POTENTIAL FOR THE PRODUCTION OF BIOENERGY IN URUGUAY

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Uruguay is a country with 3:400.000 inhabitants.
60 % of the primary energy is imported
40% is generated in Uruguay from hydroenergy, wood and biomass

Figure1.Primary energy distribution by source.

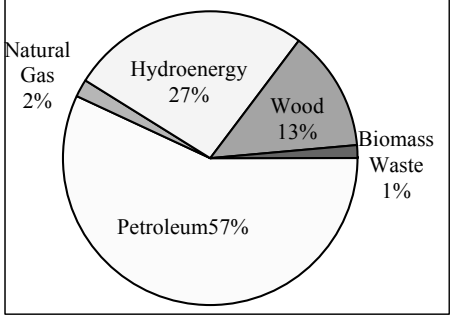
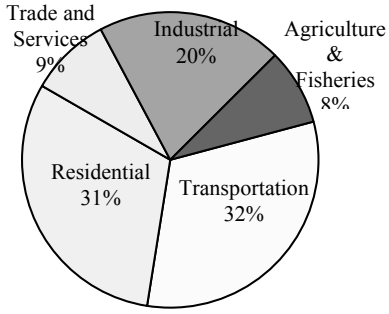


Figure2.Final energy consumption by activity.



POTENTIAL OF METHANE PRODUCTION

- Municipal Solid Waste
- Sewage Sludge
- Slaughterhouse Solid Waste
- Dairy Farms Solid waste

MUNICIPAL SOLID WASTE

- Total MSW generation is 960.000 ton/year
- From experimental data methane production is 20 m3 CH4/ton
- Potential of energy from MSW: 16.2ktep/year as biogas and 6.2ktep/year as electricity

BIOGAS FROM SEWAGE SLUDGES

Table 1 Sewage characterisation

	OSE*	Metcalf – Eddy	GTZ	Henze *et al.*	von Sperling and Chemicharo
BOD_5 (mg/L)	350	110 - 400	100 - 300	150 - 350	277 - 325
COD (mg/L)	700	250 - 1000		320 – 740	
TSS (mg/L)	375	100 - 350	100 - 500	190 – 450	360
VSS (mg/L)	280	80 - 275	70 - 400	140 - 320	
Q (L/inhab.d)	200				160 - 200
Load ($gBOD_5$/inhab.d)	70	60 - 110		55 - 70	50
Load (g TSS/inhab.d)	75	60 - 115	90	55 - 70	60

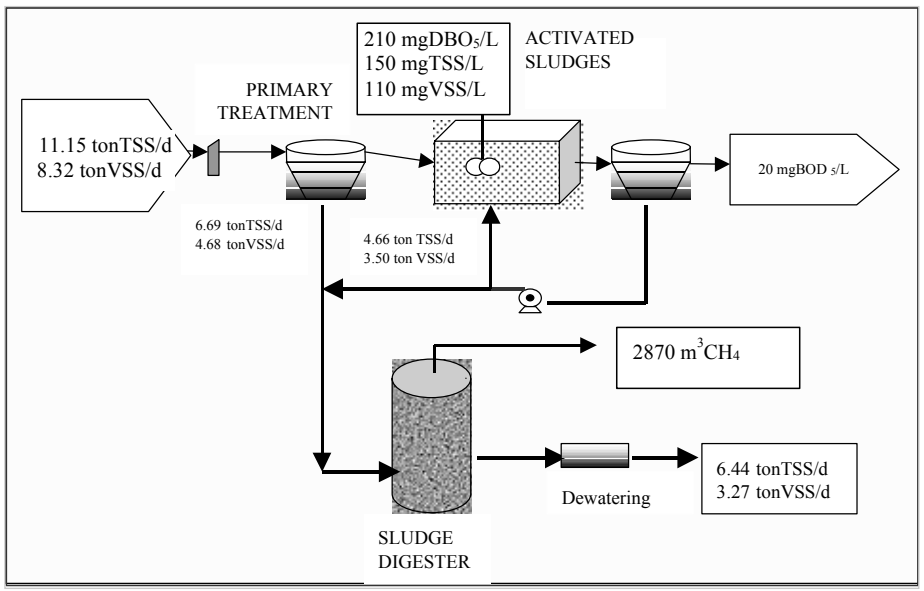
* OSE: Public enterprise supplying potable water and in charge of sewage treatment.

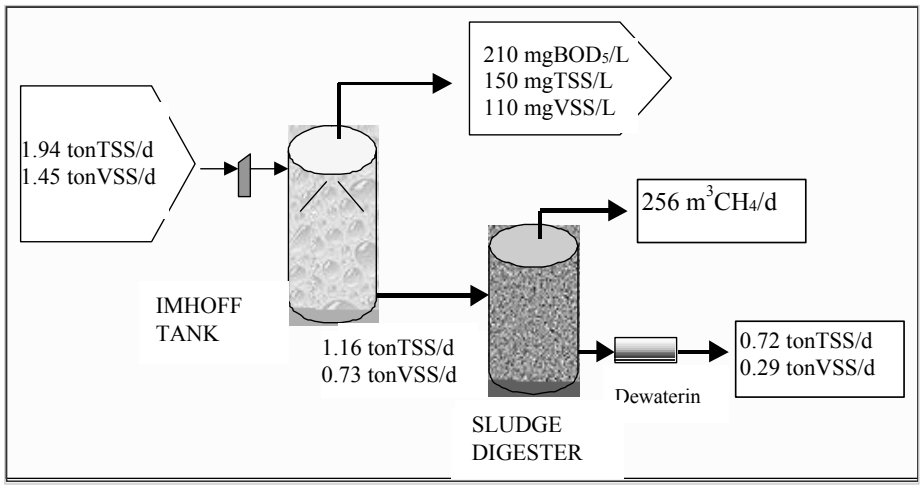
Table 2. Operational parameter

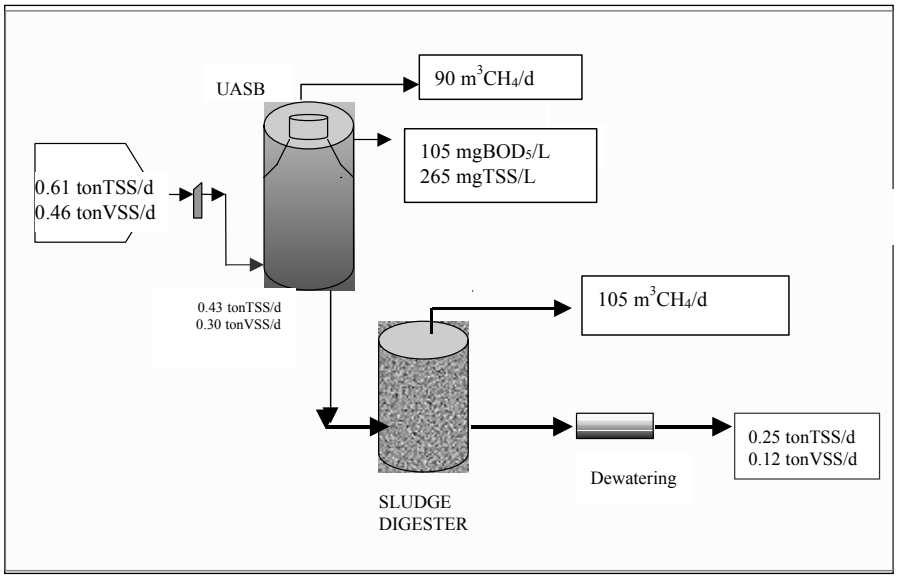
	Parameter	Value	Reference
Primary Treatment	TSS removal	60 %	Mosey, F.E.
	BOD_5 removal	40 %	Mosey, F.E.
	VSS/TSS in sludge	70 %	Carozzi, A.
Imhoff Tank	TSS removal	60 %	OSE
	BOD_5 removal	40 %	OSE
	VS digestion	10 %	OSE
Activated Sludge	BOD_5 removal	80 / 90 %	Mosey, F.E.
	Hydraulic Retention Time	5 - 10 h	Mosey, F.E.
	Yield	0.7 kg VS / kg BOD_5 rem	Mosey, F.E.
	Power	1.0 kWh / kg $BOD_{5\ rem}$	calculated
	VSS/TSS in sludge	75 %	Carozzi, A.
UASB	BOD_5 removal	70 %	Chernicharo
	COD removal	60 %	Chernicharo
	TSS removal	70 %	Lettinga, G.
	VSS/TSS in sludge	70 %	Chernicharo
	Hydraulic Retention Time	5 h	Lettinga, G.
	Methane production	0.15 Nm^3CH_4 / kg COD rem	Vieira, S.M.
	Methane content in biogas	60 %	Lettinga, G.
	Methane content in effluent	0.048 kg COD/m^3	calculated
Sludge Anaerobic Digester	VS removal	60 %	Ross *et al.*
	Retention Time	60 days	Ross *et al.*
	Biogas production	0.9 m^3 biogas/kgVS destroyed	Malina, J.
	Methane concentration	65% v/v	Malina, J.
	Production of power	1.75 kWh/m^3 biogas	Dohne, E.

Table 3 Treatment systems

TREATMENT SYSTEMS	TOTAL POPULATION (inhabitants)	SEWAGE COVERAGE (inhabitants)
Activated Sludges	424648	148626
Imhoff Tanks	73930	25875
UASB system	23384	8184




210 mgBOD5/L
150 mgTSS/L
110 mgVSS/L
1.94 tonTSS/d
1.45 tonVSS/d
256 m3CH4/d
IMHOFF
TANK
1.16 tonTSS/d
0.73 tonVSS/d
0.72 tonTSS/d
0.29 tonVSS/d
Dewaterin
SLUDGE
DIGESTER


UASB
90 m3CH4/d
105 mgBOD5/L
265 mgTSS/L
0.61 tonTSS/d
0.46 tonVSS/d
0.43 tonTSS/d
0.30 tonVSS/d
105 m3CH4/d
0.25 tonTSS/d
0.12 tonVSS/d
Dewatering
SLUDGE
DIGESTER

Considering the anerobic digestion of the sludge generated in the different options, the total energy production would be 1.04 ktep/year

BIOGAS FROM SLAUGHTERHOUSE SOLID WASTE

Partial data for slaughterhouses energy consumption in Uruguay (from 68% of total production)

Source	Consumption per month	Conversion factor	Ktep/month
Wood	1932 ton	0.27 kep/kg	0.521
Fuel Oil	899 m3	0.95 kep/L	0.854
Electricity	6.709.250 kwh	0.086 kep/kwh	0.577
Natural Gas	2000 N m3	0.83 kep/m3	0.002
Total			1.954

The previous table refers to 54244 ton meat/month, and the energy consumption was 1.95 ktep/month.
Then we have 3.6*10-5ktep/ton of meat.
The total prodution per year in Uruguay is 878 000 ton of meat.
For the total production the energy consumption would be 31.6 ktep/year

As an example, a slaughterhouse which processes 85 100 ton meat/year (9.7% of the country total) the ruminal content generation is 4 TS ton/day.
Using anerobic digestion the biogas production would be 1600 m3 CH4/day. This methane production could cover 6% of the industry energy requirements.

For all the country the total ruminal content porduction is 15000 TS ton/year, the energy production using anaerobic digestion would be 1.86 ktoe/year

BIOGAS FROM DAIRY FARM WASTES

From dairy farms there is a production of 51000 VS ton/year
Then, the biogas production would be 10.4 ktep/year.
8% of the milk pasteurised at the farms
40% of the energy from anaerobic digestion could cover the energy requirements for pasteurisation

CONCLUSIONS

- In the case of MSW and sludge from sewage treatment, solving an environmental problem an extra benefit could be obtained
- With slaughterhouse and dairy farm residues, beyond the environmental solution, energy production could significantly contribute to energy requirements

VIII TALLER Y SIMPOSIO LATINOAMERICANO SOBRE DIGESTIÓN ANAEROBIA

VIII LATIN AMERICAN WORKSHOP AND SYMPOSIUM ON ANAEROBIC DIGESTION

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Presentación de trabajos

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