

**Towards an  
electrochemical  
technology platform  
for the conversion of  
CO<sub>2</sub> and biomass  
derived substrates**

The VOLTA program

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# Avantium

Innovative Technologies for Today's Bioeconomy



Amsterdam & Brussels  
Ticker: AVTX



**€109M**  
**Raised** from **IPO**  
15 March 2017

## Renewable Chemistry

2-Gen Sugars, Renewable Technologies, Electrocatalysis  
of CO<sub>2</sub>

YXY® Technology: FDCA to PEF  
Novel Bio-Based Plastic  
JV BASF / Avantium



## Catalysis

Foundational Technology and Expertise

Leading Systems and Services Provider for Catalyst R&D



Founded in 2000  
Amsterdam

60+  
patent families



Hall of Fame  
CleanTech

160 employees  
>75% scientists  
20+ nationalities

# Avantium's Renewable Chemistry Department



Developing and commercializing innovative products and processes in the renewable & sustainable chemistries space.

## Bio-based plastic - PEF



1<sup>st</sup> commercial plant planned in Antwerp

## 2<sup>nd</sup> Generation sugar



- best in class technology
- pilot plant being commissioned

## Bio-based ethylene glycol



- 1 step process
- 100% bio-based bottle
- pilot plant construction started

## Electrocatalysis



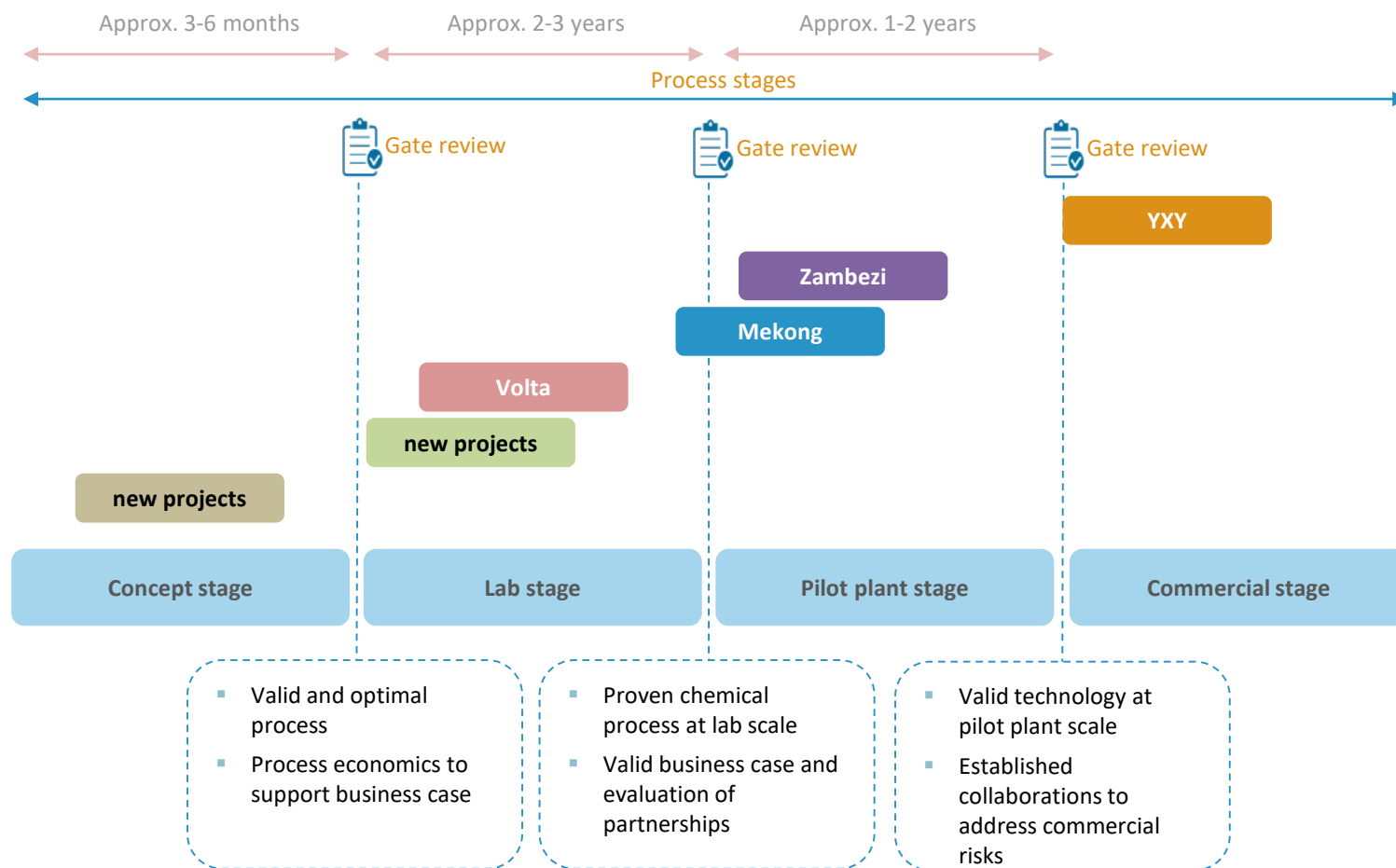
- world-leading technology platform
- New feedstocks (e.g. CO<sub>2</sub>)

## Early stage projects



New products, processes & technologies,

# Our Renewable Chemistry Portfolio



# Electrification is everywhere



Also in the chemical industry!

→ This is the right time for developing this technology



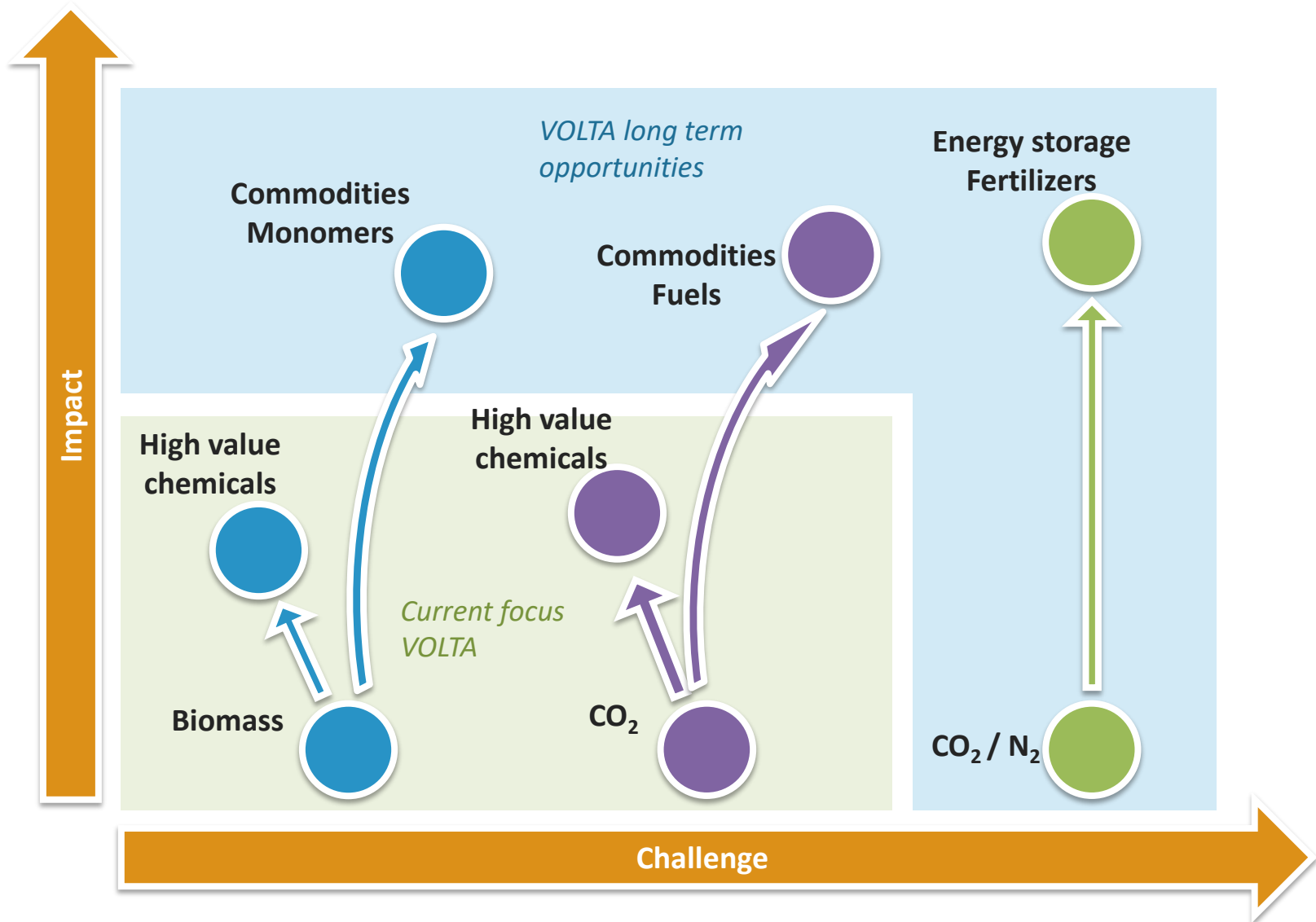
# The VOLTA program



- Avantium has been working on electrochem cell-technology and applications since 2012.
- In Nov 2016, Avantium acquired Liquid Light Inc, a Princeton 2009 start-up in which >\$35M was invested by VC's to develop CO<sub>2</sub> to MEG technology. Partners: CocaCola, DeNora, M&G, Covestro, BP etc.
- Focus on high value products
- Technology for high value chemicals is stepping stone for technology to make commodities
  - Optimize technology
  - Cell costs will go down
  - Electrochemistry is scaled out (modular), a technological improvement can be implemented in every new stack (module) of cells.

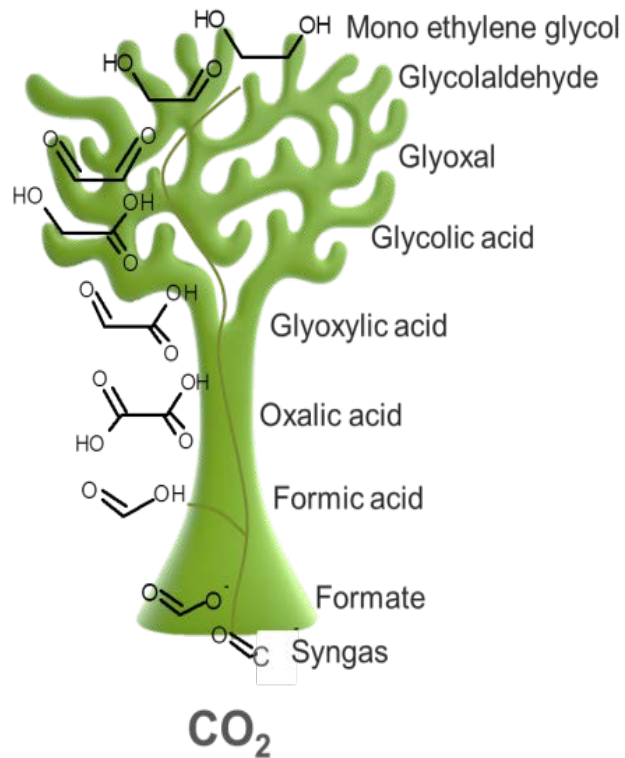
**Acquisition of assets of Liquid Light puts Avantium in the leadership position in electrocatalysis technologies and carbon dioxide reduction**

# Volta Opportunity Window



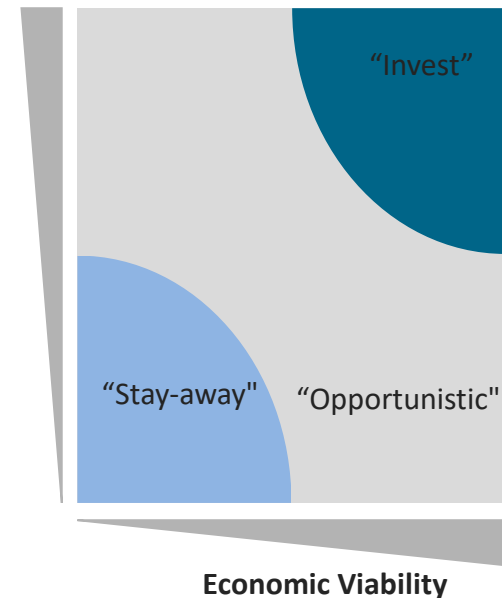
# We have assessed the Attractiveness of the Targets in the Formic Acid Product Tree

Formic acid product tree identified as main target for the Volta technology



Opportunities assessed based on market attractiveness and economic viability

Market attractiveness





# Project's overview



## ■ Collaborative Programs:

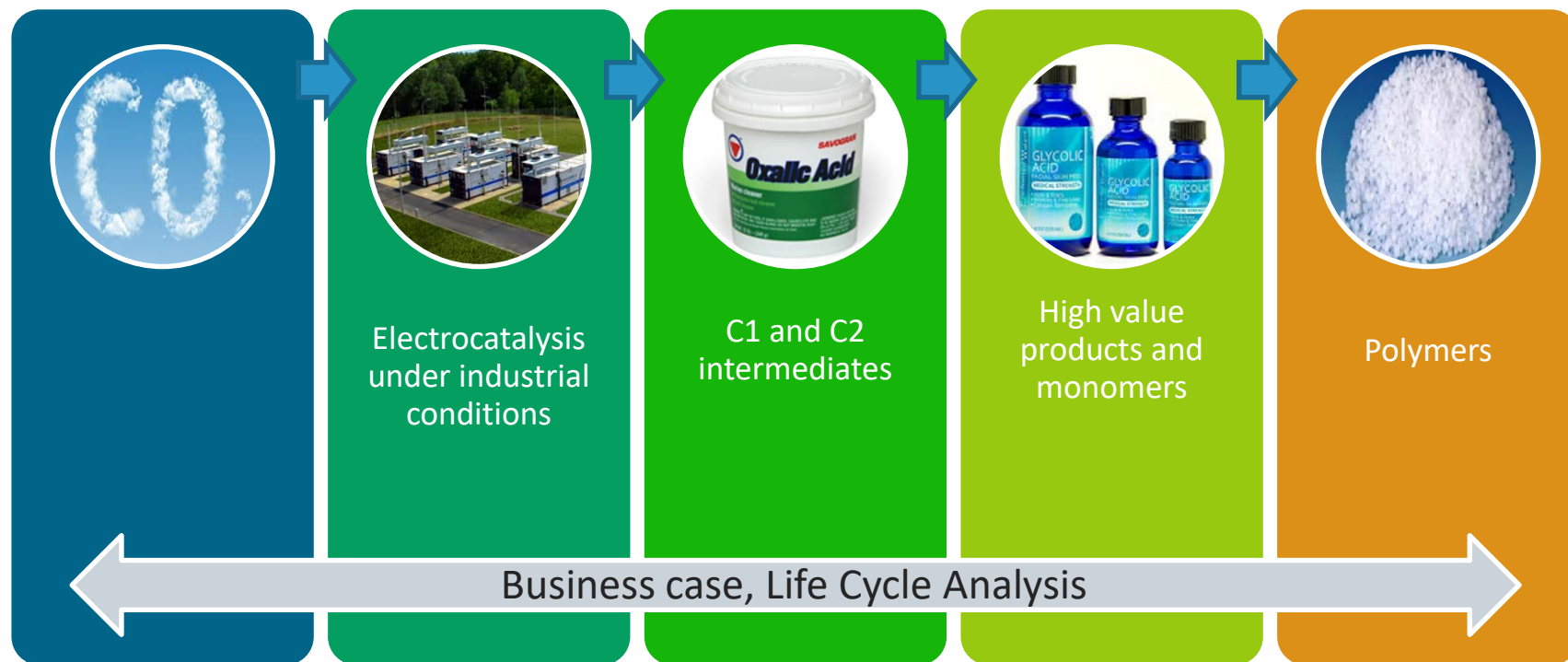
- OCEAN
  - Demonstration of CO<sub>2</sub> to formate next to industrial power plant
  - High value C2 products
- RECODE
  - Demonstration of non-aqueous CO<sub>2</sub>-to-chemicals at cement factory
- CELBICON
  - New CO<sub>2</sub>-to-chemicals technology: integration of CO<sub>2</sub> capture, electrochemical conversion to syngas and fermentation
- TERRA
  - Tandem synthesis: more efficient usage of resources and energy
- ELCOREL
  - Fundamental research on CO<sub>2</sub> reduction



*Tandem electrocatalytic reactor for energy/  
resource efficiency and process intensification*



# Project OCEAN



High value products from CO<sub>2</sub>, electrocatalysis just one-step away from commercial application

# Project OCEAN

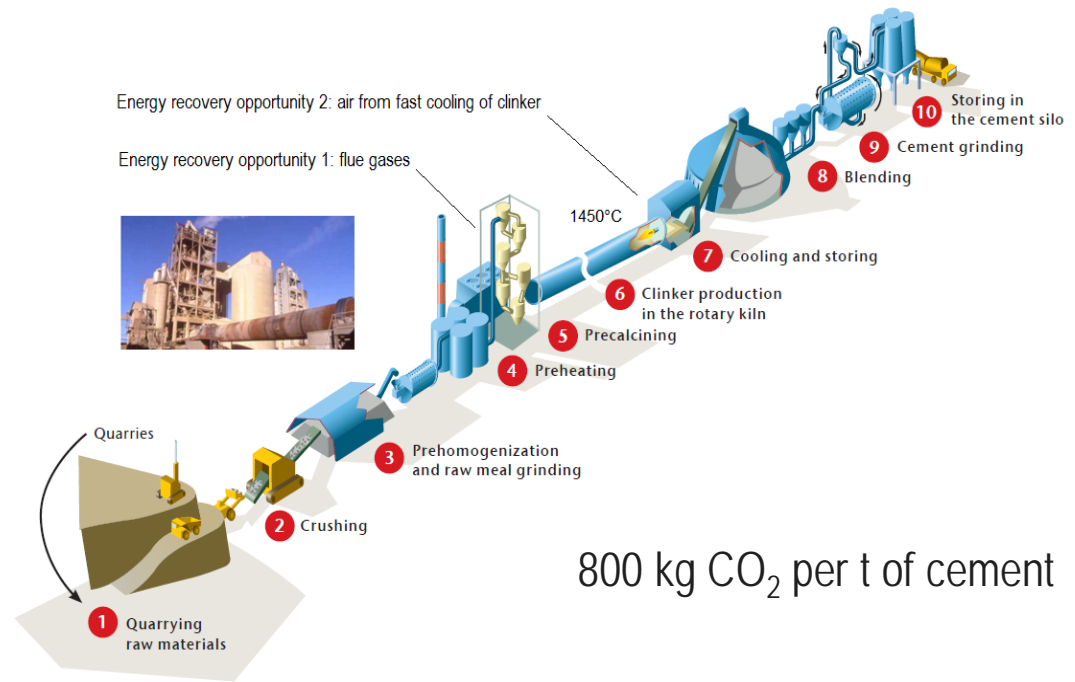


1. Electrocatalysis just one-step away from commercialization
2. Integration of electrocatalysis in industrial process

→ Address critical elements that are currently hindering new electrochemical processes by

- targeting high value products
- lower the power costs by combining oxidation and reduction
- trans-disciplinary approach that is needed for the introduction of advanced technologies.

# Project RECODE



800 kg CO<sub>2</sub> per t of cement

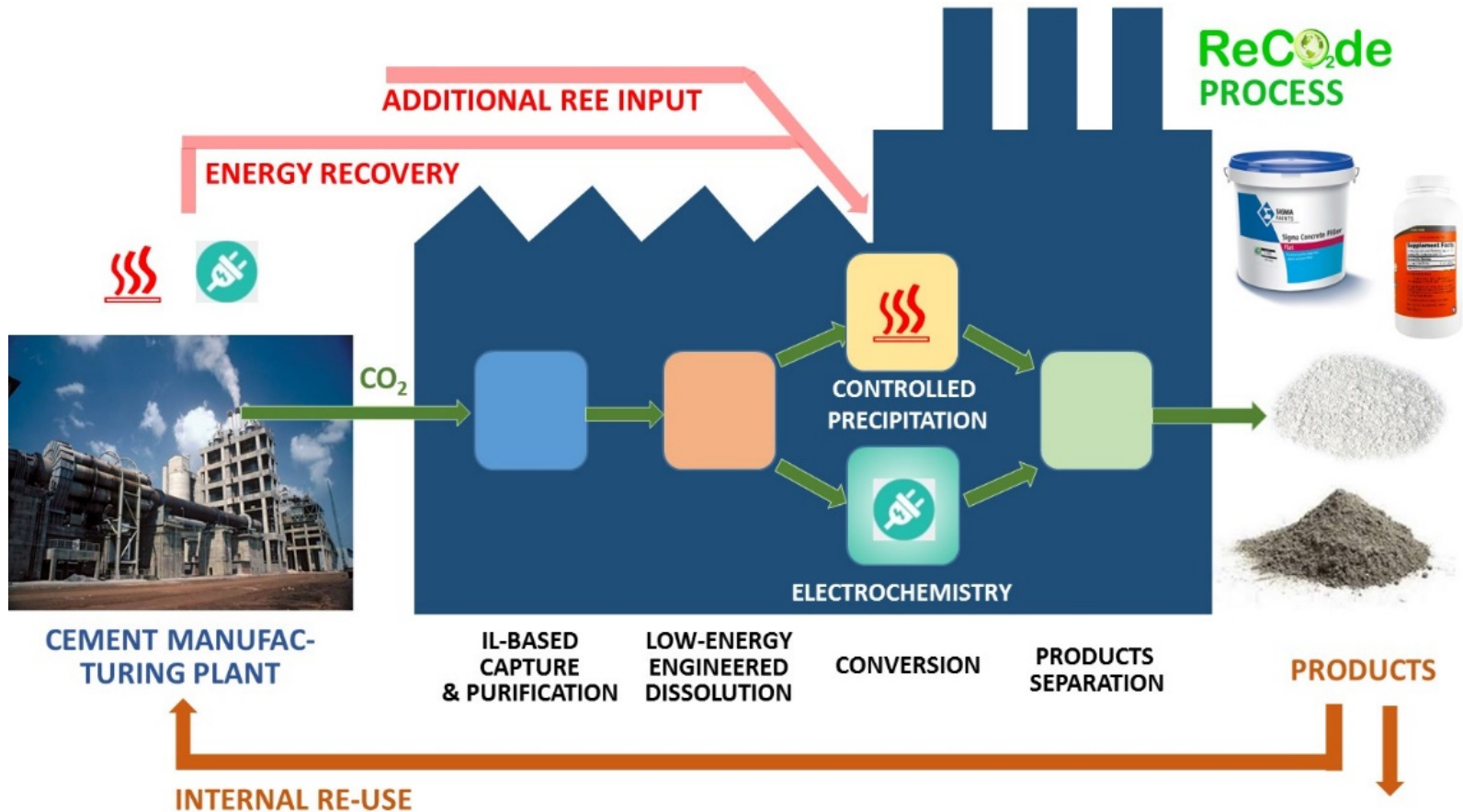
Convert the CO<sub>2</sub> produced in the cement industry to added-value chemicals: to improve cement quality and to reduce the energy intensity



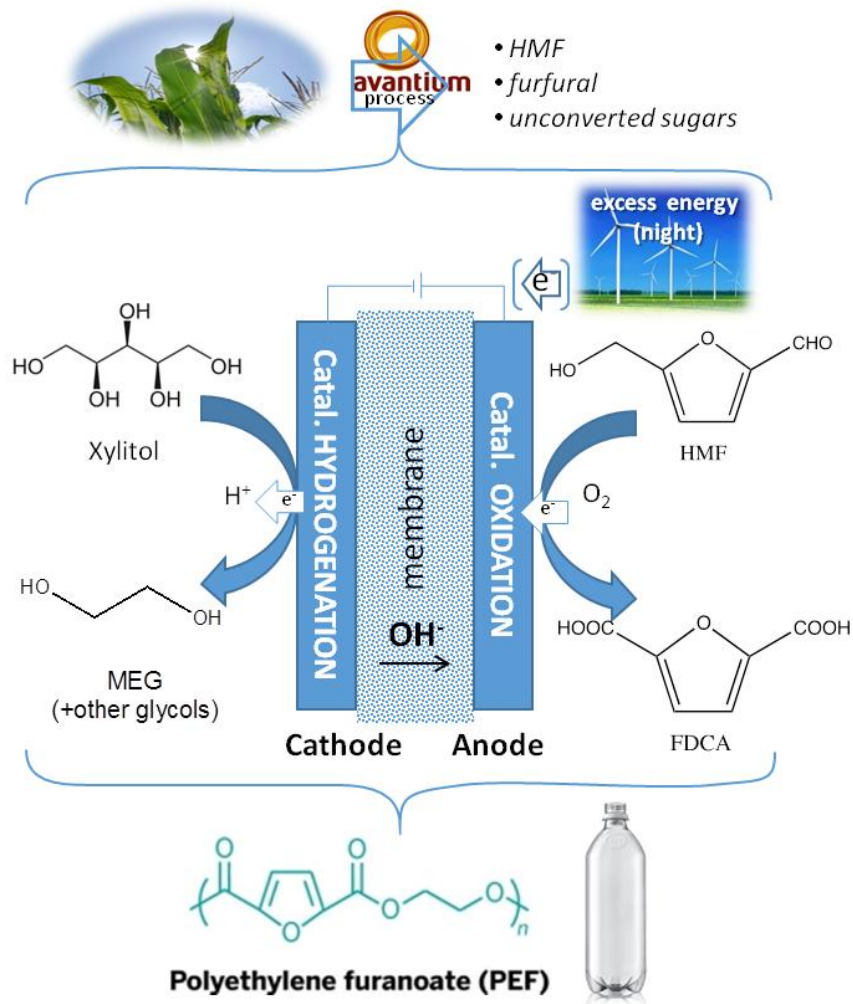
This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 768583

# Project RECODE: the concept

ReCo<sub>2</sub>DE



# Project TERRA



New technology for combined oxidations and reductions



# Project TERRA



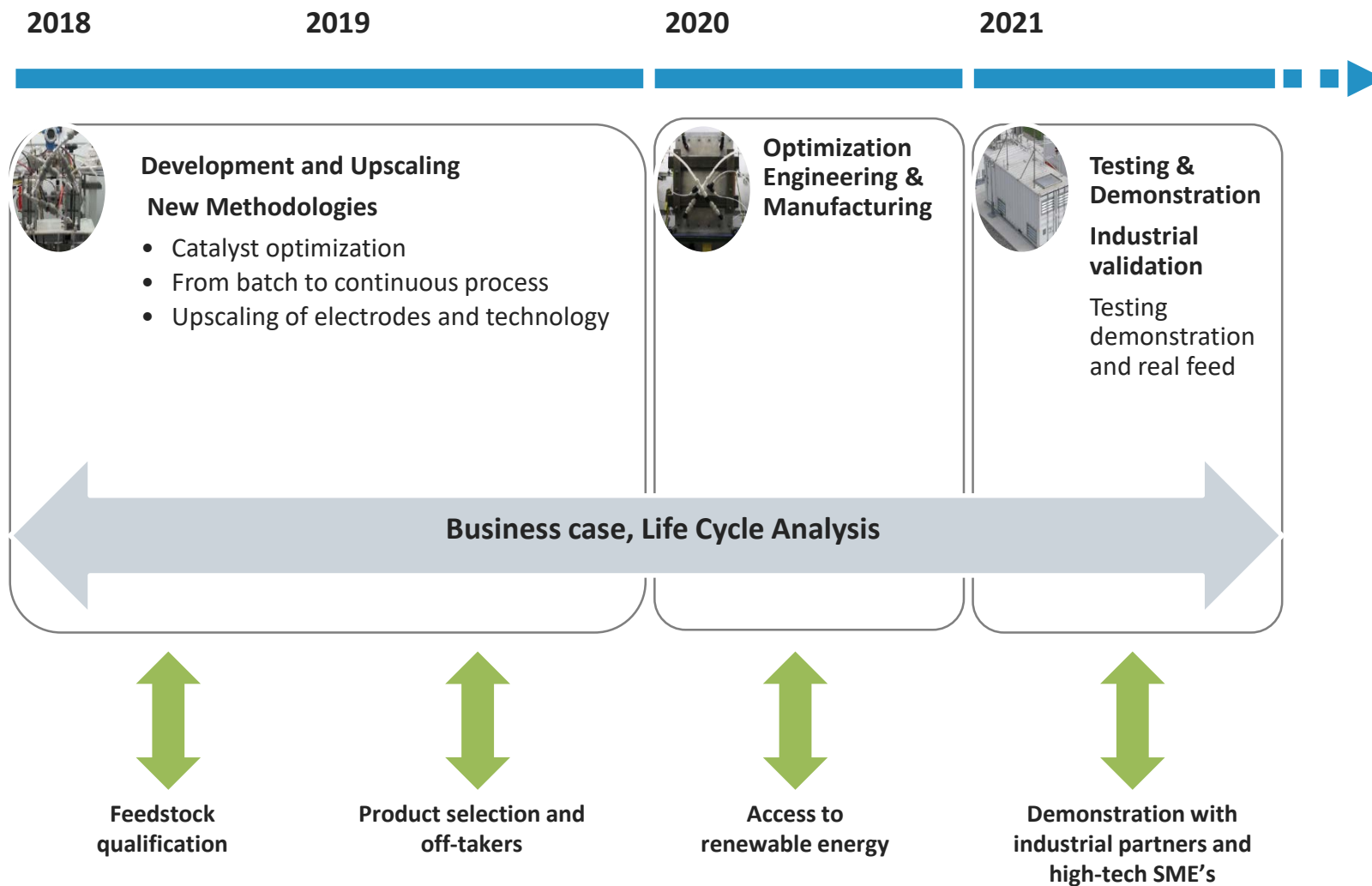
- **Tandem synthesis:** more efficient usage of resources and energy
- **Operation at higher temperatures and pressure:** higher feedstock concentrations possible
- Match the kinetics of anodic and cathodic processes **by direct heating of one of the electrodes**



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 677471



# Volta Path to Commercialization



Note: This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 767798;  
[http://cordis.europa.eu/project/rcn/211278\\_en.html](http://cordis.europa.eu/project/rcn/211278_en.html)



## Take home message

- Electrification is happening now;
- Acquisition of assets of Liquid Light puts Avantium in the leadership position in electrocatalysis technologies and carbon dioxide reduction (> 37M invested);
- Focus on electrocatalytic technology platform and business case to produce high value products; demonstration with industrial partners and high-tech SME's.

Please come and talk to us!



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