IEA Bioenergy
Technology Collaboration Programme

Task 42
Biorefining in a circular economy

The Netherlands - update

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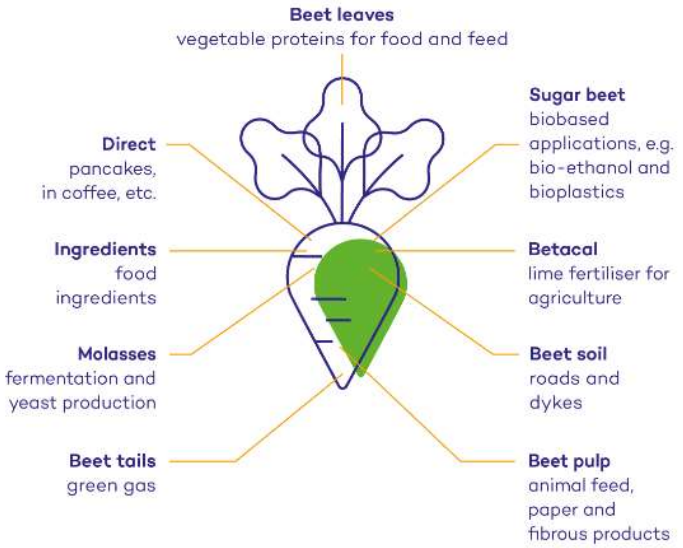
Cosun - The use of sugar beet for bio-based materials and the effects on food security

- Renewable Carbon Initiative, of which Cosun Beet Company is a founding member, publishes new insights
- Among other feedstocks, sugar beets are best in class in their performance
- Dutch sugar beets offer the highest yields among many different biomass sources: 164%, compared to potatoes for consumption (101%) and winter wheat (116%)
- Next to the above, Cosun Beet Company is valorizing the whole sugar beet with zero waste
- Apart from sugar for direct consumption in food, we also produce bioethanol and biogas contributing to the energy sector, materials from beet pulp like sustainable paper and home and personal care ingredients
- And last but not least, we use proteins from beet leaves, with a significant contribution to high caloric vegan food.

Cosun Beet COMPANY



https://www.cosunbeetcompany.com/news/the-use-of-sugar-beet-for-bio-based-materials-and-the-effects-on-food-security/353
https://renewable-carbon-initiative.com/media/press/?id=448

BBI-JU – Plentitude Flagship Biorefinery – Sas van Gent - Update

- Flagship biorefinery makes much-needed non-animal protein
- The CBE JU-funded PLENITUDE project has built a large-scale, first-of-its-kind biorefinery producing a sustainable mycoprotein (branded as ABUNDA) used in food, pet food, and food packaging
- Located at Sas van Gent, in the Netherlands, the biorefinery has an initial output capacity of 10,000 tonnes a year
- Annual production at the plant, which was opened in 2022, is expected to reach 60,000 tonnes within 5 years, with a target of 1 million tonnes set for 2032
- If this is achieved, the impact will be equivalent to replacing 5 million cows and over 1.2 billion chickens
- The production of ABUNDA will also cut CO2 emissions by 5 million tonnes a year compared with the production of meat proteins
- The plant has created 35 direct and 150 indirect jobs, including for process and maintenance engineers and laboratory technicians

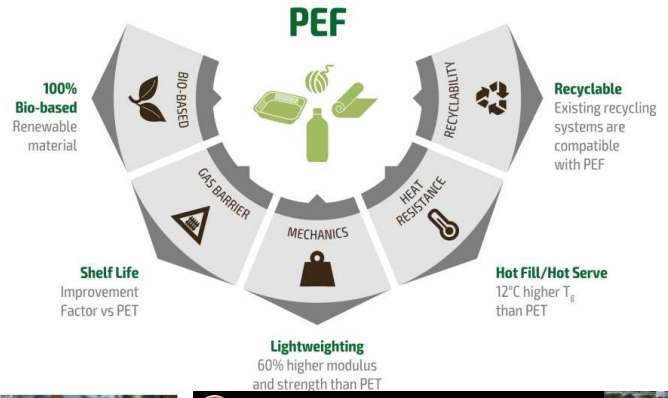
https://www.cbe.europa.eu/achievements/flagship-biorefinery-makes-much-needed-non-animal-protein & https://www.plenitude-bbi.com/

BBI-JU - PEFerence - Delfzijl - Update

- Five-year EU Flagship project to establish an innovative supply chain for FDCA and PEF
- Project coordination by Avantium
- Objectives
  - Replace a significant share of fossil-based polyesters, such as polyethylene terephthalate (PET), and packaging materials like glass and metal with 100 % bio-based PEF (polyethylene furanoate)
  - PEF can be used in a wide range of applications such as bottles, packaging, films, fibers and textiles
  - Engineer and build the flagship plant for production of purified FDCA (5,000 tonnes/year)
  - Demonstrate and validate at least three 100 % bio-based materials in end user applications
  - Commercialize the 100 % bio-based end products demonstrated in the project
  - Demonstrate and optimize the new local bio-based value chain from raw material sourcing to PEF end products
  - Evaluate the environmental and socio-economic performance of the developed products

PEFerence
The Renewable Innovation

Circular Bio-based Europe
Joint Undertaking

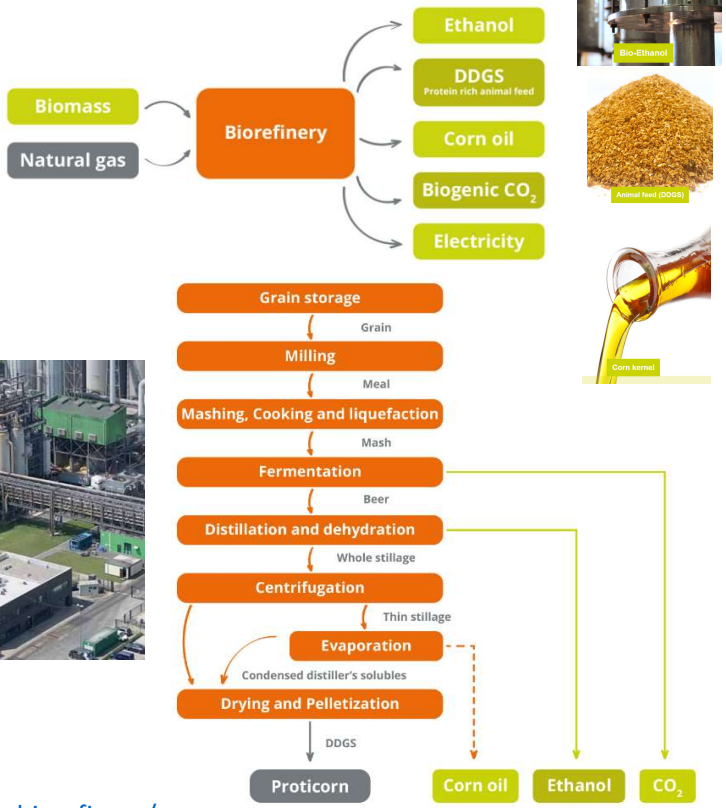



PEF injection molding samples at the Renewable Materials Conference 2023

avantium

Alcoenergy Bioefinery - Rotterdam

- The biorefinery in Rotterdam processes raw materials, mainly corn from Europe, into a number of high-quality products
- The process uses the starch (in fact sugar) in the corn and these sugars are converted into alcohol
- The most important, most nutritious part of the grain therefore remains in the food chain as DDGS (Dried Distillers Grains with Solubles) which is the main by-product
- During the evaporation of the thin (residual) stream, after pre-treatment, corn oil is separated using a centrifuge

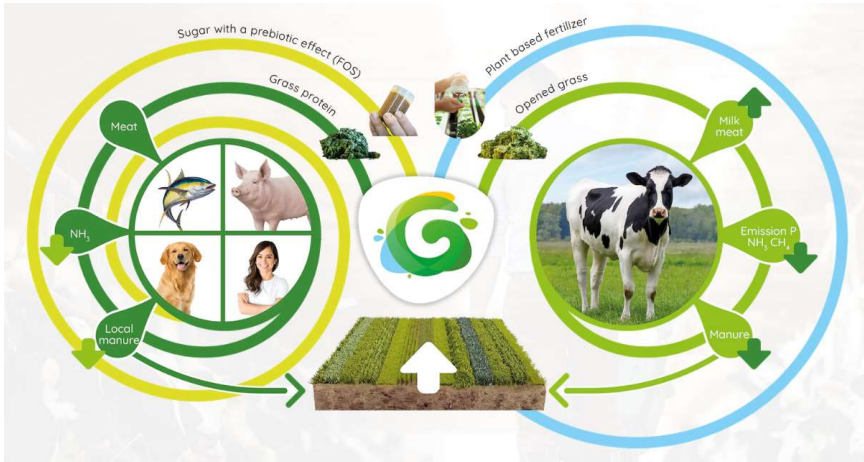


https://www.alcoenergy.com/en/our-biorefinery/

Grassa Green Refined Solutions

- Unlocking the full potential of grass
- Grass is processed into four high-quality products through a natural process of pressing, heating and filtering:
  - digested grass whose proteins are more digestible for the cow
  - grass protein as an alternative to imported soy
  - sugar with a prebiotic effect
  - minerals as a vegetable alternative to manure

Grassa
GREEN REFINED SOLUTIONS



https://grassa.nl/en/

Newfoss Biorefinery

- Small-scale green biorefinery
- NewFoss developed a biorefining process converting 100% of the residual biomass into high value products
- The plant material is used in various sustainable fiber applications such as building and construction and paper and cardboard
- The NewFoss biorefining process is also suitable for refining different crops and agricultural side streams; here the focus is on extracting high value compounds
- Patented mild extraction technology

Insulation panels:
NFF-Iso

Paper and Cardboard:
NFF-Pulp

Substrate and potting soil
NFF-Substrate

BioBased Circular Proposal with Avantium selected by National Growth Fund for funding to make plant-based materials

- The National Growth Fund (Nationaal Groeifonds) has selected the BioBased Circular (BBC) proposal for funding
- The BBC proposal includes a track dedicated to the engineering and construction of a Flagship Plant to produce plant-based glycols based on Avantium's Ray Technology™
- The BioBased Circular programme aims to set up a sustainable sugar-based chemical and materials manufacturing industry in the Netherlands
- The programme, which runs until 2032, will link up the agricultural sector with the chemical and plastics industry
- The BBC programme is conditionally awarded €338 million in total. The Ray Technology™ Flagship Plant had requested a total award of €53 million

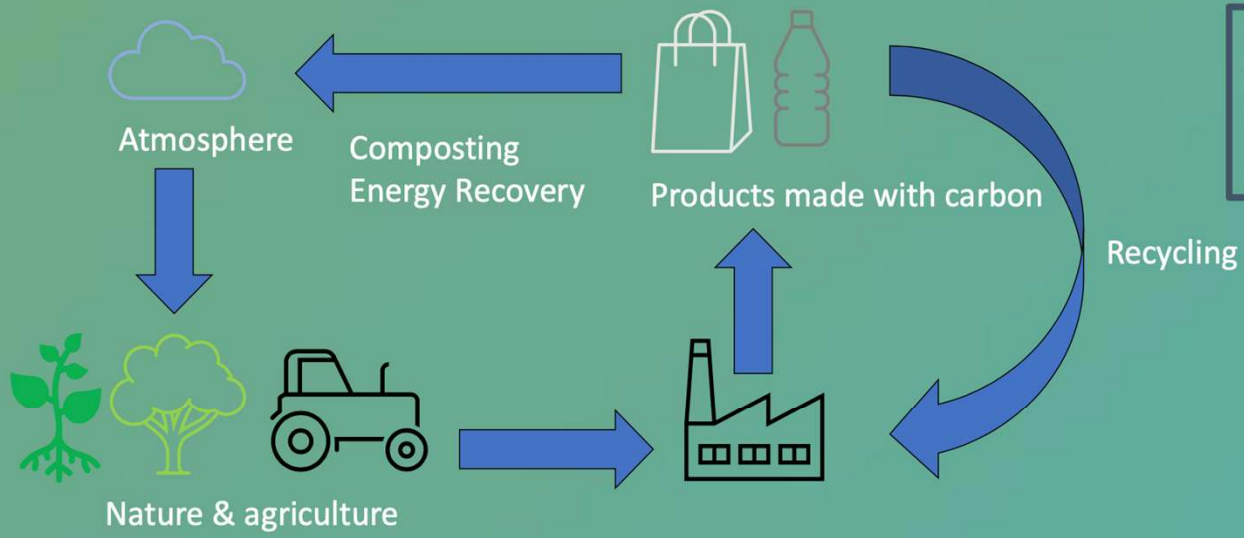
https://www.petnology.com/online/news-detail/biobased-circular-proposal-with-avantium-selected-by-national-growth-fund-for-funding-to-make-plant-based-materials

Ambition of BioBased Circular

- Both short and long term impact on both Economy and Climate
- Reaching scale
- Innovation by implementation and development
- Value circles (not new linear value chains)
- Make maximal use of what nature already provides
- Become leader in Europe
- Supported by >125 stakeholders (Industry, Universities, NGO's, Government)
- Total program 338 m€, 102 m€ already committed

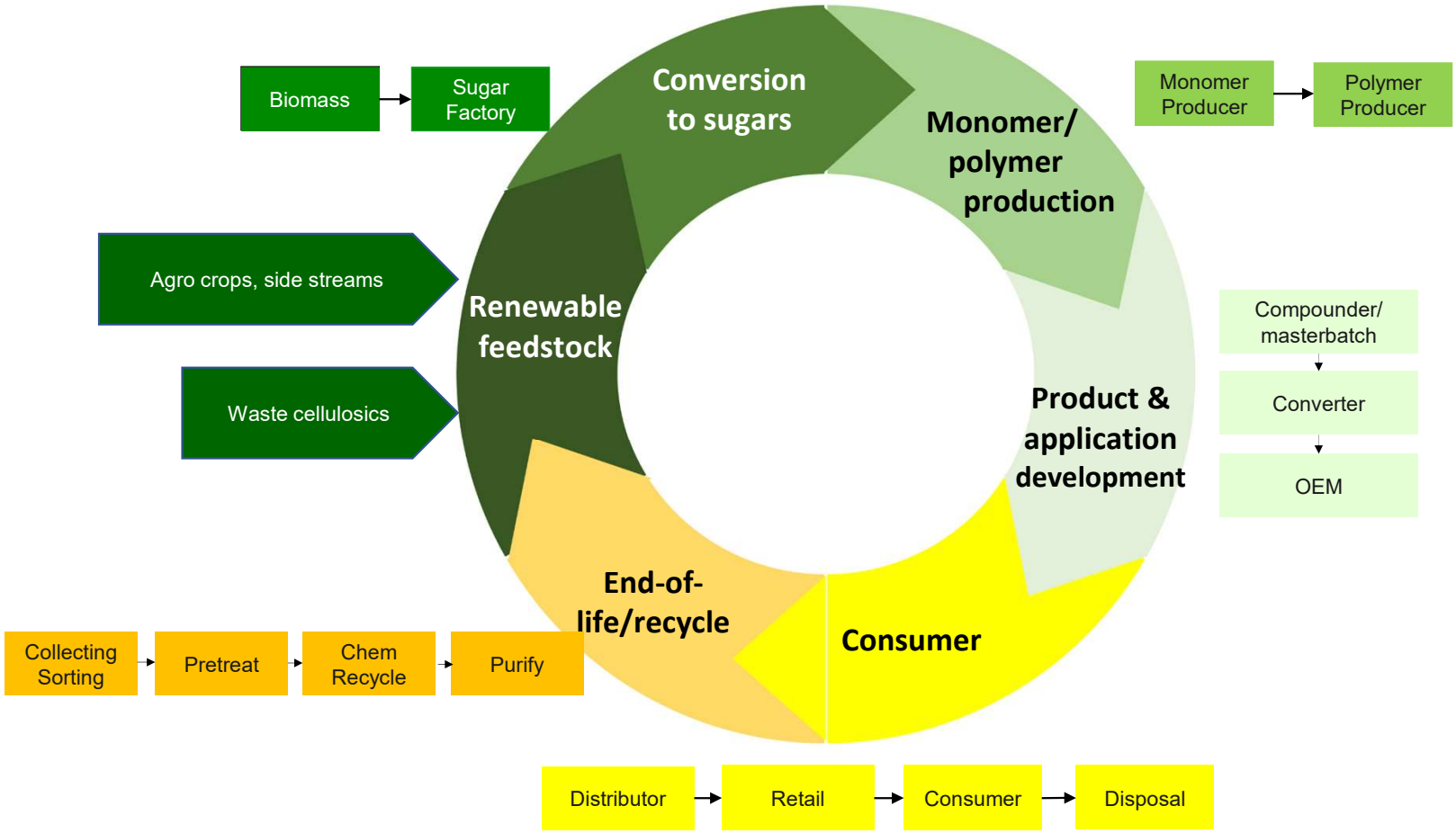
GROENE CHEMIE
NIEUWE ECONOMIE

The ambition is to setup a new Dutch industry that produces, processes, uses and re-uses at scale biobased circular bio-based materials/plastics.



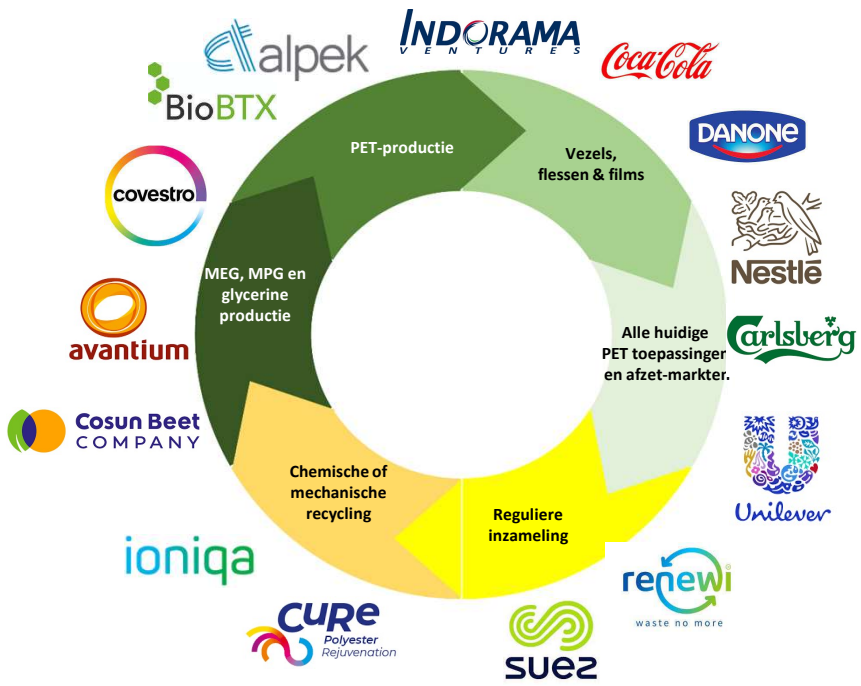
Moonshot 2050 :
25% European marktshare in biobased materials production and processing.

BioBased value Circles



Future value circles in the Netherlands

2050 – circular PET chain



- Polyester materials
- Packaging, textile, building
- Scaling
  - Flagship(s) + demonstrators
- Unique collaboration
  - chemistru/agri&food/forestry/OEM/brand owners//recycling
- D&R + Education

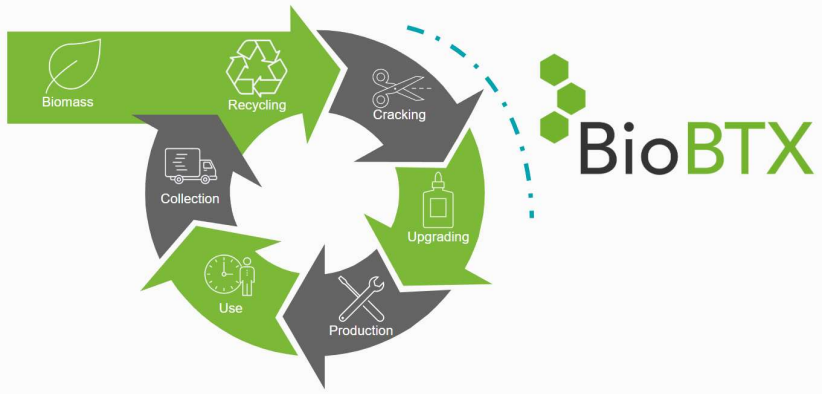
- >125 organizations involved and committed

Effect on climate and economy

- CO_2-emission reduction 2,5 ~Mton CO_2
- Economical growth of 1,5 bln. euro
- New jobs: 3.500
- Export of knowledge

Bio-BTX pilot plant - Groningen

- The BioBTX Integrated Cascading catalytic Pyrolysis (ICCP) technology is developed with the goal of making full carbon circularity possible
- The BioBTX technology consists out of two steps
- One being the pyrolysis of biomass and plastics, while the other is the catalytic upgrading of hydrocarbon vapours towards valuable aromatics and other products.
- April 2022 - BioBTX has finished the construction of the in-house designed and constructed Mini Plant
- This setup is able to process 100 gram per hour on a continuous basis and has received some important improvements and modifications based on the BioBTX pilot plant

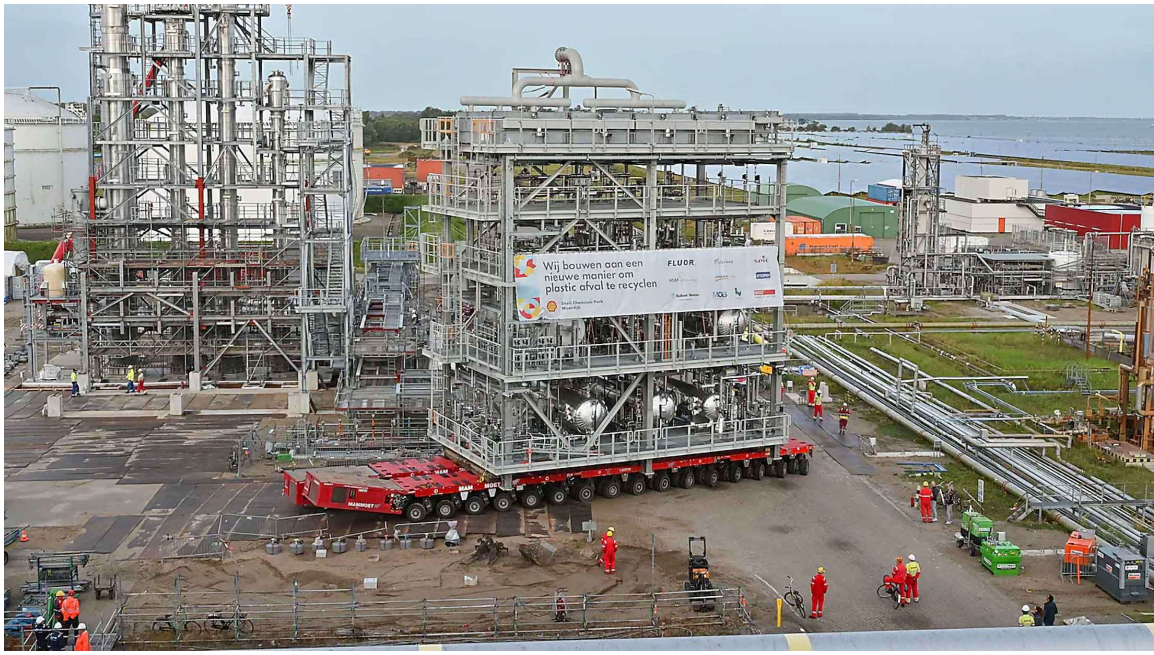


BioBTX gets €2.8 JTF grant for green chemicals from biomass and plastic waste (19/10/2023)

- The primary focus of the project is to further develop the BioBTX technology.
- That should efficiently convert biomass and mixed plastic waste into valuable materials, including the basic chemicals Butene, Toluene and Xylene

Shell installs final part of pyrolysis oil upgrader in Moerdijk

- The upgrader plant aims to make pyrolysis oil, made from waste plastics, suitable as feedstock for the current naphtha crackers
- This will allow new plastics to be made from it
- The technology for the upgrader comes from BlueAlp, with which Shell entered into a joint venture last year
- The plant should be operational by 2024 and has a capacity of 50 kton

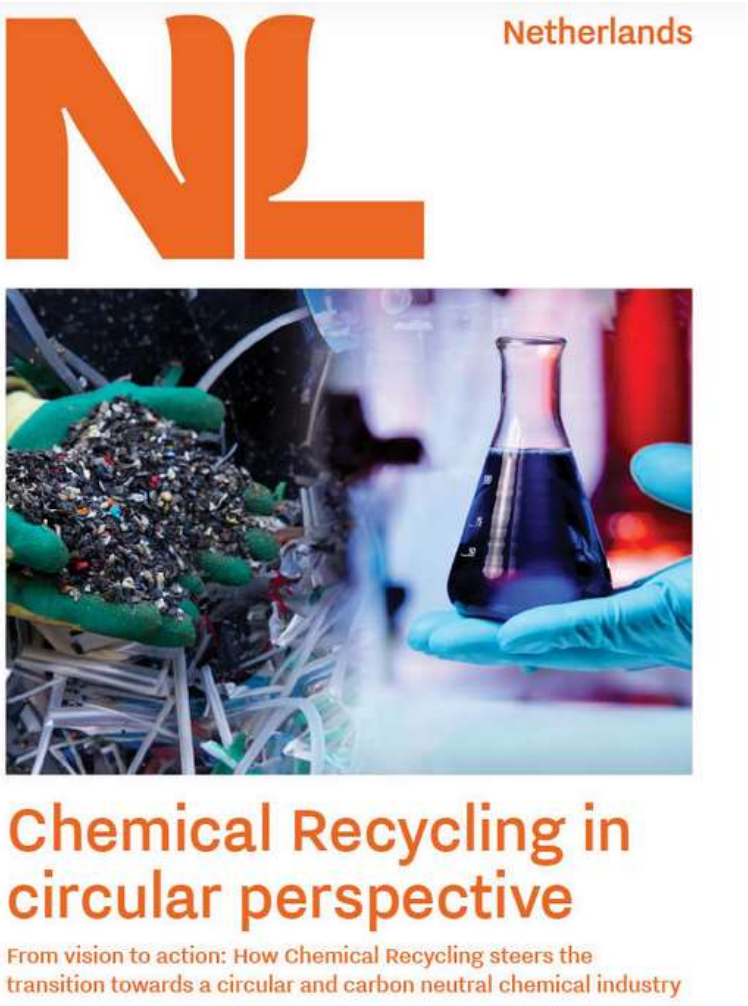


Netherlands

CIRCULAR AGRIFOOD & BIOMASS
FOOD & MATERIALS FOR A SUSTAINABLE FUTURE

Circular agrifood & biomass - Food & materials for a sustainable future

- Downloadable from: https://hollandcircularhotspot.nl/publications/
- The publication provides insight into several Dutch circular best practices and provides a good look at future entrepreneurial opportunities
- The publication results from a collaborative effort between Netherlands Enterprise Agency taking the lead, Holland Circular Hotspot, Foodvalley NL, Topsector Agri & Food, the Ministry of Agriculture, Nature and Food Quality

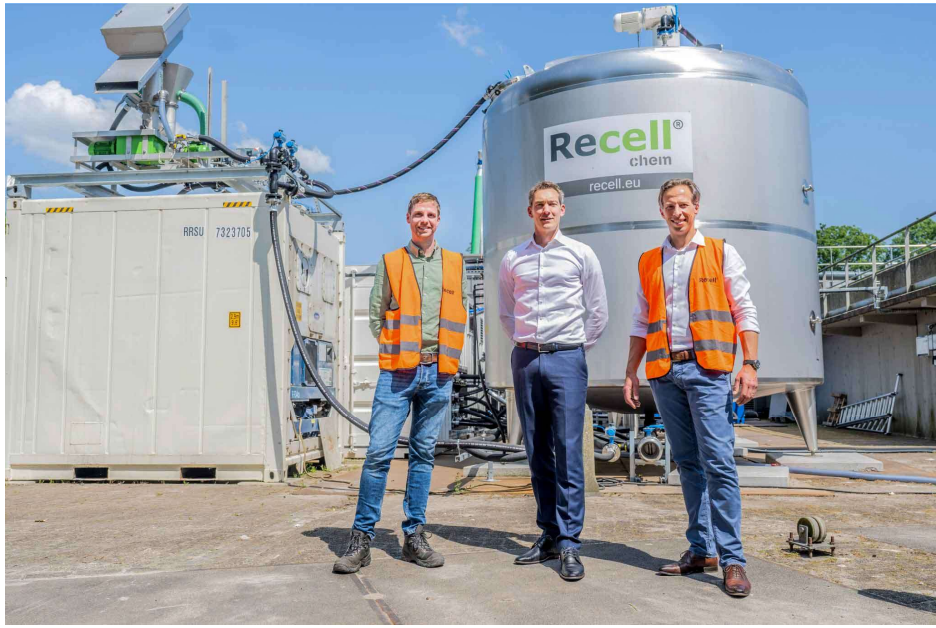


Chemical Recycling in circular perspective

- Downloadable from: https://hollandcircularhotspot.nl/publications/
- This brochure provides insights and best practices on chemical recycling, a technology that transforms plastic waste and organic residues into base chemicals and feedstocks
- This publication is the result of a collaboration between Holland Circular Hotspot, the Network Chemical Recycling of the Circular Biobased Delta, The Netherlands Ministry of Infrastructure and Water Management, Chemport Europe, Chemelot Circular Hub, ChemistryNL, TNO and Infinity Recycling.

Recell opens demo plant for green cellulose (20/06/2023)

- Together with partners, Recell developed a method to isolate cellulose from various residual and waste streams and convert it into high-quality glucose molecules (sugars), which in turn form the basis for many chemical applications on an industrial scale
- The green cellulose demo plant has a capacity of 50 kt and is situated in Leek, Northern Netherlands



Verborg Group to build biorefinery in Farmsum (28/06/2023)

- The Verborg Group is to build a biorefinery at Contitank's site in Farmsum in the Northern Netherlands, Chemport Europe region
- The plant should be operational early next year and will produce at least 200,000 tonnes of pure vegetable oil and fats annually
- The total investment is €35 million, the biorefinery is expected to create 24 new jobs

Infinity Recycling, Invest-NL and LyondellBasell invest €13 million in Pryme

- New pyrolysis plant to accelerate chemical recycling of plastic waste
- Infinity Recycling, Invest-NL and LyondellBasell are investing nearly €13 million in Pryme nv, an innovative cleantech company based in Rotterdam, the Netherlands

Hycarb/Torrgas builds commercial plant in Delfzijl

- In Delfzijl, The Northern Netherlands, HyCarb is working with the Northern Development Company (NOM) on the realization of a commercial plant for the large-scale production of green hydrogen from biobased feedstocks, via torrefaction and gasification
- 15,000 tons of green hydrogen annually

Thank you for your attention

Bert Annevelink,
Ed de Jong &
Rene van Ree

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Task 42
Biorefining in a circular economy

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