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Executive Summary

The goal of WP7 within the MAGPIE project is to develop and demonstrate non-technological innovations that enable and accelerate the implementation of low or zero-emission technological and logistical solutions. D7.1 discusses the barriers to innovation, while this report addresses non-tech measurements to address these barriers. The technical innovations to address these barriers are the subject of the other MAGPIE WPs. This task is followed by a selection of 8 options (D7.3) relevant to address those barriers limiting the implementation of MAGPIE technical solutions. At the same time D7.4 will describe how to study the effectiveness of the measures and design optimal measures.

The goal of this report is to create and assess a long list of non-technological innovations. This list is a basis from which WP7 will derive and create non-technological innovations to deal with barriers that could hinder the implementation of solutions for the transition to zero emissions as developed and studied within MAGPIE. Using both a survey under the MAGPIE participants and a literature search, a collection of innovations was made. These were reviewed and resulted in a set of generic non-technological innovation concepts that will form the basis for the further analysis from which an eventual short list will be made of the most promising solutions.

The port ecosystem represents a cluster of emissions-producing activities of which transport and energy production are the most significant polluters. Though most of the transport related emissions occur outside the bounds of ports, ports themselves constitute a key nexus where emission reduction initiatives can be implemented in coordination with a large variety of stakeholders. This Port Nexus can be understood as a complex, 'Mission-oriented Innovation System' (MIS), as discussed in D7.1, with various stakeholders, elements, and internal functions that support innovation. Its raison d'être is to develop innovations geared towards achieving the "urgent societal goal" of a successful energy transition, and the efficacy of its internal functions determine the extent to which that goal is met.

With this function in mind, three non-technological solution 'clusters' are proposed, offering the necessary breadth of scope to tackle the innovation barriers identified in previous report:

1. Policy solutions
2. Business concepts
3. Information Provision & Quality

Ascribed to these clusters is a list of solutions and measures from the aforementioned survey and literature search. It should be noted that the solution concepts should not be seen as individual innovations but as elements of such an innovation. In other words, a single innovation will consist of a combination of concepts interacting and supporting each other to achieve the desired effect. To give an example of this, the concept of benchmarking is almost always combined with an economical measure such as tariff reductions.

1. Introduction

The goal of WP7 within the MAGPIE project is to develop and demonstrate non-technological innovations that enable and accelerate the implementation of low or zero-emission technological and logistical solutions. D7.1 discusses the barriers to innovation, while this report addresses non-tech measurements to address these barriers. The technical innovations to address these barriers are the subject of the other MAGPIE WPs. This task is followed by a selection of 8 options (D7.3) relevant to address those barriers limiting the implementation of MAGPIE technical solutions. At the same time D7.4 will describe how to study the effectiveness of the measurements and design optimal measurements.

The goal of this report is to create and assess a long list of non-technological measures. This list is the basis from which WP7 will derive and create non-technological measures to deal with barriers that could hinder the implementation of the technical solutions for the transition to zero emissions as developed and studied within MAGPIE. The collection of innovations will be carried out both through an internal survey by MAGPIE participants and a semi-structured literature review. The research contributes a set of generic non-technological innovation concepts that will be analysed further in future deliverables.

In a first brainstorm session, making use of overviews on similar subjects provided by other research projects, it was decided to approach the long list with the use of a classification framework. This way the principal forces of a solution can be identified. It also allows us to be creative beyond the available examples of measures by identifying suitable options from the framework and contriving a new solution not identified earlier. Therefore, in this deliverable the framework will be discussed first, after which we will supply a long list of already identified solutions, including their key qualifications required for the selection process in the follow up of this work package T7.1.3.

2. Methodology

2.1 Situating the Classification Framework

This deliverable provides a categorized long list of potential non-technological innovations. To ensure that this long list effectively serves the goals set out by WP7 (see Annex 3: 'Description of T7.1.2'), this section will establish the rationale behind the categorization of non-technological innovations by way of a 'Classification Framework'.

It is imperative that the long list of potential non-technological innovations addresses all of the critical barriers that prevent the success of technical innovations in the port context. Therefore, this report will need to be built on the theoretical foundations laid out by the previous report, *Deliverable 7.1*, and the findings presented in it. These foundations are important for establishing what the long list of solutions aims to address, how it will do it, and whether or not there are any barriers left unaddressed

2.1.1. Theoretical foundations and barriers

Deliverable 7.1 presents a list of innovation barriers[1] experienced by stakeholders in the port context as they approach the energy transition. The report (D7.1) understands the energy transition as a complex, large-scale sociotechnical transformation of a system that inevitably must contend with well-established practices and technological trajectories.[2]

This transformation has multiple pathways of realizing system changes. In the case of the energy transition in the port context, the focus lies on substituting the dependence on fossil fuels for transport and power generation with alternative, zero emission energy carriers and supporting infrastructure, in addition to supporting energy efficient practices. The pathway of change thus concerns innovation, whereby new technologies and practices are designed and developed to replace the legacy fossil fuel-based systems accommodated by the port context.

The port ecosystem represents a cluster of emissions-producing activities of which transport and energy production are the most significant polluters. Though most of the transport related emissions occur outside the bounds of ports, ports themselves constitute a key nexus where emission reduction initiatives can be implemented in coordination with a large variety of stakeholders. This is referred to as the *Port Nexus*[3][4]. Its raison d'être is to develop innovations geared towards achieving the "urgent societal goal" of a successful energy transition, and the efficacy of its internal functions determine the extent to which that goal is met. As such, *Deliverable 7.1* aimed not only to identify the various innovation barriers that stakeholders experienced in achieving the urgent societal goal, but also to ascribe those barriers to the underlying system functions that support innovation. In this way, the report conceptualizes the specific innovation barriers as symptoms of systemic failure. The internal functions of a healthy MIS, referred to as "Innovation Processes", are shown below.

Table 1: Innovation processes necessary for the successful implementation of disruptive innovations

#	Innovation process	Description
1	Directionality (Developing strategy & policy)	Ability of various stakeholders to set a joined course of action (strategy or policy)

[1] A barrier is defined as a factor 'limiting the ability to perform the innovation process, due to the absence or lacking capability of one of the stakeholders, institutions, infrastructure or interactions.

[2] Geels, F. W., & Schot, J. (2007). Typology of sociotechnical transition pathways. *Research policy*, *36*(3), 399-417.

[3] Hekkert et al. (2020). Mission-oriented innovation systems. Environmental Innovation and Societal Transitions (34), 77.

[4] Wieczorek and Hekkert (2012). Systemic instruments for systemic innovation problems: A framework for policy makers and innovation scholars. *Science and Public Policy (39)*, 74-87.

2	Entrepreneurship & Market formation (Developing economic legitimacy)	Societal and commercial reasoning for stakeholders to do business (i.e., act based on costs, risk, and availability of finance)
3	Resource allocation (Acquiring resources)	Mobilization of human, financial and material resources to enable all other system functions.
4	Knowledge (Development & diffusion of insights)	Development and dissemination of knowledge, information and expertise

The 'innovation processes' constitute Innovation System functions. Table 1 above thus gives a systemic overview of the steps that need to be in place for the Port Nexus Innovation System to support and accommodate successful innovations. These steps serve to protect innovations against mainstream market selection, against which they tend to be disadvantaged.

Barriers to the successful implementation of innovations fall within this systemic overview. Barriers are essentially the practical, tangible examples of innovation processes not functioning well. The barrier types identified in previous research are exhibited in Table 2 below. The barrier types below are generic. Each type refers to a grouping of diverse examples from different modalities and actor types. The variety of barriers are thus presented this way for the purpose of clarity.

Table 2: Barrier types

#	**Type**	**Barrier example**
1	Economics	Lack of business case
2	Knowledge	Lack of adequate models describing multimodal dependencies
3	Standards & Regulation	Lack of non-fossil fuel standards
4	Interaction	Lack of trust between stakeholders
5	Directionality	Lack of clear emission reduction goals
6	Technology	Immature technology
7	Infrastructure	Absence of sustainable energy infrastructure

Each barrier type above indicates the exposure of a given technology to unfavorable conditions or complicating factors (see D7.1 for full list of barriers per modality). For each modality different barriers were identified, clearly differentiating between shipping and land transport. A prime example applicable to all modalities is that of the cost disadvantage that new, zero emission technologies often struggle with when compared to mature fossil fuel-based technologies with calibrated value chains. This example exemplifies that those innovations seeking to disrupt the dominance of legacy technologies and practices cannot be left unsupported against market forces. The barriers can be split into two groups, the first five (Economics, Knowledge, Standards & Regulations, Interaction and Directionality) are non-technological in nature and will be addressed in this deliverable. The last two (Technology and Infrastructure) are technological in nature and are addressed by the various Demos and WP8. Of course, WP7 will focus on the presence of these non-technological barriers within the applications developed within MAGPIE.

From the research of *D7.1,* it was concluded that the barriers could be attributed primarily to the faulty functioning of two 'Innovation Processes': *Directionality* and *Entrepreneurship & Market formation.* See Table 3 below for concluding remarks on each of the Innovation Processes.

Table 3: Discussion of Innovation Processes

#	Innovation process	Discussion
1	Directionality (Developing strategy & policy)	The directionality given by the policies and analysis under development seem to align with the sustainable goals (see Figure 4), however the timeframe and support towards implementation is currently perceived as non-realistic. This is due *to the lacking agreement between global, European, and national actors on both the type of (economic) instruments, and the timeframe as part of an extremely complex mix of political and strategic interests.*
2	Entrepreneurship & Market formation (Developing economic legitimacy)	To ensure the required entrepreneurial activities to develop and implement sustainable solutions, the actors in the value chain require an overarching and actor specific business case. For niche/first-mover actors, this perspective is already in place to facilitate pilots. However, the scale up phase is dependent on a stable long term financial outlook.
3	Resource allocation (Acquiring resources)	The overall challenge in successfully allocating the right resources, whether financial, material, or human capital-based, to the right places is seen as a secondary barrier, as successful allocation will follow the development of the business case.
4	Knowledge (Development & diffusion of insights)	The knowledge development and dissemination of technical zero-emission solutions is seen as a less critical barrier.

The long list of solutions proposed in this report takes the 'Mission-oriented Innovation Systems' (MIS) theory into account to ensure that it adequately addresses the innovation barriers that may occur as a result of the poor functioning of the Innovation Processes.

2.2 Classification Framework for solution identification

The MIS framework could be used as a structure for the identification of promising non-technological innovations. However, for the classification of the solutions, a system that organizes and aligns the type of actions available offers further benefits when considering both, a selection/evaluation model for a shortlist of non-tech solutions (T7.1.3) and a development plan for each solution (T7.2.1). These tasks will study the mechanisms used in detail to determine their potential and to select a subset to be investigated and developed further. Additionally, the MIS framework allows linking the actions back to the barriers addressed. Therefore, if another structure is chosen, it should be able to link the MIS aspects of Table 3 above in this new structure.

Based on the action-based approach, the solutions framework is structured according to a three-pronged classification framework. Although the development went hand-in-hand with the non-technical measure identification, it will be discussed first to provide a reference in the discussion of the long-list. As all solutions could be assigned to the framework, we consider the framework exhaustive, however, unknown solutions could require adjustments in the future.

The framework is comprised of three solution clusters as indicated in Table 4 below. In combination, these clusters will stimulate sufficient and sustainable interaction between the Port Nexus Innovation System and the relevant socio-technical regimes that said innovation system is seeking to disrupt. The classification of potential solutions along these clusters ensures a breadth of solution types that will address the shortcomings of the Port Nexus Innovation System identified in the previous report, Deliverable 7.1. The focus within the Port Nexus as defined within MAGPIE is on the transportation sector, not the industry within ports.

Table 4: Classification framework of non-technological innovations

Cluster	Solution Type
Policy solution	Market Intervention

	Regulation & Norm creation
	Green public procurement
	Regulation & Legislation on safety
Business concept	Burden/price sharing mechanisms
	Platform models
	(Green) Certification
	Market restructuring (consolidation)
Information provision & quality	Knowledge transfer & diffusion
	Skills & expertise development
	Quality provision of knowledge

Each cluster corresponds to the systemic challenges experienced by the Port Nexus Innovation System and simplifies the overview of measures available to decision makers at various levels. Ultimately, such a classification serves the goal of compiling a thorough list of relevant and existing non-technological innovations for further analysis.

Key strengths of the classification are that it lends itself to a vertical (level of decision maker) as well as horizontal (target sector or audience) organization of non-technological innovations. This way, the compiled long list can directly couple proposed solutions to specific barriers as identified in previous reports, and to more broad systemic challenges in the functioning of the innovation system. The added benefit is that underrepresented barriers or systemic challenges will become apparent, and the researchers will be able to address solution gaps wherever they arise.

The next subsection discusses each solution cluster in greater detail.

2.2.1. Cluster: Policy Solutions

Policy solutions refer to the creation of a policy regime that stimulates and facilitates both the development and broad implementation of innovations, which are, in this case, sustainable technologies that contribute to the energy transition in the port context. These solutions should comprise a "long-term and consistent"[5] framework of policy that advances a sustainable public good through market creation, institutional support, and financial instruments. In doing so, proposed policies must complement each other and take into account the complexity of the innovation system.

Within this cluster, the research team has identified four policy types (see table 5 below). Each type of policy acts in support of sustainable transitions by both stimulating the development of innovations within a niche and destabilizing established socio-technical regimes that prevent innovations from displacing old technologies and practices. See below for further description of each solution type within this cluster.

Table 5: Policy Solutions, Solution type and Description.

Cluster	Solution Type	Description
	Market Intervention	Taxation, Subsidies, and price fixing or differentiation measures to distort the market in favor of new, sustainable

[5] Foxon and Pearson (2007). Overcoming barriers to innovation and diffusion of cleaner technologies: some features of a sustainable innovation policy regime. *Journal of Cleaner Production (16S1)*.

Policy solution		technologies with positive externalities. E.g., the carbon tax or emission trading system.
	Regulation and norm creation	Implementation of (mandatory) requirements for sustainable product design, operation, and consumption. Aimed at the exclusion of undesired options, e.g., the European ship dismantling regulations.
	Green public procurement	Market creation for sustainable technologies by public procurement, whereby the government acts as customer e.g., ordering green vessels and infrastructure.
	Regulation & legislation on safety	Establishment of rules and regulations on safety ahead of the implementation of a new technology, or improving exemption procedures for new technology to support innovation. E.g., the Norwegian autonomous shipping fjord.

2.2.2. Cluster: Business Concepts

The 'Business concepts' cluster consists of solutions designed to stimulate the development and adoption of sustainable innovations across the various value chains. Considering the complexity of the Port Nexus Innovation System, the key feature of business concept solutions is the facilitation of interaction horizontally and vertically along value chains in terms of increased quality and frequency.

Interaction can refer to any number of activities, such as information sharing, business transactions, certification, and institutionalization that serves the purpose of value generation. In such a way, the facilitation of interaction that 'business concepts' engender can manifest value creation for sustainable innovations. This may address systemic challenges and specific barriers identified in the previous report, D7.1.

The research team identified four solution types that bode promise in addressing these key challenges and supporting innovation development and adoption.

Table 6: Business concepts, Solution types and Description

Cluster	Solution Type	Description
Business concepts	Burden/price sharing mechanisms	Financial instruments that reduce the costs borne by a given stakeholder in a value chain promoting a sustainable product or technology. In the initial stages of the transition not all partners will be equally willing or able to contribute towards green measures. The added value of these concepts is that it allows the willing and able to contribute to emission reductions. This is commonly achieved through a mass balance and the use of certificates, like the green electricity we can buy as households.
	Platform models	Facilitation of transactions, information sharing, and/or networking via a single access point (PaaS). The added value is effort reduction for customers and data aggregation at one location so that new markets can emerge, such as smart energy markets or optimized trade markets.
	(Green) Certification	Manifesting the added value of sustainable products and technologies through certification. The added value is the certainty or 'de-risking' that the certification provides to the outside world (without endangering the commercial properties). Usually this will be combined with other measures (e.g. market intervention). The certification of recycled materials and the green passport are examples of these measures.

	Market restructuring (consolidation)	Concentration of resources through horizontal (acquisitions, conglomerations) or vertical (supply chain consolidation) integration in fragmented sectors. The added value is that larger entities can more easily carry the costs of innovation and research. The effective bundling of forces and knowledge could be used to accelerate developments. Developments themselves are more likely to take place in newcomers, which do not yet have stranded assets.

2.2.3. Cluster: Information Provision & Quality

The 'Information' cluster encompasses solutions that seek to address the key systemic challenge that innovation systems face. An inherent issue in fostering large scale change to socio-technical systems through innovation is the complexity of the system as a whole, and the inertia that keeps certain practices in place despite the associated negative externalities. Innovations seeking to displace established practices, institutions, and technologies, must thus disrupt information spaces, create public awareness about the merits of a novel technology, and sustain the development of new expertise in a context that is complex, and largely unaware of alternatives.

The 'Information' cluster of solution types targets these barriers by facilitating knowledge dissemination, centralizing authoritative sources of knowledge, and sustaining knowledge development through education and training regimes. In doing so, these solutions buttress innovations systems, like that of the Port Nexus, in order for sustainable innovations to succeed.

Table 7: Information cluster, Solution types and Descriptions.

Cluster	Solution Type	Description
Information Provision & Quality	Knowledge transfer & diffusion	The active process of sharing information with those in need of it and reaching them. Information campaigns and strong marketing initiatives are examples of how this can be used to extend awareness about a given technology or issue. The goal should not be to sell, optimizing the information to your strong points, but to enlighten stakeholders.
	Skills & expertise development	The allocation of resources towards education, ensuring that the necessary expertise exists, and that it can be sustained and built upon over time. Examples are sufficiently knowledgeable crew to deal with, e.g., new fuels or digitization.
	Quality provision of knowledge	The design of knowledge dissemination efforts to be factual, simple, and easy-to-find. A concern in this regard is the lack of a central, authoritative source of information on new technologies. Hence the reliability of information is always doubtful and therefore context should be rich.

2.3 Linking the Classification Framework to the MIS framework

As can be seen in Table 8 below, the Classification Framework is designed to cover each of the Innovation Processes that feature in the Port Nexus Innovation System. This ensures that the systemic functions that require further support are duly addressed. Moreover, the clusters of non-technological measures are broad enough to cover the barrier types associated with each Innovation Process.

Table 8: Matching the Classification Framework to the System Functions

Innovation Process	Non-Technological Measures Classification Framework	
	Solution Cluster	**Solution Type**
Directionality (Developing strategy & policy)	Policy solution	Regulation & Norm creation
	Policy solution	Regulation & legislation on safety
	Business concept	(Green) Certification
Entrepreneurship & Market formation (Developing economic legitimacy)	Policy solution	Green public procurement
	Business concept	Burden/price sharing mechanisms
	Business concept	Platform models
	Business concept	Market restructuring (consolidation)
Resource allocation (Acquiring resources)	Policy solution	Market Intervention
	Information provision & quality	Skills & expertise development
Knowledge (Development & diffusion of insights)	Information provision & quality	Knowledge transfer & diffusion
	Information provision & quality	Quality provision of knowledge

2.4 Long list collection procedure

The long list collection procedure will utilize two mutually reinforcing approaches. The first approach will be the collection of solutions as found in the literature, making use of academic, peer-reviewed articles as well as reports and industrial studies. The second approach will be the collection of solution suggestions from WP7 members and Demo leaders through a survey to validate the completeness of the overview.

2.4.1 Literature Review

This collection approach aims at an informative, rather than exhaustive, collection of relevant secondary resources covering fields of interest as determined by the researchers. The approach is non-systematic by design and will rely on the judgment of the researchers to select high-quality resources on the topic of non-technological innovations for the stimulation of innovation in the port context. The parameters set for the collection process are limited to:

a) a set of keywords which was used to make the first selection of papers based on titles. Energy transition was used in all searches combined with an option from policy, measures, incentives and business concepts as well as a focus on either maritime, rail, trucking or port operations.

b) a review of the abstracts led to a selection of suitable papers and concepts to be used, which were ordered along the principles identified.

Instead of naming every instant of a non-technological innovation measure, a generalization was applied to the results of the literature study. This means that the concepts were collected in a long-list, rather than the individual approaches, which can differ slightly, but in general follow a similar approach to the barrier(s) addressed. As this overview serves as a source of inspiration for the development and detailing of non-technological innovation

measures within the MAGPIE project, this actually helps identify elements and aspects to include or combine. As it will also help to be able to review individual ideas, these results are added in Annex 2. The categorization of Table 4 is used as a support for literature research, as can be seen in Chapter 3.

2.4.2 Survey

The survey consisted of an excel list asking partners to identify and classify non-technological innovations they are aware of. This was sent around and input was collected over the period of one month. Responses were received from almost all WP7 partners. The requested input contained the solution cluster and addressed barrier, as described above, but also asked for specifics of the situation such as target group, implementer, level (e.g., national, regional), domain and modality. Furthermore, insight was requested on the Maturity Level and Scalability.

To combine the work on the literature research and surveys, the survey results were used to review the completeness of the concepts identified in the literature. Any new element was added to ensure that the long list of concepts sufficiently represents available options. All options identified were reviewed and concepts were generalized to obtain a long list of unique non-technological innovation concepts.

3. Clustered list

The clustered list is sorted by solution cluster (column 3) and mentions the key concept. The list also contains the level of applicability at which it was most frequently found (but this is not exclusive). Finally, the maturity level gives an insight into the status of the identified measures; some are only ideas, where others have been implemented with studies providing insight into its success or lack of it. The final column identifies the key barrier addressed, although this could be multiple in fact.

Table 9: Clustered list of non-technological innovation concepts

#	Solution Concept Group	Solution Cluster	Level	Maturity Level	Addressed Barrier(s)
1	Taxation and tax exemptions.	Policy solution	National	REDII, fuel levies, car taxation.	Economic
2	Flexible Kyoto Mechanisms (ETS, JI, CDM)	Policy solution	EU and National	Not yet implemented	Economic
3	Price Differentiation (Feed-in Tariffs for electricity, Port Tariff differentiation).	Policy solution	National	Existing, e.g., inland and seagoing, 5-6 schemes available, also used for wind and solar park development.	Economic
4	Service discrimination (faster service for low carbon vessels/vehicles, i.e., bunkering/repairs)	Policy Solution	Port	Not yet implement	Directionality
5	Legislation	Policy solution	National	IMO targets, EU Targets, etc.	Standards & Regulation
6	R&D Support	Policy solution	National	H2020, Horizon Europe	Directionality
7	Subsidies	Policy solution	National	Used in various forms	Knowledge
8	Speed Restriction/ Reduction	Policy solution	Port	Under discussion, not implemented	Standards & Regulation
9	Regulations	Policy solution	National	Not yet implemented	Standards & Regulation

10	Digital governance models for data and platform management	Policy solution	Port	Novel idea	Standards & Regulation
11	MoU's between Ports and relevant players to create compatible data ecosystem (platform as a service)	Business concept	Port	N/a	Directionality
12	Investment & operational cost risk mitigation (like pay per use/leasing etc)	Business concept	Global	Low, due to lack of interest	Economic
13	Voluntary Agreements/ Benchmarking/ Green or Carbon Neutral Certification	Business concept	Regional (EU)	Inland shipping rating, part of several reward schemes	Standards & Regulation
14	Energy Transition Management (Long-term Learning by doing)	Business concept	National	E.g., Dutch green Deal. Fit for 55, Norwegian restructuring programmes	Directionality
15	Split Incentive (contract offers non-sustainable incentives, TC vs VC)	Business concept	Company	Limited	Standards & Regulation
16	Green public procurement of fixed destination vehicle/vessel fleet (Leading by example)	Business concept	Port	Yes, e.g., investments in green ships by companies related to the state.	Directionality
17	Niche Development roles (targeting of niches to break the ice for further transitions).	Business concept	National	E.g., zero emission passenger transport in Norway	Directionality
18	Corporate Social Responsibility	Business concept	Company	Exist, but did not yet take hold in transport	Directionality
19	Consensus tooling	Information provision & quality	Global	Start point	Interaction between stakeholders
20	Communication strategy	Information provision & quality	Global	Programs in place, however impact is limited	Directionality
21	Creating or directing innovation hubs (CCIs) to tackle specific issues at the nexus between non-tech and tech.	Information provision & quality	Port	CCIs shown to facilitate transition by stimulating innovation	Interaction between stakeholders
22	Targeted Information Schemes (E.g., white paper series for policy makers)	Information provision & quality	National	Not yet implemented	Knowledge
23	Marginal Abatement Costs Insights	Information provision & quality	Company	Available for many ships and solutions	Knowledge

24	Port User Forums	Information provision & quality	Port	Exist, but with a different purpose	Knowledge

The long list of non-technological innovation concepts (Table 9 above) will serve as a reference and a basis for the development and validation of the non-technological innovations within WP7. It should be noted that concepts should not be seen as individual innovations but as elements of such an innovation. In other words, a single innovation will consist of a combination of concepts interacting and supporting each other to achieve the desired effect. To give an example of this, the concept of benchmarking is almost always combined with an economical measure such as tariff reductions.

4. Conclusions

Within this deliverable, the inspiration was collected for the creation of specific non-technological innovations to address the barriers to implementation that are and will be identified through the MAGPIE work on technological innovations. The broad investigation of both literature and knowledge within the partners has assured that the long list is extensive and a solid foundation for this development within WP7. The approach aligns with the work of D7.1 and will continue in the work of D7.3 (on T7.1.3) and D7.4 (on T7.2.1), creating a solid foundation for others as well.

Annex 1: Innovation Barriers identified per modality

Road Transport

#	Type (*General Barrier*)	Barrier
1	**Economic**	High Total Cost of Ownership (TCO) of zero emission trucks for consumers
		High investment risk in scaling up to high TRL
		Uncertainty over customer demands (transport companies) as there is currently no 1-size-fits-all solution with current battery technology
		Market not yet mature, so demand for zero emission trucks is inadequate
		Fierce competition disincentivizes necessary data sharing for road traffic management in and around ports
2	**Knowledge**	Lack of historical technical performance indicators for medium/heavy duty zero emission trucks due to the low technical maturity of the concept
		Customers unaware about current zero emission truck capabilities
		Lack of system level oversight hampers *operational* innovation (i.e., new transport practices and traffic management)
3	**Standards & Regulation**	Lack of supply chain wide CO_2 emission regulation
		Lack of common safety regulations and standards
		Long standardization process
	Standards & Regulation	Lack of regulation and enforcement mechanisms to facilitate data sharing
4	**Interaction between stakeholders**	Complex stakeholder system for developing useable charging infrastructure with sufficient grid capacity
		Lack of integration of traffic management jurisdictions and practices
		Unaligned stakeholder interests and strategic priorities between disparate traffic management entities hampers innovation
		Lack of trust between commercial parties disincentivizes data sharing
5	**Directionality (Cohesive policy direction)**	Slow & inefficient incentive programs kill business case
		Varying quality of incentive programs for OEMs per country
6	**Technology**	Inadequate operational range and long charge times with current generation of zero emission medium/heavy-duty trucks limit long distance transport operation options
7	**Infrastructure**	Lack of grid connection and network capacity for increasing electricity demand
		Lack of batteries and battery-swapping infrastructure
		Insufficient sustainable energy to accommodate the demand from the electricity grid (Scope 2 emissions)

8	**Other**	Lack of human capital (E.g., truck driver shortage and civil servants in traffic management)
		(Un)Known Unknowns: unpredictable barriers will emerge

Rail Transport

#	Type	Barrier
1	**Economic**	Price barrier between fossil fuel and alternative fuel
		High capital costs
		High operational costs
		Unlevel playing field for independent rail transport companies
		Context specific: Small national markets
2	**Knowledge**	Training new workforce for new technological and safety standards
		Lack of verifiable and cohesive emissions data across international rail system
3	**Standards & Regulation**	Strict safety standards limit access and raise costs for new e-shunting locomotives
		Complex homologation process may hamper investment
		Lack of European electrification standard
4	**Interaction**	Power imbalance between public and private stakeholders
		High level of communication between infrastructure provider, manufacturer, and locomotive operator required
		Unaligned interests in (international) traffic management
		Financiers demand unfavourable terms: high interest rates or equity stake
5	**Directionality**	Lack of clear ‘green’ vision from rail infrastructure managers
		Lack of incentive schemes for green track use
6	**Technology**	Proof of concept required for e-locomotive
7	**Infrastructure**	Lack of, or inadequate, grid connection for e-locomotives in the port
		High capital costs for modernizing rail infrastructure

Inland Shipping

#	Type (*General Barrier*)	Barrier
1	**Economic**	Lack of business case for solution suppliers due to small numbers of inland vessels on the market in comparison to the automotive or maritime shipping market (both in total number of vessels and the number of vessels per market segment)

		Risk of (economic) lock-in with new technology with long term assets
		Short term contract (sport-market) is predominant, causing lack of perspective
		Little investment capacity due to limited funds, especially for small scale operators which constitute a majority of the market
2	**Knowledge**	Lack of capacity to build expertise for stakeholders in comparison to the complexity of the (technical, operational, regulatory) changes
		Lack of system level insight (e.g., data, decision models) for policy makers
3	**Standards & Regulation**	Standard complexity too high for inland (e.g., due to leaning in seagoing)
4	**Interaction between stakeholders**	Innovation averse mindset
		Short term commercial relationships (spot market)
		Quality of organized interaction and representation (also multimodal)
5	**Directionality**	Inland shipping seen as niche (e.g., embedded in other policy)
		Harmonization of policy on European level (e.g., NOx or emission reduction goals)
6	**Technology**	Too many new (immature) technologies
		Lifecycle of technology (lock-in)
7	**Infrastructure**	Uncertainty linked to infrastructure required to support new technology

Seagoing Shipping

#	**Type (*General Barrier*)**	**Barrier**
1	**Economic**	Uncertainty on emission pricing / energy carrier subsidies
		Risk of (economic) lock-in with new technology with long term assets
		Absence of a level playing field
		Lack of, or uncertain, customer willingness to pay for sustainable innovations
2	**Knowledge**	Lack of capacity to build expertise for actors in comparison to the complexity of the (technical, operational, regulatory) changes
		Lack of system level insight (e.g., data, decision models) for policy makers
3	**Standards & Regulation**	Lack of, or inadequate, non-fossilbased fuel standards
		Limited (onboard and regulatory) standardization
		Lack of integrated and sufficiently flexible standards (e.g., unintended mistakes fit for 55)
		Permit uncertainty
4	**Interaction between stakeholders**	Difficulty to align, externally and internally to the wide variety and scale of stakeholders

		Global political and strategic interests in shipping
		Lacking unity or rallying for leading stakeholder(s)
		Difficulty for small stakeholders to align with major initiatives
5	**Directionality (Cohesive policy direction)**	Potential negative business impact due to unbalanced directives (e.g., fuel directives)
		Harmonization of policy on National, European and where possible global level
6	**Technology**	Too many new (immature) technologies options
		Lifecycle of technology (lock-in)
7	**Infrastructure**	Uncertainty about the presence of new infrastructure and impact of stranded assets

Annex 2: Survey and Literature results.

#	Solution Idea	Solution Cluster	Target Group	Implementer	Level	Modality	Addressed Barrier(s)	Additional info or URL
1	Dedicated fund for incentive programs/subsidies from portion of ETS revenues	Policy solution	Commercial actors in energy and transport supply chains (Renewables producers, Ship operator/ owner, OEMs, terminals, Port Authorities)	New entity within the EU ETS mechanism	Regional (EU)	More than one	Economic	The inclusion of shipping in the EU Emissions Trading System (ETS) will result in a reduction to the cost gap between SZEFs (scalable zero emission fuels) and fossil fuels. However, the expected ETS prices will be insufficient to create price parity with traditional fuels, which means that a significant cost gap will remain due to SZEF production technologies still being in their emergence phase. SZEFs are currently produced at low volumes and high costs, whereas fossil fuels have well-established technologies, supply chains and economies of scale which allow for low-cost production at high volumes. Therefore, in addition to putting a price on emissions from fossil fuels, the EU ETS should be complemented by support mechanisms that will reinvest a portion of shipping related ETS revenues into incentives for the production and use of SZEFs. This will drive down the cost of SZEFs, in a similar way to programs that supported renewable electricity such as wind and solar as explained by University of Oxford researchers in a June 2021 report. https://www.globalmaritimeforum.org/news/how-eu-contracts-for-difference-can-support-the-development-of-zero-emission-fuels
2	Contract-for-Difference	Policy solution	Commercial actors in energy and transport supply chains (Renewables producers, Ship operator/ owner, OEMs, terminals, Port Authorities)	National government	National	More than one	Economic	Incentivising private investment is key to the necessary scaling and adoption of clean shipping fuels. In its basic form, a CfD can help achieve this by allowing a public sector entity to meet the difference between the market price for a fuel or technology (the 'reference price'), and the 'strike price' required for its financial returns to be sufficiently attractive to developers and private investors. When the strike price is higher than the reference price, the scheme in effect subsidises the producer of the fuel or technology the difference. When the reverse is true, the producer repays the subsidy. Cost obstacles have been dealt with successfully in other sectors in recent years. Most notably, in the UK offshore wind industry, a renewable obligations scheme, followed by three rounds of contract-for-difference (CfD) auctions has seen the 'strike' price of wind derived electricity reduced to a third of its pre-CfD value and to a price below current baseload electricity prices (ES- 3). This remarkable result has been achieved at least partly by using CfDs to promote private sector investment and thereby stimulate technological progress and accelerate learning rates. https://www.inet.ox.ac.uk/files/zero-emissions-shipping-FINAL.pdf

3	Fuel standard that sets an interim target of five per cent use of scalable zero emission fuels (SZEF) in shipping by 2030.	Policy solution	Ship operator/ owner	European Commission, (Committee on Transport and Tourism (TRAN) leads work on this file within EP)	Regional (EU)	More than one	Strategy Alignment* (Directionality)	Currently, FuelEU Maritime only includes a fuel standard with low reduction in GHG intensity from 2025 and no real incentives to use and produce SZEFs, which will not drive the shift to SZEFs in the short term. On the contrary, analysis undertaken by CE Delft shows that the FuelEU Maritime proposal will encourage a shift towards fossil LNG (and biofuels), which may lead to multi-decade asset lock-in of LNG vessels and infrastructure, which would delay shipping decarbonization. In the debate on FuelEU Maritime, a number of suggestions have been made by industry and NGOs to revise the proposal to incentivize the use and production of SZEFs. This could for instance be a sub-target mandating that a certain proportion of the fuels used to comply with FuelEU Maritime must be SZEFs while also taking measures to ensure the necessary supply of SZEFs. It could also be to allow SZEFs to count x times more relative to fossil fuels when reporting on fuel use, i.e. use so-called multipliers. As an example, the NGO, Transport & Environment has proposed an e-fuels sub-target of six per cent of the energy demand used by ships by 2030 and a multiplier of five for sustainable e-fuels, especially green hydrogen and ammonia. https://www.globalmaritimeforum.org/news/insight-brief-how-the-eu-can-catalyze-the-global-transition-to-zero-emission-shipping-and-the-green-hydrogen-economy
4	(EU) Carbon Neutrality Certificate for Terminals	Business concept	Terminals	European Commission	Regional (EU)	Other	Standards & Regulation	port industry mainly comes from the fuel and electricity consumed by loading and unloading production, auxiliary production and auxiliary production. It states that the realization path of port carbon neutrality is mainly through renewable energy substitution, energy efficiency improvement and electrification level, carbon offset, and similar. As disclosed, 100% of the electricity at the port comes entirely from wind power and photovoltaics and is 100% used and 100% self-sufficient. Looking ahead, Tianjin Port intends to position itself as a world-class green port, accelerate the construction of a “zero-carbon port”, facilitate sustainable transportation and sustainable development, and better serve the strategy of a strong transportation country and a strong maritime country. https://www.offshore-energy.biz/worlds-1st-zero-carbon-terminal-gets-carbon-neutrality-certificate/
5	Platform/program for accurate price estimates for use of ZES charters	Business concept	Shippers	Shipping companies	Company	Inland Shipping	Knowledge	Difficulty giving high lvl estimates to customers, usually takes 2 weeks, and is low confidence. Would like us to develop a simple program where you can put different inputs to calculate price estimates of pay-per-use battery system. This includes fixed costs and operational costs (price of electricity, hydrogen, etc). (Demo 7)
6	Customized service for insurance strategy plans	Business concept	Insurance companies	CCI consultancy service	Company	More than one	Interaction	Building trust with insurance companies by offering readymade and tailored fixed insurance strategy plans to bring to insurance companies to offer a risk reduction plan for involved parties. This could be linked with a CCI

								(see below) to offer this type of intermediary/cross-segment service (Demo 7)
7	Sustainable value creation framework through workshopping	Information provision & quality	any commercial actor	CCI consultancy service	Company	More than one	Interaction	De Martino 2021. Broad use framework allows businesses looking to innovate to identify who to work with and include in their value-generation. Offers a fairly straightforward overview of actor types at both the institutional level (civil society and PAs), and supply chain level (other actors involved in the relevant supply chain). Interaction is a key driver for value creation, and there are essentially 3 types you can have (1-off or infrequent consultation, regular information sharing, or collaboration and co-designing). could be coupled with internal strategy design in business through workshops/consultancy with companies, or through manuals for e.g. due diligence, etc. This would fall in information sharing as a way of informing new business strategies. This could be especially helpful in identifying why data isn't available and how we can get it into the right hands. a part of this would be designing the right incentives for the many different and unequal stakeholders.
8	HOMER energy optimization software	Business concept	Port Authorities	n/a	Port	Other	Knowledge	Abu Bakar et al 2022. this software could be useful when tackling the lack of data currently hamstringing WP3's efforts. "Hybrid Optimization of Multiple Energy Resources (HOMER) is a simulation-based software used to optimize any integrated system by finding the right size of the equipment and the best possible system configuration while minimizing the net present cost (NPC). It simulates the designed electric power system hour by hour for a year in the specific region considering the available energy resources present at the target location. For each time step, HOMER searches for many different configurations that satisfy the technical constraints at the lowest life cycle cost to meet the electrical load. Users can simulate their proposed power system and HOMER delivers the optimal candidate design." Furthermore, it can perform sensitivity analysis to examine the impact of uncontrollable variables to see how they may affect the designed system costs. These variables include the price of fuel, which is always volatile, the price of components, lifetime data, efficiency, and other parameters that their change in the future is not known.
9	Modify regulation of EEDI and EEXI to include shore power in measurement of compliance	Policy solution	Ship operator/ owner	IMO	Global	More than one	Strategy Alignment* (Directionality)	Daniel et al 2022. Since EEDI and EEXI do not allow shore power devices in their calculation, two options have been proposed to modify the regulation. Option 1 enables the auxiliary system to be supplied for a specific ratio of the average in-port time based on the ship type. In the case of the Federal Baltic port calls data analysis, a 1.2% of EEDI and EEXI reduction is estimated. Option 2 is to add a fix parameter to the EEDI and EEXI formula reducing of 10% the score of the ship if equipped with shore power. This factor would enable similar ship design to comply with EEDI phase 3.

10	Creating or directing innovation hubs (CCIs) to tackle specific issues at the nexus between non-tech and tech.	Information provision & quality	n/a	Port Authorities/ Municipalities	Port	Other	Interaction	Gerlitz and Prause 2021. Create or instigate the creation of CCI's (Creative/Cultural industries), which are very useful innovation actors active in local innovation systems and as intermediaries underpinning the flourishing of non-tech and organization potential for innovation. CCIs contribute to customer-driven innovation creation in the absence of collaboration between traditional businesses. An example could be setting up innovation hubs, or directing existing hubs to come up with solutions specific to the collection of data at the port of Rotterdam from an enormous amount of disparate players (specifically data on energy consumption). These types of actors may well provide an excellent glue for cross-sectoral value generation.
11	Taxation	Policy solution	Ship operator/ owner	National government, EC, UN/IMO	National	More than one	Economic	CO2 Tax, fines in ECA zones, fuel levies, exemptions for green fuels, .
12	Flexible Kyoto Mechanisms (ETS, JI, CDM)	Policy solution	Ship operator/ owner	National government, EC, UN/IMO	National	More than one	Economic	ETS, JI and CDM are options for this.
13	Feed-in Tariffs	Policy solution	Ship operator/ owner	Ports, regions or Nations	National	More than one	Economic	Time limited support for a certain adaptation, used currently for green electricity production.
14	Legislation	Policy solution	Ship operator/ owner	National government, EC, UN/IMO	National	More than one	Standards & Regulation	Obligations to fulfil a target e.g. in fuel blending, energy efficiency standards, emmission limits (IMO tier 4, EURO V)
15	Information Schemes	Information provision & quality	Ship operator/ owner	All Levels	National	More than one	Knowledge	Reduce disinformation, by creating trustworthy and easily locatable information sources. Beware of censoring of course. E.g. corona website, sites on the transition from classification societies.
16	Voluntary Agreements/ Benchmarking	Business concept	Ship operator/ owner	Corridor level, EU level	Regional (EU)	More than one	Standards & Regulation	Port emission benchmarks (DNV), EEDI, EEXI, EEOI, CII, Greenships, etc.
17	R&D Support	Policy solution	Ship operator/ owner	All Levels	National	More than one	Strategy Alignment* (Directionality)	any form of R&D support from local seed money for cooperation to EU funded projects.
18	Subsidies	Policy solution	Ship operator/ owner	Ports, regions or Nations	National	More than one	Knowledge	China recycling deal, export banks, green investment subsidies.
19	Energy Transition Management (Long-term Learning by doing	Business concept	Ship operator/ owner	National government, EC, UN/IMO	National	More than one	Strategy Alignment* (Directionality)	Greendeal, Norwegian Restructuring programmes, many examples exist of long term government commitment to reach a goal.

20	Port Fee differentiation	Business concept	Ship operator/ owner	Port, but preferably all in a trade region	Port	Maritime Shipping	Economic	Reduces payback time. Using certification to differentiate in tariffs paid for ships, trucks, trains.
21	Split Incentive (TC vs VC)	Business concept	Ship operator/ owner	Charterers	Company	Maritime Shipping	Standards & Regulation	Time Charter owner have more Energy efficiency measures installed than Voyage contract sailing owner. Despite the direct incentive for the latter, contract terms (and perhaps steady income) drive the investments
22	Marginal Abatement Costs	Information provision & quality	Ship operator/ owner	Reliable institutes	Company	More than one	Knowledge	See also the IMO GLOMEEP project and the current location of the results: greenvoyage2050.imo.org. Comparison of options using impact and economics.
23	Speed Restriction/optimization	Policy solution	Ship operator/ owner	Port, Nations, EU	Port	Maritime Shipping	Standards & Regulation	Used on roads around cities both to limit accidents and impact. Could be used for vessels too.
24	Leading by example	Business concept	Ship operator/ owner	Ports, regions or Nations	Port	More than one	Strategy Alignment* (Directionality)	The port acts on its operator role and invests in clean technology (electrical or zero emission equipment).
25	Regulations	Policy solution	Ship Production	Classification Societies	National	Maritime Shipping	Standards & Regulation	Class rules, safety requirements, impact analysis (e.g DCMR in Rotterdam) etc.
26	Port User Forums	Information provision & quality	port operators and users	Ports	Port	More than one	Knowledge	energy efficiency networks have been created in switzerland and germany and included a consultation phase and a networking phase. Also the green tour for green innovations to meet potential first applicators is an example of this.
27	Niche Development roles	Business concept	All stakeholders	Ports, regions or Nations	National	More than one	Strategy Alignment* (Directionality)	Not sure if it is separate, but it is about the role of pilots and niches (geography of sustainable transitions) in achieving regime level changes (and/or frustrating them). And how to support their devolpment (e.g. Master plan).
28	Corporate Social Responsibility	Business concept	Ship operator/ owner	Public Opinion	Company	More than one	Strategy Alignment* (Directionality)	The act of reporting on your social and human development impact is not yet widely found in the transport sector.
29	Consensus tooling	Information provision & quality	All stakeholders	Policy makers, yet not exclusively. Is topic dependent	Global	Maritime Shipping	Strategy Alignment* (Directionality)	The lack of capacity to develop direction at a rate that aligns with the societal needs, endangers the transition. Especially maritime due to its segmented and complex stakeholder field requires addition support tooling to achieve this.
30	Communication strategy	Information provision & quality	All stakeholders	Salient group of stakeholders	Global	Maritime Shipping	Strategy Alignment* (Directionality)	Dominant information campaign to create clear reference line.

31	Emission tracing 'CO2 mass balance tool'	Business concept	Shipping companies	Shipping companies / shippers	Global	Maritime Shipping	Economic	Translate the emission cost of transport to a tangible component for the end customers
32	Investment & operational cost risk mitigation	Business concept	Shipping companies	Insurance / Policy makers	Global	Maritime Shipping	Economic	The capacity to invest in a vessel is present, however the capacity to mitigate cost when choosing for the 'wrong' energy carriers is absent. Risk mitigation via mutual risk with charterer, governmental assurances or other routes.
33	Systemic approach linked to carbon levy funds	Business concept	Shipping companies	Platform on behalf of shipping companies.	Global	Maritime Shipping	Economic	Depending on the likeliness of the carbon levy funds in global shipping, these funds can be allocated in many ways. Proactively decide on a tool + strategy now combined with our flag state can provide many opportunities. https://www.figma.com/proto/bNh4TdfFgbFZSSxWc9LEgk/IMRF-Prototype?node-id=0%3A93&scaling=scale-down&page-id=0%3A1
34	Digital Twin Governance	Business concept	All modalities will be affected by a DT that seeks to optimise logistics	Port authority with private sector (PPP?)	Port	More than one	Knowledge	The idea of the DT is that thru simulation logistics can be optimised. Under which conditions are actors willing to 'join' the twin, and what will they get in return? Is the twin a mere 'advisory simulation environment' or is it an actor with decision making authority based on the intelligence and automation enabled by the DT? How is the accountability for the algorithms used by the DT embedded? What is the organisational impact of the DT on the organisations whose infrastructure and assets are 'twinned"?
35	Port Data Platform	Business concept	All modalities will need to share data to the platform	Port authority with private sector (PPP?)	Port	More than one	Knowledge	A Port Data Platform is the foundation for the digital twin. The port ecosystem can also use this platform to exchange data and develop innovative information solutions. Depending on which features other than the DT are added to the platform, it can also be an instrument for managing prices and incentives that drive actors to change their behaviour (efficiency and adoption of new energy technology). Governance (ownership, financing, management, etc.) of the platform
36	Data Authority	Policy solution	All modalities will be affected	Government at a National or European level	Regional (EU)	More than one	Standards & Regulation	A data authority would oversee the fair and ethical use of data and AI used by the Digital Twin. Bias could creep into the algorithm, favouring certain sectors, countries or companies when optimising logistics flows. The data authority, in together with the local port authorities, designs guidelines about compulsory data sharing to the port data platform for all actors operating / visiting the port, and monitors compliance

37	Harmonization of inland port tariffs for barges (port use) and for trains (railway fee); Equality of both modes of transport; Possibility to change the mode of transport without economic consequences	Combination	Ship/train operator; carrier	Port Authority of DeltaPort	Port	More than one	Economic	No additional info
38	Founding of an association to cluster the interests of all stakeholders of the supply chain of the inland port DeltaPort; common goal of decarbonization	Combination	All stakeholders of the supply chain of the inland port	Port Authority of DeltaPort	Regional (EU)	More than one	Standards & Regulation	No additional info
39	Use of the digital tool "route scanner" to show the CO2 savings of ship, barge and rail compared to truck transport; transparency of all transport modes	Combination	Trading companies	Port of Rotterdam	Global	More than one	Interaction	https://www.deltaport.de/schiffahrt/routescanner/
40	Identification of goods which are currently not transported by barge or rail, but by truck; Reorganization of the transport chains for these goods to barge and rail; for example temperature controlled goods	Combination	Trading companies	Port Authority of DeltaPort ; Carrier	Global	Inland Shipping	Standards & Regulation	DeltaPort, the Port of Rotterdam and the company Nordfrost are working on the so called "Cool Corridor"; temperature controlled goods are transported by barge (not truck) to the hinterland; https://www.youtube.com/watch?v=ceQ40MR5tNM

41	Speed limits for trucks	Policy solution	Truck operator	National government	National	Road	Standards & Regulation	Supply-chain deceleration as emission abatement option
42	Emission-sensitive speed control	Business concept	Truck operator	Logistic companies	Company	Road	Strategy Alignment* (Directionality)	Supply-chain deceleration as emission abatement option
43	Track price reform	Policy solution	Rail companies	National government	National	Rail	Economic	Reduce the fix costs rail companies have to bear
44	Fuel taxation and levies reform	Policy solution	Alll stakeholders	National government	National	Road	Economic	Increase cost-reflexiveness of energy carrier pricing
45	Transport plattform for collectables	Business concept	Logistic companies	Businesses	Company	More than one	Interaction	Extend use of transport for collectables
46	Fuel labeling	Policy solution	Logistic companies	National government	Regional (EU)	More than one	Interaction	Increase transparency of applied fuels and emissions in transport
47	Standardised PPAs	Policy solution	Electricity traders	Stock market	National	More than one	Standards & Regulation	Increase tradability and risk sharing of RES generation
48	Charging coordination scheme for electric vehicles/trucks	Policy solution	Logistic companies	National government	National	Road	Knowledge	Increase utilization of the electricity grid
49	Ease weight regulations	Policy solution	Logistic companies	National government	National	Road	Standards & Regulation	Increase weight flexibility of trucks
50	fast-line for adjustments of permits for storage of renewable fuels	Combination	fuel producers/ providers	Maritime and Port Authority	Port	Maritime Shipping	Strategy Alignment* (Directionality)	preference on process for bio-molecules storages permissions at the port
51	Fast-line for low-carbon fuels bunkering	Combination	Ship operator/ owner	Maritime and Port Authority	Port	Maritime Shipping	Economic	shorter lines for bunkering, lower expense on port fees
52	5 to 4 communication letters. 5 reasons to use and 4 to not use XXX	Information provision & quality	Ship operator/ owner	Research centres and Port Authority	Regional (EU)	Maritime Shipping	Knowledge	a series of white letters signed by research institutions highlighting 5 reasons to use a particular carrier and 4 to not use. Provide impartial information for decision makers.
53	Tax exemption on low carbon	Business concept	fuel producer	Tax Authority	National	More than one	Economic	reduce FOB prices for renewable fuels

	fuels production		s/ providers					
54	Guarantee of origin for synthetic fuels produced from bio-LNG (or other bio-based carbon)	Policy solution	fuel producers/ providers	European Commission	Regional (EU)	More than one	Standards & Regulation	Currently, bio-LNG can be produced by means of guarantee of origin. Bio-methanol no. Expanding the guarantee of origin to other molecules will contribute to reduced production costs related to logistics of feedstock
55	favorable utilities use for renewable fuels clients	Combination	Ship operator/ owner	Maritime and Port Authority	Port	More than one	Strategy Alignment* (Directionality)	favorable access of port utilities by renewable fuel operators and clients.
56	specific time slots for low carbon fuels bunkering	Combination	Ship operator/ owner	Maritime and Port Authority	Port	Maritime Shipping	Economic	
57	Port subcontractors must have minimum requirements of sustainability, e.g., minimum share of renewables, carbon compensation	Policy solution	Port Authorities	Maritime and Port Authority	Regional (EU)	More than one	Interaction	
58	30% reduction of port due for zero carbon propulsion	Policy solution	Ship operator/ owner	Maritime and Port Authority of Singapore	Port	Maritime Shipping	Economic	Under the Green Port Program Singapore is now also offering reductions in port dues. Ships calling at the port can receive a 30 percent reduction by using zero-carbon fuel ranging from hydrogen to synthetic, non-carbon fuels derived from renewable electricity based on solar, wind, or hydropower. https://www.maritime-executive.com/article/ports-providing-financial-incentives-for-green-vessels

5. Annex 3: Description of T7.1.2

Task 7.1: Identification and selection of most impacting and promising non-tech innovations (Ml-Ml2) The objective of task 7.1 is to select a set of high-impact and promising non-tech innovations that will be worked out in detail as use cases in a living-lab setting. Potential innovations for development that we already identify:

Related to WP3 and its demos:

- price differentiation schemes towards maritime and inland shipping for enhancing zero-emission shipping,
- end-customer oriented blockchain based services for accelerating the use of new fuels
- pay-for-use principles for low and zero-emission fuel systems,
- specific new legislation around operations and use of new energy carriers

Related to WP 4 and its demos:

- new governance structures for digital energy-saving solutions like digital twin platforms
- new business models for digital platforms
- specific new legislation around operations and use of data and digital platforms

Related to WPS, WP6

- new market structures for sustainable last-mile transport,

More general:

- regulatory incentives,
- new legislation enabling transitions needed,
- specific start-up subsidies.

Important is to select those innovations that are most promising achieving the overall goal of greening transport. To come to this final set of most relevant non-tech innovations that we develop as use cases, the project's demos will be primary input in combination with a broader assessment of the lighthouse ports' and fellow ports' needs and opportunities.

Subtask 7.1.1 Context characterization. Do an overarching assessment of the most important issues that have to be 'cracked' I conditions that can be created by non-tech innovations to accelerate reaching the next level of TRL for different low or zero-emission solutions. This will be strongly aligned to the solutions that are developed in other WPs (WP3 to WP7), in addition a broader assessment will be done at port level. Alignment with fellow ports will be part of this.

Subtask 7.1.2 Selection of non-tech innovations. Identify a set of valuable innovations (long list), establish requirements for these innovations in each key area and rank them based upon impact and suitability in the context of this project's lighthouse ports' and fellow ports' issues and opportunities. Select the eight most promising nontech innovations for further assessment and development (shortlist).

Subtask 7.1.3 Requirements and level of implementation assessment. For each innovation in the selected set specific requirements for further development will be assessed in combination with an assessment of the level at which the innovation should be implemented: port, city/region, national, EU, global (IMO).