MBT for a Sustainable Development – Vision 2020

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2nd International Symposium MBT 2007
22. – 24. May 2007, Hanover

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Abstract

Mechanical-Biological Treatment today is not the ultimate answer to a modern waste management. This paper presents a new, modular Waste Treatment Technology that meets the standards for a sustainable development and is already implemented on industrial scale.

Keywords

NMT-Process, BioFluff, Urban Mining, Sustainable Development, Vision 2020, MBT

1 Introduction

A waste pre-treatment plant is not only a plant, but also the expression of a whole waste management concept. A waste management concept will only then be fit for the future if it fulfils the conditions of sustainability. In waste treatment, the idea of sustainability is represented in the Vision 2020. In 2020 at the latest, the material cycle is to be closed completely accompanied by a high-grade utilisation of secondary products that is as advanced as possible, making landfills unnecessary. However, a discharge of pollutants will still be part of the 2020 reality; a 100 % technical processing does not yet exist.

The sustainable MBT-plant designed by EcoEnergy has a modular layout and consists of:

- Module 1: mechanical coarse treatment
- Module 2: utilisation of the coarse high calorific fraction
- Module 3: wet-mechanical separation (Nass-Mechanische Trennung, NMT) of the fine fraction
- Module 4: wastewater purification
- Module 5: BioFluff drying
- Module 6: BioFluff conditioning and utilisation possibilities

The core component of the concept is module 3, the wet-mechanical separation of the fine fraction < 80 mm, which substantially is a ternary mixture of water, inert matter (sand, stones, glass) and organic substances.

The treatment aims at the production of materially recyclable inert fractions and materially and / or energetically recyclable organic fractions.

The development and testing of the NMT-Process was effected by EcoEnergy Gesellschaft für Energie- und Umwelttechnik mbH, was supported by the Deutsche Bundesstiftung Umwelt (DBU) and scientifically accompanied by the University of Duisburg-Essen. In summer 2006, tests proved the large-scale feasibility of NMT.

This paper presents the possible utilisation of NMT-Process products and especially of the separated and largely dewatered organic fraction (raw BioFluff). There are for example:

- energy recovery in power stations,
- utilisation by digestion into methane or ethanol,
- materials recycling as fibrous material or for soil improvement / fertilization.

The concept represents a sustainable advancement of the MBT-idea.

2 Development of MBT-technology

Originally, MBT-concepts have been developed for the division of material flow streams into a wet fine fraction and a dry coarse fraction. Till the beginning of the 80s, the wet fine fraction was intended for the production of compost. The dry coarse fraction on the other hand was supposed to be processed into refuse-derived fuels for industrial plants and was then called BRAM (BRennstoffAusMüll - fuel out of waste). This concept was supposed to allow a high-grade utilisation of all waste components. The idea of sustain-ability has obviously been present even though this notion was not common at the time in waste management.

The wet fine fraction was used for the production of optically clean waste compost which outwardly did not differ from biological waste compost. The content of pollutants, in particular of heavy metals (Hg, Pb, Cd etc.) was too high for a long-term agricultural utilisation in food production.

With a purely mechanical treatment, pollutants could not be sufficiently eliminated from the dry coarse fraction to allow a co-incineration in industrial power stations which complied with technical aspects and legal regulations regarding emission protection on a long-term basis. Furthermore, as the costs of primary energy sources sank considerably in the mid-80s, the profitability of the BRAM-concept was not given anymore.

From the middle of the 80s on, the separate collection of dry recyclables such as paper, cardboard, glass and metals was increasingly called for and the MBT-concept was modified to a pure pre-treatment for landfills.

In pilot tests at the composting plant Witzenhausen with biological waste from the separate collection of 1983 - 1986 (ANS, 2003), it was possible to prove that biological compost from separate biowaste collection is much less contaminated with pollutants and contraries than domestic waste compost. As a consequence, based on Section 3 of the waste disposal act from 1986, the then environment minister Klaus Töpfer demanded the separate collection of biowaste and of the dry recyclables paper, cardboard and carton (Papier, Pappe, Kartonagen, PPK) and glass.

The results of the model plans for a separate collection of recyclables were the basis for the adoption of the closed substance cycle waste management (KRWABFG, 1994) including the separate collection of biogenetic waste components and the definition of quality criteria for the produced biowaste composts (LAGA M10, 1995), (BIOABFV, 1998). The limit values for composts, mentioned in LAGA M10 and the Ordinance on Biowastes, were intended for the avoidance of domestic waste compost and for the orientation on technical possibilities of a separate biowaste collection. The sustainability idea was present at the beginning but not consequently implemented. Aspects such as long-term accumulation of pollutants in soils have not been considered in setting up the limit values. Only in the position paper of the Federal Environment Agency "Gleiches zu Gleichem" (like to like) (FEDERAL ENVIRONMENT AGENCY, UBA, 2002), the idea of sustainability also applied to biowaste compost, but was not transferred into a legal framework.

With the separate collection of recyclables and biowaste and because of the failure of the domestic waste compost and BRAM-concept, the MBT-idea was reduced to a mere pre-treatment prior to landfill storage. The closing of material cycles, energy efficiency and with them the idea of sustainability were pushed into the background.

The original motivation of MBT-technology was highly modern but the steps taken were obsolete and have been surpassed by the progressive sustainability idea in the field of waste management:

a. Domestic waste compost is not sustainable

Due to the high level of pollutants, it is not possible to produce agriculturally utilisable compost for food production out of mixed waste (domestic waste).

b. Compost out of separately collected biowaste is sustainable. Really?

The level of pollutants in compost out of separately collected biowaste is partly so high that it exceeds the limit values defined by the Ordinance on Biowastes (UMWELTMINISTERIUM BW, 1996), (BIFA, 2002), (BAYERISCHES LANDESAMT F. UMWELTSCHUTZ, 2003).

This means that a sustainable compost utilisation is hardly possible. According to the position paper of the Federal Environment Agency "Gleiches zu Gleichem" (like to like) (UMWELTBUNDESAMT, 2002) a composting of a big part of the separately collected biowaste is not reasonable because the biowaste compost would not fulfil the newly set requirements.

c. Implementation of the Waste Storage Ordinance

The requirements of the TASi (Technical Instructions on Waste from Human Settlements) (and of the Separate Act) have indeed been implemented since 1 June 2005. The construction and operation costs of an MBT have exceeded the expected extent.

d. Bad quality of produced refuse-derived fuels

The high calorific fraction out of municipal waste is not used as energetic recyclable against many predictions but is still considered as waste for energy recovery. As in connection with the BRAM-concept of the 80s, it was not possible to produce low contaminated fuels out of mixed waste through mechanical treatment which comply with the specifications of efficient power and heat generation plants.

e. No use of refuse-derived fuels in modern coal-fired power stations

Today, the produced refuse-derived fuels are only co-fired in old power stations with low steam parameters and a correspondingly low net efficiency. Accordingly higher are the fuel costs and - important in the future - the carbon dioxide emissions of the basic load fuel. In energy-efficient power stations, even the use of low amounts of refuse-derived fuel is out of the question because of possible operation failures.

When refuse-derived fuels out of mixed municipal waste are used in power plants, new questions considering the processing of the residues produced in the power station process arise.

f. Utilisation in cement kilns dependent on overall construction activity

A utilisation of the refuse-derived fuels in cement kilns is complicated by the high dependence on the overall construction activity. The demand for cement is still declining. Furthermore, the cement industry prefers to use wastes which have a high calorific value and can easily be dosed such as scrap tires, residual oil, paint sludge and special process waste. Refuse-derived fuel from MBT is only then used when more appropriate secondary fuels are not available or can only be procured under unfavourable economic conditions.

g. Incomplete proof of equivalence

The proof of equivalence between MBT and WI is incomplete, only considers the deposition behaviour of the treated waste and does not completely regard the emissions during the treatment. Other aspects that were not considered are:

– energy efficiency, especially regarding the storage of the fine fraction and the energy demand of the MBT including exhaust gas treatment (RTO) seen from a BAT-perspective

- recyclable properties of the stored wastes - utilisation priority
- space required by the plant technology
- overall profitability including the costs for energy recovery with pollutant reduction potential, same concerning WI

Conclusions:

The idea of a material flow stream separation aiming at a sustainable waste management is right, but the concept of an MBT as pre-treatment plant prior to a landfill has failed, because neither the sustainability idea fully comes to effect nor will a long-term operation be possible. Furthermore, several MBT-plants have difficulties with fully complying with the current legal requirements (DOEDENS ET AL., 2006), (ASA, 2006). Additionally, a conventional MBT-plant is facing the challenge that waste management is increasingly considered as raw material producer for high-grade secondary products („urban mining") (HOFFMEYER, 2005).

3 Treatment coarse fraction

The first step of a high-grade waste processing is the selective shredding with subsequent classification into a high calorific, largely dry coarse fraction and a low calorific, largely wet fine fraction consisting of organic matter and inert substances.
The waste is coarsely shredded. Inert material and coarse organic matter is shredded to grain-sizes of < 80 mm. Deformable plastics, plastic films etc. are hardly shredded at all (selective shredding). As a result, when the screening mechanism is adjusted (sieve perforation, sieve diameter, built-in structures) to the shredder, the fine fraction of < 80 mm contains 90 to 95 % of the organic matter and inert substances while the hardly shredded plastics and PPK (paper, cardboard and carton) are collected in the coarse fraction.

A sieve cut of < 80 mm is proven in the technical context. A screening which is considerably coarser than 80 mm will complicate the subsequent processing of the fine fraction.

The coarse fraction of > 80 mm can be used for energy recovery without further treatment in a refuse-derived fuel processing plant (grate firing). This is reasonable for use in highly energy-efficient combined heat and power plants.

If a direct, energy-efficient utilisation is not possible, the obvious thing to do would be a further treatment of the coarse fraction aiming at the production of (materially) recyclable fractions. Drying the material improves the treatment quality and thereby the utilisation possibilities.

A sustainable dryer has to meet the following requirements:

- The treatment of a wide grain-size range of up to 300 mm must be possible without making a further shredding of the material before drying necessary.
- The drying temperature should be less than 100°C for reasons of fire protection. Low drying temperatures prevent material changes in plastics making a material recycling possible.
- As drying energy, low-temperature heat should be used e.g. from power or CHP stations.

– The dryer should be run in recirculation mode to minimize the amount of exhaust gas and to avoid extensive exhaust gas cleaning.

The dryer principle designed by EcoEnergy is a belt dryer in recirculation mode adapted to the waste; a pendulum ground system is used as belt.

The high calorific coarse fraction (80 mm to 300 mm) containing high amounts of plastics produced during selective shredding and classification as well as the recirculated flow from conditioning are fed into the dryer.

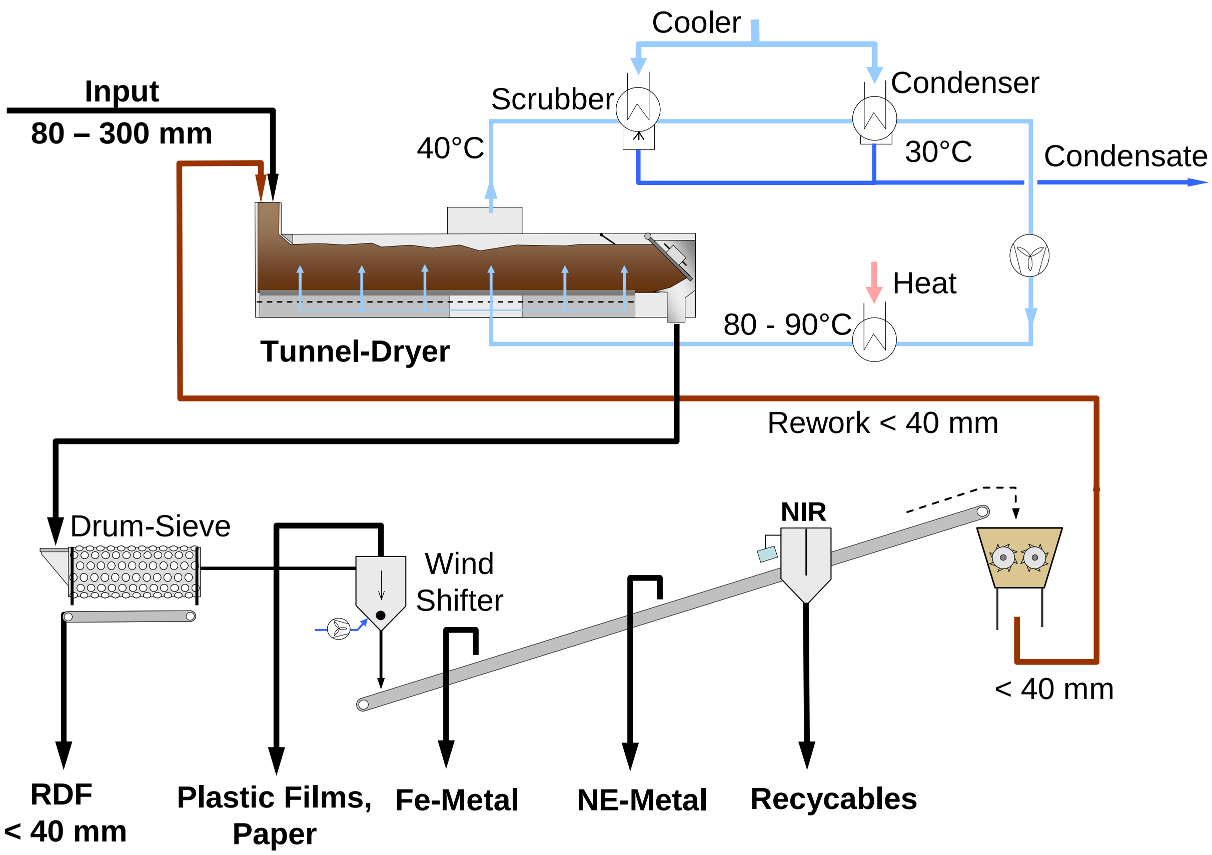

Figure 1: Process flow diagram tunnel dryer with processing

Result of the processing of the coarse fraction are dry, odourless and clean products which can be used for materials recycling and / or energy recovery.

4 Treatment fine fraction

The fine fraction < 80 mm is separated by the NMT-Process into inert fractions, organic matter fractions and a liquid fraction which contains the dissolved substances as well as the finest inert substances and organic particles. As separating fluid, recirculation water heated up to about 65°C is used. Heating up the recirculation water reduces the viscosity of the water improving its separation effect and the efficiency of the pressing.

Additionally, because of temperature interferences above 65°C and the shear effect in the screw presses, the effect of a thermo-mechanical cytolysis (TMZ) and the sanitation of the native organic matter is achieved (SCHU, 2006).

When working with biowaste and residual waste, the process produces a water surplus. Because of the missing water-holding capacity, inert substances can be dewatered down to a residual water content of < 5 %o organic products to a residual water content of 40 % to 60 %. By separating inert discharge and fractioning in advance, a thermo-mechanical cytolysis is possible resulting in defibration and cell-disruption and thus in a higher dewatering degree.

Vast dewatering of the inert fraction is also possible without drying.

The inert substances are cleaned with recirculation and fresh water to such an extent that a further processing is possible.

If required, the quality of the coarse inert fraction can be improved through construction waste processing.

On the whole, the following products can be extracted from the inert fractions:

- stones
- gravel
- sand

After screening, the organic fractions are dewatered in screw presses.

During this process, also the cell water is collected because of the special process conditions of the thermo-mechanical cytolysis.

Process-induced, the pollutant content of the biomass fraction is low.

Chlorine is not contained as PVC because of the preceding separation of plastics and can only be contained as dissolved salt in the water.

Because of the high dewatering degree without thermal drying, all dissolvable pollutants are washed out by 50 % to 90 % by the press and washer water depending on the water treatment and press concept.

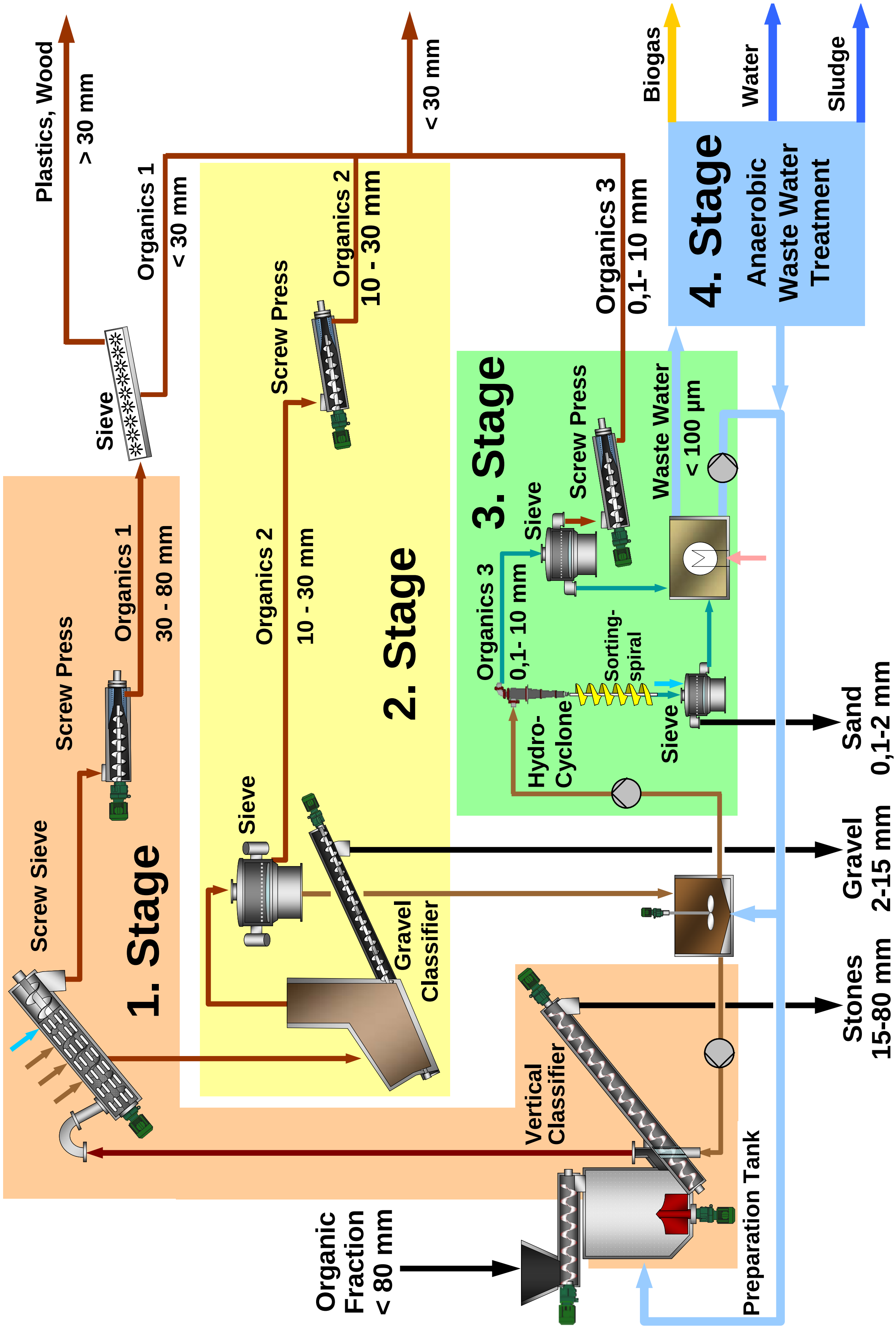

Figure 2: Process scheme of the NMT-Process

If the organic material out of the NMT-Process is supposed to be briquetted or pelletized, it will have to be dried.

After drying, the organic substances (raw BioFluff) are sieved at 5 mm while the residual plastics are separated in the screen overflow.

The screen underflow consists of up to 100 % native organic material which will be referred to as BioFluff in the following.

The dried and screened BioFluff is conditioned in accordance with the intended processing. BioFluff is low contaminated, dry-stabilised, frayed biomass which can be put to various uses.

It is pelletized for the utilisation as dry fertilizer and pelletized or briquetted for direct energy recovery.

If BioFluff is to be further processed e.g. digested into methane and ethanol or converted into insulating material, building material or filter material, pelletization and briquetting for transport may be necessary because of the low density.

Another objective of the NMT-Process is to transfer the digestible components of the waste into the recirculation water and to filter them according to the requirements of an anaerobic industrial water cleaning at about 100 pm.

In this respect, most appropriate are high-performance procedures with anaerobic fixed-bed reactors or with bio mass retention according to the UASB-process.

The COD-degradation lies, depending on the anaerobic degradable COD-content, at 75 % to 95 % and the treatment duration at about 15 to 30 hours compared to 18 to 21 days in conventional biogas plants.

The produced biogas is used in a CHP station, energy and heat are used for the whole process.

The outflow of the UASB-process is post-treated in an aerobic fixed-bed reactor and can be recirculated as washing water for the NMT-Process or passed on as surplus water to the subsequent nitrification or denitrification stage of the aerobic wastewater treatment and then recirculated.

If the salt content of the NMT-process products is too high, reverse osmosis can be applied.

The wastewater sludge, which is produced during the anaerobic and aerobic stage of the wastewater treatment, is used as pollution sink of the whole process.

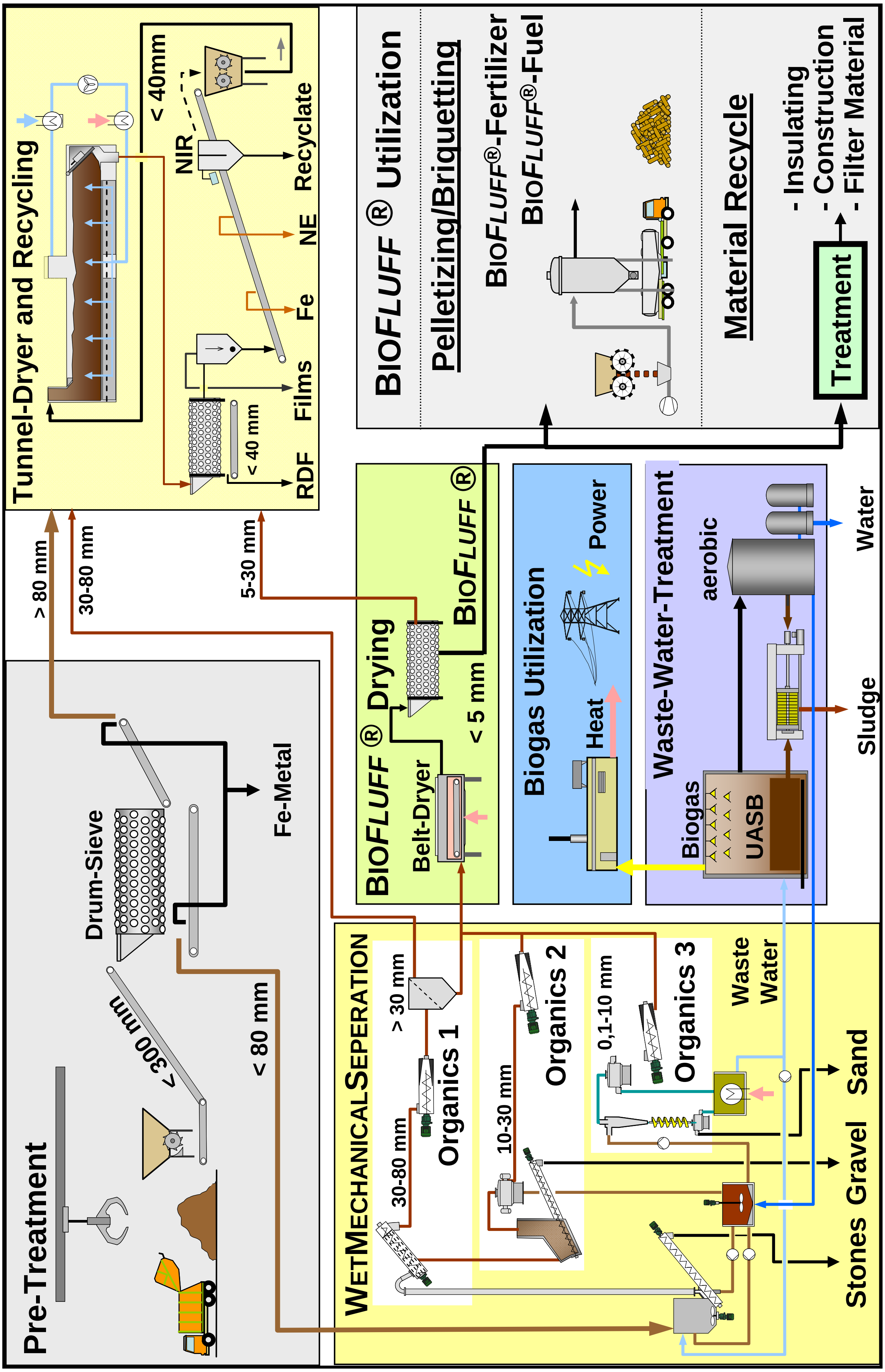

Figure 3: Process scheme total

5 Summary and perspectives

The Vision 2020 considers waste management as supplier of raw materials.

MBT-technology is not sustainable as long as the energy content of organic matter is discharged unused into the environment and residues are stored.

The multitude of the presented utilisation possibilities of waste fractions should provide incentives for supporting the Vision 2020.

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