



*Scuola Agraria del Parco di Monza*

# Technologies and trends for anaerobic digestion across Europe: a survey

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# Anaerobic Digestion of Municipal Waste

- A biological process which allows the evolution of part of the organic C present in biowaste into a methane rich gas which can be transformed in energy and/or biofuel
- Not less important, it is an option of integration and environmental rationalization of “traditional” organic waste recovery options



# Summary

Analisis of an integrated MSW management approach:

- Technologies distribution in Europe with respect to main process features
- In Italy:
  - State of the art, drivers and limiting factors for the developement of this approach
  - Integration to composting

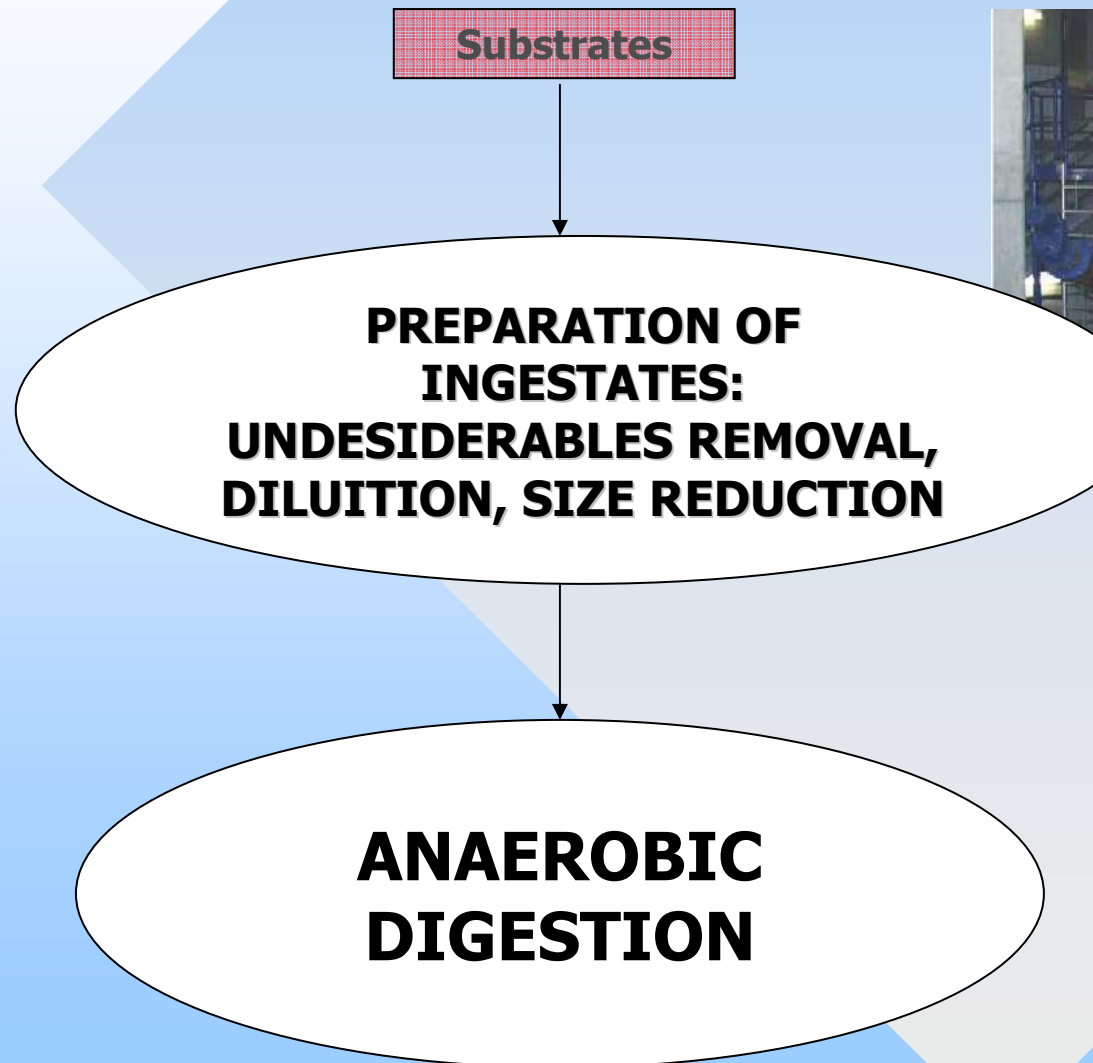


# AD facilities in Europe

- 2008 update of a survey carried out in cooperation with Insubria University
- Only plants operating by the end of 2008
- In particular, facilities:
  - treating at least 3.000 tpa of municipal waste
  - Municipal waste representing at least 10% of the overall throughput

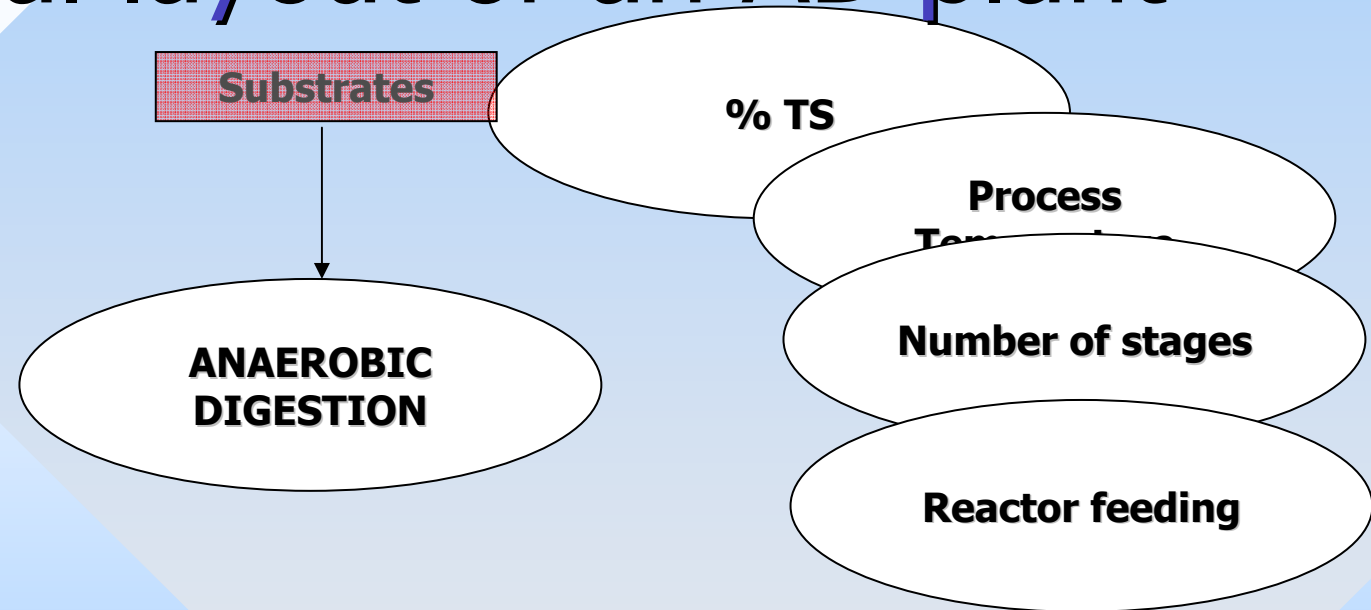


# General layout of an AD plant





# General layout of an AD plant



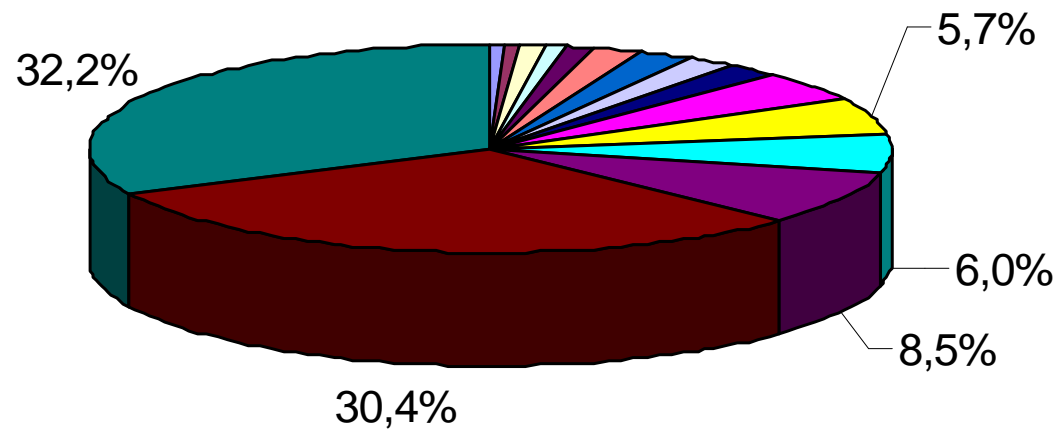


# State of the art of operating facilities in Europe

<b>Number of Countries hosting plants</b>	<b>15</b>
<b>Operating plants complying to selection criteria</b>	<b>167</b>
<b>Plants &lt;3000 tpa or with MSW&lt;10% of the total</b>	<b>13</b>
<b>MSW AD capacity</b>	<b>2.803.500 t/a</b>
<b>OFMSW AD capacity</b>	<b>2.267.700 t/a</b>
<b>OFMSW + other substrates AD capacity</b>	<b>1.968.400 t/a</b>
<b>MSW+OFMSW + other substrates AD capacity</b>	<b>473.400 t/a</b>



# Throughput distribution among EU Countries



- |           |           |        |            |          |
|-----------|-----------|--------|------------|----------|
| Finlandia | Polonia   | UK     | Portogallo | Norvegia |
| Svezia    | Svizzera  | Belgio | Austria    | Olanda   |
| Francia   | Danimarca | Italia | Spagna     | Germania |



# Number of facilities in Europe

<b>Kind of substrate(s)</b>	<b>Operating facilities</b>
<b>OFMSW</b>	<b>70</b>
<b>OFMSW + other</b>	<b>70</b>
<b>MSW</b>	<b>29</b>
<b>MSW + OFMSW</b>	<b>5</b>
<b>MSW + sludge</b>	<b>5</b>
<b>MSW + OFMSW + other</b>	<b>1</b>
<b>TOTAL</b>	<b>180</b>



# Number of facilities in Europe: process Temperature and TS content

	Wet		Semi-Dry		Dry		n.d.		TOT	
	OFMSW	MSW	OFMSW	MSW	OFMSW	MSW	OFMSW	MSW	OFMSW	MSW
Mesophile	<b>37</b>	<b>13</b>	0	0	10	7	0	0	<b>47</b>	<b>20</b>
Meso/Thermo	0	1	0	0	0	0	0	0	0	1
Thermo	16	1	2	0	<b>36</b>	<b>10</b>	2	0	<b>57</b>	<b>11</b>
Meso+Thermo	8	1	0	0	0	0	0	0	8	1
n.a.	24	6	0	0	5	0	0	1	29	7
TOT	85	22	2	0	51	17	2	1	140	40



## Number of facilities in Europe: number of stages

- Bi-phasic plants are a minority:
  - 7% according to De Baere
  - 12% according to Scuola Agraria survey



# Biogas production yield

- Few available data
- High dispersion of recovered data
  - OFMSW, average 67 Nm<sup>3</sup>/t
    - Filtering thermophile plants 79Nm<sup>3</sup>/t
    - Filtering dry plants 86 Nm<sup>3</sup>/ton
  - MSW, average (calculated) 50-80 Nm<sup>3</sup>/t



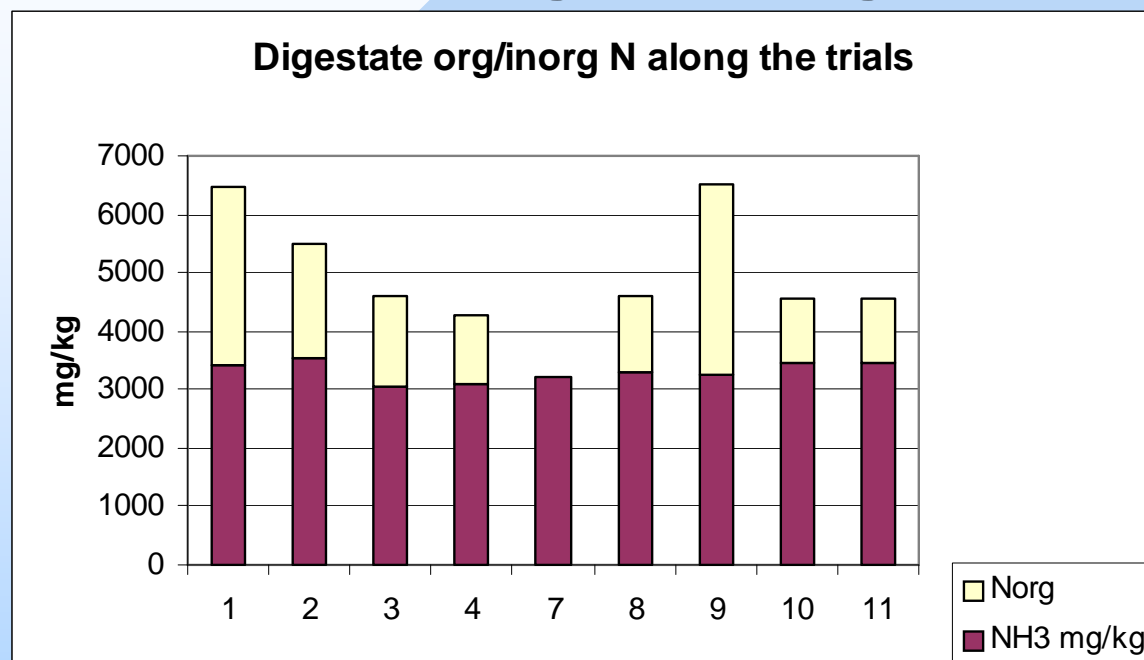
# Regarding digestate

A waste:

- Relatively stable
- High moisture content
- High N-NH<sub>4</sub> content



# Regarding Nitrogen



- D.M. about 5%
- TKN 60-130 g/kg d.m.
- N-NH<sub>4</sub> 30-100 g/kg d.m.

## In compost:

- TKN about 20 g/kg d.m.
- N-NH<sub>4</sub> <4 g/kg d.m.



# Regarding digestate

A waste:

- Relatively stable
- High moisture content
- High N-NH<sub>4</sub> content
- Possibly still microbiologically unsafe

Opportunity for a post-treatment!!!

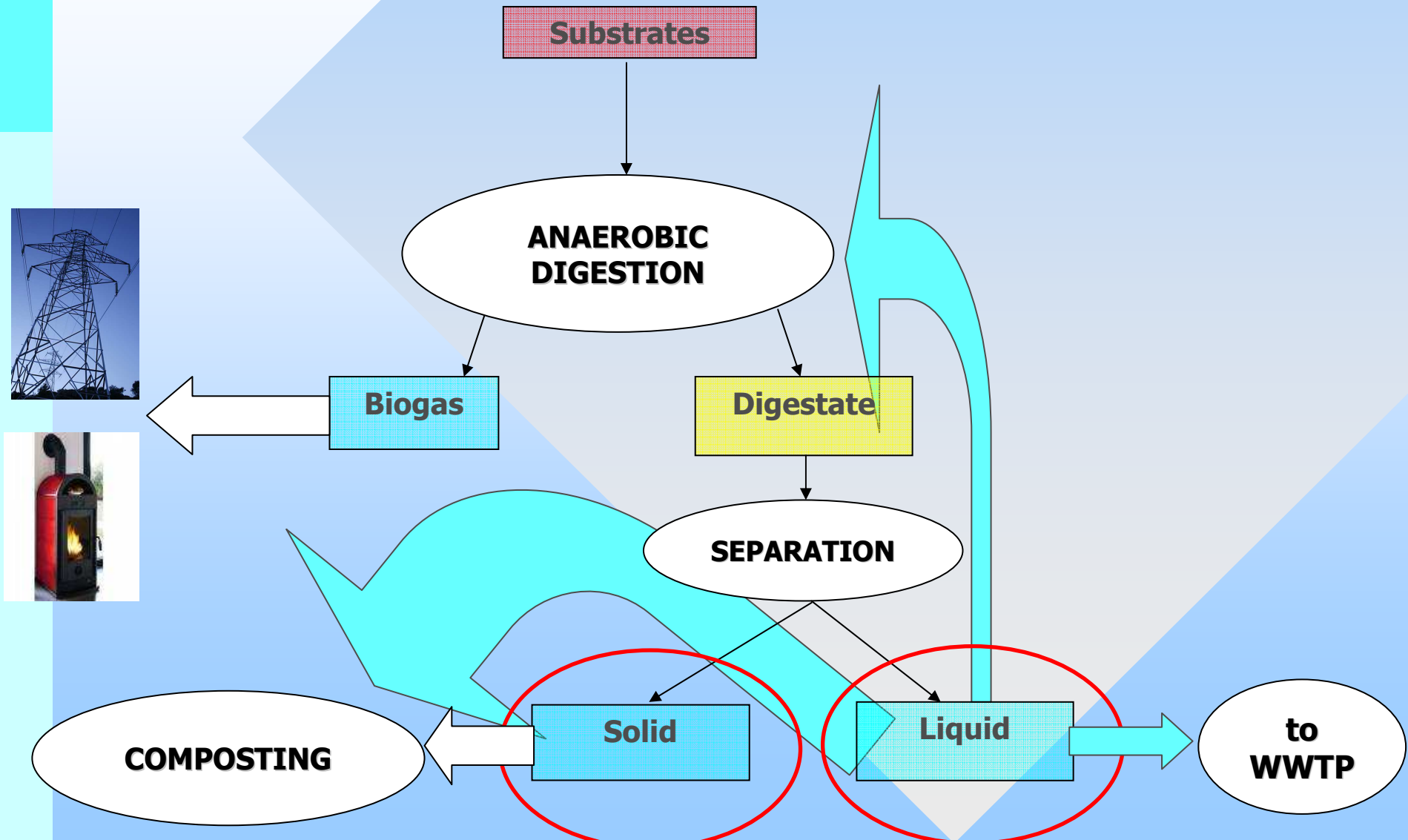


# Possibility and aims of a post-treatment

- Separation of solid and liquid phases with aerobic treatment of solid fraction mixed with bulking material
- Moisture reduction
- N evaporation and organication
- Hygienisation
- (in Italy) turning a waste into a product



# General layout of an AD plant





# Digestate management in european facilities

- Data available for approx. 70 facilities in 14 Countries
- In 63 cases digestate (or its solid fraction) is composted for a variable number of days
- Liquid fraction is treated in a WWTP of used as a liquid fertilizer



# Anaerobic Digestion in Italy

- About ten main plants operating, for roughly 700,000 t OFMSW authorised in 2007 (source ISPRA)





# Anaerobic Digestion in Italy

- several new facilities in course of definition
- waste pre-treatment is a key passage to guarantee digester operativeness in most technologies: progressive conversion of plants fed with MSW (Bassano del Grappa, Cà del Bue, Villacidro, ...): importance of separate collection quality
- Higher biogas yields with respect to other european Countries



## Possible drivers and factors limiting an integrated approach

- Biogenic C transformed in a fuel – extended benefits (renewable energy, economically funded, and amendment)
- Less dependant on bulking material availability (i.e. urban areas)
- Wide choice of layouts and technologies
- lower “footprint” than in composting
- Environmental problems reduction (odours) with respect to composting

On the other hand:

- Capital and unitary management costs generally higher than in composting
- Affected by scale diseconomies
- Waste water management costs can require an integration with solid waste and water treatment plants



# Key numbers

	<b>Composting</b>	<b>Anaerobic digestion</b>
specific surface needed	0,8-1,3 m <sup>2</sup> /tpa	0,4-1 m <sup>2</sup> /tpa
Specific investment (BAT)	200-400 Euro/tpa	450-1000 Euro/tpa



# About plants

- The choice of a proper plant solution must take in account local and specific conditions, such as:
  - Space availability
  - Capital costs
  - Reject management
  - Amount of energy supply funding
  - Opportunity of district heating
  - Availability of bulking material
  - Possible integration with WWTP, disposal and composting plants



# AD integration in existing composting plants

N° of composting plants in Italy	276
Operating plants	220
Plants treating >1.000 tpa	171
Plants able to treat: >5.000 t/a green waste >10.000 t/a OFMSW	100
Biowaste treated	3.180.000 t
1. OFMSW to composting plants	1.271.000 t
2. Green waste to composting plants	1.097.000 t
3. Sludge	498.000 t
4. Other	314.000 t
Estimation of compost produced	1.100.000 t

Elab. Centemero e Zanardi, 2009

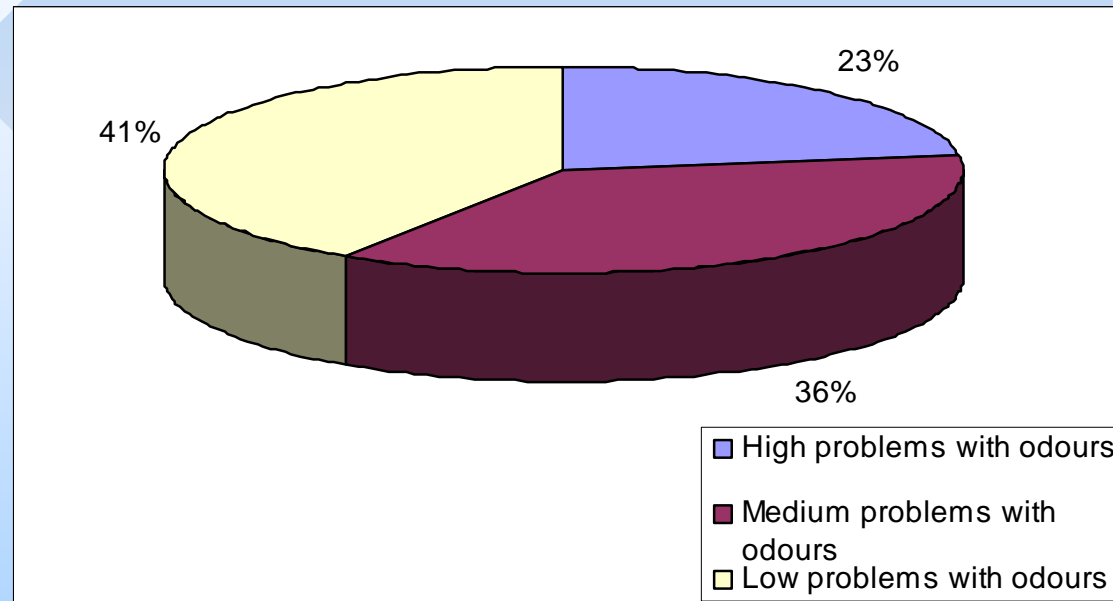


# AD integration in existing composting plants

<b>Contacted plants</b>	
<i>North</i>	12
<i>Center</i>	4
<i>South</i>	6
<b>Kind of plants by substrates treated</b>	
<i>OFMSW</i>	19
<i>Green waste</i>	2 (>20.000 t/a)
<i>Sludge</i>	1
<b>Territorial context</b>	
<i>Rural</i>	17
<i>Industrial</i>	3
<i>Urban</i>	2



# AD integration in existing composting plants

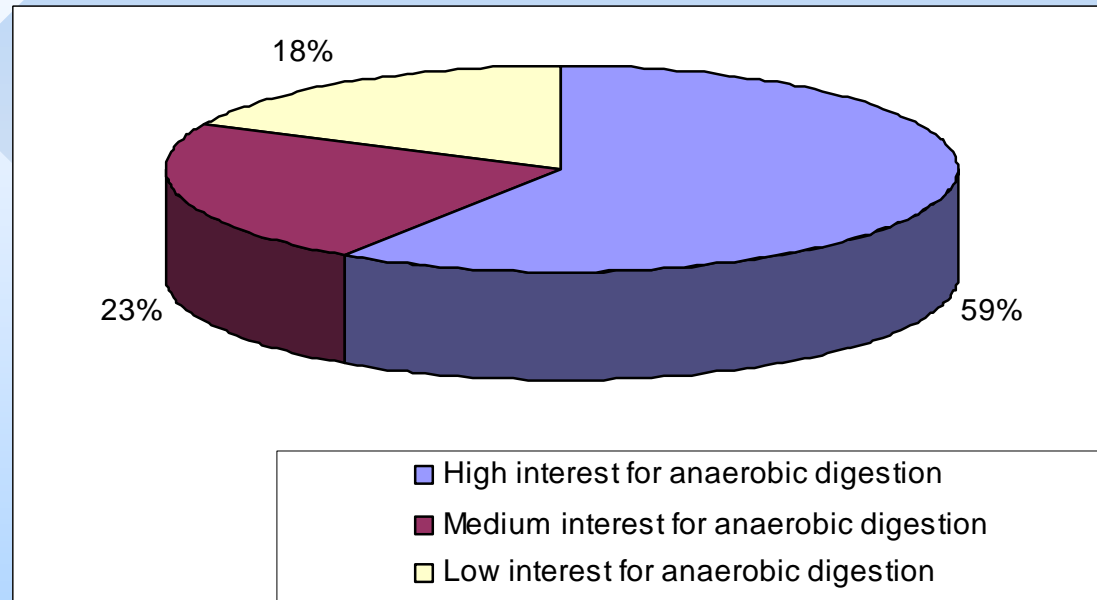


Besides:

- lack of space in 54% of plants
- problems with green waste finding in 18% of plants



# AD integration in existing composting plants



Besides:

- 54% of plants inclined to increase their treatment capacity
- available to a substantial revamping with temporary interruption of activity in 10% of plants



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**Thank you  
for your attention**

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