## Energy Storage Technologies

In a power system, energy demand must be supplied instantenously to preserve stability and quality of the system. Stability and quality of a power system decreases as an imbalance between supply and demand occurs. Scheduling of power systems with varying net load profile decreases the overall efficiency because of the deviations from optimal generation spot.

With the help of ESSs, electrical energy can be stored when generation exceeds consumption and stored energy can be used later for compensating generation shortage when needed. By doing this, generation can be maintained at a constant level, which increases the overall efficiency of the system. ESSs can also be used for balancing short-term power fluctuations.

With the increasing penetration of renewable energy to power systems, security and reliability issues must be handled carefully, because of unpredictable and inconsistent nature of renewable energy sources. To cope with this problem, ESSs can be used to smooth out variable power generation of RESs, whichh makes renewable sources more reliable.

Widely-used categorization of ESSs is according to the form of energy used; mechanical, electrochemical, chemical, electrical and thermal. These categories are as follows:

General properties of ESS can be described as follows:

* **Capacity:** energy that can be stored in the system, depends on the storage process, the medium and the size of the system
* **Power:** how fast the energy stored in the system can be discharged and charged
* **Efficiency:** ratio of the energy provided to the user to the energy needed to charge the system
* **Storage period:** how long the energy can be stored
* **Charge/discharge time:** how much time is needed to charge/discharge the system
* **Cost:** the capital and operation costs of the system

While choosing the suitable ESS, these given properties must be carefully analized for a given power system.

**Battery Energy Storage System (BESS)**

**State of Charge (SOC):** SOC of a battery is the available capacity of the battery perncetage of its rated capacity. To overcome the problem of depleting or overcharging the battery, SOC of the battery should be kept within suitable limits and controlled according to these limits.

**Deep Discharge:** With increasing depth of discharge (DOD), cycle life of a battery decreases. To prevenst this situation, maximum discharge current of a battery should be limited.

For this study, the model developed in **[5]** is used for simulating battery charge/discharge characteristics and SOC of the battery. The model proposed in **[5]** is the simplified version of third-order model developed in **[6]**, **[7]**.

**Thermal Energy Storage**

Thermal energy storage units can be used to change a building’s heating load profile by storing heat to be used later, while maintaining a comfortable temperature. With TES units, heat demand can be supplied with stored energy, which can be applied to shift electricity consumption.