Ports Energy and Carbon Savings

Output 10 D 2.1.5

Independent verification report of feasibility of an innovative medium sized wind turbine in Oostende

Project No. 2S03-009

With the financial support of

Author

NAME [USE TABLE-TITLE]	ORGANISATION [USE TABLE-TITLE]
Dimitar Bozalakov	Universiteit Gent

Revision history [This is alinea title – size 9 – bold]

REVISION	DATE	AUTHOR	ORGANISATION	DESCRIPTION
1	16.01.2019	Wim Stubbe	AGHO	[Use Table-text – size 9 – row hight is 1 cm]

Table of contents

Table of figures

Table of figures

1. Introduction

To reduce the carbon footprint of the port of Ostend, the potential of using carbon saving and renewable energy technologies is investigated. According to the Kyoto protocol, all carbon emission must be reduced by 20% by 2020. Carbon saving and renewable technologies seem very promising solution to reach these ambitious targets.

With the development of this research, ethical dilemmas like different facilities, changes of energy are possible to have some potential problems like environmental dangers and also personal benefit. For instance, installing a big wind turbine may put at risk (or in danger) bird specious, so additional measures should be taken to minimise the risk for the nature.

The goal of this report is to perform a basic examination of some possible solution so that the carbon saving is achieved in the port of Ostend. Carbon saving and renewable technologies with a high technology readiness level (TRL) are considered to conduct the feasibility studies. The outcome of these studies will be used to form business cases so that energy cost is reduced and also more effective use of the energy is achieved.

By measuring the carbon footprint of the energy consumption of the port, a carbon saving goal can be set. In the business cases, some technical, economic (including cost and benefit) and environmental challenges will be considered. Within this report, the potential of renewable energy sources such as solar, wind, wave and tidal will be briefly examined. In addition, storage elements such as chemical batteries will be also discussed. Port officers and wind turbine researchers are selected as our interview object, relevant reports are chosen for our desk research.

For port of Ostend, three business cases/pilots are investigated, concerning application of:

1. Medium-sized wind turbine with rated power of 100 kVA - D 2.1.5
2. Smart LED lights pontoon D. 2.1.6.
3. A BPS-energy pontoon - D 2.1.9

The options were selected after a pre-feasibility study and discussion with the port staff in Jan 2019. Given the very small tidal amplitude, (0,5 m), tidal energy was not considered for further investigation.

2. Energy consumption of the port

A general picture of the Port of Ostend is presented in Figure 1. The electric energy consumption of the port is to maintain its daily operation and also the companies located in the port's premises. The annual electricity consumption of the port is 1.416 GWh and the goal is to reduce this consumption with at least 20%.

Figure 1 Port of Ostend

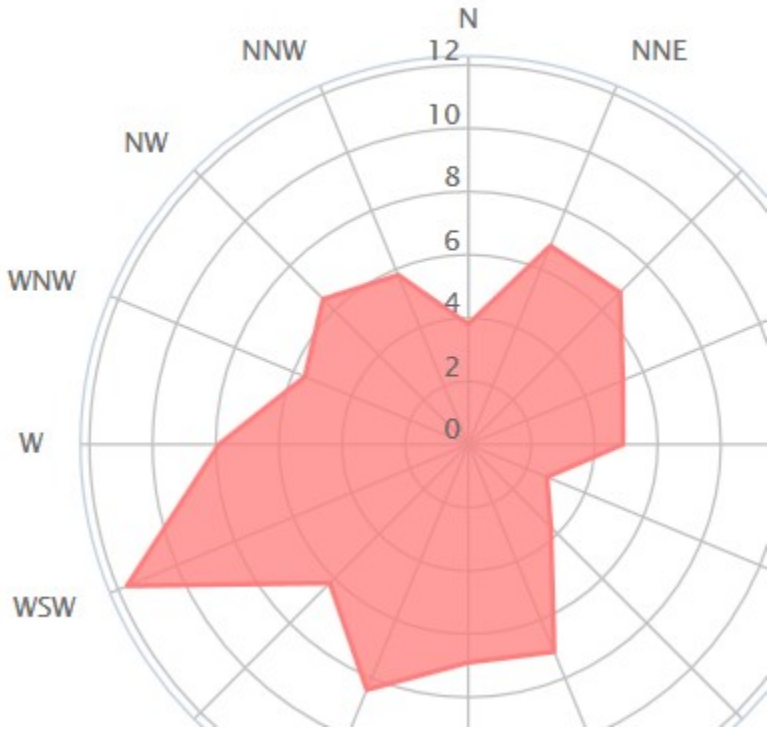

Figure 2 Wind speed and wind direction in the port of Ostend [1]

3. Wind turbine potential

Wind has an intermittent character, but wind speeds tend to be higher at night and increase significantly with the height above the surface. For Flanders, at 75 m annual averages of 5 m/s inland to about 9 m/s at the coast are attained and the wind direction can be seen in Figure 2. According to [2], large wind turbines achieve 2000 full load hours which makes them very promising solution for decreasing the carbon footprint. A wind turbine converts wind energy into electric energy. The Port of Ostend is not a leisure port and there are some industrial activities. This implies that the environmental noise can be high (but still kept within regulations) when there are

loading, unloading and other activities in the port. Since the noise level is not a critical issue, a wind turbine with a horizontal axis is selected by the port authorities for the purpose of the pilot within PECS. A wind turbine based on the "kiss" principle is chosen and it is produced by Xant.

According to the manufacturer of the wind turbine which is installed in the premises of Port of Ostend, the average wind speed is 6.2 m/s at the height of the rotor. The installed wind turbine has a power rating of 100 kVA nominal power and 150 kVA peak power. Based on the power curves of the wind turbine, the manufacturer has calculated annual energy yield of 256 MWh. Considering the fact that the total energy consumption of the Port of Ostend is 1416.1 MWh, the wind turbine will reduce the total energy consumption of the port from the distribution grid with about 18%. Given the fact that in Belgium one kWh is been produces with almost 550g of CO2, the total annual carbon emission reduction for the port of Ostend will be 141t.

4. Legal

Port of Ostend and Xant have obtained all necessary permissions for the installation of the wind turbines. Usually in Flanders, Belgium, all permits can be obtained within 4 months but ports are under the jurisdiction of the government and the required time can be considerably longer.

5. Business case

The total cost (CAPEX) of the installed wind turbine is 300 000 € and the annual maintenance cost (OPEX) is 3 200 €. This wind turbine will produce 256 000 kWh annually and taking into account the cost of the electricity which is 15 €c/kWh it will result in 38 400 € gross. Finally, when the OPEX is deduced the net profit is 35 200 €. As mention above, greenhouse emissions will be also reduced with about 141t/a. Nowadays, the reference price of CO2-emissions per ton is 20€/t which brings additional 2 820 € savings to the port. The life span of the pilot is expected to be 15 years. Considering the CAPEX and OPEX, the wind turbine will pay itself in 10 years ant it will bring profit to the port for another 5 years. In conclusion, this pilot will reduce the carbon emissions of the port with 18.08%. A summary of the business case data are listed in Table 1.

6. Conclusions

1. The wind power has a great potential to significantly reduce the carbon footprint of the ports. In this particular case, the installed wind turbine has huge impact on the carbon reduction. For the considered pilot, the greenhouse gases are decreased by 18.08%. Thus only additional 1.92% are needed to reach the goal of the total 20% reduction.
2. This business case helps the Port to reduce its carbon emission and it seems feasible from a financial perspective.

Preliminairy viability check PECS pilots **Tool: Jacob van Berkel, HZ University of Applied Scieces** **Data provided by: Wim Stubbe, Port of Oostende**	
Brief description of the system and the pilot	**Character**
Brief description of the system in which the pilot is implemented (e.g. a part of the harbour)	O&M-site Oostende Offshore Village
Where is the system boundary (e.g. the perimeter of the harbour).	Boundary lies inside the harbour, around the site
What is the PECS pilot system?	Innovative 100 kWe windturbine 
Reference electricity price [ct€/kWh]	**15**
Reference costs CO2-emission [€/tonne]	**20**
Current system performance	
What is the current annual energy consumption of the system [kWh/a]	1416100
What is the current annual CO2 emission [tonne/a]	779
Future system performance	
What is the future annual energy consumption of the system, after implementation of the pilot [kWh/a]	1160100
What is the future annual CO2 emission, after implementation [tonne/a]	638
Costs	
What are the investment CAPEX costs associated with implementation of the pilot [€]	300000
What are the annual operation costs (OPEX) associated with implementation of the pilot [€/a]	3200
Pilot lifetime	
Pilot lifetime (minimum of technical or economical) [year]	15
Annual Energy + CO2 benefit, expressed in €:	**38.016 €**
Annual costs (simple), expressed in €:	**23.200 €**
Reduction of CO2-emission of the system, after implementation of the pilot [%]	**18.08%**

TABLE 1 A SUMMARY OF THE ASSOCIATED COSTS OF THE WIND TURBINE PILOT IN THE PORT OF OSTEND

Literature:

[1] https://www.windfinder.com/windstatistics/oostende_pier

[2] Timmerman J., Deckmyn C., Vandevelde L. and Van Eetvelde G. "Low carbon business park manual : a guide for developing and managing energy efficient and low carbon businesses and business parks," 2014