

Evaluating Material Flow Cost Accounting Method for Energy Efficiency in the Forest Sector

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The European Conference on Sustainability, Energy and the Environment 2014
Official Conference Proceedings

Abstract

Resource efficiency is one of the crucial aspects in the production process of public and private sector and it affects society on the road to sustainability. Forest sector, as a sector which works for producing environmentally friendly products through sustainable forest management, is responsible for taking into account the negative environmental impacts produced in its production process, too. Their minimization is demanded so as no externalities are created to society. Several methods have been introduced for the recognition of inefficiencies in the production process which result in the creation of waste and emissions. One of these, Material Flow Cost Accounting, is evaluated in the present research for deciding if it is suitable for finding out the sources which produce the inefficiencies and externalities in the production process of forest sector. The focus is on the production of a service in the forest sector, the one of law enforcement in mountainous areas for securing the minimization of forest crime (for example illegal logging and illegal hunting). Based on the results of the research, it is discussed if it is possible to reduce the material and energy use during this activity and succeed in supplying the society with “clean” produced forest services.

Keywords: energy, environment, forestry, sustainability accounting

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Introduction

One of the crucial aspects in the production process of public and private sector is resource efficiency (Stahel, 1994). Resources can be, among others, materials and energy that are used for the production of products and services for fulfilling human needs (Jasch, 2009). The unreasonable use of these resources is responsible for many of the environmental problems worldwide and may have affected global climate. Therefore, a need was recognized worldwide to manage these resources in a sustainable way to prevent further environmental degradation (Wagner and Enzler 2006, Suh 2010).

Several scientific disciplines have been involved in proposing solutions to manage resources. Indeed, environmental management for sustaining climate is an interdisciplinary issue. One of these disciplines is environmental economics and accounting (Gray and Bebbington 2001, Schaltegger and Burritt 2000). Environmental accounting proposes methodologies for better measuring impacts of material and energy use, either in physical or in monetary units. It is believed that by having a clear picture in which sectors and products these resources are consumed, a better management can be achieved (Schaltegger et al., 2008).

Environmental accounting has evolved during the years and several sub-disciplines have emerged, such as sustainability accounting and reporting and environmental management accounting (EMA) (Jasch, 2003). Material Flow Cost Accounting (MFCA) is part of EMA and lately a lot of research is conducted for using it in the industry sector (Jasch, 2009). In this research, we evaluate if this methodology could be used by Public Forest Service in Greece for energy efficiency. Driven by our background as forest economics and forest management scientists and by our belief that sectors with an environmental mandate (Lodhia et al., 2012) should lead by example in material efficiency (Ball et al., 2009), we feel that such methodologies can have a high impact in the sector's production process.

However, as other methodologies such as Life Cycle Assessment (LCA), Life Cycle Costing (LCC), and Material Flow Accounting (MFA) have already been used for examining the impacts of wood production in the forest sector (Buonocore et al., 2014), we focus on a service that is produced by the Public Forest Service production process, the Environmental Law Enforcement. Therefore the two objectives of the research are: i) to explore if MFCA, a method arising from industry sector can assist forest managers in reducing energy use in the process of Environmental Law Enforcement, and ii) if MFCA is suitable for finding out the sources which produce the inefficiencies and externalities in the production process of this service in the Public Forest Service in Greece.

Background

Material Flow Cost Accounting

Material Flow Cost Accounting is one of the approaches for performing an Environmental Cost Accounting analysis and it is included in the more general Environmental Management Accounting framework (Burritt et al., 2002). It originates from the manufacturing sector and it has been used mainly in Germany and Japan

(Nakajima, 2006). It can also be used in the service sector (Jasch, 2009) and it has been proved that it can be a useful tool to partially augment the accountability of the nonprofit sector (Papaspyropoulos et al., 2012). It is based on the input-output analysis aspect of sustainability accounting and the principle “what goes in must come out” (Lamberton 2005, Suh 2010).

An organization should track all the material inputs and all the outputs of its production process in physical units. Material inputs are the a) raw and auxiliary materials, b) the merchandise and packaging, c) the operating materials, d) energy and e) water that enter an organization. Outputs are a) the finished goods, b) services, c) by-products, d) emissions or e) waste. Non-product output is any output which does not leave the organization as a manufactured physical product (Jasch, 2009).

Two groups of environmental costs are recognized under the MFCA framework: i) those related to the environmental protection expenditure and ii) those related to the material flow costs, that is the purchase cost of materials that become non-product output. These two groups are distinguished into six cost categories (Jasch, 2009):

- i. Materials costs of product outputs, including the purchase costs of materials that become physical products
- ii. Materials costs of non-product outputs, including the purchase costs of materials that become waste and emissions
- iii. Waste and emission control costs, including the costs for treating the non-product output, costs for restoration of environmental damages, and regulatory compliance costs
- iv. Prevention and other environmental management costs, including the costs for proactive environmental behavior
- v. Research and development costs, including costs for research in environmental issues, and
- vi. Less tangible costs, including internal and external costs related to future regulations externalities, or stakeholder relations (Jasch, 2009).

All these costs are derived from the annual expenditure accounts, refer to the same fiscal year, and under a usual cost accounting method (like activity based costing) can be assigned to cost categories, cost centers and cost carriers. These costs are afterwards distributed to the environmental domains which they affect, such as: i) air and climate, ii) wastewater, iii) waste, iv) biodiversity, and v) soil and ground (Jasch, 2009).

Public Forest Service

Public Forest Service’s main mission is the provision of forest commodities and services to society (USDA, 2007). This objective may differ among countries, among states in the same country and throughout the years (Koontz, 2007). For example, Federal Forest Service in United States has gradually changed its view about appropriate forest management from the principle of multiple-use forestry with a focus on timber production, to the provision of ecological services and recreational amenities which are now preferred compared to other commodities (Koontz, 2007). However, this is a general trend when income is increased in society and people look for other services in forests than primary produced products (Stamou, 2006). In

Greece, forestry produces low quality roundwood and mainly fuelwood, forest management is focused on timber production, but it also takes into account the principles of multiple-use forestry and sustainable production. Thus, it also produces not timber forest products, and services such as carbon sequestration, land protection, protection from erosion and floods and Environmental Law Enforcement. The latter is very significant for the protection of natural environment. Forest rangers work daily for preventing or suppressing illegal logging and illegal hunting activities, illegal clearing of forest land, waste disposal in natural environment, and generally for conserving the ecosystems. Their work, however, is energy intensive, that is it consumes big quantities of fuel for patrol. So there is an opportunity here for testing the environmental impacts produced by Environmental Law Enforcement Service and for managing this energy consumption.

Previous research

Little previous research has been conducted about the resource use in the production process of forest products and services. This research has focused mainly on timber production. This research has shown that there are significant impacts from this process and only for the logging operations of timber from plantations energy consumption may vary from 115 to 155 MJ/m³ solid under bark (Gonzalez-Garcia et al., 2009). Buonocore et al. (2014) have shown, on the other hand, that the timber and wood chip production process in a local forestry system in Italy emits less greenhouse gases than the local current capacity for carbon mitigation. Papaspyropoulos et al. (2012) have worked on the impacts of the operation of a forestry organization and found out that there are also significant positive externalities arising from the operation of such organizations which can offset the negative ones produced by their operation. What is missing in the research is to implement methodologies such as MFCA exclusively for the production process of services. A successful implementation can imply the recognition of negative environmental impacts which can be prevented and the management of energy resources in such a way that it can save money to the organization and have a positive impact on the environment.

Materials and methods

For fulfilling the objective of this research the following methods were used: we researched on the production process of the Environmental Law Enforcement in the Public Forest Service in Greece. We tested which are the inputs and outputs of the service; then we checked the annual report of the organization to see if these inputs and outputs are estimated and disclose (Ministry of the Environment, 2012). PFSG issues an annual "Activity Report" since 2003 informing stakeholders generally about its actions for forests in whole Greece and the financial resources spent or invested for these actions. The 2010 report was checked in terms of the sustainability information included. Then, Material Flow Cost Accounting theory was analyzed with the objective of finding out if and to what extent this theory could be applied to the production process of Public Forest Service in Greece and its annual report.

At a second stage an interview with open questions took place with the expert forester who is responsible for the data collection and construction of the Forest Service Activity Report. He is the only one working in this field for the last two decades with the duty to produce this report. Generally, a research interviewing experts is common

in social and economic sciences (Burritt et al., 2011), and is used when specialized information has to be obtained (Johnson and Turner, 2003). However, for such researches a minimum of 6 to 12 experts are the optimum number (Guest et al., 2006). But in this research no other expert was available. Thus, we presented the principles of MFCA to the expert forester and asked his opinion if this methodology can be implemented by the organization for managing energy consumption in the Environmental Law Enforcement activity. The questions for the interview were set by all authors, the interview was performed by the first author, and the evaluation of the answers and the conclusions were extracted by discussions among all authors.

Results and Discussion

Figure 1 presents the inputs and outputs of the production process of Environmental Law Enforcement.

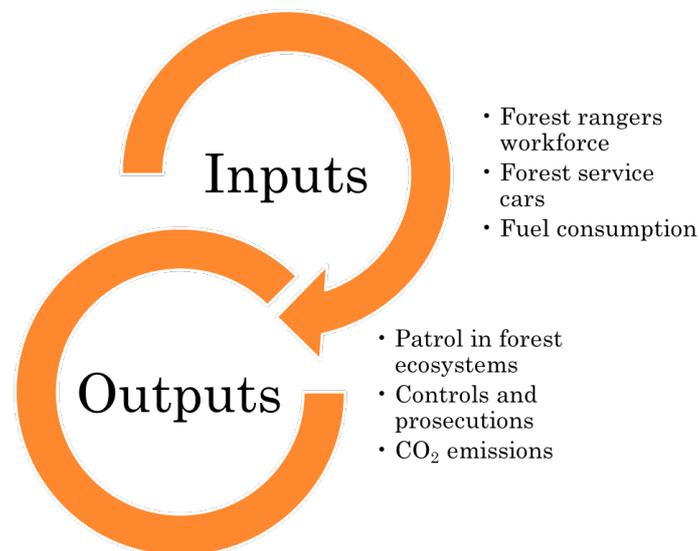


Figure 1: Production process in Environmental Law Enforcement.

The main inputs are distinguished in three categories: i) the forest rangers workforce, ii) the forest service vehicles and iii) fuel consumption. The first input is the human capital input. These people work for environmental protection, thus they are an input which can have positive impacts for the environment. However, the other two inputs are those that are responsible for the consumption of fuel and have a negative impact on the environment. The main outputs are distinguished again in three categories: i) patrol in forest ecosystems, ii) controls and prosecutions, and iii) carbon emissions. The first two outputs are those with a positive impact on the environment. These are the result of the work of the forest rangers for the prevention of illegal practices on the environment. The third one, carbon emissions, are responsible for the negative impacts on air environment and are responsible for possible future liabilities of the organization to EU environmental law. Fuel consumption, thus, affects the financial position of the organization and carbon emissions its behavior on the environment and possible future demand for offsetting the impact.

According to the MFCA theory, this output is called a non-product output. It is an output that is not part of the final product and becomes waste (emissions) disposed on the environment. Every energy input in such processes becomes waste, and especially in services production, all materials and energy are non-product outputs. So, here, energy used does not become a manufactured physical product. This is an inefficiency for the process of Environmental Law Enforcement.

Therefore, according to MFCA theory, Forest Service should collect the data of fuel consumption of all the production processes in the organization and assign the relevant quantities to this service. This will be a part of the 'materials costs of non-product output' for the Public Forest Service in Greece. Other parts for this cost category would be the wood of loggings that remains in the forest, or the wood products that fail to get sold to wood merchants. The Forest Service should find solutions for reducing the quantities of non-product outputs and decreasing the cost of production process. However, Environmental Law Enforcement efficiency should not be sacrificed. Forest Service managers could control this cost annually and make decisions for its management. They probably could find inefficiencies in energy use in some regions, for example large fuel quantities consumed and inefficient work on law enforcement. MFCA seems quite appropriate for analyzing the whole process of this service production and using it for cost reduction.

We presented the methodology and our findings to the forester who is responsible for the collection of forest statistics from all over Greece. We discussed several issues about environmental management in general and about MFCA in particular. The forester was unaware of the method. He was unaware of methodologies arising from the environmental accounting discipline. However, as presented by our above analysis, the forester agreed that energy flows are important for the operation of the organization and that the operation cost could be decreased. He stated that although he could understand the negative impacts that are produced by the production process of Environmental Law Enforcement, he had never thought that such an activity could be managed and produce cost savings and less emissions on the environment. He never had listened to the term "non-product output" and that an increase in this can have significant effects on the natural environment.

However, he believed that new staff would be needed in the Forest Service in order to apply such a methodology in the services production of the Environmental Law Enforcement. The new staff would be educated in methods like MFCA and would be ready to alter the way of operation in the organization in order to success in implementing it. For example, Forest Service does not collect the data on quantities of fuel used in the organization and, generally, there is no statistics department within the organization, something that puts burdens in applying the method. The new staff, both in terms of age, and in terms of employment, would have to change first these barriers and then set up a whole new accounting system.

Discussion and Conclusion

We explored in this research if Material Flow Cost Accounting is suitable for estimating the energy efficiency in the production process of an environmental service (law enforcement). Two ways were used for this evaluation: we corresponded the theory of the methodology to the operation of the production process of the Law

Enforcement service, and then we presented the results to the responsible forester of Public Forest Service and interviewed him about his belief of a potential use of the method in the organization. Through the first way, we found that there are non product outputs (air emissions) resulting from fuel consumption of the vehicle fleet that MFCA can identify and estimate. These energy quantities can be managed for cost reduction within the organization. We concluded that MFCA is a potentially useful method for energy efficiency in the forest sector. Through the second way, we concluded that in the current status of Public Forest Service in Greece, difficultly MFCA would be used. The expert forester doubted that with the structure of the Forest Service MFCA would be applicable. This is due to the fact that there is no relevant personnel to use it, and no one is in prior educated to similar disciplines. On the other hand, there is no statistics department in the organization and this burdens the collection of the appropriate and useful data needed in order to apply MFCA and have a clear picture for the inefficiencies of the production process and the environmental impacts that are produced.

The above conclusions show that probably guidelines which simplify the method should be created and given to the Forest Service. Future research should focus on this issue, together with focusing on a case study with real data from a local forest office for testing a real application of MFCA in Environmental Law Enforcement. This probably would make easier the adoption of the methodology in Forest Service and offer the advantages that the present research showed that can be obtained.

Acknowledgments

The first author would like to thank the IKY Fellowships of Excellence for Postgraduate Studies In Greece – Siemens Program for funding him for this research.

This paper is in memory of the third author, Professor Athanassios S. Christodoulou, who passed away during the research.

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