


ENGIE Laborelec

Why H₂ for the future ?





What is the cheapest way to produce electricity from a new installation (all cost included)?



Solar !



Germany's October tender for PV projects ranging in size from 750 kW to 10 MW has recorded a new low price record. For the first time, the average bid fell below €0.0500/kWh and reached €0.0491/kWh, as the Federal Network Agency announced on Monday 16/10/2017.

Wind !



The tender was won by Vattenfall in November 2016 at a price €49.90/MWh (\$55.34) fixed-price with no adjustment for inflation

Current cost of electricity from a new power station!

1. Wind Large scale 50 to 80 €/MWh without risks
 2. Solar large scale 30 to 60 €/MWh without risks
 3. Gas/coal > 50 €/MWh depending on fuel and CO2 costs
 4. Nuclear > 100 €/MWh without dismantling risks
- Renewables are not more an ecological dream it is now **a financial dream.**
 - The energy transition is started and will not stop, **due to economical reasons !**



The current real challenges are:



Grid stability and interconnections!

Electricity storage!

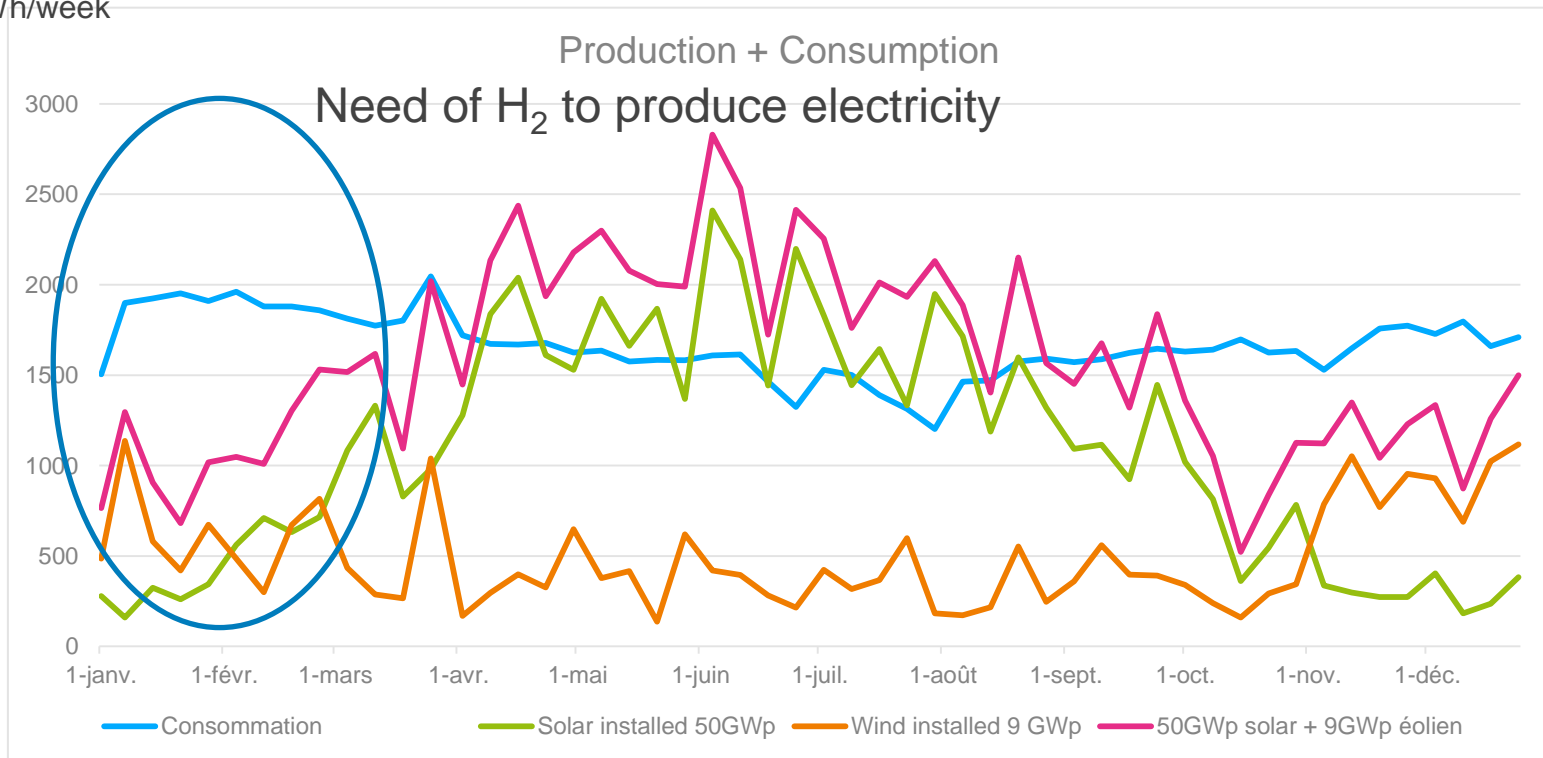


What is a world 100% renewable (i.e. Belgium 100% renewable)

Based of Belgian available data's, we can imagine how would be a world 100% renewable. The assumptions are

- 60% of Solar energy produced (in MWh/week)
- 40 % of wind energy produced (in MWh/Week)

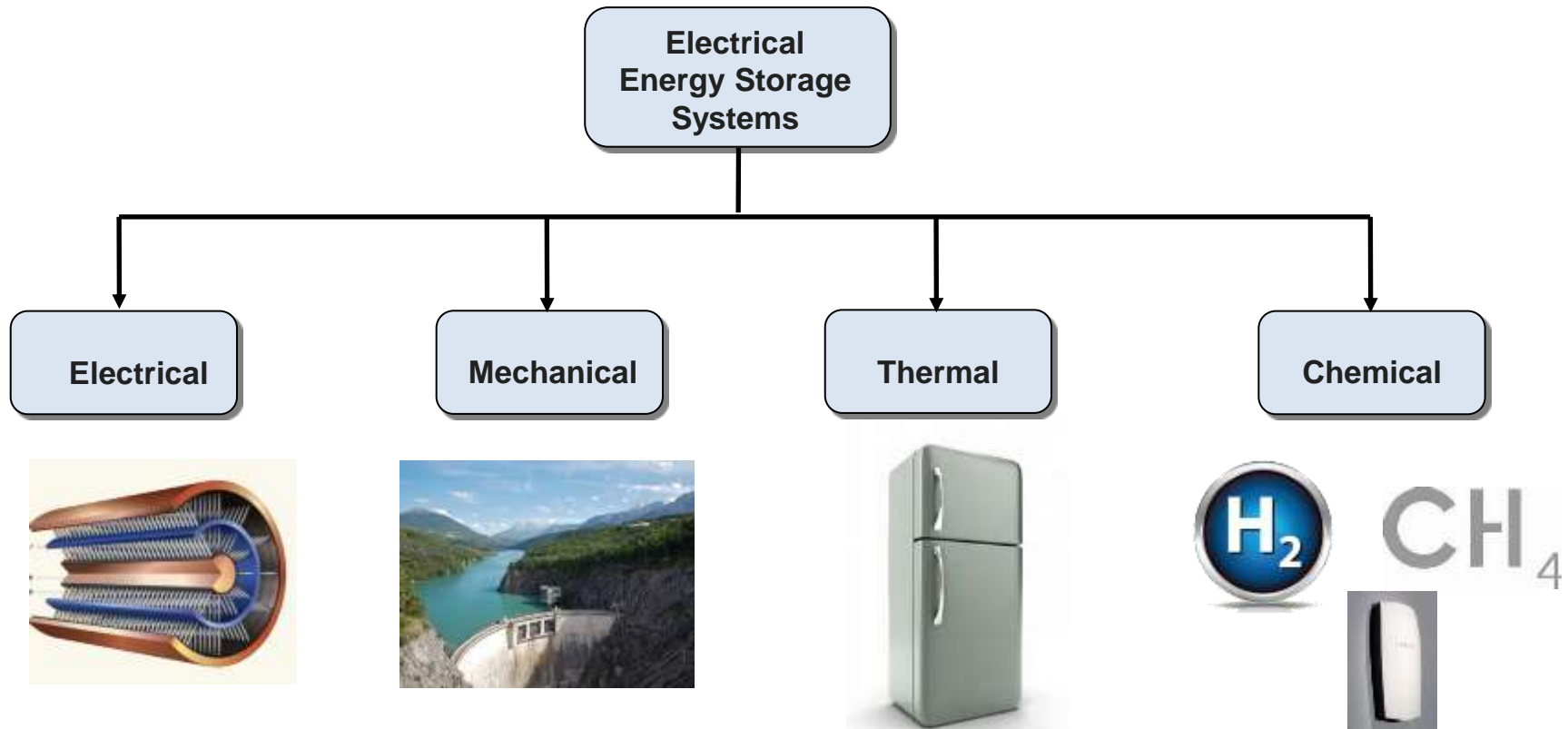
MWh/week



Electricity Storage.

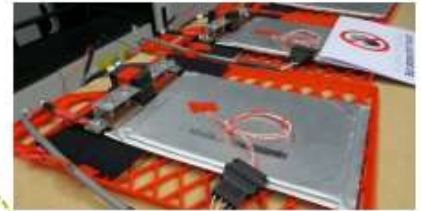
Heat mechanical and electricity.

- All storage of electricity must be used for renewable energy development.
- Level of maturity : progressive alignment
- Long, medium or short term use according to the technology of storage



Chemical storage: Peak Shifting (daily storage)

ALATA, Corsica : 1st SOLAR SMART GRID From INTERMITTENT production to GUARANTEED CAPACITY



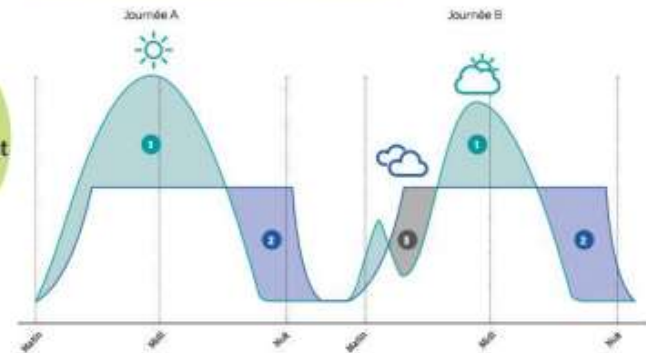
SOLAR FARM
- 4.4 MWp – 6600 MWh
- 13 450 modules - 10 ha



SMART ENERGY MANAGEMENT
- MW forecast
- Arbitrage btw grid injection & storage



BATTERIES
- 2.4 MW – 4.32 MWh (#6)
- Li-Ion LG Chem

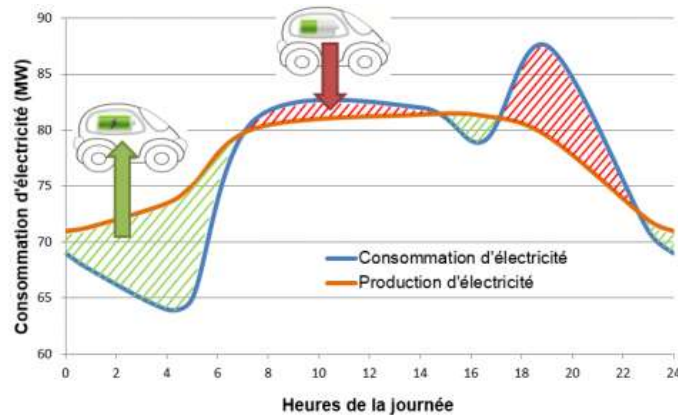


Electrical Vehicle the Electricity Storage (r)evolution



200 000 EV
5 GWh E storage

=



Second cars in Belgium represent 2 000 000 Cars = 10 Coe



Hydrogen is a key element for seasonal electricity storage

Everybody agrees that H₂ will play a major role!

But the real question is how to develop this promising market!

Estimation of cost of green H₂

Cost Electricity : 40 €/MWh

Capex cost calculated based on 7% IRR, 20 years 8000 h/year (first estimation)

Opex cost 4% Capex for electrolyse

Electrolyser < =1 MW

- Energy cost -2,0 €/kg
- Opex cost -1,0 €/kg
- Capex cost -2,4 €/kg
- Incoms R1+O2 +0,6 €/kg
- Total cost **-4,8 €/kg**

Electrolyser 10 MW

- Energy cost -2,0 €/kg
- Opex cost -0,5 €/kg
- Capex cost -1,2 €/kg
- Incoms R1&2 O2 +0,6 €/kg
- Total Cost **- 3,1 €/kg**

H₂ from CH₄ costs ~ **1€/kg**, green H₂ must be used in priority for mobility

Green H₂ vs Diesel for mobility

Public authorities want to ban Diesel from city centre and are looking for **100% CO₂ free** solution. This is a unique opportunity for Green H₂ (No competition with Black/Blue* H₂)

But nobody is ready to pay more than Diesel !

→ To be competitive in mobility **Green H₂ must be ≤ diesel cost**

Average consumption of cars to make 100 km:

- Diesel car ⇒ 60 kWh /100 km (1 l diesel = 10 kWh)
- Battery Electrical car ⇒ 20 kWh/ 100 km (100kg battery = 10 kWh, 850 kg Battery in 1 Tesla)
- Fuel Cell Electrical car ⇒ 40 kWh /100 km (FCcell efficiency 50% losses to be used to warm up car)
⇒ 1,2 kg H₂ (LCV H₂ = 33,33 kWh/kg)

If H₂ is used in a Fuel Cell engine cost of H₂ must be ≤ 5€/kg (for diesel @ 1€/l VAT excl.)

If H₂ is used in a Internal Combustion Engine cost of H₂ must be ≤ 3,4 €/kg (for diesel @ 1€/l VAT excl.)

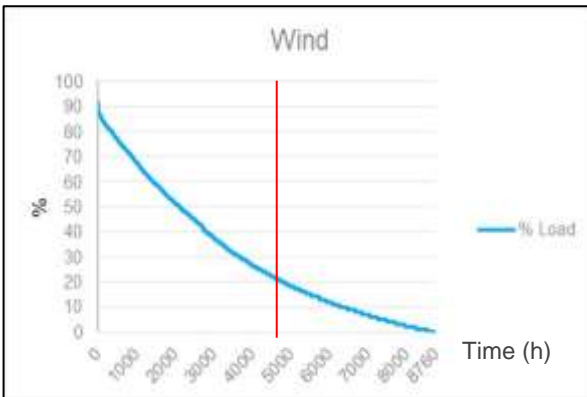
* Blue H₂ = Black H₂ + Carbon capture



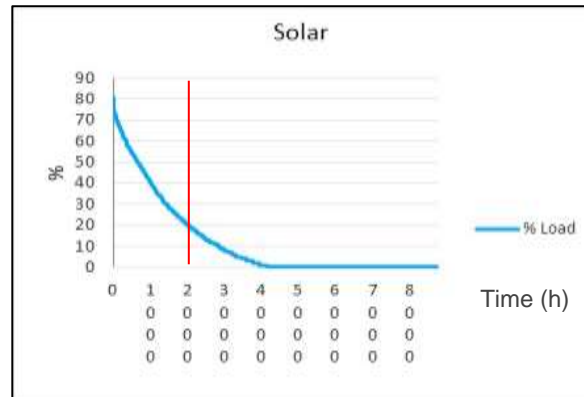
Renewable Energy Sources comparison.

Monotone diagram for different production units

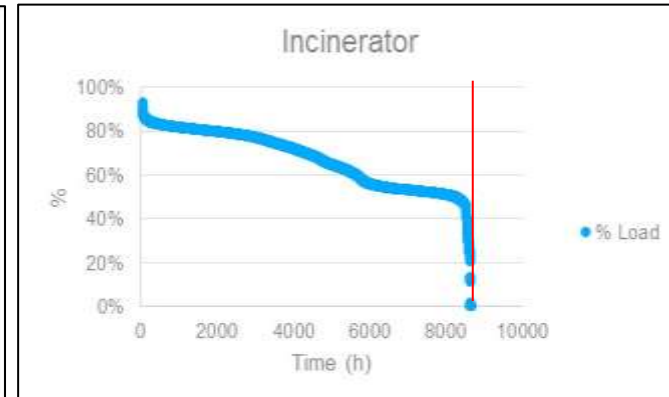
Base load unit



4700 h/year @ 20 % load



2000 h/year @ 20 % load

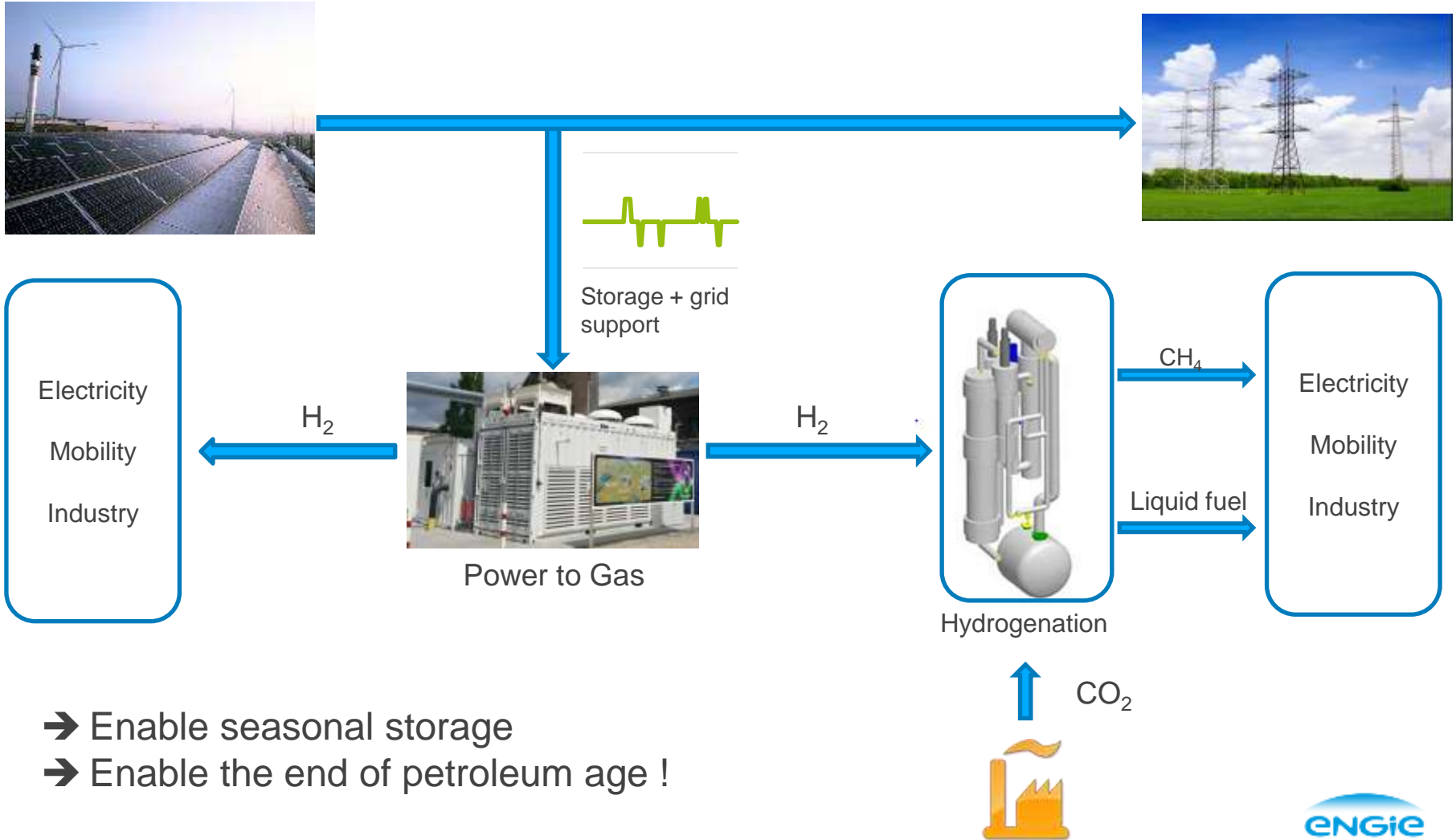


8500 h/year @ 20 % load
50% Certified as Green electricity

- ➔ With the current CAPEX cost of Electrolyser, it's necessary to run it at “base load” to have an already profitable price per kg H₂.
- ➔ In Belgium, Waste to Energy plant are the best candidates to start a massive Hydrogen production



Green Hydrogen what else?



- ➔ Enable seasonal storage
- ➔ Enable the end of petroleum age !

Conclusion

- Currently Hydrogen is produced by Steam Methane Reforming emitting lot's of CO₂ (10t/t H₂)
- Hydrogen is a key element in the Energy transition. Without green H₂ it is not possible to achieve 100% renewable!
- This Hydrogen must be produced from renewable electricity sources.
- Only a Mobility application can help to decrease the investment cost of Water Electrolysis!
- Waste to Energy plants are currently the best places to produce green H₂, it is a fantastic way to improve the image of waste incineration!
- Waste incineration should be seen as the COP 23 enabler!