Common Reeds *(Phragmites australis)* a sustainable and novel biomass feedstock in circular bioeconomy: A case study thermal insulator for building

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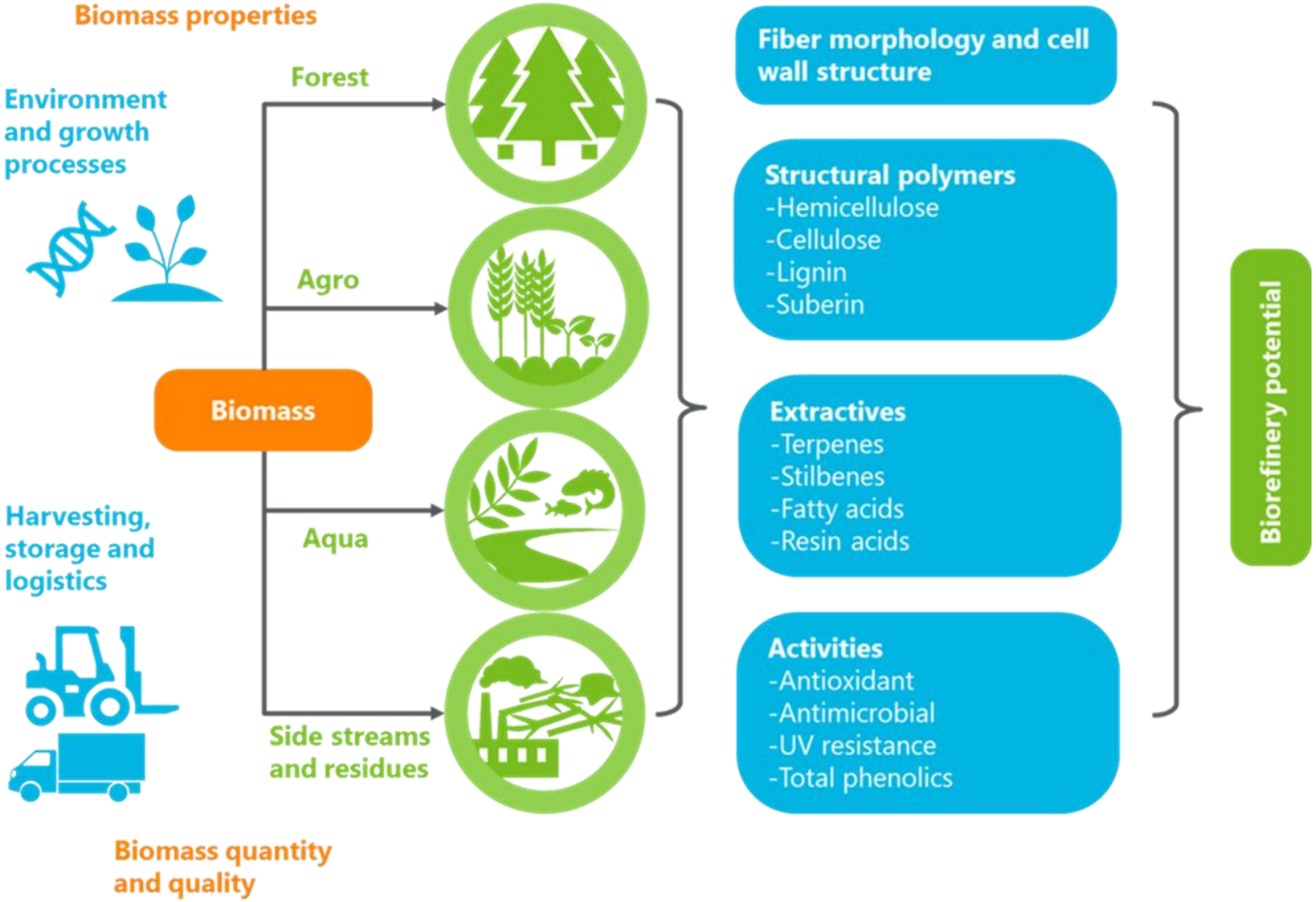
Vision

‘Sustainably towards higher value added’

Main aims (total 6 aims)

- Increase the resource-efficient use and recycling of materials and utilise side streams
- Reduce dependence on non-renewable raw materials, especially those that are fossil based



Competition: forest biomasses, fossil raw materials

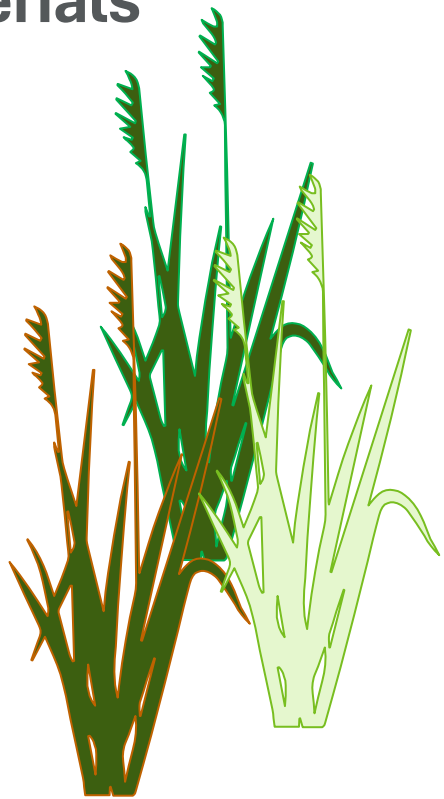
Forest biomass availability in Finland max 80 Mt/a

vs.

Biomass need 140 Mt/a to reach targets for carbon-neutrality by 2035

→

Bast/natural fibre crops provide untapped potential



Need for new biomass crops and rethinking of sustainable value-chains for bioproducts – the rapidly changing world challenges the security of supply

Common Reeds *(Phragmites australis)*

The Common Reed, in latin *Phragmites australis* (Cav.) Trin. Family Poaceae (R.Br.) Barnhart. The genus Phragmites comprises nowadays 7 species:

-*Phragmites australis* (Cav.) Trin. ex Steud

a) ***Phragmites australis* ssp. *Australis*, growing in the temperate regions of both hemispheres**;

b) *Phragmites australis* ssp. *altissimus* (Benth.) Clayton (the plant is taller and has a larger panicle than ssp. *australis*), growing in the Mediterranean area, in the Middle East, North Africa;

c) *Phragmites australis* ssp. *americanus* Saltonstall, P.M. Peterson & Soreng, growing in North America

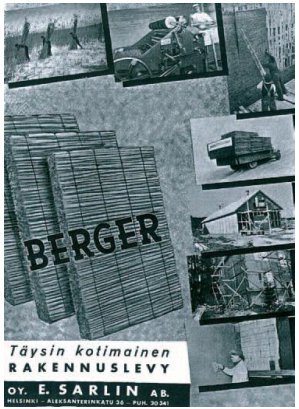
Morphologically the Common Reed is a perennial hydrophyte-geophyte with usually very high shoots (up to 4 m, seldom even 7 m).

They forms dense stands and approximately 200 shoots of 1 m^2, which leaves are helomorphic, 1-3 cm, seldom 5 cm wide.

Common Reed (Phragmites australis)
Source: Read up on reed!
Turku 2007, Southwest Finland Regional Environment Centre

Uses of Common Reeds *(Phragmites australis) in Finland*

Common Reed as thatching material

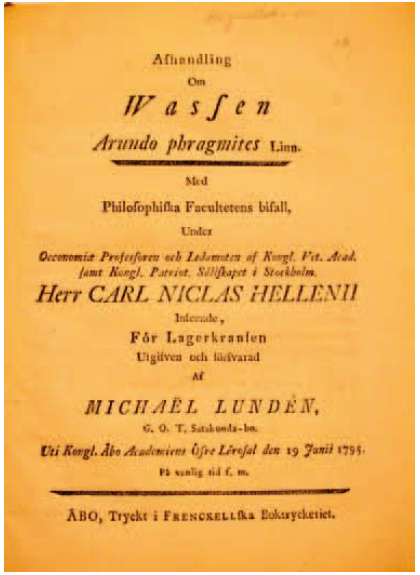


In Finland, only one company utilised Common Reed industrially: Oy E. Sarlin Ab manufactured Berger reed panels in Porvoo in 1938- 1944.

Prehistoric reed-covered dwelling may have looked like this. Kuralan Kylämäki provincial museum in Turku, Finland. Photo: Martti Nakari.

Restored reed roof of a barn. Rymättylä, Southwest Finland. Photo: Markku Hyvönen

The doctoral thesis of **Michael Lunden** entitled “Om Wassen” (About Reed) at Åbo Academy in 1795. In his thesis, Lunden writes that Common Reed is excellent fodder, roofing material (“it beats rye straw without question due to its excellent properties”), mats made of reed are used to protect young plants from excessive sun and from the “extreme harshness of the Nordic weather


Afhandling
Om
Wasen
Arundo phragmites Linn.
Med
Philosophiska Facultetens bifall,
Under
Oeconomiæ Professoren och Ledamoten af Kongl. Vet. Acad. samt Kongl. Patriot. Sällskapet i Stockholm.
Herr CARL NICLAS HELLENII
Inlemde,
För Lagerkransen
Utgifven och försvarad
Af
MICHAEL LUNDÉN,
G. O. T. Satakunda-bo.
Uti Kongl. Åbo Academiens Östre Lärosal den 19 Junii 1795.
På vanlig tid f. m.
ÅBO, Tryckt i Frenckellska Boktryckeriet.

Common Reed as cattle fodder

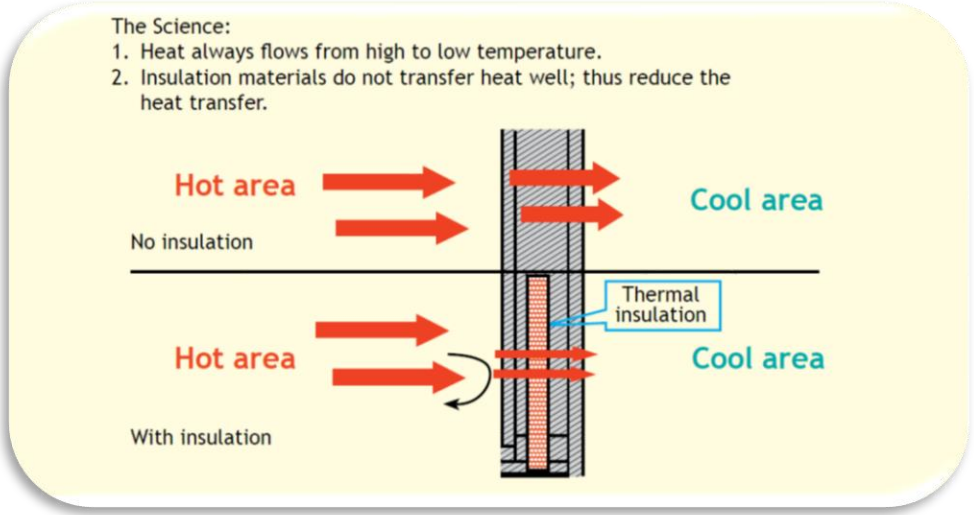
Common Reed is well-suited for providing energy

Nutrient recycling from water to agriculture fields

Thermal Insulation for buildings

Insulation materials limit the flow of energy (heat) between two bodies that are not at the same temperature.

Thermal insulation maintains a comfortable and desirable temperature throughout the building.



Source: BEE1g.pdf (gkspl.in)

Common available insulation materials

INSULATION MATERIAL	THERMAL CONDUCTIVITY W/MK - LESS INDICATES BETTER PERFORMANCE	THERMAL RESISTANCE M2K/W - MORE INDICATE BETTER PERFORMANCE
Mineral Wool		
Glass fibre	0.032 - 0.044	3.10 - 2.25
Rock fibre	0.035 - 0.044	2.85 - 2.25
Sheep's wool	0.042	2.38
Expanded polystyrene (EPS)	0.036	2.77
Hemp	0.039	2.56
Extruded polystyrene (XPS)	0.029 - 0.036	3.44 - 2.77
Polyurethane foam board (PUR)	0.22 - 0.29	0.45 - 3.44
Polyisocyanurate foam board (PIR)	0.021 - 0.022	4.76 - 4.54
Phenolic foam board	0.021	4.76
Evacuated panels - 20mm thk	0.004	5.00
Aerogel board - 10mm thk	0.013	0.77

Source: Thermal insulation for buildings - Designing Buildings

Common Reeds *(Phragmites australis)*: Thermal Insulator for buildings

Plant harvesting
- Sessional harvesting
- Transportation
- Storage

Processing of raw plant materials
- Cutting into small dimension
- Treatments (hot-water treatment)
- Analysis of chemical composition pre and post treatment

Fabrication of thermal insulator
- Processing the materials into uniform sizes
- Resin application in blender
- Mat-formation _Hot pressing

Testing of thermal insulator
- Physical properties (Density, water moisture sorption etc.)
- Compressive strength, Cycling compression
- Thermal properties (Thermal conductivity etc.)

Harvesting and pulverizing the common reeds

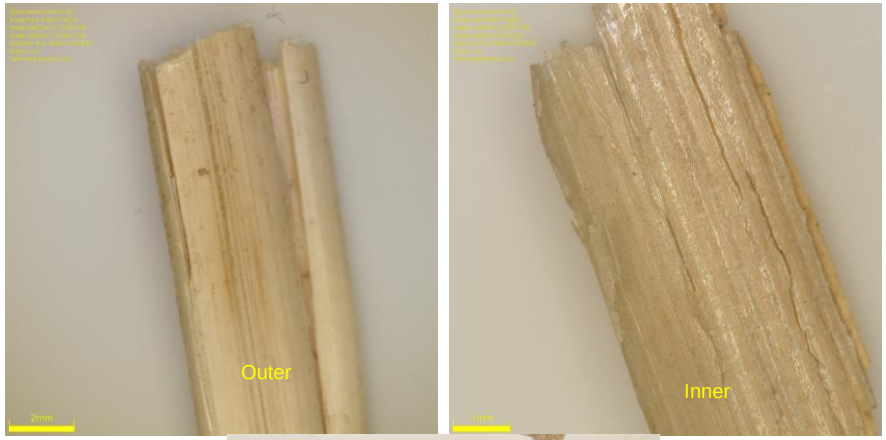
Common reed was harvested manually in week 42 (between 18-22 October 2021) in Ruukki area. Ruukki is located in the province of Oulu, a part of the Northern Ostrobothnia region of Finland.

Pressurized hot-water treatment of common reeds

The harvested and air dried-13.25 kg crushed common was extracted using heating up by steaming at around 165 °C and batch extraction around 150 °C for 60 min.

Microscopic images of CR

CR



CRE

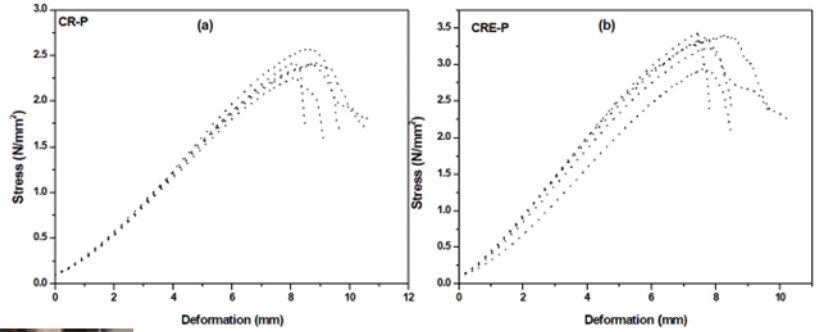
Panel manufacturing

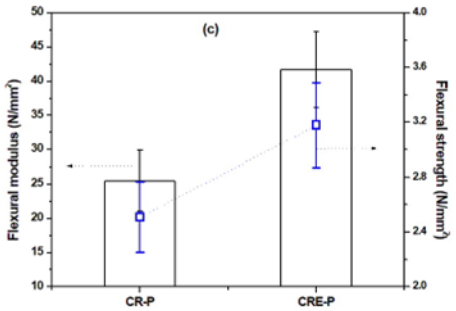
CR

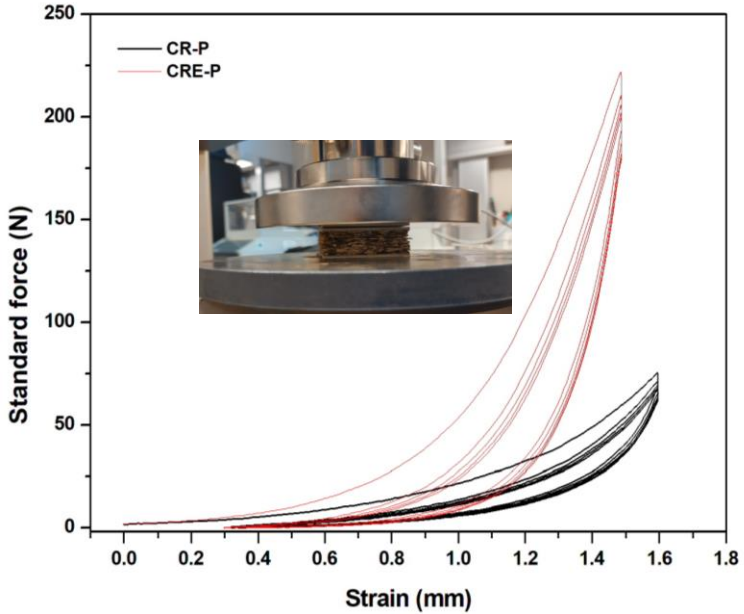
CRE

- Processing the materials into uniform sizes
- CR and Resin mixing in blending machine (in-house biobased binder)
- Mat-formation _Hot pressing
- Target density: 200 kg/m^3

Properties of CR panels







Flexural properties of CR panels

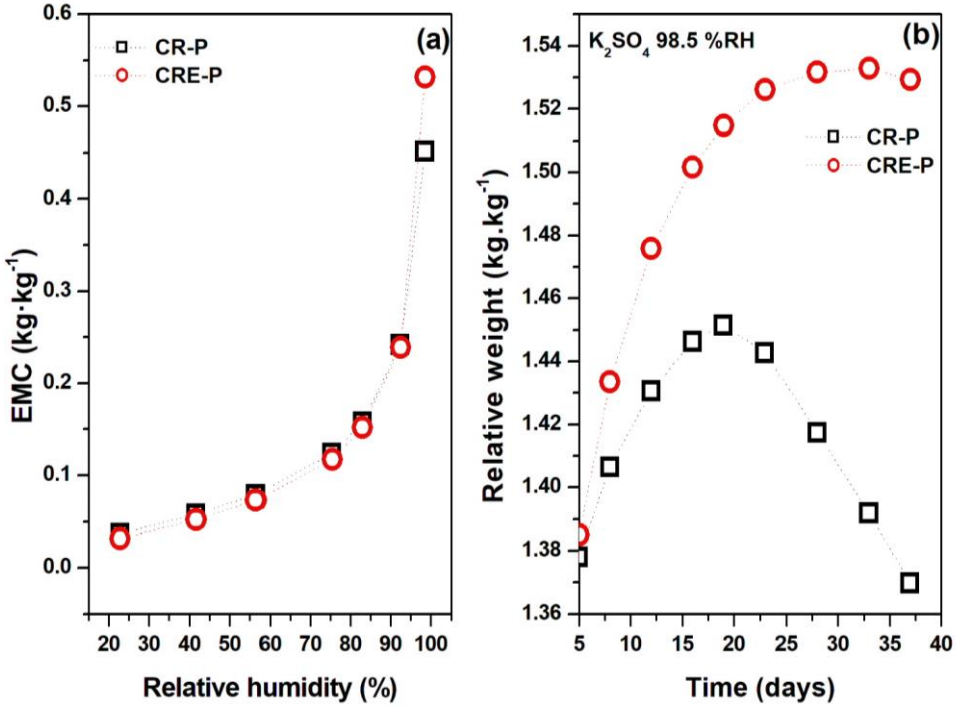
Thermal conductivity of CR panels

Heat conductivity: 0.050 W/(mK)

Heat conductivity: 0.065 W/(mK)

Moisture sorption behavior of CR panels

(*Aspergillus sp.* and *Penicillium sp.*)



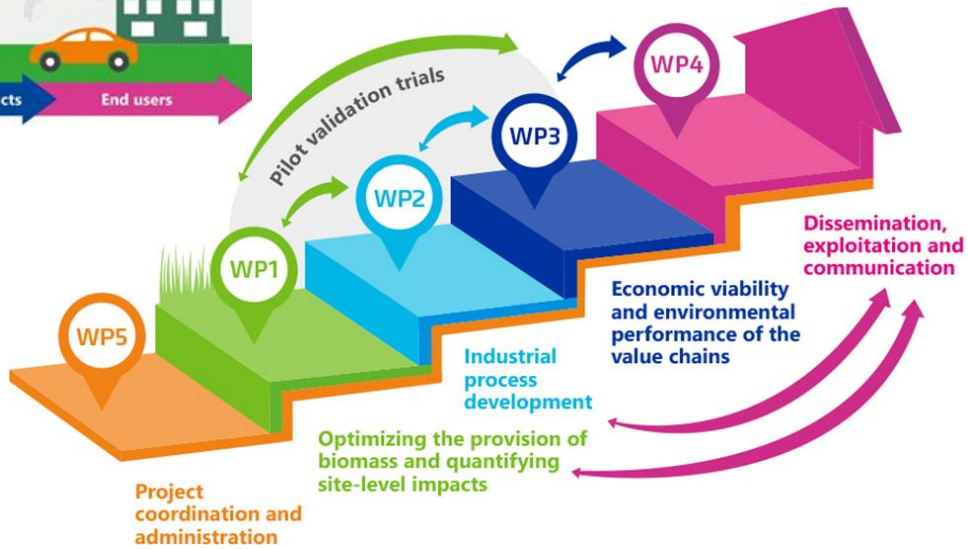
Conclusions

- Common reed combines a high volume-to-weight ratio with high air content, which makes it poor conductor of heat.
- Pressurized hot-water treatment of significantly improves the water sorption behavior, reduce the mold growth and improve the mechanical properties of flexible panels.
- Use of biobased binder makes CR panel eco-friendlier and more sustainable
- Value-added cascade use of underutilized biomass

Novel fibre value chains & ecosystem services from sustainable feedstocks *~ FIBSUN ~ 4.5 M€.*

HORIZON-JU-CBE-2022-R-05(RIA):Sustainable fibres biorefineries feedstock

Coordinator: Luke (Research prof. Kristiina Lång)



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