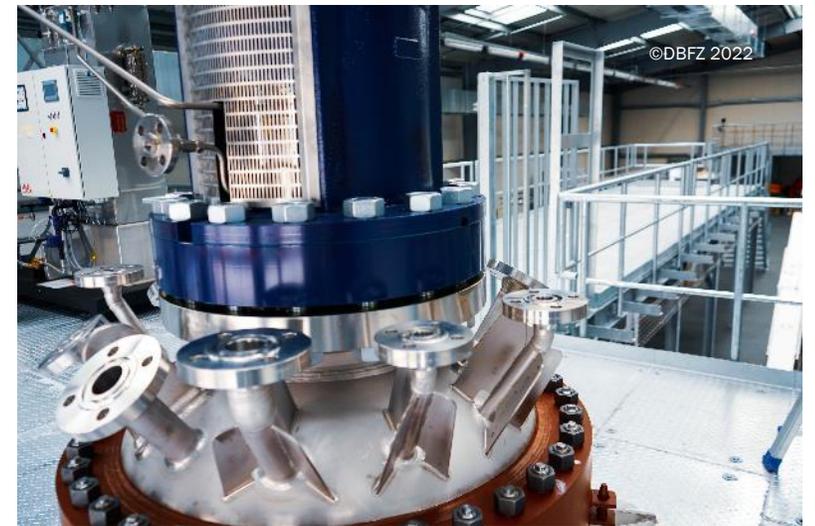




# Development of a hydrothermal multi-purpose reactor

within a pilot-scale biorefinery concept for fuel production from biogenic residues

## Project Pilot-SBG

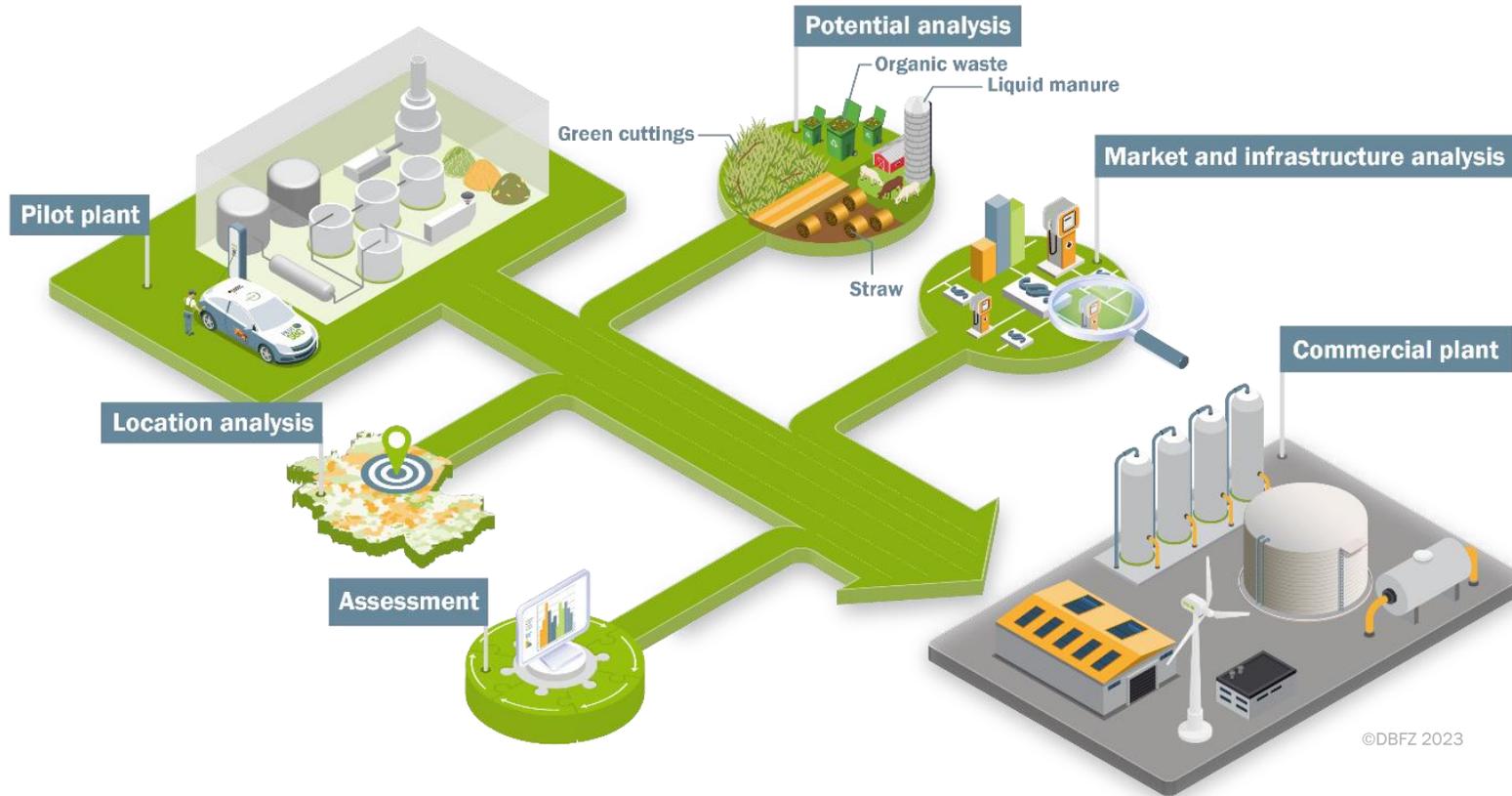


Philipp Knötig, Benjamin Herklotz, Hendrik Etzold, Timo Zerback, DBFZ Deutsches Biomasseforschungszentrum gemeinnützige GmbH, 3rd International Symposium on Hydrothermal Carbonization, May 13<sup>th</sup>, 2023

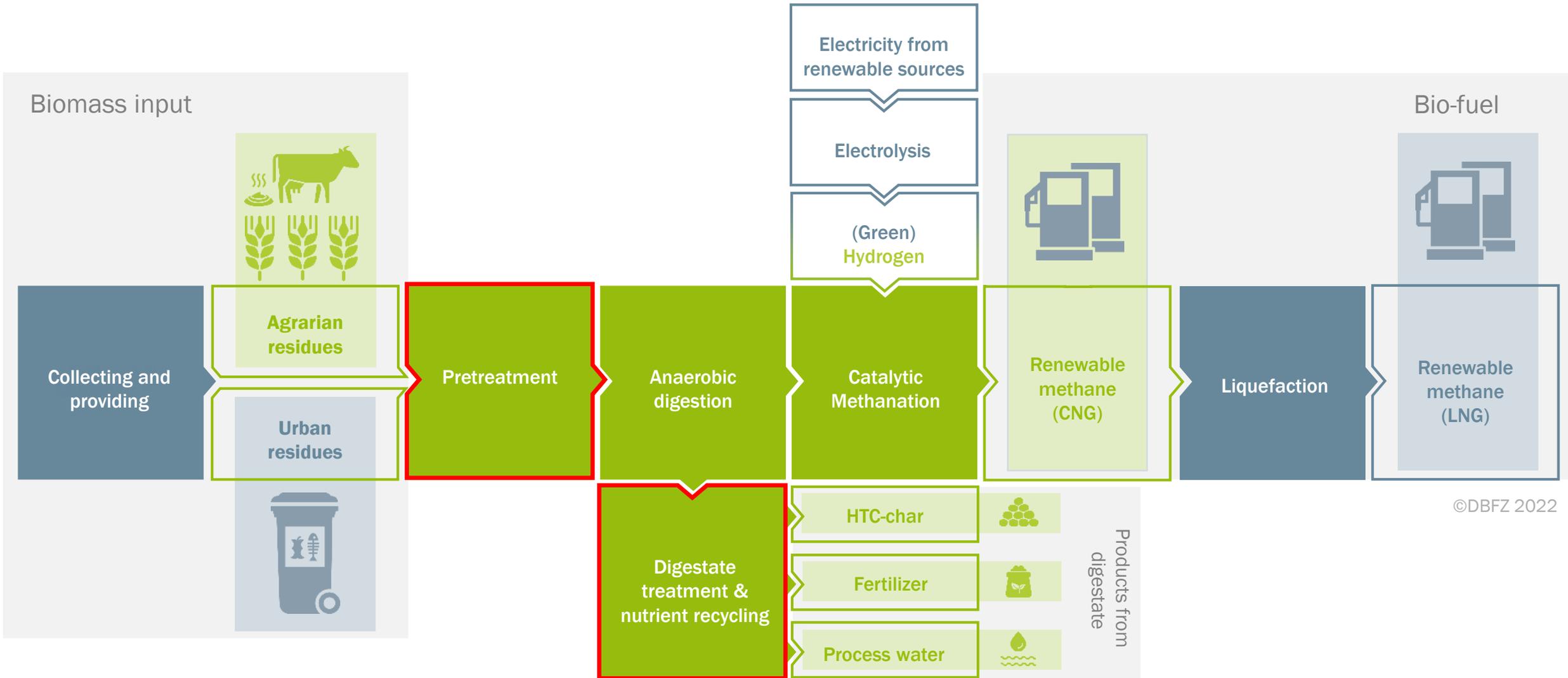
Financed by



# Project Pilot-SBG Overview



# (Pilot) plant concept



# Hydrothermal pre-treatment

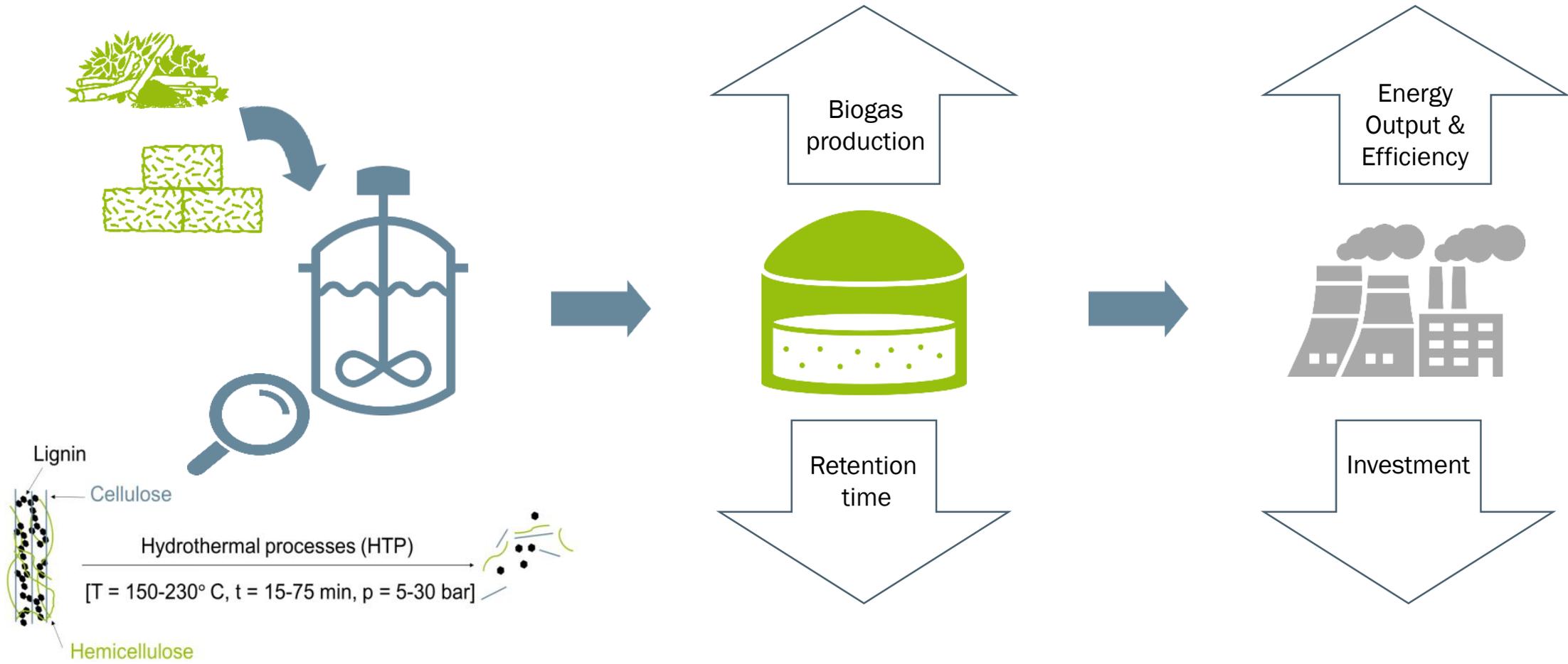


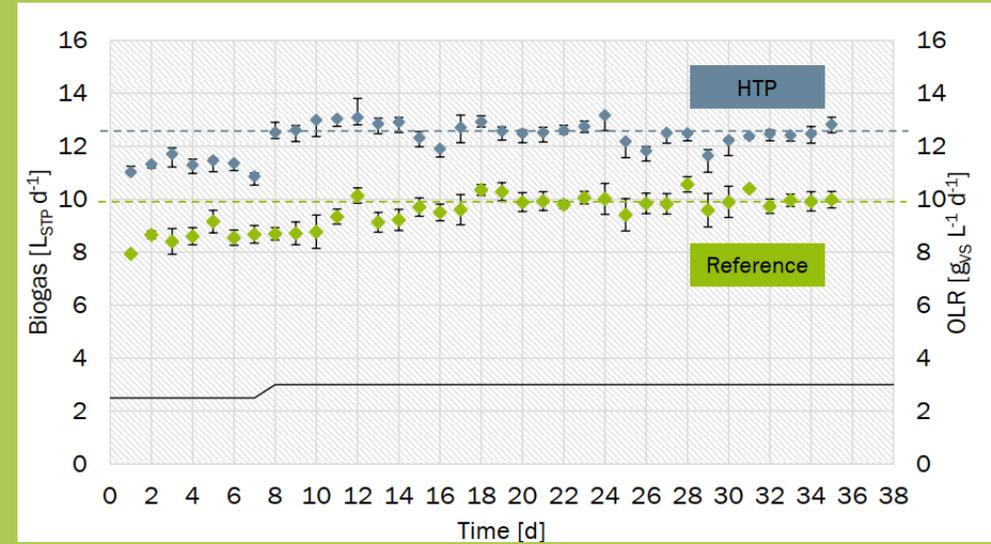
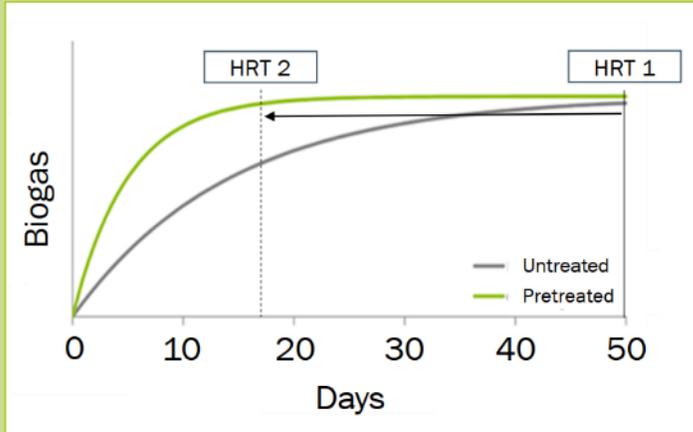
Fig. 1

# HT pre-treatment: Lab tests with wheat straw\*/manure/water mix

Batch tests

Experiment °C/min	BMP [mL·g <sup>-1</sup> VS]	Acetic Acid [mg L <sup>-1</sup> ]	Formic Acid [mg L <sup>-1</sup> ]	Inhibitors	
				Furfural [mg L <sup>-1</sup> ]	...
Untreated	261 ± 15				
160/15	302 ± 17	627 ± 12	85 ± 1	14 ± 2	
160/45	310 ± 14	826 ± 23	114 ± 3	41 ± 9	
170/30	299 ± 14	1079 ± 18	161 ± 12	66 ± 6	
180/15	298 ± 9	1252 ± 21	210 ± 4	88 ± 5	
180/45	289 ± 9	1627 ± 16	368 ± 3	368 ± 11	

Kinetics



Continuous tests

HT pre-treatment is potentially able to contribute to optimize a biorefinery concept regarding overall efficiency through:

- ... reduction of the retention time in AD
  - increase plant efficiency
  - smaller equipment needed
- ... increase of the overall biogas production



\*only the wheat straw was pre-treated under HTP conditions and afterwards mixed with manure and water (50/50 m.% straw/manure)

# Hydrothermal carbonization (HTC)

Energetic use of hydrochar

Increased HHV through more desirable H/C and O/C ratios

Nutrient recycling

Phosphorus shift from char to process water

Improved sludge dewatering

Energy savings in subsequent thermal drying processes

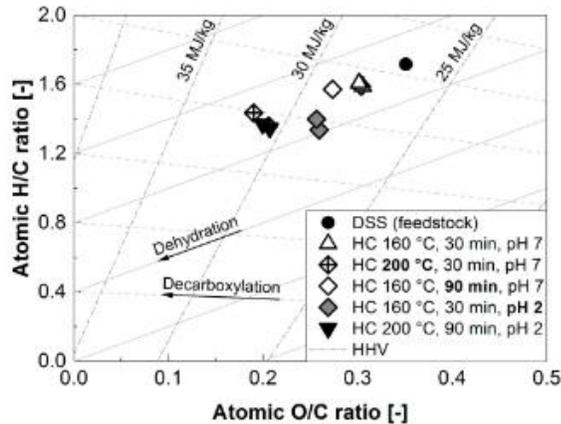


Fig. 1 - Van-Krevelen-diagram of selected hydrochars and digested sewage sludge at different process conditions

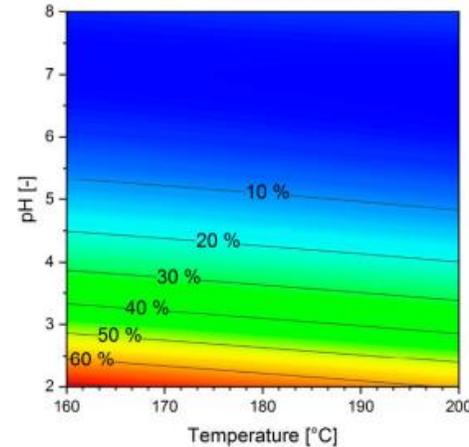


Fig. 2 - pH and reaction temp. influence on liquid phase phosphorus release (% of total P)

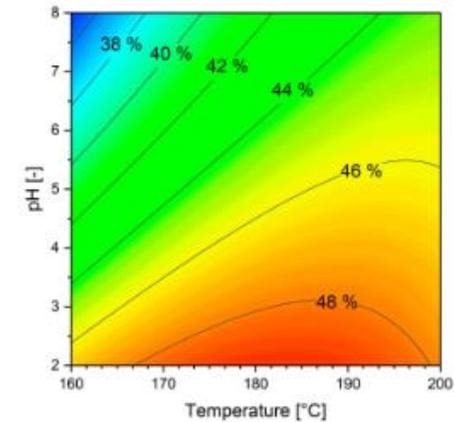
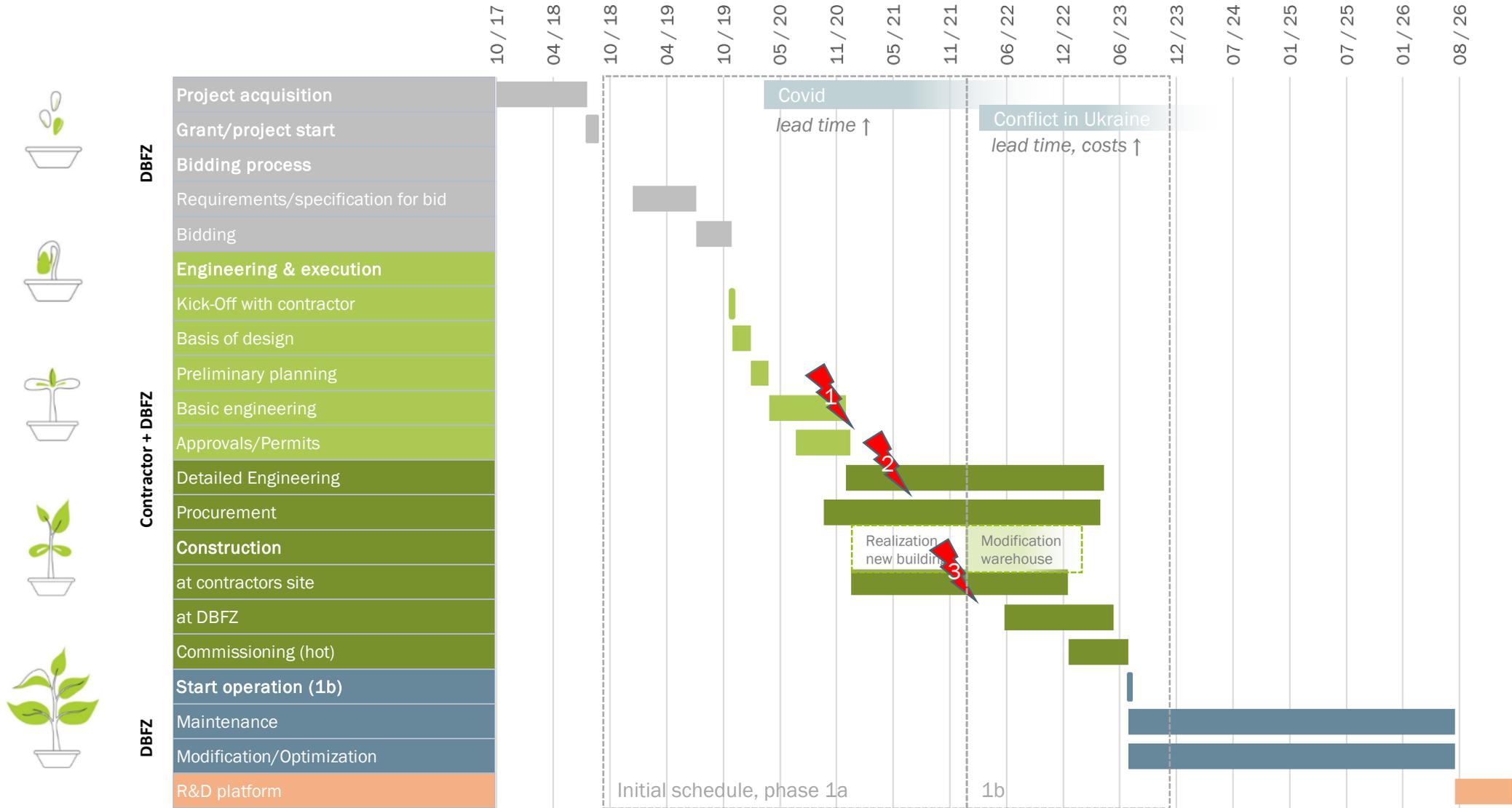
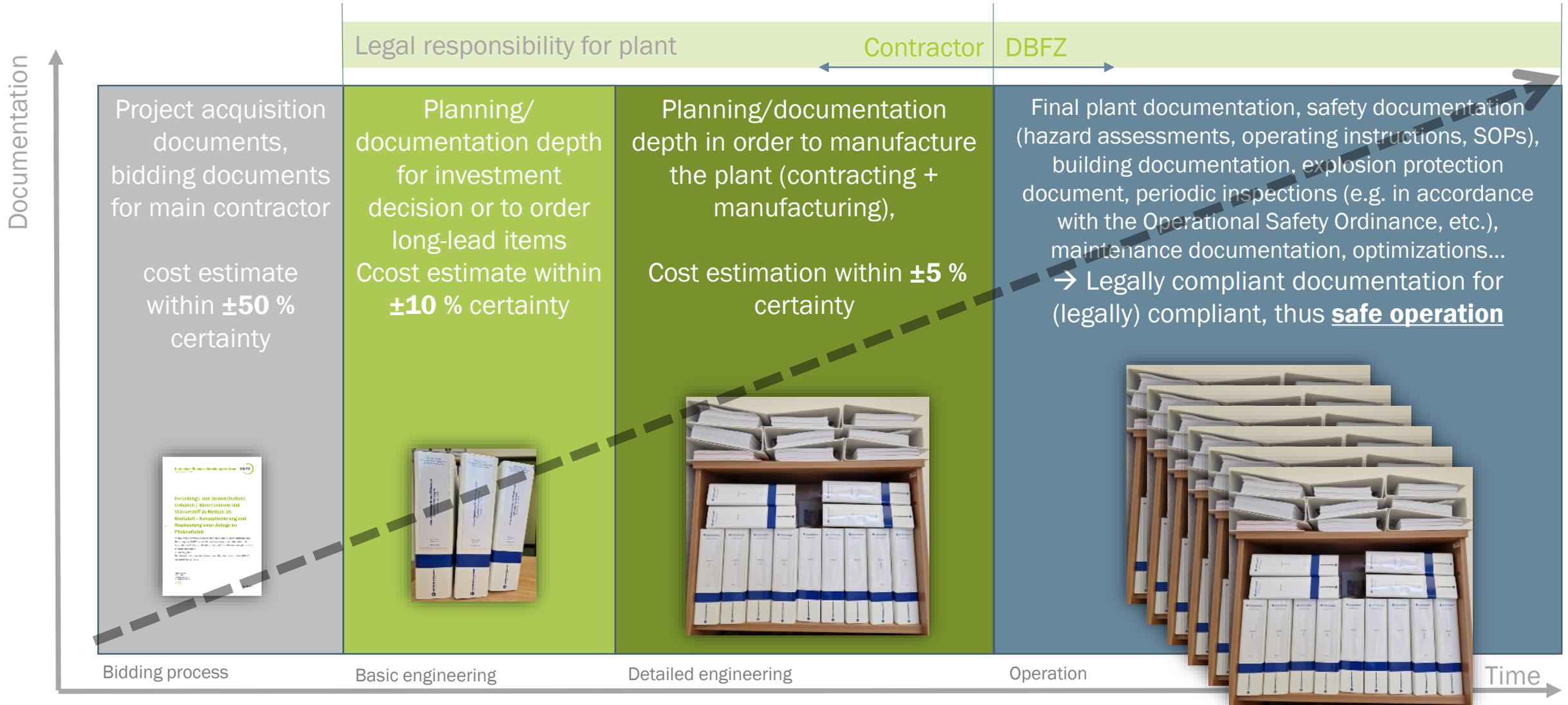


Fig. 3 - pH and reaction temp. influence on dry matter content after mechanical dewatering

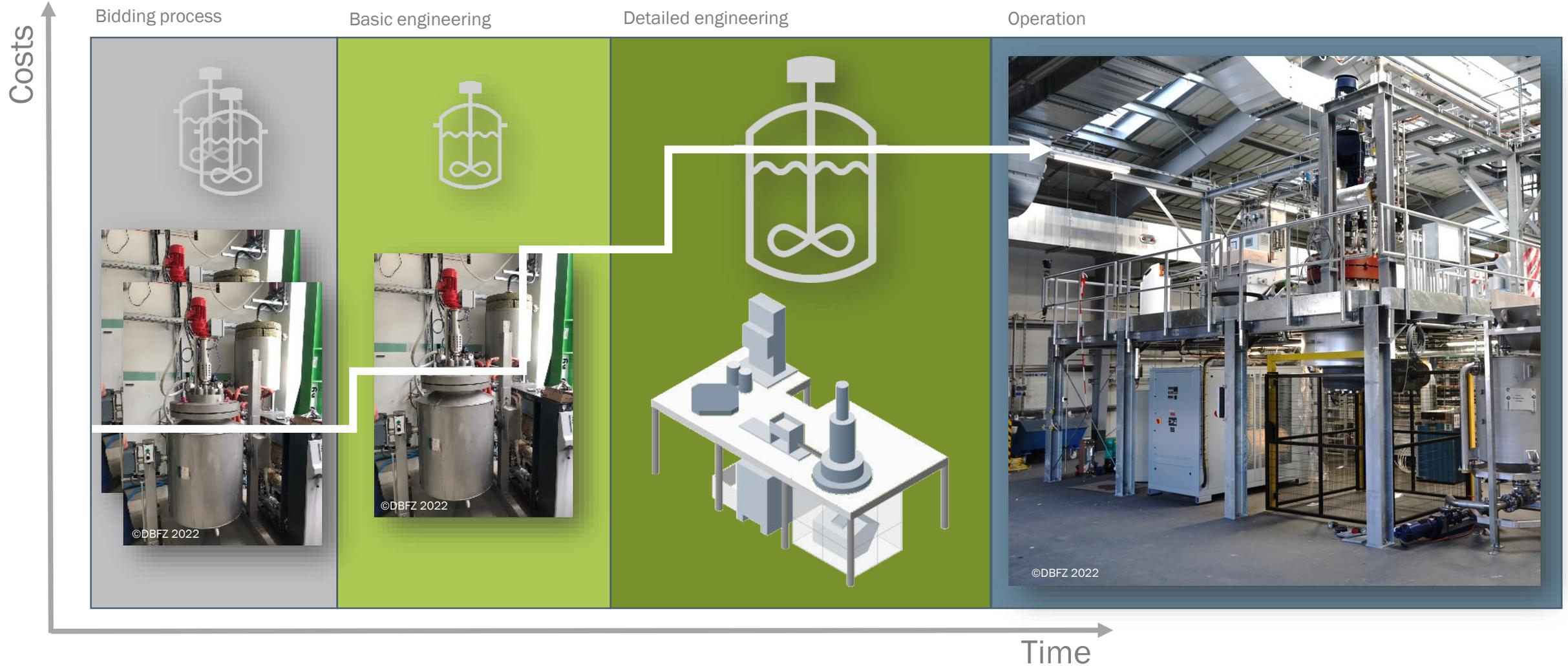
# Planning and construction schedule of the Pilot-SBG pilot plant



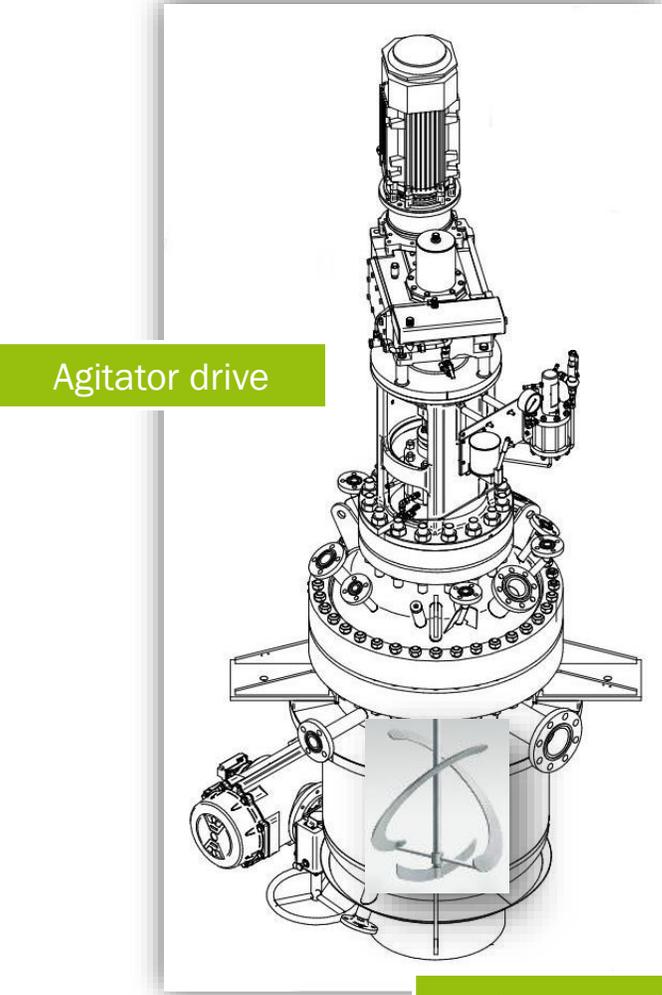
# Evolution of the documentation, costs and operator responsibilities



# Evolution of the HT-reactor within the planning phases

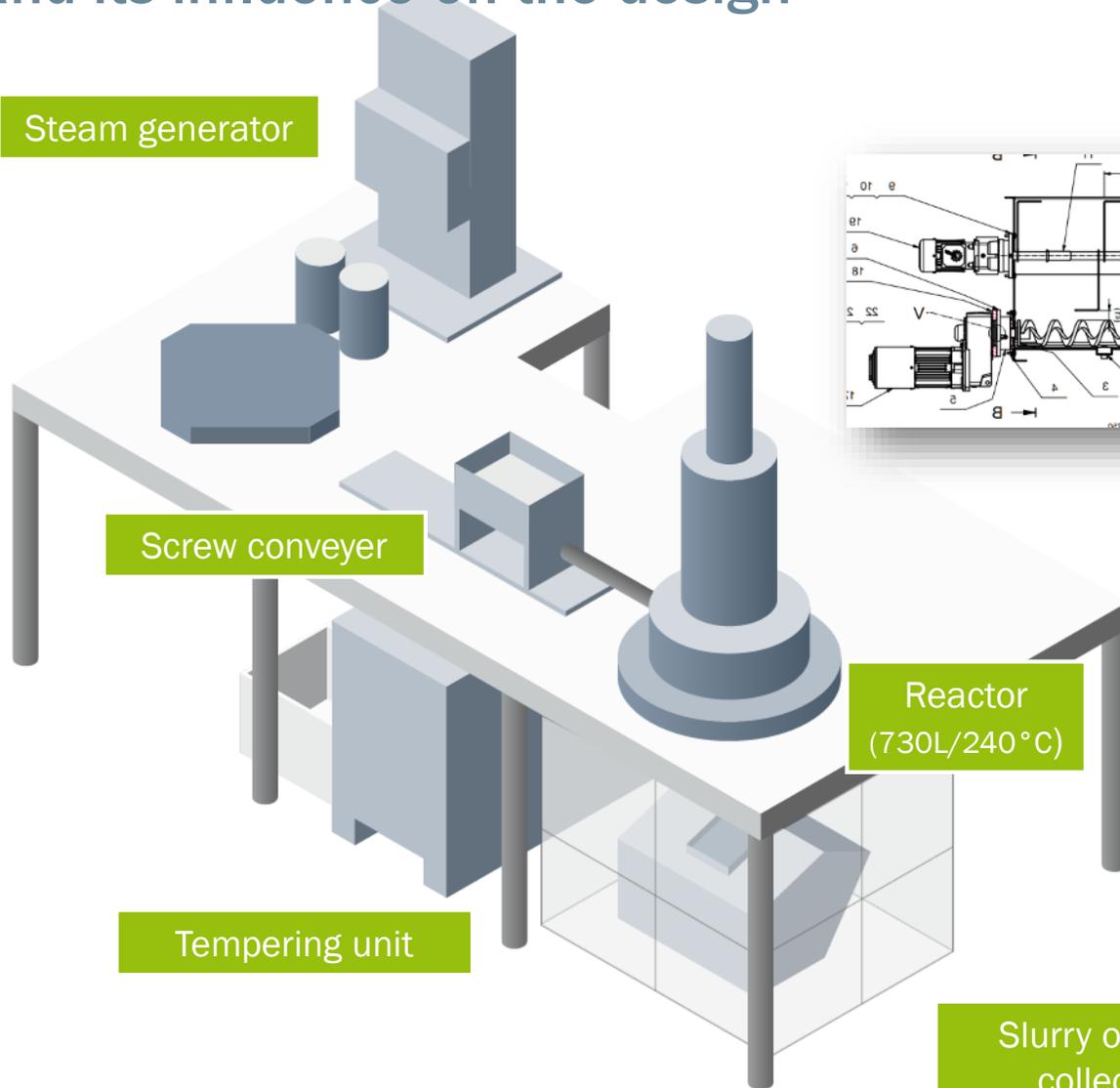


# Challenges of the substrate and its influence on the design



Agitator drive

Agitator design



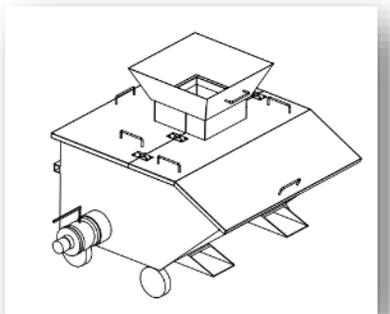
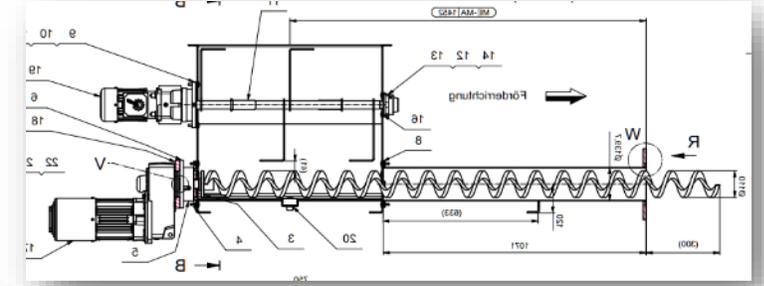
Steam generator

Screw conveyer

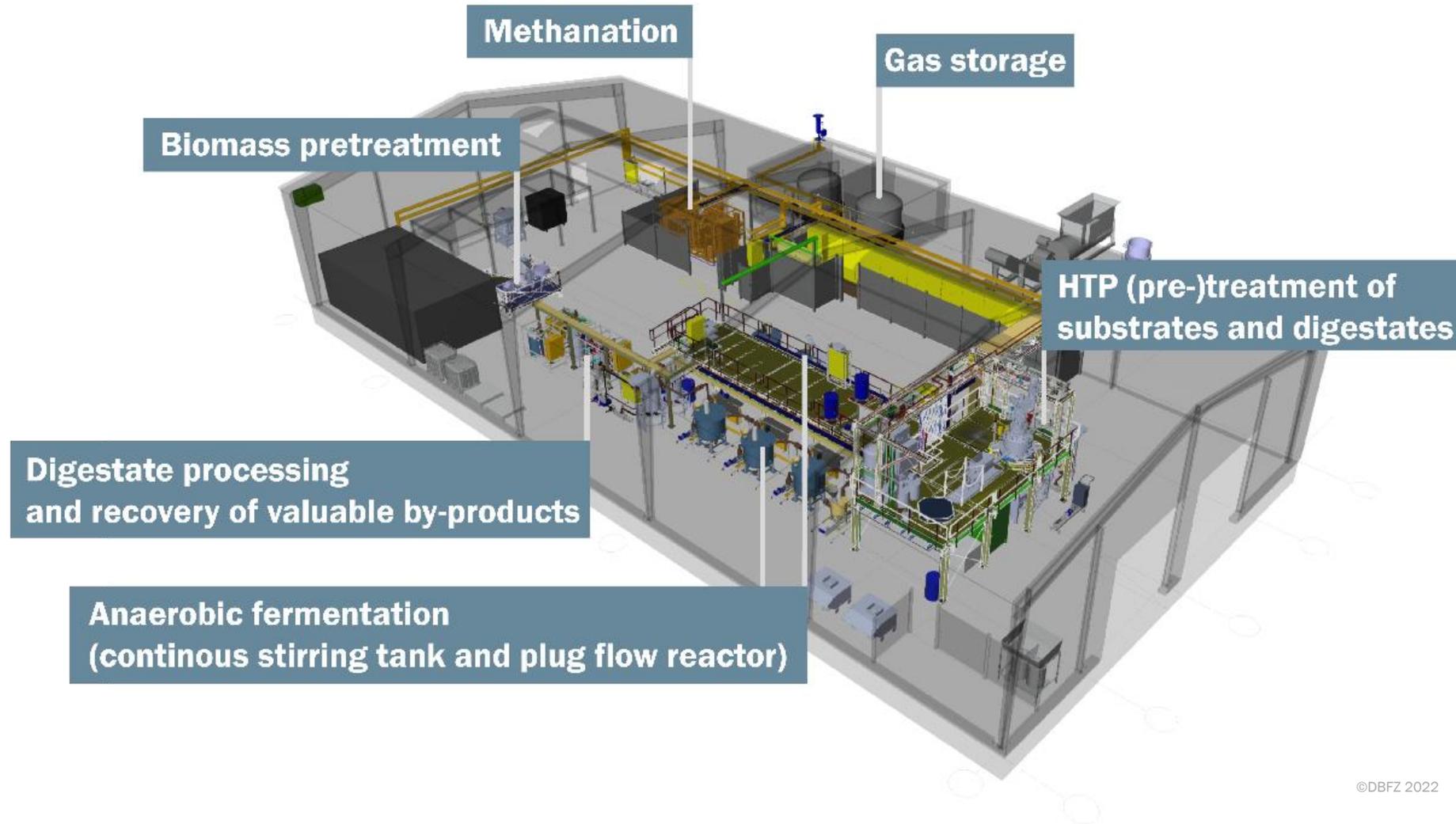
Tempering unit

Reactor (730L/240°C)

Slurry outlet & collection



# Complete 3D-model at Detailed Engineering Phase



©DBFZ 2022

# Construction Site journal



New home  
01/2022



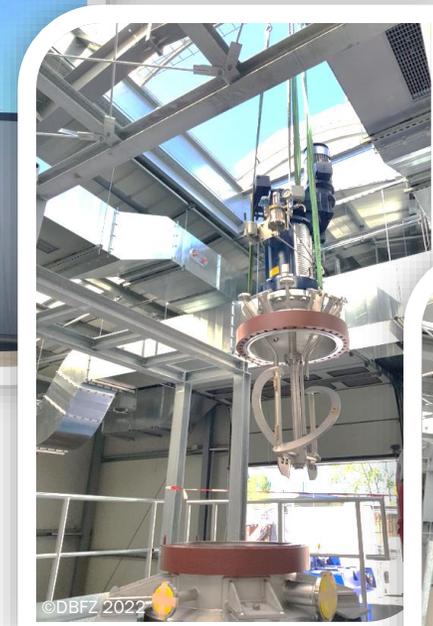
“Marriage“ of  
agitator and vessel  
06/2022



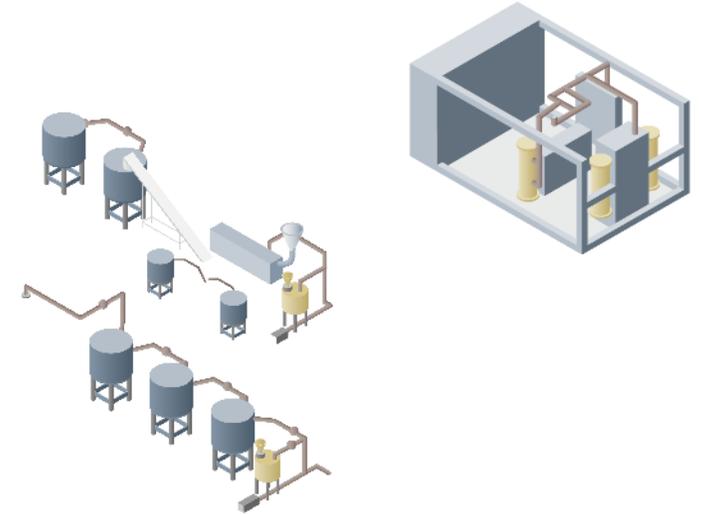
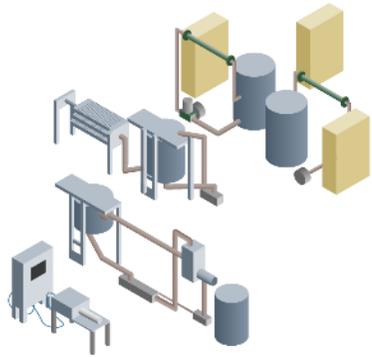
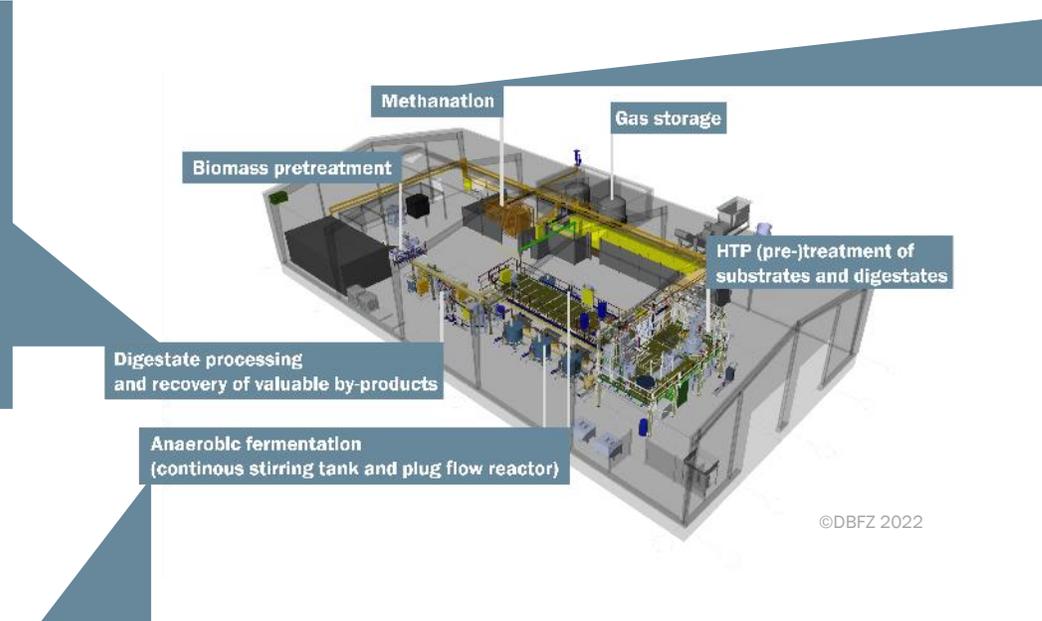
03/2022



Begin plant construction  
05/2022



# Construction Site journal



## Conclusion (take home messages)



- **HTP potentially increases overall biorefinery efficiency** in form of substrate disintegration and additional products
- A chemical plant this size inherits many additional (legal) responsibilities for the operator
- High project coordination complexity: approx. 20–30 contractors or other stakeholders with crucial functions involved

**Outlook:** Plant is currently in commissioning, **start up & operation is expected in Q3/2023**. The second phase of the project comprises **three years of operation** and accompanying research. **Economic and ecological** as well as **up-scaling assessments** together with **business and political consultation** continue to play a big role in the overall project



Project website

You are always invited to come by and visit

PILOT  
SBG



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Biorefineries Department

Scientific and Technical Coordinator of  
the Pilot Plant Pilot-SBG

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