Promoting Small Scale Anaerobic digestion systems

Santino Di Berardino, Alexis Chatzimpiros and Olga Bourka,

*Unidade de BIOENERGIA, LNEG, Est. do Paço do Lumiar, 1649-038 Lisboa, Portugal.
(e-mail: santino.diberardino@mail.ineti.pt)
** EPTA GR.

Introduction

- Current management of Organic Wastes involve considerable expenses in collection, treatment and disposal,
- Organic wastes contain considerable and valuable chemicals and energetic and fertilizing properties which are lost in land filling or incineration.
- This management model is inefficient and unsustainable and a change toward a better style of life and sustainable growth is under promotion.

Better management

requires:

- a change of mentality of all the people in relation to wastes,
- an evolution of attitude on use of natural resources and
- implementation of more efficient procedures for waste separation, recovery and recycling of relevant components.

Anaerobic digestion

- is a recognized powerful technology for organic biodegradables waste treatment, both in liquid or dry form, generating a methane rich biogas and a stabilized digestate.
- provides several benefits :
- Renewable energy production,
- waste treatment,
- greenhouse gas (GHG) emission and
- fertilizer production.

Application

- initially applied as single substrate technology
- expanded to the concept of co-digestion, a solution that looks at profiting synergies from wastes, by the mixture and joint degradation of more substrates.

Codigestion -Advantages

- provides chemical, biological, technical, economic and operational advantages:
- is less expensive than separate solutions,
- allows preparation of a feedstock with an equilibrate or improved composition,
- increases the scale of the system,
- can facilitate overcoming inhibition problems and may even improve degradation efficiency, resulting in a higher gas yield.

Codigestion -Advantages

- Generates a large quantity of biogas usable for electric energy and surplus heat.
- Compared to the sum of separate digestions, codigestion reduces investment and ecological footprint
- can solve the treatment of seasonal discharged specific organic wastes, containing organic compounds hardly biodegradable or inhibitory
- Compared to composting reduces greenhouse effect.

Existing facilities

- Codigestion application can profit existing structures treating different basic substrate, namely: Sludge, industrial wastes, solid bio waste, manure digesters etc..
- This option can make anaerobic digestion a more feasible solution, especially in decentralized regions, when not enough biogenic waste for the construction of manure or bio waste based digestion plants, is available.

AD in EUROPE

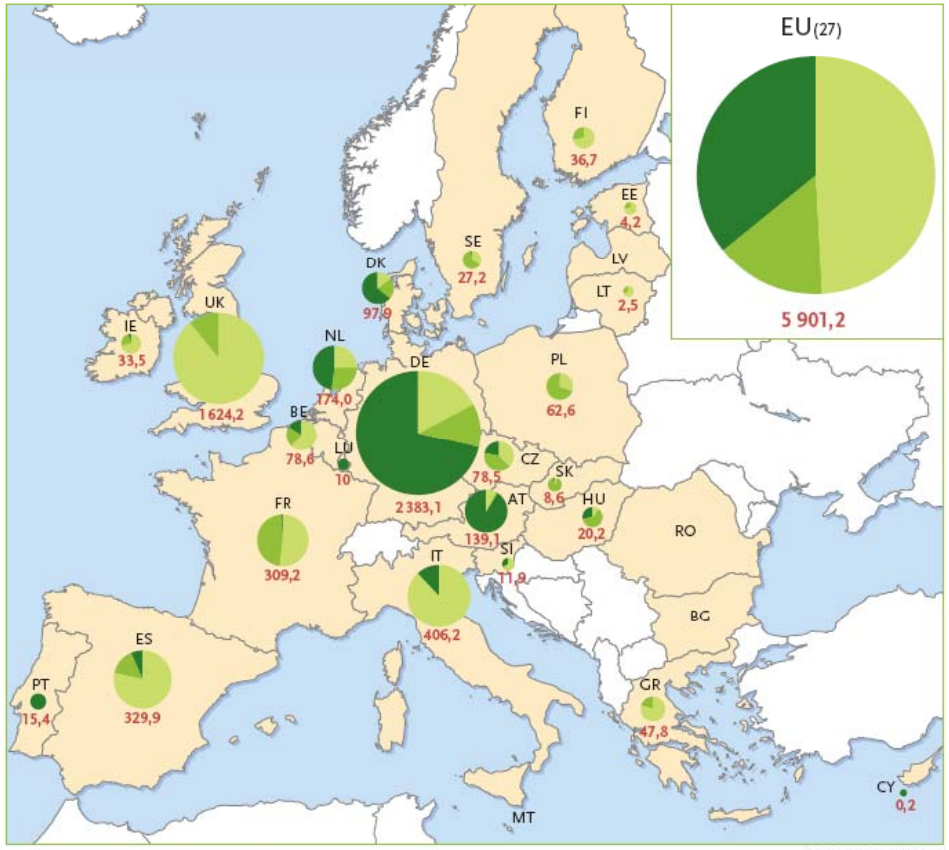
- Landfill biogas has been and still remains the main source of energy from biogas, but its evolution is uncertain.
- In next year the biogas produced from others wastes (Industrial wastewater anaerobic Treatment plant, agricultural biogas plants, municipal waste digesters and collective co digestion facilities), will be the major source, according to the sharp increase observed in the last years.

Exploited energy production in Europe (Biogas Barometer 2003-2008)

year	2001	2002	2003	2004	2005	2006	2007
Landfill gas	-	1026,8	-	2 813,8	3 172,7	2700,3	2905,2
Sludge digester gas	-	911,5	-	922,9	932,4	867,8	887,2
Others sources	-	823,7	-	540,5	854,0	1330,8	2108,0
Total	2 596	2 762	3219	4 277,2	4 959,1	4898,9	5901,2

Biogas Production em TEP

PRODUCTION D'ÉNERGIE PRIMAIRE DE BIOGAZ EN EUROPE EN 2007*
*PRIMARY ENERGY PRODUCTION OF BIOGAS IN EUROPE IN 2007**



LÉGENDE/*KEY*

Production d'énergie primaire de biogaz de l'Union européenne en 2007 (en ktep)/
Primary energy production of biogas of the European Union in 2007 (in ktoe)

- Biogaz de décharges/*Landfill gas*
- Biogaz de stations d'épuration/*Sewage sludge gas*
- Autres biogaz (unités décentralisées de biogaz agricole, etc.)/*Other biogases (decentralised agricultural plant, etc.)*

5 901,2 Les chiffres en rouge indiquent la production totale en ktep/*Red figures show total production in ktoe*

Fertilizer

- The digested residue has good fertilizing properties and is easily uptaken by crops. Contains most of nutrients constituent of the feedstock in a reduced chemical form.
- The reuse in selected agricultural crops is a quite valid option, when contains low level of toxic compound.
- The mixture of wastes, sludge and agricultural wastes can be optimized in order to provide optimal C/N ratio.

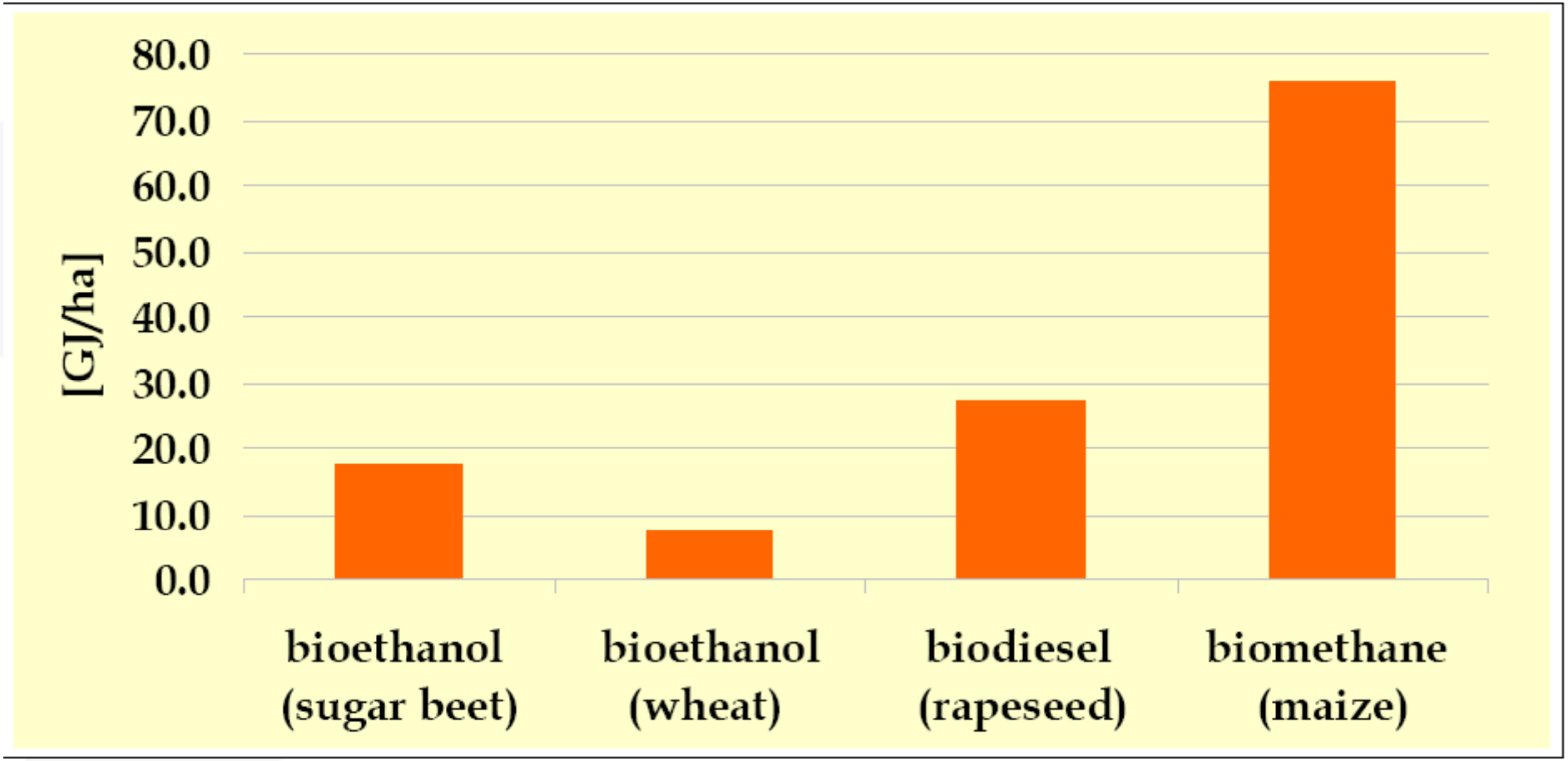
Energy Crops

- Numerous full-scale biogas digest maize silage, sorghum, whole crop cereal silage and mixtures of other energy crops.
- Another possibility is the application of digestate in multiple harvesting plants (green plant silage, grass, winter wheat, etc.). These crops fixate nitrogen into the ground.

Energy Crops

- Energetic crops (maize) for anaerobic digestion provide as much as 75 GJ/ha of net energy output (De Baere (2007))
- Anaerobic digestion provides at least 2 times higher energy yield than biofuels from wheat and rapeseed and, at least, 3 times more net energy output, making biogas a favourable option as fuel for transportation.

ROLE OF BIOGAS IN RENEWABLE ENERGY FIELD: NET ENERGY OUTPUT



- Moreover, the use of ley crops for anaerobic digestion contributes in a number of ways to the development of a sustainable agricultural production system. Solve problems with plant pathogens and insects owing to the more varied crop rotation, thereby reducing the need for pesticides, as well as the environmental and economic costs associated with their use (Nordberg, 2001).

Small-scale

- Anaerobic digestion is today a popular and successfully solution at average-high scale facilities.
- financial success of small scale AD is more difficult and requires appropriate strategy and considerable changes in residues management.
- Its operation is heavily influenced by cost and technological requirements, associated with the construction, operation and maintenance of the facility. A number of not technical and technical barriers have to be overcome.
-

Pre-treatment and modifications co-digestion

Type of Co substrate	Pre-treatment necessary	Eventual Modification of Digestion system if available
Solid Waste	Removal of big components (stones, metals, wood etc..), sieving, Maceration, removal of inerts, mixing and Homogeneization	Hydrolisation-acidification step Prevention of foaming and scume layer formation, Removal of sediments, hygienisation. Termophilic operation
Manure, liquid waste and sludge	No pre-treatment,	Increase of mixing capacity, hygienisation
Bio-waste source separated	Sieving, Maceration, removal of inerts, mixture and homogenization	Hydrolysis-acidification step Prevention of foaming and scume layer formation, Removal of sediments, hygienisation. Termophilic operation
Energetic crop	Sieving, Maceration, removal of inerts, mixture, homogenization	Hydrolisys-acidification step, additional post treatment of digestate. Termophilic operation
Industrial waste	Specific pre-treatment to prevent toxicity	Prevention of foaming and scume layer formation. Hydrolisys-acidification step.

Difficulties - Drawbacks

- High capital cost investment,
- collecting system and cooperation between several entities.
- large quantities of residues that have to be treated and disposed properly.
- Require good design and operation in order to generate some economic return.

non technical hitches,

- Administrative, regulatory and market barriers,
- Different parties, such as municipalities, constructors, people of administration, farmers, waste producers and waste collectors, population involved, etc., have to talk to each other and to work together.
- Requires appropriate strategy, planning and actions as well as considerable changes in residues management and local community involvement.

BIORES PROJECT

- **BIORES PROJECT: Reinforcing Investments in biogas technologies for small-scale RES applications in islands**

The Project

- It is a 30-month project that started in November 2007.
- Total budget is € 1.191.471.
- Co-financed at a rate of 50% by the Intelligent Energy - Europe programme of the European Commission.
- Contract No: EIE/07/045/SI2.466790
- Coordinator: EPTA Ltd (GR)

Main idea

- **Exploitation of biogas is a promising solution, especially for decentralized electricity production in insular regions**
- **Promote the planning of the small-scale energy investments based on biogas in 6 European islands.**
- **Assists local and national authorities to overcome the non-technical barriers that hinder these technologies from having a significant share of the energy market**
-

PROJECT ADDRESSES

- **The project addresses two important issues faced by islands:**
- **energy dependency from the mainland, and**
- **waste management.**

AIMS - 1

- Promote the implementation of technologies for energy polygeneration based on biogas derived from waste in European islands, which usually have insufficient energy resources.
- Decrease the energy needs of end-users of island communities.
- Promotion of sustainable waste management.

AIMS - 2

- **Development of financial tools for the assessment of the techno-economic perspectives and feasibility of the investments on these RES applications**
- **Overcoming of the administrative and regulatory barriers and financing obstacles that pose difficulties in investing on energy production from biogas derived from waste.**

Specific Objectives

- Facilitate investments in energy production from biogas derived from waste
- Provide technical and administrative means including decision support tools to potential investors and local authorities.
- Increase decentralised energy production,
- Increase in the green electricity's market share
- decrease of islands' energy dependency on fossil fuels and the mainland.

Focus

- six European islands, namely
- Samos (Greece),
- Samso (Denmark),
- Sardinia and Tremiti islands (Italy),
- Porto Santo (Portugal) and the
- Outer Hebrides of Scotland (UK).

Project first phase

- Assements of the existing potential in European islands for exploiting biogas derived from waste, as well as their energy end-use needs.
- Identification of all the technologies based on biogas derived from waste, successfully implemented in European islands
- Evaluationand dissemination of the benefits from the implementation of these small-scale RES technologies.

Project second phase

- Identification and analyses of the non-technical, administrative, regulatory and market barriers regarding the penetration of biogas technologies in the market,
- Selection of best practices for overcoming non-technical barriers.
- Development of an evaluation methodology for the detection of the most preferable technology.
- Assessement of the financial mechanisms and tariffs vs a number of parameters and characteristics of each specific area.

Project third phase

- Preparation of the DSS tool
- Offered Training on the use of the decision support system (DSS) tool to local authorities so that they would be capable of using it.
- Dissemination actions for the diffusion of the project's objectives and results, as well as for raising awareness on environmental issues at local level.

Outputs

- Action plans to propose to local and national authorities concrete institutional measures, aiming at promoting the implementation of the technologies proposed.
- Organisation of Environmental local events, national workshops as well as an EU-level event at the end of the project to inform and involve all potential stakeholders.
- Newsletters and information leaflets will be diffused in 5 languages, English, Greek, Italian, Portuguese and Danish.
- Development of a software decision support system (DSS), for investing in small-scale RES applications based on biogas from waste.

Expected results

- Raising of awareness at local level in order that local communities support these technologies,
- Achievement of environmental, energetic, socio-economic and market benefits
- On-line decision support system for local and national authorities and investors to identify the technologies and financing mechanisms and feasibility
- Identification of appropriate technologies for each region.

Target Groups and Key Actors

- Public Institutions and Local Authorities
- Local Energy Agencies and Energy Management Authorities
- Consultants, engineers, IT and economy experts
- Local communities in European islands
- Investors in energy production and end-use energy-related market actors
- Waste Management and Environmental Protection Agencies
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Partners

PARTNERS

Coordinator
EPTA Energy–Environment – Local Development Ltd
Alexis Chatzimpiros
achatzimpiros@epta.gr - www.epta.gr

ALAWS - Association of Local Authorities of West Samos
Achilleas Mandalou
d.karlovasion@kep.gov.gr

ALESA Local Agency for Energy and Environment
Eng. Gaetano Montesi
Eng. Ferdinando Stampone
spec1@alesachieti.it - www.alesachieti.it

BSI - Business Systems International S.A
Polivios Raxis
raxis@bsi.gr - http://www.bsi.gr

INETI Instituto Nacional De Engenharia Tecnologia e Inovação I. P.
Santino di Berardino
santino.diberardino@ineti.pt - www.ineti.pt

ISLENET - The Outer Hebrides of Scotland (Comhairle Nan Eilean Siar)
Panos Coroyannakis
islenet@skynet.be - www.islenet.net

PEPS - Multiss - Punto Energia Provincia di Sassari
Antonio Giovanni Rassu
Pierfranco Piredda
energyss@tin.it - www.puntoenergiass.com

SEMK Samsø Energi- og Miljøkontor
Jan Jantzen
jj@energiakademiet.dk - http://www.energiakademiet.dk/default_uk.asp

UPATRAS - University of Patras / Economic Department
Ioannis Venetis
ivenetis@upatras.gr - www.upatras.gr - www.econ.upatras.gr

Contact and informations

- **All potentially interested stakeholders are invited to visit the project website www.biores.eu for regular updates regarding the development of the various project tasks and information about events in their regions.**

SWOT Analysis

- SWOT analysis is applied to the non-technical barriers (NTB's) regarding small scale future biogas investments in islands
- The definition for NTB's is : ***A non-technical barrier is a hindrance to a project, due to a human concern as opposed to a technical hindrance.***

Analysis and deliberation

- **to take advantage of factors that are considered as strengths, to maintain them and build upon them,**
- **to exploit and optimize factors that appear as opportunities,**
- **to minimize the impacts of weaknesses, and**
- **to protect against threats.**

Results

- We have identified a pick-list of 38 potential non-technical barriers.
- We identified 26 barriers in Porto Santo, 25 barriers in Outer Hebrides, 19 barriers in Samos, 18 barriers in Samso, 16 barriers in Tremiti islands and 4 barriers in Sardinia.
- 5 barriers are common in five out of six islands. They are administrative, regulatory, economic and market related.

SWOT Analysis - Weaknesses

Internal	Weaknesses
	1. We do not have legislative incentives to deliver agricultural waste to a biogas plant
	2. We do not have legislative incentives to deliver industrial waste to a biogas plant
	3. We can grow energy crops, not intended for biogas, that have a higher profitability than biogas crops
	4. A biogas plant is a risky investment
	5. I will only consider biogas, if it does not cost me extra money
	6. Our general public is sceptical towards biogas plants
	7. The biogas distribution network and storage capacity will be limited
	8. (*) Our farmers have only limited knowledge about the agricultural by-products from biogas production
	9. We have technologies for treating municipal and industrial waste, that can compete with biogas
	10. We have commercial fertilizers at low cost that can compete with the digestate
	11. We can get other biomass fuels, such as ethanol, that compete with biogas and its digestate for heat production
	12. There will be a gate fee at a centralized biogas plant

SWOT Analysis - Strenghts

Strengths

1. The reduction in odour from spreading digestate, instead of non-digested manure, will be appreciated
2. It is feasible to supply agricultural waste to the biogas plant
3. The digestate will improve the fertilization of the fields
4. A biogas plant will improve sanitation
5. We have a limit or a ban on land-filling
6. It is feasible to supply industrial and municipal waste to the biogas plant
7. Investors can get guarantees for selling prices, subsidies, and sales amounts
8. Financing can be based on a large number of small investors
9. Excess biogas during the summer time will not be a problem
10. It is not difficult to distribute and sell heat and electricity produced at the biogas plant

SWOT Analysis - Threats

External

Threats

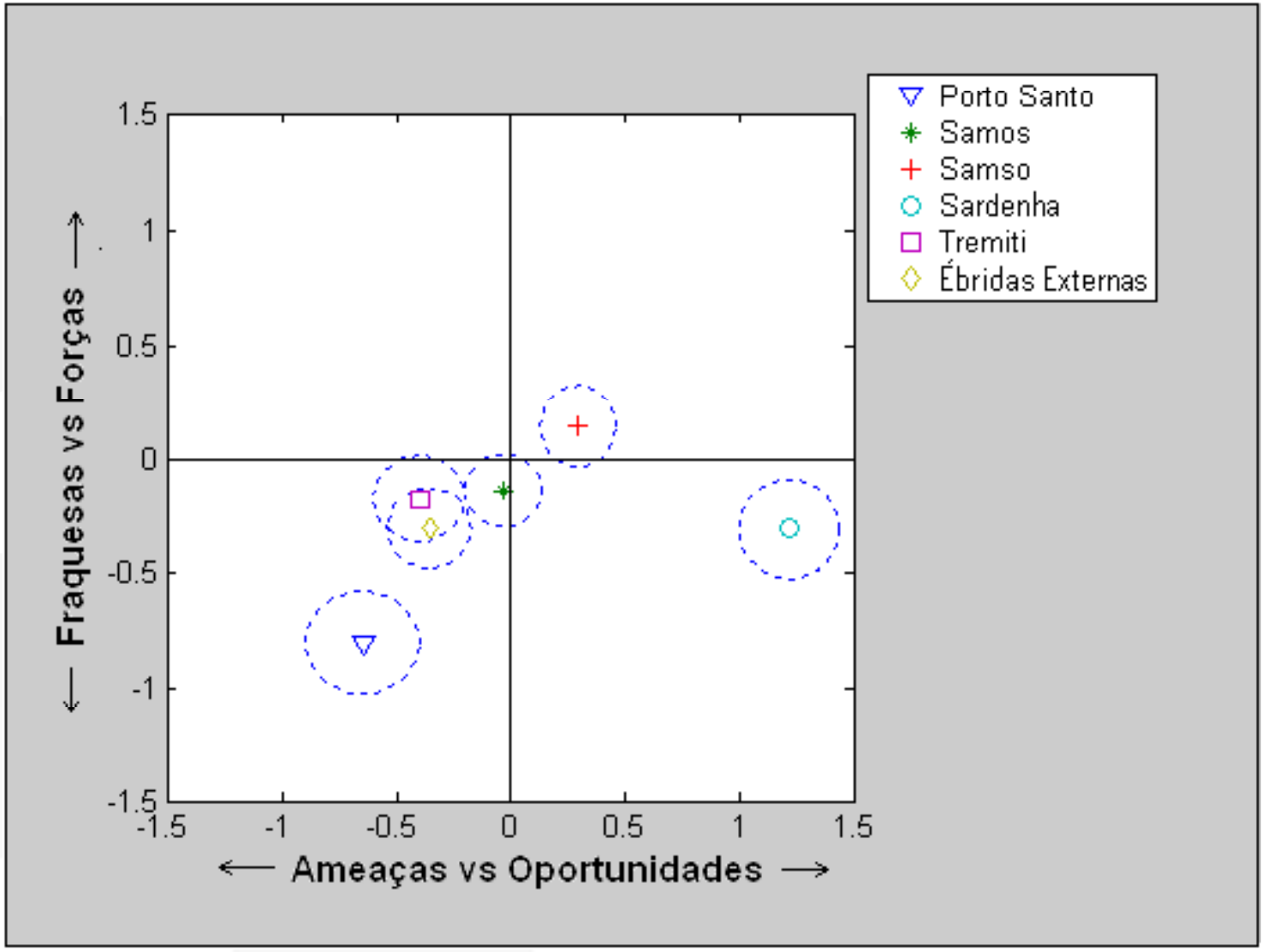
1. The average lead time to get an authorization is more than 6 months
2. There are no subsidies for biofuel vehicles
3. The agencies are slow to coordinate due to overlap in roles, responsibilities and functions
4. (*) We do not have a tax on waste incineration
5. Biofuel vehicles are more expensive than conventional, such that biofuel is difficult to sell
6. The biogas plant market is immature, such that investment costs are high
7. There are no satisfactory subsidies for investing in biogas plants
8. There are too many agencies and authorities responsible for biogas

SWOT Analysis - Opportunities

Opportunities

1. We have a legislative framework for municipal solid waste and sewage disposal
2. We have national environmental quality objectives
3. The agencies' legislative framework of operation encourages cooperation with the municipality
4. A major private investor can be found
5. We have a tax on commercial nitrogen fertilizers
6. The agencies' legislative framework of operation encourages cooperation with the private sector (industry, agriculture)
7. We can fund the biogas plant investment through a private bank loan
8. We have clear and well-established licensing procedures
9. Energy crop cultivation is subsidized
10. It is not difficult to obtain contracts with heat plants and electricity distributors
11. Biogas is promoted from energy and CO2 taxes

Análise SWOT – Results



Objectivo

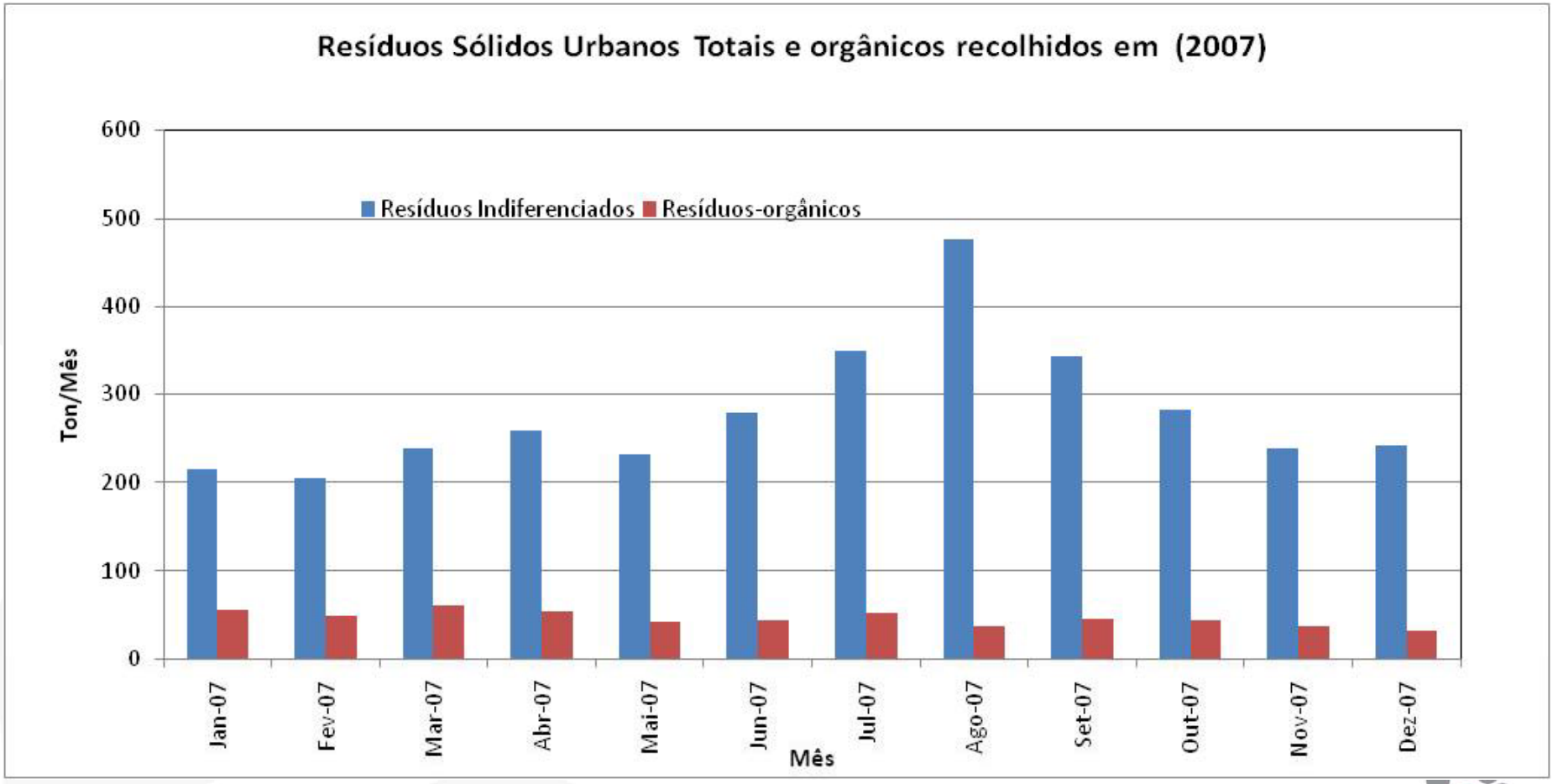
- Definir a possibilidade de implantação de um sistema de digestão anaeróbia com produção e utilização de biogás, tratando todos os resíduos orgânicos disponíveis
- Serve para validação do Instrumento de apoio á Decisão IAD.

Organic wastes available in the Porto Santo Island

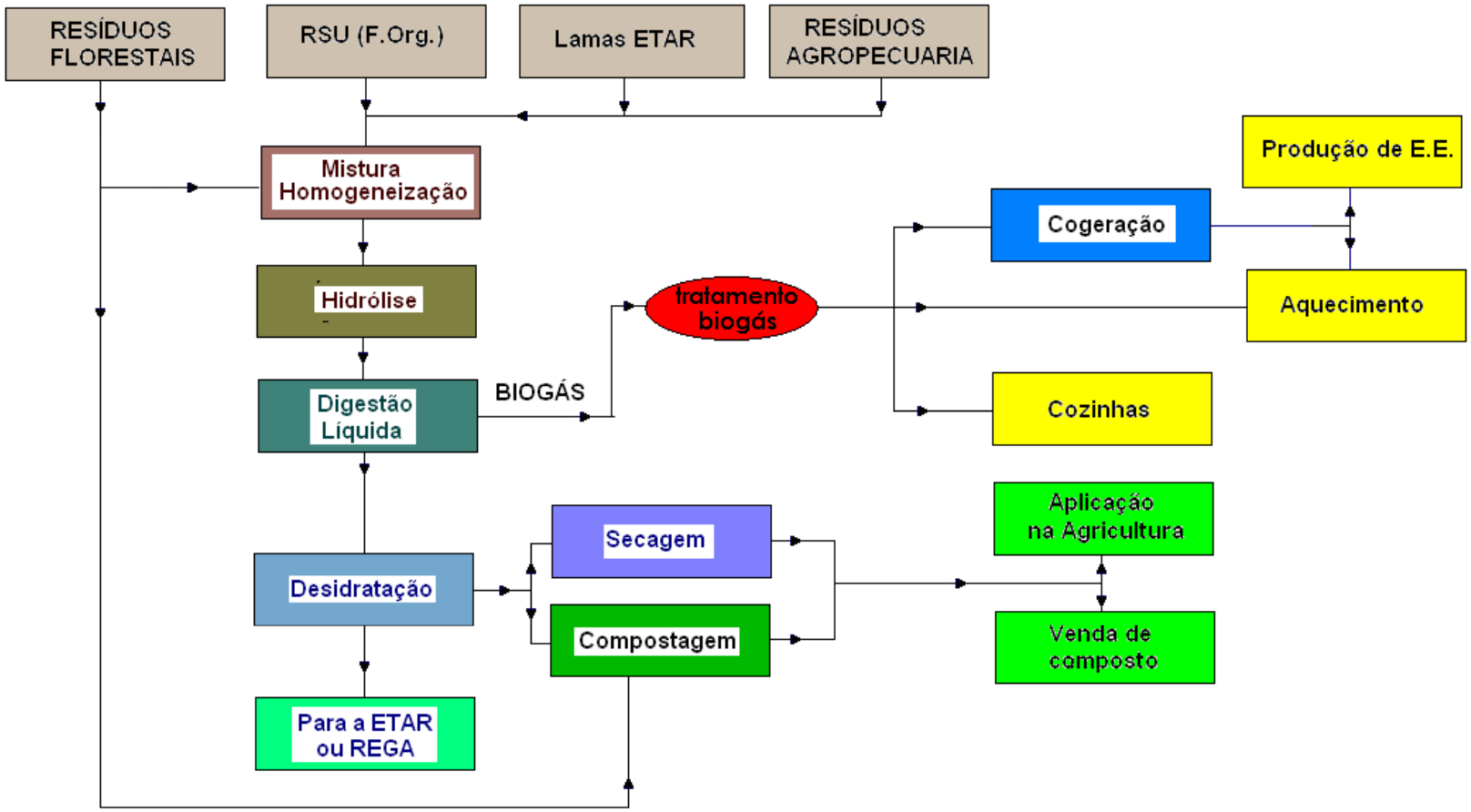
Kind of Residues	Minimum monthly amount tonnes/month)	Maximum montly amount (tonnes/month)	Yearly amount (tonnes /year)
Organic solid wastes (Biowaste)	70	150	1080
Sludge from the WWTP	45	110	740

Existing Solutions

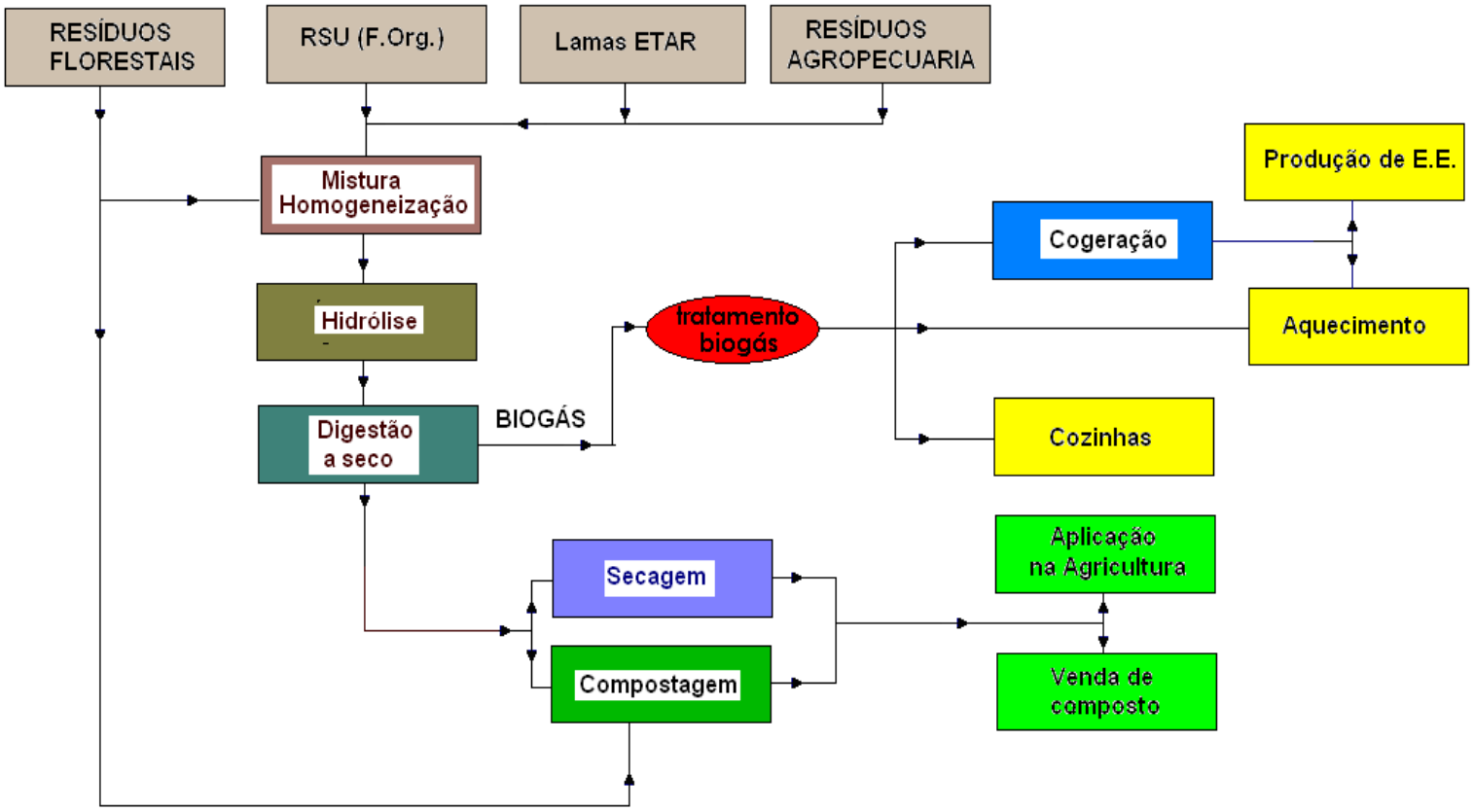
- All the collected municipal solid wastes are shipped to the incineration plant of Madeira.
- The sludge from the local WWTP has high humidity, is putrescible and not suitable for incineration.
- The green residues from gardens also have not a locally profitable use, being sent to incineration.
- The island waste and sludge treatment and disposal are today under the responsibility of a single company.

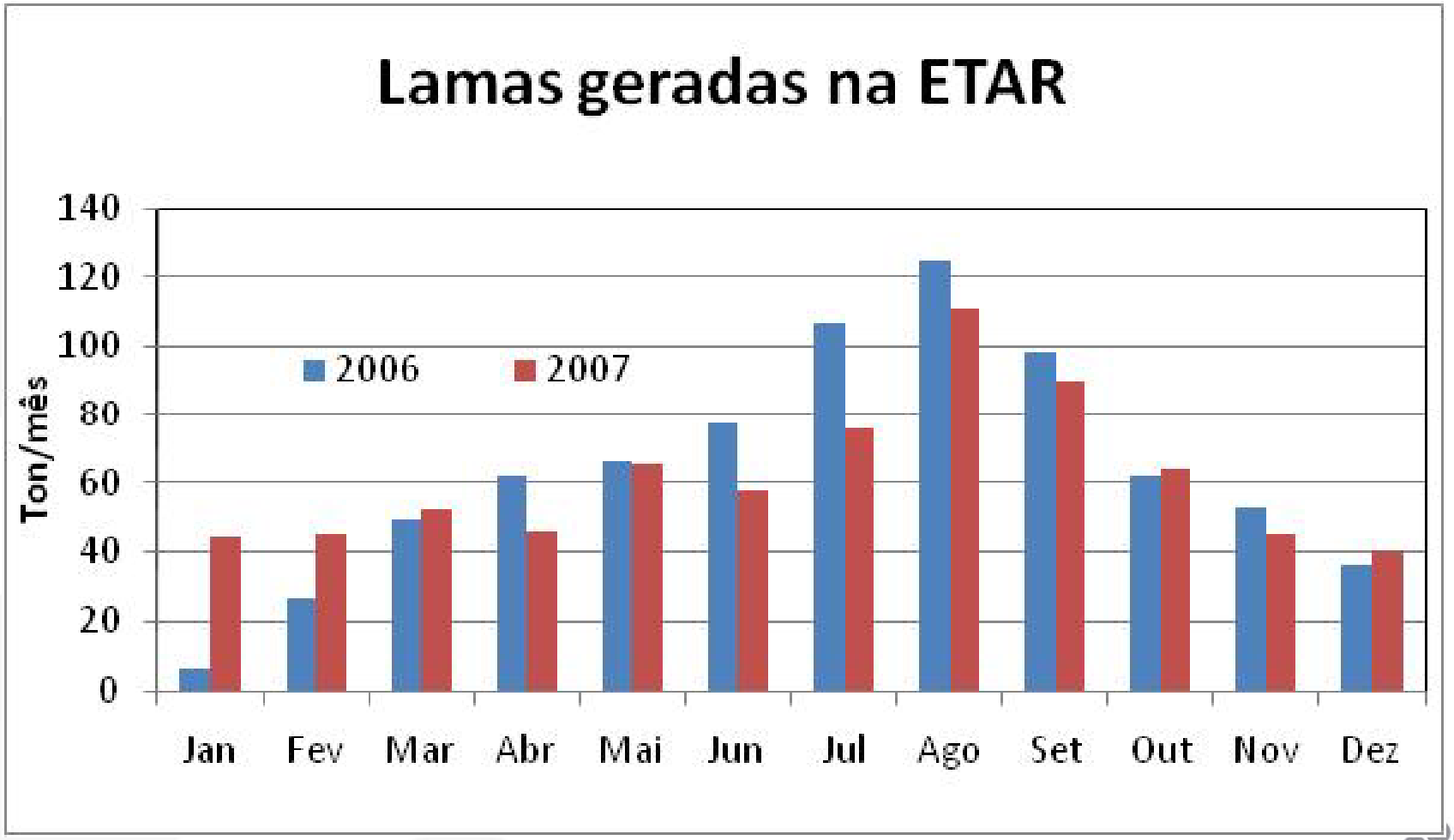

Resíduos Sólidos Urbanos Totais e orgânicos recolhidos em (2007)
Resíduos Indiferenciados
Resíduos-orgânicos
Ton/Mês
600
500
400
300
200
100
0
Jan-07
Fev-07
Mar-07
Abr-07
Mai-07
Jun-07
Jul-07
Ago-07
Set-07
Out-07
Nov-07
Dez-07
Mês

Valorization Flowsheet



Valorization Flowsheet DRY AD




Lamas geradas na ETAR
Ton/mês
140
120
100
80
60
40
20
0
2006
2007
Jan
Fev
Mar
Abr
Mai
Jun
Jul
Ago
Set
Out
Nov
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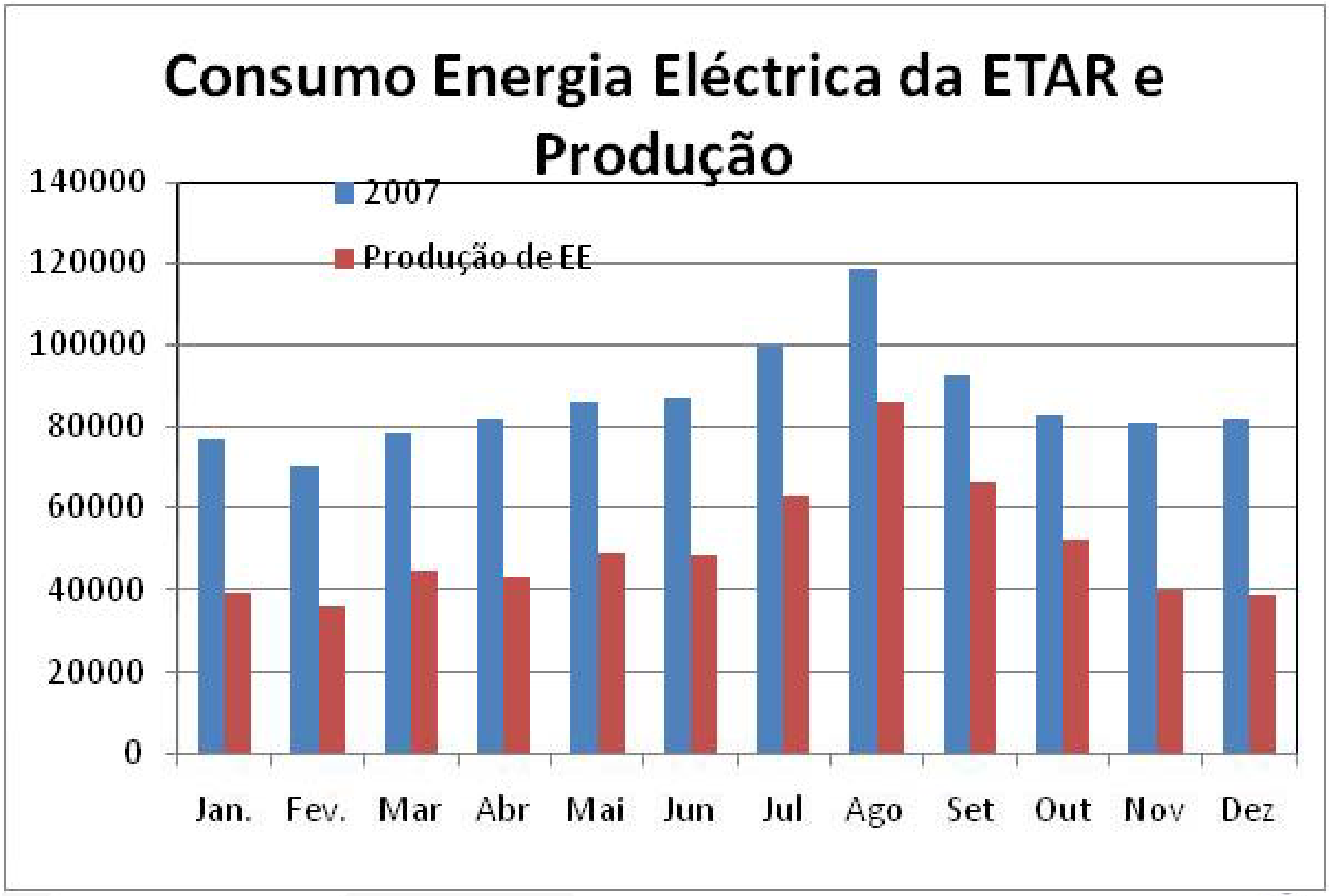
Expected energy production

Energetic Product	Annual production From waste	Annual production from grass energy crop
Biogas (m^3/year)	200 000	400 000
Methane (m^3/year)	130 000	260 000
Electric Energy (MWh)	450	750
Heat (MJ)	2400	5000


Consumo Energia Eléctrica da ETAR e Produção
2007
Produção de EE
140000
120000
100000
80000
60000
40000
20000
0
Jan.
Fev.
Mar
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Mai
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Jul
Ago
Set
Out
Nov
Dez

ELECTRIC ENERGIA

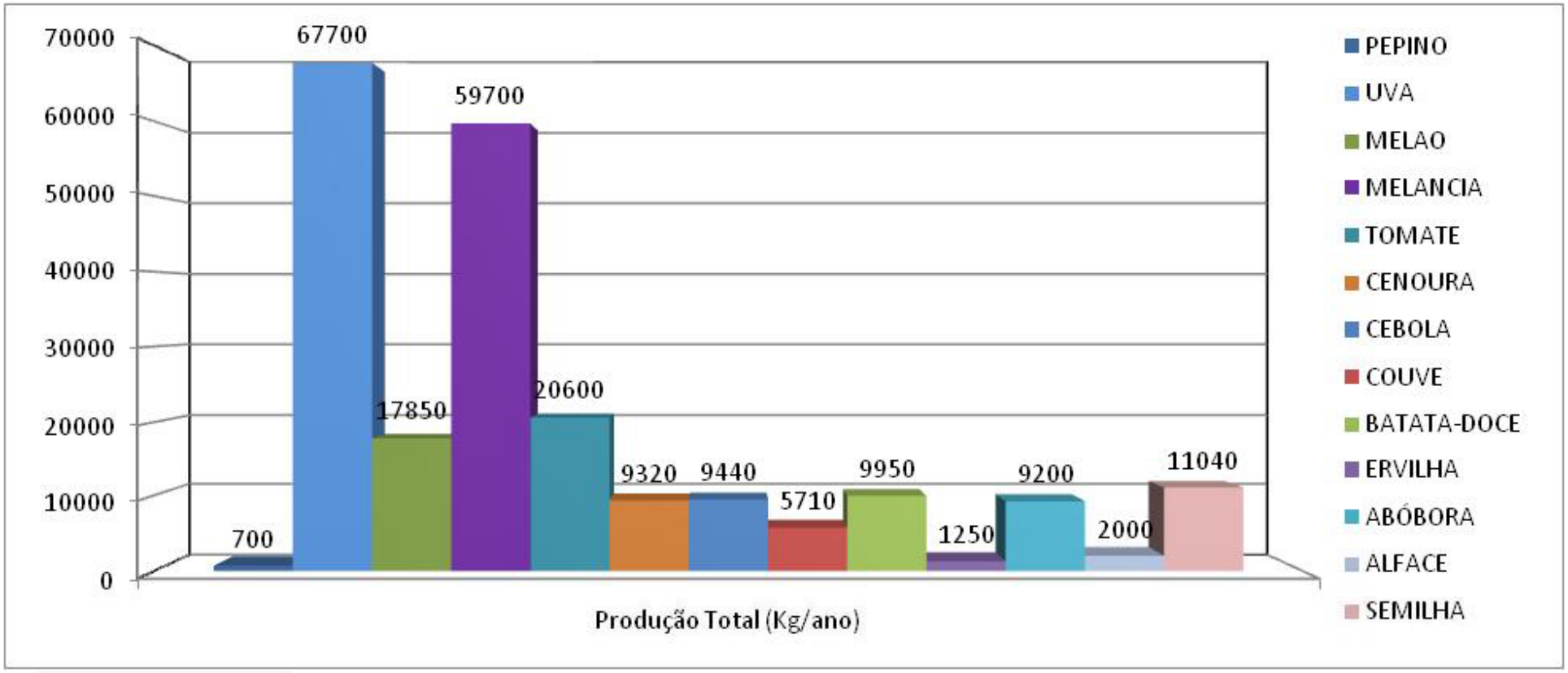
- the plant can satisfy about 1,2 % of electric energy demand of the Porto Santo island,or 3,5 % if energy crop are produced and used.
- The biogas can be used in a cogeneration unit for the combined production of electric energy end heat with two motor-generators with 80-150 kW of electric power, connected in peak electric energy demand, in order to contribute to improvement of the island electric energy balance.

Heat uses

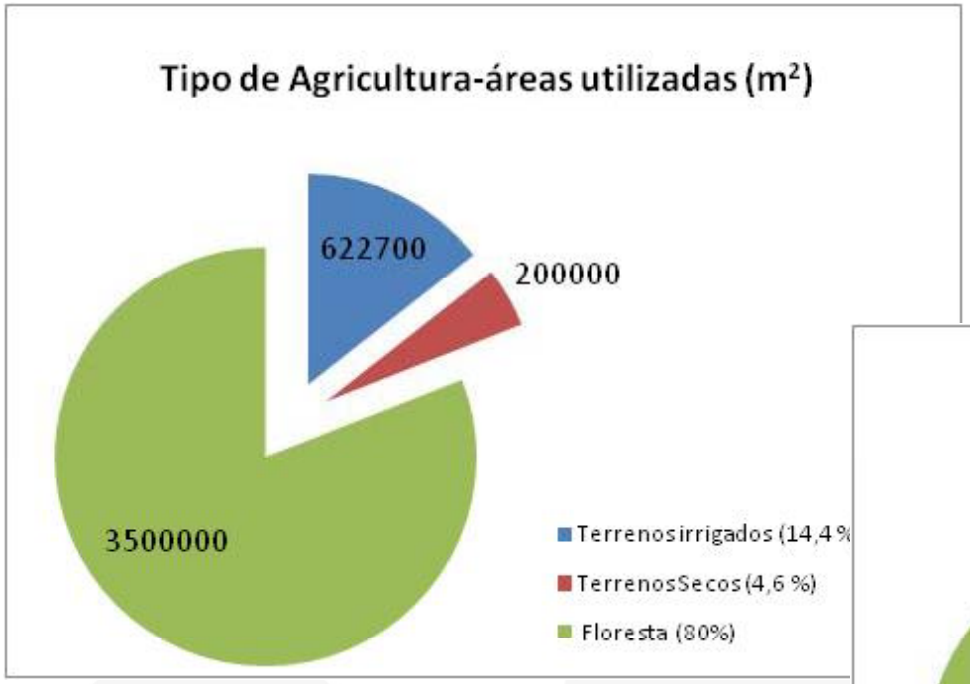
Will depend on the localization of the central biogas plant

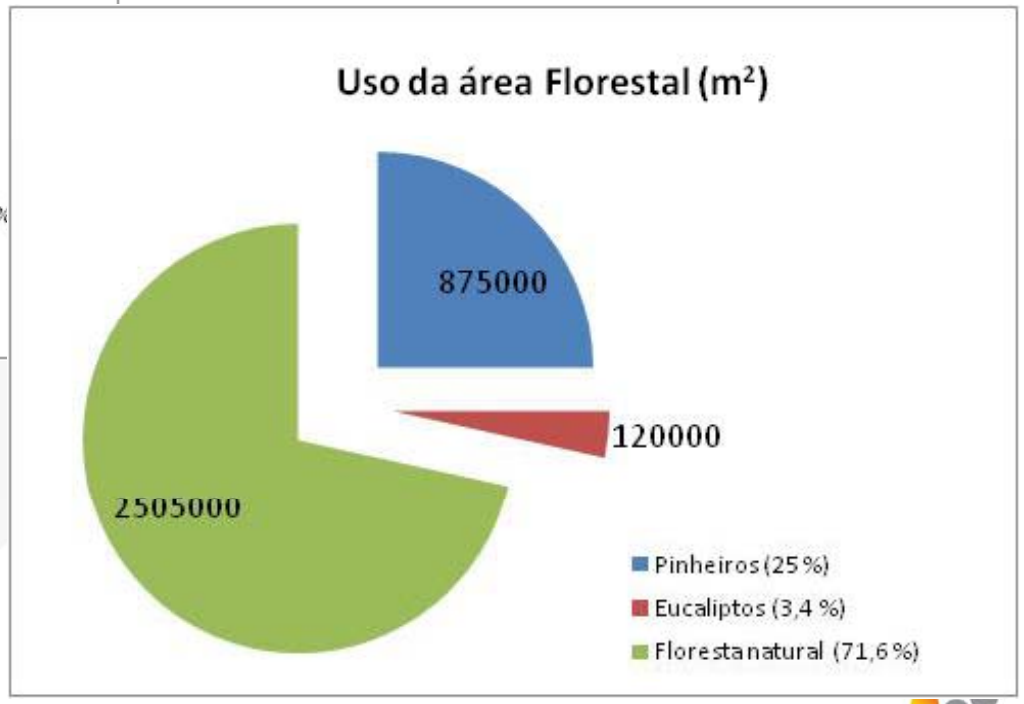
- heating/cooling of hotels,
- houses,
- Heating of swimming pools,
- Heating greenhouses.

Agricultural Production

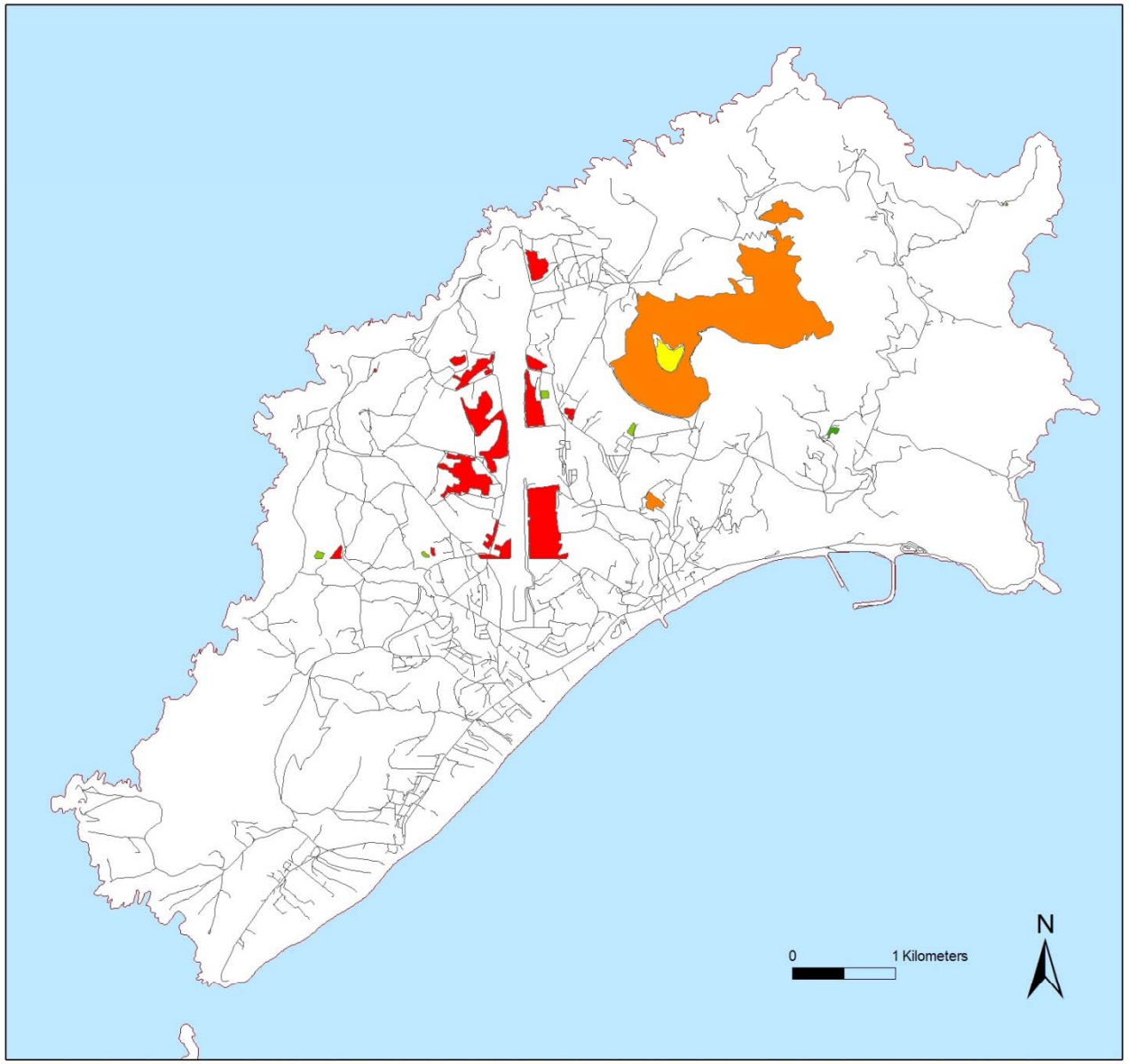


Soil use in Porto Santo





Porto Santo



Tipo de Vegetação	Área (m2)
Arvoredo Denso	2,43899.621600
Arvoredo Esparso	3,1566756.072100
Mato Denso ou Arbustos	1,52258.248400
Pomar	4,18344.638900
Vinha	14,666348.036400

Tipos de Vegetação

- Arvoredo Denso
- Arvoredo Esparso
- Mato Denso ou Arbustos
- Pomar
- Vinha
- Vias_PortoSanto


Porto Santo
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
© 2009 Europa Technologies
Image © 2009 DigitalGlobe
©2009 Google
Imagery Date: Mar 15, 2005
33°03'40.89" N 16°20'30.11" W elev 143 ft
Eye alt 50377 ft

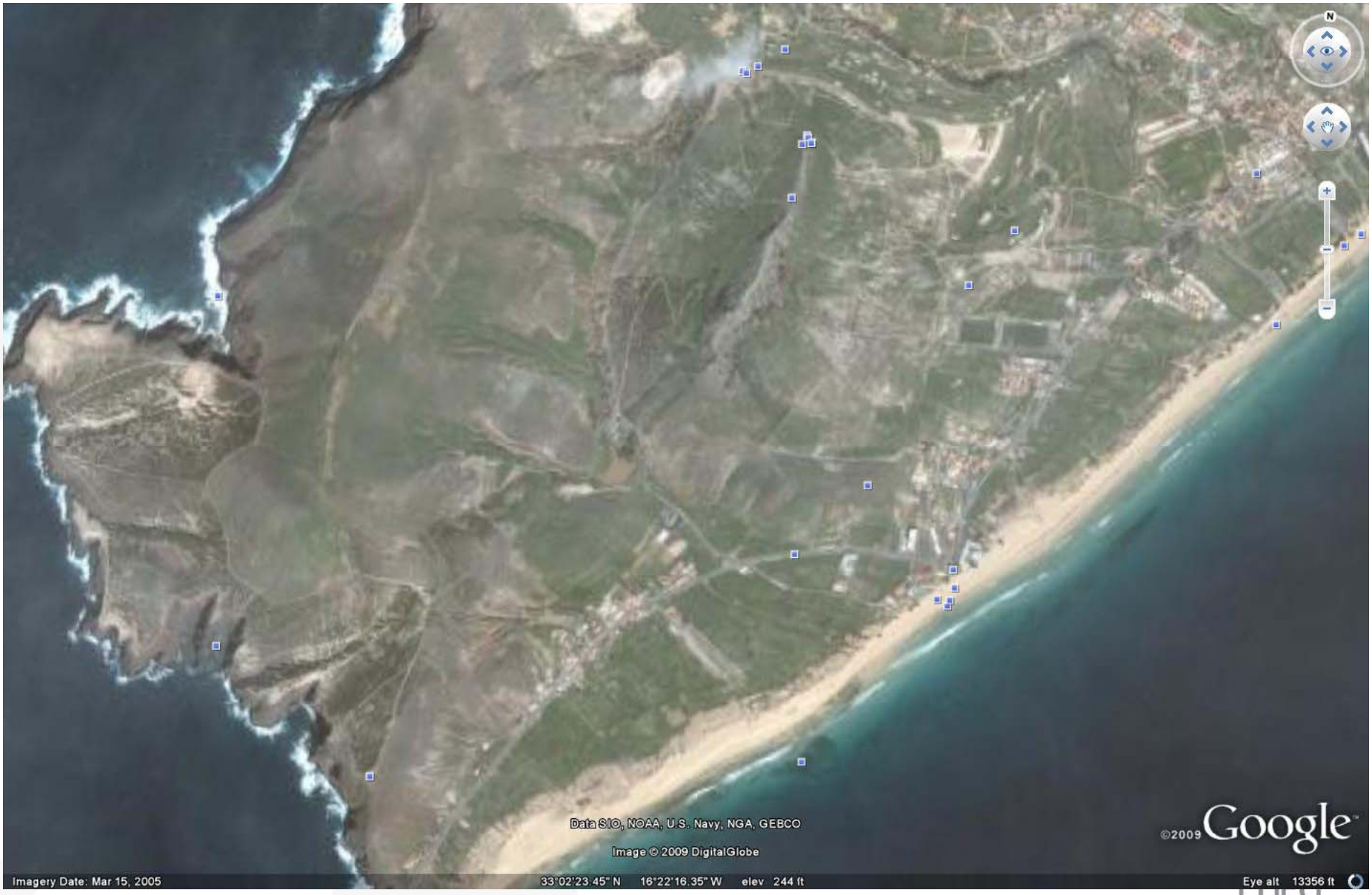

Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image © 2009 DigitalGlobe
©2009 Google
Imagery Date: Mar 15, 2005
33°02'23.45" N 16°22'16.35" W elev 244 ft
Eye alt 13356 ft


Image © 2009 DigitalGlobe
©2009 Google
Imagery Date: Mar 15, 2005
33°04'52.21" N 16°20'55.84" W elev 325 ft
Eye alt 11726 ft

Land area necessary for digestate application

Nutrient contained in the sludge	Annual Production (kg/Year)	Land area necessary for application (hectars)
Nitrogen (N)	21600	270
Phophate (P_2O_5)	3300	130
Potassium (K_2O)	3000	30

O PRODUTO DIGERIDO

- Contém macro, micronutrientes e composto do carbono importantes para a formação do húmus.
- Maior disponibilidade de Azoto para o crescimento das plantas.
- Redução dos cheiros devido á menor concentração de compostos voláteis orgânicos.
- Prevenção da queima das plantas devidas a menor concentração de ácidos.
- Incremento da diversidade biológica do solo e melhoramento da qualidade das forragens.
- Higienização por morte dos agentes infecciosos.
- Supressão de fito patogénicos devido á libertação de antibióticos libertados por microrganismos.
- Incremento da capacidade de retenção da água e nutrientes no solo
- Maior homogeneização e facilidade de uso
- Degradação de compostos infecciosos tais como os pesticidas.

ENVIRONMENTAL BENEFITS

- Reduction of emission of CO_2, NOx, SOx e CH_4 to atmosphere due to substitution of fossil fuel by biogas, for the production of electric energy end heat.
- Attenuation or elimination of smells
- Improvement of the hygienic and sanitary conditions during residue handling and
- Reductions of storage and of the number of trips between islands. .

ENVIRONMENTAL BENEFITS

- Improvement of incineration plant burning performance.
- Reduction of 360 ton/year of land filled cinder from biowaste.
- Resolution of disposal of the sludge from the WWTP.
- Promotion of an improved environmental figure of the Porto Santo Island.

Preliminary economic balance

Product	Income (€/year) Waste treatment	income (€/year) energy Crop
Electric Energy	42 500	85 000
Heat	13 500	27 000
Fertilizers	20 000	-
Reduction of transportation and incineration costs	105 000	-
Total	181 000	112 000

ECONOMIC BENEFITS

- The energetic crop can provide an additional annual income of 112 000 euro, to finance the cultivation of 50 ha of land area for energy crops production.
- The necessary capital to invest is evaluated about 1 million of euro, but avoids investments in additional sludge treatment evaluated about 500 000 €.
- The payback period evaluated in less than 5 years,
- From a macroeconomic pointy of view, the Project will contribute to create added regional value and reduce the use of imported fossil fuels.

SOCIAL BENEFITS

- Implementation of a sustainable system,
  local wastes = renewable endogenous resource
- Increases local employment, encourages the agricultural and territory defence practices.
- Less pollution and more touristic actractivity
- Promotes environmental conscience and awareness.
- contributes to selective collection of Solid wastes
- obtain carbon credits for green energy,
- Is an opportunity to set-up a new and more profitable socio-environmental structure in the Porto Santo Island.

With the colaboration of AREAM

LNEG - Laboratório Nacional de Energia e Geologia, I.P.

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