Optimisation of flywheel energy storage

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E.Vercruysse - Probatex

Program

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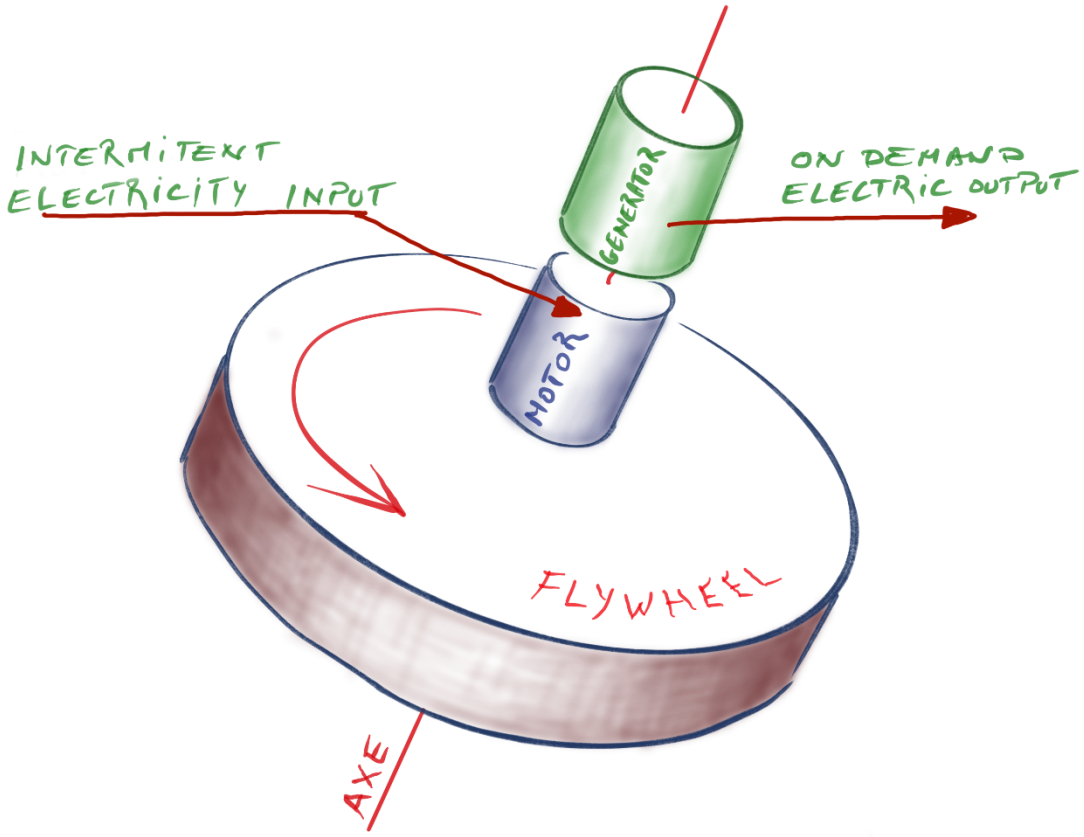
Context

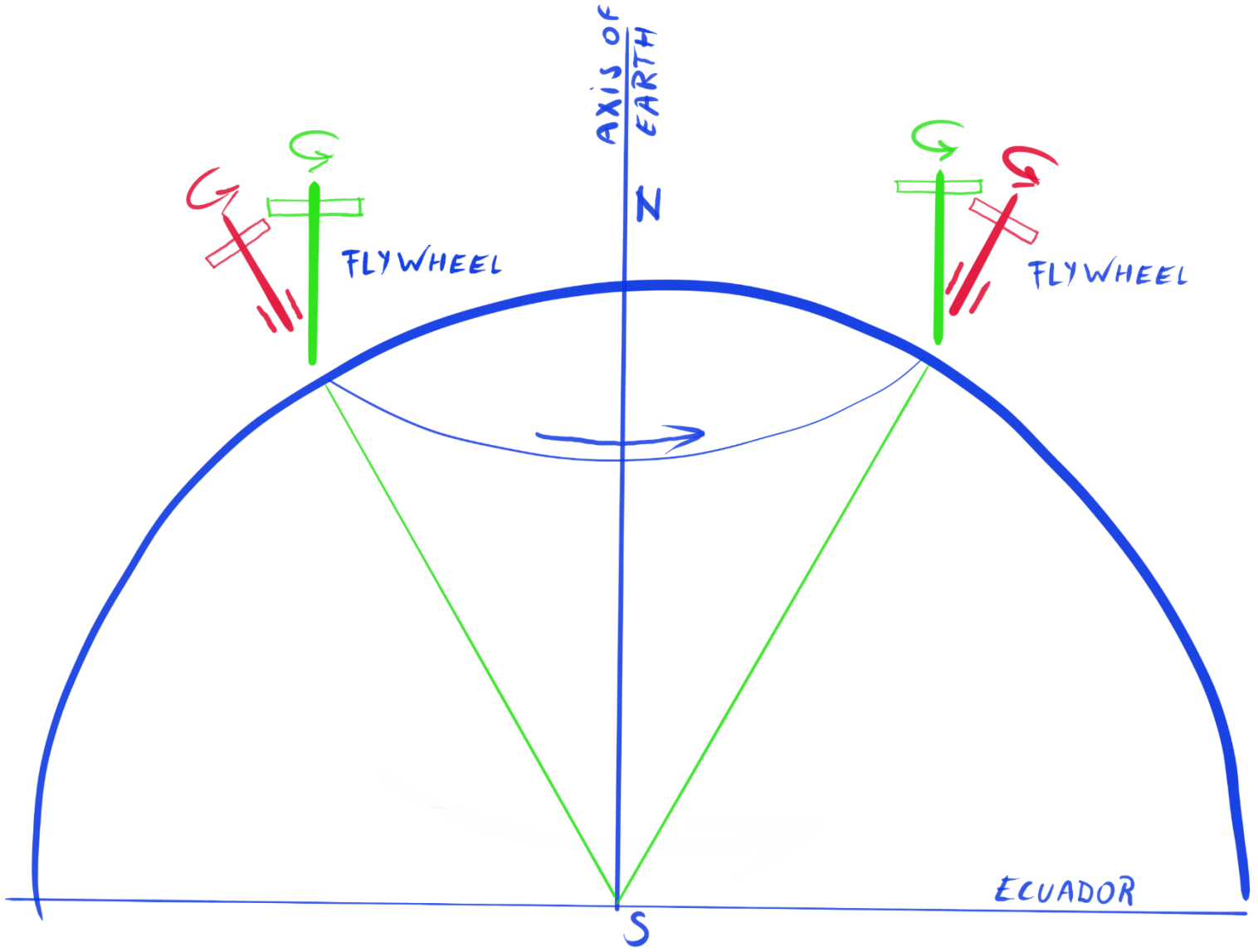
- The EU has set itself the target of reducing greenhouse gases.
- To this end, particular emphasis is being placed on renewable energies.
- These renewable energies produced in the form of electricity are intermittent.
- Energy Storage is a must.
- Kinetic flywheel is an efficient energy storage.
- A flywheel allows electrical energy to be stored as mechanical energy and subsequently returned as electrical energy.
- **It is possible to significantly improve its efficiency.**



The flywheel issue

- The intermittent renewable energy transmitted to a flywheel can be stored for a period that depends of the capacity of the flywheel and of its peripherals equipment's. The storage lasts currently for about 30 minutes and rarely exceeds 60 minutes.
- Our study proposes to extend this period up to at least 24 hours in order to enable long term renewable energy storage. This breakthrough would ensure a continuous supply to the grid from intermittent electrical energies.
- In a simple Newtonian system submitted to conservative forces, the sum of energies shall remain unchanged, the final energy shall equal the initial energy. The total amount of energy stored in a flywheel, submitted to conservative forces only, will remain unchanged forever. It is sustainable.
- Non-conservative forces, such as heat losses in bearings, reduce the final available energy compared to the initial input. How can we reduce these forces?
- Other non-conservative forces : peripheral equipments

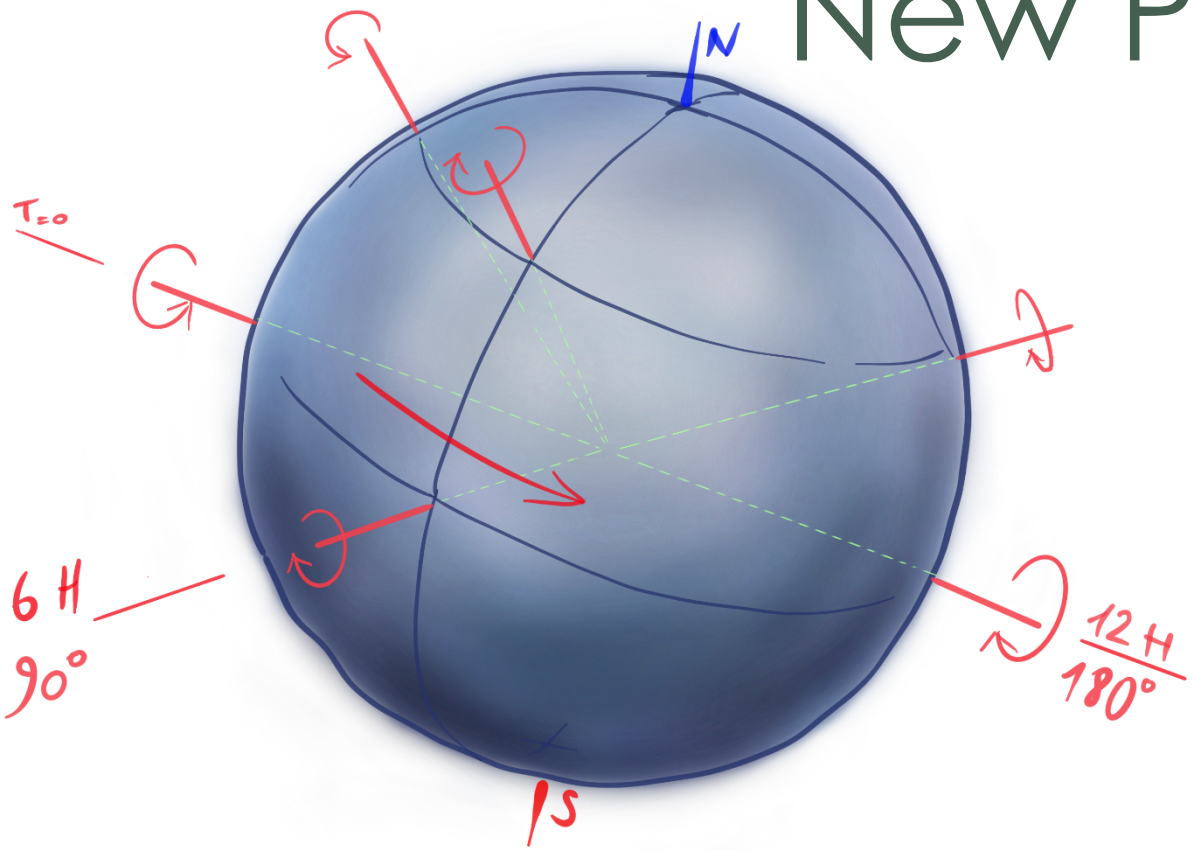
Flywheel orientation

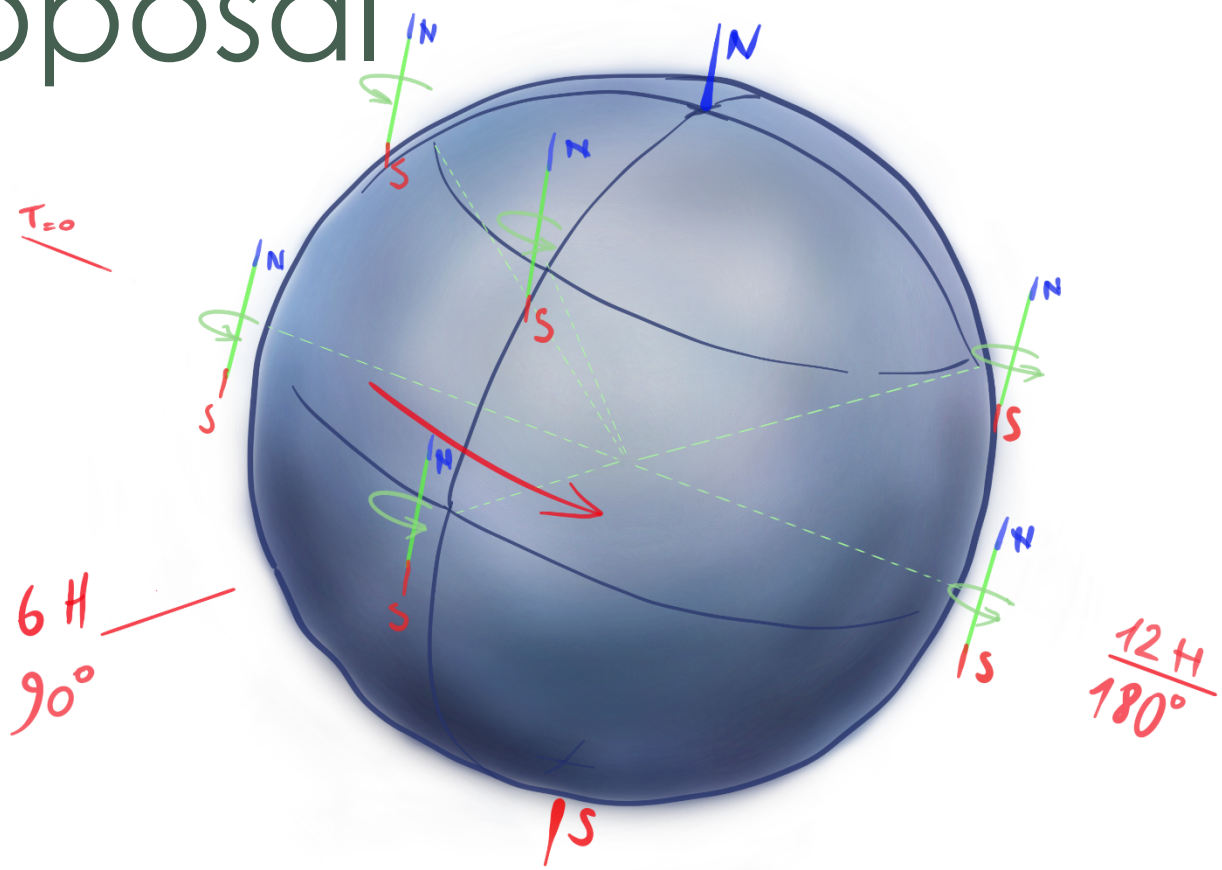


Current optimisations

- Vacuum chamber
  - The rotation of the flywheel is slowed down by resistance due to the air present in its chamber. Removing the air from the chamber will stop this resistance.
- Magnetic bearings
  - The contact of the flywheel with its bearings slows down the rotation of the flywheel. Magnetic bearings prevent this contact and friction. According to the Magnetic Bearings Organisation [1], the forces of attraction or repulsion of permanent magnets allow a body to levitate in its radial, axial or vertical direction.
  - However, according to the author, it is not possible to stabilize all the degrees of freedom of a body using only these permanent magnets. Three directions need to be stabilized for a kinetic flywheel unless the flywheel is initially stabilized parallel to the Earth axis. In this case, one less is needed. The proposal of this following author appears to be featured on sketches on page 2 [1] and guarantees this stabilization.

New Proposal



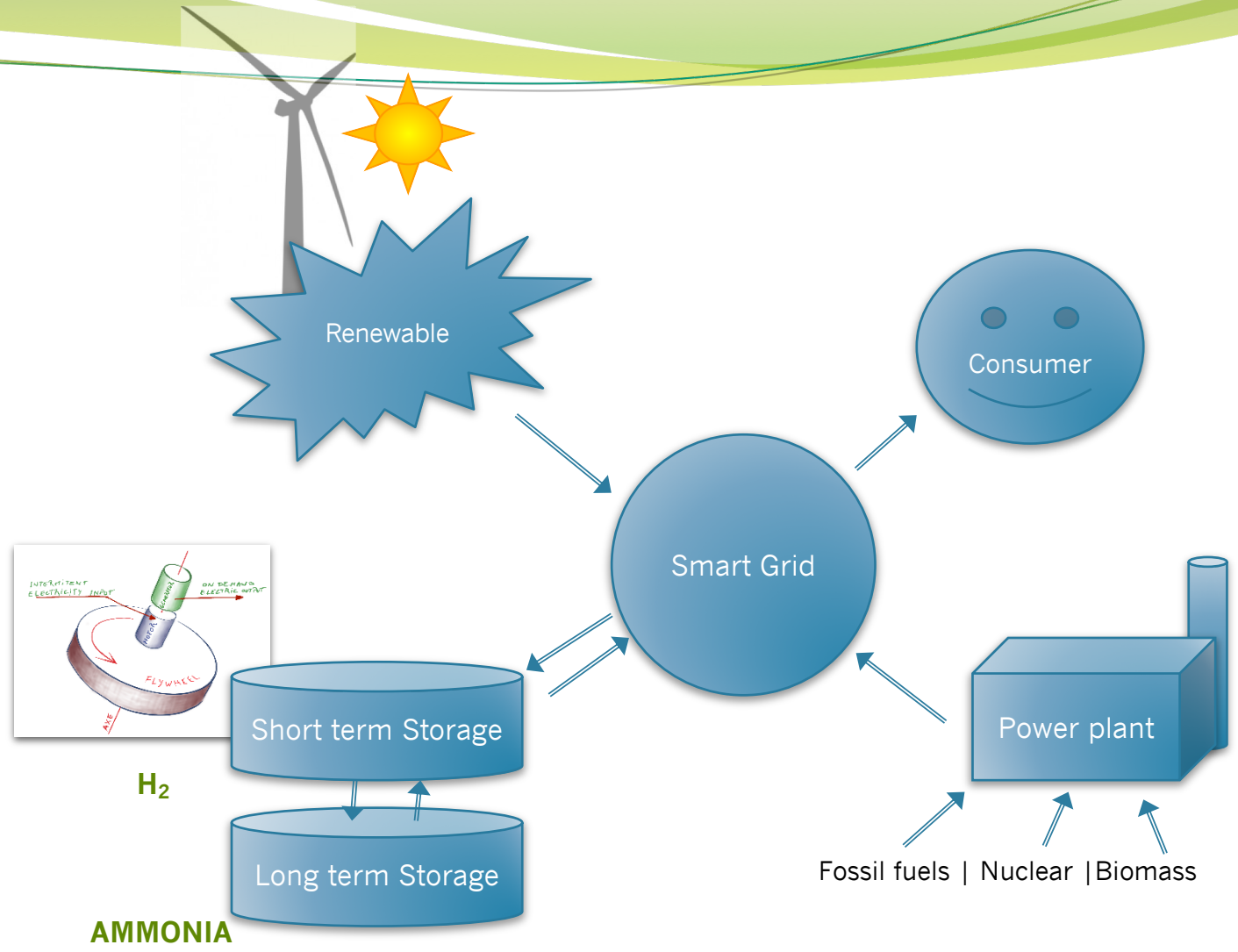


- The rotation of the flywheel is mainly braked by the friction that takes place in the bearings. It is a non-conservative force composed of a vertical part, due to the gravity, and of a variable part due to the earth rotation that modifies the initial orientation of the bearings while the wheel rotation aims at keeping its initial orientation, except in a *particular case*.
- Forced by its bearings to modify its orientation, the flywheel adapts itself and is braked by the friction forces that applies on the bearing and finally ends its movement. It is a non-conservative force which combines with the first one (gravity) and leads to energy losses.
- If the initial position of the wheel axle is parallel to the Earth axle, the Earth rotation will not modify the alignment of the wheel axle and its bearings. It is the *particular case*. In such case, the friction forces will be reduced.
- Currently, in conventional installations, the wheel axle is either vertical or horizontal without taking care of the parallelism to the Earth axle. This carefreeness leads to additional frictions between the bearings and the wheel axle whose orientation is going away from its initial orientation as the Earth turns around its axle.
- **A flywheel installed with its axle parallel to the Earth axle will however keep its energy at best and consequently extend its storage period.**

It appears that intermittent electrical energies can be stored for a prolonged period via kinetic flywheels whose axis runs parallel to the Earth axis.

Applications

- The aim of producing green electricity based exclusively on renewable resources requires significant electricity storage equipment both for resolving issues related to suitability between daily production fluctuations and consumption, and for taking into account seasonal variations in the production of renewable energies.
- Ammonia and hydrogen represent a genuine short and medium-term opportunity for Europe.
- In the short term, Europe will increase its intermittent renewable energy production capacity. These energies are becoming increasingly competitive due to their steadily decreasing production and storage costs.
- Ammonia and hydrogen therefore offer the prospect of replacing fossil energy imports with a competitive green fuel.
- In the medium term, when the European network is saturated with renewable energy, ammonia will be used for long-term storage in addition to hydrogen. Indeed, hydrogen is often proposed as a solution to store renewable energy. Ammonia supports hydrogen to facilitate storage and provide a high density and long term storage. It can even guarantee inter-seasonal storage.
- The long-term storage of intermittent electrical energies via a kinetic flywheel augurs well for numerous applications.
  - Flywheel energy storage for buildings.
  - Ammonia and hydrogen for power plants and the electricity grid of tomorrow.
  - Ammonia and hydrogen as a fuel for maritime air and earth transport



Thank you!

- This report and more available on

www.probatex.info

- References :
  - www.probatex.info - Publications – Le Stockage de longue durée de l'Energie d'un Volant Cinétique ; PROBATEX sc, Edgar Vercruysse, Ir.UG – 15 Mars 2017
  - [1] www.magneticbearings.org/technology,