WASTE MANAGEMENT IN BRAZIL

Dr. Sergio Guerreiro Ribeiro
University of Brasil – Rio de Janeiro (UFRJ)
Chairman, WTERT-Brasil

WTERT 2010 Bi-Annual Meeting at Columbia University
NEW YORK CITY, OCTOBER 7 & 8, 2010
WTERT-Brasil homepage ➔ www.wtert.com.br

Nos Estados Unidos existem 87 usinas resíduos-energia (REN) ou "waste-to-energy" (WTE) que processam 28 milhões de toneladas de resíduos sólidos urbanos (RSU) gerando cerca de 15 TWh de eletricidade por ano. Na década de 1990 todas estas usinas implementaram novas regulamentações (MACT- Maximum Achievable Control Tecnology) da Agência de Proteção Ambiental (EPA). [ler mais]

Ultimas Notícias

- COPPE e COMLURB fazem parceria para geração de energia a partir do lixo. O acordo firmado hoje em solenidade na UFRJ prevê edital para apresentação de propostas para a Prefeitura do Rio de Janeiro em 80 dias—17 de agosto de 2010
- Comissão do Senado vota proposta do senador Marcelo Crivella que obriga o uso do biogás de aterros sanitários para cidades com mais de 200.000 habitantes. Os créditos de carbono pelo MDL (Mecanismo de Desenvolvimento Limp...
BRAZIL APPROVED NEW SOLID WASTE MANAGEMENT LAW AFTER 20 YEARS OF DISCUSSION IN THE CONGRESS.

THE LAW INSTITUTES WM HIERARCHY: REDUCTION, RECYCLING, ENERGY RECOVERY (NOT SPECIFIC), FINAL DISPOSAL.

INSTITUTES THE NATIONAL SOLID WASTE PLANNING PROGRAM TO BE COORDINATED BY THE FEDERAL GOVERNMENT, UPDATED EVERY 4 YEARS, TAKING INTO ACCOUNT THE BEST INTERNATIONAL PRACTICES.

THIS PLANNING SHOULD ESTABLISH GOALS FOR RECYCLING AND ENERGY RECOVERY AND CREATE FINANCIAL SOURCES TO IMPROVE WM.

UNFORTUNATELY THE LAW IS VAGUE IN MANY ASPECTS IN SPECIAL NOT DISTINGUISHING BETWEEN INCINERATION AND METHANE RECOVERING FROM LANDFILLS.

DOES NOT INSTITUTE ORGANICS LANDFILL DIVERSION PROGRAM.
SEVERAL CITIES ARE CONSIDERING WTE TO REPLACE LANDFILLS:

CONSIDERING JUST HOUSEHOLD WASTE

1. BELO HORIZONTE (1,500 TPD)

2. RIO DE JANEIRO (4,500 TPD)

3. BRASILIA (2,000 TPD)

IS PROCESSING 60,000 TPD (INCLUDING RIO, SÃO PAULO, BELO HORIZONTE AND OTHERS) – SEVERAL LANDFILL GAS PROJECTS
NEW LANDFILL IN RIO 9,000 TPD WILL TRAVEL 80 KM TO BURY PLASTICS AND GENERATE METHANE TO GET CARBON CREDITS.
RECENT MEDIA AND EVENTS ON WTE IN RIO DE JANEIRO

1. BRAZIL-JAPAN FORUM (WM)

OCTOBER 5-6 WITH PARTICIPATION OF WTERT-GREECE (KALOGIROU) AND WTERT-BRASIL (MYSELF)

2. WASTE: SOURCE OF CLEAN ENERGY (FEDERATION OF INDUSTRIES OF RIO DE JANEIRO- SEP-28)

3. HALF HOUR TV SHOW ("CITIES & SOLUTIONS" – CHANNEL 40) ON WTE → SPECIAL EMPHASIS ON WTERT-BRASIL (OCT 6)

4. ONE HOUR TALK IN SÃO PAULO UNIVERSITY WITH SEVERAL MAYORS ATTENDING – OCT 21

ARTICLE PUBLISHED IN O Globo (#1 PAPER IN RIO) ON NOV/2009

“LANDFILL DECEPTION”
WASTE MANAGEMENT COMPANY (COMLURB) OF RIO DE JANEIRO AND COPPE-UFRJ SIGN AGREEMENT TO DEVELOPE WTE PLANTS (Aug-2010).

LHV $\Rightarrow$ THEMELIS = 8,1 MJ/Kg    CONSONNI = 8,6 MJ/Kg

RIO DE JANEIRO - MSW
ECONOMIC FEASIBILITY

1. ORIGINAL DISCREPANCY → CAPITAL COST, POWER GENERATION, ETC. ON A PER TON BASIS (COST/TON; MWhe / TON; MWh/t/ TON; etc….)

2. WHAT IS BURNING?

<table>
<thead>
<tr>
<th></th>
<th>DRY FRACTION (C₆H₁₀O₄)</th>
<th>MOISTURE</th>
<th>ASHES</th>
<th>LHV (KJ/Kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>67%</td>
<td>18%</td>
<td>15%</td>
<td>11.000</td>
</tr>
<tr>
<td>EUROPE</td>
<td>62%</td>
<td>23%</td>
<td>15%</td>
<td>10.000</td>
</tr>
<tr>
<td>BRAZIL</td>
<td>52%</td>
<td>33%</td>
<td>15%</td>
<td>8.000</td>
</tr>
</tbody>
</table>

\[ \text{C}_6\text{H}_{10}\text{O}_4 + 6.5\text{O}_2 = 6\text{CO}_2 + 5\text{H}_2\text{O} \]

ENERGY → 18500 kJ/kg

1 Kg → 1,424 Kg \text{O}_2, 1,808 Kg \text{N}_2, 0.616 Kg

1 Kg of air = 0.23 Kg of \text{O}_2 + 0.77 Kg of \text{N}_2 → 1,424 Kg de \text{O}_2 = 6,191 Kg of air

NO EXCESS AIR (STOICHIOMETRIC or LAMBDA = 1)

1 Kg MSW USA → 4,15 Kg of air
1 Kg MSW Brazil → 3,22 Kg of air (22% LESS THAN USA)
Higher moisture waste costs less to burn per ton (cost proportional flue gas flow).

<table>
<thead>
<tr>
<th>APROX. WASTE COMP</th>
<th>LHV</th>
<th>Tadiabatic = 1,200 C</th>
<th>AIR FUEL RATIO</th>
<th>APC/BOILER COST INDEX</th>
<th>GRATE/BOILER COST INDEX (C6H10O4+ASHES)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C6H10O4</td>
<td>H2O</td>
<td>ASHES</td>
<td>MJ/Kg</td>
<td>Excess Air (lambda)</td>
<td>Stack O2 (Volume)</td>
</tr>
<tr>
<td>BRAZIL</td>
<td>52%</td>
<td>33%</td>
<td>15%</td>
<td>8,0</td>
<td>1.36</td>
</tr>
<tr>
<td>EUROPE</td>
<td>62%</td>
<td>23%</td>
<td>15%</td>
<td>10,0</td>
<td>1.52</td>
</tr>
<tr>
<td>USA</td>
<td>67%</td>
<td>18%</td>
<td>15%</td>
<td>11,0</td>
<td>1.58</td>
</tr>
</tbody>
</table>

One ton of Brazilian waste:

- 22% less dry fuel (C6H10O4) than USA (needs less air to burn)
- 83% more water than USA (less air to cool)

WTE in Brazil / China should cost less 20-30% per ton than in USA and Europe.
Custos

➢ Capital de Investimento:

Capital: US$ 200,000 por tonelada instalada por dia de capacidade de processamento

Área de Implantação: 5 - 10 hectares

➢ Custos de Operação e Manutenção (O & M): US$ 30 por ton processada, incluindo:

Mão de Obra.
Materiais.
Disposição da Cinza.
Manutenção dos Equipamentos
CAPITAL $\rightarrow$ USA $\sim$ US$\,200{,}000$ / (TPD) $\rightarrow$ BRASIL $\sim$ US$\,140{,}000$ / (TPD)

792 TPD PLANT $\rightarrow$ US$\,110{,}000{,}000$

TIPPING FEE $=$ US$\,17$/ton $\sim$ US$\,39$/ton

MWhe $=$ US$\,83$

O&M $=$ US$\,22$/ton

FEASIBILITY WILL DEPEND ON IRR, TAXES AND:

EFFICIENCY( MWhe/MWht)
OPTIMIZED COMBINED CYCLE (OCC)
HIGH EFFICIENCY WITH LOW NG CONSUMPTION

SMALL GAS TURBINE PLANT SELF LOAD

USE FLUE GAS AFTER SH TO PREHEAT AIR FROM CHX AND MIX WITH GT EXHAUST TO MIXTURE SIMILAR TO LARGER GT (TEMP-T0 AND MASS FLOW) BUT О2 HIGHER ~ 16%.

USE CHX AFTER MSW BOILER TO CAPTURE LOW TEMPERATURE HEAT AND PRE-HEAT COMBUSTION AIR TO 120 C

SMALL GAS TURBINE PLANT SELF LOAD

CHOOSE OF GT X NG COST IS VERY IMPORTANT TO OPTIMUM DESIGN ➔ NEED DEDICATED SOFTWARE TO INCLUDE FINANCE.
boiler efficiency 86.5%
gross power production 29.9%

net efficiency 30%
440°C / 130 bar
320°C / 14 bar

Waste-to-Energy Plant
Germany
EBS-IKW Rüdersdorf

420°C / 90 bar (788°F / 1,319 psi)
420°C / 23.4 bar (788°F / 325 psi)

269°C / 25.4 bar (518°F / 354 psi)
36.5°C / 1.068 bar (101°F / 1 psi)
THE BRAZILIAN LAW FOR WTE INCENTIVES LIMITS THE ELECTRIC POWER TO 30 MWe.

FOR A LHV OF 8 MJ/Kg AND 22% NET EFFICIENCY \(\rightarrow\) 1,400 TPD

30% NET EFFICIENCY \(\rightarrow\) 1,000 TPD

OCC (75% MSW + 25% NG) \(\rightarrow\) 800 TPD
## COMPARISON BETWEEN BILBAO AND OCC – SAME MSW BOILER (792 TPD)

<table>
<thead>
<tr>
<th>CASE1</th>
<th>CASE2</th>
<th>CASE3</th>
<th>CASE4</th>
</tr>
</thead>
<tbody>
<tr>
<td>BILBAO PLANT ORIGINAL</td>
<td>OCC BILBAO (STANDARD ST)</td>
<td>OCC BILBAO (HIGH EFF ST)</td>
<td>OCC BILBAO (HIGH EFF ST) no GT</td>
</tr>
<tr>
<td>TPD</td>
<td>792</td>
<td>792</td>
<td>792</td>
</tr>
<tr>
<td>GAS TURBINE(MWe)</td>
<td>LM6000 (46)</td>
<td>GE5 (5.5)</td>
<td>GE5 (5.5)</td>
</tr>
<tr>
<td>HP (bar) / T (C) / Isen eff</td>
<td>100 / 540 / NA</td>
<td>100 / 400 / 0.703</td>
<td>100 / 400 / 0.85</td>
</tr>
<tr>
<td>LP (bar) / T (C) / Isen eff / Pcond (bar)</td>
<td>30 / 540 / NA / NA</td>
<td>30 / 540 / 0.865 / 0.06</td>
<td>30 / 530 / 0.91 / 0.03</td>
</tr>
<tr>
<td>PLANT GROSS POWER(MWe)</td>
<td>100</td>
<td>33,89</td>
<td>36,17</td>
</tr>
<tr>
<td>MSW ENERGY (MWth)</td>
<td>71</td>
<td>71</td>
<td>71</td>
</tr>
<tr>
<td>Nat Gas CONSUMPTION(MWth)</td>
<td>152</td>
<td>21,84</td>
<td>21,32</td>
</tr>
<tr>
<td>MSW APP EFFICIENCY</td>
<td>31,66%</td>
<td>34,51%</td>
<td>38,04%</td>
</tr>
<tr>
<td>Nat Gas EFFICIENCY - STANDALONE CC</td>
<td>51,00%</td>
<td>43,00%</td>
<td>43,00%</td>
</tr>
<tr>
<td>MSW ACTUAL EFFICIENCY</td>
<td>NA</td>
<td>32,65%</td>
<td>35,48%</td>
</tr>
<tr>
<td>Nat Gas ACTUAL EFFICIENCY</td>
<td>NA</td>
<td>49,06%</td>
<td>51,51%</td>
</tr>
<tr>
<td>MSW SHARE</td>
<td>22,48%</td>
<td>72,30%</td>
<td>74,67%</td>
</tr>
<tr>
<td>OVERALL EFFICIENCY</td>
<td>44,84%</td>
<td>36,50%</td>
<td>39,18%</td>
</tr>
</tbody>
</table>

**CASE 4 – NO GT – GOOD OPTION FOR USING LANDFILL GAS – NG CONSUMPTION ~ 8% OF BILBAO. CAN ALSO USE ETHANOL OU BIODIESEL (LPP COMBUSTION PROCESS).**
CONCLUSIONS

1. HIGH MOISTURE MSW $\Rightarrow$ BOILER AND APC ARE SMALLER PER TON OF WASTE.

2. WTE IN BRAZIL / CHINA SHOULD COST LESS 20-30% PER TON THAN IN EUROPE / USA.

3. LOWER CAPITAL + MORE ENERGY (OCC) = FEASIBILITY.
IN BRAZIL AND OTHER COUNTRIES WASTE IS STILL DUMPED AWAY AND PEOPLE TRY TO MAKE A LIVING FROM IT
MODERN LANDFILLS ARE BETTER THAN OPEN DUMPS BUT STILL REPRESENT AN ENVIRONMENTAL IMPACT THAT SHOULD AND COULD BE AVOIDED
WASTE TO ENERGY MUST FIND A WAY TO BECOME AVAILABLE IN OTHER COUNTRIES AT REASONABLE COSTS. I BELIEVE WTERT CAN PLAY AN IMPORTANT ROLE IN THIS MATTER