SUSTAINABLE RENOVATION PORT OF OOSTENDE

ANALYSIS POTENTIAL

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INTRODUCTION

This report analyses the potential for renewable energy on the site of the port of Ostend. This note aims to give a summary of the main results of a first feasibility study regarding the possible use of renewable energy on this site. For this analysis we will limit ourselves to that part of the port area that preferential is assigned to companies active in the offshore wind industry.

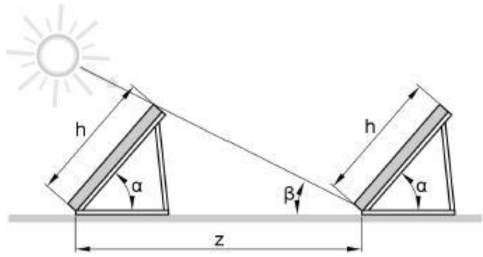
1 POTENTIAL THERMAL SOLAR ENERGY

1.1 MAIN HYPOTHESES SOLAR ENERGY

For the potential of both thermal and photovoltaic solar energy we're going to assume that all buildings have be fitted with flat roofs without light streets. In order to take account of any eaves and roof elements (fireplaces, cooling installations, etc.) we start from an available roof area of 80% of the gross roof area.

1.2 HYPOTHESES WITH CALCULATIONS

The potential of solar thermal energy is analyzed on the basis of the following hypotheses.

Parameter	Value	Interpretation
Orientation	Southwest	The mounting structure follows the orientation of the buildings against the Wharf (planned). The harbour channel southwest of these buildings also results in a minimal shading.
Slope	30°	This is the optimal slope according to the specified orientation. This slope is obtained by using special load-bearing structures on a flat roof
Shadow angle	17°	This is the angle that the length between 2 rows collectors (β in the figure below).  $\frac{z}{h} = \frac{\sin(180° - (\alpha + \beta))}{\sin\beta}$
Net result	492 kWh/m².year	This is the annual net yield of the solar collectors on the basis of the specified orientation and slope
Equivalent boiler efficiency	85%	Boiler efficiency (including distribution and system losses) of a standard gas condensation boiler
Domestic hot water consumption	9.2 liter @ 60°C	Consumption of domestic hot water (expressed @ 60 ° c) per shower turn
Natural Gas Price	0.07 €/kWh excl. vat	o.b.v. Eurostat data

1.3 FINANCIAL ANALYSIS DIFFERENT PLANT SIZES

With the following analysis, account was taken of the increased investment deduction (15.5% on the operating profit). The ecology bonus was disregarded. We can conclude that without additional funding, this technology has

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Amount of showershifts/day	20	50	100	200	500	1000
Collector surface (m²)	7.9	12.5	20	35.2	80.6	156.4
Required roof surface (m²)	25	39	63	110	252	489
Production sww (m³/day @ 60°C)	0.18	0.46	0.92	1.84	4.60	9.21
Net yield (kWh/jaar)	3,874	6,114	9,843	17,298	39,649	76,845
Natural gas savings (kWh/jaar)	4,558	7,193	11,580	20,351	46,646	90,406
Investment cost (€ excl. vat)	11,269	17,002	25,834	42,080	88,553	155,365
Yearly savings (€)	319	503	811	1,425	3,265	6,328
Increased investment deduction	594	896	1,361	2,217	4,665	8,185
Premium electricity supplier	1,575	2,484	3,750	3,750	3,750	3,750
Simple payback period (years)	28	27	26	25	25	23

1.4 MAXIMAL INSTALLATION POTENTIAL FOR THE WHOLE SITE

Op based on previous results and table below, we can say that the installation potential on the whole site is ample for the estimated number of showers per day and this for all scenarios (1).

Scenario	Roof surface (m²)	Collector surface (m²)
Current situation[1]	13,533	4,328

[1] Inclusive new buildings

Scenario 1	17,106	5,471
Scenario 2	14,276	4,566

2 POTENTIAL PHOTOVOLTAIC ENERGY (PV)

2.1 HYPOTHESES WITH TEH CALCULATIONS

The potential of photovoltaics is analyzed on the basis of the following hypotheses.

Parameter	Value	Interpretation
Orientation	southwest	Idem thermic solar energy
Slope	15°	A slope of 15 ° results in a maximum power for the available roof surface while the self-cleaning ability of the panels. This is the most common slope at non-residential projects.
Shadow angle	17°	Idem thermic solar energy
Net result	950 kWh/kWp.year	This is a typical yield per kWp installed photovoltaic power, taking into account the location and the proposed orientation and slope.
Degradation	0.8%/year	Reduction in yield of photovoltaic panels by degradation.
Power Density PV-module	150 W/m²	Hereby, we start from a standard 240 Wp module with dimensions of 1 meter to 1.6 meters.
Electricity price	See table 1	The price for electricity usually takes off with rising consumption volume. For our calculations we interpolate based on the data from table 1
Increase of prices electricity	1.75%	Fair value (excluding inflation) and only on the energy component of electricity prices
Updating Foot	4%	Fair value (excluding inflation)
Maintenance Costs	1.55%/year	Year award a maintenance contract (including replaced at defects) as a percentage of the investment cost
Ratio direct consumption/net injection	5/7	We assume that the photovoltaic system is dimensioned in such a way, that the total production is consumed directly during weekdays and the production during the weekend integral is injected.
Financing through equity	0%	We're going at 100% design example below from private funding.
Subsidies	see Table 2	We take into account the system of green power certificates (banding value from August 2013, see table below)

Table 1: Electricity price through the yearly consumption

Verbruiks-categorie	Verbruik (jaar)	Prijs 2012 excl. taksen	Prijs 2012 excl. BTW
IA	< 20 MWh	0.1656 €/kWh	0.1803 €/kWh
IB	20 MWh < x < 500 MWh	0.1321 €/kWh	0.1456 €/kWh
IC	500 MWh < x < 2,000 MWh	0.0950 €/kWh	0.1076 €/kWh
ID	2,000 MWh < x < 20,000 MWh	0.0886 €/kWh	0.1000 €/kWh
IE	20,000 MWh < x < 70,000 MWh	0.0706 €/kWh	0.0803 €/kWh
IF	70,000 MWh < x < 150,000 MWh	0.0685 €/kWh	0.0771 €/kWh

Table 2: Banding value as included in the calculations (from August 2013)

Max AC-vermogen omvormers	Bandingfactor van 1 jan tem 31 juli 2013	kWh nodig voor 1 GSC?	Bandingfactor vanaf 1 aug 2013	kWh nodig voor 1 GSC?
≤ 10 kW	0,23	1.000 kWh/0,23 = 4.348 kWh	0,28	1.000 kWh/0,28 = 3.571 kWh
> 10 en ≤ 250 kW	0,63	1.000 kWh/0,63 = 1.587 kWh	0,72	1.000 kWh/0,72 = 1.389 kWh
> 250 en ≤ 750 kW	0,49	1.000 kWh/0,49 = 2.041 kWh	0,57	1.000 kWh/0,57 = 1.754 kWh

2.2 ANALYSIS DIMENSIONING THROUGH FURTURE BUILDING

We make a quick analysis based on the plans of the future Vestas building on the site of the port of Ostend. The available roof area for this building allows a PV installation of approximately 60 kWp. The electricity consumption for this building is estimated to be 50,000 to 100,000 kWh per year (depending on the level of ambition of the building). The maximum PV power (60 kWp) connect i.e. relatively well with the own electricity consumption. Given the significant difference between the consumer price for electricity and the price that one gets for injection, however, it is important to share ' direct ' own consumption of the PV system. In addition, the cost of an asset are relatively high compared to larger 60kWp system due to some fixed costs. In other words, a clustered installation with higher power is highly recommended. Also on maximization of own consumption can give such a clustered installation benefits

2.3 FINANCIAL ANALYSIS FOR DIFFERENT POWERS

With the following analysis, account was taken of the increased investment deduction (15.5% on the operating profit) and the system of green certificates. PV installations on existing buildings have still entitled to green energy certificates (GSC). For new offices shall apply from 2014 a renewable energy obligation and GSC system falls road. For PV installations on industrial building remains, however, the system of GSC. The ecology bonus was not included.

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Installed power (kWp)	60	200	500	750
Supposed electricity consumption (MWh/year)	80	266	665	998
Price electricity (€/kWh excl. vat)	0.1774	0.1636	0.1340	0.1093
Roof surface (m²)	906	3,021	7,552	11,328
Investment cost (k€)	103	286	636	1,173
Production electricity in year 1 (MWh)	57	190	475	910
Sum of revenues and expenses in the year 1 (€)	10,198	32,976	66,898	88,377
IRR (%)	8.2	10.2	8.9	7.8
Dynamic payback period (years)	13.5	11.3	12.6	13.9

Denon-linear evolution in IRR and dynamic payback period at ascending ability is caused by the difference in banding factor between the different asset classes. The table below gives an overview of this banding factors. For the above calculations were the banding factors from 01/01/2013 to 31/07/2013 applied.

Voor installaties in dienst genomen sinds 1 januari 2013 werden volgende bandingfactoren goedgekeurd:

Max AC-vermogen omvormers	Bandingfactor van 1 jan tem 31 juli 2013	kWh nodig voor 1 GSC?	Bandingfactor vanaf 1 aug 2013	kWh nodig voor 1 GSC?
≤ 10 kW	0,23	1.000 kWh/0,23 = 4.348 kWh	0,28	1.000 kWh/0,28 = 3.571 kWh
> 10 en ≤ 250 kW	0,63	1.000 kWh/0,63 = 1.587 kWh	0,72	1.000 kWh/0,72 = 1.389 kWh
> 250 en ≤ 750 kW	0,49	1.000 kWh/0,49 = 2.041 kWh	0,57	1.000 kWh/0,57 = 1.754 kWh

Above results may vary (usually less optimistic) of the estimates and examples provided by energy companies and installers of photovoltaic panels. The most important factors that can be ' played ' are:

- the type of maintenance contract and the associated costs on an annual basis (base contract or O&M including follow-up production, cleaning, repairs, performance guarantee, etc.);
- the projected increase in electricity prices;
- investment based on 100% equity or loan capital
- the investment cost (depending on the installed capacity)

We therefore advise in quotation phase becoming a detailed (cash flow) analysis obtained from potential suppliers based on the specific situation and needs for the port of Ostend.

2.4 MAXIMAL INSTALLATION POTENTIAL FOR TEH WHOLE SITE

Based on previous results and table below we estimate that the potential installation a lot bigger than what is ideally placed for all scenarios.[2]

Scenario	Roof surface (m²)	Collector surface (m²)	Maximal power (kWp)
Current situation[3]	13,533	5,973	896
Scenario 1	17,106	7,550	1,133
Scenario 2	14,276	6,301	945

2.5 FINANCING OF A PV INSTALLATION

The financing a PV installation can be done in different ways. We make the distinction between the two basic capabilities below with their main advantages and disadvantages.

2.5.1 Own investment

The port of Ostend invests itself in a PV system. This requires a certain capital or sufficient borrowing capacity (and under good conditions) with a financial institution. The port carries a certain risk in operational terms that can be partly covered by a (comprehensive) maintenance contract. This risk translates into a relatively high efficiency, not least because of the system of green certificates.

2.5.2 Investment by third party

A third party (installation company, electricity supplier, ...) invests in the PV system. The revenue for the port of Ostend consist of a lower purchase price for electricity and any rental income from the rental of the roofs (object of negotiation). The risk for the port of Ostend is a lot lower, so also the return. The third party will collect the green certificates.

[2] Inclusive C-Power concession – surface calculation version 26/06/2013

[3] Inclusive new buildings.

3 POTENTIAL WINDENERGY

Wind turbines are divided into three categories:

- Large wind turbines: > axle height 15 meters and power 300 kW >
- Medium-sized wind turbines: > axle height 15 meters and power < 300 kW
- Small wind turbines: axle height < 15 meters and power < 300 kW

3.1 LARGE AND MEDIUM SIZED WINDTURBINES

Annex A contains 4 so-called "constraint maps" for wind energy applications in the port of Ostend and surroundings:

- Residential areas, infrastructure and landscape
- Aviation
- Natura 2000 and Ven/Ivon areas
- Risk atlas birds

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This constraint maps indicate the restrictions that apply for a wind project in this area. From the constraint aviation folder we can deduce that the port of Ostend is located entirely within by Belgocontrol excluded area. The probability of a large plant licensed in other words is extremely small. 3rd informed in the past at Belgocontrol into the possibility a XABA wind turbine (medium-sized wind turbine) in to plant in the port area. According to their response differs the impact on plants of Belgocontrol few and far between a large and medium-sized wind turbine. Talks are still ongoing; the authorization of a medium-sized wind turbine is in other words not excluded. The port of Ostend is located in the red zone of the risk atlas birds wind turbines. This means, in General, a negative opinion of the Agency for nature and forest (ANB), usually followed by the licensing authority. We can conclude that the authorization of large wind turbines in the port of Ostend is excluded. Medium-sized wind turbines, however, may be licensed. If this possibility is further investigated, we recommend – prior to any initiative – first to consult with Belgocontrol as ANB.

3.2 SMALL WINDTURBINES

For small wind turbines too (axle height 15 meters and power 300 kW < <) we recommend to contact the prior authorization with regard to both authorities. A recent report on small wind turbines States that provided aid such as the ecology premium, small wind turbines for enterprises to be profitable if they are placed on a good location and as a suitable turbine is chosen. In this case, the location definitely appropriate. Small wind turbines are, however, not on the list of exhaustive technologies. Strategic ecology support here seems not applicable because this is only valid for Ecology-investments with a minimum acceptable amount of investment of 3 million euro.

In addition, energy-saving measures or alternative renewable energy technologies (solar hot water systems, PV) often financially more interesting when one looks at the investment cost in relation to the realized energy production/energy saving. In addition, the proximity of (future) buildings result in an important share to the laminar flow pattern of the air turbulence that disrupts and thus further the effectiveness of the wind turbine. This effect is difficult to estimate without extensive measurements and detailed simulations.

4 POTENTIAL BIOMASSE

4.1 THE POSSIBILITIES

Biomasse and its use can in many different categories. There is the boiler on wood pellets, the anaerobic digestion of wood (waste), the production of electricity in a biomass power station, etc. For all of these applications, the necessary material flows can easily reach the site via the (rear) port and/or rail. In the context of this renewable energy scan we study only the use of biomass for heating of the industrial buildings. The remaining applications are much more focused on the production of renewable electricity and little building bound.

4.2 COLLECTIVE BIOMASSE BOILER FOR HEATING OF BUILDINGS

This concept is a hearth where a collective biomass boiler via a distribution system the various buildings on the site provides their heat demand.

4.2.1 Advantages and opportunity's

- This concept can both the energy demand for heating and domestic hot water cover.
- It should be invested in a combustion device only once instead of an investment for each building separately. This applies to both the boiler, the storage space for the pellets, the power system as the fireplace.
- With this concept is completed 100% of the heat demand by means of renewable energy.
- The supply of pellets is not a problem given the good accessibility of the port via water and road.
- Also existing buildings can be connected to this system, provided that the piping is extended and the system is dimensioned. The existing radiators can be maintained (provided it is in good condition).
- Currently applies a reduced VAT rate for pellets of 6%.

4.2.2 Disadvantages and risks

- The development of a heating network on the site is a large up-front investment. In addition, can also be a certain impact of the work on the company's operations at the site are expected.
- This concept offers no solution to cooling that still should be made individually for each building.
- In several European countries will in the future be used on biomass as a renewable energy source to the 2020 objectives (and thereafter). For many of these countries, however, this implies a (large) increase in net import of wood pellets. A possible scarcity will put pressure on the future price level may be. The price level and any fluctuations are difficult to predict, though the same is true also for fossil fuels.
- High temperature the circulation water is being pumped, which means that sufficient need to be insulated.

5 USE OF AMBIENT HEAT /COLD

5.1 THE POSSIBILITIES

Because of the proximity of the dock water is the use of this source of ambient heat might be the most interesting. The dock water is hereby circulated on the site by means of a distribution system. The enhancement is done by means of individual water/water heat pumps per building associated with a low-temperature delivery system.

The use of heat from the soil requires the construction of a capitation net or depth drilling spread over a relatively large area. Both options bring a large investment cost, result in a significant space and are less suitable in a fast-moving industrial infrastructure.

The use of heat from the ambient air by means of an air-to-air heat pump is a standard technology and is therefore not further discussed.

5.2 COLLECTORS WITH DOCK WATER AND INDIVIDUAL HEAT PUMPS

On the basis of a first analysis, a distribution system with dock water and individual heat pumps per building as the most interesting option put forward. Dock water is pumped from the dock and through a distribution system (primary circuit) circulated on the site. Each (new) building is equipped with a heat pump that water in a secondary circuit pumps up to the desired temperature, using the warmth of the dock water.

5.2.1 Advantages and opportunity's

- This is a ' scalable ' concept. Provided that a future-oriented design of the first parts of the piping and adjusting the circulation pumps can this concept be developed in phases with the building of any new commercial building. This allows the investment costs be spread better in time.
- Dock water on the site (on low temperature) circulated. In other words, the heat losses in the circulation net are very limited.
- The dock water can both be used as heat-and colt source. By means of reversible heat pumps can be cooled Office units.
- By the tidal effect and is the location of the port the dock water refreshed frequently reducing the risk of warming up/cooling down the source (the dock water) limited.
- The buildings are connected on this system completely electrically heated and cooled. The cost for an expansion of the existing gas network to these buildings is because of this that is avoided.
- The concurrency between energy demand for heating and/or cooling at this system and the electricity production of a photovoltaic installation typically has a positive impact on the share of own consumption (of those photovoltaic installation). This is the profitability of the total investment benefit.

5.2.2 Disadvantages and risks

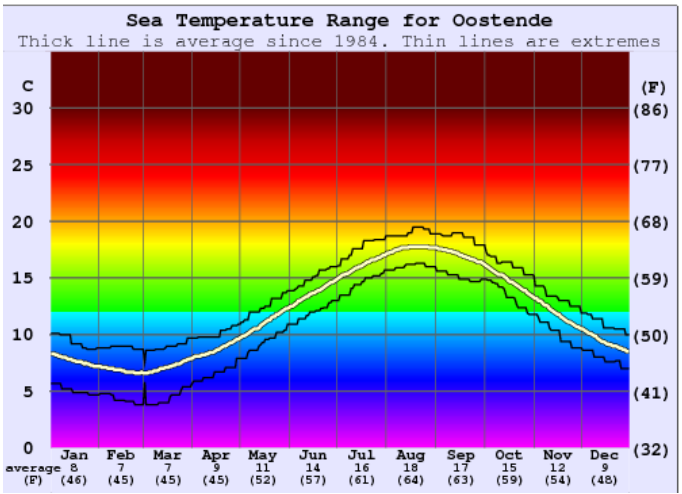
- This system requires a custom heat/cold emission system on moderate temperature. This is not a problem for new buildings. For existing buildings, however, this adaptation work that entail huge additional costs. Connecting existing buildings can only be profitable when a thorough renovation (stripping) already planned. The existing radiators are replaced by low-temperature radiators or underfloor heating.

- The high salinity of the dock water requires the use of specific plastic/stainless steel pipes.

5.2.3 Determined factors to feasibility/profitability of this concept

The feasibility of this concept hinges on the temperature profile of the dock water. If the dock water temperature too low in winter, the efficiency of the heat pump can fall so strongly that, in practice, largely by means of an electrical resistance heated. Conversely, the temperature in the dock water in summer, not too high, the heat pump would still be able to deliver the desired cooling power.

When for cooling and/or heating an extra/backup installation should be added the profitability of the system retrieves this strongly downward. The figure shows the yearly temperature profile of the seawater in Ostend. At this concept deserves further investigation to collect similar data for the dock water priority.

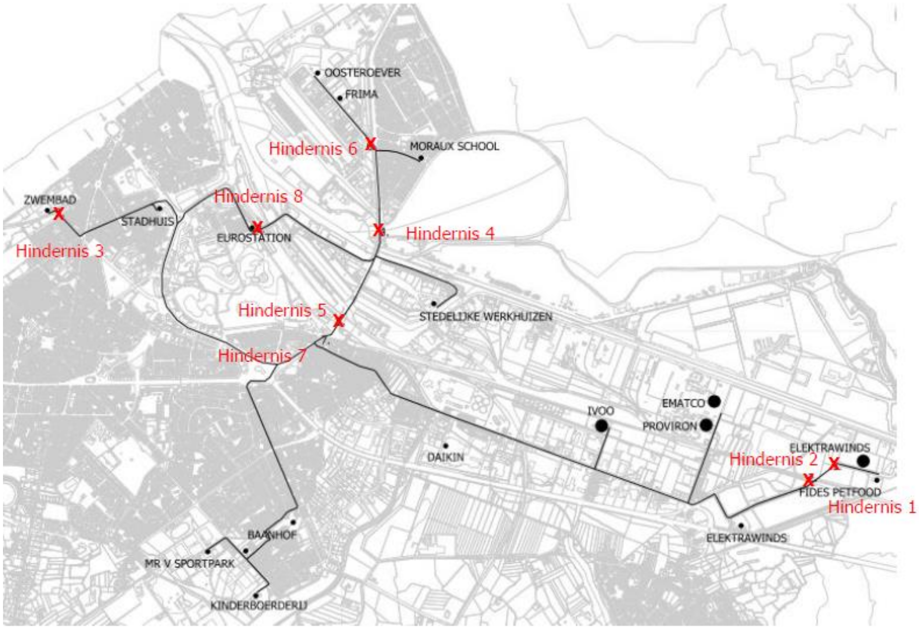


In addition, the flow rate with which one can this dock water pumping up the valorisation of heat/cold determines the feasibility and scalability of the concept.

6 POTENTIAL HEATING NETWORK

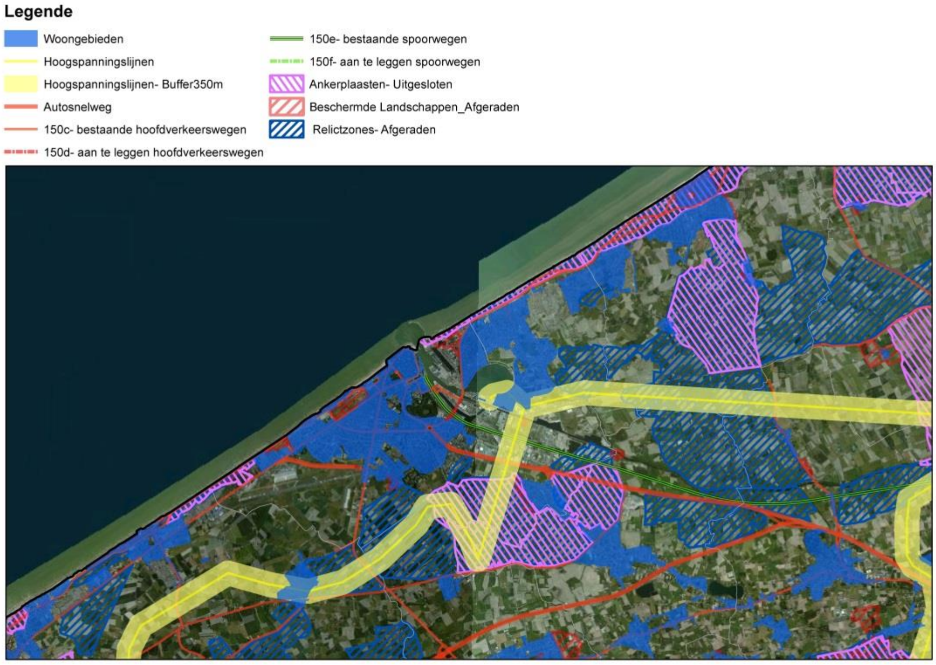
Connection to a heating network is regarded as few opportune because of following reasons:

- No need for (high-temperature) process heat
- Only limited demand to low-temperature heat for heating of the industrial buildings and/or domestic hot water production
- Relatively many obstacles between the main locations with heat surplus and the site of the port of Ostend (see figure below)
- The elaboration of a heating network in Oostende is currently still in the exploratory stage (inventory of heat producers and heat seekers). The long lead times for the development of such an infrastructure is not very compatible with the urgency for the delivery of industrial buildings with which the port of Ostend is faced.

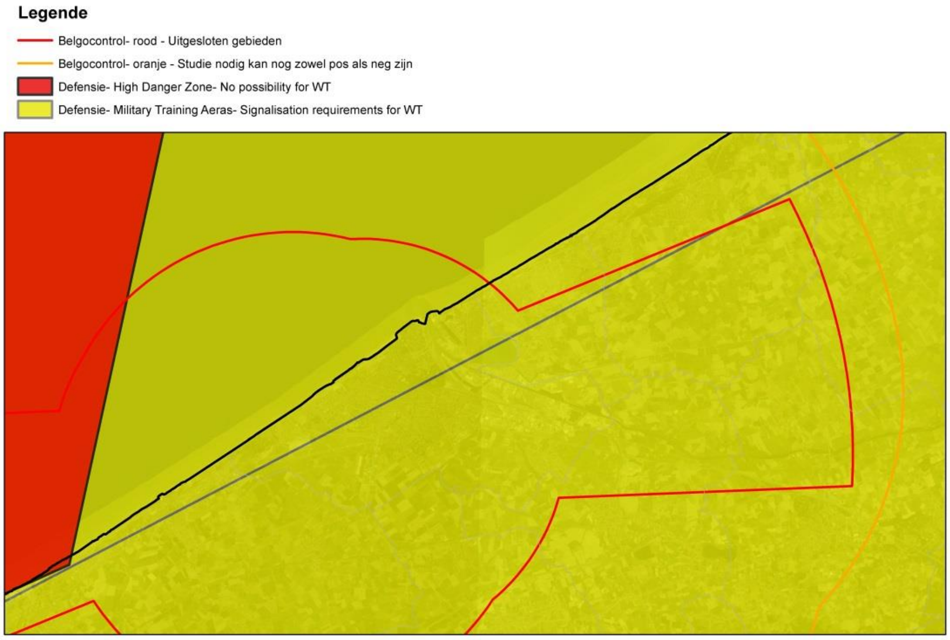


ANNEX A CONSTRAINT MAPS WINDENERGY PORT OF OOSTENDE

Constraint map residential areas, infrastructure and landscape



Constraint map aviation



Constraint map Natura2000 and Ven / Ivon areas

Constraint map Risk atlas birds-windturbines