



Portable Innovation Open Network for  
Efficiency and Emissions Reduction Solutions

## Deliverable 2.15:

# PIONEERS' Best Practise Master Plan and Handbook

### Disclaimer

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# 1 The port: know your own system

All ports are different. They operate under different geographical, climatic, infrastructural, economic, and regulatory conditions. They serve different transport modes and supply chains, have different connections to cities and hinterlands, and face different conditions depending on their access to the sea, rivers, or other waterways. Their size, functions, governance structures, available infrastructure, and local ecosystems also vary considerably.

A successful transition starts with a clear understanding of the port itself and its ecosystem. The Port Today phase is therefore all about the port ecosystem and the knowledge a port has of its own environment. It establishes the status quo and provides the evidence base from which future ambitions, pathways and actions are developed. We suggest the following sections for this chapter:

1. Characterise your port ecosystem and its stakeholders ([read more](#))
2. Determine your current environmental footprint as a starting point ([read more](#))
3. Understanding the port ecosystem ([read more](#))

## 1.1 Characterise your port ecosystem and its stakeholders

The characterisation of your port includes several attributes including geographical location, size, functions, governance structure, available infrastructure, and local ecosystems. Starting with the in-depth description of your port characteristics helps you in reflecting your starting point and provides you with relevant context for the next steps.

### 1.1.1 Why stakeholder engagement matters

One of the most important parts of your port ecosystem are your stakeholders. A GPMP cannot be developed by the port authority alone. The PIONEERS ports experienced the need to collaborate and co-create the GPMP with their stakeholders in different ways: PoAB found that greening had to be embedded into existing organisational structure of the port rather than run as a separate project, PoV, as a municipality-governed inland port, depended entirely on business and regional cooperation to make its Roadmap implementable for all.

Stakeholder engagement is a process that depends on the availability, effort and collaboration of many interested parties. It is not a singular, uni-directional process. This approach will turn the greening vision of the actual GPMP from a technical document into a shared by all transition framework. Practically, the stakeholder engagement helped PIONEERS ports to:

- ✓ Understand real needs, barriers and limits across the port ecosystem, and test whether proposed measures for greening are feasible;
- ✓ Connect the GPMP with real operations, investment plans and available funding;
- ✓ Align the GPMP with policy, regulation and infrastructure requirements;
- ✓ Build trust and shared ownership with those who will help deliver it;
- ✓ Create the building blocks for new governance models.

- ✗ **Ask yourself: Who needs to be involved in the GPMP process and what is its foreseen role in the process?**
- ✗ **No support, no delivery: a technically excellent GPMP without stakeholders' support will not be accepted and brought to life.**
- ✗ **Make every interaction count: every stakeholder activity should support a decision, an action or a learning need, not only an awareness activity.**

### Stakeholder engagement across GPMP development phases

Stakeholder engagement should follow the GPMP development. The PIONEERS ports experience shows that the engagement type in the early GPMP development stages is different from the final GPMP development stages. At the beginning, ports need a broad stakeholder mapping and an open dialogue, as a method. Later, they need more focused cooperation with the stakeholders who can support the GPMP implementation. Figure 1 shows how stakeholder engagement shifts across the four phases of the GPMP development. From discovering the main focus of the GPMP and its agreement with the stakeholders to the finalisation of the GPMP, the stakeholder engagement process is a thread through all the activities carries out in ports to green their activities

(Table 1). Bringing stakeholders together to embrace the greening principles in their activities, irrespective of their nature it is an activity that ports need investing in it.

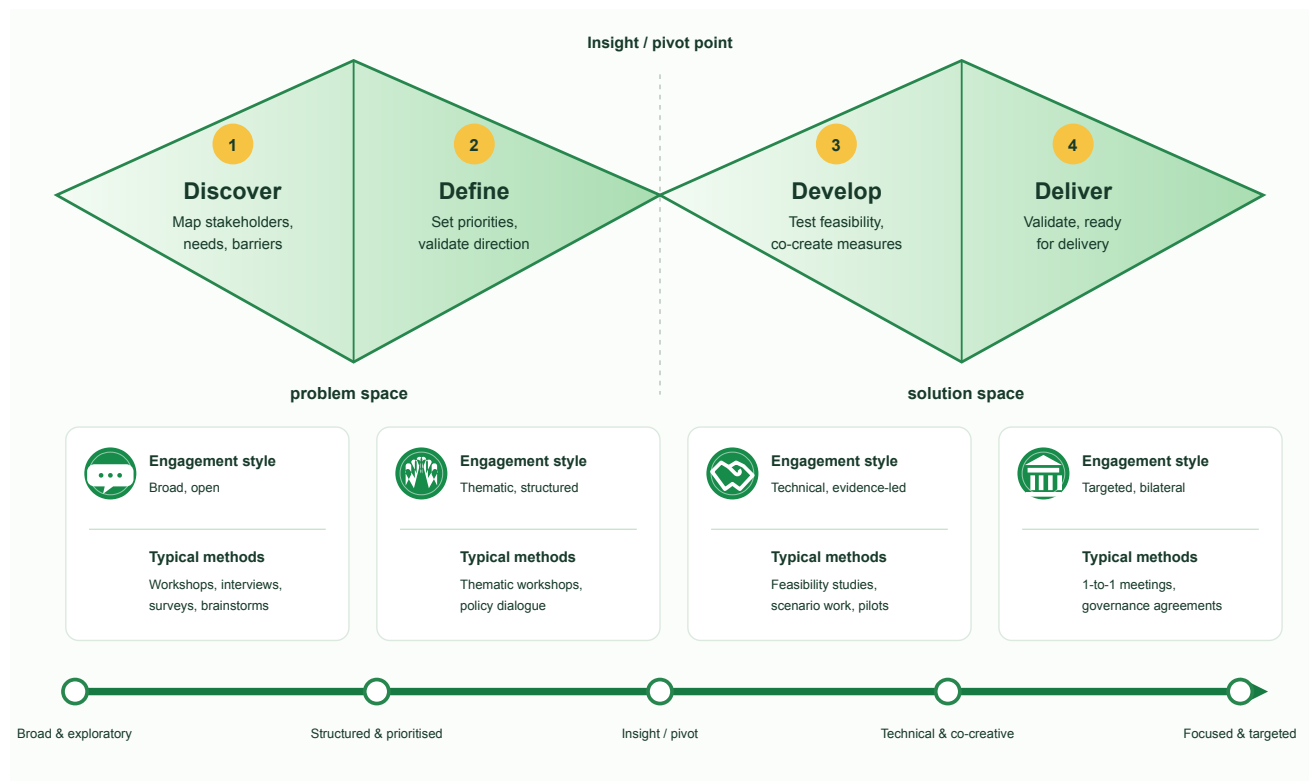


Figure 1: The Discover-Define-Develop-Deliver Diagram (source: EIP own development)

Table 1: Approach for stakeholder engagement

| Phase           | Key question                     | Do                                                                                                       | Avoid                                                                       |
|-----------------|----------------------------------|----------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|
| <b>Discover</b> | Who matters and why?             | Extensive mapping, open interviews, brainstorming sessions with internal teams and known external actors | Locking in a fixed stakeholder list too early                               |
| <b>Define</b>   | What should the GPMP prioritise? | Thematic workshops, policy dialogue, first validation of direction                                       | Missing contribution and/or validation from major stakeholders to save time |
| <b>Develop</b>  | Will this actually work?         | Feasibility studies, scenario testing, pilot discussions, co-creation workshops                          | Relying only on group workshops for sensitive topics                        |
| <b>Deliver</b>  | Are we ready to act?             | Targeted 1-to-1 meetings, governance agreements, roadmap approval                                        | Treating delivery as the end of engagement                                  |

✖ Use wider consultation to understand the system, then move to targeted engagement

- ✖ **Do not initiate a consultation with stakeholders before defining its scope and objectives.**
- ✖ **Adapt the engagement to each phase of the GPMP development: define the vision, design the GPMP, validate it, build the roadmap and deliver it.**

### 1.1.2 Stakeholder groups

The PIONEERS ports used a five-group structure to classify and track stakeholders. This structure helped PIONEERS ports to assess who was engaged when, and in which role. The engagement tracking eases the planning of tailored engagement activities for each group. In PIONEERS, businesses & operators are the largest and most operationally relevant group in every port, while communities & local neighbourhoods remained the least engaged group across all four PIONEERS ports. This gap was acknowledged by the ports and marks an important lesson learned to equally engage the different target groups, depending on the individual port context.

If you would like to start the stakeholder engagement process, please have a look into the Stakeholder groups and methods of engagement in our PIONEERS GPMP toolbox.

*Table 2: Classification of stakeholders*

| Group                                         | Usual members                                                                                      | Main contribution                                               |
|-----------------------------------------------|----------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|
| <b>Internal stakeholders</b>                  | Port authority, port management, departments (sustainability, finance, procurement, legal, IT)     | Institutional continuity, budget, data, implementation capacity |
| <b>Legislation &amp; public policy</b>        | EU/national/regional/local authorities, ministries, regulators                                     | Legitimacy, funding access, regulatory alignment                |
| <b>Businesses &amp; operators</b>             | Terminal operators, shipping lines, logistics companies, energy/fuel suppliers, industrial tenants | Operational feasibility, investment, emissions reduction        |
| <b>Communities &amp; local neighbourhoods</b> | Residents, local NGOs, community groups, media                                                     | Social acceptance, local legitimacy                             |
| <b>Education &amp; research</b>               | Universities, research institutes, training bodies                                                 | Evidence, innovation, technical validation                      |

- ✖ **When selecting the stakeholders start from the port real ecosystem, not from a generic stakeholders list.**
- ✖ **Use the five PIONEERS groups as a common structure but adapt them to your local context.**
- ✖ **Do not group stakeholders only by the organisation type. Check their role in the GPMP.**
- ✖ **Review stakeholder groups during each GPMP phase.**

### 1.1.3 Mapping stakeholders

PIONEERS ports managed the stakeholder activity and assessed their role and importance in the GPMP process since 2022. The exercise reveals that power and interest of the stakeholders was changing: Internal and business

stakeholders changed clearly their interest and role between the Discover and Deliver phases in every port, indicating the value of a continuous engagement process. The continuous stakeholder monitoring helps the ports to decide who and how to engage based on their **power** and **interest in GPMP mapping**, visualised on a heatmap, (Figure 2). The stakeholder position on the heatmap helps to better define the engagement strategy with the respective stakeholder. Each combination of power and interest fed directly into one of the five engagement strategies, from Co-exist to Integrate.

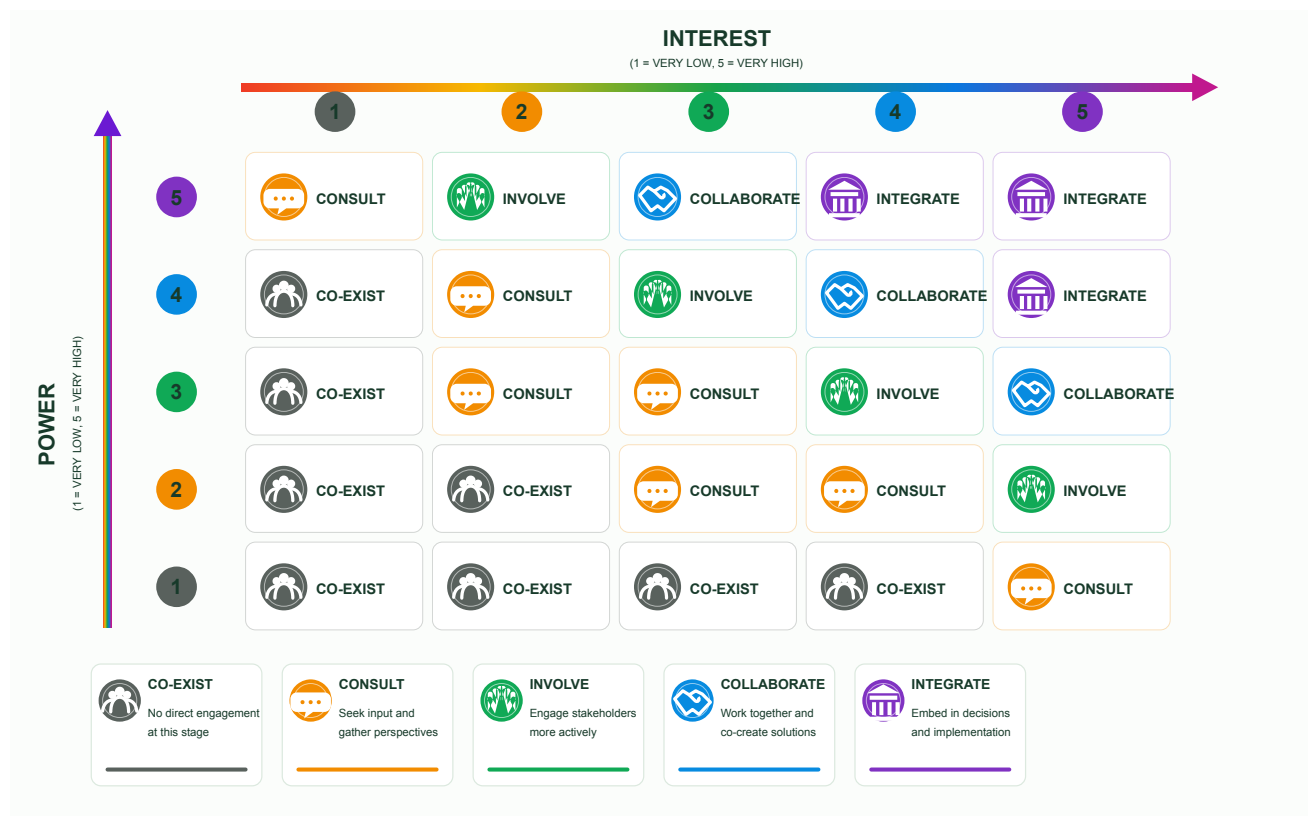


Figure 2: Mapping the stakeholders and the strategies to engage them (source: EIP own design)

The Engagement strategies and sample engagement plan is a step-by-step procedure to map the stakeholders and to determine the engagement strategy and it is available for you in our GPMP-toolbox.

- ✖ Use the heatmap as a guide, not as a rigid rule.
- ✖ Track how engagement evolves within each stakeholder group over time. The same group can, and should, move on the Co-exist – Integrate ladder during the GPMP development phases.
- ✖ Different groups may sit at different position on the heatmap, reflecting the group role in the GPMP respective phase.
- ✖ Pay attention to the groups with limited engagement.

### 1.1.4 Stakeholder Engagement methods

Each of the PIONEERS ports used a mix of engagement methods, depending on the GPMP development stage and the particular topic area. Broad formats, such as workshops or surveys were mainly chosen in the early phases, followed by co-creation and bilateral formats as the GPMP process further developed. Main methods used in PIONEERS ports are presented in Table 3.

Table 3: Methods applied by PIONEERS ports for stakeholder engagement

| Method                                | Best for                                                        | When to use                                                                       |
|---------------------------------------|-----------------------------------------------------------------|-----------------------------------------------------------------------------------|
| <b>Questionnaires, surveys</b>        | Broad, quantifiable input                                       | Good early evidence base, need to reach many actors                               |
| <b>Interviews</b>                     | Sensitive or complex topics                                     | Use when being in a group would limit openness                                    |
| <b>Workshops</b>                      | Co-creation, priority-setting, validation                       | Best for Define and Develop phases                                                |
| <b>One-to-one, bilateral meetings</b> | Investment decisions, operational constraints, sensitive issues | Essential once the GPMP is closer to the delivery                                 |
| <b>Focus groups</b>                   | In-depth feedback from a defined group                          | Useful for testing draft measures                                                 |
| <b>Hackathon, ideathon</b>            | Students, academia, internal teams, businesses, developers      | Fresh ideas or prototypes for a specific problem, especially in the Develop phase |
| <b>Conferences, public events</b>     | Dissemination, awareness, network-building                      | Not for detailed negotiation                                                      |

A comprehensive list of methods and communication channels is available for you in our GPMP-toolbox.

#### Quick checklist before choosing an engagement method:

- ☐ What decision or input do we need from this stakeholder?
- ☐ Is the topic commercially or politically sensitive?
- ☐ Do we need numbers or reasoning?
- ☐ What engagement strategy we should apply for this stakeholder?
- ☐ Will one session be enough or does this need a recurring format?

### 1.1.5 Engagement barriers and actions

Every PIONEERS port faced internal and external barriers during the stakeholder engagement process. For example, all four PIONEERS ports reported that the 2050 horizon of the GPMP felt too distant for

businesses focused on daily operations. Translating the long-term goals into the short-term, concrete actions (pilots, infrastructure upgrades, funding calls) is a solution to cope with this barrier.

In general, internal barriers relate to the port authority's own capacity, culture, organisation and way of working. External barriers relate to stakeholders, market conditions, policy uncertainty or the wider port ecosystem (Table 4). In PIONEERS we learned that the barrier identification should be made early because they affect the quality, timing and depth of GPMP engagement. An extensive barriers list identified with possible causes and possible mitigation actions is available in the GPMP toolbox. .

*Table 4: Barriers for engagement and mitigation solutions (examples of the most common ones)*

| Type            | Barriers                                                                                                                                                                       | How to overcome them                                                                                                                                                                                                                                                               |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Internal</b> | Weak engagement culture, internal silos, uncoordinated outreach, capacity and/or data gaps, unclear use of stakeholder input                                                   | Assign clear ownership, create an internal GPMP coordination group, centralise outreach, build capacity or use external consultants for peak loads, log input and show how it shapes the GPMP.                                                                                     |
| <b>External</b> | Lack of time/resources, wrong or missing stakeholder, long time horizon feels irrelevant, weak interest, lack of trust, cost concerns, technical and/or regulatory uncertainty | Keep requests concrete, translate the GPMP objectives into short-term action, link actions to concrete benefits and duties, be transparent about how stakeholder's input is used, discuss funding and phasing early, involve regulators and use pilots and/or feasibility studies. |

The engagement barriers show that the GPMP process needs better design. By acknowledging these barriers early, the ports will choose better methods for engagement, target the right stakeholders and turn engagement into a core part of the GPMP process.

#### **Rules for stakeholder engagement:**

- ✦ **Engage relevant stakeholders from the beginning, do not wait to finalise the GPMP and then to discuss it with the stakeholders**
- ✦ **Fix internal barriers first. Coordination, culture and capacity gaps weaken every external engagement effort.**
- ✦ **Match engagement activities to the GPMP phase and to each stakeholder's position on the power/interest heatmap.**
- ✦ **Combine formats of engagement, never rely on a single method.**
- ✦ **Keep evidence (surveys, minutes, etc.) of the discussions held. It helps moving the conversations from opinion to action.**
- ✦ **Set a permanent structure (community, working group, task force, etc.) to implement the GPMP process. Moreover, don't forget that the engagement does not end when GPMP is delivered!**

## 1.2 Best practise example: Stakeholder engagement in the Port of Venlo

The transition towards a climate-neutral port cannot be achieved by a port authority or municipality acting alone. GPMPs require coordinated action by public authorities, businesses, infrastructure operators, knowledge institutions and society because many of the required investments, regulatory changes and operational improvements fall outside the responsibility of a single organisation. Stakeholder engagement therefore serves two complementary purposes: First, it improves the quality of the analysis by incorporating practical knowledge from those directly involved in port operations. Second, it creates ownership of the transition process, increasing the likelihood that the roadmap will be implemented successfully.

The PoV provides a good practice example because stakeholder engagement was not organised as a single consultation exercise at the end of the planning process. Instead, stakeholders were involved throughout the development of the GPMP, from validating the Landscape Analysis and identifying priorities to refining projects, evaluating innovation opportunities and developing the implementation roadmap. Two workshops, an ideathon and continuous one-to-one discussions were carried out during the development of the GPMP. This continuous engagement transformed the GPMP from an expert-driven document into a jointly developed transition strategy that reflects both long-term policy ambitions and operational realities.

The PoV engaged stakeholders to further define, refine and validate various levels of the MLP process. At the **Landscape level**, stakeholders validated the interpretation of global megatrends, national policy developments and regional dynamics, ensuring that the analysis reflected local conditions while remaining aligned with European and Dutch transition objectives. This was particularly important because many landscape developments, such as climate change, energy transition and digitalisation, influence ports indirectly and therefore require local interpretation before they can inform strategic planning. At the **Niche level**, stakeholders assessed innovative technologies and organisational concepts emerging from the PIONEERS project and other initiatives. Together they evaluated which innovations were technically feasible, organisationally acceptable and sufficiently mature to be included in the roadmap. In this way, stakeholder engagement connected external transition pressures with existing port practices and future innovation pathways, strengthening the overall robustness of the GPMP.

### 1.2.1 A Broad and Inclusive Stakeholder Ecosystem

One of the strengths of the PoV approach was the diversity of organisations involved. Rather than limiting participation to port operators, the GPMP engaged representatives from public authorities, infrastructure managers, logistics companies, industry, universities, business associations and neighbouring ports.

The validation workshop alone brought together twenty-one participants representing consultancies, universities, the Municipality of Venlo, the Province of Limburg, Rijkswaterstaat, terminal operators, logistics companies, energy companies, business associations including Limburg Waterboard, Supply Chain Valley Limburg and KBN, together with representatives from the Port of Antwerp-Bruges. This ensured that strategic decisions reflected multiple perspectives and that dependencies between organisations became visible early in the planning process. The wider governance structure of the PoV GPMP further strengthened this collaborative approach. Besides the municipality, organisations such as BluePorts Limburg, Supply Chain Valley Limburg, Brightlands Institute for Supply Chain Innovation, Rijkswaterstaat and the Limburg Water Board all contribute to the functioning and future development of the port ecosystem. The GPMP therefore recognised governance as a network rather than a single institutional actor.

### 1.2.2 From Consultation to Co-Creation

A distinguishing feature of PoV GPMP creation is that stakeholders actively shaped the content of the GPMP instead of merely reviewing completed analyses. During the first workshop, participants identified and prioritised projects across themes including green shipping, terminals, energy systems, circular economy, spatial planning and governance. Most priority actions were placed in the 2025–2030 implementation period, demonstrating consensus on the urgency of early action.

The workshops also identified three cross-cutting strategic priorities:

- Energy system transformation through renewable energy, grid reinforcement and energy hubs;
- Modal shift and zero-emission logistics through stronger inland shipping, rail and electrified last-mile transport;
- Spatial and governance modernisation to support sustainable port growth.

These priorities subsequently formed the backbone of the Venlo GPMP. The second workshop focused on validation rather than repeating the first exercise. Participants challenged assumptions, refined priorities and translated broad ambitions into realistic implementation actions. This iterative process significantly strengthened the strategic quality of the GPMP.

The PoV also demonstrated that stakeholder engagement benefits from combining professional expertise with new perspectives. In addition to formal workshops, the GPMP included a multidisciplinary student ideathon in which independent student teams developed innovative concepts for a climate-neutral port without prior exposure to stakeholder results. Interestingly, many student proposals reinforced themes already identified during the workshops, validating the robustness of the stakeholder process. Other ideas expanded the solution space by introducing concepts related to shared infrastructure, digital coordination, automation and circular value creation. The winning concept proposed a central sustainability governance model coordinating investments, shared infrastructure and performance monitoring across the port ecosystem.

### 1.2.3 Improving the Quality of Strategic Decisions

Perhaps the greatest contribution of stakeholder engagement was not simply identifying projects but improving the quality of strategic decision-making.

Several examples illustrate this process:

- Electrification evolved from a discussion about charging infrastructure into a broader energy system challenge involving electricity grid capacity, shared energy infrastructure and coordinated energy governance.
- Rail transport priorities shifted towards general cargo rather than container transport after operational stakeholders clarified expected demand.
- Spatial planning discussions resulted in concrete proposals for protecting waterfront functions, relocating incompatible land uses and intensifying industrial land use.
- Digitalisation moved from being viewed as a supporting technology to becoming recognised as essential infrastructure underpinning energy management, logistics coordination and circular supply chains.

These refinements ensured that the final roadmap addressed systemic challenges rather than isolated technological solutions.

### 1.2.4 Integrating Stakeholder Engagement into the GPMP

Rather than concluding once the roadmap had been completed, stakeholder engagement became part of the implementation strategy itself. The GPMP includes a dedicated stakeholder engagement programme, recognising that implementation requires continuous collaboration throughout the Foundation (2025–2030), Scale-up (2030–2040) and Transformation (2040–2050) phases. Successful implementation depends on strong governance, capacity building within the municipality, transparent monitoring and sustained cooperation between regional and national partners.

This long-term perspective reflects one of the key lessons from the Landscape Analysis: because megatrends, policies and technologies continue to evolve, stakeholder engagement must also remain continuous to ensure that the Green Port Master Plan adapts to changing conditions while maintaining strategic direction.

### 1.2.5 Key Lessons from the Port of Venlo

The Port of Venlo demonstrates that effective stakeholder engagement extends well beyond consultation. Its success lies in embedding participation throughout the entire GPMP process—from interpreting global megatrends and validating analyses to identifying projects, refining priorities and supporting implementation. The process combined evidence-based analysis with practical operational knowledge, creating a roadmap that is technically sound, broadly supported and implementable.

For other ports developing a GPMP the principal lesson is that stakeholder engagement should be organised as an iterative co-creation process rather than a single consultation event. Engaging a diverse range of actors throughout the planning cycle improves the quality of strategic decisions, strengthens ownership of the transition pathway and increases the likelihood that long-term sustainability objectives can be translated into coordinated action.

## 1.3 Practical methods for stakeholder engagement

### What it is

In the development of a GPMP, your port stakeholders play a key role. Stakeholder engagement is a collaborative process to involve an active participation of your stakeholders with mutual effort and cooperation. The following section provides you with a methodology for the stakeholder engagement process based on the experiences and lesson's learned of the PIONEERS project.

### How to use it: Step-by-step approach for stakeholder engagement - a practical “to do” list

#### Step 1: Define the engagement scope

Begin with defining what the GPMP aims to achieve, which time horizon it covers, which topics will be addressed and what kind of stakeholder input is needed. This framework guides the stakeholder mapping and helps ports identify the relevant stakeholder for each topic. This provides the stakeholder engagement process with a clear reference point. Clarify what are the stakeholder needs and how their inputs will be used in the GPMP development process. The input may include data, validation, support, funding, technical input, policy alignment or social acceptance. Questions:

- What is the main goal, time horizon and the approach for GPMP elaboration?
- Which topics or decisions require stakeholder input?
- Which measures need external cooperation?
- Which stakeholders may support or block implementation?
- Which groups may be affected by the GPMP?

✱ **Clear objectives prevent waste of time. Every stakeholder contacted should be linked to a clear engagement need.**

#### Step 2: Build the stakeholder inventory

Create a working file with all relevant stakeholders. Include:

- Organisation name;
- Contact person;
- Stakeholder group and their type, e.g. Internal, Legislation & public policy, Businesses & operators, Communities & local neighbourhoods, Education & research;
- GPMP pillars involved, e.g. Clean energy, Sustainable design, Modal shift, Digital transformation;
- Dimension of influence, e.g. Political, Economic, Social, Technical, Operational, Environmental;
- Power level;
- Interest level;
- Expected role (reason for engaging);
- Engagement strategy;
- Engagement barriers with this stakeholder and ways to address them;
- Follow-up action.

- **Treat the inventory as a living tool. Update it after each interaction, such as meetings, surveys, workshops and major GPMP milestones. It is the basis for tracking how power and interest of a stakeholder shift as the GPMP process is implemented.**

### Step 3: Determine the engagement strategy

Classify stakeholders by power, interest and role in the GPMP process. This helps the port deciding how much effort to invest in the relationship with each of the stakeholders, and to decide which is the right engagement approach.

PIONEERS used a 5-phase engagement strategy, as presented in the Table xx below. This allowed the ports to better tailor the engagement activities for each of the GPMP process' phases by using the right engagement method/tool in order to maximise the engagement of the relevant stakeholders:

Table 5: Engagement strategies

| Engagement strategy (phases) | Goal                                                                        | When to use                                    |
|------------------------------|-----------------------------------------------------------------------------|------------------------------------------------|
| <b>Co-exist</b>              | Keep basic awareness                                                        | Stakeholder has low role in the current phase  |
| <b>Consult</b>               | Ask for feedback                                                            | Stakeholder can provide useful views           |
| <b>Involve</b>               | Include stakeholders in selected activities                                 | Stakeholder has relevant knowledge or interest |
| <b>Collaborate</b>           | Work jointly with stakeholders on measures                                  | Stakeholder can help shape or deliver actions  |
| <b>Integrate</b>             | Involve stakeholders in the GPMP decision and create a new governance model | Stakeholder is critical for implementation     |

- ✱ **Not all stakeholders need to be integrated. A mature GPMP uses different strategy for engagement for different actors.**

### Step 4: Prepare an engagement plan

The engagement plan should reflect who will be engaged, why, when and how. It should be realistic. A small port team should not plan more activities than it can manage.

The plan should include:

- Objectives;
- Target groups;
- Strategy
- Methods;
- Timeline;
- Internal responsibilities;
- Expected outputs;
- Communication channels;
- Follow-up process;
- Risks and mitigation actions.

Table 6: Example of engagement activity plan:

| Engagement activity focus                  | Planned date | Type of stakeholder                                          | Engagement strategy      | Method                | Stakeholders engaged                                        | Expected outcome                                                     |
|--------------------------------------------|--------------|--------------------------------------------------------------|--------------------------|-----------------------|-------------------------------------------------------------|----------------------------------------------------------------------|
| <i>e.g. Draft GPMP validation workshop</i> | Q1           | <i>Business operator, Legislation &amp; policy, Internal</i> | <i>Consult / Involve</i> | <i>Workshop</i>       | <i>Terminal operators, local authorities, internal team</i> | <i>Feedback on draft GPMP; barriers and opportunities identified</i> |
| <i>e.g. Energy transition</i>              | Q2           | <i>Business operator</i>                                     | <i>Collaborate</i>       | <i>1-to-1 meeting</i> | <i>Energy provides</i>                                      | <i>Clarify investment conditions</i>                                 |

*Recommendation: review and refresh the plan each year or quicker, cross-checking it against the master inventory (Annex 1, Step 2). The Engagement strategy column should match the stakeholder's current position on the power/interest heatmap. If it doesn't, this signals either the activity is over- or under-ambitious for that stakeholder, or the stakeholder's assessment needs revision.*

✖ **A written plan turns engagement from ad-hoc contact into a manageable, resourced activity.**

### Step 5: Engage meaningfully

Before each engagement activity define the expected output. This may be a validated priority, obtaining a list of barriers in developing the GPMP, a technical requirement, a data source, a funding need or a revised action. After each activity, record:

- Who participated;
- What was discussed;
- What was agreed;
- What concerns were raised;
- What follow-up is needed;
- How the GPMP should be altered/updated/improved.

✖ **Recording outputs is what turns individual meetings into a body of evidence for the GPMP.**

### Step 6: Use evidence to support dialogue

Stakeholders engage more actively when the GPMP is concrete. Ports should use data to support discussion. Useful evidence includes:

- Carbon footprint baselines;
- Energy demand studies;
- Emissions inventories;
- Mobility surveys;
- Infrastructure assessments;
- Cost estimates;
- Feasibility studies;
- Technology readiness checks;
- Regulatory mapping;
- Transferability assessments.

- ✖ **Evidence helps move the discussion from general ambition to practical choices.**

### Step 7: Close the feedback loop

Stakeholders need to see that their input matters. After each main engagement activity, the port should provide feedback. This could be done through:

- Short meeting notes;
- Summary emails;
- Updated roadmap tables;
- “You said, we did” summaries;
- Public progress updates;
- Revised action fiches.

- ✖ **Closing the feedback loop builds trust and reduces fatigue.**

### Step 8: Prepare post-delivery engagement

The GPMP process should not end with its formal approval. The GPMP implementation needs permanent or semi-permanent cooperation. Possible structures include:

- A port community;
- An interdepartmental GPMP group;
- A stakeholder advisory board;
- Technical working groups;
- Annual stakeholder map updates;
- A monitoring-reporting-verification cycle.

- ✖ **The stakeholder engagement should continue even after the GPMP has been defined, throughout its delivery (roadmap); this approach should be tailored to the size and the governance model of the port.**

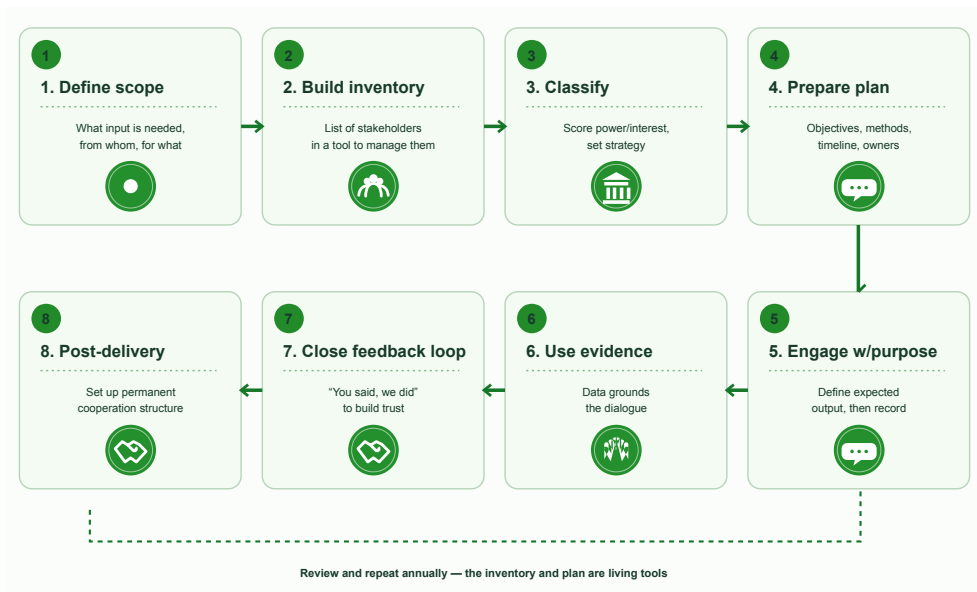


Figure 3: Overview of the Step-by-step approach for stakeholder engagement

### 1.3.1 Stakeholder groups and methods of engagement

Use this list as a starting checklist during the Discover phase. It is not exhaustive, each port should add categories specific to its own context, but it prevents relevant groups from being missed.

#### 1. Internal stakeholders

*Usual members:* Port authority, Port management, Employees, Trade unions, Shareholders, Board members, Harbourmaster

*How to engage them:*

- ✓ Create an internal GPMP working group;
- ✓ Clarify roles and decision rights;
- ✓ Involve departments before external commitments are made;
- ✓ Check whether the roadmap fits existing plans and budgets;
- ✓ Use internal meetings to prepare common messages.

#### 2. Legislation & public policy stakeholders

*Usual members:* European regulatory bodies, Ministries (transport/infrastructure, environment, etc.), Regional authorities, Local authorities, Neighbouring municipalities, Regional/local transport authority, Politicians and other decision-makers, Health & safety authorities, Customs

*How to engage them:*

- ✓ Involve them early, not only at the end;
- ✓ Clarify which measures depend on external approval;
- ✓ Connect the GPMP with regional, national and EU policy;
- ✓ Use policy dialogue to reduce future delays;
- ✓ Keep a record of dependencies and decisions needed.

#### 3. Businesses & operators

*Usual members:* Shipping companies, National/regional/local business associations (Chambers of commerce, professional associations), terminal operators, rail operators, barge operators, logistic operators, nautical service operators, Cargo handling operators, bunkering service providers, Trucking companies, Cruise lines, Industrial companies, towing service providers, public transport service providers, ICT and utility service providers, international business associations

*How to engage them:*

- ✓ Start with mapping and interviews;
- ✓ Use workshops for shared priorities;
- ✓ Use bilateral meetings for sensitive topics;
- ✓ Discuss costs, business cases and risks openly;
- ✓ Link long-term goals to short-term operational benefits.

#### 4. Communities & local neighbourhoods

*Usual members:* National/Local environmental NGOs, local authority forums, local community organisations, special interest groups, media, citizens, community groups, tourists and passengers, foundations

*How to engage them:*

- ✓ Create simple and clear communication materials;
- ✓ Explain local benefits and possible impacts;
- ✓ Use public sessions, surveys and local forums;
- ✓ Involve workers and local education bodies;
- ✓ Keep community input visible in the GPMP process.

## **5. Education & research**

*Usual members:* Universities, training & research institutions, Experts from other cities/ports

*How to engage them:*

- ✓ Invite them to support baselines and studies;
  - ✓ Use them in ideation and validation sessions;
  - ✓ Involve them in monitoring and skills development;
  - ✓ Connect research outputs with practical port needs;
  - ✓ Avoid purely academic discussions without operational value.
- ✱ **A single organisation/entity may appear in more than one category over time (e.g. a local authority may act as a public policy stakeholder during the initial phases of the GPMP and later as a partner for mobility or community related measures). Update the category if the relationship changes.**

## 1.3.2 Mapping stakeholders and engagement strategies

### How to determine the Power/Interest heatmap and engagement strategy:

1. List every stakeholder identified in the Discover phase.
2. Assess the Power (1–5) and Interest (1–5) for each of the stakeholders. Use the level definition below.
3. Locate the cell on the heatmap. The cell represents the engagement strategy: Co-exist → Consult → Involve → Collaborate → Integrate.
4. Revise the assessment at least once a year, or quicker if necessary. Power and Interest shift as the GPMP moves from planning to delivery. In practice, PIONEERS ports experienced internal and business stakeholders' scores change significantly between the Discover and Deliver phases.
5. Use the strategy as a default, not a maximum. A stakeholder can be deliberately engaged more intensively than their assessment suggested initially, if their cooperation is critical to a specific measure or phase in the process.

Table 7: Power levels (1–5)

| Score | Level     | Definition                                                              |
|-------|-----------|-------------------------------------------------------------------------|
| 5     | Very high | Can direct or have a major impact on the GPMP                           |
| 4     | High      | Can significantly affect the GPMP's scope, schedule or budget           |
| 3     | Moderate  | Can have a minor impact on the GPMP                                     |
| 2     | Low       | Cannot directly impact the GPMP, but may have access to someone who can |
| 1     | Very low  | Cannot directly impact the GPMP                                         |

Table 8: Interest levels (1–5)

| Score | Level     | Definition                                              |
|-------|-----------|---------------------------------------------------------|
| 5     | Very high | Strong interest in the GPMP's success and outcomes      |
| 4     | High      | Highly supportive of the GPMP and its benefits          |
| 3     | Moderate  | Sees a benefit in the GPMP                              |
| 2     | Low       | Sees some harm from the GPMP, would prefer it stopped   |
| 1     | Very low  | Believes the GPMP's costs are greater than its benefits |

Table 9: Engagement strategy goals

| Strategy           | Goal                                                              | When to use                                                   |
|--------------------|-------------------------------------------------------------------|---------------------------------------------------------------|
| <b>Co-exist</b>    | Keep the stakeholder informed to help them understand the process | The stakeholder has a limited role in the current phase       |
| <b>Consult</b>     | Obtain the stakeholder's feedback on relevant planning decisions  | The stakeholder can provide useful views                      |
| <b>Involve</b>     | Rely on the stakeholder's advice when making planning decisions   | The stakeholder has relevant knowledge, interest or influence |
| <b>Collaborate</b> | Work jointly with the stakeholder to design                       | The stakeholder can help shape or deliver                     |

|                  |                                                                              |                                                |
|------------------|------------------------------------------------------------------------------|------------------------------------------------|
|                  | solutions and recommendations                                                | actions                                        |
| <b>Integrate</b> | Embed the stakeholder's ideas, experience and proposals directly in the GPMP | The stakeholder is critical for implementation |

- ✖ **Assess each stakeholder on both dimensions. An incomplete assessment leads to a wrong engagement strategy.**
- ✖ **Re-assess annually or any time when the GPMP moves from one phase to another.**

### 1.3.3 Engagement methods and communication channels

Table 10: Engagement methods

| Method                                | Audience                                                   | Best used for                                                                                                                                                       |
|---------------------------------------|------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Questionnaire</b>                  | Businesses, NGOs, public bodies, citizens                  | Broad, quantifiable input at low cost                                                                                                                               |
| <b>Needs survey</b>                   | Businesses, citizens, NGOs                                 | Identifying areas of interest for follow-up                                                                                                                         |
| <b>Interview</b>                      | Public bodies, businesses                                  | In-depth or sensitive topics needing individual input                                                                                                               |
| <b>Focus group</b>                    | Businesses, NGOs, public bodies                            | Detailed feedback from a small, defined group                                                                                                                       |
| <b>Online shared whiteboard</b>       | Key/high-influence stakeholders                            | Remote visual co-creation                                                                                                                                           |
| <b>Collaborative research</b>         | Academia, research centres, public bodies                  | Embedding stakeholders directly in analysis                                                                                                                         |
| <b>Creative lab</b>                   | Key/high-influence stakeholders                            | Exploring new solutions jointly                                                                                                                                     |
| <b>Think tank</b>                     | Academia, public bodies                                    | High-level policy advice                                                                                                                                            |
| <b>Workshop</b>                       | Businesses, NGOs, public bodies                            | Co-creation, problem-solving, validation                                                                                                                            |
| <b>Hackathon / ideathon</b>           | Students, academia, internal teams, businesses, developers | Fast, intensive co-creation of concrete ideas or prototypes for a specific problem engages younger/technical audiences and brings new thinking to the GPMP process. |
| <b>Public meeting</b>                 | Businesses, citizens, NGOs, public bodies                  | Wide awareness-raising, transparency                                                                                                                                |
| <b>1-to-1, bilateral meeting</b>      | Any, especially business/investment actors                 | Sensitive, commercial or investment-related discussion                                                                                                              |
| <b>Site visit, knowledge exchange</b> | Any                                                        | Discussion based on practice in operational reality, peer learning                                                                                                  |

Table 11: Communication channels

| Channel                              | Audience                                      | Use                                        |
|--------------------------------------|-----------------------------------------------|--------------------------------------------|
| <b>Email</b>                         | Businesses, NGOs, public bodies               | Quick, direct, low-cost contact            |
| <b>Newsletter</b>                    | All                                           | Regular, digestible updates                |
| <b>Official letters or documents</b> | Public bodies                                 | Formal decisions, agreements, invitations  |
| <b>Press release</b>                 | Citizens, NGOs                                | Wide, immediate dissemination              |
| <b>Social media</b>                  | Citizens, businesses, NGOs                    | Awareness, informal engagement             |
| <b>Video conference</b>              | All                                           | Low-cost remote participation              |
| <b>1-to-1 discussions</b>            | All, especially with decision-critical actors | Trust-building, sensitive decisions        |
| <b>Presentation</b>                  | All                                           | Structured information-sharing, persuasion |
| <b>Video</b>                         | Citizens, NGOs, businesses                    | Wide, accessible explanation               |

✳ **How to apply? Cross-reference the method/channel with the stakeholder's position on the power/interest heatmap. For instance, "Co-exist" stakeholders are well addressed by newsletters**

and public meetings, while "Integrate" stakeholders should be addressed by 1-to-1 meetings and workshops.

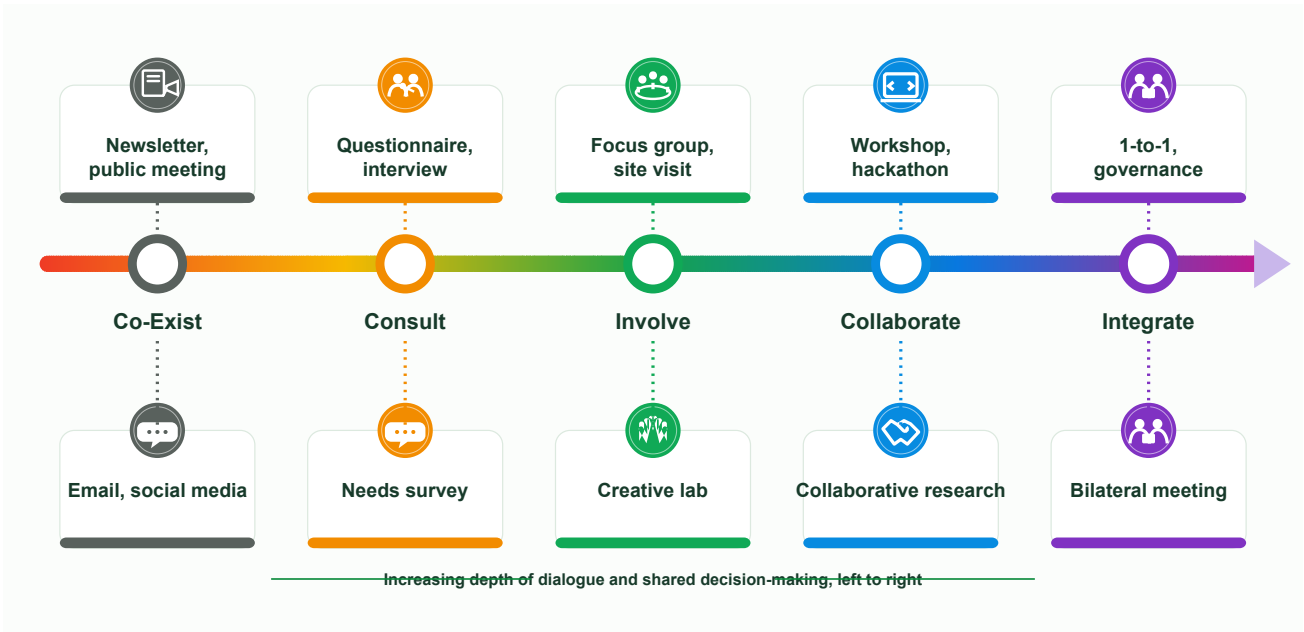


Figure 4: Engagement consortium

## 1.3.4 Engagement barriers

Table 12: Internal barriers

| Barrier                                                          | Possible cause                                                                                   | How to overcome it                                                                                                        |
|------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|
| <b>Weak internal engagement culture</b>                          | No prior practice in working together, functional and technical departments working in isolation | Start with internal alignment before external outreach; assign clear ownership                                            |
| <b>Internal silos</b>                                            | Departments working separately, no shared coordination                                           | Create an internal GPMP coordination group                                                                                |
| <b>Uncoordinated outreach across departments</b>                 | Multiple departments or projects contacting the same stakeholders independently                  | Avoid repeating requests to stakeholders by using centralised communications.                                             |
| <b>Data or capacity gaps in the port organisation</b>            | Small teams, competing project demands                                                           | Build internal capacity early; use external consultants for high-load tasks (surveys, feasibility studies)                |
| <b>Lack of time (project team)</b>                               | Competing internal priorities, understaffed engagement function                                  | Use short, focused and well-prepared meetings                                                                             |
| <b>Lack of resources (project team)</b>                          | Limited budget and/or staff dedicated to engagement                                              | Focus first on stakeholders linked to priority measures                                                                   |
| <b>Difficulty finding the right contact</b>                      | Complex stakeholder landscape and weak internal knowledge of existing relationships              | Account managers, customer relations teams and public affairs personnel can act as admins                                 |
| <b>Unclear importance of the stakeholder engagement exercise</b> | Engagement is seen as an optional or secondary to technical work                                 | Explain the importance of engagement to the management. Link this activity with the GPMP approval and funding conditions. |
| <b>Unclear use of stakeholder input</b>                          | No clear process for recording, analysing or feeding input into the GPMP                         | Use a feedback log and show how stakeholder input affects actions, priorities or roadmap updates                          |
| <b>Communicating the GPMP too abstractly</b>                     | Long-term strategy is not translated into practical messages                                     | Prepare simple messages for each stakeholder group, linking the GPMP to concrete actions, duties and benefits             |

Table 13: External barriers

| Barrier                                                          | Possible cause                                                                                                         | How to overcome it                                                                                                                                   |
|------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Stakeholders lack of time or resources</b>                    | Competing priorities, short-term operational pressure                                                                  | Keep requests specific and timed, link participation to tangible business relevance                                                                  |
| <b>Long time horizon feels irrelevant (2050)</b>                 | Strategic framing without near-term milestones                                                                         | Translate the GPMP into short-term actions, such as pilots, infrastructure upgrades, funding calls or regulatory milestones                          |
| <b>Weak interest</b>                                             | Stakeholders do not see personal or organisational relevance of the GPMP                                               | Link the GPMP to concrete benefits and duties, such as compliance, efficiency, funding, customer demand, market readiness or risk reduction          |
| <b>Stakeholder representative lack decision-making authority</b> | The person attending engagement activities cannot influence their organisation decision on the GPMP.                   | Confirm that the invited representative has decision-making authority. If not, request a mandated person                                             |
| <b>Wrong or limited stakeholder identification</b>               | Difficulties in identifying all relevant stakeholders, especially those outside their usual network                    | Use a structured mapping checklist ( <b>Annex 2</b> ). Cross check identification across departments and with peer ports. Revise the list each year. |
| <b>Lack of trust</b>                                             | Low prior cooperation, unclear motives or fear that input will not be used                                             | Be transparent about the purpose of engagement, decision limits and follow-up actions. Be clear about how their input will be used                   |
| <b>Cost concerns</b>                                             | Perceived or real cost of participation or of proposed measures                                                        | Discuss funding, incentives, phasing, cost-sharing and business cases early                                                                          |
| <b>Technical uncertainty</b>                                     | Immature technologies, lack of proven solutions, unclear infrastructure needs                                          | Use pilots, feasibility studies and expert sessions                                                                                                  |
| <b>Regulatory uncertainty</b>                                    | Unclear policy framework, permitting risks, changing requirements                                                      | Involve public authorities and regulators early; clarify which measures depend on external approval                                                  |
| <b>Stakeholder fatigue</b>                                       | Repeated consultations without visible outputs                                                                         | Avoid repeated consultations without showing results; space out asks                                                                                 |
| <b>Low community or social engagement</b>                        | Technical structure limits social dialogue                                                                             | Create dedicated, simple social dialogue channels, such as open sessions, local forums                                                               |
| <b>Dependence on external actors</b>                             | Implementation relies on grid operators, national regulation and government, funding bodies, etc. outside port control | Map dependencies early and build coalitions with those actors and around critical measures                                                           |
| <b>Market uncertainty</b>                                        | Alternative fuels, energy prices or green logistics demand are still unclear                                           | Use flexible scenarios, phased measures and regular roadmap updates                                                                                  |
| <b>Limited data from stakeholders</b>                            | Commercial sensitivity, lack of monitoring systems or no common data format                                            | Explain why data is needed, protect sensitive information and start with simple data requests                                                        |

- ✱ **Identify whether a barrier is internal or external before choosing how to address it, as they require different approaches.**
- ✱ **Address internal barrier first, as weak coordination, culture or capacity within the port will weaken any effort to address external barriers.**
- ✱ **Revise the barriers regularly, as they could change as GPMP evolves.**



## 1.4 Determine your current environmental footprint

### 1.4.1 Purpose and scope

Ports need a clear greenhouse gas (GHG) footprint to understand where emissions occur, set priorities, and monitor progress towards decarbonisation. A port inventory should therefore do more than produce a reporting figure: it should support investment decisions, stakeholder dialogue, regulatory compliance, and the design of practical decarbonizing measures.

The main challenge is that ports are complex ecosystems. The port authority may own or control only a limited share of the activities that generate emissions, while ships, terminals, logistics operators, service providers, tenants, construction contractors, passengers, workers, and public authorities all influence the final footprint. For this reason, the inventory must clearly state its boundaries, data sources, assumptions, and level of influence over each emission source.

#### Inventory structure

Most inventories follow recognised carbon accounting frameworks. The GHG Protocol classifies emissions as Scope 1, Scope 2 and Scope 3: direct emissions from owned or controlled sources, indirect emissions from purchased energy, and other indirect value-chain emissions. ISO 14064-1 provides a compatible organisation-level approach for quantifying and reporting GHG emissions and removals. Both frameworks rely on the same basic principles: relevance, completeness, consistency, transparency and accuracy.

For ports, defining inventory boundaries is a central challenge. A ship at berth, a terminal crane, a truck entering the gate or waste treated off site may be connected to the port area, but the port authority may not own, operate or directly control the activity. Ports should therefore avoid treating boundaries as a simple technical choice. They should explain which activities are included, why they are included, who controls or influences them, and where a geographical view of emissions in the port area complements the organisational inventory.

#### Main emission blocks

A practical port inventory can be organised around emission blocks rather than around departments. This helps readers understand the operational reality of the port and makes the inventory more useful for action planning.

| Emission block                | Typical sources                                                             | Key data needs                                                                      |
|-------------------------------|-----------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| <b>Ships</b>                  | Anchoring, navigation, manoeuvring and hotelling at berth                   | Port calls, time in mode, vessel characteristics, fuel type and engine assumptions  |
| <b>Port services</b>          | Tugboats, pilots, bunkering barges and other marine services                | Fuel use, engine hours, service records and manoeuvre data                          |
| <b>Land transport</b>         | Trucks, rail, worker mobility and passenger mobility                        | Trips, distances, vehicle types, cargo flows, surveys and gate or traffic data      |
| <b>Tenants and terminals</b>  | Terminal equipment, logistics operations, industrial activity and buildings | Electricity, fuels, refrigerants, equipment use and renewable generation            |
| <b>Construction and waste</b> | Materials, machinery, transport, waste collection and treatment             | Material quantities, contractor reports, invoices, waste types and treatment routes |

Table 14: Main emission blocks

#### Data, methods and emission factors

The basic calculation is simple: activity data multiplied by an emission factor produces emissions expressed in tonnes of CO<sub>2</sub> equivalent. In practice, the quality of the result depends on the quality of the activity data and the suitability of the emission factor. Fuel or electricity consumption data usually provides the most direct estimate. When this is not available, ports may need to use operational data such as distance travelled, time at berth, number of calls, tonnes handled, material quantities or survey results.

Ports should use emission factors that match the geography, year, technology and activity being assessed. International sources help maintain comparability, while local factors can improve accuracy for activities shaped by regional systems, such as electricity supply or waste treatment. The inventory should record the source and year of each factor, the greenhouse gases included, and any assumptions used to convert activity data into emissions.

Data governance is as important as the calculation method. Annual data requests, common templates, clear definitions, traceable records, validation checks and confidentiality arrangements help improve consistency. Digital data flows between port authorities, tenants and service providers can reduce manual work, limit errors and allow the inventory to become a management tool rather than a one-off reporting exercise.

### 1.4.2 Key messages and recommendations

Port GHG inventories are most useful when they are designed for decision-making. They should identify the main emission hotspots, clarify which actors can influence them, and connect the results to practical decarbonisation measures. A transparent inventory also supports dialogue with operators, customers, local communities, financial institutions and public authorities.

The main barriers are limited access to tenant data, inconsistent reporting formats, confidentiality concerns, lack of dedicated resources and the absence of a harmonised port-specific methodology.

- Define the inventory boundary before collecting data, and explain whether it follows operational control, financial control, geography or a combined approach.
- Map stakeholders early and identify who generates emissions, who holds data and who can influence reductions.
- Use recognised accounting principles and document assumptions, exclusions and uncertainty.
- Prioritise high-impact emission blocks such as ships, terminals, land transport, construction and energy use.
- Develop common templates, validation procedures and digital tools to improve data quality over time.
- Use the footprint to engage with stakeholders and motivate new initiatives.

### 1.4.3 Best practise example: Analyse the greenhouse gas emissions in the Port of Constanta

The Port of Constanta developed its Green Port Master Plan (GPMP) by first establishing a comprehensive greenhouse gas (GHG) emissions baseline. The port identified and quantified the emissions generated by port authority activities and this evidence-based approach enabled to prioritise actions where they would have the greatest environmental impact.

The work followed two main steps:

1. **Calculate the port authority's greenhouse gas emissions** for the baseline year (2024) using internationally recognised accounting principles.
2. **Develop a decarbonisation strategy** based on the identified emission sources and their relative contribution to the overall carbon footprint.

To support long-term monitoring and reporting, the calculation methodology was incorporated into a digital application that enables regular updates of the emissions inventory and supports future decision-making.

#### 1. Calculate the port authority's greenhouse gas emissions

The process for calculating the port authority's greenhouse gas emissions and development a digital application was built on a on a set of premises that guided the work end-to-end illustrated graphically in the figure 1.

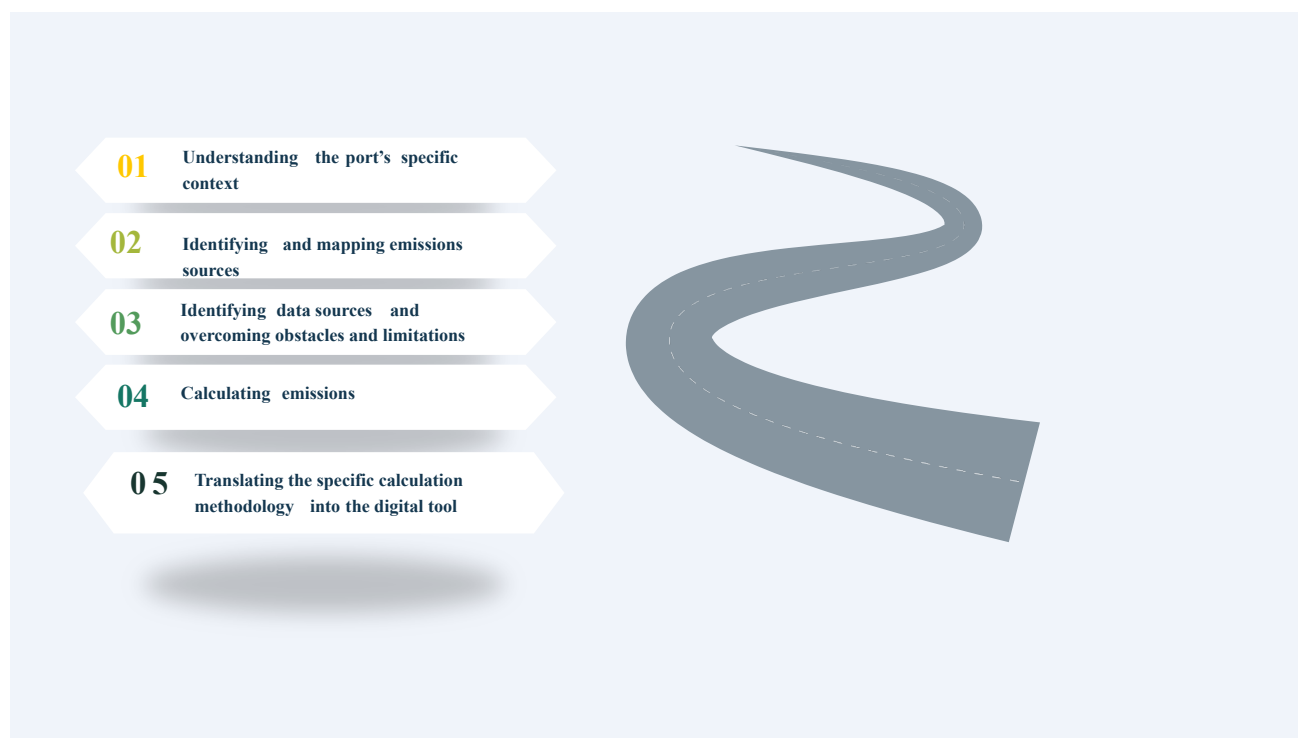


Figure 5: Process for developing the emissions baseline for the decarbonisation strategy; source: Report CO2 2024 -PoC by STRATOS

#### 1. Understanding the port context

An accurate emissions inventory begins with clearly defining the organisational and operational boundaries of the assessment. For the Port of Constanța, the inventory focuses exclusively on activities that are directly managed or controlled by the port authority in the port perimeter. This approach ensures that reported emissions reflect areas where the organisation can implement and monitor improvement measures.

The assessment includes emissions generated through the operation and maintenance of port infrastructure, energy consumption in buildings, fuel use by the vehicle fleet and technical vessels, leased assets, outsourced services, employee commuting, business travel, and procurement activities. Emissions generated by commercial shipping or by independent terminal operators are not included because these activities are outside the operational control of the port authority.

Defining these boundaries at the beginning of the process provides a transparent basis for reporting, ensures consistency over time, and allows future inventories to be compared reliably.

## **2. Identifying and Mapping Emissions Sources**

After defining the assessment boundaries, the port identified all activities that generate greenhouse gas emissions and grouped them according to GHG Protocols reporting categories. This structured approach ensures that all relevant emission sources are considered while avoiding overlaps or double counting.

The inventory distinguishes between three categories of emissions:

- **Direct emissions (Scope 1):** emissions from fuel combustion, heating systems, port vehicles, technical vessels and refrigerants owned or operated by the port authority.
- **Indirect energy emissions (Scope 2):** emissions associated with purchased electricity used in buildings and operational facilities.
- **Other indirect emissions (Scope 3):** emissions generated throughout the value chain, including purchased goods and services, waste management, business travel, employee commuting and leased assets.

Grouping emissions into these categories helps identify where the largest impacts occur and supports the development of targeted reduction measures.

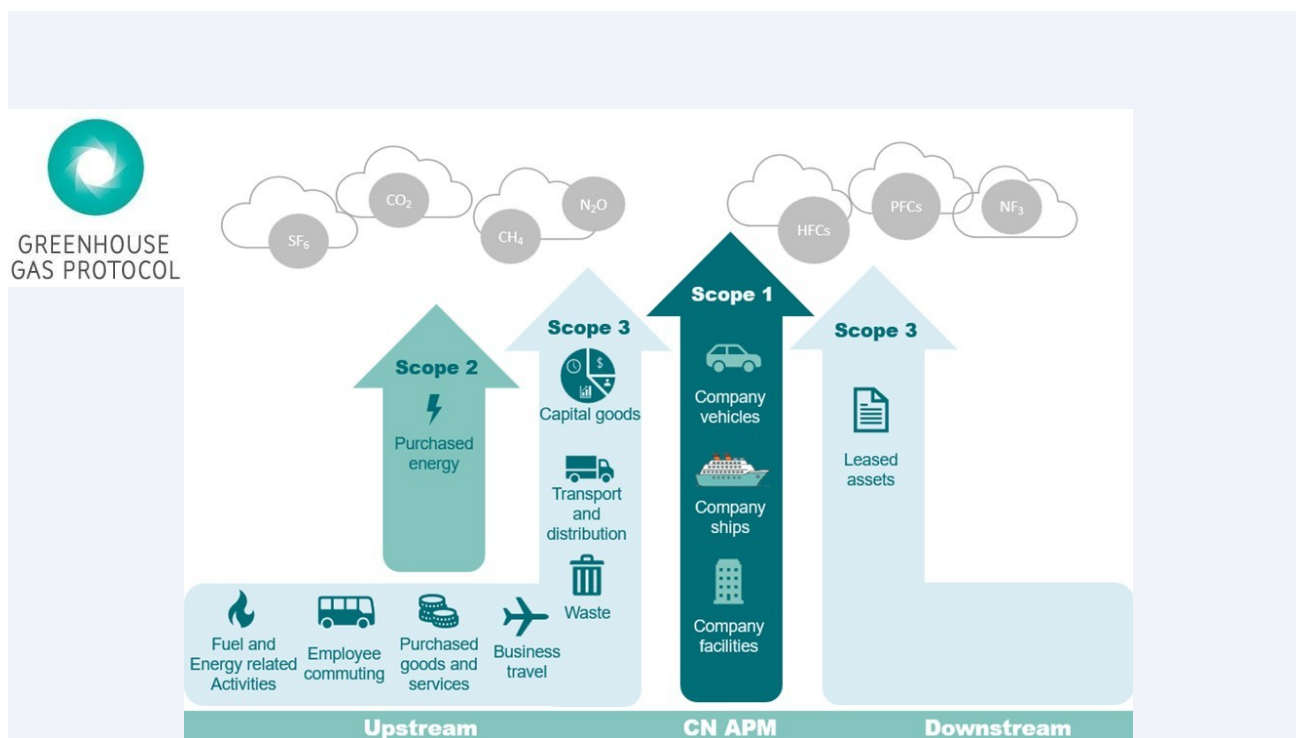


Figure 6: Emission sources included in the PORT Authority carbon footprint; source: Report CO<sub>2</sub> 2024 -PoC by STRATOS

### 3. Collecting and Managing Reliable Data

Reliable emissions calculations depend on the availability and quality of operational data. For this reason, the Port of Constanta first identified the information required for each emission source and determine where these data were available within the organisation. This process involved mapping data owners, reviewing existing records and assessing the completeness and quality of the available information.

The inventory combined data from multiple operational and administrative existing sources, including energy and fuel purchase records, meter readings, fleet consumption logs, maintenance records, procurement data, waste management records and employee mobility information.

Because the required information originated from different departments, establishing clear responsibilities for data collection proved essential. Early coordination reduced inconsistencies, improved data quality and shortened the overall assessment process.

Where complete information was unavailable, the port applied documented assumptions based on recognised international guidance. Recording these assumptions ensures that future inventories remain transparent and comparable over time.

### 4. Applying a Standardised Calculation Methodology

The Port of Constanța calculated greenhouse gas emissions using internationally recognised accounting principles and emission factors. Applying standard methodologies allows results to be compared with future reporting years and with other ports following the same approach.

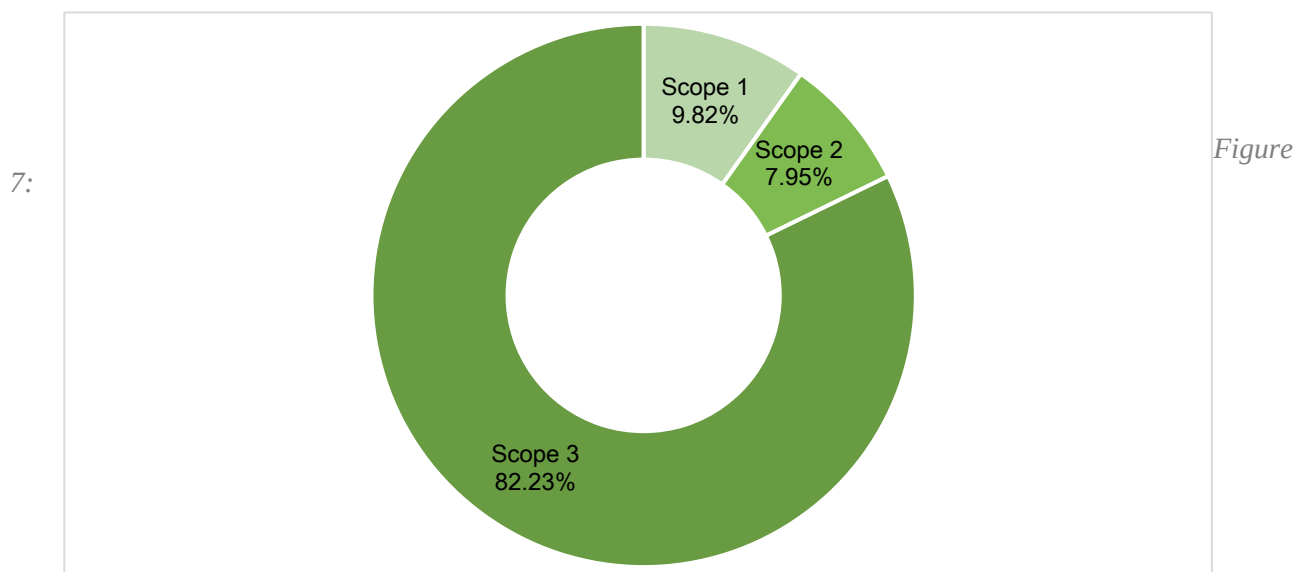
For each activity included in scope 1, scope 2 and scope 3, operational data were converted into greenhouse gas emissions using recognised emission factors. Where direct activity data were not available, transparent estimation methods were applied and documented.

A detailed description of the calculation methodology, emission factors and assumptions is provided in the background knowledge section.

## 5. Carbon Footprint Results

The greenhouse gas inventory established a clear baseline for the reference year 2024 and identified the activities responsible for the largest share of emissions.

The assessment calculated a total carbon footprint of 23,343.72 tonnes of CO<sub>2</sub> equivalent (tCO<sub>2</sub>eq) using the market-based approach. Indirect emissions (Scope 3) accounted for more than four-fifths of the total footprint, demonstrating that procurement decisions and supply chain activities have a greater influence on emissions than the port authority's direct operations.



*Distribution of greenhouse emissions by scope; source: Report CO<sub>2</sub> 2024 -PoC by STRATOS*

The results show distinct emission patterns across the three reporting categories:

- **Scope 1** represents approximately **10%** of total emissions and is mainly associated with natural gas consumption for heating and diesel used by the vehicle fleet and technical vessels.

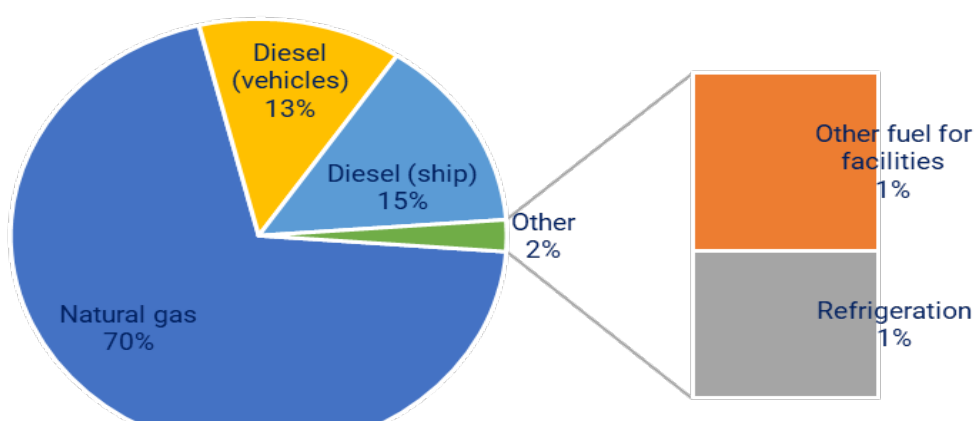


Figure 8: Scope 1 emissions distribution, Source: Report CO2 2024 -PoC by STRATOS

**Scope 2** contributes approximately **8%** of total emissions through purchased electricity. The assessment also highlights the importance of electricity procurement, as purchasing electricity with lower emission factors can significantly reduce reported emissions.

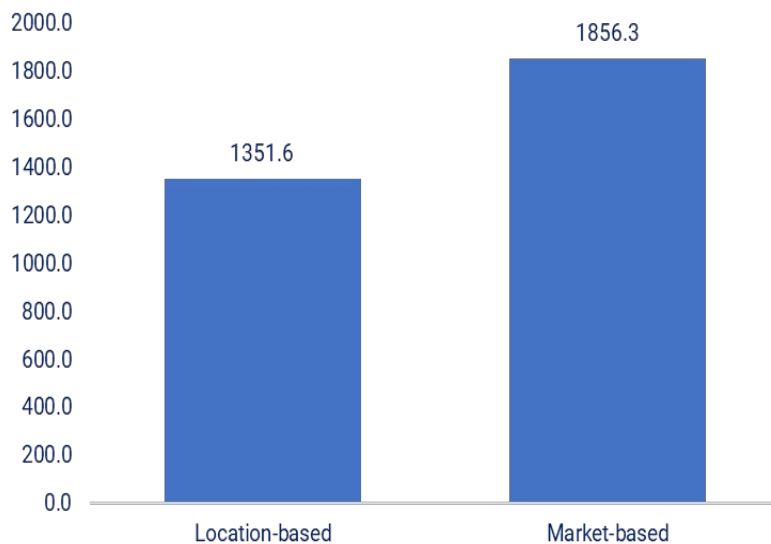


Figure 9: Scope 2 emissions – electricity consumption, Source: Report CO2 2024 -PoC by STRATOS

- **Scope 3** represents approximately **82%** of total emissions. Most of these emissions originate from purchased goods and services, capital investments and other value chain activities, indicating that procurement policies play a critical role in achieving long-term emission reductions.

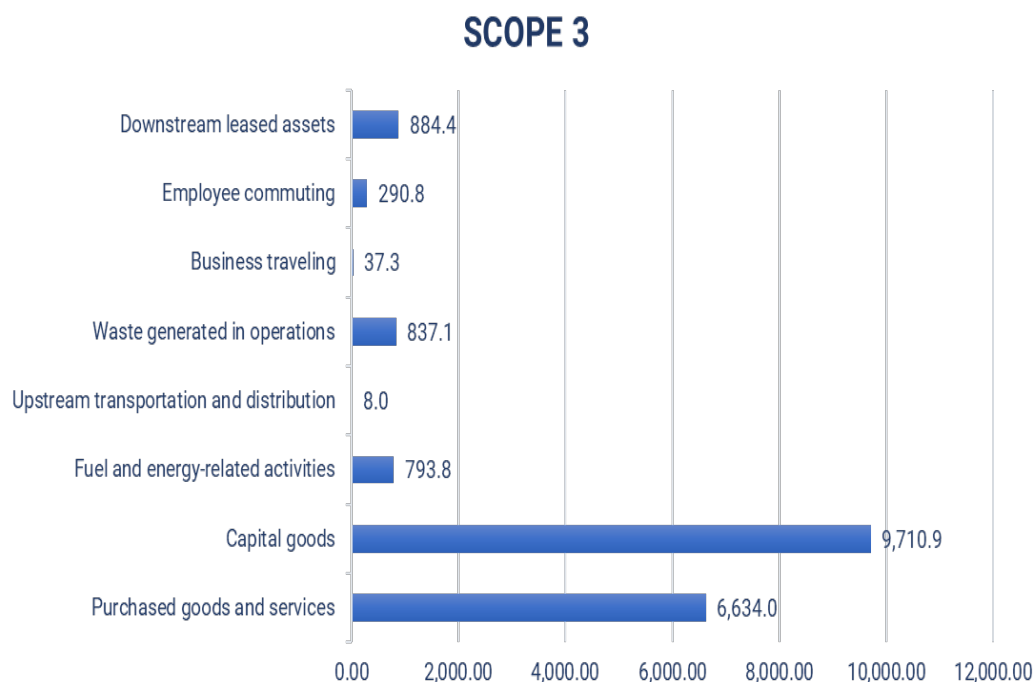


Figure 10: Scope 3 emissions – Source: Report CO2 2024 -PoC by STRATOS

The inventory demonstrates that the greatest opportunities for decarbonisation extend beyond direct energy consumption. Investment planning, procurement practices and collaboration with suppliers are therefore essential components of an effective Green Port Master Plan.

## 6. Developing the GHG Emissions Reduction Strategy

A greenhouse gas (GHG) inventory identifies where emissions occur, but it does not reduce them. The next step is to translate the inventory results into a structured emissions reduction strategy that prioritises actions, guides investments and provides a long-term roadmap towards climate neutrality.

The Port of Constanța developed its emissions reduction strategy using the 2024 carbon footprint as the baseline. The strategy establishes a phased pathway for reducing greenhouse gas emissions over the coming decades and sets progressive targets that allow the port to monitor performance and adapt actions over time.

Using the 2024 emissions inventory as the reference point, the Port of Constanța aims to achieve:

- approximately **41% reduction by 2030**;
- approximately **63% reduction by 2040**; and
- approximately **93% reduction by 2050**.

The remaining emissions are expected to require additional technological solutions, alternative fuels or carbon removal measures as these become commercially and technically viable.

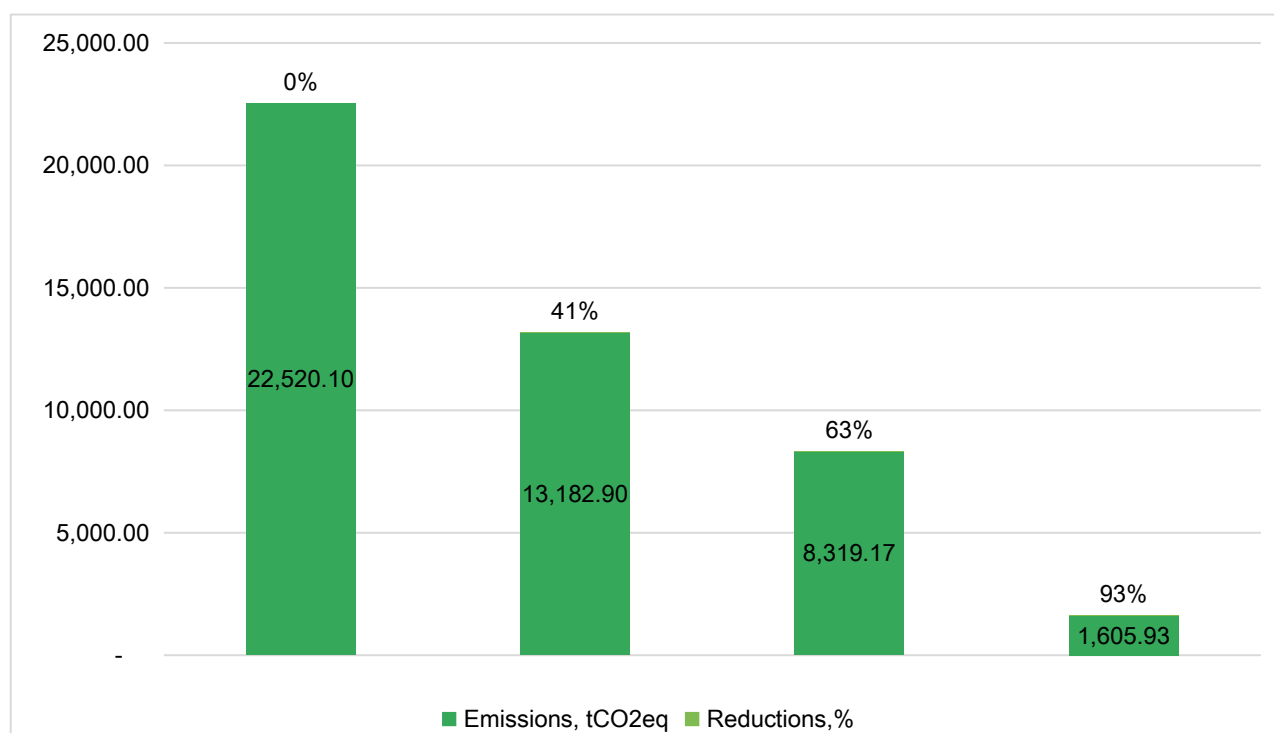


Figure 11: GHG Emissions reduction pathway (2024-2050); source POC -GPMP & Roadmap

The emissions inventory showed that indirect emissions from procurement, investments and energy consumption represent the largest share of the port authority's carbon footprint. Consequently, the strategy prioritises actions that address these major emission sources rather than focusing only on direct operational emissions.

Five strategic priority areas were identified: (1) low-carbon procurement and investments, (2) decarbonising electricity supply, (3) improving energy efficiency (4) modernising electrical infrastructure, (5) decarbonising transport and port operations.

The emissions reduction strategy is fully integrated into the Green Port Master Plan. Each strategic objective contributes to one or more GPMP pillars, ensuring that climate action supports the port's wider objectives for sustainability, resilience and operational efficiency.

| GPMP Pillars                             | Strategic Objectives                                                                                                     |
|------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| Clean energy production, storage& supply | Increase the use of renewable electricity and support electrification of port operations                                 |
| Sustainable port design                  | Improve energy efficiency, modernise infrastructure and integrate low-carbon solutions into buildings and investments    |
| Modal shift and flow optimisation        | Reduce emissions from transport, fleet operations and employee mobility                                                  |
| Circular Economy                         | Improve waste management, increase resource efficiency and reduce waste -related emissions                               |
| Digitalization and governance            | Strengthen emissions monitoring, data management and performance reporting to support evidence – based decision - making |

| GPMP Pillars | Strategic Objectives |
|--------------|----------------------|
|              |                      |

Table 15: Alignment of strategic objectives with the GPMP pillars; source PoC GPMP & Roadmap

### Best Practice:

Define organisational boundaries before collecting data and assign clear responsibilities for each data source.

Use internationally recognised reporting standards to ensure consistency and comparability and document all assumptions to improve transparency and support future updates.

Integrate the approved emissions calculation methodology directly into the digital platform to improve consistency and traceability, automate calculations and reporting to reduce manual effort and minimise errors.

Use dashboards and performance indicators to support management decisions; update the emissions inventory regularly to monitor progress and support evidence-based decision-making.

Enable scenario analysis to evaluate the impact of future investments and operational changes.

Develop the emissions reduction strategy after completing a comprehensive carbon inventory and prioritise measures according to the largest emission sources rather than implementing isolated actions.

Define long-term targets supported by intermediate milestones; integrate decarbonisation objectives into procurement, investment planning and infrastructure development.

Combine technical measures with governance, digitalisation and continuous performance monitoring.

### Lessons learned

The experience of the Port of Constanța demonstrates that a reliable carbon baseline could be the foundation of an effective Green Port Master Plan.

A digital carbon management platform is not only a reporting tool—it is a decision-support system. By combining reliable data collection, automated calculations and performance monitoring, ports can transform greenhouse gas reporting into a continuous management process that supports long-term decarbonisation and evidence-based investment planning.

An effective emissions reduction strategy is not a list of independent projects but a long-term management framework. By linking emissions data with investment planning, operational improvements and organisational governance, ports can direct resources towards the measures that deliver the greatest environmental benefit while maintaining operational efficiency and supporting future growth.

## 1.4.4 Digitalising Carbon Footprint Monitoring

### What is it?

Calculating greenhouse gas (GHG) emissions is only the first step towards effective carbon management. To support continuous monitoring and informed decision-making, the Port of Constanța translated the emissions calculation methodology into a digital platform <https://esg.portofconstantza.com/>. The tool enables the port authority to collect data, calculate emissions consistently and monitor progress towards its decarbonisation objectives.

Digitalising the calculation process reduces manual work, improves data quality and ensures that emissions are calculated using the same methodology each reporting year. It also creates a reliable source of information for strategic planning, reporting and performance monitoring.

The digital tool follows the same calculation logic as the greenhouse gas inventory. Every emission source, calculation rule and reporting category is integrated into the application, ensuring that results remain consistent with the approved methodology.

Rather than relying on spreadsheets or separate calculations, the platform provides a single environment for managing emissions data. This approach reduces the risk of calculation errors, improves traceability and simplifies annual reporting.

The application supports the complete reporting process, from data entry to the generation of emissions reports and performance indicators.

The digital platform allows authorised users to manage the entire emissions inventory through a single interface. Its main functions include:

- recording operational data for electricity, fuels, transport, waste and other emission sources;
- importing large datasets from standard spreadsheet templates;
- automatically calculating greenhouse gas emissions for all reporting categories;
- generating reports and summaries for management and external reporting;
- exporting data for further analysis;
- managing users and access rights; and
- developing and comparing future emission reduction scenarios.

### How to use it

The digital carbon footprint monitoring helps to ensure that emissions reporting becomes part of routine operational management rather than a separate annual exercise.

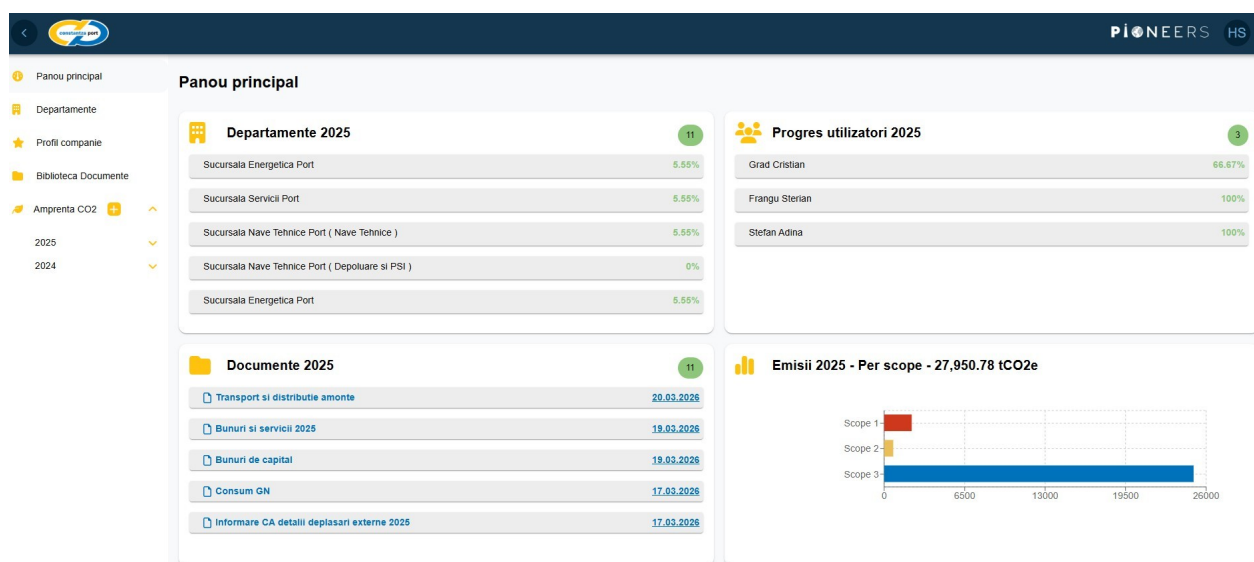


Figure 12: Carbon footprint management platform dashboard - total carbon footprint 2025 and linear graphic per scope, source PoC

Beyond emissions reporting, the platform provides management with timely and reliable information for planning investments and monitoring performance. By presenting emissions data through dashboards and graphical reports, the application allows users to identify trends, compare reporting periods and evaluate the impact of implemented measures.

Scenario analysis is another important feature. The platform enables users to assess how different investment or operational decisions may influence future emissions. This functionality supports evidence-based planning and helps prioritise measures with the greatest potential impact.

As new data become available, the emissions inventory can be updated without repeating the entire assessment process, making the system suitable for continuous improvement.

Figures 8–9 present examples of dashboard views showing emissions by reporting category and annual performance.

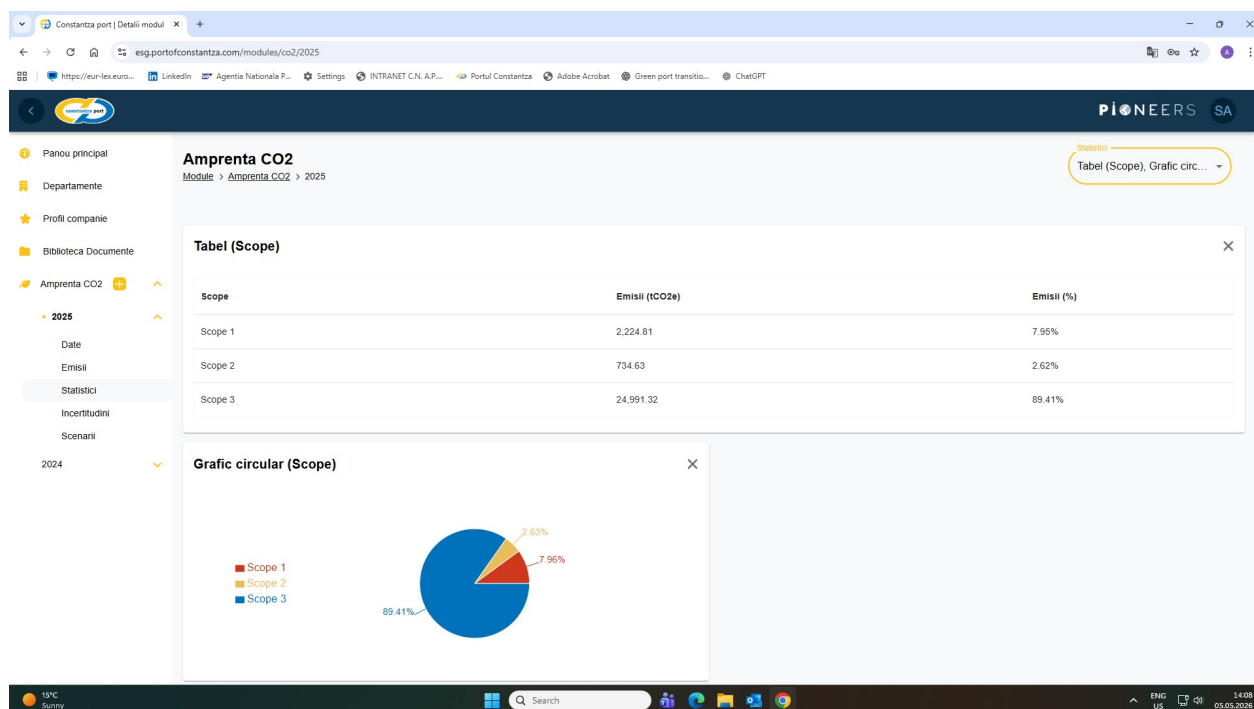


Figure 13: Carbon footprint application dashboard, emissions per scope, 2025, source: PoC

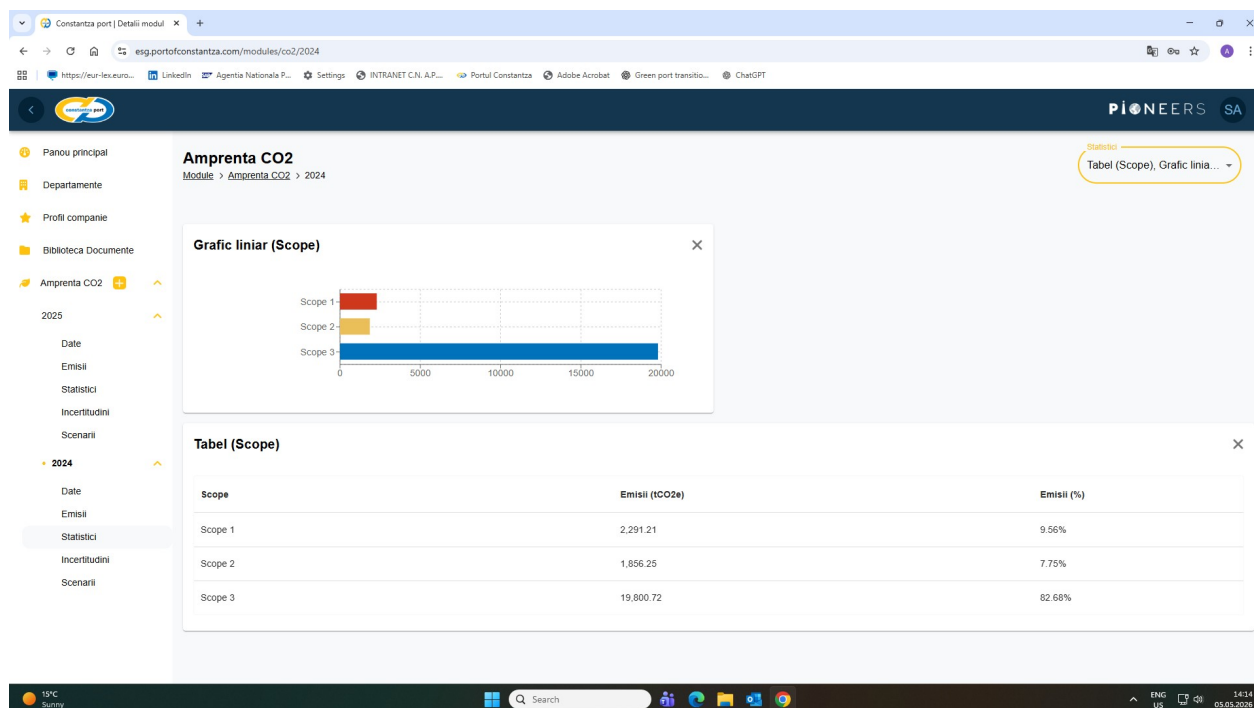


Figure 14: Carbon footprint application dashboard, emissions per scope 2024

The technical architecture of the application, including software components, database structure, system integration and deployment architecture, is provided in Background knowledge.

## 1.4.5 Calculation Methodology

### Standards used

For the determination of port authority's carbon footprint, the following calculation standards were used:

- [GHG Protocol Corporate Accounting and Reporting Standard](#): provides the core principles for the calculation, verification, and reporting of emissions.
- [GHG Protocol Scope 2 Guidance](#): standardises the way companies measure emissions from purchased electricity, steam, heating, and cooling (referred to as "Scope 2 emissions").
- [Corporate Value Chain \(Scope 3\) Accounting and Reporting Standard](#): establishes the Scope 3 emission categories, as well as the principles and calculation boundaries.
- [GHG Protocol Scope 3 Calculation Guidance](#): provides practical guidance for the calculation of emissions within Scope 3.

SCOPE 1 Calculation methodology

ROAD FLEET AND TECHNICAL VESSELS

### Data sources:

- Financial records on fuel purchases (diesel/petrol receipts/invoices).
- Logbooks / consumption records for the road fleet and technical vessels (where available).

### Calculation methodology:

- Emissions were determined from the quantities of fuel purchased (liters), converted into tCO<sub>2</sub>e using standard combustion emission factors from the [DEFRA, 2024](#) dataset.
- The greenhouse gases included in the result are CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O.
- For technical vessels, the same diesel/gasoil emission factors were applied, in line with the DEFRA methodology for liquid fuels used in transport.
- The calculation covers only the consumption of the company's own fleet; trips made using third-party transport providers are reported under Scope 3.6 (Business travel).

### Key assumptions:

- N/A

### Main emission factor sources:

- DEFRA, 2024 – conversion factors published by the UK Government, Department for Energy Security and Net Zero

### 1.4.5.1 STATIONARY COMBUSTION

#### Data sources

- Internal meter readings and records for natural gas purchases (m<sup>3</sup>),
- Financial records for fuel purchases for generator sets (diesel/petrol) and LPG/butane used in operations (welding, sleeve heating).

#### Calculation methodology

- **Natural gas:** volumes in m<sup>3</sup> were converted into tCO<sub>2</sub>e using DEFRA 2024 emission factors.
- The greenhouse gases included in the result are CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O.
- **Generators and LPG/butane:** fuel quantities in litres were converted into tCO<sub>2</sub>e using [DEFRA, 2024](#) emission factors for liquid/gaseous fuels used in stationary combustion.

### Key assumptions

- Generators are used occasionally (testing/maintenance or back-up in emergency situations), not in continuous operation; emissions are therefore based on actual fuel consumed.
- Butane is used for operational purposes (welding / sleeve heating), and the combustion factors applied correspond to these technical uses.

### Main emission factor sources

- [DEFRA, 2024](#)– Gaseous and liquid fuels (natural gas, diesel/petrol for generators, LPG/butane).

### 1.4.5.2 FUGITIVE EMISSIONS

#### Data sources

- Internal records on air-conditioning systems, including the hosting department, equipment name, internal code, refrigerant type, refrigerant charge (kg) and number of units.

#### Calculation methodology

- For the identified equipment, an annual leakage rate of 5% of the refrigerant charge was applied, in line with [IPCC/TEAP Special Report – 5.1.1.3 Ducted split residential air conditioners](#).
- Emissions were calculated as: 5% × refrigerant quantity (per gas type) × emission factor (GWP) for that refrigerant, using [DEFRA \(UK\) 2024](#) values.
- The greenhouse gases covered include CO<sub>2</sub>, HFCs and PFCs.

### Key assumptions

- The 5% annual leakage rate was used as a standard value in the absence of detailed records of refrigerant top-ups during the reporting year, consistent with IPCC/TEAP recommendations for this type of equipment.

### Main emission factor sources

- [DEFRA \(UK\) 2024](#)– Refrigerants (GWP100).
- [IPCC/TEAP Special Report – 5.1.1.3 Ducted split residential air conditioners](#) (for the 5% annual loss assumption).

### SCOPE 2 Calculation methodology

### 1.4.5.3 PURCHASED ENERGY (ELECTRICITY)

#### Data sources

- Internal procurement and consumption records
- Energy labels / supplier declarations (energy mix and emission factor).

#### Calculation methodology

- Emissions from electricity consumption were calculated using the two approaches defined by the GHG Protocol:
  - **Market-based calculation:** supplier-specific emission factors from energy labels were applied. These factors are expressed in kgCO<sub>2</sub>eq and include contributions from CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O.
  - **Location-based calculation:** the national grid emission factor for the Romanian power system, published by ANRE, was used. This factor is also expressed in kgCO<sub>2</sub>eq and covers CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O.
- **Heat/steam:** not applicable for 2024; Scope 2 results reflect electricity consumption only.

## Boundaries and controls

- Tenants' electricity consumption is not included in Scope 2; it is treated under Scope 3, downstream leased assets.

## Key assumptions

- The difference between the market-based and location-based results reflects the structure of the supplier portfolio (for example, high shares of renewable sources for some suppliers) compared with the national average mix.

## Emission factor data sources

- [Energy label HIDROELECTRICA](#) (market-based calculation).
- [Energy label TINMAR ENERGY](#) (market-based calculation).
- ANRE – national electricity emission factor (location-based calculation): although the 2024 annual report was not available at the time of calculation, the national emission factor appears on the electricity labels published by all suppliers. The factor used for 2024, applicable at national level, was therefore taken directly from one of the two energy labels above.

## Scope 3 Calculation methodology

### 1.4.5.4 PURCHASED GOODS

#### Data sources:

- Financial records and 2024 purchasing register: supplier list, invoiced amounts, descriptions.
- Accounting extracts (expense classes) used to distinguish goods from services.

#### Calculation methodology:

- Emissions were calculated using the spend-based method, applying the financial values of goods purchased in 2024.
- Each supplier was assigned an [EXIOBASE 2022](#) sector according to its commercial profile and type of products sold, and the corresponding value-based emission factor (kgCO<sub>2</sub>eq/RON) was then applied to the total amount spent.
- Items already covered under other scopes/categories (e.g. fuels, electricity/water, own transport) were excluded to avoid double counting.
- EXIOBASE emission factors are provided in EUR; these were converted into RON using the annual average exchange rate published by the National Bank of Romania (BNR) and adjusted with the annual inflation rate published by the National Institute of Statistics (INS).
- Results were aggregated at overall category level "Purchased goods and services" and separately at the "Goods" subtotal (material purchases).
- The emissions include CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O, SF<sub>6</sub>, HFCs and PFCs. The last three greenhouse gas groups mainly arise from the production of electrical and electronic equipment.

**Key assumptions:**

- The supplier–EXIOBASE sector mapping was based on the supplier’s commercial profile (NACE code, website, invoice descriptions); it was not broken down to individual product/article level.
- Lines with a “0” factor in the working file were excluded from the calculation because they were not applicable or were already accounted for under Scope 1 or 2 (e.g. fuels).

**Main databases for emission factors:**

- [EXIOBASE 2022](#) (monetary emission factors by economic sector, kgCO<sub>2</sub>eq/RON)
- [INS, annual inflation rate](#)
- [BNR, annual average exchange rate](#) (2023, 2024)

### 1.4.5.5 PURCHASED SERVICES

**Data sources:**

- Financial records and 2024 purchasing register: supplier list, invoiced amounts, descriptions.
- Accounting extracts (expense classes) used to distinguish goods from services.

**Calculation methodology:**

- Emissions were calculated using the spend-based method, applying 2024 financial data corresponding to the value of services purchased and multiplying these amounts by the relevant EXIOBASE 2022 emission factors (kgCO<sub>2</sub>eq/RON).
- To select the most appropriate EXIOBASE factors, each supplier was mapped to a sector/emission factor consistent with its main activity and/or NACE code.
- EXIOBASE emission factors are provided in EUR. These values were converted into RON using the annual average exchange rate published by the National Bank of Romania (BNR) and adjusted with the annual average inflation rate published by the National Institute of Statistics (INS).

**Key assumptions:**

- The supplier–EXIOBASE sector mapping was based on the supplier’s commercial profile (NACE code, website, invoice descriptions) and was not detailed down to individual items or units.

**Main databases for emission factors:**

- [EXIOBASE 2022](#) (monetary emission factors by economic sector, kgCO<sub>2</sub>eq/RON)
- [INS, annual inflation rate](#)
- [BNR, annual average exchange rate](#) (2023, 2024)

### 1.4.5.6 CAPITAL GOODS

**Data sources:**

- Financial records and 2024 CAPEX / commissioning (PIF) register (asset acquisition values).

**Calculation methodology:**

- Emissions were calculated using the spend-based method, similarly to the “Purchased goods and services” category.

- Only assets commissioned (PIF) in 2024 were included, applying the capitalization threshold (> 2,500 RON per asset).
- Each asset was mapped to an EXIOBASE 2022 sector according to the technical nature of the capital good commissioned.
- Monetary emission factors (kgCO<sub>2</sub>eq/RON) from EXIOBASE 2022 were applied to the entry value (RON) of each asset, and results were then aggregated at category level.
- For complex works (projects with several tranches), the values of all tranches related to the same asset were summed.
- Costs that do not represent the asset itself (such as design, permits, fees) were excluded from the calculation.
- EXIOBASE factors originally expressed in EUR were converted into RON, in line with the methodology applied and described for the “Purchased goods and services” category.

#### **Key assumptions:**

- The values used are those available at reporting date in the PIF records.
- EXIOBASE mapping was carried out at asset level, not based on detailed material “recipes”.
- For future inventories, where quantity data are available (for example m<sup>3</sup> of concrete, tons of steel) or product EPDs, it will be possible to move towards physical emission factors, improving accuracy.

#### **Main databases for emission factors:**

- [EXIOBASE 2022](#) (monetary emission factors by economic sector, kgCO<sub>2</sub>eq/RON)
- [INS, annual inflation rate](#)
- [BNR, annual average exchange rate](#) (2023, 2024)

### **1.4.5.7 WASTE**

#### **Data sources:**

- Waste management plan/report and internal handover/traceability records;
- Annual reports submitted in official systems (e.g. operational registers / PRODESS / TRAT), with quantities broken down by waste code.

#### **Calculation methodology:**

- For each waste stream, the quantity handed over (tons) was multiplied by the emission factor specific to that waste type and the treatment route, expressed in kgCO<sub>2</sub>eq and including contributions from CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O.
- Wastewater volumes were converted into tCO<sub>2</sub>e using the relevant factors for treatment at wastewater plants, which include CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O generated by the treatment processes and sludge management.
- Results were aggregated at category level, avoiding any double counting with other emission categories (e.g. combustion reported under Scope 1 or transport activities under Scope 3).

#### **Key assumptions:**

- For waste streams without a clearly recorded treatment method, standard DEFRA emission factors were applied for the most commonly used treatments associated with that waste code (conservative approach).
- Minor adjustments may occur if quantities are reconciled at a later stage (e.g. weighing/traceability corrections).

#### **Main databases for emission factors:**

- [DEFRA \(UK\) 2024](#)– UK Government GHG Conversion Factors (solid/liquid waste; typical treatment routes).

#### 1.4.5.8 UPSTREAM TRANSPORT AND DISTRIBUTION

##### Data sources:

- Internal sources on distances travelled by suppliers calculated using Google Maps.

##### Calculation methodology:

- Kilometers travelled were multiplied by the emission factor corresponding to the mode of transport, namely road transport.

##### Key assumptions:

- Distances were determined using Google Maps, so exact routes could not be identified. Transport was therefore assumed to start from the center of the locality where the supplier's registered office is located. The final destination was assumed to be Gate 1 Constanta Port.

##### Main databases for emission factors:

- [DEFRA \(UK\) 2024](#)– UK Government GHG Conversion Factors

#### 1.4.5.9 BUSINESS TRAVEL

##### Data sources:

- Records (trip lists: origin–destination, number of people, kilometers per segment, number of hotel nights).
- Accounting summaries/travel orders used to verify expenses and number of nights.

##### Calculation methodology:

- **Transport:** distances travelled with third-party operators (e.g. airlines) were multiplied by emission factors specific to each transport mode (kgCO<sub>2</sub>eq/passenger-km), expressed in kgCO<sub>2</sub>eq and including contributions from CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O.
- **Accommodation:** the number of nights was multiplied by the average emission factor for hotels in the host country (kgCO<sub>2</sub>eq/night/room), which includes CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O.
- **Aggregation:** results were summed at the level of the Business travel category (transport + accommodation). Trips made with the company's own fleet are not included here, as they are reported under Scope 1.

##### Key assumptions:

- All calculations were based on internal records regarding kilometers travelled, number of people and number of overnight stays.

##### Main databases for emission factors:

- [DEFRA \(UK\) 2024](#)– UK Government GHG Conversion Factors (air transport and other modes, expressed in kgCO<sub>2</sub>eq/km).

- For accommodation, where no specific factors were available in DEFRA 2024, values published on the [Hotel Footprints](#) platform were used, which provides average emission factors by country (kgCO<sub>2</sub>eq/night).

#### 1.4.5.10 Employee commuting

##### Data sources:

- Internal survey on commuting patterns of employees for their daily trips to and from the office, by transport mode and grouped by distance ranges.

##### Calculation methodology:

- The calculation of emissions in this category includes the average number of days worked physically in the office in 2024 and the daily distances travelled by employees for each transport mode. Emission factors expressed in kgCO<sub>2</sub>eq, including contributions from CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O, were applied.

##### Key assumptions:

- 45 employees were excluded from the calculation because they use company vehicles for their daily commute; the emissions generated are already included in Scope 1.

##### Main databases for emission factors:

- [DEFRA \(UK\) 2024](#)– UK Government GHG Conversion Factors

#### 1.4.5.11 DOWNSTREAM LEASED ASSETS

##### Data sources:

- Internal records on the areas leased to third parties for the 155 rental spaces.

##### Calculation methodology:

- As no exact energy consumption data were available for each leased space, emissions were estimated using an area-based method. To determine the specific energy consumption per square meter, reference values from the study [Evolution of the Payback Period for Energy-Efficient Residential Buildings in Romania in the Last Decade](#) were used, which indicate an average annual consumption of 250 kWh/m<sup>2</sup> for buildings in Romania.

##### Key assumptions:

- It was assumed that all the energy associated with the leased spaces is consumed by tenants and is proportional to the occupied area (m<sup>2</sup>), without differentiating between types of use (office, storage, technical space, etc.).
- For all 155 leased spaces, the same average annual consumption of 250 kWh/m<sup>2</sup> was applied, as indicated in the [Evolution of the Payback Period for Energy-Efficient Residential Buildings in Romania in the Last Decade](#), assuming this value is representative. The energy thus quantified includes both electricity and natural gas.

##### Main databases for emission factors:

- [DEFRA, 2024](#)

#### 1.4.5.12 FUEL & ENERGY RELATED ACTIVITIES

##### **Data sources:**

- Internal records on fuels, electricity and gas consumption not included in Scope 1 and Scope 2.

##### **Calculation methodology:**

- The calculation followed the same general approach as for Scope 1 and Scope 2 (for energy and fuels), with the only difference being the type of emission factors used, which reflect the specific nature of this category (network losses and upstream generation), as follows:
- For fuels, the quantities already used and reported in Scope 1 were taken as the activity data and multiplied by the well-to-tank (WTT) emission factors specific to each type of fuel (kgCO<sub>2</sub>eq/unit), based on DEFRA 2024. These factors include emissions from extraction, processing and transport up to the point of delivery and cover CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O, expressed in tCO<sub>2</sub>eq.
- For electricity, upstream emissions and grid losses were estimated as follows: the electricity consumption used in Scope 2 was also used to estimate upstream emissions by applying the emission factors for electricity generation (upstream electricity), in line with DEFRA 2024. Losses in the transmission and distribution network were estimated by applying a 5% share to the electricity consumption and multiplying by the specific emission factors for Transmission & Distribution, expressed in kgCO<sub>2</sub>eq (including CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O).
- The resulting emissions were aggregated at the level of the Scope 3 category Fuel- and energy-related activities. Direct combustion emissions (from the operation of company-owned equipment and vehicles) and the actual production of purchased electricity are reported separately under Scope 1 and Scope 2, respectively, thereby avoiding double counting.

##### **Key assumptions:**

- N/A

##### **Main databases for emission factors:**

- [DEFRA, 2024](#)

## 1.4.6 Carbon footprint platform

### Main Features

The application provides the following features:

- Manual entry of consumption data through a graphical interface
- Bulk data import using Excel files (XLS)
- Automatic calculation of carbon emissions based on GHG factors for all three scopes (Scope 1, 2 and 3)
- Generation of Word reports with detailed analysis and contextual information
- Export of Excel reports containing raw data for further analysis
- User and department management with granular access control
- Generation of consumption scenarios to support emission-reduction proposals

The application uses a modern microservices-based architecture, with each component running in a separate Docker container. This architecture provides scalability, isolation and ease of deployment. The application architecture follows a layered architecture model, with a clear separation of responsibilities:

### Presentation Layer (Frontend)

→ React.js application with Material UI for the user interface

### Application Layer (Backend)

→ Node.js/Express REST API for business logic

→ Python service for report generation

### Data Layer

→ MongoDB for structured data storage

→ MinIO for file storage

- Graphical interface for entering consumption data
- Excel file upload and validation for bulk import
- Dashboards and statistics for carbon emissions
- User and department management (for the IT Administrator role)
- Initiation of report generation and download of results
- User authentication and authorization

## 1.5 Understanding the port ecosystem

### Why should a port understand its ecosystem?

Problem exploration is the process of developing a deep understanding of a problem before attempting to solve it. In the context of port decarbonisation, this is essential: a port cannot decarbonise what it does not understand. The transition to a climate-neutral port rarely fails because of a lack of technological solutions; rather, it is slowed by the complex interdependencies between regulation, finance, technology, stakeholder interests, social acceptance, and governance. Stakeholders often hold different perspectives, root causes may be unclear, and

important constraints may remain hidden. Without first understanding how these factors interact, ports risk addressing symptoms rather than the underlying causes of the challenges they face.

### 1.5.1 Problem exploration

#### **What is it?**

Understanding the port ecosystem refers to the process of developing a comprehensive view of all the factors, actors, relationships, and external influences that shape how a port operates and how it can transition towards decarbonisation. Before any decarbonization action can be taken, all ports should understand these aspects. They include their internal activities, infrastructure, and governance, but also external factors. Think of the network of stakeholders that a port must leverage to take the appropriate actions, regulations, technologies, financial mechanisms, market conditions, social pressures, etc. A port must understand its own regime and how it is situated in the landscape.

#### **How to use it: four examples of the problem explorations of other ports**

Within PIONEERS, all four ports used the Multi-Level Perspective (MLP) as the foundation for their problem-identification methodology. This means that ports should consider not only the factors they can influence directly, but also wider landscape pressures and developments beyond their control. The starting point for effective problem exploration is therefore a robust baseline assessment of the port's existing regime. The quality of the exploration depends heavily on the quality of this baseline; without it, identifying the most significant decarbonisation challenges is difficult.

While the objective was the same across all PIONEERS ports—to identify the key barriers and drivers affecting decarbonisation—each port adopted a different analytical approach. Antwerp-Bruges developed a systems map to visualise causal relationships and intervention zones within a complex multi-actor ecosystem. Barcelona combined STEEP and SWOT analyses with stakeholder surveys and root-cause analysis to uncover barriers embedded in organisational culture and values. Venlo used a three-layer landscape framework and stakeholder workshops to assess challenges shaped by regional, national and international influences, while Constanța applied a socio-technical regime analysis focusing on legacy infrastructure and established practices. These different approaches demonstrate that there is no single correct method; the most suitable approach depends on the port's governance structure, available data and specific challenges.

A proven way to explore decarbonisation challenges is to create system and actor maps that identify the factors influencing decarbonisation and the stakeholders required to enable change. Such analyses help ports distinguish visible barriers from their root causes and identify leverage points where interventions are most likely to have a systemic impact. Equally important is validating the findings with stakeholders, ensuring that the resulting understanding reflects operational realities and creates a shared basis for action. By systematically exploring the problem space before developing solutions, ports can build a more accurate problem definition and establish a stronger foundation for effective decision-making and transition strategies.

### 1.5.2 Best practise example: System mapping in the Port of Antwerp-Bruges

The transition to a climate-neutral port requires a systemic perspective. Ports are complex ecosystems where regulation, finance, technology, infrastructure, market dynamics and stakeholder actions continuously influence one another. System mapping is a valuable tool for problem exploration because it visualises these relationships, helping ports understand not only which factors affect decarbonisation, but also how they interact. Rather than

addressing individual symptoms, system mapping reveals the underlying structures and feedback loops that determine whether the transition accelerates or stalls.

The PIONEERS Green Ports Systems Map was developed as a representation of the European port ecosystem and the factors influencing decarbonisation towards 2050. To keep the model manageable, system boundaries were defined, focusing on relevant actors and factors to the transition toward carbon-neutral ports.

The starting point to build the systems map was the actor map, which illustrates the network of stakeholders involved in the port ecosystem. The port ecosystem is a network of interdependent actors whose decisions shape whether decarbonisation accelerates or stalls. At its centre sits the port authority, not because it controls the network, but because it connects to nearly every part of it. The strongest force driving the system is regulation and policy makers, influenced by port authorities, federations, associations and unions. When climate regulation lands, its weight falls on the actors who must change how they operate: maritime, terminal and logistics stakeholders. The latter depend on investors, knowledge institutes, start-ups and other companies in a range of industries.

## Port Ecosystem Map



Figure 15: Port Ecosystem Map

The Green Port Systems Map consists of 23 leverage clusters grouped into five intervention zones: **Technology, Infrastructure and operational readiness**, **Social and ecological context**, **Governance and policy**, **Financial and market dynamics**, **Planning, coordination and data**. Together, these zones capture the key drivers, barriers and dependencies shaping port decarbonisation. The systems map helps ports identify leverage points: factors within the system where interventions can create the most significant and lasting change, linked to actors that actually have the power to put things in motion.

For example, climate regulations established by policymakers create pressure for operational change, but implementation ultimately depends on the willingness and ability of terminal operators, logistics companies and shipping lines to invest in low-carbon solutions. Such investments require confidence in both technological feasibility and stable regulatory frameworks, while emerging technologies often depend on support from energy providers, financial institutions and innovation ecosystems. In this interconnected system, the port authority can play a unique role by bringing actors together.

## Green Ports Systems Map

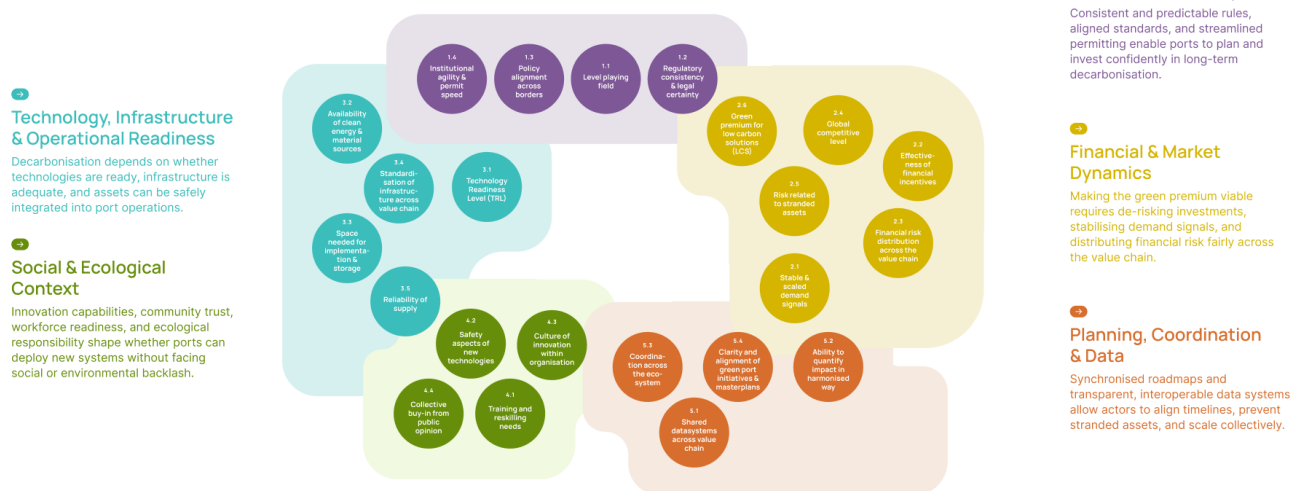


Figure 16: Green Ports Systems Map with interventions zones

### How to use it?

Although the Green Ports Systems Map provides a generic framework, its real value lies in contextualising it to the specific characteristics, stakeholders and challenges of an individual port. This enables ports to focus their efforts on the areas where they can generate the greatest systemic impact. Therefore, to use the map effectively, ports should begin by determining the biggest barriers that they can influence either directly or indirectly. At the same time it is important to focus on the factors that have the most potential to impact the system (instead of the symptoms).

A quick-start can be to “take the test” on the PIONEERS website to see what holds your port back most.

### Conclusions from the Green Ports Systems Map for port authorities

For port authorities, the Green Ports Systems Map translates into three practical action perspectives. First, they can create the conditions for innovation by reducing administrative barriers, providing space for

experimentation and facilitating the deployment of green technologies. Second, they can build coalitions by coordinating stakeholders across the value chain and aligning ambitions, investments and timelines. Third, they can shape the playing field by using their credibility and expertise to advocate for supportive policy and regulatory conditions at regional, national and European levels. Together, these roles reflect the port authority's position as a facilitator of systemic change rather than a controller of the system.