



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 Your 2050 vision

## 1.1 Introduction

The path to a climate-neutral port runs through deep uncertainty. Market dynamics, price evolutions, consumer behavioral changes, etc., makes future envisioning and planning very challenging since these aspects cannot be predicted. Future envisioning does not try to predict. It prepares a port for a range of possible futures so that today's decisions hold up whichever one arrives, and it gives the organization a desirable future worth steering toward.

In PIONEERS, different approaches have been used by the participating ports but their goals are the same: try to understand what their port might look like in the future and act accordingly to reach climate neutrality.

## 1.2 Scenario planning and backcasting

A proven method for future envisioning is scenario planning. Applying this method, a port constructs several possible futures, ranging from plausible to desired futures. They do not forecast, but ask the bigger “what if” questions to help them identify blind spots, stress-test their strategy and test assumptions against more than one vision of tomorrow.

To further utilize the outcome of the scenario planning, backcasting can be used. It is a method that starts from a future end point and works its way back to today to identify the required steps to reach the desired point. It is the mirror image of forecasting, which extrapolates forwards from today's (and yesterday's) trends. In terms of port decarbonization planning, backcasting helps ports identify where their investments and focus should be to achieve the climate goals set forward by the EU. Once the port has defined its desired 2050 outcome, it can work backwards to determine the actions needed to achieve long-term ambitions.

Both the scenario planning and backcasting methods can be qualitative (i.e. narrative scenario describing actors, dynamics and storylines) or quantitative (i.e. key performance indicators and their possible evolutions). The most reliable work combines the two: narrative supplies meaning and direction; numbers supply testability. There is no single correct method. Ports must decide for themselves which method they follow and how they can integrate it into their decarbonization strategy. The right choice depends on a port's starting point, the available data, and the questions it wants answered.

The four PIONEERS ports adopted different future envisioning approaches based on their specific context, strategic needs, and available data and methods. PoAB used an exploratory 2×2 scenario matrix to envision 4 climate-neutral futures and stress-test their existing decarbonization strategy. PoB combined a normative Cross-Impact Balance methodology with quantitative energy modelling to develop coherent scenarios and assess future energy pathways to 2050. PoV integrated regional port-flow scenarios with national macroeconomic scenarios. Constanța took a more pragmatic approach, developing three implementation scenarios that applied the same decarbonization measures at different speeds, allowing it to assess phased transition pathways rather than explore fundamentally different futures.

Reviewing the masterplans of the four PIONEERS ports, there are two routes for scenario planning. First, you can opt for ready-made scenarios. The PIONEERS desired future scenarios developed by PoAB are generic by

design: any port can pick them up and start their own vision building, scenario planning and backcasting exercises to create their roadmap or stress test their current strategy. The other option is to build port-specific scenarios, as the ports of Barcelona and Venlo did. These are at least as valuable and effective, often richer because they are grounded in your own port system with all its characteristics and specifics. You can choose this route if you can afford the additional development cost and effort. Naturally, you can also use the ready-made scenarios as a starting point or inspiration for your own scenario development.

## 1.3 Best practice example of the Port of Antwerp-Bruges: Green Ports in 2050

Port of Antwerp-Bruges developed 4 desired future scenarios for climate-neutral and economically competitive ports in 2050. These “protopian” futures were built to be ambitious enough to drive change, realistic enough to stay credible, and specific enough to guide concrete action. Protopian matters here: dystopian scenarios create paralysis and utopian ones invite dismissal.

What the scenarios are

The scenarios were constructed using two questions:

- **Who drives change?** The public sector or the private sector.
- **How fast does change happen?** Through radical or incremental innovation.

These dimensions were the starting point to build the scenarios. These drivers were judged to have the greatest impact on the greening of ports, with the greatest uncertainty on how they will pan out in the future. Crossing these axes yields four climate-neutral futures for 2050. The destination is the same, the highways differ:

- **Orchestrated Transformation** (*public-radical*): large-scale transformation driven by coordinated policy and funding to de-risk green infrastructure investment.
- **Venture Revolution** (*private-radical*): fast transformation driven by private investment, fierce competition and breakthrough climate technologies.
- **Guided Evolution** (*public-incremental*): steady, government-driven transition through regulation, upgrades and the scaling of proven technologies.
- **Value-driven Transition** (*private-incremental*): gradual, market-driven transition shaped by consumer demand and green technology cost parity.

The real road to climate-neutrality will not be any of these extremes. It will land somewhere in between, combining the scenarios. Behind the four futures sit 100+ signals already visible in Europe, connecting the foresight to real developments in technology, governance and society.

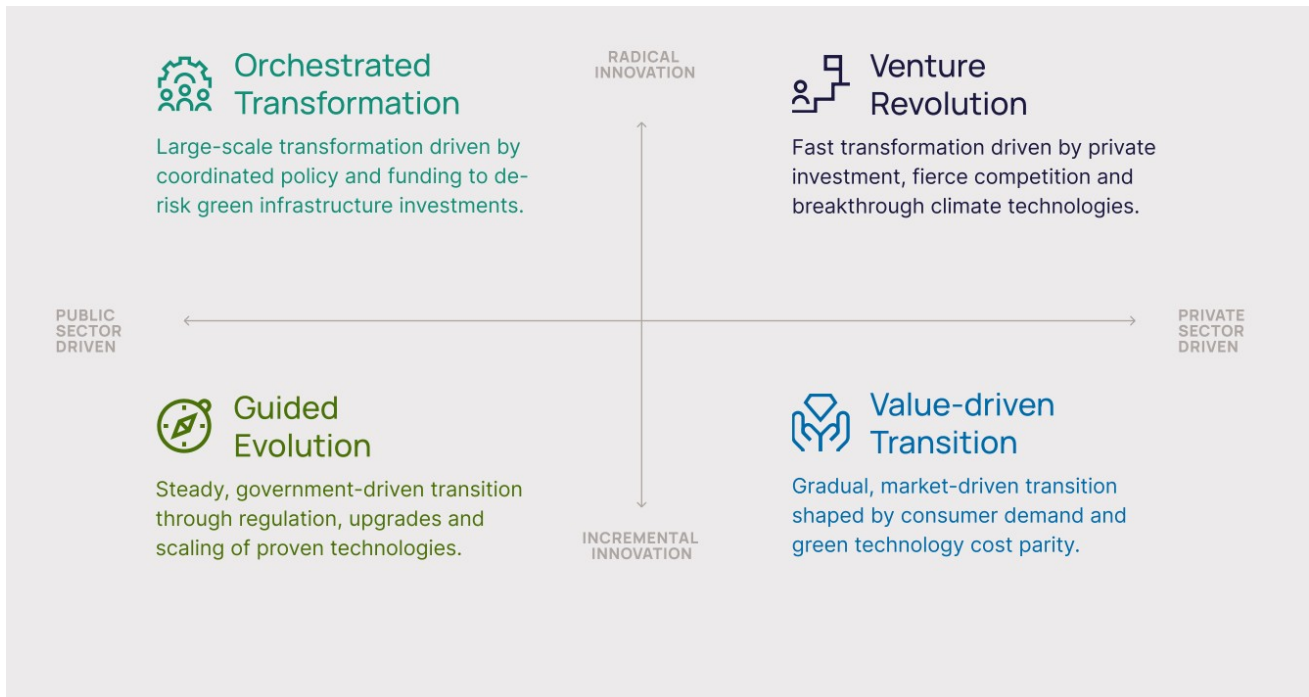


Figure 1: 4 Climate-neutral future scenarios for ports

### How Port of Antwerp-Bruges used the scenarios

Port of Antwerp-Bruges used these scenarios in a backcasting workshop. Participants received the future scenarios and were divided into groups, each focusing on one of the four scenarios. They discussed, in their smaller groups, whether the port is already moving towards that future, whether it is desirable, what it would mean for the port ecosystem, and which drivers and barriers could either drive or impede them from reaching that climate-neutral port future by 2050. Afterwards, Each group identified several key milestones and the initiatives required over the next 5, 10 and 25 years to make their respective future scenario a reality. Comparing the outcomes across scenarios helped reveal actions that remain valuable under multiple futures and prioritise robust initiatives. Comparing the overall outcomes of the workshop with the current strategy helped stress-test the current decarbonisation strategy and identify which direction their current investments are taking them.

## 1.4 Best practise example: Scenario development in the Port of Venlo

The PoV demonstrates how scenario development and backcasting can be integrated into the GPMP as complementary planning tools. Scenario development explores alternative pathways towards the future, while backcasting translates a desired long-term vision into practical implementation steps. Together, they provide a structured methodology for dealing with uncertainty while maintaining a clear direction towards climate neutrality.

The PoV developed its scenarios using the common methodology established within the PIONEERS project. Specifically, the PoV adapted existing frameworks to the regional context by not developing scenarios from scratch but by combined two well-established scenario frameworks and translating them to the inland logistics context.

The first framework consists of the **Port of Rotterdam scenarios**. Because Venlo functions as one of the principal inland logistics hubs within Rotterdam's hinterland network, developments affecting Rotterdam have direct implications for freight volumes, modal split and energy infrastructure in Venlo. The four Rotterdam scenarios, **Connected Deep Green**, **Regional Well-Being**, **Protective Markets** and **Wake-Up Call**, were therefore adapted to reflect the characteristics of inland logistics and multimodal freight transport.

The second framework consists of the **PBL WLO II scenarios**, the official long-term socio-economic scenarios used by the Dutch Government. These scenarios provide nationally recognised assumptions regarding economic growth, demographic developments, technological progress and environmental policy, ensuring that the GPMP remains aligned with national planning instruments and infrastructure models.

By combining sector-specific logistics scenarios with nationally recognised socio-economic scenarios, the PoV created a coherent planning framework that links national economic developments with regional freight transport and logistics transitions. This demonstrates an important lesson for other ports: robust scenario development can often be achieved by adapting existing, high-quality scenario frameworks rather than creating entirely new scenarios.

In addition, rather than functioning as a standalone study, scenario development became an integral component of the GPMP. The scenarios provided the foundation for the Strategic Roadmap.

The close integration of scenario development with stakeholder engagement further strengthened the process. Stakeholders assessed the plausibility of the scenarios, discussed their implications for the regional logistics system and validated the strategic priorities identified through the analysis. This iterative process ensured that the final roadmap reflected both evidence-based foresight and practical operational knowledge.

### 1.4.1.1 From Alternative Futures to Robust Strategies

A distinguishing feature of the Port of Venlo methodology is that the scenarios were not developed as an academic foresight exercise but as a practical decision-support tool. Each scenario was analysed to assess its implications for freight transport, multimodal logistics, renewable energy systems, industrial development and port infrastructure. Rather than identifying projects that would only be successful under one specific future, the analysis focused on identifying measures that perform well across multiple scenarios.

Across all four scenarios, several strategic priorities consistently emerged:

- decarbonisation of logistics and terminal operations;
- expansion of renewable energy generation and storage;

- increased use of rail and inland waterways;
- development of circular industrial activities;
- digital integration of logistics and energy systems; and
- strengthened governance and regional collaboration.

These common priorities formed the strategic foundation of the GPMP because they contribute to climate neutrality regardless of which future ultimately develops. This approach increases the resilience of investment decisions and reduces the risk of stranded assets.

#### 1.4.1.2 Backcasting: Connecting Vision with Implementation

While the scenarios explore different possible futures, backcasting provides the implementation pathway towards the preferred future. Starting from the objective of achieving a climate-neutral Port of Venlo by 2050, the project worked backwards to identify the actions, investments and governance arrangements required to reach this ambition. Rather than asking what is most likely to happen, backcasting identifies what must happen for the desired future to become achievable. The resulting implementation pathway defines progressive milestones for **2026, 2030, 2040 and 2050**. The first milestone focuses on pilot projects, stakeholder mobilisation and establishing monitoring systems. The second phase emphasises modal shift, renewable energy generation and regional cooperation. By 2040, the emphasis shifts towards integrated renewable energy systems, hydrogen infrastructure and digitally optimised logistics. By 2050, these developments collectively enable climate-neutral operations supported by circular industrial activities and adaptive governance. This staged approach ensures that short-term investments remain aligned with the long-term vision while allowing sufficient flexibility to respond to technological, economic and policy developments.

#### 1.4.1.3 Key Lessons from the Port of Venlo

The PoV demonstrates that effective scenario development extends beyond exploring alternative futures. Its strength lies in combining recognised scenario frameworks, adapting them to the regional context and translating them into robust strategic priorities through backcasting. The methodology shows how ports can build on existing national and sectoral foresight frameworks rather than developing entirely new scenarios, ensuring consistency with wider policy objectives while reducing analytical effort. By integrating scenario development with stakeholder engagement, innovation assessment and implementation planning, the PoV created a GPMP that is both strategically robust and practically implementable. For other inland and maritime ports, this approach provides a transferable methodology for managing uncertainty, aligning short-term decisions with long-term ambitions and developing resilient transition pathways towards climate neutrality.

## 1.5 Best practise example: Scenario development in the Port of Barcelona

Scenario building is useful for dealing with uncertainty; in this case, Barcelona used it as a practical strategy-design tool rather than as a forecasting exercise. The exercise developed normative transition pathways: it did not ask which future was most likely, but how the port could achieve its long-term decarbonisation objectives under different external conditions. This distinction was important because the Green Port Master Plan needed to identify robust priorities, not only describe desirable futures.

The Barcelona approach also sat between a fully qualitative exercise and techno-economic model. Stakeholder knowledge and expert judgement shaped the scenarios, while a simplified backcasting and energy projection helped translate each scenario into implications for energy demand, infrastructure and strategic action.

## 2. How Barcelona applied the method

The value of the process came from converting a complex port transition challenge into a structured discussion. Instead of presenting a generic list of technologies, the port first analysed its own system and then tested how different strategies behaved under changing external conditions.

**1. Defining the purpose of the exercise.** POB already had a clear decarbonisation direction. The scenario exercise therefore did not aim to predict the most likely future, but to explore alternative ways of reaching that direction under different external conditions. This made the scenarios directly useful for strategic planning, as each pathway tested a different combination of dominant strategies, such as sustainable fuels, electrification, carbon circularity, or regionalised supply chains.

**2. Translating evidence into descriptors.** The method converted the evidence base into a limited set of factors that could shape the transition. Interviews, surveys, workshops, SWOT analysis, activity mapping, and energy/GHG inventory were used to identify these factors. They were then simplified into descriptors such as regulatory ambition, energy security, technology development, social acceptance, data rules, safety rules, investment conditions, and willingness to pay a green premium.

**3. Establishing influence between descriptors.** For each pair of descriptor states, the exercise assessed whether one state made another more likely, less likely, or had no relevant effect. These relations were treated as structured expert judgement rather than statistical correlation. The assessment drew on stakeholder interviews, survey findings, literature review, and the port characterisation work. Each relation was then translated into a qualitative score, from strongly negative to strongly positive. For example, strong climate-policy ambition may reinforce willingness to pay a green premium and large-scale electrification, while restrictive data rules may weaken operational optimisation.

**4. Testing internal coherence with CIB.** The Cross-Impact Balance matrix made the assumptions explicit and allowed the scenario tool to test whether each combination of descriptor states was internally coherent. Combinations with conflicting assumptions were discarded, while mutually reinforcing combinations were retained. This helped reduce the risk of producing narratives that sound plausible but combine conditions that do not fit well together.

**5. Using the scenarios for strategy design.** The resulting pathways allowed the port to compare the robustness of electrification, sustainable fuels, energy efficiency, operational optimisation, intermodality and circular economy across different futures. They also helped identify when infrastructure, regulation, funding and stakeholder coordination would become critical. In this sense, the scenarios acted as a bridge between uncertainty analysis and practical decision-making.

## 3. Example output: four normative transition pathways

Barcelona selected four most coherent scenarios. Each pathway assumes that the port moves towards decarbonisation, but the dominant strategies and infrastructure needs differ. This helps other ports understand why a scenario exercise should not end with narratives only: it should also reveal what each future implies for decisions today.

| Fueled decarbonisation                                                                                                                       | Charged transition                                                                                                                                           | Captured development                                                                                                                          | Deglobalised indulgence                                                                                                                                                        |
|----------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Alternative fuels become the main route for transport and maritime uses. Efficiency and optimisation reduce exposure to higher energy costs. | Renewable electricity, storage and smart-grid management drive large-scale electrification. Rail, short sea shipping and flexible operations become central. | Carbon capture and CO2 logistics become central. Sustainable fuels develop through carbon valorisation while electrification remains limited. | A fragmented world prioritises resilience and competitiveness. Electricity supports stationary uses and regional transport; intermodality increases for shorter supply chains. |

Table 1: Normative transition pathway example

These scenarios were then translated into energy projections that achieve the GHG reduction targets, presenting how the energy supply and consumption should evolve.

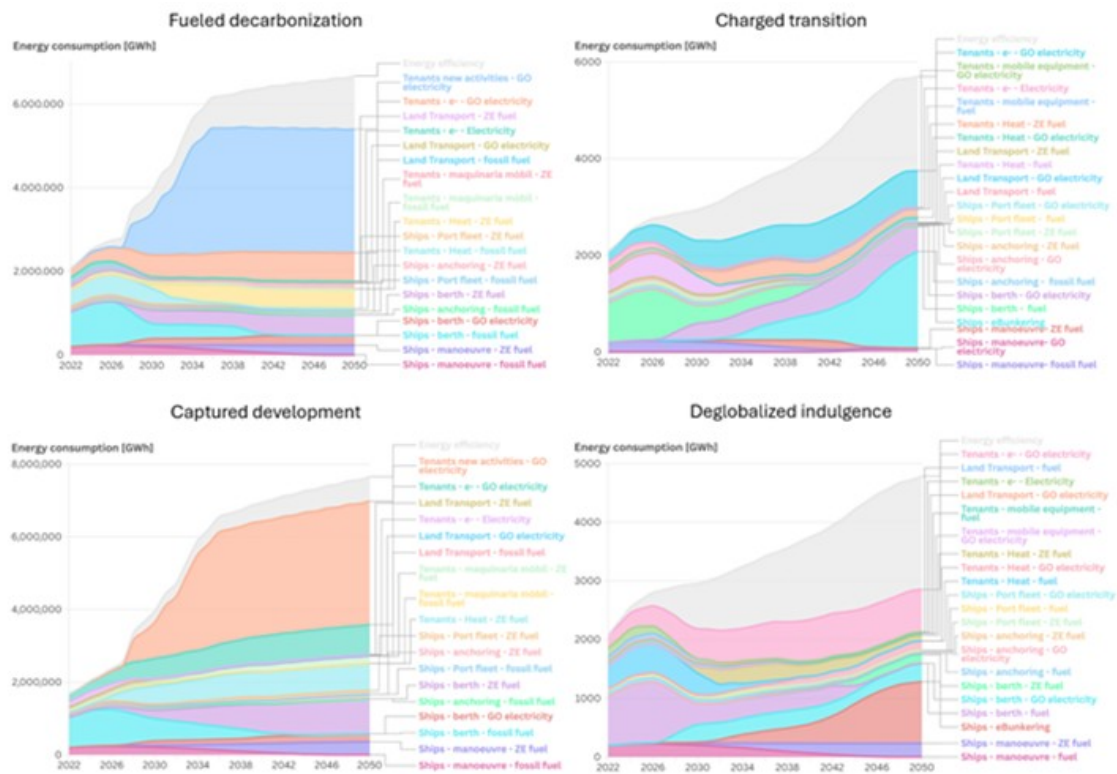


Figure 2: Energy projections based on the scenarios

#### 4. Considerations for replication

**Do not start with the scenario names.** Start with the port system: activities, energy uses, stakeholders, governance limits, infrastructure constraints and current emissions.

**Make assumptions explicit.** The main benefit of the method is transparency. Ports can see which policies, technologies or social conditions make each strategy stronger or weaker.

**Use structure to improve discussion.** The CIB matrix gives discipline to expert judgement. It does not replace stakeholder dialogue, but it helps organise it and test the internal consistency of the results.

**Move from scenarios to decisions.** Backcasting links each pathway to actions: grid reinforcement, fuel value chains, OPS deployment, rail and short sea shipping, CO2 logistics, incentives or cooperation agreements.

**Use scenarios to find robust priorities.** Strategies that remain useful across several pathways deserve early attention. Strategies that depend on one future require monitoring, partnerships or staged investment decisions.