TOWN AND COUNTRY PLANNING ACT 1990
PLANNING AND COMPULSORY PURCHASE ACT 2004

Proof of Evidence of Mr Tony Norton
CEng, MIChemE, MBA, BSc (Hons)
on behalf of Dorset Council

Appeal by Powerfuel Portland Limited
against the refusal by Dorset Council of Planning Application Ref. WP/20/00692/DCC for the construction of an energy recovery facility with ancillary buildings and works including administrative facilities, gatehouse and weighbridge, parking and circulation areas, cable routes to ship berths and existing off-site electrical sub-station, with site access through Portland Port from Castletown,

at Portland Port, Castletown, Portland, Dorset, DT5 1PP

Planning Inspectorate References:	**APP/D1265/W/23/3327692**
Dorset Council References:	**WP/20/00692/DCC**
Date:	**14th November 2023**

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GLOSSARY

Term	Meaning
CCC	Climate Change Committee
CHP	Combined heat and power
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
DESNZ	Department for energy security and net zero
DH	District heating
DHEC	District heating energy centre
EfW	Energy from waste
ERF	Energy recovery facility
ESCo	Energy services company
GHG	Greenhouse gas
GWh	Gigawatt hours (equal to 1,000 MWh)
$kgCO_2e/kWh$	Kilograms of carbon dioxide equivalent per kilowatt hour
IRR	Internal rate of return
kWh	Kilowatt hour
MW	Megawatt (MWe Megawatt electricity, MWth Megawatt thermal)
MWh	Megawatt hours (equal to 1,000 kWh) MWhe Megawatt hour electricity, MWhth Megawatt hour thermal)
RFA	Royal Fleet Auxiliary
SoC	State of charge
tCO_2e	Tonnes of carbon dioxide equivalent
tCO_2e/y	Tonnes of carbon dioxide equivalent per year

1. INTRODUCTION

1.1 My name is Tony Norton and I am a Chartered Chemical Engineer and Head of the Centre for Energy and the Environment (CEE) at the University of Exeter. My academic qualifications include a Masters degree in Business Administration and a Bachelors degree with honours in Chemical Engineering.

1.2 The CEE undertakes research into energy and environmental issues for public sector organisations in the South West of England. Among my various duties, I have advised Devon County Council, Plymouth City Council and district councils in Devon on waste related projects and district heating. Projects include the potential use of advanced thermal treatment of waste, the use of heat in district heating as part of combined heat and power (CHP) from the thermal treatment of waste and assessments of greenhouse gas (GHG) emissions from existing energy from waste facilities in Devon and Plymouth. I have also undertaken numerous GHG assessments for territorial areas and organisations, made projections of carbon reductions and quantified the measures needed to achieve such reductions.

1.3 Prior to joining the CEE in 2004 I worked in the energy supply industry for 25 years including the upstream oil and gas and energy trading sectors.

2. BACKGROUND AND STRUCTURE OF EVIDENCE

2.1 The proposed Energy Recovery Facility (ERF) is a waste facility that is not allocated in Dorset's adopted Waste Plan.

2.2 Policy 4 of the Waste Plan specifies criteria that unallocated sites should meet. In particular, the first criteria of Policy 4 states that there should be no other "available site allocated for serving the waste management need that the proposal is designed to address".

2.3 Typically, the advantages referred to in Policy 4 would be waste treatment/management advantages. However, in its Planning Supporting Statement (Section 6.95) the Appellant argues that the proposed ERF confers energy related advantages. In summary the suggested energy advantages are:

- the provision of Shore Power for cruise liners and other vessels which is otherwise not economic due to grid supply constraints in the locality;
- the ability to implement a local heat network;
- the ability to provide a significant amount of electricity to the local distribution network increasing its efficiency;
- consequent significant reductions in carbon emissions.

2.4 In the sections below I address the Appellant's arguments on each of these energy related advantages to inform the decision on the weight to be given to those advantages.

3. THE ROLE OF THE ERF IN THE PROVISION OF SHORE POWER

3.1 Government, vessel operators and ports around the UK are examining the potential benefits of vessels connecting to Shore Power while in port. Responses to the Government's call for evidence in 2022 showed 73% of respondents were supportive of Shore Power as one of the technologies to reduce vessel emissions at berth[1]. The resulting update of the Government's Clean Maritime Plan and a consultation are awaited.

3.2 Use of Shore Power, even when it is available can be challenging. Recent reports[2] analysing ship schedules at Southampton, where Shore Power is available, indicated a low take up with the underlying research suggesting that only one in ten cruise ships have used shore power since it became available in 2022. Of the vessels that did, Shore Power was used only for an average of five hours per visit despite typically spending twelve hours in port[3]. In its assessment of the barriers to Shore Power the British Ports Association[4] cites high electricity prices as a main barrier to Shore Power uptake highlighting that vessel operators will make commercial decisions on their use of Shore Power.

3.3 I note that the Appellant has a letter of support from cruise ship operator Carnival PLC which states that its vessels that can receive Shore Power would connect "subject to power being made available on commercially viable terms" which confirms that the uptake of Shore Power at Portland Port will be subject to negotiation of commercial terms and market conditions.

3.4 The Shore Power facilities proposed by the Appellant comprise a 12 MWe and a 10 MWe substation to enable shore power provision to two cruise ships berths simultaneously. At times when both berths are discharging Shore Power all the

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[1] Department of Transport, Use of maritime shore power in the UK: summary of call for evidence responses, July 2023. See https://www.gov.uk/government/calls-for-evidence/use-of-maritime-shore-power-in-the-uk-call-for-evidence/outcome/use-of-maritime-shore-power-in-the-uk-summary-of-call-for-evidence-responses accessed 09/11/2023

[2] The Guardian, Cruise ships polluting UK coast as they ignore greener power options, November 2023. See https://www.theguardian.com/environment/2023/nov/04/cruise-ships-polluting-uk-coast-as-they-ignore-greener-power-options accessed 09/11/2023

[3] openDemocracy, Revealed: 'Greenwashing' cruise ships burning diesel despite energy pledge, November 2023.See https://www.opendemocracy.net/en/cruise-ships-greenwashing-energy-shore-power-diesel-uk-ports-mislead-tourists/ accessed 09/11/2023

[4] British Ports Association, Examining the Barriers to Shore Power, May 2020 See https://www.britishports.org.uk/content/uploads/2021/10/BPA_Shore_Power_Paper_May_2020.pdf accessed 09/11/2023

'Updated for Inquiry' Carbon Assessment's [CD 11.8] 17.1 MWe of electricity export capacity (raised from 15.2 MWe previously [CD 2.17g]) will be directed to Shore Power, with the balance provided from 5 MWe of grid capacity available[5] (with two cruise ships in port the maximum power offtake would be 22 MWe).

3.5 In its Carbon Assessments [CD 11.8 & 2.17g] the Appellant estimates that 60 to 65 cruise ships will visit Portland each year with a gradual increase in the fraction of ships which are capable of taking power from the shore.

3.6 Rather than speculate on future cruise ship numbers I have analysed the 56 vessels which visited Portland in 2023 (see Appendix 1) I have made the optimistic assumption that all cruise ships arriving at the port take Shore Power. This assumption is optimistic because it will take some years before all ships are able to take Shore Power and because, depending on the price of Shore Power, some vessels may on a commercial basis decide to use their onboard generators despite having the ability to connect to Shore Power. Also, I have not shortened the Shore Power connection times to allow for connection and disconnection. This case therefore approximates maximum potential Shore Power provision at Portland.

3.7 The analysis concludes that:

- the peak offtake for a single cruise ship is 12 MWe. When two cruise ship are in the port this rises to a maximum of 22.2 MWe.
- There are 470 hours of the year when there is a cruise ship connected to Shore Power; 5% of the hours in a year.
- For 60 hours in 2023 year the potential total cruise ship shore power load exceeded the 'Updated for Inquiry' 17.1 MWe export capacity of the ERF. This happens when two larger cruise ships are in the port at the same time. High peak loads could be managed by the port avoiding multi vessel arrivals (119 hours over 10 days in 2023) or by limiting shore power to one berth.

3.8 This work uses load duration curves. These graphs show the amount of energy in every hour of the year ordered from the highest amount (hour 1) to the lowest

[5] ARUP, Energy Need Statement [CD 1.31] (para 5.2.1.4), Sept 2020

amount (hour 8760). Hour 1 identifies the peak load. Figure 1 shows the load duration curve for electricity exported from the ERF (dotted line) less the potential maximum 2023 cruise ship shore power (solid line).

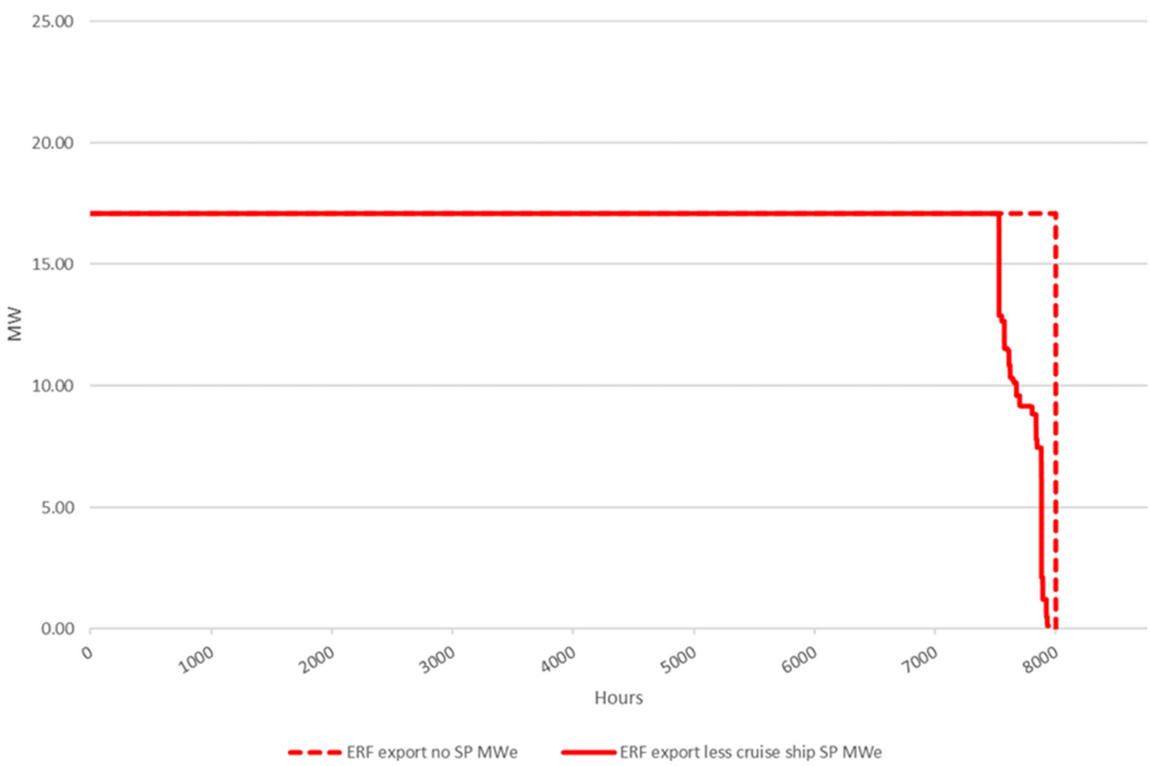

Figure 1: Load duration curve for ERF electricity export with and without potential maximum 2023 cruise ship Shore Power

3.9 This shows that without the provision of cruise ship Shore Power the ERF exports 136,800 MWhe (the area under the dotted line). With the maximum potential 2023 cruise ship Shore Power provision the ERF exports 132,296 MWhe (the area under the solid line) providing 4,504 MWhe of Shore Power (the difference between the dotted and solid lines), or 3% of the ERF's annual electricity export without potential cruise ship Shore Power.

3.10 The Appellant's Shore Power Strategy Report states that just over half of the cruise ships currently visiting Portland have the facilities for connecting to Shore Power which would have the effect of reducing the percentage of ERF power used by Shore Power to 1.5%.

3.11 The de minimis scale of cruise ship shore power in comparison to the ERF's electricity export illustrates the mismatch between the size of the proposed ERF and the provision of cruise ship Shore Power . This would remain out of proportion were the number of cruise ships taking shore power to grow to 65.

3.12 I have also considered the Royal Navy's Royal Fleet Auxiliary (RFA) Shore Power need at Portland Port. I have done this separately because:

- Grid capacity at the port (5 MWe) is sufficient to serve the required 2.75 MWe capacity stated in the Shore Power Strategy Report and also much of the 5.5 MWe if RFA vessels are double berthed.
- The Royal Navy has a track record of developing its own Shore Power provision for example at Portsmouth which has a 13 MWe CHP plant and a 3 MWe large scale battery for back up[6].

3.13 The RFA analysis is detailed in Appendix 2. This considers two cases based on the Appellant's Carbon Assessments [CD 2.17g & 11.8] from July 2021 and as Updated for Inquiry. The former states an assumption that "RFA ships spend 260 days in port a year" and the latter "RFA ships spend 390 ship-days in port a year" which assumes that an RFA vessel is in port for 365 days and that a second vessel double berths for 25 days per year.

3.14 When combined with maximum potential 2023 cruise ship Shore Power, RFA electricity consumption dominates, forming between 79% and 85% of total potential Shore Power use at Portland.

3.15 The RFA load is estimated to consume between 13% and 17% of the ERF's annual electricity output. As with cruise ships, the provision of electricity to the Royal Navy will be subject to commercial negotiation.

3.16 As the Royal Navy has shown in Portsmouth, battery technology can have a role to play in the provision of Shore Power. The Appellant's Energy Need Statement [CD 1.31] para 3.1.5 acknowledges that "fields like battery storage technology" are "fast becoming a reality". However, there is no further discussion of how battery technology might be implemented especially in respect of the short duration, 470 hour per year, cruise ship Shore Power need.

[6] Royal Navy, Three environmental care award wins for HM Naval Base Portsmouth, March 2021, See: https://www.royalnavy.mod.uk/news-and-latest-activity/news/2021/march/16/210316-three-environmental-care-award-wins-for-hm-naval-base-portsmouth Accessed 09/11/2023

3.17 Commercial battery storage systems are being installed across the UK with operators financing these installations by providing grid support and balancing services to the national and local electricity distribution grids. For example, local electricity distribution network operator SSE is installing a 50 MW/100 MWh battery energy storage system near Salisbury[7] and a larger 150 MW/300 MWh system in Yorkshire[8].

3.18 Initial analysis of the potential role for battery storage systems at Portland Port suggests that management of cruise ship arrivals to avoid double berthing may enable the provision of Shore Power using the existing 5MWe of grid capacity.

3.19 The example in Figure 2 below shows an initial analysis of how a 120 MWhe battery supplied by 5 MWe of grid capacity provides Shore Power for a week in June 2023 where 3 cruise ships berth and the RFA berths a vessel every day and double berths on one day. The dark green bars show RFA load and the light green cruise ship load in MWhe (left hand axis). The orange line shows that state of charge (SOC) of the battery in % (right hand axis). The battery and grid serve the loads with the battery retaining some charge throughout.

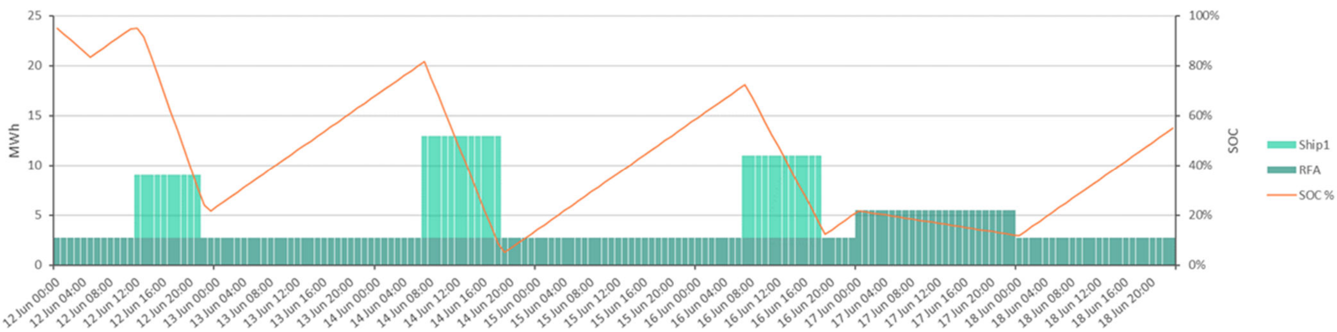

Figure 2: Modelling of Shore Power provision using a 120, MWhe battery and a 5 MWe grid connection

3.20 Without an in-depth assessment of the role of battery storage systems in the provision of Shore Power it is too early to state that "there are currently no

[7] SSE, Batteries arrival at SSE Renewables storage project at Salisbury marks key milestone for net zero ambitions, October 2023. See: www.sserenewables.com/news-and-views/2023/10/batteries-arrival-at-sse-renewables-storage-project-at-salisbury-marks-key-milestone-for-net-zero-ambitions/ Accessed 09/11/2023

[8] SEE, Solar and Battery Projects, Ferrybridge, www.sserenewables.com/solar-and-battery/projects/ Accessed 09/11/2023

commercially viable alternative options to provide grid connected Shore Power for Portland Port other than the proposed ERF" (Section 3 of the Shore Power Strategy Report).

3.21 The use of grid electricity for the provision of Shore Power will take advantage of the decarbonisation of the UK's electricity grid. The Climate Change Committee (CCC) project that the greenhouse gas (GHG) emissions factor for electricity will decline to 0.002 tCO_2e/MWh in 2047[9]. The Appellant's Carbon Assessment (Updated for Inquiry [CD 11.8]) calculates a diesel Shore Power intensity of 0.577 tCO_2e/MWh. Grid electricity therefore provides a GHG grid emission reduction of 0.575 tCO_2e/MWh in 2047. Using the Appellant's' 2047 Shore Power consumption of 32,931 MWhe gives grid electricity GHG emissions reduction of:

$$32{,}931 \text{ MWhe} \times 0.575 \text{ tCO}_2\text{e/MWh} = 18{,}935 \text{ tCO}_2\text{e}$$

This value is slightly lower than the 18,991 tCO_2e in the Carbon Assessment [CD 11.8] demonstrating that equivalent Shore Power emissions reduction can be achieved with grid electricity.

3.22 The Appellant highlights the local GHG (and air quality) benefits from the supply of electricity to berthed vessels because it reduces diesel use and results in reduced local GHG emissions (as calculated above).

3.23 The Carbon Assessment [CD11.8] (Table 5) calculates that the GHG's released from the proposed ERF's stack, from the fossil-based proportion of waste it burns, is 89,796 tCO_2e.

3.24 Local GHG emissions from the proposed ERF are therefore 4.7 times those abated by the supply of electricity to berthed vessels. Even with full supply of Shore Power, net local GHG emissions from the proposed ERF are 70,085 tCO_2e more than the emissions from berthed vessels. The provision of shore power from the proposed ERF should not therefore be seen overall as a local GHG emission reduction measure.

[9] CCC, Sixth Carbon Budget, December 2020.

4. THE ROLE OF THE ERF IN THE PROVISION OF DISTRICT HEATING

4.1 District heating is considered in two documents provided by the Appellant.

- The "Heat Report" by ARUP dated 2nd September 2020 which is also titled "CHP heat plan (including R1)" [CD 1.27].
- The "District Heating Paper" dated August 2021 [CD 2.7].

4.2 In Section 4.1, Table 1 of the Heat Report sets out the annual consumption of five possible consumers in MWhth.

Table 1: Possible consumers

Consumer	Annual Consumption (MWh/Annum)
Osprey Leisure Centre	2,486
Portland Hospital	254
HMP The Verne	6,966
Comer Homes	3,445
HMP YOI Portland	7,149

Table 1: Possible Consumers listed in the Appellant's Heat Report

The table does not specify if the consumption is for a quantity of fuel, for example natural gas, or for delivered heat (which would be the fuel consumption multiplied by boiler efficiency). I assume that the quantities of energy in the Table 1 are delivered heat.

4.3 The District Heating Paper provides a map in Section 5.7 showing two legs of proposed heat network pipework. The northern leg serves three consumers; the Osprey Leisure Centre, Portland Hospital and Comer Homes. The Southern leg serves two consumers; HMP YOI Portland, and HMP The Verne. The paper does not specify the length of the northern and southern leg heat networks (including heat pipe within the prison complexes), which I estimate to be 1000m and 5,000m respectively.

Assessment of the northern leg district heat network

4.4 I have investigated the possible consumers on the northern leg using publicly available information provided on Display Energy Certificates (DEC) for public buildings and Energy Performance Certificates (EPC) for homes.

4.5 The DEC for the Osprey Leisure Centre states its main heating fuel is grid electricity. I followed this up with John Jennison, the Manager of the facility who confirmed that the leisure centre pool is heated with an electric air source heat pump (ASHP).

4.6 ASHPs typically provide a minimum of three times as much heat as the electricity they consume making them both cost effective and, because of the continuing decarbonisation of the electricity grid, low carbon. These considerations have led to John Jennison's view that "current thinking is we remain with the heat from the AHSP as opposed to from the Incinerator"[10].

4.7 Replacement of gas heating is more practical. However, the amount of gas used by the leisure centre in 2022/23 was 90 MWhth which, with an assumed 86% boiler efficiency, gives heat demand of 77 MWhth. This figure replaces the 2,486 MWhth in Table 1 of the Heat Report.

4.8 Comer Homes has developed the Ocean Views apartment complex which lies to the south at the northern end of Castle Road. The retrospective adoption of district heating in such a complex is best suited to situations where there are centralised boilers providing heat to every apartment. These central boilers can be replaced with a district heating interface with little change needed to provide heat into each apartment. However, EPC and planning data shows that the Ocean Views apartments have individual gas boilers.

4.9 A study for the Greater London Authority[11] illustrates the complexity of retrofitting district heating to apartment blocks. Insulated district heating pipes (flow and return) are several times the diameter of gas supply pipes and will not necessarily fit in the same void spaces. Lack of space internally may require heat pipes to be run externally. Apartments connecting to district heating would need to replace their gas boilers with a heat interface unit causing disruption to occupiers/tenants/owners over the various apartment tenures involved. The cost and upheaval and, most of all, the need for agreement from those occupying/renting/owning the Ocean Views apartments mean that the retrofit of district heating is unlikely to be practical and on this basis the 3,445 MWhth Comer Homes consumption in Table 1 of the Heat Report should in my view be discounted.

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[10] Email correspondence 20/10/2023
[11] BuroHappold Engineering, Connecting Existing Buildings to District Heating Networks, 2016

4.10 It should be noted that due to the elevation of the southern leg heat network which rises to 120m above the ERF and creates pressures in excess of 12 bar at the district heating energy centre (DHEC), any northern heat network leg would need to be hydraulically separated leading to potential duplication of pipework and equipment and additional costs.

4.11 The remaining load on the northern leg is Portland Hospital (254 MWhth) which, together with the 77 MWhth from the Osprey Leisure Centre, gives a total for the northern leg of 331 MWhth or 5% of that for the northern leg heat loads listed in Table 1 of the Heat Report. This heat load needs to justify 1000m of heat network pipework and the associated back up boiler and pumping systems at a hydraulically separated DHEC which would need to be constructed adjacent to the ERF.

4.12 Linear heat density provides an approximation of how much revenue a branch of a heat network can generate for a given capital cost[12]. Industry thresholds range from 7 MWhth/m to 4 MWhth/m with 4 MWhth/m a typical lowest value for a network to be economically viable. The linear heat density of the northern leg is 0.3 MWhth/m; an order of magnitude less than the minimum threshold indicating that the reduced heat loads on the northern leg heat network mean that it would not be economically viable.

Assessment of the southern leg district heat network

4.13 Heat demands for the 5,000 m long southern leg in Table 1 of the Heat Report are restated in Section 6.8 of the District Heating Paper (a total of 14,115MWhth). An estimate of the southern leg peak heat load, which is not in the Heat Report, is also provided in the District Heating Paper (8.3 MWth).

4.14 The linear heat density of the southern leg is 2.8 MWhth/m which is below the 4 MWhth/m typically set as the lowest value for a network to be economically

[12] Scottish Government, Local Heat and Energy Efficiency Strategies, September 2019. See https://www.gov.scot/binaries/content/documents/govscot/publications/research-and-analysis/2019/09/local-heat-energy-efficiency-strategies-phase-1-pilots-technical-evaluation-report/documents/local-heat-energy-efficiency-strategies-phase-1-pilots-technical-evaluation-report/local-heat-energy-efficiency-strategies-phase-1-pilots-technical-evaluation-report/govscot%3Adocument/local-heat-energy-efficiency-strategies-phase-1-pilots-technical-evaluation-report.pdf . Accessed 09/11/2023

viable. This indicates that the southern network heat network is unlikely to be viable.

4.15 Nevertheless, I have examined the southern leg in more detail using detailed technical reports which assess the feasibility of the extraction of heat from the existing Exeter ERF[13] [CD 12.51] and the delivery of heat to Exeter's historic prison building which can be expected to have similar heating characteristics to Portland's prisons[14].

4.16 Neither the Appellant's Heat Report nor its District Heating Paper mentions heat losses. I have estimated heat losses for the southern leg using those calculated for the Exeter ERF heat transmission main and added 1,207 MWhth (9%) to the 14,115 MWhth consumer heat load to give heat demand at the ERF of 15,332 MWhth.

4.17 This work uses load duration curves. These graphs show the amount of energy in every hour of the year ordered from the highest amount (hour 1) to the lowest amount (hour 8760). Hour 1 identifies the peak load, which for heating is typically close to the coldest hour of the coldest day in the year. The shape of the curve enables the duration of capacities to be analysed.

4.18 Firstly, I have scaled the load duration curve generated for Exeter Prison to the southern leg heat demand at the ERF (15,332 MWhth). The resulting load duration curve is shown in Figure 3; the area below the curve is 15,332 MWhth and the peak load is 14.6 MWth. There are 52 hours where the load is above the 8.3 MW in Section 6.8 of the District Heating Paper.

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13 Parsons Brinkerhoff, South West Exeter DH Network and Energy Centre Design, April 2015 [CD12.51]

14 WSP, Exeter Energy Network Detailed Feasibility Study Refresh, May 2017

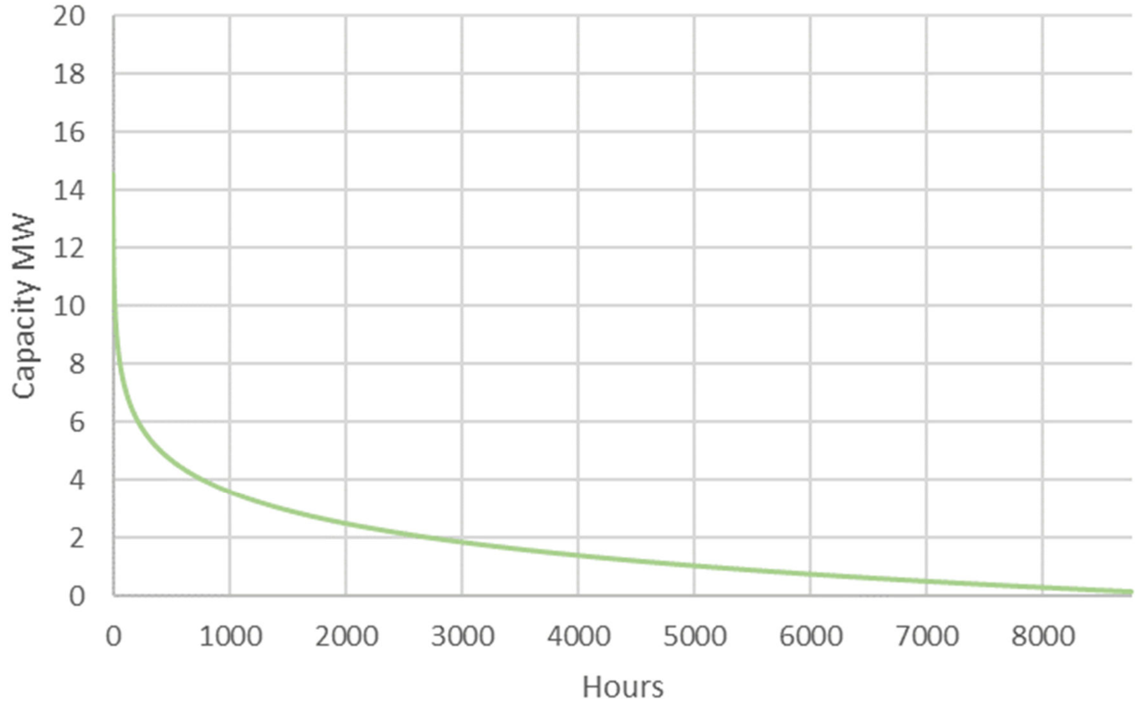


Figure 3: Load duration curve for the southern leg district heating system based on Exeter Prison

4.19 I have assumed that the ERF provides delivered heat capacity of 4MW to an Energy Service Company (ESCo) which will invest in and operate the district heating network. This capacity is sufficient to provide heat for all but 781 hours of the year or 90% of total heat demand. Top up / back up gas boilers (mentioned but not quantified in Section 4.3 of the Heat Report) provide peak heat needs of 1,547 MWhth (1,799 MWhth of gas fuel at 86% boiler efficiency). It should be noted that consumers will require the ESCo to provide full peak back up heat capacity (14.6 MWth) to guard against the possibility of steam not being available from the ERF. This provision is likely to be in the form of two 7.3MWth boilers with a third 7.3MWth stand by boiler.

4.20 The ESCo will invest in the equipment to extract the heat from the steam provided by the ERF and return the condensate to the ERF together with the back-up boilers, pumping and other equipment which will need to be housed in a district heating energy centre (DHEC) located a few meters from the ERF. Based on the South West Exeter scheme this will require the ESCo's to provide a building 15.3 by 40 meters (613 square meters see Figure 4). Additional land would be required for perimeter fencing and the boiler flue stack.

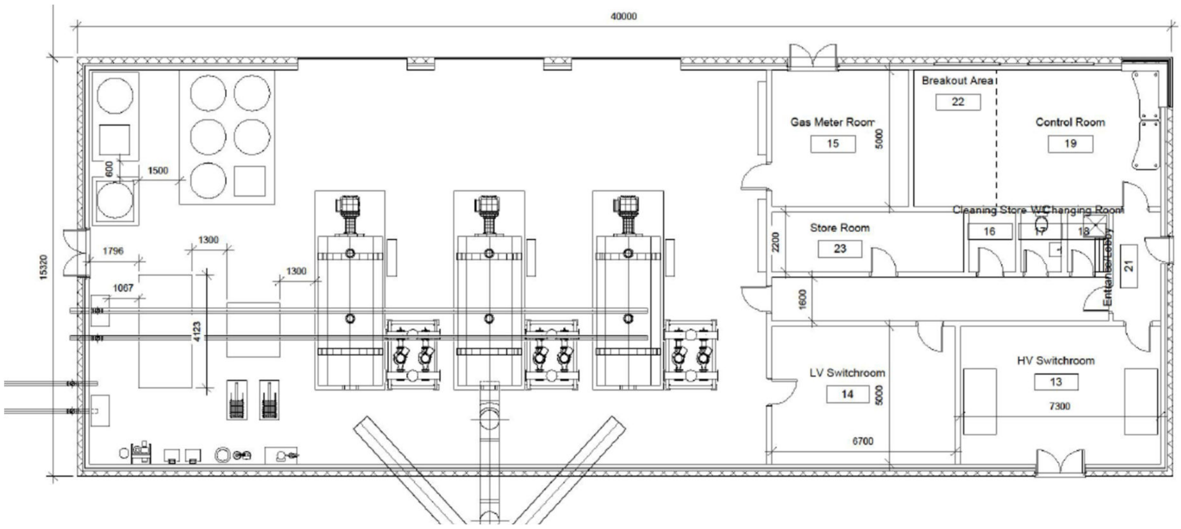


Figure 4: Drawing showing the lay out of the South West Exeter DHEC

The southern leg DHEC would also need to include the ERF heat interface; at South West Exeter this equipment was separate from the DHEC.

4.21 The 120m elevation of the two prisons above Portland Harbour is not mentioned in either of the Appellant's district heating reports. This height difference is significant as it generates a static pressure of 12 bar (174 pounds per square inch) at the ERF. This high pressure would require hydraulic separation from a network at low elevations should one be viable (as discussed in Section 4.9 above). The elevation causes unusually high pumping power requirements. Pumping power to overcome friction losses needs to be added to the 12 bar static head. This leads to a pumping power estimate of 78kW which, over the course of a year, gives pumping energy needs of 687 MWhe. Assuming other electrical loads in the DHEC (e.g. gas booster and burner supply pumps, shunt pumps, dosing pumps, control panel) conservatively add 10% to this figure gives a total parasitic electrical load of 755 MWhe. Using the average non-domestic electricity price in 2022 (£208.6 £/MWh[15]) leads to an operational cost

[15] DESNZ, Prices of fuels purchased by non-domestic consumers in the UK, Sept 2023. See https://www.gov.uk/government/statistical-data-sets/gas-and-electricity-prices-in-the-non-domestic-sector . Accessed 12/11/2023.

of £157k per annum. It is not clear if these costs have been included in the economics described in Section 8 of the District Heating Paper.

4.22 Costs of the southern leg district heating (DH) scheme have been estimated using the detailed breakdown provided for heat extraction and transmission from the Exeter ERF inflated to 2021 to enable comparison with the figure in the District Heating Paper. The cost estimate is set out in the Table 2.

Item	**£m 2021**
ERF heat interface (4 MW capacity)	0.849
DHEC (circulation and gas boiler back up etc.)	4.235
Transmission main 4.2 km (125mm)	5.642
On plot costs (pipework and commercial HIUs)	3.356
Fees & contingency	4.787
Total	18.868

Table 2: Cost estimate for the southern leg heat network

4.23 The cost estimate of £18.87m compares with £9.42m in Section 8.3 of the District Heating Paper. Higher capital and operating costs will lead to reduced internal rates of return. Examining the cash flows required to provide the 11.7% internal rate of return (IRR) stated by the Appellant but including a capital cost of £18.9m and additional operational cost for parasitic electricity of £157k per annum reduces the IRR to 3.6%. This low rate of return confirms the southern leg's below threshold linear heat density calculated above and calls into question the financial viability of the southern leg heat network for ESCo investment.

4.24 The below threshold linear heat density and the low IRR provided by the more detailed analysis of the southern leg suggest that ESCo investment in the southern leg district heating system is unlikely.

Southern leg district heating energy provision in the context of the ERF

4.25 Despite the southern leg heat network's delivery doubts it is relevant to set its potential energy need in context of the proposed ERF's energy production.

4.26 Steam provided for heat export reduces the amount of steam available for the ERF to generate electricity. Table 7 of the Appellant's Carbon Assessment [CD

11.8] assumes that 1 unit of electricity is lost for every 6.6 units of heat provided (the Z ratio).

4.27 The load duration curve for heat supplied to the southern leg from the ERF up to 4MWth is shown in green on Figure 5. The electricity foregone by the ERF is shown in red.

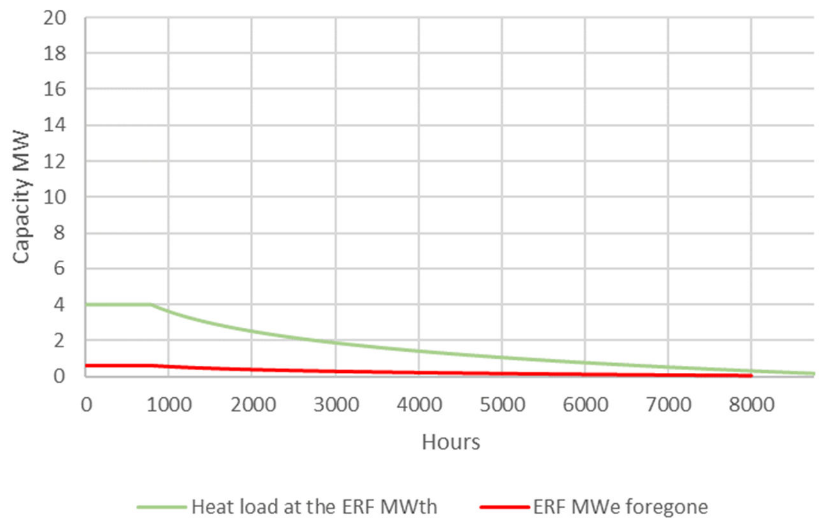


Figure 5: ERF heat and electricity forgone load duration curves for southern leg heat export

4.28 The load duration curve for ERF electricity export is flat at the ERF's capacity (updated for Inquiry at 17.1 MWe) for 8,000 hours as shown by the dashed red line on Figure 6. The difference between the dashed red line and the solid red line shows the electricity foregone as a result of providing heat to the southern leg district heating system.

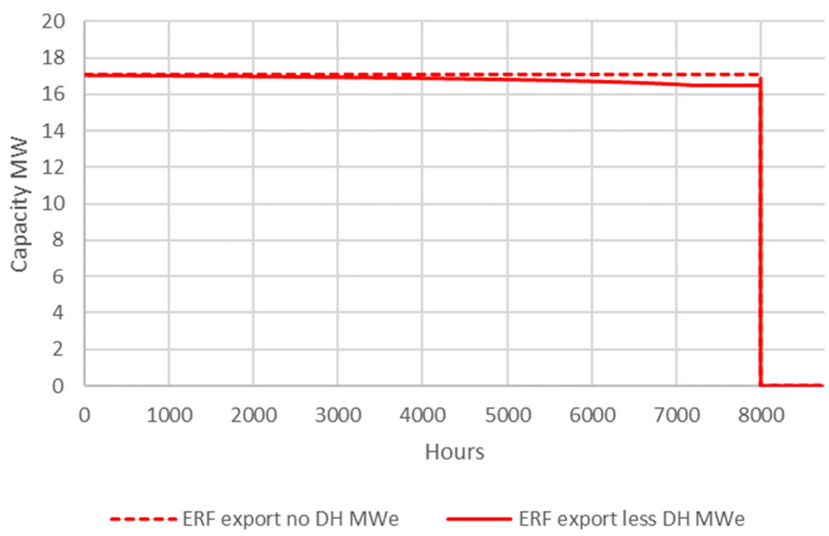


Figure 6: Load duration curve for ERF electricity export with and without southern leg heat export

4.29 Without southern leg DH the ERF exports 136,800 MWe annually. With southern leg DH the ERF exports 134,692 MWe; the electricity foregone to provide heat is 2,108 MWhe or 1.5% of electricity export without DH.

4.30 The de minimis scale of heat export in comparison with the ERF's electricity export illustrates the mismatch between the size of the proposed facility and the southern leg heat demand were it to be viable.

4.31 As neither the northern nor southern legs district heating networks are likely to be viable there are, in my opinion, no potential carbon benefits likely from the provision of district heating.

5. THE ROLE OF THE ERF IN GRID ELECTRICITY PROVISION

5.1 The Appellant states that the ERF supplies “baseload” power (e.g. in its Statement of Case para 1.53). Baseload power in the context of national energy security is delivered to the national grid consistently over a period. Nuclear power generation is often cited as the archetypal baseload power generator.

5.2 Were the ERF to potentially supply shore power over the cruise season (February to November) it would not export baseload power to the grid because, for example, with Shore Power provision as proposed by the Appellant, at times when cruise ships double berth, the ERF would be exporting no power to the grid. In these circumstances the grid would see power from the proposed ERF as variable and interruptible, not baseload.

5.3 The variable and interruptible nature of the ERF’s power export is likely to have implications for the sale of electricity from the ERF as the electricity market values certainty of supply and discounts for variability and interruptibility. The Appellant would need to be able to manage to offset the electricity export price penalties with income from the provision of price competitive Shore Power and district heating. This commercial uncertainty has implications that potentially undermine the delivery of Shore Power and district heating.

5.4 The proposed ERF operates for 8,000 hours annually. The plant is shut down for the remaining 760 hours (4.5 weeks) for annual maintenance. EfW plants typically shut down in the summer months. However, shutting down during the cruise season would affect the potential delivery of Shore Power. Equally shutting down in the heating season would affect the delivery of district heating. The Appellant does not show how the proposed ERF would continue to provide Shore Power and district heating during its annual shutdown.

6. SUMMARY AND CONCLUSIONS

6.1 The Appellant argues that the proposed ERF confers energy related advantages. In summary the suggested energy advantages are:

- the provision of Shore Power for cruise liners and other vessels which is otherwise not economic due to grid supply constraints in the locality;
- the ability to implement a local heat network;
- the ability to provide a significant amount of electricity to the local distribution network increasing its efficiency;
- consequent significant reductions in carbon emissions.

Shore Power

6.2 When in port cruise liners have traditionally run diesel generators to provide the electricity the vessel needs while docked. Plugging in to Shore Power reduces the need to run onboard generators reducing emissions. Large vessels use up to 12MWe of electricity each hour and the Appellant proposes to install Shore Power at two berths totalling 22 MWe to deal with a projected 65 vessels per year. The proposed ERF produces 17.1 MWe.

6.3 However, even when it is available, persuading cruise ships to use Shore Power can be challenging. Recent reports analysing ship schedules at Southampton, where Shore Power is available, indicated a low take up with the underlying research suggesting that only one in ten cruise ships have used shore power since it became available in 2022, with the vessels that did only using Shore Power for an average of five hours per visit despite typically spending twelve hours in port. In its assessment of the barriers to Shore Power the British Ports Association cites high electricity prices as a main barrier to Shore Power uptake highlighting that vessel operators will make commercial decisions on their use of Shore Power.

6.4 The Appellant has a letter of support from cruise ship operator Carnival PLC which states that its vessels that can receive Shore Power would connect “subject to power being made available on commercially viable terms” which confirms that the uptake of Shore Power at Portland Port will be subject to negotiation of commercial terms and market conditions.

6.5 Analysis of the 56 cruise ships that used Portland Port in 2023 shows that in practice cruise ships are in port for only 470 hours of the year (5% of the time). While power loads are high when connected, the short duration of connection means that the 50% of cruise ships currently able to take Shore Power would consume just 1.5% of the ERF's annual electricity production illustrating the mismatch between the size of the proposed ERF and the provision of Shore Power.

6.6 On ten days in 2023 two cruise ships were in the port at once (for a total of 119 hours) which, for some hours if they could both take Shore Power, would lead to a 22 MWe peak Shore Power electricity demand. This peak load could be almost cut in half through the port avoiding multi vessel arrivals or by limiting shore power to one berth.

6.7 Royal Fleet Auxiliary vessels have lower electricity demand and can currently be supplied using the grid electricity capacity available in the port. Also, the Royal Navy has a track record of developing its own Shore Power provision including the use of batteries.

6.8 Initial analysis of the potential role for battery storage systems at Portland Port suggests that management of cruise ship arrivals to avoid double berthing may enable the provision of Shore Power using the existing 5MWe of grid capacity. Without an in-depth assessment of the role of battery storage systems in the provision of Shore Power it is too early for the Appellant to state that "there are currently no commercially viable alternative options to provide grid connected Shore Power for Portland Port other than the proposed ERF".

6.9 The use of grid electricity for the provision of Shore Power will take advantage of the decarbonisation of the UK's electricity grid and the provision of low carbon grid electricity means that the proposed ERF is not required to achieve Shore Power emissions reduction.

6.10 The Appellant highlights the local carbon (and air quality) benefits from the supply of electricity to berthed vessels because it reduces diesel use and results in reduced local carbon emissions. However, locally the carbon emissions from the fossil element of the waste burnt in the proposed ERF are 4.7 times the carbon emissions that might be saved by supplying all berthed vessels with electricity. The provision of shore power from the proposed ERF should not therefore be seen as a local GHG emission reduction measure.

Heat networks

6.11 The Appellant identifies five local buildings as potential consumers for heat supplied through district heating networks that transport heat from the ERF. Three of these consumers lie on a 1,000 m northern leg and two on a 5,000 m southern leg.

6.12 More detailed assessment of the consumers on the northern leg show that two of the larger customers are not practical for connection to district heating. Analysis of the linear heat density of the residual northern leg heat load shows that it is insufficient make the northern leg economically viable.

6.13 The linear heat density of the southern leg is higher that the northern leg but also below the threshold that is generally accepted as being economically viable. A more detailed assessment confirms this and shows that, as with cruise ship shore power, the electricity foregone to provide southern leg district heating is 1.5% of the proposed ERF's annual electricity production illustrating the mismatch between the size of the proposed facility and the southern leg heat demand (were it to be viable).

6.14 As neither the northern nor southern legs district heating networks are likely to be practical/viable there are no potential carbon benefits from the provision of district heating.

Electricity supply

6.15 The Appellant emphasises the ability of the proposed ERF to provide baseload power. Baseload power in the context of national energy security is delivered to the national grid consistently over a period. Nuclear power generation is often cited as the archetypal baseload power generator.

6.16 Were the ERF to potentially supply shore power over the cruise season (February to November) and district heating with peak loads over the winter heating season (October to March) it would not export baseload power to the grid. With Shore Power provision as proposed by the Appellant, at times when cruise ships double berth and take all the proposed ERF's generation capacity, the ERF would be exporting no power. In these circumstances the grid would see power from the proposed ERF as variable and interruptible, not baseload.

6.17 The variable and interruptible nature of the ERF's power export is likely to have implications for the sale of electricity from the ERF as the electricity market values certainty of supply and discounts for variability and interruptibility. The Appellant would need to be able to offset the electricity export price penalties associated with variability and interruptibility with the potential income from the provision of small quantities of price competitive Shore Power and district heating. This commercial uncertainty has implications that potentially undermine the delivery of Shore Power and district heating.

6.18 The proposed ERF operates for 8,000 hours annually. The plant is shut down for the remaining 760 hours (4.5 weeks) for annual maintenance. EfW plants typically shut down in the summer months. However, shutting down during the cruise season would affect the potential delivery of Shore Power. Equally shutting down in the heating season would affect the delivery of district heating. The Appellant does not show how the proposed ERF would continue to provide Shore Power and district heating during its annual shutdown.

Appendix 1: Analysis of cruise ship Shore Power offtake

1. Information provided by the Appellant in the Shore Power Strategy Report (CD 1.32, Section 2 page 4) states that 41 cruise ships visited the port in 2019, with 43 bookings for 2020 and 45 for 2021 with the port expecting 65 cruise ship visits by 2025 with half the cruise ships having the facilities for connecting to Shore Power. Section 3 on Page 5 states that cruise ships typically have demand for 8MW with a maximum of 12MW.
2. Section 3.1.3.2 of the Appellant's Carbon Assessment updated on 28th July 2021 [CD 2.17g] assumes that "60 - 65 cruise ships visit Portland each year" "with a gradual increase in the fraction of ships which are capable to taking power from the shore".
3. The Carbon Assessment dated 24th October 2023 revised for the Inquiry [CD 11.8] changes the previous information in 3.1.3.2 to assuming that "65 cruise ships visit Portland each year with a gradual increase in the fraction of ships which are capable of taking power from the shore".
4. Publicly available sources[16] provide information on cruise ship port calls and the vessels using the port. In 2023 56 cruise ships visited Portland Port with 44 vessels scheduled for 2024 and 24 vessels in 2025.
5. Rather than speculate on future cruise ship numbers I have analysed the 56 vessels in the 2023 data.
6. I have made the optimistic assumption that all cruise ships arriving at the port take Shore Power. This assumption is optimistic because it will take some years before all ships are able to take Shore Power and because, depending on the price of Shore Power, some vessels may on a commercial basis decide to use their onboard generators despite having the ability to connect to Shore Power.
7. Also, I have also not shortened the Shore Power connection times to allow for connection and disconnection which takes a minimum of 30 mins[17].

[16] https://www.cruisemapper.com/ports/isle-of-portland-port-8996?month=2023-10#schedule accessed 14th October 2023 Note: the functionality of this web site has changed since accessed.
[17] Department of Transport, Use of maritime shore power in the UK: summary of call for evidence responses, July 2023. See https://www.gov.uk/government/calls-for-evidence/use-of-maritime-shore-power-in-the-uk-call-for-evidence/outcome/use-of-maritime-shore-power-in-the-uk-summary-of-call-for-evidence-responses

8. The case presented here therefore represents a data backed maximum cruise ship Shore Power offtake.
9. I have assumed that “typical” and “maximum” cruise ship offtake capacities quoted in the Shore Power Strategy Report (8MW and 12MW) equate to the 2023 average vessel size (94,000 tonnes – see Table 3) and the 2023 maximum vessel size (182,000 tonnes – see Table 3). The capacity of vessels of other sizes takes these two points and assumes a linear relationship between tonnage and capacity.
10. This methodology provides the resulting 2023 capacity and consumption vessel by vessel as shown in the table below. Total cruise ship Shore Power consumption is calculated as 4,688 MWh.

Date	Vessel	Arrival time	Departure time	Hours in port	Vessel tonnes	Capacity MWe	Consumption MWh
31/01/2023	Ponant Cruises Cruises cruise lineL'Austral	09:00:00	20:00:00	11	10,944	4.2	47
19/02/2023	AIDA Cruises Cruises cruise lineAIDAsol	10:00:00	18:00:00	8	71,304	7.0	56
07/03/2023	AIDA Cruises Cruises cruise lineAIDAbella	08:00:00	19:00:00	11	69,203	6.9	76
15/04/2023	Holland America Cruises cruise linems Zuiderdam	07:00:00	19:00:00	12	82,820	7.5	90
16/04/2023	Hurtigruten Cruises cruise lineMS Otto Sverdrup	09:00:00	20:00:00	11	15,690	4.4	49
28/04/2023	MSC Cruises Cruises cruise lineMSC Virtuosa	07:00:00	19:00:00	12	181,541	12.0	144
30/04/2023	Hurtigruten Cruises cruise lineMS Otto Sverdrup	09:00:00	20:00:00	11	15,690	4.4	49
01/05/2023	Celebrity Cruises Cruises cruise lineCelebrity Silhouette	11:00:00	19:00:00	8	122,210	9.3	74
01/05/2023	Princess Cruises Cruises cruise lineRegal Princess	07:00:00	19:00:00	12	142,714	10.2	123
03/05/2023	Celebrity Cruises Cruises cruise lineCelebrity Apex	09:00:00	18:00:00	9	129,500	9.6	87
03/05/2023	TUI Cruises Cruises cruise lineMein Schiff 3	07:00:00	19:00:00	12	99,430	8.3	99
09/05/2023	Princess Cruises Cruises cruise lineRegal Princess	07:00:00	19:00:00	12	142,714	10.2	123
09/05/2023	TUI Cruises Cruises cruise lineMein Schiff 3	08:00:00	20:00:00	12	99,430	8.3	99
13/05/2023	Norwegian Cruise Line Cruises cruise lineNorwegian Dawn	11:00:00	20:00:00	9	92,250	7.9	71
16/05/2023	Celebrity Cruises Cruises cruise lineCelebrity Apex	07:00:00	16:00:00	9	129,500	9.6	87
16/05/2023	Small Cruise Lines Cruises cruise lineMiray MV Lara	09:00:00	19:00:00	10	42,289	5.7	57
20/05/2023	Seabourn Cruises Cruises cruise lineSeabourn Ovation	05:00:00	18:00:00	13	40,350	5.6	72
21/05/2023	Princess Cruises Cruises cruise lineRegal Princess	07:00:00	19:00:00	12	142,714	10.2	123
23/05/2023	Norwegian Cruise Line Cruises cruise lineNorwegian Dawn	11:00:00	20:00:00	9	92,250	7.9	71
23/05/2023	Phoenix Reisen Cruises cruise lineMS Deutschland-World Odyssey	08:00:00	18:00:00	10	22,496	4.8	48
28/05/2023	Small Cruise Lines Cruises cruise lineMiray MV Lara	10:00:00	21:00:00	11	42,289	5.7	62
30/05/2023	Holland America Cruises cruise linems Zuiderdam	08:00:00	23:00:00	15	82,820	7.5	113
31/05/2023	Ponant Cruises Cruises cruise lineLe Champlain	09:00:00	20:00:00	11	10,700	4.2	46
02/06/2023	Norwegian Cruise Line Cruises cruise lineNorwegian Dawn	11:00:00	20:00:00	9	92,250	7.9	71
04/06/2023	Norwegian Cruise Line Cruises cruise lineNorwegian Dawn	07:00:00	17:00:00	10	92,250	7.9	79
12/06/2023	Regent Seven Seas Cruises Cruises cruise lineSeven Seas Splendor	12:00:00	22:00:00	10	55,498	6.3	63
14/06/2023	Princess Cruises Cruises cruise lineRegal Princess	07:00:00	19:00:00	12	142,714	10.2	123
16/06/2023	TUI Cruises Cruises cruise lineMein Schiff 3	07:00:00	19:00:00	12	99,430	8.3	99
08/07/2023	Princess Cruises Cruises cruise lineRegal Princess	07:00:00	19:00:00	12	142,714	10.2	123
11/07/2023	Norwegian Cruise Line Cruises cruise lineNorwegian Dawn	11:00:00	20:00:00	9	92,250	7.9	71
26/07/2023	Norwegian Cruise Line Cruises cruise lineNorwegian Dawn	11:00:00	20:00:00	9	92,250	7.9	71
28/07/2023	Norwegian Cruise Line Cruises cruise lineNorwegian Dawn	07:00:00	16:00:00	9	92,250	7.9	71
31/07/2023	TUI Cruises Cruises cruise lineMein Schiff 3	07:00:00	19:00:00	12	99,430	8.3	99
03/08/2023	Princess Cruises Cruises cruise lineRegal Princess	07:00:00	19:00:00	12	142,714	10.2	123
29/08/2023	Oceania Cruises Cruises cruise lineOceania Vista	10:00:00	22:00:00	12	67,000	6.8	81
29/08/2023	TUI Cruises Cruises cruise lineMein Schiff 3	07:00:00	19:00:00	12	99,430	8.3	99
01/09/2023	Oceania Cruises Cruises cruise lineOceania Riviera	11:00:00	21:00:00	10	66,172	6.7	67
02/09/2023	Norwegian Cruise Line Cruises cruise lineNorwegian Dawn	11:00:00	20:00:00	9	92,250	7.9	71
02/09/2023	Saga Cruises Cruises cruise lineSpirit of Adventure	08:00:00	16:00:00	8	58,250	6.4	51
04/09/2023	Celebrity Cruises Cruises cruise lineCelebrity Apex	07:00:00	16:00:00	9	129,500	9.6	87
04/09/2023	Oceania Cruises Cruises cruise lineOceania Marina	12:00:00	22:00:00	10	66,084	6.7	67
06/09/2023	Princess Cruises Cruises cruise lineRegal Princess	07:00:00	19:00:00	12	142,714	10.2	123
06/09/2023	Regent Seven Seas Cruises Cruises cruise lineSeven Seas Voyager	13:00:00	22:00:00	9	42,363	5.7	51
07/09/2023	Princess Cruises Cruises cruise lineIsland Princess	07:00:00	19:00:00	12	92,822	8.0	96
11/09/2023	Seabourn Cruises Cruises cruise lineSeabourn Ovation	05:00:00	19:00:00	14	40,350	5.6	78
11/09/2023	Small Cruise Lines Cruises cruise lineMiray MV Lara	10:00:00	21:00:00	11	42,289	5.7	62
16/09/2023	Disney Cruise Line Cruises cruise lineDisney Dream	10:00:00	18:00:00	8	129,690	9.6	77
18/09/2023	Princess Cruises Cruises cruise lineRegal Princess	07:00:00	19:00:00	12	142,714	10.2	123
23/09/2023	Norwegian Cruise Line Cruises cruise lineNorwegian Dawn	11:00:00	20:00:00	9	92,250	7.9	71
29/09/2023	MSC Cruises Cruises cruise lineMSC Virtuosa	12:00:00	20:00:00	8	181,541	12.0	96
30/09/2023	Norwegian Cruise Line Cruises cruise lineNorwegian Getaway	13:00:00	20:00:00	7	146,655	10.4	73
30/09/2023	Princess Cruises Cruises cruise lineRegal Princess	07:00:00	19:00:00	12	142,714	10.2	123
10/10/2023	Holland America Cruises cruise linems Rotterdam	08:00:00	17:00:00	9	99,800	8.3	75
22/10/2023	Norwegian Cruise Line Cruises cruise lineNorwegian Star	11:00:00	20:00:00	9	91,740	7.9	71
26/10/2023	MSC Cruises Cruises cruise lineMSC Virtuosa	12:00:00	21:00:00	9	181,541	12.0	108
04/11/2023	AIDA Cruises Cruises cruise lineAIDAmar	08:00:00	19:00:00	11	71,304	7.0	77
56	vessels	Average hours/tonnes		10.5	93,639	Total MWh	4,688

Table 3: Cruise ship visits to Portland Port in 2023

11. The potential demand from Shore Power is sporadic as illustrated by the time series in Figure 7. The green lines show the hourly capacity taken by a first cruise ship in port and the yellow lines those taken by a second cruise ship.

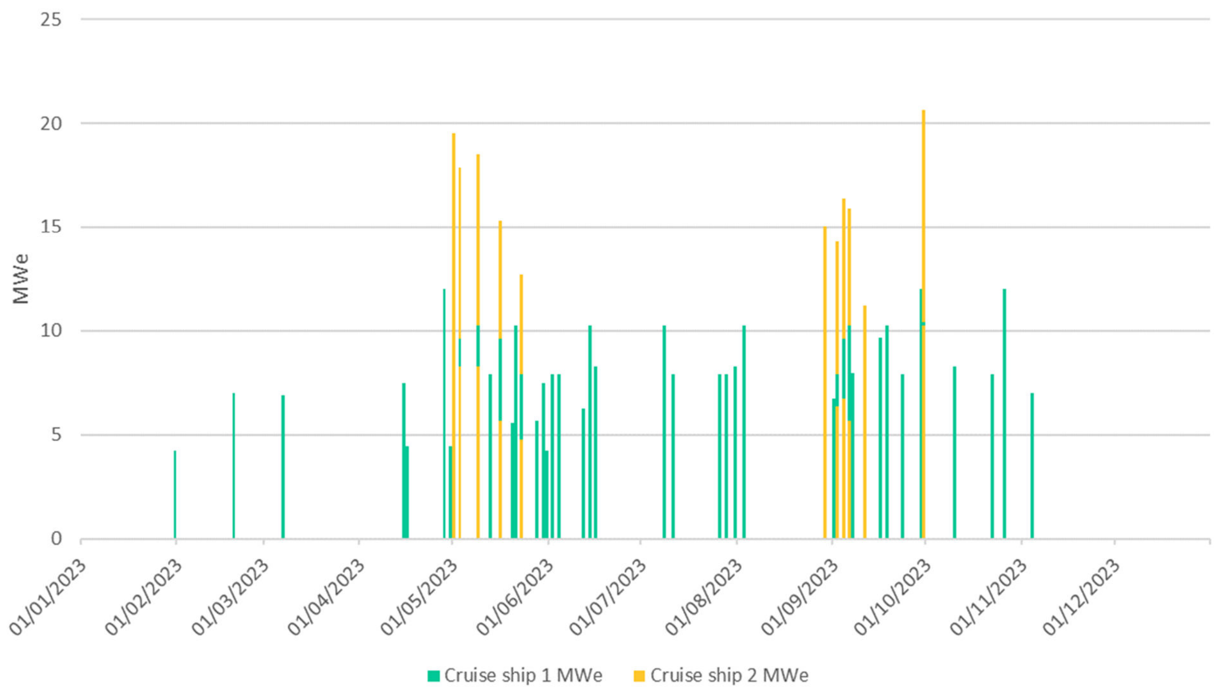


Figure 7: Potential Shore Power electricity demand from cruise ships over 2023

12. This work uses load duration curves. These graphs show the amount of energy in every hour of the year ordered from the highest amount (hour 1) to the lowest amount (hour 8760). Hour 1 identifies the peak load. The shape of the curve enables the duration of capacities to be analysed. The load duration curves for cruise ship Shore Power are shown in Figure 8.

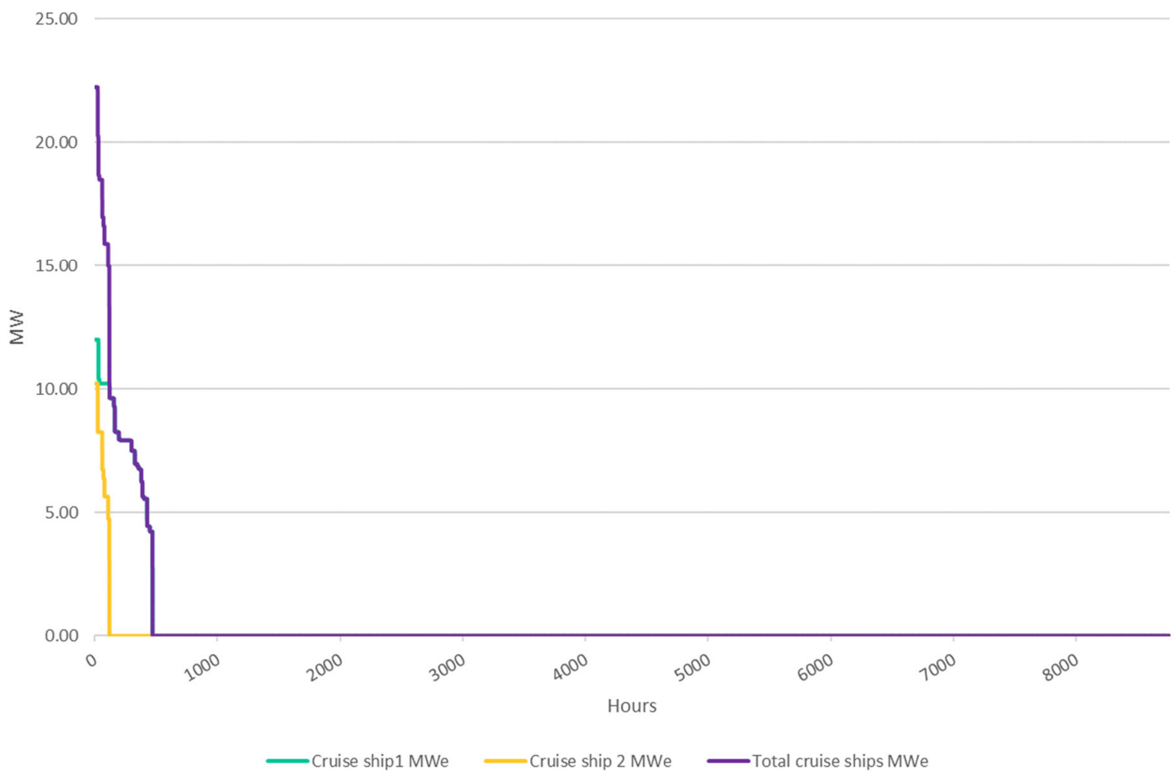


Figure 8: Potential load duration curve for cruise ship Shore Power in 2023

13. The load duration curve shows that the peak offtake for a single cruise ship is 12 MWe. When two cruise ship are in the port this rises to a maximum of 22.2 MWe. The short green cruise ship 1 line merges with the purple total line once all the 119 cruise ship 2 hours (i.e. double berthing hours) are recorded.
14. There are 470 hours of the year when there is a cruise ship Shore Power load; 5% of the hours in a year.
15. For 60 hours in 2023 year the potential total cruise ship shore power load exceeded the updated for Inquiry 17.1 MWe export capacity of the ERF. This happens when two larger cruise ships are in the port at the same time. High peak loads could be managed by the port avoiding multi vessel arrivals (10 days in 2023) or by limiting shore power to one berth.
16. The load duration curve in Figure 9 shows the electricity exported from the ERF less potential 2023 cruise ship shore power.

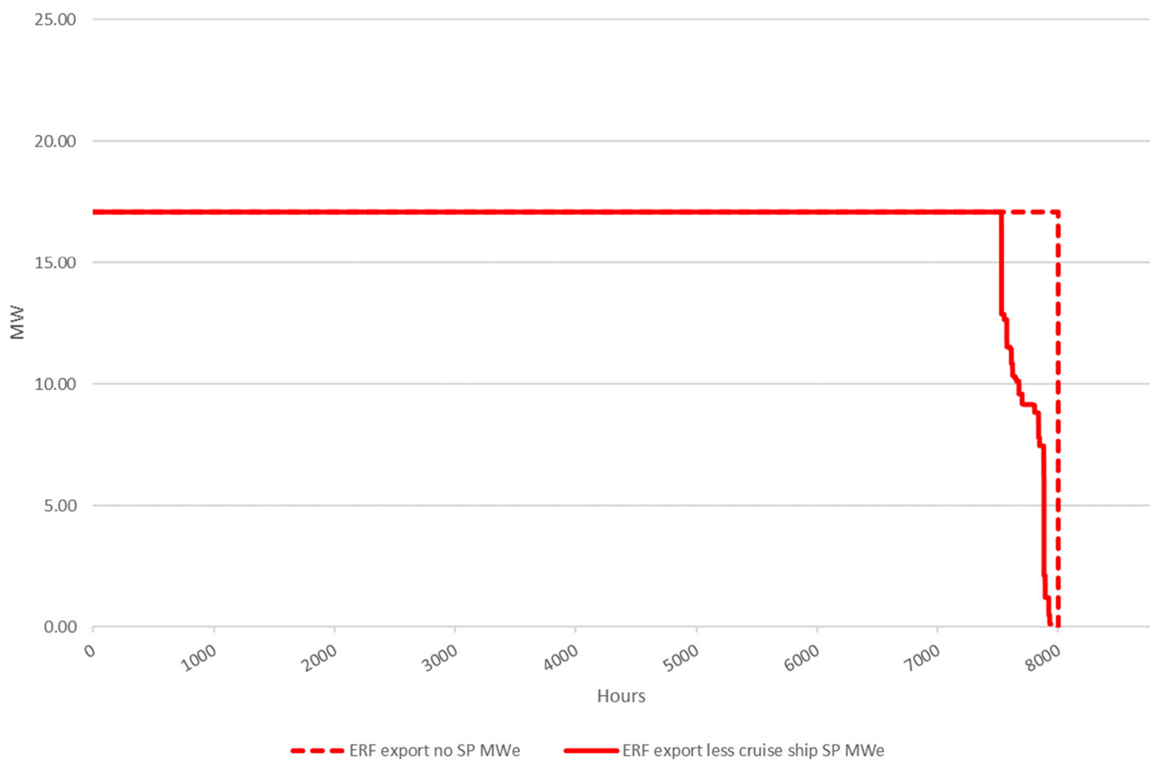


Figure 9: Load duration curve for ERF electricity export with and without potential 2023 cruise ship Shore Power

17. Without provision of cruise ship Shore Power the ERF exports 136,800 MWhe (the area under the dotted line). With potential 2023 cruise ship Shore Power the ERF exports 132,296 MWhe (the area under the solid line) and provides 4,504 MWhe of Shore Power (the difference between the dotted and solid lines), 3% of the ERF's electricity export without potential cruise ship Shore Power.
18. The Appellant's Shore Power Strategy Report states that just over half of the cruise ships currently visiting Portland have the facilities for connecting to Shore Power reducing the percentage of ERF power used by Shore Power to 1.5%.
19. The de minimis scale of cruise ship shore power in comparison with the ERF's electricity export illustrates the mismatch between the size of the proposed facility and the provision of potential 2023 cruise ship Shore Power.

Appendix 2: Analysis of Royal Fleet Auxiliary (RFA) Shore Power offtake

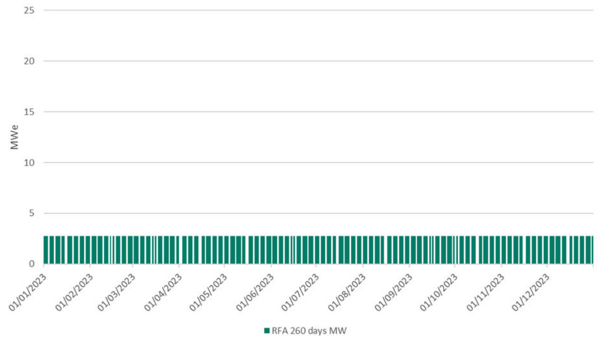
1. Information provided by the Appellant in the Shore Power Strategy Report (CD 1.32, Section 2 page 4) states in Section 3 on Page 5 that the RFA capacity requirement is 2.75 MW.
2. Section 3.1.3.2 of the Appellant's Carbon Assessment updated on 28th July 2021 [CD 2.17g] states an assumption that "RFA ships spend 260 days in port a year".
3. The Carbon Assessment dated 24th October 2023 revised for the Inquiry [CD 11.8] changes the previous information in 3.1.3.2 to an assumption that "RFA ships spend 390 ship-days in port a year" which assumes that an RFA vessel is in port for 365 days and that a second vessel double berths for 25 days per year.
4. No source is provided for the 50% increase in RFA ship days in port in the revised for Inquiry version of the Carbon Assessment [CD11.8].
5. I have analysed the potential RFA Shore Power demand for both the 260 day case and the 390 day case. In the 260 day case I assume that vessels are docked for 24 hours for 3 in every 4 days (274 days) and reduce it to 260 by removing the 14 extra days at regular intervals. In the 390 day case I assume continuous berthing of one vessel for 365 days with the additional 25 days berthing of a second vessel for a day every two weeks.
6. The two RFA cases are summarised in the Table 4.

Case	260 days per year RFA	390 days per year RFA
RFA capacity per vessel	2.75 MWe	2.75 MWe
RFA peak demand	2.75 MWe	5.5 MWe
RFA annual SP demand	17,160 MWhe	25,740 MWhe
Potential 2023 cruise ship Shore Power demand	4,688 MWhe	4,688 MWhe
Potential total Shore Power demand	21,848 MWhe	30,428 MWhe
RFA as % of total	78.5%	84.6%

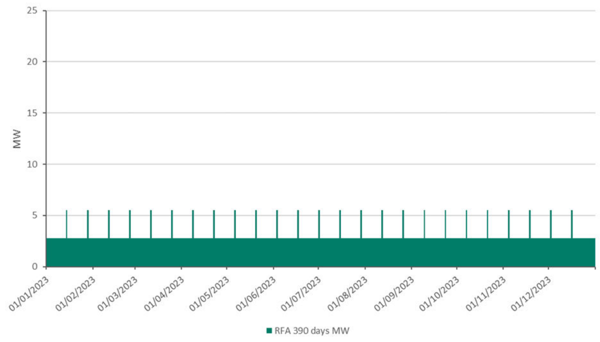
Potential 2023 cruise ship demand as % of total	21.5%	15.4%

Table 4: Assumed Shore Power demands of RFA vessels and comparison with potential 2023 cruise ship demand

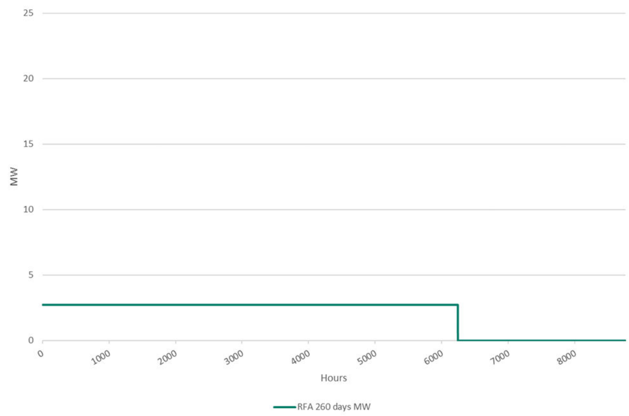
7. RFA demand dominates with the revised for Inquiry Carbon Assessment's [CD11.8] assumed Shore Power use forming 85% of potential total Shore Power demand.
8. The potential total Shore Power demands calculated above are of the same order as in the Appellant's Carbon Assessments [CD 2.17g & CD 11.8] (July 2021: 20,328 MWhe to 24,423 MWhe. Revised for Inquiry: 29,639 MWhe to 32,931 MWhe) which do not give the split between cruise ship and RFA consumption. This level of agreement indicates that 2023 actual cruise ship consumption is similar to that assumed by the Appellant.
9. Figure 10 shows the RFA timeseries, RFA load duration and ERF load duration curves for RFA Shore Power provision for the 260 day and 390 day cases.



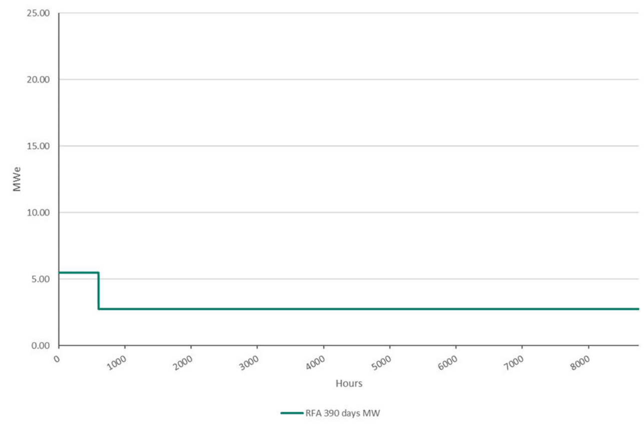
RFA time series 260 days



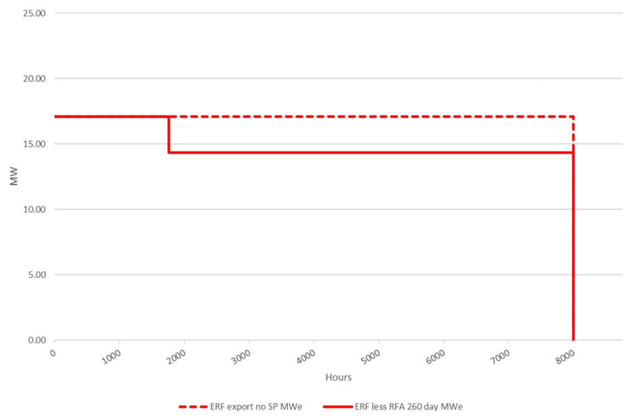
RFA time series 390 days



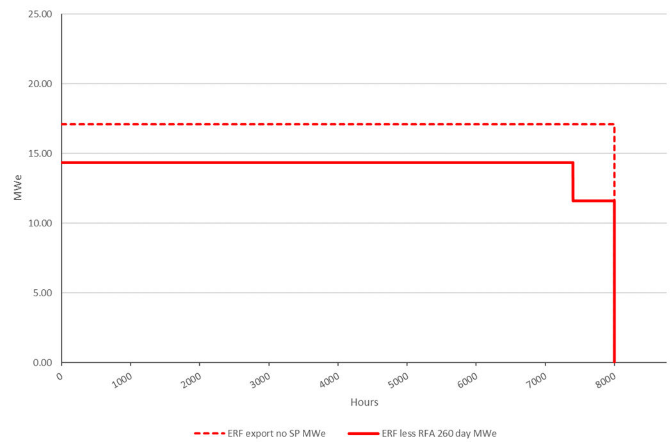
RFA load duration 260 days



RFA load duration 390 days



EFR load duration RFA 260 days



EFR load duration RFA 390 days

Figure 10: RFA timeseries and load duration curves

10. The RFA load for the two cases is summarised in the Table 5.

Case	260 days per year RFA	390 days per year RFA
ERF export no RFA	136,800 MWhe	136,800 MWhe
EFR export with RFA	119,640 MWhe	113,151 MWhe
RFA demand	17,160 MWhe	25,740 MWhe
RFA supply from ERF	17,160 MWhe	23,650 MWhe
RFA demand as % of ERF export without RFA	12.5%	17.3%

Table 5: Summary of potential RFA Shore Power provision from the ERF

11. The difference between the RFA demand and the RFA supply in the 390 day case is due to ERF availability being limited to 8,000 hours with 760 hours (31.6 days or 4.5 weeks) set aside for ERF maintenance. Although the load duration curves show this only affecting the 390 day case, the same phenomenon will affect the 260 day case as the shutdown will be continuous and not selectively on days in the timeseries when RFA vessels are not drawing power. However, this refinement is not shown in the 260 day load duration curve as it places single days together.