



Reliable

Efficient

Flexible

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Power

Activities since 2004

Commercial

- Fuel cell education tools
- Fuel cells test equipment
- Laboratory hardware



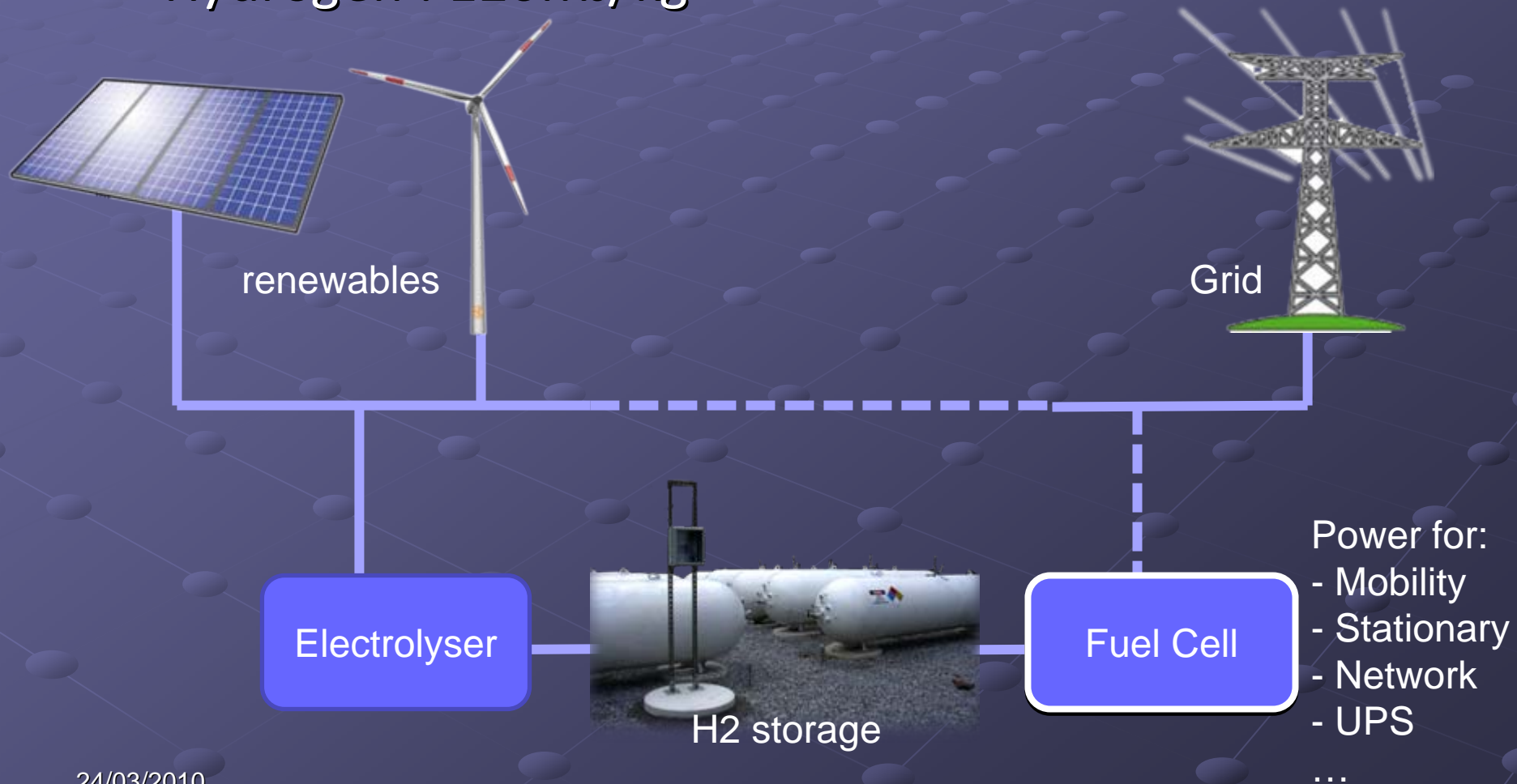
Research

- Innovative fuel cell designs
- New conductive materials for fuel cells



Hydrogen to store energy

- Which solutions to store massive amount of energy?
- Hydrogen : 120MJ/kg



« Pure » H₂ storage

Liquid form (LH₂)

- High storage density : 15%
- High volumetric density : 0,23 kWh/L
- Storage temperature : 22K
- Vaporization issue

Material issues

- Highly isolating material
- Material able to withstand very low temperature

Gaseous form

- Low/average storage density : up to 5%
- Low volumetric density : 0,016 kWh/L
- Easy to deliver (pipeline)
- Hydrogen build up

Material issues

- Hydrogen build up and consequences (cracking and fissure)
- Material able to bear high pressure
- Weight issue to increase storage density

Chemical storage

Reversible metal hydrides

Properties of some material to adsorb and release hydrogen according to the pressure and temperature conditions

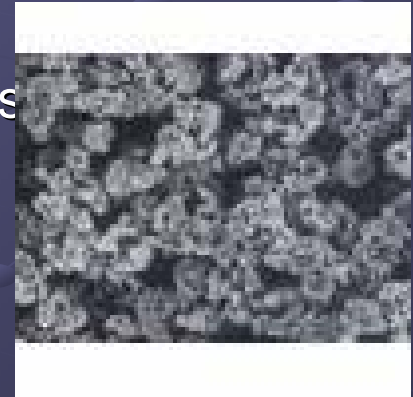
e.g. Fe-Ti alloy, Mg, LaNi₅

- Low/average storage density : up to 5%
- Various temperatures for refuelling/discharging process
- Long term stability
- High safety
- Low storage cost

- Average to high purchase cost

Material issues

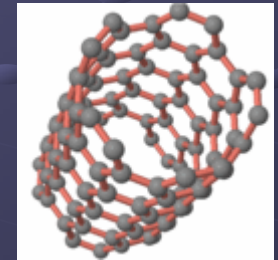
- Powder dimension as important element
- Suitable for mobile applications as well as stationary.
- Alloy/mixture components



Carbon nanotube

Hybrid way to store gaseous hydrogen into powder.

- High storage density expected (10 to 50% depending on sources)
- Low weight
- Toxicity
- Still under developpement



Material issues

- Production process needs to be scaled up to industrial level

Conclusions

- H₂ is complementary to renewable energies
- It is a great solution for storing large amount of energy and converting it into electricity as needed, leading to:
 - optimized business models
 - optimized power distribution networks
- Powders and nanotechnologies are a key sciences for delivering versatile and effective H₂ storage techniques in the near future.