Defining the best process for a Mechanical-Biological Treatment Plant

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Abstract

Before outlining a Mechanical-Biological Treatment (MBT) or Mechanical-Biological Pre-treatment (MBP) process, we should take a look at 3 points that are essential to the success of a plant project.

- Firstly, we will see why we need to have good knowledge of the composition of the source Household Waste (HW).
- Then, we will mention the new trend of favouring recovery of recyclables.
- Finally, we will show the advantages of sorting prior to pre-fermentation.

After looking at these 3 points, we will see, in simple terms, which objectives are decisive when choosing the treatment method.

Finally, we propose an MBT process enabling you to achieve the set objectives, and the possible adaptations for changing or upgrading it.

1 The essential points

1.1 Composition of the collected refuse

The quality of a finished product depends on the choice and quality of the materials that are used in the process of manufacturing it. Although this observation might seem self-evident, it is often neglected when sorting and treating household waste.

We sometimes tend to think that, merely because a particular household waste treatment method has proved its worth on certain sources, it is applicable everywhere.

Whereas actually, depending on the country, the composition of sources of household waste can differ widely. HW composition depends on lifestyle, on consumer habits, and on the waste recovery means implemented.

In certain countries, different selective collection systems are in place. In France, and here in Germany, for example, door-to-door selective collection is in place for packaging and for household refuse separately, and sometimes even for biowaste, and tips or recycling centres are available to which people can voluntarily take their sorted waste, such as garden waste, bulky items, pollutants, etc. Whereas, in some countries, the collection system is less complex, or indeed a single one.

Clearly therefore, in order to define a sorting and treatment process, it is essential to determine the various substances that make up the source waste in question, to determine their percentages, and their particle-sizes, and to identify organic matter, so as to work out the fraction that it is advantageous to recover.

By way of a small practical example, in Poland, where coal is the fuel used to heat the majority of homes, and where coal ash is to be found in household waste bins, it will be preferred to filter out the 0-25 mm fraction, so as to remove that pollutant.

1.2 Favouring recovery of recyclables

This new idea is born out of the observation that, even in countries where collection means are very complex, a large proportion of recyclables, as high as 25% sometimes, is still to be found in household waste. Naturally, in countries in which collection is not very diversified, such recyclables sometimes represent a majority fraction of the inflow of the source HW.

Regardless of the objectives to be achieved by an MBT plant, the prime purpose nevertheless remains to reduce the proportion or the weight of waste going to landfill.

Also, it would seem rather absurd to feed certain substances into the process when they constitute a pollutant for the finished product, or indeed to reject them as non-recyclable when they are recyclable or transformable in some other manner.

This applies, for example, to plastic bottles and containers, steel, etc. that constitute well-identified recyclables that are easily recoverable prior to crushing and pre-fermentation, by means of simple mechanical pre-treatment sorting.

It is also very advantageous and quite possible to recover plastic films and plastic sheeting. Those substances offer high Lower Heating Values (LHVs), and can thus be transformed into energy.

To sum up, recovery of such recyclables:

- makes it possible to reduce the reject percentage and thus to reduce the landfill percentage;
- improves the quality of the finished product (the compost), because the pollutant presence of such recyclables is reduced; and
- increases the overall percentage of recycling and transformation of the waste.

1.3 Advantage of sorting prior to pre-fermentation

Conventional MBT processes generally include 60 mm to 100 mm primary screening and in-tube accelerated pre-fermentation, or indeed direct forced pre-fermentation of all of the source HW, followed by mechanical sorting operations prior to or after fermentation, and by specific treatments depending on whether it is desired to produce ordinary compost or transformation through biomethanisation.

Although pre-fermentation tubes have proved themselves to be genuinely effective in degrading organic matter, provided that they are given sufficient time, use of them at the start of the process suffers from two major drawbacks:

- the pollution caused by mixing up all of the source HW; and
- the over-dimensioning of the pre-fermentation equipment.

1.3.1 Limiting the pollution of the source HW

We have already mentioned the advantage of recovering certain recyclables such as plastics, steels, and plastics films. It is much easier technically and more sensible to remove them before the initial fermentation.

The various types of matter are then less mixed, less sticky, and also less wet. It is thus easier to separate them by mechanical sorting (such as magnetic separation, optical sorting, air separation, etc.).

Furthermore, the recyclables to be recovered are much less soiled than if they had been left for 3 or 4 days in decomposing organic matter.

In addition, after fermentation, not only are such recyclables more difficult to recover, their soiled state sometimes make them impossible to recycle or transform. They are then often rejected to landfill.

In the same way, it is more sensible to remove the pollutants from the stream of organic matter as early as possible. As we have already said, the quality of the finished product depends on the quality of the matter fed into the process.

1.3.2 Optimising the size of the plant

In most existing household-waste treatment plants, the pre-fermentation tubes are placed at the process head. They thus sometimes receive all of the incoming source household waste.

Yet the percentage of fermentable matter, and in particular of organic matter, is falling constantly. In France, for example, it accounts for only 30% of the source household waste.

Pre-fermentation is thus often dimensioned to accept all of the incoming waste even though only 30% of the matter is genuinely degradable, resulting in a very costly investment that, in addition, requires a large area.

To sum up, sorting recyclables and transformables and preparing the fermentable fraction, so as only to send the organic portion of the household waste to fermentation, makes it possible to:

- reduce the investment and energy consumption related to accelerated pre-fermentation;
- considerably reduce the overall space required for the process;
- genuinely adapt the MBT process to match the source HW;
- increase the recovery of the non-soiled recyclable or transformable matter (plastic containers, plastic bottles, steels, and the like);
- limit the risks of polluting the fermentable fraction and improve the quality of the finished product; and
- reduce the pre-fermentation time and optimise degrading.

2 Objectives of the MBT plant

Mechanical Biological Treatment or Pre-treatment of household waste can have various objectives that are simple but that should be clearly defined.

Naturally, ideally the treatment process is also changeable or upgradeable.

These objectives, which are not mutually exclusive, are as follows:

- To produce compost.
- To stabilise the organic matter by composting.
- To produce energy.
- To recover the recyclable materials.

2.1 Producing compost

Here, the objective is to produce a quality compost that complies with the relevant standard, where there is one, or at least that can be used by local consumers such as farmers, horticulturalists, private individuals, etc.), with two sub-objectives:

- to extract to compost most of the fermentable fraction of the waste; and thus
- to limit the production of rejects sent to landfill.

2.2 Stabilisation by composting

For this objective, it suffices merely to stabilise the fermentable organic matter by composting or methanisation before it is sent permanently to landfill or dumped temporarily pending transformation into energy.

2.3 Producing energy

This takes place as follows:

- either by methanising the fermentable fraction of the household waste;
- or by transforming the high-LHV fraction into energy: through direct incineration or through deferred incineration by manufacturing recycled solid fuels…

2.4 Recovering recyclable materials

As we have already said, the idea is to use magnetic, manual, optical, or other sorting to recover recyclable materials such as ferrous metals, non-ferrous metals, cardboard, and plastics materials. This objective, which is generally merely a secondary aim of the mechanical-biological treatment, should become an essential point.

In the light of what we have said previously, it is clear that the sorting and treatment processes satisfying any of these objectives can be very open-ended and must, above all, be suitable for being changed or upgraded.

However, clearly, setting aside the social acceptability of the project, the choice also depends on the local opportunities for outlets for the recycled or transformed products and for disposing of the rejects from the treatment, and in particular on the available incineration or landfill capacities:

- Methanisation will be considered only once the biogas users have been identified.

- Similarly, the compost should be produced to meet demand that is specified by a market survey: volume, type of compost, periods of use, etc.

- Stabilisation of the waste merely reduces the quantity of waste to be stored in landfill sites: it is therefore necessary to ensure that the available landfill resources remain sufficient.

Once the objectives have been specified, the prior survey can address the economics of the project, its environmental impacts, etc., and determine which techniques to implement.

3 Standard process proposal

The standard or typical processes that we are proposing to you address several objectives. They are the result of analysis of experience and feedback, and they do not constitute genuine models. They are merely open-ended and changeable compromises.

However, we have chosen to present to you a modular sorting and treatment process, based on the objectives set, and suitable for changing depending on opportunities.

3.1 1st Process: 2 modules

This first process, already developed, meets the following objectives:

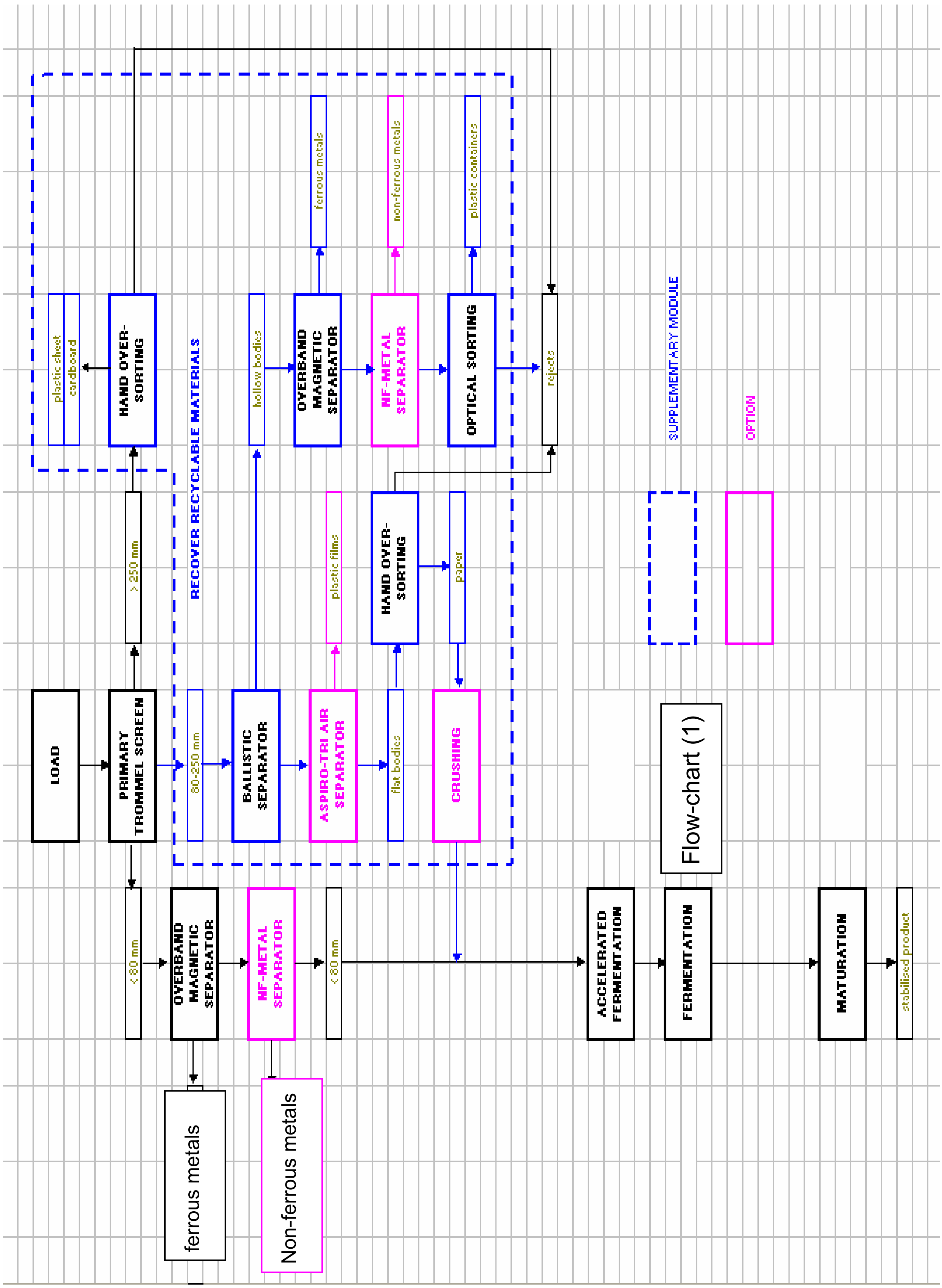
- Stabilisation, for landfill/dumping.

- Recovery of recyclables.

As you can see in the first flow-chart (1), the basic module represented by the black boxes makes stabilisation possible. It is supplemented by a module represented by blue boxes for recovering recyclables.

Naturally, the investment and the equipment selected depend on the overall tonnage to be treated, and, as we have seen earlier, on the composition of the source waste. The same applies for the separation particle sizes proposed for the trommel screen.

In addition, during the primary separation, it is also possible to consider a cut-off at 250-400 mm. The more we reduce the extent of the particle-size fraction, the easier it is to dimension the recovery equipment that follows. Indeed that equipment is then more effective.



The pink boxes are optional. Naturally, equipment is not installed if the investment for it is not justified by a sufficient tonnage of products to be recovered.

3.2 2nd process: 3 modules

This second flow-chart (2) makes it possible to meet the following objectives:

- Recovery of recyclables.
- Production of compost.

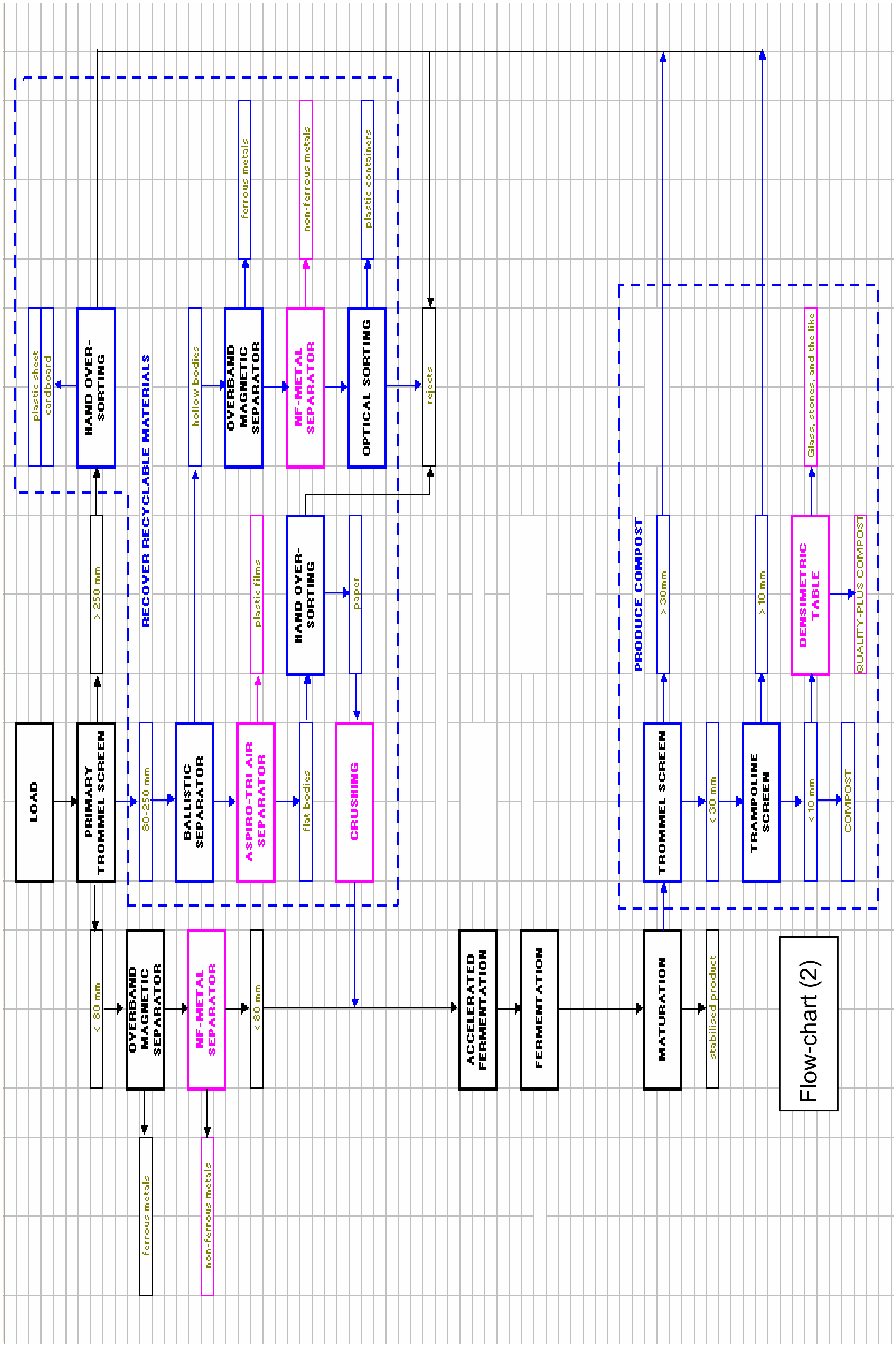
Here too, the particle sizes for the trommel screen and for the trampoline screen of the compost production module (i.e. for the ripening) will depend on the requirements concerning the compost (e.g. when a standard is to be complied with).

3.3 3rd process: 4 modules

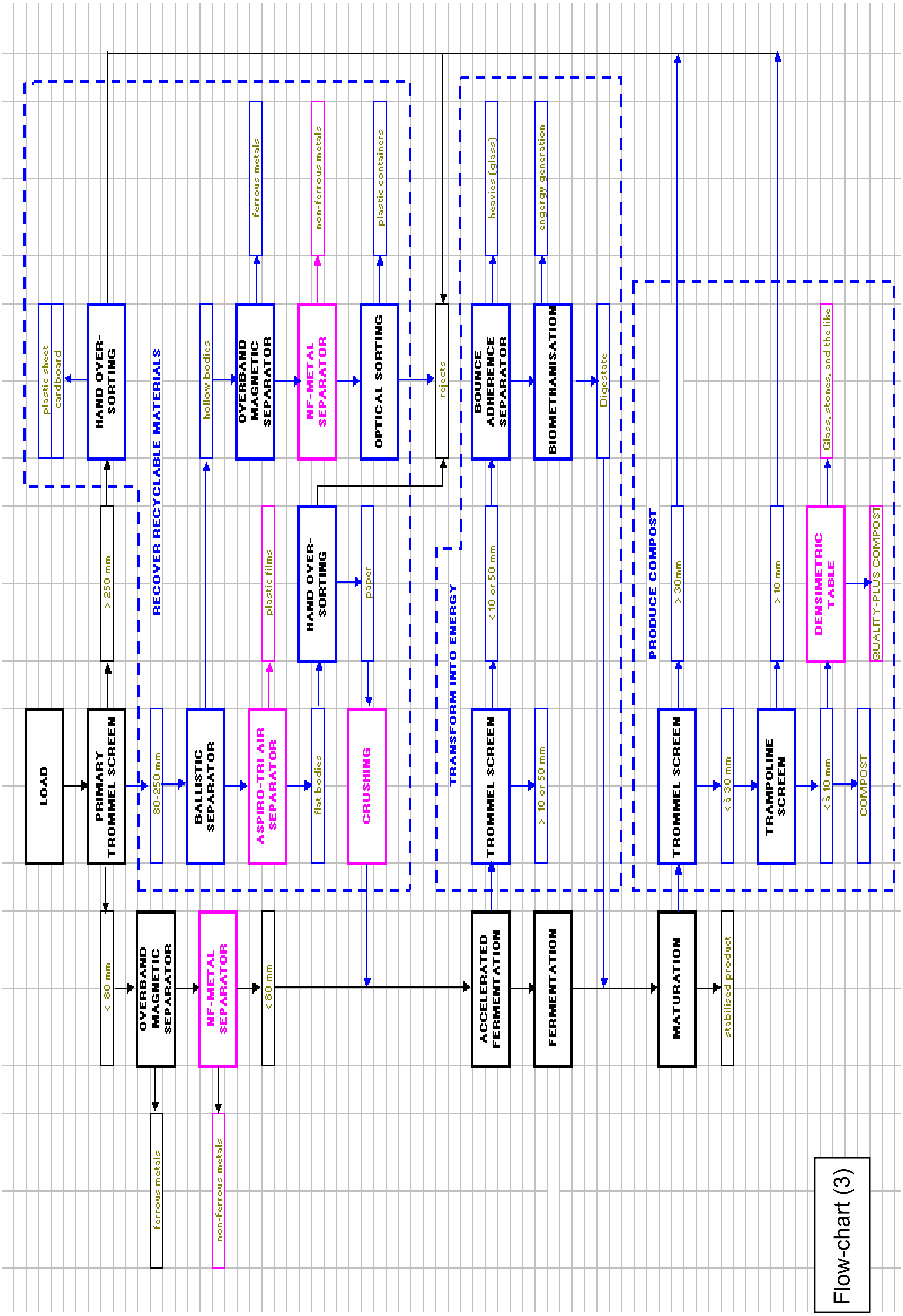
This final flow-chart (3) makes it possible to meet the following 3 objectives:

- Recovery of recyclables.
- Production of compost.
- Transformation into energy.

It is the most comprehensive because it makes it possible to optimise the added value procured from recycling and transforming household waste.


LOAD
PRIMARY TROMMEL SCREEN
> 250 mm
HAND OVER-SORTING
plastic sheet
cardboard
RECOVER RECYCLABLE MATERIALS
80-250 mm
BALLISTIC SEPARATOR
hollow bodies
OVERBAND MAGNETIC SEPARATOR
ferrous metals
ASPIRO-TRI AIR SEPARATOR
plastic films
flat bodies
HAND OVER-SORTING
NF-METAL SEPARATOR
non-ferrous metals
paper
CRUSHING
OPTICAL SORTING
plastic containers
rejects
< 80 mm
OVERBAND MAGNETIC SEPARATOR
ferrous metals
NF-METAL SEPARATOR
non-ferrous metals
< 80 mm
ACCELERATED FERMENTATION
FERMENTATION
MATURATION
stabilised product
PRODUCE COMPOST
TROMMEL SCREEN
> 30mm
< 30 mm
TRAMPOLINE SCREEN
> 10 mm
< 10 mm
DENSIMETRIC TABLE
Glass, stones, and the like
COMPOST
QUALITY-PLUS COMPOST

Flow-chart (2)


LOAD
PRIMARY TROMMEL SCREEN
> 250 mm
HAND OVER-SORTING
plastic sheet
cardboard
80-250 mm
< 80 mm
RECOVER RECYCLABLE MATERIALS
BALLISTIC SEPARATOR
hollow bodies
OVERBAND MAGNETIC SEPARATOR
ferrous metals
NF-METAL SEPARATOR
non-ferrous metals
OPTICAL SORTING
plastic containers
rejects
ASPIRO-TRI AIR SEPARATOR
plastic films
flat bodies
HAND OVER-SORTING
paper
CRUSHING
OVERBAND MAGNETIC SEPARATOR
ferrous metals
NF-METAL SEPARATOR
non-ferrous metals
< 80 mm
TRANSFORM INTO ENERGY
TROMMEL SCREEN
< 10 or 50 mm
> 10 or 50 mm
BOUNCE ADHERENCE SEPARATOR
heavies (glass)
BIOMETHANISATION
engergy generation
Digestate
ACCELERATED FERMENTATION
FERMENTATION
MATURATION
stabilised product
PRODUCE COMPOST
TROMMEL SCREEN
> 30mm
≤ 30 mm
TRAMPOLINE SCREEN
> 10 mm
≤ 10 mm
DENSIMETRIC TABLE
Glass, stones, and the like
QUALITY-PLUS COMPOST
COMPOST

Flow-chart (3)