DECARBONISATION OF GAS TURBINE BY BURNING HYDROGEN PRODUCED LOCALLY BY ELECTROLYSIS

A case study

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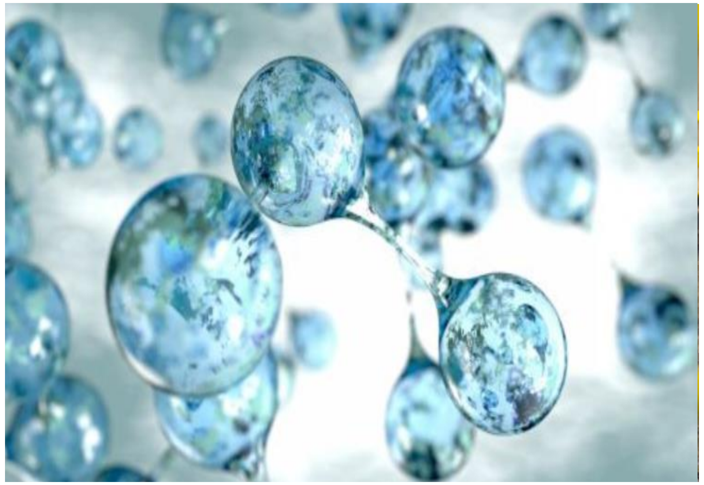
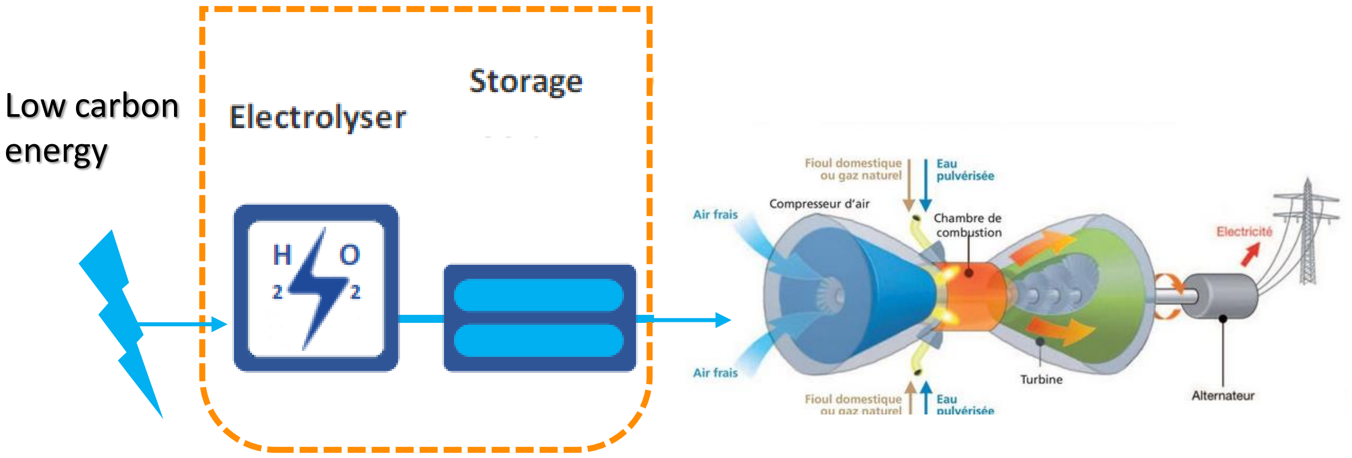


H2 turbines : Is it technically feasible and is it economically viable ?

END USER PERSPECTIVE



The path to 100% H2 in new turbines seems technologically promising but…

- How am I going to feed my turbine with H2 ?
- How am I going to ensure the right fuel storage now ?
- What are the industrial risks associated ?
- At what cost ?

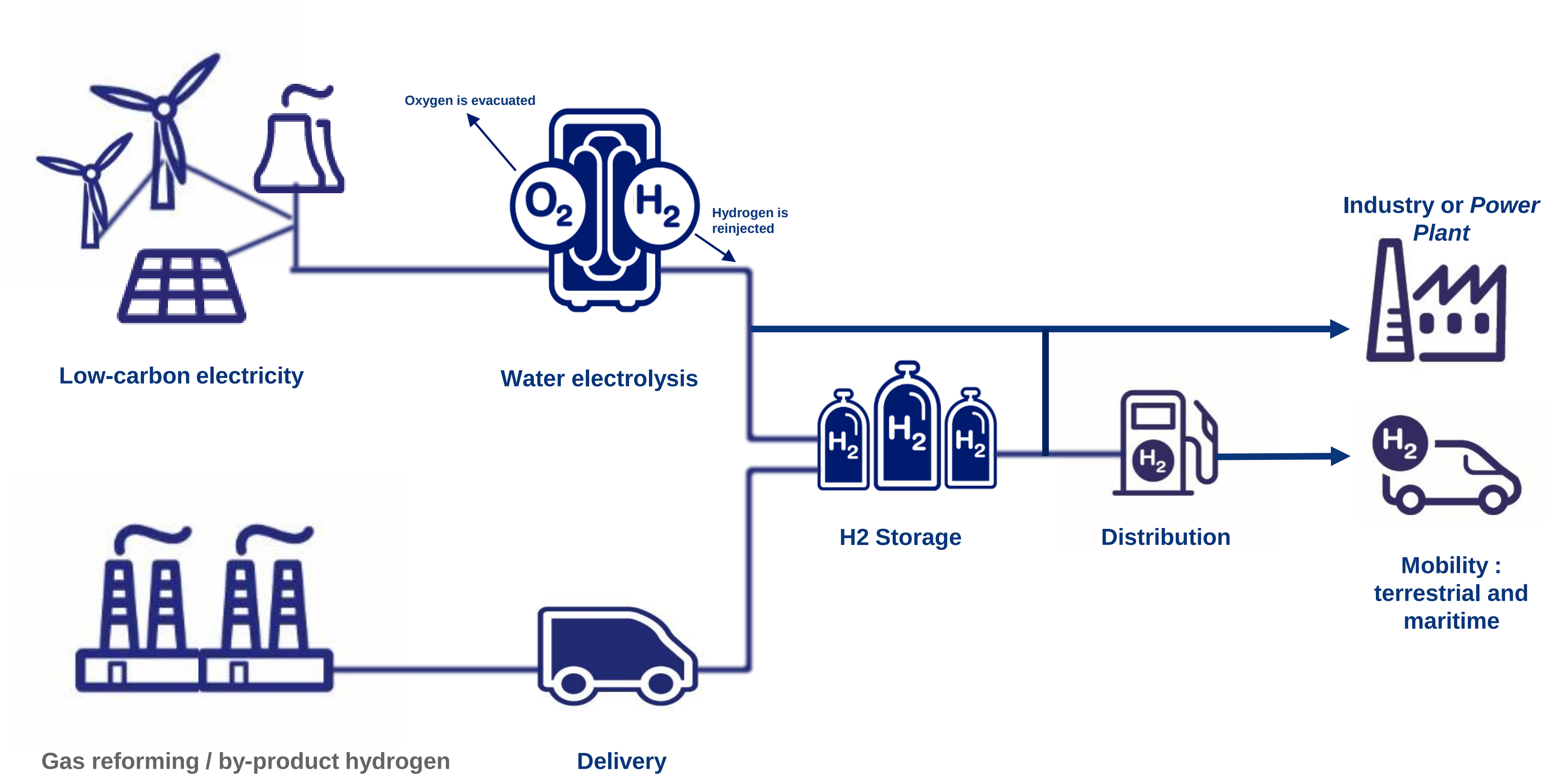
H2 for mobility, industry and as an energetic vector

Low-carbon and on-site production

- Production via water electrolysis
- Production station as close as possible to consumption

Carbon-based and centralised production

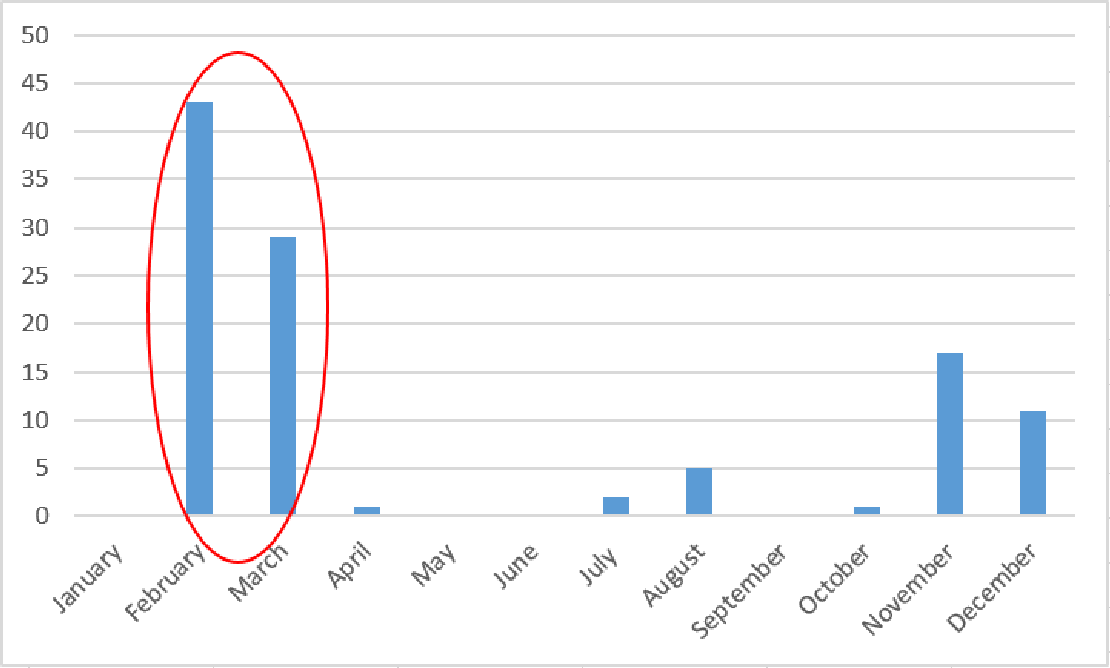
- Production based on steam methane reforming
- H2 Plant and truck delivery to the place of consumption.
- **1 kg of H2 produced ➔ 10 kg of CO2 emitted**



Peak Load Turbines

The study considers the technical data associated with a peak load turbine. Technical assumptions taken are the following:

- Power: 125 MWe,
- Average efficiency: 34% (considered the same for natural gas or hydrogen in this study)
- Operating hours: 150 h
- Annual operating profile: 50% of the total energy provided by the GT is given in winter (February and March)



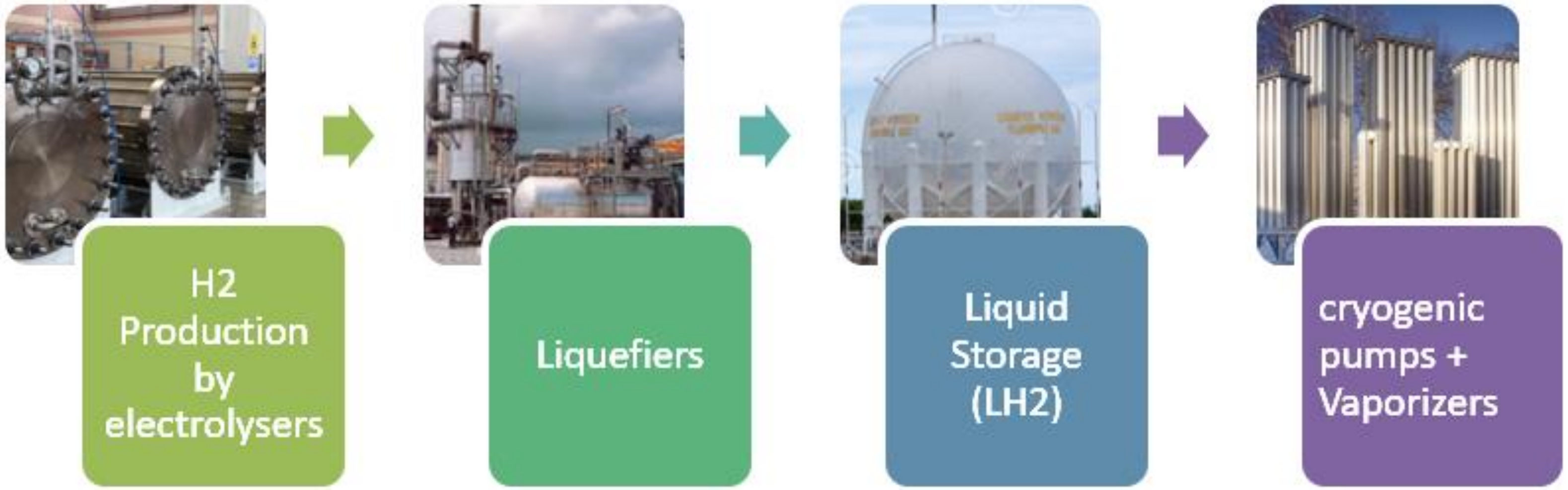
Case studies

A set of 6 cases were studied. They vary three parameters:

- ❑ **Percentage of Hydrogen** in the natural gas to fuel the turbine: 30% H2 and 70% natural gas or 100% hydrogen;
- ❑ **Storage capacity**: providing 50 hours, 120h or 25 hours of operation;
- ❑ **Refilling time** of the storage capacity: for a period of 1 month or 4 months of electrolyser operation.

1. H2 100% ; 50 h ; 1 M
2. H2 30% ; 50 h ; 1 M
3. H2 100% ; 120 h ; 4 M
4. H2 30% ; 120 h ; 4 M
5. H2 30% ; 0 h ; 0 M
6. H2 30% ; 25 h ; 1 M

Equipments in the scope of study



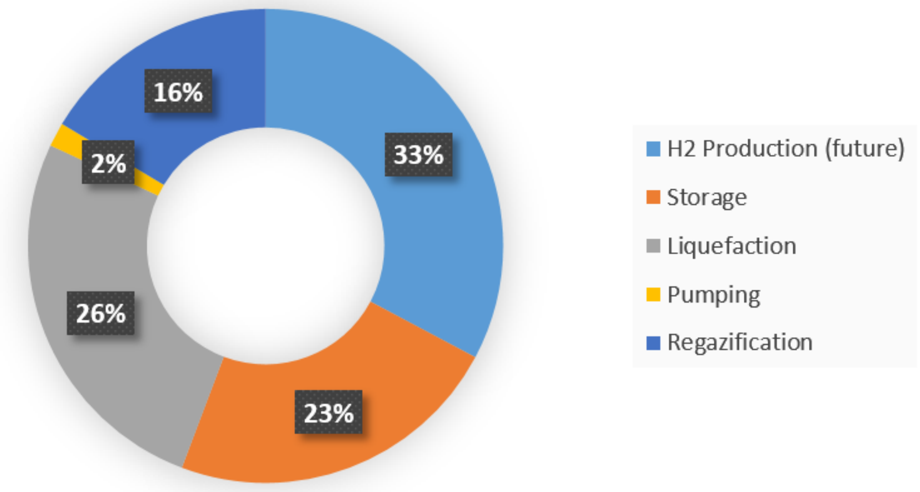
Results

Equipment	1) H2 100% ; 50h ; 1M	2) H2 30% ; 50h ; 1M	3) H2 100% ; 120h ; 4M	4) H2 30% ; 120h ; 4M	5) H2 30% ; 0h	6) H2 30% ; 25h ; 1M
H2 flow needed to feed the Turbine	116 000 Nm3/h	13 000 Nm3/h	116000 Nm3/h	13 000 Nm3/h	13 000 Nm3/h	13 000 Nm3/h
Electrolyzer capacity	21 400 Nm3/h 107 MW	2 500 Nm3/h 12 MW	12 800 Nm3/h 64 MW	1 400 Nm3/h 7 MW	13 400 Nm3/h 67 MW	1 200 Nm3/h 6 MW
Liquefier capacity	18	2	11	1,2	-	1
Liquid Storage capacity	525 t	60 t	1260 t	145 t	0 t	30 t
Cryogenic pumping + vaporizers	1 bar →35 bar 116 000 Nm3/h	1 bar →35 bar 13 000 Nm3/h	1 bar →35 bar 116 000 Nm3/h	1 bar →35 bar 13 000 Nm3/h	30 bar →35 bar 13 000 Nm3/h	30 bar →35 bar 13 000 Nm3/h

Results

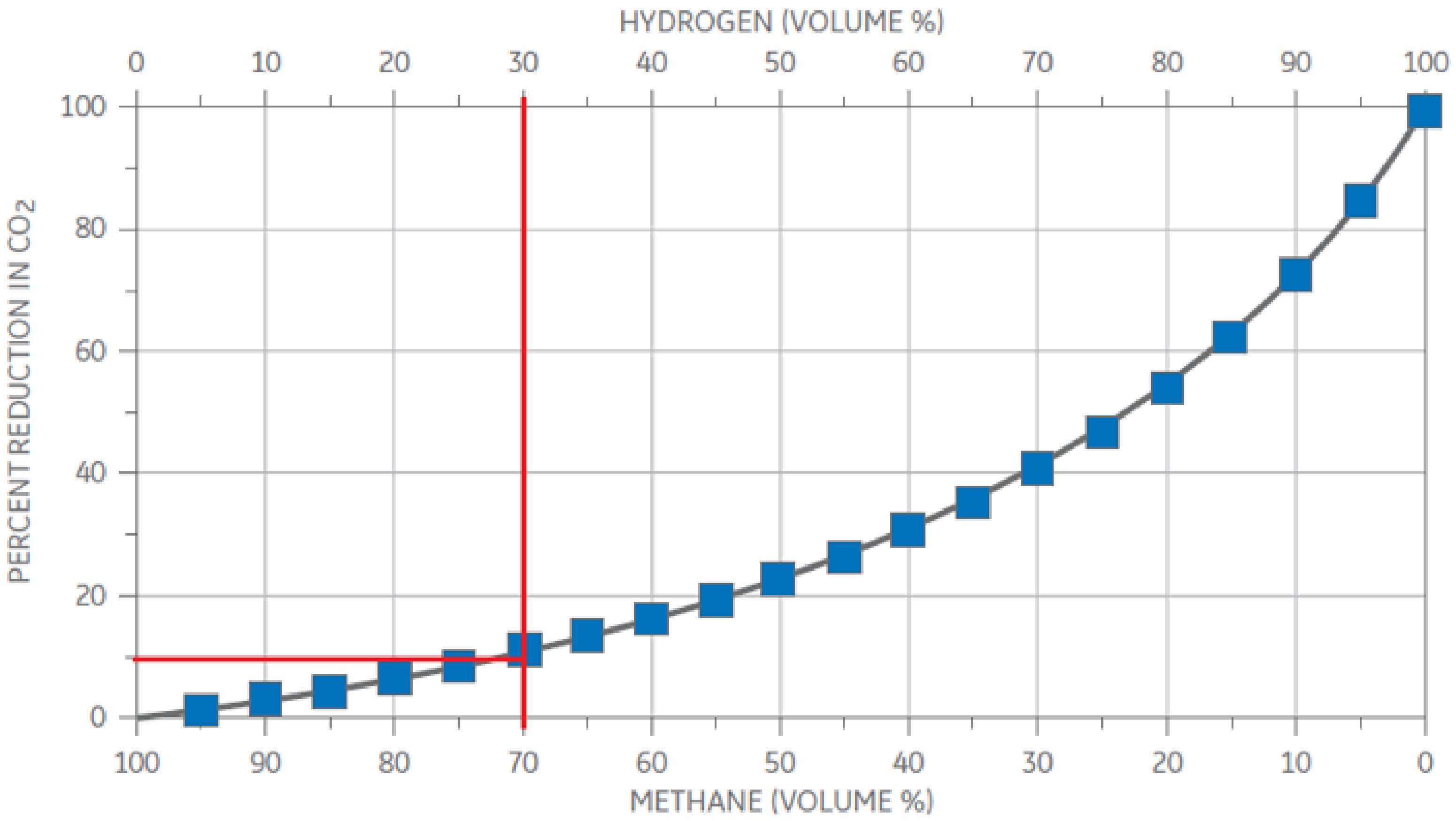
<u>**Case study n°2 (H2 30%; 50 hours; 1M)**</u> *GT supplied with 30% H2 fuel, on-site storage provides 50 hours of operation, this storage is filled during a period of 1 month of operation of the electrolyzer in 9 hours per day.*

→ project estimation ≈ 30 M€ to 40M€ (±50%)



<u>Typical Project cost allocation</u>

Results



HYDROGEN (VOLUME %)
0
10
20
30
40
50
60
70
80
90
100
PERCENT REDUCTION IN CO_2
100
80
60
40
20
0
100
90
80
70
60
50
40
30
20
10
0
METHANE (VOLUME %)

Conclusions

- ✓ **Only 2 cases would be *potentially* viable technically (even if really challenging taking into account the industrial risks associated to the storage of important volumes of H2).**

- ✓ **Cost efficiency : costs are extremely high regarding other decarbonization options.**

- ✓ Storage capacity and filling time chosen are adapted to the operation of the case study (peak load gas turbine). But the same turbine operated in another site will necessarily have a different number of hours of operation and a different distribution in the year. The conclusions of this study are therefore site specific.

- ✓ For some turbines operating daily and few hours a day, storage can be less than the values shown in this study and therefore, gas compression and gas storage should be preferred rather than liquefying and storing liquid hydrogen, because of important impacts on costs (CAPEX and OPEX).

- ✓ The costs of H2 equipment represent an important part of the CAPEX for a project (**if we consider 100% H2 feeding, costs of H2 equipment would be superior to the costs of the GT power plant**).

- ✓ Since the reduction in CO2 emissions is not proportional to the volume of H2 in natural gas, only a turbine burning blendings with a high proportion of H2 (near to 100% H2) has a significant environmental impact.

Thank you