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How to ensure the energy transition by the implementation of a disruptive technology?

1. Introduction

It is necessary to efficiently develop alternative, safe and renewable but intermittent energies such as solar energy. Storing calories or electricity can stabilize energy networks, smoothe production / consumption irregularities in the context of developing renewable energies, and supply energy to islands or remote sites.

For the production of energy, storage is essential: in reality, the production of energy is:

- either the transformation of a potential energy stock (fossil fuel, water stored in height, fissile material, etc.) into an energy directly usable for work (electricity, mechanical work) or thermal use.
- or the direct transformation of natural energy flows, over which human beings have no control. These are renewable energies, often derived from solar radiation.

From the physical point of view, there is never "energy production", but a transformation of available energy in nature. Storage is the building up of a stock of potential energy from energy flows that are not used immediately, to be disposed of later, when the demand is greater. Energy storage is a vital issue for human societies and industry. For individuals and companies, energy must imperatively be available on demand, without break. Any disruption of supply has a high economic and social cost in terms of health and safety.

Energy storage has three main motivations:

- securing the energy supply of a country or group of countries;
- adjustment of energy production according to demand;
- compensation for irregular production of so-called intermittent energies.

The two storage / destocking operations constitute a storage cycle.

The energy efficiency of a cycle corresponds to the ratio of the amount of energy recovered to the amount of energy that was initially sought to be stored. This ratio is generally less than 1 except for the natural means of storage of ambient energy where it can be considered infinite (division by zero), since nobody supplies the energy to be stored, which is in fact free. The energy efficiency of an energy storage cycle highly depends on the nature of the storage and on the physical systems used to ensure storage and retrieval operations.

In either case, each of the two storage and destocking operations invariably induces energy or material losses: some of the initial energy is not actually stored and part of the stored energy is not actually recovered. But for natural ambient energy, these losses mainly affect the economic depreciation of necessary investments: sunlight arrives even if the human does not capture it.

2. Large forms of storage

2.1 Storage of fuel

Combustion remains the most common energy process; it is the most developed storage.

2.2 Electrochemical Storage

On a smaller scale, energy storage for electricity production (electrochemical in batteries and other batteries, electrical in capacitors) is much less in terms of energy, but very important in practical terms.

2.3 Storage of calories

The storage of calories in a thermodynamic system already allows (by 2015) to shift (4 or 5 hours) the consumption peak; the hot water cumulus (3 GW of power) thus constitutes a reserve of 28 TWh, which corresponds to 10% of all the energy consumption of buildings in France.

2.4 Storage in the form of chemical energy

Storage in the form of chemical energy is widely used but does not represent the most important mode of storage. Thus, the generated hydrogen is transient and is not properly stored. It is a secondary energy and an energy vector; because resulting from a transformation of primary energy. Once produced, it is instantly consumed or lost: produced and consumed immediately to reduce pollution.

2.5 Storage in the form of mechanical energy

Storage in the form of mechanical energy consists in transforming the excess energy in the form of potential or kinetic energy. It is a virtually mandatory element in all engines, to regulate movement at very short time scales, lower than the second. It can be used for short term storage.

A. Storage in the form of potential energy

The energy is stored as a steam fluid under pressure.

B. Storage as kinetic energy

The energy is stored as kinetic energy by the rotation of one or more heavy disks called "flywheels of inertia".

2.6 Storage of thermal energy

Heat storage can be achieved through two different phenomena associated with materials that provide storage. This is referred to as sensible heat storage and latent heat storage.

A. Sensitive heat storage

In sensible heat storage, the energy is stored as a temperature rise of the storage material. The quantity of stored energy is then directly proportional to the volume, the temperature rise and the thermal capacity of the storage material. This type of storage is limited only by the difference

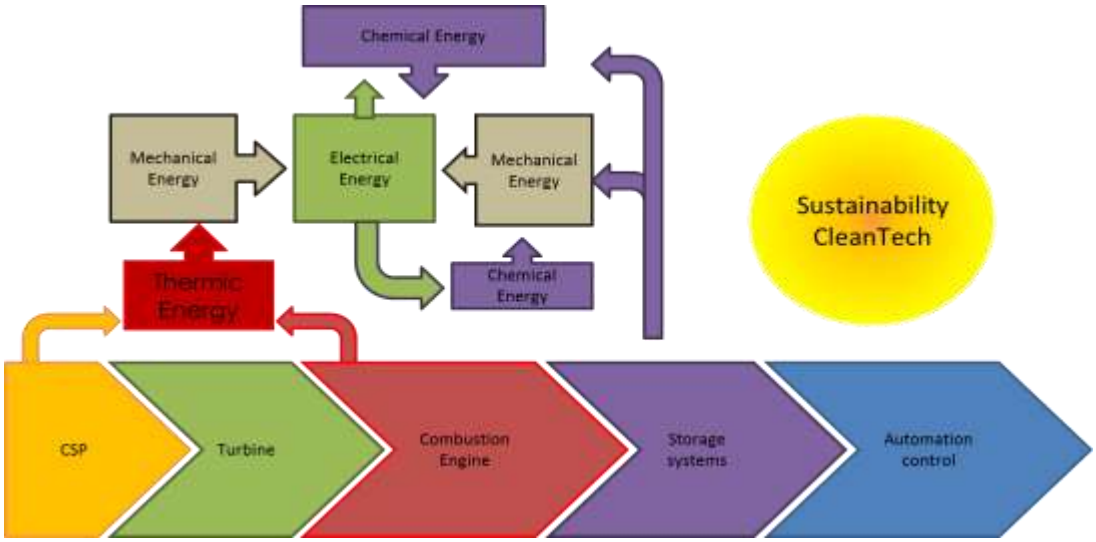
in temperature available and that supported by the material or its container, the thermal losses of the storage (linked to its thermal insulation) and by the possible change of state (or change of phase) which may be subjected to the material used for storage (vaporization).

B. Storage by latent heat

In latent heat storage, the energy is stored in the form of a change of state of the storage material (vaporization of the water). The stored energy then depends on the latent heat and on the quantity of the storage material (water) which changes state. Unlike sensitive storage, this type of storage can be effective for very low temperature differences. In the case of liquid / vapor phase changes, and for a quantity of stored energy and for water, latent heat storage requires less volume than sensible heat storage because the latent heat is much higher than the calorific capacity.

3. Conclusion

In order to generate energy on a continuous basis and in order for the micro-plant to be sized to provide the electricity needed for an individual dwelling in all circumstances, several processes are involved and collaborate. These are summarized by the following elements:



Storage form	Energy type	Reversible phenomenon	Irreversible phenomenon	Conversion
Light	Solar Energy		Refraction	Thermal Energy
Steam	Thermal Energy	Change of state		Mechanical Energy
Flywheel	Mechanical Energy	Electrical Energy -Kinetic Energy	Friction	Electrical Energy
Electric accumulator	Electrochemical Energy	oxidoreduction		Electrical Energy
Fuel	Chemical Energy		Combustion	Mechanical Energy
Hydrogen	Chemical Energy		Combustion	Thermal Energy

Some types of storage are efficient and represent future solutions such as fuel cells. However, beyond the scientific and economic potential, the cost of implementing these technologies and their maintenance must not be overlooked. The more complex a technology, the more expensive technical knowledge and equipment is required. The technologies of the LFree project are simple to implement and therefore accessible to developing countries to enable on-site manufacturing and create local jobs.