

EX POST EVALUATION OF INVESTMENT PROJECTS CO-FINANCED BY THE
EUROPEAN REGIONAL DEVELOPMENT FUND (ERDF) OR COHESION FUND
(CF) IN THE PERIOD 1994-1999

INTEGRATED SOLID WASTE MANAGEMENT IN NORTHERN LISBON



PREPARED BY:
BLOMEYER & SANZ, *GUADALAJARA*
IN PARTNERSHIP WITH CSIL, CENTRE FOR INDUSTRIAL STUDIES, *MILAN*

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The consortium selected comprises CSIL – Centre for Industrial Studies (lead partner – Milan) and DKM Economic Consultants (Dublin).

The Core Team comprises:

- Scientific Director: Massimo Florio, CSIL and University of Milan;
- Project Coordinators: Silvia Vignetti and Julie Pellegrin, CSIL;
- External experts: Ginés de Rus (University of Las Palmas, Spain), Per-Olov Johansson (Stockholm School of Economics, Sweden) and Eduardo Ley (World Bank, Washington, D.C.);
- Senior experts: Ugo Finzi, Mario Genco, Annette Hughes and Marcello Martinez;
- Task managers: John Lawlor, Julie Pellegrin and Davide Sartori;
- Project analysts: Emanuela Sirtori, Gelsomina Catalano and Rory Mc Monagle.

A network of country experts provides the geographical coverage for the field analysis: Roland Blomeyer, Fernando Santos (Blomeyer and Sanz – Guadalajara), Andrea Moroni (CSIL – Milano), Antonis Moussios, Panos Liveris (Eurotec - Thessaloniki), Marta Sánchez-Borràs, Mateu Turró (CENIT – Barcelona), Ernestine Woelger (DKM – Dublin).

The authors of this report are Roland Blomeyer, Fernando Santos and Antonio Sanz from Blomeyer & Sanz and Emanuela Sirtori from CSIL. The authors of the CBA Analysis are John Lawlor and Rory Mc Monagle from DKM Economic Consultants.

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Quotation is authorised as long as the source is acknowledged.

Cover: Valorsul plant of urban solid waste treatment. Source: Valorsul..

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LIST OF ABBREVIATIONS

AD	Anaerobic Digestion
CBA	Cost-Benefit Analysis
CF	Cohesion Fund
CH ₄	Methane
CO ₂	Carbon Dioxide
CSR	Corporate Social Responsibility
EBCR	Economic Benefit-Cost ratio
EC	European Commission
EDP	Energias de Portugal
EGF	Empresa Geral de Fomento
EIB	European Investment Bank
ENPV	Economic Net Present Value
ERDF	European Regional Development Fund
ERR	Economic Rate of Return
ERSAR	Regulatory Authority for Water and Waste Services (<i>Entidade Reguladora dos Serviços de Águas e Resíduos</i>)
EU	European Union
EUR	Euro
FBCR	Financial Benefit-Cost ratio
FNPV	Financial Net Present Value
FRR	Financial Rate of Return
GDP	Gross Domestic Product
GHG	Greenhouse gases
GWh	Giga-Watt-hour
IFDR	Financial Institute for Regional Development (<i>Instituto Financeiro para o Desenvolvimento Regional</i>)
INE	National Institute of Statistics
IRAR	Regulatory Institute of water and waste
IRR	Internal Rate of Return
ISO	International Organization for Standardisation

kg	Kilogramme
km	Kilometre
m	Metre
MBT	Mechanical biological treatment
MRF	Materials Recovery Facility
MSW	Municipal Solid Waste
MSW	Municipal Solid Waste
MW	Mega-Watt
MWh	Mega-Watt-hour
NGO	Non-Governmental Organization
NPV	Net Present Value
NUTS	Nomenclature of Territorial Statistical Units
NYMBY	Not in my backyard
OECD	Organisation for Economic Co-operation and Development
OHSAS	Occupational Health and Safety Assessment Series
PERSU	National Strategic Plan for Municipal Solid Waste (<i>Plan Estatal de Resíduos Sólidos Urbanos</i>)
S.A.	Public Limited Company (<i>Sociedade Anonima</i>)
t	Tonnes
Tj	TeraJoules
VAT	Value Added Tax
WtE	Waste to Energy

EXECUTIVE SUMMARY

This case study analyses the development of the Integrated Waste Management System in the metropolitan area of Northern Lisbon, implemented by the public company Valorsul (*Valorização e Tratamento de Resíduos Sólidos da Área Metropolitana de Lisboa Norte S.A.*).

The report evaluates (ex-post) the long term performance of such a system. Further details on the methodology are described in the box below and, more extensively, in Annex I.

OVERALL APPROACH AND METHODOLOGY

The Conceptual Framework delivered in the First Intermediate Report has been developed from the evaluation questions included in the ToR₃, and further specified and organised in accordance with the study team's understanding. In particular, the Team identified three relevant **dimensions of analysis**:

- a) The object of the evaluation (the **'WHAT'**): this relates to the typologies of long-term contributions that can be observed. Starting from the typologies identified in the ToR (socio-economic development and quality of life) the Team developed the following classification of long-term effects: 'Economic development' (including effects on GDP growth and endogenous dynamics) and 'Quality of life', taken here to be synonymous with additional social wellbeing, i.e. including effects that are not captured by the economic variables. 'Quality of life', in turn, has been divided into: social cohesion, territorial cohesion, institutional learning, environmental effects and social happiness.
- b) The timing of the long-term effects (the **'WHEN'**): this dimension relates to the point in the project's lifetime at which the effects materialise for the first time (short-term dimension) and stabilise (long-term dimension). The proper timing of an evaluation and the role it can have in relation to the project's implementation is also discussed here.
- c) The determinants of the project's performance (the **'HOW'**): the assumption here is that five aspects of project's implementation and their interplay are crucial for the project's final performance. These aspects are: project design, forecasting capacity, governance, context and managerial response. Five Working Hypotheses are related to these dimensions and explain how each of them can influence the generation of the project's short or long-term effects.

On the basis of this conceptualisation, a set of detailed evaluation questions are developed, which aim to guide the entire study and to support the provision of conclusions and recommendations.

The **methodology** developed to answer the evaluation questions consists of a combination of quantitative (Cost Benefit Analysis) and qualitative (interviews, surveys, searches of government and newspaper archives, etc.) techniques, integrated in such a way as to produce ten project histories. CBA is an appropriate analytical approach for the ex-post evaluation because it can provide quantification of or indications of some of the long-term effects produced by the project. However, the most important contribution of the CBA exercise is to provide a framework of analysis to identify the most crucial aspects of the projects' ex-post performance and final outcome. Qualitative analysis on the other had is more focussed on understanding the underlying causes and courses of action of the delivery process. On the basis of the findings of the ten case studies, the Final Report will draw lessons along the key dimensions identified of 'what', 'when' and 'how'.

Source: CSIL Milano

Portugal's economy was undergoing significant growth in the early 1990s, following structural changes in various sectors, namely industry, agriculture, coastal urbanisation and tourism. At the same time, the country had difficulties in balancing this progress with social and environmental developments. The waste sector, in particular, was managed in an unsustainable way, and Portugal struggled with the new challenges arising from EU

membership (specifically compliance with policies and legislation). MSW treatment still relied upon landfill disposal and, to a minor extent, compost production. Recycling was largely underdeveloped and no incinerator plants were in operation.

In response to this, starting from 1993 the Government reorganised the waste sector by means of new laws, policies, plans and institutions. Two Decree-Laws¹ allowed municipalities to undertake waste management activities through third-party concessions and they set the conditions for shared management systems between municipalities. Furthermore, the Strategic Plan for Municipal Solid Waste (PERSU) was launched in 1996, which set the ground for the construction of new infrastructures for waste treatment.

Within this context, Valorsul was established in 1994 as the public company responsible for municipal waste treatment of the metropolitan area of North Lisbon, including the municipalities of Amadora, Lisbon, Loures, Odivelas and Vila Franca de Xira². Its shareholders include the Councils of these municipalities as well as other public bodies at national level. In 1995 the company was granted a twenty-five year concession for the construction and management of the necessary facilities for the recovery or disposal of municipal solid waste (MSW) produced by some 1.3 million people. The overall project size can be appreciated if one considers that in 2009 the MSW produced by the municipalities in the catchment area accounted for 16% of total MSW generated in Portugal.

The initial project, financially supported by the CF and the European Investment Bank, covered the construction of a Waste to Energy Plant (WtE), a modern sanitary landfill, a material sorting facility, drop-off centre and a bottom ash processing and recovery installation. The project also envisaged the sealing of uncontrolled open dumps and the implementation of separate collection of specific MSW (albeit collection remained the responsibility of the municipalities and not of Valorsul). This project was implemented between 1995 and 2002 and involved a capital expenditure of EUR 331.4 million in current terms (at 2011 prices). The evaluation takes into account also a subsequent Cohesion Fund project, approved in 1999, involving the construction of an Anaerobic Digestion Plant producing compost from organic waste (for an investment cost of EUR 34.6 million). This plant, which started operations in 2008, complemented the Valorsul waste management aimed at providing the population of the metropolitan area of Northern Lisbon with modern and effective facilities for waste treatment and recycling.

The total investment cost for implementation of the Integrated Waste Management System considered in the analysis is EUR 366 million in constant 2011 prices. Besides the Cohesion Fund and European Investment Bank's contribution, the remaining cost were covered by Valorsul own resources, as shown in the following Table.

¹ Decree-Law 372/93 October 29th and 379/93 November 5th.

² Note that, at the time of the establishment of Valorsul, Odivelas belonged to the municipality of Loures, from which it became independent in 1998.

OVERVIEW OF INVESTMENT COSTS AND SOURCES OF FINANCING

Financing period	1995-2002; 1999-2008	
First year of operation	1996-2008	
Total investment costs (2011 prices)	EUR 366 million	100%
Sources of financing and co-funding rates over the total investment costs		
Cohesion Fund	EUR 136.8 million	37.38%
European Regional Development Fund	EUR 0	0
European Investment Bank	EUR 125.8 million	34.36%
National-regional-local public contribution	EUR 0	0
Public equity/commercial debt/internal cash flow	EUR 103.4 million	28.26%

Environmental quality is the aspect on which the project has had the most positive impact. The project contributed, in particular, to the closure of all uncontrolled landfills in the catchment, which were generating significant air and soil pollution; to proper processing of municipal waste (e.g. it reduced the amount of untreated waste sent to landfills from 100% in 1998 to 17% in 2009); to the generation of partially renewable electricity (Valorsul produces 0.7% of the national electricity of Portugal), thus reducing greenhouse gas emissions, and to increasing the recycling rates of organics and other materials.

It is worth highlighting, however, that the current recycling rates in the catchment area (which varies between 6% and 14% of total recyclable materials) are still below the national and EU targets, in contravention of EU Directive 2004/12/EC on packaging and packaging waste. Organic waste sorting is very poor, and the high improper fraction prevents from producing good quality compost. Despite the numerous education campaigns implemented by Valorsul, more time and efforts are probably needed in order to change the waste sorting behaviour of citizens.

From an economic viewpoint the project has contributed to direct economic growth in a number of areas, such as energy production, sale of recyclable products and delivery of effective waste treatment services. Notwithstanding this, the benefits to economic growth could have been greater, subject to the following conditions:

- a higher recycling rate, enabling an increase in the sale of recyclable materials;
- a better quality of compost produced, which would have generated higher revenues from the Anaerobic Digestion Plant: Valorsul is experiencing difficulties in marketing the compost due to its poor quality;
- and, if the facilities had been built in a single complex. The plants that are part of the Valorsul Integrated Waste Management System have been spread over the different municipalities involved. Their centralisation in a single location would have allowed a saving in waste transportation costs between facilities and in overhead costs, while generating relevant synergies.

Additionally, Valorsul's financial return on investment would have been higher if the tariffs paid by municipalities for the waste treatment services reflected their cost. Instead, thanks to

the governmental subsidisation of the price of energy produced by 'green' sources, Valorsul generates high income from the production of energy from waste, and as a result can charge the municipalities very low gate fees, sufficient to make a modest financial surplus³, but not covering the operation cost of waste treatment. This is in contravention of the European "polluter pays" principle⁴.

These issues are reflected in the CBA exercise. On a socio-economic basis, the project has a negative return (ENPV EUR -44 million) over a 30 year timeframe. However, if compared to the counterfactual of a landfill, which generates an ENPV of EUR -179 million, the project generates a net positive return for society of approximately EUR 135 million, with an internal rate of return of 5.9%.

Overall, the project's economic benefits, that have been quantified in the CBA, are not particularly high and they are positive only when compared to the counterfactual scenario. This is partly due to the aforementioned reasons (lost revenue opportunities from the sale of compost, the limited revenues from the sale of recyclable materials and the relative more costly decentralised system). However, in assessing the project's impact it has to be considered that the CBA does not incorporate a large number of other effects which in fact have been produced by the project.

The large scale of the project (one of the largest at that time), the new technology (incineration) and the multi-municipal management structure used, had a positive impact on capacity building, from a technical as well as a managerial perspective. Much of the expertise was acquired from international experts brought in to establish the project, with a potential positive effect on the endogenous dynamics of economic growth. With regard to institutional quality, the project helped to create in a relatively short period of time a level of expertise and capacity to deliver large and complex projects that did not exist before in Portugal. The project was 'pioneering' at the time, and it can be said that in the medium to long run, it also influenced some institutional structures in a sort of learning-by-doing process. In fact, the lessons learnt have been used to assist EU Candidate Countries involved in similar projects in subsequent years, through the EC Twinning Instrument.

Regarding territorial cohesion, the project has had an influence on reducing welfare disparities between the relatively large and rich municipality of Lisbon and the other smaller and less economically developed municipalities in the metropolitan area: if the decentralised strategy followed in the construction of the waste treatment facilities increased the transport cost of waste and the transport emissions, it also helped to distribute the employment and development opportunities generated by the new infrastructures across all the municipalities involved and, most of all, to minimize the "Not in my backyard" syndrome: since no

³ It is not uncommon for the gate fees at municipal WtE plants to be set as a residual after energy sales revenues are taken into account. It is worth noting also that final users contribute as tax payers to the subsidisation of the energy sector.

⁴ According to this principle, stated in Directive 2004/35/CE, the operator whose activity has caused the environmental damage or the imminent threat of such damage is to be held financially liable. The objective of this principle is to induce operators to adopt measures and develop practices to minimise the risks of environmental damage so that their exposure to financial liabilities is reduced.

municipality was in favour of the construction of a waste treatment complex in its area, in order not to dissatisfy any municipality, Valorsul accepted to distribute the different plants over the entire catchment area. Instead, the project did not contribute to social cohesion, since it ensured the provision of a public service to all citizens, without focusing on particular social groups.

The main non-quantified benefit is on social happiness. Local residents not only enjoy a better quality of waste services, but also have been the target of many initiatives in the area of environmental education, which increases public perception of the improvement in quality of life attained thanks to the new Integrated Waste Management System. While in its initial stages the project faced opposition from local communities and environmental organisations, Valorsul's efforts to increase the transparency of its operations, raise awareness and involve civil society organisations and other stakeholders, helped to change perceptions. The closure and rehabilitation of old dumps provided valuable public amenities while generating significant environmental improvements. Moreover, Valorsul has supported additional initiatives to increase people's quality of life, such as the construction of an indoor swimming pool and the planting of trees in public parks. As a result of this, opposition is now considered negligible and the project's impact on social happiness has been very high.

The project was highly appropriate to its context and this played a positive role in the generation of long-term effects: the large problem of waste management and the need to comply with EU policies and legislation was highly relevant in the justification of the project, which was also necessary for the success of national plans and strategies such as PERSU. The celebration of Expo '98 in Lisbon was also an important driver, since the selected location was occupied by an old dump site and a poorly functioning composting plant, for which an alternative solution had to be found. Very important too was the availability of EU funds for large infrastructures that would help Portugal to meet EU environmental standards.

Another key factor in the project's success was the limited on-going opposition to the project, which has been minimised through an adequate forecasting capacity and managerial response. On the one hand, Valorsul anticipated that the public would oppose the new technology, but it managed to change perceptions, as said, by organising communication campaigns and building strategic partnerships with companies, authorities and local associations, with particular attention to those groups who had more reservations regarding the project. On the other hand, Valorsul secured the consensus of the municipalities involved, which are both its shareholders and users of the Integrated Waste Management System, by adapting to their demands: more specifically, municipalities asked for and obtained the construction of waste facilities in each of the target territories and a ring-road serving the WtE plant so as to reduce traffic congestion. Demands of environmental organisations have also been addressed through the decision to build the composting plant.

Forecasting capacity however was limited as far as the waste volume and composition in the target area were concerned. The WtE plant's capacity turned out to be slightly higher than actual demand: it is capable of treating 662,000 tonnes of MSW per year, but in fact over recent years has received on average 560,000 tonnes; the current economic crisis, which has

constrained private consumption and thus waste generation, is further reducing the volume of waste to be treated. Nevertheless, Valorsul has demonstrated good capacity to adapt to this. With the goal of maximising utilisation of the WtE capacity and reaching economies of scale, in 2010 the company decided to merge with Resioeste, the association of municipalities responsible for waste management in the West region of Lisbon, having a population of about 400,000 inhabitants.

Regarding project design, it proved to be effective in generating the expected effects. The project was planned in a comprehensive and incremental way. At first, the most urgent issues were tackled, i.e. sealing of open dumps and construction of a modern landfill. Then the WtE plant was commissioned, and initiatives for complementary waste treatment followed.

Finally, it is worth noting the role of the EC and the European Investment Bank (EIB). The EC not only co-financed Valorsul's first project, but also gave continuous support to Valorsul's activities through the co-financing of further projects, namely: the refurbishment of municipal landfills (European Regional Development Fund); the Anaerobic Digestion Plant (Cohesion Fund); the Ecovia project (LIFE Programme), etc. The role of the EIB was also of great value. In addition to a financial contribution close to that of the CF (32% against 36% of total investment cost), the EIB also provided technical and economic assistance for the design of the project.

The main lesson that can be drawn from this project concerns the way how Valorsul involved and collaborated with local authorities, Non-Governmental Organisations and other parties in order to secure consensus among stakeholders. Projects envisaging the construction of incinerator plants are usually subject to very strong public opposition, but Valorsul successfully managed to cope with that by organising numerous awareness campaigns and ensuring high transparency towards the public since the early stage of project design. On the other hand, the project also allows to perceive the importance that good waste sorting among households has in ensuring the effectiveness of the entire waste management system: the recovery of recyclable materials in the Northern Lisbon area currently is not enough to comply with the EU targets on recycling⁵ and bad separation of organic waste prevents from producing compost to be sold to the agriculture sector. New awareness campaigns and the improvement of waste collection, which have been foreseen in the new Strategic Plan for Municipal Solid Waste, covering the period 2007-2016, are expected to improve the recycling rates in the future years.

⁵ Set in Directive 94/62/EC on packaging and packaging waste, amended by Directive 2004/12/EC.

1 PROJECT DESCRIPTION

1.1 KEY FEATURES OF THE INFRASTRUCTURE AND SERVICE DELIVERED

Valorsul was established in 1994, as a publicly owned limited company⁶ to deliver municipal waste treatment for the Northern Lisbon metropolitan area, integrating the municipalities of Amadora, Lisbon, Loures and Vila Franca de Xira⁷. The shareholders of the company included the Councils of these four municipalities as well as the public bodies Parque Expo '98 S.A., Empresa Geral do Fomento S.A. and the national energy company Eletricidade de Portugal S.A. In 1998 the municipality of Odivelas, previously part of Loures, acquired autonomy and it was automatically included as the fifth municipality of Valorsul.

On 28th September 1995 Valorsul signed a twenty-five year concession contract with the Ministry of Environment for the conception, construction and management of all the necessary installations for the recovery or disposal of municipal waste produced in this area.

For the purpose of this study we will look at Valorsul from its inception phase up to the present day. The main object of analysis will be the major project “Multi-municipal System for Urban Solid Waste Treatment for the Metropolitan Area of Northern Lisbon”⁸, co-financed by the Cohesion Fund⁹ over the period 1995-2002. The original project application was prepared by the Directorate General for Regional Development and subsequently implemented by Valorsul¹⁰: it involved an investment of EUR 186.41 million in current terms, 49.41% of which co-funded by the Cohesion Fund. The main initiatives included in the project were as follows:

1. Construction of a Waste to Energy (WtE) plant, which allows for the valorisation of waste through energy production;
2. Construction of a ring-road connecting Loures and Lisbon, serving the WtE plant;
3. Construction of a modern engineered landfill (the Mato da Cruz landfill) to provide for the reception of incinerator bottom ash¹¹ and a back-up in cases where the WtE plant was not available; biogas generated by waste is flared, in order to minimise the escape of methane emissions;
4. Construction of the Materials Recovery Facility and a drop-off centre¹², where glass, paper and packaging are sorted from the separate collection and then forwarded to the recycling industry. Waste separation is generally carried out automatically, by means of a trommel,

⁶ The legal form in Portugal is *sociedade anónima* (S.A.).

⁷ Valorsul was established under the Decree-Law No. 297/94 of November 21st. It is also based on Decree-Law No. 294/94 of November 16th, which establishes the legal regime for the granting of concessions for the exploitation and management of municipal solid waste treatment systems.

⁸ 'Sistema Multimunicipal de Tratamento de RSU da Área Metropolitana de Lisboa Norte'.

⁹ Reference number 95/10/61/026.

¹⁰ European Commission, 1994.

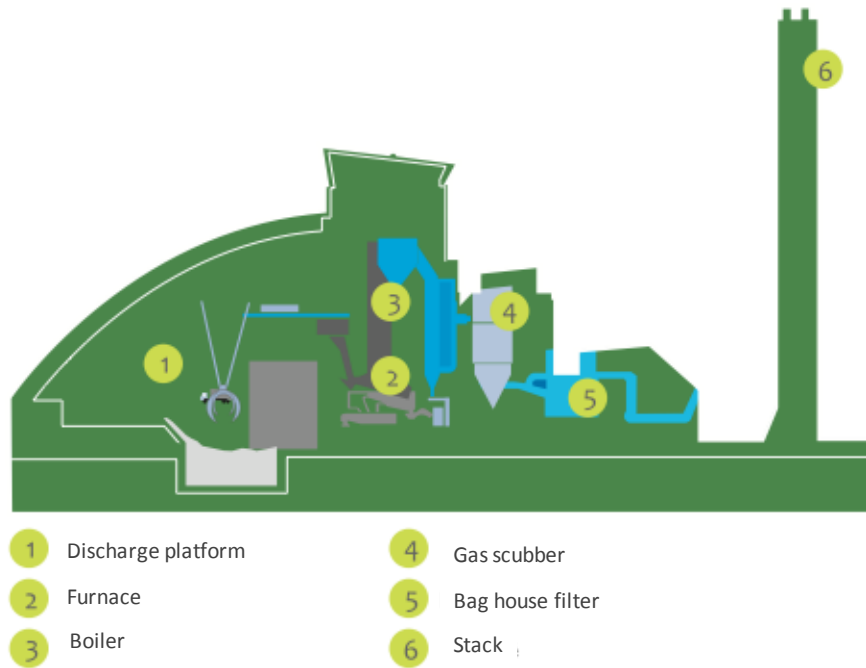
¹¹ Bottom ash can also be used in civil construction. The part that is not used in this sector is disposed of to the landfill.

¹² With a capacity of 105,000 t/year.

a bag opener, a ballistic separator, three optical separating devices and four film suction systems. The refinement of the sorting is done manually.

5. Construction of the Bottom Ash Processing and Recovery installation, which extracts ferrous metals from the bottom ash produced by the WtE plant;
6. Sealing of uncontrolled dumps in Vale Forno and Sta Iria de Azoia.

Figure 1.1 VALORSUL WtE PLANT



Source: Valorsul, 2009

The WtE plant, inaugurated in 2000, was the flagship initiative and the *raison d'être* of Valorsul. This facility also absorbed 83% of the total investment costs of the project, i.e. EUR 153.81 million¹³. The WtE plant is a traditional mass burning incineration with three lines capable of treating 28 tonnes/hour each, corresponding to a capacity of approximately 662,000 tonnes MSW per year. The civil works and equipment that are part of the infrastructure are the following (see Figure 1.1):

- a discharge platform (101 m* 28 m), receiving the MSW;
- a waste bunker with a capacity of 18,000 m³;
- two semi-automatic mixing and feeding cranes and one mill for bulky objects;

¹³ In current terms.

- three identical independent incineration lines composed of hydraulic feeders, furnaces, boilers (at 420° C) and flue gas treatment systems¹⁴;
- one steam turbine with a capacity of 50 MW;
- one generator of electricity with a capacity of 49.3 MW;
- a 60 m high chimney;
- storage tanks and buildings for input materials as well as for slag and materials from the air cleaning system.

The plant layout allows for the possibility of enlarging the incineration's capacity with a fourth line, if needed: access roads, delivery and storage facilities are also dimensioned for this possibility.

In the intervening years, Valorsul has experienced a series of important developments: additional initiatives were implemented by the company in order to provide an integrated waste treatment service to the target area. They include, in particular, the construction of the bio-waste Anaerobic Digestion (AD) Plant in 2005: this plant receives and processes organic waste, separately collected, to generate – through anaerobic digestion – compost for agricultural and domestic use and electricity from the biogas produced. This was part of another project, approved in 1999 with an investment cost of EUR 20.5 million¹⁵, 40.42% of which was co-financed by the Cohesion Fund¹⁶.

The WtE plant and the rest of the infrastructure and services of the company form the Valorsul Integrated Waste Management System. As shown in Figure 1.2, Valorsul's facilities are not concentrated in a single complex, but are located across the served municipalities. The WtE plant is located about 10 km North-East of central Lisbon, in the municipality of Loures. The Bottom Ash Processing and Recovery is located in the municipality of Villa Franca de Xira; in this municipality also the Mato da Cruz landfill is located. The Materials Recovery Facility and the drop-off centre are in the municipality of Lisbon. Finally, the Anaerobic Digestion Plant has been built in the municipality of Amadora.

An event which has to be highlighted is the recent merger (in 2010) of Valorsul and another public company, Resioeste S.A.¹⁷, responsible for waste treatment in the municipalities located in the west area of Lisbon: as a result, a 'new' Valorsul has been established, which includes 14

¹⁴ Hazardous waste resulting from flue gas treatment are channelled to the National System of hazardous waste component. Such waste is estimated to reach 3% to 4% of the weight of MSW incinerated.

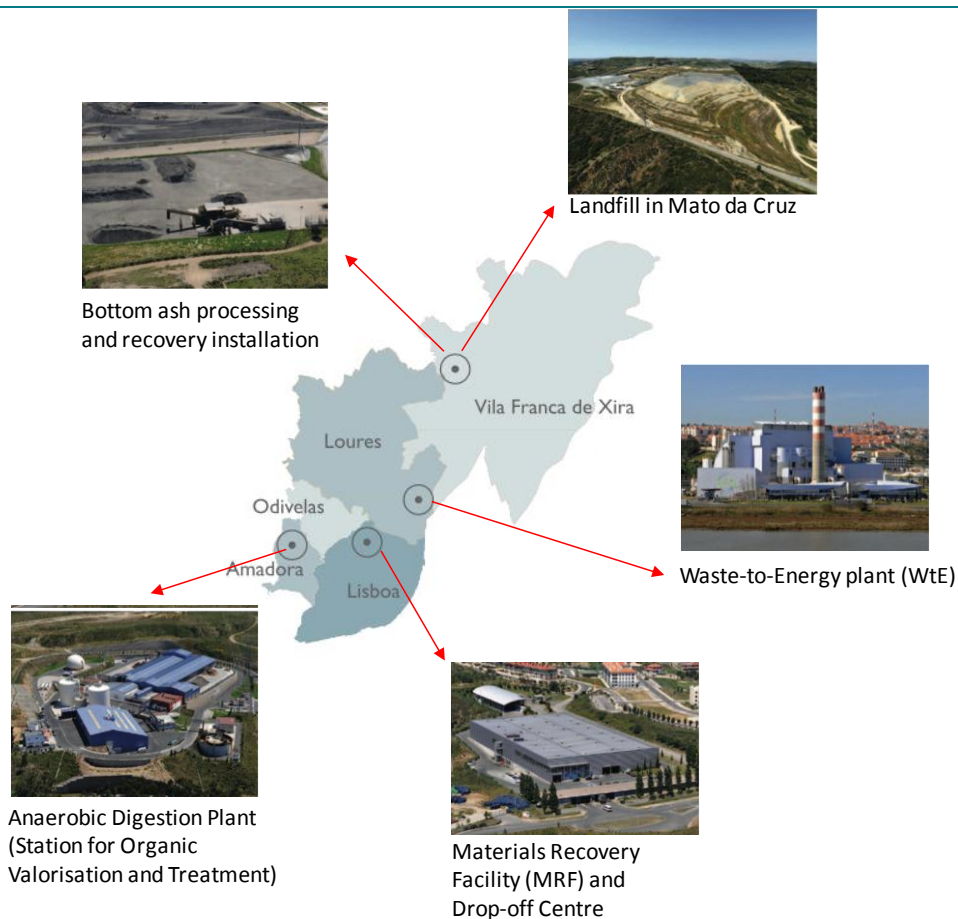
¹⁵ Reference number 1999/PT/16/C/PE/005.

¹⁶ In the same years Valorsul implemented a project for the sealing of other dump sites (Carenque, Montemor, Boba), at an investment cost of EUR 9.27 million, 75% of which was co-financed through the European Regional Development Fund (ERDF). This project has not been included in the project under assessment, because it does not affect the integrated solid waste management system put in place.

¹⁷ Resioeste is the multi-municipal system created in 1997 by Decree-Law 366/97 December 20th.

new municipalities¹⁸, serves 400,000 inhabitants and processes some 20% more waste, corresponding to almost 200,000 tonnes per year. Furthermore, this merger has allowed Valorsul to ‘acquire’ additional infrastructures and facilities for waste management (see Section 2.4 for details).

Figure 1.2 VALORSUL INFRASTRUCTURES¹⁹



Source: Author’s elaboration based on pictures from Valorsul, 2009

The scope of this evaluation is the set of infrastructures built by Valorsul and forming the Integrated Waste Management System of the Northern Lisbon metropolitan area. These infrastructures are part of different projects, all of them implemented by Valorsul and co-financed by EU funds; it has been decided to focus the analysis on the whole waste treatment system, given its integrated nature. Nevertheless, in assessing the long-term performance of the infrastructures, whenever possible, we have tried to distinguish, at least in qualitative terms, between the effects produced by each project and, in particular, by the construction of the sanitary landfill, the WtE plant, the materials recovery facility and the bottom-ash

¹⁸ The list of municipalities include Alcobaça, Alenquer, Amadora, Arruda dos Vinhos, Azambuja, Bombarral, Cadaval, Caldas da Rainha, Lisboa, Loures, Lourinhã, Nazaré, Óbidos, Odivelas, Peniche, Rio Maior, Sobral de Monte Agraço, Torres Vedras e Vila Franca de Xira.

¹⁹ Main infrastructures of Valorsul prior to the merge with Resioeste.

processing and recovery installation on the one hand, and by the Anaerobic Digestion Plant on the other hand.

By contrast, Resioeste has not been incorporated in the analysis, although some elements of the 'new' Valorsul have been taken into account where this was considered necessary for the analysis, e.g. to estimate the future amount of waste to be treated, particularly in the future scenario of the Cost-Benefit Analysis (CBA) exercise²⁰.

The total investment cost undertaken by Valorsul to finance the waste management facilities and considered in this evaluation is presented in Table 1.1. As shown, further investment were made by Valorsul in subsequent years to improve the facilities and equipment financed in the 1995-2002 major project. Some cost overruns are recorded as far as the AD plant project is concerned. While the approved expenditure was EUR 20.5 million, the total investment cost to date has been EUR 29 million (current prices). As explained in the next Sections of this report, these expenditures were required to solve a number of technical problems affecting the Plant.

Table 1.1 INVESTMENTS UNDERTAKEN BY VALORSUL (EUR THOUSAND, CURRENT PRICES)

	<i>Initial Investment*</i>	<i>Subsequent Investments</i>	<i>Total Investments</i>
Buildings	4,226	0	4,226
Closure and rehabilitation of dumps at S. Iria/Vale do Forno	5,888	0	5,888
Waste to Energy plant - Loures	153,810	18,944	172,754
Sanitary Landfill - Mato da Cruz (Vila Franca de Xira)	10,111	12,413	22,524
Sorting Plant - Lisbon	7,519	6,256	13,775
Bottom Ash Recovery plant - Vila Franca de Xira	2,021	511	2,532
Vehicles for selective waste collection	7,061	10,392	17,453
Anaerobic Digestion plant – Amadora **	0	29,429	29,429
Total	190,636	77,945	268,581

* Multi-municipal System for Urban Solid Waste Treatment for the Metropolitan Area of Northern Lisbon (CF Project 95/10/61/026).

** CF Project 1999/PT/16/C/PE/005

Source: Valorsul

1.2 TARGET POPULATION

The WtE plant, as well as other facilities and services provided by Valorsul are situated within the EU NUTS²¹ sub region Greater Lisbon²². This area, together with the other NUTS3 sub-region Peninsula de Setúbal, constitutes the NUTS2 region of Lisbon²³. The Greater Lisbon area

²⁰ See Annex II.

²¹ The NUTS classification (Nomenclature of territorial units for statistics) is a hierarchical system for dividing up the economic territory of the EU. NUTS1 are major socio-economic regions, NUTS 2 are basic regions identified for the application of regional policies and NUT3 regions are small regions for specific diagnoses.

²² Code PT171.

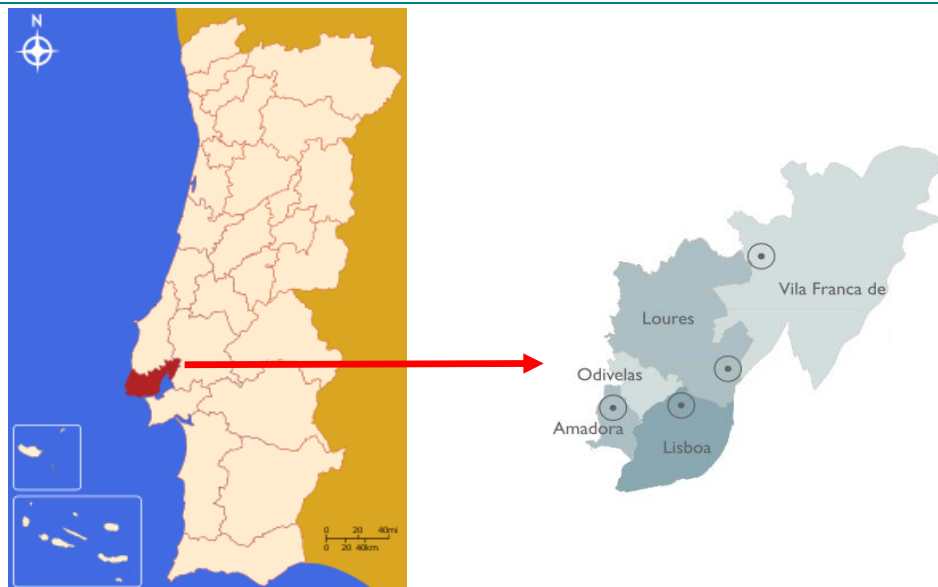
²³ Code PT17.

includes nine municipalities: Amadora, Cascais, Lisbon, Loures, Mafra, Odivelas, Oeiras, Sintra and Vila Franca de Xira.

At the time of the establishment of Valorsul and the implementation of the project, the target population included half of these municipalities, namely Amadora, Lisbon, Loures (later split into Loures and Odivelas²⁴) and Vila Franca de Xira. They accounted for some 1.3 million people out of almost 2 million residents in Greater Lisbon and 2.6 million in the region of Lisbon²⁵.

Despite the fact that the municipalities served by Valorsul occupy less than 1% of the national territory (596 km²), the waste produced in this area accounts for some 16% of all the waste produced at national level²⁶. In 1996, the population in the catchment area of Valorsul produced some 580,000 tonnes of municipal household and commercial waste, corresponding to about 61% of the waste generated in the NUTS2 region of Lisbon²⁷. It is also worth noting that the average daily per capita waste production in the Valorsul area was higher than the average in the rest of Portugal: about 1.3 kg as against 0.8 kg. The discrepancy can be explained by the high volume of waste produced by Lisbon's commercial sector and by the large number of commuters who work (and lunch) in Lisbon but live in adjacent municipalities²⁸.

Figure 1.3 VALORSUL INTERVENTION AREA



Source: *Rei-artur*, 2005, retrieved from <http://en.wikipedia.org/wiki/File:LocalNUTS3GrandeLisboa.svg> and authors' adaptation from Valorsul, 2009

²⁴ Odivelas gained the status of municipality in 1998. Source: <http://www.cm-odivelas.pt/Concelho/Historia/index.htm>

²⁵ Source: National Statistics Institute (<http://www.ine.pt>).

²⁶ Source: Valorsul, 2009.

²⁷ Which in 1996 was 950 kilo tonnes.

²⁸ Source: EIB, 1996.

Lisbon, the capital city of Portugal, is by far the largest municipality of all those being served by Valorsul; it accounts for 30% of the Greater Lisbon area population and 5% of the population of Portugal. The population in each of the other four municipalities represents between 7% and 10% of the total inhabitants of the Greater Lisbon area. Over the last decade (2001-2011), Lisbon's population has slightly decreased by -2.7%, while the whole Greater Lisbon Area has experienced a population increase (+5.1%), which was higher than the national average (+1.3%). The highest increase is recorded, in particular, in the municipalities of Odivelas (+8.2%) and Vila Franca de Xira (+12.7%). Table 1.2 sets out the populations in the target areas according to the most recent data.

Table 1.2 POPULATION OF THE MUNICIPALITIES IN THE VALORSUL AREA OF INTERVENTION

Area	Population (2001)	Population (2011)	Variation	Share of population over the total of Greater Lisbon
Portugal	10,148,247	10,281,794	+1.3%	-
Greater Lisbon	1,887,100	1,982,601	+5.1%	-
Lisbon	562,692	547,265	-2.7%	28%
Loures	191,008	196,682	+3.0%	10%
Vila Franca de Xira	117,414	132,269	+12.7%	7%
Amadora	168,219	169,020	+0.5%	9%
Odivelas	127,817	138,237	+8.2%	7%
Total Valorsul area of intervention	1,167,150	1,183,473	+1.40%	60%

Source: National Institute of Statistics (INE), <http://www.ine.pt/>

In 2003, Valorsul started to serve the other municipalities of the Greater Lisbon NUTS3 sub-region, namely Cascais, Mafra, Sintra and Oeiras²⁹. These towns, whose MSW treatment is under the direct responsibility of another inter-municipal company – TratoLixo³⁰ – have been temporarily accepted as clients by Valorsul until a solution is found to the decreasing capacity of TratoLixo's landfill. More precisely, the aforementioned municipalities, which are grouped into the association AMTRES, benefit only from the valorisation of waste through the WtE plant, but not from the other infrastructures and services of Valorsul.

²⁹ Following the Ministerial Law n° 16104/2003 of 29th July.

³⁰ TratoLixo -Trattamento de Resíduos Sólidos – EIM S.A.

Table 1.3 POPULATION OF AMTRES MUNICIPALITIES TEMPORARILY SERVED BY VALORSUL - 2011

Municipality	Population	Share of population of Greater Lisbon
Cascais	198,262	10%
Mafra	73,810	4%
Sintra	361,559	18%
Oeiras	165,497	8%
Total	799,128	40%

Source: National Institute of Statistics (INE), <http://www.ine.pt/>

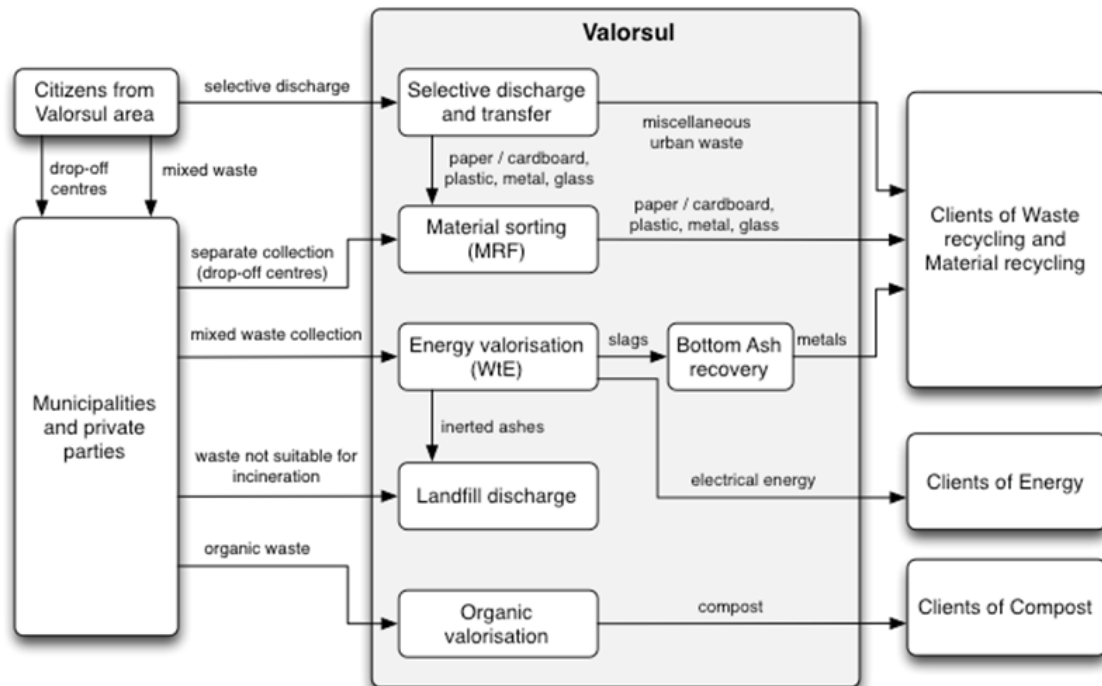
1.3 SERVICE DELIVERY

The Figure below illustrates the life-cycle of waste in the Valorsul waste management system, from the moment it is delivered by citizens to its final disposal into the landfill or other Valorsul facilities for their energetic valorisation or recycling.

Valorsul clients may include municipalities as well as private bodies (mostly companies). Municipalities have the overall responsibility for providing waste services: on their behalf, Valorsul is responsible for waste treatment and recycling activities and for the collection of separated recyclable waste discharged by individuals at the drop-off centre. The transport of the rest of the MSW to the Valorsul facilities is the responsibility of the municipalities, with the exception of the following cases: solid waste produced by companies in excess of 1,100 litres and other solid waste produced by individuals not originating from houses, such as waste originating from moving house. In both cases, the companies/individuals bear the responsibility for delivering the waste themselves.

Recyclable materials are delivered at the drop-off centres and then transported by municipalities at Valorsul Materials Recovery Facility, where waste bags are opened and the contents are separated into different materials (paper and cardboard, plastic, metal and glass). Packaging waste is then collected by the private non-profit company *Sociedade Ponto Verde*, which takes responsibility for putting it onto the recycling market. Valorsul receives a compensation by *Sociedade Ponto Verde* for each tonne of packaging waste materials recovered (see Section 2.5 for further details on *Sociedade Ponto Verde*). Organic waste is separately sorted by households and delivered to the AD plant, where it is used to produce compost. The rest of unsorted waste is either delivered to the WtE plant or to the landfill, if it not suitable for incineration. Valorsul provides for transporting the bottom ash resulting from incineration to the Bottom Ash Processing and Recovery installation, where metal is extracted to be recycled.

Figure 1.4 VALORSUL WASTE LIFE-CYCLE



Source: Authors' adaptation from Valorsul, 2009

Tariffs are differentiated by kind of waste treatment service provided by Valorsul and by type of client. For instance, municipalities do not pay any tariff for delivering the organic fraction to the Anaerobic Digestion Plant, but a tariff has been set for private clients. In this case, Valorsul charges private clients for the composting service depending on the volume of organic waste delivered and its level of contamination, i.e. the share of improper materials within the organic waste. In order to encourage the recycling of organic waste, the plant accepts material free of charge from clients who deliver high volumes of waste with low levels of contamination (see Table 1.4).

Table 1.4 TARIFFS FOR THE ANAEROBIC DIGESTION PLANT

Volume of organic waste delivered	Level of contamination (share of improper waste)	Tariff (paid only by private clients)
> 500 t/year	≥ 11%	EUR 53.84/t
	< 11%	EUR 0.00/t
< 500 t/year	≥ 11%	EUR 53.84/t
	5% - 11%	EUR 20.97/t
	< 5%	EUR 10.49/t

Note: VAT is not included. The tariff is paid on the total weight delivered by the producer.

Source: <http://www.valorsul.pt/pt/clientes/quanto-custa-depositar-os-residuos-na-valorsul.aspx> as of 20.02.12

The tariff for the treatment service provided by the WtE plant or for waste disposal at the Mato da Cruz landfill³¹ is the same, but Valorsul charges different prices depending on whether the client is a municipality or a private body, with the former benefiting from special rates. This is particularly notable in the case of the price paid for the discharge of MSW to the landfill or the WtE plant, which represents the main service delivered by Valorsul. In this case the discharge tariff set for private bodies is more than double the tariff set for municipalities (EUR 53.84/t against EUR 22.31/t).

Besides the discharge tariff, Valorsul also charges a tariff for the destruction of MSW: this is an additional service provided in special situations to governmental entities, mainly at the incineration plant, when the products, mostly for legal or fiscal reasons, have to be destroyed before being incinerated (e.g. apprehended counterfeit goods, drugs, special foods, etc.).

Table 1.5 VALORSUL TARIFFS FOR THE WtE PLANT AND LANDFILL

Type of Service	Facility	Municipalities	Private bodies
Discharge of MSW	WtE	EUR 22.31/t	EUR 53.84/t
	Landfill	EUR 25.70/t	EUR 57.23/t
Destruction of MSW (fixed rate)	WtE	EUR 132.58/day	EUR 136.03/day
	Landfill	EUR 132.58/day	EUR 136.03/day
Destruction of MSW (variable rate)	WtE	EUR 135.46/t	EUR 164.44/t
	Landfill	EUR 138.85/t	EUR 169.83/t

Note: All rates shown include the waste management tax (Taxa de Gestão de Resíduos) and “aggravation” waste management tax (Agravamento TGR), which amount to EUR 1.11/tonne and EUR 0.23/tonne respectively for the WtE Plant, and EUR 4.15/tonne and EUR 0.58/tonne respectively for the Mato Da Cruz landfill. VAT is not included.

Source: Valorsul (<http://www.valorsul.pt/pt/clientes/quanto-custa-depositar-os-residuos-na-valorsul.aspx> as of 20.02.2012)

Finally, the discharge of MSW at the drop-off centres is free both for municipalities and private clients: this measure, which allows Valorsul’s clients to save on the costs of delivering the waste to the landfill, the WtE Plant or the Anaerobic Digestion Plant, aims to promote the recycling of materials.

These tariffs *per se* would not guarantee the financial sustainability of Valorsul waste management system. Actually, operating costs are mostly covered by another source of revenues, which is the sale of energy; tariffs are kept low enough to allow the firm to earn a surplus, without pursuing profit maximisation³². No return is being earned on the element of the investment that was funded by the EU. The main beneficiaries of such a tariff setting are Valorsul’s municipalities, who have to pay a lower price than the opportunity cost of the service, as further discussed in Section 3.2.

³¹ The sanitary landfill of Mato da Cruz accepts MSW sent by the municipalities and as well as private bodies, whilst the sanitary landfill do Oeste in Cadaval, previously managed by Resioeste and today managed by the ‘New Valorsul’, only accepts MSW from the municipalities. The tariff applied in both the landfills is the same.

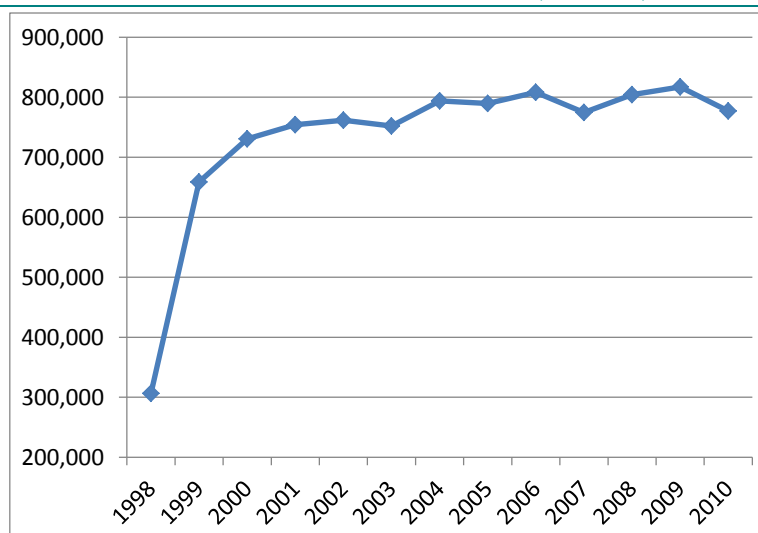
³² Retained profits in the firm as of the end of 2009 were EUR 22 million.

The so-called European “polluter pays” principle, set in Directive 2004/35/EC and requiring the producers of waste to bear the costs for its disposal, is not fulfilled by the project. Actually, although the proportionality nature of Valorsul’s tariffs for unsorted waste (which are variable according to the volume of waste produced) is in line with the notion of the “polluter pays” principle, since it ensures that those who produce more waste pay a higher fee for their disposal, the very low level of tariffs compared to the real cost of treatment and disposal incurred by Valorsul does not ensure that all costs are actually covered by waste producers.

1.4 CURRENT PERFORMANCE

The volume of MSW processed by Valorsul over the last decade has increased, reflecting the economic growth of Portugal in the same period, and in particular, the growth of Lisbon NUTS2 region. Today Valorsul processes in its facilities about 800,000 t of MSW per year (see Figure 1.5).

Figure 1.5 VALORSUL WASTE RECEPTION GROWTH (TONNES) – 1998-2010



Source: Authors’ elaboration based on data from Valorsul, 2009

The most significant increase in volume took place during the early years of Valorsul. In 1998, when the company inaugurated its first modern landfill, it was processing 306 thousand tonnes of MSW; one year later, the landfill was processing 430 thousand tonnes and the WtE plant, which was going through its first test, treated another 225 thousand tonnes; in 2000, the WtE Plant was officially inaugurated and processed 595 thousand tonnes, while the volume of MSW disposed of to the landfill decreased to 112 thousand tonnes. In just three years, Valorsul had increased its total treatment capacity by 139%, from 306 thousand to 731 thousand tonnes of MSW.

Over the intervening years, the company has continuously increased the volume of reception and processing of MSW, whilst at the same time adding new facilities and services. In 2000 the Material Recycling facility started operations, adding 22,987 t to the system; in 2005, the Anaerobic Digestion Plant received 7,020 t in a testing phase; by 2007 this had risen to 27,858

t. In short, Valorsul has gone from processing 306,296 MSW t in 1998 to 817,032 t in 2009, which represents an increase of 167% within a timeframe of 12 years.

The landfill and the WtE treatment plant outweigh the recycling facilities in terms of volume of MSW processed, although the relative share of MSW processed by different types of facilities has changed over time (Figure 1.6 and 1.7). In particular:

- The volume of MSW sent to landfill has significantly decreased over the years, going from 306,297 t in 1998 to 137,449 t in 2009, a reduction of 55%. As a result, in 2009 the MSW discharged to the landfill represented only 17% of all MSW processed by Valorsul, as compared to 100% in 1998.
- The WtE facility is the largest receiver of MSW. Leaving aside its test year, 1999, when volumes processed were lower than those sent to the landfill, it has processed an average of 561,940 t per year (2000-2009). In 2009, the MSW sent to the WtE plant accounted for 72% of all MSW processed by Valorsul. The WtE plant, which quickly took over significant volumes of waste previously sent to the landfill, has lost some share over the years, partly due to the establishment of additional facilities (e.g. recycling and compost production plants), and partly due to the current economic crisis, which has contributed to reducing the generation of waste.
- The materials recycling activity shows a distinct growth trend of MSW processed, having gone from 22,987 t in 2000 to 73,351 t in 2009, representing 219% growth. When the facility started the operations, it was receiving 3% of the total MSW; in 2009, nine years later, 9% of all MSW collected by Valorsul was sent for material recycling. Nearly half of the material recycled by Valorsul in 2009 was glass (48%), followed by paper (28%); ferrous metals and plastic represented the lowest figures (9% and 2% respectively). Looking at the growth per type, all categories of product experienced an increase from 2007 to 2009, however it is worth remarking on the 170% growth of ferrous materials sent to recycling.

Table 1.6 RECYCLING MATERIALS RECOVERED BY VALORSUL'S FACILITIES (TONNES), 2007-2009

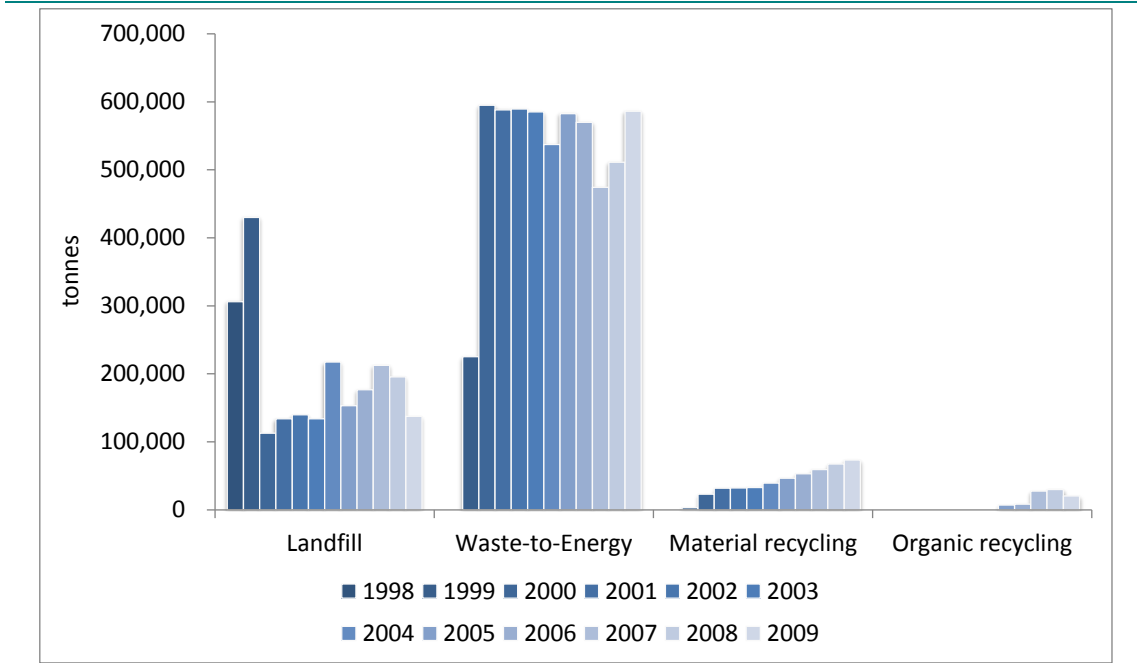
Material	2007	2008	2009	Increase 07-09
Glass	32,975	33,999	33,218	4%
Ferrous metals	2,403	5,172	6,496	170%
Non-ferrous metals	8,725	8,880	9,006	3%
Plastic	967	1,060	1,104	14%
Paper	18,369	19,619	19,833	8%

Source: Valorsul, 2009

- Finally, when organic recycling started in 2005, as part of the second CF investment project undertaken by Valorsul, it processed 7,020 t; in 2009 the Anaerobic Digestion Plant received 20,389 t, an increase of 190%. Despite this growing trend, this activity still represents a minor share of all MSW processed by Valorsul (2% in 2009). Moreover, the

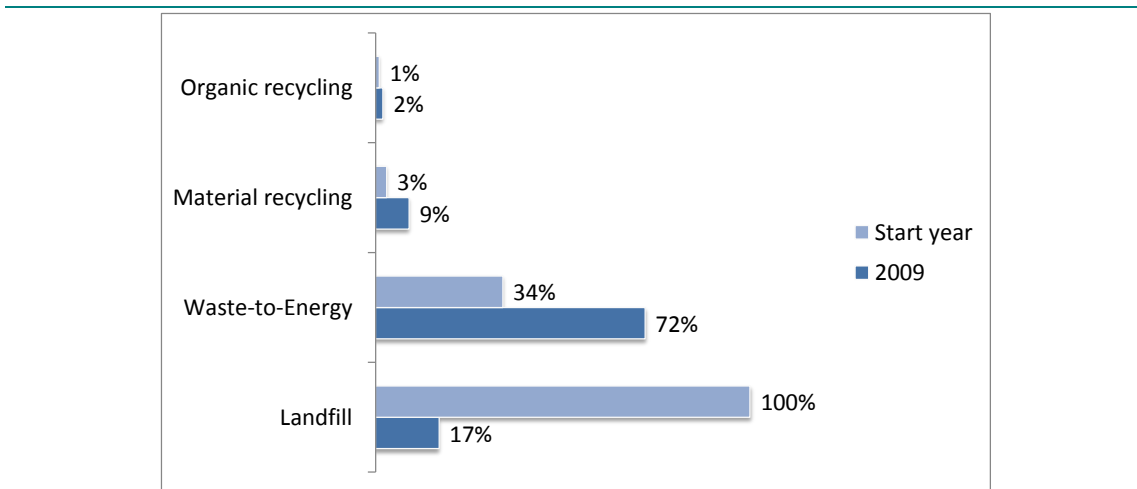
quality of compost produced is not high enough to allow its utilisation as fertiliser (see Sections 2.3 and 3.2).

Figure 1.6 PERFORMANCE OF VALORSUL IN WASTE PROCESSING OVER TIME (TONNES)



Source: Authors' elaboration based on data from Valorsul, 2009

Figure 1.7 SHARE OF MSW PROCESSING BY TYPE OF FACILITY AS A %AGE OF THE TOTAL MSW PROCESSED BY VALORSUL - FROM START OF OPERATION YEAR TO 2009



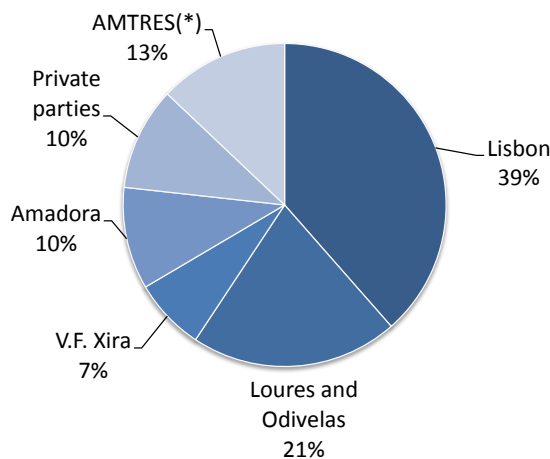
Note: Start of operation years: Landfill (1998); Waste-to-Energy (test 1999); Material recycling (2000); Organic recycling (2005).

Source: Authors' elaboration based on data from Valorsul, 2009

As a consequence of the economic crisis which has reduced consumption, in 2010 the total volume of MSW processed by Valorsul decreased compared to the previous year, going from a total of 817,302 t in 2009 to 777,243 t in 2010, which represents a 4.9% reduction.

The municipality of Lisbon is the largest client of Valorsul, as it delivers 39% of the total volume of waste treated by the company, followed by Loures (21%); each of the other municipalities delivers between 7% and 10% of the total, while the AMTRES group of municipalities temporarily benefitting from Valorsul services (as explained in Section 1.2) accounts for 13% (Figure 1.8).

Figure 1.8 ORIGIN OF MSW PROCESSED BY VALORSUL - 2009



(*) AMTRES is the association that represents the municipalities of Cascais, Mafra, Sintra and Oeiras
 Source: Authors' elaboration based on data from Valorsul, 2009

The recycling rates of waste amongst municipalities vary between 6% and 14%. The average recycling rate in the Valorsul area of intervention (9%) is slightly above Portugal's rate (8%), although still far from the targets set by the European Union (24%), which are recalled in the Box below. Hence, the project did not ensure compliance with EU Directive 2004/12/EC on packaging and waste packaging, as discussed also in other Sections of this report.

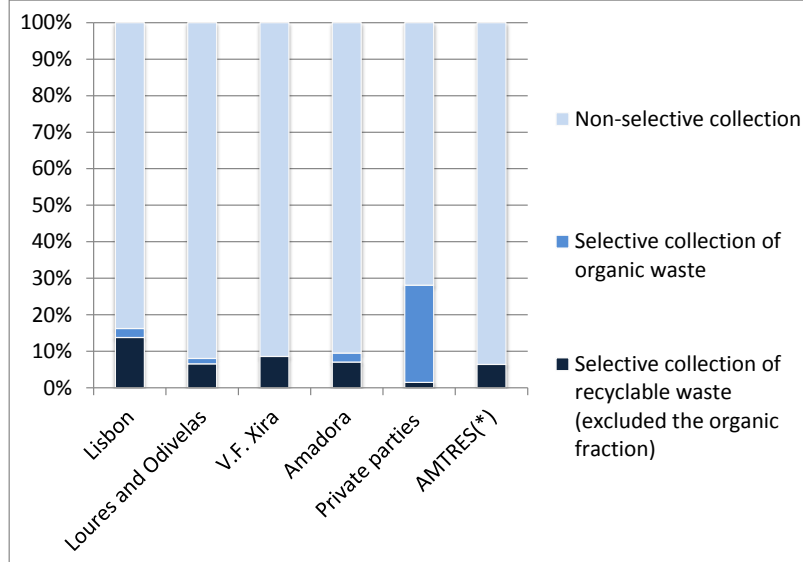
Although a large share of organic waste is now diverted away from landfill, as required by Directive 1999/31/EC on landfill management (see Box 2.1 for more details), the recycling rates of organic waste are also very low, ranging between 0% and 2%.

The largest share of collected waste (between 84% and 94%) consists of unsegregated MSW, sent either to the WtE plant or to landfill. As shown in Figure 1.9, Lisbon is the municipality with the highest share of recycling and the lowest share of waste delivered to the incinerator or landfill.

As far as private parties are concerned (both individuals and companies), only 1% of the total waste delivered to Valorsul consists of materials (paper, glass, packaging and metals) to be recycled; the share of organic waste collected from private parties, by contrast, is higher than the average volume collected by municipalities (accounting for 27%), probably due to

collection from restaurants, food-shops, hotels, etc. In any case, for this typology of clients, unsegregated waste sent to the WtE Plant and to landfill also accounts for the largest share.

Figure 1.9 TYPE OF MSW COLLECTION BY CLIENT - 2009



(*) AMTRES is the association that represents the municipalities of Cascais, Mafra, Sintra and Oeiras

Source: Authors' elaboration based on Valorsul, 2009

Box 1.1 EU TARGETS ON THE RECOVERY AND RECYCLING OF PACKAGING WASTE

The EU Directive 94/62/EC on packaging and packaging waste, amended by Directive 2004/12/EC, set specific targets for Member States on the recovery and recycling share of packaging waste. These are:

1. No later than 30 June 2001 between 50% as a minimum and 65% as a maximum by weight of packaging waste will be recovered or incinerated at waste incineration plants with energy recovery;
2. No later than 31 December 2008 60% as a minimum by weight of packaging waste will be recovered or incinerated at waste incineration plants with the energy recovery;
3. No later than 30 June 2001 between 25% as a minimum and 45% as a maximum by weight of the totality of packaging materials contained in packaging waste will be recycled with a minimum of 15% by weight for each packaging material;
4. No later than 31 December 2008 between 55% as a minimum and 80% as a maximum by weight of packaging will be recycled;
5. No later than 31 December 2008 the following minimum recycling targets for materials contained in packaging waste will be attained: 60% by weight for glass; 60% by weight for paper and board; 50% by weight for metals; 22.5% by weight for plastics, counting exclusively material that is recycled back into plastics; 15% by weight for wood.

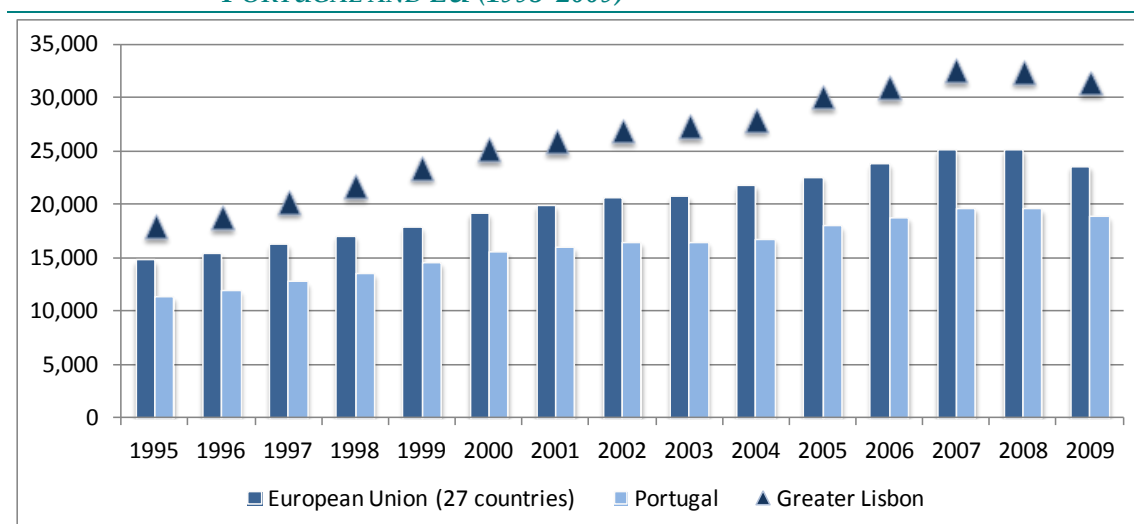
Source: Authors based on Directive 94/62/EC

2 ORIGIN AND HISTORY

2.1 CONTEXT AND LEGISLATIVE FRAMEWORK IN THE ENVIRONMENTAL SECTOR

The OECD 2001 Environmental Report on Portugal highlights the significant growth in Portugal's economy by the early 1990s following structural changes in a number of sectors, namely industry, agriculture, coastal urbanization and tourism: "In the 1990s, Portugal's GDP increased by about 25% and its population by 1%. GDP per capita rose by 23%, but is still more than 25% below the OECD average". Its level of economic development has improved, although it is still below the level of other Member States: in 2010, per capita Gross Domestic Product (GDP)³³ is 80% of the EU average, while in 1988 it was only 56%³⁴ and in 1995, 76%. It is worth pointing out, however, that the Lisbon region records a higher level of economic development, even higher than the EU average (approximately 130% of the EU average).

Figure 2.1 TREND OF PER CAPITA GDP EXPRESSED IN PURCHASING POWER PARITY - PORTUGAL AND EU (1995-2009)



Source: Authors' elaboration based on Eurostat data

During the Nineties, Portugal was facing the challenge of balancing this economic progress with social and environmental developments, in order to meet the standards set by EU policies and legislation, in particular with regard to water supply, waste water treatment and solid waste treatment.

³³ In Purchasing Power Parity terms.

³⁴ Direcção Geral do Ambiente, 2000.

Prior to 1993 the water and waste sectors in the country were managed in an unsustainable way and Portugal had difficulties addressing the new challenges arising from entry to the EU³⁵, asking for strong reduction of land filled waste and an increase of recycling rates (see Box 1.1).

Box 2.1 EU SOLID WASTE LEGISLATION

The basic requirements, definitions and principles regarding waste management in the European Union are collected in Directive 2008/98/EC (known as the Waste Framework Directive), that repeals previous Directives on waste (2006/12/EC)³⁶, hazardous waste (91/689/EC) and waste oils (75/439/EC)³⁷.

The Waste Framework Directive introduces a five-step waste management hierarchy, where prevention, i.e. reduction of waste generation, is to be considered as the favoured option, followed by re-use, recycling and other forms of recovery, including energy recovery through incineration and composting, with disposal to landfill as the last resort management system. The EU objective is to promote a waste management system across European regions that moves up the waste management hierarchy.



Other key Directives on solid waste management, which have been all transposed by the Portuguese Government into national legislation are the following:

- Directive 94/62/EC on packaging and packaging waste. It contains provisions on the prevention, re-use, recovery and recycling of packaging waste. It aims at harmonising national measures in order to prevent or reduce the impact of packaging and packaging waste on the environment. In 2004 the Directive was reviewed to increase the targets for recovery and recycling of packaging waste (see Box 1.1).
- Directive 99/31/EC on landfills. It is intended to prevent or reduce the adverse effects of landfills on the environment, in particular on surface water, groundwater, soil, air and human health. It sets stringent technical requirements for landfill sites, specific requirements for waste acceptance into the sites and introduces landfill categories depending on the waste intended to be disposed of into them. This Directive asks for a progressive redirection of biodegradable waste away from landfills, with specific targets set at year 2010, 2013 and 2016.
- Directive 2000/76/EC on incineration. It sets standards and methodologies for the practice and technology of waste incineration, in order to prevent or limit as far as practicable negative effects on the environment, in particular pollution by emissions to air, soil, surface water and ground water, and the resulting risks to human health.

Source: Authors

In 1993, the Government reorganised the environmental sector to deliver high quality services, ensure affordable prices and promote environmental sustainability. Two Decree-Laws of great importance for the waste management field were published in that year, whose main goals were to regulate service provision and to assign to municipalities the responsibility to

³⁵ Portugal joined the European Union in 1986.

³⁶ Which consolidated and replaced Directive 75/442/EC.

³⁷ This is designed to create a harmonised system for the collection, treatment, storage and disposal of waste oils, such as lubricant oils for vehicles and engines.

conduct waste management (both collection and treatment). This task can be carried out either directly or indirectly, through the concession of such activities to private parties or public associations of municipalities specialised in the operation of waste management systems, or in partnership with the State³⁸. Conditions have been laid down to allow shared management of waste treatment issues between municipalities.

In the same year Águas de Portugal was established, a private-law company with public shareholders whose main goal was to overcome the governance fragmentation characterising the water supply, waste water and solid waste management sectors, by favouring the development of multi-municipal systems³⁹. By 2000, all Portuguese government-owned environmental subsidiaries were integrated into the Águas de Portugal group. Within this framework, the public company Empresa General de Fomento (EGF), a sub-holding company of Águas de Portugal, became responsible for all activities aimed at guaranteeing proper waste treatment, within a framework of environmental and economic sustainability.

By July 1995 the National Waste Plan was drafted, which set the groundwork for the construction of future infrastructures necessary to implement the Strategic Plan for Municipal Solid Waste 1997-2006 (PERSU), adopted on 13th November 1996. This Plan fostered most waste management activities carried out in the national territory over the following years. It was the first ever strategic document to be published establishing concrete targets to improve the sector, including in terms of volume of waste to be disposed of and recycled. Besides envisaging the construction of infrastructures for waste recovery and valorisation and the implementation of separate collection systems for recyclable materials, the Plan identified different types of MSW management systems: inter-municipal bodies (formed only by municipalities), multi-municipal bodies (formed by State-owned companies and the municipalities) and public-private companies⁴⁰.

A new Plan (PERSU II) was approved in 2006 for the period 2007 to 2016. This builds on previous MSW policies but also takes in the new and more ambitious requirements formulated at national and EU level. In particular, it focuses on increasing the share of biodegradable waste diverted away from landfill, and of packaging waste recycled (consistently with Directives 99/31/EC and 94/62/EC). One of the actors which contributed to drafting this Plan was the National Institute of Waste⁴¹, set up at the beginning of 1998. It is in charge of developing planning tools in the waste field, bringing together inter-ministerial representatives

³⁸ As it was for the municipalities in the metropolitan area of Northern Lisbon, which assigned the MSW management activities to Valorsul.

³⁹ Up until then, there had been just one case of integration of operations for several administrative divisions. It was EPAL, the company that at the time supplied water to some 20 municipalities in the Greater Lisbon area, and is now integrated into AdP Group as one of its business units.

⁴⁰ In particular, Decree-Law 294/94 of 16 November 1994 established that the operation and management of municipal systems could be performed directly by the respective municipalities and associations of municipalities, or alternatively, performed (through a concession) by public or private business, as well as associations of users. On the other hand, Decree-Law 58/98 of 18 August regulated the conditions under which the municipalities or associations of municipalities can create enterprises with equity.

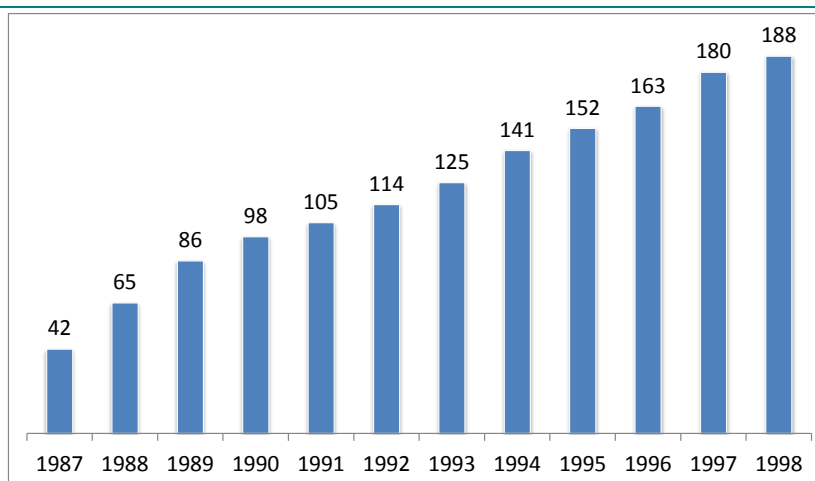
⁴¹ Instituto Nacional de Resíduos.

from the Ministries of Economy, Agriculture, Rural Development and Fisheries, Health and Environment, and the National Association of Portuguese Municipalities.

A few months earlier another institution had been established: the Regulatory Institute of Water and Waste (IRAR)⁴². It took on the role of regulatory authority for drinking water supply, wastewater management and municipal waste management in Portugal. Since 2004, IRAR has also taken on the responsibilities for drinking water quality control. In 2009 IRAR was transformed into the Regulation Authority for Water and Waste Services (ERSAR)⁴³: this change was aimed at increasing the regulatory intervention scope to all operators of these services, irrespective of the management model, and at standardising procedures with them. The mission of ERSAR is to regulate drinking water supply services, wastewater management services and municipal waste management services, with the objective of ensuring adequate protection for consumers and users of water supply and waste services, avoiding possible subsequent abuse of exclusive rights with regard to the guarantee and quality control of the public service provided, on the one hand, and supervision and control of prices, on the other.

Along with the legislative and institutional developments, it has to be mentioned that public awareness of environmental matters experienced a significant increase in the 1990s. The number of environmental Non-Governmental Organisations (NGOs) operating in Portugal steadily increased, from 42 in 1987 to 180 in 1997, nearly a 330% increase. By 1999, 3% of the population was directly involved in environmental associations and 71% declared themselves to be in favour of these activities. The areas of population most concerned with environmental issues were mainly the largest metropolitan areas of Lisbon and Porto as well as the coast of Portugal in zones such as the Algarve, i.e. where traffic growth, urban sprawl and tourism development were perceived as the main causes for environmental concern.

Figure 2.2 NUMBER OF ENVIRONMENTAL NGOS IN PORTUGAL



Source: Direcção Geral do Ambiente, 2000

⁴² Under Decree-Law no. 230/97, 30th August.

⁴³ Decree Law no. 277/2009, 2nd October.

2.2 MSW TREATMENT PRIOR TO THE IMPLEMENTATION OF THE VALORSUL PROJECT

Total production of MSW in Portugal has experienced a growing trend since 1990⁴⁴, rising by an average of 3.5% per annum over the years 1990-1998 (see Figure 2.3). Treatment of MSW in the early 1990s mainly relied on landfill disposal and, to a minor extent, on compost production. A large share of waste (about 50%) was disposed of in illegal dumping grounds, without receiving adequate treatment. Recycling was still largely under-developed: separate collection was focused on paper and cardboard, with a recycling rate of approximately 40% of total paper consumed. No incinerator plants were in operation to treat and valorise waste.

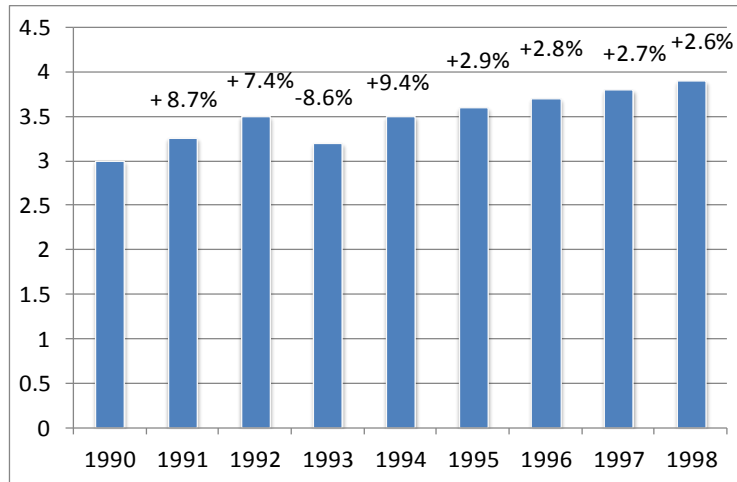
The PERSU 1997-2006 plan defined several lines of action for Portugal in the solid waste management field, including:

- the closure of all dumps by 2000;
- the closure and rehabilitation of landfills with a view to their total eradication;
- the carrying out of works and operations for the construction of infrastructures for MSW treatment;
- the support of collection and recycling services;
- the reduction of MSW generation: a 2.5% reduction target was set for the period 1995 to 2000 and 5% for the period 2000 to 2005.

Starting from 1997 and in compliance with the PERSU, some efforts were made to seal dumps, with a focus on the illegal ones, given their major negative impacts on the environment. Out of the 340 dump sites identified in 1996, 45 had been closed by the end of 1998, but 180 were still at the construction or awarding phases and 115 were active. As a result, the goal of closing all dumps in Portugal by 2000 had not been achieved. In parallel, the use of sanitary landfills, which was supposed to decrease, actually increased, given the lack of alternative treatment routes. Also, a decrease in the percentage of waste used to produce compost was observed, due to the very poor quality of compost produced, making it unusable in the agriculture sector.

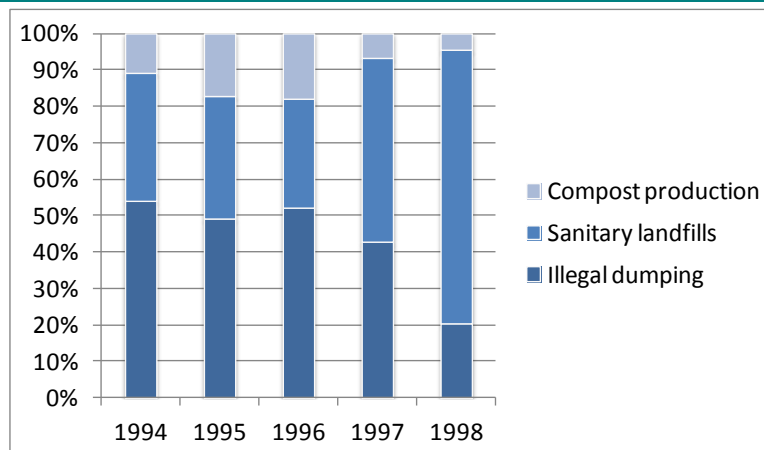
⁴⁴ Direcção Geral do Ambiente, 2000.

Figure 2.3 TOTAL MSW PRODUCTION IN PORTUGAL (MILLION TONNES AND ANNUAL PERCENTAGE VARIATIONS) – 1990-1998



Source: Direcção Geral do Ambiente, 2000

Figure 2.4 FINAL DESTINATION OF MSW – 1994-1998



Source: Direcção Geral do Ambiente, 2000

Moreover, recycling rates in Portugal were generally still far below targets for both municipal and industrial waste and waste generation kept growing, even faster than GDP and private consumption⁴⁵.

From a narrower perspective, the situation in the Valorsul area of activity was very similar to the national picture. In 1994, at the time of project inception, waste management in the Greater Lisbon area relied upon two old landfills and one composting plant for the processing of MSW. The landfills included the Vale do Forno in Lisbon, which, in addition to having run out of capacity, did not have a proper artificial sealing at its bottom, and the Santa Iria de Azóia landfill in Loures, which was close to its capacity limit. Recycling levels in the area were very low. According to the European Investment Bank (EIB), less than 5% of waste collected was recycled and composted and more than 95% was discharged into landfills without any kind of

⁴⁵ OECD, 2001.

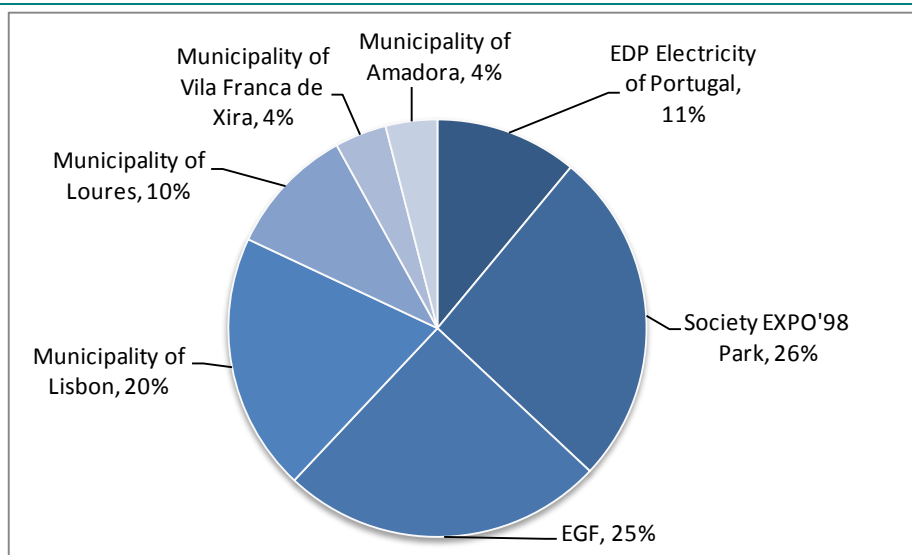
treatment⁴⁶. The only other municipal solid waste facility, the Solid Waste Treatment Station of Beirolas, was located in Lisbon, and received non-differentiated collection of waste, producing compost of low quality.

In 1992 the Portuguese Government submitted a proposal to host the 1998 World Exhibition (Expo '98), which was eventually approved. A 100 hectare area in the Oriental Quarter of Lisbon was selected for the future venue of the exhibition, i.e. where the Beirolas plant and the obsolete landfill of Lisbon were located. In preparation for this event, the Government and the State-owned company in charge of organising the Expo '98 (Parque Expo) decided to “clean up” and reorganise this area. The aim was to reduce the heavy soil pollution caused by the landfill and other industrial pollution sources and to improve the visual impact on the landscape. As a result, the Government decided to decommission the existing waste treatment plant and to provide the Greater Lisbon municipalities with more modern and adequate facilities for waste management.

2.3 ESTABLISHMENT OF VALORSUL AND PROJECT IMPLEMENTATION

In response to the challenges presented in the previous Section, Valorsul was established in 1994⁴⁷ as the multi-municipal company responsible for waste treatment in the Northern Lisbon metropolitan area, including the municipalities of Amadora, Lisbon, Loures and Vila Franca de Xira. The company was fully publicly owned, with shares distributed as follows: Society Expo '98 Park (26%), EGF – Empresa General de Fomento S.A.⁴⁸ (25%), City Hall Lisbon (20%), EDP - Energias de Portugal S.A. (11%), Loures City Council (10%), City of Amadora (4%) and the Municipality of Vila Franca de Xira (4%).

Figure 2.5 VALORSUL SHAREHOLDERS IN 1994



Source: Authors

⁴⁶ EIB, 1996.

⁴⁷ Decree-Law 297/94, of 21 November.

⁴⁸ Which is part of the AdP Group (see Section 2.1).

In 1995 the company signed a concession contract for 25 years with the Ministry for Environment, Spatial Planning and Regional Development to become responsible for the conception, construction and management of all necessary installations to recover or dispose of MSW produced in the above mentioned municipalities.

In designing the new waste treatment infrastructures, Valorsul took into account the PERSU's goals. The investment major project "Multi-municipal System for Urban Solid Waste Treatment for the Metropolitan Area of Northern Lisbon" included several initiatives: the construction of a WtE plant and Bottom ash processing and recovery installation, a new sanitary landfill (Mato da Cruz), the Materials Recovery Facility and the drop-off centre. In parallel, the project involved sealing and rehabilitation of the Vale Forno and Sta Iria de Azoia dumps. In 1996 Valorsul obtained financing from the EU (through the Cohesion Fund⁴⁹) and the European Investment Bank. The construction of these facilities started in 1995 and was concluded by 2002.

The decision about where to locate the different infrastructures was strongly influenced by the target municipalities: instead of concentrating the waste treatment activities in a single complex, the municipalities pushed Valorsul to implement a decentralised management system, building at least one facility in each of them. The main reason to have the four facilities (landfill, incinerator plant, organic waste treatment plant and sorting plant) spread over the four initial municipalities is due to the "NYMBY" (Non in my backyard) syndrome: at that time, actually, nobody wanted a waste treatment plant in their area and the decentralised management system was the only accepted solution by municipalities.

In the process of Environmental Impact Assessment, different sites were analysed as alternatives but the current locations were considered the most suitable, according to the two main criteria used, i.e. accessibility and sensitivity to air pollution⁵⁰. In addition to that, the selected areas presented further advantages, such as lower density of population⁵¹. As anticipated in Section 1.1, the Loures and Lisbon municipalities were chosen as the location for the WtE plant and sorting stations respectively, while the Bottom Ash Processing and Recovery Installation and the Mato da Cruz landfill were located in Vila Franca de Xira.

Nearly a decade later, Valorsul was awarded another CF project⁵² for the construction of an Anaerobic Digestion Plant in the municipality of Amadora. This ran its first tests in February 2005, but because of technical problems which were preventing it from properly functioning, it had to be stopped. In the following two years all the problems were solved and the plant could be formally inaugurated only in 2008.

⁴⁹ CF Project 95/10/61/026.

⁵⁰ <http://www.citidep.pt/ims/EIA/CI12.html>.

⁵¹ <http://www.citidep.pt/ims/EIA/CI1.html>.

⁵² 1999/PT/16/C/PE/005.

Box 2.2 MILESTONES IN THE DEVELOPMENT OF VALORSUL INTEGRATED WASTE MANAGEMENT SYSTEM

1994 – Establishment of Valorsul
1995 – Signature of a 25-year contract concession with the Ministry for Environment <ul style="list-style-type: none">– Directors approve the Plan for an Integrated Management of Municipal Solid Waste (POGIRSU)
1996 – Valorsul is awarded CF Project 95/10/61/026 ‘Multi-municipal System for Urban Solid Waste Treatment for the Metropolitan Area of Northern Lisbon’
1998 – Inauguration of Mato da Cruz landfill
2000 – Inauguration of the WtE Plant for the incineration of MSW with energy recovery <ul style="list-style-type: none">– Inauguration of Sta Iria de Azóia park (a former uncontrolled dump)
2002 – Inauguration of the Materials Recovery Facility MRF and drop-off centre in Lumiar (Lisbon)
2003 – Acceptance of MSW produced in Cascais, Mafra, Oeiras and Sintra ⁵³
2005 – Valorsul is awarded CF Project 1999/P T/16/C/PE/005 ‘Anaerobic Digestion Plant’ <ul style="list-style-type: none">– Initial tests of the Anaerobic Digestion Plant
2007 – Approval of the new Environmental, Safety and Quality Policy <ul style="list-style-type: none">– Awarded the ‘Prize to Water and Waste Management Quality of Service’ by ERSAR
2008 – Inauguration of the Anaerobic Digestion Plant
2010 – Merger with Resioeste to establish a ‘new’ Valorsul

Source: Authors

Besides building the infrastructures, Valorsul has played an active role in raising awareness on environmental matters, particularly on waste treatment, amongst the wider public of Greater Lisbon Area. In a way, this was imposed by the initial situation during the early years of the company when it had to face some opposition to the construction of the incinerator from various NGOs and communities living near the planned site. In response, Valorsul took a leadership role in involving and informing all stakeholders affected by the project. The approach taken resulted in significant levels of public participation in Valorsul decision process – particularly among two groups, namely, local citizens and environmental NGOs⁵⁴.

From these early days, Valorsul has continued involving, communicating and raising awareness on waste management at two levels:

- at institutional level, through cooperation with external bodies involved in public health and environmental issues⁵⁵ (see Section 3.5 on environmental effects);
- at a wider public level, in the context of its Corporate Social Responsibility (CSR) policy, through a large number of initiatives, such as communication campaigns to encourage the population to separate their waste and collaboration with schools to promote

⁵³ Ministerial Law Nº 16104/2003, of 29 July.

⁵⁴ It is worth adding that, since 2004, with the aim of becoming more transparent and closer to its stakeholders, Valorsul publishes an annual sustainability report based on the Global Reporting Initiative guidelines.

⁵⁵ Such as the Institute of Environment and Development (Instituto do Ambiente e Desenvolvimento - IDAD), the Hydrographic Institute, The Oceanographic Institute, the Laboratory dLlab, the Institute of Preventive Medicine of the University of Lisbon and the Centre for social research and intervention.

environmentally-conscious behaviour amongst youngsters (via the 'Ecovalor' programme).

Moreover, Valorsul promoted initiatives aimed at increasing recycling rates. These include the Ecovia project, which fostered the recycling of special types of materials, normally submitted for energetic valorisation or dumped to landfills (see Box 2.3).

Box 2.3 THE PROJECT ECOVIA – ECOLOGICAL ROAD

The project Ecovia - Ecological Road was funded by the EU LIFE Environment Programme⁵⁶ (LIFE ENV/P/000366 05) and led by Brisa, Auto-Estradas de Portugal S.A., in partnership with many actors, including Valorsul⁵⁷. The project was developed over 42 months during the period 2005-2009 and had a total budget of about EUR 1,24 million, EUR 617,727 of which financed by the EU⁵⁸.

The main goal of the project was to contribute to the recycling of particular materials, i.e. mixed plastic, rubber and beverage cardboard. Through a special technology (the "ART Technology") based on a process that permits mixtures of plastics incorporating a high level of ingredients, these materials were used to manufacture new products for road safety purposes, such as rails, acoustic barriers, rumble strips, road signs, road dividers and other roads-related articles.

The main outcomes of the project were:

- 434 fencing posts: these were installed along the entire road network, replacing the old wooden posts, used to demarcate the highway and block access to animals and people;
- 10 pathways or passages for telematics sites: these had the objective to facilitate the access to telematics sites for the maintenance tasks of technicians.
- 15 kerb protectors: these were installed in all concrete pavings just below the entrance to highways tolls so that the door of the vehicles were protected when stopped at toll gates, in case of unexpected opening.

Furthermore, the project raised awareness on the environment and the need for selective collection and recycling among the public. The communication and awareness raising side of the project was achieved through the building of a green mile of motorway near Lisbon (the "green stretch"), within which all building material and infrastructure were made of recycled substances.

Whilst pursuing these goals, the project covered the following fields:

- a. Collection, sorting, treatment and preparation of the materials to be used in the manufacturing of new products;
- b. Manufacturing of the new products, performance of tests and product certification to ensure a safe use and installation;
- c. Creation of the "green stretch", where the products made from recycled material were placed;
- d. Feasibility studies on the new products and drawing up of technical documentation on the properties of the products, their performance in real scenario and production process;
- e. Public awareness campaigns to increase recycling and the potential of using products made from recycled material.

The Ecovia project demonstrated the feasibility of using recycled products in road sector and the possibility of increasing recycling rates. In total, 5,900 kg of recycled materials that would have been otherwise land-filled or incinerated were used. The project promoter believes that Ecovia is very replicable to other regions of the EU.

⁵⁶ LIFE is the EU's financial instrument supporting environmental and nature conservation projects throughout the EU since 1992 (<http://ec.europa.eu/environment/life/>).

⁵⁷ Other actors involved were the Association of manufacturers of cardboard for liquids and food, the Portuguese Environmental Agency, the Portuguese Association for the Defence of Consumers, Plastval S.A., Sociedade Ponto Verde S.A., Tratolixo S.A. and Valorpneu Lta.

⁵⁸ In current prices.

Source: Authors based on

http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=search.dspPage&n_proj_id=2827&docType=pdf, <http://www.ecovia.brisa.pt/uk/> and http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=home.showFile&rep=file&fil=LIFE05_ENV_P_000366_LAYMAN.pdf

When the Anaerobic Digestion Plant was opened, some efforts were made by Valorsul to raise awareness in the area of composting. The Programme '+ Valor' was launched in 2005⁵⁹. It attempted to bring behavioural changes among restaurants, markets and canteens of Greater Lisbon Area with regard to organic waste separation. The final goal was to obtain a proper quality of separated organic waste, collected and ultimately sent to the Anaerobic Digestion Plant. Actually, it is worth mentioning that only if the improper fraction contained in the organic waste is very low it is possible to produce compost of high quality for use in the agricultural market. The compost produced by the Anaerobic Digestion Plant, which was assigned the name "RICATERRA"⁶⁰ was primarily intended to be used as organic fertiliser for the improvement of the physical, chemical and biological features of the soil, and consequently contribute to a greener production in the agriculture sector.

However, this campaign failed to bring the expected behavioural change among waste producers: the organic waste sorting is still very poor and the quality of RICATERRA is very low, so that Valorsul finds difficult to put it onto the market. Thus it was decided to give compost⁶¹ away to some employees and Valorsul would use the rest for landscaping works at its premises and for maintenance of municipal gardens⁶².

The bad quality of organic waste sorting is confirmed by the figures of the organic fraction incinerated in the WtE plant: in principle, the AD plant should have diverted the organic fraction of waste away from the WtE plant. Instead, the share of organic waste received at the incinerator plant remained unchanged in the last years, even after the AD plant started operations (ranging between 45% and 52% over the period 2002-2011).

2.4 SUBSEQUENT DEVELOPMENTS

Since its establishment, Valorsul has been continuously growing both in terms of new services and infrastructures, as well as areas of activity. Since 2003 Valorsul has been temporarily delivering its services to the association of municipalities AMTRES, representing the towns of Cascais, Mafra, Oeiras and Sintra. Tratolixo⁶³ is the public company responsible for waste management in the area of AMTRES. In compliance with the Ministerial Law N. 16104/2003, Valorsul WtE plant agreed to receive undifferentiated and untreated MSW from the AMTRES municipalities to deal with the decreasing capacity at Tratolixo's landfill, until a permanent

⁵⁹ The Programme was launched by Valorsul but after 5 years, the responsibility was transferred to the municipality of Lisbon. Nevertheless, Valorsul is still part of the Programme, offering the necessary help (technical and communication assistance) to the municipalities involved.

⁶⁰ The RICATERRA name is registered at the National Institute of Industrial Property.

⁶¹ 130 tonnes in 2009.

⁶² Source: Valorsul, 2009.

⁶³ Tratolixo - Tratamento de Resíduos Sólidos, EIM, S.A. (<http://www.tratolixo.pt/>).

solution was found. According to Valorsul Sustainability Report 2010, Tratolixo is now building new waste treatment facilities (an Anaerobic Digestion plant, three support Technical Confinement Cells and an Ecocentre) to treat its waste, which are expected to be completed by 2012. Hence, Tratolixo is expected to progressively cease delivering waste to Valorsul facilities.

The major enlargement experienced by Valorsul took place in July 2010⁶⁴ and consists of the merger between Valorsul and Resioeste. Resioeste is the multi-municipal system created in 1997⁶⁵ and responsible for the waste management of the municipalities in the West region of Lisbon. Its system integrates the association of municipalities AMO-MAIS, including 14 municipalities – Alcobaça, Alenquer, Arruda dos Vinhos, Azambuja, Bombarral, Cadaval, Caldas da Rainha, Lourinhã, Nazaré, Óbidos, Peniche, Rio Maior, Sobral de Monte Agraço e Torres Vedras – with a total population of 403,000 inhabitants. They are distributed over three sub-regions: Greater Lisbon, Leiria and Santerém. In 2008 Resioeste treated 198,000 tonnes of waste. The Resioeste system includes a number of infrastructures: these are a sanitary landfill and a sorting plant in Cadaval, a Mechanical Biological Treatment (MBT) plant in Leiria, producing compost and five transfer stations.

In recent years, Valorsul has experienced a decrease of volumes of waste delivered at the WtE plant, due to the economic slowdown in Portugal and, to a lesser extent, to an increasing diversion of waste to other facilities for MSW treatment (e.g. recycling units and the bio-waste plant). This had an immediate impact in the form of lower incomes coming from the sale of the electricity generated by the WtE plant, the major source of revenues for Valorsul. The merger with Resioeste was seen as an opportunity to increase the volumes of waste incinerated and valorised through energy recovery and thus to run the WtE plant at full capacity, by processing part of the MSW of the municipalities of Resioeste.

Upon the merger, a 'new' Valorsul was born, with a joint capital of EUR 25.2 million. It is now responsible for treating the MSW produced by 1.5 million citizens in 19 municipalities covering 3,378 km²: the MSW volume generated amounts to almost 1 million tonnes per year, which corresponds to 20% of all MSW produced in Portugal⁶⁶.

A last development in the Valorsul waste management system that is worth mentioning regards the Mato da Cruz landfill. As stated in Section 1.1, in compliance with EU Directive 99/31/EC on the landfill of waste, biogas (composed of methane and carbon dioxide) generated by Valorsul landfill⁶⁷ is collected and flared, so as to reduce the volume of gas actually emitted in the atmosphere⁶⁸. Valorsul has recently installed the technology to allow for the production of electric energy from burning the biogas, which was not originally envisaged, and in 2011 it actually commenced producing energy from its landfill.

⁶⁴ Decree-Law 68/2010 June 15th.

⁶⁵ Decree-Law 366/97 December 20th.

⁶⁶ A percentage increase of +4% compared to the situation prior to the merger (see Section 1.2).

⁶⁷ The anaerobic decomposition of biodegradable waste in a landfill generates gas, which is composed of methane (for about 55%) and CO₂ (for about 45%).

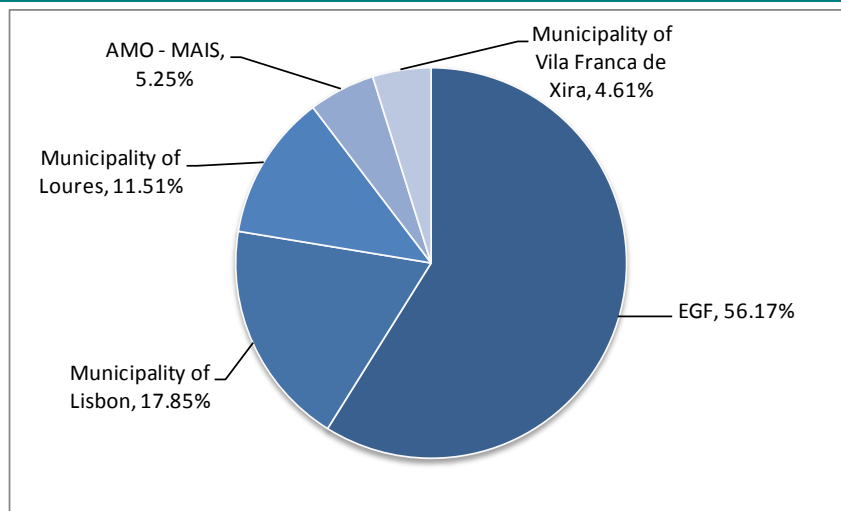
⁶⁸ In the combustion process methane is oxidised to water and CO₂.

Figure 2.6 THE 'NEW' VALORSUL AND ITS AREA OF ACTIVITY



Source: Authors' elaboration based on Valorsul
<http://www.valorsul.pt/media/134035/apresentacaojuvenil.pdf>.

Figure 2.7 SHAREHOLDER OF THE 'NEW' VALORSUL IN 2010



Note: EGF bought the shares of the electric company EDP and Society EXPO'98 in 2008.
 Source: Authors

Table 2.1 MUNICIPALITIES INCORPORATED IN THE 'NEW' VALORSUL AND WASTE PRODUCTION

	<i>NUTS 3 sub-region</i>	<i>Municipality</i>	<i>Waste production in 2010 (Tonnes)</i>
Valorsul	Greater Lisbon	Amadora	83,564
	Greater Lisbon	Lisbon	314,873
	Greater Lisbon	Loures / Odivelas	159,778
	Greater Lisbon	V.F. Xira	59,061
Total Valorsul area	1 sub-region	5 municipalities	617,276
Resioeste	Greater Lisbon	Alenquer	19,521
	Greater Lisbon	Arruda	5,324
	Greater Lisbon	Azambuja	11,589
	Greater Lisbon	Cadaval	6,245
	Greater Lisbon	Lourinha	11,668
	Greater Lisbon	Sobral M. Agraço	4,311
	Greater Lisbon	Torres Vedras	37,374
	Leiria	Alcobaça	24,891
	Leiria	Bombarrant	6,708
	Leiria	Caldas Rainha	24,309
	Leiria	Nazaré	10,974
	Leiria	Óbidos	6,472
	Leiria	Peniche	19,014
	Santerém	Rio Maior	9,277
Total Resioeste area	3 sub-regions	14 municipalities	197,677
Total 'New' Valorsul	3 sub-regions	19 municipalities	814,953

Source: Authors based on Valorsul <http://www.valorsul.pt/media/134035/apresentacaojuvenil.pdf>

2.5 KEY STAKEHOLDERS AND MANAGEMENT STRUCTURES

Within Valorsul's system, all services and facilities are structured in such a way as to provide a wide range of waste processing activities, in which suppliers and final users are linked through Valorsul's integrated approach. The main suppliers to the system are the population, the municipalities and companies in Valorsul's catchment area, which deliver their waste for processing. The users of the system are the population from Valorsul's surroundings, the customers for recyclable products or compost or energy, as well as other actors involved in the activities of Valorsul, such as visitors, students, the Scientific Community⁶⁹ and NGOs.

At a broader level, the Portuguese waste sector encompasses diverse entities that, in various ways, have responsibility for the regulation and planning of the sector and played a role in the Valorsul project. They are briefly presented in this sub-section.

⁶⁹ As explained in Section 3.5, a number of institutions operating in the environmental sector have been involved in the Environmental Monitoring Programme, such as the Institute of Environment and Development, the Oceanographic Institute and the Centre for Social Research and Intervention.

- The *Directorate General of Regional Development* of the Ministry of Planning and Territorial Administration holds the managing authority role and is responsible for liaison with the European Commission with regard to the implementation and status of projects. It was the body responsible for submitting the Valorsul project for funding under the CF instrument in 1994. The Directorate ensured proper monitoring of the EU assistance in Portugal by means of bi-annual meetings of a Monitoring Committee, supervising both transport and environmental projects. From 2000 onwards, the general Monitoring Committee was complemented by a specific Committee for solid waste projects. In 2007 the DGDR became the Financial Institute for Regional Development (IFDR) operating under the supervision of the Ministry of Economy and Employment.
- The *Directorate-General of Treasury and Finance* of the Ministry of Finance, acted as the payment authority of the project, whilst financial control was the responsibility of the General Inspectorate of Finance.
- The *Regulatory Authority for Water and Waste Services (ERSAR)*⁷⁰ provides national guidance and regulation with regard to the activities of public water supply, urban wastewater sanitation and management of municipal solid waste utilities, to ensure universal access, quality of service and equitable prices (also see Section 2.1). ERSAR aims to ensure the quality of the services rendered by drinking water supply systems, urban wastewater and municipal waste, supervising the creation, execution, management and operation of the systems, as well as to guarantee stability within the sector and the financial sustainability of these systems. As “regulatory authority” ERSAR deals with approximately 500 water and waste management operators, including Valorsul⁷¹.
- The *Portuguese Environmental Agency* is the National Authority for Waste. It is in charge of proposing, developing and monitoring the implementation of strategies for waste management, as well as issuing licences to waste management operations, and providing administrative and operational controls. Moreover, the Agency regulates the market for recyclable waste⁷².
- During the construction of the WtE Plant, Valorsul set up a *dedicated committee* responsible for monitoring the various economic, financial, and technical aspects. Quarterly reports were submitted in conjunction with the Ministry of Environment, reporting the status of physical progress and financial accomplishment.
- While Valorsul was responsible for the management – and subsequent operation - of the project, during the construction phase the company’s permanent staff received assistance from *Proet - Projectos, Engenharia e Tecnologia*, the engineering branch of

⁷⁰ Entidade Reguladora dos Serviços de Águas e Resíduos.

⁷¹ Source: ERSAR, 2011.

⁷² <http://www.apambiente.pt/apresentacao/apaENG/Paginas/default.aspx>

EDP. Proet also participated in the preparation of tender documents. Use was made of additional specialised experts as needed⁷³.

- *Sociedade Ponto Verde S.A.* is a private non-profit-making organisation that was set up in November 1996 to promote the separate collection and recycling of packaging waste in Portugal. Since 2000, Sociedade Ponto Verde collaborates with Valorsul and provides support by means of separate collection and non-reusable packaging waste sorting programmes; it guarantees the take-back, recovery and recycling of sorted waste under its contracts with manufacturers of packaging and packaging waste (paper and cardboard, glass, plastic, wood, and steel and aluminium). It also manages and deals with the final disposal of non-reusable packaging placed on the Portuguese market by packers, fillers and importers, after consumption. More information about this actor are provided in Box 2.3.

Box 2.4 FOCUS ON SOCIEDADE PONTE VERDE

According to EU legislation (Directive 94/62/EC) transposed into Portuguese law, economic operators placing packaging on the market are responsible for the management and final disposal of packaging waste. However, this responsibility can be transferred to a properly licensed entity, i.e. Sociedade Ponto Verde. In 2009, Sociedade Ponto Verde reached around 99% of Portugal's population.

The mission of Sociedade Ponto Verde is to promote the selective collection, take back and recycling of waste packaging in Portugal through the integrated packaging waste management system (SIGRE).

Sociedade Ponto Verde is licensed to manage all types of non-reusable packaging materials placed on the Portuguese market and articulates with the business operators indicated below in the management of their waste:

- Fillers, packers and/or entities responsible for placing packaged products on the Portuguese market;
- Manufacturers of packaging and raw materials for the production of packaging;
- Packaging waste managers;
- Municipalities and/or managers of multi-municipal or inter-municipal systems⁷⁴ (e.g. Valorsul).

Household packaging waste that comes from selective collection (i.e. recycling drop-off-containers, door-to-door collection and/or Valorsul drop-off centres) is directly taken back and put it onto the market by Sociedade Ponto Verde. The municipal and multi-municipal systems (e.g. Valorsul) receive the corresponding financial compensation for each tonne of packaging waste material collected.

Regarding recycling materials from complementary flows (e.g. pre-treatment of compost and incineration), these are sold directly by the municipal systems or their concessionaires (e.g. Valorsul).

Source: Authors based on Sociedade Ponto Verde, 2009

⁷³ EIB, 1996.

⁷⁴ In 2009, *Sociedade Ponto Verde* proceeded with previously existing partnerships with Municipal systems (SMAUT) which allowed it to reach around 99% of Portugal's population

3 LONG-TERM DEVELOPMENT EFFECTS

3.1 KEY FINDINGS

This Section describes the main long-term development effects generated by the project. In accordance with the guidance set out in the First Interim Report and summarised in Annex I of this report, seven categories of effects are considered and for each of them an assessment of the contribution of the project to that specific effect is given. For the most relevant effects, either positive or negative, descriptions of the timing of their materialisation and evolution are presented. The seven categories of effects are: Direct economic growth, Endogenous dynamics, Social cohesion, Environmental effects, Territorial cohesion, Institutional quality and Social happiness.

These categories are analysed using two broad methodological approaches – quantitative (i.e. Cost-Benefit Analysis) and qualitative. The nature and strength of the long-term impacts of the investment across the above categories are analysed, as well as the degree to which short-term as well as long-term impacts arise (see Table 3.1). The criteria considered to assign the scores shown by the following Tables are presented in Annex I.

In broad terms, the direct economic impact is identified quantitatively in the CBA, while the other categories are largely identified qualitatively. However, elements of these other categories, in particular environmental aspects, are captured to some extent in the quantitative analysis too.

The main impact generated by the project is on environment, thanks to the closure of all illegal landfills and to the provision of a modern and effective waste management system. Due to the nature of the initiative, the environmental effects were noticeable from the very early days of the project. In year two of the project, the first modern sanitary landfill in the Lisbon region was inaugurated, to replace the old open dumps in the area; two years later, the WtE plant started working. Around the WtE plant, additional facilities and services have been growing over the years, offering complementary waste treatment solutions that have had a positive impact on the environment (i.e. separate collection, recycling facilities, drop-off centres, etc.). The bad quality of recyclable waste separation carried out by households, however, prevented from maximising this effect, by limiting the total volume of materials actually recycled.

In the long-term, the project has contributed to direct economic growth in different ways:

- By contributing to the production of energy;

- By effectively carrying out waste management and treatment services for about 1.2 million inhabitants⁷⁵;
- By contributing to the development of the recycling market, through the sale of recyclable materials collected;
- By generating employment in the catchment area: this economic benefit is reflected in the ex-post CBA through the use of a conversion factor of less than one for labour cost, to reflect its cost.

Impacts on economic growth could have been higher under a number of conditions presented in Section 3.2. Among these, higher revenues could have been generated if the compost produced at the Anaerobic Digestion Plant could have been put onto the market; instead, because of its poor quality, people are reluctant to use it as fertiliser. Moreover, the decision to not concentrate the various facilities of Valorsul into one single area (mainly due to political interests, as explained in Section 2.3) has a negative impact in terms of transportation costs and higher quantities of emissions produced.

These benefits have been quantified in the CBA, as set out in detail in Annex II. On a financial basis, the project generates a Net Present Value of EUR -122 million (net of EU aid, it generates a positive financial return on national capital of EUR 148 million). On a socio-economic basis, the project has a slightly negative return over a 30 year timeframe⁷⁶, with an economic Net Present Value of EUR -44 million and a rate of return of +3.2%. However, when these results are compared to the counterfactual scenario, consisting in disposing of all waste to a controlled landfill without energy recovery, the project generates a net positive return for society, of approximately EUR 135 million (the economic internal rate of return is 5.9%).

The project had a positive effect in the endogenous dynamics of capacity building and technological progress acquired thanks to the expertise 'imported' from other countries for some phases of the project. It also contributed to the implementation and testing of the multi-municipal management system proposed in PERSU.

As far as social cohesion is concerned, this was defined in the First Interim Report of this evaluation study as the capacity to reduce inequalities arising across gender and different socio-economic groups, as well as reducing income and welfare inequality for less well-off groups. Since the project was not particularly focused on specific social groups, but brought an equal quality of services and economic opportunities to all sectors of the catchment population, no effect on social cohesion is recorded.

In terms of territorial cohesion, the project has had some influence in reducing welfare disparities in the metropolitan area of Lisbon: the differences, for example, between the capital city of Lisbon and the rest of the areas were quite clear before and after the project.

⁷⁵ If the AMTRES municipalities are considered, the total population served by Valorsul reaches almost 2 million.

⁷⁶ The effects of the increased volume of MSW to be treated by Valorsul's facilities as a consequence of the merger with Resioeste have been taken into account in the analysis.

Nevertheless it is worth noting that since Valorsul was established, thanks to the strategy of building at least one of the Valorsul facilities in each target municipality, no municipality felt more disadvantaged than others for having solid waste treatment facilities in its area; moreover, the geographical dispersion of plants allowed each municipality to enjoy new employment opportunities, given Valorsul preference of hiring local people.

With regard to institutional quality, the project brought in a relatively short period of time a level of expertise and capacity to deliver large and complex projects that did not exist before in Portugal. The project was ‘pioneering’ at the time, and it can be said that in the medium to long run, it also influenced some institutional structures (e.g. IFDR) in a sort of *learning by doing* process.

Finally, the project has substantially contributed to an increase in social happiness. The population of the area not only benefits now from a better quality of waste services, but also from other initiatives to improve environment education and, more generally, the quality of life. As part of the CSR policy of the company, Valorsul collaborates with local communities, schools, and environmental organisations through the delivery of seminars, training sessions, and awareness raising campaigns, which are also expected to bring indirect positive effects in the future, particularly on the recycling rates. Valorsul communication and participatory efforts has managed to maximise the public perception of the benefits brought by the project.

Table 3.1 **STRENGTH OF LONG-TERM IMPACTS**

	<i>Strength</i>	<i>Identified and Analysed</i>	
		Quantitatively (CBA)	Qualitatively
1. Direct economic growth	+2	√	√
2. Endogenous dynamics	+3		√
3. Social cohesion	0		√
4. Environmental effects	+4	√	√
5. Territorial cohesion	+1		√
6. Institutional quality	+2		√
7. Social happiness	+4		√

-5 = very strong negative effect, 0 = no effect, 5 = very strong positive effect.

Table 3.2 **EVOLUTION OF THE EFFECTS**

	<i>Evolution of Impacts</i>			<i>Comment</i>
	<i>Short run (years 1-6)</i>	<i>Long run (years 6-10)</i>	<i>Future years</i>	
1. Direct economic growth	+	++	+++	Effects on economic growth have increased as new facilities and services were offered by Valorsul.
2. Endogenous dynamics	+	++	++	Learning by doing process favouring institutional quality.
3. Social cohesion				
4. Environmental effects	+	++	+++	Large benefits produced since the short-term with the opening of the new controlled landfill and WtE plant. Environmental quality increased after the construction of additional facilities for waste management, particularly the recycling centre. The positive impact on environment could further improve via the increase of the recyclable rates.
5. Territorial cohesion	+	+	+	Reduction of disparities between Lisbon and the peripheral municipalities thanks to the provision of an integrated service and to the distribution of employment opportunities.
6. Institutional quality	+	++	++	Improvement of institutional capacities in the medium term.
7. Social happiness	+/-	+	+	In the short term Valorsul experienced some opposition from civil society, which, although being in favour of finding a sustainable solution for waste management, was against the incineration technology. Awareness campaigns and high involvement of stakeholders facilitated an improvement in perceptions of the project's benefits, with a positive impact on social happiness.

+ = slightly positive, ++ = positive, +++ = strongly positive, +/- = mixed effect

3.2 DIRECT ECONOMIC GROWTH

Whilst the main rationale behind the establishment of Valorsul and the construction of its different treatment plants was to tackle the waste problem in the metropolitan area of Northern Lisbon, the project was designed in such a way that it has transformed a problem into an opportunity for making business (via the selling of electricity to the national grid and other products, such as recyclable materials to industry and compost to the agriculture sector) and contributing to the economic growth of the target municipalities.

The Valorsul project has contributed to direct economic growth in several areas. The main beneficiaries include the construction firms that built the infrastructures; the residents, businesses and municipalities of the Greater Lisbon Area, who now enjoy a proper and integrated MSW management system, as well as having the old illegal dumps closed down and converted to public amenities; the Portuguese recycling sector, which is supplied with recyclable materials by Valorsul; the Portuguese national electricity grid, which is supplied with

electricity from the WtE and Anaerobic Digestion plants⁷⁷ and, starting from 2011, from the biogas energy recovery at the Mato da Cruz landfill.

The analysis of the project's economic effects is based on the ex-post CBA, details of which are presented in Annex II. In the CBA, the 'Do Project' scenario is compared with a 'Do Minimum' option, effectively involving a single large modern landfill to accept all the waste generated by Valorsul's catchment area, with no recycling and no energy recovery (but with flaring of methane to minimise greenhouse gas emissions).

Economic outputs of the project can be assessed in the first instance by revenues earned. For carrying out the waste treatment services, in 2009 Valorsul earned EUR 53.3 million. The major sources of revenues are the sale of electricity, produced by the waste incinerator and by the Anaerobic Digestion Plant, and the gate fees at the WtE plant and landfill (the vast bulk of these relates to discharge of MSW by municipalities)⁷⁸.

Table 3.3 VALORSUL'S FINANCIAL REVENUES – 2009

	<i>EUR thousand (current prices)</i>	<i>Share (%)</i>	<i>Related volume</i>
<i>Electricity sales</i>	24,034	45.10%	296,763 MWh
<i>Gate fees*</i>	18,110	34.00%	723,562 tonnes
<i>Sale of Recyclables</i>	9,396	17.60%	68,504 tonnes
<i>Other</i>	1,760	3.30%	
Total	53,300	100.00%	

*WtE plant and landfill only.

Source: Valorsul

Electricity production represents the main source of income of Valorsul (45% of total revenues in 2009) and the main factor that contributed to generate positive financial impacts. The OECD⁷⁹ indicates that historically Portugal has been highly dependent on imports of oil and coal. In recent years, the Government has sought to diversify its energy supply by switching to gas and further developing renewable energy. Thanks to these efforts, in 2009, renewable energy accounted for 21% of primary energy supply and 38% of electricity production, far above the OECD European averages. Portugal has pursued an active support policy on renewable energies and met its ambitious national target to provide 45% of gross electricity consumption from renewable sources by 2010.

The energy from renewable sources produced by Valorsul comes from its WtE facility and its Anaerobic Digestion Plant. Today the company produces 0.7% of the national electricity generated in Portugal, which corresponds to approximately 2% of the domestic consumption in the country. The energy produced by Valorsul has been on a growing trend, particularly at

⁷⁷ At a higher level, other studies also mention the contribution of the CF in Portugal 1993-2006 to economic growth: 'Significant impact on the GDP (6% of the GDP of 1995 approximately); direct impact on the creation of temporary employment; expected indirect effects in terms of strengthening the national competitiveness'. Source: NEMUS, CISED and CIDEC, 2007.

⁷⁸ Valorsul Annual Report 2010.

⁷⁹ OECD, 2011.

the WtE Plant, which has increased its production by 20% from 2007 to 2009 (1,029 Tj⁸⁰ to 1,236 Tj respectively). Most of this energy is sold to the national energy grid (86% in 2009) at an average selling price of EUR 81 per MWh, leaving the remainder for self-consumption. The sale ratio of the Anaerobic Digestion Plant is not so high, with an average of some 50% in the years 2007-2009. In any case, the energy produced by this facility barely reaches 1.8% of the total produced by Valorsul. In GWh terms, the WtE Plant produced in 2009 a total of 343 GWh and sold 294 GWh to the national grid. The Anaerobic Digestion Plant produced 6 GWh and sold 3 GWh to the grid. In 2010, 296 GWh and 7 GWh respectively were sold⁸¹.

Table 3.4 ELECTRICITY PRODUCED BY VALORSUL (GWH) – 2007 -2009

Electricity from WtE Plant	2007	2008	2009
Production	285.8	322.5	343.3
Self-consumption	43.6	45.8	49.4
Sold to the national grid	242.2	276.7	293.9
Electricity from Anaerobic Digestion Plant	2007	2008	2009
Production	8.1	8.9	6.4
Self-consumption	3.6	3.9	3.6
Sold to the national grid	4.4	5.0	2.8

Source: Valorsul, 2009

By producing energy from waste, Valorsul enables Portugal to reduce its usage of conventional energy sources, mainly based on imported fossil fuels. Valorsul estimates that the electricity sold to the grid by the WtE and the Anaerobic Digestion plants corresponds to some 64,000 tonnes of oil equivalent. From 2011 Valorsul started producing energy also from the combustion of biogas generated in the Mato da Cruz landfill. This activity will further increase its revenues deriving from the sale of energy,

Gate fees paid by municipalities and private clients to deliver MSW to the Valorsul facilities represent the second source of income (34% of total revenues recorded in 2009). As explained in Section 1.3, different tariffs are applied by Valorsul, mainly depending on the type of client. It has to be pointed out that the major part of this revenue stream derives from the fee paid by municipalities for the use of the WtE plant. The average gate fee is approximately EUR 25 per tonne of waste, generating an income of more than EUR 18 million in 2009.

With regard to the sales of recycled products, they represent only 17.6% of the total revenues, although there has been a 41% increase from 2007 to 2009 (from EUR 6,687,042 to 9,395,968). By type of product, packaging waste (cans, tetra pak and plastic) is the most important, accounting for 42% of the sales in 2009, followed by the sales of paper and cardboard with 29%, a situation that was nearly the opposite in 2007 when the sales of paper and cardboard represented 48% and packaging 30% of total sales of recyclables. The remaining products include glass, aluminium slag, steel slag and others.

⁸⁰ TeraJoule.

⁸¹ Source: Valorsul, 2009.

Table 3.5 REVENUES FROM THE SALE OF RECYCLED PRODUCTS (2007 - 2009)

Type	2007		2008		2009	
	EUR	%	EUR	%	EUR	%
Paper / cardboard	3,219,161	48%	3,104,495	35%	2,748,376	29%
Glass	564,103	8%	602,491	7%	859,539	9%
Packaging	2,010,390	30%	4,002,606	45%	3,937,690	42%
Aluminium slag	280,691	4%	305,833	3%	32,310	0%
Steel slag	398,453	6%	141,577	2%	487,380	5%
Others	214,244	3%	712,005	8%	1,330,673	14%
Total	6,687,042	100%	8,869,007	100%	9,395,968	100%

Source: Valorsul, 2009

As for the sales of compost, this is not of sufficient quality to command a positive price and, in fact, there is no reference to sales of compost in the reports analysed. Valorsul management explained that the market for such a product is still underdeveloped and consumers prefer to use other traditional products as fertilisers. Their lack of confidence is mainly due to the poor quality of RICATERRA, the compost produced at the Anaerobic Digestion Plant, which does not comply yet with the guidelines for the quality of compost set by the national authorities. Actually, notwithstanding that Valorsul has made some efforts to improve the organic waste sorting (see the Programme ‘+ Valor’ presented in Section 2.3), the high share of improper material contained in the organic material prevents the production of good quality compost.

The project has contributed to economic growth also by generating employment⁸². Significant direct employment has been generated over the years by Valorsul, from 67 initial jobs to 260 in 2010, with a payroll of EUR 11 million (this excludes waste collection employment)⁸³. More than 70% of staff are reported to be residents of Valorsul’s catchment area. The presence of Valorsul has also encouraged new companies to establish in the waste and environmental industry. Amongst these are the Association of Manufacturers of Cardboard Packaging for Liquid Aliments⁸⁴, Plastval S.A. and Sociedade Ponto Verde S.A., both of them involved in the recycling sector⁸⁵.

For the Cost-Benefit Analysis, we compared the project to the counterfactual of a single large modern landfill that would accept all the waste from the area of operations of Valorsul (including waste diverted from the Resioeste catchment area from the point of merger onwards). On a purely financial basis, the project is not viable, returning a Net Present Value (NPV) of EUR -122 million over 30 years and an Internal Rate of Return (IRR) of +3.6%. This confirms that grant aid or subsidisation was required. Net of EU funding, the project generates a return on national capital (NPV of EUR 148 million and IRR of 7.4%). This is reflective of the

⁸² This is valued in the ex-post CBA by means of a conversion factor minor than 1 (0.97), in order to reflect the opportunity cost for this input.

⁸³ This compares to initial expected direct employment of 76 staff (source: European Commission, 1994).

⁸⁴ Associação dos Fabricantes de Embalagens de Cartão para Alimentos Líquidos – AFCAL.

⁸⁵ The economic effects of this indirect employment have not been included in the CBA.

financial arrangements for Valorsul, agreed between its stakeholders, i.e. that, after electricity sales, gates fees are set in order to allow the firm to earn a modest surplus.

The financial results are corrected for in the economic analysis, which converts all costs and benefits to shadow prices, in order to reflect their opportunity cost. Net of the counterfactual, the socio-economic CBA generates a positive return for society, with a Net Present Value of EUR 135 million and an internal rate of return of 5.9%⁸⁶. The project's economic return could have been higher under the following conditions:

- Higher recycling share, generating an increase in the sale of recyclable materials;
- A better quality of compost produced, which would have generated higher revenues from the Anaerobic Digestion Plant;
- If the facilities had been built in a single complex: this would have reduced costs of waste transportation between facilities and overhead costs, while generating relevant synergies.

The CBA exercise has been particularly useful to figure out a crucial feature of Valorsul financial arrangement: both the gate fees paid by municipalities and the energy selling prices are highly distorted (as widely discussed in Annex II). When considering the shadow price for energy, estimated as the average selling price of electricity in the Iberian market (Portugal and Spain), it is clear that Valorsul is being “overpaid” for its electricity: its average selling price is EUR 81 per MWh, against a shadow price of EUR 52.89 per MWh⁸⁷. This high price reflects the existence of national subsidies to promote the production of energy from renewable sources, including waste incineration.

As a result of the large revenues deriving from the sale of energy, Valorsul is able to charge much lower gate fees at both the WtE plant and the landfill. It is not straightforward to find a proper shadow price for waste management services, as the costs specifically depend upon a number of factors, such as the technology used and the plant's capacity. For comparison, the gate fee for the Porto incineration, built contemporaneously to the Valorsul WtE, is approximately EUR 40 per tonne (2009 data⁸⁸). As for Spain, we know that the tariff paid by municipalities for waste treatment ranges from EUR 35 per tonne to EUR 96 per tonne⁸⁹. Hence, an average gate fee of EUR 25 per tonne seems very low and it is very likely to be distorted. The merger with Resioeste, by allowing to reach scale effects, and the sale of energy produced from biogas may lead to a further tariff decrease.

⁸⁶ See Annex II for details.

⁸⁷ This is the average price of electricity in Spain and Portugal over the period January-September 2011. It is provided by the Quarterly Report on European Electricity Markets of the European Commission (http://ec.europa.eu/energy/observatory/electricity/electricity_en.htm).

⁸⁸ <http://www.wtert.eu/default.asp?Menu=31&ShowNews=7>.

⁸⁹ Source: interviews and Greenpeace, 2010.

Through this cross-subsidisation mechanism, one can conclude that the Valorsul municipal waste management system is being subsidised by the electricity tariff system⁹⁰, thus in contravention of the already mentioned “polluter pays” principle. When considering the shadow prices in the economic analysis, the economic benefit deriving from the sale of energy significantly reduces compared to the financial analysis; by contrast, the economic benefits from waste management are higher than what the financial revenues would indicate.

3.3 ENDOGENOUS DYNAMICS

Valorsul was the engine of a major infrastructure development for the metropolitan area of Northern Lisbon, which has undergone continuous expansion and improvement through numerous projects and initiatives up to the present time, as described in Section 2. The 1995 project, in particular, represented one of the flagship projects for the creation of an integrated waste management system of Portugal at the time⁹¹, given its large scale and the new waste treatment technology introduced: actually, incineration was a treatment system previously not used in the country. Whilst the technology used by the project could not be regarded as pioneering *per se*, at the time of the project, and in the context of Portugal, the project was considered to be highly innovative. Also, the Evaluation Report of the CF 1993-2006 explicitly refers to Valorsul when describing innovative approaches in the environmental sector⁹².

Since the technical expertise for such a project was missing in Portugal, much of the know-how was ‘imported’ from other countries such as Spain, France, Austria and Germany, through international experts that collaborated with Valorsul during the design and implementation phases. The European Investment Bank also provided valuable support to enhance the quality of the project design. This had a clear positive impact on local knowledge and capacity building both in terms of technical knowledge and managerial skill development among those stakeholders directly or indirectly involved in the implementation of the project.

As it was to be the first incinerator in the country, there was a great need for technical expertise. Foreign experts and EDP – Energias de Portugal S.A. – provided technical assistance for the incinerator. For the aerobic digestion plant, Austrian consultants provided technical assistance.

Source: Fiedler and Artim, 2006

Furthermore, the project led to the establishment of a multi-municipal system for waste management in the area of Greater Lisbon through the participation of public companies as well as the municipalities. In doing so, Valorsul contributed to the implementation of one of the organisational models for MSW management recommended in the PERSU, but above all it favoured the establishment of an efficient organisation system for waste management and treatment services; actually, the multi-municipal management system facilitated the attainment of relevant economics of scale in the service delivery.

⁹⁰ It is worth noting that final users contribute as tax payers to the subsidisation of the energy sector.

⁹¹ Another one was the Lipor project in Porto.

⁹² “Organic recovery: high technology CVO (Valorsul); separate collection of organic waste on a large scale (Valorsul); integration of all infrastructures for MSW management in one single system for which the management company is responsible for the construction and operation (Valorsul); provision of knowledge transfer services (Valorsul)”. Quoted from European Commission, 2004.

3.4 TERRITORIAL COHESION

The macro-analysis on the impact of CF in Portugal highlights a positive effect on territorial cohesion, most particularly in relation to waste management. In particular, a study⁹³ focusing on the period 1993-2006 concludes that CF support not only contributed to improving the quality of the service but also its coverage. In this respect, the Portuguese population benefitting from municipal waste services went from 42% in 1993 to 94% in 1999. By 2005, the service coverage reached 100%.

Whilst it is obvious that all these effects cannot be exclusively attributed to the project, it is worth remembering that Valorsul was one of the major initiatives at the time and that the municipalities initially involved in the Valorsul project included nearly 13% of the population of Portugal (some 1,330,000 inhabitants⁹⁴): hence it is likely the project had some influence on the generation of these positive effects.

In terms of territorial development there were (and are) inter- and intra-municipal differences. Lisbon, as a capital city, shows higher levels of economic indicators, as compared to, for example, Amadora or Odivelas. The Valorsul project produced some positive effects on territorial cohesion, by contributing to the reduction of those “welfare disparities”. The project improved the waste management services in five municipalities of the Greater Lisbon area; the level of services provided was raised and the territorial differences in terms of quality were reduced.

Additionally, by having the different plants dispersed across the catchment municipalities, the project indirectly favoured the generation of employment and development in all the municipalities involved, including both the large and developed municipality Lisbon and the other smaller and less economically important neighbouring municipalities. This was made possible by Valorsul’s preference to hire local personnel for its facilities.

3.5 ENVIRONMENTAL EFFECTS

Our analysis points towards a positive impact of the Valorsul project in contributing to a proper processing of municipal waste, thus favouring environmental quality. As already explained, at the time Valorsul and the project started, in the mid-1990s, the processing of municipal solid waste in the Greater Lisbon Area (as well as in the rest of Portugal) mainly relied on landfills and open dumps. Thanks to the project, the rate of MSW properly treated has increased, by providing the municipalities, private companies and individuals with adequate disposal facilities.

The main ways by which the project contributed to improving environmental quality are the following:

⁹³ NEMUS, CISED, and CIDEDEC, 2007.

⁹⁴ Population of Portugal in 2011 is 10.555 million.

- i. *The closure of the existing open dumps and uncontrolled landfills.* The construction of the WtE plant and of a sanitary landfill made it possible to eliminate the amount of MSW disposed of in illegal dumping sites, thus reducing greenhouse gas⁹⁵ emissions as well as soil and water contamination⁹⁶. Furthermore, Valorsul's WtE plant made it possible to divert 80% of the MSW previously sent to landfill to incineration.
- ii. *The production of electricity from the WtE and Anaerobic Digestion Plants.* As already pointed out in Section 3.2, Valorsul produces 0.7% of the national electricity generated in Portugal, which corresponds to approximately 2% of the domestic consumption of the country. This allows a diversification of the Portuguese energy supply by switching from oil and coal energy sources to partly renewable energy. It has been estimated by Valorsul that the electricity sold in 2009 corresponded to the non-utilisation of about 64 thousand tonnes of oil equivalent⁹⁷.
- iii. *The increase in recycling rates of materials.* In this respect, it is worth noting how Valorsul reduced the MSW sent to landfills, from 100% in 1998 to 17% in 2009, in favour of other alternatives, including mainly waste incineration and, to a lesser extent, material recycling through its Materials Recovery Facility or organic recycling through the Anaerobic Digestion Plant. The types of material received in the sorting plant and then sent to the recycling industry include glass, metals, plastic and paper. Starting from 2008, Valorsul engaged also in the recycling of the organic fraction of waste, which is transformed into compost in the Anaerobic Digestion Plant. The volume of MSW treated by this facility is very low in comparison to the other facilities of Valorsul, i.e. 20,389 tonnes in 2009. The goal of increasing recycling rates in this area has been pursued not only by means of 'hard' initiatives (i.e. the construction of the required facilities for recycling), but also of 'soft' initiatives, such as environmental awareness campaigns (such as the ECOVIA project and the '+ Value' Programme).

It is worth highlighting, however, that recycling rates (which in the target municipalities vary between 6% and 14% of total recyclable materials⁹⁸) are still below the national and EU targets. Despite the numerous education campaigns implemented by Valorsul, the project did not allow to comply with EU Directive 2004/12/EC⁹⁹ on the

⁹⁵ 'Greenhouse gases are those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of thermal infrared radiation emitted by the Earth's surface, the atmosphere itself, and by clouds. This property causes the greenhouse effect. Water vapour (H₂O), carbon dioxide (CO₂), nitrous oxide (N₂O), methane (CH₄) and ozone (O₃) are the primary greenhouse gases in the Earth's atmosphere. Moreover, there are a number of entirely human-made greenhouse gases in the atmosphere, such as the halocarbons and other chlorine and bromine containing substances, dealt with under the Montreal Protocol. Beside CO₂, N₂O and CH₄, the Kyoto Protocol deals with the greenhouse gases sulphur hexafluoride (SF₆) hydro fluorocarbons (HFCs) and per fluorocarbons (PFCs)'. Source: The Intergovernmental Panel on Climate Change (IPCC); http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_appendix.pdf

⁹⁶ The decomposition of waste in landfills releases the so-called biogas which has significant concentrations of methane (CH₄) and carbon dioxide (CO₂). Both these gases contribute to the Greenhouse effect. Once the global warming of impact of the methane is higher than the CO₂, the landfill starts to flare the biogas, a process that transforms the CH₄ to CO₂. Other gases emitted – at almost negligible values compared to those of CH₄ and CO₂ – are SO_x, HCl, NO₂, and particles. Source: Valorsul, 2009.

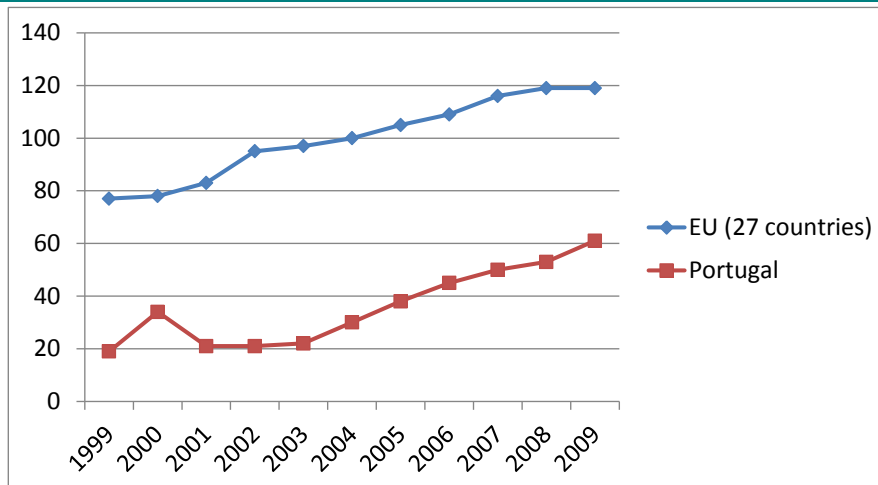
⁹⁷ Valorsul, 2009.

⁹⁸ See Section 1.4.

⁹⁹ Amending the previous Directive 94/62/EC. See Box 1.1 for details on the EU targets on the recovery and recycling of packaging waste.

recovery and recycling of packaging waste (glass, paper, metals, plastics and wood). More time and efforts are probably needed in order to change the waste sorting behaviour of citizens.

Figure 3.1 VOLUME OF MSW RECYCLED (KG PER CAPITA) – 1999-2009



Note: For previous years, no data for Portugal are available.

Source: Authors' elaboration based on Eurostat data.

The project had a positive impact on the environment thanks also to rigorous control and monitoring activities. Prior to the start of the project, Valorsul conducted a full Environmental Impact Assessment. The plant was designed to meet EU emission standards, in compliance with all requirements set by the EU Directive 2000/76/EC on incineration: even dioxins and furans, the most dangerous pollutants, are below the legal limits¹⁰⁰. Also, temperature increases in the Tagus caused by its use as cooling water were within Portuguese norms¹⁰¹. As part of the Integrated Waste Management System of Valorsul, the company established an Environment, Safety and Quality Committee (*Comissão de Ambiente, Segurança e Qualidade*), in September 2001, which set the groundwork for the establishment and implementation of an environmental management system, in accordance with the requirements of ISO 14001:1996¹⁰², and also set the basis for an occupational health and safety management system, in accordance with the norms OHSAS 18001:1999.

Valorsul has established an Environment Monitoring Programme which includes the participation of external institutions for the monitoring and surveillance of the following areas:

- a. Air quality (Institute of Environment and Development¹⁰³);
- b. Water quality and sediments (Hydrographic Institute¹⁰⁴);

¹⁰⁰ In 2010 dioxins and furans emitted from Valorsul WtE plant were 0.012 grams.

¹⁰¹ EIB, 1996.

¹⁰² The ISO 14000 series of norms aims to promote more effective and efficient environmental management in organizations and to provide useful and usable tools - ones that are cost effective, system-based, flexible and reflect the best organizations and the best organizational practices available for gathering, interpreting and communicating environmentally relevant information.

¹⁰³ IDAD - Instituto do Ambiente e Desenvolvimento.

- c. Terrestrial ecosystems and estuaries (Oceanographic Institute¹⁰⁵);
- d. Noise exposure (Laboratory dBLab);
- e. Public health monitoring (Institute of Preventive Medicine of the University of Lisbon);
- f. Residents' behaviour and attitudes (Centre for Social research and intervention¹⁰⁶), focused on the perception of environmental risks among people.

The total costs of these activities during 2009 was EUR 605,836 (see Table below).

Table 3.6 DIRECT COST OF ENVIRONMENT MONITORING ACTIVITIES, 2009

Concept	EUR
Analysis of Dioxins, Furans, Heavy metals	29,099
Analysis of Wastewater and Leachate	10,345
Air Quality Programme	158,160
Water quality and sediments	94,755
Noises	5,433
Terrestrial ecosystems	127,805
Public health	164,231
Residents' behaviour	16,009
Total	605,836

Source: Valorsul, 2009

According to stakeholder feedback and information analysed, the activity of Valorsul does not seem to pose a threat either to the health of the neighbourhood areas or to the environment. What follows are the main general conclusions of experts in the different environmental areas:

- Air quality: the area of population affected by the WtE plant is subject to very low concentration of pollutants (in compliance with legal limits), not inducing any risk to human health (Institute of Environment and Development)¹⁰⁷.
- Wastewater: there is no evidence of an increase in pollutants in the Tagus River comparing the current level of pollutants to the levels obtained in the year of reference, i.e. a year before the WtE plant started operations (Hydrographic Institute)¹⁰⁸.
- Noise: the levels of noise in the neighbourhood area of the WtE plant are below the limit values set by the General Rules of Noise (Ailton Santos & Associates - Consultants in Environment and Safety)¹⁰⁹.

¹⁰⁴ Instituto Hidrográfico.

¹⁰⁵ Instituto de Oceanografia.

¹⁰⁶ Centro de Investigação e de Intervenção Social.

¹⁰⁷ <http://www.valorsul.pt/pt/monitorizacao-do-ambiente/qualidade-do-ar/monitorizacao-descontinua.aspx>

¹⁰⁸ <http://www.valorsul.pt/pt/monitorizacao-do-ambiente/outros-programas-de-monitorizacao/monitorizacao-da-qualidade-agua.aspx>

¹⁰⁹ <http://www.valorsul.pt/pt/monitorizacao-do-ambiente/outros-programas-de-monitorizacao/monitorizacao-do-ruído.aspx>

- Terrestrial ecosystems: Valorsul facilities did not have significant impacts on the vertebrate fauna over time¹¹⁰ (Faculty of Science of the University of Lisbon)¹¹¹.
- Public health: the overall results from the study of various social groups (general public, pregnant women, and children) suggest an effective control of exposure to heavy metals (Institute of Preventive Medicine, faculty of Medicine of the University of Lisbon)¹¹².
- Residents' behaviour and attitudes: the psycho-social monitoring results over recent years indicate a low and decreasing perception of environmental risk amongst residents of the WtE plant area (Factor Social - Consulting in Social Psychology and the Environment)¹¹³.

The only element identified that may have a negative impact on the environment is the selection of the location for the different facilities of Valorsul. Having dispersed locations means that the waste has to be transported much longer distances (from households to first destination facilities, and from first to second destination facilities) than would be desirable. In any case, whilst the dispersed locations may have not been the most satisfactory from an environmental point of view, this strategy could be explained as a way to reduce the NIMBY syndrome of citizens (see Section 2.3).

Increased local traffic problems created by the garbage collection trucks were minimised through the construction of a ring road, strongly demanded by the politicians of local communities¹¹⁴. This road is used by trucks to access the WtE plant, thus avoiding congestion in other municipal roads.

3.6 INSTITUTIONAL QUALITY

At the time of the project and through the following years, many legislative changes, strategies and plans have been developed in Portugal with regard to the environment sector and also the waste treatment sub-sector. The OECD 2001 Report confirms that considerable progress had been achieved in the 1990s, namely with regard to:

- modernisation of the legal environmental framework in response to EU environmental Directives;
- development of national environmental planning;
- investing in and programming waste-related infrastructure, particularly in the context of EU Community Support Frameworks;

¹¹⁰ Except for some that are due to external factors (e.g. climate change).

¹¹¹ <http://www.valorsul.pt/pt/monitorizacao-do-ambiente/outros-programas-de-monitorizacao/monitorizacao-dos-ecossistemas.aspx>

¹¹² <http://www.valorsul.pt/pt/monitorizacao-do-ambiente/outros-programas-de-monitorizacao/monitorizacao-da-saude-publica.aspx>

¹¹³ <http://www.valorsul.pt/pt/monitorizacao-do-ambiente/outros-programas-de-monitorizacao/monitorizacao-psicossocial.aspx>

¹¹⁴ Although not considered particularly necessary by Valorsul Management (source: field interviews).

- capacity building and institutional development with the creation of several environmental bodies at State and regional level.

In particular, as far as institutional development is concerned, two key institutions were established (Section 2.1): Águas de Portugal in 1993, focusing on developing multi-municipal systems for water supply and waste water and solid waste treatment, and the Regulatory Authority for Water and Waste Services in 1997, taking on the responsibilities of regulatory authority of the water supply, waste water management and municipal waste management.

Prior to 1993, the water and waste sector in Portugal was managed in an unsustainable way and had difficulties answering the new challenges that followed the entry to the European Union. The Portuguese Government reorganized the sector in 1993 in order to more effectively ensure universal access to continuous services, guarantee a high quality of service (particularly water quality), ensure affordable prices and promote environmental sustainability.

Source: ERSAR, 2011.

The causal link between the establishment and development of new institutions and the project is twofold. On the one hand, the setting up of these entities was the basis for establishing Valorsul and designing the Integrated Waste Management system for the Greater Lisbon area. On the other hand, the establishment of Valorsul, and the implementation of the project under assessment as well as subsequent projects have induced or at least has had some influence on the development of regulatory capacity and changes in institutional structures in the waste sector. As highlighted by some interviewees, the project improved the quality, in particular, of the Financial Institute of Regional Development (IFDR): prior to this major project, Portuguese officials did not have sufficient knowledge of the EU public procurement rules and had little experience in the production of tender drafts of adequate quality. The IFDR made use of all of the knowledge acquired with Valorsul. Institutional quality improved and, the IFDR even started to export the new expertise acquired, by assisting EU candidate countries through the EC's Twinning instrument.

A learning process has been started also the weaknesses of the Valorsul management system, consisting mainly in the very low recovery and recycling shares of waste: actually, the new national plan for waste management (PERSU II) includes several measures aimed at improving the separate collection among households.

3.7 SOCIAL HAPPINESS

By producing positive impacts, particularly on the environment, for the population of the area of activity, the project contributed to improving their quality of life. Waste management now compared to the ex-ante situation of the project has changed considerably and, with this, the quality of life of the population in the area. Old open dumps have been closed and transformed into green areas and parks for leisure activities and a more efficient waste management system had been put in place.

As part of the company's CSR policy, the company has developed further initiatives aimed at improving the quality of life of the population, increasing public awareness of waste

management issues and supporting other activities to the benefit of the population: to name some of these, Valorsul financed the construction of an indoor swimming pool in collaboration with the municipality of Loures and the planting of 600 trees and 16,500 bushes in the area of Casal Ventoso. These initiatives have been positively welcomed by the population and have contributed to raise social happiness and the level of satisfaction with Valorsul's activities.

However, at its initial stage the project faced opposition from several stakeholders, which could be classified into two groups: a) politicians and local communities, who initially opposed the project and b) environmental organisations, some of which are still against it. Opposition from local communities was a means to obtain the construction of waste treatment facilities across all the involved municipalities and their hostility vanished as soon as their demands were conceded. Environmental organisations, by contrast, did not oppose the project *per se*: in fact they recognised the need for taking urgent actions to improve the environment. Yet they were mostly hostile to the technology selected (mass burning)¹¹⁵ and were instead more in favour of Mechanical Biological Treatment (MBT), which envisages the transformation of waste to produce compost and energy¹¹⁶.

After some years of operation, some NGOs¹¹⁷ have taken a more positive view of the impact of the project and have started to consider the incineration technology as an acceptable and necessary solution to the problem that the area had. This has been achieved thanks to communication activities carried out by Valorsul, as well as higher level of involvement of these organisations in the decision process. Moreover, the opening in 2008 of an Anaerobic Digestion Plant to produce compost, strongly demanded by the environmentalist groups, certainly contributed to widening consensus. Other NGOs, however, such as Quercus¹¹⁸, still show some hostility to the Valorsul project¹¹⁹.

Hence, even if opposition from NGOs may have initially reduced to some extent people's perception of the project, Valorsul's efforts to increase the transparency of its operations and implement awareness-raising campaigns amongst stakeholders certainly helped to change local community perceptions, to the point that today this opposition is considered negligible.

¹¹⁵ From the environmentalists' point of view, the incineration option was considered to have the following negative impacts:

- the WtE plant would produce more energy than a MBT unit at the cost of diminishing recycling rates, since it would not allow the recovery of the organic or the plastic fraction;
- the WtE plant would contribute to increasing gas emissions;
- WtE plants usually have higher maintenance cost and breakdowns.

¹¹⁶ In an MBT facility, waste goes through some forms of biological and mechanical processes, though the order and precise nature of these processes can vary. The mechanical stage has two main roles: (a) to break down waste into smaller parts, e.g. by shredding; (b) to remove some recyclable material. In the biological stage the waste is either composted or digested, usually in an enclosed system. If an anaerobic digestion system is used, it should produce methane which can provide energy for the plant (and possible for export to the grid). Some systems take the composted waste and then remove more recyclables, for example plastics which are no longer contaminated by food residues due to the composting process. (Source: Friends of the Earth, 2008).

¹¹⁷ Such as GEOTA, one of the most significant environmental NGOs in the region.

¹¹⁸ Quercus – National Association for the Conservation of the Nature (*Associação Nacional de Conservação da Natureza*); <http://www.quercus.pt/>.

¹¹⁹ In 2005 Quercus accused Valorsul of burning excessive amount of plastic, instead of ensuring its recycling. These allegations have been strongly rejected by Valorsul (http://www.cmjornal.xl.pt/detalhe/noticias/nacional/portugal/quercus-acusa-valorsul;http://noticias.portugalmail.pt/artigo/valorsul-nega-acusacoes-da-quercus_176911). More recently, Quercus opposed the merger between Valorsul and Resioeste, claiming that Valorsul WtE would in fact lack the capacity to treat all the collected waste (<http://www.jornaldascalas.com/index.php/2009/08/26/quercus-contesta-fusao-entre-a-resioeste-e-a-valorsul/>).

A recent study by the University of Lisbon indicates that the attitude of local communities towards the incinerator shows a neutral to positive response¹²⁰. The study also highlights that the psychosocial monitoring results over the last few years indicate no widespread disruption in the population, since the average levels of annoyance and risk perception related to the Valorsul waste management infrastructures are low. The author concludes that despite the good results, these could be improved through further work, particularly in those areas which are closer to the WtE Plant¹²¹. In addition, the customer satisfaction data produced by ERSAR shows positive results in relation to Valorsul Anaerobic Digestion Plant, as far as service coverage, selecting coverage, and claim responses are concerned¹²².

¹²⁰ Palma-Oliveira, 2010.

¹²¹ Actually, it has been shown that the closer the population to the WtE site, the higher the level of opposition: the population living within 1 kilometre of the facility site showed the highest rate of opposition to the construction (40%), which confirms the “Not-In-My-Backyard” effect of these types of infrastructure.

¹²² Source: NEMUS, CISED and CIDEDEC, 2007.

4 DETERMINANTS OF PROJECT OUTCOMES

4.1 KEY FINDINGS

Table 4.1 IMPACT OF KEY DETERMINANTS OF THE PROJECT PERFORMANCE

	<i>Strength*</i>
1. Appropriateness to the context	+5
2. Project design	+3
3. Forecasting capacity	+3
4. Project governance	±3
5. Managerial response	+2

*-5 = very strong negative effect; 0 = no effect; 5 = very strong positive effect (see in Annex I the criteria considered to assign these scores)

The delivery and performance of the project was mainly influenced by five drivers, and the interplay between them. We believe that context was the strongest determinant, especially in terms of responding to the large waste management problem in Portugal in the 1990s, aggravated by the increasing pressure from society, which was growing in environmental awareness¹²³, the formalisation of MSW policies, the World Exhibition Expo '98, and the availability of EU funding.

Design was influenced by the context of the project. On the one hand it was necessary to provide a robust solution to an important problem, within a relatively short period of time, since stakeholder pressure from all levels (EU, national politicians, NGOs, wider society, etc.) was growing stronger over time. On the other hand, Portugal had little experience (technical and managerial) in dealing with this type of project. Thanks to collaboration with a large number of experts coming from other countries and institutions (such as the European Investment Bank), the project design effectively managed to guarantee project performance and generate the expected effects.

The limited capacity to exactly forecast the demand for infrastructures led to the slight overcapacity of the WtE plant compared to the actual demand. On the contrary, forecasting capacity proved to be good when considering that Valorsul anticipated the possible opposition from the public and NGOs and successfully minimised their effects through strong communication campaigns and a participatory approach.

Managerial response also helped at building consensus regarding the project. By addressing the demands of municipalities (e.g. regarding the location of facilities) and of NGOs (which have always been in favour for the construction of an Anaerobic Digestion Plant to complement the Integrated Waste Management System), Valorsul managed to increase the

¹²³ As shown by the growing number of environmental associations established (Section 2.1).

positive perceptions of the project and thus to improve social happiness. Yet, these measures represent additional costs which constrain the project's effects on direct economic growth, as stressed in Section 3.2: on the one hand, having dispersed facilities increased the cost of transport, as well as the environmental costs due to higher transport emissions; on the other hand, the composting plant, besides generating a small quantity of energy to be sold, in fact to date has produced poor quality compost which is unusable in the agriculture sector.

Valorsul showed good managerial response also when it merged with Resioeste, in order to ensure full utilisation of the WtE plant's capacity and, specifically, to maximise the revenues generated from electricity sale.

The main feature of the project governance structure that influenced the project is the role played by municipalities, which are both shareholders of Valorsul and users of the Integrated Waste Management System. This gives them a strong role in the decision-making process within the company: in particular, by influencing the infrastructures' locations they somewhat limited the economic return to the company and increased the emissions from transport (as discussed in Section 3.2 and 3.5), while contributing to some extent to improving territorial cohesion (Section 3.4) and building social consensus regarding the project.

4.2 APPROPRIATENESS TO THE CONTEXT

The project was highly appropriate to the context existing at the time it took place. The very significant deficit in waste management in the Lisbon Metropolitan Area until the end of the 1990's, mainly due to poor infrastructures, represents the main driver for the conception of the Valorsul project. The Integrated Waste Management System put in place by Valorsul managed to provide a large number of households with a modern and functioning waste management system, mainly based on waste valorisation, rather than disposal to landfill. Valorsul also duly took into account the goals and targets set by the PERSU – Strategic Plan or Municipal Solid Waste – covering the period 1997-2007. The Plan was intended to promote waste prevention, reuse and recycling policies, to strengthen the separate collection services and to establish associations of municipalities involved in the management of MSW.

Hence, the urgent need to provide a solution to the waste management issue, so as to comply with the national strategy as well as EU Directives requiring a progressive reduction in waste disposal to landfill and an increase in waste valorisation, recycling and re-use, had strong relevance in the justification and conception of the project. The increased public awareness of environmental matters (as the increasing involvement in environmental associations has shown, see Section 2.1) further pushed the implementation of a more sustainable waste management system.

The decision to build a WtE plant has also to do with the strengthening of national incentives for the production of 'green energy'. The public demand for alternative and more sustainable energy sources and the willingness of governments to subsidise, through financial incentives, the production of electricity from alternative sources, in order to diversify the energy production mix, contributed to justifying the decision to build facilities for energy recovery

from waste. Additionally, the average selling price of electricity produced by the incinerator and the anaerobic digestion plant (an average of EUR 0.081 per kWh) is key to the financial viability of the system, as it contributes the largest part of Valorsul's revenues.

Another context specificity was considered, i.e. the preparation for and celebration of the World's Fair Exhibition Expo '98. This event had a strong symbolic focus with regard to sustainable development, preservation of environment and urban renewal. The Valorsul project was being planned in a highly demanding context in which Portugal aimed to solve key environmental problems, including waste management in Lisbon. One of the priorities laid down by Parque Expo, the state-owned company in charge of organising the exhibition, was the transformation of the brownfield site in the Oriental Quarter of Lisbon where Expo '98 would be located, as well as the sealing of the large uncontrolled landfill in the area (see Section 2.2).

Urged on by strong social and political pressure, Valorsul became part of the solution to that specific problem, i.e. the regeneration of the Oriental Quarter of Lisbon, but also to the wider situation of poor waste management in Lisbon and in the adjacent municipalities. Furthermore, the Valorsul project was considered necessary to bring on-stream higher capacity to deal with increasing demands for waste treatment services in the area of Lisbon during the construction phase and the celebration of Expo '98.

The availability of funding through EU Structural Funds for large environmental infrastructures is another context trait which Valorsul took advantage of. The CF in Portugal in the 1990s and early 2000 was very active in promoting the construction of large environmental infrastructures with the aim of bringing Portugal closer to EU standards. In addition to the CF aid, there were other sources of funding at the time from which the company benefitted, to develop its Integrated Waste Management System, i.e. the EIB loans and the ERDF for subsequent projects. It is worth noting, in particular, the role played by the EIB whose financial contribution to the initial project was close to the aid obtained from the CF.

4.3 PROJECT DESIGN

There is a general consensus amongst stakeholders on the adequacy of the main technology chosen to treat MSW, i.e. incineration. As previously explained, some local NGOs directly opposed the choice made, favouring alternatives such as MBT technology. At that time, however, the effectiveness of MBT was still being debated. Some interviewees stressed that there was no evidence indicating that MBT was a better option than incineration and, from this point of view, the project was designed with the best technology available to guarantee an effective and sustainable solution to the waste management issues in the Northern Lisbon area¹²⁴. The incinerator plant was designed to meet all EU standards laid down in Directive 2000/76/EC, including on the level of emissions, and its construction was based on an

¹²⁴ It is worth noting the fact that MBT technology was included in the typology of projects promoted by PERSU II – '*Capacity building of MBT for treating the waste resulted from undifferentiated collection*' – but not in the first PERSU. This could be considered revealing and supportive of the fact that in the Nineties there was a large degree of uncertainty about the effectiveness of MBT technology.

international open competition, which was won by the best offer on a technical and economic basis¹²⁵.

The project was planned in a comprehensive and step-by-step delivery approach. First, the most urgent issues were tackled, namely sealing of open dumps and construction of a modern landfill, followed by the WtE Plant. This was followed by further initiatives (recycling; organic valorisation; ash recovery) until an integrated waste management system of complementary treatments had been established.

Moreover, in order to cater for possible future increase of the volume of waste, Valorsul decided to design the WtE Plant with spare capacity so that it could easily incorporate a 4th burning line at a later stage. This enlargement, however, has not taken place so far, and it does not seem likely in the short-term, since the economic crisis is resulting in lower volumes of waste processed.

There is a feature of the project design, however, that did not allow the maximisation of total benefits: the territorial dispersion of Valorsul facilities. The Integrated Waste Management System is based on several infrastructures spread throughout the area of activity of Valorsul. This decision, justified by the impossibility to find one municipality willing to have all the waste treatment plants in its territory (because of the so-called NIMBY syndrome), had negative impacts from various angles, namely economic (cost of waste transportation between facilities, low level of synergies and overhead costs, etc.) and also environmental (higher emissions due to longer trips to move waste between facilities). A centralised solution would have been feasible but that was never considered.

In addition to the pressures from local politicians, Valorsul also decided to meet the demands of environmental NGOs to integrate the waste management system with an Anaerobic Digestion Plant. Valorsul's Management admitted that the construction of this facility was "imposed" by external pressures: *'we were forced to start with the organic waste treatment despite being very expensive and not profitable; yet we received huge pressure from stakeholders'*. Furthermore, Valorsul management has claimed that the gate fee to the WtE plant would be EUR 6 lower if Valorsul did not have to bear the operation costs of the composting plant.

The construction of the AD plant has been problematic; during the test period, many technical problems were detected, which, according to Valorsul management, were caused by errors made by the supplier company. This implied to stop the waste processing for several times in order to repair the equipment. It took two years to solve all the technical problems and to eventually start the composting processing.

¹²⁵ Valorsul's WtE plant uses the traditional combustion technology (as described in Section 1.1. Even if different and more efficient technologies could have been used (such as the Circulating Fluidised Bed combustion which allows to generate lower emissions of dioxins), the plant complies with all legal limits of emissions, including of dioxins.

4.4 FORECASTING CAPACITY

The WtE plant has the capacity to treat up to 662,000 tonnes of MSW per year and over the period 2000-2009 it has received on average 561,940 tonnes per year. It was equipped with three burning lines, plus spare capacity for an extra fourth line. As of yet, the fourth line has not been needed, as the plant's capacity is already larger than actual demand. The current economic situation, which is constraining consumption and, consequently, waste generation, the increasing share of recyclable waste delivered to the Materials Recovery Facility and the construction of the Anaerobic Digestion Plant, which further reduced the volume of MSW incinerated, have prevented maximisation of the use of the WtE plant. Hence, it can be argued that Valorsul was a somewhat optimistic in its forecasts.

The sub-optimal forecasting capacity, which led to the construction of a larger plant than was necessary, did not significantly affect the project's performance. The unforeseen need to provide services, even if temporarily, to the AMTRES municipalities contributed to increasing the use of the WtE plant; subsequently, in order to maximising its plant's treatment capacity utilisation and thus the revenues from gate fees and electricity sale, Valorsul decided to merge with Resioeste (this decision is further discussed in Section 4.6 on managerial response).

Valorsul's forecasting capacity, on the other hand, proved to be very appropriate in another circumstance: the company managed to anticipate the problems that the initial public and NGO resistance to the project might have caused, and to minimise its effect. The opposition to the use of the incineration technology solution was minimised through the adoption of a participatory approach. Valorsul invited the environmental NGOs to join a committee in charge of monitoring the studies conducted during the Environmental Impact Assessment process: representatives from these organisations participated as observers in the meetings of the committee¹²⁶. Several public discussion forums were organised by Valorsul to involve the public and provide them with all the relevant information about incineration. Furthermore, Valorsul assured real time information on emissions and access to its facilities, in order to gain trust and ensure social acceptance of the project.

Valorsul's initiatives and efforts to inform and involve the public proved to be successful as they enabled an increase in the perception of wellbeing among the public.

¹²⁶ The participatory approach undertaken by Valorsul was in line with the recommendations in the OECD 2001 Report, which indicated that a greater involvement of environmental associations was needed: *"Environmental Impact Assessment procedures should rely more on public hearings and open participatory processes. Environmental training is further needed to support many local communities in managing environmental projects and enforcing environmental legislation"*.

The major lesson learnt is that all that transparency was worth it, and today, 15 years later, Valorsul is regarded by the surrounding populations with great respect and confidence and as an example in terms of environmental issues to be followed by other companies.

Source: Field interview

Furthermore, the company's CSR activities, including awareness campaigns but also other activities aimed at increasing the quality of life of the target population (e.g. co-funding of a public swimming pool or planting trees in public parks) were recognised by the "InnoTrain CSR" project of the EC as a best practice example¹²⁷.

Concerns and reservations in the public associated with the construction of the WtE plant were prevalent, because this was the first facility of its kind in Portugal. Therefore, the company responded to protests and concerns with intensive communication during the planning and construction phase and pushed through strategic partnerships with companies, city administrations and local associations. By implementing comprehensive and transparent environmental monitoring as well as various social and educational initiatives, Valorsul finally succeeded in winning public acceptance ("Licence to operate") and in establishing itself as a trustworthy company.

Source: InnoTrain CSR, 2010

4.5 PROJECT GOVERNANCE

Valorsul is governed by public bodies, both national (such the public company EGF) and local, i.e. the municipalities, which own shares in the company in proportion to the MSW produced. The total share of municipalities has always been less than the aggregate of public national-wide companies: in 1994 the municipalities had 38% against the 'national' shareholders (i.e. EGF, EDP Electricity of Portugal and Expo '98 Park); in 2010, after the merger with Resioeste, municipalities' share grew to 43% against the rest owned by EGF¹²⁸.

Since the company's establishment in 1994, Valorsul's strategic decisions, such as the enlargement of the integrated waste management system with the AD plant and the inclusion of former Resioeste municipalities within its catchment area, have been promoted by the public national authorities. Nevertheless, municipalities participated to the decision-making process and they have the possibility to significantly influence the company's activities. Valorsul management considers essential to keep smooth and continuous communication with all its shareholders due to the nature of the company and its business, in which municipalities are both "owners" and "users" of the Integrated Waste Management System.

In order to satisfy the pressure of local politicians, Valorsul agreed to build the waste treatment facilities in different municipalities, so as to minimize the NIMBY syndrome. This solution, however, was not the best option that could have been pursued, as it led to higher transport economic and environmental costs. The municipalities also gave their approval to the construction of the AD plant and to the Resioeste merger. The latter proposal has been

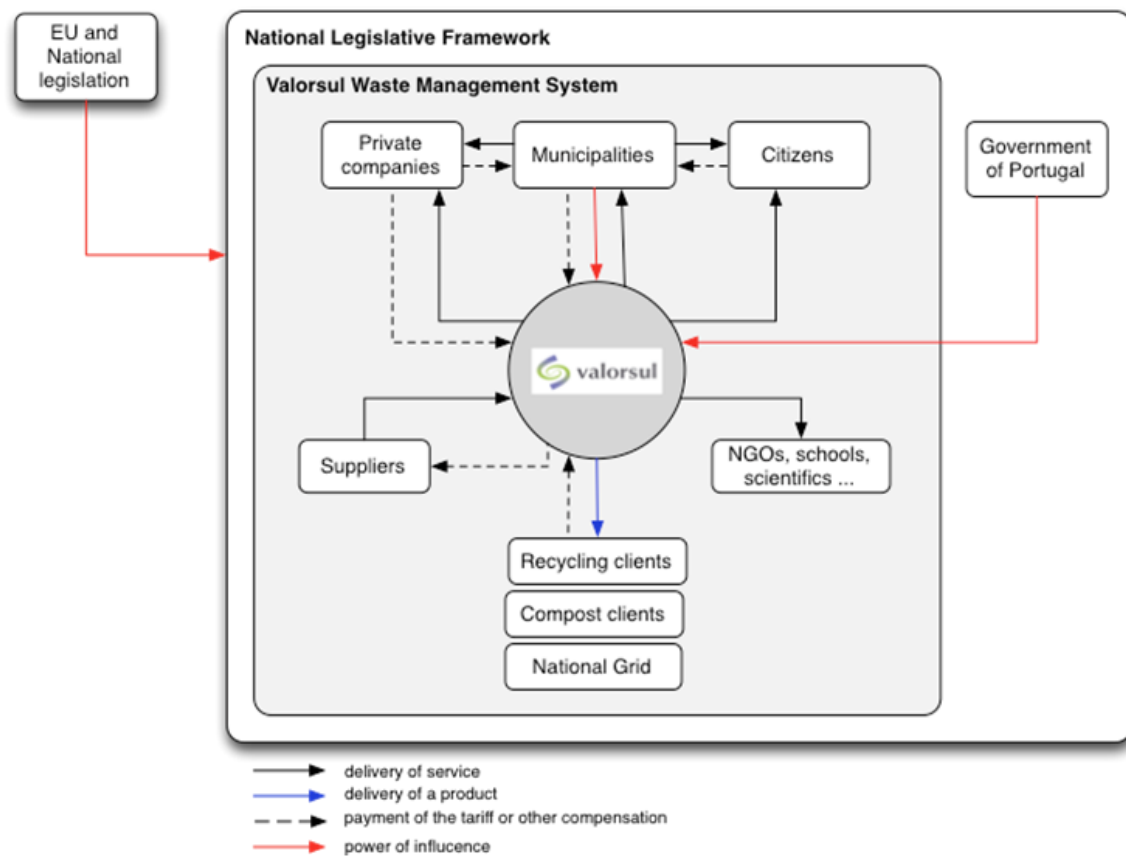
¹²⁷ The "InnoTrain CSR" project is funded by the Leonardo da Vinci Programme of the European Union and provides material to promote Corporate Social Responsibility (CSR). "InnoTrain CSR" aims to provide practice-oriented and flexible formats to involve all employees in vocational education and training (<http://www.csr-training.eu/en/home/>).

¹²⁸ See Figure 2.5 in Section 2.3.

particularly well accepted, because, by allowing the WtE plant to operate at full capacity and increase the energy sale, it may allow a tariff decrease for waste treatment. The pressure of political parties represented in the municipality where the incinerator was located (Loures) were particularly strong at the initial stages of project implementation: they asked Valorsul a number of compensatory measures against the construction of the WtE plant, including the financing of a ring-road connecting Loures and Lisbon and serving the plant and other social projects to the benefit of Loures citizens (such as a public swimming pool).

Tariff setting was influenced both by the national legislation and the municipalities. The high incentives granted by the Government to energy generation from renewable sources (including waste incineration) and municipalities' interest in keeping the gate fees as lowest as possible determined a cross-subsidisation mechanism such that the tariff is neither in line with the "polluter pays" principle nor guarantees the financial sustainability of Valorsul's system (as remarked in Section 1.3). Valorsul is aware that its financial viability is much dependent upon the energy sale, and its latest strategic choices, i.e. the merger with Resioeste and the energy recovery from landfill biogas, highlight the company's aim of maximising this source of revenue. A raise of the gate fees, which would make the company less dependent upon the energy price, is not under discussion.

Figure 4.1 PROJECT GOVERNANCE STRUCTURE



Source: Authors

In short, the Valorsul governance structure had a strong and mixed influence on the project design and thus its effects. On the positive side, the national influence allowed to put in place an effecting and integrated waste management system, which diverted most of unsorted waste away from landfills and put the basis for waste valorisation and recycling increase. The condition imposed by one municipality of building a ring-road from Loures to Lisbon slightly raised the investment cost, but it positively affected the environment, by reducing road congestion. Most of all, what the compromise between the municipalities' and Valorsul's interests allowed was to minimise opposition from local communities to the project.

On the negative side, political and social interference constrained Valorsul management room of manoeuvre: the AD plant, strongly advocated by environmentalist and political parties, was built despite been considered not profitable by Valorsul; on the same vein, municipalities pressure on the decentralised location of the plants prevented from designing the most efficient option, thus increasing economic and environmental cost of waste transport (as explained in Section 4.3). Finally, the national and local focus on generating revenues most from the energy sale rather than from tariffs may potentially put at risk the financial sustainability of the project.

4.6 MANAGERIAL RESPONSE

This sub-section is concerned with the adaptability/flexibility of project management to unforeseen events. It is worth noting the constant evolution of the Valorsul facilities and services from the outset. As Valorsul management stated, *'we started with just two projects, the incineration plant and the landfill'*. Seventeen years later, the company has widened its range of services and adapted to new legislative, political and social demands.

Valorsul made concerted efforts to anticipate potential changes and problems related to the wider public, as explained in other sections of this report. The company, for instance, is very active in working with schools and younger people. This allows Valorsul not only to deliver environmental education to these groups, thus improving recycling rates and the positive perceptions about the project, but also to learn about concerns and demands of future generations and take action in anticipation of these concerns and demands. The merger with Resioeste is another good example to illustrate the capacity of Valorsul to adapt to new circumstances, in this particular case, the economic crisis. With this, Valorsul aims to guarantee that the WtE Plant works at full capacity and increase its revenues.

Much more efforts, however, are still needed to increase the recycling shares, by organising awareness and communication campaigns to improve waste sorting behaviour among households. This will increase the volume of recyclable materials recovered and favour the production of good quality compost.

Adapting to stakeholder demands has not always proved successful for Valorsul, at least from a financial point of view. A good example of this is the Anaerobic Digestion Plant, a service that was imposed by pressure from NGOs and politicians, despite being considered very expensive

and not profitable by Valorsul management¹²⁹. Besides the difficulty encountered in selling the compost produced, particularly without a behavioural change among households about waste sorting, Valorsul claims that the plant has had too many technical problems which raised investment costs.

The Anaerobic Digestion Plan is an environmental cost that we had to pay.

Source: Valorsul management interviewed

4.7 THE ROLE OF THE EU INSTITUTIONS

Most stakeholders agree on the key role played by the EC in the implementation of the Valorsul project. As noted in the Evaluation Report of CF 1993-2006 in Portugal, financial aid was critical in helping Portugal:

- Meet EU targets and legislation regarding the environment: *'The CF has been the key for a closer alignment of Portugal with the EU targets on water supply, sanitation and MSW treatment (...) The convergence was faster during the first CF (1993-1999) due to a concentration of investments in major urban areas.'*
- And by providing the required financial assistance: *'All project promoters stressed the importance of CF co-financing in the implementation of infrastructures. In fact, without this funding, and given the lack of financial and technical capabilities, most local governments would not have been able to support the investments. The only alternative would have been a very high increase of tariffs, a situation that would have been socially unbearable as this concerns the provision of essential public services'.*

Whilst these statements refer generally to the CF investments in Portugal during the Nineties, they could be related to the Valorsul project as well. The EC was not only of great importance in the establishment of Valorsul and the implementation of its first CF project, but also it has contributed to Valorsul's continuous improvement through the co-financing of further initiatives. With regard to this issue, it is worth noting the rehabilitation of municipal landfill sites (ERDF funds), the construction of the Anaerobic Digestion Plant (Portugal CF project 1999/PT/16/C/PE/005) and the Ecovia - Ecological Road project (LIFE Programme project LIFE ENV/P/000366 05).

The EC DG Regional Policy Unit for Portugal also carry out monitoring field missions to check on the projects' progress and acquire on-the-spot knowledge of implementation problems and advise on solutions. Therefore it can be stated that the role of the EC has been key for the success and sustainability of the projects and initiatives of the company.

¹²⁹ Source: Field interview.

If we had not had the support of the EU to construct the WtE Plant, maybe we would have been able to build it anyway. However, one thing is clear: it would have been impossible for us to carry out the construction of further infrastructures and the delivery of additional services afterwards’.

Source: Valorsul management interviewed

Interviewees also stressed the important role played by the EIB. The EIB loan facilitated Valorsul in accessing financial resources under better conditions than other banks on the market. Considering all the investments made to set up the Integrated Waste Management System, the contribution that Valorsul received from the EIB loan (33% of total investment cost) was quite significant and close to that from CF (36.1%).

The loan was very important at the time to Valorsul, mainly because of the interest rates involved and the medium/long term security it brought to our project. [...] We (Valorsul) had a lot of private banks deeply interested in funding our project, but could not compete with EIB conditions.

Source: Interview to the President of the Executive Commission of Valorsul

In addition to the aforementioned financial conditions, the involvement of the EIB offered an added value to the project. Pre-loan assessment processes carried out by EIB are notably very demanding: the project is assessed by finance experts as well as economists and engineers, who also provide recommendations to enhance the quality of the project, in line with the Bank’s eligibility guidelines and rules. Such a thorough and comprehensive process does not exist in other banks and ensured the robustness of the project.

5 CONCLUSIONS

Conclusions and the main lessons learnt from this case study are presented in this last Section.

The success of the Valorsul project in increasing environmental quality was not a surprise taking into consideration the serious problems that Portugal was facing in the 1990s in the area of environmental management. The waste sector was managed in an unsustainable way and Portugal faced difficulties in complying with the policies and legislation arising from EU membership. The priority for the managers and authorities at the time was to respond quickly to an increasing problem, and the construction of modern facilities for waste treatment managed to eliminate the volume of waste being illegally dumped in uncontrolled landfills.

In order to fully understand the long-term contribution brought by the project and the mechanisms which influence the generation of effects, it is worth noting the challenge that a company of the nature of Valorsul has to face. On the one hand, as a private-law company, the management has to respond to the demands of the market and ensure the financial sustainability of the company. This is largely ensured by the national subsidies for the production of energy from waste, which generate high revenues for Valorsul. Furthermore, in order to increase income from waste treatment services and to maximise the WtE plant's utilisation, Valorsul decided to merge with Resioeste in 2010.

On the other hand, as a government-owned company, it is subject to much pressure from its shareholders, particularly municipalities, and from wider society and NGOs. In order to satisfy their requirements and secure a high level of consensus, Valorsul has had to put financial priorities in a secondary position: the construction of the Anaerobic Digestion Plant, the very low gate fees (in contravention of the EU "polluter pays" principle) and the geographical dispersal of facilities, secured the consensus of NGOs and municipalities, but also reduced the system's profitability. Additionally, the 'need' to comply with political pressures to distribute the facilities amongst all the municipalities instead of concentrate them in one area, has been detrimental to the environment, due to higher transport emissions.

It has to be acknowledged that the capacity of Valorsul to engage with the main stakeholders from an early stage was a key successful factor of the project. In response to initial protests and opposition, the company carried out communication campaigns, during the design phase, and built strategic partnerships with companies, authorities and associations. The implementation of subsequent CSR initiatives has also been very important in gaining and maintaining public acceptance. These efforts are reflected in a high impact of the project on social happiness.

From an economic viewpoint, the Valorsul project has contributed to direct economic growth by producing electricity, providing a proper waste management system to the metropolitan area of Northern Lisbon and, to a lesser degree, contributing to the development of the recycling market through the sale of recyclable products. However, despite the numerous educational campaigns to improve waste sorting, recycling rates are still below the EU targets,

in contravention of EU Directive 2004/12/EC on the recovery and recycling of packaging waste. Also, the high share of improper materials in the organic material prevent Valorsul from marketing the compost produced in the AD plant. More awareness campaigns are still needed to change the sorting behaviour of Valorsul's clients.

The CBA exercise has enabled the quantification of the economic return on the project. On both a financial and economic basis, the project generates a negative Net Present Value (EUR -122 million in the financial analysis and EUR -44 million in the economic analysis). However, if compared to the counterfactual of a landfill, which generates a much larger and negative economic NPV of EUR -179 million, the project generates a net positive return for society of approximately EUR 135 million.

The reasons for the project's limited economic return are partly related to the lost revenue opportunities from the sale of compost and recyclable materials and the higher costs deriving from decentralised infrastructures, and partly to the fact that the CBA does not incorporate a large number of other effects, the largest one related to the already mentioned benefit on social happiness. Other non-quantified benefits are summarised below.

The lack of expertise in Portugal in managing and delivering large scale projects such as Valorsul and the collaboration with a number of experts from other countries did have an impact on endogenous dynamics during the preparation and early implementation of the project. The undeveloped state of Portugal in the environment area made it possible that the project had a positive impact also on institutional quality. In a short period of time, the project enhanced the capacity to deliver large projects in Portugal. In the medium to long run, the 'pioneering' nature of the project has also influenced some institutional structures (e.g. IFDR) through a *learning by doing* process. The lessons learnt by Portugal through this process have been used to assist other EU candidate countries that have gone through similar processes (lack of expertise) in recent years. This has been done through the EC Twinning instrument for the Candidate Countries. Moreover, the very poor results in terms of recycling pushed the Government to elaborate new measures to improve waste collection and separation among households, which have been included in the new national waste management plan (PERSU II).

It is worth remarking that the Valorsul project became an emblematic project in Portuguese waste treatment. It achieved a symbolic dimension, mainly due to the pioneering character and the large scale of the Integrated Waste Management System implemented. In fact, according to stakeholders' feedback, at the time, Valorsul was considered the flagship project that would show the strengthened capacity of Portugal with regard to the implementation of large and complex infrastructures. This factor further improved the positive perception and consensus about the project.

Valorsul turned out to be an emblematic project for Portugal, further to the needs that it would solve

Source: CF Coordinator, IFDR)

Regarding the determinant factors of the project's performance, the analysis shows a very positive role played by the project's appropriateness to the context: the urgent need for a

better waste management solution, strengthened by the forthcoming Expo '98 event and by increased public awareness of environmental issues, as well as the high incentives granted by the Government for the production of energy from 'green' sources, including waste incineration, represented the main determinant factors of performance.

Project design attempted to provide the best solution to the waste management issue and at the same time secure the consensus of stakeholders, by satisfying requests concerning the localisation of facilities and the construction of the AD plant. Forecasting capacity could have been stronger, as far as the WtE plant's capacity setting is concerned, but it proved to be adequate in terms of anticipating potential opposition from residents and NGOs and of taking steps to minimise this opposition.

Both project governance and managerial response had mixed effects on the project. By reacting to the municipalities' and other actors' demands, Valorsul improved social happiness to the detriment of other aspects of the project.

The importance of EU funding for the Valorsul project was fundamental. The large scale and dimension of the project (initial eligible investment cost of EUR 186.41 million in current terms) required innovative technology and modern management structures. The CF contributed 49.41% of this cost and it seems unlikely that the Portuguese Government could have financed the whole cost alone. The role of the EIB was also of great value. It contributed with some 32% of total investment cost, and also provided robustness to the technical and economic design of the project.

ANNEX I. METHODOLOGY OF EVALUATION

The present Annex summarises the methodological approach undertaken for carrying out the project case studies and presented in the First Intermediate Report of this evaluation study. Moreover, the Annex further elaborates on and specifies the definition of long-term effects considered throughout the case study and the typology of determinant mechanisms analysed in interpreting the project outcomes. The main objective is to provide the reader with a set of information describing how the project evaluation was conducted and to enable him/her to replicate this methodology.¹³⁰

The Annex is divided into three parts: in the first one, the overall conceptual framework of the evaluation study is recalled and the definition of long-term effects and project determinants are laid out; in the second one, the methodology of analysis followed to implement the ex-post evaluation is discussed; finally, the structure of the case study reports and the tools used to standardise them is described in the third part.

CONCEPTUAL BASIS

The Conceptual Framework of this evaluation study is based on three dimensions of analysis: the object of the evaluation (the 'What'), the timing of the long-term effects (the 'When') and the determinants of the project's outcomes (the 'How').

The 'What' dimension

The Team developed a classification of long-term effects, with the aim of identifying all the possible impacts of public investments on social welfare. A broad distinction of project effects is among effects on 'Economic development' or 'Quality of life'. Investment projects can foster economic development, which is generally quantifiable by aggregate indicators, such as the Gross Domestic Product; although economic development is not disconnected from the wellbeing of society, it is acknowledged that there are a number of other factors that may affect public welfare, that are not captured by the traditional economic indicators¹³¹. For the purpose of this study, the notion of quality of life¹³² refer to the factors that affect social development, the level of social satisfaction, the perception of social reality and other dimensions which are outside the conventional economic dimension. Under these two broad categories, a taxonomy of more specific long-term development effects of investment projects has been developed. The definition of each type of effect is provided in Table I.1.

¹³⁰ Specific recommendations which may enable application of the same evaluation methodology to future projects are discussed in the Final Report of this evaluation study.

¹³¹ Dasgupta, 2011 and Stiglitz et al., 2009.

¹³² Used also as synonymous with wellbeing, as mentioned in the ToR.

Table I.1 TAXONOMY OF LONG-TERM DEVELOPMENT EFFECTS

Effects	Definition	Checklist
<u><i>Economic development</i></u>		
Direct economic growth	Following the traditional growth theory ¹³³ , both public and private investment contribute to increasing the stock of capital and thus economic growth. The direct contribution of a project to economic growth, in terms not only of real growth of GDP, but also, more generally, on economic welfare is discussed within this category of effect.	Did the project have effects on the endowment of labour or capital production factors? Did it contribute to employment creation? Did it attract new investments? Did it create new business opportunities? Did it produce time savings for business trips? Did it produce decreases in travel costs?
Endogenous dynamics	Endogenous dynamics comprise all the factors that have an indirect effect on economic growth, by improving the productivity of inputs: the increase of the stock of competences and knowledge of human capital ¹³⁴ , the introduction of a more advanced technology ¹³⁵ and changes in the organisational model of economic actors, making them more efficient ¹³⁶ , are analysed insofar they contribute to increasing the production function.	Did the project contribute to the improvement of the productivity of the economic system? Have social behaviours changed as a result of the project? Did the project provide new/improved skills, R&D investment, organisational changes that translated into an increase in labour productivity?
<u><i>Quality of life</i></u>		
Social cohesion	Public investment can affect social cohesion, by minimising disparities, avoiding social marginalisation and reducing income inequalities across different socio-economic, gender or ethnic groups.	Did the project promote social inclusion? Did it improve the conditions of specific segments of the population (e.g. elderly, migrants)? Did it improve the affordability of services?
Environmental effects	Polluting emissions, biodiversity loss and depletion of natural resources caused by large infrastructural projects can affect social wellbeing of both the present and future generations.	Did the project improve the quality of the natural environment? Did it alter wildlife habitats? Did it affect the ecosystem? Were there any environmental issues related to project implementation?
Territorial cohesion	The project can contribute to reducing welfare disparities caused by unequal distribution of resources and opportunities among regions and their population. The focus, in particular, is on core-periphery and urban/rural differences.	Did the project improve the territorial cohesion of the region/country? Did it play any role in urban-rural or core/periphery or cross-border dynamics? Did it expand the territorial coverage of the delivery of a basic service?
Institutional learning	Investment projects can bring wide spill-over effects to the quality of Public Administration and other institutions at national, regional or local level. Institutional quality is strongly related to economic growth ¹³⁷ , but it can also affect the quality of life of people, because of the intrinsic value that individuals can attribute to a well-ordered society ¹³⁸ .	Did the project induce any institutional learning at regional administrative level? Did it raise political awareness regarding a specific theme? Did it have effects on the level of corruption?
Social happiness	This category encompasses all those variables which may affect the <i>subjective perception</i> of people's wellbeing, and have to do with their psychology, family context, religion and cultural traits.	Are the project beneficiaries overall satisfied with the project's implementation and outcomes? Did the project have any effect on the perception of quality of life? Did it affect the sense of security of the target population?

In researching all the possible long-term effects of project investments, it is acknowledged that there is a risk of duplication and double-counting: for example, a project for water treatment clearly has effects on environment, which may contribute to the development of new economic activities that foster economic growth.

¹³³ Solow, 1956.

¹³⁴ Becker, 1962.

¹³⁵ Griliches, 1992 and Griffith, 2000.

¹³⁶ Tomer, 1982 and Martinez, 2009.

¹³⁷ See, for instance, Easterly et al., 2006.

¹³⁸ Sen, 1987.

The 'When' dimension

The temporal dimension of analysis relates to the point in the project's lifetime at which the effects materialise for the first time, how they develop over time and whether they have already stabilised or are still evolving. A clear distinction emerges between short-term and long-term effects, with the former being the first contributions made by the project and enjoyed by society after a relatively short time following project completion (about 1-5 years); the latter, on the other hand, become visible after a longer period of time and tend to stabilise over many years. It is acknowledged that, given the varying timeframe for different effects to appear and stabilise, the choice of the time horizon and the timeframe at which the ex-post evaluation is carried out can significantly affect the results of the evaluation.

The 'How' dimension

Project outcomes, i.e. the way projects affect the generation of certain effects and the varying timeframe for effects to appear and stabilise, are not certain, but result from a non-deterministic combination of different and interrelated factors. Five stylised determinants of project outcomes have been identified: appropriateness to the context, project design, forecasting capacity, project governance and managerial response. Five Working Hypotheses are related to these dimensions and explain how each of them can influence the generation of the project's short or long-term effects (see Table I.2).

The three dimension of analysis are logically interconnected and by combining the 'What', 'When' and 'How' dimensions the evaluator can disentangle the causal chain between the project's inputs and the outputs.

METHODOLOGY OF ANALYSIS

The methodology developed to answer the evaluation questions consists of a combination of quantitative (Cost Benefit Analysis) and qualitative (personal interviews, surveys, searches of government and newspaper archives, etc.) techniques. Qualitative techniques are probably better at determining why certain effects are generated, along what dimensions, and underlying causes and courses of action of the delivery process. The media (including websites or blogs), in particular, have proved to be an excellent source of evidence identifying or revealing both objective information and perceptions about the project, thus concurring to assess the project's impact on social happiness. At the same time, quantitative data can provide an important support to test and validate certain findings derived from interviews and other sources. The most important contribution of the CBA exercise is to provide a framework of analysis to identify the most crucial aspects of the projects' ex-post performance and final outcome¹³⁹.

¹³⁹ More details on the approach adopted to carry out the ex-post CBA exercise and, in particular, indications on project identification, time horizon, conversion factors and other features are extensively described in the First Intermediate Report of this evaluation study.

Table I.2 **KEY DETERMINANTS OF PROJECT OUTCOMES CONSIDERED**

Determinant	Definition	Working Hypothesis	Questions to be answered
Appropriateness to the context	Includes the consideration of institutional, cultural, social and economic environment into which the project is inserted.	Context traits can be more or less favourable for project performance and deserve early and careful consideration about which to take or to make. The terminology of context traits that can be either 'taken' (that is, accepted, as they are considered unchangeable) or 'made' (by changing existing or creating new traits) is drawn from Hirschman (1967).	Has the (political, cultural, socio-economic, institutional, regulatory) context played a role in influencing the attainment of long-term effects? Were there any political, social, cultural, economic, regulatory, or institutional constraints to project implementation and performance? Was the project 'trait taking' or 'trait making' in its nature? If it was intended to be trait making, did it succeed?
Project design	Refers to the technical capacity to design the infrastructure project and to select the best project option.	The technical and engineering capacity to design an infrastructure and to provide the appropriate mechanism for its financial sustainability should be sufficiently disciplined to reduce future risks; at the same time it should leave some degrees of 'latitude' to enable adjustments for unforeseen circumstances. Following Hirschman, latitude is the characteristic of a project that permits the project planner and operator to mould it, or to let it 'slip', in one direction or another. Some projects are so structured that latitude is severely restricted or completely absent: in these cases, the project is considered highly 'disciplined'.	To what extent and in what way did the technical, structural and financial features of the project influence its performance? Did the option selection process lead to the implementation of the most promising project idea? Was project design capacity a relevant factor in determining the observed ex-post performance of the project? Was the project design flexible enough to be adjusted, if needed, to external and unexpected constraints?
Forecasting capacity	Relates to the feasibility and capacity to predict future variables, such as the demand level.	A good initial investment in building the forecasting capacity does not eliminate risks, but it increases the knowledge of the context, improves the project design and optimises the distribution of responsibilities without lowering the commitment to performance.	Were the ex-ante forecasts based on a sound methodology and a comprehensive set of information? Were some important factors not sufficiently considered ex-ante? Was the forecasting capacity a relevant factor in determining the observed ex-post performance of the project?
Project governance	Concerns the number and type of stakeholders involved throughout the project cycle and how responsibilities are attributed and shared.	High stakeholder involvement, well-defined roles and responsibilities and incentive mechanisms require commitment of resources and increase the complexity of the decision-making process, which may be subject to particular pressures, but they can favour the project performance and its sustainability over time.	What are the interests and motives of different actors and incentives for decision-making? How did they change over the time-span considered? Was the ownership of the project clearly identified? Did contractual arrangements improve the co-ordination of different stakeholders towards achievement-oriented results? Was project visibility a relevant political incentive to foster proper project implementation? Was the project subject to political or other forms of pressure?
Managerial response	Defined as the managerial and professional ability to react to unforeseen events.	Unpredicted events that occur and undermine the sustainability of the project and its capacity to lead to expected benefits can be overcome by prompt and adequate response from the decision-makers and project managers, driven either by professionalism and experience or by creativity and imagination.	How did the project react to exogenous, unpredictable, events? What remedial actions were put in place? What mechanisms were used to incentivise proactive responses? Why were these events unexpected? Was it due to their purely exogenous and ex-ante unpredictable nature? Or, was it due to poor planning capacity?

STRUCTURE OF CASE STUDIES AND STANDARD TABLES OF RESULTS

Qualitative and quantitative findings are integrated in a narrative way, in order to develop ten project ‘histories’ and to isolate and depict the main aspects behind their long-term performance. All case study reports share the same outline, presented in the following Table:

Table I.3 *OUTLINE OF THE CASE STUDY REPORT*

SECTION	CONTENT
Projects description	The first section provides a brief sketch of the unit of analysis. It describes the key structural features of the infrastructure and the service delivered, the context in which it takes place, the target population and the current performance of the project.
Origin and history	This section describes the background in which the decision to initiate the project was taken, the need and objectives expected be met and the key stakeholders involved and their role. The section should present a brief chronicle of the main developments after the construction phase and the most recent facts.
Description of long-term development effects	This section should describe the main long-term development effects provided by the project. The seven categories of effects should be considered and for each of them an assessment of the contribution of the project to that specific effect, and the timing of their materialisation and evolution, should be given.
Determinants of project outcomes	The main drivers influencing the performance observed are described and elaborated here. The evaluators should provide their own assessment for each of the five key determinants of project outcomes identified in the conceptual framework.
Conclusions	The key messages in terms of lessons learnt are developed here.
Annexes	Ex-post cost-benefit analysis report, list of interviewees, other ad hoc analysis if relevant (such as stakeholder mapping).

In order to maintain the structure of all the case study reports as similar as possible, and facilitate the cross-project analysis of findings, a set of standard tables is used to summarise the main evaluation results related to three dimensions of analysis (‘What’, ‘When’ and ‘How’). Section 3 and 4 of each case study include standardised tables in which scores are assigned to each type of long-term effect and each determinant. Scores ranging from -5 to +5 are given in order to intuitively highlight which are the most important effects generated for each case study and which are the most relevant determinants explaining the project outcomes. In other words, scores are used to rank the effects and determinants, showing which ones are the most relevant. Moreover, the plus or minus signs indicate the nature of the effects produced by the project (was the impact positive or negative?) and of the determinant of project performance (did the determinant positively or negatively contribute to the project outcome?).

The same scores are used to disentangle the project’s impacts on different stakeholders. This table allows one to better interpret the aggregated score given to each effect, by understanding on which actor the project impacted the most: for example, a +3 score to “Direct economic growth” may be reflected by a very high positive effect on the infrastructure operator (valued, for instance, +5) and a slightly negative effect on other actors (valued -2). As shown by this example, the aggregate score of each effect and the scores related to different stakeholders should be consistent with each other and should results from a sort of weighted average of the impacts on individual stakeholders: an aggregate positive score is inconsistent with negative impact scores on all the different stakeholders involved.

Table I.4 SCORES ON PROJECT'S IMPACT AND DETERMINANTS OF PROJECT OUTCOMES

Score	Meaning
+5	Given the existing constraints, the highest positive effects have been generated.
+4	Given the existing constraints, high positive effects have been generated, but more could have been achieved under certain conditions.
+3	Moderate positive effects have been generated, with large scope for further improvement.
+2	Some positive effects have been produced.
+1	Very little, almost negligible, positive effects have been generated.
0	No effects have been generated.
-1	Very little, almost negligible, negative effects have been generated.
-2	Minor negative effects have been produced.
-3	Moderate negative effects have been generated, but they could have been worse.
-4	Highly negative effects have been generated.
-5	The highest negative effects have been generated.

Note: The same scores have been used for assessing both the project's impacts and determinants. In the first case, they have to be interpreted as the nature and strength of effect generated by the project; in the latter, they indicate the strength of each determinant factor in influencing the project outcomes.

The 'When' dimensions results are synthetically presented by means of another table: for each kind of effect, a score is given to explain how the nature and strength of the impact evolved over the years, by focusing in particular, on the short-run (approximately 1-5 years after the project's completion), the long-run (6-10 years after the project's completion) and the future period. The Table contains information that allows the reader to immediately understand whether the project impacts have already stabilised or not. The meaning of the symbols used and an example of their application is presented in the following two Tables.

Table I.5 SYMBOLS USED TO DESCRIBE THE TEMPORAL DYNAMICS OF THE EFFECTS

Symbol	Meaning
+ or -	Positive or negative effect.
++ or --	Positive or negative effects reinforced (in positive or negative direction) with respect to the previous stage.
+++ or ---	Positive or negative effects further reinforced (in positive or negative direction) with respect to the previous stage.
+/-	Mixed effect, it is not possible to assess whether the impact was positive or negative.

Table I.6 EXAMPLES OF TEMPORAL DYNAMICS OF THE EFFECTS

Short run (years 1-5)	Long run (years 6- 10)	Future years	Comments
+	+	+	The positive effect stabilised in the short-run.
+	++	++	The positive effect stabilised in the long-run.
+	++	+++	The effect has grown over the years and will increase also in the future.
-	+	++	The effect was at first negative; after some years it turned positive and it is still not stabilised yet.
+/-	+	++	Effects have been mixed in the initial stage, became positive in the long-run and are expected to further increase in the future.

ANNEX II. COST-BENEFIT ANALYSIS

This annex presents the ex-post CBA of the integrated Municipal Solid Waste (MSW) treatment system for North Lisbon¹⁴⁰, operated by *Valorização e Tratamento de Resíduos Sólidos da Área Metropolitana de Lisboa Norte S.A.* (Recovery and Solid Waste Management of North Lisbon Metropolitan Area S.A.), hereinafter Valorsul. It also takes into account the 2010 expansion of the system on the Merger of Valorsul with the waste management system of West Lisbon (*Resioeste - Valorização e Tratamento de Resíduos Sólidos, S.A.*), hereinafter Resioeste¹⁴¹, as it affects the infrastructures which are the subject of this evaluation.

The purpose is to quantitatively assess the performance of the project. The methodology applied is in line with the technical note provided in the First Interim Report and, more generally, with the EC Guide (European Commission, 2008). This annex presents in more detail the assumptions, inputs and results of the CBA, along with scenario and risk analysis.

METHODOLOGY, ASSUMPTIONS AND DATA GATHERING

The CBA incorporates the following assumptions:

- *Project identification*

The unit of analysis comprises all the activities carried out by Valorsul, specifically at the following infrastructures:

- A modern engineered landfill in the municipality of Vila Franca de Xira, with flaring of methane (CH₄) to minimise global warming impact. In 2011 Valorsul commenced burning this methane to generate electricity.
- A Waste-to-Energy (WtE) plant, in the municipality of Loures¹⁴², which burns municipal waste to generate electricity.
- An incineration bottom ash treatment facility¹⁴³, to recover ferrous and non-ferrous metals for recycling, located in Vila Franca de Xira.
- Construction of a stretch of public road connecting Loures and the municipality of Lisbon, to facilitate access to the WtE plant.

¹⁴⁰ Comprising the municipalities of Lisbon, Amadora, Loures and Vila Franca de Xira.

¹⁴¹ Resioeste served 14 municipalities - Alcobaça, Alenquer, Arruda dos Vinhos, Azambuja, Bombarral, Cadaval, Caldas da Rainha, Lourinhã, Nazaré, Óbidos, Peniche, Rio Maior, Sobral de Monte Agraço e Torres Vedras – with a total population of 403,000.

¹⁴² Since the WtE plant has been in operation, the key function of the landfill has been to act as a backup for when the Waste-to-Energy Plant is not available, and for the disposal of non-hazardous incineration ash not usable for other purposes. The Valorsul 2011 Financial Report indicates that in 2011 approximately 47% of the material deposited in the landfill was inert incineration ash.

¹⁴³ Hazardous fly ash (ash removed from the emissions to air from the WtE plant), which represents 3-4% the weight of MSW incinerated, is channelled to the National System of hazardous waste.

- Provision of trucks to the municipalities to assist implementation of separate collection of the recyclable elements of MSW (e.g. paper, cardboard, glass, metal and plastic) and of the biodegradable fraction.
- A Materials Recovery Facility (MRF) and bring centre for sorting recyclable streams, in the municipality of Lisbon.
- An Anaerobic Digestion (AD) Plant, which accepts the organic fraction of MSW and converts it into compost and biogas, which is then burned to generate electricity, located in Amadora.

In addition, the project involved sealing and rehabilitation of uncontrolled dumps in Vale Forno and Sta Iria de Azoia¹⁴⁴.

It can thus be seen that Valorsul comprises an integrated and comprehensive system for the processing of MSW in its catchment area (see Figure 1.3 of main report). Valorsul does not undertake waste collection itself; this remains the responsibility of the respective municipalities, although Valorsul has provided trucks to the municipalities to facilitate separate collection.

A question arises, regarding how to deal with the merger with Resioeste in 2010. With this merger, the system was expanded to incorporate a further 14 municipalities, along with a number of infrastructure facilities, namely:

- Sanitary Landfill in Cadaval;
- Separate collection of MSW streams in the region;
- Sorting Plant in Cadaval;
- Mechanical Biological Treatment (MBT) plant in Leiria.

Resioeste has also closed and rehabilitated a number of uncontrolled dumps in the region, over the years, and has received CF co-funding.

On the one hand, one could incorporate all of Resioeste from 2010 onwards, but one would have to also include its infrastructure. What then of its pre-merger operations (volumes treated, revenues, costs)? On the other hand, one cannot simply ignore the merger, as it impacts significantly on the future financial and economic viability of Valorsul. Our solution was to include only:

- (i) The infrastructure for the 'original' Valorsul;
- (ii) The amount of waste from the Resioeste system that is/will be treated in the 'original' Valorsul infrastructure.

¹⁴⁴ In subsequent years, Valorsul also closed and rehabilitated old landfills at Carenque, Montemor and Boba, in an ERDF-funded project. However, this is not included in the current project (as also explained in Section 1.1).

- (iii) The ‘original’ Valorsul’s operating costs and revenues, as adjusted for the increased volumes treated in the future.

Thus, we ignore the waste streams from the Resioeste system that continue to be treated in Resioeste infrastructure, along with all the related costs and benefits.

On this basis, the total capital cost incurred up to and including 2010 is summarised in Table II.1. In current prices, total capital cost amounted to EUR 268.6 million; in constant 2011 prices, it amounts to EUR 366 million. A fuller description of the project is presented in Section 1 of the main report.

Table II.1 CAPITAL EXPENDITURE (EUR THOUSAND, CURRENT PRICES)*

	<i>Initial Investment</i>	<i>Subsequent Investments</i>	<i>Total Investments</i>
Building	4,226	0	4,226
Waste to Energy plant - Loures	153,810	18,944	172,754
Sanitary Landfill - Mato da Cruz (Vila Franca de Xira)	10,111	12,413	22,524
Anaerobic Digestion plant - Amadora	0	29,429	29,429
Sorting Plant - Lisbon	7,519	6,256	13,775
Bottom Ash recovery plant - Vila Franca de Xira	2,021	511	2,532
Selective waste collection (vehicles)	7,061	10,392	17,453
Initial capital for concession and closure & rehabilitation of dumps at S. Iria/Vale do Forno	5,888	0	5,888
Total	190,636	77,945	268,581

*Valorsul only, excluding Resioeste;

Source: Valorsul

- *Time horizon*

The time horizon has been set at 30 years for all the project case studies. This means that the timeframe for the CBA of the Valorsul project spans from 1996 (year zero), the year in which construction of the first element of the project – the landfill – commenced, to 2026 (year 30). Since the perspective of the analysis is 2011, it presents a mix of historical and forecast data. Actual historic data are available up to and including 2011.

- *Constant prices*

The analysis is carried out in constant 2011 Euros. The latest year for which actual financial data are available is 2011 (for the merged entity). Data from 2012 onwards are estimated in real terms (2011 prices, no inflation), while available data up to and

including 2010 are historical and therefore have been inflated to convert them to 2011 Euro¹⁴⁵.

- *Discount rates*

Discount rates are as per the guidance in the First Interim Report. The financial discount rate is 5.0% real for both backward and forward analysis. In the economic analysis, specific social discount rates for Portugal for past and the future periods have been calculated. A real backward social discount rate of 4.2% and a real forward social discount rate of 2.9% have been used.

- *Counterfactual scenario*

All cash flows are incremental against a 'do nothing' scenario, i.e. a continuation of the position pre-Valorsul. However, this 'do-nothing' option was not considered tenable, as it would involve a continuation of uncontrolled and illegal dumping of waste and unacceptably poor environmental standards.

Therefore, we considered a 'do minimum' option, whereby all waste is disposed of in a single large modern landfill, located at Vila Franca de Xira (where the current Valorsul landfill is located). This is situated approximately 13 km north of the WtE plant, in a relatively sparsely populated area, and hence it was considered feasible to locate this very large landfill there.

We have assumed that no recycling, anaerobic digestion or other treatment of waste would be undertaken¹⁴⁶; landfill gas would be flared but not used to generate electricity.

The capital investment required for this option is based on a grossing up of the known landfill development cost, *pro rata* with the additional volumes that would need to be catered for. No economies of scale in the construction or operation are considered, which is conservative, but the existing actual landfill is quite large, and it may be that most economies of scale were exhausted in its sizing. We have assumed that the capital expenditure is incurred over a period of 20 years, starting in 1996 (Year 0).

We are not in a position to separate the actual operating costs of Valorsul's landfill from its WtE plant and other facilities, but we can make an estimate, allocating costs *pro rata* with staffing levels (in 2010, the landfill employed 8.5% of Valorsul's total staff).

¹⁴⁵Inflation of historic prices has been done using the yearly average percentage variation of consumer prices provided by the International Monetary Fund (IMF). With regard to construction costs and transport costs, we have used the Euroconstruct construction deflator for Portugal (www.euroconstruct.org), and the Portuguese transport price inflation index (source www.ine.pt), respectively, as these should more accurately reflect actual inflation experience for these categories of expenditure.

¹⁴⁶ Pre-Valorsul, it is estimated that some 5% of MSW was recycled, but for convenience we assume all waste goes to landfill in the counterfactual.

We have further assumed that gate fees per tonne in the landfill would be sufficient for the infrastructure to breakeven on a financial basis (given a cost of capital of 5% real), and that no other revenue would be earned. On this basis, the gate fee would average EUR 39.65/tonne (2011 money), considerably greater than the actual landfill gate fee in place currently (EUR 25.70/tonne, see Table II.2). The setting of gate fees in Valorsul is discussed in more detail later.

We also assume that EU grant aid rate would not be available for this counterfactual project, as it is unlikely that the EU would co-fund such a project.

Net additional transport costs and related environmental costs are included in the indirect/external costs of this facility, to reflect the additional 13 km to be travelled by waste trucks to access the landfill compared to the WtE plant¹⁴⁷.

An alternative counterfactual scenario, whereby each municipality would operate its own modern landfill, might also be feasible. On the one hand, transport costs would be lower, but on the other hand economies of scale might be lost, and it might not be optimal for a densely populated municipality such as Lisbon to build a modern municipal landfill within its own territory. On balance, we believe the counterfactual as set out above is a reasonable one against which to judge the project.

It should be noted that the counterfactual does not take into account the implications for Portugal of not meeting the terms of the Landfill Directive (99/31/EC), which requires a significant and progressive redirection of biodegradable waste away from landfill over the coming decade (targets to be met in 2010, 2013 and 2016). Failure to achieve these targets leaves Portugal open to potentially significant fines from the EU.

One might argue that, because the counterfactual as set out above is not compliant with EU legislation, it should not be used in our analysis. However, the purpose of the counterfactual is to have a physically feasible basis for comparison of the costs and benefits of 'Do Project', rather than present a fully realisable (politically as well as physically) alternative project *per se*.

¹⁴⁷ Strictly speaking, we should include all transport costs incurred in both 'Do Project' as well as 'Do Minimum' in the economic analysis (but not the financial analysis), because they are part of the necessary costs of waste management, regardless of the fact that they are not incurred by Valorsul. However, we do not know the transport costs incurred by the municipalities under 'Do Project', so as a second best we include an estimate of the additional transport costs only in the counterfactual.

Table II.2 TARIFFS FOR THE VALORSUL WTE PLANT AND LANDFILL, 2012

Type of Service	Facility	Municipalities	Private bodies
Discharge of MSW	WtE	22.31 EUR / (t)	53.84 EUR/ (t)
	Landfill	25.70 EUR/ (t)	57.23 EUR/ (t)
Destruction of MSW (fixed rate)	WtE	132.58 EUR / day	136.03 EUR / day
	Landfill	132.58 EUR / day	136.03 EUR / day
Destruction of MSW (variable rate)	WtE	135.46 EUR / (t)	164.44 EUR / (t)
	Landfill	138.85 EUR / (t)	169.83 EUR / (t)

Notes:

All rates shown are inclusive of waste management tax (Taxa de Gestão de Resíduos) and “aggravation” waste management tax (Agravamento TGR), which amount to EUR 1.11/tonne and EUR 0.23/tonne respectively for the WtE Plant, and EUR 4.15/tonne and EUR 0.58/tonne respectively for the Mato Da Cruz landfill.

Destruction of waste relates to specific materials, which, mainly for legal or fiscal reasons, must be destroyed before being incinerated (e.g. apprehended counterfeit goods, drugs, special foods, etc.)

The vast bulk of gate fees are in respect of discharge of waste by municipalities.

Source: <http://www.valorsul.pt/pt/clientes/quanto-custa-depositar-os-residuos-na-valorsul.aspx> as of 20.02.12.

- *Data sources*

The primary source of data was Valorsul’s annual financial reports (2006-2011) and annual environmental sustainability reports (2006-2010), available on Valorsul’s website¹⁴⁸. Attempts to access earlier reports in these series failed. From these reports we were able to identify the volumes of waste processed in each year in each infrastructure, since the commencement of Valorsul. Waste volumes processed by Resioeste, as well as those transferred from Resioeste to Valorsul infrastructure, were also available for 2009, 2010 and 2011. The full record of capital expenditure and funding sources was also provided by Valorsul, including Resioeste’s expenditure. As indicated above, we are ignoring Resioeste’s financial data, and its volumetric data except insofar as it supplies waste material to the ‘original’ Valorsul infrastructure.

However, financial operating data could only be identified for the years 2005-2011 (including Resioeste from 2009¹⁴⁹). Estimates of income and expenditure for the years 1998-2004 had to be generated based on the relationships between volumetric and monetary data for the years 2005-2011.

Environmental data on emissions to air from the Valorsul landfill and the WtE plant were only available for 2007-2009 (with limited data for 2010), and these also had to be used to backcast estimates for previous years.

At a more general level, the usual economic and demographic data are available, including population census data for 1991, 2001 and 2011. In particular, population

¹⁴⁸ <http://www.valorsul.pt/pt/biblioteca/relatorios/artigo-1.aspx>

¹⁴⁹ The 2009 Annual Report included the ‘original’ Valorsul only. In the 2010 and 2011 reports, data for the merged entity are presented, including restated data for 2009, in accordance with generally accepted accounting principles for merged entities.

and GDP data were available for the Lisbon NUTS II region, which incorporates the territory of both Valorsul and Resioeste.

- *Residual Value*

The civil engineering elements of built assets are taken to have a useful life of fifty years, and this useful life is assumed to depreciate on a straight-line basis. As of project year 30, the undepreciated residual value of these assets is credited back to the project. Land is taken to have an infinite life and thus its residual value is the same as its purchase price. All machinery and equipment is taken to have a NIL value at year 30.

FUTURE SCENARIO

This CBA is a combination of an ex-ante and an ex-post analysis, since the time horizon covers 16 years in the past (1996-2011), for which (albeit incomplete) historical data are available and 15 years in the future (2012-2026). Some hypotheses have to be made on the future trend of waste volume variables. Our approach is as set out below.

We found that there was a close historic relationship between aggregate GDP in the Lisbon NUTS II region and the volume of waste processed by the Valorsul system. We estimated this relationship using a simple regression equation.

We have assumed that the population of Lisbon and of Portugal will continue to grow at the modest rates recorded between 2001 and 2011 (-0.15% per annum and 0.19% per annum respectively).

With regard to economic forecasts, Eurostat estimates that Portuguese GDP fell by 2.2% in 2011¹⁵⁰. The IMF's long term GDP forecast for Portugal¹⁵¹ predicts a further contraction of 3.0% in 2012, followed by stabilisation in 2013 and a return to modest growth of approximately 2% per annum thereafter. We assume that the Lisbon region economy will grow at the same pace per capita (historically, Lisbon's GDP has grown at a somewhat faster pace, see Figure 2.1 in the main report). This allows us to forecast future GDP in the region, and via the regression equation, to forecast future waste volumes.

It is then assumed that the percentage split of volumes to each treatment stream remains constant, except in one respect: in future, a proportion of the stream of waste going to landfill in the Resioeste region will divert to the WtE plant at Loures¹⁵², to match the actual proportion diverted in 2011 (17.5% or approximately 31,000 tonnes). This reflects the rationale of the merger, to guarantee a flow of material to the WtE plant and hence protect the electricity generation income stream. This is the only element of Resioeste that is included in our CBA. To

¹⁵⁰ <http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&plugin=1&language=en&pcode=tsieb020>

¹⁵¹ IMF Country Report No. 11/363, p.37 <http://www.imf.org/external/pubs/ft/scr/2011/cr11363.pdf>

¹⁵² Resioeste's future volumes and the waste it supplies to the WtE plant are expected to grow in line with those in the 'original' Valorsul.

maintain comparability, under the counterfactual scenario, we assume that this same volume of Resioeste waste is disposed of in the Vila Franca de Xira landfill going forward.

FINANCIAL ANALYSIS

Sources of financing

The Valorsul project was initially financed via a combination of CF funding, EIB and commercial banking finance, and Valorsul's own equity. Subsequent investments over the years have been financed largely through internal cashflow and commercial borrowing. These are summarised in Table II.3.

Table II.3 FUNDING SOURCES FOR CAPITAL COST TO DATE (CURRENT EUR THOUSAND)*

	<i>Initial Investment</i>	<i>Subsequent Investments</i>	<i>Total</i>	<i>%age Split</i>
Total Investment cost (see Table II.1 for breakdown)	190,636	77,945	268,581	100.0%
Funded by				
Cohesion Fund	92,108	8,300	100,408	37.4%
EIB Loan	92,278	0	92,278	34.4%
Equity/Commercial loans/internal cash flow	6,250	69,645	75,895	28.3%
%age Non-EU funding	51.7%	89.4%	62.6%	

*Valorsul only, excluding Resioeste; **Valorsul's paid up share capital totals EUR 22.5 million (growing to EUR 25.5 million on the merger with Resioeste).

‡ Valorsul management indicates that the EIB loan was applied for and granted in 1996, although it was split into 2 contracts, the second of them signed in 1998. The disbursements took place between 1997 and 2002, to be repaid over the period to 2016.

Source: Valorsul

Overall, the CF has contributed 37% of total capital expenditure. A further 34% has been financed by the EIB; the balance of 28% has been financed by equity (i.e. the Portuguese public sector), internal cash flow and commercial borrowings.

Operating cost and revenues

Operating costs are drawn from the Valorsul annual financial reports. Table II.4 summarises the position in 2009 (the last year for which separate financial data for the 'original' Valorsul are available):

Table II.4 OPERATING COSTS 2009, VALORSUL (CURRENT EUR THOUSAND)*

	<i>EUR Thousand</i>	<i>%age Split</i>
Payroll	11,487	32.1%
Non-payroll	21,618	60.4%
Concession fee & other payments to Exchequer**	876	2.4%
Interest payments to EIB	2,391	6.7%
Other net interest payments	-562	-1.6%
Total	35,810	100.0%

*Valorsul only, excluding Resioeste; ** excluding profits taxes.

Source: Valorsul

Depreciation, amortisation and profits taxes are not included. Note also that the cost of collecting waste is not included, since the municipalities are responsible for collection (albeit Valorsul has bought trucks for the municipalities to facilitate separate collection of waste streams, and the cost of these is included in the project's capital costs).

Revenues are likewise derived from the Valorsul financial reports. Table II.5 summarises revenues in 2009 (the last year for which unmerged data are available).

Table II.5 REVENUE 2009, VALORSUL (CURRENT EUR THOUSAND)*

	<i>EUR Thousand</i>	<i>%age Split</i>	<i>Related Volumes</i>	
Gate fees**	18,110	34.0%	723,562	tonnes
Electricity sales	24,034	45.1%	296,763	mWh
Sale of Recyclables	9,396	17.6%	68,504	tonnes
Other	1,760	3.3%		
Total	53,300	100.0%		
Average Gate Fees EUR per Tonne **	25.03			
Electricity Selling Price EUR per kWh	0.081			

*Valorsul only, excluding Resioeste; **WtE plant and landfill combined.

Source: Valorsul

Electricity sales are the largest element of revenue, contributing 45% of the total. Gates fees contribute a further 34% while recyclables sales contribute 18%. The electricity tariff (average 8.1c/kWh) is key to the financial viability of the system, and is reflective of the renewable characteristics of the source (incineration of MSW, anaerobic digestion of biodegradable MSW and landfill gas¹⁵³). For comparison, a modern Portuguese gas-fired powergen plant in 2010 earned on average EUR 0.0525/kWh electricity export charge¹⁵⁴, tentatively indicating a price premium of over 50%¹⁵⁵ for Valorsul.

¹⁵³ The vast bulk of the revenue comes from the incinerator electricity sales.

¹⁵⁴ With a further average EUR 0.0163 capacity charge;

http://www.turbogas.pt/fotos/gca/rc_en_130495022319382528024dc7f5cf8b095.pdf

¹⁵⁵ The pricing of electricity is not straightforward, and can reflect among other things despatchability, place in the merit order (whether or not the generator is base load), and other factors. Hence the estimate above must be treated as tentative.

On this basis, earnings before taxes, depreciation and amortisation (EBTDA) in 2009 amounted to approximately EUR 17 million. Gate fees are set at a rate that allows Valorsul to make a modest surplus¹⁵⁶ (accumulated profits and other reserves to end 2009 are approximately EUR 22 million). See further discussion later on.

As indicated above, the latest financial data available for the ‘original’ Valorsul relate to 2009. However, we do have separate volumetric data (tonnages) up to 2011, and used this to estimate financial values for 2010 and 2011, which are then uplifted to 2011 prices.

With regard to future financial variables, we assume that all prices, wages, etc., remain at 2011 levels, and we then use our future volumetric forecasts as a basis for forecasting financial data. We are mindful that the EIB loan is to be repaid in full by 2016, and we assume that no additional financing is required to replace it, i.e. that this cost element is run down and eliminated by 2016.

Results of Financial Analysis

Using the cost-benefit methodology described above, we calculated:

- the Financial Net Present Value and the Financial Rate of Return on investment – FNPV(C) and FRR(C), and
- the Financial Net Present Value and Financial Rate of Return on national capital – FNPV(K) and FRR(K), i.e. net of EU grant aid.

The results are presented in Table II.6 (detailed tables at back of Annex)¹⁵⁷.

Table II.6 FINANCIAL ANALYSIS OF VALORSUL PROJECT

	FNPV(C) EUR million	FRR(C)	FBCR(C)
Investment Return	-122	3.6%	0.93
	FNPV(K) EUR million	FRR(K)	FBCR(K)
National Return	148	7.4%	1.11

The table confirms that, on a purely financial basis, the project as an investment would not have been viable, and required grant aid. NPV(C) of the project is EUR -122 million. With external grant aid, it generates a positive financial return on national capital of EUR 148 million or 7.4%.

¹⁵⁶ This implies ‘cost plus’ pricing, which in a monopoly situation may not be economically efficient.

¹⁵⁷ The ‘Do Minimum’ option is not presented here, as our methodology sets the financial NPV for this at NIL.

ECONOMIC ANALYSIS

Having assessed the purely financial performance of the project, the next step is to consider the project from a socio-economic viewpoint. This involves:

- conversion of market prices to accounting (true economic or shadow) prices, and
- inclusion of external costs and benefits.

The methodology used here mirrors that used in the evaluation of the Sogama project in Galicia, Spain, as part of the wider evaluation project.

FROM MARKET TO ACCOUNTING PRICES

Financial Costs and Benefits

In the economic analysis all input data are converted from financial to shadow prices, in order to reflect their opportunity costs. The conversion factors defined in the First Interim Report have been applied, namely:

Table II.7 SHADOW PRICE CONVERSION FACTORS

<i>Resource</i>	<i>Conversion Factor</i>	<i>Source</i>
Land	0.994	1st Interim Report, Volume 1, Table All.8
Labour	0.97	1st Interim Report, Volume 1, Table All.13
Traded goods & Services	0.994	1st Interim Report, Volume 1, Table All.8
Non-traded goods & Services	0.994	1st Interim Report, Volume 1, Table All.8
Other	0.994	1st Interim Report, Volume 1, Table All.8
Public funds	1.00	EU Commission 2008 Guide to CBA, p.54.

In the case of the revenues from the sales of recyclables, the standard conversion factor of 0.994 was applied.

Identifying the appropriate shadow prices to apply to the other main categories of revenue – electricity sales and gate fees - requires some consideration, as the markets in which they are sold are to a large degree regulated by the public sector. As indicated above, the electricity tariffs are set by reference to the electricity's "green credentials", and are significantly higher than the normal market price. Gate fees are effectively set in consultation with the municipalities, to allow Valorsul to generate a modest financial surplus.

We have indicated that Valorsul earns a premium on electricity sales, reflecting the (partially) renewable characteristics of the fuel sources. In order to estimate the shadow price of electricity sales, one can consider the long-run marginal costs of energy production in the Iberian market (the Spanish and Portuguese energy markets are integrated) of the energy

source that is “displaced” by the electricity generated and exported by Valorsul. It is reasonable to work on the basis that this electricity substitutes *pro rata* with the typical production mix for electricity in the Iberian Peninsula.

However, given the difficulty of finding data on electricity generation costs for Spain and Portugal, another method has been applied. The weighted average price of electricity in Spain and Portugal was considered, assuming that the energy sale price equals the production cost. These data are provided by the Quarterly Reports on European Electricity Markets¹⁵⁸ of the European Commission, which indicate for the period January-September 2011 (the latest available) a weighted average price of EUR 52.89 per MWh (i.e. 5.289c/KWh). This is used as the shadow price of Valorsul’s electricity production. It is notably lower than the actual electricity tariff paid, averaging over 8c/KWh.

That leaves the shadow gate fees for the landfill and the incinerator. The actual gate fees are effectively set as a “residual”, after electricity revenue is taken into account, and we have ascertained above that Valorsul earns a significant price premium on electricity sales. This would be justifiable if the emissions characteristics of Valorsul’s electricity relative to those of “conventional” electricity generation in the Iberian Peninsula were sufficiently positive. However, as will be seen in the discussion below on externalities, this is not the case.

The implication is that Valorsul’s gate fees are underpriced, indeed, that the electricity tariff regime is subsidising Lisbon’s waste management system¹⁵⁹, in contravention of the “polluter pays” principle.

What then are the appropriate shadow prices to use? These should reflect the true economic opportunity cost of the landfill and WtE services provided by Valorsul, including the relevant externalities. However, we estimate the externalities separately below, so for the moment we can ignore them.

In evaluating the counterfactual, we estimated that a breakeven price for landfill usage was approximately EUR 40/tonne, and for convenience we use this as the shadow price of landfill¹⁶⁰.

Estimating a shadow price for the incineration service is not straightforward. While estimates can be made of its operating costs, the WtE plant is operationally a mixture of waste management and electricity production, with an income stream for each. Where does one operation (and its costs) finish and the other start? In principle they may not be separable. An alternative approach is to try to identify the appropriate price from average levels elsewhere. For instance, we understand that the gate fee at the other MSW WtE plant on the Portuguese

¹⁵⁸ http://ec.europa.eu/energy/observatory/electricity/electricity_en.htm

¹⁵⁹ A complaint made by at least one Portuguese NGO in the past (<http://www.endseurope.com/8375/portugal-quotillegally-subsidising-incinerationquot?referrer=search>).

¹⁶⁰ Valorsul’s Financial Report for 2010 notes that Resioeste enjoyed a significant reduction in gate fees, from EUR 38.49/tonne to EUR 22.86/tonne, when it merged with Valorsul (page 80).

mainland, at Porto, is in the region of EUR 40/tonne¹⁶¹. The “sister” study to this one, on the Sogama waste management system in Galicia¹⁶², indicates a range of gate fees at incinerators across mainland Spain, from EUR 35 - 96/tonne, with Sogama charging EUR 51/tonne.

Our analysis of the international literature indicates a very wide range of gate fee levels, from under EUR 30/tonne to as much as EUR 200/tonne¹⁶³. Discussions with industry experts confirm that there is a number of factors that contribute to determining gate fees, and that it is not uncommon for the energy tariff earned to be a key determinant of gate fees, as is the case with Valorsul. Other factors include Government levies and technology used.

Perhaps surprisingly, some of the lowest gate fees are to be found in Scandinavia, but this reflects the fact that the WtE plants there can often sell not only electricity but also heat, as part of district heating schemes. This is less viable in other countries, and certainly in Southern Europe, where there is less demand for energy in the form of heat¹⁶⁴.

In view of the foregoing, we have used what appears might be a “reasonable” shadow gate fee of EUR 50/tonne, which as mentioned, is approximately the fee charged at the Sogama plant¹⁶⁵.

Externalities Considered And Methodology Applied For Their Quantification

A number of externalities apply to this analysis. Firstly, notwithstanding the fact that the electricity generated is partly renewable, emissions to air are generated by Valorsul’s WtE plant as well as from its landfill, and the damage caused by these must be valued. Valorsul provides data on emissions from the WtE plant and landfill for the years 2006-2010, and we extrapolate based on the relationship between waste volumes treated and emissions during those years. As against this, the emissions related to the burning of alternative fuels are

¹⁶¹ Another MSW WtE plant on the island of Madeira has a gate fee of approximately EUR 75/tonne, but this may be reflective of small scale and island conditions.

¹⁶² In the framework of this evaluation study, another project in the sector of solid waste management has been analysed. It is the case study on the “Urban Solid Waste Management in Galicia” (Spain), implemented between 1997 and 2000. It included the construction of a WtE plant and of other facilities for the collection and treatment of waste.

¹⁶³ See for example http://www.cewep.eu/information/data/subdir/190_Country_Reports_on_Waste_Management.html;
http://www.wrap.org.uk/downloads/Gate_Fees_Report_2011.95fc5e0a.11007.pdf;
http://www.forfas.ie/media/forfas101005-Waste_Management_Benchmarking_Analysis_2010.pdf;
http://www.ramboll.com/services/energy%20and%20climate/~/_media/A944A57AFE84984A12FD8D0505116AE.ashx

¹⁶⁴ Industry sources indicate that in extreme circumstances, in Denmark, WtE plant gate fees can sometimes be NIL, as the selling prices of electricity and heat are sufficient to fully cover plant costs.

¹⁶⁵ The above comes with an important proviso: we are applying shadow prices for landfill and incineration significantly higher than the actual prices being charged currently. Should actual prices be increased to the shadow price level, there would undoubtedly be a demand reaction. The municipalities would immediately face a significant increase in their waste management costs, which they would have to either absorb or pass back to their customers (i.e. the households and businesses of Lisbon), or alternatively find a less expensive means of waste management. We note for instance that gate fees at Valorsul’s recycling centre and the AD plant are NIL, which may of course represent further subsidisation. This might have to change if there was a sufficiently large shift in demand for waste management services. At the extreme, the financial viability of the WtE plant might be undermined if volumes fell sufficiently. That said, even at the higher shadow prices, the price of waste management via the WtE plant or the landfill is not excessive by international standards. In a very rough sense, if each household in Lisbon produced one tonne of MSW per annum, it would result in an annual price increase per household of EUR 25. While politically unpopular, this would not on the face of it represent an excessively large increase, whether in waste collection tariffs or in general municipal taxes.

avoided, and a benefit derives from this. Table II.8 summarises the values per tonne we have placed on emissions.

Table II.8 DAMAGE COSTS OF EMISSIONS (2011 EUR)

Gases	EUR 2011 price per kg	Source
Non biogenic CO2	0.025	European Commission, 2008 (CBA Guide) and 1st Interim report.
CH4 - methane	5.50	Average computed on the basis of European Commission, 2001
SO2 – sulphur dioxide	7.74	OECD: http://www.oecd.org/dataoecd/32/41/2053990.pdf
Particulates	9.55	OECD: http://www.oecd.org/dataoecd/32/41/2053990.pdf
NOx - nitrogen oxides	11.62	OECD: http://www.oecd.org/dataoecd/32/41/2053990.pdf
Hg - mercury	38,440	European Commission: http://ec.europa.eu/environment/waste/studies/pdf/econ_eva_landfill_report.pdf
Dioxins	22,558,397	European Commission: http://ec.europa.eu/environment/waste/studies/pdf/econ_eva_landfill_report.pdf

A review of the environmental costs of landfills was carried out by the European Commission (2000). The anaerobic decomposition of biodegradable waste in landfills generates gas, whose quantity and quality vary over time. Landfill gas is composed of methane (CH₄ - approximately 55%) and carbon dioxide (CO₂ – approximately 45%)¹⁶⁶. In managed landfills, biogas is collected and used to generate electricity or at least flared, so as to minimise the environmental impact (CH₄ is a highly potent greenhouse gas [GHG])¹⁶⁷. In the Valorsul landfill gas flaring has been used for a number of years, and electricity generation from this burning commenced in 2011.

However, even in well-managed landfills a proportion of landfill gas is not captured and escapes to the atmosphere. European Commission (2000) indicates that the recovery efficiency of methane at modern landfills ranges from 40% to 90%.

As far as the CO₂ emissions (including those from flared/burned methane) are concerned, in general one can disregard these, as they derive from biogenic sources¹⁶⁸. For the purpose of this CBA, therefore, CO₂ emissions from landfill are not valued, while the damage cost of methane is valued.

The environmental damage caused by the methane emitted, whose amount depends on the volume of waste deposited in the landfill over time, is valued at EUR 550 per tonne (2011

¹⁶⁶ Landfill gas contains also a small percentage of trace gases.

¹⁶⁷ In the combustion process methane is oxidised to water and CO₂. Very low volumes of pollutants not previously present in the biogas are also formed, such as dioxins, HCl and NO_x.

¹⁶⁸ Fossil-based carbon deposited to MSW landfills is mainly in the form of plastics, and would only decompose in the very long term.

prices), which reflects values found in the literature¹⁶⁹, but would grow in line with the forecast growth in the damage costs of CO₂.

A feature of landfills is that they will continue to generate emissions for a long period, even after waste is no longer being deposited to them. For current purposes it is assumed that the methane emissions will continue for a further 10 years after our period of evaluation; thus the residual damage costs of these subsequent emissions are included at the end of the evaluation time horizon.

Other negative externalities usually considered for landfills are in terms of disamenity impacts as a result of noise, dust, litter and odours close to the dumping site, and the risk of accidents. Undesirable wildlife can also be an issue (rats, birds, etc.). However, these are difficult to evaluate, and we are forced to leave them unvalued (in any event they are likely to be similar for both 'Do Project' and the counterfactual).

A proportion of the WtE plant's CO₂ emissions which are anthropogenic (estimated at 60%¹⁷⁰) must likewise be valued, in accordance with the guidance in the First Interim Report (base case value/tonne in 2000 equals EUR 10, rising to EUR 25 in 2010, EUR 40 in 2020 and EUR 55 in 2030, all in 2011 prices).

With regard to the electricity generated at the WtE and AD plants, we must also give credit for the saving of emissions that would have been caused by an alternative mix of energy sources. The energy production mix in the integrated Iberian market (Portugal and Spain) has been calculated¹⁷¹, and the corresponding emissions avoided as a result of the amount of energy produced by Valorsul are quantified¹⁷². Based on these and the damage costs per Table II.8, we can place a value on the emissions avoided as a result of the electricity generated by Valorsul¹⁷³.

Under the counterfactual, we must:

- Gross up the landfill-related emissions to reflect the higher volumes, a key result of which is a large increase in the volume of methane emissions recorded, and the resultant damage costs.

¹⁶⁹ According to European Commission (2001), for example, the damage cost of the methane ranges between EUR 528 per tonne to EUR 867.5 per tonne.

¹⁷⁰ http://www.ipcc-nggip.iges.or.jp/public/gp/bgp/5_3_Waste_Incineration.pdf.

¹⁷¹ The Spanish and Portuguese production mix has been estimated on the basis of Red Eléctrica de España (2010) (http://www.ree.es/sistema_electrico/pdf/infosis/Avance_REE_2010.pdf) and Rede Eléctrica Nacional (2010) (<http://www.centrodeinformacao.ren.pt/PT/publicacoes/CaracterizacaoRNT/Caracteriza%C3%A7%C3%A3o%20da%20RNT%2031-12-2009.pdf>). The source for the emissions for each powergen plant is the Database on life cycle emissions for electricity and heat generation technologies per CASES, 2008 (http://www.feem-project.net/cases/links_databases.php).

¹⁷² Per CASES (2008).

¹⁷³ It is of interest to compare the estimated valuation of the emissions from the WtE plant with that of the emissions avoided through the replacement of electricity generated from "conventional" sources. We estimate these values at 4.9c/kWh and 3.2c/kWh respectively. In other words, Valorsul's WtE plant generates more emissions per kWh of electricity than does the average conventional powergen plant on the Iberian Peninsula. However, as stated already, the WtE plant performs two functions – waste management and electricity generation – and hence one cannot draw conclusions from a straight comparison of the emissions as presented here.

- Include additional operating costs, emissions and accidents, all at the appropriate shadow price, related to the additional transport of waste materials to the landfill as opposed to the WtE plant (the landfill is a further 13 km distant from the centre of Lisbon, and for simplicity we assume that each deposition of waste, averaging 13 tonnes, requires an additional truck journey of 26 km).

ECONOMIC PERFORMANCE

The economic performance of the project – Economic Net Present Value (ENPV), Economic Rate of Return (ERR) and Benefit-Cost ratio (EBCR) – is summarised in Table II.9 (detailed tables at back of Annex).

Table II.9 **SOCIO-ECONOMIC CBA OF VALORSUL PROJECT**

	ENPV EUR million	ERR	EBCR
Do Project	-44	3.2%	0.97
Do Minimum	-179	-5.9%	0.84
Project NPV compared to Do Minimum	135	5.9%	

As can be seen, at a socio-economic level, the project imposes costs on society, of just over EUR 44 million over a 30 year timeframe. However, the valid measure is compared to the counterfactual of a landfill. On this basis, the project generates a positive return for society, of EUR 135 million. Therefore the project is worthwhile on a socio-economic basis.

SCENARIO AND SENSITIVITY ANALYSIS

A number of scenarios can be tested, based on alternative forecasts, namely:

- Higher and Lower economic growth, which will translate into higher and lower future waste volumes;
- Higher and lower value of CO₂, and hence of methane, and
- As an alternative to the base case social discount rates, we also test a rate equivalent to the social opportunity cost of capital, i.e. the return that can be generated on the marginal project in the private sector¹⁷⁴. The *Guide to Cost Benefit analysis of Investment Projects* recommends 5% real as a benchmark figure, and this is what we use.

The results are presented in the tables below (socio-economic analysis only).

- We also test one scenario from a financial as opposed to socio-economic perspective: as an alternative to the actual electricity tariff earned by Valorsul, we can test a scenario whereby in future the price paid equals the shadow price.

¹⁷⁴ In a closed economy with perfect information, no distortions and no externalities the social discount rate and the social opportunity cost of capital are equivalent.

Table II.10 SOCIO-ECONOMIC CBA OF VALORSUL PROJECT – HIGH ECONOMIC GROWTH

	ENPV EUR million	ERR	EBCR
Do Project	-36	3.3%	0.98
Do Minimum	-186	-7.9%	0.85
Project NPV compared to Do Minimum	151	6.1%	

Table II.11 SOCIO-ECONOMIC CBA OF VALORSUL PROJECT – LOW ECONOMIC GROWTH

	ENPV EUR million	ERR	EBCR
Do Project	-51	3.1%	0.97
Do Minimum	-173	-4.7%	0.84
Project NPV compared to Do Minimum	122	5.8%	

Table II.12 SOCIO-ECONOMIC CBA OF VALORSUL PROJECT – HIGH PRICE OF CARBON

	ENPV EUR million	ERR	EBCR
Do Project	-220	0.4%	0.88
Do Minimum	-313	*	0.76
Project NPV compared to Do Minimum	93	5.3%	

*not calculated.

Table II.13 SOCIO-ECONOMIC CBA OF VALORSUL PROJECT – LOW PRICE OF CARBON

	ENPV EUR million	ERR	EBCR
Do Project	107	4.9%	1.07
Do Minimum	-69	1.1%	0.93
Project NPV compared to Do Minimum	175	6.5%	

Table II.14 SOCIO-ECONOMIC CBA OF VALORSUL PROJECT – SOCIAL OPPORTUNITY COST OF CAPITAL (5% THROUGHOUT)

	ENPV EUR million	ERR	EBCR
Do Project	-141	3.2%	0.92
Do Minimum	-196	-4.9%	0.83
Project NPV compared to Do Minimum	55	5.9%	

Table II.15 FINANCIAL CBA OF VALORSUL PROJECT – ELECTRICITY TARIFF EQUALS SHADOW PRICE

	FNPV(C) EUR million	FRR(C)	FBCR(C)
Investment Return	-266	1.3%	0.84
	FNPV(K) EUR million	FRR(K)	FBCR(K)
National Return	5	5.1%	1.00

While the various socio-economic scenarios have the expected impact on the results, none overturns the ranking of the alternative projects, and thus we can conclude that our results are robust to these scenarios. However, at a social opportunity cost of capital of 5%, the net benefit of the project compared to the counterfactual is much reduced. Interestingly, the project appears more positive with a low price of carbon than with a high price. This is because of the significant volumes of GHG emissions associated with the project.

With regard to the financial scenario of electricity tariff equal to the shadow price, the project is clearly vulnerable to this, just about breaking even after the benefit of CF assistance has been factored in. This highlights the importance of the electricity tariff to the financial sustainability of the project. However, as discussed above, if the electricity revenue earned by Valorsul were to fall, gate fees (which are very low by both international and national standards) would have to be adjusted to compensate.

Furthermore, as noted above, the counterfactual does not take into account the implications for Portugal of not meeting the terms of the Landfill Directive (99/31/EC), which requires a significant and progressive redirection of biodegradable waste away from landfill over the coming decade (targets to be met in 2010, 2013 and 2016). Failure to achieve these targets leaves Portugal open to potentially significant fines from the EU.

RISK ANALYSIS

Monte Carlo Analysis was also performed on our CBA model, assigning a triangular distribution to three input variables, to simulate the future uncertainty associated with these variables. The peak of the distributions and their upper and lower bounds (at which points their probabilities fall to zero) are outlined in Table II.16¹⁷⁵.

¹⁷⁵ The software used to generate the Monte Carlo results is *Risk Analyzer* Release 11.02 (<http://www.add-ins.com/analyzer/index.htm>).

Table II.16 PARAMETERS FOR PROBABILITY DISTRIBUTIONS FOR MODEL INPUTS

Input Variable (Annual Growth Rates)	Peak (Baseline Scenario) Value	Lower Bound (Probability=0)	Upper Bound (Probability=0)
Future GDP Growth	1.4%	3.5%	-0.5%
Value of CO ₂ emissions growth	4.50%	9.0%	0.0%
Population Growth Lisbon NUTS III region	0.46%	1.5%	-0.5%

The results (Table II.17) confirm a strong economic NPV and internal rate of return for the project. The simulations were run two thousand times. The computed expected value of ENPV EUR 141 million and ERR 6.0% compare to the base case values of EUR 135 million and 5.9% respectively.

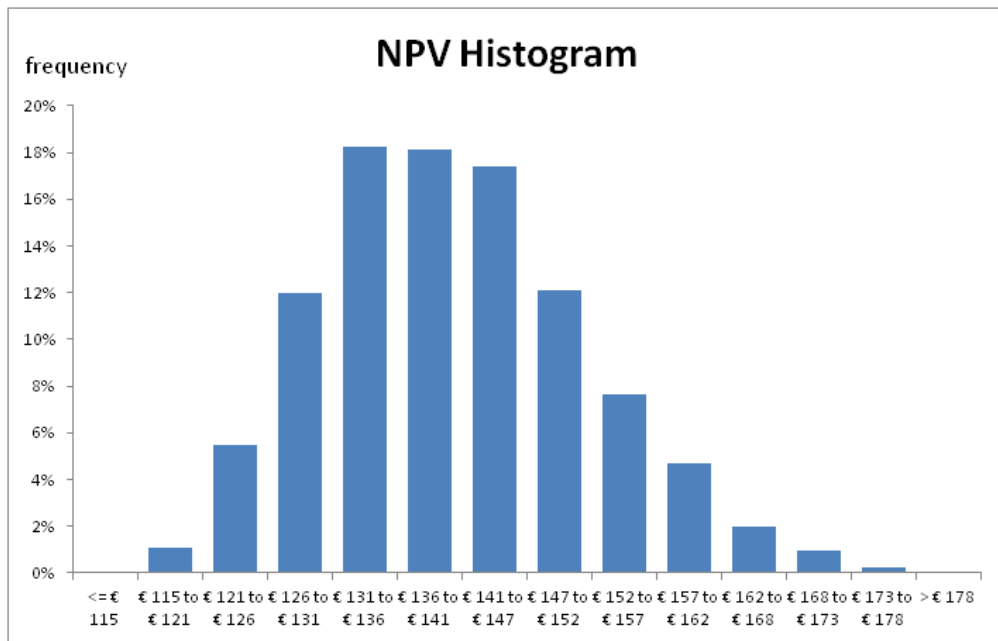
Table II.17 OUTPUT STATISTICS OF MONTE CARLO SIMULATIONS

	Economic Net Present Value (EUR million)	Economic Internal Rate of Return
Computed Expected Value	140.9	6.0%
Standard deviation	10.6	0.1%
Minimum value	115.4	5.7%
Maximum value	178.1	6.3%
Probability of being not higher than the reference value	45.8%	45.4%
Probability of being higher than the reference value	54.2%	54.7%
Probability of being lower than EUR NIL (ENPV) & 4% (EIRR)	NIL	NIL

Source: Authors

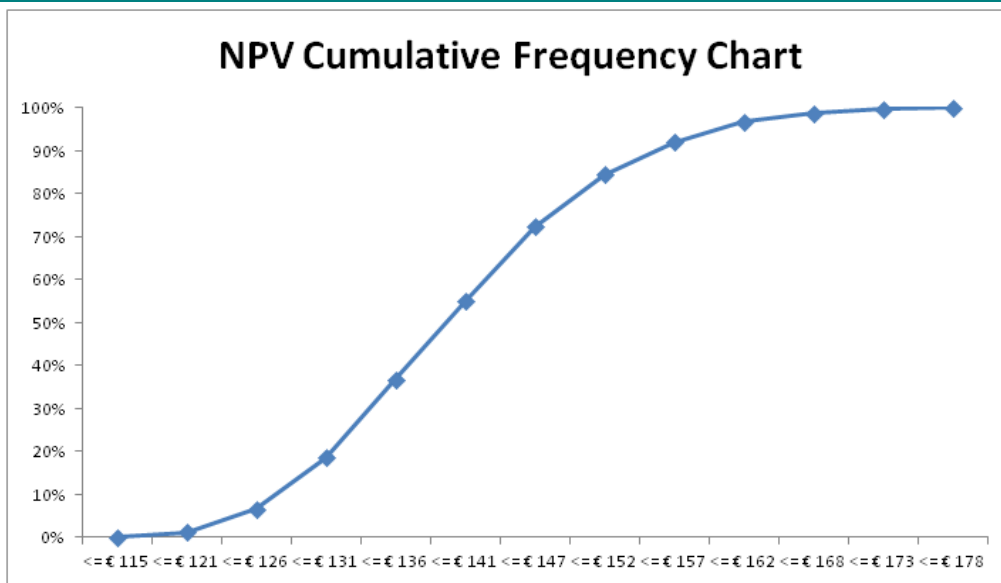
The results are further elaborated in the charts overleaf.

Figure II.1 *PROBABILISTIC DISTRIBUTION OF ECONOMIC NET PRESENT VALUE (EUR MILLION)*



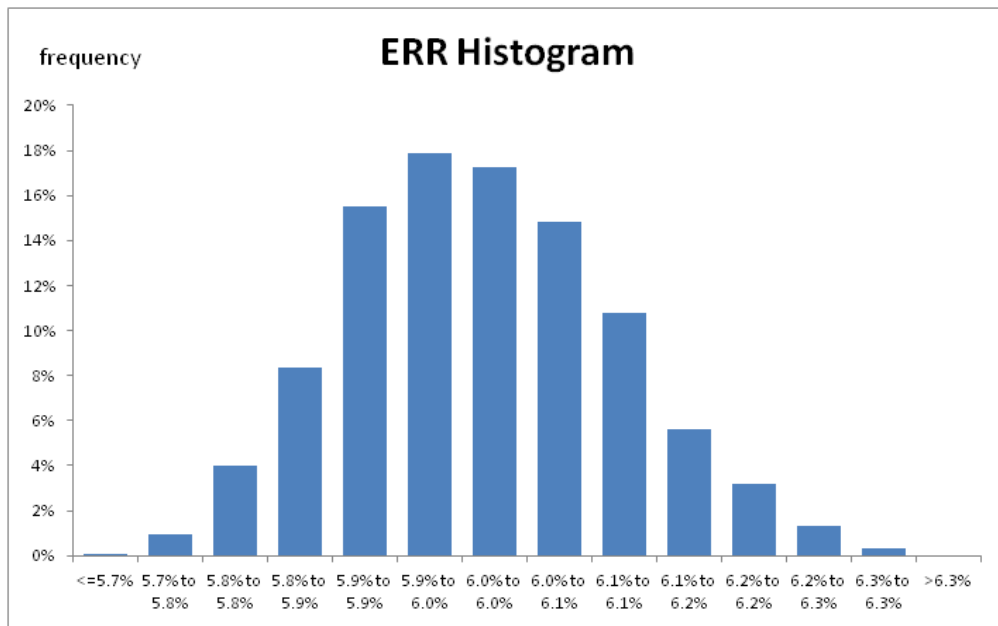
Source: Authors

Figure II.2 *CUMULATIVE PROBABILISTIC DISTRIBUTION OF THE ECONOMIC NET PRESENT VALUE (EUR MILLION)*



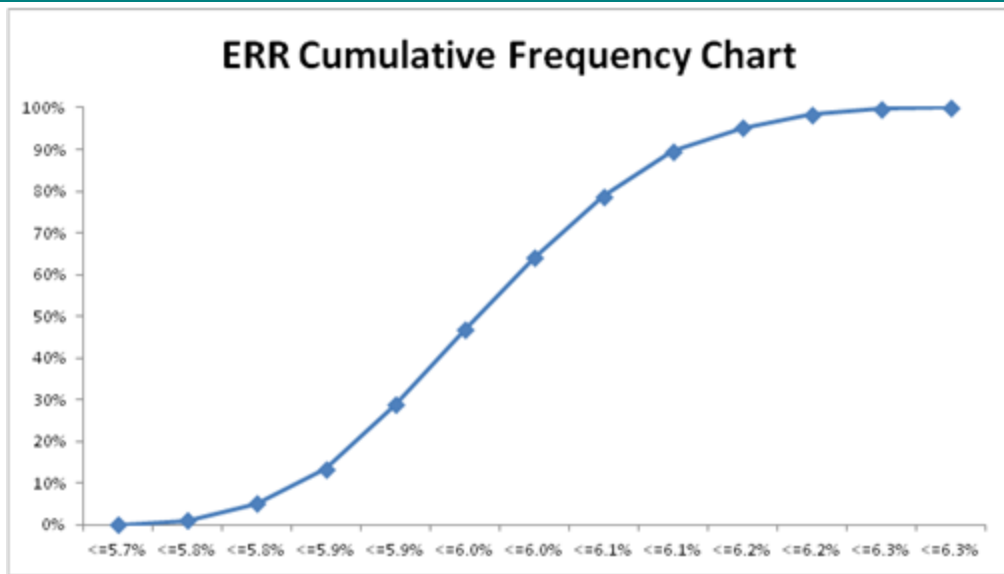
Source: Authors

Figure II.3 *PROBABILISTIC DISTRIBUTION OF ECONOMIC INTERNAL RATE OF RETURN*



Source: Authors

Figure II.4 *CUMULATIVE PROBABILISTIC DISTRIBUTION OF ECONOMIC INTERNAL RATE OF RETURN*



Source: Authors

Table II.18 DETAILED CBA – DO PROJECT (EUR THOUSAND, 2011 PRICES)

year	DIRECT COSTS (OPERATOR)			DIRECT BENEFITS (OPERATOR)				DIRECT IMPACTS (OPERATOR)			Waste Volumes (tonnes)	EXTERNAL/INDIRECT IMPACTS FACILITY OPERATIONS				SHADOW PRICE ADJUSTMENTS			SOCIO-ECONOMIC CBA						
	calendar	project	Capital Expenditure	Operating costs	TOTAL DIRECT OPERATOR COSTS	REVENUES - Gate Fees	REVENUES - Electricity	sale of Recyclables & Other	TOTAL FINANCIAL BENEFITS	UNDISCOUNTED		DISCOUNTED (@ financial discount rate)	DISCOUNTED (@ social discount rate)	EMISSIONS generated	EMISSIONS avoided	Other	TOTAL	Electricity Sales	Others	TOTAL	NET DIRECT IMPACT	INDIRECT/EXTERNAL IMPACTS	SHADOW PRICE ADJUSTMENT	NET SOCIO-ECONOMIC BENEFIT (UNDISCOUNTED)	NET SOCIO-ECONOMIC BENEFIT (DISCOUNTED)
1996	0		-8,011	0	-8,011	0	0	0	0	-8,011	-16,653	-14,848	0	0	0	0	0	48	48	-8,011	0	48	-7,963	-14,759	
1997	1		-82,909	0	-82,909	0	0	0	0	-82,909	-164,153	147,485	0	0	0	0	0	497	497	-82,909	0	497	82,411	-146,600	
1998	2		-84,961	-13,959	-98,920	8,053	0	0	8,053	-90,867	-171,344	155,127	306,297	-8	0	0	-8	0	4,708	4,708	-90,867	-8	4,708	86,167	-147,102
1999	3		-82,969	-30,017	-112,986	17,235	9,747	405	27,387	-85,599	-153,723	140,243	658,664	-2,533	2,135	0	-398	-4,250	11,734	7,485	-85,599	-398	7,485	78,512	-128,632
2000	4		-19,942	-33,271	-53,213	18,591	25,733	2,713	47,038	-6,175	-10,561	-9,709	730,085	-9,945	5,635	0	-4,310	-11,219	15,745	4,526	-6,175	-4,310	4,526	-5,958	-9,369
2001	5		-27,362	-34,364	-61,726	18,986	25,440	3,719	48,145	-13,581	-22,122	-20,493	754,053	-10,198	5,571	0	-4,627	-11,091	15,921	4,830	-13,581	-4,627	4,830	13,378	-20,186
2002	6		-25,269	-34,718	-59,987	19,179	25,502	3,766	48,448	-11,539	-17,901	-16,711	761,829	-10,585	5,585	0	-5,001	-11,118	16,024	4,906	-11,539	-5,001	4,906	11,635	-16,848
2003	7		-12,500	-34,267	-46,767	18,903	25,308	3,833	48,044	1,277	1,887	1,775	751,939	-10,870	5,542	0	-5,328	-11,033	15,758	4,725	1,277	-5,328	4,725	674	936
2004	8		-12,094	-36,175	-48,269	23,452	20,720	3,388	47,560	-709	-998	-946	793,812	-10,655	5,088	0	-5,567	-7,615	12,151	4,537	-709	-5,567	4,537	-1,739	-2,320
2005	9		-5,104	-36,360	-41,464	19,336	25,723	4,754	49,813	8,350	11,190	10,688	789,581	-11,759	5,520	0	-6,239	-9,607	16,404	6,798	8,350	-6,239	6,798	8,908	11,402
2006	10		-4,926	-35,117	-40,043	19,596	25,681	5,854	51,132	11,089	14,152	13,621	808,062	-10,484	5,397	0	-5,086	-9,543	16,446	6,903	11,089	-5,086	6,903	12,906	15,853
2007	11		0	-33,900	-33,900	17,695	20,453	7,199	45,347	11,447	13,913	13,494	774,430	-10,890	4,494	0	-6,395	-7,417	14,974	7,557	11,447	-6,395	7,557	12,608	14,864
2008	12		0	-36,775	-36,775	18,571	23,814	10,061	52,446	15,671	18,141	17,730	804,447	-13,059	4,843	0	-8,216	-8,919	15,245	6,326	15,671	-8,216	6,326	13,781	15,592
2009	13		0	-37,558	-37,558	18,994	25,207	11,701	55,902	18,344	20,224	19,917	817,302	-14,172	5,552	0	-8,620	-9,512	16,237	6,726	18,344	-8,620	6,726	16,450	17,860
2010	14		0	-37,753	-37,753	17,771	25,644	10,251	53,666	15,914	16,709	16,582	790,568	-15,173	9,439	0	-5,734	-9,603	15,863	6,260	15,914	-5,734	6,260	16,441	17,131
2011	15		0	-34,464	-34,464	17,583	28,990	8,745	55,318	20,854	20,854	20,854	762,776	-15,312	11,130	0	-4,182	-11,148	15,201	4,054	20,854	-4,182	4,054	20,726	20,726
2012	16		0	-35,730	-35,730	18,374	32,035	9,138	59,546	23,816	22,682	23,145	797,079	-16,428	11,051	0	-5,376	-12,318	15,885	3,567	23,816	-5,376	3,567	22,007	21,386
2013	17		0	-35,784	-35,784	18,551	32,316	9,226	60,094	24,310	22,050	22,959	804,777	-17,039	11,398	0	-5,641	-12,427	16,038	3,612	24,310	-5,641	3,612	22,281	21,043

year	DIRECT COSTS (OPERATOR)			DIRECT BENEFITS (OPERATOR)			DIRECT IMPACTS (OPERATOR)			Waste Volumes (tonnes)	EXTERNAL/INDIRECT IMPACTS FACILITY OPERATIONS				SHADOW PRICE ADJUSTMENTS			SOCIO-ECONOMIC CBA							
	calendar	project		Capital Expenditure	Operating costs	TOTAL DIRECT OPERATOR COSTS	REVENUES - Gate Fees	REVENUES - Electricity	sale of Recyclables & Other		TOTAL FINANCIAL BENEFITS	UNDISCOUNTED	DISCOUNTED (@ financial discount rate)	DISCOUNTED @ social discount rate	EMISSIONS generated	EMISSIONS avoided	Other	TOTAL	Electricity Sales	Others	TOTAL	NET DIRECT IMPACT	INDIRECT/EXTERNAL IMPACTS	SHADOW PRICE ADJUSTMENT	NET SOCIO-ECONOMIC BENEFIT (UNDISCOUNTED)
2014	18	0	-36,466	-36,466	19,047	33,175	9,473	61,694	25,228	21,793	23,155	826,267	-17,980	11,960	0	-6,020	-12,757	16,467	3,710	25,228	-6,020	3,710	22,918	21,034	
2015	19	0	-37,099	-37,099	19,517	33,961	9,707	63,184	26,085	21,461	23,267	846,673	-18,947	12,532	0	-6,414	-13,059	16,873	3,814	26,085	-6,414	3,814	23,485	20,948	
2016	20	0	-37,677	-37,677	19,960	34,662	9,927	64,549	26,872	21,055	23,292	865,886	-19,937	13,114	0	-6,823	-13,329	17,256	3,927	26,872	-6,823	3,927	23,976	20,782	
2017	21	0	-38,236	-38,236	20,393	35,340	10,142	65,875	27,639	20,625	23,283	884,666	-20,970	13,716	0	-7,253	-13,589	17,630	4,041	27,639	-7,253	4,041	24,427	20,577	
2018	22	0	-39,110	-39,110	20,835	36,079	10,362	67,277	28,166	20,017	23,058	903,853	-22,067	14,354	0	-7,713	-13,874	18,013	4,139	28,166	-7,713	4,139	24,593	20,133	
2019	23	0	-40,004	-40,004	21,287	36,801	10,587	68,675	28,672	19,406	22,810	923,457	-23,234	15,030	0	-8,203	-14,151	18,404	4,252	28,672	-8,203	4,252	24,721	19,667	
2020	24	0	-40,917	-40,917	21,749	36,830	10,816	69,395	28,479	18,358	22,018	943,486	-24,474	15,747	0	-8,727	-14,162	18,803	4,640	28,479	-8,727	4,640	24,392	18,858	
2021	25	0	-41,892	-41,892	22,242	37,666	11,062	70,970	29,078	17,851	21,848	964,896	-25,561	16,386	0	-9,175	-14,484	19,229	4,746	29,078	-9,175	4,746	24,648	18,520	
2022	26	0	-42,890	-42,890	22,747	38,520	11,313	72,580	29,690	17,359	21,679	986,791	-26,701	17,055	0	-9,647	-14,813	19,666	4,853	29,690	-9,647	4,853	24,897	18,179	
2023	27	0	-43,910	-43,910	23,263	39,395	11,570	74,227	30,317	16,882	21,513	1,009,183	-27,899	17,755	0	-10,144	-15,149	20,112	4,963	30,317	-10,144	4,963	25,137	17,837	
2024	28	0	-44,954	-44,954	23,791	40,288	11,832	75,912	30,958	16,418	21,349	1,032,083	-29,157	18,490	0	-10,667	-15,492	20,568	5,076	30,958	-10,667	5,076	25,366	17,493	
2025	29	0	-46,021	-46,021	24,331	41,203	12,101	77,634	31,613	15,967	21,186	1,055,503	-30,479	19,259	0	-11,220	-15,844	21,035	5,191	31,613	-11,220	5,191	25,585	17,146	
2026	30	0	18,698	18,698	24,395	41,311	12,133	77,839	96,538	46,436	62,873	1,058,288	-37,827	19,672	0	-18,156	-15,886	20,702	4,816	96,538	-18,156	4,816	83,198	54,185	
Total			366,046	1,010,690	1,376,736	574,430	857,546	235,777	1,667,752	291,016	-122,026	-13,465	24,206,734	504,341	303,451	0	200,890	-333,407	479,641	146,233	291,016	200,890	146,233	236,360	-43,665
Investment Return																									
Financial																									
Socio-economic																									

Table II.19 DETAILED CBA – DO MINIMUM (EUR THOUSAND, 2011 PRICES)

year	DIRECT COSTS (OPERATOR)			DIRECT BENEFITS (OPERATOR)				DIRECT IMPACTS (OPERATOR)			EXTERNAL/INDIRECT IMPACTS FACILITY OPERATIONS				SHADOW PRICE ADJUSTMENTS			SOCIO-ECONOMIC CBA							
	calendar	project	Total Investment cost	Capital Expenditure	Operating costs	TOTAL DIRECT OPERATOR COSTS	REVENUES - Gate Fees	REVENUES - Electricity	sale of Recyclables & Other	TOTAL FINANCIAL BENEFITS	UNDISCOUNTED	DISCOUNTED (@ financial discount rate)	DISCOUNTED @ social discount rate	Waste Volumes (tonnes)	EMISSIONS generated	EMISSIONS avoided	Other	TOTAL	Electricity Sales	Others	TOTAL	NET DIRECT IMPACT	INDIRECT/EXTERNAL IMPACTS	SHADOW PRICE ADJUSTMENT	NET SOCIO-ECONOMIC BENEFIT (UNDISCOUNTED)
1996	0	-12,149	0	-12,149	0	0	0	0	-12,149	-25,258	-22,520	0	0	0	0	0	0	0	73	73	-12,149	0	73	-12,077	-22,385
1997	1	-12,149	0	-12,149	0	0	0	0	-12,149	-24,055	-21,612	0	0	0	0	0	0	0	73	73	-12,149	0	73	-12,077	-21,483
1998	2	-12,149	-13,959	-26,108	12,145	0	0	12,145	-13,964	-26,331	-23,839	306,297	-12	0	0	-12	0	0	0	0	-13,964	-12	0	-13,976	-23,859
1999	3	-12,149	-30,017	-42,166	26,116	0	0	26,116	-16,050	-28,824	-26,297	658,664	-25	0	0	-25	0	-84	-84	-16,050	-25	-84	-16,160	-26,475	
2000	4	-12,149	-19,582	-31,732	28,948	0	0	28,948	-2,784	-4,762	-4,377	730,085	-1,596	0	-24	-1,619	0	-101	-101	-2,784	-1,619	-101	-4,504	-7,082	
2001	5	-12,149	-20,226	-32,375	29,898	0	0	29,898	-2,477	-4,035	-3,738	754,053	-1,803	0	-26	-1,829	0	-106	-106	-2,477	-1,829	-106	-4,413	-6,659	
2002	6	-12,149	-20,434	-32,584	30,207	0	0	30,207	-2,377	-3,688	-3,442	761,829	-1,994	0	-636	-2,630	0	-93	-93	-2,377	-2,630	-93	-5,100	-7,385	
2003	7	-12,149	-20,169	-32,318	29,814	0	0	29,814	-2,504	-3,699	-3,480	751,939	-2,154	0	1,625	-3,779	0	-65	-65	-2,504	-3,779	-65	-6,348	-8,822	
2004	8	-12,149	-21,292	-33,441	31,475	0	0	31,475	-1,966	-2,767	-2,623	793,812	-2,489	0	1,599	-4,088	0	-76	-76	-1,966	-4,088	-76	-6,131	-8,177	
2005	9	-12,149	-21,400	-33,550	31,307	0	0	31,307	-2,243	-3,006	-2,871	789,581	-2,711	0	1,571	-4,282	0	-76	-76	-2,243	-4,282	-76	-6,600	-8,448	
2006	10	-12,149	-20,669	-32,818	32,040	0	0	32,040	-779	-994	-957	808,062	-3,037	0	1,525	-4,562	0	-81	-81	-779	-4,562	-81	-5,422	-6,661	
2007	11	-12,149	-19,953	-32,102	30,706	0	0	30,706	-1,396	-1,697	-1,646	774,430	-3,230	0	1,412	-4,642	0	-76	-76	-1,396	-4,642	-76	-6,114	-7,208	
2008	12	-12,149	-21,645	-33,794	31,896	0	0	31,896	-1,898	-2,197	-2,147	804,447	-3,777	0	1,587	-5,364	0	-78	-78	-1,898	-5,364	-78	-7,340	-8,304	
2009	13	-12,149	-22,106	-34,255	32,406	0	0	32,406	-1,849	-2,039	-2,008	817,302	-6,319	0	1,592	-7,911	0	-81	-81	-1,849	-7,911	-81	-9,842	-10,686	
2010	14	-12,149	-22,220	-34,370	31,346	0	0	31,346	-3,024	-3,175	-3,151	790,568	-4,274	0	1,398	-5,672	0	-80	-80	-3,024	-5,672	-80	-8,776	-9,144	
2011	15	-12,149	-20,285	-32,434	30,244	0	0	30,244	-2,190	-2,190	-2,190	762,776	-4,320	0	1,514	-5,834	0	-71	-71	-2,190	-5,834	-71	-8,095	-8,095	
2012	16	-12,149	-21,030	-33,179	31,604	0	0	31,604	-1,575	-1,500	-1,531	797,079	-4,730	0	1,689	-6,419	0	-74	-74	-1,575	-6,419	-74	-8,069	-7,841	
2013	17	-12,149	-21,061	-33,211	31,909	0	0	31,909	-1,301	-1,180	-1,229	804,777	-5,004	0	1,659	-6,663	0	-77	-77	-1,301	-6,663	-77	-8,042	-7,595	
2014	18	-12,149	-21,463	-33,612	32,761	0	0	32,761	-851	-735	-781	826,267	-5,384	0	1,679	-7,063	0	-82	-82	-851	-7,063	-82	-7,996	-7,338	
2015	19	-12,149	-21,835	-33,985	33,571	0	0	33,571	-414	-341	-370	846,673	-5,781	0	1,757	-7,538	0	-85	-85	-414	-7,538	-85	-8,037	-7,168	
2016	20	0	-22,176	-22,176	34,332	0	0	34,332	12,156	9,525	10,537	865,886	-6,195	0	1,780	-7,974	0	-162	-162	12,156	-7,974	-162	4,020	3,485	

year	DIRECT COSTS (OPERATOR)			DIRECT BENEFITS (OPERATOR)			DIRECT IMPACTS (OPERATOR)				EXTERNAL/INDIRECT IMPACTS FACILITY OPERATIONS				SHADOW PRICE ADJUSTMENTS			SOCIO-ECONOMIC CBA						
	calendar	Capital Expenditure	Operating costs	TOTAL DIRECT OPERATOR COSTS	REVENUES - Gate Fees	REVENUES - Electricity	sale of Recyclables & Other	TOTAL FINANCIAL BENEFITS	UNDISCOUNTED		DISCOUNTED (@ financial discount rate)	DISCOUNTED @ social discount rate	Waste Volumes (tonnes)	EMISSIONS generated	EMISSIONS avoided	Other	TOTAL	Electricity Sales	Others	TOTAL	NET DIRECT IMPACT	INDIRECT/EXTERNAL IMPACTS	SHADOW PRICE ADJUSTMENT	NET SOCIO-ECONOMIC BENEFIT (UNDISCOUNTED)
2017	21	0	-22,505	-22,505	35,077	0	0	35,077	12,572	9,382	10,591	884,666	-6,632	0	1,832	-8,464	0	-165	-165	12,572	-8,464	-165	3,944	3,322
2018	22	0	-23,019	-23,019	35,838	0	0	35,838	12,818	9,110	10,494	903,853	-7,100	0	1,882	-8,982	0	-168	-168	12,818	-8,982	-168	3,668	3,003
2019	23	0	-23,545	-23,545	36,615	0	0	36,615	13,070	8,846	10,398	923,457	-7,602	0	1,930	-9,531	0	-172	-172	13,070	-9,531	-172	3,367	2,678
2020	24	0	-24,082	-24,082	37,409	0	0	37,409	13,327	8,591	10,304	943,486	-8,139	0	1,977	-10,116	0	-176	-176	13,327	10,116	-176	3,035	2,347
2021	25	0	-24,657	-24,657	38,258	0	0	38,258	13,601	8,350	10,220	964,896	-8,591	0	2,025	-10,616	0	-180	-180	13,601	10,616	-180	2,806	2,108
2022	26	0	-25,244	-25,244	39,126	0	0	39,126	13,882	8,117	10,137	986,791	-9,069	0	2,073	-11,142	0	-184	-184	13,882	11,142	-184	2,556	1,866
2023	27	0	-25,845	-25,845	40,014	0	0	40,014	14,170	7,890	10,055	1,009,183	-9,574	0	2,123	-11,697	0	-188	-188	14,170	11,697	-188	2,284	1,621
2024	28	0	-26,459	-26,459	40,922	0	0	40,922	14,463	7,670	9,974	1,032,083	10,107	0	2,176	-12,283	0	-193	-193	14,463	12,283	-193	1,988	1,371
2025	29	0	-27,087	-27,087	41,851	0	0	41,851	14,764	7,457	9,894	1,055,503	10,669	0	2,231	-12,900	0	-197	-197	14,764	12,900	-197	1,667	1,117
2026	30	0	84,821	84,821	41,961	0	0	41,961	126,782	60,984	82,571	1,058,288	94,677	0	2,283	-96,960	0	-868	-868	126,782	96,960	-868	28,954	18,857
Total		-242,988	-539,144	-782,132	959,797	0	0	959,797	177,665	3,450	54,366	24,206,734	236,995	0	43,603	-280,598	0	-3,893	-3,893	177,665	280,598	-3,893	-106,826	-179,040
Investment Return					NPV (€m)	IRR	BCR (discounted)																	
Financial					3	5.1%	1.00																	
Socio-economic					-179	-5.9%	0.84																	

ANNEX III. LIST OF INTERVIEWEES

Interviews and correspondence were undertaken with the following individuals. We would like to thank them for their assistance in compiling our report.

<i>Interviewee</i>	<i>Affiliation</i>	<i>Position</i>	<i>Date</i>
Mr Vitor Vieira Mr Fernando Santos	Lisbon Municipality (CML)	Director of Department Urban Waste Management	28 th October, 2011
Mr Rui Berkemeier	Quercus (Portuguese Environmental NGO)	Coordinator of Waste Management Information Centre	28 th October, 2011
Ms Francisca Cordovil	Financial Institute for Reg. Dev. (IFDR)	Coordinator Cohesion Fund	31 st October, 2011
Ms Luísa Pinheiro Ms Ana Paula Simão Mr Francisco Silva	Portuguese Environment Agency (APA)	Deputy Director-General Director of Department Waste Management Director of Division Urban Waste	2 nd November, 2011
Mr João Figueiredo Mr Tomás Serra Ms. Ana Loureiro	Valorsul	President Executive Commission Executive Administrator Director of Communication	2 nd November, 2011
Ms. Paulina Martins Ms. Maria Miguel Pereira Ms. Zélia Galinha	Lisbon Regional Administration (CCDR-LVT)	Director of Department of Environment Division Chief Environmental Licensing	17 th November, 2011
Mr Helder Careto	GEOTA / Portuguese Environmental NGO)	Executive Director	2 nd December, 2011
Ms. Filomena Lobo Mr Miguel Nunes	National Regulatory Entity for Water and Waste Services (ERSAR)	Director Department Waste Engineering	7 th December, 2011
Mr René-Laurent Ballaguy	European Investment Bank (EIB)	Senior Evaluator – Inspectorate General / Operations Evaluation (IG/EV)	16 th March, 2012

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