ASSISTANCE Gestion des déchets organiques

bio'logic

Erasmus Mundus Joint Doctorate / ETeCoS3 Summer school

**Biological and Thermal Treatment of Municipal Solid Waste**

# Status and Trends for Biological Treatment of Organic Solid Waste in France

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**Napoli – 5th May 2011**

**BIO'LOGIC *Assistance*** *is an* Expert and Engineering Consultant, created in 1995, specialist in Wastes and Sewage Management including biological treatment and specially anaerobic digestion.

## Public authorities support missions

- **Coaching for waste management policy definition**

-**Tender assistance** for biological treatment plants

- **Technical missions** (facility expertise, communication management, quality and training, feasibility studies, …)

## Industries support and training

- **Food industries management** for sustainable development

- **biological treatments** for organic waste or effluent with (composting or anaerobic digestion, biogas use, …)

- **treatment facilities assistance**

- R&D **Process development support**

## Training sessions

- made to measure
- for students, staff or operating workers

# Summary

1 - Waste treatment general data in France

2 – Regulation and other constraints

3 - Historic survey

4 – Trends and current examples

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# French annual waste, by producers

(data 2008, source : ADEME)

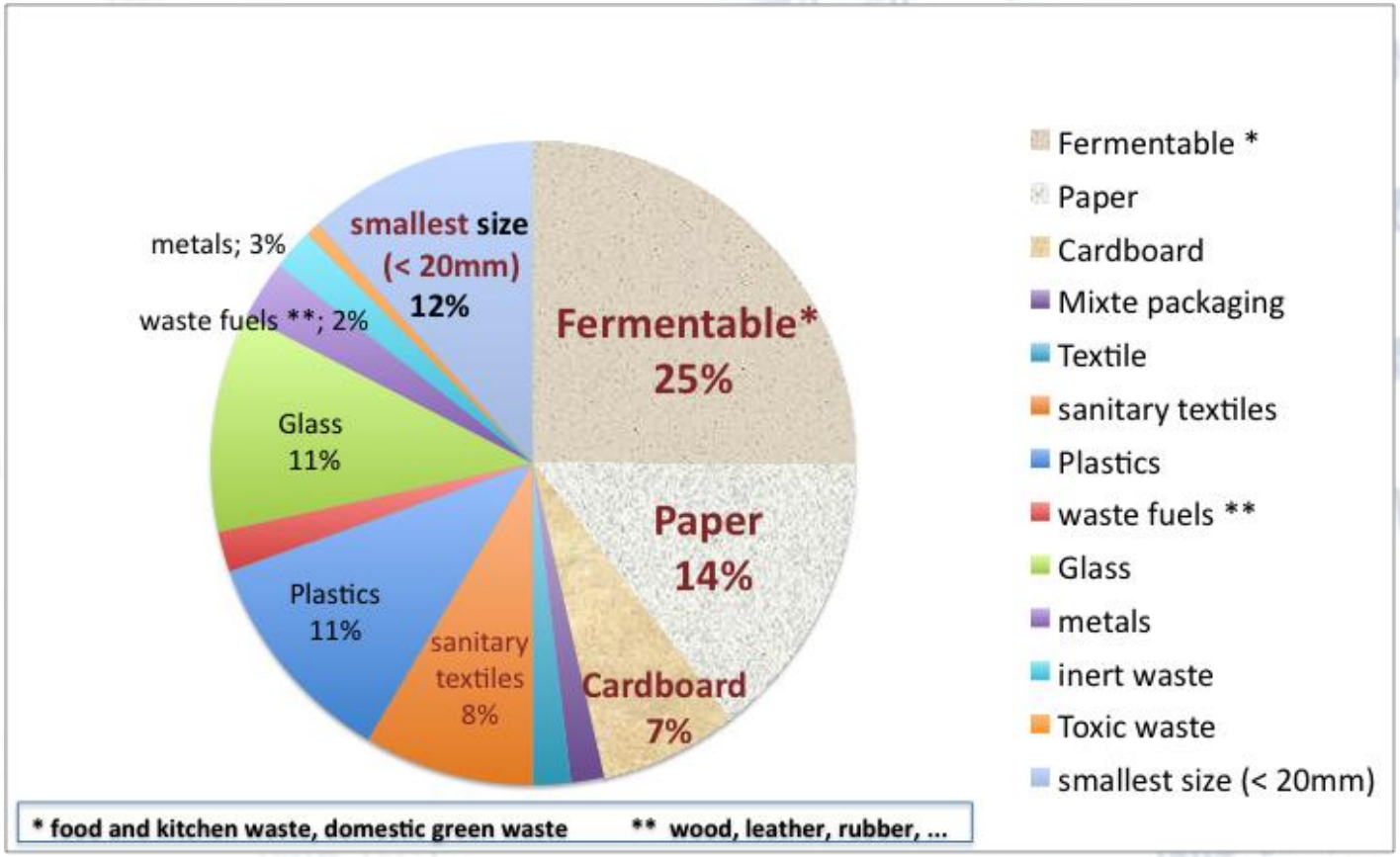
## Total production : 850 millions tons

| | | |
|---|---|---|
| - municipalities waste : | 14 | → 2% |
| - household waste: | 28 | → 4% |
| - industrial waste : | 90 | |
| - agriculture waste : | 374 | → 44% |
| - medical waste: | 0,2 | |
| - Building and public works | 343 | |

among which **global municipal collection** (sewage sludge, garden waste, garbage, market waste, stores and small industries, …) : **46 millions tons**

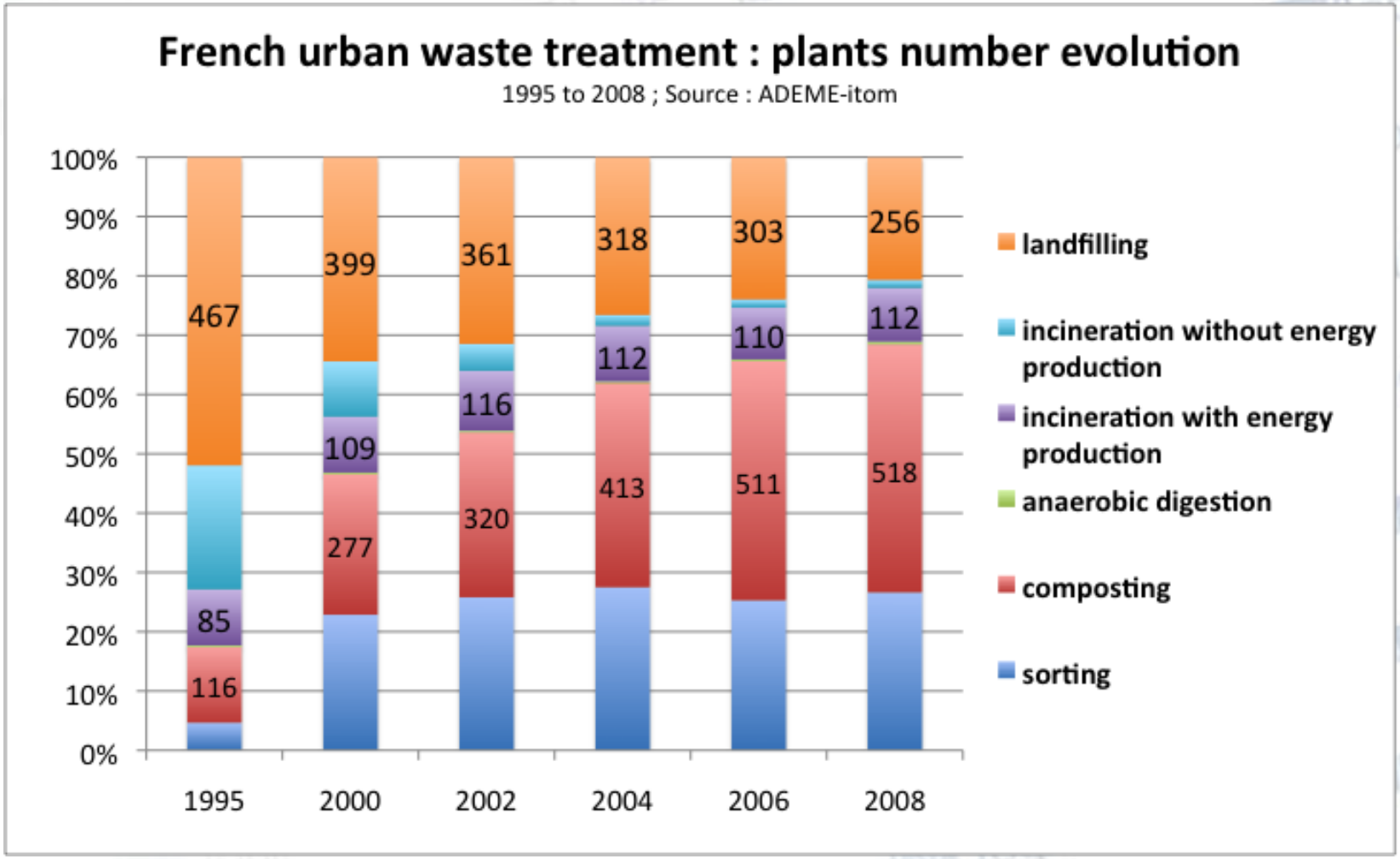
# French MSW - average composition

(source ADEME – itom 2008)

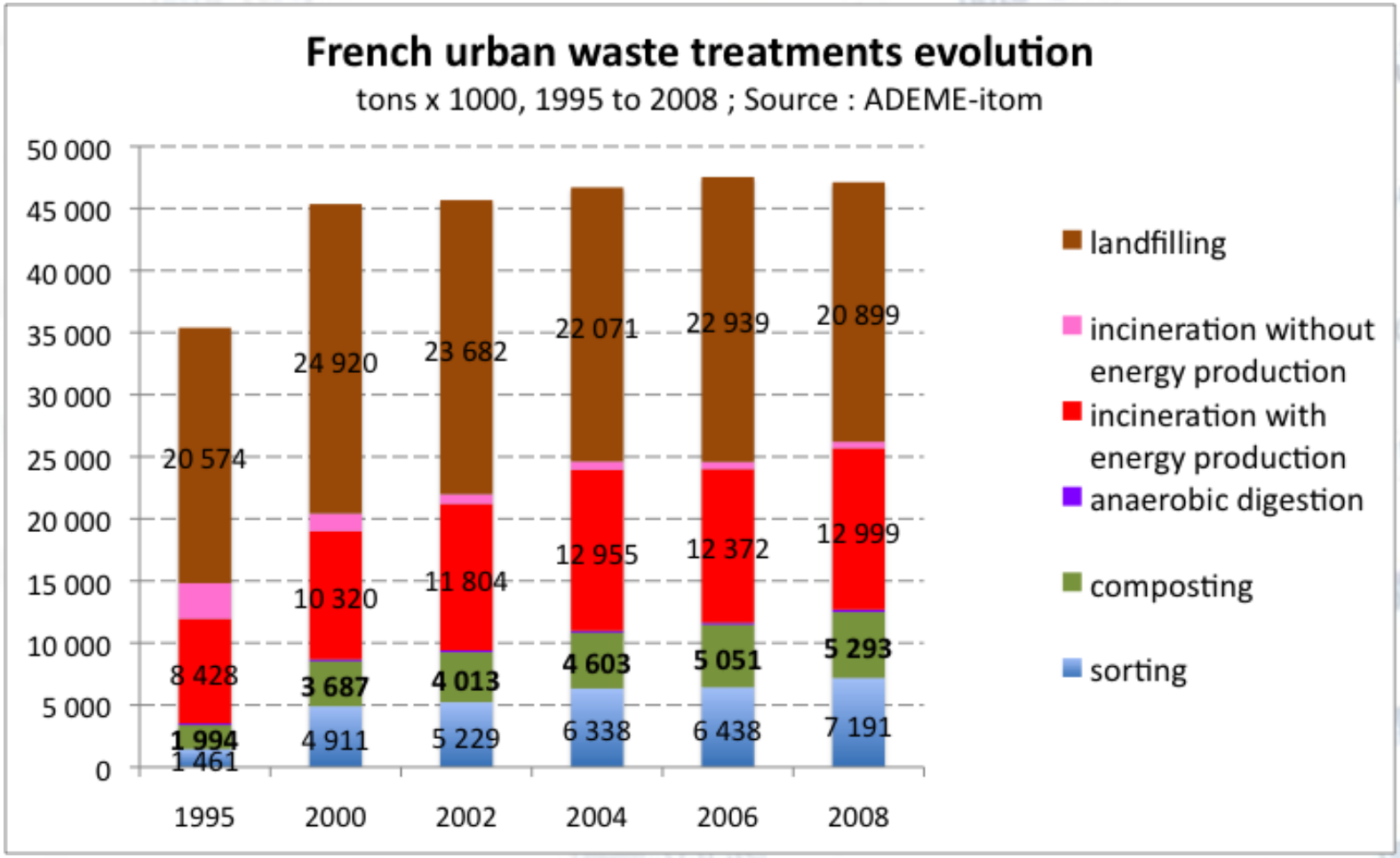



## Organic solid waste available for biological treatment reach nearly 54% total MSW collected

# French waste treatment: plant number evolution



# French waste treatment: evolution (tons/year)



# French municipal solid waste : treatment plant statistics (data from 2000 to 2008)

| 2008 data | plants | % total plants | 2010 / 2000 variation | x 1000 tons (year 2008) | % total tons | 2010 / 2000 variation |
|---|---|---|---|---|---|---|
| sorting | 330 | 27% | x 1,2 | 7 191 | 15% | x 1,5 |
| composting | 518 | 42% | x 1,9 | 5 293 | 11% | x 1,4 |
| anaerobic digestion | 6 | 0,5% | x 6,0 | 206 | 0,4% | x 2,3 |
| incineration with energy production | 112 | 9% | x 1 | 12 999 | 28% | x 1,3 |
| incineration without energy production | 17 | 1,4% | x 0,1 | 522 | 1,1% | x 0,4 |
| tipping | 256 | 21% | x 0,6 | 20 899 | 44% | x 0,6 |
| total | 1 239 | 100% | x 0,9 | 47 111 | 100% | x 0,9 |

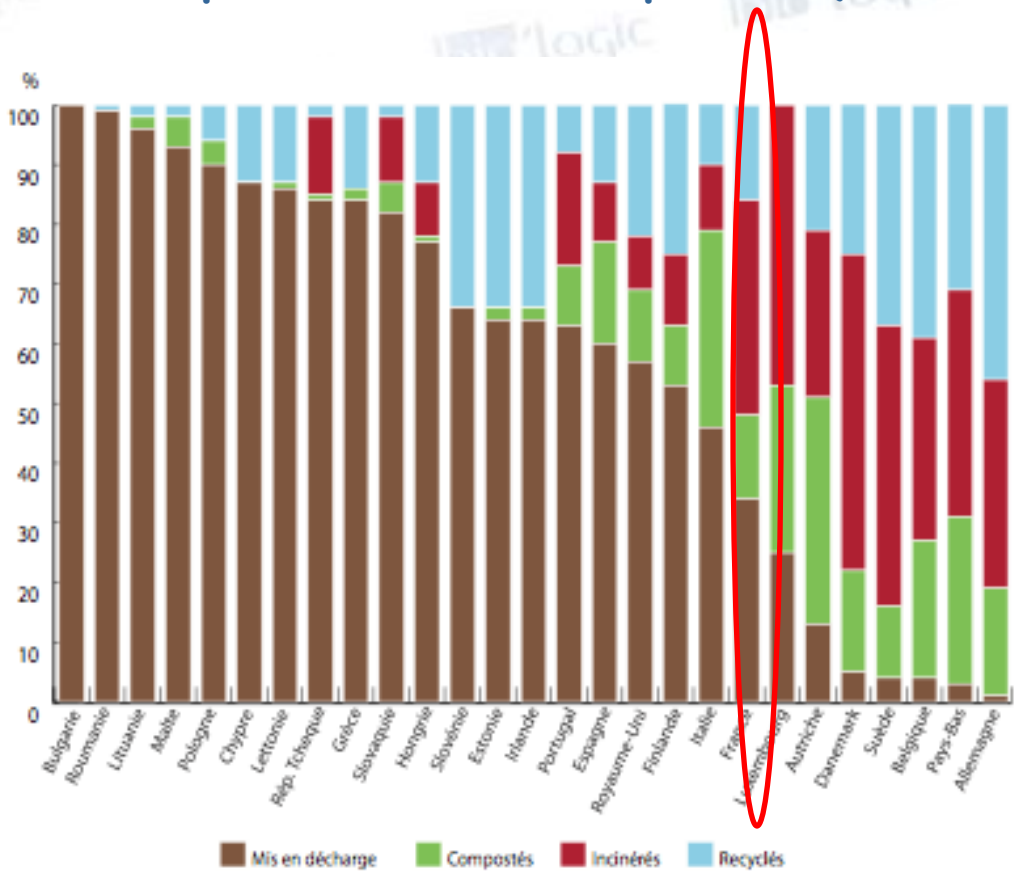
We notice :

- for biological treatments (composting, anaerobic digestion), an increase: + 42,5% total plants and + 11,4% total tons

- for incineration : a stability in plant number but an increase for treated tons (+40%)

# Waste management treatments (% total tons)

## European countries comparison (source EUROSTAT)




**We notice for France : one of the smallest recycling results and one of the highest incineration use**

1 - Waste treatment general data in France

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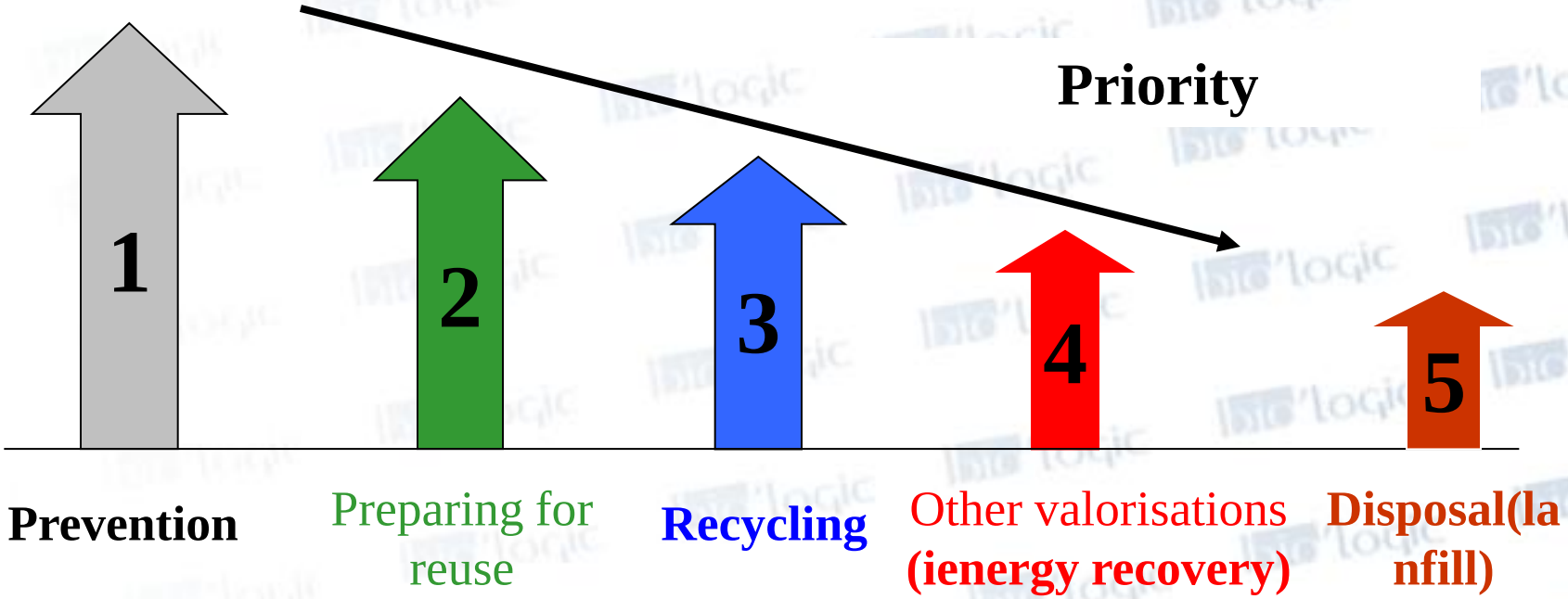
# Basic constraints : European regulations

- **Waste management Directive 2008/98/EC** (deadline transposition 12.12.2010) : legal framework, of which the treatment hierarchy



# Basic constraints (2)

- **Landfill Directive 1999/31/EC** (deadline transposition 16.07.2001 ) obligation to reduce by 2016 the amount of biodegradable waste that countries landfill **to 35% of 1995 levels**

- **Waste incineration Directive 2000/76/EC** (deadline transposition 28.12.2002, with Regulation amending act n°1137/2008), which **limit values for incineration plant emissions** (heavy metals, dioxins and furans, CO, dust, total organic carbon, HCl, HF, $SO_2$, NO and $NO_2$)

- **Bio-waste management com2010-0235** (18/5/2010) : **Commission analysis of the bio-waste management options and possible future steps** (first discussions from 1999 and 2001… )

# Biowaste "greenpaper" : some details

- **the management of bio-waste must be made a key priority** by Member States, together with the Landfill Directive

- the **overall potential** for separately collected bio-waste is estimated at up to **150 kg/inhabitant/year and 80 Mt** for EU 27 members

- about 30% of this potential (24 Mt) are been currently collected separately and treated biologically.

# Main specific French constraints (1)

- **Compost standard for soil fertiliser : NF-U444051** (2006 new standard), sets very high quality targets (low content) for inerts and plastics, which have induced new plant treatment designs

- **New environmental targets for MSW management** policy ( "Grenelle de l'environnement" 2008 and 2010 laws)
  - **Recycling and biological treatment** : 45% of total MSW collection
  - **Packaging waste recycling** : 75% of MSW Packaging waste
  - **MSW source collection reduction** : - 7% on the horizon 2015
  - **Maximum incineration rate** : 60% of total MSW collection

# Main specific French constraints (2)

## linked to renewable energies …

- **the biggest European nuclear plants park** (58 nuclear reactors, 74% of total electricity produced), inducing :
- a low electricity production cost (average : 46 €/MWh)
- a medium price for private consumers (120 €/MWh, source EUROSTAT
- a low CO2 emission for electricity production (about 80 g/kWh)

- **low price for electricity produced new energies, and so from biogas** : 7,5 to 14 c€/kWh, including an efficiency bonus (0 to 3 c€/kWh) linked to a high level target for outside plant heat cogeneration use ; imminent price rate revision, with bonus for agriculture projects)

# French compost standard NF-U44051

## Main key quality targets

**VM >= 20% wet weight (ww)** : N, $P_2O_5$ & $K_2O$ <3 % ww N + $P_2O_5$ + $K_2O$ < 7 % ww

**Inert et unwanted matters** (method XP U44-164), in % dry matter (dm)

Glass + metals > 2mm **< 2,0%dm**
Plastic films + PSE > 5mm : **< 0,3%dm**
Other plastics > 5mm **< 0,8%dm**

New criteria, which concern mainly compost produced from residual MSW (without source collection)

**Other criteria :**

- **"heavy metals"** (maximum, en mg/kg dm)

Hg : 2 ; Cd : 3 ; Ni : 60 ; Cr : 120 ; Pb : 180 As : 18 ; Se : 12 ; Cu : 300 ; Zn : 600

- **pathogenic agents**
  - living helminthes eggs: zero in 1,5 g ww
  - Salmonella : zero in 25 g ww (and for truck farming : in 1 g ww)
- **organic components traces : maximum concentration (and maximum annual flow)**
  - Fluoranthène : 4 mg/kg dm (6 g/ha/year)
  - Benzo(b)fluoranthène: 2,5 mg/kg dm (4 g/ha/year)
  - Benzo(a)pyrène : 1,5 mg/kg dm (2 g/ha/year)

**Process : AD must be followed by "characterized » composting step**

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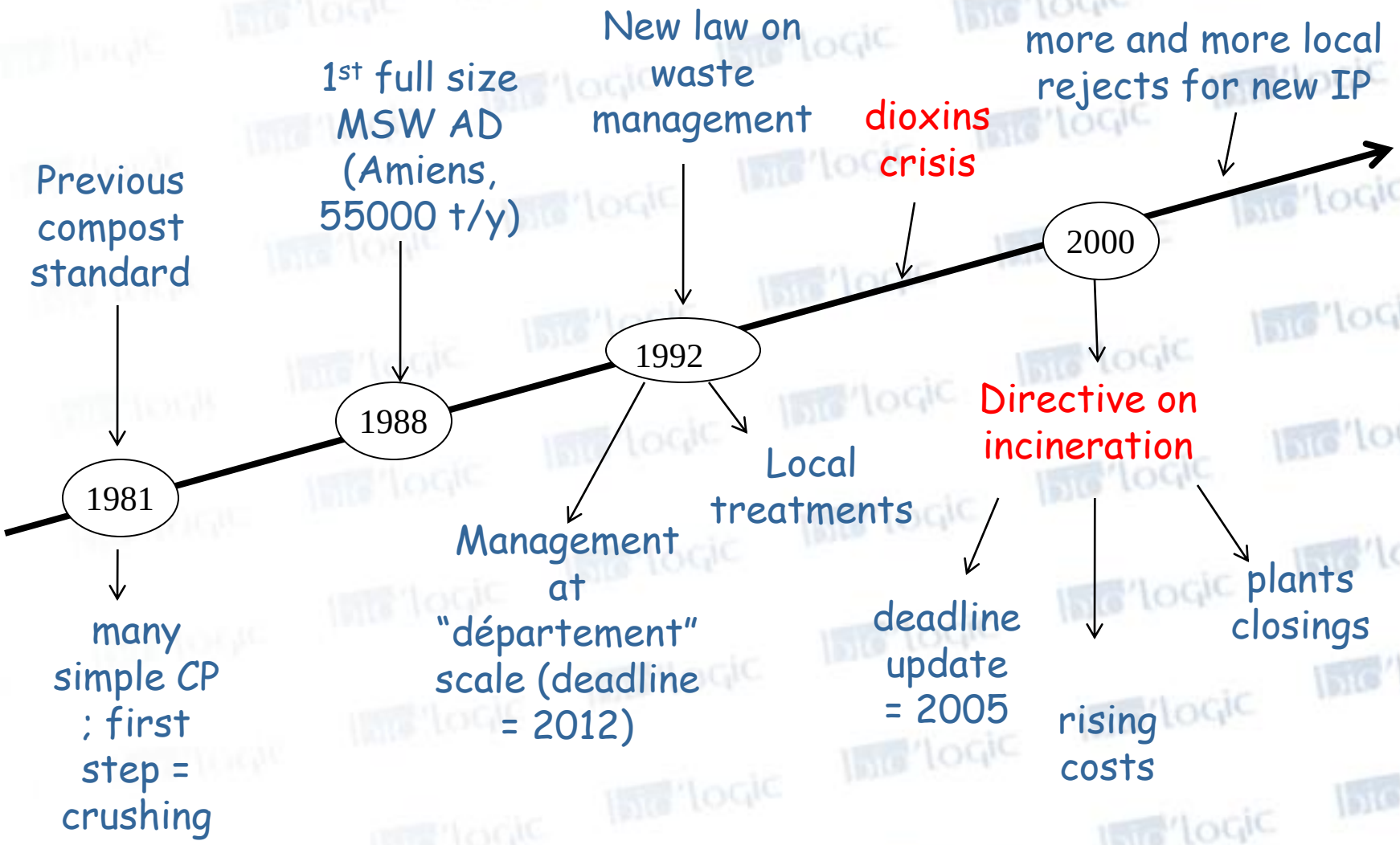
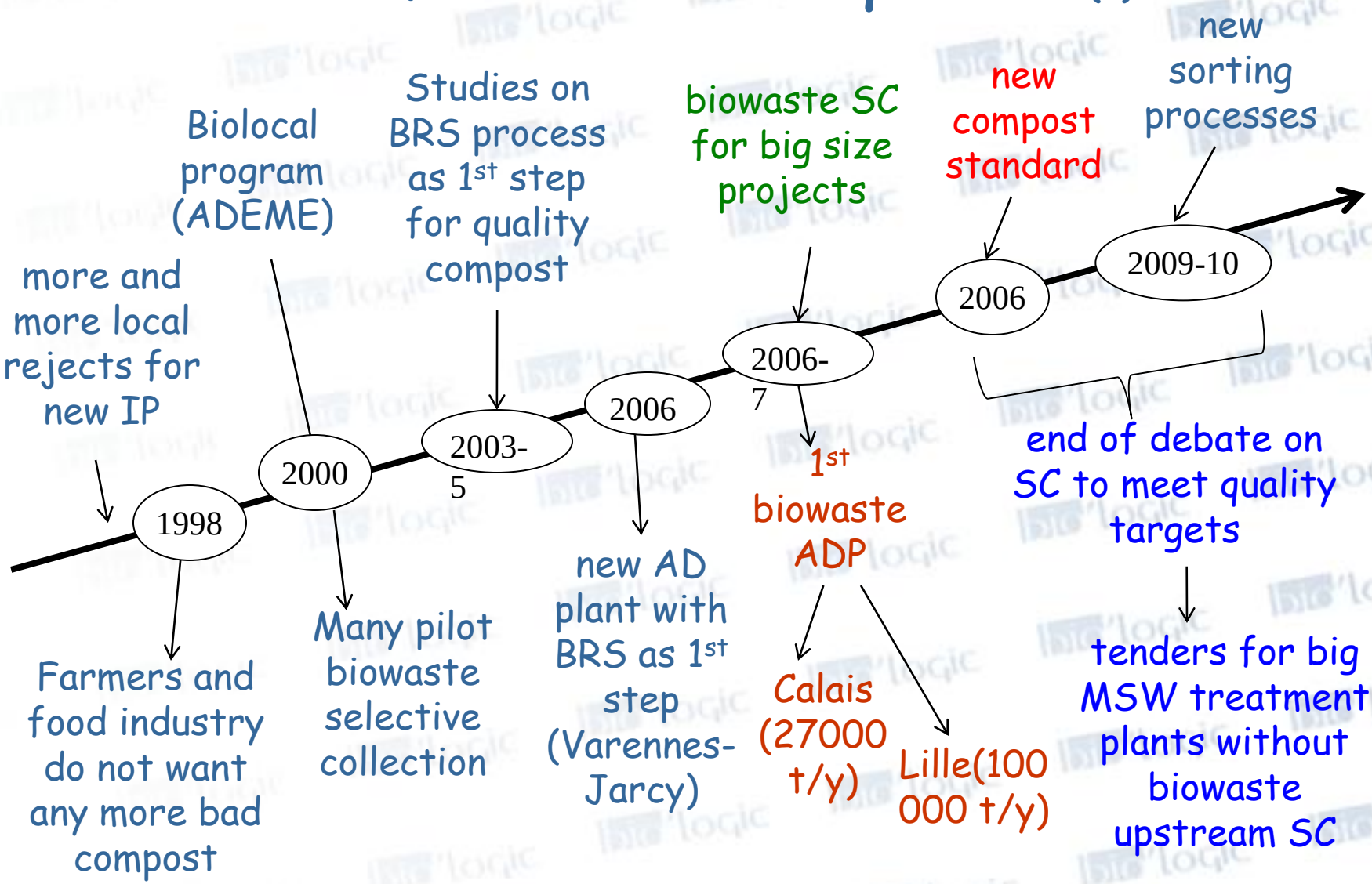
# Some facts and consequences (1)



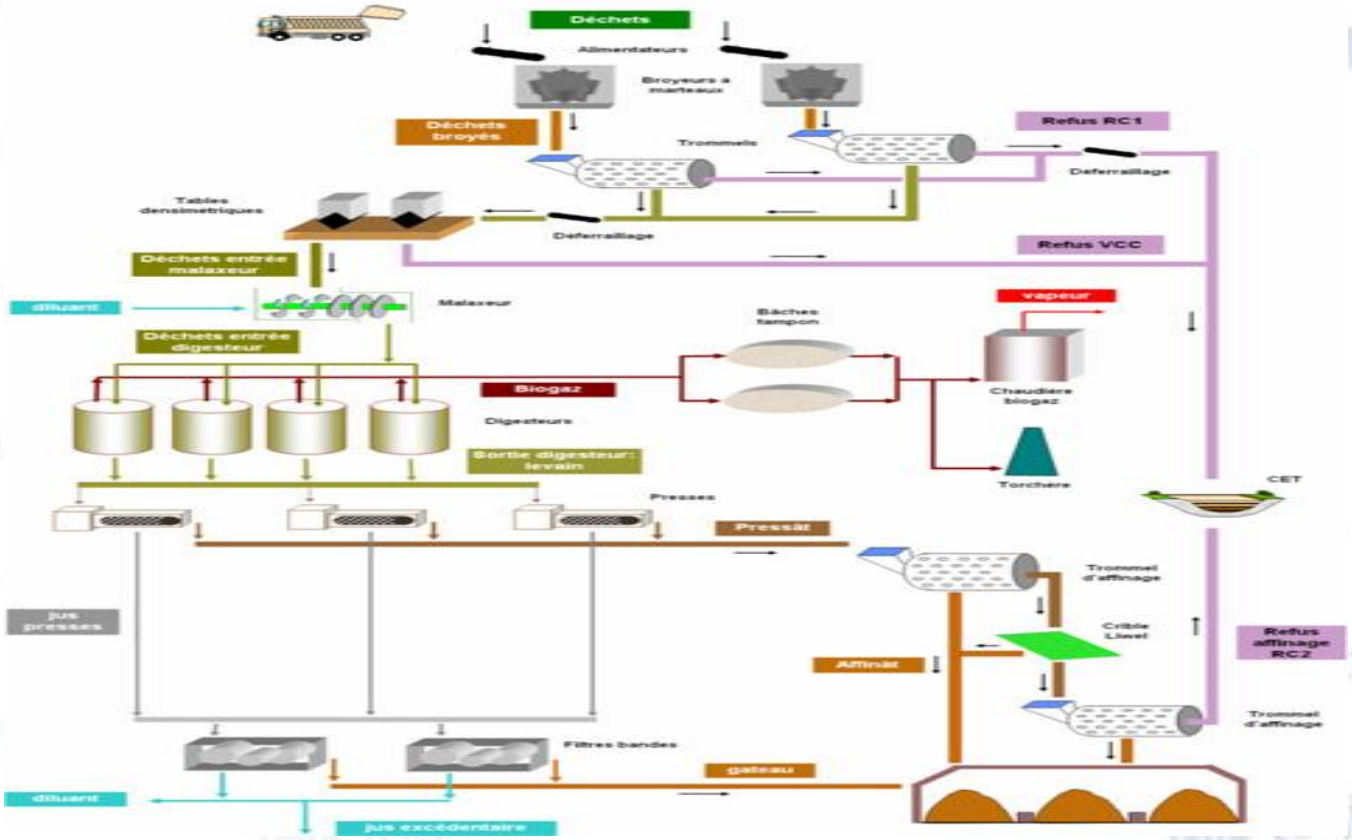

**ADP** : anaerobic digestion ; **IP** : incineration plant ; **CP** : compositing plant ; **SC** : selective collection

# Some facts and consequences (2)




**ADP** : anaerobic digestion ; **IP** : incineration plant ; **CP** : compositing plant ; **SC** : selective collection

# 88' design for MSW with AD : Amiens plant




**Result : good biogas production and valorisation**
**but bad quality compost**

# Selective collection for domestic biowaste : technical solutions

- type 1 = in bins, combining green waste and food & kitchen waste
  but : low efficiency for food and kitchen waste (kg/year)
  and very often green waste > 80% total collected
  but : not efficient for building areas

- type 2 = specific bins for domestic food & kitchen waste
  but : high costs and technical difficulties in cities centres

- type 3 : plastic coloured waste bags + optic sorting machines
  but : high costs
  full size test : Nantes and Montpellier cities

# Technical solutions to extract organic matter from residual MSW and rise up quality compost

- **Rule n°1 : stop crushing at 1st step treatment**

- **Organic matter sorting for biological treatment**
  - BRS process = soft size reduction for paper and cardboard (= 2 to 3 days pre-composting step in turning cylinder + sieving step)
  - hyper press (about 800 bars), with "pulp" production from wet organic matter *(no reference in France)*

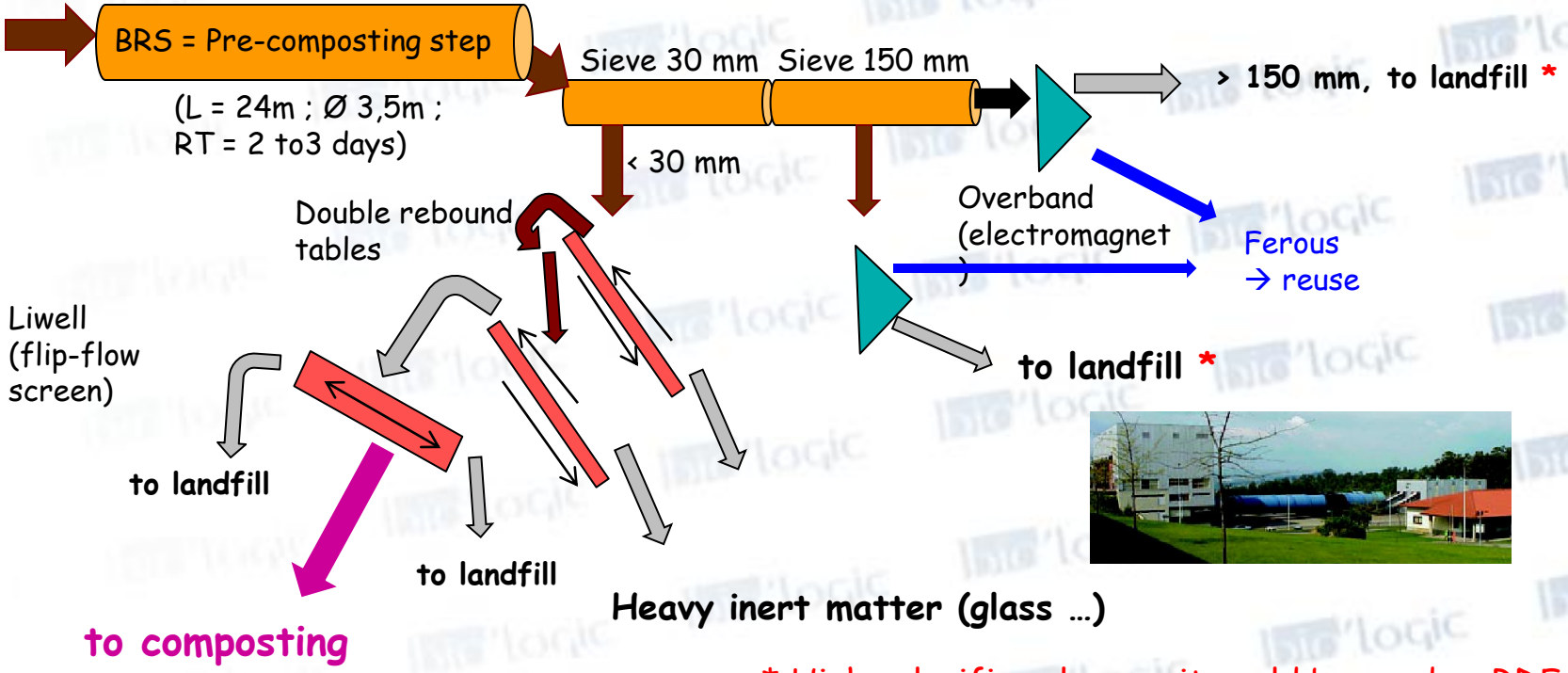
- **New sorting technologies for unwanted inert matters (which require high dry matter content, before or after biological treatment) :**
  - density sorting machines (rebound, trampoline like movement, …)
  - bounce machines
  - riddle or sieve

- **New process : wet separation after AD** (SORDISEP, patented)

# BRS + specific dry sorting

**1st process which proved that it was possible to get as good compost** (heavy metals an inert content, …) **from a residual MSW than with organic selective collection**

(Composting plant in Launay-Lantic ; 60 tons/day ; after 2006 revamping (old plant)






* High calorific value => it could be used as RDF

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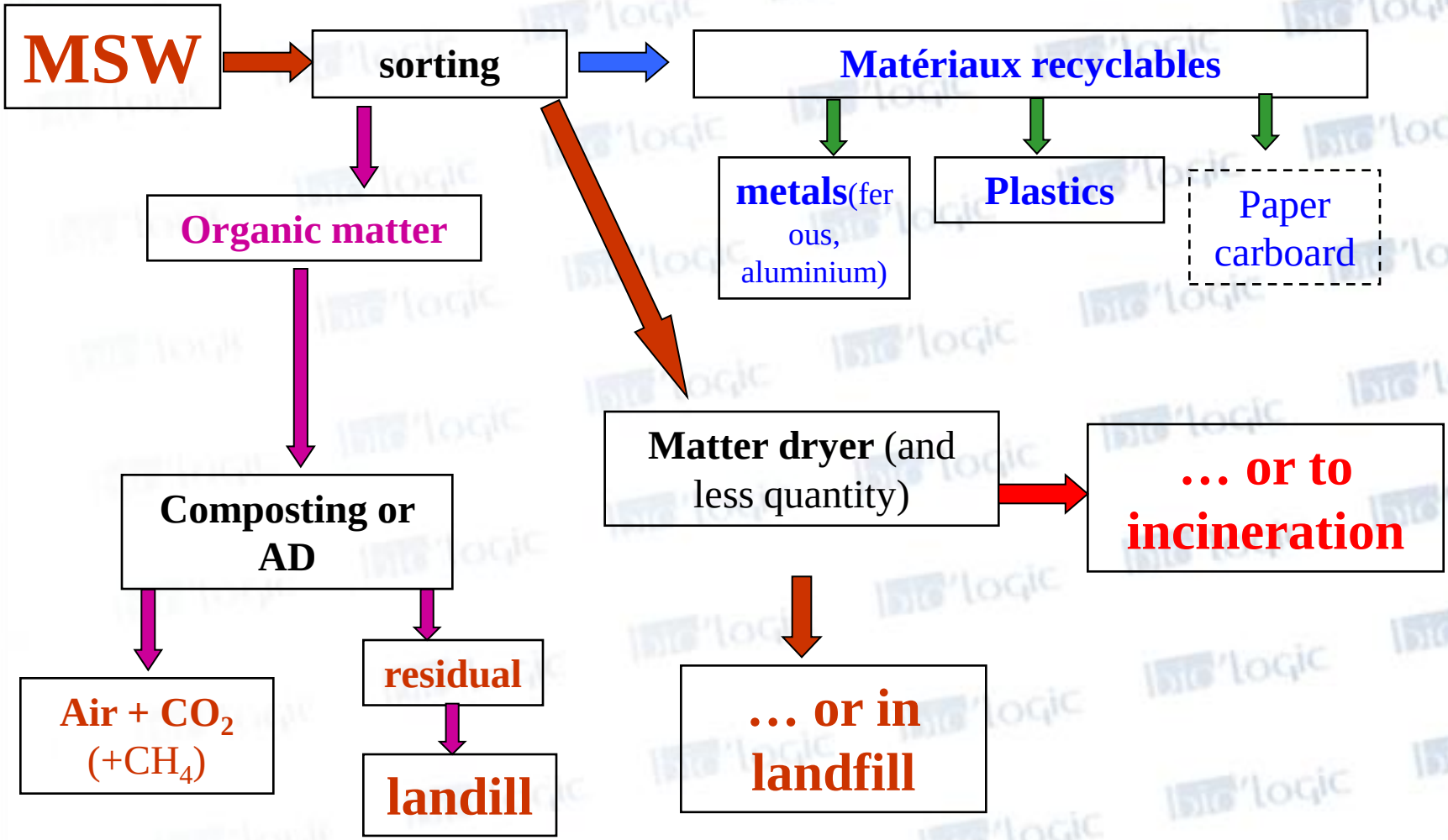
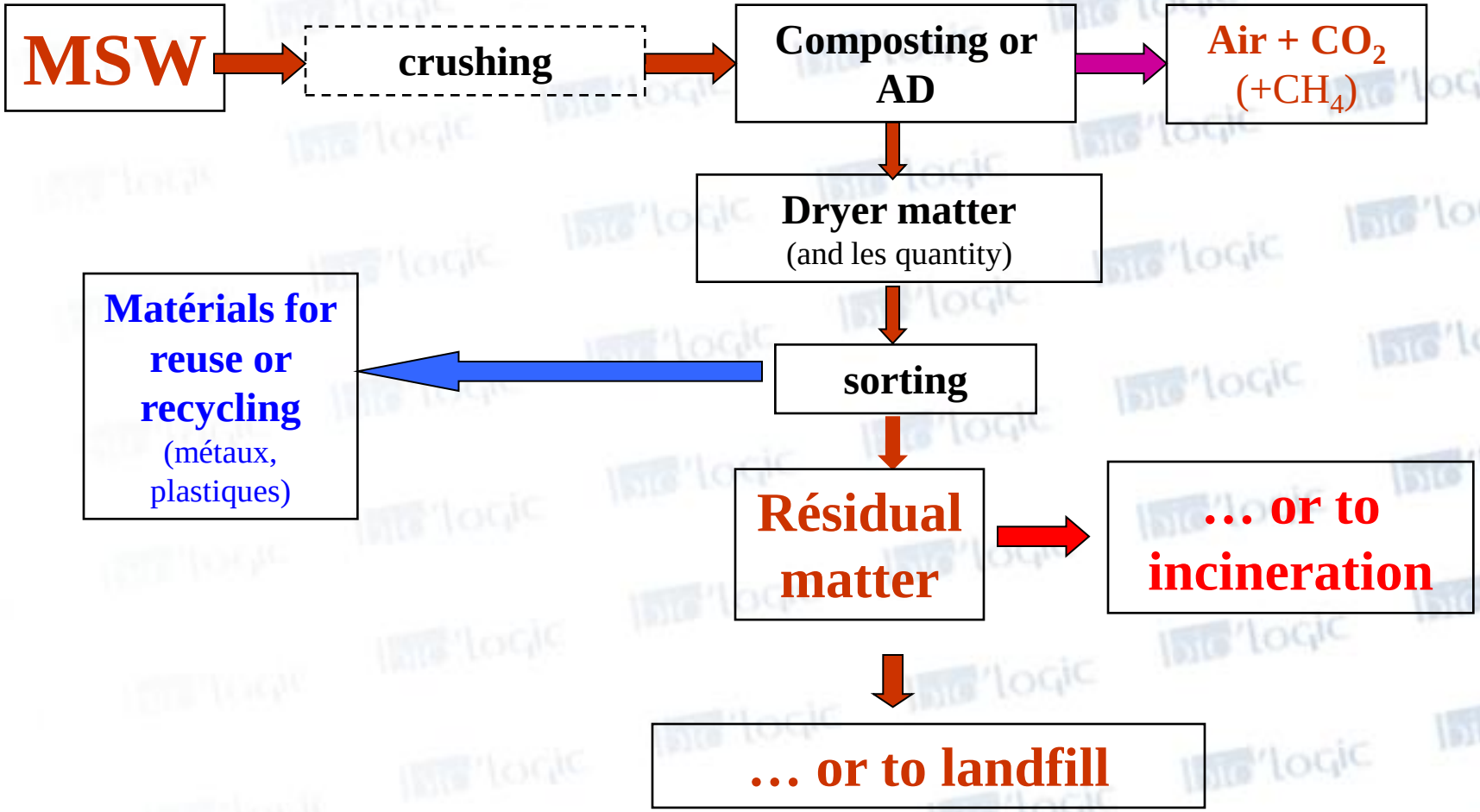
# 1st logic : sorting then biological treatment

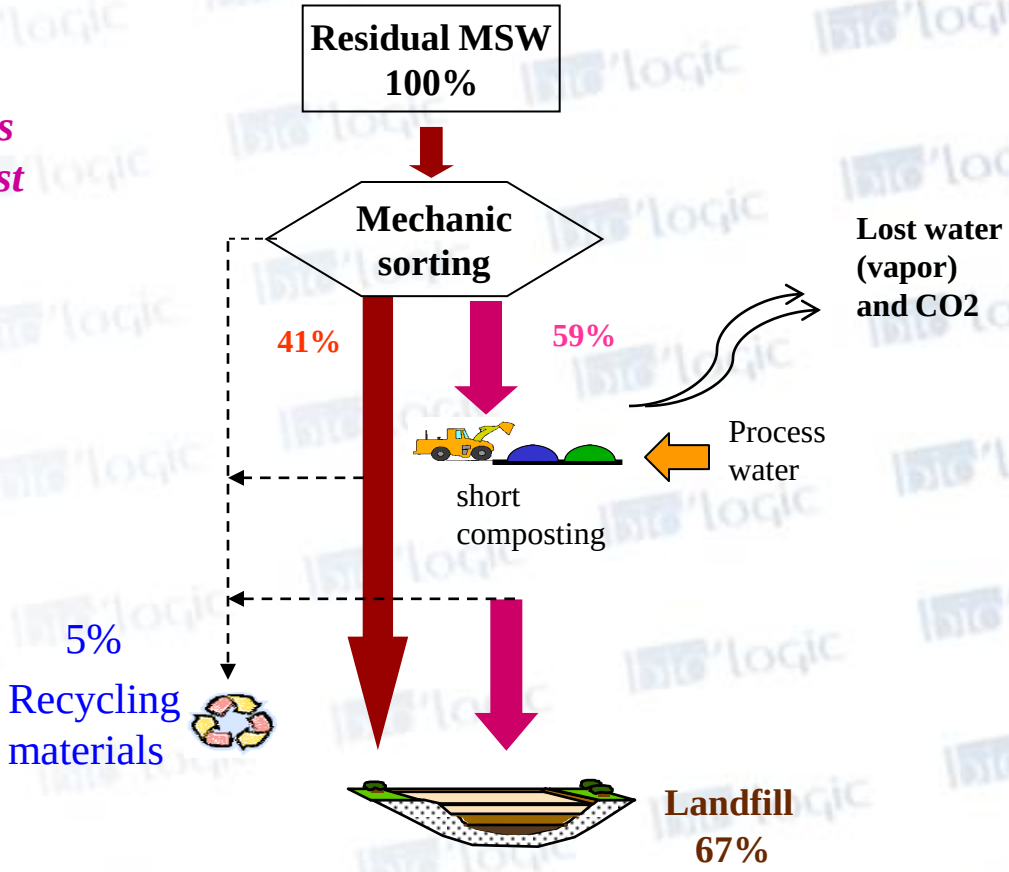


# 2nd logic : biological treatment then sorting



# Solution 1 : MBT (Mechanic Biologic Treatment) single target = stabilisation before landfilling

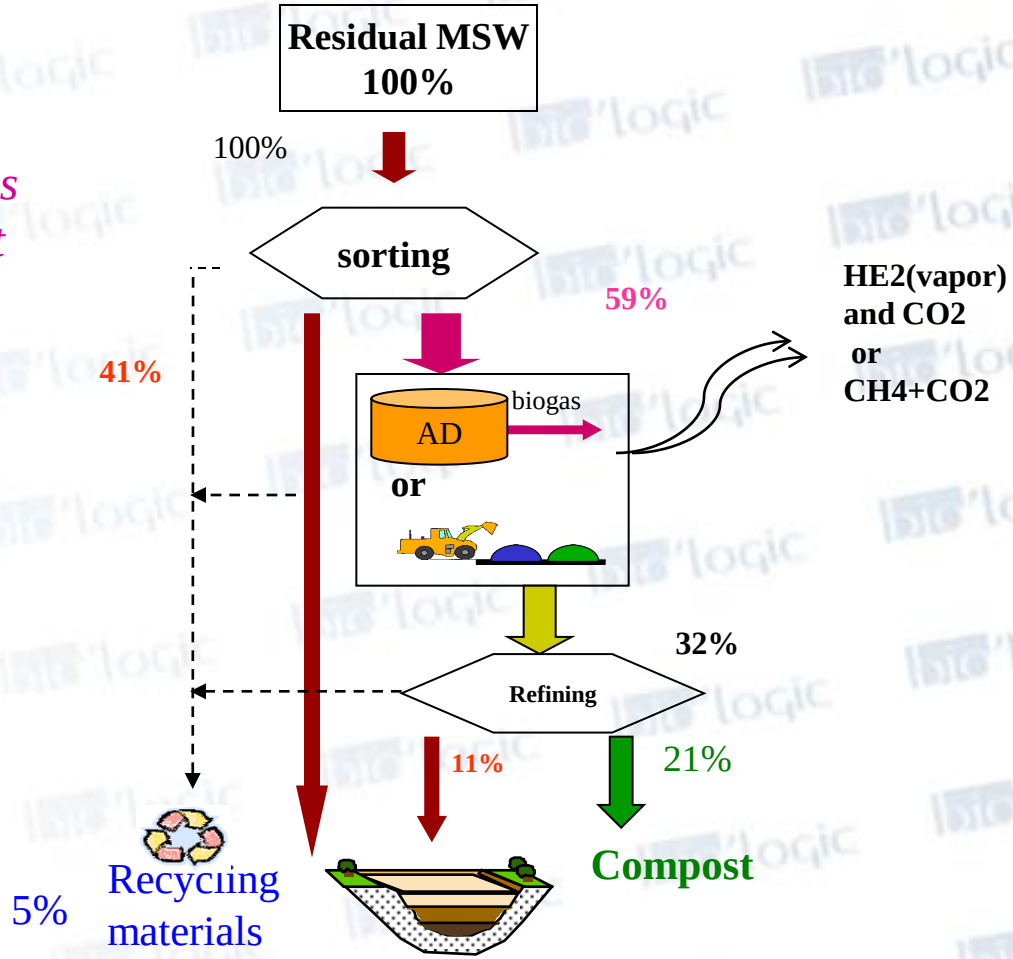
*Typical market : small municipalities and no local compost use or demand*




**Indicative % for mass balance**

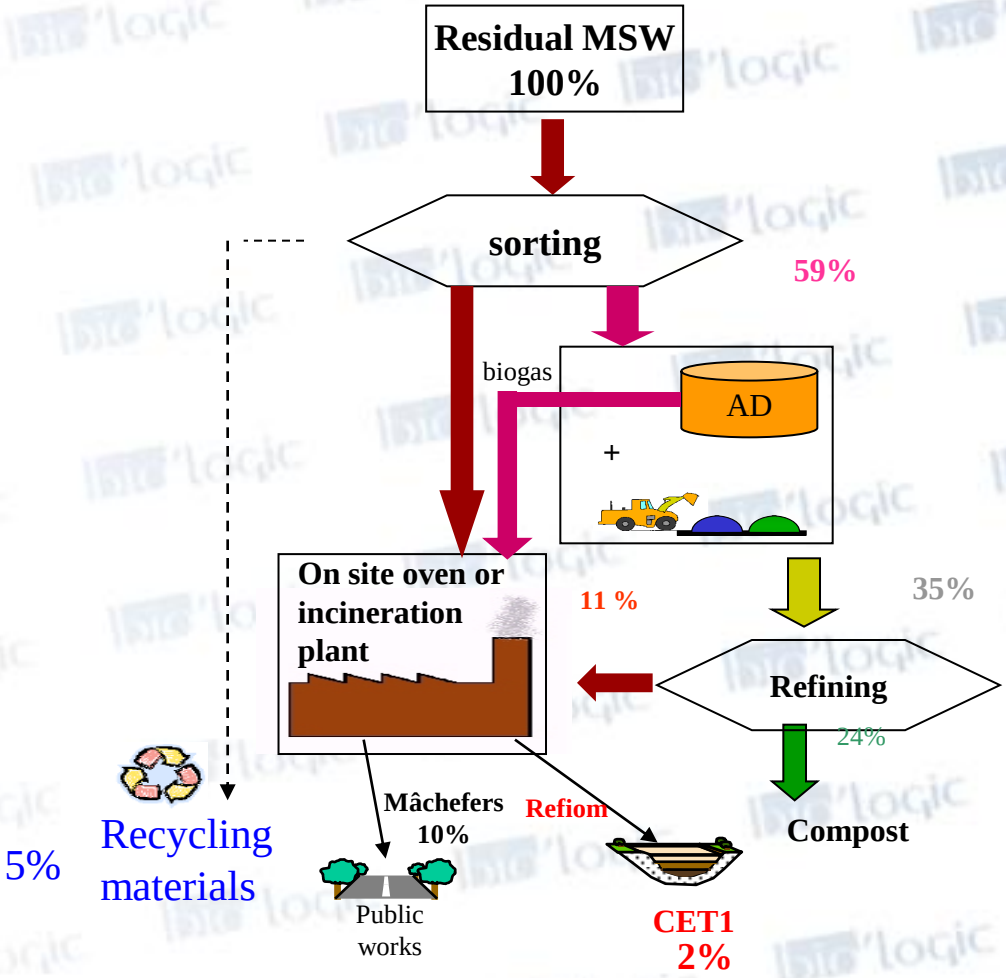
# Solution 2 : MBT with two targets =
## stabilisation before landfilling + compost production

***Typical market :***
*small municipalities with local compost use or demand*



# Solution 3 : MBT + AD + post-composting + incineration

***Typical market :***
*big area or big city*
*+ local compost use*
*+heat consumers*



# % input residual matter in landfill

## Plant design impact (from real project study),

| | |
|---|---|
| Single TMB | → 77% |
| TMB simple + CET direct | → 67% |
| TMB + extraction d'un compost d'OM | → 46% |
| TMB + compost + FRC en incinération | → 12% |

# Some earlier French plants

- Amiens Metropole (1988 & 2005) : AD, 55 000 → 104 000 t/y, MSW
- Varennes Jarcy Plant : 110 000 t/y MSW, AD (Valorga)
- SEVADEC (Calais, 2007) : 27 000 t/y, BW + GW, AD (Valorga)
- Lille Metropole (2008) : 105 000 t/y, BW + GW, AD (Strabag)
- SMITOM de la Martinique (2006) : 45 000 t/y, B + GW AD (Vinci)

* : BW + GW = biowaste + green waste ; INC = incineration

# Latest French plants (operating nearly in starting up step)

- Marseille Metropole, Evéré plant, 410 000 t/y : MSW ; AD+INC (Urbaser)
- Montpellier city area, AMETYST plant, 2009) : MSW (130 000 t/y) + BW + BW (+ 33 000 t/y), Vinci
- Forbach (42 000 t/y)- B + GW, Vinci
- Vannes aea (MSW 50 000 t/y) + BW + BW (+ 3 000 t/y), Vinci
- Angers city area, BIOPOLE plant, Vinci
- Bourg-en-Bresse plant (Ain Department plant), OWS
- SYCTOM de Paris, Romainville plant, 315 000 t/y MSW, Urbaser

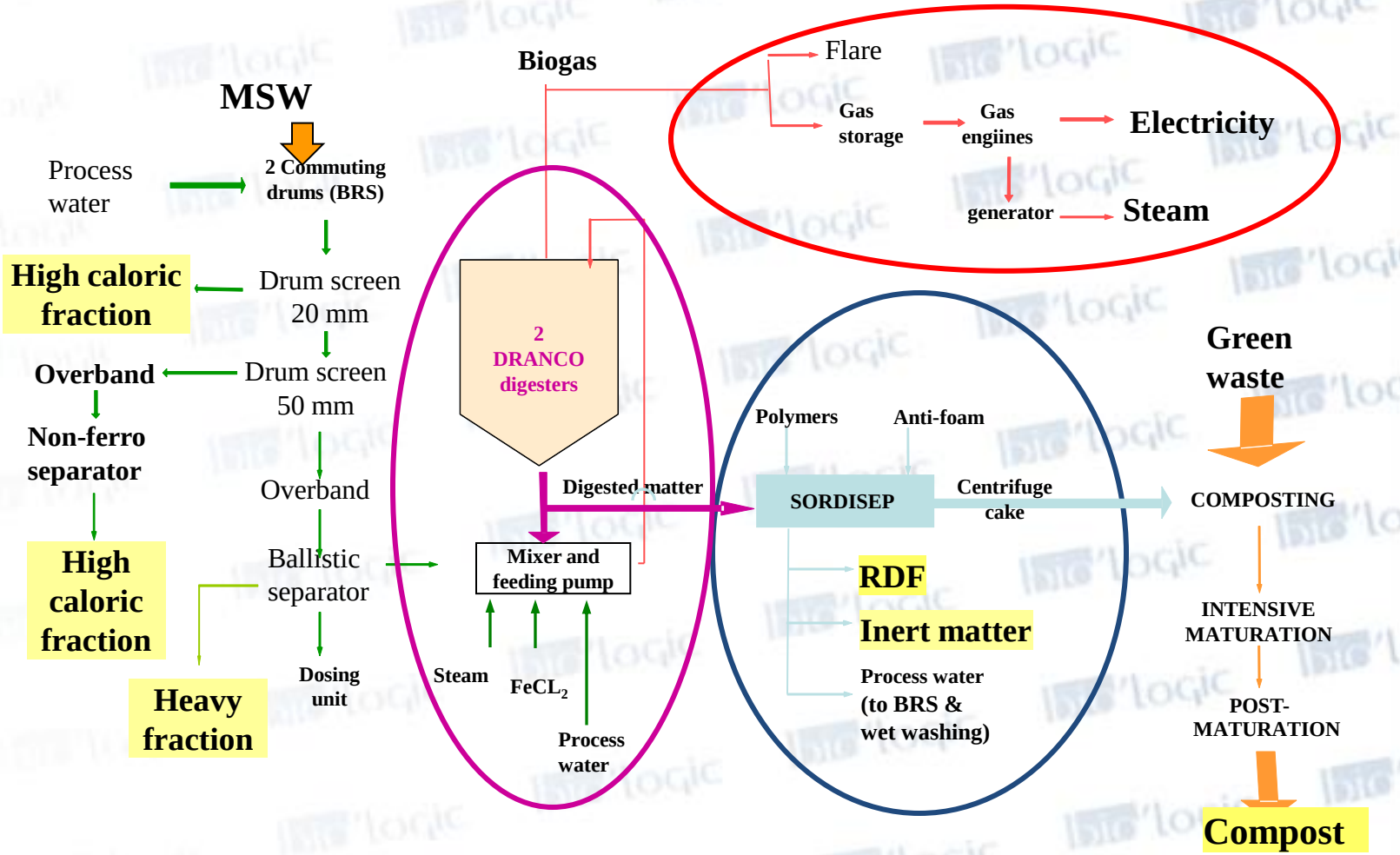
*- SYCTOM de Paris, Blanc-Mesnil plant, 85 000 t/y MSW + 10 000 t/ DM sewage sludge (tender in preparation)*

*-SYCTOM de Paris, Ivry plant,500000 t/y MSW (tender in preparation)*

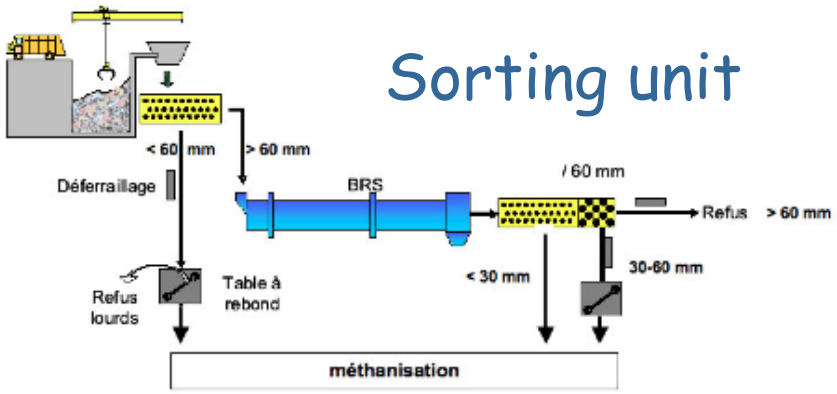
* : BW + GW = biowaste + green waste ; INC = incineration

# 2009 design for Bourg-en-Bresse plant (OWS AD process

## MSW with AD and SORDISEP (wet sorting process)

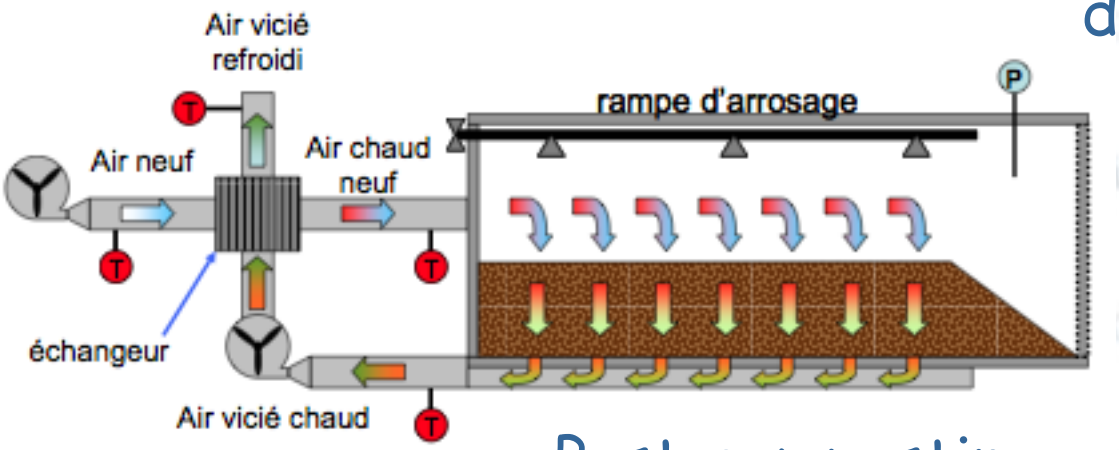


# 2010 conception : BIOPOLE plant, Angers city area, 90 000 tons/year (start up in 2011, VINCI)



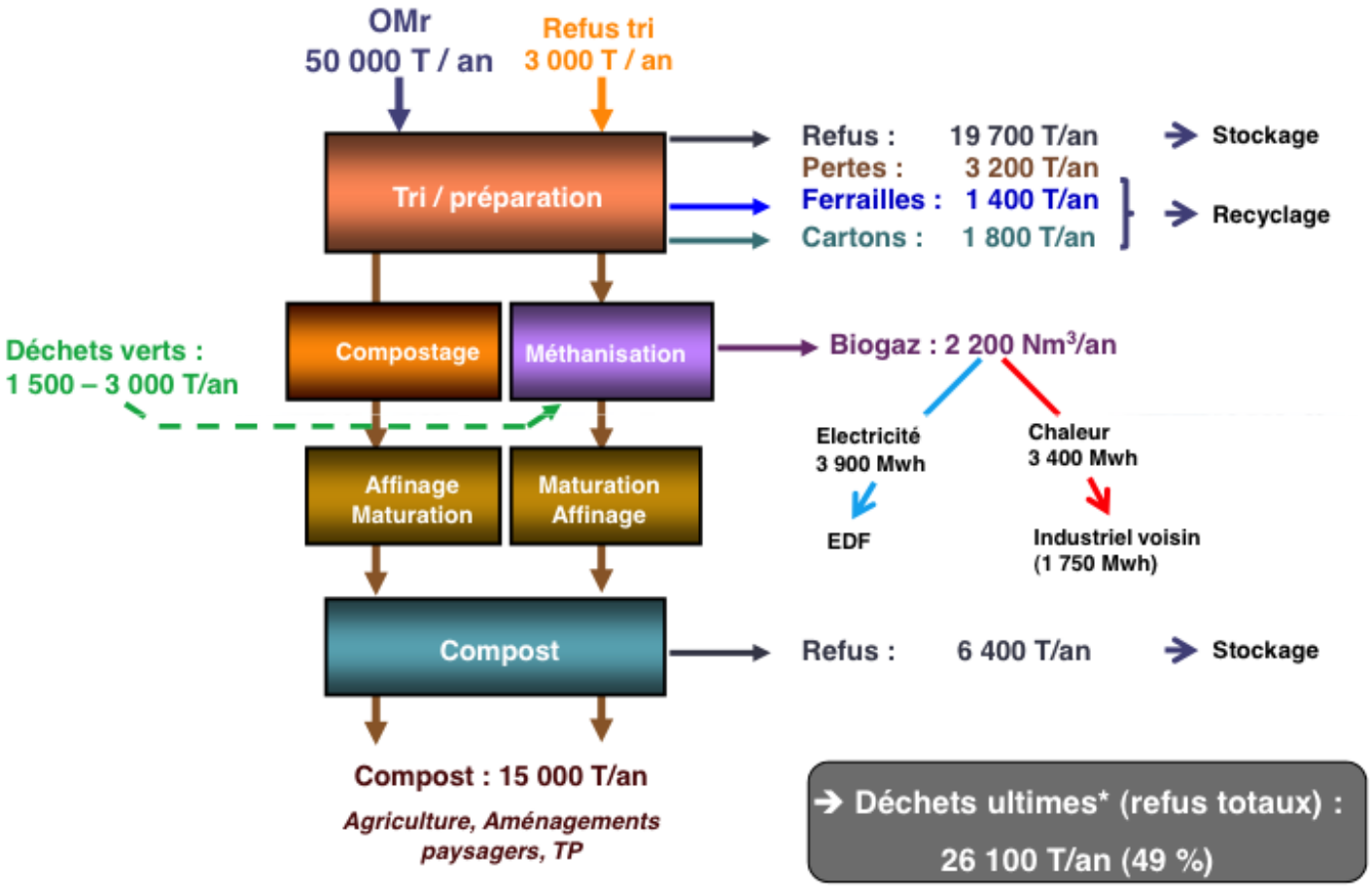

Sorting unit

digester

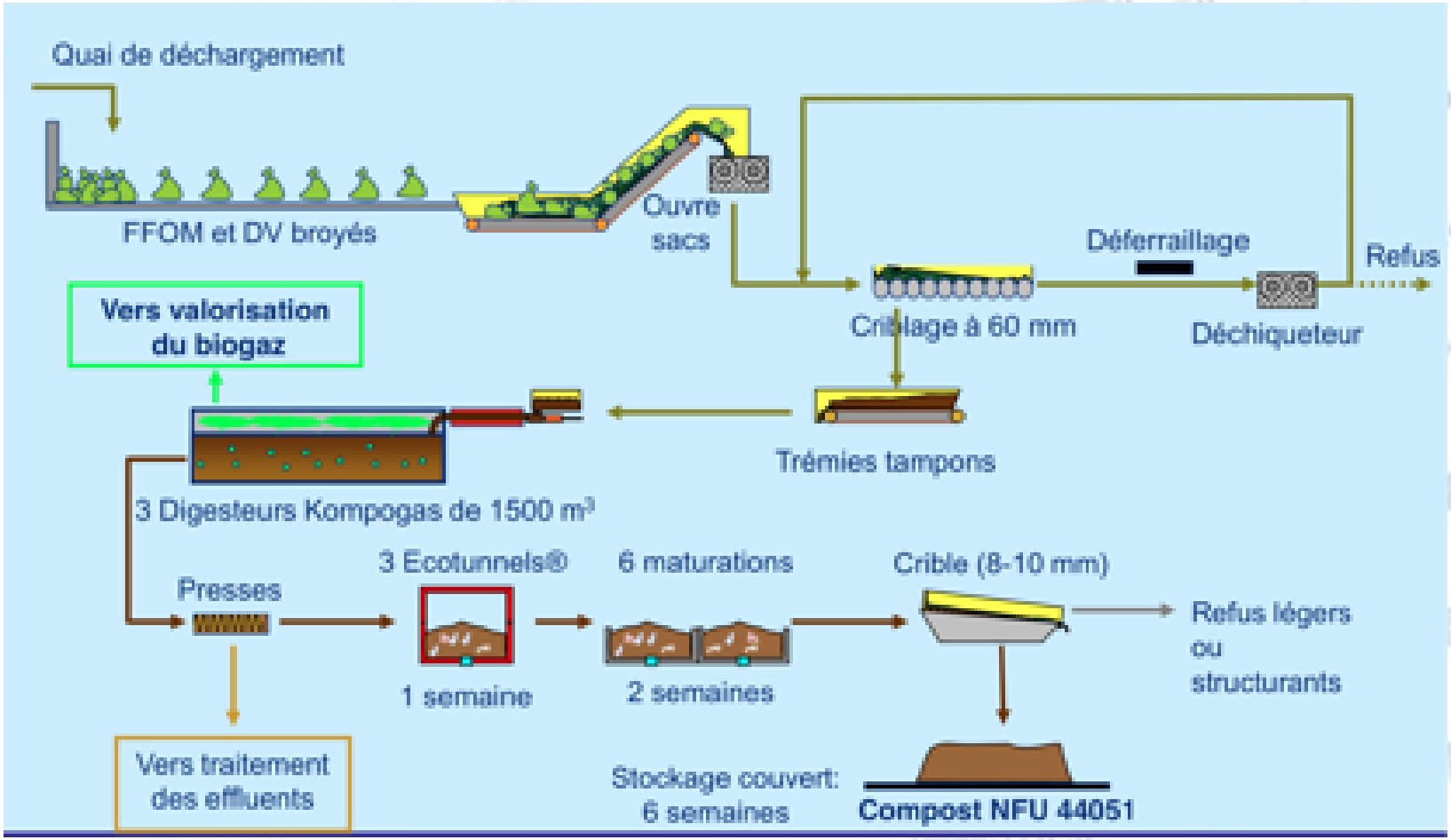



Post-composting

# Conception 2009 – SYSEM plant, Vannes city area, 243 000 inhabitants (start up in 2011, VINCI)

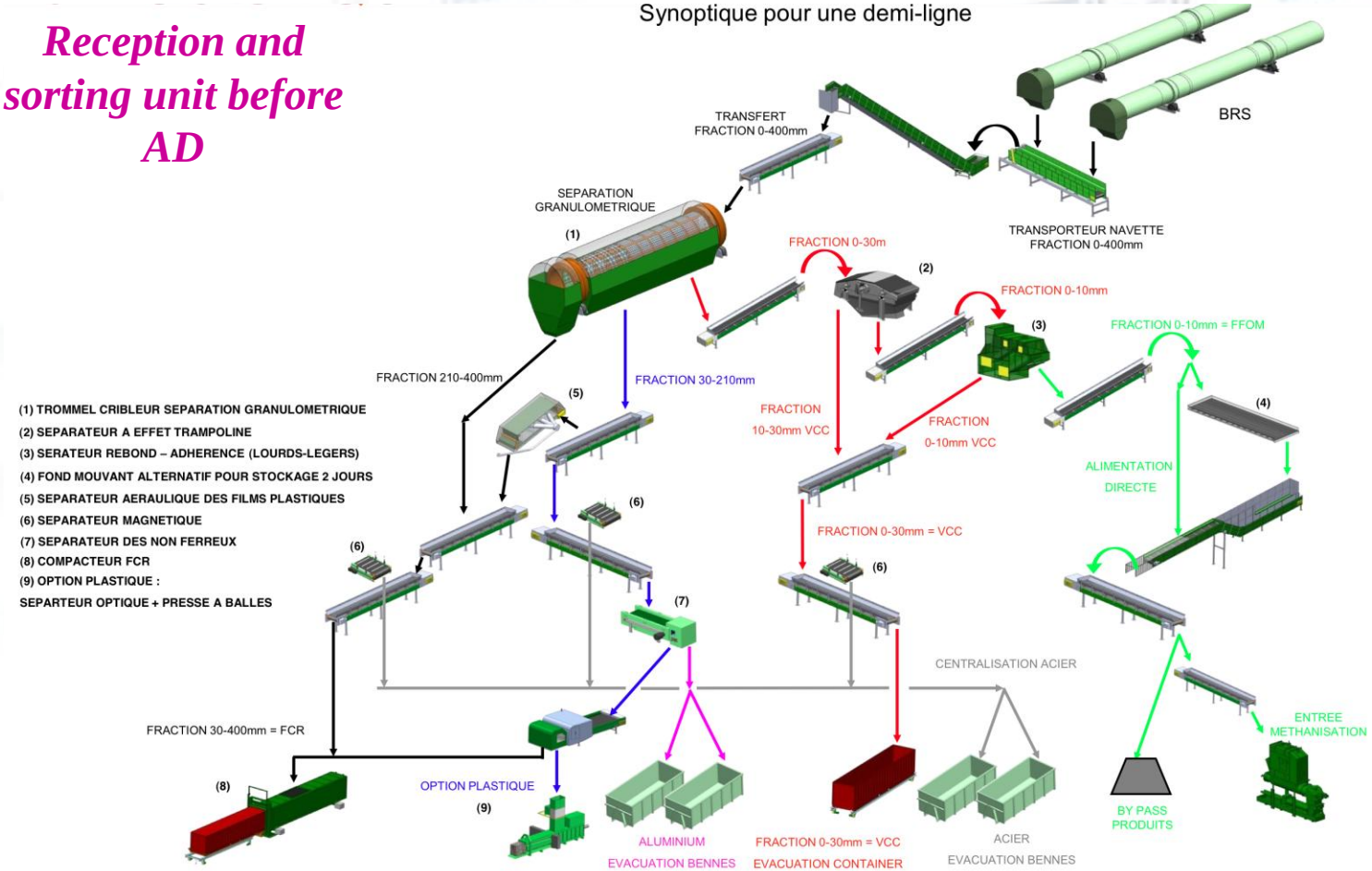


# Forbach plant, design 2009 for biowaste and green waste

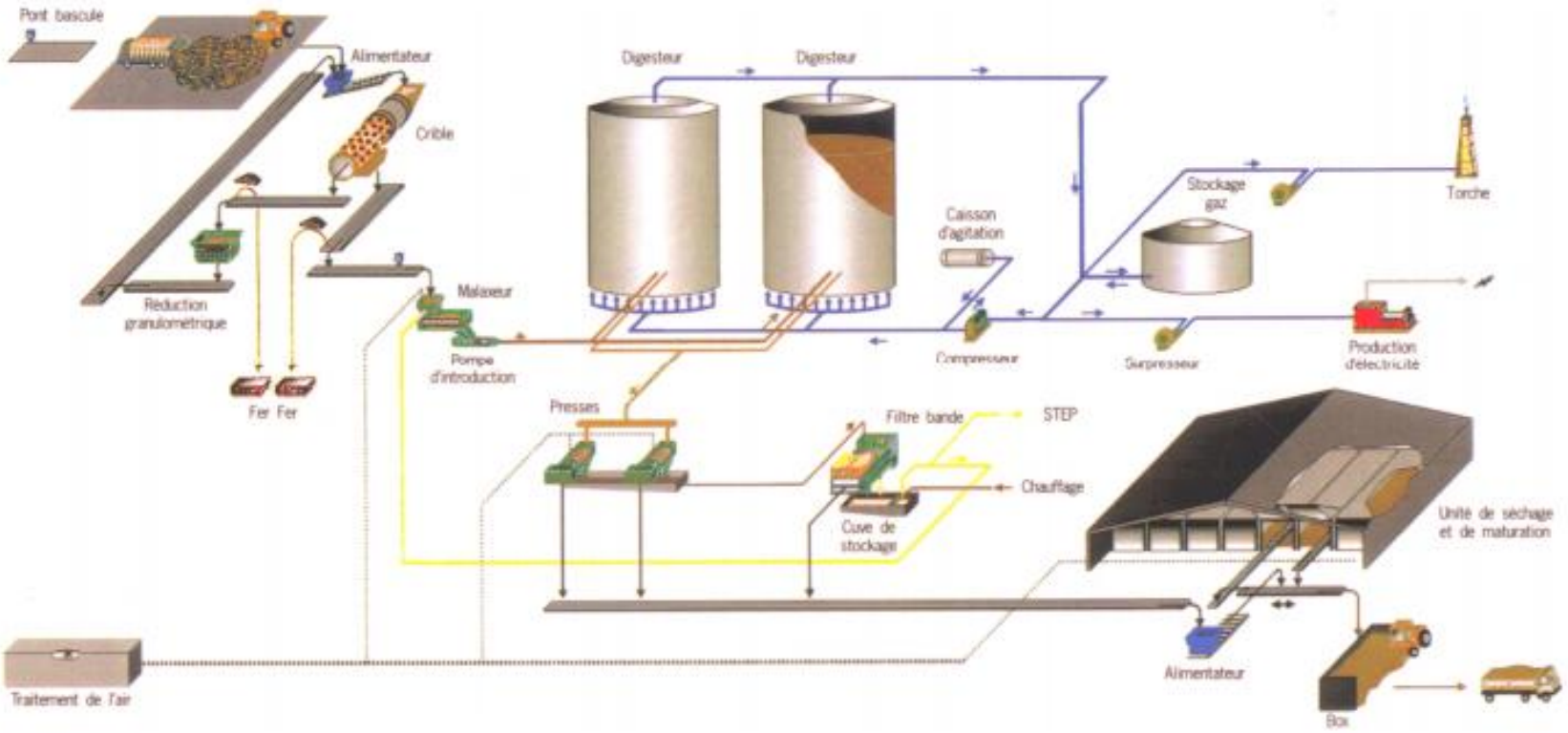


# SYCTOM de Paris / Romainville Plant, Design 2009 for residual MSW, URBASER AD process)

***Reception and sorting unit before AD***



# Standard VALORGA process (URBASER) for biowaste

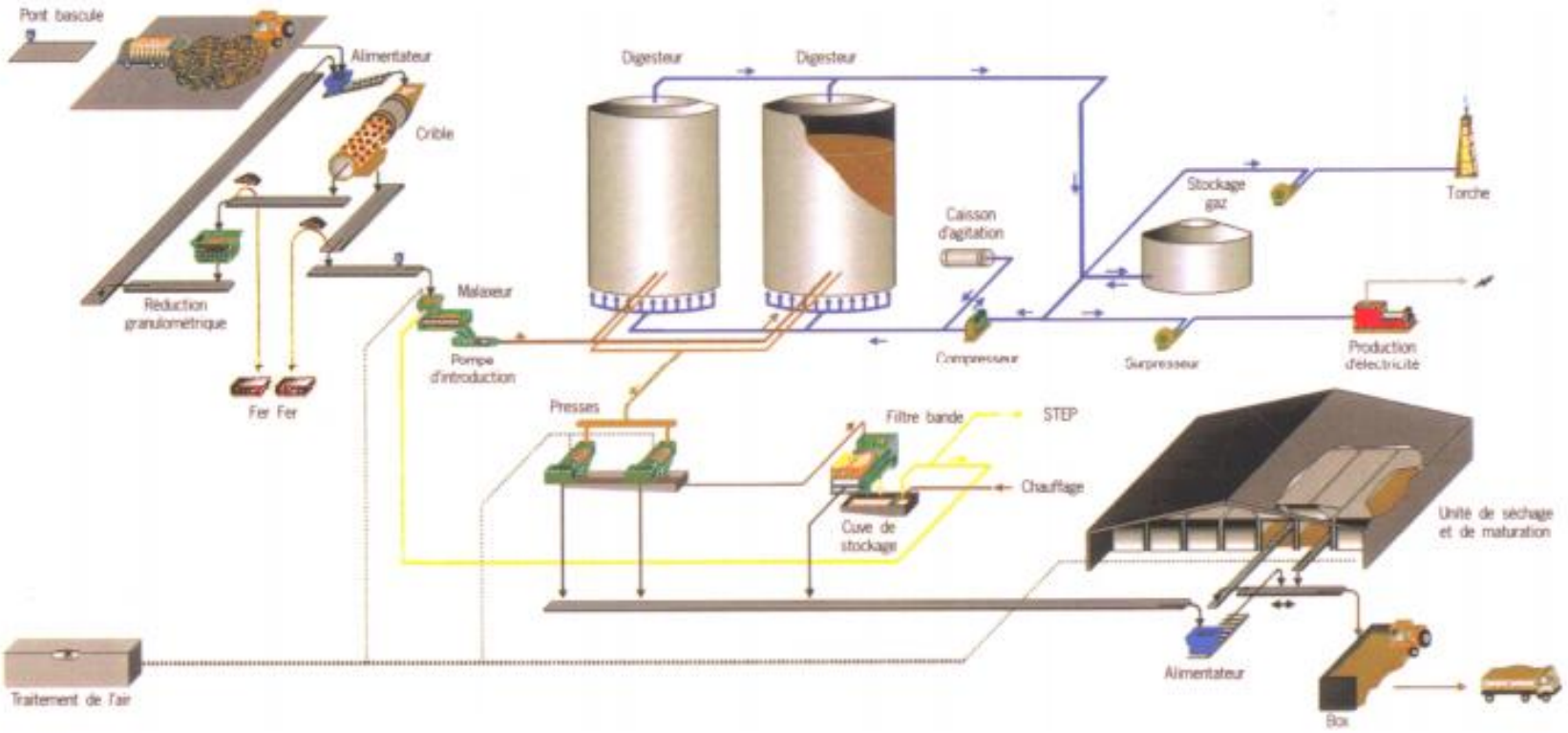


# New AD process on French market

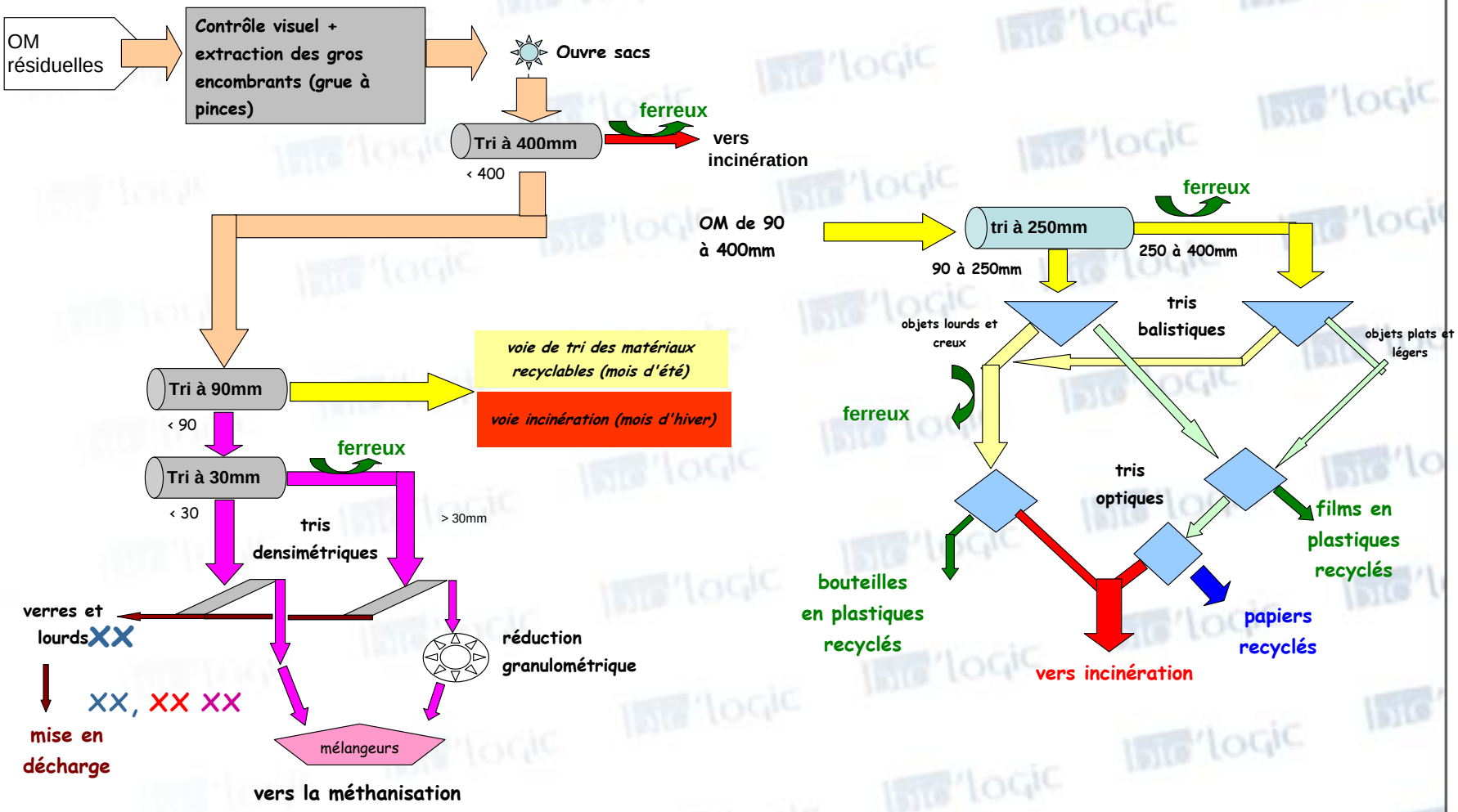
## BEKON process (from Germany) :

- batch,
-Mesophilic
- « dry » conditions (without dilution)
- in concrete tunnels

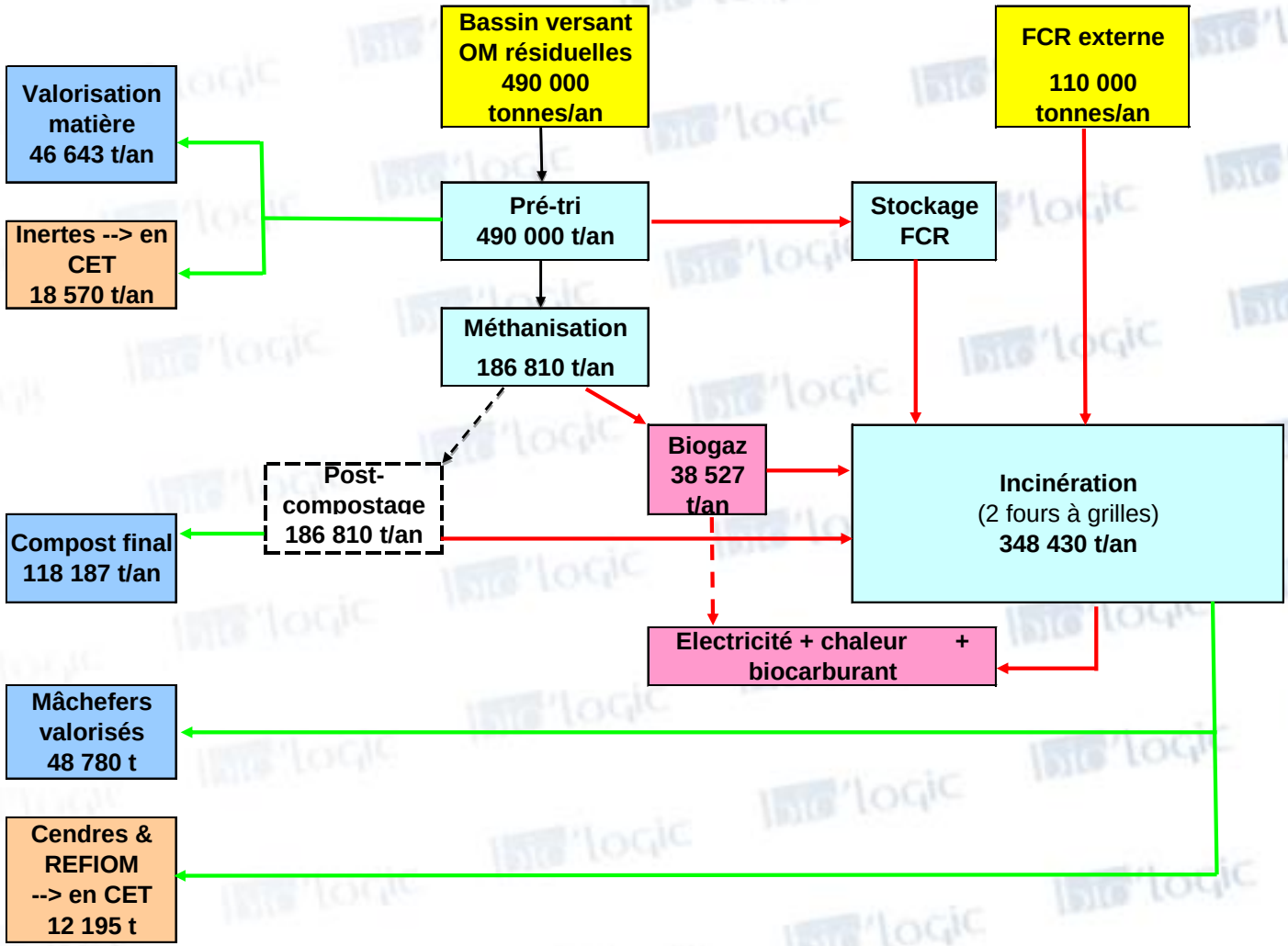
# Standard VALORGA process (URBASER) for biowaste



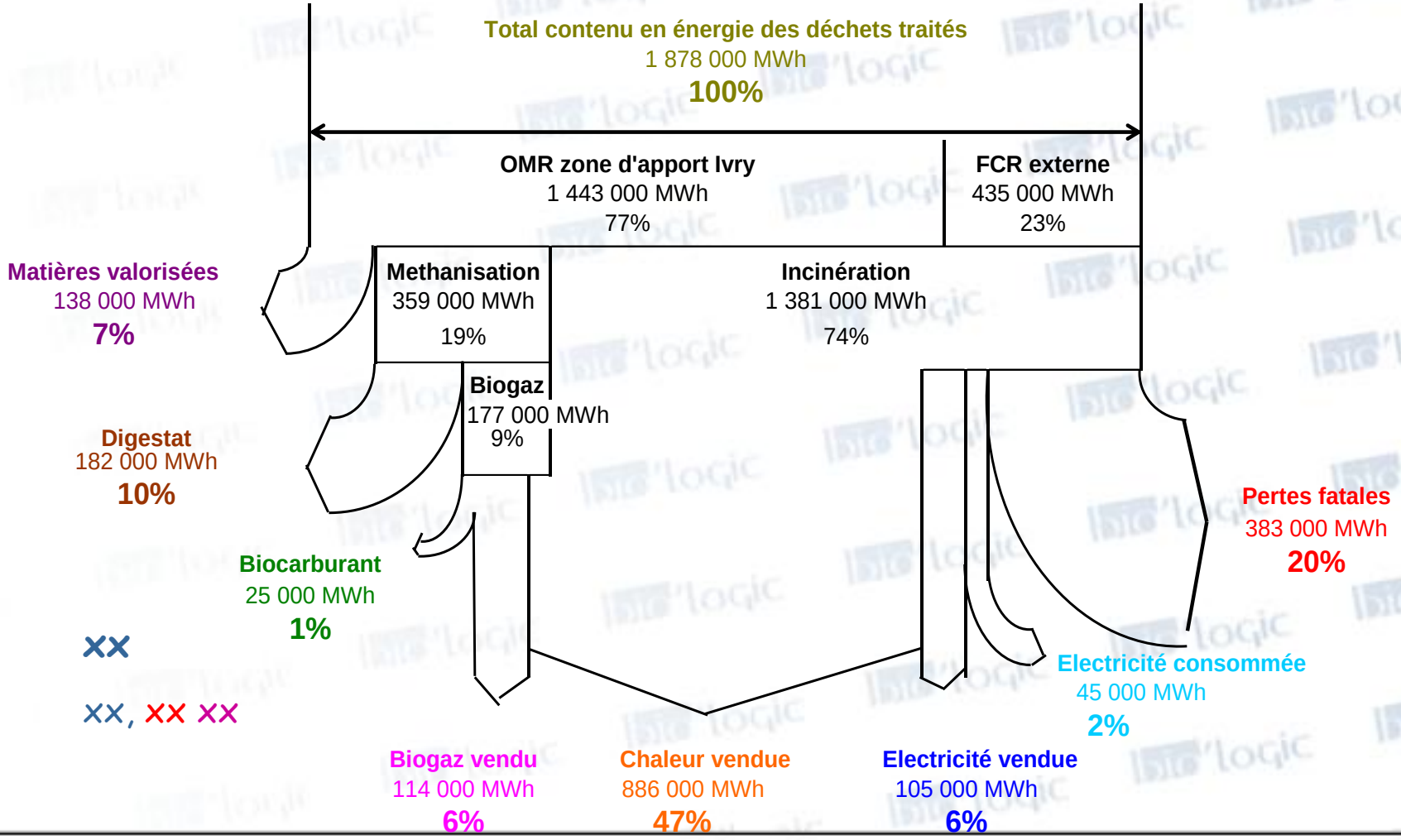
# SYCTOM – Paris (tender project) : example of a sorting unit including an optic process



# SYCTOM – Paris (tender project) : example of a mass balance



# SYCTOM – Paris (tender project) : example of an energy balance



# *Thank you for listening*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**BIO'LOGIC *Assistance is an* Expert and Engineering Consultant, created in 1995, for public authorities and private companies, specialist Wastes and Sewage Management including biological treatment and specially anaerobic digestion.**

## Public authorities support missions

- **Coaching for waste management policy definition,** from regional to local scale, including bio treatment **(anaerobic digestion**, composting) regards to local conditions (geographic, demographic, energetic, and development targets (economical, environmental, …), and for **multi-criteria projects evaluation**

- **Tender assistance** (technical aspects, or complete mission in partnership) for bio treatment plants all along the different steps (technical tender documents production, offers evaluation, contract negotiation support, building and start running step support, performances validation, …)
- **Technical missions** (facility expertise, communication management, quality and training, feasibility studies, …)

## Industries support and training

- **Food industries waste management and treatment : sustainable development** ($CO^2$ emissions reduction and global approach linked to process production, transportation, water consumption, bio treatment, energy impacts, …)
- **Bio treatment technical solutions** (composting or anaerobic digestion projects, and biogas use for all industries)
- **Biological treatment facilities assistance** (technical and biologic performances checking, process change or technical rebuilding support for best results, …)
- **R&D Process development support** (technical and economical evaluation, experiment program … for news products and services linked to bio waste management, compost quality and uses, sustainable development)
- **Training support** made to mseasure (staff or operating workers)

# XX

| | Procédés et offre industrielle de méthanisation de déchets | | | | |
|---|---|---|---|---|---|
| **Appelations courantes** | **" en liquide ", ou " classique "** | "en pâteux" **" à haute teneur en matières sèches "** "en solide" | **" en liquide après pulpeur "** | **" à sec "** | **" codigestion en liquide "** |
| **type de matières traitées** | boues de STEP | OM résiduelles | biodéchets solides | déches verts et biodéchets | biomasse agricole et biodéchets |
| | effluents industriels | biodéchets et DV | OM résiduelles | OM résiduelles | effluents industriels |
| **Principes mis en œuvre** | cuverie classique | dilution minimale après tri => pompable | tri humide (pulpeur) | tunnels en béton | cuverie classique |
| | pompes classiques | pompes de type à béton | cuverie classique | pas de dilution | pompes classiques |
| | | divers principes d'agitation | pompes classiques | remplissage et extraction au chargeur à godet | |
| **Concentration en entrée de digesteur** | **< 5%MS** | **20 à 40%** | **8 à 12%MS** | **30 à 50%** | **< 5%MS** |
| **Arrivée sur le marché français** | années 20 (boues) | début années 80 | fin années 80 | depuis 2 ans | depuis 1 à 3 ans |
| | année 70 (industries) | | | | |
| **(pays d'origine)** | Grande-Bretagne, puis tous | France et Belgique | Allemagne | Allemagne | Allemagne, Danemark, Belgique |
| **Offres commerciales** (sociétés ou marques) | OTV | VALORGA | BTA / MAT | BEKON | AGRAFERM |
| | DEGREMONT | OWS | ROS-ROCA | BAL | LEE |
| | SGN | KOMPOGAS (->VINCI) | | … | NASKEO |
| | PAQUES | STRABAG | | | … |
| | … | … | | | |
| **Applicable au projet** | non | **oui** | **oui** | **oui** | non |

XX

XX, XX XX

# Méthanisation et compostage

## Différences de bases : énergie et eau

**Méthanisation (liquide ou pâteux)**

MO + énergie --> [pré] compost + eau + ENERGIE

(biogaz = $CH_4$ + $CO_2$)

70 à 100 kWh/t 0 à 1,5 m3/t 160 à 175 kWh/t

0,7 à 1,6 l/t gazole

**Compostage (solide ou liquide sur support) = respiration**

MO + Air + ENERGIE + EAU --> compost + eau + chaleur (air chaud et saturé)

35 à 70 kWh/t 0 à 1 m3/t

10 à 12 l/t gazole

# Rendement énergétique selon la voie métabolique utilisée dans des cellules

**Méthanisation :** $C_6H_{12}O_6$ → 3 $CH_4$ + 3 $CO_2$ + **2 ATP**

**+ énergie** (mélange et chauffage) **ENERGIE** (électricité & chaleur) (61 kJ ; **Rdt = 2%**))

-> peu de biomasse

**Respiration (compostage) :** $C_6H_{12}O_6$ + 6 $O_2$ → 6 $CO_2$ + 6 $H_2O$ + **36 ATP**

**+ENERGIE** d'aération + CHALEUR (1700kJ) (1160 kJ ; **Rdt 40%**)

-> beaucoup de biomasse

**Fermentation alcoolique :** $C_6H_{12}O_6$ + → 2 $C_2H_5OH$ + 2 $CO_2$ + **2 ATP**

+ ε chaleur (79kJ) (61 kJ ; **Rdt = 2%**))

-> peu de biomasse

**2860 KJ**

**Plus il y a formation d'ATP, plus il pourra y avoir de synthèse biochimique dans la bactérie (la cellule), et plus elle pourra donc se reproduire**. La voie la plus rentable en ATP est la respiration (moteur du compostage), puis loin derrière la méthanisation ou la fermentation alcoolique