BASELINE EVALUATION AND PRIORITIZATION OF DEMO-SPECIFIC SCENARIOS

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BASELINE EVALUATION AND PRIORITIZATION OF DEMO-SPECIFIC SCENARIOS D8.2

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Executive Summary

This document is the second deliverable (8.2) of the MAGPIE WP8 (Monitoring and impact evaluation) and provides the specification of the baseline scenario for the demonstrators. A scenario consists of the baseline situation and the baseline measurements based on the key performance indicators, which are elaborated in deliverable 8.1. In this deliverable, the principles of the baseline scenario are elaborated and the methodologies for the baseline scenario are provided. This deliverable provides the explanation about the data collection, regarding the baseline scenario, and describes that, for each demonstrator, the following descriptions and values are collected:

- Up-to-date description of the demonstrator
- Description of the KPIs
- Description of the baseline measurements
- Values of the baseline measurements

The baseline situation is the current, 'as is' situation, which will be the point of comparison for the performance of the demonstrators in the result measurements and impact assessment. The benchmark refers to the current operations that will be replaced or changed by the (non-)technological innovations of the demonstrators. This means that the same scope for the demonstrator as for the baseline situation should be applied because otherwise the comparison is not possible. In order to define the baseline, the following process has been followed.

Table 1 – Process for the baseline

PROCESS FOR THE BASELINE					
	May	June	July	Aug.	Sept.
Meetings with demonstrators about the final monitoring framework (task 8.1) and introducing the content of the baseline situation and measurements (task 8.2).	■	■			
Round 1 workshops: Providing an elaborative explanation about the baseline situation/measurements and asking the demonstrators for their insights on the baseline situation/measurements.			■		
Demonstrators working on the descriptive and values with regards to the baseline and sharing the results. **Meetings** with specific demonstrators who asked for guidance on describing baseline situation and measurements.				■	
Round 2 workshops: Discussing the results of the baseline situation/measurements provided by the demonstrators.					■
Implementing the results in the deliverable					■

During the meetings and workshops with the demonstrators, it became clear that not every demonstrator has already access to the values because the baseline description is not clear yet. Therefore, in this deliverable, the main focus is on the descriptions of the baseline measurements. A detailed elaboration of the current situation and activities is complemented with an extensive explanation of methods, sources and ways to determine the values. For some demonstrators, the actual values of the baseline measurement are already available and these have been included in this report. For the other demonstrators, the process of determining the actual values will be carried out as soon as possible, within the timeline of the demonstrators. These will be elaborated as much as possible in D8.3 "*Baseline comparison report based on measurements 2 years into the project*".

1. Introduction

The MAGPIE project is an international collaboration working on demonstrating technical, operational, and procedural energy supply and digital solutions in a living lab environment to stimulate green, smart and integrated multimodal transport and ensure roll-out through the European Green Port of the Future Master Plan and dissemination and exploitation activities. The consortium, coordinated by the Port of Rotterdam, consists of 3 other ports (DeltaPort, Sines and HAROPA), 9 research institutes and universities, 32 private companies, and 4 other organisations. The project is divided in 10 main work packages which include energy supply chains, digital tools, 10 demonstrators for maritime, inland water, road, and rail transport, non-technological innovations and the development of a Masterplan for European Green ports.

The effects and outcomes of the new innovations are measured and monitored within WP8. WP8 has an important role in the integration of the different demonstrators in the project and is responsible for developing an objective method for measuring, monitoring, evaluating and scaling the impact of the demonstrators. WP8 provides guidance to the demonstrators during the project while executing the measuring activities. The same approach of the monitoring across the demonstrators is needed for a coherent comparison of the results of the demonstrators. The results of WP8 consist of an overall monitoring result of the demonstrators and an impact evaluation including related GHG abatements costs and the efficiency of solutions. The impact evaluation of the (non)-technological innovations is based on the comparison between the demonstrators' performances and the baseline scenario. The analysis of WP8 will be used as an input for the activities in WP9. The MAGPIE Handbook about the future European green port is developed within WP9. The handbook provides guidance for ports related to planning, implementing, replicating and scaling-up the (non)-technological innovations of the MAGPIE demonstrators. The results of WP8 have a significant impact on the roadmaps within the MAGPIE Handbook. Especially, the scaling up potential of the demonstrators is a relevant input for the roadmaps.

In the first six months of the MAPGIE project, deliverable 8.1 has been developed in collaboration with the demonstrators. Deliverable 8.1 consists of a measurement framework for the quantitative and qualitative assessment of environmental, operational, and socio-economic key performance indicators. The measurement requirements and the methods regarding the key performance indicators are elaborated in that deliverable to answer the question what to monitor and how to monitor. The framework was the starting point for the next tasks in WP8. The second task focuses on the specification of the baseline scenario and is used as a determined benchmark for the assessment of demonstrator specific results. This document is the second deliverable (8.2) of the MAGPIE WP8 (Monitoring and impact evaluation) and provides the specification of the baseline scenario for the demonstrators. A scenario consists of the baseline situation and the baseline measurements based on the key performance indicators, which are elaborated in deliverable 8.1. In this deliverable, the principles of the baseline scenario are elaborated and the methodologies for the baseline scenario are provided. This deliverable provides the explanation about the data collection, regarding the baseline scenario, and describes that, for each demonstrator, the following descriptions and values are collected:

- Up-to-date description of the demonstrator
- Description of the KPIs
- Description of the baseline measurements
- Values of the baseline measurements

These descriptions and values will be collected and monitored for all the demos in the project. Before this report starts with the principles of the baseline scenario and measurement, a brief description of the demos which will be monitored. The living lab approach is applied in the project where (non)-technological innovations are developed, tested and/or demonstrated. Within the living labs, the MAGPIE demonstrators focus on three different elements in the port. First, the energy requirements and the energy supply chain in the port. WP3 executes three demonstrations with regards to the energy use. The first demonstrator is devoted to the production of BioLNG for the use in maritime and inland transport on the site of an LNG terminal. Due to its position in the project, the BioLNG demonstrator isn't part of this baseline measurement deliverable. Demonstrator 2 is developing a software-based decision support tool which helps to solve energy congestion points and optimises the energy use. The objective of demonstrator 3 is to increase utilisation of a shore power hub facility by using story stored energy for shaving the peaks on the electricity grid. WP5 is developing and demonstrating new innovations in the maritime and inland water transport. This work package consists of four demonstrators (demonstrator 4-7). Demonstrator 4 is about ammonia bunkering and the storage of ammonia for barges. The fifth demonstrator has the objective to develop charging e-buoys. Demonstrator 6 aims to develop and demonstrate an autonomous e-barge and autonomous processes in transhipment. Demonstrator 7 is devoted to the development of green energy containers. The last element focuses on the land transport and relates to WP6. Three demonstrators (demonstrator 8-10) are executed as well within this work package. Demonstrator 8 is related to rail transport and is going to demonstrate a hybrid shunting locomotive. The other two demonstrators are focusing on road transport and are developing innovations related to green connected trucking (demonstrator 9) and spreading road traffic (demonstrator 10).

Together, the mentioned elements form the baseline scenario, the 'as is' situation for the demonstrators, which will be elaborated in this deliverable. This deliverable is structured as follows. Section 2 elaborates the principles of the baseline scenario, which consists of an explanation about the baseline situation and measurements. Section 3 describes the methodology, that is used to determine the baseline situation and measurements. The process of deriving the data is based on a collaboration between the demonstrators and WP8 and is also described in section 3. Results for each demonstrator is presented in section 4. I5, the conclusions and recommendations are provided.

2. Principles of the baseline scenario

The baseline scenario will be defined, for each demonstrator, to assess the impact of the demonstrators and is used as a benchmark for the assessment of the demonstrator-specific results. The baseline scenario consists of a baseline situation description and the corresponding baseline measurements. In this deliverable, a description of baseline measurement for each demonstrator is provided and, when available, also the values of the measurements. Together, this will be the starting point for future WP8 tasks for the continuous monitoring, result measurements and impact assessments.

3.1 Baseline situation

The baseline situation is the current, 'as is' situation, which will be the point of comparison for the performance of the demonstrators in the result measurements and impact assessment. The benchmark refers to the current operations that will be replaced or changed by the (non-)technological innovations of the demonstrators. The baseline situation is relevant for the impact evaluation, in which the performance of the demonstrator is compared to the baseline situation. This means that the same scope for the demonstrator as for the baseline situation should be applied because otherwise the comparison is not possible. Therefore, the starting point for determining the baseline situation is the up-to-date description of the demonstrator. During the discussions with the demonstrators, we concluded that many demonstrators consist of multiple sub-demonstrators. The sub-tasks of the demonstrator are in some cases a sub-demonstrator on its own. If the demonstrator is tested for different type of transport modalities, we need to take into account the different scenarios and the corresponding measurements. For instance, the e-charging buoy (demonstrator 5) is tested for offshore ships and ships at anchorage. This also applies when the demonstrator consists of different innovations, such as demonstrator 9 which tests electric heavy truck driving and an autonomous decoupling point. The baseline situation for each sub-demonstrator is determined in this deliverable. The baseline situation of each sub-demonstrator is an important factor for deriving the baseline measurements of the sub-demonstrator. The scope of the baseline situation determines the scope of the measurements itself. The baseline measurements are explained in the next section.

3.2 Baseline measurements

The baseline measurements of the key performance indicators (KPIs) are used as specific benchmarks for the demonstrator-specific results. The KPIs within the MAGPIE project are broadly elaborated in deliverable 8.1. The KPIs are divided into three result areas: environmental, operational, and socio-economic (see Figure 1). Not every KPI is applicable to every demonstrator. On page 26 of deliverable 8.1, there is an overview provided of the relevance of KPIs for each demonstrator after the first round of meetings held in March. The KPIs, that are applicable to a demonstrator, need a benchmark in order to execute the impact assessment in upcoming tasks of WP8. The baseline measurements are considered the benchmarks for each KPI.

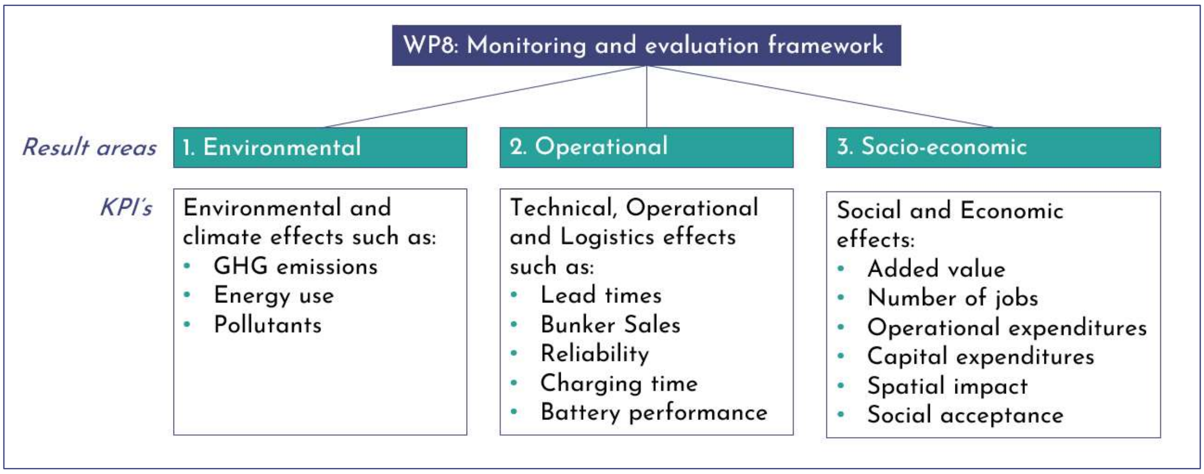

Figure 1 – Monitoring and evaluation framework based on the content of the deliverable 8.1

From the meetings with the demonstrators about the baseline measurements, it appeared there is a need to distinguish between different types of Key Performance Indicators (KPI's): Efficiency, effectiveness and impact indicators. This distinction is relevant because it allows for better understanding and use of the set of indicators within the scope of the demonstrators. This section contains a more comprehensive description of the methodology in deliverable 8.1.

We used the framework of Rob van Tulder et al. (2015)[1] for providing a more comprehensive understanding of the evaluation of the monitoring process and for making a distinction between the indicators. Figure 2 presents a systematic overview of the monitoring and evaluation process within the MAGPIE project. The process starts with formulating the **issue** at large. A global societal and environmental issue is global warming. The consequences of the current climate change are increasing temperatures, extreme weather conditions and rising sea levels. For this reason, the United Nations adopted the Paris Agreement[2] in 2015 which is a legally binding international treaty on climate change. Different support packages are provided by the European Commission to mitigate the climate change, such as FIT for 55[3]. The **aim** of the MAGPIE project is full decarbonisation by 2050 by providing solutions that can be implemented immediately to make significant steps in decarbonisation already by 2030. Therefore, new innovations related to **green, smart and integrated multimodal transport** are demonstrated within the MAGPIE project.

The result areas defined in the monitoring and evaluation framework need to be monitored to evaluate whether the new innovations – demonstrated within the MAGPIE project – are part of the solution of mitigating climate change and contributes to the aim of decarbonisation. The results of the monitoring process per result area are presented as **outcome.**

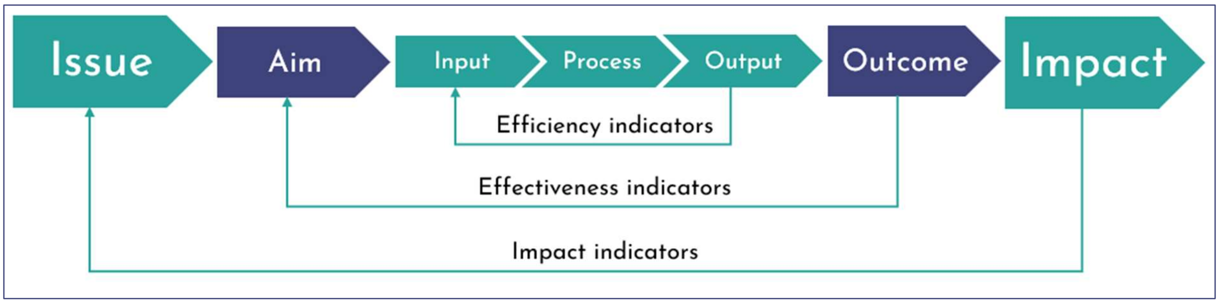

Figure 2 – Monitoring and evaluation process based on the framework from Rob van Tulder et al. (2015)

The monitoring and evaluation process for the result areas depends on three different types of KPI's. These indicators are based on three different levels: Efficiency, Effectiveness and Impact.

Level 1: Efficiency indicators – Input, process and output: The first level is based on the efficiency indicators. These indicators relate directly to the operations of the demonstrator. These indicators provide an understanding about the efficiency of the operations with regards to the result areas. The input for these indicators is provided by the demonstrators itself, e.g., CO2 measurements, the energy use, battery performance, charging time, OPEX and CAPEX. These indicators are in most cases quantitatively measurable and can be translated to effectiveness and impact indicators in later tasks of WP8. The output of these indicators contributes to answer relevant research questions within the MAGPIE project, such as how efficient is the solution in decreasing the CO2 emissions for a certain part of the supply chain.

[1] Tulder van, R., Seitanidi, M.M., Crane, A. and Brammer, S. (2015): *Enhancing the Impact of Cross-sector Partnerships.* J Bus Ethics (2016) 135:1–17 DOI: 10.1007/s10551-015-2756-4
[2] United Nations Climate Change (2015) *Paris Agreement.* URL: https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement
[3] Kenniscentrum Europa Decentraal (2021) *Onderweg naar 55% minder uitstoot in 2030: Europese Commissie presenteert 'Fit for 55' - pakket.* URL: https://europadecentraal.nl/europese-commissie-presenteert-fit-for-55-pakket/

Level 2: Effectiveness indicators – Aim and Outcome: The second level is based on the aims and the corresponding outcome of the new innovation. The effectiveness of a new innovation can be considered as the extent of mitigating the issue. The effectiveness of the solutions is dependent on the context and the interaction with a certain context, such as the characteristics of the ports. The interaction with a certain context can lead to indirect effects and affect the impact on the port and supply chain. Therefore, within WP8 we need to consider these different contexts. The efficiency indicators are a relevant input for the effectiveness of the new solution in certain contexts.

During the discussions with the demonstrators and within WP8 we noticed that the indicators social acceptance and spatial impact are very context related and are dependent on the characteristics of the port. Therefore, these indicators are considered as effectiveness or level two indicators. This means that the input for these indicators needs to be collected qualitatively together with the demonstrators and while collecting we will imitate different contexts into consideration.

Level 3: Issue and Impact – Impact indicators: The third level is the degree of impact of the new innovation: to what extent does the innovation – once scaled up to a larger scale – contribute to resolving the issue at large. The impact assessment of the new innovations is related to upcoming tasks within WP8, such as the scalability of the innovation and the roll-out plan. The degree of impact of a new innovation is based on the comparison of the baseline situation and the outcomes. This means that the same scope of the demonstrator should apply to the baseline situation, otherwise the outcome of the demonstrator cannot be compared to the baseline situation. Therefore, the additional understanding of different levels of KPI's applies to the baseline measurements.

The baseline measurements shall use, as much as possible, monitoring data for a certain period. Monitoring data over such period provides the opportunity to aggregate the data in order to smooth out the outliers. This method avoids benchmarking on random outliers of values for the indicators. Considering that not all demonstrators have the opportunity to directly measure the current situation within their scope of the demonstrator, the measurements of the baseline are sometimes based on default values and assumptions. Therefore, the values of the baseline measurements are partly based on the data of current operators and/or existing research. It is not the expectation that all the required values can actually be measured; therefore, we need to rely on modelling, default factors and assumptions if needed. Taking into account that WP8 is dependent on what is available and supplied by the demonstrators, we consider the possibility that we need to work with averages, single values or -at all- missing data instead of a monitored dataset in some cases.

The baseline measurements will eventually result in a dataset, which will serve as a benchmark against the performance outcomes of the demonstrators. The objective of impact assessment is to provide information about the efficiency of the new innovations, the scalability potential and the effects within the result areas; environmental, operational and socio-economic.

3. Methodology and process of the baseline

In this section, the methodology for collecting the input for the up-to-date demonstrator description, the baseline situation and the baseline measurements is described. As explained in the chapter above, the starting point for determining the baseline situation and measurements is the up-to-date demonstrator description. Therefore, this chapter starts with the methodology of the up-to-date demonstrator description. Then the collection of the input for the baseline situation and baseline measurements is elaborated. In the last section, the process of collecting the input for the baseline scenario is provided.

4.1 Providing the up-to-date demonstrator description

Initially, the demonstrator descriptions would refer to the descriptions provided in the proposal document of MAGPIE. However, during the meetings and workshops, we noticed that, for most of the demonstrators, some key elements had changed in the past year, such as the scope. Therefore, we asked the demonstrators to provide us with an up-to-date demonstrator description if the description in the proposal no longer applies. Besides only asking the for the up-to-date description of the demonstrator, we also emphasized the following questions, while formulating the up-to-date description.

- **What does the demonstrator consist of and how long will the demonstrator last?**
- **How does the innovation/technology of the demonstrator work?**
- **What is the aim of the innovation/technology within the demonstrator?**
- **What is the scope of the demonstrator?**

We emphasized these questions, because the provided answers to these questions are necessary inputs for determining the baseline situation. In the next section, the method for baseline situation is elaborated.

4.2 Determining the baseline situation

The baseline situation is based on the current operations that the innovation and/or technology of the demonstrator can change, i.e., the terms of reference. As described in chapter 2, the same scope for the demonstrator description should be applied for the baseline situation. Otherwise, the comparison between the baseline situation and the demonstrator description cannot be made and we cannot execute an impact evaluation of the demonstrator later on. The following questions are raised, in the template, regarding the baseline situation:

- **What is the current situation that the innovation/technology of the demonstrator can change?**
- **In the current situation, what can the innovation/technology of the demonstrator change and/or replace? (e.g., the energy form, the modality, the use of energy, the costs)**
- **What is the scope of the baseline situation? (e.g., moving unit from A to B, bunkering process)**

The baseline situation determines the scope of the baseline measurements. The inputs provided for the baseline measurements should align with the characteristics of the baseline situation. In the next section, the collection of the input for the baseline measurements is explained.

4.3 Determining the baseline measurements

Every result area (environmental, operational and socio-economic) has its own template for the baseline measurements. The set-up is the same for every result area. The templates differ only in which inputs are asked related to the Key Performance Indicators (KPI's). The templates for the baseline measurements consists of a descriptive section and a value section. In the descriptive section the **descriptions of the input** for the KPI's in the baseline situation is provided. For example, in the baseline situation the input *"fuel"* for the KPI *"CO2e emissions per unit of transport activity"* is for the energy related demonstrator's a fossil fuel, such as diesel. This means that the demonstrators provide the fuel type that can be replaced by the demonstrated fuel type, such as ammonia, hydrogen and electricity. Once the input is described, the demonstrators describe how the input for the KPI is obtained. These descriptions can be based on how the input is **collected, measured, calculated and/or modelled.**

In the second section of the templates, the values for the inputs of the KPI's are provided. In this section, the demonstrators fill in the **numeric values** and **the type of units**, such as litres, kg and euros. Based on these values the impact evaluation of the demonstrator will be made. In the image below the instructions for baseline measurement templates are presented:

Instructions

The general instructions for every KPI's are as follows:

Descriptives

- Fill in the description of the input in the baseline situation
- Fill in how the input is obtained. For example: How is the input collected, measured, calculated and/or modelled.
- Check the baseline situation at tab 1. Demo + Baseline description. The scope of the baseline situation is based on this description.
- Check the templates of deliverable 8.1 we have shared about the inputs and methodologies regarding the KPI's.
- If the KPI is not applicable to your demo, fill in n.a.

Values

- In the value section the values of the baselines measurements can be filled in.
- If there are no baseline measurements available yet, fill in n.a. in the value section.

Figure 3 - General instructions for providing the input of the baseline measurements

In principle, the demonstrators are responsible for the measurements. WP8 facilitates the carrying out of these measurements as much as possible. If no direct measurements are available, standardised sources and databases will be distributed to and used by the demonstrators. This creates consistency among the different demonstrators. If WP8 will not get the data from the demonstrators, WP8 will find alternative sources and databases as mentioned before, to find the best proxy for the data. WP8 doesn't foresee a scenario where no direct measurements and no estimations based on data sources and databases can be made. The table below gives some examples of different sources that are distributed to the demonstrators to be applied.

Table 2 - Standardised sources and databases for the indicators

INDICATOR	DATABASE OR SOURCE
NO_x	Aerius database
WTT (for demos monitoring TTW)	https://publications.jrc.ec.europa.eu/repository/handle/JRC119036 CBS (Port of Rotterdam)
Emissions from transport (WTW)	EcoTransIT World
Ship hotel use	4th GHG study

Besides the quantitative templates and KPIs, there has been a second way of determining the baseline measurements for a demonstrator, specifically for the social acceptance and spatial impact (part of Socio-economic analysis). The alternative method has been implemented due to the qualitative nature of the social acceptance and spatial impact monitoring and indicators. An extensive questionnaire has been elaborated and distributed along the various demonstrators and other stakeholders within the MAGPIE project to collect the qualitative information about these indicators. Some of the values and elements that fall within the topics of social acceptance and spatial impact can be measured quantitatively, though these might be demonstrator specific. The exact division of which indicators within these two topics will be quantitatively or qualitatively assessed is part of the carrying out of the baseline measurement.

4.4 Process for the baseline

In this section, the process (see Table 1) of collecting the input for the templates for the baseline situation and measurements is elaborated. The starting point was to make the demonstrators aware that we are going to collect the input for the baseline situation and measurements. The tasks within WP8 are related to each other. The first task was devoted to determining the monitoring framework with the key performance indicators. During the last meetings with the demonstrators with regards to task 8.1, we already emphasized the next step about the baseline situation and measurements. In the beginning of July 2022, we organised the first round of workshops with the demonstrators during which we explained the baseline situation and measurements. Four workshops were organized: two workshops about the socio-economic indicators (SE) and two about the environmental and operational (EO) indicators. The demonstrators had the choice to attend two workshops: one SE workshop and one EO workshop. We tried to spread the demonstrators equally over the workshops. During the workshops, we also invited the demonstrators to give a general status update and an update regarding the baseline situation and measurements. The following questions were raised:

- **What is the baseline of the demonstrator?**
- **How are the baseline measurements performed for the indicators?**
- **Have baseline measurements been performed/collected for the indicators?**

During the workshops, the demonstrators had the opportunity to react on each other's explanation and to learn from each other. After the discussions, we explained how we would like to receive the information regarding the baseline situation and measurements and presented the format of the templates. We also indicated that demonstrators could reach out to us when guidance is needed for filling in the templates.

During the workshops, the questionnaire that is used for social acceptance and spatial impact was discussed with the different demonstrators. By discussing the questionnaire it became clear that some demonstrators have a lot less social acceptance and/or spatial impact KPIs that are relevant, as they are non-physical or streamline current functions (e.g., demonstrator 2 and 3). Other demonstrators -for example demonstrator 4 by means of safety- do have very specific issues with regards to social acceptance and spatial impact, which was further discussed. In the summer period we had some meetings with demonstrators to clarify the templates and to think along with the demonstrators while defining the baseline situation and baseline measurements.

In the beginning of September 2022, we organized a second round of workshops. The set-up of the workshops was slightly different from the first round of workshops. The same structure was used – two SE and two EO sessions – but more specific time slots for the demonstrators were defined. The demonstrators had the option to join during a time slot dedicated to a certain demonstrator. The discussion was primarily on the input that the demonstrators provided by means of the templates. These templates were discussed, questions and remarks were raised and shared and elements that were unclear were clarified.

During the meetings and workshops with the demonstrators, it became clear that not every demonstrator has already access to the values because the baseline description is not clear yet. For instance, demonstrator 6 and demonstrator 7 are still looking for a potential barge that can be used for the operations of the demonstrators. The barge will replace a diesel-powered barge of similar size and type, and in order to determine the baseline situation, the size and type of the selected barge shall be known. Therefore, in this deliverable, the main focus is on the descriptions of the baseline measurements. A detailed elaboration of the current situation and activities is complemented with an extensive explanation of methods, sources and ways to determine the values. For some demonstrators, the actual values of the baseline measurement are already available and these have been included in this report. For the other demonstrators, the process of determining the actual values will be carried out as soon as possible, within the timeline of the demonstrators.

4. Results of the baseline measurements

This section describes the results of the baseline measurements. The input for the different components in the description of the baseline measurements for the various demonstrators has been obtained via the templates and the discussions with the demonstrators. During these exchanges with the demonstrators, it became clear that determining the exact values for all the KPIs, for all the demonstrators. is not realistic at this moment, as explained also in Section 4.4. Therefore, in this deliverable. the main focus is on the descriptions of the baseline measurements, and only when already clear and/or available on the absolute values of a demonstrator. In this section, we will briefly discuss the different demonstrators, including their descriptions and baseline measurements. In Appendix 2, the completed templates are attached for further reference.

Before discussing each demonstrator, the impact of batteries should be discussed as this involves several demonstrators. WP8 and MAGPIE are aware of the somewhat dual aspects batteries present. They are required to make the transition possible by storing green energy to bridge the gap between use and supply. In D8.1, the emissions to air for Well to Wheel/Wake impacts of the energy used were identified as key to WP8. A first exploration of this issue identified that, in general, operational emissions account for 85% -95% of all impact. However, the materials used in batteries are rare and require mining and as such impact the environment potentially significantly in other ways. To address this correctly a full lifecycle approach for each demonstrator would be required. This is an extensive effort, and not foreseen by the Grant Agreement and requested budget. This is most cases justified, but we are unsure about the battery. Therefore, a further investigation on the battery impact was started by TUD, to be able to better understand the significance of this impact. This will take up to 1 year to complete as literature on the subject is inconclusive and an actual LCA will need to be developed. The results will decide if a revision of this decision if required.

5.1 Demonstrator 2: Smart Energy Systems

Description of the demonstrator

This demonstrator aims to demonstrate smart energy solutions for green ports. It relates to objectives 2, 3, and 4 of the MAGPIE project. The aim is to identify synergies and barriers in the flexible use of energy on intermediate time scales, provide strategic decision support on congestion points and energy systems interventions. The goal is to develop a decision support tool to solve congestion points (reduce peak consumption in in-land due to large ships) and guide energy systems interventions at the Port of Rotterdam (PoR). For this, the demonstrator site (Port of Rotterdam) will be studied in the context of the future energy systems scenarios designed.

Description of the baseline situation

In the baseline situation congestion points and peak loads are bottlenecks on the electricity grid within the Port of Rotterdam. As for now, there is a lack of actual data of the current situation from the Port of Rotterdam for building/validating scenarios and performing simulations. While waiting for the data, the demonstrator is finalizing the methods for simulating the energy systems and defining the overlap with other work packages. WP4 will provide an energy matching platform and energy scenarios. After having access to data and the mentioned input, the demonstrator will start working on building the energy system simulator model.

Description of the baseline measurements

This demonstrator deals solely with the electrical supply to the port and simulation and balancing of this process, their core work is the development of a simulation model to identify and address congestions in the network. As the electrical network is not part of the studies in WP3 (on supply chains), this demonstrator will be of value in its contribution to improving the energy supply mix and operationalising more green energy in this mix by the removal of congestions and peaks. This could also reduce the energy used by the grid, further increasing efficiency and reducing operational costs. Thus, the baseline measures are focussed on the reduction of total grid emissions as well as specific KPIs on congestions.

Values of the baseline measurements

As baseline measures on the grid are not available at the moment, the demonstrator will need to develop the model first to be able to simulate both the baseline and the improved situation. Hence baseline values are not expected soon but will be comparable with the future situation as they are the result of the same simulation model.

5.2 Demonstrator 3: Shore power peak shaving

Description of the demonstrator

In demonstrator 3 "Shore power peak shaving" a shore power hub demonstrator is built upon an existing e-house in the Port of Rotterdam that connects a nearby wind farm with an e-charging infrastructure for vessels. The main goal of the demonstrator is to increase utilization of this facility and to reduce its operational cost base.

A battery system will be integrated that provides the flexibility to improve the utilization of the available energy from the wind farm and to relax the needs for power exchange with the grid. A more cost-effective multi-user shore power service is to be provided by introducing a smart real-time local marketplace that optimally exploits the shore power hub with integrated storage facility.

The planned demonstrator duration is one year, which includes a winter period with the vessels connected to the shore power hub, and a summer period with the vessels offshore wherein the shore power hub can provide flexibility (capacity and power) to ancillary service markets.

The scope of the demonstrator providing shore power for two large crane vessels of 10MW each, with the perspective to roll out shore power at a 250MW scale.

Description of the baseline situation

Insufficient capacity of public medium voltage distribution grids is a large bottleneck for connecting high (peak) loads, such as shore power. Demonstrating the economic and technical benefits of integrating electricity storage that is operated in a smart way through a local marketplace, will improve the economic perspective for these facilities. The reduced grid capacity requirements also will open up more locations and applications to connect new shore power facilities and exploit locally produced renewable electricity.

Descriptions and values of the baseline measurements

Similar to Demonstrator 2, this demonstrator concerns the use of electricity and solves the imbalance between production and use in a more direct way. As a result, there is an increase in efficiency and direct storage of green electricity. The efficiency of the system is a key aspect to monitor. The current situation already includes shore power and as a result the demonstrator will monitor how the introduction of the battery will improve the use of green energy. Specific measures on the output of the windpark connected to the battery as well as the energy demanded from the battery are planned to assess the change in energy supply. For this baseline, the current grid data from the CBS or EU could be used as a starting point, but in the future also the grid information of Demonstrator 2 may be relevant (once available). The KPIs will report directly on the improvement of the Well to tank (WTT) emissions of the electricity used by the crane vessel. The TTW emissions of electricity are zero and do not change due to peak shaving

5.3 Demonstrator 4: Ammonia Bunkering and Storage

Description of the demonstrator

Demonstrator 4 consists of a demonstration of ammonia bunkering, making use of a retrofitted / equipped inland ammonia barge and an ammonia powered vessel as the receiver. In the design safety and operational procedures will be accounted for. Once the barge has been retrofitted the Ship to ship (STS) bunkering will be demonstrated with an ammonia vessel under development in either:

- https://www.nordicinnovation.org/programs/zero-emission-energy-distribution-sea-zeeds
- https://maritimecleantech.no/project/shipfc-green-ammonia-energy-system/
- Zeeds project
- ShipFC project.

Operational lessons learnt will be drawn as part of the roll-out plan. This demonstrator will also include a concept design of a scalable green ammonia storage terminal with cracking capabilities of ammonia.

Description of the baseline situation

The baseline situation is based on the current bunkering operations in the Port of Rotterdam (PoR). The PoR has provided information about the current bunker sales and a list bunkering companies on their website.

Port of Rotterdam — BUNKER SALES PORT OF ROTTERDAM 2021 - 2022

		ULSFO	Bio-blended ULSFO	VLSFO	Bio-blended VLSFO	HSFO	Bio-blended HSFO	MGO	Bio-blended MGO	MDO	Bio-blended MDO	Methanol	LNG	Bio-blended LNG	Lubes
		in tonnes	in tonnes	in tonnes	in tonnes	in tonnes	in tonnes	in tonnes	in tonnes	in tonnes	in tonnes	in tonnes	in m³	in m³	in m³
2022	Q1	213,075	9,520	930,481	137,051	707,312	819	286,996	11,998	209,529	365	-	111,804	-	10,894
	Q2	188,177	22,167	920,223	119,174	718,325	18,679	269,833	8,617	166,583	1,002	-	63,497	-	10,691
	Q3														
	Q4														
	Total	**401,252**	**31,687**	**1,850,704**	**256,225**	**1,425,637**	**19,497**	**556,828**	**20,614**	**376,112**	**1,368**	**-**	**175,301**	**-**	**21,584**
2021	Q1	201,054	5,223	978,145	38,701	620,752	20,945	250,570	2,511	174,361	1,573	-	139,489	-	20,327
	Q2	227,099	6,010	1,021,119	17,338	614,098	17,844	249,386	7,265	177,640	5,348	250	157,027	-	16,932
	Q3	199,188	6,941	1,051,017	22,355	694,133	11,777	258,797	6,354	183,987	4,198	-	212,719	531	16,553
	Q4	186,993	13,650	1,009,610	71,148	745,271	18,665	242,081	17,904	205,795	5,302	-	94,454	-	12,558
	Total	**814,333**	**31,824**	**4,059,891**	**149,542**	**2,674,254**	**69,230**	**1,000,833**	**34,034**	**741,783**	**16,421**		**603,690**	**531**	**66,370**

Figure 4 – Bunker sales 2021-2022 Port of Rotterdam (from the PoR website : Bunkering in Rotterdam | Port of Rotterdam)

Naam	adres	Postcode	Vestigingsplaats	land	email	Telefoon	Vergunning geldig tot
Scheepvaartbedrijf A & K Kooren	Kralingse Plaslaan 85a	3061 BA	Rotterdam	Nederland	keeskooren@gmail.com	0031 6 5320 7019	1-2-2023
A. Nobel en Zn.	Uilenkade 100	3336 LP	Zwijndrecht	Nederland	info@anobel.nl	0031 78 6250 968	1-2-2023
Amulet Maritime Services B.V.	Langesteijn 124	3342 LG	Hendrik Ido Ambacht	Nederland	info@ams-bv.com	0031 78 2049 025	1-2-2023
Atlantic Schepen Exploitatie Maatschappij. B.V.	Tarwezand 2	3195KS	Rotterdam-pernis	Nederland	info@atlantic-aardolie.nl	0031 10 2314 444	1-2-2023
Belgian Trading and Bunkering	Asiadok-Oostkaai 27D	2030	Antwerpen	België	mail@btb-bunkering.com	0032 3201 2762	1-2-2023
Benelux Barging B.V.	Ringdijk 480	3331 LK	Zwijndrecht	Nederland	steven@benelux-barging.com	0031 6 2941 0049	1-2-2023
Dari Shipping Luxembourg S.à r.l.	21 Rue Edmond Reuter	L-5326	Contern	Luxemburg	info@daribv.lu	0035 2451 3150	1-2-2023
Decoil Ship Management B.V.	Kotterstraat 2	3133 KW	Vlaardingen	Nederland	Info@decoil.nl	0031 6 2326 8486	1-2-2023
Dutch Barging Services	Hofdreef 30	4881 DR	Zundert	Nederland	operations@dbsbv.com	0031 76 3030 550	1-2-2023
Elveba bunkering n.v.	Naruikstraat 8	2030	Antwerpen	België	vans@vansbunkers.be	0032 3642 6313	1-2-2023
Golden Arrow Olieproducten Amsterdam B.V.	Dukdalfweg 60	1041 BE	Amsterdam	Nederland	bunkers@goldenarrow.nl	0031 20 6844 299	1-2-2023
GoodFuels b.v.	De Lairessestraat 180 V	1075 HM	Amsterdam	Nederland	info@goodfuels.com	0031 85 8000 238	1-2-2023
Jer Shipping	Tapijtschelp 18	3225 BR	Hellevoetsluis	Nederland	info@jershipping.nl	0031 6 1468 0656	1-2-2023
Malmy Shipping & Services S. à r. l.	12 Route du Vin	L6794	Grevenmacher	Luxemburg	info@mss.lu	0035 22 674 5656	1-2-2023
Minerva NWE	Ruiterijschool 1	2930	Brasschaat	België	minervaopsara@minervabunkering.com	0032 3650 1627	1-2-2023
Naval Inland Navigation B.V.	Koningsspil 1	4661 TW	Halsteren	Nederland	info@naval-barging.com	0032 3369 3777	1-2-2023
Oliehandel Klaas de Boer B.V.	Klifweg 11	8321 EH	Urk	Nederland	bunkers@klaasdeboer.nl	0031 25 5820 210	1-2-2023
Posttrans bv	Tarwezand 2	3195 KS	Rotterdam	Nederland	barges@postoils.nl	0031 10 2314 470	1-2-2023
RTR Barging B.V.	Arie ten Toomweg 37	3089 KN	Rotterdam	Nederland	QHSE@burando.eu	0031 88 5012 500	1-2-2023
Slurink B.V.	Merwedestraat 48	3313 CS	Dordrecht	Nederland	s.slurink@slurink.nl	0031-78-6133177	11-3-2021
SBH Heijmen Rotterdam B.V.	Bunschotenweg 127 A	3089 KB	Rotterdam	Nederland	info@sbhheijmen.nl	0031 10 2361 282	1-2-2023
Unibarge	Boompjes 254	3011 XZ	Rotterdam	Nederland	fuelproducts@unibarge.com	0031 10 3136 280	1-2-2023
United Bunkers bvba	Vosseschijnstraat 140	2030	Antwerpen	België	ops@united-bunkers.com	0032 3 5400 900	1-2-2023
Varo Energy Inland Bunkerservice bv	Waalhaven zz 11	3089 JH	Rotterdam	Nederland	info@reinplusfiwado.com	0031 88 1007 714	1-4-2021
Verenigde Internationale Olie Transporteurs (Vinotra) b.v.	Brugsteen 4	4815 PL	Breda	Nederland	info@vinotra.com	0031 85 0646 040	1-2-2023
Verenigde Tankrederij B.V.	Nijmegenstraat 1	3087 CD	Rotterdam	Nederland	QSHE@vtgroup	0031 10 4876 200	1-2-2023
Victrol Chartering	Elzasweg 13	2030	Antwerpen	België	operations@victrol.be	0032 475 34 9657	1-2-2023

Figure 5 – List of bunkering companies with a permit in the PoR (from the PoR website : Bunkering in Rotterdam | Port of Rotterdam)

Descriptions and values of the baseline measurements

The input for the socio-economic indicators can be partially retrieved from the website of the PoR. The revenues of the bunkering companies are based on statistics of the bunker sales per product per quarter, which are on the website. The turnover figures in the entire port are dependent on the prices of the fuels. Currently the sales are around €6 billion. The number of jobs in the port with regards to the bunkering processes are dependent on the number of bunker vessels and the rest of the chain. There are approximately 180 bunker vessels that supply bunkers to seagoing vessels in Rotterdam. They only take care of the last transport from the terminal or refinery where the bunker fuel is produced/stored/blended to the seagoing vessel. The crew size per ship is not known, but that determines in any case the number of people who work directly on the bunker ships. In addition, staff at the offices of those bunkering vessels, at the offices of the suppliers (traders and energy companies), at the surveyors (who check for quality by taking samples and analyzing them) and at the terminals in the port. These are the four most important actors in the chain. In the past, we always spoke of 1,500 people in the bunkering work field within the Port of Rotterdam. The costs (OPEX/CAPEX) for bunker processes are being checked with the Port of Rotterdam. It is uncertain whether this information is confidential. The costs are probably mainly related to time. Information from bunkering companies within the PoR is also necessary for determining the costs.

From the discussion on social acceptance during the workshops, it is clear that one of the main factors affecting this demonstrator will be the acceptance by both workers and civil society, regarding the risks surrounding ammonia bunkering. The baseline is the current acceptance status quo of risk acceptance in bunkering. It is hard to measure this status quo quantitively, but the aim will be to see if the number of complaints increases or decreases after the implementation. The spatial impact baseline of the demonstration is also the normal area needed for bunkering activities.

With respect to the environmental and operational impact, the conclusion was that these aspects are not impacted by the demonstrator. The reason for this is that for the demonstrators we focus on the impact of the actual operations in the port. The actual emissions from the bunkering vessel are not expected to change due to the change of the fuel they provide to the seagoing vessels. It is assumed to have the same emission profile as a normal bunkering vessel. The impact of using another fuel in the seagoing ship is part of WP3, not WP8 and should not be counted here.

5.4 Demonstrator 5: Off-shore Charging Buoy

Demonstrator 5 consists of two sub-demonstrators. The first sub-demonstrator is about a charging buoy for offshore activities and the second sub demonstrator is about a charging buoy of anchored large vessels in front of the port.

Sub-Demonstrator 5.1: Charging buoy - Offshore

Description of the sub-demonstrator

Design and numerical evaluation for an electrical refuelling buoy in the range of 1-20+MW. The demonstration is based on two test cases: one application at the designated waiting areas for large vessels and the other for charging small O&M vessels in an offshore environment. First the test cases are demonstrated in a model basin to mimic realistic North Sea extreme environments. Software–in-the loop is used to allow large scale models for the buoy. In parallel, various numerical simulations will be carried out. The results of these simulations will be validated with the model test results.

A scale 1:3 buoy will be demonstrated, focussed on the mechanical integrity of the buoy for O&M vessels during period of 3-4 months offshore Rotterdam. In this period several marine operations will be executed in different sea states using a crew transfer vessel (or equivalent). Feasibility assessments are made on the technical and commercial viability of the buoy designs. The lessons learned from the demonstrations are used to review the operability of the buoy designs and to serve as basis for standards. During this offshore demonstrator no actual ships will be charged; it focusses on mechanical aspects. Therefore, the baseline of the demonstrator is less relevant. For this reason, in this document the base line is described for the full scale, operational wind park e-buoy in conjunction with a battery-operated wind park maintenance vessel.

Description of the baseline situation

At present, remote offshore wind parks are maintained used SOVs, offshore service vessel that can normally work with in wind parks for a number of weeks. These ships are diesel electrically propelled/ causing GHG emissions to the environment and noise. The scope of the baseline situation is to carry out short trips inside wind parks, transferring maintenance technicians from the ship to wind turbines and vice versa, and providing lodging to the maintenance staff for the persons when they are not working. The ship is assumed to operate within a large wind park.

Descriptions and values of the baseline measurements

The focus is on the energy used during the various operations and the resulting fuel used that will be replaced by green energy. Any impacts are derived directly from this fuel use. For the socio-economic indicators the difference in CAPEX of the systems used (Charging buoy vs engines and generators) and OPEX (Electricity costs vs fuel costs) are considered. Considering the social acceptance indicators, the baseline indicators are the noise the ships' engines make and the impact of the emissions on the crew. The objective of the buoy would be to reduce these and improve crew comfort. Considering the spatial impact, the baseline is the current number of ships that can be anchored within a given area. This shall later be compared with the number of ships that can be moored in the same area when using loading buoys.

Sub-Demonstrator 5.2: Charging buoy – Anchorage

The approach for the charging buoy is identical to that of the offshore situation. However, in this situation the costs in effort and time of connecting the buoy at the anchorage is an important factor. Data on this will be obtained from the PoR or from the AIS database if not directly available. For the hotel load of the vessel averages, like those of the 4th GHG study could provide input as well. It is currently estimated, that about 60-70 vessels are at anchorage per day and when focussing on the near shore anchorage about 30-40 vessels could be supplied with shore power. The approach of defining the baseline measurements and situation is similar to sub-demonstrator 5.1

5.5 Demonstrator 6: Autonomous e-barge and Transhipment

Description of the demonstrator

The objective of demonstrator 6 is developing collaborative planning and execution concept for inter-terminal barge operations to coordinate the autonomous operating e-barge. Already existing autonomous shipping technology will be used, complemented by algorithms that will be developed for autonomous docking, collision avoidance and risk prediction methods.

Description of the baseline situation

The type of the ship is the most relevant component for determining the baseline situation. There is still no ship available for demonstrator 6 and demonstrator 7 and therefore it is unknown which type of ship will be used for the demonstrators. The ship will not be bought, but will be rented and the demonstrator team is looking into two options at the moment:

- A completely new ship designed for electric propulsion and ready for autonomous navigation. This would be a much smaller vessel than a traditional vessel and has a maximum capacity of 28 TEU. If it becomes this type then we also have to look at legal issues as it is not a traditional ship. Permission is needed for this and if that doesn't work, we will go for a traditional ship that we will retrofit.
- Collaborate with the ship owner who has a traditional ship and retrofit it. Dimensions: e.g. 110-135 meters

Demonstrators 6 and 7 are still in the middle of the process of finding a ship that is applicable for the hydrogen, electric and autonomous technologies.

Descriptions and values of the baseline measurements

Considering that the baseline situation is unclear, it is difficult to determine the inputs for the descriptions and values for the baseline measurements. Important input for the environmental and operational indicators are the information about the ship design, such as the engine and propulsion system. Additionally, the distances and routes are relevant inputs for the environmental and operational indicators. However, these indicators are completely unknown at this moment. For the socio-economic indicators some elements can be specified at this moment, though, partially, they depend on the specific barge as well. This demonstrator has a couple of demonstrator specific social acceptance indicators that are difficult to measure quantitively. Regarding the autonomous e-barge, safety and responsibility are key aspects to consider. The baseline remains current barges, with captains holding radar certifications, who can be held responsible for accidents, and who can interact with each other. The autonomous e-barge will have to be as independent and trustworthy for it to be accepted. This will also be impacted by the number of jobs lost due to the autonomous nature. Another baseline will be the current number of employees and their level of training as several will have to be retrained and find other posts. Regarding the spatial impact of transshipment, the baseline is the current space needed for transshipment. The aim is to reduce the impact on the side of the port as the store system will be outside of the quay side. This demonstrator should allow for land to be used more efficiently, whilst increasing moving barges within the fleet.

5.6 Demonstrator 7: Green Energy Container

Description of the demonstrator

The objective of demonstrator 7 is demonstrating the application of hydrogen in a 20-foot container by designing the storage and fuel cell combination. Another objective is the demonstration of a battery container on the barge (li-ion). The battery will be built and applied to the autonomous e-barge.

Description of the baseline situation

The type of the ship is the most relevant component for determining the baseline situation. There is still no ship available for demonstrator 6 and demonstrator 7 and therefore it is unknown which type of ship will be used for the demonstrators. The ship will not be bought, but will be rented and they are looking into two options at the moment:

- A completely new ship designed for electric propulsion and ready for autonomous navigation. This would be a much smaller vessel than a traditional vessel and has a maximum capacity of 28 TEU. If it becomes this type then we also have to look at legal issues as it is not a traditional ship. We need permission for this and if that doesn't work, we will go for a traditional ship that we will retrofit.
- Collaborate with the ship owner who has a traditional ship and retrofit it. Dimensions: e.g. 110-135 meters

Demonstrators 6 and 7 are still in the middle of the process of finding a ship that is applicable for the hydrogen, electric and autonomous technologies.

Descriptions and values of the baseline measurements

Considering that the baseline situation is unclear it is difficult to determine the inputs for the descriptions and values for the baseline measurements. Important input for the environmental and operational indicators are the information about the ship design, such as the engine and propulsion system. Additionally, the distances and routes are relevant inputs for the environmental and operational indicators. However, these indicators are completely unknown at this moment.

5.7 Demonstrator 8: Hybrid Shunting Locomotive

Description of the sub-demonstrator

The main objective is to prove the viability of a full electric shunting concept by executing a pilot with 2 prototype locomotives in real operational conditions. Data about the operations and technical information, e.g., about loading and unloading cycles, speed, train load, used maximum power, will all be monitored in real-time.

The pilot will be executed in two phases; the acceptance testing of the developed prototype over the full window of operational safety and performance based on carefully designed testing protocol, and a second phase where the locomotives will be taken in commercial service and will be tested operationally over an extended period.

Executing a carefully designed testing protocol to confirm the operational safety and performance of the two prototype locomotives against the agreed supplier's specification and the operator / business case requirements. This testing period is expected to take between 3 and 6 months. During the testing period the performance of the locomotive is also with full trainloads. The period carries significant operational risks and as such no commercial contract will be executed during that period. This means that the locomotive is not tested with commercial cargo in the first phase.

In the second phase, operational conditions will be tested during commercial exploitation of the locomotives. To test the locomotives under different weather and operational conditions, the test period will be one year.

Description of the baseline situation

Nowadays the shunting of trains in port of Rotterdam is done by diesel engines that are 30-40 years old and relatively very polluting. The two hybrid locomotives, in demonstrator 8, are zero-emission by using the catenary where possible and the battery pack when necessary. In the baseline situation, the diesel locomotives are used for the shunting of trains and wagons from the rail yards to terminals and vice versa.

Descriptions and values of the baseline measurements

Environmental and operational indicators

The information for the baseline measurements of the environmental and operational indicators is retrieved from a TNO report about rail freight transport (TNO, 2017)[4]. The report provides information about energy consumption, the CO2-emissions and the NOx emissions for rail freight transport. The objective of the demonstrator is to replace the diesel usage of locomotives with electricity power in the shunting yards. The report provides values for diesel consumption and the corresponding CO2 and NOx emissions. Therefore, the values for the inputs of the KPI's for the environmental and operational indicators are available.

Socio-economic indicators

The information for the OPEX and CAPEX indicators is not available yet. Demonstrator 9 has contact with the Rail Innovation Group (RIG) about the input that is necessary for calculating the costs. However, it is not sure whether the costs of the current rail operations will be shared with MAGPIE. The other economic indicators are also dependent on the information provided by the RIG. The same space will be occupied so there should be no change for the spatial impact indicators to take into account. The social acceptance baseline of the demonstrator is the current acceptance of locomotives used by port workers and the

[4] TNO rapportage (2017): Inzicht in het energieverbruik, de CO2-uitstoot en de NOx-uitstoot van het spoorgoederenvervoer

communities through which these locomotives pass. The acceptance should increase after the implementation of the demonstrator due to reduced pollution and noise. Regarding the social acceptance of the communities that are situated on the path of the trucks, the baseline is the amount of noise complaints due to traffic noise filed annually.

5.8 Demonstrator 9: Green Connected Trucking

The main goal of Demonstrator 9 is to demonstrate (1) electric driving with heavy duty trucks (battery-electric and hydrogen) in combination with (2) the use of a decoupling point in the port area and supported by (3) automated docking for recharging of unmanned electric trucks. Within this demonstrator, new technologies, alternative fuels and logistics concepts will be tested, evaluated and improved. As a result, the running of the demonstrator will explain and quantify the extent to which emissions, efficiency and reliability are improved, compared to a baseline situation.

Sub-Demonstrator 9.1: Electric driving heavy trucks

Description of the sub-demonstrator

The first sub-demonstration consists of using about 10 heavy-duty electric trucks in normal logistic operations from several transport companies. Their deployment is set for a period of at least 12 months and concerns road freight transport of containers to and from the Rotterdam port area. Two technologies for electric driving will be analysed: battery-electric (focus of the demonstrator) and hydrogen (exploratory analysis, possibly demonstrated). This part of the demonstrator will focus on how to operate these electric trucks in the most sustainable (zero emission) and optimal way (efficient and reliable) and what needs to be arranged to make this work.

Description of the baseline situation

The baseline situation consists in the same transport companies carrying out similar transport and logistics operations using conventional diesel vehicles. The sub-demonstrator 9.1 therefore relates to the decarbonisation of heavy-duty freight transport, with a fleet replacement from conventional diesel to battery electric (and potentially hydrogen) heavy-duty trucks.

Description and values of the baseline measurements

Environmental indicators

The baseline measurement can be carried out in two ways: using primary data from transport companies or via simulation.

Once an agreement is defined with the transport companies that will take part in the demonstrator, data needed to calculate the environmental and operational KPIs will be requested, regarding their current operations with the diesel fleet. Getting primary data directly from the transport companies is important to compare as much as possible similar operations in terms of goods transported, logistics strategy and type of trip. It is expected that transport companies will provide data regarding the fuel/energy used, the weight transport and the load and unload locations. For what concerns the Well to Wheel (WTW) emissions, it is expected that transport companies will not have direct measurements (e.g., through measurement equipment), thus the values will mostly rely on default emission factors

In case that transport companies cannot provide primary data on their current transport operations, information can be retrieved from previous (TNO internal) projects or with the use of a simulation environment, to simulate the operations that will take place with the electric truck using a diesel truck instead.

Currently, no values have been retrieved.

Operational indicators

For the baseline measurements, from the operational indicators defined in Figure 1, only the lead time freight will be assessed in sub-demonstrator 9.1. In relation to the lead time freight, if possible, the refueling time will be calculated and the related rerouting operations will be tracked. In the case that data are retrieved from transport companies, a direct comparison can be made between current lead-time observation and past lead-time observations. Matching the current observations with GPS data, it is possible to attribute the "extra time" to the underlying cause and assess whether it was due to charging.

In the case that it is not possible to retrieve past data from transport companies, the fallback scenario consists in comparing current e-truck routes and see how much it would take with a diesel (without rerouting and charging) by means of simulation.

Currently, no values have been retrieved.

Socio-economic indicators

In the baseline situation, the operational expenditures (OPEX) and capital expenditures (CAPEX) will be assessed.

For the OPEX, the following components will be considered:

- Cost of fuel: obtained multiplying the tankage data by the cost of diesel per liter (to be retrieved from either the current diesel price or from the year of the baseline measure)
- Repair and maintenance costs of vehicles: to be retrieved from cost data of the transport companies involved

For the CAPEX, the following components will be considered:

- Costs of purchasing a vehicle: cost of buying a diesel vehicle, to be retrieved from cost data of the transport companies involved or from publicly available diesel vehicle prices

Currently, no values have been retrieved.

Sub-Demonstrator 9.2: Decoupling point

Description of the sub-demonstrator

The second sub-demonstrator concerns connected transport via a decoupling point. In this part of the demonstration, a decoupling point will be combined with electric driving with heavy trucks and will be built in the Rotterdam port area to decouple long haul and first/last mile transport. In this demonstration the use of a decoupling point will be shown in normal operations for a period of at least 12 months. The sub-demonstrator will define how to control the flows through a decoupling point, in combination with energy management of electric trucks, what charging infrastructure is required at decoupling points and what logistics bundling concepts can be applied to reduce transport movements.

Description of the baseline situation

The baseline situation consists in the same transport companies carrying out their operations using their conventional logistics strategy (e.g., from start location directly to the port of Rotterdam). The sub-demonstrator 9.2 therefore relates to decoupling the operations to allow for different logistics strategies.

Descriptions and values of the baseline measurements

Environmental and operational indicators

The baseline measurement for sub-demonstrator 9.2 relates to both the baseline measurement for sub-demo 9.1 as well as the outputs of sub-demonstrator 9.1. The operations via decoupling points will be compared with the operations using diesel heavy-duty trucks as well as battery-electric and hydrogen heavy duty trucks).

Socio-economic indicators

Regarding the spatial impact baseline for this sub-demonstrator, is that there is currently no space required for decoupling. The indicator will need to follow how much space will be required for the decoupling point.

Moreover, the operational expenditures (OPEX) and capital expenditures (CAPEX) will be assessed.

For the OPEX, the following components will be considered:

- Cost of fuel: obtained multiplying the tankage data by the cost of diesel per litre (to be retrieved from either the current diesel price or from the year of the baseline measure)
- Repair and maintenance costs of vehicles: to be retrieved from cost data of the transport companies involved
- Repair and maintenance costs of equipment/facilities: in the baseline, no extra facilities are included; the indicator will follow the costs of operating a decoupling point.

For the CAPEX, the following components will be considered:

- Costs of building/setting up the facilities related to the logistics operations of a decoupling point

Sub-Demonstrator 9.3: Automated docking for recharging

Description of the sub-demonstrator

The third sub-demonstrator concerns the automated docking for recharging of electric heavy trucks. In this part of the demonstrator, it will be shown how an electric heavy truck will automatically drive to the recharging station, automatically charge the battery, and drive automatically back to the parking place. This sub-demonstrator will be performed with 1 electric heavy truck and will be organized on three different days over a period of about 6 months.

Description of the baseline situation

The baseline situation refers to the operations of sub-demonstrator 9.1. The performances of electric heavy-duty trucks with automated docking for recharging will be compared to the performances of the same truck without the automated docking.

Descriptions and values of the baseline measurements

Operational indicators

In sub-demonstrator 3, only the charging time and reliability of the technology will be assessed. The charging time includes the trip from the parking lot to the recharging station and back and the time to automatically couple the charging station to the vehicle.

The charging time will be compared with the same performance indicator that will derive from sub-demonstrator 1 (the value from sub-demonstrator 1, not its baseline measure). For the reliability of technology, no comparison will be made.

Socio-economic indicators

Capital expenditure will be calculated together with transport companies and the providers of the automated docking.

Currently, no values have been retrieved.

The baseline for the spatial impact indicator is the current space needed to recharge. After the implementation of the robotic arm for the demonstration, the space lost will be measured. Social acceptance indicators that should be considered with the implementation of the demonstration include the safety perception of the robotic arm and the drivers' acceptance of the technology, as well as the user friendliness. The baseline is the current status quo of charging acceptance.

5.9 Demonstrator 10: Spreading Road Traffic

Description of the demonstrator

A network of bundling hubs will be developed to split the handling in port and the handing at the destination. The intent is to use existing infrastructure, which is available at locations within the port (at terminals, parking areas) or within the hinterland (at trucking companies or warehouses). Together with market parties, the requirements for the demonstrator in terms of operations, location and infrastructure, cooperation model, organization and supporting IT will be determined. Multiple demonstrators will be done which will provide learnings for further refinement and scale-up of the concept, as well as distilling best practices and boundary conditions for all MAGPIE ports.

Description of the baseline situation

The exact scope for the baseline situation is not definite yet. Two options have been discussed:

1. Shifting traffic and volumes from day to night transport. In this option, rather than transporting the cargo during daytime, the cargo is transported during the night. The same materials (truck, container) are used, only at different times. In this option, the baseline measurement would be to analyze the daytime operations. The nighttime operations will be compared to the daytime operations as the result measurement.
2. Besides transport during daytime, truck transport will be carried out during nighttime as well. Contrary to option 1, there is no shift from day to night, but it is additional cargo that is transported during the night. The same trucks are used, but they carry out an extra trip with additional cargo during the night. In this option, the baseline measurement would be to analyze the daytime operations. The result measurement is the combined day- and nighttime operations.

Descriptions and values of the baseline measurements

Different types of partners are connected to the demonstrator. The demonstrator consists of a warehouse company, transport (carrier) company, container terminal and a shipper. Most of the input for the baseline measurements need to be provided by these companies. The input for the following environmental and operational indicators needs to be measured and collected by **the transport company:**

- **Number of rides per shift/truck/total**
- **Transit time:** The total time it takes for goods to get from Point A to Point B, measured in hours and/or days. The transit time consists of the Truck-Turnaround-Time at warehouse, Truck-Turnaround-Time at deep-sea terminal and the transport time for moving cargo from the deep-sea terminal to the warehouse. The KPI is calculated by setting timestamps during the transit time. The transport company has a crucial role by collecting these timestamps during the transport of the cargo

- **Distances and number of empty kilometres:** The distances are calculated by the unload and load location data provided by the transport company. Three components are important for this KPI: 1. Measure the distance between deep-sea terminal and warehouse. 2. Measure the distance between warehouse and depot. 3. Measure the distance between depot and the deep-sea terminal (empty kilometres).
- **Fuel use** can be calculated in two ways:
  - Option 1: Linked to actual fuel consumption by the carrier.
  - Option 2: Calculate fuel consumption based on distances/weights and engine type.
- **The weight:** The weight is based on the load, the truck and the empty container. The weight is important to include as a control variable because the KPI. The weight has an influence on the fuel use

The input for the other environmental and operational indicators needs to be collected by the **warehouse company:**

- **Number of containers handled per person in warehouse:** The KPI should be included because the warehouse schedules also need to be adjusted to make night-time trucking possible. When it seems not profitable for the warehouse to open at night, the carriers do not have the option to expand their capacity and transport cargo at night
- **Throughput on warehouse from delivery pick-up:** The KPI is important for the shipper perspective

It is not clear yet which party can deliver the input for the KPI about the number of days demurrage (quay rental) and detention (container rental).

The **socio-economic KPI's** are based on the revenues and the OPEX/CAPEX for this demonstrator. The input for socio-economic indicators depends on the scope. Two options are possible:

- Option 1: Compare the current revenues with the revenues of the current situation including added trips at night
- Option 2: Compare revenues between daytime (current situation) and night-time (added situation) (e.g., per unloaded truck)

The same holds for the operational expenditures (OPEX). The operational expenditures can differ for daytime and night-time. For example, the salaries of truck drivers and employees of the warehouse are different the two parts of the day. The fuel costs can also differ because when there is less traffic on the roads. As both options discussed for the baseline measurement require more trips at night, the transport company will have to identify the current number of complaints linked to working hours of the drivers as a baseline for social acceptance. The transport company needs to deliver input for the socio-economic indicators.

5. Analyses and conclusions

The description of the baseline measurement of the different demonstrators showed a couple of elements:

- The baseline situation (also referred to as the current or 'as is' situation) is relatively clear for most of the demonstrators. For some demonstrators this is not the case yet.

For demonstrator 6 and 7 this is, for example, not the case due to the fact that no inland shipping vessel is found yet.

- The baseline description and thinking process about the baseline measurements resulted in additional insights about the monitoring framework and its relevance for the different demonstrators. This is useful and in line with the ideas within WP8, that the monitoring framework is a dynamic elaboration –within a certain bandwidth of course.
- In order to be able to compare different demonstrators and their effects and impact later on, aligning the different sources and elements within the demonstrators as much as possible proved useful and remains a point of utmost attention. The mentioned sources in this document –such as on page 11- help the demonstrators to standardize and use similar input when direct measurements are not available.
- The baseline descriptions and measurements so far give an overview of the existing 'as is' situation. For a lot of demonstrators this consists of fossil fuel driven propulsion, which will be replaced with the more sustainable alternative. The scope of the different demonstrators shows a relatively broad range, which is something that should be taken into account when comparing and analysing effects.
- The baseline measurement is only partially elaborated with this deliverable. One the one hand, there are already quite some details known and available in the template, such as indicators, calculation methods and data sources. On the other hand, the baseline situation and measurement are not clear at all for some demonstrators. The further collection of the baseline descriptions, but merely the (further) elaboration of the values of the baseline measurement is a continuous process throughout this project. Further elaborating and establishing the complete 'as is' situation will be done as soon as possible within the timeline of WP8 and the timeline of the different demonstrators. These will be elaborated as much as possible in D8.3 "*Baseline comparison report based on measurements 2 years into the project*".

Annex 1: Contribution to the Knowledge Portfolio

According to the requirements set by the European Commission, an annex with the Contribution to the knowledge Portfolio should be included in the deliverable. Guidelines state that is standard access conditions apply; this section can be skipped. Since D8.2 – Baseline evaluation and prioritization of demo-specific scenarios is of public access, not confidential, does not contain any patent or any other rights subject to embargo, the Contribution to the knowledge portfolio is not applicable.

Table 3 – Contribution to the knowledge portfolio : Background

BACKGROUND – BASELINE EVALUATION AND PRIORITIZATION OF DEMO-SPECIFIC SCENARIOS	
Owner(s)	EUR
Nature	Report
Registration/Protection	Not applicable
Description	This report provides a description of the baseline measurement process, including methodologies, values and other characteristics of the current, 'as is' situation.
Access conditions for research in the project / Limitations	Not applicable
Access conditions for Use / Limitations	Not applicable
Licensees in the project	Not applicable
Licensees for use	Not applicable

Table 4 – Contribution to the knowledge portfolio : Exploitable Foreground

EXPLOITABLE FOREGROUND	
Type of exploitable foreground	General advancement of knowledge
Exploitable Foreground (description)	Not applicable
Confidential	No
Foreseen embargo date	Not applicable
Exploitable product(s) or measure(s)	Not applicable
Sector(s) of application	Not applicable
Timetable for commercial use or any other use	Not applicable
Patents or other IPR exploitation (licenses)	Not applicable
Owner & Other Beneficiary(s) involved	Not applicable

Table 5 – Contribution to the knowledge portfolio : Patents, Trademarks, Registered designs, etc.

PATENTS, TRADEMARKS, REGISTERED DESIGNS, ETC.	
Type of IP rights*	Public access
Application reference(s) (e.g. EP123456)*	Not applicable
Subject or title of application*	Not applicable
Confidential*	Not applicable
Foreseen embargo date	Not applicable
Applicant(s) as on the application*	Not applicable
URL of application	Not applicable

Annex 2: Overview baseline templates

Demonstrator 2: Smart Energy Systems

Descriptives

KPI definition from the perspective of the electricity infrastructure (MV distribution network)

Assets operating under Power Congestion (Number) - Descriptive

Inputs	Description of the input in baseline situation	How to obtain this input for the baseline?
Input 1	*Power consumption data*	*Port of Rotterdam (POR) should provide the data. But, there is no data in the baseline situation.*
Input 2	*Power generation data*	*POR should provide the data. But, there is no data in the baseline situation*
Input 3	*Power flow evaluation*	*TUD will perform this evaluation, which is not applicable in the baseline situation*
Input 4	*Network topology and characteristics (capacities,...)*	*POR should provide the data. But, there is no data in the baseline situation*

Level of Power Congestion (per asset) (high, medium, low) - Descriptive

Inputs	Description of the input in baseline situation	How to obtain this input for the baseline?
Input 1	*Power consumption data*	*Port of Rotterdam (POR) should provide the data. But, there is no data in the baseline situation.*
Input 2	*Power generation data*	*POR should provide the data. But, there is no data in the baseline situation*
Input 3	*Power flow evaluation*	*TUD will perform this evaluation, which is not applicable in the baseline situation*
Input 4	*Network topology and characteristics (capacities,...)*	*POR should provide the data. But, there is no data in the baseline situation*

Power losses (kW) - Descriptive

Inputs	Description of the input in baseline situation	How to obtain this input for the baseline?
Input 1	*Power consumption data*	*POR should provide the data. But, there is no data in the baseline situation*
Input 2	*Power generation data*	*POR should provide the data. But, there is no data in the baseline situation*
Input 3	*Efficiencies of the generation units and different components*	*POR should provide the data. But, there is no data in the baseline situation*
Input 4	*Network topology and characteristics*	*POR should provide the data. But, there is no data in the baseline situation*

Self-consumption (kW) - Descriptive

Inputs	Description of the input in baseline situation	How to obtain this input for the baseline?
Input 1	Power consumption data inside the considered ne	*POR should provide the data. But, there is no data in the baseline situation*
Input 2	Power generation data inside the considered netw	*POR should provide the data. But, there is no data in the baseline situation*

Ratio Peak Power and Self-Consumption (%) - Descriptive

Inputs	Description of the input in baseline situation	How to obtain this input for the baseline?
Input 1	*Power consumption data*	*POR should provide the data. But, there is no data in the baseline situation*
Input 2	*Power generation data*	*POR should provide the data. But, there is no data in the baseline situation*
Input 3	*Network topology*	*POR should provide the data. But, there is no data in the baseline situation*
Input 4	*Self-consumption*	*TUD will provide this information (after getting the above-mentioned required inputs), which is not applicable in the baseline situation*

Renewable energy curtailment (%, kW) - Descriptive

Inputs	Description of the input in baseline situation	How to obtain this input for the baseline?
Input 1	Renewable power (PV/WT) generation	*POR should provide the data. But, there is no data in the baseline situation*
Input 2	*Power consumption data*	*POR should provide the data. But, there is no data in the baseline situation*
Input 3	Network topology	*POR should provide the data. But, there is no data in the baseline situation*

Cost of congestion (k€) - Descriptive

Inputs	Description of the input in baseline situation	How to obtain this input for the baseline?
Input 1	(Number) Assets operating under Power Congesti	*TUD will provide this information (after getting the above-mentioned required inputs), which is not applicable in the baseline situation*
Input 2	*Level of Power Congestion (per asset)*	*TUD will provide this information (after getting the above-mentioned required inputs), which is not applicable in the baseline situation*

Demonstrator 3: Shore Power Peak Shaving

Environmental - Descriptives

CO_2e per unit of transport activity (kg CO_2e/tonne km) - Descriptive

Inputs	Description of the input in baseline situation	How to obtain this input for the baseline?
Fuel / energy use data (liters, kWh, kg fuel)	N/A	*N/A*
Well-To-Wheel/Wake emission factor(s) for each fuel / energy type used (to ensure comparability WP8 can provide these on request).	*N/A*	*N/A*
For each shipment: weight and load + unload locations data	N/A	*N/A*

CO_2e per transshipment (kg CO_2e/tonne km)- Descriptive

Inputs	Description of the input in baseline situation	How to obtain this input for the baseline?
Fuel / energy use data (liters, kWh, kg fuel)	N/A	*N/A*
Well-To-Wheel/Wake emission factor(s) for each fuel / energy type used (to ensure comparability WP8 can provide these on request).	*N/A*	*N/A*
Specification of the unit of transshipment and total quantity of outbound units of transshipment within the scope.	N/A	*N/A*

CO_2e per demo per year (kg CO_2e) - Descriptive

Inputs	Description of the input in baseline situation	How to obtain this input for the baseline?
Fuel / energy use data (liters, kWh, kg fuel)	Electricity consumption (MWh/month) or other relevant time unit, distinguish between energy from the grid and direct wind energy usage for determining kg CO2 / MWh	*Continuous measurement of electrical energy supply from wind farm, from public grid as well as energy losses (in battery and local electrical power system)*
Well-To-Wheel/Wake emission factor(s) for each fuel / energy type used (to ensure comparability WP8 can provide these on request).	*Electricity consumption (MWh/month) or other relevant time unit, distinguish between energy from the grid and direct wind energy usage for determining kg CO2 / MWh*	*1) using publically available data of kg CO2/MWh of electricity from wnd energy and from the public grid (mix) 2) accounting for battery system CO2 footprint, evenly spread over its expected technical lifetime*

Energy Use (KJ) - Descriptive

Inputs	Description of the input in baseline situation	How to obtain this input for the baseline?
Fuel / energy use data (liters, kWh, kg fuel)	Electricity consumption (MWh/month) or other relevant time unit, distinguish between energy from the grid and direct wind energy usage	*Continuous measurement of electrical energy supply from wind farm, from public grid as well as energy losses (in battery and local electrical power system)*
Well-To-Wheel/Wake emission factor(s) for each fuel / energy type used (to ensure comparability WP8 can provide these on request).	*Electricity consumption (MWh/month) or other relevant period, distingush between local green energy from the grid for determining kg CO2 / MWh*	*1) using publically available data of kg CO2/MWh of electricity from wnd energy and from the public grid (mix)* *2) accounting for battery system CO2 footprint, evenly spread over ts expected technical lifetime*
For each shipment: weight and load + unload locations data	N/A	*N/A*

Emissions of other pollutants (kg NOx, SOx, PM2.5, PM10) - Descriptive

Inputs	Description of the input in baseline situation	How to obtain this input for the baseline?
Fuel / energy use data (liters, kWh, kg fuel)	SOx, NOx, NH3, VOC are listed in framework - No emissions of these compounds expected (battery system) - Is it exepcted that emissions arising from transport & installation from factory to site are included?	
Well-To-Wheel/Wake emission factor(s) for each fuel / energy type used (to ensure comparability WP8 can provide these on request).	*N/A*	
For each shipment: weight and load + unload locations data	N/A	

Socio-economic - Descriptives

Added value - Descriptive

Inputs	Description of the input in baseline situation	How to obtain this input for the baseline?
Revenue 1	*Additional revenue from electricity market by participation through battery*	*Simulated estimate from expected battery capacity*

Number of jobs - Descriptive

Inputs	Description of the input in baseline situation	How to obtain this input for the baseline?
Number of jobs	*Jobs created from power shore storage facility and electricity market participation*	*Calculated based on expected battery capacity*

OPEX - Descriptive

Inputs	Description of the input in baseline situation	How to obtain this input for the baseline?
Cost type 1	*Operational cost base shore power hub*	*Calculated based on expected reduction in transformer loading (from demo)*
Cost type 2	*Electricity cost from increased direct renewable energy usage*	*Calculated based on increase in direct use of wind energy and typical market and direct purchase (e.g. PPA) prices*

CAPEX - Descriptive

Inputs	Description of the input in baseline situation	How to obtain this input for the baseline?
Cost type 1	*Replacement cost (normalized) of shore power hub transformer*	*Calculated based on expected reduction in transformer loading (from demo)*

Demo specific - Descriptives

KPI - Descriptive

Inputs	Description of the input in baseline situation	How to obtain this input for the baseline?
Input 1	*Type of employment*	*?*
Input 2	*Direct use [%] of available wind energy*	*1) Continuous measurement of electrical energy supply from wind farm, from public grid as well as energy losses (in battery and local electrical power system)*
Input 3	*Peak power demand from public grid [MW]*	*1) Continuous measurement of electrical energy supply from wind farm, from public grid as well as energy losses (in battery and local electrical power system)*

Demonstrator 4: Ammonia Bunkering and Storage

Socio-economic - Descriptives

Added value - Descriptive

Inputs	Description of the input in baseline situation	How to obtain this input for the baseline?
Revenue 1	*PoR annual revenue from licensing bunkering opperations. Categorized in LNG, MGO, HFO, (Biofuels?)*	*input from PoR*
Revenue 2	*Combined bunkering revenue form bunkering companes licensed in PoR*	*Get full list of bunker opperators from PoR+ latest annual revelue pr. Company (2021 number: 27 licensed bunker barge companies in PoR)*
Revenue 3	*Revenue for approval, auditing and licensing companies (supporting industries)*	*Get list of combined companies from PoR (this one will probably be difficuld to get specific information for)*

Number of jobs - Descriptive

Inputs	Description of the input in baseline situation	How to obtain this input for the baseline?
Number of jobs	*Focussing on the bunkering process alone, baseline could be reference to the Chemgas number of emplyee, related to LNG opperations.* *It could be expanded to also include all emplyee in PoR that are involved in HFO/MGO/LNG bunkering, but will signifcant expand scope of data collection and afterward inpact evalaution of demo*	*Have Chemgas as demo partner to support these values. For a larger PoR evaluation, it should be possible to obtain these numbers for PoR. For MGO and HFO : reference from other bunkering companies*

OPEX - Descriptive

Inputs	Description of the input in baseline situation	How to obtain this input for the baseline?
Cost type 1	*personal cost for bunkering operation crew on LNG, HFO barges (chemgas or other)*	*Crew number for bunkering process from Chemgas. Crew numebr for HFO vessel needs to be found at another company. Averaged sallery based on standard normalized values*
Cost type 2	*Equipment annual certification/auditiong/permiting/ cost*	*either direct expenses obtained from Chemgas or indirectly as a mix of receiveing list of requred certification/auditiong/permiting and combine with generic monetary values*
Cost type 3	*Loose items required for bunkering (hoses, mooring and connection valves for bunkering opperations of LNG)*	*Chemgas to clarify normal quantity of hoses/conenction valves, mooring equipment, spares etc. normally being carried, along with estimate of normal life cycle. Potential obtain price from Chemgas as well, alternative from vendors*
Cost type 4	*Basic Bunker vessel general opex and fuel use*	*general opex cost for standard vessel equipments*
Cost type 5	*PoR expenses for environmental,safety and security services related to licensing bunkering in PoR*	*PoR to provide baseline. Needs to be categorized in minimum the categories of environmental,safety and security, but more granularity will provide better condition for impact evaluation*
Cost type 6	*PoR auditing and certifications costs for obtaining right to provide bunkering services*	*PoR to provide baseline.*
Cost type 7	*employee training needs*	

CAPEX - Descriptive

Inputs	Description of the input in baseline situation	How to obtain this input for the baseline?
Cost type 1	*bunkering vessel baseline cost*	*Information through Center and center partners*
Cost type 2	*Specific LNG/HFO, MGO bunkering vessel equipment cost*	*Information through Center and center partners*

Demonstrator 5: Charging Buoy

Environmental - Descriptives

CO2e per unit of transport activity (kg CO2e/tonne km) - Descriptive

Inputs	Description of the input in baseline situation	How to obtain this input for the baseline?
Fuel / energy use data (liters, kWh, kg fuel)	*Fuel consumption per day. Note that it is not possible to indicate the power consumption because the powe consumption is highly irregular, e.g. approaching a wind turbine, then carrying out an amplemann operation after that sailing to the next turbine. Therefore a consumption per day has been provided.*	*This is obtained from the publicly avialable data sheet of the windpark suppor vessel Acta Orion*
Well-To-Wheel/Wake emission factor(s) for each fuel / energy type used (to ensure comparability WP8 can provide these on request).	*ton CO2 emitted per day of wind support vessels*	*This is calculated as fuel consumption x 3.436. The factor 3.436 indicates kg CO2 emission / kg fuel consumption, and is obtained from Table of page 27 of MAGPIE document 1036594 MEASUREMENT REQUIREMENTS, METHOD AND KPIS FRAMEWORK*
For each shipment: weight and load + unload locations data	*Shipments are not applicable for the e-buoy concept*	*NA*

CO2e per transshipment (kg CO2e/tonne km)- Descriptive

Inputs	Description of the input in baseline situation	How to obtain this input for the baseline?
Fuel / energy use data (liters, kWh, kg fuel)	*Transshipments do not take place on the e-buoy*	*NA*
Well-To-Wheel/Wake emission factor(s) for each fuel / energy type used (to ensure comparability WP8 can provide these on request).	*NA*	*NA*
Specification of the unit of transshipment and total quantity of outbound units of transshipment within the scope.	*NA*	*NA*

CO2e per demo per year (kg CO2e) - Descriptive

Inputs	Description of the input in baseline situation	How to obtain this input for the baseline?
Fuel / energy use data (liters, kWh, kg fuel)	*Fuel used per year, based on 80% uptime*	*Fuel used per day multiplied with 80% x365*
Well-To-Wheel/Wake emission factor(s) for each fuel / energy type used (to ensure comparability WP8 can provide these on request).	*CO2 emitted per year, based on 80% uptime*	*CO2 emitted per daymultiplied with 80% x365*

Energy Use (KJ) - Descriptive

Inputs	Description of the input in baseline situation	How to obtain this input for the baseline?
Fuel / energy use data (liters, kWh, kg fuel)	*Fuel consumption per day. Note that it is not possible to indicate the power consumption because the powe consumption is highly irregular, e.g. approaching a wind turbine, then carrying out an amplemann operation after that sailing to the next turbine. Therefore a consumption per day has been provided.*	*This is obtained from the publicly avialable data sheet of the windpark suppor vessel Acta Orion*
Fuel consumption per MWh	Fuel consumption per MWh	From websited: https://www.sustainable-ships.org/stories/2022/sfc
Average power demand	Power demand	*Fuel consumption pe rhour/Fuel consumption /kWh*
Fuel / energy use data (liters, kWh, kg fuel)	*Energy use*	*The owner estimated fuel consumption per day on DP, divided by the fuel consumption factor.*
Well-To-Wheel/Wake emission factor(s) for each fuel / energy type used (to ensure comparability WP8 can provide these on request).	*kg CO2 generated/kg fuel consumed.*	*Obtained from MAGPIE document: 10 1036594 MEASUREMENT REQUIREMENTS, METHOD AND KPIS FRAMEWORK*
For each shipment: weight and load + unload locations data	*NA*	*ANA*

Environmental - Values

CO2e per unit of transport activity - Value

Inputs	Value	Unit
Fuel / energy use data (liters, kWh, kg fuel)	3	ton per day
Well-To-Wheel/Wake emission factor(s) for each fuel / energy type used (to ensure comparability WP8 can provide these on request).	9,3	ton/day
NA	NA	

CO2e per transshipment - Value

Inputs	Value	Unit
Fuel / energy use data (liters, kWh, kg fuel)	NA	NA
Well-To-Wheel/Wake emission factor(s) for each fuel / energy type used (to ensure comparability WP8 can provide these on request).	NA	NA
Specification of the unit of transshipment and total quantity of outbound units of transshipment within the scope.	NA	NA

CO2e per demo per year - Value

Inputs	Value	Unit
Fuel / energy use data (liters, kWh, kg fuel)	876	tons
Well-To-Wheel/Wake emission factor(s) for each fuel / energy type used (to ensure comparability WP8 can provide these on request).	2728	tons

Energy use - Value

Inputs	Value	Unit
Fuel / energy use data (liters, kWh, kg fuel)	3	ton per day
Fuel used per MwH	0,188	ton/MWh
Average Power demand	0,665	MW
Fuel / energy use data (liters, kWh, kg fuel)	3	ton per day
Well-To-Wheel/Wake emission factor(s) for each fuel / energy type used (to ensure comparability WP8 can provide these on request).	3,436	
NA	NA	

Emissions of other pollutants (kg NOx, SOx, PM2.5, PM10) - Descriptive

Inputs	Description of the input in baseline situation	How to obtain this input for the baseline?
Well-To-Wheel/Wake emission factor(s) for each fuel / energy type used (to ensure comparability WP8 can provide these on request).	*NOx emissions per ton fuel*	*From https://www3.epa.gov/ttnchie1/conference/ei19/session10/trozzi.pdf*
Well-To-Wheel/Wake emission factor(s) for each fuel / energy type used (to ensure comparability WP8 can provide these on request).	*NOx emissions per day*	*"Fill in how the input is obtained for the baseline situation. For example: How is the the input collected, measured, calculated and/or modelled?"*

Emissions of other pollutants (NOx, SOx, PM2.5, PM10) - Value

Inputs	Value	Unit
Well-To-Wheel/Wake emission factor(s) for each fuel / energy type used (to ensure comparability WP8 can provide these on request).	0,0106	ton/MWh
For each shipment: weight and load + unload locations data	0,1691	ton/day

Operational - Descriptives

Bunker sales - Descriptive

Input	Description of the input in baseline situation	How to obtain this input for the baseline?
Bunker sales per year without any subdivision of products or quarters	*Bunker sales per year*	*Acta marine data sheet, times 80% times 365*

Charging time - Descriptive

Input	Description of the input in baseline situation	How to obtain this input for the baseline?
Charging time observations CT1	*Time required for charging.*	*In the base case no charging is applied, so time required for this is 0, zero*

Operational - Values

Bunker sales - Value

Input	Value	Unit
Bunker sales per year without any subdivision of products or quarters	876	tons/year

Charging time - Value

Input	Time	Unit
Lead time observation CT1	0	
Lead time observation CT2	0	
Lead time observation CT3	0	

Socio-economic - Descriptives

Added value - Descriptive

Inputs	Description of the input in baseline situation	How to obtain this input for the baseline?
Future revenues	*fee for charging, subsidy by port because of emission reductions*	

Number of jobs - Descriptive

Inputs	Description of the input in baseline situation	How to obtain this input for the baseline?
Number of jobs	*Number of staff working on SOV +buoy. Electrical charged ship needs less maintenance and therefore less crew is needed on board (expected 2 crew members less).*	*Count staff on SOV. No staff will work on buoy. Information needs to retrieved from the operators itself.*

OPEX - Descriptive

Inputs	Description of the input in baseline situation	How to obtain this input for the baseline?
Cost type 1	*Cost of fuel*	*Fuel use per annum times bunker cost in Port of Rotterdam https://shipandbunker.com/prices/emea/nwe/nl-rtm-rotterdam*
Cost type 2	*Cost of crew*	*Crew number x crew cost per day(BES internal database)*
Cost type 3	*Cost of electrical power*	*0 zero in base case*
Cost type 5	*OPEX of e-buoy*	*0 zero in base case*

CAPEX - Descriptive

Inputs	Description of the input in baseline situation	How to obtain this input for the baseline?
Cost type 4	*CAPEX of e-buoy*	*0. zero in base case*
Cost type 6	*CAPEX of power cable*	*BES cost database*
Cost type 7	*CAPEX of tie in in wind park*	*BES cost database*
Cost type 2	*CAPEX of additional equipment ships*	*Cost obtained from market parties.*

Demonstrator 6: Autonomous e-Barge and Transhipment

Not available

Demonstrator 7: Green Energy Container

Not available

Demonstrator 8: Hybrid Shunting Locomotive

Environmental - Descriptives

CO2e per unit of transport activity (kg CO2e/tonne km) - Descriptive

Inputs	Description of the input in baseline situation	How to obtain this input for the baseline?
Fuel / energy use data (liters, kWh, kg fuel)	*A typical diesel locomotive in the port of Rotterdam uses in shunting operation uses 272 liters of diesel per day, which means an exhaust of 740kg CO2 per day*	*Source: TNO report 2017 R11414v2 inzicht in het energieverbruik, de CO2-uitstoot en de Nox uitstoot van het spoorgoederenvervoer*
Well-To-Wheel/Wake emission factor(s) for each fuel / energy type used (to ensure comparability WP8 can provide these on request).	*n.a.*	*"Fill in how the input is obtained for the baseline situation. For example: How is the the input collected, measured, calculated and/or modelled?"*
For each shipment: weight and load + unload locations data	*Average day of shunting locomotive consists of many different movements, loaded and unloaded.*	*Source: TNO report 2017 R11414v2 inzicht in het energieverbruik, de CO2-uitstoot en de Nox uitstoot van het spoorgoederenvervoer*

Environmental - Values

CO2e per unit of transport activity - Value

Inputs	Value	Unit
Fuel / energy use data (liters, kWh, kg fuel)	*272*	*Liter diesel/day*
Well-To-Wheel/Wake emission factor(s) for each fuel / energy type used (to ensure comparability WP8can provide these on request).	*740*	*kg CO2*
For each shipment: weight and load + unload locations data	*n.a.*	

CO2e per demo per year (kg CO2e) - Descriptive

Inputs	Description of the input in baseline situation	How to obtain this input for the baseline?
Fuel / energy use data (liters, kWh, kg fuel)	*CO2 emission per year is 365 times 740kg = 270 ton*	*Source: TNO report 2017 R11414v2 inzicht in het energieverbruik, de CO2-uitstoot en de Nox uitstoot van het spoorgoederenvervoer*
Well-To-Wheel/Wake emission factor(s) for each fuel / energy type used (to ensure comparability WP8 can provide these on request).	*n.a.*	*n.a.*

CO2e per demo per year - Value

Inputs	Value	Unit
Fuel / energy use data (liters, kWh, kg fuel)	*270*	*ton CO2/year*
Well-To-Wheel/Wake emission factor(s) for each fuel / energy type used (to ensure comparability WP8can provide these on request).		

Energy Use (KJ) - Descriptive

Inputs	Description of the input in baseline situation	How to obtain this input for the baseline?
Fuel / energy use data (liters, kWh, kg fuel)	*Fuel use in liters per year: 365 times 272 liter=*	*Source: TNO report 2017 R11414v2 inzicht in het energieverbruik, de CO2-uitstoot en de Nox uitstoot van het spoorgoederenvervoer*
Well-To-Wheel/Wake emission factor(s) for each fuel / energy type used (to ensure comparability WP8 can provide these on request).	*n.a.*	*n.a.*
For each shipment: weight and load + unload locations data	*n.a.*	*n.a.*

Energy use - Value

Inputs	Value	Unit
Fuel / energy use data (liters, kWh, kg fuel)	*99280*	*liter diesel/year*
Well-To-Wheel/Wake emission factor(s) for each fuel / energy type used (to ensure comparability WP8can provide these on request).		
For each shipment: weight and load + unload locations data		

Emissions of other pollutants (kg NOx, SOx, PM2.5, PM10) - Descriptive

Inputs	Description of the input in baseline situation	How to obtain this input for the baseline?
Fuel / energy use data (liters, kWh, kg fuel)	*Emissions measurements showed a exhaust of Nox of 25 gr/kg CO2*	*Source: TNO report 2017 R11414v2 inzicht in het energieverbruik, de CO2-uitstoot en de Nox uitstoot van het spoorgoederenvervoer*
Well-To-Wheel/Wake emission factor(s) for each fuel / energy type used (to ensure comparability WP8 can provide these on request).	*n.a.*	
For each shipment: weight and load + unload locations data		

Emissions of other pollutants (NOx, SOx,

Inputs	Value	Unit
Fuel / energy use data (liters, kWh, kg fuel)	*6750*	*kg Nox/year*
Well-To-Wheel/Wake emission factor(s) for each fuel / energy type used (to ensure comparability WP8can provide these on request).		
For each shipment: weight and load + unload locations data		

Operational - Descriptives

Bunker sales - Descriptive

Input	Description of the input in baseline situation	How to obtain this input for the baseline?
Bunker sales per year without any subdivision of products or quarters	*Usage of liter diesel per year*	*Source: TNO report 2017 R11414v2 inzicht in het energieverbruik, de CO2-uitstoot en de Nox uitstoot van het spoorgoederenvervoer*

Operational - Values

Bunker sales - Value

Input	Value	Unit
Bunker sales per year without any subdivision of products or quarters	*99280*	*liter diesel/year*

Demonstrator 9: Green Connected Trucking

Environmental - Descriptives

CO2e per unit of transport activity (kg CO2e/tonne km) - Descriptive

Inputs	Description of the input in baseline situatio	How to obtain data to calculate this KPI for the baseline?
Fuel / energy use data (liters, kWh, kg fuel)	*Fuel used in the baseline is diesel*	*To be received from transport companies involved in the demo - fuel used is received from tankage data.* ***Fall-back scenario**: retrive data from previous projects/literature/etc)*
Well-To-Wheel/Wake emission factor(s) for each fuel / energy type used (to ensure comparability WP8 can provide these on request).	*Emission factors depend on the type of data collected by the transport companies - they can either collect primary data with PEMS/SEMS equipment or rely on secondary data (modelled emission factors or default emission factors)*	*It is likely that the transport company will not have direct measures, therefore we will rely on default emission factors*
For each shipment: weight and load + unload locations data	*To calculate transport activity we need the weight of each shipment and the distance between loading and unloading locations*	*To be received from transport companies involved in the demo. In our demo it is important to compare similar logistics strategies/shipments, therefore it is better not to rely on previous projects results.* ***Fall-back scenario**: if the transport companies cannot provide past data, we can retrieve data from previous projets or turn to simulation (simulate the current operations with the electric truck using a diesel truck instead)*

CO2e per transshipment - Descriptive

Inputs	Description of the input in baseline situatio	How to obtain data to calculate this KPI for the baseline?
Fuel / energy use data (liters, kWh, kg fuel)	*Fuel used in the baseline is diesel*	*To be received from transport companies involved in the demo - fuel used is received from tankage data.* ***Fall-back scenario**: retrive data from previous projects/literature/etc)*
Well-To-Wheel/Wake emission factor(s) for each fuel / energy type used (to ensure comparability WP8 can provide these on request).	*Emission factors depend on the type of data collected by the transport companies - they can either collect primary data with PEMS/SEMS equipment or rely on secondary data (modelled emission factors or default emission factors)*	*It is likely that the transport company will not have direct measures, therefore we will rely on default emission factors*
Specification of the unit of transshipment and total quantity of outbound units of transshipment within the scope.		*To be received from transport companies involved in the demo*

CO2e per demo per year - Descriptive

Inputs	Description of the input in baseline situatio	How to obtain data to calculate this KPI for the baseline?
Fuel / energy use data (liters, kWh, kg fuel)	*Fuel used in the baseline is diesel*	*To be received from transport companies involved in the demo - fuel used is received from tankage data.* ***Fall-back scenario**: retrive data from previous projects/literature/etc)*
Well-To-Wheel/Wake emission factor(s) for each fuel / energy type used (to ensure comparability WP8 can provide these on request).	*Emission factors depend on the type of data collected by the transport companies - they can either collect primary data with PEMS/SEMS equipment or rely on secondary data (modelled emission factors or default emission factors)*	*It is likely that the transport company will not have direct measures, therefore we will rely on default emission factors*

Energy Use per unit of transport activity - Descriptive

Inputs	Description of the input in baseline situatic	How to obtain data to calculate this KPI for the baseline?
Fuel / energy use data (liters, kWh, kg fuel)	*Fuel used in the baseline is diesel*	*To be received from transport companies involved in the demo - fuel used is received from tankage data.* *Fall-back scenario: retrive data from previous projects/literature/etc)*
Well-To-Wheel/Wake emission factor(s) for each fuel / energy type used (to ensure comparability WP8 can provide these on request).	*Emission factors depend on the type of data collected by the transport companies - they can either collect primary data with PEMS/SEMS equipment or rely on secondary data (modelled emission factors or default emission factors)*	*It is likely that the transport company will not have direct measures, therefore we will rely on default emission factors*
For each shipment: weight and load + unload locations data	*To calculate transport activity we need the weight of each shipment and the distance between loading and unloading locations*	*To be received from transport companies involved in the demo. In our demo it is important to compare similar logistics strategies/shipments, therefore it is better not to rely on previous projects results.* *Fall-back scenario: if the transport companies cannot provide past data, we can retrieve data from previous projets or turn to simulation (simulate the current operations with the electric truck using a diesel truck instead)*

Emissions of other pollutants (NOx, SOx, PM2.5, PM10) - Descriptive

Inputs	Description of the input in baseline situatic	How to obtain data to calculate this KPI for the baseline?
Fuel / energy use data (liters, kWh, kg fuel)	*Fuel used in the baseline is diesel*	*To be received from transport companies involved in the demo - fuel used is received from tankage data.* *Fall-back scenario: retrive data from previous projects/literature/etc)*
Well-To-Wheel/Wake emission factor(s) for each fuel / energy type used (to ensure comparability WP8 can provide these on request).	*Emission factors depend on the type of data collected by the transport companies - they can either collect primary data with PEMS/SEMS equipment or rely on secondary data (modelled emission factors or default emission factors)*	*It is likely that the transport company will not have direct measures, therefore we will rely on default emission factors*
For each shipment: weight and load + unload locations data	*To calculate transport activity we need the weight of each shipment and the distance between loading and unloading locations*	*To be received from transport companies involved in the demo. In our demo it is important to compare similar logistics strategies/shipments, therefore it is better not to rely on previous projects results.* *Fall-back scenario: if the transport companies cannot provide past data, we can retrieve data from previous projets or turn to simulation (simulate the current operations with the electric truck using a diesel truck instead)*

Operational - Descriptives

Lead time freight - Descriptive

Input	Description of the input in baseline situatic	How to obtain data to calculate this KPI for the baseline?
Lead time observations Lti	*We will look into how the lead time changes due to charging time (including rerouting needed for charging - combination of logistics and charging strategies) and the introduction of decoupling points (can be combined or related)*	*In case of data from transport companies: We can make a direct comparison between current lead-time observation and past lead-time observations. Matching the current observations with GPS data, it is possible to attribute the "extra time" to the underlying cause and assess whether it was due to charging.* ***Fall-back scenario** : compare e-truck routes and see how much it would take with a diesel (without rerouting and charging) by means of simulation*

Socio-economic - Descriptives

OPEX - Descriptive

Inputs	Description of the input in baseline situation	How to obtain data to calculate this KPI for the baselin
Cost of fuel		*Tankage data multiplied by the cost of diesel per litre (to be retrieved from either current diesel price or from the year of the baseline measure)*
Direct material costs		*Cost data from transport company*
Repair and maintenance costs of vehicles		*Cost data from transport company*
Repair and maintenance costs of equipment		*Cost data from transport company*

CAPEX - Descriptive

Inputs	Description of the input in baseline situation	How to obtain data to calculate this KPI for the baselin
Costs of vehicles	*Cost of buying a diesel vehicle*	*Cost data from transport company or to be retrieved from publicly available diesel vehicle price*
Equipment upgrade (e.g., vehicle retrofitting, automated recharging components)	*Cost of retroffiting vehicles or upgrade it for automated recharging components is zero in the baseline situation (only applicable for the demo operations)*	*n.a.*
Costs of facilities related to logistics operations (e.g., decoupling facilities for sub-demo 2)	*Cost of logistics facilities that are currently operated by the transport company*	*Cost data from transport company*

Demonstrator 10: Spreading Road Traffic

Demo specific - Descriptives

Number of rides per shift/truck/total - Descriptive

Inputs	Description of the input in baseline situation	How to obtain this input for the baseline?
Input 1	*The demo focuses on an expansion of the capacity of the transport company. More trips are carried out with the same capital because driving at night also becomes a possibility. Within the transport company, drivers are paid per hour, but also per journeys. The number of journeys is also relevant to calculate the employment effects.*	*The transport company will provide the input for the number of journeys.*

Number of containers handled per person in warehouse - Descriptive

Inputs	Description of the input in baseline situation	How to obtain this input for the baseline?
Input 1	*This KPI is important for the shipper perspective. The KPI should be included because the warehouse schedules also need to be adjusted to make nighttime trucking possible. When it seems not profitable for the warehouse to open at night, the carriers do not have the option to expand their capacity and transport cargo at night.*	*he shipper/warehouse company need to provide the input with regards to the number of containers handled per person.*

Throughput on warehouse from delivery to pick up - Descriptive

Inputs	Description of the input in baseline situation	How to obtain this input for the baseline?
Input 1	*This KPI is also important for the shipper perspective and has the same motive for executing the KPI as the KPI above.*	*The shipper/warehouse company need to provide the input with regards to the throughput on warehouse from delivery to pick up.*

Transit time - Descriptive

Inputs	Description of the input in baseline situation	How to obtain this input for the baseline?
Input 1	*The total time it takes for goods to get from Point A to Point B, measured in hours and/or days. The transit time consists of the Truck-Turnaround-Time at warehouse, Truck-Turnaround-Time at deep-sea terminal and the transport time for moving cargo from the deep-sea terminal to the ware house.*	*The KPI is calculating by setting timestamps during the transit time. The carrier company has a crucial role by collecting these timestamps during the transport of the cargo: See the three sub-KPI's below.*

Truck-Turnaround-Time at warehouse (security in/out): - Descriptive

Inputs	Description of the input in baseline situation	How to obtain this input for the baseline?
Input 1	*Waiting time before warehouse gate*	*Transport company*
Input 2	*Handling time at warehouse*	*Transport company*

Truck-Turnaround-Time at deep-sea terminal - Descriptive

Inputs	Description of the input in baseline situation	How to obtain this input for the baseline?
Input 1	Waiting time before terminal gate	Transport company
Input 2	Handling time within the terminal	Transport company

Transport time for moving cargo from deep-sea terminal to warehouse - Descriptive

Inputs	Description of the input in baseline situation	How to obtain this input for the baseline?
Input 1	Measuring the transport time by providing two timestamps; timestamp at load location and timestamp at unload location.	Transport company

Number of days demurrage (quay rental) and detention (container rental) - Descriptive

Inputs	Description of the input in baseline situation	How to obtain this input for the baseline?
Input 1	An increase of efficiency of transporting containers can lead to a decrease of the demurrage and detention costs. Demurrage costs is based on two timestamps: Actual Time of Arrival (ATA) and the moment of leaving the gate. The earlier the container is picked up from the terminal, the lower the costs. The detention costs are also based on two timestamps. The costs start when the container has left the gate and end when the container is returned at a container depot.	Measuring the time of quay rental and container rental. How to receive input data on these two factors?

Distances and the number of empty kilometers - Descriptive

Inputs	Description of the input in baseline situation	How to obtain this input for the baseline?
Input 1	The distances driven provide an overview of transport process of the movements of the containers. The process of the transport network in the ports need to be changed to execute the demo. Depots do no have midnight shifts and cannot be used as for handing in the containers. The objective of the demo is to use the deep-sea terminals as the handing location. The empty kilometers of transporting are expected to decrease because the trucker does not need to go first to a depot and then travel towards a deep-sea terminal. The daytime situation and night situation are described below. The red marked part of the transportation is not part of the night-time transportation.	The distances are calculated by the unload and load location data. Three components are important for this KPI: 1. Measure the distance between deep-sea terminal and warehouse. 2. Measure the distance between warehouse and depot. 3. Measure the distance between depot and the deep-sea terminal (empty kilometers)

Fuel use (brandstofgebruik) - Descriptive

Inputs	Description of the input in baseline situation	How to obtain this input for the baseline?
Input 1	*Fuel use is important for calculating the energy use, CO2 emissions and other pollutants (NOx, SOx, PM2.5, PM10).*	*How to calculate/measure/collect data: 1. Option: Linked to actual fuel consumption by the carrier. 2. Option: Calculate fuel consumption based on distances/weights and engine type.*

Weight - Descriptive

Inputs	Description of the input in baseline situation	How to obtain this input for the baseline?
Input 1	*The weight is based on the load, the truck and the empty container. The weight is important to include as a control variable because the KPI. The weight has an influence on the fuel use.*	*Transport company*

Revenues - Descriptive

Inputs	Description of the input in baseline situation	How to obtain this input for the baseline?
Input 1	*The revenues can differ at nighttime for daytime and nighttime. The prices for transported goods might differ because of the changes in costs.*	*1. Scope carrier: Compare current situation with current situation including added trips at night. 2. Scope shipper: Compare revenues between daytime (current situation) and nighttime (added situation) (e.g., per unloaded truck)*

Opex - Descriptive

Inputs	Description of the input in baseline situation	How to obtain this input for the baseline?
Input 1	*The same holds for the operational expenditures (OPEX). The operational expenditures can differ for daytime and nighttime. For example, the salaries of truck drivers and employees of the warehouse are different the two parts of the day. The fuel costs can also differ because when there is less traffic on the roads.*	*Collecting the data from the carrier and shipper.*