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The sustainability of cooperative intelligence as an alternative to the small and medium-sized cities, the disposal of municipal solid waste for power generation

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Abstract

The purpose of the research is to present to the Brazilian municipalities, in particular, to the people of Paraná, a methodology for the formation of municipalities public consortia, in order to assist them to comply with federal legislation regarding the National Program for the Management of Urban Solid Waste. In this context, the survey outlined the consortium structure in Brazil, as well as the conventional systematics of the management of Urban Solid Waste, as well as its destination and reuse, as well as evaluating successful initiatives in other nations. Allied to this, the research also proposes to evaluate two technologies for the destination and treatment of Urban Solid Waste. The character of the evaluation is to analyze, identify and compare results between them. The project focused on a traditional technology that is the landfill and in another that is an innovative technology, which is gasification. The focus of the research is to highlight the importance of cooperative intelligence, especially when there are common problems, in the search for joint solutions, as well as to present technological alternatives that, in addition to providing a solution to the problem of management and destination of Urban Solid Waste, can contribute to The achievement of direct and indirect benefits, both in the environmental, social and economic sphere, the basis of sustainability. For that, the work had as methodological reference the realization of technical visits in both the Cascavel Sanitary Landfill, in the State of Paraná, as well as in the Carbogás Pilot Project in Mauá, State of São Paulo. The results obtained consisted in the presentation of a referential methodology for the formation of municipalities Consortia, as well as comparative results among the technological models that can aid in decision making.

Keywords: Intermunicipality consortia, cooperation, solid waste, sanitary landfills and gasification.

Introduction

Nowadays there are significant transformations in the world, especially with involving environmental aspects. This situation requires the continuing need of Nations in formulating new policies for the sector, under penalty of the commitment of generations to come.

It is necessary to face this point through organized actions looking redesign the organizational process, in order to boost the economic and social potential of innovative management strategies, prioritizing new models. The approach of Alves (2008), emphasizing the concept of clusters, which is characterized as a network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies, is a path to be considered as a way to get consistent solutions to the problem.

The organizational model in essence of cooperative intelligence certainly could boost the local and regional development with a view to establishing joint actions with defined aims, especially on an issue that devastates the cities in general, with regard to the environment, the management of solid urban waste, object of this research.

In this way, the problem is how to perform the solid waste management using public policies with actions and solutions based on legislation jointly, that in addition to meeting the legal premises can have economic and environmental benefits in the process.

Thus, the idea proposed is to take as a basis the structure of cooperative intelligence, which is nothing but the union of municipalities in an organized manner and in joint management of the RSU (Urban Solid Waste in Portuguese). The contemporary forms suggest that one of the alternatives of this cooperation, is the organization in public consortia, or territorial arrangements, which is nothing but associate forces, adding skills, establish a real synergy with the purpose of building a better result.

The municipalities consortia have been presented as a counterpoint to misguided policy of indiscriminate creation of municipalities in post constitution of 1988 in that respect can be considered:

These observations come to suggest a date, more viable alternatives to the municipalities is to join in the search for joint solutions, however, this is no guarantee that these joints are lasting and effective, according to Abrucio, Dieguez and Filippim (2013), the difficulties are considerable in views of the policy issues that involve such decisions.

In this context, the Brazilian municipalities, in isolation in your majority, or inter municipalities consortia have sought alternatively to the disposal of municipal solid waste-RSU in landfills, which somehow, under the environmental and legal aspect is a correct and appropriate alternative. Despite this claim to be assertive, that, in a way, also complicates, Yes, there are difficulties like: find areas to their destination, the rejection of the population adjacent to the site, the deployment and maintenance costs, permanent care that the landfill requires, among other, with these complexities, requires strategies very well elaborated in the public sector.

Gasification, according to Infiesta (2015), is a set of reactions that render inside a reactor, powered by Fuel derived from waste (CDR – initials in Portuguese), without contact with the environment and with little presence of oxygen. These reac-

tions generate gases, known as Syntesis, gases that through your burn allows the heating boilers (Rankine cycle) and from the thermal energy from the process to generate electricity. The CDR is a high-compression system RSU, forming blocks with very low humidity.

And, unlike the combustion, gasification process does not issue, the absence or poor presence of oxygen, toxic components like the NOXs, SOXs, dioxins or furans, which are chlorine radicals linked by oxygen atoms, if featuring environmentally safe process.

In this context, the purpose of the research is to contribute effectively to the municipalities have alternatives in the search for joint solutions, in an attempt to meet national law of municipal solid waste, as far as the management, as its destination. In this line, contains, under a Executive perspective, presents methods relating to public inter municipalities consortia formation, and assist in any decision-making about solid waste disposal, and performs the comparison between two technologies: the landfill of Cascavel, state of Paraná, where sought, through on-the-spot visit information on details of the operation of the same as well, the gasification technology, which focused the search on the Carbogás project in Mauá, São Paulo state.

And, the main objective of this research is to propose a methodology for the Brazilian municipalities can organize through public inter municipalities consortia for managing municipal solid waste, the allocation for power generation by gasification technology, thus eliminating environmental liabilities.

Theoretical Foundation

The public consortiums as mechanisms for cooperation and development inducer

In a country with continental dimensions such as Brazil and counting with more than 5 thousand cities, the discussion about the federalist cooperation is a hot topic in any related public schedule.

As notes, Abrucio, Dieguez and Filippim (2013) the relationship of cooperation between public bodies has been a recurring term, mainly because the dichotomy centralization versus decentralization appears increasingly worn as key to understanding the dynamics of Brazilian federalism.

According to Randolph (2014) the approach of the current discussion part of the understanding that the formulation and implementation of a regional development policy are complex processes. So, what can be seen is the need to recast the federalist process articulated form, through different forms of institutional political arrangements, borrowing the economics term who speaks in clusters.

The Brazilian Federation indicates the concentration around a unique power where decisions emanate from the State, according to Batista (2011), in this context is evidenced the need for mechanisms to bring greater coordination through regional associations, as an intergovernmental solution defends Abrucio, Dieguez and Filippim (2013).

According to the observations of Machado and Andrade (2014) regional associations alternative technically and legally most appropriate in view of the Federal Constitution of the country is the organization in public municipal consortia, as a means of distribution of costs and benefits. This theme, it is observed that:

> It is in this context that the public Consortium emerges as strategic figure, as it enables action of cooperation between federated entities and, through them, enhances the capacity of the public sector in the implementation of public policies that provide infrastructure for socioeconomic development and guarantee of social rights. (BATISTA, *et al.* 2013).

Public Consortia – Legal Framework

The first initiatives to consolidate these federalist cooperation mechanisms arise, in 1933, still in the call, Second Republic. In the new State, the Constitution of 1937, also makes mention of the groupings of municipalities with the, in the Constitution of 1967, arise the so-called covenants, as describes Machado and Andrade (2014). The constitutional amendment number 01/1969 that creates the so-called "Administrative Consortium", according to Batista (2013), but basically abused legally under the name of covenants. Were considered as agreements concluded between entities of the same kind or of the same level for the achievement of common goals.

According to Batista et al. (2011) in the 1980 's that the first successful experiences of inter municipalities cooperation, though still in need of a formal and legal framework that would allow an organic model warranty.

In the 1988 Federal Constitution, was provided for in the first paragraph of your article 23, the regulation of complementary law to establish and discipline "to cooperation between the Union, the States, the Federal District and the Municipalities" as explains the National Confederation of Municipalities-CNM (initials in Portuguese) (2007).

In 1988 a constitutional amendment number 19/1988 which will allow public consortia and the associated management of common public services may be governed by means of ordinary law and not by complementary law.

However, on April 06th of 2005, is regulated and deploys legal public consortiums law of 11.107 number. And it should be noted that the law imposing federal cooperation procedures and can be used in relations between the cities, but also in relations with the municipalities and States, still, of the Union, with the States and municipalities (CNM, 2007).

However, the effective regulation of the Act takes place through a Federal Decree to go 6017 of 17 January 2007.

Structure of the Inter Municipalities Consortia

According to Teixeira and Meneguim (2012), the inter municipalities consortia are characterized as partnerships between municipalities to carry out joint actions, in the form of enabling the improvement in the quality of public services provided to the population. The possibility of aggregation of municipalities, in the special case to those with population of less than 10000 inhabitants, can bring significant economies of scale and provide substantial improvements to population with regard to essential public services.

Municipal Solid Waste-RSU

For a long time, the humanity gave more attention to the economic production of goods and services at the expense of health and quality of life. And the reflection of

this is being felt in everyone with perverse effects for generations to come if nothing is done. And in this context the alternative is to create sustainable development mechanisms, which according to Robles Jr. and Bonelli (2008), means meeting the needs of the present generation, without compromising the right to their future generations and emphasizes that the question and the responses, the scope of the limits of actions to reduce the impact of the damage of everyday urban life, are based on solutions that can break away from vicious circle current , to a virtuous circle on the basis of the proposed public policy management (JACOBI, 2006).

One of the public policies, object of this research involves more effectively the law number 12.305/2010 referred to the Brazilian Solid Waste Policy (PNRS – initials in Portuguese) and some aspects of the law number 11.445/2007 the National Sanitation Policy.

Urban solid waste-RSU, popularly known as trash, reject generated daily, such as household food scraps, plastic bags, bottles, papers in general, clothing, remnants of pruning, remains of fairs such as: fruits, vegetables, vegetables in general, and other organic and inorganic materials. The RSU does not include medical waste, hazardous or radioactive, industrial (ABNT, 2004).

The daily production of solid residues greatly contributes, on contamination of the environment, when not handled properly. It is necessary to remember that these residues, do not cease to be a valuable product because it is thrown. Throughout the life cycle of any product, such as: raw material extraction, production, transportation, marketing, use and final destination, there is waste generation, however, the wrong destination is causing significant environmental liabilities.

Once thrown, the solid waste typically follows to landfills, where there is the decomposition of your organic part, generating methane gas (CH4), the worst of gases because it is 25 times more potent than carbon dioxide. According Brazilian Association of Public Cleaning (Abrelpe – in Portuguese) and special waste between 2007 and 2010 noted a growing amount of waste that have received inadequate disposal, 42% of the total, or 23 million tons in 2010, in open dumps or landfills "controlled", according Ibrahim, Ibrahim and Canterbury (2015).

Currently the solid residues are considered one of the biggest problems for cities and municipal administrations. They represent an important and high cost in the areas of public health, urban infrastructure and environmental agencies.

In urban areas, each person produces about 1 pound of waste every day and, according to the UN, municipal solid waste production has been growing three times faster than the world population. Give a correct destination to the RSU and other waste generated is an issue that needs to be faced. (AMAZONIA.ORG, 2015).

Panorama of the solid waste in the world

Inadequate management of solid waste in the world has become an economic problem, environmental and public health, with 1.3 billion tons of urban solid waste being produced every year and three billion people around the world without access to proper disposal facilities of that solid waste. Leveraged by population growth, urbanization and increased consumption, waste volumes, possibly will double in size in low-income cities of Africa and Asia until 2030 (WORLD BANK, 2012).

The country that generates waste per person in the world is the island of Trinidad and Tobago in the Caribbean. According to World Bank report, each person there generates 14,4 pounds of trash per day, a number well above the second position, Kuwait, where each inhabitant generates 5,72 pounds of garbage per day.

In addition to the two first placed, among the 10 largest emitters of urban solid waste per person in the world, only three other countries have population greater than one million inhabitants: Sri Lanka, New Zealand and Ireland.

According to the website Portal dos Resíduos Sólidos (in Portuguese) (2013), total solid waste products of world urban population the vast majority of the waste produced is 1,3 billion tons per year, or 1,2 pounds per day for each inhabitant of the cities. About half are produced in OECD countries (Organization for Economic cooperation and development, which includes 34 countries). The predictions are that the total will grow to 2,2 billion tons in 2025, with China that will increase to three times your amount (of 520 million tons to 1,4 billion).

Remember that due to the fact that many countries still do not have a system of elaborate data control and policies defined, the data are still incomplete. If every inhabitant of the planet to produce 1 pound of solid urban waste per day, so have over 7 million tons of waste being produced each day.

Several countries have already understood the potential in the solid waste sector and develop specific technologies to solve the problems. In this gigantic market, chances for those who invest only increase, considering that humanity won't escape of environmentally correct solutions that the sector needs. Companies that settle now can quickly expand in the near future to international markets.

The Brazil and the current Panorama of solid waste

As well as in the world, the problems of solid waste disposal in Brazil is linked to the increase in population of the cities, a highly consumerist model of society and the lack of an environmental culture, to handle consciously what is discarded and considered no longer in use.

In 2010, was instituted in Brazil the Brazilian Solid Waste Policy (PNRS), it is important to note, that second Neto (2013) there are two concepts that deserve a certain prominence, the first is related to the development, deployment and operation of solid waste management system, the second involves actions that contains important instruments to enable the progress necessary for the country in tackling the main environmental problems social and economic, arising from the inadequate management of solid waste.

The principle of Cooperation provides for the prevention and the reduction in waste generation, having as the practice of sustainable consumption habits and a set of instruments to encourage increased recycling and reuse of solid waste (what has economic value and can be recycled or reused) and environmentally appropriate disposal of tailings (what cannot be recycled or reused) suggest Philippi Jr. et al. (2012), however this is not restricted the actions, but also between the different spheres of Government and other segments of society. Cooperate is to act jointly and not separately or antagonistically. Article 10 of the law is clear to 12.305 say:

> It is for the Federal District and the municipalities integrated management of solid waste generated on their territory, with-

> out prejudice to the powers of control and monitoring of federal and State organs of the National Environmental System (Sisnama – in Portuguese), National Health Surveillance System (SNVS – in Portuguese) and the National Agricultural Health Care (Suasa – in Portuguese), as well as the responsibility for managing the waste generator According to the Law, (PHILIPPI et al. 2012).

The law also establishes the shared responsibility of waste generators: manufacturers, importers, distributors, retailers, the citizen and holders of management services of municipal solid waste in reverse logistics of waste and post-consumer packaging. Creates important goals that will contribute to the Elimination of landfills and establishing planning instruments at the levels national, state, c, metropolitan and municipal and inter municipalities, in addition to force individuals to draw up their plans for solid waste management, according to report Barbosa and Ibrahim (2014). It is in fact one of the major advances of the PNRS is shared responsibility.

> Shared responsibility is individualized and chained assignments set by manufacturers, importers, distributors and traders, consumers and of holders of public services of urban cleaning and solid waste management, to minimize the volume of solid waste and waste generated, as well as reduce the impacts to human health and environmental quality arising from the life cycle of products (BARBOSA; IBRAHIM, 2014).

Referring to the closure of landfills, the deadline initially proposed in PNRS, the eradication of these until September 2014, however did not occur. The new deadline is under discussion through provisional measure, however still no definition. However, they were not introduced any other incentives, penalties and strategies to achieve this goal, we can conclude that there will be no significant changes in relation to the current scenario. Unless, of course, that new strategies involving the three levels of Government and the private sector are set out objectively to deploy solutions that lead to total eradication of landfills.

One can cite as major problems generated by inadequate solid waste disposal: spread of diseases, contamination of soil and groundwater by manure, methane gas pollution (generated in the decomposition of organic matter present in the trash), the risk of air accidents caused by vultures, herons and seagulls that fly over dumps near airports and the environmental liabilities created in the area destined to receive these debris. The Table 1 monster that despite legislation to be very clear about the correct disposal of waste, much of the RSU produced still is grounded incorrectly, causing serious damage to health and the environment (ABRELPE, 2013).

Table 1: Final Destination of the RSU between Regions of Brazil

Destinação Final	2013 – Regiões e Brasil					
	Norte	Nordeste	Centro-Oeste	Sudeste	Sul	BRASIL
Aterro Sanitário	92	453	161	817	703	2.226
Aterro Controlado	111	504	148	645	367	1.775
Lixão	247	837	158	206	121	1.569
BRASIL	**450**	**1.794**	**467**	**1.668**	**1.191**	**5.570**

Source: ABRELPE (2013).

More than 75 million people, about one-third of the Brazilian population, still are affected by waste disposal in inappropriate locations, which shows inertia and the contempt with which this subject has been treated in Brazil. Currently, 42% of the waste collected (or almost 30 million tons per year) are still dumped in open dumps and landfill sites controlled, environmentally inappropriate spaces, which are still being used by 3.344 municipalities in all regions of the country. And also, in addition to this situation, there is the absence of updated legislation and institutional and political benchmarks, as well as financing instrument, report Philippi et al. (2012).

The situation of the s solid wastes in Paraná State

Solid waste policy of the Paraná aims, primarily, eliminating 100% of landfills in the State and the reduction of 30% of the waste generated. These goals can only be reached through the convening of every society, aiming at the change of attitude, consumption patterns, combating waste, encourage reuse, reuse of potentially recyclable materials through recycling.

The Paraná, which produces daily 20000 tons of waste from all sources, even has 93 municipalities with open air dumps. Are large, medium and small cities that suffer the absence of a proper system of environmental sanitation (IAP, 2013).

A survey by the Instituto Ambiental do Paraná-IAP (in Portuguese) (2013) shows the reality of landfill sites, landfills and dumps in all municipalities in Paraná and reinforces the importance of actions to eradicate inappropriate areas for waste disposal. More than 7 million of people (almost 70%) are serviced by duly licensed landfills, as shown the Graph 1.

However, it is worth pointing out that when it comes to final destination by municipalities, there is a large portion without 12.305/10 law service, that is, according to the report of the IAP (2013), 214 cities designed their RSU irregularly, in dumps or landfills, this corresponds to 53.6% of the total of 399 municipalities that constitute the State.

The "situation report on the disposal of municipal solid waste in the State of Paraná" was carried out by technicians of the Institute in 2012. The document is provided for in National Law of Solid Waste (12.305/2010) and part of the Regionalization plan of waste of the State Government. The studies were based on State environmental licensing and the criterion adopted was the existence or not of an environmental license for operation of the IAP.

Another action implemented in the State, through the Secretariat of State for the environment and water resources-SEMA (in Portuguese) was the creation of the program "Paraná without Dumps", through the State Decree number 8.656 of 31 July 2013, involving all government agencies that perform actions related to environmental sanitation and the production of energy from waste. Signed an agreement with the Ministry of environment (MMA – in Portuguese) for the elaboration of the Integrated Management Plan and Associated with Municipal Solid Waste in the State of Paraná- PEGIRSU-PR (2013), as one of the law enforcement steps 12.305/number 10.

In September 2015 the Government of the State of Paraná has established a Multidisciplinary and Inter Institutional Working Group, formed by various State entities, to discuss and prepare proposals for the deployment of management mechanisms and funding to the municipalities and consortia for integrated actions he and

investments arising from the State solid waste Policy (RESOLUÇÃO CONJUNTA SEMA/SEDU/PARANACIDADE number 004/2015).

The proposal is, through Public Private Partnerships (PPP's) or Special Purpose Entities (SPEs), decentralize the realization of investments in infrastructure for final disposal of solid waste, getting to the State the task of monitoring and supervising the way in which services are provided. Conceptualize and deploy an integrated system of treatment and final disposal of municipal waste is an imperious necessity that challenges the public administration; huge investments are required, implementation of complex industrial plants, use of technologies that enable a project that, first of all, must meet ecological and social need, provides for the proposed Joint Resolution number 004/2015.

Although, many municipalities conduct some kind of recovery by public cleaning services or solid waste management, the costs of the services provided are not covered by the amount collected and in most municipalities there's annual resource designed specifically for the management and services related to solid waste.

Many of the municipal problems transcend the limits of your territory, requiring joint action, one should highlight the heterogeneity of the same regarding your financial and managerial capacity. In this context, those needs can be met with inter municipalities arrangements, in the form of public inter municipalities consortia, according Neto (2013).

Energy recovery – renewable energy sources

Currently available energy sources, according to Silva (2013) are the hydraulics, wind, nuclear, solar, bio-ethanol, biodiesel, petroleum and biomass.

Already, Goldemberg and Lucon (2008), are classified as non-renewable energy sources and renewable. The non-renewable resources are fossils and nuclear, and renewables are subdivided into:

a) Primitive Biomass - wood deforestation;
b) Conventional – hydraulic;
c) Modern - modern biomass (waste), solar, geothermal, wind and tidal power.

Purpose of this work is not discussing the sources of energy, but give an emphasis, in particular modern biomass-related sources.

According to Silva (2013) biomass is a natural resource that offers bioenergy, which is any form of energy associated with forms of chemical energy accumulated.

Energy conversion of Biomass

The conversion of biomass into energy presents itself in various ways, however, second, Henrichs, Kleinbach and Reis (2016) can be classified into three types:

a) Biochemical processes-decomposition of organic waste in an oxygen-deficient atmosphere;
b) Direct Combustion – biomass burning to produce heat for heating, or electricity production;
c) Pyrolysis -thermal decomposition of waste in a gas or liquid, under high temperatures (500 to 900 degrees Celsius) in oxygen-poor atmosphere.

Although the production of useful fuels, Henrichs, Kleinbach and Reis (2016) feature another title:

a) Biological Conversion - alcoholic Fuels and biogas
b) Thermal Conversion - synthetic Gas and gasoline derived
c) Chemical Conversion – Biodiesel

Energy Recovery-Thermal Process

Considering the aspect of value recovery of waste in general, Freires and Pinheiro (2013) are divided into direct recovery strategies and process.

In the context of research, considering the energy recovery process, the purpose is to discuss and restrict thermal conversions processes, in this context, Barbosa and Ibrahim (2014) define how thermal process, any waste treatment technology that involves high temperatures during processing of waste, not open, combustion residue, in most of the process.

Energy recovery of municipal solid waste

The energy use of municipal solid waste is an alternative energy source that offers benefits in terms of sustainability, the energy pattern of contemporary innovation, which is oriented to the reduction of greenhouse gases. The generation of energy through solid waste is part of the process of a new paradigm. Consists in pressing alternative in the pursuit of technological standards that degrade the environment less aligned to environmental, social and economic sustainability.

In this context, the purpose is to present the energy recovery of municipal solid waste to an alternative to the consolidation of the solid waste management in municipalities. (The author, 2016).

Materials and Methods

Methodological procedures, for the development of the research object of research and case studies used a set of actions based on rational and systematic procedures.

Materials

For the realization of exploratory research, the materials used to guide the achievement of same consisted in the following:

a) In relation to the proposed objectives relating to evidence the associative integration, used on-the-spot visits in the following institutions: (all initials in Portuguese)

- AMP - Association of Municipalities of Paraná
- SEMA - Secretariat of State for the Environment and Water Resources
- IAP – Paraná Environmental Institute
- Water Institute of Paraná
- SEDU - Secretary of State for Urban Development
- CODAPAR – Agricultural development company of Paraná
- Promotion of Paraná.

b) In the case of Landfill of Cascavel materials adopted were the on-the-spot visits of the following areas and institutions:

- SMMA – Municipal Secretary of Environment of Cascavel

- Central Office of Environmental OT
- The Environmental OT
- Landfill of Cascavel – receipt of the RSU, storage, treatment lagoons, methane capture system, motorcycle-generation system, flare, switchboard, transformer, power distribution, recirculation of leachate system, recovered and areas of expansion.

c) Regarding the Gasification process the materials adopted outside on-the-spot visits of the following areas and institutions:

- Carbogás headquarters in Mauá – SP
- Pilot project - CDR, aerator, switchboard, gas cooler and moto-generation system
- Plans for the project.

In addition to visits to research featured in all locations supported by pictures, cartographic maps, catalogues, reports and project plans.

Method

When it comes the methodology adopted for the research the idea is to present the steps that were considered for the achievement of the purpose of the research.
Structuring of Inter Municipalities Consortia

The survey was divided into stages, presented in table 2 below:

Table 2-Stages of Structuring of Inter Municipalities Consortia

Step 1: At this stage was to identify institutions which directly or indirectly were linked the question of both the organization as environmental aspects. Then researched various theme-related institutions, as AMP - Association of Municipalities of Paraná, IAP-Environmental Institute of Paraná, SEMA - Secretariat of State for the Environment and Water Resources, SEDU - Urban Development Secretariat, Paraná City, CODAPAR – Companhia Paranaense de Agricultural Development and Promote Paraná and Paraná Waters.
Step 2: After identification and contact with institutions on timer has timed out, at this stage it was observed that, within the framework of the research, the SEMA, SEDU, Parana City and in the case of Promotion, were the entities that provide any more consistent and relevant information for research.
Step 3: The survey provided in this step, took into account the entries of the municipalities along the competent organs concerning environmental issues, especially in the aspect concerning legislation that comes to the PNGRS- National Plan for Solid Waste Management.
Step 4: Was evaluated with the SEMA more specifically on the issue of possible records and/or registers of inter municipalities consortia with specific objectives of solid waste management, in order to suit the federal legislation. And in the case of the SEDU and Paraná City, if there was any request for applications for funding or support for the program.
Step 5: In this phase of the research pursued there by the organs, like SEDU, SEMA, Paraná Cities and Paraná Provide, had the existence of models of public policies at the State level, in support of the municipalities in order to assist them in meeting the legislation.
Step 6: This step had as main objective to evaluate the characteristics of the municipalities, and had these statistics, as regards the volume of solid waste generated, the existence of hubs cities and the distances between them.

Step 7: Already step 7, if featured in identifying and evaluating what are the necessary and systematic actions for inter municipalities consortia, both from the perspective of pre structurated, the Organization and the administrative, financial and operational, including definition of the formal organizational structure. Step 8: In the final phase of this research work was to elaborate a methodological process that aims to guide the municipalities to organize in consortia, considering its particularities, legislation, management models, among other aspects relevant to the formation of the same.

Source: survey data, 2017.

Landfill of Cascavel

To meet the goals, the steps were as follows:

Table 3 - Sanitary Landfill of Cascavel

Step 1: Regarding the identification of the characteristics of the landfill in the city of Cascavel, initially the action consisted of a bibliographical and informational character research on the landfill, primarily technical and scientific publications about it. Step 2: In this step the research assessed their geographical aspects such as, location, distance from the town and a short assessment of the environmental aspects in the vicinity of the landfill, types of properties, proximity to rivers, among others. Step 3: In this phase of the research sought to identify what are the prevailing characteristics of waste produced in the municipality and the data to the same destination, such as solid waste, health services, separate collection and construction waste. Step 4: Sought to meet at this stage as was the case until the landfill disposal, identifying how to get procedures, number of vehicles, if you had any prior separation, among others. Step 5: Regarding the technical characteristics construction of the landfill in Cascavel research stick projects and guidelines passed by the Municipal Environment. Step 6: This step is also evaluated as the municipality of Cascavel performs environmental control of the process with regard to the treatment of effluents (slurry), greenhouse gas emissions, plant cover and waste compaction system. Step 7: This research phase consisted in the form, in levels and the volume of energy generated on the basis of the emission of methane gas originated in the landfill, when was the start of power generation, how long began producing gas after deployment and what is the estimated life of gas production, after the closure of the landfill. Step 8: Following the research assessed the landfill of Rattlesnake which the results obtained in the process of burning the biogas, its applications and distribution of electrical energy.

Source: survey data, 2017.

Gasification process – Pilot Plant of Maua-SP

The stages of the process of gasification of Maua-SP are described in table 4 below:

Table 4 - Steps in the Process of Gasification of Maua-SP

Step 1: In the case of the gasification plant, at first, the work was to get together the company, the technical-scientific articles and publications on the subject.
Step 2: In the case of this gasification process step, focused research in mapping the process and the physical structure of the gasification plant plan in the pilot project.
Step 3: If characterized by identifying with the company of which types of waste could be used in gasification reactor for gas production of *synthesis*, aimed at power generation.
Step 4: Regarding the gasification plant research, at this stage, focused on identifying the operational flow chart of the process, evaluating all the productive phases until the generation of energy, as well as unwanted products.
Step 5: To evaluate the constructive process of gasification plant researcher sought along the company owner of the technology, information, such as brochures, floor plans, technical materials, visit the spot, among others.
Step 6: In the case of gasification, the purpose at this stage was to identify what environmental controls that are required under the Fluidization process before and after passing through the reactor as, issuance of effluent, gas, waste, among others.
Step 7: As regards the gasification process also evaluated energy generation levels, volumes and how the input for conversion into electric power, as well as if there is use of the by-products of the process.
Step 8: In relation to this step, when it comes to technology, the researcher, as occurred in the landfill, sought to assess the results of gas generation energy *synthesis,* and also what the system for power generation has a higher utilization of calorific value of gas, as well as the distribution and application of electric energy generated.

Source: survey data, 2017.

Results

According to the evaluations and analyses during the evolution of research, guided by pre-defined goals, they made the following results to be described in this chapter.

Current situation of the municipalities of Paraná in relation to PNGRS

In consultation the SEMA on the situation of municipalities in relation to the law of 12.305/2010 PNRS, the State is still in a poor position, most municipalities does not meet as legislation demonstrates the lifting of the IAP in the diagnosis carried out in 2012.

Despite the diagnosis be 2012, few municipalities, according to SEMA, came to meet the legislation after that withdrawal. Still, according to the same registry, the problems faced by the municipalities, especially the small ones, is the lack of financial and technical resources to this end. In this sense, the proposal from the joint resolution 004/2015, already mentioned, in addition to direct the municipalities technically

about the available technologies is helping them to overcome the difficulties encountered for the formalization of funding by the French Development Agency, through the Promotion, which offers resources to the program.

In relation to the inter municipalities consortia the survey identified that there are some within the Paraná, consortia formed to the allocation of the RSU, or shared destination. It is important to consider that although they are members with shared destination not all are registered in competent organs in the accordance with the law laid down by law number 12.305/2010.

Features for inter municipalities consortia formation

The PEGIRSU- PR (initials in Portuguese) Plan submitted a proposal effective as the regionalization and distribution for the RSU disposal in landfills. In the case of man-made criteria were subdivided into three groups: Social, economic and political institutions.

For an assessment of the context presented, as reference to region 1 for analysis and discussion of the characteristics for the formation of consortia. In this region one can observe that was regarded as regional pole city of Umuarama, municipality with over 100000 inhabitants, in view of its political and institutional characteristics.

It is observed that there are two landfills in the region studied, as a reference, provided, one in city of Umuarama and another in the city of Cianorte, in addition to 10 units of transshipment in that region. The planned volume of RSU is around 320 tons/day.

As SEMA's information, there is no articulation for inter municipalities consortia formation in the region, however there are three municipalities that share. The plan submitted is undoubtedly an excellent instrumental to the base of associations, considering regional characteristics observed.

Landfill of Cascavel – PR

The landfill of Cascavel, located in the West of the State of Paraná, was opened in 1994, the second landfill in the State. It is used to supply the city of Cascavel, 98% of which originated in the urban area and 2% of rural and municipal districts. There is no sharing with another municipality. The prediction of service life of the landfill is estimated between 5 to 7 years. In this context, with regard to environmental legislation regarding to the law 12.305/10, under the PNGRS, the municipality meets all the established requirements.

Geographical and environmental aspects of Landfill

The landfill is located in the countryside of Cascavel, called Espigão Azul in the third plateau in the Western region of Paraná, with an average altitude of 785 meters, as describes Santos and Tauchen (2010). The area of deployment of even has the dimension next to 230.000 m^2 and the distance from the generator is approximately 25 km.

Solid waste generated in Cascavel

In the city of Cascavel, the RSU collection comes from urban and rural areas, produce a volume of about 279 tons/day, and are directly intended for the land-

fill. There is also, as provided for in legislation, the selective collection, coordinated by a system called Cootacar/Ecolixo with 02 (two) warehouses and the volume of this collection is on the order of 110 tons per day, distributed as follows (AMBIENTAL, 2017):

- 20% donation and door-to-door collection
- 9% collection at condos
- 71% collections of specific points.

In the case of RCC - construction Waste (in Portuguese), there is a place designed specifically for treatment of the same, after this process, the waste already processed are destined for landfill. In relation to health services Residues (RSS), the town has a station specializing with autoclave for treatment. The waste, already treated, are also intended for the municipal landfill.

In addition, the municipality waste dispenses with special attention the packaging of agrochemicals and fluorescent lamps, batteries.

Current structure of the RSU disposal to landfill

The Environment is the company responsible for the collection of the RSU and for administering the landfill of Cascavel, has the following structure:

- 17 General collection vehicles
- 6 selective waste collection vehicles
- 2 high volume vehicles
- 1 backhoe
- 1 bulldozer for compression.

Technical/constructive characteristics of the landfill

The landfill in your constructive design meets all the techniques advocated by the standards of environmental legislation, and has:

- Basic proofing with geomembranes
- Compacting of waste
- Daily coverage of the waste
- Gas drainage and percolates
- Gas recycling system
- Percolates treatment system (slurry).

Procedures and environmental controls in the landfill of Cascavel – PR

The operation of the landfill has a series of steps on RSU disposal that meet environmental legislation and procedures. The standard procedure is to weigh the truck when access to landfill, after weighing, the vehicle is designed to discharge area where it is deposited and subsequently compressed. When the cell reaches your reception capacity, is applied with inert material on the cover, according Santos and Tauchen (2010).

For treatment of percolates there are 4 (four) reception of manure lagoons, after a period of treatment, the process provides for the recirculation of leachate. Although it has not yet been used, guarantee, a sinkhole prepared and licensed, in the event of extreme situations that go beyond the capabilities of the ponds installed.

This landfill has obtained all necessary environmental licenses without major difficulties, granted by the IAP, the LP - previous license, LI – Deployment and license IT-operation license. And operations carried out by the oversight routine has found all within the normal range.

There is still, in the process of environmental control, gas collection devices in closed cells, gas, basically methane is used for power generation. When this does not occur, for a possible interruption in generation, the same is burned through devices called flares.

Levels of energy generation and operating results

According to a study developed and published by Bottega e Souza (2015), in relation to the landfill of Cascavel, with regard to the potential of biogas generation, the authors estimate for that landfill a volume of 279 million m^3 of biogas in the period of 2010 to 2150. However, the gas generation in a landfill is not constant. The landfill gas collection of Cascavel began in 2007, but still the volume does not allow a consistent power generation. The expectation of the Municipal Secretary of Environment of Cascavel is a production of 300 KWh, however, currently the moto-generator installed on site, has 150 KWh power, although the current daily output does not exceed 70 KWh generation.

In this context of production, part of the energy generated is consumed in the landfill itself, distributed to lighting, electric motors drive system of treatment and recirculation of leachate.

In 22 December of 16 was authorized by COPEL – Companhia Paranaense de Energia, the distribution on the free market of energy goes beyond the consumption of the landfill. Such energy is made available on the network of NOS - National Operator of the Electric System. The business relationship established is conditional on the following relation, the power available on the network by the landfill is compensated by COPEL as discount on account of consumption of the city of Cascavel.

Gasification Process

Gasification is not a combustion, refers to a set of reactions that render inside a reactor, without contact with the environment and with very low presence of oxygen. The technology emerged in the 1970, using coal as a fuel. The technology in this period was dominated and patented by Carbogás and Vale do Rio Doce, together.

The gas derived from this procedure is called syngas, and also known as syngas, a clean gas basically consists of carbon monoxide and hydrogen, as reports Infiesta (2015). To your production stems from the gasification of organic waste and many inorganics.

With the advent of natural gas, the production of *syngas,* which had coal-based fuel, became uneconomic when compared to natural gas. Accordingly, in order to maintain the viability of the technology, the Carbogás Company, sought alternative energy inputs for gasification process. The research indicated the general solid waste as an excellent alternative.

Recently, after a deal between the companies, the Carbogás passes the stop, exclusively, the patent on the technology of the gasification process to generate energy from solid waste processing. From 2016, is created the Legacy Group Renewable

Energy, in order to disseminate and commercialize the technology and the legal control of technology by RTQ (initials in Portuguese) – Chemical Term Reactor in circulating fluidized bed.

Structural characteristics of the pilot project of Maua-SP

The pilot project of the Carbogás unit in Maua, located in the State of São Paulo, is composed of chemical term reactor, which consists of an internally coated with refractory material reactor and containing silica that is heated to 800° Celsius Degree, has a system for targeting gas generated by chemical reaction and a system for the disposal of tailings that gray. There is also gas cooling system, like hives where gas circulates inserted in water tanks and a set of Otto Cycle Generator, which is the system of combustion engine, the type supplied with gas, for power generation.

Identification of waste used for power generation

Waste used in gasification process is same for the landfills, the main compounds are:

- Paper and cardboard
- Tetra pack type packaging
- Diapers and absorbent
- Styrofoam and foams
- Hard plastic
- Firm or soft plastic
- Rubber
- Organic
- Fatty oils and hydrocarbons (including paints)
- Wood (construction waste, packaging, waste from pruning of trees)
- Rags and textiles in General (including industrial and mechanical workshops tow).

However, it is imperative for energy efficiency, it is necessary a certain processing, named CDR (initials in Portuguese) - fuel derived from waste, which for this goes through a series of steps such as separation of metals in general, non-ferrous metals, among others. Even though gasification can receive metals for the internal temperature of the reactor chemical term, the economic value and for eventual recycling. The CDR for use directly after this processing, it could just be crushed, however, to beware of possible interruptions in the supply system of RSU, the same can be compressed, enveloped and stored.

The CDR can be produced on own power generation plant, with appropriate facilities to perform the compression technique, equivalent to 400 ts (tons/strength), which eliminates a considerable amount of liquid (CARBOGÁS, 2015) and enveloped in plastic, polyethylene type. Is a block-factor, enveloped with little humidity and protected, can even be stored outdoors and gets as stock for possible interruption of the supply of the RSU, in order not to interrupt the production of energy, as quoted previously.

The RSU collection system far more than 60 km of the gasification plant, for example, municipalities that make up a framework of inter municipalities consortia, it is recommended the installation of reception units RSU compression system and

enveloping for elaboration of the CDR, that taking into account the cost of transport to the power plant.

Operational flow and technical characteristics of the gasification process

It is important to emphasize some technicalities about the process. In step that involves gasification reaction Thermochemistry occurs without the presence of oxygen and that there is a breach of the carbon chains, and this chemical reaction is what allows the production of syngas free of particulates and toxic components like: NOx, SOx and dioxins and furans, which are chlorine radicals linked by oxygen atoms. In this process there are also the tar cracking, turning it into carbon monoxide and carbon dioxide and methane.

At the beginning of the process to which the term chemical reactor reaches the temperature of 850 degrees Celsius, the same is fed with GLP (initials in Portuguese) – liquefied petroleum gas where reaches a temperature close to 400 degrees Celsius, after that the reaction itself raises the internal temperature to 850 degrees Celsius. As the reactor is internally coated whole of refractory material, the same delay on average two days to cool completely. Thus, short interruptions in power supply, does not affect your operation.

The waste generated by the process, called inert ash, can be studied for use as components of cement, concrete and asphalt coatings. The waste, has volume corresponds to 1% of the mass and 5 to 6% of the volume of the RSU.

In relation to energy generation, as seen in the flowchart, can occur in two ways, the Otto Cycle or Cycle Rankine. The option recommended by the company owner of the technology is the Rankine Cycle, because Otto presents a maintenance cost much higher, every 300 hours oil lubricants exchange occurs, every 8000 hours is necessary to complete the rectification of the same. In addition, you need to have a yard of 20 engines, half operating and half maintenance. That for a production of 4 MW of energy.

Already the Rankine Cycle, which relies on national technology, widely used in the production of sugar and alcohol presents a cost-benefit ratio much more interesting. And in this part of the cycle water used is the treated water originating from the treatment lagoons, associated with water from an artesian well, for example.

Environmental process control procedures

In the environmental context, for the approval of the gasification process for the treatment of the RSU, as calls for the legislation, the company owner hired technology SGS Brazil, Swiss company, much respected on the world stage to perform the reports required by law.

About the ashes generated in the process, were considered inert and without the presence of significant contaminants. The resolution CONAMA - National Environmental Council, tolerate contaminants in the order of 0,5 μg/Nm^3 (zero five, microgram per cubic meter standard), CETESB – Companhia Sao Paulo State environmental, provides a maximum of 0,1 μg/Nm^3. And the reports presented by SGS 0,01 μg/Nm^3 were found. Approvals were granted by SGS reports, USP-University of São Paulo, CETESB.

Energy generation and results of gasification

Power generation combined with the treatment of RSU is the great differential of sustainability of the model. Based on the daily production of RSU in the city of Cascavel, Parana, the equivalent of 270 ton/day of RSU, this volume is enough for 4 MW of energy, which corresponds to a PCH - Small Hydroelectric Plant. According to the company and supported by technical and scientific studies.

About the systematic energy marketing, the proposal is placing for sale on the market obviously energy book that does not exclude the possibility of future participation in the auction ONS – electrical system national Operator. The initial option by the free market, takes into account the possibility of commercialization of energy, on behalf of the tax exemptions of tariffs of TUST - tariff for use of the transmission system and the use of tariff - TUSD distribution system, according to the resolution number 271/2007 of ANEEL – National Agency of Energy.

Conclusion

Is the expectation that such research can effectively contribute to your purpose. We tried to emphasize the importance of the relentless pursuit of ways of allowing organizations to promote sustainable development, based on cooperative intelligence. In this sense there is concrete evidence that they have a long way to go in search of this sustainability. Notwithstanding, the efforts dismissed for such, still, little commitment and real interest in the search for joint solutions in compliance with the legislation. In this optics the research identifies a certain leniency of public authorities on the situation.

However, in the experiment studied, can be observed that the rationalization of public resources is a limiting factor to the implementation and the construction of a territorial associations, the different views of the municipal leaders regarding the definition of priorities, is undoubtedly a difficulty of the process. Another point observed is that initiatives to stimulate and motivate the Intermunicipality cooperation are timid and incipient, although there are projects in various segments of encouraging the formation of these institutional arrangements, political myopia is still an obstacle.

Another point to be emphasized is that the complexity of the intercommunal dialogue reveals great difficulty in structuring and maintaining of such consortia. Despite the little innovative visions present in Brazilian geopolitical scenario, the research seeks to present alternatives in order to propose an evolution based on successful experiences both nationally, as internationally. The big challenge is to reduce the time required to achieve the objectives proposed on the paradigm of this federative structure based on a culture of immediacy, for a model based on sustainable and innovative cooperation.

The systematic presented, in this research, the training of inter municipalities consortia, sought to be as comprehensive as possible, in order to be a general model seeking meet various features and particularities of the municipalities, it is important to note that under the State of Paraná, the consortia initiatives for management and disposal of solid waste are practically non-existent. There is a formalized Consortium in the metropolitan region of Curitiba, where the fate of the collection is a landfill installed in Fazenda Rio Grande City, managed by the company Estre Ambiental. In addi-

tion, there are also some landfills being used shared, but far short of the capability that enables alternative.

Considering the traditional form of the organizations involving the federal entities, the proposal emphasizes that the professionalization in the collaborative environment is of fundamental importance to the success of these Intercity settlements. The figure of the political agents must be restricted definitions of priorities and medium-and long-term objectives, leaving the daily management to professionals, because in this view, the collective interest supersedes individual, since the natural tendency of the professional manager is the impartiality with focus on the goal.

The present study has on your overall objective to purpose a methodology for the Brazilian municipalities can organize through public inter municipalities consortia for managing municipal solid waste, the allocation for power generation by gasification technology, thus eliminating environmental liabilities.

The range of results was made possible by the proposed adoption of a benchmark methodology for the training of public inter municipalities consortia, through a defined organizational structure model, as well as the demonstration of technologies for energy generation from RSU, aiming to contribute to the aforementioned management in relation to the disposal of solid waste. A traditional which is the landfill and the other an innovative model and more environmentally sustainable that is gasification.

In relation to the landfill, the searched reference sticks to existing landfill in the city of Cascavel, State of Paraná, one of the oldest and most technically well-structured in the State. The research then sought to identify the General characteristics of the landfill, your geographical location and environmental aspects, the amount of waste generated in the municipality and the form that is intended for the same.

Sought to also assess the technical characteristics in the construction and operation of the landfill, the environmental control procedures, the compliance with the environmental requirements and mainly the results obtained because energy use comes from the generation of methane from the decomposition of solid waste deposited in the landfill.

The other technology that the study focused was the gasification, a process that is an innovation that is the use of a fluidized bed reactor, anaerobic, arrangements for processing of solid urban waste, aiming from this chemical reaction generating a gas, called syntheses gas to energy use.

The research sought to know the process through a visit in loco, the pilot plant installed at the Carbogás factory in the city of Mauá, São Paulo State. On that visit, the study focused on meeting the implementation, operational aspects and the functionality of the technology, in this context, still sought to identify the structural characteristics of the process, the types of waste that could be used for power generation, operational flow, environmental controls, the view from the perspective of environmental legislation with regard to technology, the operating results of energy use and energy levels.

Before all that problematic experience studied allows considers that there is still a lot to do with respect to the legislation by Brazilian municipalities to the national solid waste management.

In this context, the survey considers it perfectly feasible facing the problem of consistently and promising. It is necessary to strengthen the participation of civil society in this scenario and stimulate cooperative dialogue, based on models of successful

cooperative system of Paraná. The success of the structuring of an institutional arrangement is the ability of the Intermunicipality householders in combine institutional innovation with innovative developments of political content, and what you can conclude is that success is the ability to reconcile innovations, breaking the standard that is dominant.

In this way, the research demonstrates that the purpose established in the first specific objective, as regards the comparison of the two technologies in the economic and environmental sphere, had your reach evidenced.

In the case of the second objective, the study highlights the importance of cooperative intelligence as effectively in attendance by the municipalities to the national program for the management of solid urban Waste, laid down in legislation.

In relation to the third specific objective, for your compliance, research, analyses and presents the results from the energy technologies observed, comparing them in your essence emphasizing them, allowing the Consortium, or the municipality of isolated form a conscious and safe decision-making.

In this context, it is concluded that the formation of inter-municipal consortia for the management of the RSU, in relation to small and medium-sized municipalities is a promising alternative, and in the aspect of technology, the landfill is definitely a viable option for disposal of waste, for being a technology widely dominated, although, with environmental limitations, both in the case of delimitations of areas intended for the same and the early life of the model. In this sense the gasification process itself as an effective alternative, socially important in terms of employment and income generation, economically viable and environmentally sustainable.

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