



THE SUSTAINABLE SOLUTION

## Circular Chemistry Conference Arie van Vliet

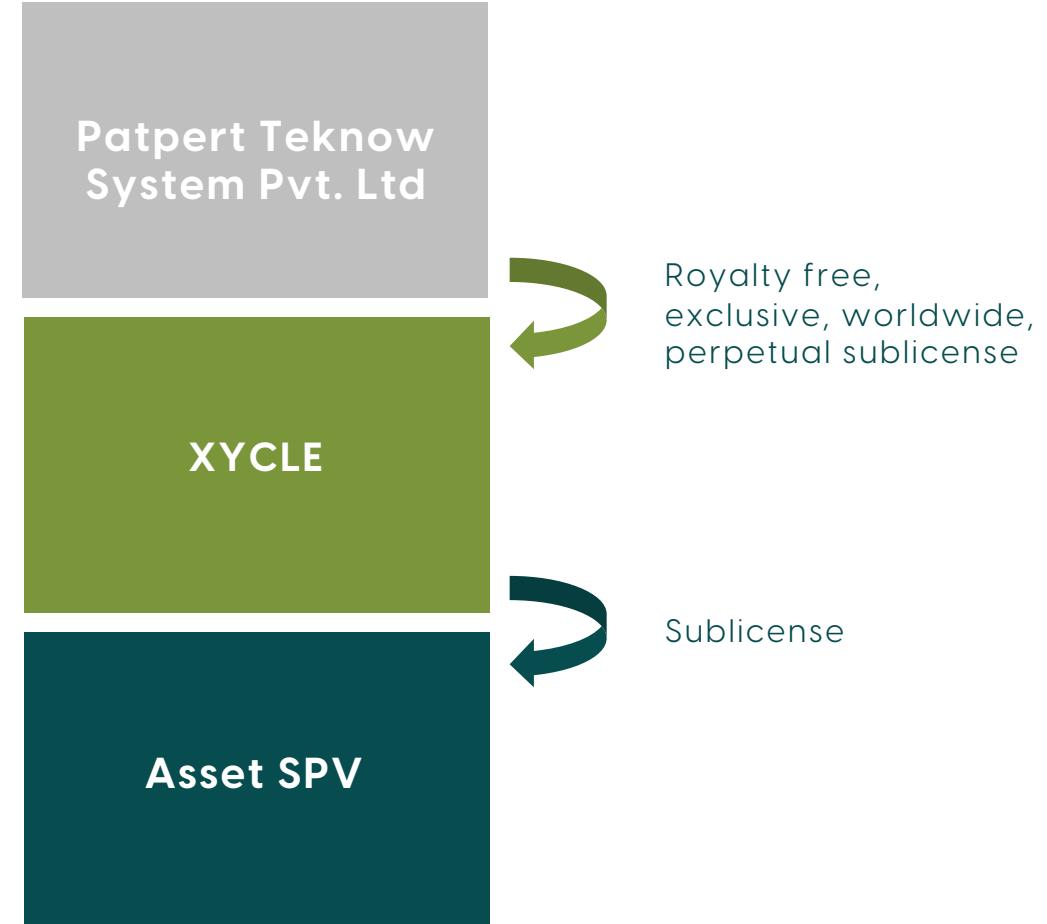
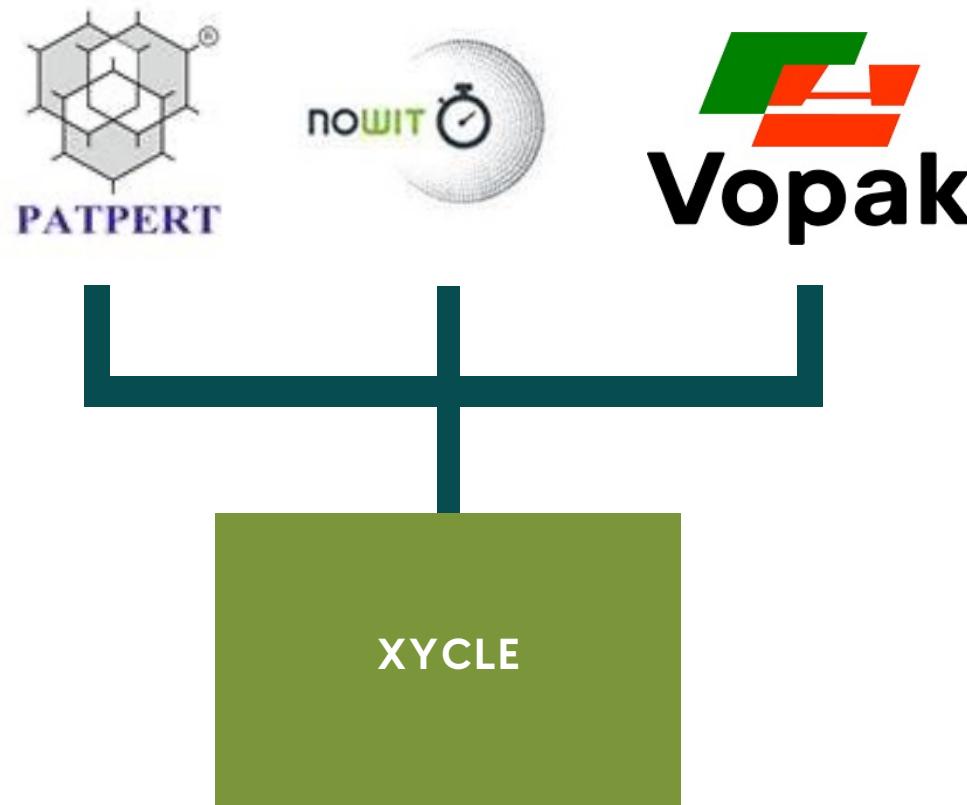
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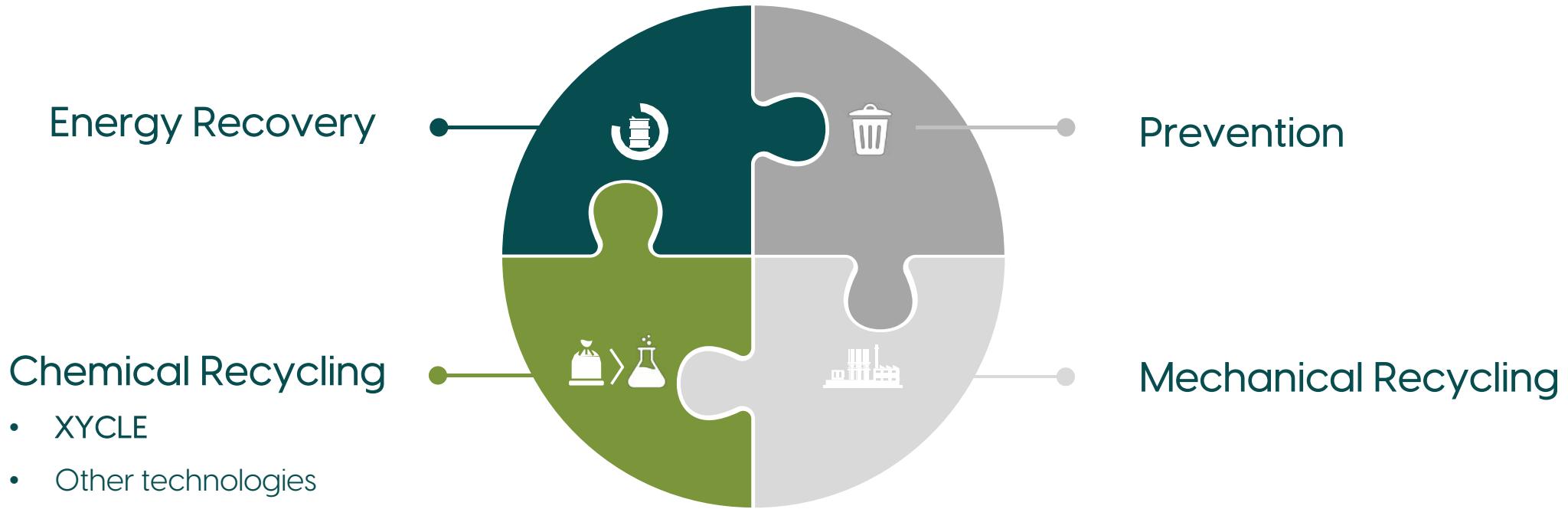
## Topics

- 1. Who is Xycle?**
- 2. Status Xycle Europoort**
- 3. Concept / Technology**
- 4. Plans & Ambition**

# Legal structure - Ownership & IP



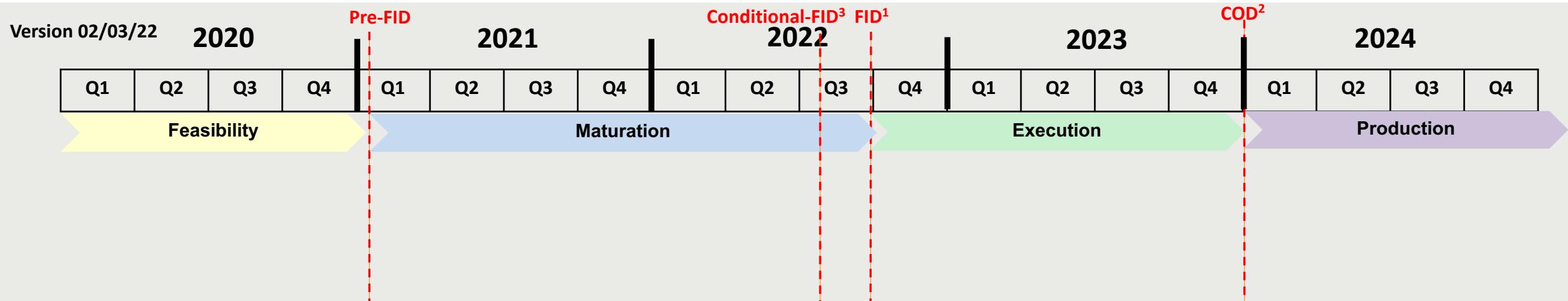
# XYCLE – essential part of the puzzle to solve the plastic problem



# 1<sup>st</sup> Asset Company - XYCLE EUROPOORT B.V.



# High level time schedule



## Feasibility phase

- ✓ Designing the basic flow diagram for the plant including mass balance, defining all out and in streams of the plant.
- ✓ Establishing the proof of concept either by finding the similar process under comparable conditions or running test with comparable equipment on lab scale or pilot plant.
- ✓ Discussion with different suppliers on scope and requirements ending out in budget offers for the final plant. Ending out in to a list of possible suppliers.
- ✓ Designing a basic plant layout based on the site defined for the project. The layout has to define the expected dimensions of buildings and needed surrounding areas.
- ✓ **Capex and Opex on a rough level have to be defined and are being used for a preliminary business case to proof that the projects is viable.**
- ✓ Starting up the environmental approval process based on the given layout and the mass balance for the plant.
- ✓ Red Flag TDD report
- ✓ NOx emissions and deposition report has to be produced
- ✓ Site secured

## Maturation phase

- The contractual basis for the tenders is defined and in a plant like the Xycle Asset BV all suppliers has to apply to the same legal contract or there has to be a very clear definition of where the loopholes are between different suppliers.
- Tenders are being prepared for the different lots and are send to the suppliers that has been shortlisted. Offers from suppliers has to include the following parts as a minimum: Equipment, Spare parts, Transport, Installation, Commissioning, Documentation, Training of operators and service staff if needed
- A detailed schedule for the Execution and Production start up phase has to be established based on the information from the suppliers and stakeholders. The schedule has to have build in some slack (extra time) to secure that we are able to keep the time line.
- Detailed layout of the plant including layout for equipment is produced. All interfaces between suppliers are specified.
- Negotiation with the suppliers to have a finalised basis that can be signed.
- Signing will not take place before we are in the execution phase.
- **Capex and Opex are defined and the business case is finalised.**

<sup>1</sup> Final Investment Decision

<sup>2</sup> Commercial Operation Date

<sup>3</sup> Except permits all milestones to take FID have been achieved

# 4 Stage Testing – Improve knowledge, Technical concept & Oil quality

## Stage 1

2019 – Moerdijk (NL)  
Test facility (50 kg Batch)

Since January 2019 over 35 different plastic waste streams have been tested and analysed

Objectives  
Building knowledge regarding feedstock composition i.r.t. Oil Specs



## Stage 2

MAR 2020 – Moerdijk (NL)  
Test facility (50 kg Batch)

### Objectives

- Input data for permitting process
- Data for defining Flue-gas cleaning
- Update of MEB, used as baseline for the Business Case
- Starting point for negotiations on feedstock & offtake contracts



## Stage 3

OCT 2021 – Pune (IN)  
Commercial plant (2,5 tpd continuous)

### Objectives

- Optimizing/Validating Pre-treatment
- Update MEB based on use of agglomerate
- Input data for design specs
- Decide on reactor capacity
- First results oil quality

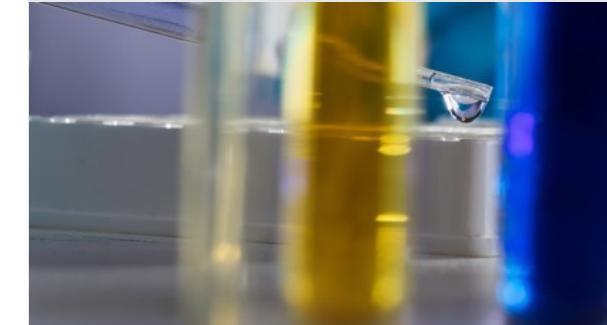


## Stage 4

JAN 2022 - Pune (IN)  
Commercial plant (2,5 tpd continuous)

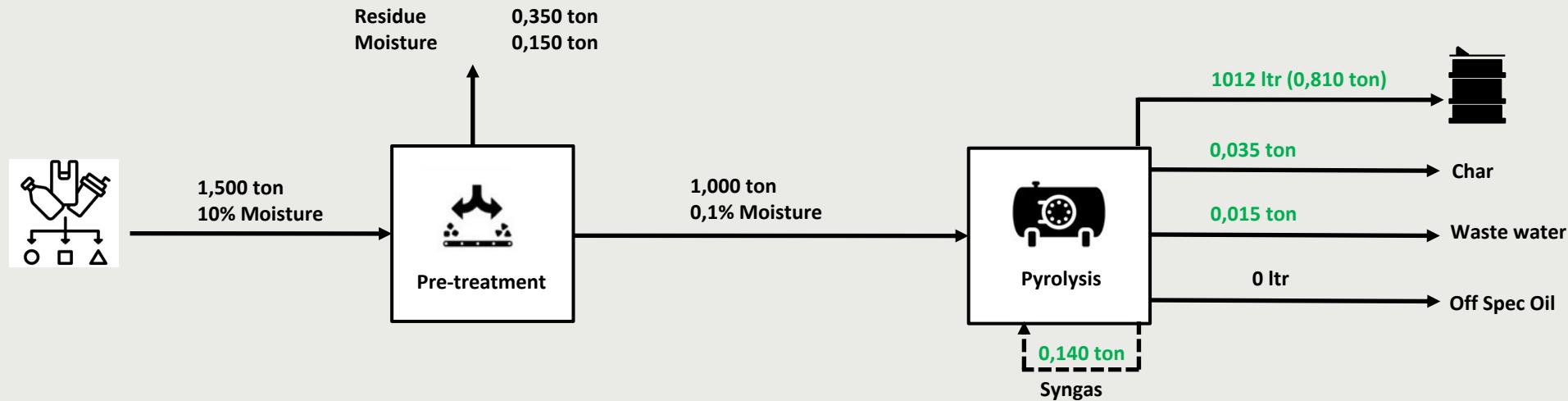
### Objectives

- Based on lessons learned Stage 3, improve oil quality
- Final update of MEB
- Final oil specs as input for offtake contracts



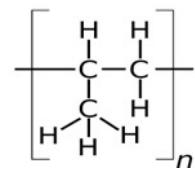
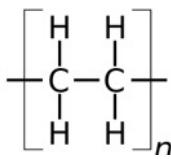
# Simplified Mass Balance (per ton input)

Version 09/02/22

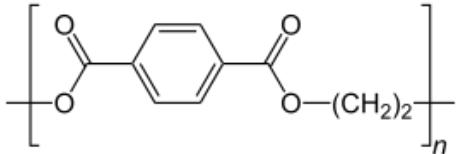
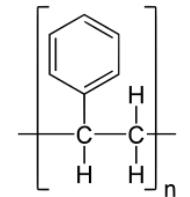


# Feedstock composition has direct impact on quality pyrolysis

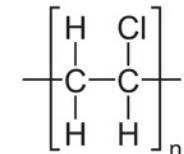
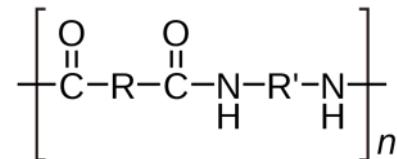
Physical characteristics	
Density	
Viscosity	
Pour point	
RVP	
IBP	
FBP	
95% BP	
ABP	



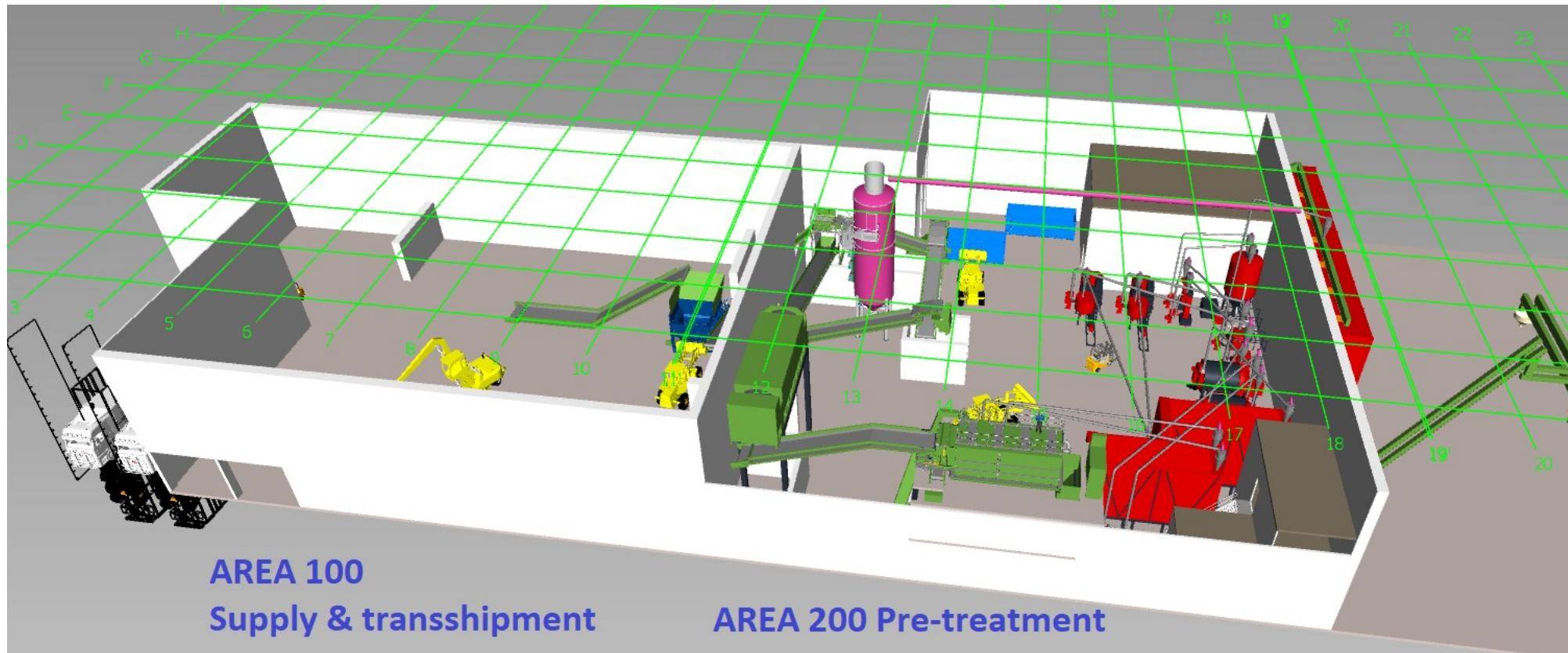
Carbohydrates	
Paraffins	
Olefins	
Naphthene's	
Aromatics	



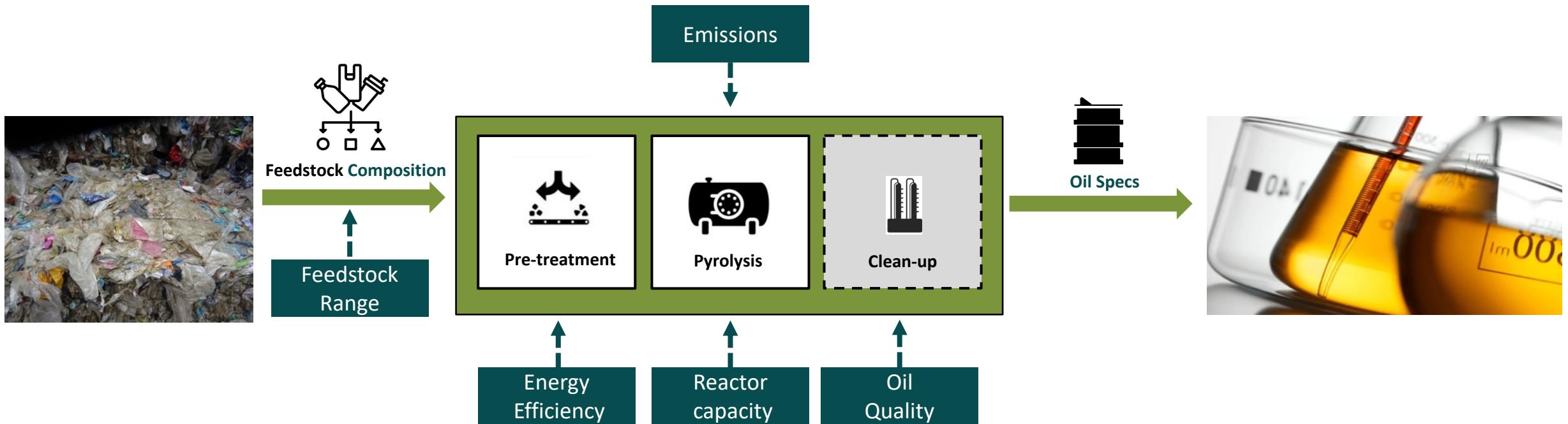
Impurities	
Oxygen	
Nitrogen	
Sulphur	
Total Heteroatoms	
Chlorides	
Fluorides	
Bromine	
Total Halogens	
Elementals	



# Robust feedstock pre-treatment



# R&D Activities



## Main focus

1. Increase reactor capacity
2. Increase feedstock range
3. Improve oil quality
4. Improve carbon footprint

# R&D – Increase Reactor Capacity

## Objective

The objective is to increase the reactor capacity from the current 5 tpd to 25 tpd

## Goals

### 1. Large scale plants

With the increased reactor capacity larger scale plants up to 100 kton p.a. are realistic.

### 2. Improve IRR

The use of bigger reactors will lower CAPEX and OPEX and makes the business case less sensitive for gate fees and offtake prices.

### 3. Small scale plants

With lower CAPEX an OPEX smaller scall plants are still viable. Depending on local conditions (e.g. feedstock availability) small scale plants may be preferable to larger scale

## Intent

The intent is to bring the 25 tpd reactor to TRL 9 asap in order to implement these in the first large scale plant (start construction 2023)

## Execution

The increase of reactor capacity to 25 tpd will be executed in 3 phases:

- Phase 1 => 6,5 tpd

SEP 2021 Execution large scale test at a commercial plant in Pune. During the test agglomerated plastics were used in stead off shredded plastics. Because of the much higher density of the agglomerate (450 kg vs 80 kg per m<sup>3</sup>), the capacity of a standard 5 tpd reactor was boosted to 6,5 tpd. Only small adjustments on the back end, e.g. coke drum and condensers, were needed.

- Phase 2 => 10 tpd

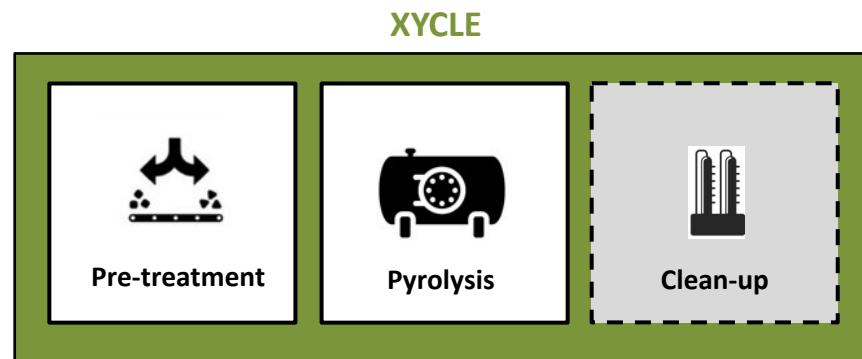
JAN 2022 Start construction of a commercial 10 tpd reactor in Pune.  
APR 2022 Commissioning 10 tpd plant.

- Phase 3 => 25 tpd

NOV 2021 Start engineering of the 25 tpd reactor.  
MAY 2022 Learnings from the 10 tpd reactor available and implemented.  
JUN 2022 Start fabrication  
DEC 2022 Commissioning

The possible locations for the 25 tpd unit are currently being evaluated. The determining factor here is time required for the permitting process

# R&D – Increase feedstock range & Oil quality



## Challenge Feedstock

- Xycle's ambition is to become one of the dominant parties on the pyrolysis oil market.
- To fulfil this ambition we intent to build multiple plants globally.
- To secure the feedstock for these numerous plants we should be able to handle a wide feedstock range as possible.
- The big challenge is to deal with the principle that the quality of the feedstock has direct impact on the quality of the pyrolysis oil.

## Execution

- The first plant(s) will process a relatively "easy" feedstock and will include a very robust pre-treatment. This ensures we will produce oil within specs – even without or a very limited clean-up step.
- For success of these R&D-activities, we need a close cooperation with our offtaker.
- In order to produce representative test results, we need a full scale installation ( a small test plant will never have same process parameters).
- Xycle Europoort is prepared for testing activities (e.g. plant layout and permits)

## Challenge Offtake

- Produce at all times oil well within offtakers specifications.
- Not only within specs, but improve even further in order to increase value for offtakers and increase overall recycling rate.
- Produce this high quality oil in a cost effective way in order to keep/gain competitive advantage.

## Roadmap

2021-2023

Lab scale tests  
Expand knowledge

2024-2025

Xycle Europoort  
Practical Testing

2025 ->

Implement in new  
plants

## Competitive pyrolysis landscape - Rat Race



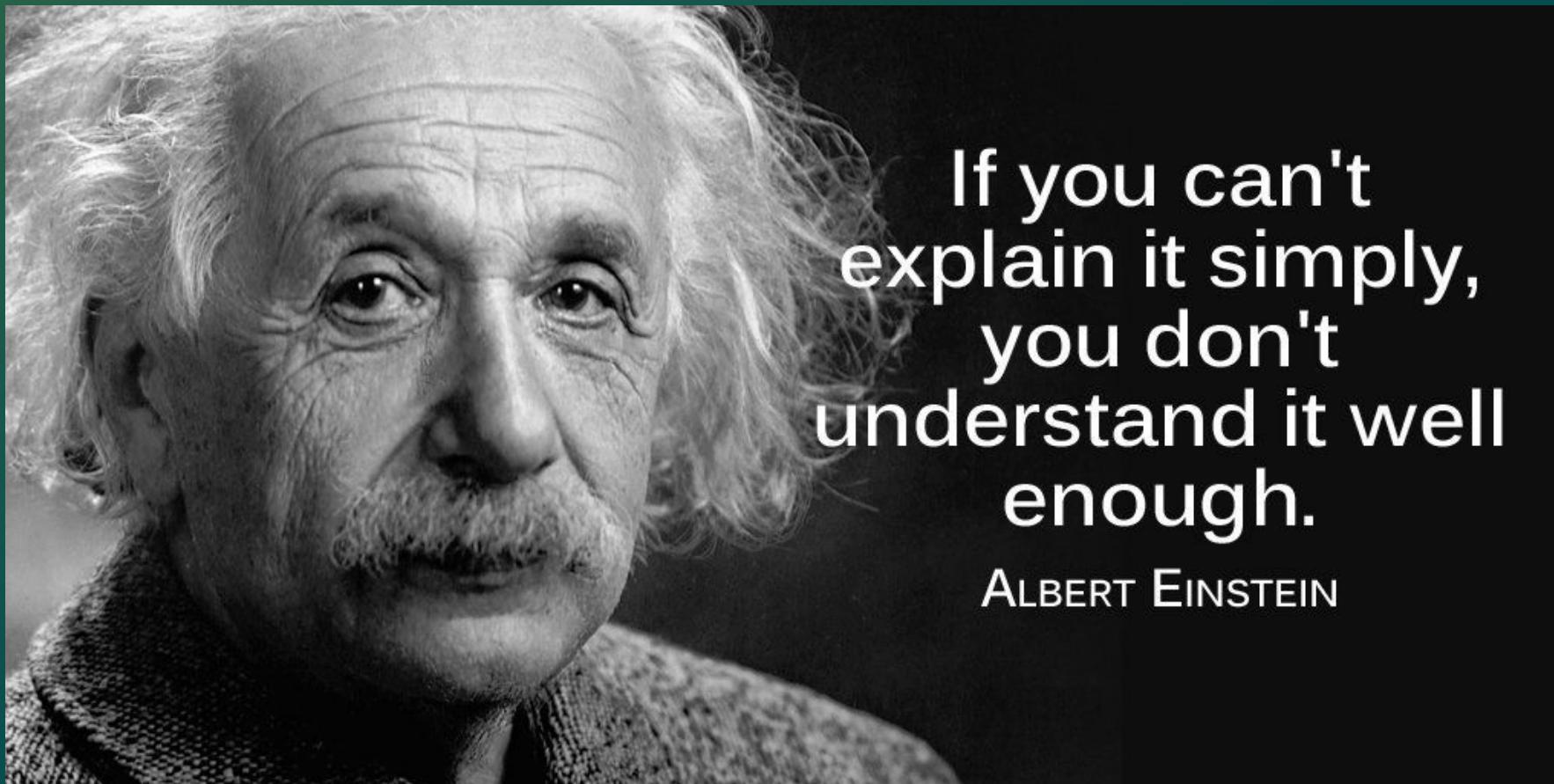
# The technology has global potential - we already have a promising project pipeline

**Xycle Europort**  
First full-scale commercial  
plant in the Netherlands



## Main Challenges

- ✓ Prove we can do it
- ✓ Speed in rollout
- ✓ Mass Balance vs Recycling percentages  
 $67\% \times 81\% \times 45\% = 24\%$
- ✓ 10% in 2030 – that little? - So much?



If you can't  
explain it simply,  
you don't  
understand it well  
enough.

ALBERT EINSTEIN