8th International Conference on Sustainable Solid Waste Management

Anaerobic digestion of lignocellulosic wastes pre-treated with ionic liquids

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ARQUIMEA GROUP

UAM Universidad Autónoma de Madrid

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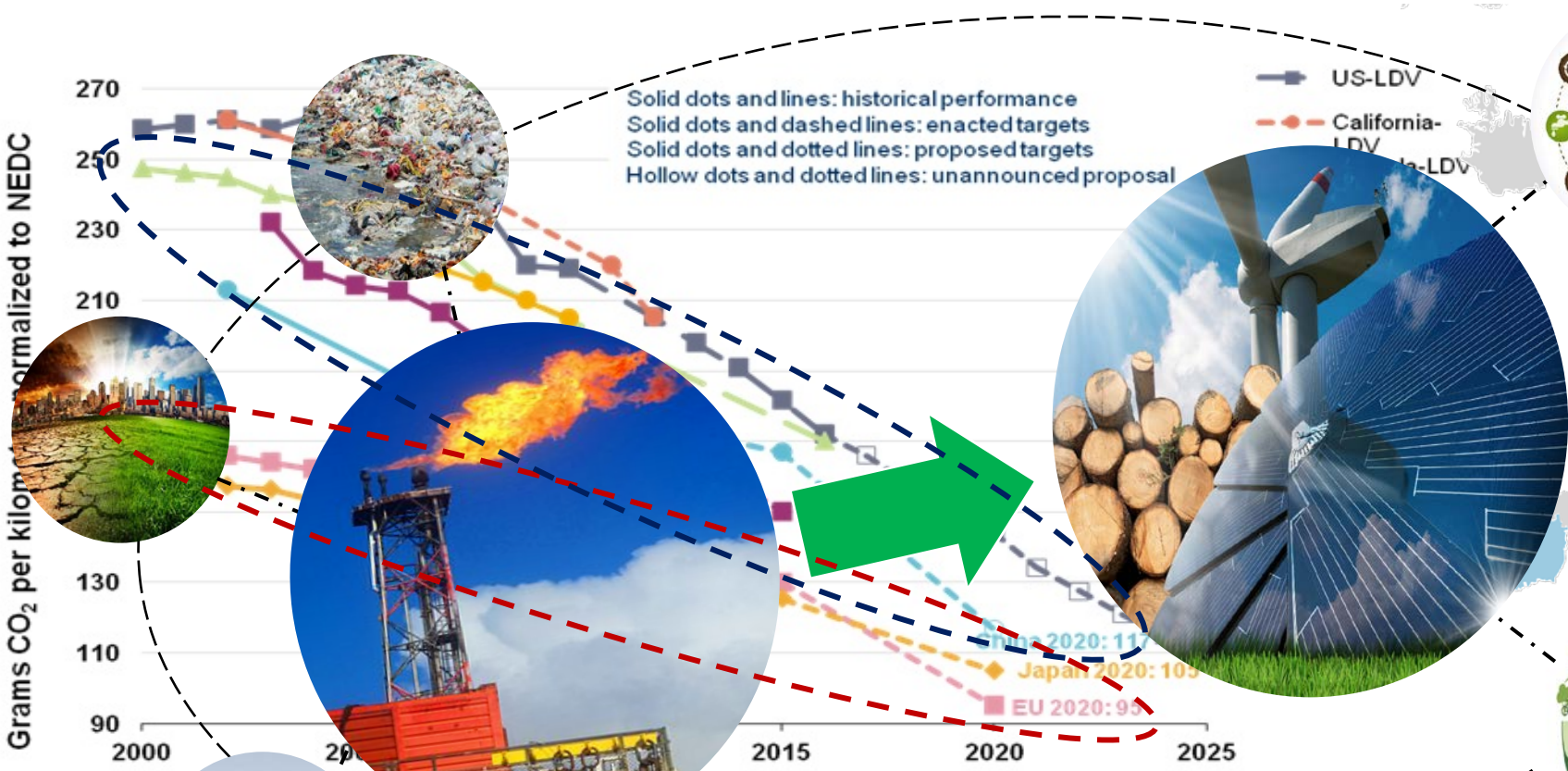

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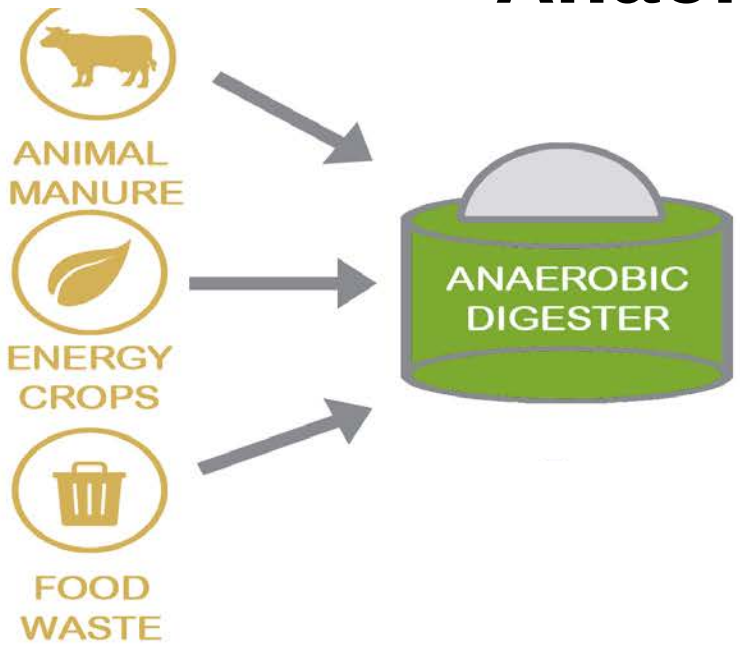
Anaerobic digestion process



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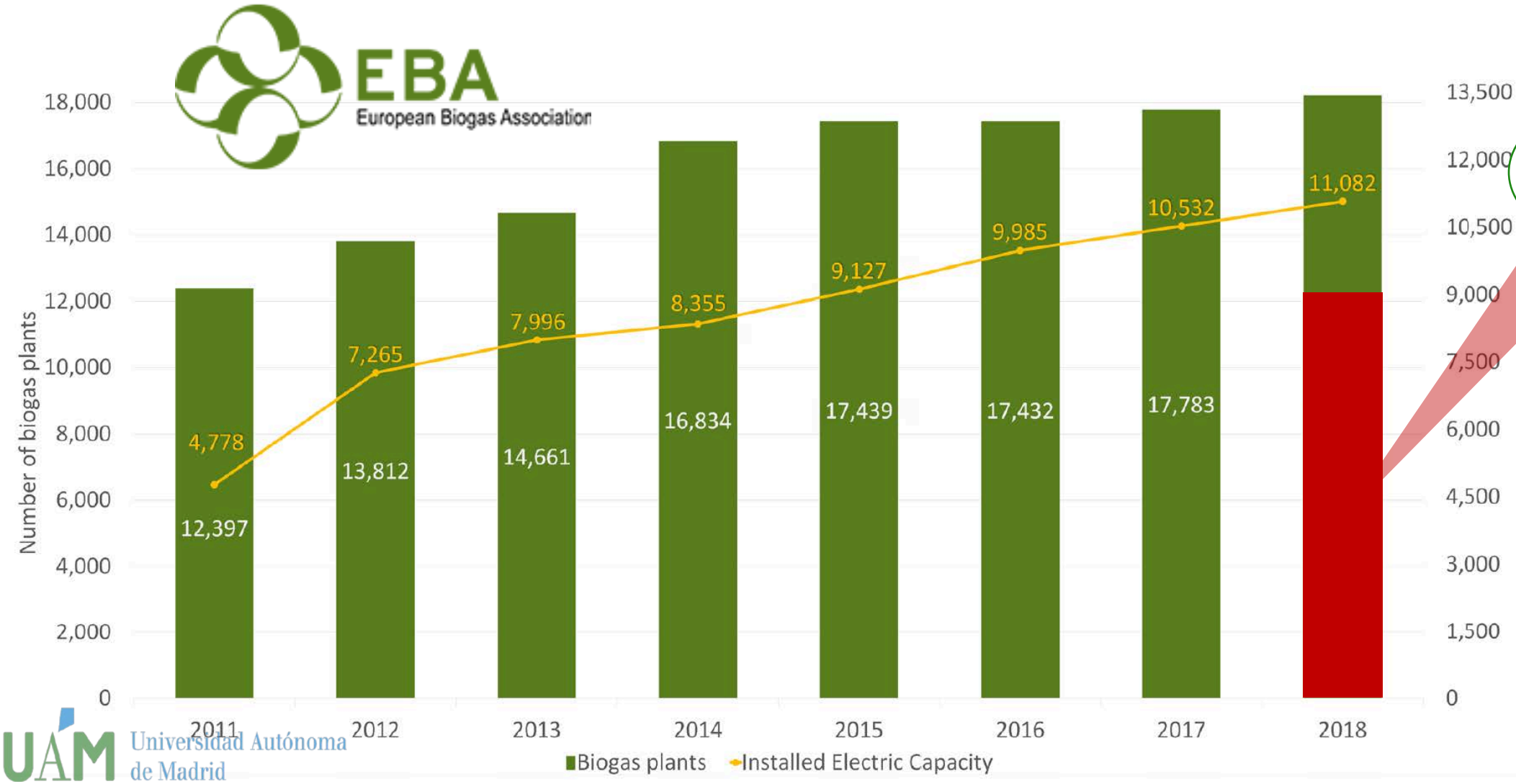

≈ 12000 biogas plants use crops and agricultural residues

Renewable Energy Directive (RED II)

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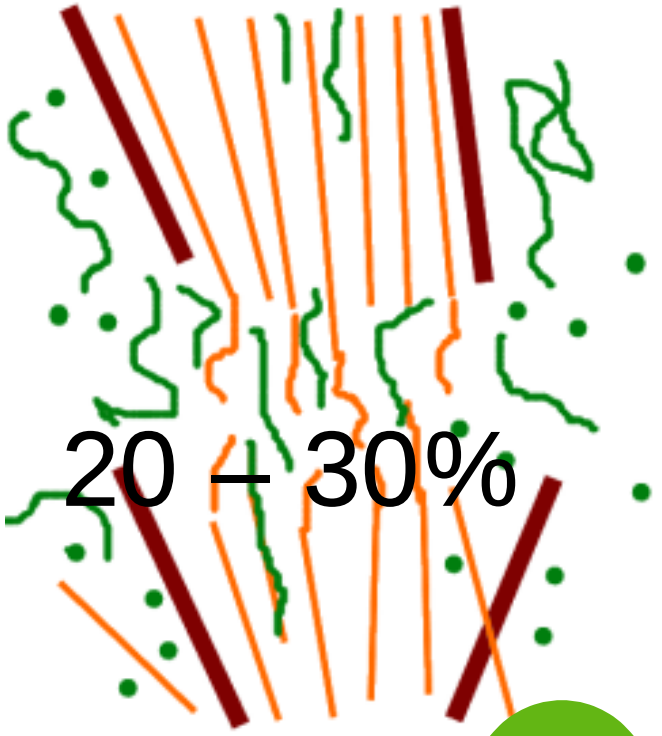
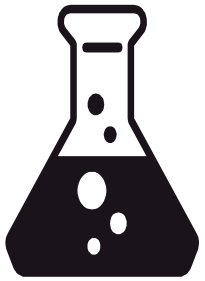
Pretreatments



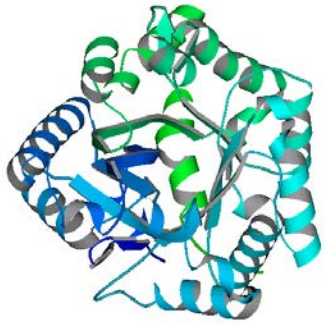
$CH_4 + CO_2$

Pretreatments

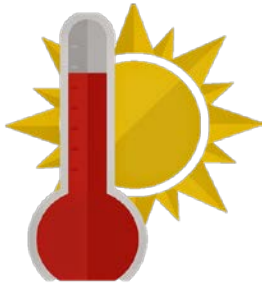
Chemical

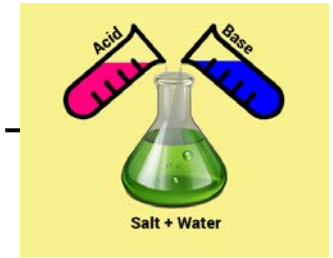


Biological

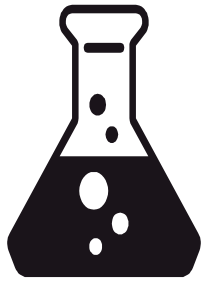


Thermal





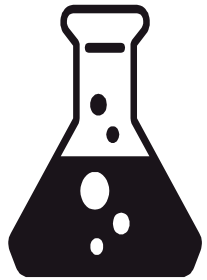
Chemical

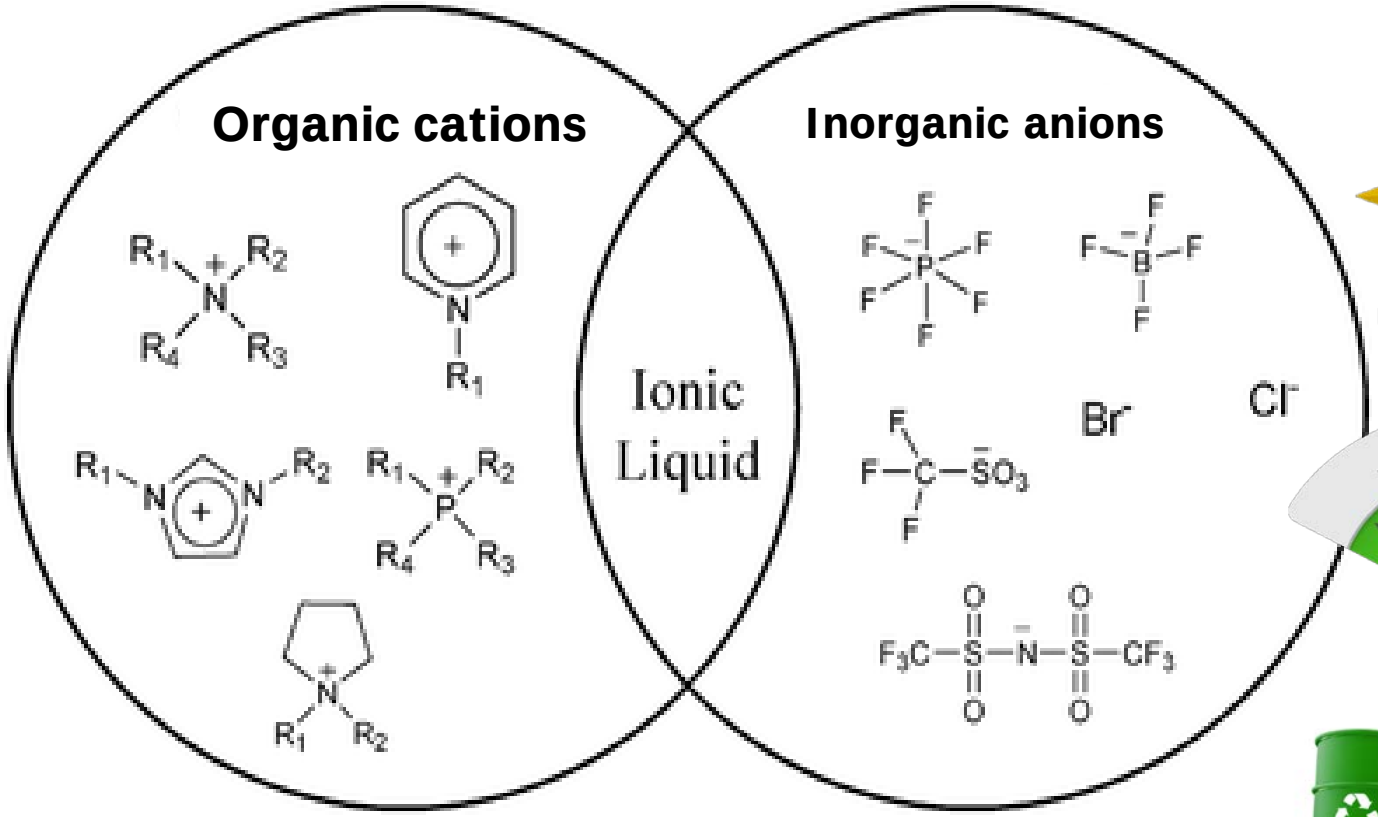


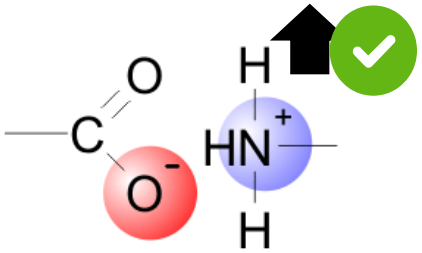
Ionic liquids (IL)

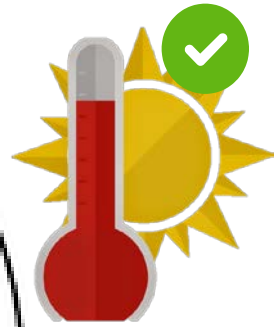
Ionic liquids (IL)

Chemical

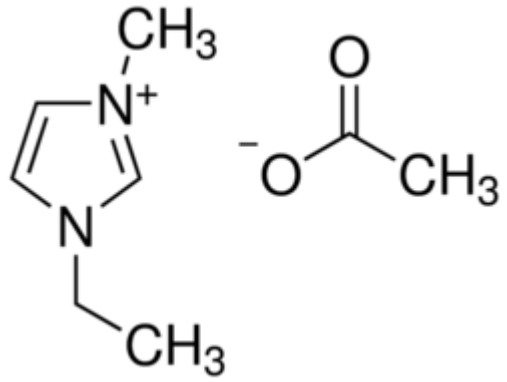








Objective

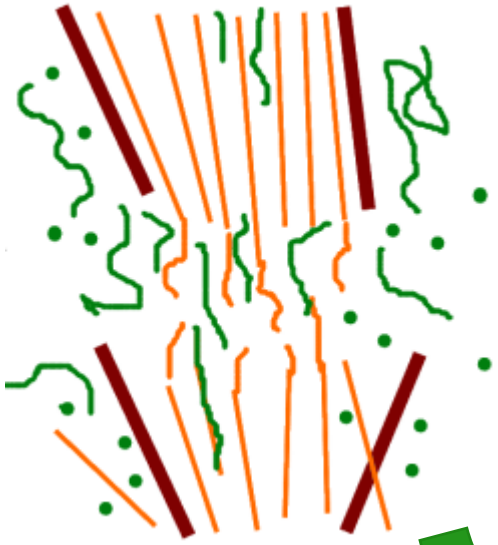


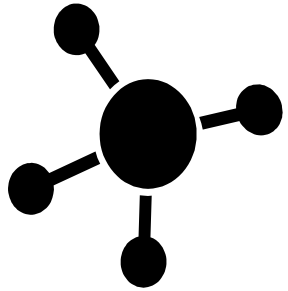
1-ethyl-3-methyl imidazolium acetate [Emim][Ac]

Barley straw (BS)

Wheat straw (WS)

Grape stem (GS)





CH_4

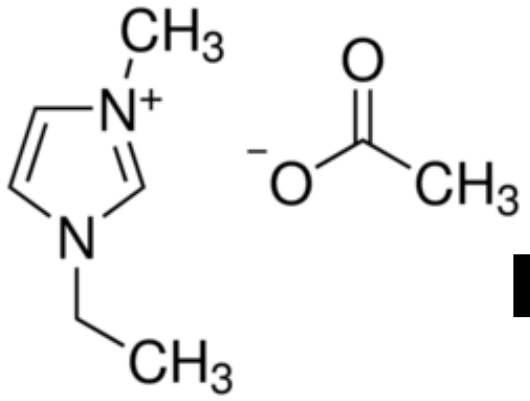
Methods

Wheat straw

Barley straw

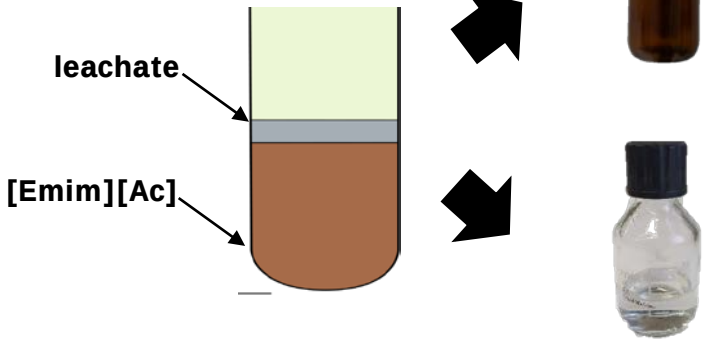
Grape stem

1-ethyl-3-methyl imidazolium acetate [Emim][Ac]



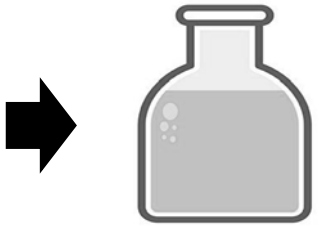
Different ratios 1:1, 1:3, 1:5 w:w biomass - [Emim][Ac]

120 °C – 120 min



CH_4

IL1, IL3 and IL5

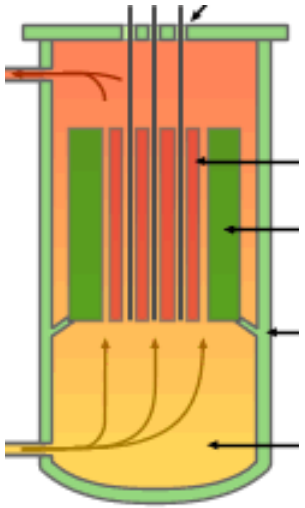


Methods

Wheat straw

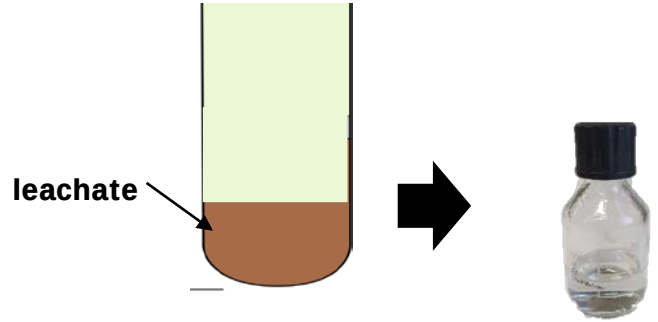
Barley straw

Grape stem



With deionized water

120 °C – 120 min



CH_4

IL1, IL3 and IL5

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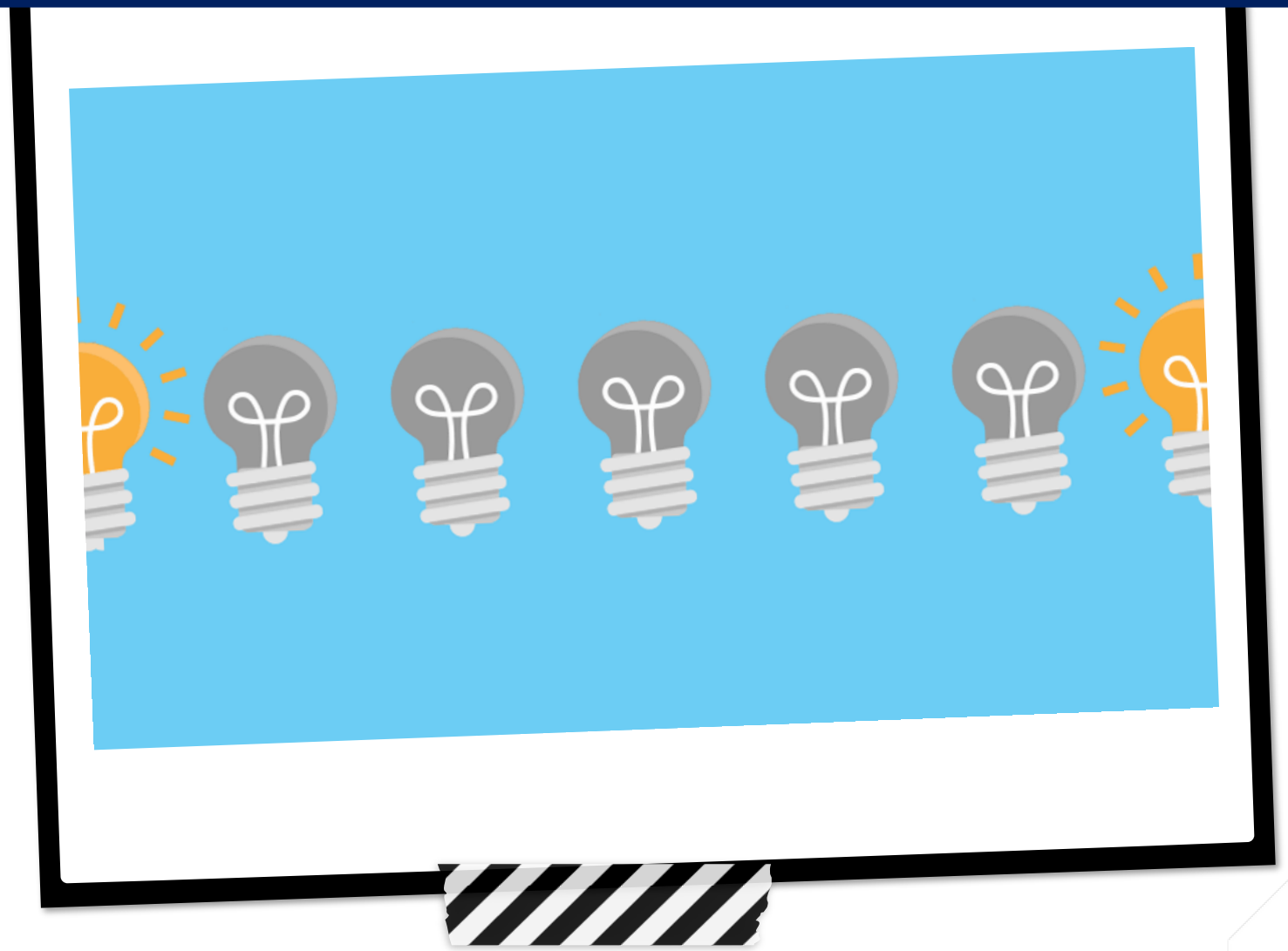


Wheat straw

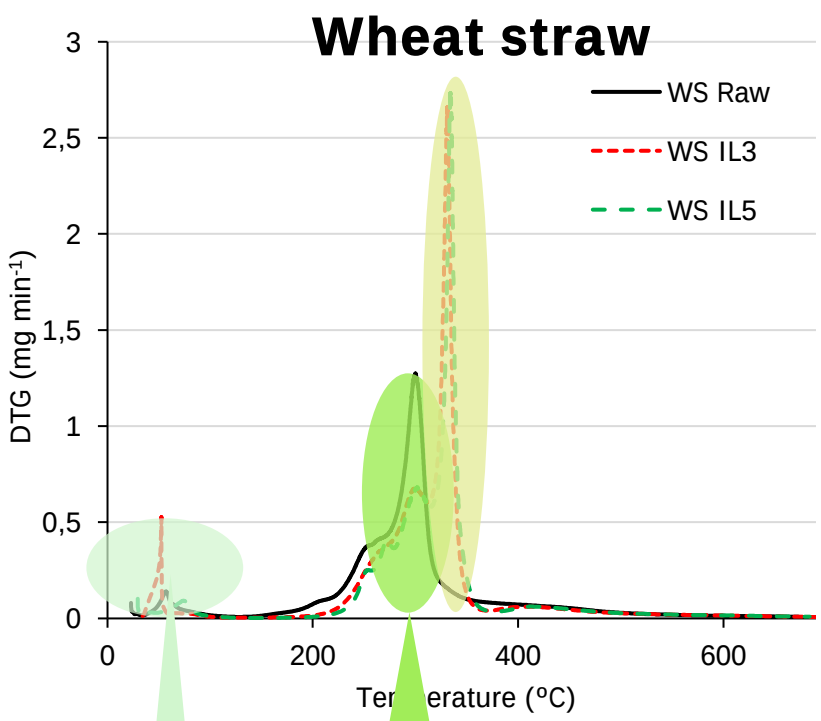
Barley straw

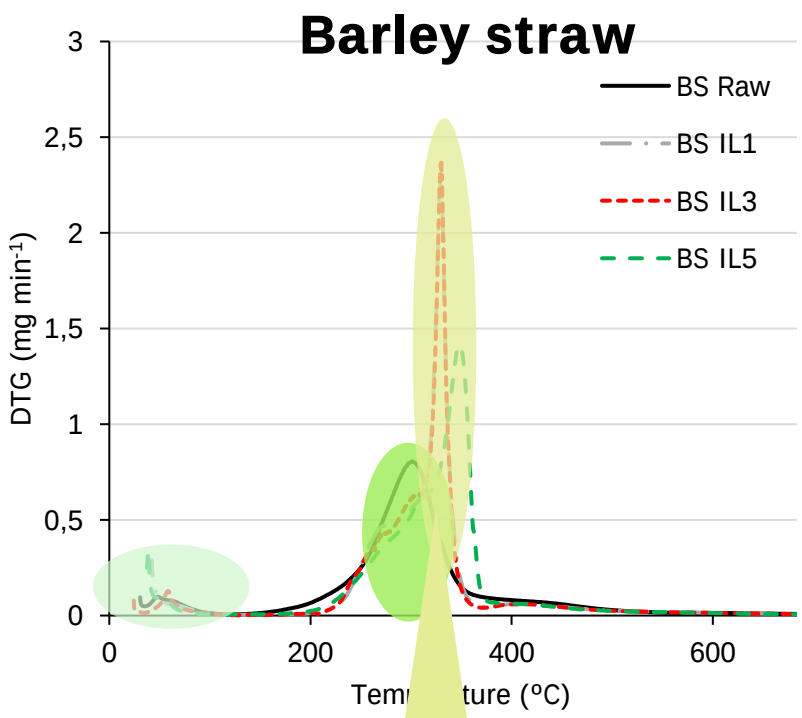
Grape stem

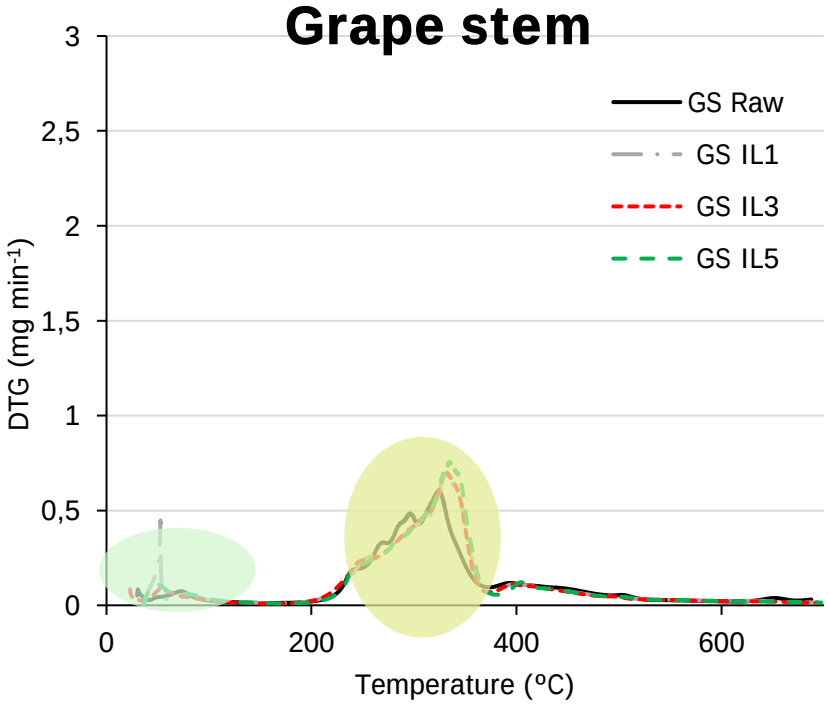
	Wheat straw	Barley straw	Grape stem
C (%)	43.32 ± 0.02	43.89 ± 0.03	47.25 ± 0.09
H (%)	5.62 ± 0.03	5.75 ± 0.05	5.60 ± 0.07
N (%)	0.63 ± 0.01	0.56 ± 0.01	1.48 ± 0.01
S (%)	0.17 ± 0.01	0.11 ± 0.02	0.10 ± 0.01
O* (%)	20.58 ± 0.02	22.39 ± 0.01	11.35 ± 0.02
VM (%)	70.30 ± 0.03	72.70 ± 0.02	65.80 ± 0.01

*By difference: O = 100 – (C + H + N + ash)

Differential thermogravimetric (DTG) profiles







Loss moisture

Volatile matter, cellulose and hemicellulose

High molecular weight compounds, lignin and fixed carbon

Higher lignin content

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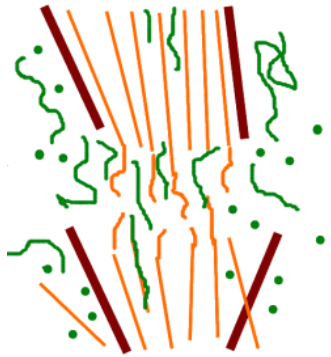
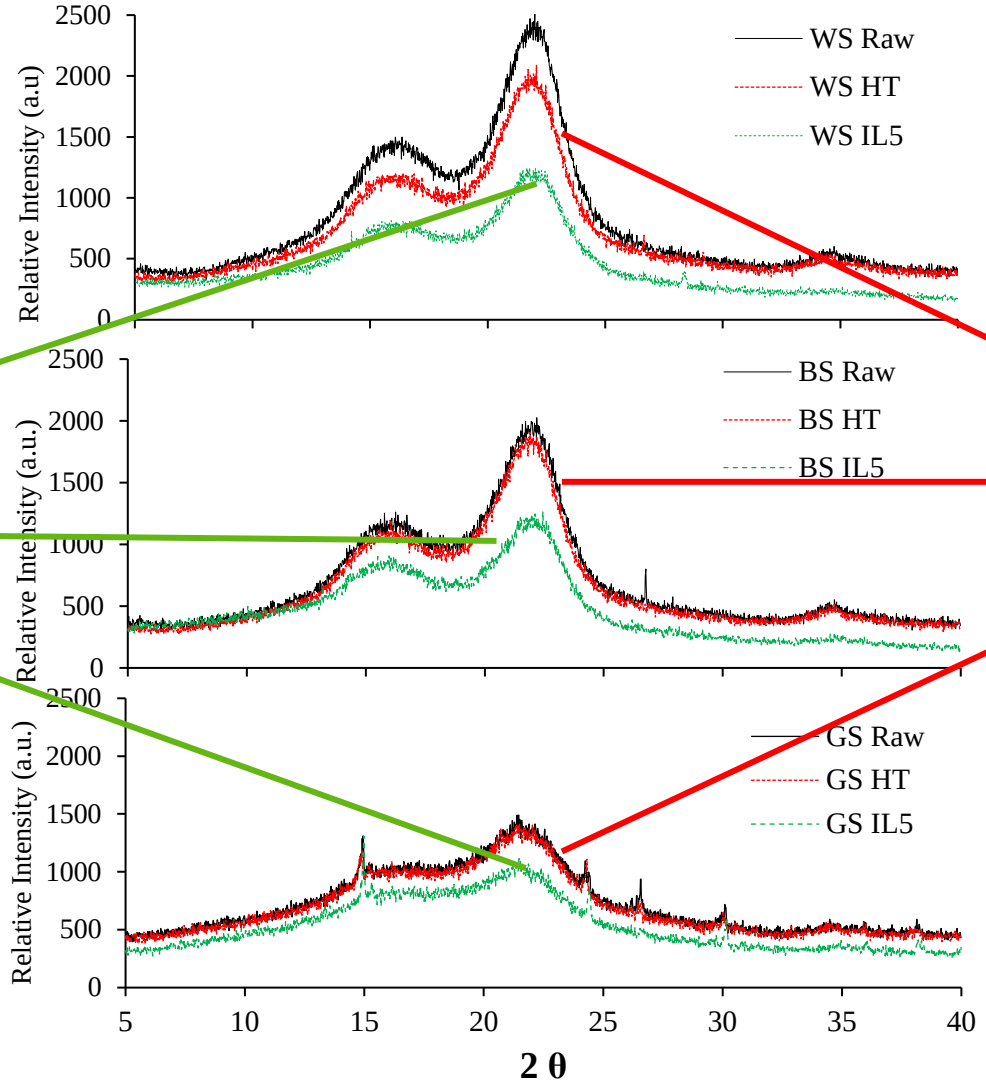
X-ray diffraction (XRD) profiles

Ionic liquid pretreatment



Reduction of cellulose crystallinity



Hydrothermal pretreatment

No significant variation

Wheat straw

Barley straw

Grape stem

Cellulose crystallinity index (CrI %)

$$CrI\ (\%) = \frac{(I_{002} - I_{am})}{I_{oo2}} \cdot 100$$

I_{002}: maximum intensity above baseline at 2 θ = 22 °
I_{am}: minimum in intensity above baseline 2 θ = 18 °

	CrI (%)				
Biomass	Raw	HT	IL1	IL3	IL5
Wheat straw	54.8	55.7	53.9	51.4	50
Barley straw	53.8	53.6	52.4	51.2	50.9
Grape stem	32.5	32.1	28.2	27.8	27.5

CrI %

5 – 16 %

Wheat straw

Barley straw

Grape stem

Sugar yield in the leachates after HT and IL pre-treatments

	Sugar yield (mg glucose g^{-1} biomass)		
Pretreatment	WS	BS	GS
HT	123.4 ± 1.1	41.2 ± 1.3	47.8 ± 0.6
IL1	127.6 ± 3.2	42.4 ± 0.8	50.0 ± 0.1
IL3	143.0 ± 4.8	45.5 ± 0.9	94.5 ± 0.7
IL5	158.2 ± 5.1	47.9 ± 1.6	188.1 ± 6.8

Sugar yield ↑ **28 %** ☹ **16 %** **293 %**

Wheat straw

WS Raw

WS HT

WS IL5

Grape stem

GS Raw

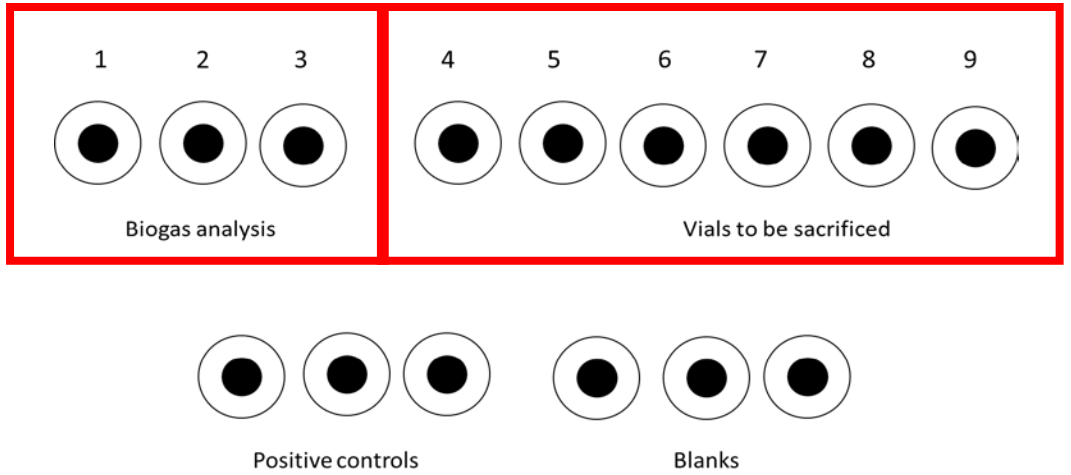
GS HT

GS IL5

Biomethane potential test

ISR = 2

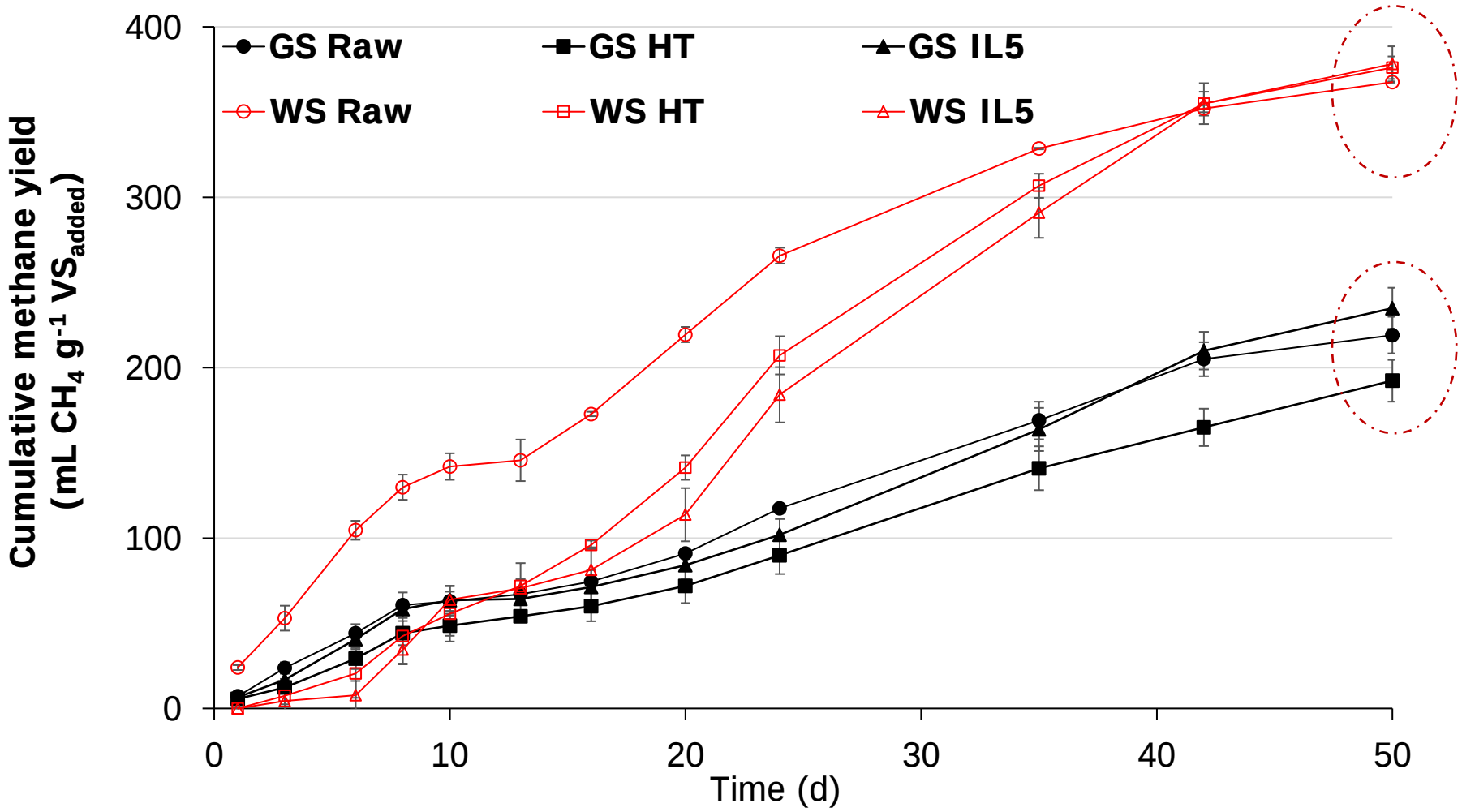
- 15 g VS L^{-1} granular anaerobic sludge
- 7.5 g VS L^{-1} substrate



Cumulative methane yield along the anaerobic digestion

Wheat straw

Grape stem



Cumulative methane yield: solid + leachate

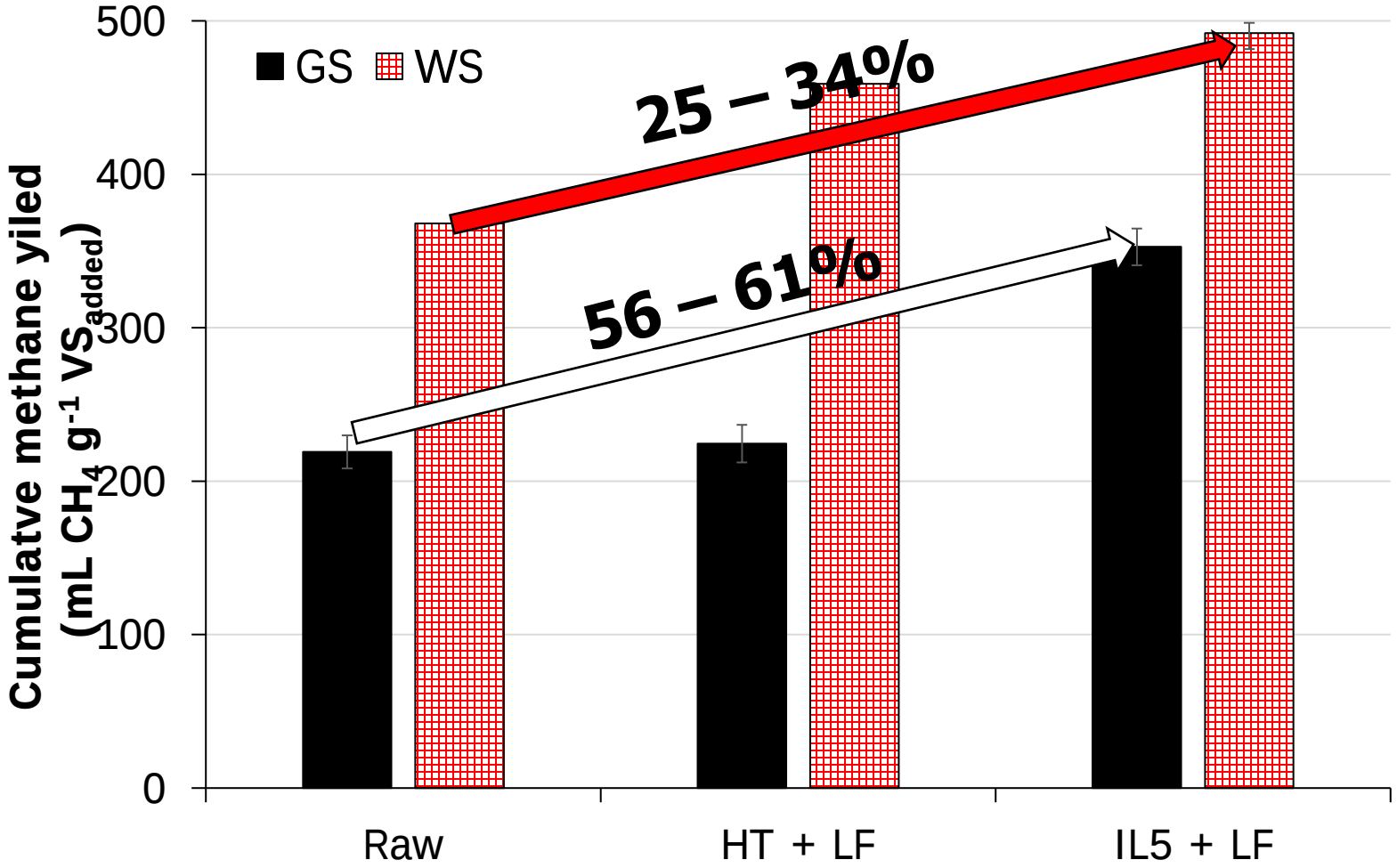
Wheat straw

Grape stem

Wheat straw

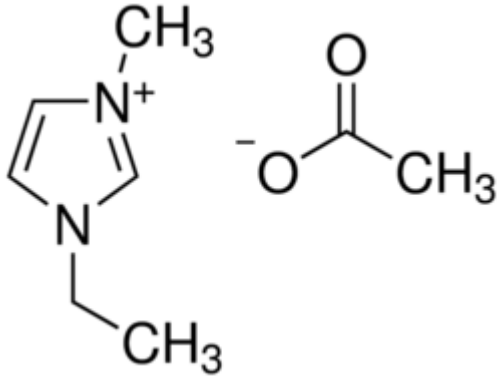
Grape stem

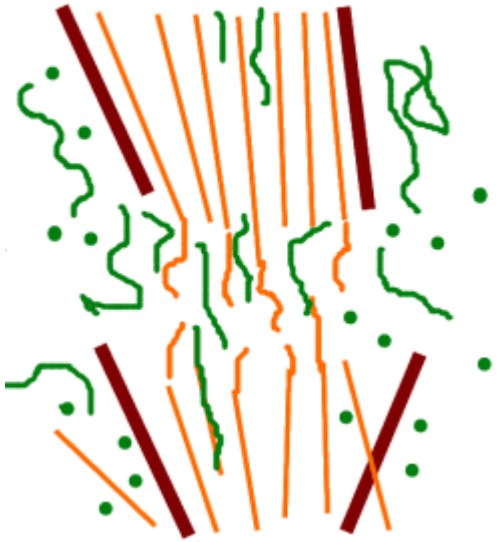
Cumulative methane yield: solid + leachate

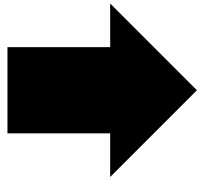


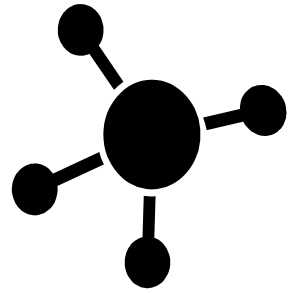
Wheat straw

Grape stem



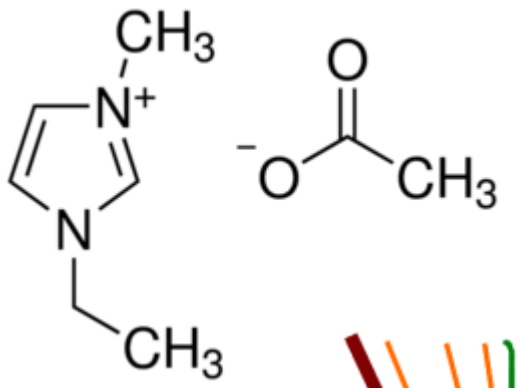


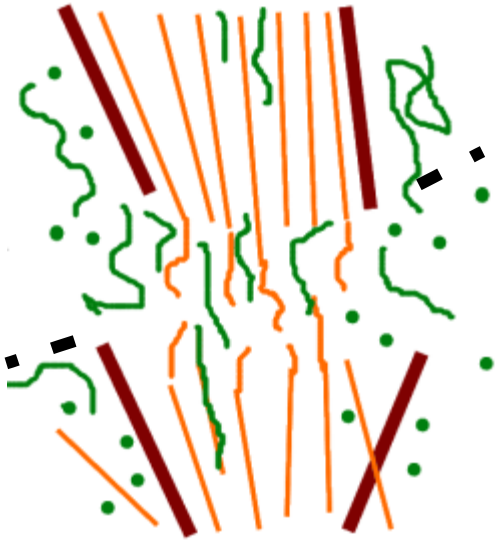


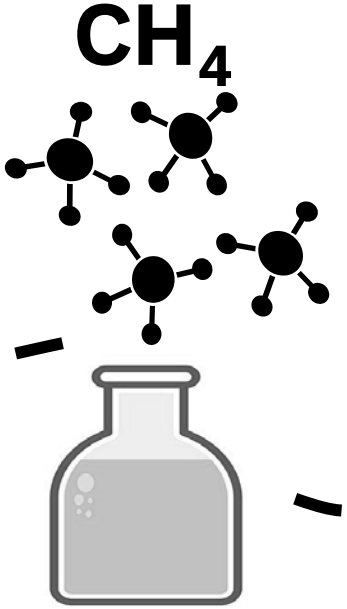


CH_4

Conclusions







Acknowledgements

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thanks

Never give up

R. P. Ipiales