen	Skolten / Montelabo	Cruise	2020	NOK 84	20	Port rec'd 50m NOK from Enova, a state owned grant scheme BKK (a renewables company) and Bergen Port apply for NOK 50 million in establishment support from Enova. The rest spit on the companies themselves, but in the calculus it is that the cruise ships cover the investment over time.
Bergen		OSV	2015	NOK 7.5	0.5	72% public funding Bergen Municipality (NOK 2 million), Hordaland County Municipality (NOK 1.5 million) and Enova (NOK 1.9 million). The rest is paid by the port authority.

Port	Terminal	Vessel types	Date	Cost (millions)	Capacity (MW)	Funding
Dunkirk		Container	2019	EUR 2.2	8	Co-financed by the Urban Community of Dunkirk, the Hauts-de-France region (via the European Regional Development Fund), and the Port of Dunkirk. The €1.2M installation at Terminal de Flandres was provided for the port authority (GPM de Dunkerque) by ACTEMIUM, part of Vinci Energies.
Genoa	Vado Gateway	Container	2020	EUR 4.5	40	Unknown
Genoa			2020	EUR 8	9.5	Unknown
Gothenburg	Quay 46-49	RoPax	2010	SEK 7	2.5	Estimated 40% from Kilmatklivet fund
Halifax	Cruise berth 22	Cruise	2014	USD 10	20	75% Public funding $10-million cooperative initiative among the Government of Canada, the Province of Nova Scotia and the Port of Halifax. Transport Canada will contribute up to $5 million to the project. The Province of Nova Scotia and the Port of Halifax will each contribute an additional $2.5 million.
Hamburg	Altona Cruise Terminal	Cruise	2016	EUR 10	12	The ten million euro shore power system in Altona was funded by the federal government and the EU with 7.2 million euros.
Hamburg	Container	Container	2022	EUR 76	33.5	Under discussion

Port	Terminal	Vessel types	Date	Cost (millions)	Capacity (MW)	Funding
Juneau (Alaska)	Princess Cruise berth		2002	USD 5.5	11	Princess spent approximately $5.5 million to construct the shore side facilities and to retrofit the vessels (about $500,000 each)
Kiel	Norwegenkai terminal (ferries - color line)	Ferry; Cruise	2019	EUR 1.5	4.5	30% (€400k) from state of Schleswig-Holstein from a fund that supports port infrastructure. The rest was from the Port of Kiel
Kiel	Ostseekai (cruise) and Stena's Schwedenkai (ferry) berth	Ferry; Cruise	2020	EUR 15	12.8	Funding from EU CEF (TEN-T), and federal state of Schleswig-Holstein (the same fund as the Norwegenkai project)
Kristiansand		Cruise	2014	NOK 4.2	0.5	Funded by the port, although the ferry company Color Line also made separate significant investment made possible by the NOx fund
Kristiansand	Ferries and cruise		2018	NOK 38	16	The plant costs close to NOK 40 million and is paid for by the EU Innovation Fund Horizon. The port itself pays the infrastructure, which amounts to NOK 3-4 million.

Port	Terminal	Vessel types	Date	Cost (millions)	Capacity (MW)	Funding
Livorno			2015	EUR 3.5	12	Livorno Port Authority received specific co-financing from the Italian Ministry of Environment (60%) and from the Region of Tuscany (20%)
Long Beach		Tanker; Cruise; Container	2008	USD 185	60	~70% grant funded. Remainder recouped from tenants (terminals)
Los Angeles		Container; Cruise	2004	USD 23.7	60	$25.5m
Marseille	Quai de la Méridionale	Ropax	2015	EUR 4.4	1.5	Part financed by national and regional government aid: funding by the GPMM , La Méridionale, the State, the Feder, l 'Ademe and the Provence-Alpes-Côte d'Azur Region
Marseille	Eastern Harbour		2022	EUR 20	25	80% public grant funding: 4.5 million ERDF(FEDER) funds; Port of Marseille (GPMM) has signed a objectives and financing agreement with the Departmental Council of Bouches-du-Rhône. The latter undertook to finance up to 41%, up to a limit of € 6M, for the electrification of four berths
Montreal	Berths 25, 27, 29 and M2	Cruise; bulk layup	2017	CAD 11	9.6	C$5m from SPTP; C$3m from Quebec Government; C$3m from the Port

Port	Terminal	Vessel types	Date	Cost (millions)	Capacity (MW)	Funding
New York	Brooklyn cruise terminal (1 berth)		2011	USD 21	20	PA/NY/NJ voted to spend $12.1 million to build a shore power station. EPA granted another $2.9 million for the project, and the Empire State Development Corporation allocated $4.3 million to the project, for a total of $19.3 million.
Oakland		Container	2013	USD 70	8	The Bay Area Air Quality Management District and U.S. Maritime Administration (MARAD) contributed $12.8 million to the Port's shore power project; up to an additional approximate $20 million were awarded to the Port by the California Air Resources Board (CARB) and the Metropolitan Transportation Commission (MTC)/Federal Highway Administration.
Oslo		Cruise	2011	NOK 7.8	4.5	Port of Oslo NOK 2 million Color line NOK 15.2 million Support Transnova NOK 2 million Support Enova NOK 3.7 million
Oslo	Utstikker 2 Vippetangen		2019	NOK 17	3	NOK 9m from Enova.
Oslo	Sjursøykai		2020	NOK 18	4	NOK 9.1m from Enova.

Port	Terminal	Vessel types	Date	Cost (millions)	Capacity (MW)	Funding
Palma de Mallorca	Muelles Paraires - Norte	Ferries	2020	EUR 2.1	1.6	20% financed by the CEF European funding instrument
Prince Rupert		Container	2011	CAD 3.6	6	Transport Canada, under the Marine Shore Power Program, will contribute $1.8 million to the project. This funding is in addition to $700,000 contributed by Western Economic Diversification Canada, $200,000 from the Government of British Columbia, and $900,000 from the PRPA and its partners, CN Rail and Maher Terminals.
Rotterdam	Parkkade		2020	EUR 1.5	0	€500,000 mainly coming from the government via the Dutch National Collaboration Programme on Air Quality, will aim to find the best way to improve air quality, particularly in urban areas. A second €1,500,000 trial is scheduled for 2020 focusing on innovative shore power concepts for larger sea-going vessels.

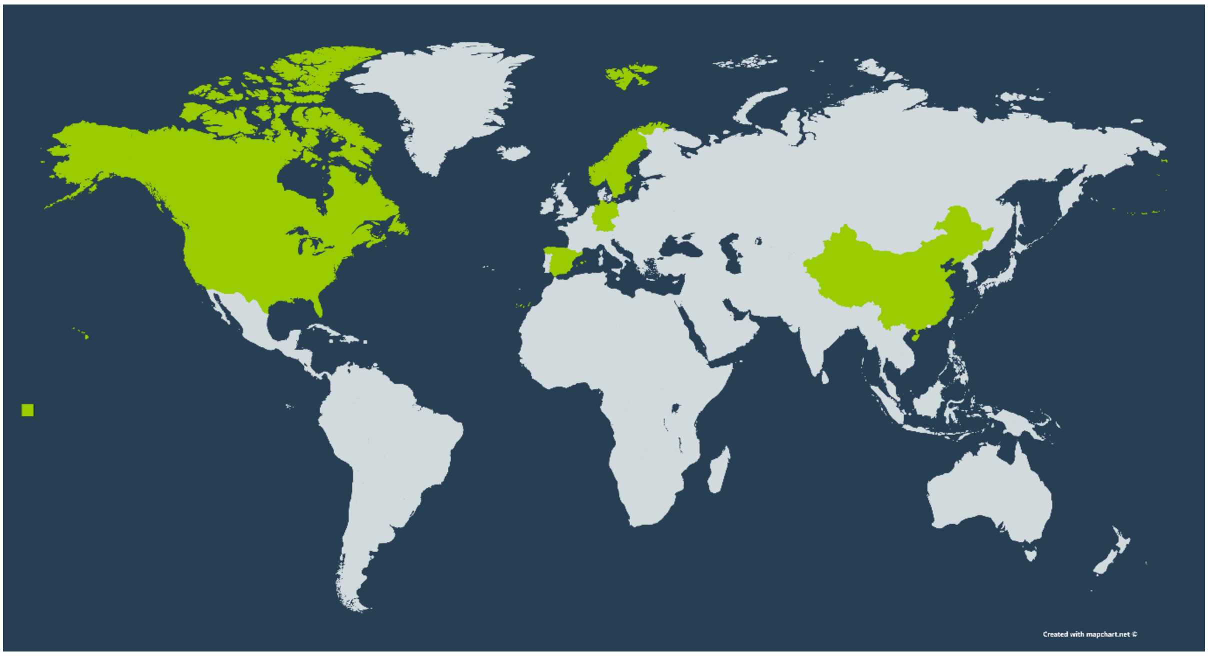
Port	Terminal	Vessel types	Date	Cost (millions)	Capacity (MW)	Funding
San Francisco	Pier 27	Cruise; reefers	2010	USD 5.2	16	$1.9 million – Bay Area Air Quality Management District (Carl Moyer Program); $1.3 million – San Francisco Public Utilities Commission (capital funds); $1.0 million – US Environmental Protection Agency (Diesel Emission Reduction Act Program); $1.0 million – Port of San Francisco (capital funds); San Francisco Public Utilities Commission budgeted $500,000 for "upstream" improvements to its electrical infrastructure.
Seattle		Cruise	2005	USD 1.8	16	Grid upgrade costs helped with a $50k grant from EPA
Toulon	Toulon Côte d'Azur (TCA) terminal	Ferries	2021	EUR 15	7	Zero Fumee plan Region (CRET + FEDER): 6.13 million € Métropole TPM: 4.39 million € Var Departmental Council: 3.6 million € State: 0.87 million €

Port	Terminal	Vessel types	Date	Cost (millions)	Capacity (MW)	Funding
Valencia			2023	EUR 8.5	30	The two projects are expected to be launched during 2020 (April in the case of the substation and June in the case of legislative homogenization) and that they have grants from the European Union. However, the president of the APV has defended that, given the relevance of both projects, "Valenciaport will continue with or without European grants."
Vancouver	Deltaport in Delta, B.C.	Container	2017	CAD 12	7.5	50% public funding Total project funding is $12 million: $6 million from Transport Canada's Shore Power Technology for Ports Program and $6 million from the Vancouver Fraser Port Authority. Both operational by the end of 2018.
Vancouver	Centerm in Vancouver	Container	2019	CAD 6.8	7.5	$3.55m from Shore Power Technology Programme; other half from Vancouver Fraser Port Authority

Sources: BPA Research from public information and some discussions with ports

Policies Supporting Shore Power in Other Countries

Below we have examined in more detail how some countries and ports have approached shore power.



Canada

Canadian ports are largely state owned – either by the federal or regional Government, generally on a landlord model with private concessionaires providing cargo and passenger operations at terminals.[46] Canadian ports handle a similar volume of cargo to UK ports, although one fifth of that is handled by one port (Vancouver).[47]

Transport Canada – the federal institution responsible for transportation policies – launched the 'Shore Power Technology for Ports Program' in 2012. This provided C$19.5m in funding to shore power projects. Funding was usually matched with regional funding or investment from other public sources. For example, the SPTP program contributed C$5m to the Port of Montreal's Alexandra Pier Shore Power Project in 2015. The Government of Quebec provided C$5.1m, with Quebec Port Authority contributing the final 25% -

[46] (Transport Canada, 2019)

[47] We could not find recent data for Canadian port throughput but in 2011 Canadian ports handled 466m tonnes (Statistics Canada, 2015) compared to 519m tonnes in the UK in the same year (Department for Transport, 2018). Breakdowns for some individual Canadian ports has been made available by the Association of Canadian Port Authorities (2016)

C$3.4m.[48] The fund closed in 2015. Other projects have been funded by federal and other public sources in earlier guises of this programme, including the Prince Rupert Port Authority, which was received approximately 70% of the project cost from public sources for the Fairview Terminal shore power project for container ships in 2010.[49]

Table 17: Funding from the Shore Power Technology for Ports Program

Province	Port	Project	Funding (CAD)
British Columbia	Seaspan Ferries Corporation	Swartz Bay Terminal Shore Power Project	88k
British Columbia	Vancouver Fraser Port Authority	Port Metro Vancouver Shore Power Upgrade and Enhancement at Canada Place Cruise Ship Terminal	347k
British Columbia	British Columbia Ferry Services	BC Ferries Shore Power Project	2.02m
British Columbia	Vancouver Fraser Port Authority	Centerm Container Terminal Shore Power Project	3.5m
British Columbia	Vancouver Fraser Port Authority	Deltaport Third Berth Container Shore Power Project	3.55m
Nova Scotia	Halifax Port Authority	Port of Halifax Shore Power	5m
Quebec	Montreal Port Authority	Port of Montreal's Alexandra Pier Shore Power Project	5m
		TOTAL	**19.5m**

Source: Transport Canada[50]

At the Vancouver Fraser Port Authority – the largest port in Canada and third largest in North America, there is a beneficial rate for shore power. This arrangement with the local energy utility means that vessels only pay for their

[48] (Cruise the Saint Lawrence, 2015)
[49] (Canadian Shipper, 2010)

[50] (Transport Canada, 2017)

metered energy and not the peak demand. This means that shore power costs are easily predictable for the end user. The power supply is interruptible although this is rare and there are battery backups as part of the system. The port also offers a 47% discount to vessels that have the ability to connect if they provide their connection requirements (although vessels are under no obligation to connect) to help the port plan future capability requirements.

China

Major ports in China are administered by local government, with separate entities responsible for port administration and commercial port operations. The Ministry of Transport has some competency over other ports and regulatory and planning at all ports.

In the past 15 years Chinese ports have been opened to some private investment and private operations, albeit in partnership with the state as joint ventures.

In 2017 the Chinese Government published Port Shore Power Plan, stating that 145 of the total 322 container berths at major coastal ports needed to have shore power, with 20 already having been installed. The plan also set out plans for 62 addition dry bulk berth installations to complement the existing cruise berth installations. 17 passenger vessel berths had been upgraded with a further 48 planned. In total, the plan targeting the construction of 317 shore power connections.[51]

We presume the cost for these connections was borne by ports and electricity network operators.

In 2019, China introduced a ‘domestic emissions control areas’ (DECA). As part of this, China introduced shore power requirements on vessels. New requirements introduced are being phased in on Chinese flagged vessels as well as cruise ships and non-Chinese flagged vessels equipped with shore connections.

The regulations also allow for alternative emission abatement or reduction options.

[51] (Ministry of Transport for the People's Republic of China, 2017)

Table 18: Summary of power requirements under the DECA[52]

Flag and ship use	Ship age	Effective date	Ship/engine types	Requirement
China-flagged ships, domestic navigation	Newbuild	Built after 1/1/2019	Applicable ship types: • Government vessels • River vessels (except for liquid cargo carriers) • River-sea vessels	Need to install shore power
		Built after 1/1/2020	Applicable ship types: • Container ships • Cruise ships • Roll-on/roll-off passenger ships • Passenger ships >3000gt • Bulk carriers >50,000gt	
	Existing fleet equipped with shore power	Effective 1/7/2019	Applicable ship types: All except for liquid cargo carriers	Need to use shore power while berthing over three hours in coastal ports (or two hours in river ports) where shore power is available unless equivalent measures[b] are used
	Existing fleet without shore power	Effective 1/1/2022	Applicable ship types[a]: • Government vessels • River vessels (except for liquid cargo carriers) • River-sea vessels • Container ships • Cruise ships • Roll-on/roll-off passenger ships • Passenger ships >3000gt • Bulk carriers >50000gt	Need to install and use shore power while berthing over three hours in coastal ports (or two hours in river ports) where shore power is available unless equivalent[b] measures are used
All ships berthing at Chinese ports	New build	Built after 1/1/2021	Applicable ship types: • Cruise ships	Need to install and use shore power while berthing over three hours in coastal ports where shore power is available unless equivalent[b] measures are used
	Existing ships without shore power	Effective 1/1/2021		
	Existing fleet equipped with shore power	Effective 1/7/2019	Applicable ship types: • All except for liquid cargo carriers	Need to use shore power while berthing over three hours in coastal ports where shore power is available unless equivalent[b] measures are used

[a] *Only applicable when these ships have >130kW engines that fail to meet with IMO Tier II regulations*

[b] *The official document lists suggestive measures, including using clean or new energy sources, onboard batteries, and auxiliary engine shutdown. However, it offers no guidance to demonstrate equivalency*

[52] (International Council on Clean Transportation, 2019). Original data from Ministry of Transport for the People's Republic of China (2018).

Germany

Most German port authorities are public institutions, managing ports for their respective states and operating largely as landlord ports. There are also some, generally smaller, privatised ports. National port policy is coordinated by the federal Government.

In October 2019 the German government announced €140m for shore power in German ports. This will be available between 2020 and 2023. Further details have not yet been published.

The German government is also considering how it can make shoreside electricity more competitive against marine fuels. Proposals include removing a large portion of a tax on electricity. German energy users pay a renewable energy levy of 6.756 cents per kilowatt hour – this is used to fund renewables projects. Policy makers are considering reducing this by 80% for shoreside electricity by mid-2020.

Proposals also under consideration include allowing electricity network operators to make special arrangements for the supply of power to shore connections. This means that 'load shedding' agreements could be permitted, meaning that energy suppliers can offer discounts on the price of electricity in return for agreeing to have the power supply cut off at short notice. This helps grid operators maintain balance in the grid.

Norway

Source: DNV GL Alternative Fuels Insight[1]

Norwegian port authorities are municipal enterprises – commercially operated but owned by local authorities. The Norwegian Coastal Administration (Kystverket) – a central Government agency – is responsible for pilotage and navigational and some port infrastructure.

Norway is arguably the most advanced country in terms of the number of ports with shore connections. According to DNV GL's Alternative Fuels Insight map, there are approximately 50 ports or terminals in Norway with shore connections.

Norway has several standing grant schemes for emissions reductions. One – Enova – has provided significant support to shore power projects. Enova is a Norwegian state funding body established in 2001 to accelerate Norway's energy transition. Enova is financed partly by electricity levy[53] and partly by state funding and invests between £160m and £320m[54] each year in energy and climate change projects.

Enova has a specific shore power funding scheme that has invested £48m in 90 shore power schemes since 2016, with a further round to be announced later in 2020.

Earlier rounds of funding provided up to 90% or 100% of funding for schemes. Funding from Enova is typically matched or part funded by municipal or country authorities with differing levels of input from the ports.

Norwegian Ports can also apply to the NOx fund for support for onshore power projects. The NOx fund supports projects that reduce NOx emissions and is

[53] Non-household consumers are charged a fee of 89 EUR per year that contributes to the financing of Enova.
[54] NOK 2-4bn. We used a 0.08 conversion to GBP.

limited to 80% of project costs. NOx Fund investment is not available to projects that are in receipt of other government funding (such as Enova).

The Port of Oslo, Norway's largest cargo-handling port – has ambitious CO_2 reduction targets set by the city. The city of Oslo has a target of reducing CO_2 emissions by 95% by 2030 (from a 1990 baseline). As part of that, the port – which is responsible for approximately 4% of the city's CO_2 emissions and 9% of NO_x including ships visiting the port – has a target of an 85% CO_2 reduction by 2030 (on a 2017 baseline).[55] The city has set ambitious targets to effectively be zero emission by 2030 and has set climate budgets to help meet those targets.

[55] Presentation at British Ports Association & UK Chamber of Shipping conference on decarbonisation – 9 January 2020, London. The city has similar targets for Nitrous Oxide and Methane.

Spain

Spanish ports are state owned, with concessions granted to private terminal operators. Port authorities report to central Government, rather than municipal or provincial authorities, as is common in Europe.

As of April 2020 there are no significant shore power facilities in Spanish ports that we are aware of, although the ports of Barcelona, Palma de Mallorca and Valencia all have projects underway to either investigate or install connections.

The Spanish National Ports Agency – Puertos del Estado – has undertaken a €6m, three-year project to draft up a masterplan for shore power in Spanish ports. This has been co-financed with €1.5m from the EU's Connecting Europe Facility. The project will include pilot studies at berths of 'national interest'. It will also investigate wider regulatory and technical barriers and potential solutions.

One of the barriers identified has been the price of electricity. Accordingly, taxes levied on electricity for vessels as berth has also been effectively abolished: the general tax rate of 5% has been lowered to a 'symbolic sum' of €0.05 per kWh. [56]

Sweden

Swedish port authorities are generally commercially run companies owned by their respective municipalities, with a central Government agency responsible for pilotage and safety of navigation across all ports. Port authorities build and own infrastructure and are responsible for safety and berthing with cargo operations generally leased to private operators.

Sweden reduced tax on shoreside electricity by 98% in 2011. The Swedish Maritime Administration, which is responsible for deep-sea pilotage and safety of navigation introduced differentiated fairway dues based on a vessel's reported environmental performance. Fairway dues cover the Swedish Maritime Administration's costs for ensuring safe navigation such as marking hazards and icebreaking.

Ports in Sweden have accessed public funding for shore power through the Klimatklivet (roughly translating as 'Climate Leap') fund. Recent shore power projects in one Swedish port we spoke to received around 40% of project funding from this fund and will likely be used for applications for future projects.

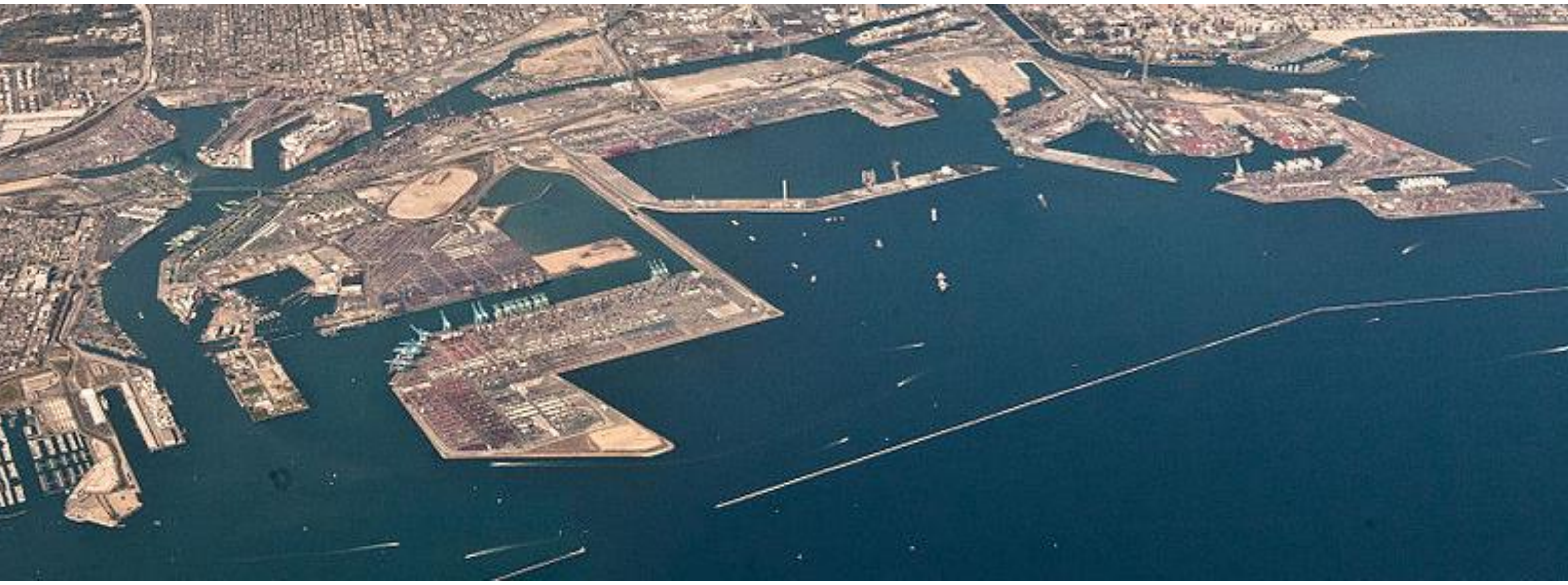
[56] (Spanish Ministry of Public Works, 2018)

United States - California

Port authorities in the United States are state-owned and operated. They mostly operate as landlord ports with private concessionaires operating cargo and passenger handling terminal operations, with some exceptions. Navigational dredging is done by the US Army Corps of Engineers and funded by a ‘harbor maintenance tax’, an ad valorem tax at 0.125% of a shipments value.[57] [58]

California is well-known for being one of the most advanced shore power programmes in the world, driven largely by significant air quality issues in cities such as Los Angeles. The California Air Resources Board (CARB) has been regulating at-berth emissions since 2007 at the ports of Los Angeles, Long Beach, Oakland, San Diego, San Francisco, and Hueneme. Fleet operators calling at Californian ports must ensure that 80% of their vessels that are at berth for more than two hours are able to connect to shore power.[59] Fleet operators have an alternative option of using an alternative power source or using an alternative abatement or control method that achieves the equivalent emissions reductions.

Terminal operators are required to report power requirements for shore power to the Port Authority. California has spent approximately $1bn on projects related to reducing air emissions, including Shore-to-Ship Power infrastructure. The Port of Long Beach is spending around $100m on shore power connections at all of its container terminals, for example.



[57] (US Army Corps of Engineers, 2020)
[58] (American Association of Port Authorities, 2020)
[59] (California Air Resources Board, 2007)

UK Case Study: Orkney

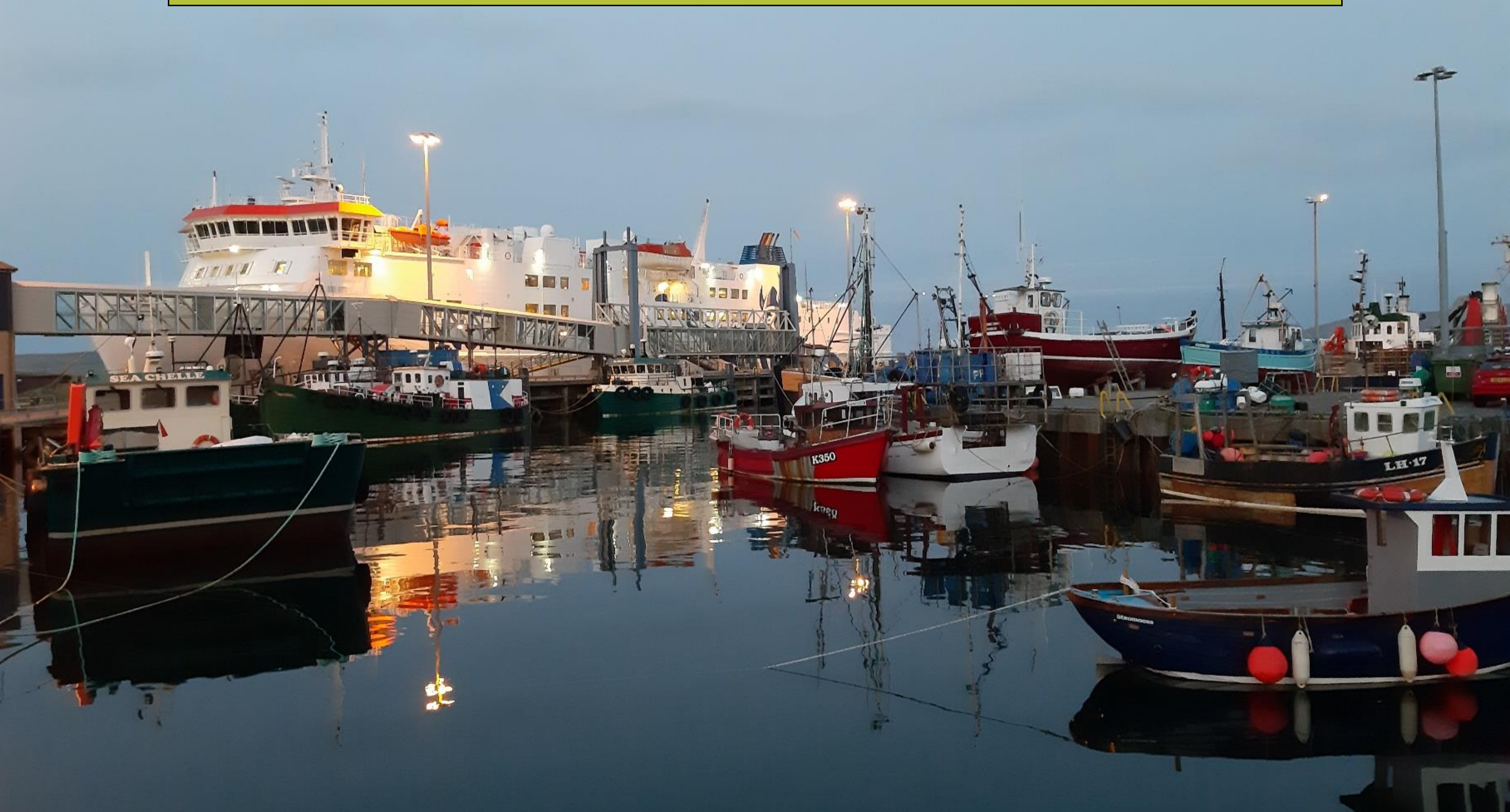
In 2019 Orkney Islands Council Harbour Authority announced a project to provide shore power at Stromness for the MV Hamnavoe – a ferry operated by Northlink. The project will be the first large commercial ship shore connection in the UK.

This will cut the current overnight carbon footprint from the vessel's diesel generators and engines, lowering the MV Hamnavoe's fuel consumption by at least 500 tonnes a year and resulting in a significant reduction in carbon dioxide (CO2). It will also make a contribution towards further reducing nitrogen oxides (NOx), sulphur oxides (SOx) and noise. This will save the lifeline ferry £160,000 in servicing costs.

Orkney's renewable energy resources will provide the power. The 'Stromness Multi-modal Low Carbon Transport and Active Travel Hub' project also includes charging points for electric buses, electric vehicles and electric bicycles.

Orkney is somewhat unusual in that the impressive renewable energy generation means there is excess power available. The project has received support from Scottish Government and European grant schemes to enable it to go ahead.

This case study bears out many of the findings in this report: shore power projects are best achieved when there is a consistent and reliable demand, public support for capital investment and energy capacity (which in this case, ensures that the supply can compete with the cost of marine fuel).



How can the UK overcome these barriers?

Our research has highlighted three broad prohibitive barriers to shore power in UK ports alongside a number of smaller but significant challenges. Many of these are not unique to UK ports and we have shown how other countries and ports have approached this issue.

Whilst the ports sector in the UK is somewhat unusual it is not unique and we do not believe there is anything about UK port models that in itself is impeding the installation of shore power.

We have put forward three proposals that we believe would support emissions reductions from ships at berth in UK ports. We have not suggested sector-specific policies (e.g. to specifically support shore power for cruise) but our proposals could be tailored towards them if necessary.

Recommendation 1: A Clean Maritime Fund

There is a clear need for Government investment to support decarbonisation and the 'greening' of the UK maritime sector more generally. Shore power is one of very few emission abatement options at berth that is proven and technologically mature with common standards. We believe it is highly likely to form part of the solution to reducing emissions at berth in the medium and long term. Our research has found that large scale shore power projects are rarely commercially viable, however.

The lack of shore power connections in UK ports is therefore not a signal of market failure – a traditional justification for public funding – but because of the market-led nature of the industry. This is an overwhelmingly positive force for the sector in terms of delivering efficient logistics but when it comes to the existential challenges of climate change, greater collaboration and support from Government is necessary.

Of the existing or planned shore power projects around the world where we could find funding information for, only one did not have a public element.[60] This might be partly explained by the ownership and governance structure in ports outside of the UK, but the overriding factor is the high upfront capital costs.

[60] This is Princess Cruises' berth in Alaska, a particularly sensitive environment. The cruise sector has shown a willingness to invest in shore power to reduce its emissions, lower costs and bolster its environmental credentials with an increasingly environmentally aware customer base and public.

As things stand, ports face an uphill struggle when considering shore power and prohibitive and punitive charges and investments to make it happen. It is not currently feasible without Government support.

In order to meet the UK's ambitious net zero targets and continue to improve air quality, some form of public capital investment will be needed soon. Whilst there are existing funds in regions or constituent nations of the UK, they are relatively small and the coverage is patchy. A game-changing multi-year challenge fund should be established dedicated to projects that will lower emissions from ports and shipping: a Clean Maritime Fund. This should be separate from funding aimed at early stage innovations such as MarRI-UK, which has been a welcome step and a form of recognition from Government that transport's 'grand challenges'[61] will need greater involvement from the state.

There has long been a consensus between industry and Government in the UK that ports invest inside the port gate in new infrastructure and services and UK Government will provide the necessary surface connectivity in the form of a suitable road and rail network, although there are examples of ports contributing to projects outside the port to improve connectivity. We believe it is reasonable – and necessary – for Government to bear a portion of the investment burden for energy infrastructure outside the port given that – as with surface and digital infrastructure – the benefits will accrue to a wide range of actors, including the general public (and indeed Government).

Government has previously identified 'split incentives' as a barrier to investment in shore power.[62] A split incentive is when the benefits of an investment by one organisation or individual accrue elsewhere. In this case, the emissions reductions benefits of shore power infrastructure by ports and terminals will accrue to shipping, and to some extent the Government and the public. This barrier should not be underestimated and is a critical part of the case for public funding.

We would therefore advocate for a funding structure that covered significant portions of feasibility studies and pre-project work as well as capacity upgrades and network reinforcement work or off-grid generation. We accept that ports should bear a heavier burden on costs for infrastructure inside the port than work

[61] (Department for Business, Energy & Industrial Strategy, 2019)
[62] (Department for Transport, 2019b)

on the wider network, although this can still be prohibitively expensive so some support will be needed. We would welcome a discussion between industry and Government(s) as to the particulars of such a fund.

Table 19: Proposed Public-Private Funding Splits for Shore Power Projects

Project Element	Cost ranges	Government Support	Industry Investment
Feasibility Studies; Surveys etc	£5k to £70k	Up to 80%	20%+
Network capacity upgrades, reinforcement etc	£2m to £25m for a 16MW connection	Up to 80%	20%+
Off-grid generation	Up to £6m	Up to 80%	20%+
Infrastructure inside port or terminal, including groundwork etc.	£0.3m to £10m	Up to 66%	33%+
Retrofitting Vessels	Up to £1m	Up to 66%	33%+

Source: BPA estimates from research and discussions with suppliers, ports, and energy stakeholders

<u>Power demand</u>

Modelling for the BPA by Arkevista suggest that vessels at berth in the UK used over 641,086,164 kWh of energy in 2019. Removing vessels that were at berth for less than two hours, that number falls to 502,411,805.

Research by Frontier Economics for the Department for Transport in 2019 forecasted energy demands from UK ports from shore power under a business as usual scenario to be around 5GWh in 2026 and over 200GWh in 2051. Under an ambitious decarbonisation scenario shore power demand could be double that in 2051.[63]Whilst there are many unknown variables between now and 2050 we think that those are reasonable estimates.

We intend to examine demand scenarios in more detail in a separate piece of work and would welcome collaboration from other industry partners in that.

[63] (Frontier Economics, 2019, for the Department for Transport)

Figure 2: Total Power Usage of Vessels at Berth in individual UK Ports in 2019, monthly totals in kWh

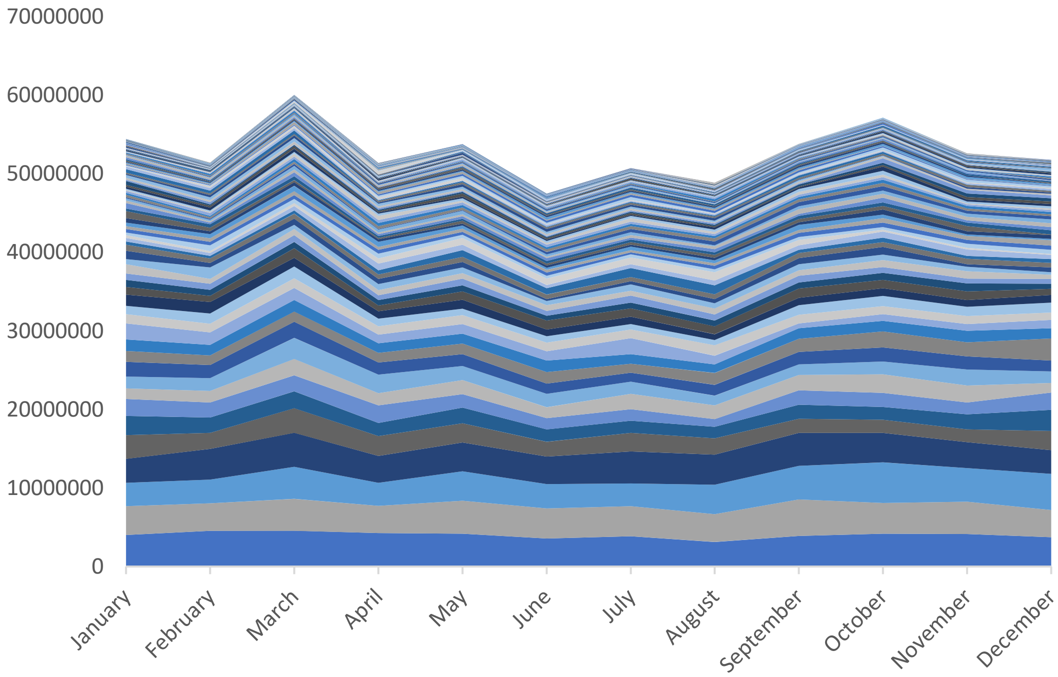
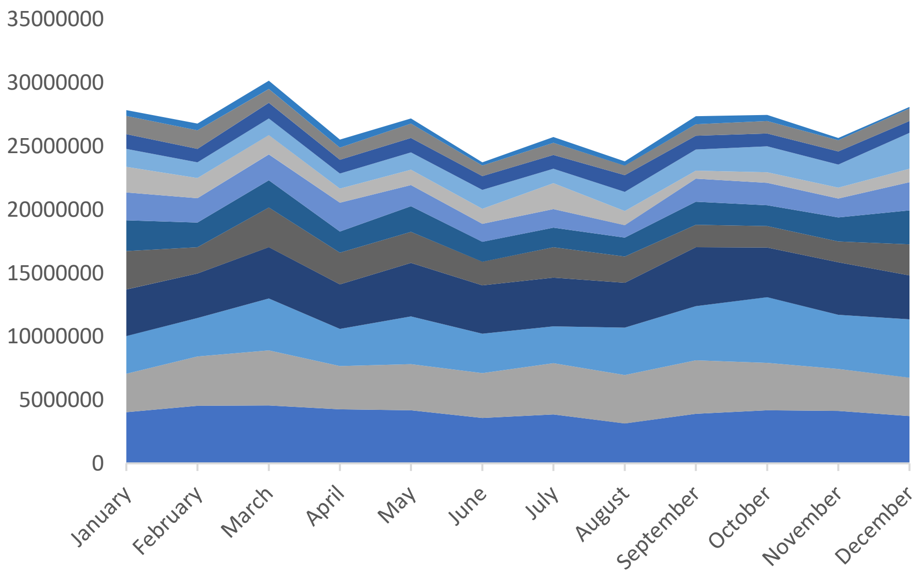
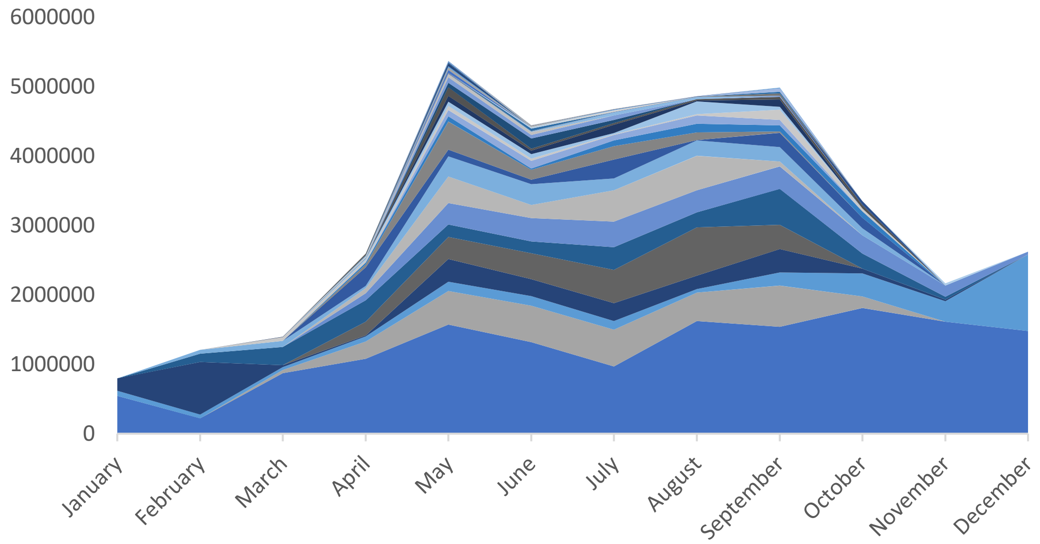


Figure 3: Total Power Usage of Vessels at Berth in 10 largest UK Ports in 2019, monthly totals in kWh



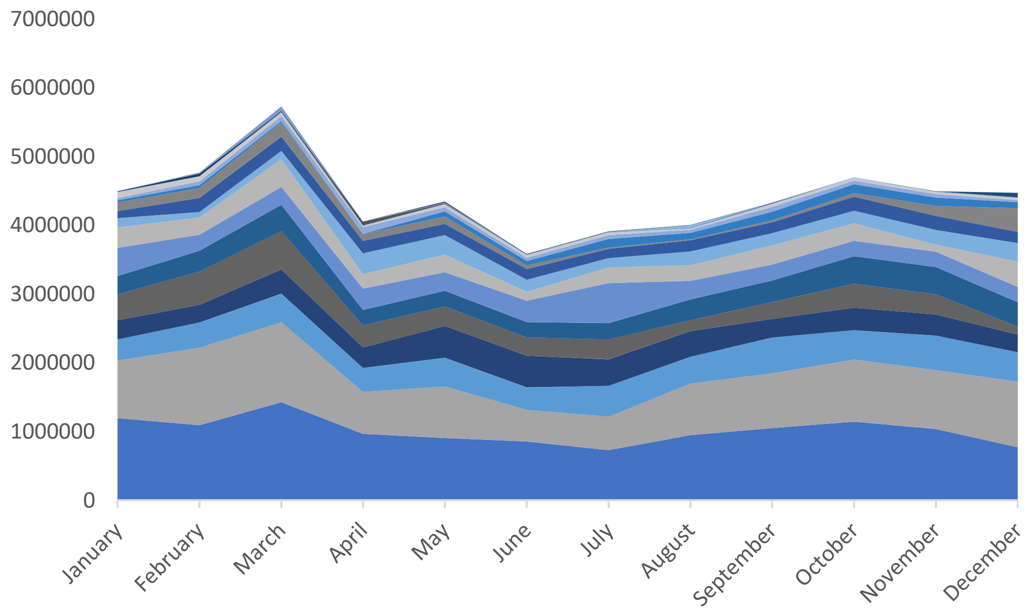
This chart shows demand variance throughout the year, however what it does not capture is that for every port there will be many berths. A more in-depth look at the underlying data might give a better indication of where reliable demand might be found In 2019 cruise ships used 38,461,304 kWh of energy at berth in UK ports. Unsurprisingly, power usage of cruise ships at berths peaks during cruise season.

Figure 4: Total Power Usage of Cruise Vessels at Berth in individual UK Ports in 2019, monthly totals in kWh



In 2019 container vessels used 52,888,592 kWh of energy at berth in UK ports. Significant variation is observed over the course of the year.

Figure 5: Total Power Usage of Container Vessels at Berth in individual UK Ports in 2019, monthly totals in kWh



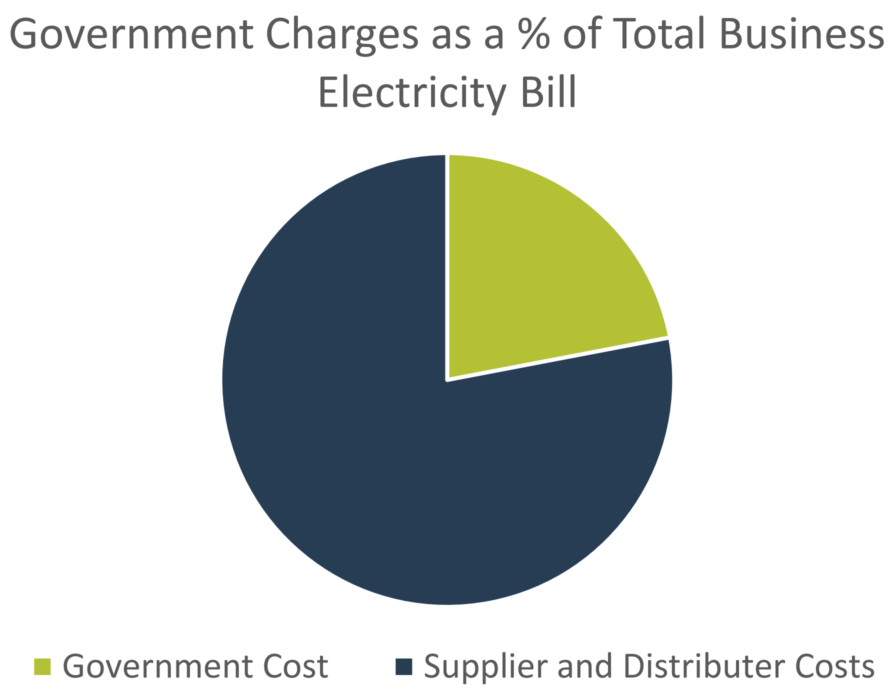
Recommendation 2: Remove taxes on electricity as a marine fuel

It has been the position of the British Ports Association and the European Seaports Organisation for years that electricity when used as a marine fuel must be able to compete against marine diesel if it is to achieve widespread take up.

Our research found that many ports regarded this as a significant barrier, making it difficult to build a business case for providing electricity as a marine fuel at berth when the incumbent product was cheaper, for many. We heard that, for some, they saw electricity as a cheaper option than marine fuel – for instance certain ferries at berth overnight. However this is not the experience of most that we spoke to. Most shipping lines, particularly those seen as most likely to adopt shore power, such as large container vessels and cruise ships, are more likely to be able to use their purchasing power to lower the effective price per kilowatt/hour of marine fuel.

Our view is that Government should help incentivise the use of shore power where it is available by reducing taxes on electricity when used for marine fuel, including auxiliary engines/generators at berth.[64] Essentially this would mean a VAT exemption and a blanket removal of the climate change levy from shoreside electricity.

[64] An alternative proposal would be to make marine fuel less competitive by increasing taxes. However as shipping is global and many vessels will not bunker in UK ports, this will not have the intended effect and may end up incentivising modal shift to less efficient forms of freight transport, thereby increasing emissions.



The Climate Change Levy (CCL) has been applied to electricity bills to incentivise industry customers to use less energy and reduce emissions since 2001. The CCL has been increased three times in the last three years is now charged at 0.847p per kilowatt hour of usage. A significant increase since 0.583p was levied against each kWh in 2018. As the CCL directly increases with every kWh used, the actual percentage of the total bill attributed to the CCL can vary hugely; we estimate can be up to 35% of a final bill.

Whilst businesses can sign up to the government's Climate Change Agreement (CAA) to reduce the levy in return for agreeing to significantly reduce consumption of energy, we believe that the CCL should not disincentivise emissions reduction through shore power across the board.

Government charges can make up to 22-55% of the total electricity bill paid by ports (dependant on whether the port has entered into a CAA).

Recommendation 3: Regulatory Incentives: a Goal Based Approach

We have identified the lack of demand for shore power as a significant barrier to uptake in the UK.

The Government has sought to encourage a move to electric vehicles through a mixture of financial incentives and regulation in the form of the planned prohibition of combustion engines from 2035. A similar two-pronged approach might support emissions reductions from shipping in ports.

We have made the case for public funding in this paper, but we are not convinced that that alone will change behaviour in the timeframe needed to meet net-zero targets. Having made a case for public investment to overcome barriers to supply, we also believe that a goal-based regulatory approach to create or grow the demand for emissions abatement solutions, of which shore power is likely to be a significant option.

We therefore propose as a topic for exploration a zero-emission berth standard – developed with industry and introduced by Government in an appropriate timeframe – for UK ports. It would need a sufficient lead-in time to allow industry to prepare and invest.[65] This would be a significant undertaking and would require appropriate levels of consultation with the ports and shipping industries to understand reasonable timescales and necessary support and potential exemptions.

Our initial preference would be for a requirement for vessels over a certain size at berth in a UK port for more than a certain period of time to be required to have net-zero emissions by either using zero-emission fuel, plugging in to shore power[66], offsetting emissions through an accepted scheme, or paying into a Government administered levy. The levy would be based on the emissions profile of the vessel for its time at berth and adjusted for different types of vessel. The receipts from this could be reinvested into a clean maritime fund.

Over time, funds collected from a levy could support innovative new green projects in the UK maritime industry. Such a scheme would need to be carefully designed to ensure that it would not affect the competitiveness of particular

[65] Our initial view on a suitable timeframe would be 2035 but even this is challenging and so this would need careful consultation and consideration

[66] We accept that shore power does not abate 100% of emissions

sectors or trades whilst also ensuring that it did drive behavioural change and private investment.

A ‘Zero Emission Berth Standard’ for the UK would create a powerful policy lever for Government and drive behaviour change in the shipping industry. This could be tailored to target specific types of vessel such as the most polluting. It would need to be Government administered to ensure a consistent approach across every port. We believe that it would be important for any funds raised to be reinvested into clean maritime projects if possible.

We support a technology neutral approach to reducing emissions at berth. This allows ports to tackle the issue in a manner best suited to their unique circumstances. It would even allow for different solutions within the same port. Many UK ports are multipurpose logistics hubs, handling different types of ships and cargoes. Our research shows that even the largest shore power projects in the world typically install less than 10 connection points. Major ports in the UK will have more than 10 berths and whilst certain ships will often call at the same berth this is not always the case. It is not feasible for all berths in the UK to have shore power available so clearly different approaches to meeting a net zero at berth target will be needed.

We are open to alternative, realistic proposals on driving up demand for emissions reductions solutions. The British Ports Association is committed to an open discussion with industry and Government about a zero emission berth standard or an appropriate alternative.

Other recommendations & Next Steps

Demystifying Emissions Abatement Options

The Government announced in the Clean Maritime Plan that it will establish the Maritime Emissions Regulation Advisory Service (MERAS). This will provide dedicated support to “innovators using zero emission propulsion technologies, assisting them through the regulatory process.” We would welcome a service or platform to provide similar advice for the wider industry on the regulatory and planning process. Several ports we spoke to told us they liked the idea of providing shore power but whenever they looked into it they found a wall of bewildering rules and punitive processes.

We would welcome a discussion with wider industry partners about this and other ideas about making shore power and other emissions reductions options more accessible.

In our discussions we have also been interested in the idea of ‘shore power as a service’. Several ports told us that providing energy in the form of shore power is not their business, but we would like to explore the emerging model of shore power provision by third party with providers to provide expertise. This could even help tackle potential issues around first-mover competitive disadvantage in that a third-party operator could be present in multiple ports in the UK and Europe.

Quantifying the Costs & Benefits of Emissions Abatement Options

We have discussed how investing in shore power can present significant risks to ports whereas the benefits in terms of emissions reduction accrue elsewhere. We would welcome a detailed examination of the costs and benefits of different emissions abatement options and technologies. This would help both Government and industry understand the benefits of their investments and where the most valuable ‘green’ investment could be directed. This could include, for example, a shore power emissions calculator as we have seen developed by some other countries.[67]

The BPA is currently exploring these issues and would welcome interest from Government or industry in collaboration in this area.

[67] (United States Environmental Protection Agency, 2017)

A Review of Energy Planning and Maritime Decarbonisation

The current system of planning the long-term energy needs for ports and the wider maritime sector needs further consideration. The electricity demand of ports and the wider transport and logistics sector will clearly rise rapidly in the coming decades. Ports need certainty on what the longer-term costs will be and what capacity will be available.

Upgrades to energy networks offer wider benefits for other decarbonisation options as well as to other local users. The way in which this is decided and paid for needs closer examination.

We have not considered this in detail in this paper but would welcome a thorough discussion with industry partners and Government as to how we overcome capacity challenges and other issues relating to energy networks.

Alternative Proposals considered

The European Union is currently considering proposals to mandate the use of shore power at Union ports. We believe that this approach is not feasible and could disincentivise innovation and alternative – potentially more suitable – emissions reductions solutions. It would likely result in higher costs for shipping as costs are passed on which could weaken the sectors competitiveness against other less efficient modes of freight transport. We would strongly oppose similar proposals in the UK.

Ports around the world have chosen to introduce green incentives for vessels – giving discounts to ships that meeting more rigorous environmental standards. Whilst we celebrate any port that chooses to voluntarily reward environmentally-friendly investments, we do not believe that this on its own would be enough to change behaviour at scale. Harbour dues are a critical source of income for ports that are used to fund infrastructure maintenance and improvements and other statutory duties such as safety of navigation.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Annex A: BPA Shore Power Survey Summary

Respondents to this survey formed a wide variety of the UK ports industry. Results include the responses of both major and minor ports, and ports from England, Scotland, Wales and Northern Ireland are represented.

Do you currently have any plans to install shore power capacity?

28% of respondents reported that they have 'no plans' at present to install shore power capacity. 44% of respondents are 'currently considering it', 6% noted they are in the process of planning or installing shore power, and 17% reported they believe they 'already have enough shore power capacity'.

Some noted in the comments that shore power connections are already installed and they plan to increase facilities. Others noted that they are only planning for smaller vessels at the moment (fishing, leisure, service & patrol vessels etc.)

Have you made estimates of requirements needed for your port to supply high voltage shore power connections to port users?

There was an even split in the responses to this question, a third said yes, a third said no, a third said that are planning to in the next year.

Have you had inquiries from customers/port users about the availability of shore power at your port(s)?

22% reported that they had not had any enquiries, 33% noted that they had had 'one or two', 34% said they had had 'some', 11% said they had had 'a lot'. Comments that expanded on this answer noted that the fishing sector already makes regular use of shore power, others noted that RoRo customers were now investigating the potential of ship-to-shore connections and others reported that enquiries had come from 'smaller cruise vessels'.

What percentage of your customers would you estimate are currently ready to connect to shore power?

Responses to this question were hugely varied. Many ports commented that there were very few vessels within their customer based with shore power capacity installed (around 2%). Others made the distinction between smaller vessels and larger vessels, noting that for smaller vessels this is 90-95%, but 0-10% for other commercial vessels. One port who predominantly sees dry bulk carriers and general cargo, fishing and leisure vessels said they thought the figure was closer to 100%, but that ‘some chose not to connect to shore power based on fuel costs vs. electricity charges’.

What percentage of your customers/port users would you need to plug in to make shore power financially viable for your port?

12% of respondents said 25-49%, 12% said 50-74%, 29% said financial viability is not an issue, 29% said even with 100% of vessels having the capacity to plug in, they would not see it as viable. Some respondents commented to note that this wouldn’t necessarily factor into their assessment of viability; rather it was more about the power demand from vessels that did require a shore power connection. One port noted that for their port, ‘costs would not be remotely recovered in a commercial time frame’

To what extent are the following a barrier to shore power in your port?

Most strongly identified as the greatest ‘barrier’ to shore power was ‘capital costs’, then ‘lack of capacity in the local transmission network’, followed by ‘costs of electricity v marine fuel’ and finally ‘lack of demand’.

We also asked respondents to record which statements they agreed/disagreed with.

The statement that drew the strongest agreement was ‘Some level of public investment in shore power is a good use of public funds’. Next, still showing strong agreement was ‘Shore power will be an important part of reducing shipping emissions in the UK in the next 30 years’ tied with ‘Shore power will be an important part of improving air quality around UK ports in the next 30 years’. Finally, a statement which evenly split people between ‘agree’ and ‘disagree’ was ‘Government and the shipping industry should focus solely on the bigger prize of zero-emission fuels’.

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SHORE POWER

COLD IRONING

ONSHORE POWER SUPPLY

SHORE TO SHIP POWER

ALTERNATE MARITIME POWER

BRITISH PORTS ASSOCIATION