

**LABORATORY OF HEAT TRANSFER AND  
ENVIRONMENTAL ENGINEERING**

**DEPARTMENT OF MECHANICAL ENGINEERING  
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# **Thermal treatment of waste in Greece**

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**WTERT biannual meeting, 15-16 October 2008 – New York**

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- Introduction on the Hellenic SWM situation.
- Waste management aspects.
- Estimation of waste generation
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- Landfill gas: Capture and energy recovery
- Incineration of medical waste
- Constraints of WtE projects in Greece
- Opportunities and best practices: Biomass
- Conclusions

# Introduction

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## Thermal treatment of waste

Waste to energy:

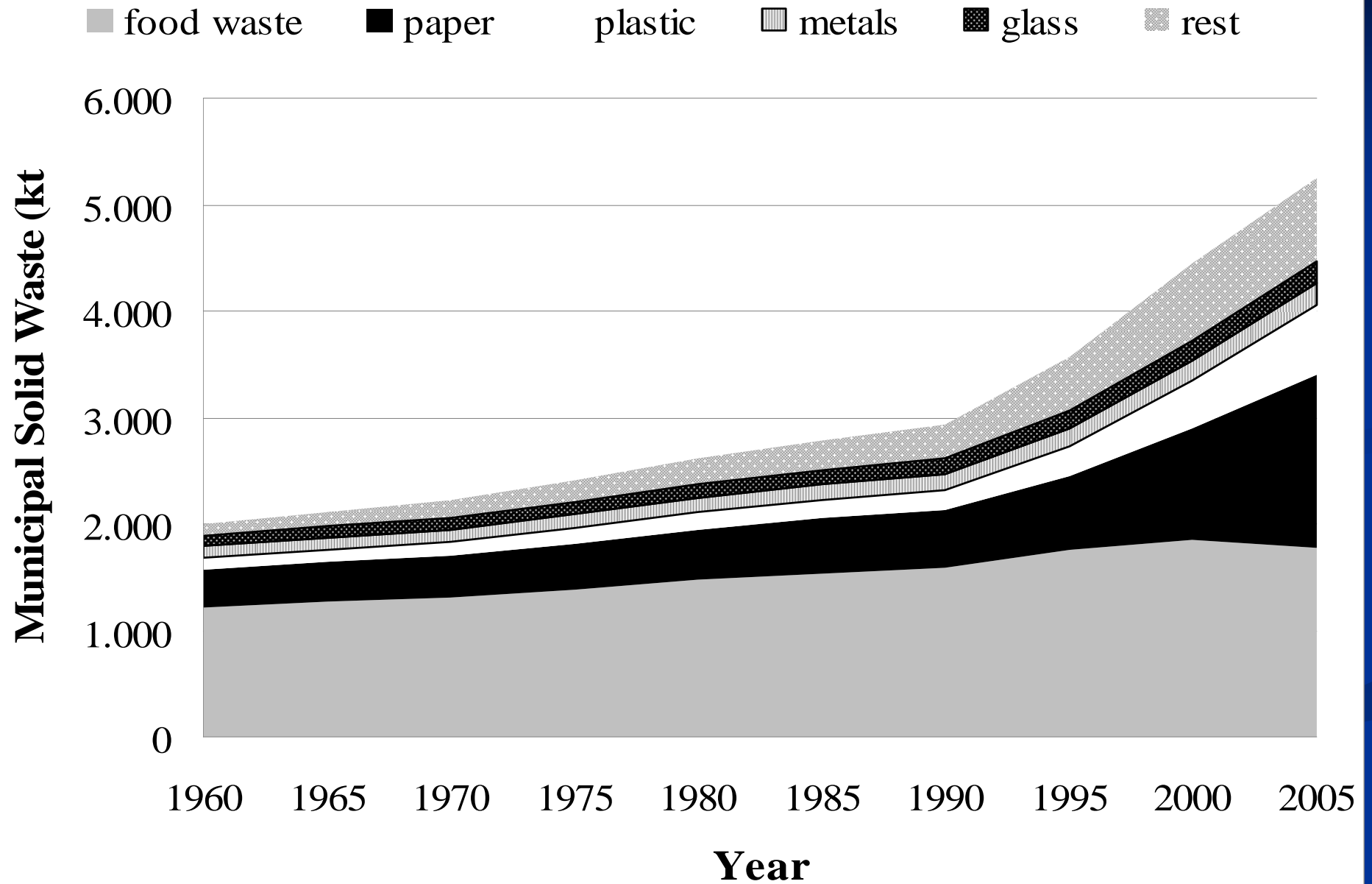
1. Incineration of Municipal solid waste
2. Incineration of RDF

Biogas – landfill gas utilization

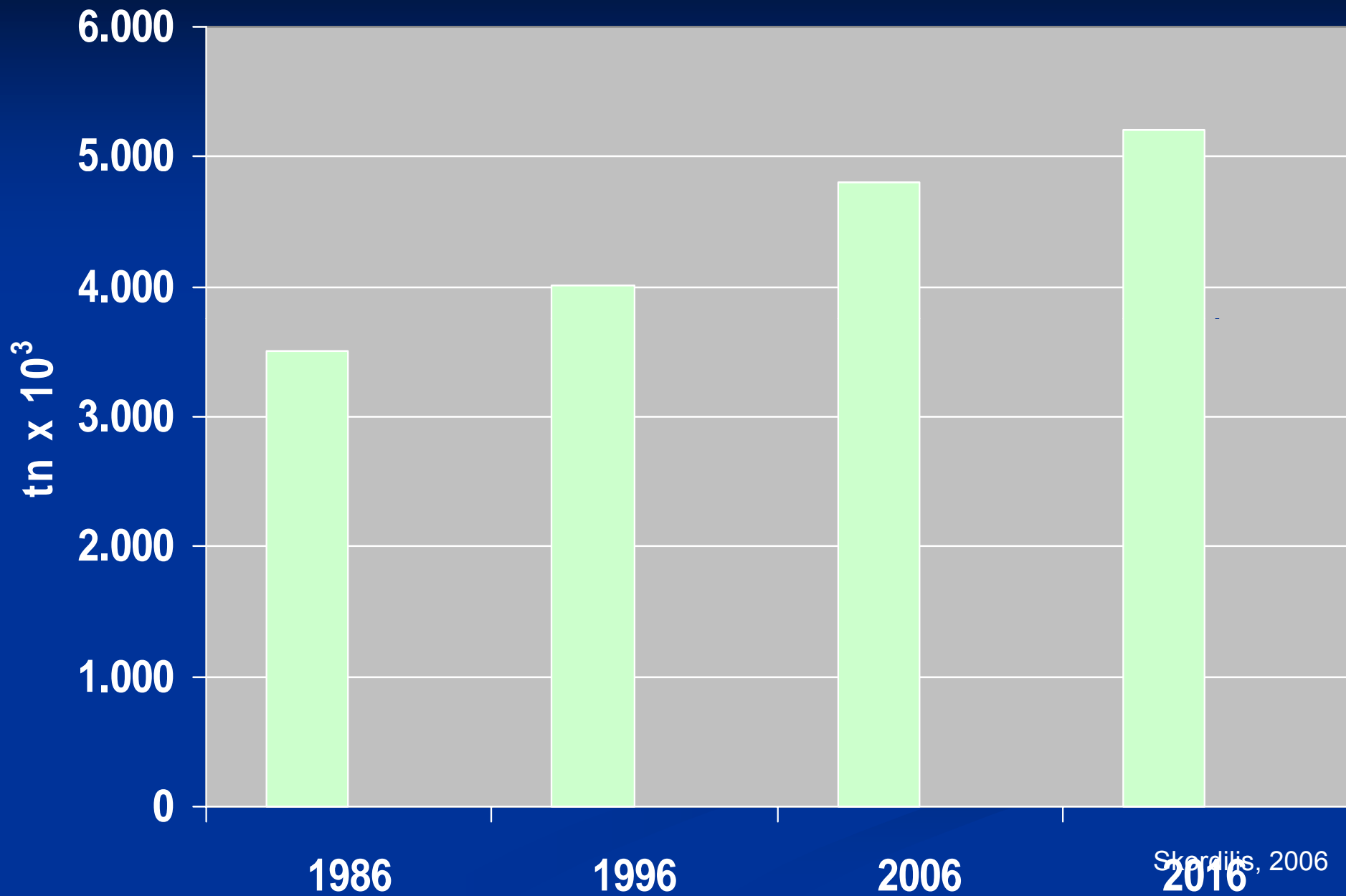


Waste to Energy plant in Vienna  
([en.wikipedia.org](https://en.wikipedia.org))

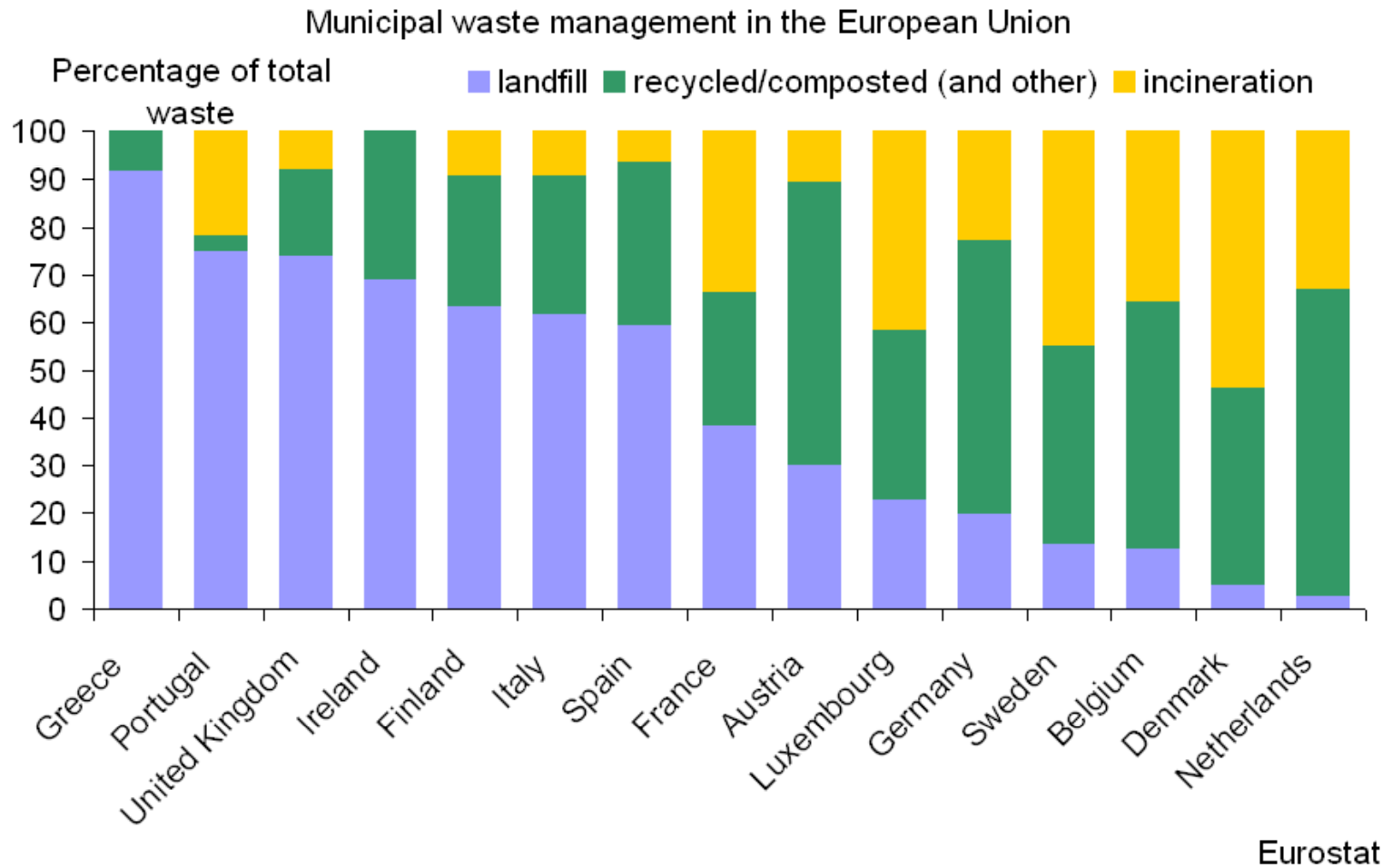
# Estimation of waste production in Greece



# Recent development and trends



# Waste management in Greece



No incineration in Greece

# Example of a WtE plant in Greece for MSW

1983

Small-scale WtE plant to serve Zakynthos

Construction cost: funded  
100% by EEC

Operational cost: Local  
authorities (to undertake...)

MSW at that time: high  
water content, low heat  
value; no business plan!

- Addition of oil (by the bucket!)

- The plant operated just for 3 months!



# Consideration of WtE in Greece

## Mid – 90s – Island of Santorini

Estimated capacity: 15,000 t/year.

- Plant was to operate 6-7 months/y;
- for the remaining months: balling of waste.
- Plant was not constructed due to (allegedly):
  - > High operational cost,
  - > Political myopism; institutional missing capacity
  - > Limited experience on such projects



# Consideration of WtE in Greece – Construction cost of WtE plants in Europe

Location	Year	Capacity (t/year)	Construction cost (million €)	Construction cost (€/t)
Kempton, Germany	1996	78.000	82	1.051
Pirmasens, Germany	1998	155.500	189	1.215
Hamburg R. Damm, Germany	1999	225.000	140	622
Niklasdorf, Austria	2003	100.000	55	550
Freiburg, Germany	2005	150.000	77	513
Zorbau, Germany	2005	300.000	100	333
Antwerpen, Belgium	2005	400.000	180	450
Ringaskiddy, Ireland	2007	100.000	75	750
Garranstown, Ireland	2007	150.000	85	567
Halle, Germany	2007	80.000	47	588
Amsterdam, Holland	2006	500.000	340	680
Posieux, Switzerland	2006	45.000	20	444
Roosendaal, Holland	2007	180.000	90	500
Urvier, Switzerland	2007	60.000	30	500
Barzenheit, Switzerland	2008	40.000	30	750

(Psomas, 2005)

# Consideration of WtE in Greece – Operational cost of WtE plants in Europe

Country	Incineration cost €/t	Cost of treatment of ash
Austria	97-332	Bottom ash 63 €/t, Treatment of residues 363 €/t.
Belgium	62-83	-
Great Britain	65-86	Fly ash 100 €/t.
France	67-129	13-18 €/t.
Germany	65-250	Bottom ash 28 €/t, Treatment of residues 256 €/t.
Denmark	43	Bottom ash and treatment of residues 34 €/t.
Switzerland	21-53	-
Ireland	46	-
Spain	34-56	-
Italy	41,3-93	Bottom ash 75 €/t, Fly ash and treatment of residues 129 €/t.
Luxemburg	97	Bottom ash 16 €/t, Treatment of residues 8 €/t.
Holland	71-110	-

(Psomas, 2005)

In comparison: Landfilling in Greece is still in some areas charged (but not really costs, of course):  
5 – 20 €/t !

# Waste derived fuel - Terminology

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RDF (Refuse Derived Fuel)

REF (Recovered Fuel)

PPF (Paper and Plastic Fraction)

PEF (Processed Engineered Fuel)

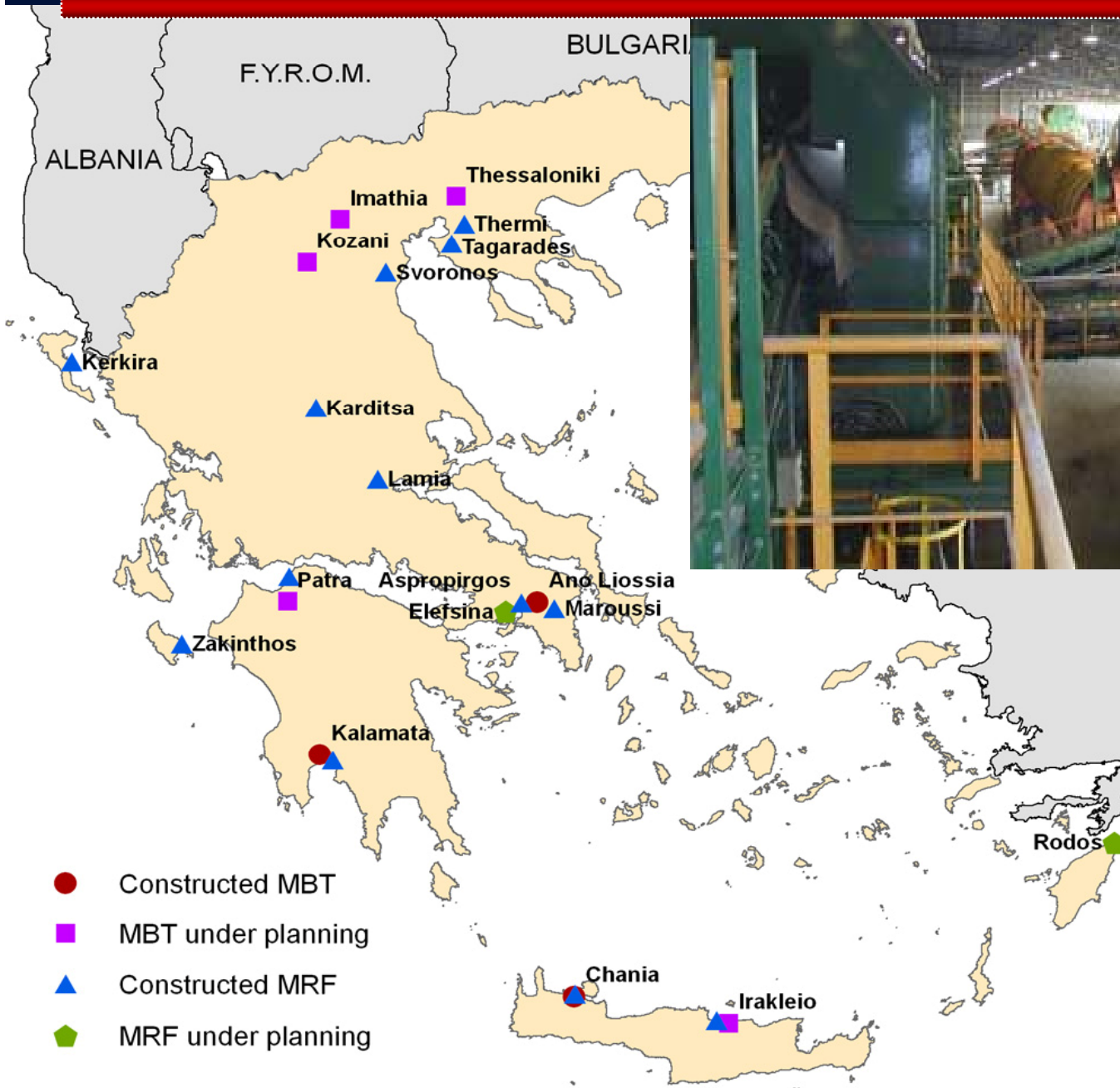
TDF (Tire Derived Fuel)

PDF (Packaging Derived Fuel)

SRF (Solid Recovered Fuel)

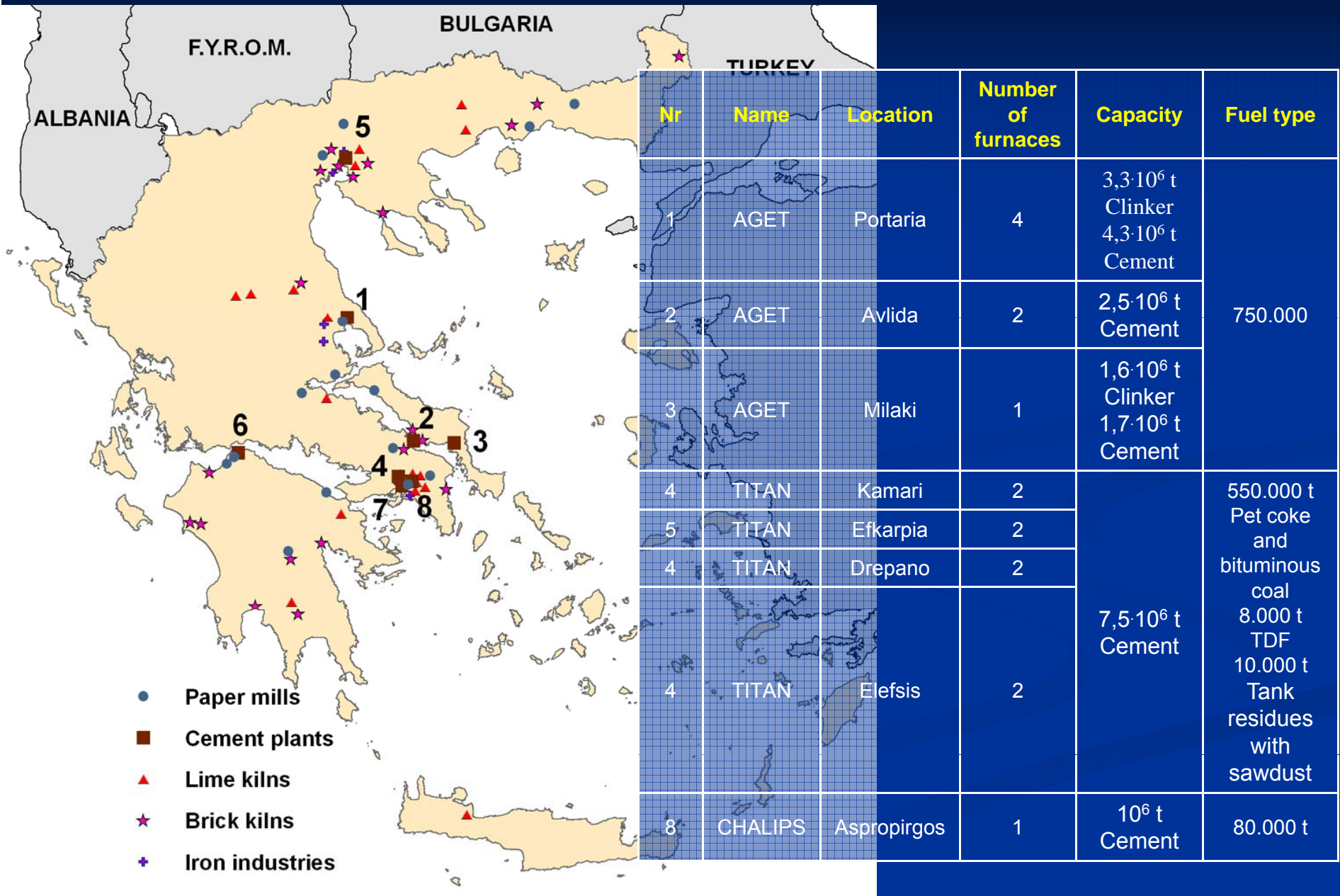
*RDF Pellets*

# RDF Production in Greece (existing, foreseen, potential)

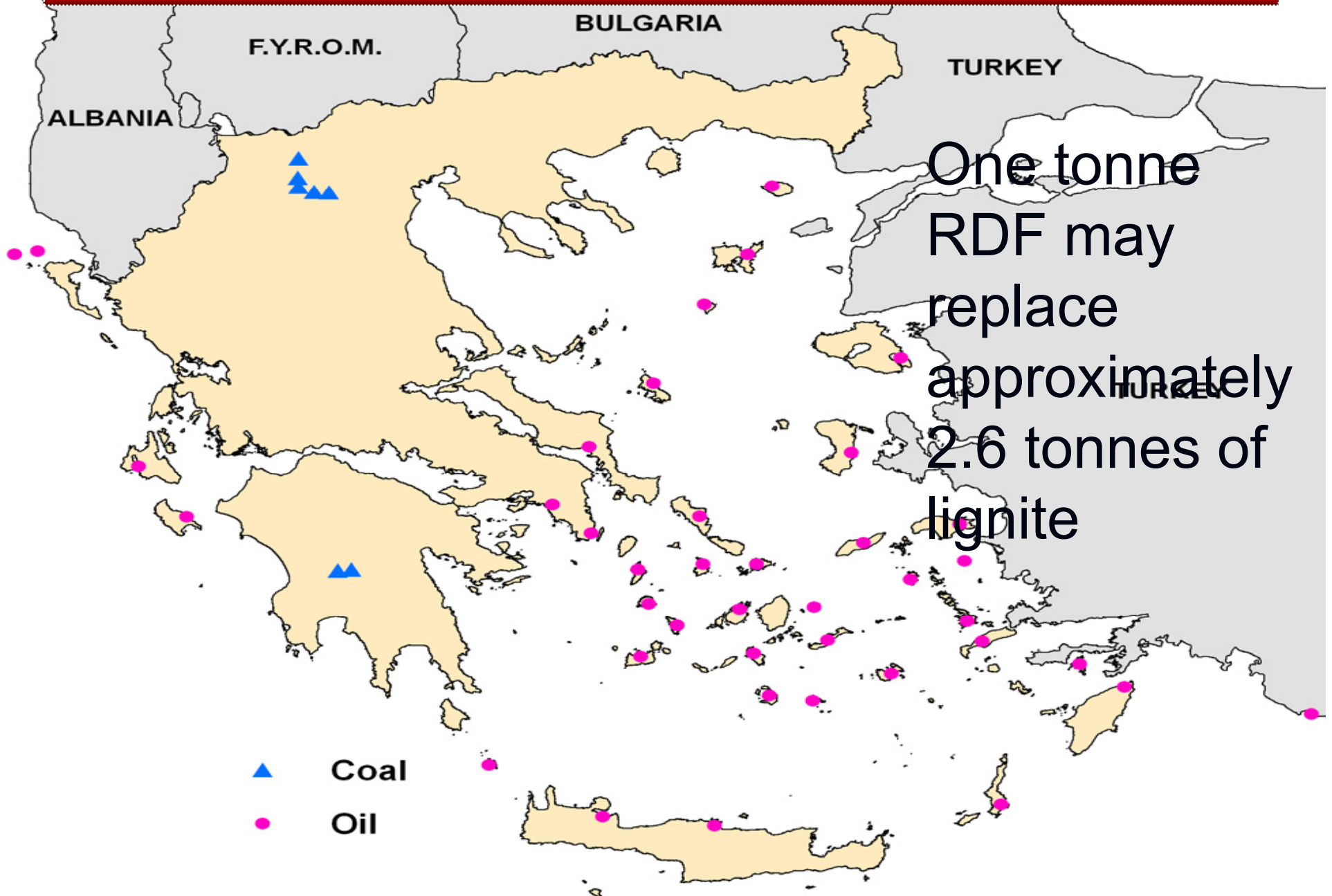


MBT at Ano Liossia:  
*RDF*  
*capacity:*  
*350 t/day*

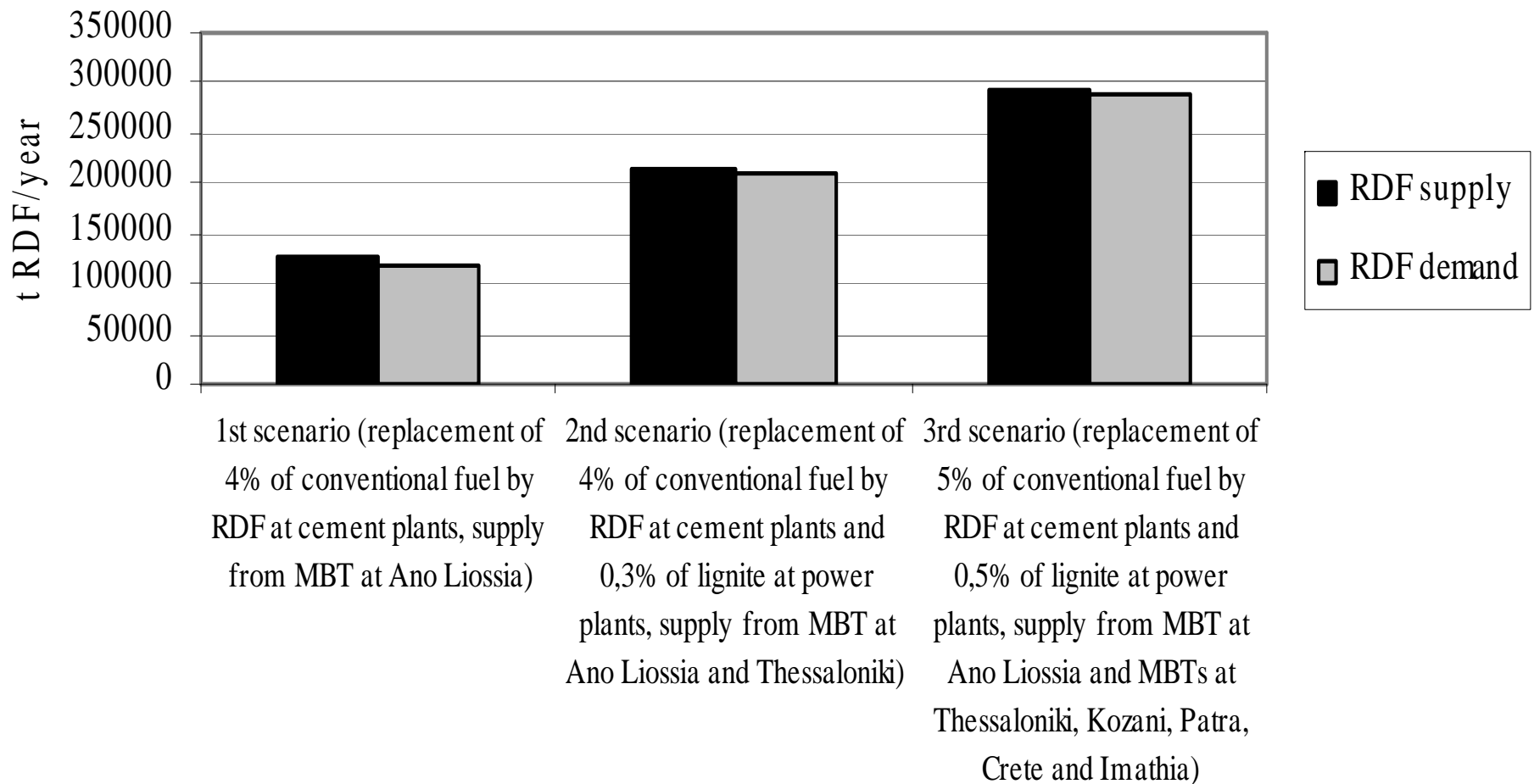
# Location of potential RDF consumers in Greece



# Power plants in Greece

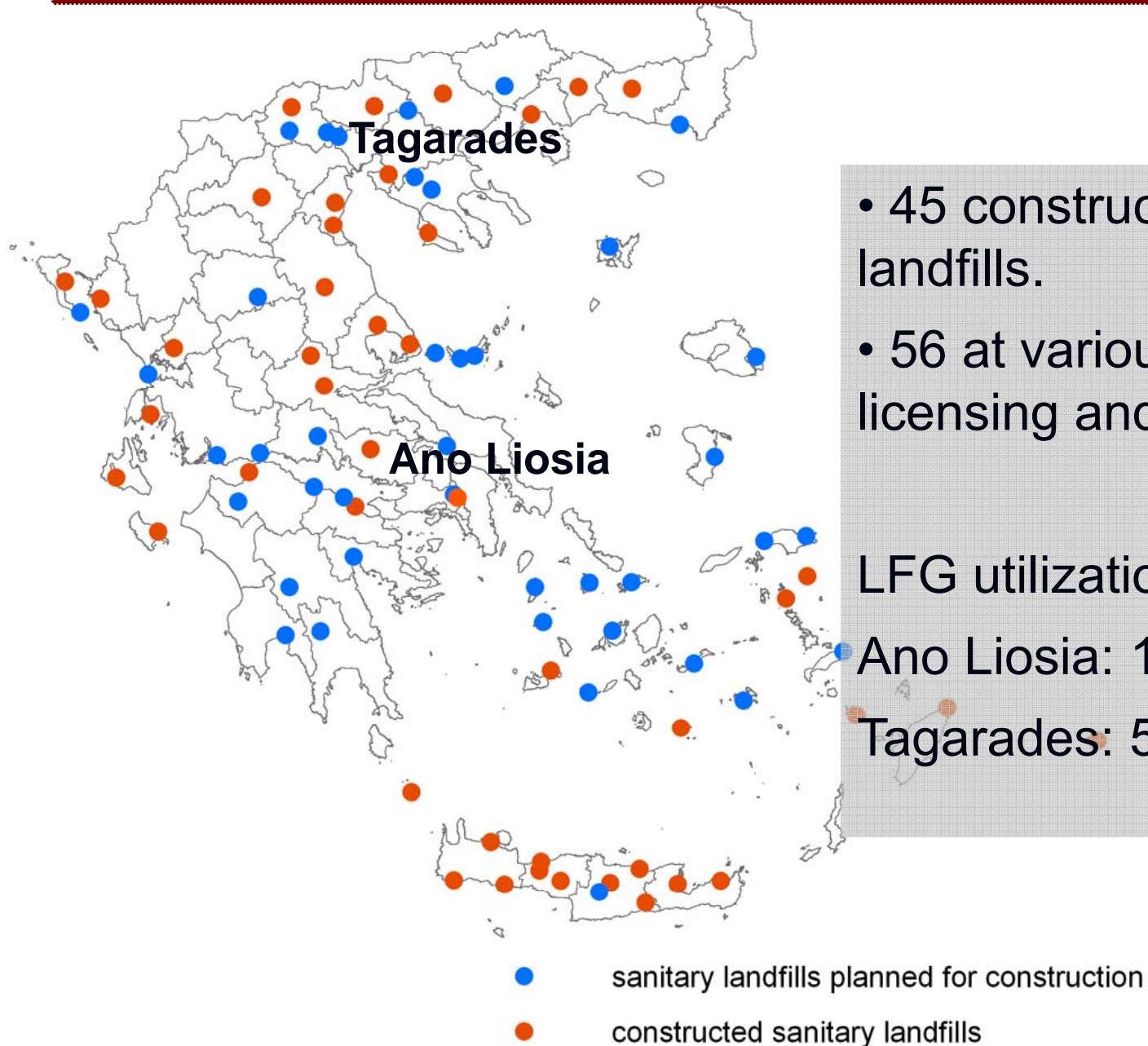


# RDF supply-demand scenarios



Key parameters: Logistics, quality, social acceptance, mono-/oligo-polistic market situations, cost transparency

# Landfill gas utilization



- 45 constructed sanitary landfills.
- 56 at various stages of licensing and construction.

LFG utilization:

Ano Liosia: 13.9 MW<sub>e</sub>.

Tagarades: 5MW<sub>e</sub>.

# Landfill gas utilization



Ano Liossia  
(Grossraum  
Athen):  
13.9 MW<sub>e</sub>

Tagarades  
(Grossraum  
Thessaloniki):  
5 MW<sub>e</sub>



# Sanitary landfill at Ano Liosia

- Largest disposal site in Greece (probably among the 3 largest in the EU). Continuous extensions.
- Surface: 870,000 m<sup>2</sup>.
- Period of operation: 35 years (1973 – 2008) already, up to...?



# Ano Liossia biogas plant (landfill)





# Psittaleia biogas plant (WWTP)



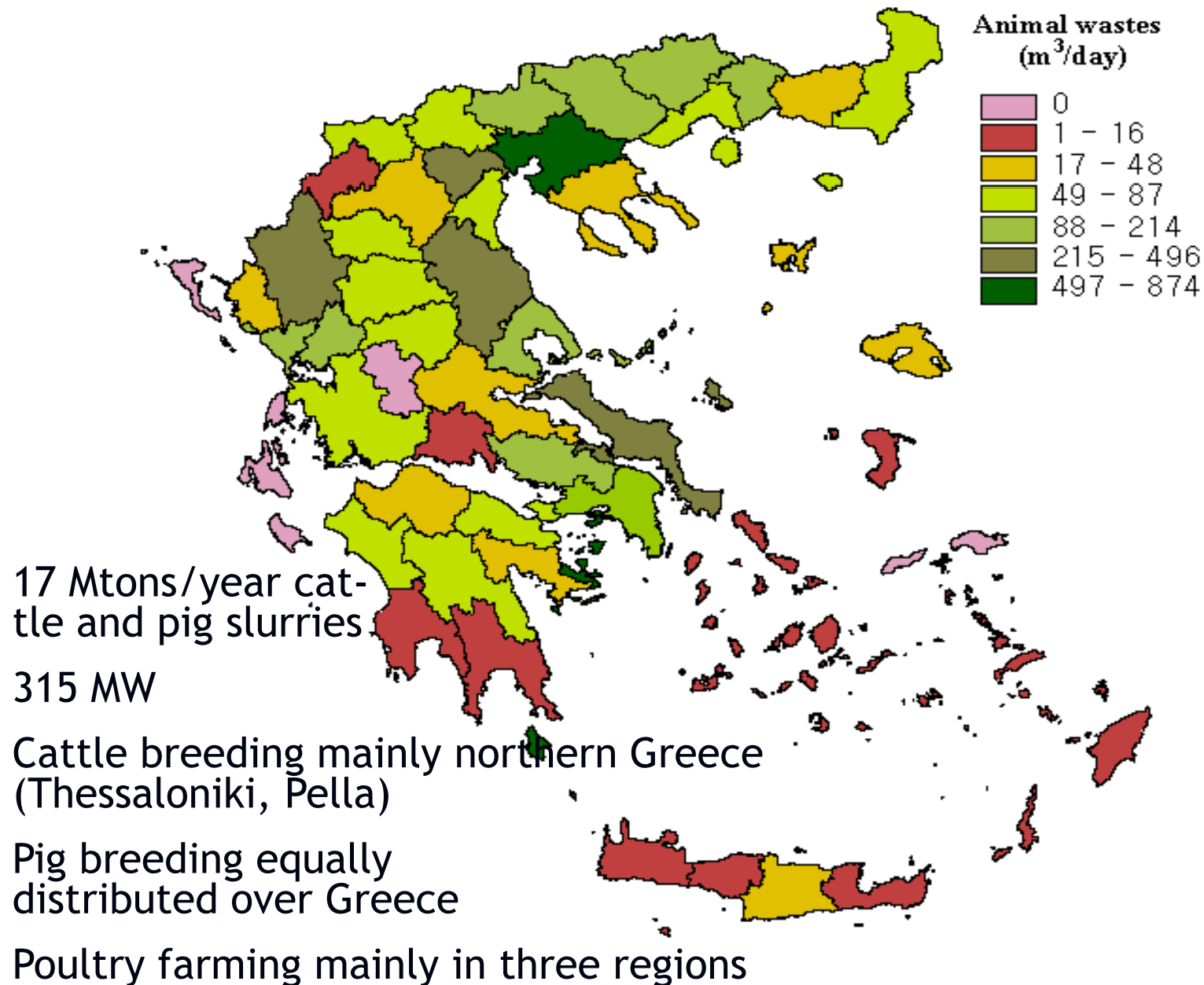
Quelle: ΕΥΔΑΠ



# *National energy potential from animal farming...*

Quellen	Einheiten	Kapazitaeten	Abfaelle t/year	Leistung (MW)
Cattle farms	32.875	727.040 cattle	14.540.800	278
Big farms	36.593	140.645 pig-'mothers'	2.268.220	37
Slaughterhouses	101	77.242 t/year (cat 2) 127.690 t/year (cat 3)	204.932	28
Cheese producers	548	160.362,4 τ/y for 447.705,2 τ/y production	425.647	7,21
	<b>Total</b>		<b>17.439.599</b>	<b>350,21</b>

# Animal waste potential (source: CRES)



# Medical waste incineration in Athens



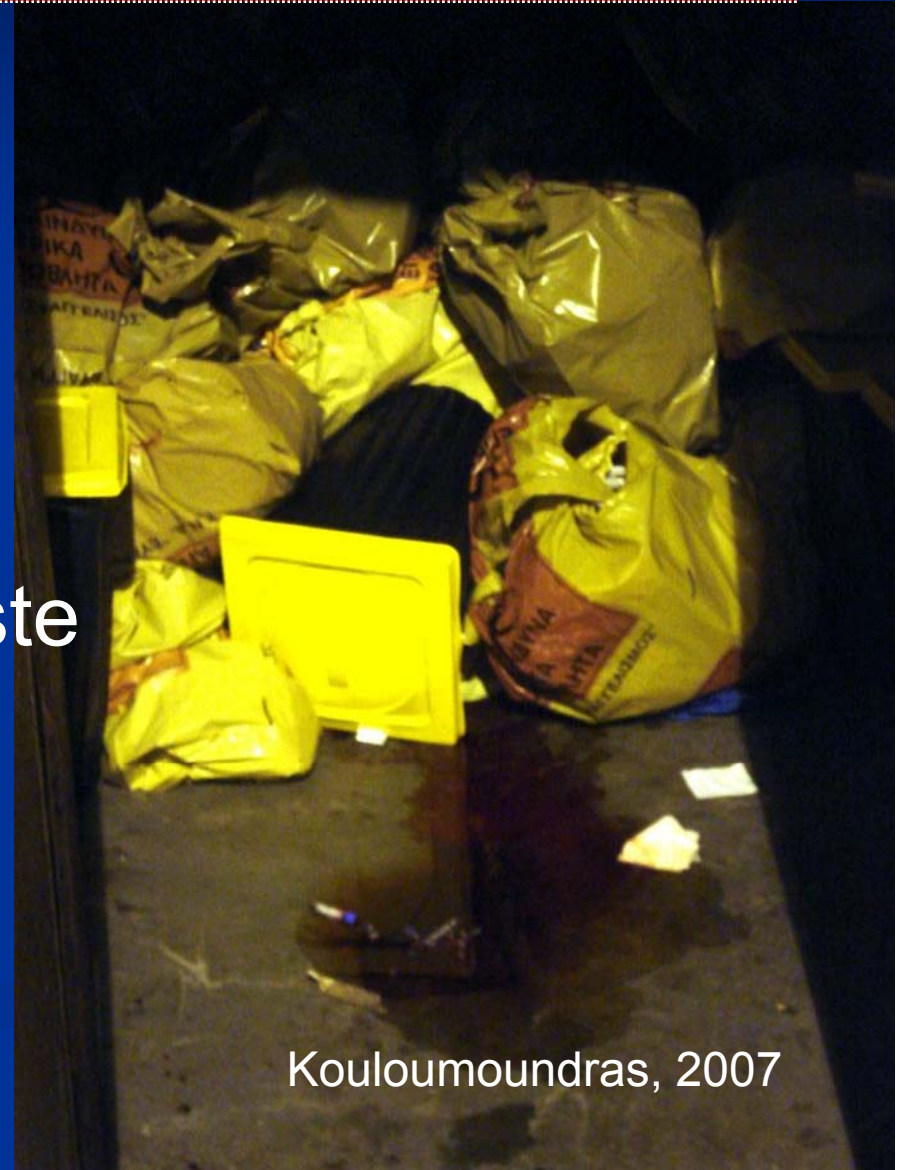
Incineration of medical waste: 3,500 t/year

Production of medical waste in Attiki: 7,000 t/year

Rest: Hydroclave (as well as in rest of country)

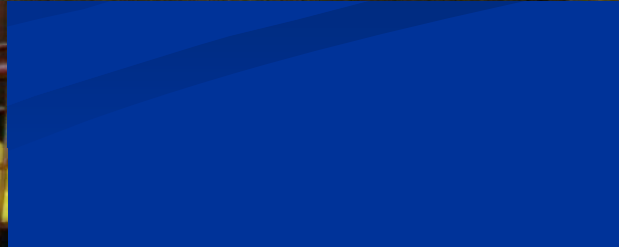
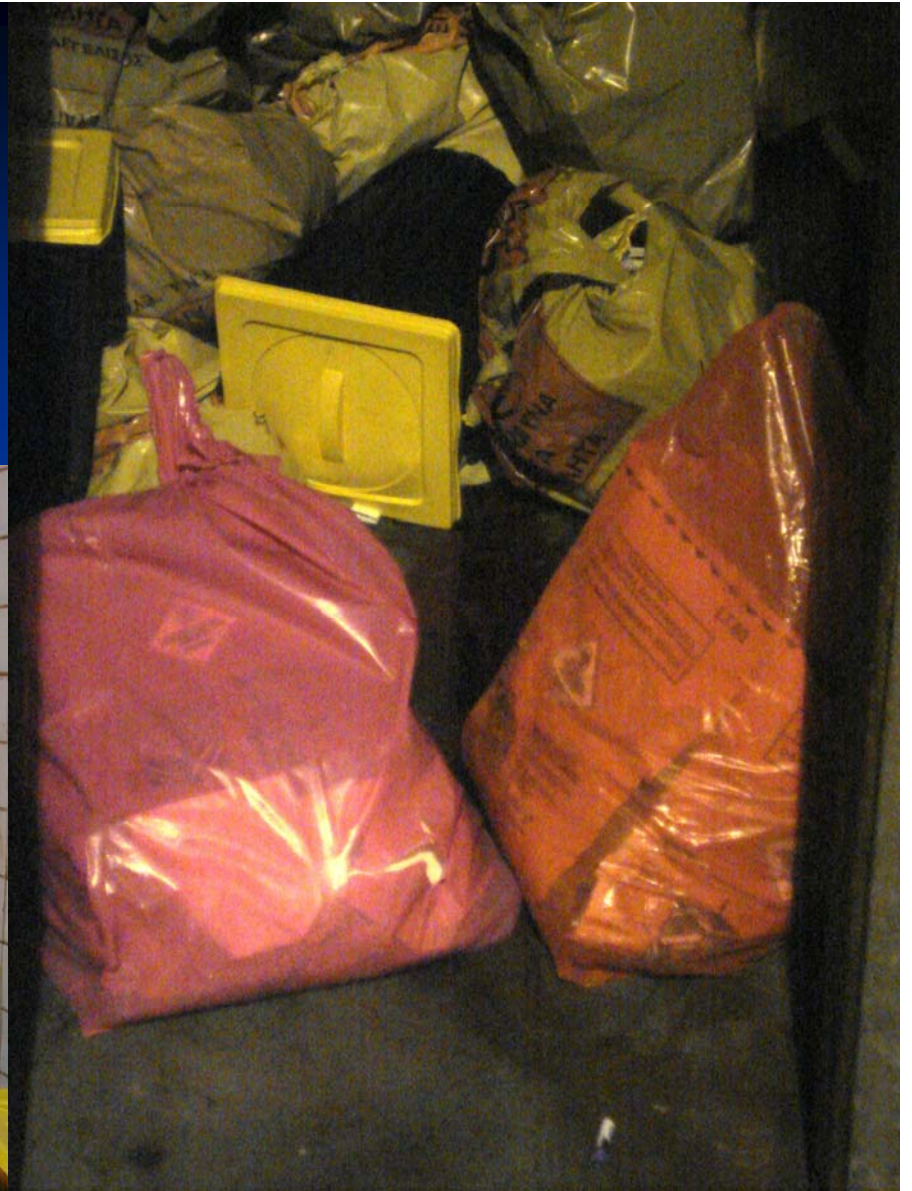
# Incineration of medical waste in Attiki: problems in collection and transportation

- Sharp items in bags.
- Leakages.
- Radioactive materials.
- Excessive weight of waste in packages.
- Inappropriate temporary storage rooms



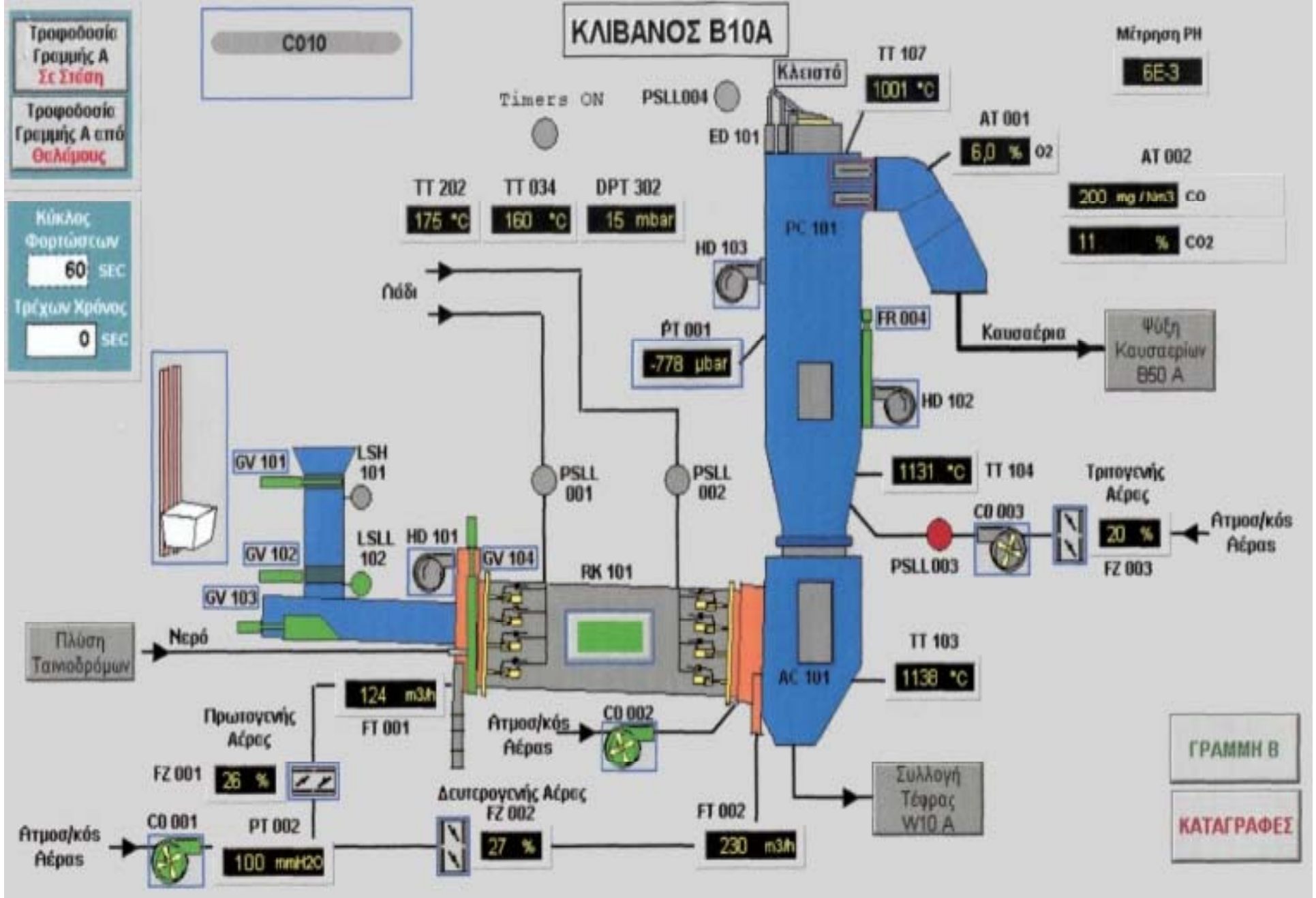
Kouloumoundras, 2007

# Collection and transportation issues





# Kiln operation



# Barriers of Waste to Energy projects in Greece (1/2)

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- History barrier.
- Political barrier.
- The landfill dependence and cost barrier.
- A new WtE lobby...



MBT at Ano Liossia  
(Skordilis, 2006)

# Barriers of Waste to Energy projects in Greece (2/2)

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- The Waste Management Authorities barrier.
- The RDF market barrier (quality, demand).
- The national legislation and public administration barrier.

RDF at Ano Liossia  
(Skordilis, 2006)



## Conclusions (1/4)

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- Currently landfilling is unfortunately still the prevailing waste management option in Greece.
- Therefore, LFG-to-energy projects are of interest (also in a rising local LFG management market) and partly already implemented.
- Beside LFG, engineered thermal treatment is applied only on medical wastes and (also for energy recovery) certain types of biomass.

## Conclusions (2/4)

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There are various reasons (or, rather, excuses, of also varying significance and technical seriousness) which still hinder the construction and operation of mass-burn WtE facilities. Most 'important' ones:

- High construction and (mainly) operational costs (in comparison to still very cheap landfilling and absence of strict PPP and PAYT schemes).
- Disamenity / mistrust of general public (historic / cultural...).
- Perception of (less) environmental impacts (fading excuse) and (more) technical failures (floating excuse, no matter what the guarantees...also from academics and NGOs).
- Negative experience of a (old, over 20 years ago...) badly planned WtE project in Zakynthos (fading excuse).

## Conclusions (3/4)

- Compared to MSW, RDF/SRF is currently promoted by certain actors in Greece as a 'silent WtE substitute' to overcome public opposition.
- Significant numbers (and total capacity) of RDF potential consumers.
- It was thought that fewer barriers were to overcome in comparison to MSW incineration. This seems to change.
- A new MBI area seems to rise on a political and social level (tbc in praxis) both in Greece's mainland and to the islands.
- There is still registered opposition of residents and NGOs against co-combustion of RDF in cement plants.
- Milder paths are implemented also by the cement industry (e.g. biomass) ...

# Conclusions (4/4)

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- Key RDF parameters:
  - Logistics (collection, pretreatment),
  - Quality (standards, market value, certification),
  - Social acceptance (around receivers, not producers) and security of supply,
  - Mono-/oligo-polistic market situations (receivers),
  - Cost transparency (to pay or to be paid?).
- Rising market: Paper industry
- Showcases: >100 SME-scale (mostly agro-) industrial facilities are combusting biomass and organic residues for energy recovery since the 1970's.

## Rice husk WtE plant (industrial area of Thessaloniki).

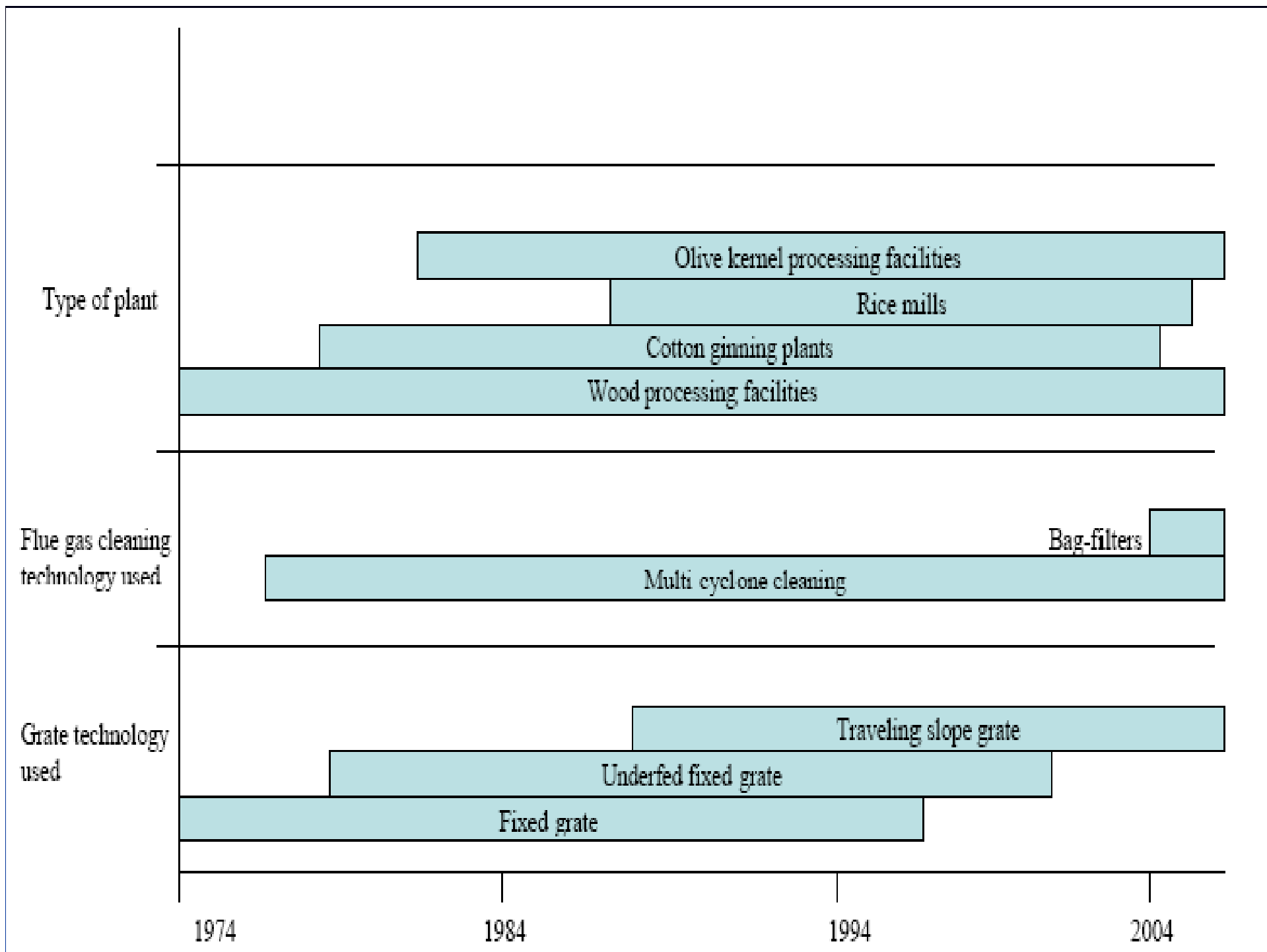


# Waste-wood EfW facility (Akritas co) in Evros



# Waste-wood EfW facility (Shellman co) outside Thessaloniki





# Concluding remarks

- End-of-waste criteria and mentality in the WtE field (renewable energy, additional material recovery)
- Basic milestone: Streamline the permitting procedure (not to reach crisis situations)
- Extensive small-scale and long-term know-how from numerous industrial biomass applications.
- MBI in Greece:
  - Last EU case with no MBI for MSW. For how much longer?
  - A recent public survey in Thessaloniki presented from AUT on 13.10.2008 indicated a significant pro-WtE shift of public opinion in Thessaloniki compared to landfilling.

