InterGreen-Nodes

# KPI-System for performance measurement in multimodal freight transport

TAKING
**COOPERATION**
FORWARD

# KPI-System for performance measurement in multimodal freight transport

## Author-information

Annika Schulze, Philip Michalk, Lisa Hartmann
Contact information for this document:
michalk@th-wildau.de, hartmann@th-wildau.de

## Acknowledgment

## Disclaimer

## Date of this document

May 04th, 2022

## Interreg Central Europe Region Project #CE1444: "Intermodal Green Alliance - Fostering Nodes"

## Index

## Abbreviations

KPI — Key Performance Indicators
SOP — Standard Operating Procedure
TCO — Total-Costs-of-Ownership

TAKING
COOPERATION
FORWARD

# 1 Introduction

In the context of climate change, reducing emissions is also becoming increasingly important in the transport sector. To reduce the environmental impact, companies and organisations in the field of multimodal freight transport are looking for new, more environmentally friendly technologies that they can integrate into their processes.

However, it is not yet clear how to quantify the environmental impact without forgetting the economic aspect and the additional costs that could be caused by a greener alternative. The InterGreen-Nodes project has developed a scoreboard that allows monitoring of both: environmental impacts and economic performance.

Suitable Key Performance Indicators (KPIs) were selected after an analysis of the performance monitoring requirements at the InterGreen-Nodes demonstrator organisations: Berlin Port and Warehouse Company, Rostock Port GmbH, Port of Venice, Freight Village Bologna, Freeport of Budapest Logistics Ltd. and Luka Koper, port and logistic system. The result is a KPI system divided into two parts. Part one includes KPIs on energy consumption and greenhouse gas emissions, focusing on environmental impact.

Part two covers economic performance with total costs of ownership (TCO) and reported variable and fixed costs. Calculation on best practice examples have shown, that clearly defined processes and aims are necessary to obtain suitable results. When these definitions are done correctly, though, the results can help in monitoring already implemented, greener technologies, or finding a suitable solution for future implementation. The attached Standard Operating Procedure (SOP)

provides guidance on the implementation of the scoreboard for the purpose of monitoring, as well as making decisions for future process changes.

# 2 InterGreen-Nodes

The InterGreen-Nodes project brings together regions located along the Central Europe Region stretch of the Scandinavian-Mediterranean Core Network Corridor (ScanMed).

InterGreen-Nodes aims at developing green, intermodal, last-mile freight transport in urban areas. The project will demonstrate highly innovative solutions in a practical and tangible way and disseminate them throughout the CE Programme region. Flanking strategic measures on the spatial planning and political level will ensure a strategic foundation for the project.

Nodes are the most logical spatial/geographical scale for working on improving the coordination of freight transport stakeholders. Nodes on the one hand have the critical mass for achieving a change for supporting an environmental friendly transport. On the other hand, the responsible parties on a node level have the necessary regional and practical knowledge, in order to implement effective and sustainable solutions. However, as they mainly operate on a regional level, they lack intercommunion with other actors, thereby confining their ideas and solutions to their respective region. InterGreen-Nodes is networking the actors from practice and politics.

# 3 Aim and Purpose

This SOP describes the implementation and use of a standardised KPI-System for

performance measurement of chosen processes in multimodal freight transport. The system aims at supporting the monitoring of process performance regarding environmental impact and economic performance, especially of greener technologies. Beside the monitoring, the scoreboard can help you in making decisions when changing a process and investing in new technologies. By juxtaposing two process solutions, meaning two different technologies used for the same process, the performance evaluation can be performed by means of comparison. Possible comparisons could for example be the following, but there are many more options, of course:

<div align="center">

Diesel truck vs. E-truck

Non-certified vs. Certified warehouse

LNG truck vs. E-truck

</div>

The SOP is valid for the monitoring and comparison of different technologies used in transport, handling or storage processes of multimodal freight transport by applying a standardised method. The scoreboard is applied for processes, which allow the application of at least two technologies for achieving the result of this defined process.

# 4 Methodology

The KPI-system is available in form of an excel-document, which contains one sheet for each field of application (transport, handling and storage). The sheets are structured into different sections for inserting data of the processes and visualisation of results, as depicted below. Inserted data concerning mainly energy consumption and costs are then processed to determine the KPIs' values. The left part of the system covers the environmental effect with the KPIs "energy consumption" and "Greenhouse gas emissions". The right part depicts the results of a total-cost-of-ownership-analysis.(see Figure 1)
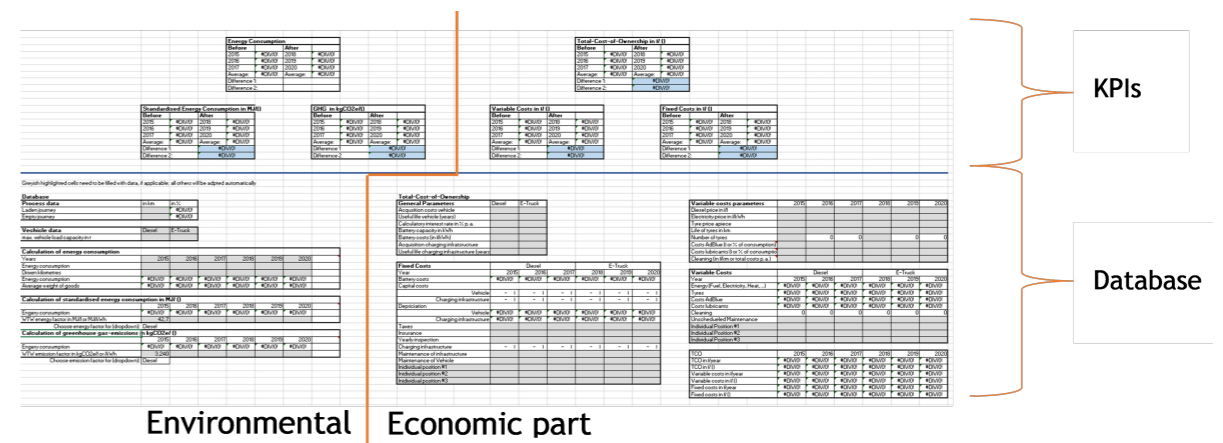


Figure 1: Overview of sheet-structure

For calculating the KPIs, common formula used in climate assessment and business administration is being applied. Results can then be evaluated and interpreted according to the individual aim of the company or organisation. The results in the excel files are structured like this:

| Name of KPI | | | |
|---|---|---|---|
| Before | | After | |
| Year x-3 | | Year x | |
| Year x-2 | | Year x+1 | |
| Year x-1 | | Year x+2 | |
| Average: | | Average: | |
| Result 1 | | | |
| Result 2 | | | |

The results 1 and 2 are there to help you with your evaluation. Result 1 is the absolute difference between the most recent value of the new process version and the average of the old version. Result 2 is the relative difference. With those two results, you can see the current improvements at one glance. The next steps will lead you through different tasks, resulting in a filled scoreboard.

# 5 Process Steps

## Step 1: Choose and define the process
Before starting with the actual collection of data and calculation of the KPIs, eligible processes need to be identified and defined. How this is done is explained here.

## Step 1.1: Choose the process
Eligible processes are those in transport, handling and storage. It doesn't matter if you already implemented the new technology which you want to monitor, or if you are planning to change to a greener solution and haven't decided on a technology yet. In the latter case, you can use the tool to compare different options and choose the one with the best results supporting your goals. What is important for the calculations in both cases is, that the process itself is always the same. This means, that it didn't undergo a radical change, when you introduced the new technology, but remained the same in its function and operating principle. When you are still searching for the right solution, always consider that it is not the process to be changed, but the technology used for it. Therefore, for choosing an eligible process, answer the following questions:

? Did we currently change to a greener technology for a process in the field of transport, storage or handling? If yes, did the process itself remain the same?

? Can we identify the energy consumption of this single process? Can we also identify the costs related to this process?

If no:

? Do we want to implement a greener technology in one or more of our processes in the field of transport, storage or handling?

If yes:

? What is our aim in changing? Do we want to reduce our GHG-emissions, no matter the costs, or do the costs play an important role as well? Make sure you know about your decision criteria to evaluate the results. (More on this topic is explained later on in "Decision upon one process or technology")

? Can we identify the energy consumption of this single process we are considering to change in its current state? Can we also identify the costs related to this process?

In both cases, make sure you know what you want to achieve by using the scoreboard. Define what your goals are, so that you can use and evaluate the results at the end in an appropriate way. Do you want to decide on a new technology, that can be implemented in future? Have a look in the chapter "Decision upon one process or technology" for further advice on what to do with the results and how you could make your decision. Do you want to use the scoreboard for monitoring purposes of an already implemented process? Have a look for the chapter "Responsibilities".

## Step 1.2: Define the process
Once the process has been determined, it has to be defined clearly, answering the following questions:

? What does the process include? Where are the process boundaries, considering the need of determining the energy consumption and costs related to the process? Or in other words: Where does the process start and where does it end?

? Which technology was replaced (or is considered to be replaced) by what? Categorise your process into one of the three fields: transport, storage, handling.

? When did the change take place?

? What are the expected results from this change?

As part of the project, a transport process of the BEHALA, which is used here as an example to show the meaning of "process boundaries". The process we would like to monitor is about transporting containers from the container terminal to the point of storage and the return trip to the terminal. Before changing the technology, the transport was done by a diesel truck, now it is an E-truck which is used in exactly the same way. Looking at the picture now, we can see the process steps 1 to 3, which are about the arrival of containers in the terminal and their transhipment. However, these steps are not connected to the truck we want to monitor. Therefore, the process starts with step 4, the transportation of



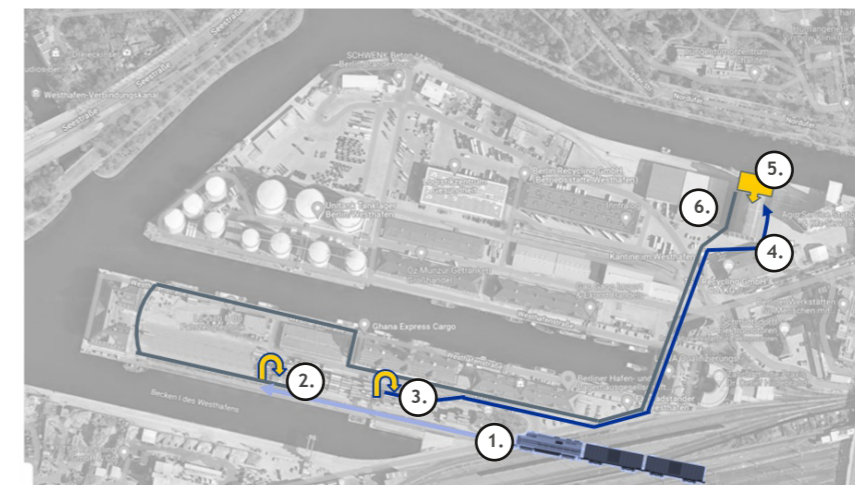| 1. Arrival of train in the Westhafen-terminal | 2. Handling of container from train to terminal | 3. Transhipment of container onto container chassis | 4. Transport to silo (approx. 0,8km) | 5. Storage of coffee | 6. Return of container to terminal (approx. 1,4km) |

Figure 2: Example Process

the container by the truck, continuing with step 5, which includes waiting for the container to be emptied and ends with step 6, the return trip to the terminal. These are the process boundaries. Energy consumption and costs need to be captured for these steps only.

## Step 2: Collect and insert data

Before starting with the collection of data, choose the excel sheet appropriate for your process (transport, handling or storage). They differ slightly by the parameters included in the database and the units for the results (e.g. storage processes will usually require values in m², transport processes tkm). The database in the excel sheets contains all parameters that you should collect data on for the calculation. Insert all values requested in the greyish highlighted cells, the rest is inserted automatically.

As you can see, for each version of the process (here a diesel shunting vehicle and an electric shunting vehicle) data is included for three years. For the former processes, the years included will always be the last three, in which the technology was used. For the new versions, it will be the most current three years. Of course, you can start using the scoreboard in the first year of use already and then build up the set of data over the next years. As soon as three years' data are included and a fourth year needs to be added, the oldest set of data will drop out of the calculation. Make sure however, for the last year of the old process as for the first year of the new process, that at least 10 months of data of the years are available. This is to prevent any inaccuracies due to leaving out seasonal peaks or months in which electricity consumption is higher than usual (e.g. for air-conditioning). If you didn't

introduce the new process at the beginning of the year, start monitoring with the next full year. If you didn't use the old process for 10 months in its last year, leave it out and include only the last entire three years. If the process hasn't been adapted yet, try to create a set of data with the expected values.

### Step 2.1: Consumption data

Firstly, add data on consumption on the left part of the database. Make sure to use values that fit the previously defined process in order to ensure comparable results. Only data collected within the scope of the process can be included.

#### For transport and handling processes:

Insert the distance driven divided into the laden journey and the empty journey (process data); state the types of vehicle used (starting with the former type) and the maximum weight of goods in tons carried by the vehicle. Fill in the row "years" to assign the period of time that is measured. Next, consumption data has to be added. It consists of the energy consumed per year in litres or kilowatt-hours and the driven kilometres in the exact same time frame. Lastly, choose the energy and emission factor from the dropdown menu in accordance to the type of drive of the vehicles. Consider creating company specific factors (see paragraph "Individual energy and emission factors").

#### For storage processes:

For the storage process, it is assumed that the comparison will be between non-certified and certified buildings, which is therefore pre-indicated in the section "warehouse data". If necessary, more precise distinctions can be inserted (e.g. two different types of certification). Fill in the row "years" to assign the period of

time that is measured. Next the energy consumption for each year needs to be added in kWh. This includes all area that was defined in step one and also all types of energy usage (electricity, heating, cooling). Ensure that you use the same time interval for measuring the energy consumption every year. The interval needs to have a length of at least 10 months in order to provide a reliable result. The area needs to be stated in square metres and according to the process defined in step 1. Lastly, choose the energy and emission factor from the dropdown menu in accordance to the type of drive of the vehicles. Consider creating company specific factors (see paragraph "Individual energy and emission factors").

Before continuing with filling the second part of the scoreboard.

### Step 2.2: Data on costs

Next, fill in the missing cells on right part of the database. One block covers the fixed costs, and the other the variable costs, aiming at the calculation of the Total-cost-of-ownership. It is important to include all costs associated to the process and everything that might provoke a difference between the two compared versions of the process (e.g. changes in personnel costs). As the cost factors are slightly different for each company and process, consider replacing pre-defined positions or adding them into the provided cells. Everything added in the highlighted tables will be considered for the end result.

#### For transport and handling processes:

Fill in the box with the general parameters, which will be used to calculate in particular the capital costs and depreciation (linear). Furthermore, add all fixed costs that are related to the process. Yearly inspection should include costs for

the main inspection, and if applicable, the emission test. The variable costs will mainly be calculated with the help of the values entered into the box "variable costs parameters", only unscheduled maintenance costs and other individual positions need to be inserted apart from the parameters. Costs for AdBlue and lubricants can be inserted as a total value or as a percentage: in percent of the fuel costs for the lubricants and in percent of fuel consumption for AdBlue. For the latter, an additional value of € per litre of AdBlue is needed. However, if you would like to enter a percentage, convert it to a decimal number (e.g. 0,05 instead of 5%). Costs for cleaning can be included as total costs or be given as €/km.

#### For storage process:

Insert the values relevant to calculate the total-cost-of-ownership. These should be at least the proposed cost factors. As warehouses are mostly written off with a fixed percentage, you should add a percentage to calculate the linear depreciation. Based on the type of certificate, consider adding costs for recertification.

With both parts finished, you can now start the evaluation.

# 6 Individual energy and emission factors

Included in the excel-document is a sheet called "Individual electricity mix". Here, you can add the proportions of each energy source on your electricity mix in %. The energy sources that can be indicated follow the sources that need to be stated by energy providers to their end consumers according to the European directive (2003/54/EC), so that the values could be

copied from that information. Once all shares account to 100%, the factors are generated in the greenish highlighted cells. They can be used for the calculations by choosing "Electricity by individual mix" from the two dropdown menus in the left part of the database section of each calculation sheet. This enables more accurate results for the KPIs "GHG emissions" and "standardised energy consumption". However, it is also a tool for estimating possible future improvements in environmental impact, that would occur if you changed your electricity mix.

# 7 Decision upon one process or technology

**(when the scoreboard is used to support the decision making)**
When you consider reducing your GHG-emissions by replacing for example a vehicle with a combustion engine with another, greener, vehicle, you might have various options to do so. There might be various processes that could be eligible to be conducted with a greener technology, or different solutions for one process. The scoreboard can help in making this decision, as mentioned earlier. You need to make sure, however, that you know your decision criteria when evaluating your results. These depend on your strategy and goal as well. Some typical criteria are the following:

- ■ "The solution with the biggest reduction of GHG-emissions compared to the current technology in absolute numbers will be chosen."
  ➡ Consult the KPI "GHG-emissions" and there "Difference 1".
- ■ "The solution with the biggest reduction of GHG-emissions compared to the current technology in percent will be chosen." ➡ Consult the KPI "GHG-emissions" and there "Difference 2".
- ■ "The cheapest solution that is still providing at least a minimal reduction of GHG-emissions will be chosen."
  ➡ Compare all your considered and calculated solutions with the KPIs "GHG-emissions" and "TCO/reference unit". Check which one is the cheapest and if it still offers a reduction in GHG-emissions that is acceptable for achieving your goal.

Instead of looking at the GHG-emissions, you could also argue that it is important to reduce the energy consumption to preserve scarce resources.
The excel-file includes a sheet "Collection of results". You can use it to collect all the results you obtained for all your possible solutions. The results mainly concern the "differences" calculated for the KPIs. Once you made all calculations and inserted the results into the table, sort the relevant column and see which solution provides the best results according to your decision criteria. You can use the filter function of the table to sort correctly. The picture shows you the part of the excel file, which you can use for the collection. In case you would like to make your decision based on other criteria, you can simply change the columns headlines as well.
Also decide who is part of the decision process and who takes care of what:

- ❓ Who collects data and is responsible for the calculation?
- ❓ Who will evaluate the results?
- ❓ How are they going to be communicated and who, in the end, will make the decision?

# 8 Responsibilities
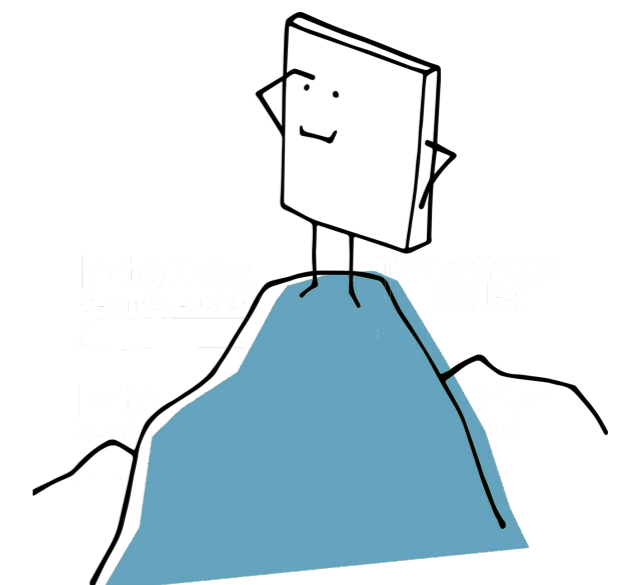
**(when the scoreboard is used for monitoring)**
In order to use the scoreboard as a supporting tool for monitoring the performance of technologies used for defined processes, it is necessary to maintain it. Data needs to be updated once a year. Updates should be made either at the end of a year or at the beginning of the year for the previous one. Assign a responsible person for conducting the update and maintaining the document. It could also be helpful to instruct this person to communicate the new results as soon as they are available and provide an overview of the current performance to the stakeholders. When implementing the scoreboard, decide who needs to know about the results and who evaluates them. Answer the following question:

- ❓ Who are the stakeholders and how do the results need to be prepared before communication?
- ❓ Should everyone interpret the results independently or should the task force process the results, e.g. for the management?
- ❓ What do we want to achieve with the results?
- ❓ Is there anything we would like to decide based on them, e.g. further roll-out of a technology?

## Contributing partners

Technische Hochschule Wildau
*Technical University of Applied Sciences*

WIR SIND HAFEN!
BEHALA
HAUPTSTADT.LOGISTIK

ROSTOCK PORT

NORTH ADRIATIC SEA PORT AUTHORITY

LUKA KOPER
Port of Koper

BUDAPEST DOCK
Szabadkikötő
Logisztikai és Ipari Park

## Download the KPI-System for your Organisation

# TAKING
# **COOPERATION**
# FORWARD

**InterGreen-Nodes**