CLUSTER “PLATFORM POWER TO GAS”

AGENTSCHAP INNOVEREN & ONDERNEMEN
POWERTOGAS Industry Cluster Flanders
Samen voor sterk innoveren

General meeting

June 21, 2017
Mechelen

AGENDA

14.00-15.00

- Presentation new cluster members (Port of Zeebrugge, Tractebel, Borit)
- Status project teams
- Coming Flemish funding options
- International H2 developments

15.00-16.00 with Jochen de Smet from Cabinet Tommelein

- Proposal for study H2 Flanders
- Vision of Flemish government on:
  - ❑ H2 refuelling stations and vehicles
  - ❑ Grid fees and possible special treatment of hydrogen projects.
- Discussion

STATUS PROJECT TEAMS

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Terranova Solar in Gent

H_2 refuelling stations/users

Air Liquide,
Atlas Copco
Colruyt
Eandis,
E-trucks,
Hydrogenics
NPG
Pitpoint
Terranova Solar
Toyota
Umicore
Van Wingen
VDL

Off-shore wind

Storage large energy volumes

Aspiravi,
Colruyt,
Deme,
Hydrogenics,
Toyota

Power to Gas

H_2 injection in gas grid

Aspiravi
Atlas Copco,
Colruyt
Eandis,
Fluxys
Hydrogenics,

Port of Zeebruges

H_2 for marine application

H_2 or methanol in ships

Air Liquide,
Deme
Havenbedrijf Antwerpen,
Shipit
Van Wingen,

Power to Fuel

$H_2 + CO_2 \rightarrow$ methanol

Eandis,
Havenbedrijf Antwerpen,
Hydrogenics,
Toyo

Port of Antwerp

Certification

"Green" H_2, gas, methanol..

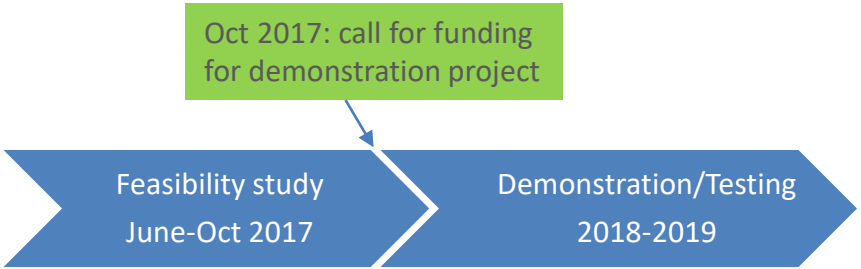
Air Liquide
Colruyt,
Eandis,
Havenbedrijf Antwerpen,
Hydrogenics
Polders Investeringsfonds

TERRANOVA SOLAR (1)

- **May 2017: application for feasibility study done @ Flux50**

- **"SUNSHINE" project:**
  SUN -based **S**olid State battery and **H**ydrogen **I**ntegrated **N**ovel **E**nergy-concept

Project partners for feasibility study:
- Lampiris
- Terranova Solar nv
- Havenbedrijf Gent nv van publiek recht
- U-Gent
- WaterstofNet vzw



Consortium to be elaborated for demonstration project

- **Battery + hydrogen storage (start with 1MW)**

- Hydrogen consumers to be identified

TERRANOVA SOLAR GENT (2)

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Concept

Solar Power

+ wind?

Battery

Electrolyser

H_2

Integral system design
Business case development
TNS

- Frequency Control regulation (primary reserve)
- Trading on spot market
- Improved output profile to the grid (flattened, more predictable)

Lampiris –U-Gent - TNS

- Storage @ 350 bar/700 bar
- Customers in and around port of Ghent

Port of Ghent – WaterstofNet-TNS

ZEEBRUGGE (1)

H2 production @ Fluxys GASSCO counting station
(Near Toyota site)

High capacity gas pipeline available
(capacity to inject up to 100MW -> H2
given current <2% H2/CH4 restriction)

On-shore wind available (500m from counting terminal)
2017: 2 Eneco turbines on Toyota site and 2 on WWL terminal
connected at the Elia-grid via a small 36kV-post (@Toyota-terminal)
Coming years: expansion to 28MW
Direct connection of electrolyser to turbines
Turbines connected to grid

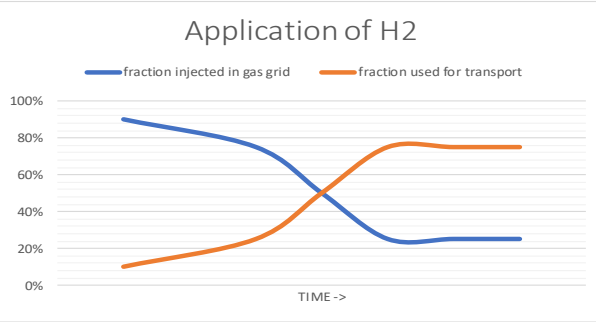
ZEEBRUGGE: APPLICATIONS/BUSINESS CASE

- Injection in gas grid and selling premium "green" gas/GoO to:
  1. Gas traders, cfr Greenpeace Energy Mainz, CNG stations, ...
  2. Refineries, using H2 for desulphurisation of fuel

     @ (2) legislation change required :
     - Green certificates exist for renewable hydrogen and can be traded, i.e. locations for production and use of the green hydrogen are decoupled
     - Green hydrogen supplied to refineries that can decrease the carbon footprint of fossil fuels, count w.r.t. quota for transport in the EU RED (today explicitly excluded w.r.t. the RED)

- Implement H2 in transport applications
- Grid balancing – "fast" primary reserve (ELIA)

- Later: methan(olis)ation with CO2 from Engie CCGT plant Herdersbrug



ZEEBRUGGE: PROPOSED TIMELINE

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	June 2017	28 Sept 2017	April 2018	.....
		EFRO	FCH-JU	.....
Electrolyser + injection in gas grid		Demonstration 2MW	Upscaling electrolyser to 12MW	
H2 refuelling station		Demonstration		
CCS and H2 to methane or methanol		Feasibility study		Demonstration
Power to power with fuel cell		Feasibility study + Small scale demonstration?		Demonstration

MARINE APPLICATION OF H2 (1)

- Two concepts :

Ship “ZULU”: Shipit / Blue Line Logistics (B)

Hybrid Diesel/H2 combustion engine

Technology: Revolve (UK)

Ship “Poolster”: Patrick Borms (B)

Hybrid H2 generator/electric engine

Technology: Van Wingen

- Bunkering (Air Liquide):
  - Option 1:
    Filling of fixed tanks on board similar to buses in Antwerp (fixed filling point in port filled by A.L. tube trailers)
  - Option 2:
    Exchangeable container on board that is filled off-site (e.g. at current filling point for the buses) .

MARINE APPLICATION OF H2 (2)

- Main issue = operational cost ; price of H2

  Red diesel = 0,5 €/l => Cost of H2 to be competitive < 2€/kg
  … No taxes, fees to play with in inland shipping….

- Next steps:
  - ❑ Check certification – classification issues of H2 ships for inland shipping
  - ❑ Decide for applying in funding programs Interreg 2 zeeën, Eurostars
  - ❑ …..

OFF-SHORE WIND (MEETING DEC 2016)

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- **Vision of the different partners** (having off-shore activities) on this topic:
  - Make hydrogen on sea at windfarms, to fuel ships
  - Need for storage/balancing of on-shore and off-shore wind energy
    (e.g. no feed-in tariffs will be paid in case of periods of negative prices)
  - Advantages of large centralised hydrogen production on sea, combined with a hydrogen or gas distribution network to land, e.g.

- **Key Question** is: trade-off power cables to land + H2 production on land versus H2 production on sea
- **Next steps**:
  - Have a **knowledge /vision document about Off-shore Hydrogen production by Sept 1, 2017**
    - ❑ Use the next three months (Jan- March 2017) to broaden our views
    - ❑ Make literature overview (WN) as first step
  - IBN Off-shore –Energy: contact meeting wo 3/5/2017 (Sirris, OWI-lab, U-Gent)

- **Input from cluster partners welcome…**

CERTIFICATION / LEGISLATION

Green gas-hydrogen

- Follow-up project of CertifHY (European certification scheme for green H2) not started yet
- RED II recognizes the importance of GoO for green gas (biogas, H2..)
- Green gas certifiation schemes exist on national level (e.g. UK: http://www.greengas.org.uk/)
- Tackle green hydrogen (GoO) in running projects
  e.g. for Zeebrugge project: involve VREG?

EU projects concerning H2 legislation

- WaterstofNet represents Flanders/Belgium in FCH-JU project Hylaw (identify barriers)
- Flanders has signed MoU for regions with FCH-JU
  Project to help regions/cities to develop FCH projects
  – and bring them together with the European industry

Hydrogen Europe: joint initiatives for identification of barriers in current legilsation

LEGISLATION

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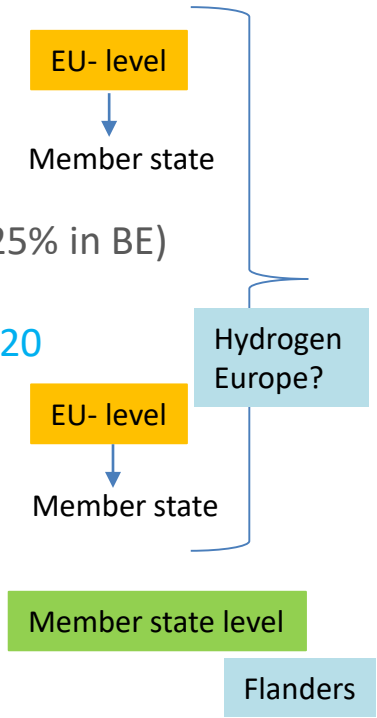
- RED II: Renewable energy 10% minimum share in transport
  Advanced biofuels count 2x (e.g. green H2 for use in FCEV)

  Condition for 100% "renewable" or "green" hydrogen is:
  - Direct connection of electrolyser to RES, not connected to the grid
  - RES is newly installed (so not valid for existing RES)

  Else: fraction renewable hydrogen = **average renewable share** in the grid mix (25% in BE)

- Fuel Quality Directive: CO_2 footprint of all fuels=> Minimum 6% reduction by 2020
  "Green" hydrogen in refineries is explicitely not acknowledged as biofuel
  (does not change end-product and emission values);
  Upstream CO2 reduction is not yet taken into account.

- Energy storage systems are treated as end consumer
  => business cases for Power-to-Gas are hindered by grid fees and taxes



COMING FUNDING OPTIONS

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VL

• EFRO Vlaanderen	10M€ total subsidy (40% funding)	deadline Sept 28, 2017
• VLAIO Intercluster-funding	details tbd	deadline Sept 28, 2017
• VLAIO Transitiepijlers	details tbd	deadline Sept 28, 2017
• VLAIO via FLux50	50k€ for feasibility study (40% funding)	deadline Sept 2017
• VLAIO via Flux 50	Demonstation projects	deadline Oct 2017?

B

• Transition fund Marghem	10M€ total subsidy	deadline tbd; call in fall?

EU

• TEN-T Synergy call 2017	60% funding	deadline tbd ; nov2017?
• FCH-JU call 2018 (12MW)	75% funding	deadline April 2018
• LIFE call 2017	60% funding	deadline Sept 12, 2017

(no infrastructure)

EFRO VLAANDEREN

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- **EFRO VLAANDEREN** – oproep Prioriteit 1 – Stimuleren van onderzoek, technologische ontwikkeling en innovatie; (call launched recently; clarification session was on 22/5)
  - Focusing on **demonstration** projects
  - Projects should fit within **Flemish cluster policy** (proposals can only be submitted by cluster or in agreement with a cluster)
  - Total subsidy budget for this call = **10M€** (at **40%** subsidy rate => 25M€ projects can be submitted ; + max. 10% from other public funding)
  - Minimal project budget = **1M€** ; **> 50%** are **investment** costs
  - Pre-registration proposal: Friday September 8, 2017
  - Full proposal: **Thursday September 28, 2017**

INTERCLUSTER VLAANDEREN

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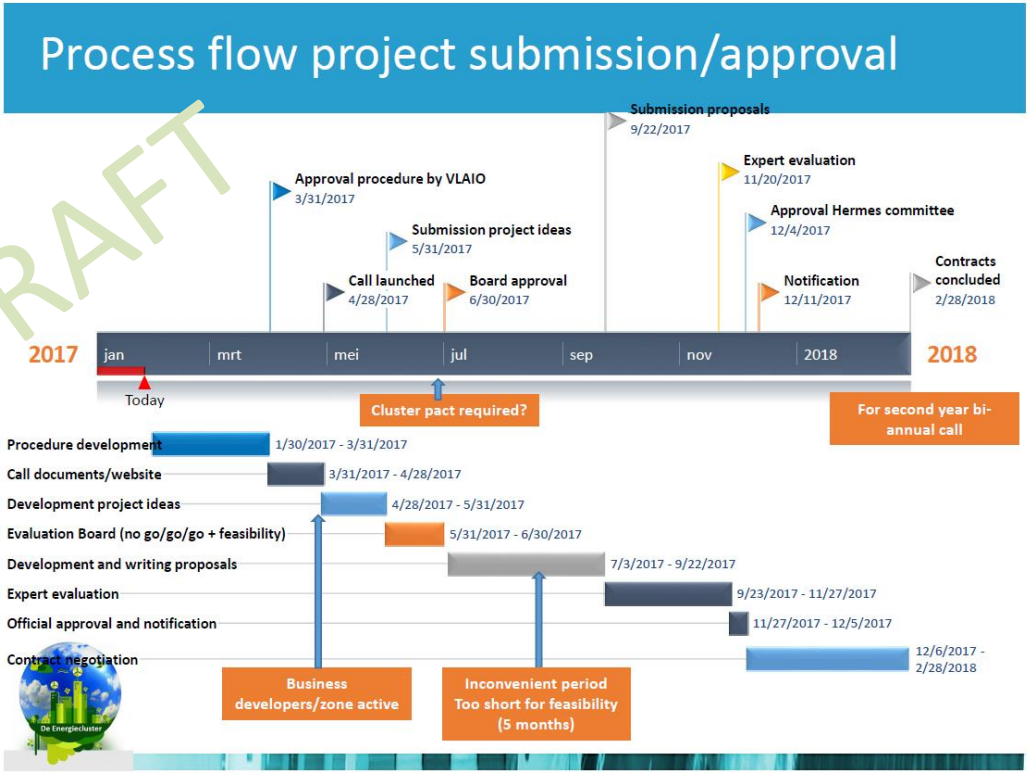
- At least to **2 innovation clusters** have to be involved :

  IBN and/or speerpuntclusters

  - ❑ Cluster organisation submits the proposal
  - ❑ Members of the consortium are cluster members
- Type of activities:
  - ❑ Feasibility studies (VIS-project of O&O-HS)
  - ❑ Knowledge building by knowledge institutes (VIS-projecten, SBO)
  - ❑ Knowledge building related joint company research by several companies: O&O in ICON-or in CoöperatiefPlusformule
  - ❑ Knowledge building related knowlegde transfer and dissimination: VIS projects
- Budget?

FLUX50



Project ideas:
Feas. Studies max. 50kEuro

Project proposals:
Order of 3 – 4 M € (10M€/year forseen for Energy cluster)

Cooperation between cluster and IBN is recommended!

COMING FLEMISH FUNDING OPTIONS

Zeebrugge	=> EFRO Vlaanderen
Port of Antwerp – power to methanol with Catalysti en Flux50	=> Intercluster
?	=> Transitiepijlers

INTERNATIONAL H2 DEVELOPMENTS

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- **300 FC buses in China in 2017 and rapid increase coming years**
  - ❑ Hydrogenics to provide 1,000 fuel cell bus power modules to Blue-G in China; $50M deal
  - ❑ Ballard awarded $18M follow-on fuel cell deal with Broad-Ocean for 400 buses and trucks in China

- **Olympics Tokyo 2020**:
  - ❑ Fleets of fuel cell cars and buses to transport athletes
  - ❑ Target of 160 HRS, 100 fuel cell buses and 40000 cars before olympics

- **Green Hydrogen Economy plan in the Northern Netherlands**
  - ❑ High level roadmap for large scale hydrogen economy to replace the natural gas economy (Ad Van Wijk, Delft)

- **Amazon invests in Plug power**
  - ❑ Amazon will buy $70 million worth of Plug Power's hydrogen fuel cells and other technology this year and will equip forklifts at 11 warehouses this year with hydrogen fuel cells

- **Nel ASA signs industrial-scale power-to-gas framework agreement with H2V PRODUCT (France)**
  - ❑ Nel will construct a hydrogen production facility with an initial power target of 100 MW and 40 electrolysers for H2V, to inject hydrogen as a substitute to natural gas into the natural gas pipelines (2018-2020)

VARIA

- **Website PtG**:
  - More effort needed to make this a living medium (extra cap. within WN)
  - Open for news from the cluster partners related to hydrogen
    => relevant press releases/news can be sent to WN for publication on website

- **Brochure PtG cluster**: proposal ready ~~end of May~~ in June => will be sent around for comment
  - Aim and activities of the PtG cluster
  - What is Power-to-Gas
  - Members (separate leaflet within brochure)

- **Possible joint booth from PtG cluster at Hannover Messe 2018?**
  - Suggestion from Bart B. (FCH-JU)
  - Other regions are represented as region/country (NRW, BW, Aberdeen, Norway)

- **Visit PtG project in fall 2017-2018**, suggestions?

JOCHEN DE SMET; ENERGY ADVISOR CABINET

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- Proposal for study H2 Flanders (Adwin)

- Vision of Flemish government (Jochen De Smet) on:
  - ❑ H2 refuelling stations and vehicles
  - ❑ Grid fees and possible special treatment of hydrogen projects.

- Discussion

PROJECTIDEE H2VLAANDEREN

ISABEL FRANÇOIS EN ADWIN MARTENS
WATERSTOFNET

WHAT ROLE CAN HYDROGEN PLAY IN THE ENERGY TRANSITION 2020 - 2030 – 2050 ?

TOPICS

- Hydrogen production
- Hydrogen use
- Environmental impact
- Impact on energy-independence
- Financial impact

HYDROGEN PRODUCTION

Samen voor sterk innoveren

8	EU 25	BE211	Belgium - Belgique - België	Antwerpen	Antwerpen	BASF	416	Ethylene		By-Product
9	EU 25	BE211	Belgium - Belgique - België	Antwerpen	Antwerpen	Fina Antwerp Olefins	744	Ethylene		By-Product
10	EU 25	BE211	Belgium - Belgique - België	Antwerpen	Antwerpen	BASF	74	CS		By-Product
11	EU 25	BE211	Belgium - Belgique - België	Antwerpen	Antwerpen	BASF	301	Styrene		By-Product

Abbreviations of processes as following:

CK:	Chlorine potassium hydroxide electrolysis	COG:	Coke oven gas	CS:	Chlorine sodium hydroxide electrolysis
POX :	Partial Oxydation	PSA :	Pressure Swing Adsorption	S:	Sodium chlorate
SMR :	Steam Methane Reformer	SR:	Steam Reformer	TCR :	Topsoe Convection Reformer
WE :	Water Electrolysis				

HYDROGEN PRODUCTION

ID	Zone	NUTS 3	Country (= NUTS level 0)	Region (= NUTS level 3)	Plant site	Owner	Capacity [10^3 m^3/day]	Process / source	Current Use / Remarks	Availability
12	EU 25	BE211	Belgium - Belgique - België	Antwerpen	Antwerpen	Air Liquide	204	SMR + PSA	on BASF site; supplies refinery and petrochemistry and feeds pipeline	Merchant
13	EU 25	BE211	Belgium - Belgique - België	Antwerpen	Antwerpen	Air Liquide	2160	SMR + PSA	on BASF site; supplies refinery and petrochemistry and feeds pipeline	Merchant
14	EU 25	BE211	Belgium - Belgique - België	Antwerpen	Antwerpen	Air Liquide	2160	SMR + PSA	will double hydrogen production capacity on BASF site	Merchant
15	EU 25	BE211	Belgium - Belgique - België	Antwerpen	Antwerpen	Bayer-Shell Isocyanates	271	SR + PSA and CS by-product	Aniline.	Captive
16	EU 25	BE211	Belgium - Belgique - België	Antwerpen	Antwerpen	ExxonMobil Chemical	1130	SMR	Refinery	Captive
17	EU 25	BE211	Belgium - Belgique - België	Antwerpen	Antwerpen	Total	337	SMR + PSA	Refinery	Captive
18	EU 25	BE211	Belgium - Belgique - België	Antwerpen	Antwerpen	Bayer-Shell Isocyanates	32	CS	Hydrochloric acid	By-Product
19	EU 25	BE211	Belgium - Belgique - België	Antwerpen	Antwerpen	SolVin SA (Solvay BASF)	156	CS	Hydrochloric acid	By-Product
20	EU 25	BE211	Belgium - Belgique - België	Antwerpen	Antwerpen	SolVin SA (Solvay BASF)	82	CS	Aniline, sales	By-Product
21	EU 25	BE221	Belgium - Belgique - België	Arr. Hasselt	Tessenderlo	Tessenderlo Chemie	40	CS/CK	Hydrochloric acid, sales	By-Product
22	EU 25	BE221	Belgium - Belgique - België	Arr. Hasselt	Tessenderlo	Tessenderlo Chemie	187	CS		By-Product

HYDROGEN PRODUCTION

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Chloorelectrolyse	20.000	t/year
Aardgas (SMR)	150.000	t/year
Byproduct ethylene	35.000	t/year
Captive	55.000	t/year
Total	260.000	t/year

WEGTRANSPORT VLAANDEREN (2013)

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		snelwegen	H2 [ton]	Wind [MW] offshore 3300 h/y
▪ Personenauto's	46,8 mld km	18,7 mld km	187.000	3.400
▪ Bestelwagens	6,4 mld km	2,5 mld km	125.000	2.300
▪ Vrachtwagens	6,0 mld km	3,5 mld km	350.000	6.300
		gewest/prov		
▪ Bussen	0,5 mld km	0,35 mld km	35.000	630

▪ diesel 1,0 + 0,14 + 1,3 + 0,1 = 2,54 mld liter

ANDERE SECTOREN

- Maritiem transport
- Luchtvaart
- Chemie
- Residentieel / tertiair

GROENE ELEKTRICITEIT

Offshore wind

- Gepland 2.200 MW (België), potentieel 8.000 – 21.000 MW (?)
- Mogelijk 10.000 MW (Noordzee, 2020)
- Noordzee 60.000 MW (600 plt), 135.000 MW – 600.000 MW Maritiem transport

Onshore wind

920 MW naar potentieel 9.000 – 20.000 MW

Zon Vlaanderen

2.300 MW naar potentieel 63.000 MW