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Cross-Cultural Assessments and Stakeholder Consultancy towards Resource Waste Reduction and Climate Change Prevention

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Abstract

Concerns are growing across the board about the increasing resource demand by society and the poor way in which society has been dealing with waste and recovery of natural resources. It is clear that the time of what seemed to be abundant and cheap natural resources is coming to an end with the growing needs of a ever increasing global population combined with concerns about the security of supply of many essential materials, energy and products. At the same time, there is a rise in interest in understanding coming from different stakeholder groups in the sustainable management of natural resources and protection of the environment, linked with civil society's concerns about the continuing and growing practise of landfilling.

Concerns voiced by stakeholders and the disappointing track record of waste management decisions is now so pressing that it is inconceivable to adopt new technologies without closely involving stakeholders at each stage and each level and assess social acceptance levels. Extraction and re-use of waste sourced biomass, after initial treatment in MBT plants, as a renewable biomass fuel could provide one possible route to compliance to landfill reduction. However how can we know what the acceptance levels are to one proposed technological solution across different EU countries?

In this study different stakeholders are identified and contacted in the 3 chosen countries of Germany, UK and Greece in order to carry out a common cross-cultural assessment of acceptance levels to a boosted recycling process to recover a renewable biomass fuel, and to show what the obstacles and opportunities are to an appropriate and environmentally sound decision-making process for better governance in sustainable solid waste management. All in all, a project or proposal might be technically feasible and environmentally sound, but might not be accepted by stakeholders for a set of reasons that have nothing to do with technicalities or environmental constraints. The problem is not to identify the most efficient technical solution from an engineering or economic point of view, but instead the solution that is most appropriate and acceptable in the local context where it should be applied.

The countries studies have shown that there are similar concerns between local authority decision makers regarding MSW; however show vastly different psychological interests and concerns within the general public. This shows that there are no optimum "one-size fits all" solutions, and it is simply not easy to transpose one successfully demonstrated technology from one country to another. Any study that bases its analysis on technology choice, LCA or even advance multi-criteria analyses without socio-psychological analyses will not present an accurate picture of stakeholder acceptability. The acceptability and chances for successful implementation based on new technologies rely on a multiplicity of complex factors such as social acceptance, political climate, level of infrastructures, investment opportunities, including the state of play in the waste management systems already in place. The results obtained in the cross cultural studies have highlighted the stark differences between the countries under study, in spite of common EU legislation, and in readiness to take up new technologies, and certainly brought other important psychological issues to light.

Keywords: Stakeholder participatory actions; Municipal waste management; Recycling; Cross cultural assessments; Science for governance

Nomenclature

AEA - Annual Emission Agreement; Efw - energy from waste; AD – Anaerobic Digestion; ETS – Emission Trading Scheme; EUA - EU Allowances; EVZ - Entsorgungs- und Verwertungszentrums; GHG – Greenhouse gas; I.A.R. - Department of Processing and Recycling; NF metals – Non-ferrous metals; SRF - Solid recovered fuels; UAB - Universitat Autònoma de Barcelona; MMSW - Mixed Municipal Solid Waste; MSW - Municipal Solid Waste; MBT - Mechanical Biological Treatment; MARSS – Material Advanced Recovery Sustainable Systems; LCA - Life Cycle Assessment; EC - European Commission; EU - European Union; RDF - Refuse Derived Fuel; WtE - Waste to Energy; CHP – Combined Heat and Power; RRBF - Refuse Recovered Biomass Fuel; PIA - Participatory methods for Integrated Assessments PAR – Participatory Appraisal Research; CR – Czech Republic; UMSICHT - Fraunhofer Institute for Environmental, Safety, and Energy Technology; DEFRA – UK Department for Environment, Food and Rural Affairs; LACW – Local Authority Collected Waste; PPP – Public Private Partnerships; CLO – Compost like Output.

Introduction

Problem background

The European Union has had the effect of bunching together very different countries under common laws, which aim to protect the environment and deal with common themes such as waste, energy, and recovery of resources. This is no easy task as each national country came into the EU portraying different levels of development and having an array of different national interests. In line with having to comply with EU common laws after entry, there has been a growth in interest by stakeholders wanting to understand the significance of the "wished for" EU-wide green economy and calls for good governance in the sustainable management of natural resources and protection of the environment. These interests are also linked with civil society's concerns about the continuing and growing practise of illegal dumping of waste and legal landfilling. Therefore there is a need to understand the differences and similarities between cross-cultural stakeholder groups when confronted by an innovative technology and to engage the interested parties in participatory stakeholder consultancies. These stakeholders or interested parties can and are usually identified quite easily. Not only is it important to properly identify the stakeholders who are most concerned with the proposed implementation of a technology or policy, but also it is also important to analyze their characteristics, concerns and interests [1]. Knowing who the key actors are, their knowledge, interests, positions, alliances, and importance related to the policy or plan allows policy makers and managers to interact more effectively with key stakeholders and determine levels of support for a given policy or change. This paper assesses the importance of decision-support strategies based on participatory stakeholder consultancies when considering a possible introduction of an innovative technology to produce a renewable biomass fuel from municipal solid waste; however, this approach could equally apply to any situation where a decision must be taken when a new technology or activity is proposed.

Building consensus through stakeholder consultancy – state of the art

Standard stakeholder consultancies cannot be considered "true participation". Arnstein, for example, considered that *true participation* has to involve a high level of empowerment of the public and a direct input into the decision process, and criticized any approaches that seemed to be participative yet gave no real powers to those consulted as is the way in many typical public meetings where issues surrounding conflicts of interest are discussed [2]. Some countries, such as Germany and the UK, are leading the field in promoting public participation in policy and public decision making in different fields such as transport planning, environmental issues, and health care and is claiming the interest of academics, practitioners, regulators, and governments. In fact, public participation has gone a long way from local meetings to a lengthy legally based procedure as part of many planning processes [3]. The details of these procedures cannot be found in specific pieces of legislation, but are generally considered to be effective in building up consensus through a participatory deliberative action, usually focusing on the local community and stakeholders. This is part of the move towards a renewal of local democracy in local authorities decisions, which should reflect the wishes of the community without actually stating how this can be achieved and this process started a long time ago [4]. The aim of this paper is not however to compare the strengths and limitations of existing public participation programmes and stakeholder consultation methods per se. This has been covered by many academic papers, and is a field in itself but to name just a few, Abelson, et al. provides a useful review of their respective advantages and weaknesses [5]. Susana Aguilar Fernandez clearly laid down the basic EU principles of subsidiarity highlighting the importance of shared responsibility and partnership all linked to sustainable development [6]. Her main point is the need and value in enabling citizens and local communities to take part in environmentally related decisions and much progress has been made in the last 15 years since this publication in consultative programmes in planning processes across the EU. Rowe & Frewer support her viewpoint and also go into some detail about the necessary framework for evaluation of the effectiveness of the methods used in public participation programmes [7]. Petts evaluated the effectiveness of alternative methods of stakeholder consultancies including citizens' juries used in waste management planning [8].

Role of PIA in understanding climate change and sustainability issues

However it is the challenge of how to deal with the

most difficult and complex problems, such as climate change, that has led to the growth of Participatory methods of Integrated Assessments (PIAs). There is an incompatibility here in that climate change is measured over an extremely long time frame in terms of thousands or millions of years. The sheer long length of time is unimaginable really to all of us in real terms as we measure time based on years in our own lifetimes, or in my generation. So there is a clear difference between being concerned about the present – my health, my quality of life, the quality of life of other populations in the planet - or the future – quality of life of our children and grandchildren or perhaps people we will never meet. We are more inclined to take care of and be concerned with the present, while politicians are more inclined to promise improvements for the future. Nevertheless, politicians need to understand the concerns of their stakeholders. One could say that the current collection of unimaginable amounts of data on the Internet will soon be used to feed into participatory integrated assessments in the future.

PIA has evolved from the broad field of Integrated Assessments however with the difference that the role and level of participation of stakeholders is central to achieving understanding and results that feed into policy decisions. The motivation behind the recent broad uptake of PIA has been directly due to the increasing scope and complexity of the challenges such as climate change and waste management being researched, with the acceptance that no single discipline (based on a multi-discipline approach) was equipped to adequately address them in isolation (requiring an inter-disciplinary approach). PIA approaches seem to be used more for local regional projects where an immediate solution is required to a local complex problem such as the choice for a new solid waste management recycling plant such as MARSS.

EU aspects of waste and stakeholder consultancy.

As all waste managers know, waste in one location is not the same as in another and it constantly changes over time needing different ways of dealing with it depending on the options and finances available at local and regional levels. Waste, and its management, is not a simple issue. It is also affected by the demand for secondary materials, municipal resources, levels of development, local/national environmental concerns, personal identity, human behavior, finance, global market forces, and much more. Therefore the complexity of waste management requires an appropriate approach built up on a combination of tools that each provide added value to the understanding, evaluation and final indications of what would be the best management decisions to take in that particular location. Cross cultural assessment provide a means to achieve a deeper understanding of the inter-play of economic, environmental, technical and social aspects where each decision maker is working in a different and complex cultural and historical background. The EU has set ambitious targets to turn waste into a resource as a key part of the drive towards a circular economy. Due to the recently agreed package for circulating the EU economy, published on the 2nd December 2015, one can expect an increased interest on how or whether it is feasible to achieve the 65% common recycling targets [9]. The objectives and targets set out in a diverse number of European directives, especially the 1999 Landfill Directive [have acted as key drivers to improve solid waste management and reduce landfilling, but this legislation is seen as a burden by many EU countries [10]. Germany already fulfils the 1999 Landfill Directive and has a particular history in waste management. Other EU countries are also on the way towards fulfilment of the EU Directives (e.g. The Netherlands, Austria, Sweden, among others ;) to a different extent [11]. In the early 1990's, it was chosen to solve the problems of Municipal Solid Waste (MSW) treatment mainly via expensive high-tech incineration in Germany among others. At that time, CO_2 emissions from plastic combustion were not under direct scrutiny and climate change was not considered as an urgent issue as it is today. However, some countries like Italy still show a high level of consumer resistance to such incineration technologies.

Other European countries have only just started to decide on and set up their waste management systems and are looking for ways to comply with the Landfill Directive as fast as possible. However, the other side of the coin is the problem of how to convince the consumers and stakeholders in different EU countries to support and follow the same principles and laws laid down by the EU whatever the economic situation in their region. The wisdom of stakeholder consultation is no longer in question. As stated in the official EU Guidelines for Stakeholder Consultation *"Stakeholder consultation helps EU law making to be transparent, well-targeted and coherent. It is enshrined in the Treaties. Consultations - together with impact assessments, evaluations, fitness checks and expertise - are a key tool for transparent and informed policy-making"* [12]. It is also becoming increasingly clear that no decisions affecting the public domain, such as in waste management, can be taken without embracing a comprehensive stakeholder consultancy based on technical transparency, economic and social constraints, environmental burdens and social attitudes [13]. This paper acknowledges this standpoint and takes stakeholder consultancy a step further by carrying it out in parallel in 5 countries based on the presented technological option, namely the production of a recycled recovered biogenic fuel from municipal rubbish.

Dependence on Landfilling: The main challenges for the local and regional authorities are to set up workable and sustainable waste management strategies to reduce landfilling, based on transparent integrated sustainability assessments, in compliance with national/European waste management plans. This task is not easy. Each year, EU member states are responsible for producing over 2 billion tonnes of waste and local authorities have the responsibility to dispose of it on a daily basis. The final

waste management plan to be adopted must also fit the culture and climate of that country, and that the final compromise must at least have the support from local stakeholder groups so that planning can proceed. This is the point where local stakeholders become involved and show the most interest in the final waste management plan to see how it affects them personally. The decision about which combination and level of processing technologies, as well as the siting of these activities, is very complex and difficult. Support from the local community and main stakeholder groups is really essential if local waste management authorities' decisions are to be translated into effective action. In many cases, local authorities are faced with strong opposition, so that much time and money needs to be invested in dealing with the fears and opinions of local community groups. A combination of national and European waste policies and directives has helped to drive up recycling and recovery rates, leading to an inherent shift away from landfill dependency towards a more resource efficient environment, however it is not enough. Greece still depends highly on landfilling of MSW with a rate estimated at about 82% (2011 - Hellenic National Waste Management plan), which the UK reported just over 26% (2012 – DEFRA UK Statistics issued 15.12.2015) and Germany reported levels below 5% (Eurostat Statistics in Focus 2011). Greece has no incineration plants to deal with MSW, whereas Germany depends on incineration technologies to deal with over 66% MSW produced nation-wide. This of course has helped the sharp shift away from landfilling in Germany. These facts already highlight the clear differences between different EU countries.

Waste management as a viable business: Recent failures in achieving targets set by the EU in recycling quotas between the different EU countries have highlighted the fact that there are significant differences in the different cultures and countries even at a time where the same waste management strategies are being used. The launch of new technologies is a major change on several levels such as new business models and possible changes of consumer's habits. Professionals in solid waste companies are no longer optimistic about future operations in spite of rapid expansion. The largest multinational companies in the sector are now Veolia and Suez, followed by FCC and Remondis to name a few [14]. To show the extent of the multi-cultural operations, Violia operates in Austria, Belgium, Czech Republic, Denmark, Estonia, France, Germany, Hungary, Ireland, Italy, Norway, Poland, Switzerland, UK, and the Ukraine. As confirmed by the EPSU 2012 report, these companies are getting less business and less profit than forecasted because the industrial and commercial waste markets have shrunk across the EU. Attempts are being made to regain former profits by cutting costs including cutting their contracts with municipalities. This is an important point as many contracts can span over many years, locking in both sides with probable significant investment in additional infrastructures. So any mistakes made at the beginning can have significant impacts years down the line. This puts an extra burden on the decision makers, who need to push through fast and economically sensible decisions on which solid waste management technology to use without creating conflicts within their stakeholder groups. There is a need therefore to understand not only what has worked in other EU countries, but also what the differences are between the same stakeholder groups in culture and acceptance levels in different countries. So there is a need to understand the significance of cultural differences when the general public is faced with choices or decisions for or against a chosen waste management technology via stakeholder consultancies.

This paper acknowledges the difficulties of carrying out cross-cultural international consultancies. The authors also acknowledge that any system of communication using and involving translation of language will be an inaccurate and problematic science. This difficulty has also been acknowledged by many researchers since the notable paper many years ago written by Sechrest, et al. where he identified the problems that terms used may lack equivalents across languages, and even though equivalence of idiom and grammar could be approximated, the equivalence (or differences) in terms of experiences and cultural preferences is probably the most important factor of all [15]. Direct translation from one language to another cannot assure an equivalent verbal message.

Materials and Methods

The authors have based their stakeholder consultancy on a case study run in Naples (Italy). The approach used of participatory stakeholder consultancy generally enables and empowers the local stakeholders towards sharing and analysing their own knowledge of municipal waste management in their regions and countries and the options/solutions that are available. The authors also recognize the wealth and value of local knowledge and information within the stakeholder communities consulted in Germany, the UK and Greece, without which it would be impossible to understand the stakeholder's points of views. This methodology is in line with a move towards a people centered approach (more known as Participatory Action Research, PAR) to carry out research in communities that emphasizes participation and action by local stakeholders who are clearly and sometimes passionately involved in the research question at hand. Therefore the authors decided to emphasize collective inquiry using written questionnaires, followed by face to face interviews as well as follow-up in-depth anonymous meetings for all interested parties to attend and have the chance to air their views and opinions in a discussion format. This is based on the concept of collaborative reflection. As Chambers so succinctly said, this means that PAR is not a monolithic body of ideas and methods but rather a pluralistic orientation to knowledge-making and social change [16]. This is also very much in line with Reason & Bradbury where communities of inquiry and action evolve and address

questions and issues that are significant for those stakeholders who participate as co-researchers [17].

Tools for stakeholders consultancy

Local expert's teams (including the authors of this paper) were identified to carry out the agreed common consultancy programme. A common general country analysis methodology was set up and followed in all investigated countries. Focus points for the country studies were agreed with the local experts before work began. A country analysis was then carried out looking at the key stakeholder, with possible options for inclusion of combustion of biomass fuels within the countries existing and future infrastructures, as well as considering any new laws recently adopted before the end of 2015.

Questionnaires: Identical questionnaires were set up in the local languages, issued by local experts to the identified key stakeholder groups in their country, followed up with meetings and interviews and providing assistance in interpretation of the results. Each expert identified the main stakeholder groups that were most interested in MSW management as well as the MARSS technology. In order to get responses from non-technical stakeholders, in addition to putting the web on the MARSS web site, a range of general public members were asked to be involved including students, friends, families and academic teachers at their universities. The authors admit that this may seem an ad hoc approach, but it was important to get as many responses as possible within the short remaining time of the EU funded project. The master English questionnaire was designed to address three key areas: general information about the stakeholder identity, stakeholder knowledge, and stakeholders' perceptions and feelings about the technology under investigation. General information about stakeholders (gender, education, province of residence, age and job's position) was requested in order to establish a profile of respondents. In the general area of the survey the goal was to understand how waste management, collection and recycling are organized locally, how stakeholders are informed about the ways to separate and collect waste, to what extent were they satisfied about present waste management matters in their area/region/country. The interview guidelines and questionnaires were set up by the authors and agreed with the partners and experts who had them translated and checked before distribution in the local country language.

A first analysis and test run of this methodology had already been made of Naples as a special case study in Italy [18]. This provided good experience to then modify and optimise the second rounds of consultancies in the other countries. Stakeholder consultancies can be problematic when dealing with sensitive issues therefore experience already gained in the already carried out first Italian stakeholder consultancy about acceptance of a new technology proved to be very useful [19].

Web forms were prepared in electronic format in the different languages for easy access and collection of responses. Emphasis was put on face-to-face interviews with identified key stakeholder groups and individuals. Face to face interviews supported by on-line questionnaires were carried out by the local expert team consulting a wide range of stakeholders including the government ministries, leading coal and cement producers, students, municipal authorities, waste managers, recycling companies, power station operators, NGOs, environmental protection associations, universities, and SMEs. Meetings were also carried out with decision makers or leading associations in the target countries to get an enhanced viewpoint on some issues. Analyses of work carried out, including close attention to the interview notes, was made to ascertain the potential applicability of the new technology considering the existing market conditions in the different countries.

The innovative waste management technology investigated in the study

The MARSS technology was developed to produce a Renewable Recovered Biomass Fuel (RRBF), as an EU-wide option, in the frame of an EU Life Plus funded demonstration project starting September 2012 and ended December 2015. Project partners consist of RWTH Aachen University (acting as Coordinator), pbo GmbH (engineering design company), RegEnt GmbH (demonstrator), as well as the Universitá degli Studi di Napoli (Life Cycle Analyses) and the Universitat Autónoma de Barcelona (Socio-economic integrated analyses). This project is unique in Germany and is operated and owned by RegEnt in Mertesdorf, which houses the MARSS demonstration plant. The plant processes about 225,000 tonnes of residual Mixed Municipal Solid Waste (MMSW) produced by 532,000 inhabitants each year. The main technical aim of the project is to demonstrate effective recovery of organic fractions from mixed MSW and produce RRBF. The MARSS plant has a throughput of 10tons per hour producing an RRBF with a biomass purity of about 97% designated for the production of heat and power in Combined Heat and Power plants using fluidised bed combustion technologies [20]. Testing of the produced biomass fuel in a combustor was carried out by UMSICHT – Fraunhofer Institute in Oberhausen, Germany and results are publicised for public scrutiny on the official project web site and are available from UMSICHT. The MARSS modules are designed as an add-on system to existing MBT plants.

Research on the acceptability and environmental impacts of the MARSS process was carried out by the team at the University of Naples Parthenope using integrated assessments including LCA, socio-economic assessments, and stakeholder consultancies in Naples were carried out on the acceptability and impacts of the MARSS process [21]. Their results from the LCA indicated that the MARSS process performed well. However none of the proposed alternatives for MMSW management provides

optimal and final solutions within all the investigated impact categories, although some performed much better than others. Scenarios including conversion of waste into electricity and heat suggest minor impacts on climate change and human toxicity but larger loads on resource depletion due to increased fraction of materials for plants. There was a mitigation of the impacts found due to the environmental benefits from savings in virgin resources (fossil energy and raw material). In fact, within a consequential approach, scenarios capable to recover materials, such as metals, and energy definitely show improvements proportional to the amounts and quality of recovered flows [22].

The investigated systems

Waste Management in Germany – A reference case study.

Germany already fulfills the Landfill Directive and is considered one of the most advanced countries in solid waste management. A large increase in waste volume in the 1980s, and detectable environmental damages caused from the storage of not pre-treated urban wastes, as well as polluted leachate and the greenhouse methane gas emissions, led for search of better disposal concepts. Waste experts recognised the need for pre-treatment of the waste prior to the storage in landfills besides the requirement for a more intensified waste recovery [23]. The considerable drop in amounts of landfilled municipal waste in Germany compared to Greece and the UK was primarily due to the untreated municipal waste landfill ban that entered into force on 30 June 2005.

Use of MBT technology in Germany: TGermany pretreats a total of around 25 % of urban waste using MBT technology (MBT = Mechanica2l-Biological Waste Treatment). This technology is based on a material stream specific waste treatment. It means that the material properties of residual wastes - which are varying to a large extent - determine the selection, order and specification of treatment steps. In 1993 the Federal Council of Germany stipulated in the Technical Instructions for Urban Waste (TASi) the pre-treatment for biologically degradable wastes with waste incineration as the only accepted alternative option. The TASi granted the public waste disposal authorities a transitional period of 12 years to reorganise and restructure their plants. The political stipulation on waste incineration plants as the only technology was among experts at that time contradictorily discussed and often couldn't be realised and get a majority in the municipalities. Public opinion showed resistance against waste incineration plants because of expectations of air pollutions (e.g. dioxins, heavy metals). A great many planning projects for waste incineration plants failed and countrywide planning of projects and the search for sites were withdrawn. In the early 90s, a large number of landfill sites were built due to the pressure by the Federal states on the competent local authorities to fulfil their tasks to deal with waste fast, safe and efficiently. The 1996 Closed Loop and Waste Management Act ("KrW-/AbfG") underlined the new moves towards closed loop waste management and producer responsibilities and this was compounded by intense political discussions about which method was more suitable for pre-treatment and final disposal of waste with a look at some new technologies (including Thermoselect etc), some of which later proved not to be as useful or workable as they were claimed to be. This led to a greater interest in one emerging technology known as MBT, where waste is generally source separated, then selected recyclables and other fractions sorted out, where the biodegradable residues are stabilized or biologically treated using either a composting or anaerobic digestion system. Figure 1 below shows the geographical location of the 48 MBT plants in Germany, which shows a concentration in the North, centre and East, with only 2 plants in the South. The selected out high calorific components, such as plastics and mixed origin carbon fractions including organic materials, are called Refuse Derived Fuels (RDF) amount to about 3 million t/y and are sent to energy from waste combustion plants. Some MBT plants treat the biogenic fractions using anaerobic digestion producing a gas, which in turn is used in Combined Heat and Power plants to make heat and energy; but without any feed-in tariffs or financial benefits from the German Renewable Energy Act (EEG). The inert residues are then stored in landfills.

Figure 1: Geographical location of the 48 MBT plants in Germany

Waste Management in the United Kingdom: Waste Management is the individual responsibility of the four constituent countries, which make up the UK (by population size these are England, Scotland, Wales and Northern Ireland). This situation arises as a result of political devolution; however as a Member State of the European Union the reporting of waste management occurs at the national scale, thus requiring similar

reporting from the constituent parts. The future effects of the UK leaving the EU are not known at this point. Prior to the turn of the century the vast majority of waste produced in the UK had been landfilled, at a minimal (financial) cost due to low landfill gate fees, and recycling was in its relative infancy. For example, only 7% of household waste was recycled in England in 1997/8. Since that time the rate of recycling of household waste has risen rapidly to 36.3% in 2007/08 and to over 40% on the most recent figures [24]. This has been driven by a combination of regulatory, policy and financial measures such as recycling targets, landfill tax, and targeted financial support. From lagging well behind, the UK has now reached a comparable level of performance with many countries in the EU. However, residual waste fractions still remain significant and require the application of wider systemic thinking in order to deliver the optimum application of the waste hierarchy.

Use of MBT in the UK: Mechanical Biological Treatment (MBT) technologies and plants are increasingly viewed as a significant alternative for treating residual Local Authority Collected Waste (LACW) , particularly in mainland Europe [25]. Such treatment plants integrate mechanical processing, such as size reduction and air processing, as well as bio drying (biological drying) in combination with bioconversion reactors, such as composting or anaerobic digestion [26]. Outputs (dried organic fractions with high calorific values) from such bio drying operations are typically defined as Secondary Recovered Fuels (SRF) [27]. However, given the types and quality of outputs, cost of technologies and the tier of the waste hierarchy (primarily recovery – with energy from waste) addressed, the policy focus for organic wastes in the United Kingdom has been on capturing increasingly large percentages of the organic fraction of LACW and dealing with these primarily via composting and Anaerobic Digestion (AD). Indeed, the governments within the UK have actively been promoting AD as the technology of choice for Food Waste (FW), typified with the introduction in 2011 of an 'Anaerobic Digestion Strategy for England' [28]. MBT plants are commonly used as a pre-treatment to dry waste and produce a material that is suitable for treatment in another process such as gasification or pyrolysis. Typical land take in the UK per MBT plant is between 1 and 4 hectares, which is a considerable area in the context of the limited available land in locations where the treatment could be utilised. Typically, the technology has been utilised in conjunction with other treatment and recovery technologies (e.g. with MRFs and AD plants prior to EfW). The cost range of the technology is high compared with other technologies at around £15-20m per facility [29]. Based on the 2010 Waste Infrastructure Report, the Environment Agency reported 19 permitted MBT facilities in England with a total permitted annual capacity of 2.73 Mt, with plants ranging in the capacity of 50,000 to 305,000tpa [30]. However, this permitted capacity is a theoretical maximum with the real throughput to such facilities likely to be between 10-20% of this total.

Market conditions within the UK:

The global economic downturn and ensuing constraints on Local Authority budgets has contributed to a situation where residual LACW is increasingly being exported to Europe as public sector contracts have shifted towards private sector delivery. Increasingly expensive gate fees, transportation costs, and other costs making export to European facilities (particularly in The Netherlands, Germany and Estonia) an attractive medium-term solution in the transition towards greater sustainability in the UK waste system(s) have largely driven this.

However, the debate around this transition has for a number of years looked towards bringing on-stream UK based capacity (particularly EfW). Indeed, the development pipeline for EfW (Figure 2) is increasing capacity significantly as commissioned projects become operational [31].

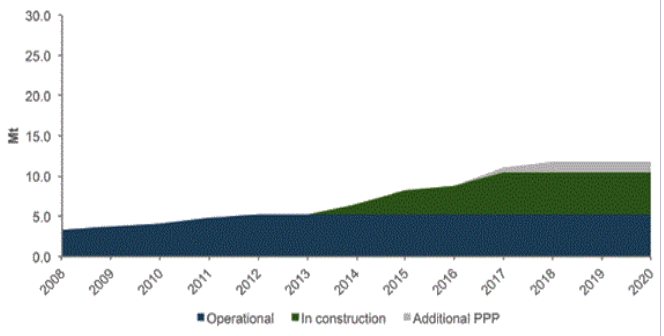

Figure 2: Projected Energy from Waste capacity in the UK (including PPP) (Source: GIB, 2014 [31])

Outlook UK: British Refused Derived Fuel (RDF) and Solid Recovered Fuels (SRF) contain a very high proportion of organic materials (because of the calorific values associated with many of these waste materials). Consequently, they are typically combusted in power stations, kilns and converted industrial boilers and power plants as a substitute for or supplement to conventional fossil fuels, such as coal or petroleum coke, thus contributing to carbon reduction targets from the energy portfolio [32]. Indeed, one of the key players in the UK waste market (as well as wider European market) has recently indicated that the loss to the energy generation mix for the UK of continued RDF/SRF export market development could peak at 2.8 million Megawatt hours by 2018 [32]. This situation has been causing increased levels of concern within the UK, both from materials and energy perspectives in light of developments around circular economy [33]. In particular, the lower quality recycling outputs associated with MBT, when compared with those of other waste treatment technologies; and the growing emphasis on value linked to optimising quality from treatment operations; reduces the likelihood of RDF/SRF becoming a long-

term option within the UK sustainable waste management matrix. The MARSS technological innovation, with its emphasis on creating a more efficient biomass based fuel as well as extracting greater quantities of valuable waste fractions, may provide a more attractive option for LA's and private merchant facility operators to increase the flow of residual wastes towards pre-treatment. However, the low level of uptake within the UK in spite of the technological developments around MBT in general would indicate only limited scope/opportunity for applying the MARSS approach. The scale of organic fraction, which remains within the residual waste stream in the UK, would indicate there is potential for applying a technological innovation such as MARSS.

Greece country study and stakeholder consultancy

Current situation on Municipal Solid Waste Management in Greece: In Greece, Municipal Solid Waste (MSW) management includes the actions of collection, transportation and disposal. The legal framework that designates the direction of waste management in Greece follows closely the development of European waste management and the corresponding Directives. Over the last decade all relevant EU Directives have been transposed to Greek laws, with the most recent case being e transposition of the Waste Framework Directive, in the Law 4042/2012 of 2012 [34,35]. According to the updated Greek National Solid Waste Management Plan (2015) MSW source-separation practices are promoted, especially for biowaste. The main objectives of the plan are to increase the MSW recycling rates and to restrict landfilling of biodegradable organic waste including biowaste which constitutes a significant part of total MSW produced mainly due to the dietary habits in the country (around 40% w/w of MSW) [36]. The MSW production in Greece during 2001 was around 4.5 million tons, while in 2011 the annual production increased to 5.6 tons. In 2020 it is estimated to reach 5.8 million tons. Collection and transportation network of MSW covers 100% of the country; however, the vast majority of MSW is collected as a total fraction (mixed MSW). As of 2011, the recycling rate is approximately 15% of the total MSW production, when at the same time the amount of organic fraction is mainly recovered through mixed composting is about 3% of total MSW production. The remaining 82% is being landfilled in controlled (77%) or uncontrolled sites (5%). The Hellenic Recycling Agency (HRA) is responsible for the design and implementation of recycling policy in Greece under Law 2939/2001 including the approval of national alternative waste management systems and the progress monitoring of recycling. The recycling process in Greece contains the packaging recycling which includes mixed packaging recyclable materials (plastic, metal, glass packaging) collected through the network of "blue bins" and treated at MRFs. In Greece 28 MRFs are currently in operations covering approximately 76.2% of the Greek population; however the recycling process recovers only 4.14% of the MSW; whereas an additional 0.14% of packaging recovery is achieved in 4 MBT plants (Ano Liosia, Chania, Heraklion and Kefallonia). The remaining recycling of 10.72% refers to industrial recyclables that resemble to MSW (i.e. printed paper, packaging). The recovery of MSW organic fraction is mainly performed at 3 MBT plants at Ano Liosia, Chania and Kefallonia and is subjected to composting in channels after mechanical separation of mixed MSW. Organic material recovery is also performed in the 4th MBT plant in Heraklion (Crete), where a bio-drying unit is installed and used for the production of Solid Recovered Fuel (SRF), the majority of which is currently being landfilled [36].

Waste management contracts in Greece – current situation: In Greece, the collection and transportation of MSW are mainly performed by the cleaning services of the municipalities. In rare occasions private companies are assigned to collect and transport MSW. A significant part of MSW management authorities, have assigned the collection and transportation of solid waste as well as their management to inter-municipal companies where more municipalities are participating in the scheme. However, no particular policy is followed concerning the type and duration of the contracts with the private companies/enterprises. Preparatory private interviews were carried out with selected stakeholders, in order to have a clear and complete perspective on the contracts already signed for the treatment of MSW. Information from Attica region, Crete (Chania & Heraklion) and Kefallinia were obtained and analyzed. The waste management authority in Attica Region (ESDNA) has entered into a contract with private companies from 31/12/2013 for the management of the MBT plant and the Sanitary Landfill at Ano Liosia. The total duration of the contract is three (3) years [37]. Kefallonia and Ithaca islands, have assigned the overall MSW management to a private company under a contract with no specified duration [38].

According to the statement of the interviewed persons at the region of Heraklion, the contract will have duration of up to two or three years, in order to follow and implement the changes of the Regional MSW Plan [39,40]. Biodegradable fractions account for about 40% as well as the recyclables (paper, plastic and metal) which amount about 54% of the total MSW and finally the remaining 6% represents other materials.

Outlook Greece: The perspectives of biomass in Greece are very favorable, as there is significant potential, much of which is directly available and in many cases, cost-competitive compared to conventional energy sources. In recent time, the economic recession in Greece, has forced many industries to use low cost biomass fuels (e.g. olive husk, peach kernel and other types of biomass fuel) as alternative to fossil fuels aiming to reduce the total energy costs [41,42]. A recent census has been estimated that all readily available biomass in Greece consists of approximately 7.5 million tons of agricultural crop residues (cereal, maize, cotton,

tobacco, sunflower, canes etc.) and by 2,700,000 tons of forest logging residues (branches bark, etc.). However, the demand of biomass fuel in Greece is difficult to quantify due to the lack of representative data. The exploitation of MSW biomass in Greece is relatively low and related to the current partial use of RDF/SRF produced in the existing MBT facilities for energy recovery purposes in a limited number of industries. It should be stressed that currently in Greece there aren't any thermal treatment units installed for the energy recovery of MSW biomass fuel. Additionally, the relevant policy framework as specified in the new National Solid Waste Management Plan states that thermal energy recovery of secondary solid fuels such as combustion, gasification, pyrolysis, gasification, etc. are considered as high environmental impact methods and on the basis of the precautionary principle processes they are considered as unsuitable for the treatment of MSW. The main reason is related to the fact that the production and energy recovery of RDF / SRF at dedicated thermal plants removes materials from other potential recycling routes.

Results

Due to the large amount of information about the research carried out in larger country studies and stakeholder reactions, as well as to the fact that some results have already been published, this paper will concentrate only on the results from stakeholder consultancies undertaken in the UK and Greece. The following table shows the response rate to questionnaires issued in the different country studies.

A large number of questionnaires were sent out with varying degrees of success as seen in the summary (Table 1) below.

Table 1: Response rates to the questionnaires issued in the country studies

	UK case study data	Greek case study data	Czech Republic case study	Germany
Total Nr questionnaires sent out	404	234	450	48
Nr sent to general public	>100	200	320	0-available on web site
Response rate from public	23%	91%	95%	15
Nr sent to LAs	183	4	145	48
Response rate from LAs	8.10%	75%	68%	1
Nr sent to specialised waste companies	121	7	58	48
Response rate from SWCs	17.5%	57%	38%	
Informal interviews with specialise waste companies (face to face and telephone)	>8	>25	>20	1(with ASA – member organisation of MBT operators) 1 (with ART regional authority)

UK Country study Stakeholder consultancy

Issues encountered: The main issue highlighted during the questionnaire and interview stages related to the meaning of the new MARSS technology and what this offered in terms of delivering the requirements of the waste hierarchy. This was overcome with explanations from the researchers and referral of participants to the project documentation at the MARSS website. A lesser issue related to the need for such an approach within the UK given the policy focus on AD. This was raised by participants with more detailed knowledge of the waste systems within the UK and was not picked out as an issue with participants from the general public. Given the nature of some of the questions (e.g. asking about the financial weaknesses and capacities of organisations represented) a number of questionnaires were returned with certain questions omitted/unanswered. These were followed up in some cases and there was an unwillingness to provide this information in conjunction with identifier information (e.g. organisation name). This was overcome by allocating each of the respondents an identifier according to the types of organisation (e.g. Waste Disposal Authority – WDA).

Stakeholders' profiles and participation: The questionnaire was designed to capture the viewpoints of two distinct groups of stakeholders: those from Local Authorities (in the UK context this represented waste planning officers from District, County and Unitary Authority levels within Local Government with statutory responsibility for waste planning in their areas) and the loosely termed 'cross-cultural stakeholders' (essentially comprising those with specialist knowledge of the waste industry; including trade associations; and groups impacted in their daily lives, such as the general public). In order to achieve high quality and representative set of results, a number of personal interviews were carried out with interested parties looking at the current LACW management systems and the possible acceptability of MARSS technology within the UK. In total, questionnaires were sent to over 260 stakeholders as well as a further 100 to members of the general public from a representative sample covering genders and age ranges. Deeper investigation within the studied countries showed that the relevant stakeholder groups consulted

Table 2: Stakeholder evaluation of statements – psychological factors, (UK)

Statement	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree
Sorting waste and recycling make me feel a better person	2.33%	11.63%	16.28%	30.23%	39.53%
I care what my neighbours think about me and how I deal with my rubbish.	23.26%	11.63%	9.30%	32.56%	23.26%
I would be proud of my community if we all dealt with rubbish in a more environmental way.	6.98%	18.60%	34.88%	18.60%	20.93%
I want to give my children and good example so I try to recycle as best as possible.	13.95%	11.63%	23.26%	30.23%	20.93%
I think that I should get some benefit (money back) for my recycling activities.	13.95%	11.63%	20.93%	32.56%	20.93%

were very different. The main groups were identified as being the local authorities responsible for waste management including the supporting local waste management companies that worked with the local authorities. However due to the fact that there is a very different level of development between the chosen study countries, it was not possible to assume who or which organisations should be considered as "main stakeholders". Deeper investigation into the different countries was needed to identify these groups. The only common group of respondents grouped as the "general public" were mainly students and academics, and related friends, who were happy to fill out the questionnaires and showed a real interest in the research work. The master questionnaire was designed to capture the viewpoints of two distinct groups of stakeholders: those from Local Authorities (in the UK context this represented waste planning officers from District, County and Unitary Authority levels within Local Government with statutory responsibility for waste planning in their areas) and the loosely termed 'cross-cultural stakeholders' (essentially comprising those with specialist knowledge of the waste industry; including trade associations; and groups impacted in their daily lives, such as the general public).

Local support was therefore invaluable in order to get accurate information about who should be consulted and how. In contrast to the UK, the main stakeholders consulted in Czech Republic and Greece were government ministries, leading coal and cement producers, power station operators, environmental protections associations, universities, SMEs and many others.

Local Authorities: Stakeholders from Local Authorities were seen as a key group for this study as it is at this level that infrastructure provision is often initiated, typically as LA run operations or in partnership with private contractors. There was a high level of reticence amongst this group to provide feedback in a manner that could identify themselves or the organisations they represented. This is reflected in the response rate from LA stakeholders (8.19%), a total of 183 questionnaires were forwarded sent to this stakeholder group with 15 completed forms returned. To overcome these inhibiting factors a number of informal interviews were conducted which proved useful in establishing the level of interest, which LAs may have in the MARSS approach to capturing materials from the residual waste stream.

Trade association members and representatives of waste companies: There are a number of directly and indirectly relevant trade associations for waste management and more general sustainability related issues (e.g. Resource Association or the Renewable Energy Association). In addition, the UK waste management sector, like much of mainland Europe is dominated by a small number of large operators (e.g. Suez and FCC) but with a substantial number of smaller operators due to a historic legacy of small-scale approaches to waste centred on towns and areas of cities. A representative sample of expert stakeholders was sent questionnaires (120 forms) with a total of 21 forms (7 from trade associations or industry bodies with the remainder from private companies) received either completed or partially completed, representing a 17.5% response rate.

General public: Waste management is an activity with which all households are familiar in the UK in terms of presenting their waste for collection on a weekly basis (as well as through more sophisticated alternate weekly collection schemes for recyclate and residual fractions) and through campaigns to raise awareness of recycling and other aspects of the waste hierarchy. In order to gain understanding of the public's view of a new technology such as MARSS, a total of 100 questionnaires were sent out with 23 completed forms received from this stakeholder group, a response rate of 23%.

UK Questionnaire and interview findings

Local Authority results – Part 1: As the one of the key stakeholder groups in the procurement and commissioning process for MBT technologies, it was telling that all respondents from LA's felt the policy emphasis from government was low. In the UK context this is not surprising as there has been a strategic commitment to AD since the Waste Review which has been emphasised within the National Waste Management Plan for England as well as being highlighted as a central feature within the Zero Waste approaches of Scotland and Wales for materials recovery prior to final disposal [28,29,43,44].

There was an overwhelmingly negative response when respondents were asked about future investment in infrastructure, with MBT being seen as the least likely investment option (alongside landfill provisioning) during subsequent discussions. Indeed, this reluctance to consider MBT (and thus MARSS) technologies as part of their future plans was reflected in responses when asked if their LA was likely to consider producing a biomass fuel, with a number of respondents indicating they already sent RDF to energy form waste (EfW) recovery operations. However, 5 respondents (36%) did indicate the presence of biomass CHP plants within their areas, but given the small number of LA's responding this cannot be taken as representative. Indeed, EfW with CHP is becoming increasingly prevalent, with a number of such facilities coming through the planning pipeline currently.

A range of LA types were asked to respond to the questionnaire from all of the constituent countries within the UK. Figure 3.1.1 shows the main respondents as coming from WCAs (Waste Collection Authorities) and UAs (Unitary Authorities). There was a significant variation within the percentages reported which on follow-up was attributed to old data sets (with no new studies available); time of year data was collected (impacted by seasonality); and estimations used in the absence of up-to-date compositional studies. Those questioned were then asked to give an indication of the impact on their decision-making that a number of considerations may have, see (Figure 3.1.2). They were asked to classify these considerations on a scale relating to the seriousness of the impact on decision-making (e.g. very serious through to not relevant. None of those questioned ranked any consideration within the 'very serious' category.

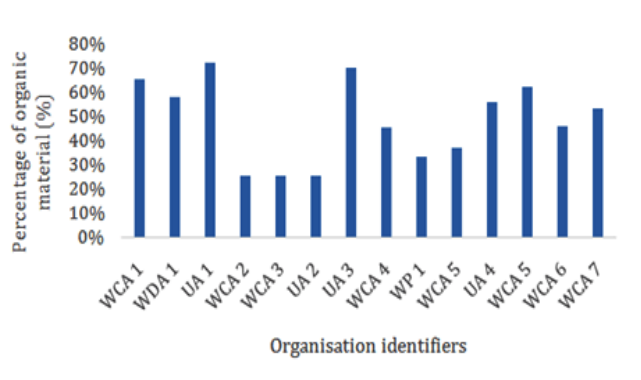

Figure 3.1.1: Percentage (%) of organic material present in LACW by weight for Local Authorities

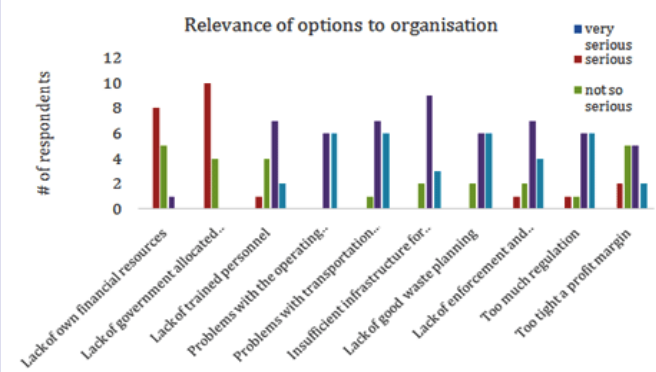

Figure 3.1.2: Relevance of options to organisation for strategic decision-making

Only two options were classed as primarily of serious concern (lack of own financial resource and lack of government allocated economic resource) reflecting public sector concerns over finances and budgets. At an operational scale (for trained personnel, plant, transport and infrastructure) there was very little concern with many indicating these issues were not relevant to their organisation. Planning for waste management was another area of very low concerns overall, but regulation was flagged by a small number of organisations as being of 'serious' or 'not serious' concern. Lack of enforcement and profit margins were surprisingly low concerns given issues in the UK over fly-tipping and operational procedures at some sites as well as the underlying concern with economic efficiencies within LA's widely reported in the relevant press [45].

Table 2.1: Stakeholder evaluations of statements – psychological factors, Greece

Statement	Strongly agree
Sorting waste and recycling make me feel a better person	24%
I care what my neighbors think about me and how I deal with my rubbish	5%
I would be proud of my community if we all deal with rubbish in a more environmental way	37%
I want to give my children and good example so I try to recycle as best as possible	24%
I think that I should get some benefit (money back) for my recycling activities	11%

Cross-cultural stakeholders and general public results – Part 2

Profile question: A larger sample of stakeholders was garnered for cross-cultural stakeholders, likely as a result of lower concern about being identified within the process. The sample was marginally representative of gender (male 55.8% and female 44.2%) with a diverse range of age groups represented (Figure 3.1.3). The sample was also split between urban (67%) and non-urban (33%) which is representative of the level of urbanisation within the UK.

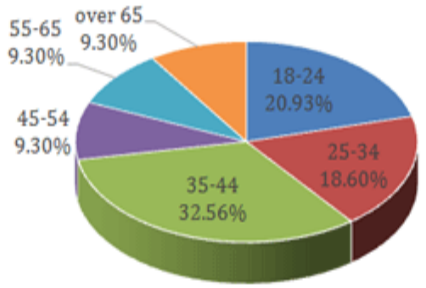

Figure 3.1.3: Age ranges of respondents

Respondents had an above average level of educational attainment, with 98% having attended higher education as a minimum. Of this total, 40% had attained post-graduate level qualification, which is typical of those providing technical advice, consultancy and managerial level support within the UK waste management sector.

Personal questions: Stakeholders, in general, were aware of what happened to their wastes once collected from their homes. In addition, a significant proportion 39.5% could give a description of what their local waste system did with their household wastes (e.g. sent to landfill, processed to RDF for incineration, etc). However, there was a more limited understanding of the costs of local waste services (Figure 3.1.4).

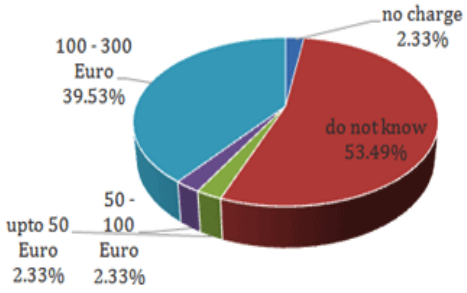

Figure 3.1.4: Stakeholder view on costs of waste management to household

Tellingly, more than 50% of respondents did not know what happened once collected and a small fraction thought there was no charge for these services. Notwithstanding, those who indicated an awareness of the cost range for their waste services were able to give a fairly accurate assessment (e.g. a total of 39.53% of stakeholders accurately placed costs between 100-300 Euro per annum). Further, almost all stakeholders indicated they did not pay by weight within their local areas, nor did they think they paid too much for these services.

When asked to give an indication of whom stakeholders would most or least trust to provide guidance on waste management (Figures 3.1.5 and 3.1.6), academics and LAs were seen as reliable sources of information and thus most trusted to provide information. When asked if they would be prepared to pay more for their waste services there was a surprising majority indicating they would (>58%), providing there was evidence of environmental benefit.

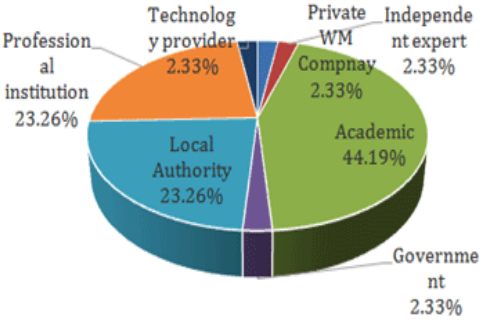

Figure 3.1.5: Stakeholders choice whom they would MOST trust for waste management advice

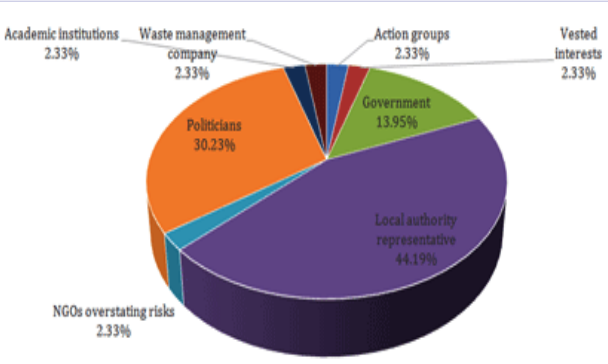

Figure 3.1.6: Stakeholders choice whom they would LEAST trust for waste management advice

A further surprising result was found when asked about proximity to waste facilities, with more than 50% of stakeholders willing to live within 15km of a waste facility (Figure 3.1.7). This result is counter to the difficulties experienced within the UK planning system on gaining approval for waste facilities (particularly EfW which can take up to 5 years to move from

A further surprising result was found when asked about proximity to waste facilities, with more than 50% of stakeholders willing to live within 15km of a waste facility (Figure 3.1.7). This result is counter to the difficulties experienced within the UK planning system on gaining approval for waste facilities (particularly EfW which can take up to 5 years to move from application to consent [32]. In terms of behaviour amongst stakeholders at the household level, a very large proportion (72%) indicated they spent 30 minutes or more separating their waste materials into the required segregations (Figure 3.1.8).

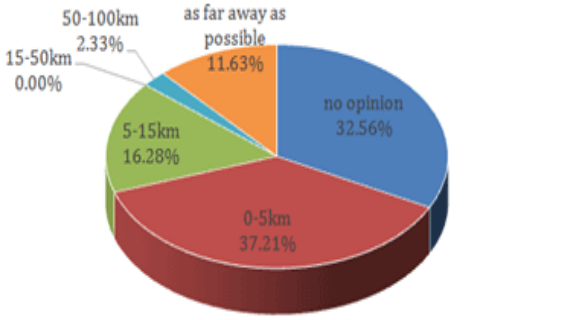

Figure 3.1.7: Stakeholder evaluation of living in proximity to waste facilities

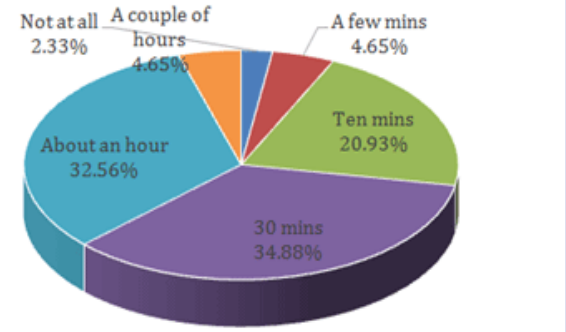

Figure 3.1.8: Stakeholder responses for time spent sorting waste materials each week

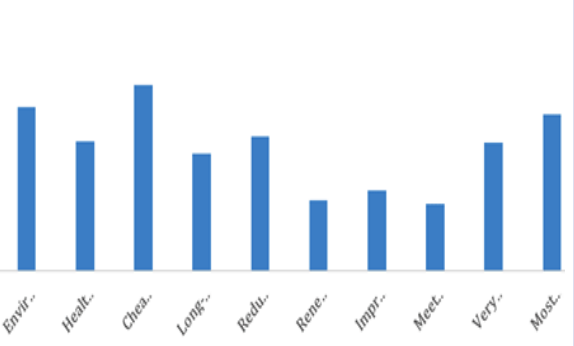

Figure 3.1.9: Most important aspects of waste management in locality to stakeholders

When giving an indication of the importance of aspects of waste management in their localities (Figure 3.1.9) stakeholder responses were scored on a range of 1-10 (with 10 being the most important). These scores were averaged to give an indication of difference across all stakeholders questioned in order to reduce the subjectivity of individual responses. The 'cheapest option' was reported as the most important consideration with 'environmental protection' and being the 'most convenient option' also scoring highly. In contrast, stakeholders gave least importance to 'renewable EfW' and 'meeting targets'.

Stakeholder opinions: The level of satisfaction with local waste management services was high among 42% of stakeholders with only 28% indicating any dissatisfaction with their service provision. This question was further developed in terms of the perceptions of problems associated with waste in general and at different geographic scales (Figure 3.1.10).

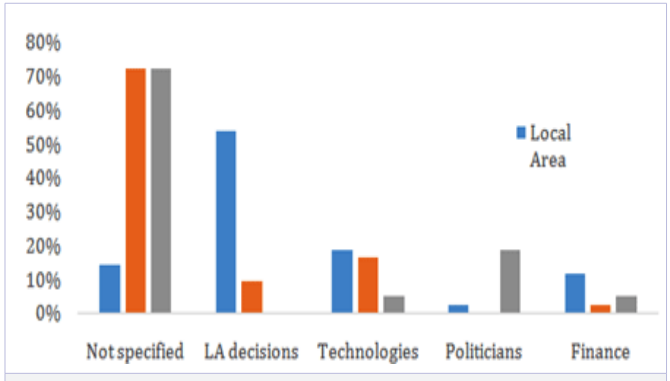

Figure 3.1.10: Stakeholder perceptions of waste problems at different scales

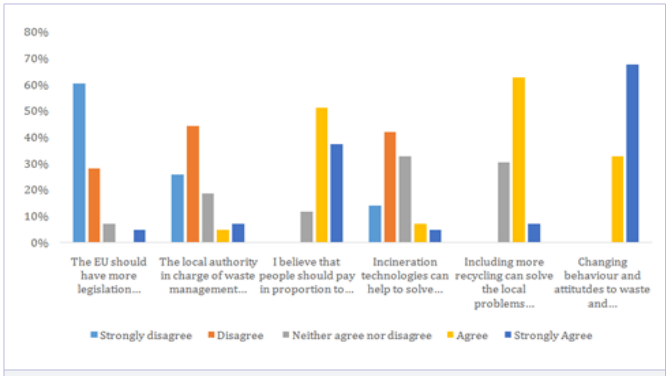

Figure 3.1.11: Stakeholder evaluation of statements to solve the waste problem

Results were most detailed at the local scale with LA decisions seen as contributing most at this scale with technology and finance being lower level concerns at this scale. Regionally, technologies were seen as the biggest issue for waste management, whereas politicians were seen as having the largest contribution to waste problems at the national scale. In general, waste management issues were seen as being compounded by

financial considerations, somewhat contradicting the answers given for different geographic scales.

When asked to evaluate statements proposing solutions to waste problems, changing behaviour and paying in proportion to the amount of waste generated had the strongest levels of agreement from stakeholders (Figure 3.1.11).

In contrast, interventions from the European scale and a greater role for local authorities met with the most disagreement (90% and 70% respectively), with increased incineration of wastes as an option also garnering significant disagreement. This consideration around incineration was further supported when stakeholders were asked to indicate the highest risk to human health. Figure 3.1.12 shows that incineration scored highest after landfill as the highest level of risk perception, with almost 90% of stakeholders assigning highest and high levels of risk to human health.

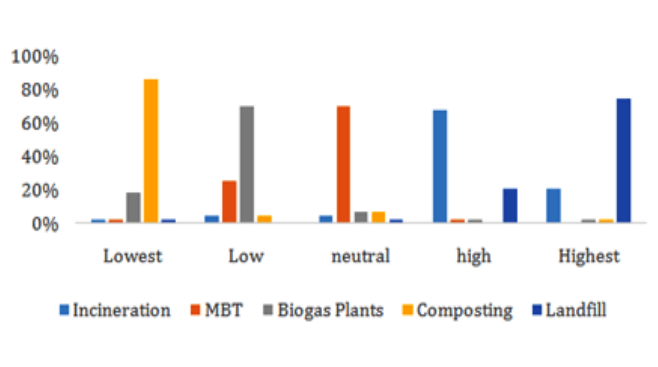

Figure 3.1.12: Stakeholder assessment of technology risk to human health

Taking one comparison, the Greeks seem not to care about what the neigbours think (5%), whereas the British consider this to be an important factor (23%). The country studies have shown that there are similar concerns between local authority decision makers regarding MSW; however show vastly different psychological interests and concerns within the general public between the different country studies. This calls for more detailed research work into the underlying factors resulting in these remarkable differences obtained. In general stakeholders were positive about the credentials of a boosted recycling process to recover energy and materials used in this study, but had more pressing concerns over issues with waste at the local scale, which contrasts with the strategic benefit which may be obtained from MBT in delivering regulatory targets. However, a combination of financial constraints impacting Local Authority waste planning, other policy priorities to deliver on waste hierarchy commitments and the emphasis on value and quality through transitioning towards a circular business model, means realistically that the UK provides a limited opportunity for MARSS market penetration currently.

Greece country study and stakeholder consultancy

Issues that were raised during the questionnaire distribution:

During the research and mainly during the interviews with the stakeholders, several issues were raised but were effectively managed. The most important issue that had to be confronted was due to the structure of the stakeholders' questionnaire that asked for the responder's name. This initially made the stakeholders reluctant, and cautious about making any statements, and this resulted in a number of non-representative answers to many questions (particularly to those referring to the governmental support and management problems within their organization). The majority of the stakeholders were very reluctant to answer due to the possibility of the results' publication and the probability of exposing their organization's weaknesses. This problem was overcome by informing them that all results and reports would be anonymous and researchers would only mentioning the institution name. Another significant issue that had to be handled during the interviews was the fact that much more time than expected had to be spent in the interviews in order to achieve more focused answers to assess the real level of acceptability for an innovative technology such as MARSS. Moreover, several stakeholders were not willing to respond to some questions because interviewees did not consider themselves responsible or informed enough to represent the opinion of their organization.

Categories of stakeholders: nIn order to achieve high quality and representative results for this report, a large number of personal interviews and contacts were held with interested parties related to the current MSW management systems and the possible acceptability of a boosted recycling process for biomass fuels in Greece. The expert research team aimed at selecting stakeholders that could provide coherent information from competent entities involved with the national MSW management system.

Furthermore, stakeholders that were selected that could provide insights into the Greek potential for MSW biomass fuel exploitation. The total number of the fully completed stakeholder questionnaires was 24, but also there were a significant number of private follow-up interviews and telephone meetings conducted, which were more focused and more dedicated to the possible end-users of such a technology. The stakeholders that were chosen for the interviews were representatives from the public and private MSW management sector in Greece. More specifically, permanent staff was selected to be interviewed, coming from public administration bodies and private companies/enterprises that are related to MSW management from Attica, Crete (Chania and Heraklion) and Kefallonia, areas chosen mainly due to the presence of MSW treatment plants in their region (Table 3). The aim of the present research was to explore and analyze thoroughly the stakeholders' acceptability and to understand the

market potential of using the MARSS technology application in Greece.

Table 3: Main Stakeholders consulted (from the public sector)

Region	Stakeholder
Crete	
Heraklion	United Association of Solid Waste Management in Crete (http://esdak.gr/)
Chania	Inter-municipal Enterprise of Solid Waste Management (http://dedisa.gr/)
Attica	Attica Region Solid Waste Management Association (http://www.edsna.gr/)
Kefallinia	Inter-municipal Enterprise of Cleaning and Environmental Protection in Kefallonia

Private stakeholders consulted included:

•Intrakat S.A. Constructing Company, related to solid waste treatment plants, wastewater treatment plants, responsible for the construction of many premises in Greece and abroad.

•Kafsis S.A. MSW private stakeholder related with the construction of treatment plants, management of solid MSW, consulting.

•Helector S.A. Constructing company that is responsible for the wastewater treatment plant of Psitaleia island, the biggest plant in Attika region and in Greece and participates in several MSW projects in many regions of Greece and the Balkans.

•Titan Group. Cement industry.

•Thermossol S.A. Industrial stakeholder that produces equipment that processes 1st generation biomass fuels, leader in the market.

•Halyps Cement (Italcementi Group). Cement industry.

•Lafarge Holcim Group. Cement industry.

Greek Questionnaire and interview findings

Summary of the interviews' findings – Part 1

As mentioned above, the selected stakeholders were representatives from public and private municipal solid waste management sector throughout the Greek region. The majority of them are permanent employees in MSW management bodies, such as waste management associations, municipalities etc.

In the first question, when they were asked: "*Is the MSW treated in any way? If yes, then how?* If no, then what happens to the waste?" the majority of the responders knew the general procedures that are followed for the MSW management, however, there were significant differences on the specific MSW management practices among regions due to different needs and demands. More specifically, responders from Attica Region answered that recycling is mainly limited to the source-separation and recovery of packaging waste through the established "blue bin" network along with the MRF facilities where further mechanical sorting is taking place for delivering materials to the corresponding market. The residual MSW from MRF units is transported to the landfill site at Ano Liosia [37]. A proportion of Attica's mixed MSW is transported to the MBT facility for the recovery of ferrous metals, aluminum, CLO and SRF.

However, the market exploitation of CLO and SRF is very limited or even absent. Interviewees from the region of Heraklion (Crete) answered that the existing MSW source separation practices are limited to the application of the "blue bin scheme" which presents significantly low recycling rates. Only recycling of the packaging materials in big shopping centers is applied efficiently. The residual MSW is delivered to the MBT bio-drying facility for partial recovery of recyclable materials [40]. The remaining dried material (SRF) is mainly disposed in the landfill. In the region of Chania (Crete), Compost like Output (CLO) is produced in the MBT facility that processes the organic fraction of mixed MSW (not source separated). The operators of the MBT stated that the produced CLO acquires good quality characteristics and currently it is marketed and used as soil improver in the local agricultural activities [39].

Moreover, in the question concerning separate collection of biowaste (kitchen and garden waste), the prevailing opinion was that *"No relevant management scheme has been established yet"*, due to the fact that nothing similar has ever been applied in recent years (only in a small scale or pilot projects e.g. LIFE+ ATHENS BIOWASTE project or through small scale home composting). The only biowaste source separation scheme that is in place is related to green waste in public areas of various Greek municipalities, which are collected and transported at the MBT facilities in Ano Liosia (Attica Region) and Chania (Region of Crete). At these MBT facilities collected green waste is shredded and used as bulking agent at the composting process of mixed organic fraction of MSW.

Regarding the question *"Is there any interest in investing in a technology for further processing MSW, aiming at increasing the recycling outputs?"* it was concluded that indeed there is a significant interest by 91% stakeholders (Figure 3.2.1) which is also evident by the updated National Solid Waste Management Plan that promotes the decentralized management of MSW and the extensive application of source-separation programs [36].

The different groups of stakeholders who responded to the Greek study and their percentage representation can be found in the (Figure 3.2.1) below.

Many of the responders mentioned that the governmental lack of support and the problem of poor waste management are not related. Thus there is a belief that the most important factor for a sustainable waste management is the willingness of the authorities to follow the governments'

directives and instructions. Consequently, and taking into account the aforementioned opinion, in the question *"How would you describe the state support and the bodies responsible for the creation of MBT plants in your area?"* the majority of the respondents (52%) answered that the government support on waste management sector is "low", a large percentage (31%) of them responded that it is "very low" and there were also those that claimed that it is "non-existent (Figure 3.2.2). Conclusively, 87% believes that the government is not giving adequate support or that the governmental actions do not rise up to the expectations of the citizens in that field.

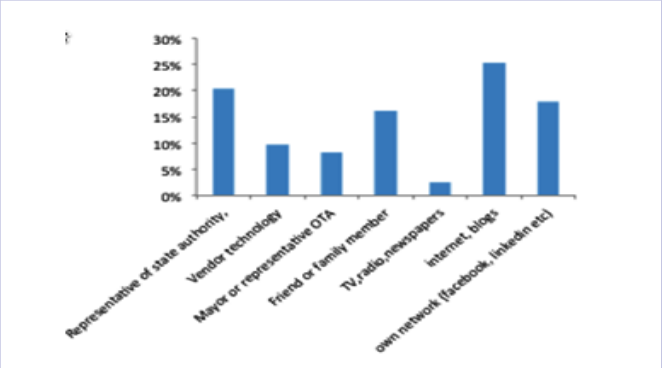

Figure 3.2.1: Types of stakeholders in percentages in the Greek study

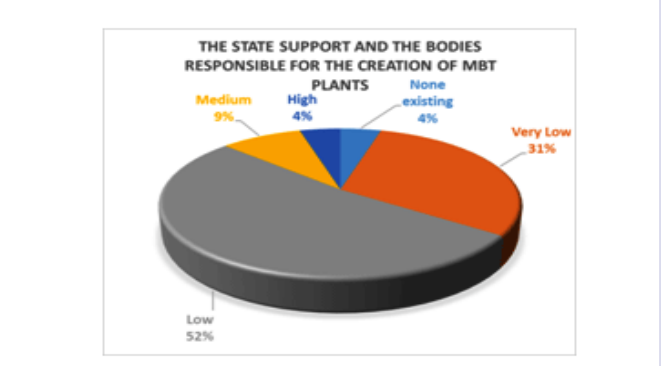

Figure 3.2.2: State support and the bodies responsible for the creation of MBT plants

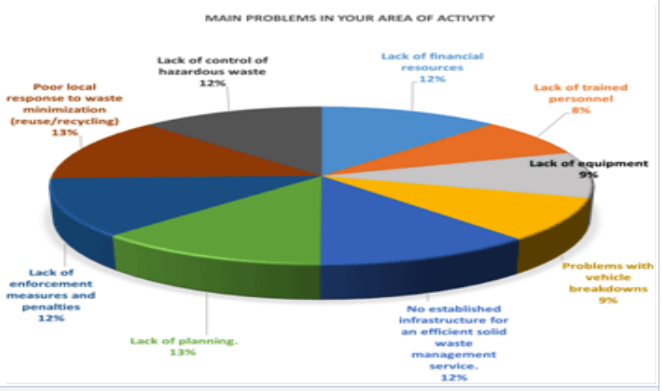

Figure 3.2.3 Main problems in your area of activity

According to (Figure 3.2.3), which illustrates the main problems within the stakeholders' area of activity, the most significant problems are the "lack of planning" and the "poor local response to waste minimization" while 12% states the following problems of lack of funds/ financial resources, lack of control of hazardous waste, lack of enforcement measures and penalties and a non established infrastructure for efficient solid waste management services.

Cross-cultural stakeholders and general public results – Part 2

In order to acquire some knowledge about the level of the general public's awareness on environmental issues and the probability of acceptance of a technology like MARSS in Greece, a representative number of responders (123 persons) from all age groups and academic levels were selected. The questionnaires were forwarded to different groups and at the same time face-to-face interviews were also performed in the premises of the Technical University of Athens, municipalities and private companies. The sample included people working in municipalities, employees of public sector and private companies, civilians of different educational and financial background and finally students from the National Technical University of Athens.

The general public questionnaires analysis gave some interesting findings concerning public awareness levels on environmental and mainly on waste management issues. More specifically, when they were asked, *"Do you know how your municipal waste are processed after they are leaving households?"* the majority of the responders (57%) answered that they are aware of the procedure. At that point it should be emphasized that only a few of the responders really knew exactly what the MSW treatment procedure was, although most of the correspondents thought that they actually were aware of the whole chain of events. This was established in the post-questionnaire interviews. In more detail, 44% of the general public who responded to the questionnaires believes that the applied methods include recycling and sanitary landfill for the mixed MSW, 30% believe that only sanitary landfill techniques is applied, 11% of the responders believe that the MSW goes to MBT plant and afterwards follows the dumpsite disposal. A small minority, of 3%, 1% and 1% of the responders believe that recycling, incineration with recycling and landfill disposal are applied, respectively (Figure 3.2.4).

As far as the amount of waste management fees is concerned (high or low), the majority of the responders (59%) do not know what they pay for their waste. Only a small number of the interviewees knew the approximate amounts (23%), but not the exact ones. Even though citizens are obliged to pay large amounts for waste management through municipal fees for a non-effective municipal waste management system, they don't actually know how much and to whom they pay these amounts.

Given the fact that the recovery of materials is very poor, and nearly 82% of MSW are landfilled, the system is proven to be non-cost-efficient and unfortunately people are unaware of it.

The general public's level of acceptability on new waste management technologies (i.e. MARSS technology) is very high (90%). This result was also obtained in the Naples, UK and Czech studies. We separated two categories of replies: 43% of the questioned subjects would support it without any conditions, while 47% would support it under certain conditions. The conditions that were mentioned under which the new technology would be accepted are shown in (Figure 3.2.5).

A minority of 8% of the responders would be opposed on any new technology implemented in MSW management. According to our findings, the majority of the general public demand environmental friendly interventions, when it comes to MSW management (Figure 3.2.5).

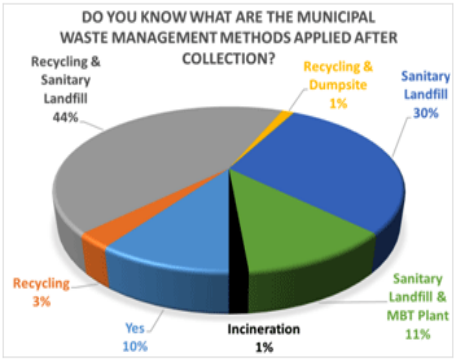

Figure 3.2.4: Do you know what Municipal waste management methods are applied, after collection?

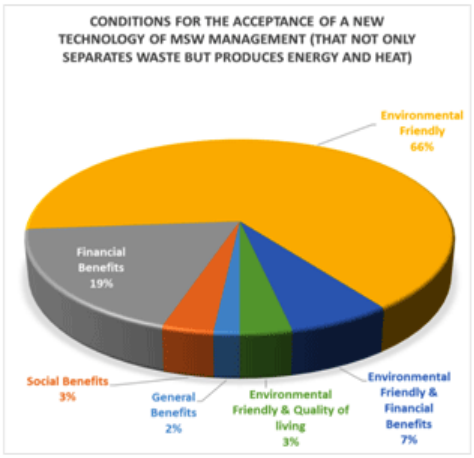

Figure 3.2.5: Conditions for the acceptance of a new technology on MSW management

In relation to MSW biomass fuel exploitation in Greek Industries, a targeted interview was conducted with Thermossol Company S.A. (experts on biomass fuel market and constructors of industrial boilers that consume biomass). It was mentioned that biomass fuels market in our country is a market directly related to industries' demand (i.e. cement industry). However, there is a misconception from their side that the uses of biomass fuels from treated MSW imply an environmental hazard and therefore can attract social opposition, complaints and even lawsuits. Industries in this case would be obliged to use appropriate, anti-pollution equipment, which has an additional cost [42].

Considering the above, the demand of MSW biomass fuel is limited to the rather low exploitation of the RDF/SRF that is produced by the existing MBT plants, whereas the end-users of the material are predominantly the cement industries.

The main barriers identified in the consultancies related to the market development of renewable energy based on biomass fuels derived from MSW in Greece are presented below:

•Many mayors consulted simply stated in the preparatory interviews that they did not have the resources and/or money to make any improvements in local waste management, whatever the EU had to say, and found it a waste of time to fill in any questionnaires either in written or oral form. In addition, the whole exercise was considered "academic" as there is a serious economic and social crisis within the country.

•The lack of confidence in a MARSS like approach was compounded by a complete absence of thermal treatment facilities for the energy recovery of MSW biomass fuel. The new waste management government policy framework does not favor the development of thermal treatment plants using MSW biomass fuel.

•The tariff system related to energy production (€/MWh) from MSW biomass that is still vague compared to alternative biomass feedstock (i.e. agricultural biomass) and the industrial demand for MSW biomass fuel is limited.

•The lack of MSW biomass fuel standardization processes that support the marketability of waste derived fuels and provide information on the level of the biogenic fraction of the feedstock used. (Only recently the Ministerial Decision 56366/4351/2014 has set specifications and classifications for SRF/RDF according to EN 15359. However, it does not provide information for other waste derived biomass fuels.)

•The low social acceptance of thermal treatment processes which is mainly attributed to lack of public awareness and information programmes.

Results from the general public questionnaires demonstrated that the Greek population has high levels of

awareness on environmental issues and would easily accept a new technology, if it presented significant environmental, financial and social advantages in the field of MSW management. On the other hand, stakeholders and the private enterprises would be more cautious, due to the lack of governmental guidelines and financial support. Based on our experience, they would easily accept innovative technologies with proper guidelines. Relevant waste derived products could have a chance to be successfully introduced in the Greek market, but only if they are in line with the existing legislative provisions and market demands. The use of biomass as alternative fuel has increased in Greek industries the last years due to the economic recession however the use of MSW biomass fuels cannot be easily incorporated primarily due to the required investment cost (i.e. combustion and anti-pollution equipment) but also due to the misconception that the use of biomass fuels from treated MSW imply an environmental hazard which attracts social opposition, complaints or even lawsuits. It seems that a boosted biomass recycling technology could potentially be adopted in the Greek cement industry, which has the capacity to receive about 480,000 tons/year biomass fuel, whereas long term companies voluntary agreements (as foreseen by the Ministry of Energy) is expected to aid towards this direction.MBT plants in Greek regions could be approached in order to discover their willingness in using this technology and to increase the added value of their products. Finally the citizens are open to all new MSW management technologies which are environmental friendly and beneficial for the society's quality of life.

Discussion

Stakeholder consultancy and engagement with stakeholder groups when any new technology is being introduced is not new, but the understanding about the value and importance bringing stable long term benefits when these groups are allowed to participate actively in that consultancy, and maintained throughout the decision making process, is beginning to be better understood and appreciated. It is only quite recently now becoming adopted as part of the active consultation processes before any major policy decisions are formulated or taken. Table 4 below summarized the main differences and similarities found in the two cross-cultural case studies.

Table 4: Main differences and similarities between the two case studies

Differences	
UK case study	**GR case study**
There was on overwhelming negative response from LAs on future investment in infrastructure, with MBT being seen as the least likely investment option.	The majority (91%) of the stakeholders who responded to the questionnaire showed a high interest in investing in a technology for further processing MSW, aiming at increasing the recycling outputs.
UKs' general public spends more than 30mins to sort their waste.	The majority of the general public spends less than a few minutes to sort their waste, which explains the low recycling rates.
UK public do not trust information given by LAs and politicians, and would trust academics the most to provide information about new waste technologies	The majority would have more trust in information from the internet.
The level of satisfaction with local waste management services in UK was high reaching 42% and only 28% indicating any dissatisfaction	The level of satisfaction in GR with the local waste management services was low, reaching 24,5% with only the 6.5% of public to be high satisfied.
The current trend is for EfW and AD and not MBT as method to reduce landfilling	Landfilling still seen as main option for dealing with MSW but MBT is an option

Similarities

1. General:
   - i. Residual waste remains an issue for many EU Member State, regardless their geographical and socio-economical characteristics.
   - ii. In both countries MBT plants are used as a pre-treatment practice. In general stakeholders were positive about the credentials of a boosted recycling process to recover energy and materials used in this study.
   - iii. Agreement that both governments are not giving adequate financial support or that the governmental actions do not rise up to the expectations of the citizens in that field
   - iv. There was a high level of reticence amongst LAs to provide feedback and a common need for more financial resources.
2. Questionnaires:
   - i. In both countries the general public has a high level of awareness on environmental issues and a low level of trust in politicians. Both case studies responders found that a change in behaviour of consumers was the key to increased levels of recycling and not more EU legislation. Incineration, landfilling and biogas were all seen to have a higher risk to human health than MBT or composting.
   - ii. In both countries general public would pay more for their waste services, providing the evidence of environmental & health benefits. Here it is important to underline that in Greece the majority of the responders didn't know what they actually pay for within the waste management schemes. Both studies showed a strong mistrust of decisions and information given out by Local authorities and politicians.

These different cross-case studies showed that there are definable and distinct differences and similarities in stakeholder opinions, which can be understood only with an appropriate background analysis of the local situation as well as direct consultation via interviews with these different groups of stakeholders. One main conclusion seems to be that cross-cultural assessments and stakeholder consultancy ARE the ways to achieve the final goal, NOT the innovative technologies as such. The country studies have shown that national differences are very strong, and that there are different paths towards a green economy and protection of the environment in spite of common goals set by EU legislation. The urge to protect the environment was endorsed in the cross-cultural studies where it was a common finding shown by the over-whelming majority of stakeholders and many indicated a willingness to pay even more for waste management if innovations would favour the environment and family health. Inclusion of stakeholders, who may be for or against the said innovation or proposed decision, can not only inform the decision makers about potential conflict points, but also in turn educate their stakeholders about the different pros and cons of the proposed action, leading to what can be seen as an enhanced positive interest in local and regional affairs. This is further endorsed by the post-survey strong interest was shown by the country experts and consulted decision makers in continuing the collaboration.

The authors are aware that a cross cultural study of this kind can be criticized for many methodological and analytical weaknesses; however it is only a start and should continue as a work in progress. There is no doubt that simply carrying out this consultancy work has opened up discussions between the country experts and the stakeholder groups consulted, and has set in place an informal communication network that is positive in itself. We also found that the way stakeholders can or should be involved in a stakeholder consultancy and participatory process is a very complex issue. By carrying out this analysis before implementing a policy or programme, policy makers and managers can detect and act to prevent potential misunderstandings and/or opposition to the implementation of the policy or programme. A policy or programme will more likely succeed if a stakeholder analysis, along with other key tools, is used to guide its implementation" [46].

The high level of mistrust shown by the stakeholders consulted in giving out any opinions or data was common to all studies. Data protection was a consistent issue to be dealt with sensitivity throughout the different country studies. The issue of trust in fact was consistent throughout the studies at different levels and different scales. However, our results clearly show that we need to go further in understanding who the respondents are and the relation of their role and person to the sometimes over-enthusiastic responses in the adoption of the proposed new technology being able to solve all waste management problems in the other country studies. A further step would be to initiate open discussions between the identified stakeholders about how to reach consensus on what the goals should be and whose interests should be represented.

One major challenge in our research work was how to present the stakeholders with un-based information enabling them to make decisions with a certain level of expertise and how to involve them in the decision making process. The message givers must also acknowledge and deal with a wider conflict of the level and extent of information to be given out. No new technical development or process can realistically take place without some element of entrepreneurship together with private monitory interests in making a profit. This puts even more responsibility on the shoulders of the decision-makers in the public domain about how to assess the introduction and impacts of agreeing to a new venture or technology in their community. For this reason the authors call for a change in perspective in that involving stakeholders in these complex decisions can not only speed up these introductions and prevent a-priori opposition within the stakeholder groups, but can lead to lasting coalitions between civil society and public decision makers.

One aim of the research was to get a better understanding of acceptance levels of the introduction of the new technology under study, and to see what the immediate barriers were to possible acceptance by stakeholder groups. All countries studied showed strong interest from the general public in using recycled biomass for renewable energy as part of a move away from centralized incineration plants towards decentralized CHP plants. This was seen as a better option for the environment. However, these results do not mean that those other less-well developed countries that are struggling to reach the landfill targets, cannot consider introducing standard technologies – it depends on the national and local situation. Stakeholder consultancy work has shown that it is important to have direct contact with stakeholders and also to transmit results and send "success stories" back into the local communities to maintain interest and provide input back into communities. Especially with regard to those countries with a low level of development in treatment of solid municipal waste, introduction of new technologies depend on having a certain level of infrastructures, investment funds and markets for recyclables as well as an open market for energy production from biomass derived fuels.

Our results clearly show that there are no optimum solutions and that each of the countries studied presented a very different historical development, national preferences and capacities (or government support schemes) for investment in advanced MSW treatment and reduction of landfill. The results obtained in the cross cultural studies have highlighted the differences between the countries under study, in spite of common

EU legislation, has shown up stark differences in readiness to take up new technologies, and certainly brought other important issues to light.

Conclusions

The country studies have shown that it is simply not easy to transpose one successfully demonstrated technology from one country to another. The acceptability and chances for successful implementation based on new technologies rely on a multiplicity of complex factors such as political climate, level of infrastructures, investment opportunities, including the state of play in the waste management systems already in place.

Acceptance and uptake of a new waste treatment technology by local authorities depends specifically on the national regulations in force in that country. General stakeholders are more concerned about environmental protection. Government funding and support is seen as a significant factor in both case studies. In the case of the technology under study, additional limitations came from the strict license restrictions in place preventing CHP plant operators from switching easily from one specific biomass fuel feedstock to one coming from mixed household waste. In fact, some of the countries do not allow or authorize a waste derived biomass fuel to be used or accredited for use as a biomass feedstock for the production of renewable energy; whereas others do allow this. For those countries that decide to go down the route using RRBF as a renewable fuel, there is a need for standardization and norms for biomass fuels on a pan-European level.

The results of the questionnaires to the general public indicate that there is a high level or even an over-enthusiasm about the innovative technology under study being able to solve all the problems of their national/local MSW waste management. There was a surprising high level of a willingness to pay more for waste management, but only if it really brings benefits to the environment. There were also marked differences in socio-psychological opinions between UK and Greece when asked about attitudes to MSW and waste management. This finding was present in all the country studies. In addition, environmental protection, cheapest option and convenience were seen as being important local considerations which could be supported by changes in behaviour and introducing pay as you throw policies.

The problem of availability of finance for investment in new technologies based on MBT plants was a problem in all the countries studies, including surprisingly Germany, where it is forecasted that no more MBT plants will be built due to the small profit margins for operators. But this should be seen against the backdrop that MBT technology itself is on the increase in Europe as a whole as it does provide a robust sorting technology for other countries. Italy leads the field worldwide with the greatest number of MBT plants and there are none operating in the Czech Republic to date. So the differences are significant across Europe in the solutions that local authorities chose to deal with their waste.

An interest was shown by the local experts and consulted stakeholders in the transfer of Best Available Practices (BAPs) by the countries under study, and to extend the collaboration to exchange information and "lessons learnt". It seems that direst consultation in the framework of Participatory Appraisal can bring about the first positive steps in understanding and longer-term international collaboration, even though the end national decisions may differ radically from one EU country to the next. In conclusion, it seems that there will always have to be a compromise decision that has to be taken, as a result of a constant consultation process and cross-cultural assessments including all stakeholder groups if EU targets are to be met and good governance prevails.

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