Electricity storage for the energy transition

19th of April 2016 - JSPH2

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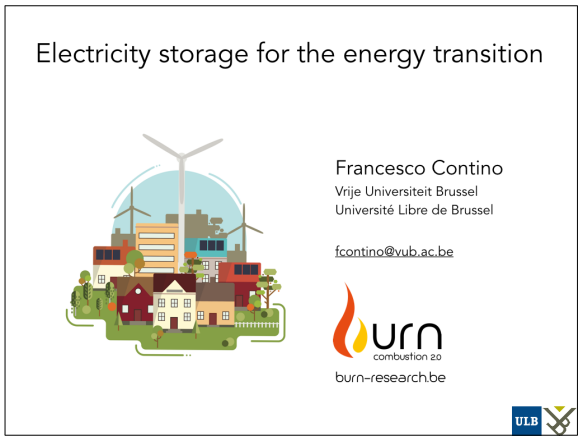
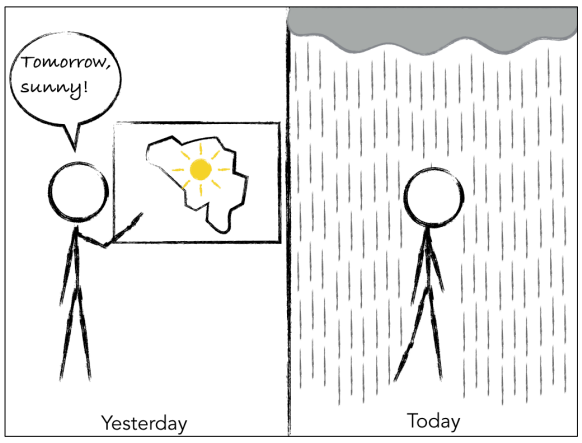
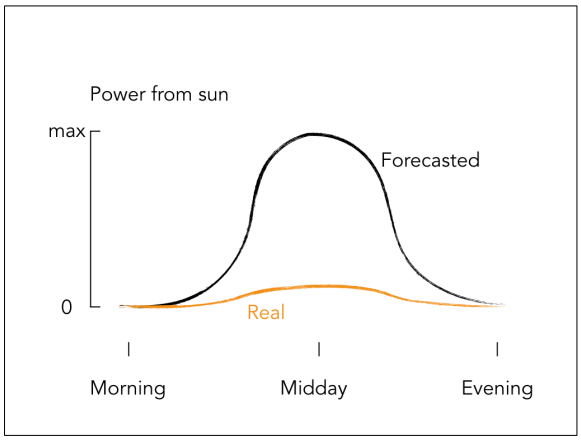
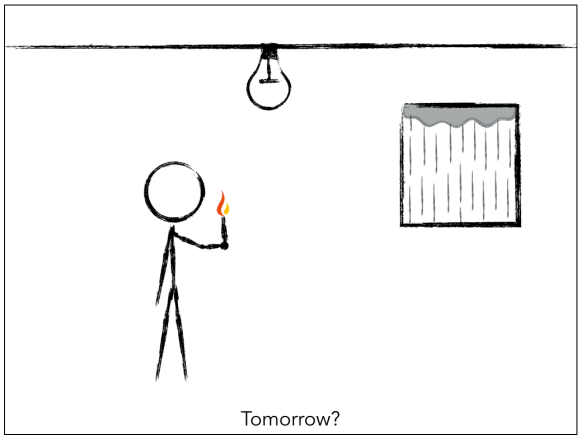


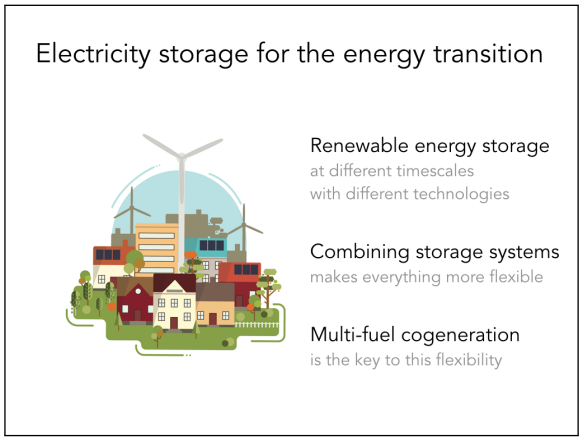




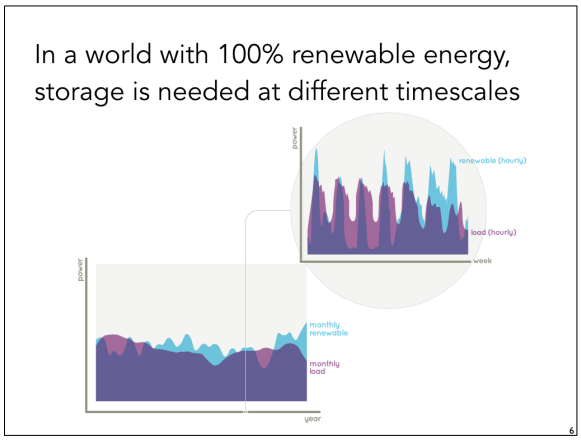
When a forecasted sunny day becomes a typical Belgian rainy day, the difference between the expected power production coming from the sun and the real production is significant.
In the current context, this leads to no real issues except some headaches for the TSOs, and DSOs.



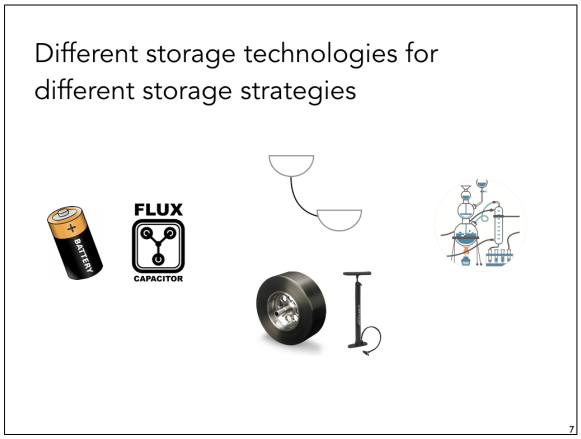
In a future where we hope to have much more renewables. Is that going to be a problem?



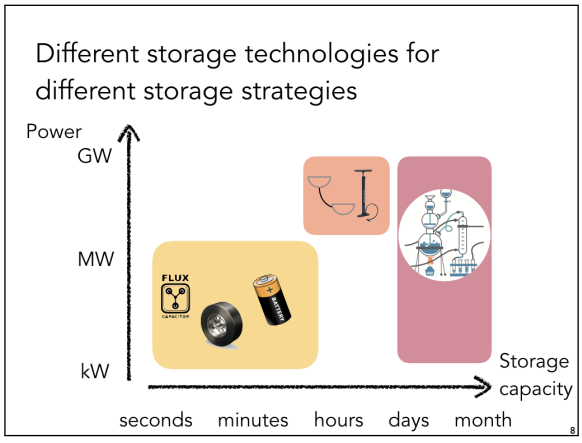
This presentation focuses on the solutions for electricity storage presented in three main parts.



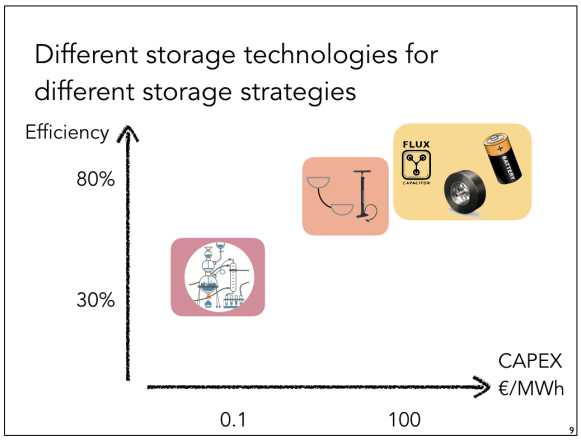
Within 2050, we expect to have a significant portion (if not all) of the electricity produced from renewable sources.
Some of these sources are hardly predictable and anyway in mismatch with our consumption. This mismatch is not only at the scale of a year but also at the scale of minutes.
Therefore storage is needed in a large span of timescales.



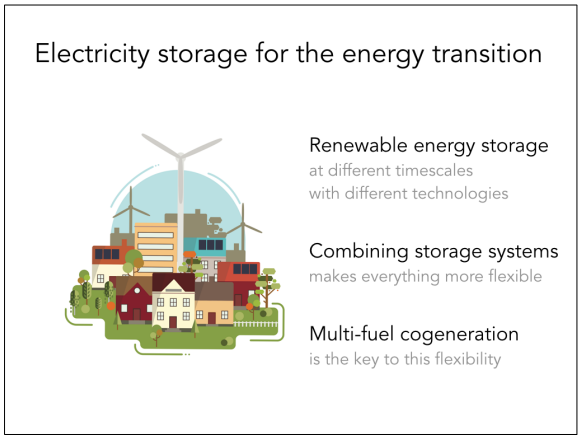
Many storage systems exist. They are based on different principles: electric/magnetic, mechanical, or chemical.

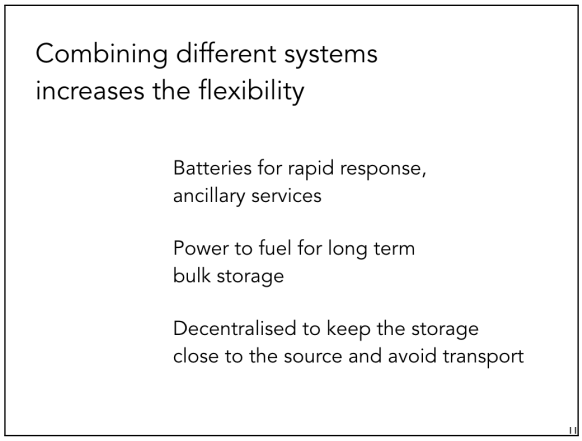


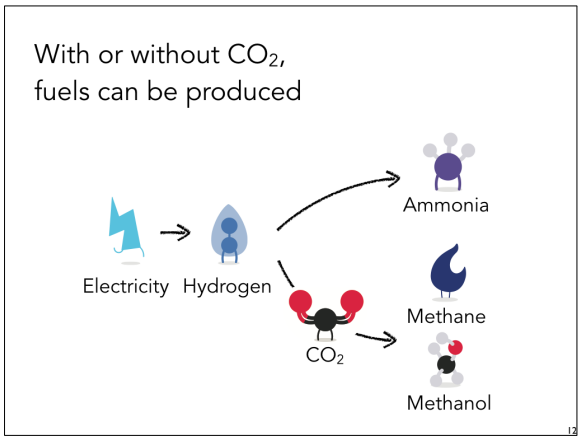
The two important features for storage systems are the amount of energy they can store (capacity) and at what power they can discharge this energy. Batteries, super-capacitor, and flywheels are generally at low to medium power with a very small capacity. They are used for quick response. Pumped hydro and compressed air energy storage are generally at medium to very high power and have medium capacity. Chemical storage (or power-to-fuel) have extremely long storage capacity and a wide range of power.



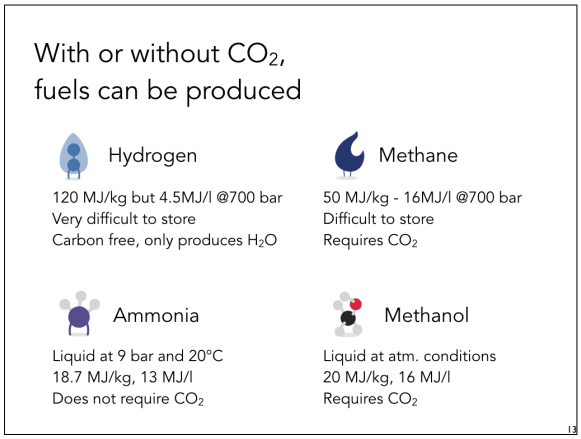
Another important comparison in addition to the previous slide is the roundtrip efficiency (from electricity stored to electricity retrieved) versus the investment per unit stored energy.
The power-to-fuel solutions have low efficiency (30-40%), much lower than the other solutions. But they have extremely low cost of storage, which explains why they are so applicable to long time storage. This all relates to the high energy density of the fuels.



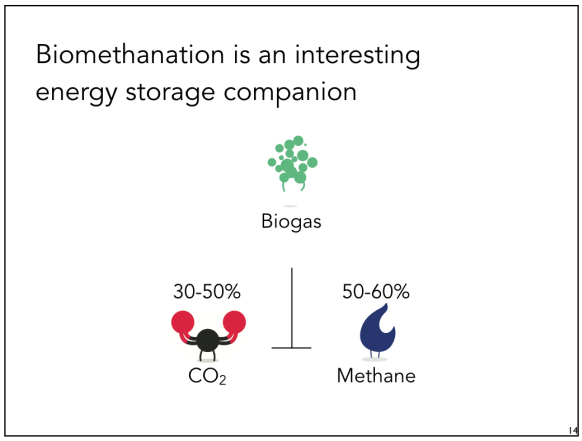




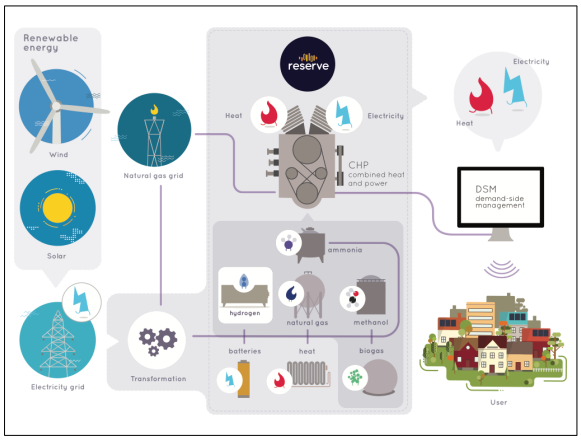
When storing electricity into fuels. Several options are available. The first step is generally water splitting and the production of hydrogen in an electrolyser.
When no CO2 is available, we can use the nitrogen from air and produce ammonia (NH3).
When CO2 is available, we can further convert hydrogen into methane or methanol.



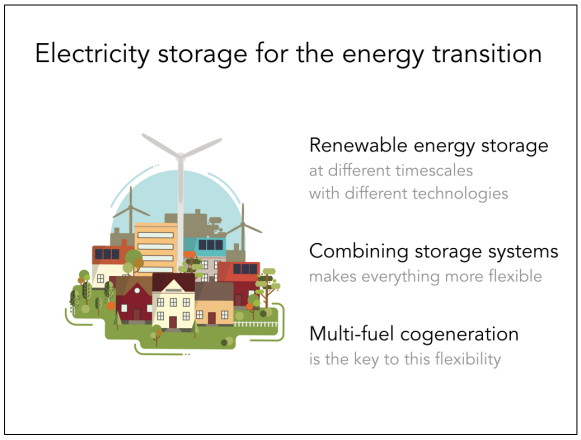
Hydrogen has a very small density and therefore is very difficult to store.
Converting hydrogen to ammonia helps solving the density problem since ammonia is easily liquified.
Converting hydrogen to methane or methanol has the advantage to reusing CO2 as a building block and building a circular carbon economy. Going to methanol provides an additional benefit since it is liquid at atmospheric conditions and then with higher energy density.

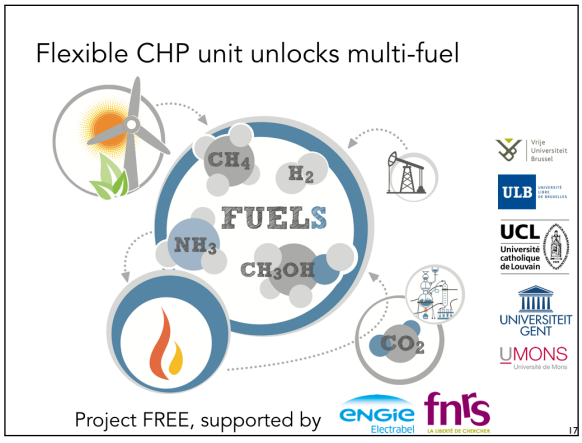


Several processes can be coupled to the storage system because they present interesting synergies. One of these processes is biomethanation. Since biogas has a large share of CO2, it is less energy intensive to recuperate and use in the carbon based fuels.



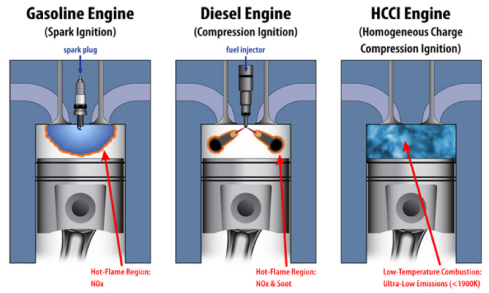
We have called the whole concept RESERVE (Renewable Energy StoragE in Resilient and Versatile systEms)





One of the key concepts that needs to be addressed is the use of flexible combustion systems able to be efficiently operated with different fuels. This topic is studied in the project FREE (more details on www.burn-research.be)

Concept based on engine operated in homogeneous charge compression ignition



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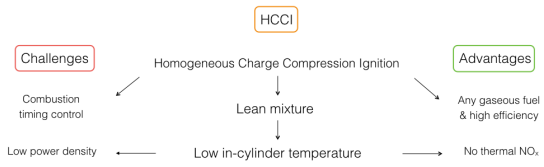
Despite their suitability for multifuel, HCCI engines raise 2 challenges



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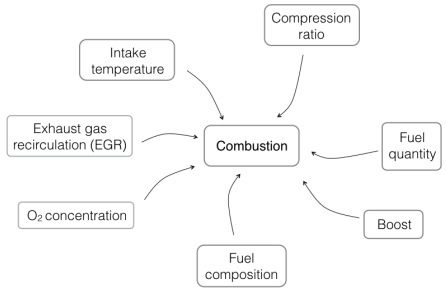
Fuel flexible HCCI engine require appropriate control techniques



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Some additional flexibility could be provided

- Multi-mode (switching with traditional SI)
  - Using natural gas
  - Flexible power
  - Flexible heat to power ratio
- O_2 utilisation
  - From electrolyser
  - Additional control and boost for engine

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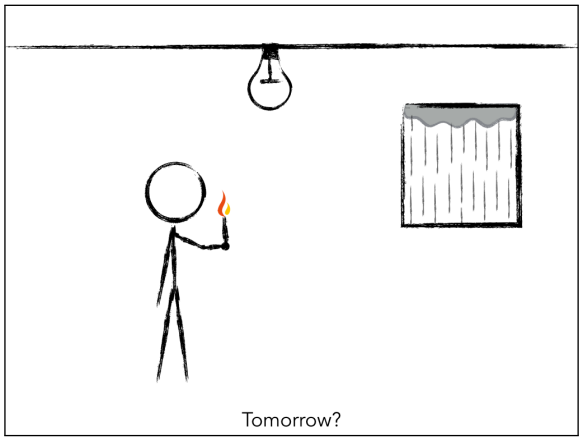
Electricity storage for the energy transition

Renewable energy storage
at different timescales
with different technologies

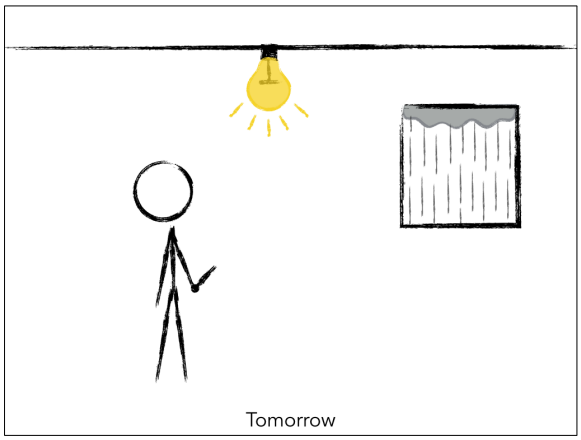
Combining storage systems
makes everything more flexible

Multi-fuel cogeneration
is the key to this flexibility



Tomorrow?

Our electricity consumption in the future will most probably not be directly affected by the weather. But it will require a massive rollout of storage solutions



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