METHODOLOGY OF IMPLEMENTING ENVIRONMENTAL LIFE-CYCLE COSTING IN SUSTAINABLE PUBLIC PROCUREMENT

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ABSTRACT

Transportation sector, including maritime transport, exerts significant environmental impact. Public procurement as a policy strategy instrument which applies to the purchase of transport means, construction of infrastructure and the provision logistic services in supplying the goods, services and executing of works must integrate environmental considerations in the contract award procedures.
The aim of this paper is to propose an environmental life-cycle costing (LCC) method that could be used to assess integral environmental impact of different marine power systems, including integrated and hybrid power systems, for the purpose of public procurement. While conventional LCC is based on four categories to be assessed e.g. investment, operation, maintenance and end-of-life disposal expenses, the environmental LCC method also takes into account the external environmental costs. This method is universally applicable and provides a fair basis for evaluating ships energy efficiency and environmental impact.
The authors advocate clean and energy-efficient maritime transport ensuring effective implementation of environmental policy objectives and targets and emphasize the role of public authorities and entities in fostering the inclusion of environmental externalities in calculation of LCC.

KEY WORDS

life-cycle costing, public procurement, marine power systems

1. INTRODUCTION

Public procurement means the purchase of goods, services and works by governments and state-owned enterprises. In 2011, on average, general government procurement spending represented 29% of total general government expenditures, or 13% of GDP (OECD 2013).
Public procurement should also be an instrument for public authorities and entities to demonstrate the ways of purchasing the products, works and services which are least harmful for natural ecosystems, the people and the climate (Luttenberger et Runko Luttenberger 2016). Transportation sector itself exerts significant environmental impact and although a number of rules and regulations have been imposed with the objective of reducing environmental impacts from ships, no systematic cradle to grave analysis has been performed for the maritime transportation sector to provide a total view on which policy development and research and development priorities can be based (DNV 1998). The concept of

environmental life cycle costing (LCC) summarizes all costs associated with the life cycle of a product that are directly covered by one or more of the actors in that life cycle (e.g. supplier, producer, user or consumer) and those involved at the end of life. Externalities that are expected to be internalized in the decision-relevant future must also be included. LCC cannot be approximated by the market price as the price reflects only costs from the cradle to the point of sale. It is an assessment method, not an economic cost-accounting method (Swarr et al. 2011). The paper analyses the concept of sustainable procurement, environmental life-cycle costing, externalities component of LCC formula developed on the basis of triple-bottom line (TBL) concept which takes into account environmental and social impacts. The paper also presents how the Energy Efficiency Design Index (EEDI) developed by the Marine Environment Protection Committee (MEPC) takes into account innovative energy efficient technologies and recognizes it as a possible measure that could be used in sustainable public procurement.

2. LIFE-CYCLE COSTING

Although life-cycle costing (LCC) is sometimes confused with life-cycle assessment (LCA), they are very different. Where LCC calculates the costs of a product throughout its life cycle (which can include giving a monetary value to environmental externalities), LCA assesses the environmental impacts, such as greenhouse gas emissions, over the life cycle (ICLEI 2014; Runko Luttenberger 2000). Therefore, LCA and LCC are two different sciences governed by considerably different considerations (IISD 2015). An environmental LCC methodology takes into account four main cost categories plus external environmental costs. The latter may originate from LCA analyses on environmental impacts, such as global warming contribution associated with emissions of different greenhouse gases. It must be pointed out that LCC can play a role in public and private procurement and may be used to measure the profitability of environmentally adapted choices (Schau et al. 2011). A relatively simple formula for calculating life-cycle cost used by US Forest Service (USDA 2015) should be extended by one more addendum, i.e. the externalities (Luttenberger et Runko Luttenberger 2016).

Externalities can be more or less established in the society as (a) those that are already paid by someone along the value chain and are not included in the market transaction, for example municipal waste disposal, health costs and increased safety features of a product beneficial for the society (e.g. pedestrian protection), job security and benefits of improved infrastructure for society, (b) those that can be monetized, are not intentionally paid, benefited, or gained by someone, and are not included in the market transaction (e.g. impacts from CO2 emissions), (c) those that can be monetized, are intentionally benefited by an actor and are not included in market transaction (e.g. free rider) and (d) those that are difficult to monetize (e.g. the aesthetic value of a species or product, or wellness) (Steen et al. 2008).

One of the possibilities of calculating externalities is the TBL framework developed by Elkington which besides financial performance incorporates social and environmental dimensions. Since in TBL approach the three separate accounts cannot easily be added up as it is difficult to measure the planet and people accounts in the same terms as profits, the challenge is therefore to devise a formula to allocate the weight to ecological and social components (Slaper and Hall 2011; Lenzen et al. 2006).

3. ENERGY EFFICIENCY DESIGN INDEX (EEDI)

At its 62nd session Marine environment protection committee (MEPC) adopted resolution MEPC.203(62) (MEPC 2011). Resolution includes amendments to the revised Annex VI of MARPOL. As stated in resolution these amendments intend to improve energy efficiency for ships through a set of technical performance standard. MEPC decided that the Annex VI was the best instrument to implement mandatory technical and operational energy efficiency measurements. So a new chapter 4 was added at the end of the Annex. Regulations presented in that chapter apply to all ships of 400 gross tonnages and above engaged in international shipping. Measures for improving energy efficiency

that were considered were divided in: technical, operational and market based. Chapter 4 includes Energy Efficiency Design Index (EEDI) as technical and Ship Energy Efficiency Management Plan (SEEMP) as operational measure. For every new ship the Attained EEDI has to be calculated and not higher than the Required EEDI which is calculated according to the EEDI reference line value and an appropriate reduction factor.
The EEDI can be used to determine the energy efficiency of a ship and compare it to the fleet of ships. The formula for the calculation of the EEDI already takes into account innovative energy efficient technologies, even though some modification to the formula might be needed in order to make it an appropriate measure for the public procurement.

4. INNOVATIVE ENERGY EFFICIENT TECHNOLOGIES

Improvements to the ship energy efficiency through innovative energy efficient technologies are divided into 3 categories, according to the Guidance on Treatment of Innovative Energy Efficiency Technologies. Category A technologies shift the power curve, so the propulsion power can be reduced, while keeping the speed constant. Optimization of the hull, the propulsor optimization, or low friction coatings are examples of technologies that would fall into this category.
Category B technologies reduce the propulsion power, while keeping the speed constant. The difference between Category A and Category B technologies is that Category B technologies can be turned off. Furthermore, these technologies can be divided into subgroups B-1, technologies which can be used at any time, and B-2, technologies which can be used at their full output only under limited conditions. The example of B-1 technology is Air lubrication system which reduces the ships drag, while wind power system (kites or sails) are an example of B-2 technology.
Category C technologies on the other hand generate electricity. These technologies can also be divided into C-1 technologies, which can be used at any time, and C-2 technologies, which can be used at their full output only under limited conditions. C-1 technologies include: waste heat recovery system, engine optimizations, improved engine controls, improved power system configuration (integrated and/or hybrid), use of alternative power supply through fuel cells and other. Photovoltaic power generation systems or wind power systems are considered C-2 technologies.

4.1. Wind power systems

Wind power can be used as a thrust to support ship propulsion system, as a B-2 technology, or to produce electric power, as a C-2 technology. Here a double benefit can be recognized in integrated power systems, because the electric power produced by the wind power system can be used both for the propulsion, as well as for other auxiliary purposes.
First of all, it has to be emphasized that the Attained EEDI is calculated at the reference speed assuming the weather is calm with no wind and no waves. So the influence this system can have on the attained EEDI is only in possible savings during the operation, but not for the design conditions. The Guidance defines the available effective power of the system depending on the reference speed, the wind propulsion system force matrix and the wind probability matrix. This calculation is very simplified. To obtain more precise results, more complex calculations are required, based on the wind probability matrix for the Adriatic Sea and the ship speed and course. The influence of the wind technologies on the EEDI calculated in this way is rather small. Since one of the main goals is to increase the production of energy from renewable sources, the calculation should be modified in order to stimulate the implementation of such technologies (Ancic et al, 2014).

4.2. Photovoltaic power generation system

A photovoltaic (PV) power generation system is a technology that can provide electric power, and is classified in as category C-2 technology. In conventional ship power systems this power can be used for auxiliary purposes only, while in integrated power systems this power can be used also for the propulsion.
The nominal maximum generated PV power P_{max} can be calculated based on the average power of 120 W/m2 and the available area on the sun deck that could be covered with PV modules. It has to be pointed out that the current methodology to

calculate the EEDI tries to take into account the entire lifetime of a ship. In this case, it means that it also takes into account night. Ships engaged in the short-sea shipping usually sail during the day meaning that the influence of the PV technologies on the reduction in the CO2 emission during summer months is much higher. Assuming that this ship operates only during the day, and consumes most of the auxiliary power on the AC, the average power available would be much higher. The irradiation in the Adriatic Sea is highest around noon, peaking around 980 W/m2, when the AC power requirements are also the highest. The average irradiation during the day is around 652 W/m2 being lowest early in the morning and late in the evening. This means that the power reduction during summer days is much higher. If the effect of the insulation which PV modules have is added, then the application of the PV power generation system is not only feasible, but reasonable.

5. CONCLUSIONS

The paper analyzed the concept of sustainable procurement, as well as environmental life-cycle costing including externalities component of LCC formula developed on the basis of TBL concept which takes into account environmental and social impacts. The paper also presented how the EEDI developed by the MEPC takes into account innovative energy efficient technologies and recognizes it as a possible measure that could be used in sustainable public procurement.

The next step would be to incorporate the EEDI into the sustainable public procurement through methodology that would encourage the increase of energy efficiency and the reduction of environmental impact.

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