An example of Anaerobic-Aerobic Integrated System for Solid Waste Treatment

D. Mainero – ACEA Pinerolese

ACEA ENVIRONMENT

Summer School: Biological and Thermal Treatment of Municipal Solid Waste Napoli, Italy, 2-6 May 2011

ACEA Pinerolese Industriale S.p.A.

Outline

- ACEA
  - Our origins and activities
- Why choosing anaerobic-aerobic integrated system?
  - Drivers
  - Trends
- The waste treatment district: organic fraction for energy and soil conditioner
  - Managing a complex system
  - Energy production through cogeneration
  - Energy data and efficiency
  - Highlighting the need to match community expectation
- Conclusions

ACEA Pinerolese Industriale S.p.A.

Outline

- ACEA
  - Our origins and activities
- Why choosing anaerobic-aerobic integrated system?
  - Drivers
  - Trends
- The waste treatment district: organic fraction for energy and soil conditioner
  - Managing a complex system
  - Energy production through cogeneration
  - Energy data and efficiency
  - Highlighting the need to match community expectation
- Conclusions

ACEA Pinerolese Industriale S.p.A.

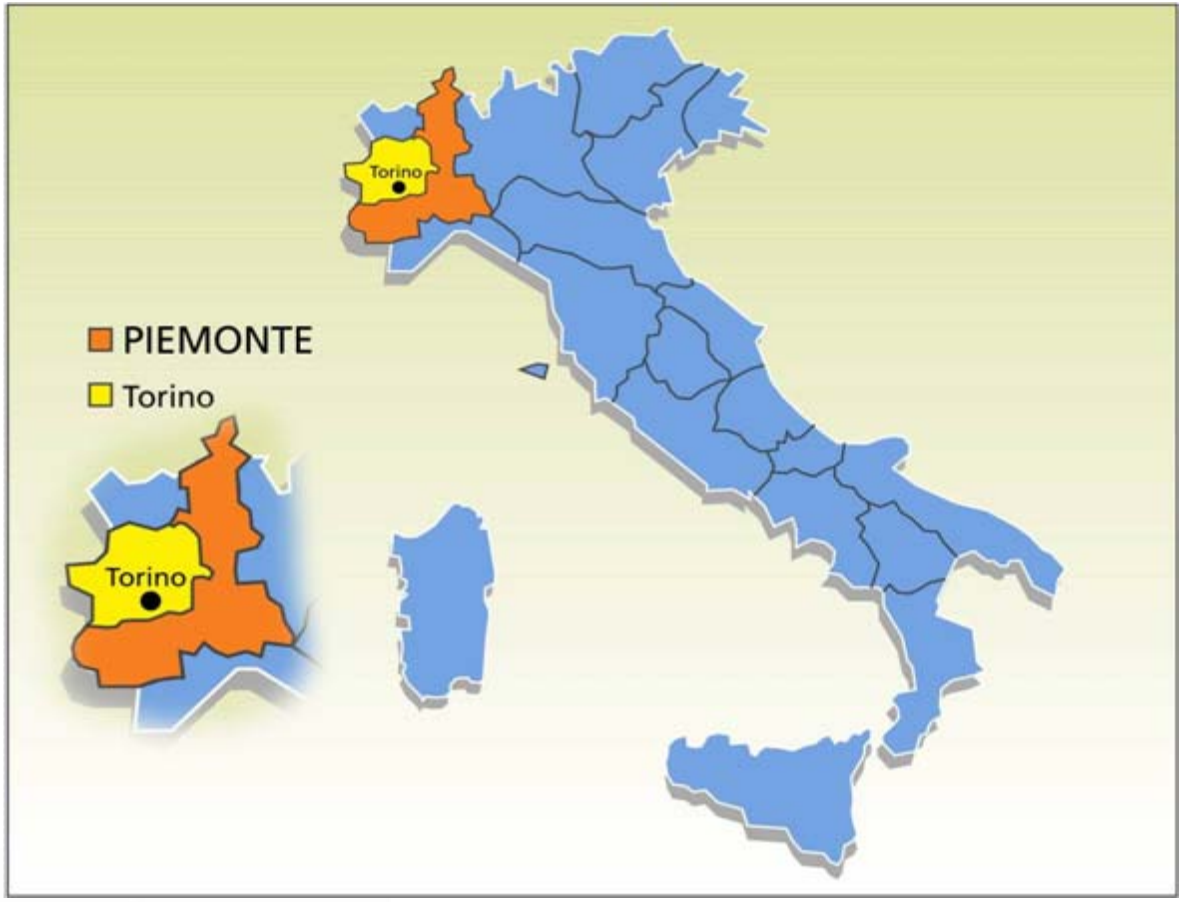
Our Origins

Officina del Gas	*1856*	*Italian-French society for gas production from distilled coal*
Acquedotto Municipale di Pinerolo	*1914*	*Municipal Service for drinking water distribution in Pinerolo*
A.M.G.A. (Azienda Municipalizzata Gas Acqua)	*1964*	*Municipal Service for drinking water and natural gas distribution in Pinerolo*
A.M.G.A.S. (Azienda Municipalizzata Gas Acqua Servizi)	*1976*	*A.M.G.A. gains the management of Municipal Solid Waste*
Consorzio Pinerolese Energia Ambiente	*1986*	*Creation of the Consortium*
ACEA Azienda Consorziale Energia Ambiente	*1993*	*Creation of ACEA*
GRUPPO ACEA	*1st January 2003*	*Creation of multiservice Group (Joint-stock Company)*

ACEA Pinerolese Industriale S.p.A.

ACEA Group

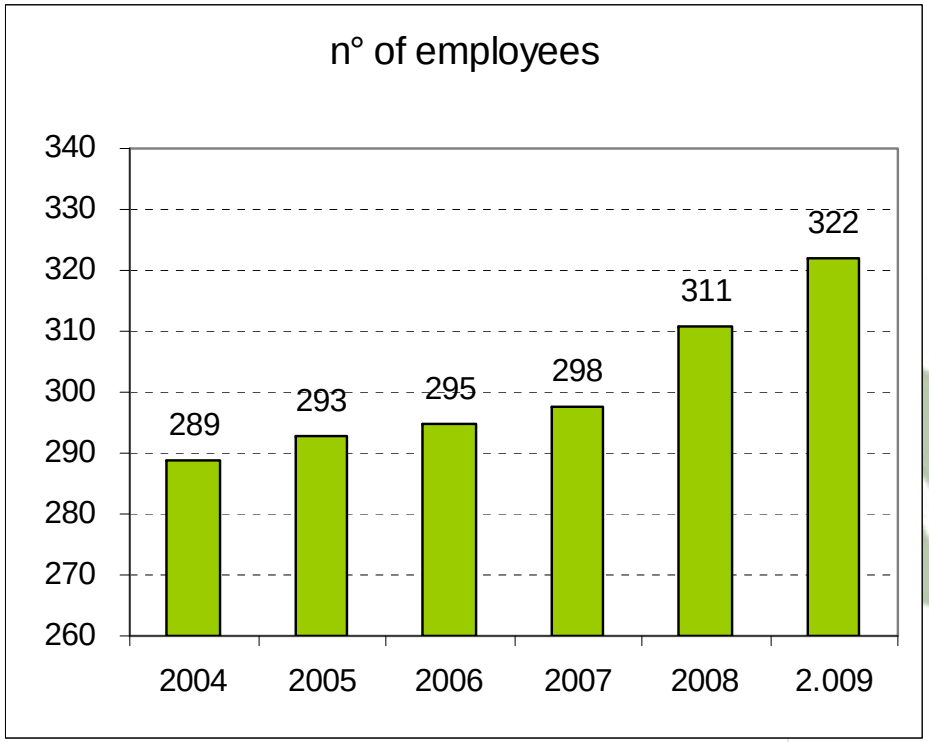
ACEA is a modern Italian multi-utility company, which currently provides services for Municipalities, private companies and citizens. In more than 150 years the company has continued its territorial growth and the current Group operates in **47 Municipalities situated in the North West of Italy and serves a user base of over 150.000 inhabitants.**

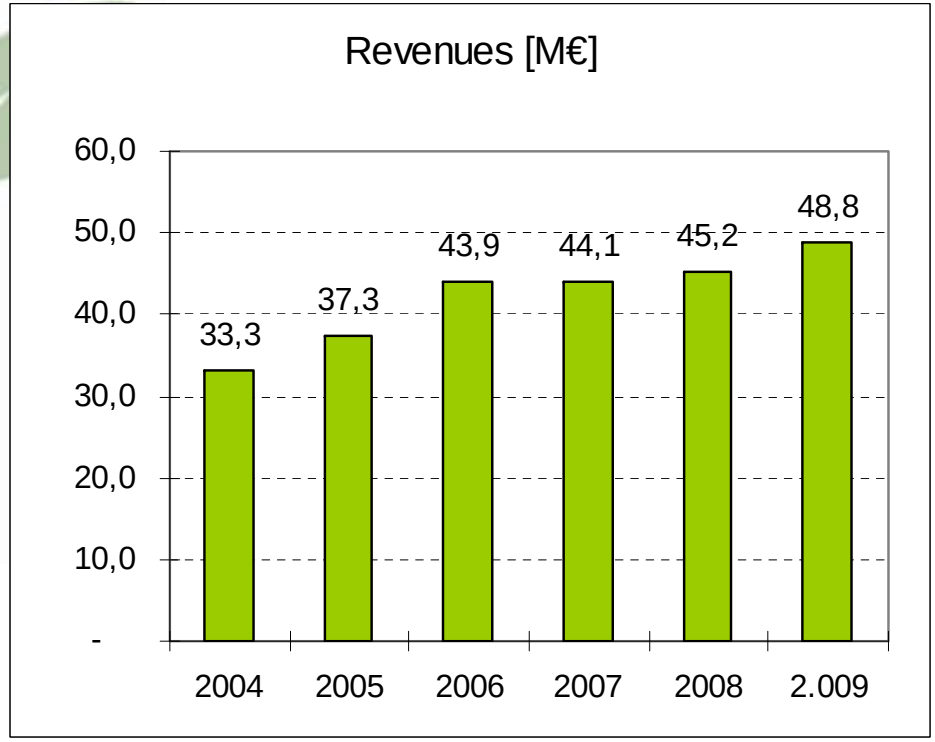


ACEA Pinerolese Industriale SpA is the joint stock company that control the Group. The special nature of the corporation is that the shareholders are the 47 Municipalities of the served area.

ACEA Pinerolese Industriale S.p.A.

ACEA Operation figures (consolidated)





The Activities Of The Group

Business Units

WATER → Water Distribution and waste water treatment

ENERGY → Natural Gas distribution and Heat Management

ENVIRONMENT → Waste collection and treatment

ACEA Pinerolese Industriale S.p.A.

Environment Department

The ENVIRONMENT department operates in the south west area of Turin province for **47 communities** and **150.000 inhabitants** with:

- **MSW collection**
- **Separate waste collection**
- **Street sweeping and cleaning**
- **Waste treatment** (including an ISO 14001 certified landfill and an ISO 14001 and 9001 Composting plant)

Now the Anaerobic-Aerobic Integrated System works for a third of the entire Turin province (800.000 inh. circa)

ACEA Pinerolese Industriale S.p.A.

Outline

- ACEA
  - Our origins and activities
- Why choosing anaerobic-aerobic integrated system?
  - Drivers
  - Trends
- The waste treatment district: organic fraction for energy and soil conditioner
  - Managing a complex system
  - Energy production through cogeneration
  - Energy data and efficiency
  - Highlighting the need to match community expectation
- Conclusions

Drivers…

"The Council of the European Union […] IS AWARE that the issue of biodegradable waste is partially addressed, among others, by Directive 1999/31/EC on the landfill of waste, which sets the reduction targets for landfilling of biodegradable municipal waste, and by Directive 2008/98/EC on waste, which invites the Member States, among others, to introduce measures supporting separate collection and appropriate treatment of bio-waste […] ENCOURAGES the Commission to continue the impact assessment with a view to preparing, if appropriate, a EU legislative proposal on biodegradable waste by 2010[…]" from Council Conclusions Green Paper on the management of bio-waste in the European Union 2953rd ENVIRONMENT Council meeting Luxembourg, 25 June 2009

The Soil Framework Directive…

In Europe the so called landfill directive has created the fundamental push to ban organic fraction from landfill (answers comes different from different countries).

In Italy:

the delay and lack of technological solutions at the beginning of the 90's for treating waste and, paradoxically, an already existing "end of waste" directive (748/84 law now 75/2010 law) has helped to developed the answers for collecting and treating the Organic Fraction of Municipal Solid Waste.

Incentives for renewable energy production were introduced in 1999, called Green Certificate (CV) on each 0,1 MWh produced for 8 years changes comes in 2004, 2007, …, L99/2009 where CV stand for 15 years and 1MWh (the incentives are a political decision - in times of austerity they changes rapidly)

ACEA Pinerolese Industriale S.p.A.

Solutions available

Available technologies can be basically divided by total solid content into three categories:

- Dry: Over 20% TS
- Semi-dry: between 10 and 20%TS
- Wet: Under 10% TS

Temperature pays an important role (mesophillic or thermophillic) as well the pattern flow (mixed, plug flow) and number of steps (one or two)

Solutions are deeply influenced by the material available (MSW or OFMSW) especially pre-treatment complexity.

ACEA Pinerolese Industriale S.p.A.

Europe plant distributions

European plant distribution based on different feeding typology

Feeding typology	Numbers of operative plants
OFMSW	75
OFMSW + others biomasses*	81
MSW	31
MSW + OFMSW	8
MSW + others biomasses*	6
MSW + OFMSW + others biomasses*	1
TOTAL	202

* typically agricultural wastes, sewage sludge

(from Confalonieri A. “Novità e prospettive sulla digestione anaerobica dei rifiuti urbani in Europa e nel nostro Paese” – Atti della XII Conferenza Nazionale sul Compostaggio. Produzione di ammendante compostato e biogas da rifiuti. Rimini, 3-6 novembre 2010 and personal communications – 08/2010 data)

Meso or Thermo, Wet or Dry?

Thermal distributions vs typology

	Wet		Semi-Dry		Dry		n.d.		TOT	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Mesofilo	39	14	1	0	15	10	3	0	58	24
Mesofilo/Termofilo	0	1	0	0	0	0	0	0	0	1
Termofilo	16	1	2	0	40	12	1	0	59	13
Mesofilo+Termofilo	7	1	0	0	0	0	0	0	7	1
n.d.	26	6	0	0	6	0	0	1	32	7
TOT	88	23	3	0	61	22	4	1	156	46

(1) = plants fed by OFMSW + other biomasses
(2) = plants fed by MSW + other biomasses (OFMSW included)

(from Confalonieri A. “Novità e prospettive sulla digestione anaerobica dei rifiuti urbani in Europa e nel nostro Paese” – Atti della XII Conferenza Nazionale sul Compostaggio. Produzione di ammendante compostato e biogas da rifiuti. Rimini, 3-6 novembre 2010 and personal communications – 08/2010 data)

ACEA Pinerolese Industriale S.p.A.

Why choosing anaerobic-aerobic integrated system?

The key factors that have led ACEA to the final choice are:

- complying with the legal framework
- easier control in odour emission of the integrated process compared to the simple composting process (decrease the odour impact)
- less surface needed per treated ton compared to the only compost solution
- high efficiency in recovering material (compost) and energy (biogas), in order to reduce the climate impact and to close the nutriment cycle using digestion residues as fertilizer
- Net energy producing process, open perspective on a long term for biogas as an energy vector
- available technical competence in ACEA

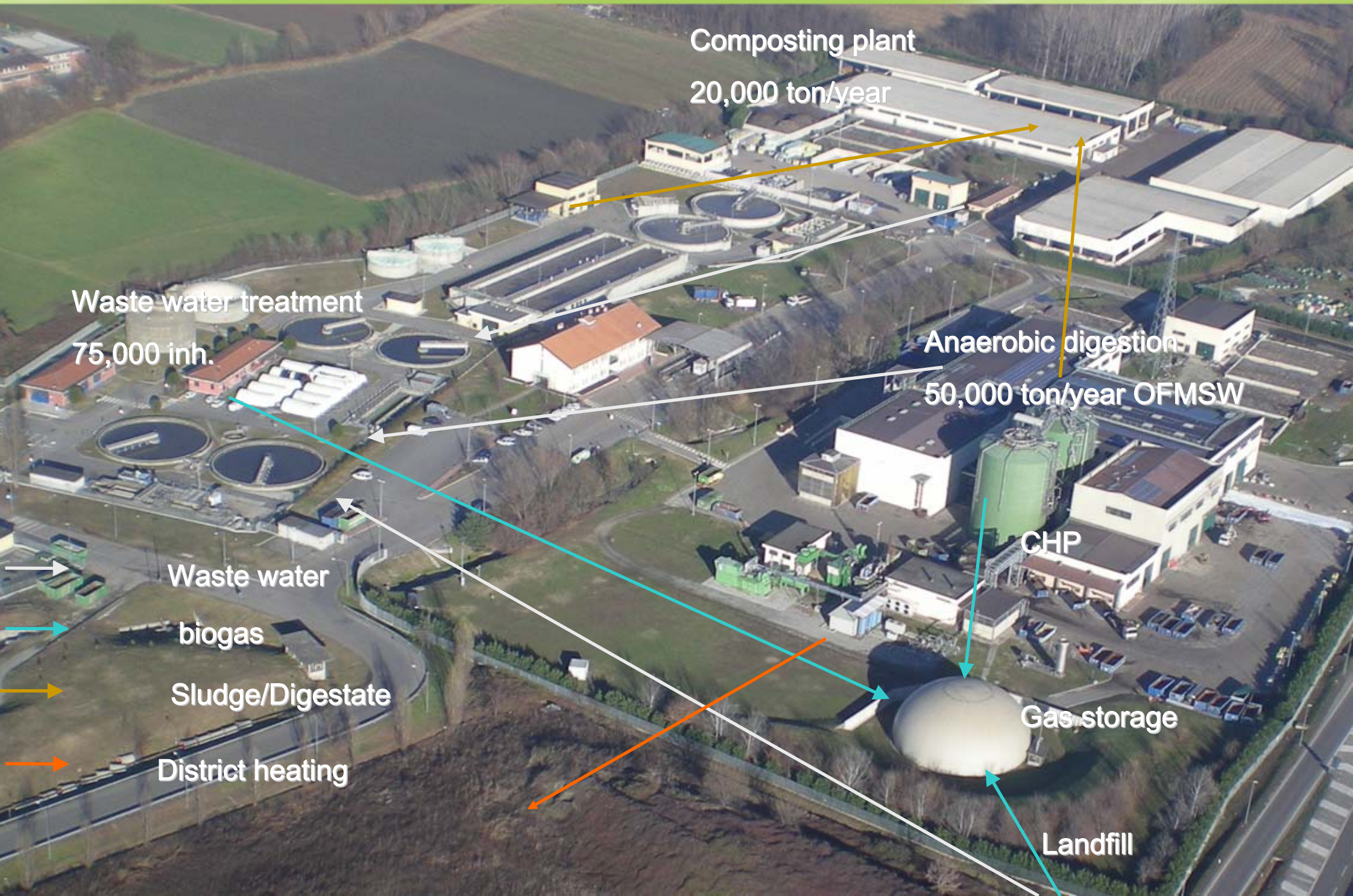
Drawing on its experience and technological know-how, ACEA has developed a Wet Thermophillic solutions fed with only OFMSW

ACEA Pinerolese Industriale S.p.A.

Outline

- ACEA
  - Our origins and activities
- Why choosing anaerobic-aerobic integrated system?
  - Drivers
  - Trends
- The waste treatment district: organic fraction for energy and soil conditioner
  - Managing a complex system
  - Energy production through cogeneration
  - Energy data and efficiency
  - Highlighting the need to match community expectation
- Conclusions

The waste treatment district



Incoming Material

Organic fraction

SS-OFMSW

- Households

SC-OFMSW

- Restaurants
- Canteens
- Markets

Green waste

- Green public area
- Domestic green waste

AD-line

Composting line

Anaerobic phase

The process consists of two digestion treatment lines based on:

- a mechanical pre-treatment (shredding and sieving)
- a mixing and particle reduction system in a continuous way to obtain a medium solid content (TS 10 %)
- a buffer tank (185 m^3) to reach the right digester feeding temperature (60 – 65°C)
- a bioreactor (2,500m^3) fed discontinuously (185 m^3 max)

Digestate is transferred to the aerobic treatment

Biogas is converted to energy thanks to three CHP for 3,3 $MW_{electric}$ installed, after a pretreatment and a gas storage

ACEA Pinerolese Industriale S.p.A.

Flow chart anaerobic line

FLORAWIVA PROCESSO

BUNKER

BAG OPENER

DISC SCREEN

Plastic scraps

Light scraps

ANAEROBIC DIGESTER

Acea patent application (2007) n. EP2028162.

Acea patent application (2007) n. EP2020434

BUFFER TANK

LORAWIVA MOR

Heavy scraps

Light scraps

Acea patent application (2009) n. n. TOA000736

Not biodegradable scraps

LUDGE TREATMEN

DIGESTATE

BIOGAS

Flow chart aerobic line

Digestate (organic fraction)

Mixing

Bio oxidization (30 days)

Green waste

Shredding

Maturing (60 days)

Sieving

FLORAWIVA® COMPOST DI QUALITÁ

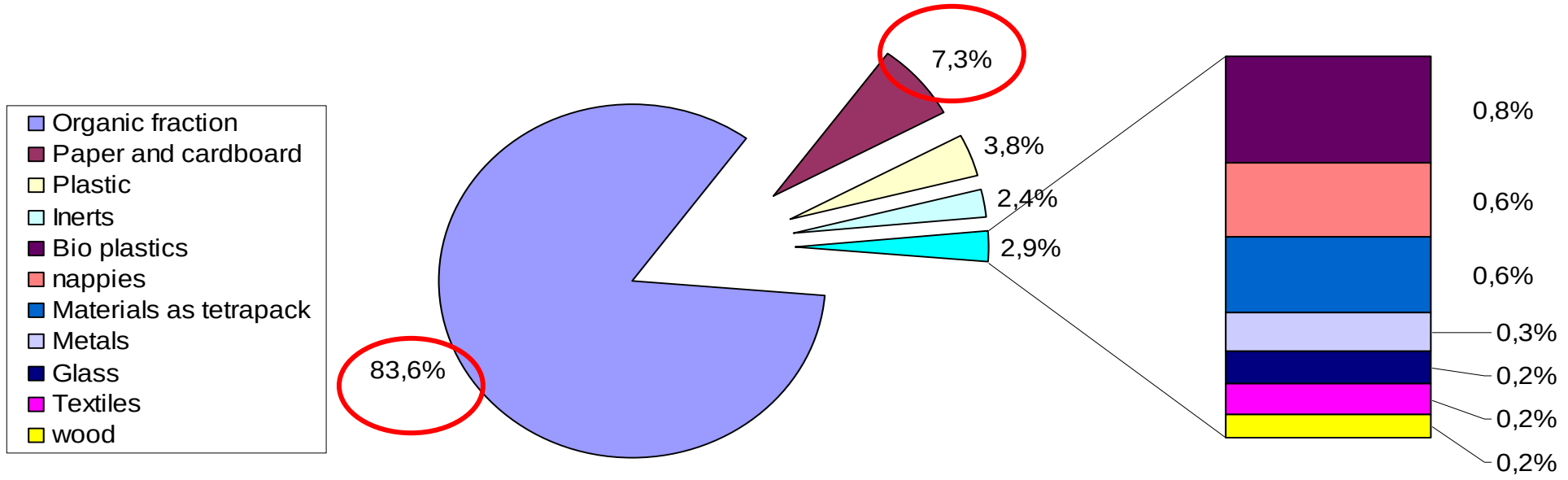
The Composting plant is in operation since 2001 with sewadge sludge

ACEA Pinerolese Industriale S.p.A.

Outline

- ACEA
  - Our origins and activities
- Why choosing anaerobic-aerobic integrated system?
  - Drivers
  - Trends
- The waste treatment district: organic fraction for energy and soil conditioner
  - Managing a complex system
  - Energy production through cogeneration
  - Energy data and efficiency
  - Highlighting the need to match community expectation
- Conclusions

Process control – anaerobic phase feeding

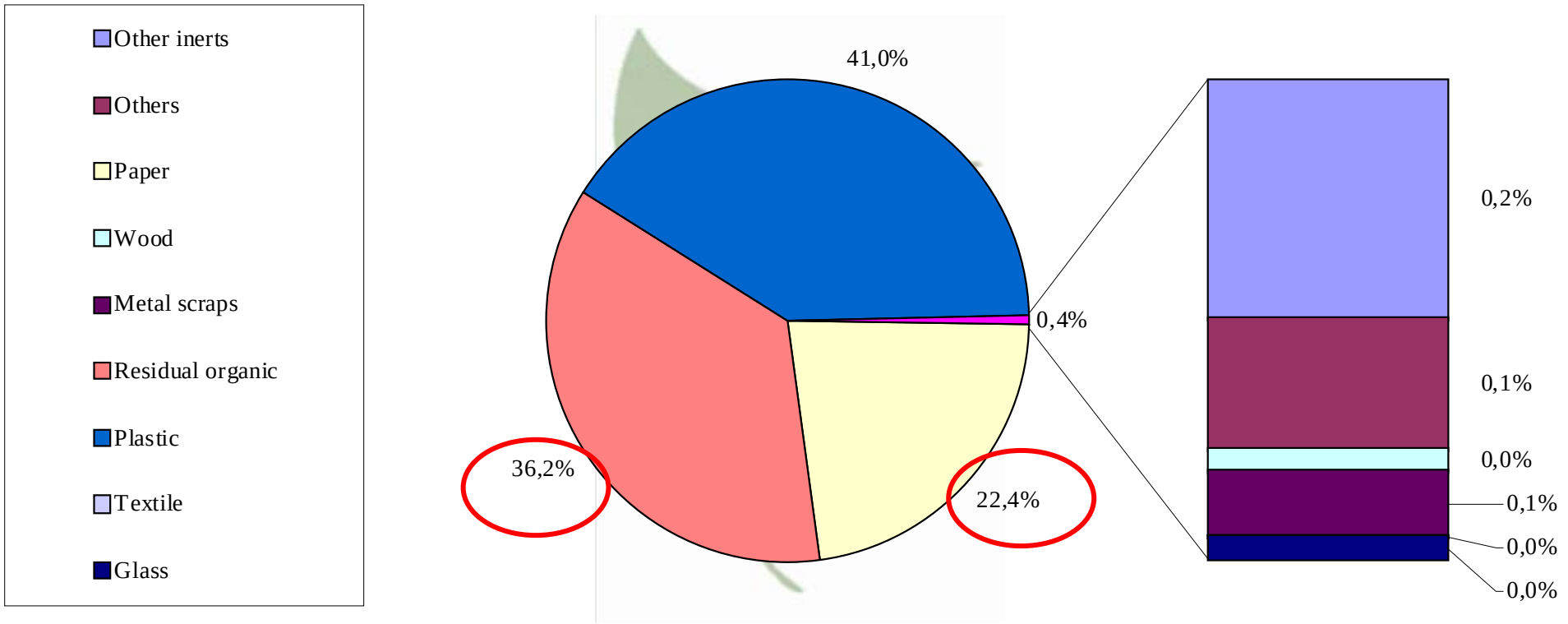


Over size material = K*light fraction (8-10%)

Where K depends on technology and state of the art

- Waste quality control (18 samples 2008-2009)

Over size sieving material K factor



- Waste quality control (6 samples 2006)

Danes examples – anaerobic phase feeding

Table 1: Amounts of organic fraction of municipal solid waste (OFMSW) treated in Danish biogas plants 2001 and collection and pretreatment methods used (according to information from the biogas plants).

Start	Grindsted 1997	FA, HA, NY 2001	Ålborg 1990s	Snertinge 2001	Studsgård 1990s	Århus 2001
OFMSW (t/year)						
2001	2000	6000	300	900	11000	2000
Expected	4000	12000	3000	1800	11000	17000
Other types of waste (t/year)						
Manure	–	175000	–	40000	113000	100000
Sewage sludge	28000	–	–	–	–	–
Industrial waste	4000	n. d.	–	8000	9000	–
Collection system						
Indoor	Paper bags	Plastic bags	Plastic bags	Plastic bags	Plastic bags	Plastic bags
Outdoor	Paper bags or container	Paper bags or container	Paper bags or container	Paper bags or container	Paper bags or container	Plastic bags (green for OFMSW, black for grey waste)
Pretreatment						
Method	Crushing	Drum sieve + addition of straw	Dewaster	Dewaster	Roller sieve	Roller sieve
Ratio of reject	3%	25–30%	15–45%	20–40%	15–25%	15–45%

n.d., no data; FA, Fangel, HA, Hashøj, NY, Nysted.

Extracted from “Efficiency of the anaerobic treatment of the organic fraction of municipal solid waste: collection and pretreatment” su Waste management & Research 22/2004

ACEA Pinerolese Industriale S.p.A.

AD line feeding

OFMSW weekly medium fed	850 Mg
Waste produced from oversize sieve fraction	25 %
Total solid content in OFMSW	30 - 35%
Volatile solid content ratio to total solid content VS/TS	85% +/- 2%
pH value in feeding	4 - 5 +/- 10%
COD solubile	85.000 +/- 20%
Total solid content in the prepared digestor input	10 +/- 10%

ACEA Pinerolese Industriale S.p.A.

Process control – anaerobic phase

Analytical control:

•Feeding to the digestor (TS, VS)

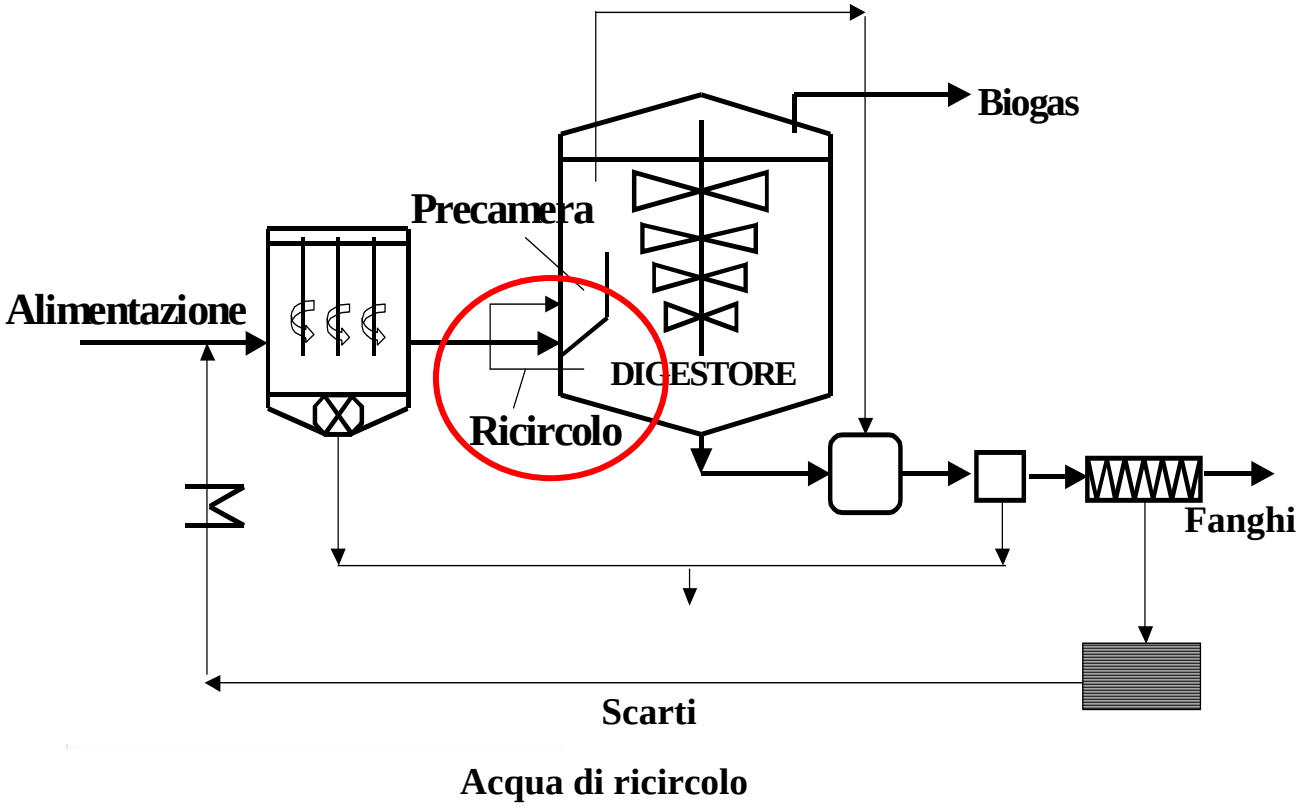
• injection bacteria (Rα as AcOH/CaCO3)

Instrumental control:

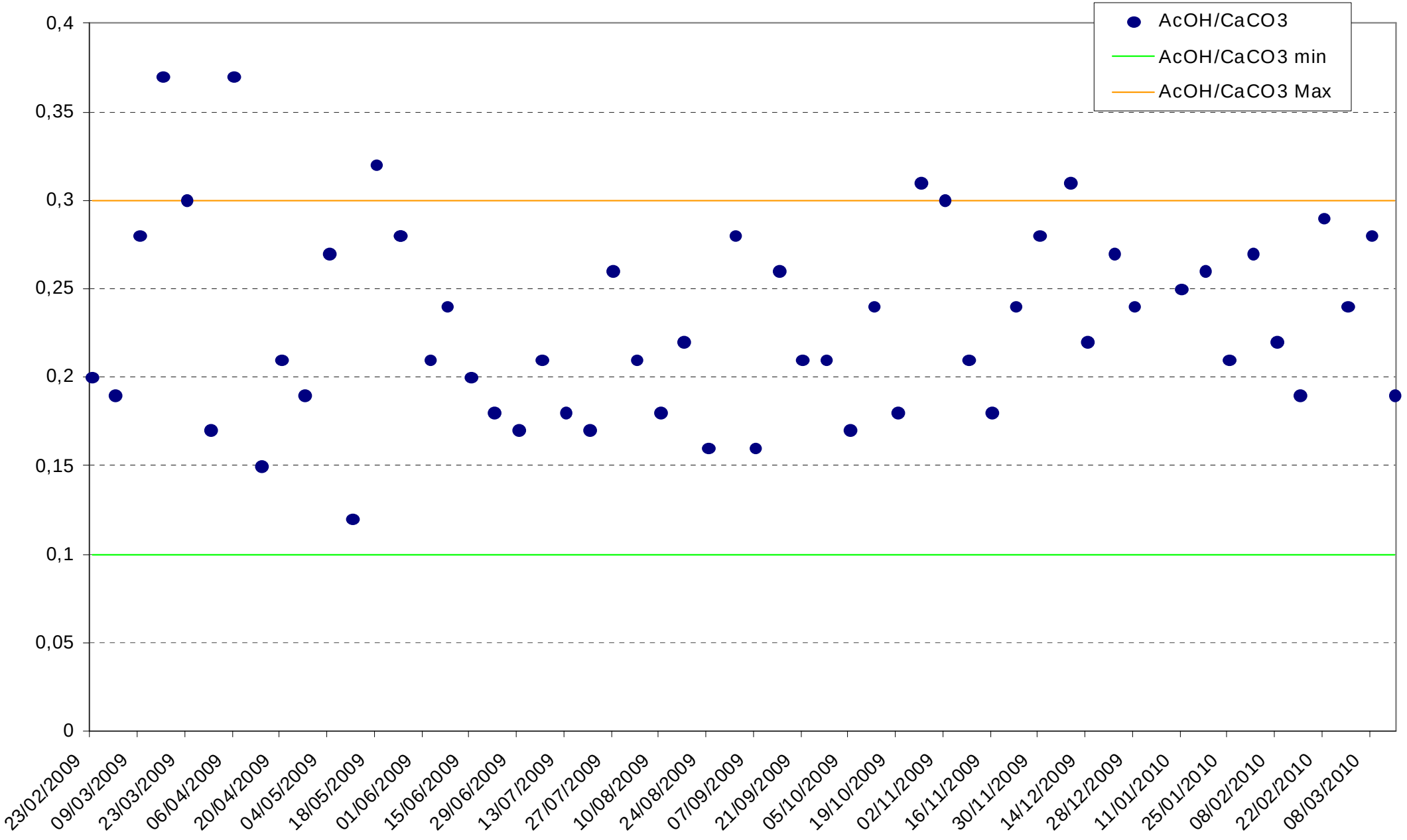
•Biogas flow measure

•CH4/CO2

•Digestor temperature

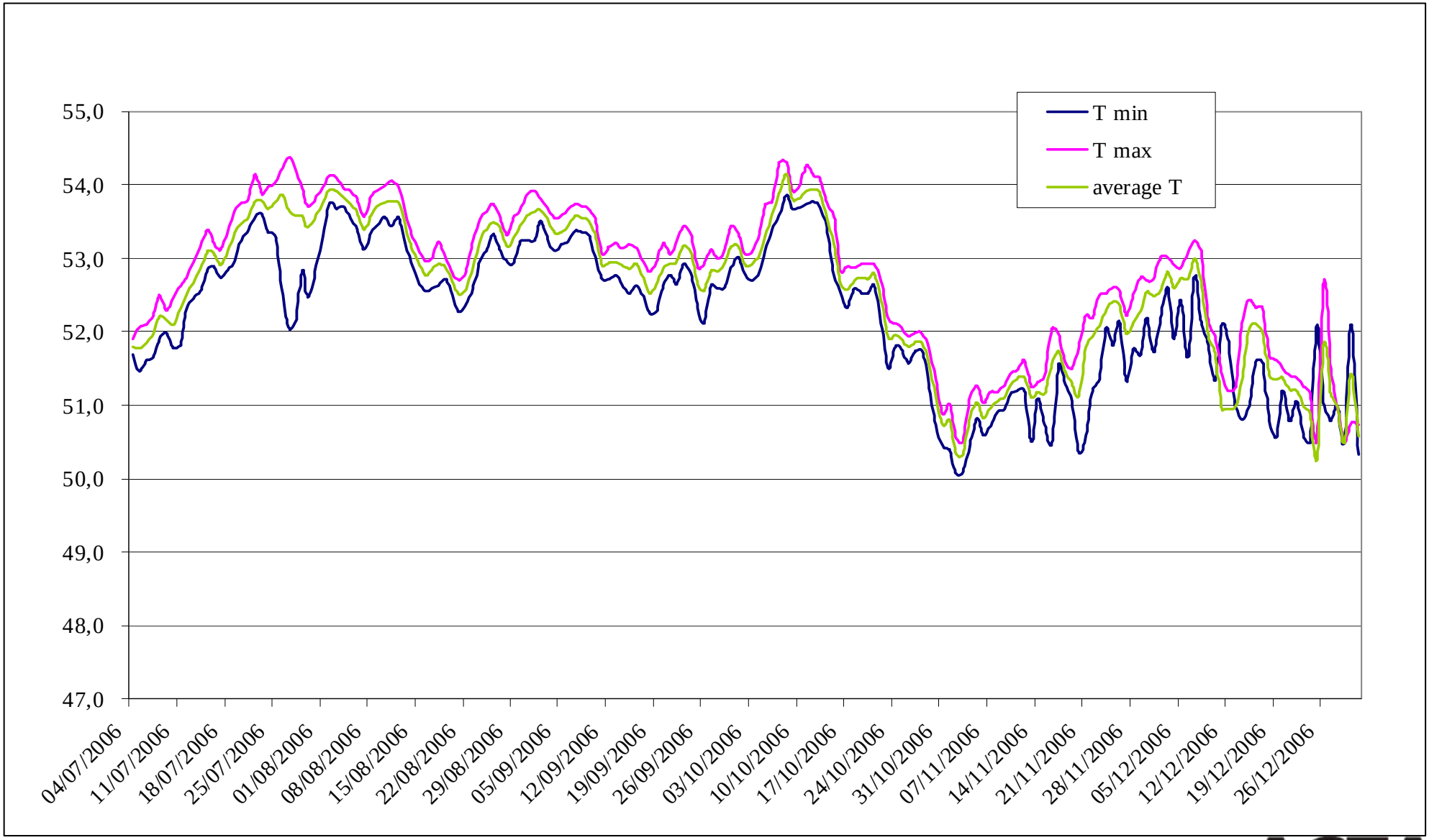


Process control – anaerobic phase - process



- Example of AcOH/CACO3 ratio control 20009 data line A

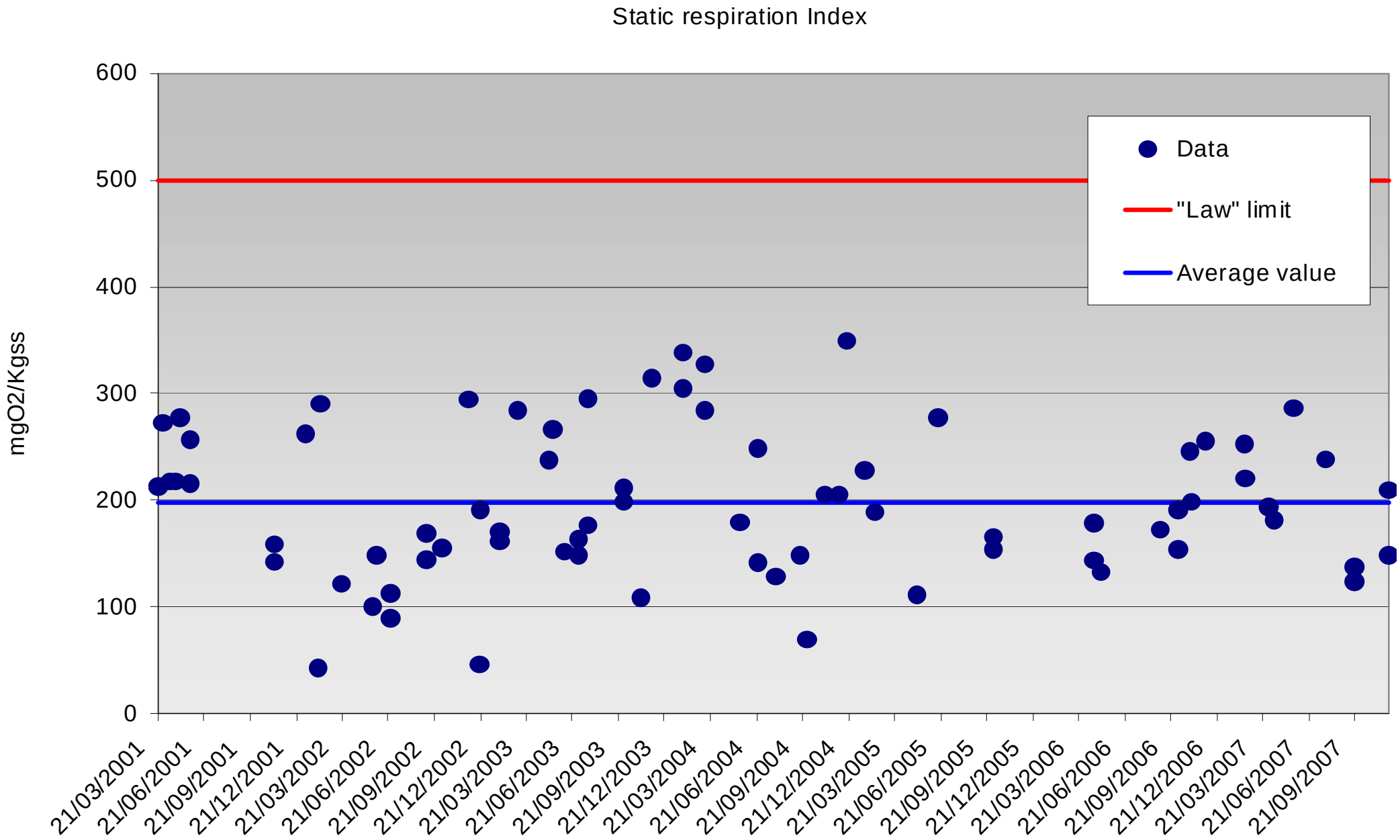
Process control – anaerobic phase – digestion T



Temperature in bioreactor A line

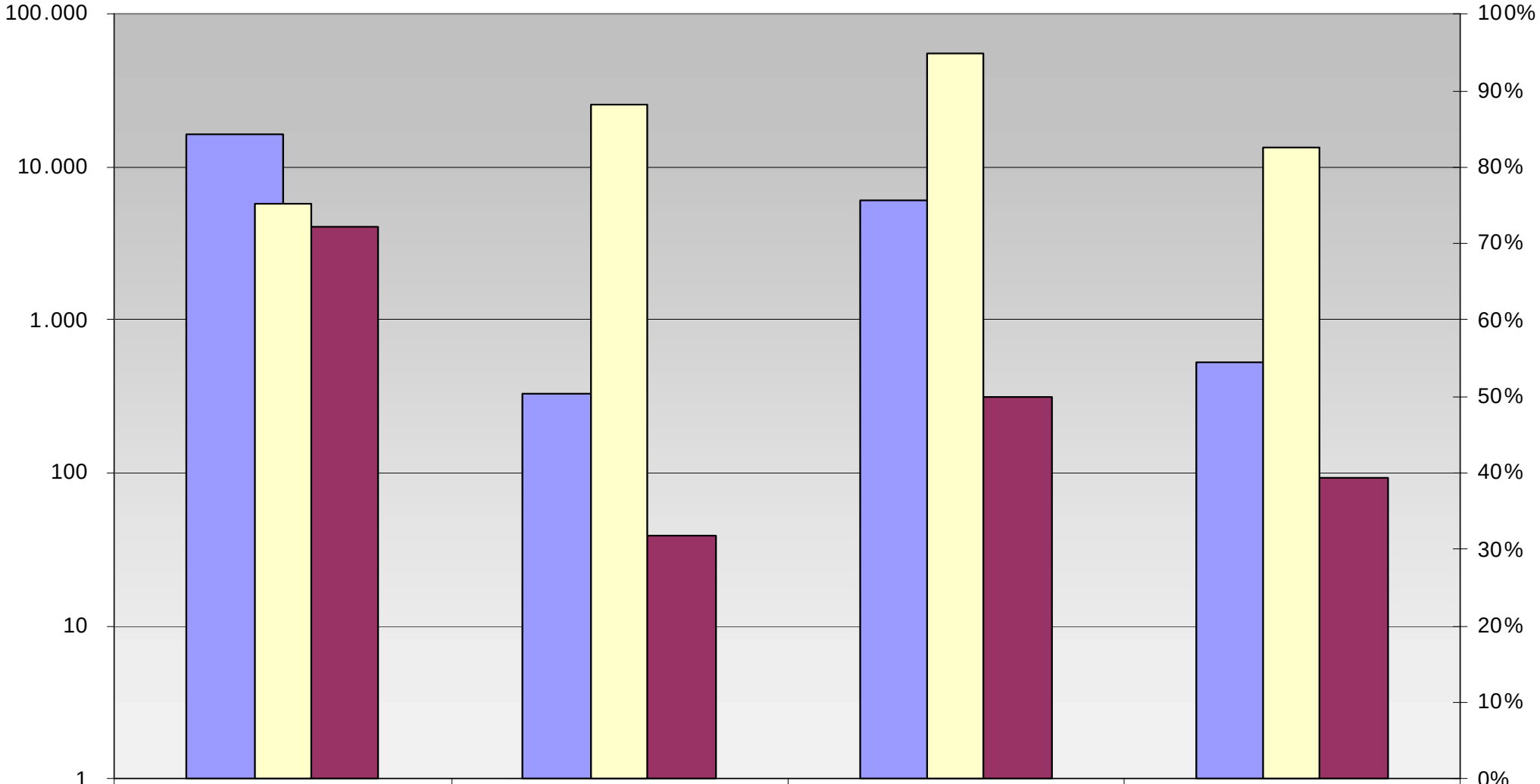
ACEA Pinerolese Industriale S.p.A.

Process control – aerobic phase - process



(Oxygen demand for complete compost oxidation - 78 samples)

Process control – Biofilter Emissions



	VOC [ppb]	H2S [ppb]	NH3 [ppb]	Odour concentration (EN13725:2003)
average Input	16.478	332	6.086	531
Average Output	4.086	39	317	92
Removal efficiency	75%	88%	95%	83%

(Average on 80 samples on biofilter)

ACEA Pinerolese Industriale S.p.A.

Customer care – traceability system

Through process control each lot is identified. This simple system allow us to define an ID card for each lot, giving back a **complete traceability system from organic waste to the compost user**.

	MODULO	M.06.ICF
GRUPPO ACEA PINEROLESE		Rev. 1 del 16/07/2007
	Identificazione cumulo fanghi	Pag 1 di 1

SCHEDA PRODOTTO

LOTTO N. : 644 CL 10 F 16 DATA:

RAPPORTI VOLUMETRICI DELLE DIFFERENTI MATRICI MISCELAT

Codice Matrice	Percentuale	
- 190699 fng valorizzatore	- 0% 0 benne da 5.5 m3	-
- 190805 fng depuratore	- 17% 9,5 benne da 5.5 m3	- Dal rfj277407-09,rfj277408-10-09,rfj277713-09,rfj277414-09
- 200201 verde	- 83% 45.5 benne da 5.5 m3	-

el lot.

o sul lotto. pu (41.96 t) e valo al 0% (t)

COMPOST QUALITÀ C.I.C.

First compost in Italy registered as a GPP product

The system is ISO 9000 and 14001 certified

UKAS ENVIRONMENTAL MANAGEMENT Reg. No. 059-C

UKAS QUALITY MANAGEMENT Reg. No. 059-A

ACEA Pinerolese Industriale S.p.A.

Compost application

Bob winter Olympic stadium San Sicario (TO)
Disposal 05/2007 Results 07/2007

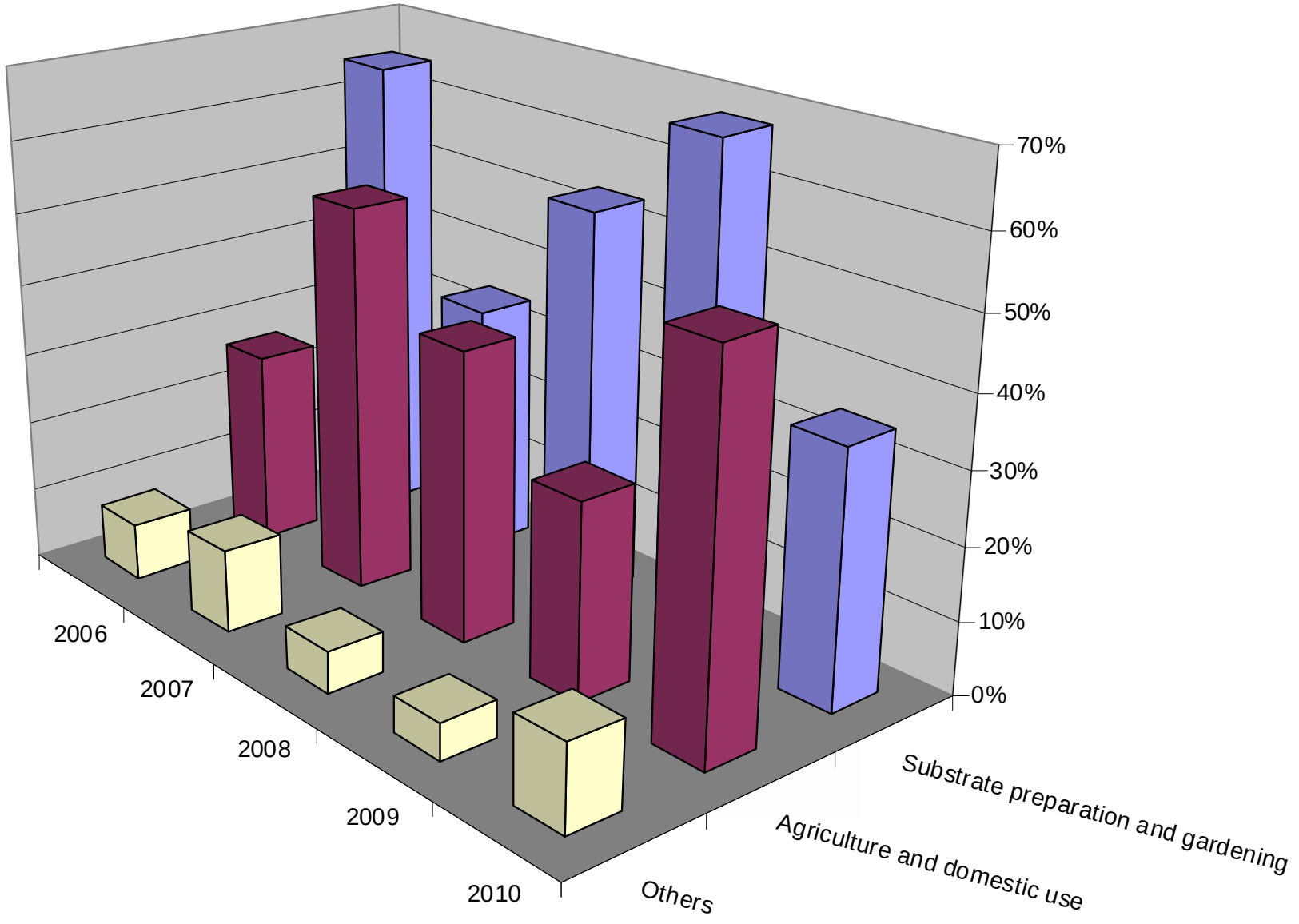
ACEA Pinerolese Industriale S.p.A.

Compost application

Example of compost application in greenhouse (anemone and strawberry production)

ACEA Pinerolese Industriale S.p.A.

Market distribution



Average value selling price early 2011: 14€/ton

Outline

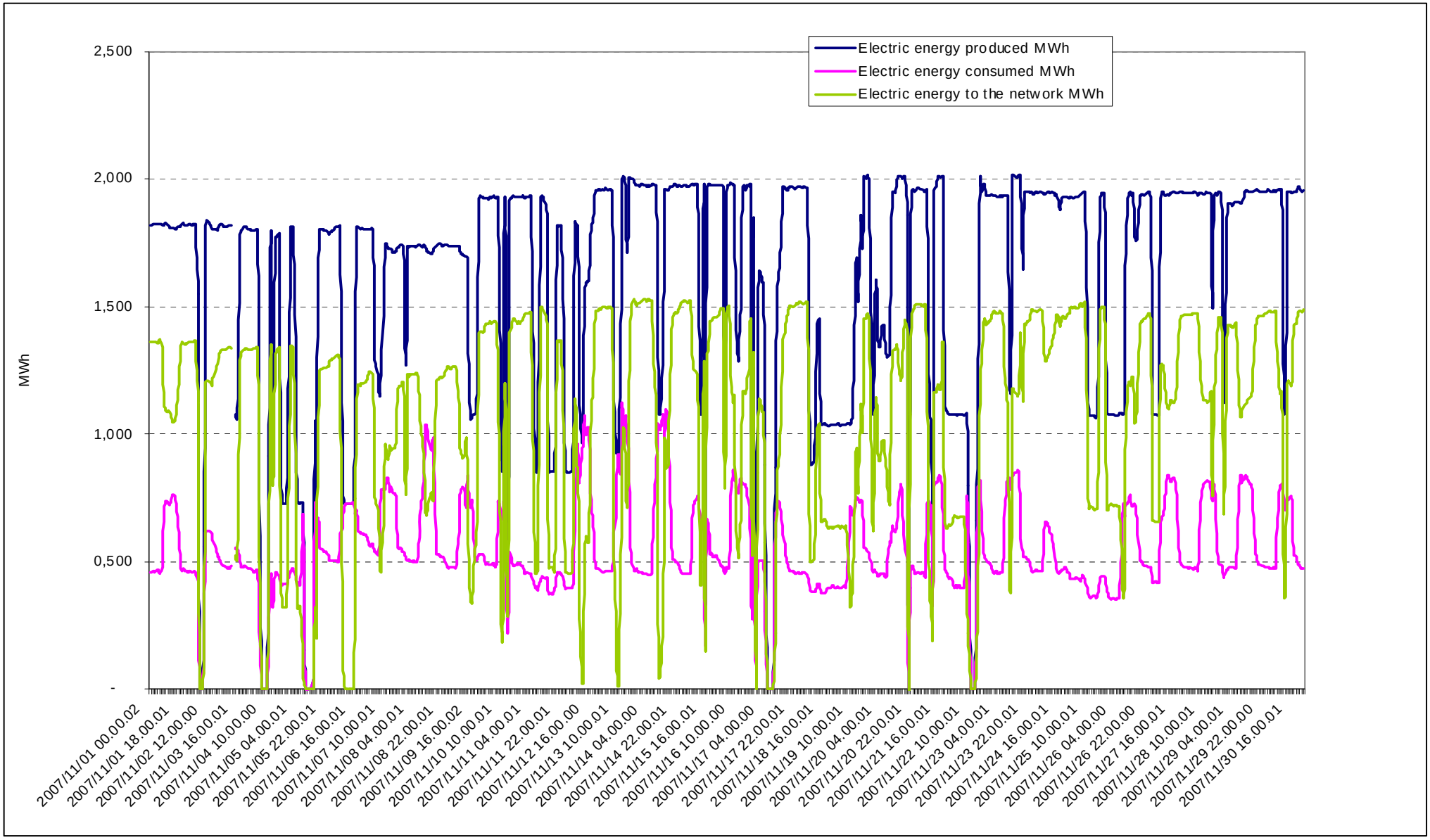
- ACEA
  - Our origins and activities
- Why choosing anaerobic-aerobic integrated system?
  - Drivers
  - Trends
- The waste treatment district: organic fraction for energy and soil conditioner
  - Managing a complex system
  - Energy production through cogeneration
  - Energy data and efficiency
  - Highlighting the need to match community expectation
- Conclusions

Energy production through cogeneration

The plant is based on three CATERPILLAR Combine Heat Power 1106 KWe and 1371 KWt each

ACEA Pinerolese Industriale S.p.A.

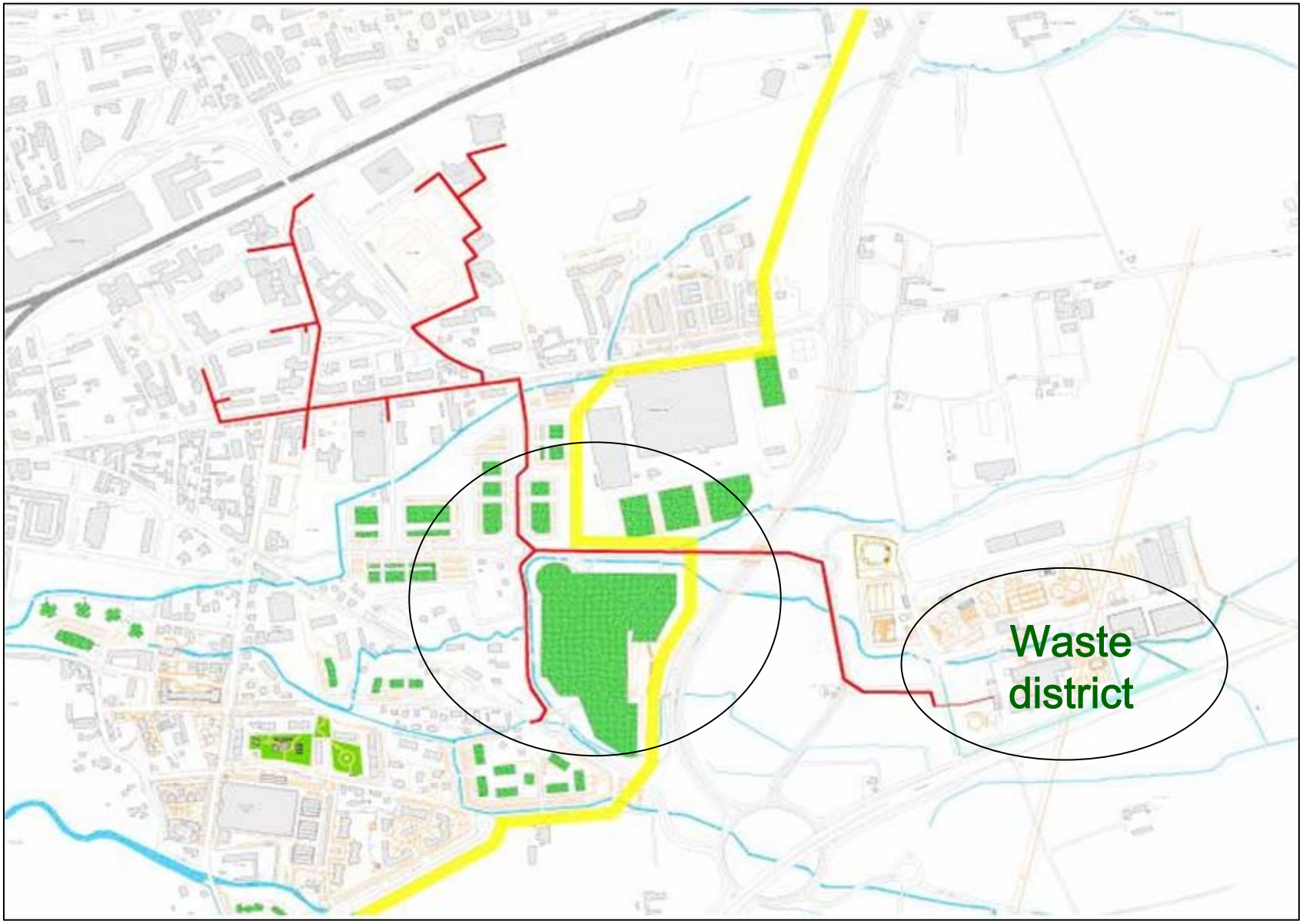
Electric energy production



- Example of Electric Energy consumption, 11/2007

ACEA Pinerolese Industriale S.p.A.

Heating district



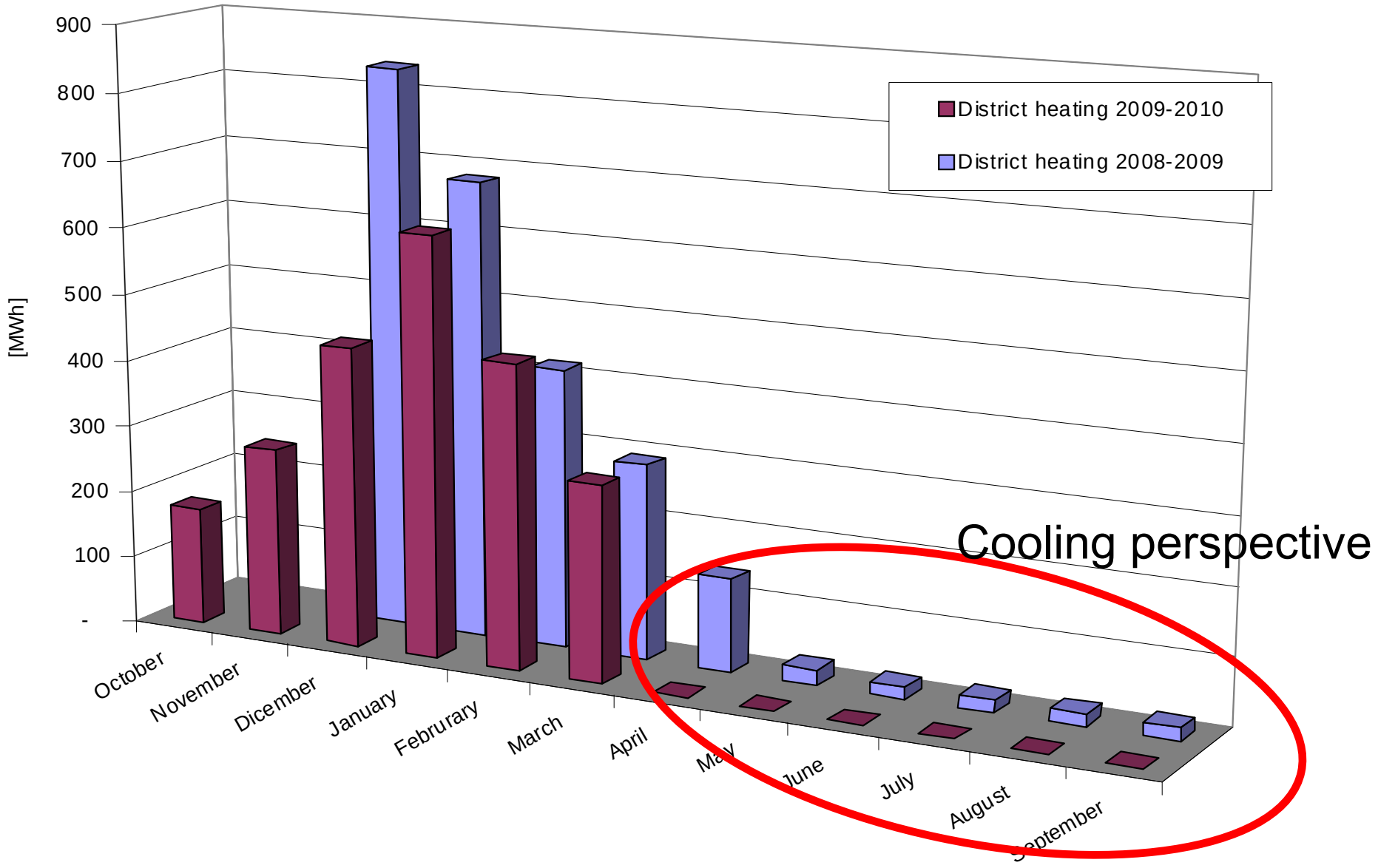
4 MW served grid end 2011

District heating 2009/10

Production	3 CHP biogas fed 3*1,3 MWt
	2 boiler fed on NG 2*1,75 MWt
Thermal energy recovered by CHP	4,3 GWh
Thermal energy from boilers	2 GWh
Heated volume	13.000 m^3 (domestic)
	145.000 m^3(shopping mal)
Distribution point	3
Heating district grid	1,8 km
Heating district temperature distribution	120°C
Heating district temperature return	70°C

ACEA Pinerolese Industriale S.p.A.

District Heating



- First data on distribution heating

Outline

- ACEA
  - Our origins and activities
- Why choosing anaerobic-aerobic integrated system?
  - Drivers
  - Trends
- The waste treatment district: organic fraction for energy and soil conditioner
  - Managing a complex system
  - Energy production through cogeneration
  - Energy data and efficiency
  - Highlighting the need to match community expectation
- Conclusions

Electric and thermal energy

	2008	2009
Biogas from AD OFMSW [Mm^3]	3,7	4
Biogas from landfill and waste water [Mm^3]	4	4,1
Potential Energy contained in biogas [GWh]	28,3	32,12
Electric energy (EE) produced [GWh]	10,1	12,3
EE consumed on the waste treatment district [GWh]	5,9	7,0
EE sold to the grid [GWh]	4,2	5,3
Thermal Energy (TE) produced [GWh]	11,1	13,5
TE recovered [GWh]	5,5	6,6
TE used on waste treatment district [GWh]	4,5	5
TE to the heating district [GWh]	1	1,6

Data are referred to the entire biogas production

ACEA Pinerolese Industriale S.p.A.

Efficiency control

Process efficiency (based on ANPA, ONR-2002)

Hydraulic retention time HRT [days]	19
TS feeded material [%]	10
Organic Load Rate OLR [Kg organic/m3bioreactor*day]	4-5
Specific biogas production in m3 biogas at 60%CH4/ton fed	140
Specific biogas production at 60% CH4 [m3/tonVs feeded]	560
Substrate removal effectiveness Vs% [%]	70%
Biogas production rate [m3biogas/m3bioreactor *day]	4
Electric energy specific production [KWhe/ton feeded]	310

Energy used

Specific electric energy (EE) consumed per tonne	75 KWhe/ton
Consumption of EE on the production	25 %

(2006 – 2010 data)

ACEA Pinerolese Industriale S.p.A.

Outline

- ACEA
  - Our origins and activities
- Why choosing anaerobic-aerobic integrated system?
  - Drivers
  - Trends
- The waste treatment district: organic fraction for energy and soil conditioner
  - Managing a complex system
  - Energy production through cogeneration
  - Energy data and efficiency
  - Highlighting the need to match community expectation
- Conclusions

ACEA Pinerolese Industriale S.p.A.

Community involvement

All waste management processes require consensus and participation

Community consensus can only be achieved through an EFFETECTIVE COMMUNICATION STRATEGY

- Waste treatment industry should be seen as a solution, not a problem
- Waste management and treatment facilities are necessary
- Waste recycling facilities can work only with a correct source selection of household waste

Pinerolese Industriale S.p.A.

Communication strategy - Objectives

- Give “reasonable reasons” for convincing people to accept the plant:
  - *Production of renewable energy and soil conditioner*
  - *Less waste going to landfill*
- Highlight the benefits:
  - *High efficiency compared to “classical” composting plant*
  - *Exportable technology*
  - *Provide work for local community*
- Gain stakeholders/investors confidence
- Increase quality standard of source selected waste from household

Communication strategy - Lines

POSTER and PRINT ADVERTISEMENT

BROCHURE

ACEA Pinerolese Industriale S.p.A.

Communication strategy - Lines

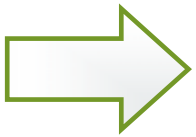
MEETINGS

VISITS

ACEA Pinerolese Industriale S.p.A.

Work in progress...first results

- More than 1.000 people involved in **visits** each year
- More than 20.000 **students** reached with yearly **activities**
- More than 500 participants to our **composting courses** each year
- More than 50.000 **communications** yearly sent to Citizens



- **Citizens have accepted the plant**
- **Good reputation of the integrated system, now seen as a resource**
- **Increase of selected waste (from 30% in 2006 to 50% in 2009)**

ACEA Pinerolese Industriale S.p.A.

Outline

- ACEA
  - Our origins and activities
- Why choosing anaerobic-aerobic integrated system?
  - Drivers
  - Trends
- The waste treatment district: organic fraction for energy and soil conditioner
  - Managing a complex system
  - Energy production through cogeneration
  - Energy data and efficiency
  - Highlighting the need to match community expectation
- Conclusions

Conclusions 1

Good results obtained by our integrated anaerobic/aerobic system and the know how acquired give us the opportunity to draw a brief set of considerations on our experience

- The processes supplement each others by degradation and transformation, good odour management and sanitation
- Quality and homogeneity of the digestate allow us a good compost production easily respecting the law limit for the final product (Italian law act 75/2010) and allow us to produce a compost well accepted and easily sold.
- Energy recovery of the organic waste through anaerobic digestion meet energy and environmental requirement.
- A communication strategy connected and effective with the system transferring to citizens, stake holders and investors the benefits obtained (environmental, social and economic aspects) plays a key role.
- Managing a complex system needs professional staff and only much more accurate control will allow a better management of the entire system, giving ability to improve efficiency and controlled results.

ACEA Pinerolese Industriale S.p.A.

Conclusion 2

BioEnergy Italy
Biomasse e Rinnovabili
Vegetalia VIII° Edizione
18-20 Marzo 2011 - Quartiere Fieristico di Cremona
CREMONAFIERE
INTERNATIONAL

ACEA Waste treatment district has been **awarded as**

best practice excellence example in using biotechnology, march 18th 2011 at Cremona fiere by a national committee (www.bioenergyitaly.com)

SEZIONE ENTI PUBBLICI

Premio Migliori Pratiche BioEnergy Italy 2011

1° PREMIO

Polo Ecologico Integrato ACEA

Pinerolo (TO)

Referente: Cristina Savino - cristina.savino@aceapinerolese.it - www.aceapinerolese.it

D. Mainero ACEA Pinerolese industriale S.p.A.

davide.mainero@aceapinerolese.it

www.ambiente.aceapinerolese.it