

# Towards a sustainable biomass market

Hacia un mercado de la biomasa sostenible

Valladolid, October 21<sup>st</sup>, 2014  
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## Session I

"Advances in baling, storage, pelletization and torrefaction  
to increase the competitiveness of bioenergy"

## Sesion I

"Avances en el empacado, almacenado, peletizado y torrefacción  
para aumentar la competitividad de la bioenergía"

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Session I

## El briquetado y el peletizado de cultivos energéticos y otros recursos

Michiel Carbo

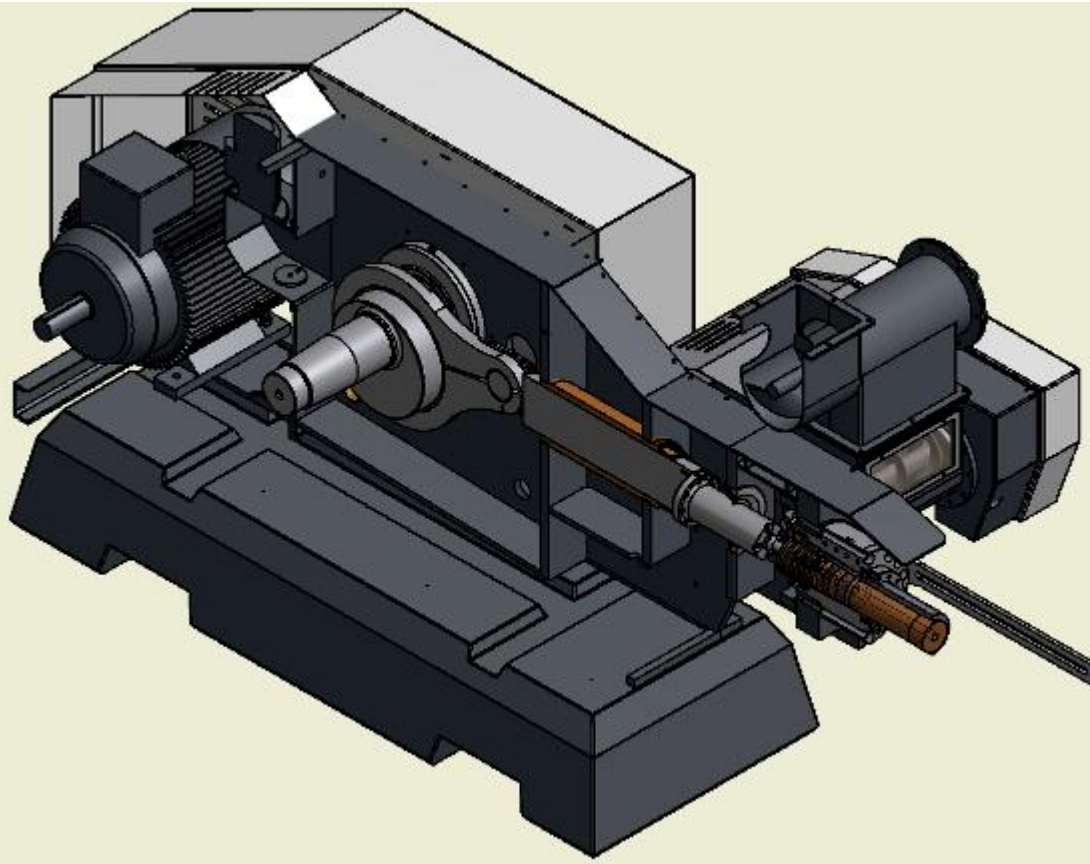
ECN



# Introduction

- Briquetting experiments of raw and torrefied biomass conducted by CF Nielsen in Denmark
- Pelleting experiments of raw biomass conducted by Risø-DTU in Denmark

# Briquetting principle



- High pressure (up to 200 Mpa) reached each time piston strikes
- Heat development occurs because of friction (between 70-150°C)
- Lignin in material reaches softening point and acts as binder
- Mechanical actions on material makes fibers become entangled, adding to cohesion
- Binder typically not necessary for most materials

# Lab-scale press CF Nielsen



- Main motor: 22kW
- Capacity: 200 kg/hour
- Die size: 40 - 50mm in various conicities
- Contents of batch/buffer storage: 400 L
- Physical dimensions (LxHxW): 2.500x2.500x700mm
- Weight: 2.000 kg

# Lab-scale briquetting experiments

- Feedstocks and characteristics

Species	Supplier	Region	Harvest	Moisture content (wt%)	Particle size (mm)	Bulk density (kg/m <sup>3</sup> )
Triticale	CENER	Extremadura, Spain	2013	10.2%	10	100
Sorghum	CENER	Spain	2013	10.2%	8	155
Miscanthus	BP	Burgundy, France	2013	15.0%	10 (CFN)	107
Willow	CRL	Retford, Nottinghamshire, UK	2013	12.0%	10 (CFN)	125

# Lab-scale briquetting experiments

- Results

Species	Die temperature (°C)	Die size (mm)	Capacity setpoint (kg/h)	Capacity measured (kg/h)	Power consumption main motor	Briquet density (kg/m <sup>3</sup> )
Triticale	95	50	150	120	26A = 15 kW	1085
Triticale	105	50	150	120	23A = 13 kW	1018
Sorghum	100	50	200	120	38A = 21 kW	1097
Miscanthus	80	50	150	102	23A = 13 kW	969
Miscanthus	100	50	150	102	21A = 12kW	931
Willow	80	50	150	126	35A = 19 kW	1152
Willow	100	50	150	126	31A = 17 kW	1133



# Lab-scale briquetting experiments





# Lab-scale briquetting experiments

- Die temperature influences:
  - Briquette quality; Lower temperature generally creates more friction and increased backpressure during densification, leading to higher density
  - Logistics costs for the finished product; Lower temperature usually results in higher density
  - Power consumption; Higher temperature usually leads to lower power consumption
- Depending on distance between briquetting plant and end user, transport costs may be of a larger importance than power consumption for production.
- Optimum conditions should be determined for each individual case, comparing additional production costs with savings on logistics

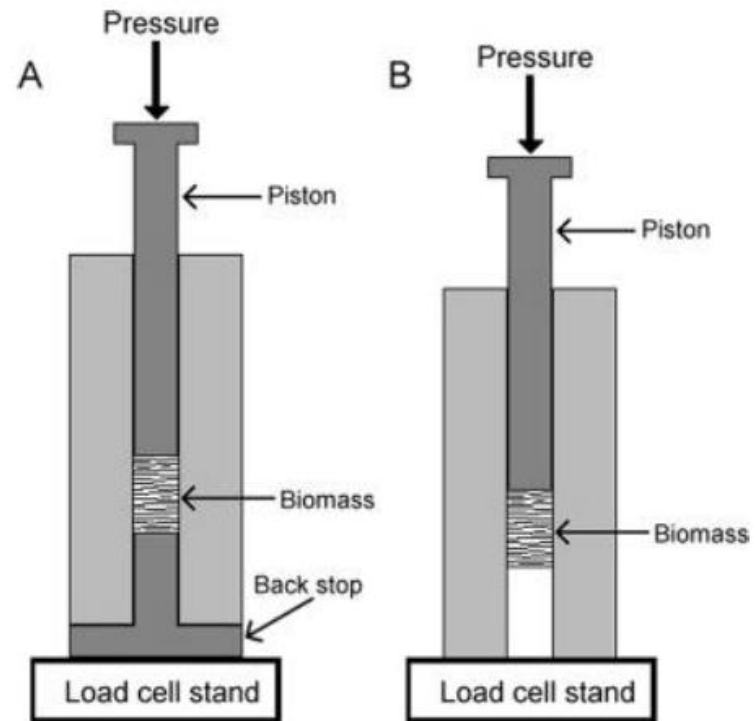
# Lab-scale pelleting experiments

- Feedstocks and characteristics

Species	Supplier	Region	Harvest	Moisture content (wt%)	Single pellet press	Bench-scale press
Triticale	CENER	Extremadura, Spain	2013	10.0%	x	x
Fescue	INRA	Versailles, France	2013	9.0%	x	x
Alfalfa	INRA	Versailles, France	2013	9.0%	x	
Sorghum	INRA	Versailles, France	2013	10.0%	x	
Miscanthus	BP	Burgundy, France	2013	15.0%	x	
Green miscanthus	RRes	Woburn, Bedfordshire, UK	2013	50.0%	x	X
Willow	CRL	Retford, Nottinghamshire, UK	2013	12.0%	X	

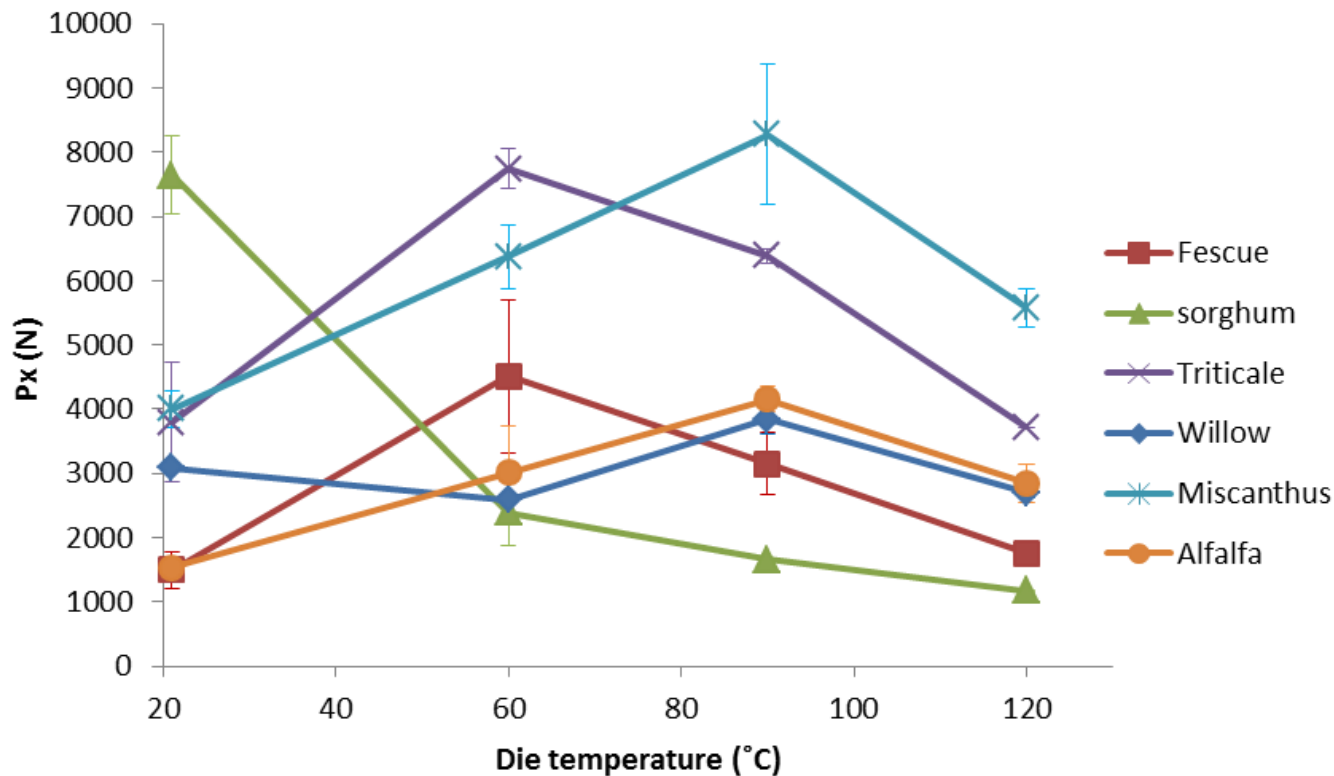
# Lab-scale pelleting experiments

- Single pellet press:



# Lab-scale pelleting experiments

- Static friction single pellet press as function of die temperature



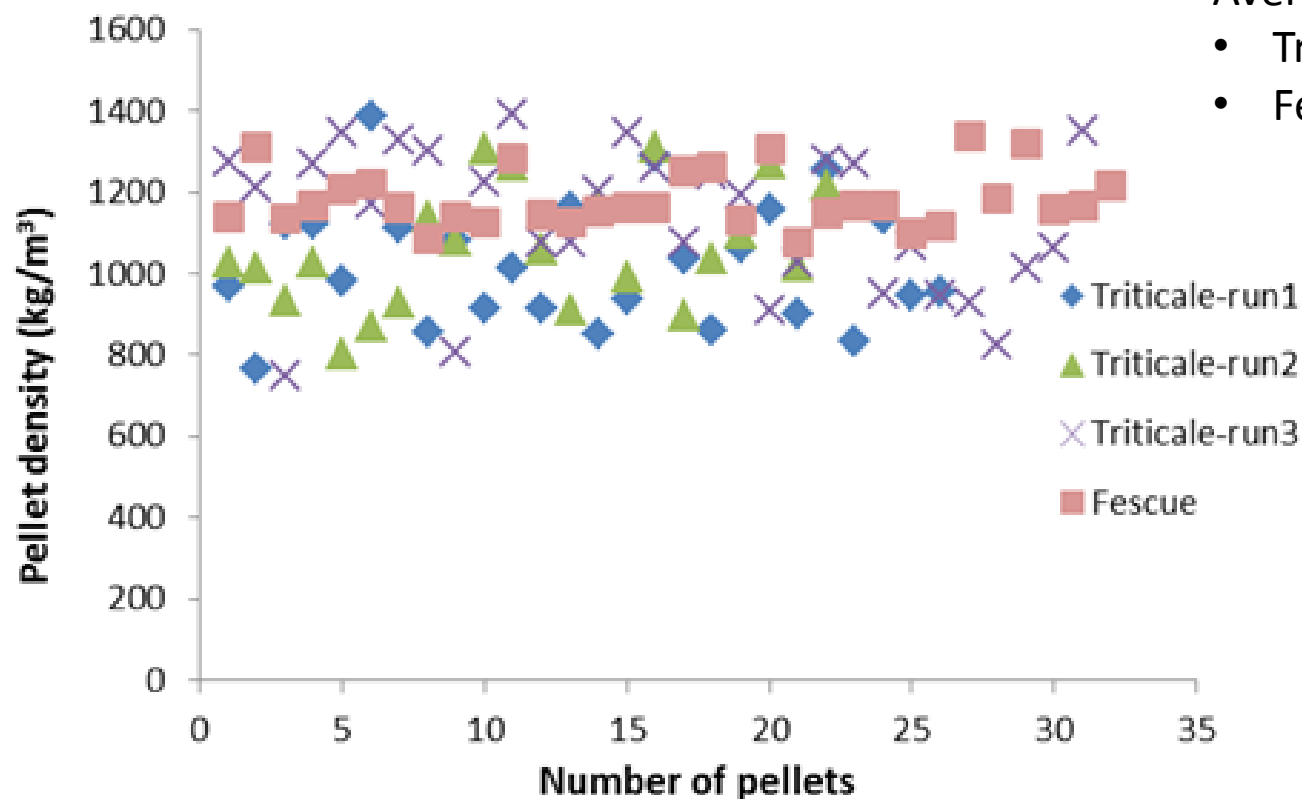
# Lab-scale pelleting experiments

- Bench-scale ring die press



# Lab-scale pelleting experiments

- Individual pellet density bench-scale press





# Lab-scale pelleting experiments

- Bench-scale press pellets, triticale (left) and fescue (right)



# Thank you :: Gracias

- Michiel Carbo
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