Study of different use cases of the grid connected Battery Energy Storage System in India

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Greening the Grid (GTG) Program

A Partnership between USAID/India and Government of India

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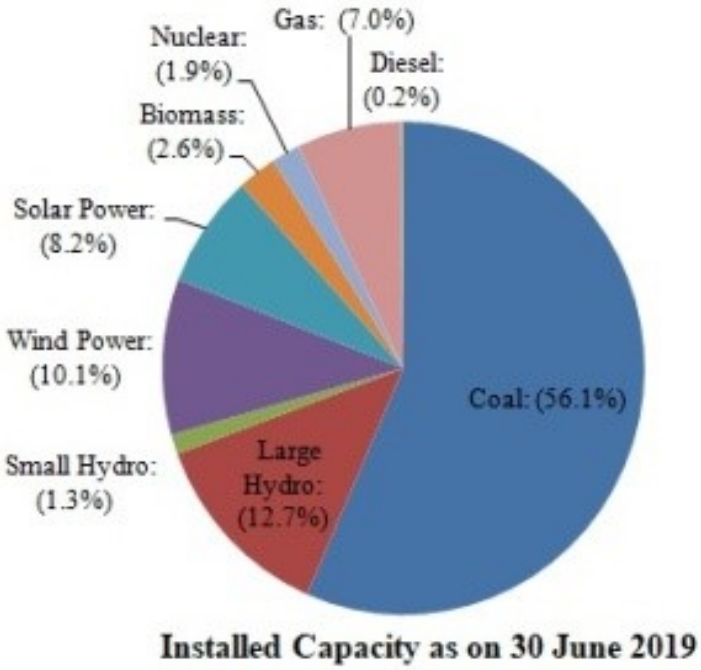
Indian Power scenario

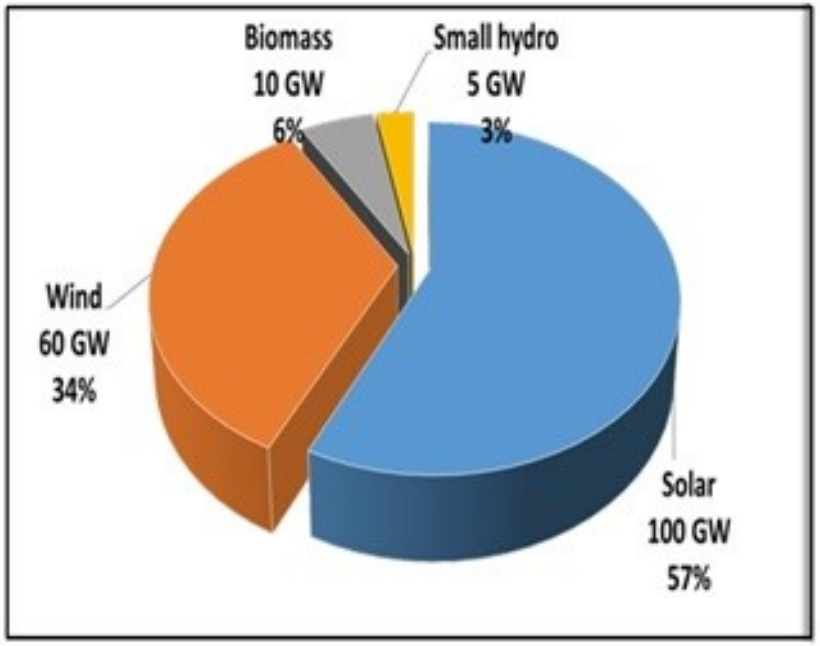


Installed Capacity as on 30 June 2019

- Third largest grid in the world
- Rapid growth in power sector due to Economic growth, increase in industries, Urbanisation and increase in demand due to agriculture over couple of years
- More than 350GW installed capacity
- Largest transmission network with highest transmission voltage of 400KV, 765KV, 1200KV HVAC and ±500KV, ±800KV HVDC

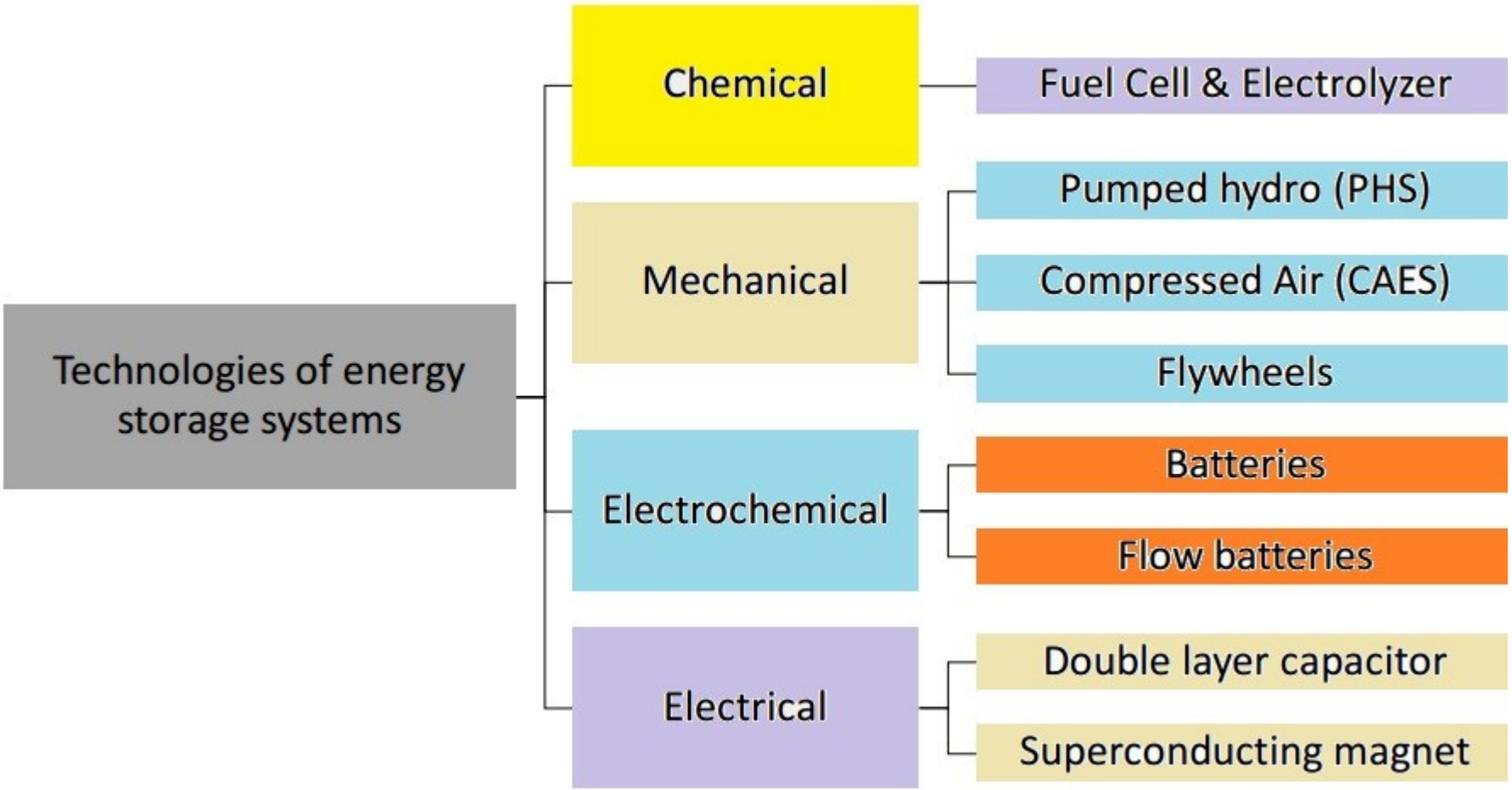
Renewable energy and its challenges in India

- India is one of largest Renewable Energy Installed country
- It has target addition of 175GW RE Generation by 2022
- Challenges includes intermittency and uncertainty in RE generations
- Power quality issues – THD, increase in demand of reactive power, voltage fluctuations etc.

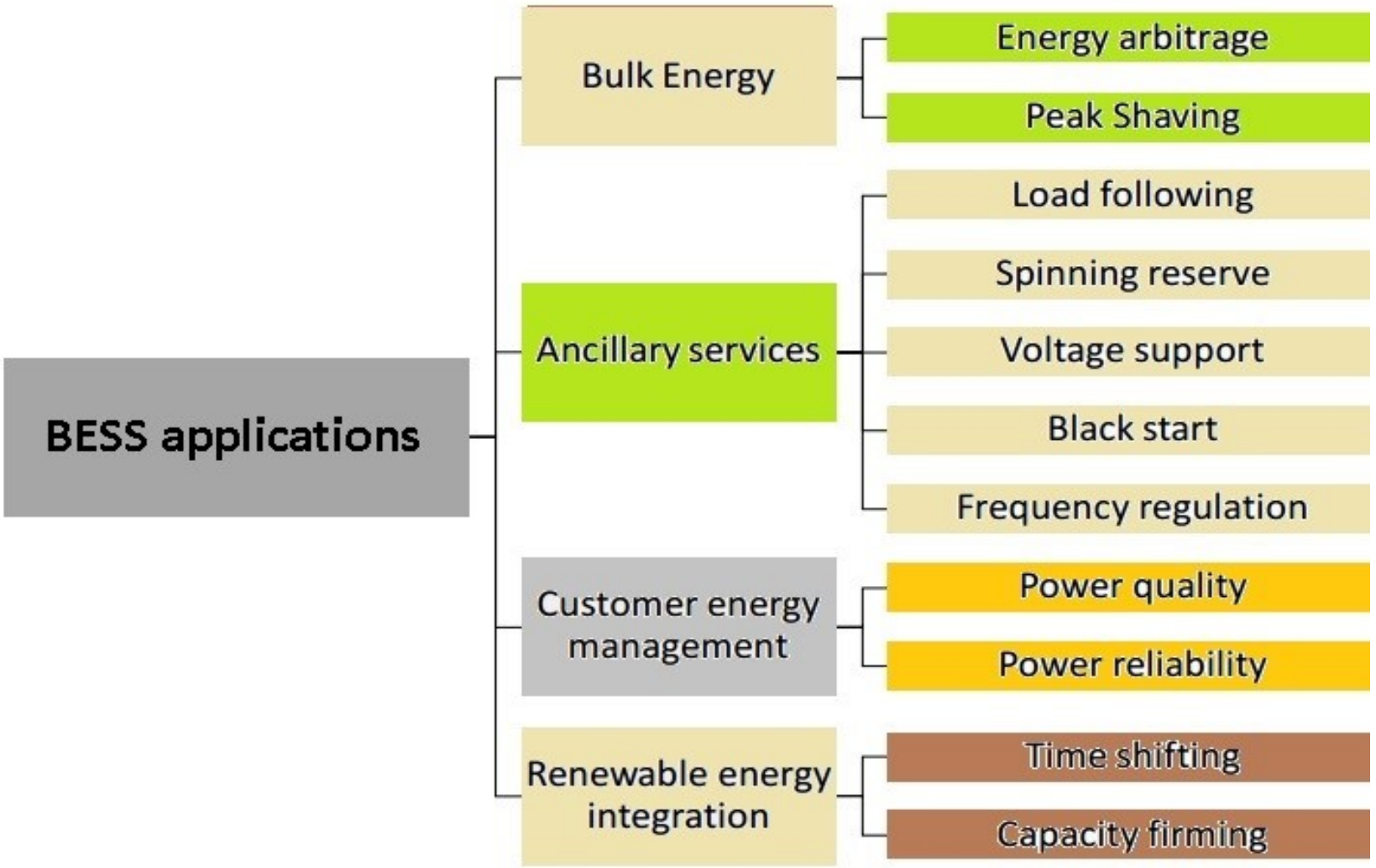


RE installation target by 2022

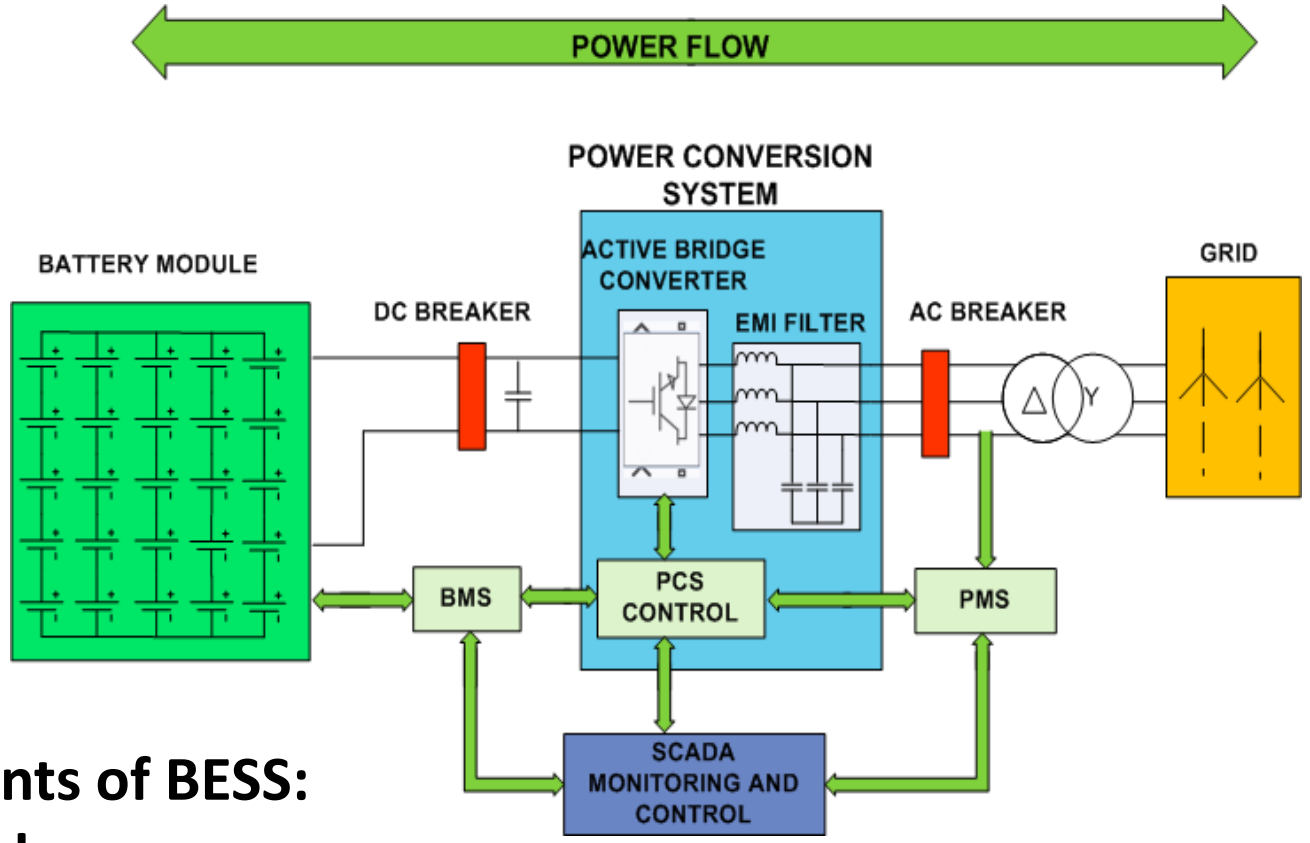
Battery Energy Storage Systems and its applications



Battery Energy Storage Systems and its applications



Battery Energy Storage System: Architecture



Major components of BESS:

1. **Battery modules**
2. **Battery Management System (BMS)**
3. **Power Conversion System (PCS)**
4. **Power Management System (PMS)**
5. **Bay Control Unit (BCU)**
6. **SCADA for monitoring and control**

Pilot Project-Puducherry

- POWERGRID has taken initiative to test different battery technologies for various grid scale applications. It has planned for three different technologies namely Li-ion, Advanced Lead Acid and Flow batteries of 1.25MW capacity together on pilot basis

Advanced Lead Acid	Lithium Ion	Flow battery
• Mature technology • Less Maintenance Requirement • Economical	• Fast maturing • Large number of Pilots worldwide • High Power Density	• Higher Depth of Discharge • Longer Life • Upcoming technology

Technical details of pilot implementations

Parameters	Li-ion Battery (BESS-I)	Advanced lead Acid Battery (BESS-II)	Flow Battery (BESS-III)
Capacity	250 kWh	250 kWh	1000 kWh
Power	500kW for half-hour	500kW for half-hour	250kW for four hours
Charging rate	3 hrs. from rated DoD to Full Capacity	3 hrs. from rated DoD to full capacity	5 hrs. from rated DoD to full capacity
DC-DC Round-trip efficiency	>90%	>80%	>75%
Service Life	10 years	10 years	10 years
Life-cycle	4000 cycles (900 MWh)	3000 cycles (675 MWh)	3000 cycles (2700 MWh)
Status	Under operation	Under operation	Under implementation

Applications of BESS pilot project

Under operation:

1. Frequency Regulation
2. Energy Time Shift

Under implementation:

1. Dynamic FR
2. RE firming
3. Load following
4. Reactive power compensation
5. Integrated applications

Frequency Regulation…

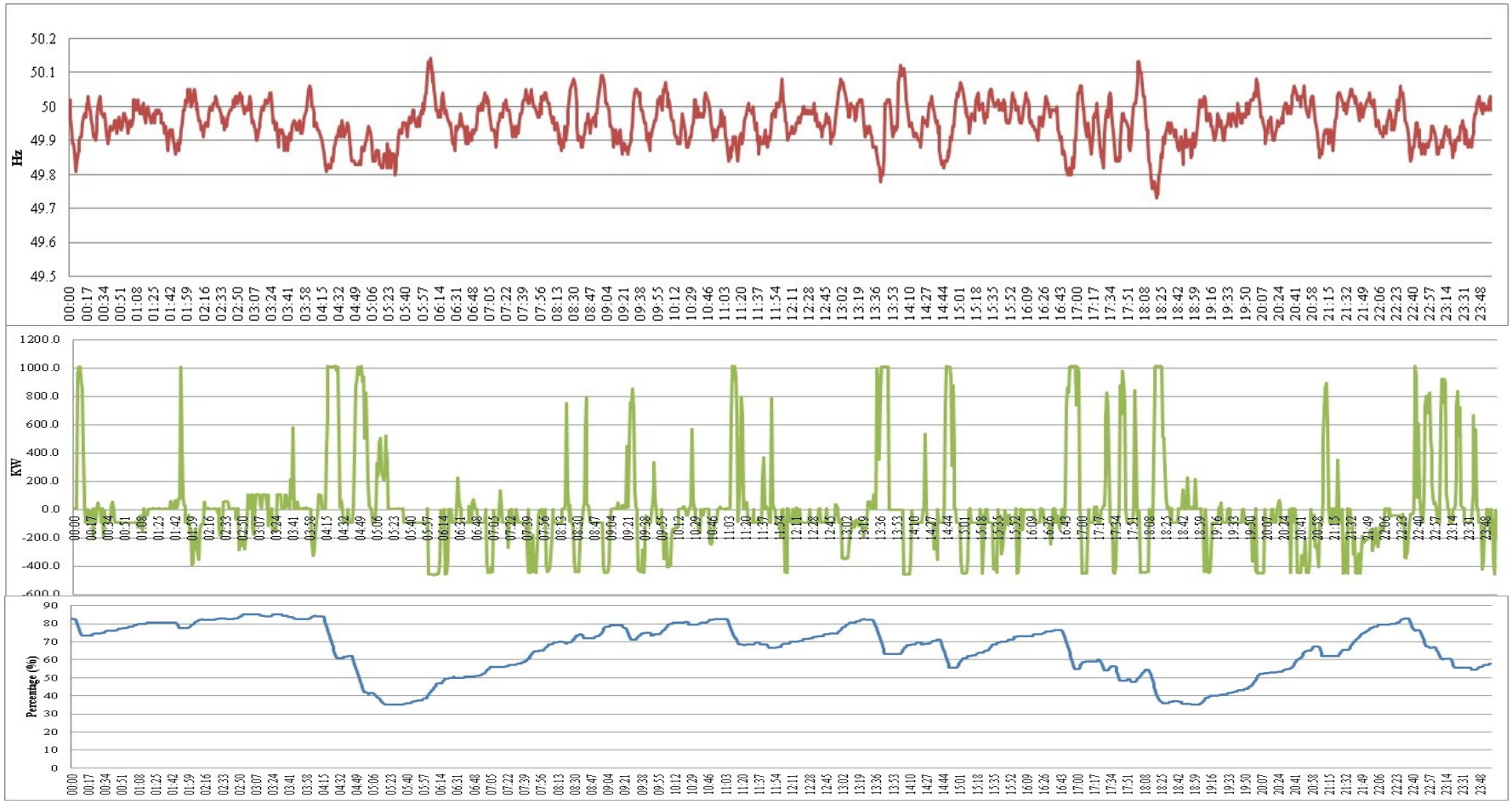


Fig:Frequency, BESS power and SOC under FR application for 24-hours

Regulatory requirements and commercial implications

- Ancillary services
- DSM regulations

Conclusion

- Increasing penetration of uncertain and intermittent renewable energy sources such as solar and wind can cause various problems in grid such as dynamic frequency, voltage fluctuations and demand-supply imbalance.
- A fast responding storage device such as Battery Energy Storage System (BESS) could be used to mitigate these problems in real time operation of power system by providing various grid applications including Frequency Regulation, Energy time shift and RE firming etc.
- This paper discussed about various ancillary services such as frequency regulation and energy time shift by different battery technologies. A real case of installation of 1.25MW capacity of BESS with Li-ion, Advanced Lead Acid and Flow batteries initiated by POWERGRID has been considered for the study.
- Recommendations made based on performance of battery systems and real time data analysis.
- This paper also discussed about various ancillary services proposed by CERC. Based on regulations for deviation settlement mechanism and ancillary services, recommendations made for regulatory and commercial framework to be adopted by Regulators in allowing large RE integration in Indian grid scenarios.

Thank you