Green shipping corridors in and out of Spain:

Assessing route-based opportunities

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Summary

Spanish Translation below

Green shipping corridors are specific shipping routes where the feasibility of zero-emission shipping is catalysed by a combination of public and private actions. Previous work has shown that the development of green corridors represents a significant opportunity for the Spanish economy and that the country is well positioned to become a first-mover nation due to clear advantages in the production and distribution of future bunker fuels, presence of strong companies throughout the value chain, potential demand for decarbonised freight, and the robust regulatory framework in place to support renewable energy.

Methodology

This study identifies several promising international routes for establishing green corridors in Spain, building on the route assessment methodology described in The Next Wave. It offers a structured approach to prioritising routes and engaging key stakeholders at all stages of the process.

The underlying logic of the route prioritisation process is that decarbonising a route should significantly contribute to the overall decarbonisation of global shipping while still being comparatively feasible from an implementation standpoint within and reasonable timeframe. To arrive at the final list of route-based opportunities, an initial list of route suggestions provided by the ports was refined and ranked based on an assessment of their impact and feasibility against a set of criteria summarised

Impact	Feasibility			
Trade scale	**Fuel pathway**	**Cargo and demand**	**Policies**	**Stakeholders**
Estimated cargo volume and energy demand, growth projections	Feasibility of the supply of zero-emission fuels	Traded goods, relative price increase and Scope 3 importance within the traded sector(s)	Alignment of national policies of the participating countries	Ease of the stakeholder environment

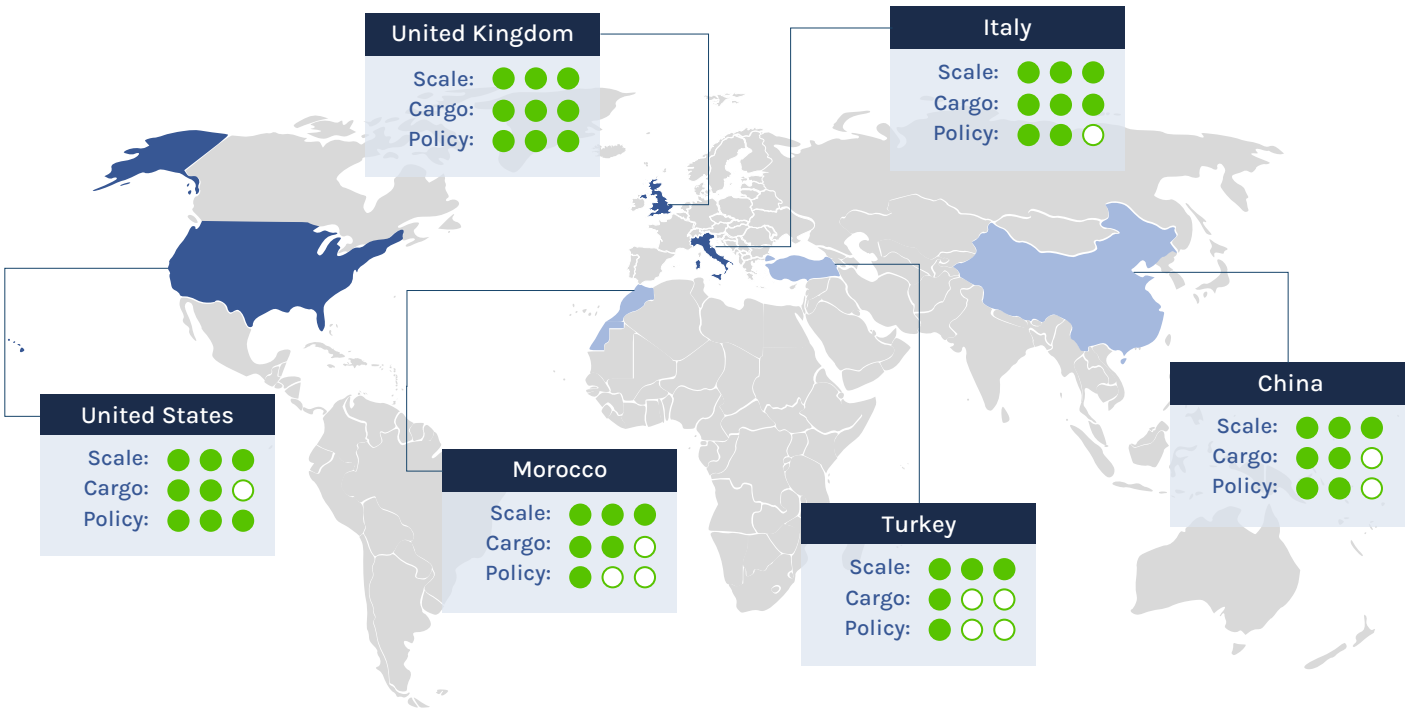
below. This was done through an iterative process combining desk research, a survey and two rounds of discussions with stakeholders.

Results

The assessment demonstrated high levels of interest and varying degrees of activity around zero-emission fuels among Spanish ports. An overview of planned green hydrogen projects demonstrated generally favourable conditions for potential bunkering of hydrogen-based zero-emission fuels across the country's major ports.

On the shipping segment side, the results point to opportunities within the container, roll-on/roll-off (ro-ro), and cruise segments. Targeting routes with cargo owners within food and beverage, car manufacturing and textile sectors was recommended due to large volumes, high-value trade and balanced trade flows within these sectors.

Based on the scale of trade, energy demand, dominant trade segments and policy environment, the analysis identified several bilateral partnership opportunities within



the European continent and beyond. The United Kingdom, Italy and the United States were identified as the most promising partner countries, followed by Turkey, Morocco, and China.

Route	Impact	Feasibility			
		Fuels	Demand and cargo	Policy	Stakeholders
Container; Liverpool - Bilbao	●	●	●	●	●
Container; Valencia – Turkey	●	●	●	●	●
Container; Valencia, Algeciras – United States East Coast	●	●	●	●	●
Container; Barcelona, Valencia – China	●	●	●	●	●
Ro-ro; Spain – United Kingdom	●	●	●	●	●
General cargo; Valencia – Italy	●	●	●	●	●
Cruise; Barcelona	●	●	●	●	●
Cruise; Spain Atlantic – United Kingdom	●	●	●	●	●

Finally, several short- and deep-sea opportunities for green corridors in Spain were identified, each with their own advantages and drawbacks across the categories of impact and feasibility, as demonstrated in the table below.

Next steps

Provided relevant stakeholders are interested in pursuing the identified opportunities, a next step could be undertaking corridor-specific feasibility studies that place emphasis on the infrastructure, policy and financial needs and conditions for securing local fuel supply from within Spain. Moving forward, relevant policymakers should be involved in the process of developing the corridors' implementation plans, as national, bilateral, and regional policy measures will be key to the success of the corridors. Additional corridors not included in the final list may be explored by interested stakeholders with the help of the methodology outlined in this report.

Resumen

Los corredores marítimos verdes son rutas de navegación específicas en las que la viabilidad de la navegación con cero emisiones se promueve mediante una combinación de acciones públicas y privadas. **Trabajos anteriores** han puesto de manifiesto que el desarrollo de corredores verdes representa una oportunidad importante para la economía española, y que el país está bien posicionado para convertirse en una nación pionera debido a las claras ventajas en la producción y distribución de futuros combustibles de transporte marítimo, presencia de empresas sólidas en toda la cadena de valor, la demanda potencial para una carga descarbonizada y el robusto marco regulatorio vigente para apoyar las energías renovables.

Metodología

Este estudio identifica varias rutas internacionales prometedoras de cara a establecer corredores verdes en España, que se basan en la metodología de evaluación de rutas descrita en **The Next Wave**. Brinda un enfoque estructurado para priorizar rutas e involucrar a las partes interesadas que son clave en todas las fases del proceso.

La lógica en la que se basa el proceso de priorización de rutas es que la descarbonización de una ruta debería contribuir significativamente a la descarbonización general del transporte marítimo global, sin dejar de ser comparativamente viable desde el punto de vista de la implementación dentro de un plazo razonable. Para llegar a la lista final de oportunidades, se perfiló y clasificó una lista de sugerencias de rutas proporcionadas por los puertos en función de una evaluación de su impacto y viabilidad frente a un conjunto de criterios que se resumen a continuación. Esto se hizo a través de un proceso iterativo que combinó investigación documental, una encuesta y dos rondas de talleres con las partes interesadas.

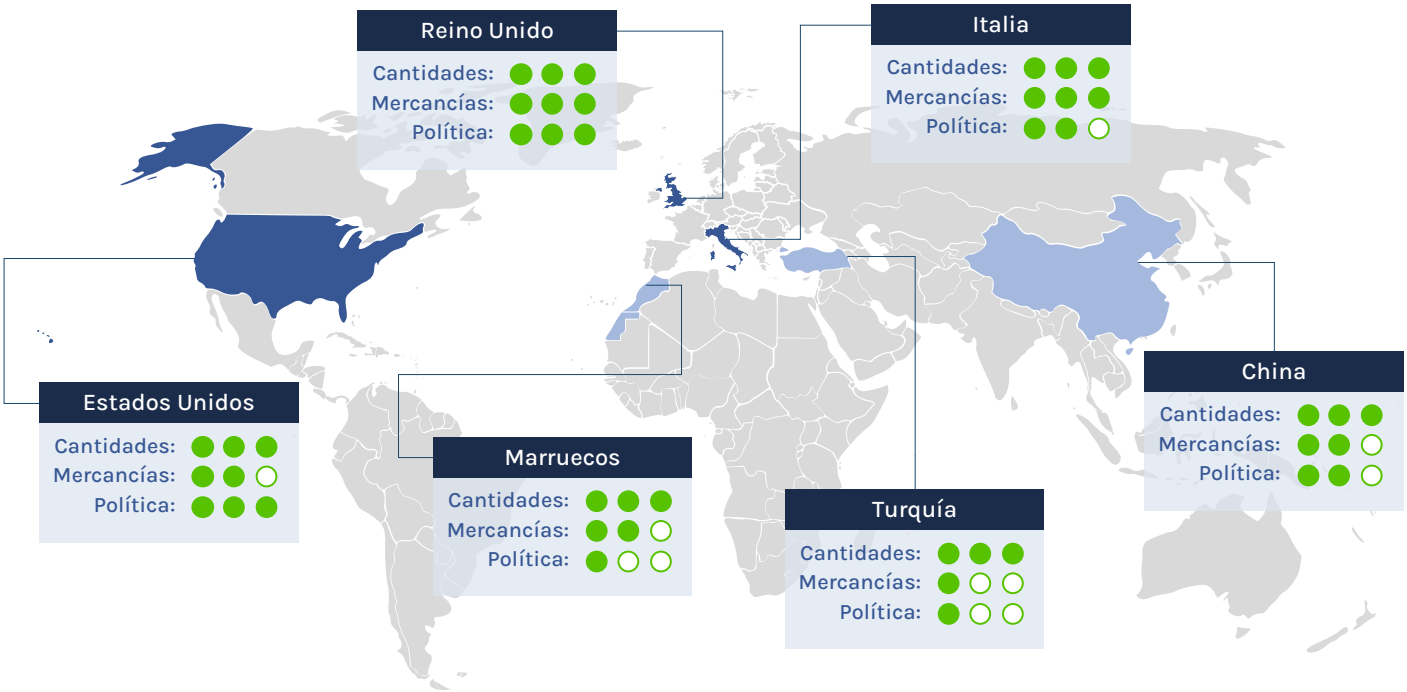
Impacto	Viabilidad			
Escala comercial	**Ruta de combustible**	**Carga y demanda**	**Políticas**	**Partes interesadas**
Volumen de carga estimado y demanda de energía, proyecciones de crecimiento.	Disponibilidad y coste del suministro de combustibles de cero emisiones.	Bienes comercializados, subida relativa de precio e importancia de Alcance 3 dentro del sector o sectores comercializados	Alineación de las políticas nacionales de los países participantes	Facilidad del entorno de las partes interesadas en la ruta.

Resultados

La evaluación revela un alto nivel de interés y diversos grados de actividad en torno a los combustibles de cero emisiones entre los puertos españoles. Una descripción general de los proyectos de hidrógeno verde planificados muestra unas condiciones generalmente favorables para un abastecimiento potencial de combustibles de cero emisiones con base de hidrógeno en los principales puertos del país.

En cuanto al aspecto del transporte en sí, los resultados apuntan a oportunidades dentro de los segmentos de contenedores, roll-on/roll-off (ro-ro) y cruceros. Se recomienda apuntar a rutas con propietarios de carga dentro de los sectores de alimentación y bebidas, fabricación de automóviles y textiles debido a los grandes volúmenes, el comercio de alto valor y unos flujos comerciales equilibrados dentro de estos sectores.

Sobre la base del comercio, la demanda de energía, los segmentos comerciales dominantes y el entorno político, el análisis identifica varias oportunidades de asociación bilateral dentro del continente europeo y fuera del mismo. El Reino Unido, Italia y los Estados Unidos se identifican como los países socios más propicios, seguidos de Turquía, Marruecos y China.



Finalmente, se identificaron varias oportunidades de corredores verdes en aguas de distancia corta y profunda, cada una con sus propias ventajas e inconvenientes en las categorías de impacto y viabilidad, como se demuestra en la siguiente tabla.

Ruta	Impacto	Viabilidad			
		Combustibles	Mercancías	Política	Actores
Contenedor; Liverpool - Bilbao	●	●	●	●	●
Contenedor; Valencia – Turquía	●	●	●	●	●
Contenedor; Valencia, Algeciras – Estados Unidos, Costa Este	●	●	●	●	●
Contenedor; Barcelona, Valencia – China	●	●	●	●	●
Roro; España – Reino Unido	●	●	●	●	●
Mercancía general; Valencia – Italia	●	●	●	●	●
Crucero; Barcelona	●	●	●	●	●
Crucero; España, Costa Atlántica – Reino Unido	●	●	●	●	●

Pasos siguientes

En tanto en cuanto las partes interesadas relevantes estén interesadas en aprovechar las oportunidades identificadas, el siguiente paso podría ser realizar estudios de viabilidad específicos del corredor que hagan hincapié en las necesidades y condiciones políticas, financieras y de infraestructura, para garantizar el suministro local de combustible desde España. Con vistas al futuro, los responsables de formular las políticas pertinentes deben participar en el proceso de desarrollo de los planes de implementación de los corredores, ya que las medidas de política nacionales, bilaterales y regionales serán clave para el éxito de los corredores. Las partes interesadas pueden estudiar corredores adicionales que no estén incluidos en la lista final ayudándose de la metodología recogida en este informe.

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Introduction

Green shipping corridors

Green shipping corridors, as defined by the Getting to Zero Coalition (GtZ), are specific shipping routes where the technological, economic and regulatory feasibility of the operation of zero-emission shipping is catalysed by a combination of public and private actions[1]. Green corridors will be an important part of shipping's long-term transition if they are able to overcome the 'chicken and egg' problem and accelerate the coordinated deployment of scalable, zero-emission fuels, vessels, and fuelling infrastructure needed in the long run.

Several building blocks need to be in place to establish a green corridor, namely a viable fuel pathway, customer demand for green shipping, enabling policy and regulation and cross-value chain collaboration. Green corridors are therefore complex initiatives that benefit from the involvement of a wide range of stakeholders, including fuel producers, shipping companies, cargo owners, ports, and policymakers. More than 20 green shipping corridors are currently being developed globally, led by governments, ports and industry across multiple continents[2].

The Spanish Opportunity

This new work aims to put Spain on the map of green shipping corridors by identifying promising international routes and facilitating stakeholder dialogue. The work builds on the results of the discussion paper Green Corridors: *The Spanish Opportunity*[3], conducted by the Global Maritime Forum and the Energy Transitions Commission in collaboration with the British Embassy in Madrid.

The authors of the earlier paper concluded that the development of green corridors represents a significant opportunity for the Spanish economy and that the country is well-positioned to become a first-mover nation. On the policy side, a robust regulatory framework in place to support renewables provides a good platform for policy action on zero-emission shipping fuels, and the country's participation in the Clydebank Declaration[4] clearly signals the intent to advance green corridors. On the industry side, potential demand for decarbonised freight and the presence of strong companies throughout the international shipping value chain further strengthen the case. However, at the core of the Spanish opportunity lies the country's renewable energy potential. According to the authors, Spain has good prospects to be among the cheapest green hydrogen production locations in the world and a hub for European production. Indeed, this potential is already starting to be realised. Ten major green hydrogen projects have been approved by the Spanish government, putting the country on track to be in the global top three in cumulative hydrogen production capacity by 2030, behind only Australia and the US[5].

If it moves quickly, Spain has a unique opportunity to gain share in future hydrogen-derived maritime fuel markets, benefiting the industry and the economy and putting the country at the forefront of international shipping decarbonisation. With its strategic location and over 500 million tonnes in annual port traffic[6], the possibilities for establishing green shipping corridors in Spain are plentiful.

This new study offers a structured approach to navigating these possibilities and prioritising routes, one that recognises that soft factors such as broader stakeholder readiness and interest play a key role in decision-making processes. The list of opportunities suggested in this report is not exhaustive, and many other routes can be considered worth pursuing. Instead of providing strict guidance, this study prioritised giving the participants tools and platforms to assess the advantages and disadvantages of potential green corridor routes from multiple angles.

Method and process

The study is based on the methodology for identifying potential green corridor routes outlined in the 2021 report The Next Wave[7]. The underlying logic of the route prioritisation process is that decarbonising a route should significantly contribute to decarbonisation of global shipping, while still being comparatively feasible from an implementation standpoint and within a reasonable timeframe. Prioritising routes thus becomes a multicriteria decision problem across the broader categories of impact and feasibility, which can both be assessed through a combination of qualitative and quantitative indicators (Figure 1).

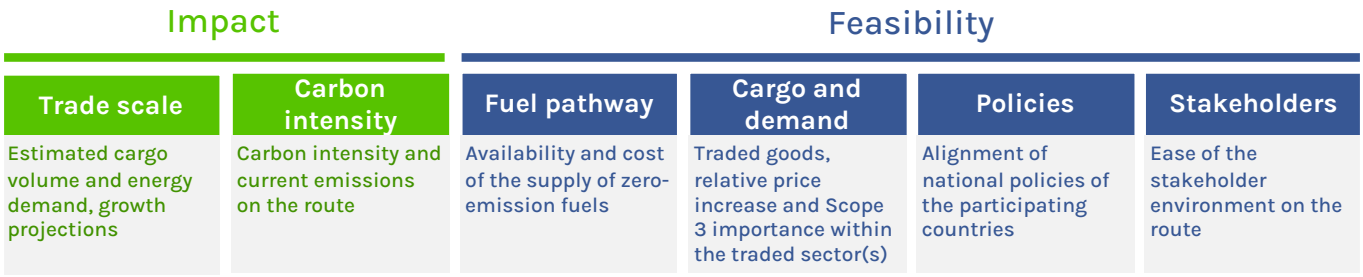

Figure 1 – Groups of criteria for identifying and assessing green corridors, based on The Next Wave (2021)

The Next Wave deals with green corridors on a global scale. Zooming in on a specific country requires adjustments to both the process and the methodology. For example, this study placed more emphasis on stakeholder engagement, with relevant stakeholders from all parts of the value chain contributing during both the data collection and data analysis stages. In terms of methodology, we adjusted The Next Wave's selection criteria to accommodate the country-specific scope and focused more on qualitative data.

Identification and assessment criteria

This chapter unpacks the categories of impact and feasibility applied in this study and outlines the list of criteria used to identify and assess route-based opportunities. These criteria served as the backbone for the iterative and participatory process of route prioritisation, which combined several rounds of filtering out and ranking routes based on a combination of desk research and workshops.

Impact

The potential impact of decarbonising a route can be measured by looking at the current and future volumes of trade on the route, as well as the current emissions and emission intensity. In the context of Spain, and with consideration of data constraints, we used the following data to arrive at combinations of countries and ports with potentially high impact:

- Spain's biggest maritime trade partners

- Main export and import items on promising country pairings
- Growth projections for the sectors of interest
- Total energy demand on country pairings
- Main Spanish ports serving the country pairings of interest
- Ports and destinations with high potential for capturing modal shift in favour of zero-emission shipping
- Most important routes as identified by representatives of Spanish ports
- Total volumes on selected routes, where available

Feasibility

To understand how feasible decarbonising a route will be, one may consider how it would perform against the four green corridor building blocks – fuel pathway, customer demand, policy environment and cross-value chain collaboration (general stakeholder environment).

Feasibility – Fuel pathway

In terms of fuels, we are ultimately interested in the feasibility of supply and bunkering of zero-emission fuels on the routes. For the purposes of this study and following group discussions, we assumed that hydrogen-based fuels could be available to all the major Spanish ports to a similar extent and that, in the context of Spain, a stable, predictable and significant energy demand from a port is a bigger determinant of the availability than the distance from the closest production site. The feasibility of fuel supply through local production varies more across the ports, particularly for green ammonia. As part of this study, we mapped planned green hydrogen and green ammonia production (focusing on projects that haven't reached the final investment decision stage yet) against the location of the country's biggest ports.

For the purposes of this study, the following fuel-related factors were considered:

- Ports' interest and current activity in the space of scalable zero-emission fuels (SZEFs)
- Planned green hydrogen and ammonia production in Spain
- Estimated number of bunkering stops and potential SZEF bunkering locations along the route
- Presence of industrial clusters near the ports

Feasibility – Cargo and demand

The type of cargo being shipped has several consequences for the feasibility of establishing a corridor. First, it has previously been suggested that certain shipping segments might be easier to decarbonise than others. For example, container and ro-ro segments are likely to decarbonise faster, and with fewer bottlenecks, than the dry and liquid bulk segments, due to the regularity of the routes and the economics of the transported cargo.

Second, the traded goods' sector needs to be investigated to understand the importance of Scope 3 emission reduction for the cargo owners along a route, as well as the potential effects of decarbonisation on the final price of the goods. With Spanish maritime trade representing a fraction of global trade in both volumes and value, stakeholders indicated that decarbonising any given Spanish route is unlikely to generate the necessary volumes to justify a green premium from most globally active major cargo owners. Still, the involvement of the right cargo owners is beneficial for building the case for the corridor, and focusing on cargo segments that are important for the economies of Spain and the partner country increases the likelihood of gaining policy support.

Several factors related to cargo and customer demand were considered:

- Main cargo segments by volume and value
- Main trade partner countries for cargo segments of interest
- Main trade items for the biggest trade partners
- Type of cargo on the routes of interest
- Interest of potential cargo owners on the route to engage in green shipping corridors

Feasibility – Policies

Given the gap between the price of zero-emission and conventional fuels and the previously established limited potential for cargo owners to cover the gap, the policymakers at both ends of the corridor may have to intervene to make the corridor economically viable. To assess the policy environment along the routes, we used the following criteria:

- Whether the partner country signed the Clydebank Declaration
- Status of the partner country's net-zero goal setting
- Any relevant bilateral agreements between countries
- Importance of Spain as a trade partner to the partner country

Feasibility – Stakeholders

The broader stakeholder environment on the corridor, in terms of stakeholder complexity, willingness to engage, and already-established collaborations, has several implications for feasibility. For example, a higher number of ports of call on the route increases the complexity of permitting processes, while for each potential bunkering port on the route, physical infrastructure needs to be available in time. On the stakeholder environment side, we considered the following criteria:

- Ports' willingness to engage in green shipping corridors
- Shipping companies' willingness to engage in green shipping corridors as measured through their GtZ and other relevant commitments
- Ports' interest in zero-emission fuels and ongoing dialogue with SZEF producers as a measure of cross-value chain collaboration
- Number of ports of call on the route and potential locations of bunkering ports on the route

Data collection and stakeholder engagement

After developing the list of criteria, data collection for this work started with a **survey of Spanish ports**. The survey was used to identify the ports' most important routes across shipping segments and geographies, as well as to assess their interest, current activity, and long-term plans relevant to the development of green corridors. Fifteen ports that together cover 80% of Spain's maritime traffic responded to the survey, including nine of the ten biggest ports. A total of 75 potential routes were identified through this process.

In parallel, **desk research** was conducted to complement data collected through the survey. The research focused on trade-related data and port-level statistics. The results were combined to create an initial list of potential routes through a process of filtering and ranking of route suggestions provided by the ports, based on the criteria described above. This was followed by a **virtual workshop**, where the participants discussed the shortlisted routes in terms of their advantages and disadvantages, suggested additional routes to explore, and provided their views on the prioritisation criteria. Both the list of routes and the criteria were revisited and adjusted following the workshop. The refined list was then brought to a **meeting in Bilbao** in conjunction with World Maritime Week, where the participants evaluated the routes based on the finalised selection criteria and formed initial groups of interest around the specific routes.

Results of the previous three steps were used to develop the final list of routes contained in this report. Figure 2 features a summary of the process, as well as stakeholder statistics for each step.

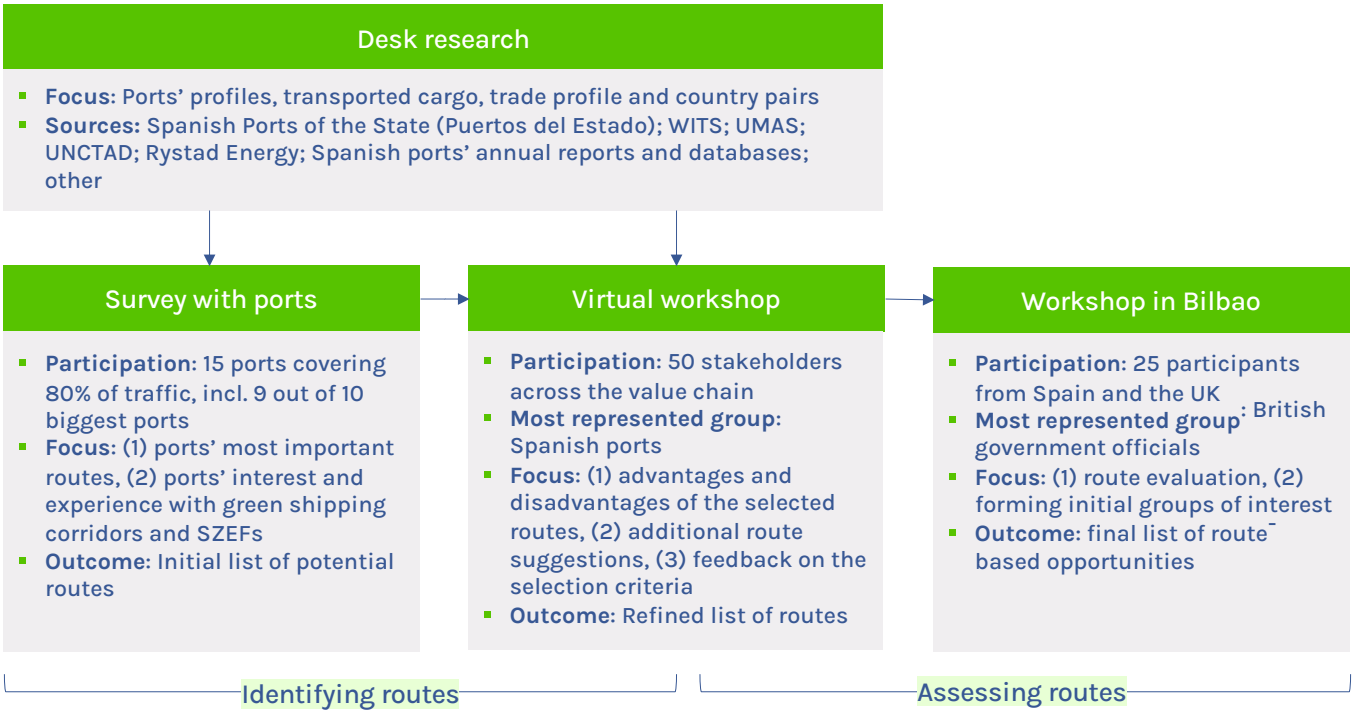

Figure 2 - Overview of the process

Identifying priority green corridors for Spain

In this chapter, we describe the information we used to narrow down the initial list of routes to a more manageable subset that would then undergo a detailed assessment. Through combining cargo, port, trade and fuel-related data, we sought to identify promising combinations of shipping segments, ports and countries to form potentially impactful and feasible green corridors.

Port profiles and transported cargo

With its large coastline extending along both the Mediterranean and the Atlantic, Spain is home to important ports, both regionally and globally. Port of Valencia is one of the top 30 busiest container ports in the world, and the fifth biggest in Europe; Port of Barcelona is one of Europe's five busiest ports across all segments and is in the global top 10 for the cruise segment, while Port of Algeciras is a major global bunkering hub.

Each year, over 500 million tonnes of goods pass through the country's ports, representing around 60% of the country's exports and 75% of imports. The five biggest Spanish ports – Algeciras, Valencia, Barcelona, Bilbao, Tarragona – cover over 50% of the *total* maritime traffic. Barcelona, Valencia, Algeciras and Huelva are leading *export* ports, each handling over 10 million tonnes of cargo destined for export. *Import* traffic is less concentrated, with nine ports covering more than 10 million tonnes each. Of the biggest ports, Algeciras has the highest share of *transit* traffic. Valencia and Barcelona feature a mix of transit and non-transit traffic, while Huelva, Bilbao and Tarragona and Cartagena are predominantly non-transit ports.

The ports' total goods throughput is split unequally between shipping segments, as demonstrated in Figure 3.

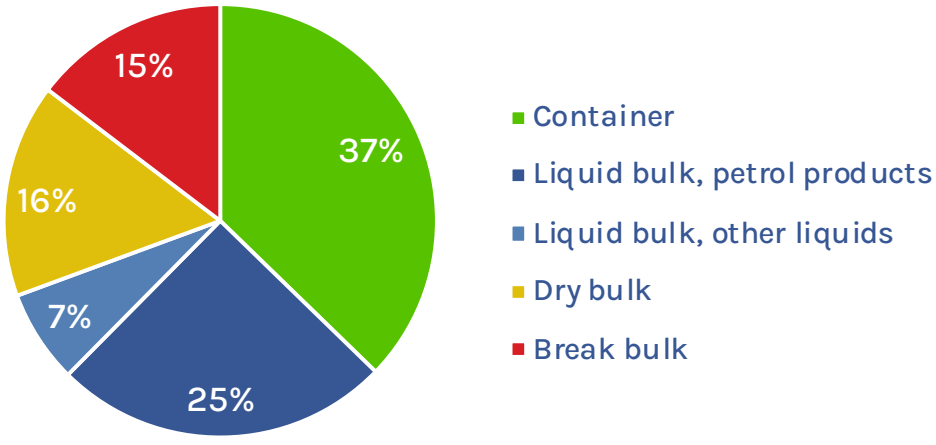

Figure 3 – Total throughput by shipping segment

Container traffic represents the largest single shipping segment for Spain, capturing over 37% of the total goods throughput. The segment is heavily concentrated around the five biggest container ports (Valencia, Algeciras, Barcelona, Las Palmas and Bilbao), which together cover around 90% of the segment.

In the liquid bulk segment, the ports of Algeciras, Huelva and Cartagena are the largest, handling over 20 million tonnes each and over 50% of Spain's overall throughput. The segment is predominantly fossil-based, with 3.5 times more fossil-based product traded. Huelva, Barcelona and Bilbao are responsible for over 50% of non-fossil liquid bulk.

In the solid bulk segment, the ports of Gijón and Castellón are responsible for 14% and 11% of the total volume, respectively. Within the break bulk segment, including ro-ro, car carriers and general non-containerised cargo, Valencia, Algeciras, Baleares and Barcelona are the most important ports, together covering 63%, or roughly 49 million tonnes, of traffic.

In terms of total throughput by product category, the energy segment represents the biggest for both inbound and outbound traffic, with roughly twice as much inbound (Figure 4). It is followed by food and agriculture, featuring a balance between inbound and outbound traffic, and vehicles and transport items, featuring a surplus of outbound traffic.

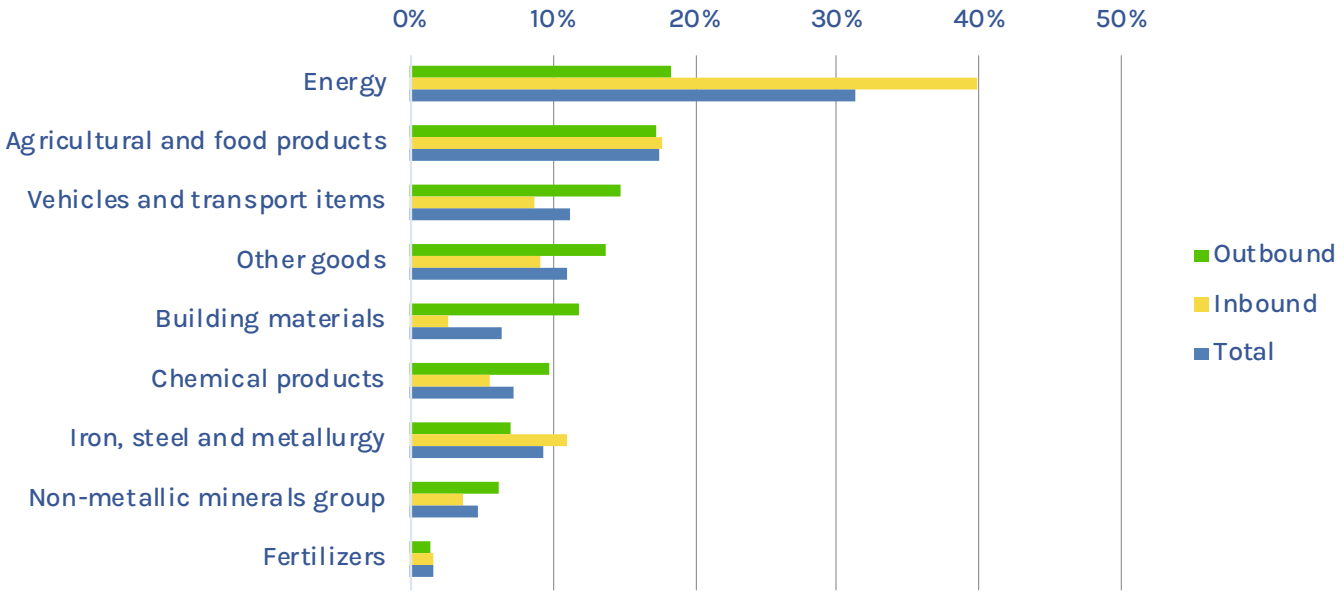

Figure 4 - Total throughput to and from other countries by product category, % of total tonnage

Table 1 features examples of some of the ports active in different product segments.

Table 1 - Examples of ports and trade items of significance within different categories of goods, excluding fossil fuel traffic

Sector	Ports and trade items of significance
Energy	Port of Huelva is responsible for moving around a third of all internationally traded biofuels to and from Spain. The amounts may increase with the construction of a biofuel plant by Cepsa and Bio-Oils, expected to supply around 2.5 million tonnes of second-generation biofuels per year by 2030.
Iron, steel and metallurgy	The Port of Gijón handles most of the country's import of iron ore (around 5.8 million tonnes and $700 million). The product represents half of Gijón's inbound traffic and is likely to be imported to supply the needs of the nearby ArcelorMittal plant, with around 2 million tonnes in annual capacity for steel production. For steel products and other metal products, Valencia is the largest port, transporting around 1.4 million tonnes per year for export and 3 million tonnes per year for import. The Port of Ferrol specialises in other mineral ores. The port accounts for half of the country's total international throughput of 8 million tonnes, and the product category represents over half of the port's traffic.
Non-metallic minerals	In this category, the Port of Castellón stands out with its 6.6 million tonnes of bulk goods, notably feldspar, clay and kaolin to supply the needs of the nearby ceramics cluster. Consisting of more than 200 companies, the cluster produces over 90% of the country's ceramic products. The sector represents over 40% of the port's total traffic, and the port has implemented a number of economic measures to keep attracting the supply.
Chemical products	The ports of Algeciras, Barcelona and Valencia each move more than 6 million tonnes of chemical products, split equally between outbound and inbound traffic.
Building materials	Manufactured building materials represent over 17% of Port of Valencia's total outbound traffic (30% non-transit traffic) and amount to 8.2 million tonnes for outbound traffic and 2 million tonnes for inbound traffic.

	Food and agriculture	Soybeans are only imported, and their traffic is almost exclusively limited to the ports of Barcelona, Bilbao and Cartagena. Cereals and their flours, the largest category of goods within agriculture, are also primarily imported, a quarter through the Port of Tarragona. More than half of all outbound traffic of wine, alcohol and beverages passes through the Port of Valencia (2.4 million tonnes). Food products – including fruits and vegetables, oils, tinned food, and other foods – pass through the ports of Valencia, Algeciras and Barcelona in a range of 8-15 million tonnes per port, split equally between inbound and outbound traffic.
	Vehicles and transport items	Roughly a third of all traffic of motor vehicles and their parts, more than 2.5 million tonnes split equally between export and import, are shipped through the port of Valencia. In 2022, more than 600,000 vehicles passed through this port, representing a significant share of the 1.8 million vehicles exported from Spain in 2021.
	Machinery, tools and parts	Algeciras, Barcelona, Valencia each handle more than 1.5 million tonnes in inbound and outbound traffic.
	Other goods	Algeciras, Valencia and Barcelona together cover over 85% of total traffic of other goods, more than 20 million tonnes split equally between inbound and outbound traffic

Of all these segments, two are of particular interest due to high volume, high-value trade and balanced trade flows: **food** (mostly container trade) and **vehicles** (mostly ro-ro and car carriers). In addition, both the previous study and port survey results suggested that **textile** could be a segment of interest, due to the societal pressure on the sector to decarbonise, its closeness to the consumer and the high added value trade in traded goods. In the statistics above, textiles are concealed under the category of "other goods."

Passenger traffic was not covered in the analysis above. Early project discussions indicated that the **cruise** segment might be worth looking into due to its economic significance for the country. Before COVID-19, the Spanish cruise industry generated over $6 billion in turnover. In terms of number of cruise passengers passing through its ports, Spain ranked among the top two countries in Europe, surpassed only by Italy. Following a drastic dip during the pandemic, the Spanish cruise sector has quickly bounced back, witnessing double-digit growth in 2022 and strong five-year growth projections. Several cruise lines have already announced they are planning to increase their presence in Spain, notably MSC[8]. In general, over two-thirds of all cruise passengers are concentrated on the country's Mediterranean coast. Prominent ports within the segment include the ports of Barcelona and the Balearic Islands. Port of Barcelona is also Spain's most prominent home port for cruise passengers.

Spain trade profile and main trade partners

A country's trade profile represents another data point for analysing potential routes, as understanding the trade flows helps identify high-potential country pairings for the establishment of green corridors. By combining bilateral trade data, including trade value (based on data from UNCTAD[9] and the World Bank[10]), the volume of maritime traffic with different countries (based on data by Ports of the State[11]), and complementary data related to energy demand on country pairings (based on data from UMAS[12]), a list of promising partner countries by scale was produced. Looking deeper into trade characteristics, main trade categories for country pairings and countries' policies related to broader decarbonisation in general and decarbonisation of shipping specifically generated additional insights into feasibility. Below are the highlights from the analysis, as well as the summary of country-based opportunities.

The following partner countries trade the largest *volumes* with Spain: United States, Italy, Morocco, Turkey, China, United Kingdom, France, and the Netherlands (total volumes for inbound and outbound flows). Almost all these countries are high on the list of country pairing *energy demand*, with Italy in the lead. To gain insight into trade *values*, we looked at two related parameters for a selection of countries: top export and import items (Table 2), and top countries and trade value for the identified segments of interest (Figure 5).

Table 2 - Top trade segments with the selected countries, measured in trade value (measured in USD, not restricted to maritime trade)

Country	Top 3 export items in trade value	Top 3 import items in trade value
United States	Refined petroleum (7.6%); unglazed ceramics (3%); pure olive oil (3%)	Packaged medicaments (15%); petroleum gas and crude petroleum (26%)
Italy	Cars (11.6%); pure olive oil (3.6%); industrial fatty acids, oils and alcohols (3.2%)	Refined petroleum (4,6%); motor vehicles, parts and accessories (3.9%); broadcasting equipment (3.4%)
United Kingdom	Cars (14.6%); gold (5%); delivery trucks (4.5%)	Gold (13.7%); cars (8.5%); gas turbines (4%)
Morocco	Refined petroleum (13.5%); motor vehicles, parts and accessories (6.5%); cars (3.7%)	Insulated wire (16%); non-knit women's suits (12%); cars (5.5%)
China	Pork (23.2%); copper ore (8.7%); edible offal (6.2%)	Broadcasting equipment (5.1%); semiconductor devices (3.4%); electric batteries (2.3%)
Turkey	Cars (17.6%); raw zinc (7.7%); cyclic hydrocarbons (3.4%)	Non-knit women's suits (9.4%); cars (8.8%); coated flat-rolled iron (6.6%)

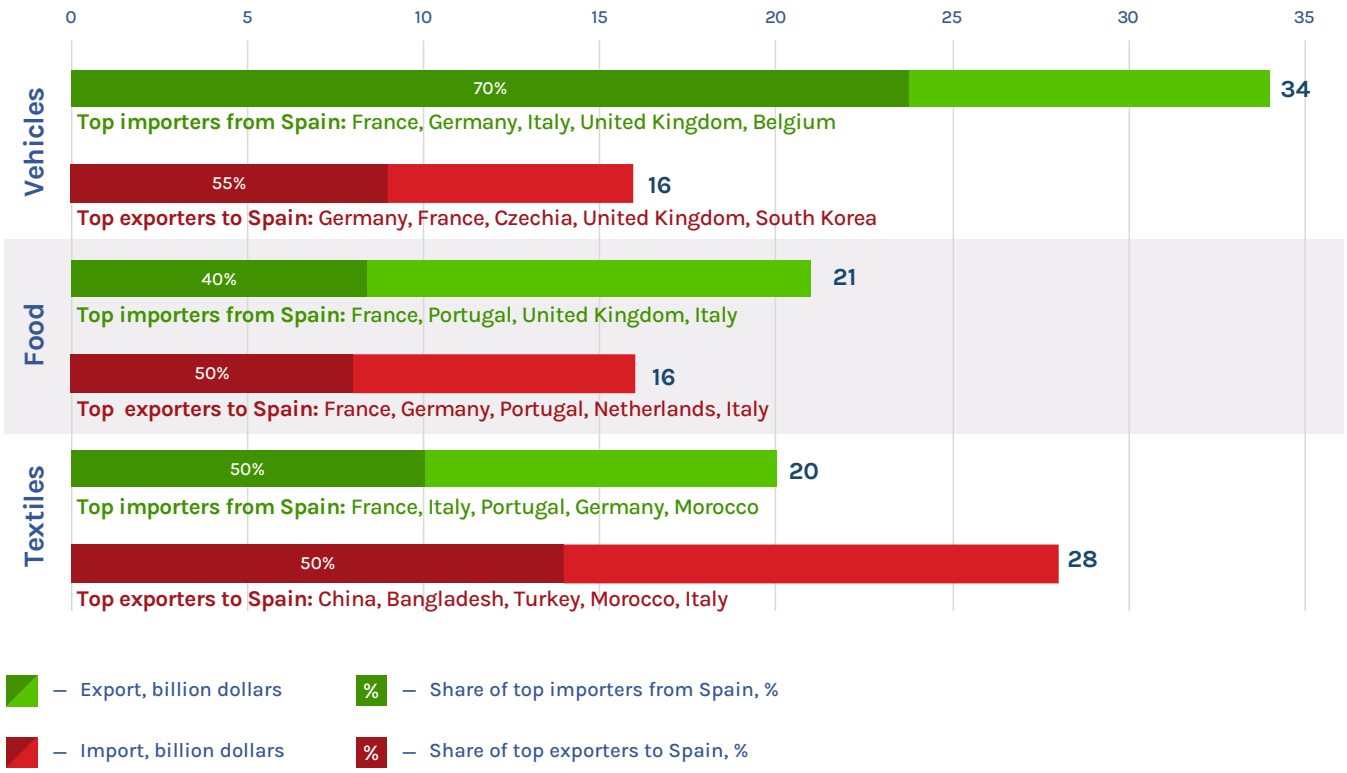

Figure 5 - Trade values and main trade partners for the selected trade segments (not restricted to maritime trade)

Figure 6 features a summary of the country-based analysis and focuses on the strengths and weaknesses of the potential partner countries based on the volume of trade, cargo characteristics and the policy environment.

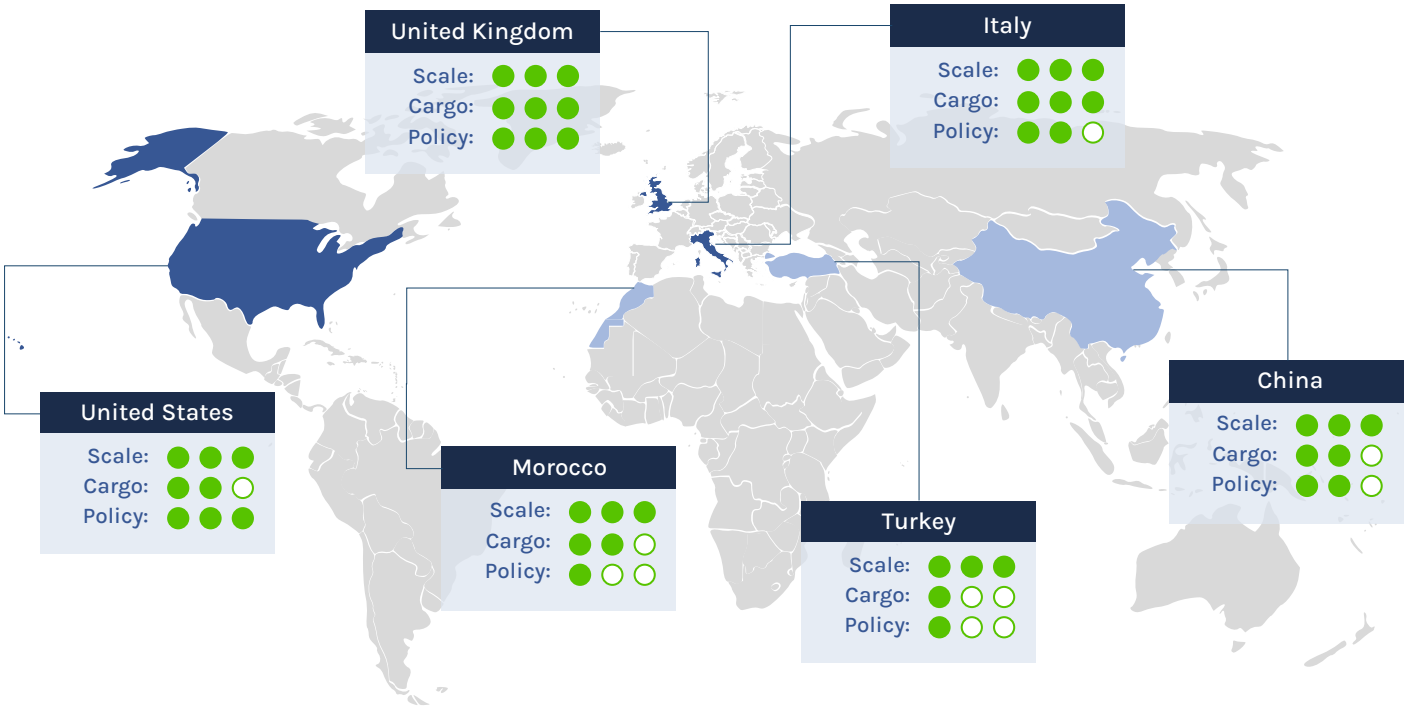

Figure 6 - Promising country pairs for Spanish green corridors

The European continent offers many bilateral partnership opportunities for Spain, notably with the United Kingdom and Italy, both of which offer a good balance between impact and feasibility. The United Kingdom, Spain and Italy all signed the Clydebank Declaration and have committed to net zero, indicating a generally favourable policy environment. In addition, Spain is an important trade partner for both Italy and the UK, increasing the likelihood of potential collaborations. Trade with these countries is characterised by a high share of high-value goods in the general cargo segment (both containerised and non-containerised), such as food products and cars. Meanwhile, China and the United States present advantages due to the scale of trade; container traffic between these countries and the ports of Valencia, Barcelona and Algeciras is globally significant. In the case of the United States, the policy environment is generally favourable. However, Spain is not an important trade partner for either of these two countries. In turn, Turkey and Morocco, while potentially challenging on the policy and stakeholder criteria, offer significant opportunities due to strong bilateral trade ties and trade volumes.

To move closer to identifying specific routes, we looked at the biggest ports serving these countries (Table 4).

Table 4 - Top ports for each of the selected countries, measured in tonnes of throughput

Country	Main ports for export	Main ports for import
United States	Valencia, Algeciras, Barcelona	Algeciras, Valencia, A Coruna
Italy	Barcelona, Valencia, Tarragona	Barcelona, Valencia, Algeciras
United Kingdom	Cars (14.6%); gold (5%); delivery trucks (4.5%)	Gold (13.7%); cars (8.5%); gas turbines (4%)
Morocco	Algeciras, Cartagena, Valencia	Algeciras, Las Palmas, Valencia
China	Barcelona, Valencia, Algeciras	Valencia, Barcelona, Algeciras
Turkey	Valencia, Algeciras, Barcelona	Valencia, Castellón, Algeciras

Ports' interest and activity around scalable zero-emission fuels

In addition to handling goods and passengers, Spanish ports supply over eight million tonnes of liquid fuel, around 80% of which is provided by the country's biggest bunkering hubs: Algeciras, Las Palmas and Barcelona. Figure 7 features an overview of the ports' interest and activity around SZEFs, as per survey results.

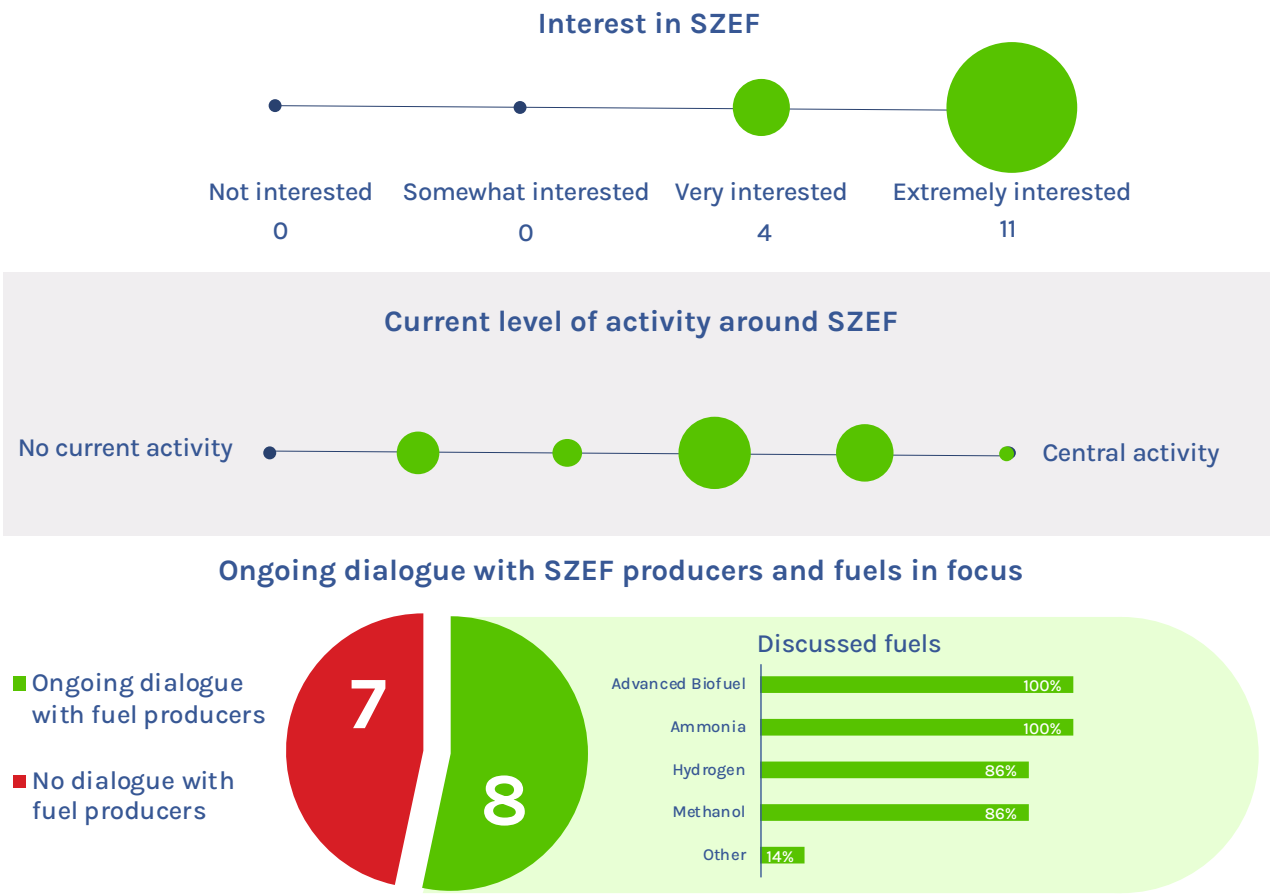

Figure 7 - Overview of the ports' interest and activity in the space of SZEFs

The results suggest that the Spanish ports that responded to the survey show a similarly high level of interest in the topic of green corridors, while levels of current activity are more diverse. Roughly half are currently in dialogue with SZEF producers, with bigger ports more likely to engage in such dialogue, indicating potential preparations for infrastructure investments.

However, no clear fuel preference was observed in the survey, and the ports seem to be considering all the options. While this unlocks many potential green corridor configurations, it may also indicate the nascent stages of infrastructure planning. Still, some activity can already be observed. For example, in 2022, the ports of Huelva, Algeciras and Valencia joined an international study exploring safety aspects of using and bunkering ammonia as a shipping fuel.

By 2030, Spain's annual production of green hydrogen is expected to reach more than 1.9 million tonnes. Just three of the biggest projects – HyDeal Spain with a planned production site in northern Spain[13], the Catalina Project in the northeast[14], and the Andalusian Green Hydrogen Valley in the south[15] – represent over 11 gigawatts of installed electrolyser capacity by 2030. Most of the projects are currently at the feasibility study stage[16], indicating potential interest in new off-takers, and many mention ammonia as one of the uses.

As part of Andalusian Green Hydrogen Valley, in February 2023, Cepsa signed an agreement with the ACE Terminal at the Port of Rotterdam to supply green ammonia for conversion into green hydrogen or direct use for maritime transport[17]. Through the same project, an agreement was signed between Cepsa and Fertiberia to, among other things, explore the potential to expand green ammonia production in various provinces in Spain[18].

Figure 8 features a map of some of the major green hydrogen production projects and planned green ammonia production linked to these projects, as well as planned hydrogen transmission lines expected to be ready by 2030.

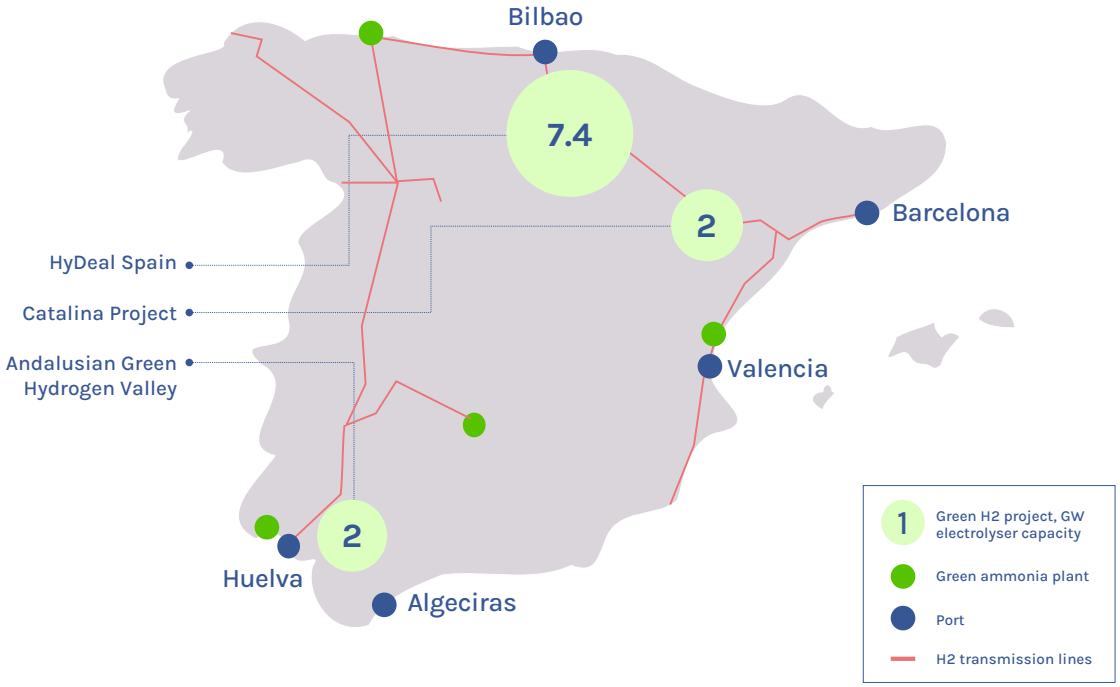

Figure 8 – Fuel infrastructure expected to be ready by 2030, selection of projects, focus on ammonia. Illustrative, non-exhaustive. Based on projects data and press-releases, IEA database, and data from Hydrogen Infrastructure Map

The figure shows that conditions are generally favourable across the major ports for securing the local supply of hydrogen-based fuels, particularly ammonia, but that the progress related to infrastructure on the port level has to accelerate to capture this opportunity.

Assessing candidate green corridor routes

The country, port, fuel and cargo data described in this section were matched against the survey results to narrow down the initial list of 75 routes provided by the ports to a more manageable number for an in-depth analysis. The shortlisted routes, as well as the results of the assessment are featured below.

After refining the list to specify destinations and other ports of call, we arrived at a list of eight routes to undergo further assessment. Data availability and the level of specificity varies across the suggested routes; in many cases, the level of detail correlated with stakeholder interest in the route. Figure 9 below summarises the identified opportunities.

Figure 9 - Overview of the identified route-based opportunities

The list contains several deep-sea opportunities in the container segment, such as container trade between China and the ports of Barcelona and Valencia. Notable companies servicing these routes include MSC, Maersk, Hamburg Süd, ONE. Container trade with the United States is another option, notably the lines passing through both ports of Valencia and Algeciras and, at the opposite end, the ports of Norfolk, New York and Houston. Seven weekly regular lines originating in and ending in Algeciras are serviced by, among others, Hapag Lloyd and CMA-CGM.

Short sea opportunities within Europe were also identified, such as container traffic between the ports of Bilbao and Liverpool, container traffic between Valencia and Turkey and general cargo traffic between Valencia and Italy (both containerised and

non-containerised). Italy covers a significant share of the port's total volumes, and general cargo trade with the country is likely to contain a high share of both food items and vehicles. Over 20% of the total vehicle traffic through the port, or over 125,000 vehicles, are destined for Italy or originate in Italy.

Ro-ro traffic with the UK may also form a good base for a green corridor. Vigo and Santander are two examples of candidate ports for this route, with more than 500,000 and 300,000 total vehicles passing through them respectively, with the UK potentially representing a significant share of that traffic. Within the cruise segment, Mediterranean cruises originating and ending in Barcelona and Atlantic cruises with the UK are promising candidates.

The matrix on Figure 10 summarises the routes' ranking based on the aggregated parameters of impact and feasibility.

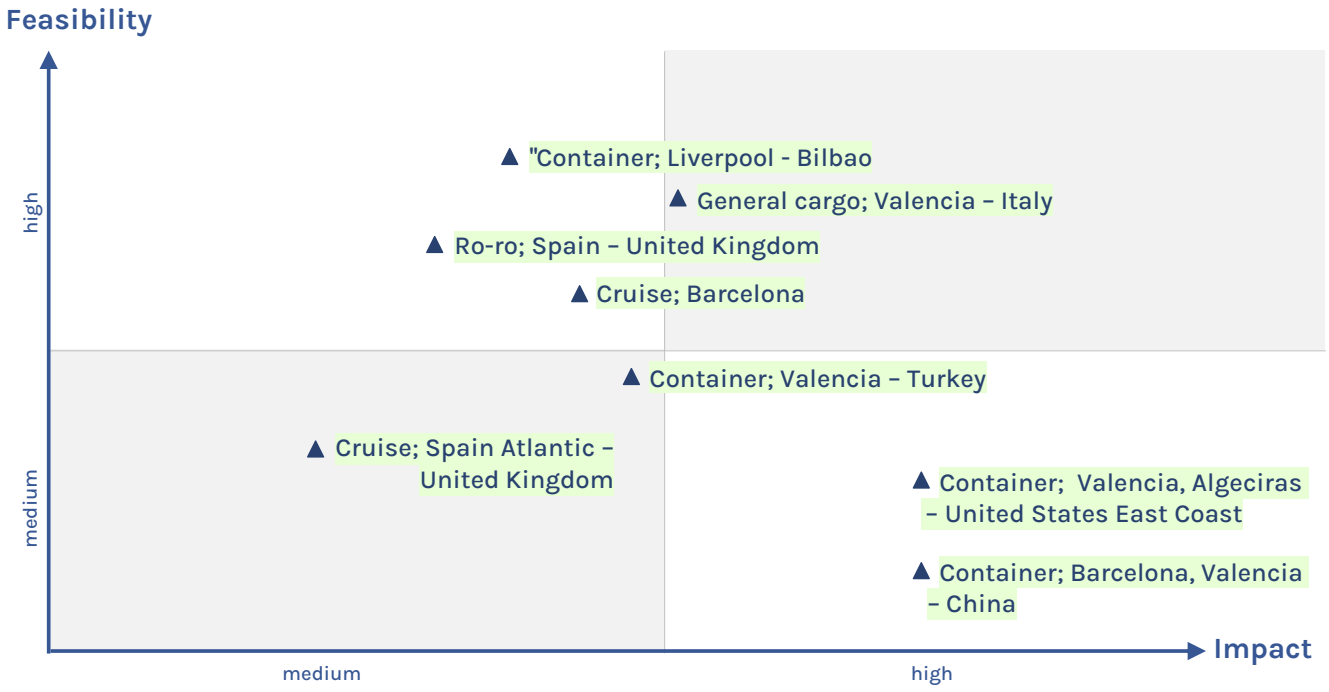

Figure 10 - Assessment of the relative impact and feasibility of the selected routes

The analysis shows two clusters of routes reflecting different approaches to selecting green corridors: high-impact, medium-feasibility corridors and high-feasibility, medium-impact corridors. On a corridor level, both clusters offer advantages, but come with different challenges. For example, for high impact corridors, meeting the timeline and coordinating stakeholders may form a bigger obstacle.

Table 7 goes more in depth into the feasibility side of the selection and highlights the main strengths and areas of concern or uncertainty for each of the identified routes. This evaluation is the combined result of desk research and workshop exercises.

Table 7 - Multicriteria assessment of the selected routes (dark green – very high impact/feasibility, light green – high impact/feasibility, yellow – medium impact/feasibility)

Route	Impact	Feasibility			
		Fuels	Demand and cargo	Policy	Stakeholders
Container; Liverpool - Bilbao					
Container; Valencia – Turkey					
Container; Valencia, Algeciras – United States East Coast					
Container; Barcelona, Valencia – China					
Ro-ro; Spain – United Kingdom					
General cargo; Valencia – Italy					
Cruise; Barcelona					
Cruise; Spain Atlantic – United Kingdom					

Deep sea container routes are comparatively the most impactful based on volume, regularity and large individual ship capacity, which offers a possibility for capturing big volumes and generating high and stable energy demand by decarbonising a relatively small number of ships. At the same time, the level of stakeholder complexity is also high, with the average number of ports of call on the routes exceeding 10, and likely more than one bunkering stop required. While feasibility of bunkering SZEFs in Algeciras and Valencia is high, other bunkering opportunities along the route are more varied.

Container trade between the ports of Bilbao and Liverpool is the option that generated the most interest during the workshops. The route's attractiveness is based on multiple criteria, including the generally favourable policy environment, the ports' potential interest and a strong relationship between the participating ports. Adding to the benefits is the presence of maritime industrial clusters and nascent hydrogen ecosystems at both ends of the route, increasing the likelihood of future fuel availability. Several prominent shipping lines, such as WEC and Containerships, operate on the route. For this route, long-term growth projections for maritime trade between the two ports, particularly inbound flows from Liverpool, have to be looked at in more detail, as pointed out during group discussions.

General cargo between Valencia and Italy scored relatively well on all criteria, particularly in terms of volumes of traffic in relation to distances travelled, but interest of the stakeholders across the Mediterranean has to be investigated further. In addition, this route represents a portfolio of shipping segments, including ro-ro traffic and containerised trade, contributing to the complexity of the potential corridor. For **container trade with Turkey**, main concerns are related to the challenging policy and stakeholder environment. On the fuel side, the Port of Valencia is well placed to secure the local supply of SZEF, and the distances covered by ships on these two routes may mean that one bunkering stop could be enough. **Ro-ro traffic with the United Kingdom**, while significant enough in terms of total volumes, might be too fragmented across different ports to make any port-specific corridor highly impactful.

Mediterranean cruise, with Barcelona as home port, has perhaps unique potential to contribute to decarbonisation of the segment by becoming the first cruise corridor in Europe, and only the second in the world. Greening the cruise might also offer several indirect benefits for local stakeholders and help address some of the growing concerns around the impacts of the cruise industry and unsustainable tourism on the city. **Atlantic Spain - UK cruise**, while significantly smaller in terms of annual passenger numbers, generated a lot of interest during the workshops, including from some of the ports of call, but the potential issue of irregularity was emphasized. For both cruise routes, the potential to explore and capitalise on passengers' willingness to pay the green premium was highlighted, while the main question mark and potential bottleneck has to do with the segment's comparatively limited fuel options and the associated fuel availability.

Conclusions and next steps

The study identified several promising opportunities for establishing international green shipping corridors to and from Spain across several shipping segments, countries, and ports. But above all, it encountered an impressive enthusiasm and deep understanding across the stakeholder groups of the potential of green corridors for the country and its industry, a rapid advancement from just over a year ago when Green Corridors: The Spanish Opportunity was published. Of the eight routes identified in this study, we consider that at least one has reached critical mass in terms of stakeholder interest to quickly move into the feasibility study phase. Such an exceptional stakeholder environment provides a head start for further route-specific action, but as the study participants themselves pointed out, many bottlenecks remain.

Several areas for immediate action were highlighted in the discussions. The participants concluded that an even broader stakeholder involvement and consultation is required during the next stages of exploring the route-based opportunities. For example, since local, port-level policies and permitting processes play a big role in the development of the corridors, international ports along the routes represent a crucial group to involve going forward. Similarly, more active involvement from the Spanish government will be required in the short to medium term. Workshop participants stressed the importance of national, bilateral, and regional policy measures for any of the identified corridors to succeed. Contracts for difference – mechanisms that could be supported in a bilateral fashion by national governments involved in the corridors – and targeted research funding were highlighted as particularly effective ways to bridge the SZEF cost gap. In the context of Spain, where the possibility to pass over the costs to the final consumers is limited, the importance of such measures is even higher.

Notwithstanding the potential, international shipping has been given a rather peripheral role in Spain's national hydrogen roadmap to date; and the sector's significance as an off-taker for hydrogen-based fuels has not been sufficiently explored. Joining forces around specific routes and extending action across the value chain may allow the shipping community to tap into Spain's bold energy transition plans to secure its zero-emission future. Thus, we recommend that future corridor-specific feasibility studies place an emphasis on exploring the needs and conditions in terms of infrastructure, policy and finance for securing a local fuel supply within Spain, to help build a stronger political case for the corridor. Once the feasibility of priority corridors is confirmed – if not before – relevant policymakers should be involved in a structured way in the process of developing the corridors' implementation plans.

Endnotes

1 https://www.globalmaritimeforum.org/content/2021/11/The-Next-Wave-Green-Corridors.pdf

2 https://www.globalmaritimeforum.org/content/2022/11/The-2022-Annual-Progress-Report-on-Green-Shipping-Corridors.pdf

3 Green-Corridors-The-Spanish-Opportunity.pdf (globalmaritimeforum.org)

4 https://www.gov.uk/government/publications/cop-26-clydebank-declaration-for-green-shipping-corridors/cop-26-clydebank-declaration-for-green-shipping-corridors

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15 Valle Andaluz Hidrógeno Verde (cepsa.es)

16 Hydrogen Projects Database - Data product - IEA

17 https://www.cepsa.com/en/press/cepsa-and-ace-terminal-will-create-green-hydrogen-supply-chain

18 Cepsa y Fertiberia se alían para producir hidrógeno verde

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About the Getting to Zero Coalition

The Getting to Zero Coalition is an industry-led platform for collaboration that brings together leading stakeholders from across the maritime and fuels value chains with the financial sector and other committed to making commercially viable zero emission vessels a scalable reality by 2030.

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