SOLID WASTE MANAGEMENT: SOCIAL AND ECONOMIC COSTS VS ENVIRONMENTAL COMPLIANCE

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SUMMARY

Based on the waste management hierarchy that constitutes a fundamental principle within the European Union policies, the experience of technologically advanced and environmentally aware societies has proven that recycling goals can be met in a more efficient way through a combination of separation at source programs and modern waste treatment facilities. The current granting schemes determine that the required results of such funding include the development of prerequisites for the leverage of private capitals and the attraction of investments. The selection of the applicable waste treatment method among the variety of technologies should embrace the local market characteristics and the existence of potential off-takers in the vicinity of the facilities, in order to enhance the feasibility of the investments, as well as to minimize the

environmental burden. A strategic approach should take into account a basic commitment framework that involves all levels of the administration, as well as potential synergies between private and public sectors. The social and economic benefits arising from the implementation of environmental friendly schemes can only be achieved once a thorough, integrated and mutually accepted waste management policy is in place, since such actions can be funded provided that the required conditions are met.

KEYWORDS: Waste management, waste treatment plants, waste hierarchy, environmental policy, recycling, European Union, separation at source, PPPs

1. INTRODUCTION

Waste management hierarchy constitutes a fundamental principle within the European Union (EU) policies (Broitman et al. 2012). The experience from technologically advanced and environmentally aware societies has proven that recycling goals can be met in a more efficient manner through a combination of separation at source programs and modern waste treatment facilities (Andrea 2015; Kontopoulos 2014).

The current granting schemes determine that the required results of such funding include the development of prerequisites for the leverage of private capitals and the attraction of investments (Marconsin & Rosa 2013).

The selection of the applicable waste treatment method among the variety of technologies should take into consideration local market characteristics and the existence of potential off-takers in the vicinity of the facilities, in order to enhance the feasibility of investments (Rentizelas et al. 2014), as well as to minimize environmental burdens (Andrea 2015).

The motivation of the local authorities through the implementation of local management plans is of vital importance in the framework of the improvement of waste collection and transportation (Liu et al. 2013), source separation schemes (Broitman et al. 2012), waste prevention and reuse programs (Suthar & Singh 2015). The local authorities should also ensure that the societies consent in the site selection for waste management infrastructures (Blengini et al. 2012).

In addition, it is proven that the implementation of integrated waste management infrastructures rather than single and isolated facilities is suggested as most cost efficient practice, under the influence of economies of scale (Kontopoulos 2014).

The purpose of this paper is an attempt to examine key challenges in the schemes of municipal solid waste management arising from environmental, cost efficiency and societal burdens.

2. LITERATURE REVIEW

2.1 THE NECESSITY OF WASTE MANAGEMENT FRAMEWORK

The waste management framework consists a field of complex consultation during the last years (Liu et al 2013), while the determination of a waste management policy faces particular challenges, such as population growth in large urban centers and the burden of economic crisis, being a global phenomenon, directly linked to economic factors (López-Hernández et al 2012; Benito-López et al 2011). Public administration, as being the stakeholder who is responsible for social training and environmental awareness, as well as for the implementation of the legislative framework, should aim towards the achievement of high efficiency rates in the applied services for the benefit of the citizens (Plata-Díaz et al 2014). Hence, in order to cope with the waste management challenges, the environmentally advanced countries have developed modern methods and guidelines for the implementation of best practices in waste management issues (Ezeah & Roberts 2012), so that problems associated directly with the environment, the society and the economy of each country are confronted (Rentizelas et al. 2014).

It is a fact that a number of environmental issues are linked with waste management practices, while they can be attributed to greenhouse gas emissions, intensifying the climate change phenomenon (Zhang & Huang 2014). Nevertheless, Wittmaier et al.,

(2009), claim that the reduction of greenhouse gas emissions can be achieved by using power production as part of the waste management scheme, while Habib et al., (2013) stress the necessity for energy and material recovery throughout these procedures.

Waste management constitutes a procedure that should preserve sustainability, while the efficiency of the technologies should in any case insure social acceptance, environmental protection and economic viability (Marconsin & Rosa 2013; Hanan et al 2013; Morrissey & Browne 2004).

According to Klang et al (2003), the proper and effective waste management framework should lean on social parameters so that environmental decision making procedure is sustainable. Furthermore, Ananda & Herath (2003) suggest an alternative model that involves all stakeholders in the decision making process. The multi criteria analysis for such type of decision making is a widespread method for the assessment of qualitative and quantitative data, in which all stakeholders interact, so that the proper alternative method is selected, taking into consideration an important number of criteria (Hung et al. 2007).

Rentizelas et al., (2014) estimate that the selection of the proper method is mainly based on economic factors, for the formation of a system that guarantees the lowest risk and the higher financial returns for the investors, as well as lowest cost for the local communities.

Furthermore, current guidelines of the EU regarding environmental issues, highlight the necessity for the formation of a circular economy, encouraging the development of waste recycling and prevention of the loss of valuable resources, the creation of new employment opportunities and financial growth under modern business models that emphasize on zero waste production (European Commission 2014). Hence, the trends in a European level form a new basis for analysis, dialogue and determination of a modern economic policy for waste management.

A strategic approach for a primary commitment waste management framework should involve at least policies for waste production prevention, waste recycling and reuse, waste treatment, under specific requirements for secondary products, as well as a structured legislative framework for project development and implementation.

2.2 THE SELECTION OF WASTE TREATMENT METHOD

There are a number of proven technologies within the framework of waste management sector that could be applied in order to become compatible with the relative guidelines of the EU. It is commonly understood that there is no prominent technology adaptable under all cases and circumstances (Plata-Díaz et al. 2014). In contrary, the selection of the proper technology should primarily take into consideration the local needs (Andrea

2015), the existence of complementary infrastructure, as well as end-users for recovered secondary products (Kontopoulos 2014).

In general, an integrated waste management policy consists of a variety of alternative methods, such as Mechanical Biological Treatment or Thermal Treatment. However, the efficient waste treatment as a holistic project presupposes an effective collection and transportation scheme (Karanikola & Tampakis 2008).

According to Kontopoulos (2014) the required characteristics of the selected technology can be summarized as follows:

- Concentration of minimum quantities for the implementation of new infrastructure, due to economies of scale
- Guaranteed disposal of secondary products
- Expandable
- Flexible to adapt to content variations
- Commercially proven
- Economically acceptable

In addition, it is crucial to identify potential secondary products that may be recovered from the waste mass, depending on the technology applied as well as on the local

conditions (Broitman et al. 2012). According to (Kollias 2004) these secondary products may include:

- Recyclables
- Compost (depending on the selected technology)
- Energy (depending on the selected technology)
- Secondary fuel (under the precondition of categorization)
- Residues (for all technological applications)

As a supporting tool in the direction of compliance with waste hierarchy, material recovery and recycling seems to constitute the main axis on which rests the new policy on waste management, with the target to increase efficiency of resource savings through waste recovery promotion. The combination of Separation at Source practices with complementary yet independent waste treatment facilities that promote and insure material recovery is a precondition for the successful increase of recycling rates, regardless from the development of costly source separation programs (Kontopoulos, 2014). The existence of waste treatment plants with high material recovery rates is a reliable and profitable from both environmental and economic aspects for the achievement of high recycling levels, since it is beneficial even during the development phases of source separation systems, while it is similarly useful for preselected materials

after a period of time, should such systems are sufficiently implemented (Vaccari et al. 2013).

2.3 CURRENT SITUATION IN GREECE

According to Eurostat (2014) landfilling is still the main waste management method in Greece, maintaining considerably low material recovery and even lower energy recovery rates. However, the majority of the people consider recycling as of vital importance, taking into consideration the related environmental and financial benefits despite the fact that awareness practices are considered inadequate (Karanikola et al. 2005, Tampakis et al. 2004). In addition, uncontrolled landfilling for which Greece has been convicted by the EU is associated with a number of environmental hazards (Kouimtzi et al. 1998).

The nominal capacity of the additional infrastructure, which is inevitably required in order to comply with the EU legislative waste management framework, is connected with the construction and operational costs and, in turn, with the tendering procedure. Based on information from current tendering procedures, the following table (Table 1) shows construction and operational costs for two waste treatment facilities in Greece of Mechanical Biological Treatment (MBT), under different tendering procedures, namely Public work and Public Private Partnerships (PPPs):

Table 1. Operational costs for two MBT waste treatment facilities in Greece, under Public work and PPPs tendering procedures

Capacity of MBT plant	**35.000 tpa**	**100.000 tpa**
Tendering method	Public work	PPP
Construction cost (€)	22.000.000 €	35.000.000 €
Unitary construction cost (€*ton-1*year-1)	630	350
Operational cost (€*year-1)	5.000.000	6.000.000
Unitary operational cost (€*ton-1*year-1)	140	60

It can be derived that the implementation cost through a Public-Private Partnership can be considerably lower in comparison with a typical public work, since emphasis is given on the achievement of lower operational cost.

2.4 SOCIAL ASPECTS OF WASTE MANAGEMENT

A parameter of vital importance for the assessment of construction and management cost of a waste treatment facility is the land acquisition costs, as well as its value after

the completion of such project (Liu et al 2014). The initial design that also includes site selection usually contains socially related oppositions (Zurbrügg et al. 2012), mainly due to the proven inability to operate similar facilities, the resulting negative impacts and health effects for the local population as well as land value decrease in a broader area surrounding the facilities (Rentizelas et al. 2014).

Hung et al. (2007) conclude that the main reason for conflicting interests and, in turn, stakeholders' opinions lie in the complexity in the ethic system in each one of them and propose the implementation of an innovative decision making support tool that combines multi criteria analysis with consent model analysis, that quantifies the consent rate and opinion matching among all the alternatives.

2.5 WASTE MANAGEMENT AND CIRCULAR ECONOMY

The efficiency of measures related to integrated waste management is influenced by economic and political parameters, such as management cost and the wider fiscal pressure (Plata-Díaz et al. 2014). In large urban centers with higher waste production rates, waste management is required to include an integrated procedure with advanced technologies, resulting inevitably to higher management cost (Marconsin & Rosa 2013).

In Greece, waste management cost per household is based on the surface of each residence, while the amount attributed for such policy is not clear to the citizens (Karanikola et al. 2005).

In order to organize the approach and strategy for a waste management framework, it is necessary to estimate the efficiency of each alternative, using typical cost – benefit analysis (Chang et al. 2012), with the aim to quantify sufficiently the environmental and ecological impacts associated with indirect managerial costs and benefits (Boardman et al. 2001), rather than economical and technical conditions and prerequisites used in the past (Azapagic & Clift 1999).

Public-Private Partnership (PPP) schemes constitute a recent example for the financial funding of integrated waste management projects, being a relatively modern institutional tool for a number of countries (Marconsin & Rosa 2013).

The current trends in the European Commission under the strategy Europe 2020 that is orientated towards a more efficient and sustainable holistic economic growth with the aim to maintain the added value of projects and the reduction in waste production focus on the creation of circular economy with the preservation of financial resources and reuse of end-products. Such policy presupposes the modification in all production chain stages, such as product design that will be addressed to new business and commercial models, new methods for the transformation of waste to valuable secondary resources and new consumer behavior standards (European Commission 2014).

3. CONCLUSIONS

In order to design and implement an integrated waste management scheme, it is vital to examine regional plans and prospects for the improvement of existing measures and infrastructures, the necessity for new projects on the grounds of EU hierarchy and policy for the waste management, as well as, certain challenges arising from social status quo which are closely affiliated with the adaptation of new practices.

Accordingly, a strategic approach should take into account a basic commitment framework on a national basis involving all levels of administration through a bottom-up or bottom-down system, as well as potential synergies between private and public sector. Moreover, in Greece it is of outmost importance that the legislative framework is improved towards the direction of facilitating the procedures concerning future waste treatment projects. The national policy should focus on the assurance of funding sources in order to cover the differential cost, since it is obvious that new facilities are inevitable and necessary, in the perspective of compliance with the EU legislation and the avoidance of non-compliance penalties.

In fact, social and economic benefits arising from the implementation of environmental friendly schemes can only be achieved once a thorough, integrated and mutually

accepted waste management policy is in place, since such actions can be funded provided that the required conditions are met.

Therefore, it should be clarified that the development of new infrastructures requires funds and capitals and may increase the current waste management fees which are currently based on incomplete facilities and, in some cases, illegal practices.

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