

SHORE POWER DEMAND FOR SOUTH AFRICAN PORTS



IMPRINT

As a federal owned enterprise, GIZ supports the German Government in achieving its objectives in the field of International cooperation for sustainable development.

Published by:

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Registered offices:

Bonn and Eschborn, Germany

International PtX Hub
Köthener Str. 2-3
10963 Berlin, Germany
T +49 61 9679-0
F+49 61 96 79 -11 15

E info@ptx-hub.org

I www.ptx-hub.org

Responsible:

Johannes Arndt (GIZ)

Authors:

Manjunath Basappa Ayanna (CSIR),
Jan-Hendrik Grobler (CSIR),
Dr. Lawrence Pratt (CSIR),
Stefan Karamanski (CSIR),
Christopher Marz (CSIR),
Mandla Masoga (CSIR),
Dimakatso Raputo (CSIR),
Dr. Kittessa Roro (CSIR),
Dr. Rigardt Coetzee (CSIR),
Thomas Roos (CSIR)

Smart Places
CSIR
PO Box 395
Pretoria 0001, South Africa
T + 27 12 841 2911
www.csir.co.za

Reviewers:

Stefan Karamanski (CSIR)

Project Management:

Dr Rigardt A.M. Coetzee (CSIR)

racoetzee@csir.co.za

Project leader:

Thomas Roos (CSIR)

throos@csir.co.za

Acknowledgment:

The Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) contributed to this publication via the International Power-to-X Hub. The International Power-to-X Hub is funded by the International Climate Initiative (IKI) of the German federal Ministry of Economic Affairs and Energy.

The opinions and recommendations expressed do not necessarily reflect the positions of the commissioning institutions or the implementing agency.

Please cite as:

Snyman-van der Walt, L., Lochner, P. & Abed, R. 2025. High-level environmental constraints analysis to identify potential renewable energy sites for PtX production at the ports of South Africa. CSIR. Report no: CSIR/SPLS/Ems/ER/2025/0021/A.

Pretoria, September 2025

Supported by:



on the basis of a decision
by the German Bundestag



Table of Contents

Executive Summary.....	6
1. Introduction	7
2. Methodology.....	8
2.1. Input Port Data.....	8
2.2. Methodology Developed to Estimate Shore Power Demand	9
2.2.1. Clean and Filter Input Port Data	9
2.2.2. Perform Merge Operation on 2021-2022 and 2022-2023 datasets	9
2.2.2.1. Pre-processing Procedure before Merging	10
2.2.2.2. Perform Nearest Key Forward Search by Matching the Next Forward Appearance of Data Entries in the Departure Dataset.....	10
2.2.2.3. Post-processing Procedure after Merging	10
2.2.3. Convert of Data Types of Data Columns	10
2.2.4. Convert Vessel Type column into a Standard Vessel format.....	11
2.2.5. Estimate the Hotel Demand of each Vessel	12
2.2.6. Create Time Series of Shore Power Demand	14
2.2.7. Plot Visuals and Determine Maximum Power Demand per port	14
3. Results and Discussion.....	15
3.1. Merged Data Results for 2021-2022 and 2022-2023	15
3.2. Shore Power Demand Results	17
3.2.1. Shore Power Demand results for Durban 2018-2019.....	17
3.2.2. Peak and Average maximum Shore Power Demand for Durban.....	17
3.2.3. Shore Power Demand results per financial year for all ports.....	18
3.2.4. National Peak Shore Power Demand	20
4. Conclusion.....	22
5. References.....	23
Appendix	24

Supported by:

List of Figures

Figure 1: Example of Sustainable Ship Data on Website	12
Figure 2: IMO Shore Power data [4].....	13
Figure 3: Linear Relationship between GRT and DWT	14
Figure 4: Calculated Peak Utilization Maximum and Average Utilization Maximum for Durban in 2018-2019 Financial Year.	17
Figure 5: Calculated Absolute Maximum Utilization and Average Utilization Maximum Power Demand for Durban Port .	18
Figure 6 Average Utilization Maximum and Peak Utilization Maximum Shore Power for all the Ports	20
Figure 7 Peak Shore power Demand and location	21

List of Tables

Table 1: Features of Input Data	8
Table 2: 2021-2022 and 2022-2023 Merged Data Statistics	16
Table 3: Peak Utilization Maximum and Peak Average Utilization Maximum Shore Power Demand for All Ports Per Financial Year.....	19

List of Abbreviations

DNV	Det Norske Veritas
EMSA	European Maritime Safety Agency
IMO	International Maritime Organisation
IPCC	International government Panel on Climate Change
TNPA	Transnet National Port Authority

Executive Summary

This report describes the methodology and the results obtained from estimating the maximum shore power demand at eight South African ports. Given that maritime cargo transportation accounts for 80% of world trade and is a major contributor to greenhouse gas emissions, providing readily available shore power for incoming vessels in South Africa can help reduce their reliance on onboard power.

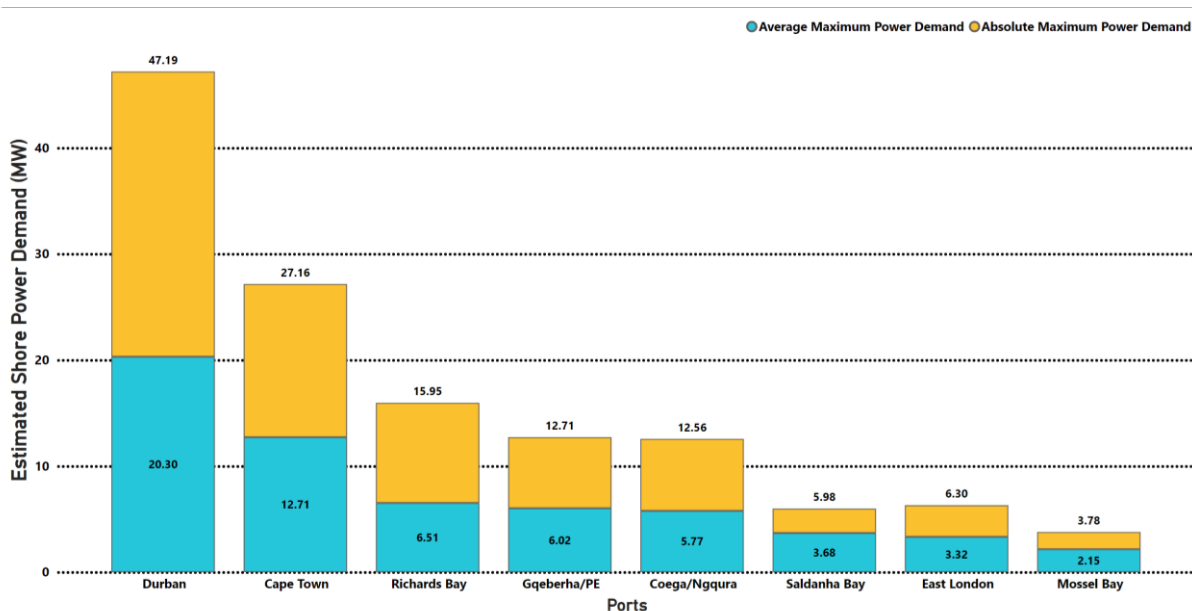
Using vessel logging data provided by TNPA for each of the ports for financial years between 2018 and 2025, a custom data analytics methodology was developed to estimate shore power demand. The methodology involved:

- Cleaning and filtering data
- Merging data for specific years to account to missing data features such as time in port
- Converting column of data to specific types for additional feature engineering and easy of use
- Categorise Vessel types into a standard vessel format
- Use Linear Regression on correlated variables to estimate critically required data
- Estimate Average and Maximum Shore power time series using reference data

Some years, such as 2021-2022 and 2022-2023, were omitted for some ports due to vessel type classing incorrectness in the original dataset provided.

The methodology resulted in time series created for each port for every year where data was available. Using the time series, the aim of this report can be achieved by visualisation of both the peak average and maximum power demands per port. The figure below shows a bar chart of the all the ports' estimated peak average and maximum power demand between 2018 and 2025.

Average Utilization Maximum and Peak Utilization Maximum Shore Power for all the Ports



Source: Own creation.

Supported by:



Federal Ministry
for Economic Affairs
and Climate Action



INTERNATIONAL
CLIMATE
INITIATIVE



on the basis of a decision
by the German Bundestag

1. Introduction

Maritime international transport of merchandise is the most cost-effective mode of transportation compared to rail and road [1]. It is the means by which global trade occurs. This is given by the fact that international shipping via sea constitutes 80% of the world trade by volume [2]. It therefore will continue to be an essential industry when it comes to global economic trade. However, the advantage of using this mode of transport comes with an emissions cost in the form of air pollution. According to the International governmental Panel on Climate Change (IPCC), global shipping as sector contributes as a percentage of each respective emission type: 8.52 % of sulphur dioxide (SO₂) and 18.87 % of nitrogen oxides (NO_x) in 2014 [3]. Additionally, carbon dioxide (CO₂) made up approximately 2.89 % of total CO₂ emission in 2018 [4]. This serves as the motivation behind providing on-demand shore power for vessels in port as they use diesel engines to provide electricity for hotelling. Providing shore power will not only reduced air emissions, but so will the need to rely on-board auxiliary diesel generators. Potentially, this may lead to cost-savings on auxiliary diesel generator maintenance as well as less diesel needed on board.

South Africa has eight ports along its coastline all loading and uploading a variety of cargo namely:

- Cape Town
- Durban
- Gqeberha (formerly Port Elizabeth)
- East London
- Mossel Bay
- Coega (Ngqura)
- Richards Bay
- Saldanha Bay

It is desired for these ports to also serve as a 'plug point' for relevant vessels to abate forementioned usage of on-board diesel generators. It is thus the aim of this report to provide the reader with a justified estimation of maximum annual power demand per port. This report shall describe:

- the methodology used to the determine the estimation of power demand
- limitations of the reported results given
- results of the methodology

Note that the results given in this report are given as an estimation and are limited by the assumptions stated.

Supported by:

2. Methodology

In order to achieve the stated aim of estimating the maximum power demand drawn by vessels in a port, a clear justified methodology must be developed. In addition to the methodology, adequate port data must be provided. The maximum power demand drawn is in relative to any power drawn at any given point in time over a given period. Therefore, ideally a time series of power demand per port should be created as serve a technical output. The methodology developed is simply the step-by-step procedure used to create the time series to power demand per port.

The sections below describe the input data used as well as the methodology developed to estimate the maximum power demand per port.

2.1. Input Port Data

The data used to generate the time series, was provided by Transnet National Port Authority (TNPA). This data is in the form of a spreadsheet where a log is provided. In other words, every spreadsheet serves as a record of vessel activity at a port per year. Every data entire is a record of what a particular vessel is doing at that port and for how long. Other data included is the type of vessel it is, identification, vessel specification such as length or gross tonnage and destination. Spreadsheets are given as an annual collection of logs of vessel activity per port. So, for 2018-2019, the spreadsheet would contain a log of vessel activity for Cape Town, Durban, Gqeberha (Port Elizabeth), East London, Mossels Bay, Coega (Ngqura), Richards Bay and Saldanha Bay where each port is given its own sheet. Data is given for the following financial years.

- 2018-2019
- 2019-2020
- 2020-2021
- 2021-2022
- 2022-2023
- 2023-2024
- 2024-2025

The data features that are contained in the spreadsheets are given in Table 1.

Table 1: Features of Input Data

Term	Description
VCN	A unique identifier assigned to a vessel's arrival and departure at a port
Vessel Name	Name of the Vessel
IMONo	A unique seven-digit identification number assigned to vessels. It's used to track and identify ships, regardless of changes in ownership, flag, or name, throughout their operational life, and even after they are scrapped
Agent Name	A representative for shipowners, charterers, or operators, handling various aspects of a ship's port call
Movement Type	Is the vessel arriving or departing, Arrival or Departure
Vessel Type	The type of vessel
Flags	Nationality of the vessel
Last Port	Previous docking location
Next Port	Next docking location
Reason	Reason why the vessel is in the port
Port Limits	Where vessels are requested to wait before docking
Callsign	A unique identifier assigned to a vessel for radio communication purposes

Supported by:

GRT	Gross registered tonnage: a measure is the total internal volume of space available within the vessel. Indicates the ship's size and carrying capacity. This is measurement of space (volume) in registered ton which is equivalent to 100 cubic feet (2.83 cubic metres).
DWT	Dead weight tonnage: The sum total of weight (in tonnes) that the vessel can carry (carrying capacity). It does not include ship's own weight.
LOA	Length Overall. The total length of the vessel in metres.
Fwd Draft	The depth to which the bow (front) of a vessel is submerged in the water.
Aft Draft	The depth to which the stern (rear) of a vessel is submerged in the water.
B.W(In)	Time the vessel docked at the berth
B.W(Out)	Time the vessel leaves the berth
Berth	A designated location at a port where a ship can dock to load or unload cargo or passengers

Of all data features shown, the most relevant in estimating shore power demand is 'Vessel Type', 'GRT', 'DWT', 'B.W(In)' and 'B.W(Out)' features. This is because the shore power demand of a particular is mostly a function of what kind of vessel it is (given by Vessel Type data feature) as well as how large it is (given by GRT or DWT). The total amount of power drawn at any given time is only affected by the amount of time in the port affects and by the number of vessels in the port at that time. But the amount of time a vessel spends in the port has no effect on the power demand of that individual vessel, that only effect energy consumption.

Note for data for years 2021-2022 and 2022-2023, a custom merging process was developed because of missing B.W (In), B.W(Out) and Vessel Type features. Instead, only breakwater time feature was available to use as a time indicator. For the rest of years, most entries have repeat within the spreadsheet. However, repeated data is identical the only difference between the 2 is the Movement Type column where one is listed an 'Arrival' and the other is 'Departure'. However, the important part is everything else is same, including arrival (B.W(In)) and departure (B.W(Out)) times. So, 1 of entries can be treated as a duplicate of the other and therefore can be removed. This is considered 'cleaning' the dataset and a necessary pre-processing procedure. But this procedure cannot be done for 2021-2022 and 2022-2023 data.

This custom process is described below.

2.2. Methodology Developed to Estimate Shore Power Demand

The methodology developed is broken down into in executable steps. Assumptions and explanations are given when necessary for particular processes.

2.2.1. Clean and Filter Input Port Data

This step involves the following:

- Reading the raw input data
- Checking if all relevant column names are in the dataset and re-ordering the columns in a constant standard
- Removing entries with missing critical data (for example, if a vessel log has a missing B.W(In) or B.W(Out), it must be removed because it is not useful data).
- Removing duplicate data based on Movement Type

2.2.2. Perform Merge Operation on 2021-2022 and 2022-2023 datasets

This step is required because these datasets had a different way of logging the data. As stated in the last paragraph in Section 2.1, these datasets are missing B.W(In), B.W(Out) and Vessel Type features. These are critical in estimate store power. So, the following procedure was used to augment the dataset into the format required. The data will be sorted, split into 2 separate datasets by vessels arriving and departing giving by the Movement Type column, sorted again and merged based on matched matching Vessel Names in both datasets.

Supported by:

2.2.2.1. Pre-processing Procedure before Merging

- Sort/order the data by Vessel Name, Reason, Call Sign and Breakwater. This will order the data according to column names given
- Convert Breakwater column into a datetime data type
- Split data into 2 separate datasets into arrivals and departures
- Renaming the 'Breakwater' columns by their corresponding dataset name (e.g. for the arrival dataset renaming the breakwater to 'Breakwater_arr'). This avoids conflicting data during merging so naming columns by a different name keeps said data.

2.2.2.2. Perform Nearest Key Forward Search by Matching the Next Forward Appearance of Data Entries in the Departure Dataset

This merge works by using the arrival dataset as a reference. By specifying what columns must match in both datasets the merge operation will perform a nearest key search in the departure data using the Breakwater column. Anytime a match is found, the data in the arrival and departure datasets is merged together on the specified columns. The nearest key search is set to forward search only because matches should only be merged if departure for that particular data entire appears later not before arrival. This is why the data must be sorted.

2.2.2.3. Post-processing Procedure after Merging

These steps are performed to ensure accurate data the outputted from this merging procedure.

- Extract data where only departure date is greater than arrival date
- Find unmatched arrivals data that has no corresponding departure and vice versa.
- Extract, rename and sort only relevant data columns in the merged dataset so that it matches the rest of the data that did not need merging.

2.2.3. Convert of Data Types of Data Columns

In order to perform additional manipulation on the data, data columns made must converted into a particular data type. This allows the user to perform a multitude of operations that are specific to that data type on that column of data. Two conversions are used.

- Convert all naming columns to string data type. Naming columns are:
 - Vessel Name
 - Agent Name
 - Movement Type
 - Vessel Type
 - Flag
 - Reason

Doing this conversion means that Python will know that these data are text. String methods can be applied to make the data easier to read. In this case, all the text is converted into a capitalized format where text is replaced with capitalization of the first letter in each word. This removes all upper and lowercase text and replaces it with their equivalent capitalization format for easy reading.

- Convert date columns into datetime data type. Date columns are:
 - Port Limits
 - B.W(In)
 - B.W(Out)

Supported by:

The difference in time can be found by subtracting B.W(Out) from B.W(In) and converted to either days or hours. This will indicate the amount of time the vessel spent in the port.

2.2.4. Convert Vessel Type column into a Standard Vessel format

Currently, all the Vessel Type data varies from port to port and year to year. There is no consistency when it comes to convention. As stated in the second last paragraph of Section 2.1, the most relevant data to estimate shore power is Vessel Type. So, a standard convention needs to be applied into the Vessel Type column for consistency. This is because in the following steps, the vessel type shall be used to estimate the shore power demand for each ship using a Shore Power Reference data. This guide shall be described below in Section 2.2.5.

The main part that is important is that shore power is associated with vessel type and must be present in the dataset in a constant manner in order to apply an estimation method onto each vessel. The range of how much power would be drawn with in each vessel class is based on DWT.

For example, TNPA data files contained different naming classes for similar vessel types, for instance a containership in Cape Town could be classified as “container” while the term “ctn=containership” was used in Saldanha Bay.

To resolve this, a standard vessel naming convention was established. All vessel types stored under the vessel type column were re-classified and stored according to the naming convention used on the Sustainable Ships’ Average Shore Power Demand website [5]. It is simply a collection of shore power data by vessel type from various sources such as International Maritime Organization (IMO), European Maritime Safety Agency (EMSA) and Det Norske Veritas (DNV).

The Vessel Types were converted and standardized. The standardized terms are:

- Containership
- Chemical Tanker
- Crude Oil Tanker
- Oil products Tanker
- General Bulk Carrier
- Ore Carrier
- General Cargo Ship
- LPG Carrier
- RO-RO Cargo
- RO-RO Cargo vehicle carrier
- RORO Passenger
- Reefer
- Passenger Ship
- Fish Carrier
- Fish Factory Ship
- Trawler

There are three scenarios where renaming is done:

1. Manually classify all the vessels in the data by the list above using the ‘Vessel Type’ column
2. Use a hatch table (dictionary) to map vessel name to vessel standard name
3. If there is no ‘Vessel Type’ column (e.g. 2021-2022 and 2022-2023) is empty, the ‘Reason’ column is used instead and renames the data using a hash table.

Supported by:

2.2.5. Estimate the Hotel Demand of each Vessel

Here, both the 'Vessel Type' and 'DWT' data is used to estimate the hotel demand of each vessel. This is achieved by using Sustainable Ships' website. The website contains a collection of shore power data given per vessel type and varying by DWT. Per vessel type, the shore power ranges are categorised and grouped by DWT. By using both Vessel Type and DWT data of each vessel, the shore power demand can be estimated. The shore power demand is split into three categories: Low, Average and High. Figure 1 shows an example of the data from Sustainable Ships website. An assignment operation consists of 2 steps:

- check what is vessel type the vessel is
- find where the DWT value is ranged between in the Sustainable Ships' data and get the average and high shore power demands

In the event that DWT value is not available for a particular vessel, GRT can be used to determine DWT using the linear relationship between the 2 variables for all vessel types. Using GRT, a linear regression model can be established on known GRT and DWT values per vessel type. That linear relationship can be used to estimate the DWT. The linear relationship is shown in Figure 3.

Note that only the IMO-sourced data was used as it serves as a reputable source of data. The assumption made is that the auxiliary engine power output during berthing can be used as estimate for shore power demand. The original source of the data is shown in Figure 2.

Figure 1: Example of Sustainable Ship Data on Website

Ship type ↕	Dimension ↕	Unit ↕	Low ↕	Average ↕	High ↕	Source ↕
General Liquid Carrier	0 - 999	DWT	0 kW	250 kW	500 kW	IMO
General Liquid Carrier	1,000+	DWT	0 kW	250 kW	500 kW	IMO
Crude Oil Tanker	1,000 - 4,999	DWT	0 kW	125 kW	250 kW	IMO
Crude Oil Tanker	5,000 - 9,999	DWT	0 kW	188 kW	375 kW	IMO
Crude Oil Tanker	10,000 - 19,999	DWT	0 kW	288 kW	690 kW	IMO
Crude Oil Tanker	20,000 - 59,999	DWT	0 kW	300 kW	720 kW	IMO
Crude Oil Tanker	60,000-79,999	DWT	0 kW	271 kW	620 kW	IMO
Crude Oil Tanker	80,000-119,999	DWT	0 kW	352 kW	800 kW	IMO
Crude Oil Tanker	120,000 - 199,999	DWT	0 kW	731 kW	2,500 kW	IMO
Crude Oil Tanker	200,000+	DWT	0 kW	731 kW	2,500 kW	IMO
Chemical Tanker	0 - 4,999	DWT	0 kW	73 kW	170 kW	IMO
Chemical Tanker	5,000 - 9,999	DWT	0 kW	213 kW	490 kW	IMO
Chemical Tanker	10,000 - 19,999	DWT	0 kW	213 kW	490 kW	IMO
Chemical Tanker	20,000 - 39,999	DWT	0 kW	323 kW	790 kW	IMO
Chemical Tanker	40,000+	DWT	0 kW	323 kW	790 kW	IMO

Source: Sustainable-Ships.org

Supported by:

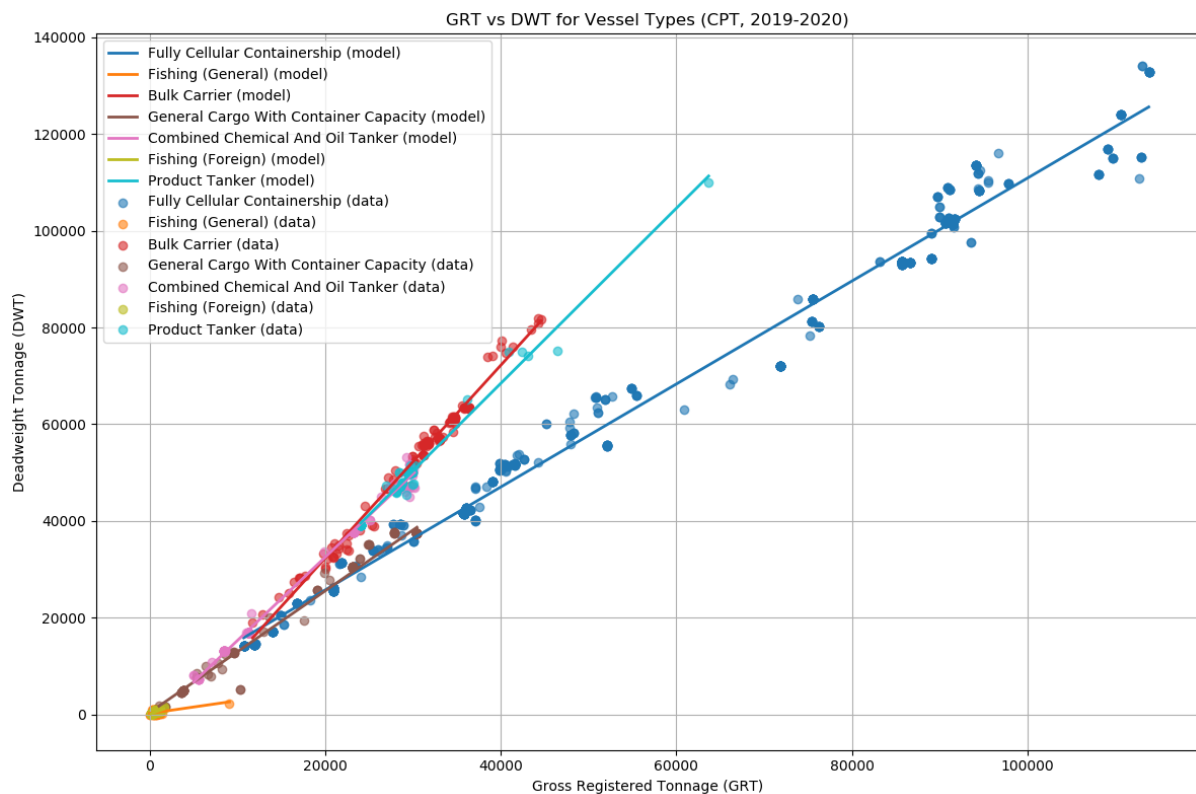
Figure 2: IMO Shore Power data [4]

Ship Type	Size	Unit	Auxiliary Boiler Power Output (kW)				Auxiliary Engine Power Output (kW)			
			At berth	Anchored	Manoeuvring	Sea	At berth	Anchored	Manoeuvring	Sea
Bulk carrier	0-9,999	dwt	70	70	60	0	110	180	500	190
	10,000-34,999		70	70	60	0	110	180	500	190
	35,000-59,999		130	130	120	0	150	250	680	260
	60,000-99,999		260	260	240	0	240	400	1,100	410
	100,000-199,999		260	260	240	0	240	400	1,100	410
	200,000-+		260	260	240	0	240	400	1,100	410
Chemical tanker	0-4,999	dwt	670	160	130	0	110	170	190	200
	5,000-9,999		670	160	130	0	330	490	560	580
	10,000-19,999		1,000	240	200	0	330	490	560	580
	20,000-39,999		1,350	320	270	0	790	550	900	660
	40,000-+		1,350	320	270	0	790	550	900	660
Container	0-999	TEU	250	250	240	0	370	450	790	410
	1,000-1,999		340	340	310	0	820	910	1,750	900
	2,000-2,999		460	450	430	0	610	910	1,900	920
	3,000-4,999		480	480	430	0	1,100	1,350	2,500	1,400
	5,000-7,999		590	580	550	0	1,100	1,400	2,800	1,450
	8,000-11,999		620	620	540	0	1,150	1,600	2,900	1,800
	12,000-14,499		630	630	630	0	1,300	1,800	3,250	2,050
	14,500-19,999		630	630	630	0	1,400	1,950	3,600	2,300
	20,000-+		700	700	700	0	1,400	1,950	3,600	2,300
General cargo	0-4,999	dwt	0	0	0	0	90	50	180	60
	5,000-9,999		110	110	100	0	240	130	490	180
	10,000-19,999		150	150	130	0	720	370	1,450	520
	20,000-+		150	150	130	0	720	370	1,450	520
Liquefied gas tanker	0-49,999	cbm	1,000	200	200	100	240	240	360	240
	50,000-99,999		1,000	200	200	100	1,700	1,700	2,600	1,700
	100,000-199,999		1,500	300	300	150	2,500	2,000	2,300	2,650
	200,000-+		3,000	600	600	300	6,750	7,200	7,200	6,750
Oil tanker	0-4,999	dwt	500	100	100	0	250	250	375	250
	5,000-9,999		750	150	150	0	375	375	560	375
	10,000-19,999		1,250	250	250	0	690	500	580	490
	20,000-59,999		2,700	270	270	270	720	520	600	510
	60,000-79,999		3,250	360	360	280	620	490	770	560
	80,000-119,999		4,000	400	400	280	800	640	910	690
	120,000-199,999		6,500	500	500	300	2,500	770	1,300	860

Source: Sustainable Ships, "Average Shore Power Demand," 2025. [Online]. Available: <https://www.sustainable-ships.org/tools/average-shore-power-demand>. [Accessed July 2025].

Supported by:

Figure 3: Linear Relationship between GRT and DWT



Source: Own creation.

2.2.6. Create Time Series of Shore Power Demand

The shore power of every vessel is now known as well as the amount time spent in the port. Before the time series can be generated, a final data cleaning routine is performed whereby any vessel that:

- Have negative durations are removed i.e. B.W(In) time is later than that of B.W(Out)
- Have missing B.W(In) or B.W(Out) times
- Are in the port for repairs and duration is extend the date of year in question

The time series is developed by:

- Determining the start and end date of the year in question. This is given by B.W(In) and B.W(Out) data
- Create a 24-hour time sliding window which sums all the shore powers within the window and assign the summed value to the timestamp of that 24-hour represents.

2.2.7. Plot Visuals and Determine Maximum Power Demand per port

Using the time series developed in Section 2.2.6, the following plots are generated.

- Time Series plot of Maximum and Average power demand per port per year
- Geographic plot of shore power demand at each port mapped into South Africa
- Bar Chart showing Average and Maximum Shore Power Demand per port

Supported by:

3. Results and Discussion

This Section shall describe the results of the methodology from Section 2. Results include the following:

- Merged data statistics table and why additional data is included to compensate for any loss due to incorrect data.
- Time Series plot of both average and maximum shore power estimates. Note plots were created for each port of each financial year resulting in many plots. The results show an example of the plot for Durban for the financial year of 2018-2019. These plots can be seen the Appendix of this report.
- Bar chart comparing the Average and Maximum Shore Power per financial year at a particular port. Again, these plots are voluminous in number and are included in Appendix.
- A table showing the peak average and maximum shore power demand per port per year.
- A geographic plot showing each port of South Africa with the maximum shore power demand located at each.

3.1. Merged Data Results for 2021-2022 and 2022-2023

As mentioned in Section 2.2.4., the 2021-2022 and 2022-2023 datasets did not have Vessel Type data. Instead, the 'Reason' data was used to determine the Vessel Type standardisation. However, manual searches of vessel names from these datasets show that stated vessel type given by the reason data is incorrect. Therefore, if the reason is incorrect so will the vessel type standardisation. So, data from these datasets were omitted from being used to generate time series.

The merging of arrival and departure data was correct. In other words, there was a corresponding departure for every arrival most of time. Table 2 shows the merging data statistics. It shows the number of matches, unmatched data for both arrivals and departures as well as all corresponding percentages of their totals. This indicates that the merged data would be reliable and useful if all Vessel Type data was correct.

Therefore, to compensate the loss in data, 2023-2024 and 2024-2025 years' data were included in order to have at least 5 years of time series data for most ports.

Abbreviation	Full Description
PN	Port Name
TA	Total Arrivals
TD	Total Departures
NTM	Number of Total
NUA	Number of Unmatched Arrivals
NUD	Number of Unmatched Departures
CO	Cross Over
NY	Next Year

Supported by:

Table 2: 2021-2022 and 2022-2023 Merged Data Statistics

Year	PN	TA	TD	NTM	% of TA that are TM	NUA	% of TA that are UA	NUD	% of TD that are UD	CO Matches with NY
2021-2022	CPT	1207	1176	1132	93.79	75	6.21	79	6.72	10
2021-2022	DBN	1924	1883	1864	96.88	56	2.91	32	1.70	4
2021-2022	EL	250	248	247	98.8	3	1.2	1	0.40	1
2021-2022	MSB	555	546	540	97.3	14	2.52	23	4.21	6
2021-2022	NGQ	636	633	629	98.9	7	1.1	9	1.42	0
2021-2022	PE	541	505	511	94.45	30	5.55	10	1.98	0
2021-2022	RCB	1552	1530	1525	98.26	26	1.68	18	1.18	1
2021-2022	SLD	602	601	595	98.84	7	1.16	15	2.50	1
2022-2023	CPT	1429	1384	1333	93.28	92	6.44	55	3.97	
2022-2023	DBN	2887	2876	2838	98.3	49	1.7	45	1.56	
2022-2023	EL	295	294	291	98.64	4	1.36	3	1.02	
2022-2023	MSB	1028	1031	1012	98.44	16	1.56	30	2.91	
2022-2023	NGQ	682	677	676	99.12	6	0.88	2	0.30	
2022-2023	PE	737	730	721	97.83	16	2.17	11	1.51	
2022-2023	RCB	1456	1455	1440	98.9	15	1.03	20	1.37	
2022-2023	SLD	519	517	511	98.46	8	1.54	9	1.74	

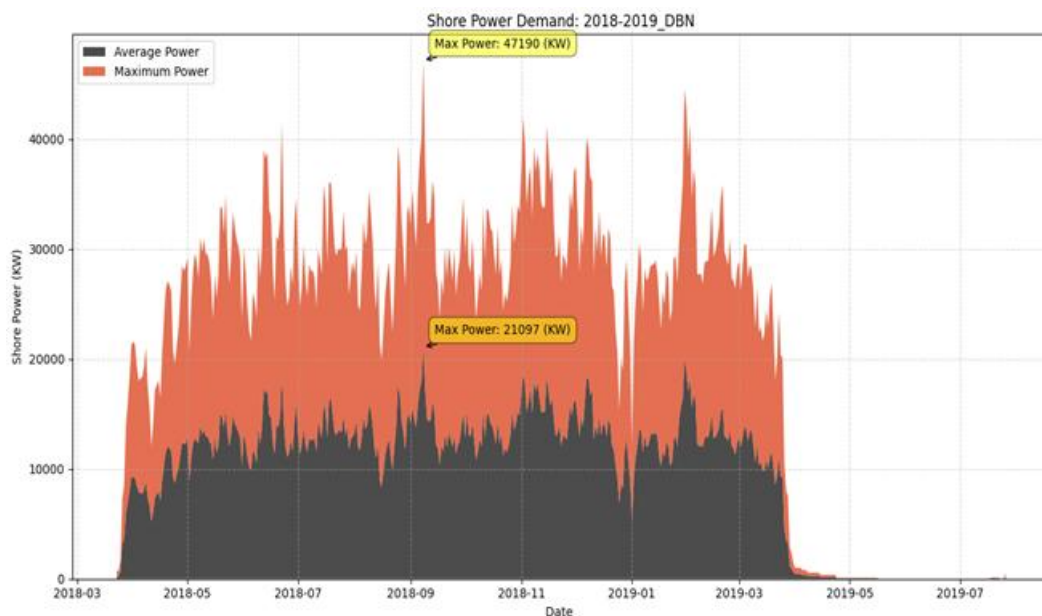
Supported by:

3.2. Shore Power Demand Results

3.2.1. Shore Power Demand results for Durban 2018-2019

Figure 4 shows two time series for Durban shore power demand for the financial year 2018-2019. One time series is illustrating the maximum power requirement and the other at average power requirement. Using the plot, it can be seen that the peak maximum demand is estimated to be 47.19 MW while the average peak power demand was estimated at 21.1 MW. This result was obtained from using the methodology described and similar plots were made for all the ports for available financial years data and can be seen in Appendix A.

Figure 4: Calculated Peak Utilization Maximum and Average Utilization Maximum for Durban in 2018-2019 Financial Year.



Source: Own creation.

3.2.2. Peak and Average maximum Shore Power Demand for Durban

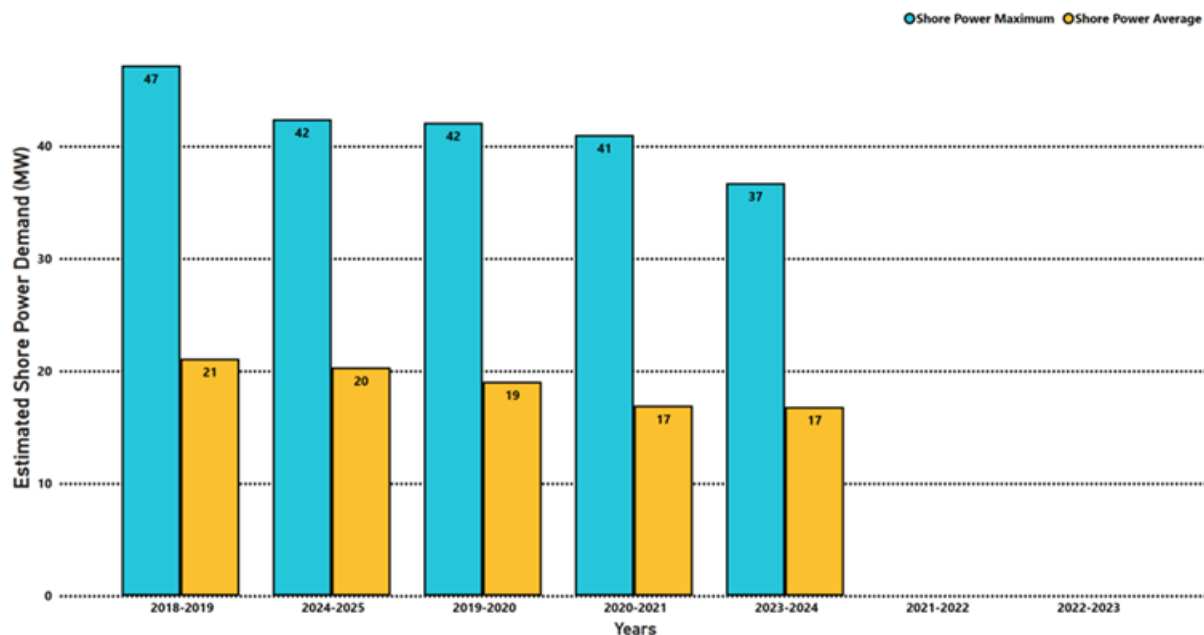
From the plots similar to

Figure 4, the absolute peak and average peak demand power are plotted in Figure 5. Both the absolute maximum and average power demand can be extracted from

Figure 4 and the other time series plots for the each available financial year data within the Durban port. From Figure 5, the financial year 2018-2019 presents the highest peak demand power of 47 MW and the same year has the highest average demand power of 21 MW.

Supported by:

Figure 5: Calculated Absolute Maximum Utilization and Average Utilization Maximum Power Demand for Durban Port



Source: Own creation.

3.2.3. Shore Power Demand results per financial year for all ports

Table 3 shows the table with all the ports, showing both the peak utilization maximum and peak average utilization maximum.

- The absolute peak utilization maximum is the maximum power demand within a port for vessels assumed to have a maximum operating power. It is the highest value of summation using the maximum power shore power from the time series. In other words, the highest shore power values are used from the reference data for each vessel.
- The average peak utilization maximum: is the maximum shore power demand for ships assumed to be operating at average power through the specific financial year. Here, the average value shore power demand is used from the reference data. Again, this value is determined by looking for the highest demand on the time series plots.

Supported by:

Table 3: Peak Utilization Maximum and Peak Average Utilization Maximum Shore Power Demand for All Ports Per Financial Year.

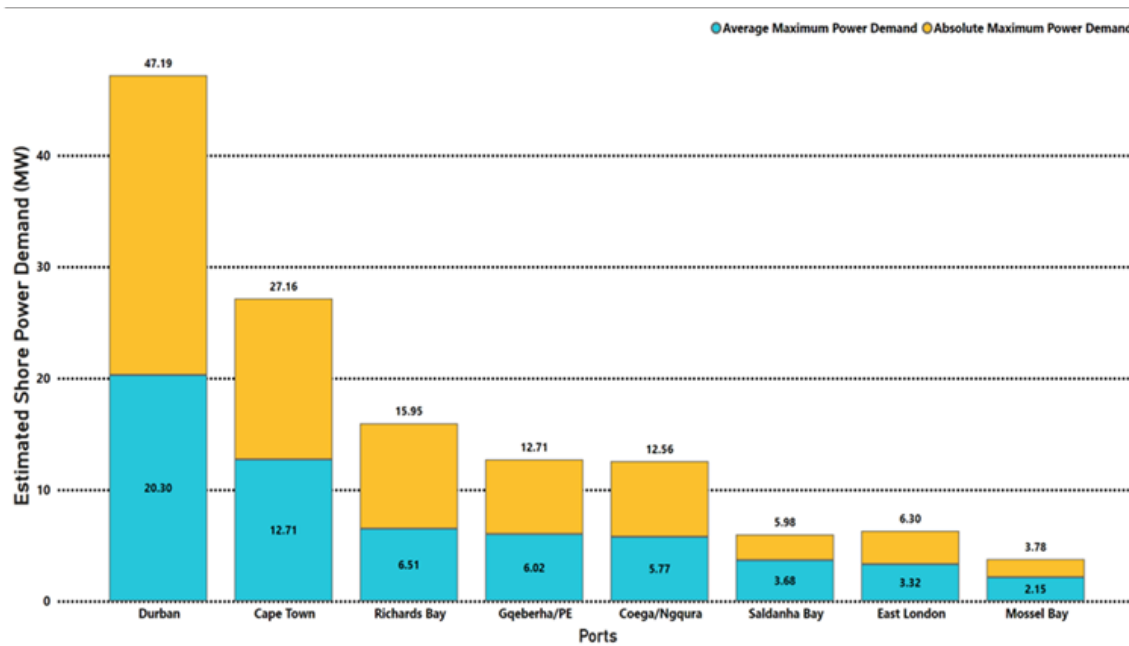
	Financial year period							
Ports	2018-2019	2019-2020	2020-2021	2021-2022	2022-2023	2023-2024	2024-2025	Shore Power Demand
Durban	47	42	41	-	-	37	42	Peak Utilization Max
	21	19	17	-	-	17	20	Average Utilization Max
Cape Town	25.1	27.2	26.5	-	-	24.8	24.8	Peak Utilization Max
	12.1	12.7	12.3	-	-	11.9	12.2	Average Utilization Max
Richards Bay	15.1	11.1	10	16	12.8	-	-	Peak Utilization Max
	6.5	4.6	4.3	6.4	4.9	-	-	Average Utilization Max
Gqeberha/PE	12.7	7.2	11.1	12.3	9.2	-	-	Peak Utilization Max
	6	3.5	5.1	5.7	4.2	-	-	Average Utilization Max
Coega/Ngqura	10.6	12.6	9.8	11.5	9.5	-	-	Peak Utilization Max
	4.7	5.8	5	5.2	4.3	-	-	Average Utilization Max
Saldanha Bay	6	5.6	4.8	-	-	4.8	-	Peak Utilization Max
	3.7	3.4	3.1	-	-	3.2	-	Average Utilization Max
East London	6.3	3.1	4.7	3.6	4	-	-	Peak Utilization Max
	3.3	1.4	2.1	1.5	1.7	-	-	Average Utilization Max
Mossel Bay	2.1	1.9	-	-	-	3.8	-	Peak Utilization Max
	1.4	1.3	-	-	-	2.2	-	Average Utilization Max

Supported by:

3.2.4. National Peak Shore Power Demand

Figure 6 shows the national shore power demand for all the ports. The displayed values for the shore power demand are the absolute peak utilization maximum and average peak utilization maximum. The shore power demand is calculated for each financial year and the chosen values between the time span between 2018-2025 are displayed.

Figure 6: Average Utilization Maximum and Peak Utilization Maximum Shore Power for all the Ports



Source: Own creation.

Supported by:



Federal Ministry
for Economic Affairs
and Climate Action



INTERNATIONAL
CLIMATE
INITIATIVE

giz Deutsche Gesellschaft
für Internationale
Zusammenarbeit (GIZ) GmbH

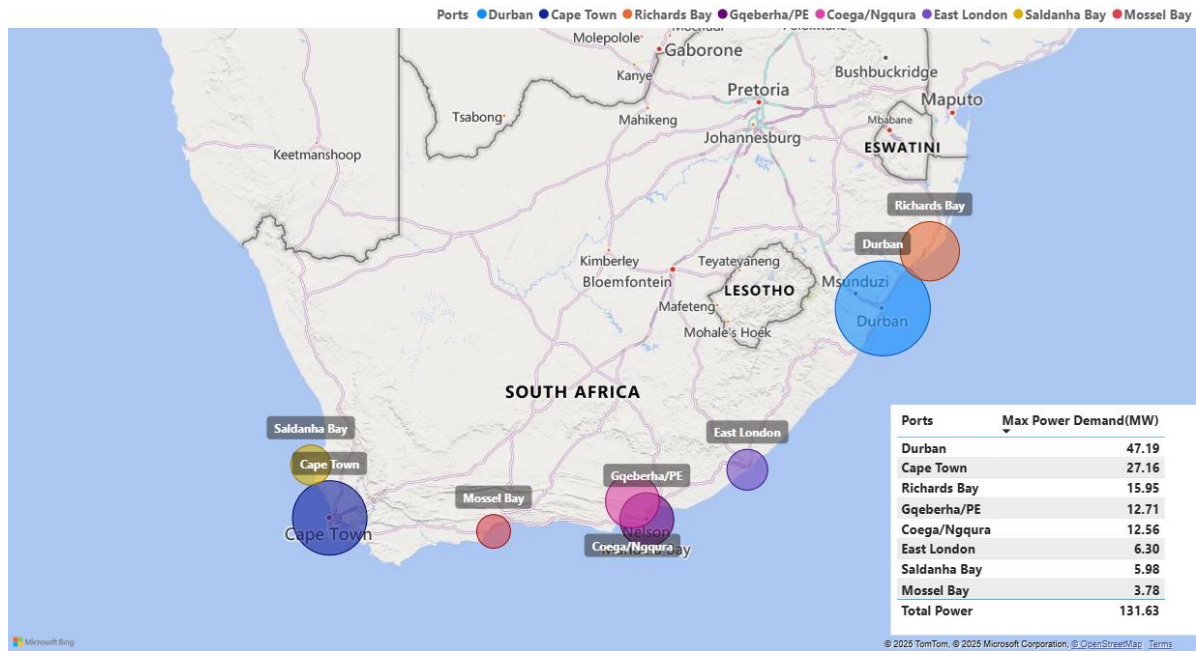


CSIR
Touching lives through innovation

on the basis of a decision
by the German Bundestag

Figure 7 shows a comparative shore power demand and location within the South African ports with also the peak shore power demand.

Figure 7 Peak Shore power Demand and location



Source: Own creation.

Supported by:



Federal Ministry
for Economic Affairs
and Climate Action



INTERNATIONAL
CLIMATE
INITIATIVE



4. Conclusion

In this study the shore power demand for eight South African ports was estimated using the shore power reference guide. A developed methodology involved a data-driven approach whereby TNPA data was used to create time series for power demand for each port between the year 2018 and 2025. Furthermore, these time series serve as estimate for shore power demand based on the frequency (number of) of vessels in the ports. The findings highlight variability in shore power demand based on the vessel types, quantity and frequency of the vessels in ports. The calculated shore power demand is an estimate based on the shore power reference data. However, not all vessel types were represented in the calculation. Therefore, the demand given is meant to serve as an estimate of the demand. By comparing the all time series plots, the maximum power demands were extracted and plotted on a bar chart.

The shore power demand is calculated for various years to obtain insight on the maximum expected power demand for shore power. This was done by creating two time series plots: maximum and average shore power demand at each port. This study provides a foundation for decision-making in port electrification projects. Furthermore, it can give an approximation of the power demand for ports aiming. This ultimately could reduce air pollution, add to compliance with environmental regulations and provide reliable power supply to vessels with on-board consumption of fuel.

Supported by:



on the basis of a decision
by the German Bundestag



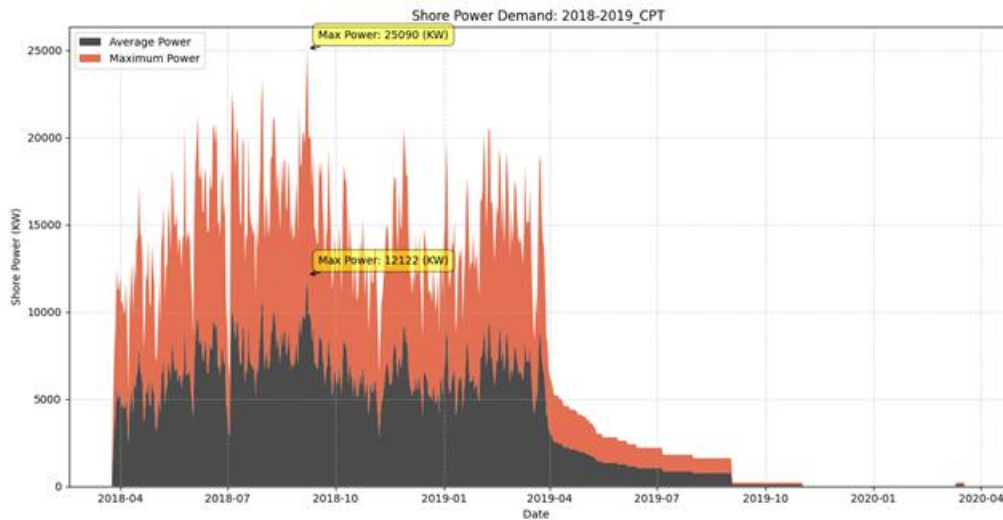
5. References

- [1] Council of Canadian Academies, “The Value of Commercial Marine Shipping to Canada,” Council of Canadian Academies, Ottawa, 2017.
- [2] UNCTAD, “Review of Maritime Transport,” United Nation Publication, 2015.
- [3] K. Zbigniew, “Chapter 6 of the Working Group I Contribution to the IPCC Sixth Assessment Report - data for Figure 6.3,” NERC EDS Centre for Environmental Data Analysis, 2023.
- [4] Sustainable Ships, “Average Shore Power Demand,” 2025. [Online]. Available: <https://www.sustainable-ships.org/tools/average-shore-power-demand>. [Accessed July 2025].
- [5] International Maritime Organisation, “Fourth IMO Greenhouse Gas Study,” International Maritime Organisation, London, 2021.

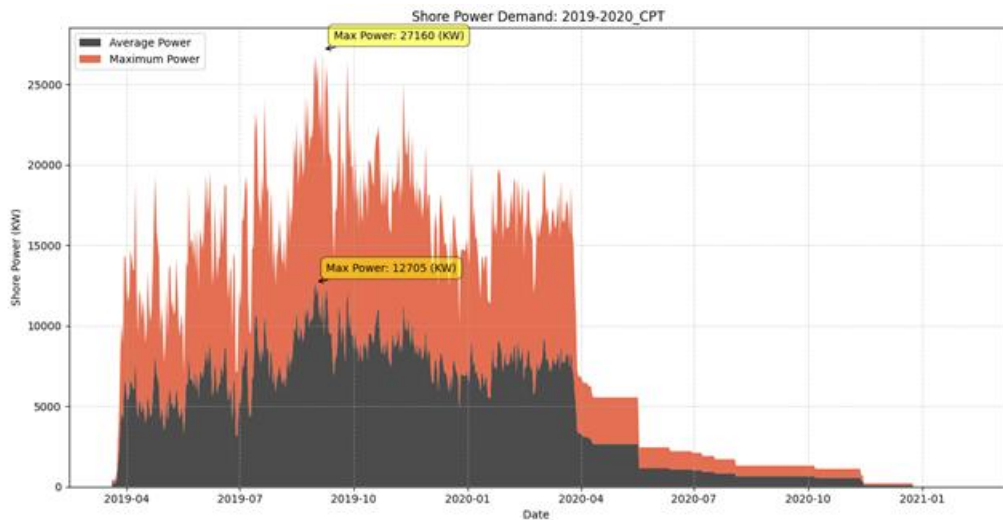
Appendix

Source: All figures own creation.

FigureA 1 Calculated Peak Utilization Maximum and Average Utilization Maximum for Cape Town in 2018-2019 Financial Year.

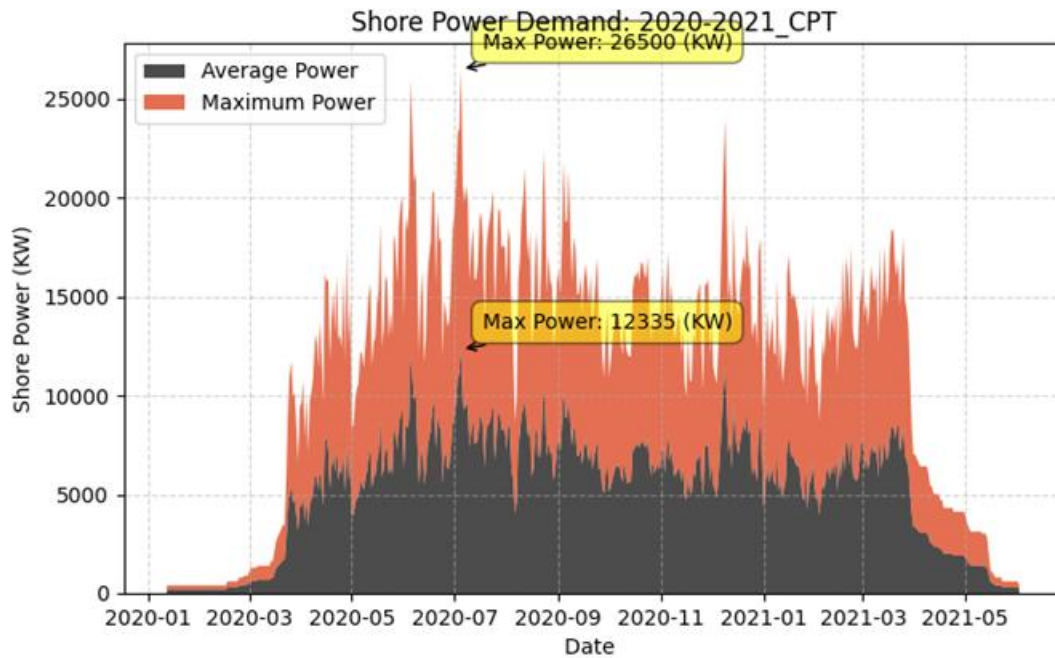


FigureA 2 Calculated Peak Utilization Maximum and Average Utilization Maximum for Cape Town in 2019-2020 Financial Year.

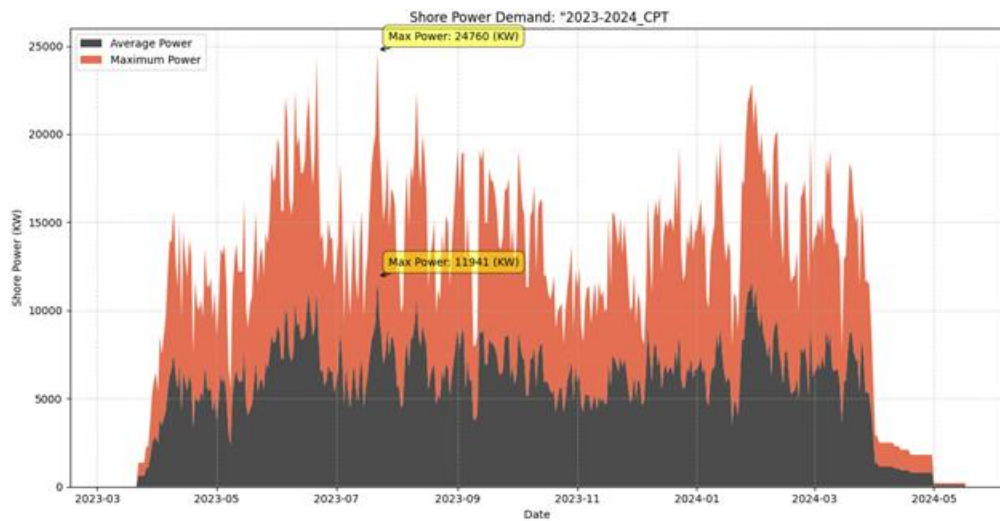


Supported by:

FigureA 3 Calculated Peak Utilization Maximum and Average Utilization Maximum for Cape Town in 2020-2021 Financial Year.

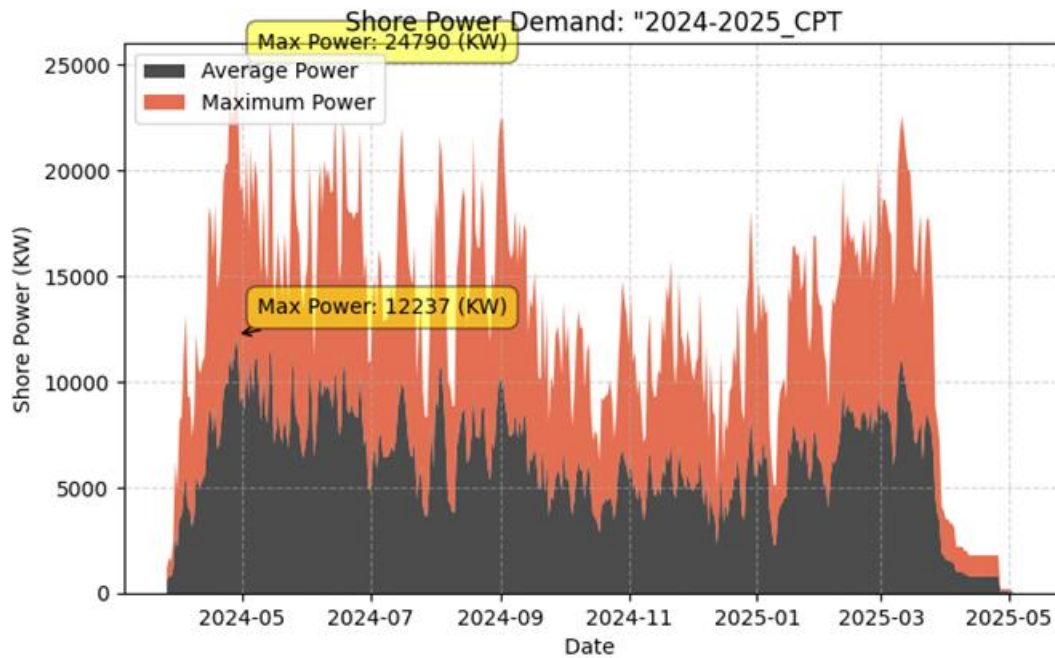


FigureA 4 Calculated Peak Utilization Maximum and Average Utilization Maximum for Cape Town in 2023-2024 Financial Year.

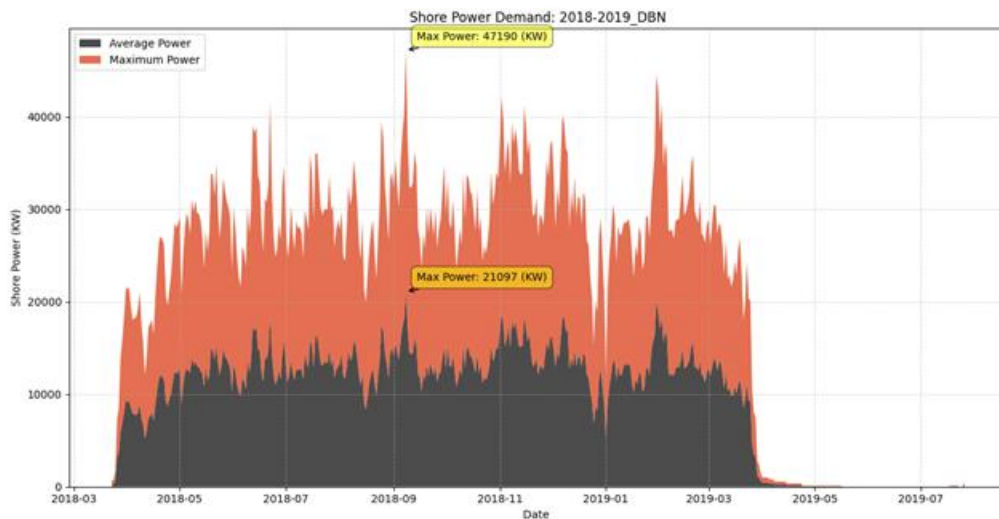


Supported by:

FigureA 5 Calculated Peak Utilization Maximum and Average Utilization Maximum for Cape Town in 2024-2025 Financial Year.

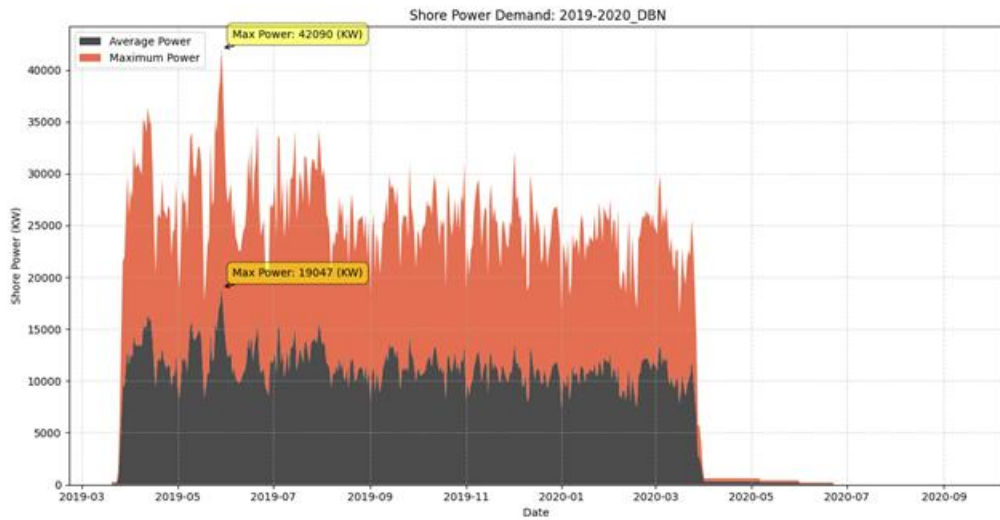


FigureA 6 Calculated Peak Utilization Maximum and Average Utilization Maximum for Durban in 2018-2019 Financial Year.

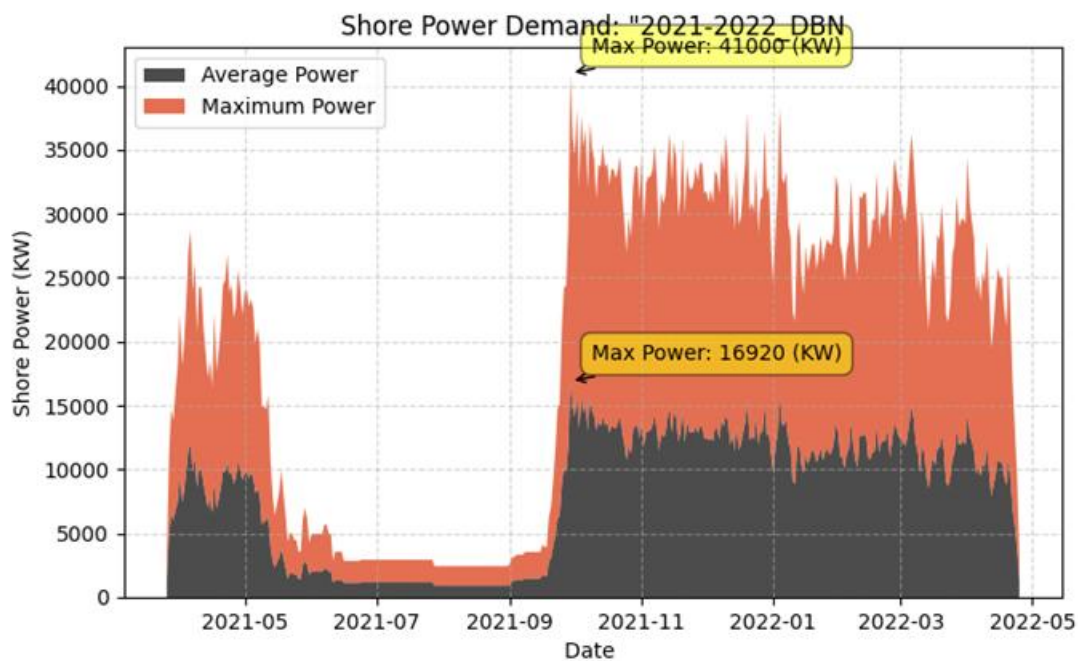


Supported by:

FigureA 7 Calculated Peak Utilization Maximum and Average Utilization Maximum for Durban in 2019-2020 Financial Year.

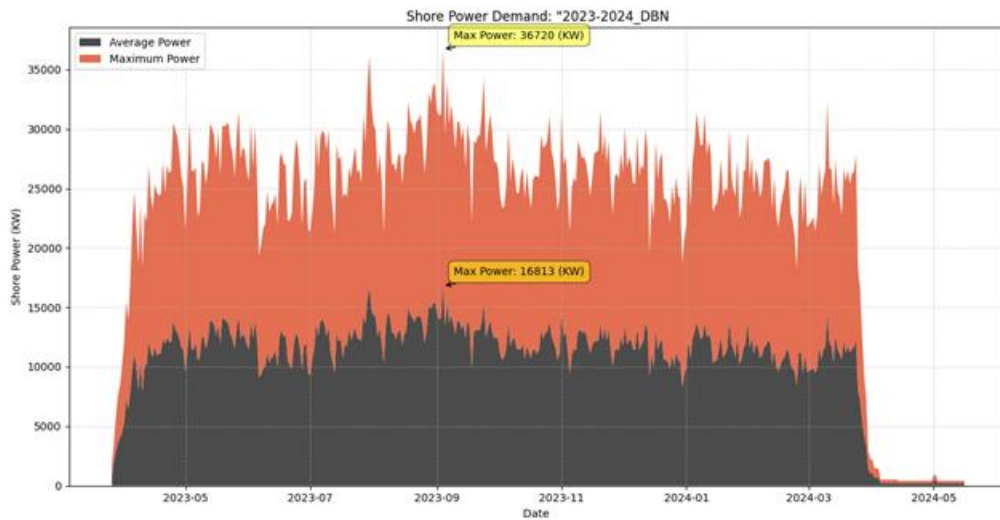


FigureA 8 Calculated Peak Utilization Maximum and Average Utilization Maximum for Durban in 2021-2022 Financial Year



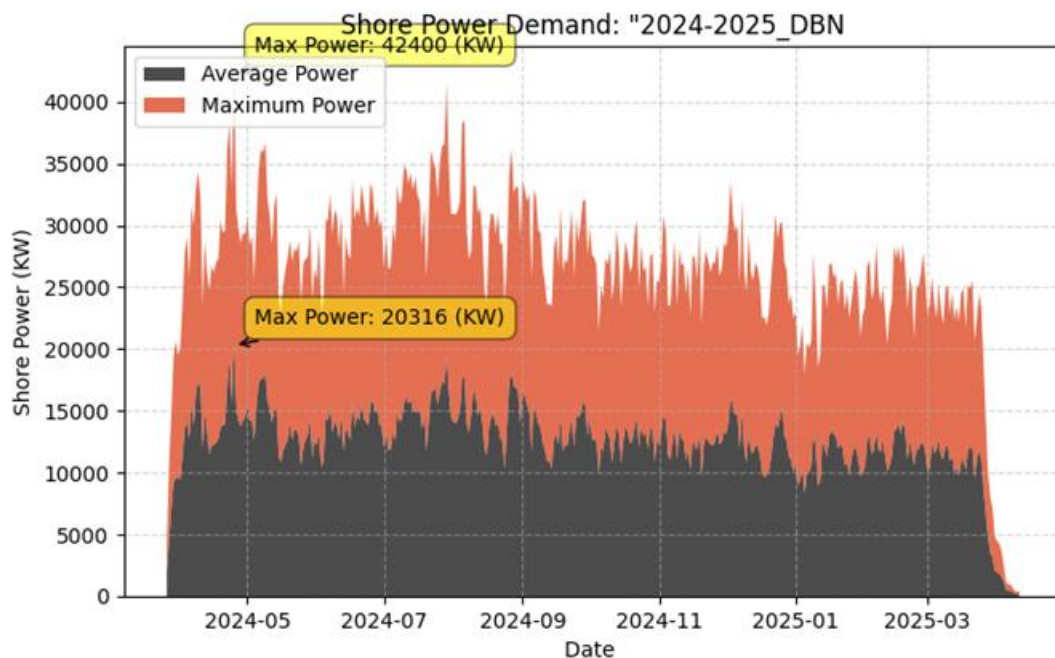
Supported by:

FigureA 9 Calculated Peak Utilization Maximum and Average Utilization Maximum for Durban in 2023-2024 Financial



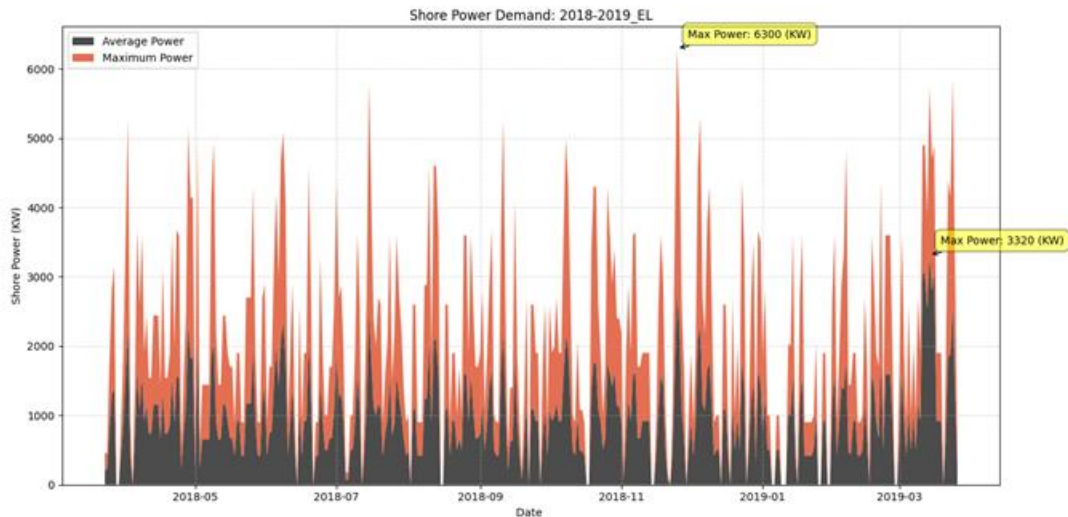
Year

FigureA 10 Calculated Peak Utilization Maximum and Average Utilization Maximum for Durban in 2024-2025 Financial Year

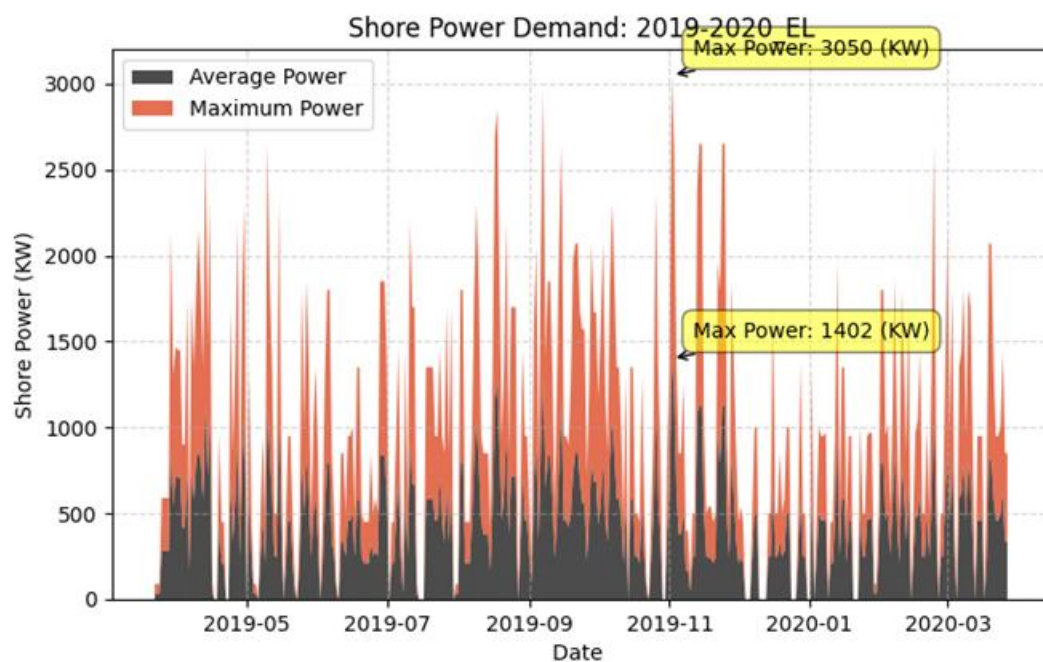


Supported by:

FigureA 11 Calculated Peak Utilization Maximum and Average Utilization Maximum for East London in 2018-2019 Financial Year

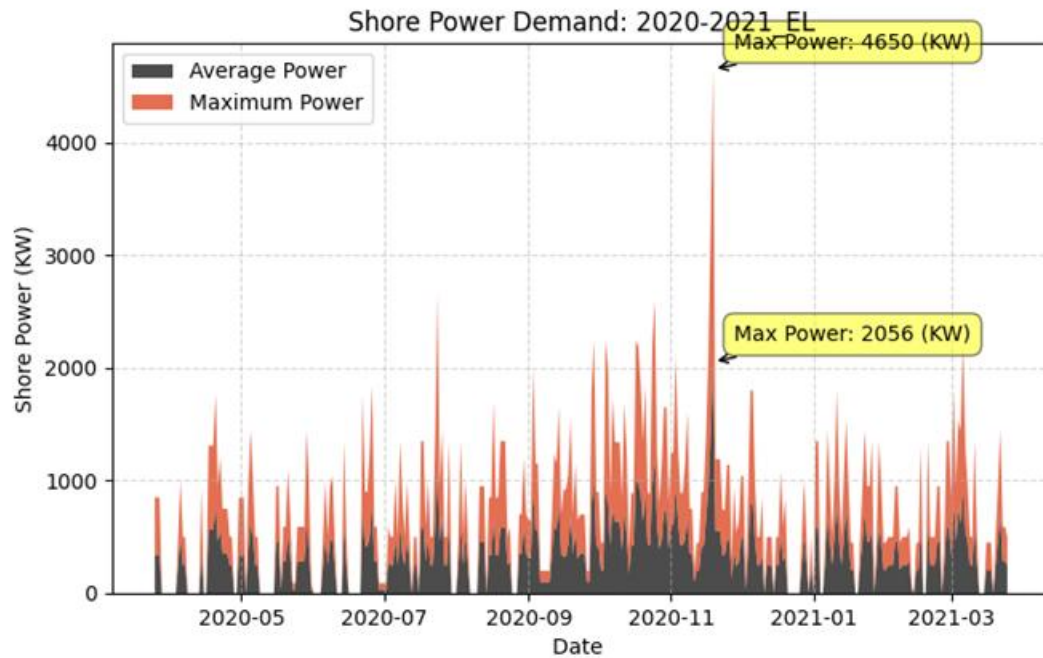


FigureA 12 Calculated Peak Utilization Maximum and Average Utilization Maximum for East London in 2019-2020 Financial Year

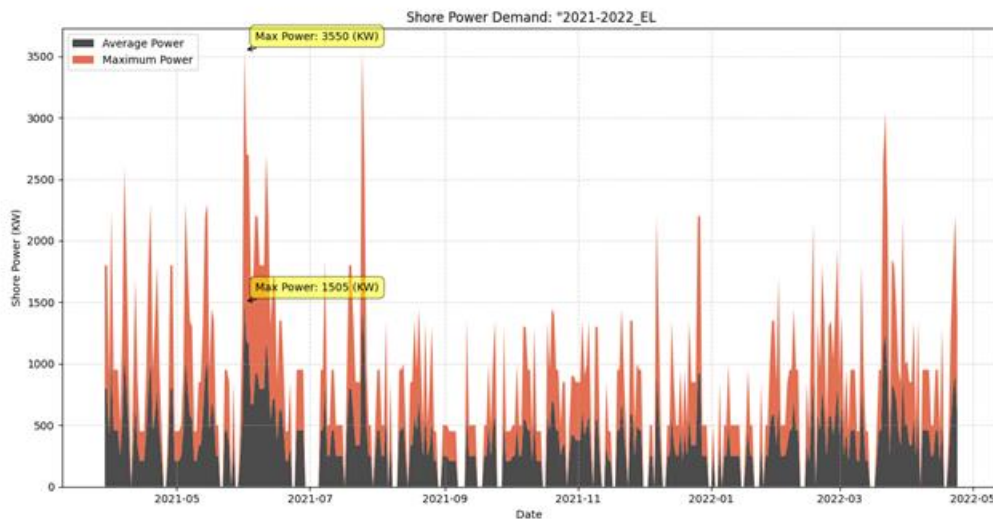


Supported by:

FigureA 13 Calculated Peak Utilization Maximum and Average Utilization Maximum for East London in 2020-2021 Financial Year

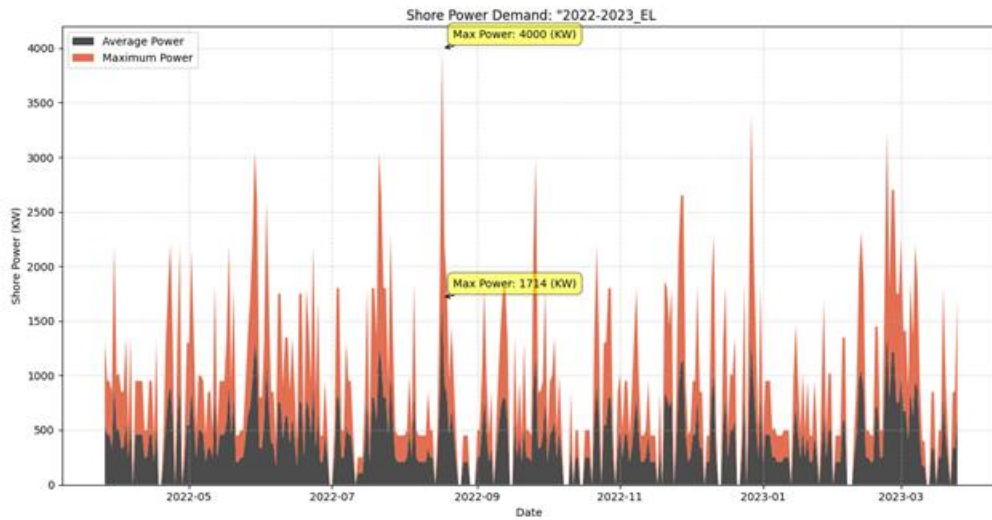


FigureA 14 Calculated Peak Utilization Maximum and Average Utilization Maximum for East London in 2021-2022 Financial Year

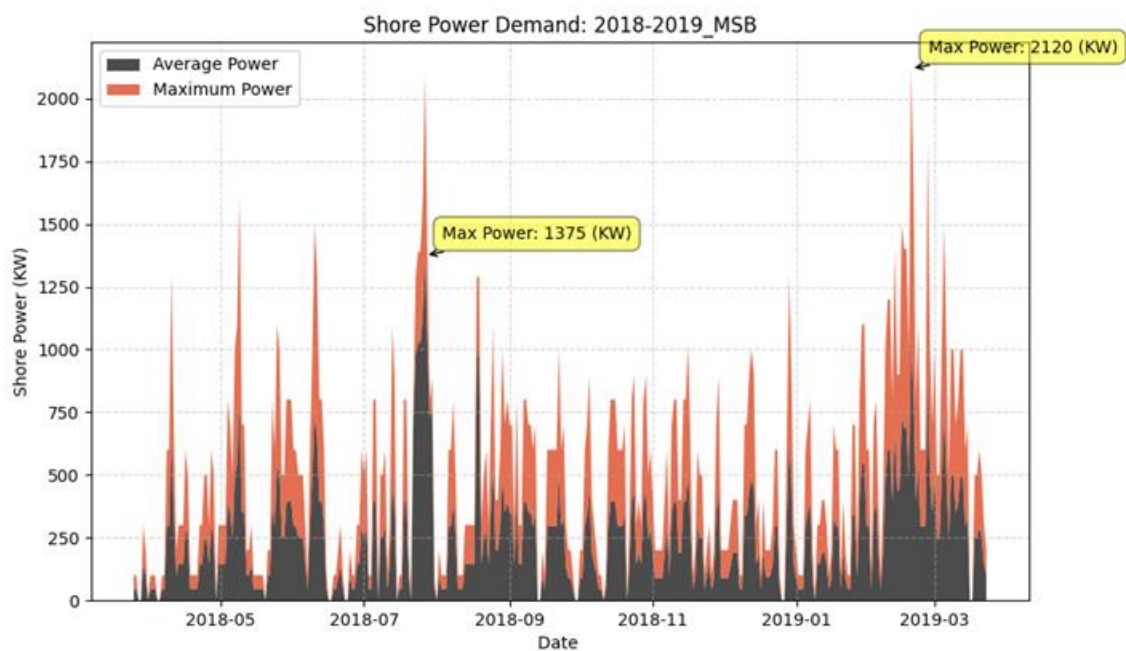


Supported by:

FigureA 15 Calculated Peak Utilization Maximum and Average Utilization Maximum for East London in 2022-2023 Financial Year

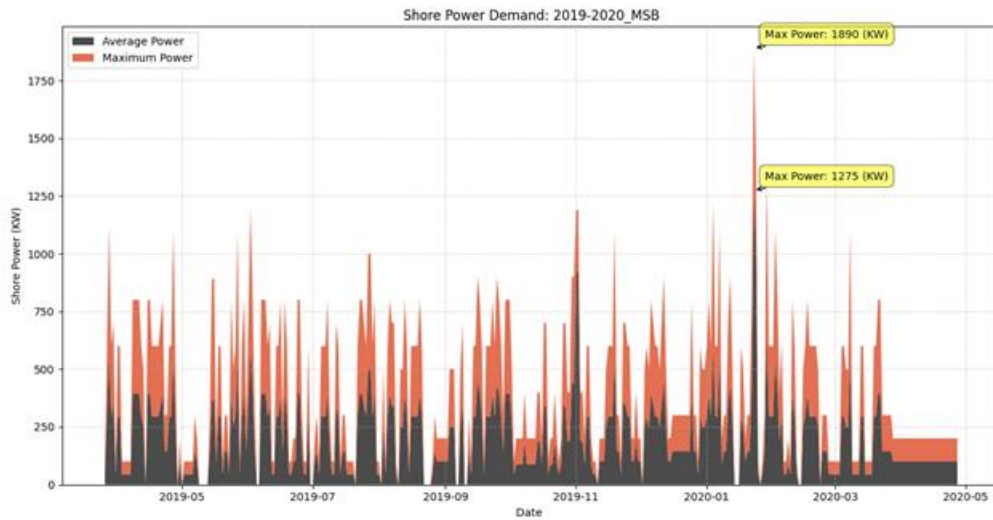


FigureA 16 Calculated Peak Utilization Maximum and Average Utilization Maximum for Mossel Bay in 2018-2019 Financial Year

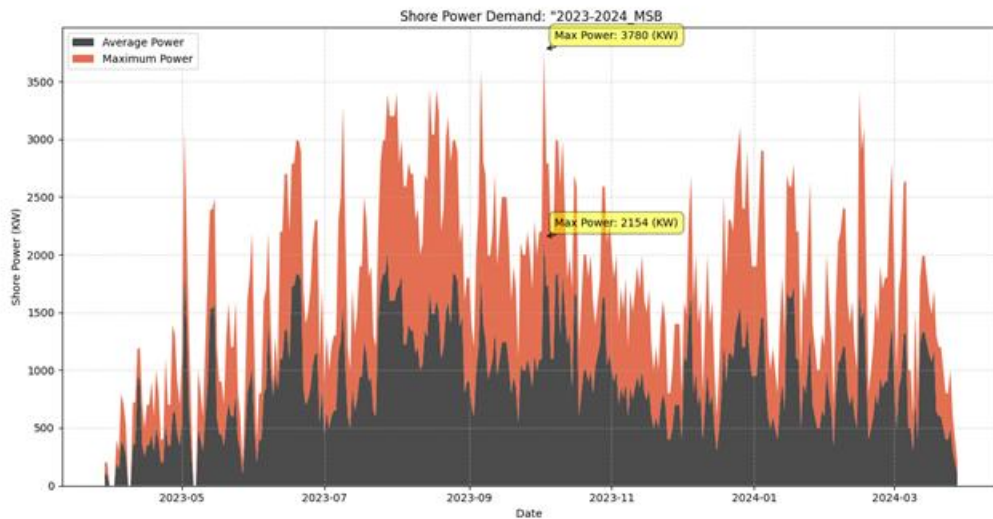


Supported by:

FigureA 17 Calculated Peak Utilization Maximum and Average Utilization Maximum for Mossel Bay in 2019-2020 Financial Year

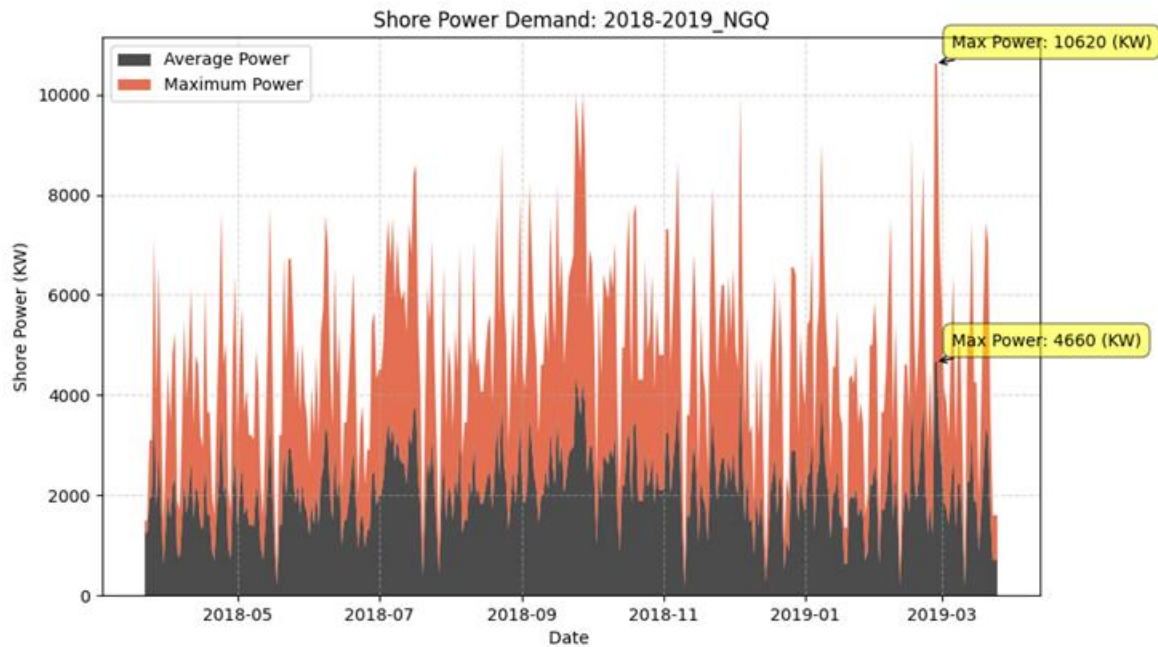


FigureA 18 Calculated Peak Utilization Maximum and Average Utilization Maximum for Mossel Bay in 2023-2024 Financial Year

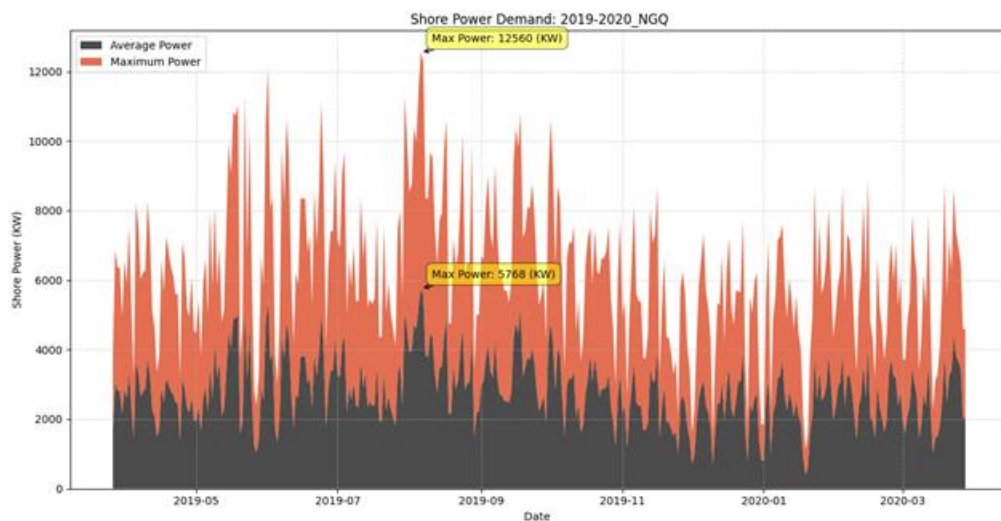


Supported by:

FigureA 19 Calculated Peak Utilization Maximum and Average Utilization Maximum for Coega/Ngqura in 2018-2019 Financial Year.



FigureA 20 Calculated Peak Utilization Maximum and Average Utilization Maximum for Coega/Ngqura in 2019-2020 Financial Year.



Supported by:



Federal Ministry
for Economic Affairs
and Climate Action



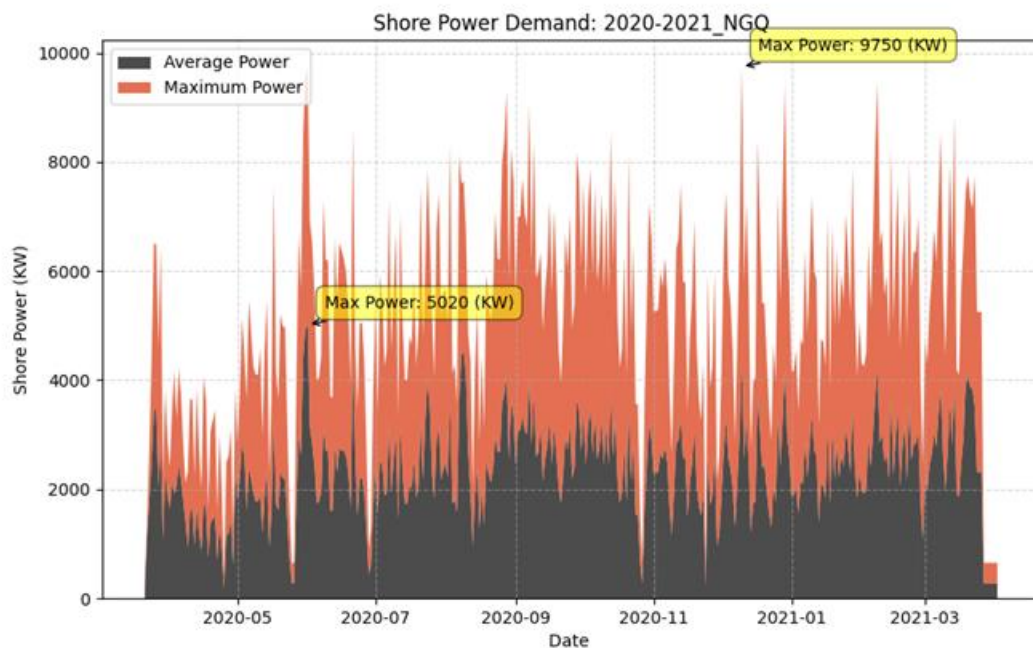
INTERNATIONAL
CLIMATE
INITIATIVE



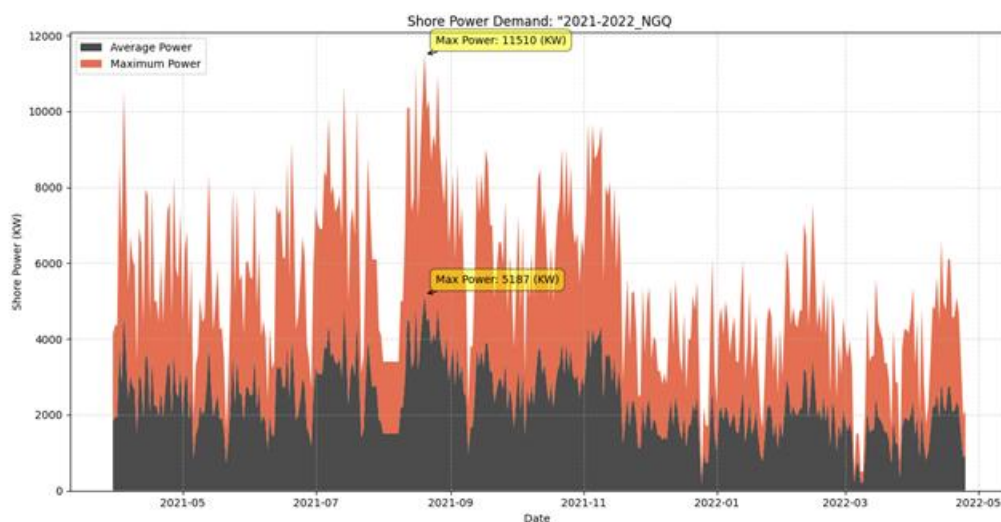
Touching lives through innovation

on the basis of a decision
by the German Bundestag

FigureA 21 Calculated Peak Utilization Maximum and Average Utilization Maximum for Coega/Ngqura in 2020-2021 Financial Year.



FigureA 22 Calculated Peak Utilization Maximum and Average Utilization Maximum for Coega/Ngqura in 2021-2022 Financial Year.



Supported by:



Federal Ministry
for Economic Affairs
and Climate Action



INTERNATIONAL
CLIMATE
INITIATIVE

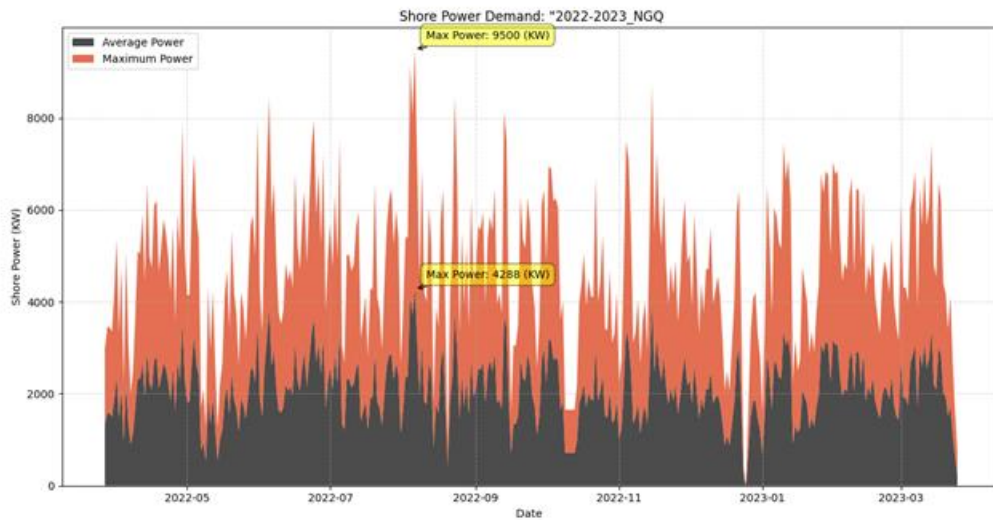
giz Deutsche Gesellschaft
für Internationale
Zusammenarbeit (GIZ) GmbH



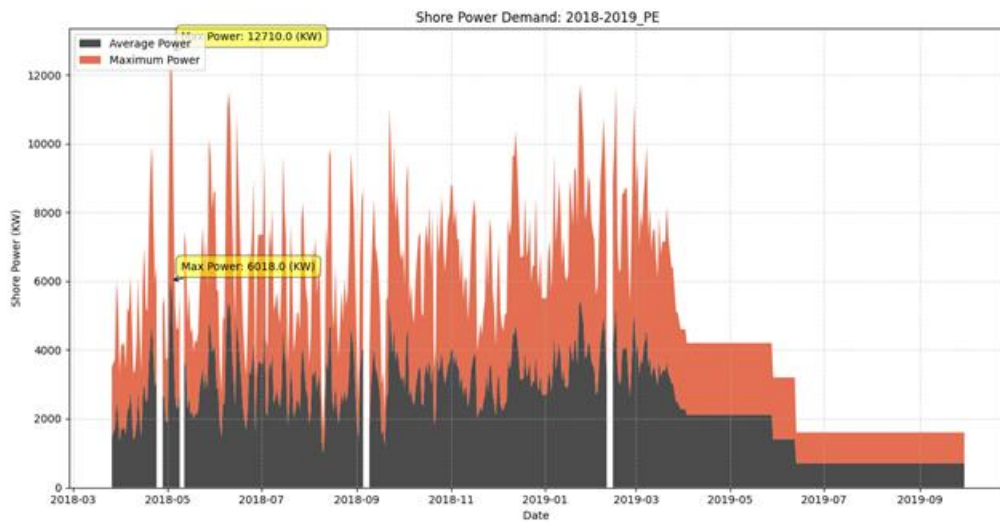
CSIR
Touching lives through innovation

on the basis of a decision
by the German Bundestag

FigureA 23 Calculated Peak Utilization Maximum and Average Utilization Maximum for Coega/Ngqura in 2022-2023 Financial Year.

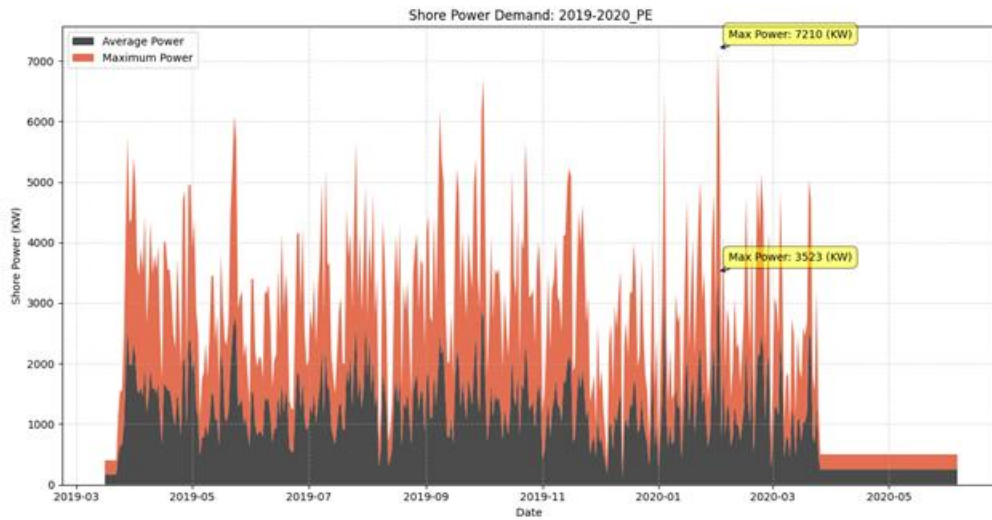


FigureA 24 Calculated Peak Utilization Maximum and Average Utilization Maximum for Port Elizabeth in 2018-2019 Financial Year.

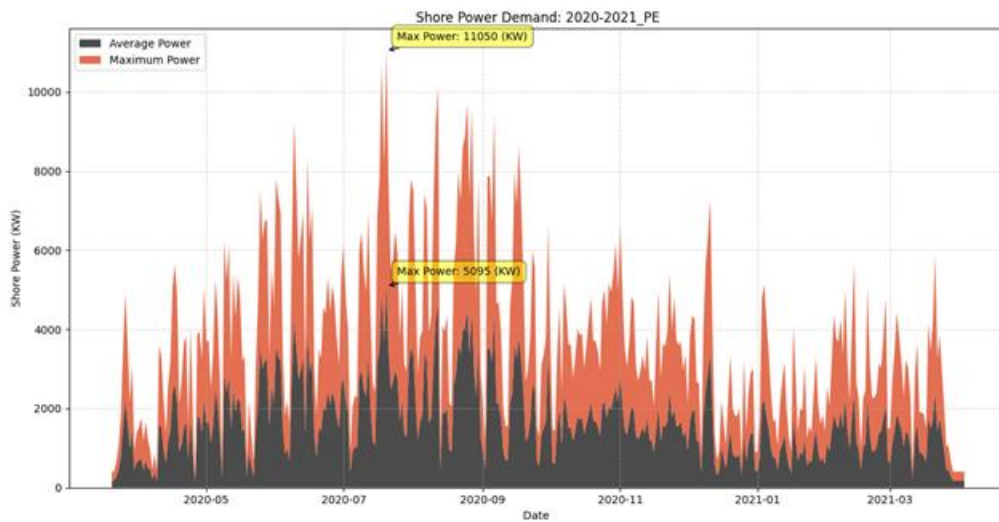


Supported by:

FigureA 25 Calculated Peak Utilization Maximum and Average Utilization Maximum for Port Elizabeth in 2019-2020 Financial Year.

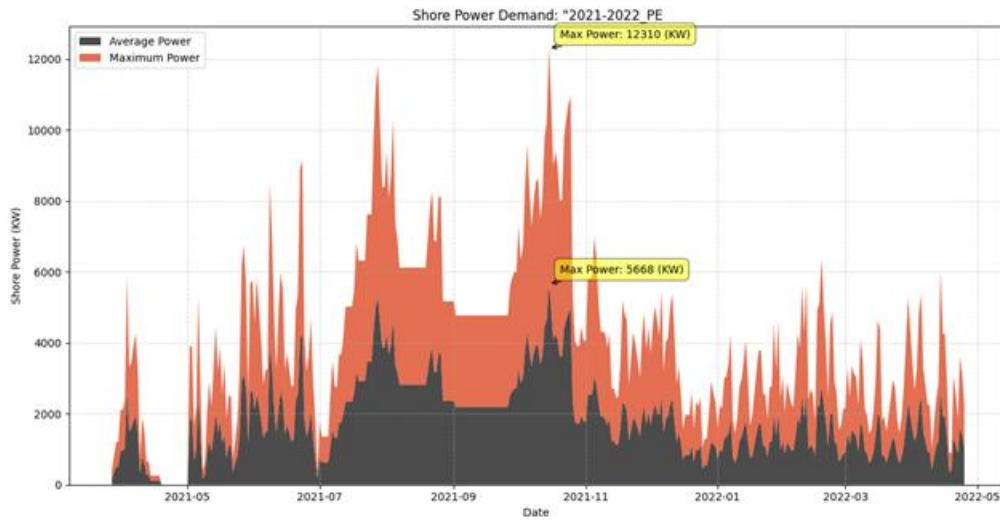


FigureA 26 Calculated Peak Utilization Maximum and Average Utilization Maximum for Port Elizabeth in 2020-2021 Financial Year.

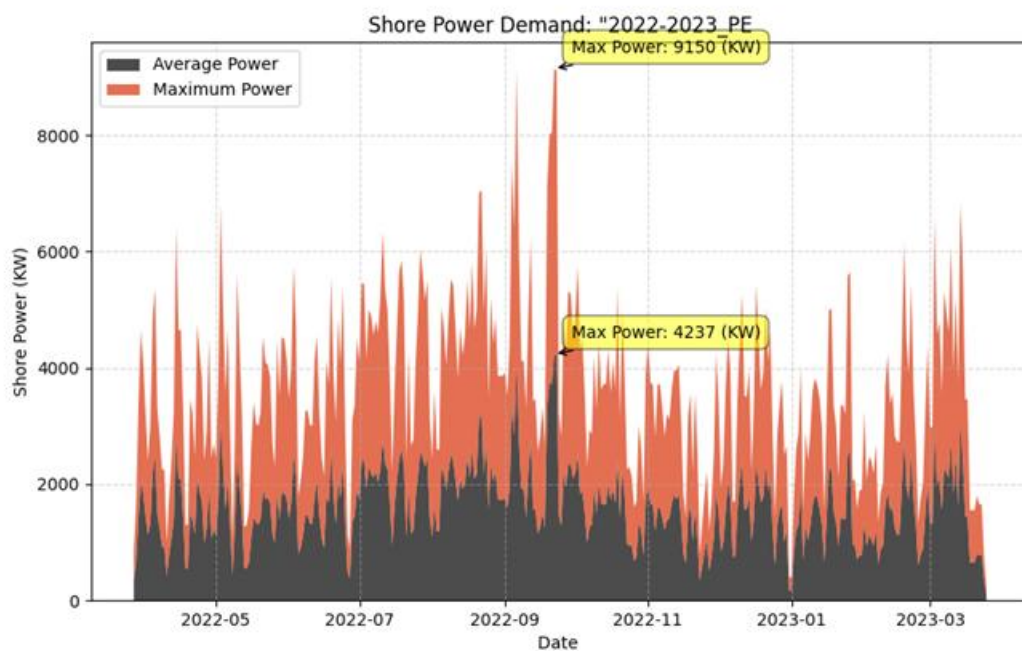


Supported by:

FigureA 27 Calculated Peak Utilization Maximum and Average Utilization Maximum for Port Elizabeth in 2021-2022 Financial Year.

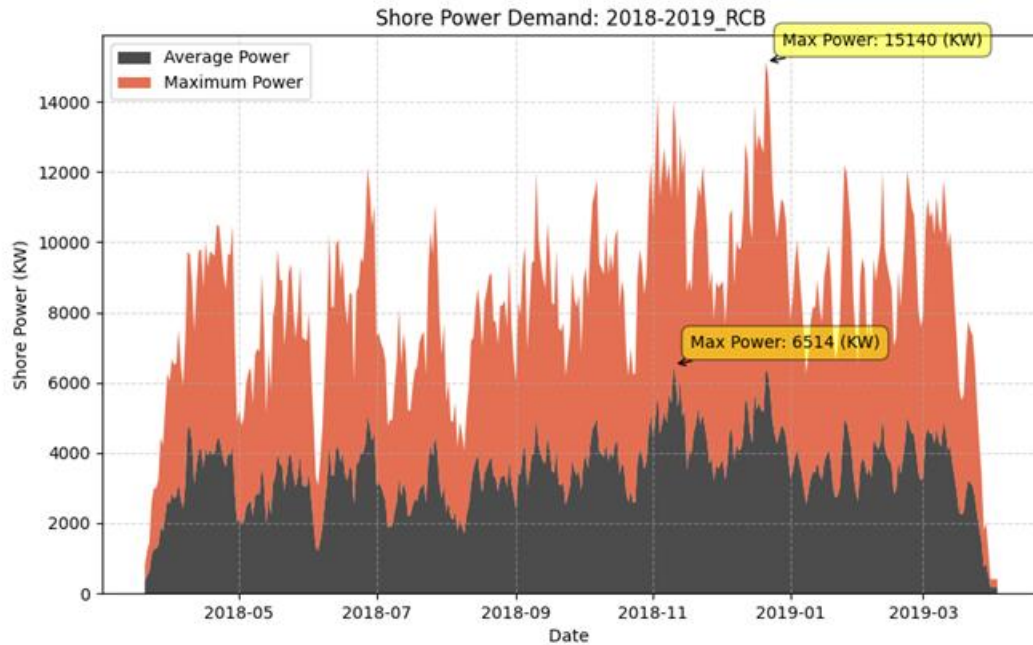


FigureA 28 Calculated Peak Utilization Maximum and Average Utilization Maximum for Port Elizabeth in 2022-2023 Financial Year.

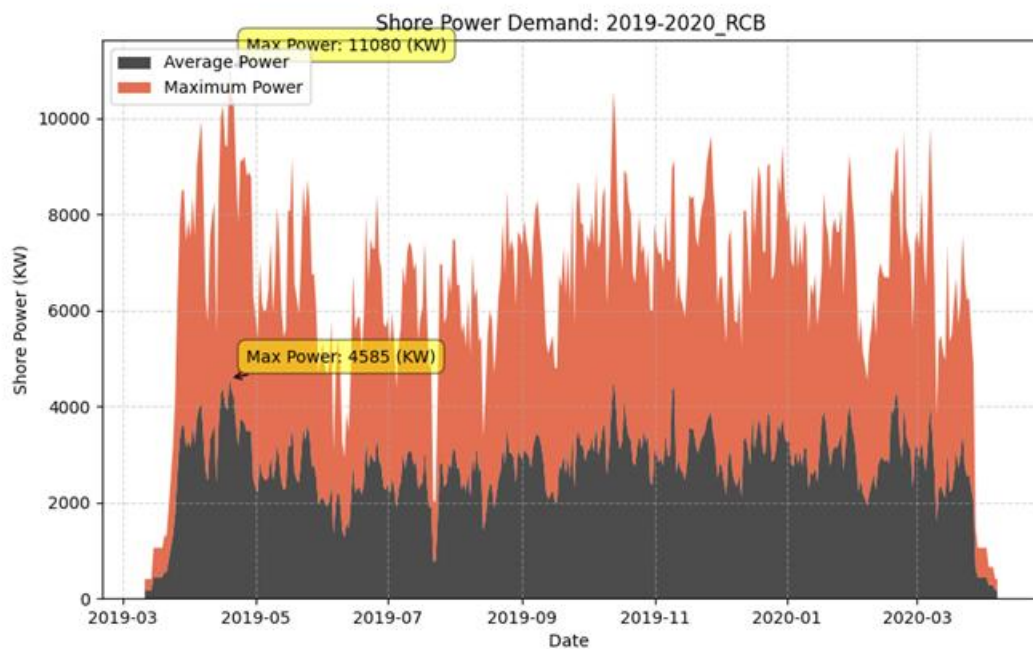


Supported by:

FigureA 29 Calculated Peak Utilization Maximum and Average Utilization Maximum for Richards Bay in 2018-2019 Financial Year.

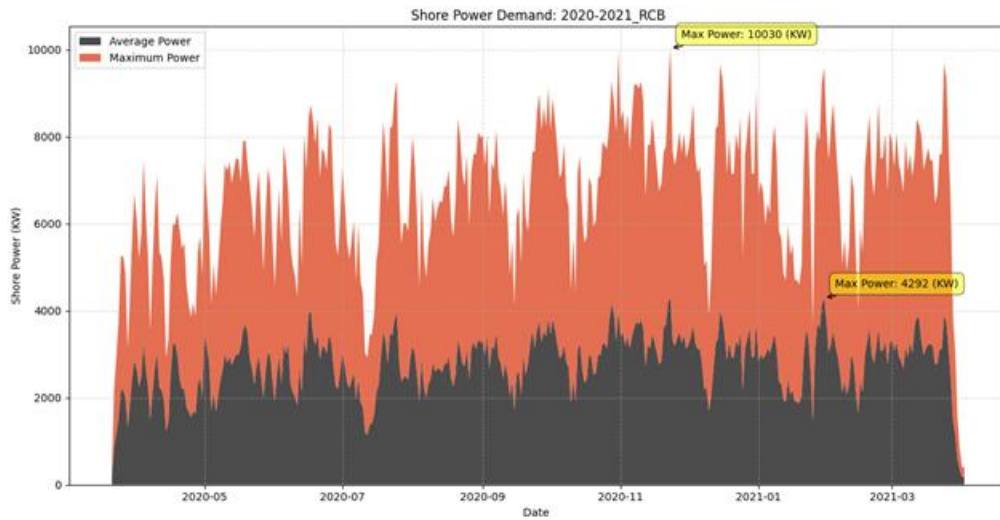


FigureA 30 Calculated Peak Utilization Maximum and Average Utilization Maximum for Richards Bay in 2019-2020 Financial Year.

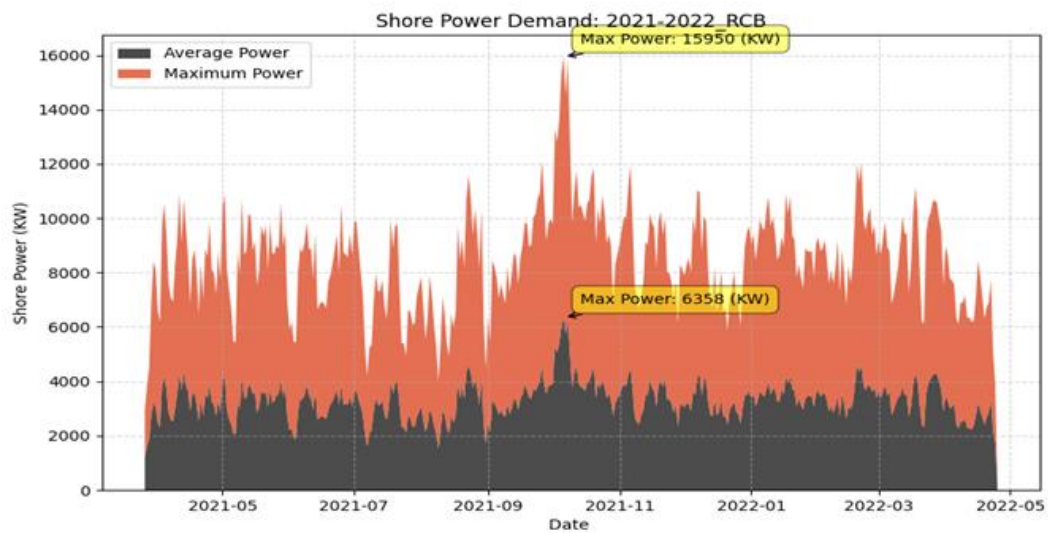


Supported by:

FigureA 31 Calculated Peak Utilization Maximum and Average Utilization Maximum for Richards Bay in 2020-2021 Financial Year.

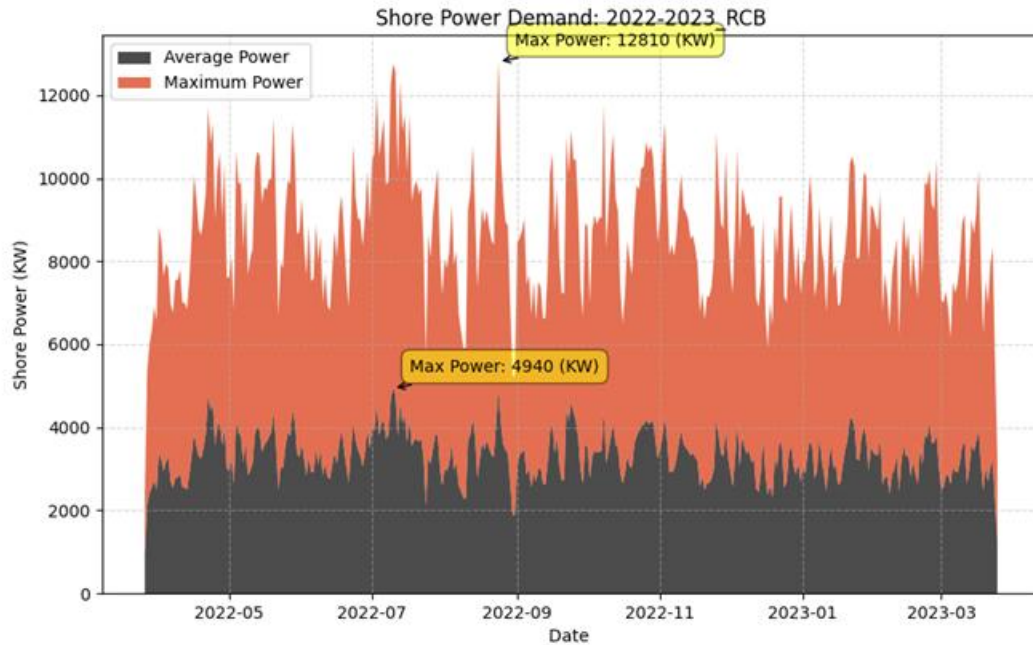


FigureA 32 Calculated Peak Utilization Maximum and Average Utilization Maximum for Richards Bay in 2021-2022 Financial Year.

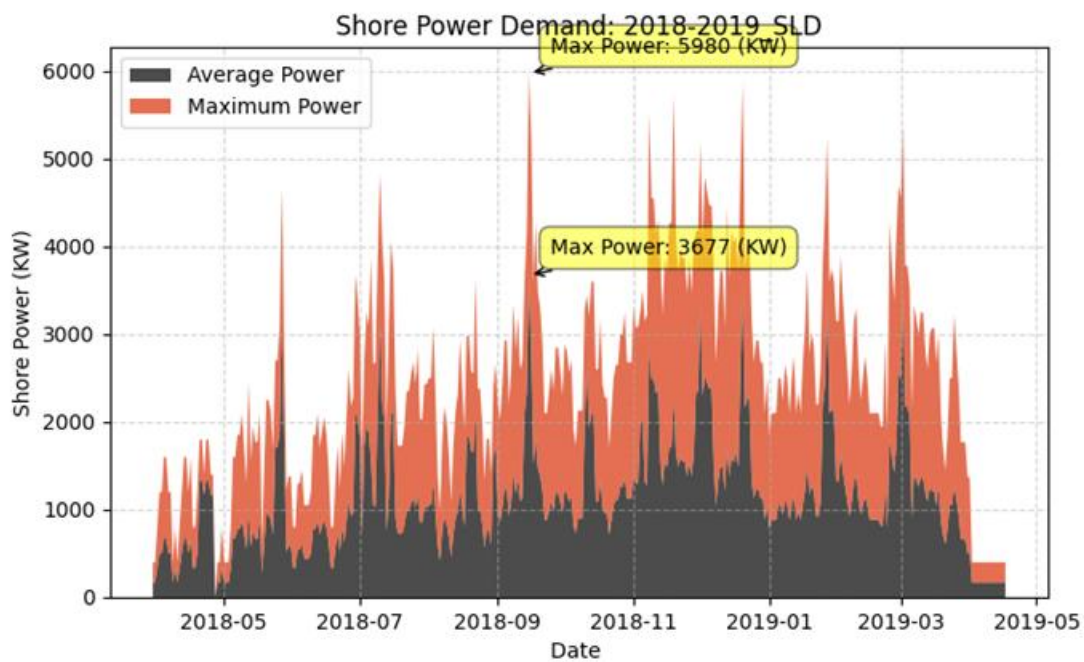


Supported by:

FigureA 33 Calculated Peak Utilization Maximum and Average Utilization Maximum for Richards Bay in 2022-2023 Financial Year.

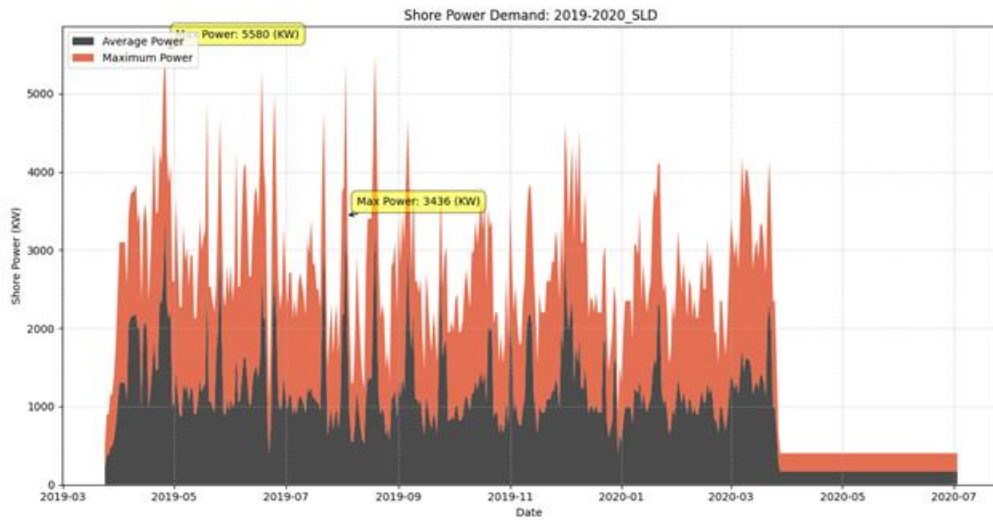


FigureA 34 Calculated Peak Utilization Maximum and Average Utilization Maximum for Saldanha Bay in 2018-2019 Financial Year.

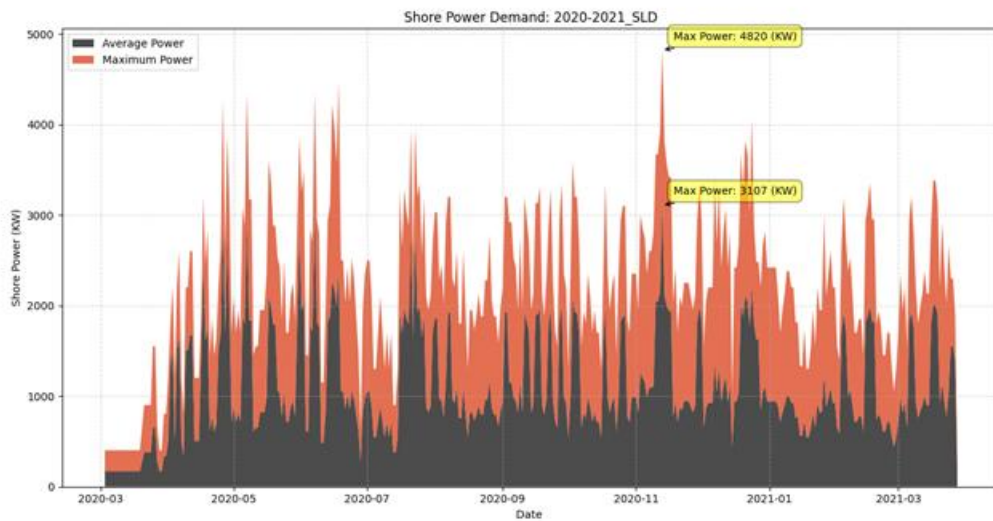


Supported by:

FigureA 35 Calculated Peak Utilization Maximum and Average Utilization Maximum for Saldanha Bay in 2019-2020 Financial Year.

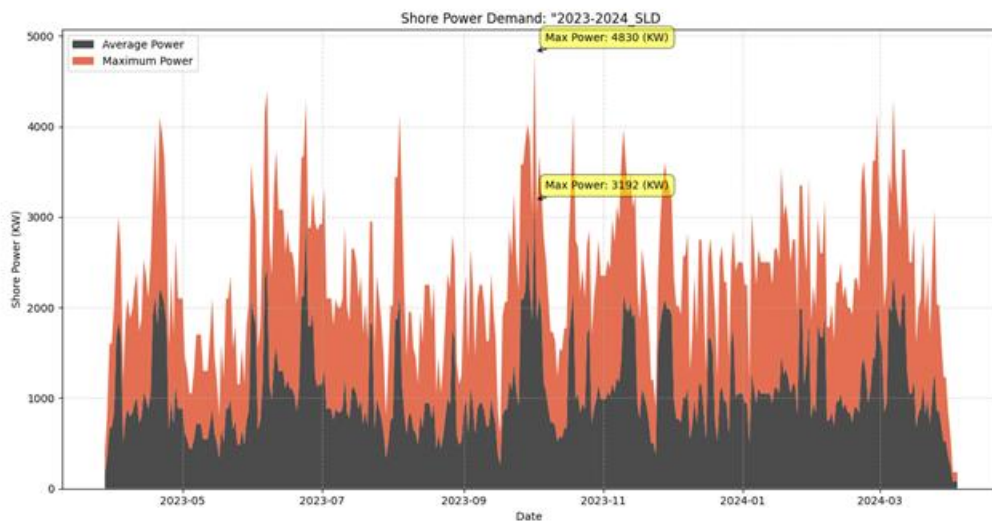


FigureA 36 Calculated Peak Utilization Maximum and Average Utilization Maximum for Saldanha Bay in 2020-2021 Financial Year.

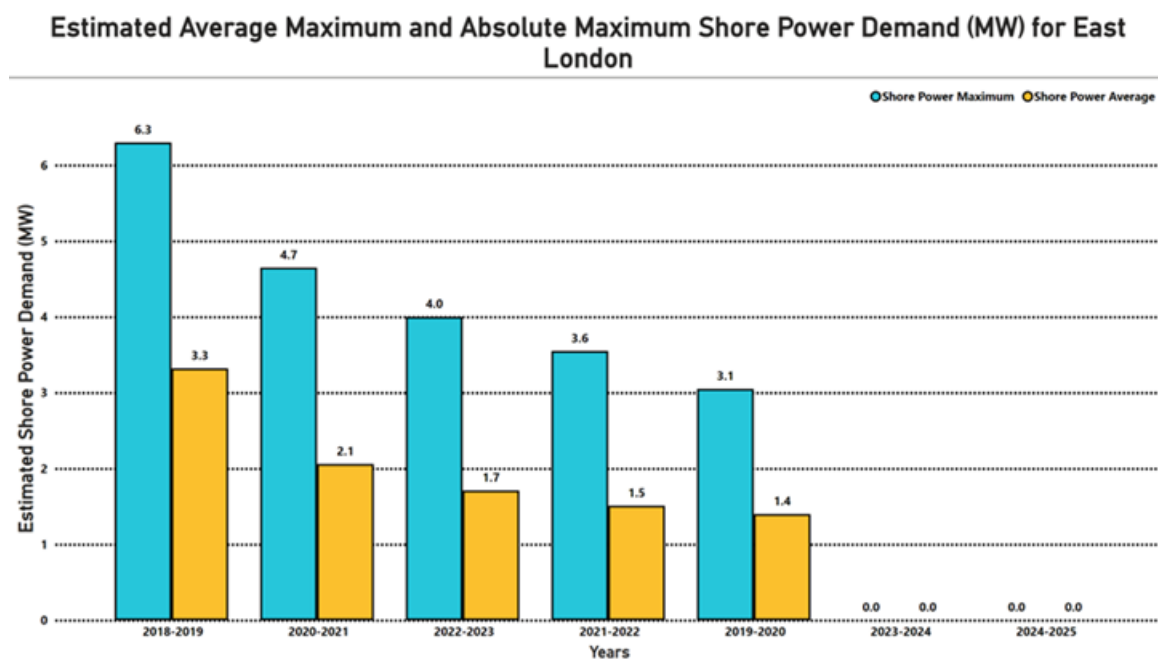


Supported by:

FigureA 37 Calculated Peak Utilization Maximum and Average Utilization Maximum for Saldanha Bay in 2023-2024 Financial Year.

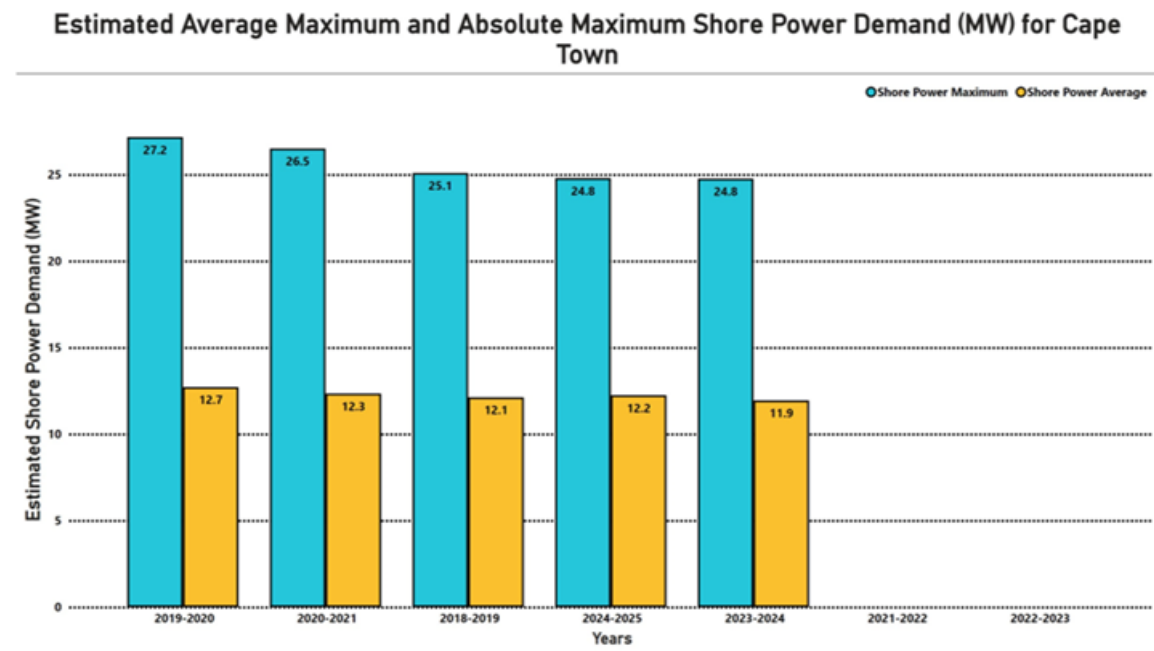


FigureA 38 Estimated Peak Maximum and Peak Average Power Utilization Demand (MW) for East London

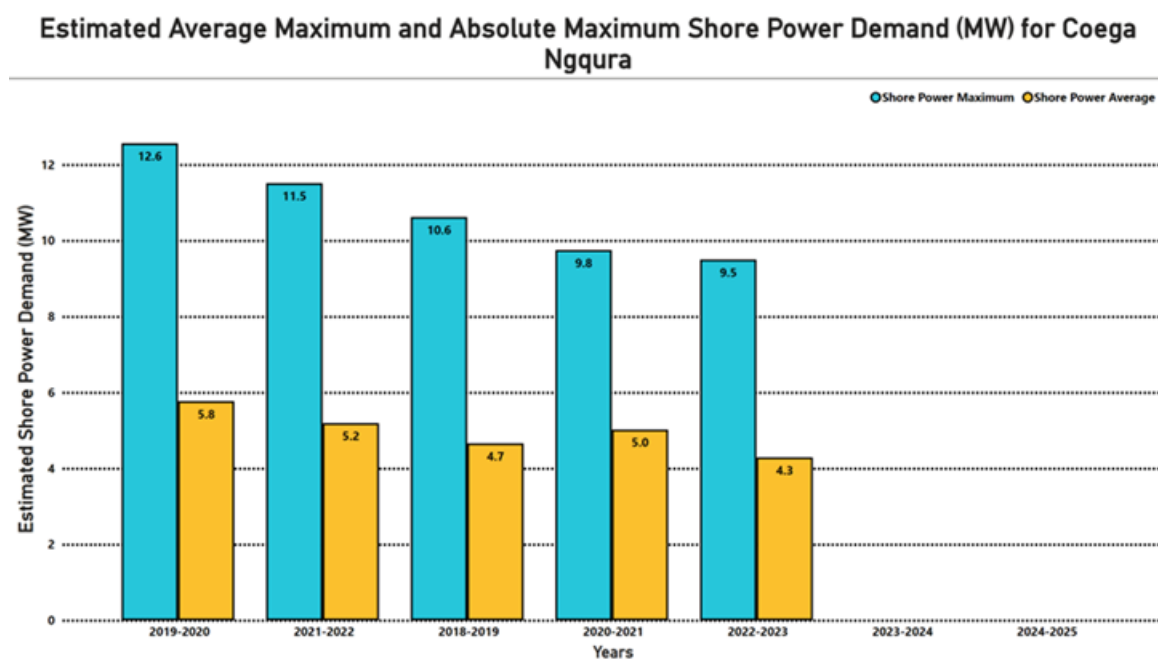


Supported by:

FigureA 39 Estimated Peak Maximum and Peak Average Power Utilization Demand (MW) for Cape Town

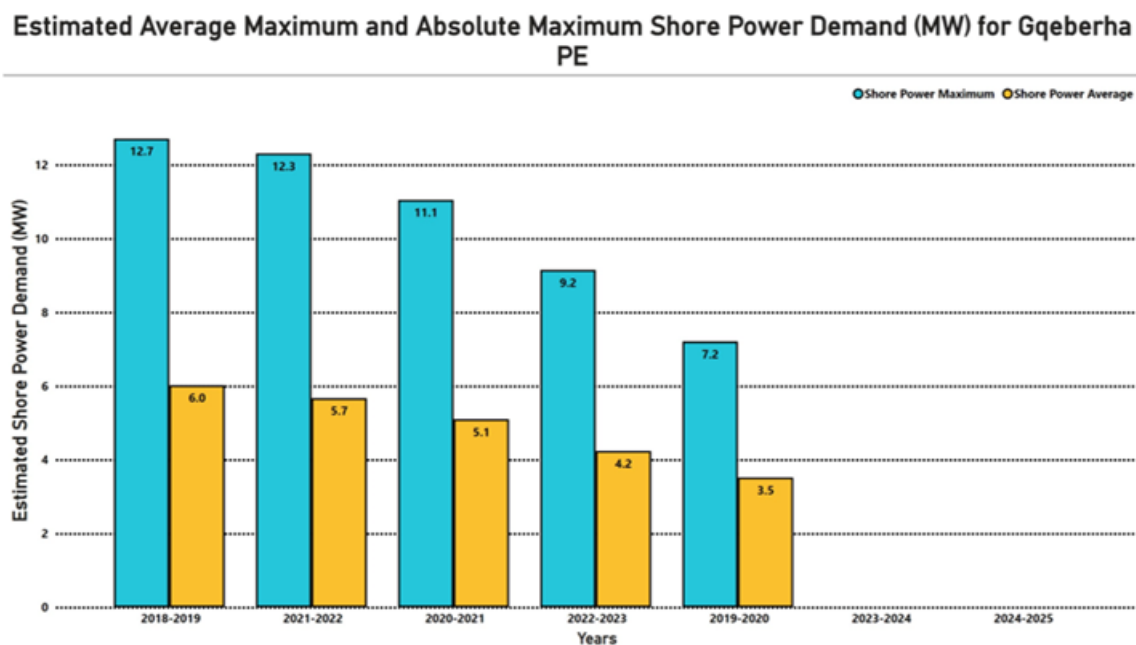


FigureA 40 Estimated Peak Maximum and Peak Average Power Utilization Demand (MW) for Coega/Ngqura

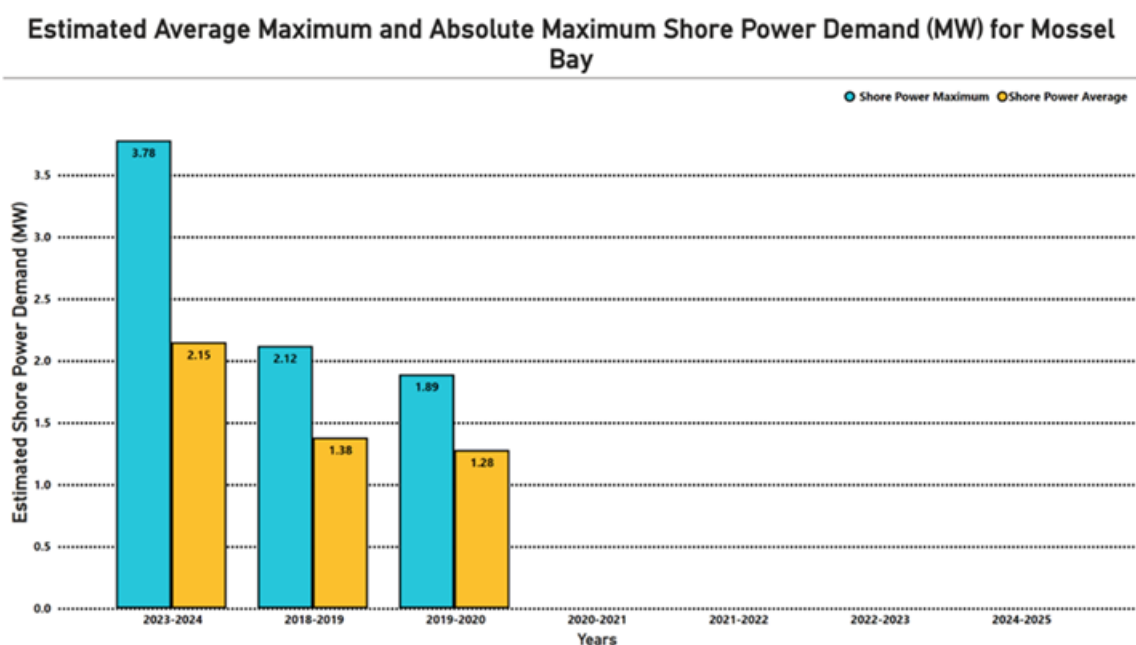


Supported by:

FigureA 41 Estimated Peak Maximum and Peak Average Power Utilization Demand (MW) for Gqeberha

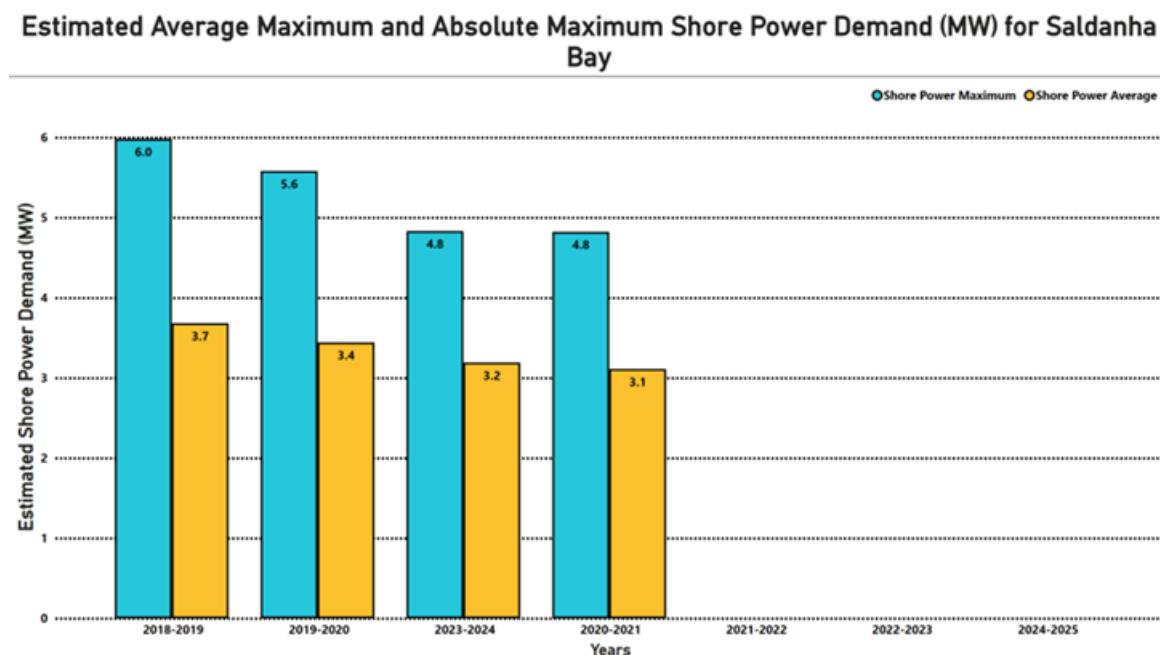


FigureA 42 Estimated Peak Maximum and Peak Average Power Utilization Demand (MW) for Mossel Bay

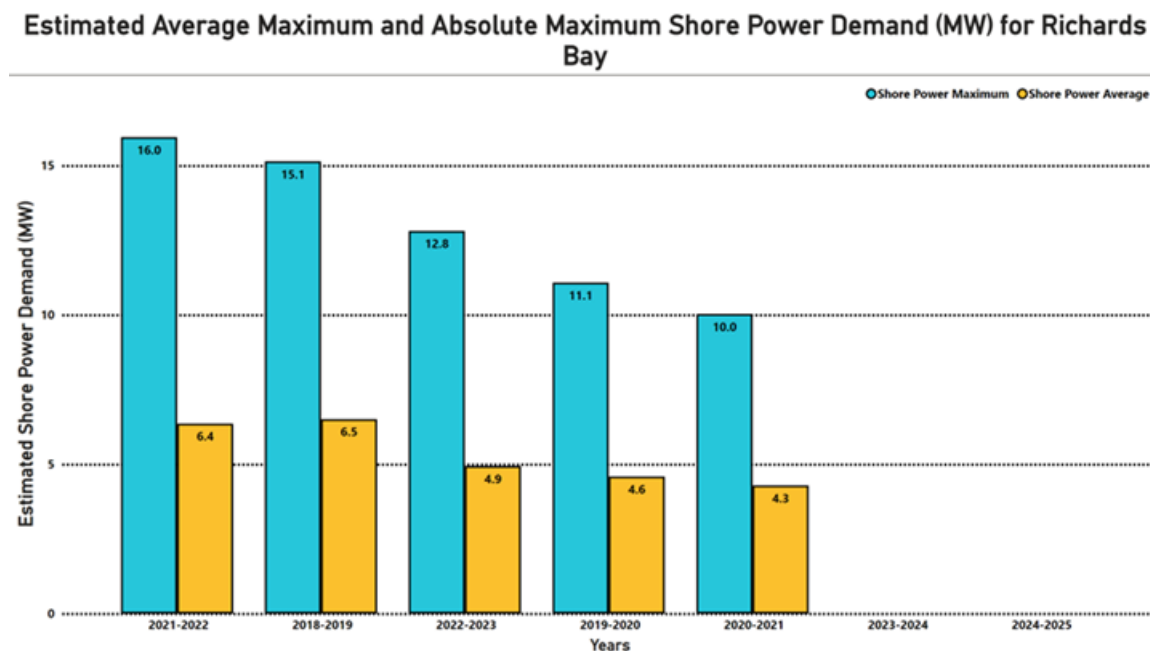


Supported by:

FigureA 43 Estimated Peak Maximum and Peak Average Power Utilization Demand (MW) for Saldanha Bay



FigureA 44 Estimated Peak Maximum and Peak Average Power Utilization Demand (MW) for Richards Bay



Supported by: