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# ROADMAP STUDY POWER-TO-GAS (PTG) IN FLANDERS

## Final results

## Presentation for Congres Waterstofregio 2.0

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# POWER-TO-GAS ROADMAP FOR FLANDERS IN A NUTSHELL

- Duration: 14 months (01/10/2014 - 31/01/2016)
- Funding : Flemish Region, Belgium



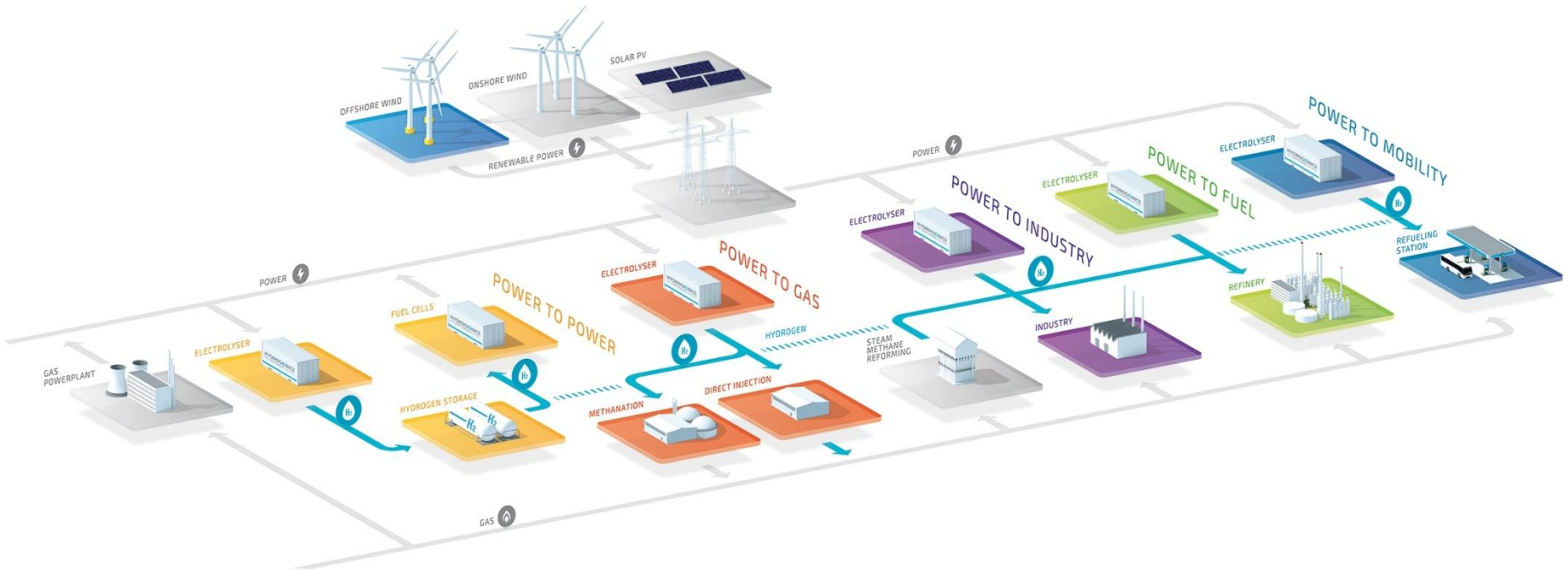
- Project partners:



- Coordinator: Hydrogenics

# POWER-TO-GAS ROADMAP FOR FLANDERS

## OBJECTIVES



- Analyze the **actual (2015) and future (2030-2050) status of Power-to-Gas (PtG) in Flanders** (technology, economics, legal framework, market opportunities)
- Study various PtG **business cases** and identify **early markets**
- Elaborate a **roadmap** which will serve as the backbone for the actions of a **Power-to-Gas Cluster** in Flanders
- **Prioritize the actions** in order to create a **PtG framework** for the development of projects in Flanders and abroad
- Identify potential **demonstration projects** in Flanders

# OVERVIEW OF CALCULATED P2G BUSINESS CASES

Case	Size electrolyser	Typical application	Reference product
<b>POWER-TO-INDUSTRY</b>			
PtH <sub>2</sub> (large): Power-to-Hydrogen (large scale)	100 MW	H <sub>2</sub> as feedstock in large industry (Ammonia production or refinery)	H <sub>2</sub> produced with onsite SMR from CH <sub>4</sub> or H <sub>2</sub> delivered by pipeline
PtH <sub>2</sub> (small): Power-to-Hydrogen (small scale)	1.2MW	H <sub>2</sub> as feedstock in small to medium size industry	H <sub>2</sub> delivered by tube trailers trucks
<b>POWER-TO-GAS</b>			
PtH <sub>2</sub> (blend) : Power-to-Gas (direct injection)	15 MW	Direct injection of hydrogen in gas grid	Natural gas from gas grid
PtCH <sub>4</sub> : Power-to-Gas (methanation)	15 MW	Transformation H <sub>2</sub> into SNG and injection in gas grid	Natural gas from gas grid
<b>POWER-TO-MOBILITY</b>			
PtFCEV (cars): Hydrogen Refuelling Station for cars	500 kW	Hydrogen as a fuel for FCEV (cars)	Diesel
PtFCEV (buses): Hydrogen Refuelling Station for buses	2.2 MW	Hydrogen as a fuel for FCEV (buses)	Diesel
<b>POWER-TO-FUELS</b>			
PtCH <sub>3</sub> OH (fuel): Power-to-Methanol (as a fuel)	50 MW	Partial substitution of diesel with bio-methanol produced from H <sub>2</sub> and CO <sub>2</sub> in a methanolisation process.	Diesel
<b>POWER-TO-POWER</b>			
PtP (small): Power-to-Power (small scale)	500 kW	Hydrogen-based electrical energy storage in medium-sized industry with own renewable energy production ( <i>prosumer</i> )	Power from the grid
PtP (large): Power-to-Power (large scale)	400 MW	Hydrogen-based electrical energy storage (at utility scale)	Power from the grid

# BUISNESS CASES

## BUILDING BLOCKS

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- RES development in Belgium towards 2050
- **Power price duration curve for Belgium**
- Grid fees
- Electrolyser + cell stack replacement model
- Methanation
- Hydrogen storage and compression
- Hydrogen refueling Station + Mobility (buses and cars)
- Methanolisation
- Fuels cells
- Hydrogen prices
- CO<sub>2</sub> prices
- Ancillary services
- Prosumer model (self-consumption)
- Societal benefits
- Physical and Property data

Grid connected systems, green/renewable hydrogen certification via guarantees of origin certificates (cf. [www.certifhy.eu](http://www.certifhy.eu))

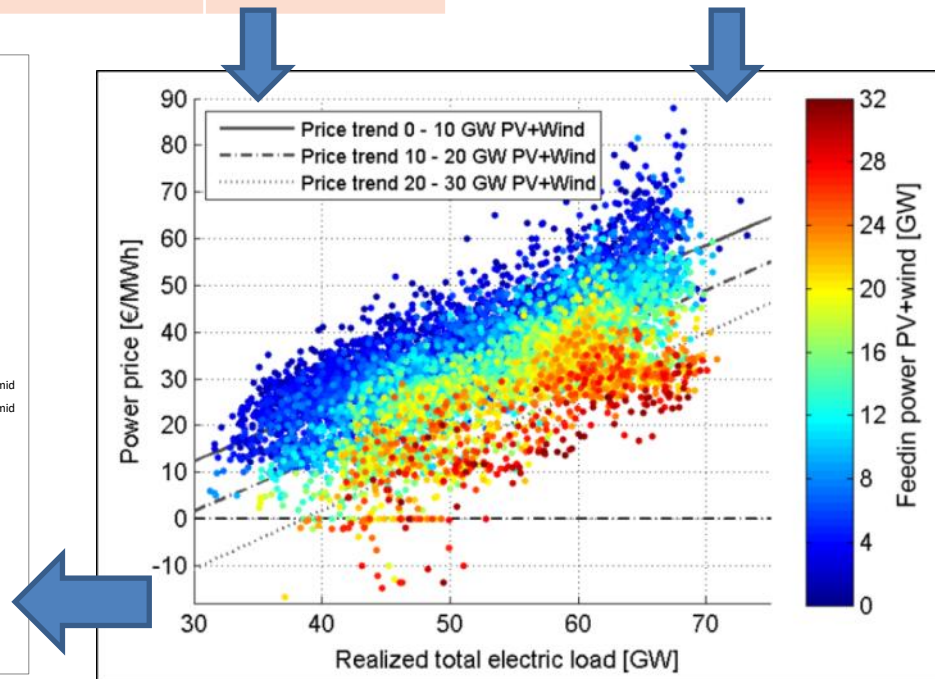
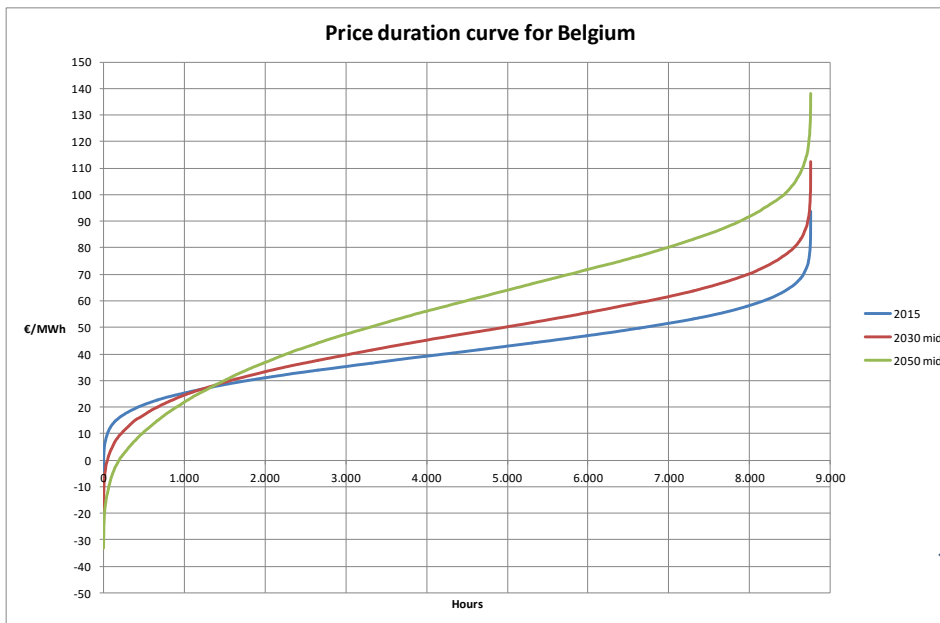
# ELECTRICITY PRICE 2015-2030-2050

## ASSUMPTION

- Based on a German model
- Use the correlation between power price, RES production (wind + solar) and power demand
- Back-up power assumed with gas fired power-plants

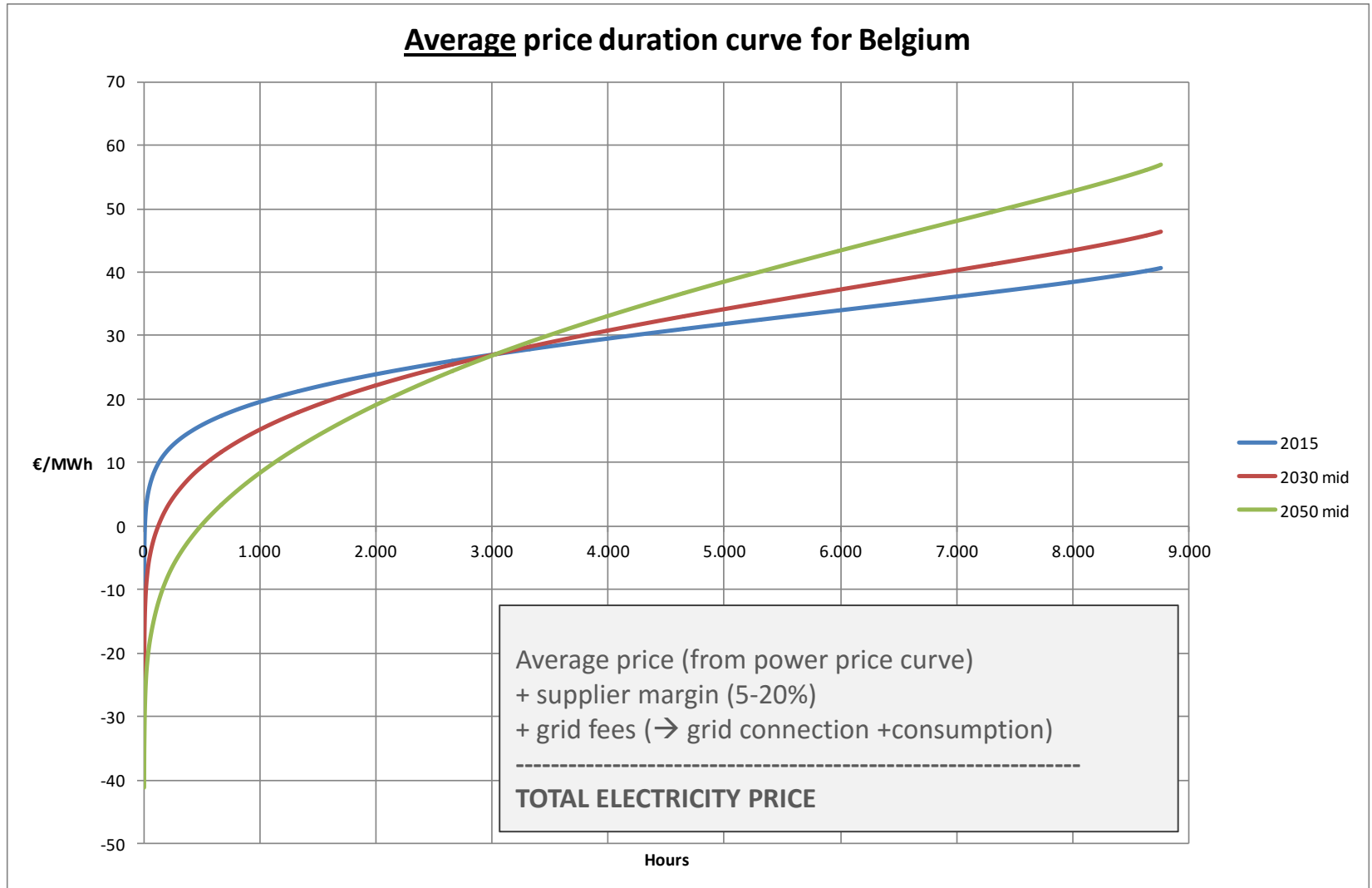
Installed capacity in BELGIUM	Onshore wind	Offshore wind	PV
2014	1.246	712	3.105
2030	4.678	3.522	4.800
2050	7.213	7.687	10.000

Use of historical data  
2014 for Belgium: BELPEX  
prices + wind + solar



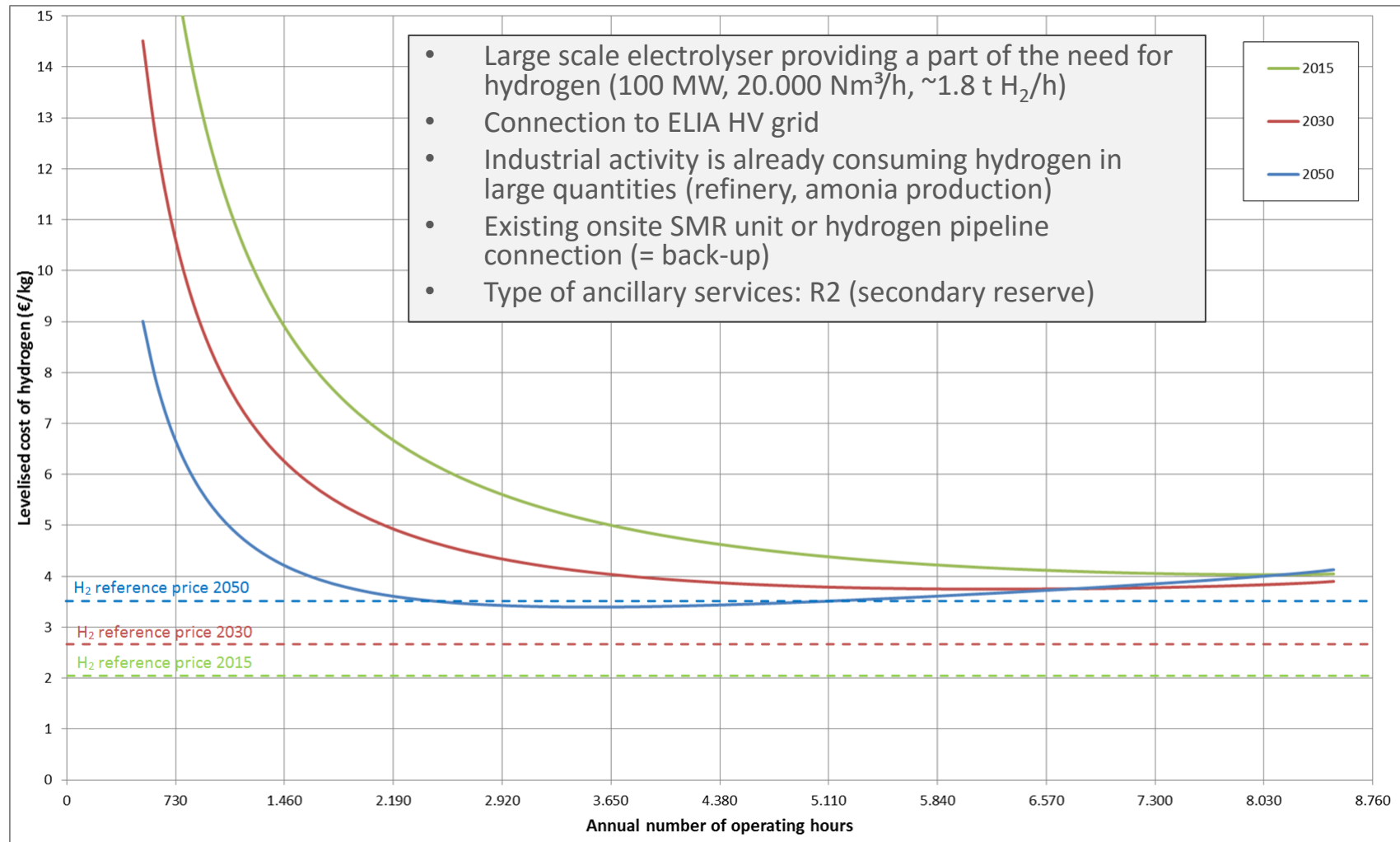
# ELECTRICITY PRICE 2015-2030-2050

## ASSUMPTION



# POWER-TO-INDUSTRY (LARGE SCALE)

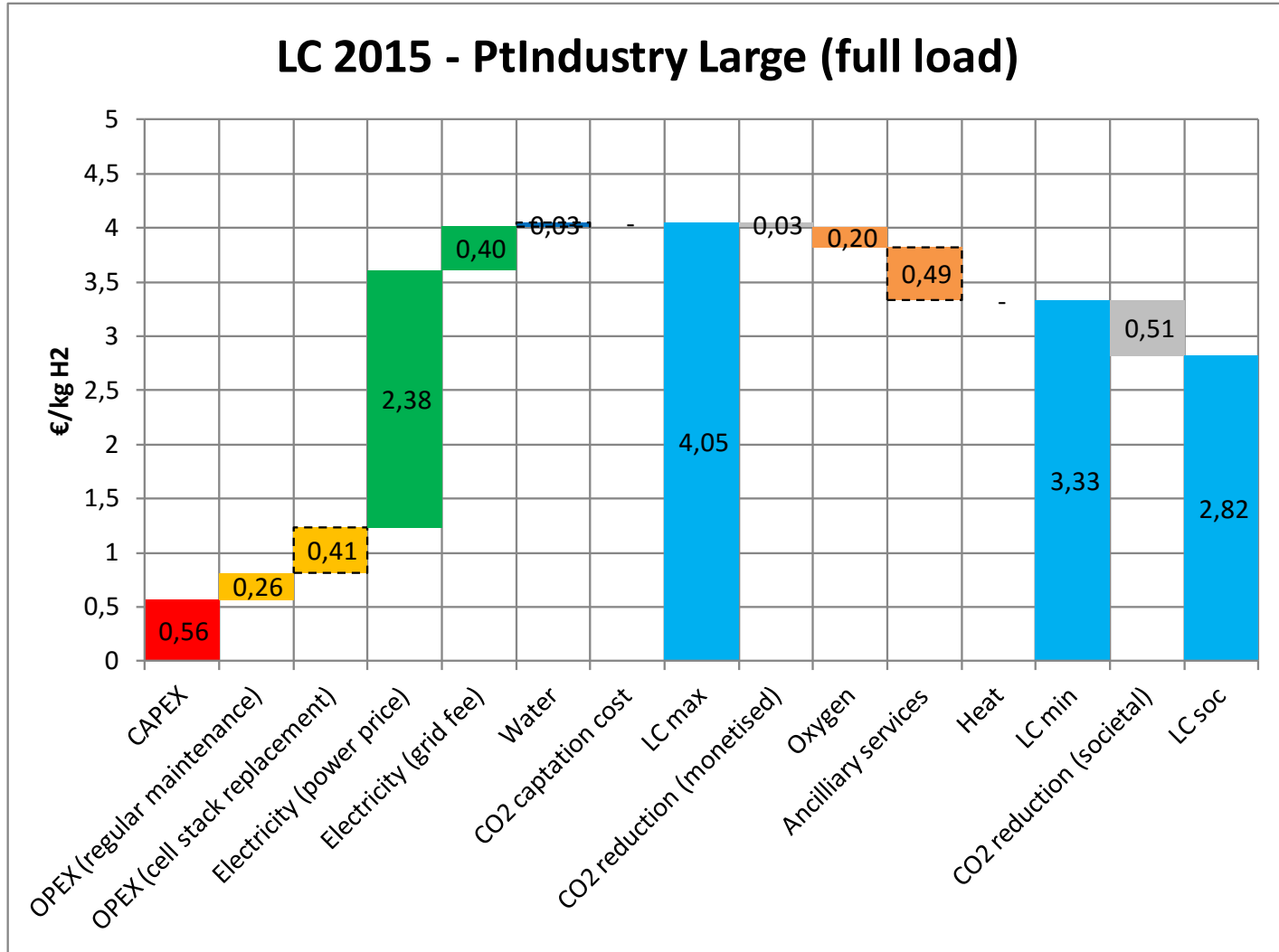
## LCOH+ VS OPERATING HOURS





# POWER-TO-INDUSTRY (LARGE SCALE)

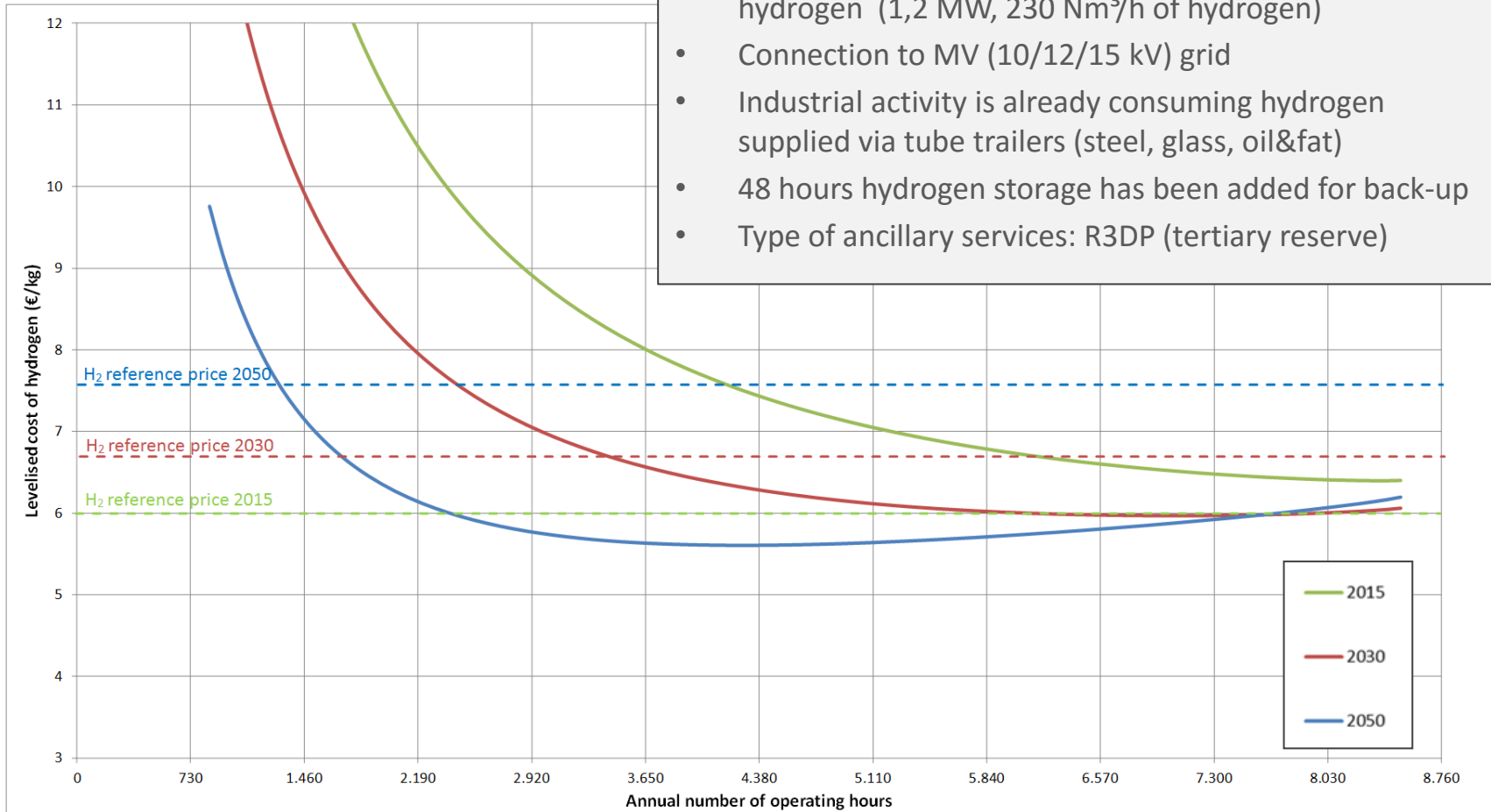
## WATERFALL GRAPH: $LC_{MAX}$ , $LC_{MIN}$ , $LC_{SOC}$



# POWER-TO-INDUSTRY (SMALL SCALE)

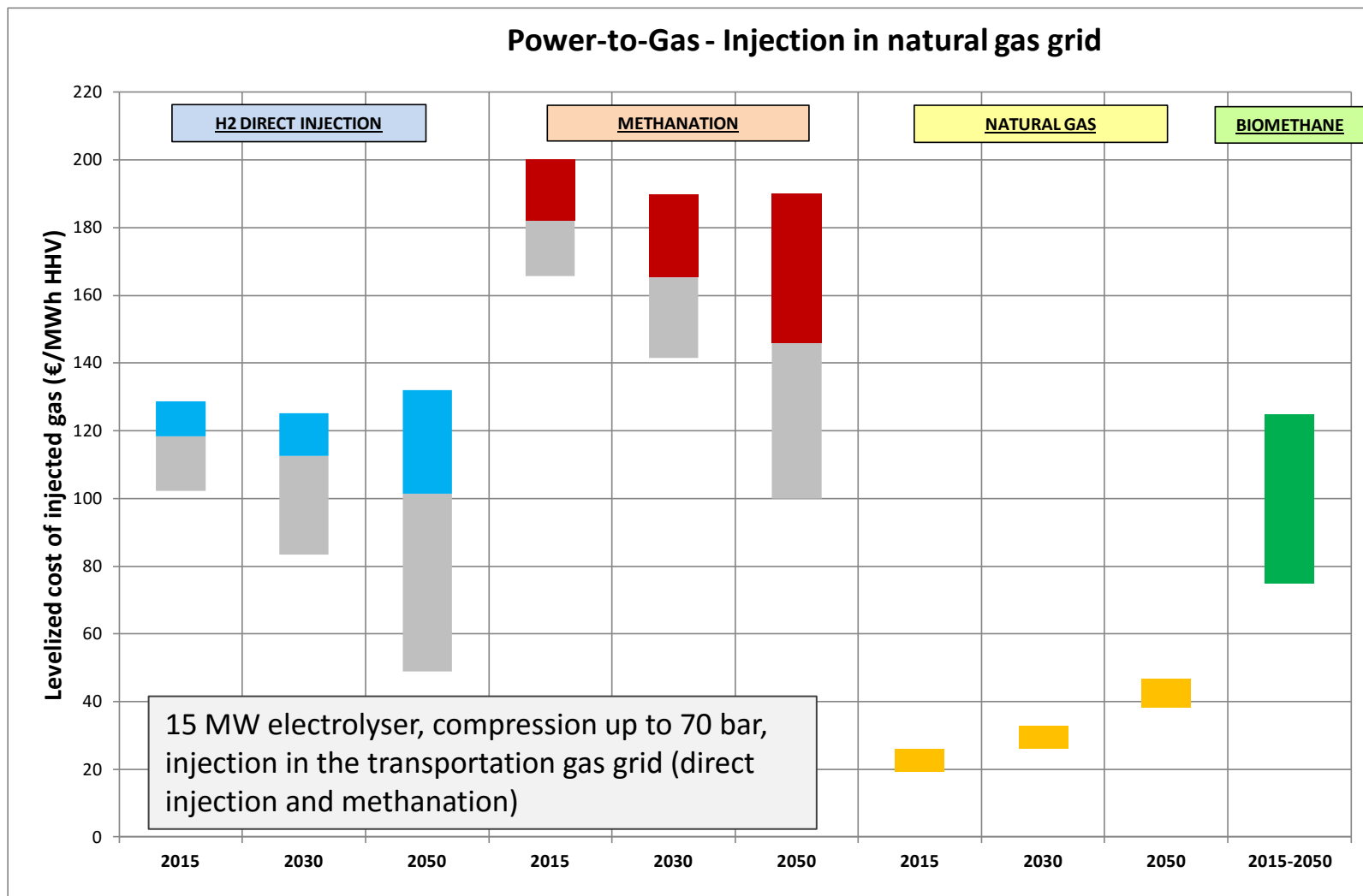
## LCOH+ VS OPERATING HOURS

- Small scale electrolyser providing a part of the need for hydrogen (1,2 MW, 230 Nm<sup>3</sup>/h of hydrogen)
- Connection to MV (10/12/15 kV) grid
- Industrial activity is already consuming hydrogen supplied via tube trailers (steel, glass, oil&fat)
- 48 hours hydrogen storage has been added for back-up
- Type of ancillary services: R3DP (tertiary reserve)



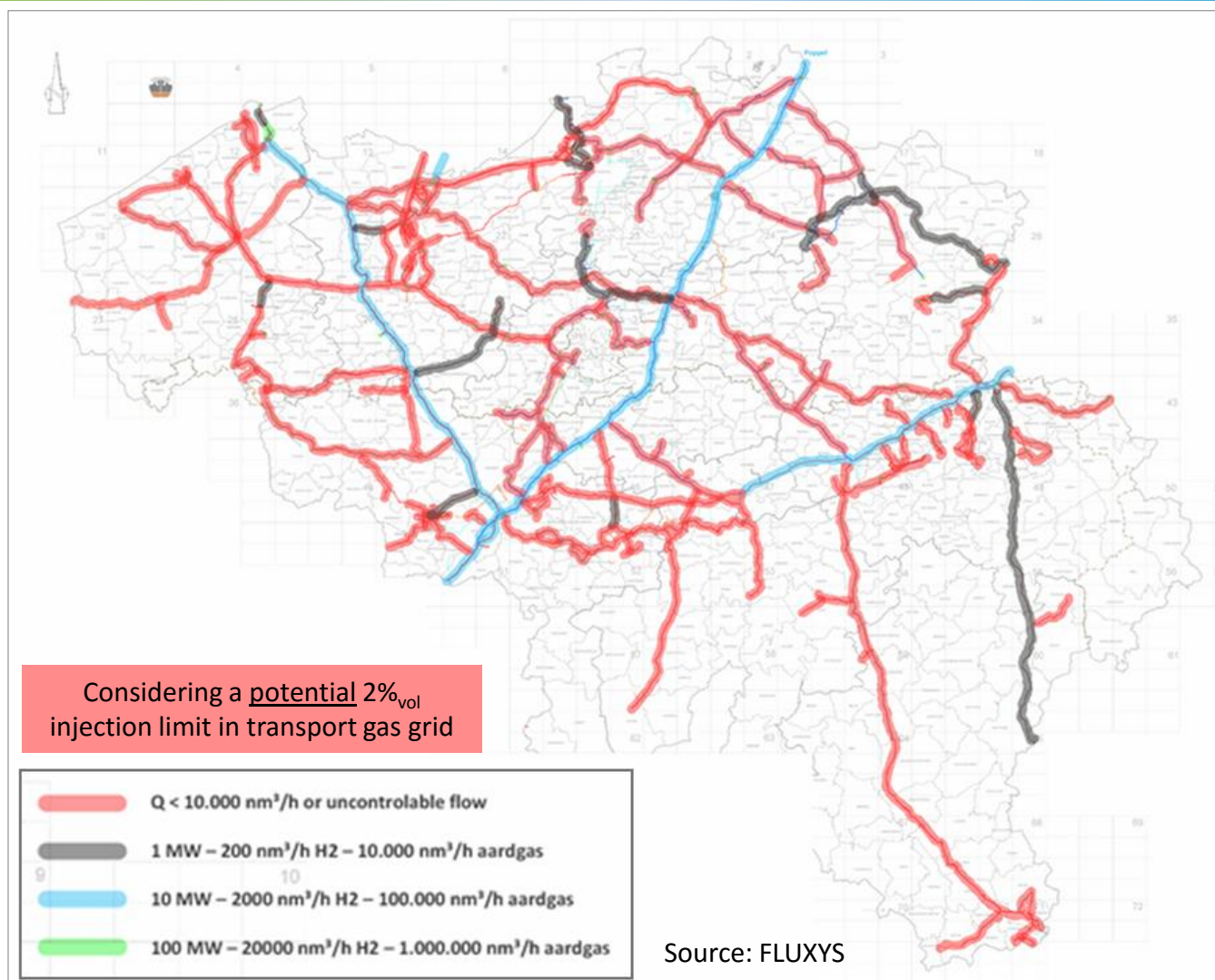
# POWER-TO-GAS

## DIRECT INJECTION, METHANATION, BIOMETHANE



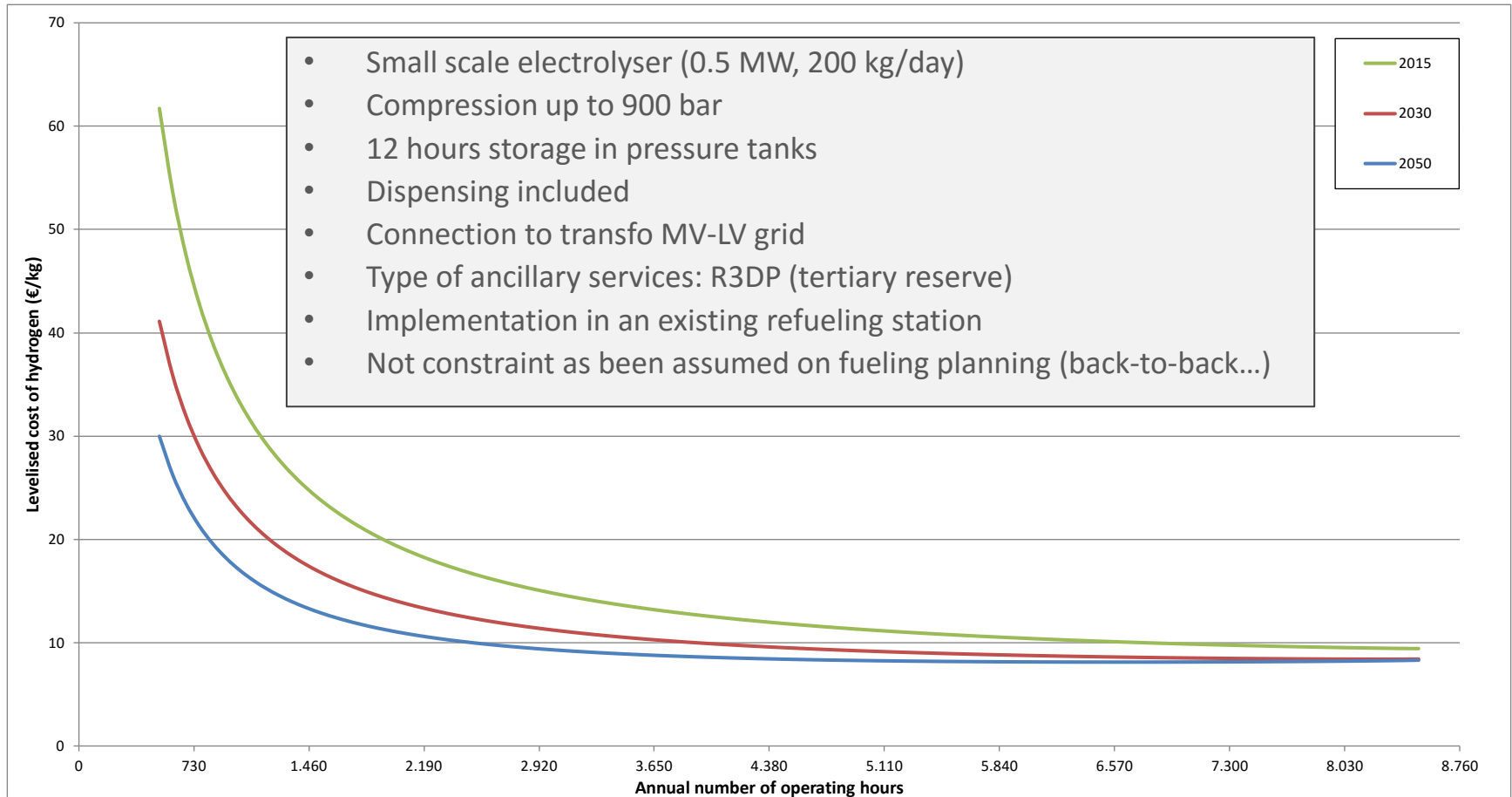
# POWER-TO-GAS

## POTENTIAL IN BELGIUM FOR DIRECT INJECTION



# POWER-TO-MOBILITY: HYDROGEN REFUELING STATION

## 50 CARS/DAY : $LC_{MAX}$ vs OPERATING HOURS



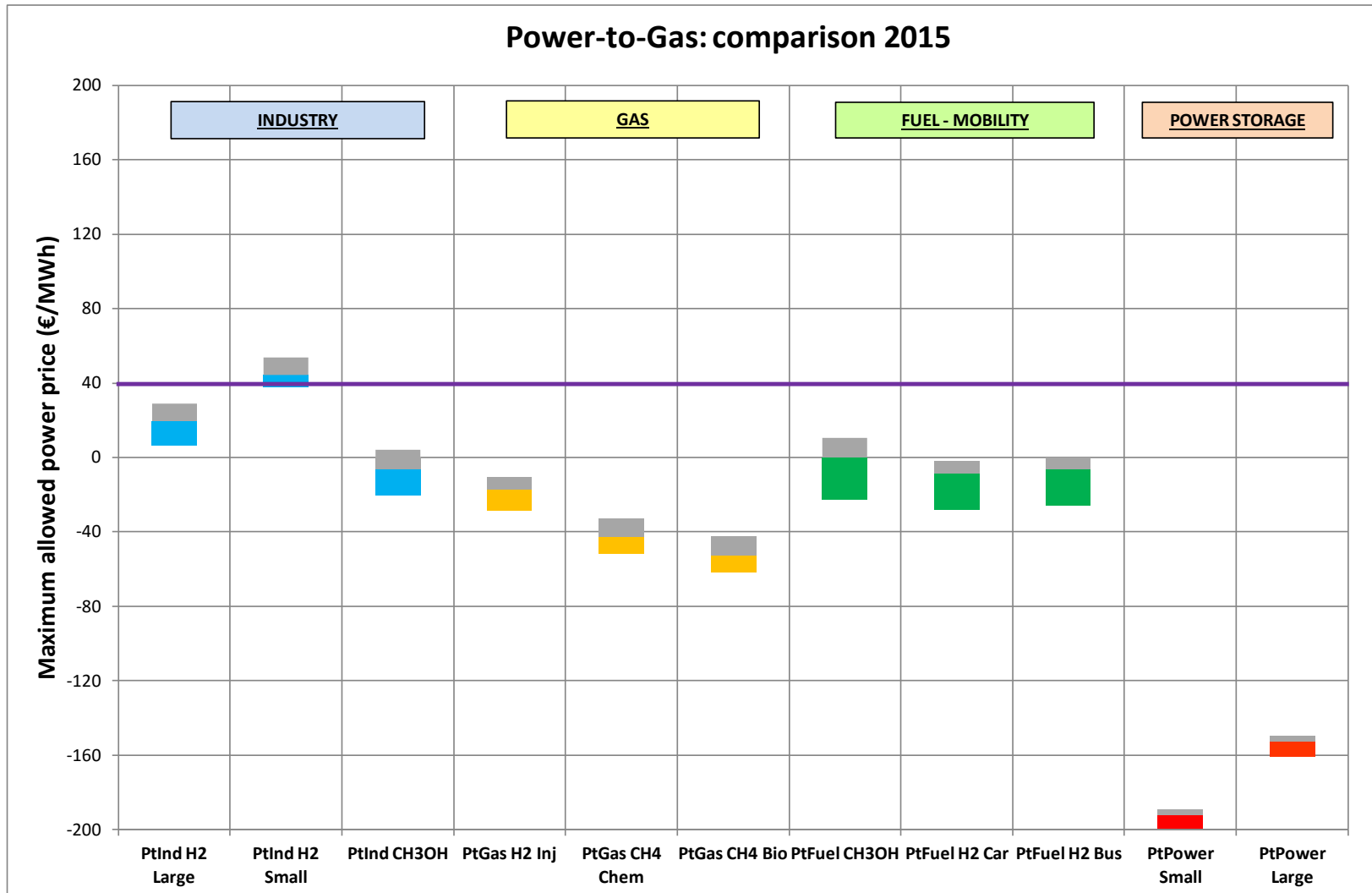
# CASES COMPARISON 2015-2030-2050

## « HOT » MAP

	2015	2030	2050
Power-to-Industry - small scale	Yellow	Green	Green
Power-to-Industry - large scale	Red	Red	Yellow
Power-to-Gas - direct Injection	Red	Red	Red
Power-to-Gas - synthetic natural gas (methanation)	Red	Red	Red
Power-to-Fuel - methanol	Red	Red	Yellow
Power-to-Mobility - HRS for cars	Red	Yellow	Green
Power-to-Mobility - HRS for buses	Yellow	Green	Green
Power-to-Power - small scale	Red	Red	Red
<i>NB: This table refers to the analysis of the different business cases in a 'business as-usual' scenario assuming no fundamental policy changes.</i>			

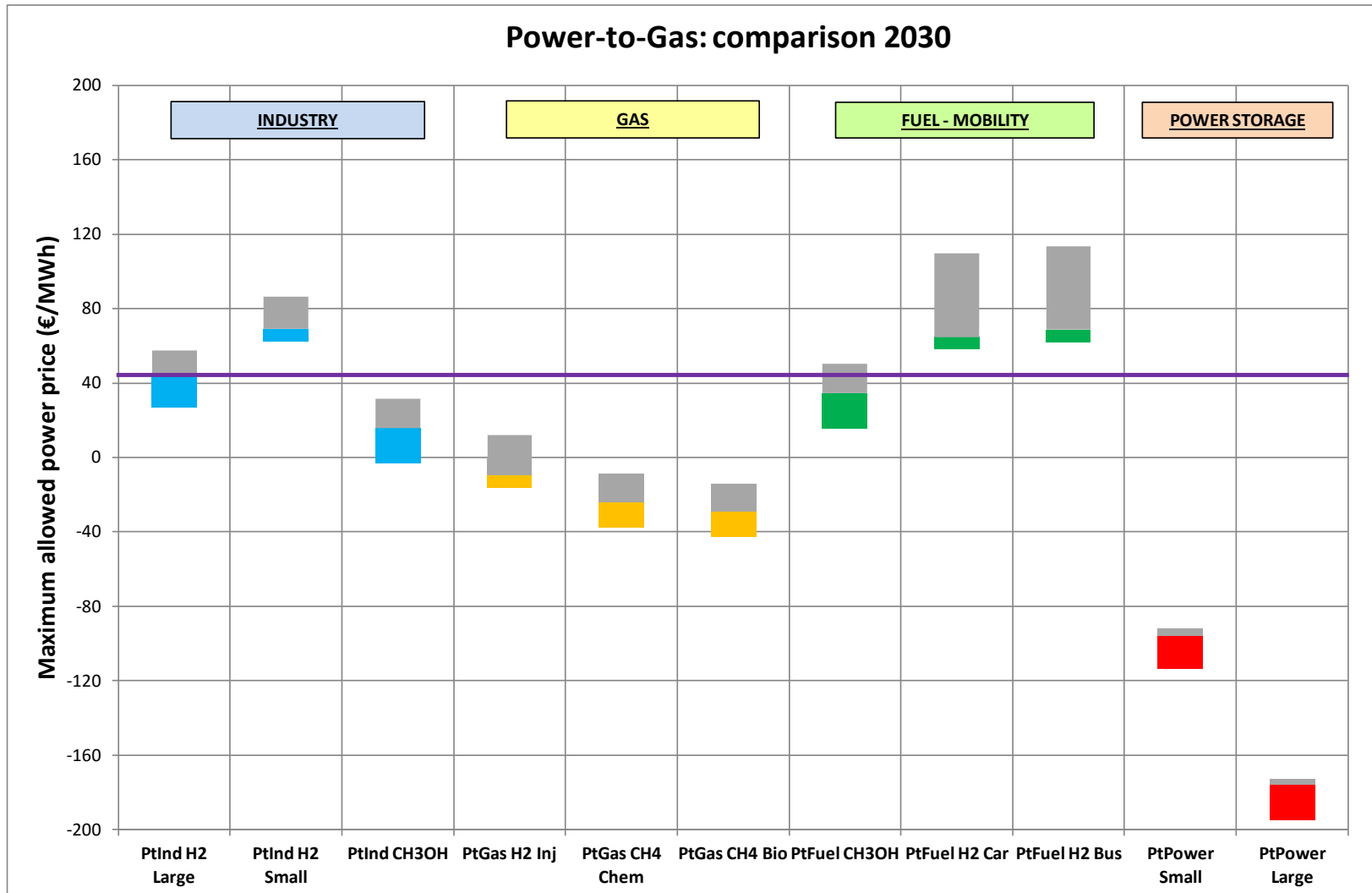
# CASES COMPARISON 2015

## ALLOWABLE POWER PRICE FOR BREAK-EVEN



# CASES COMPARISON 2030

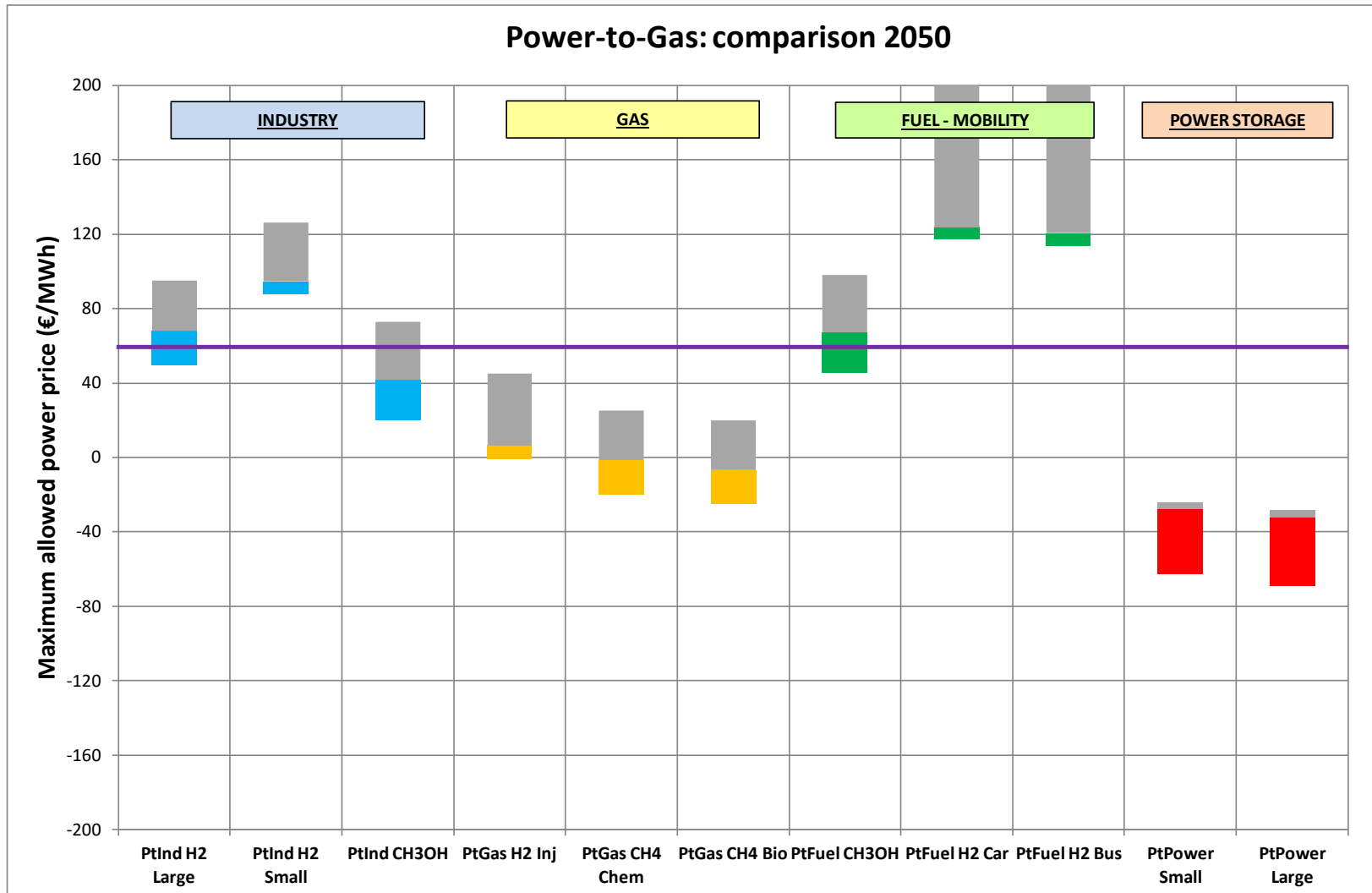
## ALLOWABLE POWER PRICE FOR BREAK-EVEN





# CASES COMPARISON 2050

## ALLOWABLE POWER PRICE FOR BREAK-EVEN



# P2G ROADMAP FOR FLANDERS

## MAIN CONCLUSIONS

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- Power-to-Gas is a clear answer to the objectives of the **energy policy** in Flanders: environment, competition, security of supply, public acceptance
- **Fundamental changes are expected** in the power, gas, industry and transport markets driven by ambitious policy (higher CO<sub>2</sub> price, more renewables, clean transport, green gases...)

### **A supportive regulatory framework is needed including:**

- Removal of existing barriers mainly due to the absence of specific legislation addressing hydrogen and P2G (sector coupling)
- Setting up a green/renewable hydrogen certification mechanism
- Provision of a financially attractive environment (pull and push measures) to stimulate investments in H<sub>2</sub> and P2G in Flanders

### **Other actions are needed**

- Supporting the roadmap execution and the P2G cluster
- Showing the example (ex: FCEV fleets for ministries)
- Communication, awareness and education.

# P2G ROADMAP FOR FLANDERS

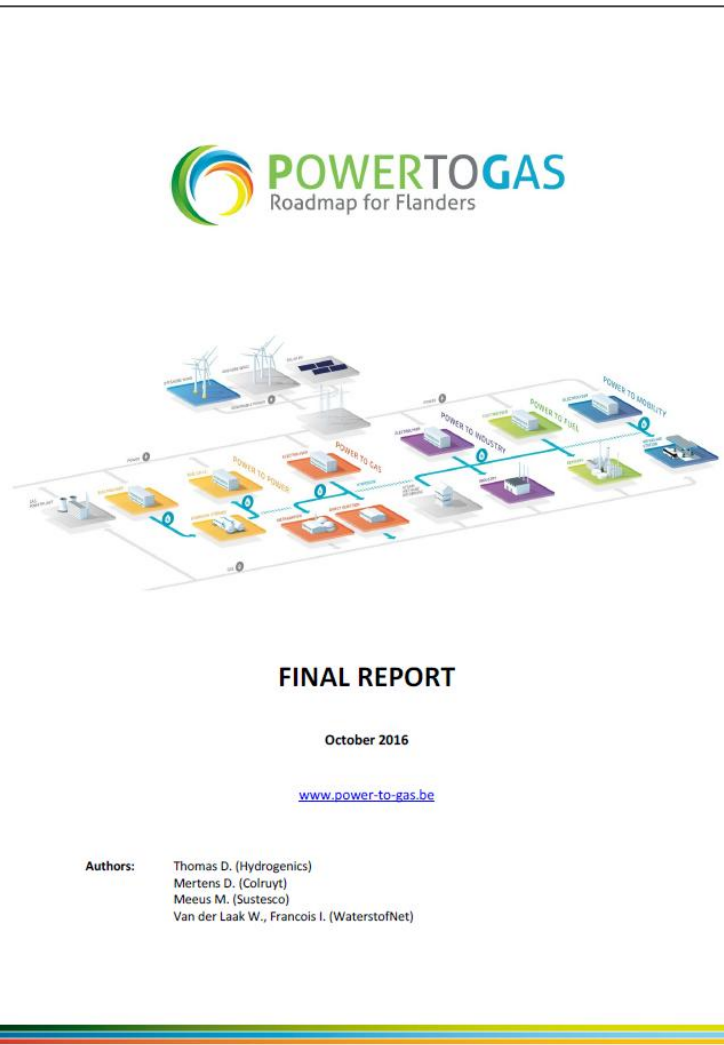
## FINAL REPORT IS AVAILABLE

<http://www.power-to-gas.be/roadmap-study>

**Webinar on 26 October 2016 at 2 pm**

Registration required:

[isabel.francois@waterstofnet.eu](mailto:isabel.francois@waterstofnet.eu)



- This roadmap was a 1<sup>st</sup> essential step to:
  - confirm the P2G opportunity
  - identify the challenges and priorities
  - increase awareness on the topic
- The creation of a P2G cluster was the 2<sup>nd</sup> step to start the implementation of the roadmap with a broad industry involvement
- **Political commitment and support will be essential for future steps !**

# BEDANKT VOOR UW ANDACHT !

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More info: [www.power-to-gas.be](http://www.power-to-gas.be)

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