



INSTITUT TECHNOLOGIQUE



Union de la Coopération Forestière Française



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Suitability of Wood Chips from Forestry & Different Biomass Feedstocks for Use in a Semi-industrial Plant of BtL Production by Gasification

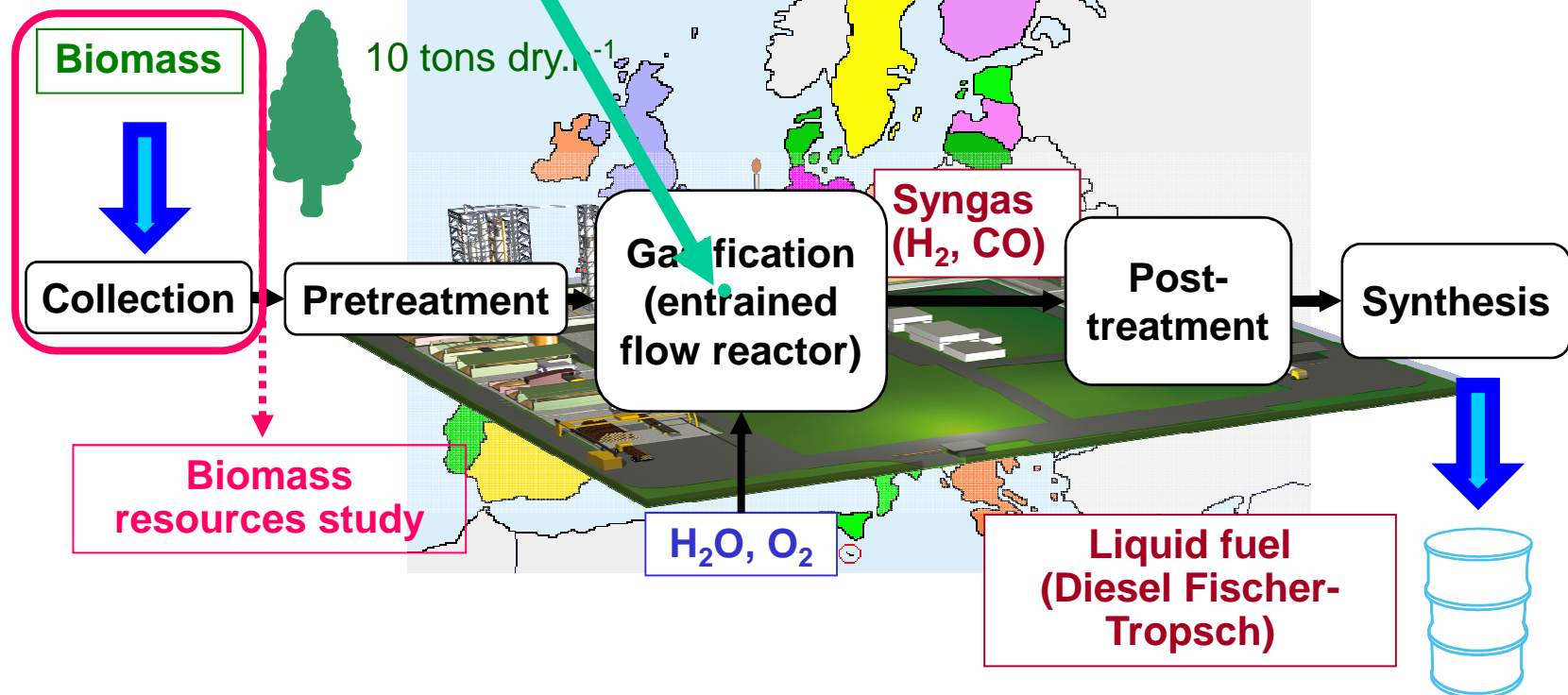
*Capucine DUPONT, Sylvie ROUGE, Alain BERTHELOT, Denilson DASILVAPEREZ,
Ambroise GRAFFIN, Françoise LABALETTE, Céline LABOUBEE,
Jean-Claude MITHOUARD, Sophie PITOCCHI*

The Bure project



◆ Where is Bure?

- ◆ **Objective of the Bure project:** To build a semi-industrial plant of BtL production by lignocellulosic biomass gasification.



Biomass regional resources study



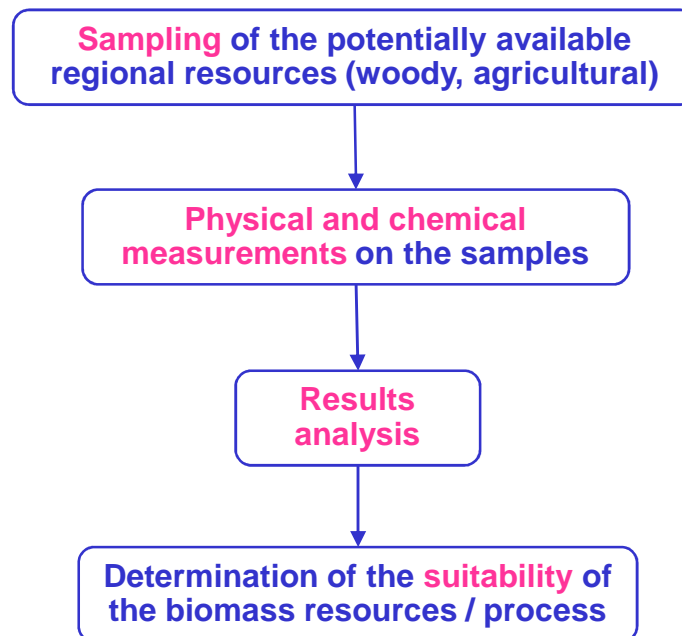
1. Resources potential availability and supply feasibility

↳ Resources partners

2. Suitability biomass resources / process

↳ Process partners: CEA

♦ Working plan:



Biomass regional samples



- ◆ 92 samples gathered into 3 main families:

- 60 Wood chips from forestry:

- ↪ Alder, ash tree, aspen, beech, birch, false acacia, hornbeam, lime, oak, poplar, Scot pine, spruce, willow



- 11 Wood chips from (Very) Short Rotation Coppice:

- ↪ Poplar (5 VSRC, 4 SRC)
 - ↪ Willow (2 VSRC)



- 21 Agricultural raw materials:

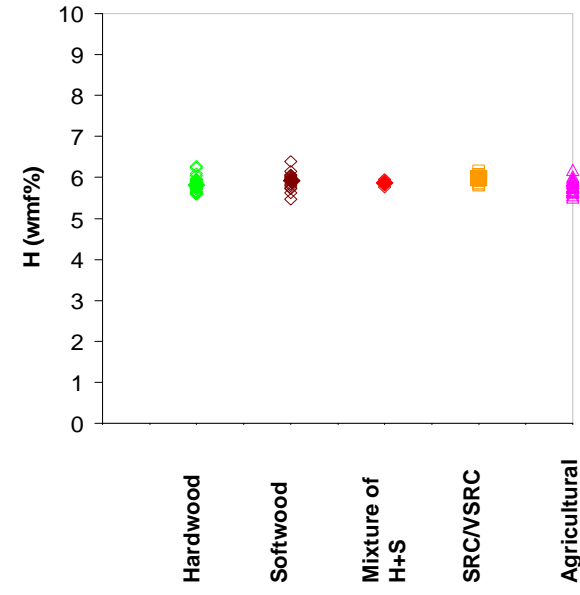
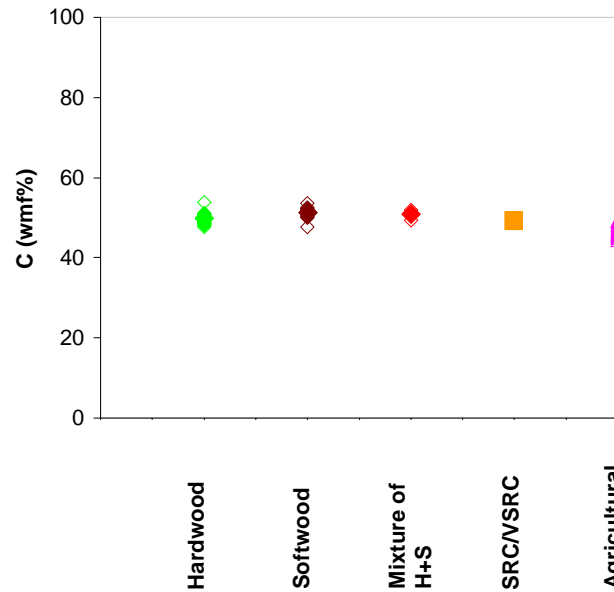
- ↪ Straw: barley, corn (3), rape, wheat (2)



- ↪ Energy crops: alfalfa, miscanthus (6), sweet and fiber sorghum, switchgrass (3), tall fescue, triticale.



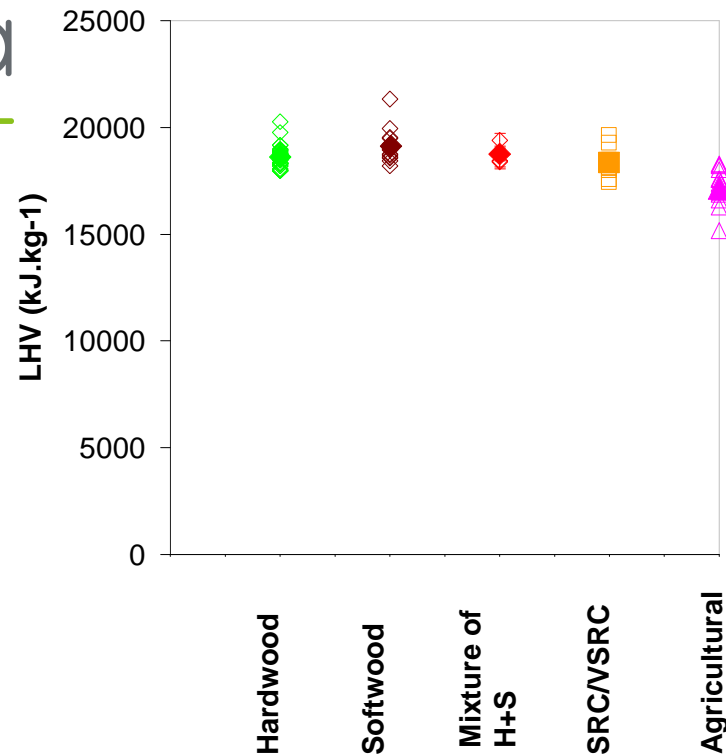
Major elements



O calculated by difference

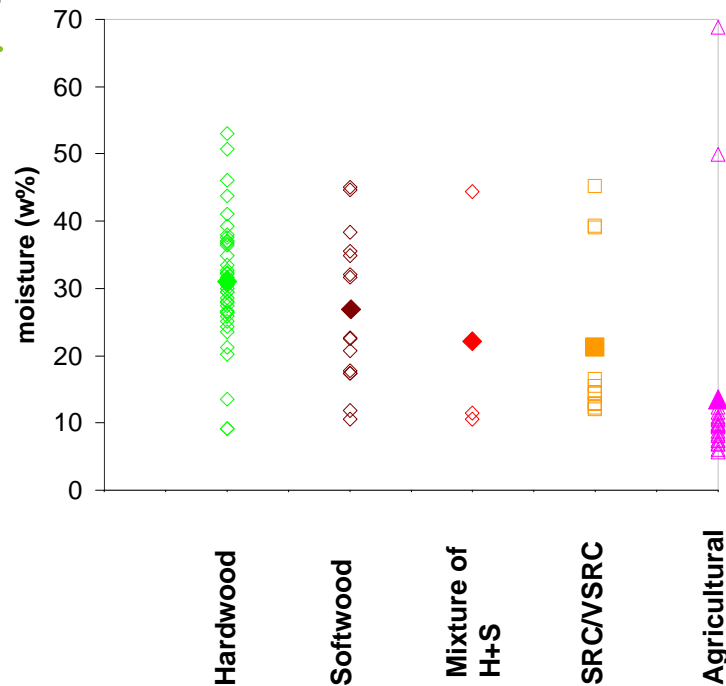
- ◆ Very little variability
- ◆ Average value: C: 49 wmf% H: 5.9 wmf% O: 42.3 wmf%

Lower Heating Value (LHV)



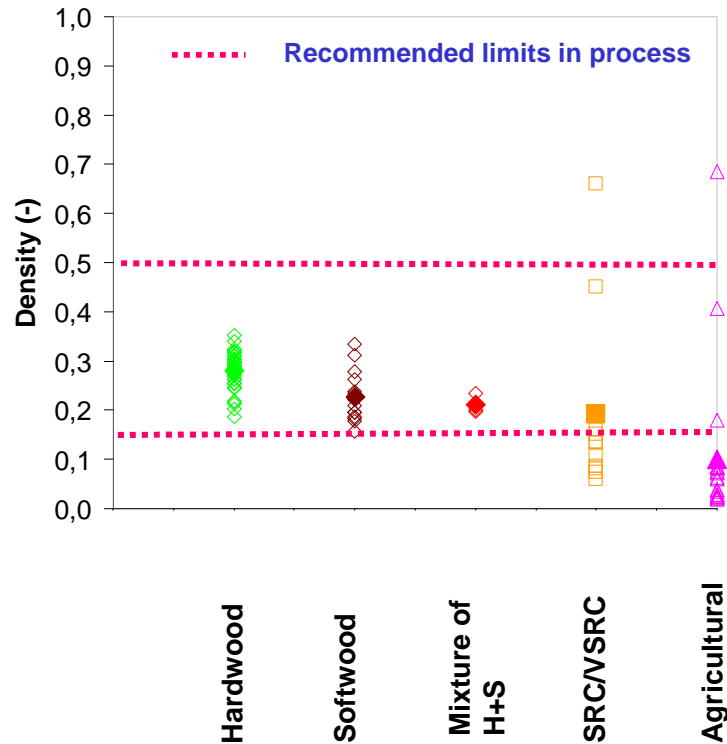
- ◆ Little variability
- ◆ $LHV(\text{forestry}) = LHV((V)SRC) = 18.8 \text{ MJ.kg}^{-1}$
- ◆ $LHV(\text{agricultural}) = LHV(\text{wood}) - 1 \text{ MJ.kg}^{-1}$

Moisture content



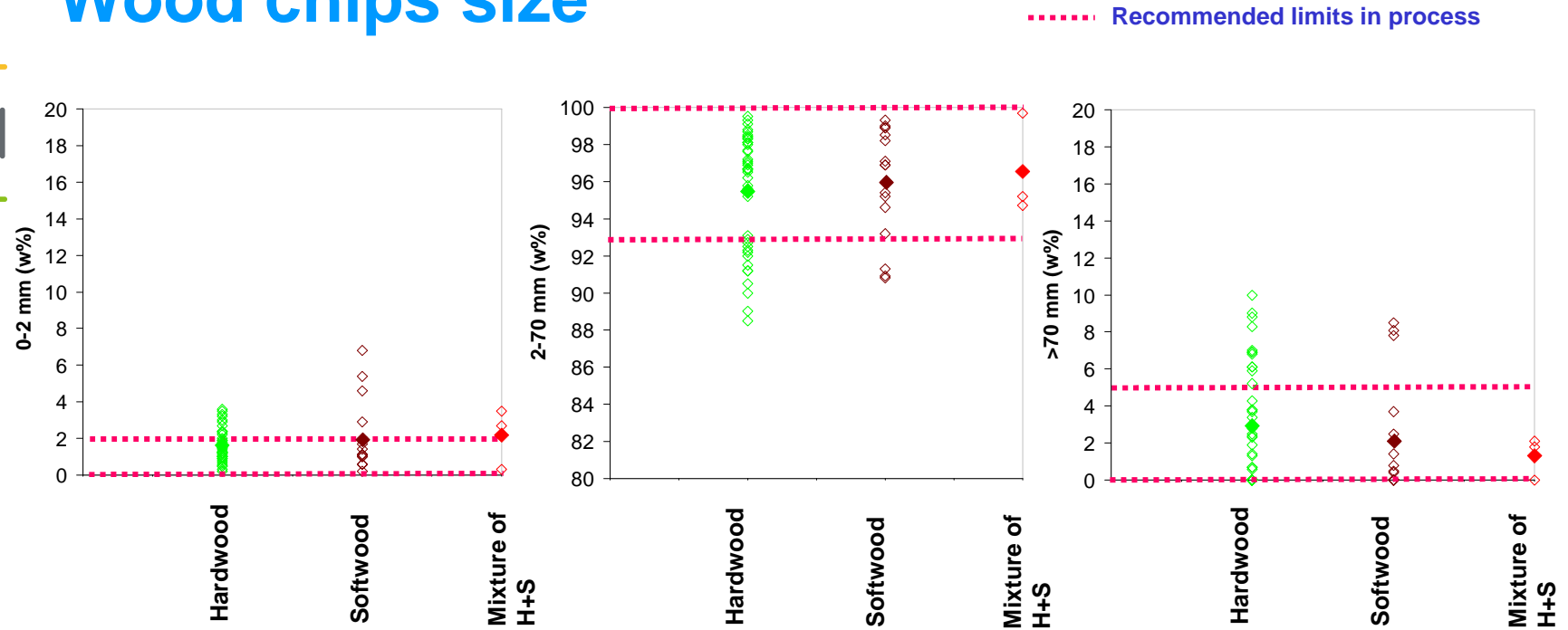
- ◆ Large variability (5→70 w%)
- ◆ Related to:
 - The drying time for wood
 - The harvesting date for agricultural biomass (miscanthus, switchgrass)
 - ↪ Before or after winter
- ◆ No strict process constraint
 - ↪ Dryer on the unit
- ◆ Wood chips: 30-50 w%

Apparent density



- ◆ Correlated with:
 - moisture
 - sample form
- ◆ Not significant on (V)SRC
- ◆ Wood: little variability
 - Average value : 0.25
 - ↪ Process: OK
- ◆ Agricultural biomass: too low < 0.1
 - ↪ Densification needed

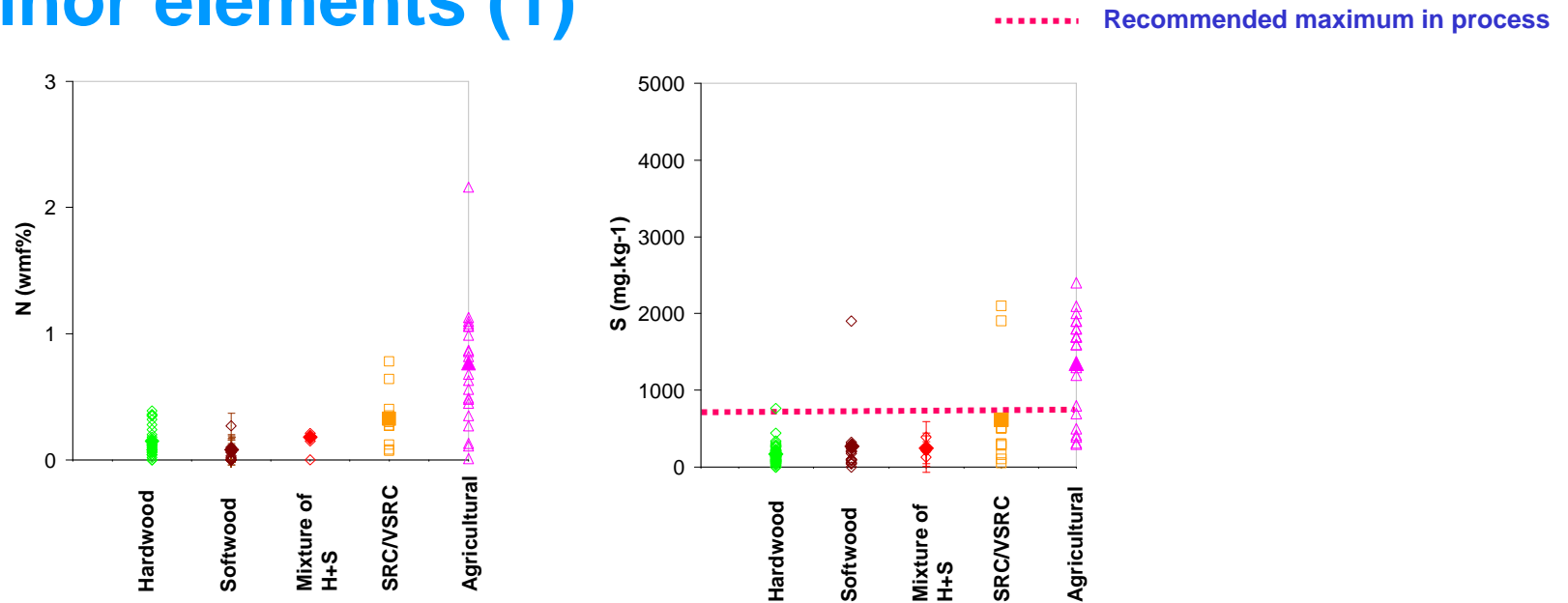
Wood chips size



- ◆ Too many fine particles (<2 mm)
- ◆ Too many large particles (>70 mm)

↪ To be checked by suppliers

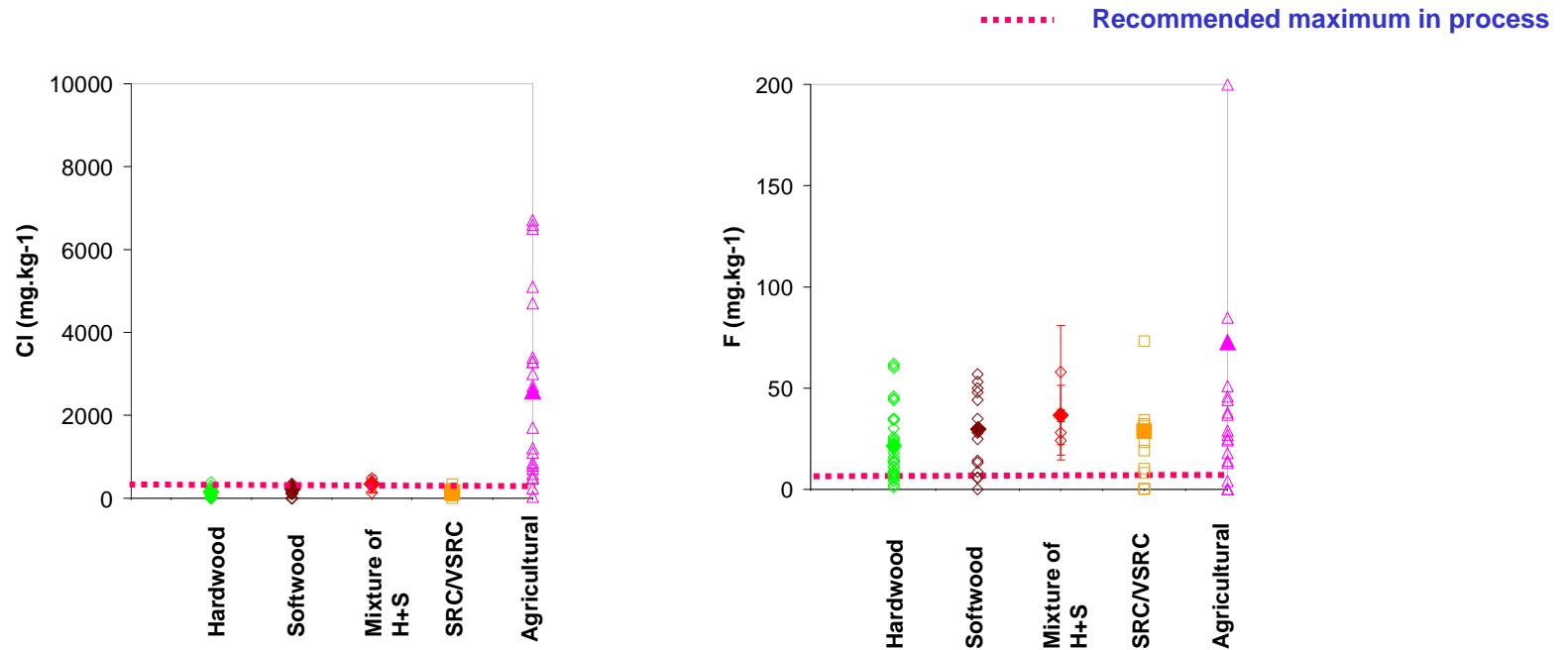
Minor elements (1)



- ◆ **Nitrogen:** relatively low amount (<1 wmf% except in alfalfa)
 - Wood: little variability (average: 0.4 wmf%)
 - Agricultural biomass (1 wmf%) > wood (forestry, VSRC)
 - ↳ Fertilizers
 - No strict process constraint

- ◆ **Sulfur:** <0.2 wmf% in nearly all samples
 - Wood (forestry, VSRC): OK in most samples
 - Agricultural biomass: slightly higher than specifications in most samples

Minor elements (2)

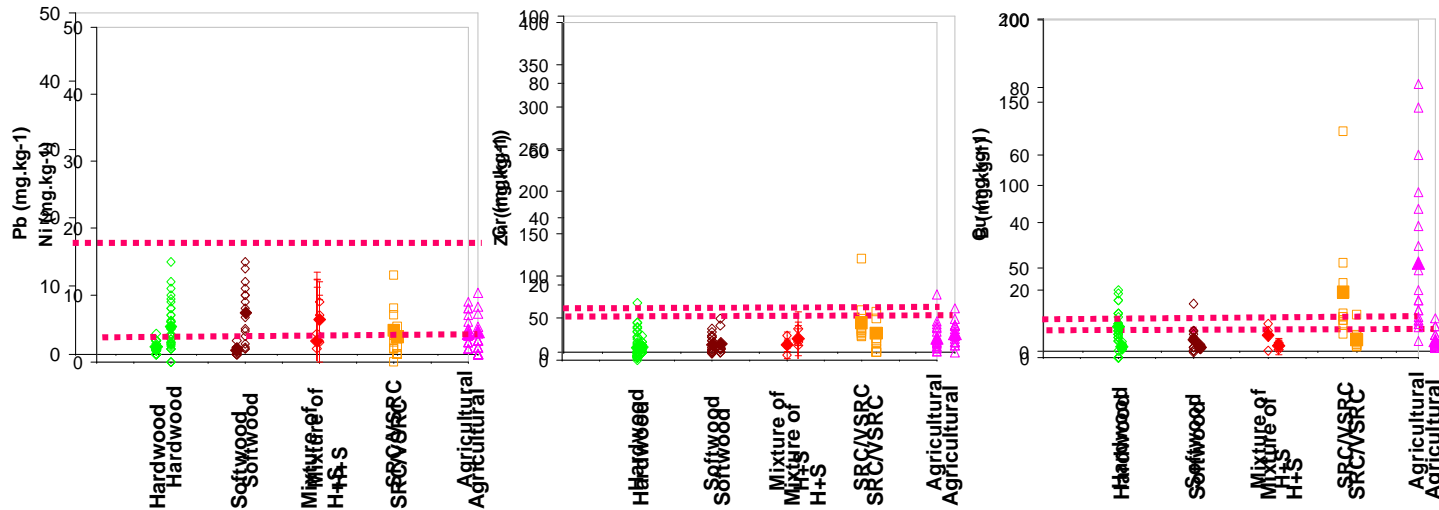


- ◆ **Chlorine:** Strong difference between wood (forestry, VSRC) / agricultural biomass
 - Wood (forestry, VSRC): OK – little variability (50→240 ppm)
 - Agricultural: much higher than specifications in nearly all samples (average: 2500 ppm)
- ◆ **Fluorine:** little variability (about 35 ppm)
 - Very harmful for the process even in low amount

Metals

..... Recommended maximum in process

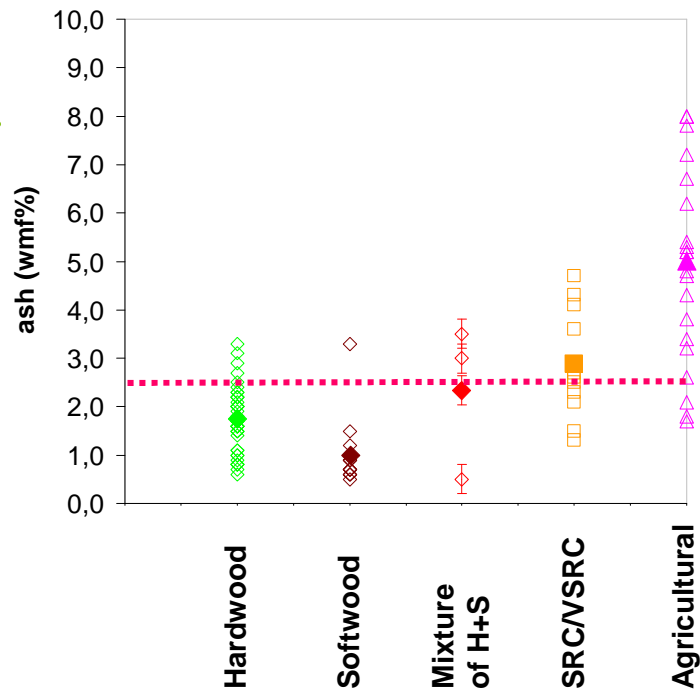
- ◆ **Arsenic, Cadmium, Mercury: below detection limit - OK**



- ◆ **Chromium, Lead, Copper: near measurement uncertainty - OK**
- ◆ **Nickel: Very low amount allowed → Some samples slightly higher than specifications**
- ◆ **Zinc: OK except in poplar from forestry and willow (VSRC)**
- ◆ **Boron: OK – slightly high in some VSRC and agricultural samples**

➔ **Metals content: <100 mg.kg⁻¹ → OK except in a few samples**

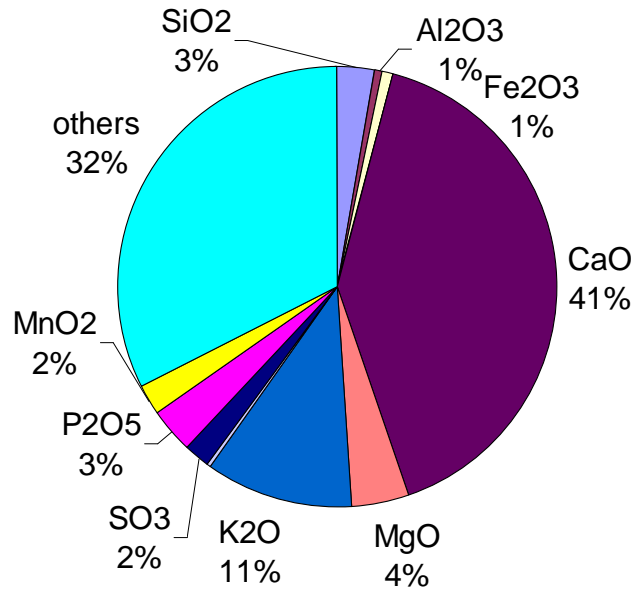
Ash content



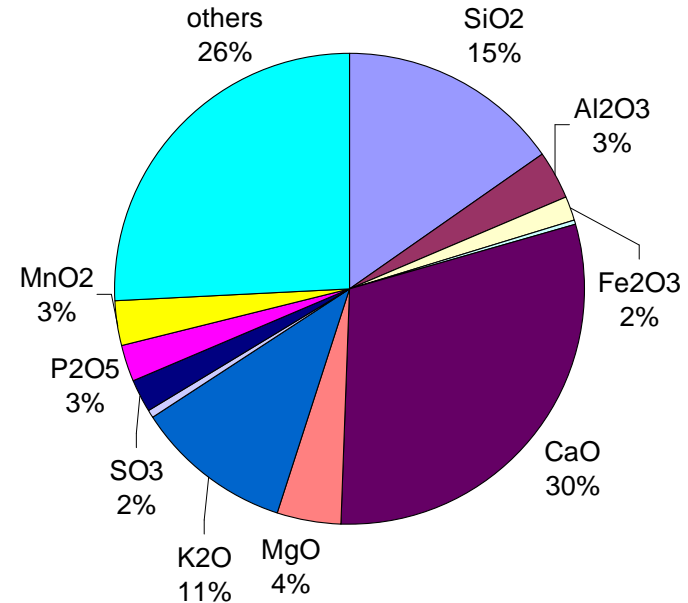
..... Recommended maximum in process

- ◆ Ash (forestry) < ash (VSRC) < ash (agricultural)
- ◆ Forestry wood: OK in nearly all samples (1-2 wmf%)
- ◆ (V)SRC: higher than specifications in most samples (~3 wmf%)
 - Less ash in willow (1.5 w%)
- ◆ Agricultural: higher than specifications in nearly all samples (~5 wmf%)
 - No link between species and ash content
 - Influence of the harvesting modality

Ash composition: woody biomass



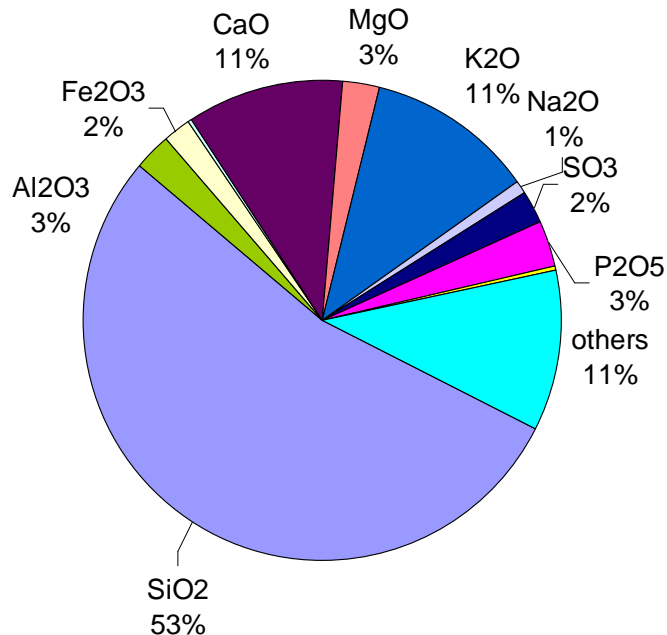
Case 1



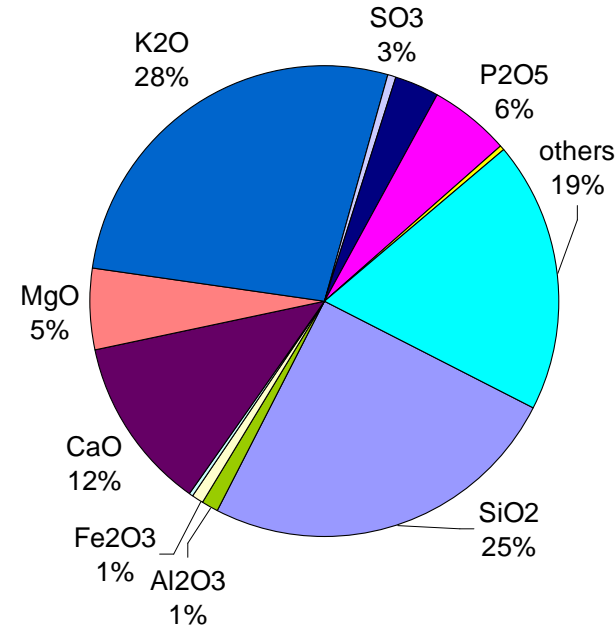
Case 2

- ◆ Little variability – 2 main cases:
 1. Most samples (including (V)SRC): CaO >> K₂O > SiO₂
 2. 1/3 of the samples: CaO > SiO₂ > K₂O
- ◆ CaO tends to increase woody ash melting point

Ash composition: agricultural biomass



Miscanthus, switchgrass,
wheat straw



Other agricultural biomasses
(except rape and alfalfa)

- ◆ Two main families:
 - SiO₂ >> CaO et K₂O
 - SiO₂ = K₂O > CaO
- ◆ SiO₂ and K₂O tend to decrease agricultural biomass ash melting point

Synthesis of the results



- ✓ Good suitability of most properties in all biomasses
- ✓ Little variability inside each family (forestry, (V)SRC, agricultural)

✗ Problematic properties:

- Density: too low in agricultural biomass
- Particle size: too many fines in wood chips
- S, F: too high amount in most samples
- Cl: too high amount in agricultural samples
- Zn, B: slightly too high amount in some samples
- Ash content: slightly too high in VSRC – too high in agricultural
- Ash melting point: linked with ash composition → probably lower for agricultural biomass

Conclusion



♦ Suitability biomass resources / process?

- Wood chips from forestry: the most suitable
 - ➔ Starting feedstock for the process
- Wood chips from (V)SRC: relatively close to wood from forestry
 - ↪ Problematic issue: ash content
 - ➔ Short-term alternative
- Agricultural material: more difficult
 - ↪ Problematic issues: density, CI content, ash content and melting point
 - ➔ Short to mid-term option used in mixture

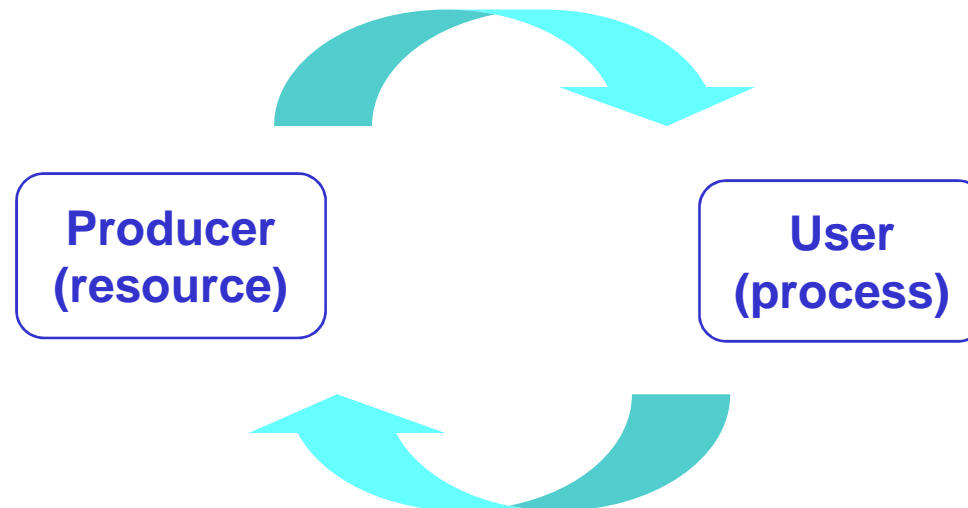
Further work



Biomass quality improvement:

✓ Cultivation method (fertilizer, harvesting date...)

✓ Species



Process flexibility improvement:

✓ Pretreatment (torrefaction, pelletization...)

✓ Use of biomass mixtures



Obrigada !
Thank you !
Merci !

*If you have any questions, please contact:
capucine.dupont@cea.fr*

