

Techno-Economic Analysis of RDF Preparation Solutions

Abstract

Until today, it was not possible to decouple the economic growth from the increase of environmental impacts, namely through waste production, making imperative the search for strategies that promote the waste valorisation. The use of Refuse Derived Fuel (RDF) represents one of the possible contributes for the resolution of this problematic. Although several strategic and legislative programs developed, it is not clear which are the conditions that guarantee the RDF sustainability on the national perspective, and this study intends to be a contribution for the clarification of these conditions. With this objective a technical analysis was performed, based on an extensive literature review, which allowed to know which are treatments that the reject fraction needs, to ensure the necessary characteristics to produce a RDF with economic value and market flow, namely for the cement industry. Based on this analysis it was concluded that the reject fraction needs to be shredded and dried, which can be performed through bio-drying or thermal drying. It was studied the benefits and costs of drying processes through the Low Temperature Belt Dryer, for different heat sources, and Bio-drying with canvas, for different needs of investment, using the Cost Benefit Analysis methodology. This study allowed the identification of disadvantages and uncertainties with bio-drying, despite the financial viability of this technology, as well as the feasibility of thermal drying and market associated with RDF through a tariff rise.

Keywords: Refuse-Derived Fuels (RDF); Cost-Benefit Analysis (CBA); Solid Recovered Fuel (SRF); Waste Fuels; Mechanical-Biological Treatment (MBT).

Introduction and State-of-the-Art

This study aims to describe and analyse the Refuse-Derived Fuels (RDF) preparation solutions applied to the existing MSW context in Portugal, focusing on the process phase next to the mechanical and biological treatment (MBT), from which results the reject fraction, until the final marketable product, the RDF itself. From a technical and economic perspective, based on an extensive literature review, it intends to conclude about which solutions achieve the best economic balance and thus contribute to determine the viability of the RDF market. The waste sector in Portugal is already equipped with a part of the necessary technologies to improve the RDF (3Drivers 2015), however there is still a lack of investment in this fuel, namely at the market and process levels, through the development of a process line that, with the lowest associated costs, produces the best product possible. The RDF quality is a broad concept which depends essentially on its destination. The cement industry is the destination with more use potential of this fuel. For this reason, it is used in this thesis a RDF quality concept associated with this market destination.

Currently, the RDF is one of the possible ways to recover the rejects from the municipal solid waste (MSW) through screening units, mechanical treatment (MT) or MBT, and the fuel may also include a mix fraction of non-recycled waste, not dangerous and with a non-urban origin. Based on this, the RDF and its preparation process may be an important contribute for a sustainable management of waste and resources, namely through the deviation of waste from the landfills and the use of these as an alternative fuel as well as for the economic sustainability of the MSW Management Systems, taking into account the dynamics of the RDF market and the use of endogenous energetic resources.

This strategic option is reinforced by the reduction of waste quantity placed in landfills and the increase of waste that is sent to MBT in Portugal. The former decreased in 2014, from 42% in relation with 2010 and 1,4% when compared with 2013. In the case of MBT, the quantity of MSW treated by these installations increased 104% in 2014 when compared with 2010 (APA 2015). This last information is especially relevant because the RDF preparation is made from a fraction that results from this treatment process. Accordingly, it can be considered an indicator of the RDF production potential existent in

Portugal. The RDF production from MSW was registered in the country for the first time in 2011. This production increases significantly in 2012 and remains constant in the next year. In 2014, due to the contribute of the MSW Management Systems *Tratolixo* and *Resitejo*, an increase of RDF production was registered. In Portugal, there are a total of 6 MT and 15 MBT installations across several MSW Management Systems. Besides there are also two installations for RDF preparation existing at ERSUC and one unit at Amarsul and Valnor (APA 2014b).

The term RDF is a general designation for fuel produced from non-dangerous waste. As a way to guarantee the quality criteria of these combustibles and promote the RDF acceptance in the European market, the European Committee for Standardization published a set of standards about this matter. This standard defines the Solid Recovered Fuel (SRF) as a waste fuel in accordance with specific according to the NP 4486:2008, in the case of Portugal. The RDF Portuguese Strategy (MAOTDREI 2009) defines the RDF as solid fuels with homogeneous characteristics, significant calorific value and biogenic content, made from non-hazardous waste in order to be used for energy recovery in incineration and co-incineration. This strategy (*Despacho* No. 21295/2009) was a result of PERSU II (MAOTDR 2007) in order to encourage the development of RDF in Portugal. The last strategy with mention of RDF published in Portugal, PERSU 2020, has strengthened the focus on this fuel, identifying the following measures or strategies (MAOTE 2014):

- Encourage the construction of RDF preparation/drying lines;
- Articulate the contracting of RDF flow in the industry, including the cement;
- Assess, with the industrial sector and MSW Management Systems, the feasibility of installing cogeneration units that use RDF for electricity and heat supply;
- Review the RDF Portuguese Strategy;
- Promote the contracting of paid RDF flow in the sector and with the industrial sectors outside the MSW management sector (co-processing in cement and recovery in cogeneration units);
- Assess the feasibility of the end-of-waste status for RDF;
- Promoting the substitution of fossil fuels by RDF produced from MSW, where this is feasible.

The trust in product quality is of the utmost importance for the RDF users, based on this have been created standards with the purpose of developing more horizontal criteria, an example of these measures is the class code established in Portugal by the NP 4486:2008. In addition, potential consumers of RDF may establish additional requirements in particularly on economic, environmental or process criteria. The classification code is an important assessment tool of RDF; it analyses this fuel based on three fundamental parameters:

Table 1: RDF Classification System. Reference: NP 4486:2008

Parameter	Statistical Measure	Units	Classes				
			1	2	3	4	5
LHV (Economic Parameter)	Average	MJ/kg (as received)	≥ 25	≥ 20	≥ 15	≥ 10	≥ 3
Cl Content (Technologic Parameter)	Average	% (dry basis)	≤ 0,2	≤ 0,6	≤ 1,0	≤ 1,5	≤ 3,0
Hg Content (Environmental Parameter)	Median	mg/MJ (as received)	≤ 0,02	≤ 0,03	≤ 0,08	≤ 0,15	≤ 0,50
	Percentile 80	mg/MJ (as received)	≤ 0,04	≤ 0,06	≤ 0,16	≤ 0,30	≤ 1,00

Based on the classes codes system, the following characteristics of a RDF can be considered as ideal: maximization of the low heating value (LHV), low corrosion of the combustion chamber components (Cl) and low level of atmospheric emissions (Hg).

Technological Analysis

The waste that enters in the RDF production phase is the reject fraction with combustion characteristics resulting from MBT process. As a result of this treatment, four distinct fractions were obtained:

- Residual Fraction (has the landfill as destination);
- Combustible Fraction (used for RDF production);
- Wet Fraction (organic compost);
- Unsorted Waste and Metals (recyclables).

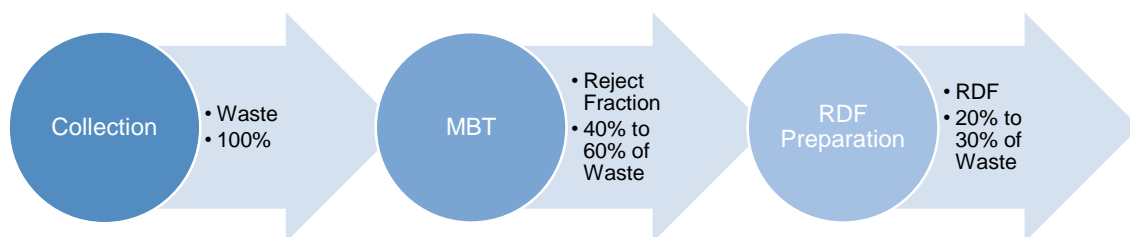


Figure 1: Mass Balance of the Process. Reference: Montejo et al. 2011; Rotter et al. 2004

Ideally, the combustible fraction that originates RDF should be constituted of plastic (mixed), paper and card, packaging compounds, films and textiles (celluloses), other fractions of light materials, wood and an organic compound (where are inserted the food and garden wastes). These materials do not satisfy the quality requirements to be recovered or recycled but have a high energetic content that makes feasible their transformation into a fuel. According to Nasrullah, the RDF energetic content is distributed by the materials that constituted the fuel in this way:

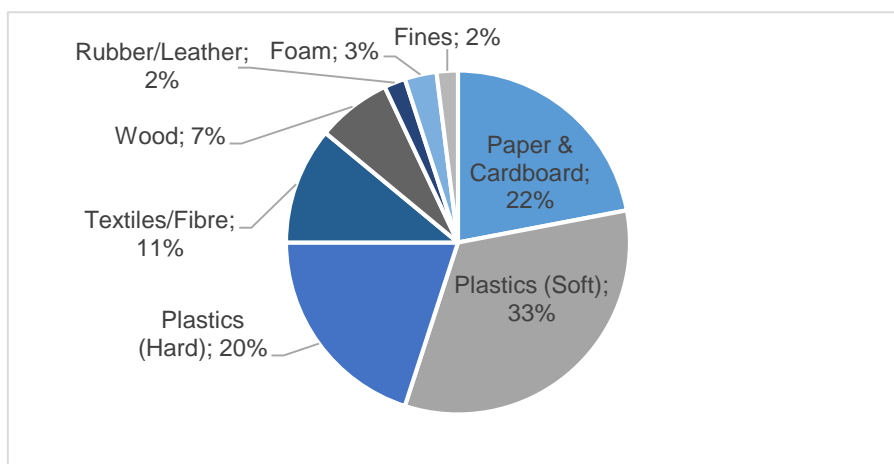


Figure 2: Distribution of RDF Energetic Content. Reference: Nasrullah et al. 2015

Waste from food, garden or paper with a high moisture content are acceptable, since they can be subject to a drying process. When dry, the paper and the organic component have a LHV of approximately 17 MJ/kg (Rotter et al. 2004). In case of combustion in industrial installations, the RDFs are primarily used as co-fuels, in such a way to not influence negatively the process efficiency. According to Akdag, Atimtay and Sanin tests, the increase of the RDF fraction correlates negatively with the efficiency of combustion. However, the addition of RDF to the mixture is also synonymous of decreased emissions of SO₂, while keeping the levels of NO_x emissions intact (Akdag, Atimtay and Sanin 2016).

It can be said that the success of the RDF preparation process, which is the subject of this work, is based on three main objectives: yield of the process itself, enrich the calorific value and removal of hazardous substances. Given that the production of the MBT is performed in the organic recovery

centres of the MSW Management Systems in Portugal, and the major success of dangerous waste separation upstream, we can say that this process ensures the removal of contaminants of RDF samples (Carvalho 2011) certifying a level of Cl and Hg classification consistent with the required by the market at the environmental and technological level.

It is considered that a mechanical treatment (MT) system for a proper marketable RDF consists in at least two or three stages of shredding, at least two stages of magnetic separation (for rejecting ferrous metals), at least one eddy-current separator (for rejecting non-ferrous metals), and depending on the user requirements, at least two sieving stages (Sarc and Lorber 2013). Given the above information collected, the treatment through MBT that wastes are already subjected ensures the implementation of these processes. Once the necessary environmental and technological conditions are assured and with the objective of optimizing the RDF classification obtained, it is necessary to improve the economic value of the product, in particular through its LHV.

The main issue is related to the water content (moisture) existing in the RDFs samples, which is a factor that causes a considerable discrepancy between the LHV and HHV (Gallardo et al. 2014), or in other words, the minimum and expected heating value of the waste and the maximum and achievable calorific value of it. By implementing procedures to correct this situation, an increase of the efficiency associated with the use of RDF would be obtained and the market would be promoted.

Reinforcing the facts presented previously, the waste flow out of MBT has an average moisture of 40% to 50%, depending on factors such as the place of collection and seasonality, while the resulting RDF must have at the most a 20% moisture (Mendes 2014). The materials that contribute more to this water content are organic matter, paper and cardboard and textiles (Montejo et al. 2011). Therefore, it is concluded that the drying of the RDF is a necessary addition to be made to the process. Furthermore, it contributes to the improvement of their classification which means this process becomes almost mandatory when the commercialization of the fuel is taken into account.

The main target of this marketing should be the cement industry, which uses the RDF as a co-fuel to heat their kilns, given the specificities of fuel, the combustion characteristics and the product itself. However, for the RDF to be sold to cement factories and used in their kilns, the particle size must not exceed 10 mm (Garcés et al. 2016) and this is an important factor for the burning process. In addition to cement industry, other energy-intensive industries could be the RDF marketing target, as it is done in Germany, where the RDF is used in co-combustion system in this type of facilities.

Thus, it is possible to identify the need for incorporation of two additional treatments with the aim of improving the quality rating and the classification of the RDF, as well as increasing the possibility of marketing competitiveness and commercialization of the fuel. Based on this, it is suggested that waste shredding occurs first and after that the drying process is performed. Given that the use of smaller particles improves drying efficiency and since this process is costlier, it is expected that the proposed order increases the final efficiency.

The shredders have the function of reducing the RDF particles size in order to provide the dimensions required by the market for combustion. As expected, the characteristic that most influences the specifications of the shredding are precisely the size of the particles when going in and coming out of the equipment. The shredding system runs identically on all equipment of several suppliers and it is based on three essential components:

- Rotor (laminar): produces the action of shredding;
- Electro-Hydraulic or Vibratory System: "pushes" the waste in the rotor direction;
- Perforated Screen: classify the particles according with the desired dimensions.

The RDF drying possibilities can be divided into two main groups, which differ primarily by the energy source used: bio-drying, where the energy source is the metabolic activity of the microorganisms that degrade the waste; and thermal drying, where there is a power consumption from an exterior source. In addition to the water vapour and potential exhaust gases produced by drying processes, the low

temperature drying processes (such as those studied) produce volatile organic compounds. This issue was not considered in the technological nor the economic analysis, given the possibility of adding a treatment phase to the process.

Bio-drying can be defined as a process for reducing the water content by convective evaporation, which uses as a heat source the energy released by the biodegradation of the waste and introduces an air flow. The introduced air flow is responsible for transport the excess of water in the waste, since the moisture passes from this to the stream and then it dilutes itself into the ambient air. Bio-drying processes have the objective of reducing moisture content, differentiating from composting processes by preserving most of the existing biomass in the waste matrix, as well as its calorific value. Through this drying process it is possible to increase the waste's LHV from 30% to 40% (Adani et al. 2002).

According to Rada and Ragazzi, biodrying should only be considered when the food (or organic) waste fraction is equal to or greater than 50% of the sample in study and a limiting factor can even be considered when this fraction is equal or less than 30%. However, all samples that follow these guidelines and that are subjected to biodrying demonstrate a significant improvement in their LHV (Rada and Ragazzi 2014). Regarding the moisture content, biodrying proves to be ineffective in obtaining an average moisture content below 20% (Mendes 2014). In specific cases, such as for obtaining a RDF with moisture content less than 20%, this process must be reinforced with thermal drying.

The biodrying processes can be divided in biodrying with canvas, windrow tunnel biodrying and biodrying with canvas in trenches. When using the first option, the RDF is arranged in a stack form and covered with a special geocomposite which has characteristics that prevent the entrance of water (from outside to the inside of the stack), protecting the waste from the precipitation phenomena, but allows water outlet by evaporation from the stack into the air. The biodrying with canvas in trenches option uses a cement construction (covering 3 of the 4 sides). The windrow tunnel biodrying is carried out in large tunnels, usually modular systems, in which the use of canvas is not necessary and which also includes a strong ventilation, however it requires both larger facilities and investment.

Although having exactly the same purpose, thermal drying uses as a heat source the energy released by a combustion process which may not be directly related to the material to be dried, differentiating it from the bio-drying. There is also an air flow which assists the drying process being responsible for the transport of moisture. Thermal drying processes can occur by conduction, convection and radiation, which is another difference from the biological drying. Due to the need for an external heat source, the cost associated with the thermal energy consumption is higher, making it a more expensive process when compared.

Nevertheless, thermal drying has advantages and conditions that are not possible to achieve through biodrying. This process can be regulated to obtain any desired moisture content and even decrease the water content in the material to 0%. When using the Rotary Drum Dryer, the RDF is subjected to the drying process with pre-heated air into a rotary drum, which can be at vacuum conditions or atmospheric pressure. The dried waste accumulates in layers on the walls of the drum, and as the temperature increases, the evaporation of its water content occurs. This technology is characterized by a "turbulent wash" of RDF with hot air, and it is expected that the process is more efficient due to the rotational movement of the waste within the drum, which promotes the drying of all particles.

In the specific case of waste drying there are several constraints to consider. In general, rotary dryers are of direct-burning type, in which the drying air is in direct contact with the material. However, the indirect type dryers should be used for RDF because in this case the air flow is externally heated and passes through the drum in a way that avoids direct contact between the material and the drying air. Drying by indirect-burning promotes heat transfer through the drum cover, due to this, tumbling flights are added to help the rotation of the material along the walls and to ensure process consistency.

The Low Temperature Belt Dryer promotes the decrease of the RDF moisture through a continuous process at a low temperature relative to the reference temperature of heating. The RDF is fed

continuously to a belt that transports waste, uniformly distributed and with an adaptable depth of bed based on the drying requirements. During the drying process, which is carried out in a chamber for this purpose, the hot air flows through the waste layer and removes its moisture by convection, i.e. the moisture passes from the waste to the air flow due to the heat exchange, in a process similar to the drum dryer. The supplied air flow and the speed of the belt can be adjusted along the length in order to better adapt to the respective drying section. For example, the feeding area has a higher moisture content than the discharge area, so there is a need for more flow in the first section and this adaptation increases the efficiency of the process. In order to obtain a more homogeneous and dry RDF, its layers are moved and mixed in a controlled manner through a turning device.

Economic Analysis

For the evaluation of the economic component, an assessment tool called Cost-Benefit Analysis (CBA) was used (European Commission 2014). This is an appreciation and assessment method for investment projects required by the European Union for decision-making processes in cases of Community co-financing. This analytical tool should be used for assessing investment decisions, based on a set of predefined objectives for the project in question. The analysis uses, among other techniques, the assignment of a monetary value to all effects on the welfare, so it is based on the opportunity cost arising from the intervention. In the guide are described all the details associated with this method.

Given the project nature, some adjustments to the model were made in order to perform this case study. The social impact produced by the intervention was associated to the charging of a tariff rise that ensures the financial sustainability of the project, if necessary. The calculation of this rise was made by determining the RDF production financial deficit as function of the processed waste. The depreciation of the investment had to be considered in the calculation of this deficit, in order to ensure that the charged value would cover both the CAPEX and OPEX of the project.

The extra tariff ensures the project's profitability by the attachment of a 5% margin to the extra amount charged by the MSW Management Systems, which is the margin usually applied in other similar cases. Through this mechanism and with the purpose of covering the generated losses, the tariff increase aims to guarantee IRR of 12%. In addition, it is expected that the Net Present Value (NPV) and the Internal Rate of Return (IRR) take similar values, regardless of the technology under study. This adaptation removes some importance to these factors, however the tariff becomes an evaluation indicator of the most viable technology. As a result, the IRR will also be studied based on the tariff rise, making the analysis of the project's return for a specific technology possible in the case the same value is charged.

In addition to the social impact through a tariff increase proposed in the financial analysis, the economic analysis aimed to evaluate the impacts out of the market, resulting from this intervention. In particular, by considering cost savings which would not be produced by the absence of the project. Since there are no cash flows, these savings were not included in the financial analysis. Nonetheless, they are introduced in the evaluation of the economic potential of the intervention. Regarding the risk analysis, since it is a model for comparative purposes and not exactly for a final project evaluation, it was considered that the performing of a risk analysis would not bring relevant benefits to this study.

Results

Based on the CBA methodology, the financial viabilities of the RDF drying process with the Low Temperature Belt Dryer and with the Biodrying with canvas were verified, given the greater potential use of these technologies in Portugal.

The costs considered can be divided into CAPEX and OPEX, i.e. capital costs and operation costs. These will mark a substantial difference between the two technologies. The Low Temperature Belt Dryer

will be assessed taking into account three different heat sources: natural gas, pellets and available heat. It is noted that CAPEX has a small variation due to the cost of a specific equipment and this cost is function of the heat source used. The OPEX is highly influenced by the thermal energy costs. Taking into account the absence of such costs when considered the available heat, this heat source has a clear advantage. Furthermore, when pellets are used there is a need for its transport, which is included in the associated extra costs, however it has a residual impact when compared with the other costs.

Biodrying uses as a source of heat the energy released from the organic waste activity, so there are no costs associated with thermal energy. It is expected that this difference has a significant impact on the analysis, considering that in the previous case the thermal energy costs represents a major proportion of the OPEX. In this case, the CAPEX will have a greater impact on the analysis, and four scenarios will be considered according to the necessity (or not) of assets' acquisition that enable the use of the technology: the need for a windrow turner (V), the need for an implementation area of the bio-drying structures (A), a scenario in which is necessary to purchase both (VA) and one in which none of them is acquired.

The revenues consist on the benefits from the sale of the RDF produced and the tariffs charged by the MSW Management Systems, due to the positive social impact of the project. The benefits from the RDF sales are independent of the considered technologies and scenarios, since the production and sales unit price are the same in either case. The tariff is a function of the RDF production deficit associated to each heat source, i.e., it is expected that the higher the cost, the greater the deficit and, therefore, the less viable the project. In the biodrying case, there is no production deficit. The revenues from the RDF sales are higher than the process expenses. Consequently, it is considered that there is no need for an additional fee for waste disposal to be charged, in order to finance this process. With the Low Temperature Belt Dryer, the results show that a tariff is necessary. This tariff rise was calculated and it is presented in the table 2.

As it was explained previously during the methodology analysis, the tariff rise implementation will have as consequence the harmonization of the obtained financial results, because it aims to cover the losses associated to each technology and guarantee an IRR of 12%. Thus the evaluation of the tariff impact has an extra value that was studied through several variation tests. The verification of the corresponding results was obtained in graphics, however in this summary those results will not be presented. Only the IRR results as function of an equal extra tariff in all the Low Temperature Bel Dryer scenarios will be included. Taking into account that with biodrying there is no necessity of charging an extra tariff, the study is completely different and not so relevant. The table 2 presents the results obtained from the financial viability study through the CBA methodology.

Table 2: Results of the Financial Viability Study

	Natural Gas	Available Heat	Pellets	Biodrying	Biodrying (V)	Biodrying (A)	Biodrying (VA)
Internal Rate of Return	12%	12%	12%	15%	7%	9%	4%
Net Present Value	414 745 €	365 574 €	384 262 €	511 806 €	211 806 €	311 806 €	11 806 €
Investment Return Time	8 years	8 years	9 years	7 years	11 years	10 years	14 years
Tariff Rise	6,60 €	1,70 €	4,60 €	0 €	0 €	0 €	0 €

Analysing the previous table, it is possible to conclude that without the tariff application, the RDF production process will have a financial deficit in any of the heat source scenarios for the Low Temperature Belt Dryer. Only in the case of available heat exists a margin to be applied a lower tariff.

To study the tariff impact on the several technologies and to know the IRR differences between them, the viability of a constant tariff was calculated. For example, with a fixed increase of 7€, the minimal that guarantees return in the natural gas case, the obtained results are the following:

Table 3: IRR results for an equal tariff charged

Heat Source	IRR
Natural Gas	16%
Available Heat	66%
Pellets	33%

With these evidences, it was relevant to assess which is the financial balance of RDF production, per tonnes of RDF produced, considering that a tariff will not be applied in any case. The following tables show the costs/revenues of RDF production by tons of product for each hypothesis in the study.

Table 5: RDF Production Cost (LTBD)

Heat Source	RDF Production Cost (€/ton RDF)
Natural Gas	20,79 €
Available Heat	3,91 €
Pellets	13,62 €

Table 6: RDF Production Benefits (Biodrying)

Scenarios	RDF Production Benefits (€/ton RDF)
Biodrying	3,22 €
Biodrying (V)	2,03 €
Biodrying (A)	2,43 €
Biodrying (VA)	1,24 €

Besides the financial aspects, this evaluation can be based on an economic perspective. Namely, taking into account the cost savings from the deposition fees and the CAPEX and OPEX of landfill management. The waste quantity deviated from the landfill is sufficiently high for these savings to have a significant impact on the economic analysis. The costs savings related with the landfill activity were calculated based on its management costs by deposited waste and the waste quantity deviated. The deposition fee (TGR) savings were calculated based on the fee established by law, that fluctuates until 2020 and which was considered constant in the years after, being function of the waste quantity that will not be deposited. In the following table, the results of the economic analysis are presented:

Table 7: Results of the Economic Viability Study

	Natural Gas	Available Heat	Pellets	Biodrying	Biodrying (V)	Biodrying (A)	Biodrying (VA)
Economic Internal Rate of Return	46%	97%	61%	121%	79%	89%	64%
Economic Net Present Value	2 539 746 €	5 045 371 €	3 550 609 €	6 433 214 €	6 147 499 €	6 242 738 €	5 957 023 €

As expected, when taking into account the cost savings for the MSW Management Systems, the economic analysis has results significantly better than the financial analysis. Based on these assessment conditions, it is possible to eliminate extra tariffs and still ensure the project economic viability. This economic analysis might have also included the social benefits resulting from the waste valorisation, namely the environmental advantages, however due to the difficulty in quantifying economically this impact it was chosen not to include them in the analysis.

Conclusion

To achieve the required characteristics of a marketable RDF, this study identified as crucial the implementation of two additional steps after the MBT, with the aim of producing a competitive and

desirable RDF for the market: the development of a shredding step, to give the RDF the dimensions required by the consumer industry, and a drying step in order to increase its LHV, and thus to add economic value to the RDF and to ensure its promotion and flow in the market, mainly associated with the cement industry. Despite the technological analysis to which all processes were exposed, only the Biodrying with canvas and Low Temperature Belt Dryer were subject to a financial-economic analysis, based on the filtering already explained.

The financial results show very different realities for each case and when compared with the economic one. The biodrying process is financially viable despite the high investment costs, which are outweighed by the revenues from the RDF sales over the 15 years of analysis. However, its technological study shows that there are a number of limitations that must be taken into account, such as:

- The biodrying should only be considered whenever the organic waste fraction is equal or greater than 50% of the sample, and when this fraction is equal or smaller than 30%, it can be a limiting factor;
- Despite achieving average moisture reductions of 25%, bio-drying is unable to promote a moisture reduction in the waste to less than 20%;
- The implementation of the process requires a fairly large implementation area - the analysis performed considered an area of 2 ha.;
- The residence time of the waste ranges between two weeks and one month - this value is extremely high when compared to thermal drying;
- The procedure can only be performed in case of existence of a large amount of waste, being impossible to implement it with smaller quantities, and the waste flow must also be constant to avoid the waste storage associated.

The Low Temperature Belt Dryer case has substantial differences from the biodrying, and like most of the activities related with waste in Portugal, it is a loss-making process, which requires a tariff increase. This extra tariff was calculated based on the generated losses, in addition a tariff impact study was carried out on the financial results of the project, namely the IRR. This study allowed us to know the consequences of the tariff rise applied, to what is its impact on the project viability and to the possibility of comparing the results which were based on the same tariff for all cases. The results, as well as the calculated RDF production cost showed that the thermal drying with the available heat technology has the lowest associated costs, followed by the use of pellets and finally natural gas. As a complement to this analysis would be interesting to evaluate the sustainability of this project at the energy and environment level.

Biodrying technology has several constraints that proved that this technology can only be considered in very specific situations since it is difficult to accomplish in many cases. Within the existing possibilities in thermal drying, the technological analysis presented that the Low Temperature Belt Dryer is considerably better over the Rotary Drum Dryer, particularly in terms of electrical and thermal efficiency as well as atmospheric emissions and pollution. The Low Temperature Belt Dryer use, although financially disadvantageous when compared to biodrying, is technologically reliable and essential for obtaining the proper and desired RDF for the Portuguese picture.

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