Management of solid residue from sewage sludge conversion in Waste-to-Energy Plants

HERAKLION 2019

26 – 29 June 2019

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Objective and content

*The aim of this work is the evaluation of **ash management** from different thermal conversion technologies processing sewage sludge to assess their potential utilization.*

1. Background: SS disposal and alternatives for its valorization
2. Methodology
3. Valorization alternatives: Characterization of solid waste
4. Conclusions

SS disposal: Europe and Spain

Europe

- SS generation has largely increased in the last 20 years
- Disposal: Soil Amendment and Energy Recovery (incineration)

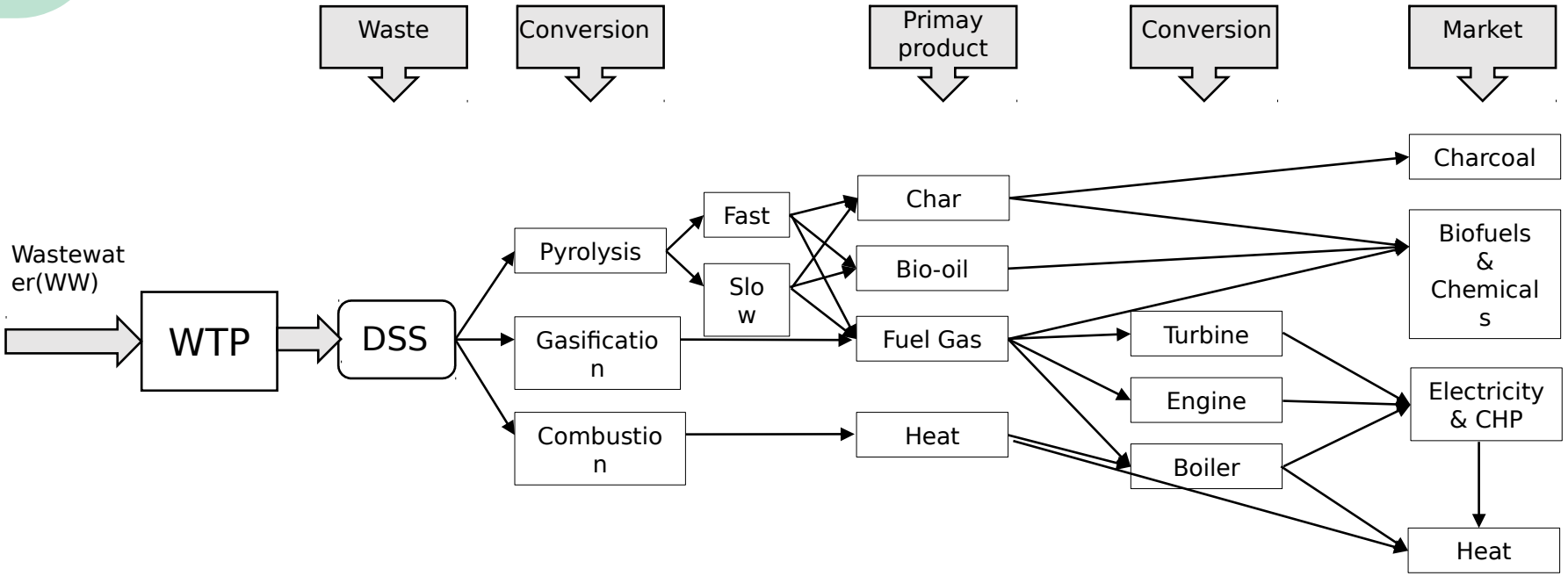
Spain

- SS production: 1,130,761 dry tons/year
- Disposal: agriculture (81%), Landfill (7.1%), Incineration (6,6%) and others (5.3%)

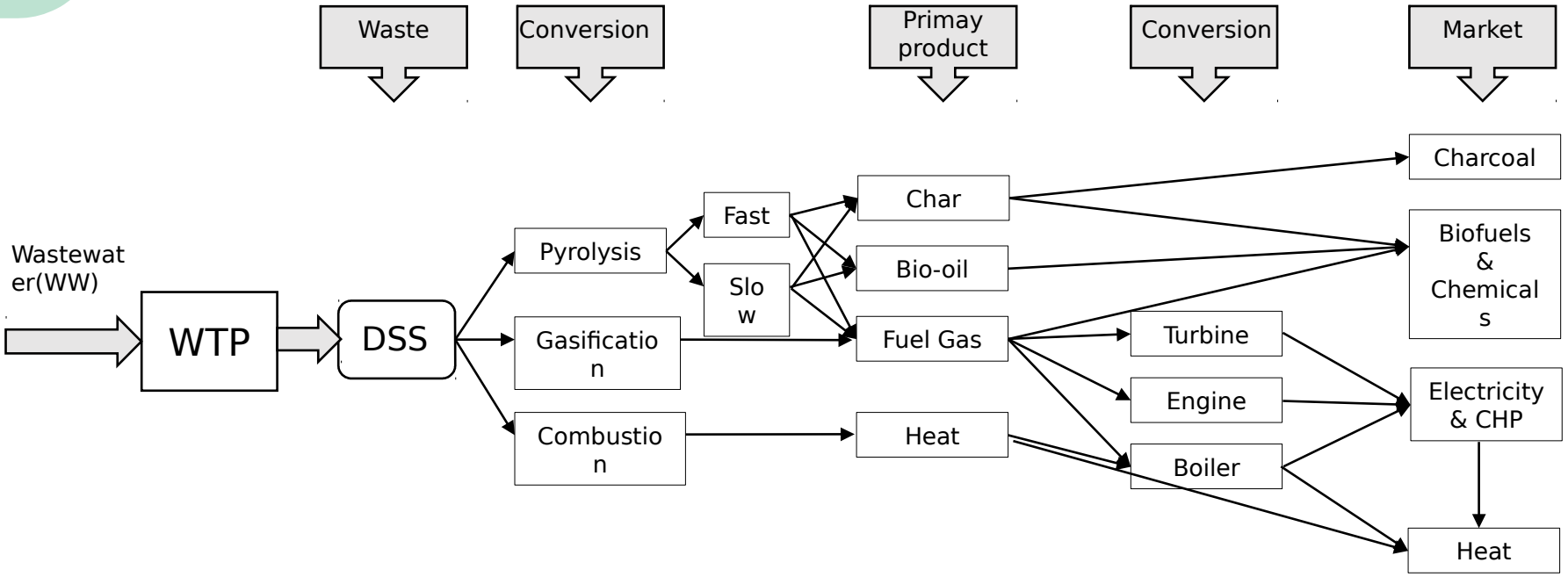
- ✓ The EC is developing a sustainability plan focussed on the efficient conversion of biowaste into higher value products and on the reduction of landfill (max. 7%)
- ✓ Need of finding **sustainable ways for SS valorisation**. Focussed on:

The recovery of nutrients, energy and chemicals

SS valorisation



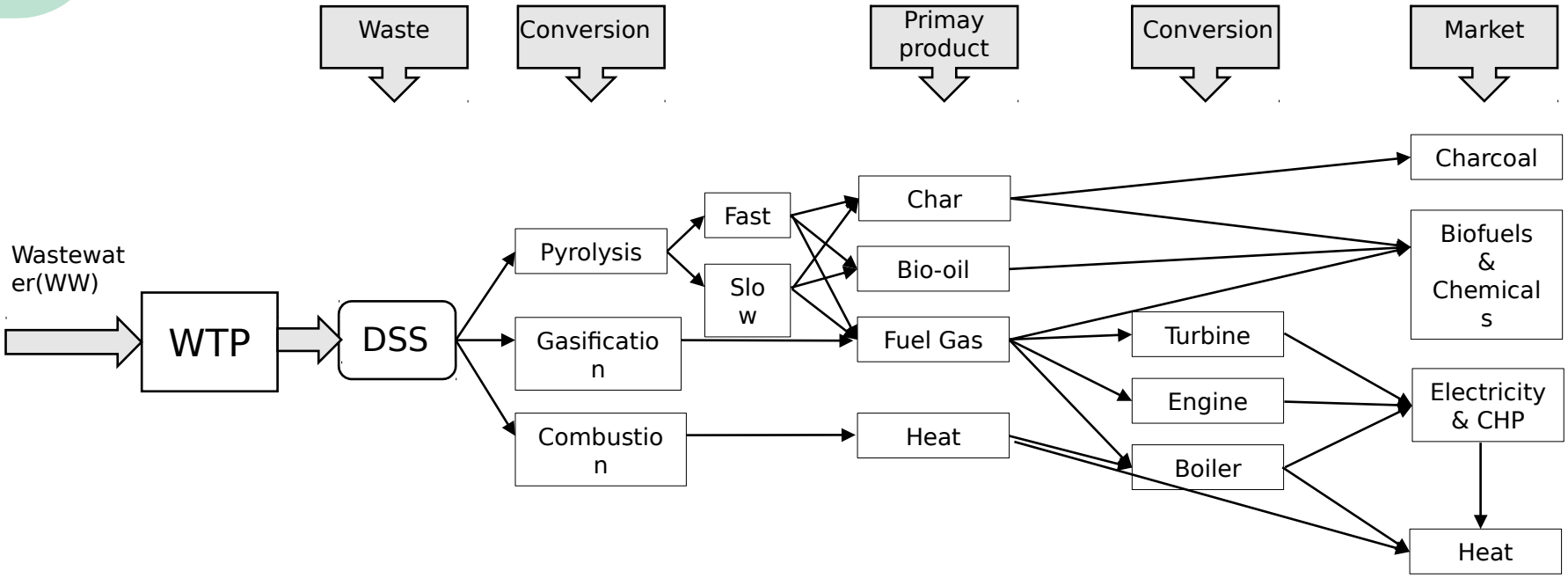
SS valorisation



- ✓ Technological feasibility
- ✓ Economical feasibility
- ✓ Energy efficiency

Waste Management ?

SS valorisation



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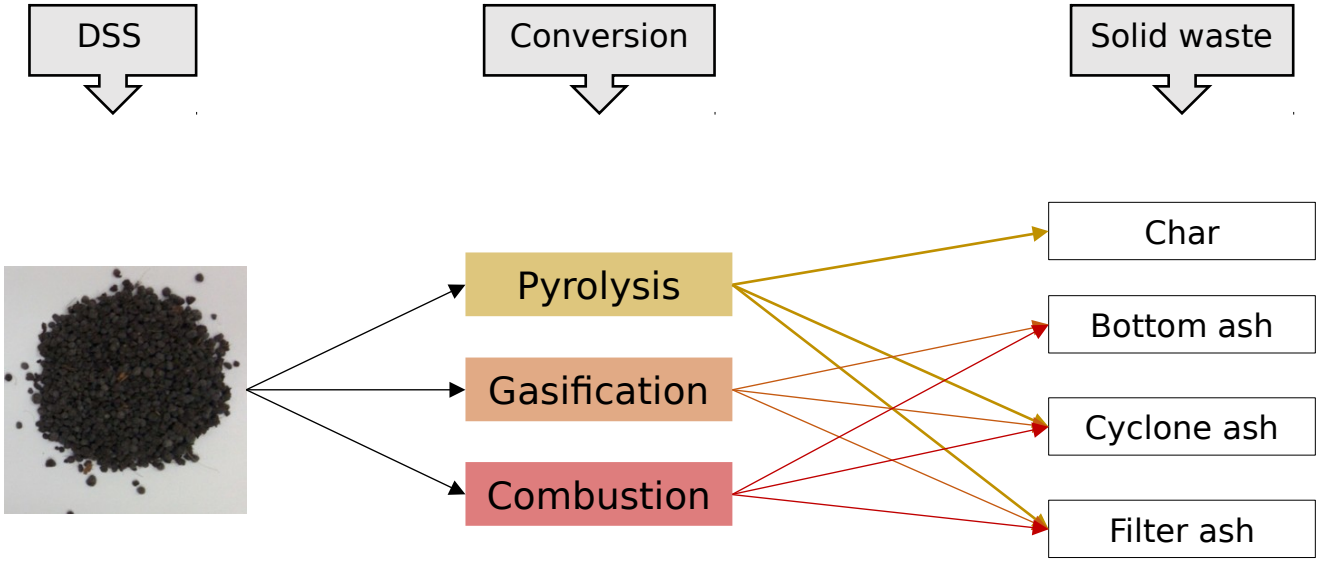
Waste Management ?

The properties of ashes have significant implications for waste management and handling

A comparison between the ash management from different types of processes is needed for the selection of the most promising technology

Methodology

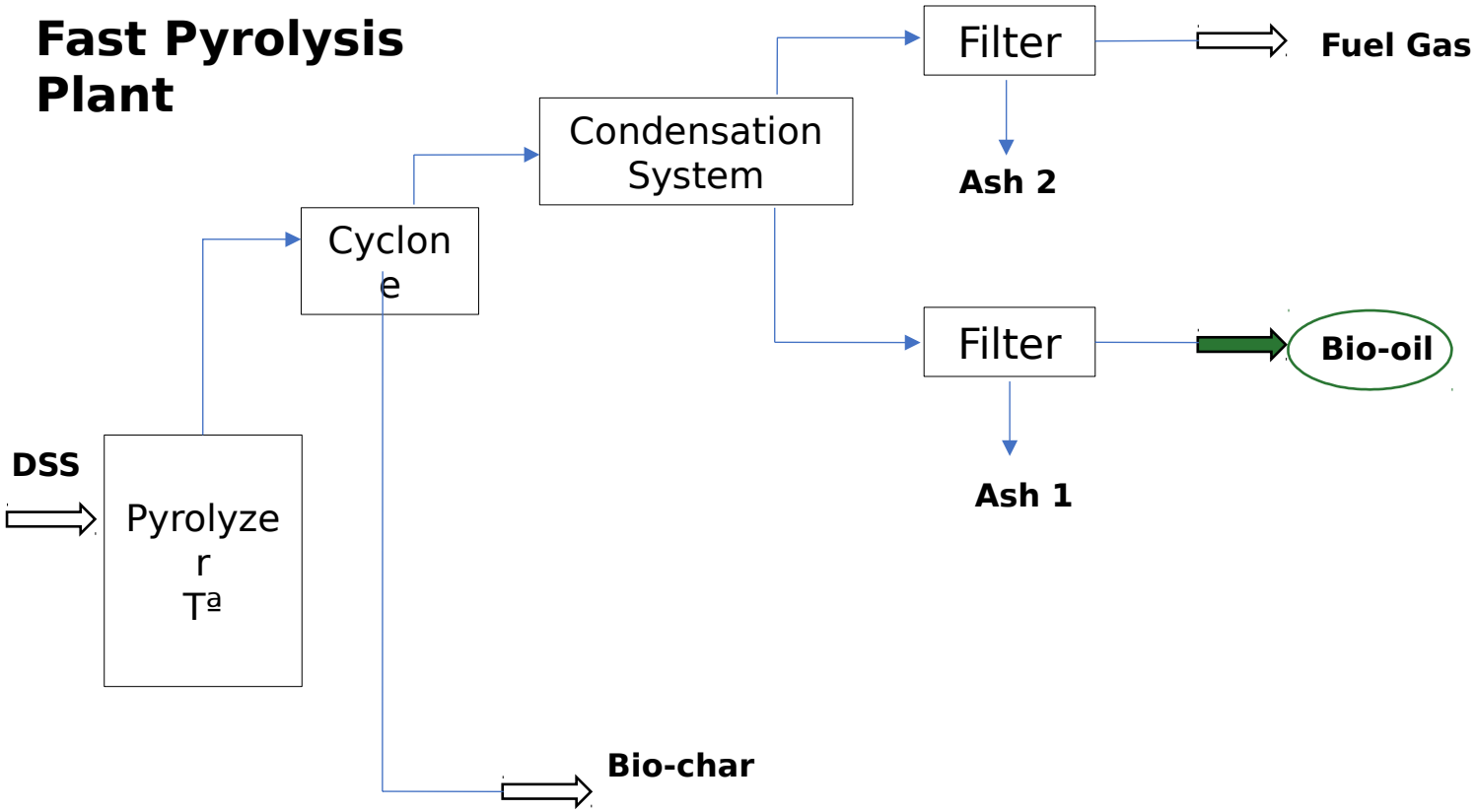


LCV (MJ/kg$_{db}$)	14.20
Moisture (% w/w)	16.5
Ashes (% w/w, db)	23.32
Elemental analysis, db, % w/w	
C	33.20
H	5.26
O	31.28
N	5.38
S	1.53
Cl	0.03

- Yields
- Characterization
- Management proposals

Thermal Valorization-I: Pyrolysis

Fast Pyrolysis Plant



Operational conditions:

- Tª=500ºC
- $\eta_{cyclone}$: 97%
- Residence time < 5 s

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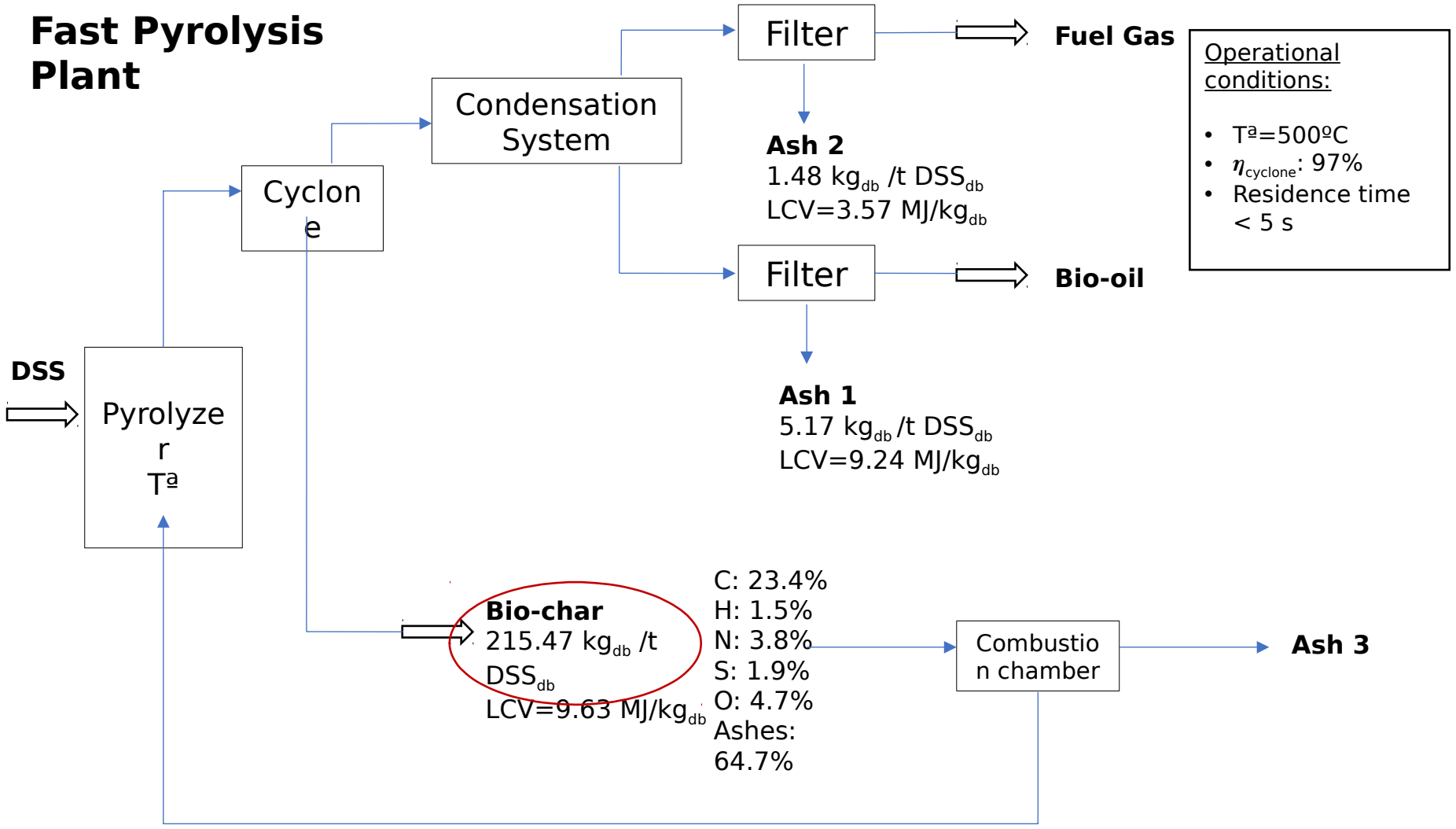

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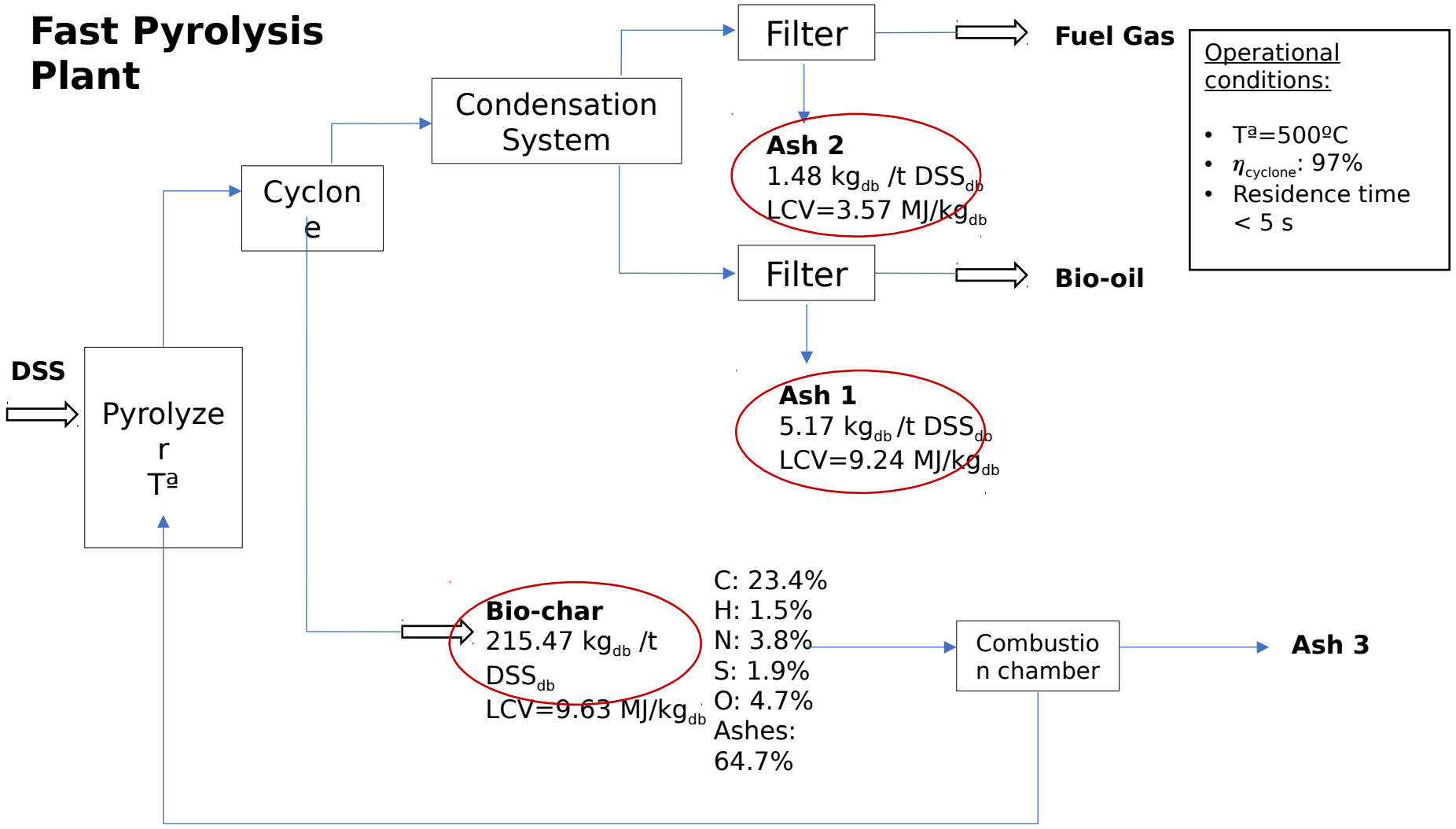

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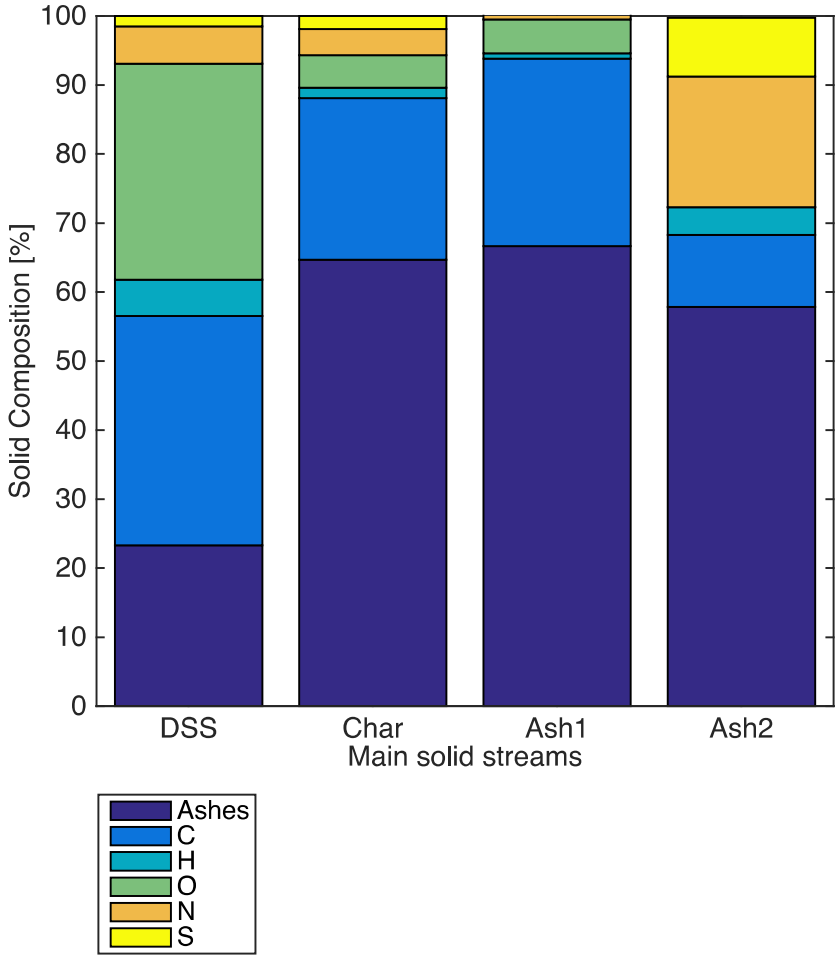

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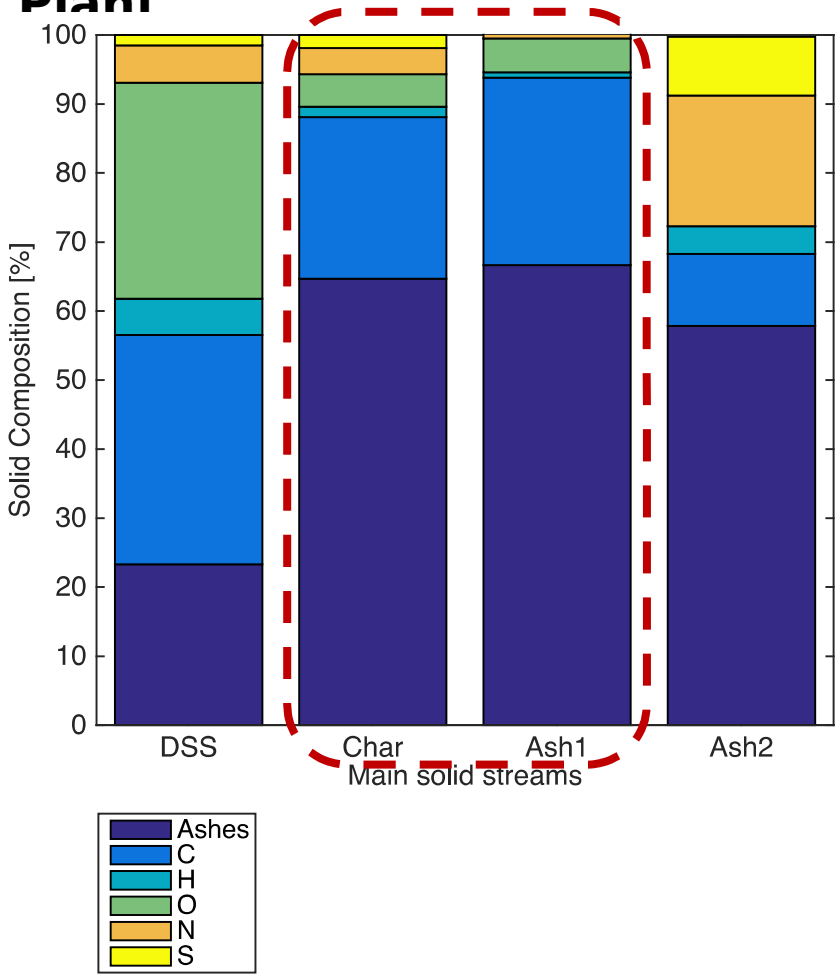

Char and ash 1 (cyclon ash)

- High content of C
  - Combustion purposes
  - Co-combustion with other biomass-char (to improve their fuel properties)

- A carbonaceous structure concentrating the nutrients and the metals
  - Landfill applications: conditioned by leachability of char (mainly for low HM content in DSS: Cr, Co, Mo, Ni and Zn)
  - Recovery of any high-value nutrients present in original DSS

- BET surface areas ~ 25 m^2/g
  → Applications as adsorbent

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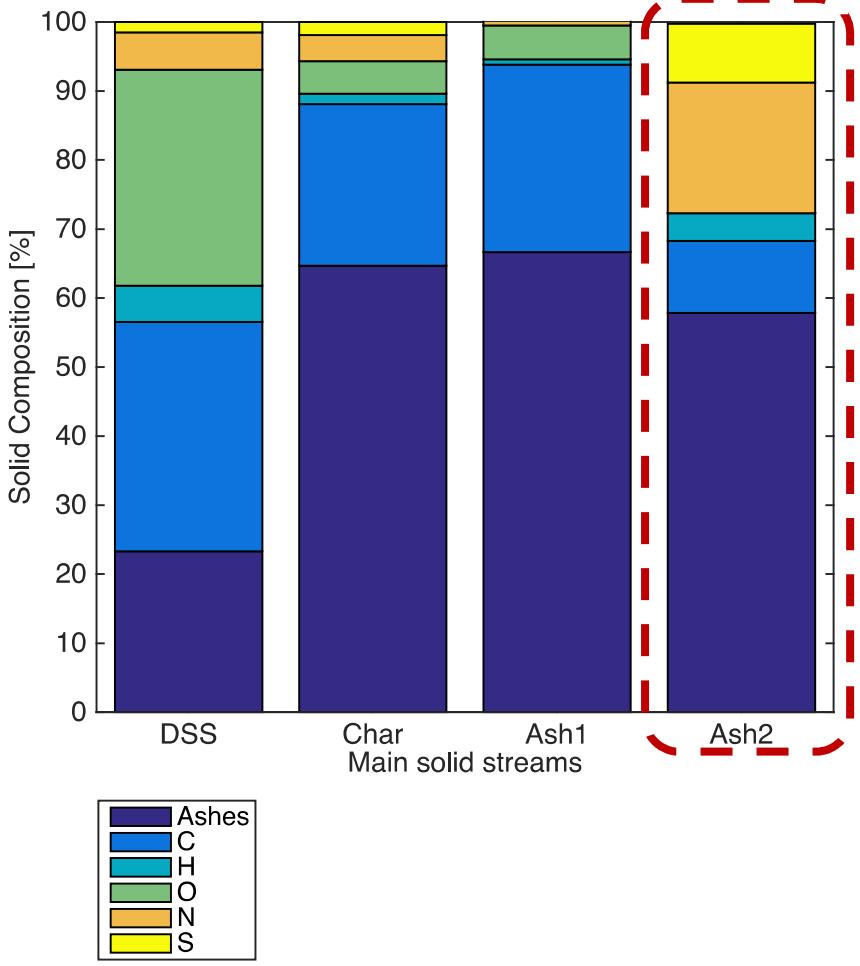

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Ash 2 (fylter ash)

- Low obtained amount and pollutant charge
  - Needed to HM analysis to determine the classification as waste

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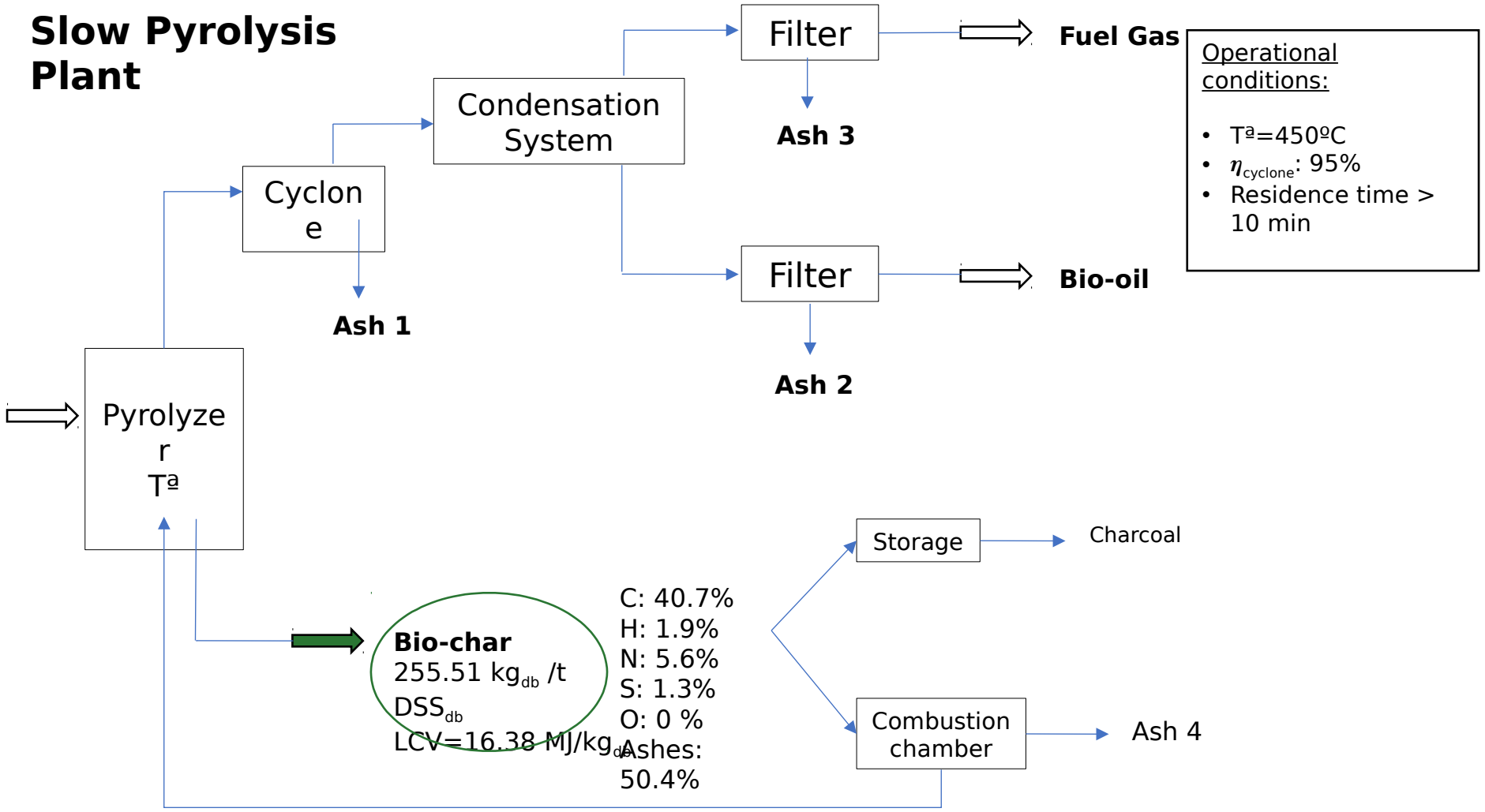

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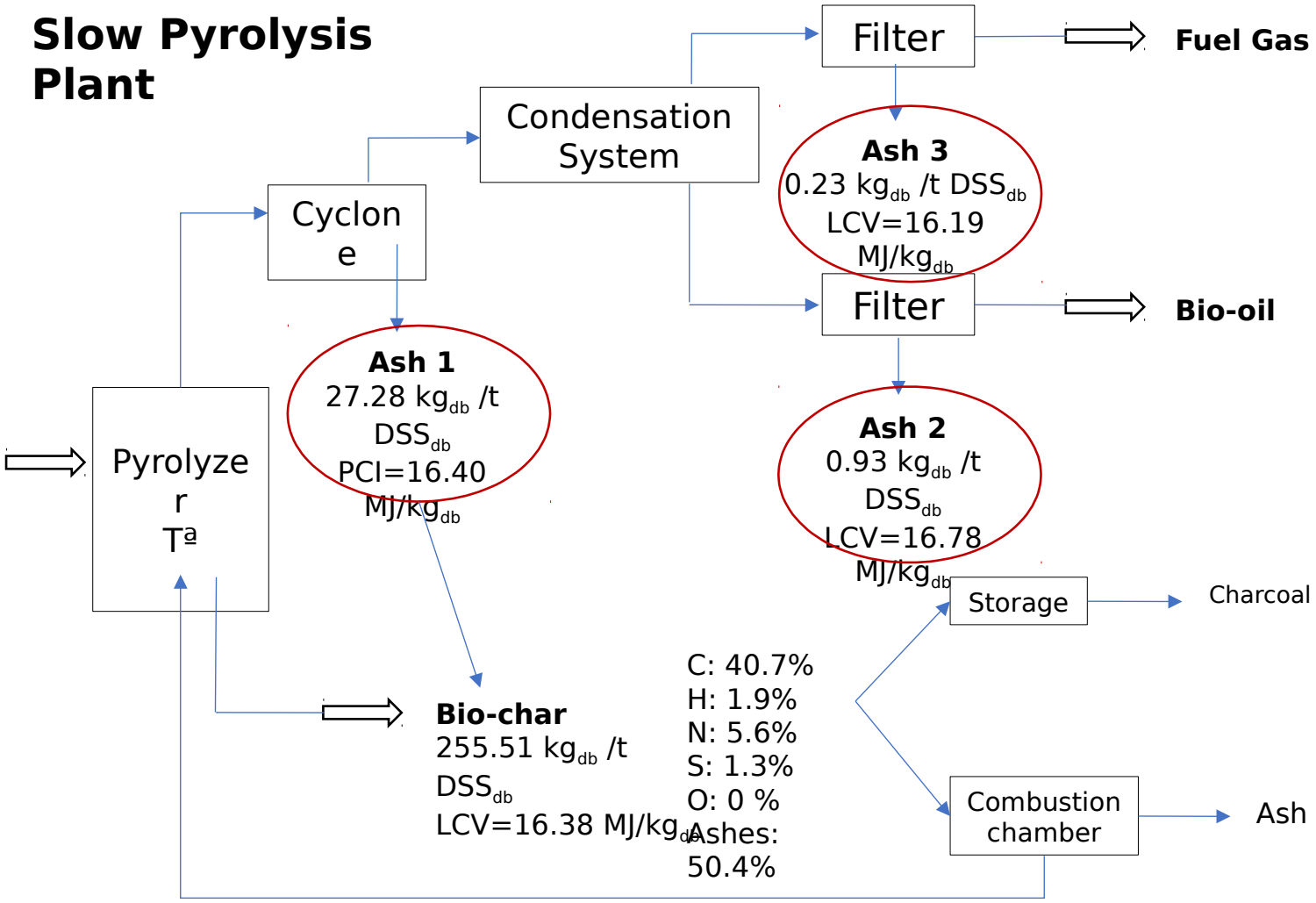

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- $\eta_{cyclone}$: 95%
- Residence time > 10 min

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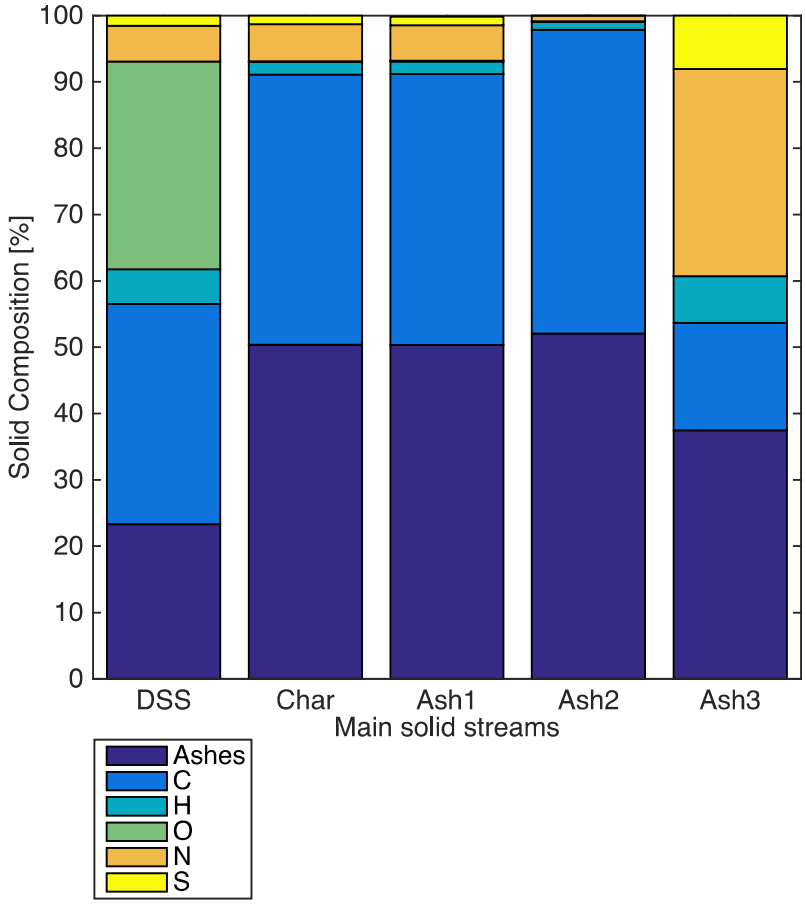

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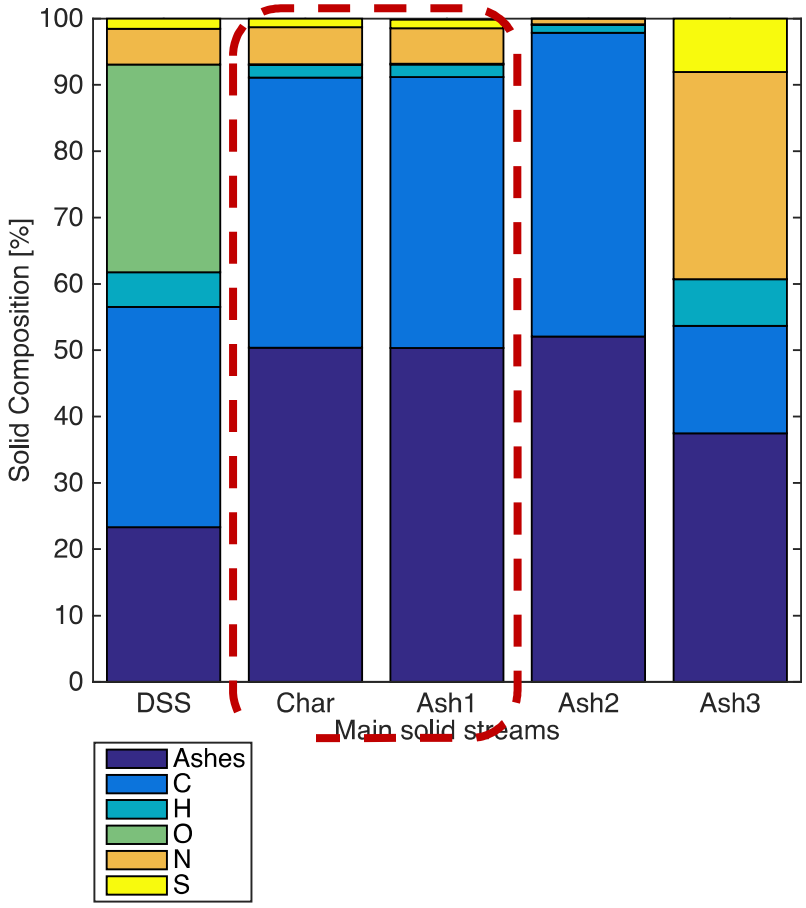

Char and ash 1 (cyclon ash)

- High LCV
  - Combustion purposes
  - → To sale as charcoal
- Acid-soluble or insoluble ashes
  - Landfill applications
- High content of aluminosilicates and moderate BET surface area
  - Applications as adsorbent
  - To capture volatile compounds during combustion

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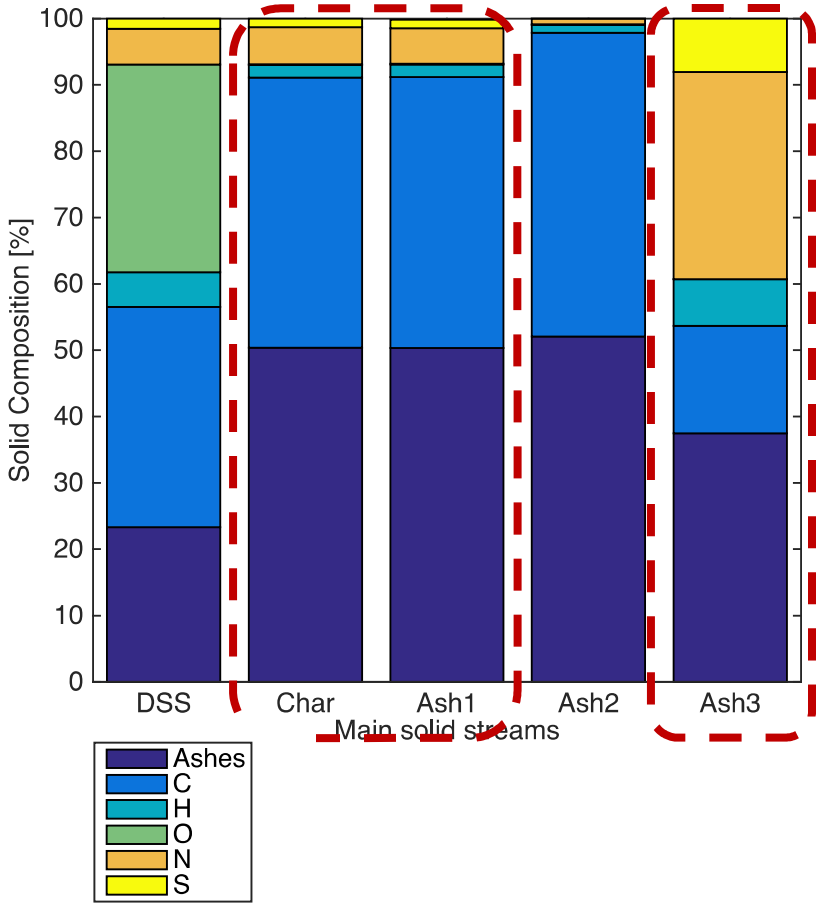

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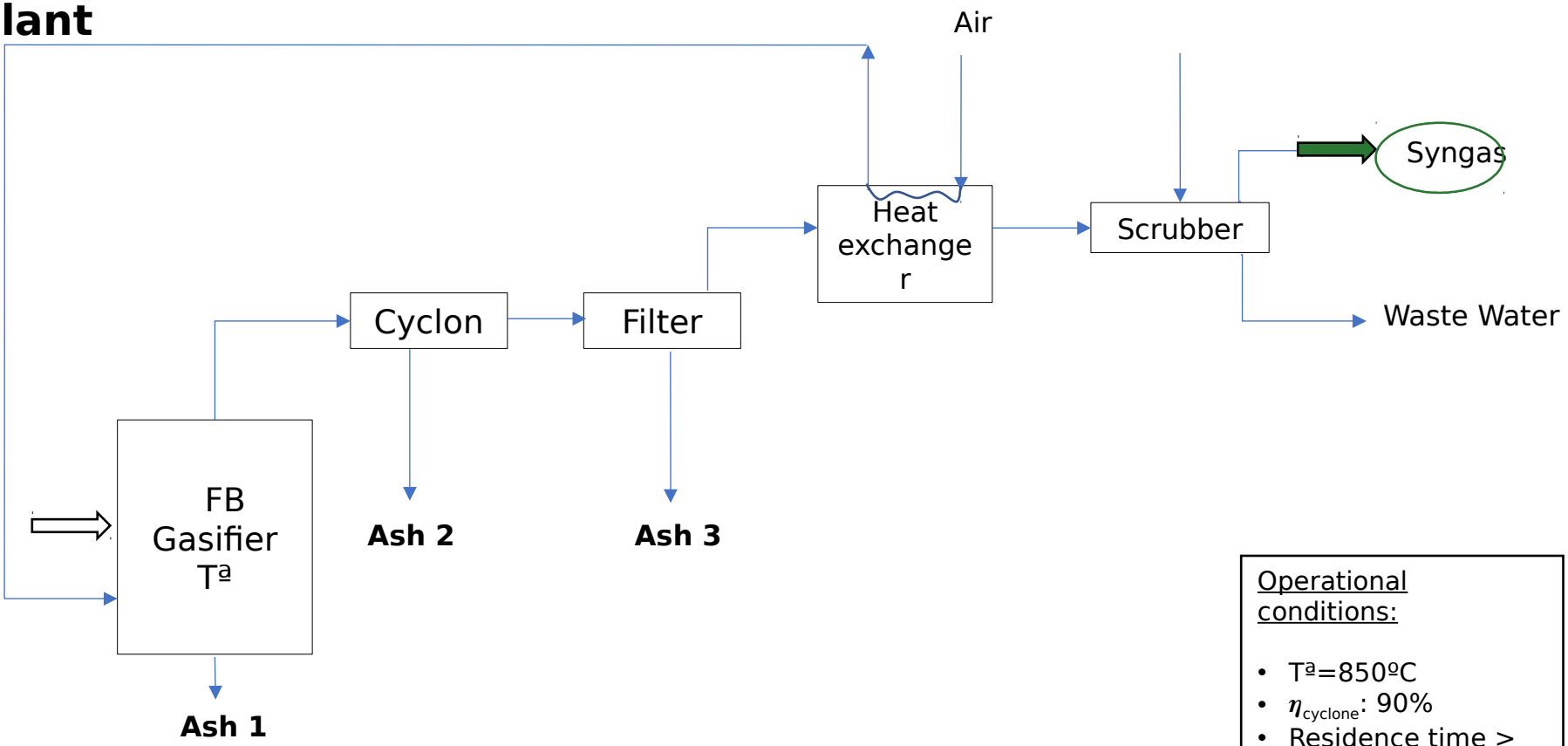
- Acid-soluble or insoluble ashes
  - Landfill applications
- High content of aluminosilicates and moderate BET surface area
  - Applications as adsorbent
  - To capture volatile compounds during combustion

Ash 3 (filter ash)

- High content of N
  - Agriculture purposes
- Low obtained amount
  - Management in dumps
  - Needed to HM analysis to determine the classification as waste

Thermal Valorization-II: Gasification

Gasifiation Plant



Operational conditions:

- Tª=850ºC
- $\eta_{cyclone}$: 90%
- Residence time > 10 min

Thermal Valorization-II: Gasification

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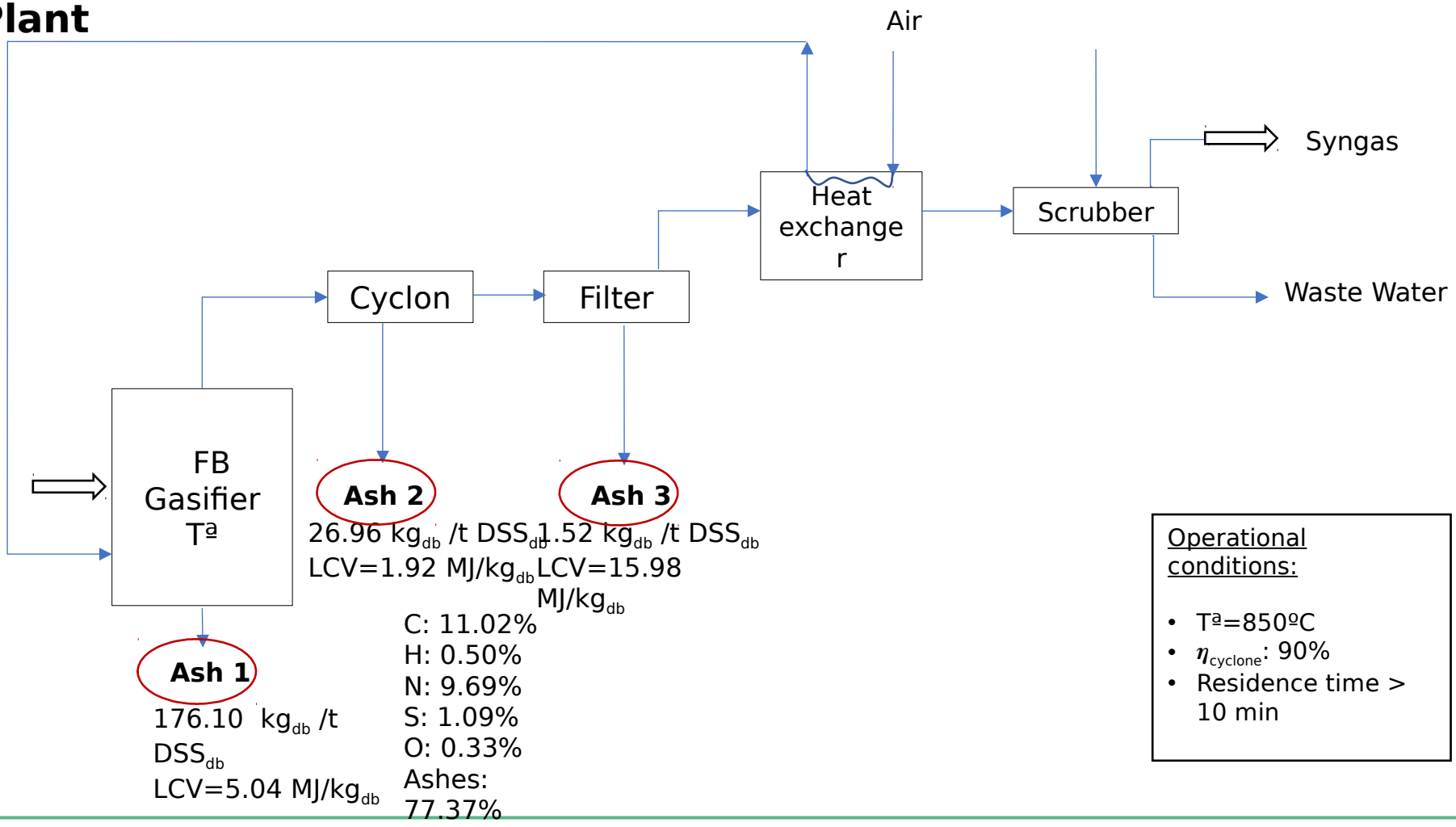

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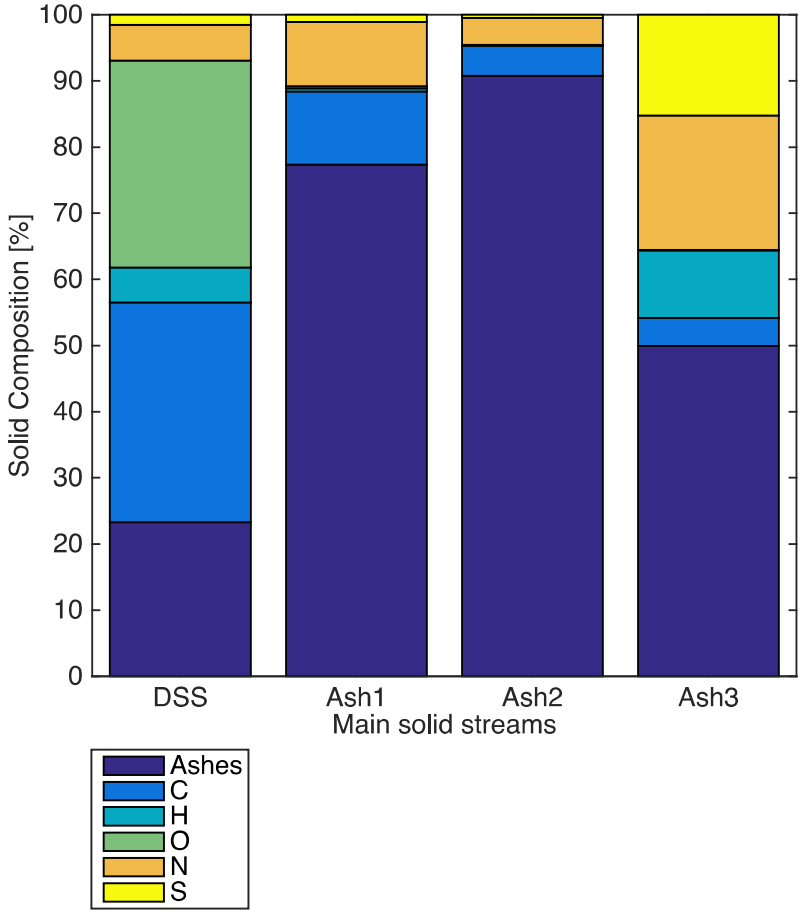

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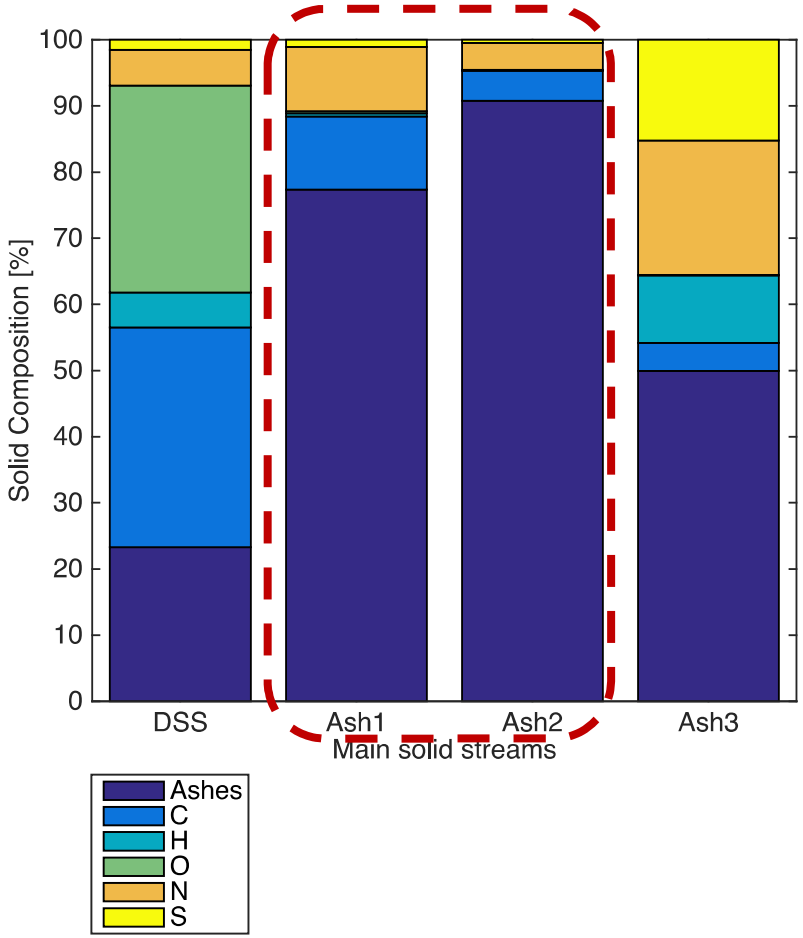

Ash 1 (Bottom ash) and Ash 2 (cyclon ash)

- Low LCV

  → Co-combustion with other biomass-char (to improve their fuel properties)

- Concentration of HMs is unclear

  → Leaching test are necessary to landfill applications

  → They are characterized by amorphous glassy phases which retain HMs

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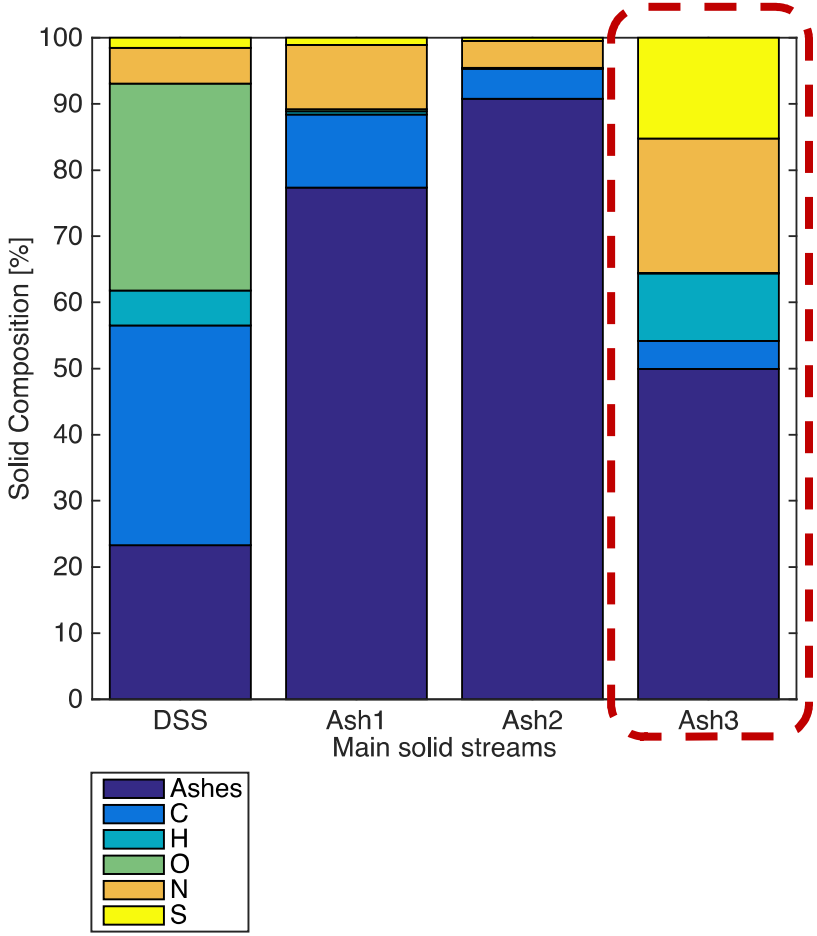

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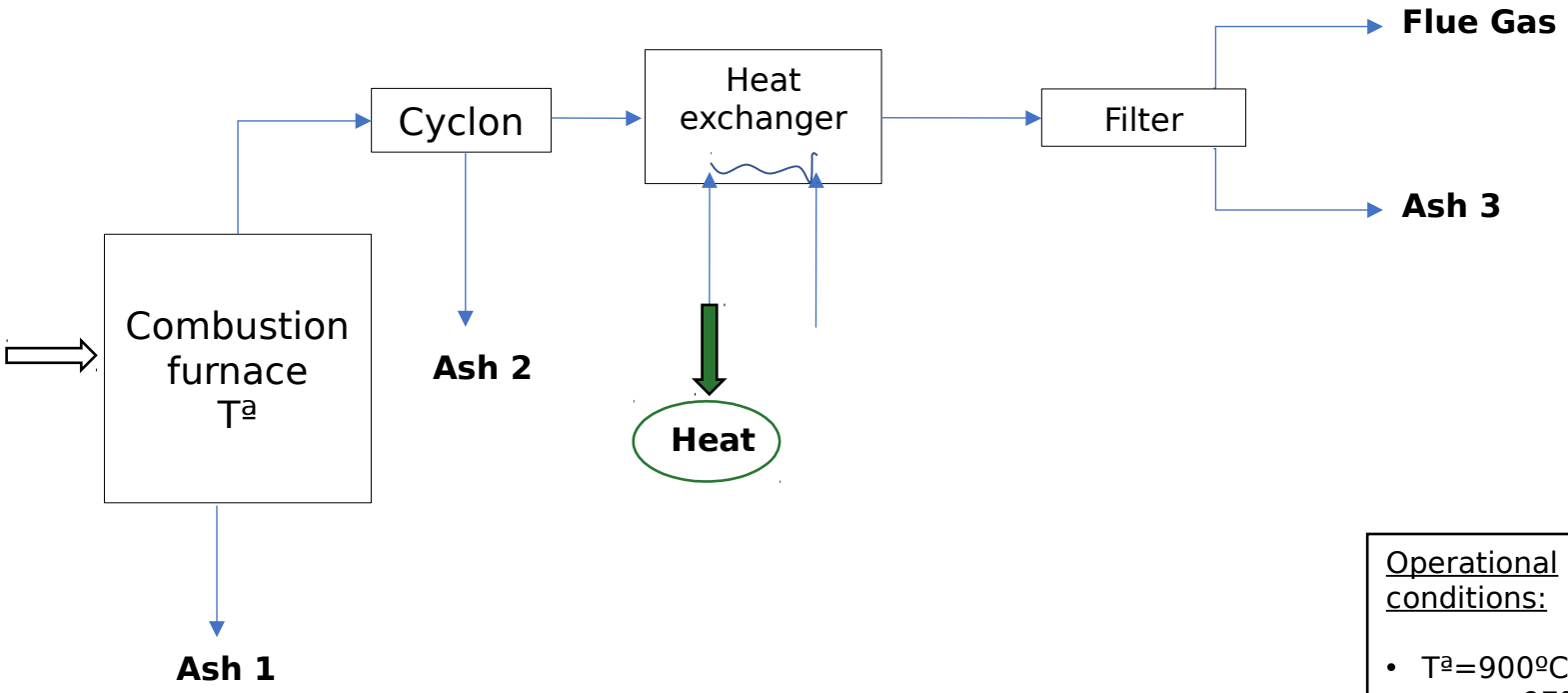
Ash 3 (fylter ash)

- High contents of HMs
  → Treated as Hazardous Waste

- High surface area
  → Applications as adsorbent

Thermal Valorization-III: Combustion

Combustion Plant



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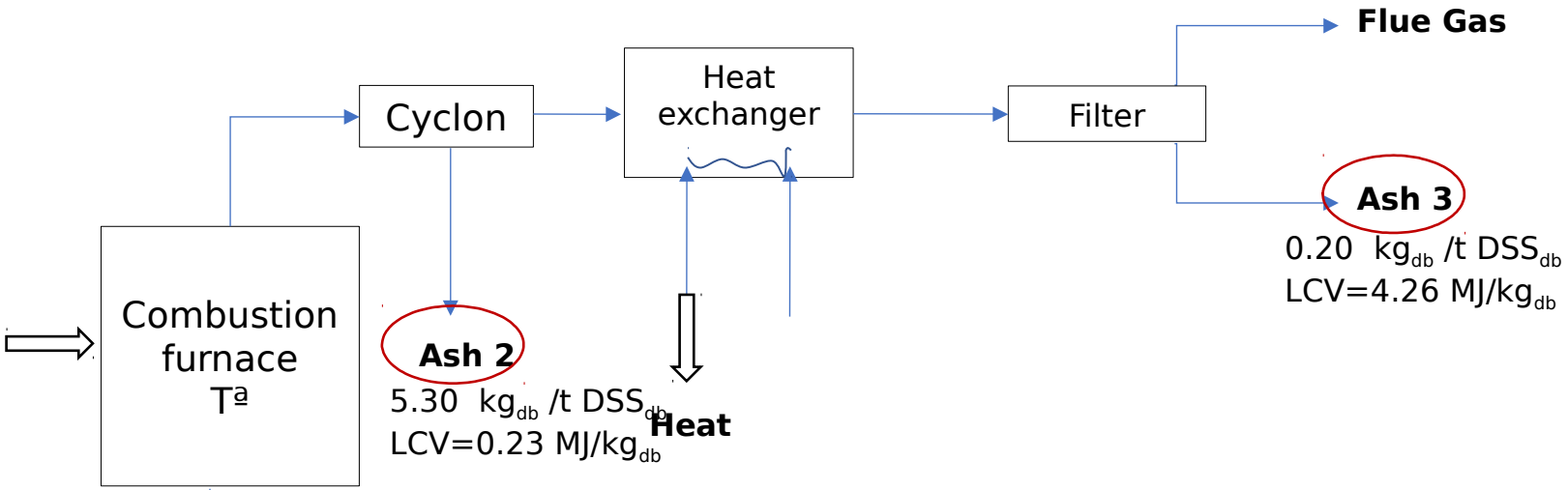

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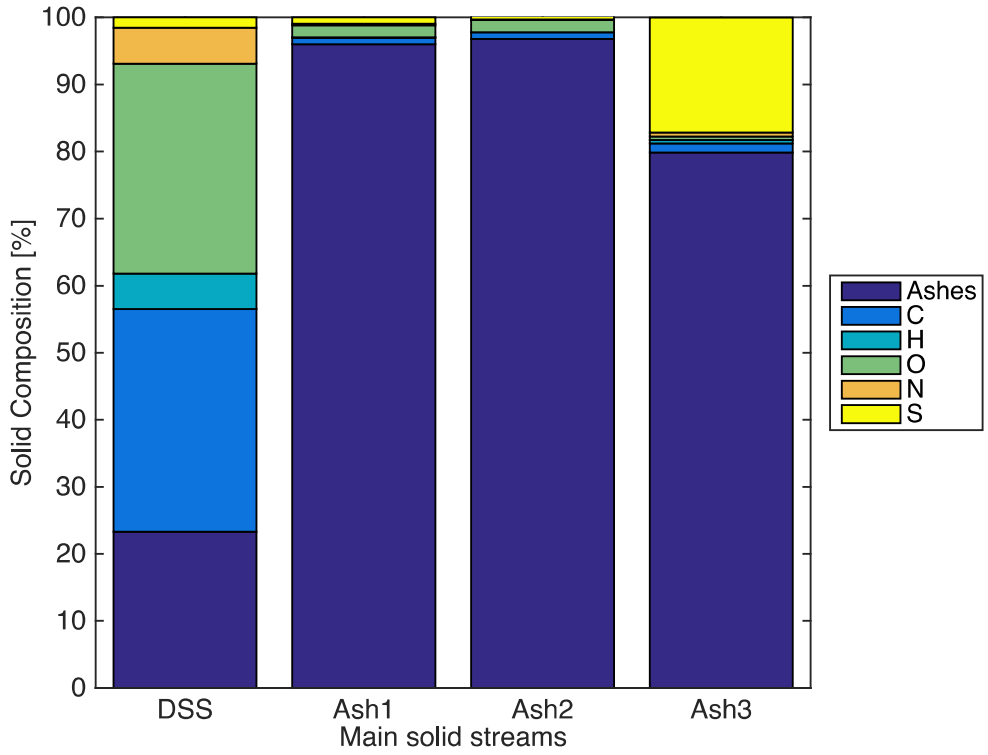

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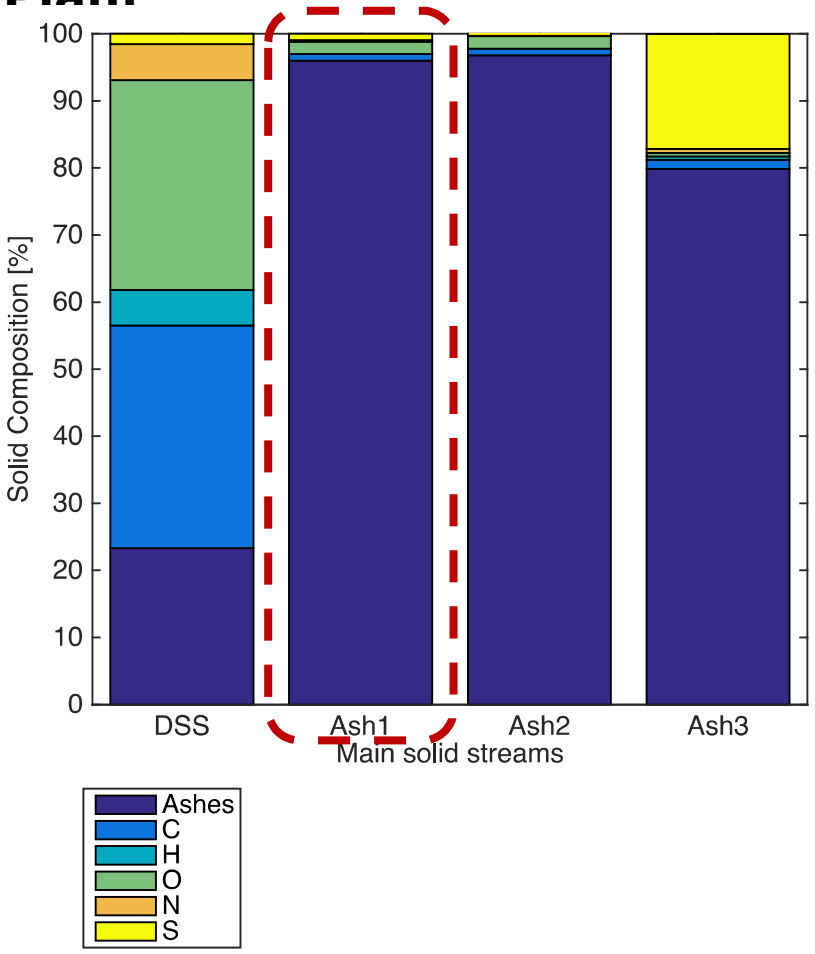

Ash 1 (Bottom ash)

- <u>High content of P</u>
  → Phosphate recycling after a treatment to remove heavy metals

- <u>High content of metals</u>
  → Erichment of Zn, Cu, Ba, Ni, Cr and As. To recover them

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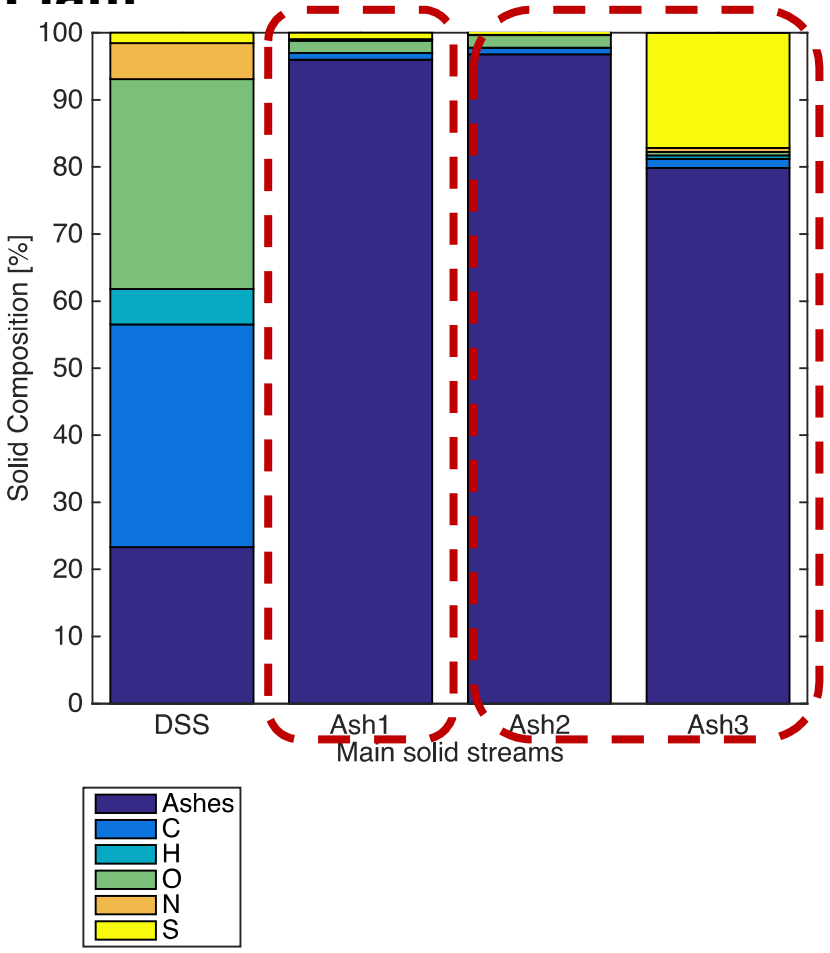

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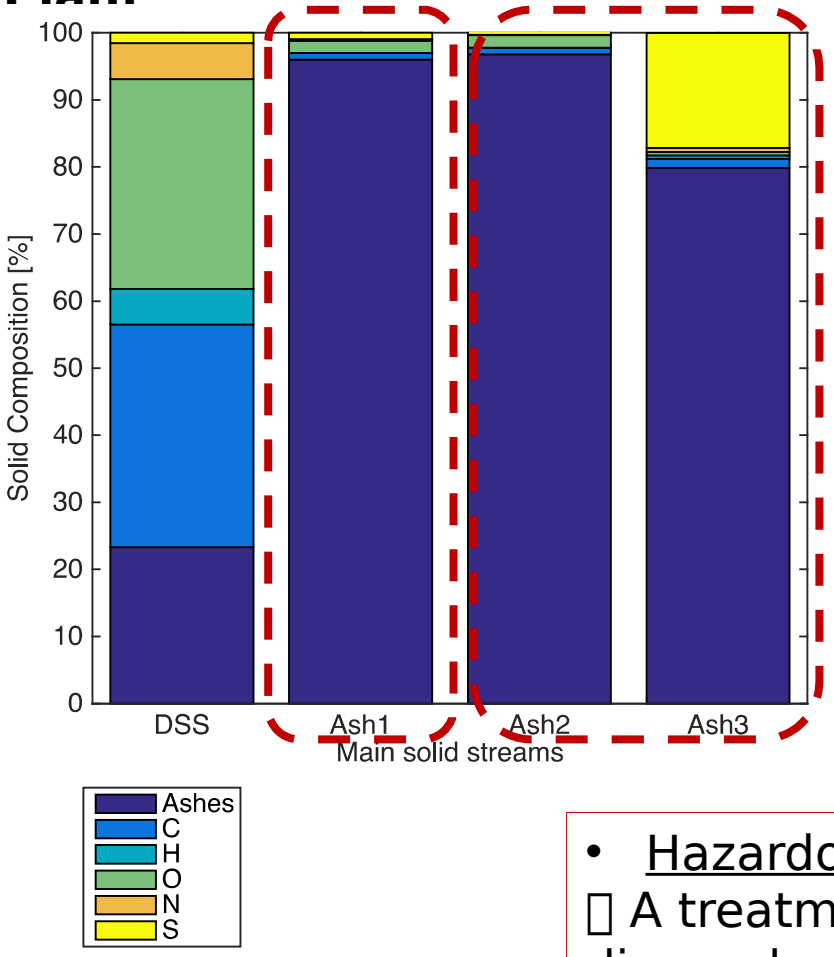
Ash 2 and 3 (Fly ash)

- High contents of HMs
  - Waste enrichment of Pb and Hg
  - Concrete and construction applications after treatment to remove HMs
- High pH value
  - As a neutralizing and liming agent

Thermal Valorization-III: Combustion

Combustion Plant



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- High pH value
  - As a neutralizing and liming agent

- Hazardous wastes

A treatment must be done prior to landfill and disposal

Concluding Remarks

- The use of SS in waste-to-energy needs the **management of produced solid residues**
- The slow pyrolysis produces the **highest amount of solid residue** but with **highest added value**
- The management of solid residues from SS thermal conversions technologies is **limited due to the presence of heavy metals** and other inorganic compounds
- The variability in heavy metal concentration in ash arises from the feedstock, and hence **the composition for ash is unclear**
- **There is not an application for all kinds of ash**
  - Ash with high content of C may be recycled to the boiler or furnace to improve energy output and increase the process efficiency
  - Ash with high content of nutrients may be used as agricultural fertilizers
  - Ash with high content of non-dangerous metals may be used as an additive in construction materials
  - Ash with high pH value may be utilized as a neutralizing and liming agent

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hank you for your attentio

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Acknowledgements

UNIÓN EUROPEA
FONDO EUROPEO DE DESARROLLO REGIONAL
"Una manera de hacer Europa"

GOBIERNO DE ESPAÑA
MINISTERIO DE ECONOMÍA Y COMPETITIVIDAD

This work is supported by the Spanish Ministry of Economy and