Linking technology development to the market – what are the (R&D) needs in the immediate term

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Linking technology development to the market – what are the (R&D) needs in the immediate term

Black is the colour: thermally treated biomass and its role in our future energy mix

Pre-conference workshop AEBIOM European Bioenergy Conference

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Two main questions

- What is hampering the commercial market introduction of thermally treated biomass?
- Based on that: what are the main R&D needs (in the immediate term)?
- Focus on torrefaction

Basic drivers for torrefaction still hold (1)

- Biomass is a difficult energy source in view of:
  - Logistics (handling, transport and feeding)
  - End-use (combustion, gasification, chemical processing)

- Difficult properties are:
  - Low energy density (LHV_{ar} = 10-17 MJ/kg)
  - Hydrophilic
  - Vulnerable to biodegradation
  - Tenacious and fibrous (grinding difficult)
  - Poor "flowability"
  - Heterogeneous

Basic drivers for torrefaction still hold (2)

- Biomass upgrading enables decoupling of biomass production and use in:
  - Place
  - Time
  - Scale

- By converting biomass into high-quality bioenergy carriers (solid, liquid or gas), that:
  - Better fit in (existing) logistic infrastructures
  - Allow efficient, reliable and cost effective conversion into electricity and heat, transport fuels and chemicals

Solve biomass related problems at the source

Basic drivers for torrefaction still hold (3)

	Wood chips	Wood pellets	Torrefied wood pellets	Charcoal	Coal
Moisture content (wt%)	30 – 55	7 – 10	1 – 5	1 – 5	10 – 15
Calorific value (LHV, MJ/kg)	7 – 12	15 – 17	18 – 24	30 – 32	23 – 28
Volatile matter (wt% db)	75 – 85	75 – 85	55 – 80	10 – 12	15 – 30
Fixed carbon (wt% db)	16 – 25	16 – 25	20 – 40	85 – 87	50 – 55
Bulk density (kg/l)	0.20 – 0.30	0.55 – 0.65	0.65 – 0.80	0.18 – 0.24	0.80 – 0.85
Vol. energy density (GJ/m^3)	1.4 – 3.6	8 – 11	12 – 19	5.4 – 7.7	18 – 24
Hygroscopic properties	Hydrophilic	Hydrophilic	(Moderately) Hydrophobic	Hydrophobic	Hydrophobic
Biological degradation	Fast	Moderate	Slow	None	None
Milling requirements	Special	Special	Standard	Standard	Standard
Product consistency	Limited	High	High	High	High
Transport cost	High	Medium	Low	Medium	Low

Abbreviations:
db = dry basis
LHV =Lower Heating Value

sources: ECN (table, fig.1, 3), Pixelio (fig. 2, 5), ofi (fig. 4)





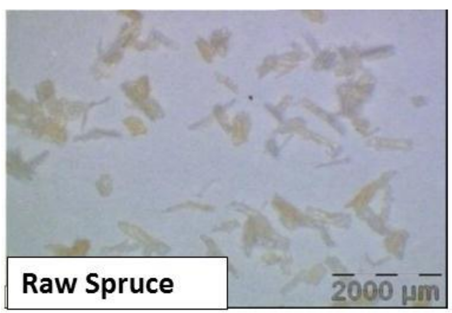
What is hampering the commercial market introduction of torrefied biomass?

ECN

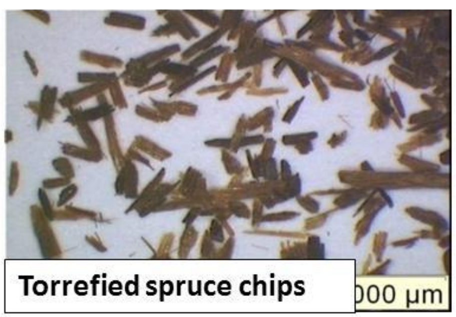
- More restricted financing possibilities following the economic crisis
- Launching end-user market (co-firing in pulverised-coal-fired utility power plants in Europe) is facing difficult times
- It takes time and effort to build end-user confidence and have torrefied biomass accepted as a commodity that can be traded (internationally)
- Initial expectations were set too high which led to disappointment
- Biomass in general is under debate and opinions on biomass use are changing
- ……..

Launching end-user market (co-firing in Europe) is facing difficult times

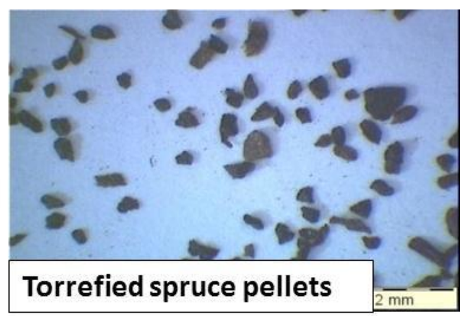
- NL Energy Agreement includes max. 25 PJe/year co-firing, providing an opportunity for torrefied biomass
- Also still possibilities in other European countries (e.g. Finland)
- Potential for co-firing in other parts of the world (e.g., Asia, North America)
- Torrefaction enabling technology for (dry feed) entrained-flow gasification of biomass
- Smaller-scale applications, such as industrial Heat (and Power), may provide easier launching markets as the scale better fits the scale of torrefaction production units



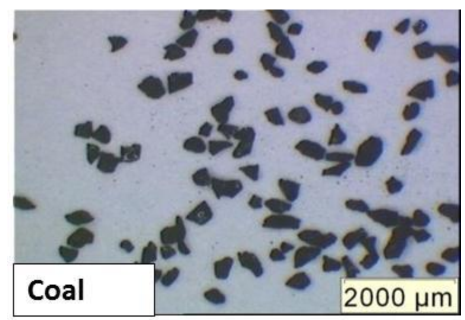
Raw Spruce



Torrefied spruce chips



Torrefied spruce pellets



Coal

Successful co-firing trials help to build end-user confidence and allow product quality optimisation

- Torrefaction technology in demonstration phase with >10 demo-units and first (semi-)commercial units in operation (e.g., Torr-Coal)

- Successful co-firing trials, e.g.:
  - Buggenum IGCC (NUON, 2012)
    - 1200 ton pellets
    - Co-milling
    - Up to 70% co-firing
  - Amer 9 (Essent, end of 2013)
    - 2300 tonne Topell pellets
    - 5-25% co-milling
    - 1-4% co-firing
  - Studstrup 3 (DONG, March 2014)
    - 200 tonne Andritz pellets
    - Dedicated mill
    - 33% co-firing
  - Helsingin Energia Hanasaaren (March 2014)
    - 140 tonne Torr-Coal pellets
    - 14% co-firing

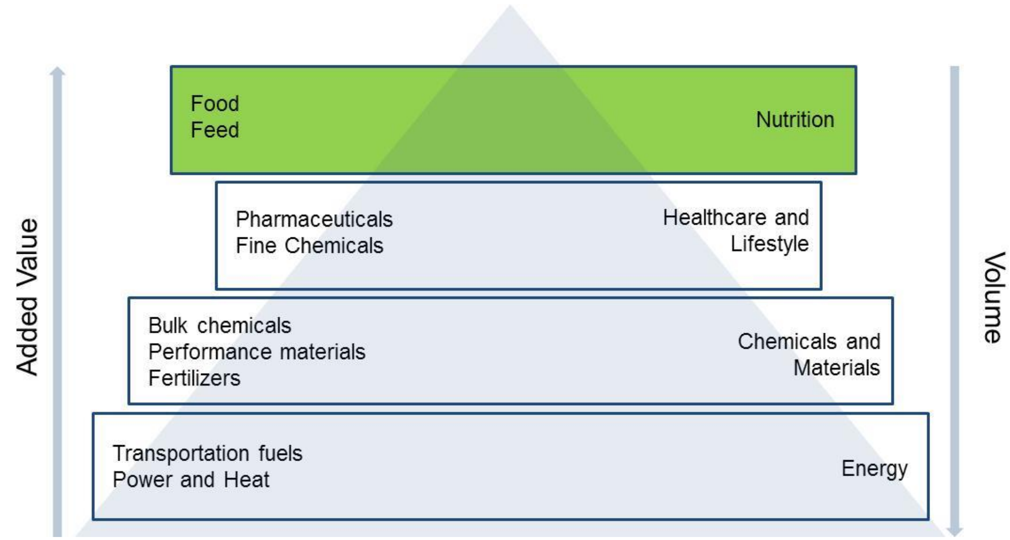
Initial expectations were set too high which led to disappointment

- Initial expectation based on small samples, not on industrial production
- One has to be convincing to get something going
- Instead of yielding immediately *the* ideal feedstock, torrefied biomass pellets development has to follow a learning curve, just as with white wood pellets
- High initial expectations hold in particular for hydrophobicity

Biomass under debate

Biomass use – markets and preferred options

- Shift from focus on bioenergy to focus on biobased economy
- Use C and molecular capital
- Aim for maximum added value



- But:
  - Energy sector more than an order of magnitude larger than chemical sector We need all renewable energy options, we cannot exclude major ones
  - There is enough sustainable biomass to make biomass a major renewable energy option (1/4 – 1/3 of future global energy use)
  - Some parts of the energy sector difficult to cover with other renewables (e.g., HT process heat, biofuels for heavy vehicles, aviation and marine applications)
  - Not all biomass qualifies for high-value applications (e.g., heterogeneous and/or contaminated streams)

What are the main R&D needs (in the immediate term)?

- (Continued technology optimisation, scale-up and cost reduction)
- Product quality characterisation, optimisation and standardisation
  - Address torrefaction *and* densification
  - Guarantee health and safety (e.g., MSDS, REACH-registration)
  - Meet logistics and end-user requirements for a range of applications
  - Facilitate (international) trading (commodity)
- Independent assessment (technology, cost, LCA)
- Broadening the feedstock base
  - Wood residues
  - Lower-quality biomass (e.g., agroresidues, SRF)
- Torrefaction as part of co-production schemes for bioenergy carriers and high added value products

The SECTOR project

- Collaborative project: SECTOR
- Project start: 01.01.2012
- Duration: 42 months
- Total budget: 10 Mio. Euro
- Participants: 21 from 9 EU-countries
- Coordinator: DBFZ

www.sector-project.eu

This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement n° 282826

Densification: Pilot-scale tests (CENER)

Date	Durability	Pine
October 2012	88.8	
January 2013	92.3	
June 2013	94.7	
November 2013	95.7	

Date	Durability	Straw
February 2013	84.2	
September 2013	94.3	
October 2013	96.6	
November 2013	97.6	

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Logistics: Outdoor storage and handling tests (EON)

Two outdoor storage piles built in June 2013

Peaked-topped pile

- Model the formation of piles after it has been delivered
- 4 tonnes
- 2.34 x 2.36 x 1.5 m^3

Flat-topped pile

- Model the formation of piles after compaction (though no compaction occurred)
- 3 tonnes
- 2.34 x 2.36 x 1.5 m^3

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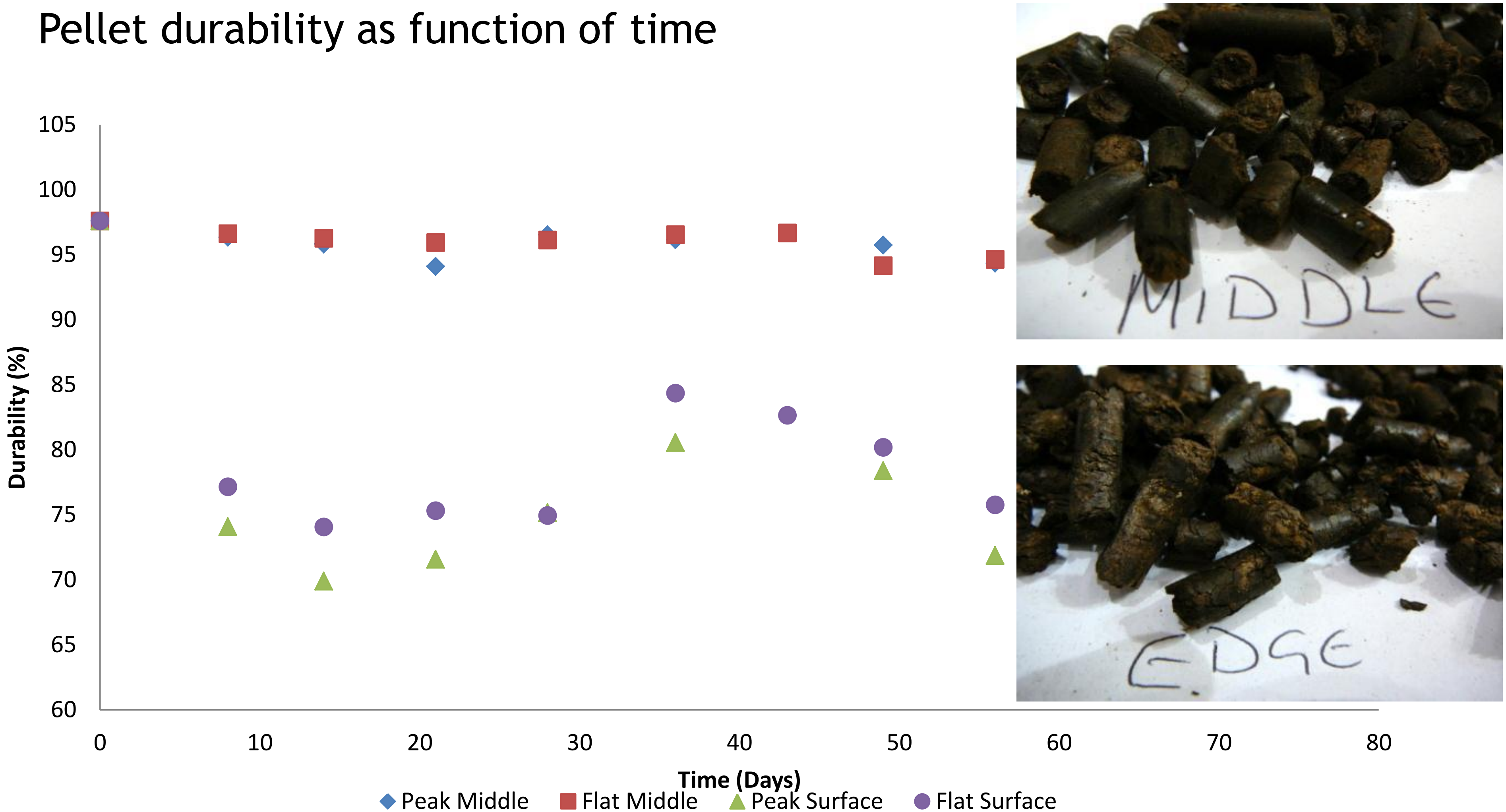
Logistics: Outdoor storage and handling tests (EON)

- Pellet durability as function of time



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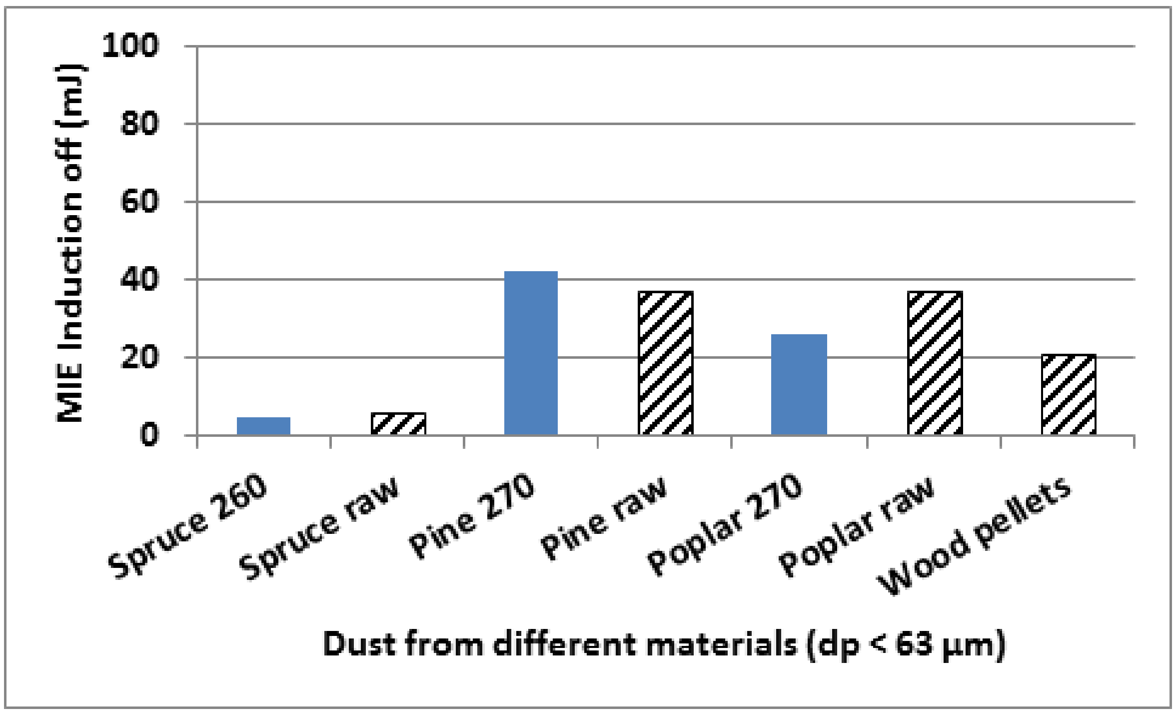
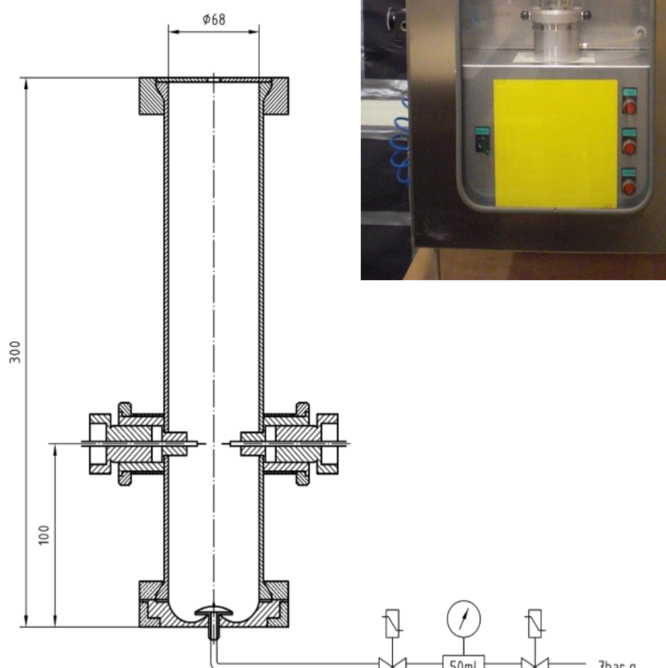
Explosivity

Risks with/without torrefaction are comparable

- **Explosivity MIE**: modified Hartmann tube, as the explosion vessel, and following the European Standard EN 13821:2002

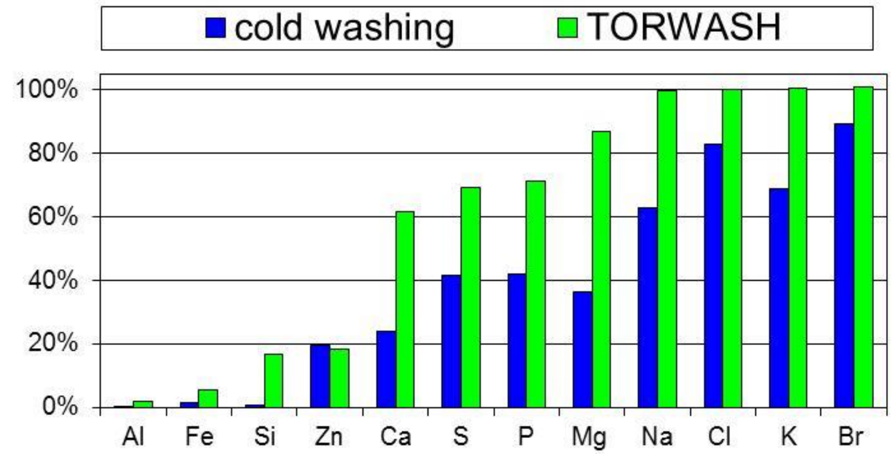




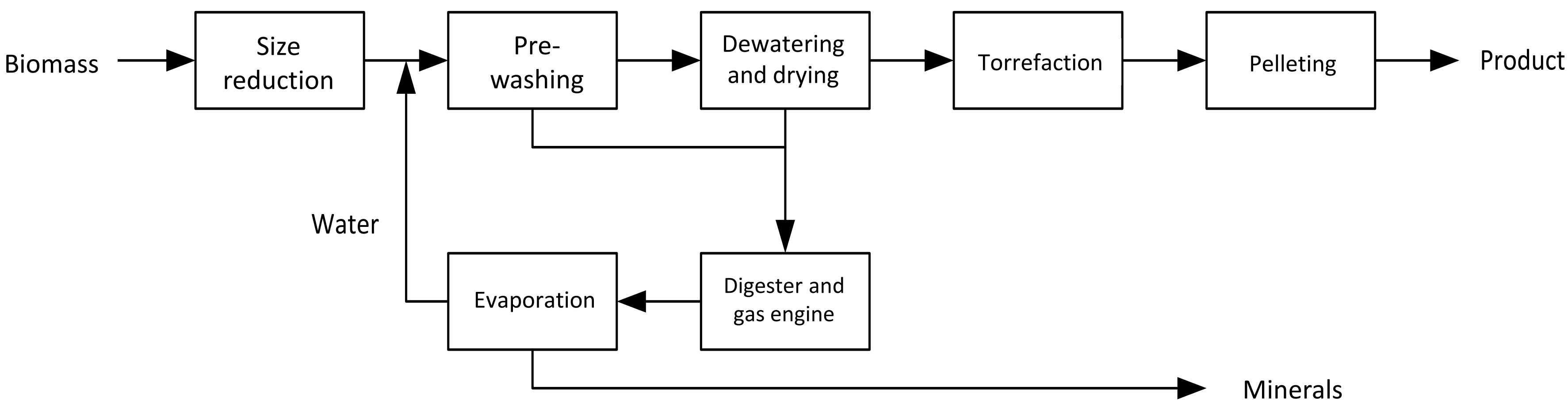
Torrefaction + washing (and drying)

Efficient removal of mineral components

- Pre-washing + dry torrefaction
- Dry torrefaction + post-washing
- TORWASH (wet torrefaction)

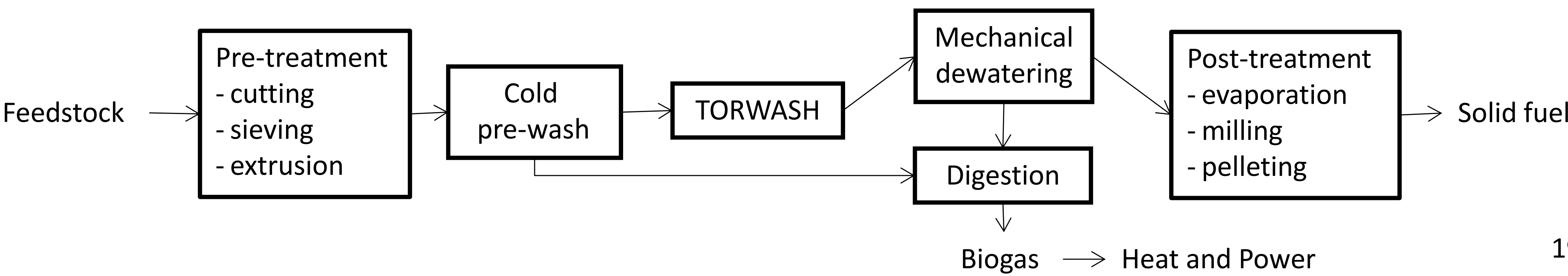


Removal fractions for batch washing of hay



TORWASH (Wet torrefaction)

- Combines:
  - Torrefaction
  - Salt removal (>90%)
  - Dewatering
- Aim: maximum energy recovery in the form of solid residues
- Product: torrefied fuel pellets or briquettes
- By-product: biogas
- Optional: nutrient separation



Summary conclusions

- Torrefaction technology is ready for commercial market introduction and the basic drivers for torrefaction still hold
- But several factors hamper this introduction, including:
  - European utility sector is facing difficult times – co-firing perhaps not the best launching end-user market (also in view of scale) – smaller-scale industrial or district heat better option?
  - It takes time and effort to build end-user confidence
  - Instead of yielding immediately *the* ideal feedstock, torrefied biomass pellets development has to follow a learning curve, just as with white wood pellets
  - Biomass in general is under debate and opinions on biomass use are changing
- However, many constructive and successful efforts (e.g., in the EU-SECTOR project) have been made to remove the barriers for market introduction
- R&D to further improve torrefaction-based biomass upgrading should focus on:
  - Product quality characterisation, optimisation and standardisation (addressing torrefaction *and* densification)
  - Broadening the feedstock base (including lower-quality biomass (e.g., agroresidues, SRF))
  - Torrefaction as part of co-production schemes for bioenergy carriers and high added value products

Thank you for your attention!

Production at ECN of tonne-scale test batches for industrial trials

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