An innovative iber recovery

Efficient & high-quality recycling for papers and multilayers

Date: 2023-10-05

Maria Roboter GmbH , Germany
Repulping Technology GmbH & Co. KG, Germany

Innovative Pulper Technology for Resource Efficiency

Repulping Technology

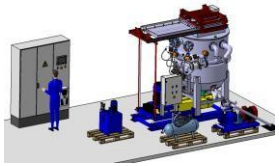
Introduction

Innovative Pulper Technology for Resource Efficiency

Repulping Technology

Status Quo

Introduction: Our history and milestones

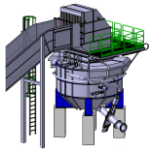


Practicle process development by our test equipment

2014 / 15

Article: *Coffee-to-go-cups are 100% recyclable as of now*

Primary development completed



2018

Award: KUMAS Lead project 2019

2019

Engineering and commissioning of the FIRST INDUSTRIAL PLANT

2021 / 22

Further international projects for delivery and operation

2014

Company foundation

2017

International patent application

Promotion received

2019

Cooperation with the University of Hamburg

Start of sales activities

2020

Award: EUROPEAN PAPER RECYCLING AWARD 2019

Award: Bavarian Envirionmental Award 2020

Introduction

Services

Projects

- Concept studies
- Engineering
- Turnkey projects
- Operation / Joint Ventures

Safety & services

- Technical documentation
- Safety concepts
- After-sales-service

Economic efficiency

- Investment calculation
- Subsidies/subventions consulting
- Economics evaluations

Technology & products

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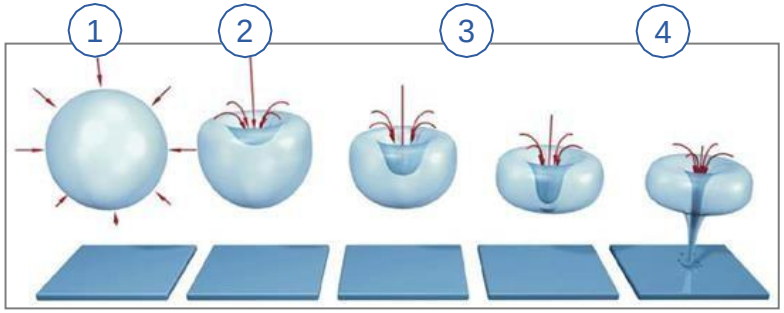
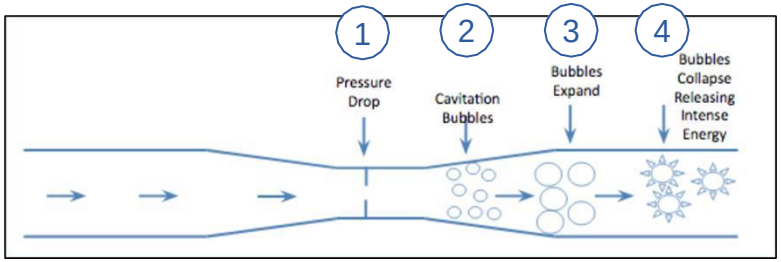
Technology & products

What is cavitation?



Cavitation principle
showed by water bubble



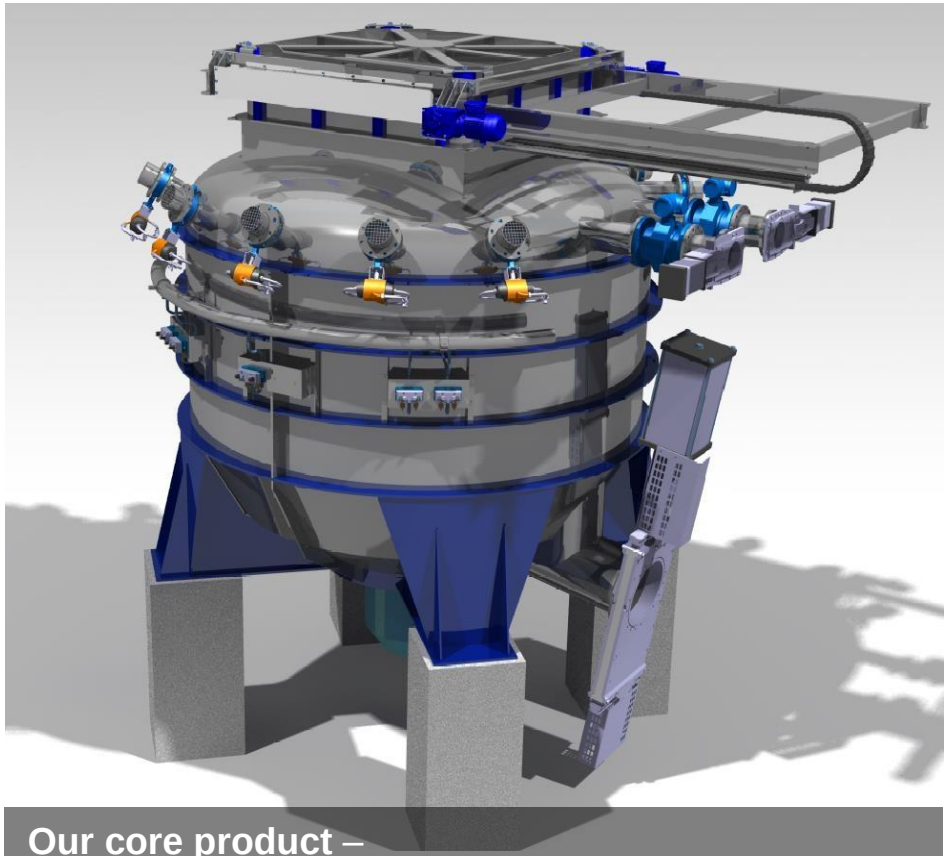
Venturi pipe
by Viktor Kaplan (Austria)

Influencing phyiscal variables
- *Medium*
- *Pressure inside the medium*
- *Flow of the medium*

1. **Pressure drop:** decreasing evaporation temperature >> water bubbles
2. **Pressure compensation:** stopping evaporation >> condensing water bubbles
3. **Implosion / bubble expand:** „Donutshaped“ collapsing bubbles >> sudden water return flow
4. **Bubble collapse:** hydrogen bonds between the fibres are destroyed by microjets

Technology & products

Cavitation pulper (KSL)



Our core product –
the cavitation pulper

Size and throughput

- Pulper size (net volume): 10 – 30 m^3
- Consistency: 12 – 18%

Technology

- Innovative drive concept: direct drive
- Fully automated process
- Spiral rotor for high consistency

Application

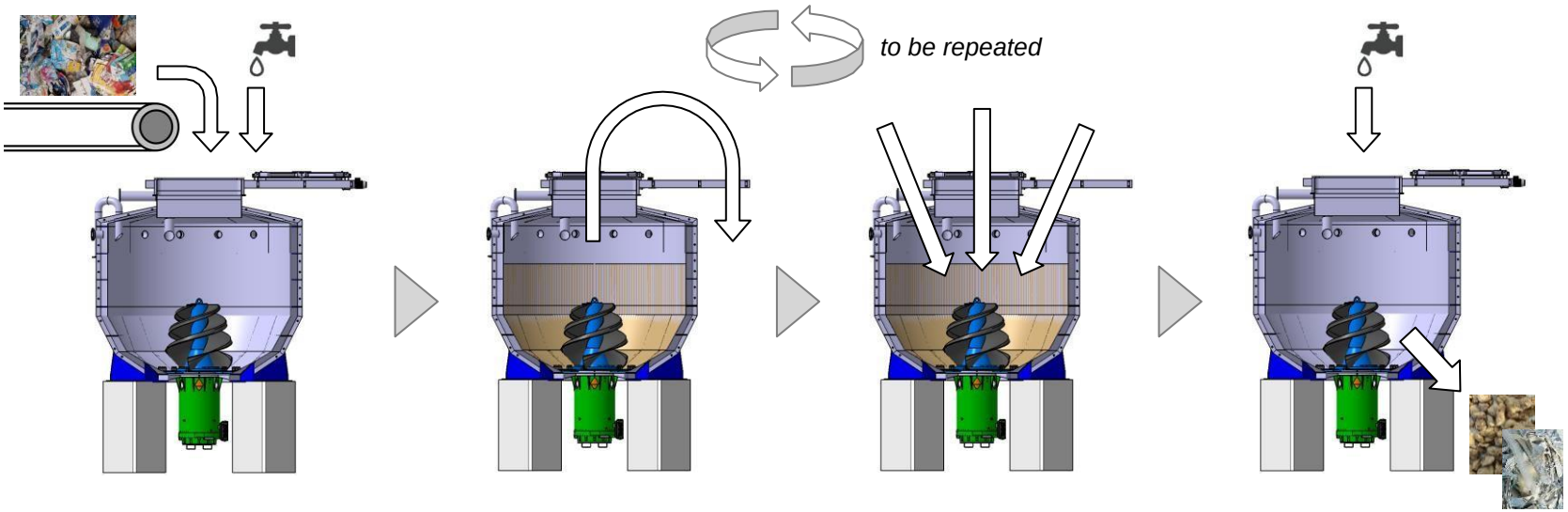
- Replacement for conventional technology
- Additional line for „delicate“ waste paper sorts

Additional info: *in addition to the operating data mentioned above, the possible throughput depends on the consistency of the raw material*

Technology & products

Processing procedure of the RT-technology

1. Input	2. Cavitation process	3. Output



INPUT: Raw material and process water	**Cavitation process (to be repeated):** • Pressure reduction • Pressure compensation: abrupt pressure change back to atmospheric pressure	**OUTPUT:** Fibres and almost fibre-free reject material
Input-time: approx. 3min (1)	Process time: approx. 12min (1)	Output-time: approx. 10min (1)

(1) *Average time determined during tests; values vary depending on raw material and conditions on site.*

Results and advantages

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Results and advantages

Increase of resource- and environmental efficiency

Up to 30% more
resource efficiency

- Increasing fibre yield
- Increasing dry content in reject
- Conservation of original resources

Increase of
environmental efficiency

- Lower CO_2 emissions
- Increasing proportion of recyclable materials
- Reject to raw material

Results and advantages

Increase of production- and energy efficiency

Up to 50% more
production efficiency

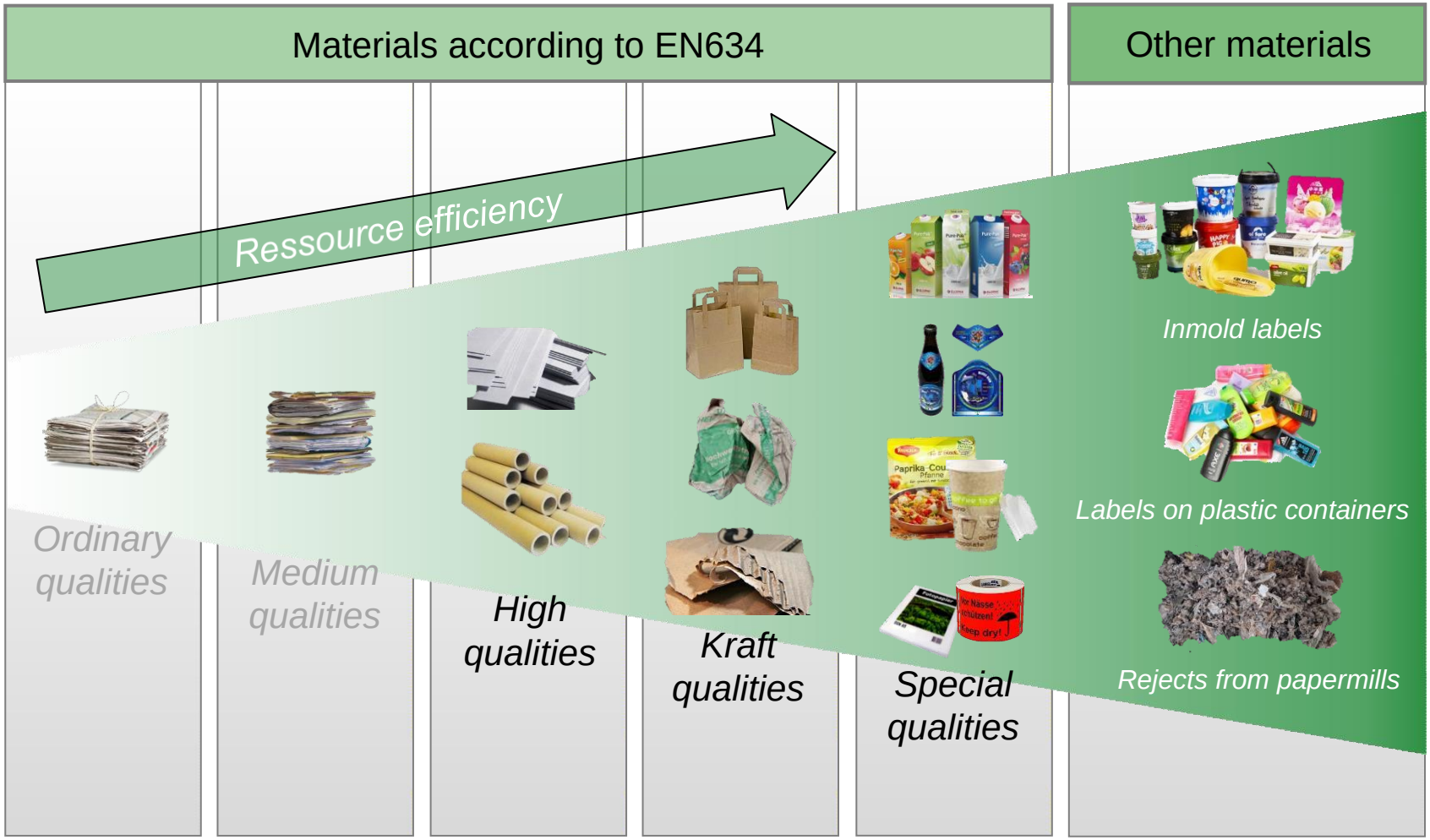
- Minimized fibre damages
- Large-scale seperation of composite materials
- Insertion of additives into the fibre

Up to 50% more
energy efficiency

- Shorter process time
- New, efficient drive concept by direct drive
- Optimized downstream sorting and cleaning process

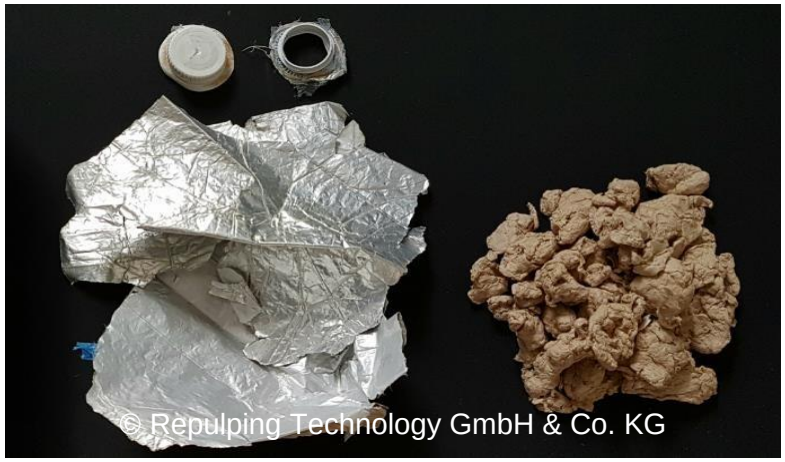
Results and advantages

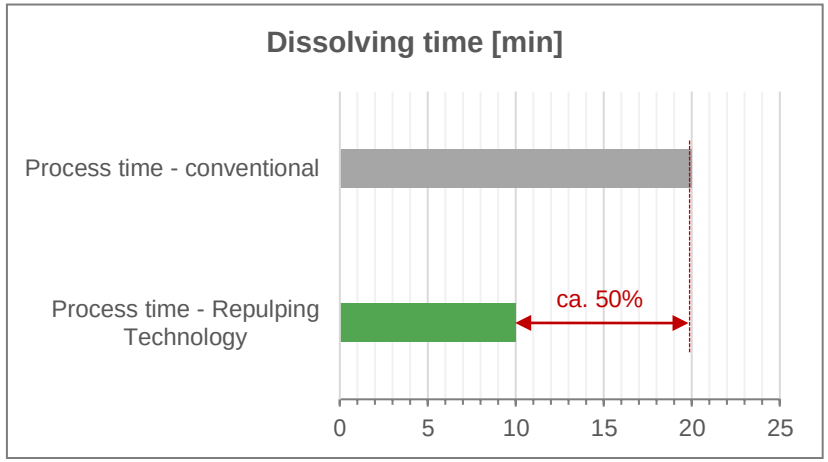
Types of raw materials



Results and advantages

Dissolved samples – used liquid packagingboard





Measured values

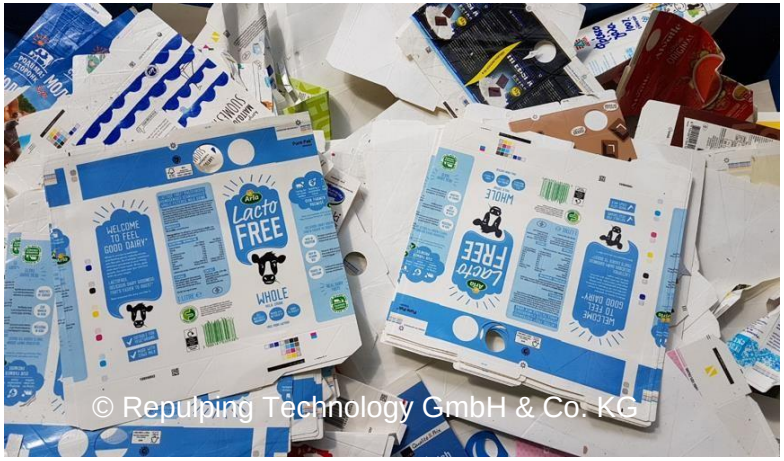
• Dissolving unit:	Field-test-system „V-KSL“
• Process time conv.:	ca. 20 min (1)
• Process time RT:	ca. 7 – 10 min (2)

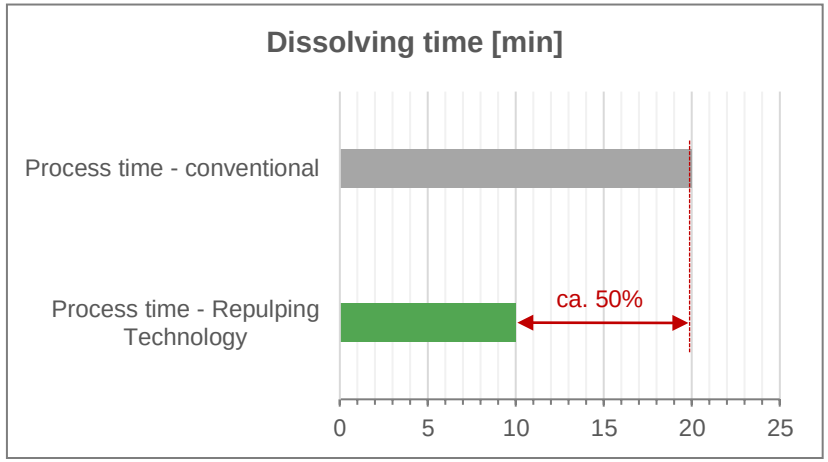
(1) Determined by V-KSL without cavitation

(2) Process time = dissolving time without filling- and emptying process

Results and advantages

Dissolved samples – white LPB (pre-consumer)





Measured values

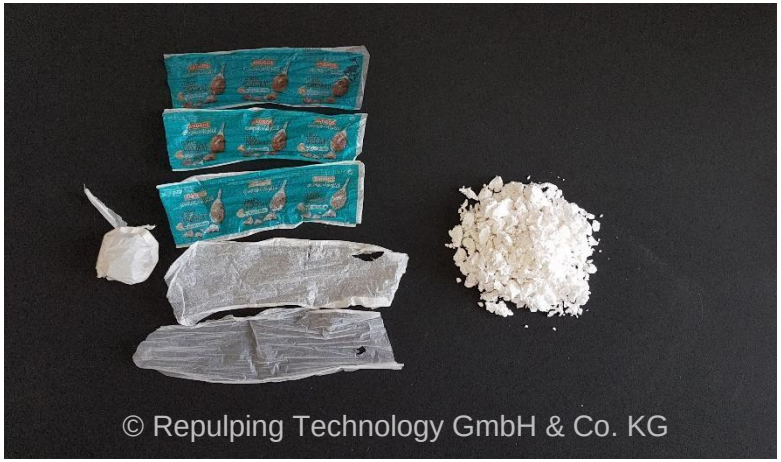
• Dissolving unit:	Field-test-system „V-KSL“
• Process time conv.:	ca. 20 min (1)
• Process time RT:	ca. 7 – 10 min (2)

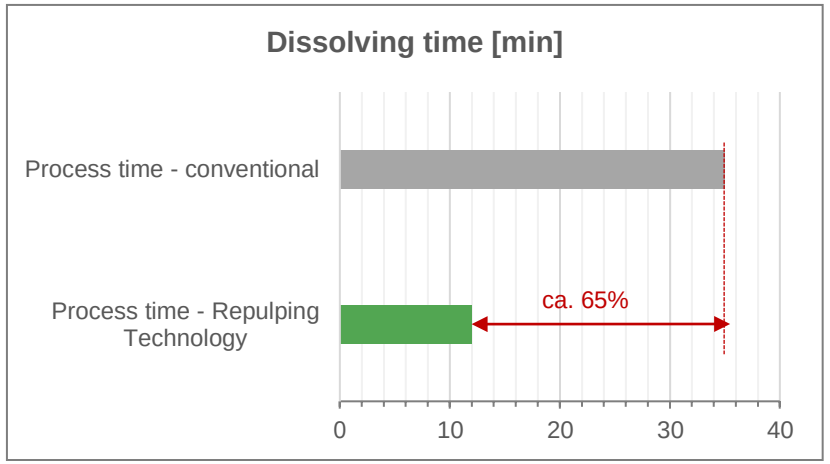
(1) Determined by V-KSL without cavitation

(2) Process time = dissolving time without filling- and emptying process

Results and advantages

Dissolved samples – paper cups (double side PE-coated)





Measured values

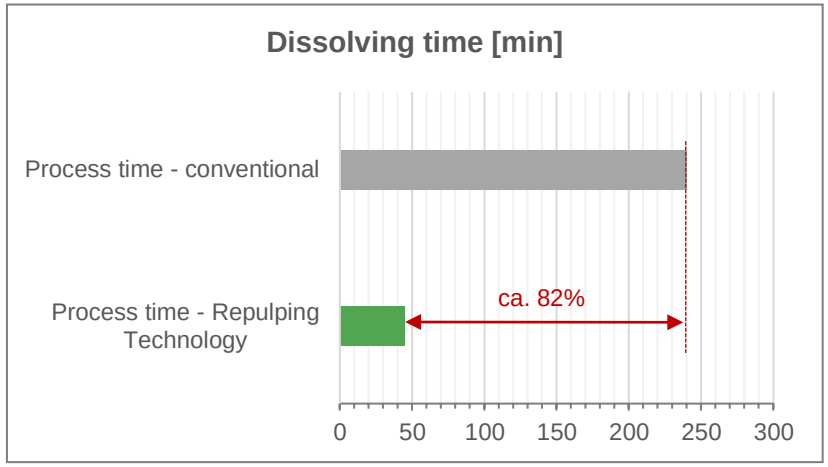
• Dissolving unit:	Field-test-system „V-KSL“
• Process time conv.:	ca. 35 min (1)
• Process time RT:	ca. 9 – 12 min (2)

(1) Determined by V-KSL without cavitation

(2) Process time = dissolving time without filling- and emptying process

Results and advantages

Dissolved samples – wet strength adhesive labels



Measured values

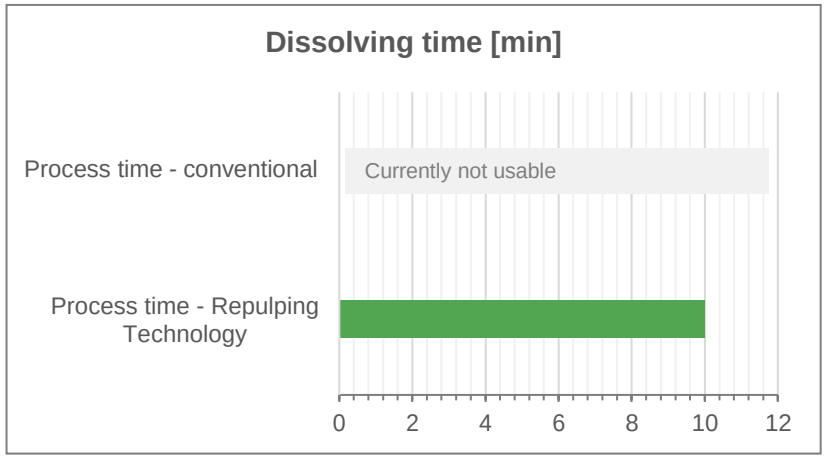
• Dissolving unit:	Field-test-system „V-KSL“
• Process time conv.:	ca. 240 min (1)
• Process time RT:	ca. 41 – 45 min (2)

(1) Determined by V-KSL without cavitation

(2) Process time = dissolving time without filling- and emptying process

Results and advantages

Dissolved samples – paper core (not shredded)



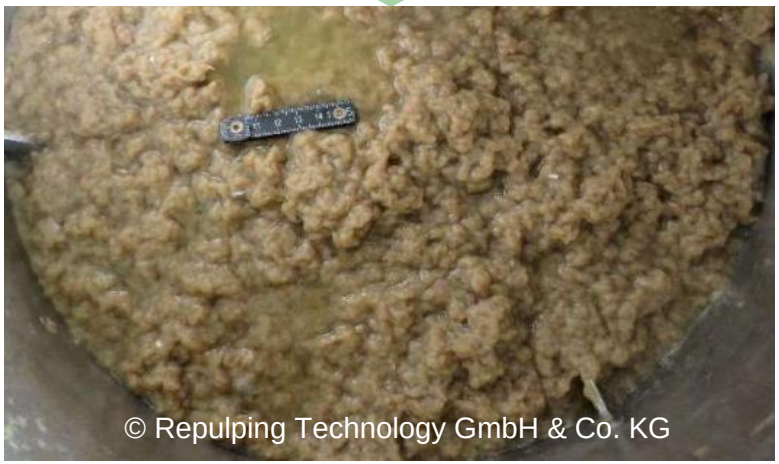
Measured values

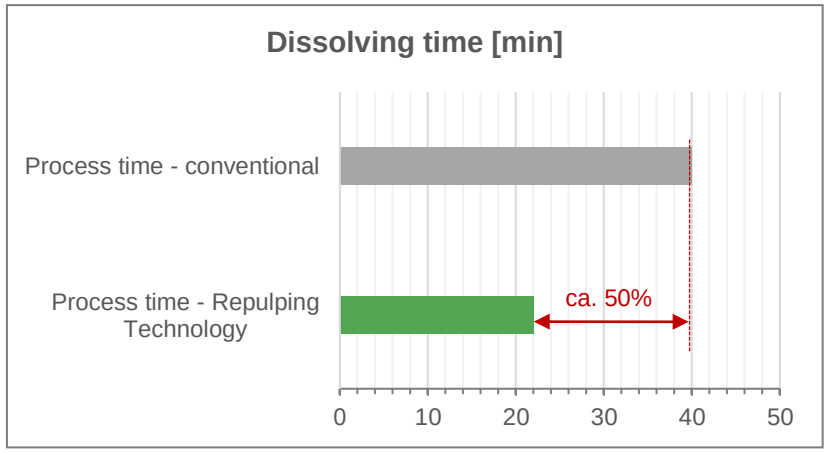
• Dissolving unit:	Field-test-system „V-KSL“
• Process time conv.:	*currently not usable*
• Process time RT:	ca. 7 – 10 min (1)

(1) Process time = dissolving time without filling- and emptying process

Results and advantages

Dissolved samples – feed bags / sacks with PE (notshredded)





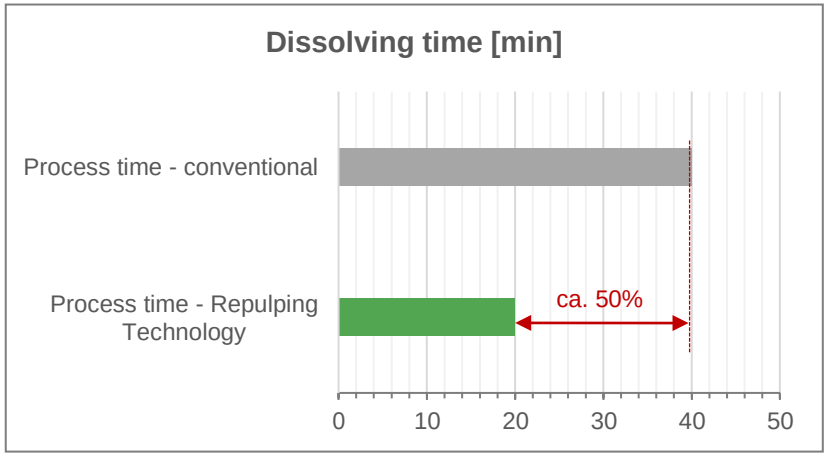
Measured values

• Dissolving unit:	Field-test-system „V-KSL“
• Process time conv.:	ca. 40 min
• Process time RT:	ca. 20 – 22 min (1)

(1) Process time = dissolving time without filling- and emptying process

Results and advantages

Dissolved samples – cement sacks with craft (notshredded)



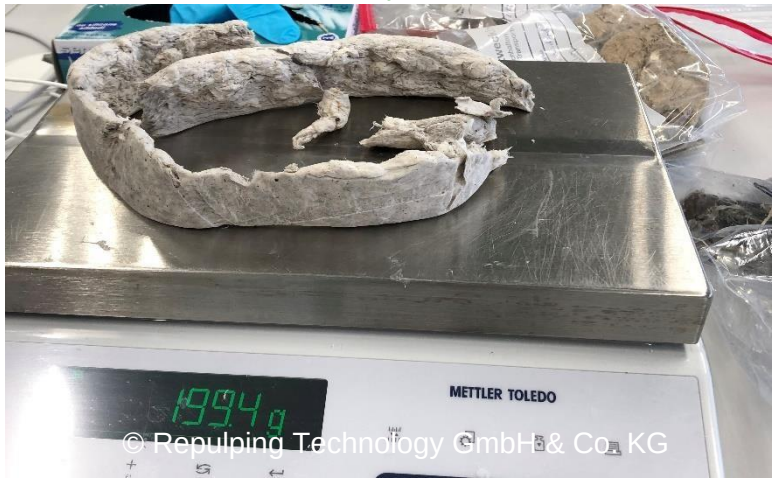
Measured values

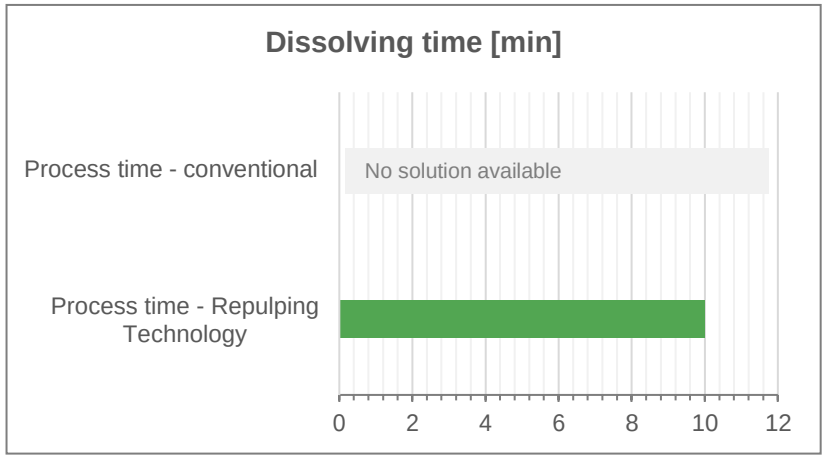
• Dissolving unit:	Field-test-system „V-KSL“
• Process time conv.:	ca. 40 min
• Process time RT:	ca. 17 – 20 min (1)

(1) Process time = dissolving time without filling- and emptying process

Results and advantages

Dissolved samples – fibres from rejects





Measured values

• Dissolving unit:	Field-test-system „V-KSL“
• Process time conv.:	*currently not usable*
• Process time RT:	ca. 10 min [1]

[1] Process time = dissolving time without filling- and emptying process

Results and advantages

Dissolved samples – foils and plastic containers withlabels

Foils with adhesive lables

Altmost fibre free foils, fibres can be recovered

Used plastic containers (not shredded)

Containers without labels, clean and odorless

Test-Equipment

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Your way to energy- and resource efficiency

Three steps to success

Demons-tration

Demonstration of our technology with the lab system – **in cooperation with the „HM Munich“**

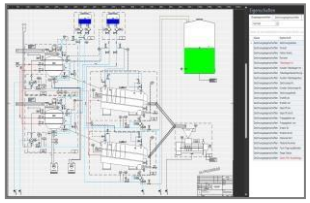
Phase 2

Feasibility study and plannings

Techn. feasibility

- Scope of work
- Tests with field-test-system

Conception



- Proposal for periphery concept
- Budget prices
- Investment calculation

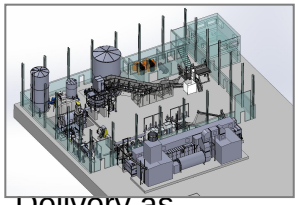
Engineering

- Technical design for mass flux and components
- Basic engineering
- Final offer

Phase 3

Project

Delivery contract



Delivery as Turnkey-Provider from manufacturing to operation and support

NDA → Framework contract → Individual contract

Your way to energy- and resource efficiency

Tech. feasibility with field-test-system (V-KSL)

Our field-test-system is available **for technical feasibility** under real production conditions

Capacity

- Net volume: about 1 m^3
- Batch: about 100 kg raw material

Technology

- Fully automatic operation
- Additional periphery possible (for example washing drum)

Application

- Usable for long-term tests to proof the technical feasibility
- Mobile usage

Your way to energy- and resource efficiency

Tech. feasibility with field-test-system (V-KSL)

Test setup with V-KSL and washing drum

V-KSL incl. equipment

Setup for fibre dewatering after washing drum

Washing drum for reject treatment

Services & Engineering

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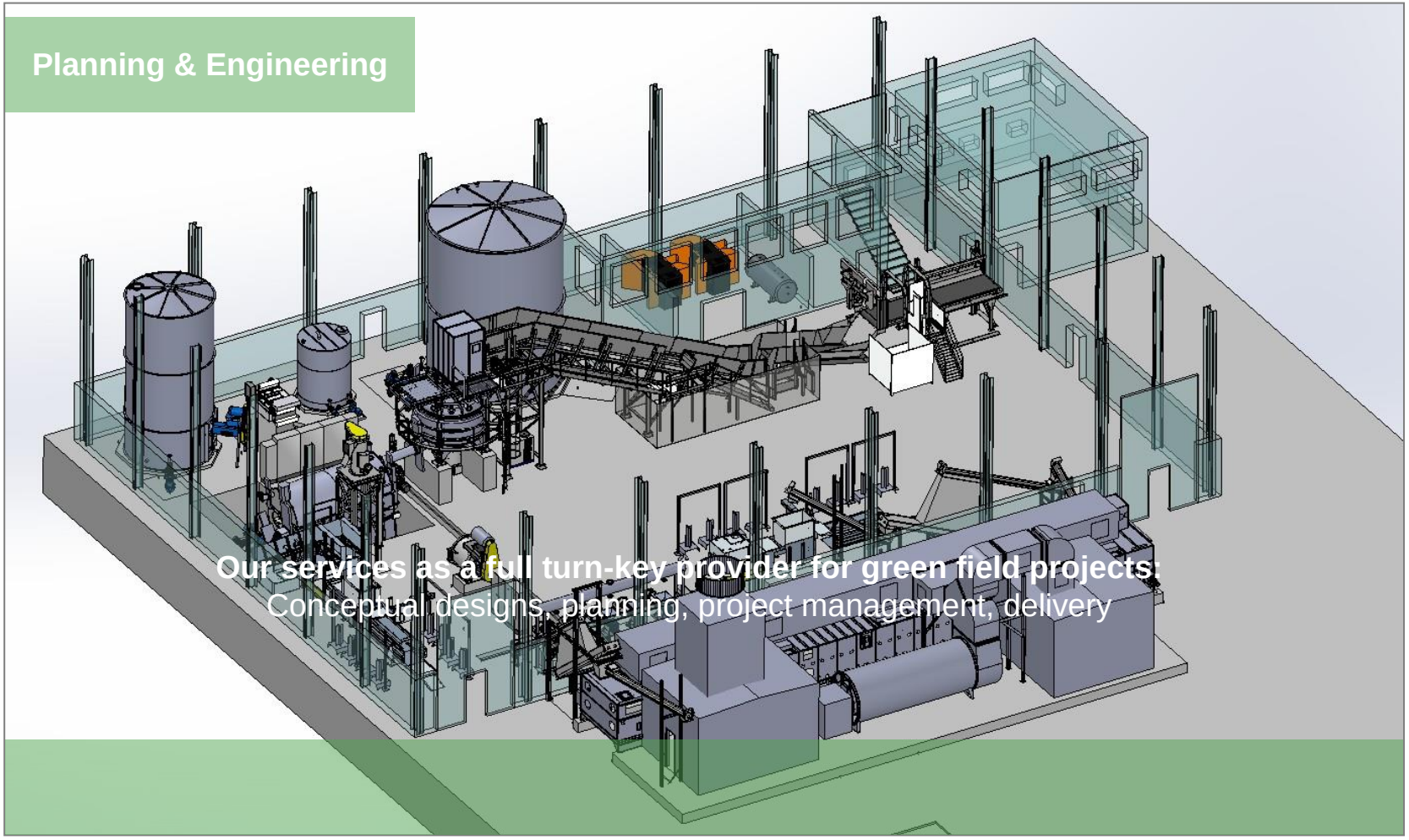
Services & Engineering

Mechanical treatment plant for LBP/UBC recycling



Services & Engineering

Mechanical treatment plant for LBP/UBC recycling

Thank you for your attention!

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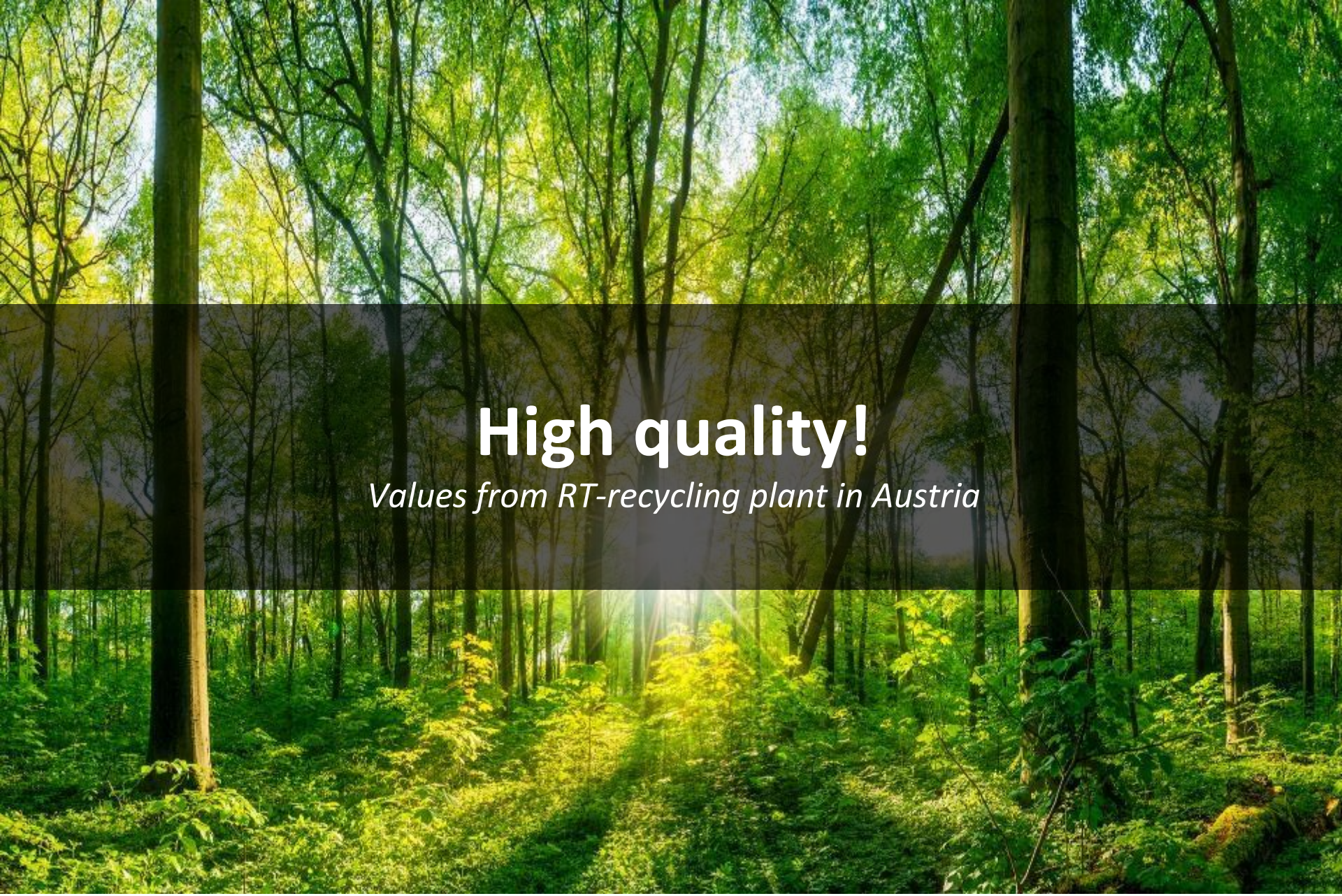
Winner of the EUROPEAN PAPER RECYCLING AWARD 2019

LEITPROJEKT 2019

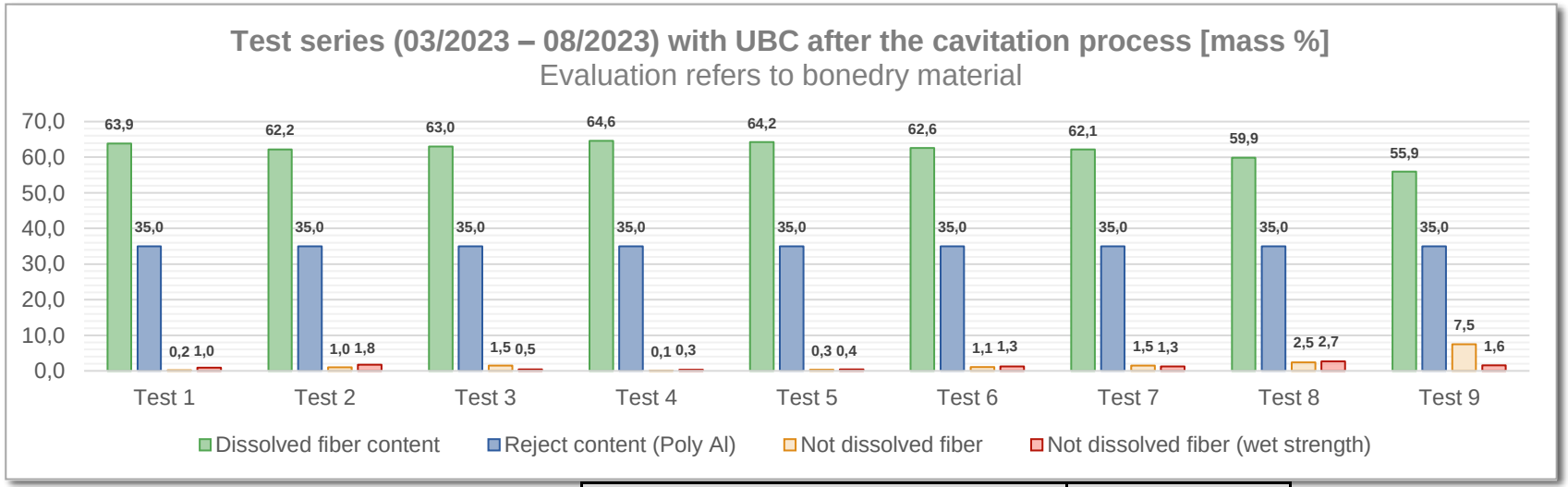


High quality!

Values from RT-recycling plant in Austria

High quality – Desintegration with cavitationpulper

Fiber yield (recycling plant in Austria)



Designation	Average [%]
Dissolved fiber content	62,1
Not dissolved fiber	1,7
Not dissolved fiber (wet strength)	1,2
Reject content	35,0
Total	*100%*

RT-process fiber yield > 97%

High quality - Rejects

Reject quality from RT-process (recycling plant in Austria)

Plant in Austria

Future standard

INPUT
E.g. UBC-material

RT-Process
Dissolution of raw mat.

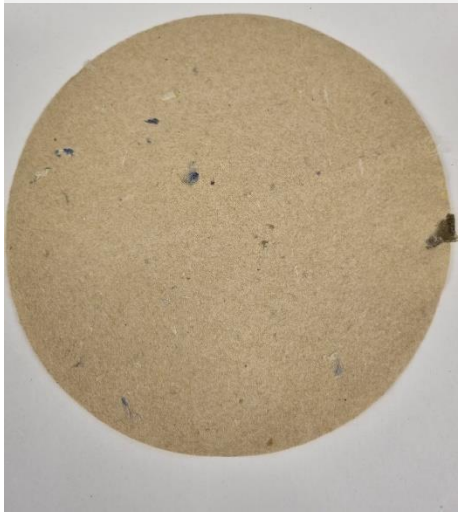
Reject washing St.1
Washing drum

Reject washing St.2
Friction washer

High quality - Fibers

Flakes content (recycling plant in Austria)

After cavitation pulper process



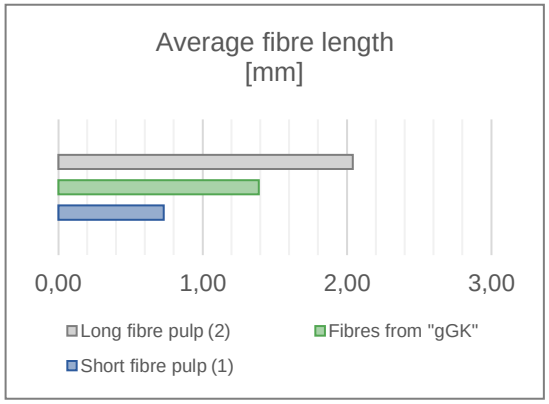
After coarse screening

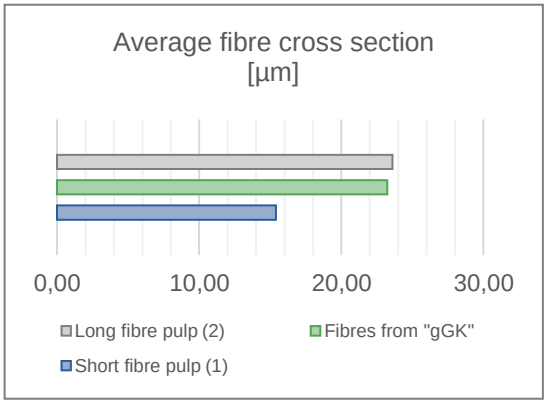
Test series with UBC	Average flake content [%]
Cavitation pulper	5,6
After coarse screening (RT plant Austria)	1,3

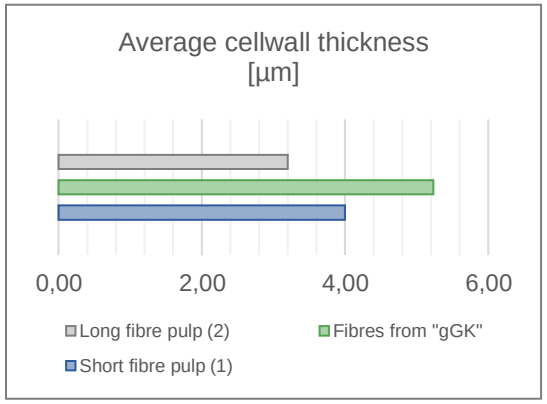
RT-process flakes content < 2%

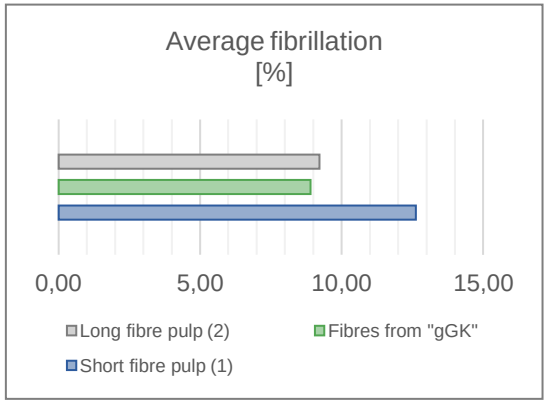
High quality - Fibers

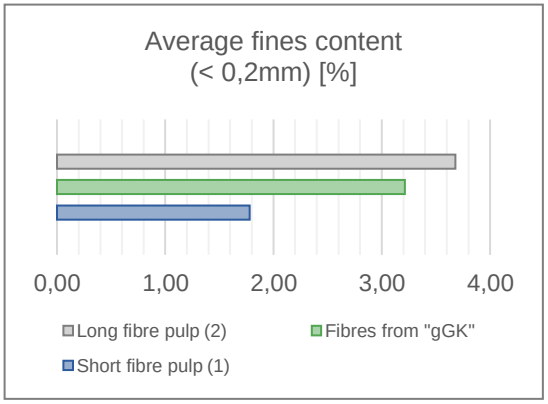
Fiber analytics (from UBC´s) – comparison with virgin kraft fiber









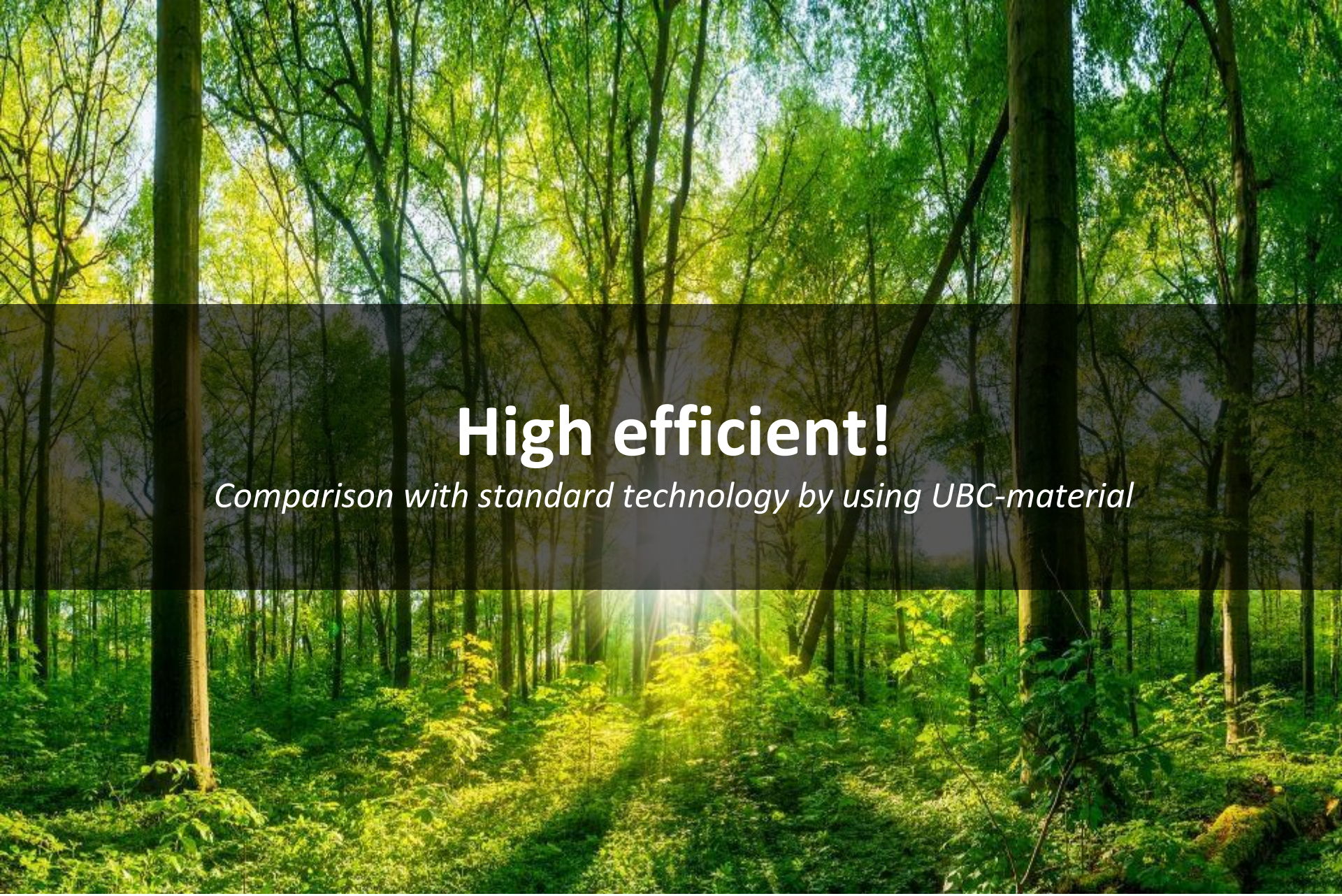


Conclusion: the fibre quality of used liquid board packaging (LPBs) after the RT-process is (still) relative high. The characteristics and qualitys of the fibres have partly a higher level then short fibre pulp.

The fibers from „gGK“ were produced by tests with the RT laboratory system

(1) Short fibre pulp „South American BHK hard wood kraft pulp“

(2) Long fibre pulp „European NBSK“



High efficient!

Comparison with standard technology by using UBC-material

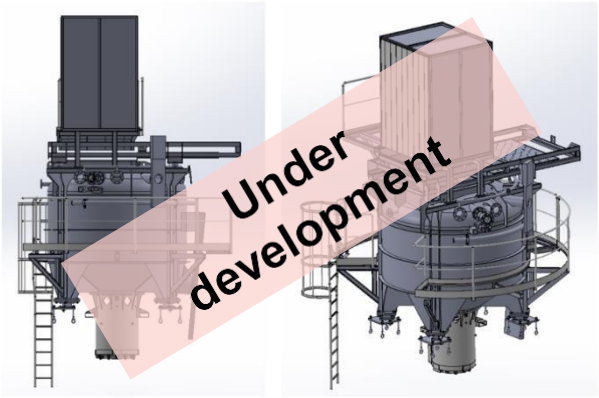
High efficiency – Cav. Pulper improvements

Comparison of standard HC-pulper and RT-Technology

KSL – Generation 1

first installed plant

- Installed in Austria – in operation since 2022
- Further equipment: 1-step reject washing (customer requirement, not our standard)



KSL – Generation 2

new standard design

- Further improved energy- and efficiency balance
- Improved vacuum process
- Improved rotor design
- Improved filling- and discharge processes
- Standard for further projects: 2-step reject washing

High efficiency – Desintegration & washing

Illustration of a batch (reject washing parallel)

Bale dewiring | Feed belt | **RT-process** | **Reject washing St.1** | Reject washing St.2 | Reject handling | Pulp storage | Coarse screening | Fiber handling

RT-Process
Cavitation pulper (KSL)

Filling
ca. 2 min

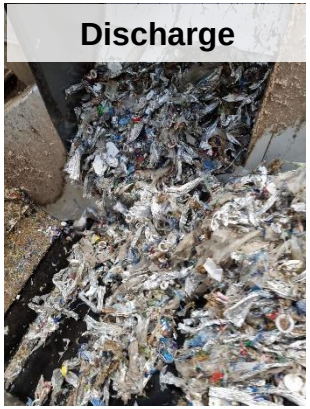
Process
ca. 12,6 min

Discharge
ca. 2,5 min

Reject washing St.1
Washing drum

Washing process

Discharge

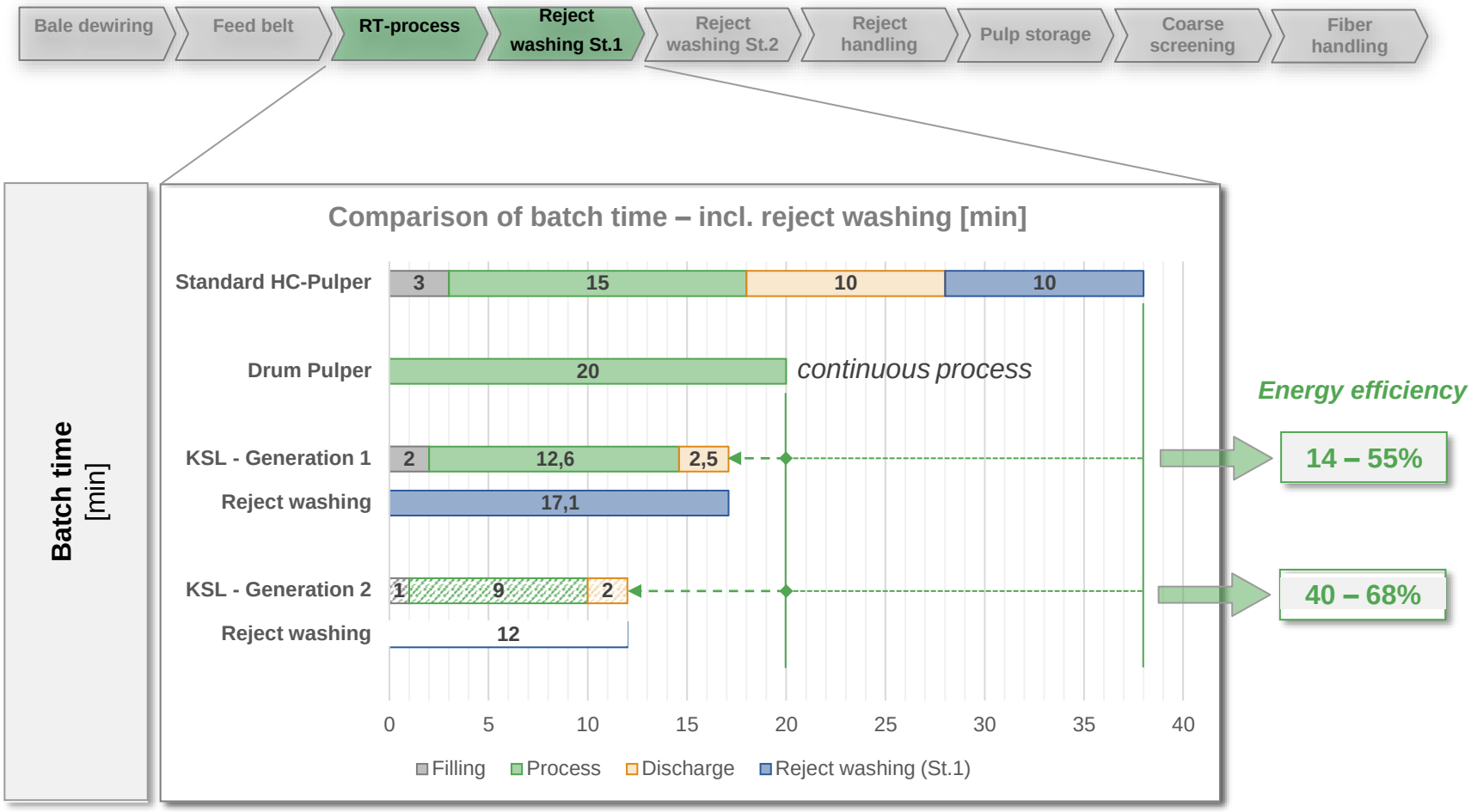


1 Batch (parallel)
RT-process + Reject washing step 1

Batchtime ~ 17min

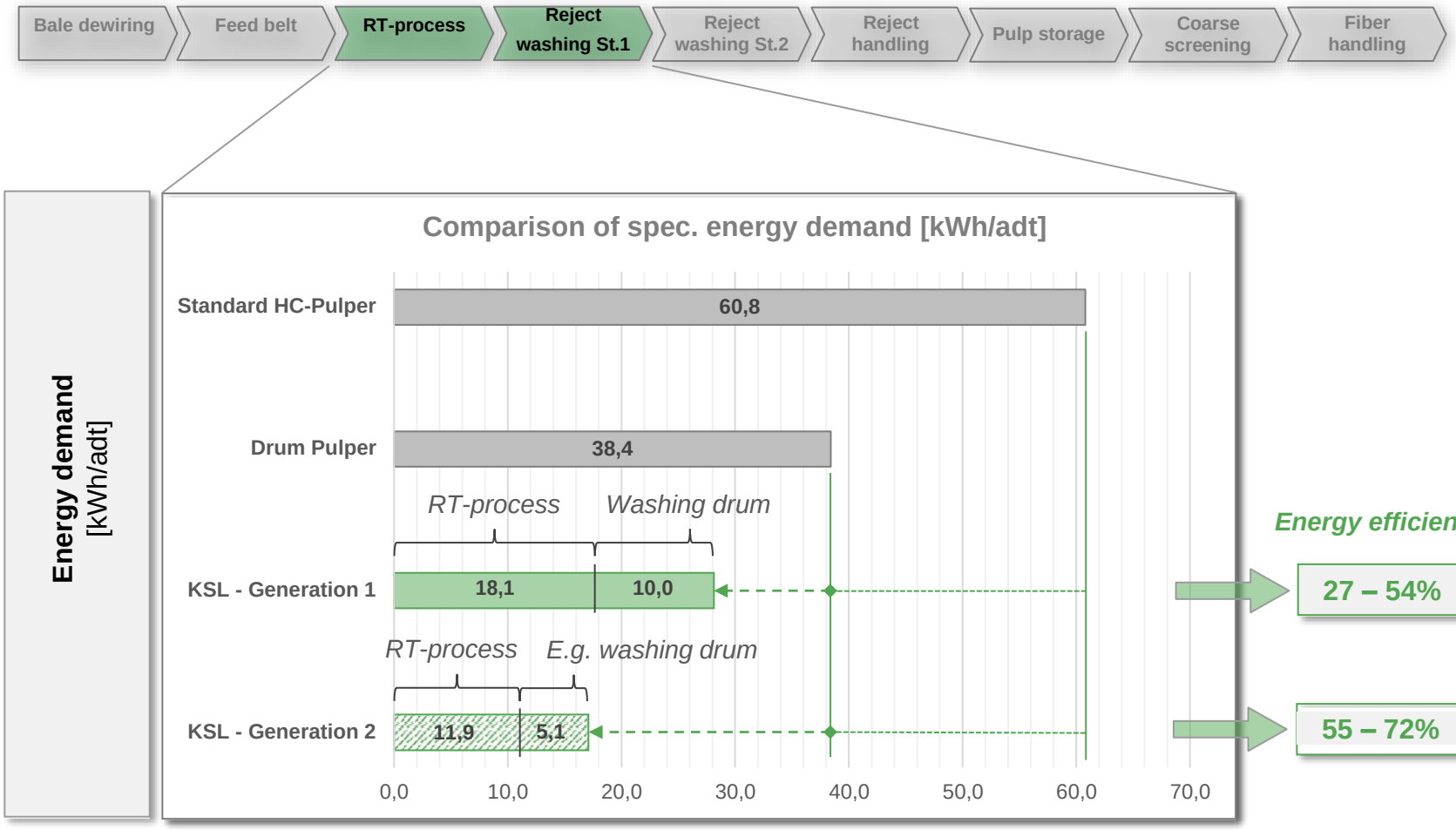
High efficiency – Desintegration &washing

Comparison of standard HC-pulper and RT-Technology



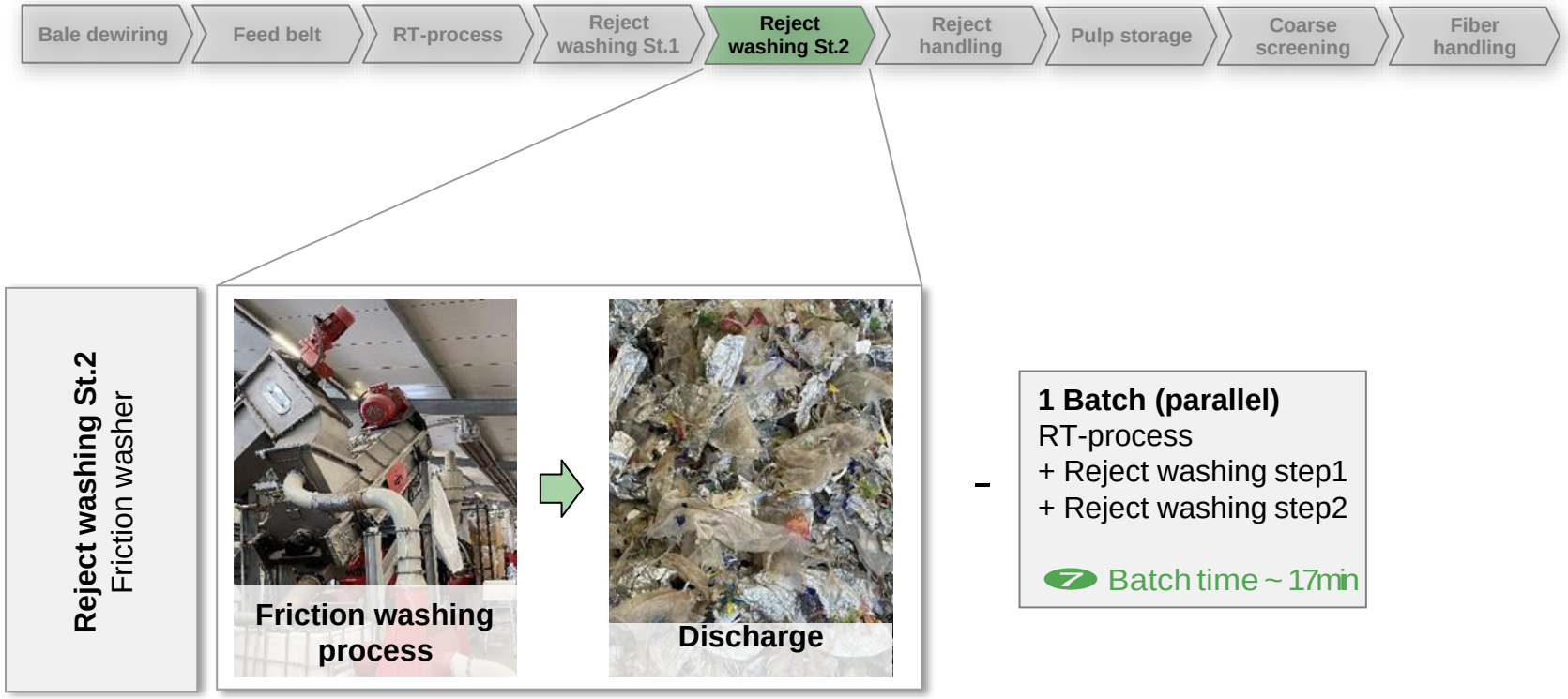
High efficiency – Desintegration &washing

Comparison of standard HC-pulper and RT-Technology



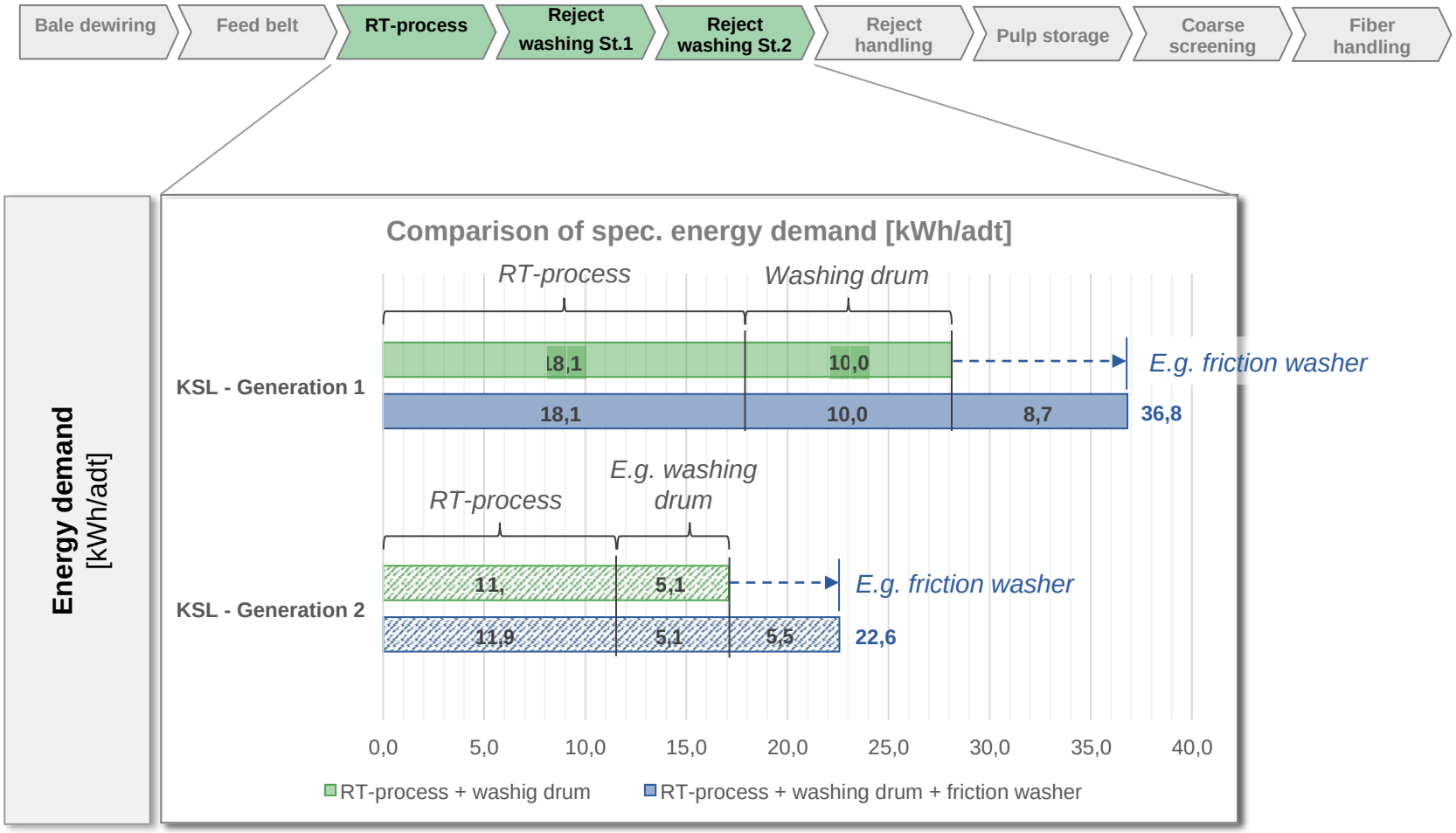
High efficiency – Desintegration & washing

Illustration of a batch (reject washing parallel)



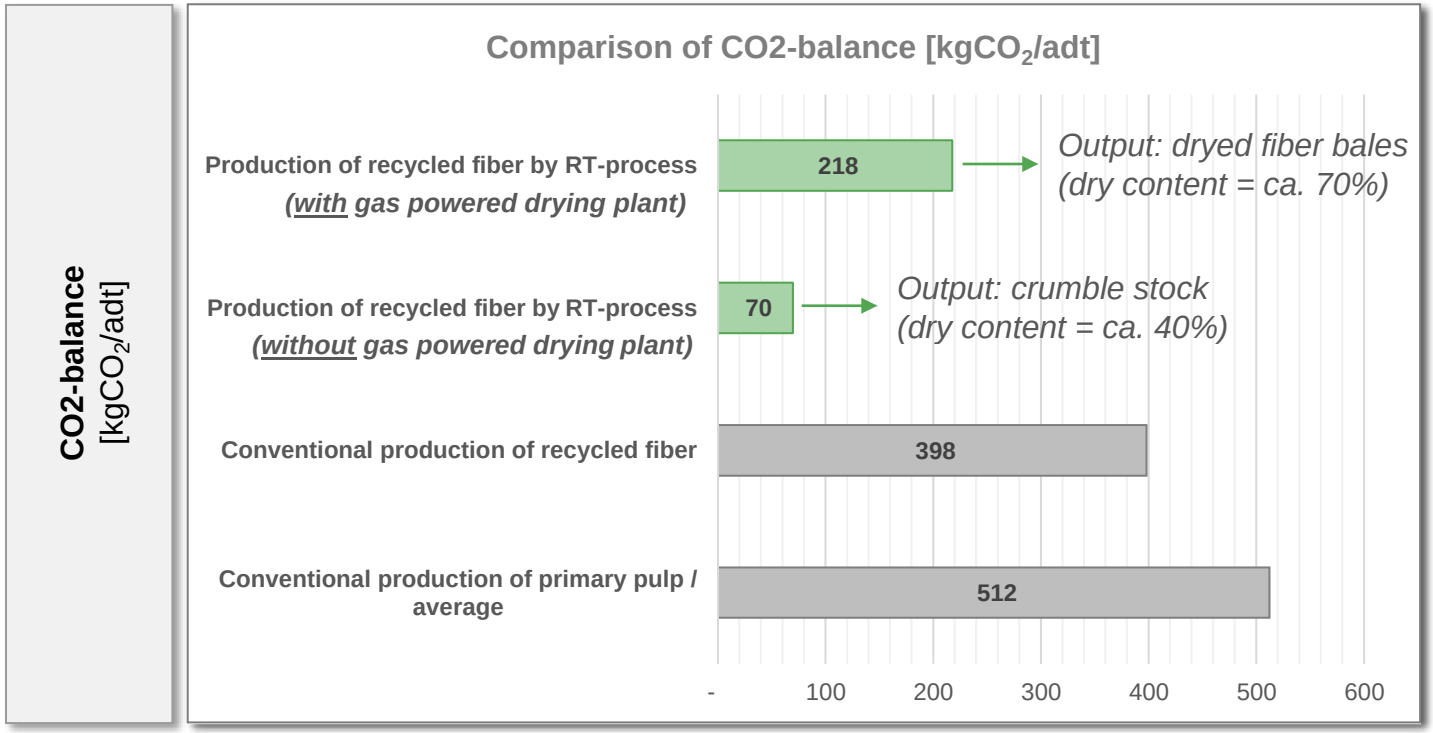
High efficiency – Desintegration & washing

Energy demand for complete reject washing



High efficiency – Overall plant emissions

Comparison of CO_2-balance

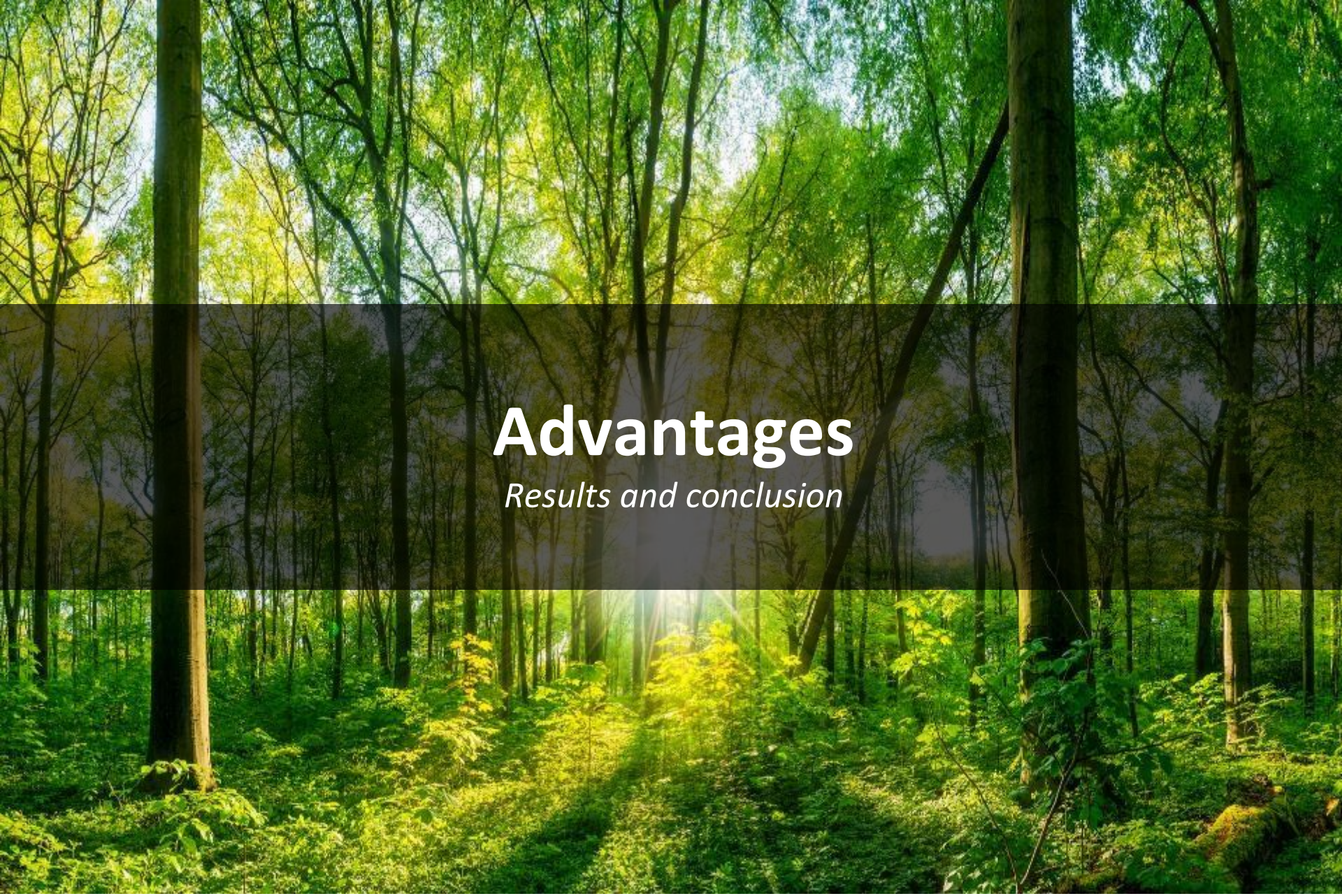


Please note:

- RT-calculation is based on values from the installed RT-plant in Austria
- RT-calculation is based on the german electricity mix = 0,4 $kgCO_2$/kWh

Source of CO_2 emission (conventional production):

- University of Bonn-Siegen, study of 2017
- Forschungsgesellschaft für Energiewirtschaft, study of 2018

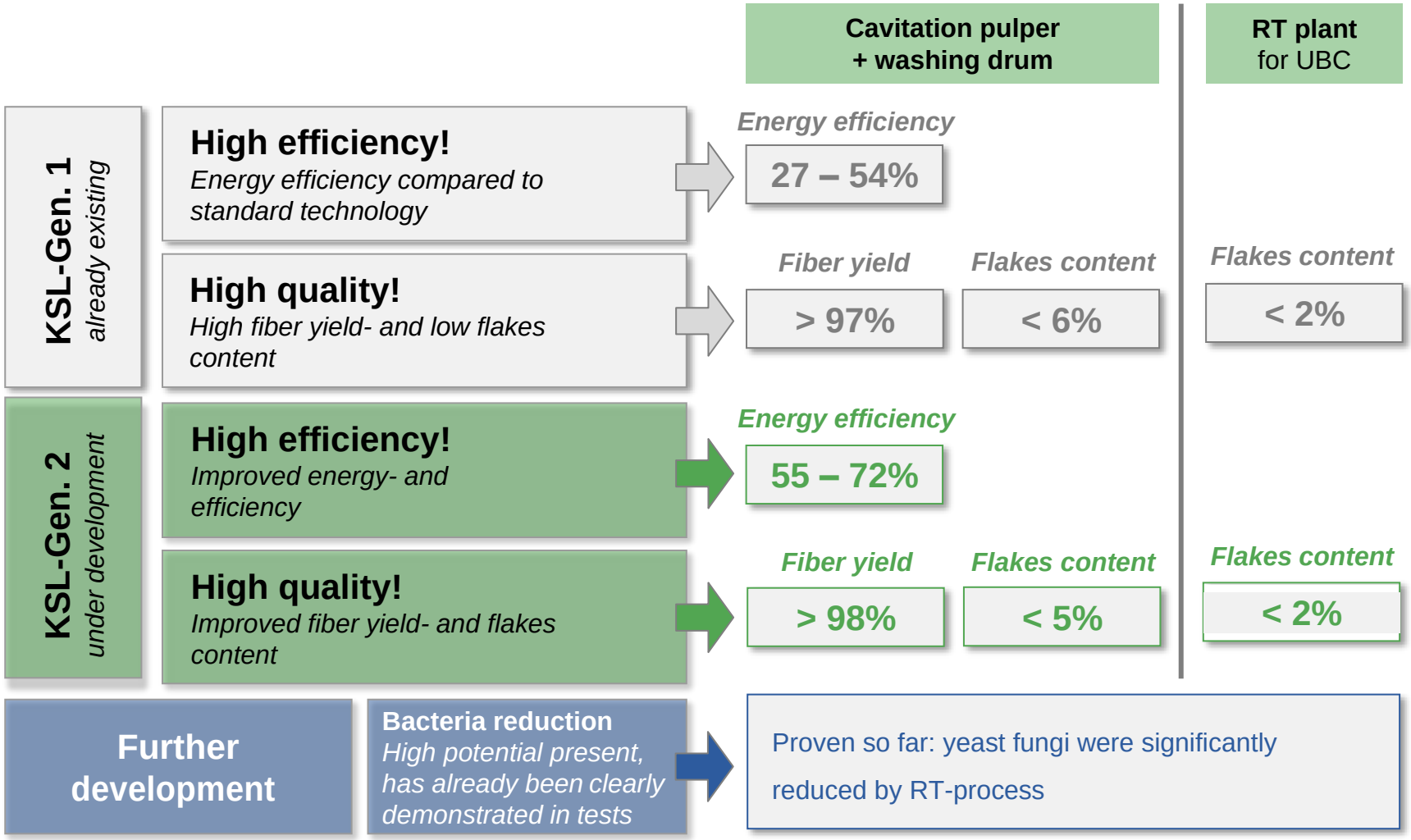


Advantages

Results and conclusion

Results and conclusion

Advantages (material for comparison: UBC)



Scope of Delivery

Brownfield vs. greenfield projects

Brown field
Integration in existing peripherie



Scope of delivery „brown field“

- Cavitation pulper
- Reject washing St.1 (e.g. washing drum)
- Reject washing St. 2 (e.g. friction washer)

Designation	Unit	Design-capacity	
		40.000 adt/a	80.000 adt/a
Installed power	[MW]	ca. 0,3	ca. 0,5
Energy demand / year	[GWh/a]	ca. 1,7	ca. 2,2
Spec. energy demand / ton	[kWh/adt]	ca. 36,8	ca. 26,8

Scope of Delivery

Brownfield vs. greenfield projects

Green field
Complete fiber-recycling plant

Scope of delivery „green field“

- Pulper feeding (feed belt)
- Cavitation pulper + peripherie
- 2-step reject washing
- Reject handling (e.g. reject press)
- Coarse screening
- Fiber dewatering + fiber drying
- Auxiallary equipment (pumps, etc.)

Designation	Unit	Design-capacity	
		40.000 adt/a	80.000 adt/a
Installed power	[MW]	ca. 1,2	ca. 2,0
Energy demand / year	[GWh/a]	ca. 4,8	ca. 7,5
Specific energy demand / ton	[kWh/adt]	ca. 102	ca. 100

Back-up
Pilot plant Austria

Innovative Pulper Technology for Resource Efficiency

Repulping Technology

Current status

First RT-recycling plant in Austria

Project UBC-recycling plant in Austria

<u>Project requirements</u>

- Focus on throughput (4,8 t/h), fiber extraction and fiber quality

<u>Current status</u>

- Cavitation pulper succesfully in operation – quality targets achieved to 100%
- Identification of further energy optimization

Current status

Operating recycling plant: Output fiber fraction

Variant 1: Crumble stock

- Output as bulk material directly after pulp dewatering
- Dry content = ca. 30 – 40%
- Reject content < 0,5%
- Quality target achieved

Variant 2: Fiber bales

- Output in pressed form (bales) after the drying plant
- Dry content = ca. 60 – 90%
- Reject content < 0,5%
- Quality target achieved

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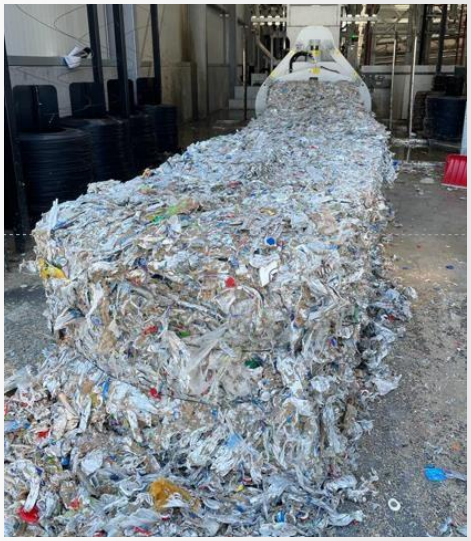
Current status

Operating recycling plant: Output / Optimization reject fraction

First customer requirement
1-stage reject aftertreatment (washing drum)

Implementation after initial planning

- Reject not completely free of fibers
- Focus = thermal rejects utilization



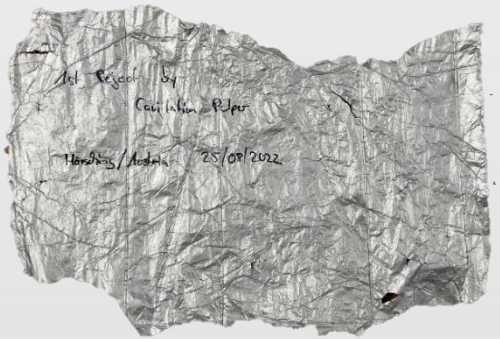
New customer requirement / currently in planning
2-stage reject aftertreatment (washing drum + additional reject washing)

Optimization: additional installation

- Second washing stage and process water treatment

Objective of the optimization

- Fiber content < 3% in the rejects
- Prerequisite for complete PolyAl treatment
- **Target: closed-loop and full mechanical recycling!**



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Vielen Dank FÜR Ihre Aufmerksamkeit!

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