TECHNICAL AND ECONOMICAL ASSESSMENT OF SOLID WASTE TREATMENT TECHNOLOGIES
-Chilean case-

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GESCAM
CONSULTORES AMBIENTALES

BACKGROUND

1) Two basic projects:

"ECONOMIC, ENVIRONMENTAL AND SOCIAL ASSESSMENT OF INTEGRAL TREATMENT CENTERS "(SUBDERE)

"FEASIBILITY AND MINIMUM COST STUDY OF THE TECHNOLOGICAL ALTERNATIVES FOR THE INTEGRATED SOLID WASTE MANAGEMENT IN THE ARAUCANÍA REGION" (AMRA)

2) More other projects GESCAM SA

June 22, 2011

Content

1. Diagnostic
2. Objetives
3. Methodology
4. Background
5. Results
6. Case of study – GESCAM Project in Araucanía Region, 2013
7. Conclusions

Diagnostic

- Poor infrastructure
- Non-assessed waste technologies
- Technical and financial deficiencies
- Integral plans needed

Project objetives

Generate information to support municipalities in preliminary project evaluation

Economic indicators of investment, profitability and cost efficiency

Information for different scales plants, regarding population and MSW generation rates

Methodology

Per capita MSW generation rates, composition, humidity, calorific power, etc.

Regional and zonal diagnostic. Vial connectivity and association perspectives.

Review of the available MSW treatment technologies.

Pre-feasibility studies and results (+/- 30%)

BACKGROUND

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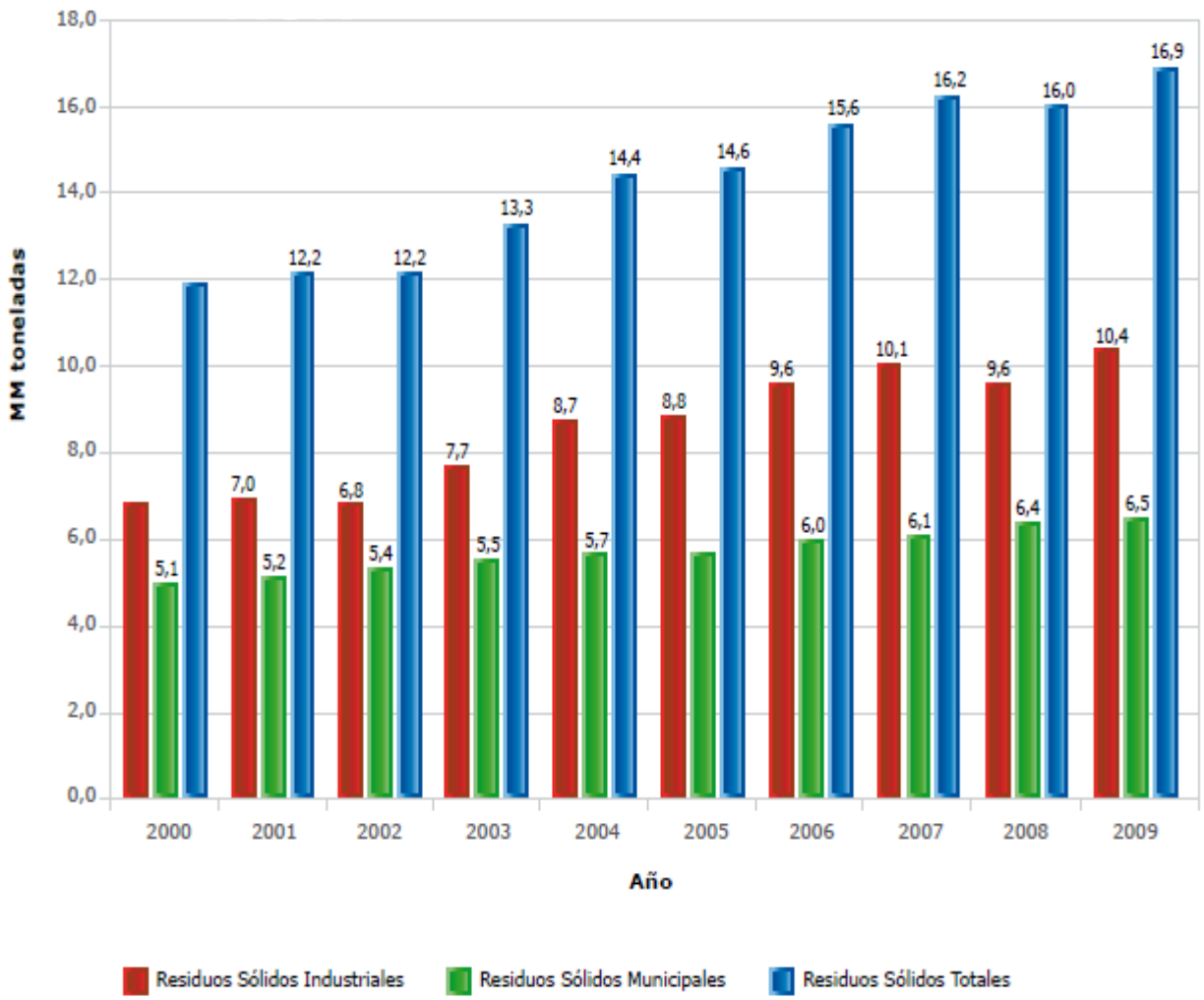
Background 1

Gráfico 3.2-1: Generación de residuos sólidos en Chile. Años 2000 al 2009



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Background 2

Energetic potential values
(October 2011)

	MSW annual average	Biogas yield (m3/y)	Biogas captured 45% (m3/y)	CH4 (m3/y)	Energy Potential (MW)
Landfill	379.006	53.941.053	24.273.474	11.772.635*	5,3**
Pyro gasification	379.006	-	-	-	29,5
Wet Ferm.	123.766***	15.223.187	15.223.187	9.133.912****	4,1**
Landfill (OM extraction)	255.240	25.428.463	11.442.808	5.549.762	2,5
Landfill and Wet Ferm.	379.006	40.651.650	26.665.995	14.683.674	6,7

*48,5 % of CH4.

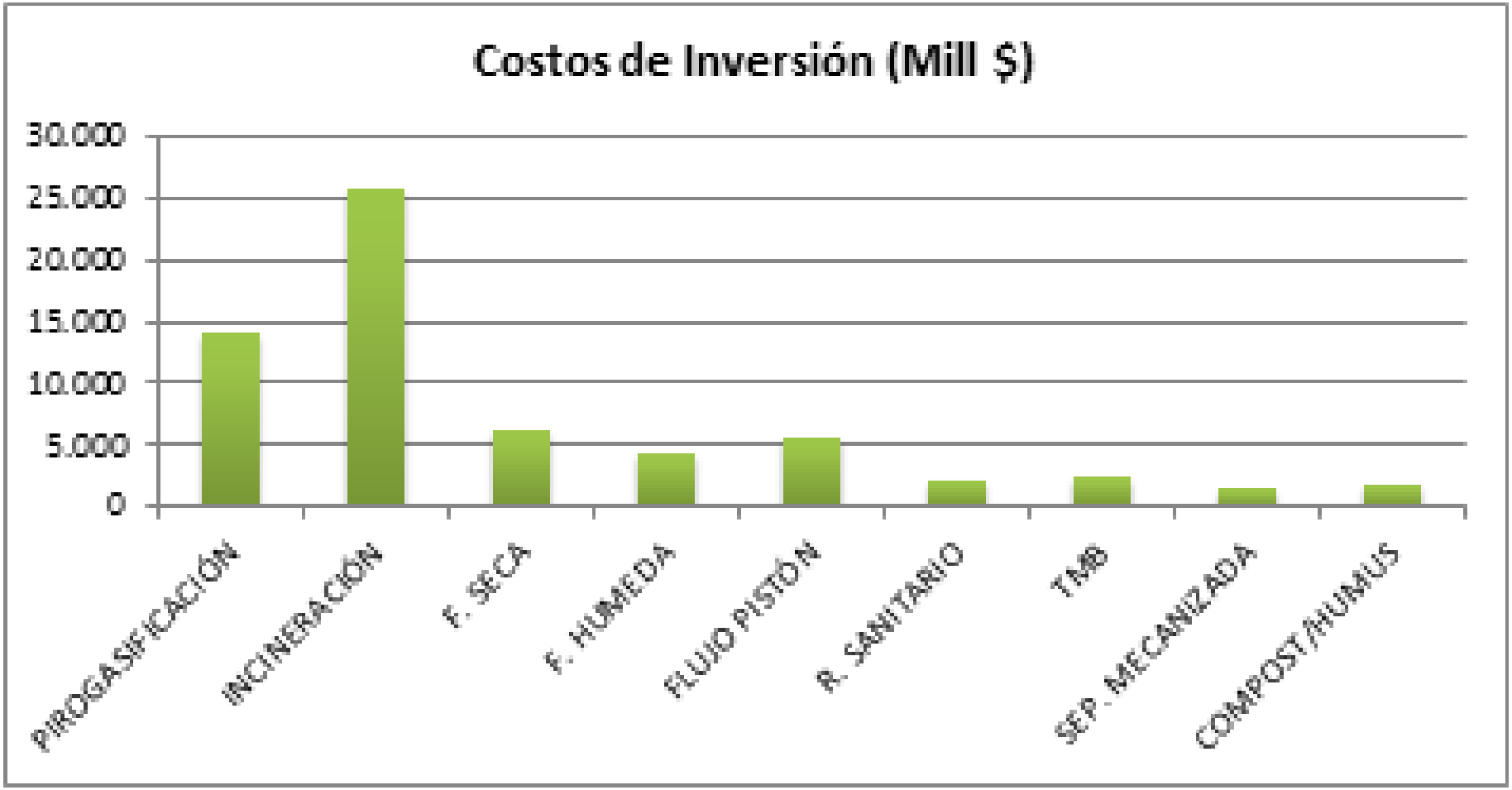
**Calorific power CH4= 10 kwh/m3. Energy efficiency: 40%

*** 60% of the total amount of Org. Matter

****60% of CH4

Notes:
-Pyro gasification data was provided by the vendor
-Landfill & Wet Fermentation data were calculated using bibliographic information

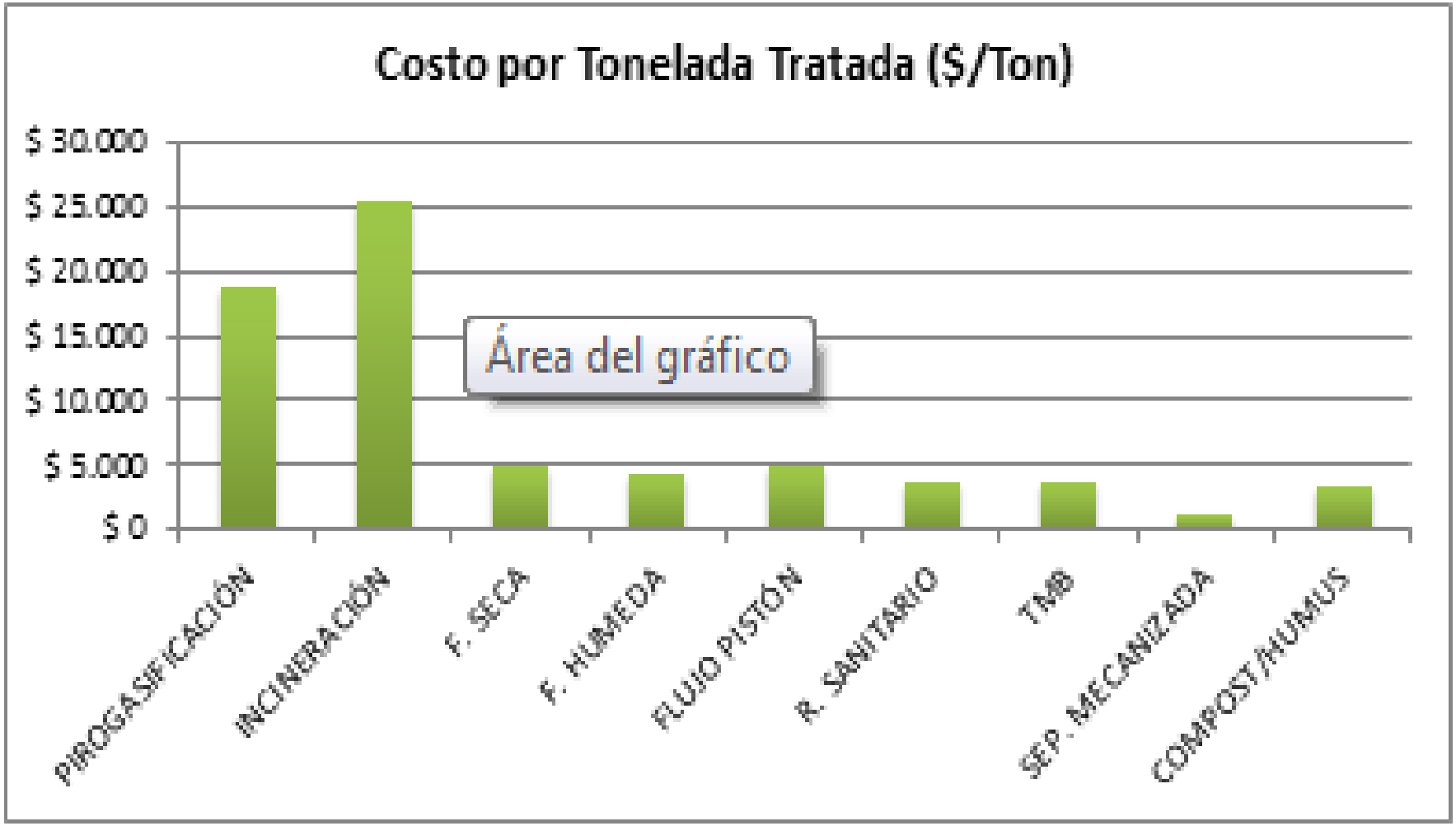
Background 3



500 t/d - 100.000 t/y for incineration

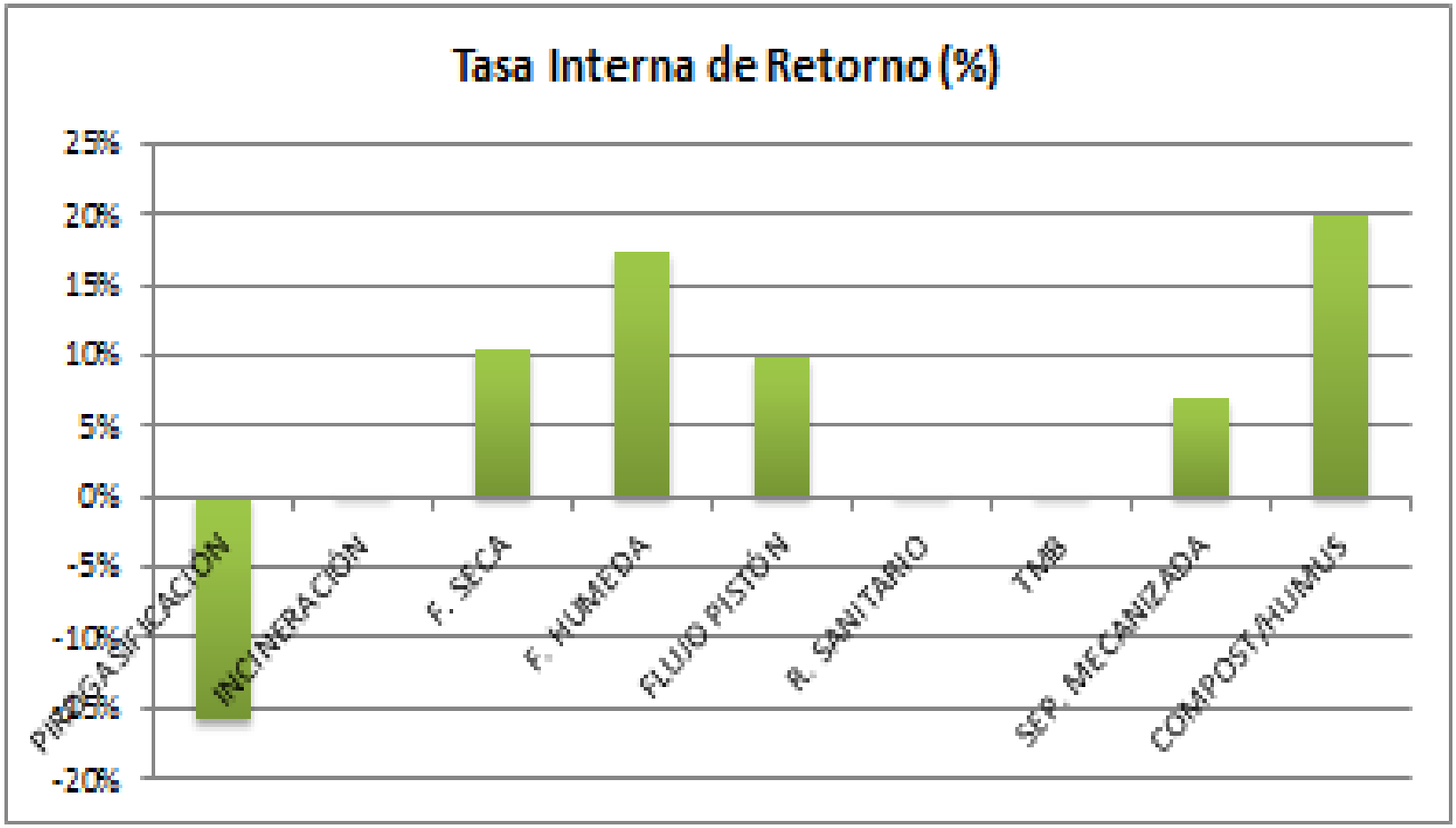
Background 4

Figura VII.10. Gráfico comparativo de CTT por alternativa



Background 5

Figura VII.11. Gráficos comparativos de TIR de las alternativas



(*) Nota: las alternativas que no presentan barra, se debe a que su rentabilidad es tan baja, que es imposible calcular la TIR.

Background 6

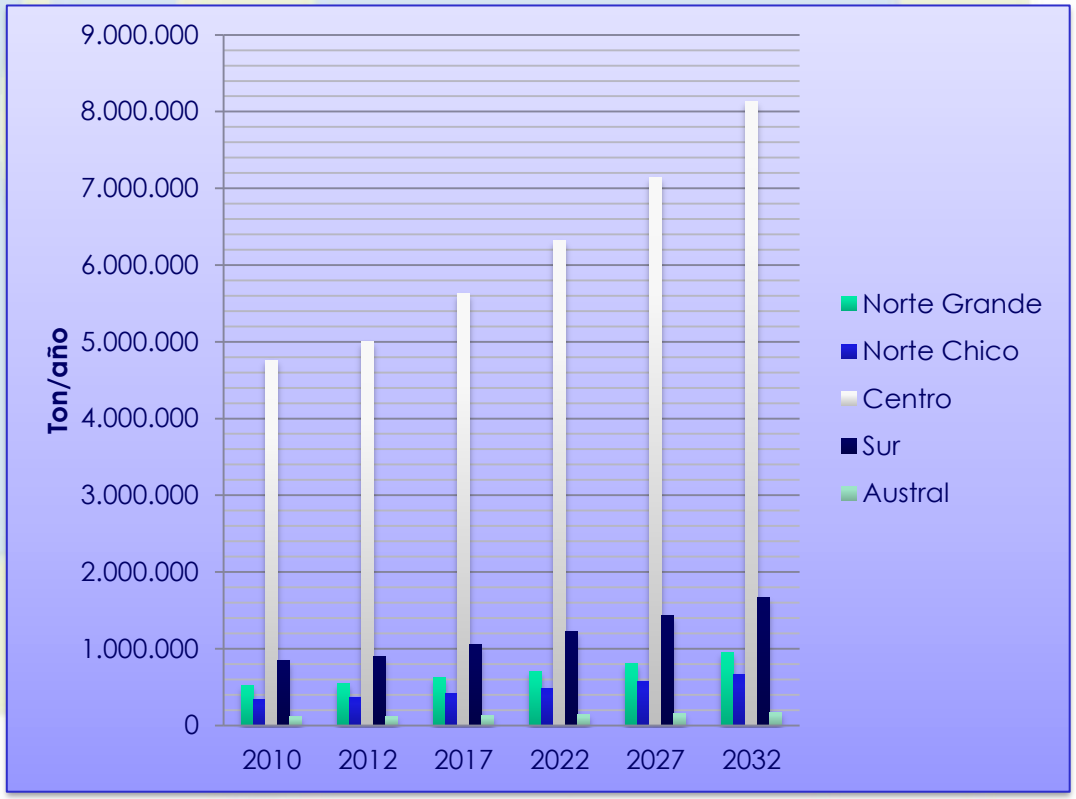
O/D

Offer & Demand

The offer: **5,5 millions ton/y.**

The demand: **6,9 millions ton/y.**

For **2032**, the demand could reach **11,6 millions ton/y.**



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Background 7

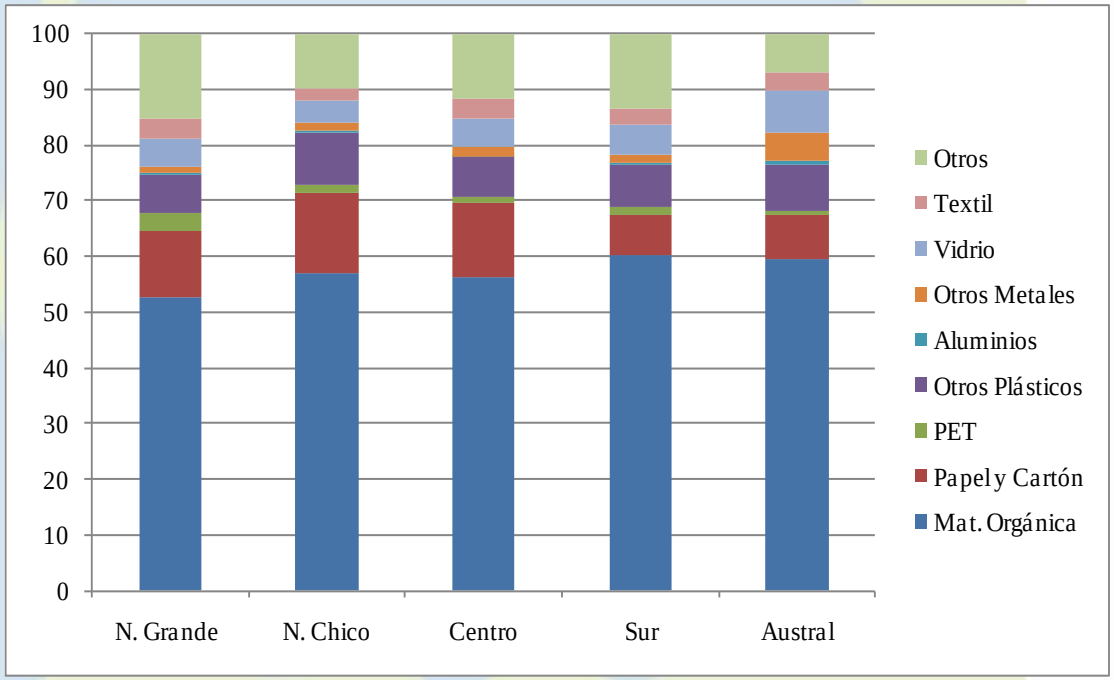
MSW characteristics

MSW characteristics

Organic Matter shows an increasing trend from "Norte Grande" to "Sur" macrozone.

Paper and paperboard show a decreasing trend from the "Norte Grande" to the "Austral" macrozone.

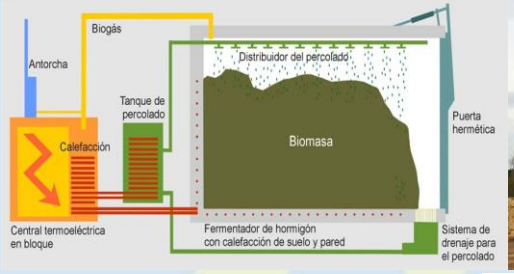
Aluminum and other metals, a high percentage is observed in the "Austral" macrozone.



	Macrozones				
Parámetro	N. Grande	N. Chico	Centro	Sur	Austral
PPC (kg/hab/d)	0,7	0,8	0,95	0,6	0,5
Humidity (%)	39,83	42,16	41,81	44,67	43,71
Calorific power (kcal/kg)	1.196 – 1.316	1.023 - 1.215	921 – 1.013	731 - 804	487 - 536

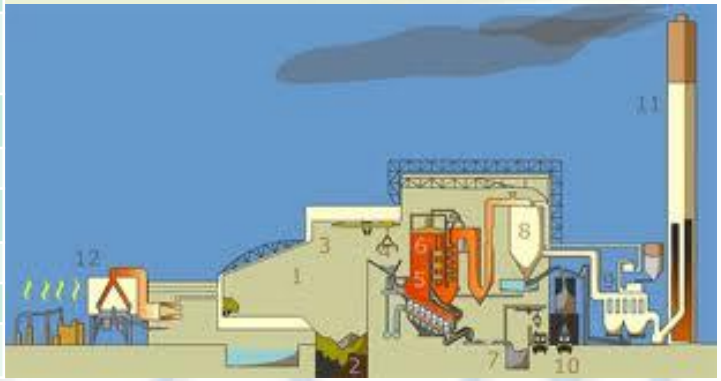
MSW Treatment Alternatives

Incineration
Pyro gasification
Anaerobic fermentation (wet and dry),
Sorting plants,
Composting plant,
Landfill and Transfer stations.



- INCINERATION

Costs (Planta de 200,000 ton/y ≈ 560.000 hab) PCI 1.400 a 2.200 kcal/kg	US$
Obras civiles y naves	31.338.991,2
Equipo mecánico y eléctrico	59.912.777,8
Otros	19.942.994,3
Total	**111.194.765**
Costes operativos Fijos	US$ (tasa de cambio 1,32)
Personal	1.259.672,04
Mantenimiento y reposición	1.175.489,04
Imprevistos	165.695,64
Total	**2.624.717,04**
Costes operativos Variables	US$ (tasa de cambio 1,32)
Mantenimiento y reposición	1.108.512,24
Agentes químicos	1.175.489,04
Otros (consumibles y residuos)	1.550.366,4
Otros (no especificados)	387.591,6
Total	**4.221.959,28**
Costes variables por tonelada	21,12



- PYROLISYS (Pyro Gasification)

No info for MSW

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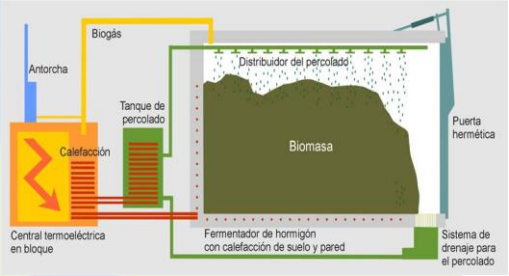
- RAPID THERMIFILIC DIGESTION SYSTEM

Capacidad del sistema	22 m3/mes	80 m3/mes
	USD	USD
Ingreso Anual	**223.790**	**783.265**
Costos Directos Anuales		
Costos de electricidad	51.100	163.520
Costos por consumo de GLP	22.995	95.813
Costos por enzimas	183.960	613.200
Costos Laborales	14.600	29.200
Mantención del sistema de digestión	730	730
Total Costos Anuales	**273.385**	**902.463**
Margen Neto	**-910**	**41.515**
Inversión	**750.000**	**2.200.000**

- DRY FERMENTATION

Fermentación Seca (Planta de 60.000 ton/año residuos orgánicos)	USD
Motores generadores	1.020.000
Cámaras de concreto	5.848.000
Proyecto eléctrico	615.796
Ingenierías	714.000
TOTAL	8.197.840

Esquema de la Planta de Fermentación Seca



- WET FERMENTATION

Fermentación Húmeda (Planta de 60.000 ton/año residuos orgánicos)	USD
Motores generadores	1.700.160
Digestores	2.328.480
Obras menores	150.920
Equipos	1.509.200
Montajes	946.176
Ingenierías	612.000
Proyecto eléctrico	529.610
TOTAL	7.776.546

Planta de Fermentación húmeda

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- SORTING PLANTS

Inversiones (Planta para 180.000 ton/año ≈ 990.000 hab)	Monto
	USD
Inversiones terreno (7.900 m²)	10.000
Estudios	242.000
Equipos nave clasificación	1.560.162
Servicios y estudios proveedor	42.210
Equipos auxiliares	330.447
Construcciones y obras civiles	601.145
TOTAL	2.785.964

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- COMPOSTING

Inversiones (Planta de 60.000 ton/año residuos orgánicos)	USD
Inversiones terreno (5 ha)	32.464
Estudios	308.000
Infraestructura	1.364.267
Inversiones maquinarias y equipos	953.649
TOTAL	2.658.379

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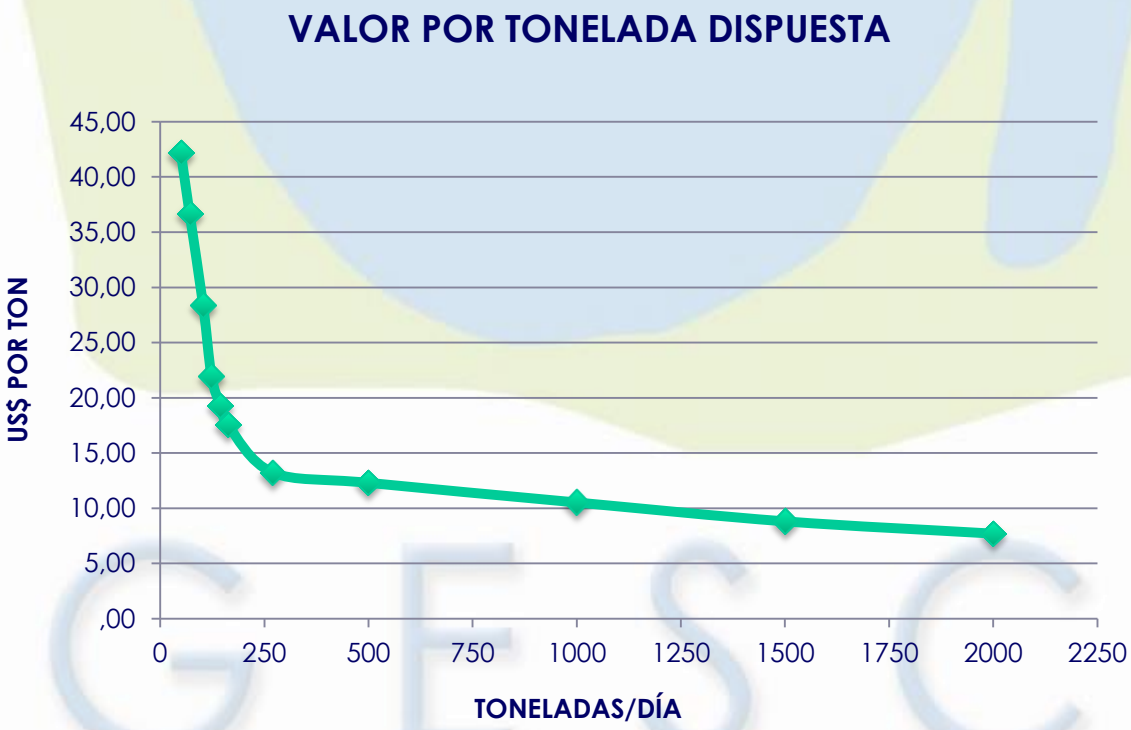
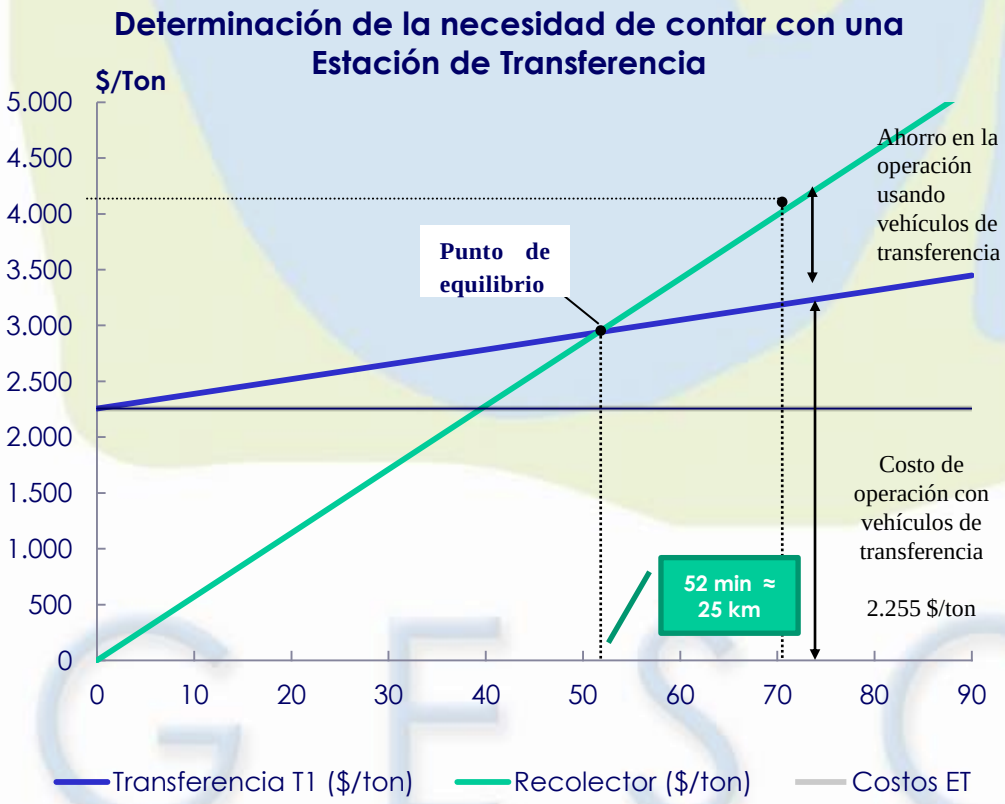
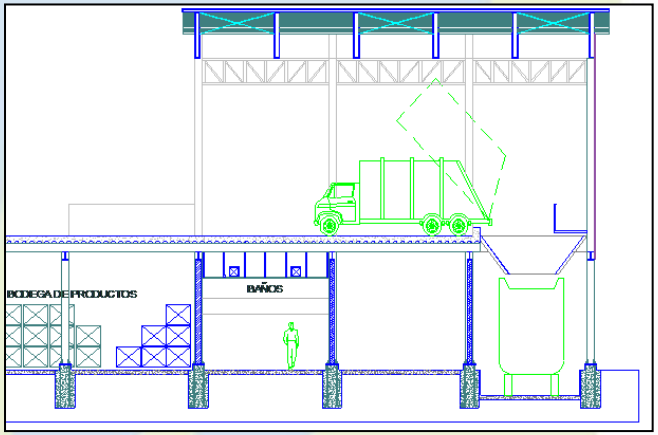
- LANDFILL


VALOR POR TONELADA DISPUESTA
US$ POR TON
45,00
40,00
35,00
30,00
25,00
20,00
15,00
10,00
5,00
,00
0
250
500
750
1000
1250
1500
1750
2000
2250
TONELADAS/DÍA

Cómo es un relleno sanitario
MODULOS
El área se divide en módulos. Los camiones circulan por terraplenes hasta el módulo que se está llenando.
EXTRACCION DE LIQUIDOS
Deben ser retirados para recibir tratamiento.
GASES
La descomposición de la basura produce gases, principalmente metano, que se eliminan por venteo.
POZO DE CONTROL
Para tomar muestras de agua de la napa.
NAPA FREATICA
1,5 m
IMPERMEABILIZACION
El relleno debe estar aislado para evitar que la filtración de líquidos contamine las napas. La base se cubre con polietileno de alta densidad.
La basura debe ser tapada cada día con una capa de tierra compactada de 20 cm.
Fuente CEAMSE.
CLARIN

- # TRANSFER STATION





RESULTS

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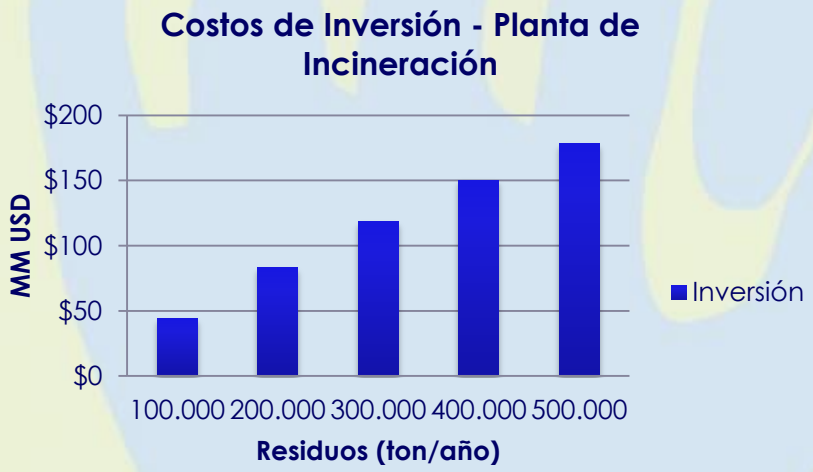
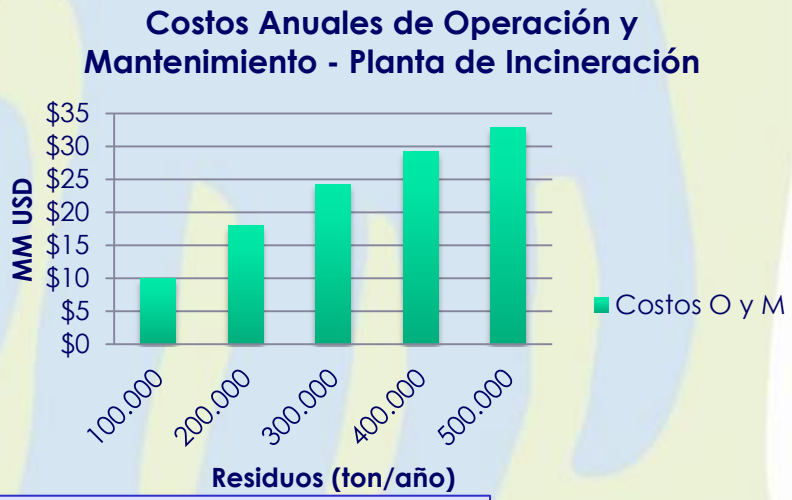
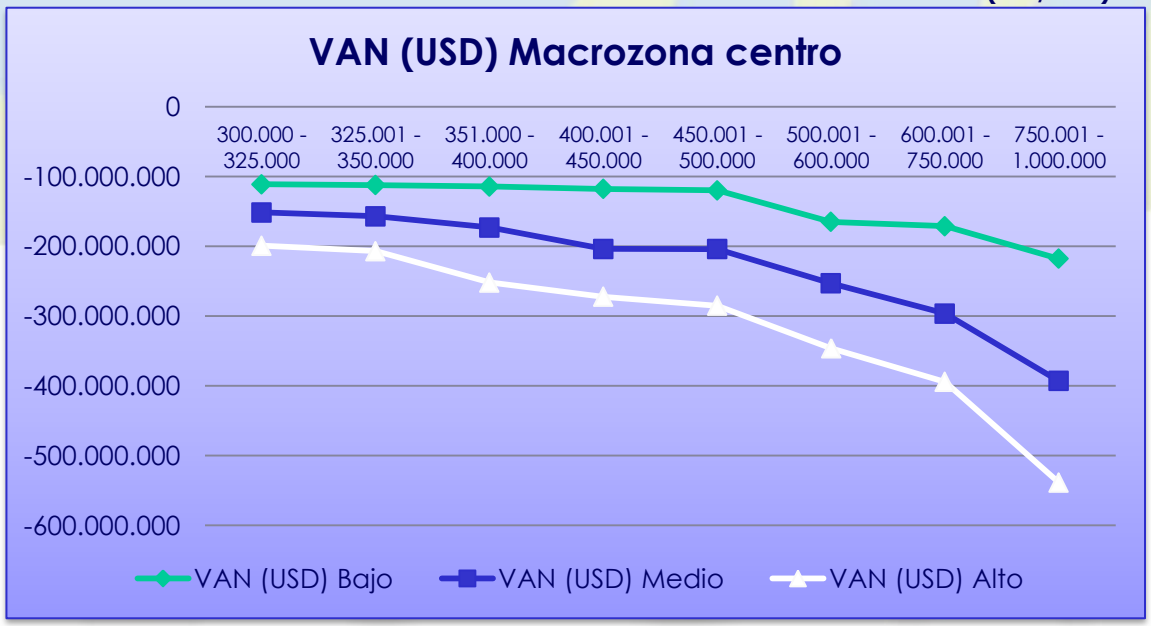
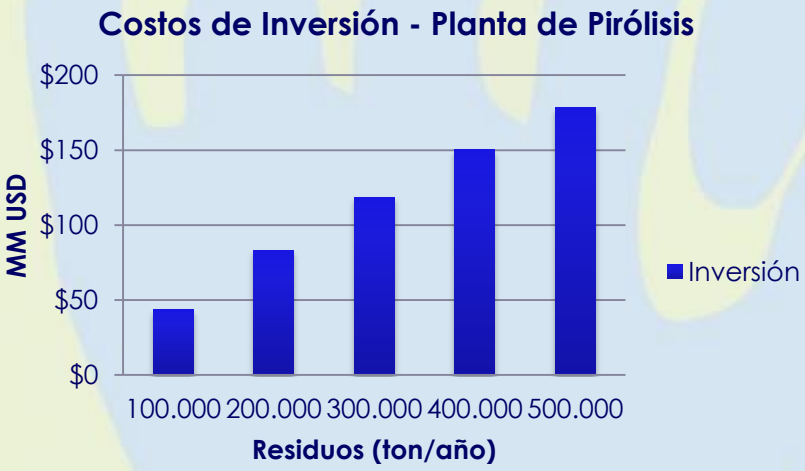
Incineration Plant Results

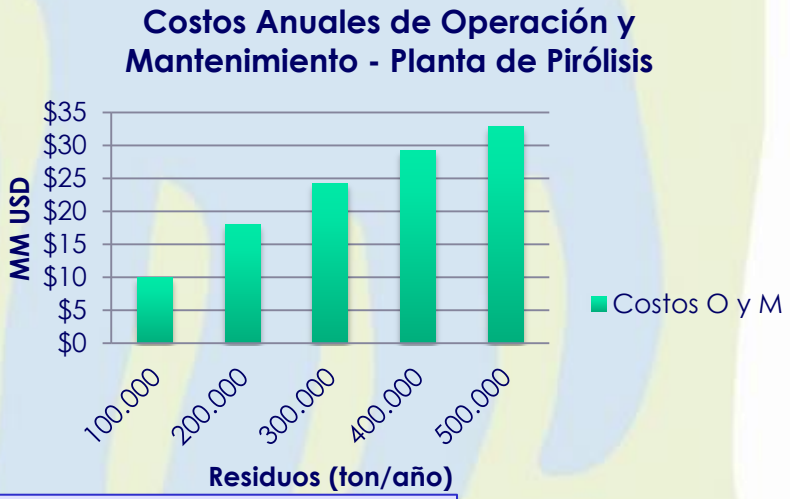


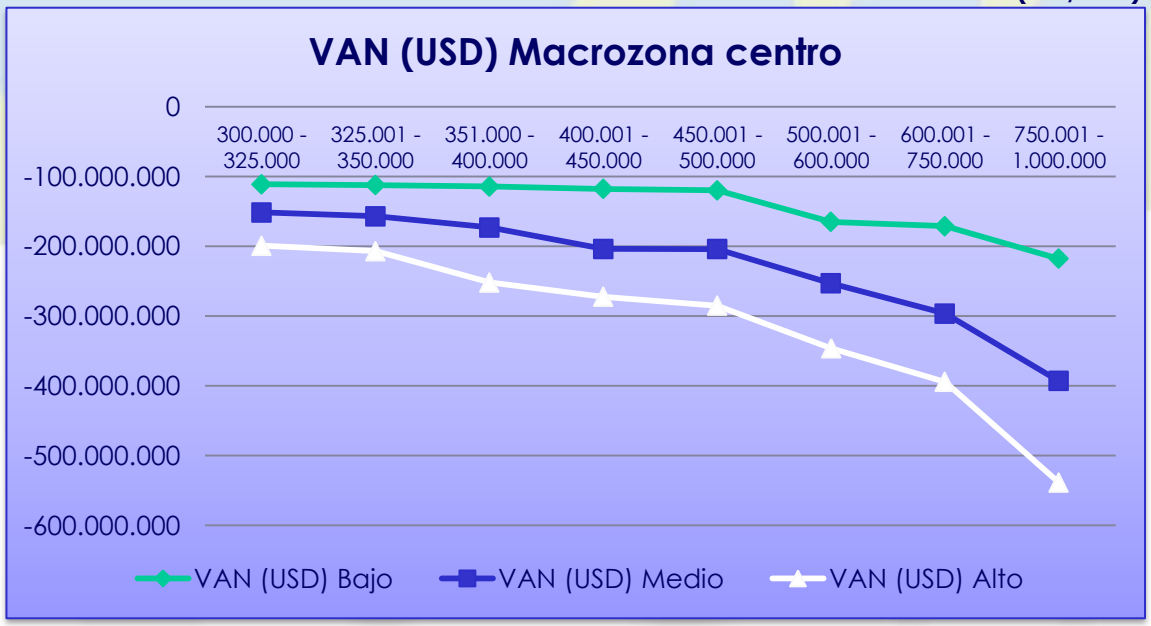




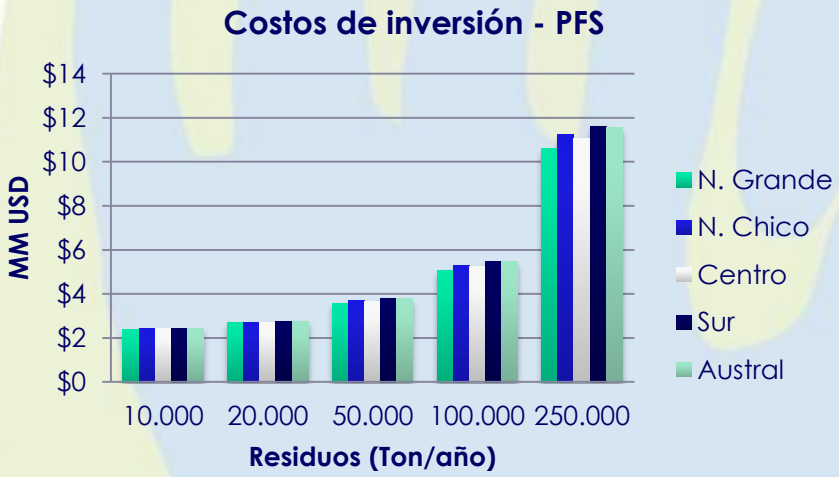
Pyro Gasification Results DRAFT

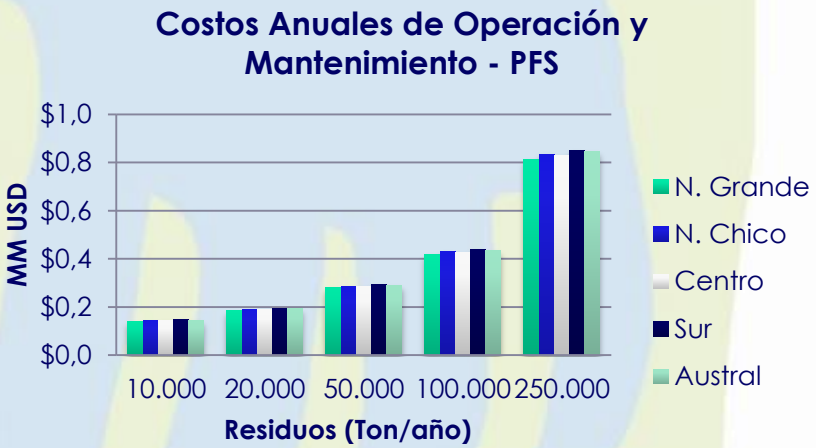


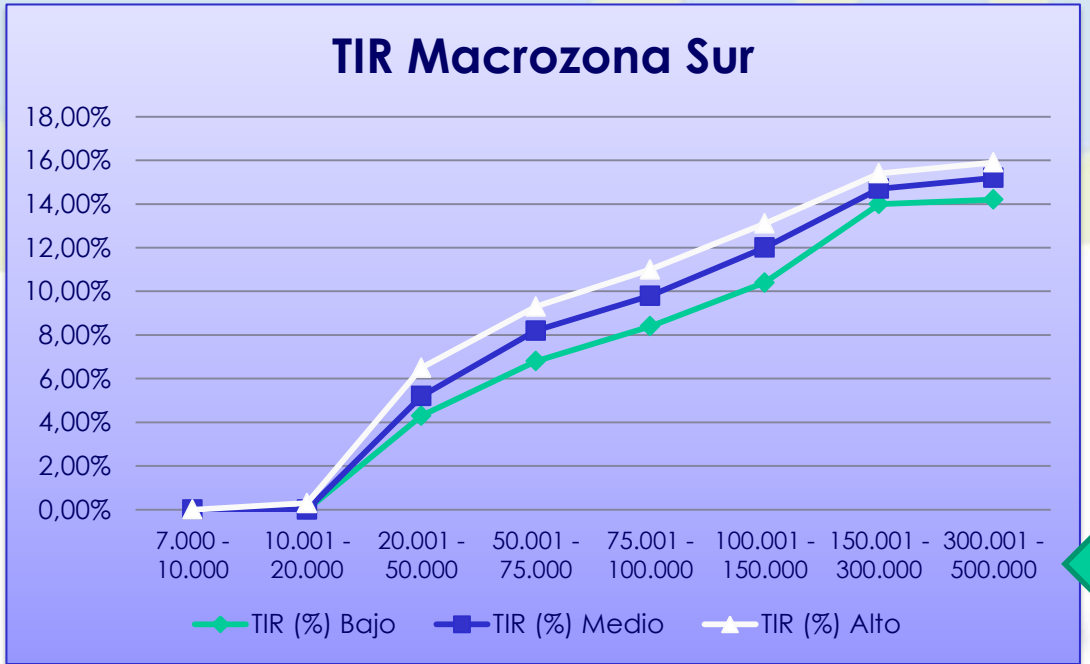




Dry Fermentation Results

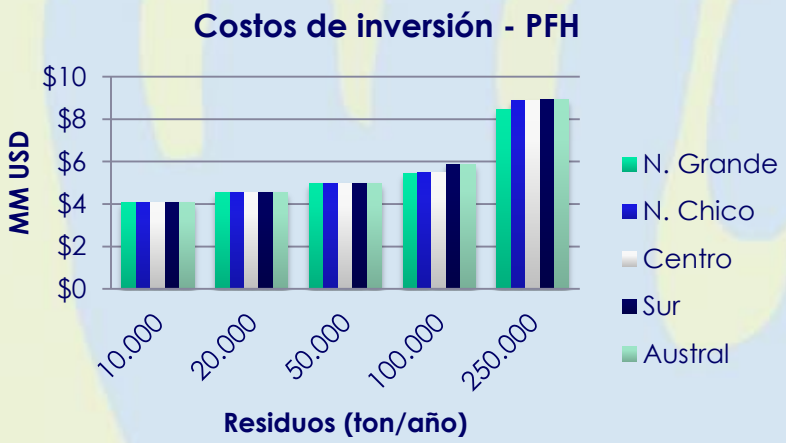


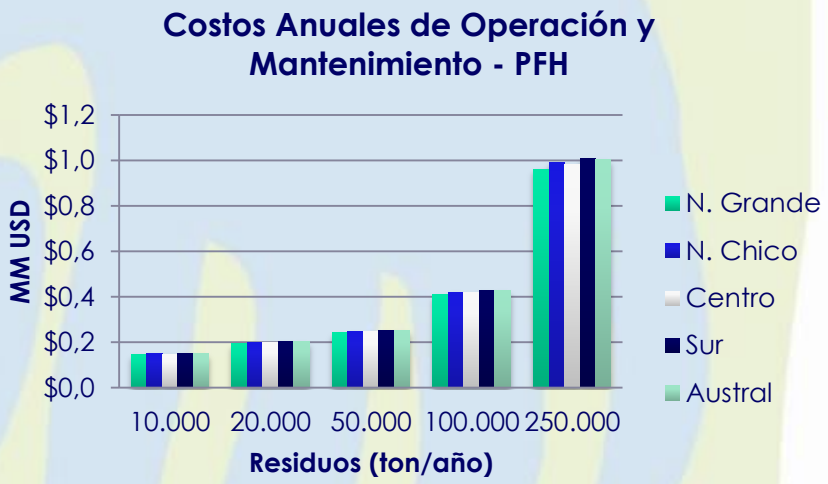


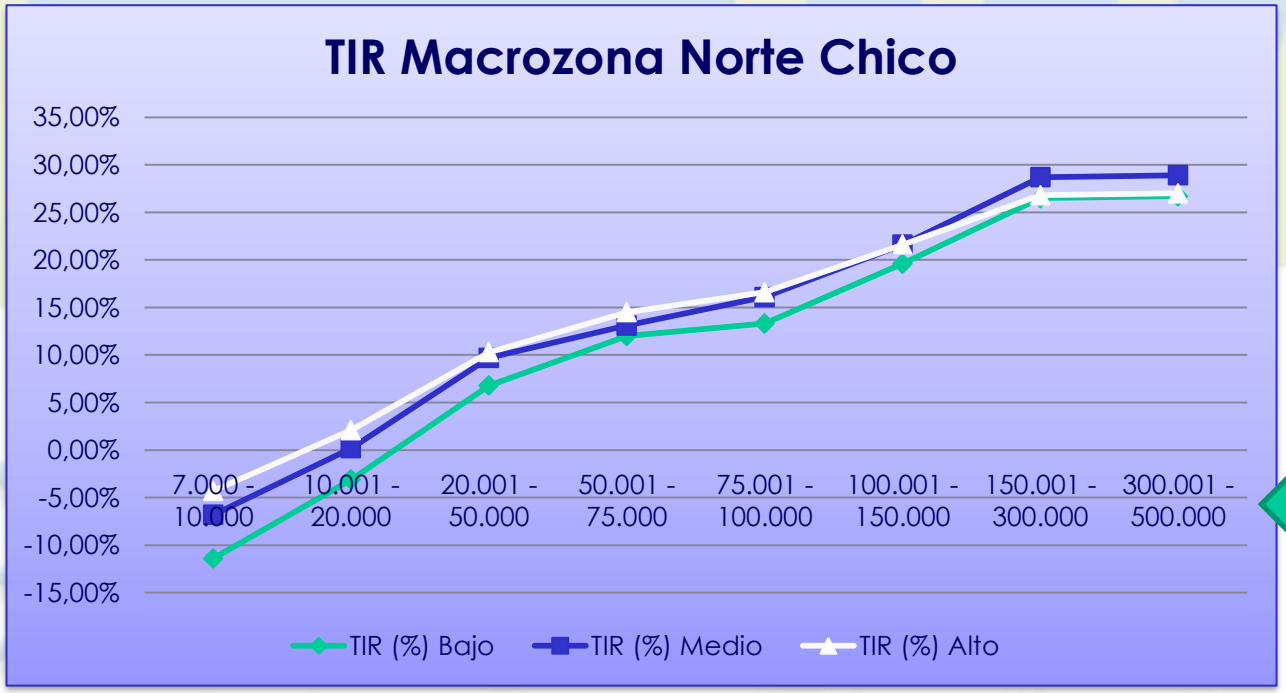


Rango de número de habitantes

Wet Fermentation Results

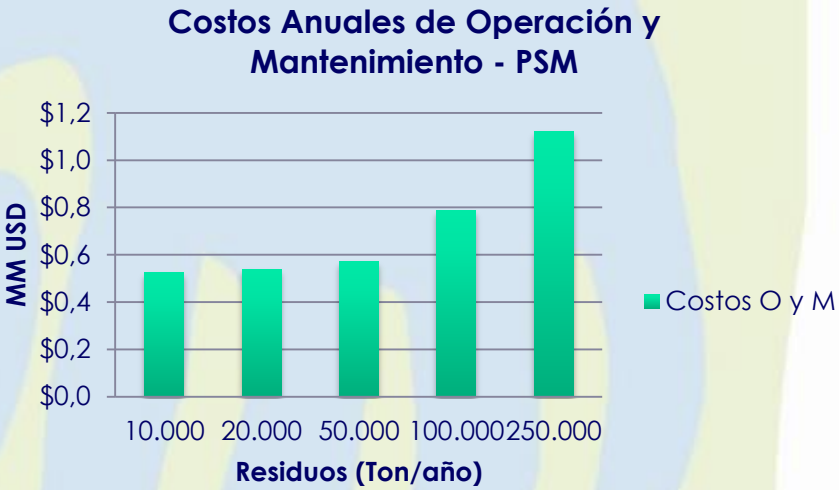


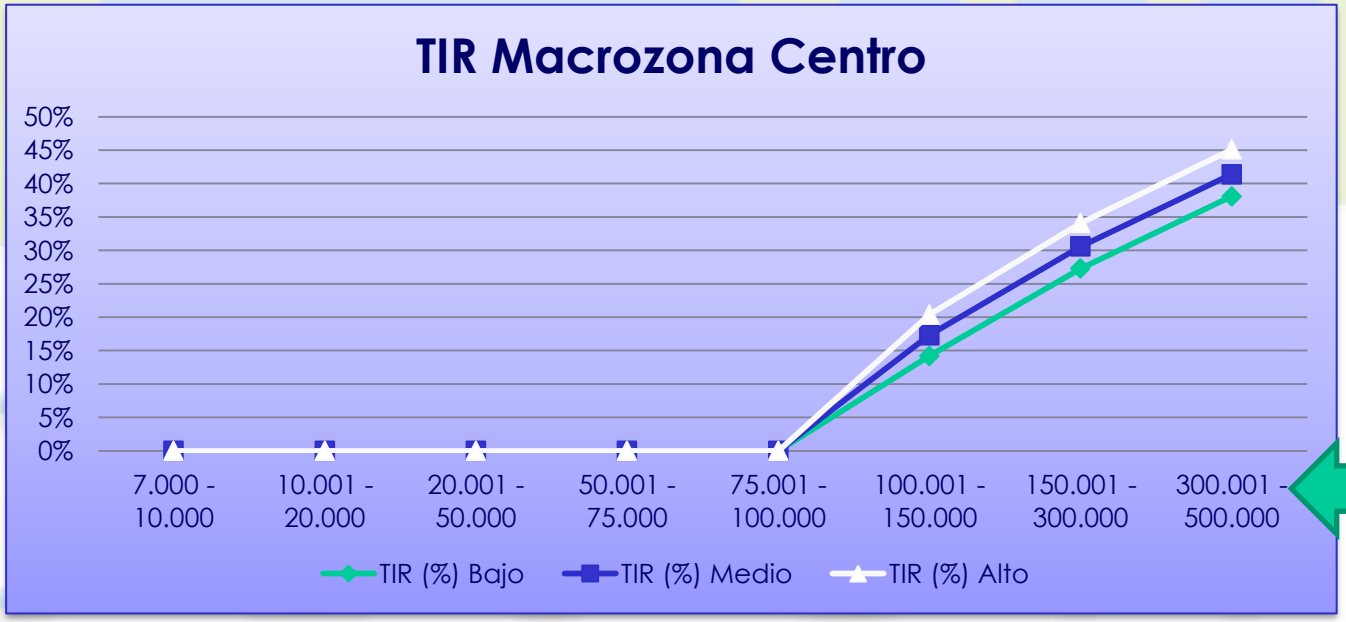




Rango de número de habitantes

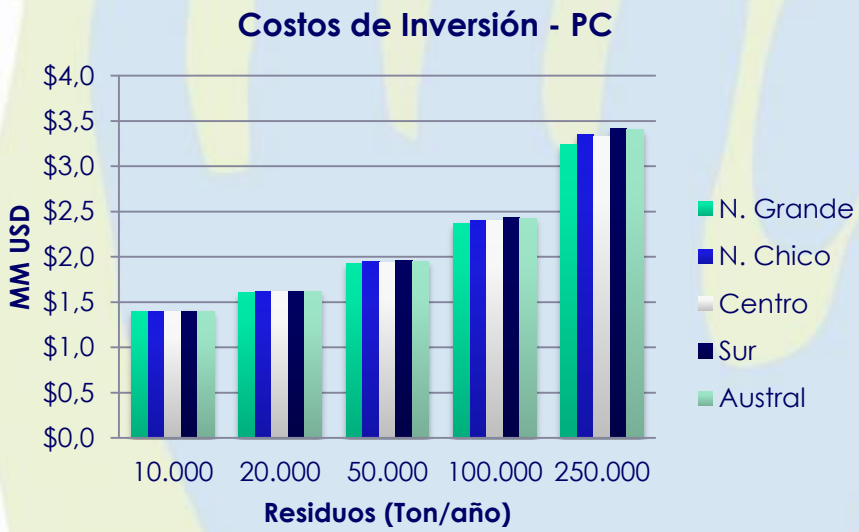
Sorting Plants Results

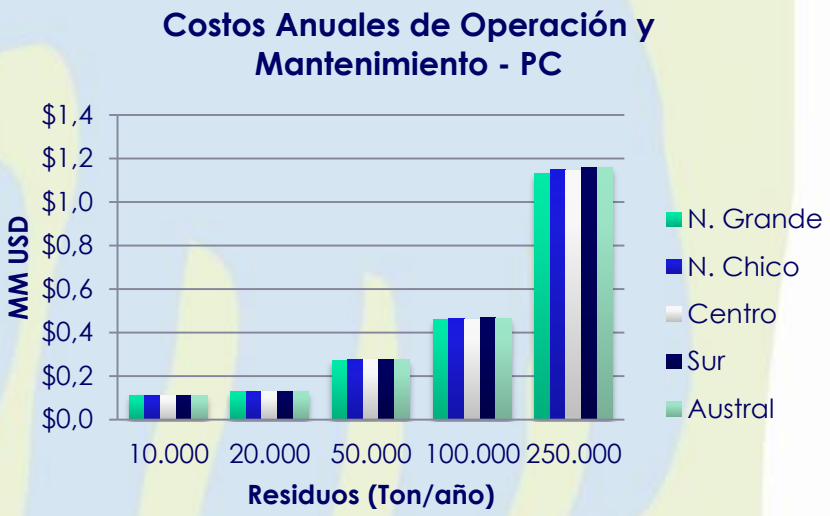


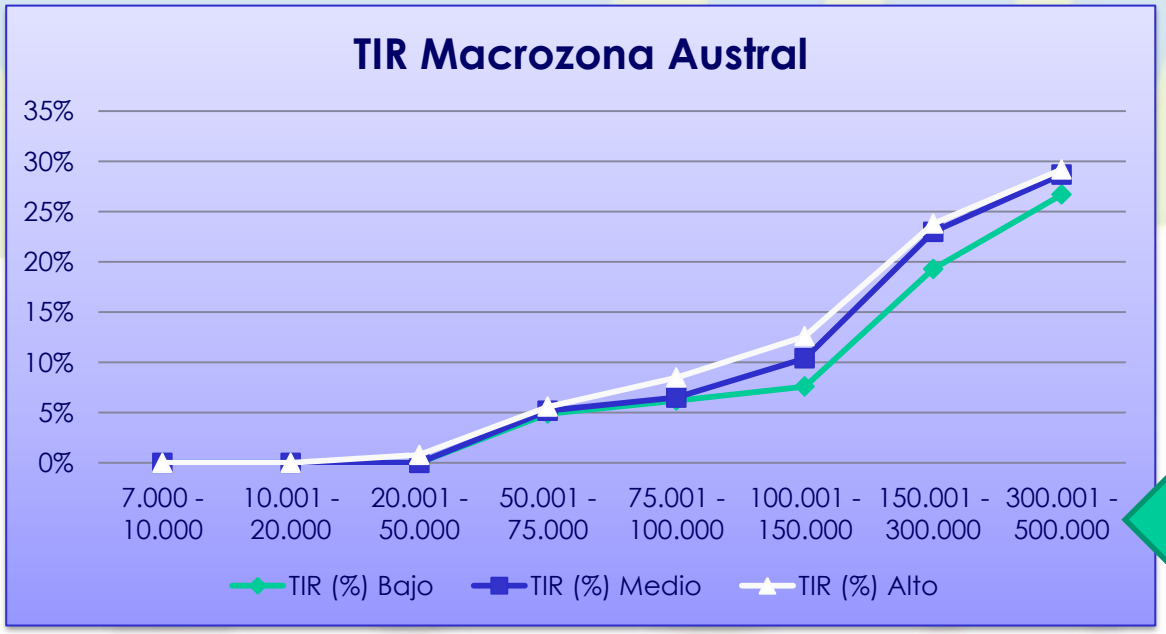


Rango de número de habitantes

Composting Results

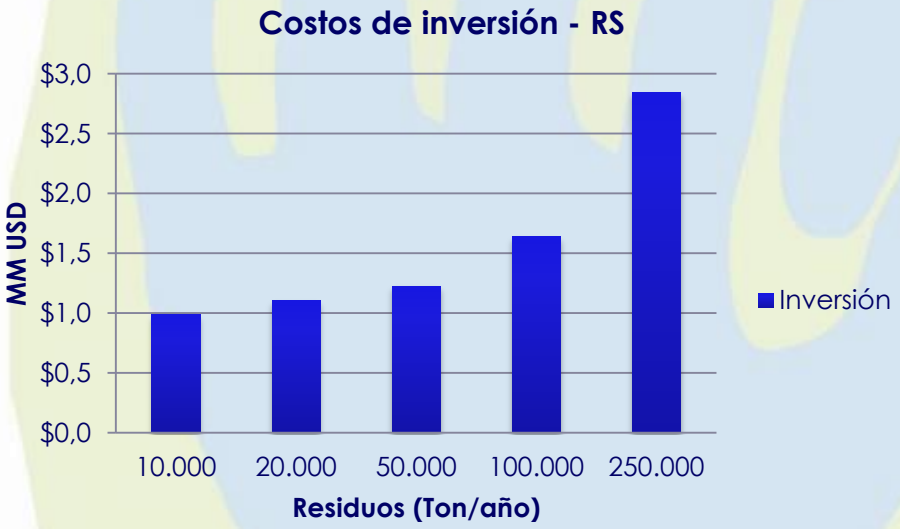


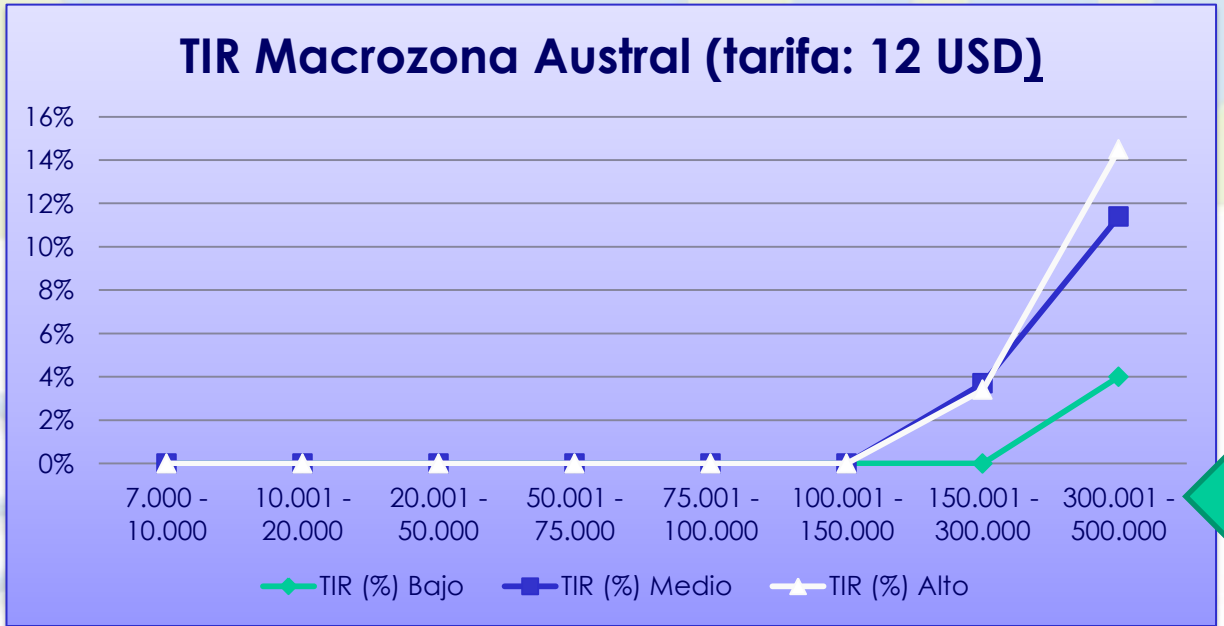




Rango de número de habitantes

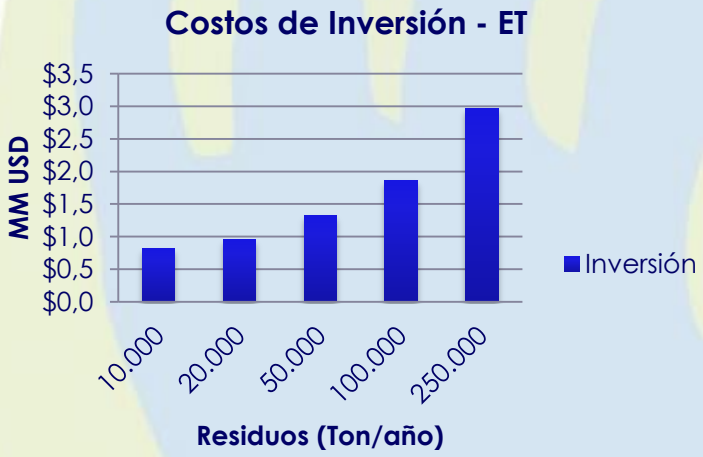
Landfill Results

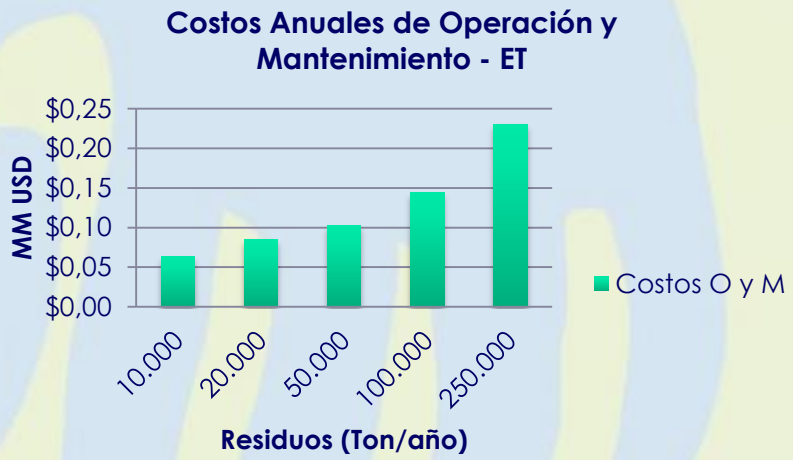


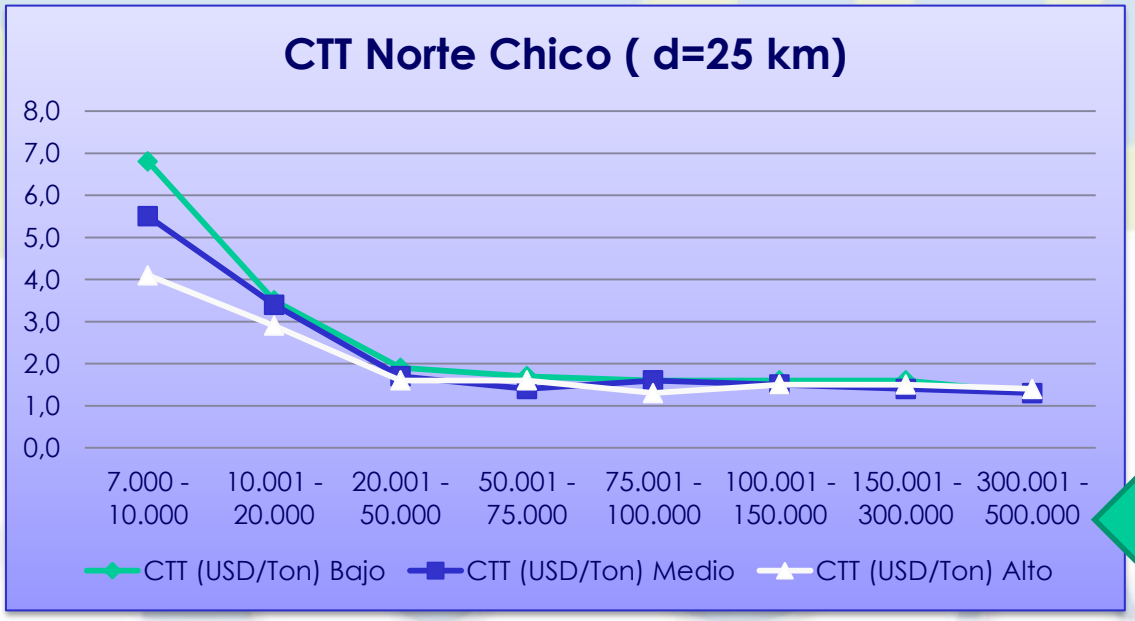


Rango de número de habitantes

Transfer Station Results







Rango de número de habitantes

Macrozones: Geographic Description

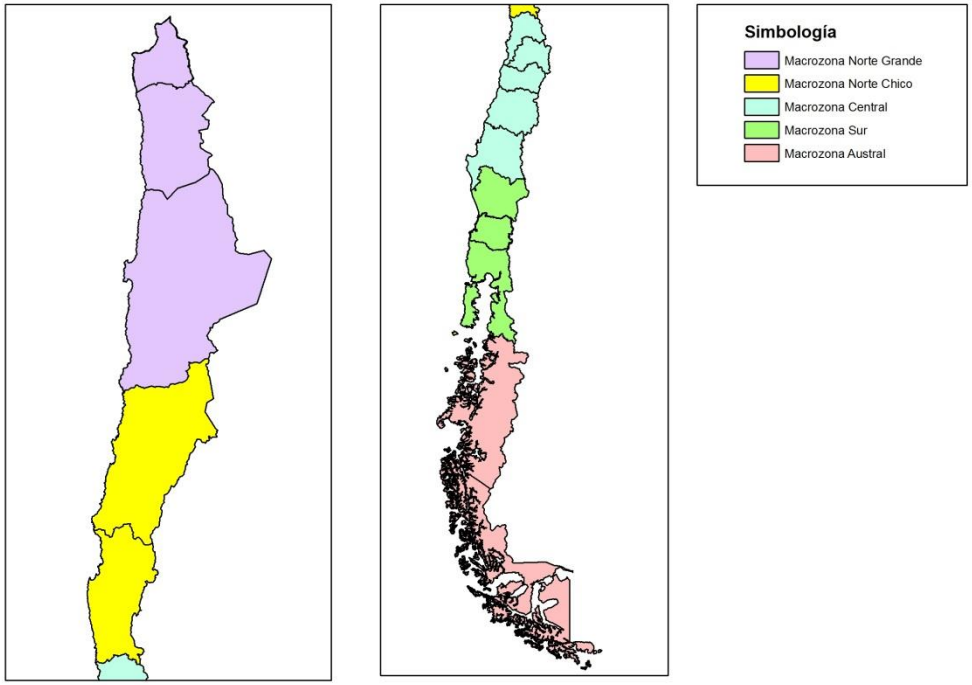
MACROZONA NORTE GRANDE: regiones de Arica y Parinacota (XV), Tarapacá (I) y Antofagasta (II).

MACROZONA NORTE CHICO: regiones de Atacama (III) y Coquimbo (IV).

MACROZONA CENTRAL: regiones de Valparaíso (V), Metropolitana (XIII), Libertador Bernardo O´Higgins (VI), Maule (VII) y Biobío (VIII).

MACROZONA SUR: regiones de Araucanía (IX), de Los Ríos (XIV) y de Los Lagos (X).

MACROZONA AUSTRAL: regiones de Aisén del General Carlos Ibáñez del Campo (XI) y de Magallanes y Antártica Chilena (XII).



Association prospects Arica Parinacota

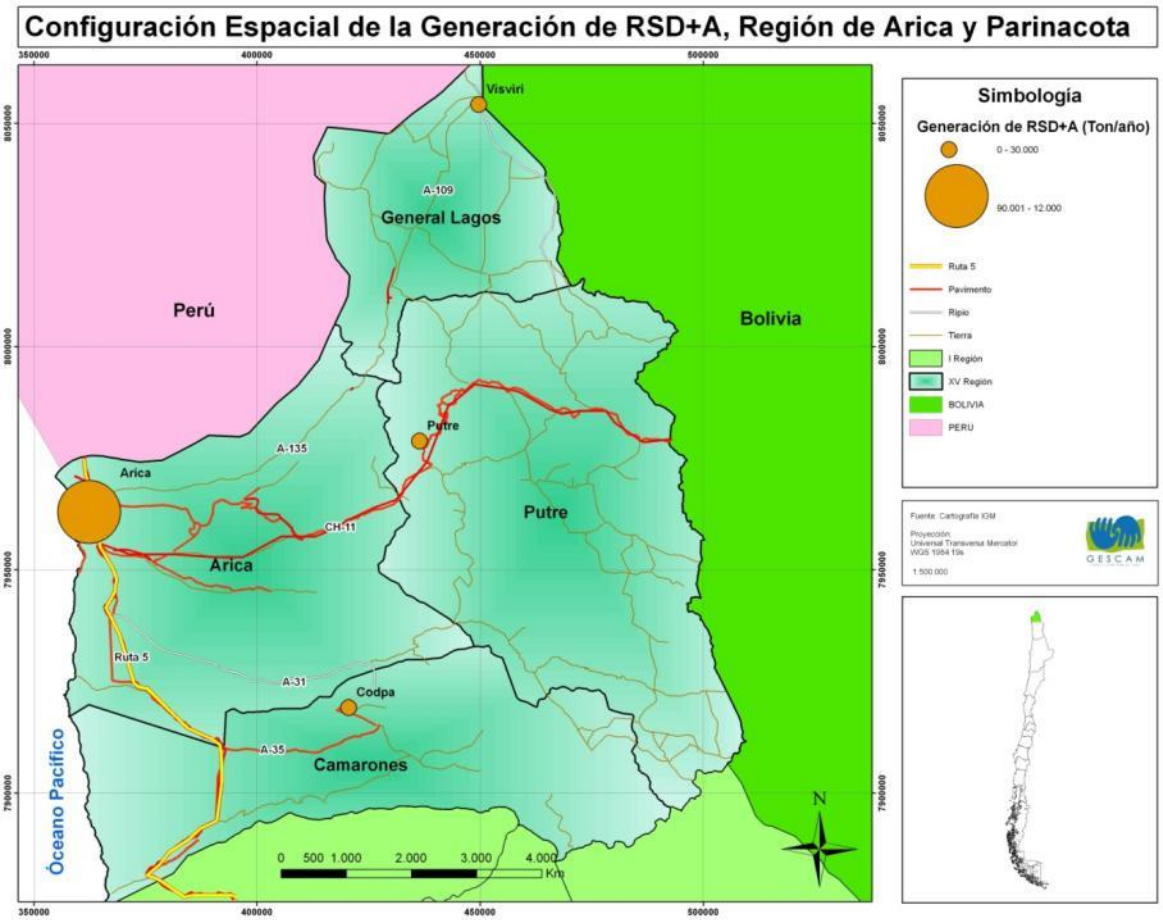
Low Prospects

Arica reaches 98% of MSW generation of the region and is located in a coastal area north-west of the country.

General Lagos, Putre and Camarones have very isolated towns

At first glance, its require separate solutions for these communities.

For Arica is interesting to study the implementation of treatment and waste recovery processes (136,140 t/y).



Association prospects Coquimbo

Medium Prospects

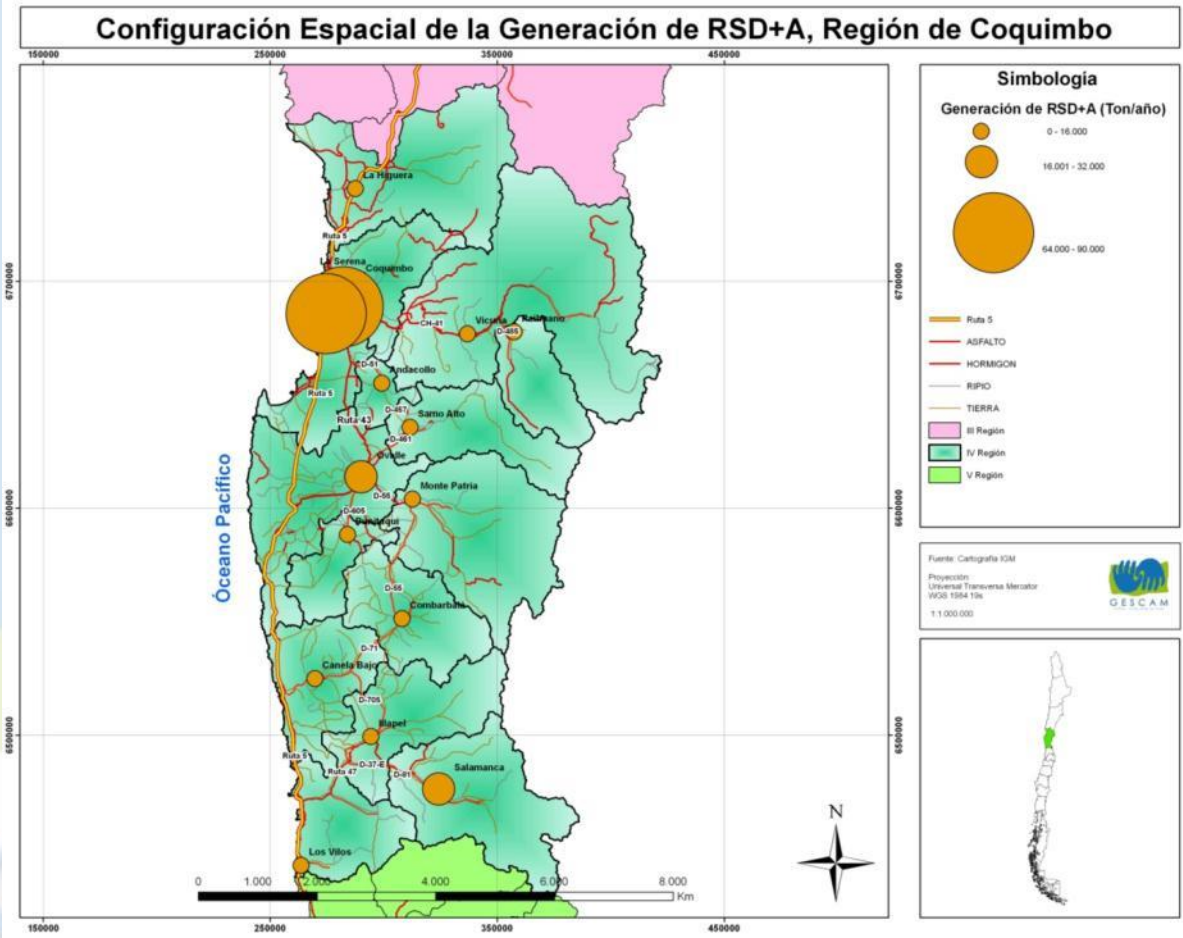
Coquimbo-La Serena group concentrates the 63% of the waste in the region .

Sufficient infrastructure for treatment and / or disposal of waste.

In this case it is necessary to note that there is greater proximity to the southern region and towns.

Salamanca, because of its isolation a particular solution is required.

It may be noted that in this case the prospects are positives if you think interregional solutions.



Association prospects Araucanía

High Prospects

It has a significant concentration in the central area. Temuco, Padre Las Casas and Vilcún represent 147,800 t/y (36% of total).

Lumaco, Los Sauces, Purén and Traiguén, located in the northwestern part of the region, with good connectivity among them.

Puerto Saavedra, Cholchol, Carahue, New Imperial, located in the central coast area of the region with connectivity to each other and to Route 5.

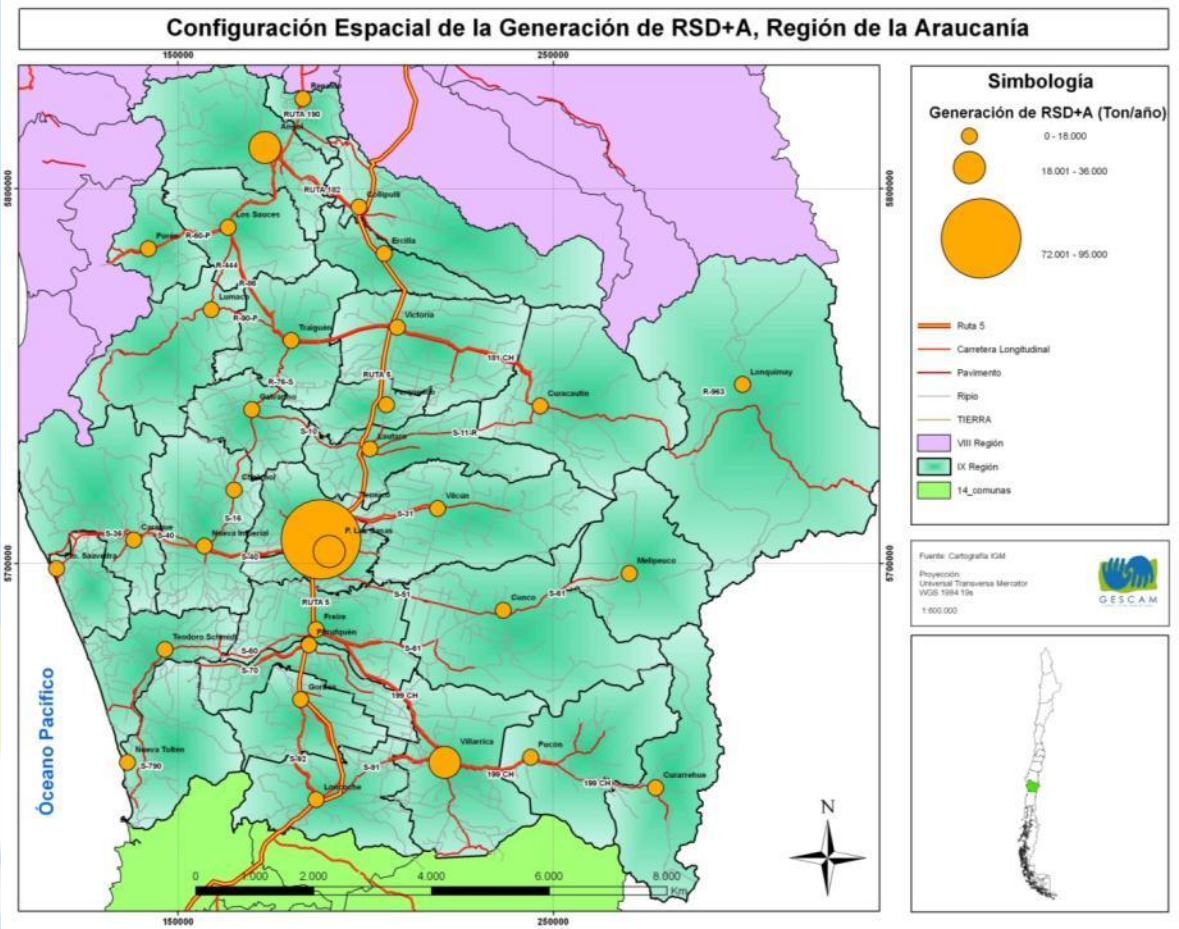
T. Schmidt and Toltén, located in the south-west, on the coast, with connectivity to each other

Galvarino, Perquenco, Lautaro, Victoria, located in the northern region around Route 5 .

Freire, Gorbea, Loncoche Pitrufquén and corresponds to the municipalities of the south-central part of the region.

Melipeuco and Cunco located in the central-eastern part of the region, with good connectivity to each other and to Route 5, do not have good connectivity to the communes of the north-east or the south-east communes.

Curarrehue, Villarrica and Pucon, corresponds to the communes of the lake area in the region, with very good connectivity with each other.



Prospects for growth in MSW generation

Proyecciones de RSD

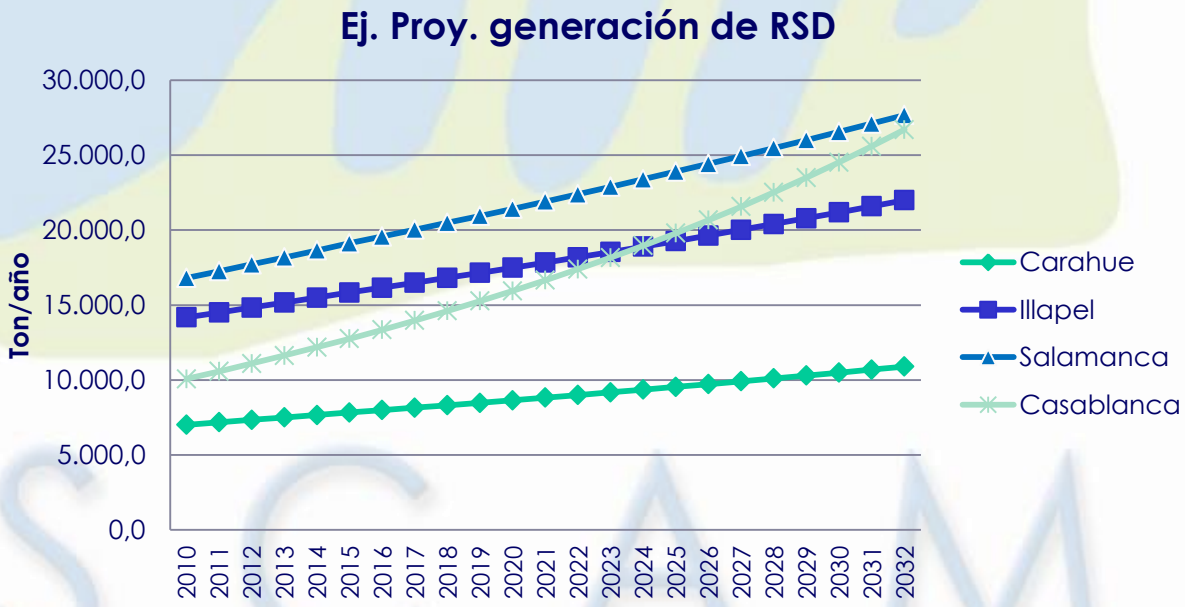
Growth prospects in MSW generation for all communes in the country were estimated.

Socioeconomic characteristics,

demographic and urban-rural distribution

Estimates of PPC per commune, was made on CONAMA. "First Report on Solid Waste Management in Chile." Santiago, 2010,

Average annual growth of MSW	Prospects for growth in MSW generation
< 1,5%	Low
1,5% ≥ ; <3,0%	Medium
≥ 3,0%	High

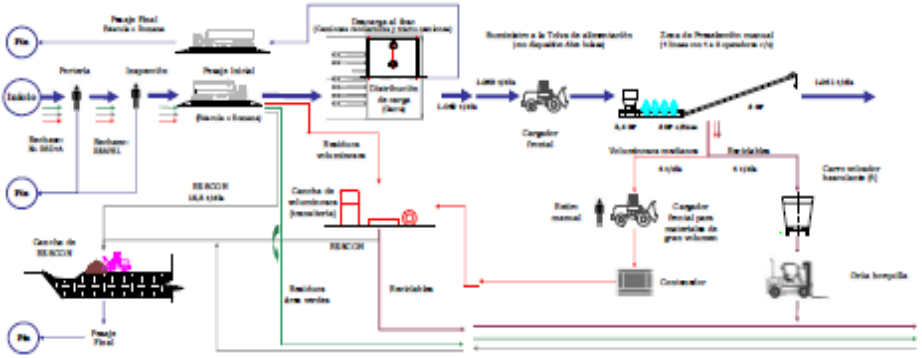


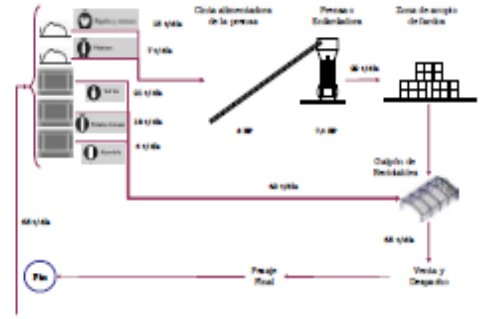
CASE PROJECT ARAUCANIA REGION 2013

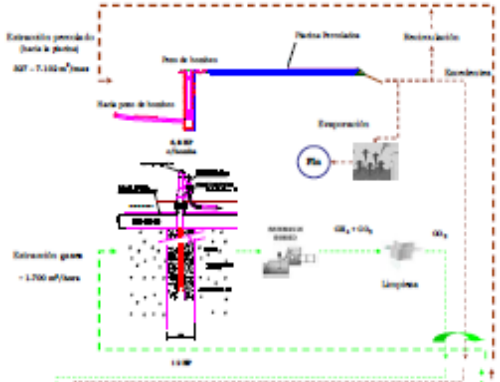
GESCAM

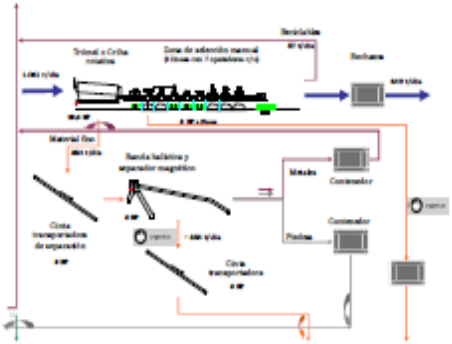
CENTRO DE TRATAMIENTO INTEGRAL REGIONAL, OPCIÓN 3

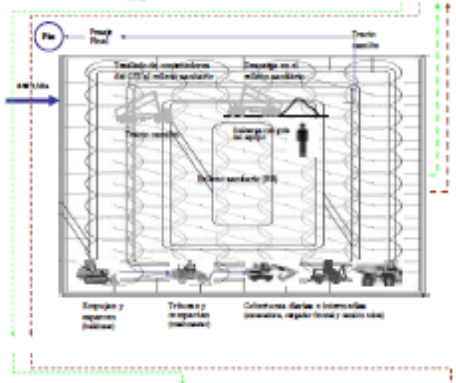
GESCAM
CONSULTORES AMBIENTALES

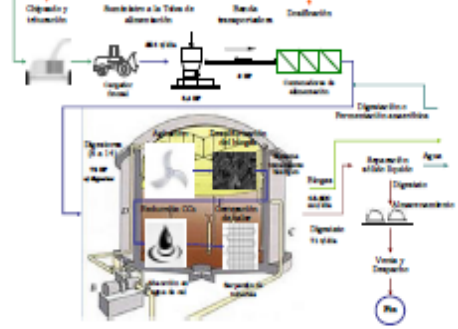


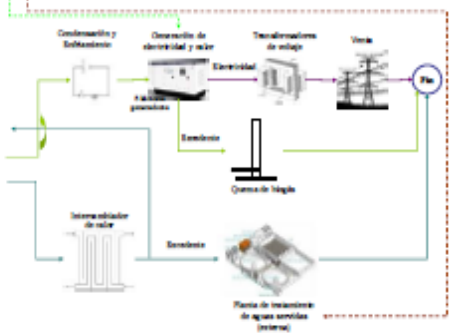












CTI R – Simbología Flujos

- Flujo principal
- Residuos áreas verdes
- RESCON / Piedras
- Residuos voluminosos / Voluminosos medianos
- Reciclables
- Material fino / Orgánicos
- Percolados
- Gases
- Biogás
- Digestato
- Agua
- Electricidad

Costs for the communes

(CLP 2013)

- **24 % of costs reduction, from CLP $ 4.1 billions per year to CLP $ 3.1 billions per year.**
- **Environmentally Appropriated Wastes Management (Gestión Ambientalmente Adecuada de Residuos)**

	ESCENARIO C			Gastos asociados al Manejo de RSD ($/ton)		
	Recolección y Trans ($/ton)	Transf,Transp Trat y DF ($/ton)	TOTAL ($/ton)	Recolección y Transporte ($/ton)	Disposición final ($/ton)	Gasto actual ($/ton)
Lumaco	22.581	4.688	**27.269**	73.320	10.898	**84.219**
Los Sauces	22.581	4.688	**27.269**	39.221	13.896	**53.117**
Purén	22.581	4.688	**27.269**	29.149	5.549	**34.698**
Traiguén	22.581	4.688	**27.269**	8.080	8.288	**16.368**
Puerto Saavedra	20.833	4.688	**25.521**	59.679	35.807	**95.486**
Cholchol	20.833	4.688	**25.521**	40.829	11.401	**52.229**
Carahue	20.833	4.688	**25.521**	32.628	10.946	**43.575**
Nueva Imperial	20.833	4.688	**25.521**	37.984	4.849	**42.832**
Teodoro Schmidt	25.950	4.688	**30.638**	12.935	6.468	**19.403**
Toltén	25.950	4.688	**30.638**	48.714	15.729	**64.443**
Galvarino	17.158	4.688	**21.846**	19.261	9.659	**28.920**

	ESCENARIO C			Gastos asociados al Manejo de RSD ($/ton)		
	Recolección y Trans ($/ton)	Transf,Transp Trat y DF ($/ton)	TOTAL ($/ton)	Recolección y Transporte ($/ton)	Disposición final ($/ton)	Gasto actual ($/ton)
Perquenco	17.158	4.688	**21.846**	30.836	20.557	**51.393**
Lautaro	17.158	4.688	**21.846**	19714	3.663	**23.377**
Victoria	17.158	4.688	**21.846**	20.395	4.108	**24.503**
Vilcún	12.587	4.688	**17.275**	21.280	4.534	**25.814**
Padre Las Casas	12.587	4.688	**17.275**	21.099	6.285	**27.384**
Temuco	12.587	4.688	**17.275**	14.461	4.449	**18.911**
Freire	27.365	4.688	**32.052**	20.862	5.778	**26.639**
Gorbea	27.365	4.688	**32.052**	37.361	5.726	**43.088**
Pitrufquén	20.904	4.688	**25.592**	23.558	3.681	**27.239**
Curacautín	20.904	4.688	**25.592**	6.372	7.345	**13.717**
Melipeuco	25.474	4.688	**30.162**	46.041	1.775	**47.816**
Loncoche	27.204	4.688	**31.891**	22.535	9.381	**31.916**
Cunco	27.204	4.688	**31.891**	52.905	7.741	**60.645**
Curarrehue	18.444	4.688	**22.586**	26.818	-	**26.818**
Villarrica	16.636	4.688	**20.777**	27.897	10.353	**38.249**
Pucón	18.444	4.688	**22.586**	32.092	14.263	**46.355**

Conclusions

- A wide offer of waste treatment technologies exists nationwide.
- Association and connectivity between neighboring communes is an important aspect to analyze when evaluating projects.
- Public authority capable of managing and controlling treatment is required. Market is not enough.
- Economy of scale allows to choose the most profitable and cost-efficient.
- Is required to assess prospects for MSW generation.
- In most of the projects evaluated the differences in the waste composition in the macrozones are NOT relevant.
- The differences are significant between PD and PVD are so different technologies.

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