FACT SHEET NO.: 3 / 4 **PERFORMED BY: PRO** x

A GENERAL INFORMATION

A 1	**Category**	**Infrastructure (Transport & Information/Communication)**
A 2	**Subcategory**	**EU transport infrastructure in view of energy efficiency needs and climate change challenges**
A 3	**Transport policy measure (TPM)**	**Support of "On shore Power Supply" (OPS) in ports**
A 4	**Description of TPM**	Ships generate a significant amount of air pollutants when they are travelling, but also when they are at berth in a port. When berthed, ships require power to support activities like loading / unloading, heating/cooling, lighting and other on board activities. Nowadays, this power is generally produced by auxiliary engines (mainly diesel generators on board) that produce severe amounts of carbon dioxide (CO2), air pollutants and noise nuisance [1] [7]. As an alternative to current on board power generation (mostly by diesel engines), vessels can be linked up to an onshore power supply, i.e. connected to the local electricity grid. This way, ships' operations at berth can proceed uninterrupted and negative effects can be reduced significantly. Currently, most ports are neither equipped with OPS to supply vessels with electricity from the dockside, nor are vessels equipped to receive power from OPS systems [7].
A 5	**Implementation examples**	- There are several ports already using OPS, mainly in Europe (i.a. Antwerp, Goteborg, Stockholm, Oulu, Lübeck), but also in Canada (Vancouver) and the U.S. (i.a. Los Angeles, Long Beach, Seattle). A full list is available at www.wpci.com - The "Environmental Ship Index" (ESI) is a voluntary system designed to improve the environmental performance of sea going vessels. It offers an instrument to visualize the environmental performance of ships regarding air pollutants and CO2 [3]. - "On Shore Power Supply - an integrated North Sea network" (Part of Priority Project 21). The project objective is to establish OPS at three freight ferry terminals for three kind of freight ferries (ro-ro vessels) that frequently call the terminals [5]. - In 2005 the European Commission decided to restrain sulphur levels in fuel used by ships at berth (Directive 2005/33/EC) to 0,1 % (sulphur limits of the fuels used by ships operating in European sea areas are 1.5%). This Directive should be seen as the first step in an ongoing process to reduce marine emissions [6].
A 6	**Objectives of TPM**	Main objective of OPS is to reduce the environmental impact of seagoing vessels in ports and increase well-being of workers and residents near ports.
A 7	**Key changes concerning:**	
A 7.1	- Choice of transport mode / Multimodality:	No key changes
A 7.2	- Origin and/or destination of trip:	Ports with a OPS will have an advantage compared to those who have not. Vessels and maritime transport operators which adjusted their ships to link to OPS will prefer ports with OPS, although existing transport patterns are not likely to change due to OPS.
A 7.3	- Trip frequency:	No key changes
A 7.4	- Choice of route:	No key changes , although changes in origin / destination can influence the choice of routes.
A 7.5	- Timing (day, hour):	Electricity is less expensive at night, so ships can change some activities from daytime to night. Still, travel times and most activities will not change because of working hours of harbour employees.
A 7.6	- Occupancy rate / Loading factor:	No key changes
A 7.7	- Energy efficiency / Energy usage:	Energy efficiency usage will depend on the energy source being used for OPS. Renewable energy is able to eliminate air pollutants and greenhouse gas emissions almost completely, but when energy is being used from coal power plants OPS will emissions from ports to power plants.
A 8	**Main source**	[1] [7]

B IMPACTS

B 1 OVERVIEW ON IMPACTS

		AFFECTED SEGMENTS: Passengers: Road	Rail	Air	Public transport	Slow modes	Transport operators: Road	Rail	IWW	Air	Maritime	Public transport	Employees in transport	Residents	Economy	Public bodies	Society	Geographical level: 1st level	2nd level	Source: Source of assessment	Spatial level of source
B 1.1	**Summary**																	L	N	S	I/N
		- Although the facts will point out the high implementation costs (and minor possible savings during operation) for maritime transport operators, there are already several maritime operators investing in OPS systems. Main reason for this encouragement under maritime transport operators are the environmental benefits and the improved working conditions. [7] - The fostering of shore-side electricity supply will strengthen cooperation between ports because these are encouraged to exchange best practices concerning shore-side electricity supply. [1] - The environmental impacts will largely depend on the energy source being used for OPS. Renewable sources (wind, solar, water, etc.) will decrease air pollutants significantly, but energy used from e.g. coal power plants will only re-locate air pollutants from ports to power plants. - Public bodies (when stakeholder or owner of ports) or ports will have to invest in OPS systems. These costs increase significantly when an electricity converter is needed. [10] - No traffic impact are expected as OPS clearly focuses on ships at berth.																			
B 1.2	**Summary: Income groups**	- Residents and port workers will benefit significantly from the reduced noise emissions and air pollutants. [1] [8]																			
B 1.3	**Summary: Age groups**																				
B 1.4	**Summary: Disabled people**																				
B 1.5	**Summary: Gender groups**																				
B 1.6	**Summary: Ethnic groups**																				

B 2 TRAFFIC IMPACTS

		AFFECTED SEGMENTS: Passengers: Road	Rail	Air	Public transport	Slow modes	Transport operators: Road	Rail	IWW	Air	Maritime	Public transport	Employees in transport	Residents	Economy	Public bodies	Society	Geographical level: 1st level	2nd level	Source: Source of assessment	Spatial level of source
B 2.1	Travel or transport time										➔							L		S	I
B 2.2	Risk of congestion										➔							L		S	I
B 2.3	Vehicle mileage										➔							L		S	I
B 2.4	Service and comfort										➔							L		S	I

B 2.I	**Overall impacts on social groups**	
B 2.II	**Implementation phase**	
B 2.III	**Operation phase**	
B 2.IV	**Summary / comments concerning the main impacts**	- The use of OPS focuses entirely on vessels at berth, hence not during their journey. Therefore, no traffic impacts can be expected. Even service and comfort will not change significantly as it was not indicated as an argument to use or install OPS in a questionnaire on "current status and future plans regarding Onshore Power Supply 2009" from 53 worldwide ports. Also traffic or travel time arguments are not mentioned as reasons to install OPS. [4]
B 2.V	**Quantification of impacts**	

B 3	ECONOMIC IMPACTS	AFFECTED SEGMENTS																Geographical level		Source	
		Passengers					Transport operators						Employees in transport	Residents	Economy	Public bodies	Society	1st level	2nd level	Source of assessment	Spatial level of source
		Road	Rail	Air	Public transport	Slow modes	Road	Rail	IWW	Air	Maritime	Public transport									
B 3.1	Transport costs										↗										
B 3.2	Private income / commercial turn over										↗					↗		N	I	S	I
B 3.3	Revenues in the transport sector										↘										
B 3.4	Sectoral competitiveness										↗							L	R	E	
B 3.5	Spatial competitiveness										↗							N	I	S	I
B 3.6	Housing expenditures																				
B 3.7	Insurance costs																				
B 3.8	Health service costs																				
B 3.9	Public authorities & adm. burdens on businesses															↗		L	N	E	
B 3.10	Public income (e.g.: taxes, charges)																				
B 3.11	Third countries and international relations																				

B 3.I	**Overall impacts on social groups**	
B 3.II	**Implementation phase**	- High installation costs of OPS for ports (marked by the red arrow for public bodies!), because ports are sometimes semi-public or at least owned by public shareholders (local and national governments). [1] - Member states will have to offer economic incentives to operators and ports to use shore-side electricity which will lead to higher administrative burdens and higher expenses of local and national authorities. [1] - Electricity supply in Europe generally has a frequency of 50 Hz. A ship designed for 60 Hz electricity can use 50 Hz electricity for some activities, such as domestic lighting and heating. However, it will not be able to use 50 Hz for motor driven activities such as pumps, winches and cranes. Therefore, a ship using 60 Hz electricity will require 50 Hz electricity to be converted to 60 Hz by an quayside electricity converter. The installation of a converter increases the costs during implementation phase considerably. [8] - It has been calculated that a converter will increase the installation costs with about 50 %. [10]
B 3.III	**Operation phase**	- The crucial operating costs for ships concern the costs of fuel. Calculations made on savings of fuel costs of ships show that costs for electricity will replace costs for fuel entirely (depending on ship size and fuel prices). When compared (fuel to electricity), for all ship sizes the operating costs for shore-side electricity are higher than the operating costs with diesel (0.1% Sulphur level) at low fuel prices. An increase of (diesel) fuel prices by 20 to 30% will lead to equal operating costs between shore-side electricity and diesel powered engines. As a consequence, transport costs will rise and revenues will decrease. [8] - Ports will charge ships for using OPS in order to compensate their investments (installation costs / investments), as a consequence transport costs will increase. [1]
B 3.IV	**Summary / comments concerning the main impacts**	- The annualised total OPS system costs depend on three factors: size of ships' engines, installed technology (ship age dependent (retrofitting)) and on electricity and marine fuel costs [1]. - Transport costs will increase and revenues will decline. This will be caused by higher port costs (OPS will be charged by ports in order to compensate their expenses) and in some cases electricity can be more expensive compared to diesel (depends on the three above mentioned factors). [1] [7] [8] - Spatial competitiveness will increase between ports providing and not providing ODS systems.The main reasons for ports to invest in OPS is image (I) and reputation/goodwill (II). By installing OPS, ports hope to increase their attractiveness (III) in comparison to other ports [4]. - Public bodies will have to invest in power grids to deliver the needed power to ports (in some cases power grids are already nearly overloaded). **3 level impact:** - Competitiveness between ports increases. Selected ports (those installing OPS) will become more expensive which will increase the attractitiveness of nearby ports without OPS. - Some power grids near ports will have to be extended in order to handle the additional demand for electricity. This will lead to more costs for public bodies which means that they will not be able to invest in other parts of the power grid (or in general will have to cut expenses on other measures).
B 3.V	**Quantification of impacts**	- The programme Clean Air for Europe (CAFE) examined that reducing ship emissions is increasingly cost-effective compared to further measures in other sectors. The annual monetised benefits of reducing air pollutants at 500 berths are estimated between EUR 103 and 284 million (assuming 0,1 % sulphur fuel is being used). [1] There are two types of costs for installment of OPS: quayside and shipside investments. **1. Quayside investments** have been studied for several times with results between US $ 300,000 to 4 million investment costs per berth, depending on port location, power demand, voltage and frequency and vessel type. A feasibility study for the Port of Rotterdam calculated € 4 million per berth, while at the Port of Gothenburg the figure was only a fraction of this (€ 255,000 for 2 berths), because of the already available high-voltage power supply, the lack of a need for a frequency converter and the limited power requirements of RoRo vessels. The Port of Long Beach estimated costs per berth vary significantly, depending on power requirements and berth location, ranging from US $ 1 to 4 million. Studies by the Port of Amsterdam and by the European Commission indicate that investments for cruise ships are likely to be around € 6 million per berth.[7] **2. Shipside investments** can range from US $ 300,000 to 1-2 million, depending on vessel type and size and the need for an onboard transformer. Furthermore, retrofitting will be far more expensive compared to installment in new ships. [7]

B 4	SOCIAL IMPACTS	AFFECTED SEGMENTS																Geographical level		Source	
		Passengers					Transport operators						Employees in transport	Residents	Economy	Public bodies	Society	1st level	2nd level	Source of assessment	Spatial level of source
		Road	Rail	Air	Public transport	Slow modes	Road	Rail	IWW	Air	Maritime	Public transport									
B 4.1	Health (incl. well-being)										↗		↗	↑			↗	L	N	S	I
B 4.2	Safety										↘		↘					L		S	I
B 4.3	Crime, terrorism and security																				
B 4.4	Accessibility of transport systems																				
B 4.5	Social inclusion, equality & opportunities																				
B 4.6	Standards and rights (related to job quality)																				
B 4.7	Employment and labour markets																				
B 4.8	Cultural heritage / culture																				

B 4.I	**Overall impacts on social groups**	
B 4.II	**Implementation phase**	
B 4.III	**Operation phase**	
B 4.IV	**Summary / comments concerning the main impacts**	- Despite the high costs, some shipowners already partly invested in OPS technology. These include NYK Line, Evergreen, Princess Cruise and Holland America Line, China Shipping, Evergreen, MOL, Stena Line, Wagenborg, TransAtlantic, SOL, TransLumni, ICL, and Cobelfret. Main reasons are the benefits for the environment and the improved working conditions for workers at ports and ships. [7] - Well-being of workers in ports or at ships at berth will increase because of reduced air pollutants and noise emissions. [1] [4] - Safety has to be considered when port workers have to work with high voltage cables. [9]
B 4.V	**Quantification of impacts**	

B 5	ENVIRONMENTAL IMPACTS	AFFECTED SEGMENTS																Geographical level		Source	
		Passengers					Transport operators						Employees in transport	Residents	Economy	Public bodies	Society	1st level	2nd level	Source of assessment	Spatial level of source
		Road	Rail	Air	Public transport	Slow modes	Road	Rail	IWW	Air	Maritime	Public transport									
B 5.1	Air pollutants													↓			↘	L	N	S	I
B 5.2	Noise emissions													↘				L		S	I
B 5.3	Visual quality of the landscape																				
B 5.4	Land use																				
B 5.5	Climate																↘	N		S	I
B 5.6	Renewable or non-renewable resources																↘	N		S	I

B 5.I	**Overall impacts on social groups**	
B 5.II	**Implementation phase**	
B 5.III	**Operation phase**	
B 5.IV	**Summary / comments concerning the main impacts**	- If renewable energy sources are used, OPS can nearly neutralize CO2 and other air pollutants (depends on energy source). Still, this effect will considerably depend on the energy source being used. If electricity being used is produced by coal power plants than the net effect of air pollution will be marginal. [8]. - Mainly residents near harbours will benefit from reduced air pollutants and noise emissions (Ship noise and vibration can come from several sources, including auxiliary engine exhausts, engine room, etc.). [1] [7] [8]
B 5.V	**Quantification of impacts**	Estimated reductions (per vessel) in local emissions calculated on the basis of the average EU-25 production mix are [8]: - NOx will decrease with 97% - SO2 will stay the same 0% - PM will decrease with 89% - VOC will decrease with 94%. [8] - CO2 will decrease with 13% [11]

C REFERENCES

C 1	**Other TPMs of this subcategory**	
C 2	**References**	**International** [1] European Commission (2006): Commission recommendation on te promotion of shore-side electricity for use by ships at berth in Community ports (2006/339/EC), Brussels: Official Journal of the European Union [3] World Ports Climate Initiative (2009): Environmental Ship Index - An instrument to measure a ships air emission performance. [4] Dutt, S. (2009): Results from the questionnaire on current status and future plans regarding Onshore Power Supply 2009, Port of Gothenburg: World Ports Climate Initiative [5] European Commission (2011): On Shore Power Supply - an integrated North Sea network, 2011-EU-21002-P, Part of Priority Project 21, Brussels: T-TEN Executive Agency [6] European Commission (2005): Regards the sulphur content of marine fuels, Directive 2005/33/EC, Brussels: Official Journal of the European Union [7] World Ports Climate Initiative (2012): Onshore power supply, available at www.wpci.iaphworldports.org [8] European Commission Directorate General Environment (2005): Service Contract on Ship Emissions: Assignment, Abatement and Market-based Instruments, Task 2a: Shore-Side Electricity, Entec UK Limited [9] World Ports Climate Initiative (2008): Guidance document – Onshore Power Supply, C40 World ports climate conference Rotterdam 2008 [11] Schade W. et. al. (2011): Bottom-up quantifications of selected measures to reduce GHG emissions of transport for the time horizons 2020 and 2050: Cost assessment of GHG mitigation measures of transport. Deliverable D3.1 of GHG-TransPoRD. Project cofunded by European Commission 7th RTD Programme. Fraunhofer-ISI, Karlsruhe, Germany. **National** [2] Roels, P. (2009): Onshore Power Systems (OPS) - SIHARBOR / SIPLINK, Brussels: Siemens NV, Energy Transmission and Distribution [10] Ericsson, P., Fazlagic, I. (2008): Shore-side power supply: A feasibility study and a technical solution for an on-shore electrical infrastructure to supply vessels with electricity while in port, Göteborg: Chalmers University of Technology, Department of Energy and Environment