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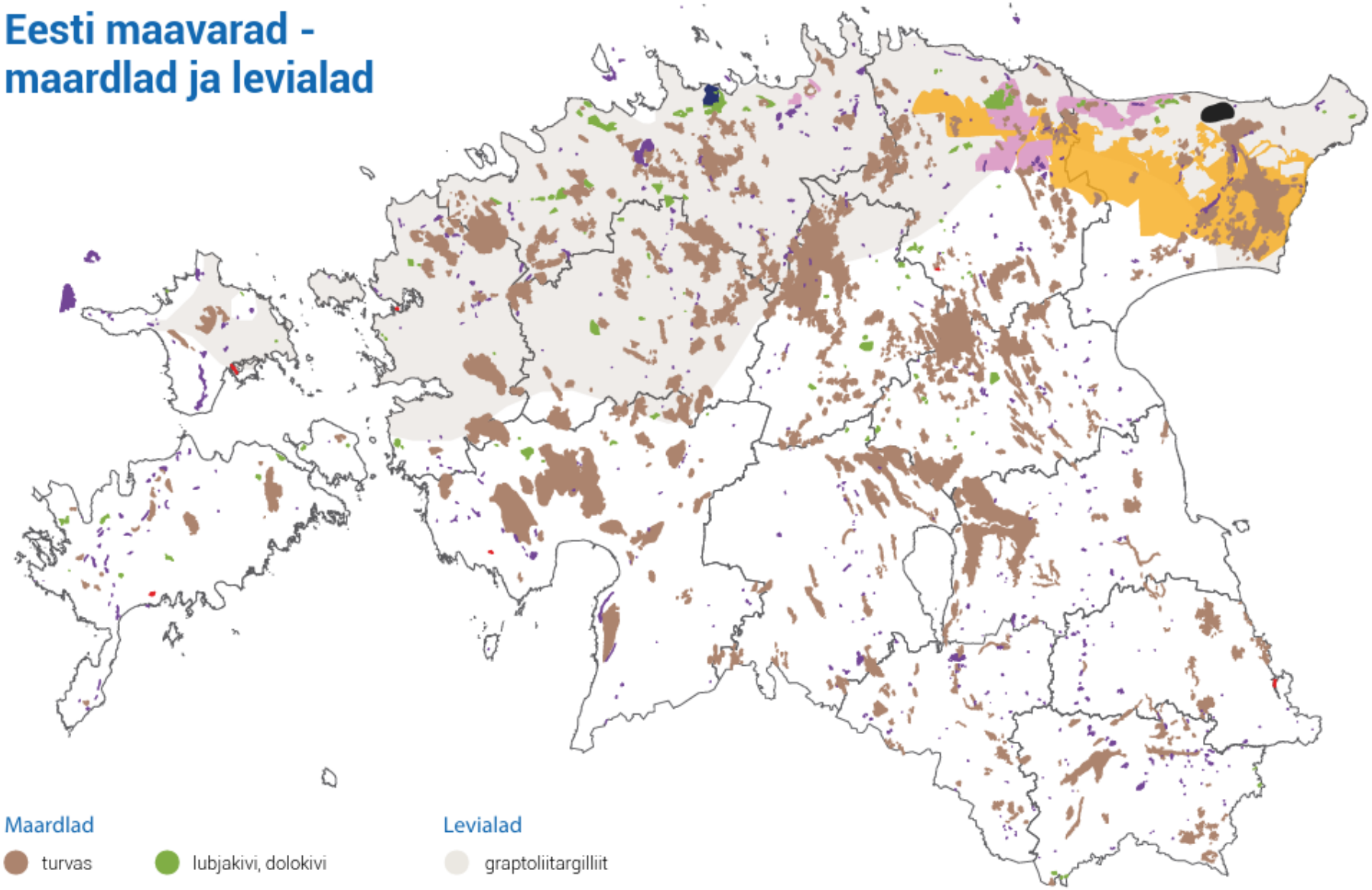
Väheväärtusliku puidu täielik keemiline väärindamine

Gert Preegel, PhD

Eesti maavarad - maardlad ja levialad



Maardlad

- turvas
- põlevkivi
- liiv, kruus
- fosforiit
- lubjakivi, dolokivi
- savi, muda, järvelubi
- graniit (aluskorra ehituskivi)

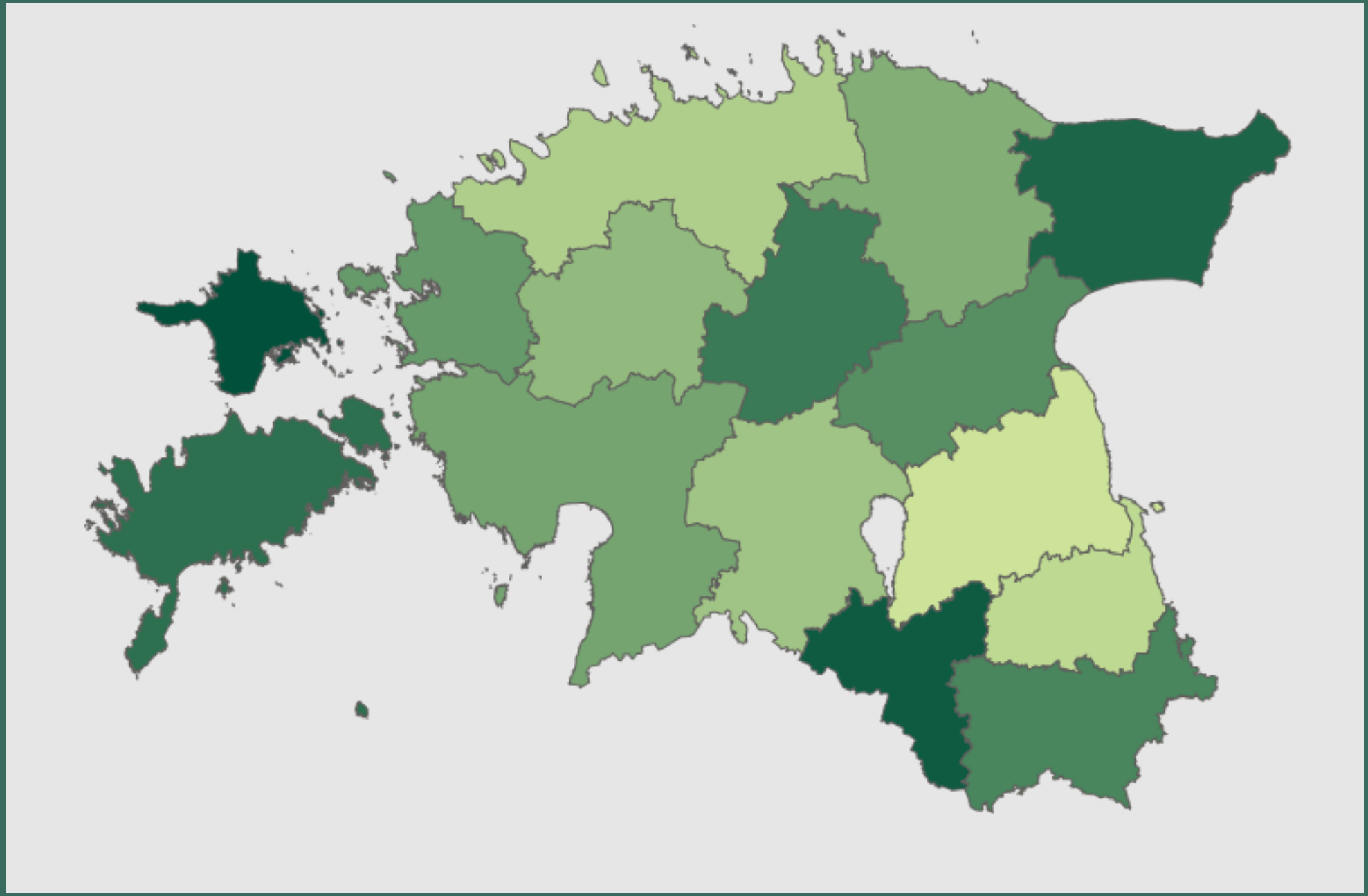
Levialad

- graptoliitargilliit
- rauamaak

Kaardil on kujutatud keskkonnaregistris arvel olevad maardlad seisuga juuni 2018.

KESKKONNAMINISTEERIUM

Eesti rikkus on mets!



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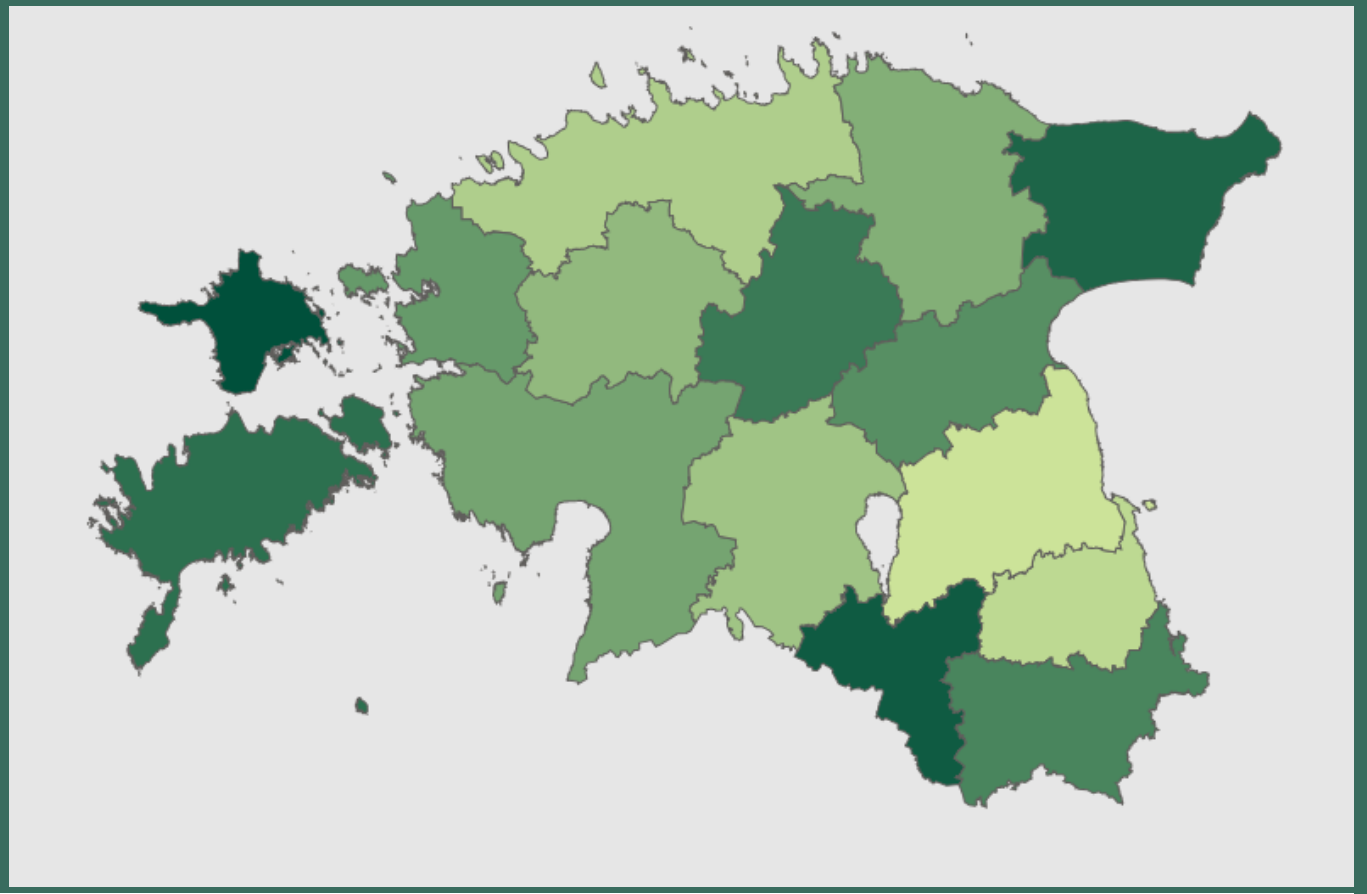
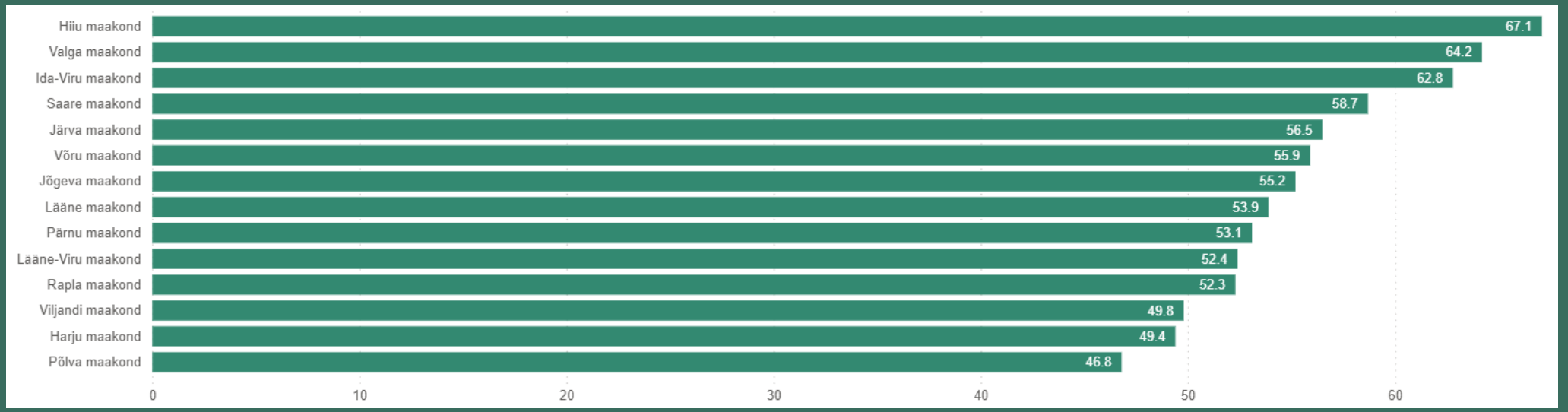
https://keskkonnaportaal.ee/et/teemad/mets




Hiiu maakond 67.1
Valga maakond 64.2
Ida-Viru maakond 62.8
Saare maakond 58.7
Järva maakond 56.5
Võru maakond 55.9
Jõgeva maakond 55.2
Lääne maakond 53.9
Pärnu maakond 53.1
Lääne-Viru maakond 52.4
Rapla maakond 52.3
Viljandi maakond 49.8
Harju maakond 49.4
Põlva maakond 46.8
0
10
20
30
40
50
60

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A symbiotic industrial ecosystem

Trees are grown for houses: the rest is made with residues and recycling

2000 m^3 of sawn wood products*

Grows in European forests every 6 minutes

=

This is enough to build an 8-storey apartment building

64 apartments (65m^2 for a total of 128 residents)

+

And will additionally provide its 128 residents with

(what the total production can correspond to)

- **43 years** consumption of packaging
- **33 years** consumption of hygiene paper
- **30 years** consumption of textiles
- **31 years** consumption of paper
- **6 years** consumption of household elecricity
- **9 years** heating with district heating
- **2300 km** driving with biofuels per household

Sources: Swedish Forest Industries Federation, Södra, Cepi

*To produce 2000m^3 timber, 6000m^3 round wood is harvested

Calculated with residues from wood working industry and average EU paper recycling performance and average EU consumption data.

Põlekivi (mittetaastuv)

Aastane kaevandamismaht

10,6 miljonit tonni

24% sellest on orgaaniline materjal

2,5 MILJONIT TONNI

Puit (taastuv)

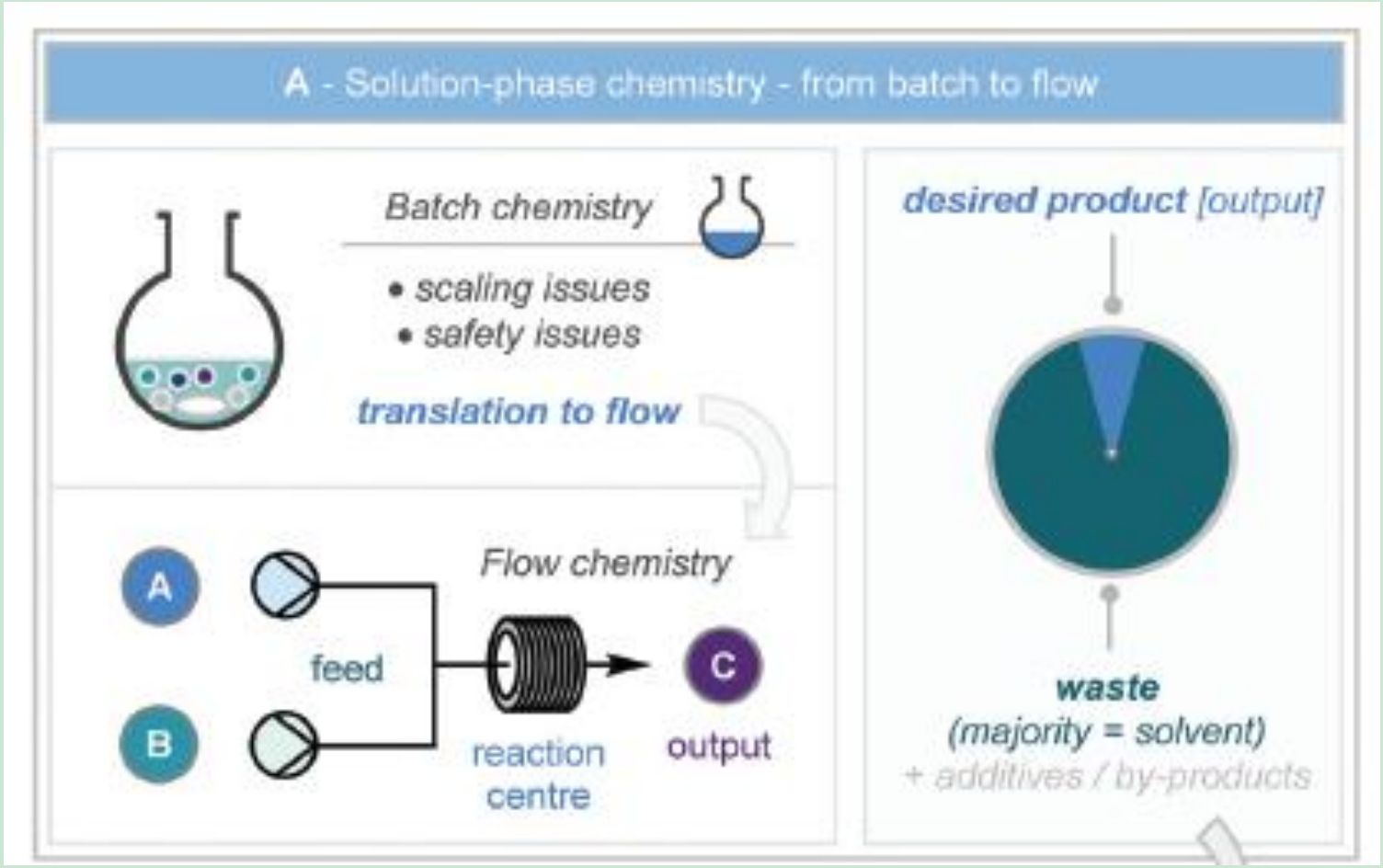
Aastane raiemaht

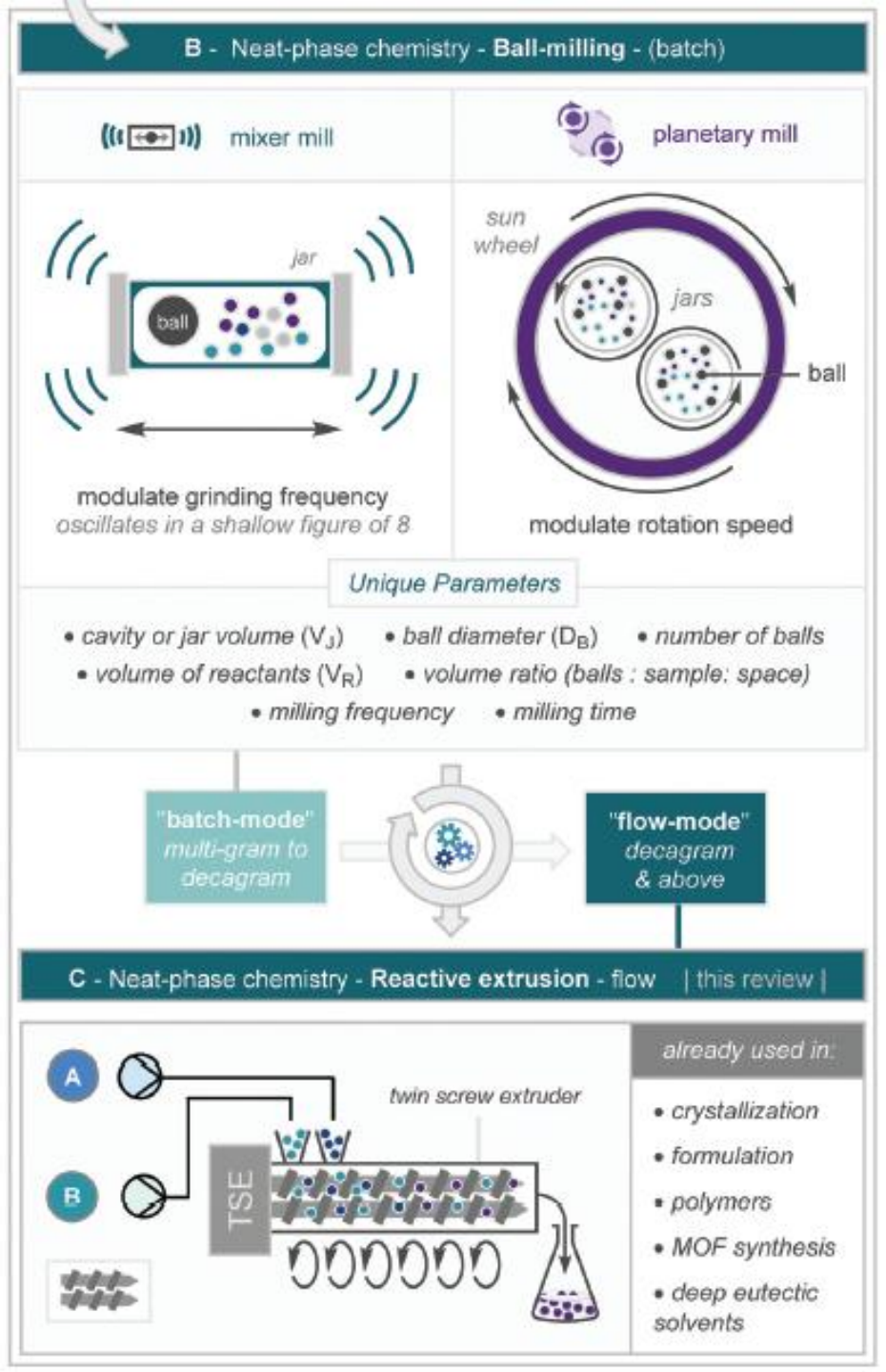
6 – 6,6 miljonit tonni

55% sellest on orgaaniline materjal

3,3 MILJONIT TONNI

Tehnoloogia areng keemias





DOI: 10.1039/d1cs00657f


Why we do it
The Challenge: to
Defossilise
Industrial value chains

Fibenol today

2016-2017
SUNBURST (USA) new technology

2018
SWEETWOODS project

2020
PILOT LINE
testing & samples

2024
DEMO PLANT
RAMP UP

Capacity (demo):

+ 20 000 ton C5 & C6 wood sugars
+ 6 500 ton LIGNOVA™
+ Specialty cellulose on ton scale

+ Global engagement: 400+ institutions
+ Investment & EU grants: > 100 mEUR

EPD®

HOME OK compost TÜV AUSTRIA HOME S2807

OK compost TÜV AUSTRIA INDUSTRIAL S2807

SOIL OK bio-degradable TÜV AUSTRIA SOIL S2807

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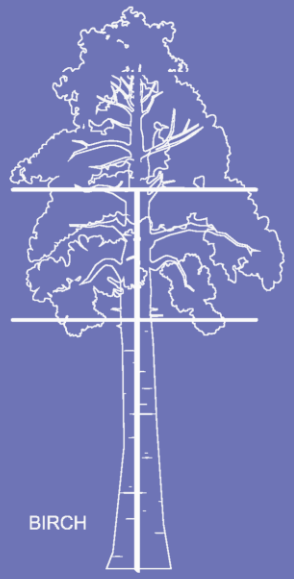
SWEETWOODS

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 792061

Horizon 2020
European Union Funding
for Research & Innovation

Bio-based Industries Consortium

OUR WAY



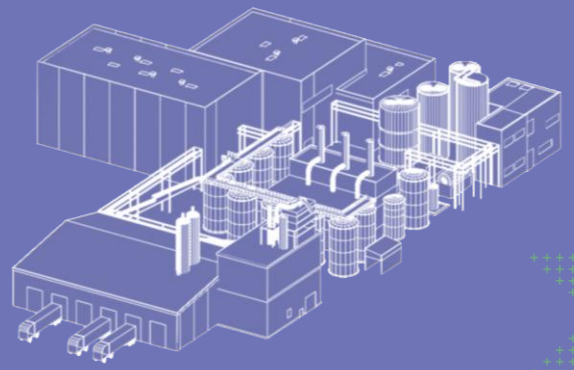
energy

pulp / paper

sawmills/
plywood industry

low-quality
hardwood &
forestry residues

plywood
processing
residues



95%
water reuse

100% renewable energy

LIGNIN

WOOD SUGARS

SPECIALTY CELLULOSE

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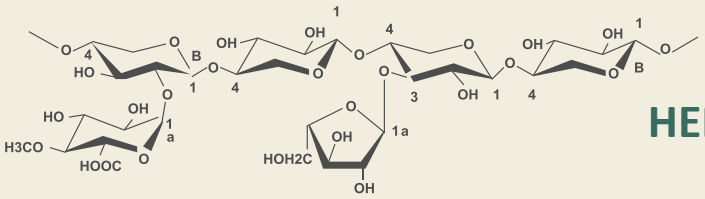
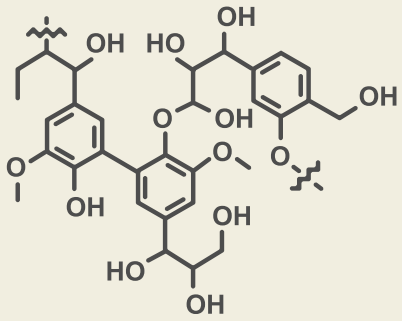
Technological breakthrough

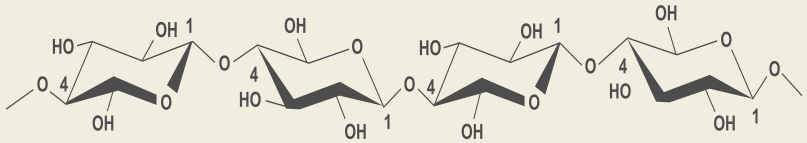
COMPOSITION OF WOOD



HEMICELLULOSE
25% - 35%



LIGNIN
20% - 30%



CELLULOSE
35% - 45%

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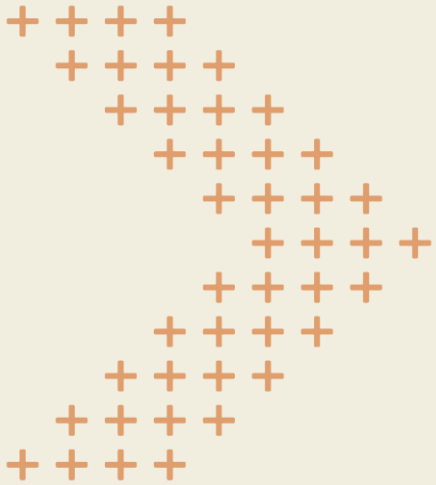
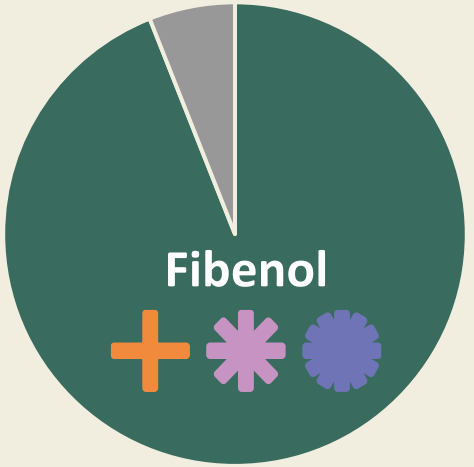


from one product focus to whole wood valorization

40%-50%
VS
> 90%



Innovation Beyond Borders

Fibenol and Sunburst™ pre-treatment technology Empowers Global Hardwood Valorization

→ **Process:** temperature + pressure + mechanical force
→ **Result:** chemically unmodified, high-purity products

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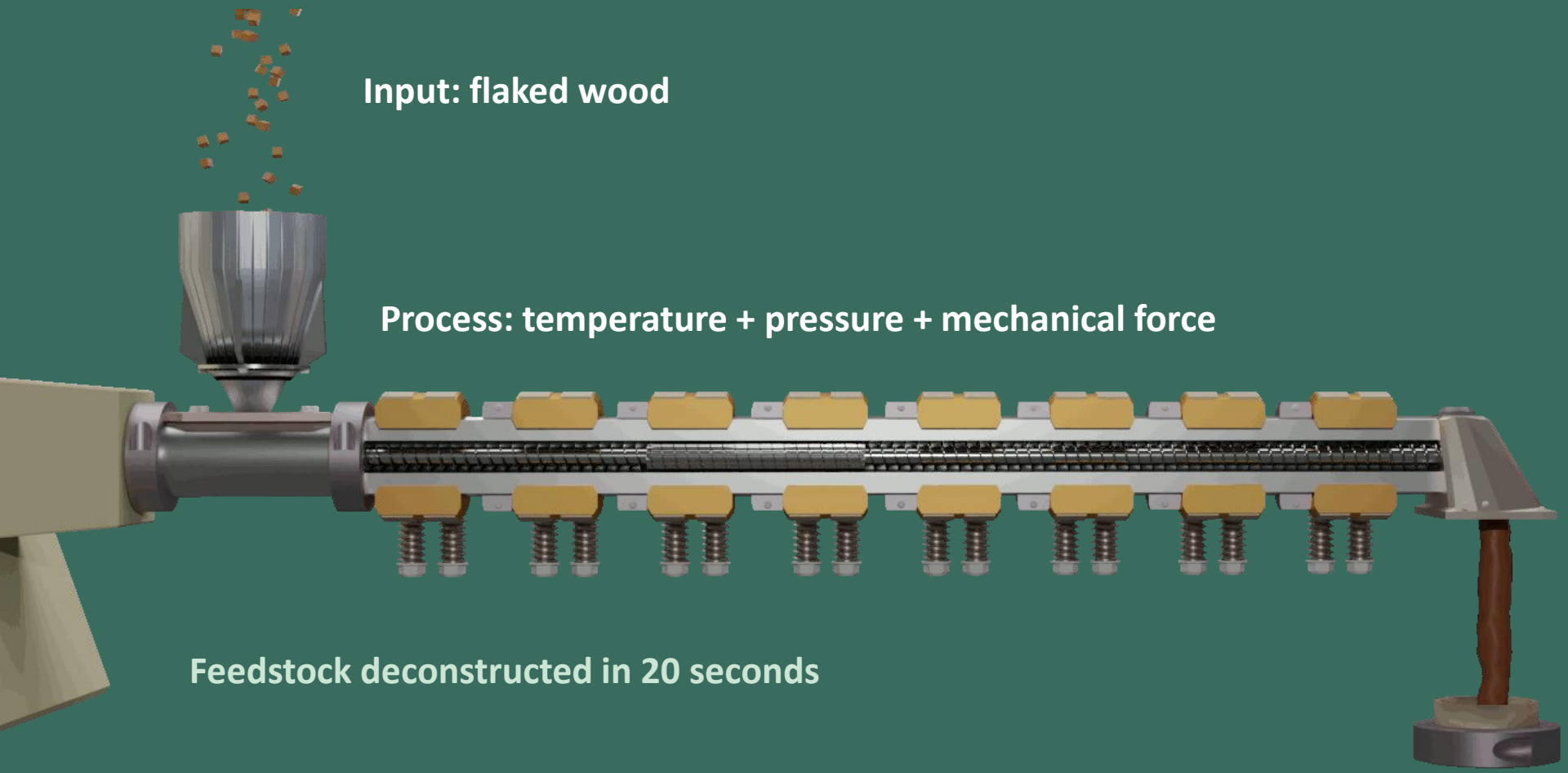
Fibenol is a Sunburst technology IP holder from 2023

Technology: SUNBURST™ pre-treatment

Input: flaked wood

Process: temperature + pressure + mechanical force



Feedstock deconstructed in 20 seconds

Fibenol

Result: chemically unmodified, high-purity products

C5 SUGARS

C6 SUGARS

LIGNOVA CRUDE

SEPARATION

ENZYMATIC HYDROLYSIS

SUNBURST™

RESIDUAL HARDWOOD

LIGNIN CELLULOSE CAKE (LCC)

SEPARATION

BLEACHING

REFINING

DRYING

PURIFICATION

CRUDE MCC

BLONDE MCC

WHITE MCC

REFINED WHITE MCC

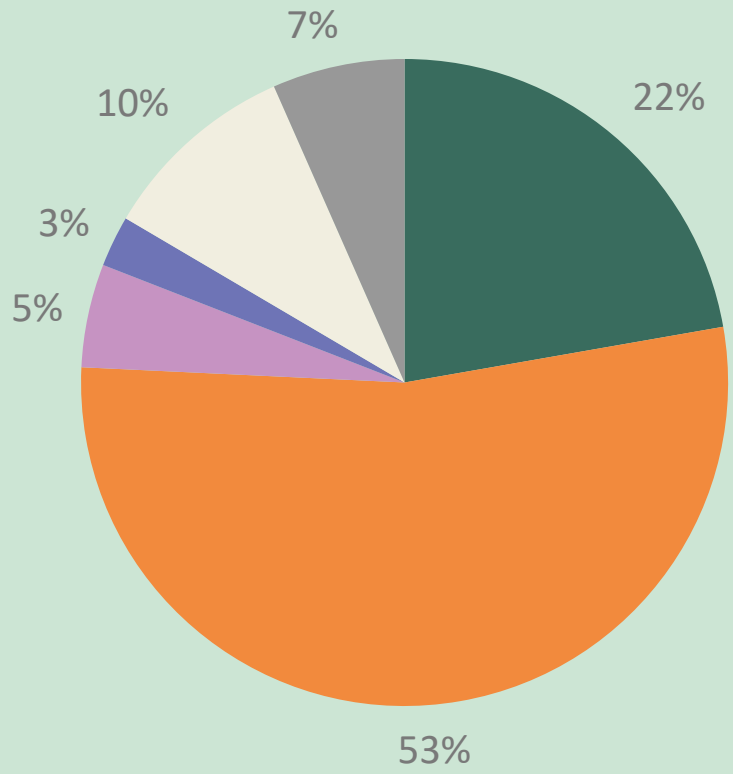
DRY WHITE MCC

By-product: LIGNOVA PURE

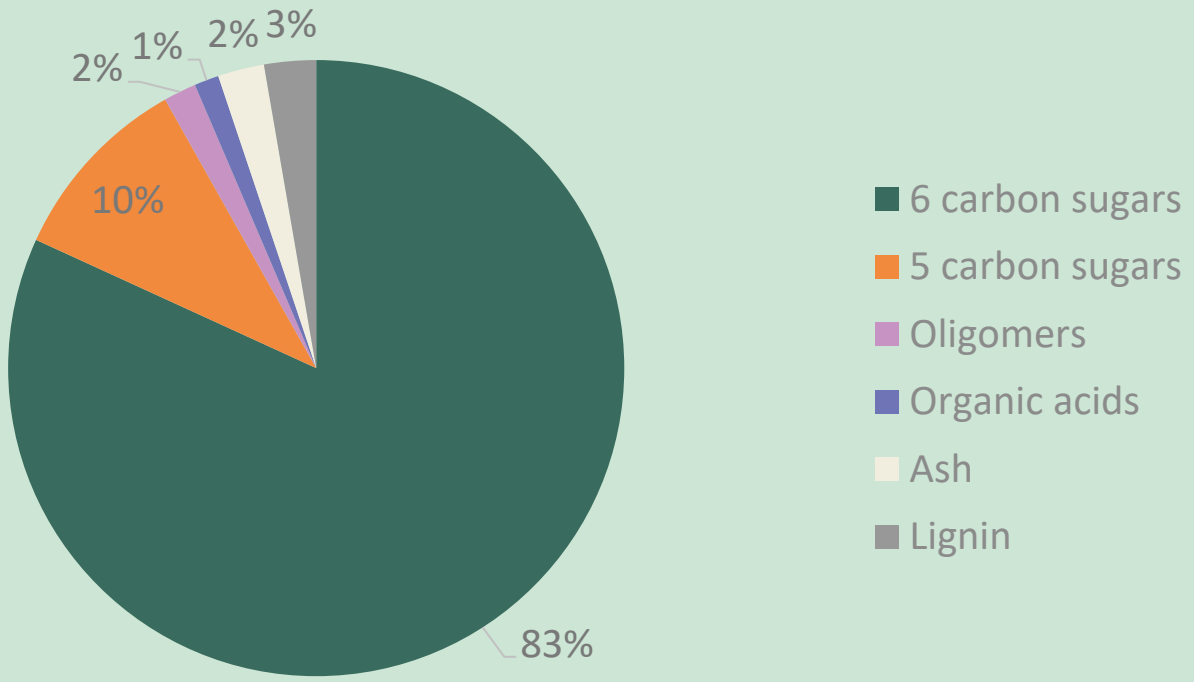
Fibenol


250
200
150
100
250
200
150
100
250
200
150
100

C5 CELLULOSIC SUGAR



C6 CELLULOSIC SUGAR



C5 - looking for non-conventional microbes & conversion processes for valorization

C6 - compatible with most conventional dextrose-based production processes

Wood sugars

Use-cases with: ÄIO and Enifer

- Enifer: protein-rich PEKILO® Aqua protein ingredient biomass for aquafeed.
  - The process to produce PEKILO® Aqua mycoprotein uses fungal fermentation to convert industrial by-products into dry protein ingredients. These ingredients can replace soy protein concentrate and fishmeal.

- ÄIO: Lipid rich biomass fermentation for sustainable: fats & oils.

Applications in food, cosmetics, household

- Fit for human consumption
- Premium CO_2 footprint!

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Cellulosic sugars for industrial bioprocesses

Use-case of Bio-BDO

- C6 sugars fermentation
- Bio-BDO - the building block for biodegradable and compostable bioplastics

The VEHICLE project received funding from the Bio-based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement no. 837866

Wood sugars use-case in biosurfactants

holiferm

Applications in home & personal care, industrial cleaning etc

+ Highly fermentable
+ Premium CO_2 footprint!
+ Non-food competitive

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LIGNOVA properties

- Hardwood (birch)
- Near native structure
- Low sulphur
- No malodor
- Solid content 50-97 %
- Particle size d90 = 100 – 250 µm

LIGNOVA$_{CRUDE}$

LIGNIN %	85 - 92
CARBOHYDRATES %	6.3
MONOMERIC %	1 - 6
POLYMERIC %	1 - 6
ASH %	< 1
NITROGEN %	< 1
SULPHUR %	< 0.2
MOLECULAR WEIGHT (kDa)	50

LIGNOVA$_{PURE}$

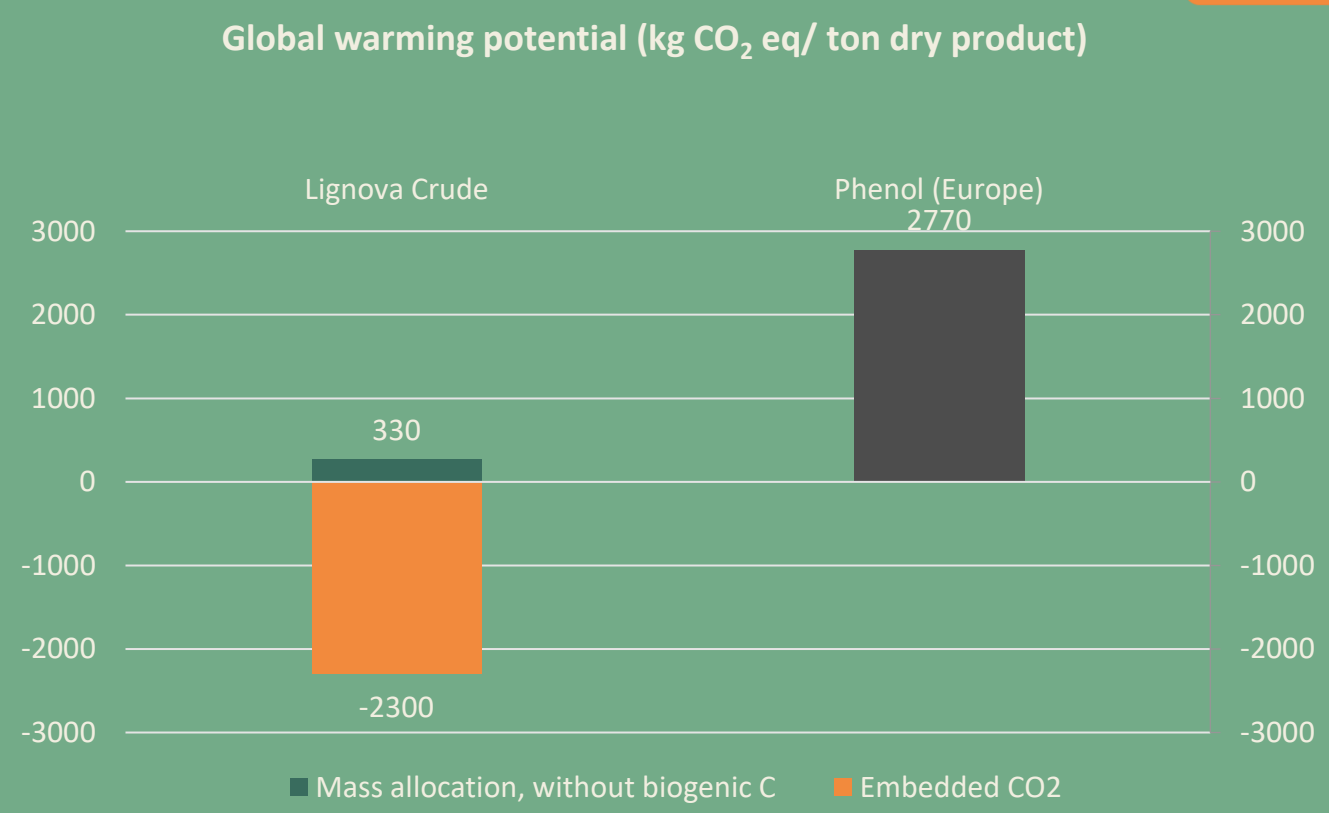
LIGNIN %	92 - 96
CARBOHYDRATES %	1.0
MONOMERIC %	1.0
POLYMERIC %	0.0
ASH %	< 2
NITROGEN %	< 0.5
SULPHUR %	< 0.2
MOLECULAR WEIGHT (kDa)	50

Use-case with Lignin Industries & LIGNOVA™

- Lignin Industries applies lignin LIGNOVA™ to produce RENOL®, a renewable and functional thermoplastic that replaces fossil plastics, significantly reducing CO_2 emissions.

- RENOL® can be used in various plastic applications such as PE, PP and ABS.

LIGNOVA™ use-case in plywood



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VIOBOND

LIGNOVA™ use-case in road construction

FUTURE: carbon storing roads

+ Lower carbon footprint
+ Promote resource independence
+ Long-term carbon sequestration
+ Local resources

HOW?

Biofuel use at asphalt making +

25% LIGNOVA substitution = Carbon-neutral road

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Carbon-neutral road project, June 2023, Estonia

LIGNOVA™ use-case in Superinsulation

Lignin bioaerogel provides superinsulation properties and reduces the heat transfer within the tiny nanometer-sized pores compared to conventional insulation materials.

+ Lower carbon footprint

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MICRO-CRYSTALLINE CELLULOSE

CRUDE

BLOND

WHITE

Key Features of MCC:

1.Enhanced Barrier and Mechanical Properties
Improves paper and thermoformed product performance.

2.Versatility with Fibenol Lignova
Combines cellulose with lignin for unique properties.

3.Small Particle Size
Perfect for barrier coatings.

4.Sustainable and Compliant
Biobased, Biodegradable, Repulpable
FSC Certified, SUPD Compliant

5.Regulatory Compliance
Certified by **BfR** and **FDA** standards.

6.Rheology Modifier
Enhances the viscosity and stability of paints and construction materials.

	CRUDE	BLOND	WHITE	Refined WHITE
APPEARANCE	Paste	Paste	Paste	Paste
CELLULOSE CONTENT wt%	60-70	75-85	90-95	90-95
LIGNIN CONTENT wt%	20-30	5-10	2-5	2-5
HEMICELLULOSE CONTENT wt%	1-2	1-2	1-2	1-2
INORGANIC CONTENT wt%	3-5	2-3	1-2	1-2

WOODCELL

FAST FORWARD FROM
FOSSILS TO BIOBASED

DS Smith
PAPERS AND BARRIERS

skeleton
ENERGY STORAGE

EPFL
RND INSTITUTE

ARKEMA
RHEOLOGY

Hes·so
RND INSTITUTE

FOREKO
WOODMASS

RI.SE
RND INSTITUTE

LIST
LCA AND SSBD

Fibenol

About REDYSIGN

REDYSIGN is a European project focused on the development of resource-efficient processes dedicated to the production and circularization of a biobased, recyclable, and smart fibre-based packaging (FBP) alternative for fresh meat distribution as a substitute for current non-circular multi-plastic solutions.

13 PARTNERS

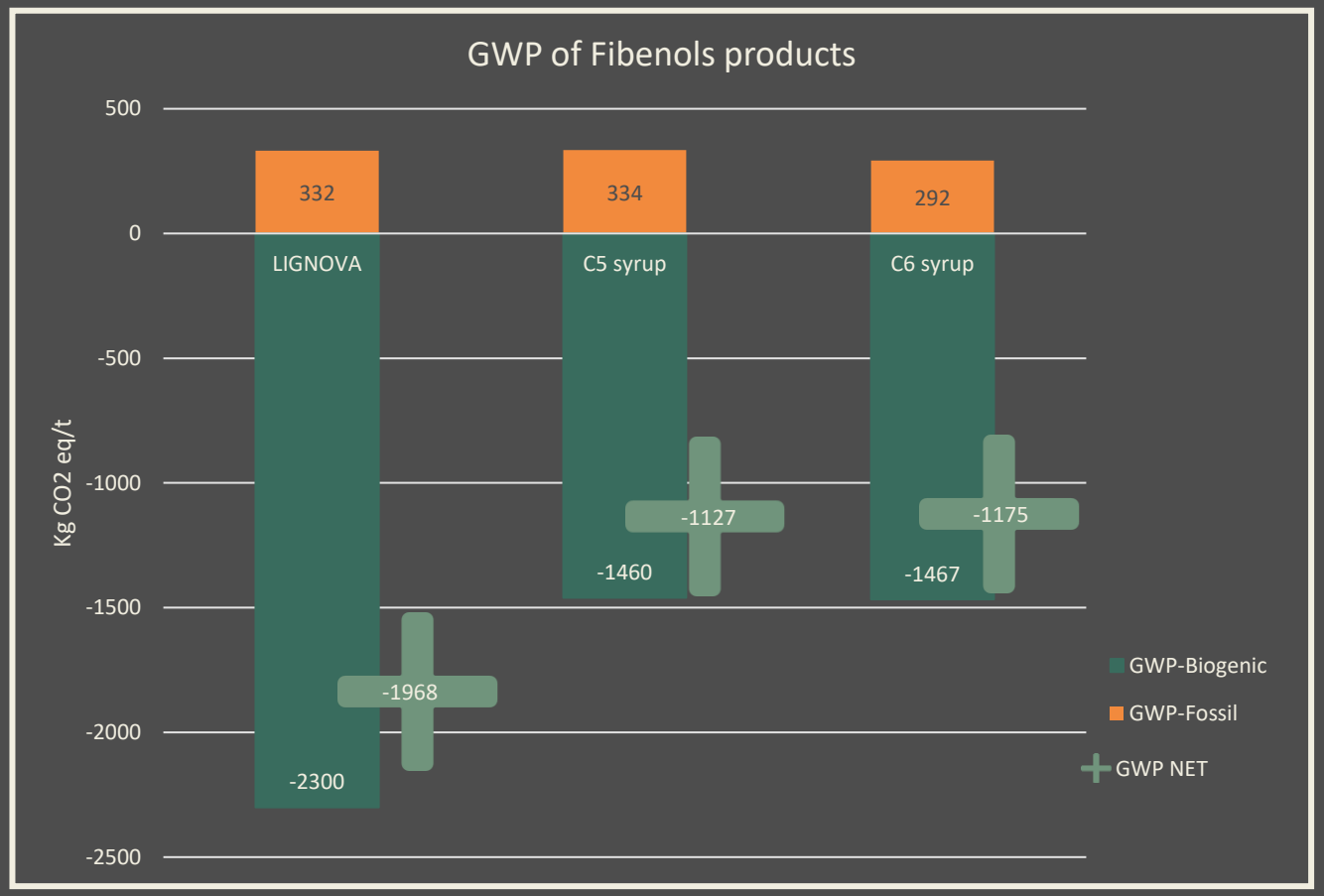
7 COUNTRIES

5 MILLION EUROS BUDGET

4 YEARS

redysign

Environmental Impacts of LIGNOVA, C5 and C6 sugars



Product Category Rules (PCR):	PCR 2021:03 Basic chemicals (v 1.1)
UN CPC code:	3413 Phenols (→ lignin defined as main product)
Declared unit:	1 ton dry matter of product
Software:	SimaPro 9.5
Allocation:	mass (dry), energy production based on exergy
Primary data:	operational data from 2021-2023
Secondary data:	ecoinvent v3.9
Method:	EPD Method EN 15804 (in conformity of ISO 14025)
Cut-off rules:	no cut-off rules applied

Link to EPD: https://www.environdec.com/library/epd9726

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SWEETWOODS

2016

2023

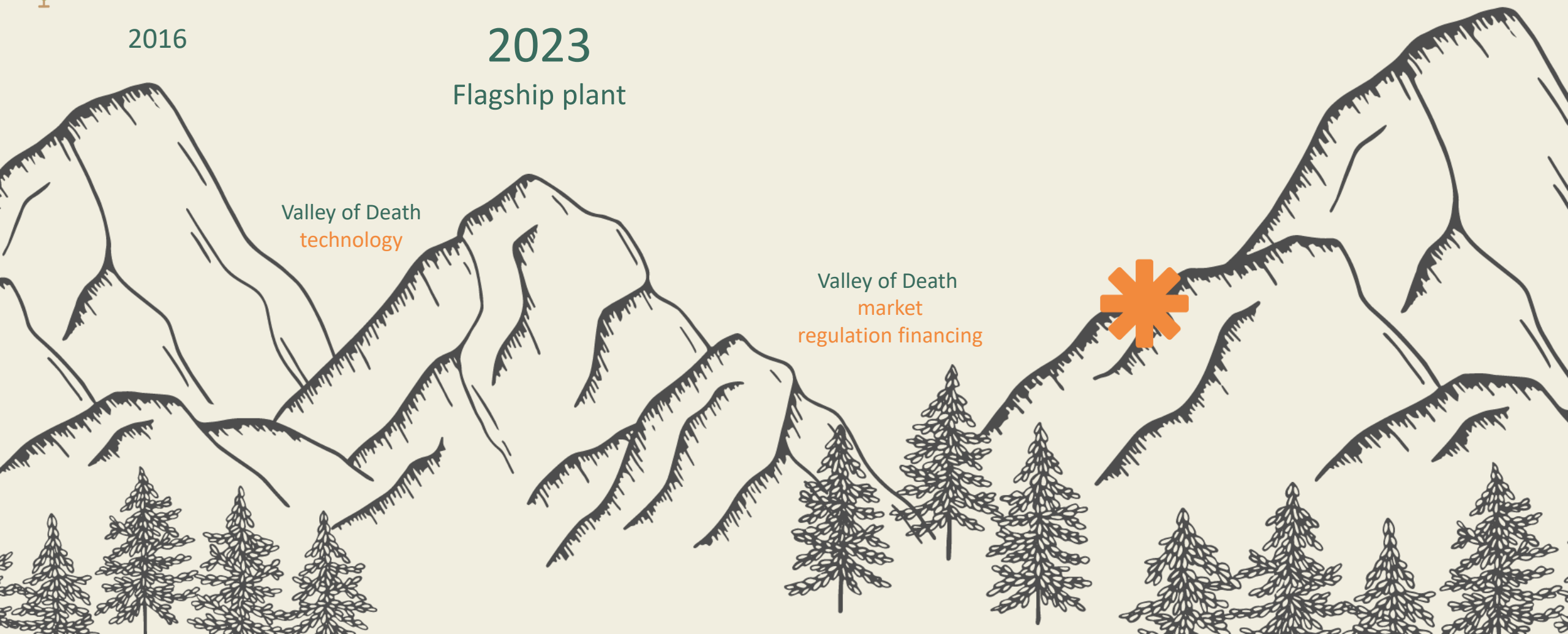
Flagship plant

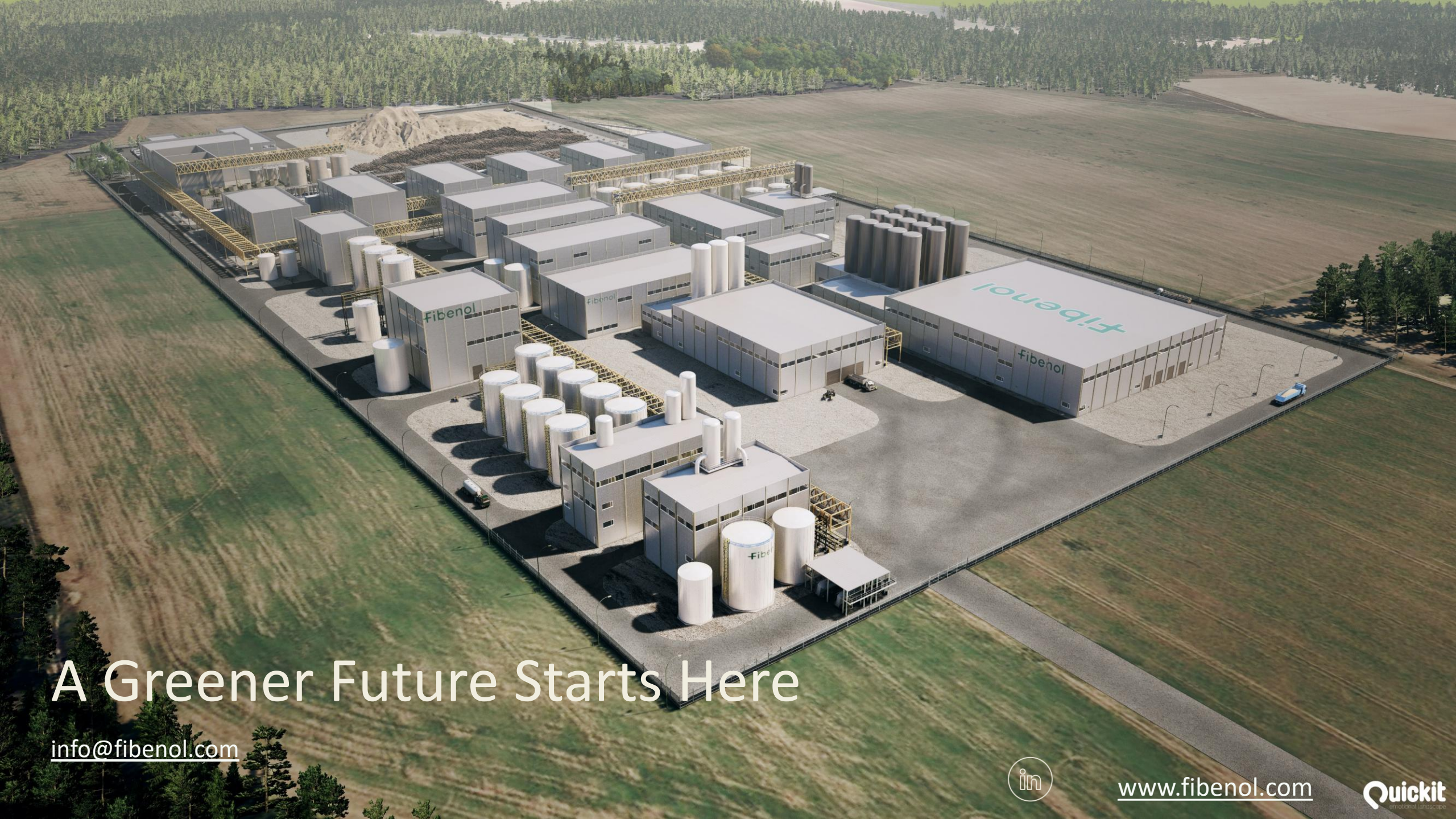
2030

Fibenol 1

Valley of Death
technology

Valley of Death
market
regulation financing





A Greener Future Starts Here

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