Ports Energy and Carbon Savings

Deliverable 1.6.3

Energy savings in ports

Final Report about energy savings in ports

Project No. 2S03-009

With the financial support of

Author

SEBASTIEN DELHOMELLE	CEREMA

Revision history

REVISION	DATE	AUTHOR	ORGANISATION	DESCRIPTION
V0	02/05/2019	Sebastien DELHOMELLE	Cerema	Draft complete
V1	20/05/2019	Audrey PIERRE	Cerema	Reviewed
V2	30/05/2019	Sebastien DELHOMELLE	Cerema	Reviewed after workshop
V3	03/06/2019	Jerry Clarke	Portsmouth	Completed
V4	16/06/2019	Jacob Van Berkel	HZ	Reviewed
V5	25/06/2019	Sebastien DELHOMELLE	Cerema	Final version

Table of contents

Table of figures

1. Introduction

Energy saving options can be sorted out into different aspects:

- Lighting
- Heating and cooling
- Fuels (including ship-to-shore power yard equipment – RTG, yard tractors, reach stackers, container forklifts)
- Specific equipment (cranes, container reefers, etc.)

A single tool can hardly handle all those aspects while remaining user-friendly and not time-consuming.

Cerema tried to propose a simple and user-friendly tool, keeping in mind that this approach means that the results should be regarded as tendencies that should lead ports to explore different solutions of energy savings.

This deliverable aims mainly to test the use of the tool (D1.5.2) and the accuracy of the methodology (D1.5.3) on energy savings.

Therefore, the ports of Oostende, Hellevoetsluis, Ijmond and Portsmouth have employed the concept method. The port of Dunkerque, as mentioned in the application form, was not included in the experimentation due to his size that aims to a very complicated experimentation.

This report, based on the experimentation in ports using the concept method, and on the exchange between partners, conclude the experimentation phase of the method to determine energy savings in ports.

2. Hellevoetsluis

2.1. Results of the experimentation

What kind of energy savings are possible in your port ?

Lightings

Switching for LEDs	0	kWh	#DIV/0!	of energy savings on electricity
Using controls and sensors	85654	kWh	18%	of energy savings on electricity
De-lamping and daylight	13595	KWh	3%	of energy savings on electricity

Heating and cooling

Insulation

TOTAL (kWh/yr)	Offices	warehouses	sanitary blocks
52295	37243	6250	8802

19% of energy savings on the heating and cooling bill

Heating system

TOTAL (kWh/yr)	Offices	warehouses	sanitary blocks
33935	24034	5500	4401

12% of energy savings on the heating bill

Cooling system

TOTAL (kWh/yr)	Offices	warehouses	sanitary blocks
640	640	0	0

1% of energy savings on the heating and cooling bill

Control devices

TOTAL (kWh/yr)	Offices	warehouses	sanitary blocks
26772	18621	3750	4401

10% of energy savings on the heating and cooling bill

Fuels

Reducing time in port	**NS**	**savings on fuel used by shipping operation in port**
On shore power supply	**0%**	**savings on fuel used by ship at berth***
Eco-driving	**NS**	**savings on fuel used by the company's vehicules**

* Other energy is then used as remplacement but it is less emitting and produced with more efficiency and potentially with a share of renewable energy
NS : non significant, Synthesis can't reflect a global tendencie

Specific equipment

From hydraulic to electric spreader	**0%**	**energy savings on energy used by spreaders**
From Diesel RTG to e-RTG	**0%**	**energy savings on energy used by RTG cranes**
From Diesel STS to e-STS	**0%**	**energy savings on energy used by STS cranes**
Installing a roof shade	**0%**	**energy savings on energy used by reefer contai**

Other considerations

Potential for a district heating between industries:	**no**
Potential for a district cooling between industries:	**no**

TABLEAU 1: ENERGY SAVINGS FOR HELLEVOETSLUIS

2.2. Difficulties and remarks

Hellevoetsluis
Way of using the tool
The tool was used 4 times. The port is divided in 4 areas and the tool was used in each area.
Strengths
easy to use
Weaknesses and difficulties
Problems to answer the questions on STS crane and RTG cranes. Overall energy consumption and not the consumption for lighting and heating separately is actually known.
Remarks
Some companies are also living in the harbour. How do we calculate this?

TABLEAU 2: HELLEVOETSLUIS, SYNTHESIS OF DIFFICULTIES AND REMARKS

2.3. Partial conclusion for this port

Even if this tool is simple to use, collecting the data is the major difficulty (lack of time, knowledge, dialogue between companies, …)

Dividing the ports in physical areas or administrative areas could be interesting, because some data are more easily available for some areas. Thus, the addition of energy savings of these areas show a more accurate picture of the energy savings for the global port. This method has a limit with the no numeric data entries (for example, "have your employees been trained to eco-driving?") that should be analysed area by area: it is more accurate, but the global vision for the whole port is lost.

3. Ijmond

3.1. Results of the experimentation

What kind of energy savings are possible in your port ?

Lightings				
Switching for LEDs	**3391293**	kWh	**5%**	of energy savings on electricity
Using controls and sensors	**10348343**	kWh	**15%**	of energy savings on electricity
De-lamping and daylight	**1365938**	KWh	**2%**	of energy savings on electricity

Heating and cooling

Insulation

TOTAL (kWh/yr)	Offices	warehouses	sanitary blocks
15533122	2174818	13358304	0

28% of energy savings on the heating and cooling bill

Heating system

TOTAL (kWh/yr)	Offices	warehouses	sanitary blocks
2249818	2174818	75000	0

4% of energy savings on the heating bill

Cooling system

TOTAL (kWh/yr)	Offices	warehouses	sanitary blocks
11100670	0	11100670	0

20% of energy savings on the heating and cooling bill

Control devices

TOTAL (kWh/yr)	Offices	warehouses	sanitary blocks
14430713	1087409	13343304	0

26% of energy savings on the heating and cooling bill

Fuels

Reducing time in port	0%	savings on fuel used by shipping operation in port
On shore power supply	95%	savings on fuel used by ship at berth*
Eco-driving	0%	savings on fuel used by the company's vehicules

* Other energy is then used as remplacement but it is less emitting and produced with more efficiency and potentially with a share of renewable energy

Specific equipment

From hydraulic to electric spreader	#DIV/0!	energy savings on energy used by spreaders
From Diesel RTG to e-RTG	0%	energy savings on energy used by RTG cranes
From Diesel STS to e-STS	0%	energy savings on energy used by STS cranes
Installing a roof shade	0%	energy savings on energy used by reefer conta

Other considerations

Potential for a district heating between industries:	no
Potential for a district cooling between industries:	no

TABLEAU 3: ENERGY SAVINGS FOR IJMOND

3.2. Difficulties and remarks

Ijmond
Way of using the tool
Easy to use
Strengths
Quick results
Weaknesses and difficulties
Less accurate than the TNO tool (see further)
Remarks

TABLEAU 4: IJMOND, SYNTHESIS OF DIFFICULTIES AND REMARKS

3.3. To go further: energy savings at company level?

3.3.1. Determining the potential of energy savings at a company level: The TNO Tool

Ijmond has gone a step further in the determination of the energy savings options in their ports; by determining the potential of energy savings at the company level. For that, Ijmond used a tool developed by TNO, a Dutch knowledge institute.

The tool is a model that analyzes the potential for energy savings and local renewable energy production (solar PV) on a business park. Inputs for the model are publicly available data. Based on this data, and additional parameters formulated by TNO and ECN (another Dutch knowledge institute), the tool computes the results. TNO wrote a sort of script on Microsoft Access. All data is loaded into Access, and many queries have to be run, to calculate the outcome.

The so-called 'potential scan' from TNO is an energy audit tool that consists of multiple components. Firstly, TNO analyzed on a company level, then, TNO made an overview on a business park level. The results are split up into sustainable technology options and isolation techniques. TNO has delivered the results of the study in Dutch; therefore, the following example is a translation.

Company name XXXXXX

Current energy use

The estimated annual energy use of your property is:
-308.000 kWh of electricity
-30.000 m3 of gas
This is equal to 162 tons of CO_2 emissions

Estimated annual energy use of your production process is:
-2.239.000 kWh of electricity
-175.000 m3 of gas

This is equal to 1106 tons of CO_2

Your share of energy use compared to the business park is 8,5%

Sustainable technology options

LED

LED lamps are an energy efficient light source. In many cases this can be done in the existing fixture. The lifespan of LED lamps is longer than many other lamps, making the replacement less frequent.

Measure	Production/savings	Investment	Payback period	Environmental benefit (CO2)
LED	67.800 kWh	€10.500	1 years	24 tons

Solar PV

A solar panel or photovoltaic panel, shortly PV panel is a panel that converts solar energy into electricity. This means your roof is used for generating electricity.

Measure	Production/savings	Investment	Payback period	Environmental benefit (CO2)
PV	302.000 kWh	€371.000	9 years	107

Heat pump

A heat pump is a renewable heat source to replace a gas boiler. A heat pump uses heat from the soil, the outside air, ventilation air or groundwater for the heating of buildings.

Measure	Production/savings	Investment	Payback period	Environmental benefit (CO2)
Heat pump	8.900 m3	29.300	7 years	11 tons

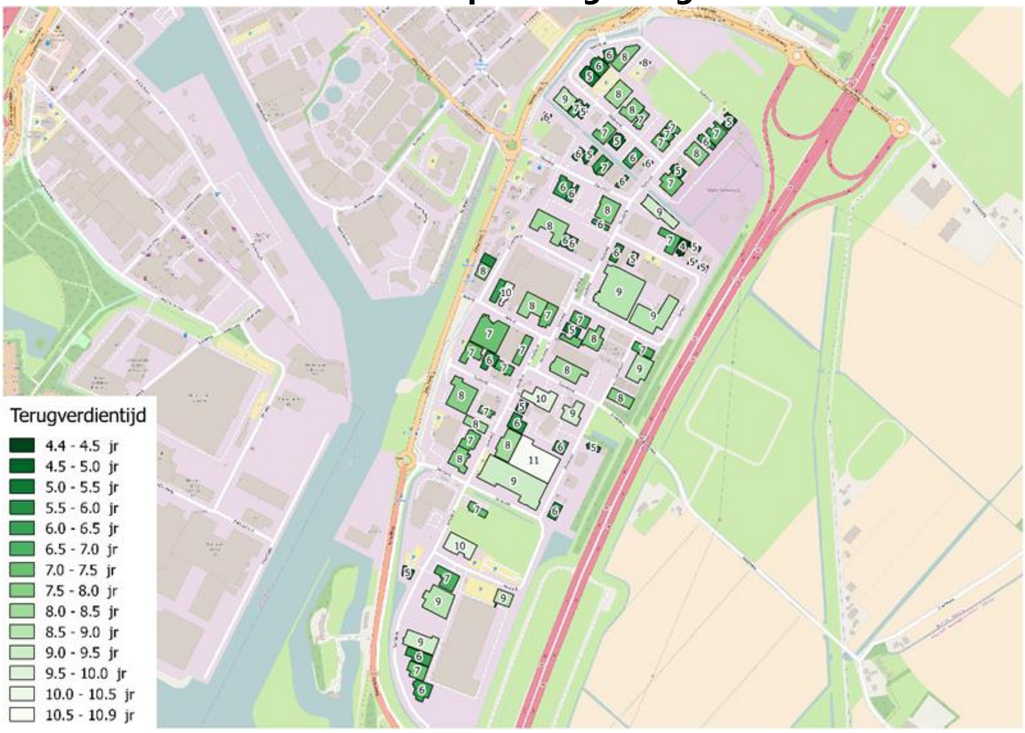
Isolation options

Measure	Production/savings	Investment	Payback period	Environmental benefit (CO2)
Roof insulation	9.500 m3	€47.700	9 years	17 tons
Façade insulation	3.700 m3	€23.800	11 years	7 tons
Glazing	0 m3	€0	0 years	0 tons
Heat recovery installation	7.800 m3	€24.700	5 years	14 tons

Annual CO2 emissions after implementation of all measures: 1087 tons

TABLEAU 5 : EXAMPLE OF AN ANONYMIZED ANALYSIS ON COMPANY LEVEL

Business park Kagerweg



Estimated annual current energy use:

-23.797.000 kWh of electricity
-3.085.000 m^3 of gas

The environmental impact of this energy use is equal 13.900 tons of CO_2 emissions.

Relevant options

Measure	Production/savings	Investment	Yearly revenue/savings	Environmental benefit (CO_2)
LED lighting	1.629.000 kWh/yr	€285.000	€243.000	578 tons
Solar PV	15.343.000 kWh/yr	€17.911.000	€2.429.000	5.447 tons
Heat pumps	462.000 m^3	€1.735.000	€192.000	638 tons
Roof insulation	303.000 m^3	€1.759.000	€177.000	540 tons
Façade insulation	145.000 m^3	€812.000	€85.000	259 tons
Glazing	28.000 m^3	€246.000	€17.000	50 tons
Heat recovery installation	209.000 m^3	€121.000	€121.000	371 tons

Total investment: €23.321.000
Total average payback time: 7 years
Total CO2 emission reduction: 7.883 tons

TABLEAU 6: EXAMPLE OF THE ANALYSIS ON BUSINESS PARK LEVEL

3.3.2. Main conclusion on the use of the TNO tool

The main conclusion we can draw about the TNO potential scan is as follows:

The tool is easy and(?) cheap to use, because the entire model relies on publicly available data. The outcomes are straight forward and easily understood; therefore, this tool helps to make a rough estimate of the major energy saving options on the business park. In the Netherlands, the public data comes from the BAG (system that registers the size and place of buildings), Chamber of Commerce (which identifies the type and location of the businesses), LISA (amount of employees), ECN (parameters to compute energy use). Thus, the accuracy of the model also depends on the data quality of these publicly available data sets. One of the weaknesses is therefore also accuracy. The model could be improved if the measured electricity use (from smart meter data) is implemented in the model. Also, a data source or tool that can estimate the dimensions of buildings better, would improve the outcome of the model.

	Positive	Negative
Internal	**Strengths** -Quick scan, so it is easy to execute -Cheap -Gives a clear overview of larger and smaller energy consumers -Provides insight in the costs and rate of return of different energy saving measures -Provides insight in possible solutions	**Weaknesses** -Constructed at a distance (desk research) -Energy demand is a estimation, which means it could differentiate from the actual/real energy demand -Based only on averages/key figures
External	**Opportunities** - Easily scalable	**Threats** **-** Entrepreneurs do not understand why the outcome of the scan differs from reality - Based on data that might only be available in the Netherlands

TABLEAU 7: IJMOND, SWOT OF THE POTENTIAL OF ENERGY SAVINGS AT A COMPANY LEVEL

Another drawback is the amount of time it takes to run the model. It is quite an intensive process now. This is because the model runs mainly in Microsoft Access, the process could be accelerated by making the EPS a little less intensive to run, for example by transforming it into a python based model.

3.4. Partial conclusion for this port

The tool is easy to use. The example of this port is quite relevant because it shows the main difference between the simplified tool and a more complex one. On the other hand, special attention must be paid to the quality and the availability of the data, both for the Netherlands and should the tool be used in other countries.

4. Oostende

4.1. Results of the experimentation

What kind of energy savings are possible in your port ?

Lightings				
Switching for LEDs	**58283**	kWh	**2%**	of energy savings on electricity
Using controls and sensors	**8537**	kWh	**0%**	of energy savings on electricity
De-lamping and daylight	**23475**	KWh	**1%**	of energy savings on electricity

Heating and cooling

Insulation			
TOTAL (kWh/yr)	Offices	warehouses	sanitary blocks
113358	10246	96950	6161
11% of energy savings on the heating and cooling bill			
Heating system			
TOTAL (kWh/yr)	Offices	warehouses	sanitary blocks
156352	8874	145425	2054
15% of energy savings on the heating bill			
Cooling system			
TOTAL (kWh/yr)	Offices	warehouses	sanitary blocks
686	686	0	0
0% of energy savings on the heating and cooling bill			
Control devices			
TOTAL (kWh/yr)	Offices	warehouses	sanitary blocks
66374	5123	58170	3081
6% of energy savings on the heating and cooling bill			

Fuels

Reducing time in port	**2%**	**savings on fuel used by shipping operation in port**
On shore power supply	**0%**	**savings on fuel used by ship at berth***
Eco-driving	**10%**	**savings on fuel used by the company's vehicules**

* Other energy is then used as remplacement but it is less emitting and produced with more efficiency and potentially with a share of renewable energy

Specific equipment

From hydraulic to electric spreader	**#DIV/0!**	**energy savings on energy used by spreaders**
From Diesel RTG to e-RTG	**0%**	**energy savings on energy used by RTG cranes**
From Diesel STS to e-STS	**0%**	**energy savings on energy used by STS cranes**
Installing a roof shade	**0%**	**energy savings on energy used by reefer contai**

Other considerations

Potential for a district heating between industries:	**no**
Potential for a district cooling between industries:	**no**

TABLEAU 8: ENERGY SAVINGS FOR OOSTENDE

4.1.Difficulties and remarks

Oostende
Way of using the tool
Easy to use, the experimentation is on an 1 year period (2018) and the area is limited (blue area on the map below).
Strengths
Easy to use, results are clear
Weaknesses and difficulties
The port of Oostende has about 5 significant office buildings, 9 different warehouse buildings and multiple sanitary blocks. Some were built more than 50 years ago, some are brand new. Same for the heating installations inside. It is impossible to fill only one table for all that kind of building, and making a new document for every building seems like a lot of work and will scatter the results. Maybe different tabs for office, warehouse and sanitary blocks, with in each tab the provision for e.g. 10 buildings could be an improvement of the tool.
Remarks

TABLEAU 9: OOSTENDE, SYNTHESIS OF DIFFICULTIES AND REMARKS

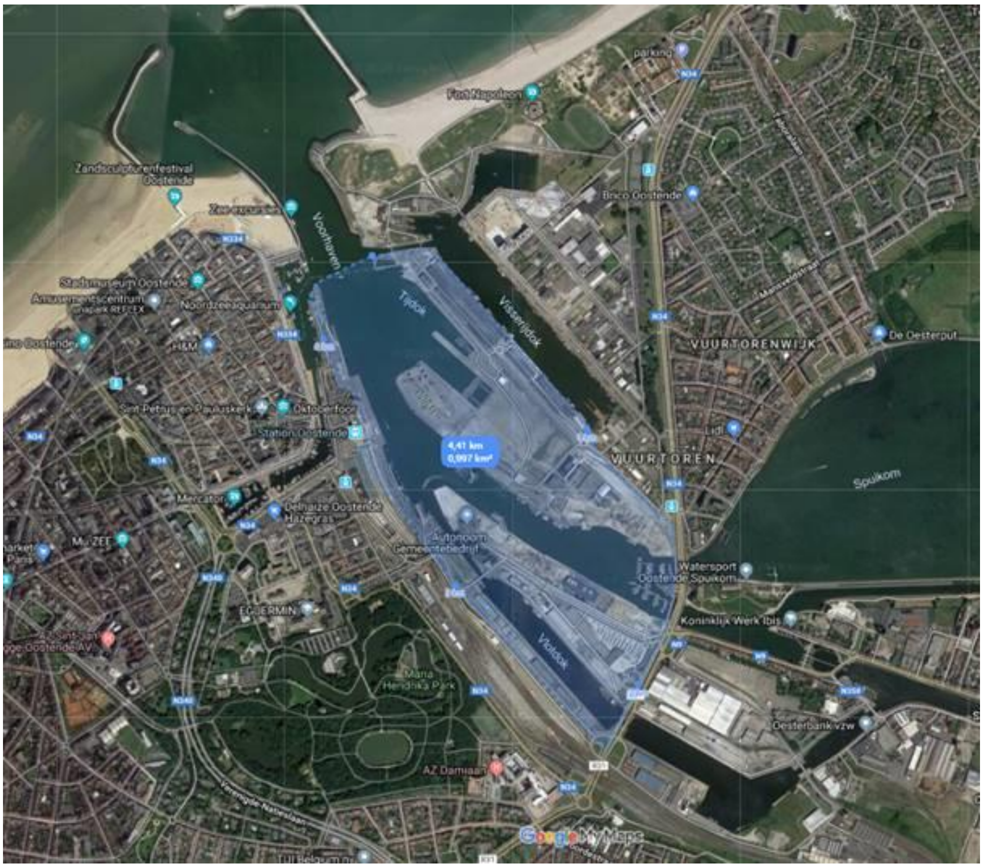


FIGURE 1: PORT OF OOSTENDE: AREA OF THE TOOL EXPERIMENTATION

4.1. Partial conclusion for this port

The main difficulty for Oostende was to use the tool that is deliberately simple with different kind of buildings, warehouses, built in different years, with different kind of installations without making a new document for each buildings. The potential way of improving the tools is to split some entry tables of the tool, which seems to be a point that increase the complexity of the tool.

Portsmouth

4.2. Results of the experimentation

What kind of energy savings are possible in your port ?

		Lightings		
Switching for LEDs	**0**	kWh	**0%**	of energy savings on electricity
Using controls and sensors	**220686**	kWh	**8%**	of energy savings on electricity
De-lamping and daylight	**33402**	KWh	**1%**	of energy savings on electricity

	Heating and cooling		
	Insulation		
TOTAL (kWh/yr)	Offices	warehouses	sanitary blocks
2044561	334031	1674120	36410
28% of energy savings on the heating and cooling bill			
	Heating system		
TOTAL (kWh/yr)	Offices	warehouses	sanitary blocks
0	0	0	0
0% of energy savings on the heating bill			
	Cooling system		
TOTAL (kWh/yr)	Offices	warehouses	sanitary blocks
1407472	12372	1395100	0
19% of energy savings on the heating and cooling bill			
	Control devices		
TOTAL (kWh/yr)	Offices	warehouses	sanitary blocks
1692325	0	1674120	18205
23% of energy savings on the heating and cooling bill			

	Fuels	
Reducing time in port	**8%**	**savings on fuel used by shipping operation in port**
On shore power supply	**95%**	**savings on fuel used by ship at berth***
Eco-driving	**10%**	**savings on fuel used by the company's vehicules**

* Other energy is then used as remplacement but it is less emitting and produced with more efficiency and potentially with a share of renewable energy

	Specific equipment	
From hydraulic to electric spreade	**0%**	**energy savings on energy used by spreaders**
From Diesel RTG to e-RTG	**0%**	**energy savings on energy used by RTG cranes**
From Diesel STS to e-STS	**0%**	**energy savings on energy used by STS cranes**
Installing a roof shade	**12%**	**energy savings on energy used by reefer conta**

Other considerations	
Potential for a district heating between industries:	**no**
Potential for a district cooling between industries:	**no**

TABLEAU 10: ENERGY SAVINGS FOR PORTSMOUTH

4.3. Difficulties and remarks

Portsmouth
Way of using the tool
No major difficulties to use the tool
Strengths
The strength is in its simplicity. It should not get more sophisticated as the data 'IN' at this level does not lend itself to further analysis without going back to source and getting far more detailed information. At this level the tool can be used for decision making at Executive Level and further detailed analysis will follow.
Weaknesses and difficulties
The only weakness would be exposed by using the tool to delve deeper into the analysis when the initial start data 'Data In' is at a relatively unsophisticated level.
Remarks
A good tool that will help Portsmouth 'kick-off' further Carbon saving efforts, which are now being directed more towards improving Air Quality.

TABLEAU 11: PORTSMOUTH: SYNTHESIS OF DIFFICULTIES AND REMARKS

4.1. Partial conclusion for this port

The tool is useful as a 'starter' to try and get further executive 'Buy-In' for further Carbon Reduction efforts in the port. The tool is especially useful (and the whole PECS project itself has proved timely) as Portsmouth International Port must produce an Air Quality Strategy by the end of 2019. Whilst a Carbon Reduction project is not an Air Quality project, the two are inextricably linked and the tool has proved useful in showing the potential in both showing the scope of possible further Carbon reduction efforts and the potential of improving Air Quality at the port should those efforts be taken up

5. Energy savings

The table 12 below summarizes the potential of energy savings in each of the four ports:

Energy savings	Hellevoet.	Ijmond	Oostende	Porthmouth	
Lightings					
Switching for LEDs	0%	5%	2%	0%	of energy savings on electricity
Using controls and sensors	18%	15%	0%	8%	of energy savings on electricity
De-lamping and daylight	3%	2%	1%	1%	of energy savings on electricity
Heating and cooling					
Insulation	19%	28%	11%	28%	of energy savings on the heating and cooling bill
Heating system	12%	4%	15%	0%	of energy savings on the heating bill
Cooling system	1%	20%	0%	19%	of energy savings on the heating and cooling bill
Control devices	10%	26%	6%	23%	of energy savings on the heating and cooling bill
Fuels					
Reducing time in port	0-2%	0%	2%	8%	savings on fuel used by shipping operation in port
On shore power supply	0%	95%	0%	95%	savings on fuel used by ship at berth
Eco-driving	0-10%	0%	10%	10%	savings on fuel used by the company's vehicules
Specific equipment					
From hydraulic to electric sprea	0%	0%	0%	0%	energy savings on energy used by spreaders
From Diesel RTG to e-RTG	0%	0%	0%	0%	energy savings on energy used by RTG cranes
From Diesel STS to e-STS	0%	0%	0%	0%	energy savings on energy used by STS cranes
Installing a roof shade	0%	0%	0%	12%	energy savings on energy used by reefer containers
Other considerations					
Potential for a district heating :	no	no	no	no	
Potential for a district cooling :	no	no	no	no	

TABLEAU 12 : POTENTIAL OF ENERGY SAVINGS IN PARTNER'S PORTS

The results of table 12 allow drawing the following conclusions:

- Ports are very diverse, also regarding their potential of energy savings. E.g. onshore power supply, in some ports (Hellevoetsluis and Oostende) zero in the other ports (IJmond and Portsmouth) close to 100 % ,
- Insulation and control devices on heating and cooling seems to be a levy common to all ports to induce energy savings, even if the efficiency of this measure is not the same for all ports.

6. Roadmap for improvement for the tool

6.1. Avenues to improve the tool

6.1.1. Cranes

Based on the expertise of Blue Power synergy, the use of electric cranes could lead to maintenance difficulties. Ports that do not explore this way of energy savings should not be regarded as the odd man!

Spreaders are largely used in loading and unloading somewhat everywhere in the ports and industry. Many types exist not just electric-grid or hydraulic-diesel but also hydraulic-electrical and electric-diesel.

Depending of the application and location different type of actuation is used. For fixed cranes with an own electricity supply mostly electric-grid connected spreaders are chosen to a certain extend. For mobile container forklifts, a hydraulic power take-off will be used. Often manufacturers use the same spreader structure equipped with an adapted type of actuator, going from manual for small size, hydraulic for mobile units or where electoral cables are not applicable or for applications demanding high actuation forces, electrical or pneumatic.

To realise energy savings there is a need for modernisation and improvement of those tools, especially the choice of high-performance steel instead of simple construction steel is important to save weight and so to save energy. More and more manufacturers of spreaders propose high performance spreaders in modern materials for any which powering. For each powering improvements on structure, materials and design can grant valuable energy savings.

6.1.2. Lighting

In addition to the method, lighting computations (lumen), which are currently based on area, we could also include the number of lights per unit area. For instance, maybe only 2 lights would be sufficient on small offices but ports could be using 3 or 4.

6.1.3. Boilers

Boilers have efficiency ratings (https://www.britishgas.co.uk/smarter-living/save-energy/green-deal/products-included-in-green-deal/a-rated-boilers.html) and that information from ports could improve potential heat savings estimates.

6.2. Is it relevant to improve the tool?

The best way to use those remarks seems to be only by having a second look at the potential of energy savings of the ports after the use of the tool. Due to the evidence that, even if the tool is very user friendly and need no specific knowledge in energy savings, the access to the data is a major obstacle to fill the tool.

7. Conclusion

Experimentation of this tool has been done in four different ports of the project, allowing to estimate the possibility and the kind of energy savings.

In addition, the main feedback of this experimentation is the difficulty to have data or the difficulties to use the tool with different kind of data available in different areas of the ports.

This tool should be considered as a guide to determine which global type of energy savings is possible in a port and need further investigations. Indeed, increasing the accuracy of this tool should be approached with care because of the correlated rise of data collection that is the major barrier to a large diffusion of the tool.

The Current complexity level of the tool seems to be a rather good compromise between its ease of use and its accuracy.