Ports Energy and Carbon Savings

DELIVERABLE 1.3.2: DRAFT METHOD FOR ASSESSMENT OF THE RENEWABLE ENERGY POTENTIAL IN PORTS

Edited by:

Dr. ir. J. van Berkel

Professor at HZ-University of Applied Sciences

Research group ∆-power: Renewable Energy in delta Areas

2.1 Introduction

To what extend can renewable energy techniques -in general[1]- facilitate in the reduction of fossil fuel related energy consumption and carbon-dioxide emissions in ports? That is the underlying question of this report.
To answer this question, first the port as a system will be defined in section 2.2 of this report. As the potential of renewable energy techniques in general is strongly related to surface area, this is an important aspect of the port definition.
Section 2.3 covers a description of energy consumption and carbon emissions in ports, whereas section 2.4 deals with the potential of renewable techniques within the port perimeter.
In section 2.5 the balance will be made up, giving more insight in the potential of renewable energy techniques in ports.

2.2 Port description, size

The PECS project includes 5 ports: Portsmouth (UK), Dunkerque (FR), Oostende (BE), Hellevoetsluis (NL) and IJmond (NL). The ports can be characterised as:

1. Medium sided industrial and/or passenger ports (Portsmouth, Dunkerque, Oostende and IJmond)
2. Small size marina (Hellevoetsluis)

In general ports include the town or city, as well as the harbour.

Figure 2.1 Port of Oostende. https://www.portofoostende.be/info/maritime-access

Within PECS we exclude the residential areas and focus on the habour-area, see figure 2.2.

[1] The feasibility of the specific measures (pilots) will be addressed in a separate report, WP2 output 6.

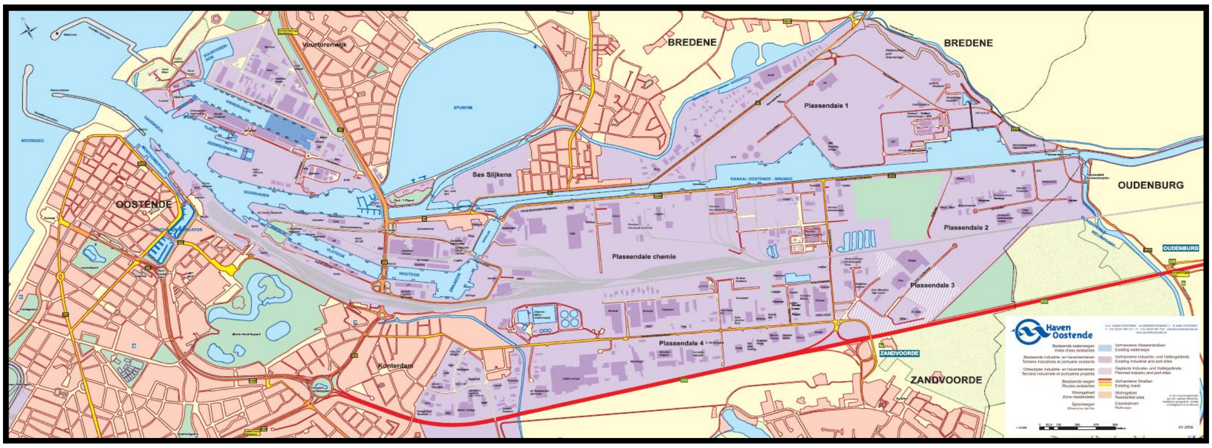

Figure 2.2 Port of Oostende. Designated in purple is the harbour area, including industrial activities, but excluding residential areas ref: http://www.vlaamsehavencommissie.be

The other end of the port-spectrum within PECS is formed by small marinas, like Hellevoetsluis.

Figure 2.3 Port of Hellevoetsluis.

The port of Hellevoetsluis houses yachts, which sail in summertime during the day and seek shelter during the summer nights and the rest of the year. No industrial activity takes place within the port boundary.
The precise boundary between the actual port (harbour) and its surroundings is not easily determined. As plan area (surface) is an important in the potential of renewable sources, table 2.1 provides an estimate on the basis of Google-Maps images:

Table 2.1 Port dimensions

Port	Water front [km]	Plan area (water and land) [km2]	
Dunkerque	9	30	(incl industrial sites)
IJmond	5	16	(incl Tata steel)
Oostende	1,5	7,5	(including industry warehouses)
Portsmouth	2	6	(excl. lake)
Hellevoetsluis	1	1	(marina only)

2.3 Port energy consumption

Due to the diverse character of Ports (ship-births, cranes, storage peers, warehouses, industry, offices) a general figure for energy consumption and carbon-dioxide emission is hard to give.
As the scope of this general section is directed towards development of a method, here general estimates are used for port energy consumption:

Table 2.2 Density of power consumption

Type	Power density [W/m2]	remark
Heavy industry	675	Ref: Tata steel: 165 PJ, 8 km2
Business park	7	Kagerweg: 23.797.000 kWh electricity, 3.085.000 m3 gas, 0,9 km2
Marina	0,07	Hellius habour, 300 MWh, 0,5 km2

The energy consumption of a specific port can be estimated if the area and type are known. The carbon emissions follow from the fuel mix that may differ per country, see table 2.3:

Table 2.3 CO_2-emission per kWh

Country	CO2 euivalent [kg CO2/kWh]
NL	0,53 (Hell), 0,59 (IJmond)
BE	0,75 (BPS), 0,55 (AGHO)
UK	1,04 (Portsmouth)
FR	0,55 (IndaChlor)

2.4 Potential of renewable energy sources

Fossil fuel consumption and related CO_2-emissions can be reduced by implementation of renewable energy, Practical options for renewable energy are:

1. Sun: thermal and/or electrical energy
2. Wind
3. Water: tidal, wave and salinity gradient (if the port is located at a river mouth)
4. Geothermal.

Table 2.4 gives power densities of some renewable energy sources:

Table 2.4 Density of power production by renewable energy techniques.

	Power density [W/m2]	Remark
Solar Thermal	70	Assuming 1000 kWh/m2.a and 60 % collector efficency
Solar PV	17	Assuming 1000 kWh/m2.a and 15 % panel efficency
Wind turbines	2- 3	ref. www.withouthotair.com
Wave energy	15	Nothsea climate 15 kW/m, port area 1 x 1 km2
Tidal energy	2	Assuming 3 m tidal range
Geothermal energy	?	?

Comparing table 2.2 (power consumption density) and table 2.4 (renewable power density) shows that industrial ports cannot be made energy self-sufficient; energy must be imported from outside the port. For less energy intensive ports (business parks and marinas) the potential of becoming energy- and carbon neutral is more promising.

2.5 Method to assess the potential of renewable energy in ports

The previous sections provide the ingredients for assessment of the potential of renewable energy to reduce fossil fuel energy consumption and related carbon-dioxide emissions.
This section gives the principles of the general calculation tool.
The method in essence is straightforward as it compares the current energy consumption (electricity, gas and heat), with the potential of renewable techniques.
The current energy consumption follows from the energy audit, for which a method is described in work package 1.
The potential of renewable energy is directly related with the area (land and water) and length of the water front. For an indication of the potential, the power density outlined in table 2.4 may be used. When a renewable technique is promising, feasibility may be elaborated in more detail at a followings stage.

2.6 Conclusions

Based on the method developed for assessment of the potential of renewable energy sources, conclusions are:

1. Ports and marinas can be characterised by their power consumption density [W/m2]. Industrial ports may show a power consumption density of several hundreds of Watts per square meter, whereas marinas may show a density of several hundredths of Watts per square meter.
2. The potential of renewable energy sources can be accessed on the basis of typical plan area (solar, wind, tidal) and shore length (wave), using typical values for power density of the individual sources.
3. By comparing the power consumption density of port with the potential power production density, a first rough indication of the feasibility of renewable energy can be determined. This method is developed and will be fitted in an Excel spreadsheet in project deliverable "1.3.3 Calculation tool to determine the potential of renewables in SMS ports".