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Efficiency and System Approach in Communal Solid Waste Management

Theses of Doctoral Dissertation

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Preface

My ideas about obtaining a scientific degree after graduation date back a long time ago. In 1998, when I worked at the Mecsek Ore Mining Company, I submitted a research topic of related to mining, and it was accepted by the doctoral council of the university at that time.

Soon the situation changed, I started to work at other fields, first as an official in charge of environmental issues at the Local Government of the City of Pécs, then in 1994 I became the head of the local Public Cleaning Company under reorganisation. It was the time when new environmental standards were introduced in Hungary in line with our accession to the European Union, requiring more serious professional competences.

As in the field concerned, there was no serious professional background in Hungary, in many cases I had to rely on my experiences and knowledge I obtained in the course of the mining engineering and environmental trainings, with a special regard to the institution where I had learnt all that, the Mineral Preparation and Mine Cultivation Department of the Faculty of Mining Engineering.

It was the time when we organised study trips in order to learn about the establishment of selective waste collection system started in Hungary in 1996. We actually designed on the site the systems and facilities still in operation, and they serve as best practice I respect of today's developments. At that time we had neither experiences nor time to control our ideas, however they have been verified in practice thereon, as the systems we have built – as pioneers in Hungary – still operate effectively and efficiently in line with their planned capacity.

Based on the above experiences, ten years ago I decided within the new circumstances to restart my work aimed at obtaining a scientific degree in the field of waste management. That was the time of Hungary's accession to the EU, and due to Hungary's commitments towards the EU and the grants available, waste management has become a separate sector of the industry.

This might have been the reason of my research work becoming more and more complicated and complex, as my objective was not only to examine a specific field, but to explore – as indicated in the title of thesis – technical, economic and legal interrelations, as well as to put forward development proposals. I hope that this goal of mine has been reached according to the readers of my work, too.

Finally, I wish to express my thanks to the colleagues working at the Faculty

of Technical Geosciences of the Miskolc University, especially to my thematic leaders and my colleagues and friends whose support and positive attitude contributed greatly to writing this thesis work.

Background of the Research and Objectives

As a result of accelerated socio-economic changes, both the developed and the developing societies have to face several new challenges in the form of local and global problems. In particular, the management and the decontamination of waste are tasks that require more attention and resources due to the consumption-oriented lifestyle.

Until the early 90's, the regulations in force allowed for performing waste management services with simple means and technologies, therefore there was no need for securing professional background and equipment necessary today. In the second half of the decade, as the environmental regulations were made more stringent, the cheap services used earlier (transportation, collection, dumping) have become more expensive because of the necessity to perform technical developments. The logistics of collection and transportation had to be optimised, and the sparing of storage place due to the increased investment costs of the dumping sites required the introduction of effective compacting technologies.

As a practising professional, I have seen even in the middle of the 90's that in the field of waste management – in contrast with the sector of waterworks – there were no models of industrial administration and we missed the professional experience related to this specific sector. The lack of the above hindered effective the planning of investment projects for modern systems, the selection and the sizing of adequate technologies, and the performing of efficiency calculations. The potential solutions included the transposing of planning and sizing methods used in other specific fields – in particular, technical geosciences, systems of mining procedure technologies – as well as the partial adaptation of foreign waste management systems.

In my job, I gained first hand experience about the level of applicability of optimization calculation models used in the case of establishing shafts or in transportation systems in the mining industry, in the planning of a waste selection site or a secondary raw material collection system. My knowledge accumulated

in the course of the above work and expanded on a continuous basis inspired the elaboration of the starting points of the present research, namely: how to plan a complex solid waste management system on municipality level that can be operated economically, at the same time providing for the enforcement of short term economic objectives, long term community interests, and global commitments – the sustainable use of natural and human resources.

Then Methodological Basis of the Research

The methodological basis of the research includes knowledge and experiences accumulated in natural sciences, technical geosciences and environmental sciences – as a new discipline emerged around the borderlines of the former – as well as the fields of economic sciences. In the course of studying the ecology system approach formed in the second half of the past century, I realised that although the biosphere can secure homeostasis for itself through organic feedbacks – i.e to grant that the important parameters of physiology remain within a specified threshold and to tend back towards the optimal value upon an external influence – this does not mean that no waste is created in the ecology systems, as stated by some experts1. To the contrary, the treatment of waste is an essential part of maintaining stability. In the course of billions of years, the processes of material and energy supply have been developed successfully in an experimental way through self-regulation based on the feedback of information, resulting in a system selecting automatically the rate and the method of the waste to be returned into the primary processes and to be taken out of the circulation.

This process is based on natural and organic feedback methods, on the basis of which the natural ecosystems can decide and regulate what is the matter to be recycled after full decomposition, and what are the parts to be stored temporarily or for ever.

The man-made economy – striving with similar problems today – could follow the example of the ecology system operating for billions of years. Thus

1 c.p. Szépvölgyi, J. (2002): *Ipari ökológia: az ipar és a környezet kapcsolatának újragondolása. (Industrial ecology: rethinking the relation between industry and environment)* Magyar Tudomány 2002. December.

in the case of the waste problems of the modern societies, we should not aim to recycle everything, but to maintain a state of dynamic equilibrium. It is useless to make excess sacrifice and to use excess resources to recycle materials, rather we have to make decisions on the basis of a given level of "demand" about what to return inversely into the primary economy. Therefore we need a system where the decisions on handling actually needless materials are based on adequate information collection and feedback.

Waste management is an activity of a relatively short history, lacking its own methods. Thus it is necessary to examine the applicability of the methods of those scientific fields the characteristics if which are similar to the problems emerged in environmental and waste management.

Thesis 1.

The area of technical geosciences is a field like that, offering a method formed on the basis of knowledge and experience accumulated through several centuries, determining the actual potentials of exploiting and processing raw materials, on the basis of evaluating information collected from various fields of technology, economy, natural- and social sciences. It means more than a technical-technological system of procedure; it is an attitude and a system-focused approach, containing many analogies with the field of waste management. By taking into account individual characteristics and specialities, it can be used effectively in the elaboration of system approach-based procedures of municipality solid waste management[2].

When the problem of waste was raised, the attitude to waste treatment was like "an unregulated, prehistoric situation". At that time, space was sparsely populated, thus the management of waste was not problematic at all: the materials deemed unfit for further use were "decontaminated" aside the dwelling areas.

With the increase of the population and the development of settlements with long term dwelling, the first regulations emerged, primary in the field of enforcing the principles of public health. In that period, the primary aim was to remove waste from the living quarters, in order to limit the danger of infections and diseases in the areas of high population density. The results were due to the development of removal techniques, but the storage of waste emerged as a task forming a serious professional challenge.

When the aspects of protecting the environment were raised – induced due to the pollution of the immediate dwelling quarters – more attention was paid to where the removed materials were placed, in order to prevent further and greater

2 The statements connected to the thesis are detailed under subsection 3.2.

contaminations – e.g. the water bases in the neighbourhood of a settlement. This way, waste management has become an individual duty of the population of the settlement, including the tasks of waste collection, transportation, processing and decontamination.

Thesis 2. *The aims of compliance with the public health and environmental regulations in force, and the minimization of environmental burdens remained important for waste management, but a new priority has emerged due to the socio-economic changes: the enforcement of environmental-economic principles has become more important, such as prevention, recycling, re-utilisation and re-use. Modern industrial societies had to realise that in the age of less and less natural resources the environmental activities can mean actual savings, and they can be the fundamental tools of modernising the economy and increasing competitiveness. Consequently, the attitude towards materials and waste had to be changed as well, focusing more on the conscious management of natural resources in contrast with the wastage of raw materials.*

Figure 1. summarizes the problems and the relevant socio-economic answers related to waste production, clearly illustrating the cyclical character of the process.

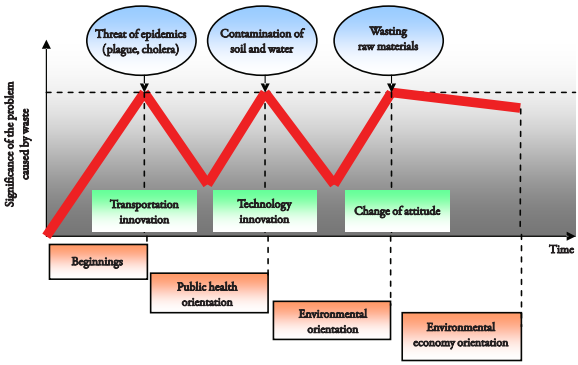

Figure 1.: The main phases of managing waste as a problem source
Source: edited by the author

There is a present and increasing demand for the utilisation of waste as secondary raw materials and source of energy. That is why we have to pay a special attention to the treatment and further utilisation of communal solid waste and industrial waste, as those materials mean a source of energy renewing regularly

in the short run while the amount of mineral raw materials decreases constantly. Realising all the above, the environmental and waste management approach has emerged in respect of the treatment of industrial and communal solid waste:

- The essence of production-integrated environmental protection is the prevention of creating industrial waste which requires treatment and deposition. One of the most effective methods to achieve this is the closed waste management within the industrial site.
- The most important element of product-integrated waste management is the creation of the optimal conditions for closed-cycle material management of waste, by designing the products for best recycling performance.

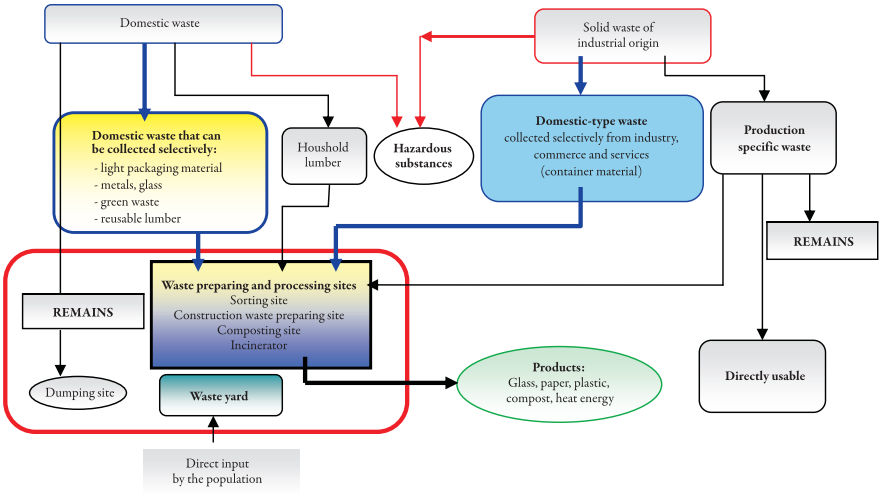

Figure 2: Waste management system for solid communal waste
Source: Csöke-Böhm-Kiss 2000:4.

The demonstrated process shows that the collection of communal solid waste is significantly different from that of industrial, production waste, created in a much larger amount. One of the reasons is that production-technology waste is usually created in a concentrated way in large volume. The waste is generated in the course of processes managed and supervised by experts, and prior to collection, adequate pre-treatment methods often take place in accordance with

the requirements of hand over. Industrial waste is usually more homogeneous than communal solid waste, and it contains much less – or don't contain at all – biologically degradable materials which may cause serious problems in the case of storage. Factories and companies must keep records and make reports on waste: it is a registered and controlled process. This type of waste is a significant amount in the raw material and waste management on national level, however, in respect of the topic of the thesis this is not the main issue – despite of being more significant on the level on the national economy. The recording, placement and the decontamination of industrial waste is well regulated in the laws in force[3] and there is proper professional background for the implementation of such regulations. Summing up, the treatment of industrial waste in the framework of production-oriented environmental protection is significantly more efficient and "easy handling" category than the treatment of solid household waste.

In the case of communal waste generated by the population and by the institutions, the way of waste creation and collection is different than the practice related to industrial waste. The special features of the process are: it mostly takes place on public ground, in the public, the provision and the use of the services is mandatory[4]. Because of the special character of the product-integrated waste management process, in the course of the collection and the treatment of the waste, the tracing of the waste requires constant control, since we can't regulate in details the activity itself. Nevertheless, this task can't be managed by the inhabitants or the local government, as they are not trained professionally to perform waste management on their territory. It supports the idea of establishing an organisation suitable for the coordination of this duty with due account to all of the influencing factors (prices, technical parameters, regulations etc.)[5].

Based on the examination of the results of ecology and of technical geosciences, it has become clear for me that the waste management problems mentioned

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3 The government decree 164/2003.(X.18.) Korm. deals with the records related to waste. According to the law, the *producer, holder and the handler* of the waste shall keep up-to-date records by site concerning the quantity and the composition of all waste produced during its activity, received by other means, handed over by others, and handled by him.
Records must be reported annually not later than the 1st of March after the relevant year, and the failure to make the report results in the obligation to pay *waste management fine*.

4 Users must use the public service of waste transportation on the basis of the Act XLIII of 2000 taken effect on 1 January, 2001.

5 The model proposed for the coordination of the task in shown in subsection 3.3.4.

above can primarily be solved by applying the system approach that has already proved its benefits elsewhere.

The creation of a system-model begins with defining the element suitable for the collection and the systemisation of information, since we need input of adequate quantity and quality to start a series of decisions aimed at the establishment of a regulated system. It is followed by the definition of the part where the data and information are processed, supporting well founded decisions. Finally we must define the system element responsible for giving feedback to the decision-makers, in order to pass a relevant decision.

After defining the logical foundations of the system-model, I chose the methods of analysing documents and preparing case studies to perform the necessary elements of the research. At the same time – because the solutions with system approach always require the application of a multidisciplinary knowledge base – I used the knowledge of planning and analysis gained in my technical, environmental, and economic studies.

Presentation of the Research and the Results

The first step of creating the system model – in the phase of sensing and data collection – we need to apply a complex system of information collection and processing: in my system this is the waste analysis which can be used as a kind of "stock estimation", in the course of which we can monitor the amount of the waste-components available as well as their composition according to particle-fractions, in order to manage the depository capacity or to determine the amount of reusable materials.

Thesis 3.

Waste analysis, therefore, must be one of the determining bases of raw material management and of technological planning. To supply adequate data for decisions to be made in the course of planning, it takes more detailed examinations than defined in the methodology contained in the relevant standards6. When the waste analysis used in the planning is not more detailed than the standard, the information available will surely be less than enough to elaborate the most effective – i.e. the optimal – technology line. That is why I propose – on the basis of the experiences of the research performed – to make a detailed waste analysis before planning regional systems or other waste processing facilities, in order to separate the screen fractions

6 MSZ 21420-29:2005

under 150 mm into smaller fractions, by using screens of decreasing size by 10-15 mms, and to analyse those fractions by material components on the basis of their biological, chemical, and physical features.[7]

The next steps of the system model are data analysis, processing and evaluation. It can be performed by applying the approach used in raw material management and system approach. Raw material management means a complex decision preparing, managing and implementing activity encompassing all phases of the all the processes during the activity, including the harmonisation of economic demands with the raw material resources available on the basis of the laws of supply and demand.

Waste management requires the same system approach, as there we have to plan systems by answering the question what expenditure is worth spending on obtaining from the waste the materials for further use? Actually today almost everything is feasible technologically, but we have to examine if the obtaining of materials for further use is profitable or not. *Consequently, well founded decisions also in the field of waste management require calculations with a similar function as the exploitability calculations used for a long time in the management of raw materials and mineral stocks. One should also take account of the fact, however, that the task of waste collection and treatment is a mandatory service to be performed and used on the basis of statutory obligations*[8]*. Therefore, in the case of waste management, this process requires a complex cost-benefit analysis*[9] *which – in contrast with raw material management – offers analytic and decision-making support not for deciding on exploitability, but for choosing the operational method granting the most effective way of complying with the various obligations*[10]*.*

Thesis 4.

At present, the waste treatment procedures complying with the laws in force are extremely complex and complicated, therefore they require a high amount of funds to invest, the local governments – obliged to perform such waste treatment – can only make with the help of significant support from the EU or the government. In addition to that, the costs of operating the projects can not be covered by the incomes resulting from waste collection and treatment and from the income from selling secondary raw materials and energy. That is why various

7 The statements connected to the thesis are detailed in subsection 4.1.

8 See the provisions of Act XLIII of 2000.

9 See the details of the relevant calculations in subsection 2.1.6.

10 The statements connected to the thesis are detailed under subsections 3.2.2. and 4.3.

subventions are necessary to compensate the lack of funds.

Thesis 5

Based on the above principles, in the course of planning waste management systems and during making decisions on obtaining secondary raw materials, the calculations used in the primary raw material management must be corrected the following way: the costs of transportation and preparation – altogether the costs of waste treatment – should not exceed the amount of the actual price on the world market plus the amount of subventions in force in the relevant period. Consequently, while in the case of raw material management the efficiency of the exploitation is determined by the world market price, in the field of waste management, it is state intervention – through subventions and sanctions – that determines and influences the technical level of the waste management systems as well as of the potentials of enforcing long-term environmental aspects.

The world market price is formed by internal market automatisms based on the relation between supply and demand. The proper operation of the subvention system requires a mechanism similar to the market pricing automatism, in order to make decisions and apply the necessary corrections on the basis of comparable information in place upon the waste analysis and the cost-benefit analysis performed.

Fixing subventions is a complex and dynamic process of analysis and optimisation, in the course of which we must take into account the reasonable and the sustainable utilisation of both the economic and the natural resources. It means that when the level of the subventions is extremely high, the economic resources are used in a wasteful way, and when the level of the subventions is too low, then – due to reasons of efficiency – the formation and the operation of environmental and waste management systems, necessary for the protection of natural resources, are jeopardised.

As a result of the tools of traditional marketing formed after the recurring overproduction crises in the late 19th and the early 20th centuries, the actors of the economy automatically perform the collection and the feedback of information necessary for the production and the distribution, for the sake of safeguarding the market balance. On the other hand, the collection of information needed for the elaboration of the adequate form and the level of the subventions is not very important for the business organisations, however, it is necessary for making the right decisions. This duty can be performed by eco-marketing – formed in the last decade – the ideology of which is very similar to the philosophy of the

self-regulating system securing the operation of the biosphere, and the set of its tools is almost identical with the traditional marketing methods. Due to this two sidedness, eco-marketing can support the automatic optimisation of the level of state-induced or external interventions for the determination of subventions, just like the traditional marketing facilitates the formation of balance between supply and demand in the business sphere.

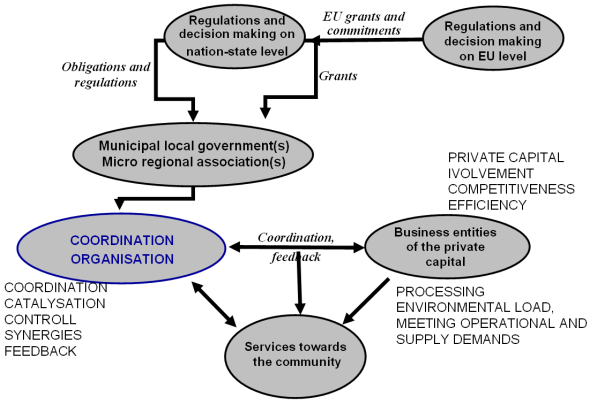

Figure 3: Structure of the coordination model
Source: edited by the author

Thesis 6

I *propose to set up a regional coordinator organisation to perform the functions presented, within the legal framework detailed in the dissertation*[11]*. A practical example for that is the existing network of agricultural integrators, organised and supervised by the Ministry of Agriculture and Rural Development*[12]*. It should be different in the case of waste management by covering not only the business sphere, but the local governments and their associations as well, as they can't be handled*

11 The statements connected to the thesis are detailed in subsection 4.2.

12 Integration: cooperation regulated in general by a medium or long term contract for one year or more, based on the mutual economic interest of the parties, where one of the contracting parties (the integrator) offers market- and/or production security for the other contracting party (the integrated party), and gives various services and/or financing to support the private agricultural producers or companies. The integration can be either horizontal (between agricultural producers of the same production activity) or vertical (between activities built on each other concerning a give product line), or a combination of the above. The participants of the integration take common risk to a certain degree. (Source: based on Annex 5 to the Decree 3/2003. (I. 24.) FVM)

according to the regulations pertaining to the companies. Therefore it would be much better to use the concept of coordination, which means the process of harmonising the mutual interests of more parties, thus fulfilling an intermediary function between public administration and the business sphere[13].

It is the essence of the coordination model to promote the enforcement of the idea of system approach and the long term community requirements – e.g. by fixing the adequate level of subventions – and at the same time it does not exclude – indeed, it includes – the competition forming the market balance. Through the feedbacks and interactions generated by the coordination organisation, the cooperation between the participants of the system can be regulated, by defining the way of collecting, forwarding, processing and using information. In addition to that, it offers feedback of results to the decision makers and regulators, and it controls the implementation of the objectives in line with the joint interests. Thus, it creates and operates information channels, allowing the information to react automatically to the cooperation, in a short time upon the change. It can create a cooperation framework able of self correction and implementing effective self regulation, enforcing in the long run the interests of natural-economic sustainability.

On the basis of the recent years' experiences, it has become clear that we miss from the structure of the institutional system of waste management a central participant in charge of coordination on national level, who can coordinate the actors of the present waste management market, and who harmonises the implementation of the various tasks resulting from the EU's and the national commitments mentioned above – in particular the EU projects. This organisation should also coordinate the demands for development and create optimal (cost effective) economic conditions in respect of both the investment

13 The global problems occurring more often in the late 60's, early 70's raised a demand for requirements of market rationality in many non-market sectors as well. Using the tools of marketing is the (forced) answer to those "challenges". On the other hand, the significant functional dysfunctions of the developed market economies result in a theoretical demand for a new definition of marketing: instead of / in addition to a market tool serving the purpose of profit making, marketing is seen as a "general" servant of the public good. [...] In theory, the philosophy and the tools of marketing – in their original or adapted form – can manage the preparation and the implementation of an exchange of any type. However, the organic development of marketing can only be found and interpreted in the framework of coordination on the market (Orosdy 1995:144)

and the operational costs[14]. The lack of such an organisation is very marked, as the problem of waste affects all actors of the business sphere and the public sphere and therefore all economic processes occur inversely. Another justification is the long time existence of coordinating organisations, authorities on national level, such as the Hungarian Mining and Geology Office and the Energy Management Office.

The above tasks can be reasonably divided as summarised in table 1:

National tasks	Regional tasks
Establishment of a waste management office supervised by the Ministry of Environment and Water	Harmonising forum of local government association(s)
Elaboration and coordination of a national waste management strategy (quotas etc.)	Selecting the operator in charge of coordination between the actors
Coordination between ministries (Environment and Water, Economy etc.) and other state authorities (e.g. national Development Agency)	Keeping contacts with local decision makers

14 The need for national-level coordination is supported by the fact that according to Act LVI of 1995 and the government decree 53/2003 Korm., the organisations marketing waste must demonstrate a certain degree of recollection rate in order to get exempted from the obligation of paying product fee, and it is managed through the coordination organisations. At the same time, in the case of waste management systems financed from EU support, the capacities of the tools used for selective collection – holders, collection vehicles, sorting sites etc. – are, at present, not in line with the level of the obligation of packaging material recollection. Consequently, the coordination organisations shall offer support for the quantity required for exemption, therefore the specific costs of collection over the threshold of the support are going to increase, and their financing can be jeopardised. To avoid that, we need regulations in the field of waste management as well, similar to the one applied in the energy sector in respect of the establishment of power station capacities. There was a similar system in operation at the time of the 1996's product fee system, where the sorting sites to be established with state subsidy had to prove in advance – with a declaration of intent – that the planed volumes are going to be received there. Thanks to that, the sorting site of Pécs can operate with maximum efficiency on the limits of its capacity.

Elaborating the legal background	Elaborating the legal form
Offering EU and state support	Supportive participation in the licensing procedures
Professional proposal in connection with the establishment of individual waste management regions	Passing a regional decision on the establishment of waste management regions, on the basis of the recommendations by the state
Monitoring implementation	Harmonisation of regional supplementary developments
Central PR	Regional PR

Table 1: National and regional tasks in the field of waste management
Source: edited by the author

Thesis 7

However, in addition to facilitating reasonable management, the state's role taken up can mean a further possibility not presented above. In the field of waste management, it can offer a chance on national level for the optimisation of primary and secondary raw material utilisation, and of obtaining energy from waste, as a result of internal coordination between the Hungarian Mining and Geology Office, the Energy Management Office and the Hungarian Waste Management Office to be set up. Based on the above, it is worth considering proposing the establishment of a National Waste Management Office under the supervision of the Ministry of Environment and Water[15].

To sum up the theoretical research, one can conclude that with the help of the coordination model the legal requirements raised in respect of the operator of the regional waste management system can be met, and at the same time the aspects of competitiveness and community demands can also be fulfilled, serving environmental sustainability and the economic interests, too. This way, a construction can be created where the coordination process ends up in realising the optimum balancing between the economic and the environmental interests of the society.

15 The statements connected to the thesis are detailed in subsection 3.3.5.

Usability of the Research Results

My research was aimed at performing a structuring and systematic work in the framework of which I intended to explore the scientific, technical, economic and legal interrelations of waste management as a multidisciplinary field. One of the most important conclusions of the work done is that waste management market is a special area where the state's regulative and coordinating role is needed, but the freedom of the competition must be maintained as well in order to guarantee efficiency. These requirements could be met by establishing a national Waste Management Office and a network of Coordinator organisations harmonising the regional developments. Such a two-level structure could facilitate economic modernisation and the increase of competitiveness, and also support the improvement of the country's supply of energy and raw materials.

The research results can be used by practising experts, by supplying a methodological basis for planned or operating projects, in respect of making decisions on the method and the volume of processing the waste available: to what level and with what expenditure and energy is it profitable to obtain various waste components, i.e. primary or secondary raw materials – or the combination of the two – should be used.

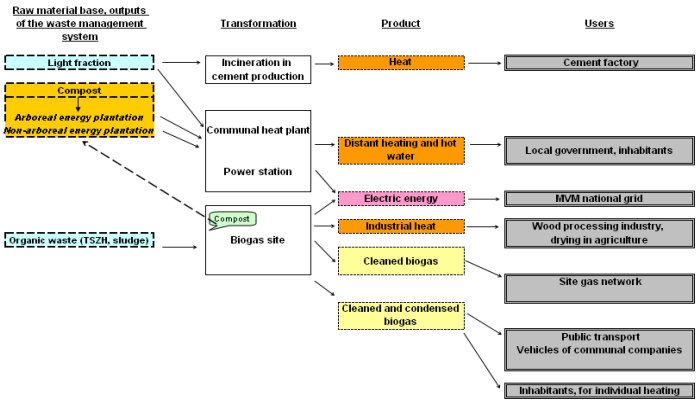

Figure 4: Outputs of the complex waste management system and the possibilities of utilisation connected to settlement management
Source: edited by the author

In addition, it can be used for preparing any environmental or technological development where a system approach is to be emphasized in order to improve efficiency, together with the need to form environmentally and economically sustainable systems.

The application of this model can be in particular useful in regional developments where the joint facilitation of the coordination model and the tools of eco-marketing can harmonise in part the determining theories of economics – the classical one, the concept of Keynes and the neo-liberal one – not on the macro level, but on mezzo level, i.e. in the economic development programmes of the regions and micro regions, primarily with regard to finding local sources to meet the demands of raw materials and energy.

By applying the above detailed approach in the case of regional developments, the solving of the problem can be started from self organisations on regional level towards higher levels.

Thesis 8

It means that the system approach of waste management and its outputs can be channelled as inputs into other economic processes, to form a basis of creating a settlement operation and development model with regional system approach. Similarly, with the application of other technology solutions and the utilisation of potential synergy effects, the demands of a settlement or a group of settlements can be met by using locally available resources. As a result, the municipalities and towns or whole regions utilising such synergies can offer public services with better tariffs, thus making themselves more attractive for investment projects in the productive sector[16]*. This connection is shown in figure 4.*

Thus the system approach can offer competitive advantages, and the resulting economic boom can provide long term development for a settlement or a region. Moreover, if those developments involve research activities as well, with appropriate training and education background they can greatly contribute to the emergence of a knowledge-based economy producing more added value and linked to the locality much more.

This way, the results of the research could also be used in training professionals in the environmental industry and waste management. The system approach and the multidisciplinary approach applied can form a basis for the elaboration of extension trainings and professional educations that offer single trainings where the professionals can get acquainted with a complex set of knowledge in the fields

16 The statements connected to the thesis are detailed in subsection 5.3.

of technology, environment, economics, and social sciences. At present, such knowledge can only be acquired in the course of various individual trainings at different institutions.

The further development of the system approach elaborated in the work could be used as a know-how model to be sold in other regions and countries for the purpose of solving questions of waste management and/or resource management, where the modernisation of the existing infrastructure systems has not been completed yet.

Let me note as a closing remark – although it goes beyond the limits of this work as a statement related to future research – that in my opinion the vertical and horizontal networks and clusters linked to each other, formed on the level of regions, may in the future result in the creation of a "human" homeostasis covering whole continents or the whole Globe, and in a favourable situation it can be a part of the biosphere or it can be linked to that by way of a special symbiosis with mutual interdependence.

Publications Connected to the Topic of the Dissertation

Kiss, T.– Girán, J. [2006.]: ***Local Resources, Local Values; The Pécs ECOCITY – Mecsek-Dráva ECOREGION Program*** **Sustainable Triangle 1.**; Pécs–Graz–Maribor; Sciences, Municipalities, Companies for the Sustainable Future. PTE, Pécs

Kiss, T.- Girán, J. – Tekker T. [2006]: ***Csomagolóanyagok inverz logisztikája a hulladékgazdálkodás szemszögéből (The inverse logistics of packaging materials in the aspect of waste managemen)*** Logisztikai Híradó (prior to publication)

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