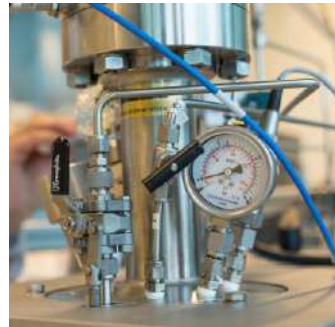


# Technology & Markets Day

## *Path to a Fossil-Free World*

6-June-2019



## Welcome and Agenda

### **14:30 – 16:00 Plenary presentations:**

- Path to Commercialization: Strategy of Avantium – Tom van Aken
- Path to Flagship Plant: Deep Dive Synvina – Marcel Lubben
- Q&A session

### **16:00 – 16:15 Break**

### **16:15 – 17:15 Breakout sessions:**

- Path to the Future – Gert-Jan Gruter (Palladium)
- Path to Products Synvina – Marcel Lubben (Silver)
- Path to Partners Renewable Chemistries – Zanna McFerson (Magnesium)

### **17:15 Wrap up & Networking Drinks**

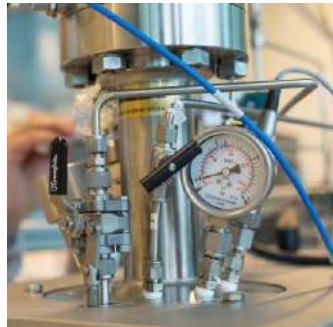
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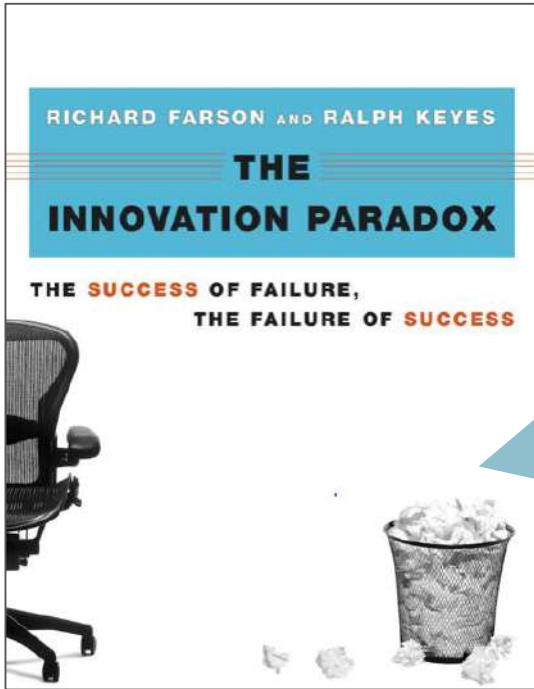
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# Strategy of Avantium

## *Path to Commercialization*



# The Innovation Paradox



RISKS OF DEVELOPING  
DISRUPTIVE TECHNOLOGIES

VERSUS

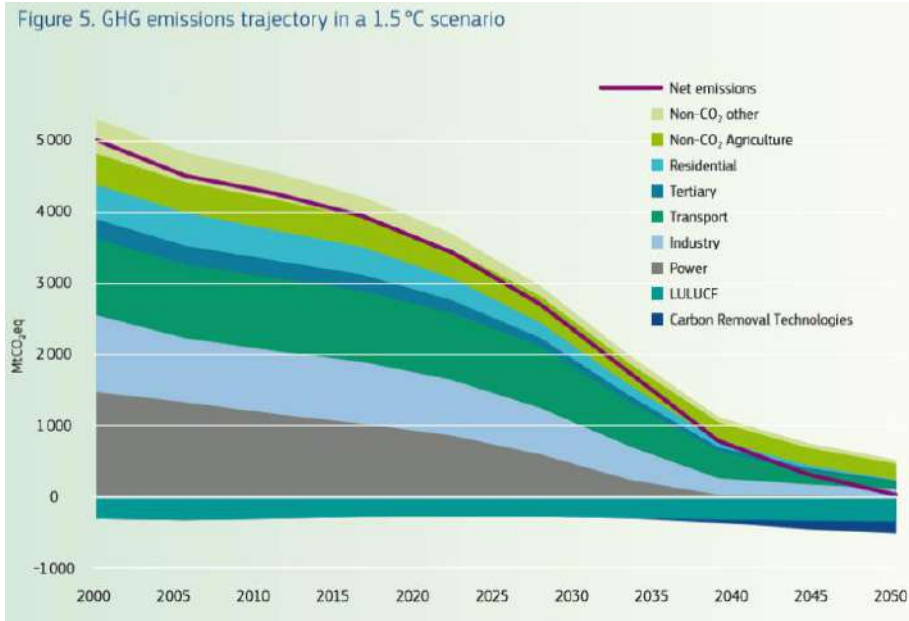
THE DESIRE TO HAVE  
PREDICTABLE RESULTS

# Company Strategy

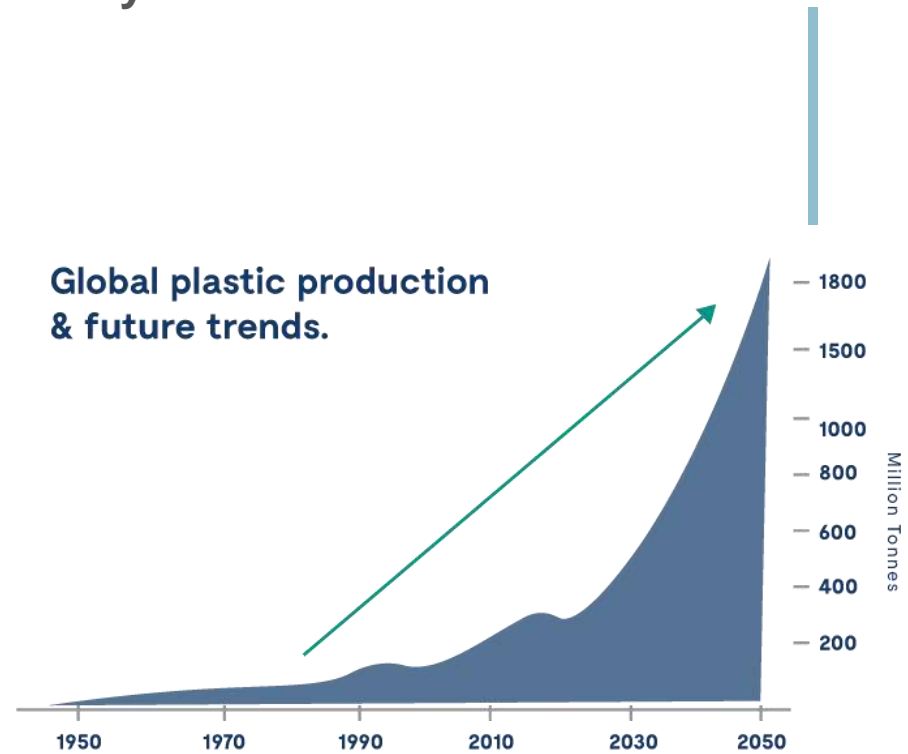
## *Path to a Fossil-Free World*



# The Dilemma: Going Climate-Neutral by 2050 vs Global Plastics Production



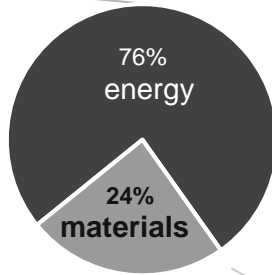
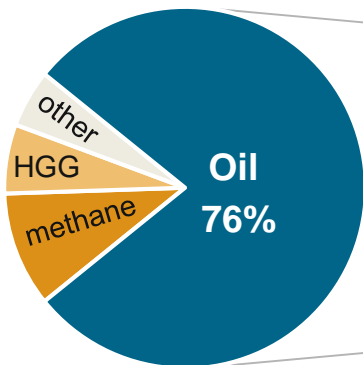
Source:  
 European Commission, brochure on going climate-neutral by 2050 – a strategic long-term vision for a prosperous, modern, competitive and climate-neutral EU Economy (2018).



Source:  
 Ryan, A Brief History of Marine Litter Research in M. Bergmann, L. Gutow, M. Klages (Eds.), Marine Anthropogenic Litter, Berlin Springer, 2015; Plastic Europe.

# We Need Alternatives to Fossil Resources

CO<sub>2</sub> emissions  
by source



## Energy Alternatives



Wind



Solar

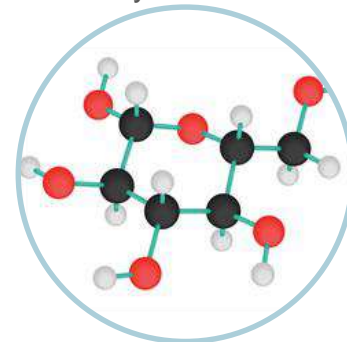


Hydro



Biomass

## Industrial sugars: A Key Alternative

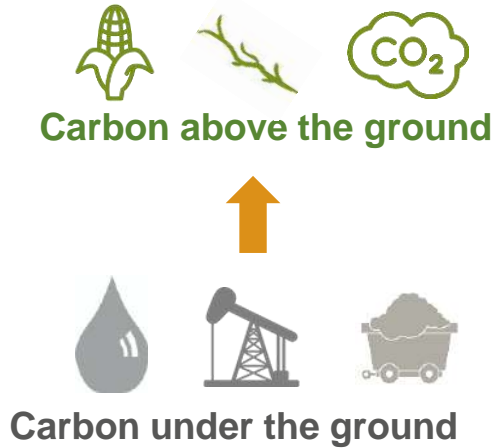


## Materials Alternatives

CO<sub>2</sub> emissions: U.S., 2016, total 6,511 million metric tones of carbon dioxide equivalent (CO<sub>2</sub>e)  
HGG = High greenhouse warming potential gases, such as HFC, PFC, SF6, NF3; Source: U.S. Energy Information Administration ([www.eia.gov](http://www.eia.gov))



# Transition of the Chemical Industry Driven by Megatrends



# A Wealth of Carbon above the Ground

The three renewable carbon sources that enable a circular economy

**Plant-based carbon**



**Air-based carbon**



**Man-made carbon**



## Avantium's Role in this Transition

- Lead the transition of the chemical industry to renewable chemicals and polymers
- Develop breakthrough technologies to make sustainable, plant-based products that compete on performance and costs
- Commercialize these technologies in partnership with industrial companies



# Company Structure



# Avantium Business Units

## Renewable Polymers (fka Synvina)

- Catalytic conversion of plant-based sugars into FDCA
- Polymerization from FDCA into PEF
- PEF: 100% plant-based & recyclable packaging material



## Renewable Chemistries

- DAWN : industrial sugar from non-food biomass
- Mekong: 1-step conversion to plant-based MEG
- Volta: CO<sub>2</sub> to chemicals via electrochemistry



## Catalysis

- Leading service and systems provider
- Blue chip clients



# Catalysis: Tomorrow's Catalysis Today

Leading provider of superior catalysis systems and services, serving a blue chip customer base

## Services

- High-throughput catalyst testing and contract R&D, heterogeneous as well as homogeneous
- Over 700 reactors, fixed bed and batch



## Systems

- Accelerate screening of catalysts and chemistries with highly accurate, reliable and flexible Flowrence high-throughput catalyst testing systems



## Technology

- Technology foundation
- Protected by a portfolio of 9 patent families
- Supported by extensive network of industry experts and academic catalyst R&D centers



# Strategy and Organization Review Q1 2019



Focus on highest value opportunities; continuous evaluation of the development programs



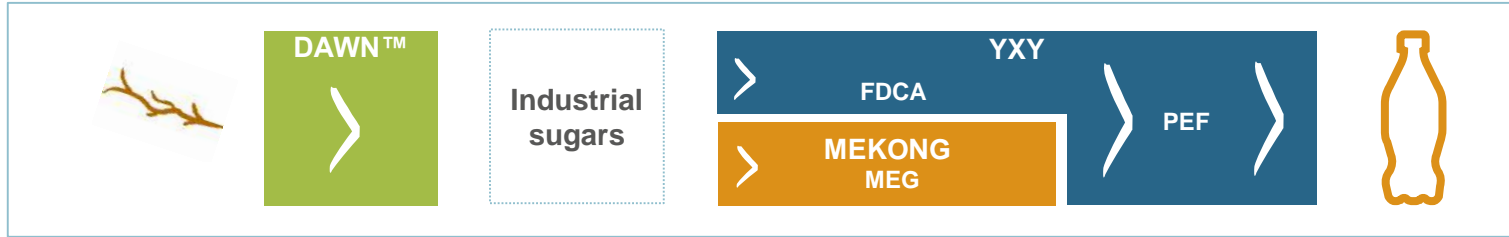
Implementation of cost reduction program to extend our financial runway



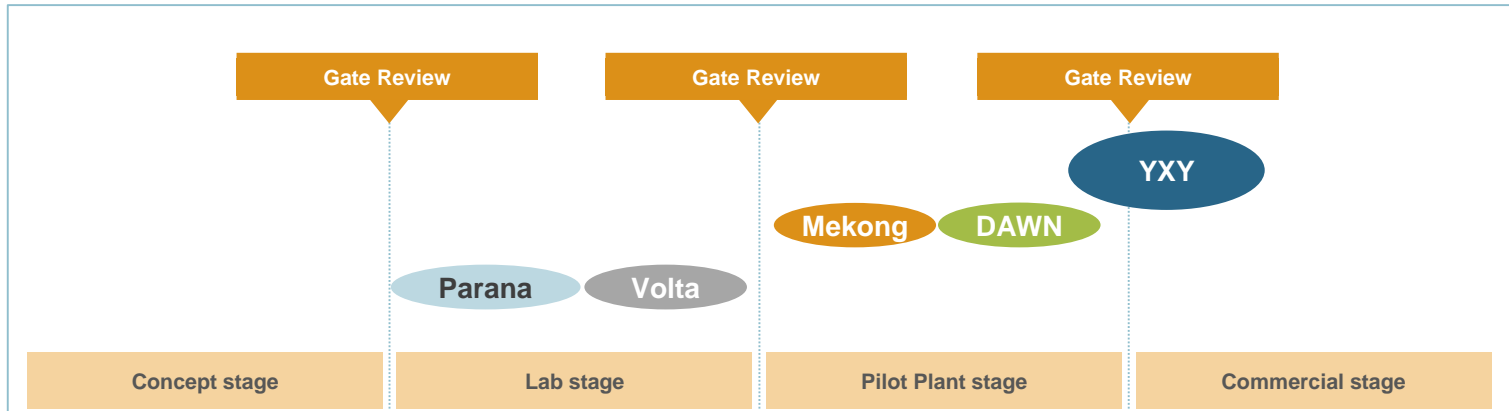
Implementation of new organizational model designed for focus and delivery

# A Coherent Portfolio of Technologies

Coherent portfolio, each targeting blockbuster markets



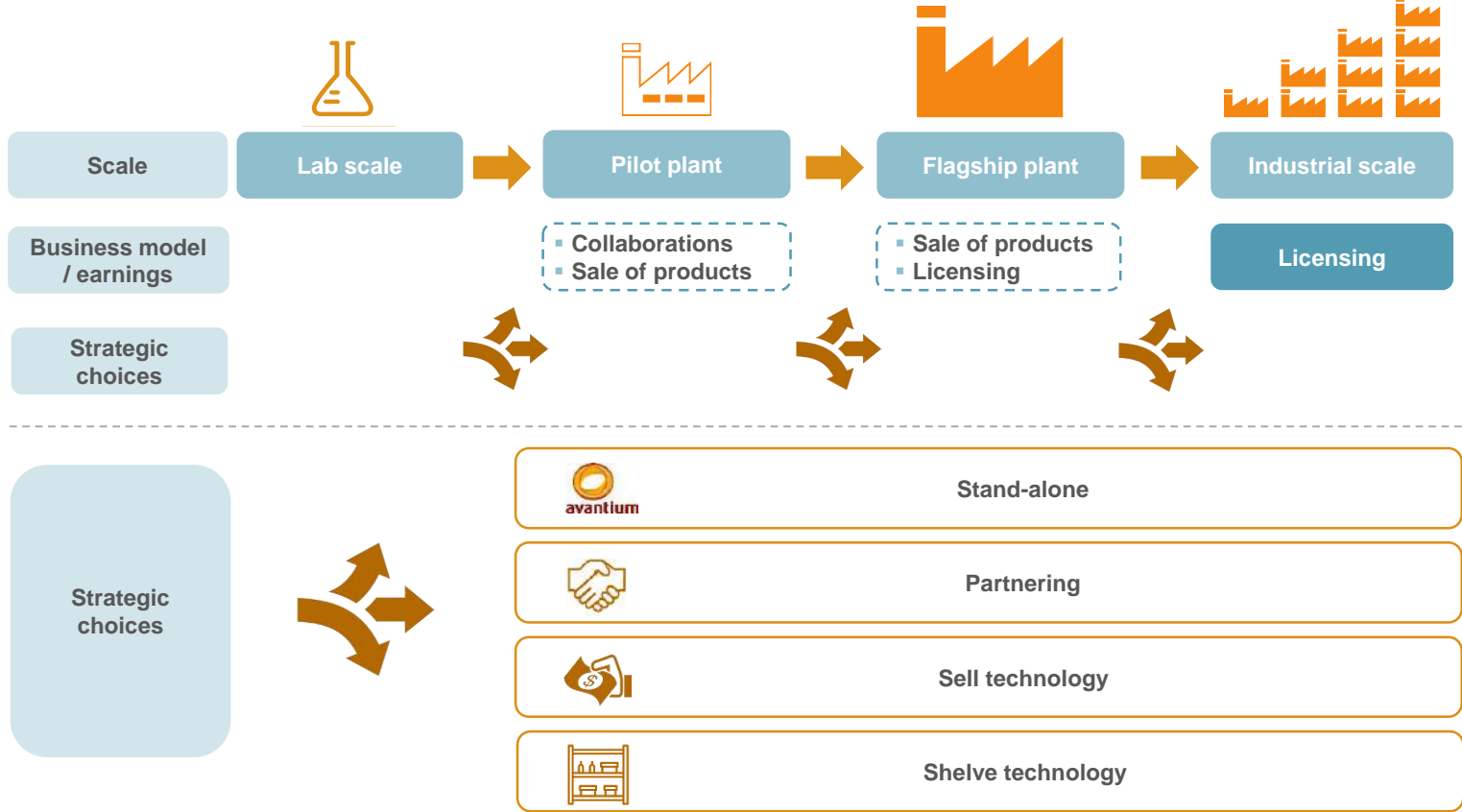
Pursuing the most attractive opportunities through stage gate process





# Value Creation

## Multiple Strategic Routes to Monetize Our Technologies



## Introduction Avantium Technologies - video



die zich in een vergevorderd stadium  
richting commercialisatie bevinden.



# Avantium Renewable Polymers (fka Synvina)

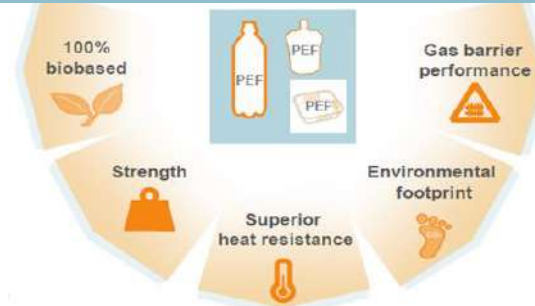


# Avantium Renewable Polymers

Catalytic technology to convert plant-based sugars to FDCA and PEF



## Benefits PEF



Market potential > € 200bn



## PEF Benefits – in use

### Performance

- Shelf life extension
- Lightweighting
- High barrier films

### Circular Economy

- Reuse: enable washing
- Reduce: lightweighting
- Recycle: replace multi-layer

### Renewable

- 100% plant-based
- Reducing carbon footprint



## PEF Benefits – after use

- PEF is designed for recycling and reuse
  - > Proven fit with existing sorting and recycling facilities
- What happens if PEF ends up in nature?
  - > Tests Biodegradation of PEF by Organic Waste Systems (OWS), Gent, Belgium
  - > First results show that PEF degrades much faster than PET (years instead of hundreds of years)
  - > Field trials Avantium ongoing
- PEF benefits in and after use
  - > Safe and stable
  - > 100% Recyclable
  - > Faster degradation in nature to avoid future accumulation



# New Commercialization Strategy Renewable Polymers

## Scale-up and market launch strategy

- |                            |  |
|----------------------------|--|
| ▪ Scale of flagship plant: | 5 kiloton per year   |
| ▪ Technology:              | De-risked  |
| ▪ Market focus:            | High value / performance products                            |
| ▪ Financial objective:     | Cash flow positive   |
| ▪ Purpose:                 | > market launch<br>> enable licensing in high-volume markets |
| ▪ Partners:                | Committed partners throughout the value chain                |
| ▪ Timing:                  | Flagship plant operational in ~2023                          |
| ▪ Funding:                 | EUR 150m   |

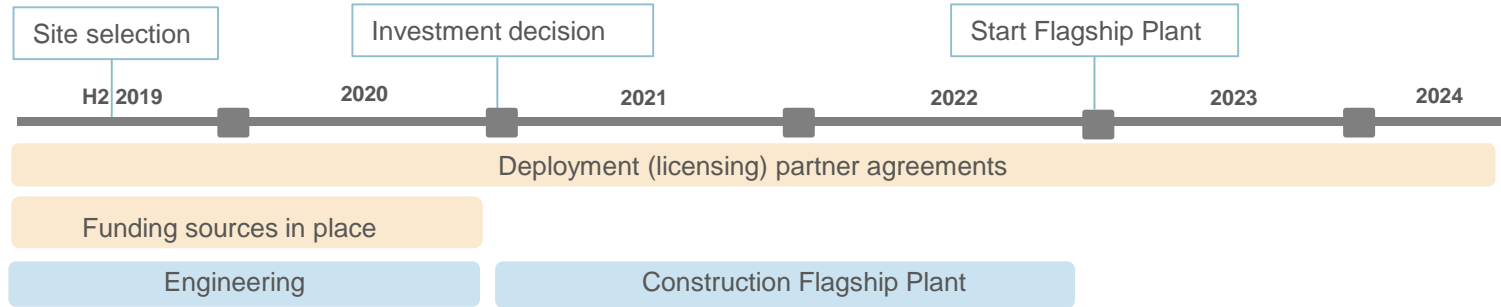
## New Commercialization Strategy Renewable Polymers

- Avantium to maintain control of flagship and licensing business
- Collaborating with committed partners throughout the value chain:
  - > Negotiations with multiple partners ongoing
  - > High level of interest in supply of raw materials, production of FDCA and PEF, and application of PEF for commercial products in multiple end markets
  - > Commitments for financial contribution to flagship plant expected prior to investment decision (2020)





# Timetable New Commercialization Strategy Renewable Polymers



## Site selection

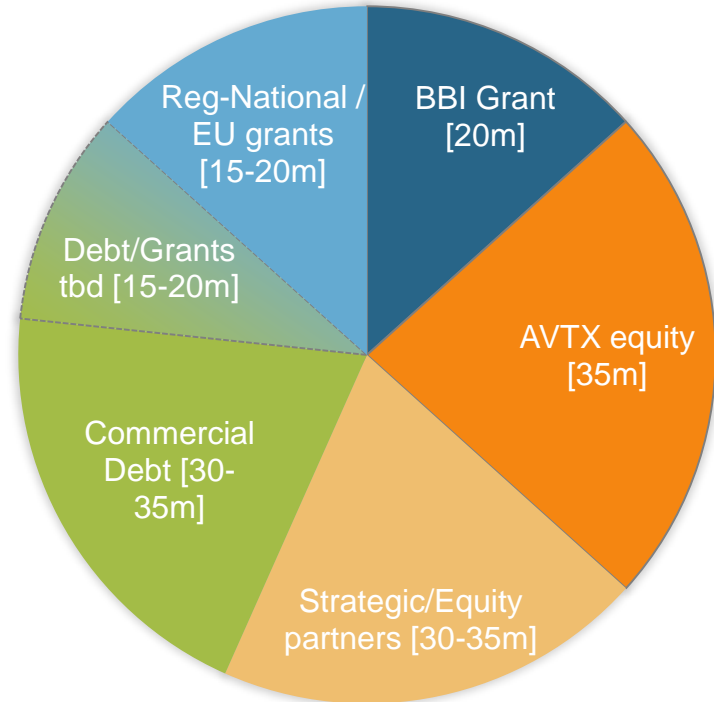
- Site for the flagship plant selected in the second half of 2019
- Site to be located in northwestern continental Europe
- Selection based on balancing operational and financial criteria

# Funding Requirements Flagship Plant to Produce FDCA

## Total funding need

- EUR 150 million ( $\pm$  20% contingency)
  - > CAPEX (ISBL + OSBL)
  - > Start-up costs
  - > Working capital
  - > Ongoing Renewable Polymers expenses until cash-flow positive (2019-2023)
- Objective to have funding sources in place before end of 2020

## Total funding sources

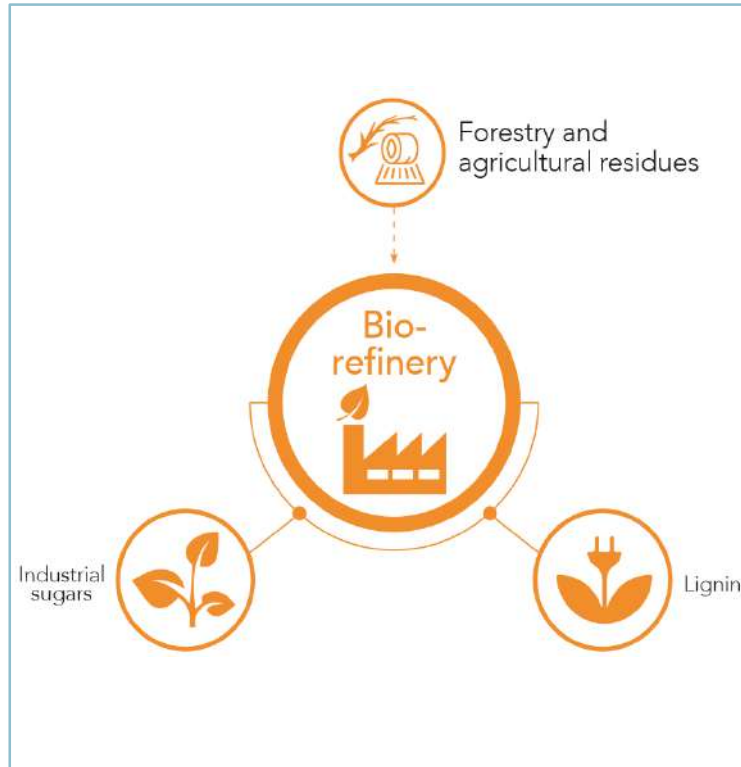


# Avantium Renewable Chemistries



# Avantium Renewable Chemistries Dawn Technology™

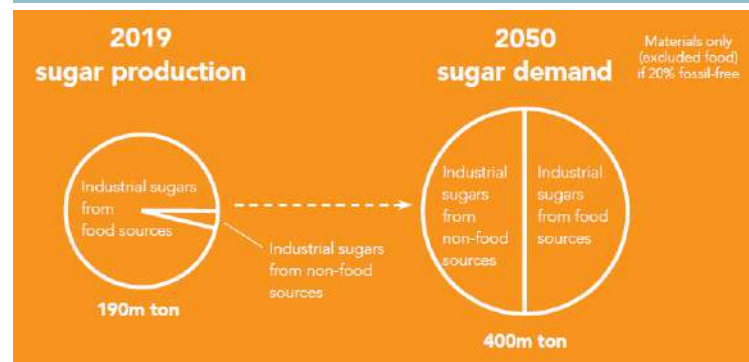
## Biorefinery process for industrial sugars and lignin from non-food biomass



### Benefits industrial sugars from non-food sources

- Reduce land use and environmental impact of 1G sugars
- Cascading the use of biomass for chemicals, materials and energy
- Suitable for locally sourced biomass

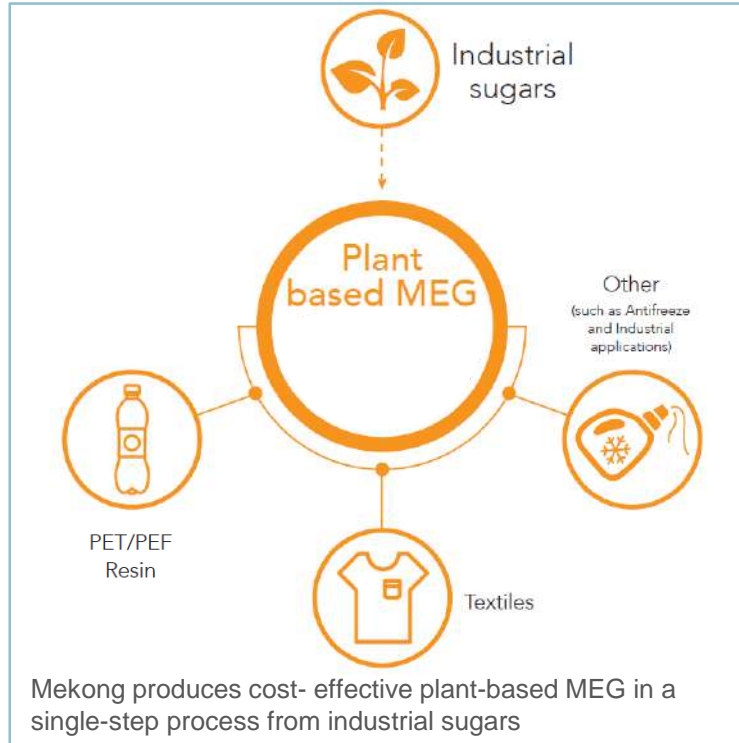
### Market potential industrial sugars from plant-based feedstock



# Avantium Renewable Chemistries

## Mekong technology

Catalytic, single-step process for producing plant-based (MEG) from industrial sugars



### Benefits Mekong technology

- Single-step process to produce plant-based mono-ethylene glycol (MEG)
- A drop-in product identical to fossil-based MEG
- Competitive in terms of cost and quality

### Market potential global MEG market consumption

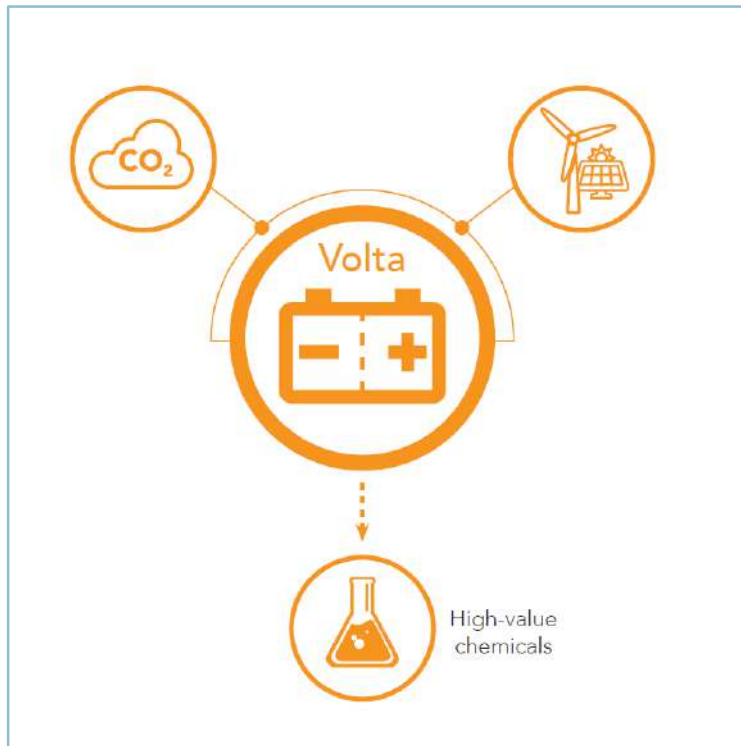


Source: Nexant report 2017

# Avantium Renewable Chemistries

## Volta

Converting CO<sub>2</sub> to high value chemicals via electrochemistry



### Benefits Volta

- Preventing CO<sub>2</sub> emissions of industrial parties
- Unlocking a new renewable feedstock for the chemical industry
- Enabling cleaner chemical processes

### Business Development

- Leading patent portfolio: global top-5 in electrochemical CO<sub>2</sub> conversions
- Avantium's Volta team cooperates with over 35 partners in European grant consortia, also providing Avantium with over €5m of grants
- Avantium is founding member of CO<sub>2</sub> Value Europe

# Avantium Renewable Chemistries

## Volta: Pre-pilot units in Prodock Amsterdam



# Avantium Renewable Chemistries

## Volta: Extensive Partnerships

### Feedstock providers



### Technology developers



### Producers of Chemicals / products



### Universities & Research Institutes



### Associations





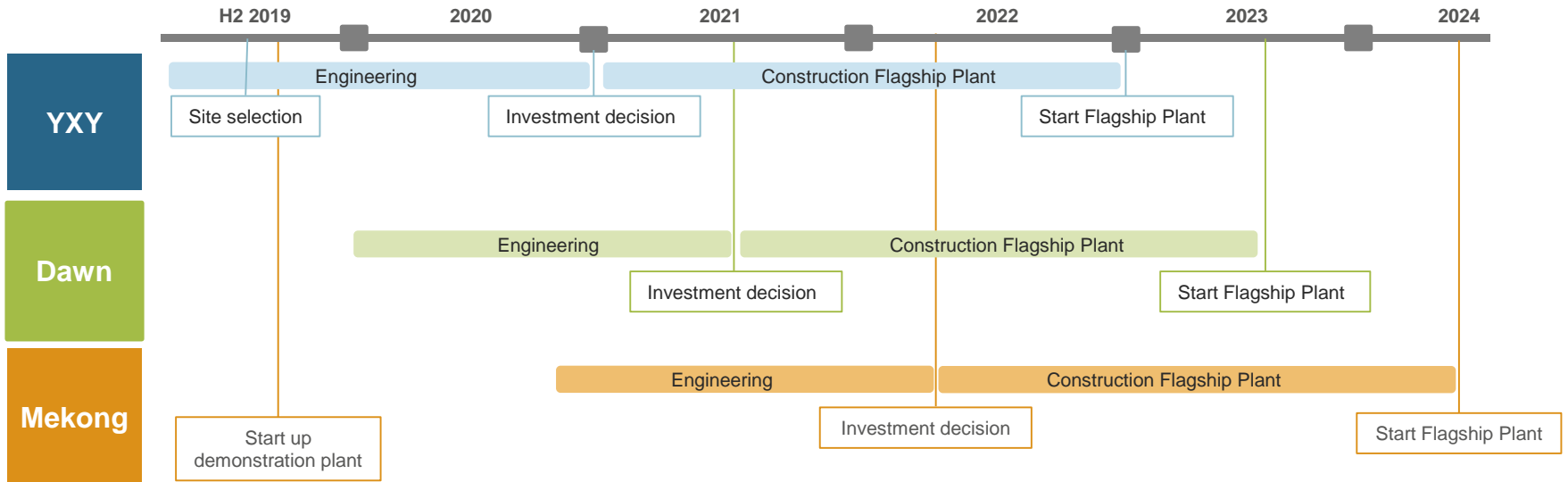
# Timelines



# Timelines per Technology



## Clear roadmap to commercialization



# Thank you

