Mid-term storage strategies ensuring flexibility by using hybrid power system

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Worldwide concerns about climate change, the Climate Agreement, and the energy crises created by geopolitical tensions have all contributed to accelerating the energy transition to a sustainable energy sector. Thus, replacing traditional fossil-fuelled power plants with clean, renewable generation is key for the energy sector transition. Currently, wind and photovoltaics are the two dominant renewable energy sources. This is due to the large cost reductions of these technologies resulting in the fastest-growing forms of renewable generation in recent years, and they are likely to generate the highest shares of renewable energy in the future. The energy transition faces significant challenges as the electricity grids must maintain a balance between demand and supply. Energy generation from conventional fossil-fuelled power plants can be controlled and generated depending on the energy demand. Currently, electricity grids have enough flexibility to balance changes in demand due to the existing fossil-fuelled power plants.

On the contrary, photovoltaic and wind turbines are variable renewables and are inflexible. As the availability of natural resource determines their potential for energy generation. As the penetration of renewables increases, balancing energy supply and demand becomes increasingly challenging. To reduce this intermittency, combinations of renewable energy technologies will be required. Wind based hybrid systems with photovoltaic are the most promising for power generating sources, due to their complementary nature which is an advantage. Wind speeds are often low in periods when the solar resource is at its best. On the other hand, the wind is often stronger in seasons when there is less solar resource. But these sources depend on the highly unpredictable weather, thus making the design of a hybrid system complex. Storage is a key renewable technology that will limit the challenges posed, by the intermittency of the sources. But no single storage technology is well suited for the complete time scale; thus, multiple storage technologies will be required.

This thesis aims to investigate medium-term storage of duration of 4hrs to 200hrs [1] to compensate for the intermittency of wind and solar generations. During this thesis, different types of storage technologies that are suitable for medium-term storage will be explored. These storage technologies will be used to design an optimum configuration for medium-term storage to increase the flexibility of the renewable energy generation system so as to be able to meet the required energy demand.

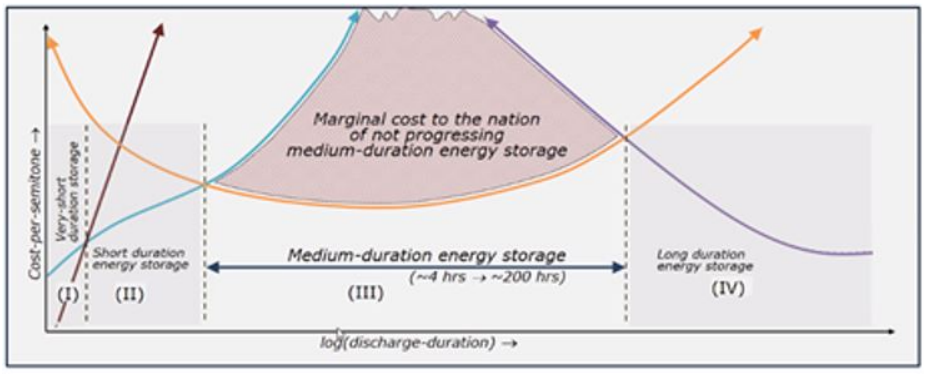

Figure 1: The Four main durations of energy storage.