

10.00-10.20: Introduction & Presentation new cluster members

10.20-10.40: Cluster news (*WaterstofNet*)

10.40-11.10: Hydrogen in maritime applications (*CMB* and *Port of Antwerp*)

11.10-11.40: Hydrogen in government plans

11.40-12.30: Presentation and visiting tour Plastic Omnium

12.45-13.30: Lunch

13.30-14.30: Discussion hydrogen storage (*University of Antwerp and Solenco Power*)

14.30-15.00: Hydrogen policy and contacts with the government (*WaterstofNet*)

15.00-16.00: Projects presentation from cluster members (*Port of Antwerp, E-trucks and WaterstofNet*)

PRESENTATION NEW CLUSTER MEMBERS



AGENTSCHAP
INNOVEREN &
ONDERNEMEN



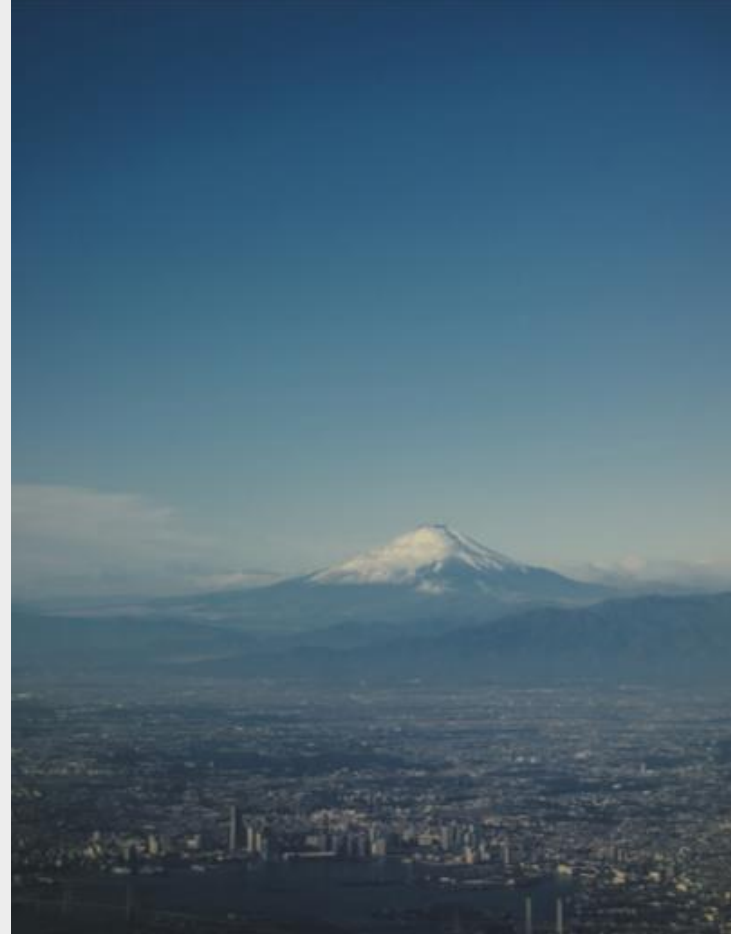
Samen voor sterk innoveren





**NIPPON
GASES**

The Gas Professionals



Taiyo Nippon Sanso

In business for more than a century, **Taiyo Nippon Sanso Corporation** is Japan's leading industrial gases producer. The Company has built a broad business portfolio encompassing a diverse range of industrial gases, as well as related equipment, facilities and technologies, worthy of its corporate slogan, "**The Gas Professionals**", through which it has contributed to the advancement of both industry and humanity.

Looking ahead, **Taiyo Nippon Sanso** will continue working to ensure safe and stable supplies of industrial gases, with the aim of helping realize a healthy and prosperous society.

The Gas Professionals

TNSC prides themselves on their ability to act on customer feedback and to partner with a wide range of industries to help improve the quality of life.

Market responsiveness and collaborative innovation are their two core values.

These values are at the heart of everything they do as they shape the future through gas technologies, crafting a harmonious relationship between people, society and the planet.

“
**We are the Taiyo Nippon Sanso Group,
where professionals
come together.**

collaborative
innovation:

We pledge to listen to the views of stakeholders
and to contribute-through both our gas

The Company

Philosophy

Market-driven collaborative innovation: Improving the future through gases.

Guiding Principle

Progressive United in creativity Forward looking

We pledge to listen to the views of stakeholders and to contribute through both our gas technologies and collaboration with partners in other industries – to the creation of a spiritually and materially wealthy society.

Slogan

The Gas Professionals

Striving tirelessly to fulfill our potential as industrial gas professionals and as the global leader in this field in terms of both market position and expertise.

Corporate symbol

Taiyo Nippon Sanso's corporate logo represents the seamless integration of state-of-the-art technology and nature, as well as the Company's business domain, founded on its advanced technologies for controlling oxygen, nitrogen, argon and other gases.

The logo also evokes the Company's resolve to achieve growth through superior quality and transparency and to ensure a future that is clean, safe and healthy.



TAIYO NIPPON SANSO
The Gas Professionals



**NIPPON
GASES**
The Gas Professionals



**NIPPON
GASES**
The Gas Professionals

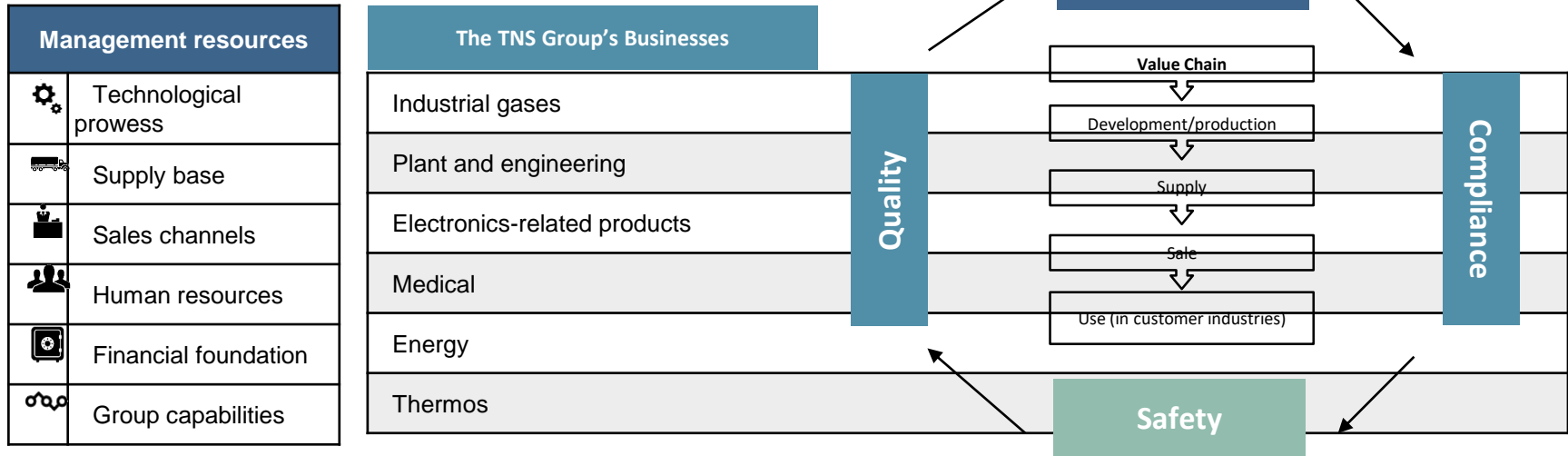
Taiyo Nippon Sanso in data

- Established in October 30, 1910
- Head Office in Tokyo, Japan
- Employees: 15,860
(+ 2.700 in Europe now)
- Capital: €290.9 million
- Revenue: €4.9 billion
(2018 Forecast)
- + €1,3 billion from Nippon Gases
Europe (2018 FCST)



Value Creation Process

In line with the group philosophy, “Market-driven collaborative innovation: Improving the future through gases,” we will continue working to apply our state-of-the-art gas technologies with the aim of addressing issues affecting society and the environment, thereby helping to create new social value and at the same time increasing our corporate value.



Engineering

- TNSC plant engineering center in Kawasaki City, Japan.
- Basic and applied research for air separation processes.
- Design, build, operate, and maintenance capabilities.
- Cold box and column packing design and fabrication.
- Over 850 plants built and installed throughout Japan, Southeast Asia, Middle East, and North America over the last 65 years.

1. *Plant & Engineering Center – Kawasaki City, Japan*

2. *Sasol & Lotte Chemical onsite plants – Lake Charles, Louisiana*

1.



2.



R&D



Tsukuba, Japan Laboratory

Tsukuba: analysis, cryogenic gas separation, ultra low temperature technologies, semiconductor gases, and related equipment.



Yamanashi, Japan Laboratory

Yamanashi: gas applications for oxygen combustion, welding, thermal cutting, heat treatment, and cryogenic preservation.



Longmont, CO Laboratory

Longmont: purification and gas delivery system technologies.

Principal Industrial Sectors TNSC serves



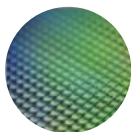
Steel

(Since 1964, we have installed on-site plants (“sanso centers”) at steel production facilities to ensure stable supplies of industrial gases, thereby supporting the growth of Japan’s leading steelmakers.)



Chemicals

(We supply gases to chemical production sites through pipeline networks extending across large-scale industrial complexes, ensuring uninterrupted supplies of nitrogen, which are essential to the safety of such facilities).



Electronics

(We construct total gas centers (TGCs), which supply nitrogen and electronics materials gases, on sites adjacent to large-scale semiconductor fabs.)



Transportation equipment and machinery

(Cutting and welding are key processes in automobile manufacturing facilities, shipyards and construction sites. In addition to gases for cutting and welding, we supply such facilities with a variety of related equipment and materials.)



Food

(We provide a variety of products that represent applications of nitrogen-filled packaging, freezing and other food related gas technologies, under the brand name Bistranza.)



Life sciences/ medical

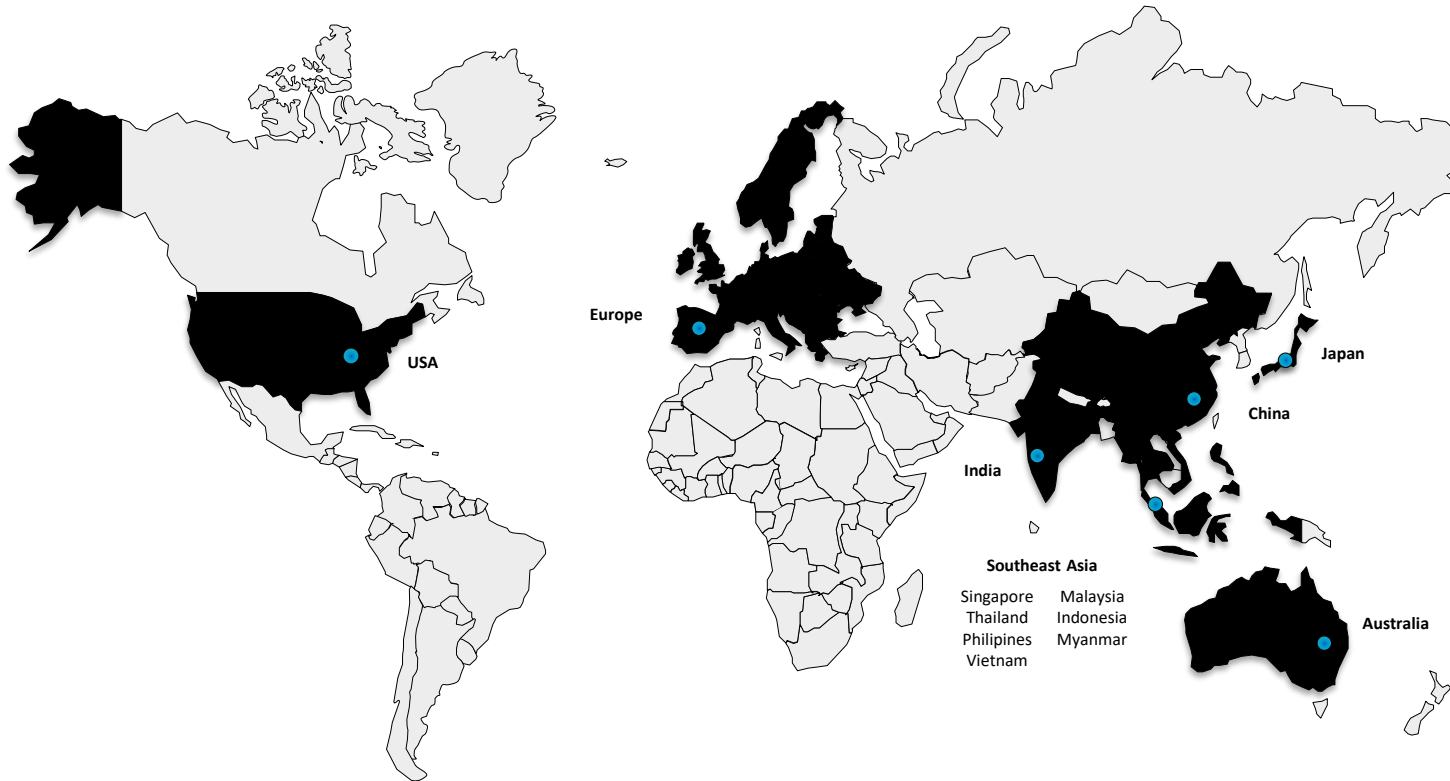
(In 2004, we started operation of the world’s first plant for producing stable isotope Water-18O, used in reagents for positron emission tomography (PET), through the application of air separation technologies. We have since established the world’s most extensive supply framework for this crucial material.)



Energy

(We supply environment-friendly, safe propane for use in homes, commercial premises and other premises that play a role in everyday life)

Global footprint




Nippon Gases Europe

OUR NUMBERS SPEAK

- Presence in 12 countries - Spain, Portugal, Germany, Italy, Belgium, Holland, Denmark, Norway, Sweden, France, United Kingdom, Ireland.
- Employees: 2,700.
- Customers: More than 100,000.
- Sales (2017): € 1,28 billion.
- Sales forecast 2018: € 1,34 billion (+5%).



Presence in Europe

 Around 2.700 Employees


 Over 100.000 Customers

 6 Pipelines

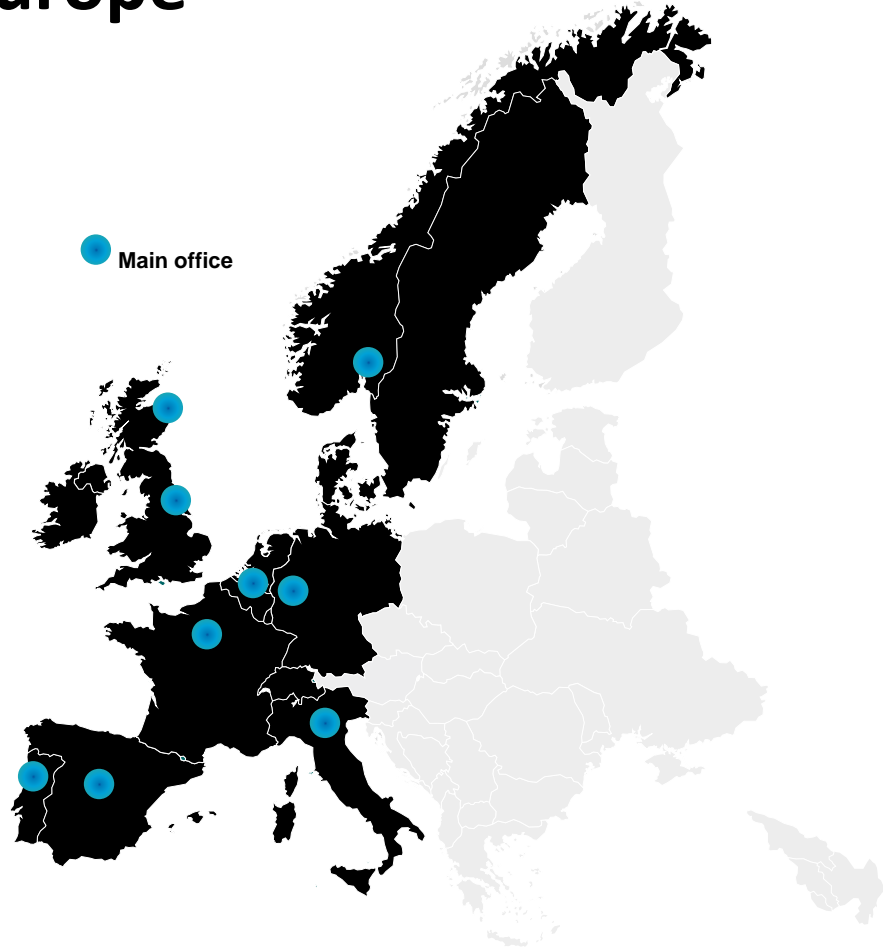
 4 Specialty Gases Laboratories

 27 Air Separation Units

 6 Hydrogen plants

 52 Small On-Site

 Main office




 12 CO₂ plants


 Over 600 trucks

 Over 2.6 millions cylinders

 34 Filling Stations

 13 Dry Ice Plants

 7 CO₂ Terminals

 3 CO₂ Ships

Safety - highest standards



2018: Strong Focus on the Human Factor

- Safety is a **CRUCIAL AXIS** of our company and is constantly improving thanks to the search for risk factors that allow us to improve and good performance of all our indicators.
- Our **commitment to safety** is integral, so we apply this premise in all our products -development, design and distribution- as well as human and environmental control.

	Lost Workday Case Rate / 200.000 hours	EIGA Lost Workday Case Rate / 200.000 hours	Recordable Injury Rate / 200.000 hours	EIGA Recordable Injury Rate / 200.000 hours
2012	0.04	0.42	0.35	0.88
2013	0	0.36	0.43	0.74
2014	0.04	0.36	0.09	0.62
2015	0.04	0.35	0.16	0.7
2016	0.12	0.42	0.12	0.81
2017	0.23	0.42	0.38	0.72
2018 ytd	0.05	0.37	0.14	0.73

Rate: Number of incidents / 200.000 hours

Our Principles



Safety

- All accidents can be prevented
- Safety is the responsibility of line management
- Every employee is responsible for his/her own safety
- Every employee must stop a job if it cannot be done safely
- Efforts in safety yield results in safety
- Safety is a condition of employment



Compliance

- All compliance breaches can be prevented
- Compliance is the responsibility of line management
- Every employee is responsible for his/her own ethical behavior
- Every employee must stop a job if it cannot be done ethically
- Efforts in compliance yield results in compliance
- Ethical behavior is a condition of employment



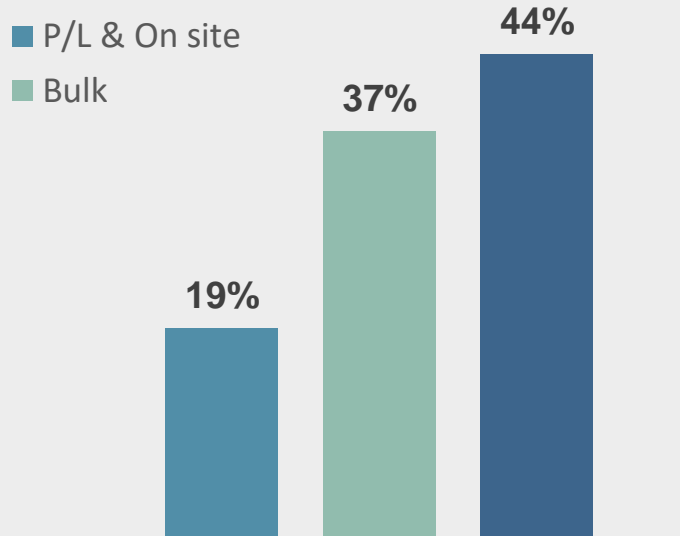
Diversity & Inclusion

- Diversity and Inclusion are essential to our work and workplace.
- Inclusion is a line-management accountability
- You are responsible for being a model for inclusive behavior
- Every employee must stop non-inclusive actions or conduct
- Efforts in diversity & inclusion will increase engagement and improve business results
- Inclusiveness is a condition of your employment

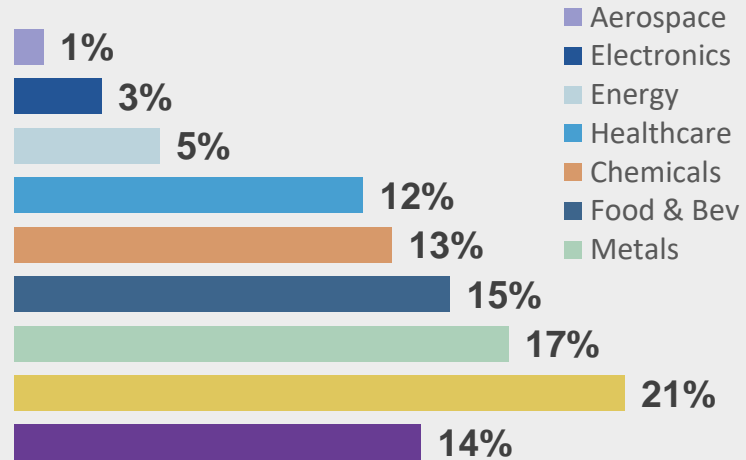
2018 Sales Breakdown



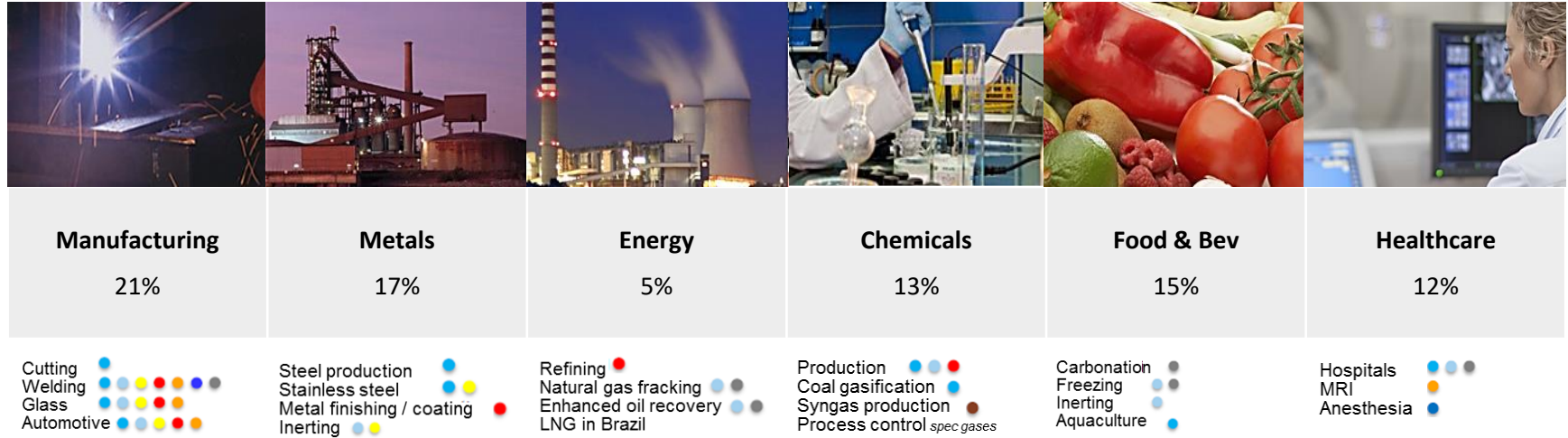
Sales by Supply Method



Sales by End-Market



Diverse end-markets and the gases we supply



Gases

Atmospheric



Process



Rare



Spec Gases



Customer Benefits

We are continuously recognized as leaders in:

- Safety.
- Uninterrupted supply.
- Expertise in the industries we serve.
- Responsiveness to customer requirements.







Helping customers in:

- Improve productivity.
- Decrease energy consumption.
- Produce higher quality products.
- Cost-effectively achieve environmental and safety standards.







Applications



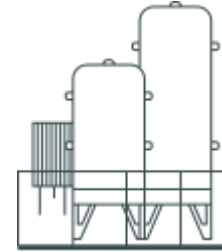
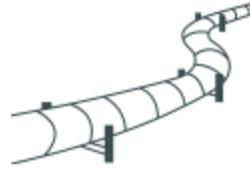
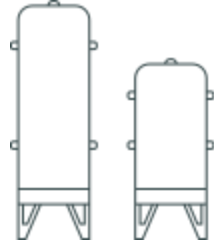
MARKETS	APPLICATIONS	CUSTOMER BENEFITS	PRODUCTS
 METAL FABRICATION	Welding & cutting	Productivity, Cost Reduction Product Quality	Argon
 PRIMARY METALS	Combustion in electric arc furnaces	Productivity, Energy Savings	Oxygen
	Refining of metal products	Product Quality	Argon
	Cast iron melting in rotary furnaces	Flexibility Cost Reduction	Oxygen
 CHEMICALS & PHARMACEUTICALS	Vent-gas recovery of volatile organics	Environmental	Nitrogen
	Vapor and liquid phase oxidation	Productivity, Cost Reduction	Oxygen
	Catalyst regeneration	Productivity	Oxygen
 PETROLEUM REFINING	Enhanced oil and gas recovery	Productivity	Nitrogen
	Gasoline reformulation	Environmental	Hydrogen
	Catalyst regeneration	Productivity	Oxygen
 FOOD	Freezing and chilling	Productivity, Flexibility, Shelf Life, Flavor, Safety	Nitrogen, CO ₂
	Packaging	Quality, Shelf Life	Nitrogen
 BEVERAGE	Carbonation	Quality	Carbon dioxide

Applications



MARKETS	APPLICATIONS	CUSTOMER BENEFITS	PRODUCTS
 ELECTRONICS	Semiconductor fabrication	Productivity	Total Materials
	Lower cost, Reliability	Management	Specialty Gases
	Atmosphere control	Product Quality	Nitrogen
 HEALTHCARE	Respiratory assistance	Patient Health	Medical Oxygen
	Magnetic resonance imaging	Performance, Reliability	Helium
 METALS & MATERIALS PROCESSING		Product Quality	Gas Mixtures
	Heat treating	Productivity	Argon Hydrogen
 ENVIRONMENTAL REMEDIATION	Water treatment, pH control	Emissions Reductions, Flexibility	Oxygen
		Flexibility	Carbon Dioxide
	Whitening pulp and paper	Chlorine Elimination	Oxygen, Ozone
	Waste incineration	Emissions Reduction, Productivity	Oxygen

Supply Options



PACKAGED GASES (CYLINDERS)	BULK LIQUID GASES (MERCHANT)	PIPELINE DISTRIBUTION	ON-SITE PLANTS
All gases	Oxygen, nitrogen, argon, carbon-dioxide, hydrogen, helium	Oxygen, nitrogen, hydrogen, carbon monoxide, air	<ul style="list-style-type: none"> • Cryogenic: oxygen, nitrogen, argon • Non-cryogenic: membrane nitrogen, VPSA oxygen • Process gases: hydrogen, helium, carbon dioxide



Thank you

nippongases.com



Limburg, a place where every great entrepreneurial idea has the potential to conquer the world



SAMENWERKEN AAN EEN STERK LIMBURG



POM Limburg

DIENT RUIMTELIJKE ECONOMIE

Ruimte om te ondernemen

KENNISCEL

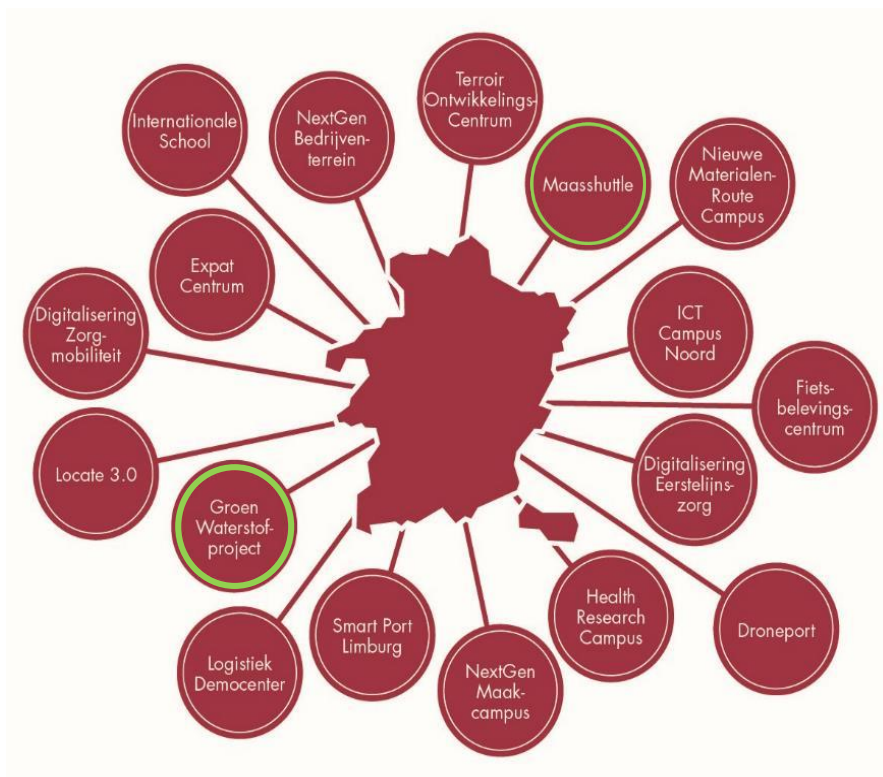
Ontwikkeling van economische kennis

PROJECT- EN PLATFORMWERKING



- Sectoren** waar POM Limburg de platformwerking organiseert en projecten doet.
- Sectoren** waar POM Limburg via een overeenkomst werkt met derden voor de platformwerking, maar ook zelf projecten kan doen.
- Sectoren** waar POM Limburg enkel in samenspraak met anderen projecten doet.

17 HEFBOOMPROJECTEN VOOR LIMBURG





**GROEI IS NIET PUUR TOEVAL MAAR HET
RESULTAAT VAN KRACHTEN DIE
SAMENWERKEN**



Koolmijn, Houthalen

7 Mines

Discovered 1 juni 1901 - AS

Start 1917- 1935

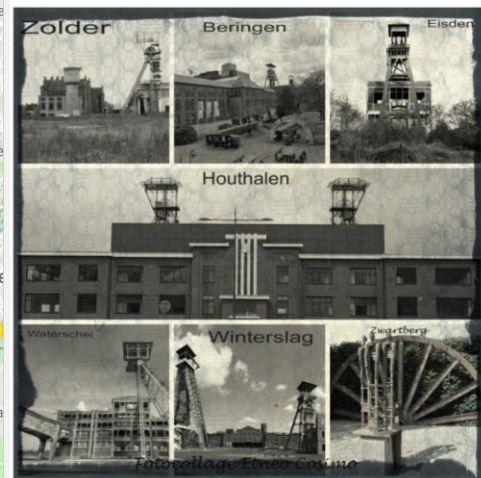
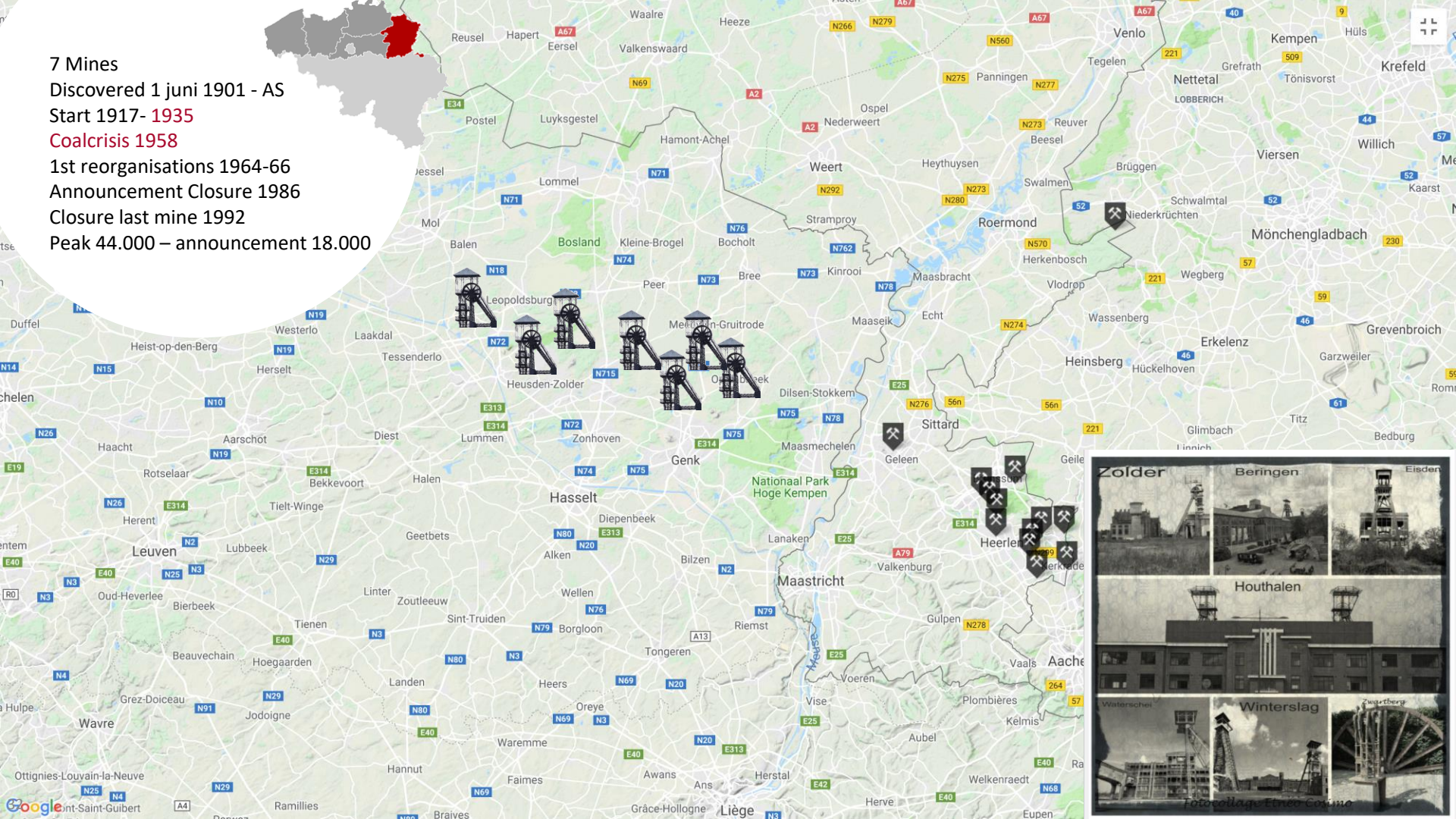
Coalcrisis 1958

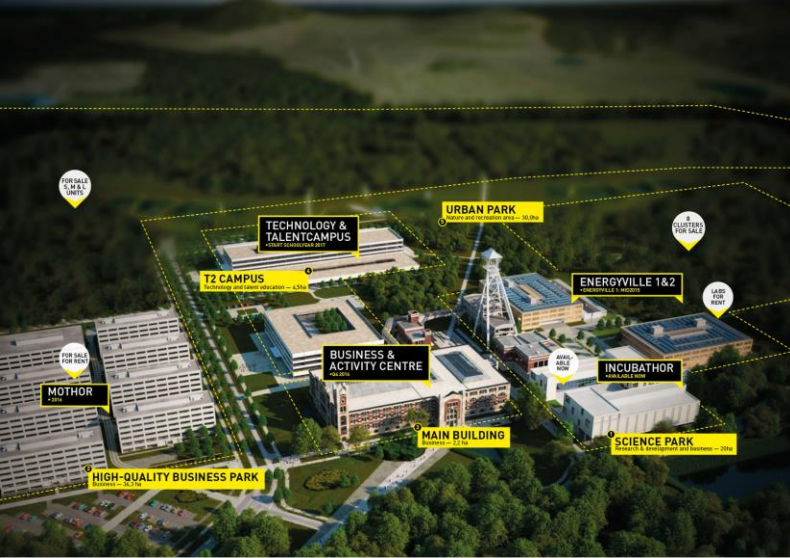
1st reorganisations 1964-66

Announcement Closure 1986

Closure last mine 1992

Peak 44.000 – announcement 18.000







Largest solar park of the Benelux



Great potential for geothermal energy



Largest capacity wind power/inhabitant



Terhills battery (18 MW), one of the largest in Europe to act as a primary reserve

Why GREEN hydrogen in Limburg?

Sustainable Development Goals of the United Nations



Renewable Energy Directive EU



Renewable Energy – Recast to 2030 (RED II)

Member States must require fuel suppliers to supply a minimum of 14 % of the energy consumed in road and rail transport by 2030 as renewable energy.

Coalition agreement 2019-2024

We have the ambition to become the European leader in hydrogen.

Covenant of mayors

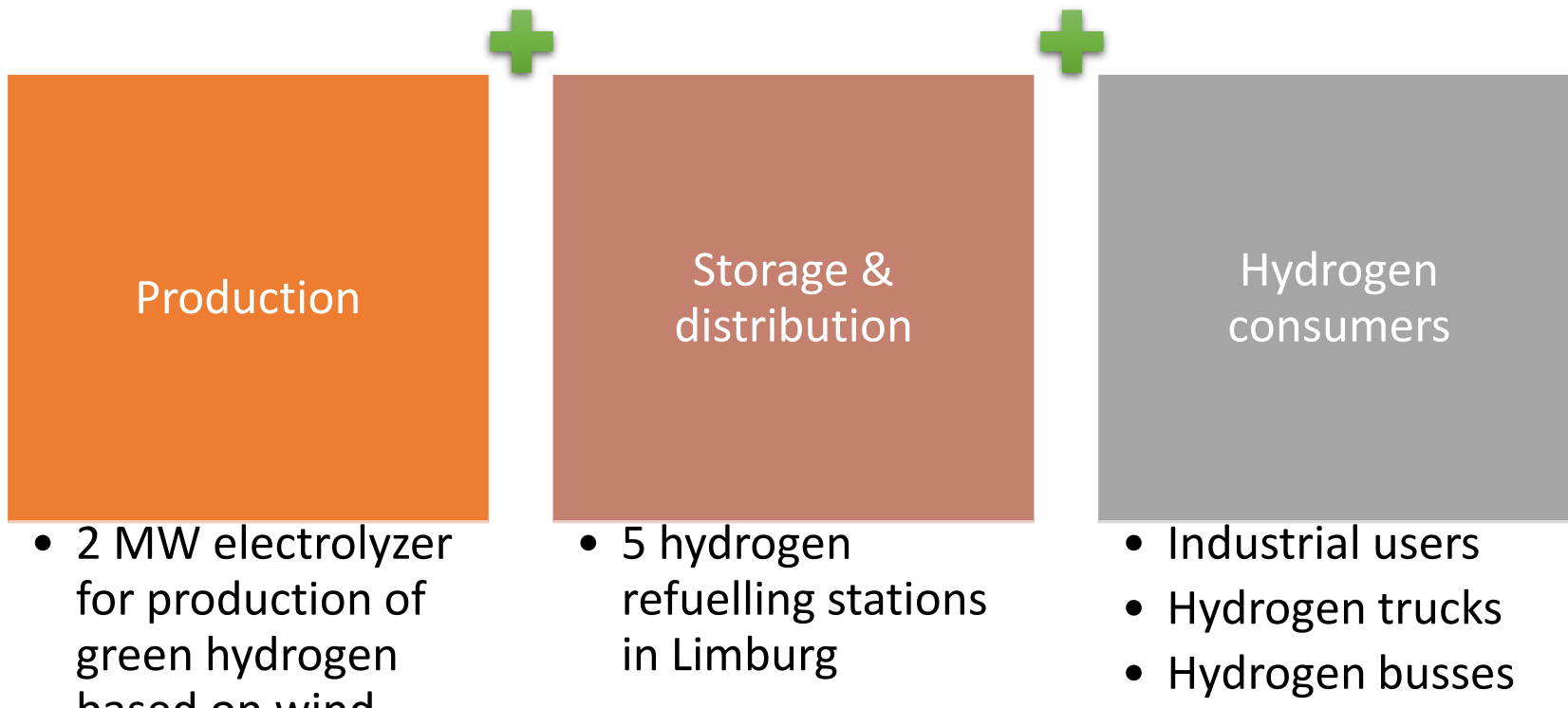
Cities and towns must reduce CO₂ emission with 40 % by 2030.

Green hydrogen (H₂)

- Free from CO₂, if produced from renewable energy
- Simple to store and to transport
- Fuel of the future for heavy weight and long distance transport:
 - Large autonomy
 - Fast refuelling
 - Independent of ambient temperature
- Replacement of black H₂ in industrial processes
- Long term storage of large quantities of renewable energy



Green hydrogen ecosystem





pom

Limburg
economisch
versnellen

Company name: ParticipatieMaatschappij Vlaanderen nv (PMV)

Main activities:

- Venture capital for promising technology companies (early stage and growth)
- Project finance for infrastructure & real estate
- Guarantee mechanisms related to bank financing of projects or companies
- Mezzanine financing for growth companies

Experience with H2:

- Several investment files investigated or under investigation
- Active direct investor in Borit
- Partner in P2MeOH-project (VMH)
- Investor in H2-related companies via fund-of-fund

Specific topics of interest within the cluster:

- Companies & projects that have financing needs as indicated above

Company name: Blue Gate Antwerp Public Holding nv (PMV/DVW/AG Vespa)

Main activities:

- brownfieldherontwikkeling, site Blue Gate Antwerp: voormalige petroleumhaven (1904-heden): op- en overslag (raffinage) van petroleum
- herontwikkeling tot watergebonden regionaal eco-ffectief bedrijventerrein (O&O, logistiek en productie)
- CO2-neutraal, warmtenet/transportnet, opzet SPV energie (WKK, PV, ... H2)

Experiences with H2:

- braakliggende kavel (Schelde, laad- en losinfrastructuur)
- Transitie bestaande op- en overslag petroleum
- haalbaarheidsstudie waterstof hub (VLAIO, WaterstofNet, Antea, BGA/Willebroek Noord)

Specific topics of interest within the cluster:

- haalbaarheidsstudie waterstof hub



CLUSTER "PLATFORM POWER TO GAS"

47 LEDEN



AGENTSCHAP
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Samen voor sterk innoveren



BUS & COACH



NEW!

- End of funding of IBN: future of the cluster
- Steering group & strategy
- Visit power to gas project (abroad)
- Projects to be started:
 - VIL Hydrolog
 - Study Hydrogen in the built environment
- Newsletter

END OF FUNDING OF IBN



AGENTSCHAP
INNOVEREN &
ONDERNEMEN



Samen voor sterk innoveren

- VLAIO IBN cofunding ended in august 2019
- No “formal” continuity in terms of government support
- But: cluster will move on “on its own”
- New start: steering group, strategic goals, more activities, ...



POWERTOGAS
Industry Cluster Flanders

- **Internal rules**

- Good working order
- Rights and obligations of the members
- Intellectual property, membership fee, ...

- **Steering group**

- Sound board for the cluster organisation
- Directs the cluster working
- Definition /approval of:
 - ✓ Strategy and activity planning of the cluster
 - ✓ Messages towards policy makers/governments
- 8 companies + WaterstofNet



- Proposal for a **roadmap** for future activities/projects
 - ✓ Suggestions welcome!

- Setting up a **“Hydrogen plan”** with government

- Focus on **common technological & economical challenges**
 - ✓ Common bottlenecks of companies
 - ✓ Set up cluster-broad projects/teams to deal with these bottlenecks

- Possible **collaborations with other organisations** (Benelux, other regions, ...)



PROPOSAL VISIT POWER TO GAS PROJECT



AGENTSCHAP
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ONDERNEMEN

POWERTOGAS
Industry Cluster Flanders

Samen voor sterk innoveren

- Suggestion: Northern Netherlands (Groningen)
 - Hydrogen Valley: HEAVENN project
 - Possible visits: Hystock, Holthausen Clean Technology, Waterstofwijk Hoogeveen, Port facilities, potential industrial partners, ...
- Downside: distance to reach + will take 1,5 days to visit
- Timing: first half of May
- **Other suggestions?**



PROJECT TO BE STARTED: HYDROLOG VIL (FLEMISH LOGISTICS CLUSTER)



AGENTSCHAP
INNOVEREN &
ONDERNEMEN



Samen voor sterk innoveren

- Logistical hydrogen applications
- Business model for shared hydrogen refuelling equipment for industrial areas, (air)ports and areas with important logistic activities.
- Possible production of green hydrogen on industrial site
- Proof of concept: test of mobile fueling station with logistic applications
- End result: use cases for specific locations defined



PROJECT TO BE STARTED: HYDROLOG VIL (FLEMISH LOGISTICS CLUSTER)



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ONDERNEMEN

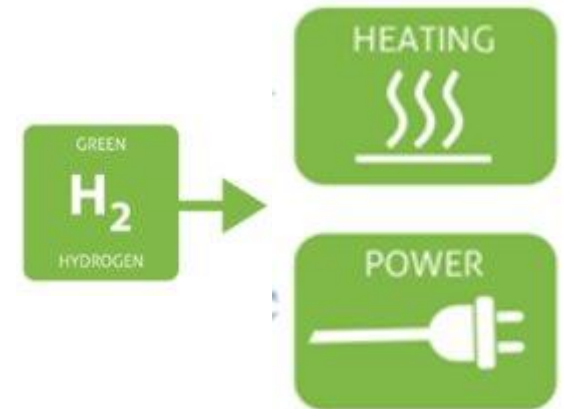


Samen voor sterk innoveren

- Study to be performed by VIL & WaterstofNet
 - Small fee from companies. Already subscribed: Antwerp Euroterminal, Aertssen, Ecosource, Still, Air Liquide and Mexiconatie
- **COOCK project (VLAIO)** “Collectief Onderzoek & Ontwikkeling en Collectieve Kennisverspreiding/-transfer”
 - Subsidised by Flemish government for at least 50%
 - Performed by a university with “knowledge transfer” to companies
- Kick off January 28 2020
- Communication
 - By VIL to its members
 - By WaterstofNet to its members
 - Candidates?



- Scope = bottom-up use case analysis
 - Use of hydrogen in buildings for heating or combined heat and power generation
 - Study benefits and drawbacks compared to alternatives - different use cases
 - Different contexts (urban, new residences..)
 - Pure H₂/mixed with CH₄
 - Locally produced/centrally produced
 - Different applications (CHP, boilers, electrolysers,...)
- First step towards a feasibility study and potential demonstration pilot project



- How?
 - Performed by University of Leuven and WaterstofNet IF enough **companies want to participate** with a small commitment
 - Or “COOCK” project
- Timing:
 - Mail to check interest will be send next week
- Possible participants:
 - Cluster members
 - Project developers

- We have a newsletter 😊
- At least 4 times a year
- Both news from cluster members and international trends
- Have news yourself? Let us know!
- More people interested? Let us know!
- Check your spam folder (sender: Power-to-Gas Cluster)
- Need for more information? Info portal?

Newsletter Power-to-Gas Cluster

November 2019

Dear Yannick,

In this newsletter, which from now on will be sent on a regular base, it's our intention to keep you informed about relevant hydrogen news both from our cluster members and developments in the world.

If you have any related news items from your company or come across developments you would like to see published in our newsletter, please contact our project managers (contact details below).

News from our cluster members



Busworld Europe 2019, held in Brussels at the end of October, has awarded the Grand Award Bus to the hydrogen-powered Van Hool Exqui City 18 bus. This "ambus" – which we could admire and test during our cluster meeting at Van Hool in June – is destined for the French city of Paris. Thanks to its 300-kilometer capacity of operational autonomy, the hydrogen fuel cell bus has also been awarded the Ecology label award. The jury praised the safety features, the completely separated driver's desk with centrally located controls, the excellent visibility for the driver and the multitude of cameras covering the entire external area of the bus.

- Wednesday March 4 AM
- Wednesday June 3 AM + PM
- Wednesday September 16 AM
- Wednesday December 2 AM + PM

Save
the
Date

➤ **If overlap with big hydrogen events: let us know!**

Hydrogen in maritime applications

CMB

Port of Antwerp



Dual Fuel H₂– Diesel MAN D2862

Proposal for co-development

November 2019

CMB
.TECH

Content

1. CMB
2. Hydrogen as a fuel for shipping
3. Dual fuel combustion engine
4. The Hydroville Project
5. CMB projects with hydrogen



1. CMB

- Belgian shipping company based in Antwerp
- CMB was founded in 1895
- CMB is 100 % family owned
- Offices in Tokyo, Hong Kong, Singapore, Hamburg and London
- CMB owns and operates **95 ships** through Bocimar (dry bulk), Delphis (containers) and Bochem (chemical tankers)
- CMB.TECH invests in **technological innovation** (a.o. hydrogen powered ships) and **fleet performance management** systems
- Reslea is CMB's **real estate** division and owns 2 plots of land in Antwerp (De Gerlachekaai and Maritime Campus Antwerp)





CMB



BOCIMAR



BOCHEM



DELPHIS

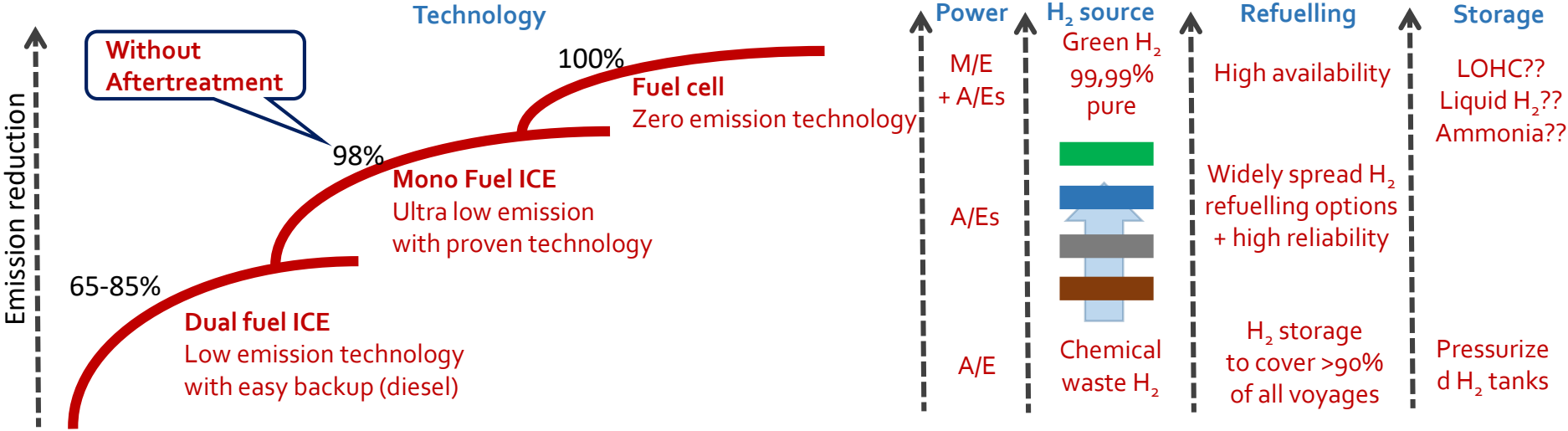
CMB
.TECH



2. Hydrogen as a fuel for shipping

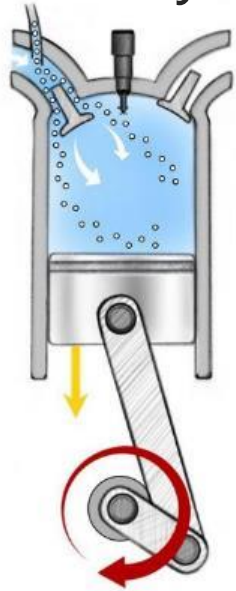
- Batteries: Ships require a large energy buffer, resulting in a battery size which is too large, too heavy and too expensive. There are no means to charge this battery during port call;
- Photo-Voltaic panels: the ship's surface is not big enough to even provide 10% of the required power;
- Wind energy: more interesting for slow sailing vessels. Deck space is challenging, but with a projected saving of 10-30% the IMO limit of 50% GHG reduction can not be reached;
- Nuclear: too expensive, not insurable, requires too much personnel;
- LNG: Due to methane slip during production, storage & combustion, GHG effect saving is almost zero;
- Bio fuel: not enough biomass available;
- E-fuels (with Hydrogen as a base):
 - Ammonia: toxic, ADR complexity and produces more NO_x during combustion;
 - Methanol: Can be a good solution to solve the storage problem of hydrogen. But the conversion step from Hydrogen to methanol will cost energy. And methanol still emits CO₂ during combustion.
 - DME: same as methanol, it still emits carbon.

Heavy industries (such as shipping) require incremental innovation instead of disruptive innovation



→ Dual fuel technology is the first step towards the zero emission goal, while the service can be guaranteed as one always can rely on diesel

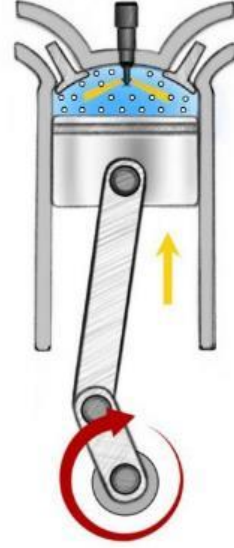
3. H₂-Diesel co-combustion: ability to combine fuel flexibility and efficiency with environmental performance



Hydrogen is injected at the port and aspirated in the cylinder during intake stroke



Hydrogen mixes further into a uniform and homogeneous mixture during the compression stroke



A small amount of pilot fuel (diesel) is injected into the chamber just before top dead centre



Diesel auto-ignites (due to high temperature and pressure) and co-combusts with all the H₂, forcing the piston down during the power stroke



The cylinder is cleaned during the exhaust stroke, having lower NO_x and CO₂ emission in the exhaust gas



4. Hydroville Showcase Project

HYDROVILLE



<https://www.youtube.com/watch?v=5kNxUqCIDno>

5. CMB projects with hydrogen : HydroCat

- Based on Hydroville technology, the Hydrocat is being developed in a joint venture with Windcat Workboats to serve offshore wind parks operated by Vattenfall.
- Design is based on the proven and efficient WindCat MK3.5.
- Dual fuel capability diesel – hydrogen.
- Hydrogen storage at 350bar.
- H₂ refuelling of 200kg saving 1.9ton CO₂.
- 2x1000hp in total resulting in a 30 knots max speed with 13,3t bollard pull.
- The Hydrocat is expected to sail end of 2020.



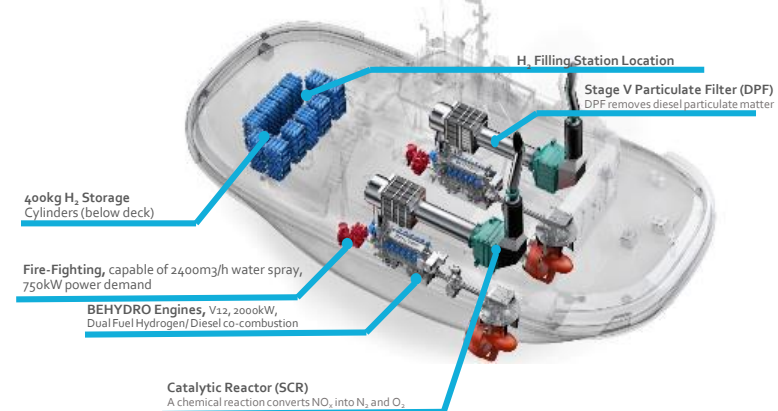
HydroBingo

- Tsuneishi and CMB are developing a hydrogen powered ferry, the HydroBingo
- Tsuneishi has experience in developing & building environmentally-friendly vessels, such as electric propulsion ships.
- 'HydroBingo' will fit the requirements of the gross tonnage class up to 19 tons.
- 2x High speed engines will power the vessel.
- Capacity: 80 passengers.
- Refuelling is done with a trailer via Ro-Ro principle.
- Maximum sailing speed of 26kn. Cruise speed will be between 18-22kn.



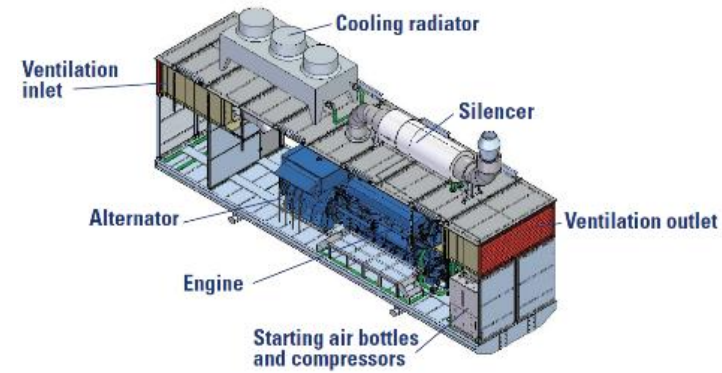
HydroTug

- In cooperation with the Port of Antwerp, CMB will build a hydrogen powered tugboat, the HydroTug.
- 5000hp in total for propulsion.
- The vessel will be used by Port of Antwerp for its daily operations.
- 400kg of H₂ is stored in the aft compartment below deck. Each refilling saves the total emissions of 1 car during 1 year.
- This project can be an enabler for large H₂ infrastructure in port areas.
- The HydroTug will sail by Q3 2021.



Other H₂ applications: Cold ironing with clean technology

- Marine gen-set delivers automatically at correct Voltage/Frequency next to the vessel
→ no expensive power converters required.
- Mobile & safe solution, available as mono fuel as well as dual fuel.
- Up to 1,5 MW power available.
- 1x 40ft container can hold up to 1ton of H₂, enough to run for 24h on 100% pure H₂ at 700kW hotel load avoiding 10 tons of CO₂ a day while all soot, SO_x and 95% of the NO_x are saved from the port location.
- Low pressure H₂ piping can provide fuel for the cold ironing gen set.



The port of Antwerp will house the first dual use (maritime and public) H2 station developed by CMB



The refuelling station will produce its own green hydrogen with an onsite 1MW PEM electrolyser

1. 1MW PEM electrolyser
2. 2stage 950bar compressor
3. 1 refilling station for cars (700bar)
4. 1 refilling station for busses and trucks (350bar)
5. Refilling station for 2 trailers (up to 500bar)
6. 500bar H₂ buffer
7. Marine bunkering location (200 & 350bar)
8. 3 electric fast chargers



CMB can offer 10 years of experience with hydrogen projects on various applications

- CMB acquired Revolve Technologies Ltd., which is at the forefront of dual fuel H₂ diesel combustion technology for more than 10y.
- Training programs for crews have been developed to operate H₂ systems safely.
- The team exists of 30 skilled engineers with dyno test cells and a prototype workshop.
- ISO 9001 (Quality Management) & ISO 14001 (Environmental Management) accredited.



CMB .TECH

Roy Campe, R&D Manager,

CMB NV

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CMB.tech

Prospect Way

Brentwood CM13 1XA, UK

T: +44 1277 261400

enquiries@cmb.tech



Port of Antwerp

Towards a sustainable future in shipping



**Port of
Antwerp**

Wouter Parys
Sustainable Transition Expert

Content

1. Port of Antwerp

Vision, mission and roles

2. Project multifuel port

3. Pilot projects onw assets

Retrofit
New built



Part 1

Vision, mission and roles



**Port of
Antwerp**

Port of Antwerp –vision, mission and roles

“Thuishaven als hefboom voor een duurzame toekomst”

Port of Antwerp

- Public authority, cluster manager and **landlord** of **second largest European port**
- Operator of offshore and onshore infrastructure with an **in-house tugboat fleet** and other smaller (controlling) vessels
- Antwerp fifth largest **bunker port** in the world
- +/- 1600 employees
- Business plan 2018-2020 with **Transition** as one of the five top priorities





Sustainable shipping in the port

- Catalyst for transition towards alternative fuels (platform)
 - ➔ Remove burdens for operators and adapt regulations
- Frontrunner and innovator (own assets)
 - ➔ Efficiency gains: alternative propellers, hybrid drive trains, new hull types,...
 - ➔ Incorporation of new fuels: methanol, hydrogen,...

Part 2

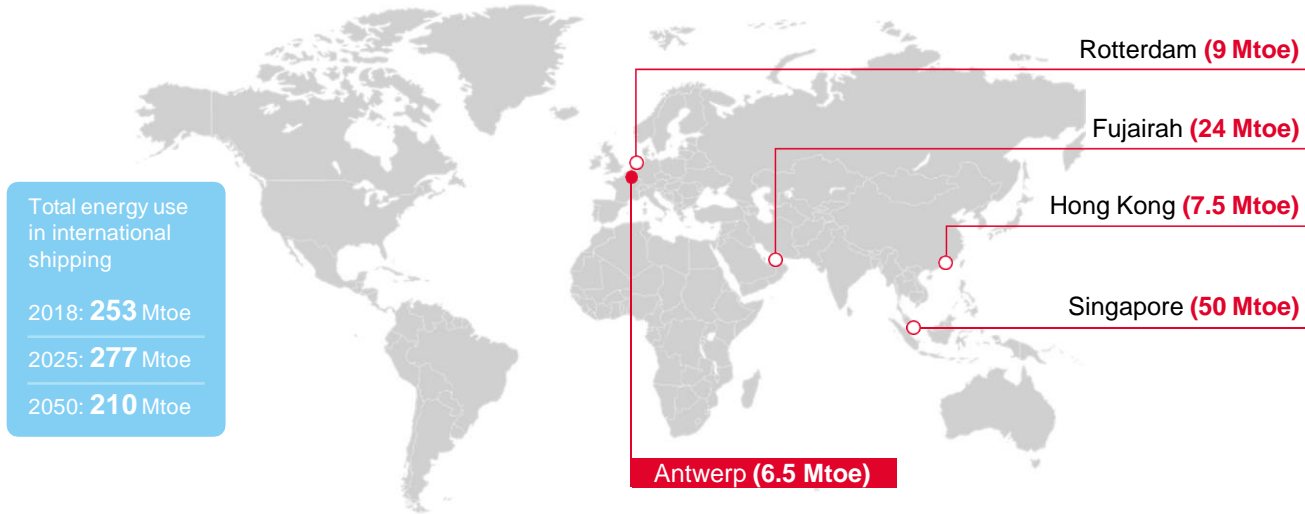
Antwerp as a multifuel port



Port of
Antwerp

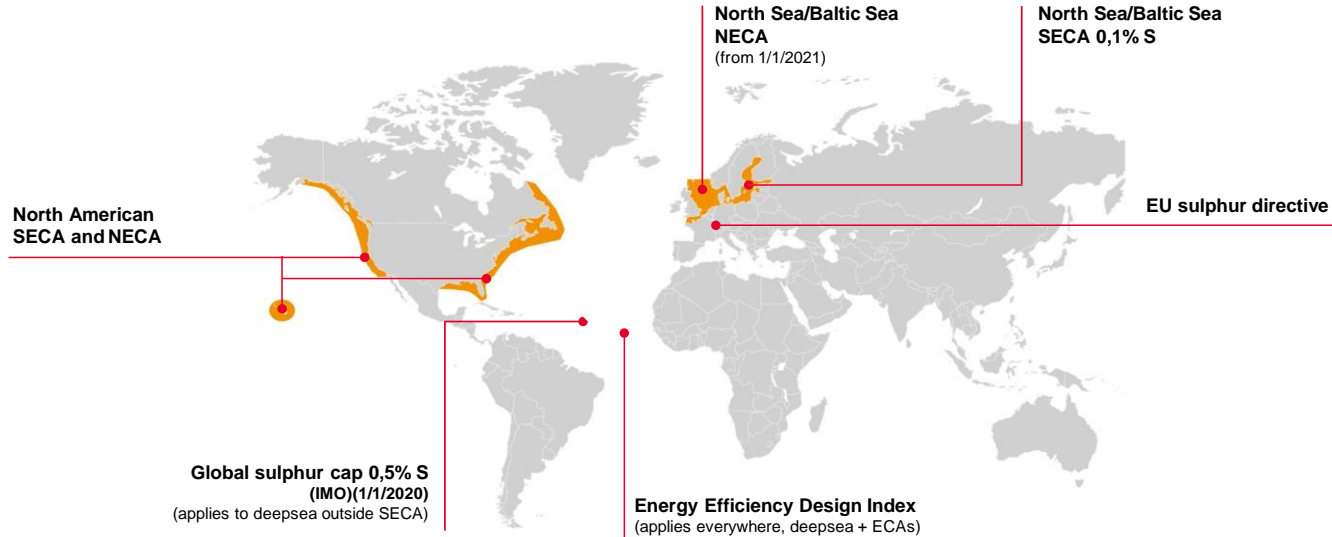
Conventional bunkering in the Port of Antwerp

Antwerp 5th largest bunker port worldwide

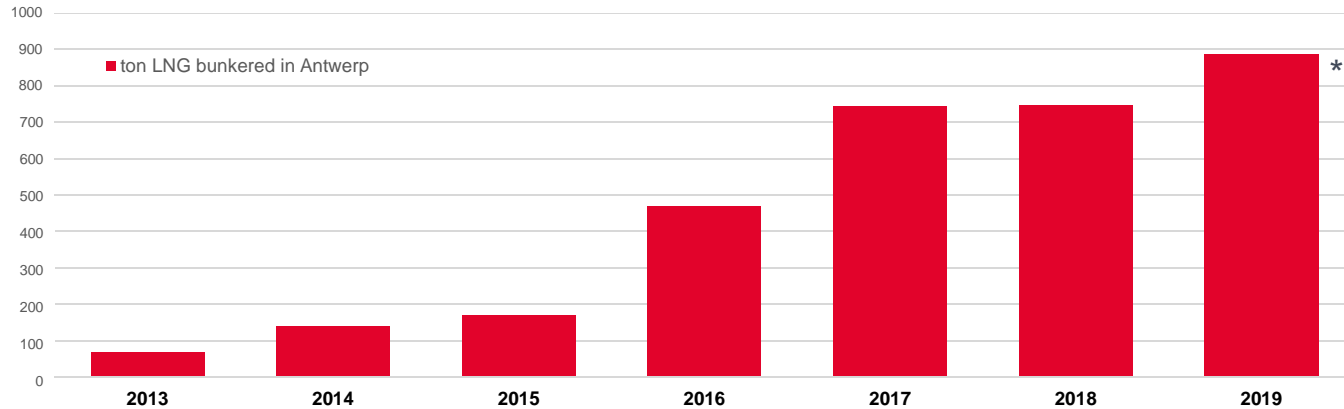


Driving the uptake of alternative fuels in international shipping

Air quality and environment regulations as a push



LNG bunkering in the port of Antwerp by truck-to-ship



Vision Antwerp Multi Fuel Port

LNG is just the start

Port of Antwerp is **fully engaged** to also integrate **methanol, hydrogen** and **electric power** in its bunker market **by 2025**

Tackle challenges with regard to



Regulations



Supply chain



Technology



Finance



Not in my backyard

From our four roles as port authority



Community builder



Regulator



Landlord



Operator

Port dues (LNG)

Reduction of 15% on port dues for seagoing vessels and inland vessels



Seagoing vessels

<https://www.portofantwerp.com/nl/tariefverordening-op-de-zeeschepen-2019-0>



Inland vessels

<https://www.portofantwerp.com/nl/tariefverordening-op-de-binnenvaart-2019-0>



Part 3

Pilot projects alternative fuels



Port of
Antwerp

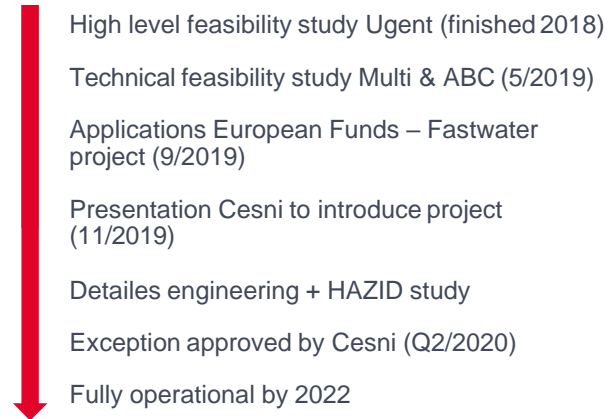
Project 1: retrofit tugboat to dual fuel methanol-diesel

Starting points & timeline

Starting points

- 'Greenify our own operations' = **Walk the talk**
- Lifespan of tugboats > 20-30 years
 - Transition should go faster
 - Retrofit solutions?
- New solutions/innovations should have a positive effect on both climate as air quality
- Certified as inland vessel (CCR regulations)

Timeline



Project 1: retrofit tugboat to dual fuel methanol-diesel

Fastwater consortium: Application for Horizon 2020 subsidiary traject Mobility for Growth

“Develop and demonstrate an evolutionary pathway for methanol technology”

- Commercialize medium speed and high speed **methanol engines**
- Demonstrate **reduced pollutant and CO2 emissions**
- Demonstrate the **reliable operation** of 3 vessels
- Develop a **training program** for crew
- Demonstrate the **complete supply chain** from renewable methanol producers to ship bunkering
- Develop **rules and regulations** (including a methanol fuel standard)

Partners:



Project 1: retrofit tugboat to dual fuel methanol-diesel

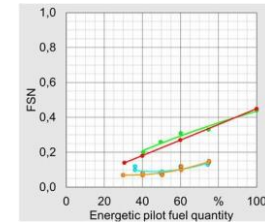
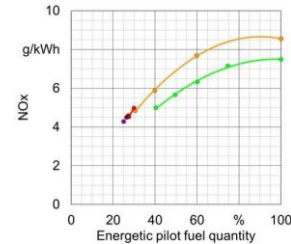
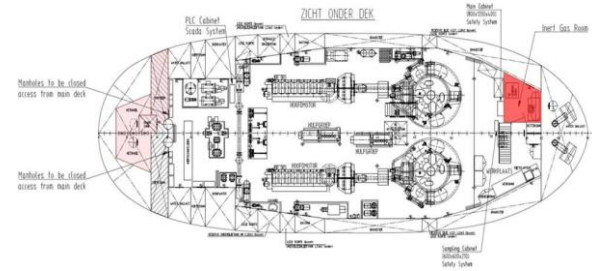
Technical feasibility study

Ship modifications (affected areas)

- Methanol tank (12,1m³) in old ballast tank
- Bunker station (hazardous zone perimeter of 4,5m)
- Inert gas station
- Double walled pipes and tankss
- Pump room
- Venting!

Engine modifications (2x ABC engines 1945 kW)

- Port fuel injector and injector control system
- Temperature control
- Methanol mixture (towards 60-70%)
 - NOX reduction of 50-60%
 - PM reduction of 75%
 - CO2 reduction 60-70% if green methanol used



Project 2: Newbuilt tugboat with dual fuel hydrogen-diesel engines

Built by CMB

- Joint Venture with ABC for engine development (BeHydro)

Up to 85% Hydrogen

- Diesel pilot injection

Operational by 2021

Certified as a sea-going vessel



25
Sep '19

World's first hydrogen-powered tugboat to debut at port of Antwerp



by Flanders Today, Editorial team at Flanders Today
Recent articles: AllezNL makes practicing Dutch in the capital fun; Photo of the week: Times up, Ban on late-night drinking in Brussels' pedestrian zone

SUMMARY

Compagnie Maritime Belge is building the first tugboat in the world that will guide container ships to port with a hydrogen-diesel hybrid engine



'KEY TO SUSTAINABLE SHIPPING'

The port of Antwerp has ordered a tugboat, partially powered by hydrogen, the first in the world. This unique Hydrotug will be driven by combustion engines that burn hydrogen in combination with diesel.

Tugboats help guide massive container ships into crowded ports. They usually have diesel engines and are known for burning a great deal of fuel.

The Hydrotug will be built by Compagnie Maritime Belge (CMB), one of Europe's oldest shipping companies. The tug's hybrid engine will comply with the EU's Stage V, the lowest-rated for emissions on the market.

Hydrogen in government plans

Bart De Caesemaeker

VLAIO

- Flemish coalition agreement:
 - Transition to climate neutral and sustainable society: needs worldwide action
 - hydrogen mentioned in terms of technological innovation
 - Emphasis on technological innovation (carbon capture, hydrogen, ...)
 - Ambition to become European leader on (research on) hydrogen
 - Investments in R&D (sustainable and renewable energy)

- Policy note **Energy**

- Industrial processes (chemical, steel industry, ...)

- Sustainable transport

- ❖ Hydrogen, CNG, battery-electric, ...

- Hydrogen for energy storage

- Policy note **Economy & Innovation**
 - Ambition to become European leader in hydrogen technology
 - Importance of research (R&D&I) and valorisation of research in Flanders and beyond
 - Support for demonstration projects related to hydrogen
 - International cooperation

- AIM: **carbon neutral Flemish industry**, by development of market-ready innovative technologies in Flanders by 2040.
- **Strategic Basic Research (SBO)**, (industry can steer & monitor in Advisory board)
- Coordinating organisation is **CATALISTI** (in synergy with other SPC)
- Commitment of **€20 million /year** during 20 years
- **4 MOT's (Moonshot Onderzoekstrajecten)**– 3 projects per domain are being worked out now):
 - 1) bio-based
 - 2) Circularity of carbon in materials
 - 3) **electrification & radical transformation of processes**
 - 4) **energy-innovation**



- ENOVER: the energy consultation between the federal level and the regions
- Working groups relevant for hydrogen:
 - Hydrogen/storage → general hydrogen topics
 - Renewable Energy → RED II discussion
 - Renewable fuels → bio-fuels and ReFuNoBio
- Made an interfederal reflection note on **hydrogen**
 - ✓ Detection of opportunities and bottlenecks
 - ✓ Focus on collaboration between entities
 - **Step up for national policy in hydrogen?**



- Worldwide challenge → worldwide markets
→ worldwide competition
- Importance of international contacts and cooperation
- Example:
 - The Netherlands
 - IEA

- Flanders: VLAIO (Agentschap Innoveren & Ondernemen)
 - Information, advice, support, subsidy, financing, ... for companies in Flanders
 - Generic instruments for all companies
 - Especially interesting for hydrogen:
 - Ecologiepremie
 - Research and development (higher TRL-levels)
 - EFRO, Interreg, ...
 - IPCEI (?)

- Europe
 - ETS innovation fund
 - Connecting Europe Facility,
 - EIB
 - IPCEI (?)



PLASTIC OMNIUM NEW ENERGIES DELTA TECH

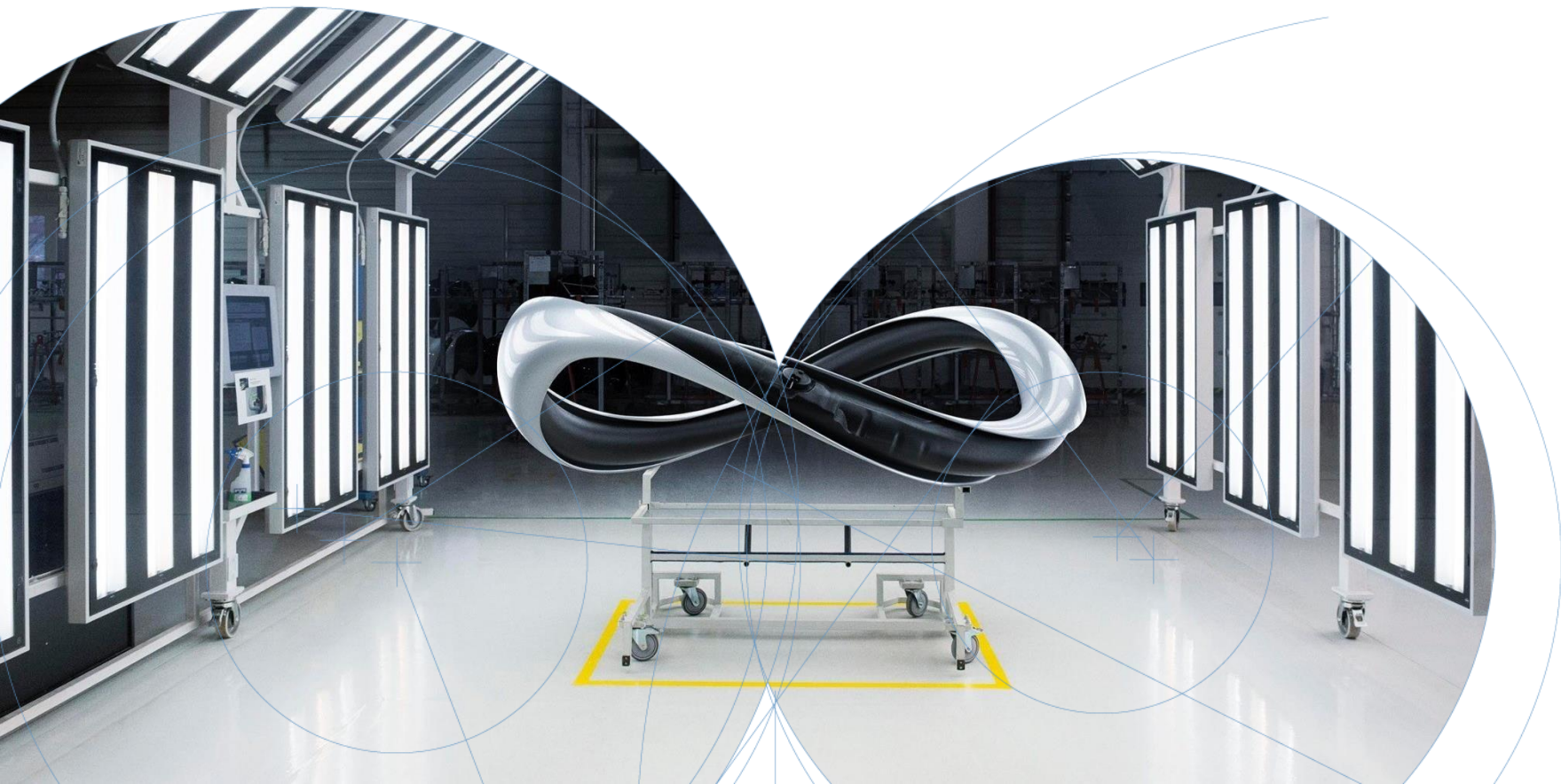
WATERSTOFNET / POWER 2 GAS

GEERT NOUWEN
PO-ZON

BUSINESS UNIT PRESENTATION - NOVEMBER 2019



Company Presentation



A family owned group

INDEPENDENCE

INVESTMENT

INNOVATION

INTEGRATION

INTERNATIONALIZATION





€ 9 Bn Sales
in 2018

**INTELLIGENT EXTERIOR
SYSTEMS**

1 worldwide
1 in 6 vehicles equipped

**CLEAN ENERGY
SYSTEMS**

1 worldwide
1 in 4 vehicles equipped

**HBPO
MODULES**

1 worldwide
1 in 5 vehicles equipped

PLASTICOMNIUMNEW ENERGIES

Development & Production of body components & systems

Lightweighting – Aerodynamics – Design



#1 worldwide with **16%** market share

30 M bumpers produced per year

1/6 vehicle equipped by PlasticOmnium

Assembly of complex modules

Function Integration

HBPO
THE MODULE COMPANY



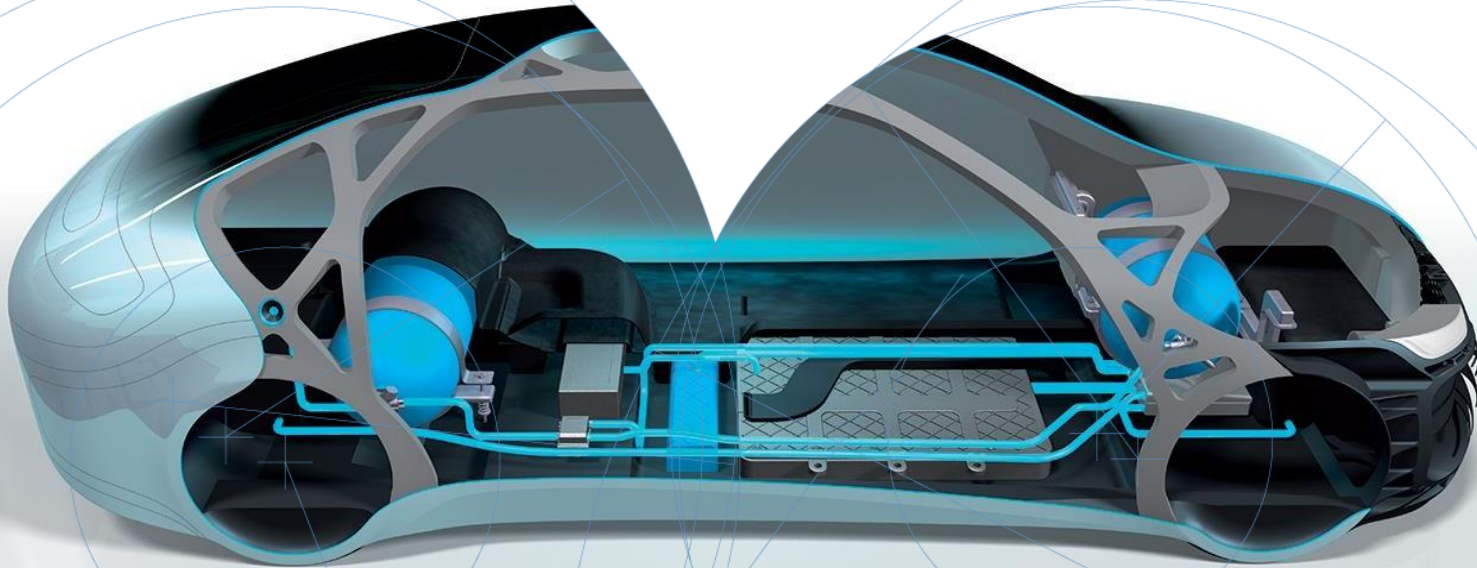
#1 worldwide with **17%** market share

6 M front-end modules assembled per year

1/5 front-end modules assembled worldwide

Plastic Omnium Clean Energy Systems

FOCUS ON CLEAN ENERGY SYSTEMS DIVISION



€ 2,8 Bn Sales
in 2017



36 plants in
19 countries



7 200 employees



6 R&D centers

ENHANCED ENERGY STORAGE

Conventional & pressurized tanks
Smart components
Advanced control strategies



20,2 Mio
produced
in 2017

EMISSIONS REDUCTION SYSTEMS

SCR* systems
Water injection systems
Mechatronic



1,2 Mio
produced
in 2017

NEW ENERGIES

High pressure gas vessels
Hydrogen fuel cells
System management



*Selective Catalytic Reduction



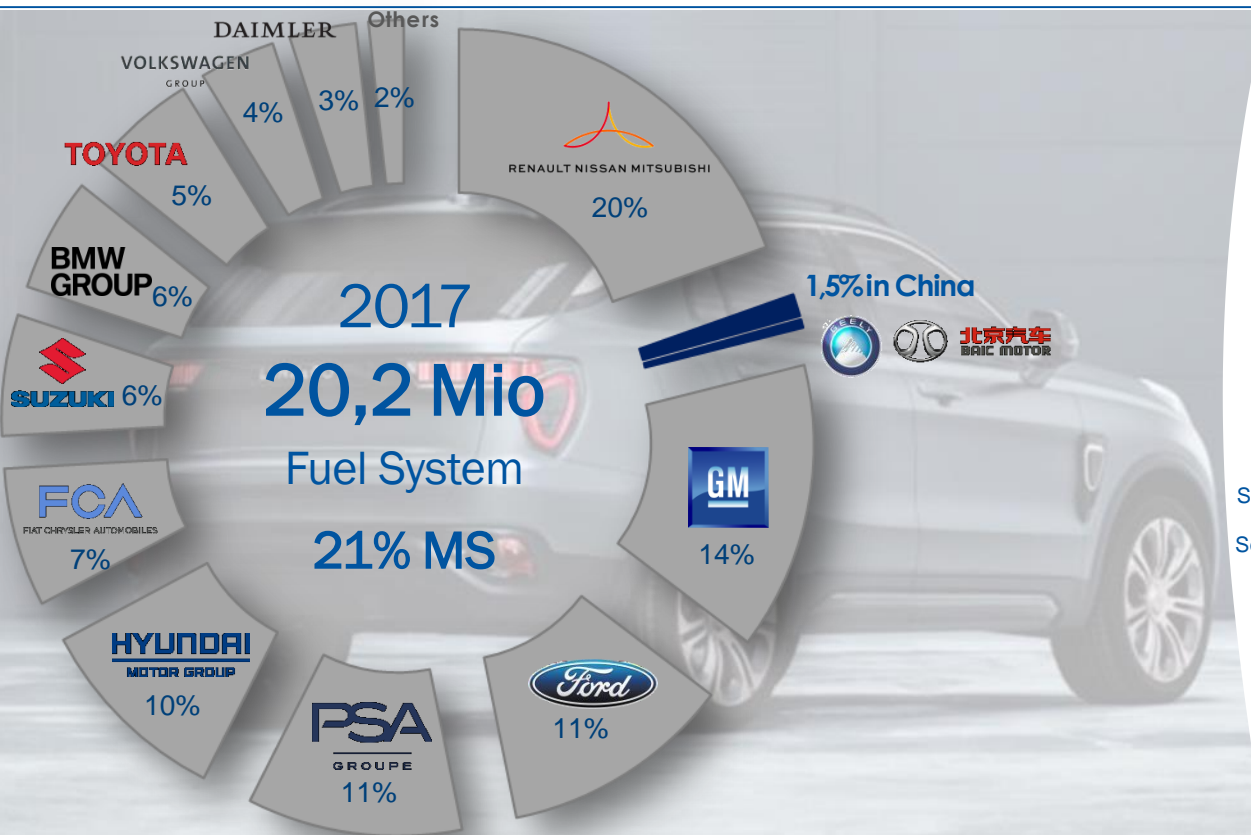
1 in 4 cars
worldwide



our expertise is recognized by more than 54 brands

PLASTIC OMNIUM NEW ENERGIES

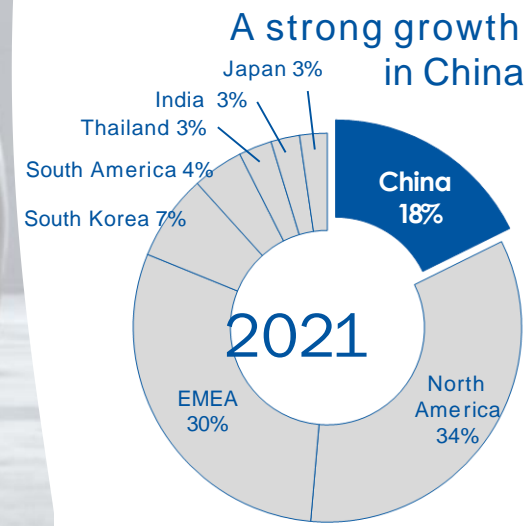
Our customer portfolio



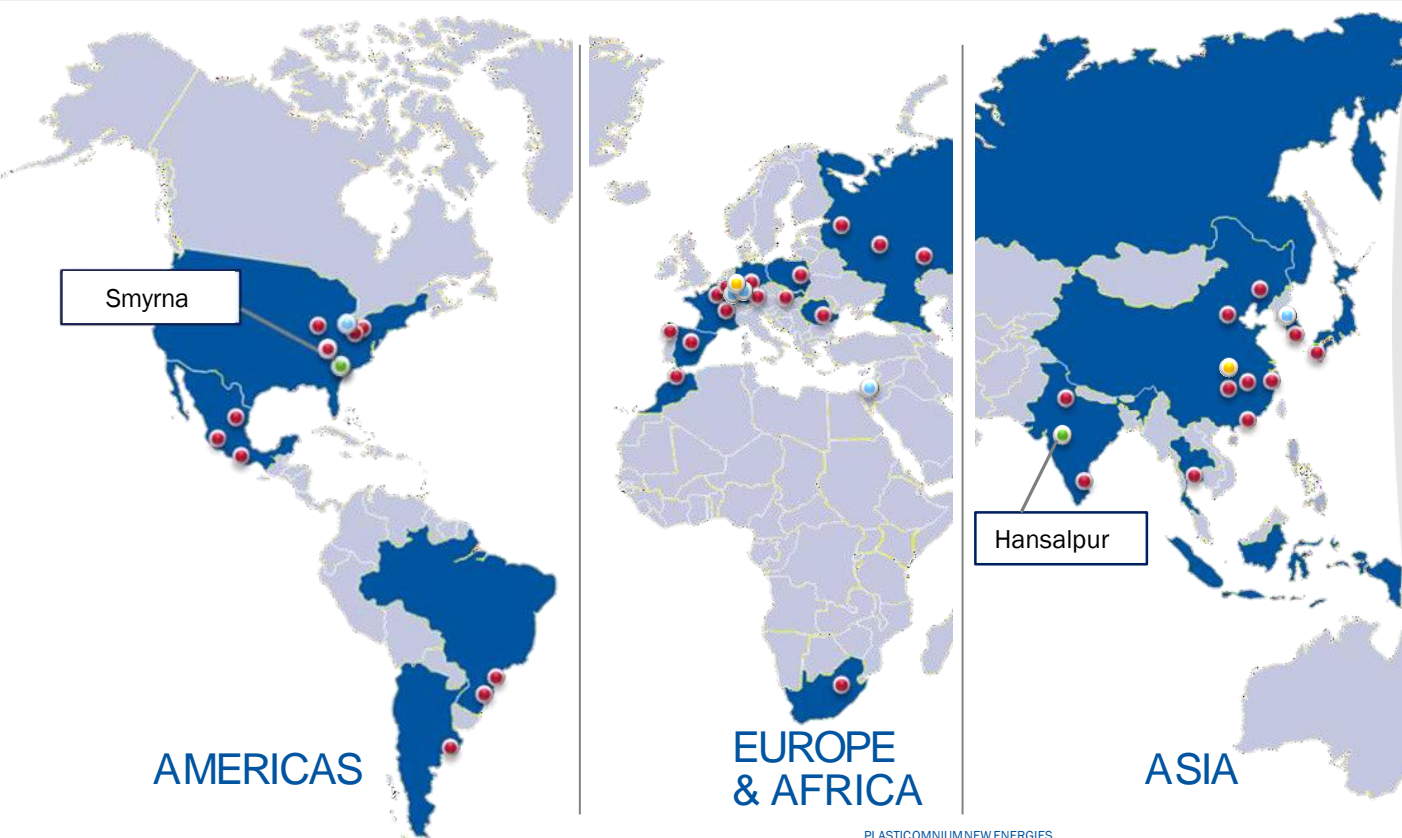
A leader in growing segments

20,2 Mio units

SUV & Pickup	Others
47%	53%



PLASTICOMNIUM NEW ENERGIES



36 plants
19 countries

6 R&D centers
+2 New R&D centers
 ω -Omegatech
 Wuhan, China - 2019
 Δ -Deltatech
 Brussels, Belgium - 2019

+2 New plants by 2018

PLASTICOMNIUM NEW ENERGIES

385

active
patents



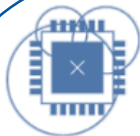
35

recorded
in 2017



1000

R&D
engineers



100

specialists
in mechatronic
& systems

6

R&D Centers

A worldwide network

α-Alphatech
Compiègne, FRANCE



ALPHATECH

Δ-Deltatech
Brussels, Belgium



DELTATECH

ω-Omegatech
Wuhan, CHINA



OMEGATECH

≡ PO-CellTech
Caesare, ISRAEL

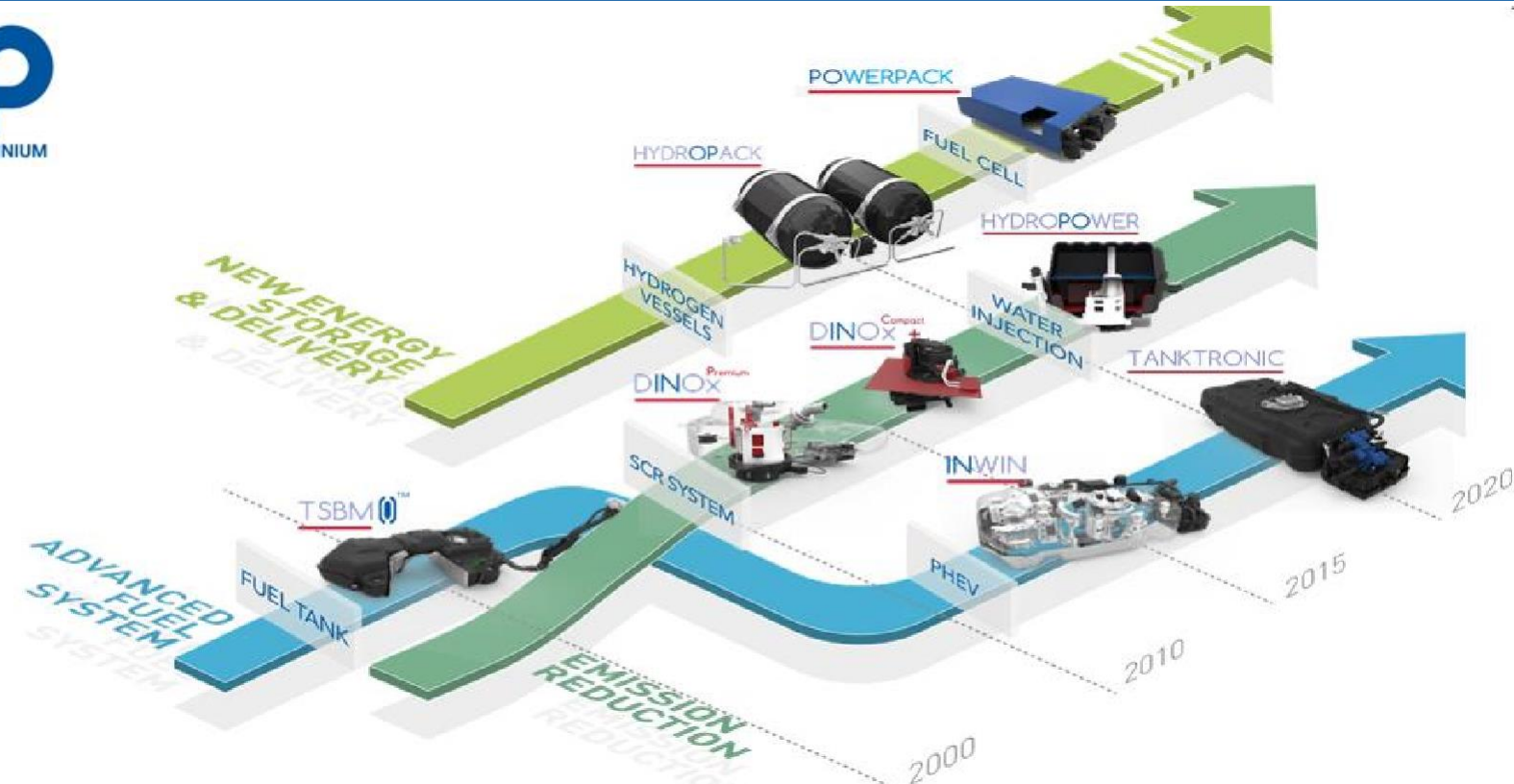


PO-CELLTECH

Tech. centers
Suwon, KOREA
Troy, USA

PLASTICOMNIUM NEW ENERGIES

Innovation roadmap



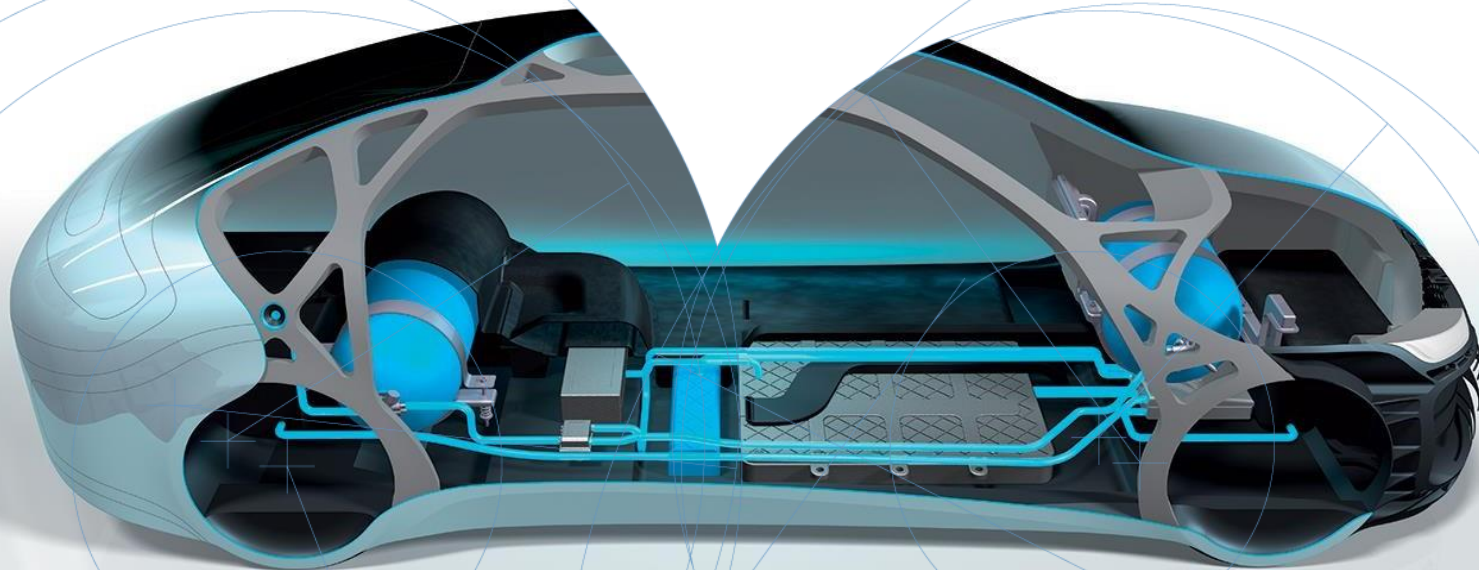
PLASTICOMNIUM NEW ENERGIES

CONFIDENTIAL

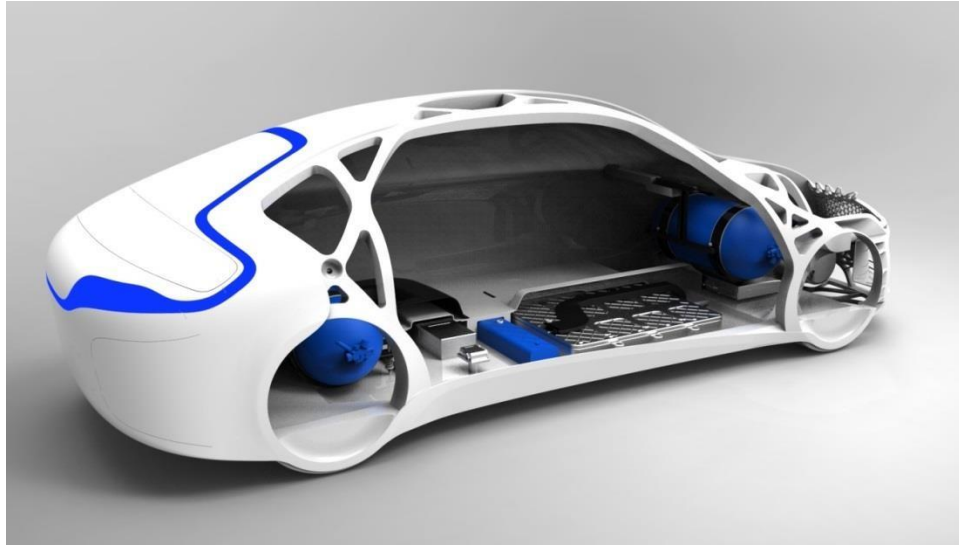


Plastic Omnium New Energies Business Unit

CLEAN ENERGY SYSTEMS



Creation of the « New Energies » business unit



A new business unit to offer the complete system for fuel cell propulsion, including pressurized vessels, fuel cells and balance of plant.

BOOST
INNOVATION
CAPACITY



BUILD OUR
KNOW HOW



AGILE WORKING
METHODS



H



INDUSTRIALIZATION
& AUTOMOTIVE
EXPERTISE



GLOBAL
FOOTPRINT



BOOST
INNOVATION
CAPACITY



Levallois, November 21, 2019,

A significant contract and the first certification of a pressurized tank confirm Plastic Omnium's hydrogen positioning

Plastic Omnium has recently won a significant order from a German manufacturer for the development of 350-bar hydrogen tanks. The contract signed for bus equipment is the largest project in Europe at this time for this type of vehicle.

In parallel to this success, Plastic Omnium has just obtained its first certification for a 700-bar hydrogen storage tank designed to equip passenger cars. The certification, R134, is an international standard that ensures the respect of the strictest specifications of high-pressure hydrogen tanks regulations. Other certifications are underway for 350-bar hydrogen tanks and for CNG tanks.

This contract and this first certification demonstrate the recognition of Plastic Omnium's technological know-how, developed in the field of high-pressure composite plastic tanks over the last four years.

They form a significant milestone in the group's development in new energies, a strategy that has recently been reinforced by the opening of two R&D centers, Δ-Deltatech in Brussels and ω-Omegatech in Wuhan, China, where a pilot carbon filament winding line has recently been inaugurated. In 2020, Plastic Omnium will also install a dedicated production line of hydrogen tanks at its Herentals plant in Belgium, which currently produces fuel tanks. At the same time, the investment in AP Ventures, a venture capital fund based in London and dedicated solely to hydrogen, provides Plastic Omnium with opportunities and interesting choices for the future.

Plastic Omnium, global leader in fuel and emissions control systems, thus confirms its position as a major player in the clean mobility market.

- H2 vessel R134 certification: 80li, 700bar
- H2 vessels: Contract European bus manufacturer: 350bar

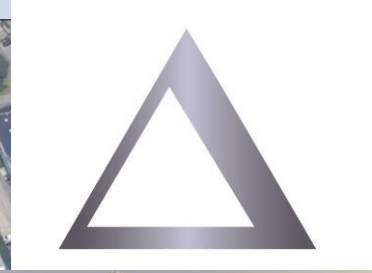
Deltatech –Research Center

CLEAN ENERGY SYSTEMS



A bit of history

- 2011: End of the JV –Inergy becomes 100%PO
- 2012: Decision to leave the Solvay Campus
- 2015: Decision to build a new research center in Brussels.
- 2016: Choice of land Rue de la Fusée
- 2018 (Jan) : Demolition of the existing buildings
- 2018 (Apr) : Start of construction
- 28/06/2019 : Opening
- Sept 2019: Completion of works



2011

2012

2015

2016

2017

2018

2019

10 ACTIVE RESEARCH PROJECTS

Product, Process
Tools & methodology
Fuel systems
Depollution
New Energies

122 PEOPLE

16 Nationalities
43 MSc
17 PhD

MAIN EQUIPMENT

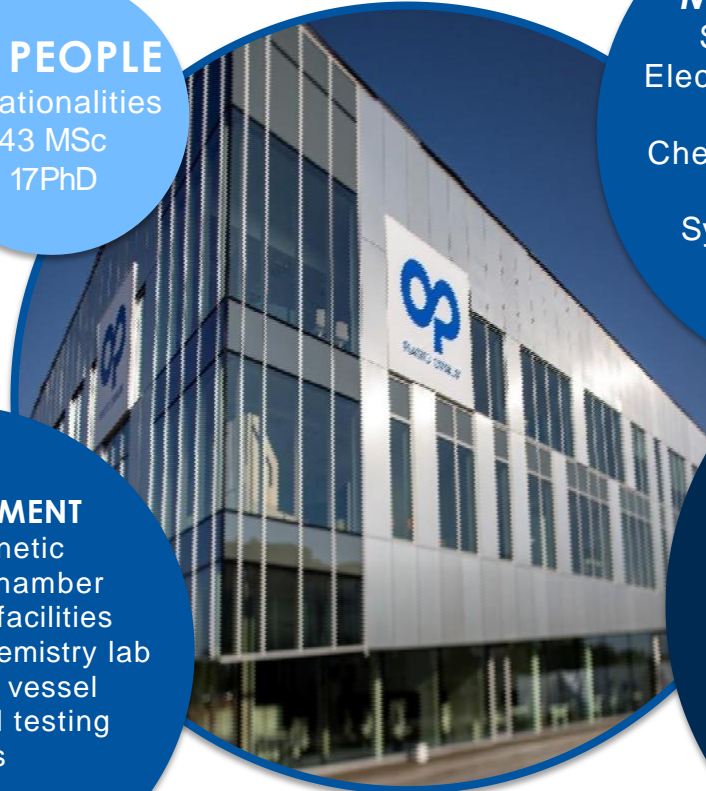
Electromagnetic
compatibility chamber
Fuel Atex test facilities
Chemistry / Biochemistry lab
High pressure vessel
production and testing
facilities

MULTIDISCIPLINARY

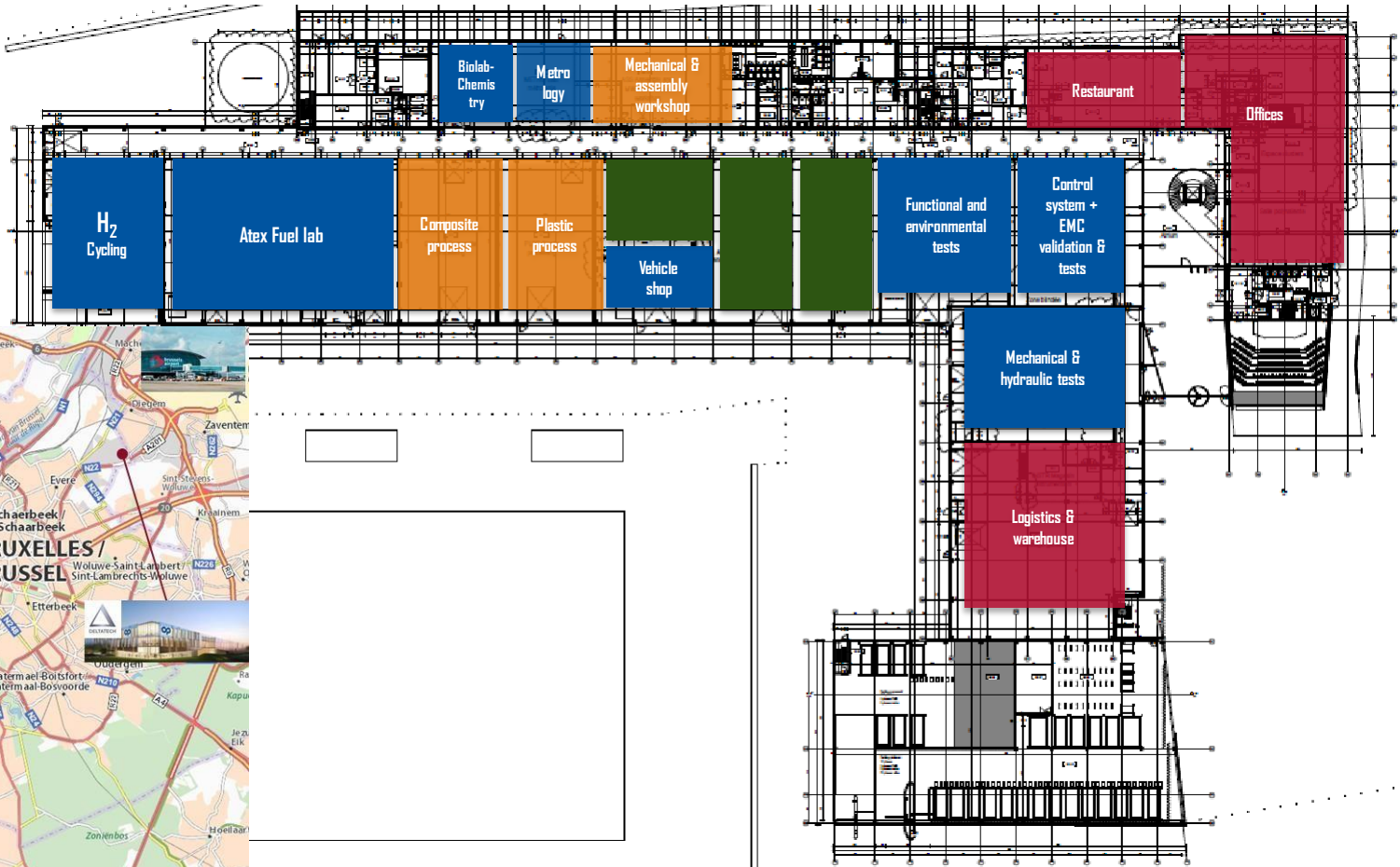
System engineering
Electronics / Mechatronics
Thermodynamics
Chemistry / Bio-chemistry
Materials
Systems & component
modelling

KEY FIGURES

Designed for 200 people
Useful surfaces (lab + shop floor +
offices): 11352 m²
Total surfaces: 15530 m²
2600 m² of photovoltaic panels
< 50M€ investment
Located in Brussels
5 min from Brussels International
Airport
Construction work: Jan 2018 to Sept
2019



Site map



DECEMBER 19

DELTA TECH - RESEARCH PRESENTATION

CONFIDENTIAL





- New robotic production line for research purpose.



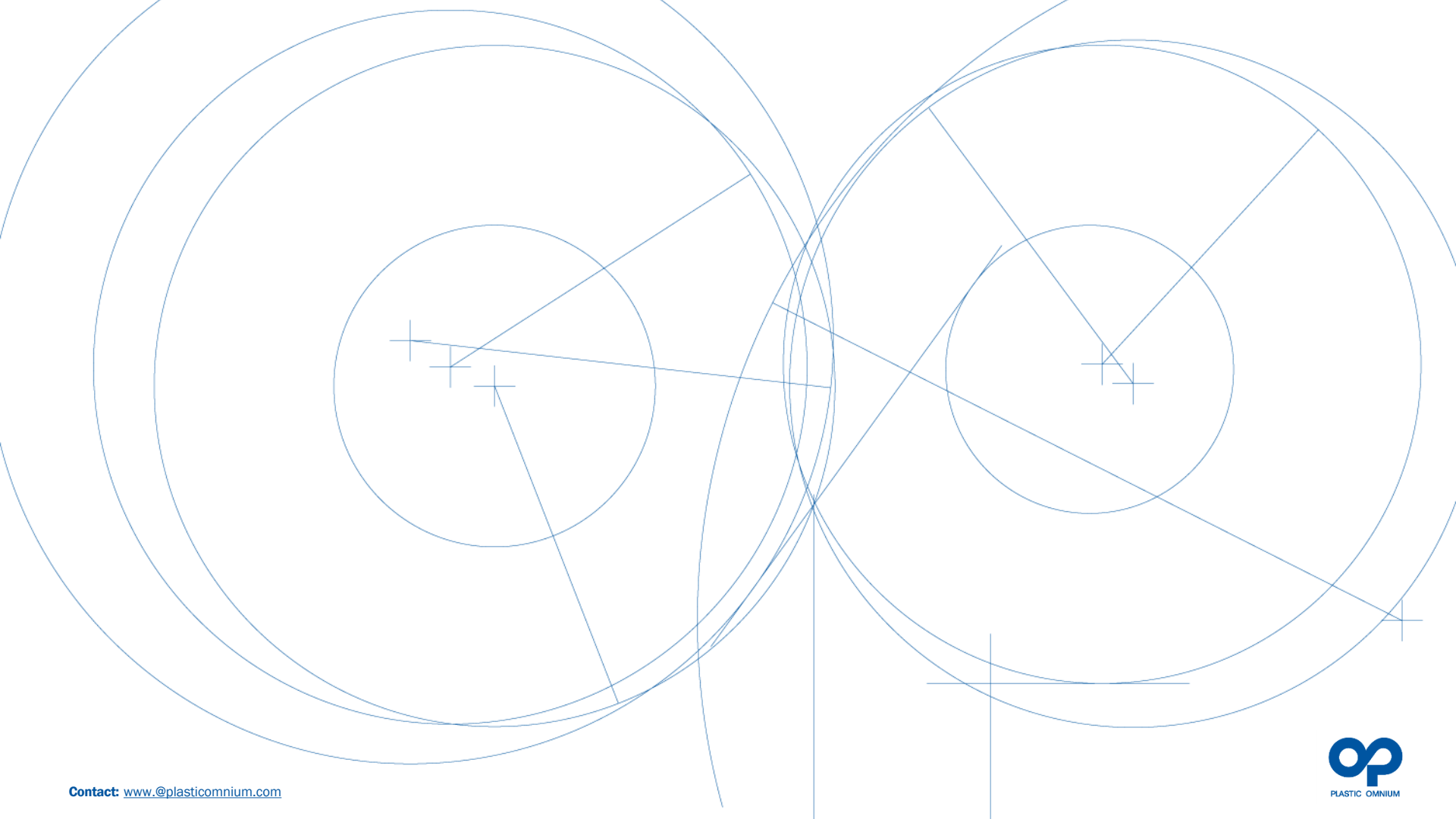
- Proof tests 1050 bar
- burst tests 2000 bar
- Temp hydraulic cycling 1050 bar
- High speed camera



- EOL tightness test of (vessel+valve)
- Sniffer test @ 700 bar
- Helium or test gas (5% H₂ + 95% N₂)



- Hydrogen cycling bench 875bar
 - Permeation tests on vessels
 - Buckling analysis on vessels (TPRD opening)



13.30-14.30: Discussion hydrogen storage (*University of Antwerp and Solenco Power*)

14.30-15.00: Hydrogen policy and contacts with the government (*WaterstofNet*)

15.00-16.00: Projects presentation from cluster members (*Port of Antwerp, E-trucks and WaterstofNet*)

- Pitch
 - Ludovic Laffineur (University of Antwerp)
 - Sven Duchatelet (Solenco Power)
- Aim of the discussion
 - Knowledge sharing
 - Identification of common bottlenecks
- How can the cluster help in making progress?
 - Need for dedicated workforce in the cluster?
 - Sources of information? Other partners?



Waterstofnet 04/12/19

University of Antwerp (general)

- Young, dynamic ecosystem embedded university
- Ranked **18th** in the *QS university rankings*[®] of universities under 50 years, **worldwide 2020**
- Staff (data 2019):
 - > 20,000 students
 - > 5,900 employees
- **>3600 scientific publications yearly**
- Received the European Commission quality label **“HR Excellence in Research”**



Antwerp as an innovation ecosystem for green Hydrogen

- ❑ 2nd large chemical cluster worldwide →
- ❑ 2nd large European port →
- ❑ Heart of economy and innovation →
- ❑ Strong collaboration with Port, City and industrial parties such as CMB



Blue gate +
Antwerp
Maritime
Campus (MCA)



HYDROVILLE

First passenger ship on
Hydrogen (compressed)
built by CMB

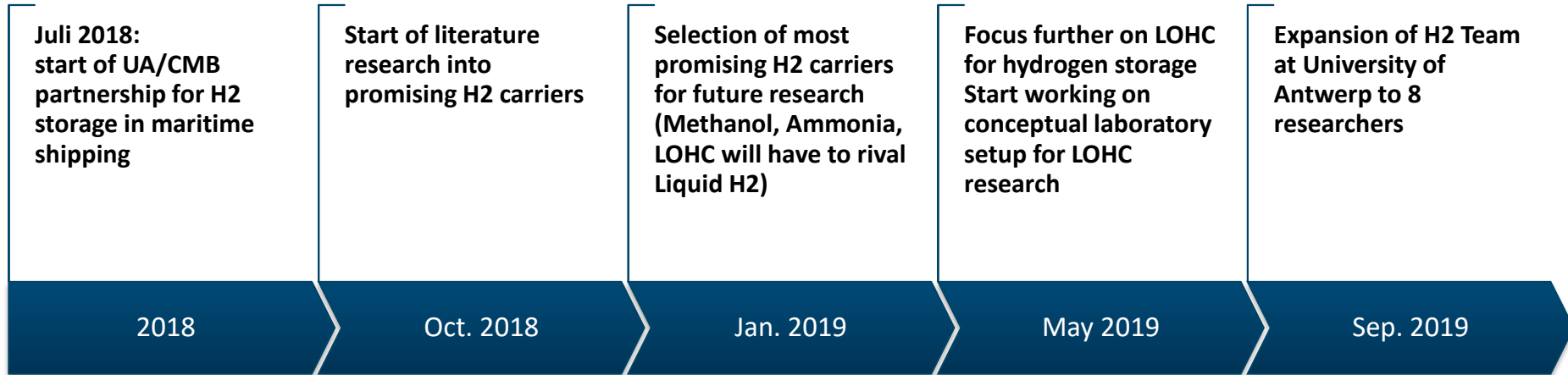
HYDROTUG
First tugboat on
hydrogen (compressed)
built by CMB



Progress of H₂ research at DuEL →



Sustainable Energy,
Air & Water Technology
University of Antwerp



OVERVIEW

...courtesy of  **CMB**

Hydrogen
Storage
Process

Hydrogen
Release
Process

CO₂ –
Emissions

Storage,
stability &
durability

Safety &
Transport
Operations

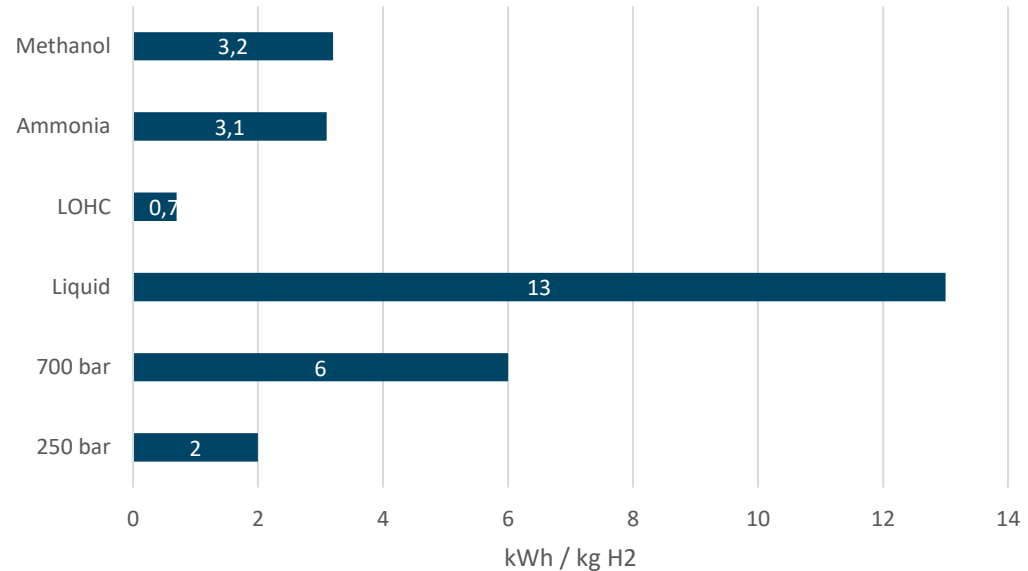
Round – trip
efficiency

H₂ Storage Processes

- Density of H₂ at STP:
0.08988 kg m⁻³
→ 3.02 kWh m⁻³
- Energy Density of Diesel:
→ 10 080 kWh m⁻³

⇒ To be of practical use H₂ has to be processed further to increase the density
This processes requires further energy

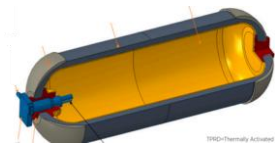
Energy Requirements for H₂ storage



H₂ Storage Processes

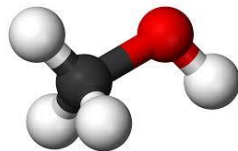
- Compression

- 250 bar – steel cylinder
1.7 wt. % & 592 kWh / m³
- 700 bar – composite cylinder
5.7 wt. % & 1372 kWh / m³



- Liquefaction

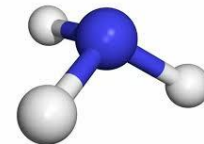
- - 253 °C – isolated tank
2352 kWh / m³



- Ammonia

- Haber – Bosch process
$$\text{N}_2 + 3 \text{H}_2 \rightarrow 2 \text{NH}_3$$

17.6 wt. % & 4128 kWh / m³



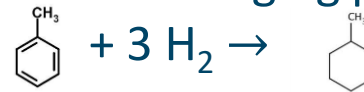
- Methanol

- CO₂ – reduction process
$$\text{CO}_2 + 3 \text{H}_2 \rightarrow \text{CH}_3\text{OH} + \text{H}_2\text{O}$$

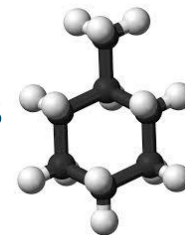
12.5 wt. % & 4324 kWh / m³

- LOHC

- LOHC – charging process



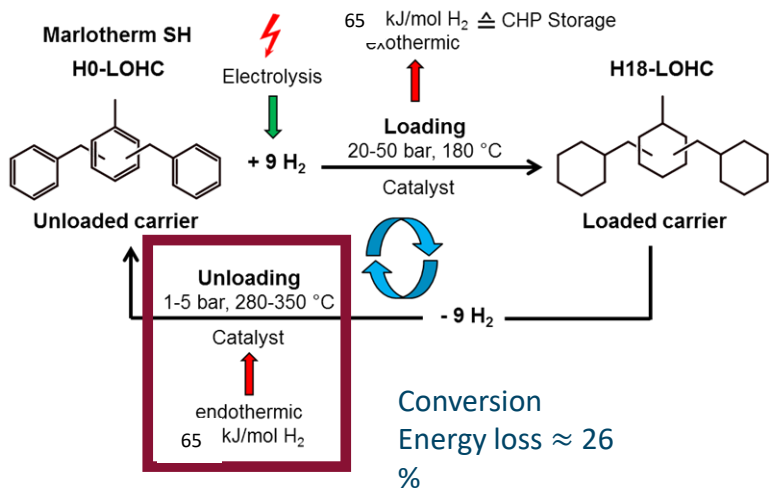
6.2 wt. % & 2010 kWh / m³



Release Process

- To release H₂ from the carrier energy is needed (endothermic processes)
- Challenges in reactor design, catalyst development and heat management
- Research Focus at University of Antwerp

LOHC



Ammonia

- NH₃ bad fuel properties (narrow flammability, low flame speed)
 - pilot fuel required = H₂
- Cracking NH₃ to give a NH₃ – N₂ – H₂ mixture
 - proper tuning characteristics
- 2 NH₃ + HEAT → N₂ + 3 H₂
- Reaction does not require 100 % conversion in NH₃ engines
- NH₃ PEM FC pollutant, 100 % conversion required
- Conversion energy loss ≈ 14 %

CO₂ – Emissions

- No end point CO₂ – emissions from
 - H₂ : Compressed / Liquid
 - LOHC
 - NH₃

- Methanol: CH₃OH

- Combustion reaction:



$$\text{LHV} = 5.45 \text{ kWh / kg}$$

- CO₂ emissions: 0.25 kg CO₂ / kWh \approx value for Diesel

\Rightarrow CO₂ emissions cannot be reduced by using methanol

Using H₂ as a fuel only has environmental benefits if the production is green:

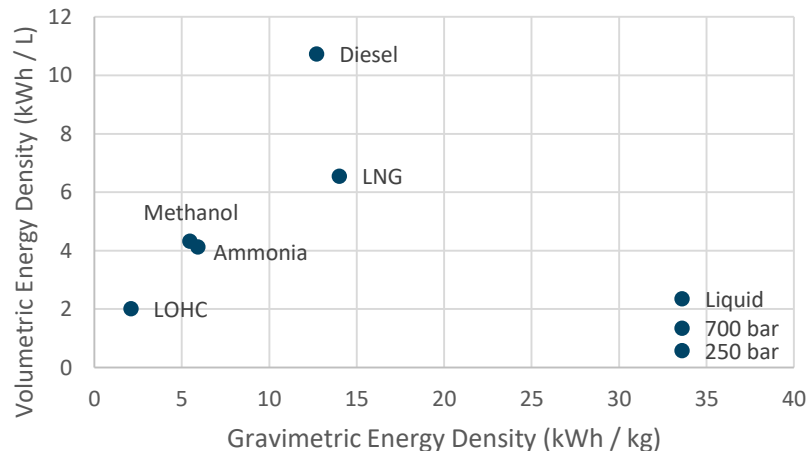
H₂ generation from NG produces 40% more CO₂ per kWh compared to Diesel

Storage: Efficiency, Stability and Durability

Overall: Volumetric Energy Density of H₂ can never reach fuel density of Diesel

- **Stability:**
 - H₂ stored in chemical carriers
→ stable products
 - Liquid H₂
→ 0.1 % boil – off per day
 - Compressed H₂ tanks
→ long operating life time

Theoretical Storage Capacities of H₂ carriers



Safety and Transport Operations

Hazards with storage

- Compressed H₂:
designed to be safe in all normal conditions (keep away from high T)
- Liquid H₂:
- 253 °C liquid → cryogenic hazards
- Ammonia:
Toxic gas
- Methanol:
Toxic liquid, low BP
- LOHC (DBT)
Risks ≈ Diesel

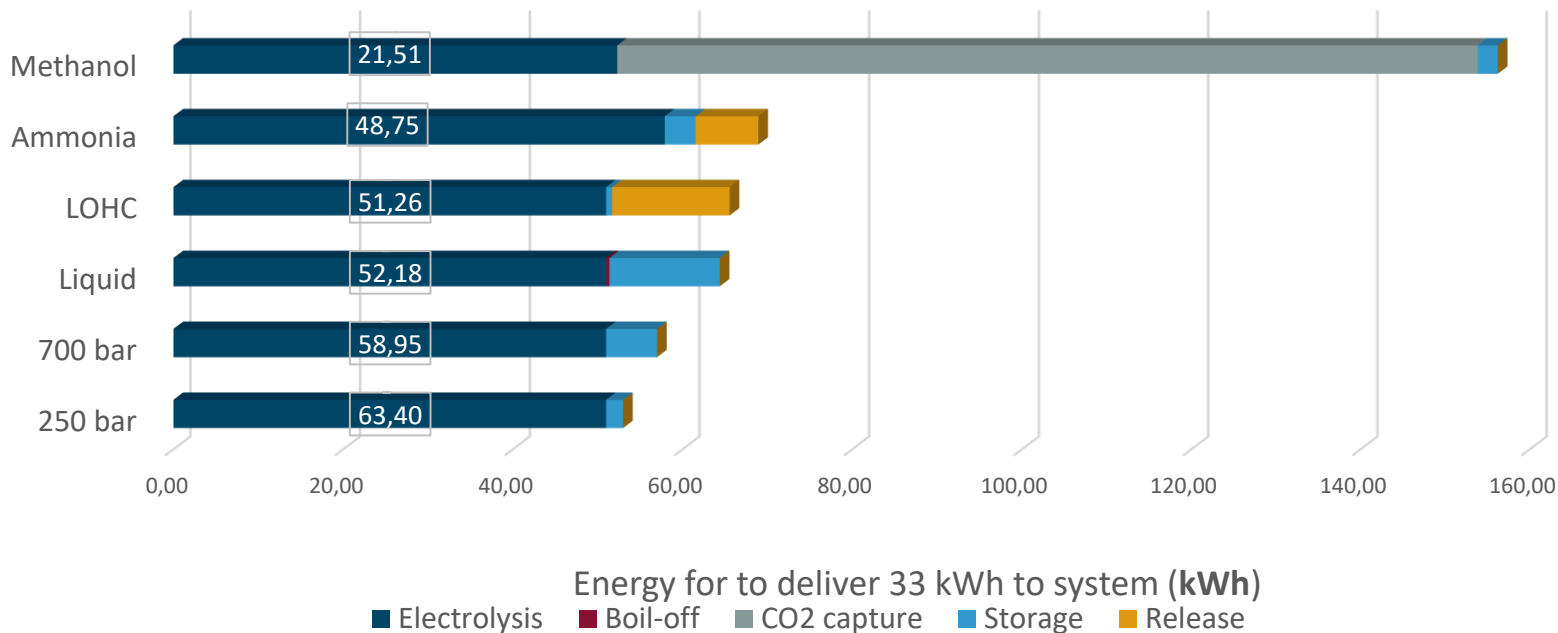


Large scale transport of H₂

- Existing maritime transport of
 - Ammonia
 - Methanol
- Liquid Hydrogen ship under development by Kawasaki Heavy
- Compressed H₂
 - Small testing ships
- LOHC
 - Yacht under construction

Conclusion: Round trip efficiency

Energy requirement to supply 33 kWh to ICE / FC



33 kWh = 1 kg of H₂

	UNIT	Liquid	Compressed (750 bar)	Ammonia	Methanol	LOHC
Energy Storage on land	kWh / kg _{H₂}	6 - 15	1	2 – 4	1.3 – 1.8	0.7
Global Availability	Globally Stored Ton H ₂ Per Day	300		~ 72 000	2	R&D phase
Energy Release on board	% of LHV	/	/	~ 13	~ 7	~ 27
Temperature for H₂ Release	° C	/	/	> 450	220	290
CO₂ capture needed	N.A.	No	No	No	YES	No
Low Flashpoint fuel	N.A.	Yes	Yes	Yes	Yes	NO
Storage conditions	N.A.	- 253 °C	250 bar	10 bar & RT / 1 bar & - 33°C	Ambient	Ambient
Bunkering Operations	N.A.	Cryogenic	Pressurized system	Stringent counter measures vs spills required	Depends on CO ₂ handling	Off-loading of spent fuel required



Waterstof opslag
Voor residentiële toepassingen

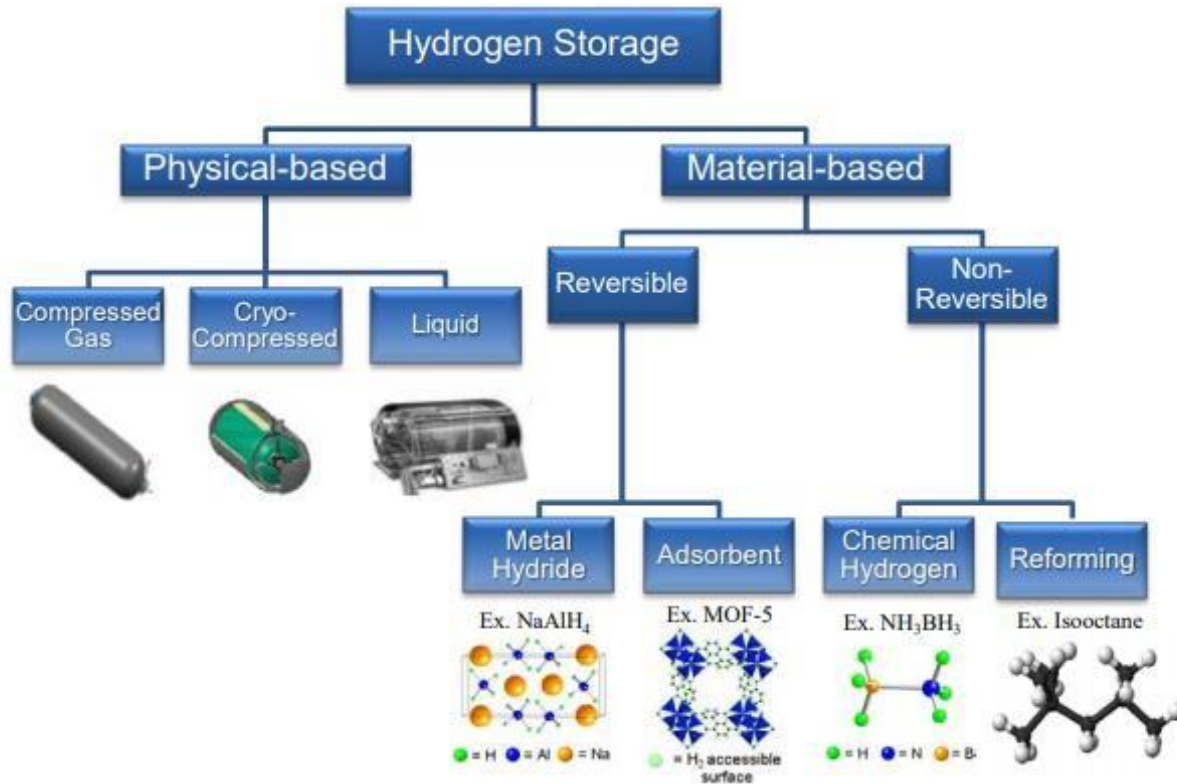


Table 2. Projected Performance of Hydrogen Storage Systems ^a				
Hydrogen Storage System	Gravimetric (kWh/kg sys)	Volumetric (kWh/L sys)	Cost (\$/kWh; projected to 500,000 units/yr)	Year Published
700 bar compressed (Type IV) ^b	1.4	0.8	15	2015
300 bar compressed (Type IV) ^b	1.8	0.6	13	2013
Cryo-compressed (500 bar) ^c	2.3	1.4	18	2017
Metal Hydride (NaAlH ₄ /Ti) ^d	0.4	0.4	43	2016
Sorbent (MOF-5, 100 bar, HexCell, LN ₂ cooling) ^d	1.3	0.7	15	2016
Chemical Hydrogen Storage (AB-liquid) ^d	1.5	1.3	17	2016
2020 Target Values	1.5	1.0	10	N/A
2025 Target Values	1.8	1.3	9	N/A
Ultimate Target Values	2.2	1.7	8	N/A

Footnotes to Status Table:

^a Assumes a storage capacity of 5.6 kg of usable H₂

^b Based on Argonne National Laboratory performance and Strategic Analysis cost projections^{16,18}

^c Based on Argonne National Laboratory performance and Strategic Analysis cost projections^{19,20}

^d Based on Hydrogen Storage Engineering Center of Excellence performance projections²¹



[Hydrogen](#), [Infrastructure](#), [Storage](#)

China on track to increase production of hydrogen fuel-cell vehicles by 53% in 2019

By [Liu Yuanyuan](#) | 11.25.19

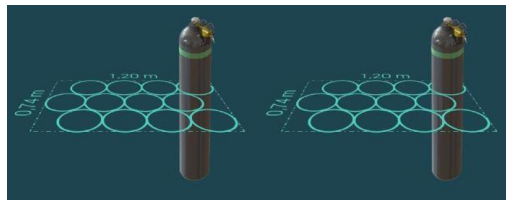


China produced 1,170 hydrogen fuel-cell vehicles during the first half of 2019 and the country's automakers are on schedule to produce 2,340 hydrogen fuel-cell vehicles this year, compared to 1,527 such vehicles in 2018, and 629 in 2016 and 2017. Over the recent years, the country's hydrogen fuel-cell vehicle sector experienced very rapid growth, posting an annual growth rate exceeding 100 percent for several consecutive years. With the ongoing build out of the infrastructure and roll-out of the subsidy policy by the central and many local governments, the country is forecast to continue to see positive growth in production volume of the vehicles over the next several years.



NETfficient: metaalhydrides of compressed?





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HYDROGEN POLICY AND CONTACTS WITH THE GOVERNMENT



AGENTSCHAP
INNOVEREN &
ONDERNEMEN



POWERTOGAS
Industry Cluster Flanders

Samen voor sterk innoveren

- Overview pending EU and national policies/plans related to hydrogen
 - EU
 - Green Deal
 - Renewable Energy Directive (II) as part of Clean Energy for all Europeans
 - Gas Package
 - National policies
 - National Energy and Climate Plan (NECP)
 - Study Flemish Energy Agency
 - Intentions of the Flemish governments: H2 plan?
 - Cluster contacts with the cabinets/administration



Done 2019:

- **REDII implementation in Belgium** (policy paper; April 2019)
- **Memorandum on hydrogen** (May 2019)
- **National Energy & Climate Plan** (Recommendations July 2019)

Running:

- **Visit(s) to administration/cabinets**

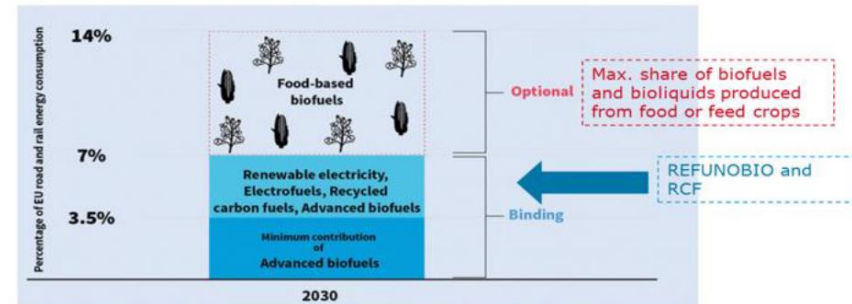
on H2 plan for FL/(B)

- EU is adopting a series of directives and EU regulations affecting the climate and energy landscape for the period 2021-2030: **Green Deal**
- Clean Energy Package for all Europeans, Clean Mobility package and a Gas package
- Goal: climate-neutral Europe by 2050



- REDII: defines the renewable energy objectives to be reached in the power, heat and transport sectors towards 2030
 - ✓ a number of legal provisions that can stimulate hydrogen in the transport sector
 - ✓ Hydrogen could realise significant part of RES-T target (10%) in Belgium
 - Need for regulatory framework for Hydrogen and e-Fuels
- Multipliers different for H2 versus electricity
- Delegated acts concerning accounting

Methodology of ReFuNoBio's expected by end of 2021



RENEWABLE ENERGY DIRECTIVE II

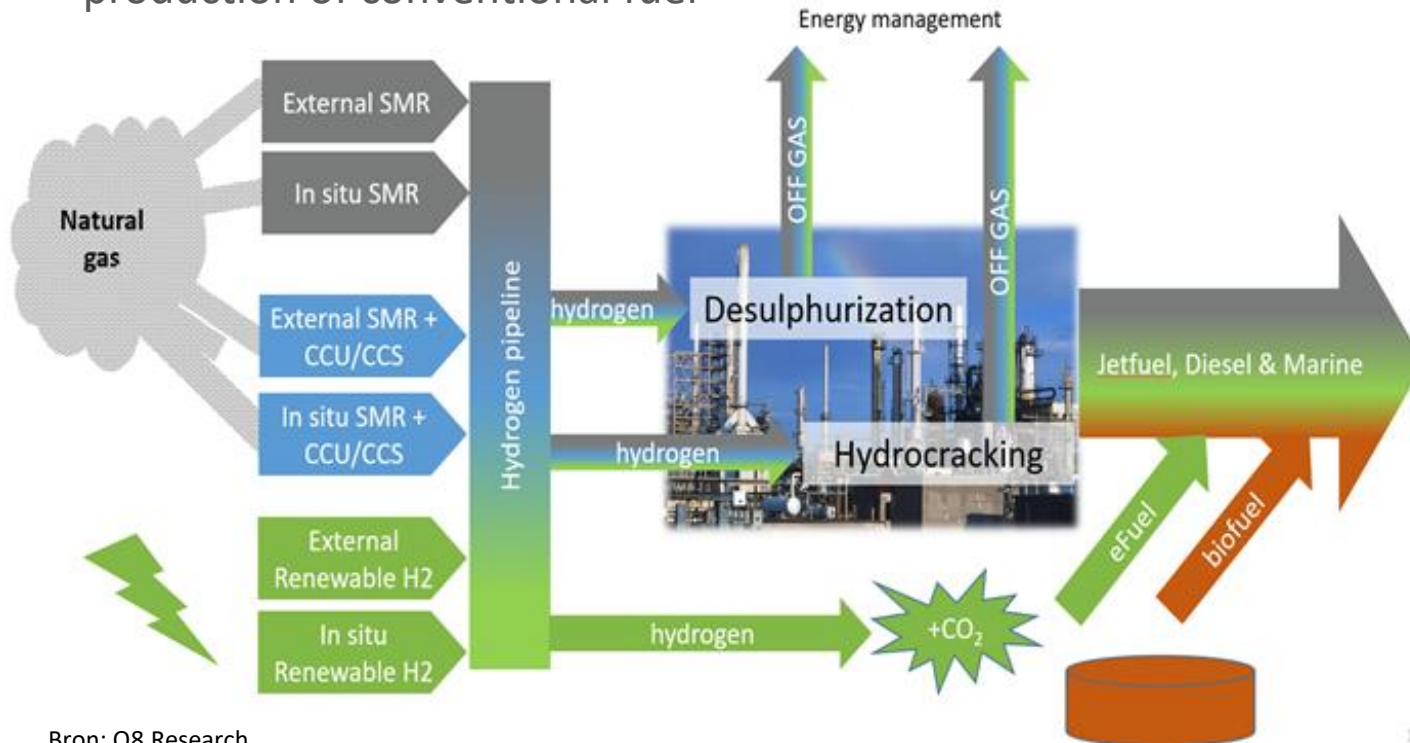


AGENTSCHAP
INNOVEREN &
ONDERNEMEN



Samen voor sterk innoveren

- H2 can count towards the RES-T target also when used as intermediate products for production of conventional fuel



- EU is working on Gas Package
- Decarbonisation strategies for the gas sector in 2030 and 2050
- Legislative framework for
 - Production and storage of renewables in the form of hydrogen
 - Injection of H₂ in the natural gas grid
 - Construction and expansion of H₂ grids
- Expected in 2020
- First stakeholder meeting in November
- Needs watching on Belgian/Flemish level



- Member states to submit final plans by 31 December 2019 to the European Commission
- Hydrogen in the federal National Energy and Climate Plan (draft)
 - **Hydrogen mentioned a lot and for different applications**
 - **BE needs to increase renewable energy share**
 - **BE needs to set ambition in transport higher**
- No targets, goals or quantitative plans for H2
- **Hydrogen needs a specific framework for implementation**

- Flemish Energy Agency: study to determine ‘priorities for green hydrogen’ performed by Dirk Meire
- Finalised in October with follow-up with stakeholders on 21/11/2019
- Main conclusions:
 - Green hydrogen as feedstock for industry
 - Heavy duty applications
 - Lack of renewable energy means general low potential for green hydrogen
 - Need for import



- Main comments from WaterstofNet
 - Lack of ‘hard conclusions’ for different hydrogen applications
 - No roadmap for hydrogen implementations
 - No recommendations towards policy
 - No sense of urgency or any link with national or European goals/policies
- Formal reaction by 7/12
 - Send us your input!

- Has ambition: “We hebben de ambitie om Europese koploper te worden in onder meer waterstof” (coalition agreement)
- Realised & ungoing hydrogen projects
- Ideal test hub:
 - Active companies
 - hydrogen / natural gas network
 - Ports
- But... moderate climate goals and no H2 plan?



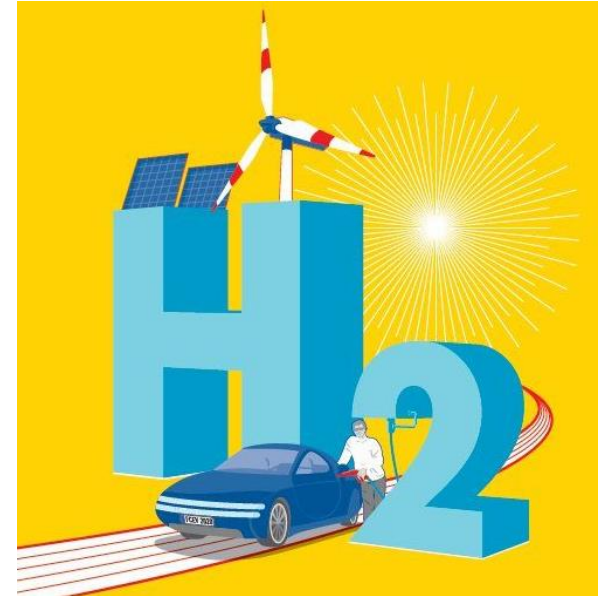
- H2 plan for Flanders
 - Both short and long term vision
 - Actual goals for different H2 applications in different time perspectives
 - Can help to realise climate and energy goals
 - Can be a framework for other legislative challenges
 - H2 plan = stable base for companies to invest
 - Study work is done



- Bottom line: **need for H2 plan**, cfr, neighbouring countries:
- **NL**
 - Hydrogen program in climate agreement
 - Funding € 30-40 million for pilot projects
- **Germany**
 - Nationalen Innovationsprogramms Wasserstoff- und Brennstoffzellentechnologie: 1,4 billion euro until 2026
 - Nationale Wasserstoffstrategie at the end of the year
- **France**
 - Plan hydrogène with targets: 5 000 hydrogen cars, 200 heavy duty applications and 100 fuel stations
 - Funding: 100 million euro yearly until 2024

- Administrations:
 - **VEA** (Flemish Energy Agency) – 25/11/2019
 - Hydrogen must be part of clean energy policy
 - Renewable energy important for green hydrogen projects
 - **VLAIO** (Flemish Agency for Innovation and Entrepreneurship) - TBD
 - Support for demonstration projects
 - Hydrogen calls
 - CAPEX support

- Cabinets:
 - MP Jan Jambon (N-VA) 6/12
 - General policy: “leading H2 region in EU...”
 - Foreign Policy: collaboration with NL, ...
 - Zuhair Demir (N-VA) 6/12
 - Energy: H2 plan, climate goals,...
 - Environment: Permits H2 infrastructure, ...
 - Hilde Crevits (CD&V) 18/12
 - Economy: hydrogen calls, CAPEX support, ...
 - Innovation: demonstration projects, ...
 - Matthias Diependaele (N-VA) - TBD
 - Finance: traffic taxation
 - Lydia Peeters (Open VLD) – TBD
 - Mobility: Bus project De Lijn



Projects presentation from cluster members

Port of Antwerp, E-trucks and WaterstofNet

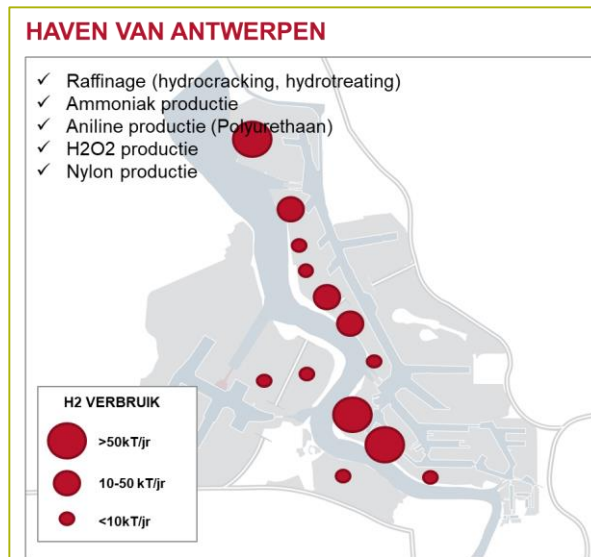
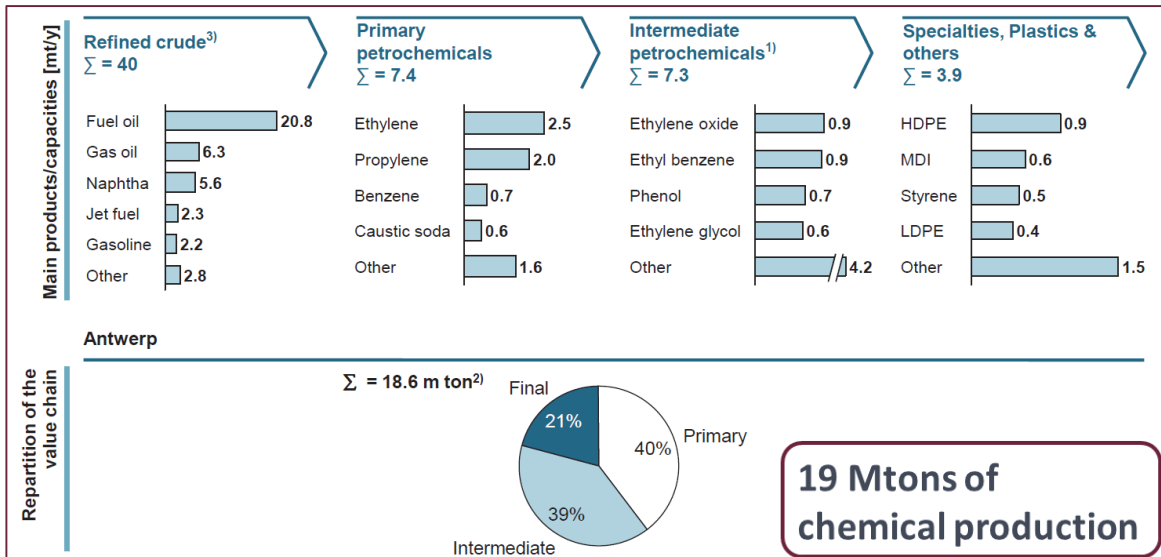
Port of Antwerp Waterstof-importcoalitie



Port of
Antwerp

PoA as an energy interface

Relevant 'H' port numbers



40 Mtons primary distillation capacity

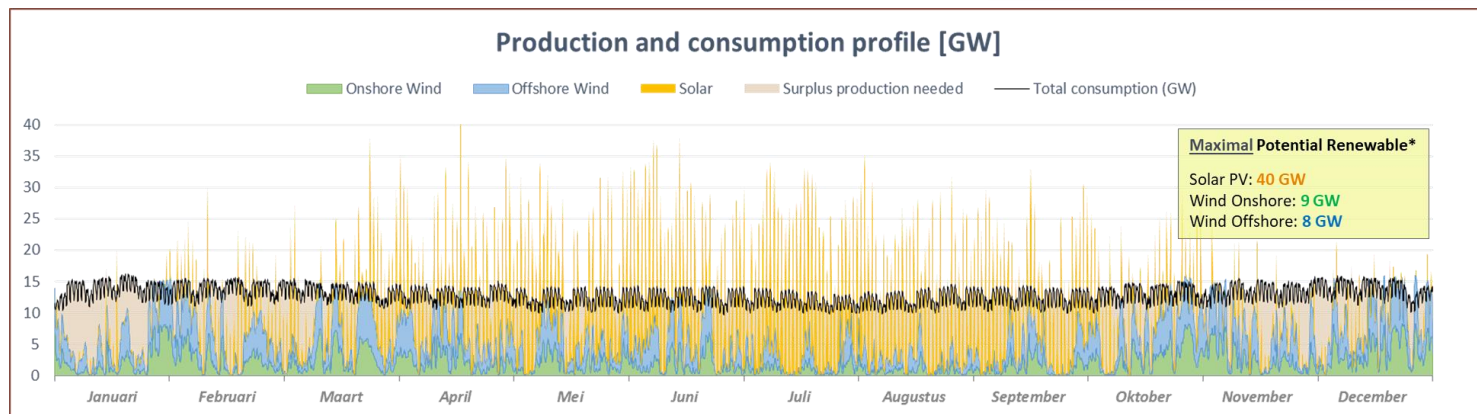
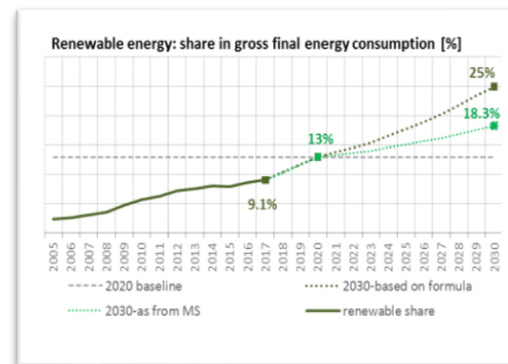
6,5 Mtons of bunker fuels: nr 5 bunker port WW

Ca. 400kTa of Hydrogen gas used

287 MW of RE installed and growing Mainly wind

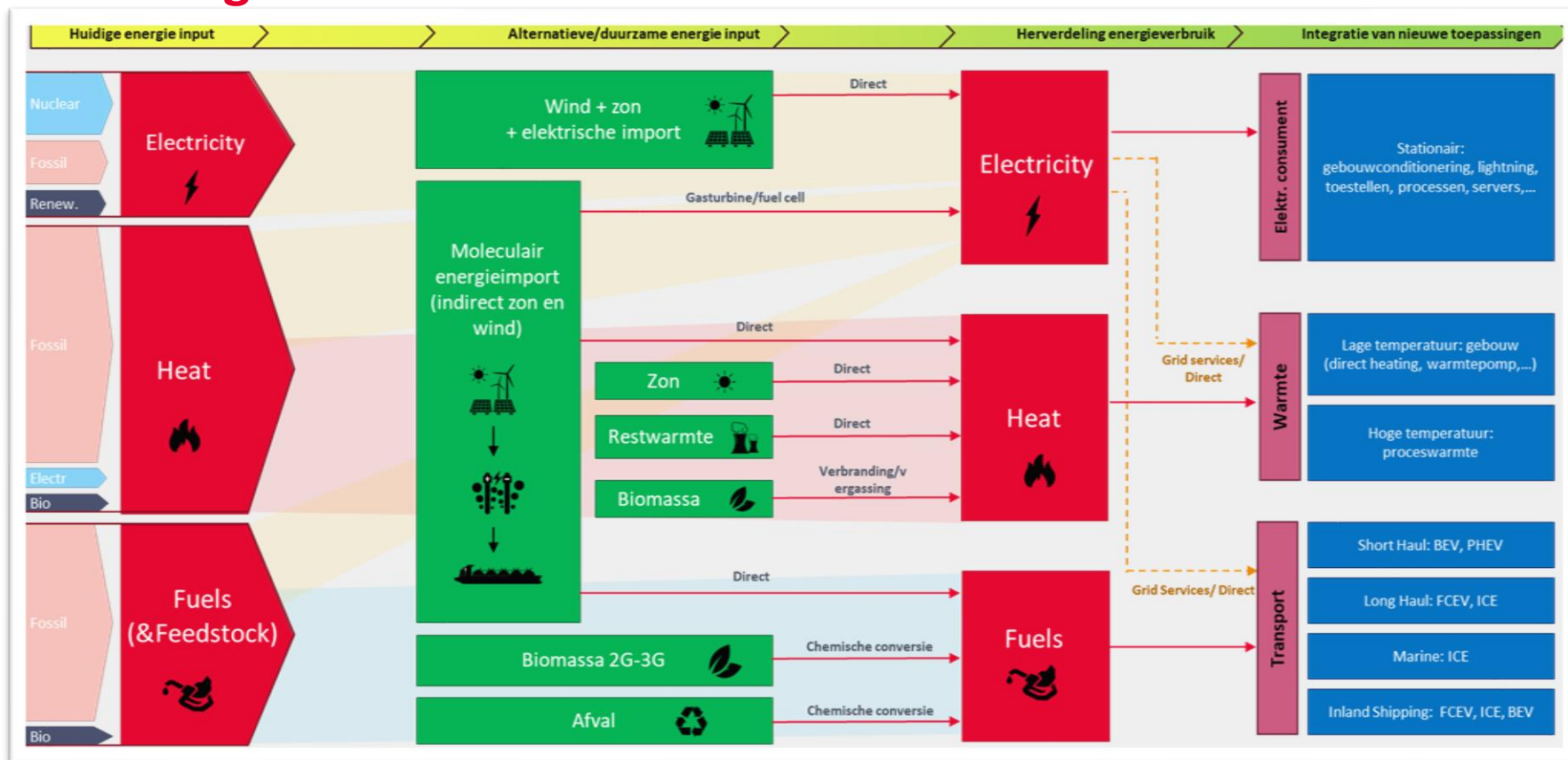
Potential of domestic H2 production (>2050 scenario?)

Bron	Vermogen [MWe]	Geraamd Energievolume [GWh]
WKK-STEG	1070	9100*
Windturbines	188	412**
Zon (PV)	58	52
Biomassa	42	340***

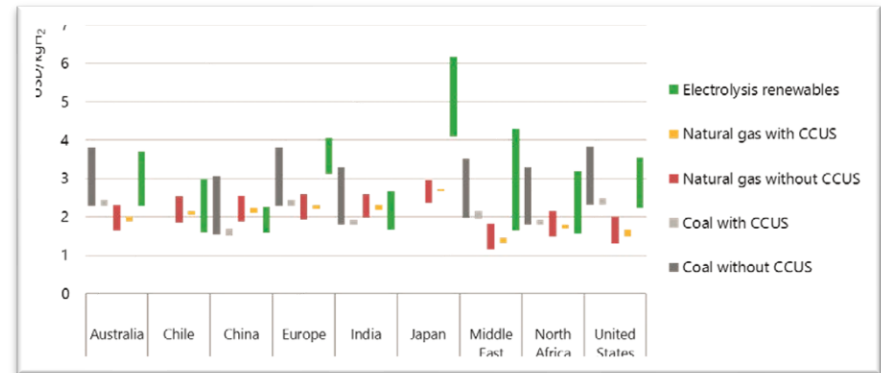
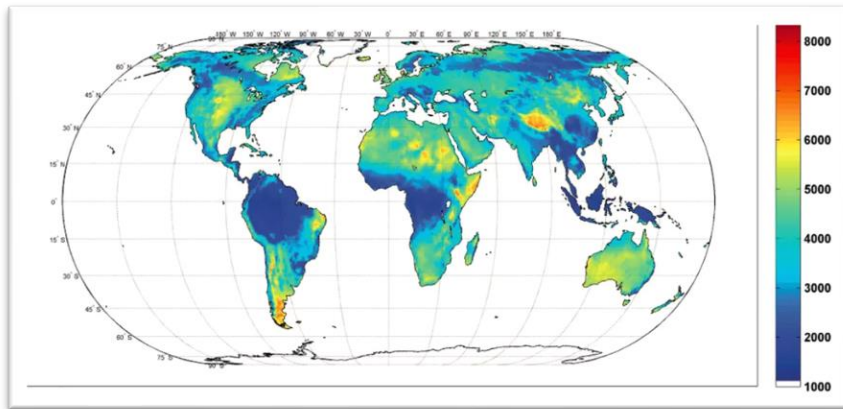
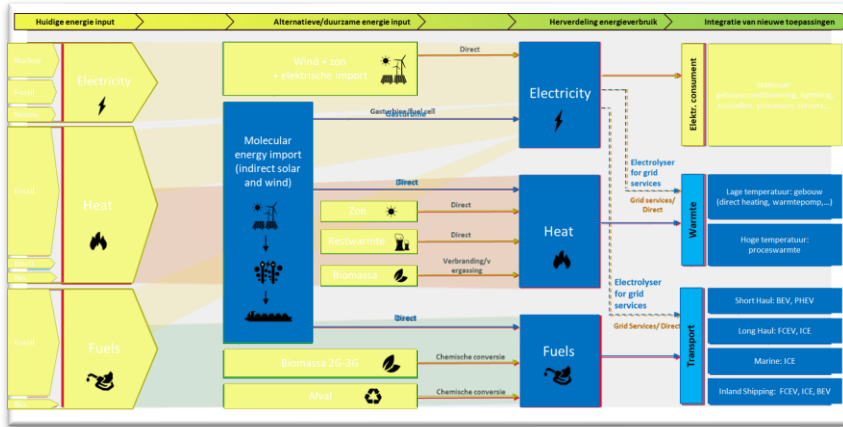


*source: Elia: Electricity scenarios for Belgium towards 2050, November 2017

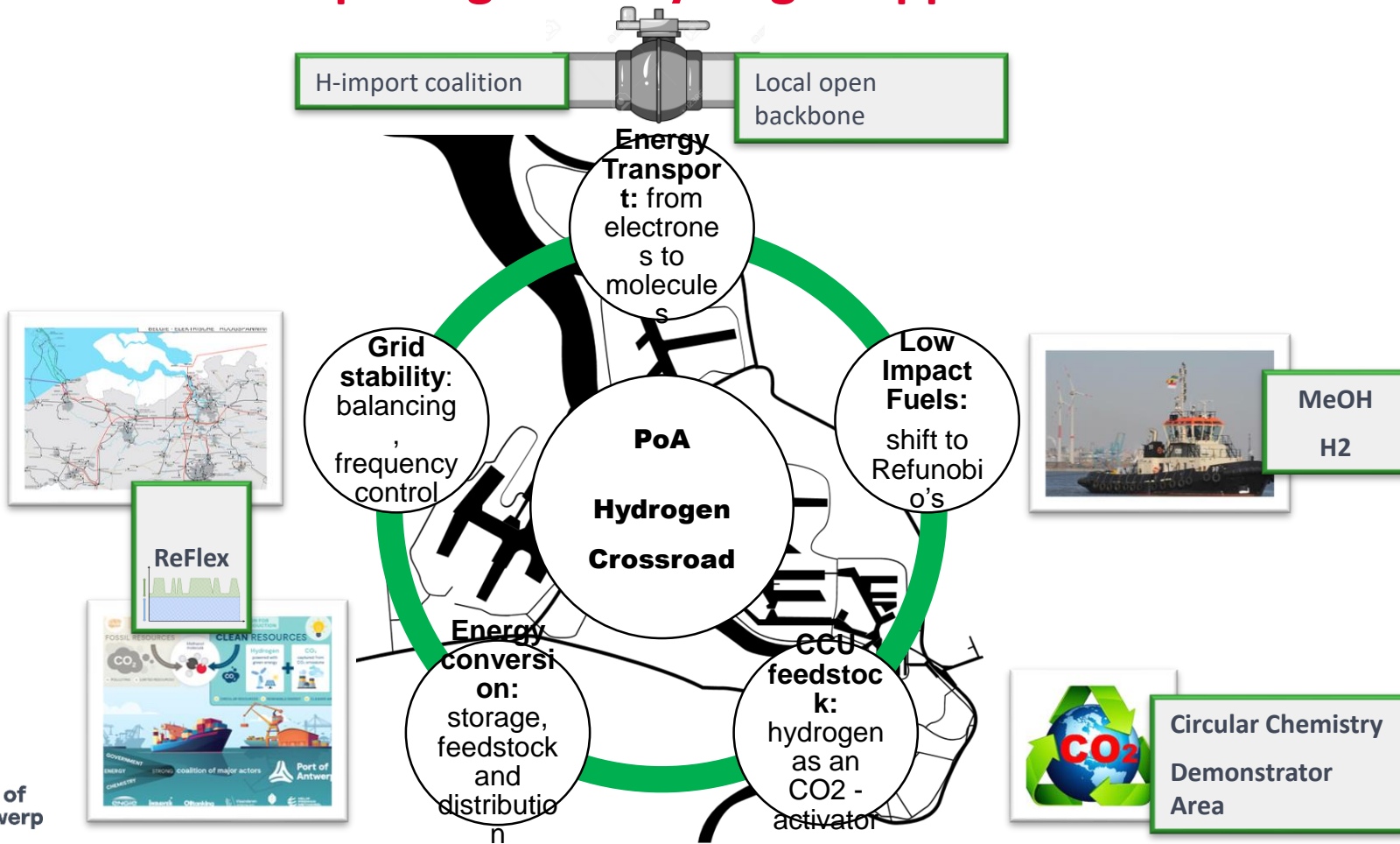
De energietransitie – verwachte evoluties



The Energy and Feedstock Transition General Outlook

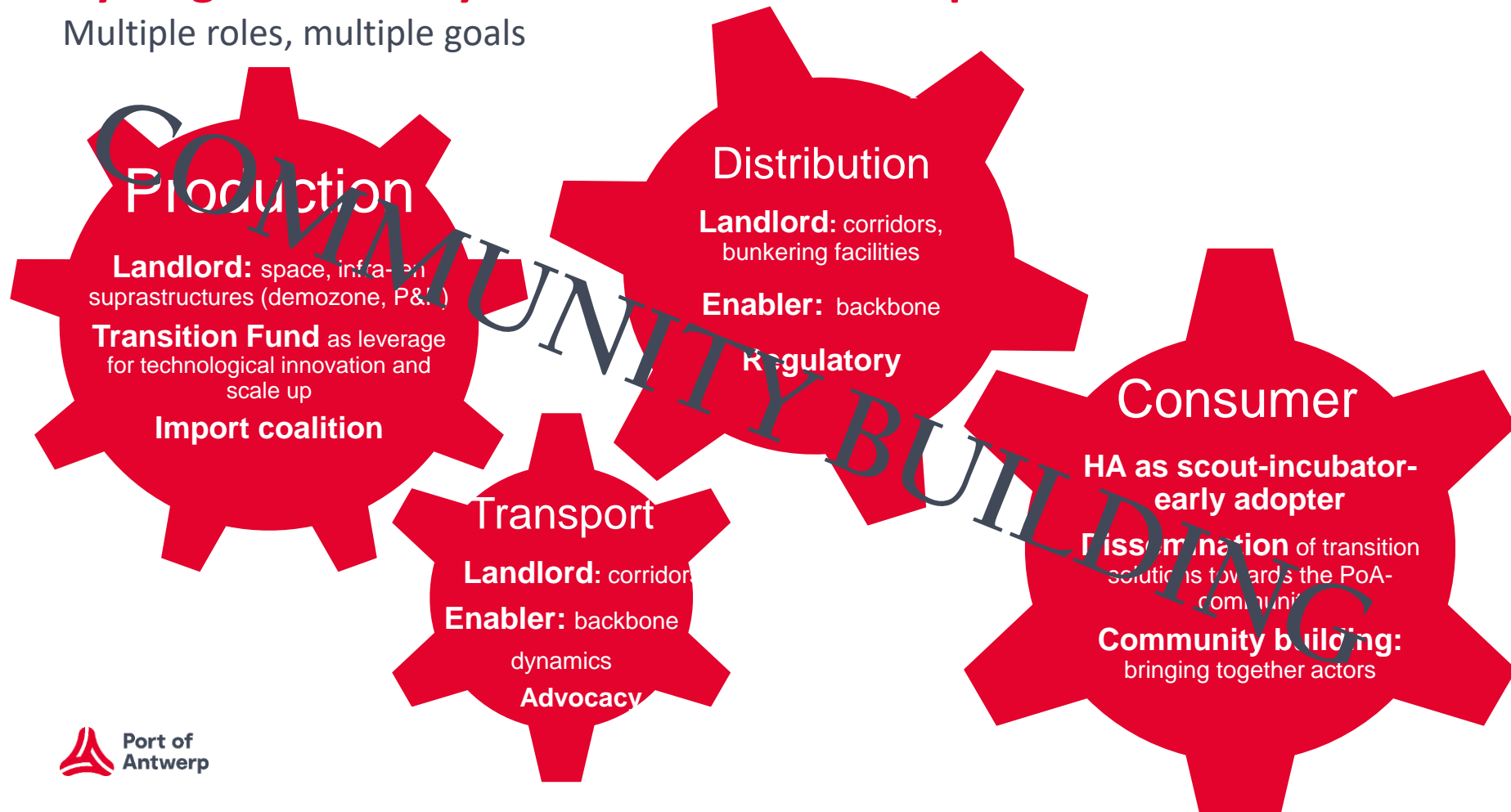


The Port of Antwerp integrated Hydrogen approach



Hydrogen Economy in the Port of Antwerp

Multiple roles, multiple goals



Luik 2 – scope samenwerking

Voorstel aanpak

Bepalen drager: van longlist (H_2 - CH_4 - CH_3OH - LOHC - NH_3 - ...) naar shortlist

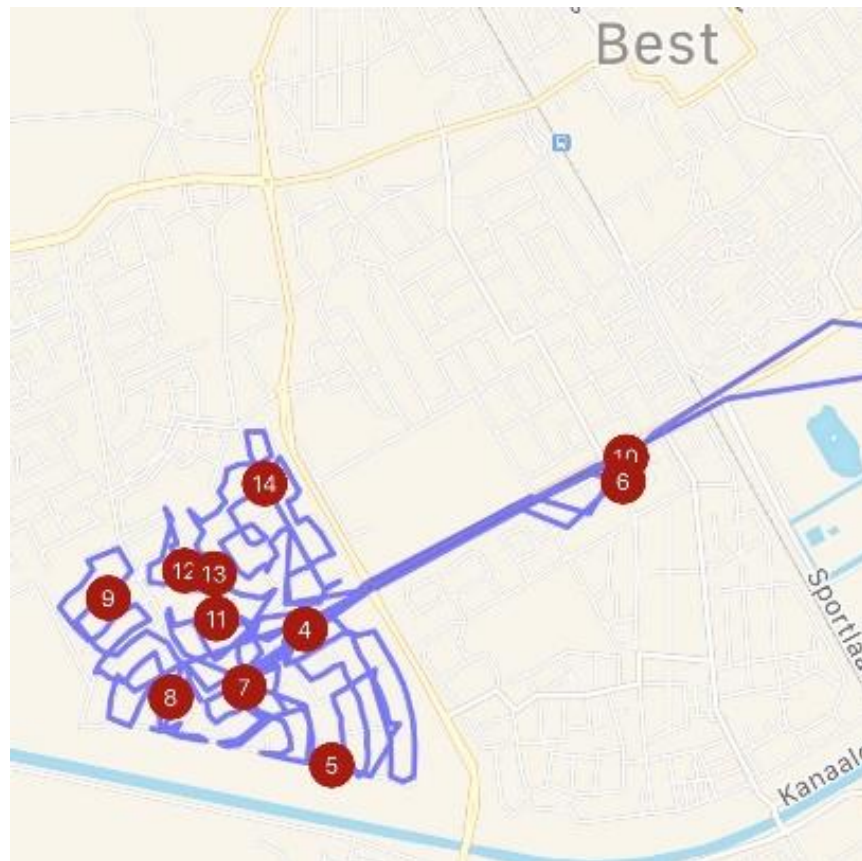


Component	Production high LF RE Electrolysis	On shore transport	Terminalling/ Carrier shift	Shipping	Terminalling / Regasification	Pipeline transport	Use cases
Basis analyse	Analyse literatuur + eigen know how		Analyse literatuur + eigen know how	Analyse literatuur + eigen know how	Analyse literatuur + eigen know how	Analyse literatuur + eigen know how	Analyse literatuur + eigen know how
Deliverable	LCOH (sel. carriers), constraints		LCOH (sel. carriers), constraints	LCOH (selected carriers), constraints	LCOH (selected carriers), constraints	LCOH (selected carriers), constraints	LCOH LCOE LCOF, constraints

Opstellen en bewaken overall business case

Regulatory and policy











Projecten: aanvraag en realisatie

Adwin Martens
WaterstofNet

Brussel, 4 december 2019

Inhoud

- Traject van aanvraag tot indiening
- Uitvoering



Aanvraag tot indiening



- Definieer wat bedrijven/overheden willen, waar ze zelf in willen investeren en waarvoor subsidie nodig is

voorbeeld:

bouw van een 1 MW fuel cell plant op restwaterstof

bouw van een aantal tankstations in Vlaanderen/Nederland

opvolg project voor 2 vuilniswagens op waterstof

- Identificeer logische/complementaire key-spelers, die willen samenwerken en willen investeren

voorbeeld:

1 MW plant Solvay/Umicore/Nedstack

stations: Shell, PitPoint, DATS24,.....

vuilniswagen: E-Trucks,...

Aanvraag tot indiening



- Identificeer geschikt en financieel passende subsidieprogramma:

voorbeeld:

1 MW-plant : demonstratie, Vlaamse/Nederlands **Interreg VI/NL**
5 M€ past

stations : uitrol – infrastructuur – member states **CEF-TEN-T**
project tussen 10 – 20 M€ past

vuilniswagens: demonstratie 2 voertuigen in praktijk in vergroening
afvalsector: **Life**
project tussen 2 – 4 miljoen euro past

timing: voortdurend open of calls met deadlines

Aanvraag tot indiening



- Optimaliseer project naar doelstellingen subsidieprogramma (overleg):
voorbeeld:
 - 1 MW-plant : demonstratiewaarde – aanbestedingstechnisch ok
 - stations : 3 landen maakt het sterker: Benelux, real life trials
 - vuilniswagens: 2 duidelijke klanten + demonstraties in meerdere landen (NI, B, D, I)
- 3 A4's, die logisch moeten zijn, die draagvlak hebben en die moeten passen:
 - projectbeschrijving
 - partners
 - budget
- Logisch, duidelijk projectvoorstel tijdig indienen

Aanvraag tot indiening



- Goedgekeurd na variërende voorbereidingstijd van

1 MW-plant : Waterstofregio, o.a. 1 MW fc plant

1 jaar

stations : H2Benelux 8 stations, 80 auto's in 3 Benelux

2 jaar

vuilniswagens: Life&GrabHy: 2 vuilniswagens in 5 steden

2 weken

Uitvoering



- Uitdagingen:
 - technologisch
 - subsidie impliceert vaak 'omgaan met bureaucratie (aanbestedingen, uurregistratie,...)
 - nieuwe projecten impliceren vaak lange trajecten voor vergunningen/keuringen/.... (één van de redenen van subsidie)
 - risico-volle projecten met zichtbare resultaten worden gewaardeerd
 - je kunt een 'track-record' opbouwen in subsidie-kanalen met als voordeel:
 - je leert zelf en weet waar je aan begint
 - je volgende ideeën worden met aandacht