Generation of recovered fuel from biomass residues and sewage sludge (7 FP project ENERCOM)

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ENERCOM

PF7 program “Energy” project “Polygeneration of energy, fuels and fertilisers from biomass residues and sewage sludge (ENERCOM)” (No TREN/FP7/EN/218916)

Project coordinator - Ifas - Institute for Applied Material Flow Management (Germany).

Project partners:

- Soil-Concept S.A. (Luxembourg),
- LEE (Luxembourg),
- Bisanz Anlagenbau GmbH (Germany),
- BIOS Bioenergiesysteme GmbH (Austria),
- KTU APINI (Lithuania),
- Kuhbier Law Firm (KLF) (Belgium),
- B.A.U.M. Consult GmbH (Germany).

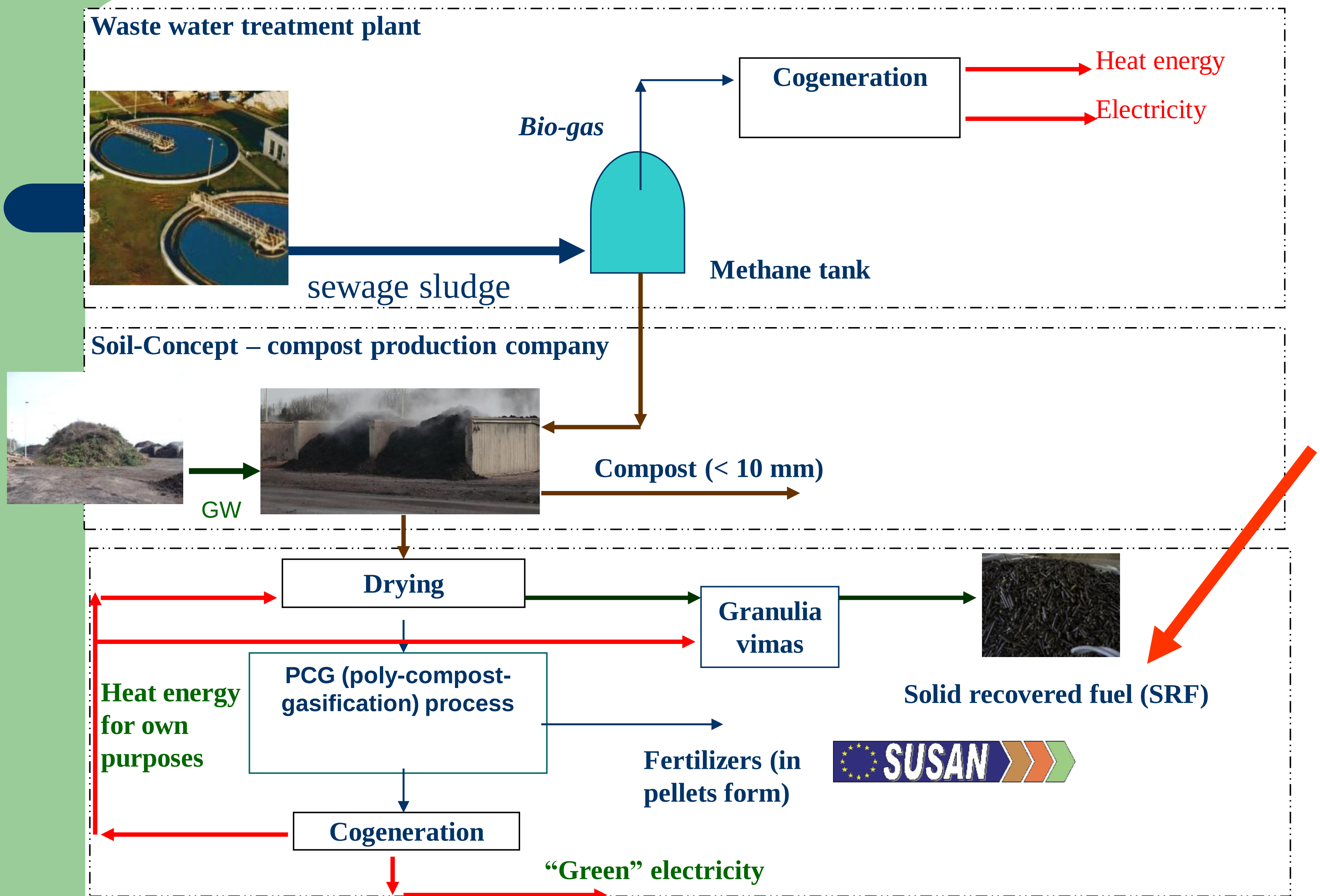
The aim of the project

The aim of the project was to demonstrate high-efficient polygeneration of electricity, heat, solid fuels and high-value compost/ fertilisers from sewage sludge and green waste mixed with biomass residues.

The project concept allows achieving high overall energy efficiency by

- (1) mixing sewage sludge with greenery waste and biomass residues, and using low-temperature environmental heat, and heat from the composting process for drying sewage sludge;
- (2) highly efficient gasification process;
- (3) saving transport energy due to a better overall material flow management inherent to the concept [ENERCOM].

Principal scheme

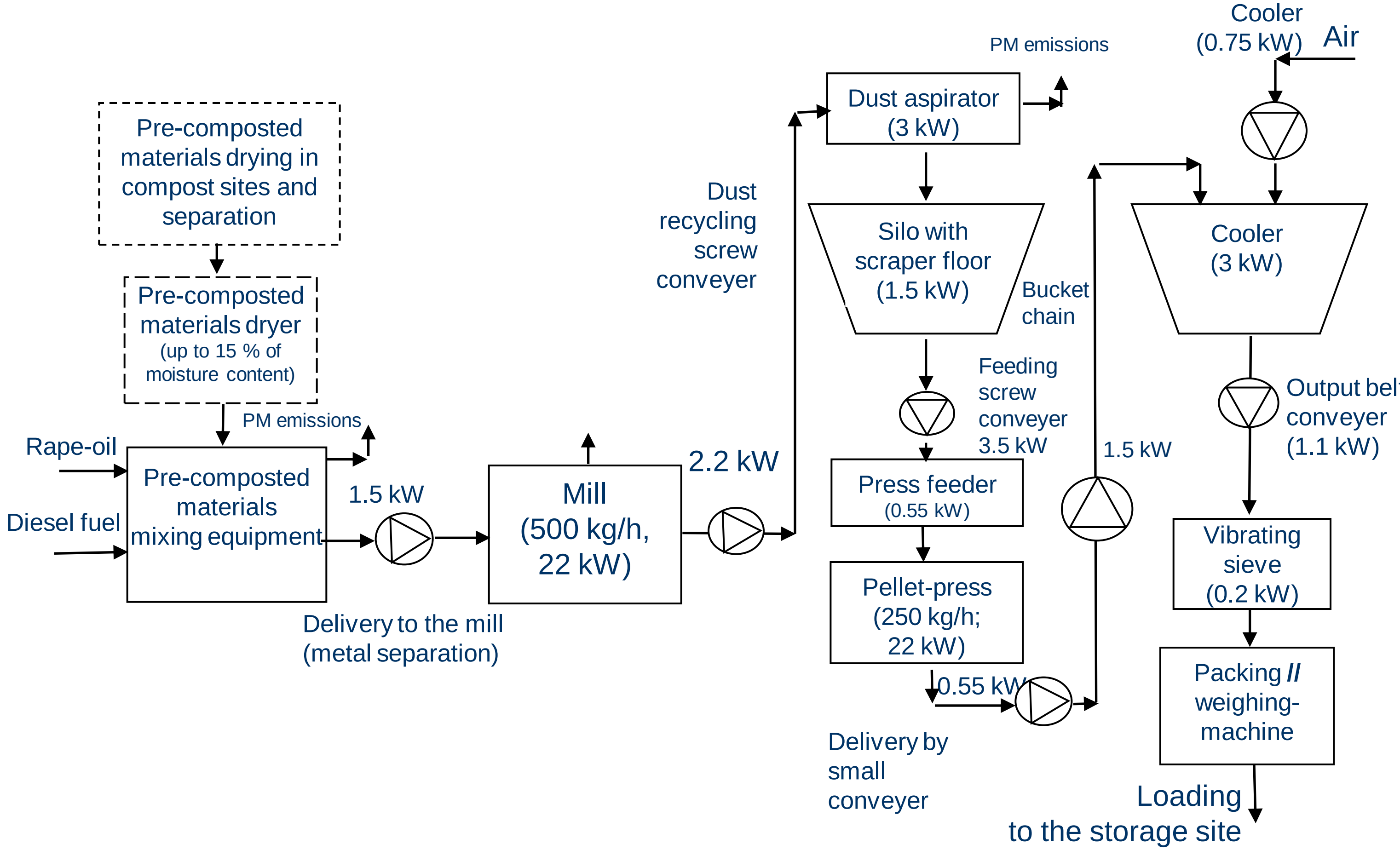


SRF production

One of the goals of the ENERCOM project was to assess the possibilities of producing SRF from the pre-composted materials:

- stabilize sewage sludge with 25-30% of dry substance (DS) content,
- municipal green waste (grass, branches, etc.) with 40-50% of DS, and
- bark with 60% of DS.

Functional scheme of pelleting process in Soil-Concept



Pellets production technology in the Soil-Concept Company

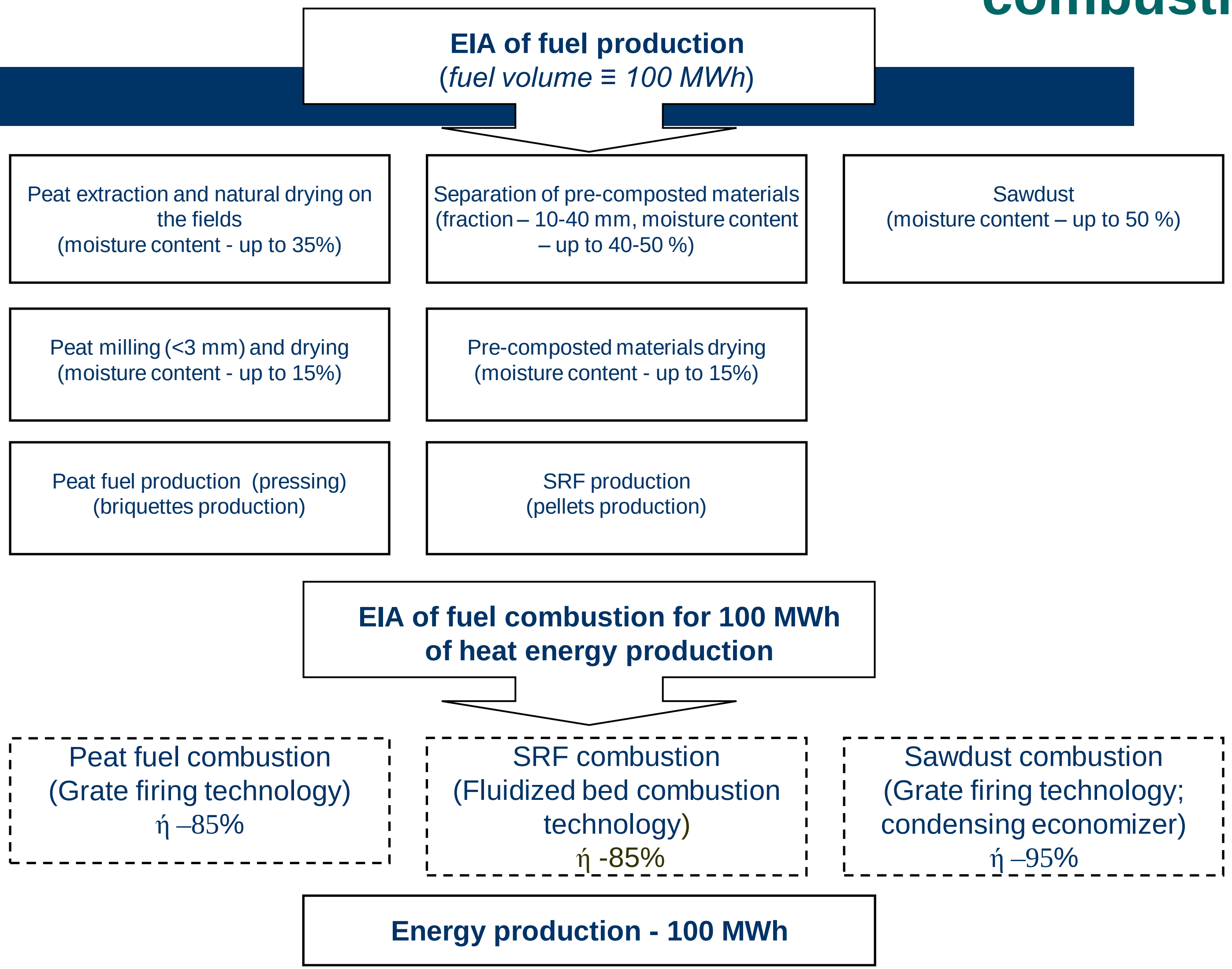
Monitoring of the pelleting process was performed in 2010/2011

Relative EI of SRF production (pellets production from pre-composted materials)

Input and output variables	EI
Consumption of pre-composted materials (10-40 mm fraction) (moisture content before mixing – 14.5%), kg/[1]kg	1.0840
Rapeseed oil consumption, kg/[1]kg	0.0110
Amount of air emission (PM), kg/[1]kg	0.0313
Waste volume (metal parts), kg/[1]kg	0.0210
Waste volume (losses), kg/[1]kg	0.0100
Electric energy consumption, kWh/[1]kg	0.1640
Diesel fuel consumption, kg/kg	0.0080
Air emissions from mobile sources, kg/[1]kg	0.0010

[1]kg – 1 kg of produced product – pellets.

Methodology for the comparison of environmental impact during different fuel production and combustion



Comparison of SRF of pre-composted materials with the classification system of SRF (CEN/TC 343)

Recovered fuel composition, %	SRF of pre-composted materials (10-40 mm fraction)	
Recovered fuel form	pellets	
	value	class
Net calorific value as received, MJ/kg	13.73	4 (≥10)
Chlorine (Cl) content in dry matter, %	0.138	1 (≤0.2)
Hydrargyrum (Hg) content, mg/MJ (median)	0.084	4 (≤0.15)

Evaluating results of the laboratory analysis, the produced SRF was compared to the standard requirements for SRF according to CEN/TC 343. The comparison shows that SRF corresponds to the standard requirements for the recovered fuel [European Committee for Standardization CEN/TR 15508:2006, EN 15359:2011].

Air emissions (t) burning different fuel (sawdust, peat briquettes, SRF) for 100 MWh of heat energy production

Fuel type	[2] Fuel volume, t	CO, t	SO_2, t	NOx, t	HCl, t	[1]PM, t	HM, t	CO_2, t
Wood sawdust	31.600	0.372	0.023	0.046	0.002	0.002	$0.800*10^{-4}$	-
Peat briquettes	28.235	0.415	0.209	0.009	0.001	0.049	$0.900*10^{-4}$	44.894
SRF of pre Composted materials	30.847	0.023	0.129	0.061	0.003	0.008	$0.911*10^{-4}$	-

Comment:
[1] Efficiency of fly ash removable systems:
98.5% - in case of sawdust burning (due to double treatment: with multi-cyclone and condensate economizer);
90% - in case of peat fuel burning;
99.5% - in case of electrostatic filter.
[2] Fuel lower calorific value:
15 MJ/kg – for peat briquettes,
12 MJ/kg – for sawdust (with 50% of the moisture content),
13.73 MJ/kg – for SRG of pre-composted materials

Total energy consumption for the production of 1 kg of fuel (*comparison table*)

Energy:	*Energy consumption, kWh/kg*	
	SRF (pellets)	*Peat fuel (briquettes)*
Diesel fuel: for mixing: for extraction:	 0.095 -	 - 0.119
Heat energy for raw material drying	0.225	0.208
Electricity for drying: for pressing:	0.042 0.164	0.042 0.077
Total :	**0.526**	**0.446**

Comparison table: main inputs processes' variables of fuels production and combustion for 100 MWh of heat energy production (I)

Main inputs variables and other criteria	Dimen sions	100 MWh of heat energy production, burning		
		Sawdust	Peat briquettes	SRF pellets
Fuel characteristics: Moisture content Fuel lower calorific value Volume for 100 MWh of heat energy production	% MJ/kg t	50 12 31.600	15 15 28.235	15 13.73 30.847
Main characteristics of combustion plants: Capacity Efficiency Technology	 MW % 	 <35 95 grate firing with condenser economizer	 <35 85 grate firing	 35 85 FBC
Main inputs:		Sawdust	Milled peat	Pre-composted materials
Raw materials moisture content before drying	%	50	35	45
Raw materials for fuel production: Before drying After drying	 t t	 31.600 31.600	 37.86 28.950	 51.68 33.44
Total energy consumption:	**MWh**	**2.100**	**16.969**	**23.631**
Rape-oil (additional material for SRF)				0.389
Matrix consumption			0.007 (1 unit / 4000 t of peat briquettes)	0.04 (1 unit / 800 t of pellets)

Comparison table: <u>main outputs</u> processes' variables of fuels production and combustion for 100 MWh of heat energy production (II)

Main outputs variables and other criteria	Dimen-sions	100 MWh of heat energy production, burning		
		Sawdust	Peat briquettes	SRF pellets
Heat energy production	MWh	*100*	*100*	*100*
Heat energy losses during production	MWh	5.33	17.65	17.65
Air emissions during fuel burning for 100 MWh of heat energy production and drying process (only for peat and compost) PM, *inc. HM* CO NO_x SO_2 HCl CO_2	t	*0.445* 0.002, *inc. 0.00008* 0.372 0.046 0.023 0.002 0	*0.729 and 47.904 of CO_2* 0.052, *inc. 0.000096* 0.443 0.010 0.223 0.001 47.904	*0.248* 0.008, *inc.0.0001* 0.025 0.068 0.144 0.003 0
Indirect impact: air emissions during electricity consumption (for example, burning natural gas: CO; NOx; CO_2)	t	*0.457*	*1.969*	*2.599*
Particulate matters' (PM) emissions to the air during fuel production (pressing)	t	-	0.136	0.966
Non-hazardous waste (*ash from treatment equipment, bottom ash and remains production losses*; *sand with slag from FBC metal waste)*	t	*0.316*	*3.148* - -	*10.752*
Waste water (neutralized condensate)	m^3	40	-	-

Positive aspects of EIA of SRF production and combustion are the following

- 82% of biodegradable waste, inc. *sludge of municipal waste water treatment plant and green waste* (raw materials for SRF production) are convertible to the energy; 18% of mass becomes waste (ash, bottom ash, and remains);
- the amount of energy needed for the SRF production and combustion does not exceed that obtained during SRF combustion (23.631 MWh/100 MWh);
- the volume of CO_2 emitted during SRF combustion equates zero due to biogenic nature of raw materials used in SRF production;
- total air emissions during the heat energy production burning SRF of pre-composted materials, inc. the SRF production process and indirect impact due to electricity consumption are 2.8 times lower than the air emissions during peat briquettes production (excluding CO_2) and over 17 times lower in case of CO_2 evaluation.

Negative aspects of EIA of the SRF production and combustion are the following

- SRF of pre-composted materials results in the high ash content (more than 30%); therefore PM emissions to the air during SRF combustion after treatment before 99.5% are four times higher, compared to the sawdust combustion;
- the heavy metals content in pre-composted materials is more than 17 times higher, compared to the sawdust and about 6 times higher, compared to the peat;
- the amount of total energy, needed for the SRF pellets production and its combustion for 100 MWh of heat energy production is 1.4 times higher, compared to the peat briquettes production and combustion and more then 11 times higher, compared to the sawdust combustion

Recommendations

- For the purpose of reducing an environmental impact on the air, first of all chemical and physical characteristics of separate pre-composted materials fractions are to be evaluated for the purpose discovering more suitable ones for fuel production for each parcel. Besides, pre-composted materials can be mixed with sawdust (up to 10% of the total SRF raw materials volume) or SRF can be burnt together with biofuel.
- In case of adding peat fuel adding to raw materials for SRF production, some peat fuel characteristics are improved: decrease of NOx, CO_2 emissions to the air decrease. Furthermore, peat fuel can to improve on some recovered fuel characteristics: increase the calorific volume, decrease energy consumption for raw materials drying. In case of mixing pre-composting materials mixing with peat, the briquettes production becomes more proper from economical and environmental point of view.

Thank you for attention

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