Territorial Needs Assessments of Porto Nogaro (Carbon Footprint)

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Contents

Introduction

This document has been drafted in the framework of the European project CLEAN BERTH, which aims to strengthen the institutional capacity of ports in the cross-border area of the Interreg ItalySlovenia Programme and create the basis for a coordinated and permanent governance in the field of port environmental sustainability and energy efficiency, by jointly developing action plans and a long-term strategy, increasing coordination and cooperation between ports to strengthen their sustainability and competitiveness.

In particular, the objective of this document is to draw up an inventory of Greenhouse Gases (GHG) also known as "Carbon Footprint" and an action plan for their reduction, within the Porto Nogaro port area, in accordance with the contents of the following documents:

- "Document 1 -D.3.1.2.1_STATUS_QUO_ITA.pdf"
- "Document 2 - D.3.1.3.1_metodologia_AP_ITA.pdf"
- "Document 3 - SUSPORT_D.3.2.1_TNA_methodology_FINAL.pdf"
- "Document 4 - SUSPORT_D.3.3.1_AP_model_FINAL.pdf"

The methodology identified to approach the study and production of the analysis refers to the UNI EN ISO 14064 standard, which identifies carbon dioxide equivalent (CO_{2eq}) as the unit of measurement for assessing GHG emissions, as established by the Convention on Climate Change (UNFCCC).

The principles to be followed in drawing up the GHG inventory are defined by the UNI EN ISO 14064 standard and are as follows:

- Relevance: the final result of the evaluation must represent an understandable and reliable basis for subsequent decisions
- Completeness: the completeness of the Carbon Footprint report must include all sources of port emissions within the pre-established boundaries. All important steps and possible exclusions must be reported and justified
- Consistency: consistency in applying the methodology is important to obtain a meaningful comparison of information related to greenhouse gases over the years. Any change (in data, boundaries, factors, etc.) must be documented transparently

- Transparency: all issues relating to the carbon footprint report must be documented effectively and consistently, based on verification. Any assumptions or forecasts must be made public and the sources used for the data and methodologies must be indicated.
- Accuracy: the quantification of greenhouse gas emissions must be as realistic as possible, i.e. the level of uncertainties must be reduced as much as possible.

This methodology makes it possible to develop a current and prospective assessment of energy requirements, providing the tools to guarantee the environmental sustainability of the port area over time, with the same quality of services offered, through the identification of innovative technical and organisational solutions linked to the supply and use of energy, whatever form it takes. This energy and environmental plan, in addition to limiting the energy needs of the port area, sets as its objectives the reduction of GHG emissions, with particular attention to CO_2.

Reducing GHG emissions from ports is not only a measure to tackle global warming, but also contributes to promoting innovation, implementing energy efficiency and improving the quality of life in the surrounding areas.

Although emissions in port areas represent only a small part of the total emissions that can be associated with the whole maritime transport logistics chain (which includes land transport to ports, port operations and maritime transport), any reduction of emissions in the port area not only improves local air quality and noise reduction, but also helps to reduce the global climate effect in a synergistic way. In this sense, port area management authorities have an important role to play in engaging actors in the port community to be more environmentally friendly and facilitate through initiatives the implementation of best environmental practices and the encouragement of measures aimed at improving energy efficiency and promoting the use of renewable energy in the port area.

Legal framework and context

Maritime transport emits about 940 million tonnes of CO_2 per year and is responsible for about 2.5% of global GHG emissions. According to the 3rd IMO study, it is predicted that emissions from maritime transport could increase by between 50% and 250% by 2050. For this reason, both the EU and Italy, but more generally the international community, have adopted new strategies to reduce CO_2 emissions in maritime transport and ports.

The following paragraphs are intended to provide an overview of the regulations and policies adopted at international and national level to combat climate change.

Italian and European legislation relating to the reduction of GHG emissions and in particular CO_2 in the maritime and port sector

The reduction of CO_2 emissions is one of the main objectives of the EU, which has issued several directives that have been adopted by the Member States. The main ones are:

- EU Directive Emission Trading (ETS 2018/410) regulates emissions from energy-intensive sectors by setting a reduction target of -43% by 2030, stressing the need to take action on emissions from maritime transport, and periodically reviewing the work of the IMO;
- Decision Effort Sharing allocates the emission reduction target in the sectors not covered by the ETS Directive (transport, buildings, agriculture and waste) in a binding manner between Member

  States;
- EU Directive Carbon Capture and Storage defines a common regulatory framework for the industrial-scale development of CO_2 capture, transport and storage projects;
- EU Directive 2009/30 CE sets out the characteristics that petrol and diesel must have in order to be commercialised in the EU. It requires fuel suppliers to reduce GHG emissions per unit of energy produced during the life cycle of fuels by up to 10% by 2020;
- Regulation (EU) 2015/757 of the European Parliament and of the Council stipulated that from 2018 shipping companies must monitor and from 2019 report: CO_2 emissions, fuel consumption, distance travelled, time spent at sea and goods transported per voyage. All ships sailing to EU ports must be equipped with a compliance document

In Italy, since low, n. 84 of 28.01.1994 the concept of environmental sustainability of ports has been introduced as part of port system planning, in line with the policies promoted by the relevant EU Directive. Legislative Decree no. 169 of 04.08.2016 promotes the drafting of the Port System Energy and Environmental Planning Document (DEASP) by the Port System Authorities, with the aim of pursuing CO_2 emission reduction objectives through the implementation of measures to improve energy efficiency and promote the use of renewable energies. The Guidelines adopted by MATTM in 2018, define the methodologies to be followed for the drafting of DEASPs, which in analogy to the requirements of this document, recall some normative references that must be taken into account in the context of the carbon footprint of a port and in the definition of a related action plan aimed at a reduction of GHG emissions. The measures and interventions considered must be subjected to a cost-benefit analysis in accordance with the Guidelines for the evaluation of investments in public works issued by the MIT and the European standard ACB DG REGIO, 2014.

In addition to the standards listed above, other standards that have been taken into account in the drafting of the document are listed below:

- Directive 2007/71/CE, (implemented by Ministerial Decree of the Ministry of the Environment, Food and Rural Development of 01.07.2009) on port reception facilities for ship-generated waste and cargo residues;
- The Communication from the Commission to the EU Parliament and the Council COM 2002/595 of 20.11.2002 An EU strategy to reduce atmospheric emissions from seagoing ships in which it invited Port Authorities to impose, encourage or promote cold ironing;
- Directive 2012/33/UE on the sulphur content of marine fuels;
- Directive 2005/35/CE of 07.09.2005 on ship-source pollution and on the introduction of penalties for violations;
- Green Paper “Towards a future Maritime Policy for the Union : a European vision for the oceans and seas”7.6.2006, COM (2006) 275;
- Commission Recommendation of 08.05 2006 on the promotion of the use of cold ironing for ships at berth in Community ports close to residential areas.
- The Communication from the Commission to the EU Parliament and the Council “An Integrated Maritime Policy for the European Union”, 10.10.2007 COM (2007) 575;
- The Communication from the Commission “Communication on a European Ports Policy”, 18.10.2007 COM (2007) 616;
- Communication from the Commission to the EU Parliament, the Council, the EU Economic and Social Committee and the Committee of the Regions “20 20 by 2020 Europe's climate change opportunity”, 23.1.2008 COM30;
- “Directive 2008/50/CE on ambient air quality and cleaner air for Europe;
- “Marine Strategy Framework Directive”, 17.6.2008, 2008/56/CE;

- “Greening Transport”, 8.7.2008, COM (2008) 433;
- Directive 2014/52/UE on the assessment of the effects of certain public and private projects on the environment;
- New PIANC reference standards;
- ISPRA report "Maritime transport and environmental management in Italian port areas", 17.5.2016;
- Publications and workshops by ESPO (European Sea Ports Organisation)/EcoPorts (the main environmental initiative of the European port sector);
- IMO's MARPOL International Convention for the Prevention of Pollution from Ships (Annex VI), which requires the use of marine fuels with a sulphur content of less than 0.5% m/m from 2020.

Italian and European policies related to the reduction of greenhouse gas emissions, in particular in the maritime and port sector

Italy, as a member state of the EU, has been at the forefront of policies to reduce GHG emissions since 1992. At the Rio de Janeiro Conference that year, it joined the United Nations Framework Convention on Climate Change (UNFCCC), and in 1997 it joined the international treaty known as the Kyoto Protocol. Under the Kyoto Protocol, the EU pledged to reduce its greenhouse gas emissions from 1990 levels by 8% and Italy by 6.5%. Subsequently, the EU adopted a series of targets for 2020, set out in the “Climate & Energy Package 2020”: -20% CO_2, +20% RES and +20% EE.

From 1990 to 2018, the EU has reduced its greenhouse gas emissions by 23%, exceeding the 20% target. The Kyoto Protocol has led to other international agreements to which Italy and the EU have always adhered with the aim of further reducing their GHG emissions, including: the financial commitment for climate signed in 2009 at COP15 in Copenhagen and the adoption in 2012 of the Doha Amendment to reduce emissions by at least 18% by 2020 compared to 1990. In 2016, Italy signed, together with the EU and 190 others, the Paris Agreement, the first universal and legally binding agreement on climate change, whose objectives are to keep the average global temperature increase below 2C° compared to pre-industrial levels, to ensure that global emissions peak as soon as possible and to achieve a balance between emissions and removals in the second half of the century. The EU's contribution under the Paris Agreement is to reduce its GHG emissions by at least 40% by 2030 compared to 1990 levels.

To implement the Paris Agreement, the EU adopted the " Climate & Energy Package 2020", consisting of a set of directives and regulations aimed at achieving the 2030 targets (-40% CO_2 + 32% RES +32.5% EE). In 2019, the EU Commission presented the Green New Deal a "growth strategy aimed at transforming the EU into a fair and prosperous society with a resource-efficient and competitive economy that generates no net GHG emissions in 2050". In the Green Deal, the EU's 2030 target to reduce GHG emissions to at least 50-55 % is increased. Within this overall framework of European and national targets and policies, the contribution that shipping can make to reducing emissions is potentially high. In 2018, the IMO adopted a strategy to reduce annual GHG emissions from shipping by at least 50 % by 2050 compared to 2008 and to continue efforts to phase them out as early as possible in this century. The EU has set out a strategy to reduce GHG emissions from this sector in EU Commission Communication 479.

The strategy is divided into consecutive phases involving the monitoring, reporting and verification of CO_2 emissions from large ships calling at EU ports, GHG reduction targets for the maritime transport sector and further medium and long-term measures. In Italy, at the beginning of 2020, the MISE published the “Piano Nazionale Integrato per l'Energia e il Clima” (PNIEC), through which it sets national targets for the reduction of CO_2 emissions by 2030, foreseeing that the most significant contribution will come from the transport and civil sectors. The PNIEC is part of a favourable national context made up of strategic documents including the National Climate Change Adaptation Strategy (2015) and the National Energy Strategy (2017), and documents that direct national policy towards the decarbonisation of the transport sector as "elements for a sustainable mobility roadmap" (2017), the National Infrastructure Plan for the Recharging of Electricity-powered Vehicles, the National Strategic Framework for the development of the alternative fuels market in the transport sector and the implementation of related infrastructure within which the provision of refuelling points in ports of LNG for shipping and the use of hydrogen in the maritime sector is envisaged.

In the update note to the 2019 Economic and Financial Document (naDEF2019), an increase in investments is also planned to encourage the electrification of ports and strengthen their connection with airports through the railway system. The PNIEC also aims to improve air quality by promoting the electrification of consumption in the transport sector, specifying the interest in equipping ports with electrified docks (cold ironing). The PNIEC identifies the modal shift as a measure to reduce emissions due to freight transport, promoting the integration between ship transport and local distribution by road with low environmental impact vehicles, confirms the Marebonus mechanism that provides incentives to road haulage companies where they adopt combined road-sea transport modes, and promotes the development of the National Logistics Platform (PLN), with the aim of optimising transport through increased interconnection and facilitating data management. In line with the "DAFI Directive on the establishment of an infrastructure for alternative fuels", the PNIEC identifies the development of LNG as a strategic measure to reduce emissions from maritime transport and port services, providing that by 2025 an adequate number of refuelling points will be built as well as implementing incentive tools for the construction of depots and / or distributors and the use of LNG vehicles.

Description of the port area

The Aussa - Corno industrial area has a port known as 'Porto Nogaro' which is composed of the two public structures of Porto Nogaro 'Vecchio' (located near the town of Porto Nogaro), the Porto Margreth structure and the private quay of the former Industrie Chimiche Caffaro, which is reached by the Banduzzi artificial canal.

The Port Margreth, located at a distance of 10.9 km from the Adriatic Sea and connected to its by the sea channel Corno, has an evolution basin with a useful width of 250 m and a quay length of 860 ml. Following the recent dredging carried out by the FVG Region, the Corno sea channel has a bottom level of -7.50.

The Margreth port area benefits from 25 hectares of port quays and yards behind the quay, which are equipped with railway connections, covered warehouses, covered canopies, uncovered storage areas, areas outside the customs barrier, road-rail weighbridges, fire prevention system, scrap iron treatment plant, video surveillance system, office building and green areas. The ships that gravitate to Porto Nogaro weigh on average 3-4,000 tons, with peaks of up to 7,000. Due to the fluvial nature of the access channel to the Port, flat-keeled ships have an easier access.

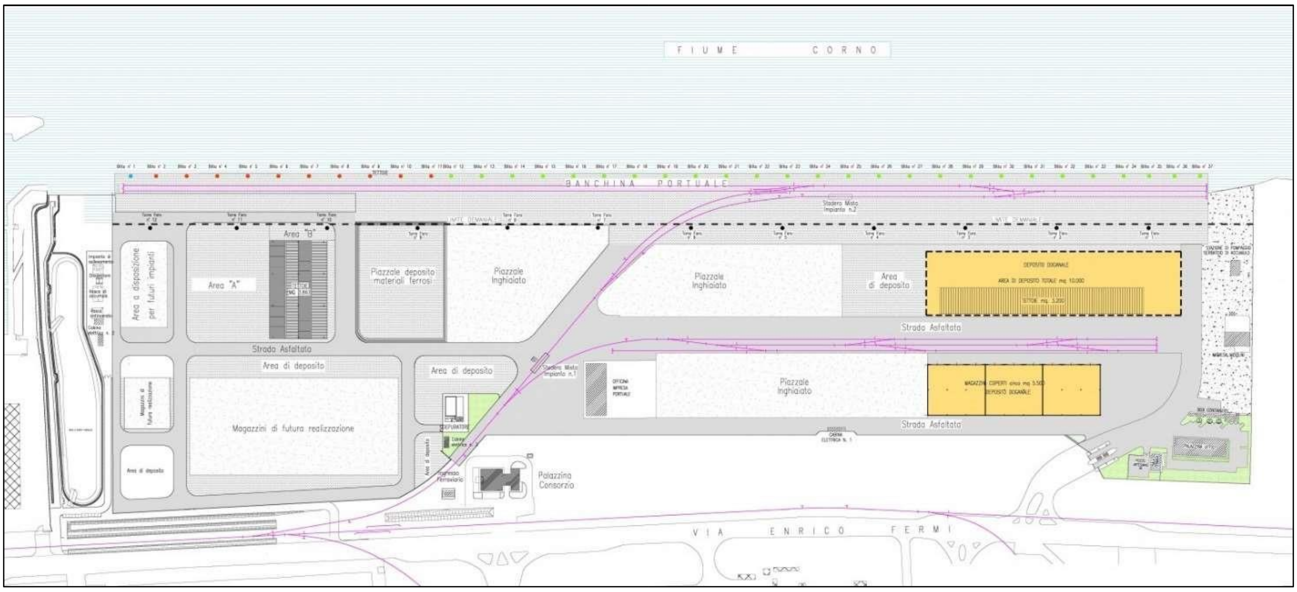

Figure 1 – Area of Port Margreth

The organisation of the multiple port services is assigned to competent and authorised operators. Of considerable importance is the future strengthening of the connection with the nearby Interporto Alpe Adria in Cervignano del Friuli, in order to improve intermodality and logistics at Porto Nogaro.

In the industrial area of Aussa-Corno, which is closely connected to Porto Nogaro, a series of private initiatives for the storage and processing of goods are being implemented. Among these, we can mention the creation of Consorzio Portonuovo, a private company for the management of services and the maintenance of Porto Nogaro's facilities.

A number of companies operate within the port area of Porto Margreth, including maritime agencies, port companies and companies related to port services. The following table summarises the operators active in the port area under analysis.

Type	Operator
Port service	Consorzio Portonuovo
	Gruppo Ormeggiatori del Porto di Monfalcone e Porto Nogaro
	Pratici di Mare Porto Nogaro
Port companies	Impresa Portuale Porto Nogaro s.r.l
	Midolini F.lli S.p.A
Maritime Agencies and Forwarding Agencies	Ciscato & Company
	Ferest Shipping
	Friultrans
	Marlines
	Navimar
	Nogarosped
	Tradax
Other	Ufficio Circondariale Marittimo di Porto Nogaro
	Agenzia delle Dogane di Udine - Sezione operativa di Porto Nogaro - Cervignano
	Guardia di Finanza - Comando Compagnia San Giorgio di Nogaro
	Apostolato del Mare

Table 1 – Port authorities and operators active in the Porto Nogaro

The main function in terms of surface area occupied is the commercial one associated with the goods handling activities carried out by the two port companies operating in the area under concession.

In order to better understand the activities carried out in the port area that is the object of analysis, some information and data explaining the goods handled and the equipment and vehicles present in the port area in 2019 are given below.

Freight traffic data for the Porto Margreth 2019

YEAR	LOADED GOODS [ton] (a)	UNLOADED GOODS [ton] (b)	TOTAL [ton] (a+b)
January	47.160	64.017	111.177
February	49.256	39.494	88.750
March	47.365	45.473	92.838
April	66.330	81.908	148.238
May	48.783	73.340	122.123
June	44.640	66.516	111.156
July	52.621	75.428	128.049
August	36.455	55.201	91.656
September	48.564	82.648	131.212
October	58.014	63.366	121.380
November	49.676	73.916	123.592
December	67.576	47.771	115.347
TOTAL	616.440	769.078	1.385.518

Table 2 - Freight traffic data 2019 Port Margreth

List of vehicles and equipment used for handling goods in the Porto Margreth area

TYPE	QUANTITY	FUEL
Harbour Crane	7	Diesel oil
Forklift truck	11	Diesel oil
Locotractor	1	Diesel oil
Wheel loader	5	Diesel oil
Sweepers	1	Diesel oil
Tractor	2	Diesel oil
Car	4	Diesel oil
Auticulated truck	6	Diesel oil
Van	1	Diesel oil

Table 3 - List of equipment and vehicles operating in the Port Margreth 2019

Traffic data in/out for vessels and port operational vehicles

TYPE	NUMBER
Vessel traffic	318
Road traffic	48.000
Rail Traffic	114

Table 4 - Sea and land transport data 2019

Mapping out stakeholders

The drafting of this document was possible thanks to a fruitful collaboration of all the main stakeholders who carry out activities in the area of Porto Margreth.

Stakeholders were involved through initial presentations of the project's aims and methods.

Data on the main GHG sources contributing to direct and indirect emissions from the port area were then collected. This activity was carried out through the administration of a questionnaire to the Managing Authority and to all the Concessionaires considered to be the most energy intensive, which allowed for a rapid and efficient collection of data relative to the energy consumption of the subjects operating within the identified Operational Boundaries, for the reference year 2019. The definition of the interventions, on the other hand, took place through the gathering of useful information during the meetings with the main Concessionaires characterised by the most energyintensive activities, in order to discuss the most effective opportunities for containing energy consumption and reducing GHG emissions, in line with the development plans of their activities and with any actions already planned.

Below is a list of the stakeholders included in the analysis and the type of involvement that concerned them.

NUMBER	STAKEHOLDER	PORT	TYPE	ENERGY DATA COLLECTION	DEFINITION OF INTERVENTIONS
1	COSef	Porto Nogaro	Managing Authority	✓	✓
2	Consorzio Portonuovo	Porto Nogaro	Port services provider	✓	✓
3	Impresa Portuale Porto Nuovo	Porto Nogaro	Port terminal company	✓	✓
4	Midolini F.lli S.p.A	Porto Nogaro	Port terminal company	✓	✓
5	TS Traction & Service s.r.l. – CO.RAC.FER. s.r.l.	Porto Nogaro	Port services provider	✓	
6	Regione Autonoma Friuli Venezia	Porto Nogaro	Managing Authority		✓

	Giulia			
7	Gruppo Ormeggiatori di Monfalcone	Porto Nogaro	Port services provider	√
8	Ocean s.r.l.	Porto Nogaro	Port services provider	√

Table 5 – Mapping out stakeholder

Status quo: terrestrial and maritime emissions - Carbon footprint emission estimation

The "Carbon Footprint" aims to define the emission status in terms of CO_2 equivalent of the Porto Margreth, according to the methodology described in the UNI ISO 14064:2006 standard and its specific implementation protocols.

This calculation method is useful in order to be able to view the data collected in an aggregate and organic manner.

The calculation of GHG emissions is functional to the objective of assessing the environmental impact of the port area, identifying the main causes and planning reduction measures aimed at containing the Port Community's energy requirements and implementing systems based on the use of renewable sources.

The "Carbon Footprint" must guarantee the respect of the following principles in order to comply with UNI ISO 14064:2006:

- Relevance: the final result of the evaluation must represent, for both COSEF and all users, an understandable and reliable basis for subsequent decisions
- Completeness: the completeness of the Carbon Footprint report must include all sources of port emissions within the pre-established boundaries. All important steps and possible exclusions must be reported and justified
- Consistency: consistency in applying the methodology is important to obtain a meaningful comparison of information related to greenhouse gases over the years. Any change (in data, boundaries, factors, etc.) must be documented transparently

- Transparency: all issues relating to the carbon footprint report must be documented effectively and consistently, based on verification. Any assumptions or forecasts must be made public and the sources used for the data and methodologies must be indicated.
- Accuracy: the quantification of greenhouse gas emissions must be as realistic as possible, i.e.

  the level of uncertainties must be reduced as much as possible.

The definition of the Carbon Footprint of the port area related to Porto Margreth includes the following steps:

1. Definition of organisational boundaries
2. Definition of operational boundaries
3. Definition of baseline year
4. Calculation of the GHG inventory

This Chapter illustrates the hypotesis and methodological assumptions made for the definition of organisational and operational boundaries, the development of the inventory, the quantification of emissions and the evaluation of the uncertainty associated with the calculation of the "Carbon Footprint".

The Organisational Bondaries

The UNI ISO 14064-1:2006 standard, referred to by the Guidelines of the MATTM for the drafting of the Documents for the Energetic and Environmental Planning of Port Systems (DEASP), defines as a first phase that of delimiting the organisational boundaries that serve to determine the operations included in the GHG inventory of the port area, in this specific case it was decided to define them according to the criterion of the functional relationship. In the present document, therefore, both the emissions due to activities over which COSef has financial and/or operational control are considered, as well as those of the main subjects operating within the scope of functions related to the specific activities of ports such as maritime transport.

Functions included in the “Carbon Footprint”
Buildings of COSef and other public authorities and bodies in the port area
Management and maintenance of common parts in the port area
Port terminals (freight)
Other private buildings in the port area other than those in the terminals
Road service mobility within the port
Commercial and service vessels, at anchor and in the mooring phase
Commercial and service vessels during manoeuvre and navigation in the por
Intermodal road/rail terminals in the port area

Table 6 – List of functions included in the Carbon Footprint

Operational Boundaries

In order to define the Operational Boundaries of this analysis, necessary to identify the GHG emissions associated with the operations carried out by COSef and its Concessionaires, it is necessary to establish whether an emission source is direct (controlled or owned by COSef) or indirect (influenced by COSef but controlled by third parties).

The relationship between COSef and its operating terminals is important for the division of emissions into direct, indirect from energy consumption and other indirect emissions.

Emissions are divided into three scopes as described below:

- Scope 1: direct emissions under the organisational control of COSef and all emissions of subjects, other than COSef, operating within the port areas and having a contractual relationship with COSef;
- Scope 2: indirect GHG emissions from the consumption of electricity from the national grid;
- Scope 3: indirect emissions outside Scope 2, such as transport of materials, products or persons.

These areas are described in numerous national and European guidelines and are part of the methodology of the emission inventory calculation. In this regard, it is necessary to classify the relations of influence and control by COSef towards each operator located within the port area. From the intersection of the functions included in the analysis, defined in the previous section, with the areas described above, the operational boundaries have been defined and are reported in the table below:

Functions included in the “Carbon Footprint”	Scope
Buildings of COSef and other public authorities and bodies in the port area	1 (direct emissions) 2 (indirect emissions)
Management and maintenance of common parts in the port area	1 (direct emissions) 2 (indirect emissions)
Port terminals (freight)	1 (direct emissions) 2 (indirect emissions)
Other private buildings in the port area other than those in the terminals	1 (direct emissions) 2 (indirect emissions)
Road service mobility within the port	1 (direct emissions) 2 (indirect emissions)
Commercial and service vessels, at anchor and in the mooring phase	1 (direct emissions)
Commercial and service vessels during manoeuvre and navigation in the port	1 (direct emissions)
Intermodal road/rail terminals in the port area	1 (direct emissions)

Table 7 – Emission scopes associated with functions included in the Carbon Footprint

From the table it emerges that the functions that will be analysed for the calculation of the "Carbon Footprint" concern only areas 1 and 2, therefore the energy consumption of GHG sources from both the national electricity grid and from the on-site use of fossil fuels will be analysed

Baseline year

The assessment of GHG emissions refers to a specific base period, generally coinciding with the most recent calendar or financial year for which Inventory data are available and verifiable. Following the definition of the "Carbon Footprint", we chose to analyse the year 2019 as it is the most recent useful year for which there is uniform data availability for all 12 months.

The identification and formalisation of the Operational Boundaries guarantees the consistency of the inventory and temporal comparability between the different years.

If, in subsequent years, changes in the Operational Boundaries, the relocation of GHG sources inside or outside the Operational Boundaries or changes in GHG quantification that result in significant changes in the value of calculated GHG emissions are detected, a recalculation procedure will be implemented for the base year that takes these changes into account.

GHG inventory calculation

Identification of GHG sources and data collection methodology

Identification of GHG sources

The UNI ISO 14064-1:2006 standard requires the GHG sources included in the previously defined Operational Boundaries and considered in the calculation of the "Carbon Footprint" to be made explicit. The table below shows the GHG sources present in the area of Porto Margreth for each function considered and reference area.

Functions included in the "Carbon Footprint"	Scope	GHG Sources
Buildings of COSef and other public authorities and bodies in the port area	1	Fossil fuels for cooling/heating of buildings
	2	Electricity exchanged with the grid
Management and maintenance of common parts in the port area	1	Fossil fuels for operational/road vehicles
	2	Electricity exchanged with the grid
Port terminals (freight)	1	• Fossil fuels for operational/road vehicles • Fossil fuels for cooling/heating of buildings

		• Fossil fuels for vessels in port area
	2	Electricity exchanged with the grid
Other private buildings in the port area other than those in the terminals	1	Fossil fuels for cooling/heating of buildings
	2	Electricity exchanged with the grid
Road service mobility within the port	1	Fossil fuels for road vehicles
Commercial and service vessels, at anchor and in the mooring phase	1	Fossil fuels for vessels in port area
Commercial and service vessels during	1	Fossil fuels for vessels in port area

Functions included in the "Carbon Footprint"	Scope	GHG Sources
manoeuvre and navigation in the port		
Intermodal road/rail terminals in the port area	1	Fossil fuels for vessels in port area

Table 8 – Definition of GHG sources related to the functions included in the "Carbon Footprint"

Definition of the quantification methodology

The quantification methodology identified for the calculation of GHG is based on data relating to activities carried out in the port area to which emission factors have been associated that meet the requirements of accuracy, consistency and reproducibility required by the UNI ISO 14064-1:2006 standard, minimising the uncertainty associated with them.

Activity data may refer to quantities, generated or used, describing GHG-related activities, expressed in terms of energy (MJ or kWh), hours (h) or kilometres (km).

In the present analysis, the activity data belongs to the three types illustrated in the following diagrams.

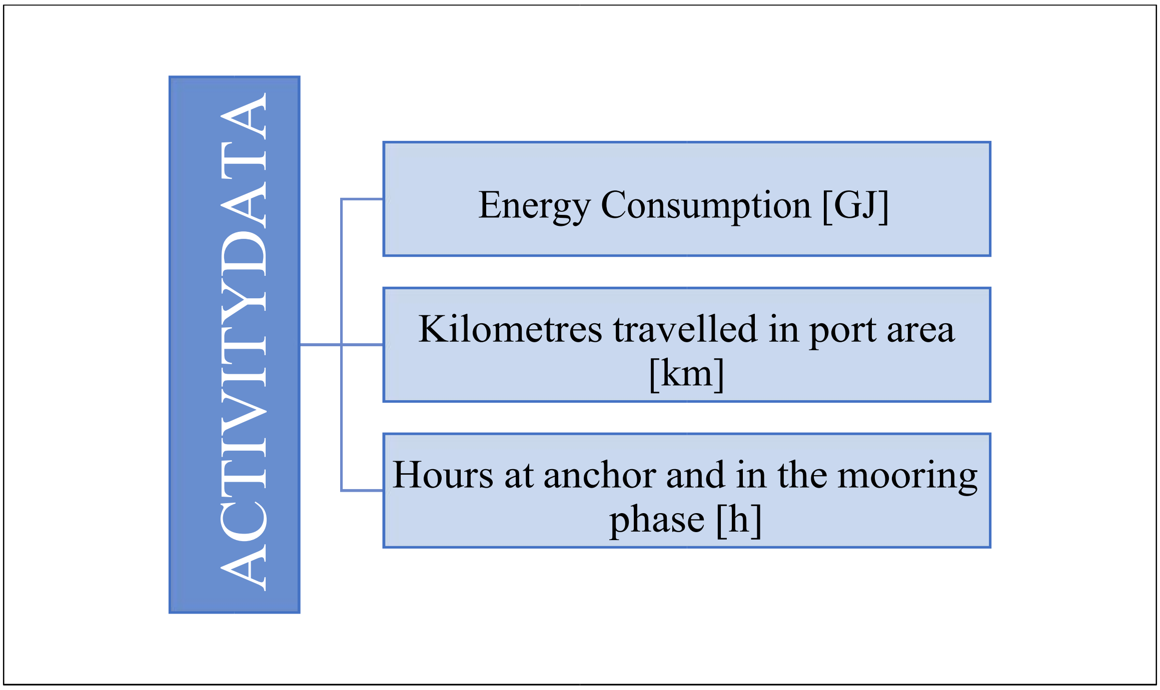

Figure 2 - Scheme of activity data analysed

In particular, activity data expressed in kilometres and hours were used to describe the functions for which energy consumption data could not be found.

In detail, the kilometres travelled were used to quantify the emissions associated with the function relating to " Intermodal road/rail terminals in the port area ", while the activity data expressed in hours of manoeuvring and hotelling were used to characterise the functions relating to " Commercial and service vessels, at anchor and in the mooring phase " and " Commercial and service vessels during manoeuvre and navigation in the port ".

It should be noted that after an evaluation of the available data, it was decided to limit GHG reporting to carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) emissions, as the presence of fluorinated gas emissions (HFCs, PFCs, SF6) in air conditioning systems is currently not technically and economically measurable. In order to obtain these values, it would be necessary to change the contracts with the building maintenance companies so that they collect data on all sites according to the same criteria.

Climate Change (UNFCCC), were applied. The emission factors identified made it possible to convert the quantity of each type of GHG into tonnes of CO_2 equivalent, using the relative GWP values. The GHG emissions considered in the report were then converted into tonnes of CO_2 equivalent, which is the unit of measurement adopted in the GHG inventory. The quantification methodology identified for the estimation of GHG emissions is based on the multiplication of activity data related to GHG sources by appropriately selected GHG emission factors and the subsequent transformation of these emissions into CO_2 equivalent using the appropriate GWP values, defined in the "IPCC Fifth Assessment Report, 2014 (AR5)". The formula used is set out below:

$$\boldsymbol{CO_{2eq}\ emission[t]} = Activity\ data * [EF * GWP + EF * GWP + EF * GWP\ ]$$

Where:

- Activity data: is the quantity, generated or used, that describes the GHG-related activity, expressed in terms of energy (MJ or kWh), hours (h) or kilometres (km); EF: is the factor that relates activity data to GHG emissions or removals
- GWP: GWP values at 100 years expressed in [kg_{CO2}/kg_{GHG}].

Data collection of GHG-related activities

The data related to the activities directly managed and controlled by COSef or carried out by subjects contractually linked to COSef and that take place within the Organisational and Operational Boundaries described above have been collected through the administration of a Questionnaire.

In agreement with COSef, the collection of the data involved exclusively the subjects operating within the two port areas and identified as those most relevant from the energy and environmental point of view with respect to the activities carried out.

This questionnaire allowed to collect the main energy and environmental information related to the buildings, industrial processes and goods handling activities carried out by COSef, the operators and the Concessionaires operating within the port area of Porto Margreth.

Below is the list of Concessionaires considered for the collection of activity data related to GHG and necessary for the quantification of the "Carbon Footprint", each subject has been attributed the port area, activity, scope and relative GHG sources.

CONCESSIONAIRES	PORT AREA	ACTIVITIES	SCOPE	GHG SORCES
COSef	Porto Margreth	Managing Authority	1	• Fossil fuels for cooling/heating of buildings
			2	• Electricity exchanged with the grid
Consorzio Portonuovo	Porto Margreth	Port services provider	1	• Fossil fuels for cooling/heating of buildings • Fossil fuels for vessels in port area • Fossil fuel for intermodal road/rail transport in/out port area
			2	• Electricity exchanged with the grid
Impresa Portuale Porto Nogaro	Porto Margreth	Port terminal company	1	• Fossil fuels for cooling/heating of buildings • Combustibili fossili per veicoli aziendali • Fossil fuels for operational/road vehicles • Fossil fuels for vessels in port area • Fossil fuel for intermodal road/rail transport in/out port area
			2	• Electricity exchanged with the grid

Midolini F.lli S.p.A	Porto Margreth	Port terminal company	1	Combustibili fossili per veicoli aziendali Fossil fuels for operational/road vehicles Fossil fuels for vessels in port area Fossil fuel for intermodal road/rail transport in/out port area
			2	Electricity exchanged with the grid
TS Traction & Service s.r.l. – CO.RAC.FER. s.r.l.	Porto Margreth	Port services provider	1	Fossil fuel for intermodal road/rail transport in/out port area

Table 9 – Summary of subjects considered in the elaboration of the "Carbon Footprint" and relative GHG sources

Evaluation of energy consumption in the land and sea environment

In the previous Chapter, the methodology for quantifying emissions was described, based on the final energy consumption data related to the activities carried out within the identified Operational Boundaries.

In particular, the final energy consumption referred to 2019 and related to thermal and electric vectors and to the traffic of ships and vehicles of the subjects listed in the previous table have been considered, as they are the most relevant from an energy and environmental point of view.

Below is an analysis of energy consumption for port activities carried out on land and an analysis of consumption for port activities carried out at sea

Land-based energy consumption

This paragraph describes all energy consumption that generates emissions on land.

In particular, these energy consumptions come from fixed sources (e.g. thermal power plants, indoor and outdoor lighting) or mobile sources (cars, equipment, ships).

These consumptions derive from the combustion of methane, petrol, diesel and Low Sulfur Fuel Oil (LSFO) produced by all those operators that carry out activities within the port area and have a contractual relationship with the Authority, carrying out functions related to maritime transport. The data on electricity consumption were obtained from the analysis of the bills with respect to the individual delivery points (POD) distributed throughout the port areas. These data are therefore only available in aggregate form regardless of the different uses downstream of the POD. On the basis of the header of the delivery points it was however possible to break down the consumption by type of operator.

Consumption was accounted for by expressing the quantities of final energy in MWh.

Energy consumption by carrier

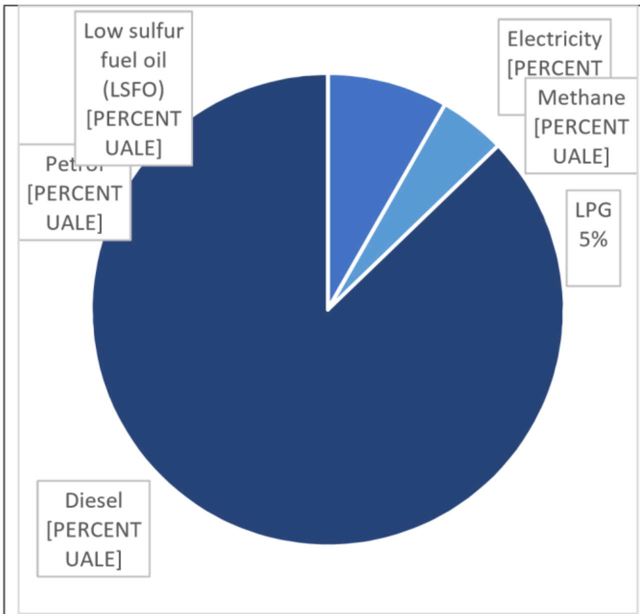

Figure 3 - Terrestrial energy consumption by energy carrier

This graph shows the percentage distribution of energy vectors.
The prevalence of diesel fuel used by both port operating equipment (cranes, forklift trucks, etc.) and heavy vehicles (TIR) and railcars used to transport goods in and out of the port area is evident.

Energy carrier	Consumption [MWh]	[%]
Electricity	343	8%
Methane	0	0%
LPG	188	5%
Diesel oil	3.622	87%
Petrol	0	0%
Low sulfur fuel oil (LSFO)	0	0%
TOTAL	**4.153**	**100%**

Energy Consumption by type of user

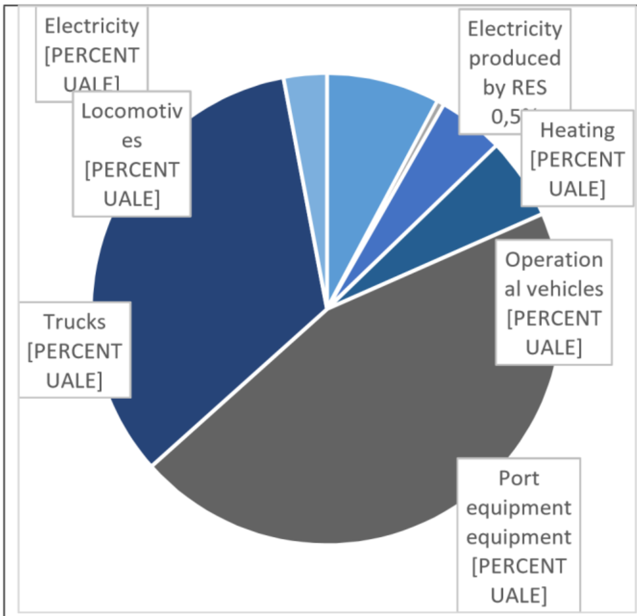

Figure 4 - Land-based energy consumption by type of use

The analysis divided by type of user shows that almost all consumption in the land area is attributable to the activities of port operating vehicles and the traffic of goods by road inside and outside the port area.

The contribution from electricity consumption is also significant.

Type of user	Consumption [MWh]	[%]
Electricity	323	8%
Electricity produced by RES	21	0,5%
Heating	188	5%
Operational Vehicles	232	6%
Port operating equipment	1.869	45%
Heavy trucks Articulated	1.398	34%
Locomotives	123	3%
TOTAL	**4.153**	**100%**

Maritime energy consumption

This section describes all energy consumption that generates emissions in the maritime environment. These consumptions are associated to the vessel's movements: at anchor, mooring phase and during manoeuvre and navigation in the port.

Energy consumption by carrier

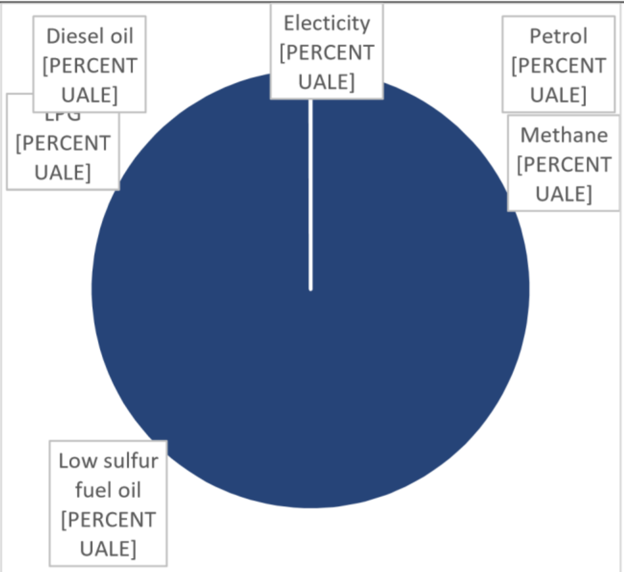

Figure 5 - Maritime energy consumption by energy carrier

This graph represents the percentage distribution of energy carriers.
It is clear that low-sulfur fuel oil used by vessels during manoeuvring and mooring outweighs other energy sources.

Energy carrier	Consumption [MWh]	[%]
Electricity	0	0%
Methane	0	0%
LPG	0	0%
Diesel oil	0	0%
Petrol	0	0%
Low sulfur fuel oil (LSFO)	48.223	100%
TOTAL	**48.223**	**100%**

Energy consumption by type of user

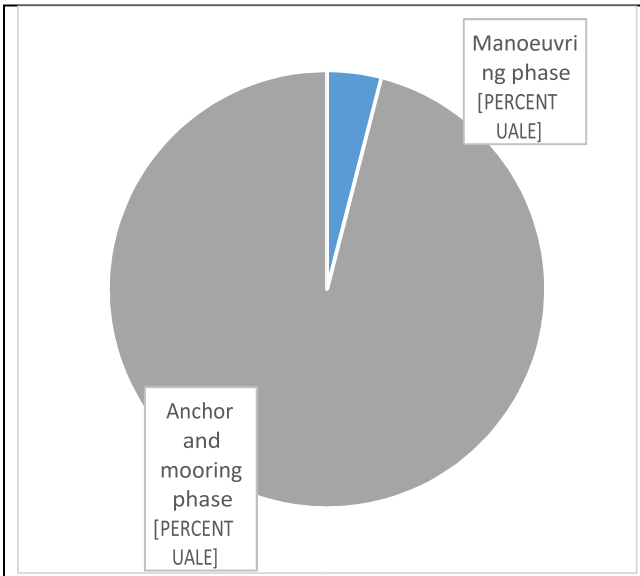

Figure 6 - Maritime energy consumption during the two phases

The analysis divided by type of user shows that almost all consumption in the maritime sector is attributable to the anchor and mooring of vessels at the quay.

Type of operation	Consumption [MWh]	[%]
Manoeuvring phase	1.929	4%
Hotelling and mooring phase	46.294	96%
TOTAL	48.223	100%

Analysis results

The following table summarises the final energy consumption for each type of activity in the land and sea port areas and shows which activities are responsible for the highest energy consumption.

Type of activity	Electricity [MWh]	Methane [MWh]	GPL [MWh]	Diesel [MWh]	Petrol [MWh]	LSFO [MWh]	Total [MWh]	Total [%]
Electricity	323	-	-	-	-	-	323	0,6%
Electricity produced by RES	21	-	-	-	-	-	21	0,0%
Heating	-	-	188	-	-	-	188	0,4%
Operational vehicles	-	-	-	232	-	-	232	0,4%
Port operational equipments	-	-	-	1.869	-	-	1.869	3,6%
Heavy trucks Articulated	-	-	-	1.398	-	-	1.398	2,7%
Locomotives	-	-	-	123	-	-	123	0,2%
Other	-	-	-	-	-	-	-	0,0%
Vessel during manoeuvring phase	-	-	-	-	-	1.929	1.929	3,7%
Vessel at anchor or during mooring	-	-	-	-	-	46.294	46.294	88,4%
TOTAL	343	0	188	3.622	0	48.223	52.376	100%

Table 10 – Summary of final energy consumption by type of port activity and energy carrier

The analysis shows, as the graphs below show, that in the port area of Porto Margreth the most energy-consuming activities are those related to the hotelling of vessels at the quay (88%). However, the consumption of ships during the manoeuvring phase (4%) and that of operational vehicles involved in the handling of goods (4%) are also significant. There is also a very significant incidence of LSFO consumption associated with ship traffic compared to other energy carriers.

Sankey's chart below associates the energy carriers with the main types of activities taking place within the identified Operational Boundaries, highlighting maritime traffic activities as the most energy intensive type and LSFO as the preferred energy carrier.

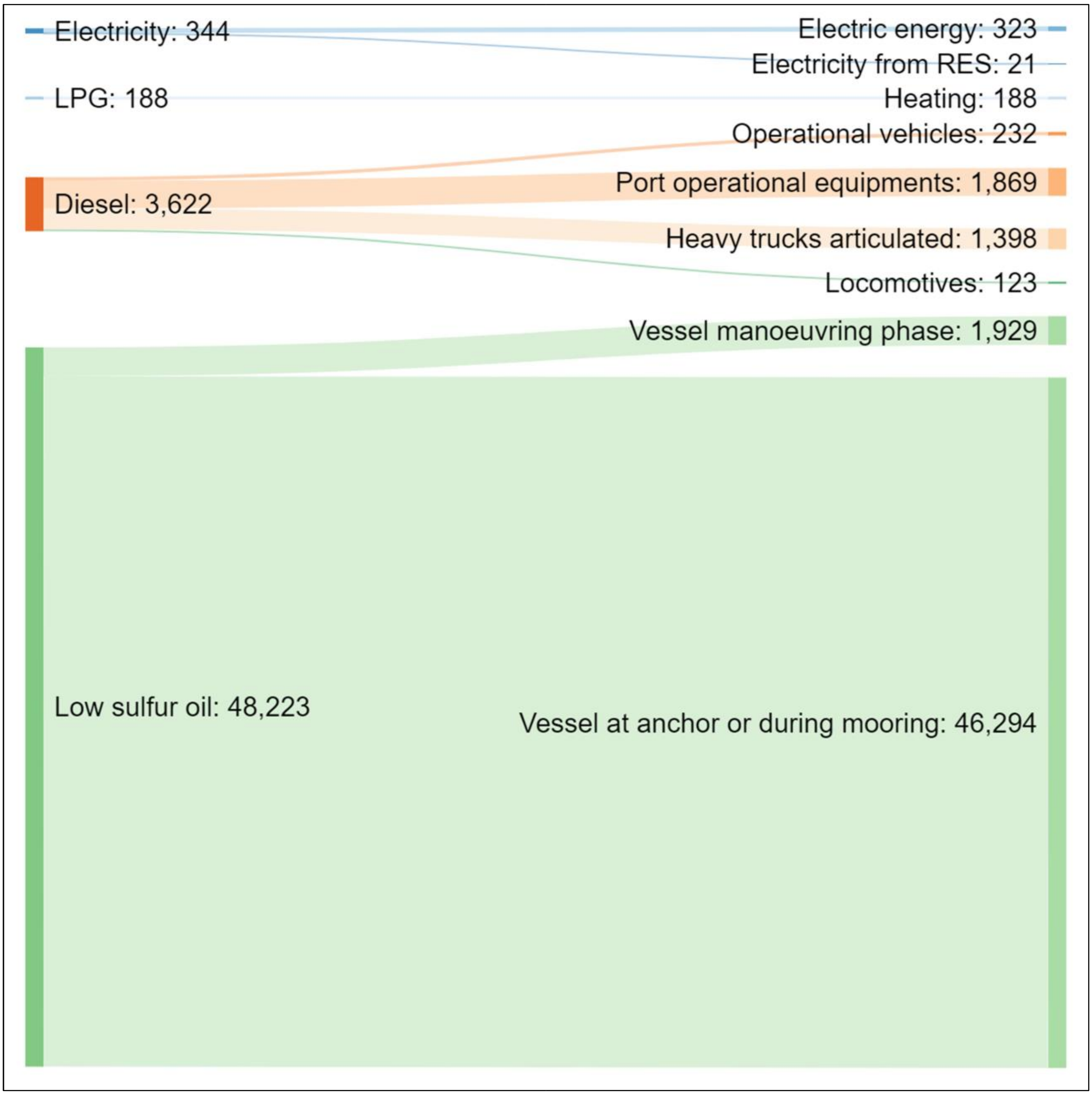

Figure 7 – Sankey diagram of energy consumption as a function of individual carriers and main port activities

Emission Factors

The GHG emission factors of the sources identified in the operational boundaries were selected based on the following criteria:

- Recognised source;
- Consistency and applicability to the specific source;
- Validity of emission factors at the time of quantification;
- Minimisation of the uncertainty associated with individual emission factors according to the type of source.

The "National Inventory Report 2019", elaborated by ISPRA, is the most reliable source for the extrapolation of emission factors, as it guarantees an accurate and coherent representation of data with respect to the system under analysis. The Inventory, updated annually, provides a picture of national GHG emissions related to anthropogenic activities on the Italian territory, as well as the methodologies and individual emission factors that can be traced back to the different sources and sectors analysed. Specifically, the emission factors related to energy vectors for stationary combustion in non-industrial contexts have been used with reference to the year 2019. As far as the electricity vector is concerned, the emission factors associated with GHG sources have been taken from the ISPRA publication "Historical series of national emission factors (19902018) for electricity production and consumption", in which the values of CO_{2eq} emission factors updated to 2018 from the electricity sector for electricity consumption are indicated. The table below summarises the emission factors used to define the "Carbon Footprint".

GHG SOURCES	GHG EMISSION FACTORS [kg/GJ]		
	CO_2	CH_4	N_2O
Petrol	73,234	0,008	0,001
Diesel oil	73,578	0,007	0,002
LSFO	76,604	0,003	0,002
Methane	57,512	0,003	0,001
LPG	65,592	0,001	0,002

GHG SOURCES	CO_{2eq} EMISSION FACTORS [gCO_{2eq}/kWh]		
Electricity from grid	276,254	0,657	1,501

Table 11 - Emission factors CO2, CH4, N2O by GHG sources

As regards the quantification of CO_2-equivalent emissions associated with road and rail freight transport connecting with the port (inside and outside the port), for which the kilometres travelled within the port were estimated, the average emission factors for the GHGs considered were used, as reported in the database of average emission factors for road transport in Italy produced annually by ISPRA (2017).

In particular, the average emission factors for the heavy-duty trucks - diesel - articulated 20-28 t category were applied, whose values are reported in the following table:

GHG SOURCES	GHG EMISSION FACTORS [kg/km]		
	CO_2	CH_4	N_2O
Heavy trucks Articuled 20-28 t Diesel	0,77345	0,0000835	0,00003

Table 12 – GHG emission factors CO2, CH4, N2O per Heavy trucks Articulated 20-28 t Diesel

For the choice of the Global Warming Potential (100 years) of the analysed greenhouse gases, reference was made to the latest IPCC report - "Fifth Assessment Report (AR5)", following the indications of the UNI ISO 14064-1:2006 standard.

GWP [t_{CO2eq}/t_{GHG}]	CO_2	N_2O	CH_4
100-year horizon	1	265	28

Table 13 - GWP (Global Warming Potential) 100 years for GHG with direct effect

"Carbon footprint": land and maritime emissions

Greenhouse gas emissions associated with the activities carried out in Port Margreth were calculated from the previously analysed energy consumption data.

The calculation is developed according to the approach defined by the IPCC, where the emissions are quantified by multiplying the activity data by the relevant emission factors and by the conversion factor to carbon dioxide equivalent, as shown in the following formula:

$$\boldsymbol{CO_{2eq}\ emission}\ [\boldsymbol{t}] = Activity\ data * [EF * GWP + EF * GWP + EF * GWP\ ]$$

- Activity data: is the quantity, generated or used, that describes the GHG-related activity, expressed in terms of energy (MJ or kWh), mass (kg) or kilometres (km); EF: is the factor that correlates activity data with GHG emissions.
- GWP: GWP values at 100 years expressed in [kg_{CO2}/kg_{GHG}].

The standard that provides specific indications for assessing the environmental sustainability of organisations and/or companies in the context of specific projects is ISO 14064:2006, which defines a procedure for the quantification and reporting of greenhouse gases (GHG).

A GHG inventory must guarantee compliance with the following principles in order to comply with UNI ISO 14064:2006:

- Relevance: the final result of the evaluation must represent, for both COSEF and all users, an understandable and reliable basis for subsequent decisions
- Completeness: the completeness of the Carbon Footprint report must include all sources of port emissions within the pre-established boundaries. All important steps and possible exclusions must be reported and justified
- Consistency: consistency in applying the methodology is important to obtain a meaningful comparison of information related to greenhouse gases over the years. Any change (in data, boundaries, factors, etc.) must be documented transparently
- Transparency: all issues relating to the carbon footprint report must be documented effectively and consistently, based on verification. Any assumptions or forecasts must be made public and the sources used for the data and methodologies must be indicated.

- Accuracy: the quantification of greenhouse gas emissions must be as realistic as possible, i.e. the level of uncertainties must be reduced as much as possible.

More generally, emissions must take into account not only direct and indirect sources of GHG, but also any accumulation systems installed (absorbers). In this specific case, direct and indirect GHG absorbers were excluded from the quantification of GHG emissions and definition of the "Carbon Footprint" as they are not currently present in the two port areas considered.

As described in the previous paragraphs, these emissions are grouped in areas to be monitored over time and will be recalculated following studies and projects that aim to reduce GHG emissions while increasing carbon absorption.

Land-based GHG emissions

The energy carriers included in the analysis are methane, electricity, LPG, diesel, LSFO and petrol. Overall, the largest share of CO_{2eq} emissions comes from port activities with diesel consumption accounting for about 84% of all land-based emissions.

CO_{2eq} emissions by GHG sources

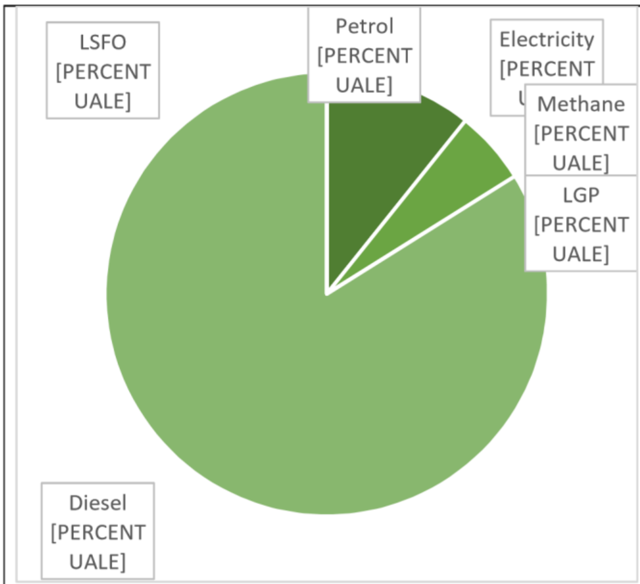

Figure 8 - Land-based CO_{2eq} emissions by GHG sources

The graph shows the percentage distribution of emissions with respect to energy carriers (GHG sources). The prevalence of diesel fuel (84%) over other energy carriers is evident.

GHG Souces	GHG emission [tCO_{2eq}]	[%]
Electricity	90	11%
Methane	-	0%
LPG	45	5%
Diesel oil	700	84%
Petrol	-	0%
Low sulphur fuel oil (LSFO)	-	0%
TOTAL	**835**	**100%**

CO$_{2eq}$ emissions by user type

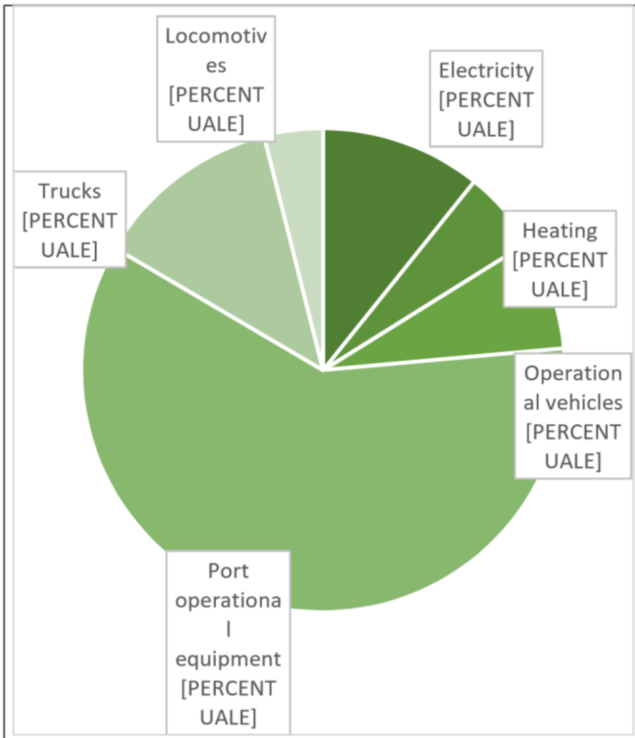

Figure 9 - Land-based CO$_{2eq}$ emissions by type of user

With regard to the land area, most emissions are related to the activities of port operating equipment (port cranes, forklifts, etc.), which account for about 60% of emissions in this area. However, emissions from electricity consumption (11%) and road freight traffic (13%) are also significant.

GHG Souces	GHG emission [tCO$_{2eq}$]	[%]
Electricity	90	11%
Electricity produced by RES	-	0%
Heating	45	5%
Operational Vehicles	62	7%
Port operating equipment	500	60%
Heavy trucks Articulated	105	13%
Locomotives	33	4%
TOTAL	**835**	**100%**

Maritime GHG emissions

This paragraph describes all emissions from the maritime sector.

These emissions are associated to the vessel's movements: at anchor, mooring phase and during manoeuvre and navigation in the port.

CO_{2eq} emissions by GHG sources

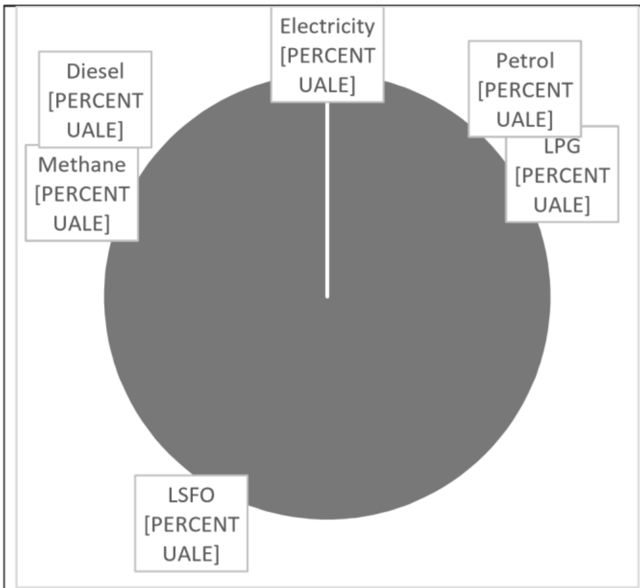

Figure 10 - Maritime CO_{2eq} emissions by GHG sources

The graph shows the percentage distribution of emissions by energy carrier. The prevalence of LSFO (100%) over other carriers is evident.

GHG Souces	GHG emission [tCO_{2eq}]	[%]
Electricity	-	0%
Methane	-	0%
LPG	-	0%
Diesel oil	-	0%
Petrol	-	0%
Low sulphur fuel oil (LSFO)	13.405	100%
TOTAL	**13.405**	**100%**

CO2eq emissions by type of operation

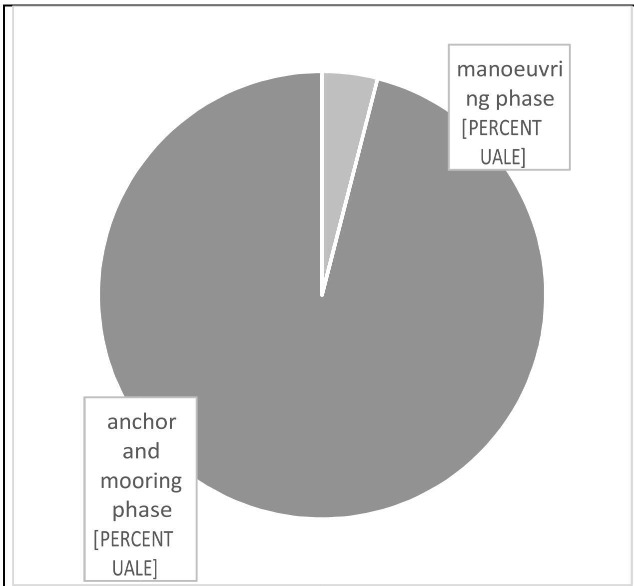

Figure 11 - Maritime CO 2eq emissions by type of operation

In the maritime sector, the mooring phase is responsible for almost all the emissions recorded in this area.

Type of operation	GHG emission [tCO 2eq]	[%]
Manoeuvring phase	536	4%
Hotelling and mooring phase	12.869	96%
TOTAL	13.405	100%

"Carbon Footprint" results

The following table summarises the total greenhouse gas emissions, both Direct and Indirect, broken down by category and activity, with the total t_{CO2eq} by category and the percentage of the total.

Type of activity	Electricity [t_{CO2eq}]	Methane [t_{CO2eq}]	LGP [t_{CO2eq}]	Diesel [t_{CO2eq}]	Petrol [t_{CO2eq}]	LSFO [t_{CO2eq}]	Total [t_{CO2eq}]	Total [%]
Electricity	90	-	-	-	-	-	90	1%
Electricity produced by RES	-	-	-	-	-	-	-	0%

Heating	-	-	45	-	-	-	45	0%
Operational vehicles	-	-	-	62	-	-	62	0%
Port operational equipment	-	-	-	500	-	-	500	4%
Heavy trucks Articulated	-	-	-	105	-	-	105	1%
Locomotives	-	-	-	33	-	-	33	0%
Other	-	-	-	-	-	-	-	0%
Vessel during manoeuvring phase	-	-	-	-	-	536	536	4%
Vessel at anchor or during mooring	-	-	-	-	-	12.869	12.869	90%
TOTAL	90	0	45	700	0	13.405	14.240	100%

Table 14 – CO2eq emissions related to the Porto Margreth - Porto Nogaro

As shown in the graphs below, in the Port Margreth area the activities that generate the most emissions are those related to the hotelling of ships at the quay (90%). However, emissions from ships manoeuvring (4%) and those from operational vehicles involved in the handling of goods (4%) are also significant.

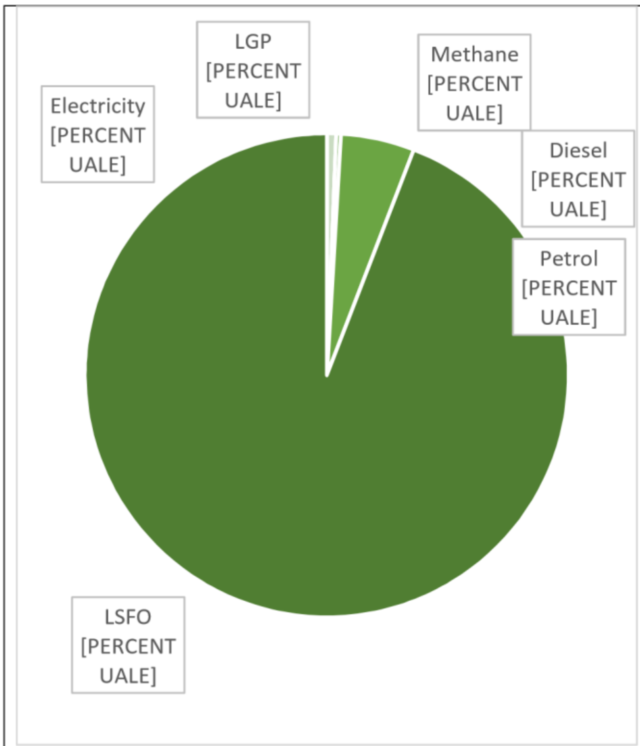

Figure 12 - CO_{2eq} emissions of Porto Margreth by type of energy carrier.

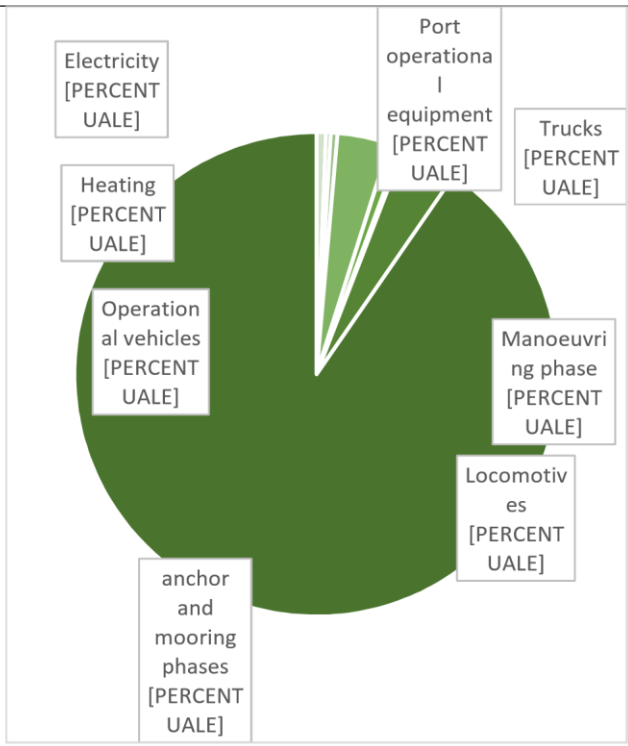

Figure 13 - CO_{2eq} emissions of Porto Margreth by type activity

Ultimately, the Carbon Footprint for the Porto Margreth is 14.420 tonnes of CO_{2eq} considering the functions included within the Organisational and Operational Boundaries.

Sankey's graph, shown below, associates the energy vectors with the main types of activities that take place within the identified Operational Boundaries, highlighting the importance of activities related to maritime traffic as the most energy consuming type and low sulphur fuel oil (LSFO) as the preferred energy vector.

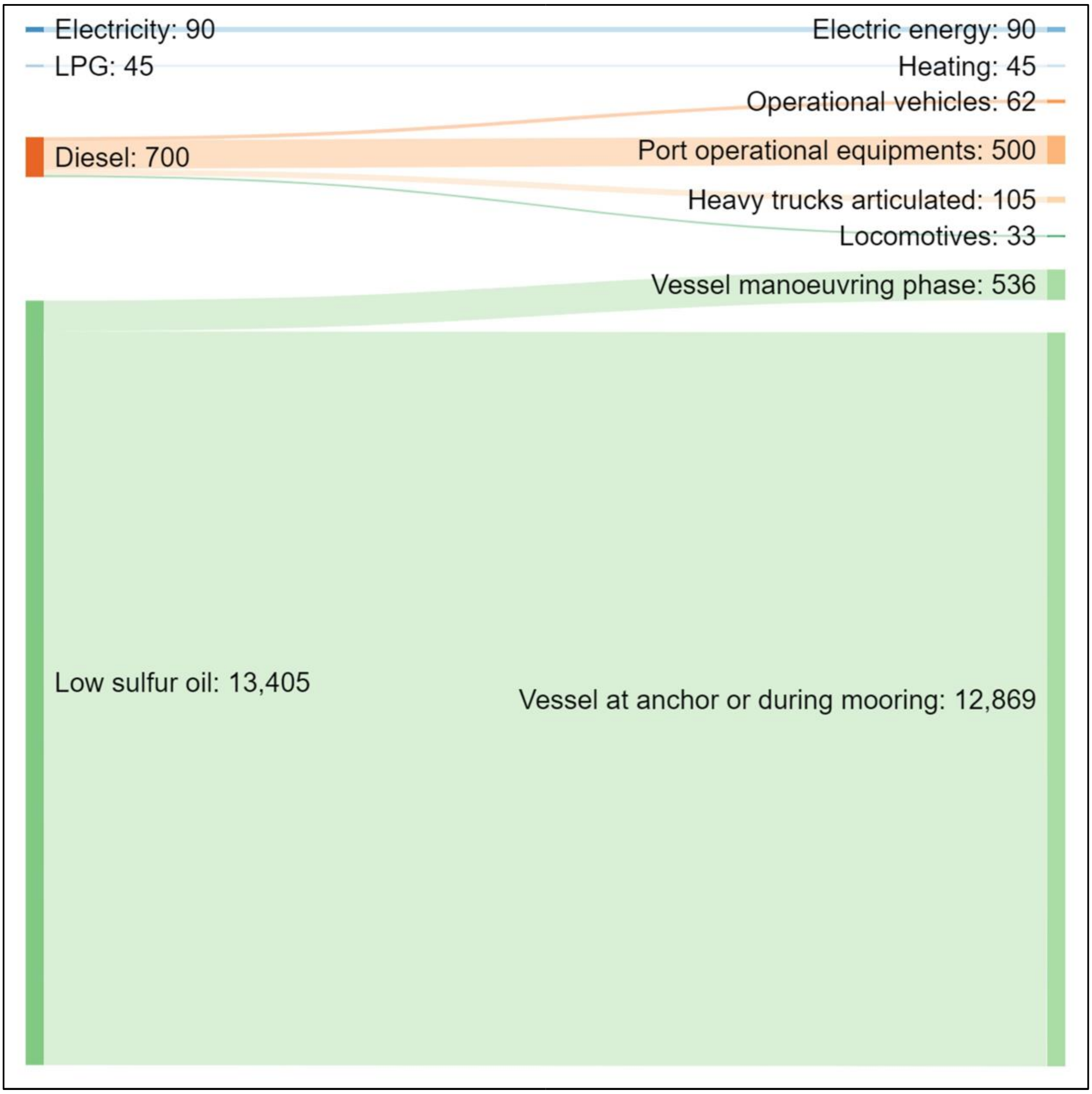

Figure 14 – Sankey diagram of CO2eq emissions as a function of energy carriers and main port activities

Uncertainty assessment

In order to complete the analysis of the carbon footprint and the preparation of the inventory of carbon dioxide equivalent emissions, it is necessary to implement an assessment of the uncertainty related to greenhouse gas emissions/removals.

Statistically, uncertainty is a term used to represent the degree of accuracy and precision of a set of available data. The bibliography to which the UNI ISO 14064 standard refers to the "Guide to Expression of Uncertainty in Measurement" whose statistical bases are also taken from the Intergovernmental Panel on Climate Change (IPCC).

As specified by the Guidelines, these documents propose different emission estimation methodologies divided into three levels of detail, called Tier, from the most simplified (Tier 1) to the most accurate (Tier 3) to be applied depending on the available information.

In the following paragraphs we will analyse in detail all the contributions necessary to calculate the uncertainty of the inventory taking into account: emission factors and emission activities ordered according to the categories defined by the corresponding IPCC.

The estimation of uncertainty is an essential element of a complete inventory. The study of uncertainties should help to avoid the potentially significant consequences of inaccurate information and ensure proper monitoring against target setting. Information on uncertainty is not used to challenge the validity of inventory estimates, but to set priorities for improving inventory accuracy and to guide decisions on methodological choices.

The 2006 IPCC Guidelines define two approaches (fully reflected in the GB EMEP/EEA) to estimate uncertainties:

- Approach 1: error propagation equations;
- Approach 2: Monte Carlo simulations.

Approach 1 has been used to define the uncertainty associated with this emission inventory.

Activity Data Uncertainty

The uncertainty values associated to emission activities depend on the quality of the available data: measured or directly measured data will have a lower uncertainty, while estimated data will have a higher one.

In this regard, in order to define the percentage of uncertainty to be associated with emission activities on the basis of the quality of the data, it was decided to use table 2.15 of the 2006 IPCC, whose uncertainty ranges used in this "Carbon Footprint" are shown in the following table. It is specified that the wording "Sector" has been introduced to identify the uncertainty associated with the type of activity and the quality of the relative data.

Table Uncertainty Activity	Sector	Well-developed statistics using questionnaires	Sector	Well-developed statistics using data mining
Main activity with electricity consumption and heat production	1 A	Less than 1%	1 B	3-5%
Combustion processes in commercial, institutional and residential environments	2 A	3-5%	2 B	5-10%

Table 15 - Association of uncertainty with emission activity

Emission factors uncertainty

Based on the IPCC methodology, the estimation of the uncertainty of the emission factor was carried out according to a level of detail identified as 'Tier 2', for which nationally valid values from the National Inventory Report 2019 were used, which refers to data from 2018, the same year as the base year used in this document. These percentages are grouped into categories that refer to those identified in the NIR2019, which in turn can be traced back to those of the IPCC 2006. The use of national emission factors ensures proper accounting of emissions as the national energy context is considered.

Categories NIR2019	CO_2	N_2O	CH_4
Combustion for road transportation	3%	40%	40%
Combustion for rail transportation	3%	40%	40%
Combustion for waterborne navigation	3%	50%	50%
Combustion in other sectors -commercial, residential, agriculture liquid fuels	3%	50%	50%
Combustion in other sectors commercial, residential, agriculture gaseous fuels	3%	50%	50%
Electricity consumption	4%	50%	50%

Table 16 - NIR2019 categories considered for each GHG in the uncertainty calculation

As described in Section 2.4 of the 2006 IPCC for fossil fuel combustion, uncertainties in CO_2 emission factors are relatively low. These emission factors are determined by the carbon content of the fuel, the variation of which is limited both by physical constraints and rather stringent specifications (especially on petroleum products) and by the fact that they come from a relatively small number of refineries and/or import terminals.

Emission factors for CH_4 and especially N_2O as opposed to CO_2 are highly uncertain. High uncertainties in emission factors can be attributed to a lack of relevant measurements and subsequent generalisations, uncertainties in measurements or an insufficient understanding of the emission generation process.

Emission inventory uncertainty calculation

It is now necessary to combine the two uncertainties associated with emission factors and activities to define the overall uncertainty related to the inventory (Carbon Footprint).

The use and definition of the uncertainty values are described in the previous sections where the uncertainty percentages associated to emission factors by GHG type and NIR2019 Category and to activity data by Sector type have been specified.

In order to combine these uncertainty values, the corresponding Sector defined in Table ... was associated to each NIR2019 Category for the uncertainty on the quality of the activity data.

Sector Activity factor	Categories NIR2019
2 A	Combustion for road transportation
2 B	Combustion for rail transportation
2 B	Combustion for waterborne navigation
2 A	Combustion in other sectors -commercial, residential, agriculture liquid fuels
2 A	Combustion in other sectors commercial, residential, agriculture gaseous fuels
1 A	Electricity consumption

Table 17 - Table linking Activity Data Sectors and NIR2019 Categories

The calculation procedure follows the error propagation model divided into two parts: the first evaluates the product of multiple uncertainties needed to calculate the uncertainty associated with the individual NIR2019 category and the second as the sum of uncertainties to obtain the overall uncertainty of the inventory.

The 2006 IPCC Guidelines prescribe in the case of products of multiple uncertainties to combine them quadratically for each of the categories considered through the following relationship:

$$U_{totale} = \sqrt{U_1^2 + U_2^2 + \ldots + U_n^2}$$

U_{total} is the percentage uncertainty of the product of the quantities

U_i is the percentage of uncertainty associated with each term (uncertainty of emission and activity factor)

The equation below was used to calculate the uncertainty associated with the entire inventory. This equation should be used when it is necessary to combine and add up the uncertainty of several terms, such as the uncertainties of the emission and activity categories.

$$U_{totale} = \frac{\sqrt{(U \bullet x_1)^2 + (U \bullet x_2)^2 + \ldots + (U \bullet x_n)^2}}{|x_1 + x_2 + \ldots + x_n|}$$

U_{totale} is the percentage of uncertainty in the sum of the quantities x_i e U_i are respectively the amount of uncertainty and the percentage of uncertainty associated with each term.

The table format used for the calculation is taken from the IPCC 2006 documentation, precisely from table 3.2 "APPROACH 1 UNCERTAINTY CALCULATION" in which the data necessary for calculating the uncertainty of the inventory have been inserted.

		Incertezza emissioni					
	A	B	D	E	F	G	H
Settore fattore di attività	Categoria NIR2019	Gas	GHG anno 2019 (tCO_{2eq})	AD uncertainty	EF uncertainty	Combined $\sqrt{E^2+F^2}$	Contribution to variance $\frac{(G \bullet D)^2}{(\Sigma D)^2}$
2 A	Combustion for road transportation	CO_2	104	5%	3%	0,058	0,00000
		N_2O	1	5%	40%	0,403	0,00000
		CH_4	0	5%	40%	0,403	0,00000
2 B	Combustion for rail transportation	CO_2	33	8%	3%	0,085	0,00000
		N_2O	0	8%	40%	0,408	0,00000
		CH_4	0	8%	40%	0,408	0,00000
2 B	Combustion for waterborne navigation	CO_2	13.299	8%	3%	0,085	0,00637
		N_2O	92	8%	50%	0,506	0,00001
		CH_4	15	8%	50%	0,506	0,00000
2 A	Combustion in other sectors -commercial, residential, agriculture liquid fuels	CO_2	557	3%	3%	0,042	0,00000
		N_2O	4	3%	50%	0,501	0,00000
		CH_4	1	3%	50%	0,501	0,00000
2 A	Combustion in other sectors commercial, residential, agriculture gaseous fuels	CO_2	44	3%	3%	0,042	0,00000
		N_2O	0	3%	50%	0,501	0,00000
		CH_4	0	3%	50%	0,501	0,00000
1 A	Electricity consumption	CO_2	89	1%	4%	0,042	0,00000
		N_2O	0	1%	50%	0,501	0,00000
		CH_4	0	1%	50%	0,501	0,00000
			Sum D				Sum H
			14.240				0,0064
							$\sqrt{Sum\ H}$
							7,99%

Table 18 - Uncertainty calculation using the error propagation approach (IPCC 2006)

Column D shows the consumption contributions extrapolated from the "Carbon Footprint" analysis subdivided by emission category and greenhouse gas; to be comparable they must be expressed in tCO_{2eq}. Column E contains the abbreviation "AD uncertainty", an abbreviation of "Activity Data uncertainty", which represents the uncertainty of the activity. Similarly, column F "EF uncertainty" expresses the uncertainty of the Emission Factor. Calculations of the product of several uncertainties correspond to column G while those of the sum are described in column H.

The percentage in the box $\sqrt{Sum\ H}$ represents the uncertainty of the inventory. It should be noted that the emissions used in the table do not have the contribution of Shipbuilding because this contribution is not mentioned in any of the areas assessed.

When compiling the data, it can be observed that for all gases (CO_2, CH_4, N_2O) an overall uncertainty of about 8% has been calculated for Scope 1 and 2 of the Inventory.

This is an acceptable percentage if one considers the high uncertainties of the emission factors for the gases CH_4 and N_2O, which for the categories described above are around 40-50%. The largest weight is related to consumption by maritime activities, which is the most emissive category.

Uncertainty calculation	Uncertainty CO_2, N_2O, CH_4 [%]
Carbon Footprint 2019	7,99

Table 19 - Table summarising final uncertainty value

Estimation of SO2 and NOx emissions associated with vessel transport Port Margreth

Foreword

The EMEP/EEA air pollutant emission inventory guidebook 2019, in its chapter on shipping, details the main emission sources associated with vessel transport and the emission contribution from shipping-related activities. Shipping causes emissions of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), as well as carbon monoxide (CO), non-methane volatile organic compounds (NMVOCs), sulphur dioxide (SO_2), particulate matter (PM) and nitrogen oxides (NO_x). As reported in the study conducted by EMEP/EEA, SO_2 and NO_x emissions attributable to domestic traffic may constitute an important portion of total national emissions, as shown in the table below.

Pollutant	Vessel transport contribution to total national emissions [%]
SO_2	0-80
NO_x	0-30
NMVOC	0-5
CO	0-18
TSP	0-3
PM_{10}	0-4
$PM_{2,5}$	0-5

Table 20 - European range of shipping contribution to total emissions

Note:

0 = calculated emissions but their contribution is lower than the 0,1%

Exhaust emissions from shipping arise from:

- engines used as main propulsion engines;
- auxiliary engines used to provide power and services inside ships.

The aim of this part of the report is to estimate the emissions associated with vessel transport in the Porto Margreth area in relation to the phases of manoeuvring in and out of the port area and in the mooring and anchoring phases on the quay (hotelling), as explained in the following diagram:

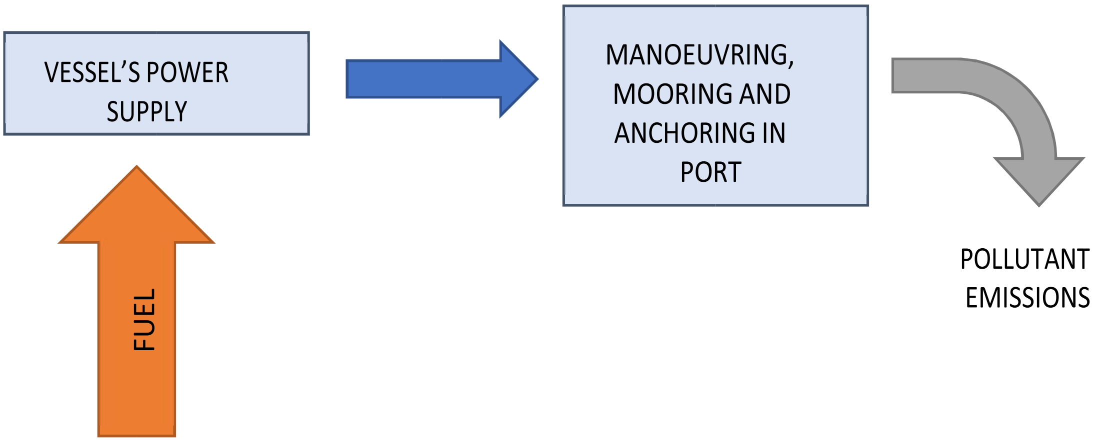

Figure 15 - Scheme of the consumption and emission phases of ships manoeuvring mooring and anchoring in port

Methodology used

The estimation of SO_2 and NO_x emissions associated with vessel traffic within the port area of Porto Margreth was carried out with a bottom-up approach following the MEET (Methodology for Estimate air pollutant Emissions from Transport) methodology, developed by Carlo Trozzi and Rita Vaccaro, in the framework of a project financed by the European Commission, concluded in 1998 and subsequently updated in 2006.

This methodology proposes two procedures, a simplified method and a more detailed method. The choice of method for a particular application depends mainly on the amount of information available to describe the navigation activity.

In this case, on the basis of the data found, it was decided to use the detailed methodology, which allows the emissions associated with individual ships passing through the port to be assessed, distinguishing between the different phases in which they are involved:

- Manoeuvring
- Hotelling
- Crusing

- Auxiliary generation
- Loading/offloading

The detailed methodology uses a classification system to describe the pollutants considered, the type of ships, the fuels used and the ship's distinctive operating modes.

These classifications are shown in the tables below and described within the MEET document in the section "Calculating transport emissions and energy consumption".

Code	Name
NO_X	Nitrogen oxides
SO_2	Sulphur oxides
CO	Carbon monoxide
VOC	Volatile organic compounds
PM	Particulate matter
CO_2	Carbon dioxide

Table 21 - Classification of pollutants

Code	Name
SB	Solid Bulk
LB	Liquid Bulk
GC	General Cargo
CO	Container
PC	Passenger/Ro-Ro/Cargo
PA	Passenger
HS	High speed ferries
SS	Sail ships
TU	Tugs

Table 22 - Classification of vessels

Code	Name
BFO	Bunker fuel oil
MDO	Marine diesel oil
MGO	Marine gas oil
GF	Gasoline fuel

Table 23 - Classification of fuels

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Code	Name
C	Cruising
M	Manoeuvring
H	Hotelling
T	Tanker offloading
A	Auxiliary generators

Table 24 - Vessel operating phases

MEET methodology also provides the average daily consumption of the different types of ships at maximum power and the fraction of maximum consumption associated with the distinctive operational phases of the ships, as shown in the tables below.

Name	Average consumption at maximum power [t/d]
Solid Bulk	33,8
Liquid Bulk	41,2
General Cargo	21,3
Container	65,9
Passenger/Ro-Ro/Cargo	32,3
Passenger	70,2
High speed ferries	80,4
Sail ships	3,4
Tugs	14,4

Table 25 - Average fuel consumption at maximum power by vessel type

<table>
<tr><th colspan="2">Phase</th><th>Portion</th></tr>
<tr><td colspan="2">Cruising</td><td>0.80</td></tr>
<tr><td colspan="2">Manoeuvring</td><td>0.40</td></tr>
<tr><td rowspan="4">Hotelling</td><td></td><td>0.20</td></tr>
<tr><td>Passenger</td><td>0.32</td></tr>
<tr><td>Tanker</td><td>0.20</td></tr>
<tr><td>Other</td><td>0.12</td></tr>
<tr><td rowspan="3">Tug</td><td>Ship assistance</td><td>0.20</td></tr>
<tr><td>Moderate activity</td><td>0.50</td></tr>
<tr><td>Under tow</td><td>0.80</td></tr>
</table>

Table 26 - Portium of maximum fuel consumption at different phases

The consumption values reported in Table 25 have been updated taking into consideration the technological evolution that has characterised the ship fleet in circulation at global level between 1997 (reference year of the first analysis 'Methodologies for estimating air pollutant emissions from ships') and 2010 (reference year of the update of the previous methodology).

In particular, the consumption value expressed in Table 25 has been recalculated on the basis of the power of the main engines for each type of ship as indicated in the following table.

Name	Main engine power (kW)	
	1997 fleet	2010 fleet
Solid Bulk	8.032	4.397
Liquid Bulk	6.695	6.543
General Cargo	2.657	2.555
Container	22.929	14.871
Passenger/Ro-Ro/Cargo	7.898	4.194
Passenger	3.885	10.196
Tugs	2.059	2.033
Fishing	837	734
Other	2.778	2.469

Table 27 – Estimated average main engine power by vessel type

As for the data on the number of vessels, their type and the hotelling period, these were provided by the Consorzio Portonuovo, which manages the activities of the two port companies operating in the port area for the reference year 2019.

At this point, it was possible to associate each ship with an estimate of fuel consumption relative to the phases of manoeuvring and hotelling in the port area.

On the basis of the fuels used by the individual vessel and the relevant emission factors, the total SO_2 and NO_x emissions from vessel within the Port Margreth area were quantified.

Analysis results

Below is a table summarising the results of the analysis in which the total fuel consumption of the ship's manoeuvring and hotelling phases was estimated. This quantification was carried out by means of the tables reported in the previous paragraph.

Port	Type of vessel	Type of fuel	n° vessels	Manoeuvring hours [h]	Hotelling hours [h]	Fuel consumption [GJ]
Port Margreth	GC	LSFO	318	477	22.896	173.603
Total			318	477	22.896	173.603

Table 28 – Energy consumption by vessel typology

Once the fuel consumption associated with vessel traffic was estimated, the SO_2 and NO_x emissions were quantified using the emission factors described in the previous section.

The following table shows the results of the analysis of pollutant emissions divided by ship type. In addition, efficiency indicators have been defined for ships at berth, expressed in kg of pollutant gas emitted per hour of berth time [kg/h].

These values provide an indication of the average hourly quantities of emissions for each type of ship and can be useful in assessing the most impactful and directing possible measures to contain emissions.

Port	Type of vessel	Type of fuel	n° vessel	NO_x emissions [kg]	SO_2 emissions [kg]	NO_x indicator [kg/h]	SO_2 indicator [kg/h]
Port Margreth	GC	Olio BTZ	318	10.416	16.839	0,45	0,72
Total			318	10.416	16.839	0,45	0,72

Table 29 - SO2 e NOx emissions by vessel typology

Once the SO_2 and NO_x emissions due to ship traffic in the two port areas had been estimated, the marginal costs associated with the emission of the two types of pollutants into the atmosphere were quantified.

As made explicit in the Guidelines drawn up by the MIT for DEASPs (Energy and Environmental Planning Documents for Port Systems), the methodological reference to be followed for the monetary evaluation of the benefits of reducing SO_2 and NO_x emissions from land sources placed at ground level or with low chimneys, associated with energy-environmental interventions in the port, is the following table for the evaluation of investments in public works (DM. 300 of 16 June 2017), which in turn is derived from the unit damage values of ground-level chimney emissions

(low high of release) of the NEEDS-CASES project (2008) reported by the EC-DG MOVE "Update the Handbook on External Costs of Transport", 2014. These values should also be applied to ship emissions when stationed on the quayside or manoeuvring in port.

Pollutant	€/tonn
SO_2	9.875
NO_x	10.824

Table 30 - Marginal costs of pollutant emissions (€2010 per tonne emitted, at factor cost adjusted for purchasing power parity) - Source: DG MOVE, Update of the Handbook on External Costs of Transport, 2014

The following table summarises the economic quantification of the benefits associated with the reduction of SO_2 and NO_x emissions.

Port	Type of vessel	n° vessel	NO_x emissions [kg/y]	SO_2 emissions [kg/y]	Marginal cost NO_x [€/y]	Marginal cost SO_2 [€/y]
Port Margreth	GC	318	10.416	16.839	112.745	166.290
Total		318	10.416	16.839	112.745	166.290

Table 31 - Marginal costs by vessel type and port areas

The estimation of vessel traffic in 2019 shows a total marginal cost of €279.034 from SO_2 and NO_x emissions associated with vessel traffic within the Port Margreth.

This value can be a starting point for the implementation of a more in-depth investigation of the real impacts associated with the manoeuvring and hotelling of ships in the port and for the identification and definition of more effective and timely measures aimed at reducing polluting emissions in the port.

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