Latvia University of Agriculture
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COMPACTING OF HERBACEOUS BIOMASS PARTICLES FOR SOLID BIOFUEL

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INTRODUCTION

European Union energy policy determines the aim to increase using of renewable energy resources providing independence from imported energy and reduction of fossil fuel use.

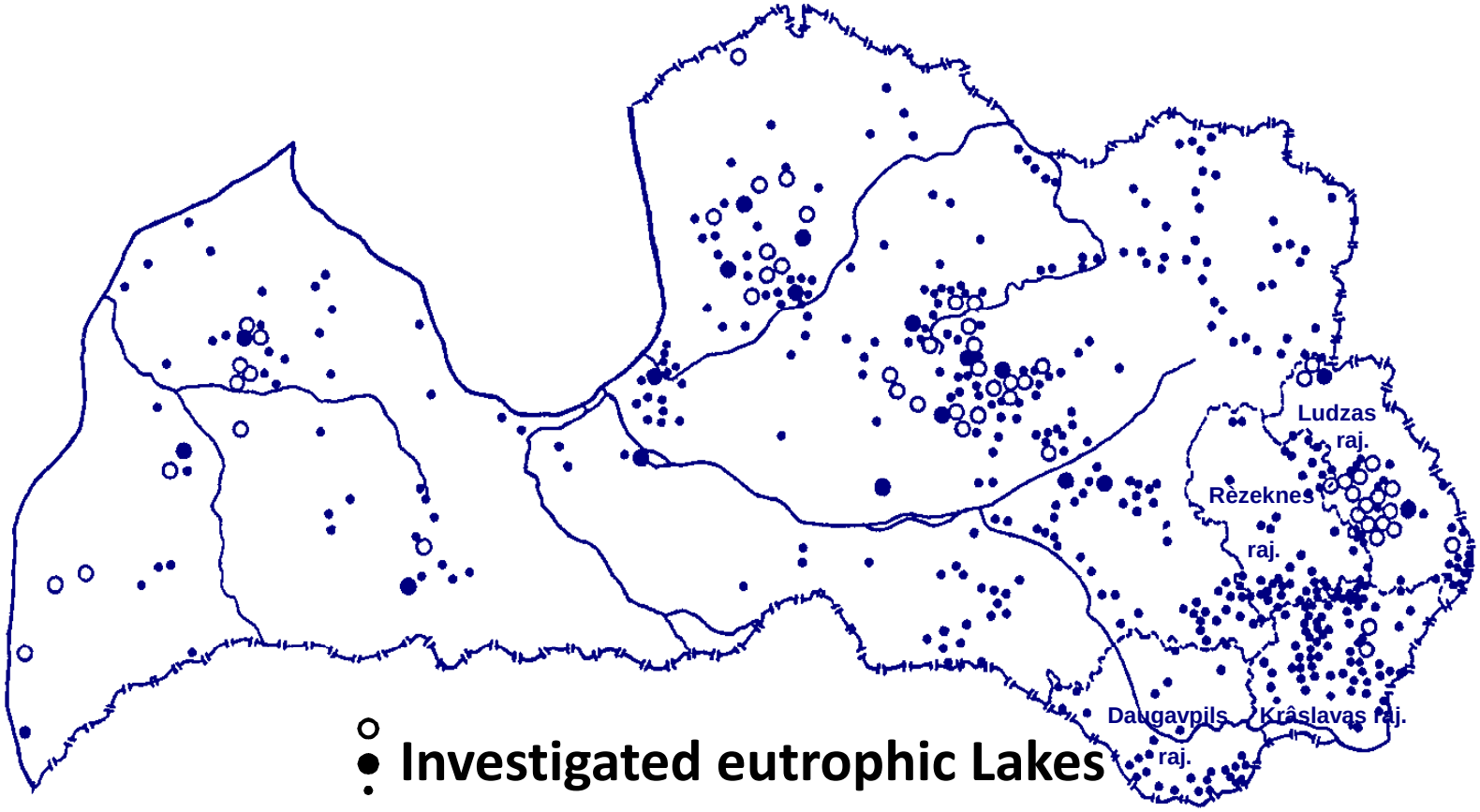
Substitution of fossil feedstock for energy by biomass is important measure also for greenhouse gas (GHG) emission mitigation.

Latvia has target in 2020 for renewable energy resources to be 40% in gross final consumption of energy. In Latvia approximately of 14.6% of unfarmed agricultural land can be used for herbaceous energy crop growing

Harvested energy crop stalk biomass is material of low bulk density (60 – 80 kg m^{-3}), therefore compacting of biomass is one of the important processes for effective handling, transport and storage of this biomass fuel material.

Resources OF COMMON REEDS

Common reeds are important natural biomass resource, because there are more than 2000 lakes with shorelines overgrown by common reeds in Latvia.



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Resources OF COMMON REEDS

Common reed field on shore line of Lake

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PURPOSE OF WORK

The aim of herbaceous biomass compacting characteristics investigation is to find necessary size reduction in shredding and compacting energy evaluation.

Materials and methods

- **Common reed biomass particless were used as energy crop representative material for compacting exsperiments.**

- **Compacting experiments had been carried out in closed die with diameter 35 mm by means of laboratory hydraulic press equipment.**

- **Maximum pressure of compacting was 212 MPa.**

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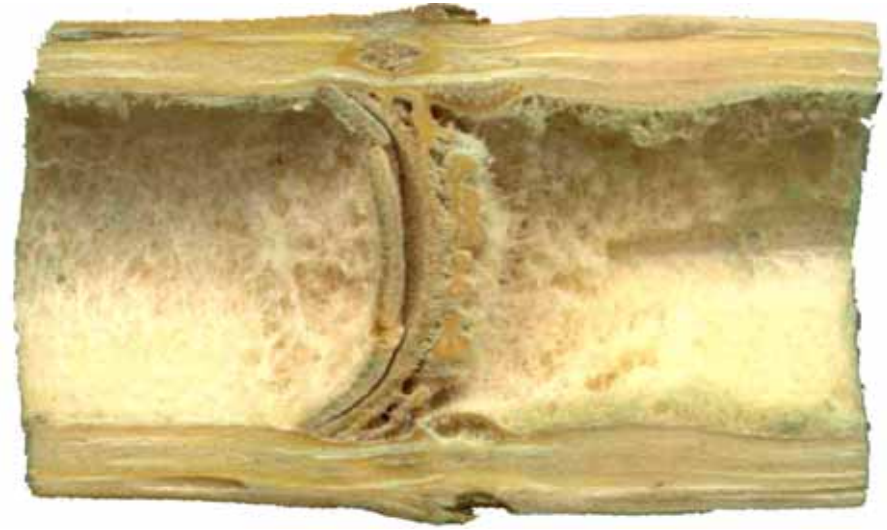
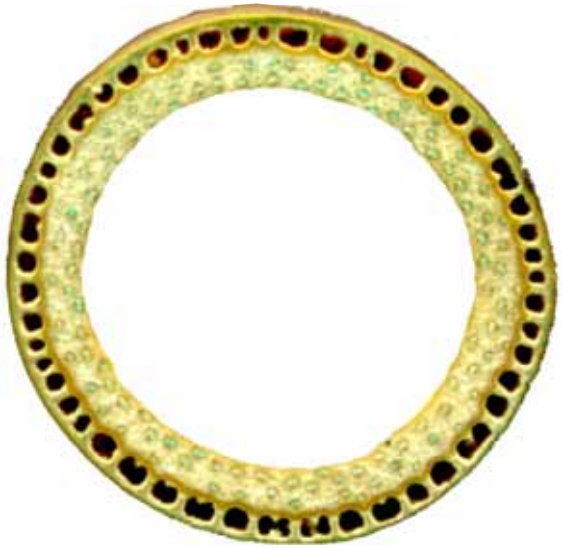
Materials and methods

- For displacement measurement was used displacement transducer, for force measurement force sensor and for data collection – Pico Data Logger.
- Chopped common reeds particles dosage for every briquette pressing was 35 grams.
- Material moisture content – 8 % (standard BS EN 14774-2:2009).
- Particle size of chopped common reeds was determined from sieve analysis: < 0.5; 1 – 2; 3 – 4; 5 – 6; 7 – 8; 12 – 13; 22 – 23; 32 – 33 mm.
- Electronic scales *Sartorius GM312* with division 0.01 g and sliding calipers (division 0.1 mm) for briquette density determination.

COMMON REEDS CHARACTERISTICS

Common reeds stalk material ultimate tensile strength is 330 ± 29 N mm^{-2}. As common reed are the strongest stalk material between other energy crops, they can be used as representative energy crop in investigations of mechanical properties.





Cross section of reed stalks shows it complicated structure

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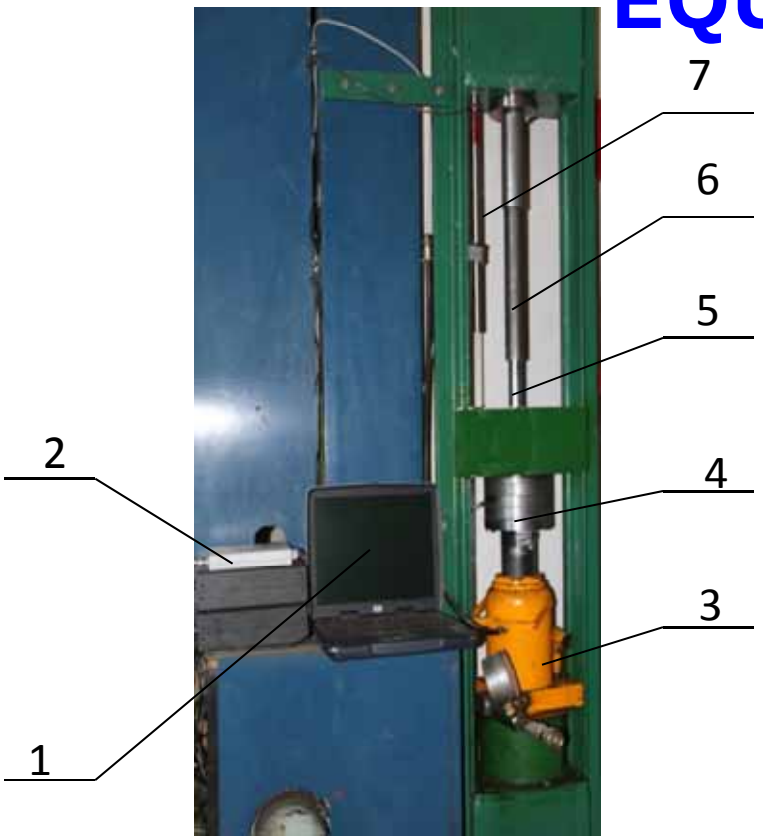
LABORATORY HYDRAULIC PRESS EQUIPMENT



1 – computer; 2 – Pico Data Logger; 3 – hydraulic press; 4 – force measurement sensor; 5 – piston; 6 – cylindrical die; 7 – displacement transducer

Common reed briquettes

Material < 5 mm

Material 1 - 2 mm

Material 3 - 4 mm

Material 5 - 6 mm

Material 7 - 8 mm

Material 12 - 13 mm

Material 22 - 23 mm

Material 32 - 33 mm

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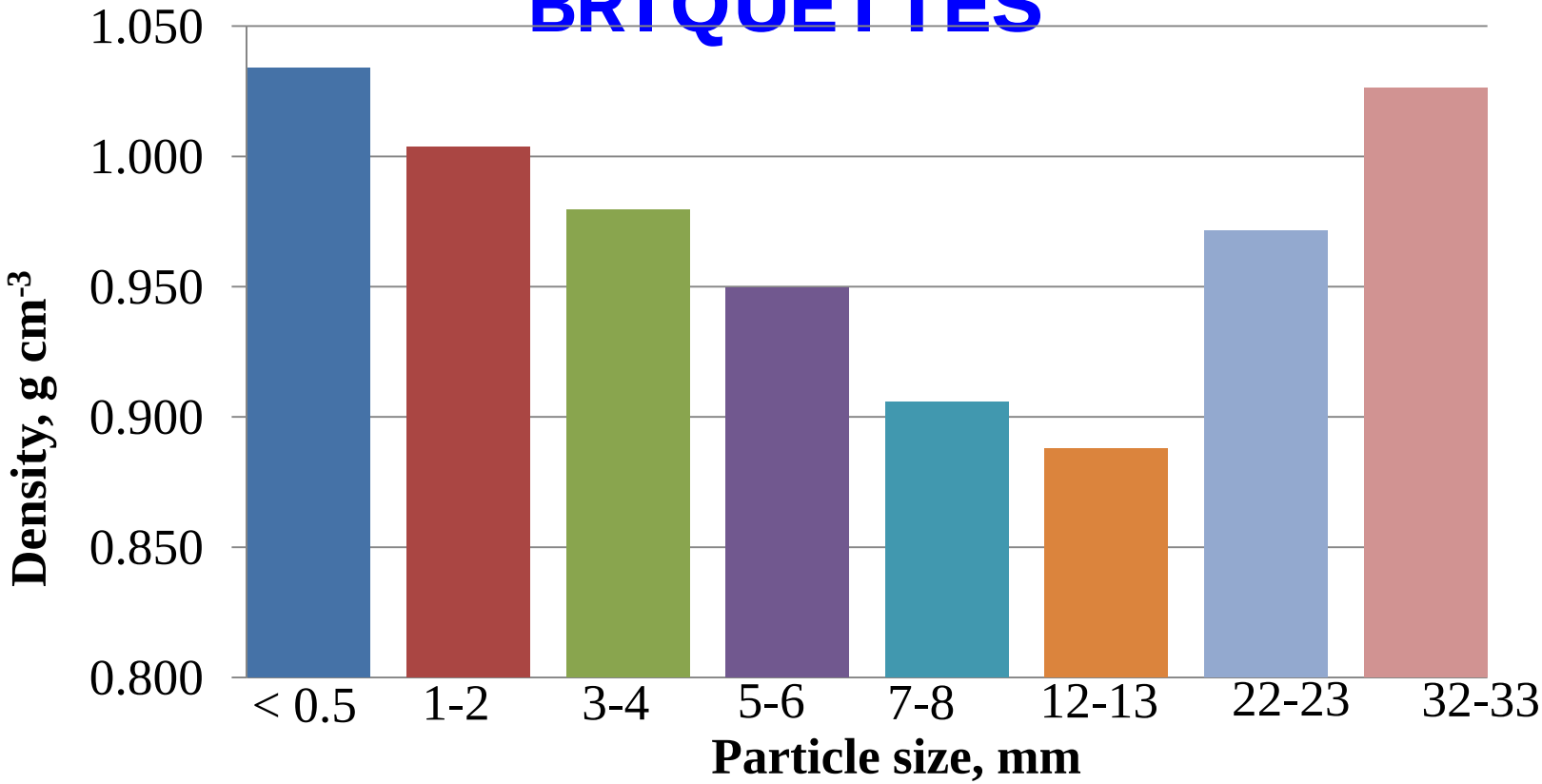
DENSITY OF COMMON REED BRIQUETTES



The minimum of density 0.87 g cm^{-3} have briquettes with particle size 12 – 13 mm, but maximum density 1.03 – 1.04 g cm^{-3} two particle sizes less than 0.5 mm and 32 – 33 mm briquettes.

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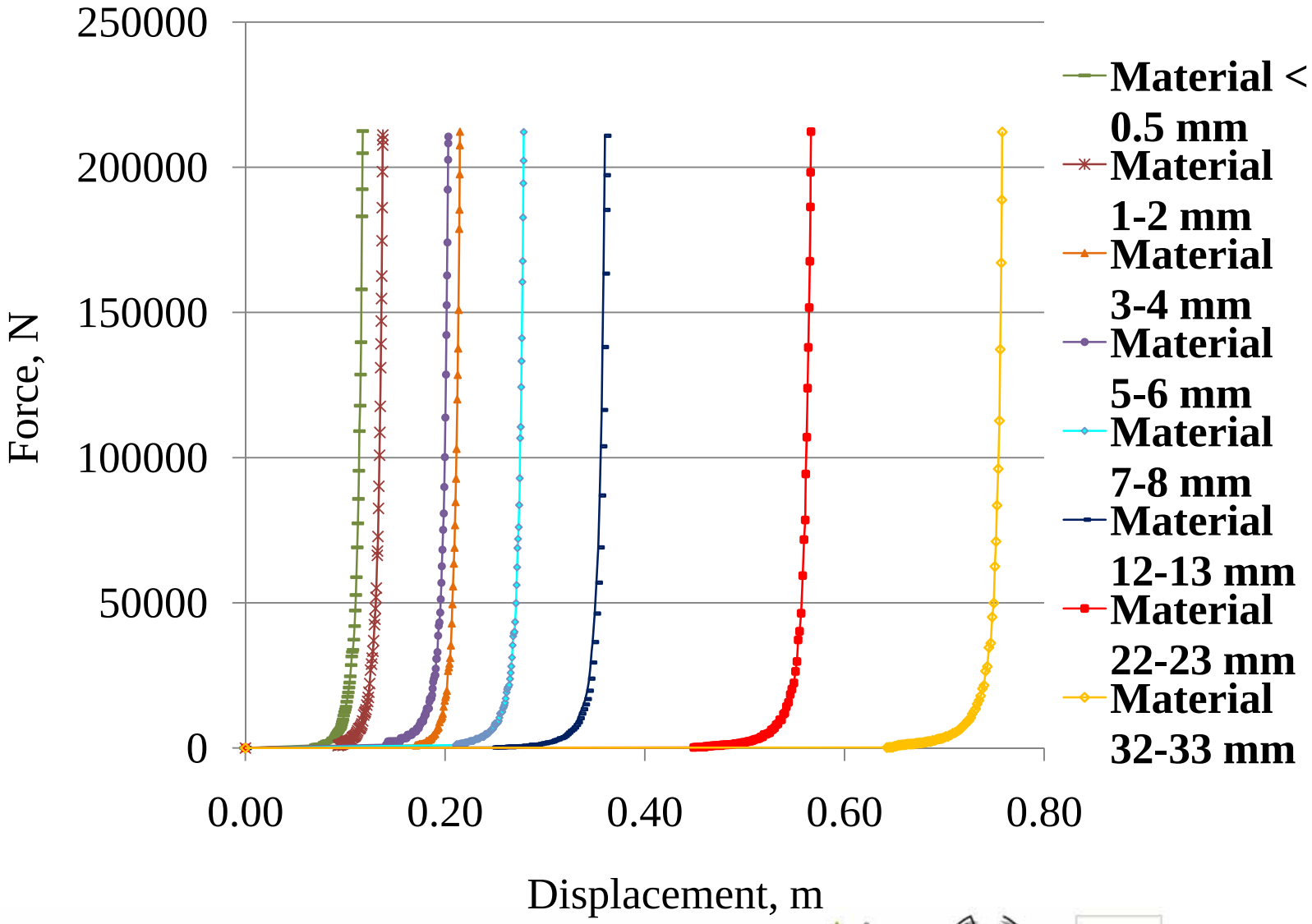
FORCE – DISPLACEMENT CHARACTERISTICS OF COMPACTING



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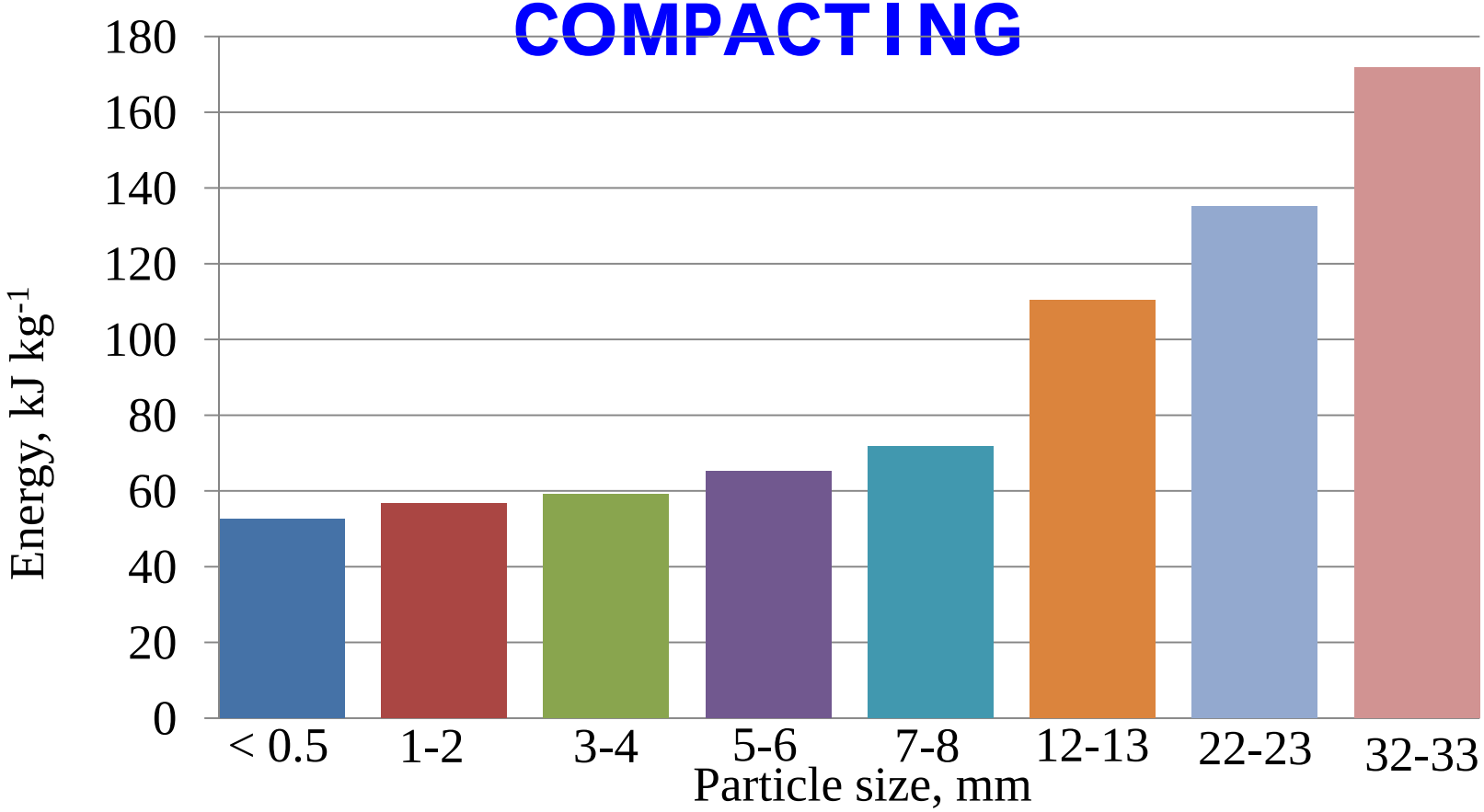
SPECIFFIC ENERGY CONSUMPTION OF COMPACTING



Briquetting of reed particles with size 32 – 33 mm have maximum value 172 kJ kg^{-1} but briguetting of particles with size less than 0.5 mm have minimum value 53 kJ kg^{-1}.

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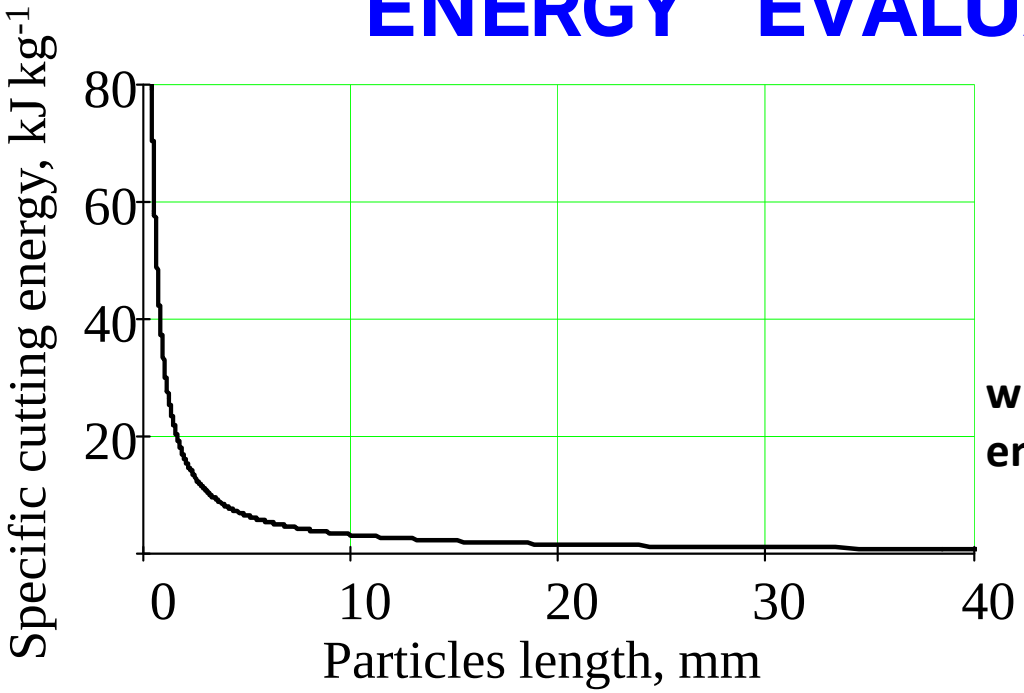
SPECIFFIC CUTTING AND COMPACTING ENERGY EVALUATION



$$E_c = \frac{E_{sc}}{l\rho}$$

where E_{sc} – speciffic cutting energy, per unit area, J m^{-2};
l – particles lenght, m;
ρ – material density, kg m^{-3}.

Comparing specific cutting energy and specific compacting energy results show that total energy consumption is 62 kJ kg^{-1} for particle size less than 0.5 mm and 1 kJ kg^{-1} for particle size 32 – 33 mm. The difference is 61 kJ kg^{-1}.

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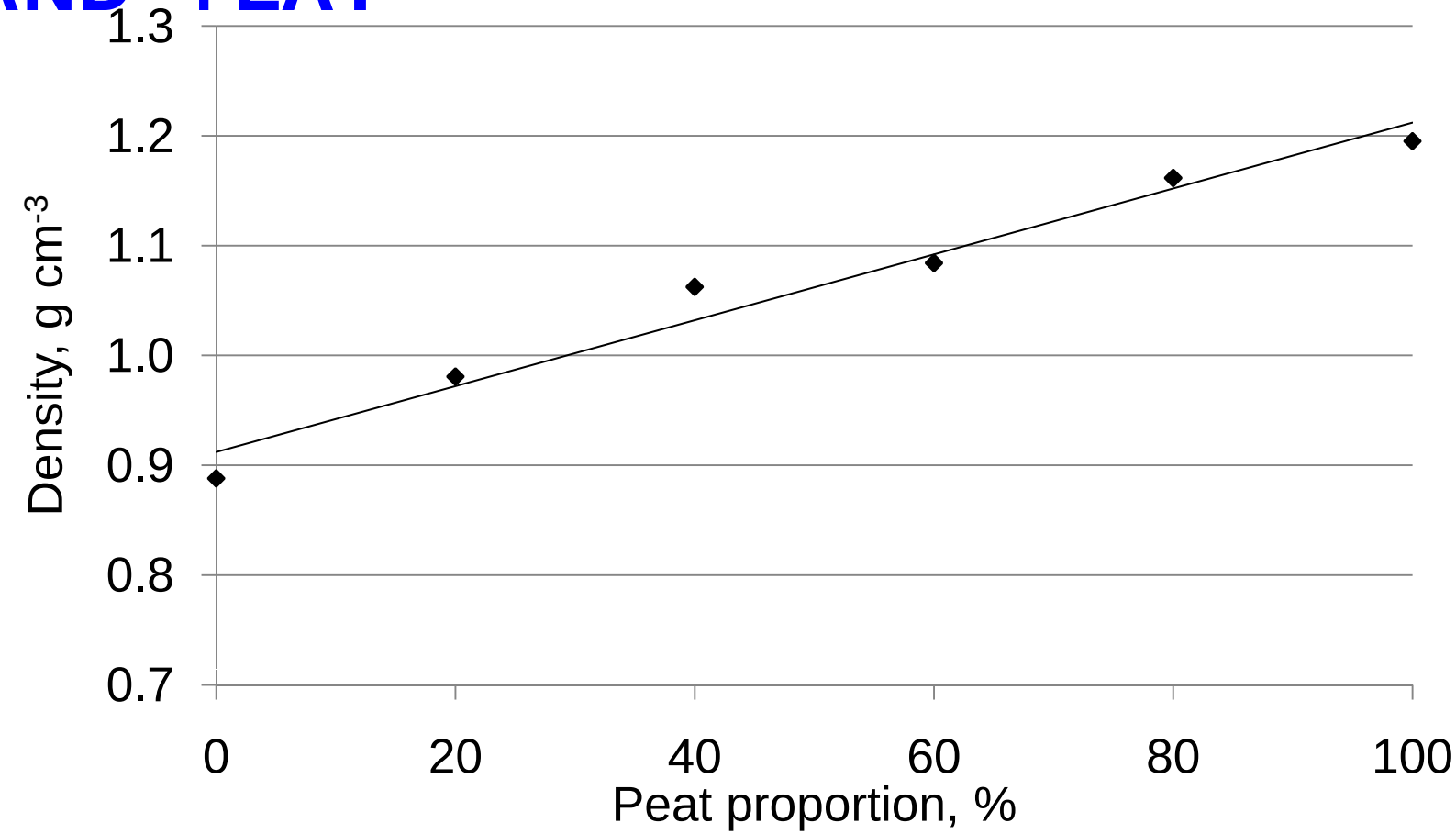
Density of reed particles (12 – 13 Mm) AND PEAT



Peat additive > 30% can be used for increasing the density of briquettes > 1 g cm^{-3}.

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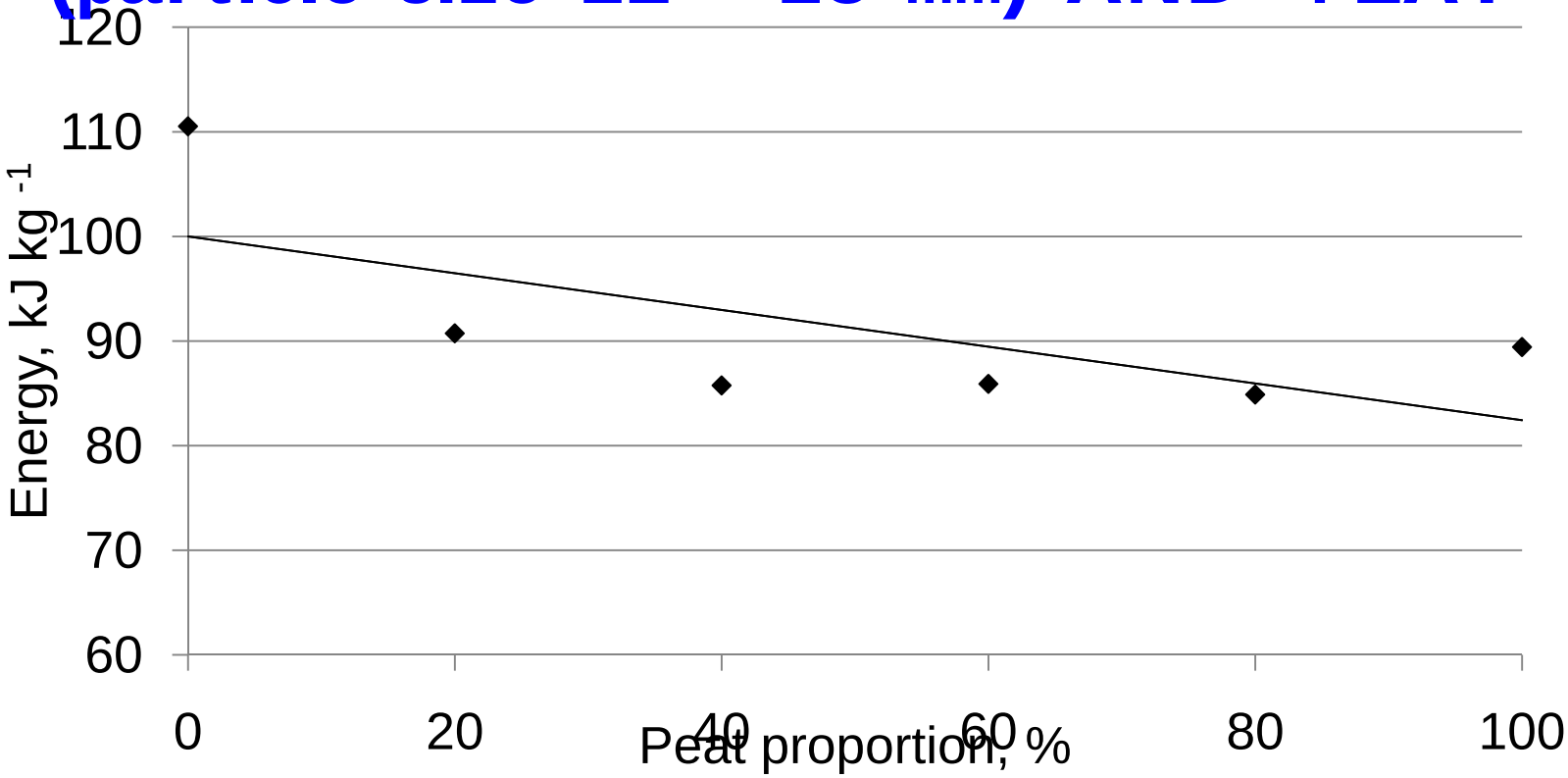
Pressing energy for composition of reed (particle size 12 – 13 mm) AND PEAT



Peat additive > 40% does not decrease energy consumption for compacting.

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CONCLUSIONS

1. The minimum density 0.87 g cm^{-3} have briquettes with particle size 12 – 13 mm, but maximum density 1.03 – 1.04 g cm^{-3} has two particle sizes < 0.5 mm and 32 – 33 mm briquettes compacted with pressure 212 MPa in closed die.

2. Pressing energy consumption maximum value 172 kJ kg^{-1} has been stated for reed particle size 32 – 33 mm, but minimum value 53 kJ kg^{-1} for particle size less than 0.5 mm.

3. Specific cutting energy maximum value 62 kJ kg^{-1} has been calculated for reed particle size less than 0.5 mm but minimum value 1 kJ kg^{-1} for particle size 32 – 33 mm. Energy economy 58 kJ kg^{-1} is for pressing particles size less than 0.5 mm comparing with pressing reed particle size 32 – 33 mm then cutting energy is taken into account.

CONCLUSIONS

4. Peat additive > 30% can be used for increasing the density of briquettes > 1 g cm^{-3}.

5. Peat additive > 40% does not decrease energy consumption for compacting, therefore peat additive 30 – 40% is recommended.

6. Comparing consumption of pressing energy for pure common reeds particles and their composition with peat 30% additive, energy economy is about 24 kJ kg^{-1} if composition is used. Peat can be used as additive for production of solid biofuels from herbaceous stalk material, because peat improves density and machanical characteristics of briquettes

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Thank you for attention!

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