IMPORTANCE OF STORAGE SYSTEMS IN DEVELOPING MICRO-GRIDS AND SMART TECHNOLOGIES

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Abstract: Storage technologies have a huge financial impact on the clean energy sector by reducing financial losses due to outages and poor power quality. They can improve the return the investments in renewable energy structure and reduce end-user electricity costs. Because of their abilities, storage devices represent an important component of micro-grids; this structure being, basically, a weak electrical grid which can be easily subjects to disturbances. Also, the micro-grids can become the incubators of smart grid technologies, because they comprise almost all of the components of a larger grid. This paper is an overview of storage systems, and a review of micro-grids and the latest smart technologies.

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Keywords: energy storage systems, micro-grid, smart technologies.

1. INTRODUCTION

Energy consumption is rapidly growing worldwide and because fossil fuels are becoming fewer, exist a tendency to increase renewable energy use. The new renewable energy technologies are very useful to exit from the energy crisis that exist worldwide, but these technologies have also some, we can say major, drawbacks. Also, in the context of new energy policies adopted by EU, in the long term, attention must be directed not only to support renewable energy (which have already been widely implemented across Europe) but also investments must be made in energy efficiency in transport and industry , on which not much attention has been given so far.

The European Commission set important targets to improve energy efficiency by 2020, which is easier to achieve for countries such as Denmark, Germany, and France but for the recent EU entrants who have much to recover and face the acid financial crisis, will not be easy. The energy efficiency sector, where Romania, and not only, has much to recover, we can make a comparison of the level to which EU states are found by analyzing the tracker for energy efficiency from Table 1 [1].

Table 1.Tracker for energy efficiency within the EU, scaled from A (excellent) to G (poor) Published by Power-Gen Worldwide, Source: WWF and Ecofys [1].

COUNTRIES	INDUSTRY	ELECTRICITY SUPPLY	BUILDINGS	TRANSPORT	TOTAL
AUSTRIA	E	E	F	F	F
BELGIUM	F	F	F	E	E
BULGARIA	E	G	E	G	G
CYPRUS	E	E	G	E	E
CZECH REPUBLIC	G	E	F	F	F
DENMARC	D	E	E	D	D

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ESTONIA	D	E	F	F	E
FINLAND	F	F	F	E	F
FRANCE	F	F	E	C	E
GERMANY	F	D	D	F	E
GREECE	G	E	G	F	F
HUNGARY	E	D	F	G	F
IRELAND	F	C	F	D	E
ITALY	E	E	G	F	F
LATVIA	E	E	F	F	F
LITHUANIA	D	E	F	E	E
LUXEMBOURG	F	E	F	F	F
MALTA	F	G	F	F	F
NETHERLANDS	F	F	F	E	E
POLAND	G	F	F	G	F
PORTUGAL	E	E	G	F	F
ROMANIA	G	F	G	G	G
SLOVAKIA	F	F	F	F	F
SLOVENIA	D	F	F	E	E
SPAIN	E	D	G	F	E
SWEDEN	E	G	E	D	E

In terms of renewable energy, we can say that Romania is still in the category of “states left behind” which includes almost all the recently EU entrants and this is because of some disadvantages of renewable technologies. These would be high cost to implement the latest technologies in the field of clean energy and at the same time still a high cost of energy from renewable sources. For countries that are facing economic crisis these two big drawbacks lead to a slowdown in the process of implementing clean technologies. One solution to this problem would be to use the local network, isolated, new renewable generation, named micro-grid, which, although they have the same structure as a national distribution grid, implies lower costs.

2. ENERGY STORAGE TECHNOLOGIES USED UNTIL NOW

The possibility of storing electrical energy exist from long time but storage methods are still the weakest link of the energy domain, and in the same time is a key element for the growth of renewable energies. More than this, storage becomes crucial if the energy source is intermittent and located in an isolated area [2].

The most widely used storage technologies are far [2-4]:

- Pumped hydro storage (PHS);
- Thermal energy storage (TES);
- Compressed air energy storage (CAES);
- Energy storage coupled with natural gas storage (NGS);
- Energy storage using flow batteries (FBES);
- Fuel cells-Hydrogen energy storage (FC-HES);
- Chemical storage;
- Flywheel energy storage (FES);
- Superconducting magnetic energy storage (SMES);
- Supercapacitors.

Energy storage systems provide the ability to [5]:

- balance power demand and supply;
- reduce electric surges and sags;
- maintain power frequency;
- ensure power remains available for critical loads when power outages occur;
- supply enough power to maintain operations until systems can be shut down;
- furnish enough power until other on-site generation sources come on-line.

Because of these skills, storage technologies have a huge impact on developing smart technology. All these storage systems can be divided in two categories, represented schematically in Figure 1.

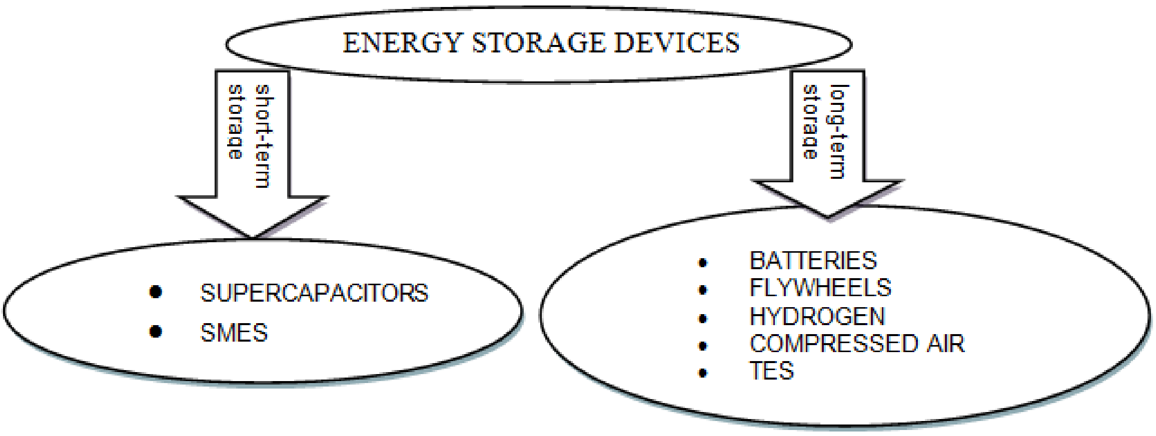

Fig.1. Classification of energy storage systems.

3. MICRO-GRIDS AND SMART TECHNOLOGIES

One of the main objectives of the European Union is that until 2020 to cut greenhouse gases by 20 per cent from 1990 [1] and a solution to achieve this, in the electric utilities, is to implement Smart Grid and smart meter technology. With the use of smart grids less power needs to be generated, also the frequency and duration of outages are less. Substituting high carbon emitting energy sources such as fossil fuels with renewable energy can reduce emissions and help achieve the European Union's 2020 target of cutting carbon emissions [6].

To make the grid 'smart', numerous technologies and devices for implement new electric system are needed. In Figure 2 are found the various components of the Smart Grid as described by the US Department of Energy (US DOE) [7].

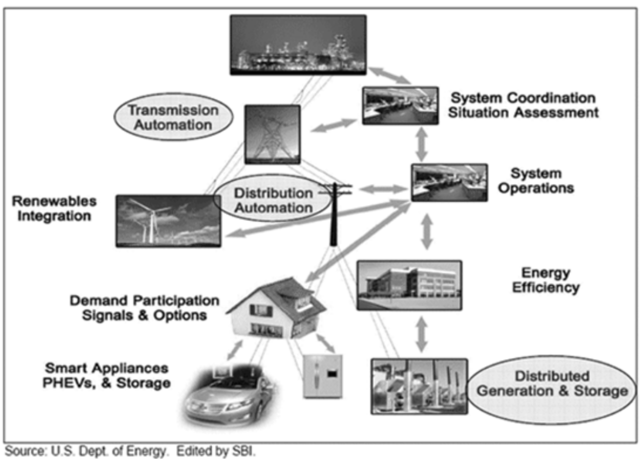

Fig.2. Smart Grid components schematic. Published by Power-Gen Worldwide, Source: US DOE, SBI Energy [7].

However, for development the Smart Grid, the transmission and distribution system needs to be upgraded and provided with intelligent components and devices that can act autonomously when required, and collect and transmit grid operational data in real-time to allow operators to react to potential problems before they occur.
The micro-grid offers an alternative way for smart grid development because they comprise almost all of the components of a larger grid, but are much smaller.

The main components of a micro-grid are:

1) Energy sources for power generation (from fossil fuels to renewable sources);
2) Power storage devices;
3) Elements for distribution to user loads.

Considering all these we can say that the microgrids can become the „incubators" of smart grid technologies much faster and for much less cost than can be done on the larger electric grid. Because they use distributed energy resources of all types, micro-grids could be interconnected to form a large Smart Grid [7].

The micro-grids are also known as minigrids, off-grids and remote electrification grids and they can be classified into four categories:

1) Smart micro-grids;
2) Islanded or decentralized micro-grids;
3) Hybrid micro-grids;
4) Rudimentary micro-grids.

Micro-grid installations around the world include „everything from diesel generator-based rural electrification projects supplying electricity to small remote villages to large futuristic cities and theme parks powered by multiple forms of renewable energy" [8].

4. CONCLUSIONS

- The support for renewable has been widely implemented across Europe but improvements in energy efficiency in transport and industry was left behind.
- Most important benefits offer by energy storage solutions are that they can improved flexibility for grid operators, can increased national energy security, and reduced environmental impact.
- We already know that the possibility of storing electrical energy exist, whenever and wherever they are needed and in any quantity but the cost for implementation new technologies in energy sectors is a major drawback.

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