Università degli studi di Roma "Tor Vergata"

Analysis of potential recycling/recovery strategies for bioplastic municipal solid waste based on their chemico-physical properties and numerical modeling of pyrolysis process as recycling strategy

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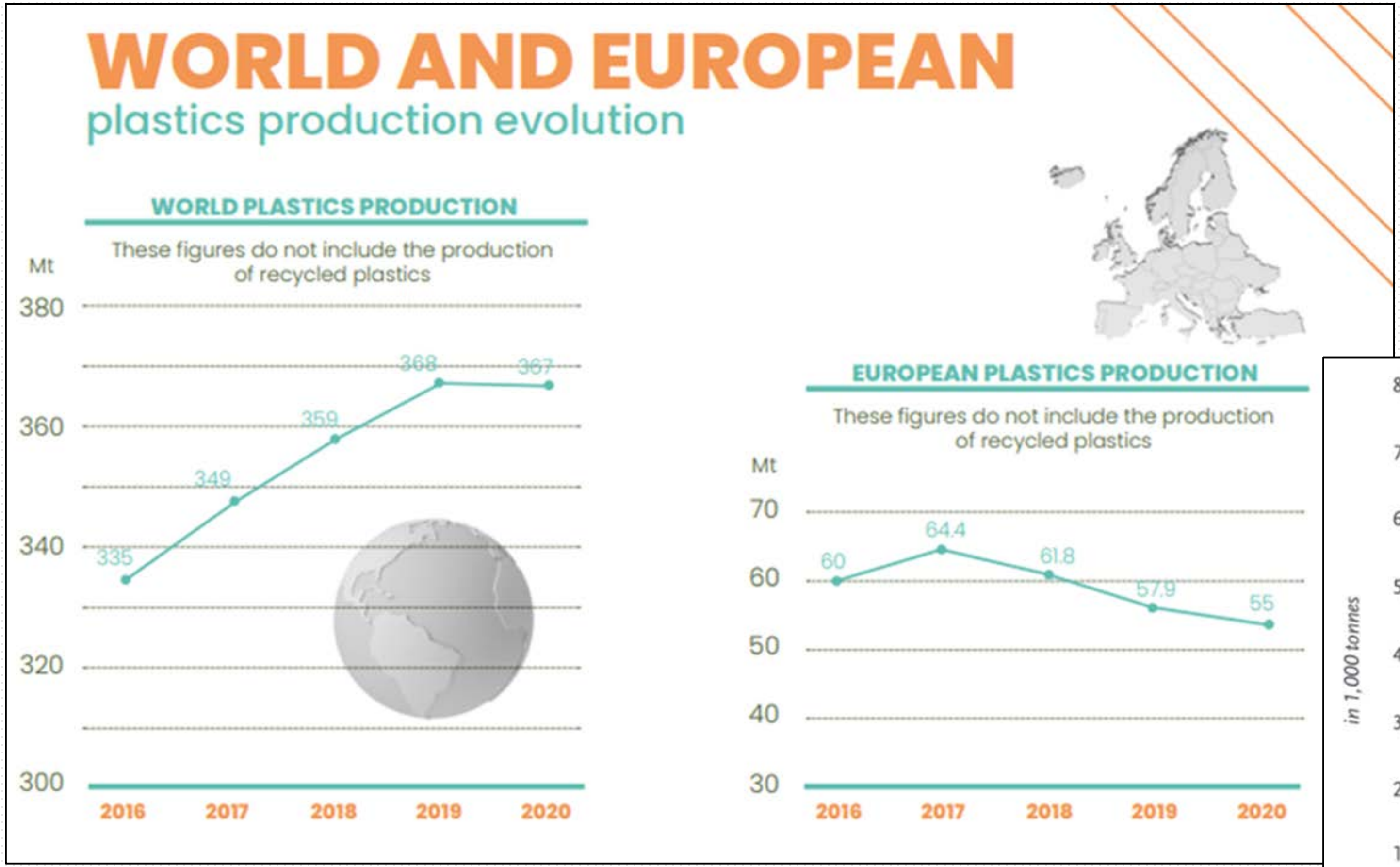
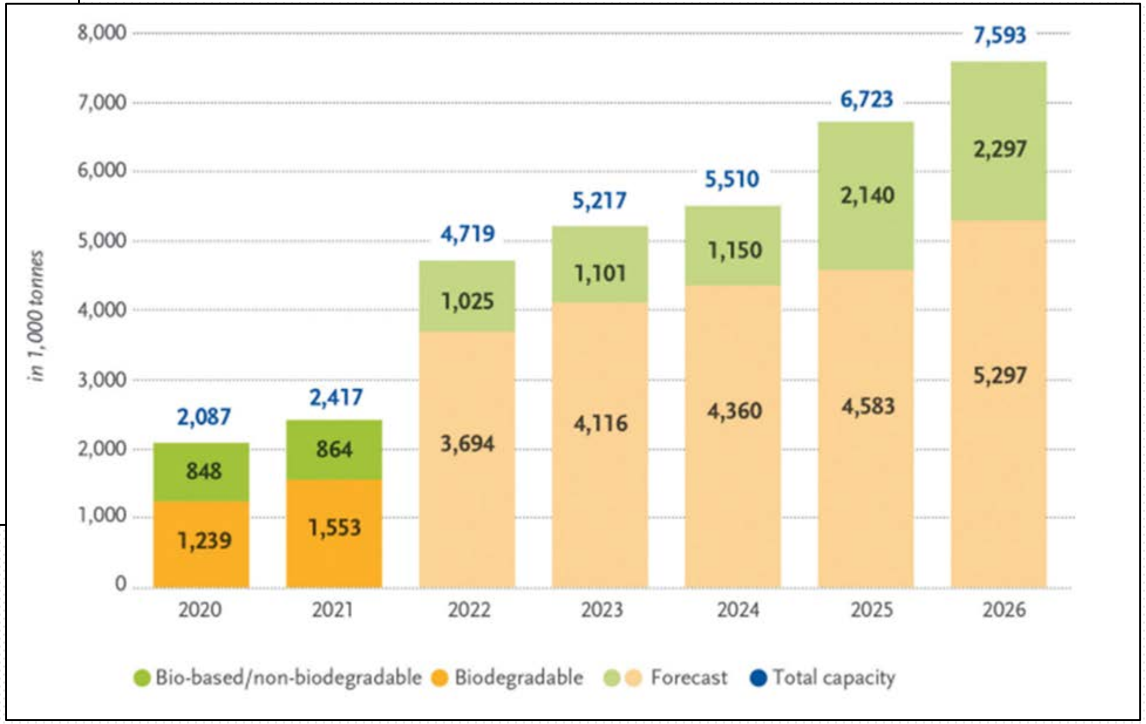
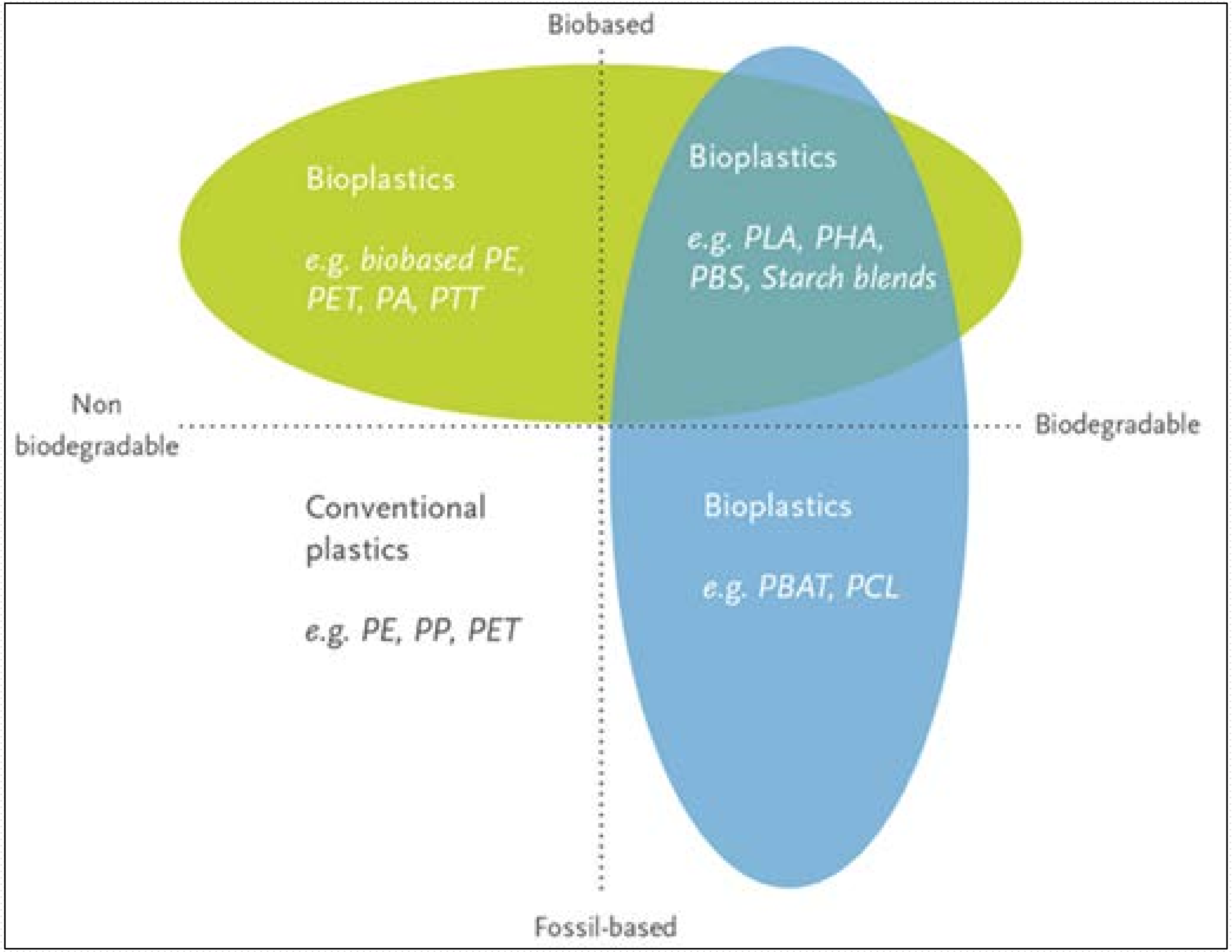
Plastic & Bioplastic Production



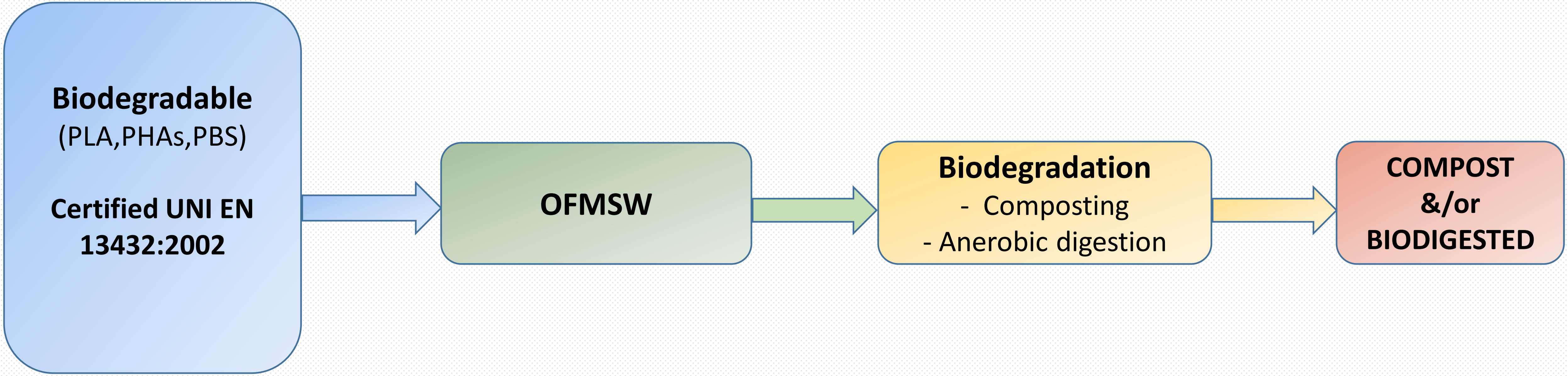


BIOPLASTIC CLASSIFICATION



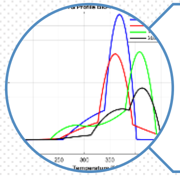
BIOPLASTIC CHARACTERIZATION: PURPOSE

THE ITALIAN CASE STUDY
(D.LGS 152/06 ART. 182 TER)

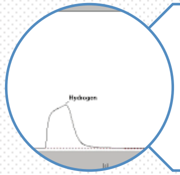


SAMPLES

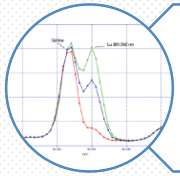
Sample	Classification
PLA Glasses	*BR-1*
B-Bioplastic Dishes	*BR-2*
Mater-Bi Dishes	*BR-3*
Mater-Bi Film Bag	*BF-1*



Thermogravimetric analysis

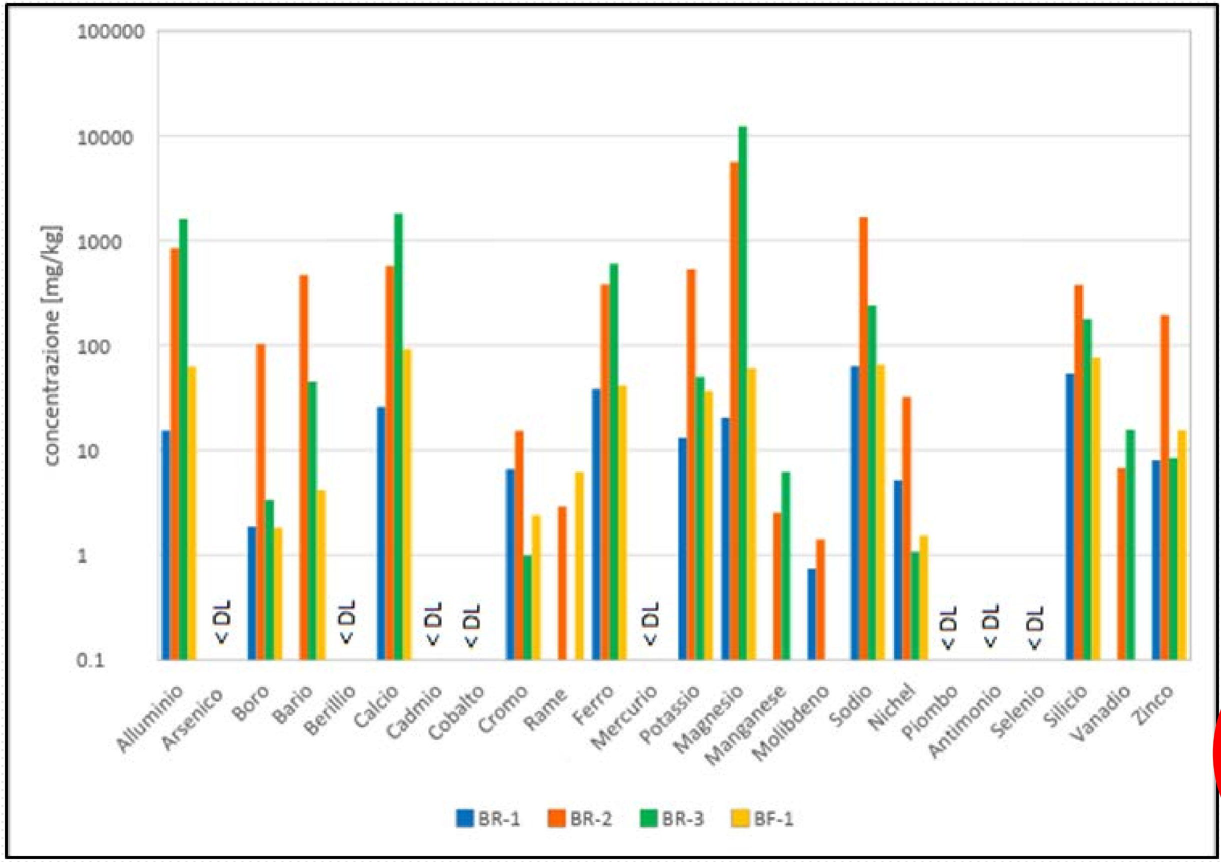


Elemental analysis



ICP-OES analysis

ICP-OES Analysis Results



Comparison with the legislative limits about compost (mg/kg)								
Sample	Cd	Cr	Cu	Ni	Pb	Zn	AS	Hg
Average Bioplastic	<LR (0,65)	6,3	2,5	10,0	<LR (0,65)	56,6	<LR (3,9)	<LR (3,9)
Compost from sludge	1,24	51	142	27	89	525		
Compost from OFMSW	1,17	65	117	25	94	313		
Compost from lignocellulosic waste	0,92	39	52	23	76	188		
Compost from zootechnical waste	1,3	19	84	13	26	317		
Compost from mixed waste	3,3	235	369	105	462	931		
PFC1 (A)	1,5	2	300	50	120	800	40	1
PFC3 (A)	2	2	300	50	120	800	40	1

Regulation
(EU) **2019/1009**

ELEMENTAL ANALYSIS RESULTS

Sample		N	C	H	S	O
BR-1	%	0,03	52,74	4,04	0,02	43,17
	Dev. St.	n.d.	0,3	0,1	n.d.	0,3
BR-2	%	0,04	45,56	3,64	0,06	33,67
	Dev. St.	n.d.	0,5	0,1	0,0	0,7
BR-3	%	0,03	37,14	3,25	0,03	26,43
	Dev. St.	n.d.	0,2	0,1	n.d.	0,3
BF-1	%	0,03	59,53	5,15	0,48	34,81
	Dev. St.	n.d.	1,6	0,2	0,3	1,5

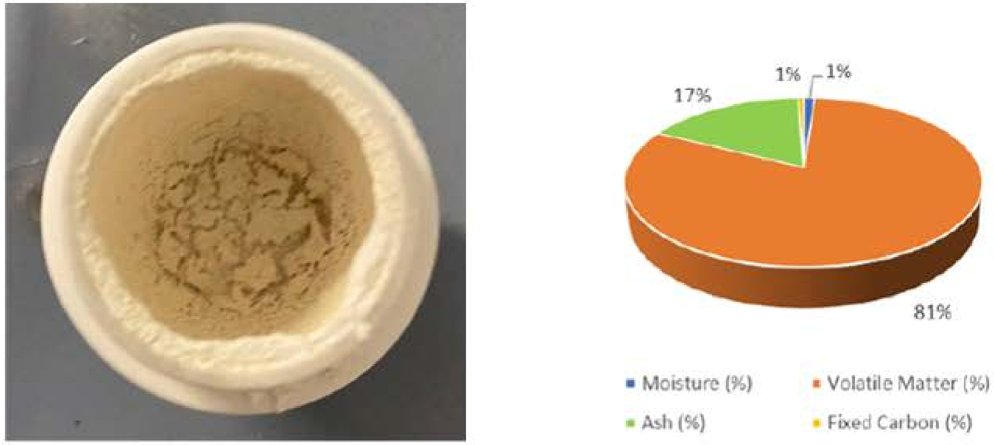
Sample	HHV [MJ/kg]
PE	49,40
HDPE	46,81
LDPE	48,15
BR-1	15,89
BR-2	14,58
BR-3	12,48
BF-1	21,28

$$HHV\left[\frac{MJ}{Kg}\right] = \frac{338{,}2C + 1442{,}8\,(H - \frac{O}{8})}{1000}$$

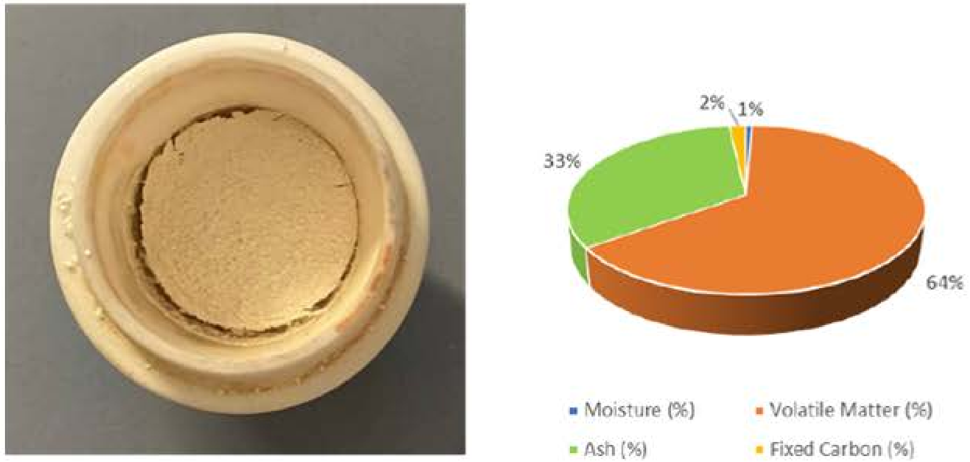
Thermogravimetric Analysis Results

BR-1

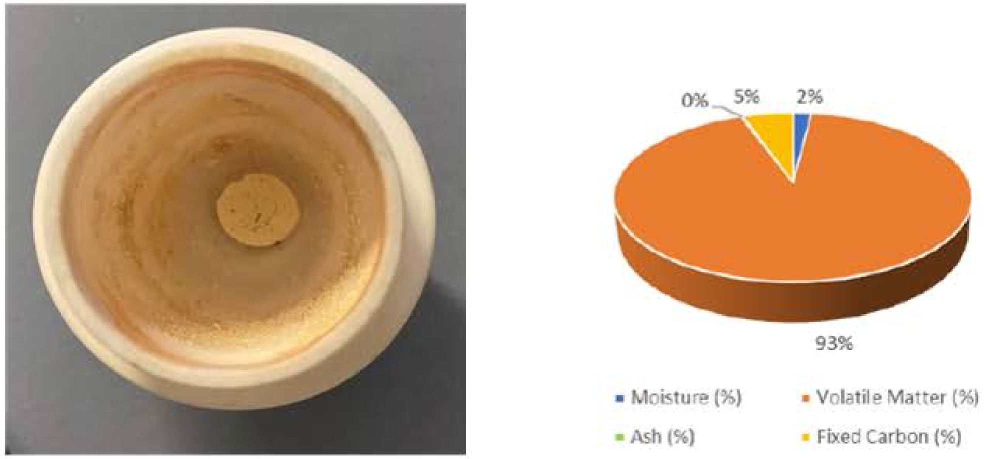
BR-2



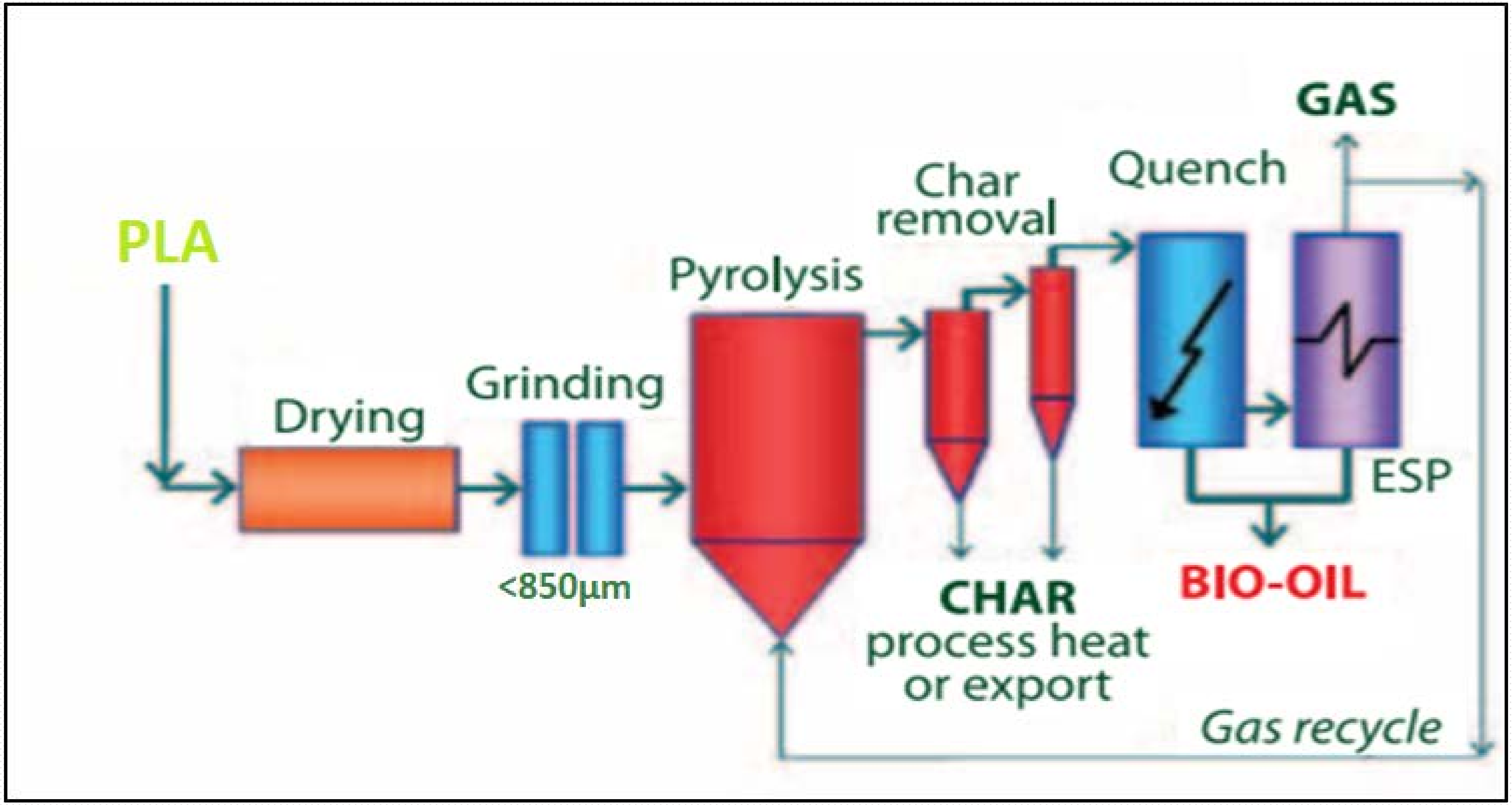
BR-3



BF-1



Pyrolysis of PLA (BR-1), Why?

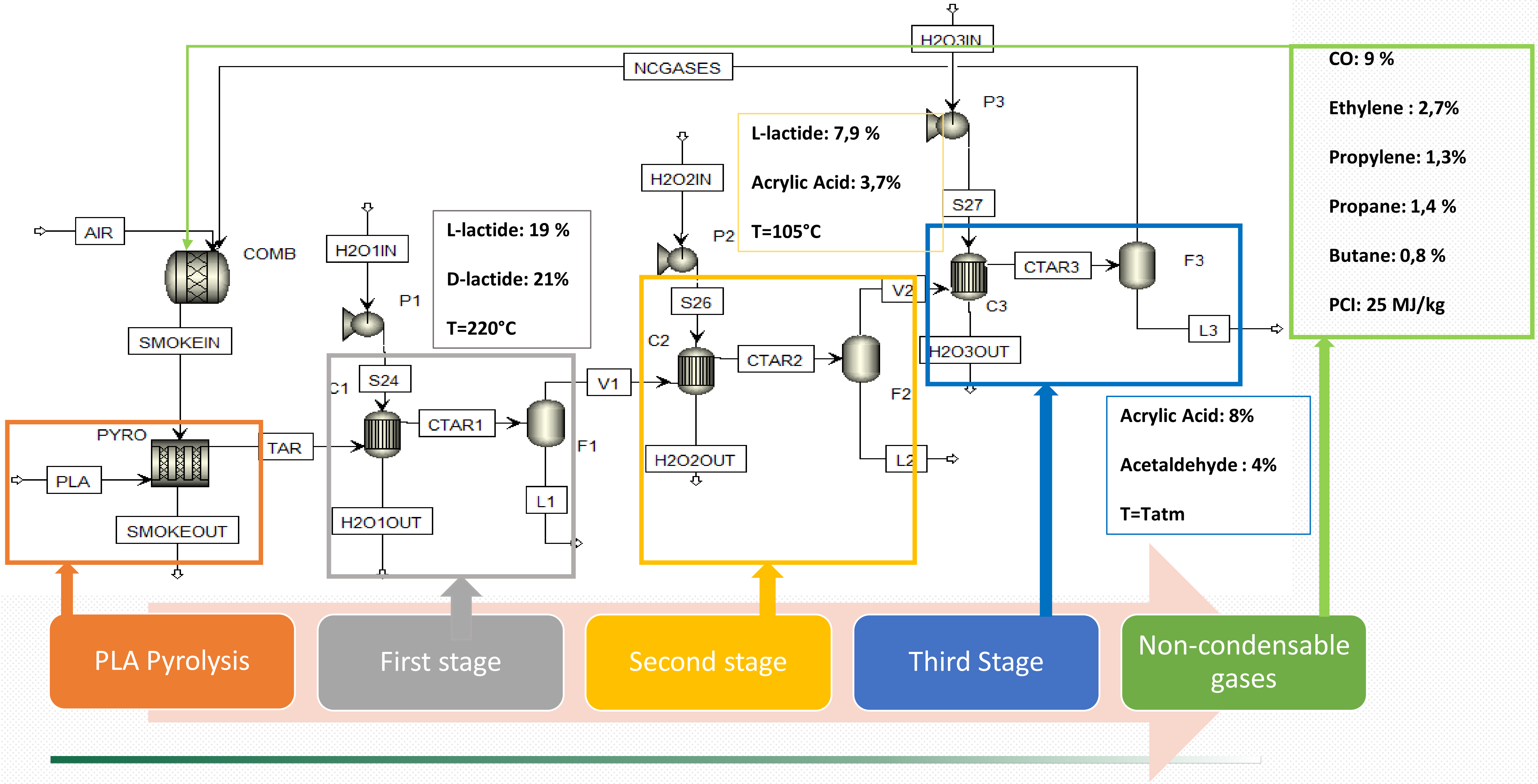


Pyrolysis Simulation (Aspen Plus®)

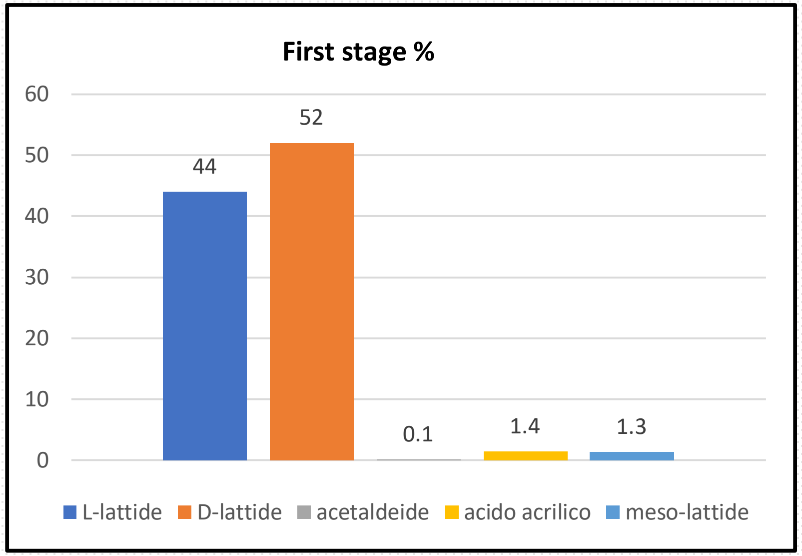
Hypotesis

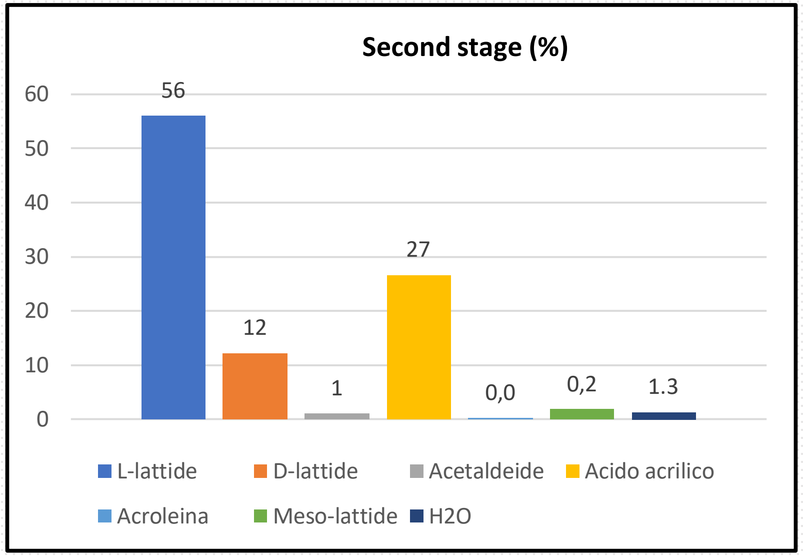
1. Absence of char and presence of only gaseous products at the reactor outlet
2. No pressure loss in the heat exchangers
3. Flynn-Wall-Ozawa Kinetik Model (OFW)
4. Simplified Chemical Model

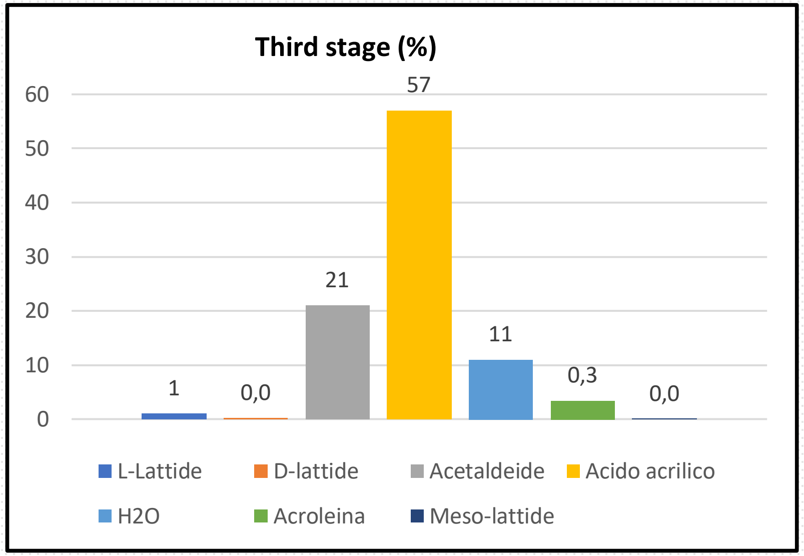
Pyrolysis Simulation (Aspen Plus®)



Pyrolysis Simulation: Products







D-lattide e L-lattide capable to form new PLA

Acrylic acid usable for example in the paint industry or water treatment purpose

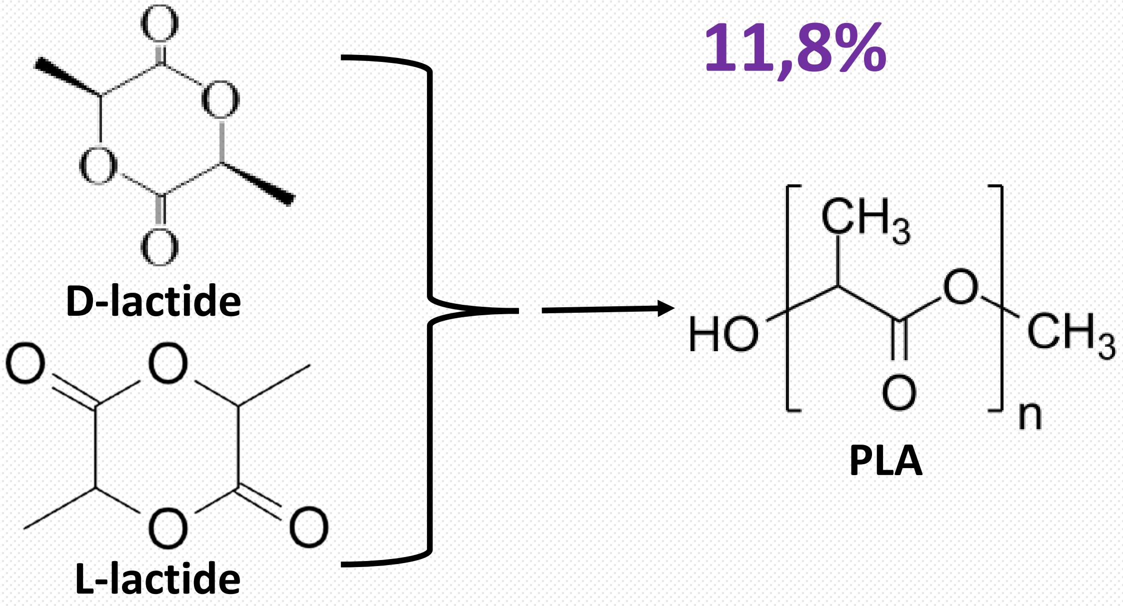
Acetaldehyde usable in the chemical industy

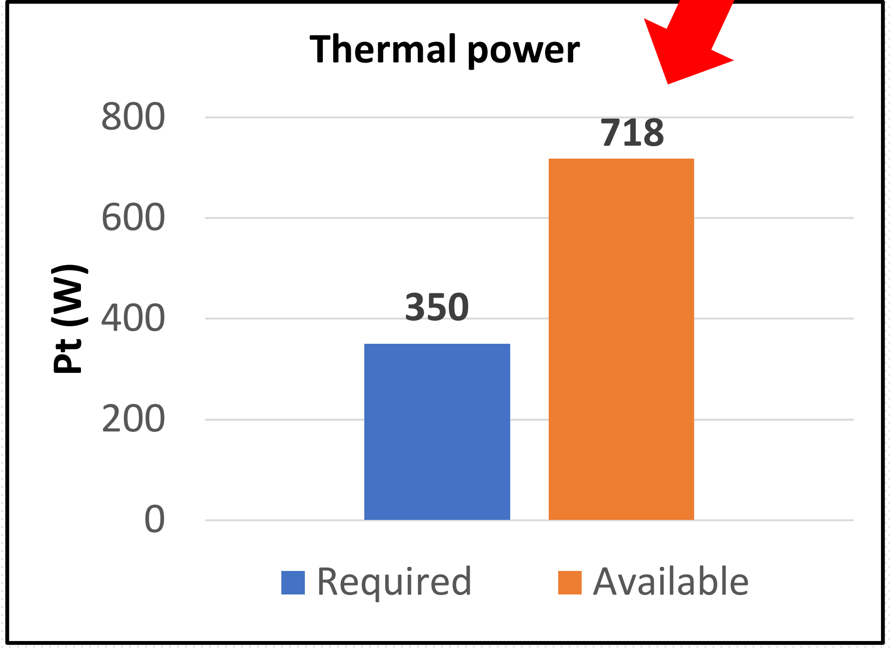
PYROLYSIS SIMULATION: SUMMARY

PLA (100%)					
L-Lactide (%)	D-Lactide (%)	Acrylic Acid (%)	Acetaldehyde (%)	Other Bio-Oil (%)	Non-condensable gases (%)
26	23	11,8	4,2	3	32

49%

11,8%





Conclusions

- Composting in a real industrial condition plant could be an applicable recycling route
- Bioplastics do not give a negative heavy metal contribution to the compost because every value is under National limits
- The pyrolysis is a solution better than incineration because allows the recovery of material rather than solely energy recovery
- The pyrolysis of PLA is a promising chemical recycling path
- Validate the pyrolysis model at the laboratory, pilot and real scale

Thanks for your attention!