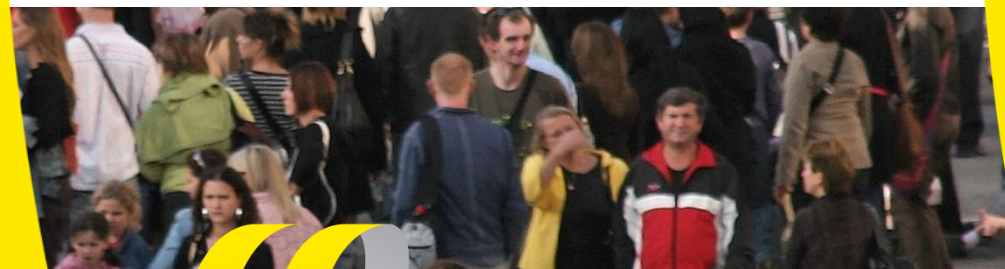




# Market study and ETS aspects of CCU in Rotterdam Harbour Industrial Complex

March 30, 2017



# CE Delft

- Independent research and consultancy since 1978
- Transport, energy and resources
- Know-how on economics, technology and policy issues
- 50 Employees, based in Delft, the Netherlands
- Not-for-profit

Clients: industries, mainly Rijnmond, European Commission and Parliament, national and regional governments, Dutch provinces, PBL and NGO's

All our publications [www.cedelft.eu](http://www.cedelft.eu) or @CEDelft



# 1. Introduction

CE Delft market study on CCU for Deltalinqs with the support of Uniper:

1. Goal is carbon emission reduction, Paris Agreement at **90+ % emission reduction**  
Requires disruptive technologies, so less 'Lock-in effects'
2. What applications can be found for CO<sub>2</sub> from Uniper coal fired power plant and other CO<sub>2</sub> sources in Rotterdam HIC
3. Which intermediates and products can be produced with this CO<sub>2</sub>
4. What is the economic viability for these products
5. How does the ETS system treat CCU

# 1. Introduction

There is ample momentum for sustainable innovations and CCU in The Netherlands:

## **Deltaplan voor klimaat**

De DSGC sluit zich aan bij de eerdere oproep van VNO-NCW, MKB-Nederland en LTO Nederland voor een Deltaplan Energie en Klimaat voor de periode 2020 tot 2030. De nieuwe minister van Economische Zaken moet coördinerend minister voor energie, klimaat en circulaire economie worden.

**NL next level**

**Nederland heeft veel in huis. Maar om een beter Nederland te kunnen bouwen – welvarend, duurzaam en met kansen voor iedereen – is er méér nodig.**

Daarvoor zullen we onze bedrijven, onze instituties en onze economie naar een volgend niveau moeten brengen. Onder de noemer NL Next Level presenteren ondernemingsorganisaties VNO-NCW, MKB-Nederland en LTO Nederland daarom een uitgewerkte toekomstvisie inclusief een brede investeringsagenda. Zodat ons land op alle fronten tot de wereldtop blijft horen.



# 1. Introduction

Germany is ahead of us with CCU projects started from 2009 with budgets of 100 million Euros have been granted for 33 collaborative research and development projects, consisting of more than 150 individual projects

These DREAM and Kopernikus already led to Bayer-Covestro demonstration plant for CCU polyols for polyurethane



# 1. What is CCU?



CO<sub>2</sub> point source



CO<sub>2</sub> is captured / purified

H<sub>2</sub>



e<sup>-</sup>



CO<sub>2</sub> is converted

# 1. CCU is a clear form of industrial symbiosis and requires supply chain integration

< animation >

## 2. Sources of CO<sub>2</sub> - different concentrations/cost prices

Major point sources comprise:

Alco  
Shell  
Uniper MPP3  
Engie

	Potential in NL <u>Mton</u> <u>CO<sub>2</sub>/a</u>	Emission per source <u>Mton CO<sub>2</sub>/a</u>	Vol% CO <sub>2</sub>
<u>Concentrated</u> - EtOH, NH <sub>3</sub> , PER+	2-3	0,1-1,0	> 95%
H <sub>2</sub> -production	1-2	0,5	40-70%
Blast <u>furnace</u>	5	2-3	25%
Coal fires <u>powerplant</u> , blast furnace gas fed power plant	20-25	4-8	10-15%
Large boilers <u>and furnaces</u> , <u>petrochemical</u> , <u>refineries</u>	10-15	0,2-1,0	10-15%



## 2. Various cost of CO<sub>2</sub> feeds

- a. For CCS, via grid purified, super critical
- b. For CCU via grid, purified
- c. For CCU, local use, not or moderately purified



## 2. Many CCU processes - development top 4

Rotterdam HIC:

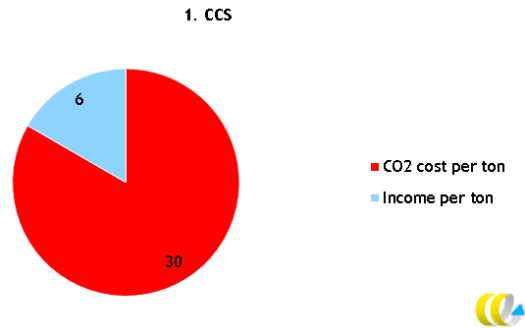
1. Algae - high added value,  
- limited volume
2. Mineralisation - business case,  
- moderate
3. Polyols and di-isocyanates  
for poly-urethanes  
- high added value  
- business in sight

CCU process	Example / company name	Expected volume
Algae	<u>Photanol</u>	Limited, depends on market for product
Polyols	Huntsman Dow	120 <u>kton</u>
Di-isocyanates	Huntsman Dow	400 <u>kton</u>
Mineralisation	<u>Carbstone</u> <u>Solidia</u> Green Minerals	300 <u>kton</u>
Methanol	BP Exxon Shell Hexion	40 <u>Mton</u>

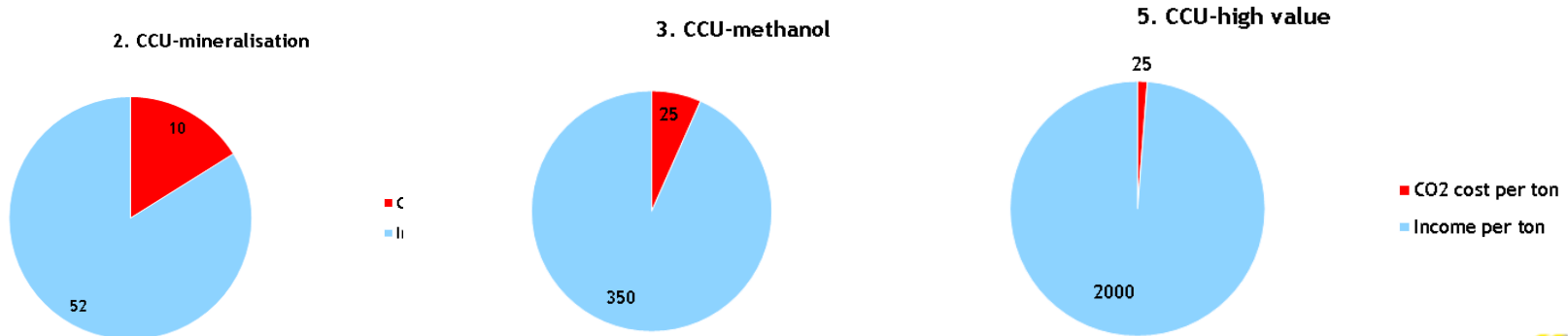
4. Methanol  
- strategic value, many applications, removes Dutch dependency from oil  
- enormous potential of > 40 M tons

# 3. CO<sub>2</sub> cost and cash flow

1. In CCS CO<sub>2</sub> capture and storage cost is dominant and today exceeds income



2. In CCU the CO<sub>2</sub> cost contribution to cash flow is moderate to very small



## 4. ETS and CCU

- **Today ETS**

ETS does not include CCU yet  
only CCS and blast furnace gas may be transferred

- **Next ETS**

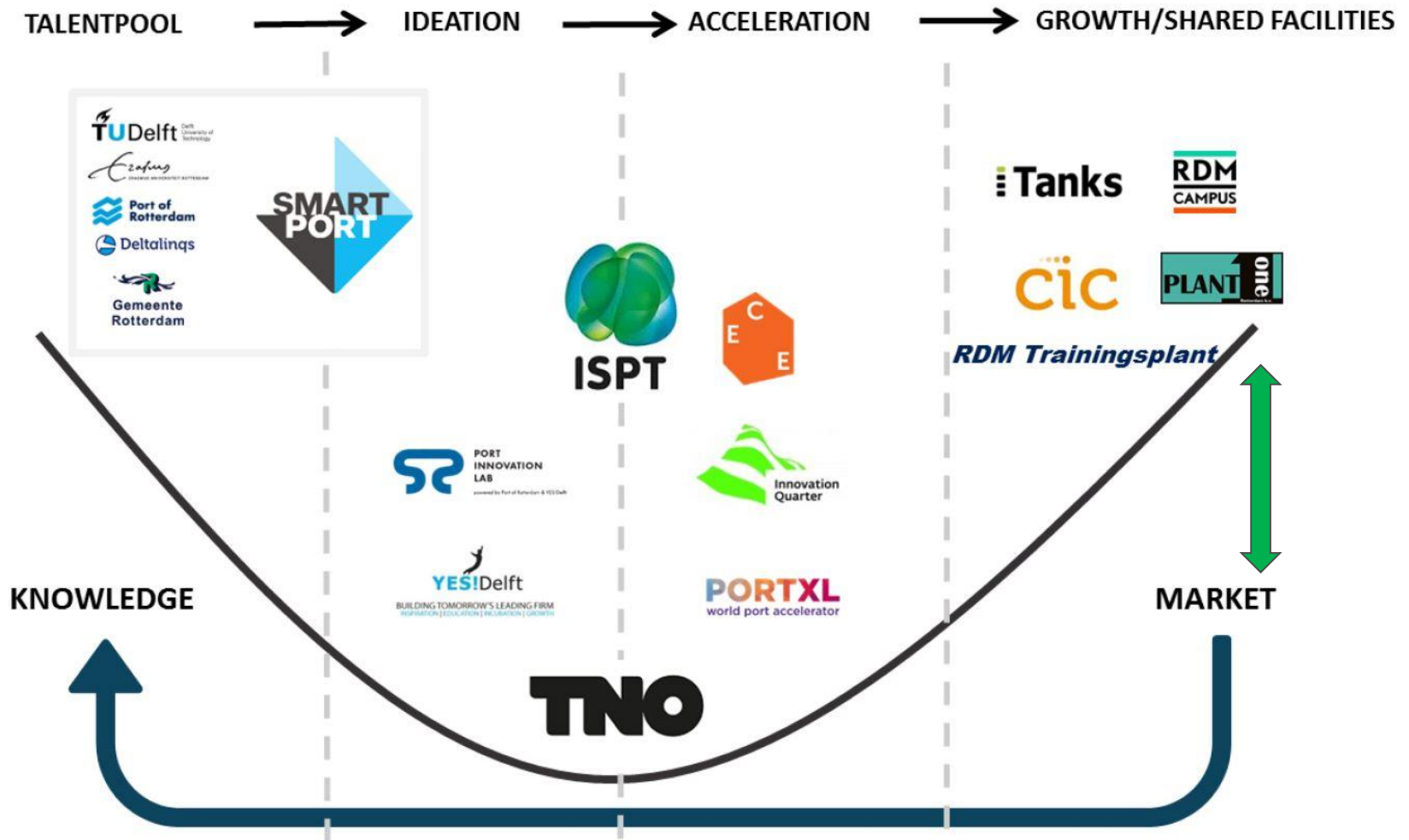
CCU will be included  
Details are not yet known

- Issue of transfer of CO<sub>2</sub> emissions: who gets what 'share'? → LCA

<animation>

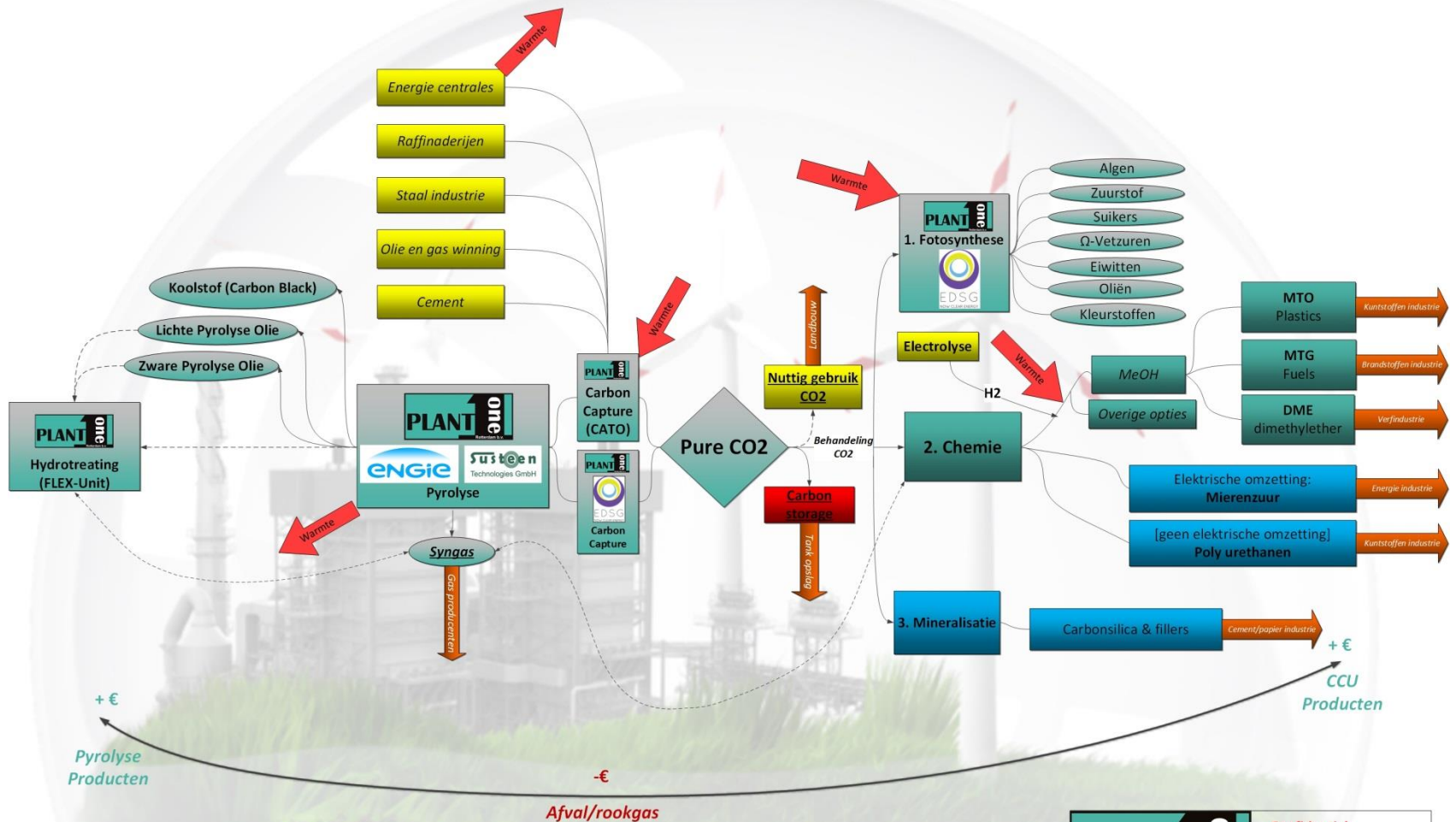
## 5. Plant One Rotterdam - study Rein Willems

# Business Innovation Eco System





# 5. Plant One - CCU mini-grid



<b>PLANT one</b>		Confidential		
Brainmap POR				
Carland Lopez	Rev Date	DWG NO	REV	
Jordy Heijblom	24-11-2016	BRMP_1001-CL	4.0	
SCALE	1:1	SHEET	1	

## 6. Next steps - initiation of pilots



pixtastock.com - 17577990

- Feasibility studies on most interesting CCU options
- Project plans for pilot development and testing at Plant One Rotterdam
- Contact: [jaspers@ce.nl](mailto:jaspers@ce.nl) , Deltalinqs or Plant One Rotterdam