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Ingegneria Ambiente S.r.l.

# Anaerobic co-digestion of market waste: an Italian experience

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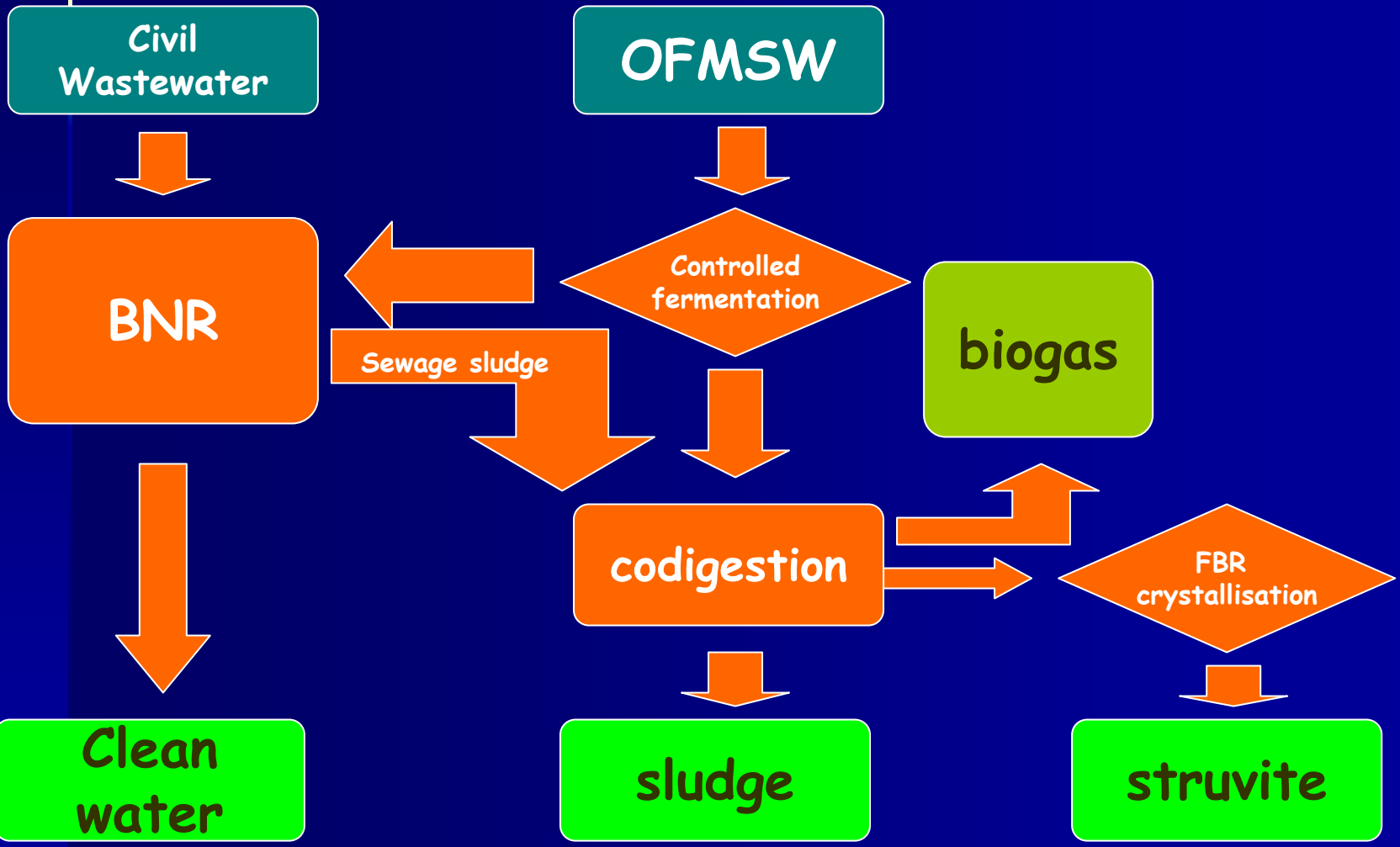
# Italian laws about wastewater and Municipal Solid Waste

- European Community directive 271/91 lead to D.L.vo 152/99 as nutrient control on WWTP discharge

- European Community directives 91/156, 91/689 and 94/62 lead to D. L.vo 22/97 (decreto Ronchi) lead to different disposal for dry and wet fraction of waste



# Integrated process AF-BNR-SCP



# Plant capacity and loads

- Equivalent inhabitants: 50.000+20.000
- waste capacity: up to 20 t/d
- Hydraulic loading: 14.000+9600 m3/d
- Organic loading: 3570+1200 KgBOD/d
- Nitrogen loading: 602+241 KgN/d
- Phosporous loading: 84+34 KgP/d
- F/M (ox): 0.125
  KgBOD/KgMLSS

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# WASTEWATER CHARACTERISTICS

| Parameter | Wastewater | | | | Septage | | | | Sewage sludge | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | avg | min | max | S.D. | avg | min | max | S.D. | avg | min | max | S.D. |
| TSS, mg/l | 113 | 12 | 644 | 86 | 18880 | 3000 | 51060 | 10897 | | | | |
| TVSS, mg/l | | | | | 13901 | 1685 | 41614 | 7101 | | | | |
| TS, g/kg | | | | | 20 | 4 | 84 | 14 | 8.4 | 3.6 | 15.1 | 2.4 |
| TVS, g/kg | | | | | 14 | 3 | 80 | 13 | 5.2 | 2.3 | 9.8 | 1.5 |
| Alkalinity, mg$CaCO_3$/l | 299 | 225 | 410 | 44 | | | | | | | | |
| TCOD, mg$O_2$/l | 107 | 37 | 374 | 40 | 14423 | 6000 | 48113 | 7946 | | | | |
| BOD, mg$O_2$/l | 55 | 18 | 132 | 20 | 4893 | 6 | 10500 | 2213 | | | | |
| SCOD, mg$O_2$/l | 46 | 10 | 167 | 31 | 1354 | 0 | 5300 | 1216 | | | | |
| TKN, mgN/l | 11.1 | 1.7 | 27.1 | 3.7 | 394.6 | 66.0 | 955.2 | 212.7 | | | | |
| Total N, gN/kgTS | | | | | | | | | 33.3 | 11.0 | 54.6 | 10.6 |
| $NH_3$-N, mgN/l | 6.6 | 1.3 | 16.0 | 2.4 | 172.7 | 14.0 | 592.3 | 116.5 | 1.8 | 0.0 | 14.2 | 2.7 |
| $NO_3$-N, mgN/l | 1.5 | 0.1 | 5.9 | 0.8 | 3.2 | 0.5 | 9.7 | 2.7 | 1.6 | 0.0 | 4.6 | 1.2 |
| $NO_2$-N, mgN/l | 0.1 | 0.0 | 1.0 | 0.1 | | | | | 2.9 | 0.0 | 7.8 | 3.0 |
| Total P, mgP/l | 2.6 | 0.3 | 8.6 | 1.4 | 87.0 | 23.0 | 388.5 | 40.0 | | | | |
| Total P, gP/kgTS | | | | | | | | | 14.7 | 0.54 | 3.40 | 0.56 |
| $PO_4$-P, mgP/l | 1.0 | 0.1 | 4.2 | 0.6 | 16.0 | 1.7 | 64.0 | 12.3 | 1.0 | 0.0 | 19.5 | 2.6 |

# Market waste CHRACTERISTICS
## (as collected)

| Parameter | Average | Std.Dev. | min | max |
|---|---|---|---|---|
| TCOD, $gO_2$/kgTS | 2127 | 281.4 | 1726 | 2384 |
| TKN, g/kgTS | 30.9 | 4.9 | 15.5 | 26.3 |
| Total P, gP/kgTS | 7.1 | 1.9 | 4.5 | 8.5 |
| TS, g/kg | 296.4 | 93.1 | 201.3 | 350.2 |
| TVS, %TS | 76.3 | 10.1 | 65.8 | 89.1 |

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# TREVISO WWTP



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# Mass balance of waste pre-treatment

| OFMSW | |
|---|---|
| Organic | 590.5 |
| Plastic | 145.8 |
| Metals | 22.0 |
| Glass | 25.4 |
| Textiles | 13.3 |
| Wood | 15.3 |
| Paper | 164.7 |
| Inerts | 23.0 |
| **Total** | **1000.0** |

| Iron removal | |
|---|---|
| Organic | 4.2 |
| Plastic | 5.6 |
| Metals | 11.8 |
| Glass | 0.1 |
| Textiles | 0.6 |
| Wood | 0.1 |
| Paper | 1.6 |
| Inerts | 0.5 |
| **Total** | **24.6** |

| Floats | |
|---|---|
| Organic | 38.4 |
| Plastic | 33.9 |
| Metals | 0.0 |
| Glass | 0.0 |
| Textiles | 1.8 |
| Wood | 10.2 |
| Paper | 0.5 |
| Inerts | 3.4 |
| **Total** | **88.2** |

Pre-treatment → Mixer → Fermenter

| Outlet | |
|---|---|
| Organic | 450.7 |
| Plastic | 9.5 |
| Metals | 0.0 |
| Glass | 0.4 |
| Textiles | 2.9 |
| Wood | 2.1 |
| Paper | 121.7 |
| Inerts | 7.7 |
| **Total** | **595.0** |

| Screen | |
|---|---|
| Organic | 45.4 |
| Plastic | 81.9 |
| Metals | 5.1 |
| Glass | 0.0 |
| Textiles | 7.0 |
| Wood | 2.6 |
| Paper | 12.9 |
| Inerts | 10.6 |
| **Total** | **165.6** |

| II°iron removal | |
|---|---|
| Organic | 5.5 |
| Plastic | 0.4 |
| Metals | 2.6 |
| Glass | 0.2 |
| Textiles | 0.1 |
| Wood | 0.1 |
| Paper | 0.2 |
| Inerts | 0.3 |
| **Total** | **9.3** |

| Bottom | |
|---|---|
| Organic | 46.2 |
| Plastic | 14.5 |
| Metals | 2.4 |
| Glass | 24.7 |
| Textiles | 0.9 |
| Wood | 0.3 |
| Paper | 27.8 |
| Inerts | 0.4 |
| **Total** | **117.4** |

# waste characteristics after pre-treatment

| Item | Average | Std.Dev. | Max | Min |
|---|---|---|---|---|
| TCOD, $gO_2$/kgTS | 2144 | 422 | 2744 | 1800 |
| SCOD, $gO_2$/kgTS | 222 | 78 | 278 | 111 |
| TKN, gN/kgTS | 33 | 2 | 38 | 30 |
| $NH_3$-N, gN/l | 49.3 | 8.6 | 50.4 | 48.0 |
| TP, gP/l | 13 | 4 | 19 | 8 |
| TS, g/kg | **90** | 17 | 105 | 51 |
| TVS, %TS | **87** | 4 | 93 | 79 |
| VFA, mgCOD/l | 1123 | 314 | 1485 | 740 |

**Which means:**

**99 % metals removal**

**90 % non putrescible fraction removal**

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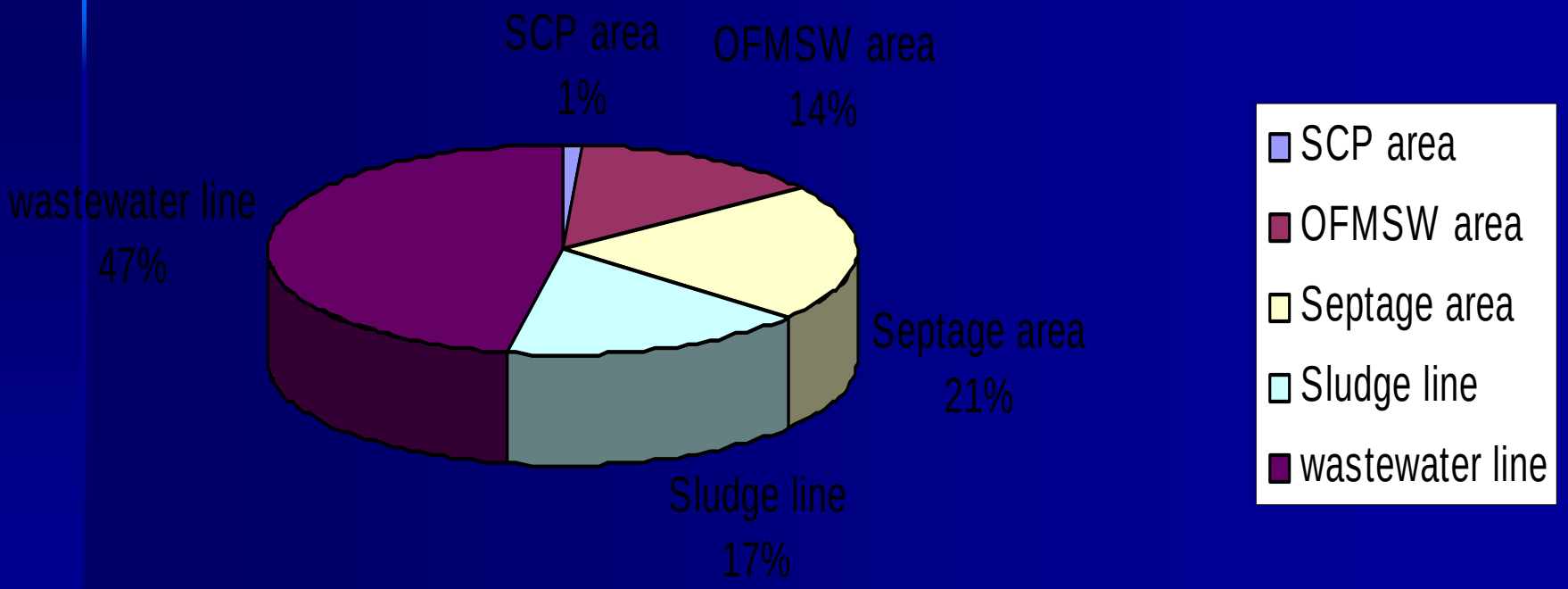
# Comparison between sludge digestion and co—digestion performances

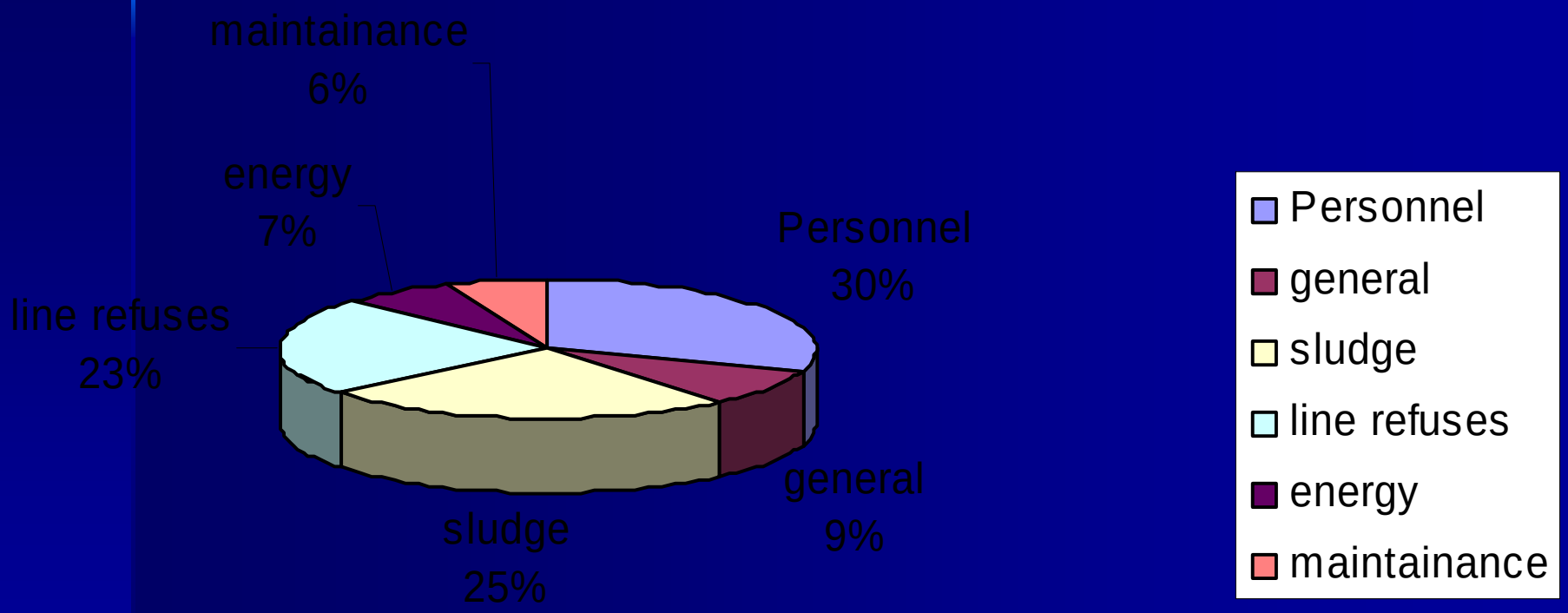
| Parameter | Sludge only | Co-digestion |
|---|---|---|
| HRT, d | 37.2 | 35.6 |
| OLR, kgTVS/m3 d | 0.53 | 0.78 |
| TS, g/Kg | 36.0 | 41.0 |
| TVS, %TS | 62 | 67 |
| GPR, m3/m3 d | 0.10 | 0.34 |
| SGP, m3/kgTVS | 0.13 | 0.43 |
| pH | 6.90 | 7.2 |
| TA(4), mgCaCO3/l | 1865 | 3058 |

Which means, on a monthly basis, a change from 3300 to 20.000 m3/month of biogas produced

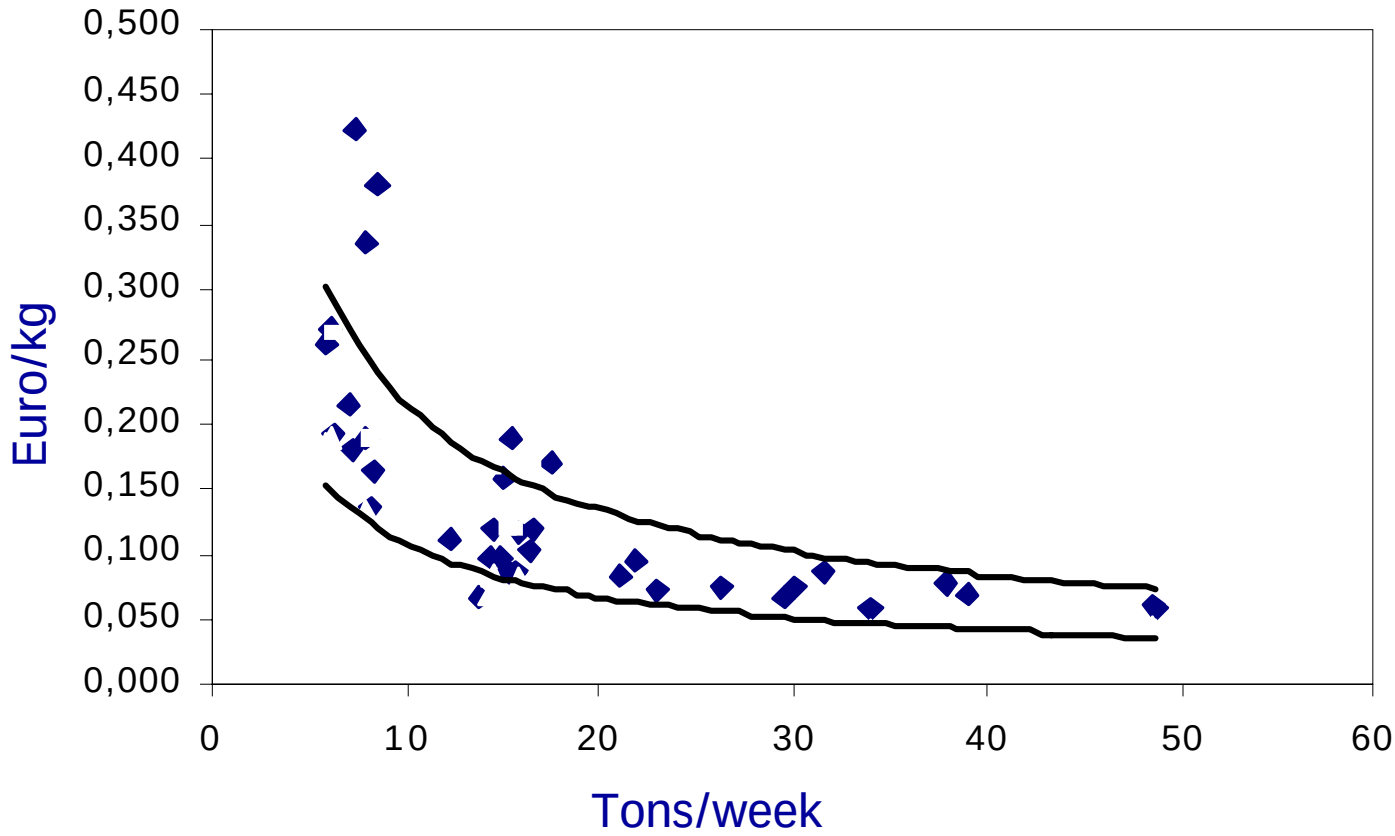
# Cost fractionation in the whole plant



# Cost fractionation for the waste treatment area



# Cost x tonn referred to the tons treated per week



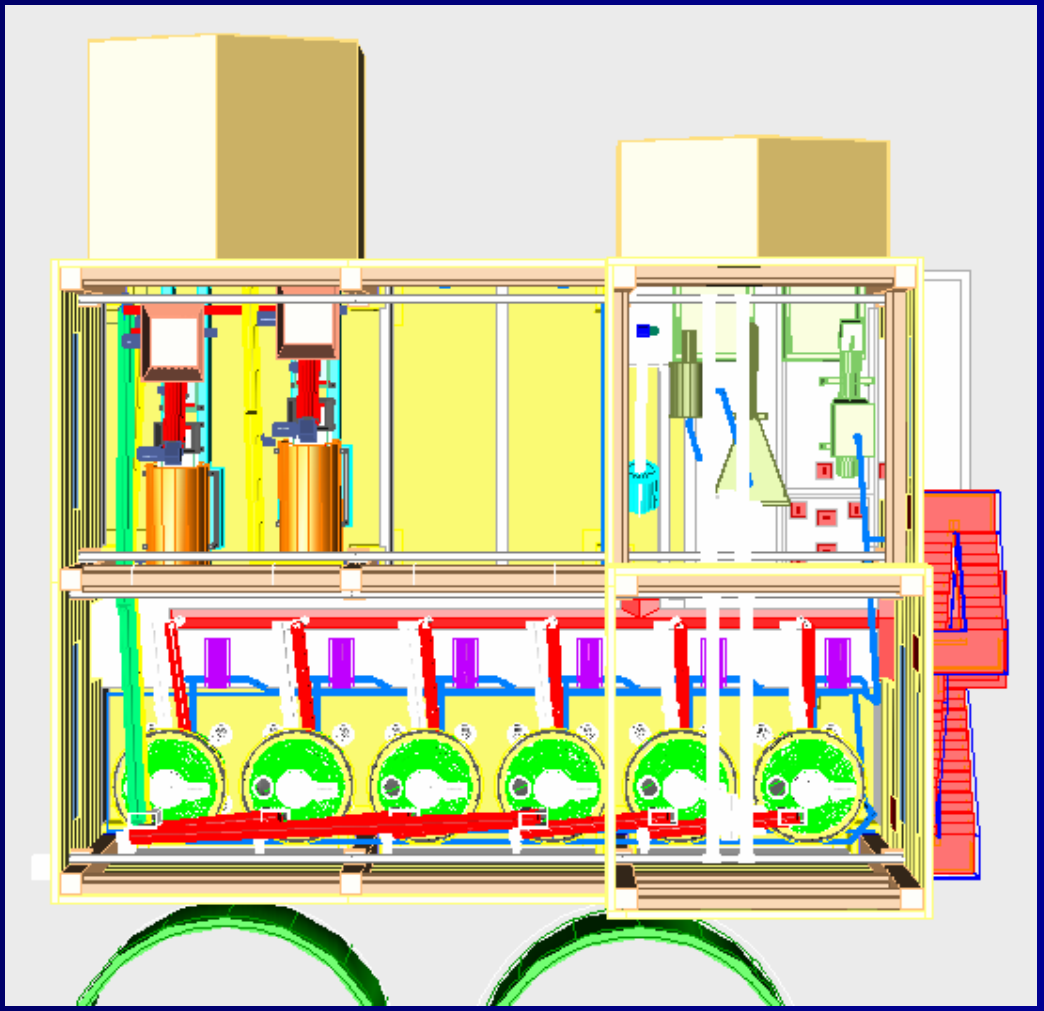
# These costs are evaluated without energy incomes!

- In Italy, a ‘bonus’ income coming from the application of process which use renewable resources for energy production is given in the form of 97.39 Euros/MW
- Considering the actual average value of energyand the yields obtained, an income of about

**80-93 euros x ton can be considered**

# The same approach is foreseen for the new WWTP of Viareggio (100.000 E.I., centre Italy)

# Sorting line overview



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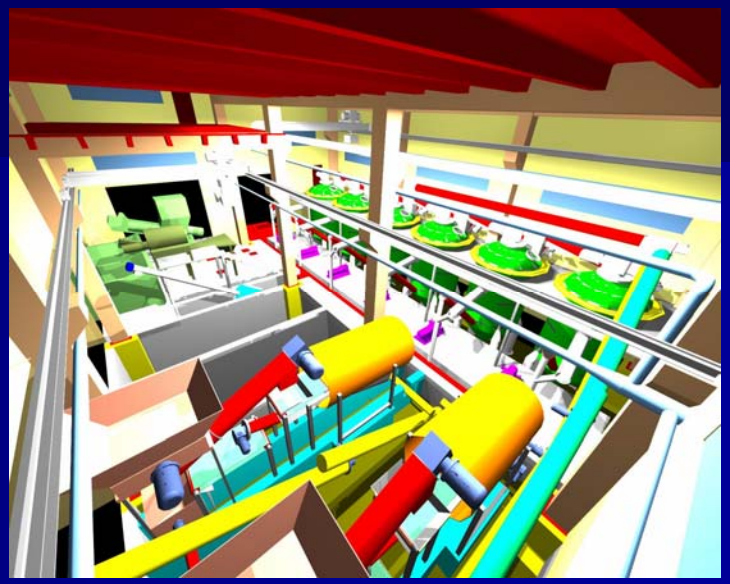

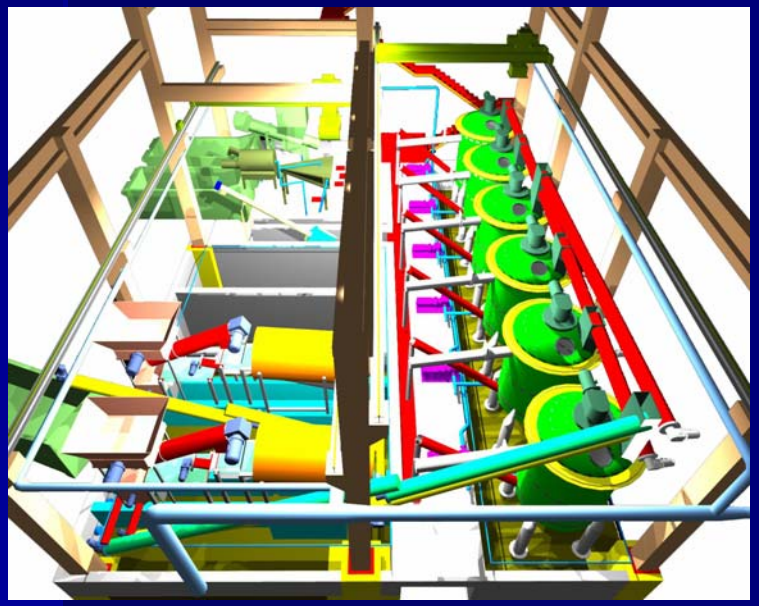

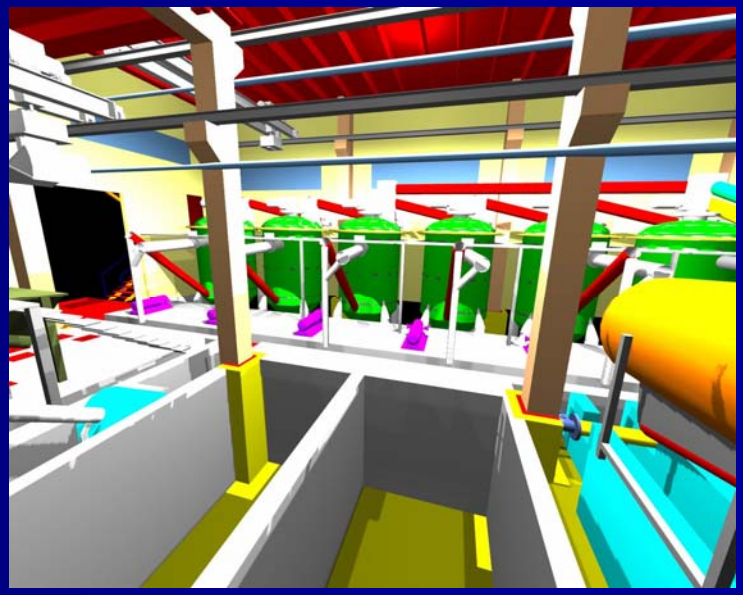




# Conclusions (1/4)

- The waste pre-treatment proposed allows removal yields of 99% about metals and 90 % about other non putrescible fractions;
- The effluent from the sorting line has optimal characteristics: 90 g/KgTS and nearly 90 % TVS




# Conclusions (2/4)

- The biogas production increase from 0.10 to 0.34 m3/m3 d as GPR and from 0.13 to 0.43 m3/kgTVS as SGP. This means a change from 3300 to 20.000 m3 of biogas produced on a montly basis

- The use of the solid residue of fermented OFMSW allows a double SGP value comparing the sludge alone production (from 0.13 to 0.27 m3/kgTVS). This option allows to use the liquid residue to improve denitrification step in water treatment.




# Conclusions (3/4)

The cost of the waste area management represent only the 14 %;

- The energy cost is only the 7 % of the total management cost for the area: the main costs are given by residue and sludge disposal (48 %);
- With the actual plant, the cost of waste disposal can ba maintained below the 50 euro/ton when a capacity of 50 tons/week is reached, which is lower than the average cost of organic waste disposal

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# Conclusions (4/4)

- An average income of 80-93 euros/ton of waste treated con be considered

# Engineering:

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# Thank you for your attention

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