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# Energy Valorisation of Grasses by Dry Process



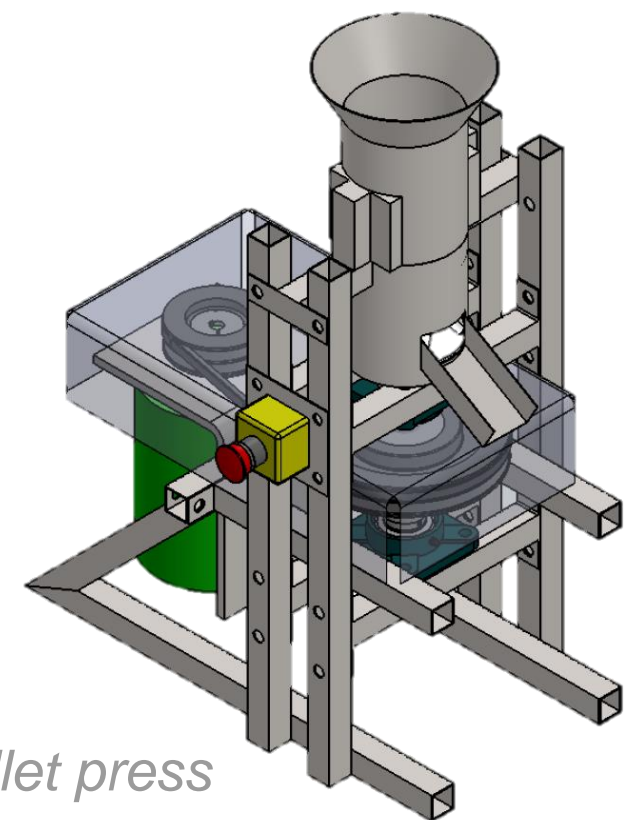
Grass clippings

## 1- Context and aims

- ▶ **A waste** : mainly in Europe grass clippings represent a residues and so cost for disposing.
- ▶ **Conventional valorisation** : leave on lawn, compost or in anaerobic digestion
- ▶ **Aim of the work** : study others ways for energy valorisation by dry processes: **Biomass energy (energy storage) and fuel&char by pyrolysis**

## 2- Challenges :

- ▶ Process for energy storage: dry&shape process
  - **Stabilization of biomass** (short time decomposition <48h) due to the high level of moisture (50-80%)
  - **Obtain a useful shape** : grass clippings have not a helpful shape for storage or process
- ▶ **Best Energy carriers** by dry process : biomass energy VS fuel (gas/liquid) and char
- ▶ **Economic** : low-cost process in energy point of view (energy balance)



Pellet press

## 3a- Materials and methods - Process for energy storage -

- ▶ **Shredders** : improve the moisture diffusion
- ▶ **Pellet** : pellet press developed by Icam (Ø 6mm, L≈15mm)
- ▶ **Log** : hydraulic press logs of grass + starch or paper (Ø 50mm, L=150mm)
- ▶ **Drying** : ambient air/ tower with forced ventilation

## 3b- Materials and methods - Energy valorisation -

- ▶ Calorimetric bomb : PARR model 6200
- ▶ TGA system : SETARAM Setsys-Evo
- ▶ Pyrolyser : batch process developed by Icam
- ▶ Kinetic method : Arrhenius law with FWO model

$$K(T) = A \exp\left(\frac{-E_a}{RT}\right)$$



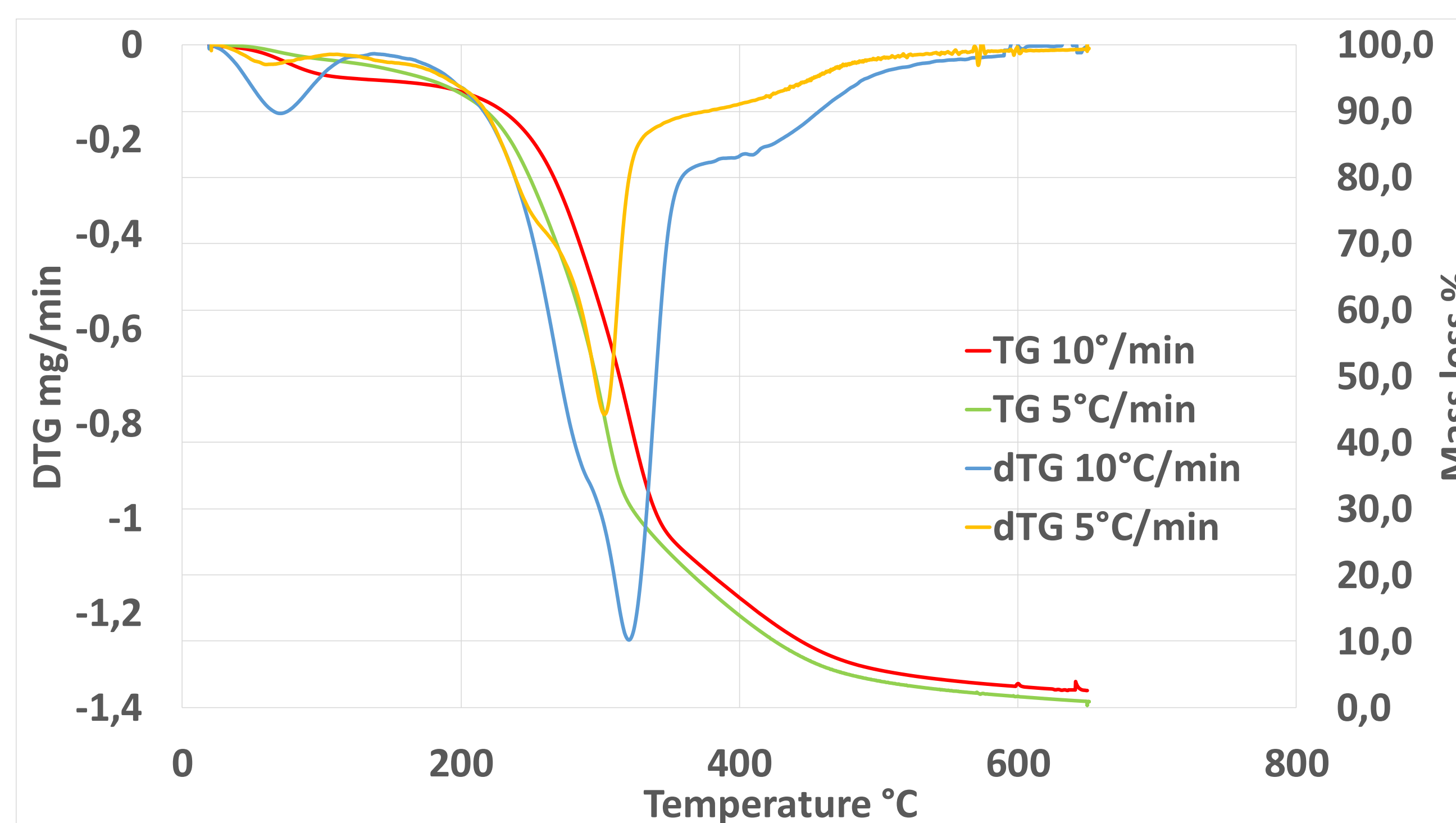
Log of grass



Grass pellets

## 4a- Results - Biomass characteristics, energy potential -

- ▶ **Efficiency** : Ratio between thermal energy of log/pellet prod and energy spent and >15
- ▶ **Mechanic handling** : ok with/without starch, ok with paper (if paper < 4%wt)



Some TGA results

	Grass - this study -	Herbs residues Guo&Al	Douglas wood
%H	50-80	N/A	N/A
LHV (kWh)	4,6	N/A	5,5
C wt%	74	42	48,1
H wt%	6,6	6,2	5,5
O wt%	17,5	47,4	45,8
N wt%	0,4	1,86	0,4
S wt%	1,5	0,15	0
H/C	0,09	0,15	0,11
O/C	0,24	1,13	0,95
Ashes (%)	7,0	10,8	0,25

## 4b- Results : TGA & kinetic results

- ▶ **TGA** : 3 degradation steps :  
200°C to 290°C (a part of) hemicellulose  
300°C to 360°C hemicellulose + cellulose  
360°C to 600°C lignin

### ▶ Kinetic coefficients

	Grass -this study-	Herbs residues Guo&Al
A [s <sup>-1</sup> ]	1,06E+06	1,00E+06
Ea [J/mol]	146	105-130

- ▶ Slow pyrolysis at 600°C :  
Yields: 69% char, 21%liquid,10%gas

## 5- Conclusions and Perspectives

- ▶ **Dry&shape process** defined to stabilize, store and handling for energy storage (thermal energy)
- ▶ **Kinetic degradation studied** : parameters for dry process valorization identified
- ▶ Work in progress : identification of conversion potential into fuel and char by **pyrolysis**

Guo, F., Dong, Y., Lv, Z., Fan, P., Yang, S., and Dong, L. (2015). Pyrolysis kinetics of biomass (herb residue) under isothermal condition in a micro fluidized bed. *Energy Convers. Manag.* 93, 367–376.

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