Athens 2014
2ND INTERNATIONAL CONFERENCE
on Sustainable Solid Waste Management

Analysis of mesophilic and thermophilic anarobic digestion of pressed biowaste and mesophilic co-digestion with waste activated sludge

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AD of biowaste is a well established and still growing technology

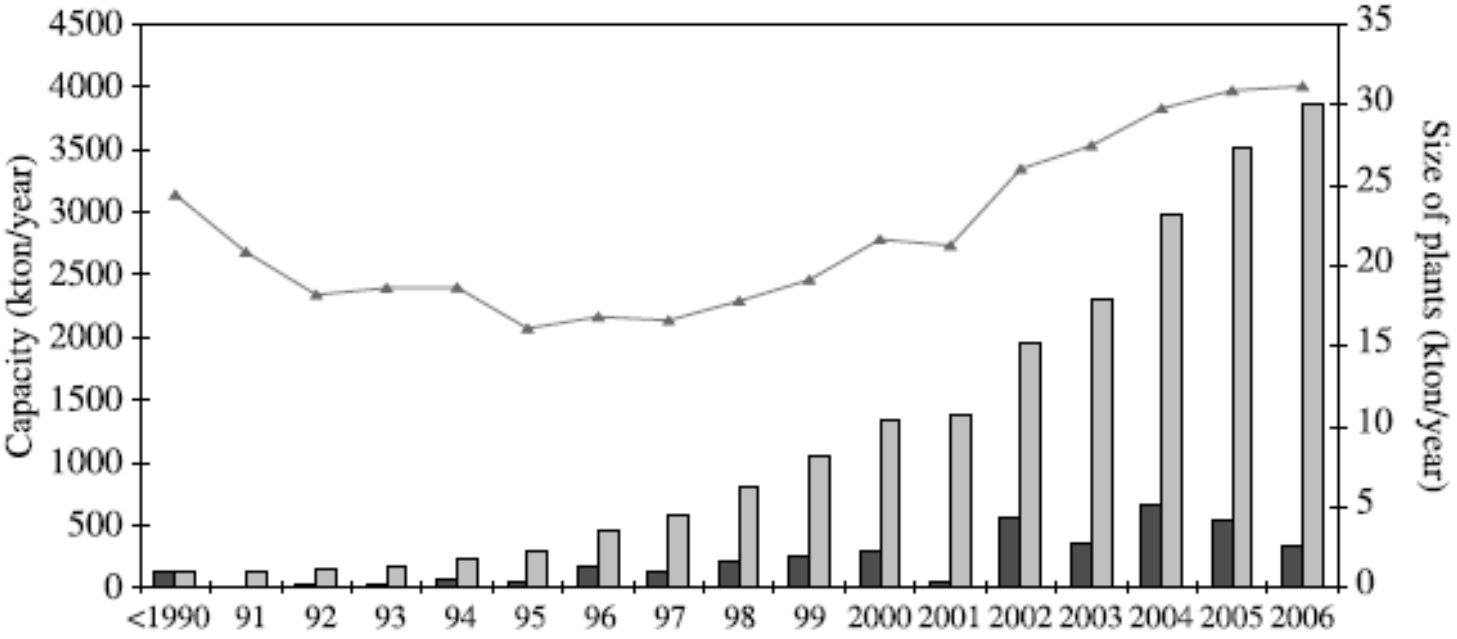
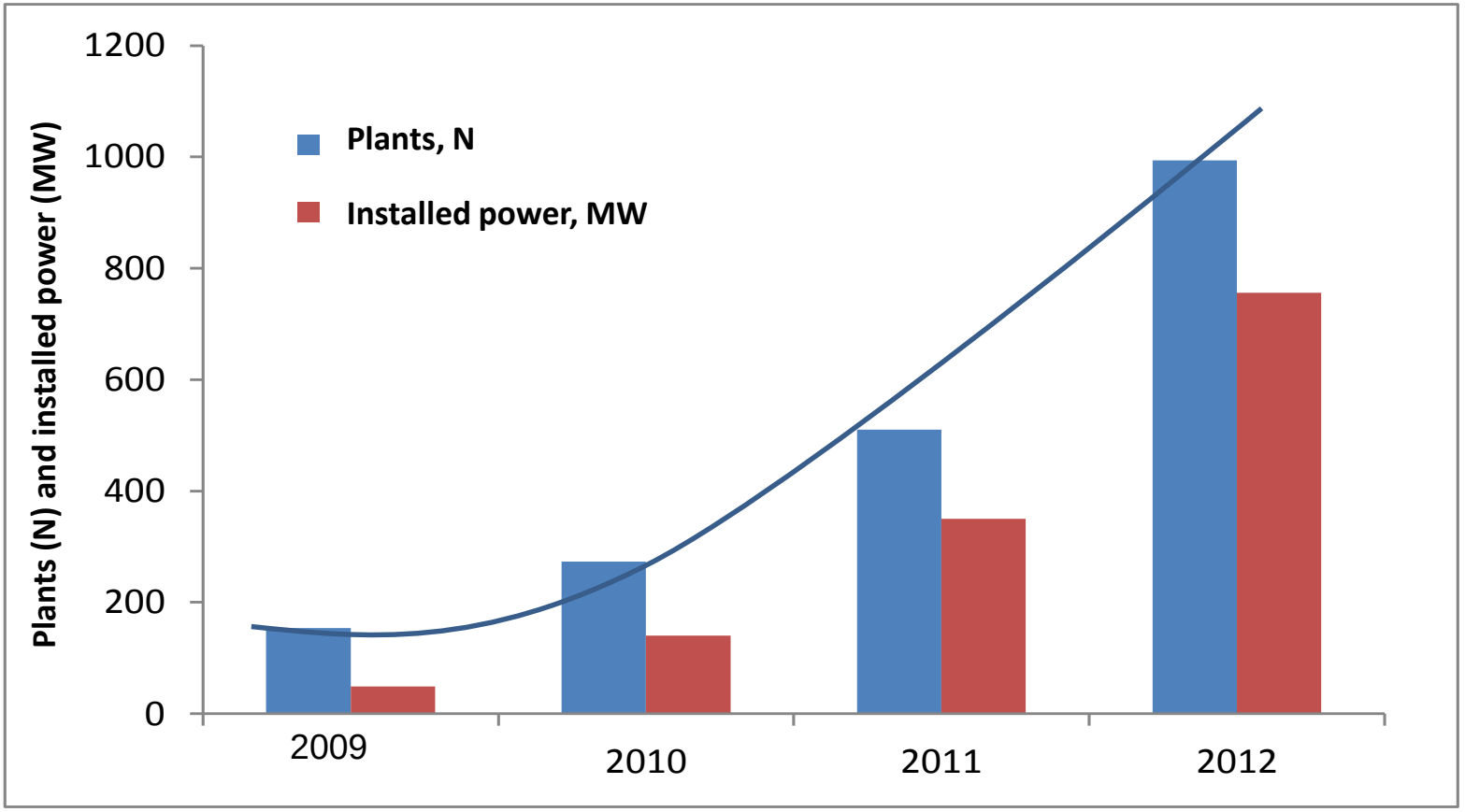


Figure 1 annual ■, cumulative ■, and cumulative average installed capacity -◆-

De Baere, WST, 2006

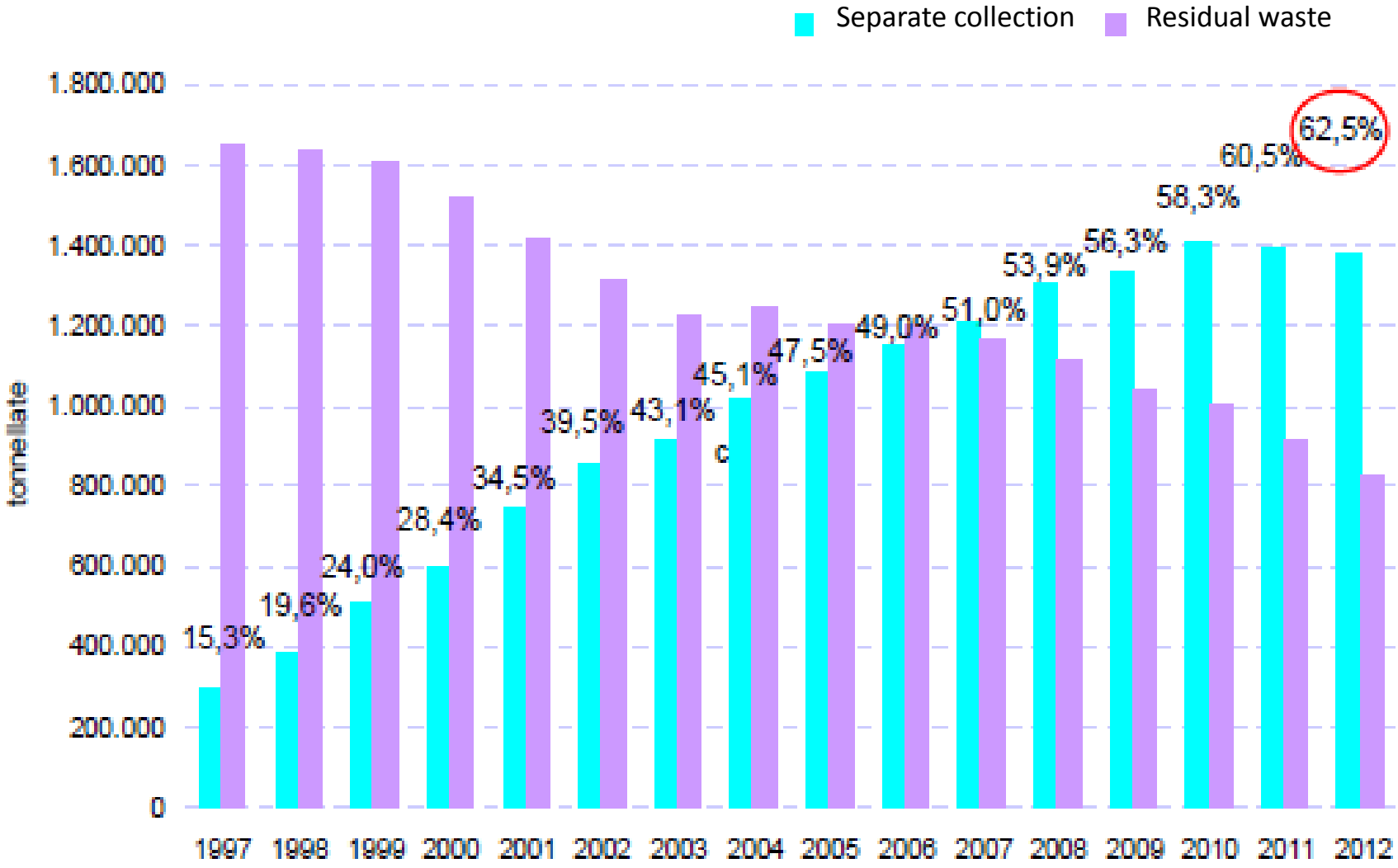
1000 plants in 2012, 3,5 billions Euros investments, 800 MW installed, 7,000 GWh/year produced (electric)



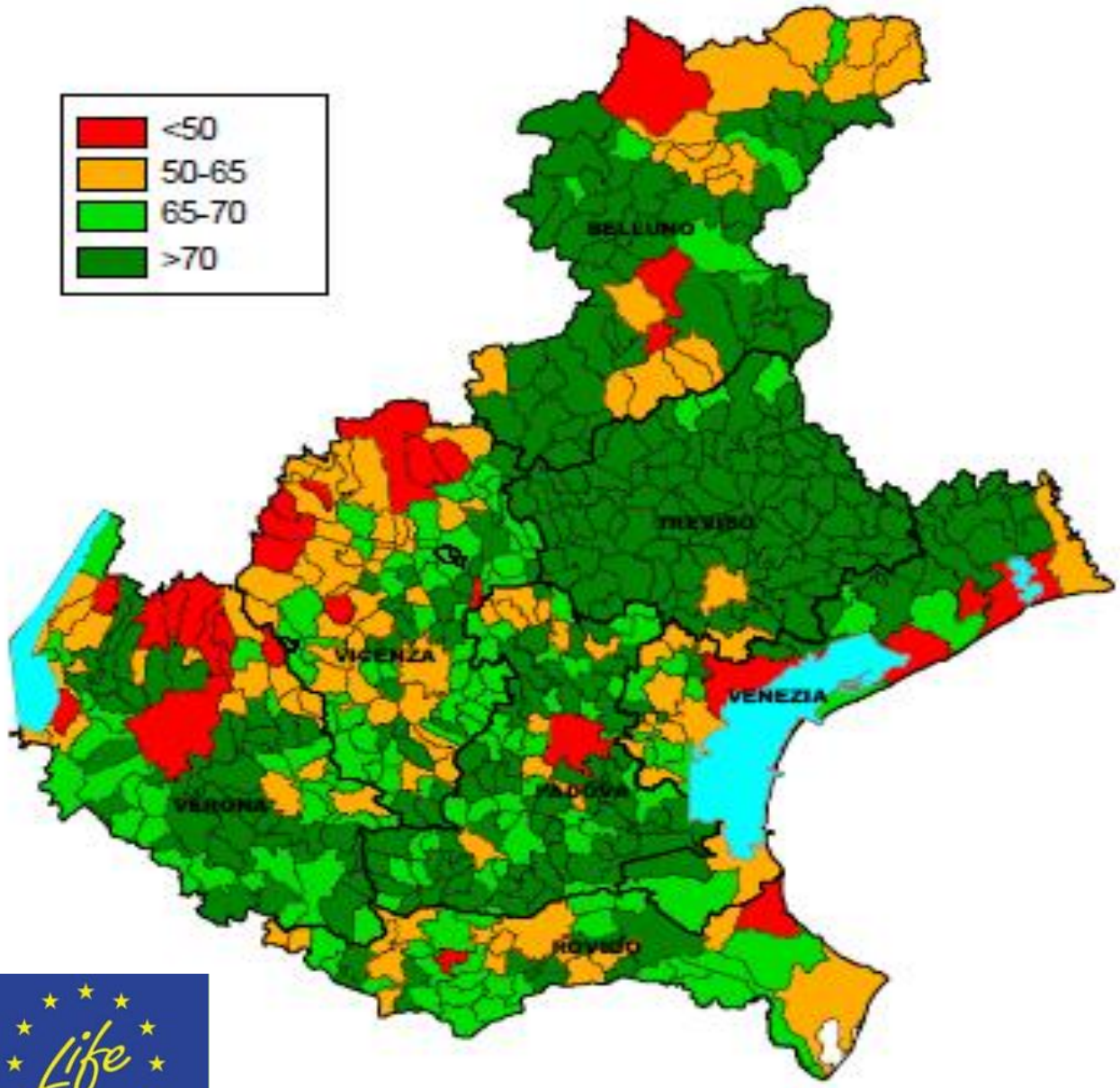
Efficent separate collection is the key for AD success !!

Case study
the Veneto Region

- **7 Provinces**
- **5,0 milion people**
- **2,213,653 tons municipal waste**
- **63% separate collection (on avg.)**
- **647,000 tons organic**
- **284,000 tons paper**
- **191,000 tons glass**
- **98,000 tons plastic**

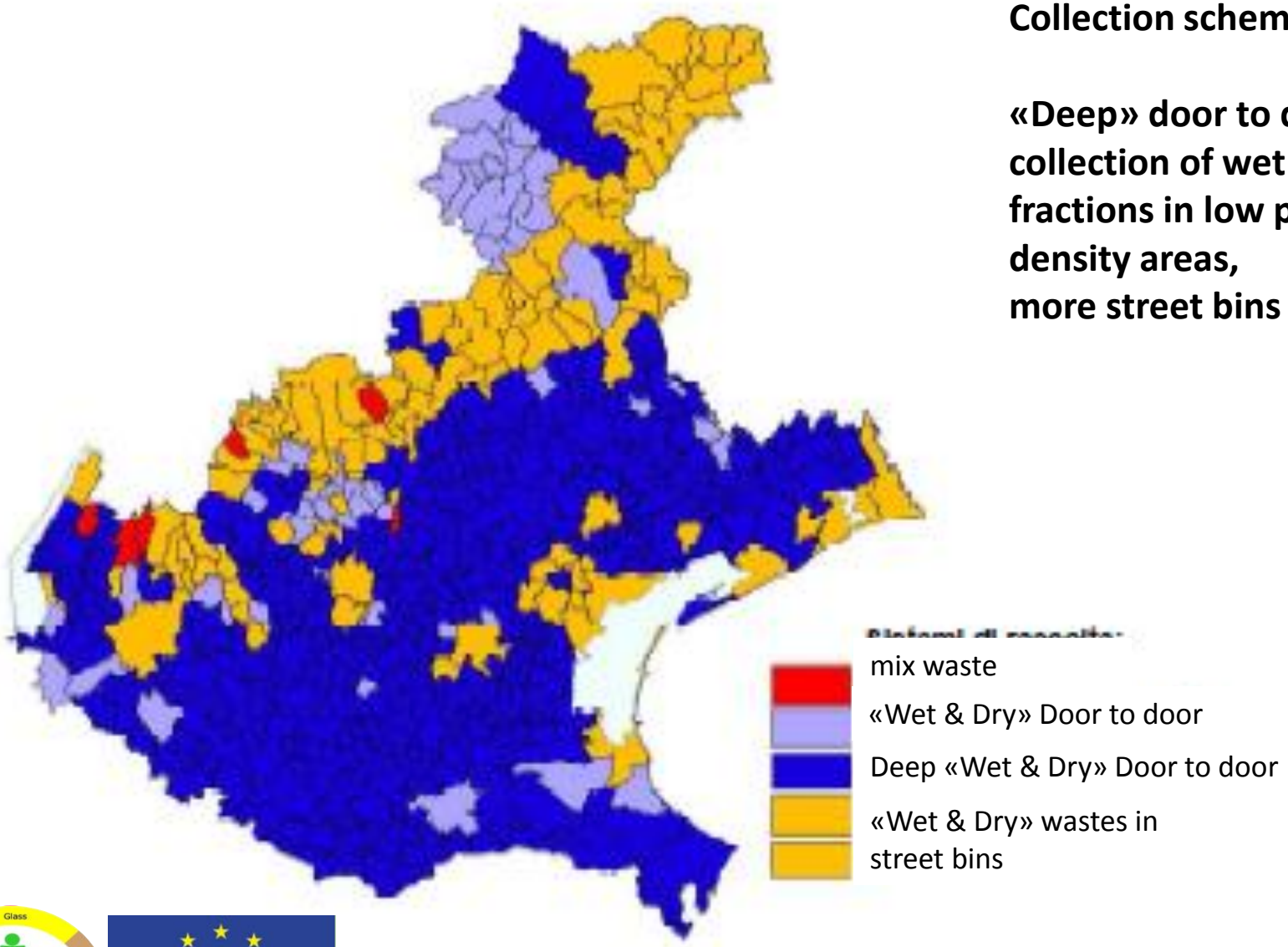

Separate collection
Residual waste
tonnellate
1.800.000
1.600.000
1.400.000
1.200.000
1.000.000
800.000
600.000
400.000
200.000
0
15,3%
19,6%
24,0%
28,4%
34,5%
39,5%
43,1%
45,1%
47,5%
49,0%
51,0%
53,9%
56,3%
58,3%
60,5%
62,5%
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012

Successful in areas with a “low population density” … less impressive in the cities …



Collection schemes: street bins for biowaste, glass, paper, plastic …

Door to door collection in small caddies.
Bio-polymer or paper bags are used for biowaste



Collection schemes:

«Deep» door to door collection of wet and dry fractions in low population density areas,
more street bins in the cities

143 € per inhabitant per year
(290 € per ton of waste)

- **60 € per inh per year for mixed waste (collection+transport+disposal)**
- **30 € per inh per year for separate waste streams (collection+transport+treatment)**
- **12 € per inh per year for street cleaning**
- **35 € per inh per year for management/admin**
- **6 € per inh per year for capital cost (amortisation)**

Changing biowaste characteristics changes the paradigm in plants pre-treatments configuration ……..

Shredded food waste

Courtesy of Michael Chesshire

Passing from “complicated” pre-treatment lines …..

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Passing from “complicated” pre-treatment lines …..

Figure 2: Waste separation using a trommel screen

Passing from “complicated” pre-treatment lines …..

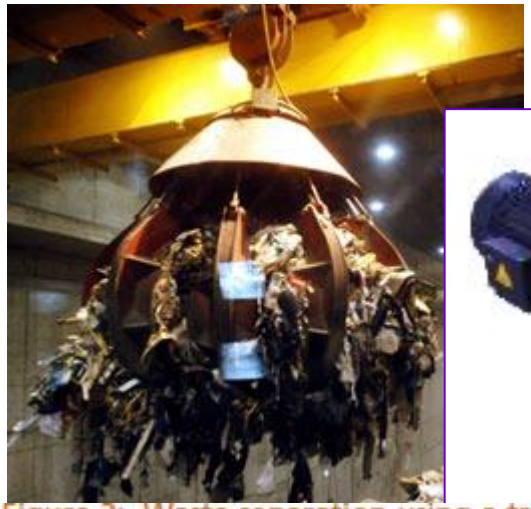
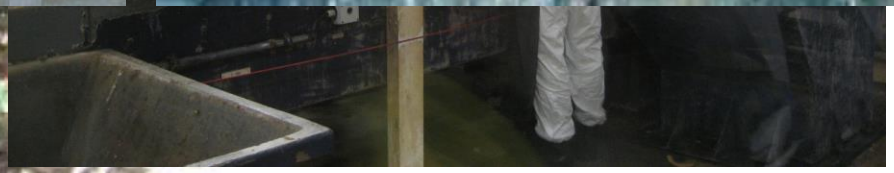


Figure 2: Waste separation using a trommel screen

Passing from “complicated” pre-treatment lines …..



….. to simplified systems ….


HS 640
Tiger
HS 640

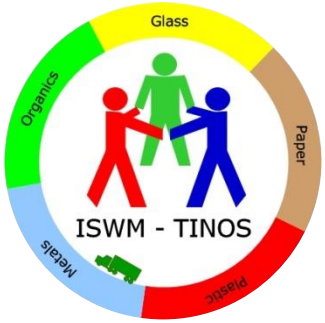
….. to simplified systems ….


Doppstadt
DSP 20

Solid stream

Liquid stream

According to this scenario In the TINOS LIFE+ ENVIRONMENT PROJECT LIFE 10/ENV/GR/000610 we decided to treat the separately collected organic waste in a press and to anaerobically digest the liquid stream … .

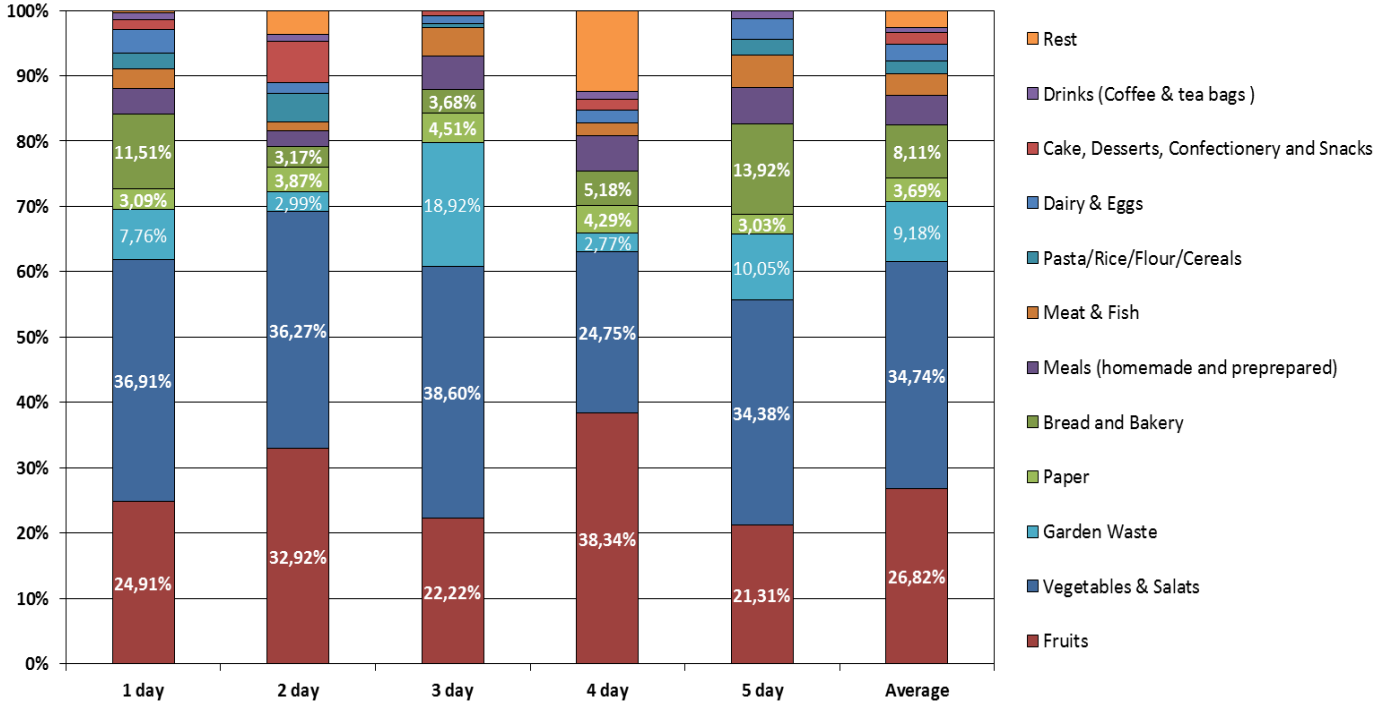


Development and implementation of a demonstration system on Integrated Solid Waste Management for Tinos in line with the Waste Framework Directive

ISWM-TINOS

LIFE10 ENV/GR/000610

Tinos Biowaste composition analysis



Source Collected biowaste

Shredding

Press

Liquid stream to meso-thermo AD

Solid

Liquid stream to meso/thermo AD

Digestate to Post-treatment

	Mesophilic	Thermophilic
Temperature, °C	37	55
OLR, kgVS/m3d	3,5 up to 4,5	3,5 up to 4,5
HRT, d	20	20
Yields		
SGP, m3/kgVS	0,64 up to 0,82 (0,76)	0,78 up to 0,94 (0,85)
GPR, m3/m3d	2,2 up to 3,6 (3,1)	2,7 up to 4,2 (3,4)
GP, m3/ton biowaste	160	180
CH4, %	66	66
VS removal, %	80	90

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GP, m3/ton biowaste	160	180
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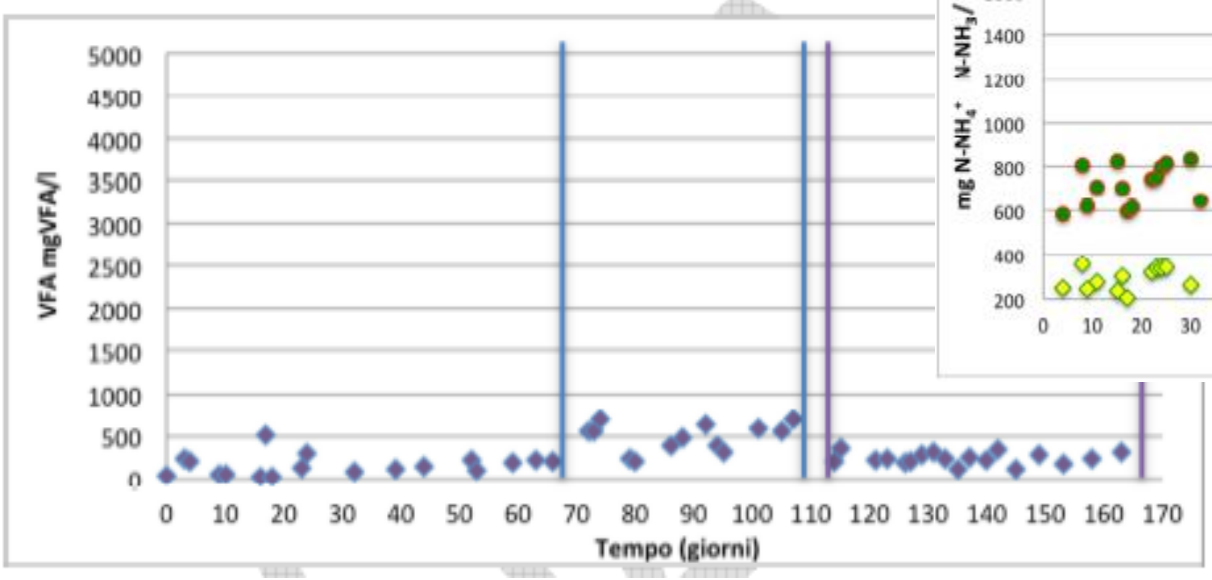
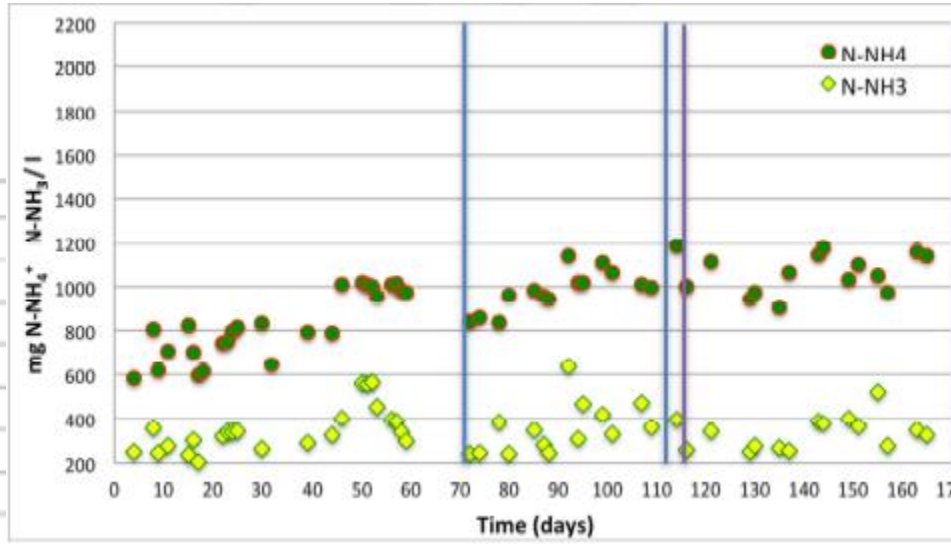
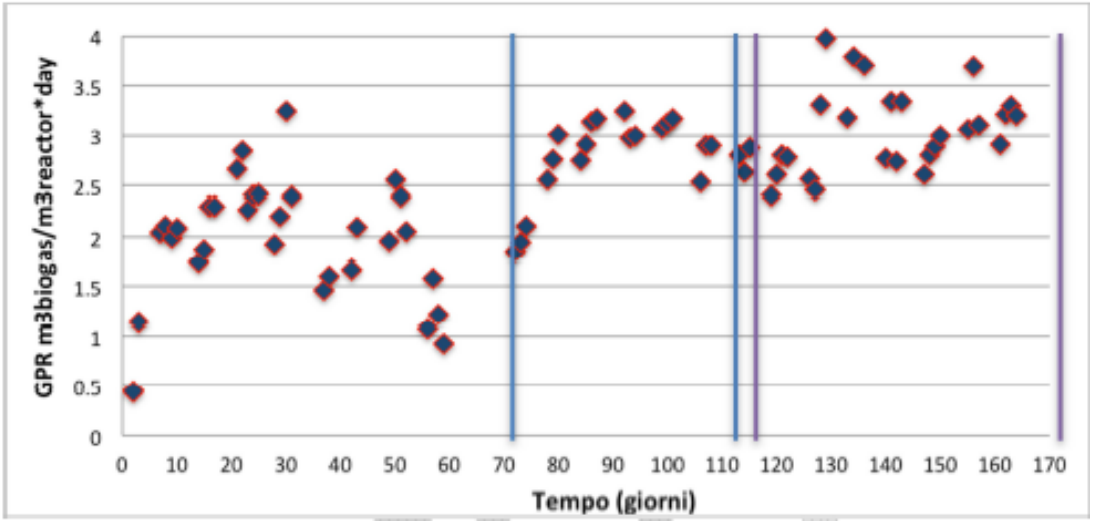
VS removal, %	80	90

Stable process, also in thermophilic conditions !







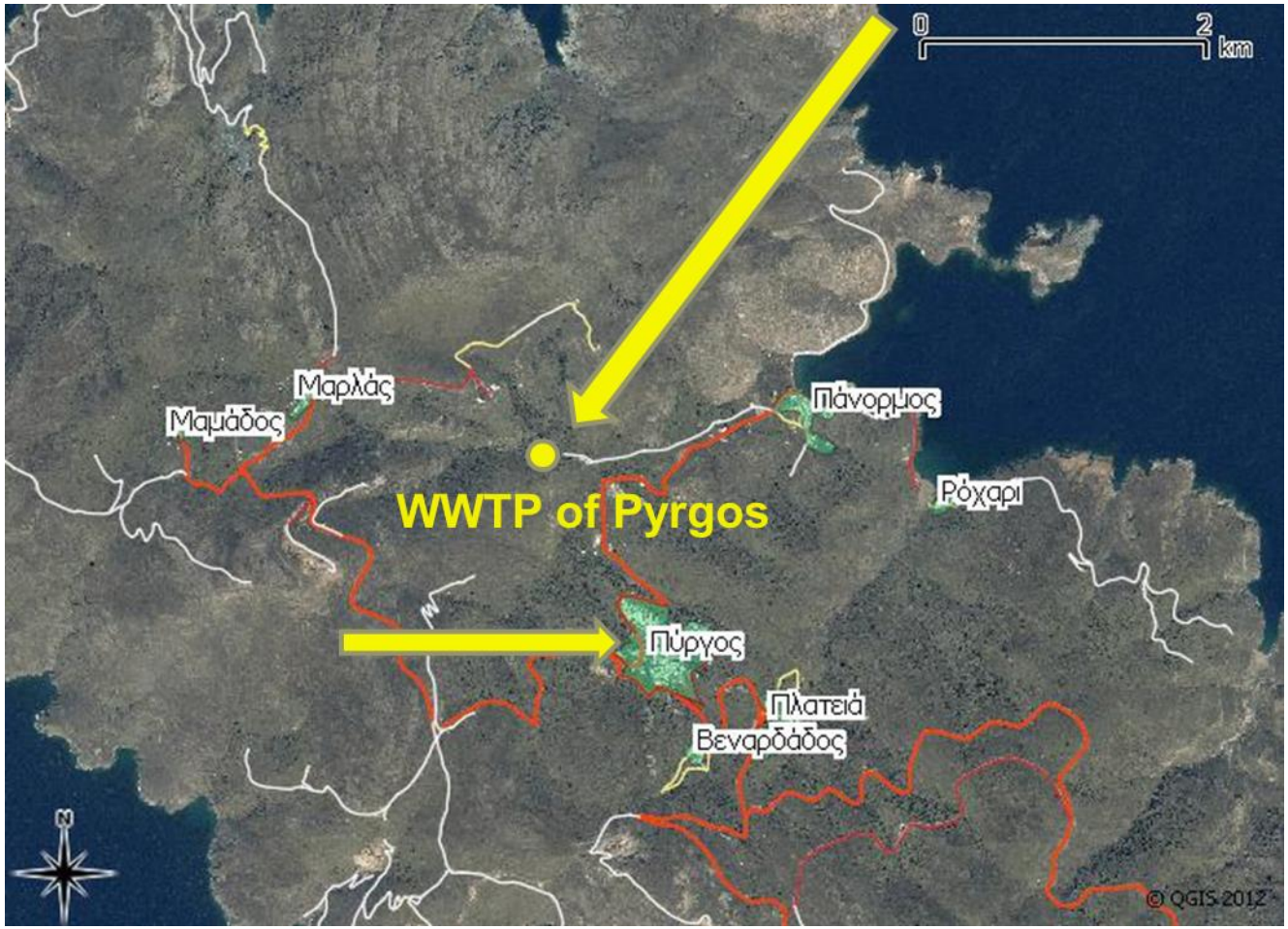
ISWM - TINOS

Digestate quality and EoW – heavy metals

	Italian DLgs. 75 – 2010	EoW 2014	Biowaste	Meso digestate	Thermo digestate
Cu mg/kg s.s.	150	200	47	68.1	52.5
Zn mg/kg s.s.	500	600	112	155	129
Pb mg/kg s.s.	140	120	1.54	17.3	7.81
Ni mg/kg s.s.	100	50	43.7	42.1	27
Cr_{tot} mg/kg s.s.	-	100	61.5	85.9	51.5
Cd mg/kg s.s.	1.5	1.5	0.4	0.23	0.26
Hg mg/kg s.s.	1.5	1	0.055	0.24	0.08
As mg/kg s.s.	5	10	0.24	0.25	0.19

Digestate quality and EoW – pathogens

	Escherichia coli	Total Coliphorms	Salmonella spp
Biowaste	$4 \cdot 10^4$ - $7 \cdot 10^5$ UFC/g	$6 \cdot 10^5$ - $1 \cdot 10^6$ UFC/g	Absent in 25 g
Meso digestate	$2\text{-}3 \cdot 10^3$ UFC/g	$2\text{-}3 \cdot 10^3$ UFC/g	Absent in 25 g
Thermo digestate	$1\text{-}4 \cdot 10^3$ UFC/g	10^3 - 10^4 UFC/g	Absent in 25 g
EoW 2014	1000 UFC/g	---	Absent in 25 g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Μαμάδος
Πάνορμος
WWTP of Pyrgos
Ρόχαρι
Πύργος
Πλατειά
Βεναρδάδος
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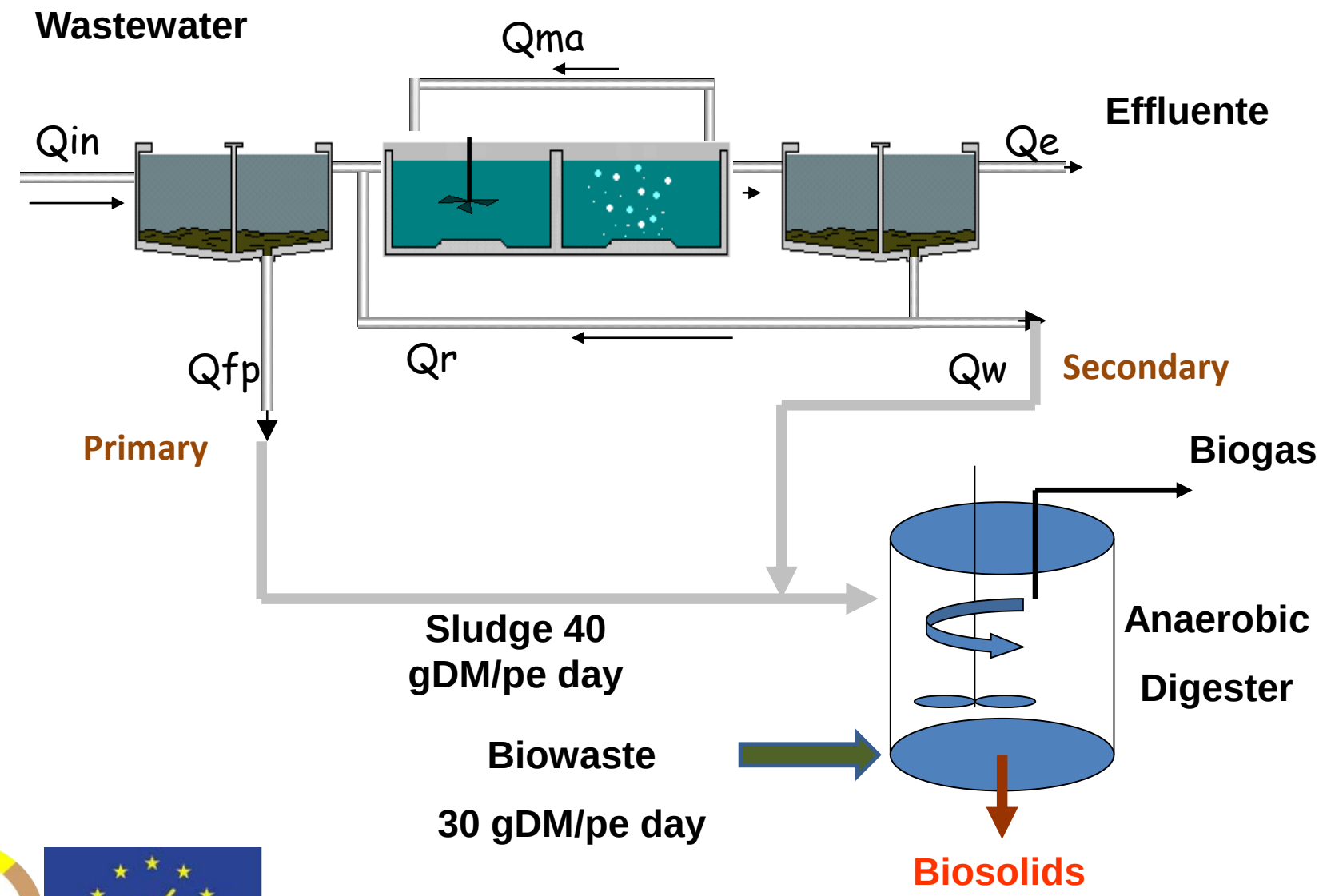
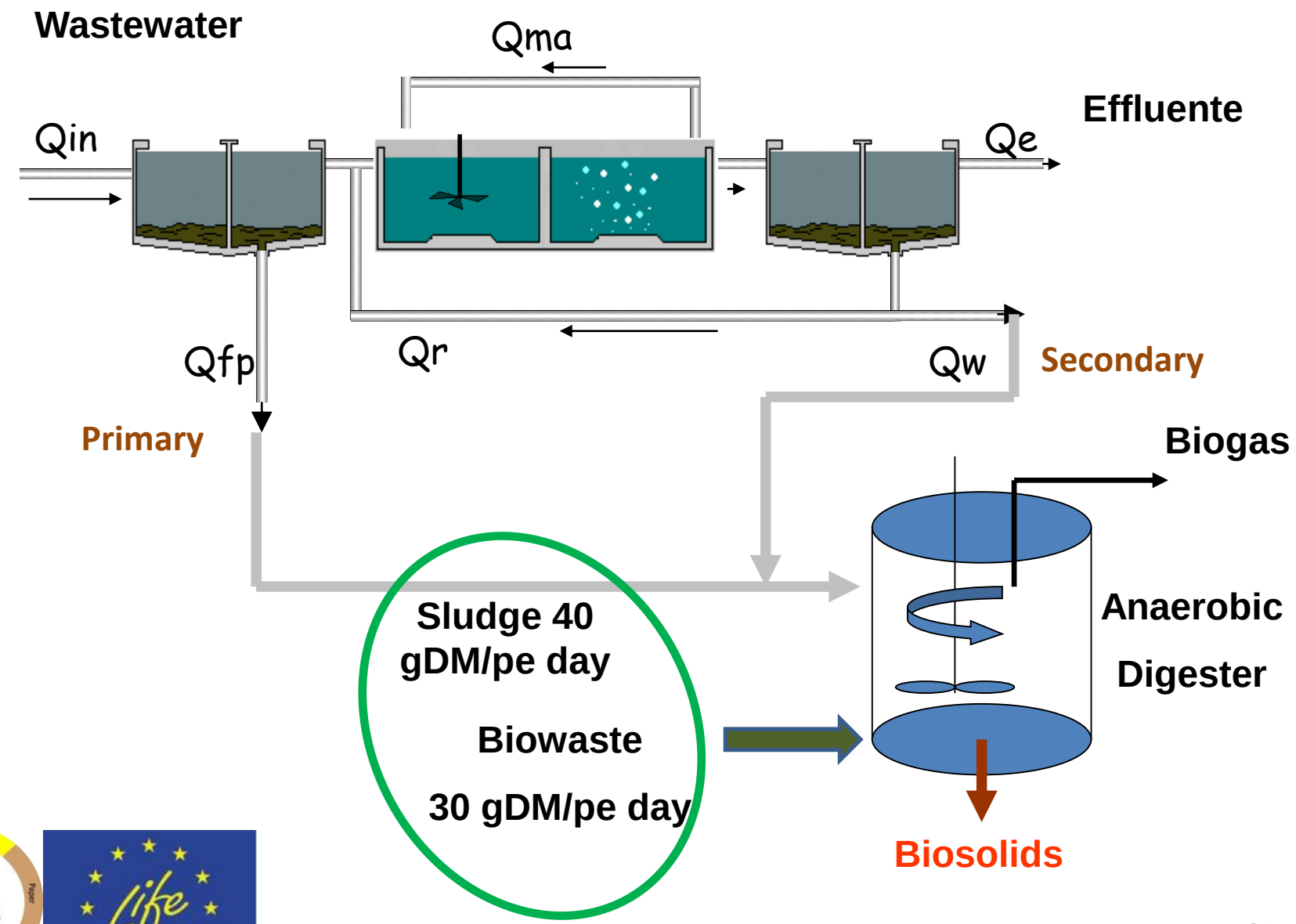
© QGIS 2012

Co-digestion of biowaste and sludge



Co-digestion of biowaste and sludge



	Mesophilic	Thermophilic
Temperature, °C	37	55
OLR, kgVS/m3d (60/40 sludge/biowaste)	1,7	1,7
HRT, d	20	20
Yields		
SGP, m3/kgVS	0,56	0,63
GPR, m3/m3d	0,9	1,0
CH4, %	66	66
VS removal, %	50	55

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GPR, m3/m3d	0,9	1,0
CH4, %	66	66
VS removal, %	50	55

Digestate quality and EoW – heavy metals

	EoW 2014	Biowaste	Sludge	Meso co- digestion	Thermo co-digestion
Cu mg/kgs.s.	200	47	249	138	106
Zn mg/kgs.s.	600	112	1015	452	352
Pb mg/kgs.s.	120	1.54	39	0.2	0.1
Ni mg/kgs.s.	50	43.7	30	17.4	23.5
Crtot mg/kg s.s.	100	61.5	40	34.8	29.4
Cd mg/kgs.s.	1.5	0.4	0.2	0.1	0.1
Hg mg/kgs.s.	1	0.055	0.2	0.1	0.1
As mg/kgs.s.	10	0.24	9	0.2	0.1

	Escherichia coli	Coliformi Totali	Salmonella spp
Biowaste	$7x10^5$ UFC/g	$6x10^5$ UFC/g	Absent in 25 g
Sludge (WAS)	$1x10^4$ UFC/g	$3x10^6$ UFC/g	Absent in 25 g
Thermo co-digestate	$3x10^3$ UFC/g	$1x10^3$ UFC/g	Absent in 25 g
Meso-co-digestate	$3x10^3$ UFC/g	$2x10^4$ UFC/g	Absent in 25 g
EoW 2014	$1x10^3$ UFC/g	---	Absent in 25 g

Conclusions – take home messages

- ✓ **separate collection is a pre-requisite to have waste streams of good quality for further treatment …. Treating low quality streams will result in low yields and poor by-products (no market)**

- ✓ **it can be implemented at reasonable costs**

- ✓ **anaerobic digestion of biowaste from a door to door collection scheme is highly effective both in terms of energy recovery and final digestate quality**