

Socioeconomic, Energetic and Carbon Impacts of a Large-Scale Model of Municipal Solid Waste Treatment in the Largest Brazilian Metropolitan Region

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ABSTRACT

The National Solid Waste Policy (PNRS) by the Law 12,305 of Aug. 2nd in 2010, is the Brazilian initiative to manage the Municipal Solid Waste (MSW) generated in the national territory.

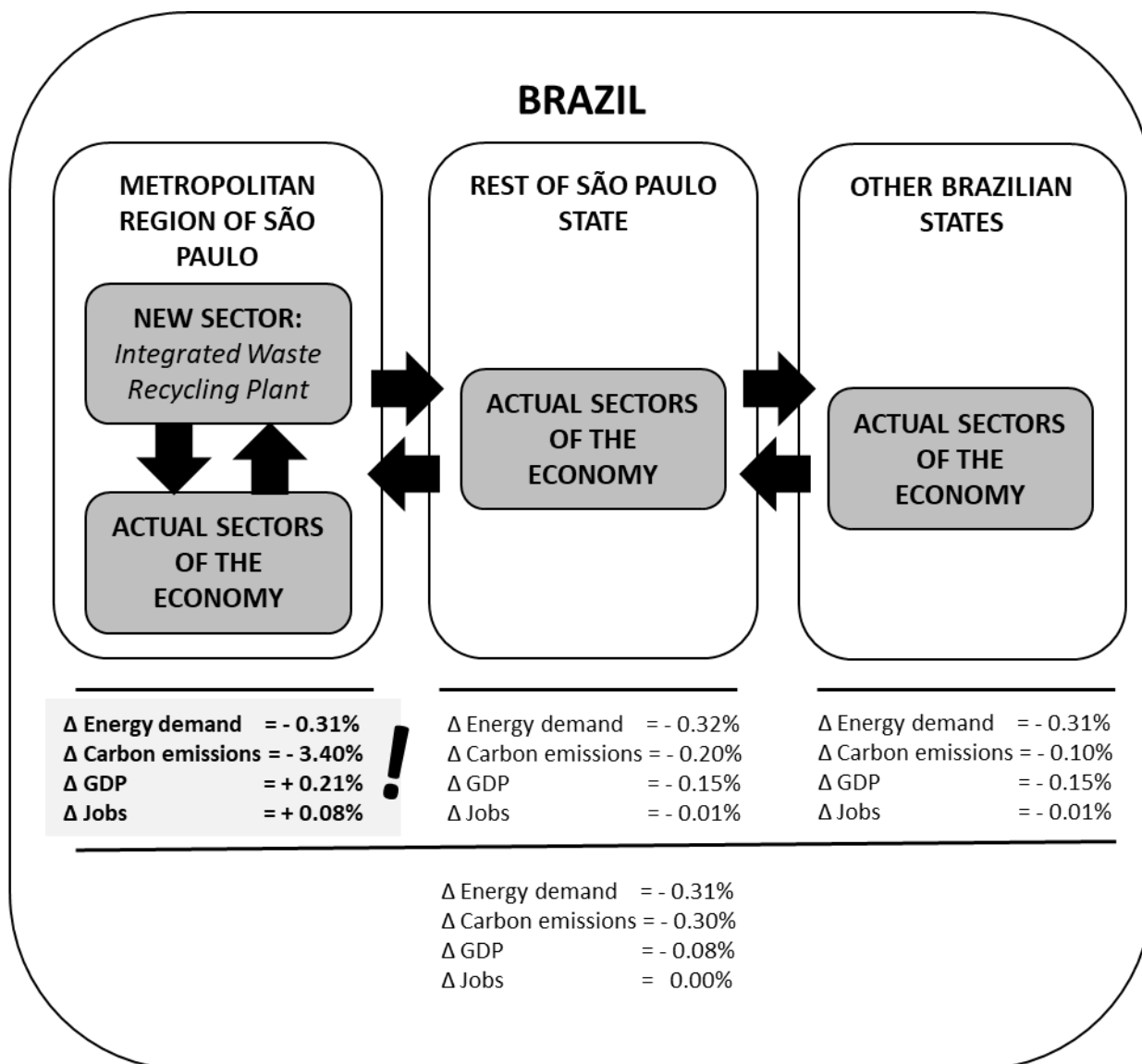
The Metropolitan Region of São Paulo (MRSP) is the largest Brazilian economic macro-region which generates 10% of all MSW in the country which is practically 100% treated in landfills, as suggested by the PNRS. However, its landfills are close to the exhaustion and build new ones collide with the lack of land availability in the region surrounded by water reservoirs. Areas far from the waste generation do not seem to be an economical alternative, due to high freight fee and requirements for environmental licensing.

This article comes to present socio-economic, energetic and CO₂ emissions' impact when considering a large-scale integrated plant to treat MSW from MRSP as an alternative to landfills and a source of renewable energy.

Based on 2013's interregional economic transactions data, the proposed Input-Output model has shown reductions in the local energy demand (-0.31%), carbon emissions (-3.40%). On the other hand, the simulation has suggested gains in the GDP (+0.21%) and formal job positions (+0.08% or 10.6k) when recyclables are introduced massively in the economy.

Keywords: Waste-To-Energy, Input-Output, Recycling, Renewable Energy, Municipal Solid Waste, Metropolitan Region of São Paulo.

GRAPHICAL ABSTRACT



Summary: New sector on the studied region and its impacts on it and beyond.

STATEMENT OF NOVELTY

This is the unique and complete case of an interregional economic transactions Input-Output modeling applied to the most important economic region of Brazil and any other found in the literature. Based on most recent data available, this article brings a simulation of how and what would be the impacts to the economy if considered products and services from a huge integrated urban waste treatment system replacing the usual ones.

An alternative to the landfills, the study intends to increment Brazilian researches for the integration of solutions to treat the urban waste as a way to reach the ideal circular economy.

CHAPTER ONE

INTRODUCTION

The Metropolitan Region of São Paulo (MRSP) is the biggest economic center of wealth generation in Brazil. This macro-region holds a large part of the national private capital with the most important industrial complexes, commercial and financial headquarters installed, and it is responsible for the Brazilian economic activity [1].

These characteristics have created and concentrated important economic activity and its value defined by the dependence upon production, planning, publishing, marketing, insurance, consulting and other. Its 2013's GDP was R\$ 947.6 billion (or USD 405 billion), approximately, 55.5% of São Paulo State, or 19.4% of Brazil. With 20.8 million people, GDP per capita was R\$ 45.6 thousand (or USD 19.4 thousand), based on an annual exchange of R\$ 2.43 per USD (3). In comparison with Brazilian GDP per capita (R\$ 26.4 thousand or USD 11.3 thousand), MRSP's one was 1.7 times bigger in the same period [1], [2].

Directly associated with value and income generation, the amount of Municipal Solid Waste (MSW) is equally high in this Brazilian region. The MRSP has São Paulo city, capital of São Paulo State, with 11 million people, considered the largest of Brazil and one of the largest worldwide urban agglomerations. With 39 cities, this region produces 21.4 thousand metric tons per day or annually 7.7 million metric tons of MSW. This amount corresponds to 10% of all Brazilian's MSW, and only São Paulo city produces 62.5% of this total amount [3], [4].

The absence of an efficient Integrated Municipal Solid Waste Management (IMSWM) is one of the factors that make difficult to coordinate integrated actions between municipalities.

This article comes to propose an MSW's model based on an integration of waste treatment steps. Mechanical selection of recyclables (waste sorting to separate and compact metal, paper, glass, and plastic), biological organic composting (bio-process to produce fertilizer), and a thermal treatment process where remaining waste, called Refuse Derived Fuel (RDF), is burned to produce energy (see **Figure 1**). Considering some Mechanical Biological Treatment (MBT) with Waste-to-Energy (WtE) downstream facilities (or simply MBT+WtE) well-distributed in the region could be an alternative to landfills to densely populated areas, such as MRSP. The well-succeed practice of MSW treatment with energy generation in too many countries in Europe, especially in Germany, is considered state-of-the-art regarding controlled emission and land-use mitigation, as mentioned in last COP 21 [5].

Studies are proposing similar initiatives to mitigate or eliminate, landfills usage, considering their capacity of saving energy and the potential of electricity generation through waste. RUOFEI and SIBEI report about sharp population growth in China and its residues' generation without appropriate treatment [6]. The solution to the problem, as well as the majority of articles found in developing countries, is to replicate well-succeed European cases, especially Danishes MSWM's models. This task seems to be simple and trivial if it was not by the fact GDP's Denmark is three times bigger than MRSP's one, and five times higher than Brazilian's one. It is one of the six European nations, which has at least 90% of its MSW destined to save and generate energy through a selective collection and Waste-to-Energy (WtE) for electricity and heating. In these developed countries, there is an awareness culture of environmental impact mitigation based on conscious consumption through the 3Rs (Reduce, Reuse and Recycle). There is a clear understanding of waste is a public health problem, and due to these governments, investments are made to get solutions alternative to the land-use, mainly because several times it is not available in Europe.

An example is that one presented in PIPO's thesis, where it proposes an MSWM to Kostomukska city in Russia based on a successful case of Oulu city in Finland. In this work is not verified an awareness with land-use mitigation [7]. It discusses how to structure a selective collection to bring recycling feasibility, and landfills come as an additional adequate practice to treat what remains. There is no discussing waste energy content and neither about potential land and air contamination with leachates and methane produced in anaerobic digestion.

Pioneer simulating environmental impacts through input-output (I-O) models, LEONTIEF has inspired too many scientific works on waste management [8]. NAKAMURA and KONDO have estimated a waste input-output (WIO) table for Japan and applied it to evaluating effects of alternative waste management. They have found that concentrating treatment in a small number of large incinerators, combined with an increased degree of sorting, could decrease both landfill usage and CO₂ emissions [9]. LENZEN and REYNOLDS extended WIO, incorporating a supply-use routine, resulting in waste supply-use tables (WSUTs) in 2014. They presented the theoretical underpinnings of the WSUT calculus using economic and waste data for the Australian economy in 2008–2009 [10].

There are some local papers and authors, such as SANTOS [11] discussing about landfills and incinerators, LIMA [12] approaching technological alternatives to several Brazilian regions, and VIEIRA [13] defending electricity through the waste, but everybody does not present an integration of existing technologies for MSW treatment in the light of sustainability. PIMENTEIRA [14] has shown preliminary analyzes taking into account socioeconomic aspects from Rio de Janeiro's MSWM. In his dissertation, an I-

O model was used to verify the impacts and effects of recyclable materials in the economy. After eight years, the same author presented his doctoral thesis, complementing the dissertation with I-O model analyzing the impact of MSWM policy at Rio de Janeiro's government and its economy [15]. However, in both studies, the author has not considered building an integrated plant to treat 100% of the RSU. He has considered integrating current initiatives as a way to get economic and social benefits to the economy of Rio de Janeiro and pointed out high costs to the society if proposed another mechanism to treat MSW, such as WTE plants.

CHAPTER TWO

OBJECTIVE

This paper aims to present, through an interregional input-output (I-O) modeling, socioeconomic, energy, and carbon impacts if adopted a large-scale sector for MSW treatment at Metropolitan Region of São Paulo, the largest one in Brazil.

CHAPTER THREE

MATERIALS AND METHODS

The model proposed in this article intends to simulate the impact of a new sector responsible for treating MSW in the economy of MRSP. This sector, called here as MBT+WtE, would offer the service of MSW treatment, recyclable materials (metal, plastic, glass, and paper), the organic compost (fertilizer) and energy (electricity) which could replace current “virgin” products (services, materials, and electricity) in the market.

The economy and their interregional transactions, where the I-O model works, are organized in 62 sectors and their 116 products from 2009’s Use and Make tables estimated by GUILHOTO [16] and updated by the author to reproduce the 2013 IBGE’s data [2].

Service and products are valued in section 3.1 and taken into account to feed the proposed model. Replacing current service of MSW treatment and “virgin” materials is natural to expect potential savings of energy consumption and GHG emissions. Section 3.2 shows the 2013’s inventories for energy and emissions and, despite section aggregation, their values were extremely important to confirm them or not.

Due to this, the I-O model proposed will show different impacts in current sectors of the MRSP’s economy and other regions, such as the rest of São Paulo State and the rest of Brazil.

In I-O modeling it is not necessary to adopt an economy based only on products or industries’ technology. Based on this fact, a combined hypothesis will be used in the same model, so that associations can be done based on new products and services replacing regular ones, or a sector impacting other [17]. There are several different methods to mix these technologies, and CUNHA’s proposal was taken by the author to build a model with the number of products bigger than the sectors [18]. Section 3.3 shows the proposed modeling in a didactic way where the new sector, or the MBT+WtE sector, is interacting with the economy through its service and products.

3.1. WASTE, POTENTIAL VALUE ADDED AND OPERATIONAL ASSUMPTIONS

The gravimetric composition assumed to MRSP’s MSW is the one used by Municipal Environmental Sanitation Service of Santo Andre, a social and economic representative city from MRSP, described in SEMASA [19]. Even being a data from 2008, it fits with IPEA study performed four years later, where MRSP’s waste composition is shown [20].

In **Table 1** are summarized, and broken-down processes, products, service, and revenues from the MBT+WtE sector used to impact the economy.

Fractions of the 21 thousand metric tons per day of waste treated in each process were assumed through **Table A 1** and **Table A 2**.

The information about mass amount fractioned in wet and dry portions was as an idea of how much is possible to recover from a simple sorting. Without any additional process (washing and drying), recyclers would buy recyclables (metal, plastic, glass, and paper) compacted and in bales. Organics, the fraction extremely wet in the waste, would be segregated to produce fertilizer. Other waste contents also considered wet, but, recognized as dirty, were deduced to burn.

Note the important waste recovery rate of 67% potentially achieved just considering organic composting and recycling. This rate would be a remarkable level in comparison with the 10% sought by São Paulo, and not achieved by now, or with the insignificant 2% performed nowadays in Brazil, by ABRELPE [3].

Values (or revenues) to impact the economy was calculated assuming 2013's market prices (**Table A 3**), Lower Calorific Value (LCV) references (**Table A 4**) and the average waste's LCV for the MRSP (**Table A 5**).

About WtE process, technical configuration no. 3 (**Table 2**) and electricity price were used to calculate its value proposition to the model.

The energy value used is the one from ANEEL Auction A-5 for biomass generation in 2014, and the amount generated by 12 WtE units would be 4.0 TWh (or 353 k toe) in 2013 [21]. Emissions of GHG by WtE units were assumed following BELANGER study which recommends using 460 kg of CO₂ eq per metric ton of waste treated [22].

Thus, considering service and products offered by the MBT+WtE sector, it is estimated at R\$ 3,594 million (or USD 1,800 million) annually added to MRSP's economy. Recyclables would be responsible for 46%, electricity 25%, waste treatment service 17% and organic composting 12%.

This new sector would use some resources from the economy, such as public (gas, water, urban cleaning) and maintenance services. WtE facilities normally produce 8% (relative to the amount burnt) of ashes as a by-product, and they need to have a destination in landfills, abandoned mines or to built pavements. Maintenance and overhauling are also eventually required to keep the facilities working properly. So, this study assumed 1.5% and 6% of the annual gross income to by-product disposal and maintenance, respectively [22]–[24].

Other import operational assumption to the MBT+WtE is the number of jobs. Following what is recommended by FERRI, when considering collectors to select materials, it is strongly recommended to use one collector picking up 730 metric tons of waste per year [25]. So, in this article will be accounted 10,678 workers, including those to operate the WtE process.

3.2. INVENTORY OF ENERGY CONSUMPTION AND GHG EMISSIONS

Unfortunately, there are not detailed regional sectorized energy and emissions inventories to the Brazilian economy. There are responsible agencies to these issues, such as Mines and Energy Ministry (MME) and Science, Technology and Innovation Ministry (MCTI), or national publications, such as National Energy Balance (BEN) and System of GHG Estimative (SEEG). However, the level of aggregation of these energy and emissions data are extremely high, what makes it difficult to reach how impacted is a specific sector (see **Table A 6**).

In this case, where only 18 sectors are available for all Brazilian economy, and the model was prepared to work with 62 sectors interacting in 3 regions, the author has disaggregated the data based on GDP's subsectors and regions. For example, the Textile's sector has three available subsectors in GUILHOTO's Tables. The total 2013's GDP for this sector was R\$ 46,311 million (or USD 23,190 million), where 36% represents the subsector *Textile*, 42% for the subsector *Articles and Accessories of Clothing*, and 22% for the subsector *Leather Goods and Footwear*. Based on these contributions, energy consumption and emissions were the ones calculated and considered to build the subsector's baseline. In the same way, considering the GDP of each subsector was possible to estimate energy consumption and GHG among the regions.

This procedure certainly does not guarantee accuracy on getting subsector's energy consumption and GHG emissions, but do not interfere about having how much energy or emissions can increase or decrease with the new sector in the entire Brazilian economy.

3.3. PROPOSED I-O MODEL – a didactic approach

Suppose an economy with 12 sectors S_n ($n = 12$) and 19 products Q_m ($m = 19$), described as follows: S_1 – MBT+WtE; S_2 – Extraction of Non-Metallic Minerals; S_3 – Other from Extractive Industry; S_4 – Chemical Products; S_5 – Aluminum's Metallurgy; S_6 – Paper and Cardboard; S_7 – Glass; S_8 – Resins and Elastomers Manufacturers; S_9 – Rubber and Plastic; S_{10} – Oil Based Electricity Generation; S_{11} – Urban Cleaning Service; and S_{12} – Other from Economy. And taking into account their products: Q_1 – Organic composts; Q_2 – Aluminum Scrap; Q_3 – Paper Scrap; Q_4 – Glass Scrap; Q_5 – Plastic Scrap; Q_6 – Electricity; Q_7 – MSW Treatment Service; Q_8 – Minerals Extraction for Fertilizers and Other Chemicals Products; Q_9 – Non-Metallic Minerals; Q_{10} – Non-Ferrous Metallic Minerals; Q_{11} – Inorganic Chemical Products; Q_{12} – Aluminum Metallurgy; Q_{13} – Paper and Cardboard; Q_{14} – Glass and Products; Q_{15} – Resins; Q_{16} – Rubber and Plastic Articles; Q_{17} – Oil Based Electricity; Q_{18} – Urban Cleaning Service; and Q_{19} – Other Products from Economy. The model's formulation derives from a system of equations based on Use (U) and Make (V) matrices whose structures are in **Figure 2** and **Figure 3**. Here, MBT+WtE and its products are mentioned but not used.

The matrix U shows sectors and products used in existing productions. The products used in the production of each sector are in the matrix V.

The linear system of equations related to the didactic model is as follows below:

I. Equation from Make Matrix (V) based on Products considering the new MBT+WtE sector (E. 1):

$$Q = C^T \cdot X_1 \quad (E. 1)$$

$$[Q] = \begin{bmatrix} 0,10 \\ 0,30 \\ \dots \\ 0,05 \end{bmatrix} \cdot X_1 \Rightarrow \begin{bmatrix} Q_1 \\ Q_2 \\ \dots \\ Q_7 \end{bmatrix} = \begin{bmatrix} 0,10 \\ 0,30 \\ \dots \\ 0,05 \end{bmatrix} \cdot X_1$$

$$E. 1 - 1) Q_1 = 0,10 \cdot X_1 \Rightarrow 0,10 \cdot X_1 - Q_1 = 0$$

$$E. 1 - 2) Q_2 = 0,30 \cdot X_1 \Rightarrow 0,30 \cdot X_1 - Q_2 = 0$$

⋮

$$E. 1 - 7) Q_7 = 0,05 \cdot X_1 \Rightarrow 0,05 \cdot X_1 - Q_7 = 0$$

Where:

X_1 – Production value from sector 1 (MBT+WtE)

C^T – Production technical coefficients in a sector

Q – Values of 7 seven products from MBT+WtE sector

Based on the economy from **Figure 3** and its tech coefficients, there are seven equations (E. 1).

II. **Equation from Make Matrix (V) considering existing sectors in the economy and based on their types of industries (E. 2):**

$$X = D \cdot Q \quad (\text{E. 2})$$

$$\begin{bmatrix} X_2 \\ X_3 \\ \dots \\ X_{12} \end{bmatrix} = D \cdot \begin{bmatrix} Q_8 \\ Q_9 \\ \dots \\ Q_{19} \end{bmatrix}$$

$$\text{E. 2 - 8) } X_2 = 0,95 \cdot Q_8 + \dots + 0,01 \cdot Q_{19}$$

⋮

$$\text{E. 2 - 18) } X_{12} = 0,05 \cdot Q_8 + \dots + 0,95 \cdot Q_{19}$$

Where:

X_n – Production value from 11 sectors of the economy

D – Production technical coefficients from a product in several sectors

Q – Values from 12 products in 11 sectors of the economy

Based on the economy from **Figure 3** with its technical production coefficients, there are 11 equations (E. 1).

III. **Equations for the destiny of the MBT+WtE's products in Use Matrix (U)(E. 3):**

$$Z + E = Q \quad (\text{E. 3})$$

$$\text{E. 3 - 9) } Z_1 + E_1 = Q_1$$

$$\text{E. 3 - 20) } Z_2 + E_2 = Q_2$$

⋮

$$\text{E. 3 - 23) } Z_5 + E_5 = Q_5$$

$$\text{E. 3 - 24) ... 33) } \left(\sum_{j=2}^{12} Z_{6,j} \right) + E_6 = Q_6$$

$$\text{E. 3 - 34) ... 43) } \left(\sum_{j=2}^{12} Z_{7,j} \right) + E_7 = Q_7$$

Based on the economy from **Figure 4**, there are seven equations (E. 3) where MBT+WtE's products are in the economy.

iv. **Equations which represent the destiny of the existing products in the economy and shown in the**

Use Matrix (U):

$$(B \cdot X) + E = Q \quad (\text{E. 4})$$

$$\text{E. 4 - 44) } (0,00 \cdot X_2 + 0,00 \cdot X_3 + \dots + 0,00 \cdot X_{11} + 0,00 \cdot X_{12}) + E_8 = Q_8$$

$$\text{E. 4 - 45) } (0,00 \cdot X_2 + 0,00 \cdot X_3 + \dots + 0,00 \cdot X_{11} + 0,02 \cdot X_{12}) + E_9 = Q_9$$

⋮

$$\text{E. 4 - 46) } (0,25 \cdot X_2 + 0,32 \cdot X_3 + \dots + 0,34 \cdot X_{11} + 0,51 \cdot X_{12}) + E_{19} = Q_{19}$$

Where:

B – Use technical coefficient from a product in a sector

X – Production value of the sector

B · X – Part of the products from the economy destined to the intermediary consumption

E – Part of the products from the economy destined to the final demand

Q – Products' value from the economy

In the economy from **Figure 5** with its technical coefficients, there are 12 equations (E. 4).

v. **Equations for replacing “virgin” products with the ones produced by MBT+WtE sector:**

$$Z + U = B \cdot X \quad (\text{E. 5})$$

$$\text{E. 5 - 47) } Z_{1,4} + U_{1,4} = 0,200 \cdot X_4$$

⋮

$$\text{E. 5 - 50) } Z_{4,7} + U_{4,7} = 0,150 \cdot X_7$$

$$\text{E. 5 - 51) } Z_{5,9} + U_{5,9} = 0,350 \cdot X_9$$

$$\text{E. 5 - 52) } Z_{6,2} + U_{6,2} = 0,002 \cdot X_2$$

⋮

$$\text{E. 5 - 62) } Z_{6,12} + U_{6,12} = 0,000 \cdot X_{12}$$

$$\text{E. 5 - 63) } Z_{7,2} + U_{7,2} = 0,001 \cdot X_2$$

$$\text{E. 5 - 64) } Z_{7,12} + U_{7,12} = 0,001 \cdot X_{12}$$

Where:

Z – Recyclable's product value produced by MBT+WtE sector

U – Value of the “virgin” product, which will be replaced by MBT+WtE's products.

As an example, it is shown the value of the product plastic scrap ($Z_{5,9}$) replacing resins value ($U_{5,9}$), attending the product's tech coefficient (**B**) in the sector Rubber and Plastic (X_9):

$$X_9 = \left(\frac{U_{5,9} + Z_{5,9}}{0,350} \right) \quad (\text{E. 6})$$

Here it is necessary to consider a Techno-Economic Factor (r) to replace “virgin” for recyclable materials because there are relevant market restrictions to recyclables usage. Thus, the equation (E. 6) to be considered in the model is:

$$X = \left[\frac{U + \left(\frac{Z}{r} \right)}{B} \right] \quad (\text{E. 7})$$

On a hypothetical case with a Product (P) blended with 60% of recyclable costing (y) 50 less than a “virgin” one, equation (E. 7) is:

$$r_P = \left[\frac{0,60 \cdot \left(\frac{y}{2} \right)}{0,40 \cdot y} \right] = \left(\frac{0,30}{0,40} \right) = 0,75 \quad (\text{E. 8})$$

This rational (E. 8) represents 1.0 monetary unit of “virgin” replaced by 0.75 monetary unit of recyclable.

The number of equations here is 27, taking into account the information in **Figure 4** and **Figure 5**.

VI. Equations from Final Demands (E) for the recyclable and “virgin” products to the Families and Government, such as Electricity and Urban Cleaning Service:

$$\text{E. 9 – 65) } E_6 + E_{17} = E_{17}^0 \quad (\text{E. 9})$$

$$\text{E. 9 – 66) } E_7 + E_{18} = E_{18}^0 \quad (\text{E. 10})$$

Where:

E_6 – Final demand for the product Electricity produced by the MBT+WtE sector

E_7 – Final demand for the product Urban Cleaning Service offered by the MBT+WtE sector

E_{17}^0 – Initial demand for the product Electricity based on oil fuel in the economy

E_{18}^0 – Initial demand for the product Urban Cleaning Service in the economy

E_{17} – Final demand for the Electricity considering the MBT+WtE supply

E_{18} – Final demand for the Urban Cleaning, considering the MBT+WtE supply

In this opportunity will not be considered the Techno-Economic Factor (r) because there’s no restriction to use the electricity or the cleaning service supplied by the MBT+WtE sector.

Here are only two equations (E. 9) and (E. 10) based on data from **Figure 5**.

VII. Equations to get the new amount of “virgin” when the MBT+WtE sector begins to work in the economy:

$$E_i = \alpha_{i,j} \cdot E_i^0 \quad (\text{E. 11})$$

$$\text{E. 11 – 67) } E_{17} = \alpha_{17,E_{17}} \cdot E_{17}^0 = 10 \cdot E_{17}^0$$

$$\text{E. 11 – 68) } E_{18} = \alpha_{18,E_{18}} \cdot E_{18}^0 = 2 \cdot E_{18}^0$$

$$U_{i,j} = \alpha_{i,j} \cdot U_{i,j}^0 \quad (\text{E. 12})$$

$$\text{E. 12 – 69) } U_{6,2} = \alpha_{6,2} \cdot U_{6,2}^0$$

⋮

$$\text{E. 12 – 79) } U_{6,12} = \alpha_{6,12} \cdot U_{6,12}^0$$

$$\text{E. 12 – 80) } U_{7,2} = \alpha_{7,2} \cdot U_{7,2}^0$$

⋮

$$\text{E. 12 – 90) } U_{7,12} = \alpha_{7,12} \cdot U_{7,12}^0$$

Where:

E_i – New final demand considering the “virgin” products i

E_i^0 – Initial demand for the “virgin” products i

$U_{i,j}$ – New use to the “virgin” product i for the sector j

$U_{i,j}^0$ – Initial use to “virgin” product i for the sector j

$\alpha_{i,j}$ – Adjustment factor to get the new amount of “virgin” products i, Electricity based on fuel oil and Urban Cleaning Service, for the sectors j

The total equations are 24, based on data in **Figure 5**.

With 90 equations and 108 variables in this didactic model, it is possible to get ENDOGENOUS (M) and EXOGENOUS (N) matrixes in an equilibrium market hypothesis:

$$M + N = 0 \quad (\text{E. 13})$$

Where:

M – Values of Supply

N – Values of Demand

The ENDOGENOUS matrix (M) is in **Figure 6**, and it considers only intermediary consumption data.

It is important to separate demand’s variables (or EXOGENOUS) to get the impact of introducing the MBT+WtE sector in the SUPPLY (M); including those from the new sector and its production value (see **Figure 7**).

It is from this matrix that which the SHOCK value (Y) is done on the DEMAND (N) as shown in **Figure 8**. Multiplying the matrices $[-N]_{90 \times 18} \cdot [EXOGENOUS\ VARIABLES]_{18 \times 1}$ the SHOCK value is obtained to be done on the economy's intermediary consumption, as follows:

$$[M]_{90 \times 90}^{-1} \cdot [SHOCK]_{90 \times 1} = [IMPACT]_{90 \times 1} \quad (E. 14)$$

This IMPACT is noted on the ENDOGENOUS VARIABLES, or on the new composition of products from the MBT+WtE sector and the existing ones in the economy (see **Figure 9**).

The introduction of this new sector in the economy brings new alternative products and services, including jobs, which could socially and economically impact the regional and national economy through the amount of MSW generated.

Once impacted, it is possible to analyze the economy with the new sector through Direct and Indirect effects on Production values (X), as shown below:

$$X = X_{\text{direct}} + X_{\text{indirect}} \quad (E. 15)$$

The Production value affected by the direct effects (X_{direct}) comes from the SHOCK (Y) and the direct inputs from several economy's sectors (n):

$$X_{\text{direct}} = Y + \sum_1^n A^n \cdot Y \quad (E. 16)$$

Alternatively:

$$X_{\text{direct}} = (I + A) \cdot Y \quad (E. 17)$$

Remember that:

$$X = (I - A)^{-1} \cdot Y \quad (E. 18)$$

Then:

$$X_{\text{indirect}} = X - X_{\text{direct}} \quad (E. 19)$$

The Value of the Products (Q) with the equation (E. 4) in (E. 2) offers:

$$B \cdot D \cdot Q + E = Q$$

$$E = Q - B \cdot D \cdot Q$$

$$E = (I - B \cdot D) \cdot Q$$

$$Q = (I - B \cdot D)^{-1} \cdot E \quad (E. 20)$$

Thus, with the equation (E. 17), the value of products under direct effect (Q_{direct}), is given by:

$$Q_{\text{direct}} = (I + B \cdot D) \cdot E \quad (\text{E. 21})$$

As in (E. 19):

$$Q_{\text{indirect}} = Q - Q_{\text{direct}} \quad (\text{E. 22})$$

3.4. TECHNICAL AND ECONOMIC FACTS ABOUT USING RECYCLABLES

The use of recyclables replacing “virgin” raw materials offers some advantages, mainly as regards to saving resources, such as:

- *Energy*
- *Water*
- *Minerals*
- *Fuels*
- *Other*

Once recyclable materials save part of the value chain, it is reasonable to expect a sensitive GHG emission reduction, detailed in subsection 3.2.

However, it must be considered technical and economic aspects when replacing “virgins” to recyclables.

Concerning technical aspects, it is important to emphasize negative impacts about reprocessing and contamination, which can compromise recyclables use. A classic example is that one for plastic materials. In the process of transformation into products, the thermal and mechanical cycle can break primary chemical bonds, which results in reducing some mechanical properties, such as tensile strength. Once the product reaches the end of its life, and after its discard to be reprocessed, it is foolhardy its use in the same application. In Brazil, the National Health Surveillance Agency (ANVISA) prohibits to use recyclable plastics to produce packaging and appliances that will be in contact with food. However, excepting other applications such as automotive, plastic bags, containers and other domestic appliances can have from 20% to 100% of recyclables in their composition [26]. In bags used to carry waste is common to be produced using 100% recycled plastic. They have mechanical resistance and some losses of visual aspect improved with increasing the thickness and using some pigments, dyes or whitening.

From an economic point of view, it is common to find a range of prices for recyclable plastics, which goes from 20 to 80% of the “virgin” product.

So, taking as a basis the example where, technically, in average is found blends with 60% of recyclable plastics, the total cost for the raw material is:

$$\text{Total Cost (raw material)} = 0.60 \cdot \text{Price for recyclable} + 0.40 \cdot \text{Price for "virgin"}$$

Considering the economic factor where, on average, the recyclable costs 50% less than the “virgin”, the cost is:

$$\text{Total Cost (raw material)} = 0.60 \cdot (0.50 \cdot \text{Price for "virgin"}) + 0.40 \cdot \text{Price for virgin}$$

Calculating the Techno-Economic Factor (r) to replace “virgin” for recyclable:

$$r_{\text{Plastic}} = \frac{0.60 \cdot (0.50 \cdot \text{Price for "virgin"})}{0.40 \cdot \text{Price for "virgin"}} = \frac{0.30}{0.40} = 0.75$$

Other recycled materials, such as paper and organic, also follow the same rationale that considers technical and economic factors. However, there are instances where there is no technical restriction on product replacement, for example, is the case of aluminum scrap. Thus, it assumes that 100% recycled can be used for just the price of the recycled product and "Virgin". By the Brazilian Aluminum Association (ABAL) and Business Commitment for Recycling (CEMPRE), in 2009 the average price of scrap aluminum was 2,800 R\$/t, while the aluminum "Virgin" on average was R\$ 3,279/t [27], [28]. Thus, the calculation of r factor of aluminum replacement will be:

$$r_{\text{Aluminum}} = \frac{\text{Price for recyclable}}{\text{Price for "virgin"}} = \frac{\text{R\$ 2,800/t}}{\text{R\$ 3,279/t}} = 0.85$$

Besides aluminum, recycled glass, as well as electricity and MSW treatment service, offered by the large-scale integrated model in this article, also follow considering in their r factor the price ratio because there is no technical restriction to replace. In **Table A 7** are presented the technical-economic factors (r) mentioned in subsection 3.3 and used in the results discussed in Chapter 4.

Thus, the r factor must be read, for example in the use of plastic, as 0.75 monetary value of recyclable replaces each one monetary value expended to the "Virgin" plastic.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

The model presented in this article was fed with the inter-regional economic transactions of 62 sectors and 116 products shown in Use (U) and Make (V) matrices estimated by GUILHOTO [16] and updated by the author to the year 2013, based on IBGE.

The impact in the regional economy is the introduction of the MBT+WtE sector treating 100% of MRSP’s MSW in 2013, and the results come from direct and indirect effects into the region, state, and country.

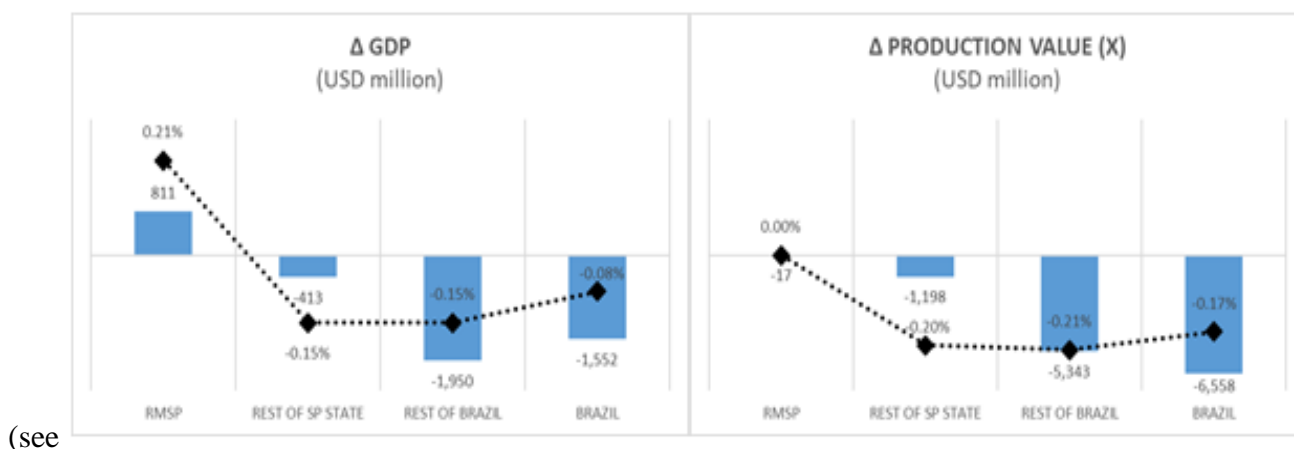
Section 4.1 shows and discusses the results from the socio-economic point of view, where Production Value (X), Jobs and Gross Domestic Product (GDP) are the main factors.

The estimated new environmental and energetic scenarios are in section 4.2 where there are Greenhouse Gases (GHG), and Energy Consumption results considering the operation of the MBT+WtE sector at MRSP.

4.1. SOCIOECONOMIC IMPACTS

According to the model that considers establishing an MBT+WtE sector at MRSP, the effects over the regional economy would be, predominantly, indirect ones (see **Table B 1**).

The metropolitan’s GDP would increase by 0.21% keeping the same level of production value in 2013



Figure

10a

and

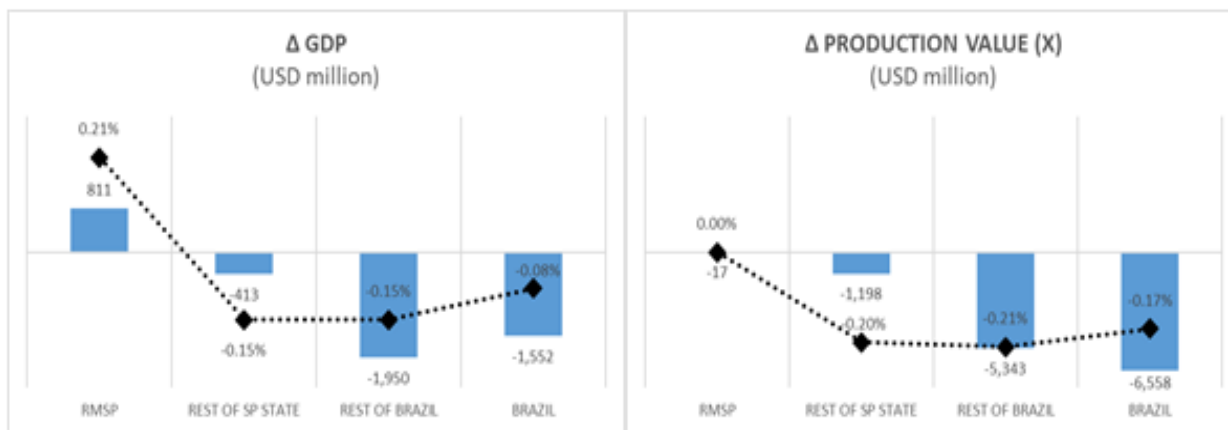


Figure 10b). The new sector (**S0 – MBT+WTE**) would be responsible for adding value to the local economy by itself, and demanding local services from sectors **S40 – Electricity, Gas, Water, Sewage and Urban Cleaning** (+0.1%) and **S47 – Maintenance and Repair Services** (+2.7%) to keep its 12 facilities working. And, on the other hand, reducing values from sectors related to current cleaning services, organic composts and recyclables, such as: **S62 – Urban Cleaning Services** (-49.8%), **S5 – Other from Extractive Industry** (-12.3%), **S17 – Resins and Elastomers Production** (-5.8%), **S58 – Production of Paper, Cardboard and their Products** (-5.2%) and **S57 – Non-Metallic Minerals Extraction** (-3.0%), detailed in **Table C 1** and **Table E 1**.

Another sector strongly impacted would be the **S61 – Electricity Production** (fuel oil-based). Considering a total installed capacity of 504 MW and selling energy cheaper than the fossil fuel-based one, the new sector would decrease by 25% the demand for a thermoelectric generation in São Paulo State or 2% in Brazil. The amount of electricity would be enough to cover 100% of the State's demand for public lighting.

Both, rest of São Paulo State and Brazil would have their GDP and production value decreased by 0.15% and 0.20%, respectively.

An MBT+WtE sector at MRSP treating 100% of all its waste would decrease Brazilian's GDP and production value.

The potential MBT+WtE's job creation is 10,678 opportunities in the MRSP. Moreover, as presented in **Table D 1**, the new sector would mean an increment of 10,559 jobs (+0.08%) taking account, approximately, the total of 12.6 million ones (see **Figure 11**). Sectors producers of Papers and Plastics would be slightly impacted (-0.50% or 219 jobs) despite being more efficient than recyclables collection's supply from the new sector. On the other hand, demanded services (i.e., maintenance to recycling and WtE

assets) in the local economy represented by the sector **S47 – Maintenance and Repair Services** would have +0.19% (or 562) job opportunities.

The impact in the rest of São Paulo State would be less 691 jobs or -0.01% of the total 9.8 million opportunities. The sectors most impacted would be those who produce Papers and their Forestry raw material with almost -0.4% (or 254) jobs.

In the rest of the country, the indirect effect of MRSP's new sector on the losses of jobs would be even higher in absolute numbers (-5,061 jobs), or -0.01% of the total, approximately, 80.0 million ones. In this case, the sectors with more significant losses would be those who produce Paper, Non-Metallic Minerals Extraction and Services decreased by recyclables' supply.

However, nationally speaking, the new MBT+WtE sector working at MRSP would increase up to 4,807 jobs in 2013.

4.2. IMPACTS ON ENERGY CONSUMPTION AND GHG EMISSIONS

Energy Consumption and GHG Emissions' inventories, presented in section 3.2, fed the I-O model proposed in this article. As a result, the MRSP would have a reduction of 0.31% in its energy consumption, and 3.4% in GHG emissions (or 2.99 Mton CO₂ eq), as shown in **Figure 12a** and **Figure 12b**. The answer to that comes from the indirect effect of the sector's installation. It would offer MSW treatment (alternative to landfill and without releasing CH₄), electricity produced with RDF (alternative to oil based), recyclable raw materials (metal, plastic, glass, and paper) and organic compost (fertilizer).

Less energy consumed when replacing the use of "virgins", fewer greenhouse emissions when reducing raw materials consumption, and choosing release CO₂ instead of CH₄ within WtE process.

In **Table F 1** is shown that the sectors that most contribute to the reduction of energy consumption would be the **S58 – Production of Paper, Cardboard and their Products**, **S17 – Resins and Elastomers Production** and **S61 – Electricity Production** (oil based).

It is also possible to verify an energy consumption reduction of 0.3% in both regions, the rest of São Paulo State and the rest of Brazil. A highlight to the great contribution of the sector **S58 – Production of Paper, Cardboard, and their Products** depending on the production localization and the weight of their energy consumption level in the economy.

In **Table G 1** is possible to note the model points to GHG emission reduction in the MRSP, mainly by the **S62 – Urban Cleaning Services** (-95.4%). Certainly, the result is due to the choice of the new MSW treatment without emission of CH₄. In the rest of São Paulo State and the rest of Brazil, the reduction of GHG emissions would be 0.2% and 0.1%, respectively.

GHG releases in all Brazilian territory would reduce by 0.3% due to the direct and indirect effects of the new sector.

CHAPTER FIVE

CONCLUSIONS

Taking into account the results from the simulation, a large-scale model treating 100% of MRSP's MSW would increase 0.21% the GDP of the region in 2013. However, the state and Brazilian would have their ones reduced.

The number of jobs would be increased in the MRSP, resulting almost 4.8 thousand new formal opportunities in Brazil.

On the other hand, energy consumption would reduce by 0.3% in all country. Also, GHG emissions would be in a level 3.4% lower than it was in 2013 at RMSP, or 0.3% lower in Brazil.

The sectors more impacted would be those related to waste treatment services and raw materials producers, mainly paper, plastic, and glass. In the case of waste treatment, the greatest contribution would come from the methane-free waste disposal when the initiative suggests being an alternative to landfills, recycling materials, producing organic composts and electricity. The sectors that produce paper, plastic, and glass would have a significant reduction in the value of generation and jobs, due to the recyclables replacing “virgins” in the economy.

At the same time, what seems to be a problem can be a solution to mitigate, or eliminate losses. These producers could increase their product and business portfolios with post-consumed by-products and electricity for their use.

DECLARATIONS

– AVAILABILITY OF DATA AND MATERIAL

Materials and data availability at UNICAMP Bibliographic Repository (<http://repositorio.unicamp.br/handle/REPOSIP/333323>).

– COMPETING INTERESTS

There are no competing interests affecting this article developed in a public institution of scientific researches.

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– AUTHORS' CONTRIBUTIONS

Through this article, the author intends to promote more discussions about alternatives to treat urban waste and its potential to save and produce energy with notorious benefits to the Brazilian society and environment.

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– AUTHOR'S INFORMATION

A Brazilian researcher with 23 years of experience dedicated to study economic viability and impacts of materials, composites, sources of energy and recycling to the society and environment.

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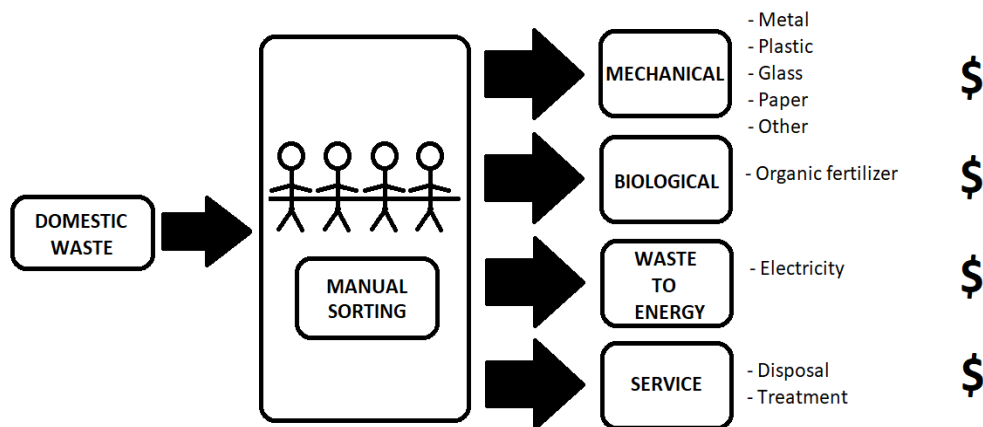


Figure 1. Integrated waste recycling plant, or MBT+WtE facility

Use Matrix (U) $T_{Initial}$	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	E	Q	
	MBT+WtE	Extraction of Non-Metallic Minerals	Other from Extractive Industry	Chemical Products	Metallurgy of Aluminum	Paper and Cardboard	Glass	Resins and Elastomers Production	Rubber and Plastic	Electricity Generation (oil based)	Urban Cleaning Service	Other from Economy	Final Demand		
Q_1 Organic Compounds	$Z_{1,4}$												E_1		
Q_2 Aluminum scrap	$Z_{2,5}$												E_2		
Q_3 Paper scrap	$Z_{3,6}$												E_3		
Q_4 Glass scrap	$Z_{4,7}$												E_4		
Q_5 Plastic scrap	$Z_{5,9}$												E_5		
Q_6 Electricity	$Z_{6,2}$	...	...	...	...	...	...	...	...	...	...	$Z_{6,12}$	E_6	
Q_7 Service of MSW Treatment	$Z_{7,2}$	...	...	...	...	...	...	...	...	...	...	$Z_{7,12}$	E_7	
Q_8 Extration of Minerals for Fertilizers and Other Chemical Products	27.76												10.00	37.76	
Q_9 Non-Metallic Minerals				6.94				11.05				27.00	20.00	64.99	
Q_{10} Non-Ferrous Metallic Minerals				2.78	12.06							40.50	25.00	80.34	
Q_{11} Inorganic Chemical Products	11.29	7.48	8.33	0.80	8.06	5.16	4.07	0.86	0.26	0.04	54.00	15.00		115.34	
Q_{12} Aluminum's Metallurgy					3.22							27.00	10.00	40.60	
Q_{13} Paper and Cardboard			2.14	1.39	1.21	25.20	0.74	0.68	0.86	0.13	0.04	40.50	30.00	102.87	
Q_{14} Glass and its Products				1.39			1.01	3.68					27.00	40.00	74.44
Q_{15} Resins	29.98											13.50	25.00	68.48	
Q_{16} Rubber and Plastics parts	5.65	2.14	5.55	4.02	3.02	1.47	1.36	2.57	0.38	0.14	27.00	35.00		88.30	
Q_{17} Electricity (oil based)	0.21	0.54	0.41	0.18	0.44	0.44	0.21	0.10	0.01	0.03	0.20	10.00		12.78	
Q_{18} Urban Cleaning Service	0.12	0.07	0.13	0.01	0.16	0.04	0.02			0.01			1.20	2.00	3.77
Q_{19} Other Products from Economy	28.24	34.17	55.52	8.04	24.19	15.48	28.47	14.56	4.98	1.20	688.52	500.00		1,403.38	
X^T Production Value													(monetary units)		
	112.95	106.80	138.80	40.19	100.81	73.69	67.79	85.66	12.78	3.54	1,350.04				

Figure 2. Original Use matrix (U) based on the type of industries and products (combined technology) - color

Make Matrix (V)	Q ₁	Q ₂	Q ₃	Q ₄	Q ₅	Q ₆	Q ₇	Q ₈	Q ₉	Q ₁₀	Q ₁₁	Q ₁₂	Q ₁₃	Q ₁₄	Q ₁₅	Q ₁₆	Q ₁₇	Q ₁₈	Q ₁₉
	Organic Compounds	Aluminum scrap	Paper scrap	Glass scrap	Plastic scrap	Electricity	Service of MSW Treatment	Extraction of Minerals for Fertilizers and Other Chemical Products	Non-Metallic Minerals	Non-Ferrous Metallic Minerals	Inorganic Chemical Products	Aluminum's Metallurgy	Paper and Cardboard	Glass and its Products	Resins	Rubber and Plastics parts	Electricity (oil based)	Urban Cleaning Service	Other Products from Economy
X ₁	MBT+WtE	0.10	0.30	0.10	0.05	0.20	0.20	0.05											
X ₂	Extraction of Non-Metallic Minerals								0.9500	0.9700									0.0100
X ₃	Other from Extractive Industry									0.9800									0.0200
X ₄	Chemical Products									0.9600									0.0200
X ₅	Metallurgy of Aluminum										0.9900								
X ₆	Paper and Cardboard											0.9800							
X ₇	Glass												0.9900						
X ₈	Resins and Elastomers Production													0.9900					
X ₉	Rubber and Plastic														0.9700				
X ₁₀	Electricity Generation (oil based)															1.0000			
X ₁₁	Urban Cleaning Service																	0.9400	
X ₁₂	Other from Economy								0.0500	0.0300	0.0200	0.0400	0.0100	0.0200	0.0100	0.0100	0.0300	0.0600	0.9500

Figure 3. Make matrix (V) based on the type of industries and products (combined technology) – color

Use Matrix (U) T _{final}	X ₁	X ₂	X ₃	X ₄	X ₅	X ₆	X ₇	X ₈	X ₉	X ₁₀	X ₁₁	X ₁₂	E
	MBT+WtE	Extraction of Non-Metallic Minerals	Other from Extractive Industry	Chemical Products	Metallurgy of Aluminum	Paper and Cardboard	Glass	Resins and Elastomers Production	Rubber and Plastic	Electricity Generation (oil based)	Urban Cleaning Service	Other from Economy	Final Demand
Q ₁	Organic Compounds	Z _{1,4}											E ₁
Q ₂	Aluminum scrap	Z _{2,5}											E ₂
Q ₃	Paper scrap	Z _{3,6}											E ₃
Q ₄	Glass scrap	Z _{4,7}											E ₄
Q ₅	Plastic scrap	Z _{5,9}											E ₅
Q ₆	Electricity	Z _{6,2}	...	...	...	...	...	...	...	...	...	Z _{6,12}	E ₆
Q ₇	Service of MSW Treatment	Z _{7,2}	...	...	...	...	...	...	...	...	...	Z _{7,2}	E ₇
Q ₈	Extraction of Minerals for Fertilizers and Other Chemical Products	U _{1,4}											E ₈
Q ₉	Non-Metallic Minerals	U _{4,7}											E ₉
Q ₁₀	Non-Ferrous Metallic Minerals	U _{2,5}											E ₁₀
Q ₁₁	Inorganic Chemical Products	U _{3,6}											E ₁₁
Q ₁₂	Aluminum's Metallurgy	U _{3,6}											E ₁₂
Q ₁₃	Paper and Cardboard	U _{3,6}											E ₁₃
Q ₁₄	Glass and its Products	U _{3,6}											E ₁₄
Q ₁₅	Resins	U _{5,9}											E ₁₅
Q ₁₆	Rubber and Plastics parts	U _{5,9}											E ₁₆
Q ₁₇	Electricity (oil based)	U _{6,2}	...	...	...	...	...	...	...	...	...	U _{6,12}	E ₁₇
Q ₁₈	Urban Cleaning Service	U _{7,2}	...	...	...	...	...	...	...	...	...	U _{7,12}	E ₁₈
Q ₁₉	Other Products from Economy	U _{7,12}											E ₁₉

(monetary units)

Figure 4. Proposed Use Matrix (U) considering the new MBT+WtE sector - color

Technical Coefficients Matrix (B) $T_{initial}$		X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	E		
		MBT+MVE	Extraction of Non-Metallic Minerals	Other from Extractive Industry	Chemical Products	Metallurgy of Aluminum	Paper and Cardboard	Glass	Resins and Elastomers Production	Rubber and Plastic	Electricity Generation (oil based)	Urban Cleaning Service	Other from Economy	Final Demand		
Q_1	Organic Compounds	$Z_{1,4}$											E_1			
Q_2	Aluminum scrap	$Z_{2,5}$											E_2			
Q_3	Paper scrap	$Z_{3,6}$											E_3			
Q_4	Glass scrap	$Z_{4,7}$											E_4			
Q_5	Plastic scrap	$Z_{5,9}$											E_5			
Q_6	Electricity	$Z_{6,2}$	...	...	...	...	...	...	...	...	...	...	$Z_{6,12}$	E_6
Q_7	Service of MSW Treatment	$Z_{7,2}$	...	...	...	...	...	...	...	...	...	...	$Z_{7,2}$	E_7
Q_8	Extraction of Minerals for Fertilizers and Other Chemical Products	0.200											10			
Q_9	Non-Metallic Minerals	0.050											0.150	0.020	20	
Q_{10}	Non-Ferrous Metallic Minerals	0.020											0.300	0.030	25	
Q_{11}	Inorganic Chemical Products	0.100	0.070	0.060	0.020	0.080	0.070	0.060	0.010	0.020	0.010	0.040	0.040	15		
Q_{12}	Aluminum's Metallurgy	0.080											0.030	0.020	10	
Q_{13}	Paper and Cardboard	0.020	0.010	0.030	0.250	0.010	0.010	0.010	0.010	0.010	0.010	0.030	0.030	30		
Q_{14}	Glass and its Products	0.010											0.050	0.020	0.020	40
Q_{15}	Resins	0.350											0.010	25		
Q_{16}	Rubber and Plastics parts	0.050	0.020	0.040	0.100	0.030	0.020	0.020	0.030	0.030	0.040	0.020	0.020	35		
Q_{17}	Electricity (oil based)	0.002	0.005	0.003	0.005	0.004	0.006	0.003	0.001	0.001	0.009	0.000	0.000	10		
Q_{18}	Urban Cleaning Service	0.001	0.001	0.001	0.000	0.002	0.001	0.000	0.000	0.001	0.001	0.001	0.001	2		
Q_{19}	Other Products from Economy	0.250	0.320	0.400	0.200	0.240	0.210	0.420	0.170	0.390	0.340	0.510	500			

Figure 5. Original Technical Coefficients' Matrix (B) from the economy – color

	X_2	...	X_{12}	Q_1	...	Q_{19}	E_6	E_7	E_{17}	E_{18}	Z_1	...	Z_5	$Z_{6,2}$	...	$Z_{6,12}$	$Z_{7,2}$	...	$Z_{7,12}$	$U_{1,4}$	...	$U_{5,9}$	$U_{6,2}$	...	$U_{6,12}$	$U_{7,2}$	...	$U_{7,12}$	$\alpha_{17,j}$	$\alpha_{18,j}$
Eq.1	0,000	...	0,000	-1,000	...	0,000	0,000	0,000	0,000	0,000	0,000	...	0,000	0,000	...	0,000	0,000	...	0,000	0,000	...	0,000	0,000	...	0,000	0,000	...	0,000	0,000	0,000
Eq.7	0,000	...	0,000	0,000	...	0,000	0,000	0,000	0,000	0,000	0,000	...	0,000	0,000	...	0,000	0,000	...	0,000	0,000	...	0,000	0,000	...	0,000	0,000	...	0,000	0,000	0,000
Eq.8	-1,000	...	0,000	0,000	...	0,010	0,000	0,000	0,000	0,000	0,000	...	0,000	0,000	...	0,000	0,000	...	0,000	0,000	...	0,000	0,000	...	0,000	0,000	...	0,000	0,000	0,000
Eq.18	0,000	...	-1,000	0,000	...	0,950	0,000	0,000	0,000	0,000	0,000	...	0,000	0,000	...	0,000	0,000	...	0,000	0,000	...	0,000	0,000	...	0,000	0,000	...	0,000	0,000	0,000
Eq.19	0,000	...	0,000	-1,000	...	0,000	0,000	0,000	0,000	0,000	1,000	...	0,000	0,000	...	0,000	0,000	...	0,000	0,000	...	0,000	0,000	...	0,000	0,000	...	0,000	0,000	0,000
Eq.25	0,000	...	0,000	0,000	...	0,000	0,000	1,000	0,000	0,000	0,000	...	0,000	0,000	...	0,000	1,000	...	1,000	0,000	...	0,000	0,000	...	0,000	0,000	...	0,000	0,000	0,000
Eq.26	0,000	...	0,000	0,000	...	0,000	0,000	0,000	0,000	0,000	0,000	...	0,000	0,000	...	0,000	0,000	...	0,000	1,000	...	0,000	0,000	...	0,000	0,000	...	0,000	0,000	0,000
Eq.37	0,250	...	0,510	0,000	...	-1,000	0,000	0,000	0,000	0,000	0,000	...	0,000	0,000	...	0,000	0,000	...	0,000	0,000	...	0,000	0,000	...	0,000	0,000	...	0,000	0,000	0,000
Eq.38	0,000	...	0,000	0,000	...	0,000	0,000	0,000	0,000	0,000	1,000	...	0,000	0,000	...	0,000	0,000	...	0,000	1,000	...	0,000	0,000	...	0,000	0,000	...	0,000	0,000	0,000
Eq.64	0,000	...	-0,001	0,000	...	0,000	0,000	0,000	0,000	0,000	0,000	...	0,000	0,000	...	0,000	0,000	...	0,000	0,000	...	0,000	0,000	...	0,000	0,000	...	0,000	0,000	0,000
Eq.65	0,000	...	0,000	0,000	...	0,000	1,000	0,000	1,000	0,000	0,000	...	0,000	0,000	...	0,000	0,000	...	0,000	0,000	...	0,000	0,000	...	0,000	0,000	...	0,000	0,000	0,000
Eq.66	0,000	...	0,000	0,000	...	0,000	0,000	1,000	0,000	1,000	0,000	...	0,000	0,000	...	0,000	0,000	...	0,000	0,000	...	0,000	0,000	...	0,000	0,000	...	0,000	0,000	0,000
Eq.67	0,000	...	0,000	0,000	...	0,000	0,000	0,000	0,000	0,000	0,000	...	0,000	0,000	...	0,000	0,000	...	0,000	0,000	...	0,000	-1,000	...	0,000	0,000	...	0,000	0,208	0,000
Eq.90	0,000	...	0,000	0,000	...	0,000	0,000	0,000	0,000	-1,000	0,000	...	0,000	0,000	...	0,000	0,000	...	0,000	0,000	...	0,000	0,000	...	0,000	0,000	...	0,000	0,000	2,000

90 X 90

Figure 6. Matrix for supply (intermediary consumption)

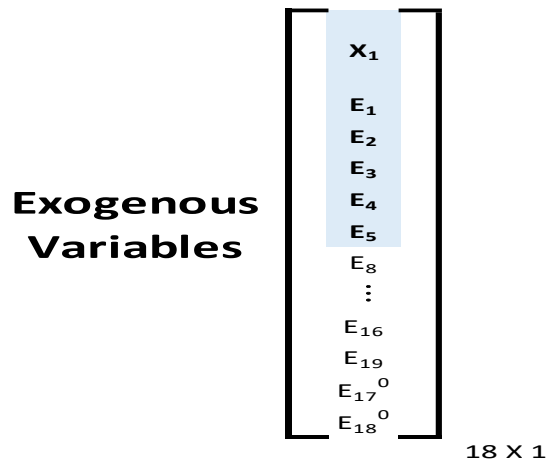


Figure 7. Matrix for Exogenous' variables – color

	X_1	E_1	...	E_5	E_8	...	E_{16}	E_{19}	E_{17}^0	E_{18}^0
Eq.1	-0,100	0,000	...	0,000	0,000	...	0,000	0,000	0,000	0,000
⋮	⋮	⋮	\	⋮	⋮	\	⋮	⋮	⋮	⋮
Eq.7	-0,050	0,000	...	0,000	0,000	...	0,000	0,000	0,000	0,000
Eq.8	0,000	0,000	...	0,000	0,000	...	0,000	0,000	0,000	0,000
⋮	⋮	⋮	\	⋮	⋮	\	⋮	⋮	⋮	⋮
Eq.18	0,000	0,000	...	0,000	0,000	...	0,000	0,000	0,000	0,000
Eq.19	0,000	-1,000	...	0,000	0,000	...	0,000	0,000	0,000	0,000
⋮	⋮	⋮	\	⋮	⋮	\	⋮	⋮	⋮	⋮
Eq.25	0,000	0,000	...	0,000	0,000	...	0,000	0,000	0,000	0,000
Eq.26	0,000	0,000	...	0,000	-1,000	...	0,000	0,000	0,000	0,000
⋮	⋮	⋮	\	⋮	⋮	\	⋮	⋮	⋮	⋮
Eq.37	-0,300	0,000	...	0,000	0,000	...	0,000	-1,000	0,000	0,000
Eq.38	0,000	0,000	...	0,000	0,000	...	0,000	0,000	0,000	0,000
⋮	⋮	⋮	\	⋮	⋮	\	⋮	⋮	⋮	⋮
Eq.64	0,000	0,000	...	0,000	0,000	...	0,000	0,000	0,000	0,000
Eq.65	0,000	0,000	...	0,000	0,000	...	0,000	0,000	1,000	0,000
Eq.66	0,000	0,000	...	0,000	0,000	...	0,000	0,000	0,000	1,000
Eq.67	0,000	0,000	...	0,000	0,000	...	0,000	0,000	0,000	0,000
⋮	⋮	⋮	\	⋮	⋮	\	⋮	⋮	⋮	⋮
Eq.90	0,000	0,000	...	0,000	0,000	...	0,000	0,000	0,000	0,000

90×18

Figure 8. Matrix for demands

Endogenous Variables

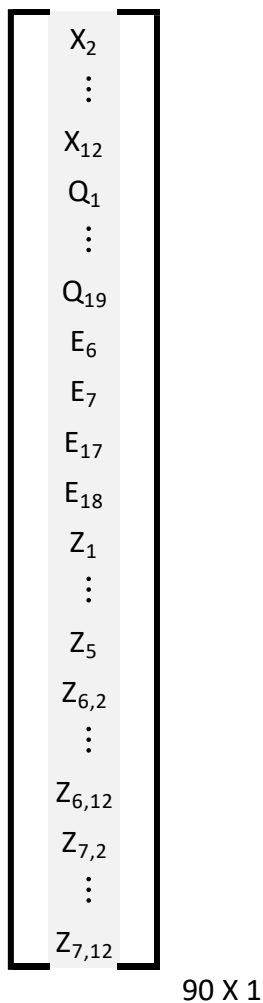


Figure 9. Matrix for Endogenous' variables

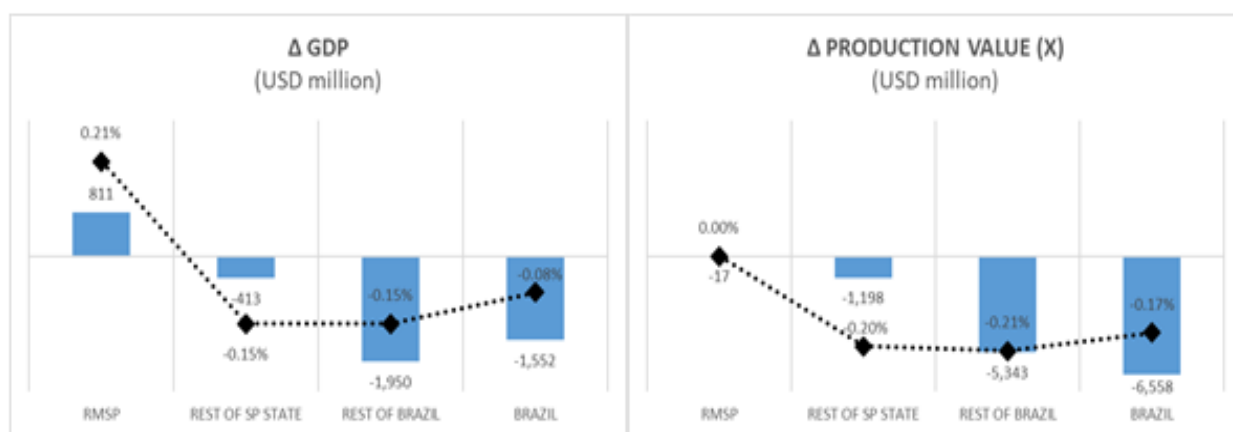


Figure 10. (a) GDP and (b) Production Value in 2013 - color

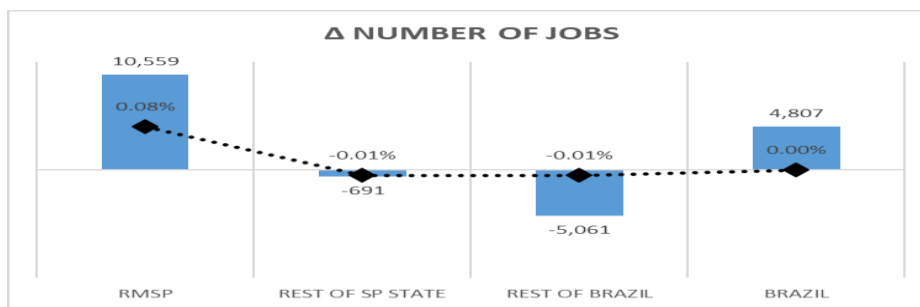


Figure 11. Number of jobs in 2013 – color

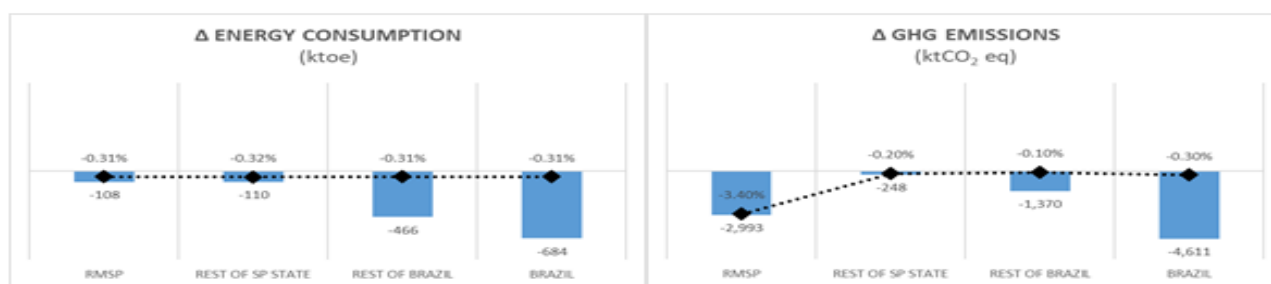


Figure 12. (a) Energy consumption and (b) GHG emissions in 2013 - color

IN	PROCESS FLOW				OUT	
		Process	Fraction	"Raw Materials"	Fraction	PRODUCTS/SERVICE
MSW	100 %	Biological	43%	Organic	43%	Fertilizer
		Mechanical (Recycling)	24%	Paper	8%	Recyclables
				Plastic	8%	
				Metal	1%	
				Glass	1%	
				Other (e.g., electronics)	6%	
		WtE	33%	Dirty plastics	24%	Electricity
Textile, dirty papers, city cleaning	9%					
Urban Waste Service						Treatment
TOTAL	100 %	All Processes	100%	All Recyclables	100%	All Revenues

Table 1. Processes, Materials and Revenues' breakdown

Source: Author's compilation from Table A 2, Table A 3, Table A 4 and Table A 5

Config.	Waste Capacity (mt/day)	Min. LCV (kcal/kg)	Installed Capacity (MW)	Operatio n (h/year)	Electricity Potential (MWh)	Electricity Efficiency
#1	600	1,200	10	8,000	80,000	29%
#2	600	3,200	26	8,000	208,000	28%
#3	600	5,200	42	8,000	336,000	28%
#4	600	6,600	60	8,000	480,000	31%

Table 2. Configurations and Specs for WtE units

Source: CNIM spec and configurations [23]

APPENDIX A. Waste Parameters: Composition, Recyclability, Energy Content and Market

MATERIAL	WET	DRY
	76%	24%
	GRAVIMETRY (%)	
Aluminum	0.46	1.2
Rubber	0.12	1.22
Styrofoam	0.27	0.21
Natural wood	0.71	0.07
Processed wood	0.13	0
Metal	0.58	1.59
Paper	4.97	16.14
Cardboard	2.58	10.71
PET bottles	0.77	1.88
Various plastic	1.11	4.05
PP bags, vessels, and packages	0.86	1.15
PE bags, vessels, and packages	28.73	24.39
Fabric	3.82	4.68
Tetrapack® packages	1.18	3.79
Glass	0.47	2.82
Organics	49.9	19.7
Other (e.g., lamps, batteries, electronics)	3.34	6.4
MSW's TOTAL COMPOSITION (%)	100.00	100.00

Table A 1. Gravimetric composition to the MSW at MRSP

Source: Author's estimate based on SEMASA's data [19]

MRSP's MSW TOTAL (metric ton per day)	21,357.44	
	WTE*	SORTING
	33%	67%
	7,153.29	14,204.15
	MATERIALS	
Aluminum	0.00	136.18
Rubber	19.48	62.53
Styrofoam	43.83	10.76
Natural wood	115.24	3.59
Processed wood	21.10	0.00
Metal	0.00	175.64
Paper	806.71	827.30
Cardboard	418.78	548.97
PET bottles	124.98	96.36
Various plastic	180.17	207.59
PP bags, vessels, and packages	139.59	58.95
PE bags, vessels and packages	4,663.35	1,250.18
Fabric	620.05	239.89
Tetrapack® packages	0.00	385.80
Glass	0.00	220.84
Organics	0.00	9,109.37
Other (e.g., lamps, batteries, electronics)	0.00	870.19

Table A 2. Potential sorting effect on MRSP's MSW treated in the MBT+WtE sector

(*) Considered wet by WTE heating and aerobic process

Source: Author's potential estimate based on SEMASA's data [19]

REVENUE	DESCRIPTION	MARKET'S PRICE				REFERENCE
MSW disposal	Disposal	80	R\$ per metric ton	34	USD per metric ton	[4] [29]
Recyclables	Metal	2,800		1,197		
	Glass	180		77		
	Paper	510		218		
	Plastic	1,700		726		
	Organic compost	125		53		
Energy	Electricity	197	R\$ per MWh	84	USD per MWh	[21]

Table A 3. Price references to the sales revenues**Source:** Author's elaboration based on market references

MATERIAL	Humidity (%)	LCV (kcal per kg)
Organic	66	712
Plastics	17	8,193
Paper or cardboard	21	2,729
Fabric or leather	36	1,921
Wood	25	2,490
Rubber	5	8,633

Table A 4. Lower calorific values for components in wet MSW**Source:** [24]

MSW's COMPONENT	FRACTION		
	33%		
	7,153.29		
	metric ton per day	Composition (%)	LCV (kcal per kg)
Aluminum	0.00	0.00%	0.00
Rubber	19.48	0.27%	23.51
Styrofoam	43.83	0.61%	50.20
Natural wood	115.24	1.61%	40.12
Processed wood	21.10	0.29%	7.35
Metal	0.00	0.00%	0.00
Paper	806.71	11.28%	307.76
Cardboard	418.78	5.85%	159.76
PET bottles	124.98	1.75%	143.15
Various plastic	180.17	2.52%	206.36
PP bags, vessels and packages	139.59	1.95%	159.88
PE bags, vessels and packages	4,663.35	65.19%	5,341.16
Fabric	620.05	8.67%	166.51
Tetrapack® packages	0.00	0.00%	0.00
Glass	0.00	0.00%	0.00
Organics	0.00	0.00%	0.00
Other (e.g., lamps, batteries, electronics)	0.00	0.00%	0.00
MRSP's MSW TOTAL	7,153.29	100.00%	6,605.75

Table A 5. The energetic potential for the fraction destined to the heat treatment

Source: Author's potential estimated based on SEMASA's data [19]

SECTORS	2013	
	Energy Consumption (*)	GHG Emissions (*)
	(10 ³ toe)	(10 ⁶ ton CO ₂ eq)
Transport	83,153	214
Energy (Oil & Gas)	26,139	37
Energy (Ethanol)		14
Energy (Electricity)		67
Food and Beverages	23,339	27
Pig Iron, Steel, Ferrous Alloys	17,781	39
Paper and Cellulose Pulp	10,575	12
Agriculture	10,662	74
Livestock		912
Chemical	6,986	8
Commercial	8,064	2
Non-ferrous and other Metals	6,936	15
Ceramics	5,069	6
Public Services (Public Cleaning)	3,868	48
Public Services (Other)		1
Cement	5,316	42
Mining and Pelleting	3,247	7
Textile	1,101	1
Other	7,945	22
TOTAL	220,181	1,548

Table A 6. Energy consumption and GHG emissions

Source: BEN [30] and SEEG [31]

(*) Residential sector not considered

PRODUCT	Value for Recyclables	Value for “Virgin”	% of Recyclable	% of “Virgin”	r Factor
Waste Treatment (R\$/t) ^a	80	80	100	-	1.00
Aluminum (R\$/t) ^b	2,800	3,279	100	-	0.85
Glass (R\$/t) ^c	180	220	100	-	0.82
Paper (R\$/t) ^d	510	2,737	50	50	0.19
Plastic (R\$/t) ^e	1,700	3,400	60	40	0.75
Organic compost (R\$/t) ^f	125	725	80	20	0.69
Electricity (R\$/MWh) ^g	197	233	100	-	0.85

Table A 7. Techno-Economic Factors to use recyclables (based on 2009’s prices)

Source: Author’s compilation based on following references:

a) [3]; b) [27]; c) [32]; d) [33]; e) [28]; f) [34]; and g) [21].

APPENDIX B. Regional Direct and Indirect Effects

2013's SECTORS OF THE ECONOMY	Metropolitan Region of São Paulo (MRSP)		Rest of São Paulo State		Rest of Brazil		Rest of Brazil	
	Direct Effect	Indirect Effect	Direct Effect	Indirect Effect	Direct Effect	Indirect Effect	Direct Effect	Indirect Effect
(S0) MBT+WtE	100.0%	0.0%	-	-	-	-	100.0%	0.0%
(S1) Agriculture, Forestry and Forestry	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%
(S2) Livestock	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%
(S3) Oil & Gas	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%
(S4) Iron ore	0.3%	99.7%	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%
(S5) Other from Extractive Industry	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%
(S6) Food and Beverage	0.0%	100.0%	0.2%	99.8%	0.0%	100.0%	0.0%	100.0%
(S7) Products from Smoke (Tobacco)	0.3%	99.7%	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%
(S8) Textiles	0.0%	100.0%	0.0%	100.0%	0.6%	99.4%	0.0%	100.0%
(S9) Articles and accessories of	2.2%	97.8%	1.0%	99.0%	0.0%	100.0%	0.0%	100.0%

Clothing								
(S10) Leather Goods and Footwear	0.1%	99.9%	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%
(S11) Wood Products - except Furniture	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%
(S12) Cellulose and Paper Products	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%
(S13) Newspapers, Magazines and Discs	0.1%	99.9%	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%
(S14) Petroleum Refining and Coke	0.7%	99.3%	0.5%	99.5%	0.1%	99.9%	0.0%	100.0%
(S15) Alcohol	0.4%	99.6%	0.5%	99.5%	0.0%	100.0%	0.0%	100.0%
(S16) Chemical Products	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%
(S17) Resins and Elastomers Production	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%
(S18) Pharmaceutical Products	0.2%	99.8%	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%
(S19) Agricultural Defensive Agents	0.0%	100.0%	0.0%	100.0%	0.1%	99.9%	0.0%	100.0%
(S20) Perfumery, Health and Cleaning	1.9%	98.1%	0.8%	99.2%	0.0%	100.0%	0.0%	100.0%
(S21) Paints, Varnishes and Lacquers	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%
(S22) Products from various Chemicals	0.0%	100.0%	0.0%	100.0%	0.1%	99.9%	0.0%	100.0%
(S23) Rubber and Plastic Articles	1.3%	98.7%	0.3%	99.7%	0.0%	100.0%	0.0%	100.0%
(S24) Cement	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%
(S25) Other Products from Non-Metallic Minerals	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%
(S26) Steel Production and Derivatives	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%
(S27) Metallurgy of Non-Ferrous Metals	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%

(S28) Metal Products - except Machines and Appliances	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%
(S29) Machines and Appliances - including Maintenance and Repairs	0.1%	99.9%	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%
(S30) Household Appliances	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%
(S31) Office Machines and Computing Devices	0.0%	100.0%	0.0%	100.0%	0.1%	99.9%	0.0%	100.0%
(S32) Machines, Devices and Electric Materials	1.2%	98.8%	0.4%	99.6%	0.0%	100.0%	0.0%	100.0%
(S33) Electronic Materials and Communication Appliances	0.9%	99.1%	0.2%	99.8%	0.0%	100.0%	0.0%	100.0%
(S34) Devices, Medical instruments	0.0%	100.0%	0.1%	99.9%	0.0%	100.0%	0.0%	100.0%
(S35) Passenger cars and utilities	0.0%	100.0%	1.9%	98.1%	0.0%	100.0%	0.0%	100.0%
(S36) Trucks and Buses	0.0%	100.0%	0.0%	100.0%	0.1%	99.9%	0.0%	100.0%
(S37) Parts and accessories for automobiles	6.0%	94.0%	1.3%	98.7%	0.0%	100.0%	0.0%	100.0%
(S38) Other Appliances for Transport	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%
(S39) Furniture and Other Products from diverse Industries	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%
(S40) Electricity, Gas, Water, Sewage and Urban Cleaning	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%
(S41) Building	0.8%	99.2%	0.1%	99.9%	0.0%	100.0%	0.0%	100.0%
(S42) Commerce	1.8%	98.2%	0.1%	99.9%	0.1%	99.9%	0.0%	100.0%
(S43) Transport, Storage and Mail	0.6%	99.4%	0.2%	99.8%	0.0%	100.0%	0.0%	100.0%
(S44) Information Services	0.3%	99.7%	0.1%	99.9%	0.0%	100.0%	0.0%	100.0%
(S45) Financial Intermediation and Insurance	0.2%	99.8%	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%
(S46) Estate Services and Rent	0.3%	99.7%	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%
(S47) Maintenance and Repair	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%

Services								
(S48) Housing and Food Services	0.6%	99.4%	0.1%	99.9%	0.0%	100.0%	0.0%	100.0%
(S49) Services for Companies	0.9%	99.1%	0.1%	99.9%	0.0%	100.0%	0.0%	100.0%
(S50) Commercial Education	0.2%	99.8%	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%
(S51) Commercial Health	0.4%	99.6%	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%
(S52) Services for Families and Associative	1.7%	98.3%	0.3%	99.7%	0.0%	0.0%	0.0%	100.0%
(S53) Domestic Services	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%
(S54) Public Education	1.5%	98.5%	0.1%	99.9%	0.0%	100.0%	0.0%	100.0%
(S55) Public Health	0.9%	99.1%	0.1%	99.9%	0.0%	100.0%	0.0%	100.0%
(S56) Public Administration and Social Security	2.0%	98.0%	0.1%	99.9%	0.0%	100.0%	0.0%	100.0%
(S57) Non-Metallic Minerals Extraction	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%
(S58) Production of Paper, Cardboard and their Products	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%
(S59) Production of Glass and their Products	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%
(S60) Aluminum Metallurgy	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%
(S61) Electricity Production (Oil based)	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%
(S62) Urban Cleaning Services	2.8%	97.2%	0.0%	100.0%	0.2%	99.8%	0.1%	99.9%
TOTAL	1.0%	99.0%	0.1%	99.9%	0.0%	100.0%	0.2%	99.8%

Table B 1. Direct and Indirect effects

APPENDIX C. Impacts over Production Value

2013's SECTORS OF THE ECONOMY	Metropolitan Region of Sao Paulo (MRSP)				Rest of Sao Paulo state				Rest of Brazil				BRAZIL			
	Δ PRODUCTION VALUE (X)				Δ PRODUCTION VALUE (X)				Δ PRODUCTION VALUE (X)				Δ PRODUCTION VALUE (X)			
	R\$ million	USD million	Sector relevance	Economy relevance	R\$ million	USD million	Sector relevance	Economy relevance	R\$ million	USD million	Sector relevance	Economy relevance	R\$ million	USD million	Sector relevance	Economy relevance
(S0) MBT+WTE	3,594	1,536	100.0%	-9215.6%	-	-	-	-	-	-	-	-	3,594	1,536	100.0%	-23.4%
(S62) Urban Cleaning Services	-1,021.15	-436.39	-49.8%	2618.4%	-0.95	-0.41	-0.1%	0.0%	-7.50	-3.21	-0.1%	0.1%	-1,029.60	-440.00	-8.1%	6.7%
(S58) Production of Paper, Cardboard and their Products	-785.51	-335.69	-5.2%	2014.2%	-829.70	-354.57	-4.6%	29.6%	-1,720.56	-735.28	-6.1%	13.8%	-3,335.77	-1,425.54	-5.5%	21.7%
(S17) Resins and Elastomers Production	-517.94	-221.34	-5.8%	1328.1%	-323.24	-138.14	-6.1%	11.5%	-1,318.76	-563.57	-6.1%	10.5%	-2,159.93	-923.05	-6.0%	14.1%
(S45) Financial Intermediation and Insurance	-235.89	-100.81	-0.1%	604.9%	-79.63	-34.03	-0.1%	2.8%	-342.72	-146.46	-0.1%	2.7%	-658.24	-281.30	-0.1%	4.3%
(S61) Electricity Production (Oil based)	-162.43	-69.41	-256.8%	416.5%	-82.25	-35.15	-256.8%	2.9%	-1,454.45	-621.56	-259.0%	11.6%	-1,699.13	-726.12	-258.6%	11.1%
(S43) Transport, Storage and Mail	-154.81	-66.16	-0.2%	397.0%	-123.64	-52.84	-0.2%	4.4%	-640.15	-273.57	-0.2%	5.1%	-918.60	-392.57	-0.2%	6.0%
(S14) Petroleum Refining and Coke	-143.96	-61.52	-0.8%	369.1%	-348.12	-148.77	-0.6%	12.4%	-948.10	-405.17	-0.5%	7.6%	-1,440.17	-615.46	-0.6%	9.4%
(S49) Services for Companies	-134.44	-57.45	-0.1%	344.7%	-62.90	-26.88	-0.1%	2.2%	-262.18	-112.04	-0.1%	2.1%	-459.52	-196.38	-0.1%	3.0%
(S16) Chemical Products	-125.71	-53.72	-0.9%	322.3%	-165.37	-70.67	-0.8%	5.9%	-918.34	-392.45	-1.3%	7.3%	-1,209.42	-516.85	-1.1%	7.9%
(S23) Rubber and Plastic Articles	-117.51	-50.22	-0.4%	301.3%	-51.07	-21.83	-0.2%	1.8%	-110.38	-47.17	-0.2%	0.9%	-278.96	-119.22	-0.3%	1.8%
(S44) Information Services	-103.70	-44.32	-0.1%	265.9%	-26.54	-11.34	-0.1%	0.9%	-158.68	-67.81	-0.1%	1.3%	-288.92	-123.47	-0.1%	1.9%
(S22) Products from various Chemicals	-70.94	-30.32	-0.8%	181.9%	-56.40	-24.10	-0.8%	2.0%	-79.23	-33.86	-0.9%	0.6%	-206.57	-88.28	-0.8%	1.3%
(S28) Metal Products - except Machines and Appliances	-51.54	-22.03	-0.2%	132.2%	-47.29	-20.21	-0.2%	1.7%	-83.84	-35.83	-0.2%	0.7%	-182.68	-78.07	-0.2%	1.2%
(S32) Machines, Devices and Electric Materials	-46.09	-19.70	-0.2%	118.2%	-30.26	-12.93	-0.2%	1.1%	-45.15	-19.29	-0.1%	0.4%	-121.50	-51.92	-0.2%	0.8%
(S42) Commerce	-39.59	-16.92	0.0%	101.5%	-87.34	-37.33	-0.1%	3.1%	-529.36	-226.22	-0.1%	4.2%	-656.29	-280.47	-0.1%	4.3%
(S29) Machines and Appliances - including Maintenance and Repairs	-34.82	-14.88	-0.1%	89.3%	-46.97	-20.07	-0.1%	1.7%	-61.30	-26.20	-0.1%	0.5%	-143.09	-61.15	-0.1%	0.9%
(S20) Perfumery, Health and Cleaning	-27.85	-11.90	-0.2%	71.4%	-9.14	-3.90	-0.1%	0.3%	-80.86	-34.56	-0.4%	0.6%	-117.85	-50.36	-0.3%	0.8%
(S46) Estate Services and Rent	-27.11	-11.59	0.0%	69.5%	-13.54	-5.78	0.0%	0.5%	-88.25	-37.71	0.0%	0.7%	-128.90	-55.08	0.0%	0.8%
(S19) Agricultural Defensive Agents	-26.89	-11.49	-0.3%	68.9%	-25.87	-11.06	-0.3%	0.9%	-53.81	-22.99	-0.5%	0.4%	-106.56	-45.54	-0.4%	0.7%
(S21) Paints, Varnishes and Lacquers	-25.77	-11.01	-0.3%	66.1%	-10.13	-4.33	-0.3%	0.4%	-29.24	-12.50	-0.4%	0.2%	-65.14	-27.84	-0.3%	0.4%
(S13) Newspapers, Magazines and Discs	-25.04	-10.70	-0.1%	64.2%	-8.65	-3.70	-0.1%	0.3%	-39.37	-16.82	-0.1%	0.3%	-73.07	-31.22	-0.1%	0.5%
(S52) Services for Families and Associative	-24.03	-10.27	-0.1%	61.6%	-6.44	-2.75	0.0%	0.2%	-39.79	-17.01	0.0%	0.3%	-70.27	-30.03	0.0%	0.5%
(S56) Public Administration and Social Security	-22.88	-9.78	0.0%	58.7%	-6.08	-2.60	0.0%	0.2%	-62.10	-26.54	0.0%	0.5%	-91.07	-38.92	0.0%	0.6%
(S57) Non-Metallic Minerals Extraction	-15.65	-6.69	-3.0%	40.1%	-36.12	-15.44	-3.0%	1.3%	-884.92	-378.17	-4.6%	7.1%	-936.70	-400.30	-4.5%	6.1%
(S26) Steel Production and Derivatives	-14.19	-6.06	-0.1%	36.4%	-14.42	-6.16	-0.1%	0.5%	-149.33	-63.82	-0.2%	1.2%	-177.94	-76.04	-0.2%	1.2%
(S8) Textiles	-12.43	-5.31	-0.1%	31.9%	-21.63	-9.25	-0.1%	0.8%	-50.00	-21.37	-0.1%	0.4%	-84.07	-35.93	-0.1%	0.5%
(S41) Building	-8.86	-3.79	0.0%	22.7%	-4.66	-1.99	0.0%	0.2%	-28.14	-12.02	0.0%	0.2%	-41.66	-17.80	0.0%	0.3%
(S27) Metallurgy of Non-Ferrous Metals	-8.48	-3.62	-0.1%	21.7%	-4.45	-1.90	-0.1%	0.2%	-18.29	-7.81	-0.1%	0.1%	-31.22	-13.34	-0.1%	0.2%
(S12) Cellulose and Paper Products	-8.33	-3.56	-0.5%	21.4%	-9.71	-4.15	-0.6%	0.3%	-68.49	-29.27	-0.7%	0.5%	-86.53	-36.98	-0.6%	0.6%
(S5) Others from Extractive Industry	-7.73	-3.30	-12.3%	19.8%	-1.99	-0.85	-10.5%	0.1%	-536.35	-229.21	-4.7%	4.3%	-546.08	-233.37	-4.8%	3.6%
(S48) Housing and Food Services	-7.31	-3.12	0.0%	18.7%	-4.70	-2.01	0.0%	0.2%	-18.00	-7.69	0.0%	0.1%	-30.00	-12.82	0.0%	0.2%
(S37) Parts and accessories for automobiles	-7.25	-3.10	0.0%	18.6%	-14.95	-6.39	0.0%	0.5%	-32.72	-13.98	-0.1%	0.3%	-54.91	-23.47	-0.1%	0.4%
(S18) Pharmaceutical Products	-5.96	-2.55	0.0%	15.3%	-2.13	-0.91	0.0%	0.1%	-7.68	-3.28	0.0%	0.1%	-15.77	-6.74	0.0%	0.1%
(S60) Aluminum Metallurgy	-5.39	-2.31	-0.2%	13.8%	-9.16	-3.92	-0.1%	0.3%	-15.22	-6.50	-0.1%	0.1%	-29.78	-12.72	-0.1%	0.2%
(S9) Articles and accessories of Clothing	-5.31	-2.27	0.0%	13.6%	-1.40	-0.60	0.0%	0.1%	-3.81	-1.63	0.0%	0.0%	-10.52	-4.50	0.0%	0.1%
(S6) Food and Beverage	-4.99	-2.13	0.0%	12.8%	-24.59	-10.51	0.0%	0.9%	-52.34	-22.37	0.0%	0.4%	-81.91	-35.01	0.0%	0.5%
(S3) Oil & Gas	-2.95	-1.26	-0.2%	7.6%	-5.60	-2.39	-0.2%	0.2%	-539.37	-230.50	-0.4%	4.3%	-547.92	-234.15	-0.4%	3.6%
(S39) Furnitures and Other Products from diverse Industries	-2.62	-1.12	0.0%	6.7%	-4.31	-1.84	0.0%	0.2%	-11.64	-4.98	0.0%	0.1%	-18.57	-7.93	0.0%	0.1%
(S25) Other Products from Non-Metallic Minerals	-2.30	-0.98	-0.1%	5.9%	-6.97	-2.98	-0.1%	0.2%	-39.16	-16.73	-0.1%	0.3%	-48.43	-20.70	-0.1%	0.3%
(S36) Trucks and Buses	-1.87	-0.80	0.0%	4.8%	-0.11	-0.05	0.0%	0.0%	-0.60	-0.26	0.0%	0.0%	-2.58	-1.10	0.0%	0.0%
(S51) Commercial Health	-1.71	-0.73	0.0%	4.4%	-1.31	-0.56	0.0%	0.0%	-7.38	-3.15	0.0%	0.1%	-10.40	-4.45	0.0%	0.1%
(S59) Production of Glass and their Products	-1.59	-0.68	0.0%	4.1%	-0.75	-0.32	0.0%	0.0%	-0.96	-0.41	0.0%	0.0%	-3.30	-1.41	0.0%	0.0%
(S31) Office Machines and Computing Devices	-1.44	-0.61	0.0%	3.7%	-3.51	-1.50	0.0%	0.1%	-2.96	-1.27	0.0%	0.0%	-7.91	-3.38	0.0%	0.1%
(S1) Agriculture, Silviculture and Forestry	-1.28	-0.55	-0.3%	3.3%	-53.45	-22.84	-0.1%	1.9%	-363.85	-155.49	-0.1%	2.9%	-418.57	-178.88	-0.1%	2.7%
(S33) Electronic Materials and Communication Appliances	-1.23	-0.52	0.0%	3.1%	-2.80	-1.19	0.0%	0.1%	-7.45	-3.19	0.0%	0.1%	-11.48	-4.90	0.0%	0.1%
(S50) Commercial Education	-1.06	-0.45	0.0%	2.7%	-0.95	-0.41	0.0%	0.0%	-4.22	-1.81	0.0%	0.0%	-6.24	-2.66	0.0%	0.0%
(S11) Wood Products - except Furnitures	-0.99	-0.42	-0.1%	2.5%	-2.85	-1.22	-0.1%	0.1%	-16.30	-6.97	-0.1%	0.1%	-20.14	-8.61	-0.1%	0.1%
(S15) Alcohol	-0.52	-0.22	-0.2%	1.3%	-48.93	-20.91	-0.2%	1.7%	-30.09	-12.86	-0.2%	0.2%	-79.54	-33.99	-0.2%	0.5%
(S38) Other Appliances for Transport	-0.44	-0.19	0.0%	1.1%	-1.52	-0.65	0.0%	0.1%	-4.73	-2.02	0.0%	0.0%	-6.69	-2.86	0.0%	0.0%
(S24) Cement	-0.39	-0.17	0.0%	1.0%	-1.17	-0.50	0.0%	0.0%	-7.11	-3.04	0.0%	0.1%	-8.67	-3.71	0.0%	0.1%
(S54) Public Education	-0.22	-0.09	0.0%	0.6%	-0.20	-0.08	0.0%	0.0%	-0.63	-0.27	0.0%	0.0%	-1.05	-0.45	0.0%	0.0%
(S10) Leather Goods and Footwear	-0.05	-0.02	0.0%	0.1%	-0.41	-0.17	0.0%	0.0%	-1.90	-0.81	0.0%	0.0%	-2.36	-1.01	0.0%	0.0%
(S2) Livestock	-0.04	-0.02	0.0%	0.1%	-2.69	-1.15	0.0%	0.1%	-23.41	-10.01	0.0%	0.2%	-26.14	-11.17	0.0%	0.2%
(S4) Iron ore	-0.02	-0.01	-0.1%	0.0%	0.00	0.00	0.0%	0.0%	-30.91	-13.21	-0.1%	0.2%	-30.93	-13.22	-0.1%	0.2%
(S55) Public Health	0.00	0.00	0.0%	0.0%	0.00	0.00	0.0%	0.0%	-0.01	0.00	0.0%	0.0%	-0.01	0.00	0.0%	0.0%
(S7) Products from Smoke (Tobacco)	0.00	0.00	0.0%	0.0%	0.00	0.00	0.0%	0.0%	0.00	0.00	0.0%	0.0%	0.00	0.00	0.0%	0.0%
(S53) Domestic Services	0.00	0.00	0.0%	0.0%	0.00	0.00	0.0%	0.0%	0.00	0.00	0.0%	0.0%	0.00	0.00	0.0%	0.0%
(S34) Devices, Medical instruments	0.08	0.03	0.0%	-0.2%	-0.97	-0.41	0.0%	0.0%	-1.62	-0.69	0.0%	0.0%	-2.51	-1.07	0.0%	0.0%
(S30) Household Appliances	1.35	0.58	0.0%	-3.5%	0.67	0.29	0.0%	0.0%	-0.31	-0.13	0.0%	0.0%	1.71	0.73	0.0%	0.0%
(S35) Passenger cars and utilities	1.99	0.85	0.0%	-5.1%	-0.03	-0.01	0.0%	0.0%	-0.54	-0.23	0.0%	0.0%	1.42	0.61	0.0%	0.0%
(S40) Electricity, Gas, Water, Sewage and Urban Cleaning	35.02	14.97	0.1%	-89.8%	-66.40	-28.38	-0.2%	2.4%	-446.84	-190.96	-0.2%	3.6%	-478.22	-204.37	-0.2%	3.1%
(S47) Maintenance and Repair Services	386.77	165.29	2.7%	-991.7%	-6.73	-2.88	-0.1%	0.2%	-21.91	-9.37	-0.1%	0.2%	358.13	153.05	0.6%	-2.3%
TOTAL	-39.00	-16.67	0.0%	100.0%	-2,802.46	-1,197.63	-0.2%	100.0%	-12,503.32	-5,343.30	-0.2%	100.0%	-15,344.77	-6,557.60	-0.2%	100.0%

Table C 1. Production Value (X)

APPENDIX D. Impacts over Number of Jobs

2013's SECTORS OF THE ECONOMY	Metropolitan Region of Sao Paulo (MRSP)			Rest of Sao Paulo state			Rest of Brazil			BRAZIL		
	Δ JOB POSITIONS			Δ JOB POSITIONS			Δ JOB POSITIONS			Δ JOB POSITIONS		
	Qty	Sector relevance	Economy relevance	Qty	Sector relevance	Economy relevance	Qty	Sector relevance	Economy relevance	Qty	Sector relevance	Economy relevance
(S0) CENTRAL OF RECYCLING	10,678	100.0%	101.1%	-	-	-	-	-	-	10,678	100.0%	222.1%
(S58) Production of Paper, Cardboard and their Products	-164	-0.4%	-1.6%	-173	-0.3%	25.1%	-443	-0.4%	8.7%	-780	-0.4%	-16.2%
(S49) Services for Companies	-93	0.0%	-0.9%	-43	0.0%	6.3%	-350	0.0%	6.9%	-486	0.0%	-10.1%
(S43) Transport, Storage and Mail	-83	0.0%	-0.8%	-67	0.0%	9.6%	-456	0.0%	9.0%	-605	0.0%	-12.6%
(S42) Commerce	-40	0.0%	-0.4%	-89	0.0%	12.9%	-877	0.0%	17.3%	-1,007	0.0%	-20.9%
(S23) Rubber and Plastic Articles	-31	0.0%	-0.3%	-14	0.0%	2.0%	-41	0.0%	0.8%	-85	0.0%	-1.8%
(S44) Information Services	-30	0.0%	-0.3%	-8	0.0%	1.1%	-76	0.0%	1.5%	-114	0.0%	-2.4%
(S52) Services for Families and Associates	-27	0.0%	-0.3%	-7	0.0%	1.0%	-77	0.0%	1.5%	-111	0.0%	-2.3%
(S45) Financial Intermediation and Insurance	-24	0.0%	-0.2%	-8	0.0%	1.2%	-60	0.0%	1.2%	-92	0.0%	-1.9%
(S17) Resins and Elastomers Production	-24	-0.4%	-0.2%	-15	-0.4%	2.2%	-80	-0.4%	1.6%	-119	-0.4%	-2.5%
(S28) Metal Products - except Machines and Equipments	-20	0.0%	-0.2%	-19	0.0%	2.7%	-56	0.0%	1.1%	-95	0.0%	-2.0%
(S57) Non-Metallic Minerals Extraction	-16	-0.2%	-0.2%	-37	-0.2%	5.3%	-463	-0.3%	9.2%	-516	-0.3%	-10.7%
(S22) Products from various Chemicals	-15	-0.1%	-0.1%	-12	-0.1%	1.7%	-24	-0.1%	0.5%	-51	-0.1%	-1.1%
(S56) Public Administration and Social Security	-11	0.0%	-0.1%	-3	0.0%	0.4%	-34	0.0%	0.7%	-48	0.0%	-1.0%
(S32) Machines, Devices and Electric Materials	-10	0.0%	-0.1%	-7	0.0%	1.0%	-13	0.0%	0.3%	-30	0.0%	-0.6%
(S29) Machines and Equipments - including Maintenance and Repairs	-9	0.0%	-0.1%	-13	0.0%	1.8%	-21	0.0%	0.4%	-43	0.0%	-0.9%
(S8) Textiles	-9	0.0%	-0.1%	-16	0.0%	2.2%	-63	0.0%	1.2%	-87	0.0%	-1.8%
(S13) Newspapers, Magazines and Discs	-9	0.0%	-0.1%	-3	0.0%	0.4%	-22	0.0%	0.4%	-33	0.0%	-0.7%
(S9) Articles and accessories of Clothing	-8	0.0%	-0.1%	-2	0.0%	0.3%	-9	0.0%	0.2%	-20	0.0%	-0.4%
(S16) Chemical Products	-8	-0.1%	-0.1%	-10	-0.1%	1.5%	-65	-0.1%	1.3%	-83	-0.1%	-1.7%
(S41) Building	-7	0.0%	-0.1%	-4	0.0%	0.6%	-33	0.0%	0.7%	-44	0.0%	-0.9%
(S48) Housing and Food Services	-6	0.0%	-0.1%	-4	0.0%	0.6%	-31	0.0%	0.6%	-41	0.0%	-0.9%
(S61) Electricity Production (Oil based)	-5	-18.0%	0.0%	-3	-18.0%	0.4%	-92	-18.1%	1.8%	-100	-19.2%	-2.1%
(S20) Perfumery, Health and Cleaning	-4	0.0%	0.0%	-1	0.0%	0.2%	-18	0.0%	0.4%	-24	0.0%	-0.5%
(S5) Others from Extractive Industry	-4	-0.9%	0.0%	-1	-0.7%	0.2%	-127	-0.3%	2.5%	-133	-0.4%	-2.8%
(S46) Estate Services and Rent	-3	0.0%	0.0%	-2	0.0%	0.2%	-10	0.0%	0.2%	-15	0.0%	-0.3%
(S21) Paints, Varnishes and Lacquers	-3	0.0%	0.0%	-1	0.0%	0.2%	-4	0.0%	0.1%	-9	0.0%	-0.2%
(S1) Agriculture, Silviculture and Forestry	-2	0.0%	0.0%	-81	0.0%	11.7%	-1,178	0.0%	23.3%	-1,261	0.0%	-26.2%
(S39) Furnitures and Other Products from diverse Industries	-2	0.0%	0.0%	-3	0.0%	0.4%	-12	0.0%	0.2%	-17	0.0%	-0.4%
(S19) Agricultural Defensive Agents	-2	0.0%	0.0%	-1	0.0%	0.2%	-4	0.0%	0.1%	-7	0.0%	-0.1%
(S37) Parts and accessories for automotives	-1	0.0%	0.0%	-3	0.0%	0.4%	-8	0.0%	0.2%	-13	0.0%	-0.3%
(S27) Metallurgy of Non-Ferrous Metals	-1	0.0%	0.0%	-1	0.0%	0.1%	-5	0.0%	0.1%	-7	0.0%	-0.1%
(S6) Food and Beverage	-1	0.0%	0.0%	-6	0.0%	0.9%	-17	0.0%	0.3%	-24	0.0%	-0.5%
(S25) Other Products from Non-Metallic Minerals	-1	0.0%	0.0%	-4	0.0%	0.5%	-35	0.0%	0.7%	-40	0.0%	-0.8%
(S50) Commercial Education	-1	0.0%	0.0%	-1	0.0%	0.1%	-7	0.0%	0.1%	-9	0.0%	-0.2%
(S51) Commercial Health	-1	0.0%	0.0%	-1	0.0%	0.1%	-8	0.0%	0.2%	-9	0.0%	-0.2%
(S26) Steel Production and Derivatives	-1	0.0%	0.0%	-1	0.0%	0.1%	-13	0.0%	0.3%	-14	0.0%	-0.3%
(S18) Pharmaceutical Products	-1	0.0%	0.0%	0	0.0%	0.0%	-1	0.0%	0.0%	-2	0.0%	0.0%
(S11) Wood Products - except Furnitures	-1	0.0%	0.0%	-2	0.0%	0.2%	-20	0.0%	0.4%	-22	0.0%	-0.5%
(S12) Cellulose and Paper Products	0	0.0%	0.0%	-1	0.0%	0.1%	-6	0.0%	0.1%	-7	0.0%	-0.1%
(S14) Petroleum Refining and Coke	0	-0.1%	0.0%	-1	0.0%	0.1%	-9	0.0%	0.2%	-10	0.0%	-0.2%
(S59) Production of Glass and their Products	0	0.0%	0.0%	0	0.0%	0.0%	0	0.0%	0.0%	-1	0.0%	0.0%
(S60) Aluminum Metallurgy	0	0.0%	0.0%	0	0.0%	0.1%	-2	0.0%	0.0%	-3	0.0%	-0.1%
(S54) Public Education	0	0.0%	0.0%	0	0.0%	0.0%	-1	0.0%	0.0%	-1	0.0%	0.0%
(S33) Electronic Materials and Communication Equipments	0	0.0%	0.0%	0	0.0%	0.1%	-1	0.0%	0.0%	-2	0.0%	0.0%
(S3) Oil & Gas	0	0.0%	0.0%	0	0.0%	0.0%	-19	0.0%	0.4%	-19	0.0%	-0.4%
(S31) Office Machines and Computing Devices	0	0.0%	0.0%	0	0.0%	0.1%	0	0.0%	0.0%	-1	0.0%	0.0%
(S36) Trucks and Buses	0	0.0%	0.0%	0	0.0%	0.0%	0	0.0%	0.0%	0	0.0%	0.0%
(S15) Alcohol	0	0.0%	0.0%	-7	0.0%	1.1%	-10	0.0%	0.2%	-17	0.0%	-0.4%
(S38) Other Equipments for Transport	0	0.0%	0.0%	0	0.0%	0.0%	-1	0.0%	0.0%	-1	0.0%	0.0%
(S10) Leather Goods and Footwear	0	0.0%	0.0%	0	0.0%	0.0%	-2	0.0%	0.0%	-3	0.0%	-0.1%
(S2) Livestock	0	0.0%	0.0%	-2	0.0%	0.4%	-56	0.0%	1.1%	-58	0.0%	-1.2%
(S24) Cement	0	0.0%	0.0%	0	0.0%	0.0%	-1	0.0%	0.0%	-1	0.0%	0.0%
(S4) Iron ore	0	0.0%	0.0%	0	0.0%	0.0%	-2	0.0%	0.0%	-2	0.0%	0.0%
(S55) Public Health	0	0.0%	0.0%	0	0.0%	0.0%	0	0.0%	0.0%	0	0.0%	0.0%
(S7) Products from Smoke (Tobacco)	0	0.0%	0.0%	0	0.0%	0.0%	0	0.0%	0.0%	0	0.0%	0.0%
(S62) Urban Cleaning Services	0	0.0%	0.0%	0	0.0%	0.0%	0	0.0%	0.0%	0	0.0%	0.0%
(S53) Domestic Services	0	0.0%	0.0%	0	0.0%	0.0%	0	0.0%	0.0%	0	0.0%	0.0%
(S34) Devices, Medical instruments	0	0.0%	0.0%	0	0.0%	0.1%	-1	0.0%	0.0%	-1	0.0%	0.0%
(S35) Passenger cars and utilities	0	0.0%	0.0%	0	0.0%	0.0%	0	0.0%	0.0%	0	0.0%	0.0%
(S30) Household Appliances	0	0.0%	0.0%	0	0.0%	0.0%	0	0.0%	0.0%	0	0.0%	0.0%
(S40) Electricity, Gas, Water, Sewage and Urban Cleaning	2	0.0%	0.0%	-4	0.0%	0.5%	-35	0.0%	0.7%	-37	0.0%	-0.8%
(S47) Maintenance and Repair Services	562	0.2%	5.3%	-10	0.0%	1.4%	-62	0.0%	1.2%	490	0.0%	10.2%
TOTAL	10,559	0.08%	100.0%	-691	-0.01%	100.0%	-5,061	-0.01%	100.0%	4,807	0.00%	100.0%

Table D 1. Number of Jobs

APPENDIX E. Impacts over GDP

2013's SECTORS OF THE ECONOMY	Metropolitan Region of Sao Paulo (MRSP)				Rest of Sao Paulo state				Rest of Brazil				BRAZIL			
	Δ GDP				Δ GDP				Δ GDP				Δ GDP			
	R\$ million	USD million	Sector relevance	Economy relevance	R\$ million	USD million	Sector relevance	Economy relevance	R\$ million	USD million	Sector relevance	Economy relevance	R\$ million	USD million	Sector relevance	Economy relevance
(S0) MBT+WIE	3,210	1,372	100.0%	169.1%	-	-	-	-	-	-	-	-	3,210	1,372	100.0%	-88.5%
(S62) Urban Cleaning Services	-493.28	-210.81	-49.8%	-26.0%	-0.46	-0.20	-0.1%	0.0%	-3.59	-1.54	-0.1%	0.1%	-497.34	-212.54	-8.2%	13.7%
(S58) Production of Paper, Cardboard and their Products	-265.39	-113.42	-5.2%	-14.0%	-280.33	-119.80	-4.6%	29.0%	-563.40	-240.77	-6.1%	12.3%	-1,109.12	-473.98	-5.4%	30.6%
(S45) Financial Intermediation and Insurance	-147.86	-63.19	-0.1%	-7.8%	-49.91	-21.33	-0.1%	5.2%	-213.86	-91.39	-0.1%	4.7%	-411.63	-175.91	-0.1%	11.3%
(S17) Resins and Elastomers Production	-95.11	-40.65	-5.8%	-5.0%	-59.36	-25.37	-6.1%	6.1%	-230.89	-98.67	-6.1%	5.1%	-385.36	-164.68	-6.0%	10.6%
(S43) Transport, Storage and Mail	-80.16	-34.26	-0.2%	-4.2%	-64.02	-27.36	-0.2%	6.6%	-311.76	-133.23	-0.2%	6.8%	-455.94	-194.85	-0.2%	12.6%
(S49) Services for Companies	-74.31	-31.76	-0.1%	-3.9%	-34.77	-14.86	-0.1%	3.6%	-163.45	-69.85	-0.1%	3.6%	-272.54	-116.47	-0.1%	7.6%
(S44) Information Services	-51.12	-21.85	-0.1%	-2.7%	-13.08	-5.59	-0.1%	1.4%	-77.40	-33.08	-0.1%	1.7%	-141.60	-60.51	-0.1%	3.9%
(S61) Electricity Production (Oil based)	-47.33	-20.23	-256.8%	-2.5%	-23.96	-10.24	-256.8%	2.5%	-396.36	-169.38	-259.0%	8.7%	-467.65	-199.85	-258.6%	12.9%
(S23) Rubber and Plastic Articles	-39.49	-16.88	-0.4%	-2.1%	-17.16	-7.33	-0.2%	1.8%	-37.29	-15.94	-0.2%	0.8%	-93.94	-40.15	-0.3%	2.6%
(S14) Petroleum Refining and Coke	-34.65	-14.81	-0.8%	-1.8%	-83.78	-35.81	-0.6%	8.7%	-234.47	-100.20	-0.5%	5.1%	-352.90	-150.81	-0.6%	9.7%
(S16) Chemical Products	-30.28	-12.94	-0.9%	-1.6%	-39.83	-17.02	-0.8%	4.1%	-217.54	-92.97	-1.3%	4.8%	-287.65	-122.93	-1.1%	7.9%
(S42) Commerce	-25.76	-11.01	0.0%	-1.4%	-56.82	-24.28	-0.1%	5.9%	-361.33	-154.42	-0.1%	7.9%	-443.91	-189.71	-0.1%	12.2%
(S46) Estate Services and Rent	-22.78	-9.74	0.0%	-1.2%	-11.37	-4.86	0.0%	1.2%	-75.72	-32.36	0.0%	1.7%	-109.87	-46.95	0.0%	3.0%
(S28) Metal Products - except Machines and Equipments	-22.48	-9.61	-0.2%	-1.2%	-20.63	-8.82	-0.2%	2.1%	-37.17	-15.89	-0.2%	0.8%	-80.29	-34.31	-0.2%	2.2%
(S22) Products from various Chemicals	-21.75	-9.29	-0.8%	-1.1%	-17.29	-7.39	-0.8%	1.8%	-24.43	-10.44	-0.9%	0.5%	-63.47	-27.12	-0.8%	1.7%
(S32) Machines, Devices and Electric Materials	-15.58	-6.66	-0.2%	-0.8%	-10.23	-4.37	-0.2%	1.1%	-15.17	-6.48	-0.1%	0.3%	-40.97	-17.51	-0.2%	1.1%
(S56) Public Administration and Social Security	-14.03	-6.00	0.0%	-0.7%	-3.73	-1.59	0.0%	0.4%	-39.03	-16.68	0.0%	0.9%	-56.79	-24.27	0.0%	1.6%
(S13) Newspapers, Magazines and Discs	-12.46	-5.33	-0.1%	-0.7%	-4.31	-1.84	-0.1%	0.4%	-20.32	-8.68	-0.1%	0.4%	-37.09	-15.85	-0.1%	1.0%
(S52) Services for Families and Associates	-12.38	-5.29	-0.1%	-0.7%	-3.32	-1.42	0.0%	0.3%	-21.03	-8.99	0.0%	0.5%	-36.73	-15.70	0.0%	1.0%
(S29) Machines and Equipments - including Maintenance and Repairs	-11.85	-5.06	-0.1%	-0.6%	-15.99	-6.83	-0.1%	1.7%	-20.68	-8.84	-0.1%	0.5%	-48.52	-20.74	-0.1%	1.3%
(S21) Paints, Varnishes and Lacquers	-9.79	-4.18	-0.3%	-0.5%	-3.85	-1.64	-0.3%	0.4%	-11.33	-4.84	-0.4%	0.2%	-24.96	-10.67	-0.3%	0.7%
(S20) Perfumery, Health and Cleaning	-9.41	-4.02	-0.2%	-0.5%	-3.09	-1.32	-0.1%	0.3%	-27.99	-11.96	-0.4%	0.6%	-40.48	-17.30	-0.3%	1.1%
(S19) Agricultural Defensive Agents	-6.05	-2.58	-0.3%	-0.3%	-5.82	-2.49	-0.3%	0.6%	-11.58	-4.95	-0.5%	0.3%	-23.44	-10.02	-0.4%	0.6%
(S57) Non-Metallic Minerals Extraction	-4.97	-2.12	-3.0%	-0.3%	-11.46	-4.90	-3.0%	1.2%	-287.85	-123.01	-4.6%	6.3%	-304.28	-130.03	-4.5%	8.4%
(S8) Textiles	-4.73	-2.02	-0.1%	-0.2%	-8.23	-3.52	-0.1%	0.9%	-19.39	-8.29	-0.1%	0.4%	-32.35	-13.82	-0.1%	0.9%
(S26) Steel Production and Derivatives	-4.65	-1.99	-0.1%	-0.2%	-4.72	-2.02	-0.1%	0.5%	-50.88	-21.74	-0.2%	1.1%	-60.25	-25.75	-0.2%	1.7%
(S41) Building	-4.45	-1.90	0.0%	-0.2%	-2.34	-1.00	0.0%	0.2%	-14.37	-6.14	0.0%	0.3%	-21.16	-9.04	0.0%	0.6%
(S5) Other from Extractive Industry	-4.04	-1.72	-12.3%	-0.2%	-1.04	-0.44	-10.5%	0.1%	-258.46	-110.45	-4.7%	5.7%	-263.53	-112.62	-4.8%	7.3%
(S48) Housing and Food Services	-3.19	-1.36	0.0%	-0.2%	-2.05	-0.88	0.0%	0.2%	-9.07	-3.88	0.0%	0.2%	-14.30	-6.11	0.0%	0.4%
(S18) Pharmaceutical Products	-2.81	-1.20	0.0%	-0.1%	-1.00	-0.43	0.0%	0.1%	-3.90	-1.67	0.0%	0.1%	-7.71	-3.30	0.0%	0.2%
(S12) Cellulose and Paper Products	-2.54	-1.09	-0.5%	-0.1%	-2.97	-1.27	-0.6%	0.3%	-21.65	-9.25	-0.7%	0.5%	-27.16	-11.61	-0.6%	0.7%
(S27) Metallurgy of Non-Ferrous Metals	-2.44	-1.04	-0.1%	-0.1%	-1.28	-0.55	-0.1%	0.1%	-5.21	-2.22	-0.1%	0.1%	-8.93	-3.82	-0.1%	0.2%
(S9) Articles and accessories of Clothing	-2.26	-0.96	0.0%	-0.1%	-0.60	-0.26	0.0%	0.1%	-1.68	-0.72	0.0%	0.0%	-4.53	-1.94	0.0%	0.1%
(S37) Parts and accessories for automobiles	-2.26	-0.96	0.0%	-0.1%	-4.66	-1.99	0.0%	0.5%	-10.08	-4.31	-0.1%	0.2%	-17.00	-7.26	-0.1%	0.5%
(S60) Aluminum Metallurgy	-1.57	-0.67	-0.2%	-0.1%	-2.67	-1.14	-0.1%	0.3%	-4.29	-1.83	-0.1%	0.1%	-8.52	-3.64	-0.1%	0.2%
(S6) Food and Beverage	-1.18	-0.50	0.0%	0.0%	-5.83	-2.49	0.0%	0.6%	-10.88	-4.65	0.0%	0.2%	-17.89	-7.64	0.0%	0.5%
(S39) Furnitures and Other Products from diverse Industries	-1.15	-0.49	0.0%	-0.1%	-1.90	-0.81	0.0%	0.2%	-5.08	-2.17	0.0%	0.1%	-8.13	-3.47	0.0%	0.2%
(S3) Oil & Gas	-1.11	-0.48	-0.2%	-0.1%	-2.11	-0.90	-0.2%	0.2%	-199.03	-85.06	-0.4%	4.4%	-202.26	-86.43	-0.4%	5.6%
(S51) Commercial Health	-0.93	-0.40	0.0%	0.0%	-0.71	-0.30	0.0%	0.1%	-4.05	-1.73	0.0%	0.1%	-5.69	-2.43	0.0%	0.2%
(S25) Other Products from Non-Metallic Minerals	-0.88	-0.38	-0.1%	0.0%	-2.67	-1.14	-0.1%	0.3%	-15.43	-6.59	-0.1%	0.3%	-18.97	-8.11	-0.1%	0.5%
(S59) Production of Glass and their Products	-0.71	-0.31	0.0%	0.0%	-0.34	-0.14	0.0%	0.0%	-0.45	-0.19	0.0%	0.0%	-1.50	-0.64	0.0%	0.0%
(S50) Commercial Education	-0.66	-0.28	0.0%	0.0%	-0.59	-0.25	0.0%	0.1%	-2.66	-1.14	0.0%	0.1%	-3.92	-1.67	0.0%	0.1%
(S1) Agriculture, Silviculture and Forestry	-0.59	-0.25	-0.3%	0.0%	-24.82	-10.61	-0.1%	2.6%	-217.76	-93.06	-0.1%	4.8%	-243.18	-103.92	-0.1%	6.7%
(S11) Wood Products - except Furnitures	-0.42	-0.18	-0.1%	0.0%	-1.21	-0.52	-0.1%	0.1%	-6.83	-2.92	-0.1%	0.1%	-8.46	-3.62	-0.1%	0.2%
(S36) Trucks and Buses	-0.38	-0.16	0.0%	0.0%	-0.02	-0.01	0.0%	0.0%	-0.11	-0.05	0.0%	0.0%	-0.51	-0.22	0.0%	0.0%
(S31) Office Machines and Computing Devices	-0.33	-0.14	0.0%	0.0%	-0.82	-0.35	0.0%	0.1%	-0.63	-0.27	0.0%	0.0%	-1.78	-0.76	0.0%	0.0%
(S33) Electronic Materials and Communication Equipments	-0.31	-0.13	0.0%	0.0%	-0.71	-0.30	0.0%	0.1%	-1.65	-0.70	0.0%	0.0%	-2.67	-1.14	0.0%	0.1%
(S15) Alcohol	-0.18	-0.08	-0.2%	0.0%	-16.56	-7.08	-0.2%	1.7%	-9.64	-4.12	-0.2%	0.2%	-26.38	-11.27	-0.2%	0.7%
(S54) Public Education	-0.15	-0.07	0.0%	0.0%	-0.14	-0.06	0.0%	0.0%	-0.46	-0.20	0.0%	0.0%	-0.75	-0.32	0.0%	0.0%
(S24) Cement	-0.12	-0.05	0.0%	0.0%	-0.37	-0.16	0.0%	0.0%	-2.32	-0.99	0.0%	0.1%	-2.82	-1.21	0.0%	0.1%
(S38) Other Equipments for Transport	-0.12	-0.05	0.0%	0.0%	-0.42	-0.18	0.0%	0.0%	-1.26	-0.54	0.0%	0.0%	-1.81	-0.77	0.0%	0.0%
(S10) Leather Goods and Footwear	-0.02	-0.01	0.0%	0.0%	-0.15	-0.06	0.0%	0.0%	-0.71	-0.30	0.0%	0.0%	-0.88	-0.38	0.0%	0.0%
(S2) Livestock	-0.01	0.00	0.0%	0.0%	-0.85	-0.36	0.0%	0.1%	-12.12	-5.18	0.0%	0.3%	-12.98	-5.55	0.0%	0.4%
(S4) Iron ore	-0.01	0.00	-0.1%	0.0%	0.00	0.00	0.0%	0.0%	-15.17	-6.48	-0.1%	0.3%	-15.18	-6.49	-0.1%	0.4%
(S55) Public Health	0.00	0.00	0.0%	0.0%	0.00	0.00	0.0%	0.0%	0.00	0.00	0.0%	0.0%	-0.01	0.00	0.0%	0.0%
(S7) Products from Smoke (Tobacco)	0.00	0.00	0.0%	0.0%	0.00	0.00	0.0%	0.0%	0.00	0.00	0.0%	0.0%	0.00	0.00	0.0%	0.0%
(S53) Domestic Services	0.00	0.00	0.0%	0.0%	0.00	0.00	0.0%	0.0%	0.00	0.00	0.0%	0.0%	0.00	0.00	0.0%	0.0%
(S34) Devices, Medical instruments	0.04	0.02	0.0%	0.0%	-0.53	-0.23	0.0%	0.1%	-0.88	-0.38	0.0%	0.0%	-1.37	-0.58	0.0%	0.0%
(S35) Passenger cars and utilities	0.35	0.15	0.0%	0.0%	-0.01	0.00	0.0%	0.0%	-0.09	-0.04	0.0%	0.0%	0.26	0.11	0.0%	0.0%
(S30) Household Appliances	0.39	0.17	0.0%	0.0%	0.20	0.08	0.0%	0.0%	-0.09	-0.04	0.0%	0.0%	0.50	0.22	0.0%	0.0%
(S40) Electricity, Gas, Water, Sewage and Urban Cleaning	18.14	7.75	0.1%	1.0%	-34.39	-14.70	-0.2%	3.6%	-236.45	-101.05	-0.2%	5.2%	-252.70	-107.99	-0.2%	7.0%
(S47) Maintenance and Repair Services	261.84	111.90	2.7%	13.8%	-4.55	-1.95	-0.1%	0.5%	-15.88	-6.78	-0.1%	0.3%	241.41	103.17	-0.2%	-6.7%
TOTAL	1,898.75	811.43	0.2%	100.0%	-965.63	-412.66	-0.2%	100.0%	-4,562.25	-1,949.68	-0.1%	100.0%	-3,629.13	-1,550.91	-0.1%	100.0%

Table E 1. Gross Domestic Product (GDP)

APPENDIX F. Impacts over Energy Consumption

2013's SECTORS OF THE ECONOMY	Metropolitan Region of Sao Paulo (MRSP)			Rest of Sao Paulo state			Rest of Brazil			BRAZIL		
	Δ ENERGY CONSUMPTION			Δ ENERGY CONSUMPTION			Δ ENERGY CONSUMPTION			Δ ENERGY CONSUMPTION		
	10 ³ toe	Sector relevance	Economy relevance	10 ³ toe	Sector relevance	Economy relevance	10 ³ toe	Sector relevance	Economy relevance	10 ³ toe	Sector relevance	Economy relevance
(S0) MBT+WHE	-	-	-	-	-	-	-	-	-	0.00	100.0%	0.0%
(S58) Production of Paper, Cardboard and their Products	-49.08	-5.2%	45.3%	-51.84	-4.6%	47.0%	-104.19	-6.1%	22.4%	-205.11	-5.4%	30.0%
(S43) Transport, Storage and Mail	-29.83	-0.2%	27.6%	-23.83	-0.2%	21.6%	-116.03	-0.2%	24.9%	-169.69	-0.2%	24.8%
(S17) Resins and Elastomers Production	-4.96	-5.8%	4.6%	-3.10	-6.1%	2.8%	-12.05	-6.1%	2.6%	-20.11	-6.0%	2.9%
(S61) Electricity Production (Oil based)	-4.66	-256.8%	4.3%	-2.36	-256.8%	2.1%	-39.03	-259.0%	8.4%	-46.05	-258.6%	6.7%
(S14) Petroleum Refining and Coke	-3.41	-0.8%	3.2%	-8.25	-0.6%	7.5%	-23.09	-0.5%	5.0%	-34.75	-0.6%	5.1%
(S62) Urban Cleaning Services	-2.60	-49.8%	2.4%	0.00	-0.1%	0.0%	-0.02	-0.1%	0.0%	-2.62	-8.2%	0.4%
(S13) Newspapers, Magazines and Discs	-2.30	-0.1%	2.1%	-0.80	-0.1%	0.7%	-3.76	-0.1%	0.8%	-6.86	-0.1%	1.0%
(S26) Steel Production and Derivatives	-2.09	-0.1%	1.9%	-2.13	-0.1%	1.9%	-22.91	-0.2%	4.9%	-27.13	-0.2%	4.0%
(S23) Rubber and Plastic Articles	-2.06	-0.4%	1.9%	-0.90	-0.2%	0.8%	-1.95	-0.2%	0.4%	-4.90	-0.3%	0.7%
(S16) Chemical Products	-1.58	-0.9%	1.5%	-2.08	-0.8%	1.9%	-11.35	-1.3%	2.4%	-19.01	-1.1%	2.2%
(S22) Products from various Chemicals	-1.13	-0.8%	1.0%	-0.90	-0.8%	0.8%	-1.27	-0.9%	0.3%	-3.31	-0.8%	0.5%
(S27) Metallurgy of Non-Ferrous Metals	-1.10	-0.1%	1.0%	-0.58	-0.1%	0.5%	-2.35	-0.1%	0.5%	-4.03	-0.1%	0.6%
(S60) Aluminum Metallurgy	-0.71	-0.2%	0.7%	-1.20	-0.1%	1.1%	-1.94	-0.1%	0.4%	-3.85	-0.1%	0.6%
(S45) Financial Intermediation and Insurance	-0.57	-0.1%	0.5%	-0.19	-0.1%	0.2%	-0.83	-0.1%	0.2%	-1.59	-0.1%	0.2%
(S21) Paints, Varnishes and Lacquers	-0.51	-0.3%	0.5%	-0.20	-0.3%	0.2%	-0.59	-0.4%	0.1%	-1.30	-0.3%	0.2%
(S20) Perfumery, Health and Cleaning	-0.49	-0.2%	0.5%	-0.16	-0.1%	0.1%	-1.46	-0.4%	0.3%	-2.11	-0.3%	0.3%
(S12) Cellulose and Paper Products	-0.47	-0.5%	0.4%	-0.55	-0.6%	0.5%	-4.00	-0.7%	0.9%	-5.02	-0.6%	0.7%
(S57) Non-Metallic Minerals Extraction	-0.44	-3.0%	0.4%	-1.02	-3.0%	0.9%	-25.73	-4.6%	5.5%	-27.20	-4.5%	4.0%
(S42) Commerce	-0.38	0.0%	0.3%	-0.84	-0.1%	0.8%	-5.31	-0.1%	1.1%	-6.53	-0.1%	1.0%
(S5) Other from Extractive Industry	-0.36	-12.3%	0.3%	-0.09	-10.5%	0.1%	-23.11	-4.7%	5.0%	-23.56	-4.8%	3.4%
(S19) Agricultural Defensive Agents	-0.32	-0.3%	0.3%	-0.30	-0.3%	0.3%	-0.60	-0.5%	0.1%	-1.22	-0.4%	0.2%
(S49) Services for Companies	-0.29	-0.1%	0.3%	-0.13	-0.1%	0.1%	-0.63	-0.1%	0.1%	-1.05	-0.1%	0.2%
(S6) Food and Beverage	-0.21	0.0%	0.2%	-1.06	0.0%	1.0%	-1.97	0.0%	0.4%	-3.24	0.0%	0.5%
(S44) Information Services	-0.20	-0.1%	0.2%	-0.05	-0.1%	0.0%	-0.30	-0.1%	0.1%	-0.55	-0.1%	0.1%
(S25) Other Products from Non-Metallic Minerals	-0.16	-0.1%	0.2%	-0.50	-0.1%	0.5%	-2.89	-0.1%	0.6%	-3.55	-0.1%	0.5%
(S18) Pharmaceutical Products	-0.15	0.0%	0.1%	-0.05	0.0%	0.0%	-0.20	0.0%	0.0%	-0.40	0.0%	0.1%
(S59) Production of Glass and their Products	-0.13	0.0%	0.1%	-0.06	0.0%	0.1%	-0.08	0.0%	0.0%	-0.28	0.0%	0.0%
(S3) Oil & Gas	-0.11	-0.2%	0.1%	-0.21	-0.2%	0.2%	-19.60	-0.4%	4.2%	-19.91	-0.4%	2.9%
(S24) Cement	-0.10	0.0%	0.1%	-0.31	0.0%	0.3%	-1.93	0.0%	0.4%	-2.34	0.0%	0.3%
(S46) Estate Services and Rent	-0.09	0.0%	0.1%	-0.04	0.0%	0.0%	-0.29	0.0%	0.1%	-0.42	0.0%	0.1%
(S28) Metal Products - except Machines and Equipments	-0.09	-0.2%	0.1%	-0.08	-0.2%	0.1%	-0.14	-0.2%	0.0%	-0.31	-0.2%	0.0%
(S56) Public Administration and Social Security	-0.07	0.0%	0.1%	-0.02	0.0%	0.0%	-0.21	0.0%	0.0%	-0.30	0.0%	0.0%
(S8) Textiles	-0.07	-0.1%	0.1%	-0.13	-0.1%	0.1%	-0.30	-0.1%	0.1%	-0.50	-0.1%	0.1%
(S32) Machines, Devices and Electric Materials	-0.06	-0.2%	0.1%	-0.04	-0.2%	0.0%	-0.06	-0.1%	0.0%	-0.16	-0.2%	0.0%
(S52) Services for Families and Associates	-0.05	-0.1%	0.0%	-0.01	0.0%	0.0%	-0.08	0.0%	0.0%	-0.14	0.0%	0.0%
(S29) Machines and Equipments - including Maintenance and Repairs	-0.05	-0.1%	0.0%	-0.06	-0.1%	0.1%	-0.08	-0.1%	0.0%	-0.19	-0.1%	0.0%
(S9) Articles and accessories of Clothing	-0.04	0.0%	0.0%	-0.01	0.0%	0.0%	-0.03	0.0%	0.0%	-0.07	0.0%	0.0%
(S1) Agriculture, Silviculture and Forestry	-0.03	-0.3%	0.0%	-1.05	-0.1%	1.0%	-9.21	-0.1%	2.0%	-10.28	-0.1%	1.5%
(S15) Alcohol	-0.02	-0.2%	0.0%	-1.63	-0.2%	1.5%	-0.95	-0.2%	0.2%	-2.60	-0.2%	0.4%
(S41) Building	-0.02	0.0%	0.0%	-0.01	0.0%	0.0%	-0.06	0.0%	0.0%	-0.08	0.0%	0.0%
(S48) Housing and Food Services	-0.01	0.0%	0.0%	-0.01	0.0%	0.0%	-0.03	0.0%	0.0%	-0.06	0.0%	0.0%
(S37) Parts and accessories for automobiles	-0.01	0.0%	0.0%	-0.02	0.0%	0.0%	-0.04	-0.1%	0.0%	-0.07	-0.1%	0.0%
(S39) Furnitures and Other Products from diverse Industries	0.00	0.0%	0.0%	-0.01	0.0%	0.0%	-0.02	0.0%	0.0%	-0.03	0.0%	0.0%
(S51) Commercial Health	0.00	0.0%	0.0%	0.00	0.0%	0.0%	-0.02	0.0%	0.0%	-0.02	0.0%	0.0%
(S50) Commercial Education	0.00	0.0%	0.0%	0.00	0.0%	0.0%	-0.01	0.0%	0.0%	-0.02	0.0%	0.0%
(S11) Wood Products - except Furnitures	0.00	-0.1%	0.0%	0.00	-0.1%	0.0%	-0.03	-0.1%	0.0%	-0.03	-0.1%	0.0%
(S36) Trucks and Buses	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%
(S31) Office Machines and Computing Devices	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	-0.01	0.0%	0.0%
(S33) Electronic Materials and Communication Equipments	0.00	0.0%	0.0%	0.00	0.0%	0.0%	-0.01	0.0%	0.0%	-0.01	0.0%	0.0%
(S4) Iron ore	0.00	-0.1%	0.0%	0.00	0.0%	0.0%	-1.36	-0.1%	0.3%	-1.36	-0.1%	0.2%
(S54) Public Education	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%
(S2) Livestock	0.00	0.0%	0.0%	-0.04	0.0%	0.0%	-0.51	0.0%	0.1%	-0.55	0.0%	0.1%
(S38) Other Equipments for Transport	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	-0.01	0.0%	0.0%
(S10) Leather Goods and Footwear	0.00	0.0%	0.0%	0.00	0.0%	0.0%	-0.01	0.0%	0.0%	-0.01	0.0%	0.0%
(S55) Public Health	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%
(S7) Products from Smoke (Tobacco)	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%
(S53) Domestic Services	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%
(S34) Devices, Medical instruments	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	-0.01	0.0%	0.0%
(S35) Passenger cars and utilities	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%
(S30) Household Appliances	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%
(S47) Maintenance and Repair Services	1.01	2.7%	-0.9%	-0.02	-0.1%	0.0%	-0.06	-0.1%	0.0%	0.93	0.5%	-0.1%
(S40) Electricity, Gas, Water, Sewage and Urban Cleaning	1.79	0.1%	-1.7%	-3.39	-0.2%	3.1%	-23.28	-0.2%	5.0%	-24.88	-0.2%	3.6%
TOTAL	-108.24	-0.3%	100.0%	-110.27	-0.3%	100.0%	-465.96	-0.3%	100.0%	-684.46	-0.3%	100.0%

Table F 1. Energy Consumption

APPENDIX G. Impacts over GHG Emissions

2013's SECTORS OF THE ECONOMY	Metropolitan Region of Sao Paulo (MRSP) Δ EMISSIONS OF GHG			Rest of Sao Paulo state Δ EMISSIONS OF GHG			Rest of Brazil Δ EMISSIONS OF GHG			BRAZIL Δ EMISSIONS OF GHG		
	10 ⁶ t CO ₂ eq	Sector relevance	Economy relevance	10 ⁶ t CO ₂ eq	Sector relevance	Economy relevance	10 ⁶ t CO ₂ eq	Sector relevance	Economy relevance	10 ⁶ t CO ₂ eq	Sector relevance	Economy relevance
	(S0) MBT+WIE	1.10	100.0%	-36.8%	-	-	-	-	-	-	1.10	100.0%	-23.9%
(S62) Urban Cleaning Services	-3.90	-49.8%	130.5%	0.00	-0.1%	1.5%	-0.03	-0.1%	2.1%	-3.94	-8.2%	85.4%
(S43) Transport, Storage and Mail	-0.08	-0.2%	2.6%	-0.06	-0.2%	24.8%	-0.30	-0.2%	21.8%	-0.44	-0.2%	9.5%
(S58) Production of Paper, Cardboard and their Products	-0.06	-5.2%	1.9%	-0.06	-4.6%	23.8%	-0.12	-6.1%	8.7%	-0.23	-5.4%	5.1%
(S61) Electricity Production (Oil based)	-0.02	-256.8%	0.7%	-0.01	-256.8%	4.5%	-0.19	-259.0%	13.6%	-0.22	-258.6%	4.8%
(S14) Petroleum Refining and Coke	-0.01	-0.8%	0.4%	-0.03	-0.6%	11.3%	-0.08	-0.5%	5.7%	-0.12	-0.6%	2.6%
(S17) Resins and Elastomers Production	-0.01	-5.8%	0.2%	0.00	-6.1%	1.4%	-0.01	-6.1%	1.0%	-0.02	-6.0%	0.5%
(S26) Steel Production and Derivatives	0.00	-0.1%	0.2%	0.00	-0.1%	1.9%	-0.05	-0.2%	3.7%	-0.06	-0.2%	1.3%
(S13) Newspapers, Magazines and Discs	0.00	-0.1%	0.1%	0.00	-0.1%	0.4%	0.00	-0.1%	0.3%	-0.01	-0.1%	0.2%
(S27) Metallurgy of Non-Ferrous Metals	0.00	-0.1%	0.1%	0.00	-0.1%	0.5%	-0.01	-0.1%	0.4%	-0.01	-0.1%	0.2%
(S23) Rubber and Plastic Articles	0.00	-0.4%	0.1%	0.00	-0.2%	0.4%	0.00	-0.2%	0.2%	-0.01	-0.3%	0.1%
(S16) Chemical Products	0.00	-0.9%	0.1%	0.00	-0.8%	1.0%	-0.01	-1.3%	0.9%	-0.02	-1.1%	0.4%
(S45) Financial Intermediation and Insurance	0.00	-0.1%	0.1%	0.00	-0.1%	0.2%	0.00	-0.1%	0.2%	0.00	-0.1%	0.1%
(S60) Aluminum Metallurgy	0.00	-0.2%	0.1%	0.00	-0.1%	1.1%	0.00	-0.1%	0.3%	-0.01	-0.1%	0.2%
(S22) Products from various Chemicals	0.00	-0.8%	0.0%	0.00	-0.8%	0.4%	0.00	-0.9%	0.1%	0.00	-0.8%	0.1%
(S57) Non-Metallic Minerals Extraction	0.00	-3.0%	0.0%	0.00	-3.0%	0.9%	-0.06	-4.6%	4.1%	-0.06	-4.5%	1.3%
(S24) Cement	0.00	0.0%	0.0%	0.00	0.0%	1.0%	-0.02	0.0%	1.1%	-0.02	0.0%	0.4%
(S49) Services for Companies	0.00	-0.1%	0.0%	0.00	-0.1%	0.1%	0.00	-0.1%	0.1%	0.00	-0.1%	0.1%
(S5) Other from Extractive Industry	0.00	-12.3%	0.0%	0.00	-10.5%	0.1%	-0.05	-4.7%	3.7%	-0.05	-4.8%	1.1%
(S21) Paints, Varnishes and Lacquers	0.00	-0.3%	0.0%	0.00	-0.3%	0.1%	0.00	-0.4%	0.0%	0.00	-0.3%	0.0%
(S20) Perfumery, Health and Cleaning	0.00	-0.2%	0.0%	0.00	-0.1%	0.1%	0.00	-0.4%	0.1%	0.00	-0.3%	0.1%
(S44) Information Services	0.00	-0.1%	0.0%	0.00	-0.1%	0.1%	0.00	-0.1%	0.1%	0.00	-0.1%	0.0%
(S12) Cellulose and Paper Products	0.00	-0.5%	0.0%	0.00	-0.6%	0.3%	0.00	-0.7%	0.3%	-0.01	-0.6%	0.1%
(S3) Oil & Gas	0.00	-0.2%	0.0%	0.00	-0.2%	0.3%	-0.07	-0.4%	4.9%	-0.07	-0.4%	1.5%
(S19) Agricultural Defensive Agents	0.00	-0.3%	0.0%	0.00	-0.3%	0.1%	0.00	-0.5%	0.1%	0.00	-0.4%	0.0%
(S1) Agriculture, Silviculture and Forestry	0.00	-0.3%	0.0%	-0.01	-0.1%	4.4%	-0.10	-0.1%	7.0%	-0.11	-0.1%	2.3%
(S6) Food and Beverage	0.00	0.0%	0.0%	0.00	0.0%	0.5%	0.00	0.0%	0.2%	0.00	0.0%	0.1%
(S46) Estate Services and Rent	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.1%	0.00	0.0%	0.0%
(S28) Metal Products - except Machines and Equipments	0.00	-0.2%	0.0%	0.00	-0.2%	0.1%	0.00	-0.2%	0.0%	0.00	-0.2%	0.0%
(S15) Alcohol	0.00	-0.2%	0.0%	-0.02	-0.2%	7.9%	-0.01	-0.2%	0.8%	-0.03	-0.2%	0.7%
(S25) Other Products from Non-Metallic Minerals	0.00	-0.1%	0.0%	0.00	-0.1%	0.2%	0.00	-0.1%	0.2%	0.00	-0.1%	0.1%
(S18) Pharmaceutical Products	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%
(S32) Machines, Devices and Electric Materials	0.00	-0.2%	0.0%	0.00	-0.2%	0.0%	0.00	-0.1%	0.0%	0.00	-0.2%	0.0%
(S59) Production of Glass and their Products	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%
(S52) Services for Families and Associatives	0.00	-0.1%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%
(S29) Machines and Equipments - including Maintenance and Repairs	0.00	-0.1%	0.0%	0.00	-0.1%	0.1%	0.00	-0.1%	0.0%	0.00	-0.1%	0.0%
(S2) Livestock	0.00	0.0%	0.0%	-0.01	0.0%	3.7%	-0.13	0.0%	9.7%	-0.14	0.0%	3.1%
(S8) Textiles	0.00	-0.1%	0.0%	0.00	-0.1%	0.1%	0.00	-0.1%	0.0%	0.00	-0.1%	0.0%
(S42) Commerce	0.00	0.0%	0.0%	0.00	-0.1%	0.1%	0.00	-0.1%	0.1%	0.00	-0.1%	0.0%
(S41) Building	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%
(S9) Articles and accessories of Clothing	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%
(S48) Housing and Food Services	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%
(S37) Parts and accessories for automobiles	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	-0.1%	0.0%	0.00	-0.1%	0.0%
(S56) Public Administration and Social Security	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%
(S39) Furnitures and Other Products from diverse Industries	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%
(S51) Commercial Health	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%
(S50) Commercial Education	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%
(S11) Wood Products - except Furnitures	0.00	-0.1%	0.0%	0.00	-0.1%	0.0%	0.00	-0.1%	0.0%	0.00	-0.1%	0.0%
(S36) Trucks and Buses	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%
(S31) Office Machines and Computing Devices	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%
(S33) Electronic Materials and Communication Equipments	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%
(S4) Iron ore	0.00	-0.1%	0.0%	0.00	0.0%	0.0%	0.00	-0.1%	0.2%	0.00	-0.1%	0.1%
(S38) Other Equipments for Transport	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%
(S10) Leather Goods and Footwear	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%
(S54) Public Education	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%
(S7) Products from Smoke (Tobacco)	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%
(S55) Public Health	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%
(S53) Domestic Services	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%
(S34) Devices, Medical instruments	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%
(S35) Passenger cars and utilities	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%
(S30) Household Appliances	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%
(S47) Maintenance and Repair Services	0.00	2.7%	-0.1%	0.00	-0.1%	0.0%	0.00	-0.1%	0.0%	0.00	0.5%	-0.1%
(S40) Electricity, Gas, Water, Sewage and Urban Cleaning	0.01	0.1%	-0.3%	-0.02	-0.2%	6.5%	-0.11	-0.2%	8.1%	-0.12	-0.2%	2.6%
TOTAL	-2.99	-3.4%	100.0%	-0.25	-0.2%	100.0%	-1.37	-0.1%	100.0%	-4.61	-0.3%	100.0%

Table G 1. Greenhouse Gas (GHG)