Large-scale electrification & hybridization of ferries, service, and offshore vessels: business opportunities in the Italian market.

Market analysis & business intelligence

Report made by

SRM - Permanent Observatory on maritime transport and logistics

on behalf of

INNOVATION NORWAY – Milan, Italy

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CHAPTER I

MARKET MATURITY

The purpose of the chapter is to provide an overview of the state of maturity of electrification and hybridization technologies of ferries, service vessels and offshore units in Italy. The issue appears to be of particular importance at a national level, especially given the increased sensitivity and awareness towards environmental sustainability-related issues, which in Italy and Europe have paved the way through the definition of ambitious goals in terms of environmental performance improvement. The increased attention towards these issues has considerably affected the port and maritime transport sector, which is notoriously a highly energy-intensive sector, being also responsible for large quantities of polluting emissions. In this context, a wide variety of measures have been already taken or have been planned in order to comply with EU and international standards in terms of energy efficiency and environmental sustainability.

The chapter first outlines the current state of the legislation concerning emissions targets or limitation for maritime transport, and the main measures taken at a national level to encourage the transition towards more energy-efficient solutions, specifying any technological and environmental requirement that may be envisaged to access funding mechanisms devoted to these green technological solutions.

Subsequently, the chapter proceeds to analyze the current state of the Italian fleet in terms of total vessels, size, and age, providing some empirical examples of practical applications aiming at pursuing the decarbonization and energy efficiency goals for the maritime transport business in Italy.

1.A. Are there local/regional emission targets in the city, port or areas - possibly the year of introduction of such targets (E.g., zero emission zones in city/port).

In January 2020, the new IMO (International Maritime Organization) regulation came into force, aiming at regulating sulfur emissions generated by ship bunker. The IMO regulation set a maximum sulfur content of 0.5% compared to the previous threshold of 3.5%. The measure applies to all shipping carriers – regardless of their size – operating outside the so-called Emission Control Areas (ECAs) where an even stricter threshold is already in force.

Relatedly, shipping companies operating in the Italian waters are subject to IMO regulations, as well as all the other European Countries. The IMO 2020 standards, therefore, make effective the decision taken by the Marine Environment Protection Commission (MEPC) in 2016, which revised the terms of Annex VI of MARPOL 73/78.

Shipowners, to comply with the IMO 2020 standards, are asked to conform to the new standards revising their strategic choices concerning fueling or hard investments. Shipping companies, in this perspective, are essentially asked to comply to the new regulation by choosing between 5 alternatives:

- ✓ Use a bunker with a sulfur content below the 0.5% limit.

- ✓ Use MGO (Marine Gas Oil) or distillates.
- ✓ Use LNG (Liquefied Natural Gas).
- ✓ Install scrubbers, i.e., exhaust gas cleaning systems, while continuing to use fuels characterized by a higher sulfur content.
- ✓ Install technologically advanced engines, such as hybrid or electric propulsion systems.

The bunker limit of sulfur content equal to 0.5% m/m, which aims to reduce sulfur emissions with the finality to protect the environment and public health, refers only to non-SECA areas, such as the Mediterranean and the Italian waters, and is less stringent than the threshold in force in the Sulfur Emission Control Areas.

In fact, in order to mitigate SO_x (sulfur oxides) emissions in the North Sea, the Baltic Sea, the English Channel, both east and west North American coasts and the Caribbean Sea, the Contracting Parties to Annex VI of the MARPOL convention have agreed that as of 1 January 2015 ships are obliged to use fuels with a maximum sulfur content of 0.1% or to install exhaust emission reduction technologies (scrubbers). In addition, in 2021, a Nitrogen Emission Control Area (NECA) came into force in the same regions, establishing that newly built ships will have to meet the "Tier III" standard which drastically reduces NOx emissions, e.g., by means of catalysts, in-engine measurements or alternative fuels.

Due to the growth of maritime transport, air pollution from ships in Europe, and particularly in the Mediterranean, is constantly increasing. It is estimated that, in the Mediterranean Sea, up to 10,000 ships operate every day, mainly using heavy oil (HFO) which has a very high sulfur content due to the milder emission regulations currently in force in the Mediterranean area.

Due to the critical emission levels affecting the Mediterranean area, the designation of an emission control area that addresses the problem of sulfur and nitrogen oxide emissions across the Mediterranean Sea constitutes a highly discussed issue. In addition, the establishment of an ECA in the Mediterranean is expected to restore an equal playing field in the European market where maritime operators and ports in the South and West are required to comply with the same regulatory standards as in the North. The ECA in the Mediterranean would also encourage the adoption and development of technologies for reducing emissions as well as the transfer of the necessary know-how within the European Union, fostering European leadership in the field of environmental technologies. In this way, higher emission standards at European level will help to ensure the sustainability of the EU maritime industry, fostering job creation and the economic competitiveness of European industry.

In this perspective, during the 22° Conference of the Parties to the Barcelona Convention in Antalya, the Contracting Parties agreed to submit to the IMO's Committee on the Protection of the Marine Environment (MEPC 78) the proposal for the designation of the entire Mediterranean Sea as a Controlled Sulphur Oxide Emission Area ("Med SOX ECA").

The resolution, following the decision-making process coordinated by the IMO, defined a new and more stringent limit (0.10%) on sulfur content in fuel oil used on board of ships operating within the "Med SOx ECA", that will enter into force from 1 January 2025.

The proposal was widely shared: Albania, Algeria, Austria, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Egypt, Estonia, Finland, France, Germany,

Greece, Hungary, Ireland, Israel, Italy, Lebanon, Latvia, Libya, Lithuania, Luxembourg, Malta, Netherlands, Monaco, Montenegro, Morocco, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Syrian Arab Republic, Tunisia, Turkey. Consequently, it is clear that the need and urgency to identify new solutions to combat air pollution in the Mediterranean Sea is strongly felt.

TABLE 1. MAIN IMPLICATIONS FROM THE INTRODUCTION OF AN ECA AREA IN THE MEDITERRANEAN SEA.

Environmental implications	Health implications	Economic implications
Up to 80% reduction of SOx emissions	4,100 deaths avoided by 2030	8-14 bil € savings in healthcare
Up to 70% reduction of NOx emissions	10,000 deaths avoided by 2050	Esteems not available
Up to 30% reduction of PM 2.5	Esteems not available	Esteems not available

Source: www. ec.europa.eu.

1.B. Are there environmental/climate requirements in tenders from public or private purchasers (operator, shipowner).

In Italy it is possible to access an array of financing solutions to enhance the implementation of new entrepreneurial projects and to support new investments in the maritime and port industry. Access to the financial resources made available in the numerous tenders are often linked to compliance with environmental and social requirements. The main plan of contributions and financing currently active in Italy is the National Recovery and Resilience Plan (PNRR), a document that highlights the program of reforms and investments planned until 2026 as part of the Next Generation EU programme.

To benefit from the financial resources made available by the Next Generation EU programme, all Member States were asked to explain how their Recovery Plan was consistent with the objectives of the European Green Deal, ensured a socially fair and just transition, and respected the principle of "do no significant harm" (DNSH) to the environment, provided by the legislative framework to encourage sustainable investment, through the definition of a classification system (Taxonomy).

Such taxonomy makes it possible to assess if a measure is likely to cause damage to the six environmental objectives identified in the Paris Agreement (European Green Deal). "Significant damage" is considered any activity which:

1. generates significant greenhouse gas emissions, hindering the climate change mitigation efforts;
2. leads to a worsening of the negative effects of the current climate and the expected future climate on people, nature or assets, causing damage to adaptation to climate change;
3. causes damage to the sustainable use and protection of water and marine resources to the good status or good ecological potential of bodies of water, or to the good environmental status of marine waters;
4. causes damage to the circular economy, including the prevention and recycling of waste, leading to significant inefficiencies in the use of materials or in the direct or indirect use of natural resources, or if it leads to a significant increase in the production, incineration or disposal of waste, or if long-term disposal of waste could cause long-term damage to the environment;

5. causes damage to the prevention and reduction of pollution by significantly increasing emissions of pollutants into air, water or soil;
6. undermines the protection and restoration of biodiversity and ecosystems, significantly harming the good condition and resilience of ecosystems or the conservation status of habitats and species, including those of Union interest.

The DNSH principles provide specific technical requirements, which depend on the scope of the investment. In particular, *ad hoc* requirements are laid down concerning maritime transport activities, respectively of passengers and goods, port operations and ancillary activities.

For examples, with reference to the maritime and coastal transport of goods, port operations and ancillary activities, the following requirements are foreseen if the investment is subjected to major contribution from the Next Generation EU programme.

- Until 31 December 2025, the retraining activity shall reduce the ship's fuel consumption, expressed in liters of fuel per tons/km, by at least 10%, as demonstrated by a comparative calculation for the representative navigation areas (including representative load profiles) in which the ship will operate or by the results of model tests or simulations.
- Refitted or modernized ships may not be used for the transport of fossil fuels.

In addition to the DNSH principles, investments in Italy are always subject to additional qualitative and environmental constraints. Tenders for the allocation of public contracts, in fact, often require compliance with high quality standards. The procedure for awarding the contract for the realization of cold ironing plants within the port of Genoa, for example, required compliance with the UNI EN ISO 14001: 2015 standard, which specifies the need for the provision of an internal Environmental Management System, able to identify environmental impacts and risks and related opportunities for improvement in concerning the investment.

1.C. Do the buyer have special technology requirements.

Although technological innovation is highly relevant in the maritime port sector, given the novelty of the issue, the Italian legal framework does not provide common technological or technology-related requirements for the implementation of innovative investments in the maritime-port domain (except for digital technologies).

The existing requirements, conversely, focus mainly on legal or financial aspects, requiring the supplier/private operator to comply with fixed conditions of generic or specific nature.

For example, the public tender for the realization of cold ironing plants within the port of Genoa required the participants to demonstrate adequate financial soundness proven with statements of assurance issued by banking institutions, or the possession, by the entity that will perform the project, of quality certifications, such as ISO 9001: 2015 and ISO 14001: 2015.

More specific requirements are imposed for the assignment of public maritime transport services for passengers, vehicles and goods with a public service obligation for maritime territorial continuity in Italy, that are regulated by the Italian Ministry of Infrastructure and Transport. In this case, the tenders usually specify that the naval units must comply with national, Community and international standards that guarantee the adoption of technical and

strategic solutions for the prevention of environmental pollution, as far as applicable to national navigation.

Vessels operated for providing the aforementioned public transport services are expected to guarantee precise standards in terms of cruising speed, passenger seats and cabins available on board, devices for access to the ship, on-board services and devices for the safety of both passengers and crew.

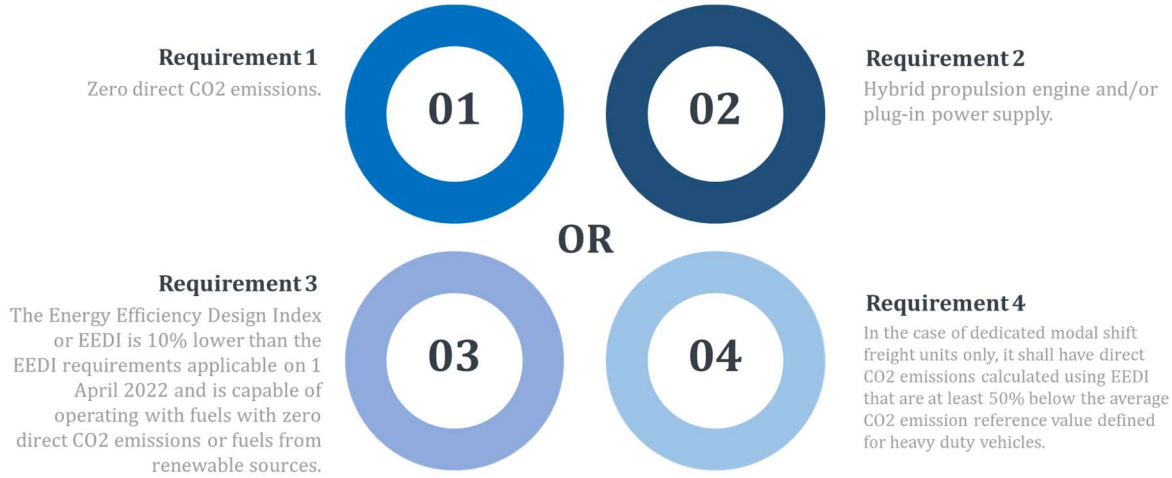
A further case study appears to be particularly relevant in terms of technological requirements. Such case study is represented by the tender included in Mission 2 - "Green revolution and ecological transition" - Component 2 - "Renewable energy, hydrogen, network and sustainable mobility" of the Complementary Fund to the PNRR. More in detail, as reported in section 3.d, the call for proposals aims at renewing the maritime fleet to make it more environmentally friendly. In the aforementioned tender, the purchase or renewal of naval units defined as "clean vehicles" is financed, i.e., a ship that meets the requirements reported in Figure 1, namely:

- ✓ Zero CO_2 direct emissions; or
- ✓ hybrid propulsion and/or plug-in powered engine for its normal operation at sea and in ports; or
- ✓ the naval unit achieves a EEDI value[1] 10% lower than the EEDI requirements applicable on 1 April 2022 and it is capable of running on fuels with zero direct emissions of CO_2 or on fuels produced from renewable sources; or
- ✓ in the case of freight units dedicated to the modal shift only, it has direct CO_2 emissions (calculated through EEDI) at least 50% lower than the average CO_2 emission reference value defined for heavy-duty vehicles.

A set of technological requirements have been defined concerning the public tender for the realization of renewable energy and energy efficiency interventions promoted by the Italian Ministry of the Ecological Transition (Public Notice of expressions of interest for the formulation of design proposals within the component intermodality and integrated logistics – Investment 1.1: Renewable energy interventions and energy efficiency in ports – Green Ports). In this case, referring to the introduction of new equipment for port handling activities (Green Ports), specific requirements concerning the amount of energetic recovery (minimum 40%) and propulsion systems were set. More in detail, the tender only considered as eligible the investments concerning electricity- or hydrogen-powered equipment.

[1] EEDI: The Energy Efficiency Design Index was introduced by the IMO and provides a newbuilding standard, assuring that ship designs achieve a certain level of efficiency and decrease carbon emissions.

FIGURE 1. TECHNOLOGICAL REQUIREMENTS - TENDER PNRR (COMPONENT 2 - "RENEWABLE ENERGY, HYDROGEN, NETWORK AND SUSTAINABLE MOBILITY")



Source: Authors' elaboration.

Whereas there are no harmonic requirements at national level defining technological standards, the increasing attention towards the sustainability-related issues in the port and maritime sector is demonstrated by the recent initiatives undertaken from the main national transport operators. For example, Rete Ferroviaria Italiana (the national railway infrastructure manager) has published a public tender for the supply of two Dual Fuel ships worth 52 million euros, financed with the PNRR resources. The tender includes the possibility for the addition of a third ship with the same characteristics, for an amount of 22,5 million euros.

Among the requirements defined within the tender, a dual fuel (diesel/gas and electric power) propulsion system is requested, aiming at pursuing high energetic efficiency that will allow zero emissions of CO_2 and greenhouse gases during navigation, berthing and port maneuvers.

TABLE 2. PUBLIC TENDERS TECHNOLOGICAL AND ENVIRONMENTAL REQUIREMENTS: RECENT CASE HISTORIES.

Proponent	Tender/call name	Requirements	Technological requirements	Environmental requirements
Port Authority of Mar Ligure Occidentale	Cold Ironing project - Port of Genoa	Financial and quality	-	ISO 14001: 2015.
Rete Ferroviaria Italiana	Dual Fuel Passenger Ships	-	Dual fuel propulsion	-
Ministry of Transport and Infrastructure	Maritime Territorial Continuity	Technical and capacity	-	National, EU and International standards compliance
Ministry of ecological transition	Green Ports	-	Electricity or hydrogen-powered equipment	-

Source: Authors' elaboration.

Another set of requirements can be demanded by ship operators referring to newbuilding or refitting investments. In order to comply with IMO regulations in terms of energy efficiency, in

fact, naval units must meet increasingly ambitious technological standards. More in detail, the main energy efficiency requirements can be summarized as follows:

1. Energy Efficiency Design Index (EEDI);
2. Energy Efficiency Operational Indicator (EEOI);
3. Energy Efficiency eXisting ship Index (EEXI).

More specifically, the Energy Efficiency Design Index (EEDI) was introduced in the MARPOL Convention Annex VI in response to growing concerns about greenhouse gas emissions and their effects on global warming. It is an energy efficiency indicator that aims to promote the use of energy efficient propulsion systems, with the consequent emission reduction. In 2011, in which the EEDI was first introduced, the index was referred to the CO_2 emissions of tankers, bulk carriers, gas carriers, general cargo, containerships and reefer; but with an amendment of 2014 introduced by the Marine Environment Protection Committee (MEPC), the application of the EEDI has been extended also to Ro-Ro ships, Ro-Pax ships and LNG carriers. The maximum value limits of the EEDI are revised and made more stringent every 5 years, until reaching in 2025 a reduction of 30% of the value of the index compared to the value of phase 0 (IMO, 2014). EEDI is proportional to the fuel consumption of the vessel divided by its carrying capacity and speed (IMO, 2014); it is expressed as grams of CO_2 per tons-mile (gCO_2/ton-mile), therefore the higher the energy efficiency of the ship the lower the EEDI.

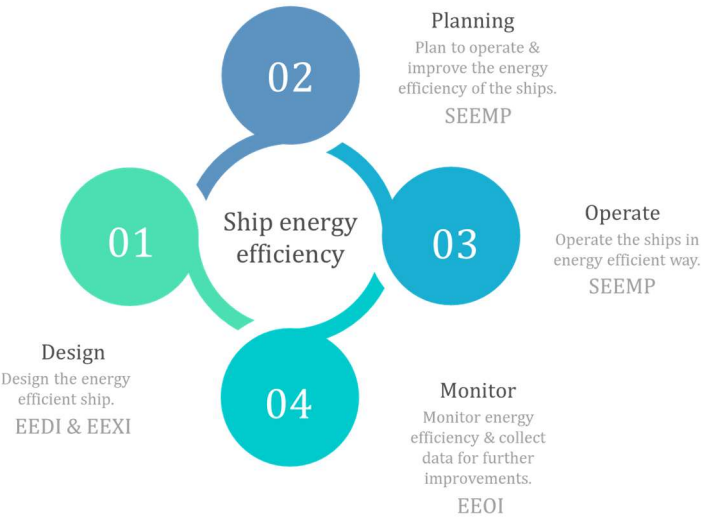
The Energy Efficiency Operational Indicator (EEOI), is an indicator of the average annual carbon intensity of a ship in its actual operating conditions, taking into account the cruising speed, draught, capacity actually used, distance travelled, hull and engine deterioration and weather. Although EEOI is referred to as an energy efficiency indicator, it is technically more accurate to refer to it as a carbon intensity measure, being calculated as gCO_2/ton-mile (UCL Energy Institute, 2015). The major difference between EEOI and EEDI is that while EEDI is a technical indicator for the propulsion systems of ships under construction, the EEOI consists of an indicator referring to the operational factors of the ships under navigation and is therefore applied not only to new ships but also to ships already operating before the introduction of the index. Therefore, an optimization of ship's operations, like an improvement in the energy management or the trip optimization, will have a positive impact on the EEOI while it will not be visible in the EEDI.

The Energy Efficiency eXisting ship Index (EEXI) is a measure introduced by the IMO to reduce the greenhouse gas emissions of ships. The EEXI is a measure related to the technical design of a ship. Ships have to attain EEXI approval by participating in the periodical survey that will be launched in 2023 at the latest. The required EEXI value is determined by the ship type, the ship's capacity and principle of propulsion and is the maximum acceptable attained EEXI value. The attained EEXI must be calculated for the individual ship, which falls under the regulation.

It is essential to highlight that there is a close relationship between the three indicators, which are fundamental for the definition of appropriate procedures for improving the conditions of environmental impact for the different ships (Figure 2**Error! Reference source not found.**). In this vein, it is specified that one of the instruments employed by the various ship companies for the monitoring of the conditions of the ships and for the application of corrective in case of detection of any problematic situation, is the Ship Energy Efficiency Management Plan (SEEMP) an operational measure establishing a mechanism to improve the energy efficiency of a ship in

a cost-effective way. The SEEMP also provides shipping companies with an approach to manage the efficiency performance of ships and fleet over time, for example by using the Energy Efficiency Operational Indicator (EEOI) as a monitoring tool. The SEEMP Development Guidelines for new and existing ships incorporate best practices for fuel efficient operation, as well as guidance for voluntary use of EEOI for new and existing ships (MEPC.1/Circ.684). The EEOI enables operators to measure the fuel efficiency of a ship in operation and to assess the effect of any operational changes, such as better voyage planning or more frequent cleaning of the propeller, or the introduction of technical measures such as waste heat recovery systems or a new propeller. The SEEMP urges shipowners and operators at every stage of the plan to consider new technologies and practices to optimize ship performances.

FIGURE 2. SHIP ENERGY EFFICIENCY PROCESS.



Source: Authors' elaboration.

1.D. Are there national incentive schemes for low/zero emission solutions.

Within the Italian PNRR, great attention has been paid to investments and initiatives aimed at decarbonizing the transport and mobility sectors, which are considered a key factor for the country's sustainable recovery. Therefore, two of the six missions defined in the plan concern both the energy and infrastructure profiles of green transport, in particular Mission 2 "Green revolution and ecological transition" and Mission 3 "Infrastructure for sustainable mobility".

More in detail, the PNRR defined, within Mission 2, an investment plan aimed at renewing the Italian fleet, mainly referring to passenger ships. The main objective of the investment is to contribute to the reduction of the environmental impact of maritime transport, improve social cohesion by ensuring territorial continuity through sustainable maritime services of which attractiveness and comfort for passengers will be enhanced.

The program provides for the allocation of a total of 800 million euros as a contribution to shipowners for the purchase of new ships or the modernization of existing or under construction ships, and improve the availability of alternative marine fuels, with the aim of promoting the ecological transition of the fleet. In particular, the resources provided by the Complementary Plan to the National Recovery and Resilience Plan (PNRR) will be allocated to projects presented by shipping companies that are able to ensure better environmental

performance and a significant reduction in polluting emissions from ships, including while berthing in ports, thanks to the use of latest generation propulsion systems, electric batteries, hybrid or innovative solutions from a hydrodynamic point of view, digital control systems or material sustainability.

The substantial investment complements the interventions already underway for the transformation of Italian ports areas and for the electrification of the docks, so that moored ships can turn off polluting engines and use electricity taken from the ground. These various interventions are aimed at promoting the ecological transition of maritime transport, a fundamental component of the Italian economic system. The considerable resources made available will make it possible to encourage the renewal of fleets by encouraging shipowners to purchase new ships equipped with the latest generation technologies, with engines capable of using fuels with low environmental impact (LNG, bioLNG, methanol, hydrogen, ammonia), or to transform ships already in operation to allow them to use fuel systems with a lower environmental impact, also through the use of biofuels.

More in detail, the program is composed by three sub-sections:

- Sub-investment I (total cost of 500 million euros): Renewal of the Mediterranean naval fleet with fuel units able to reduce the overall environmental impact. The sub-investment is further composed by two interventions, namely:
  - Refitting and construction of new ships.
  - Commissioning of new ships.
- Sub-investment II (total cost of 80 million euros): Renewal of the naval fleet for the crossing of the Messina strait. The sub-investment is further composed by two interventions, namely:
  - Hybridization 3 ships ferry trains in the Strait of Messina.
  - Realization of 3 fast naval units.
- Sub-investment III (total cost of 220 million euros): Investments aiming at increasing the availability of alternative marine fuels (LNG). The sub-investment is further composed by three interventions, namely:
  - Commissioning of micro-liquefiers of at least 50,000 tons per year of production capacity also through modular solutions.
  - Construction of small ships suitable for bunkering activities.

  National regasification adaptations in harbor within with infrastructures for the marine and terrestrial supply and relative accessory infrastructures.

More in detail, a ministerial decree has been already approved concerning sub-investment I. The aforementioned sub-investment is set to finance three types of intervention:

- 225 million euros are earmarked for ship renewals (purchase of new naval units equipped with a propulsion system with low environmental impact, in line with the definition of "clean vehicle" according to the guidelines of the European Commission);
- 225 million euros for the completion of new naval units equipped with propulsion systems with low environmental impact, or for modification of naval units or transformation works that involve a radical change in their characteristics;

- Within the aforementioned resources, 50 million euros are reserved for the renewal of naval units operating in Italian ports, such as tugboats and other service vessels. The interventions include the purchase of new naval units with low environmental impact, the completion of new units or works of transformation in an ecological sense of naval units already operational.

Improvements in terms of reducing emissions of climate-changing gases that can be achieved through the proposals submitted for eligibility for the grant will have to be certified by specialized third parties.

TABLE 3. PNRR MISSION 2.

Program	Mission	Component	Intervention	Investments	Budget	Timeline
PNRR	M2 - Green Revolution and ecological transition	Renewable energy, Hydrogen, sustainable network and mobility	Fleet Renewal - sustainable ships	Construction of new naval units equipped with a type of propulsion system with low environmental impact	800 mln €	2021 - 2026

Source: Authors' elaboration.

Concerning the third Mission of the PNRR, it includes a series of investments aimed at developing a modern, digital, sustainable and interconnected transport infrastructure network, which can increase the electrification of transport and digitalization, and improve the overall competitiveness of the country, in particular in the Southern regions.

The aim of the investment program is to make port activities more compatible with activities and urban life, thanks to interventions to reduce energy consumption and increase environmental sustainability, also through the use of renewable energy. These measures will help reduce greenhouse gas emissions by 55% by 2030.

The funding program dedicated a total amount of 270 million euros to the investments, which will be completed by 2025. Within the PNRR - Mission 3, interventions aimed at energy efficiency and the promotion of the use of renewable energy in ports will therefore be carried out. The projects are to be selected among those that the individual Port System Authorities have indicated in their Environmental Energy Planning Documents of port systems (DEASP). Finally, this investment includes purchasing zero-emission service vehicles and vessels or transforming fossil fuel vehicles and service vessels into zero-emission vehicles.

In addition, Italy has approved a National Plan for complementary investments to the PNRR, with a total allocation of about 31 billion euros, aiming at financing specific actions that complement the projects included in the PNRR. In the field of port sustainability, the Complementary Plan includes three further lines of intervention, as better specified in section 2.a, namely:

- the development of maritime accessibility and resilience of port infrastructure to climate change;
- the selective increase in port capacity;
- the electrification of port docks.

TABLE 4. PNRR MISSION 3.

Program	Mission	Component	Intervention	Investments	Budget	Timeline
PNRR	M3 - Infrastructures for sustainable mobility	Intermodality and Integrated Logistics	Interventions for the environmental sustainability of ports (Green Ports)	Interventions aimed at increasing energy efficiency and promoting the use of renewable energy in ports.	270 mln €	2021 - 2026
PNC	M3 - Infrastructures for sustainable mobility	Intermodality and Integrated Logistics	Developing maritime accessibility and port infrastructure resilience to climate change	Strengthening and consolidation interventions on dams, piers and docks, also aiming at allowing adaptation to the growing tonnage of ships.	1470 mln €	2021 - 2026
PNC	M3 - Infrastructures for sustainable mobility	Intermodality and Integrated Logistics	Selective increase in port capacity	Interventions aiming at increasing port capacity, both through dredging works and through the development of new piers and / or new logistics platforms.	390 mln €	2021 - 2025
PNC	M3 - Infrastructures for sustainable mobility	Intermodality and Integrated Logistics	Port dock electrification (cold ironing)	Implementation of a network of systems for the supply of electricity from shore to ships during the mooring phase, in order to minimize the use of on-board auxiliary engines for the self-generation of electricity.	700 mln €	2021 - 2026

Source: Authors' elaboration.

1.E. Conditions of existing fleet (age, size) and any special requirements for vessel.

Aiming at assessing the conditions of the ferry, service and offshore fleet, an ad hoc dataset has been developed gathering data and information from the Database IHS Seaweb, adequately integrated through additional information from original sources, specialized news press and technical insights from experts in this field contacted thorough in-depth interviews. The dataset includes data related to all the ferry, service and offshore vessels operating predominantly in Italy, and commercially deployed in the near geographic markets. For the aims of the study, three queries/extractions have been carried out in order to obtain technical information concerning all the vessels operating in the sample businesses. In particular, the analysis has been performed focusing on all ships characterized by a Group Owner, Registered Owner or Operator with headquarters located in Italy. In particular, the three draws led to the following results: 341 ships with Group Owner with domicile in Italy, 336ships with Registered Owner with domicile in Italy and 335 ships with Operator with domicile in Italy. It should be noted that the final dataset originates from the integration of these three different extractions with a key variable such as the "IMO Number" of ships.

Once the data gathering phase was completed, after integrating the dataset and fulfilling the missing or blank cells, a final original dataset composed by 385 ships was available. The sample vessels have been grouped into 15 technical categories, according to traditional international labelling and categorization systems. Related main statistics are reported in Table 5. The

dataset is predominantly composed by ferry ships (approximately 70%) followed by the service vessels (24%) and, offshore vessels/platform (6%).

TABLE 5. DISTRIBUTION OF DIFFERENT VESSEL TYPE.

Ship type	No. Ship	Incidence	Priority Vessel Type
Passenger/Ro-Ro Ship (Vehicles)	187,00	48,95%	Ferry
Ro-Ro Cargo Ship	79,00	20,68%	Ferry
Diving Support Vessel	3,00	0,79%	Offshore
Drilling Ship	3,00	0,79%	Offshore
FPSO, Oil	3,00	0,79%	Offshore
FSO, Oil	3,00	0,79%	Offshore
Gas Processing Vessel	2,00	0,52%	Offshore
Offshore Construction Vessel, jack up	1,00	0,26%	Offshore
Pipe Layer	1,00	0,26%	Offshore
Pipe Layer Crane Vessel	6,00	1,57%	Offshore
Anchor Handling Tug Supply	34,00	8,90%	Service
Crew/Supply Vessel	29,00	7,59%	Service
Offshore Support Vessel	2,00	0,52%	Service
Offshore Tug/Supply Ship	6,00	1,57%	Service
Platform Supply Ship	23,00	6,02%	Service
Total	**382,00**		**100%**

Source: Authors' elaboration.

Once the data gathering, cleaning and management was accomplished, main technical information related to the conditions of existing fleet (age, size) and any special requirements for vessel were scrutinized focusing on the following variables:

- ✓ **Vessel identification information**: IMO number, name of ship and operational status;
- ✓ **Data related to ownership and management structure**: Group Owner, Registered Owner, Operator and Shipmanager;
- ✓ **Dimensional Information (size- and capacity-related variables)**: Gross Tonnage, Length, RORO Lanes Length (in the specific case of the Ferry category), Draught, Breadth;
- ✓ **Ship construction information**: year of construction, shipbuilder and build location;
- ✓ **Data on main and auxiliary engines**: auxiliary engine design, auxiliary engine stroke type, engine model, engine stroke, engine builder, engine design, engine type;
- ✓ **Guidance on propulsion and consumption systems**: fuel type 1, fuel type 2, fuel consumption main engines, fuel consumption total, propeller type and propulsion type.

To assess the state-of-the-play in the sample maritime businesses and evaluate the condition of existing fleets, key dimensions such as ships' age and ship size have been scrutinized, and main results are reported in Table 6 and discussed below.

TABLE 6. SUMMARY OF AGE DESCRIPTIVE STATISTICS.

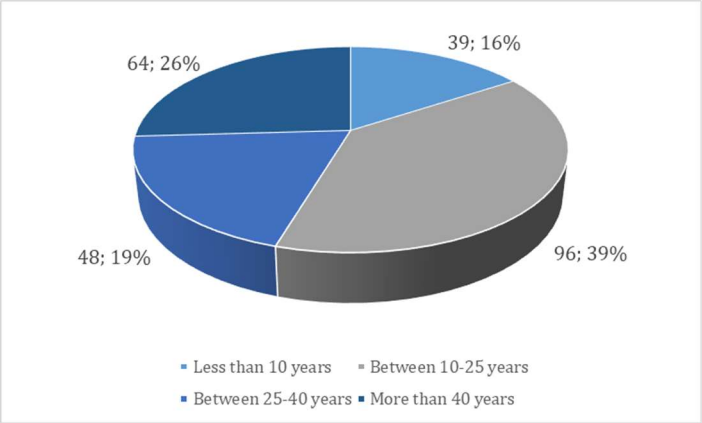
Vessel Type	Average AGE	MIN	Q1	Q2	Q3	MAX
Ferry	**27,26**	**-**	**13,00**	**23,00**	**41,00**	**94,00**
Passenger/Ro-Ro Ship (Vehicles)	33,50	1,00	21,00	33,00	43,00	94,00
Ro-Ro Cargo Ship	11,77	-	7,00	11,00	16,00	31,00
Offshore	**25,57**	**1,00**	**12,00**	**22,00**	**33,00**	**72,00**
Diving Support Vessel	29,67	1,00	12,00	22,00	33,00	72,00
Drilling Ship	6,50	1,00	3,75	6,50	9,25	12,00
FPSO, Oil	41,33	33,00	39,00	45,00	45,50	46,00
FSO, Oil	26,00	23,00	25,00	27,00	27,50	28,00
Gas Processing Vessel	10,00	1,00	5,50	10,00	14,50	19,00
Offshore Construction Vessel, jack u	26,00	26,00	26,00	26,00	26,00	26,00
Pipe Layer	16,00	16,00	16,00	16,00	16,00	16,00
Pipe Layer Crane Vessel	28,50	8,00	10,50	17,00	40,75	72,00
Service	**19,74**	**5,00**	**11,00**	**14,00**	**22,00**	**51,00**
Anchor Handling Tug Supply	15,59	7,00	10,00	12,00	14,00	47,00
Crew/Supply Vessel	23,57	6,00	12,50	20,50	38,50	47,00
Offshore Support Vessel	24,50	13,00	18,75	24,50	30,25	36,00
Offshore Tug/Supply Ship	27,33	18,00	20,25	21,50	36,25	42,00
Platform Supply Ship	18,71	5,00	9,00	13,00	20,00	51,00

Source: Authors' elaboration.

The ferry fleet is 27 years old on average, given the severely old age of passenger ships (33,5 years on average). Vessels currently operated by Italian shipowners and shipping companies appear older than the European average (23,5 years) and also suggest the need for additional investment

As reported in Figure 3, the 39% of ferry ships are between 10 and 25 years old; while only 16% are under 10 years old. However, it should also be noted that at the time of extraction (October 2022) 18 ships are not operational because they are still in the construction and commissioning process.

FIGURE 3. DISTRIBUTION OF THE FERRY FLEET BY AGE GROUP.



Source: Authors' elaboration.

In this perspective, data gathered demonstrate an increasing attention towards innovative green projects launched by Italian group owner: as reported in Table 7, Grimaldi Group SpA ordered 10 ships belonging to the "GG5G" vessel category, which include several green technologies embedded in the equipment (as further deepened in section 1F), in order to renew the current fleet and expand their operations.

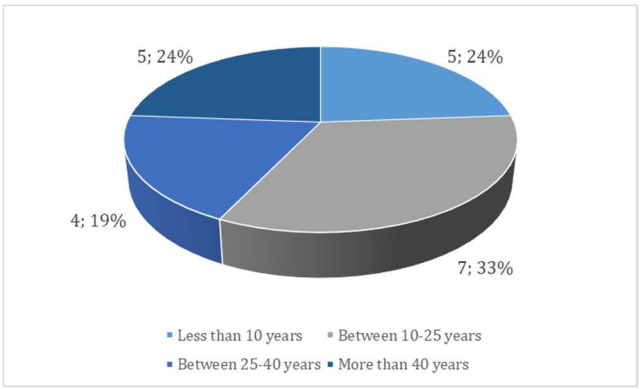
TABLE 7. SHIPS UNDER CONSTRUCTION FERRY SEGMENT (OCTOBER 2022).

Name of Ship	Ship Type	Group Owner	Registered Owner	Operator	Status
EOLIE	Passenger/Ro-Ro Ship (Vehicles)	Unknown	Naos Ship & Boat Desig	Naos Ship & Boat Design	Keel Laid
SEFINE 60	Passenger/Ro-Ro Ship (Vehicles)	Caronte Shipping SpA	Caronte & Tourist SpA	Caronte & Tourist SpA	On Order/Not Commenced
GUANGZHOU 21110001	Passenger/Ro-Ro Ship (Vehicles)	Grandi Navi Veloci SpA	Grandi Navi Veloci SpA	Grandi Navi Veloci SpA	On Order/Not Commenced
GUANGZHOU 21110002	Passenger/Ro-Ro Ship (Vehicles)	Grandi Navi Veloci SpA	Grandi Navi Veloci SpA	Grandi Navi Veloci SpA	On Order/Not Commenced
GUANGZHOU 21110003	Passenger/Ro-Ro Ship (Vehicles)	Grandi Navi Veloci SpA	Grandi Navi Veloci SpA	Grandi Navi Veloci SpA	On Order/Not Commenced
GUANGZHOU 21110004	Passenger/Ro-Ro Ship (Vehicles)	Grandi Navi Veloci SpA	Grandi Navi Veloci SpA	Grandi Navi Veloci SpA	On Order/Not Commenced
ECO ADRIATICA	Ro-Ro Cargo Ship	Grimaldi Group SpA	Grimaldi Euromed SpA	Grimaldi Euromed SpA	In Service/Commission
ECO ITALIA	Ro-Ro Cargo Ship	Grimaldi Group SpA	Grimaldi Euromed SpA	Grimaldi Euromed SpA	Keel Laid
ECO MALTA	Ro-Ro Cargo Ship	Grimaldi Group SpA	Grimaldi Euromed SpA	Grimaldi Euromed SpA	In Service/Commission
ECO MEDITERRANEA	Ro-Ro Cargo Ship	Grimaldi Group SpA	Grimaldi Euromed SpA	Grimaldi Euromed SpA	In Service/Commission
GREAT ANTWERP	Ro-Ro Cargo Ship	Grimaldi Group SpA	Grimaldi Group SpA	Grimaldi Group SpA	Keel Laid
HYUNDAI MIPO 8361	Ro-Ro Cargo Ship	Grimaldi Group SpA	Grimaldi Group SpA	Grimaldi Group SpA	Under Construction
HYUNDAI MIPO 8362	Ro-Ro Cargo Ship	Grimaldi Group SpA	Grimaldi Group SpA	Grimaldi Group SpA	On Order/Not Commenced
HYUNDAI MIPO 8363	Ro-Ro Cargo Ship	Grimaldi Group SpA	Grimaldi Group SpA	Grimaldi Group SpA	On Order/Not Commenced
HYUNDAI MIPO 8364	Ro-Ro Cargo Ship	Grimaldi Group SpA	Grimaldi Group SpA	Grimaldi Group SpA	On Order/Not Commenced
HYUNDAI MIPO 8365	Ro-Ro Cargo Ship	Grimaldi Group SpA	Grimaldi Group SpA	Grimaldi Group SpA	On Order/Not Commenced
MOBY FANTASY	Passenger/Ro-Ro Ship (Vehicles)	Moby SpA	Moby SpA	Moby SpA	Launched
MOBY LEGACY	Passenger/Ro-Ro Ship (Vehicles)	Moby SpA	Moby SpA	Moby SpA	Keel Laid

Source: Authors' elaboration.

Regarding to the section "Offshore", an average age is emerged very similar to that of the section ferry, pairs to little more than 25 years. Given the wide variety of sub-categories and the specific characteristics of the various European markets, it is extremely difficult to carry out a comparison analysis at European level. Inside the macro-category, the vessel type that introduces in average a higher age is constituted by the Floating production storage and offloading units (FPSO), floating units of production, storage and drainage used for the offshore oil production (little more than 41 years), while the average minor age is that of the Gas Processing Vessel (10 years). In this specific category these is a predominancy of vessels that are between 10 and 25 years old (33% - Figure 4) in line with the average age reported in Table 6.

FIGURE 4. DISTRIBUTION OF THE OFFSHORE FLEET BY AGE GROUP.



Source: Authors' elaboration.

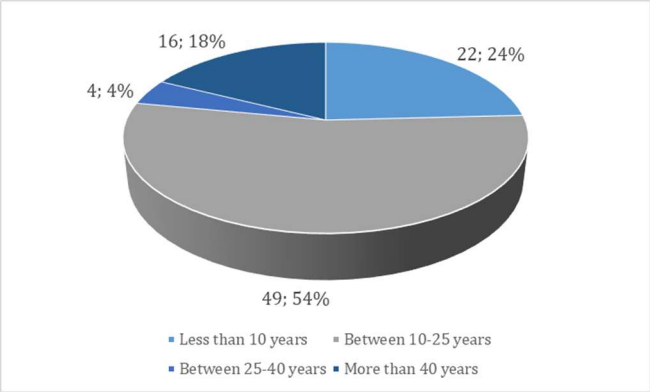
Finally, with reference to the ships of the category "service", an average age pairs to 19,74 years for the operating ships is observed and, inside of the same category the following values are emerged:

- ✓ Tug ships and support ships to supply platforms to offshore vessels: 24-27 years;
- ✓ Anchor handling Tug supply (mainly built to move anchors for oil platforms, tow them in place and use them to fix platforms in place): just over 15 years;

- ✓ Platform Supply Ship (employed in order to resupply oil platforms and of offshore gas): little more than 18 years.

Attended the importance of the Tug ships inside of the Italian context, an in deep analysis was conducted regarding the comparison of the average age of the ship object of analysis with numerous on field studies and analysis. Under this profile, the studies of field evidence average age of the European ship of approximately 27 years, perfectly in line with the mean emerged inside the database. Figure 5 shows that more than 50% of the ship are between 10 and 25 years old; although 24% of ships are less than 10 years old, which is why there is a general rebalancing of the age of the fleet.

FIGURE 5. DISTRIBUTION OF THE SERVICE FLEET BY AGE GROUP.



Source: Authors' elaboration.

Concerning the size of the three main vessel typologies categories, Table 8 shows an overview of the following dimensions:

- ✓ Average GT;
- ✓ Average Length;
- ✓ Average Draught;
- ✓ Average Breadth.

TABLE 8. SUMMARY OF "SIZE" DESCRIPTIVE STATISTICS.

Vessel Type	Average GT	Average Length	Average Draught	Average Breadth
Ferry	25.556,03	153,40	5,88	23,21
Offshore	63.448,36	204,28	9,79	38,07
Service	1.386,78	55,84	4,08	12,53

Source: Authors' elaboration.

1.F. Example of completed projects

In Italy, there are numerous examples of project aimed to decarbonize the shipping industry and to reduce the negative emission generated by said sector, through the use of new technological solutions such as hybrid/electric engines, batteries, fuel cells, photovoltaic systems and so on. Specifically, Italian shipping companies implemented those technologies, and are working to implement even greener solutions, in order to not only be compliant with the current regulations set by the IMO, the European Union and state, but also to meet the

changing requests coming from the demand and to ensure a lasting, defensible and on-easily imitable competitive advantage within the relevant market.

One of the most relevant projects in the Italian market was initiated by the "Grimaldi Group", a multinational corporation operating in the maritime transport and logistics, founded in 1947 with its headquarters in Naples, which controls several shipping companies operating in both the passenger and freight transport businesses. In the maritime passenger transport, the Grimaldi Group operates through several subsidiaries in diverse country markets, including among other:

- Grimaldi Euromed, founded in 2000, which operates in the maritime sphere for the passenger transport in the Mediterranean Sea;
- Grimaldi Minoan Lines, founded in 2017 following the entry of the company's Greek Minoan Lines into the Grimaldi Group, which operates in the seas of Greece;
- Finnlines, founded in 1947, a Finnish shipping company that operates mainly in the Ro-Ro and ferry business in the Baltic Sea and the North Sea;
- Trasmed GLE, founded in July 2021 and based in Valencia, a Spanish company specialized in passenger and cargo transport between the Iberian Peninsula and the Balearic Islands.

The Group's total fleet consists of 130 ships, 120 of which it owns, including 6 cruise ferries, 38 Ro-Ro type vessels, 27 Ro-Pax type vessels, 39 Container/Ro- Ro and 20 Pure Car Truck Carriers. The Group, absolute leader in the Ro-Ro sector and top player in the Ferry and Ro-Pax segments, plays a key role within the industry in terms of the implementation of green strategies aimed at mitigating the emissions generated by the operations of his fleet. The Grimaldi Group, in its 2020 sustainability report, stated that "*the present of Grimaldi is green and the long-term goal is freight and passenger transport with zero emissions*". The large-scale project aimed at the substantial reduction of the negative environmental impact ascribable to the Group, includes the realization of substantial investments in green technologies for the refitting of the existing fleet as well as in new ships equipped with innovative green systems.

More particularly, to comply with the IMO 2020 regulations which limits the sulfur content for ships operating outside SECAs to a maximum of 0.5 percent, the Group decided to equip 104 ships in its fleet with exhaust gas treatment systems (scrubbers), specifically wet open-loop and wet hybrid scrubbers. The Group reports that with the installation of the scrubbers, SO_x emissions to the atmosphere have been reduced by 85 percent in 2020 compared to 2019 levels and over the course 2021 the emissions of SO_x into the atmosphere have been further reduced by 17 percent compared to 2020. Additionally, in the early months of 2022, the Grimaldi Group, in collaboration with Wartsila[2], presented to the market a highly innovative technology capable of making open-loop type scrubbers a tool aimed not only at safeguarding the environment and combating climate change, but also at protecting the oceans and marine species: these systems

[2] Wartsila is a Finnish company specialized in the manufacture of propulsion systems and other equipment in the marine and energy sectors.

are capable of filtering the water from the exhaust gas purification systems installed on board in order to retain microplastics, thus preventing them from being ingested by fish and other marine organisms and entering the food chain. In this way, open-loop type scrubbers can draw seawater for exhaust gas purification and at the same time can collect microplastics present in the oceans during their normal operation.

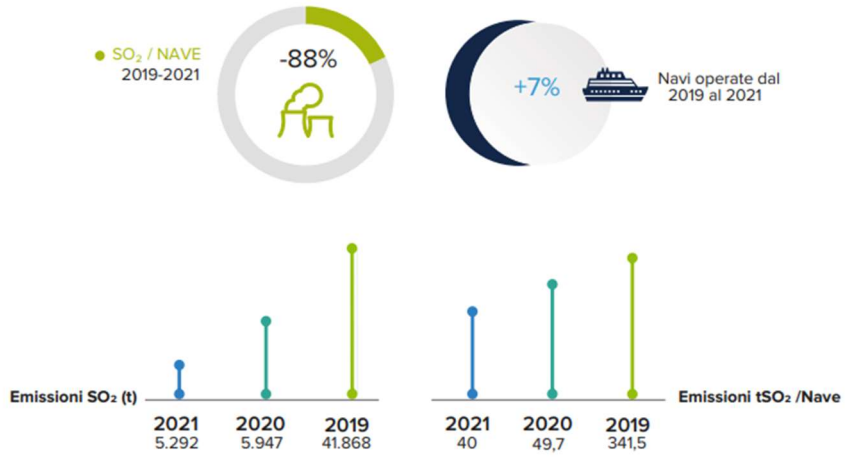
In terms of ship hydrodynamic efficiency, several units have been equipped with the Air Lubrication System, a system that, through the creation of microbubbles on the ship's hull, reduces the friction of the ship's hull with the sea water, thereby increasing the hydrodynamic performance and enabling fuel savings with positive consequences in terms of savings in operating costs and reduced emissions.

Within the large-scale project aimed at the substantial reduction of the negative environmental impact ascribable to the Group, it's essential to mention the "zero emission in port" Project, which aims at the implementation of technologies capable of allowing the ship's auxiliary engines to be turned off during docking in port with the consequent elimination of the environmental impacts that would otherwise be generated by them. Through the installation of a lithium mega battery plant with a capacity of more than 5 MWh on board of the sister ships "Cruise Roma" and "Cruise Barcelona" in 2019, on the new GG5G class ships, and through other interventions to optimize the electricity consumption onboard, it was possible to achieve a reduction in CO_2 emissions into the port's atmosphere by more than 2.300 tons during the year 2021, as well as a reduction in carbon monoxide, hydrocarbons and nitrogen oxides emissions.

With regards to the investments carried out for the purchase of new ships equipped with innovative green systems, it seems essential to mention the ship class "Grimaldi Green 5th Generation", or GG5G. The Grimaldi Group, during the year 2018, ordered the construction of 12 hybrid vessels "GG5G class", which have currently been delivered in full, and a few days ago during the XXV Euromed Convention announced that it has ordered two more ships of the same class. More specifically, the GG5G-class ships are equipped with the latest technologies in environmental sustainability, including lithium-ion batteries with a total capacity of 5 MWh, which are recharged during navigation thanks to the shaft generators and 350 sqm of solar panels, to power the ship during dockings in port, the Air Lubrication System, solar panels that can generate renewable energy, scrubber systems to reduce SO_x and PM emissions, an innovative bulbous bow design, and state-of-the-art main engines that can reduce fuel consumption.

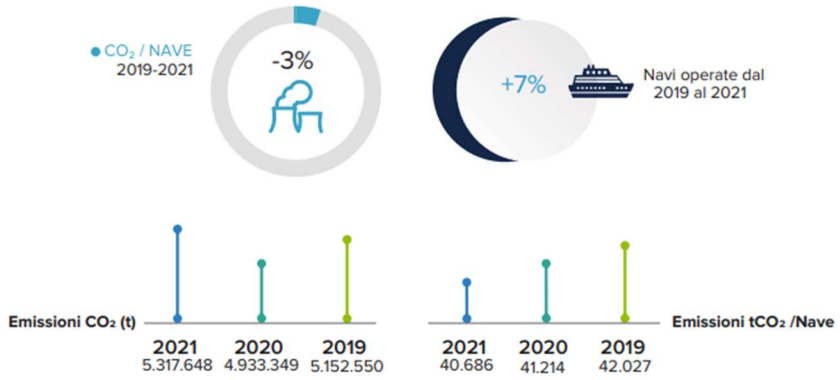
All the interventions as outlined above have resulted in an overall lowering of the main harmful emissions attributable to the operations of the group's ships, as can be appreciated at the Figure 6 and Figure 7.

FIGURE 6. TOTAL AND INDIVIDUAL SHIP SO_2 EMISSIONS IN THE YEARS 2019-2020-2021.



Source: Grimaldi Group Sustainability Report, 2021

FIGURE 7. TOTAL AND INDIVIDUAL SHIP CO2 EMISSIONS IN THE YEARS 2019-2020-2021.



Source: Grimaldi Group Sustainability Report, 2021.

Given the above, it seems clear that the Italian market is ready to implement important projects in order to reduce the emissions attributable to ship operations, especially through electrification and hybridization technologies.

FIGURE 8. MAIN HIGHLIGHTS - CHAPTER 1

IMO 2020 emission limit and future introduction of a Mediterranean ECA

Relevance of DNSH principles and increasingly stringent technical/environmental requirements for future investments.

Do No Significant Harm

ENERGY FOR GREEN PORTS

GreenPort LOGISTICS

Growing attention towards energy efficiency and sustainability in the port and shipping domain through funding schemes and other solutions (key role of PNRR).

Growing attention towards energy efficiency and sustainability from shipping operators through the implementation of innovative technologies, refitting of existing naval units and newbuilding.

Source: Authors' elaboration.

CHAPTER II

INFRASTRUCTURE / ENERGY SUPPLY

Chapter 2 provides an overarching conceptual framework for understanding the current state of play in the electrification and hybridization process of the Italian port infrastructures, aiming at assessing the practical business opportunities which originate for Norwegian technological providers.

More in details, first, section 2.A. offers an overview of the Italian port system and related infrastructures, as well as a focus on infrastructure interventions that will be implemented within the PNRR and the DEASP of major Port Authorities (PSAs/AdSP – Autorità di Sistema Portuale). Moreover, Section 2.B. defines the current energy mix of the country, also providing a brief overview of the value drivers affecting the port sector in line with a general rethinking of the energy mix both in the seaside and landside. Finally, Section 2.C. introduces and discusses detailed information of the most diffused forms of energy supply in the maritime and port domain. In this perspective, main strategies performed by Italian Port Authorities in their DEASP are scrutinized unveiling unprecedented business opportunities for Norwegian technology providers capable to supply technical solutions for electrifying and hybridizing Italian port infrastructures (e.g., cold ironing systems).

2.A. Infrastructure

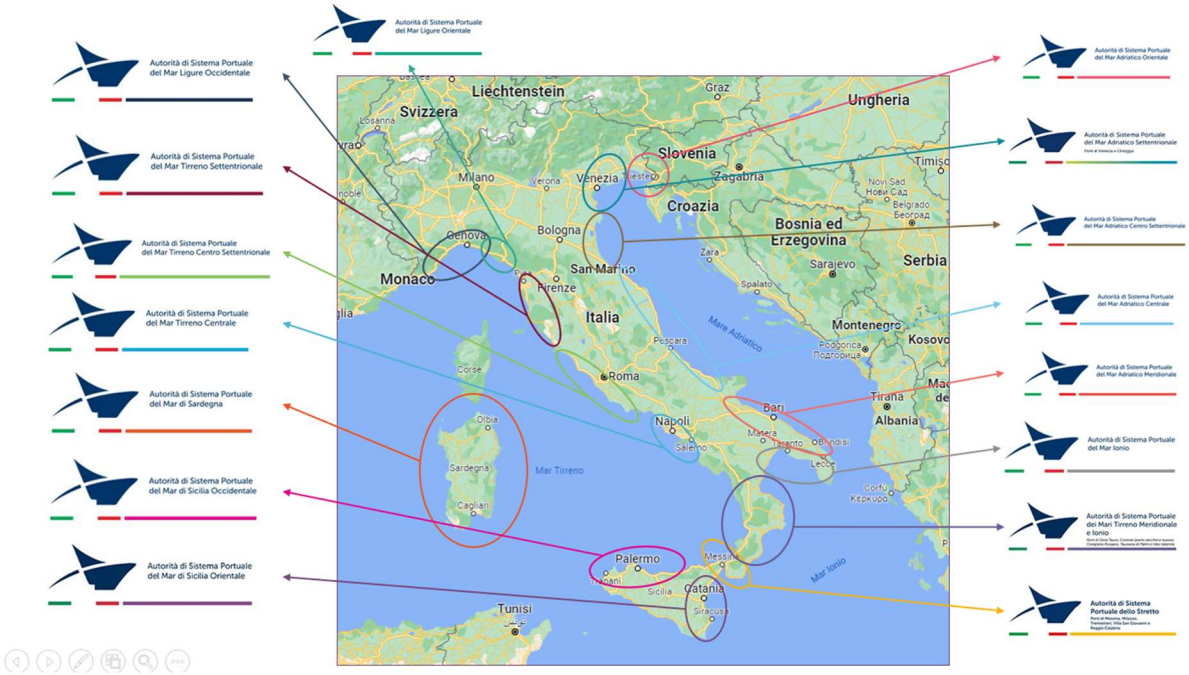
According to a report published by the Ministry of Infrastructure and Sustainable Mobility in 2022, Italy currently has 286 ports of which 53 are in Northern Italy, 41 in Central Italy, and 174 in Southern Italy and in the Island. Within those ports, there are 2.120 docks for a total length of 480.188 meters. These docks are intended for both passenger ship berthing (ferries, ro-ro, ro-pax and pleasure vessels) and cargo ship berthing (tankers, liquid cargo ships, dry bulk ships, containerships, other cargo ships and fishing vessels), as well as for service vessels and offshore vessels. More particularly, 559 docks are destined to passenger ships, 817 to pleasure vessels, 253 to service vessels and the others to cargo ships.

Notably, in Italy, 16 Port Authorities (PAs), labelled (Autorità di Sistema Portuale – AdSP) have been established for managing the overall Italian port system, which are entrusted with a strategic role in guiding, planning and coordinating the port embedded in their area of responsibility. More specifically, the PSA are (Figure 9):

- ✓ PSA of the Western Ligurian Sea (Genoa, Savona and Vado);
- ✓ PSA of the Eastern Ligurian Sea (La Spezia and Marina di Carrara);
- ✓ PSA of the North Tyrrhenian Sea (Livorno, Capraia, Piombino, Rio Marina, Portoferraio and Cavo);
- ✓ PSA of the North-Central Tyrrhenian Sea (Civitavecchia, Fiumicino and Gaeta);
- ✓ PSA of the Central Tyrrhenian Sea (Naples, Castellammare di Stabia and Salerno);

- ✓ PSA of the Sardinian Sea (Ports of Cagliari, Olbia, Golfo Aranci, Porto Torres, Oristano, Portovesme and Santa Teresa Gallura);
- ✓ PSA of the Sea of Western Sicily (Palermo, Termini Imerese, Porto Empedocle and Trapani);
- ✓ PSA of the Sea of Eastern Sicily (Augusta and Catania);
- ✓ PSA of the Strait of Messina (Messina and Milazzo);
- ✓ PSA of the Ionian Sea (Taranto);
- ✓ PSA of the Central Adriatic Sea (Ancona, Falconara, Pescara, Pesaro, San Benedetto del Tronto and Ortona);
- ✓ PSA of the North Central Adriatic Sea (Ravenna);
- ✓ PSA of the Southern Adriatic Sea (Bari, Brindisi, Manfredonia, Barletta and Monopoli);
- ✓ PSA of the Eastern Adriatic Sea (Trieste);
- ✓ PSA of the Northern Adriatic Sea (Venezia and Chioggia)
- ✓ PSA of the Southern Tyrrhenian and Ionian Seas (Gioia Tauro, Corigliano, Crotone, Palmi and Vibo Valentia.

FIGURE 9. ITALIAN PORT AUTHORITIES (PSA).



Source: Authors' elaboration.

Regarding the performance of the Italian port industry, as well as the challenges and opportunities it faces, it is necessary to emphasize how central the issue of environmental sustainability and port resilience has become for the country. In particular, Italian's 16 PSA are in the front row for reducing the environmental impact of maritime logistics activities and supporting the decarbonization of the whole industry, as shown within the Port System Environmental and Energy Plan (Documento di Pianificazione Energetico Ambientale del Sistema Portuale - DEASP) of each PSA, a compulsory document that examines the current and future port's energy demand and provides the main green strategies that can be implemented

in order to reduce the environmental impact of maritime logistics activities. More particularly, the DEASPs that appear to be the most ambitious in terms of green strategies to implement for reducing negative environmental impacts attributable to port activities are those related to the PSA of the Western Ligurian Sea, PSA of the Eastern Ligurian Sea, PSA of the North Tyrrhenian Sea and PSA of the Sardinian Sea. In fact, according to the respective DEASP, all these PSAs are strongly committed to green strategies, and they are participating in several European projects in order to reduce the environmental impact of the industry in question. To enable an understanding of the magnitude of interventions that these PSA have planned within their DEASPs, Table 9 is provided, which shows the number of green strategies related to each PSA taken into account.

TABLE 9. NUMBER OF GREEN INVESTMENTS INCLUDED IN THE DEASP OF THE FOUR 4 SAMPLE PSA.

Port Authority	No. of green strategies
Western Ligurian Sea	28
Eastern Ligurian Sea	22
North Tyrrhenian Sea	16
Sardinian Sea	15
Overall	**81**

Source: Authors' elaboration.

The 81 green investment/action related to the four sample PSAs taken into account can be traced to 8 main typologies, as shown in Table 10.

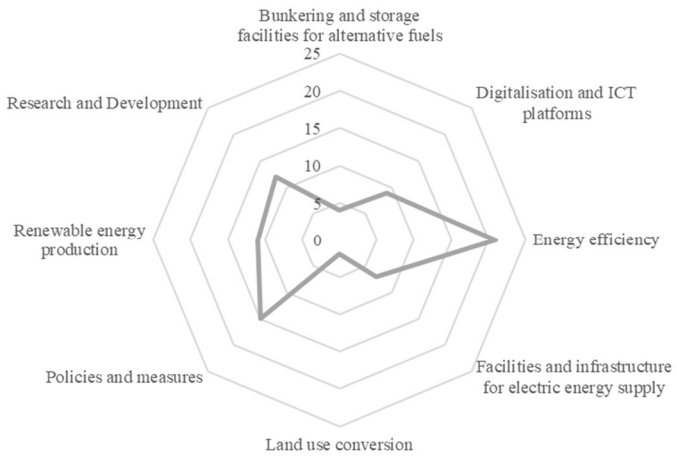
TABLE 10. GREEN STRATEGIES TYPOLOGY.

Green strategies typologies	Description
Digitalisation and ICT platforms	Development of digital solutions (e.g., IoT, blockchain, etc.) to reduce the environmental impacts of maritime logistics activities in the port domain by improving their operational efficiency. These strategies also include ICT platforms, smart sensors, and other technologies for monitoring emissions and, in general, environmental externalities in the port domain.
Energy efficiency	Strategies to improve the energy efficiency of maritime logistics activities in the port domain. They include the replacement of lighting systems and other technical and technological solutions to reduce energy consumption and related GHGs and harmful emissions.
Renewable energy production	Development and installation of renewable energy production systems in the port domain. These strategies include the installation of photovoltaic panels as well as the use of wind and wave power to produce energy.
Policies and measures	Policies and incentives to stimulate maritime logistics actors to adopt greener practices and behaviours. They include measures for the acquisition of green energy as well as the establishment of special technical committees for monitoring and promoting the environmental commitment of the maritime cluster. They can also refer to agreements for creating networks aiming at supporting the port's green transition.
Bunkering and storage facilities for alternative fuels	Construction of bunkering and storage facilities for alternative fuels in the port domain, including liquefied natural gas, hydrogen, ammonia, biofuels, etc.
Facilities and infrastructure for electric energy supply	Construction of facilities and infrastructure for electric energy supply in the port domain. These strategies include the electrification of docks (i.e., cold ironing) and facilities for charging electric vehicles.
Land-use conversion	Strategies for converting the current intended use of specific port areas in favour of local communities. They include the construction of new neighbourhoods, parks, museums, and edutainment centres focused on the maritime logistics industry, as well as touristic attractions.
Research and Development	Projects and studies carried out by the AdSP (alone or with scientific/industrial partners) to achieve a more sustainable port.

Source: Authors' elaboration.

Most of the green actions/intervention performed/planned by the sample PSA addresses improvement in energy efficiency (26% of the green strategies), followed by green policies and measures (19%), and research and development investments (15%) (Figure 10).

FIGURE 10. GREEN OPTIONS PERFORMED/PLANNED BY THE 4 SAMPLE PSAS IN THEIR DEASP.



Source: Authors' elaboration.

It is specified that information has been provided regarding the green strategies related to the DEASPs of only the PSA of the Western Ligurian Sea, Eastern Ligurian Sea, North Tyrrhenian Sea and Sardinian Sea, as they account for 36% of cargo and 32% of passengers transported in the country in 2019 (Assoporti, 2019), and they appear to be particularly committed to implementing green strategies to reduce the negative environmental impacts of the industry.

According to what emerges from the DEASP of the Italian PSAs, it is clear that there is an urgency for Italian ports to meet the requirements set by the European Green Deal and the recent EU legislative proposals "Fit for 55" for reducing by at least 55% GHG emissions by 2030. Said requirements, particularly, can also be achieved through a strong introduction of the emerging digital technologies to favor green transaction and through the implementation of innovative technologies in the field of the energy production. Therefore, port infrastructures generate unprecedented business opportunities and hold valuable market potential for high-tech companies which provide solutions for battery electric / hybrid electric propulsion systems which could be implemented in port areas (see Figure 11).

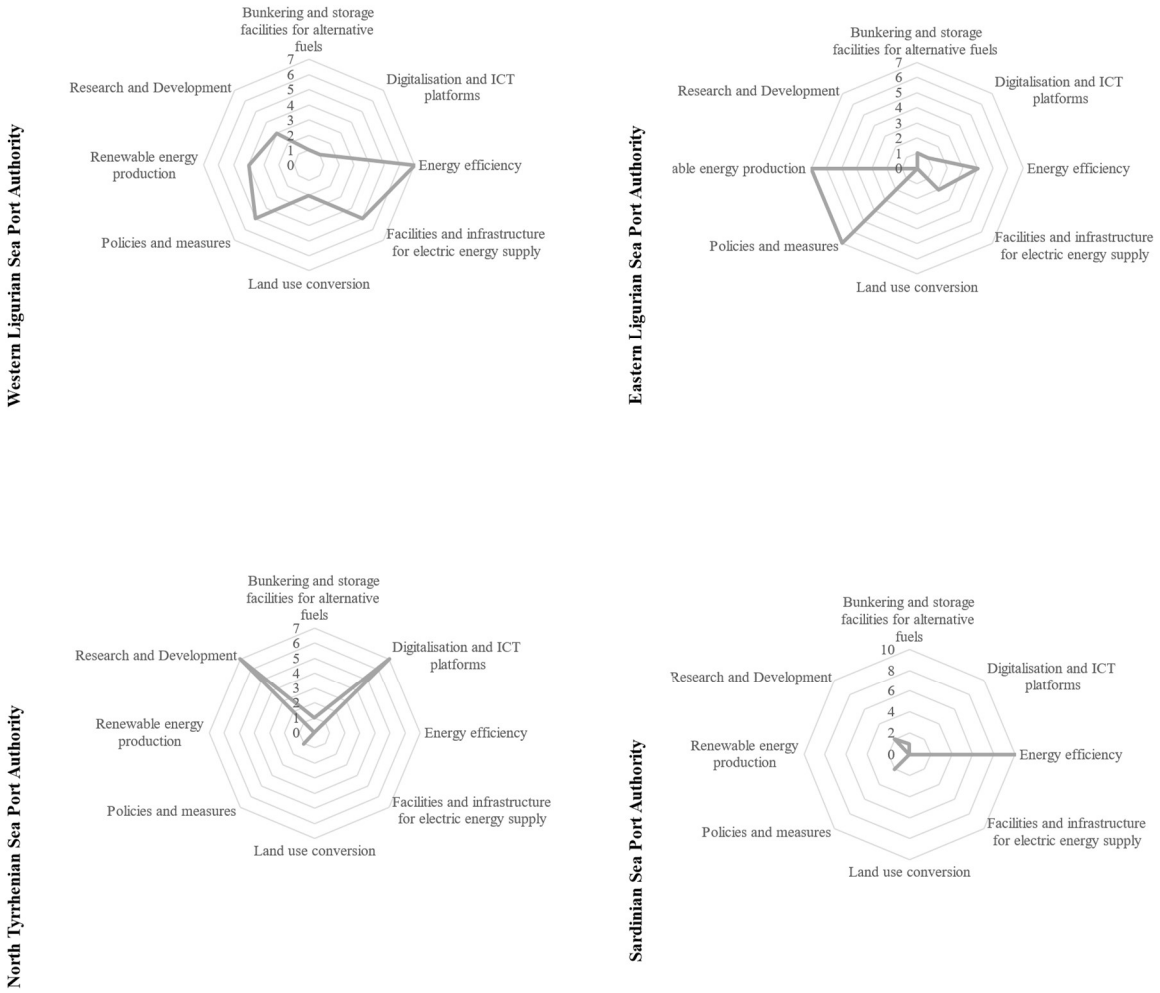
FIGURE 11. PORT ELECTRIFICATION SOLUTIONS.

Source: Authors' elaboration.

In this vein, the analysis of the DEASP developed by the aforementioned sample PSA provides useful insights of the energy and environmental programs of the Italian Port Authorities and unveils impressive market potentials for providers of battery electric and cold ironing solution.

Below, Figure 12 reports the list of green actions, projects and programs included in the DEASP of some of the most relevant Italian PSAs, i.e., PSA of the Western Ligurian Sea, PSA of the Eastern Ligurian Sea, PSA of the North Tyrrhenian Sea and PSA of the Sardinian Sea.

FIGURE 12. GREEN OPTIONS PERFORMED/PLANNED BY THE 4 SAMPLE PSA IN THEIR DEASP: SPECIFICITIES.



Source: Authors' elaboration.

Therefore, additional business opportunities for Norwegian technologies providers exist both in the areas of energy mix and energy production (see Section 2.b and 2.c, respectively).

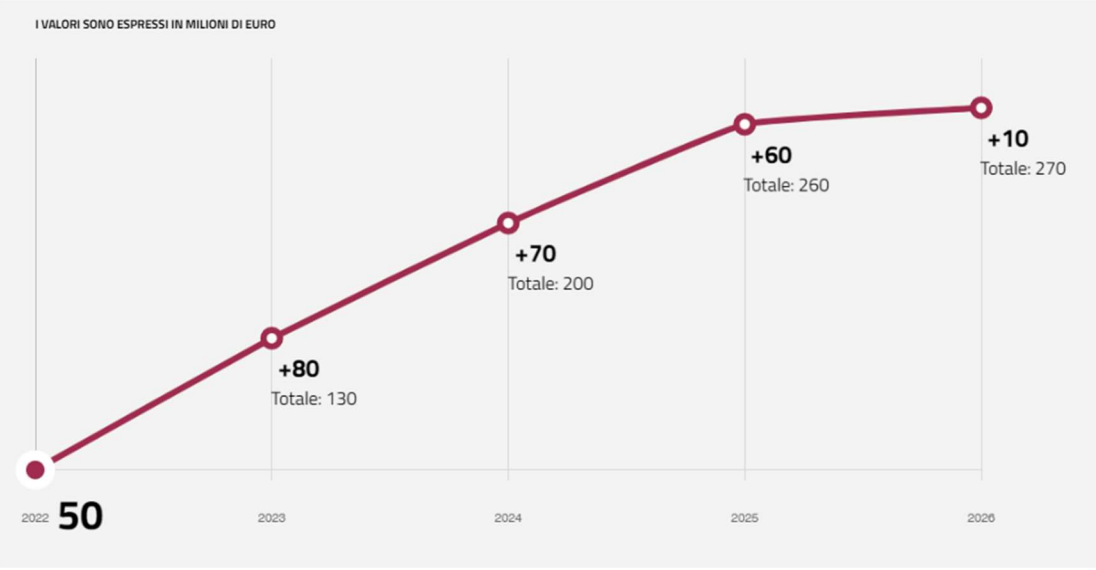
Additional attention towards port sustainability, port resilience and reliability of energy supply sources has emerged after the pandemic crisis and the Russian-Ukrainian conflict. In fact, Italian ports have shown their resilience during the pandemic period, but it has now become essential to strengthen their competitiveness and ensure their sustainable development to invest in advanced technologies in terms of environmental sustainability and digitization, not only to comply with the regulatory constraints dictated by European legislation, but also to diversify the energy supply sources and to meet the changing demands of port service users. In this respect, a key role is played by the PNRR and the National Supplementary Fund (NSF) to the PNRR, which set ambitious and challenging goals for the ecological and digital transition of Italian ports. The diversification of energy supply sources will make the link between ship and port even closer, and solutions will be provided to meet a much more varied demand. The main investments concerning ports infrastructures, planned within the PNRR and NSF to the PNRR,

are contained within the Component 2 of the Mission 3 of the PNRR. In particular, the planned interventions concern:

A. interventions for the environmental sustainability of ports (**green ports**);
B. the development of maritime accessibility and resilience of port infrastructure to climate change;
C. the selective increase in port capacity;
D. the electrification of the docks (Cold Ironing).

Through the interventions for the **environmental sustainability of ports (green ports)**, it will be possible to increase the sustainability of port activities to make such operations compatible with the urban contexts settled in the areas adjacent to the ports, to promote the environmental sustainability of port areas and to conserve the national natural heritage as well as biodiversity, with particular attention to marine biodiversity. Under this intervention, investments will be implemented with the aim of increasing energy efficiency and to promote of the use of energy produced from renewable sources in ports. The implementing entities of the above-mentioned investments are the nine PSA of Central-Northern Italy, which were called upon to indicate in their "Environmental & Energy Planning Documents of the Port System" (DEASP - Documento di Pianificazione Energetica e Ambientale del Sistema Portuale) the projects to be funded through financial resources available in the GREEN PORT framework, which may also include interventions selected from the proposals produced by private concessionaires and/or terminal operators operating within the port areas. The funding program dedicated a total amount of 270 million euros to the interventions for the environmental sustainability of ports (green ports), apportioned between the years from 2022 (investment start year) to 2026 (investment end year) as shown in Figure 13.

FIGURE 13. "GREEN PORTS" FUNDING PROGRAM: BUDGET TEMPORAL ALLOCATION.



Source: italiadomani.gov.it.

The 270 million euros allocated for this intervention are distributed among the 9 PSAs in the north-central region as shown in Figure 14 and Figure 15.

FIGURE 14. FINANCIAL ALLOCATION OF THE BUDGET FOR "GREEN PORTS" PROJECT BY PSAS.

	Autorità di Sistema Portuale	Totale tonn.	Totale TEU	Unità Ro-Ro	Totale Passeggeri	soglia	tonn	teu	roro	passeggeri	Media dei coefficienti di attività	Fattore moltiplicativo (media coeff+2)/3	QUOTA BASE CORRETTA [(media coeff+2)/3]xquota base	QUOTA BASE CORRETTA E ARROTONDATA (milioni di €)
1	Mar Ligure Occidentale	67.151.934	2.669.917	550.130	4.547.261	1	1,87	3,44	1,91	1,40	2,16	1,39	34,63 €	35
2	Mar Ligure Orientale	18.882.849	1.490.537	19.589	649.586	1	0,53	1,92	0,07	0,20	0,68	0,89	22,32 €	22
3	Mar Tirreno Settentrionale	44.973.226	789.833	713.609	9.786.648	1	1,26	1,02	2,48	3,01	1,94	1,31	32,83 €	33
4	Mar Tirreno Centro Settentrionale	14.601.237	112.249	232.942	4.460.979	1	0,41	0,14	0,81	1,37	0,68	0,89	22,36 €	22
5	Mare Adriatico Centrale	11.804.844	176.193	143.874	1.202.973	1	0,33	0,23	0,50	0,37	0,36	0,79	19,64 €	20
6	Mare Adriatico Centro Settentrionale	26.256.248	218.138	66.853	17.536	1	0,73	0,28	0,23	0,01	0,31	0,77	19,27 €	19
7	Mare Adriatico Settentrionale	26.306.185	593.126	79.274	1.814.485	1	0,73	0,76	0,28	0,56	0,58	0,86	21,52 €	22
8	Mare Adriatico Orientale	66.091.743	790.542	227.805	189.261	1	1,85	1,02	0,79	0,06	0,93	0,98	24,40 €	24
9	Mare di Sardegna	46.268.730	151.405	558.677	6.583.298	1	1,29	0,19	1,94	2,03	1,36	1,12	28,02 €	28
	Totale	322.336.996	6.991.940	2.592.753	29.252.027								225	225
	Media per AdSP	35.815.222	776.882	288.084	3.250.225									
	Quota base per AdSP (€)	25,000												
	Proporzione riferimento	Valore medio : Valore riferimento = 1 : x												
	Fonte: https://www.assoporti.it/media/8282/adsp_movimenti_portuali_2019_agg_19febbraio2021.pdf													

Source: Ministry of Ecological Transition, 2021.

FIGURE 15. FINANCIAL ALLOCATION AMONG THE PSAS FOR THE BUDGET RESERVED TO CONCESSIONAIRES.

	Autorità di Sistema Portuale	Totale tonn.	Totale TEU	soglia	tonn	teu	Media dei coefficienti di attività	Fattore moltiplicativo (media coeff+2)/3	QUOTA BASE CORRETTA [(media coeff+2)/3]xquota base	QUOTA BASE CORRETTA E ARROTONDATA (milioni di €)
1	Mar Ligure Occidentale	67.151.934	2.669.917	1	1,87	3,44	2,66	1,55	7.759.718,91 €	8,0
2	Mar Ligure Orientale	18.882.849	1.490.537	1	0,53	1,92	1,22	1,07	5.371.536,31 €	5,5
3	Mar Tirreno Settentrionale	44.973.226	789.833	1	1,26	1,02	1,14	1,05	5.226.976,37 €	5,0
4	Mar Tirreno Centro Settentrionale	14.601.237	112.249	1	0,41	0,14	0,28	0,76	3.793.474,12 €	4,0
5	Mare Adriatico Centrale	11.804.844	176.193	1	0,33	0,23	0,28	0,76	3.796.999,25 €	4,0
6	Mare Adriatico Centro Settentrionale	26.256.248	218.138	1	0,73	0,28	0,51	0,84	4.178.241,24 €	4,0
7	Mare Adriatico Settentrionale	26.306.185	593.126	1	0,73	0,76	0,75	0,92	4.581.639,16 €	4,5
8	Mare Adriatico Orientale	66.091.743	790.542	1	1,85	1,02	1,43	1,14	5.719.113,55 €	5,5
9	Mare di Sardegna	46.268.730	151.405	1	1,29	0,19	0,74	0,91	4.572.301,09 €	4,5
	Totale	322.336.996	6.991.940						45.000.000	45,0
	Media per AdSP	35.815.222	776.882							
	Quota base per AdSP (€)	5.000.000								
	Proporzione riferimento	Valore medio : Valore riferimento = 1 : x								
	Fonte: https://www.assoporti.it/media/8282/adsp_movimenti_portuali_2019_agg_19febbraio2021.pdf									

Source: Ministry of Ecological Transition, 2021.

Through the intervention of the development of **maritime accessibility** and **resilience of port infrastructure to climate change**, it will be possible to improve maritime accessibility through interventions to develop, strengthen and consolidate port infrastructure, with specific regard to dykes, piers and quays, as well as to stimulate the creation of new logistics platforms that are able to meet the changing needs of the sector, with particular reference to the

phenomenon of naval gigantism, which determines the need for logistic-port infrastructures adapted to receive increasingly larger ships, and the energy transition of maritime mobility, an increasingly relevant phenomenon that makes it necessary to equip logistic-port infrastructures with the necessary equipment to meet the new energy demands from ships.

Through the intervention of the **selective increase** in **port capacity**, it will be possible to increase the capacity of some of Italy's largest ports through dredging works, the construction of new piers as well as the creation of new logistics platforms. In addition, also within the scope of this measure, the dry port connections aimed at developing "New Free Zones" nearby and inside of the port of Trieste and the port terminal of Noghere for the transport of cargo of goods will be enhanced, and the foundations for the development of other logistic-industrial activities in the same area will be laid.

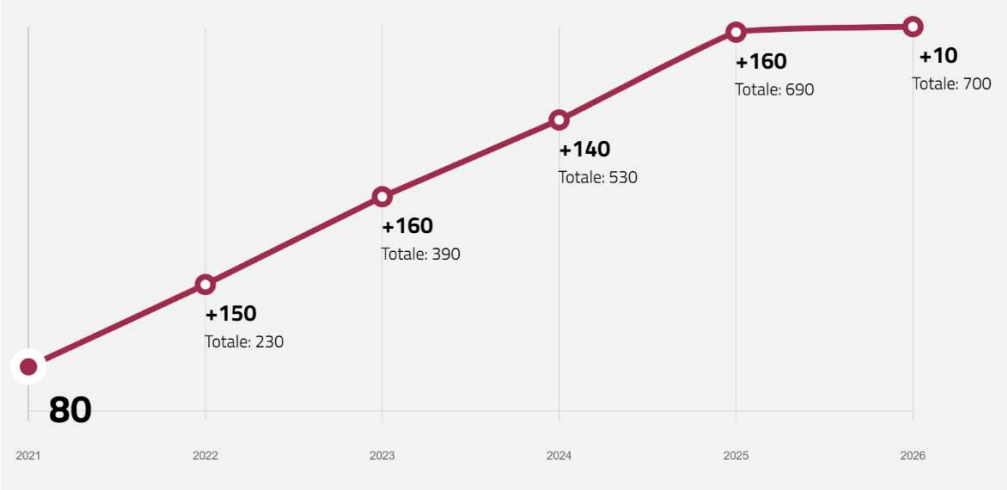
Finally, through investments dedicated to the **electrification of the docks (cold ironing)**, it will be possible to minimize the dependence on fossil fuels of the shipping and port sector and, consequently, to reduce the negative environmental impact attributable to those sectors, mainly by intervening in ports in the core network of the "Trans European Network Transport" or TEN-T Network. The proposed intervention focuses on 34 Italian ports, of which 32 belong to the TEN-T network (Figure 16), and consists in the implementation of a network of systems for the supply of electricity from the port soil to ships during the mooring phase, in order to minimize the use of auxiliary engines on board for the self-production of the necessary electricity, with significant reduction in terms of emissions of CO_2, nitrogen oxides and particulate matter, as well as noise impact. Currently in Italy, unlike in other European countries, the presence of infrastructure for Cold Ironing is pretty limited, and those present are not capable of powering cruise ships, ferries or other types of ships characterized by high energy consumption but provide electricity to ship repair terminals or cranes intended for cargo handling.

Therefore, the line of investments included in the Complementary Plan to the PNRR functional to electrify the docks is intended to bring about a strong reduction in the environmental impact attributable to the shipping sector in the port area, allowing at the same time to increase the competitiveness of Italian ports by offering ancillary energy-related services requested by national and international shipowners and shipping companies. More in detail, the Italian PNRR has allocated a total amount of € 700 million for the electrification of port docks, and the investment will be carried out in the timeframe 2021 – 2026 according to the distribution reported in Figure 17.

FIGURE 16. ITALIAN PORTS INCLUDED IN THE TRANS-EUROPEAN TRANSPORT NETWORK (TEN-T).

Source: Report "Porti Verdi: la rotta per uno sviluppo sostenibile", Enel X & Legambiente, 2021.

FIGURE 17. ALLOCATION OF RESOURCES FOR BERTH ELECTRIFICATION 2021 - 2026.

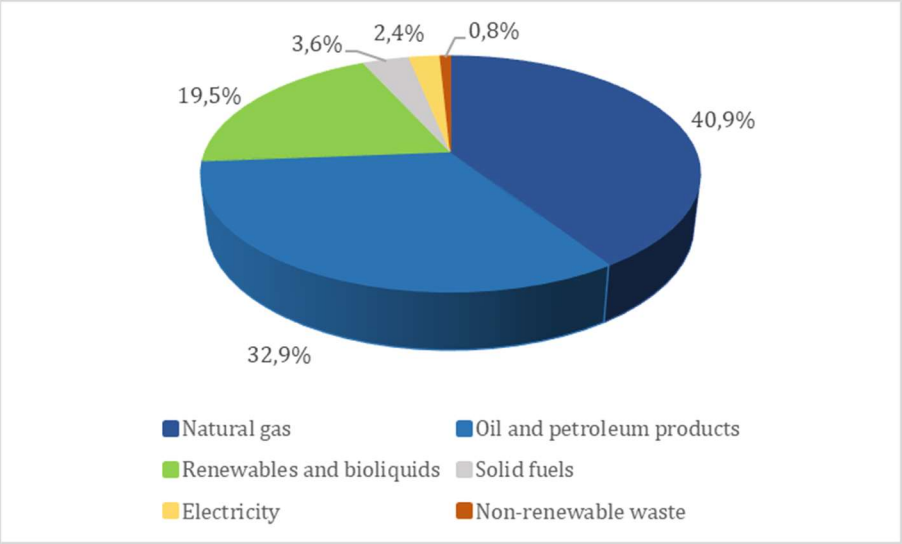


Source: italiadomani.gov.it.

2.B. Energy mix

According to the Annual Report on the current energy mix in Italy produced by the Ministry of Ecological Transition in July 2022, primary energy demand (in terms of gross energy availability), stood at 153,024 thousand tons of oil equivalent (ktoe), in 2021 with an annual increase of 6.2% respect to 2020, compared to a 6.6% percent increase in GDP. Italian energy mix is represented by the energy sources reported in Figure 18.

FIGURE 18 - ITALIAN ENERGY MIX.



Source: Ministry of Ecological Transition, 2022.

Italy's dependence on foreign sources of supply is strong: in 2021, domestic production of energy has decreased by a total of 3,4% while net energy imports increased by 8.3%. The share of net imports in gross energy availability, an indicator of the country's degree of foreign dependence, increased: from 73.5 percent in 2020 to 74.9 percent in 2021.

In 2021, final energy consumption increased by a total of 11.4% Year on Year (YoY), to 114,781 thousand tons of oil equivalent. The increase affected all sectors, especially transportation (+22.1%), residential (+8.2%) and industry (+6.7%).

Electricity demand in 2021 was 317.6 TWh (provisional data), up 5,5% from the previous year, but still slightly below pre-pandemic levels (-0.6% compared to 2019). While the traditional thermoelectric source remains the one with the largest demand coverage, the wind source in 2021 reached an unprecedented threshold of nearly 21 TWh of production. In 2021, 86,5% of the electricity demand was met by domestic production, and the remaining 13,5 percent by net imports from abroad. The largest contribution to power generation comes from nonrenewable thermoelectric (59.7% of total power generated), with 6.1% from plants powered by solid fuels, 3.8% from petroleum products and other fuels, and 49.9% from plants powered by natural gas.

In 2021, Renewable Energy Sources (RES), were widely adopted with the national energy supply system for both power generation, heat production and in the form of biofuels; overall, the share of RES on the gross final consumption is estimated at around 19 %. In this regard, Italy's renewable energy incentive system, particularly in the electricity sector, has played a decisive role over the past years in the spread of plants throughout the country and the achievement of high levels of renewable penetration in the electricity sector. At the end of 2021, the total number of incentivized renewable electricity generation plants reached one million, with a capacity of about 38 GW and incentivized renewable energy of 65 TWh.

In the light of the recent trends in the overall geo-political arena, and specifically due to the Russian-Ukrainian conflict that has determined significant negative effects on the global supply

chain for energy, as well as the growing attention paid by the Italian government and in particular by the maritime-port sector as a result of the increasing issues related to environment and climate change, there is now a particular need for Italy to rethink its energy mix, with a transition from the use of fossil sources to sustainable sources.

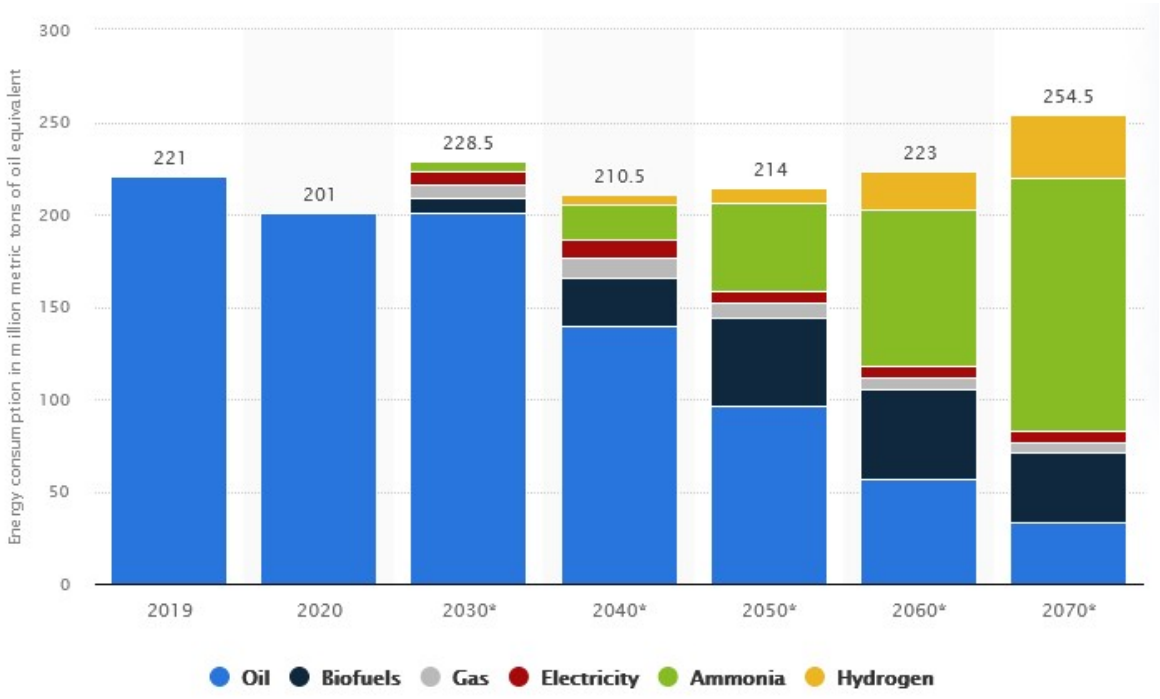
In fact, Italy imported from Russia, in 2021, 40% of his natural gas, the primary energy source within the current national energy mix and has therefore become decisive for the future of the country to make a difficult and prompt conversion of energy policies and strategies in order to break free from Moscow, with the goal of reducing national dependence on Russian gas as quickly as possible. This challenge, however daunting, also represents an opportunity for the country to rebalance its energy mix in favor of sustainable energy sources, and port infrastructure will play a crucial role within this transition. As a matter of fact, national energy supply security depends first and foremost, of course, on the quantities of resources available and their continuity in supply systems, but an additional decisive factor in its preservation is the state of transportation services, interconnection infrastructure and the grid. Therefore, it seems clear that the substantial investments that will be made in order to strengthen the country's logistics and port system (with particular reference to the interventions planned within the PNRR), also and above in order to make it more environmentally sustainable, will contribute to improve the Italian energy mix with important positive effects on the economy and sustainability of the entire peninsula. The path towards the diversification of the energy mix within the Italian port contexts finds the main obstacle in the current infrastructural situation, which is still affected by significant shortcomings. Such infrastructural deficiencies make it difficult to establish a widespread network of energy supply, with regards to LNG and electricity supply.

In this context, the further development potential for Italian port hubs appears to be evident, since port nodes can no longer be considered exclusively as energy-demanding infrastructures, but on the contrary represent strategic actors in decarbonizing the entire maritime transport sector.

The willingness of Italian port to play a crucial role in supporting the increase of maritime energy efficiency has already been proved by the numerous initiatives and projects that have affected Italian ports, which are now working to respond to the ever-changing demands of the market and the communities.

If we consider the current and future energy mix of maritime operators, it is easy to observe a progressive abandonment of traditional fuels in favor of alternative solutions such as gas, electricity, ammonia and hydrogen, as reported in Figure 19.

FIGURE 19. CURRENT AND FUTURE MARITIME ENERGY MIX.



Source: Statista, 2022.

In this perspective, Italian ports will need to support the progressive withdrawal of fossil fuels, setting up their port infrastructures for the production and supply of new energy sources.

2.C. Energy Supply.

When it comes to the national energy supply system, Italy is highly dependent on foreign energy suppliers and that domestic production appears to be rather limited. Specifically, in 2021, domestic production of energy sources decreased by a total of 3.4% while net energy imports increased by 8.3%. The share of net imports in gross energy availability, an indicator of the country's degree of foreign dependence, increased: from 73.5% in 2020 to 74.9% in 2021. On the other hand, as far as electricity is concerned, in 2021, 86.5% of the demand was satisfied by domestic production, which, net of energy absorbed for auxiliary and pumping services, amounted to 274.8 TWh (+2.2 percent compared to 2020), and the remaining 13.5% by net imports from abroad, which amounted to 42.8 TWh.

As discussed extensively in the previous sections, the current geopolitical settings and the increasing attention to environment and climate change have triggered toward greater attention in guaranteeing national energy sources, being renewable sources preferred (e.g., photovoltaics, wind and hydro).

Relatedly, the national port system is expected to significantly rethink the general vision and the strategic approach to its energy supply, and to alternative sources that can provide energy to ships, which are manifesting new exigency in terms of the type of energy they need.

In particular, the shipping industry is carrying on a process of energy transition to the use of cleaner fuels, such as LNG, ammonia, and biofuels, and to the use of electricity, through the

employment of hybrid engines, electric engines and batteries. Therefore, port infrastructures are called to take the pace with ongoing trends in port users' requests. In this perspective, ports are expected to invest into infrastructural endowment for LNG bunkering/storage as well as Cold Ironing solutions. A key role is played by the PNRR, which, as outlined above, envisages significant investments to make port infrastructure more sustainable and capable of providing energy sources to ships calling Italian ports, in line with the new needs of the sector (see interventions planned within the Green Ports Project and actions aimed at electrifying docks and berths in ports reported in the section 2.A).

A critical role for greening the overall Italian port system aiming at providing the energy sources required by the maritime transport sector is played by programs, interventions and actions planned in the DEASP of the national PSAs: in fact, as briefly mentioned above, an important number of interventions planned within the DEASPs concern the development and installation of renewable energy production systems in the ports domain (with particular regard to the installation of photovoltaic panels as well as the use of wind and wave power to produce energy), the construction of bunkering and storage facilities for alternative fuels in the port domain (with particular regard to Liquefied Natural Gas, Hydrogen, Ammonia and Biofuels), and the construction of facilities and infrastructure for electric energy supply in the ports domain (with specific regard to the electrification of docks (i.e. Cold Ironing) and facilities for charging electric vehicles).

Figure 20 and

Figure *21* provide an overview of the interventions regarding the development and installation of renewable energy production systems, the construction of bunkering and storage facilities for alternative fuels and the construction of facilities and infrastructure for electric energy supply that some of the most relevant Italian PSA (i.e. PSA of the Western Ligurian Sea, the Eastern Ligurian Sea, the North Tyrrhenian Sea and the Sardinian Sea) have planned within their DEASPs. Figures summarize for each sample PSA the following profiles: name of the project; timeframe period; a brief description of the intervention; budget provided within the DEASP; environmental benefits resulting from the implementation of the intervention; green strategy typology.

Examining the most diffuse technological solutions adopted for supplying energy along with the interventions planned in the DEASPs of the sample PSAs (see Figure 22), it is possible to note that there is a clear preference for photovoltaic solutions for energy production in the port area and the construction of the infrastructure and facilities for Cold Ironing to the ships berthed in ports.

These results are perfectly in line with the shipping industry requirements as well as with the country's goals, as it will be possible to facilitate the energy transition process that the shipping sector is experiencing through the construction of the infrastructure for Cold Ironing by producing internally, and from sustainable sources, the necessary electricity.

FIGURE 20. INTERVENTIONS IN THE AREA OF ENERGY SUPPLY OF THE PSA UNDER CONSIDERATION.

Port Authority	Project title	Timeframe period	Description	Budget (M €)	Environmental benefits	GS Typology
Eastern Ligurian Sea	Development of infrastructure LNG supply	nd	Development of a series of scenarios and projects to implement a strategic road map for the LNG supply chain in the Port of La Spezia.	nd	Supporting the deployment of LNG as a greener maritime fuel.	Bunkering and storage facilities for alternative fuels
Eastern Ligurian Sea	Electrification of the docks in the first port basin	2020-2025	Realization of cold ironing infrastructure in the port of La Spezia powered through an independent system of 10MW.	7,7	Expected reduction of CO2eq emissions: 3100 t/year (with electricity supply from 100% renewable sockets compared to the use of BTZ oil)	Facilities and infrastructure for electric energy supply
Eastern Ligurian Sea	Electrification of the docks in the Gulf Terminal	2021-2023	Realization of cold ironing infrastructure and network through one connection of 6 MW and one of 4 MW which will supply two ships simultaneously.	5,7	Expected reduction of CO2eq emissions: 1946 t/year (with electricity supply from 100% renewable sockets compared to the use of BTZ oil)	Facilities and infrastructure for electric energy supply
Eastern Ligurian Sea	Photovoltaic electricity production-Port of La Spezia	nd	Feasibility analysis to produce electricity from photovoltaics through an approach based on a GIS (Geographic Information System), which has allowed to realize a mapping of solar radiation and potential production of energy.	0,4	Supporting the deployment of renewable energy and cut of GHG emissions and pollutants.	Renewable energy production
Eastern Ligurian Sea	Photovoltaic modules integrated into the soundproof barrier in the port city of La Spezia	2018-2019	Realization of a photovoltaic system to be installed on the road sound barriers near the road underpass with the adoption of photovoltaic modules of size 1000x1560mm with a peak power of 327 Wp.	0,1	The expected reduction of CO2eq emissions by 15 t/year.	Renewable energy production
Eastern Ligurian Sea	Photovoltaic production system on the roof of the existing warehouse-Cantieri Apuania	2019-2020	Installation of a 100 kWp photovoltaic system on the roof of an existing shed: 9 strings are polycrystalline Sunerg XP 60/156-250, 250 Wp each.	0,1	The expected reduction of CO2eq emissions by 70 t/year.	Renewable energy production
Eastern Ligurian Sea	Photovoltaic production system on the roof of warehouses-Ferretti SpA	Concluded in 2020	Installation of a 244.8 kWp photovoltaic system on the roof of two warehouses in the port of La Spezia.	0,3	The expected reduction of CO2eq emissions by 129 t/year.	Renewable energy production
Eastern Ligurian Sea	Two photovoltaic production systems on the roofs of two warehouses in the project-The Italian Sea Group	2020-2021	Installation of two photovoltaic systems of 100 kWp each on the roof of two new warehouses.	0,3	Reduction of CO2eq emissions expected by 118 t/year.	Renewable energy production
Eastern Ligurian Sea	Wave power generation	nd	A preliminary analysis for the installation of wave power systems in the Gulf of La Spezia and Marina di Carrara.	nd	Supporting the deployment of renewable energy and cut of GHG emissions and pollutants.	Renewable energy production
Eastern Ligurian Sea	Wind power generation	nd	Installation of wind power generation systems in the Gulf of La Spezia and Marina di Carrara, analysing the data collected by the anemometer stations.	nd	Supporting the deployment of renewable energy and cut of GHG emissions and pollutants.	Renewable energy production
North Tyrrhenian Sea	GNL FACILE	2018 -2021	Encourage a progressive reduction in the use of the most polluting fuels and dependence on oil and promoting the deployment of LNG for maritime propulsion.	2,3	The adoption of LNG for shipping will reduce about 20% of CO2, over 99% of SOx and PM, and 80% of NOx emitted by boats.	Bunkering and storage facilities for alternative fuels
Sardinian Sea	GNL FACILE	2018 -2021	Encourage a progressive reduction in the use of the most polluting fuels and dependence on oil and promoting the deployment of LNG for maritime propulsion.	2,3	The adoption of LNG for shipping will reduce about 20% of CO2, over 99% of SOx and PM, and 80% of NOx emitted by boats.	Bunkering and storage facilities for alternative fuels

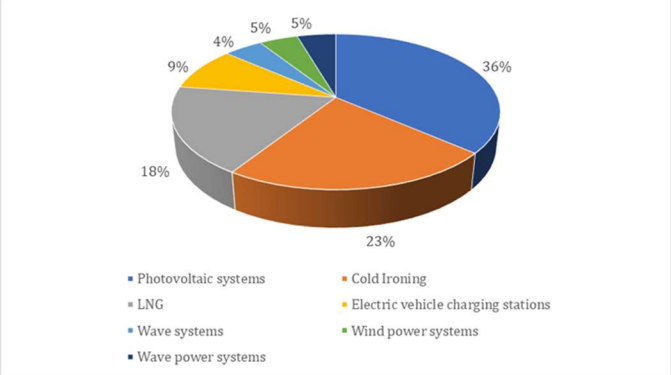
Source: Authors' elaboration.

FIGURE 21. INTERVENTIONS IN THE AREA OF ENERGY SUPPLY OF THE PSA UNDER CONSIDERATION.

Port Authority	Project title	Timeframe period	Description	Budget (M €)	Environmental benefits	GS Typology
Western Ligurian Sea	GNL FACILE	2018-2021	Encourage a progressive reduction in the use of the most polluting fuels and dependence on oil and promoting the deployment of LNG for maritime propulsion.	2,3	The adoption of LNG for shipping will reduce about 20% of CO2, over 99% of SOx and PM, and 80% of NOx emitted by boats.	Bunkering and storage facilities for alternative fuels
Western Ligurian Sea	Cold Ironing-Genoa Cruises and Ferries terminal	2021-ongoing	Realization of cold ironing infrastructure in the Genoa Cruises and Ferries terminal.	29,4	Annual reduction of CO2, NOx and PM2.5 emissions parameterised based on the results of the electrification of the docks of the Genova Prà container terminal.	Facilities and infrastructure for electric energy supply
Western Ligurian Sea	Cold Ironing-Terminal Container Genova Pra'	2021-ongoing	Realization of cold ironing infrastructure in the Genoa Prà terminal.	9	Annual reduction of CO2 emissions equal to 2,800 t/year, NOx equal to 89.3 t/year, PM2.5 equal to 2.1 t/year. This reduction is due to the reduction in MGO consumption of 1,520 t/year.	Facilities and infrastructure for electric energy supply
Western Ligurian Sea	INES	2015-2021	Electrification of the docks of the port terminal of Genova Prà to achieve a significant reduction of polluting and acoustic emissions produced by ships at berth.	4,5	Annual reduction of CO2 emissions equal to 2,800 t/year, NOx equal to 89.3 t/year, PM2.5 equal to 2.1 t/year. This reduction is due to the reduction in MGO consumption of 1,520 t/year.	Facilities and infrastructure for electric energy supply
Western Ligurian Sea	Installation of electric vehicle charging stations and purchase of vehicles-Port of Genoa	2020-2022	Installation of electric vehicle charging stations and interventions for the gradual replacement of service cars and commercial vehicles with new electric traction vehicles.	1,5	Annual reduction of CO2 emissions equal to 1,170 t/year, NOx equal to 4.9 t/year, PM2.5 equal to 0.03 t/year. This reduction is mainly attributable to the reduction in the use of diesel and petrol.	Facilities and infrastructure for electric energy supply
Western Ligurian Sea	Installation of electric vehicle charging stations and purchase of vehicles-Port of Savona/Vado Ligure	2020-2022	Installation of electric vehicle charging stations and interventions for the gradual replacement of service cars and commercial vehicles with new electric traction vehicles.	0,5	Annual reduction of CO2 emissions equal to 150 t/year, NOx equal to 0.6 t/year. This reduction is mainly attributable to the reduction in the use of diesel and petrol.	Facilities and infrastructure for electric energy supply
Western Ligurian Sea	Photovoltaic system in the Stazioni Marittime Terminal-Port of Genoa	2020-2021	Installation of a photovoltaic system on the buildings of Stazione Marittima and replacement of natural gas boiler with air/water heat pump.	0,4	Annual reduction of CO2 emissions equal to 103 t/year (of which 23 t/year for reducing electricity consumption and 80 t/year for reducing LNG consumption), NOx equal to 0.1 t/year.	Renewable energy production
Western Ligurian Sea	Photovoltaic systems on roofs of buildings located within the state boundaries-Port of Genoa	2020-2022	Realization of photovoltaic systems on the roof surfaces of buildings located within the state property boundaries in the port of Genoa. Total exploitable surface 123.880 sqm.	9,6	Reduction of annual CO2 emissions of 3,100 t/year, NOx of 2.4 t/year, PM2.5 of 0.1 t/year.	Renewable energy production
Western Ligurian Sea	Photovoltaic systems on roofs of buildings located within the state boundaries-Port of Savona/Vado Ligure	2020-2022	Realization of photovoltaic systems on the roof surfaces of buildings located within the state-owned boundaries in the port of Savona-Vado Ligure. Total exploitable surface 54.720 sqm.	4,3	Reduction of annual CO2 emissions of 1,600 t/year of NOx of 1.2 t/year.	Renewable energy production
Western Ligurian Sea	Wave energy-Port of Genoa	2020-2022	Realization of a 1:1 scale prototype of the OWCM (Oscillating Water Column Motor) system.	15	Annual reduction of CO2 emissions equal to 1,600 t/year, NOx equal to 1.2 t/year.	Renewable energy production

Source: Authors' elaboration.

FIGURE 22. TECHNOLOGICAL SOLUTIONS ADOPTED BY SAMPLE PSA FOR GREENING PORTS (NO. OF PROJECTS PLANNED IN DEASP).

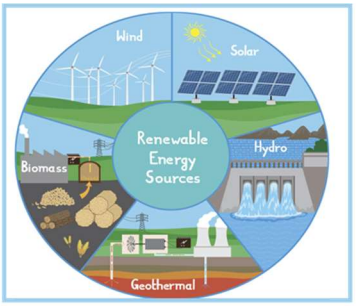


Source: Authors' elaboration.

FIGURE 23. MAIN HIGHLIGHTS - CHAPTER 2.

1. Key role of PSA and DEASPs in programming and planning interventions for energy efficiency, renewable energy production, green policies & measures, R&D.
2. Therefore, port infrastructures generate unprecedented business opportunities in Italy and hold valuable market potential for solutions related to battery electric / hybrid electric propulsion systems which could be implemented in port areas (see Figure 11).

1. Current geopolitical context and trend in sustainability constitute an opportunity for the country to rebalance its energy mix in favor of sustainable energy sources;
2. Italian port infrastructures will play a crucial role within this transition.



Italian ports are making an effort to trigger a transition process towards renewable energy production systems, the construction of bunkering and storage facilities for alternative fuels and the construction of facilities and infrastructure for electric energy supply in the ports domain.

Source: Authors' elaboration.

CHAPTER III

MAPPING OF CUSTOMER GROUPS – PURCHASING SYSTEM

This Section maps customer groups in Italy and provide managerial insights from the mostly diffused national purchasing systems to facilitate Norwegian technological providers of green technologies for hybrid and electric solutions for shipping companies operating ferry, service, and offshore vessels.

For this aim, in Section 1.A, main central decision makers and customers for the different vessel types are scrutinized and reported. In particular, the group owner, registered owner, and operator of more than 382 vessels (266 ferry, ro-ro and ro-pax ships; 22 offshore vessels and 94 service vessels) are identified as well as valuable data and information provided. Relatedly, Section 3.B provides useful insights on the major Italian shipping companies operating current vessels in the sample industries, through multiple business cases analysis. Section 3.C is devoted to describing how a public tender is announced in Italy and which channels are used for the disclosure of tenders related to the shipping and port industry. In Section 3.D, grounding on publicly available data and information, larger contracts expected to be announced in Italy in the future are scrutinized. Finally, the last section (3.E.) summarizes special local conditions thar should be considered when entering the Italian market through dedicated branches or subsidiaries.

3.A. Central decision makers / customers for the different vessel types (ref priority vessel types).

Governance and shareholding settings are notably a key issue for understanding the practical ownership structure of complex business groups with several business affiliation, branches and subsidiaries as well as identifying effective decision-making processes which affect the shipping and port domain. Relatedly, to provide an overview of the central decision makers/customer for the different vessel types in the sample businesses (i.e., ferry, service, and offshore fleets), a detailed empirical investigation has been performed on the dataset of vessels owner or operated by Italian group owners/ultimate owners, registered owners or operators.

In particular, once accomplished data gathering and cleaning tasks related to the sample of vessels described in section 1.E., it was possible map the most prominent central decision makers/customers for the different vessel types.

For the aim of the study, the distribution by number of ships both with reference to the variable “Group Owner” and with reference to the variable “Registered Owner” were taken into account, as different degree of centralization exists in terms of decision-making processes in the various shipping businesses included in the analysis. These data also provide useful insights for understanding the different degree of market concentration in the sample Italian shipping businesses.

When it comes to the "ferry/ro-pax/ro-ro" segment, Table 11 unveils that 7 leading actors are the key players in the Italian market, i.e.:

- ✓ Grimaldi Group SpA (80 ships) mainly focused on ro-pax and ro-ro activities
- ✓ Grandi Navi Veloci SpA (with ultimate owner Mediterranean Shipping Company – 25 ships) which is the key player in the ferry and ro-pax business
- ✓ Moby SpA (18 ships) and Tirrenia di Navigazione SpA (25 ships), which share the same ultimate owner, i.e., Onorato Armatori S.p.A. (Onorato Group has entered an important alliance for the rescue of the company Moby SpA with the MSC Group. Consequently, the alliance makes the group MSC the main shipowner in the maritime sector).
- ✓ Ignazio Messina & C Spa (7 ro-ro ships) which is part of the Messina Group;
- ✓ Caronte Shipping SpA with 30 ships characterized by a significant lower size respect to the fleet of the prior competitors)
- ✓ Tourship Group with 13 ships belonging to the corporate fleet.

Data unveil an undoubted sever market concentration with these 7 key player account for 74.5% of the overall fleet in terms of number of vessels, 93% in terms of total Gross Tonnage (GT) and 93.5% in terms of ro-ro lane meters capacity. These data allow to identify the Central decision makers / customers who shape the ferry, ro-pax and ro-ro business in Italy. Table 11 also provide useful insights on the average size and age of the vessels belonging to each group owner, including ships in different operative conditions (e.g., in service/commission, in casualty, launched, keel laid, etc.), whereas Table 12 compares data related only to ships in service/commission.

TABLE 11. FERRY, RO-PAX & RO-RO SAMPLE VESSELS: DISTRIBUTION BY GROUP OWNER (OVERALL SAMPLE SHIPS).

Groupowner	NO. Of ferry/ro-pax/ ro-ro ships	Fleet GT (Gross Tonnage)	Fleet RORO Lanes Length (meters)	Vessels avg. Age (years)	Vessel avg. GT (Gross Tonnage)	Vessels avg. Length (meters)	Vessels avg. Draught (meters)	Vessels avg. Breadth (meters)
Grimaldi Group SpA	80	3,870,963	300,297	12.2	48,387.0	213.4	8.3	30.6
Grandi Navi Veloci SpA	25	879,967	57,192	17.8	35,198.7	192.1	5.7	27.3
Moby SpA	18	432,131	23,288	35.5	24,007.3	153.8	5.8	23.5
Ignazio Messina & C SpA	7	356,386	44,450	8.3	50,912.3	239.4	11.1	37.5
Tirrenia di Navigazione SpA	25	323,195	19,105	28.8	12,927.8	118.1	4.7	18.2
Tourship Group	13	319,686	17,334	31.8	24,591.2	161.4	6.0	23.7
Caronte Shipping SpA	30	140,836	7,757	34.2	4,694.5	98.5	4.0	17.0
Unknown	12	106,906	6,155	47.7	8,908.8	93.2	3.9	15.0
Frittelli Maritime Group SpA	3	58,398	4,760	30.7	19,466.0	167.5	6.1	24.3
Visentini Giovanni Transporti	2	51,459	4,530	10.0	25,729.5	184.1	7.1	25.9
St Peter Line Rus LLC	1	37,583	1,120	36.0	37,583.0	176.8	6.7	28.4
Siem Shipping Inc	1	32,936	4,076	4.0	32,936.0	209.8	6.8	26.0
CLdN Shipping SA	1	29,429	3,663	10.0	29,429.0	193.0	8.6	26.0
Snav SpA	2	23,887	900	32.0	11,943.5	104.0	4.3	21.0
Ernst Russ AG	2	20,976	3,248	23.0	10,488.0	153.4	7.0	20.6
Toll Transport Pty Ltd	1	20,343	2,378	23.0	20,343.0	184.0	6.4	23.6
Peter Doehle Schiffahrts-KG	1	18,265	2,500	22.0	18,265.0	174.0	6.8	25.0
Delcomar SAS	11	12,750	951	38.5	1,159.1	68.7	2.6	14.1
Seamed Trading Shipping Srl	1	12,711	780	41.0	12,711.0	129.6	5.0	21.0
Medmar Navi SpA	7	11,186	980	47.0	1,598.0	75.1	3.3	13.4
Rete Ferroviaria Italiana	3	10,507	550	4.7	3,502.3	118.4	3.8	18.2
Amadeus SpA	1	8,166	778	36.0	8,166.0	113.6	4.7	18.7
BN di Navigazione SpA	1	4,997	345	25.0	4,997.0	113.6	4.8	18.7
ACTV	6	3,223	-	38.3	537.2	58.3	1.5	12.6
Libera del Golfo Srl	1	2,312	-	23.0	2,312.0	60.0	3.0	16.5
Gestour Srl	2	2,176	190	44.0	1,088.0	61.8	3.5	12.1
Marnavi SpA	2	1,317	203	55.5	658.5	65.2	2.2	12.4
Ges Tur SNC	1	1,280	-	58.0	1,280.0	55.8	2.8	11.0
SNAP	1	1,246	-	49.0	1,246.0	47.5	3.0	11.7
Palombo Agenzia	2	946	55	41.0	473.0	52.1	2.4	9.1
Tra Spe Mar Srl	1	820	-	54.0	820.0	82.7	2.3	10.2
Nuova Naviservice Srl	1	699	-	57.0	699.0	60.3	2.9	9.3
Procida Lines 2000	1	222	-	55.0	222.0	33.7	2.7	8.5
Overall sample fleet	**266**	**6,797,904**	**507,585**	**25.7**	**25,556.0**	**153.4**	**5.9**	**23.2**

Source: Authors' elaboration.

TABLE 12. FERRY, RO-PAX & RO-RO SAMPLE VESSELS: DISTRIBUTION BY GROUP OWNER (IN SERVICE/COMMISSION SAMPLE SHIPS).

Groupowner	NO. Of ferry/ro-pax/ ro-ro ships	Fleet GT (Gross Tonnage)	Fleet RORO Lanes Length (meters)	Vessels avg. Age (years)	Vessel avg. GT (Gross Tonnage)	Vessels avg. Length (meters)	Vessels avg. Draught (meters)	Vessels avg. Breadth (meters)
Grimaldi Group SpA	73	3,296,388	264,297	13.5	45,156.0	210.0	8.1	29.8
Grandi Navi Veloci SpA	21	691,611	44,792	21.8	32,933.9	187.2	6.8	26.8
Ignazio Messina & C SpA	7	356,386	44,450	8.3	50,912.3	239.4	11.1	37.5
Tirrenia di Navigazione SpA	25	323,195	19,105	28.8	12,927.8	118.1	4.7	18.2
Tourship Group	13	319,686	17,334	31.8	24,591.2	161.4	6.0	23.7
Moby SpA	16	293,131	15,758	40.0	18,320.7	143.3	5.6	22.4
Caronte Shipping SpA	29	132,058	7,757	35.4	4,553.7	97.3	4.0	16.9
Unknown	11	98,672	5,735	52.1	8,970.2	91.6	3.8	14.6
Frittelli Maritime Group SpA	3	58,398	4,760	30.7	19,466.0	167.5	6.1	24.3
Visentini Giovanni Transporti	2	51,459	4,530	10.0	25,729.5	184.1	7.1	25.9
St Peter Line Rus LLC	1	37,583	1,120	36.0	37,583.0	176.8	6.7	28.4
Siem Shipping Inc	1	32,936	4,076	4.0	32,936.0	209.8	6.8	26.0
CLdN Shipping SA	1	29,429	3,663	10.0	29,429.0	193.0	8.6	26.0
Snav SpA	2	23,887	900	32.0	11,943.5	104.0	4.3	21.0
Ernst Russ AG	2	20,976	3,248	23.0	10,488.0	153.4	7.0	20.6
Toll Transport Pty Ltd	1	20,343	2,378	23.0	20,343.0	184.0	6.4	23.6
Peter Doehle Schiffahrts-KG	1	18,265	2,500	22.0	18,265.0	174.0	6.8	25.0
Delcomar SAS	11	12,750	951	38.5	1,159.1	68.7	2.6	14.1
Medmar Navi SpA	7	11,186	980	47.0	1,598.0	75.1	3.3	13.4
Rete Ferroviaria Italiana	3	10,507	550	4.7	3,502.3	118.4	3.8	18.2
Amadeus SpA	1	8,166	778	36.0	8,166.0	113.6	4.7	18.7
BN di Navigazione SpA	1	4,997	345	25.0	4,997.0	113.6	4.8	18.7
ACTV	6	3,223	-	38.3	537.2	58.3	1.5	12.6
Libera del Golfo Srl	1	2,312	-	23.0	2,312.0	60.0	3.0	16.5
Gestour Srl	2	2,176	190	44.0	1,088.0	61.8	3.5	12.1
Marnavi SpA	2	1,317	203	55.5	658.5	65.2	2.2	12.4
Ges Tur SNC	1	1,280	-	58.0	1,280.0	55.8	2.8	11.0
SNAP	1	1,246	-	49.0	1,246.0	47.5	3.0	11.7
Palombo Agenzia	2	946	55	41.0	473.0	52.1	2.4	9.1
Tra Spe Mar Srl	1	820	-	54.0	820.0	82.7	2.3	10.2
Nuova Naviservice Srl	1	699	-	57.0	699.0	60.3	2.9	9.3
Totale complessivo	**249**	**5,866,028**	**450,455**	**27.2**	**23,558.3**	**149.9**	**5.9**	**22.7**

Source: Authors' elaboration.

Unsurprisingly the analysis of the sample fleet carried out by registered owners (Table 13) shows a higher fragmentation, also suggesting the presence of articulated shareholding structures charactering the larger shipping companies operating the market.

Finally, in Table 14, data related to the average and total value of the fleets managed by each operator are reported, shedding lights on the different approaches toward decision-making processes which characterize each shipping company operating in this business.

TABLE 13. FERRY, RO-PAX & RO-RO SAMPLE VESSELS: DISTRIBUTION BY REGISTERED OWNER (OVERALL SAMPLE SHIPS).

Register owner	NO. Of ferry/ro-pax/ ro-ro ships	Fleet GT (Gross Tonnage)	Fleet RORO Lanes Length (meters)	Vessels avg. Age (years)	Vessel avg. GT (Gross Tonnage)	Vessels avg. Length (meters)	Vessels avg. Draught (meters)	Vessels avg. Breadth (meters)
Grimaldi Euromed SpA	34	1,462,208	145,517	11.9	43,006.1	212.7	7.1	28.7
Grimaldi Deep Sea SpA	23	1,282,946	77,157	12.3	55,780.3	218.2	9.8	33.3
Grandi Navi Veloci SpA	20	746,905	44,118	21.2	37,345.3	192.3	5.3	27.6
Grimaldi Group SpA	7	564,310	31,250	0.4	80,615.7	246.4	10.6	37.5
Moby SpA	18	432,131	23,288	35.5	24,007.3	153.8	5.8	23.5
Forship SpA	12	316,156	17,334	32.3	26,346.3	166.2	6.4	24.4
Compagnia Italiana Di Navigaz	9	296,220	17,758	19.2	32,913.3	199.3	7.0	26.1
Ignazio Messina & C SpA	5	254,276	31,750	8.6	50,855.2	239.4	10.9	37.5
Malta Motorways of the Sea Ltd	5	146,468	16,077	16.6	29,293.6	194.0	8.1	25.7
Trasmed Gle SL	5	137,231	11,160	17.8	27,446.2	174.3	6.5	26.2
ACL Invest 2003 AB	2	113,320	7,030	21.5	56,660.0	213.9	9.4	32.3
RoRo Italia SpA	2	102,110	12,700	7.5	51,055.0	239.5	11.5	37.5
Visemar Levante Srl	3	67,900	7,942	6.3	22,633.3	183.4	7.6	26.2
Visemar Ropax Srl	2	65,162	5,132	1.5	32,581.0	203.3	6.6	25.6
Caronte & Tourist Isole Minori	17	63,632	2,652	38.1	3,743.1	88.5	3.9	16.0
Adria Ferries SpA	3	58,398	4,760	30.7	19,466.0	167.5	6.1	24.3
ACL Invest AB	1	56,642	3,505	24.0	56,642.0	214.0	9.7	32.3
ACL Ship Owners 2005 AB	1	56,642	3,505	23.0	56,642.0	213.9	9.7	32.3
Visentini Giovanni Transporti	2	51,459	4,530	10.0	25,729.5	184.1	7.1	25.9
Grimaldi Holding SpA	2	51,196	5,096	12.0	25,598.0	199.0	6.4	26.6
Rimec Enterprises Corp	1	44,307	697	26.0	44,307.0	172.0	6.6	30.4
SPL Princess Anastasia Ltd	1	37,583	1,120	36.0	37,583.0	176.8	6.7	28.4
Caronte & Tourist SpA	8	35,900	1,573	26.0	4,487.5	109.0	4.0	18.1
SY RoRo 1 Pte Ltd	1	32,936	4,076	4.0	32,936.0	209.8	6.8	26.0
CLdN RoRo SA	1	29,429	3,663	10.0	29,429.0	193.0	8.6	26.0
Cartour Srl	1	26,450	2,800	12.0	26,450.0	186.4	6.9	25.6
Marinvest Srl	2	23,887	900	32.0	11,943.5	104.0	4.3	21.0
Crimson Navigation Ltd	1	20,343	2,378	23.0	20,343.0	184.0	6.4	23.6
Toll Transport Pty Ltd	1	20,343	2,378	23.0	20,343.0	184.0	6.4	23.6
EM 1 Maritime Ltd	1	18,265	2,500	22.0	18,265.0	174.0	6.8	25.0
Cadena Roro SA	1	16,342	1,760	10.0	16,342.0	152.0	5.4	22.0
TOREMAR	7	13,654	587	31.6	1,950.6	79.7	3.6	14.7
Kevalay Company for Maritime	1	13,004	670	50.0	13,004.0	146.6	5.0	20.5
Seamed Trading Shipping Srl	1	12,711	780	41.0	12,711.0	129.6	5.0	21.0
Caronte & Tourist Lines Srl	2	12,234	300	30.5	6,117.0	117.5	4.2	17.8
Delcomar Srl	9	11,820	951	36.0	1,313.3	70.6	2.7	14.9
CAREMAR	7	11,342	640	33.9	1,620.3	70.2	3.4	13.3
Medmar Navi SpA	7	11,186	980	47.0	1,598.0	75.1	3.3	13.4
Caroline Russ Schiffahrts	1	10,488	1,624	23.0	10,488.0	153.4	7.0	20.6
Pauline Russ Schiffahrts	1	10,488	1,624	23.0	10,488.0	153.4	7.0	20.6
Naos Ship & Boat Design	1	8,234	420	-1.0	8,234.0	110.0	4.8	19.5
Amadeus SpA	1	8,166	778	36.0	8,166.0	113.6	4.7	18.7
Rete Ferroviaria Italiana	1	5,448	550	9.0	5,448.0	147.2	5.3	18.7
Bluferries Srl	2	5,059	-	2.5	2,529.5	104.0	3.1	18.0
BN di Navigazione SpA	1	4,997	345	25.0	4,997.0	113.6	4.8	18.7
Corsica Ferries France SA	1	3,530	-	26.0	3,530.0	103.6	2.3	14.5
ACTV	6	3,223	-	38.3	537.2	58.3	1.5	12.6
Maddalena Lines Srl	2	2,620	432	48.5	1,310.0	77.7	3.5	16.5
Libera del Golfo Srl	1	2,312	-	23.0	2,312.0	60.0	3.0	16.5
Genova Trasporti Marittimi Srl	1	2,181	230	36.0	2,181.0	64.3	3.3	13.8
Gestour Srl	2	2,176	190	44.0	1,088.0	61.8	3.5	12.1
Laziomar SpA	2	1,979	120	45.0	989.5	55.3	3.3	12.0
Green Fleet Srl	2	1,317	203	55.5	658.5	65.2	2.2	12.4
Ges Tur SNC	1	1,280	-	58.0	1,280.0	55.8	2.8	11.0
SNAP	1	1,246	-	49.0	1,246.0	47.5	3.0	11.7
Maregiglio di Navigazione Srl	2	946	55	41.0	473.0	52.1	2.4	9.1
Delcomar SAS	2	930	-	49.5	465.0	60.1	2.2	10.3
Tra Spe Mar Srl	1	820	-	54.0	820.0	82.7	2.3	10.2
Fantasy Cruises	1	699	-	57.0	699.0	60.3	2.9	9.3
Italy Govt Trans & Nav Mngmt	1	549	-	17.0	549.0	46.3	2.3	9.6
Trinacria Line	1	498	-	83.0	498.0	44.3	4.0	10.0
Mergellina Navigazione	1	394	-	83.0	394.0	52.1	3.5	7.8
Ala Srl	1	386	-	69.0	386.0	50.6	2.0	8.5
Oltremare Di Navigazione SRLS	1	348	-	94.0	348.0	52.9	1.5	7.1
Marine Club Srl	1	320	-	82.0	320.0	43.0	1.9	7.5
Procida Lines 2000	1	222	-	55.0	222.0	33.7	2.7	8.5
Overall sample fleet	**266**	**6,797,904**	**507,585**	**25.7**	**25,556.0**	**153.4**	**5.9**	**23.2**

Source: Authors' elaboration.

TABLE 14. FERRY, RO-PAX & RO-RO SAMPLE VESSELS: DISTRIBUTION BY OPERATOR (OVERALL SAMPLE SHIPS).

Operator	NO. Of ferry/ro-pax/ ro-ro ships	Fleet GT (Gross Tonnage)	Fleet RORO Lanes Length (meters)	Vessels avg. Age (years)	Vessel avg. GT (Gross Tonnage)	Vessels avg. Length (meters)	Vessels avg. Draught (meters)	Vessels avg. Breadth (meters)
Grimaldi Group SpA	55	2,815,664	189,737	12.7	51,193.9	216.5	8.9	31.2
Grimaldi Euromed SpA	16	807,724	88,141	8.3	50,482.8	219.6	7.3	30.6
Grandi Navi Veloci SpA	22	801,700	46,439	21.5	36,440.9	189.6	5.5	27.4
Moby SpA	18	437,412	22,408	36.4	24,300.7	151.8	5.8	23.7
Ignazio Messina & C SpA	9	397,072	49,206	11.6	44,119.1	227.1	10.0	34.4
Compagnia Italiana Di Navigaz	12	390,887	27,497	17.3	32,573.9	200.7	7.1	26.0
Corsica Ferries France SA	13	319,686	17,334	31.8	24,591.2	161.4	6.0	23.7
Trasmed Gle SL	5	137,231	11,160	17.8	27,446.2	174.3	6.5	26.2
Caronte & Tourist SpA	11	74,584	4,673	25.5	6,780.4	117.6	4.3	18.7
Adria Ferries SpA	3	58,398	4,760	30.7	19,466.0	167.5	6.1	24.3
Snav SpA	3	49,417	3,500	25.3	16,472.3	135.7	5.0	22.8
LD Seaplane SAS	2	43,767	5,092	7.0	21,883.5	179.4	7.6	26.2
Grendi Trasporti Marittimi SpA	2	40,279	4,190	7.0	20,139.5	166.9	6.4	24.1
Caronte & Tourist Isole Minori	11	34,760	2,204	44.3	3,160.0	88.6	3.9	16.5
Cia Trasmediterranea SA	1	32,581	2,566	2.0	32,581.0	203.3	6.6	25.6
Visemar Ropax Srl	1	32,581	2,566	1.0	32,581.0	203.3	6.6	25.6
SIREMAR	8	31,492	880	32.3	3,936.5	85.7	3.9	15.3
Corsica Linea SASU	1	30,144	2,500	23.0	30,144.0	188.3	6.2	28.7
Valiant Shipping SA	1	29,004	3,663	13.0	29,004.0	193.3	8.6	26.0
Stena Line Ltd	1	27,522	2,100	16.0	27,522.0	186.5	6.8	25.6
DFDS A/S	1	25,666	2,496	12.0	25,666.0	199.0	6.4	26.6
Mann Lines Ltd	1	24,133	2,850	5.0	24,133.0	191.4	7.6	26.2
DFDS Denizcilik ve Tasimacilik	1	18,265	2,500	22.0	18,265.0	174.0	6.8	25.0
Nuova Naviservice Srl	2	13,703	670	53.5	6,851.5	103.4	4.0	14.9
TOREMAR	7	13,654	587	31.6	1,950.6	79.7	3.6	14.7
Seamed Trading Shipping Srl	1	12,711	780	41.0	12,711.0	129.6	5.0	21.0
Medmar Navi SpA	7	11,186	980	47.0	1,598.0	75.1	3.3	13.4
Tirrenia di Navigazione SpA	1	10,488	1,624	23.0	10,488.0	153.4	7.0	20.6
CAREMAR	6	9,415	640	35.7	1,569.2	70.0	3.5	13.5
Delcomar SAS	8	8,337	542	41.6	1,042.1	66.1	2.6	13.2
Naos Ship & Boat Design	1	8,234	420	-1.0	8,234.0	110.0	4.8	19.5
Amadeus SpA	1	8,166	778	36.0	8,166.0	113.6	4.7	18.7
Rete Ferroviaria Italiana	1	5,448	550	9.0	5,448.0	147.2	5.3	18.7
Bluferries Srl	2	5,059	-	2.5	2,529.5	104.0	3.1	18.0
BN di Navigazione SpA	1	4,997	345	25.0	4,997.0	113.6	4.8	18.7
Libera del Golfo Srl	3	4,625	-	38.3	1,541.7	60.5	2.5	12.5
Delcomar Srl	3	4,413	409	30.0	1,471.0	75.7	2.6	16.3
ACTV	6	3,223	-	38.3	537.2	58.3	1.5	12.6
Genova Trasporti Marittimi Srl	1	2,181	230	36.0	2,181.0	64.3	3.3	13.8
Gestour Srl	2	2,176	190	44.0	1,088.0	61.8	3.5	12.1
MultiService Group Srl	2	1,979	120	45.0	989.5	55.3	3.3	12.0
Ges Tur SNC	1	1,280	-	58.0	1,280.0	55.8	2.8	11.0
SNAP	1	1,246	-	49.0	1,246.0	47.5	3.0	11.7
Marnavi SpA	1	847	203	55.0	847.0	71.9	2.8	14.0
Tra Spe Mar Srl	1	820	-	54.0	820.0	82.7	2.3	10.2
Maregiglio di Navigazione Srl	1	748	55	49.0	748.0	61.7	2.9	11.0
Italy Govt Trans & Nav Mngmt	1	549	-	17.0	549.0	46.3	2.3	9.6
Trinacria Line	1	498	-	83.0	498.0	44.3	4.0	10.0
Green Fleet Srl	1	470	-	56.0	470.0	58.5	1.6	10.8
Mergellina Navigazione	1	394	-	83.0	394.0	52.1	3.5	7.8
Oltremare Di Navigazione SRLS	1	348	-	94.0	348.0	52.9	1.5	7.1
Marine Club Srl	1	320	-	82.0	320.0	43.0	1.9	7.5
Procida Lines 2000	1	222	-	55.0	222.0	33.7	2.7	8.5
Palombo Agenzia	1	198	-	33.0	198.0	42.5	1.8	7.2
Totale complessivo	**266**	**6,797,904**	**507,585**	**25.7**	**25,556.0**	**153.4**	**5.9**	**23.2**

Source: Authors' elaboration.

When it comes to the "offshore" segment, the first player is the business is SAIPEM SpA followed by ENI Spa and Micoperi Spa (2 vessels), both as Group Owner and Registered Owner (Table 15

Table 16). Due to the very low average number of ships owned by each group owner (2.75 ships per Group Owner on average), it is possible to argue that contrary to the ferry market, this industry is fairly fragmented and less concentrated than the previous one.

TABLE 15. OFFSHORE VESSELS: DISTRIBUTION BY GROUP OWNER (OVERALL SAMPLE).

Groupowner	No. of vessels	Fleet GT (Gross Tonnage)	Vessels avg. Age (years)	Vessel avg. GT (Gross Tonnage)	Vessels avg. Length (meters)	Vessels avg. Draught (meters)	Vessels avg. Breadth (meters)
SAIPEM SpA	9	593,244	21.4	65,916.0	227.1	11.5	42.1
Unknown	5	522,444	28.6	104,488.8	246.2	9.5	40.0
Eni SpA	2	73,921	26.5	36,960.5	137.6	10.1	36.3
Micoperi SpA	2	21,635	59.5	10,817.5	128.9	4.8	29.0
Banca Monte dei Paschi	1	3,362	9.0	3,362.0	78.0	4.8	20.0
Exmar NV	1	117,916	19.0	117,916.0	306.5	12.3	48.0
Lighthouse SpA	1	2,367	22.0	2,367.0	74.5	4.7	17.8
Samsung Heavy Industries Co	1	60,975	1.0	60,975.0	227.8	13.0	42.0
Overall sample fleet	**22**	**1,395,864**	**25.4**	**63,448.4**	**204.3**	**9.8**	**38.1**

Source: Authors' elaboration.

TABLE 16. OFFSHORE VESSELS: DISTRIBUTION BY REGISTERED OWNER (OVERALL SAMPLE).

Registered owner	No. of vessels	Fleet GT (Gross Tonnage)	Vessels avg. Age (years)	Vessel avg. GT (Gross Tonnage)	Vessels avg. Length (meters)	Vessels avg. Draught (meters)	Vessels avg. Breadth (meters)
SAIPEM Portugal Comercio	6	335,557	19.2	55,926.2	203.0	10.8	42.6
Eni Liverpool Bay Operating Co	2	73,921	26.5	36,960.5	137.6	10.1	36.3
Micoperi SpA	2	21,635	59.5	10,817.5	128.9	4.8	29.0
SAIPEM Offshore Norway AS	2	123,081	16.0	61,540.5	244.2	9.3	34.5
Coral FLNG SA	1	346,165	1.0	346,165.0	432.0	0.0	66.0
Ecos Srl	1	117,916	19.0	117,916.0	306.5	12.3	48.0
Energean Italy SpA	1	61,921	23.0	61,921.0	261.5	15.5	42.0
Floaters SpA	1	59,491	33.0	59,491.0	268.3	14.4	42.5
Lighthouse SpA	1	2,367	22.0	2,367.0	74.5	4.7	17.8
Paschi di Siena/L&F/SF Imprese	1	3,362	9.0	3,362.0	78.0	4.8	20.0
SAIPEM SpA	1	134,606	46.0	134,606.0	337.0	20.2	54.5
Samsung Heavy Industries Co	1	60,975	1.0	60,975.0	227.8	13.0	42.0
Saromar Srl	1	54,673	28.0	54,673.0	233.3	14.0	42.6
Ut Group Holding SAS	1	194	58.0	194.0	35.7	3.4	7.0
Overall sample fleet	**22**	**1,395,864**	**25.4**	**63,448.4**	**204.3**	**9.8**	**38.1**

Source: Authors' elaboration.

TABLE 17. OFFSHORE VESSELS: DISTRIBUTION BY OPERATOR (OVERALL SAMPLE).

Operator	No. of vessels	Fleet GT (Gross Tonnage)	Vessels avg. Age (years)	Vessel avg. GT (Gross Tonnage)	Vessels avg. Length (meters)	Vessels avg. Draught (meters)	Vessels avg. Breadth (meters)
Ecos Srl	1	117,916	19.0	117,916.0	306.5	12.3	48.0
Eni Liverpool Bay Operating Co	1	71,229	27.0	71,229.0	220.3	16.8	44.5
Eni SpA	1	346,165	1.0	346,165.0	432.0	0.0	66.0
Floaters SpA	1	59,491	33.0	59,491.0	268.3	14.4	42.5
Lighthouse SpA	1	2,367	22.0	2,367.0	74.5	4.7	17.8
Micoperi SpA	3	24,997	42.7	8,332.3	111.9	4.8	26.0
PB Tankers SpA	1	61,921	23.0	61,921.0	261.5	15.5	42.0
Petrofac Facilities Mgmt Ltd	1	2,692	26.0	2,692.0	54.9	3.3	28.0
SAIPEM Offshore Norway AS	1	21,049	22.0	21,049.0	163.5	8.0	30.0
SAIPEM Portugal Comercio	6	388,640	19.5	64,773.3	227.5	10.8	41.4
SAIPEM SpA	3	244,530	18.3	81,510.0	247.6	14.6	47.5
Saromar Srl	1	54,673	28.0	54,673.0	233.3	14.0	42.6
Ut Group Holding SAS	1	194	58.0	194.0	35.7	3.4	7.0
Overall sample fleet	**22**	**1,395,864**	**25.4**	**63,448.4**	**204.3**	**9.8**	**38.1**

Source: Authors' elaboration.

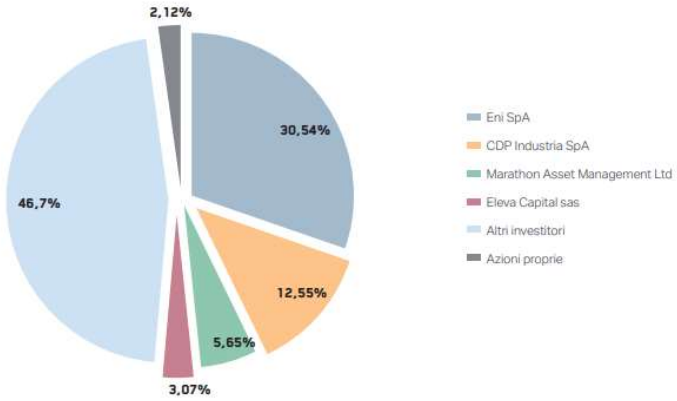
Table reports data on the offshore fleet managed by each operator, with no significant changes respect to info gathered for group owners and registered owners.

The analysis, therefore, suggests that the offshore vessel business do not constitute the most promising area for business opportunities originating in Italy for Norwegian technology providers in the field of large-scale electrification & hybridization. Nonetheless, some prompt central decision makers / customers exist, such as SAIPEM and ENI which have some shareholding links and are characterized by significant links with national Government and CDP (Cassa Depositi e Prestiti[3]).

In this vein, Figure 24 and Figure 25 show the ownership structure at the end of the last fiscal year, which confirm the abovementioned statements.

[3] Cassa Depositi e Prestiti (CdP) is an Italian financial institution, in the form of a joint-stock company, controlled for about 83% by the Ministry of Economy and Finance and for about 16% by various banking foundations. Through an integrated offer of finance, equity instruments, guarantees and advisory services, it supports businesses and administrations.

FIGURE 24. SAIPEM SPA - OWNERSHIP STRUCTURE.



Source: Saipem – "Relazione sul governo societario e gli assetti proprietari", 2021.

FIGURE 25. ENI SPA - OWNERSHIP STRUCTURE

Source: Eni, "Relazione sul Governo Societario e gli Assetti Proprietari", 2021.

Therefore, they are expected to be more incline to adopt green strategies for their business activities and vessels respect to other competitors operating in the same business, due to their governance and shareholding settings.

Concerning the "service" segment interesting results emerge from the analysis of the group owners (Table 18), the registered owners (Table 19) and the operators (Table 20) who own/manage the sample vessels. Data unveils a mixed competitive structure, being the market fragmented, with some key players capable to own and manage fleet of specialized vessels providing heterogenous ancillary services (Table 20). Among others, Bambini Spa, Marnavi, Cafiero Mattioli Group, Righetti Navi Srl, Vroon Group (Vroon Offshore BV + Vroon BV) and Micoperi Spa show the most prominent figures both in terms of number of vessels and overall fleet gross tonnage (GT). More in detail, Bambini SpA has pursued strategies to centralize the ownership of its assets, with a perfect match between group owner and registered owner for all ships. The company owns and manages 14 "Crew/Supply Vessel" and 2 "Platform Supply Ship". Marnavi SpA, conversely holds an heterogenous portfolio of ships that include 5 "Anchor Handling Tug Supply", 4 "Platform Supply Ship", 2 "Offshore Tug/Supply Ship" and 1 "Offshore

Support Vessel". Vroon Offshore BV and Cafiero Mattioli Group, instead, constitute highly specialized providers in the maritime and port domain.

TABLE 18. SERVICE VESSELS: DISTRIBUTION BY GROUP OWNER (OVERALL SAMPLE).

Groupowner	NO. Of ferry/ro-pax/ ro-ro ships	Fleet GT (Gross Tonnage)	Vessels avg. Age (years)	Vessel avg. GT (Gross Tonnage)	Vessels avg. Length (meters)	Vessels avg. Draught (meters)	Vessels avg. Breadth (meters)
Bambini SpA	16	4,244	23.9	265.3	41.7	1.7	8.5
Marnavi SpA	12	30,218	11.4	2,518.2	67.1	5.3	14.8
Cafiero Mattioli Group	9	22,108	14.9	2,456.4	70.2	6.0	16.5
Righetti Navi Srl	7	1,611	25.0	230.1	40.8	1.6	8.0
Vroon Offshore BV	7	16,737	9.3	2,391.0	67.5	5.7	16.3
Micoperi SpA	6	11,844	27.5	1,974.0	67.3	5.1	14.6
Unknown	4	1,932	36.3	483.0	42.2	3.6	9.7
Federimorchiatori	4	8,232	22.8	2,058.0	65.1	5.5	14.8
Med Offshore SpA	3	6,132	13.7	2,044.0	66.3	5.4	14.8
Vremar Srl	3	713	26.0	237.7	40.6	1.9	7.8
Vroon BV	3	5,034	11.3	1,678.0	59.3	5.0	15.0
Giuffre & Lauro Srl	2	1,249	44.5	624.5	55.8	4.2	11.6
Neri Group SpA	2	3,473	9.0	1,736.5	59.7	4.9	15.2
Ocean Srl	2	996	13.0	498.0	38.0	3.8	11.8
Rimorchiatori Riuniti SpA	2	5,618	14.0	2,809.0	75.3	6.6	17.3
Augustea Group Srl	1	1,658	16.0	1,658.0	55.4	6.2	15.5
Crismani Group	1	421	20.0	421.0	50.0	2.5	9.1
Diamar Srl	1	1,680	10.0	1,680.0	59.3	5.0	15.0
Famar Prestacao de Servicos	1	454	6.0	454.0	54.8	3.2	9.0
Gruppo Cafimar	1	466	20.0	466.0	36.0	4.5	10.2
IFA Srl	1	399	20.0	399.0	37.8	3.3	9.7
Marin Srls	1	454	13.0	454.0	53.4	2.1	9.8
Orange Marine	1	1,969	15.0	1,969.0	60.0	4.8	15.6
Rana Diving & Marine	1	143	36.0	143.0	26.4	2.2	5.6
SERS Srl	1	398	9.0	398.0	51.0	2.7	10.0
TIS Management Holdings Ltd	1	1,680	10.0	1,680.0	59.3	5.0	15.0
Tra Spe Mar Srl	1	494	51.0	494.0	54.5	3.4	11.0
Overall sample fleet	**94**	**130,357**	**19.5**	**1,386.8**	**55.8**	**4.1**	**12.5**

Source: Authors' elaboration.

TABLE 19. SERVICE VESSELS: DISTRIBUTION BY REGISTERED OWNER (OVERALL SAMPLE)

Registered owners	No. of vessels	Fleet GT (Gross Tonnage)	Vessels avg. Age (years)	Vessel avg. GT (Gross Tonnage)	Vessels avg. Length (meters)	Vessels avg. Draught (meters)	Vessels avg. Breadth (meters)
Bambini SpA	16	4,244	23.9	265.3	41.7	1.7	8.5
Marnavi SpA	10	21,796	11.7	2,179.6	62.7	5.0	14.3
Augusta Offshore SpA	6	13,917	15.3	2,319.5	68.0	5.9	16.2
Righetti Navi Srl	6	1,341	25.8	223.5	39.7	1.8	7.8
Micoperi SpA	4	9,953	26.0	2,488.3	75.4	5.3	15.7
Asso Maritima Ltda	3	8,191	14.0	2,730.3	74.6	6.2	17.1
Med Offshore SpA	3	6,132	13.7	2,044.0	66.3	5.4	14.8
Portosalvo	3	8,037	16.3	2,679.0	76.9	6.1	17.0
PSV Express VIII BV	3	9,422	8.3	3,140.7	76.7	6.5	17.6
Vremar Srl	3	713	26.0	237.7	40.6	1.9	7.8
Giuffre & Lauro Srl	2	1,249	44.5	624.5	55.8	4.2	11.6
Ocean Koper doo	2	996	13.0	498.0	38.0	3.8	11.8
Westerschelde Shipping BV	2	3,356	10.5	1,678.0	59.3	5.0	15.0
Alem Srl	1	162	47.0	162.0	30.9	3.0	7.3
ARGO Srl	1	1,680	10.0	1,680.0	59.3	5.0	15.0
Augustea Ship Management Srl	1	1,658	16.0	1,658.0	55.4	6.2	15.5
DSMC Srl	1	893	41.0	893.0	58.7	3.9	12.2
Elettra Tlc SpA	1	1,969	15.0	1,969.0	60.0	4.8	15.6
Famar Offshore Lda	1	454	6.0	454.0	54.8	3.2	9.0
Finarge Apoio Maritimo Ltda	1	2,719	14.0	2,719.0	74.3	6.5	17.0
Finarge Armamento Genovese Srl	1	2,899	14.0	2,899.0	76.3	6.8	17.5
IFA Srl	1	399	20.0	399.0	37.8	3.3	9.7
Impresa Tito Neri Srl	1	1,537	10.0	1,537.0	58.7	4.8	14.6
Marigest Srl	1	4,499	7.0	4,499.0	90.2	5.9	18.8
Marin Srls	1	454	13.0	454.0	53.4	2.1	9.8
Micoperi SP SA de CV	1	1,392	47.0	1,392.0	64.1	5.5	13.0
Molimar	1	500	22.0	500.0	36.0	4.5	10.2
Navigazione Adriatica Srl	1	270	20.0	270.0	47.2	0.0	9.1
Neri Group SpA	1	1,936	8.0	1,936.0	60.6	5.1	15.8
Offshore Support Vessels 20 BV	1	1,678	10.0	1,678.0	59.3	5.0	15.0
Offshore Support Vessels 23 BV	1	2,281	7.0	2,281.0	65.0	5.2	16.0
Offshore Support Vessels 24 BV	1	1,678	12.0	1,678.0	59.3	5.0	15.0
Offshore Support Vessels II BV	1	1,678	11.0	1,678.0	59.3	5.0	15.0
Rana Diving & Marine	1	143	36.0	143.0	26.4	2.2	5.6
Rimorchiatori Riuniti Panfido	1	195	42.0	195.0	29.8	3.6	8.0
Sea Service Srl	1	421	20.0	421.0	50.0	2.5	9.1
Seashiptanker Srl	1	3,923	13.0	3,923.0	88.8	7.2	16.0
Secomar SpA	1	377	35.0	377.0	43.0	3.0	9.3
Somat SpA	1	466	20.0	466.0	36.0	4.5	10.2
TI Good Wind Ltd	1	1,680	10.0	1,680.0	59.3	5.0	15.0
Tra Spe Mar Srl	1	494	51.0	494.0	54.5	3.4	11.0
Unifin Financiera SAPI de CV	1	499	14.0	499.0	38.0	3.8	11.8
United Ships Srl	1	398	9.0	398.0	51.0	2.7	10.0
Vroon Offshore Services Srl	1	1,678	13.0	1,678.0	59.3	5.0	15.0
Overall sample fleet	**94**	**130,357**	**19.5**	**1,386.8**	**55.8**	**4.1**	**12.5**

Source: Authors' elaboration.

Data show that the "service" Italian fleet constitute a promising business opportunity for Norwegian technology providers operating in the field of large-scale electrification & hybridization not only in terms of current and prospect market size but also for the main characteristics of the main leads. Anchor handling tug supply and crew/supply vessels could constitute the most interesting business opportunities when entering the Italian "service" market.

TABLE 20. SERVICE VESSELS: DISTRIBUTION BY OPERATOR (OVERALL SAMPLE).

Operator	No. of vessels	Fleet GT (Gross Tonnage)	Vessels avg. Age (years)	Vessel avg. GT (Gross Tonnage)	Vessels avg. Length (meters)	Vessels avg. Draught (meters)	Vessels avg. Breadth (meters)
Bambini SpA	17	4,698	22.9	276.4	42.5	1.8	8.5
Vroon Offshore Services Srl	9	18,834	10.0	2,092.7	63.9	5.3	15.7
Righetti Navi Srl	8	2,009	23.0	251.1	42.0	1.7	8.2
Augusta Offshore SpA	7	16,225	15.6	2,317.9	68.6	5.9	16.2
Marnavi SpA	7	15,986	11.9	2,283.7	62.7	5.2	14.4
Micoperi SpA	5	11,345	30.2	2,269.0	73.1	5.4	15.2
Phoenix Offshore Srl	4	11,949	10.5	2,987.3	74.2	5.6	15.4
Med Offshore SpA	3	6,132	13.7	2,044.0	66.3	5.4	14.8
Tidewater Marine UK Ltd	3	8,037	16.3	2,679.0	76.9	6.1	17.0
ARGO Srl	2	3,360	10.0	1,680.0	59.3	5.0	15.0
Asso Maritima Ltda	2	5,883	12.5	2,941.5	75.9	6.3	17.6
Giuffre & Lauro Srl	2	1,249	44.5	624.5	55.8	4.2	11.6
Neri Group SpA	2	3,473	9.0	1,736.5	59.7	4.9	15.2
Ocean Koper doo	2	996	13.0	498.0	38.0	3.8	11.8
Vremar Srl	2	533	18.0	266.5	42.6	2.2	8.0
Alem Srl	1	162	47.0	162.0	30.9	3.0	7.3
Augustea Maritime Trans Ltd	1	1,658	16.0	1,658.0	55.4	6.2	15.5
DSMC Srl	1	893	41.0	893.0	58.7	3.9	12.2
Elettra Tlc SpA	1	1,969	15.0	1,969.0	60.0	4.8	15.6
Finarge Apoio Maritimo Ltda	1	2,719	14.0	2,719.0	74.3	6.5	17.0
Finarge Armamento Genovese Srl	1	2,899	14.0	2,899.0	76.3	6.8	17.5
IFA Srl	1	399	20.0	399.0	37.8	3.3	9.7
Marin Srls	1	454	13.0	454.0	53.4	2.1	9.8
Micoperi SP SA de CV	1	499	14.0	499.0	38.0	3.8	11.8
Molimar	1	500	22.0	500.0	36.0	4.5	10.2
Nuova Naviservice Srl	1	180	42.0	180.0	36.6	1.2	7.3
Rana Diving & Marine	1	143	36.0	143.0	26.4	2.2	5.6
Sea Service Srl	1	421	20.0	421.0	50.0	2.5	9.1
Secomar SpA	1	377	35.0	377.0	43.0	3.0	9.3
Somat SpA	1	466	20.0	466.0	36.0	4.5	10.2
Tra Spe Mar Srl	1	494	51.0	494.0	54.5	3.4	11.0
Tripcovich D	1	195	42.0	195.0	29.8	3.6	8.0
United Kingdom Govt MCGA	1	2,283	12.0	2,283.0	70.0	5.1	15.5
Vroon Offshore Services	1	2,937	9.0	2,937.0	75.0	6.6	17.3
Overall sample fleet	**94**	**130,357**	**19.5**	**1,386.8**	**55.8**	**4.1**	**12.5**

Source: Authors' elaboration.

TABLE 21. SERVICE VESSELS: GROUP OWNERS' PORTFOLIO OF VESSELS IN VARIOUS SEGMENTS.

Group owner	No. of vessels	Anchor Handling Tug Supply	Crew/Supply Vessel	Offshore Support Vessel	Offshore Tug/Supply Ship	Platform Supply Ship
Bambini SpA	16		14			2
Marnavi SpA	12	5		1	2	4
Cafiero Mattioli Group	9	5				4
Righetti Navi Srl	7		7			
Vroon Offshore BV *	7	4				3
Micoperi SpA	6	4				2
Unknown	4		1		2	1
Federimorchiatori	4				1	3
Med Offshore SpA	3	3				
Vremar Srl	3		3			
Vroon BV *	3	3				
Giuffre & Lauro Srl	2	1				1
Neri Group SpA	2	2				
Ocean Srl	2	2				
Rimorchiatori Riuniti SpA	2	2				
Augustea Group Srl	1	1				
Crismani Group	1		1			
Diamar Srl	1	1				
Famar Prestacao de Servicos	1		1			
Gruppo Cafimar	1				1	
IFA Srl	1					1
Marin Srls	1		1			
Orange Marine	1					1
Rana Diving & Marine	1			1		
SERS Srl	1		1			
TIS Management Holdings Ltd	1	1				
Tra Spe Mar Srl	1					1
Total	**94**	**34**	**29**	**2**	**6**	**23**

Source: Authors' elaboration.

3.B. Shipping companies operating current vessels.

Grounding on main data reported in Section 3.A, key player operating current vessels in the three sample businesses (ferry, service and offshore) has been mapped and investigated. In this section, the most valuable shipping companies operating in the sample businesses are presented and discussed.

When it comes to the ferry sector, the market analysis performed in Section 3.A has demonstrated that the business is concentrated in a handful of large corporations. Among them, Grimaldi Group includes seven major shipping companies, such as Atlantic Container Line (ACL), Malta Motorways of the Sea (MMOS), Minoan Lines, Finnlines, Grimaldi Euromed, Grimaldi Lines and Trasmed GLE.

More specifically, the main companies by number of ships are Grimaldi Lines and Grimaldi Euromed which share part of the assets used and altogether hold an asset portfolio composed by 30 ships. Grimaldi Lines offers passenger transport services mainly in the Mediterranean area, with several calls in the major Italian ports. Also Greece, Spain, Morocco and Tunisia are included in the main passenger and cargo maritime transport services provided (Figure 26), whereas Grimaldi Euromed provides Ro-Ro and Ro-Pax services also in the Northern Europe area (Figure 27).

FIGURE 26. GRIMALDI LINES ROUTES

Source: Grimaldi Lines, Corporate website.

FIGURE 27. GRIMALDI EUROMED ROUTES

Source: Grimaldi Euromed, Corporate website

As for the Northern Europe/Mediterranean route, the company has conceived and developed the Euro-Med service, focused on the maritime transport of different types of vehicles, also offering direct delivery to dealers, operating with a fleet that includes the largest PCTC (Pure Car & Truck Carrier) in the world.

When comparing the Grimaldi Group's fleet with those belonging to the other key actors populating the industry (Figure 28), it can be argued that the Group holds and manage the youngest (average age of only 13.54 years) and greener fleet in service. In addition, given the weight of Ro-Ro ships included in the overall fleet a higher average gross tonnage per ship emerges respect to vessels include in the fleet of the other key players.

FIGURE 28. FERRY SEGMENT: COMPARISON DASHBOARD.

Source: Authors' elaboration.

The second company by number of ships is by Caronte Shipping SpA with 30 ships and active in the areas of Southern Italy (Figure 29) with the companies Caronte & Tourist and Siremar. Nonetheless, the group has significantly lower figures respect to other shipping companies in the ferry market such as GNV, Moby and Tirrenia. Caronte Shipping SpA is a regional player which play a key role in guaranteeing "territorial continuity", through daily connections from / to Sicily. Caronte Shipping SpA constitute an interesting potential lead for the Norwegian technological providers operating in the field of latest generation propulsion systems, hybrid and innovative solutions as the company has demonstrated ad effective green attitude towards investments in new orderbooks and innovative equipment for lowering negative environmental emissions and due to business model of the shipping company that strongly rely upon participating to public call for "regulated" transport services sponsored by the national government.

Regarding technical characteristics of the ships, in this case there are values that are not in line with the industry averages. In fact, the summary dashboard shows an average age much higher than the average of the priority vessel type "ferry" (35.45 against 27.26), while the variables relating to length, breadth and draught are much lower compared to the sector averages.

FIGURE 29. CARONTE SHIPPING SPA ROUTES

Source: Caronte Shipping SpA, Corporate website

The third ranked shipping company by number of ships owned/managed is Grandi Navi Veloci S.p.A. The company which unveils a significant fleet capacity, belong to the MSC/Aponte Group and serves a number of port destinations located in the Mediterranean countries, such as Spain, France, Greece, Tunisia and Morocco (Figure 30).

The technical analysis of the main characteristics of the fleet in service shows average figures better than the overall sector both in terms of ship age and size and technical characteristics. The company is expected to invest in green innovations in the next years as it managed by a young and highly skilled management with a long-term strategic vision concerning environmental issues.

FIGURE 30. GRANDI NAVI VELOCI SPA ROUTES.

Source: Grandi Navi Veloci SpA, Corporate website.

Also, Tirrenia di Navigazione SpA, whose ultimate owner is Onorato Group, holds a prompt market position in the Italian Market and manage a portfolio of 30 ships. The company provides passenger transport services from/to the main Italian ports, providing services of territorial

continuity for both Sicily and Sardinia (Figure 31). The comparison of the fleet characteristics respect to those managed by the player which populate the market segment, with regard to the age of ships and the technical characteristics, has highlighted values in line with the average parameters of the industry.

FIGURE 31. TIRRENIA DI NAVIGAZIONE SPA ROUTES

Source: Tirrenia di Navigazione SpA, Corporate website.

To complete the top five of the main operators in the ferry sector in Italy there is Moby SpA, which belongs to the Onorato Group and operate vessels exclusively in the Italian market (Figure 32). Its fleet unveils technical characteristics below the industrial average, with the mean age significantly extremely than the sector (40 years).

FIGURE 32. MOBY SPA ROUTES

Source: Moby SpA, Corporate website.

To renew the fleet, the company has ordered two ships currently under construction:

- ✓ MOBY FANTASY: is the largest passenger ferry so far built by the Chinese shipyard Guangzhou Shipyard International and its delivery, according to Chinese press sources, is expected in November 2022. The ferry accommodates 2,500 passengers on board and 3,800 linear meters of rolling cargo (almost 800 cars) and present 13 decks, 533 cabins and a 5 decks garage;
- ✓ MOBY LEGACY: the ship, is currently in construction at the Chinese shipyard Guangzhou Shipyard International and will share the same technical characteristics of the Moby Fantasy twins.

When it comes to the Offshore business, the data reported in Section 3.A highlighted the key role played in the Italian market by SAIPEM SpA (9 ships), which operates in the field of the service provision for the energy and infrastructure sector. SAIPEM SpA manage a fleet which is traditionally deployed worldwide with a focus in the Mediterranean area and in Africa, in order to ensure adequate support to the entire supply chain (Figure 33).

FIGURE 33. AREAS SERVED BY SAIPEM SPA.

Source: Authors' elaboration.

The comparison of the corporate fleet technical features with the industry averages, highlighted an almost perfect coincidence and linearity with what has been observed in the sample. The average age of the fleet is slightly lower than the industry average (Table 22). Under this profile, it should be noted that the company has always shown particular attention to issues related to the engineering innovation of the mechanisms and instruments adopted to on board, as well as the sustainability of the activities conducted.

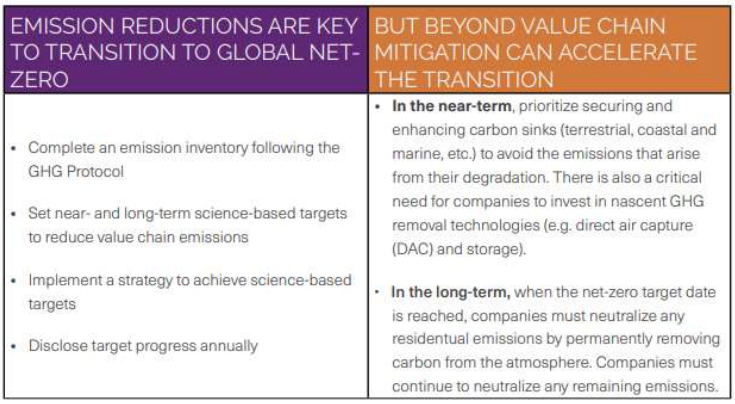
TABLE 22. COMPARISON BETWEEN SAIPEM SPA AND OFFSHORE SECTOR

Variable	SAIPEM SpA	Service Sector (average)	Variation
Average AGE	21,38	27,26	-5,89
Average GT	66752,88	63448,36	3304,51
Average Length	226,98	204,28	22,70
Average Draught	11,42	9,79	1,63
Average Breadth	42,13	38,07	4,06

Source: Authors' elaboration.

In particular, the company has launched the "Net Zero" program, more ambitious than the "Carbon Neutrality" programs because of the application of green solutions to reduce carbon emissions in the whole organization and its value chain. This means reducing indirect carbon emissions from upstream suppliers to end users, a complex undertaking in a world where companies do not control the entire value chain. The program, based on "mitigation standards" focuses on short-term objectives and long-term objectives, stability from the Science Based Targets initiative in 2021 (FIGURE *34.* "NET ZERO" PROGRAM TARGETSFigure 34).

FIGURE 34. "NET ZERO" PROGRAM TARGETS



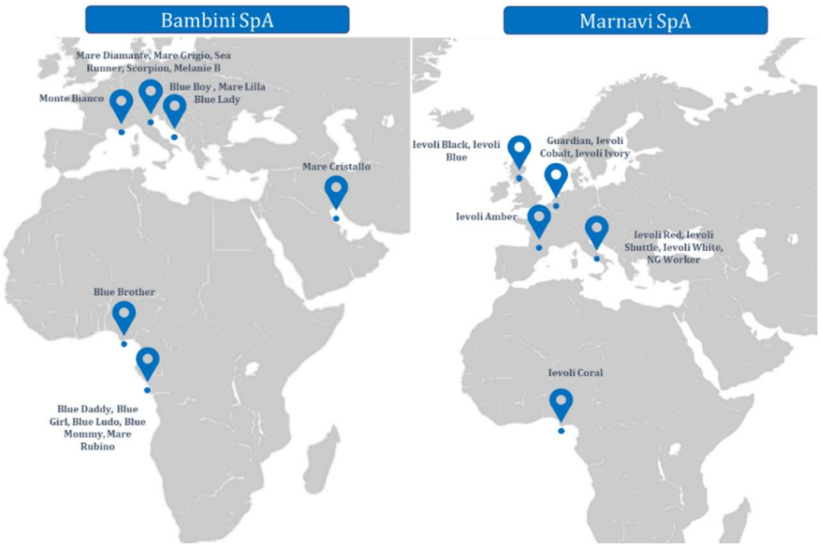
Source: Science Base Target "SBTI Corporate Net-Zero Standard", 2021.

Finally, when it comes to the "service" segment, in-depth information related to two potential leads (references) are here provided, i.e., Bambini SpA and Marnavi SpA, which operate fleets of 16 and 12 ships, respectively.

By examining the called ports and the geographical areas where the assets are predominantly deployed (Figure 35), Mediterranean, North Europe and west Africa emerge as the key commercial regions. However, it should be noted that although they fall within the "service" segment, the two companies offer different services and, more specifically:

- ✓ Bambini SpA manages a fleet almost entirely constituted by "Crew/Supply Vessels", self-propelled vessel used for carrying supplies to and from off-shore and in-harbor locations including, but not limited to, off-shore work platforms, construction sites, and other vessels;
- ✓ Marnavi SpA manages a heterogeneous fleet composed by "Offshore Support Vessel", "Offshore Tug/Supply Ship" and "Anchor Handling Tug Supply" which provides ancillary services and support to platforms and offshore ships.

FIGURE 35. AREAS SERVED BY BAMBINI SPA AND MARNAVI SPA



Source: Authors' elaboration.

Concerning technical characteristics of the fleet, the summary table (Table 23) shows that the company Marnavi SpA is more in line with the sector statistics; while the fleet of Bambini SpA holds an older fleet (average age of 25 years against the average age of the sample vessels equivalent to 19) and different technical features compared to the overall "service" sector.

TABLE 23. COMPARISON BETWEEN BAMBINI SPA, MARNAVI SPA AND SERVICE SECTOR

Valori	Bambini SpA	Marnavi SpA	Service Sector (average)
Average AGE	24,93	18,08	19,52
Average GT	252,00	2384,85	1386,78
Average Length	40,91	68,47	55,84
Average Draught	1,68	5,01	4,08
Average Breadth	8,39	14,84	12,53

Source: Authors' elaboration.

3.C. How is a public tender announced?

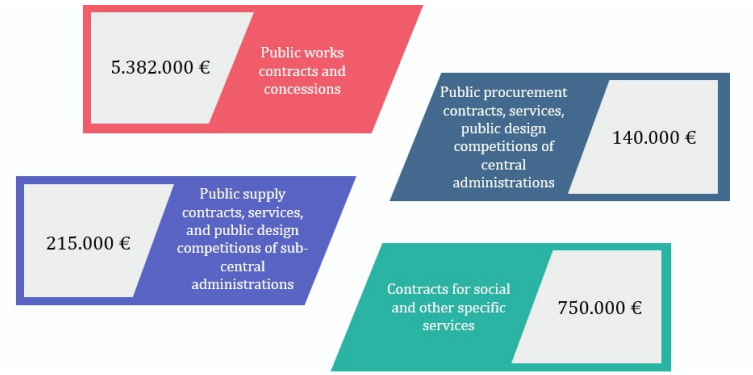
In line with the European Union principle of ensuring maximum transparency, acts relating to public contracts/contractual agreements in Italy are subject to mandatory reporting and dissemination obligations, to allow the widest possible participation of economic operators in public tendering procedures. The Italian regulatory framework applicable to calls for tenders and tender results by the Contracting Authorities are set by Articles 36 c. 9 (in the case of ordinary procedures with a value below the Community threshold) 70, 71, 72 and 98 of Legislative Decree 50/2016 (hereinafter "Code") and to the Ministerial Decree of 2 December 2016 issued by the Ministry of Infrastructure and Transport (hereinafter "D.M.").

The publication by the Contracting Authorities of the calls for tenders (so-called "legal advertising") concerns all tender procedures with public evidence, such as ordinary procedures (open and restricted) and dynamic acquisition systems, regardless of their economic value. In fact, the economic value must be considered only when setting the legal instrument or the type

of channels through which the notices must be disseminate. In this perspective, it is necessary first to understand the definition of the Community thresholds and secondly to make a distinction between contracts with a budget lower/higher than the EU thresholds (established by Article 35 paragraph 1 of the Procurement Code).

The relevant thresholds are represented by classes of amounts, differentiated by the type of activities to be performed, services and supplies. These thresholds establish the obligation to open a tender to companies/entities headquartered in an EU Member State, guaranteeing free access to all the economic operators in possession of the required standard. More specifically, the thresholds of Community relevance are highlighted in Figure 36.

FIGURE 36. THRESHOLDS OF COMMUNITY RELEVANCE PER TYPE OF CONTRACT.



Source: Authors' elaboration.

Another profile to be considered is the type of contract, making it necessary to distinguish between supply and service contracts and those concerning technical activities, as well as between the procurement or concession procedure.

Regarding the methods of publication of tender notices, it should be clarified that notices and invitations to tender should be published at national level on the digital platform created by A.N.A.C., which, however, is not currently operational. Consequently, the obligation of publication at national level must continue to be fulfilled through the Official Gazette of the Italian Republic (GURI) special series dedicated to public contracts.

Concerning the ordinary tender procedures for supply and service contracts with a value below the Community threshold, it is specified that they must be published on the GURI, and within 2 days, on the profile of the customer and on the MIT IT platform also through regional computerized systems (Art. 73 of the Code and Article 2 of the Ministerial Decree).

Notices of ordinary tendering procedures relating to supply, service, and concession contracts with a value above the Community threshold must be published, as well as through the channels described in the previous point, in the Official Journal of the European Union (OJEU) (art. 72 of the Code), as well as on two newspapers with national circulation and on two with local circulation in the place where the contracts are held (art. 3 c. 1 letter b of the D.M.).

The publication in GURI of the notices referred to in this point must take place within 6 days from the date of publication in GUUE, while on the MIT IT platform / regional computerized systems within 2 working days from GURI.

The notices are published in the newspapers after 12 days from the transmission (and not publication) to the OJEU or after 5 days from transmission if the Contracting Authority has benefited from the reductions in the terms referred to in Articles 60 and 63 of the Code.

Notices of ordinary tender procedures concerning works contracts with a value of less than € 500,000.00 must be published in the Praetorian Register of the Municipality where the works are carried out, as well as on the profile of the client and on the MIT IT platform.

In the case of tender with a value exceeding € 500,000.00 and below the Community threshold must be published on the GURI, by extract in a national newspaper and in a local newspaper at the place where the contracts are held (Article 3 c. 1 letter a of the Ministerial Decree), on the profile of the client and on the MIT IT platform also through regional computerized systems.

For the procedures referred to in this point, the publication of notices in newspapers must take place within 5 days from the date of publication in GURI.

Article 3 c. 1 of the Ministerial Decree does not specify the publication times relating to the concessions, nonetheless given the commonalities with other type of contracts, the rule established for the above-mentioned contracts generally tend to apply.

As far as the results of the tender are concerned, the channels through which the publication must take place are the same as those provided for the previously processed notices. The articles that regulate this type of notices are the 98 of the Code and the 4 of the D.M. It should be noted that Article 4 of the Ministerial Decree contains only the reference to the technical activities; so, there is a relevant regulatory gap regarding the timing of the first publication of the tender result for procedures concerning supplies and services of an amount below the Community threshold.

For these procedures it is therefore considered appropriate to adopt the same criterion as for the works, therefore, to respect the deadline of 30 days from the date of award.

The costs related to the mandatory publication of notices and invitations to tender (in GURI and newspapers, given the free use of the OJEU and other computerized systems) must be reimbursed to the Contracting Authority by the successful tenderer within 60 days of the award.

To support operators and private entities in the research of public tenders, the TED platform (Tenders Electronic Daily) has been created as the online version of the supplement to the Official Journal of the European Union dedicated to European public procurement. The platform publishes about 676,000 tender notices per year, including 258,000 calls for tender worth about 670 billion euros. Through the link www.ted.europa.eu, operators can consult the opportunities offered to the various actors in the European Union, the European Economic Area and elsewhere free of charge. Every day, from Monday to Friday, about 2,600 new public procurement notices are published on the site. To ensure the widest possible dissemination, information on each procurement document shall be published in the 24 official EU languages.

In the specific case of the priority sectors considered in this study (ferries, service, and offshore vessel), there has recently been (21 June 2022) the publication of a tender for the supply of two dual fuel fast vessels for the Strait of Messina, to provide greener and more sustainable ferry services. In particular, the tender was launched by Rete Ferroviaria Italiana (Gruppo FS Italiane) which proceeded, within the required time, to the publication in the Official Journal of

the notice concerning the tender notice. Given the amount of the budget, amounting to 52 million euros, the above-mentioned notice was configured as "above threshold" with respect to the limits laid down at Community level, which is why it was necessary to comply with more stringent advertising obligations. Regarding the budget, the notice has previewed the option for RFI to entrust to the supplier the supply of a third ship with the same features, for an amount of 22,5 million euros. The new ships will have a double power diesel/gas and electric, with technologies to high energetic efficiency that allow zero emissions of CO_2 and gas greenhouse. Each ship will have a length of approximately 50 meters and will be able to transport 350 persons.

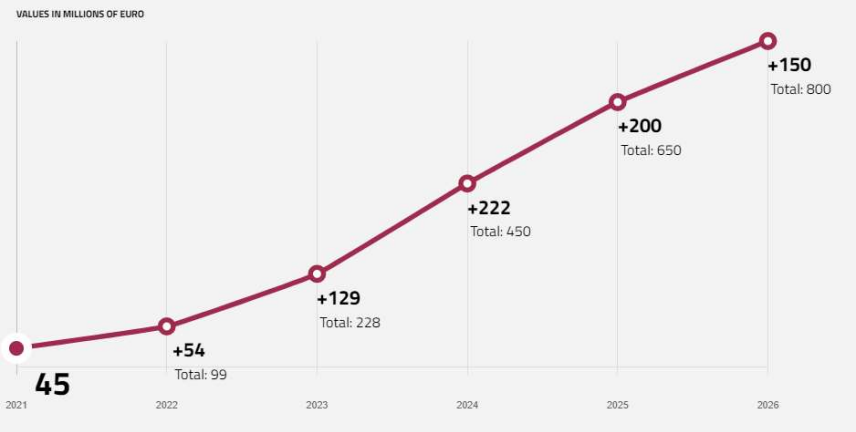
3.D. Larger contracts that are expected to be announced in the future? Estimated size of these?

The importance that is placed in Italy on the issues of environmental sustainability, the use of renewable energy sources and the use of alternative fuels in the maritime transport and port sectors, led to the introduction of numerous funding and co-funding opportunities in the Complementary Fund to the National Recovery and Resilience Plan (PNRR) that intend to finance and support "green" projects.

More specifically, within Mission 2 – "Green Revolution and Ecological Transition" - Component 2 – "Renewable energy, hydrogen, network and sustainable mobility", a call has been included aimed at reducing atmospheric emissions and environmental impact of maritime transport, as well as the use of alternative marine fuels such as Liquefied Natural Gas (LNG).

The total financial commitment to achieve these objectives is equal to 800 million euros, divided between 2021 and 2026 as shown in Figure 37.

FIGURE 37. PNRR - MISSION 2 - "GREEN REVOLUTION AND ECOLOGICAL TRANSITION" - COMPONENT 2 – "RENEWABLE ENERGY, HYDROGEN, NETWORK AND SUSTAINABLE MOBILITY": BUDGET BY YEAR.



Source: www.italiadomani.gov.it.

Three different inherent sub-investments are envisaged, the main characteristics of which are summarized in Table 24 and which refer to:

- Sub-investment I - Renewal of the Mediterranean naval fleet with clean fuel naval units which focuses on the renewal of the naval fleet in the Mediterranean with high-performance units, equipped with the latest generation propulsion systems, hybrid and

innovative solutions and digital control systems. In this respect, public co-financing measures will be implemented for the retrofitting of existing naval units with the latest generation propulsion systems (e.g., dual fuel engines, LNG engines, batteries, hybrid systems) as well as through the creation of new units or updating of orders in progress according to the most stringent energy efficiency criteria of the IMO with the integration of innovative solutions and latest propulsion systems generation;

- Sub-investment II - Renewal of the naval fleet and in the Strait of Messina to reduce emissions in line with modern ecological standards including the renewal of the Blue Jet fast vehicle fleet with the purchase of 3 vessels in order to significantly reduce CO_2 emissions and consumption; and the existing fleet hybridization for RFI ships used for railway ferrying;
- Sub-investment III – Increase the availability of alternative marine fuels in Italy through liquefaction plants connected to the national gas network each with a capacity of at least 50,000 tons also modular on the Italian territory with particular focus on the south and central and southern Italy. LNG will be supplied to these ships through the infrastructural adaptation of regasification terminals for reloading small ships.

TABLE 24. PNRR - MISSION 2 - "GREEN REVOLUTION AND ECOLOGICAL TRANSITION" – COMPONENT 2 – "RENEWABLE ENERGY, HYDROGEN, NETWORK AND SUSTAINABLE MOBILITY": SUB-INVESTMENTS.

Sub-Investment	Title	Budget	Timing
I	To renew the Mediterranean naval fleet with fuel units able to reduce the environmental impact.	500.000.000,00 €	2021-2026
II	Renewal of the naval fleet for the crossing strait of Messina.	80.000.000,00 €	2021-2023
III	Increase the availability of alternative marine fuels (LNG).	220.000.000,00 €	2021-2026

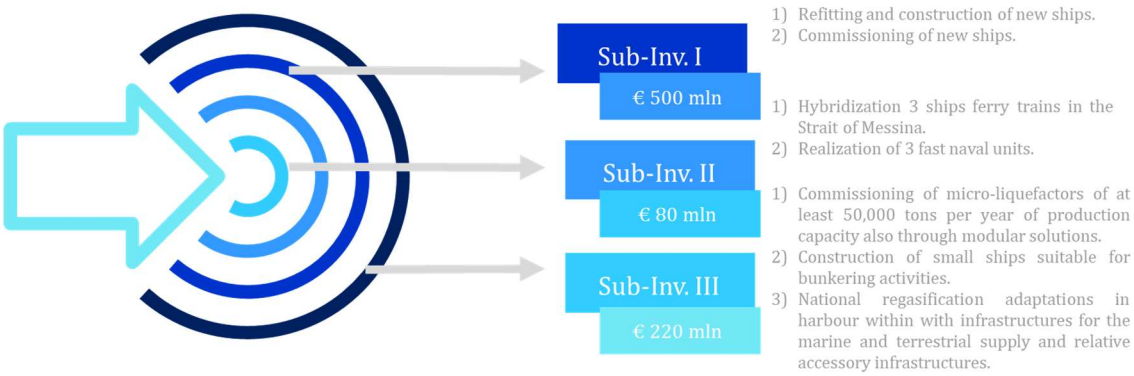
Source: Authors' elaboration.

The implementation of the following interventions will ensure adequate support in the overall reduction of the environmental impact produced due to the modernization of the systems used by ships and the use of alternative fuels. The benefits to be obtained through these investments can be summarized as follows:

- ✓ Offer environmentally sustainable maritime passenger transport;
- ✓ Make the service of connecting coastal areas more efficient;
- ✓ Improve the attractiveness of tourist areas related to maritime transport.

In line with these benefits, the priority strategic goals for each sub-investment can be identified, as highlighted in Figure 38.

FIGURE 38. PRIORITY STRATEGIC OBJECTIVES



Source: Authors' elaboration.

3.E. Any special local conditions that should be considered.

The main special local conditions that must be considered to adequately understand potential barriers and benefits for companies entering the Italian market are represented by (FIGURE *39*):

- ✓ Allocation of a specific share of resources to firms and other companies with local subsidiaries located in the regions of the "Mezzogiorno" (regions located in the South of the Country);
- ✓ Special Economic Zones and Simplified Logistic Zones and their benefits.

FIGURE 39. SPECIAL CONDITIONS OF ITALIAN MARKET

Source: Authors' elaboration.

Regarding the first profile, it should be noted that this is an intervention aimed at respecting the principle of territorial cohesion enshrined at Community level by art. 174 and 178 of the Treaty on the Functioning of the European Union. In fact, cohesion policy is the European union's strategic investment policy and offers benefits to all EU regions and cities by supporting economic growth, job creation, business competitiveness, sustainable development, and environmental protection.

From this point of view, the National Recovery and Resilience Plan (PNRR) is an opportunity for the revival of the "Mezzogiorno" (which includes the regions shown in Figure 40) and for the resumption of the convergence process with the most developed areas of the country. Social and territorial cohesion is one of the fundamental pillars on which the programming and content of the entire PNRR. The Plan therefore pursues the territorial rebalancing and the

revival of the South as a transversal priority to all the internal missions. The strategic axis of social inclusion aims to reduce the citizenship gap, to overcome the deep inequalities, often accentuated by the pandemic, to overcome the structural weakness of the production system of the South, accompanying the process of convergence between South and Centre-North as an objective of economic growth, as repeatedly requested in the Recommendations of the European Commission.

FIGURE 40. LIST OF REGIONS WHICH CONSTITUTES "MEZZOGIORNO"

Source: Authors' elaboration.

According to what is expressly indicated in the PNRR, the Plan makes available to the Southern regions a complex of financial resources equal to no less than 40% of the territorial resources of the PNRR, for the eight regions of the South, compared - it is emphasized in the Plan - of 34% provided for by the current legislation in force in favor of the South Italy for the distribution of ordinary investments destined throughout the national territory.

It should be noted that the PNRR does not show a territorial distribution of resources; however, there are indications on the distribution of resources for each Mission, provided directly by the Italian Government and summarized in TABLE *25*.

TABLE 25. DISTRIBUTION OF SOUTH RESOURCES FOR EACH PNRR MISSION

No. Mission	Mission	Budget	%
1	Digitisation, innovation, competitiveness and culture.	14,58 bn€	36%
2	Green revolution and ecological transition.	23 bn€	34%
3	Infrastructure for sustainable mobility.	14,53 bn€	52%
4	Education and research.	14,63 bn€	46%
5	Inclusion and cohesion.	8,81 bn€	39%
6	Health.	6 bn€	35-37%
	Total	81,55 bn€	

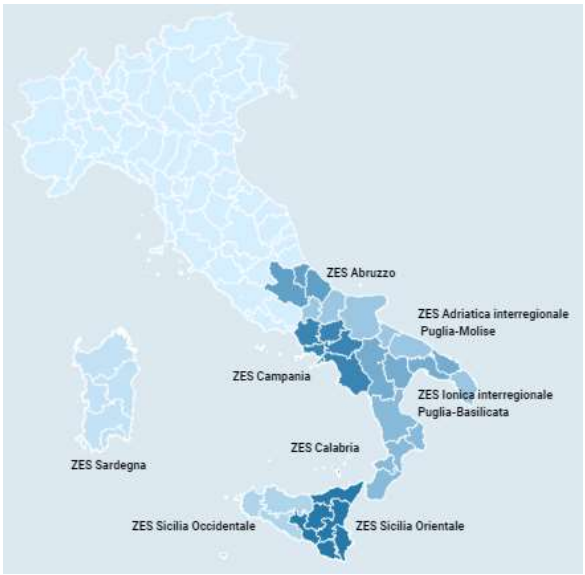
Source: Authors' elaboration.

With regard to the Special Economic Zones (SEZs) and the Simplified Logistics Zones (SLZs), it should first be noted that the creation of special economic areas, variously modulated, represents the instrument chosen by governments to attract investments by acting in the field of facilities to promote trade, through the preparation, in delimited territorial areas, of various tax measures, customs and administrative advantages for the establishments of companies and

for the performance of their activities in the areas of the Southern Italy. However, the decree-law establishing the SEZs(Decree-Law no. 91 of 20 June 2017, converted with amendments by Law no. 123 of 3 August 2017) and the approval of the implementing regulation, the reflection on the facilities for the ports of the Northern Italy gave rise to a special measure approved with an amendment made to the 2018 Budget Law, which provides, in fact, for the establishment of port areas in which companies will be able to benefit from some simplified procedures already granted to Special Economic Zones (SEZ) and called Simplified Logistics Zones (SLZ). SLZ are an attenuated form of SEZs in terms of benefits that can be used by companies; however, after the changes and additions made to the original basic regulatory text, the profile of the two institutes to date substantially coincides above all with reference to the SLZs "strengthened" as the regulations establish that new business settlements and existing ones operating in the Simplified Logistics Zones benefit, in addition to the facilitations and simplifications valid for ordinary Simplified Logistics Zones also of some tax benefits such as the tax credit.

To date, in Italy there are 8 SEZ areas reported in Figure 41, while the SLZs are in continuous and constant evolution. By way of example, on 6 October 2022 the Decree of the President of the Council of Ministers (DPCM) was signed, establishing the SLZ "Port of Venice-Rodigino", which, according to estimates by the Veneto Region, in ten years can produce economic investments of 2.4 billion euros, an increase of 177,000 jobs, an increase in exports of 40% and 8, 4% of port traffic.

FIGURE 41. LOCALIZATION OF SEZS IN ITALY.



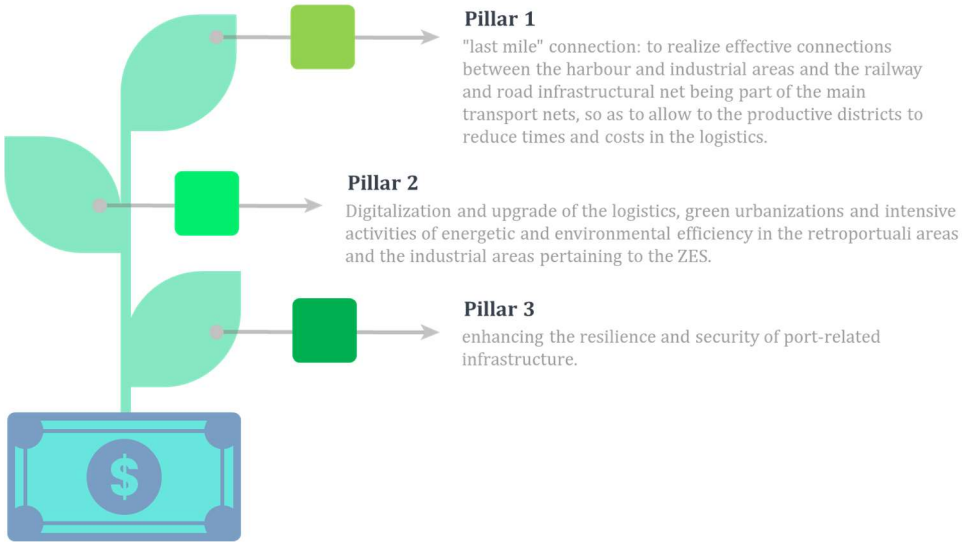
Source: Agenzia per la Coesione Territoriale, 2022.

Given the importance of these areas, specific incentive schemes are provided within the National Recovery and Resilience Plan (PNRR), as it allocates 630 million euros, divided between the 8 areas, for infrastructure investments aimed at ensuring an adequate development of the connections of the SEZ areas with the national transport network, in particular with the Trans-European networks (TEN-T), to make the implementation of the SEZs effective. To these resources, there are additional 1.2 billion euros that the PNRR reserves for interventions on the main ports of the South and 250 million euros on the Development and

Cohesion Fund for special Development Contracts aimed at simplifying and reducing the time of interventions.

More specifically, these are investments based on three main pillars (Figure 42) that respond to the more general objective of development and growth of the various areas mentioned above.

FIGURE 42. MAIN PILLARS OF INFRASTRUCTURAL INVESTMENT OF THE SEZS.



Source: Authors' elaboration.

FIGURE 43. MAIN HIGHLIGHTS - CHAPTER III

Source: Authors' elaboration.

CHAPTER IV

COMPETITIVE SITUATION AND POTENTIAL PARTNER

This section is entirely devoted to assessing the Italian competitive arena which characterizes the business of hybrid/alternative marine propulsion systems as well as the electrification of the maritime port industry and map potential partners headquartered in Italy, for business development purposes.

For the aim of the section, first, main green vessel solutions recently launched in the Italian market are mapped for scrutinize substitutive technologies and some business cases from green-oriented shipping companies operating ferry, service, and offshore vessels in Italy are introduced and discussed. Second, national maritime clusters and clusters with focus on related technological/scientific areas are reported for suggesting valuable partnerships and technical network of key actors embedded in the Italian market. Finally, an in-depth overview of the overall Italian supply chain is performed aiming at supporting Norwegian companies eager for entering the Italian Market. An ad hoc list of potential industrial/technological partners and commercial leads operating in the upstream and downstream, respectively, is reported.

Favorable geographic locations for developing new ventures or subsidiaries operating in the field of green technologies for the shipping and port industry are envisaged, considering the presence of a wide range of potential partners in the supply chain as well as business, technology and market opportunities originating from economies of proximity. Two relevant business partners with strong attitude towards green innovations in the maritime and port industry and a successful market and competitive positioning in Italy are finally suggested and discussed.

4.A. Have other green vessel solutions been launched in the market?

As reported in Section 1.F, some innovative green vessels have been recently launched in the Italian market: they include both passenger ferries and Ro-Ro ships, as well as service vessels and offshore vessels. Most diffuse green technologies and alternative solutions aimed at mitigating the main negative externalities from the industry can be grouped into five broad categories of green investment options, i.e., ship propulsion systems & alternative fuels; technological solutions for energy & environmental efficiency; water treatment systems; waste treatment systems; automation & digital technologies (Notteboom, Satta, Morchio & Vottero; 2021).

In addition to the already mentioned Grimaldi Green 5th Generation ships, launched in the Italian market by the Grimaldi Group starting from 2020, it is worth mentioning some other green technical solutions introduced in the Italian market by leading shipping companies operating in the three sample businesses, i.e., ferry, Ro-Ro and Ro-Pax sectors, service, and

offshore vessels. When it comes to the ferry, Ro-Ro and Ro-Pax business, in particular, a number of more sustainable ships, characterized by extremely innovative solutions aimed at pursuing environmental sustainability, have entered the market.

In this section we provide an exhaustive, albeit synthetic, overview of the Italian market by scrutinizing the strategic approach pursued by the leading competitors in the market and describing some alternative green vessel solutions launched within the Italian field. It should be noted, however, that, for parsimony, this is a concise and non-exhaustive overview of all the solutions implemented nationwide.

When it comes to the role of automation a& digital technologies & key role in both seaside and landside for shipping and ports will be played by the development of the Italian Port Community System (PCS) aimed at integrating the national logistics and transport network.

All the afore mentioned green options are argued to significantly mitigate the negative environmental spillover originated by vessels operating in the sample shipping businesses, e.g., air pollutants, loss of biodiversity, GHG emissions, light pollution, noise pollution, water and effluents emissions.

FIGURE 44 - GREEN INVESTMENTS OPTIONS FOR FERRIES, SERVICE AND OFFSHORE VESSELS

Ship propulsion systems & alternative fuels	Tech. solutions for energy & environ. efficiency	Water treatment systems	Waste treatment systems	Automation & digital technologies
Integrated Electric Prop. (IEP)/Battery	Exhaust Gas Cleaning System (scrubber)	Adv. wastewater purif. systems (AWWPS)	Waste reduction policies	Autonomous shipping
Diesel-Electric engines	Hull air lubrication ("bubble technology")	Ballast water Exchange	Unsorted/separated waste compactors	Digital technologies
Wind assisted propulsion	Fuel saving propeller attach. & ship design	Onboard treatment	Wet waste compactor (Converter NV)	Etc.
VLSFO/ULSFO	New bulbous bow (nose job)	Etc.	Hazardous chemical waste management	
LNG/LPG	Heating, Ventilation and Air Conditioning			
Hydrogen/Fuel Cell (FC) systems	Solar power			
Biofuels	Cold ironing			

Source: Authors' elaboration.

Green Strategy of Caronte & Tourist Lines

The Caronte & Tourist Lines (see Section 3.B) is an Italian ferry company with a strong green vision, which has recently invested valuable financial resources (over 200 mln €) for renewing the fleet by ordering 4 innovative LNG-propelled (Liquified Natural Gas-) ships. Technical data related to three out of these four vessels are reported below in Table 26.

TABLE 26. LNG-PROPELLED FERRIES IN THE CARONTE & TOURIST LINES' FLEET: AN OVERVIEW.

Name of Ship	Status	Year	Built	Flag	Deadweig	GT	Operator
ELIO	In Service/Commission	2018	2018-10	Italy	1,673	9,943	Caronte & Tourist SpA
EOLIE	Keel Laid	2023	2023-04	Italy	1,400	8,234	Naos Ship & Boat Design
SEFINE 60	On Order/Not Commenced	2024	2024-04	Italy	11,742	8,778	Caronte & Tourist SpA

Source: Authors' elaboration.

The LNG-powered Ro-pax vessel "Elio" has been delivered to its owner Caronte & Tourist Lines in Messina, Italy, under the GAINN4MOS project[4] and it is claimed to be the first LNG-powered ferry to sail the Mediterranean.

The Italian Ministry of Transport (MIT) within the GAINN4MOS project coordinated the elaboration of the basic and detailed engineering studies of the small Ro-pax LNG powered ferry of Caronte & Tourist Lines. After completing the engineering studies, the prototype of this LNG Ro-pax ship has been built by the Turkish Sefine shipyard and was delivered on the end of October, 2018. According to official news presses, Elio currently is operated in the Strait of Messina, linking Sicily and Italy mainland.

This vessel is a small Ro-Ro passenger vessel, a double-ended seven-decks ferry designed to operate in EU Class D areas able to carry passengers, private cars, trucks, and trailers, with a maximum capacity for 290 private cars, 1500 people and 35 trucks.

The main Wartsila dual-fuel engines will be fueled with LNG stored in 150-cbm tanks. Service and maximum speeds are respectively 12.5 and 15 knots. The ship is Italian flagged, and RINA classed with Gas Fueled notation (IGF compliant).

The Green Strategy of Grandi Navi Veloci S.p.A.

The shipping company Grandi Navi Veloci S.p.A. (GNV) was founded in Genoa in 1992 and is now active on the most important routes in the Italian territory, connecting Genoa, Civitavecchia and Naples with the main ports of Sicily and Sardinia. GNV operates successfully on primary Mediterranean routes connecting Italy with Tunisia, Morocco, Albania, France, also providing itineraries for Spain and the Balearic Islands. The company's fleet consists of 25 ships, a number that demonstrates the importance of the company in the Italian and European context, and the Development Plan includes the construction of 4 new ships to be operational in 2024. In recent years, Grandi Navi Veloci S.p.A. has paid increasing attention to the implementations of green strategies to reduce its footprint on the climate and on the health of the seas in which it sails. Among the green strategies pursued by GNV, it's worth mentioning the sustainable disposal of waste generated on board, the adoption of sustainable practices within the services offered on board, the improvement of energy efficiency and the reduction of CO_2 emissions and other air pollutants, with specific reference to sulfur oxides. Furthermore, in addition to the refitting efforts of the ships it already owns with a view to environmental sustainability, the company has drawn up a plan to invest in newly built ships that will be equipped with features to classify them as green ships, demonstrating the growing focus on the issue of environmental sustainability that the company is placing.

[4] The GAINN4MOS action, funded by the Connecting Europe Facility (CEF) programme, aims to improve the Motorways of the Sea network in 6 Member States (Spain, France, Croatia, Italy, Portugal, and Slovenia) by carrying out engineering studies on ship retrofitting and/or newbuilding, port LNG infrastructures, bunkering stations throughout pilot projects.

Going into detail about the solutions the company have initiated to make their ships more sustainable, it is essential to mention the collaboration with the innovative start-up ECODYGER S.r.l., which produces the machinery known as Ecodyger. The collaboration stems from the shipping company's desire to optimize and make virtuous the disposal of organic waste generated on board, with a view to modern Zero Waste policies. Each Ecodyger equipment is capable of processing more than 100 kg of wet-organic waste per day, through a regeneration cycle that takes about 7 hours. The equipment guarantees the sustainable reduction of the ship's wet-organic waste by up to 80% of its weight and volume, returning a dry solid residue which can be used as 100% natural fertilizer and soil conditioner. Through Ecodyger, GNV has been able to eliminate odors, limit the proliferation of germs and bacteria, and greatly limit the waste collected in port, and consequently the flow of waste leaving the port to the landfills. In addition, the use of these machines has resulted in an important reduction in CO_2 emissions both on board of the ships in which it is installed and onsite, because of the fewer trips required to transport waste from the port to the landfills.

Grandi Navi Veloci has been cooperating for more than 10 years with Ecolab, a world leader in water, sanitation and energy technologies and services. As a result of this collaboration, GNV has been able to reduce plastic consumption on board by more than 50%, by replacing the products used with more sustainable alternatives such as biodegradable disposable materials, reduced water and energy consumption by 10% through the use of an operations monitoring and control system and extended the life cycle of tableware used on board ship by 20% by optimizing the procedures for washing them. Moreover, the shipping company has replaced the old lighting system with more than 70,000 LED lights, a solution significantly more environmentally and economically sustainable. In fact, the investment allowed a 70% reduction in CO_2 emissions, with a reduction that is quantified as 2785 tons less per year, and in addition, thanks to the long life of LED products (about 50,000 hours) and low energy consumption, the costs of system maintenance and material dismantling were also optimized.

In August 2020, the company installed the first Exhaust Gas Cleaning System (scrubber), specifically on the M/n Majestic. The scrubber installation is aimed at the company's compliance with the more stringent regulation on sulfur oxide emissions into the atmosphere dictated by the IMO, and the consolidation of the position that the company holds in the sustainability domain. In fact, the investment in the installation of scrubbers on the ships that make up the fleet currently owned by the company, has enabled a reduction in sulfur oxide emissions from exhaust gases by 80% compared to the current legal limits (from 0.5 to 0.1 percent), which denotes GNV's willingness not merely to comply with the limits imposed by law but to invest with a view to making its company more sustainable.

In addition to the sustainable refitting work carried out on the ships it already owns, GNV recently announced the purchase of 4 newly built ships, 2 of which will be LNG-powered, a significantly more sustainable energy source than traditional fuels such as Heavy Fuel Oil (HFO).

The overall green solutions implemented by Grandi Navi Veloci S.p.A. can be appreciated in Figure 45.

FIGURE 45. GREEN SOLUTIONS IMPLEMENTED BY GRANDI NAVI VELOCI S.P.A.

Green solution \ Impact	reduction of CO_2 emissions	reduction of NO_x emissions	reduction of SO_x emissions	Energy efficiency improvement	Waste reduction
Ecodyger	✓				✓
Usage of biodegradable disposable materials	✓				✓
Operations monitoring and control system	✓			✓	✓
Replacement of the old lighting system with LED lights	✓			✓	✓
Scrubbers installation			✓		
Purchase of LNG-powered ships	✓	✓	✓		

Source: Author's elaboration.

The "E-pelikan" green solution

A few days ago (October 4, 2022) the brand-new E-pelikan (Figure 46) was unveiled, a fully electric and environmentally friendly service boat intended for waste and plastic collection in docks and harbors. More in detail the E-Pelikan, designed by the Garbage Group in collaboration with Enel X Way (the ENEL Group's company dedicated to electric mobility), is the first 100% electric workboat sailing in Italian marine waters, is a zero-emission boat and can collect all kinds of waste at sea thanks to the use of drones, submarine rows and probes to search for waste.

The boat is made of fiberglass, is 7 meters long and 2.5 meters wide: it is wheelable: as a result, it can be transported by road along shorelines to operate in different municipalities. It has a 40-horsepower all-electric motor, two battery packs of 20 kw each, and the canopy is equipped with photovoltaic panels to recharge the service batteries. The E-pelikan at a speed of 3 knots, in working trim, has 20-25 hours of autonomy, which is crucial for the operators who don't have to recharge every time they return, while at a cruising speed of about 6 knots the autonomy is about 2.5 hours of sailing. The boat is 100% produced by the Italian supply chain, including shipyard, engine, batteries and photovoltaic systems.

FIGURE 46. E-PELIKAN.

Source: ANSA, 2022.

According to Garbage Group, in spring 2023 there will be a consistent number of E-Pelikan operating in Italian ports that will collect solid and liquid waste in the Italian ports. E-Pelikan testifies that it is possible to develop a 100% electric service boat, an important market for shipbuilding in which Italy can represent the new excellence in green shipping.

The Garbage Group has been active for more than 60 years in the provision of waste collection, transportation, treatment, recovery and disposal services of all kinds and types, as well as environmental remediation and recovery, cleaning of beaches, shores, bodies of water, marine/land anti-pollution and remediation of both compact and friable asbestos. The boats operated by the company are not only efficient vessels with a low environmental impact on the ecosystem, but also a shared system of know-how and technologies to protect the environment.

The "Opv" green solution

Built by Cantiere Navale Vittoria in collaboration with Damen Shipyards Group, the Guardia di Finanza's new green Opv (offshore patrol vessel) is over 60 meters long, 9.5 meters wide, has a draft of 3.5 meters and can be operated at a maximum speed of more than 26 knots, with an Axe Bow that ensures excellent seaworthiness even in troubled weather and sea conditions without having to limit the speed. The offshore vessel is equipped with a diesel-electric hybrid engine that allows it to carry out its operations while generating very few emissions and causing a much lower negative environmental impact than the industry standard. The two main engines are flanked by reversible electric motors of 270 kw each, which can act as propulsion engines on patrol or provide electrical power at other gaits. The offshore vessel can accommodate up to 30 crew members on board, with the possibility of accommodating an additional 8 people for Frontex personnel (Figure 47).

The naval unit will be deployed to carry out the tasks entrusted to the Guardia di Finanza Corps and in particular patrolling, maritime surveillance, development of Maritime Situational Awareness (MSA), countering illegal immigration and trafficking perpetrated by sea both under National Command and the control of the FRONTEX Agency.

The offshore Patrol vessel will obtain the highest class stipulated by the Italian Naval Register (Registro Italiano Navale - RINA) and the notations Efficient Ship EEDI (Energy Efficiency Design Index), Green Plus and Green Passport Plus due to technical characteristics aimed at guaranteeing environmental sustainability, especially when compared with the industry standard.

FIGURE 47. GREEN OFFSHORE PATROL VESSEL

Source: Ares Osservatorio Difesa, 2020.

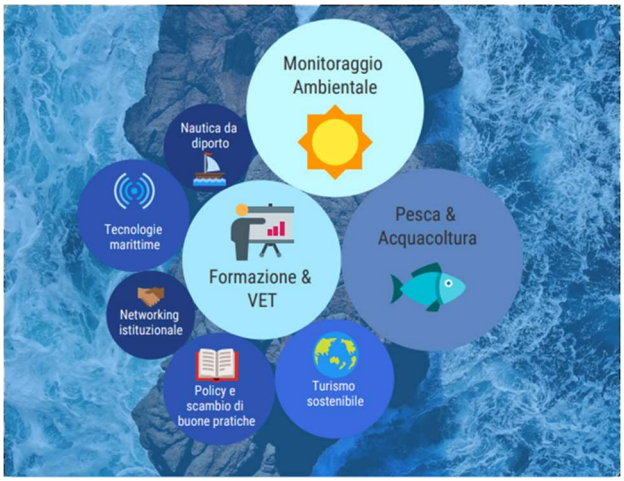
Additional green vessel solutions recently launched in the market are reported and discussed in the next Section 4.C "Key partners in the market".

4.B. National maritime clusters or clusters within related areas (e.g., green energy).

Italy counts a significant number of Technological Clusters focuses on innovations for greening the shipping and ports industry, both operating at a national and a regional level. These Technological clusters groups main public and private entities operating in the field of industrial research, training and technology transfer, but also several key shipping companies and shipyards: such clusters include companies, universities, public and private research institutions, start-up incubators and other subjects active in the field of sustainable innovation of maritime transport. The following section aims at describing the main industrial clusters involved in sustainability-related issues concerning port and shipping activities (Figure 50).

- ✓ Cluster Tecnologico Nazionale "Blue Italian Growth": The CTN - BIG is open to all national actors interested in Blue Growth. The purpose of the organization is to create an aggregative community and to create a meeting point between regional and national administrations. CTNBIG aims to conduct consultations and coordination actions of the main actors of the public and private research system, also in collaboration with the other Clusters. The cluster in question aims to promote industrial growth, job creation, international scientific visibility in the blue economy sector (Figure 48). The cluster includes 70 members of which 29 Universities, the main Italian Research Entities (CNR, OGS, INGV, INFN, ENEA, SZN, ISPRA), major industries (such as ENI, ENEL, FINCANTIERI, E-GEOS), SMEs from all over the national territory, 5 regional technological districts and 11 Regions (Abruzzo, Campania, Emilia-Romagna, Friuli-Venezia Giulia, Lazio, Liguria, Marche, Puglia, Sicily, Tuscany, Veneto).

FIGURE 48. ACTIVITIES PERFORMED BY CLUSTER TECNOLOGICO NAZIONALE "BLUE ITALIAN GROWTH".



Source: Relazione attività Cluster BIG, 2020.

- ✓ Cluster nazionale trasporto: The cluster includes more than 200,000 workers and 33 companies of all sizes operating in the production of means, technologies and transport services. The Cluster brings together the major national industrial and scientific actors, operating in road, rail, waterway, and intermodal mobility, in the field of telematics applied to transport and integrated transport services. The aim of the cluster is to create synergies between the different supply chains and identify future research and innovation trajectories in the transport sector, also to efficiently allocate the available resources. Particular attention is paid to training activities for new professional profiles involving universities, research centers and companies with the aim of creating a national network of distinctive skills for the transport sector.
- ✓ Distretto tecnologico della nautica e della portualità (Tuscany): the cluster develops activities related to innovation and technology with specific actions dedicated to shipyards, marinas, and ports, involving over 200 companies and 20 research organizations. The district has set 4 strategic patterns with ad hoc roadmaps:
  - Boat design in line specific suitable criteria for disassembling/dismantling (DFD);
  - Propulsion systems with reduced environmental impact;
  - Port innovation & development (energy, monitoring and control, security);
  - Integrated and "Intelligent" management of on-board systems and instruments: (automation and drones).

  RETE PENTA is the managing body of the "Distretto tecnologico della nautica e della portualità". The district created an aggregate of 300 innovative and technological companies, and it has developed agreements with 50 laboratories and the main Tuscan universities (Figure 49). The 150 innovation projects developed so far by PENTA have focused on the themes of: automation, digitalization, boat-port relationship, new materials, product life cycle, new propulsions.

FIGURE 49. MAIN NUMBERS OF DISTRETTO TECNOLOGICO DELLA NAUTICA E DELLA PORTUALITÀ.

Source: Authors' elaboration.

- ✓ Polo di Ricerca ed Innovazione sulle tecnologie del mare ed ambiente marino (Polo DLTM) (Liguria): the cluster aims to optimize the aggregation of skills active in the field of "Marine Technologies" in the area and make them more accessible to Ligurian companies. The activity of the DLTM Pole is focused on the design & development of actions attributable to 4 main lines of intervention:
  - Support to Cooperative Research & Innovation projects referring to regional, national and EU calls;
  - Creation of a system of Cooperative Research Laboratories active on the main sectors of the Economy of the Sea and networking of existing laboratories in the Ligurian territory;
  - Planning & delivery of post-graduate specialized training courses and creation of an International School on Marine Technologies;
  - Establishment of a package of advanced services to companies, provided at "counter", on request (Innovation Desk).
- ✓ Distretto Tecnologico Trasporti Navali Commerciali e da Diporto Sicilia (Sicily): is a consortium operating in the naval transport sector. The aim of the district is to support:
  - Development of scientific research & technological innovation activities, in order to enhance the territorial economic and technological heritage thus increasing the competitiveness of the Sicilian socio-economic system at an international level;
  - Collaboration and technology transfer between universities, research centers, public and private, and productive sectors.

The district promotes scientific research activities and develops innovative projects, initiating technology transfer processes between universities, public and private research centers and companies. The district aims to transform the economy of the sea, thanks to networking, cooperation, and internationalization interventions, supporting the processes of intellectual property management, the marketing of innovative technologies and the creation of spin-offs.

- ✓ The Maritime Technology Cluster - FVG (Friuli Venezia Giulia): is a group of companies, universities, research centers, and training institutions, which share the aim to increase their capacity to compete through joint projects/ventures. The cluster promotes collaborative projects aimed at increasing and stimulating networking as well as interregional/international collaborations. In addition, the cluster is devoted to research projects for supporting the reporting phases of activities, events and initiatives aimed at increasing relations between research and innovation actors and supporting open innovation processes, facilitating the meeting between ideas / research results and users of innovation.

FIGURE 50. MAIN INDUSTRIAL CLUSTERS INVOLVED IN SUSTAINABILITY-RELATED ISSUES CONCERNING PORT AND SHIPPING ACTIVITIES.

Source: Authors' elaboration.

4.C. Key partners in the market (e.g., shipyard).

In order to map potential key partners in Italy within the maritime-port sector for Norwegian technology providers interested in the hybridization and electrification of the ferry, service and offshore vessels, an ad hoc empirical investigation of the entire supply chain has been performed.

In this vein, the companies with operational headquarters in Italy, operating in businesses that are complementary to the sectors covered by the report (i.e., ferry, off-shore and service vessels) have been scrutinized through the use of the "AIDA – Bureau Van Dijk" database. For the aim of the study, Company's ATECO Code (Italian equivalent to NACE at European level) was used as the main selection criteria. In particular, an ad hoc query has been performed, extracting all active companies operating in the following ATECO Codes

- ✓ 33.15.00: Repair and maintenance of commercial vessels and pleasure craft, **OR**;
- ✓ 30.11.02: Repair and maintenance of commercial vessels and pleasure craft, **OR**;

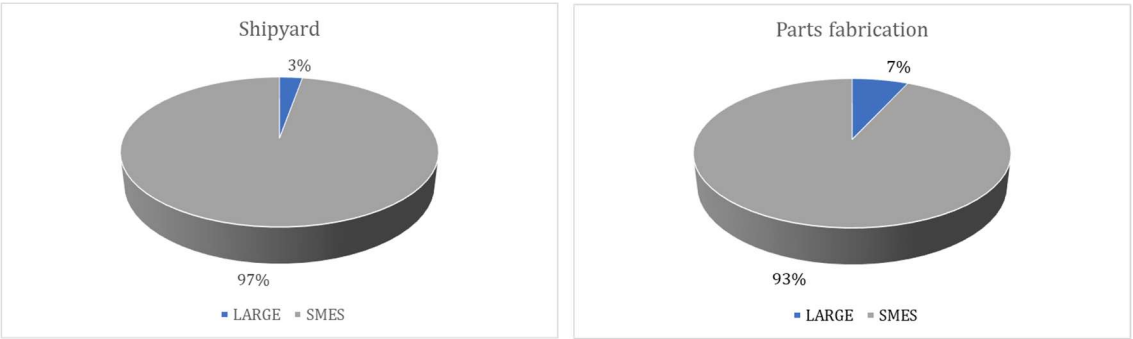
- ✓ 28.11.11: Manufacture of internal combustion engines, **OR**;
- ✓ 28.11.20: Manufacture of turbines and turboalternators.

Companies operating in "Repair and maintenance of commercial vessels and pleasure craft" or in "Repair and maintenance of commercial vessels and pleasure craft" have been then grouped into the "Shipyard" category, whereas firms focused on Manufacture of internal combustion engines or Manufacture of turbines and turboalternators were assigned to the "Spare & parts fabrication" category.

Overall, 1,119 corporation involved in the Shipyard business were extracted by the database, but only active companies has been included in the final sample, which consists of 792 corporations. Similarly, 172 corporations involved in engine spares and parts fabrication were identified, with only 132 currently operating in the business. The final dataset developed for the aim of the analysis is therefore composed of 922 corporations with operational headquarters in Italy. The dataset includes data and info related to the identification of the company (company name, corporate purpose, ATECO 2007 Code and ATECO 2007 Description), the location of the activity (operational headquarter region) and the company size (revenue, employees, assets of the last balance sheet).

Research outcomes unveil that the investigated supply chain is predominantly populated by small and medium-sized enterprises (SMEs) both in the shipyard business (97%) and in the field of spares & parts fabrication (93%). Results are in line with the typical characteristics of the national industry characterized by a significant number of highly specialized small and medium enterprises, which focuses on customized small productions to be sold to the leading international large corporations which provide the final product on global markets: these large corporations hold a key role in the industry as they are endowed with the marketing and financial resources and well as the manufacturing capabilities necessary for targeting B2B (Business to Business) clients worldwide (large corporations act as "anchor firms" which develop complex network of small companies, putting together the respective technological capabilities, technical competences and other skills). The market is therefore highly fragmented as it is composed by a large number of small-sized operators in terms of number of employees, revenues and assets of the last balance sheet as well as market share (Figure 51).

FIGURE 51. DISTRIBUTIONS BY SIZE OF TWO SAMPLES.

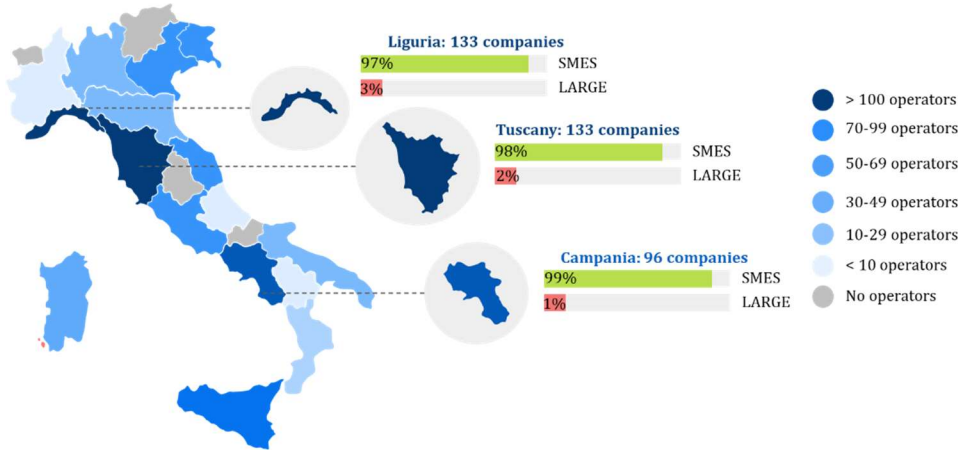


Source: Authors' elaboration.

Figure 52 shows the geographical distribution by regions of sample corporations belonging to the "Shipyard" sub-group. Data suggest a strong regional specialization in the case of Liguria

(133), Tuscany (133) and Campania (96). These areas are suggested as the best locations for developing new ventures or subsidiaries operating in the field of green technologies for the shipping and port industry, due to the presence of a huge range of potential partners in the supply chain as well as business, technology and market opportunities originating from economies of proximity. Within the individual regions, the trend observed on the distribution of companies between small/medium and large companies is reconfirmed. It should also be noted that no operators were detected in the regions of Valle d'Aosta, Trentino Alto Adige, Umbria and Molise, regions also characterized by the lack of access to the sea and a low rate of collaboration with the port regions.

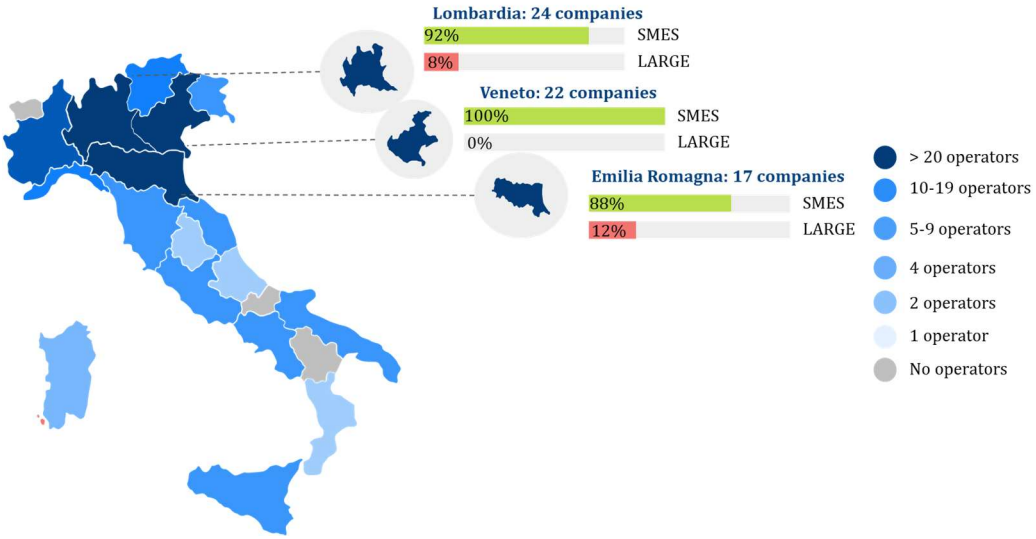
FIGURE 52. DISTRIBUTION BY OPERATIONAL HEADQUARTER OF SHIPBUILDERS.



Source: Authors' elaboration.

When it comes to the second sub-group composed by corporations involved in spares and parts fabrication/provision (i.e., the manufacture of internal combustion engines as well as turbines and other components) a higher geographical dispersion of operational units in the Italian territory emerges. The largest number of corporations are located exclusively in the North and Middle of the country (Lombardia, 24; Veneto, 22; Emilia Romagna, 17) as reported in Figure 53. Although SMEs prevail in all the aforementioned regions, 8% of the corporations located in Lombardia are large companies, and 12% of those headquartered in Emilia Romagna belong to the same dimensional group. Similarly, these regions should also constitute favorable locations for setting new ventures or subsidiaries operating in the field of green technologies for the shipping and port industry. Unsurprisingly, no corporations were detected in Valle d'Aosta, Basilicata and Molise.

FIGURE 53. DISTRIBUTION BY OPERATIONAL HEADQUARTER OF INTERNAL COMBUSTION ENGINES AND OTHER COMPONENTS PRODUCERS.



Source: Authors' elaboration.

To support the scouting of key partners for business networking and technology transfer in the Italian maritime and port industry, thus supporting Norwegian technology providers eager to enter the Italian market, Table 27 reports key figures related to the Top 10 sample companies operating in the shipbuilding sector. Notably, 7 out of 10 are large companies and 3 belong to the SMEs dimensional group; those companies are located almost entirely in Northern Italy, except for Palumbo Superyachts Ancona Srl with operational headquarters in the Marche region. Among them Fincantieri S.p.A ranks first with over 4.2 billion euros of revenue and over 8,6 thousand employees. The corporation is part of the larger group operating the business in Italy, i.e., Fincantieri Group.

TABLE 27. TOP 10 SHIPBUILDER BY REVENUE.

ID	Company name	ATECO 2007 Code	ATECO 2007 Description	Operational headquarter region	Revenue	Employees	Capital	Size
1	FINCANTIERI S.P.A.	30.11.02	Metal and non-metallic shipbuilding (excluding seats for ships)	FRIULI-VENEZIA GIULIA	4.209.613.000,00 €	8.636	8.977.314.000,00 €	LARGE
2	THE ITALIAN SEA GROUP S.P.A.	30.11.02	Metal and non-metallic shipbuilding (excluding seats for ships)	TUSCANY	186.054.000,00 €	366	235.084.000,00 €	LARGE
3	DE WAVE S.R.L.	30.11.02	Metal and non-metallic shipbuilding (excluding seats for ships)	LIGURIA	179.057.080,00 €	319	237.580.334,00 €	LARGE
4	OFFICINE MECCANICHE NAVALI E FONDERIE SAN GIORGIO DEL PORTO S.P.A.	33.15.00	Repair and maintenance of commercial vessels and recreational craft (excluding their engines)	LIGURIA	132.483.735,00 €	175	151.241.604,00 €	LARGE
5	PALUMBO SUPERYACHTS ANCONA SRL	30.11.02	Metal and non-metallic shipbuilding (excluding seats for ships)	MARCHE	84.491.331,00 €	74	56.907.530,00 €	LARGE
6	CANTIERE NAVALE VISENTINI S.R.L.	30.11.02	Metal and non-metallic shipbuilding (excluding seats for ships)	VENETO	70.480.663,00 €	56	298.745.882,00 €	LARGE
7	CANTIERE NAVALE VITTORIA S.P.A.	30.11.02	Metal and non-metallic shipbuilding (excluding seats for ships)	VENETO	63.834.252,00 €	72	157.732.650,00 €	LARGE
8	BLUEGAME S.R.L.	30.11.02	Metal and non-metallic shipbuilding (excluding seats for ships)	LIGURIA	43.580.000,00 €	32	35.233.000,00 €	SMES
9	CARTUBI - SOCIETA' A RESPONSABILITA' LIMITATA	30.11.02	Metal and non-metallic shipbuilding (excluding seats for ships)	FRIULI-VENEZIA GIULIA	40.703.587,00 €	75	52.113.464,00 €	SMES
10	NAVALIMPIANTI - S.P.A.	30.11.02	Metal and non-metallic shipbuilding (excluding seats for ships)	LIGURIA	38.201.111,00 €	153	84.324.727,00 €	SMES

Source: Authors' elaboration.

Analogously, Table 28 shows the same data for the top 10 companies by revenue operating in the manufacture of engines, turbines and other components. In this case the presence of 6 large

operators and 4 SMES emerged, located exclusively in Northern Italy, with the only exception represented by Isotta Fraschini Motori S.P.A. operating in Puglia.

TABLE 28. TOP 10 INTERNAL COMBUSTION ENGINES AND OTHER COMPONENTS PRODUCERS BY REVENUE.

ID	Company name	ATECO 2007 Code	ATECO 2007 Description	Operational headquarter region	Revenue	Employees	Capital	Size
1	ANSALDO ENERGIA S.P.A.	28.11.20	Manufacture of turbines and turbo-alternators (including parts and accessories)	LIGURIA	802.641.000,00 €	2.467	3.063.377.000,00 €	LARGE
2	LOMBARDINI S.R.L.	28.11.11	Manufacture of internal combustion engines (excluding engines for road transport equipment and aircraft)	EMILIA-ROMAGNA	288.307.269,00 €	705	211.267.895,00 €	LARGE
3	WARTSILA ITALIA S.P.A.	28.11.11	Manufacture of internal combustion engines (excluding engines for road transport equipment and aircraft)	FRIULI-VENEZIA GIULIA	197.647.000,00 €	1.157	292.101.000,00 €	LARGE
4	YANMAR ITALY S.P.A.	28.11.11	Manufacture of internal combustion engines (excluding engines for road transport equipment and aircraft)	LOMBARDY	65.128.147,00 €	122	78.468.001,00 €	LARGE
5	SPIRAX - SARCO S.R.L.	28.11.20	Manufacture of turbines and turbo-alternators (including parts and accessories)	LOMBARDY	56.397.226,00 €	234	42.797.361,00 €	SMES
6	DINAMIC OIL S.P.A.	28.11.20	Manufacture of turbines and turbo-alternators (including parts and accessories)	EMILIA-ROMAGNA	54.480.308,00 €	179	70.385.301,00 €	LARGE
7	TURBODEN S.P.A.	28.11.20	Manufacture of turbines and turbo-alternators (including parts and accessories)	LOMBARDY	50.939.113,00 €	232	105.676.898,00 €	LARGE
8	CUMMINS ITALIA S.P.A.	28.11.11	Manufacture of internal combustion engines (excluding engines for road transport equipment and aircraft)	LOMBARDY	49.698.541,00 €	54	28.762.306,00 €	SMES
9	FRANCO TOSI MECCANICA S.P.A.	28.11.20	Manufacture of turbines and turbo-alternators (including parts and accessories)	LOMBARDY	46.217.440,00 €	136	91.569.310,00 €	SMES
10	ISOTTA FRASCHINI MOTORI S.P.A.	28.11.11	Manufacture of internal combustion engines (excluding engines for road transport equipment and aircraft)	PUGLIA	34.142.103,00 €	121	72.816.608,00 €	SMES

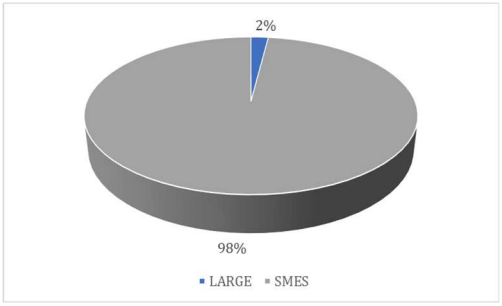
Source: Authors' elaboration.

To provide a more comprehensive understanding of the whole industry as well as further insights on additional potential key commercial partners operating in Italy, also potential leads populating the Italian supply chain have been investigated. In this perspective, the companies operating through Italian branches and subsidiaries in the downstream of the supply chain have been selected using the following ATECO codes:

- ✓ 50.20.00: Maritime and coastal transport of goods, which also includes towing, docking, pilotage, maritime signaling, and maritime rescue;
- ✓ 52.22.01: Liquefaction and regasification of gases for maritime and waterborne transport;
- ✓ 52.22.09: Other service activities related to maritime transport, which also include management of ports and docks, management of locks, navigation activities, etc.

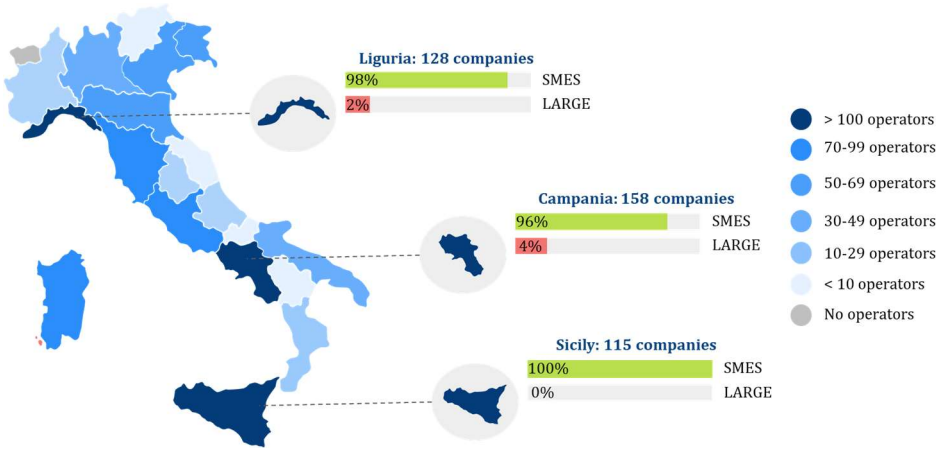
A list of 1,197 corporations headquartered in Italy has been extracted; further investigations have allowed to iron out non-operating companies, thus bringing to a final sample of 950 corporation currently active in the target businesses. Also, in this case SMES strongly prevails on large corporations (98% of the total, Figure 54). Figure 55 reports the geographic distribution by regions of the corporation operating in the downstream; two regions of Southern Italy emerged, Campania with 158 companies (1st) and Sicily with 115 companies (3rd), whereas Liguria ranks second with 128 companies. It should also be noted that no operators were detected exclusively in the Valle d'Aosta region.

FIGURE 54. DISTRIBUTION BY SIZE OF CLIENT SAMPLE.



Source: Authors' elaboration.

FIGURE 55. DISTRIBUTION BY OPERATIONAL HEADQUARTER OF CLIENT SAMPLE.



Source: Authors' elaboration.

The importance of considering this part of the supply chain also lies in the possibility of exploiting important synergies by developing both technology/technical/scientific and commercial partnerships with corporations operating in the complementary sectors (shipbuilding and manufacture of engines, turbines, and other components) and in the downstream, respectively.

To further support the scouting of key potential industrial and technological partners in Italy two valuable business studies have been investigated in details, i.e., Fincantieri S.p.A. and Wärtsilä (Figure 56), as they are the most important players located in Italy in their respective businesses as well as due to their growing attention toward issues related to electrification issues and hybridization of ferries, services and offshore vessels.

FIGURE 56. POTENTIAL PARTNERS - EXAMPLES

Source: Authors' elaboration.

Fincantieri S.p.A. is an Italian company operating in the shipbuilding sector and is the most important naval group in Europe. Already owned by IRI since its foundation, it is now 71.3% controlled by Cassa Depositi e Prestiti Industria, a financial company of Cassa Depositi e Prestiti (83% controlled by the Ministry of Economy and Finance). The company is listed on the Milan Stock Exchange in the FTSE Italia Mid Cap index. Over the course of more than 230 years of history, the company has designed and built over 7,000 ships in 18 shipyards spread over four continents (Figure 57).

FIGURE 57. FINCANTIERI S.P.A. SHIPYARDS.

Source: Fincantieri corporate website.

The Italian shipyard has always focused on technological innovation aimed at increasing the quality standards of the processes offered and above all the reduction of the environmental impact in the maritime-port sectors. In this respect, it has developed over the years multiple partnerships and strategic alliances with key actors in the industry, as summarized in the Figure 58. Below some examples are reported and discussed:

- ✓ Memorandum of Agreement with Explora Journeys (brand of the MSC group) for two new generation hydrogen-powered ships with industry-leading features, which will allow ships to operate at "zero emissions" in port with the engines turned-off;
- ✓ Agreement with Enel Green Power (Enel Group) which provides for the possibility of collaborating for the supply of green hydrogen from renewable energy to naval, submarine and surface units;

- ✓ Agreement with Enel X (Enel Group) for the electrification of the docks, the so-called cold ironing, which allows ships moored in port to "turn off the engines" (limiting negative environmental emissions) grounding exclusively on electricity;
- ✓ Joint Venture between the subsidiary Fincantieri SI and Faist Electronics to create a site for the manufacturing of batteries and the design, assembly, marketing and after-sales services for battery modules/systems.

FIGURE 58. FINCANTIERI S.P.A. "GREEN" PARTNERSHIP.

Source: Authors' elaboration.

In 2021, the Group recorded new orders of euro 3,343 million compared to euro 4,526 million in 2020, with a book-to-bill ratio (new orders/revenues) of 0.5 (0.8 in 2020). Economic and financial figures were affected by the contraction of the cruise ship market due to the pandemic Covid-19, also demonstrating an excellent result in the systems, components and services segment. The Group's total workload reached the level of euro 35.5 billion at 31st December 2021, of which euro 25.8 billion was backlog (euro 27.8 billion at 31 December 2020) and euro 9.7 billion soft backlog (euro 7.9 billion at 31 December 2020) with a development of the orders in the portfolio expected until 2029. The backlog and the overall workload guarantee respectively about 3.9 and about 5.3 years of work when compared to the revenues developed in 2021. In addition, during the first quarter of 2022, the Group confirmed its excellent growth trends (Figure 59) by delivering 5 ships and proceeding with the construction of other 7 naval units. The company currently also owns 93 ships in backlog and 18 ships in soft backlog.

FIGURE 59. FINCANTIERI S.P.A. 1Q 2022 MAIN RESULTS

Source: Fincantieri 1Q 2022 RESULTS, 2022.

The second potential key partner, Wärtsilä, is a global leader in innovative technologies and life-cycle solutions for the marine and energy markets which has a strong presence in Italy for both R&D activities and manufacturing. It has always placed emphasis on innovation in sustainable technology and services to support its main clients in the continuous improvement of environmental and economic performance. In this regard, it holds a dedicated team of 17,000 professionals in more than 200 locations in 68 countries engaged in the transformation of the decarbonization of operating sectors around the world. In 2021, Wärtsilä's net sales amounted to euro 4.8 billion. The company is now listed on Nasdaq Helsinki.

When it comes to initiatives for sustainability and technological development, Wärtsilä has launched multiple projects and partnerships, summarized in Figure 60 and described below:

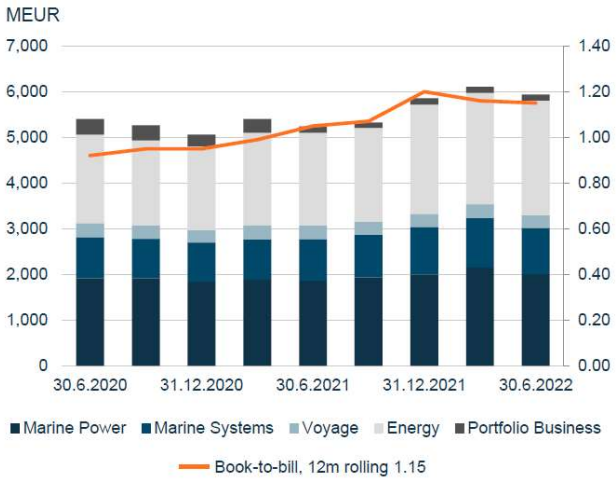
- ✓ ZEEDS (Zero Emission Energy Distribution at Sea): launched in 2019, the initiative includes a network of offshore platforms to make zero-emission fuels available to the marine industry;
- ✓ SEATECH: the Wärtsilä Technology Group, together with a consortium of six other industrial and academic partners, has secured EU funding for a major project aimed at reducing fuel consumption and lowering emissions levels for maritime transport by creating two symbiotic ship engine and propulsion innovations which, when combined, could lead to a 30% reduction in fuel consumption;
- ✓ H2OCEANO: the project is bringing together several players in the maritime sector such as Repsol, Murueta, Port Bilbao, Sener, Tecnalia, Ingeteam. The project involves the creation of an environmentally friendly system for the production of H_2, a consumer map, and a living lab represented by floating barges pushed by zero-emission technological tugs that sail on the Bilbao River;
- ✓ INTELLITUG: in collaboration with PSA Marine and MPA, Wärtsilä has embarked on a venture to improve the capabilities of the port tugboat. In fact, to meet the needs of the evolving port, the collective is working together to create a smarter tugboat that will perform a series of routine missions designed to further improve the safety and efficiency of tugboats, while reducing the workload and pressures of operators in one of the world's most demanding port environments;
- ✓ FUEL CELLS PROJECT: Wärtsilä is engaged in research on the use of future zero-emission fuels for viable use in marine engines and is active in the study of alternative means to eliminate emissions, including the use of fuel cells.

FIGURE 60. WÄRTSILÄ "GREEN" PROJECTS & PARTNERSHIPS.

Source: Authors' elaboration.

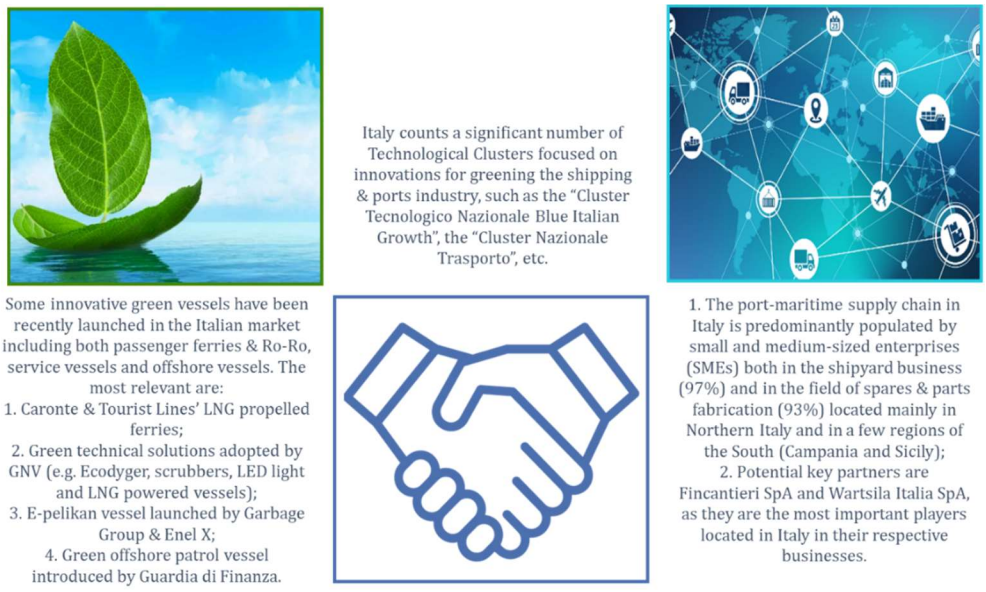
In 2021, the overall Wärtsilä Group recorded order intake for euro 5.735 million compared to euro 4.359 million in 2020 and a book-to-bill of 1.20 (0.95 in 2020). As for the first months of 2022, despite the protracted effects due to the pandemic crisis and the slight recovery of the market, as well as due to the consequences of the Russian-Ukrainian conflict, the company has witnessed an increase in orderbooks (Figure 61).

FIGURE 61. WÄRTSILÄ 1 SEMESTER OF 2022 MAIN RESULTS.



Source: Wärtsilä Corporation Half year report January-June, 2022.

FIGURE 62. MAIN HIGHLIGHTS - CHAPTER IV



Source: Authors' elaboration.