Urban bio-waste valorization – resource evaluation and characterization for energy recovery by anaerobic digestion

7th International Conference on Sustainable Solid Waste Management
Heraklion, 26–29 June 2019

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1- Introduction

Challenge of urban biowaste management

•***Urban biowaste*** include of organic waste produced in urban areas, such as garden and park waste, food and kitchen waste from households, restaurants, caterers and retail premises, and comparable waste from food processing plants ;

•**Yet**, biowaste production is still growing in most cities, following the growth of population ;

•**In agreement with the European Directives, separated source collection of bio-waste and the implementation of a public service for resources recovery from them will be made mandatory in 2025 ;**

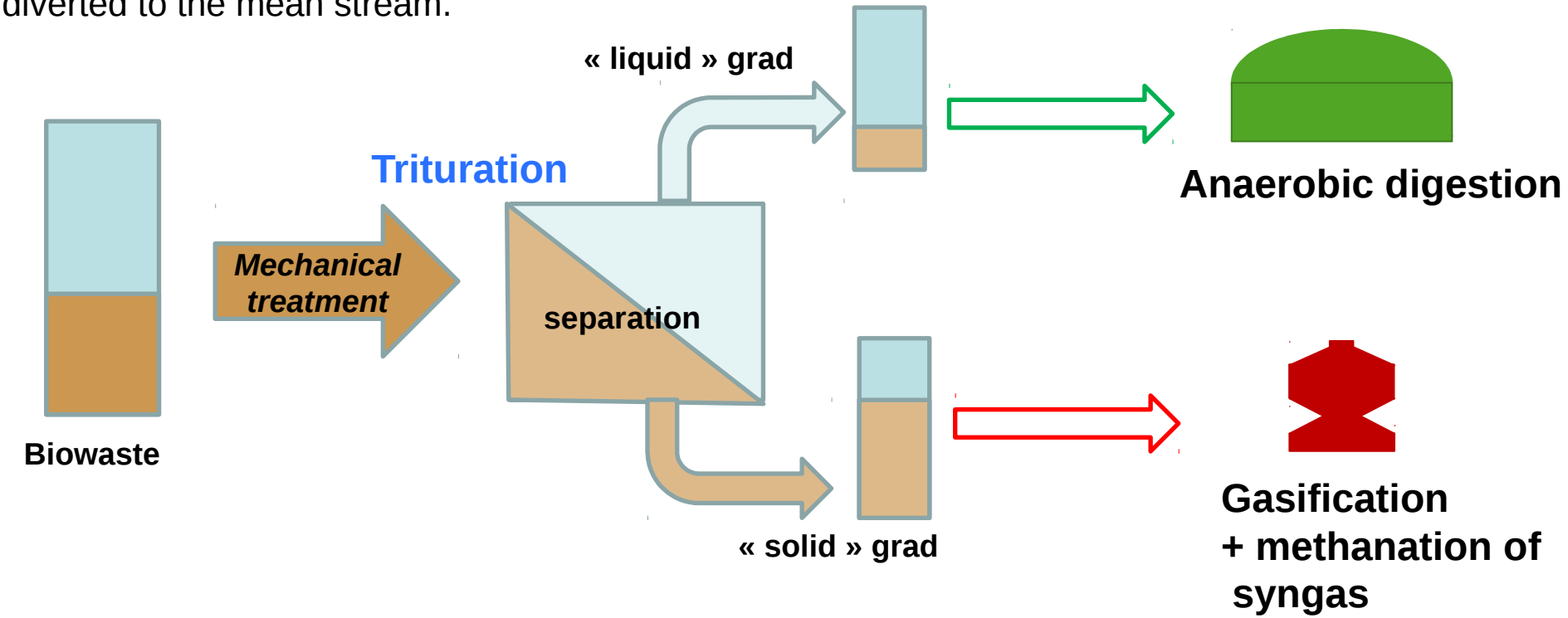
•In many urban areas however, the efficiency of source separated collection often remains relatively poor, in particular for urban biowaste;

•The environmental quality of biowaste is strongly affected by the presence of several undesirable fractions, including in some cases hazardous domestic waste, making it difficult to recycle organic matter for agricultural purposes.

1- Introduction

Technical option selected: methane conversion

UrbanBioM project : A new strategy to treat **urban biowaste** could be the production of a single energy vector, **methane**. This fuel can be produced using proven technologies: **anaerobic digestion** and methane production for liquid and easily fermentescible fraction, and thermochemical process combining **gasification and methanation of syngas** to treat solid fraction diverted to the mean stream.



The objective of the first step of the multi-partners project URBANBIOM is to identity and characterize biowaste streams produced in an urban territory, with regards to their potential use as feedstock for anaerobic digestion.

2- Urban biowaste identification

Targeted territory

GRANDLYON
la métropole

Urban territory : Lyon Métropole

1,4 million inhabitants

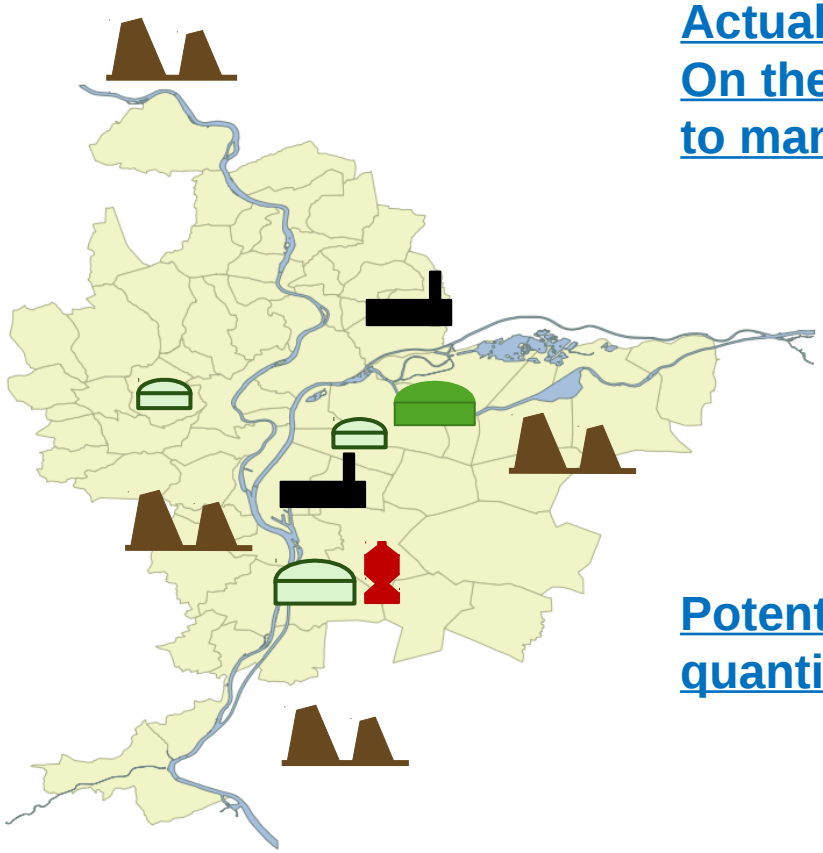
4 840 restaurants,
including 17 starred restaurants
(guide Michelin 2019) !!

Oui!

The UrbanBioM project will provide decision support for solutions and, ultimately, projects for new recovery facilities to be favored. These elements will also feed into the reflections initiated by Lyon Metropole on the implementation of biowaste selective sorting by 2025, and the treatment methods to be considered in the case of the capture of part of the biowaste generated in this urban area.

2- Urban biowaste identification

Targeted territory



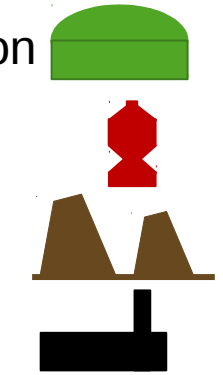
Actual issues On the territory to manage waste :

Anaerobic digestion

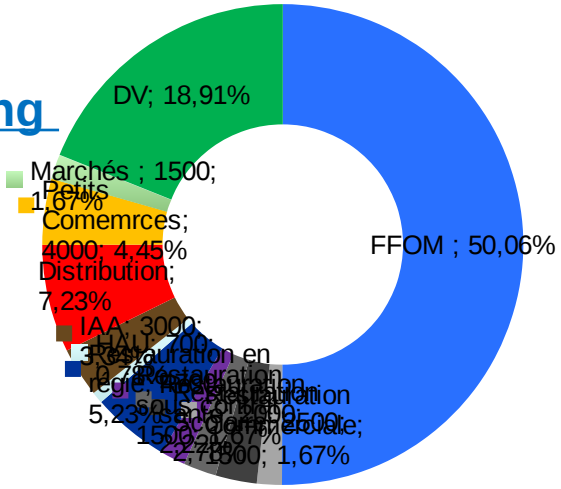
Gasification

Composting

Incineration



Potential mobilizing quantity:

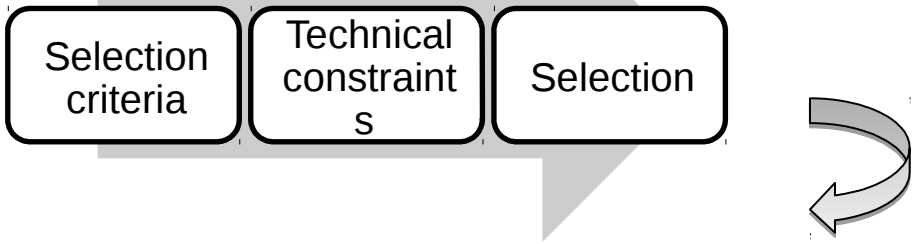


Food waste from restaurants

2- Urban biowaste identification

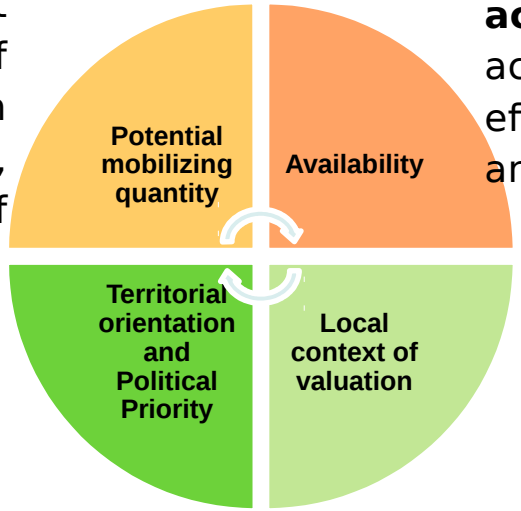
Selection of the major stream

Selection of the major stream (to characterize) was based on several criteria:



Potential mobilizing quantity: take into account the quantitative issues of valorization of the biowaste. In fact, the larger the biowaste, the greater interest of valuation

Territorial orientation and Political Priority: take into account the political and societal issues specific to the territory: political decision, local dynamics, ongoing projects



Availability (dispersion, accessibility, adhesion): take into account the issues related to the effective implementation of the sector and more particularly the collection;

Local context of valuation: take into account the existing sectors established locally (maturity of the processing and valorization, development, implantation projects), and thus preferentially target the flows currently little or not valued.

3- Urban biowaste characterization

Selection of biowaste for a full characterization

Food waste from households (HBW)

2 scenarios of collect: from 9 000 t/year to 45 000 t/year

Food waste from restaurants (RBW)

6 400 t/year to 8 200 t/year

Food wastes from Supermarkets (SMBW)

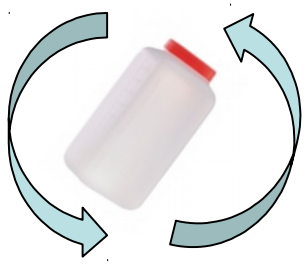
3 000 t/year to 6 500 t/year

Urban Green Waste (GBW) from domestic, municipal and private activities

15 000 t/year to 16 000 t/year

Multiphasic analytical procedure

The **procedure** was based on water extraction of the raw sample, which enabled the measurement of the contributions of **water-soluble** and **particulate phases** of biomass dedicated to anaerobic digestion



Leaching procedure: 10:1 water/TS ratio during 2 h under constant flip-flop rotation (10 rpm)

Raw sample

Analysis

TS; VS; BMP

Elementary analysis (CHNOS)

OOM + inert materials, (Plastics, gravels, glass)

Granulometry

Water retention capacity

Particulate

Analysis

TS; VS; COD; TKN;

Organic fibers (Van't Soest extraction)

TG-DSC

Water soluble

Analysis

TS; VS;

BMP

pH

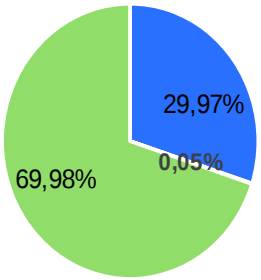
COD; WSC; VFA

TKN; NH_3-N

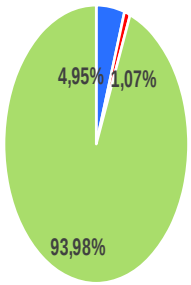
Global composition :

Oxydisable organic fraction Minerals Plastics

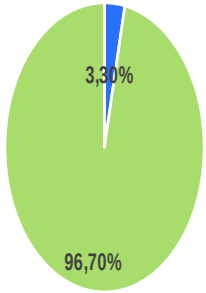
Urban Green Biowaste (GBW)



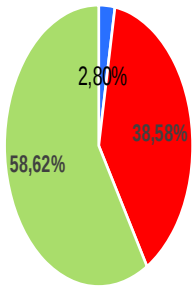
Food waste from Restaurants (RBW)



Food waste from Households (HBW)



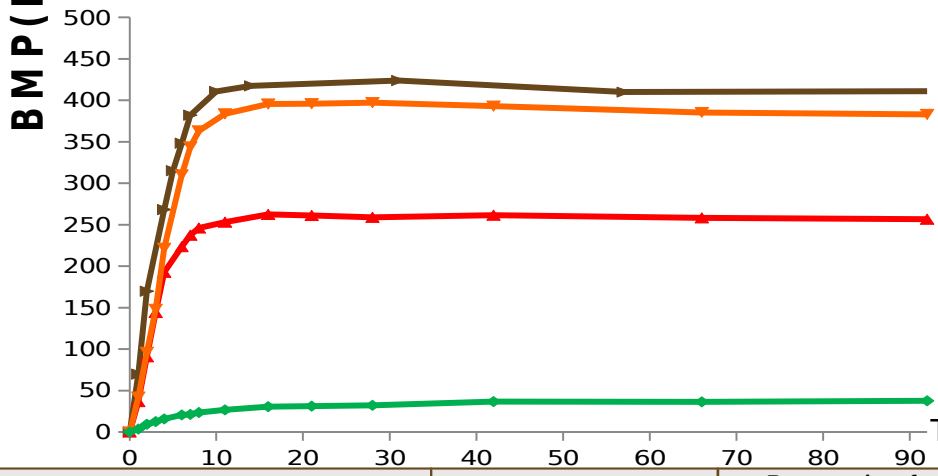
SuperMarket food Biowaste (SMBW)



- Inert content nearly 30% for green waste;
- Around 3% of inert mat. in biowaste from households and biowaste from supermarket biowaste, and close to 5%TS in biowaste from restauration;
- Presence of close to 40%TS synthetic plastic-type organic materials from packaging

3- Urban biowaste characterization

BMP



Supermarket food wastes (SMBW), packaging extracted

Food waste from Restaurants (RBW)

Food waste from Households (HBW)

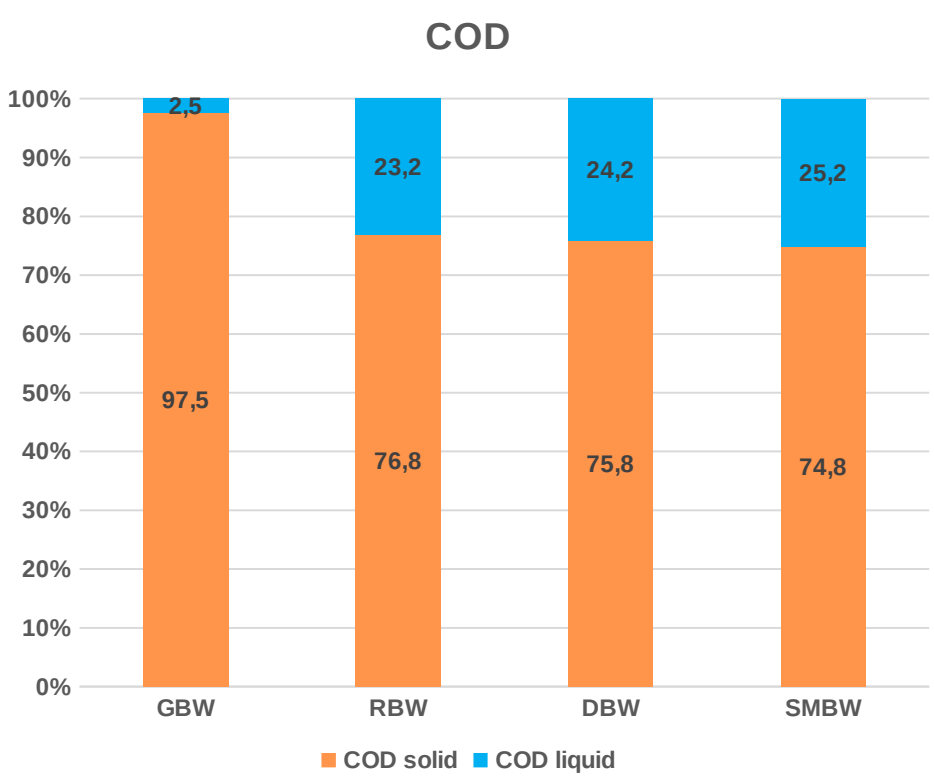
Urban Green Biowaste (GBW)

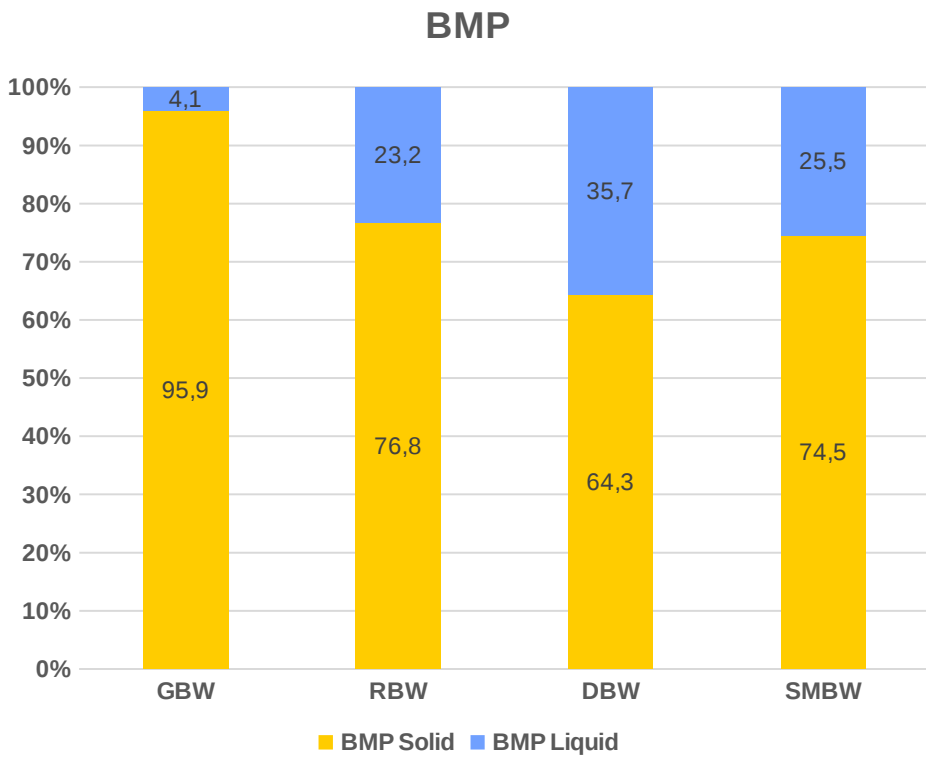
Biowaste :	Urban Green Waste	Restauration. food Biowaste	Food waste from households	Supermarket food wastes
	GBW	RBW	DBW	SMBW
COD ($g.kg^{-1}_{TS}$)	1035	1477	1505	1372
BMP ($NL_{CH4}.kg^{-1}_{TS}$)	31	397	263	450
BD (%)	8.4	76.8	49.9	88.2

No significant differences in methane bioconversion rates were observed. Except for green biowaste, 95% of the BMP were expressed in less than 20 days of incubation. This results suggested that food waste from restauration, supermarket and households have fairly the same potential of bioconversion in AD.

The overall BMP of food waste from restauration (RBW), households (HBW) and supermarket (SMBW) ranged between 250 and 470 NLCH4.g-1 . HBW showed the lowest BMP value, probably in relation to the

Liquid/Solid distribution of COD and PBM ***after leaching test***





The green biowaste GBW differed here from the other three samples by a very high DCOL / DCOS ratio of 26 whereas the other samples ranged between 2.9 to 3.3. GBW also showed lower overall BMP, and a very low BMP of the solid fraction, between 40 and 71 NL_{CH4} .g-1, ie 5 to 10 times lower than observed with the other biowaste.

However, the distribution of BMP, compared to COD was relatively similar in the 4 samples.

4- Conclusion and future technical trends

Biowaste selection for pretreatment

- **The Green Waste does not have the favorable characteristics for methane bioconversion: soluble fraction that can not be easily mobilized in contact with water. PBM of the particle fraction is much too low to justify its selection for anaerobic digestion. Its high content of inert and mineral materials (nearly one third of the total content) leads to consider it as being unsuitable for recovery by AD.**

- **Despite a lower bioconversion rate, biowaste obtained from a "source" selective collection from households (HBW) remains interesting, since part of the PBM is easily extractable in contact with water - leaching (31%, with a simple contact L / S ratio 10, 2h with gentle stirring), which suggests its selection for AD and a good potentiality of pretreatment for liquid to solid separation.**

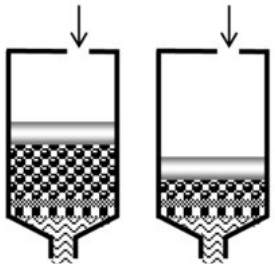
- **With its highest BMP potential, biowaste collected from restaurant (RBW) is well suited to recovery methane by anaerobic digestion. The extraction rate of the BMP in contact with water is of the order of 21% (and 23% for COD), requiring the need to pretreat this biowaste in order to extract the PBM predominantly present in the solid fraction.**

- **The biowaste collected from supermarket (SMBW) differs from the other three biowaste with the presence of nearly 40% of plastics from packaging. Despite this, its total BMP is between 450 $NLCH_4.kg^{-1}$, after packaging collection.**

4- Conclusion and future technical trends

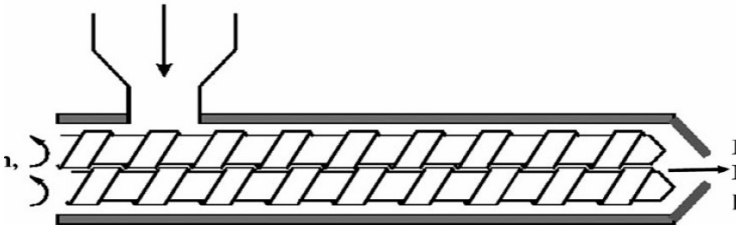
Pretreatments selected

The preparation conditions of the four biowaste will be the subject of the next steps of the project, the objective of which is to determine their suitability for trituration pretreatment (mechanical preparation) and liquid / solid separation in order to produce a solid grade dedicated to thermochemical treatment and a liquid grade, pulp consisting mainly of biodegradable organic material dedicated to anaerobic digestion, wet process



Filtrer press

Spin-dryer



Extrusion

Lab-scale under work since march, and up-scaling in September 2019 for demonstration on :

- **AD on “liquid gra**
- **Gasification on “Solid**
- **+ syngas methanation**

Thank you for your attention!

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Acknowledgements :

The authors thank the French National Environmental Agency (ADEME) for funding this project through the GRAINE-ADEME program 2016 (grant number n°1806C0003)

Technical team from DEEP and PROVADEMSE, notably Carole Gaignaire, Jean-Philippe Tagutchou, Karim Lounis, Bernard Sarrazin, Nathalie Dumont and Richard Poncet

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la métropole

2- Urban biowaste identification

Quantitative production and selection of the major stream

Tableau 66 : Proportions des différents gisements dans le cas d'une collecte généralisée de la FF

Flux de biodéchets	Part estimation basse (%)	Part estimation haute (%)
FFOM généralisée	49,50%	50,06%
Restauration Commerciale	0,83%	1,67%
Restauration Scolaire	0,83%	2,78%
Restauration santé	2,31%	2,22%
Restauration sous contrat	0,99%	1,67%
Restauration en régie	7,43%	5,23%
HAU	0,99%	0,78%
IAA	1,98%	3,34%
Distribution	4,95%	7,23%
Petits Commerces	1,65%	4,45%
Marchés	2,15%	1,67%
DV	26,40%	18,91%

2- Urban biowaste identification

Quantitative production and selection of the major stream