

CuRe Technology

The Polyester Rejuvenation revolution



March 6, 2024

Confidential Information

A 64 Billion Kilogram Challenge

WHY

Polyester is one of the most common plastics. Because they are colored or contaminated or contain additives, 91% of all polyester products are not recycled.

The result: **64 billion kilograms** of waste, year after year, contributing to the growing plastic waste mountain.

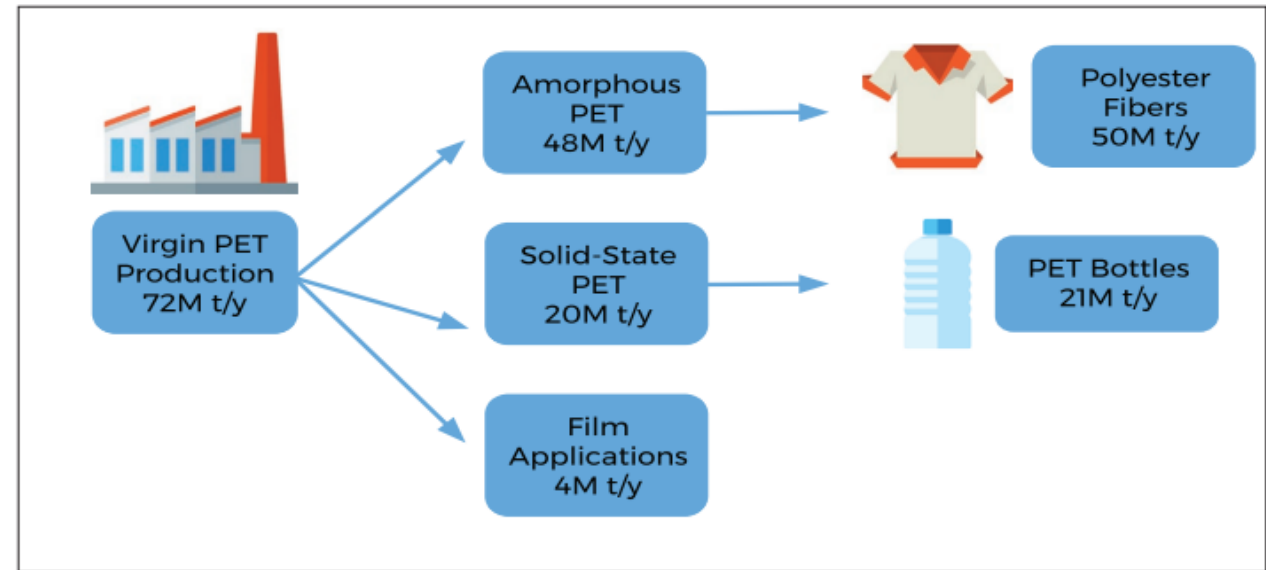
50 billion kilograms every year is textile, 14 billion kilograms packaging.

HOW

We CuRe used polyester by removing the color and converting it into clear pellets with the same properties as virgin grade polyester. We partner across the value chain and offer solutions in feedstock preparation, design for recycling, mechanical recycling as well as depolymerisation.

WHAT

Our ground-breaking CuRe Technology for polyester rejuvenation offers low energy recycling for used polyester in a fully circular chain.



CuRe Technology position on EFSA regulations

Food Contact Approval

1. Safety for food contact in packaging for consumers is leading.
2. EU policies should stimulate development of new recycling technologies that are safe and competitive.
3. Approvals should be based on proven end quality and safety of the recycled plastics using well-defined tests and procedures, not on technology route used.
4. Proposed are challenge tests, NIAS testing, working as per GMP practices and guaranteed traceability in combination with carefully selected raw materials.

Updated status

1. Recycling regulation 1616/2022.
2. CuRe Technology actively involved via PETCore group including direct contact with the DG Santé.
3. Based on current draft CuRe Technology has applied for Novel Technology status to become Suitable technology
4. This will take time and will be pursued, no impact on starting up CuRe Technology at commercial scale
5. Pilot plant can be used to generate data for novel technology application to become a suitable technology
6. Long term impact **positive** as wider range of feedstock can be used

CuRe Technology Key Facts



CuRe Technology = 100 % recycled polyester fit for purpose



Continuous uncatalyzed process



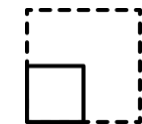
lowest energy consuming depolymerisation technology



Focus on large variety of used polyester as input feedstock



Patent pending modular technology



Plant assets available for scale-up in a 25 kta Demonstration Plant



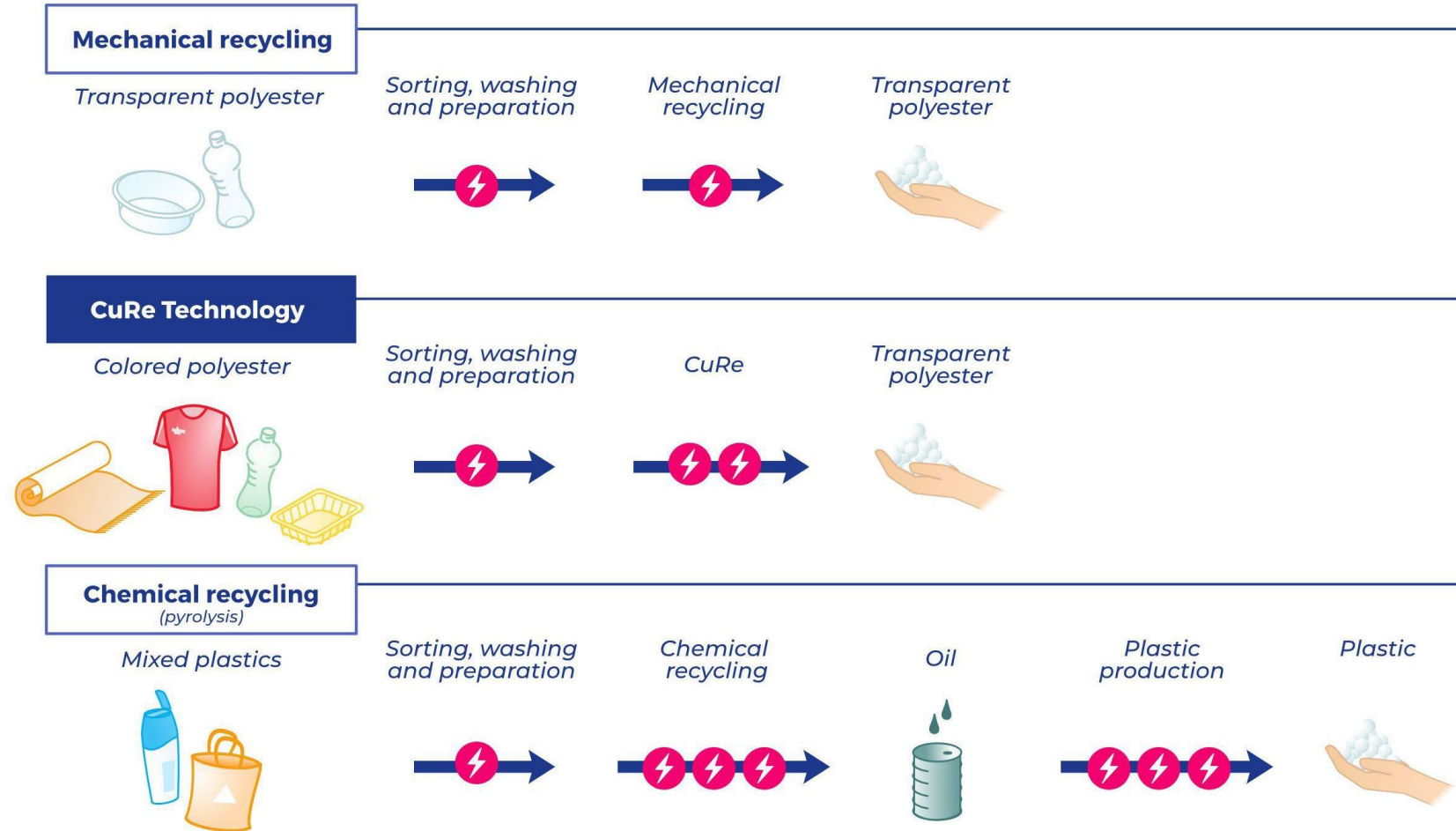
Decades of experience in polyester



One stop shop to close the loop offering mechanical recycling, feedstock preparation, design for recycling and depolymerization



CuRe Rejuvenation = Depolymerization not Pyrolysis



INVESTING IN CLOSING THE LOOP

Coca-Cola European Partners (CCEP) is funding CuRe – a new technology start up which seeks to help close the loop on PET recycling.

REJUVENATING HARD TO RECYCLE WASTE

HELPING TO ELIMINATE THE NEED FOR VIRGIN OIL-BASED PET.



UNLOCKING TONNES OF POTENTIAL

Tonnes of difficult to recycle PET waste could be transformed to provide a new recycled PET (rPET) supply to meet the demand.

DEPOLYMERISATION RECYCLING CAN HELP US TO ELIMINATE 200,000 TONNES OF VIRGIN OIL-BASED PET PER YEAR

~~200,000~~

THE FUTURE IS **100%** rPET & RENEWABLE

TECHNOLOGIES WORKING TOGETHER

DEPOLYMERISATION RECYCLING & MECHANICAL RECYCLING

Are complementary processes helping us reach our zero virgin oil-based PET ambition, sooner.



BREAKING NEW GROUND

Strategic investments to support innovation that will return value to lower grade PET and help accelerate the transition to a circular economy.



A CLOSED **LOOP** FUTURE

We are committed to helping accelerate the transition towards a circular economy by supporting innovation that will help to ensure lower grade PET is kept in the material loop and recycled.

Circularity is a Team Sport with CuRe uniquely positioned

Successful closing of the loop needs collaboration across the chain.

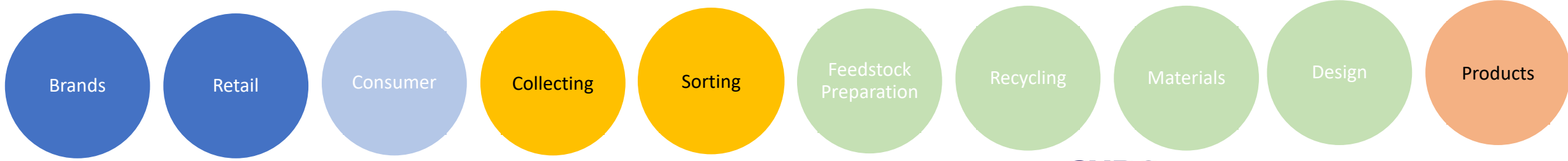
CuRe Technology is uniquely positioned as it can cover the chain from feedstock preparation all the way to providing input on design for recycling of end products.

To close the loop collaboration with brands as well as other partners for collecting & sorting, preform production, fiber spinning, weaving or knitting and garment manufacturing required.



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CuRe well connected within a complex textile chain



Apparel

Sportswear

ETHICS GROUP

Industrial

Collecting

Sorting

Interior

Feedstock Preparation

Recycling

Materials

Other Stakeholders

Fiber Sort	Worn Again	JE Plan
RICE (SW)	HKIA	H&M recyclable clothing
DyeCoo	FFG	Oerlikon
Texperium	Centexbel	ITA
AMIBM	Saxion	Insitute Bremen
Institute Chemnitz		HKIA
Universiteit Gent		

Design

Products



A World Class Pilot Plant



Pilot plant goes from flake to purified oligomers to enhanced recycled polyester.



We kick off with a pilot plant in Emmen (The Netherlands), ready for rapid scale-up to prove the technical and economic sustainability of our CuRe Technology for polyester rejuvenation.



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CuRe

Competences across whole chain in CuRe



LCA Screening confirms Low Energy Consumption

Figure 2 - Carbon footprint comparison of the production of one tonne PET, t CO₂ eq./t PET

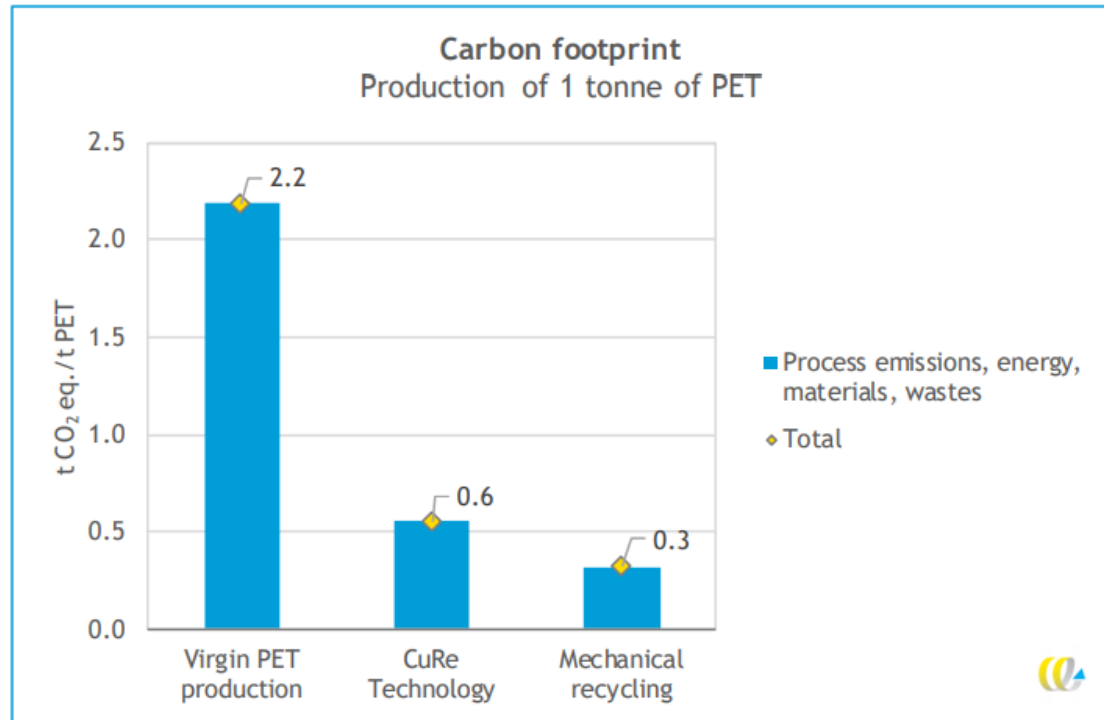
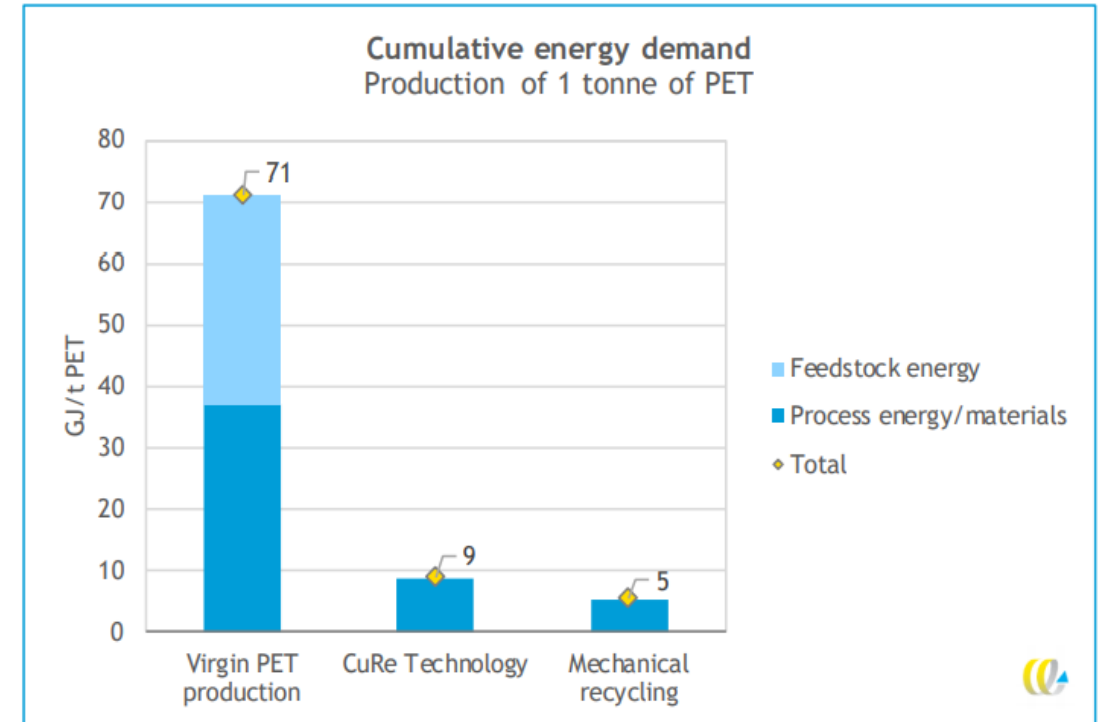


Figure 3 - Cumulative energy demand comparison of the production of one tonne PET, t CO₂ eq./t PET

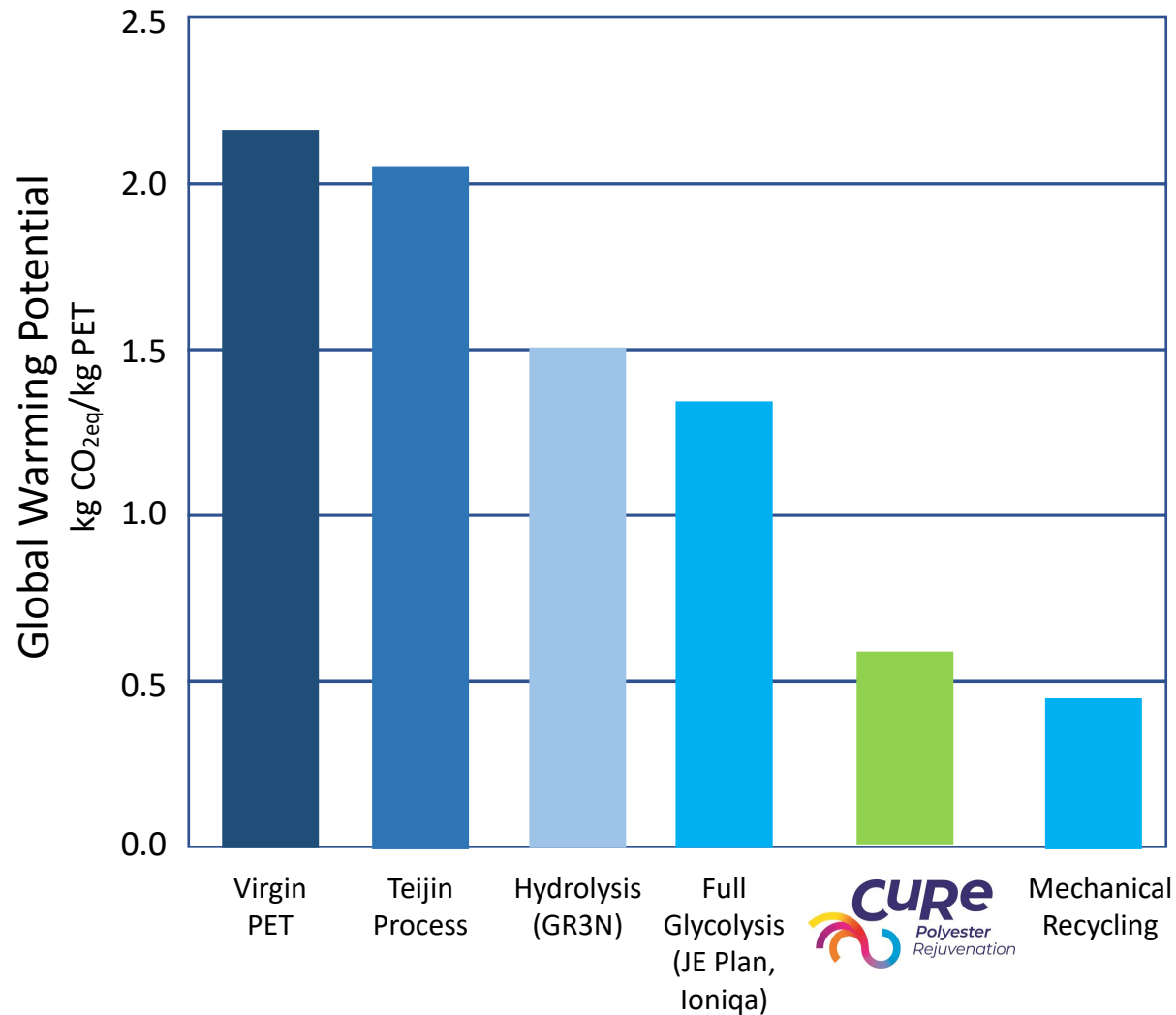


Notes:

- Calculations for CuRe Technology carried out by CE Delft
- Dutch energy mix used, using fully renewable energy can lower GWP impact further
- rPET with bottle grade viscosity as basis for calculations



LCA Screening confirms CuRe's leadership position



Global warming potential is direct indicator of energy use in the process, and thereby of the OPEX of the process.

Comparing LCAs is difficult unless all assumptions are the same.

The data in the graph are the data from various technologies as reported by their respective companies.

Notes:

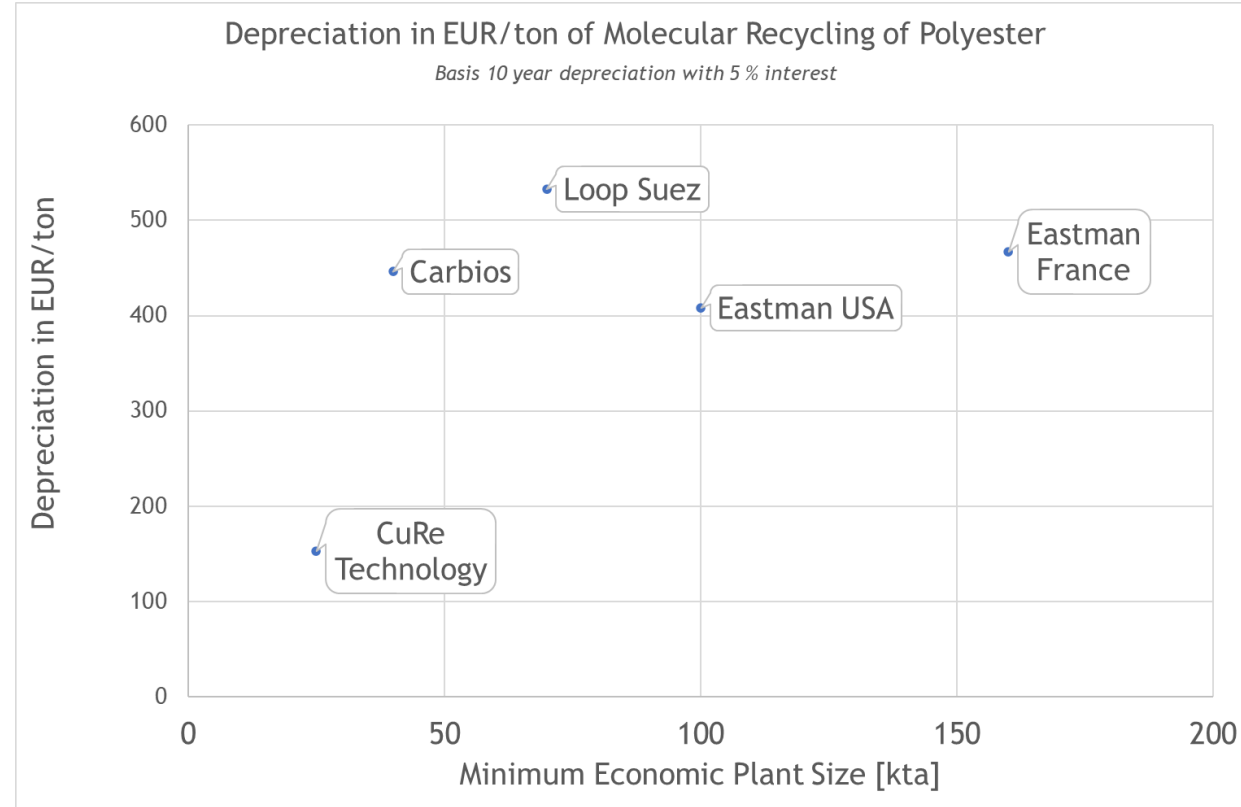
- Calculations for CuRe Technology carried out by CE Delft
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CuRe has lowest CAPEX and lowest scale to be economic

CuRe Techology	Carbios	Eastman	Loop / Suez
Depolymerisation to oligomers	Depolymerisation to PTA	Depolymerisation to DMT	Depolymerisation to DMT
repolymerisation	Repolymerisation by others	Repolymerisation	Repolymerisation
SSPC	SSPC by others	SSPC	SSPC
30 mln € 25 kta	140 mln € 40 kta	US: 330 mln € 100 kta F: 250 mln € 70 kta	250 mln € 70 kta



CuRe Technology has the **lowest minimum economic plant size** making it a lower risk to start, and easier to grow capacity as more feedstock volume becomes available.

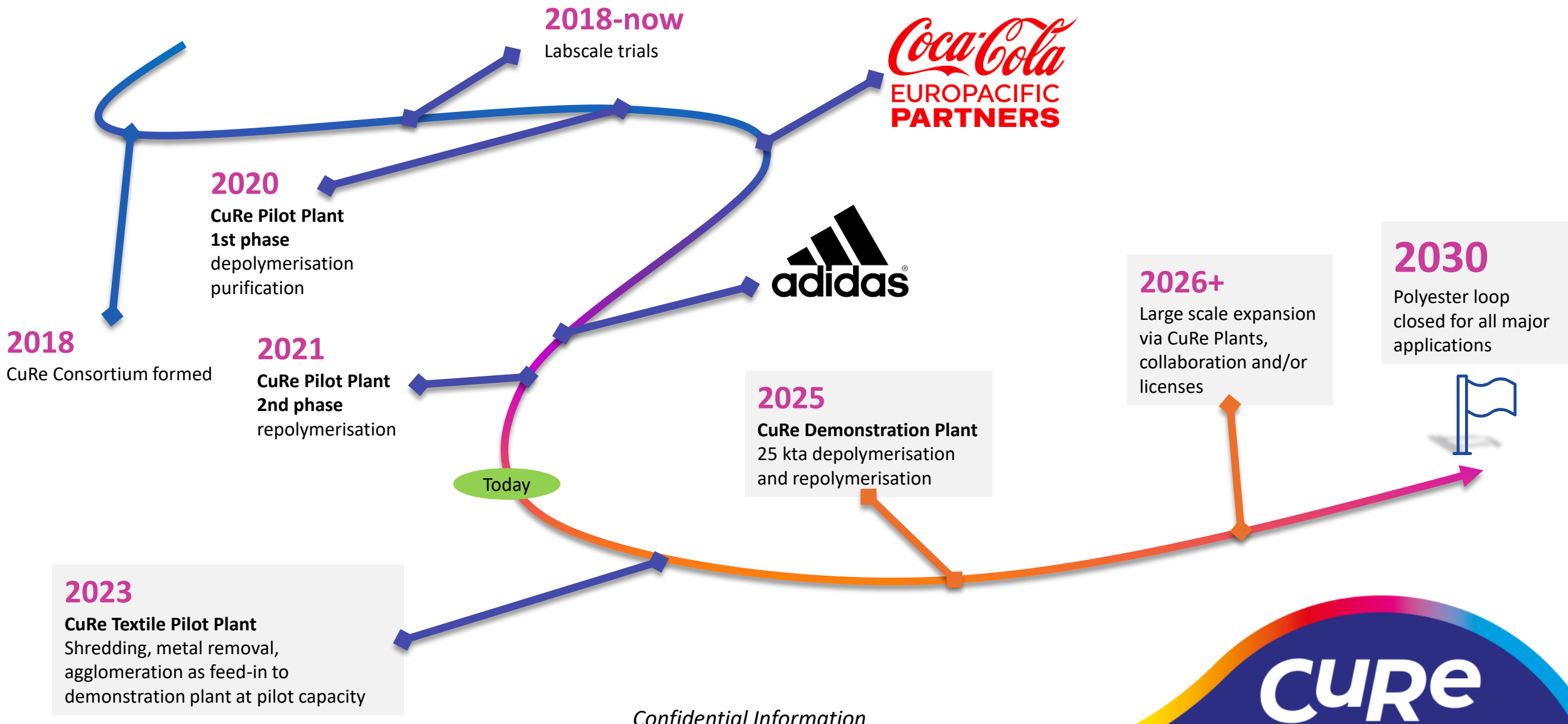
Notes:

- Basis is announced capacities and investments, Carbios 100 mln EUR for 40 kta PTA (requires additional 40 mln EUR to produce rPET), Eastman 250 mln USD / 220 mln EUR for 100 kta DMT (requires additional 100 mln EUR to produce rPET)



CuRe Ambition - recycling used polyester and making this the new normal

All polyester to be made from used polyester or biobased feedstock.





Join the polyester recycling revolution!

www.curetechnology.com

We are grateful for the funding from:



• Stimuleert • Faciliteert • Verbindt

provincie Drenthe



EUROPESE UNIE

Europees Fonds voor regionale ontwikkeling

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A multifaceted challenge

Food Tray Only

1. Volume
> 1 mln ton EU trays not recycled

2. Complexity
Complex contamination requiring multiple cleaning and recycling steps

3. Supply
Food trays come from all over the world, difficult to regulate

7. Economics
Mechanical recycling routes not mature yet and output quality limits application



4. Time to impact
Design for recycling options take a lot of time to have real volume impact

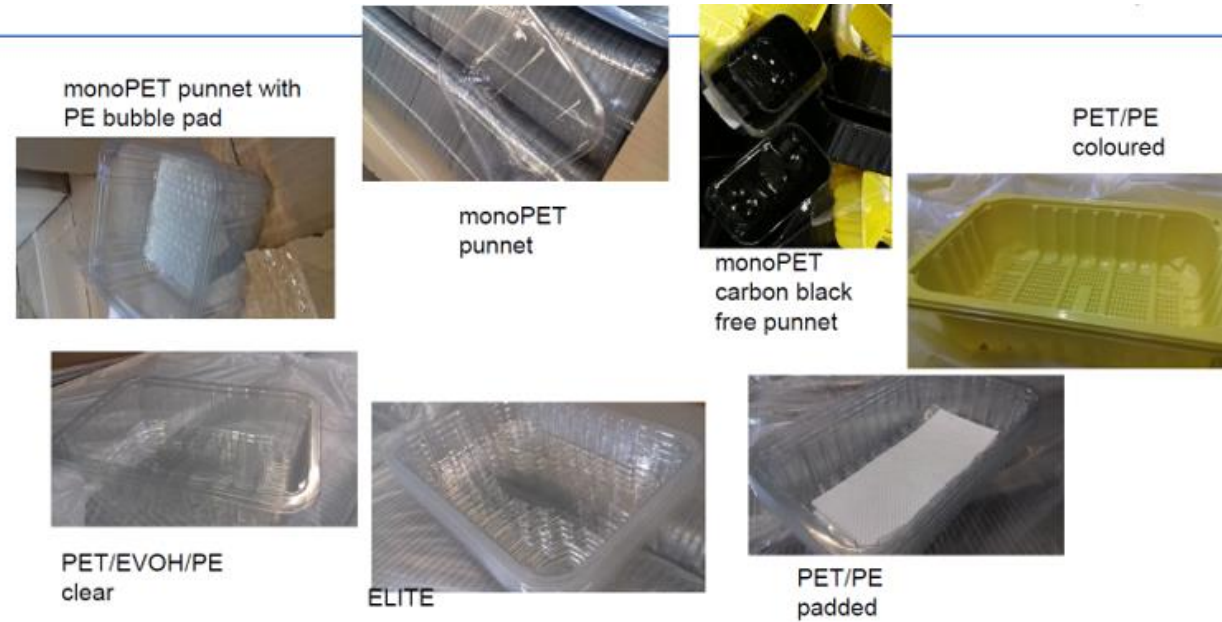
6. Former Food Contact
Trays used in food contact mix with nonfood contact packaging

5. Sorting
trays difficult to sort and sorting efficiency not 100 %



Polyester Food Tray Recycling - Technical Challenges

- | | | | |
|----------------------------|----------------------|-------------------|----------------------|
| 1. Vlees, vis en kip trays | 5. Salade schalen | 9. Yoghurt bekers | 13. Eierdozen |
| 2. Vleeswaren schaaltes | 6. Pasta trays | 10. Koek trays | 14. Borrel schaaltes |
| 3. Fruit schalen | 7. Bakkerij blisters | 11. Noten cups | 15. Blisters |
| 4. Groente schalen | 8. Broodsalade cups | 12. Kaas trays | 16. Kaartblisters |



Organic contamination

Trays brittle, loss via fines

Other polymers PE / EVOH / PA

Other waste left after sorting

Color



The solution lies in chemical recycling

Food Tray Only



Mixed Trays (mono & multi)

Sorting
sorting of unwanted objects, mono and multimaterial separation

Mono Trays

Shredding, Washing
shredding and removal of organic contamination

Mechanical Recycling
Extrusion

Sorting
sorting of unwanted objects

Shredding, Washing
shredding and removal of organic contamination

Organic waste, multi component trays

~~Incineration / Landfill~~

No longer desired / allowed

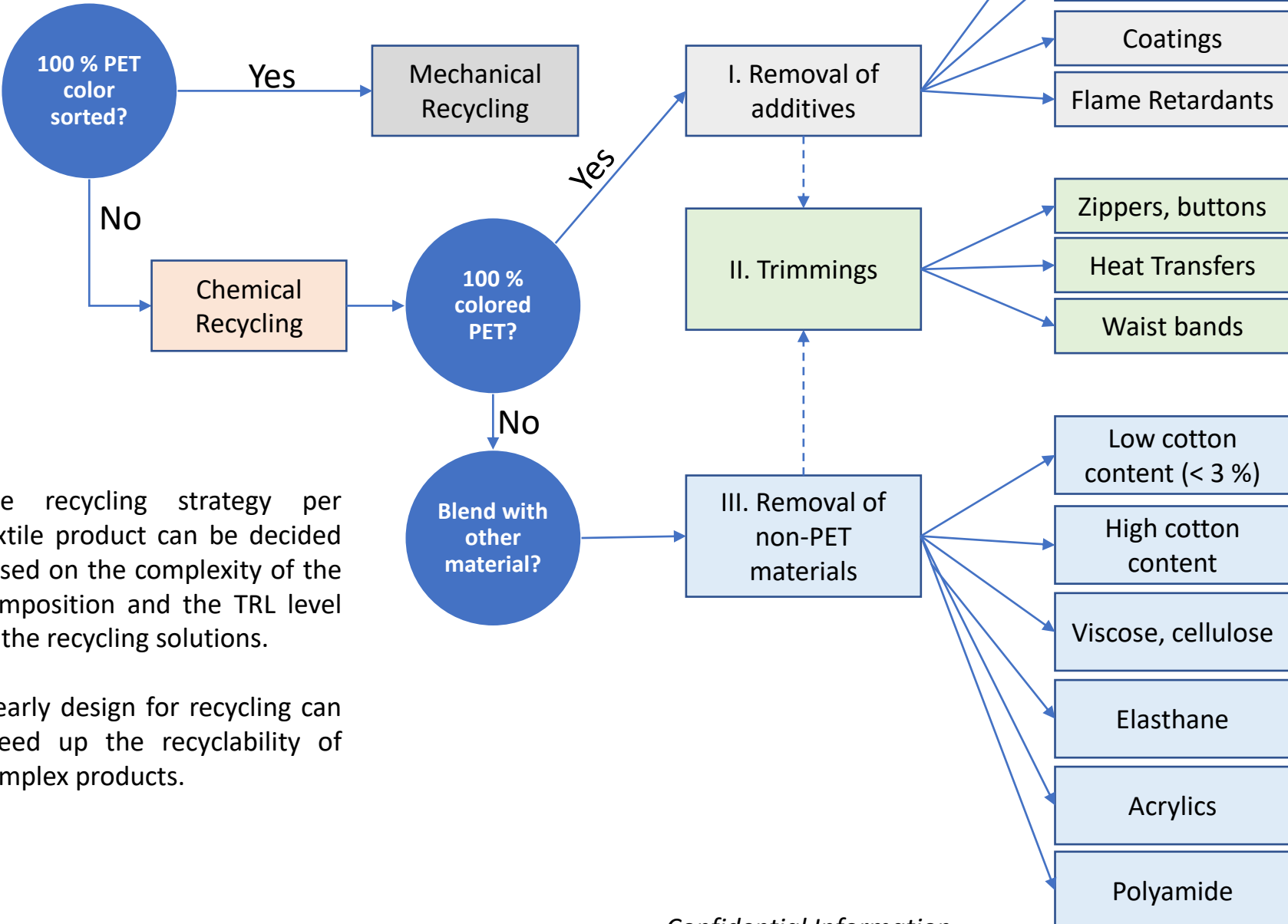
Mixed Trays (mono & multi)

Chemical recycling
(CuRe Technology)

- Chemical Recycling Advantages**
1. High(er) yield from waste to rPET
 2. Can handle multi-material trays
 3. Implementation of mechanical route not yet successful
 4. Already fit for today's waste composition, not only for 'design for recycling' waste



Decision Tree Textile Recycling




The recycling strategy per textile product can be decided based on the complexity of the composition and the TRL level of the recycling solutions.

Clearly design for recycling can speed up the recyclability of complex products.



Comparison of Molecular Recycling Technologies

Technology	Output	Initiatives	Type of Feed	CAPEX	OPEX	CO ₂
Mechanical	PET	Many	Transparent bottles	+++++	+++++	+++++
Flake to Resin	PET	limited	Transparent flakes	+++	+++	+++
 CURE Polyester Rejuvenation	PET	DSM, Morssinkhof, Cumapol	ODR, Food trays, Textile, Carpet	+++	+++	+++
Glycolysis	BHET	Ioniqa, JE Plan, Garbo	ODR, Food trays,	++	++	++
Methanolysis	DMT	Eastman, Loop	ODR, Food trays,	++	+	++
Hydrolysis	MEG, PTA	GR3N	ODR, Food trays, Textile	+	+	+
Enzymatic	MEG, PTA	Carbios	unclear	+	+	+++

++++ = Excellent
 +++ = Good
 ++ = Fair
 + = Poor



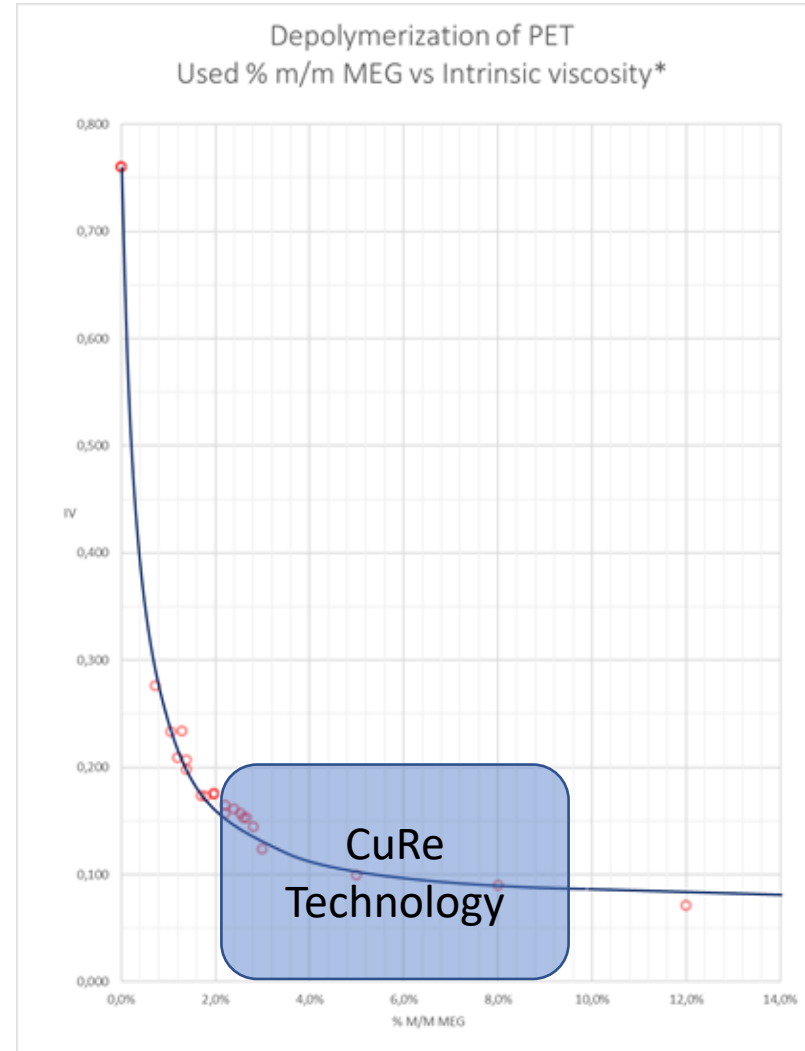
Depolymerization via Reactive Extrusion

Depolymerization

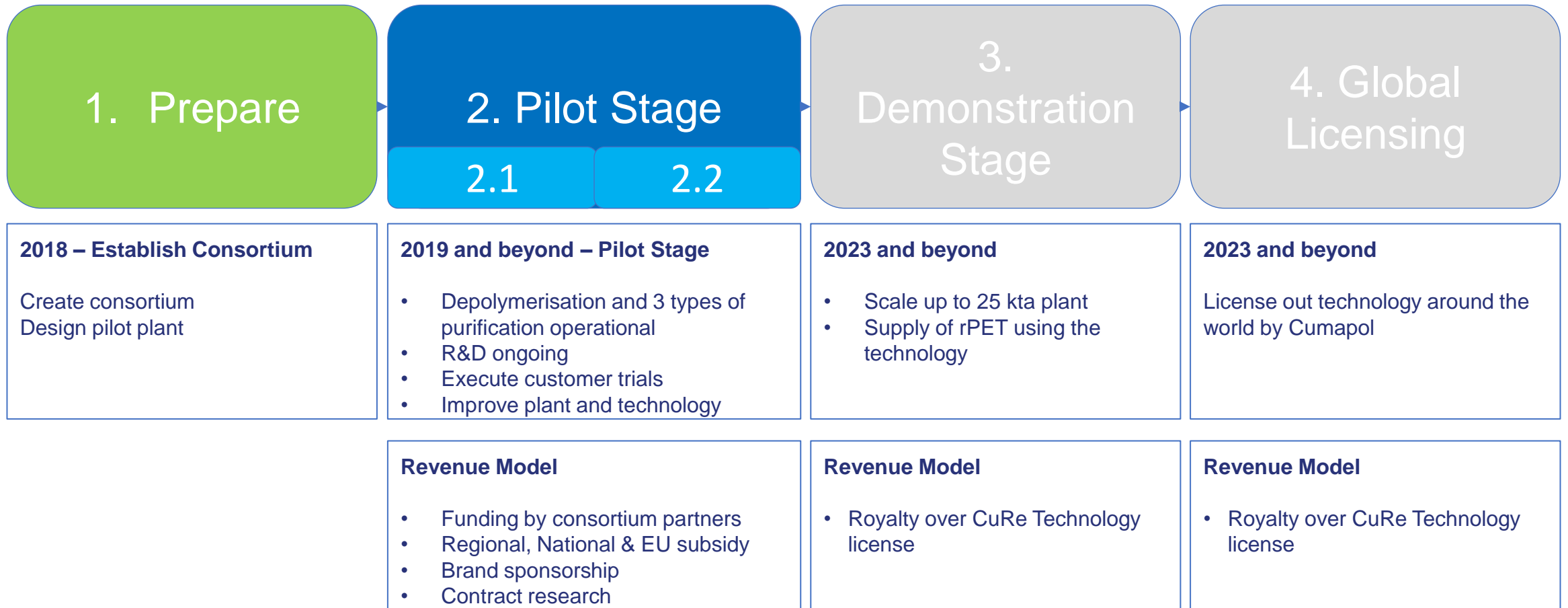
- Commissioning of pilot plant completed
- Depolymerization extensively tested in pilot plant
- Confirms ability to use low %age MEG to reach low viscosity oligomer mix
- IP filing completed
- Further optimizations ongoing

Decolorization

- pilot plant R&D in full
- First results confirm that TiO_2 , carbon black and red give very promising results
- Scanning per color and purification method needed



Phasing, Strategy & Business Model



Pilot Phase – Expanded into 2 Steps

2.1

Pilot Plant

- 2 step Extrusion
- Depolymerization
- Purification via
 1. active carbon slurry
 2. packed beds
 3. microfiltration

At nearby partner facilities

- Waste preparation
- Repolymerization
- Solid state post-condensation
- Fiber spinning
- Preform manufacturing

2.2

Pilot Plant Expansion:

- Waste preparation
- Purification via
 1. distillation
 2. crystallization
- Repolymerization

At nearby partner facilities

- Solid state post-condensation
- Fiber spinning
- Preform manufacturing

Phase 3 –Demonstration Stage

Conceptual Engineering

- Engineering partner selection
- Conceptual engineering study for Emmen site at 25 kta
 - Greenfield study
 - Brownfield study (conversion of existing vPET production assets)
- Conceptual engineering study for licensing
 - Greenfield study 50 and 100 kta
 - Make modular so various locations can be analyzed

Basic Engineering

- Prepare for CAPEX decision

Engineering Procurement & Construction phase

Start-up

Targeted Applications

Application



Subgroups

Opaque & Difficult to Recycle Bottles

100 % PET
PET + Spandex
PET + Cotton

Niaga®
Technology
Latex based
Non-wovens

Single layer
Multi layer
Film pure PET
Film multi layers

Seat belts
Ropes
Monofilaments
Other

Contaminants

Colorants, fillers, catalysts, Other polymers, Scavengers, barrier materials

Colorants, Other polymers, Spandex, cotton

Colorants, Carpet backing, fillers, Other polymers spin finish, flame retardants, catalysts

Colorants, catalyst, Other polymers, Silicones, organic waste

Colorants, fillers, Other polymers, spin finish, flame retardants, catalysts

- Typical Contaminants**
- Colorants
 - Fillers
 - Catalysts
 - Scavengers
 - Barrier materials
 - Flame retardants
 - Processing agents
 - Polyolefins
 - Polyamides
 - Other polymers
 - Other polyesters
 - Cotton



CuRe Technology position to meet EU ambition level

Food Contact Approval

Dilemma

EFSA regulations are based on mechanical recycling. Regulations for chemical recycling are based on monomer production, not on rPET production, so no fit with CuRe Technology

CuRe Position

1. Safety for food contact in packaging for consumers is leading.
2. Stimulate development of new recycling technologies that are safe and competitive.
3. Approvals on the basis of **proven end quality and safety** of the recycled plastics using well-defined tests and procedures.
4. Proposed are challenge tests, NIAS testing, working as per GMP practices and guaranteed traceability in combination with carefully selected raw materials.

Climate Targets & Recycling Rates

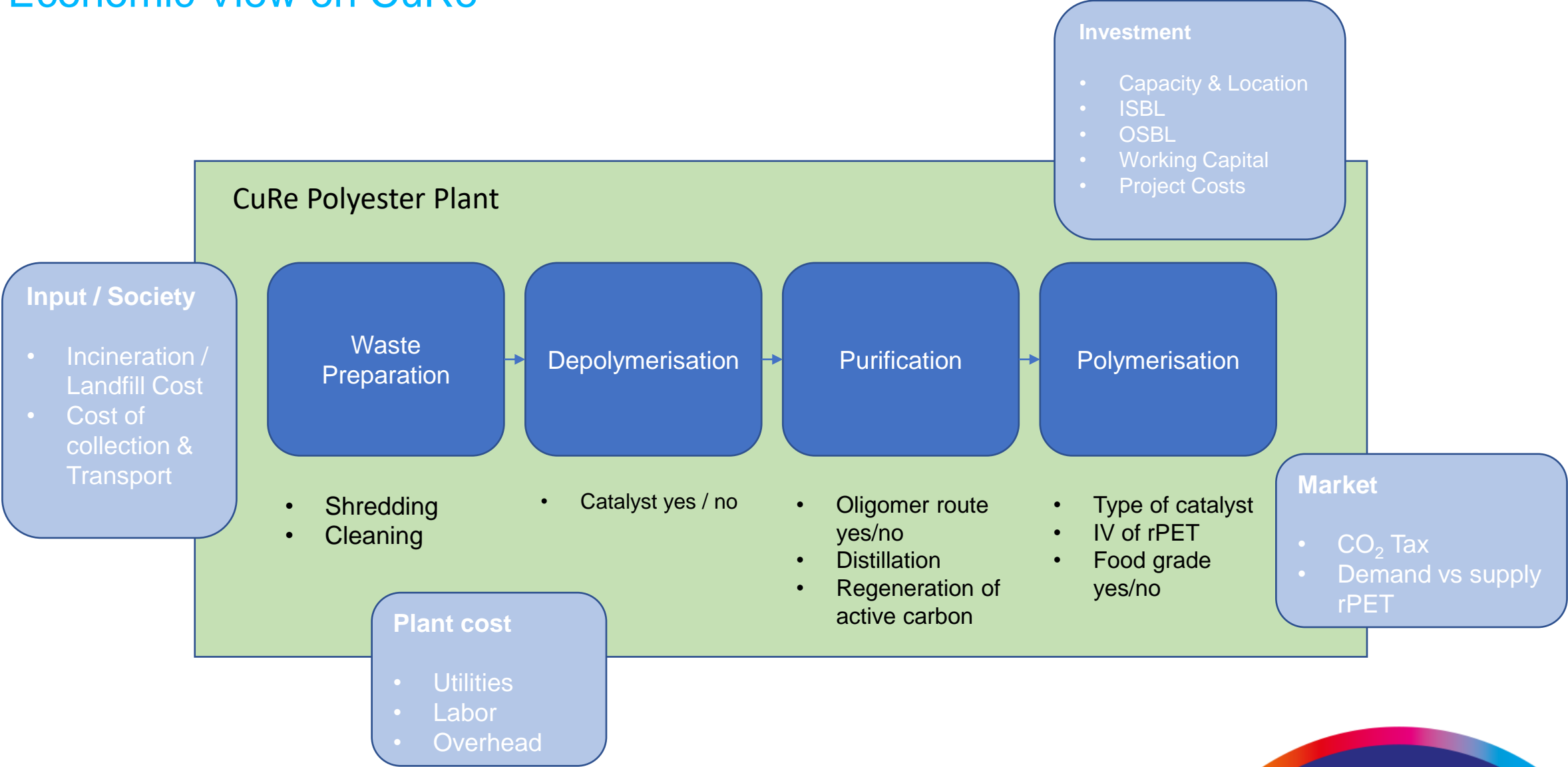
Dilemma

Good structure in place for packaging, but this concerns only 1/3 of all polyester, the balance reaching the EU as clothing or other textile products, and there are no EPRs yet.

CuRe Position

1. EU directives including a minimum percentage recycled content in new products big driver for success to push the industry to new technologies, capacity expansion and economic recycling infrastructure.
2. Accelerate waste collection and sorting by extending the EU directives on recycled content for textile applications.
3. Combine this with obligatory transparency on ingredients via material passports to make recycling possible.

Economic View on CuRe



Economical Considerations to date

1. Pilot plant stage so too early to assess the true economic potential of the technology. However the oligomer route has the potential to deliver the lowest cost structure possible.
 - Lowest energy use
 - No need to transport BHET (with 30 % MEG), PTA or DMT to a polyester plant
 - No need to cool down and reheat up the depolymerized polyester
2. Feedstock pricing crucial for overall cost structure, and no infrastructure exists outside of bottles yet (textiles, carpet and food trays), so impossible to judge real cost into the plant, expected to be (very) positive though. Current societal setting will drive development of this infrastructure in the next years.
3. Phase 3 concerns a vital demonstration step at small (25 kta) but commercial size, but not representative of final cost potential because:
 - Plant will be operated with a specialty polyester strategy with a premium pricing strategy
 - CAPEX lower than for a green field plant due to reuse of existing assets
4. True potential will be exploitable in Phase 4 via global licensing
5. We do not need to sell our technology exclusively to a polyester producer as we are a polyester producer ourselves, creating strategic freedom

Collaboration Models

	Phase 2 Pilot	Phase 3 Demonstration	Phase 4 License	Funding
Licensing <i>(as of 2023/4 once demo plant runs)</i>			Specific royalty bearing license	
(Brand) Sponsorship	Long-term tailor-made program incl team expansion and CAPEX	Right to take off %age of commercial volumes	Specific agreement wrt licensing phase	Substantial upfront financial commitment
Contract Research	Short term <i>tailor made</i> program based on existing team & assets	n.a.	n.a.	Tailored cost based package 10 to 250 kEUR
Collaborative Research	Mid long-term program for <i>consortium</i> of partners	n.a.	n.a.	Subscription type TBD



CuRe Contract Research Approach

Well-defined step by step approach to avoid unnecessary cost and time delay.

Phase 1

- material characterization
- Labscale pre-investigation
- Depol pilot plant trials
- Microfiltration Pilot plant
- Repol labscale
- material characterization

Phase 2

Full evaluation on pilot plant including application experiments



CuRe Textile Contract Research Options

To support companies active in the textile chain to assess the recyclability of their products including the recycling strategy and/or suggestions for design for recycling a range of options is available at various scales.

Type	Objective	Options	Sample size	Cost
Mechanical Recycling	Validation of recyclability into a fit for use rPET that can be spun into fibers without color removal	<ol style="list-style-type: none"> 1. Pilot scale extrusion 20 kg/h 2. Commercial scale extrusion 400 kg/h (subject to availability) 3. Shredding & agglomeration 4. Solid State Post Condensation (small / medium / commercial scale) 	<ol style="list-style-type: none"> 1. ~ 200 kg 2. ~ 5000 kg 	<ul style="list-style-type: none"> • Pilot scale extrusion EUR 1500 per day • Commercial scale to be quoted on case-by-case basis and subject to capacity availability • Shredding and agglomeration now done via third party: quoted at cost and as per availability • SSPC cost depending on scale
Chemical Recycling	Validation of recyclability into a fit for use rPET that can be spun into fibers with removal of key contaminants	<p>1 – Lab Scale</p> <ul style="list-style-type: none"> • Bill of Materials review & analysis • Lab scale depolymerisation and analysis • Lab scale repolymerisation and analysis <p>2 - Pilot Plant Validation</p> <ul style="list-style-type: none"> • Validation (20 kg/h) <p>3 – Pilot Plant Production</p> <ul style="list-style-type: none"> • Production (20 kg/h) 	<ol style="list-style-type: none"> 1. ~ 1 kg per SKU 2. ~ 200 kg 3. ~ 500-1000 kg 	<ul style="list-style-type: none"> • Lab scale typically 5 kEUR per SKU, subject to tailor made quotation based on actual compositions • Pilot Plant typically 7 to 10 kEUR per day and one day needed for start-up and one day for cleaning
Fiber Spinning	Production of yarns to validate yarn production and dyeability	<ol style="list-style-type: none"> 1. Small scale mono or multi filament yarns 5 kg/h spinning 2. Pilot scale fine denier multifilament or monofilament yarn spinning 20 kg/h 3. Pilot scale industrial multifilament yarn spinning 20 kg/h (550+ dTex) 4. Commercial scale spinning industrial HT polyester filament yarn 5. Pilot scale spun yarn spinning 	rPET to be produced out of samples of mechanical or chemical recycling	<ol style="list-style-type: none"> 1. Small scale ~ EUR 2500 per day 2. Pilot scale ~ EUR 3000 per day (available as of H2 2021) 3. Pilot scale ~ EUR 4500 per 24 hrs (available as of H2 2021) 4. Price to be prepared on case-by-case basis and subject to capacity availability 5. Price on case-by-case basis, tests externally.

CuRe ambition reached by growing assets in steps

CuRe assets are following the order of the TRL level. We can grow these assets in scale and scope step by step, with each step needing its own funding through sponsoring and subsidy, and for commercial scale assets a positive business case with clarity on rPET take off agreements.

Asset	Objective	Assets	Future CAPEX
CuRe Pilot Plant (CPP)	<ul style="list-style-type: none"> • Depolymerisation • Purification • Repolymerisation 	<ul style="list-style-type: none"> • Depol + purification operational • Repol operational from Q2 2021 • additional purification technologies 2022 	~ 1 mln EUR
CuRe Textile Pilot Plant (CTPP)	<ul style="list-style-type: none"> • R&D on textile feedstock preparation • Feeding textile feedstock to existing CuRe Pilot Plant • Pretreatment high cotton content 	<ul style="list-style-type: none"> • Precutter • Agglomeration (small) • High cotton content removal vessel • Ancillary equipment 	~ 0.9 mln EUR (0.4 mln EUR via subsidy) • Decision H2 2021, start-up appr. Q2 2022
Textile Feedstock Preparation Plant (TFPP)	<ul style="list-style-type: none"> • Mechanical recycling of pre-consumer 100 % polyester textile • Produce compacted material that can be fed to CuRe Pilot Plant and later CuRe Demonstration Plant 	<ul style="list-style-type: none"> • Cutter / Guillotine • Metal removal (2x) • Shredder / size reduction • Agglomeration or optional: Twin screw extruder + stuffer, filter 	~ 3 mln EUR ISBL, subsidy request submitted • Design & purchase foreseen H1 2022, Start-up appr. Q4 2022 • Location To Be Decided • Capacity to be reviewed (5 or 10 kta)
Feedstock Preparation Plant (FPP)	<ul style="list-style-type: none"> • Shredding, washing of post consumer packaging (food trays, bottles) • Produce washed material that can be fed to CuRe Demonstration Plant 	<ul style="list-style-type: none"> • Shredding • Hot and cold wash 	~ 20 mln EUR • Decision timing TBD • Funding to be organised • Location : Heerenveen or other location • Expected capacity 40 kta
CuRe Demonstration Plant (CDP)	<ul style="list-style-type: none"> • 25 kta CuRe Demonstration Plant • Fed with pre and post consumer textile waste from TFPP 	<ul style="list-style-type: none"> • Depolymerisation, purification, repolymerisation • TFPP to prepare feedstock for CDP • Not included: washing for post consumer consortium 	~ 25 mln EUR • Decision foreseen H1 2022 • Funding to be organised • Location : Emmen or greenfield

Virgin Polyester. Used polyester. ~~End.~~ **CuRe**. Repeat.

Sponsorship Consortium being set-up

Partner target

Appr. 4 to max 6 brand owners spread over the targeted applications
At least 1 long term global engineering partner and at least 1 waste management partner

Sponsor contribution

1. In-kind contribution via application know-how
2. Pro-active collaboration on implementing closed loop approach
3. Financial contribution as pre-financing loan and / or grant

CuRe contribution

1. Access to technology
2. Access to engineering study on CAPEX for greenfield plants
2. Allocated volume (10 kta for 2 years) of Cure rPET in Phase 3 for sponsors
3. First right of refusal on additional volume
4. First right of refusal on license in Phase 4 for defined Field of Use
5. Pay back of 50 % of sponsoring once commercial supplies are realized in Phase 3

Financial target

Minimum contribution 750 kEUR per brand

Remarks

- No need for financial contribution foreseen in Phase 3
- No general exclusivities, willingness to create clear commercial benefits

CuRe Technology Partners



Cumapol provides recycling solutions for post-consumer and post-industrial polyesters. Our services contain: Regranulation, Compounding, Crystallization and Solid State Polymerization.



With a production of more than 300,000 tons per year on 11 locations, Morssinkhof Rymoplast is one of Europe's largest producers of high grade mechanically recycled raw materials.



DSM-Niaga has the mission to redesign everyday products from the ground up. The aim is to make products fully recyclable in an easy and affordable way, without compromising on quality or price.



With over 40 years of experience in polymer development and processing, DuFor is able to translate the customers' requirements into the recipe of the polymer needed.



Our multi-campus university of applied sciences is firmly rooted in the northern part of the Netherlands where we are based, while at the same time maintaining a strong international focus.