# Cold Ironing: An Analysis of Policies and Its Implementation in Europe with a Focus on the Italian Context and the Future Prospects in Sardinia

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**Abstract.** This article studies the policies and current state of Cold Ironing. The research reveals that on the one hand this policy was successfully implemented in Alaska twenty years ago, while its development in Europe is recent and not widespread. The Port of Gothenburg is one of the leading ports in Europe, which has developed several sustainable maritime policies such as shore power and methanol propulsion. In Italy, several challenges, such as different electricity supply requirements and high electricity supply costs, hinder the implementation of Cold Ironing. However, the proximity of Italian ports to urban centers offers opportunities to promote cold ironing technology and mitigate port emissions. The implementation of cold ironing in Europe, Italy and particularly Sardinia, offers significant potential to reduce greenhouse gas emissions and promote further sustainable maritime practices.

**Keywords:** Cold Ironing · Sustainable Maritime Policies · Port of Gothenburg · Italian Ports · Sardinia's Ports

## 1 Key Environmental Policies for Ports

The European Union's "Strategy for Sustainable and Intelligent Mobility: Putting European Transport on the Right Path for the Future" [1] attributes 5% of EU GDP to the transport sector, employing 10 million people. The importance represented by the growth and structuring of mobility over time is, however, increasingly burdened by the costs arising from it, social, environmental and therefore also economic, which contribute to the expression of increasingly stringent policies in favor of sustainability, circularity and environmental protection. The strategy is a useful tool in pursuing the goals of the European Green Deal (11.12.2019), which aims "…to transform the EU into a just and prosperous society with a modern, resource-efficient and competitive economy that generates no net greenhouse gas emissions in 2050 and in which economic growth is decoupled from resource use" [2]. The pollution factor caused by emissions from various human activities, the weight of which in the EU accounts for 75%, inevitably leads to the decarbonization of the energy sector, which is essential to face climate change and global warming that the Paris Agreement (2015) set at 1.50.

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The intent of the agreement was to reduce CO2 emissions by 40% by 2030, compared to 1990 levels, while it is in 2021 that the EU climate law passed by the Parliament sets climate neutrality by 2050 as legally binding in the Green Deal program [3]. The dynamism of policies related to these issues is also evident in this law, which proposes a new threshold, the reduction of emissions by at least 55% below 1990 levels by 2030, and formulates a regulatory package called "Fit for 55," a set of proposals to revise and update EU regulations, which aims to make Europe a zero-emissions continent by 2050 [4].

It is in this context that the mobility strategy with its 10 flagship initiatives, the second of which, creating zero-emission airports and ports, directs these facilities toward multimodality and the transformation of mobility into more sustainable forms of connectivity. Ports can play the role of new hubs in which alternative and low-carbon energies and techniques related to the circular economy serve as inputs for the improvement of entire areas. Globally, major ports of call are investing in sustainability through the energy transition, setting themselves up as a complex system of systems where multiple independent systems interact creating a network [5]. An example of this is the bunkering of new propellants such as LNG that finds space in as many as 178 ports, usable by ships for connections to the shore power grid, cold ironing. Ports with multiple prerogatives and services that are considered instruments of geopolitical influence as they connect and create synergies with those countries considered strategic [6]. Growing global awareness of the dictates of environmental sustainability has changed many of the rules of behavior of society as a whole, and according to the transposition of the policies that each country has adopted, the practices chosen in the various sectors of the economy have evolved in order to abate the sources of pollutants derived from it. The efficiency provided by new technologies, however, still fails to abate greenhouse gas emissions from transport, the European Environment Agency in fact states that these emissions have been increasing over the past 30 years, contrary to the European Union's goal of reducing emissions from transport by 90% by 2050, compared to 1990 levels. While, therefore, transportation has undoubtedly become more efficient, this progress still fails to balance its growing volume [7].

The Report on the Environmental Impact of European Maritime Transport (2021), prepared by the European Environment Agency reports that 77% of European foreign trade and 35% of trade between EU member states is by sea, representing the main international supply chain. Among the various types of transport, at the level of greenhouse gas emissions, maritime transport ranks third (13.5), after road transport (71%), the most polluting by far, and air transport (14.4). The introduction of increasingly stringent measures at European ports in the coming years should further cut emissions. Future challenges envisioned by the report include sea rise in ports, further reduction of emissions that can be abated by reducing the speed of vessels docking, use of nontraditional energy sources and fuels, and shore power supply (which involves turning off engines when ships are docked in port).

The aforementioned "Fit for 55" package calls for an 80% reduction in emissions from ships by 2050 compared to 2020, and mandatory, by 2030, for container ships and passenger vessels to be connected to the power supply of the docks in the port where they will stall.

The current geopolitical moment may have important repercussions on the Mediterranean and Italian logistics and port system, and long-range international trade will be relevant as well as necessary to connect distant and internationalization-oriented production systems translating into increased demand for port services and onshore cargo traffic.

The Ministry of Sustainable Infrastructure and Mobility's (MIMS) "Climate Change, Infrastructure and Mobility" [7], highlights that the Mediterranean Sea is still an important route in terms of container traffic but highlights a concern about the impacts of climate change that in ports translates into planning more resilient infrastructure in terms of both greenfield and brownfield investments.

Italy's port logistics network has 58 ports and 24 interports, and the country is the second largest in Europe (second only to the Netherlands) for the movement of goods by sea, thus the importance that has been given to the sector by the National Plan for Recovery and Resilience (PNRR) is clear. The NRP has dedicated as much as 750 billion euros to the Next Generation EU (NGEU) program to combat the crisis which raised by the Pandemic from Covid 19. The program, which supports various activities, is divided into strategic axes and missions and devotes specific objectives to mobility and ports whose sustainability, intermodality, climate change resilience and energy efficiency it is concerned with. At its core, the Green Ports project "aims to make port activities sustainable and compatible with urban port contexts through the financing of interventions aimed at the efficiency and reduction of energy consumption of port facilities and activities" [9]. Additional goals are the preservation of natural heritage and biodiversity, all through interventions such as:

- energy production from renewable sources;
- energy efficiency of port buildings;
- energy efficiency of lighting systems;
- use of electric means of transportation;
- interventions on inefficient port energy infrastructure;
- construction of infrastructure for the use of electricity;
- reduction of pollutant emissions from ships at the docks.

The map in Fig. 1 shows the 47 Italian ports dedicated to electrification.

Given the complexity of the cold ironing infrastructure, a strategy has been defined that is based on six pillars, factors, and objectives, the details of which are provided in the PNRR, and only the six pillars are named here, which are subject to further declination: port identification, availability of electric power capacity, reform of the authorization process, electric tariff, type of ships, and supply chain management [9].

Among the Urgent Measures for the Implementation of the National Recovery and Resilience Plan (NRP) D.L.36/2022, Article 33, "in implementation of a reform envisaged by the NRP for the simplification of authorization procedures for cold ironing facilities, considers projects intended for the construction of works and facilities for the electrification of ports to be of public utility and characterized by indifference and urgency…" [10].




**Fig. 1.** Italian ports dedicated to electrification. Source: own processing with ESRI and MIMS data.

## 2 Methodology

In this article has been carried out a review of the academic literature, an analysis of the legislation and a survey of local newspapers. The literature review was conducted in order to gain a theoretical understanding of the policy of Cold Ironing and its implications. This involved studying scientific articles relating to the environmental impact of Cold Ironing and its implementation in Europe and Italy. The literature review helped to understand the historical context, current status and future prospects of this policy.

A review of the rules and regulations of this policy was carried out which covered national and international regulations on Cold Ironing, environmental standards and maritime laws. The regulatory analysis provided insights into the legal and regulatory framework relating to Cold Ironing, its implementation and the funding provided for this policy.

Local newspapers were examined to understand the practical aspects of cold ironing implementation, in particular for the analysis relating to the Sardinia region. Local newspapers provided information on ongoing projects and progress made in implementing Cold Ironing.

## 3 Cold Ironing in Europe

The first successful implementations of cold ironing can be traced back to about twenty years ago in Alaska, where energy costs were lower than in Europe, a continent where the development of cold ironing occurred only in recent years and only in some ports [11].

The application of Cold Ironing policies in Europe is mainly observed in the port of Gothenburg. Other policies have also been combined which have made it possible to further mitigate port emissions. Port Collaborative Decision Making (PortCDM) was implemented, a practice that powers docked ships, which allows for the reduction of greenhouse gas emissions [12].

The map in Fig. 2 shows the five ports, with red icons, along the city of Gothenburg, which have adopted cold ironing policies.

In the process of electrification of the docks where tankers moor in Energihamnen, Göteborgs Hamn AB has initiated a project called "Green Cable" which, in collaboration with different stakeholders, including shipping companies in Donsö, national ports and European ports, companies Port Oil and the Swedish Transport Agency, aims to establish a new global standard for shore power for tankers berthed in national ports [13]. The environmental benefit following the electrification of the Energihamnen docks can be quantified as a reduction of 1,800 tons of carbon dioxide per year, compared to when tankers use their diesel-powered engines while at berth [13].

The Port of Gothenburg, a pioneer in offering coastal energy in Europe [14], is also involving shipping companies such as Furutank, Donsötank, Tärtank, Ektank, Veritas Tanker based in Donsö and Tarbit Tanker on the island of Tjörn and aims to create a new structure at the Energy Terminal, aimed at ensuring safety in the spaces that house the electrical equipment [13]. These are plants that guarantee a reduction of 1,800 tonnes of CO2 every year thanks to the use of green energy and as announced by the port of Gothenburg, the first tanker will be connected to this network in the first quarter of 2024 [14]. This project was partially financed by the Swedish government through the Climate Investment Support Program with approximately 1 million euros. It is also part of the Gothenburg Port Authority projects in which approximately 60 million euros were financed by Sweden to be able to implement emissions mitigation measures by 2030 [13, 15].

The Gothenburg Port Authority can be seen as a driving force for the sustainability of the city's port. It plays an important role in achieving the global sustainable development

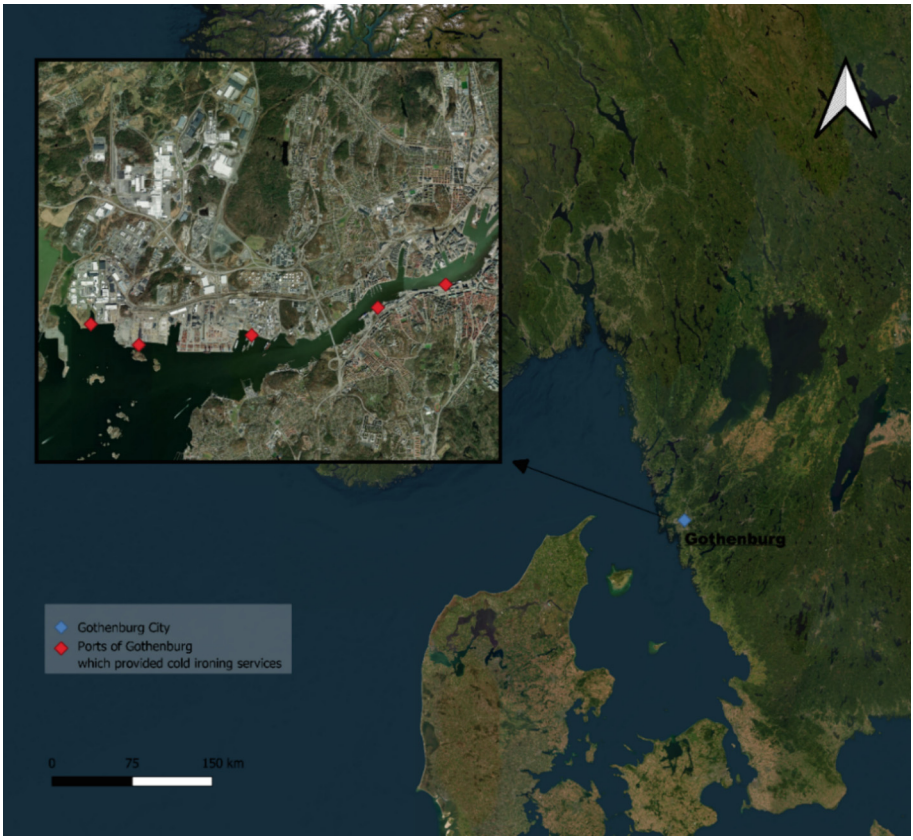


**Fig. 2.** Cold Ironing in Gothenburg. Source: own processing with ESRI data.

goals dictated by the European Union. Furthermore, its commitment extends to 15 of the 17 objectives of the 2030 Agenda in its industrial plan [13].

The port of Gothenburg thus paves the way for the environmental sustainability of ports through innovative solutions, reported in this paper, which should lead to substantial CO2 reductions in the port area.

## 4 Cold Ironing in Italy

The implementation of cold ironing has been developed in the main Italian ports and in this context it is possible to mention the port of Ancona and the port of Venice [16; 17].

### 4.1 Venice

The Venice cruise terminal is one of the main ports in the Mediterranean [18] and welcomes a large part of the national maritime traffic and is mainly made up of cruise ships [17].




**Fig. 3.** Cruise terminal of Venice, Italy. Source: own processing with Google Satellite data.

The map in Fig. 3 shows the Cruise terminal of Venice dedicated to electrification.

In recent case study [19] the analysis focuses on the technical and economic aspects of the port of Venice, pays particular attention to the reduction of emissions and attributes the high energy consumption of cruise ships to on-board equipment. This research proposes different scenarios to deal with this type of emissions, one of which requires the reassignment of ships to the docks, moving the mooring of the most polluting ships in the Isonzo and Tagliamento basins, a condition that requires an overall reconfiguration of ship mooring.

In the case study of the port of Venice by Pasetto and Giacomello [20], was performed a multi-criteria analysis (MCA) using the Analytic Hierarchy Process (AHP). The results suggest that the optimal solution, in order to reduce the maritime pollution in Venice, would be to connected the Port of Venice to both the Montesyndial terminal and the port of Padua via a rail shut-tle train service.

Furthermore, their study shows that the implementation of cold ironing in the port of Venice also requires constant review by port authorities and could improve maritime trade for both the city of Venice and nearby cities, particularly Padua, Treviso and Rovigo and this is in line with the improvement and development of the ports outlined by the PNRR, which also provides funding for the construction of new maritime infrastructures [20].

Regarding the concrete implementation of cold ironing policies, the Northern Adriatic Sea Port System Authority (AdSPMAS), responsible for promoting sustainable investment programs, has submitted a request for an agreement with SOGESID S.p.A. of the Ministry of Infrastructure and Sustainable Mobility, which is granted on 21 February 2022. Consequently, on 3 March 2022 an agreement was signed between AdSPMAS and SOGESID S.p.A., to regulate the provision of services aimed at implementing the interventions by AdSPMAS. Based on the agreement obtained, SOGESID S.p.A. will be provide technical support for the Cold Ironing project of the port areas of Marghera and Venice whose total amount is 1,181,429.11 euros [21].

### 4.2 Ancona

The port of Ancona, shown in Fig. 4, is located along the Italian Adriatic coast and serves as the main logistics hub of the central Adriatic region [22, 23].

In the study by Esposito et al. [16] three different Cold Ironing application scenarios were tested within the port of Ancona. Through an environmental analysis, emissions within the port were then analyzed and compared. The results of this study show a reduction in emissions in all three scenarios. The first one involves the implementation of a cogeneration plant which will start the electrification of the docks serving mooring in this port.

In such manner, a more significant reduction in emissions was achieved compared to the other two scenarios. The reduction counted is in fact equal to 98.58% for nitrogen oxides, 79.06% for PM10 and 100% for sulfur oxides.

Therefore, the implementation of a cogeneration plant in this port, as demonstrated in the research by Esposito et al. [20] mitigates the environmental impact and reduces emissions in the port area of Ancona.

## 5 Current State of Cold Ironing in Sardinia

The ports of Sardinia have recently enrolled a process of sustainable conversion of port systems, through the publication of the “technical-economic feasibility design for the construction and commissioning of a shore power system for the electrical supply of ships moored in the ports of Cagliari (Porto Storico and Porto Canale), Olbia – Isola Bianca, Golfo Aranci, Santa Teresa Gallura, Porto Torres and Portovesme” [24].

The importance of cold ironing in Sardinia is also underlined by the PNRR 2022 report, “Investments and reforms for the port”, which aims to improve port energy supply at a national level [8].




**Fig. 4.** Port of Ancona, Italy. Source: own processing with ESRI data.

### 5.1 Policies and Funding for Cold Ironing in Sardinia

The six ports of Sardinia, as reported in this paper, join the development of sustainable port systems in response to the examples of the Cold Ironing policies implemented in the various ports of the European Union [24, 25].

The main objective of the onshore energy project in Sardinia is to supply energy to moored ships through installations of shore-based electrical power systems which allow the ships' engines to be turned off, with a consequent reduction in emissions [26–28].

Figure 5 shows a cartographic representation of the main ports in Sardinia that are actively implementing cold ironing policies.

The following ports are maked in blue on the map: Cagliari (Porto Storico and Porto Canale), Olbia (Isola Bianca), Golfo Aranci, Santa Teresa di Gallura, Porto Torres and Portovesme, previously mentioned.

The technical-economic feasibility planning for the implementation of Cold-Ironing thus gave rise to Sardinia's Green Revolution, as defined by the Sardinia Port System

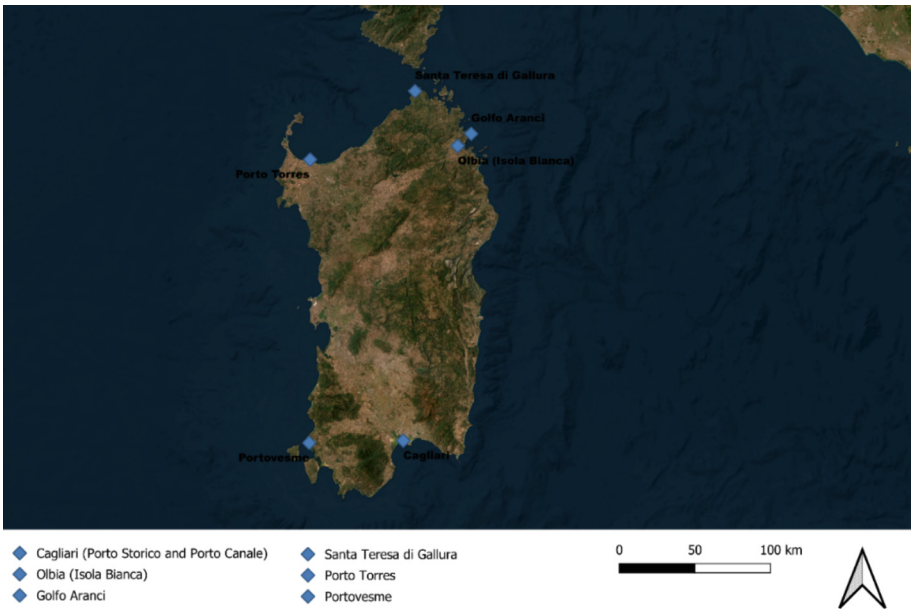


**Fig. 5.** Ports of Sardinia active in Cold Ironing policies. Source: Own processing, with ESRI data.

Authority [24]. This study verifies the electrification process of the docks at the commercial ports of Sardinia, for which the PNRR has allocated a total of 70,830,000 euros [26]. The objective of the feasibility program is to analyze the opportunities and possible critical issues of the implementation and adoption of cold ironing systems on the island [24]. Specialist technical reports, archaeological checks, sustainability checks and also environmental impact studies are part of this process [26].

The facilities envisaged by the project provide total financing of 21,560,000 euros for the port of Olbia, 2,400,000 euros for Golfo Aranci, 500,000 euros for Santa Teresa and Portovesme, 12,750,000 for Porto Torres, and as regards Cagliari, 20,900,000 for Cagliari Porto Storico and "ro-ro terminal" and 12,200,000 for Porto Canale [26]. Furthermore, in terms of electrical energy power, the plants envisaged by the project provide 22 megawatts of power for Olbia, 3 megawatts for Golfo Aranci, 0.6 MW for Santa Teresa and Portovesme, 15 MW for Porto Torres, 22 MW for the port of Cagliari (Porto Storico and ro-ro terminal) and 13 megawatts for Porto Canale [27].

## 6 Conclusions

Cold ironing is a practice that powers docked ships via land-based electricity. It has emerged as a promising solution to reduce greenhouse gas emissions in the maritime sector and its first implementations can be traced back to twenty years ago in Alaska.

However, Cold Ironing in Europe has only been promoted in recent years. The port of Gothenburg represents one of the main European ports to have embraced this sustainable policy. The commitment in the Italian context has been observed in the ports of Venice and

Ancona and is also starting to develop in other regions. Sardinia has recently started the assignment of the technical-economic feasibility design for the creation of a cold ironing system for the electrical supply of ships moored in six of its ports. The implementation of cold ironing on the Island thus represents an opportunity to contribute to the global effort in reducing greenhouse gas emissions and promoting sustainable port systems.

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