Costing-Pricing Methodology of Solid Waste Management Services from Regional Solid Waste Management Bodies in Greece

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Keywords: Regional Solid Waste Management Body, FODSA, costing-pricing methodology

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1. Abstract

The Regional Solid Waste Management Bodies (FODSA) in Greece are the competent agencies which are in charge of temporary storage, transshipment, elaboration and disposal of solid waste. The adoption of cost-pricing models is of great importance for the operation of the Regional Solid Waste Management Bodies, since the rational use of these models will contribute to the improvement of financial management of the Bodies as well as to the tariff rationalization. In this way, the Regional Solid Waste Management Bodies will operate properly on a daily basis and will perform the needed investment program, ensuring thus the best provision of services.

Consequently, the Regional Solid Waste Management Bodies need to implement common costing mechanisms which will rely on the same general rules and principles and will concern all the production processes which are applied for each managerial unity separately and for each provided solid waste management service (temporary storage, transshipment, maritime transport of municipal solid waste, elaboration, waste recovery and disposal of solid waste).

The costing models provide with the cost components which are needed for the establishment of a fair and retributive policy. This policy is necessary for the agencies who participate in the Regional Solid Waste Management Bodies reinforcing the acceptance of the provided services.

Under the above framework, the determination of the pricing policy, which should be adopted by the Regional Solid Waste Management Bodies, will be based on benchmarking cost models and on the current spatial conditions.

The following paper concerns the development of a costing-pricing methodology of waste management services for the Regional Solid Waste Management Body of Central Macedonia. It is a pilot project, which will contribute to the development of the costing-pricing methodology for all the Regional Solid Waste Management Bodies of our country.

The adopted methodological approach for the above project is structured under three distinct Stages which are described as following:

Stage A concerns the description of the current situation of FODSA of Central Macedonia (information concerning workforce, existing operational procedures , legal framework , income-expenditure ,clients , tariff structure , quantities and categories of waste , existing infrastructure , investment programs)

Stage B concerns the evaluation of the collected data and the development of a cost model regarding the supplied services using a specific algorithm.

Stage C concerns the development of a tariff structure regarding the supplied services of the Body.

The pricing policy of the Regional Solid Waste Management Body is determined based on the achievement of goals that the Legislation sets, under the framework of the Regional Integrated Solid Waste Management System. The Regional Solid Waste Management Body is going to apply an integrated pricing policy aiming to provide the Local Authorities with incentives for the reduction of production waste and the percentage increase of the waste recovery rate.

The pricing policy is determined by:

a) The implementation of the principle " the polluter pays",
b) The principles of retribution and transparency
c) The creation of incentives for the reduction of waste volume and dangerousness as well as incentives for the waste recovery- recycling and utilization
d) The fulfillment of all requirements that the Ministerial Decision 29407/2002 sets as it was modified and is valid until today

2. Introduction

2.1. Description of the Regional Solid Waste Management Bodies (FODSA) in Greece

The Regional Solid Waste Management Bodies (FODSA) in Greece are the competent agencies which are in charge of temporary storage, transshipment, elaboration and disposal of solid waste. The goal of a Regional Solid Waste Management Body is the integrated management, according to the Regional Waste Management Plan (RWMP), and more specifically the specialization and implementation of its objectives and actions aiming to the temporary storage, transshipment, maritime transport (of solid waste), elaboration, recovery and disposal of solid waste under specific territorial jurisdiction. The duration time of a Regional Solid Waste Management Body is 30 years.

The Regional Waste Management Plan is prepared and implemented from the Regional Solid Waste Management Body of Central Macedonia and its action lines are briefly introduced in the following table.

Table 1: Action Lines of the Regional Waste Management Plan of the Region of Central Macedonia

	Action Lines of the Regional Waste Management Plan of the Region of Central Macedonia
1	Safe Disposal of Solid Waste
2	Shutdown and restoration of uncontrolled waste disposal sites
3	Emphasis on the achievement of quality and quantity goals for the waste reduction for disposal and elaboration of the organic fraction
4	Fulfillment of specific conditions of work of the Cohesion Fund
5	Operation Improvement of the Regional Solid Waste Management Bodies (FODSA)
6	Development of proposals for the management of special waste streams

7	Updating-awareness and active participation of the citizens
8	Administrative initiatives for the support and promotion of the necessary energies and actions

2.2. Vision - General Goals of FODSA

The vision of a Regional Solid Waste Management Body is the ensurance of the required personnel, for the operation of the planned infrastructure and logistics so that the Body provides integrated solid waste management services efficiently.

The determination of the general rules is necessary, basically under the framework of the following goals such as:

- The optimal use of the environmental policy, as it is determined by the legislative framework
- The minimization of the environmental impacts
- The maximization of the thriftiness of the system operation
- The optimal application of the current technology, as well as the continuous monitoring of the technological advances.

The above Project concerns the support of the Regional Solid Waste Management Body of Central Macedonia for the development of the major legislative framework of pricing policy for the solid waste management services, within the geographical limits of the Body.

The implementation of the above Project aims to the provision of consulting services for technical support towards the development of a costing model of the Solid Waste Management Services as well as the development of a proposal concerning the pricing policy. The development of the costing model and pricing policy framework is a matter of vital importance for the operation of a Solid Waste

Management Body since the rational use of these tools ensures the necessary inflow of revenues for the viability of the Body.

The current Project is expected to have multiplied effects and a special added value both for the services of the Body and the recipients of the services of the Body (Municipalities), since it will contribute both to the improvement of financial management of the Body and the tariff rationalization. Thus, the Solid Waste Management Body (FODSA) will function well on a daily basis, ensuring the best provision of services.

The current legislative framework in Greece regarding the solid management is an adaptation of the Greek Law to the Community Legal Framework.

More specifically the legislative framework defines the terms and prerequisites for:

- Collection and transport of solid waste
- The disposal, utilization and temporary storage and transshipment of solid waste
- The management of dangerous solid waste
- The transboundary transport of solid waste

3. Materials and Methods

The above Project is structured under three distinct Stages where various methods are used for the analysis and are described in details in this section.

The Stage A of the above pilot project concerns the description of the current situation of FODSA of Central Macedonia and refers to the following:

1. The current organizational structure of the Body and its human resources, per organizational unit

2. The operational situation of the Body. There will be provided the way of internal operation of the organizational units and their communication, both in the same unit and with other services and Organizations. The malfunctions and other problems of operations will also be described.
3. The current procedures, the role and responsibilities of the major liability positions.
4. The current institutional and legislative framework that concerns the operation and pricing policy of the Regional Body.
5. The financial statements of the last years.
6. Its clients.
7. The provided solid waste management services.
8. The pricing of its services.
9. Its revenue which come from the annual contributions of the Local Governments, its participation in programs, other revenues from each source such as trading of materials, biogas and renewable sources of energy, imposed fines, investment grants, donations, heritages and bequests.
10. Its expenditures such as: payroll and staff costs, third party expenses , supplies of consumables , taxes, fees and other operational expenses.
11. The quantities and categories of solid waste managed.
12. The current infrastructure as well as those that are under construction.
13. Its investment program.

The methods used for the collection and inventory of the above information are briefly presented below:

- Visits of the project team work to the installations of the Regional Solid Waste Management Body of Central Macedonia.
- Face to face interviews with the responsible bodies.
- Quantitative and Qualitative Analysis of the elements gathered through visits and interviews.

The Region of Central Macedonia is divided in seven regional units which are the following:

1. Regional Unit of Thessaloniki
2. Regional Unit of Kilkis
3. Regional Unit of Imathia
4. Regional Unit of Pella
5. Regional Unit of Pieria
6. Regional Unit of Serres
7. Regional Unit of Halkidiki

The collection and inventory of information concluded that there are 11 landfills, one in the regional unit of Thessaloniki, one in Kilkis, three in Pella, two in Pieria, one in Serres, and three in Chalkidiki. All the operational problems of the landfills were mentioned after visits to each of them and discussions with the competent agencies and the survey showed that two of them have recently stopped working (one in Pella and one in Chalkidiki). Furthermore in two of them , at the Regional Unit of Pieria the Body is not in charge of the Operation of the Landfills yet. The rest of them are working directly under the supervision of the Regional Solid Waste Management Body of Central Macedonia or through contracts with Municipalities or contractors. In addition, there are three active transfer stations (two in Serres and one in Chalkidiki), one material sorting center which has recently stopped working in Thessaloniki and two Environmental Parks in Thessaloniki as well.

The amount of waste that each landfill gathers is analytically presented in the following table:

Table 2: Total Weight (tons) of solid waste in Central Macedonia

Total Weight (tons) of solid waste in Central Macedonia	
Landfill	**tons 2014**
Kassandra	5.150
Anthemounta (Triglia)	39.571
Poluguros	23.781
Kilkis	30.752
Serres	55.739
Mavroraxi	422.917
Giannitsa	34.753
Edessa (Almopia, Naousa, Skydra)	33.202
Katerini*	37.246
Litohoro	No data is available
Total	**683.111**

***Given Data is not valid**

As it becomes apparent from Table 2, 422.917 tons of waste concern the Regional Unit of Thessaloniki corresponding to 62% of the total amount of waste.

3.1. Current Pricing Policy of the Regional Solid Waste Management Body

The pricing policy of the Regional Solid Waste Management Bodies is developed based on the achievement of goals that the Legislation sets under the framework of an Integrated Solid Waste Management System. The Regional Solid Waste Management Body should apply an integrated pricing

policy aiming to provide the Local Authorities with incentives for the reduction of production waste and the percentage increase of the waste recovery rate.

The annual cost management concerning the managerial unit is approved from the Board of Directors of FODSA and the provided services cost is calculated annually in €/ton.

More specifically the annual managerial cost of FODSA is divided into the following costs :

- The annual operating cost of FODSA.
- The costs that refer to the closure and post-closure costs of the landfills, which are calculated based on the characteristics of each installation, according to feasibility studies.
- The costs that refer to the construction and investment program of FODSA.

The Solid Waste Management Body of Central Macedonia provided with the following table concerning its current pricing policy:

Table 3: Current Pricing Policy

County	**Price/ton**
Thessaloniki	22 €
Imathia	20-25 €
Kilkis	23-25 €
Pella	20-25 €
Pieria	-
Serres	20 €
Chalikidiki	33 €

As it is obvious from Table 3 the prices are different in the seven regional units. Moreover, the current pricing policy does not possess adjustment mechanism and includes only the Municipalities since the

prices for the private sector are not included. In addition, the current pricing policy refers only to the landfill service and does not include the other services that the Solid Waste Management Body could provide.

The Stage B concerns the evaluation of the collected data and the development of a costing model regarding the supplied services using a specific algorithm.

During the second stage of the Project various methods were used in order to evaluate the collected data and proceed to the development of the costing model. More specifically, the methods of financial analysis, statistical analysis as well as benchmarking comparison are described in detail below.

Table 4: Revenues of the Body

REGIONAL UNIT	RETRIBUTIVE REVENUES	PRIVATE REVENUES	REVENUES FROM BIOGAS	RECYCLING REVENUES	INTEREST REVENUES	OTHER REVENUES	TOTAL REVENUES
THESSALONIKI	6.018.945	401.098	232.632	12.222	163.808	2.491.792	9.320.497
PELLA	1.010.000	7.013	0	0	1.195	0	1.018.208
KILKIS	667.000	288.205	0	0	565	0	955.770
SERRES	1.115.961	0	0	0	956	0	1.116.917
CHALKIDIKI	2.148.300	0	0	0	1.231	0	2.149.531
PIERIA	0	0	0	0	0	0	0
IMATHIA	630.000	0	0	0	0	0	630.000
TOTAL	11.590.206	696.316	232.632	12.222	167.755	2.491.792	15.190.923

Conducting the financial analysis of the revenues, the most important deductions of the Table 4 are the following :

1) The revenues of the Body come mainly from the retributive contributions of Local Authorities (76% of total revenues).
2) Apart from the Regional Unit of Thessaloniki, the other units do not have any revenues from the sectors of recycling and selling biogas.
3) The private revenues consist of 4,6 % of the total revenues from waste management, while the amount of waste approaches as well 4,5 % of the total amount of waste managed.

4) The Regional Unit of Pieria does not have any revenues (however it does not also have expenses since the Body has not been actively involved yet in the waste management process).

5) The category of other revenues in Thessaloniki Region is captured with extremely high revenues since it includes the amount for the payment of compensating benefits.

Table 5: Administrative-Financial Costs

ADMINISTRATIVE-FINANCIAL COST (OVERHEADS)		SUM OF TONS	COST (€)
		FODSA /PER YEAR	PER Ton
PAYROLL AND STAFF COSTS	895.356,00	683.325	2,75
THIRD PARTY EXPENSES	236.117		
UTILITIES	127.354		
CONSUMABLES	61.852,00		
OTHER EXPENSES	232.398,00		
INVESTMENTS	234.464,00		
DEPRECIATION	0,00		
VAT	90.584,00		
TOTAL	1.878.125,00		

Table 6: Expenses related to Landfills and Waste Transfer Stations

SERVICES OF LANDFILL -WASTE TRANSFER STATIONS	R.U. THESSALONIKI	R.U. SERRES	R.U. CHALKIDIKI	R.U. KILKIS	R.U. PELLA	R.U.PIERIA *	R.U.IMATHIA*
TOTAL TONNAGE (Ton)/YEAR	422.917	55.818	68.502	30.752	68.157	37.246	0
PAYROLL AND STAFF COSTS	1.511.094,00	118.762	127.816	10.117	12.143	0	0
THIRD PARTY EXPENSES	14.500,00	179.398,00	1.004.810,00	123.127,00	607.011,00	1.151,00	11.938
UTILITIES	638.100,00	106.288,00	45.812,00	154.898,00	53.855,00	0,00	2.335,00
CONSUMABLES	615.050,00	63.740,00	21.700,00	107.493	0,00	0,00	0,00
VEHICLES FEES	16.059,00	2.640,00	5.941	0,00	186	0	0
OTHER EXPENSES	16.739,00	301,00	6.007,00	3.227,00	0,00	0,00	4.000,00
VAT	235.139,00	52.911	166.700,00	46.976	80.675	265,00	3.687,00
INVESTMENTS	1.580.000,00	0,00	0,00	0,00	0	0,00	0
DEPRECIATION **	2.700.000,00	1.915,00	11.354,00	3.996,00	10.180,00	0,00	0,00
TOTAL OPERATING COST	7.326.681,00	525.955,00	1.390.140,00	449.834,00	764.050,00	1.416,00	21.960,00
OPERATING COST/TON	17,32415817	9,422677273	20,29342209	14,62779657	11,21014716	0,03801751	
* IN THE REGIONAL UNITS OF PIERIA AND IMATHIA THE DATA ARE NOT VALID							
R.U. : REGIONAL UNIT							
** the majority of the assets of the Body have been derived through co-financed programs and consequently the amount of 2,5 million € returns as special income since the assets are sponsored.							

Table 7: Green Services-Recycling Expenses

GREEN SERVICES (PARKS)		SUM OF TONS/YEAR	COST(€)
		R.U. THESSALONIKI	PER Ton
PAYROLL AND STAFF COSTS	950.118,00	422.917	
THIRD PARTY EXPENSES	0		
UTILITIES	108.994,00		
CONSUMABLES	1.314,00		
OTHER EXPENSES	656,00		
INVESTMENTS	0,00		
DEPRECIATION	0,00		
VAT	817,00		
TOTAL	1.061.899,00		2,5108922
RECYCLING SERVICES			
PAYROLL AND STAFF COSTS	1.014.080		
THIRD PARTY EXPENSES	0,00		
UTILITIES	23.264,00		
CONSUMABLES	0		
OTHER EXPENSES	970,00		
INVESTMENTS	50.000,00		
DEPRECIATION	0,00		
VTA	1.057,00		
TOTAL	1.089.371,00		2,5758506
COMPENSATING	1.909.726,00		4,5156047
TOTAL	4.060.996,00		9,6023475

Based on the financial analysis of the expenses through the Tables 5-7, the following deductions are observed:

1) Apart from the Regional Unit of Thessaloniki, the other Units do not present great amounts of depreciation. Based on the chartered accountants' assessments of the properties of the various Regional Units, it turns out that complete transfer of the assets of the Regional Units

has not been achieved. In these assessments , there are some amounts that agree or approach the numbers of Table 6 (such as in Serres) whereas in other assessments the amounts seem to be devalued (such as in Chalkidiki where the amount of depreciation should overcome 100.000 €). In general, the depreciation of the assets of the Body, excluding the Regional Unit of Thessaloniki, is low because only their use has been assigned from the Local Authorities without the respective property. In addition, the majority of the assets of the Body have been derived through co-financed programs and consequently the amount of 2,5 million € returns as special income since the assets are sponsored.

2) Regarding the Regional Units of Pieria and Imathia ,as presented in Table 6, the appeared expenses are substantially non-existent . The respective expenses for the Regional Unit of Imathia concern the Regional Unit of Pella.
3) Regarding the Regional Units of Pella, Serres and Kilkis the appeared expenses, as it seems from Table 6, are low enough, therefore any costs,that have not been included, should be investigated .
4) The category of Taxes-Fees presents high numbers owing mainly to VAT (value added tax), which is regarded as expense in case of FODSA and this expense should consist of distinct cost while building the costing model.
5) The category of payroll and staff costs presents, apart from the Regional Unit of Thessaloniki(where it is extremely high), low assessment. In all other Units the above category is covered from contractors (third party expenses) or from the Local Authorities (through special agreements) . These agreements, have not already been accounted, however they should be included in any case.

6) The information presented at Table 7 refers, at the current period, only to the Regional Unit of Thessaloniki.

Table 8: Indicators

REGIONAL UNIT	LANDFILL	WASTE	POPULATION	PRODUCTION OF WASTE
		tn/year	(NUMBER OF RESIDENTS	PER PERSON
THESSALONIKI	MAVRORAHI	422.917	1.104.460	0,382917444
PELLA	GIANNITSA	34.753	111.002	0,313084449
PELLA	EDESSA	33.202	83.330	0,398439938
KILKIS	KILKIS	30.752	78.975	0,389389047
SERRES	SERRES	55.739	176.050	0,316608918
HALKIDIKI	POLIGIROS	23.781	43.605	0,545373237
HALIKIDIKI	TRIGLIA	39.571	62.297	0,635199127
PIERIA	KATERINI	37.246	101.530	0,366847237

Table 9: Indicators (KPIs)

REGIONAL UNIT	THESSALONIKI	SERRES	CHALKIDIKI	KILKIS	PELLA	PIERIA*	IMATHIA*
SUM OF TONS/YEAR	422.917	55.818	68.502	30.752	68.157		
PAYROLL AND STAFF COSTS	1.511.094,00	118.762	127.816	10.117	12.143		
PERSONNEL INDICATOR / Ton	3,573027332	2,127664911	1,865872529	0,32898673	0,1781622		
THIRD PARTY EXPENSES	14.500,00	179.398,00	1.004.810,00	123.127,00	607.011,00		
THIRD PARTY INDICATOR / Ton	0,034285687	3,213981153	14,66833085	4,00386967	8,9060698		
INDICATOR (Personel&Third party)/Ton	3,607313019	5,341646064	16,53420338	4,3328564	9,084232		
FUELS OF VEHICLES	446.248,56	52.676,21	19.826,49	82.675,76	0,00		
INDICATOR OF FUEL /Ton	1,055168177	0,943713677	0,28942936	2,68846774	0		
CHEMICAL MATERIAL	39.039,30						
INDICATOR OF CHEMICAL MATERIAL /Ton	0,092309602						
ELECTRICITY	197.525,87	81.689	34.003		47.061		
INDICATOR OF ELECTRICITY /Ton	0,467055876	1,46348848	0,496379668	0	0,6904793		
COATING MATERIAL		8.267,42					
INDICATOR OF COATING MATERIAL /Ton	0	0,14811387	0	0	0		
VEHICLES' MAINTENANCE	244.563,63	12.311,12	1.270	11.851,70			
INDICATOR OF VEHICLES' MAINTENANCE /Ton	0,578278078	0,220558243	0,018539605	0,38539607			
INSTALLATIONS' MAINTENANCE	35.630	9.170,79	6.288	5.800			
INDICATOR OF INSTALLATION'S MAINTENANCE /Ton	0,084248209	0,164298076	0,09179294	0,18860562			
INVESTMENTS (OWN- RESOURCES)	1.580.000	0	0	0	0		
INDICATOR OF INVESTMENTS/Ton	3,735957647						
DEPRECIATION	2.721.663	1.915	11.354	3.996	10.180		
INDICATOR OF DEPRECIATION/Ton	6,435454238	0,034307929	0,165746985	0,12994277	0,149361		

Conducting the statistical analysis in Tables 8 and 9 the following observations are presented:

1) Regarding the Regional Unit of Thessaloniki, the average production waste per person (0,38) approaches the average European production index .

2) Regarding the Regional Unit of Chalkidiki , the average production rate is especially high (0,54 and 0,64) which is probably owing to the intense touristic activity developed in this unit. However, the production rates per person for the other Regional Units are close to that of the European production index.
3) As it is obvious from Table 9, there are not indicators for all Regional Units since there are expenses included in other Costing Units, therefore further investigation should be conducted.
4) There are differences among the indicators due to local particularities and differences concerning the solid waste management process. However, in some categories (such as in fuels and electricity) the difference among the indicators is not justified.
5) Regarding the Regional Units of Pieria and Imathia, there are not indicators due to the existence of related data.

In Table 10 , comparative costs of landfill in Different Member States are presented

Table 10: Comparative Costs of Landfill in Different Member States (€/ton)

Country	Operational Expenditure (€/ton)	Costs (excl tax) (€/ton)	Gate Fees (excl. tax) (€/ton)	Tax (€/ton)	Total Costs (incl. tax) (€/ton)	Tendency (costs excl. tax)
AU		67		43	110	Rising due to tax and improvements at old sites. Also, standards for pre-treatment imply diminishing importance
BE (FL)			47.5	52-55	100	Becoming less relevant for MSW due to bans

Country	Operational Expenditure (€/ton)	Costs (excl tax) (€/ton)	Gate Fees (excl. tax) (€/ton)	Tax (€/ton)	Total Costs (incl. tax) (€/ton)	Tendency (costs excl. tax)
BE (Wa)		45			45	
DK			44	50	94	Becoming less relevant for MSW due to bans
FI	4		37-46	15	52-61	Likely to become less relevant due to incoming bans
FR	3-5 (for 100 ktpa) 6-8 (for 20 ktpa)	31-85 (high for low rates of input)		9	40-94	Ban for 'ultimate waste' due to come into force
GE	7.3 (for 300 ktpa)	20 (for 300 ktpa) 51 (for 50 ktpa)	35-220		30-51	Gate fees in turbulent state-costs likely to remain broadly constant. Standards for pre-treatment imply diminishing importance
GR	1.5-15 (larger for lower rates of fill)				9-30	Costs likely to increase significantly in coming years due to Landfill Directive
IR	13 (approx. 100 ktpa at 2 million cubic metre site)		35-78	19	60-95	Costs have increased significantly in recent years

Country	Operational Expenditure (€/ton)	Costs (excl tax) (€/ton)	Gate Fees (excl. tax) (€/ton)	Tax (€/ton)	Total Costs (incl. tax) (€/ton)	Tendency (costs excl. tax)
IT	13 (125 ktpa at 1.25 million cubic metre site)	52 (at 1.25 million cubic metre site)		Varies	70-75	Underlying costs increasing due to Landfill Directive
LUX	35-43 (40 ktpa and 32 ktpa respectively)	123 (40 ktpa in 400.000 cubic metres) 147 (32 ktpa in 400.000 cubic metres)			123-147	Underlying costs unlikely to change much
NL			43-100 (avge 75)	64	107-164	Becoming less relevant due to bans on landfilling MSW
PO			6-15 (est)		6-15	Costs likely to increase significantly in coming years due to Landfill Directive
SP		25-35 (est,	6-40		25-35	Costs likely to increase significantly

Country	Operational Expenditure (€/ton)	Costs (excl tax) (€/ton)	Gate Fees (excl. tax) (€/ton)	Tax (€/ton)	Total Costs (incl. tax) (€/ton)	Tendency (costs excl. tax)
		depending upon revenue from energy recovery)				in coming years due to Landfill Directive
SW			20-60	30.6	50.6-90.6	Combustible waste cannot be landfilled from 2002, organic waste cannot be landfilled from 2005
UK	6.5-8 (up to 250 ktpa) 3-4 (500 ktpa)	28 (175 ktpa at 1.75 million cubic metre site)	8-35	19.2	40-48	Costs likely to increase slightly in coming years due to Landfill Directive (also, older, lower costs sites filling up)

[1] Where only gate fees are available, this is based on estimated average gate fees

[2] Estimate based upon assumption of complete pass-through of landfill tax

[3]Varies by region (and sometimes, degree of source-separation in municipality or level of pre-treatment)

[4]The costs quoted are for landfilling inclusive of mechanical biological pre-treatment

[5]The costs are estimated for new landfills of different size and fill rates. Older landfills (still operating) have lower costs associated with aftercare and other items.

The gate fee paid represents a unit (usually per ton) payment made by the local authority to the service provider to generate a stream revenue. As it is obvious from Table 10, gate fee is not mentioned in case of Greece since the enforcement of the gate fee has been suspended until 31/12/2015.

4. Results and Discussion

4.1. Costing Model

4.1.1. Selection of Key Parameters for the costing model design

Selection of spatial scale for the calculation of costing model

The analysis conducted during the first stage of the Project as well as during the beginning of the second stage showed that the procedures related to the operation and administration of the installations of the Body should be homogenized in all the Regional Units. Through the analysis of the first stage of the Project, it turned out that waste of Local Authorities of the same or different Regional Units are processed in different installations within the same regional unit (for example landfills of Giannitsa and Edessa). Therefore, the Body should, for operational and financial reasons , concerning the flexibility of the Body, as well as the improvement of the operational situation of its installations and income,

proceed to a unified pricing within every Regional Unit. Thus, the design of the costing model will be organized within the spatial geographic scale of the Regional Unit.

Selection of cost modules

Since the costing model is structured within the scale of the Regional Unit, all the cost modules concerning each regional unit should be investigated. These modules, according to what has been mentioned in the previous analysis, are dealing with:

a) The operational managerial cost, which depends on the direct operational managerial expenses of the managerial installations that have been chosen at each regional unit
b) The administrative-financial costs (Overheads), related to the cost concerning the central administrative, financial and technical support of the Body in its regional structures
c) The Environmental cost that includes the "sustainability costs" which are accrued by the subsequent management method
d) The Investment cost, that concerns the necessary investments for the development of infrastructure, concerning new management technologies or the modernization of current technologies
e) Outlays that do not concern any of the above modules, which though are incorporated in the overall management cost and should be recovered.

4.2. Analysis of Cost Modules

According to the above assumptions, the analysis of each cost module, separately, is described below:

4.2.1. MODULE OF OPERATING MANAGEMENT COST

The installations of the Body in all the regional units (apart from the regional unit of Thessaloniki) concern landfills. The operational management cost of a landfill is divided in the following costs:

- Energy cost
- Payroll and Staff Costs
- Coating Material
- Operation –Machinery Maintenance
- Maintenance/Restoration Damage
- Cost of leachates treatment units (chemicals /maintenance)
- Machinery Operational Cost
- Environmental Monitoring Cost
- Third Party Expenses
- Infrastructure Insurance
- Taxes
- Machinery Depreciation
- Other Expenses

4.2.2. Administrative-Financial Cost Module of the Body

The expenses that should be included when calculating the administrative-financial cost, deal with the total cost that concern the central administrative, financial and technical support that the Body will provide horizontally in all of its regional structures. This cost is divided in the following costs:

- Payroll and Staff Costs
- Third Party Expenses

- Utilities
- Taxes-Fees
- Other Expenses
- Consumables
- Investments
- Depreciation

The cost calculation coming from the allocation of the above expenses will be distributed ,proportionally per ton of waste managed, in all regional units divided by the sum of tons of waste managed by the Body.

4.2.3. Environmental Management Cost

The Environmental Cost, includes each time the “sustainability costs” that are caused by the management method related to landfills

During the current period, the Body is in charge of the landfills without any previous treatment of waste in all the regional units. The direct monetary cost of the landfill should be calculated according to the Community Directive 99/31 (concerning the landfill) , that has been incorporated in the Greek Law with the Joint Ministerial Decision 29407/3508 (Measures and terms for the landfill). The landfill cost should include, apart from the direct operational project costs, the so called “sustainability costs”. The sustainability costs are those that ensure the smooth and environmentally safe operation of the project in both the operation phase and the post-closure phase. Simultaneously , the sustainability costs ensure the construction of the new cells. Thus, the above costs should include the project closure cost, the post closure cost, the construction cost of a new landfill (cell), which will be ready at the end of the operation as well as the depreciation of the national participation, in the occasions of projects co-financed by national and community resources.

In addition, according to the Law 4042/2012 and more specifically the article 43 predicts that the organizations or enterprises which dispose specific categories of waste in landfills (waste without previous treatment operations) are charged from the 1st January 2014 with paying a special burial fee per ton of waste disposed. The special burial fee is defined in 35 Euros per ton of waste disposed and is increased annually by 5 Euros per ton by the amount of 60 Euros per ton.

The residues of processing operations, which are disposed in the landfills, are not charged with the special burial fee. The special burial fee of waste is deposited at the "Green Fund" of the Law 3889/2010 and is disposed exclusively for the funding of programs and projects concerning the recovery and disposal of waste.

The application of the above legislative provision has been suspended until 31/12/2015 as executives of the Body mentioned on request of the Central Union of Municipalities and Communities of Greece. The above suspension does not imply cancellation of the specific prediction, which is though a Community Law Requirement.

Thus, the environmental cost consists of the following individual costs:

A) **Closure cost**

The closure cost of the already active landfills charges exclusively its users. This cost must be estimated each time, based on the relevant specifications of each landfill (required rehabilitation surface). This cost should be retrieved within the total years of operation of each landfill, thus, there should be an added operational financial reserve per year of operation of landfill. The operational financial reserve will arise based on the initial calculation of the closure cost per ton multiplied by the tons of waste managed per year. The initial calculated closure cost per ton of waste arises from the division of the predicted closure cost to the total predicted sum of tons of waste managed during the total operation of the landfill.

B) **Cost of the new landfills (cells)**

At the end of the operation of the current cells of landfills, new cells should be constructed. The construction cost of the new cells is estimated based on the market requirements for new spaces, foreclosure, expansions of the biological treatment etc.) for a predicted lifetime of at least 10 years. This cost should be retrieved within the years of operation of the current landfills (cells) , thus an extra operational financial reserve per year of operation of landfill should be estimated. The operational financial reserve will arise based on the initial calculation of the construction cost of the new landfills per ton managed multiplied by the sum of tons of waste managed per year. The initially estimated construction cost per waste managed of the new landfills (cells) arises from the division of the predicted construction cost to the total predicted sum of tons of waste managed during the total operation of the landfill (cell).

C) **Post-closure cost**

The post-closure cost of the landfills, which will have a duration of 30 years, includes the expenses after the end of the operation period. During the post-closure phase the following costs should be calculated:

- Monitoring costs (estimated in 50 % of the monitoring cost during the function of the landfills)
- Maintenance costs (estimated in 3 % of the construction cost annually)
- The insurance cost of the project for the closure and post-closure phase (estimated in 2 % of the closure cost per year)

During the post-closure period, which is 30 years, the expenses of Table 11 should be covered:

Table 11:Post- Closure Expenses

POST-CLOSURE YEARS	**30**
INSURANCE COST (1% OF THE CLOSURE COST/YEAR)	
MONITORING COST (50% OF THE MONITORING COST OF THE OPERATION PERIOD/YEAR)	
MAINTENANCE COST - PROJECT OPERATION (1% OF THE CLOSURE COST/YEAR)	
ANNUAL POST-CLOSURE COST (€/ YEAR)	
TOTAL POST-CLOSURE COST (€) (ANNUAL COST * 30)	
POST-CLOSURE COST / OPERATION YEAR (TOTAL OF POST-CLOSURE COST /TOTAL OF OPERATION YEARS)	

Thus, the extra financial reserve per operation year of the landfill, which will concern the post-closure cost/ton of waste managed, will stem by dividing the annual post-closure cost to the total annual sum of tons of waste managed.

D) **Depreciation Cost**

This cost concerns the national participation in the construction cost of the operating landfills and it is estimated as % of the cost of respective projects (the residual value is the calculation basis). This cost should be retrieved within the years of operation of the current landfills, thus an extra operational financial reserve per year of operation of landfill should be estimated. The operational financial reserve will arise based on the initial calculation of the depreciation cost of the projects related to landfills per ton managed multiplied by the total sum of tons of waste managed per year. The initially estimated depreciation cost of the projects related to the landfills per waste managed arises from the

division of the predicted depreciation cost to the total predicted sum of tons of waste managed during the total operation period of the landfill.

E) **Special burial fee**

The special burial fee will be imposed per ton of waste which is disposed without any previous treatment operations.

4.2.4. Investment Cost

The investment cost includes the necessary investments for the development infrastructure concerning new management technologies (Recycling, Composting etc.), or the modernization of current infrastructure, in issues related to the improvement of their operational results (reduction of operational expenses, increase of productivity etc.). The prediction of the above investment cost should be included in the Strategic-Business Planning of the Body, for each Regional Unit separately. The investment cost, per year, will be divided with the total of the predicted sum of tons of waste managed per year for each Regional Unit.

4.2.5. Non-relevant Expenses

Based on the material provided by the Body, it turns out that in the Regional Unit of Thessaloniki and possibly in the future in other Regional Units, there are expenses which do not belong to any of the above categories. These expenses are integrated in the total cost of the Body and in any case they should be distinctive. Such expenses concern:

a. The operation and maintenance of the Environmental Parks (major expenses that are not related to the legislative obligation of post-closure of the relevant spaces and are distant from expenses that concern updating- sensitivity actions of the citizens).
b. Semi-working or non-working services of alternative management (ex. Recycling)

c. The expenses coming from the provision of compensating benefits to the Municipality of Lagada does not stem from any kind of legal obligation of the Body and it may create a cause for similar claims from other Local Authorities, leading to unpredictable financial impacts for the Body.

The above expenses should each time be distinctive per Regional Unit. The cost of these services may be recovered either indirectly (to be included in the total management cost, case of recycling) or directly through program contracts with the beneficiaries of Local Authorities (case of parks) or lastly to be abolished or be differentiated to a great extent (case of compensating benefits).

4.3. Presentation of the Costing Model

The costing model aims to determine the cost price per ton of waste treated. Therefore, all the expenses concerning the operating cost, the administrative-financial cost, the environmental cost, the investments as well as the other provided services of the selected region (Regional Unit) are analyzed and processed.

Under the above framework, special calculation tabs were developed per unit, in which the user fills the spaces. The costing model automatically calculates the operating and monitoring indicators for each module and provides with benchmarking indicators calculating the final amount of the cost per ton managed for the selected region (Regional Unit).

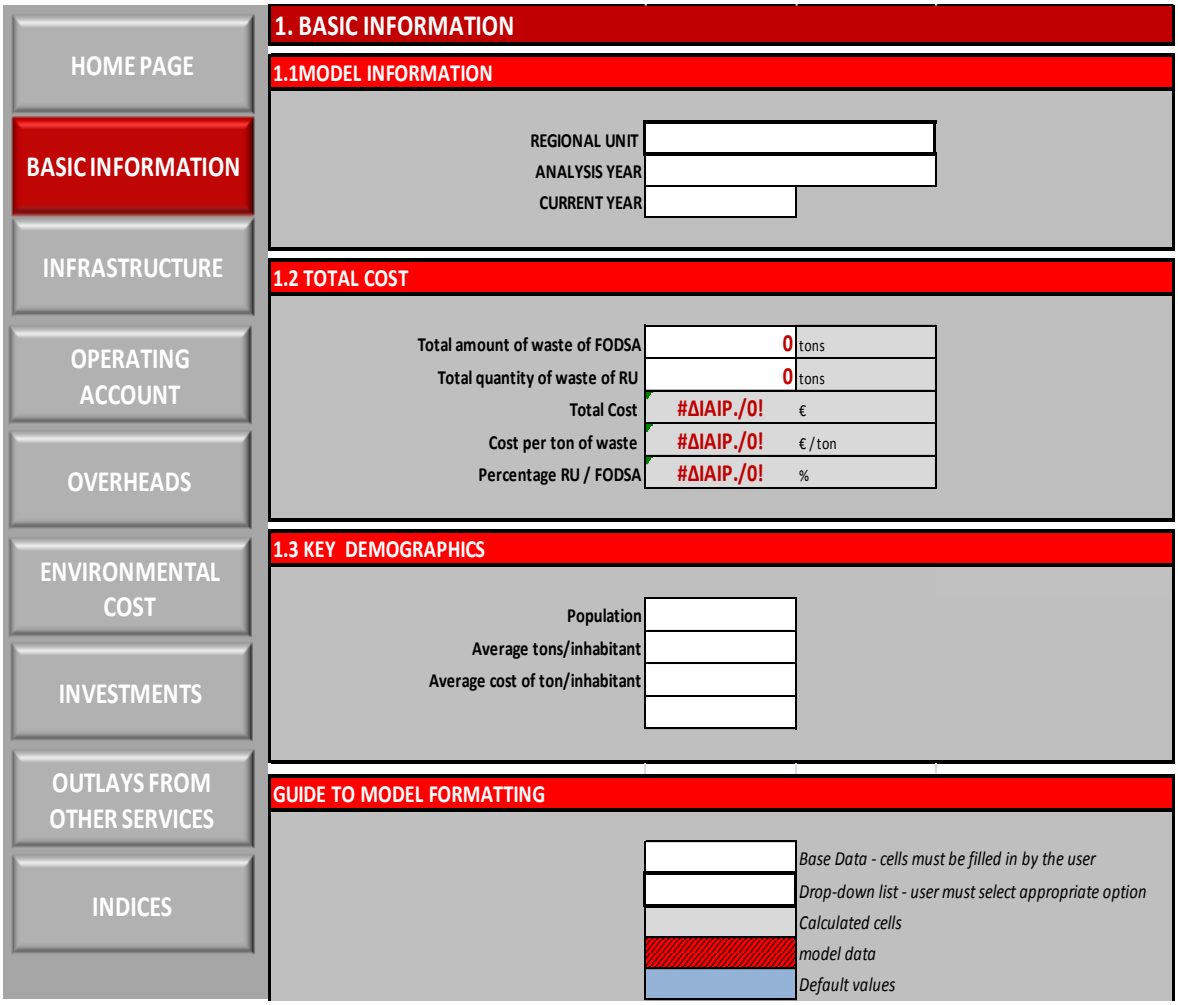
4.3.1. Special calculation tabs

The special calculation tabs are cited below following a brief description for each of them :

TAB: HOME PAGE

TAB: BASIC INFORMATION

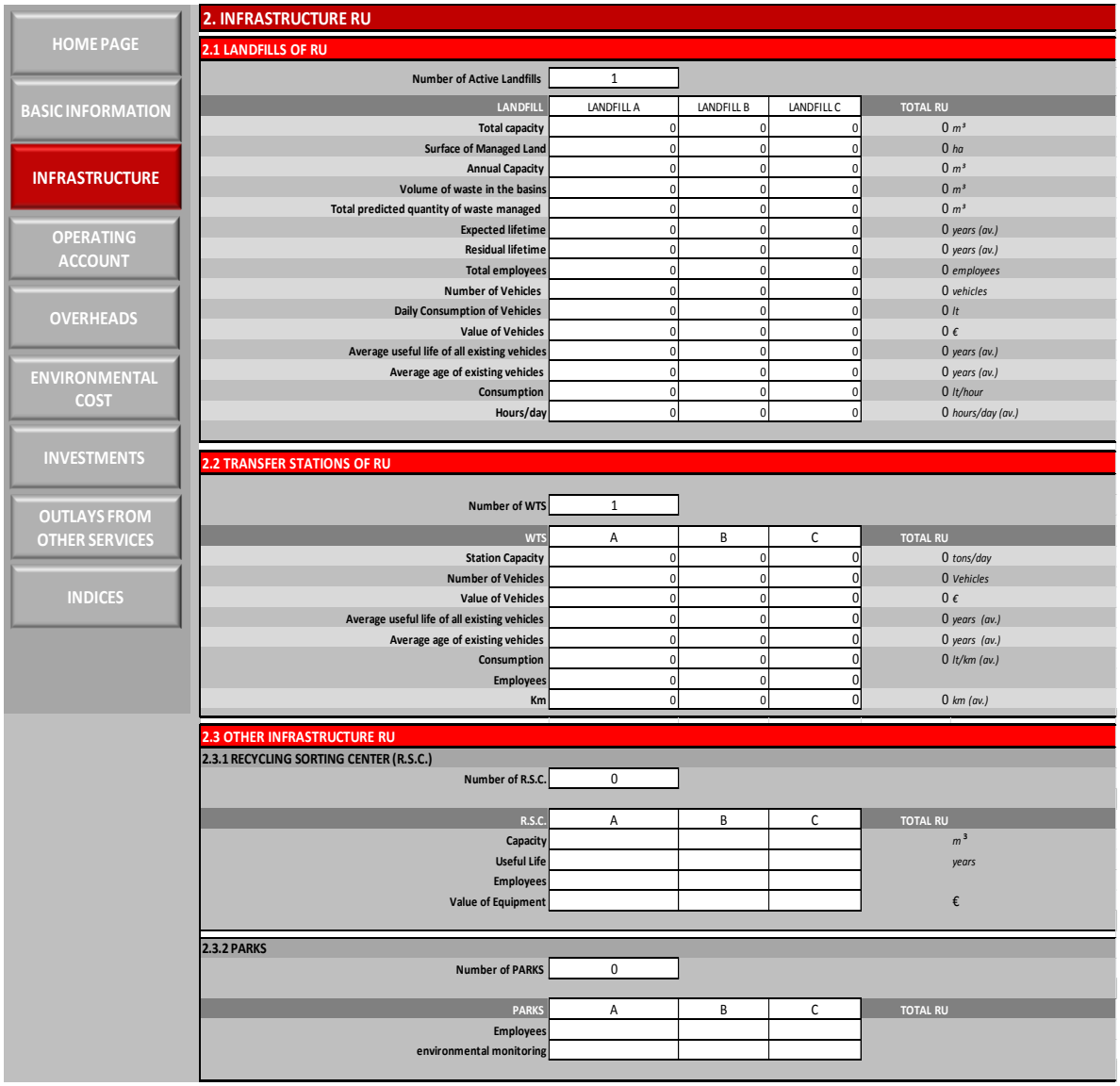
In this tab the user fills the spaces concerning the specific geographical - administrative area which will be analyzed through the costing model. The major outcomes of waste management costs are estimated. In addition, the following information is defined: the analysis year , the current year , the total volume of waste managed by the Body and the volume of waste of the selected area (Regional Unit). The key element in this tab is that after the analysis , the cost per ton for the selected region (Regional Unit) will be calculated according to the data introduced in the model.



TAB: INFRASTRUCTURE

In this tab, there is all the major information concerning the specifications of the landfills, the waste transfer stations, the material sorting centers and Parks working in the selected region (Regional Unit). This information is related to the characteristics of the infrastructure operation, such as the capacity, surface of managed land , the volume of waste in the basins and the lifetime. In addition, the personnel, the vehicles and their special characteristics are reflected.

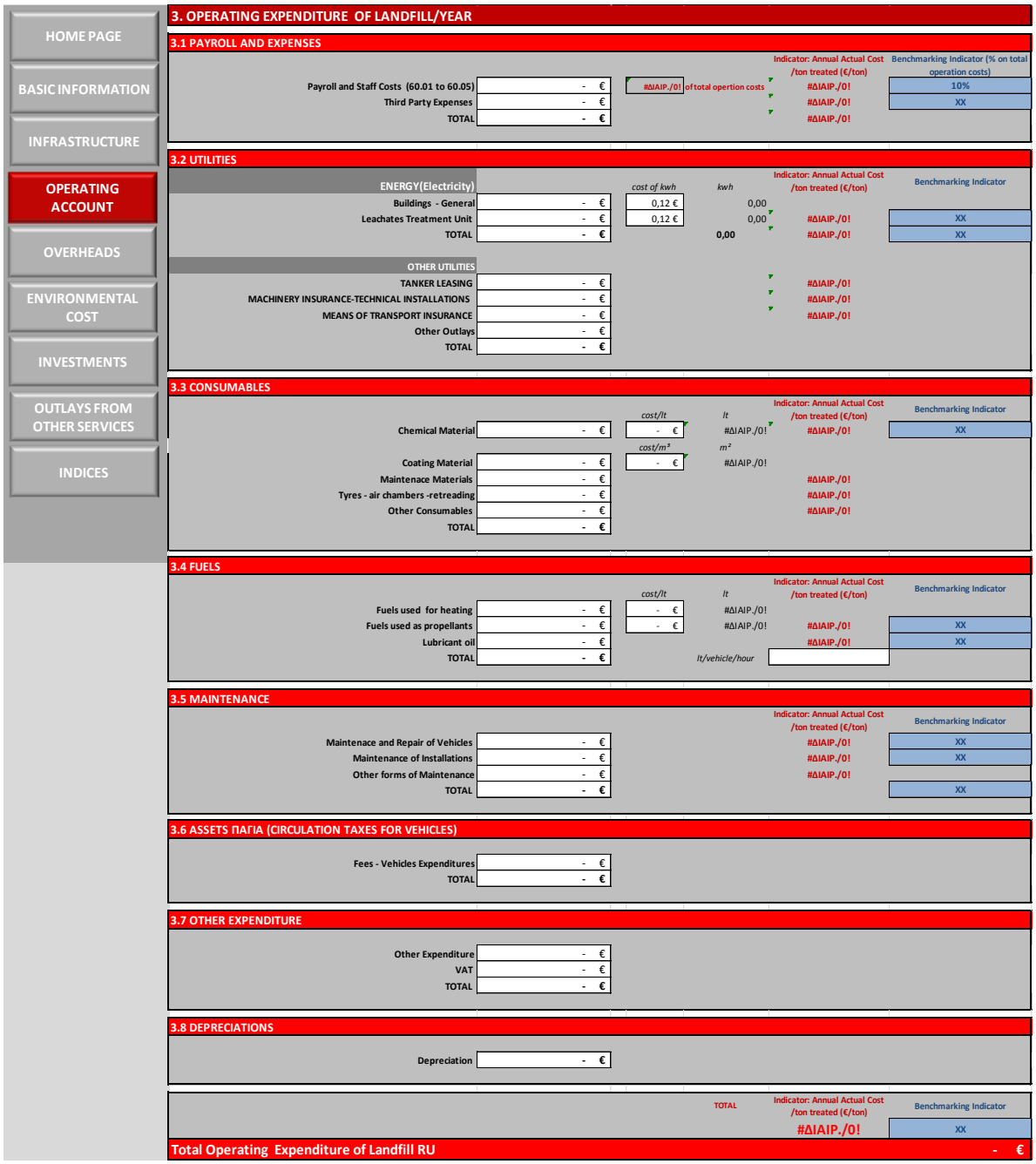
The information of this tab is important for further analysis and calculation conducted by the model leading to specific conclusions.



TAB: OPERATING EXPENDITURE OF LANDFILL/YEAR

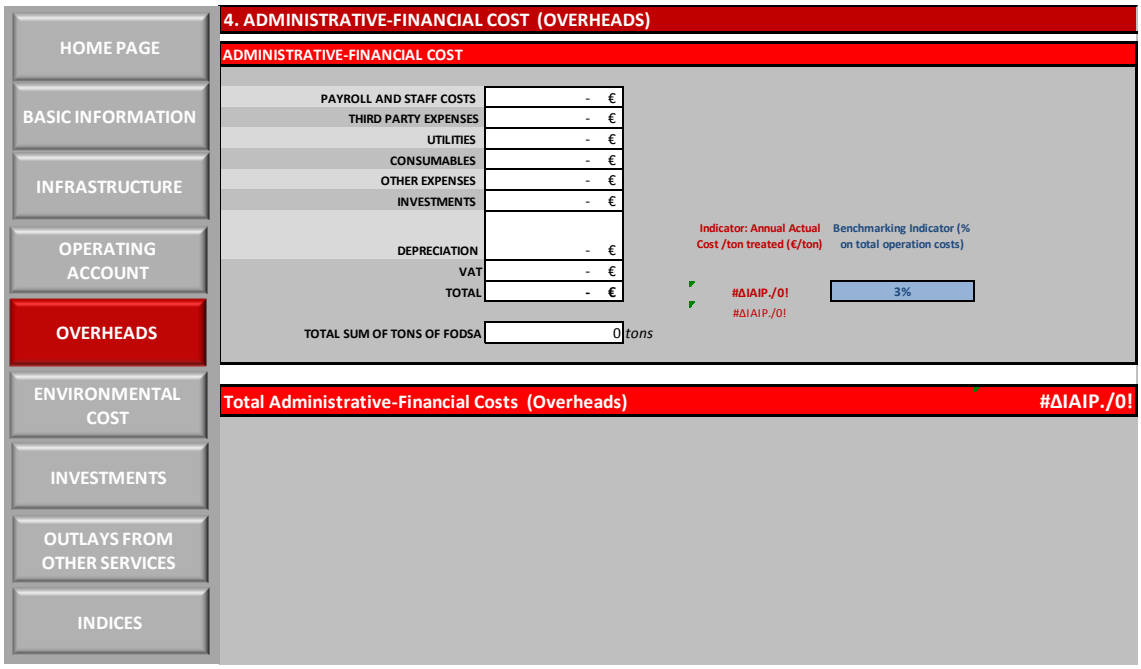
In this tab the following information is gathered: the operating expenditure of landfills per year, such as the payroll and staff costs, the utilities (electricity etc.) , the consumables (chemicals, coating material, tyres, the expenses for fuels (heating, mobility), the maintenance expenses, the taxes-fees and other

outlays of a landfill. The above information is important due to its great contribution to the definition of the final cost per ton of waste managed.



TAB: OVERHEADS

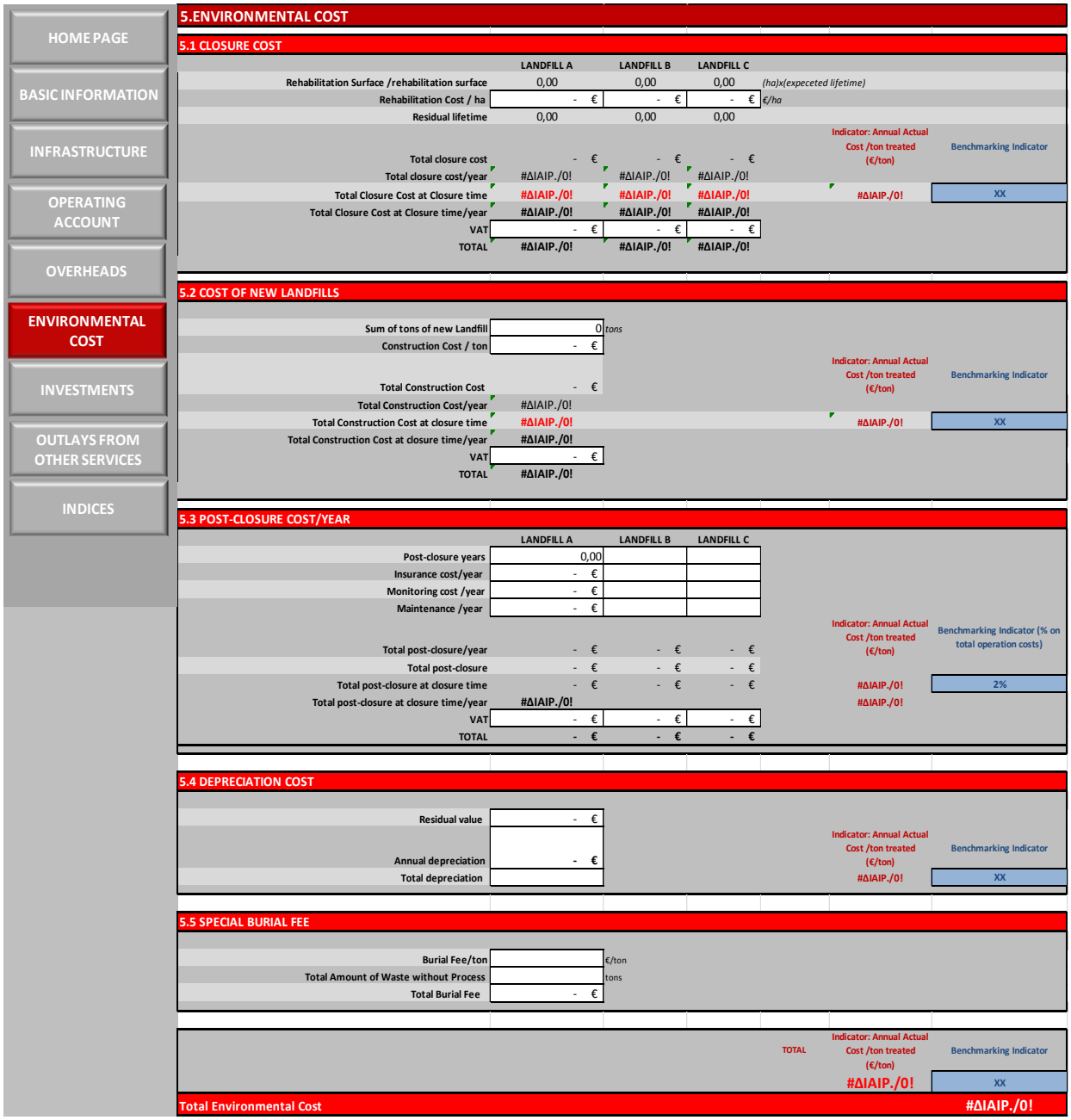
This tab includes the total Administrative – Financial cost per year of the Body, such as the payroll and staff costs, the utilities, the consumables and other expenses. This administrative-financial cost charges all the administrative regions of the Body at a respective percentage in proportion with the quantity of waste managed for each administrative region every year.



TAB: ENVIRONMENTAL COST

This tab includes the information needed for the interventions and actions required at the end of the lifetime of a landfill . More specifically, this information is related with the closure cost of the landfill, the construction cost of a new landfill, the post-closure cost , the depreciation cost and the special burial fee. The total cost for the above interventions during at the end of the lifetime of the specific landfill is estimated.

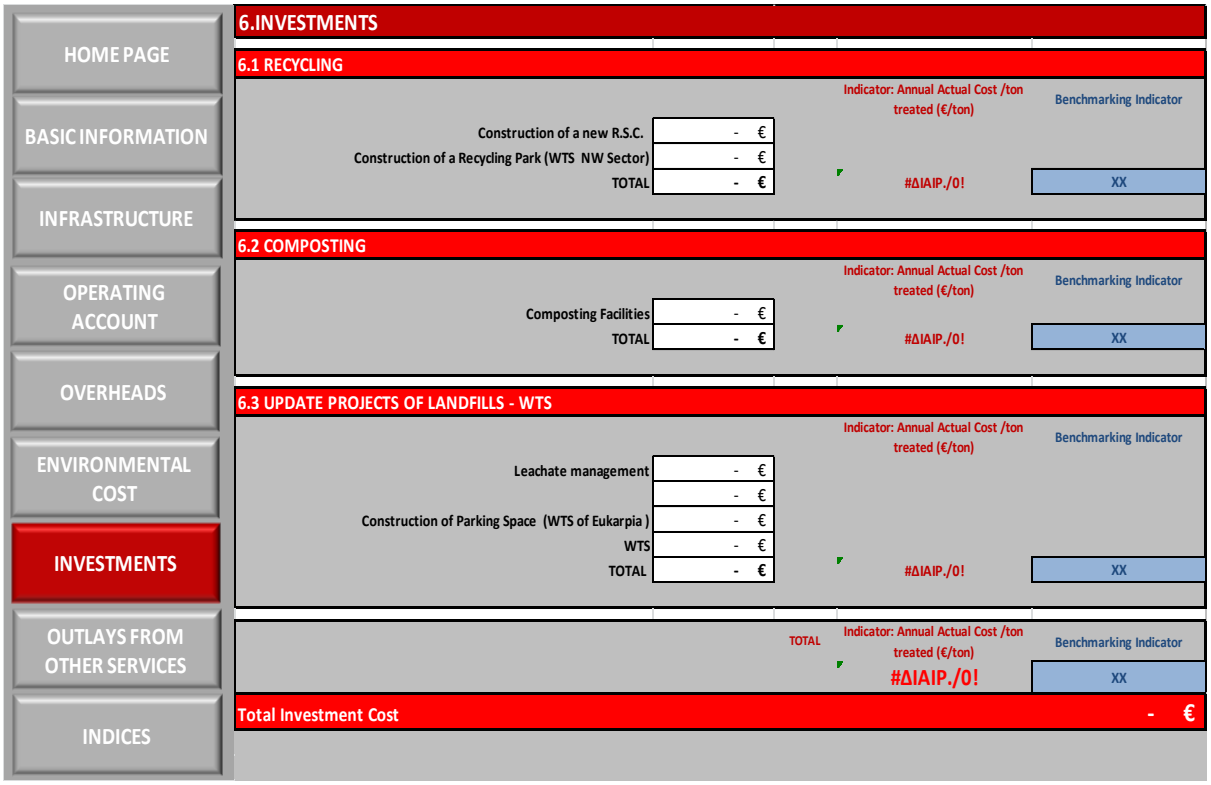
The goal of this tab is the achievement of the savings required for the above interventions at the end of the lifetime of the landfills, which is incorporated in the final cost of the cost per ton managed.



TAB: INVESTMENTS

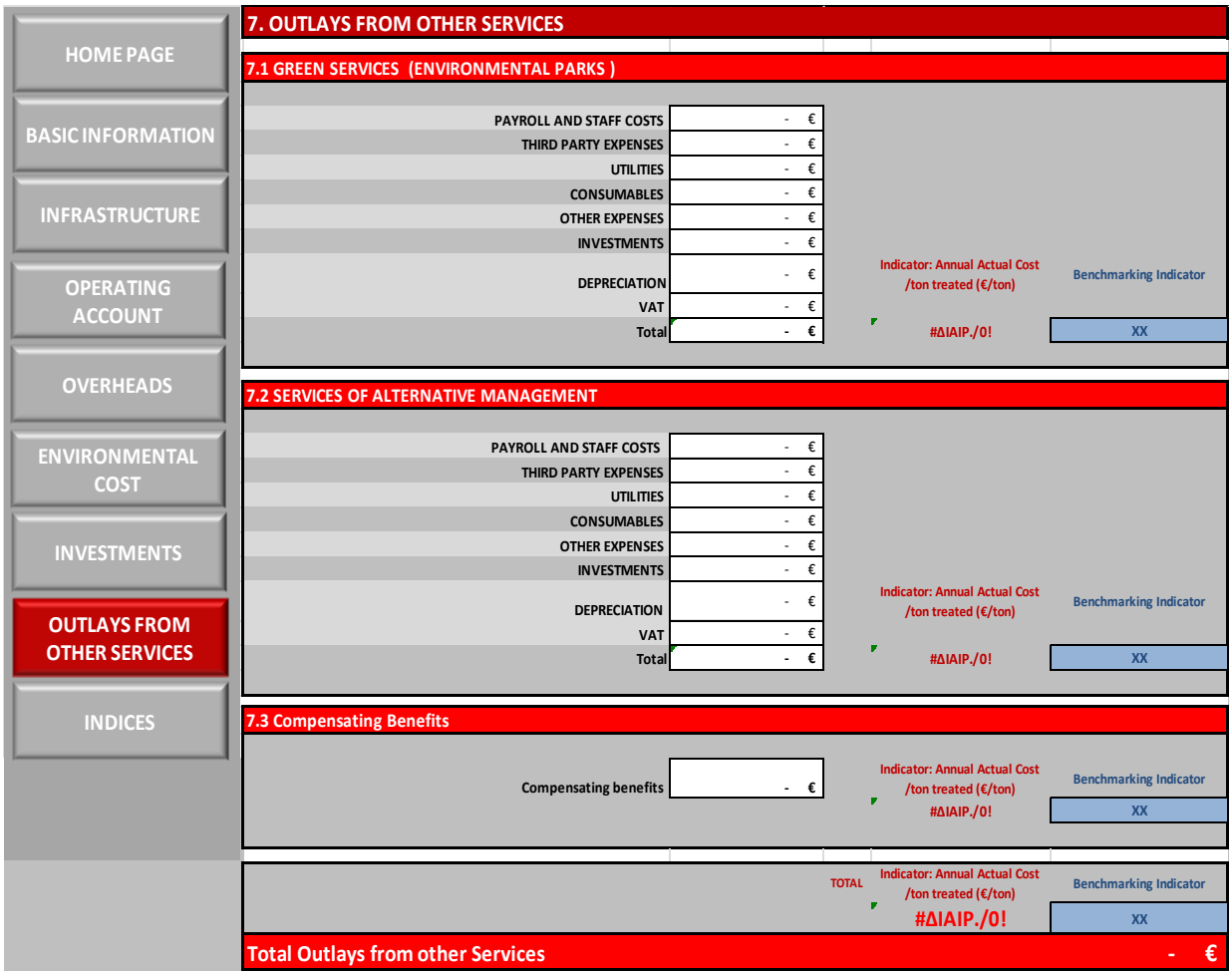
This tab includes the investment budgets for the current year concerning recycling, composting, modernization of the landfills and Waste Transfer Stations of the selected region (Regional Unit).

This cost is added to the total cost per ton managed per year for each selected region.



TAB: OUTLAYS FROM OTHER SERVICES

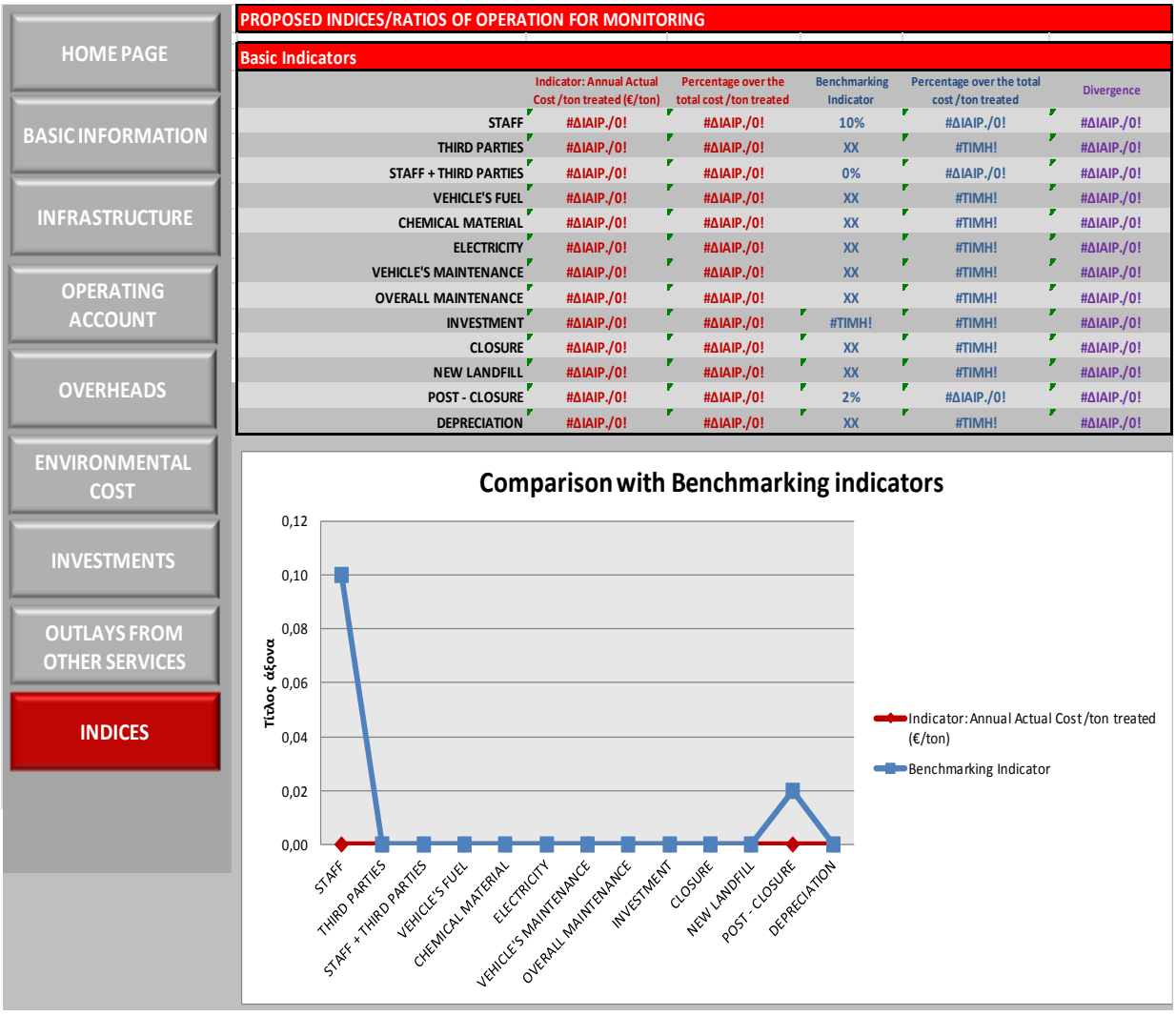
This tab provides with the operating expenditure of the services that are not integrated in the above infrastructure (Landfill, WTS, Central Administration) of the Body per year, such as the payroll and staff costs, the utilities, the consumables and other expenses. This cost is added to the final cost per ton managed per year for each selected region.



TAB: INDICES

In this tab, the overall picture of the cost per ton managed is reflected through the use of operation and monitoring indicators in selected fields, such as personnel, fuels, electricity, maintenance,

rehabilitation. The charge rate of each indicator over the final cost per ton managed, is presented and there is a comparison with the respective benchmarking ratios.



5. CONCLUSIONS AND RECOMMENDATIONS

This report summarizes the current situation in the solid waste management policy at municipal level, and in the competent Bodies (FODSA), as well as suggestions to help achieve the objectives set by the Bodies and the optimization of their operation. Through research and theoretical analysis presented above, the most important observations are briefly described below:

- The necessity to develop an improved and upgraded policy of solid waste management, which will be more environmentally friendly concept(recycling, reuse materials, biological treatment methods, etc.), becomes more and more imperative in accordance with the environmental policy of the European Union (EU).
- The current pricing policy is limited to the stage of the landfill and excludes all other stages comprising an integrated solid waste management process. In addition, this pricing policy refers only to the financial obligations of the municipality, and doesn't include the private share.
- The current costing policy is, to an extent, arbitrary hampering the proper operation of the competent Bodies. Therefore they cannot provide a properly structured and feasible framework for solid waste management, and still, in many cases are also unable to meet their expenses.
- Many existing facilities are below capacity or their operation has completely been interrupted. Thus, the requirement of rehabilitation of the defective infrastructure as well as the development of new infrastructure arise so that the process of solid waste management is properly implemented.

The following concluding remarks are mentioned below :

- ❖ It is necessary to create a costing model which meets the current operational requirements of the Body as well as the comprehensive and proper operation of all the various stages concerning the solid waste management process. In addition, this model should be applicable under the existing conditions and infrastructure. Such a costing model was presented in detail above, as a result of research and theoretical and statistical analysis of the data collected to develop this report.
- ❖ Apart from forming a specific costing model, it is also necessary to create a monitoring plan of this model so that the model will be improved, evolved and adapted to the respective existing conditions and needs. Furthermore, consulting services for both the pricing policy and the solid waste management policies should be provided.

Regarding future research and suggestions, the following observations are mentioned:

- ➢ Conducting a more comprehensive research and analysis of environmental policies. More specifically, the integration, in the overall policy of solid waste management, of stages such as the separation of materials, recycling, reuse, anaerobic digestion (organic waste) and other methods aimed at minimizing environmental pollution – as well as the solid waste management cost.
- ➢ Awareness of citizens concerning the necessity of reducing the amount of (solid) waste, and their active participation in recycling practices.
- ➢ Further investigation should be done , in the next stage of this study in order to build a tariff policy for the Body for the services provided in the next five years through the introduction of the related costing material in the costing model. During this period the Body will reorganize

the mixture of its provided services (such as recycling, composting) on which a new pricing policy will be built.

6. REFERENCES

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4. Final Report to Directorate General Environment European Commission (2001)
5. Material from the Solid Waste Management Body of Central Macedonia