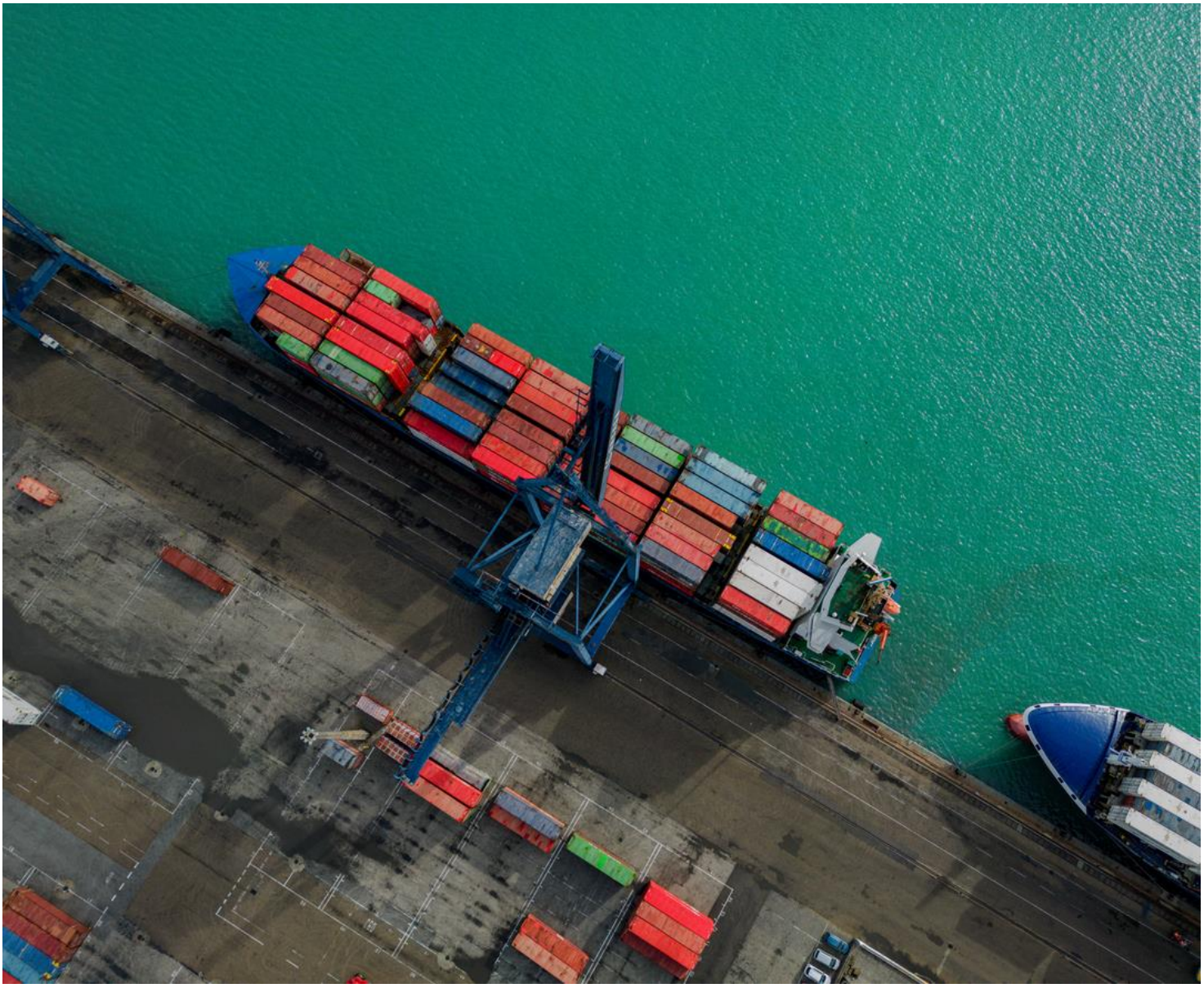
MENON ECONOMICS

REPORT

THE ECONOMIC IMPACT OF SOUTHERN REGION PORTS

An analysis of the current economic impact of the port sector, and its potential for contributing to growth in emerging marine sectors



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Preface

On behalf of the Southern Regional Assembly, Menon has conducted an economic impact analysis of the Southern Region's ports in Ireland. In the first part of the project, we assess the economic impact of the existing port activity in the region, both directly in the ports and in their supply chain. In the second part, we analyse the potential for growth in select marine economic sectors, and the ports' role in this growth.

Jonas Erraia has been the project owner, while Øyvind Vennerød has been the project manager. Sander Aslesen, Kaja Haug and Odin Dager Moe have been project collaborators, while Maren Basso, Oddbjørn Grønvik and Even Winje have formed the expert group responsible for quality assurance.

Menon Economics is a research-based analysis and advisory firm at the intersection of economics and business and industry policy. We offer analysis and advisory services to businesses, organisations, municipalities, county authorities and ministries. Our primary focus is on empirical analysis of economic policy, and our team has deep expertise backed by rigorous scientific research.

We thank the Southern Regional Assembly for an interesting project, as well as the Tier 1 and Tier 2 ports in the Southern Region for good cooperation. We also thank all interviewees in the project. Menon and the authors are responsible for all content.

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September 2024

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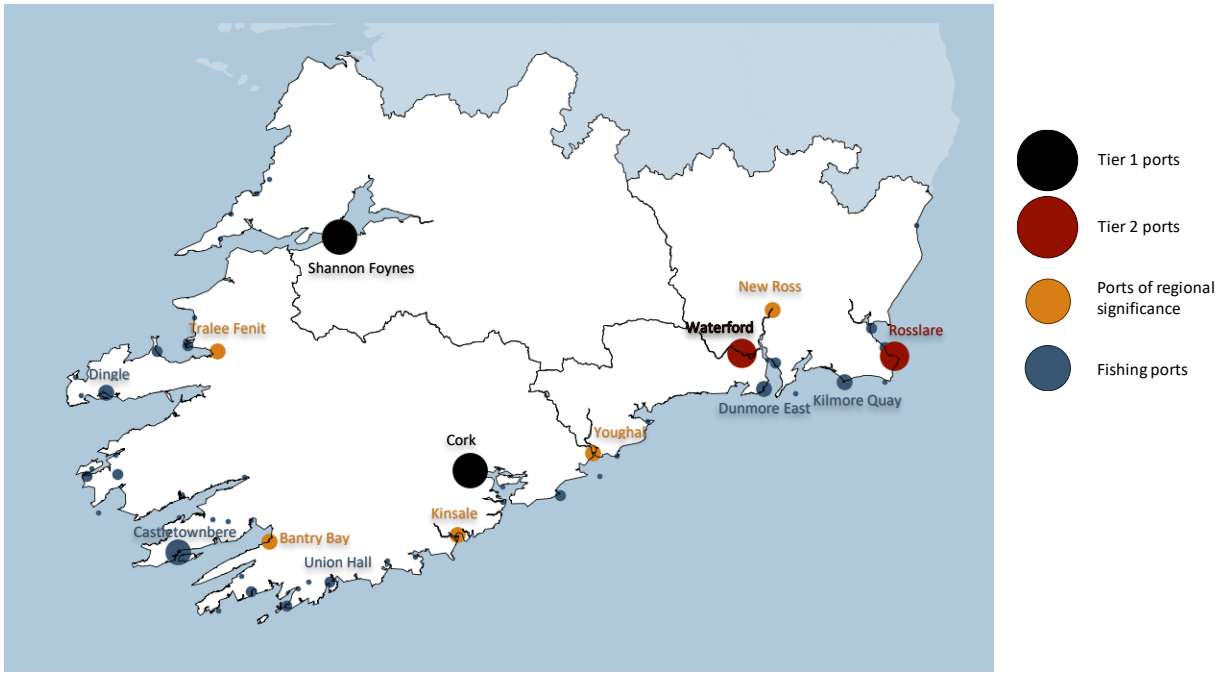
Summary of the report

Menon has been commissioned by the Southern Regional Assembly to conduct a study on the current and future economic impact of the region's ports. This report has two main parts. The first part analyses and estimates the economic impact of the port sector in the Southern Region, examining both the economic activity within the sector and its broader economic impact along the value chain. In the second part of the report, we look at the potential growth in four emerging marine sectors (offshore wind, alternative fuels, marine tourism and aquaculture) exploring how ports can support their growth and identifying the barriers that need to be overcome. In this summary, we go through the key takeaways of the report.

Four of the five major ports in Ireland are in the Southern Region

Four of Ireland's five ports of national significance[1] are situated in the Southern Region. These are the ports of Cork, Shannon Foynes, Waterford and Rosslare respectively. Combined, the ports handle a little under half of Ireland's sea-based tonnage and passenger traffic. In addition to the ports of national significance, there are six ports of regional significance as well as numerous fishing ports in the Southern Region. The map below shows the locations of the largest ports in the region.

Figure 1: Map of the ports in the Southern Region.[2] Source: Menon Economics



The port sector generates a gross value added of EURm 293 and employ around 3,100

The port sector as defined in this report includes the commercial port companies themselves, as well as maritime transportation (shipping) companies and auxiliary services such as cargo handling and warehousing. Additionally, it includes the activities of the Irish sea fisheries, which rely on fishing ports for their operations. Based on a

[1] The ports of national significance are the Tier 1 and Tier 2 ports as defined by the National Ports policy, representing the major ports in Ireland.

[2] The size of the fisheries corresponds to the value of the fish landed in the ports. Castletownbere is both the largest fishing port and a port of regional significance – it is here coloured as a fishing port, its primary function.

comprehensive mapping of relevant companies, data from CRO, CSO national accounts statistics, and the Orbis database, we have estimated the extent of the port-related economic activity in the Southern Region. The table below presents the employment, revenue and gross value added (GVA) for each of the sub-sectors.

	2023 (estimated numbers)	Commercial ports	Maritime transport	Auxiliary services	Fisheries	Total
	**Employment**	310	690	810	1,290	3,100
	**Revenue (EURm)**	88	266	240	156	740
	**Gross value added (EURm)**	57	79	77	84	293
	**Wages (EURm)**	29	38	38	43	149

As can be seen in the table, there are around 3,100 people employed in the port sector in the Southern Region, generating a little under EURm 300 in gross value added. The maritime transport, auxiliary services and fisheries sub-sectors all generate around EURm 80 in GVA, while the commercial ports generate a little under EURm 60. The fisheries employ the most workers (almost 1,300), whereas the commercial ports boast the highest labour productivity (defined as GVA divided by employment), producing substantial GVA with comparatively few employees.

The South-West port sector is the largest, and accounts for approximately 60 percent of the total GVA, while the South-East and Mid-West account for around 25 percent and 15 percent respectively. The largest differences in size between the sub-regions are for the fisheries, which are large in the South-West and almost non-existent in the Mid-West.

To ensure accuracy, we have cross-checked our estimates against relevant studies on Ireland's broader maritime sectors, such as the Irish Ocean Economy[3] and the EU Blue Economy Observatory[4]. While their definitions differ slightly from ours, the results align well with expectations in terms of scale. In addition, we have looked at the results in terms of the Southern Region's share of total national employment in Ireland and found the broadly in line with what one would expect based on the Southern Region's share of Irish port activity.

The total economic impact of the port sector was EURm 695 in 2023

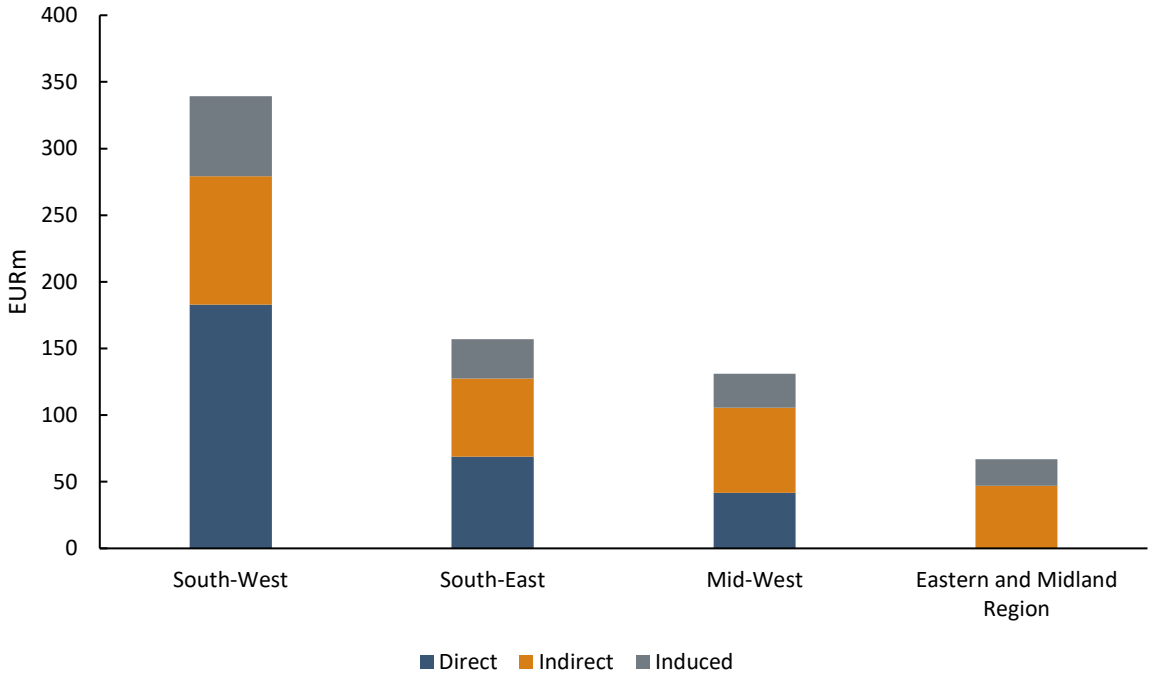
Beyond creating jobs and contributing to the gross value added within port-related companies, port activities also have a wider indirect impact on the regional economy. Through purchases of goods and services, the sector sustains economic activity with its suppliers and sub-suppliers throughout the supply chain. Moreover, induced effects arise when employees of the port and its suppliers spend their wages on goods and services, further stimulating economic activity. In this report, we calculate the total economic impact consisting of both the direct effects (the activity within port sector companies), the indirect effects (which occur throughout the supply chain) and the induced effects. To estimate this total impact, we used a tailor-made regionalised model specifically designed for the Southern Region.

Our calculations show that the port sector sustains GVA of around EURm 695 in 2023, with a EURm 293 coming from direct effects, EURm 265 coming from indirect effects and around EURm 135 from induced effects. We find that the total economic impact is the largest in the South-West with around EURm 340. This is mainly driven by

[3] *Available here*
[4] *Available here*

the presence of the port of Cork. It is interesting to note that though the direct effect is larger in the South-East than in the Mid-West, the magnitude of the indirect effect is reversed. The annual economic impact of the port sector is around EURm 150 in both regions.

Figure 2: Regional total economic impact from the port sector in the Southern Region. Source: Menon Economics



Roughly 50 EURm of the total economic impact is not created in the Southern Region, but among suppliers in the Eastern and Midland Region.

In terms of total employment, we estimate that the port sector supports a total of around 6,850 employees in the region. The distribution of these jobs in the sub-regions mirrors the GVA distribution shown above closely.

The port sector is an important driver of broader economic growth

Though this report focuses on the rather narrow economic impact from the port sector, it is important to note that ports, and the broader maritime sector, is a major driver of economic growth in Ireland.

Firstly, ports are a major facilitator of international trade. Ireland is one of the most trade-dependent economies in the world, with the sum of imports and exports constituting more than 230 percent of GDP in 2023. A large part of that trade is in goods, and as an island economy around 90 percent of Ireland's goods trade goes through its ports – and almost half of that through the Southern Region ports. There are two main reasons why facilitating trade is important. Firstly, it increases the range of goods available to Irish consumers and businesses, and secondly, it helps facilitate exports, and exporting industries are typically highly productive, contributing to increased GDP in Ireland.

In addition to facilitating trade with the outside world, ports also play an important role for so-called "port-attracted companies". These are defined by the OECD as companies that are attracted to a particular area

because of the presence of a port.[5] These companies locate themselves near ports to minimise transportation costs and time associated with moving bulky or heavy goods. Examples of port-attracted companies include those that export or import commodities, metals or chemicals. Being close to the port reduces the logistical complexities and expenses involved in shipping.

To illustrate the importance of ports for manufacturing, we have used detailed geographical data on employment in manufacturing industries to estimate how far from ports manufacturing industries are. Our analysis indicates that around a quarter of the manufacturing jobs in the Southern Region are located within 5 kilometres of the nearest port of national or regional significance, while approximately half are located within 15 kilometres. For companies operating in sectors which frequently use the ports, the share of companies located close to a port is even higher.

The same trend in proximity to ports can be seen for many of the multinational companies that have established themselves in the Southern Region through Foreign Direct Investment and in relation to the IDA. Many of them are clustered near the major ports.

Offshore wind needs ports to succeed, and may provide an economic boost to the Southern Region

The Irish government has set ambitious plans for offshore wind development, and ports equipped with the necessary infrastructure and space will be essential for reaching these ambitions. If the Irish ports develop the capabilities to aid in installing and maintaining the wind parks, it will lead to both a cheaper and faster build-out as well as the creation of jobs in the coastal communities.

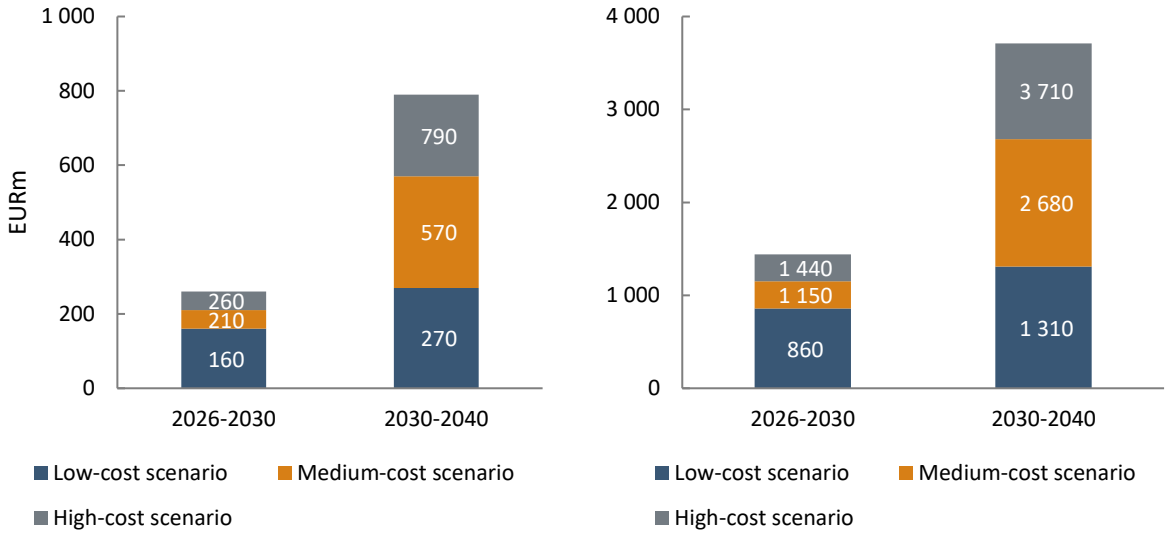
Assembly and installation ports play a crucial role in the value chain for both floating and bottom-fixed turbines, albeit with a slightly different role. Floating wind turbines require large deep-water quays and sheltered areas within the port for assembly and storage, whereas bottom-fixed turbines rely on ports for logistical support and services close to the installation site.

The Southern Region ports are well-positioned to serve as assembly and installation hubs for much of Ireland's planned offshore wind capacity. In this report, we examine Ireland's offshore wind ambitions and quantify the potential economic impact that the assembly and installation of offshore wind in Southern Region ports may create. To illustrate this, we developed a scenario where Southern Region ports support the assembly of 4.5 GW of offshore wind capacity by 2030 and a further 15 GW by 2040. The 2030-scenario aligns with the current offshore wind project pipeline, while the 2040-scenario reflects Ireland's broader ambitions for total capacity. This is not a projection, but an illustrative scenario to demonstrate the potential economic impact from assembly and installation activities if Ireland's offshore wind goals are successfully realised and Southern Region ports serve as assembly ports.

In the figure below, we show the estimated GVA and employment effects in three cost scenarios. As offshore wind matures as an industry, costs are expected to fall, although there is uncertainty with regards to how much, and we therefore present a low-, medium- and high-cost estimate.

[5] *See for instance "The Competitiveness of Global Port-Cities" available here*

Figure 3: Potential economic impact of the offshore wind assembly and installation activities. Left: GVA. Right: employment. Source: Menon



Between 2026 and 2030, the GVA in the base case is estimated to be around EURm 210 annually, while supporting a little under 1,200 employees. As production scales up towards 2040, and an increasing share of the production is floating offshore wind, the GVA effects increases to a EURm 570. At the same time, the activity at the port related to assembly and installation of offshore wind will support 2,700 employees annually.

The difference between the low-, medium- and high-cost scenarios underscore the uncertainty in forecasting the economic impact of offshore wind. If installation costs fall, that will make it cheaper to build out offshore wind in Ireland and increase the likelihood of reaching the national ambitions, but it also reduces the potential economic impact of the installation and assembly phase.

There are other sources of uncertainty than just the cost. These include the size and speed of the offshore wind investments in Ireland, and how much will be installed and assembled in Southern Region ports. That depends not only on what the Southern Region ports do, but also on what other (Irish and non-Irish) ports do, and whether the ambitions for offshore wind capacity are met. We have found that a key barrier for reaching these goals is the uncertainty faced by the ports in their investment decisions. The ports need to make large infrastructural investments in the near future, to be able to facilitate offshore wind development further in the future. This mismatch in timing can normally be bridged by debt or equity financing, but as there is no guarantee that future projects will accrue to any given port, there are relatively few available funds for the ports.

The ports may play an important role in Ireland's hydrogen future

With the impressive offshore wind ambitions described above, Irish renewable power production is expected to surge. Beyond 2030, Ireland's electricity balance will most likely reach a surplus. One possible use of the surplus energy is to produce electrolytic (green) hydrogen, which is one of the only technologies which can decarbonise areas such as production of steel, cement and certain chemicals. Hydrogen-based fuels are also expected to play a key role in decarbonising maritime transport and aviation. Ireland's hydrogen strategy foresees a large potential hydrogen need from industry and processing, totalling up to 15 TWh, or around 10 percent of Ireland's current total energy consumption.

The areas around ports are natural locations for the production of hydrogen and hydrogen-derived fuels from offshore wind energy. They are near the offshore wind resources, and the port infrastructure provides the means of transporting the alternative fuels comparatively easily. As explained above, they are also often located in proximity to industries that will likely demand hydrogen.

In this report, we analyse the potential economic effect of hydrogen production. Overall, we find that the production is not going to create large employment effects in the hydrogen production facilities themselves. The potential benefits of hydrogen production stem from utilising the surplus electricity from planned offshore wind expansion to achieve climate emissions reductions at existing companies, increase national and regional GVA, and to increase Irish exports. In addition, as hydrogen are costly to transport, it is likely that the production of hydrogen close to ports will create new businesses using the hydrogen directly. These could be the production of green steel, zero-emissions fertilizer or similar. Such companies are more likely to create more jobs than hydrogen production facilities do.

Southern Region ports will need to supply alternative fuels infrastructure

Hydrogen is not only important for ports as a potential new commodity to be produced. It is also an important fuel for the future decarbonisation of the shipping industry. Currently, about 98 percent of the global fleet relies on fossil fuels, but European and Irish ambitions suggest that all ships eventually need to transition to emission-free propulsion systems. This transition has already begun, with the maritime sector gradually being integrated into the Emissions Trading System by 2026, meaning that the shipping industry will have to pay for their emissions.

In shipping today, there are two main alternatives to fossil fuels: electrification using batteries, or the use of alternative hydrogen-based fuels, such as methanol and ammonia. Smaller vessels and short-distance routes may find battery-electric solutions sufficient, while larger ships will likely depend on alternative fuels. Ports will need to decide whether to offer one or both of these fuelling options.

Based on past reports and port visits, it appears that Southern Region ports are less focused on offering alternative fuel bunkering compared to ports in regions like the Nordics. This will need to change, as the shift to alternative fuels by ships could create challenges for the Southern Region if it lags behind. Ships running on alternative fuels may have shorter ranges, necessitating more frequent refuelling stops and possibly altering their sailing routes. This shift could lead to the development of new bunkering hubs and green shipping corridors. Ports that do not adapt by providing alternative fuels infrastructure risk losing business, as ships might bypass them.

Bunkering with alternative fuels presents new challenges for shipping companies and ports. One major issue is space: the storage of hydrogen, ammonia, and methanol requires additional space, and bunkering with these fuels demands a large safety zone. This poses a problem for ports in the Southern Region with limited available free space, especially as they are already planning to use much space to accommodate installation and assembly facilities for offshore wind. Another challenge is the high cost of infrastructure investments, compounded by uncertainty over future fuel demand. Ports face significant upfront costs for bunkering infrastructure and risk economic loss if they invest in a fuel that does not become dominant in the market.

This report also explores the growth potential for marine tourism and aquaculture. Unlike the offshore wind and alternative fuels industries, ports play a less critical role in the growth of marine tourism and aquaculture. We nonetheless assess their potential for growth and the role of ports in achieving that growth. More details on this can be found in the report.

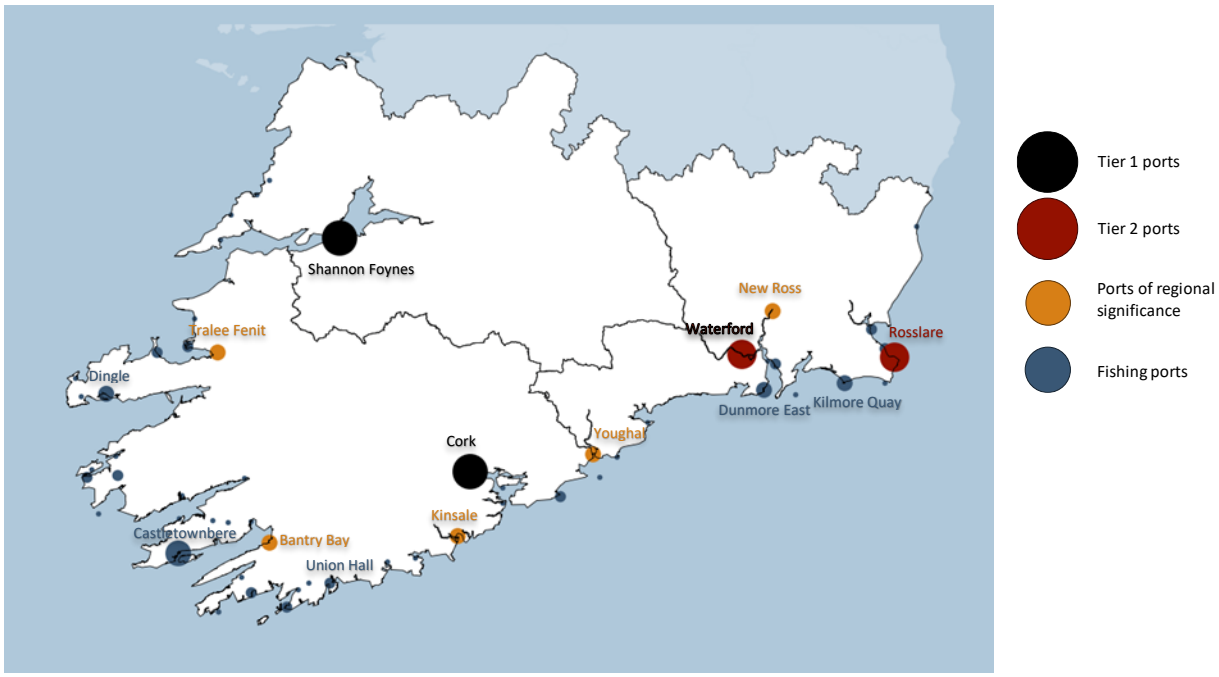
1. Overview of ports in the Southern Region

Four of Ireland's five ports of national significance are situated in the Southern Region, which all together handle substantial shares of the overall tonnage through Irish ports and serve as essential gateways for international goods trade. Complementing the ports of national significance are six ports of regional significance as well as numerous fishing ports, located all along the coast.

Ireland has five ports of national significance[6], of which four are located in the Southern Region. Among the ports of national significance, three are designated as Tier 1 ports, including *Dublin Port Company, Port of Cork* and *Shannon Foynes Port Company*. The latter two are both in the Southern Region. Tier 1 ports of national significance each handle between 15 and 20 percent of the overall tonnage through Irish ports and have the potential to lead future port capacity development. The Tier 1 ports all serve as essential gateways for international goods trade, handling a diverse range of cargoes.[7]

In addition to the Tier 1 ports, there are two Tier 2 ports in the Southern Region, namely the *Port of Waterford* and *Rosslare Europort*. The Tier 2 ports each handle at least 2.5 percent of overall tonnage in Ireland and have a potential to handle higher volumes of unitised traffic with transport links serving national markets. The Port of Waterford primarily handles lift-on/lift-off and bulk cargo, while Rosslare Europort facilitates both passenger and freight services between Ireland and mainland Europe. In addition to the Tier 1 and Tier 2 ports, the Southern Region is home to a large number of smaller ports, including ports of regional significance and numerous fishing ports, as illustrated in the map below.

Figure 4: Map of the ports in the Southern Region.[8] Source: Menon Economics



[6] *https://www.imdo.ie/Home/site-area/maritime-policy/ports-policy/national-ports-policy*
[7] *Irish Maritime Development Office. https://www.imdo.ie/Home/site-area/maritime-policy/ports-policy/national-ports-policy*
[8] *The size of the fisheries corresponds to the value of the fish landed in the ports. Castletownbere is both the largest fishing port and a port of regional significance – it is here coloured as a fishing port, its primary function.*

There are a total of six ports of regional significance in the Southern Region, including New Ross, Youghal, Kinsale, Bantry Bay, Castletownbere and Tralee Fenit. The ports of regional significance handle the remaining commercial freight in Ireland and mainly serve localised markets. These ports act as important facilitators of trade for their regional and local hinterlands, supporting balanced regional development.[9] Additionally, they may specialise in certain types of trade or marine tourism, such as dry or liquid bulk and manufactured goods.

Fishing ports are strategically distributed all along the Southern coast of Ireland, varying in size. Five of them are particularly large, namely Castletownbere, Dingle and Union Hall in the Southwest, and Dunmore East and Kilmore Quay in the Southeast. These ports play a crucial role in supporting the local fishing industry, providing infrastructure and services for the fishing community, and contributing to the regional economy through fisheries activities.

The table below sums up the Southern Region's ports' main activities, including cargo throughput, number of cruise and ferry passengers as well as the value of landed fish.

Table 1 Cargo tonnes, ferry and cruise passengers, and landed fish values for ports in the Southern Region in 2023. Source: CSO, Sea-Fisheries Protection Authority/2023, Irish Marine Development Office[10]/2024.

	RoRo (in 1000 tonnes)	LoLo tonnes (in 1000 tonnes)	Dry, liquid and break bulk (in 1000 tonnes)	Cruise passengers	Ferry passengers	Landed fish (in EURm)[11]
Cork	219	2,043	6,295	186,426	118,256	17
Shannon Foynes	-	-	8,187	1,149	-	-
Waterford	-	260	1,527	17,054	-	-
Rosslare	3,355	-	-	-	634,130	3
Ports of regional significance	-	-	410	4 737	-	100
Other ports	-	-	-	-	-	84
Total	**3,574**	**2,303**	**16,418**	**209,366**	**752,386**	**205**
Share of Irish total, %	**22**	**35**	**64**	**56**	**30**	**52**

The Southern Region ports play a significant role in the country's cargo throughput, contributing 44 percent of the total cargo tonnes regardless of type. Broken down by cargo type, the Southern Region ports hold a 22 percent market share for roll-on/roll-off (RoRo) tonnes and a 35 percent market share for lift-on/lift-off (LoLo) tonnes in 2023. In the bulk category, which includes dry, liquid and break bulk, the Southern Region ports account for 64 percent of the Irish total.

[9] https://www.gov.ie/pdf/?file=https://assets.gov.ie/11557/277d22d364fe4c13be390493282c0557.PDF#page=null
[10] The data for RoRo and LoLo tonnes is CSO table TBA08, while the data for bulk and other cargo as well as passengers is the IMDO's Irish Maritime Transport Economist. Available at https://www.imdo.ie/Home/sites/default/files/IMDOFiles/IMDO_Docs/ShippingandResearch/IMTE/IMTE2024VOL21.pdf
[11] The values shown in this table represent the total value of the landed fish, regardless of whether the fisheries were Irish or foreign.

As we can see, the Southern Region accounts for a large share of Ireland's port trade with the world, highlighting the Southern Region ports' importance for connecting Ireland with the world. As an island nation, Ireland is heavily reliant on the maritime transport sector. We go further into this in chapter 2.3.

Southern Region ports transported a little over 200 000 cruise passengers in 2023, with visits to Cork constituting the majority of these. This is a large share of the total number of Irish cruise passengers – at around 56 percent of the cruise passenger market – but this is not especially large in an international context. The Southern Region also had around 750 000 ferry passengers in 2023, mostly coming from the UK, France and Spain into Rosslare and Cork.

The Southern Region has a large number of fishing ports. For the most part, the ports which are important for fisheries are not the Tier 1 and Tier 2 ports, but rather a variety of specialised fishing ports, as shown in Figure 4. Out of the five ports with the largest value of landed fish in 2023, four are in the Southern Region. This is also reflected in the value of the total landings, where a little over half of the fish in Ireland is landed in the Southern Region, measured by value.[12]

[12] *Measured by tonnage, they make up a substantially smaller portion, as the fish landed in the Southern Region is (on average) more valuable.*

2. Economic impact of port sector activities

We estimate that the port sector in the Southern Region generates a revenue of EURm 740 annually, creates a gross value added (GVA) of EURm 293, and employs 3 100 people. In the analysis, we split the activity into four sub-sectors: the commercial ports themselves, the companies facilitating maritime transportation (such as shipping companies), auxiliary services (such as logistics and warehousing), and sea fisheries.

	2023 (estimated numbers)	Commercial ports	Maritime transport	Auxiliary services	Fisheries	Total
	Employment	310	690	810	1,290	3,100
	Revenue (EURm)	88	266	240	156	740
	Gross value added (EURm)	57	79	77	84	293
	Wages (EURm)	29	38	38	43	149

The fisheries account for the largest number of employees, while the maritime transportation companies and those supporting maritime operations have the highest revenue. In terms of GVA all four sub-sectors create regional value added of between EURm 57 and EURm 85 annually.

The economic impact of the port sector goes beyond just the activities happening in the port. This happens through the sector's purchase of goods and services from other industries. Using a state-of-the-art modelling framework, we estimate that the total economic impact of the port sector is around 6,850 employees and EURm 695 in GVA. The largest share of this economic impact is in the South-West, with both the most fisheries, the port of Cork, and a large shipping industry.

2.1. Direct effects in the port sector

Definition and methodology

In this subchapter, we examine the economic value of port-related activities in the Southern Region.[13] During this analysis, we faced two main challenges.

First, the port sector can be defined in various ways.[14] In discussion with the Southern Regional Assembly, we have decided on a definition of the port sector. This definition includes the following activities and companies:

- **The commercial ports:** Companies that own and operate the ports, hereunder executing cargo loading, container operations and repair facilities
- **Auxiliary services:** Companies that support maritime operations, such as cargo loading, warehousing and marine construction
- **Maritime transport:** Traditional shipping companies, but not the commercial ports themselves.

[13] *This is the NUTS Level II statistical region "Southern Region".*
[14] *As it most narrow, the port sector can be defined as port activities, including administrative services, cargo handling, storage, and ship services. At its broadest however, the port sector can be defined as the full maritime economy.*

- **Irish sea fisheries:** Activity of the fisheries themselves, but not the seafood processing or subsequent value chain.

Secondly, there is a lack of publicly available data on the economic value of the port sector in the Southern Region. Hence, to estimate the economic value of the port sector, we followed a three-step process:

1. **Identifying relevant companies:** We compiled a comprehensive list of relevant companies using two large international databases, Orbis Database and Clarksons Database.[15] The databases were supplemented with local inputs from visits to the ports of Cork, Shannon Foynes, Waterford, and Rosslare.
2. **Estimating economic activity:** While the Orbis Database provided some financial data, the database is not complete, and we therefore had to collect additional financial statements from the Companies Registration Office (CRO).
3. **Quality assurance:** A key source for this was the Labour Force Survey, which has detailed employment data at the regional level for several industries, although slightly more aggregated than our data. We here quality-assured against relevant sub-sectors of the Irish Ocean Economy and the EU Blue Economy Observatory studies.

Detailed methods for quality assurance and estimation of direct effects are provided in Appendix A.

Economic footprint of port sector activities in the Southern Region

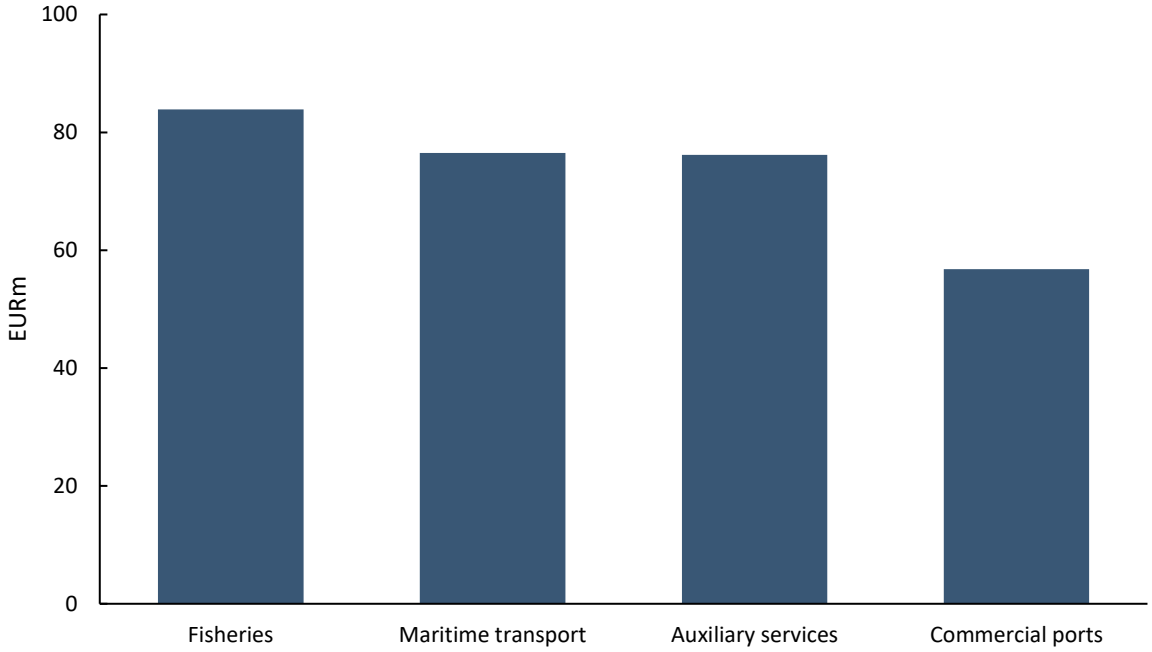
We estimate that the Southern Region's port sector generated a GVA[16] of EURm 293 in 2023.[17] The figure below illustrates the distribution of GVA among the different activities.

[15] The Orbis Database, provided by Bureau van Dijk, is a comprehensive global resource that contains information on millions of companies across the world. It includes detailed financial data and company information. The Clarksons Database, is a specialised resource that focuses on the maritime industry, providing detailed information on shipping companies and vessels.

[16] A company's gross value added is defined as the sum of wage costs and the company's operating profit, adjusted for capital depreciation and write-downs. In other words, GVA can be understood as the sum of the company's returns allocated to employees (wages), capital owners (profits), creditors (interest), and the government (taxes).

[17] Where data is not available for 2023, we have used 2022 numbers.

Figure 5: Gross value added in different port activities in the Southern Region, 2023. Source: Menon Economics

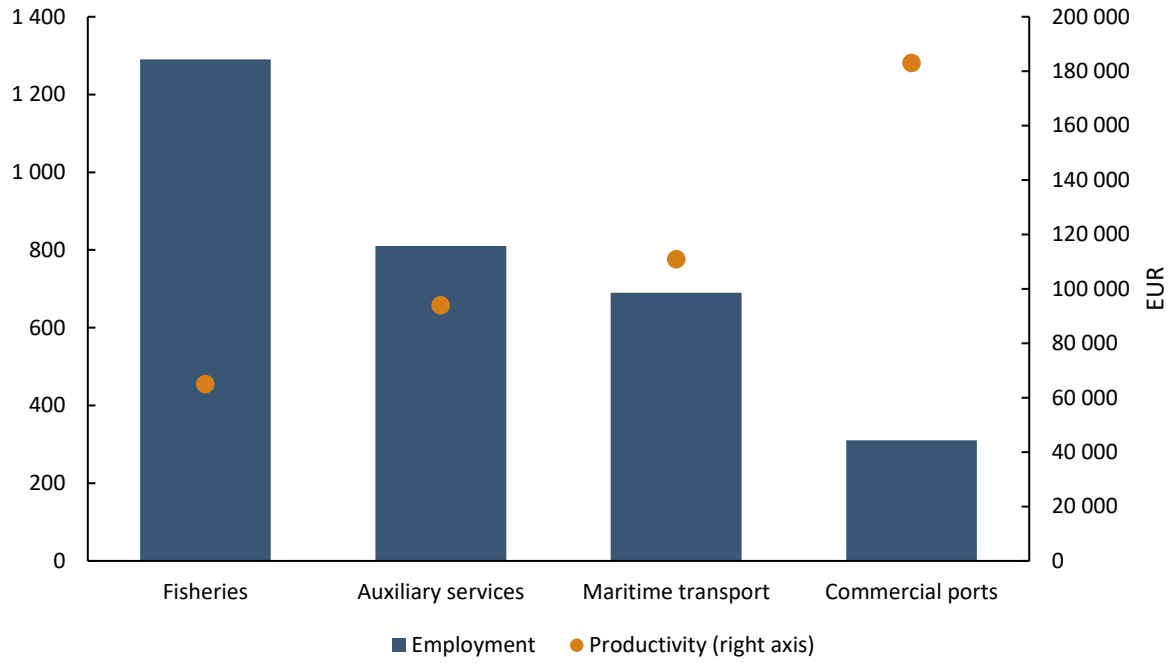


Fisheries, maritime transport and auxiliary services all contributed around EURm 80 in gross value added. Fisheries contributed the most to the total gross value added within the port sector, amounting to approximately EURm 84. It is important to note that the gross value added in the fisheries sector only includes the gross value added from Irish fisheries, not all fisheries that land fish in the ports. Both maritime transport and auxiliary services generated around EURm 80 in 2023. Lastly, the commercial ports themselves generated a value added of just over EURm 56 per year, with the Port of Cork as the largest accounting for approximately half of the total.

Gross value added can be decomposed into the number of employees and their labour productivity[18], respectively. The graph below shows the number of employees and labour productivity across the four sub-sectors.

[18] *Labour productivity is defined as gross value added per employee.*

Figure 6: Employment and labour productivity in different port activities in the Southern Region, 2023. Source: Menon Economics

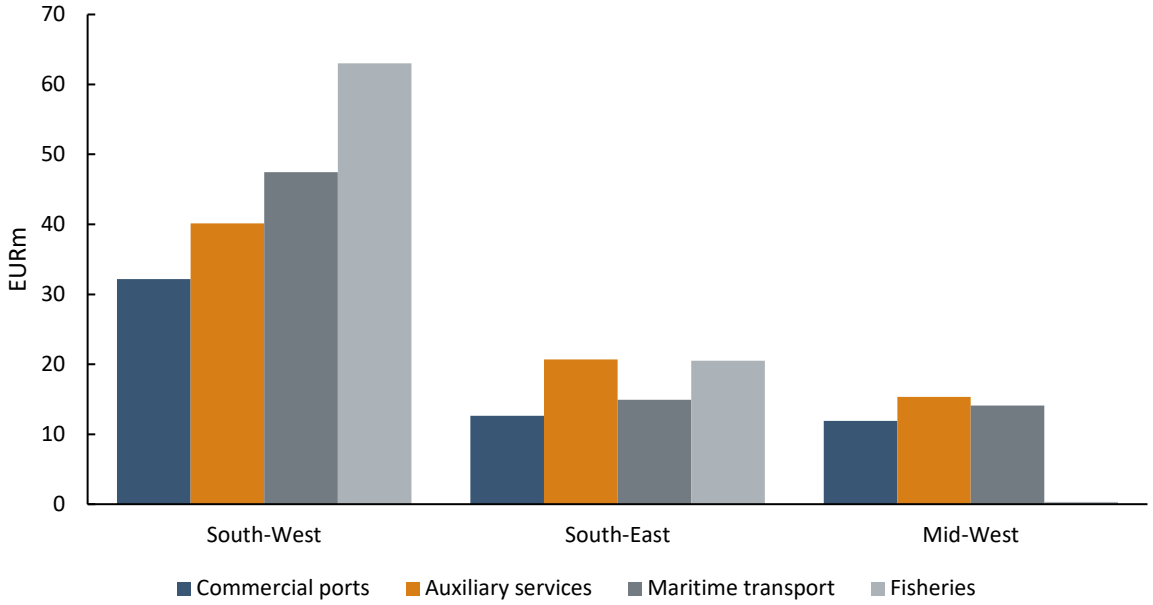


In 2023, port sector activities employed a total of 3,100 people, with the fisheries sector accounting for the largest share of employment. At the same time, we see that the other sub-sectors had a higher labour productivity. Notably, the commercial ports exhibited significantly higher labour productivity than all other sectors, surpassing the average labour productivity in both the Southern Region and Ireland as a whole. This is logical, as capital-intensive businesses, such as commercial ports, are generally expected to exhibit high labour productivity according to economic theory.[19]

The economic footprint of port sector activities in the Southern Region is spread across the sub-regions of Mid-West, South-East, and South-West. The graph below illustrates the distribution of gross value added in the different sectors among these sub-regions.

[19] With regards to fisheries, part of the reason they have a lower labour productivity is also that many of the employees are not full-time fishermen. This is for instance highlighted by the Annual Fisheries Report, which shows that there are approximately 45 percent more employees than full time equivalents (https://bim.ie/wp-content/uploads/2023/10/BIM_Annual-Fisheries-Report-2023.pdf).

Figure 7: Gross value added in different sub-regions. Source: Menon Economics



As illustrated by the chart, the South-West region contributed the most to the gross value added in the Southern Region, accounting for over 60 percent of the total. The value added in the South-West was more than double that of any other region across all sectors. The sub-sectors in the South-East region generated slightly below EURm 70 in value added, which was EURm 25 more than the Mid-West region. The difference is mostly from the fisheries sub-sector, which is almost non-existent in the Mid-West.

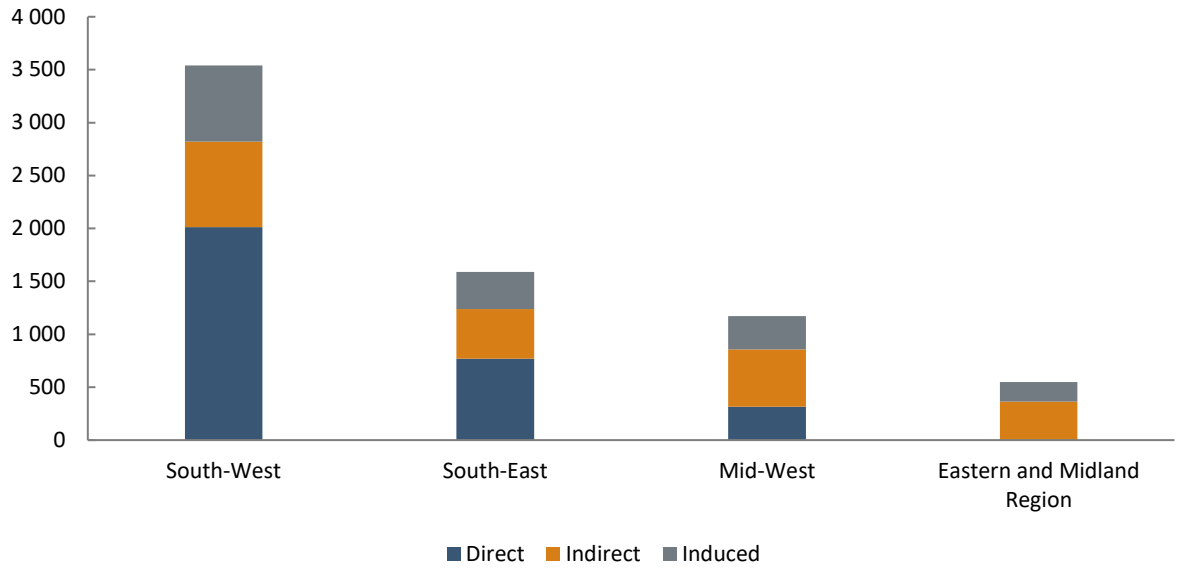
2.2. Indirect effects of port sector activity

Different sectors of the economy are closely intertwined. Economic activity in one area, such as a port, affects activity in other sectors. We quantify these effects with an economic impact analysis employing a tailor-made regionalised input-output matrix, which was published in *Nature*.[20] Our model then analyses the value chain effects stemming from initial economic activities at the port by examining how industries trade goods and services with one another. The input-output matrix also has a regional dimension, showing interactions between industries in different parts of Ireland.

The basis for the economic impact assessment is the direct economic activity presented above. Using national fractions between revenue, purchases and employment, we derive the total GVA, purchases of goods and services and employment linked to port activities. For example, when the ports buy a service related to security, this will support GVA and employment in the security company. In turn, the security company will have purchases of goods and services from their suppliers, which supports GVA and employment with their suppliers. This means that the initial purchase of security services has effects further up the value chain. This effect is what we quantify in an economic impact assessment, for more detailed methodology, please see appendix B. Because we assess the economic impact, and follow the economic impulse up the value chain, the analysis includes both specialised and non-specialised companies. Overall, the port activities support approximately 6,850 employees in the value chain. The figure below displays the regional distribution of these employees.

[20] *The input-output matrix can be found here: https://www.nature.com/articles/s41597-023-02117-y*

Figure 8: Regional distributed employment from port activities in Ireland. Source: Nature, Menon Economics, CSO and Orbis

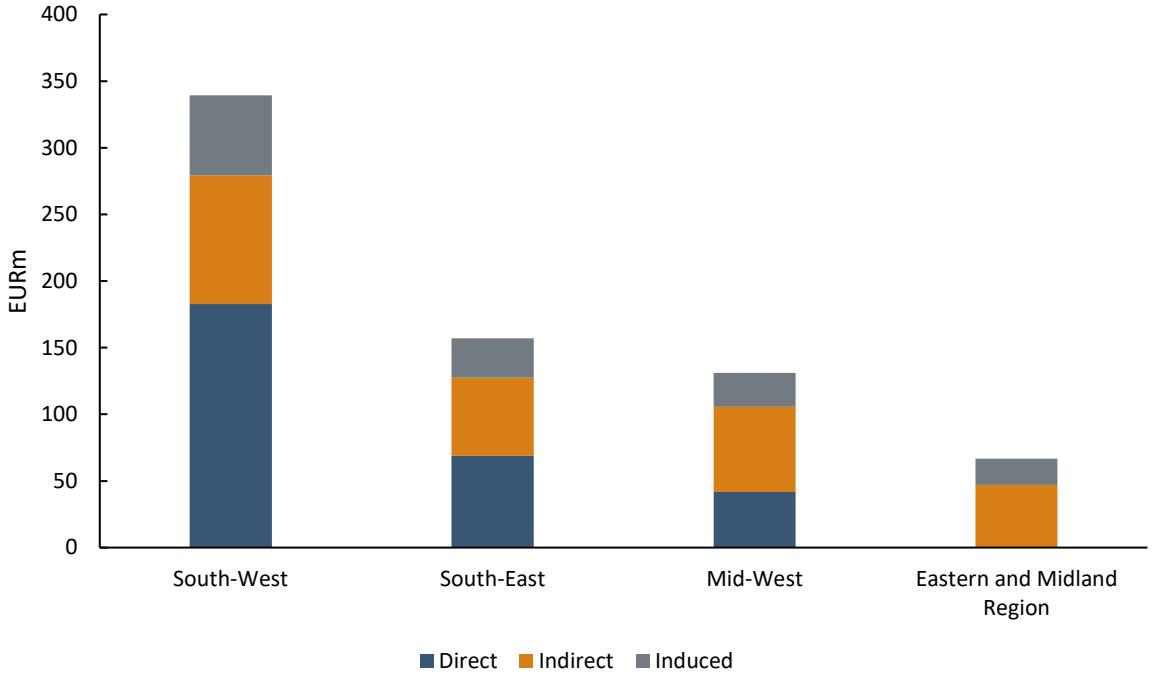


As indicated by the figure, the largest employment effects are concentrated in the South-West. The reason that South-West has the largest employment effects is twofold. Firstly, Cork port is located in this region and because this is the largest port, a larger direct economic effect is located in this region. Secondly, the industry in the South-West is larger than in the South-East and Mid-West, which means that there are larger economic effects in this region.[21]

Furthermore, the indirect and induced employment effects are distributed across Ireland, with Southern Ireland's port activities supporting approximately 3,750 employees further along the value chain.[22] The largest indirect effects in Southern Ireland occur in the South-West. This is explained by the proximity of companies in the South-West to the initial economic activity as well as the presence of specialised value chains, which are capable of producing the necessary goods and services to support the port activities. In addition to the employment, port activities also support GVA further up the value chain. These effects are estimated within the economic impact model as well. The figure below shows the regional distribution of the GVA effects, related to the port sector.

[21] For this calculation, we have assumed that the induced effects occur in the region where the employee works. This is true for a large majority of the induced effects, but some will be spent outside of the region.
[22] This implies a multiplier of 1:2.23 for each employee in the maritime sector.

Figure 9: Regional total economic impact from port activities in Ireland. Source: Menon Economics

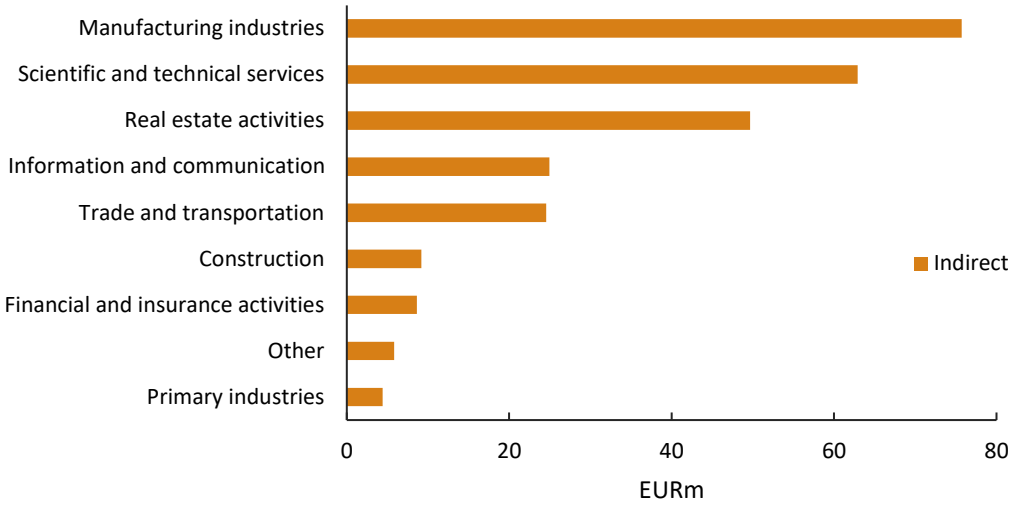


The total GVA contribution of the port sector in the Southern Region in 2023 is estimated to be about EURm 695 in GVA. As the figure illustrates, the most significant GVA effects are expected in the South-West, the region of Cork port, the largest of the Southern ports. In total, around EURm 340 in GVA is produced in the South-West. Not only does the South-West house the largest port, but it also boasts the largest industries. Consequently, a greater share of the indirect effects will occur in this region.

In total, approximately EURm 400 are generated as indirect and induced GVA effects respectviely, constituting a little under 50 percent of the total GVA.[23] As indicated by the figure, the Eastern and Midland Region experiences only indirect and induced effects. This is because the analysis focuses on the Southern Region ports, where all direct economic activities occur. Nonetheless, there is significant economic activity in the Eastern and Midland Region as well, totalling EURm 67, with the majority of these effects concentrated in the Dublin region. As the initial economic impact is traced up the value chain, the economic activity originating from the port will spread through different industries. The figure below illustrates how the GVA supported by the port activities is distributed by industries in the input-output matrix from Nature, highlighting the interconnectedness and broad impact of these activities on the economy.

[23] *This implies a multiplier of 1:2.1 for GVA.*

Figure 10. Industry distributed GVA. Source: Menon Economics



The figure highlights that the primary indirect effects along the value chain are found in the manufacturing industry, encompassing traditional industry, followed by scientific and technical services. Both of these have both general companies and specialised suppliers delivering to the port sector.

Both the profits of companies in the port sector and the wages of their employees are taxable income. Our input-output model estimates that the income tax and corporate tax paid on this income totals EUR 135 million in 2023 combined for the direct and indirect effects.

Uncertainty in the model and interpretation

All economic impact studies carry uncertainty, and the results in this report are no exception. While the direct effects are comparatively less uncertain being estimated based on company data, the indirect effects involve more uncertainty because they are derived from models. This is especially true for the regional distribution, which relies on transport data, demographic distribution, and regional industries. Since these figures are model-based, they should be interpreted with caution and considered as representing the "most likely" regional distribution.

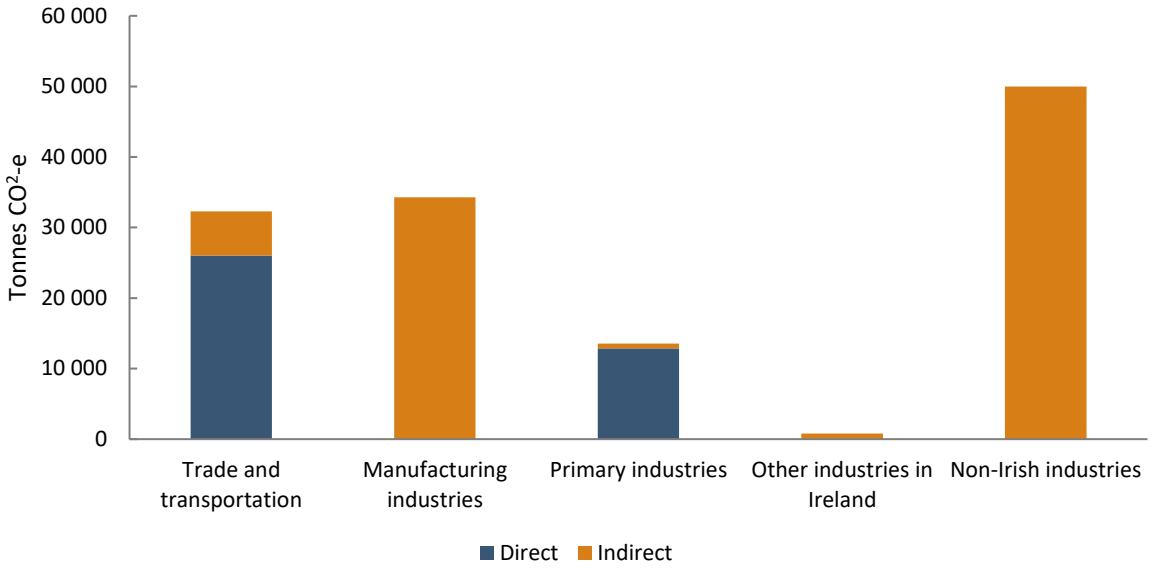
A key feature of the data we have used is that it indicates relatively limited trade between regions in Ireland compared to other countries. As our model uses the data matrix as a key input, this means that intra-country trade is relatively constrained in the model as well. Additionally, the input-output matrix is not derived directly from National Accounts but is based on model calculations from an article published in *Nature*. This distinction is important for understanding the limitations and context of the economic impact assessments presented.

Equally important to understanding what an economic impact study is, is recognising what it is not. Results from economic impact studies are expressed in the form of gross numbers. This means that they do not account for the alternative use of resources. For example, if the study concludes that port activities support 100 employees, this does not address whether those employees would have had other jobs if the port activities did not exist. This is especially true for an economy such as the Irish where there is full employment, and where several regions and industries struggle to meet demand because of a lack of workers.

Climate footprint of port sector activity

The economic activity of the port sector also affects the climate. Using data from the economic impact analysis and emission intensity figures from Eurostat, we have calculated the climate footprint for the port sector and its value chain. For commercial ports, auxiliary services, fisheries, and their suppliers, we estimate total emissions to be approximately 130,000 tonnes of CO^2-equivalents, including emissions in both Ireland and globally. The breakdown of these emissions across different industries is shown in the figure below. The maritime transportation industry presents a notable challenge, as its emissions are notoriously difficult to estimate due to the complexities of the shipping sector, and is therefore not included in the figure below.[24]

Figure 11: Estimated total emissions, including value chain effects from the port activities, excluding the direct maritime transportation companies. Source: Menon Economics



As shown in the figure, a large share of emissions comes from trade and transportation, with total emissions estimated at around 32,000 tonnes of CO^2-equivalents. Of this, approximately 80 percent, or 26,000 tonnes, are linked to auxiliary services and commercial ports, while the remainder originates from suppliers in the trade and transportation sectors. Additionally, Ireland's manufacturing industries supplying inputs to the port sector contribute to emissions, with an estimated 35,000 tonnes of CO^2-equivalents tied to the port sector's value chain.

A notable portion of the economic activity connected to the port sector's value chain takes place outside Ireland. In total, the economic activities of Ireland's port sector are responsible for approximately 50,000 tonnes of CO^2-equivalent emissions in other countries.

[24] As mentioned, these numbers do not contain the emissions of the maritime transportation industry. If we apply our methodology to the maritime transportation companies using Eurostat's emission figures, then that results in an estimate of around 90,000 tonnes of CO^2-equivalents. This estimate is extremely uncertain, however. Emissions in the maritime industry is challenging due to the sector's complexity and variability. Ships operate on a with diverse fuel types, differing operational practices, and engine technologies, making it hard to estimate emissions without a detailed analysis of each company. We do, however, include the emissions of the suppliers to the maritime transportation companies.

A significant portion of the economic activity associated with the value chain of the port activities occurs outside Ireland. In total, the economic activity of the port sector in Ireland is responsible for approximately 50,000 tonnes of CO^2-equivalents in emissions in other countries.

2.3. The wider economic benefits of port-related activities

In the report so far, we have examined the port activities of the port sector. However, it is important to recognise that the economic benefits of ports extend well beyond these companies. Several studies have pointed out that ports serve as an important driver of economic growth.[25] These wider economic effects work through at least two mechanisms:

1. **Trade facilitation:** Ports are essential in enabling and enhancing trade, acting as critical hubs for the movement of goods both domestically and internationally. Well-functioning ports spur increased trade and lower transaction costs in the value chain for Irish companies.
2. **Port-attracted companies:** Many companies, referred to as port-attracted companies, are attracted to a region because of the presence of a port. This includes companies that export commodities, or firms that import products or raw materials such as chemicals or factories. Proximity to the ports is essential for these firms, and well-functioning ports are therefore a key criterion when deciding where they localise.

In the following section, we examine both these mechanisms.

Southern Region ports are vital facilitators of trade

Ports are essential facilitators of international trade, serving as critical infrastructure that supports both national and regional economies. Ireland is one of the most trade-dependent economies in the world, with the sum of imports and exports constituting more than 230 percent of GDP in 2023. A large part of that trade is in goods, and as an island economy around 90 percent of Ireland's goods trade goes through its ports – and almost half of that through the Southern Region ports. Furthermore, past studies have estimated that if port efficiency increases by 10 percent, that contributes to an increase in trade of around 3.2 percent.[26] This underscores the role that ports play in enhancing trade volumes.

There are two main reasons why facilitating trade is important. Firstly, it increases the range of goods available to Irish businesses and consumers. By engaging in international trade, Irish businesses can access a diverse array of products and raw materials that may not be readily available domestically. This expanded access enables companies to innovate and improve the quality of their offerings, making them more competitive in both local and global markets. Consumers will also benefit from a wider selection of goods and services, often at more competitive prices. Trade allows consumers to purchase products from different parts of the world, bringing unique items and brands to market that would otherwise be unavailable.

Secondly, facilitating trade bolsters export activities. Exporting industries often possess high levels of productivity, leading to significant contributions to the country's GDP. Moreover, exports are vital for job creation within the Irish economy. According to Eurostat estimates, exports in transport-intensive industries support

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[25] See for instance "The Competitiveness of Global Port-Cities" available at https://www.oecd.org/en/publications/the-competitiveness-of-global-port-cities_9789264205277-en.html for more on port-attracted companies
[26] Blonigen, B. A., & Wilson, W. W. (2008). Port efficiency and trade flows. Review of international Economics, 16(1), 21-36.

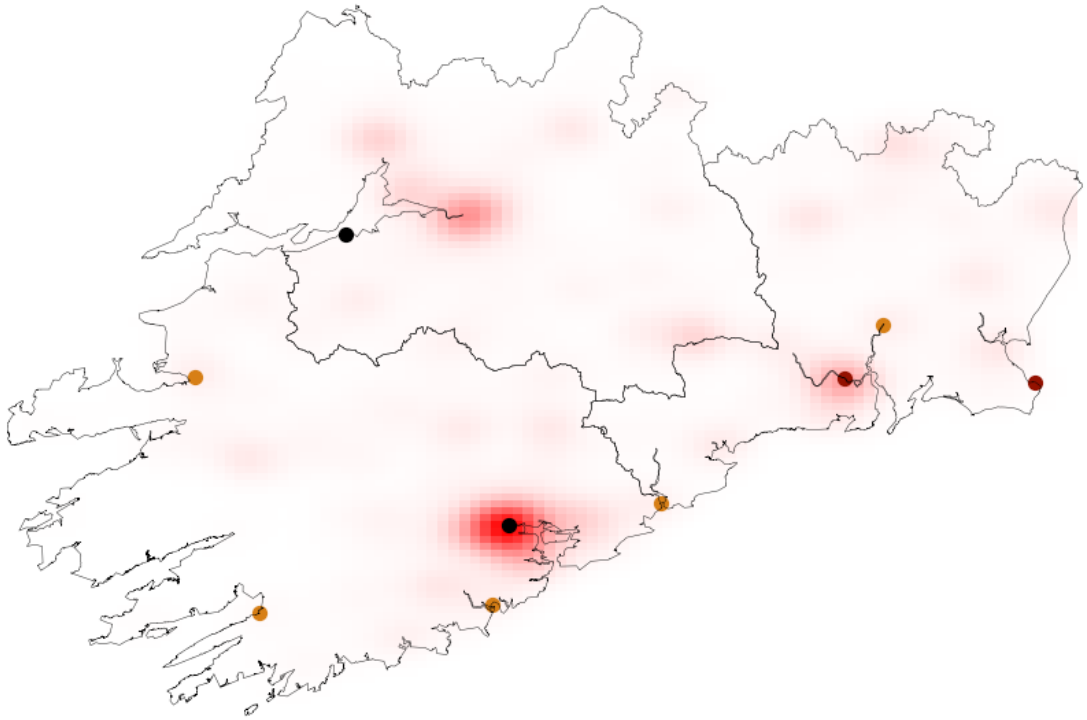
approximately 400,000 jobs[27] across Ireland. Most of these industries produce goods which are expensive to export by air freight, and the ports are therefore a necessary infrastructure for many of them.

Port-attracted companies

Port-attracted companies are typically in industries that export high-volume goods or import high-volume import products or raw materials. These businesses are often manufacturing companies, necessitating proximity to efficient and effective port systems to minimise substantial transportation costs associated with moving bulky or heavy goods. They therefore establish themselves near ports with good connections to relevant markets.

To illustrate the importance of ports for manufacturing, we have used detailed geographical data on employment in manufacturing industries to estimate how far from ports manufacturing industries are. The data is presented in the figure below, showing a heatmap of employment in the manufacturing industries in the Southern Region.

Figure 12: Heatmap of manufacturing companies' employment in the Southern Region along with ports. Areas with a strong red colour have a higher number of manufacturing employment. Source: Labour Force Survey small area dataset



As can be seen from the figure, the largest manufacturing hubs are Cork followed by the Shannon Estuary. The Shannon Foynes port company has terminals along the estuary in addition to the point on the map, including near the manufacturing clusters. The third largest manufacturing hub is in Waterford.

Our analysis indicates that around a quarter of the manufacturing jobs are located within 5 kilometres of the nearest port of national or regional significance. Approximately half are located within 15 kilometres. The definition of manufacturing in this dataset is quite broad, and includes the entirety of the manufacturing

[27] *These industries include primary industries, manufacturing industries, trade industries and the tourism industry.*

industries, including many which do not use ports much. For the companies that primarily use the ports, we expect that the share which is close to the ports is even higher.

Many of the port-attracted companies in the Southern Region are multinational companies that have established themselves in the region through Foreign Direct Investment and in relation to the Industrial Development Agency (IDA). This is evident for two main reasons. Firstly, the IDA's illustration of where the companies are located shows that a substantial proportion of these companies have positioned themselves near major ports.[28] Secondly, many of these firms operate in trade-dependent sectors, relying heavily on efficient and cost-effective transportation of their inputs and exports via the ports.

Foreign direct investment is important to the Irish economy. According to the Irish Department of Enterprise, Trade and Employment, multinational companies based in Ireland directly employ around 250,000 people, accounting for approximately 20 percent of all employees in the Irish private sector.[29] By playing an important role in attracting and supporting the establishment of these multinational companies, Irish ports contribute to the nation's economic growth and job creation.

[28] The localisation of the companies can be seen here: https://www.idaireland.com/map
[29] https://enterprise.gov.ie/en/what-we-do/trade-investment/foreign-direct-investment-fdi-/

3. Potential for growth in marine economic sectors

In this chapter, we examine the role of ports in supporting the growth of four marine economic sectors:

- Offshore wind
- Alternative fuels and renewable energy hubs
- Marine tourism
- Aquaculture and fisheries

For each of these industries, we have assessed the potential for growth going forward, what roles the Southern Region ports may have in facilitating that growth, and what key barriers must be overcome to achieve the growth.

Of these sectors, the most important roles of the Southern Region ports are as in **assembly and installation ports** for offshore wind and as **renewable energy hubs** for alternative fuels.

Assembly and installation ports are a key part of the value chain for offshore wind, and the services and facilities of ports will be crucial for developing this offshore wind capacity. The Southern Region ports are well positioned to function as assembly and installation ports for much of Ireland's planned capacity. If successful, they will have a large economic impact in the Southern Region ports and offshore wind supply industry. In the subchapter on offshore wind, we quantify the potential economic impact of the offshore wind assembly and installation activities, the key success criteria for offshore wind, and some central barrier which ports must be overcome. We find that the economic potential of offshore wind assembly and installation activities, given a base cost scenario, is as high as 2,700 jobs and EURm 570 of GVA annually between 2030 and 2040, though this requires significant market share and a rapid build out of offshore wind.

Ports can play a major role as **renewable energy hubs**. They have an important role both in producing hydrogen for decarbonising Ireland's hard-to-electrify industries and have an important role in facilitating the use of alternative fuels to decarbonise shipping. In the subchapter on alternative fuels and renewable energy hubs, we go through the role of ports in both these endeavours, as well as the barriers that need to be overcome. We find that hydrogen production creates comparatively few jobs, but that the production can have a range of other positive benefits, such an increased exports and new business opportunities. For bunkering, we find that the ports in the Southern Region have relatively few plans, which might be a problem going forward.

The role of ports is less important for achieving growth in **tourism** and **aquaculture and fisheries**. While the number of passengers to Southern Region ports will likely grow, the ports make up only a small share of passenger traffic to Ireland. The most important role of the ports for the marine tourism industry may therefore be to facilitate the use of alternative fuels in the longer run. The aquaculture industry in Ireland has stagnated, and future growth is uncertain, while catch fisheries are limited by quotas and unlikely to grow. The need for investments to assist these industries is, at least in the short term, therefore much smaller in these two industries than for offshore wind and renewable energy hubs.

3.1. Offshore wind

Ireland has ambitious plans for offshore wind development, and ports play a key part in this effort. Ports and their supporting infrastructure play an important role in the successful delivery of offshore wind projects, as all components are transported through these gateways. The ports connect marine operations with land-based activities, both in the operational phase and during the assembly and installation phase. The assembly and

installation phase comes first, and has the largest barriers to overcome, and is therefore the main focus of this analysis.

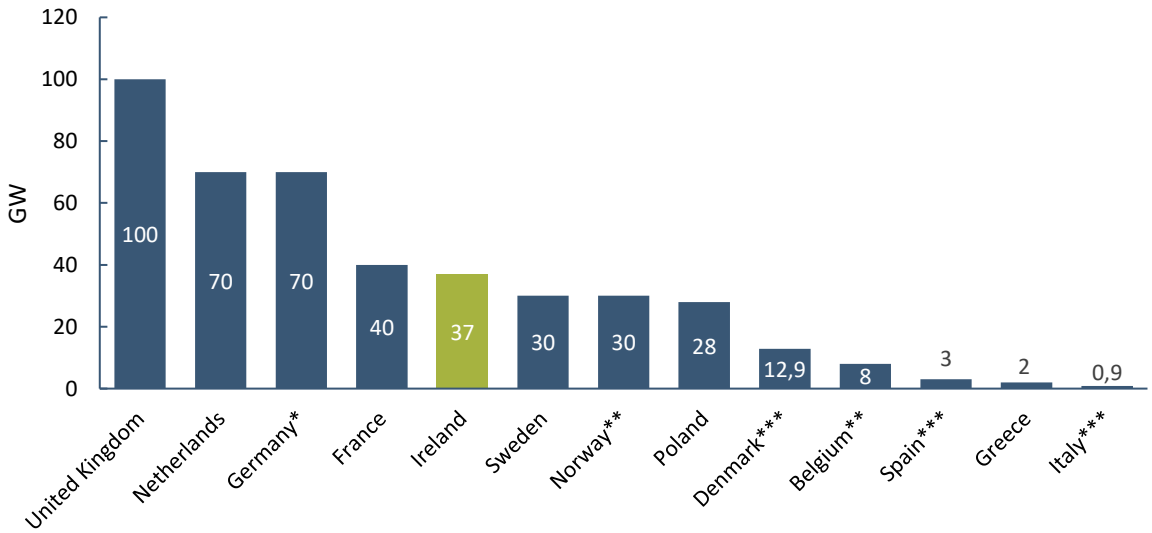
In the assembly and installation phase, the various components, such as the turbines, blades, nacelles and the substructure, are brought to the port. The precise role of the port then depends on whether the turbines are floating or bottom-fixed. Floating wind turbines require large deep-water quays and sheltered areas for assembly and storage, while bottom-fixed turbines need ports to provide logistical support and port services close to the installation site. The ports in the Southern Region are well-positioned to offer many of these services.

Achieving Ireland's offshore wind goals will require significant investment but promises to deliver substantial economic benefits to ports and suppliers in the offshore wind industry. In this chapter, we firstly examine Ireland's ambitions plans for offshore wind energy, then explore the potential economic impact of the offshore wind assembly and installation activities in the Southern Region.

Ireland's potential and plans for delivering offshore wind energy

The EU has set ambitious targets for offshore wind development. The EU's target for 2030 was recently increased to 111 GW offshore wind, from 60 GW. Additionally, the EU aims to achieve 300 GW of installed offshore wind capacity by 2050, with the aim of meeting 25 percent of Europe's energy needs through offshore wind.[30] European authorities are planning significant expansion of offshore wind capacity across Europe leading up to 2050, as shown in the figure below.

Figure 13: Quantified objectives for offshore wind development set by European authorities (regardless of technology). Note that some countries have specified ambitions for 2045 (*), 2040 (**) and 2030 (***). Source: Menon Economics



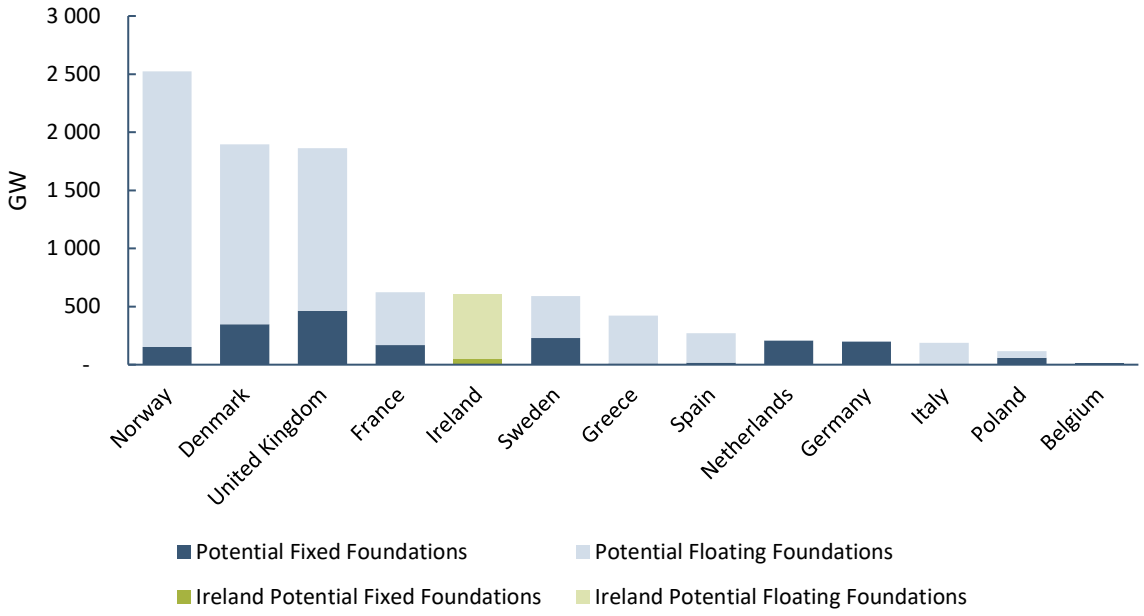
Ireland's technical potential for offshore wind

As an island nation situated at the edge of the Atlantic Ocean, Ireland has significant potential for offshore wind. With ample wind resources and a maritime area seven times the size of its landmass, Ireland is well positioned

[30] *European Commission (2023). Member States agree new ambition for expanding offshore renewable energy. https://energy.ec.europa.eu/news/member-states-agree-new-ambition-expanding-offshore-renewable-energy-2023-01-19_en*

to producing more renewable electricity than it consumes, and thus become a net exporter of energy. [31] The gross technical resource capacity within the Irish exclusive economic zone is estimated to range between 51 and 62 GW for fixed bottom offshore wind and 553 to 579 GW for floating offshore wind.[32] Even in an European perspective, the Irish technical potential for offshore wind development is significant, with only four countries having larger potential, as shown in the figure below.[33]

Figure 14: Technical potential for offshore wind for European countries, split into potential for bottom-fixed and floating technology. Source: World Bank/2021



Ireland's plans for offshore wind development

Ireland has ambitious plans for the development of offshore wind energy. When compared to Ireland's technical potential and the equivalent plans of other European nations, the Irish plans do not seem to be overly ambitious. The Irish Government's Climate Action Plan 2023 has a target for 80 percent of renewable electricity by 2030.[34] This includes an objective to build out at least 5 GW of offshore wind, along with an additional 2 GW designated for green hydrogen production. Furthermore, in response to the European energy crisis of 2022, the government's ambitions were increased to 20 GW of offshore wind capacity by 2040 and at least 37 GW by 2050.[35]

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[31] Climate Action Plan 2023 – CAP23. https://www.gov.ie/pdf/?file=https://assets.gov.ie/270956/94a5673c-163c-476a-921f-7399cdf3c8f5.pdf#page=null

[32] World Bank (2021). Global Offshore Wind Technical Potential (lowest estimate) https://datacatalog.worldbank.org/search/dataset/0037787/Global-Offshore-Wind-Technical-Potential & Offshore Renewable Energy Development Plan II (2023) (highest estimate) https://www.gov.ie/pdf/?file=https://assets.gov.ie/248270/7338cf63-e174-4932-8c61-6b840e447f3d.pdf#page=null

[33] The technical potential for offshore wind considers the technically feasible generation capacity based on wind speed and water depth. It does not take into account other marine infrastructure, corridors for maritime transport or similar.

[34] Climate Action Plan 2023 – CAP24. https://www.gov.ie/pdf/?file=https://assets.gov.ie/270956/94a5673c-163c-476a-921f-7399cdf3c8f5.pdf#page=null

[35] Accelerating Ireland's Offshore Energy Programme – Policy Statement on the Framework for Phase Two Offshore Wind (2023). https://www.gov.ie/pdf/?file=https://assets.gov.ie/249823/bbd8b13c-73cd-46d4-9902-533fbf03d7fe.pdf#page=null

To date, Ireland's only offshore wind project is the Arklow Bank Wind Park Phase 1. Fully commissioned in 2004, this park has a capacity of 25.2 MW.[36] Ireland is carrying out a three-phased approach to reaching their offshore wind ambitions. Phase One, the Offshore Renewable Energy Support Scheme (ORESS1), involved a renewable energy auction that awarded seabed occupation rights to six projects, totalling 4.2 GW. Phase Two aims to achieve the remaining 5 GW ambition by 2030. To facilitate Phase Two the South Coast Designated Maritime Area Plan for Offshore Renewable Energy (SC-DMAP) was made by the Minister for the Environment, Climate and Communications on 24 October 2024, which aims to facilitate 900MW by 2030 and up to 5GW in total. The SC-DMAP highlights it will be dependent on sustainable infrastructure development across several port and harbour facilities.

Phase Three, the Future Framework for Offshore Renewable Energy, launched in 2024, outlines a long-term vision for offshore renewable energy in Ireland, targeting 37 GW of offshore wind by 2050.[37] The Future Framework states that bottom fixed technology will dominate in Ireland towards 2030, as this is more cost effective in the short term. Large-scale deployment of bottom-fixed turbines has already been successful in other regions, making it the most promising solution for delivering affordable offshore wind in the near future. Both bottom-fixed and floating wind technologies are stated to play a vital role in aiming for 20 GW of offshore wind generation by 2040 and 37 GW by 2050.[38]

Some investments are already being made in Southern Region ports to facilitate offshore wind. A recent development, announced as part of the budget, has been the agreement between the Ireland Strategic Investment Fund (ISIF) and the Port of Cork for an investment commitment of EURm 88.5 million by ISIF that will support the development of critical port infrastructure needed to facilitate the deployment of offshore wind in Ireland.[39]

Potential economic impact for the ports in the Southern Region

As discussed in the last subchapter, there are significant plans for offshore wind in Ireland, and the ports play an important role in supporting this growth. The activity in the ports and the supplementing supply industry could generate a substantial economic impact. In this chapter we calculate the economic impact of assembly and installation activities for a successful offshore wind build-out in Ireland. The chapter starts by looking at the competitive situation for the Southern Region ports related to offshore wind, before we estimate the capacity of offshore wind that is going to be built in Ireland. Lastly, we calculate the economic impact of the offshore wind industry in a scenario where Southern Region ports provide the installation and assembly of offshore wind matching Ireland's ambitions to 2040.

Competitive situation

The ports in the Southern Region are geographically well-positioned for servicing the offshore wind market.[40] They are located near most of the planned offshore wind farms in Ireland, and as transportation costs are high,

[36] *4C Offshore*
[37] *https://www.gov.ie/pdf/?file=https://assets.gov.ie/291905/4ecb292f-990f-4317-8f67-ca9bc2f9b8f8.pdf#page=null*
[38] *Future Framework for Offshore Renewable Energy (2024). https://www.gov.ie/pdf/?file=https://assets.gov.ie/291905/4ecb292f-990f-4317-8f67-ca9bc2f9b8f8.pdf#page=null*
[39] *https://isif.ie/news/port-of-cork-company-and-ireland-strategic-investment-fund-announce-unique-partnership-enabling-irelands-future-as-a-major-renewable-energy-hub*
[40] *See for instance the Regional Approach for development of a Smart Specialisation Strategy in the Southern Region, available at https://www.southernassembly.ie/uploads/general-files/SRA_S3_Final_Report.pdf*

it is more cost efficient to operate from logistical bases close to the location of the wind farms. The proximity is therefore a competitive advantage for the Southern Region ports.[41]

Distance from port to the wind farm is especially important for bottom-fixed turbines, which are assembled on the site of the wind farm, requiring proximity for efficiency. For bottom-fixed turbines, ports mainly serve as logistics hubs, where components are transported by vessels to the site, for on-site assembly and installation.

There is more uncertainty whether proximity will be important when it comes to floating wind turbines. Some argue that proximity is crucial due to the costs associated with towing including potential damage to the turbines. Others argue that wind turbines can be towed over long distances, and that this is a more advantageous option because it avoids the need to develop specialised assembly ports all across Europe. Given that floating offshore wind still is in a development stage, it is challenging to draw definitive conclusions. There are, however, examples of successful long-distance towing, such as the Hywind Scotland wind farm, where wind turbines were towed from Peterhead, Scotland to Gulen, Norway for maintenance work.[42]

Floating offshore wind could therefore potentially be assembled in foreign ports and towed to Ireland. Similarly, it is conceivable for Irish ports to function as assembly ports for projects beyond Irish waters, thus expanding their market potential. Through interviews with the ports, it has become evident that the primary objective of the Southern Region is to supply the Irish offshore wind market. However, they are not necessarily limited to this region going forward, and their short-term ambitions are not limited to supplying just the areas in the Southern Region. Rosslare has plans to facilitate offshore wind development far up the Irish sea, and Shannon Foynes has plans along the entire west coast of Ireland.

In other words, there are several potential scenarios for the role of Southern Region ports as assembly and installation ports. In a pessimistic scenario, they may play a major role with regards to local development of bottom-fixed installations, but most floating wind projects could be assembled abroad and towed to Ireland, resulting in a more limited economic impact. On the other hand, an optimistic scenario would see Southern Region ports not only serve as key assembly and installation hubs for Ireland, but also capture a significant share of the European floating wind market. The actual outcome will depend on various factors, many of which are beyond the control of the Southern Region ports, such as technological advancements and decisions made by other ports in Ireland and abroad.

In the remainder of this chapter, when we analyse the potential economic impact of assembly and installation activities in Southern Region ports, we do this for an illustrative scenario where they take full market share in Ireland but deliver nothing to wind farms in other countries.

Irish capacity

To calculate the economic impact, we first estimate the capacity of offshore wind that will be needed to be built. We do this in a two-step analysis of the planned build-out capacity for offshore wind.

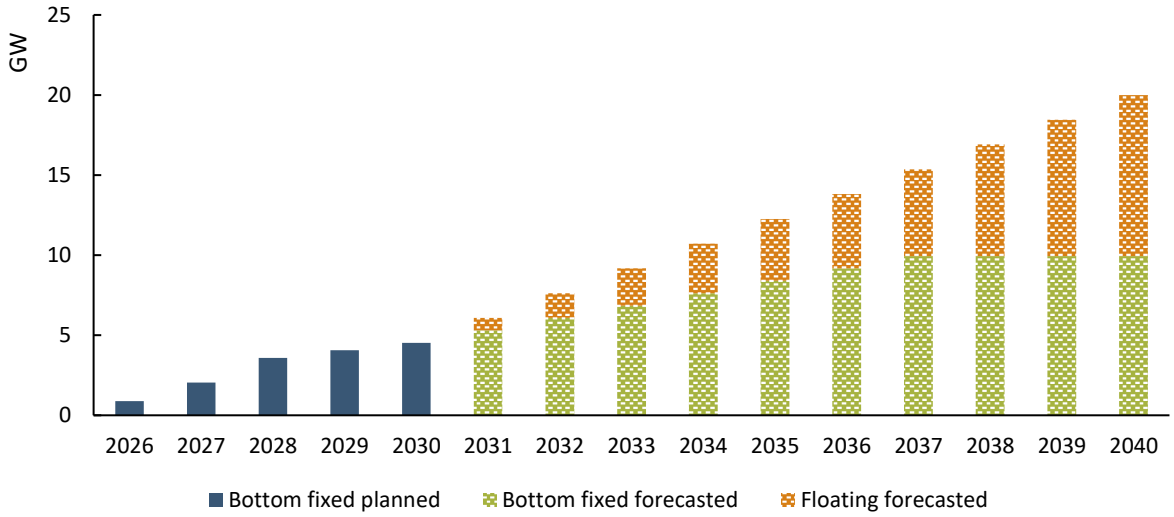
[41] ARUP (2020). Ports for offshore wind. https://www.crownestatescotland.com/sites/default/files/2023-07/ports-for-offshore-wind-report.pdf

[42] For more on the role of distance for offshore wind parks, see our study "Feasibility study of assembly and installation ports within the offshore wind market – a Norwegian perspective" for Norwegian Offshore Wind. Full version available here in Norwegian and English summary here

- For the period up to 2030, we use the pipeline of announced offshore wind projects in Ireland, using data from 4C Offshore.[43] According to their database, a total of 4.5 GW of bottom-fixed offshore wind is planned built in the country.
- For the period from 2030 to 2040, we use the Irish government's national target for offshore wind, which aims for a total capacity of 20 GW by 2040. In our scenario, 4.5 GW is built by 2030, leaving 15.5 GW additional capacity needed to meet the target in 2040.[44]

The projected timeline for these projects is depicted in the figure below.[45]

Figure 15: Timeline of the accumulated capacity needed to meet the target of 20 GW offshore wind by 2040. Source: Menon Economics, based on 4C Offshore



If the planned and estimated capacity expansion of offshore wind in Ireland is realised, it will generate substantial economic effects, particularly in the ports during the assembly phase. The large role in the assembly phase is because the cost of building offshore wind is front loaded by nature, i.e., the wind turbines require a large initial investment. It is important to note that the analysis based on this data is meant to be illustrative, it is not a prognosis for how we expect the offshore wind to develop in Ireland.

To illustrate the potential size of this investment, we have estimated the total cost to build 20 GW of offshore wind capacity using the Levelized Cost of Energy (LCOE) for both bottom-fixed and floating offshore wind solutions in 2023.[46] We have distributed the different cost-categories for the LCOE based on existing data and literature. The distribution of these costs is detailed in the figure below.'[47]

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[43] Offshore Market Intelligence & Marine Cable Consulting | 4C Offshore

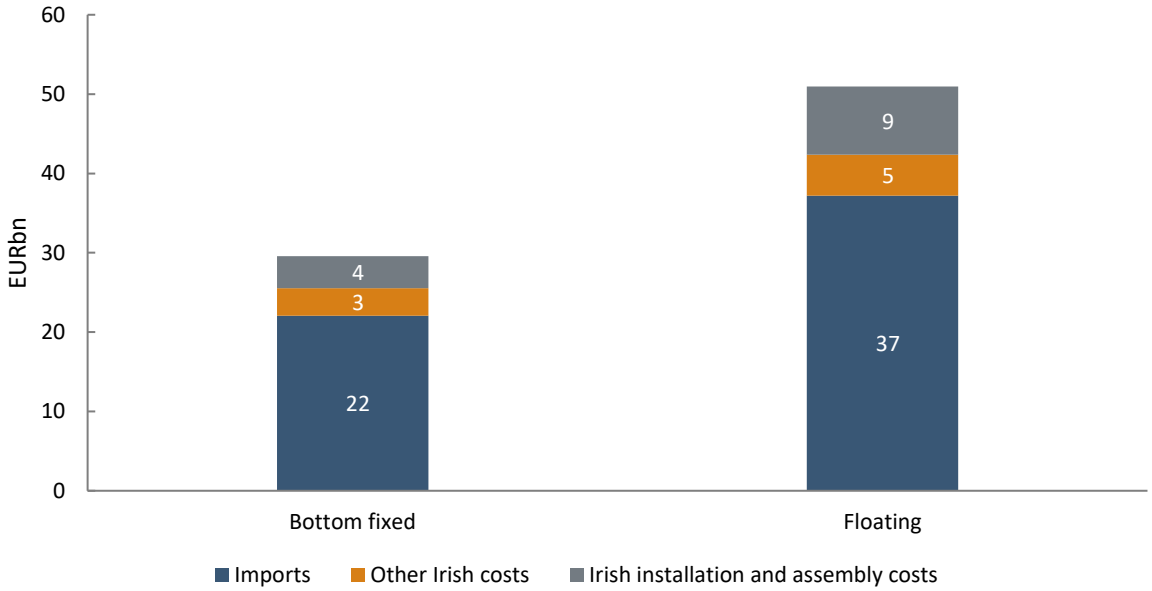
[44] *Based on workstreams from BVG Associates related to the assessment of renewable energy export potential in Ireland, we assume that bottom-fixed technology will account for a total of 10 GW of the total offshore wind capacity towards 2050 (BVG Associates/2024). Since bottom-fixed technology is more mature, we assume that the 10 GW will be developed before 2040. Consequently, floating offshore wind constitutes an increasing share of the total capacity towards 2040.*

[45] *For simplification, we assume that the capacity will be built out with the same amount annually.*

[46] *The LCOE is estimated based on a combination of data from 4COffshore and Norwegian Water Resources and Energy Directorate. (NVE).*

[47] *It is important to note that the costs of floating offshore wind today are too high to be able to compete on free market terms. This necessitates relatively high subsidies to make the technology competitive at today's prices. It is expected that prices will decline substantially as the technology matures, but the speed and scale of the decline is highly uncertain and will be determinative for the economic impact.*

Figure 16: Cost of installing 20 GW offshore wind capacity by 2040. Cost measured in 2023-euros. Source: 4COffshore, NVE and Menon Economics



The construction of 10 GW bottom-fixed and 10 GW floating offshore wind facilities is estimated to cost around EURbn 29 and 51, respectively. For the bottom-fixed segment, about EURbn 7 of the construction cost will involve purchases from Irish companies. Of these EURbn 7, around EURbn 4 are related to installation and assembly activities directly, while the rest are purchased from Irish companies outside the port sector. The corresponding figure for the floating segment, if EURbn 14 in total Irish costs, and EURbn 9 in Irish installation and assembly. In total, the installation and assembly costs are thus EURbn 13 for the 20 GW of offshore wind capacity.

Building floating offshore wind is more expensive per GW than bottom-fixed installations. There are two main reasons for this difference: Firstly, the technology for floating wind is less developed than that for bottom-fixed wind. Secondly, the construction of floating facilities is both more challenging and requires higher volumes of inputs such as steel and cement.

The Irish share of the deliveries above is based on the current industry in Ireland. Many of the products are not produced in Ireland, and will need to be imported – for instance, turbines will probably be purchased from Danish or German companies. In the short run, this is a safe assumption. In the longer run, however, specialised offshore wind supply industry could be developed if offshore wind becomes a success in Ireland. However, for simplicity the, we have not included the emergence of a specialised supply industry outside of the port sector.

The numbers presented in Figure 16 are based on the LCOE for 2023. As offshore wind matures as an industry, costs are expected to fall, although there is uncertainty with regards to how much. Past analyses by Menon Economics for Offshore Norway have found that the floating segment of offshore wind could see cost reductions of approximately 60 percent by 2040, while the bottom-fixed segment might achieve reductions of around 40 percent for the total costs presented in Figure 16.[48] How large the cost reduction will be for the assembly installation activities is uncertain, however. There are likely not as large savings in this phase compared to for

[48] *The report is available here: https://www.offshorenorge.no/contentassets/20ff8014df8840b990e8d42d921fa0d0/havvind---kostnader-og-utviklingstrekk_final-1.pdf (in Norwegian only)*

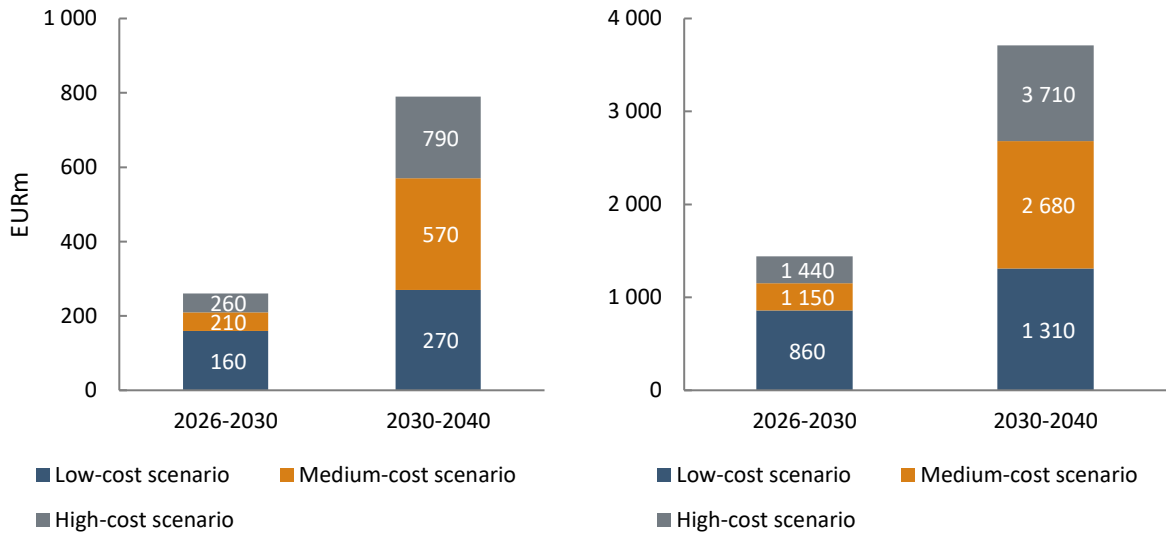
instance from standardised manufacturing. Due to this uncertainty, we make three scenarios for the potential cost reduction:

- Low-cost scenario: The cost savings are as large for installation and assembly as forecast for the full technology. The LCOE for bottom-fixed is reduced by 40 percent and 60 percent for floating technology.
- Medium-cost scenario: The cost savings are half as large for installation and assembly as forecast for the full technology. The LCOE for bottom-fixed is reduced by 20 percent and 30 percent for floating technology.
- High-cost scenario: There are no cost savings, and the LCOE for both bottom-fixed and floating wind are the same in 2040 as they are in 2023.

Economic impact analysis

To illustrate how the construction of the offshore wind can affect the Irish economy, we perform an analysis to determine the economic impact of the assembly and investment activities at the ports. This impulse in the economic impact analysis is the investments shown in Figure 16 that comes from Irish assembly and installation activities. The economic impulse will create both direct effects in the ports and for the port sector, and indirect effects in the wider Irish economy through purchases from other sectors to deliver goods and services at the port. To estimate this, we use a model we have previously built for offshore wind in Norway, and tailor it to Irish data.[49] The figure below illustrates the estimated yearly average GVA, and employment effects supported by the estimated construction.

Figure 17: Potential economic impact of the offshore wind assembly and installation activities. Left: GVA. Right: employment. Source: Menon



Between 2026-2030, the average annual GVA is estimated to be range from EURm 160 to 260, depending on the reduction in offshore wind costs. During this period the sector is estimated to employ between 860 and 1,440 people. As production scales up towards 2040, the annual GVA is estimated to rise substantially, ranging from EURm 270 and 790, with a medium scenario of EURm 570. Employment in assembly and installation activities is

[49] For more on the past studies using the model, see for instance https://www.menon.no/wp-content/uploads/2023-122-2-Executive-summary-Assembly-and-installation-ports-offshore-wind.pdf

expected to support between 1,300 and 3,700 employees with a base case of around 2,700 employees.[50] The considerable uncertainty for the 2030-2040 period is driven mostly by uncertainty with regards to how much more efficiently offshore floating wind can be assembled and installed in the future.

The difference between the scenarios highlights the uncertainty in forecasting the effects of offshore wind. If installation costs fall, that is beneficial for the build-out of offshore wind in Ireland, but it also reduces the economic impact of the installation and assembly phase.

The numbers shown in Figure 17 show the economic impact both directly of the assembly and installation activities, which are mostly done by port sector companies, and the indirect effects along the supply chain. These indirect effects include specialised and generic services primarily from engineering and construction. Some of these indirect effects will be dispersed throughout Ireland, but a large share of the effects will stem from specialised suppliers which locate themselves near the port.

It is important to state that the estimates for the economic impact are illustrative and come with significant uncertainties. The future size of the offshore wind industry by 2040 and the market share of Irish ports carry substantial uncertainties. Should the built-out wind capacity be less than anticipated or if Southern Region ports capture a smaller market share as assembly points, the economic effects would be lower than currently estimated. Conversely, if the Irish supply industry expands and attracts more specialised suppliers to establish operations in Ireland, the economic impact could exceed the current projections.

Potential barriers to success

As we have shown in the previous subchapters, ports play an important role in the successful delivery of offshore wind projects. We mentioned some uncertainties in the previous chapter, but in addition to these, there are several barriers that must be overcome in the ports. The arguably largest of these barriers are related to preparing the ports in the Southern Region for the assembly and installation phase.

There are large investments needed to be made in the ports for securing the sufficient space and infrastructure. Ports must have the capacity to receive, store, and assemble offshore wind installations, requiring ample land and quays that can support significant weight. Additionally, they need deep waterways to accommodate ships. Floating wind turbines requires access to deep-water quays and extensive storage areas due to their need for significant water depths. For a commercial-scale floating wind farm, this translates into extra stringent requirements for space, quays, and potential sea-based storage facilities. Some of the Southern Region ports lack this space and will need to reclaim land to facilitate offshore wind, which is costly.

The ports need to finance large infrastructure investments, but they do not have sufficient funds to do so themselves. This creates a key challenge centred around uncertainty and timing. Ports must make large investments in facilities and land expansion now to potentially facilitate large benefits from offshore wind in the future. But there is an inherent uncertainty in the demand. If the Irish government were to scale down its ambitions, or proximity were to become of little relevance for floating offshore wind, then the ports may make large investments now that generate little income in the future.

This uncertainty makes it hard for the ports to lend money to finance the investments. There is also a question of whether loan financing the investments would be sensible. Since the size of the investment is very high

[50] *Note that we have not included operation and maintenance (O&M) in our calculations. Potential jobs created in O&M during the lifetime of the offshore park, will come in addition to the results shown here.*

compared to the port's current income, a loan-financed bet on offshore wind that does not pay off could damage the port's economic stability. In sum, the ports need a certain income before making investments in expanded facilities, but since the majority of the planned capacity is still only planned, that is not feasible. If the ports do not make these investments, however, then reaching Ireland's offshore wind goals may become challenging.

Uncertainty in relation to the planning process is also an issue raised by stakeholders as one of their key concerns. The average time taken to determine a Strategic Infrastructure case has risen from 28 weeks in 2019 to 44 weeks in 2023.[51] The number of judicial reviews against planning decisions has also increased, in 2012 there were 17 judicial reviews against An Bord Pleanala decisions, while in 2023, there were 93.[52] The new Planning and Development Act signed into law on 17th October 2024 seeks to overcome these issues and streamline the planning system, and may alleviate this problem.[53]

From a social planning perspective, there are two ways to fail when making uncertain investments: either by investing in preparation for growth that never materialises, or by not investing at all, thereby ensuring that the potential for growth is never realised. Since the ports lack the sufficient funds to make these investments themselves, they require someone else, most likely the government, to provide the funding for the investments. If sufficient financing for investments in necessary port infrastructure is not made, Ireland will fall into the second category.

3.2. Alternative fuels and renewable energy hubs

Alternative fuels such as green hydrogen have a large potential to decarbonise many Irish industries which would otherwise be hard to decarbonise. While many industries can be decarbonised through direct electrification based on renewable energy, electrification is not a feasible solution for some industries which today have large emissions. These industries which cannot simply be electrified are typically known as hard-to-abate industries. In these industries, alternative energy carriers, such as green hydrogen, will likely need to be used.

The hard-to-abate industries include manufacturing of cement, steel and chemicals. These industries rely on processes that demand very high temperatures, which are difficult to achieve with electricity alone. Alternative energy carriers such as green hydrogen can be used instead to achieve these temperatures and make those production processes emission-free. Ireland's hydrogen strategy foresees a large potential hydrogen need from industry and processing, totalling up to 15 TWh, or around 10 percent of Ireland's current total energy consumption.

Another hard-to-abate industry is shipping. The shipping industry is today almost entirely reliant on fossil fuels and 98 percent of the world fleet uses conventional fuel.[54] In the future, battery electric solutions may suffice for smaller, shorter maritime needs, but larger vessels will likely rely on alternative fuels such as liquified hydrogen, ammonia, and methanol.[55] These alternative fuels are not cost-competitive with fossil fuels today, but EU regulations such as Fit for 55, Fuel EU and the inclusion of the maritime sector in the EU Emissions Trading System, are likely to drive the adoption of alternative fuels. Green hydrogen prices are also expected to fall from

[51] *https://www.pleanala.ie/getmedia/3354e565-9900-4f58-b589-0edca9ebcfd2/Appendices-to-Annual-Report-2023-Final-English.pdf?ext=.pdf*

[52] *https://www.pleanala.ie/getmedia/330bb0e4-4ab2-409a-b5ec-14f7a8b2c813/Annual-Report-2023-Final-following-Auditor-cert-30-07-2023-English.pdf?ext=.pdf*

[53] *https://www.oireachtas.ie/en/bills/bill/2023/81/*

[54] *As of June 2024, according to the DNV Maritime outlook*

[55] *Some ships and ferries already use battery electric solutions for line traffic. Of the ships currently on shipping companies order books, around a quarter use alternative fuels (although half of this is LNG) according to the DNV Maritime outlook*

current levels, and as the alternative energy carriers become more competitive in terms of price, an increasing share of ships will run on emissions-free propulsion. Southern Region ports will have to find ways to supply these ships with alternative fuels or electricity, otherwise they will be unable to service the ships.

Ports therefore play at least two important roles when it comes to the transition to alternative fuels:

- Firstly, ports are natural locations for **the production of hydrogen** from offshore wind energy. The ports are near the offshore wind resources, and the port infrastructure provides the means of transporting the produced energy relatively easily. They are also near industries that will likely demand hydrogen, such as export-oriented companies which are often located near ports.[56]
- Secondly, ports will need to function as **alternative fuel hubs** for the maritime industry to be able to decarbonise through alternative fuels. This requires building out the necessary infrastructure in ports to allow for efficient bunkering.

In other words, ports are expected to play both an important supply and demand role regarding hydrogen-based products. Production and demand do not necessarily need to be linked, however, and the ports used for bunkering do not necessarily need to produce hydrogen (and vice versa). Ammonia and methanol are globally traded commodities, which although somewhat costly, can be made available anywhere by ship transportation.

In the rest of this chapter, we first analyse the ports' role in hydrogen production, and then subsequently their role as alternative fuel hubs for the maritime industry.

Hydrogen production in Southern Region ports

As mentioned in the previous chapter, Ireland has large plans for offshore wind, with a goal of a production capacity of 37 GW by 2050. This equates a total power production of around 150 TWh produced per year.[57] This corresponds to an energy production roughly equal to Ireland's current energy demand.[58] If successful, this may change Ireland from being a net importer of energy – as it is today, importing almost 80 percent of its energy[59] – to both covering all of its own energy needs and having an energy surplus which it can either use for direct exports or use in new energy intensive industries. Green hydrogen may play an important role both in replacing fossil fuels in domestic use, and as an emerging export industry.

The National Hydrogen Strategy highlights that commercial ports are well positioned for being hydrogen production hubs. They are near the offshore wind resources, and the port infrastructure provides the means of transporting the produced hydrogen/ammonia relatively easily. Additionally, many of the hard-to-abate industries tend to be placed near ports since they already export their goods using the ports. The ports are therefore near the demand for green hydrogen, and placing the green hydrogen production in ports can reduce the transportation costs from production to use. The strategy highlights that further work is needed to determine what the ideal locations for this hydrogen production are, but highlights Cork, Dublin and Foynes as promising candidates.

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[56] Many of the port attracted companies as mentioned in chapter 2 are in hard-to-abate industries, and there are therefore many potential hydrogen sinks near the ports.
[57] According to the National Hydrogen Strategy, available at https://www.gov.ie/pdf/?file=https://assets.gov.ie/263248/f982c10f-eca6-4092-a305-90000e5213ed.pdf#page=null
[58] https://www.seai.ie/data-and-insights/seai-statistics/annual-energy-data/energy-demand/final-energy-demand/
[59] https://www.seai.ie/publications/Energy-in-Ireland-2023.pdf

Potential economic benefit of hydrogen production

The production of green hydrogen is in simple terms converting electricity into an energy carrier which can be used at a later point in time. Hydrogen production is therefore highly energy-intensive, requiring significant amounts of electricity. Hydrogen production facilities typically do not create many jobs. The processes involved are often automated and require a relatively small workforce to manage operations, resulting in low employment compared to the scale of energy consumed.

Hydrogen projects in other countries have been estimated to require one employee per every 25 to 100 GWh of power input.[60] Larger plants are typically less labour intensive, and future plants are therefore likely to be less employment intensive rather than more. The employment effects from hydrogen production are in other words likely to be relatively limited. A hydrogen production plant with a capacity of 1 GW using power from offshore wind will likely only employ in the region of 80 people.[61] The benefits of hydrogen production are therefore not related to direct employment in the hydrogen plants, but stem from utilising the surplus electricity from planned offshore wind expansion and high export values. Furthermore, local production of green hydrogen production eliminates transport costs for local hydrogen use thus facilitating decarbonisation of hard-to-abate Irish industries.

Facilitating the decarbonisation of Irish industries may also cause economic benefits for those companies. As carbon prices will increase going forward, access to green hydrogen may be a competitive advantage for Irish producers in hard-to-abate industries. In the longer run, there is little alternative to decarbonising for these industries to continue to exist, and green hydrogen may be necessary for the hard-to-abate industries to continue their operations. Without domestic production of green hydrogen, Ireland would in this case need to import it to sustain these businesses.

Green hydrogen has a substantial potential export value. As mentioned above, a hydrogen plant producing with power input from 1 GW of offshore wind would sustain in the region of 80 employees. The export value of the green hydrogen would likely be in the region of EURm 120 to EURm 400 per year depending on the price of electricity.[62]

Bunkering with alternative fuels in Southern Region ports

European and Irish ambitions indicate that all ships will have to transition from fossil fuels to emission free propulsion systems. The process has already started, and the maritime sector is being included in the Emissions Trading System (EU ETS) gradually from 2024 and will be fully phased in by 2026. The system covers all of the vessels' emissions when sailing within the EU. For vessels where the voyages start or ends outside the EU, the shipping companies must purchase emission allowances for 50 percent of the emission caused by the voyage. To

[60] *See for instance the University of Groningen's "The employment impact of the NorthH2 Project" available at https://pure.rug.nl/ws/portalfiles/portal/149300240/NorthH2_Report_Final.pdf ,*

[61] *Offshore wind with a capacity of 1 GW will produce in the region of 4 000 GWh per year. With one employee per 50 GWh, that would be 80 employees at the hydrogen plant using 4 000 GWh.*

[62] *Offshore wind capacity of 1 GW can produce around 4 000 GWh, which can be used to produce around 80 000 tons of green hydrogen (Assuming around 50 kWh of energy need per kg of hydrogen, or an efficiency of around 67 percent. See for instance https://www.carboncommentary.com/blog/2021/6/11/some-rules-of-thumb-of-the-hydrogen-economy for more). The future price of green hydrogen is uncertain, with many estimates in the region of EUR 1.5-5 pr kg (see for instance https://sustainability.crugroup.com/article/energy-from-green-hydrogen-will-be-expensive-even-in-2050 for more) . For 80 000 tons of green hydrogen, this equals EURm 120 to 240.*

begin with, only larger ships (over 5 000 gross tonnage) will be covered, but smaller ships are planned to be included going forward.[63]

In other words, the shipping companies are going to pay for their emissions. As carbon prices increase going forward, alternatives to fossil fuels will become more and more competitive. Southern Region ports will have to supply these ships, or risk losing their business.

There are generally two main alternatives to fossil fuels in shipping: either alternative fuels, such as methanol and ammonia, or using electrical power and batteries. At present, it looks like battery electric solutions will suffice for smaller, short-distance vessels, while larger vessels will likely have to rely on alternative fuels. Ports will therefore have to decide whether they will supply one or both of these.

The Irish Marine Development Office has found that little action has been taken to provide sufficient alternative fuels infrastructure in Ireland.[64] Going forward, that cannot remain the case, and Irish ports will need to provide such infrastructure.

Which ports will supply the infrastructure and where ships will bunker is uncertain. Broadly speaking, there are two main factors affecting where alternative fuelling infrastructure capabilities should be developed. The first is where ship demand for refuelling will be, and the second is how large the individual port-specific barriers to bunkering are. In the rest of this chapter, we go through these two points.

Ship demand for bunkering and changing sailing routes

It appears likely that ships using alternative fuels will have a shorter range and will have to bunker more often. Where ships today may bunker only in one port along a route, those using alternative fuels may require bunkering in multiple ports along the way.[65] If there is no sufficient alternative fuelling infrastructure along the existing route, ships may have to change their routes. The potential change in sailing routes and higher frequency of bunkering may lead to a different bunkering structure than what exists today. This also includes establishment of green shipping corridors and energy hubs in different ports.[66] Ports that fail to take part in the transition may find that ships will no longer visit them due to refuelling challenges.

Ireland's location poses some potential additional challenges for bunkering with alternative fuels. Compared with other European nations, Ireland has a relatively long distance to ports in other countries due to being an island. While ports in Europe that do not provide relevant alternative fuels for a ship may still be able accommodate those ships as they can bunker in a nearby European country, this will not be the case in Ireland if Irish ports do not successfully deliver alternative fuelling infrastructure. The UK being outside of the EU may contribute to strengthening this issue.

Ireland's location in the west of Europe may also give rise to increased bunkering demand related to transatlantic traffic. The shorter range of alternative fuels could cause increased demand for decarbonised transatlantic ships to bunker in Ireland. In addition, transatlantic ships travelling on fossil fuels may be incentivised to offload their

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[63] https://climate.ec.europa.eu/eu-action/transport/reducing-emissions-shipping-sector_en

[64] "A feasibility study on The Development of Alternative Fuel Infrastructure in Irish Ports" available at https://www.imdo.ie/Home/sites/default/files/IMDOFiles/13774%20IMDO%20Development%20of%20Alternative%20Fuel%20V6%20HR.PDF

[65] For more, see "The Nordic Roadmap for the introduction of sustainable zero-carbon fuels in shipping. Infrastructure and bunkering challenges for zero-carbon fuels". Available at: https://www.menon.no/wp-content/uploads/2022-2B-Future-Fuels-for-Shipping.pdf

[66] The IMDO is for instance working on feasibility studies for green shipping corridors between Ireland and the UK https://www.marine.ie/site-area/research-funding/research-funding/feasibility-studies-green-shipping-corridors

cargo at the first possible point in Europe – in other words in Ireland – for the goods to be reloaded onto smaller, decarbonised ships.

Whether these changes to ship sailing patterns will come to pass is difficult to say, as this depends both on which new technologies succeed, how potent they become, and the actions of both regulators and the maritime industry. They are important to keep track of, however, both to reap potential benefits and to reduce the risk of becoming less relevant.

Barriers for individual ports with regards to bunkering with alternative fuels

Not all ports are equally well suited for bunkering with alternative fuels, and this also affects where alternative fuelling infrastructure should be built. Based on past studies, some core barriers for individual ports include:[67]

1. **Safety issues in population centres:** Most potential zero-carbon fuels have properties that pose different safety and regulations challenges from those of conventional fuel. This includes risks such as toxicity of ammonia and high flammability of hydrogen. The danger of these is especially large in ports near population centres, where more people may be affected by problems.
2. **High costs of infrastructure investments**: The need for substantial investments in new infrastructure, particularly for hydrogen and ammonia, poses a significant barrier. These costs are influenced by factors like the distance from the production site and the availability of existing infrastructure. Ports may need to build new storage and bunkering facilities from scratch, which is a major financial challenge.
3. **Uncertainty about future demand** for alternative fuels creates a significant barrier to investing in bunkering infrastructure, as ports risk economic losses from over-investment or investing in the wrong fuel, while the need for minimum efficient scale and the indivisibility of infrastructure further complicate decision-making. This uncertainty is further enhanced by the fact that different alternative fuels with different bunkering requirements are being considered for use in the maritime transport.
4. **Space constraints**: The need for extra storage space for fuels such as hydrogen, ammonia, and methanol pose a significant challenge for ports. Bunkering with hydrogen-based fuels further complicates matters, as it requires a large safety zone. This is especially challenging for ports with limited available land, as expanding storage capacity and safety zones necessitates more space, which some ports in the Southern Region lack.

3.3. Marine tourism

This chapter first examines the role ports in the Southern Region have for tourism, followed by an analysis of the potential for growth in the industry and then a discussion of the potential barriers to growth.

The role of ports in Southern Region tourism

Port infrastructure is important to facilitate growth in certain sub-sectors of the tourism industry. In 2023 there were close to a million passengers in Southern Region ports, with either ferry or cruise, as shown in Table 1.

Their importance has also grown in recent years, especially with regards to the cruise industry. The development in cruise passengers and passenger cars on ferries is shown in the figure below.

[67] *We especially draw on our work in "The Nordic Roadmap for the introduction of sustainable zero-carbon fuels in shipping. Infrastructure and bunkering challenges for zero-carbon fuels" here.*

Figure 18: Left: Number of cruise passengers to ports in the Southern Region. Right: Number of passenger cars to ports in the Southern Region. Source: CSO

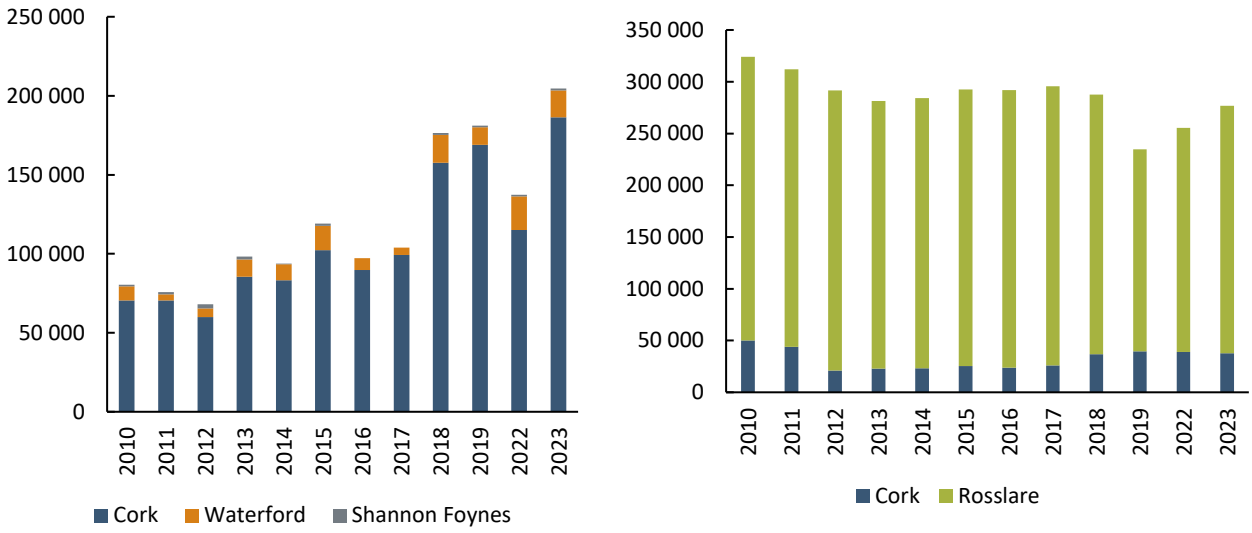


Figure 18 illustrates a significant increase in cruise passengers at Southern Region ports, which more than doubled between 2013 and 2023, while the number of passenger cars has remained relatively stable

Despite the growth in passengers, the Southern Region ports handle a relatively limited number of passengers. The figure below compares the Southern Region to other NUTS2[68] regions in Europe.

[68] *NUTS2 regions are statistical territorial units within the European Union used for regional analysis and policy, typically representing medium-sized areas with populations ranging between 800,000 and 3 million.*

Figure 19: Number of passengers embarking or disembarking in ports by NUTS2-regions in 2019. Each bar is a separate region in the EU, with the Southern Region highlighted in red. Source: Eurostat

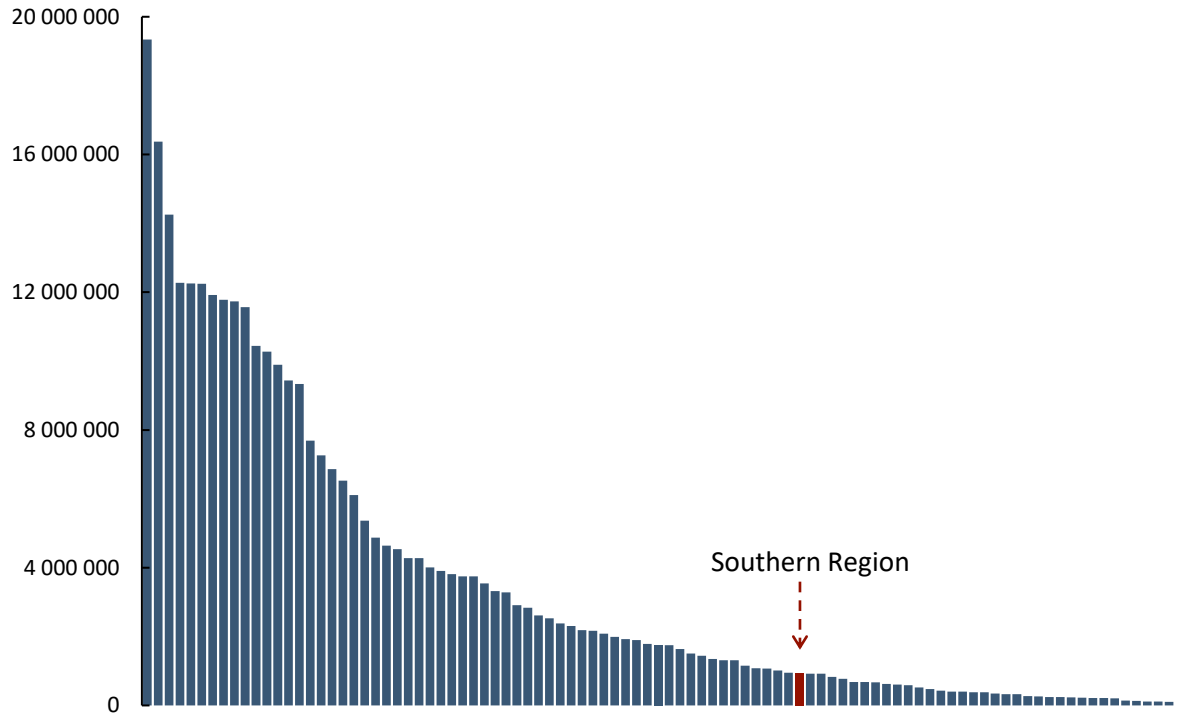


Figure 19 shows that the Southern Region ports handle far fewer passengers compared to other NUTS2 regions. Another way of illustrating the size of the Southern Region ports' passenger volume is in comparison to the more than 30 million passengers at Dublin airport, which facilitates the travel of the vast majority of tourists to Ireland.

The key takeaway from the above is that in passenger volume, the Southern Region ports are relatively limited in size, but that the volumes – especially for cruise – are growing.

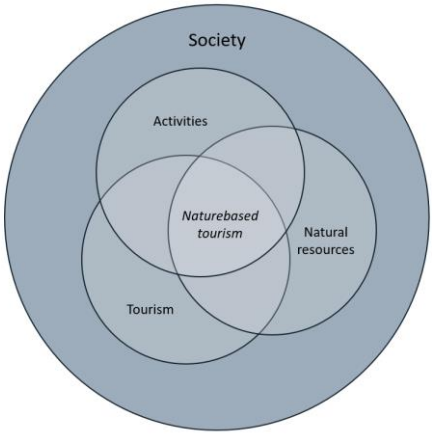
Potential for growth in marine tourism

The demand for the cruise industry is also likely to keep growing. As incomes rise across the world, people spend an increasing amount on tourism. A meta study of hundreds of scientific papers has estimated that for every 1 percent increase in income, people increase their spending on tourism by over 2 percent.[69] This drives growth in the cruise industry. This growth results both in more passengers, and more spending per passenger.

[69] *Peng, Grace & Song, Haiyan & Crouch, Geoffrey & Witt, Stephen. (2014). A Meta-Analysis of International Tourism Demand Elasticities. Journal of Travel Research. 54. 10.1177/0047287514528283.*

An additional driver of growth for the Southern Region is the increased interest in nature-based tourism. Studies have found that nature-based tourism is one of the fastest-growing segments in the tourism industry. It centres around travel aimed at experiencing natural landscapes and biodiversity. This type of tourism can take many forms, such as wildlife and birdwatching, ecotourism, hiking, cycling, fishing, boating, adventure trips, and so on.[70]

Figure 20: Illustration of nature-based tourism. Source: Fossgard and Fredman



Nature based tourism is already a key reason for visiting Ireland. In Fáilte Ireland's Tourism Experience Port Survey 2019, the top reasons for visiting Ireland were the beautiful scenery, interesting history and culture, and the good range of natural attractions, and the natural, unspoilt environment.

The focus on nature-based tourism in the Southern Region is also reflected in Ireland's regional tourism strategies. Two of Ireland's regional tourism plans overlap with the ports in the Southern Region:[71]

- **The Wild Atlantic Way** in the west, overlapping with the ports in the Mid-West and most of the South-West (apart from Cork)
- **Ireland's Ancient East** overlapping with Cork and the ports in the South-East.

These strategies are both focused on creating a brand for nature-based tourism and creating more valuable tourism experiences in Ireland's nature. Ports play a role in this endeavour beyond just bringing tourists to the Southern Region. They can also function as hubs for experiences on the sea and nearby activities. Marine tourism, defined as activities such as swimming, surfing, boating, yachting, cruising, sea kayaking, beaching and diving is already responsible for around 12 percent of overseas spending in Ireland according to a study by the University of Galway.[72] Both ports in large cities and small villages can facilitate tourism and leisure experiences in and around the sea.

One example of this is coastal cruises. As the cruise market is growing, it is in a sense splitting in two. Globally, the largest cruise ships are becoming larger, with an increasing passenger capacity, but there is also substantial growth among the smallest cruises which can deliver more tailored experiences and visit smaller destinations.

In total, nature-based tourism is posed for high growth, and it is both one of the Southern Region's specialties and focus areas of current plans. The potential for high growth in Ireland is also echoed by both industry and the government. The Irish Tourism Industry Confederation has ambitions for a growth of 50 percent in value added by 2030,[73] while the tourism minister has goals of a similar growth of 5.6 percent per year up to 2030.[74]

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[70] For more on nature based tourism, see Knut Fossgard, Peter Fredman (2019). Dimensions in the nature-based tourism experiencescape: An explorative analysis, Journal of Outdoor Recreation and Tourism. Available at https://www.sciencedirect.com/science/article/pii/S2213078019300234, as well as https://www.umb.no/statisk/ina/publikasjoner/fagrapport/if42.pdf

[71] A third plan, Ireland's Hidden Heartlands, also overlaps with the Southern Region, but not with its ports.

[72] https://www.universityofgalway.ie/media/researchsites/semru/files/SEMRU-Overseas-Marine-Tourism-Report-Final1.pdf

[73] https://www.itic.ie/vision-2030/

[74] https://www.tourismireland.com/news-and-press-releases/press-releases/article/tourism-ireland-launches-2024-marketing-plan

Potential barriers to success

The evolving landscape of tourism is increasingly being defined by sustainability. The growing demand for sustainable practices spans various aspects, from environmental protection to reducing the carbon emissions of transport. This presents specific challenges for Ireland, given its reliance on sea and air transport for tourism. As carbon prices rise, visiting Ireland may become increasingly expensive unless Ireland succeeds with the transition to decarbonised transportation for both planes and ships.

Southern Region ports can help address this challenge by providing the necessary infrastructure for alternative fuels, which are critical for a green maritime transition (as discussed in Chapter 4.2). If alternative fuels are provided effectively, this can contribute to Ireland's tourism brand and spur tourism growth in the region. Conversely, if ways to decarbonise shipping are not provided, it could discourage visitors from coming and hinder Ireland's potential to attract sustainable tourism in the future.

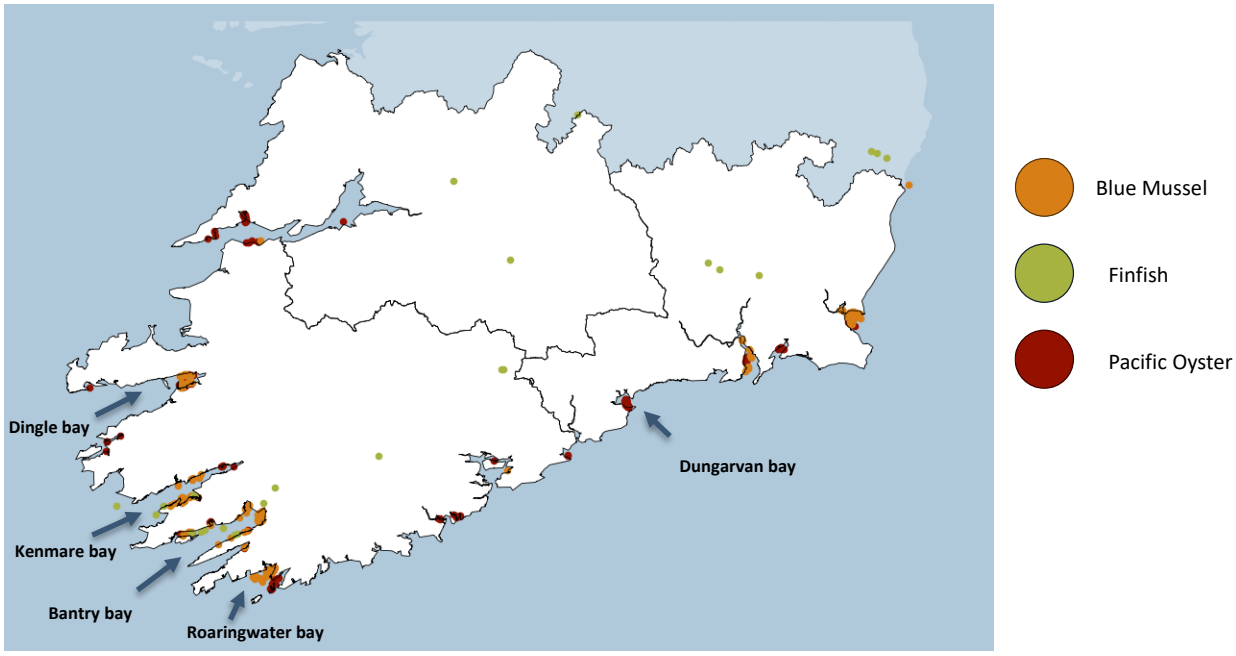
3.4. Aquaculture and fisheries

This chapter first examines the role of aquaculture and fisheries in the Southern Region, followed by a review of their past growth and future outlook in Ireland.

Aquaculture and fisheries in the Southern Region

The map below shows the location of aquaculture licenses in the Southern Region.

Figure 21: Map of the aquaculture license sites in the Southern Region of Ireland, as well as the five major bays in the Southern Region as defined by BIM. Source: The Department of Agriculture, Food and the Marine[75] and BIM[76]



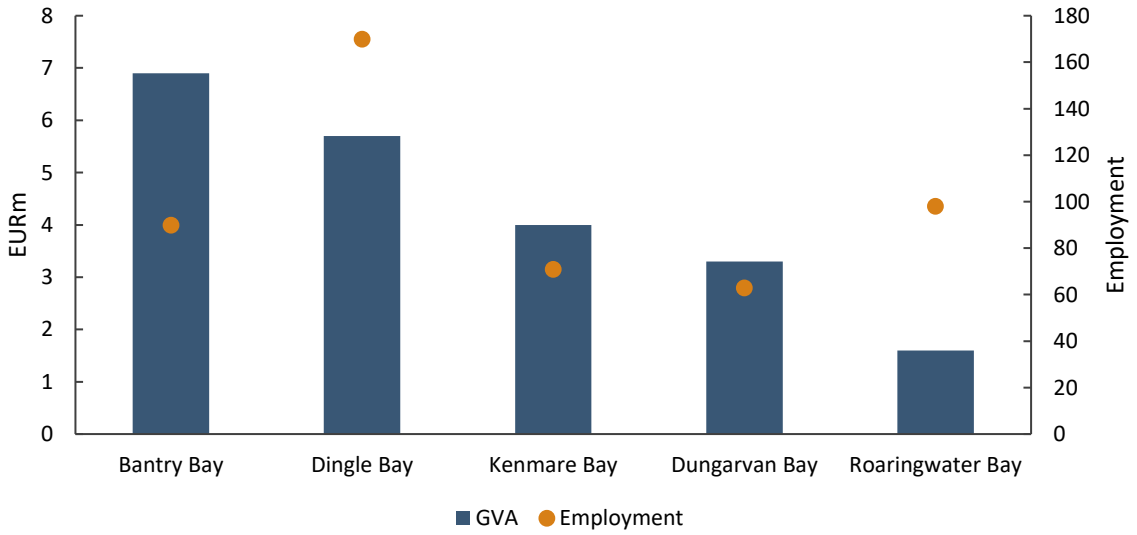
[75] *https://opendata.agriculture.gov.ie/dataset/https-dafm-maps-marine-ie-aquaculture-viewer*
[76] *https://bim.ie/wp-content/uploads/2022/05/BIM-Collective-Bay-Areas-Report-SPREADS.pdf*

As the map shows, most of the aquaculture in the Southern Region is centred around three forms of aquaculture: Mussels, finfish (primarily salmon) and pacific oyster. Most of the production is in the South-West, with four major bays of production.

Aquaculture activities vary across the five major bays in the Southern Region. In Bantry Bay, there is primarily mussel and other shellfish farming, although finfish farming stands for the largest share of turnover in the bay. Dingle Bay is predominantly engaged in oyster farming, with some activity in mussel and other shellfish farming. The activity in Dungarvan Bay is oyster farming only. Kenmare Bay is mainly involved in mussel farming, but production of oysters and finfish farming are also present locally. Similarly, the activity in Roaringwater Bay involves mussel and other shellfish farming, with some local oyster farming as well.[77]

Of the five bays, aquaculture in Bantry Bay has the largest value-added contribution to the Southern Region, while Dingle Bay has the largest contribution to employment, as shown in the figure below. These two bays also make the most significant economic contributions among Ireland's bay areas.[78] Altogether, the bays' aquaculture activity contributes several million euro in value-added and employment, highlighting their significant economic footprint along the Southern Region coastline.

Figure 22: Direct gross value added (GVA) and employment in the five major aquaculture bays in the Southern Region in 2020. Source: BIM/2022



Altogether, the Southern Region contributes 35 percent of the national sales value of aquaculture in Ireland, amounting to EURm 65.[79] As previously mentioned, the bays of the Southern Region are the primary location for mussel production, but various aquaculture activities, including pen and hatchery salmon, farmed oysters, trout, and seaweed units are also present in the region. In the South-West, the focus is on pen salmon, mussels, and oysters. Meanwhile, the Southeast specialises in oyster and mussel production.

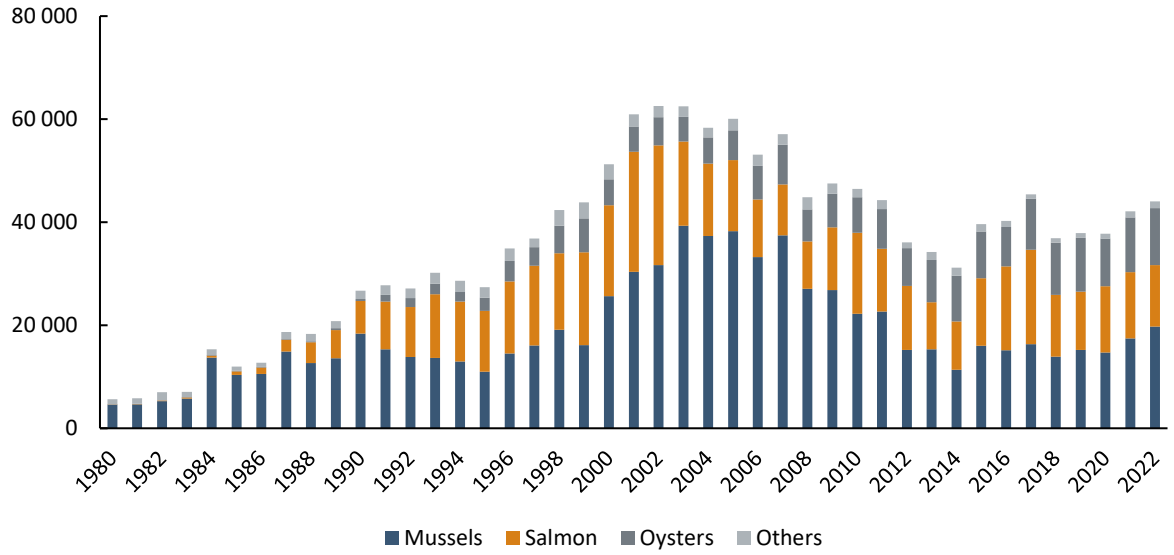
[77] *The Economic Contribution of the Aquaculture sector across Ireland's Bay Areas (2022). https://bim.ie/publications/aquaculture/*
[78] *Across Ireland's 11 most representative bay areas, as identified by BIM: https://bim.ie/wp-content/uploads/2022/05/BIM-Collective-Bay-Areas-Report-SPREADS.pdf*
[79] *https://bim.ie/wp-content/uploads/2023/10/BIM_Annual-Aquaculture-Report-2023.pdf*

We showed the fishing ports and their sizes in chapter 1. As shown in the economic impact analysis in chapter 2, fisheries in the Southern Region account for over 1 200 employees and value added of EURm 80, across the Southern Region.

Past growth in Ireland

From the 1980s until the start of the current millennium, the aquaculture industry in Ireland had a high growth rate, until it stagnated in the early 2000s.

Figure 23: Aquaculture production in Ireland, measured in tons. Source: FAO's fisheries and aquaculture database[80]



From a production of a little over 5 000 tonnes in 1980, the industry grew more than tenfold to over 60 000 tonnes in 2002. Since the peak in 2002, aquaculture production has fallen substantially, however. Salmon production approximately halved from 2002 to 2022, while mussels have fallen by a third. Oysters has bucked the trend and doubled.

Researchers have highlighted licensing and regulatory challenges as one important cause for the stagnation and fall in the industry. A paper from 2018 found that "in particular dysfunctional licensing arrangements are a major constraint on the development of the sector".[81] In interviews with stakeholders, we have received input that a core reason for the licensing challenges is that Ireland places higher emphasis on sustainability and avoiding negative impacts and less on industrial development, than other countries with a higher aquaculture production such as Norway.[82]

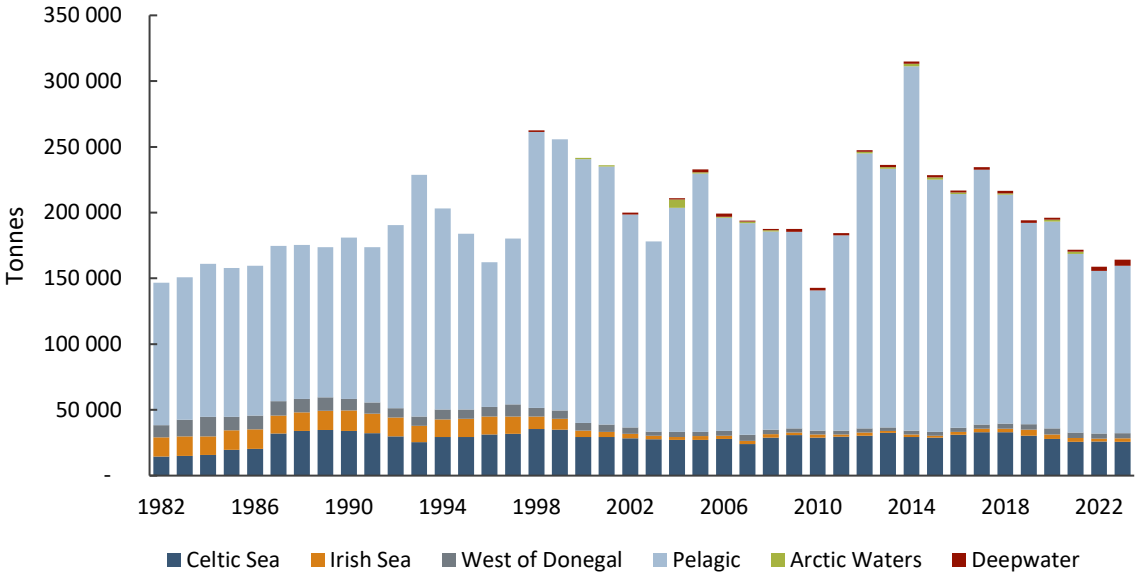
This corresponds well with challenges identified by Bord Iascaigh Mhara (Ireland's Seafood Development Agency) in their surveys of aquaculture producers with regards to barriers to growth and business information. In a 2022 study, they found that a significant majority (almost 9 out of 10) of aquaculture producers in the bay area had operated locally in the sector for more than 10 years.[83] Furthermore, the main challenge to growth was

[80] *https://www.fao.org/fishery/en/knowledgebase/107*
[81] *https://www.sciencedirect.com/science/article/abs/pii/S0308597X1730310X*
[82] *This strong focus on stakeholders and sustainability ahead of industrial growth is also reflected in the focus of the National Strategic Plan for Sustainable Aquaculture*
[83] *https://bim.ie/wp-content/uploads/2022/05/BIM-Collective-Bay-Areas-Report-SPREADS.pdf*

considered to be regulations and licensing, which 7 out of 10 respondents considered a main constraint on growth.

Activity in traditional fisheries has been relatively flat over the past 40 years, with no long-running trend. Fisheries are a conditional renewable resource, where production is determined by quotas. The below figure shows the development of the fishing quota in Ireland.

Figure 24: Evolution of the Irish fishing quota. Source: BIM[84]



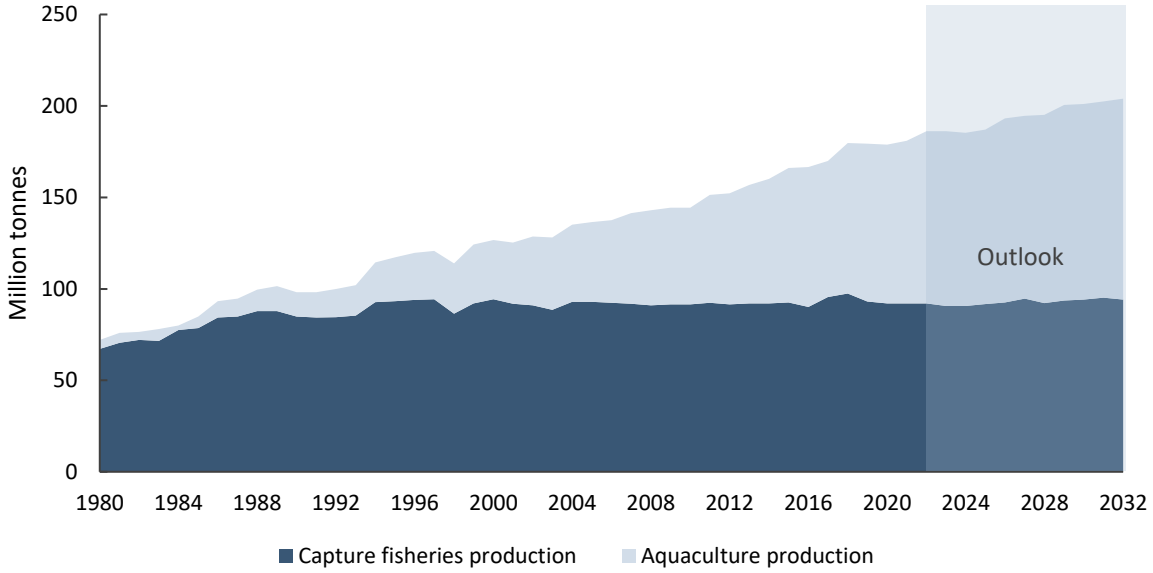
As can be seen from the figure, there has not been a long-running trend in the size of Irish fishing quotas.

Outlook for aquaculture and fisheries

Globally, aquaculture has been a growing industry over the past five decades. From a low starting point, there is now more aquaculture production than catch fisheries.

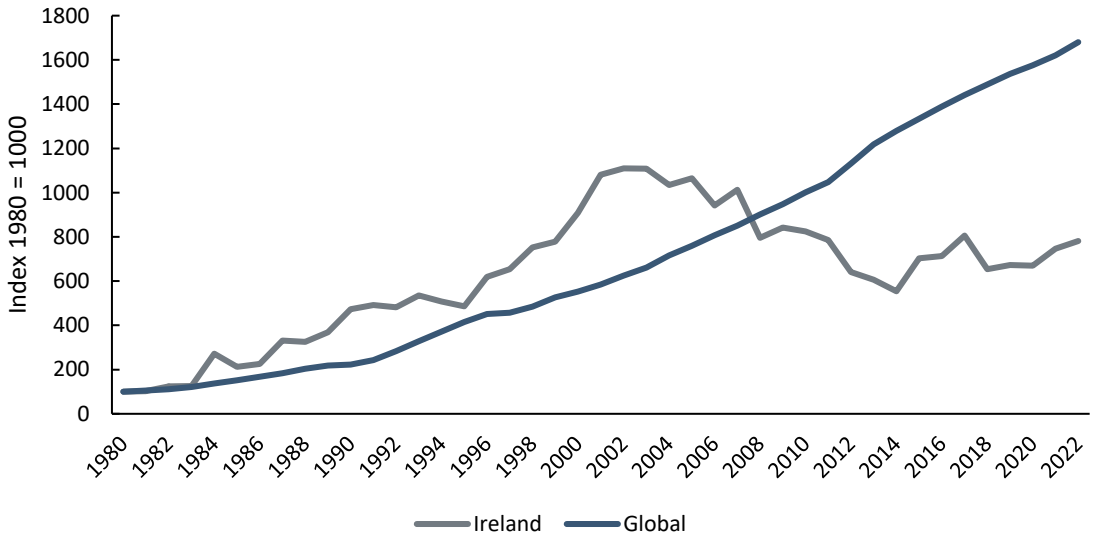
[84] *https://bim.ie/wp-content/uploads/2023/04/BIM-The-Business-of-Seafood-2022.pdf*

Figure 25: Capture fisheries and aquaculture production globally. Source: FAO[85]



The outlook to 2032 entail a continued growth for the aquaculture industry, but at a lower growth rate than has been seen historically. It is worth noting that for much of its history, the Irish aquaculture industry grew as swiftly as it did globally. This is shown in the figure below.

Figure 26: Historic growth in aquaculture in Ireland and globally. Source: FAO



As can be seen from the figure, Irish aquaculture grew even more swiftly than global aquaculture did from the 1980s to the early 2000s. As mentioned, a key factor for the limited growth after that period is reported to be licensing-related challenges due to sustainability and stakeholder concerns. As long as this remains the case, growth in Ireland is likely to be lower than in countries with a higher emphasis on production growth.

[85] *https://openknowledge.fao.org/server/api/core/bitstreams/5f787603-40c8-447d-9a78-7bbee1ad73f7/content*

High prices for salmon along with limited opportunities in areas were salmon is traditionally farmed has spurred development in closed offshore aquaculture may in the longer run cause growth in Ireland. The closed offshore aquaculture can reduce the industry's environmental footprint and make production in Ireland more relevant. This technology is currently being developed and tested in countries with a more prominent position in aquaculture, but if successful there, there could be potential in Ireland as well.[86]

The combined size of the fishing and aquaculture sector is therefore not likely to grow at a high rate going forward. The majority of the current activity is related to fisheries, which will likely have a minimal change in volumes, and the growth in aquaculture is likely to be limited, unless the emphasis on sustainability over industrial development shifts, or new technologies spur increased growth.

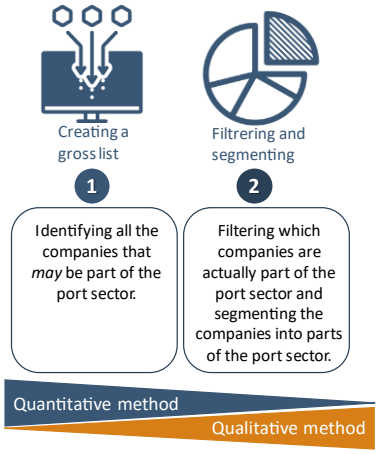
[86] *We have analysed these issues extensively in Norway, see for instance https://www.menon.no/wp-content/uploads/2024-116-Akvakulturnaeringen-og-leverandorene-potensial-mot-2035.pdf (in Norwegian)*

Appendix A: Methodology for estimating the size of the port sector

Together with the Southern Regional Assembly, we agreed upon a definition of the port sector, as explained in chapter 2. To estimate the size of these companies, we have performed a process in three steps.

The first step entails identifying the companies that are part of the port sector in the Southern Region. The companies in the port sector operate in varying industries, and there does not exist a universal mapping of which companies belong in it. We have therefore used a process with two sub-steps, as illustrated in Figure 27.

Figure 27: Methodology for step 1: identifying the companies in the Southern Region



Sub-step 1: Creating a gross list of companies which may be part of the port sector.

This step includes creating a gross list of all companies which may be part of the port sector. We have four main sources for identifying these companies:

- **The Orbis database** provided by Bureau van Dijk is a comprehensive global resource that contains information on millions of companies across the world. It includes detailed financial data and company information for many of them, as well as industry classifiers. For the gross list, we collected
    - All companies in industry classification 50: Water transportation located in the Southern Region
    - All companies in industry classification 52.10: Warehousing and storage located in the Southern Region
    - All companies in industry classification 52.22: Service activities incidental to water transportation located in the Southern Region
    - All companies in industry classification 52.24: Cargo handling located in the Southern Region
    - All companies in industry classification 52.29: Other transportation supply services located in the Southern Region
    - Large companies headquartered in Dublin with the above industry classifications. Some of these have branches in the Southern Region with activity there, even when not headquartered there.
- **The Clarksons database** is a specialised database that focuses on the maritime industry, providing detailed information on shipping companies and vessel information. For our gross list, we collected all companies which either operate a ship in the Southern Region or own a ship which operates in the Southern Region.
- **Lists of companies** received from the ports of Rosslare, Waterford, Cork and Shannon Foynes, as well as companies identified during visits to these ports.
- **The annual reports of the ports** of Cork, Waterford, Shannon Foynes, as well as Irish Rail for Rosslare.

Sub-step 2: Filtering the companies which are actually part of the sub-sector. The gross list created in sub-step 1 provided a relatively comprehensive list of companies which may be in the port sector, but also many companies which were not, such as for instance warehousing companies located inland, inland cargo handling companies

and trucking companies. In the filtering stage, we removed these companies. We also segmented companies into their respective categories, where the differentiation between maritime transportation and auxiliary services was the most challenging. Many companies in the Southern Region operate in both of these sectors, such as for instance Doyle Shipping Group. There was therefore some discretion used in segmenting the companies, especially those identified through the Clarksons database or from the ports which had industry codes not usually connected to either the maritime transport industry or auxiliary services. For some companies which clearly operate in both sectors, such as Doyle Shipping Group, we shared the economic activity between the two segments.

Combined, sub-steps 1 and 2 resulted in a list of port sector companies with activity in the Southern Region, most of them headquartered in the Southern Region, but some also headquartered outside with activity in the Southern Region.

Step 2: Estimating the economic activity of the companies in the Southern Region

For many of the companies in the Southern Region, we had the financial data necessary to estimate employment, value added and revenue from the Orbis database. The Orbis database is not complete, however, and we therefore had to collect additional financial statements from the Companies Registration Office (CRO). We purchased financial statements and annual reports from the relevant companies which had them available at the CRO, and used revenue, employment and value added from these. Combined, these two sources gave us precise data for the majority of companies.

For some companies, however, we only had employment data, but not financial data. This included companies with no financial data in Orbis or CRO. An example of this is unlimited liability companies. For these companies, we estimated the value added and revenue based on ratios for revenue/employment and value added/employment for companies in the same sector.

For companies headquartered outside the Southern Region, but with employment in the Southern Region, we collected data on the employment in the Southern Region, and then assumed constant revenue/employment and value added/employment across branches in Ireland. To identify the number of employees in the Southern Region, we used a combination of branch information in Orbis, the companies' websites, and email exchanges with the companies.

The Orbis database, provided by Bureau van Dijk, is a comprehensive global resource that contains information on millions of companies across the world. It includes detailed financial data and company information. The Clarksons database, on the other hand, is a specialised resource that focuses on the maritime industry, providing detailed information on shipping companies and vessels.

Step 3: Quality assurance

The final step of the analysis was to perform quality assurance. A key source for this was the Labour Force Survey, which has detailed employment data for several industries, although slightly more aggregated than our data. We doubled checked that our employment figures make sense compared to the totals in the labour force survey.

We also double-checked our numbers to the totals for the Irish Ocean Economy study[87] and the EU Blue Economy Observatory[88] at the national level to ensure that our numbers are in-line with past results. These studies provide numbers only for the whole of Ireland, and the sectors they analyse differ from ours, but they are broadly similar.

In the Irish Ocean Economy study, the industry that is most similar to what we analyse is shipping and maritime transport. It includes the industrial codes 50.1, 50.2, 52.22, 52.24*, 52.29* and 77.34*, where the industries noted by * are not fully marine and they estimate the maritime share. These industries overall overlap strongly with the companies we identified in the gross list in step 1. There are some main differences, however.

- For the industries that are not fully marine, the filtering of relevant activity differs – the number of warehousing companies and trucking companies which are relevant to the ocean economy is a wider definition than for the port sector. This means that for these industries, the Irish Ocean Economy's Shipping and Maritime transport has a somewhat wider definition than this report.
- This report also includes relevant companies from the Clarksons database and the ports themselves, and many of these companies are located in other industrial codes. They are port related, but not included in the "Shipping and maritime transport" in the Irish Ocean Economy, and the definition in this report is therefore somewhat broader in this sense.

The Blue Ocean Economy has two sectors that overlap with the present study. "Port activities", consisting of industrial codes 42.91, 52.10*, 52.22, 52.24*, and "Maritime transport", consisting of industry codes 50.1, 50.2, 50.3, 50.4, 77.34 and 52.29. These two sectors together include the same as the Irish Ocean Economy's, along with 42.91. The methodology between the two studies differs a little, however, and the Blue Ocean Economy has a slightly lower total GVA estimate than the Irish Ocean Economy does. Compared to our study, the same differences as mentioned above apply.

Considering the differences in definition, the scale of our numbers compared to the Irish Ocean Economy study make sense considering the share of employment these industries have in the Southern Region according to the Labour Force Survey.

Fisheries

For the fisheries sector, we received data from Bord Iascaigh Mhara on the total revenue, value added and employment from the top 10 ports in Ireland and the share in the east sub-region of the Southern Region. We combined this data with information on the value of fish landings from CSO in all Irish ports to estimate the total values for the Southern Region. The fishing ports for which we received information from Bord Iascaigh Mhara account for over three quarters of the total landed value in the Southern Region, while the last portion was estimated using ratios for employment/value of landed fish and value added/value of landed fish.

[87] *Available at* *https://oar.marine.ie/bitstream/handle/10793/1882/Ireland%27s%20Ocean%20Economy%202023.pdf?sequence=6&isAllowed=y*
[88] *Available at* *https://blue-economy-observatory.ec.europa.eu/dashboard-0_en*

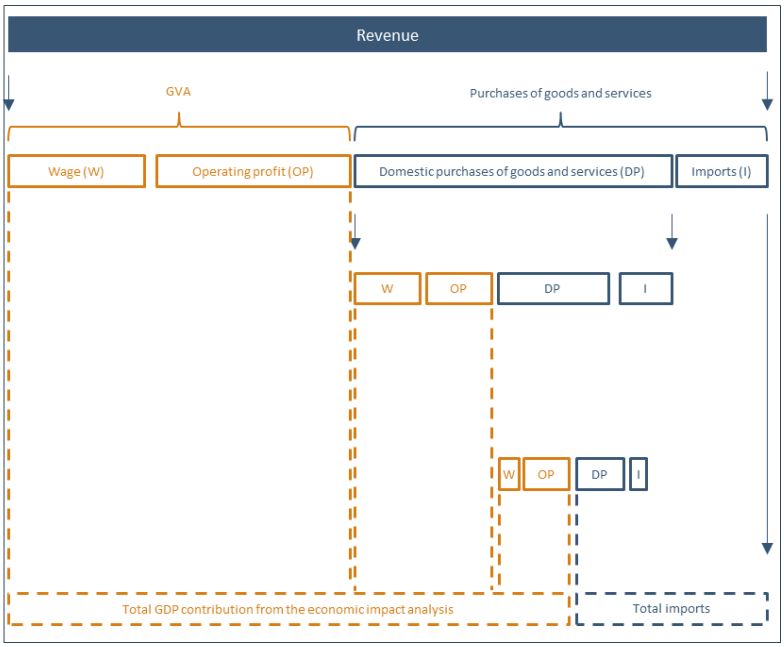
Appendix B: Methodology for estimating the economic impact

The activities in various sectors of the economy are closely interconnected. This means that a change in demand from one sector will affect activities in other sectors, thereby impacting Irish employment and GVA. We quantify these effects for economic activity using an economic impact analysis.

The demand for products and services related to economic activity has two immediate effects. Firstly, it supports employment directly within the industries involved. Secondly, these industries will demand goods and services from other sectors that are part of their value chain. Initially, the demand supports employment at the direct suppliers to these industries. As economic activity increases at these suppliers, their suppliers also experience increased activity. This effect continues in principle indefinitely up the value chain, though with a weaker effect at each link in the chain.

Technically, the revenue of each business in the entire value chain can be divided into four different categories:

- Purchases of goods and services from Ireland
- Purchases from other countries
- Wage
- Operating profit



The sum of the latter two constitutes what is called GVA, while purchases of Irish goods and services form revenue for the businesses in the next link of the value chain. The figure on the right shows a diagram of how the economic activity has effects far up the value chain. The sum of the orange boxes in all links constitutes the cumulative GVA effects. This is shown in stylized form in the figure to the right. As seen from the figure, all revenue will eventually be converted into either Irish GVA or imports.

We have modelled the demand impulse from the economic activities to their suppliers and its effects on employment based on a *Nature*-published regional input-output analysis.[89] The *Nature* input-output matrix provides a regionalised input-output matrix for different industries and NUTS2 regions in Europe. We then use employment data to distribute the economic activity from NUTS2 to NUTS3 regions. This is done by assessing the size, measured by employees, of each industry in each NUTS3 region. We the weight out the purchases within the NUTS 2 region based on the size of the industry for the NUTS3 region.

To calculate the induced effects, we use total wages paid to the employees of the port sector and its suppliers as an initial impulse. These wages form the basis for future consumption, which again contributes to increased

[89] *This input-output matrix can be found here. We have used the latest version of the input-output matrix as of the 8th of September 2024.*

employment and GVA. To estimate this, we use data from the CSO National Accounts for Ireland, which provide a detailed breakdown of how household expenditures are distributed across different industries. By multiplying the total wages by this distribution vector, we estimate how the employees' expenditures are allocated across industries. With this industry-specific expenditure data, we conduct a new economic impact analysis. In this analysis, the economic impulse is the expenditure of the employees, allowing us to assess the total economic effects stemming from their spending.

To measure taxation effects, the model uses the estimated wages and estimated profits of the companies, both directly and indirectly, and applies the average tax raid paid for those industries by data from the input-output matrix and CSO national accounts.

To assess the environmental effects, we utilise data from Eurostat on the emission intensities of various industries.[90] This data includes both country-specific emission intensities and the average emission intensity for the 27 EU countries. These figures, when combined with the GVA from the economic impact assessment, form the basis of our analysis. More specifically, we calculate the emissions by taking the GVA contributions of each industry and multiplying them by the corresponding industry-specific emission intensities. This process yields the total emissions in tonnes of CO^2-equivalents attributed to the economic activity of the port sector, both within Ireland and internationally.

Any economic impact analysis is inherently a gross analysis, which means it does not take into account the alternative use of capital and labour. This contrasts with a net analysis, which assesses what the GVA and employment level would have been in the absence of a given social actor. It is important to note that gross GVA is always higher than (or equal to) net GVA. In the event of a labour shortage, the employment effects may come from other industries and regions and therefore do not lead to an overall increase in Irish employment.

[90] *Which can be found here: Greenhouse gas emission statistics - emission inventories - Statistics Explained (europa.eu)*

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