Interreg 2 Seas Mers Zeeën PECS

Ports Energy and Carbon Savings

DELIVERABLE 2.1.1: MANUAL TO PREPARE A FEASIBILITY STUDY AND TO EXECUTE AN INDEPENDENT VERIFICATION

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9.1 Introduction

Within PECS, output 6 focuses on specific measures carries out to reduce fossil fuel related energy consumption and emission of carbon-dioxide.

Table 9.1 Pilots in PECS

	Deliverable	Description
1.	2.1.2	6 small wind turbines Hellevoetsluis
2.	2.1.3	100 solar panels Hellevoetsluis
3.	2.1.4	storage in the port of Hellevoetsluis
4.	2.1.5	Medium sized wind turbine Oostende
5.	2.1.6	LED-lights pontoon Oostende
6.	2.1.7	Local energy market software platform IJmond
7.	2.1.8	Waste Steam turbine Indachlor
8.	2.1.9	Energy production-storage pontoon BPS
9.	2.1.10	Linkspan Portsmouth

For each pilot a technical/economical feasibility study will be executed, following a common, predefined template.

9.2 Technical feasibility

Technical feasibility can be characterised by the TRL: Technology Readiness Level, range 1-9, see table 9.2

Table 9.2 Technology Readiness Levels (TRL's), from en.wikipedia.org/wiki/Technology_readiness_level

Technology readiness level	Description
1. Basic principles observed and reported	This is the lowest "level" of technology maturation. At this level, scientific research begins to be translated into applied research and development.
2. Technology concept and/or application formulated	Once basic physical principles are observed, then at the next level of maturation, practical applications of those characteristics can be 'invented' or identified. At this level, the application is still speculative: there is not experimental proof or detailed analysis to support the conjecture.
3. Analytical and experimental critical function and/or characteristic proof of concept	At this step in the maturation process, active research and development (R&D) is initiated. This must include both analytical studies to set the technology into an appropriate context and laboratory-based studies to physically validate that the analytical predictions are correct. These studies and experiments should constitute "proof-of-concept" validation of the applications/concepts formulated at TRL 2.
4. Component and/or breadboard validation in laboratory environment	Following successful "proof-of-concept" work, basic technological elements must be integrated to establish that the "pieces" will work together to achieve concept-enabling levels of performance for a component and/or breadboard. This validation must be devised to support the concept that was formulated earlier, and should also be consistent with the requirements of potential system applications. The validation is "low-fidelity" compared to the eventual system: it could be composed of ad hoc discrete components in a laboratory.
5. Component and/or breadboard validation in relevant environment	At this level, the fidelity of the component and/or breadboard being tested has to increase significantly. The basic technological elements must be integrated with reasonably realistic supporting elements so that the total applications (component-level, sub-system level, or system-level) can be tested in a 'simulated' or somewhat realistic environment.
6. System/subsystem model or prototype demonstration in a relevant environment (ground or space)	A major step in the level of fidelity of the technology demonstration follows the completion of TRL 5. At TRL 6, a representative model or prototype system or system - which would go well beyond ad hoc, 'patch-cord' or discrete component level breadboarding - would be tested in a relevant environment. At this level, if the only 'relevant environment' is the environment of space, then the model/prototype must be demonstrated in space.
7. System prototype demonstration in a space environment	TRL 7 is a significant step beyond TRL 6, requiring an actual system prototype demonstration in a space environment. The prototype should be near or at the scale of the planned operational system and the demonstration must take place in space.
8. Actual system completed and 'flight qualified' through test and demonstration	In almost all cases, this level is the end of true 'system development' for most technology elements. This might include integration of new technology into an existing system.
9. Actual system 'flight proven' through successful mission operations	In almost all cases, the end of last 'bug fixing' aspects of true 'system development'. This might include integration of new technology into an existing system. This TRL does *not* include planned product improvement of ongoing or reusable systems.

To be applied as a pilot in PECS, the TRL-level should be above 5 (as a system tested in the laboratory)

9.3 Economical feasibility

Economical feasibility indicates that over the lifetime of the system, more value is created (in terms of saving of energy, avoidance of CO2-emissions, taking costs into account) than that of the alternative (doing nothing, or using another system).

The evaluation of economic feasibility is done in an Excel spreadsheet, with input:

1. Description of the port, the reference system, boundary.
2. Model input like: reference kWh-costs, tonne CO2-costst.
3. Currents reference system performance: Fossil fuel energy consumption and CO2-emission.
4. Future reference system performance (after implementation of the pilot): remaining fossil fuel energy consumption and CO2-emission.
5. Costs associated with the pilot: investment; Capital expenditure (CAPEX) and Operational Expenditure (OPEX).
6. Lifetime of the pilot.

On the basis of these inputs, the calculation tool gives:

1. Annual benefits in terms of reduction of fossil fuel consumption and CO_2-emission.
2. Annual costs, assuming that investments costs are amortised over the (technical) life time of the system.
3. Reduction of CO2-emission for the reference system. Note that the PECS target value (20 %) is the benchmark reference.

Cash-flows are considered as true cash-flows, and not discounted in a Nett Prevent Value method. To this end it must be acknowledged that at this moment the interest rate is low (slightly positive) and the risk involved moderate as systems are tested at least in the laboratory.

As an example, table 4.2 gives an application of the calculations tool for the wind turbine pilot in the Port of Oostende.

9.4 Calculation tool (example Oostende)

As an example, the feasibility of the Xant wind turbine installed in Oostende is given in table 9.3

Table 9.3 Spreadsheet to assess the economic viability of a pilot (example Oostende)

Plakken | Klembord | Lettertype | Uitlijnin

D36 | fx

	A	B	C	D
1				
2		**Preliminairy viability check PECS pilots**		
3		**Tool: Jacob van Berkel, HZ University of Applied Scieces**		
4		**Data provided by: Wim Stubbe, Port of Oostende**		
5				
6		**Brief description of the system and the**	**Character**	**Remark**
7		Brief description of the system in which the pilot is implemented (e.g. a part of the harbour)	O&M-site Oostende Offshore Village	
8		Where is the system boundary (e.g. the perimeter of the harbour).	Boundary lies inside the harbour, around	
9		What is the PECS pilot system?	Innovative 100 kWe windturbine according to "kiss" principle 	
10		**Reference electricity price [ctl/kWh]**	**15**	**As provided by Wim**
11		**Reference costs CO2-emission**	**20**	
12				
13		**Current system performance**		
14		What is the current annual energy consumption of the system [kWh/a]	1416100	1416,1 GWh is total, divide by 5 for one zone (O&M-
15		What is the current annual CO2 emission	779	Based on 0,55 kg/kWh
16				
17		**Future system performance**		
18		What is the future annual energy consumption of the system, after implementation of the pilot [kWh/a]	1166100	
19		What is the future annual CO2 emission, after implementation [tonne/a]	641	
20				
21		**Costs**		
22		What are the investment CAPEX costs associated with implementation of the pilot [l]	350000	
23		What are the annual operation costs (OPEX) associated with implementation of the pilot [l/a]	0	
24				
25		**Pilot lifetime**		
26		Pilot lifetime (minimum of technical or economical) [year]	15	
27				
28		**Annual Energy + CO2 benefit,**	**l 40.250**	
29		**Annual costs (simple), expressed in l:**	**l 23.333**	
30				
31		**Reduction of CO2-emission of the system, after implementation of the**	**17,65%**	

9.5 Conclusions

Conclusions are:

1. Technical feasibility of a pilot system is assessed and expressed in a Technology Readiness Level (TRL), range 1-9. Systems with a TRL > 5 are considered suitable for implementation as a pilot in the PECS-project.
2. Economical feasibility is evaluated by comparing (added) value in terms of energy savings and reduction of CO_2-emissions, with costs associated. This is done in a compact and straightforward Excel-spreadsheet, with the Oostende turbine as an example.

The economical feasibility of all pilots is assessed in project deliveries 2.1.2-2.1.10.