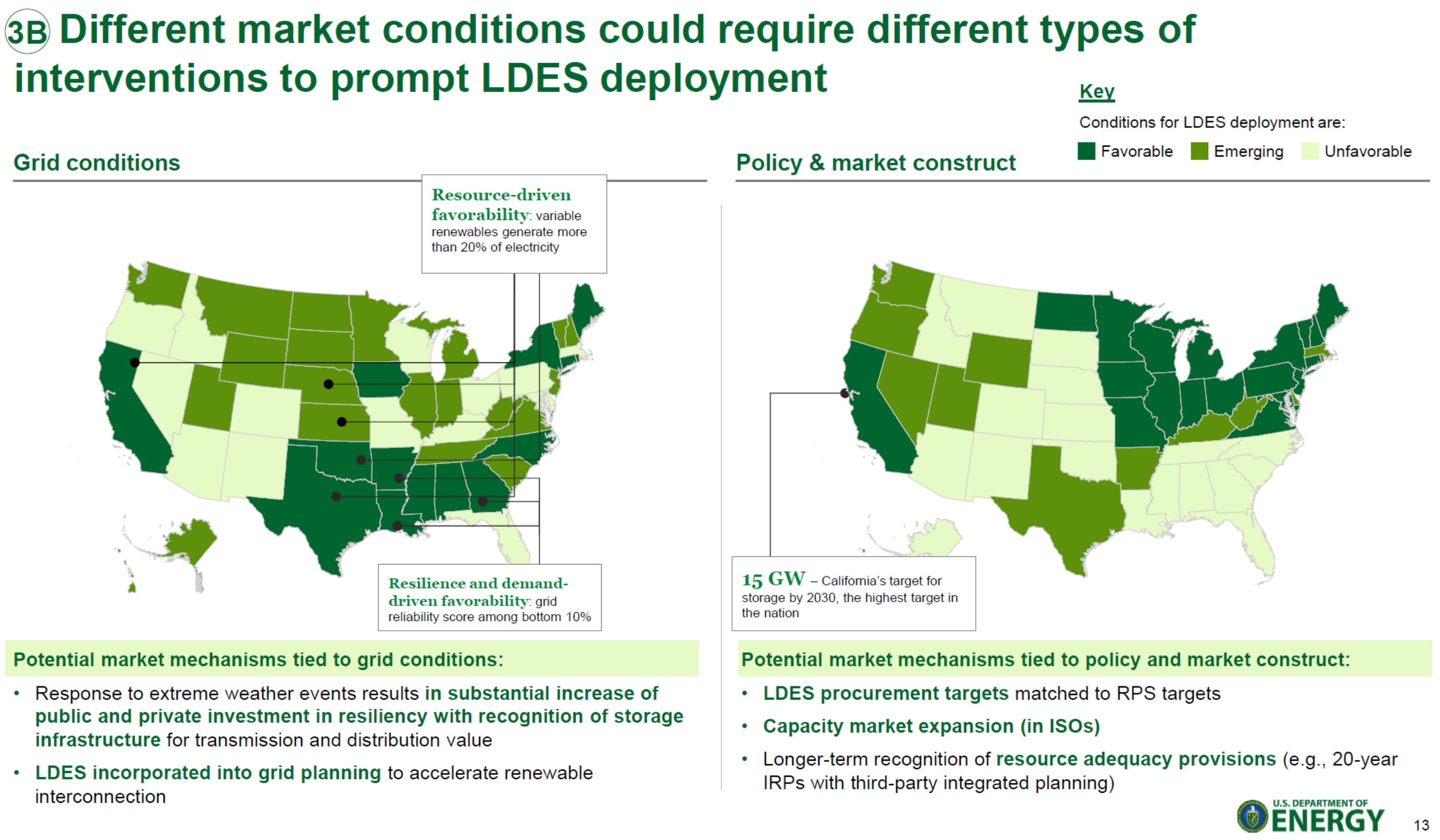
GRID INFRASTRUCTURE

VENKAT DURVASULU (ON BEHALF OF S M SHAFIUL ALAM)

Mission Statement Summary

- How does interconnection queue affect?
- How do interconnection requirements vary from the front to the behind of the meter?
- How does the following affect the LDES type and size decision?
  - Power hardware.
  - Software.
  - Model and information needs.
  - Season of operation.
  - Electrical hybrid.



LDES NATIONAL CONSORTIUM

Image Source: https://liftoff.energy.gov/long-duration-energy-storage/

Scope: Grid Integration of ESS

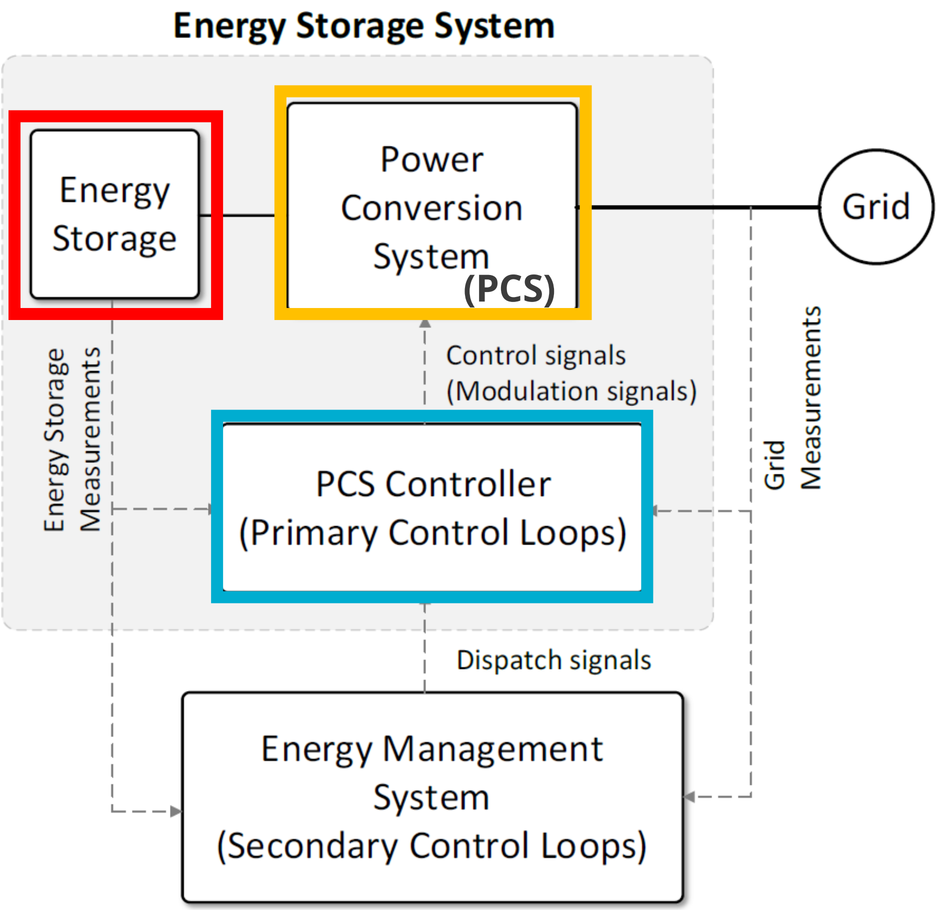


Figure 6. Components of an energy storage system

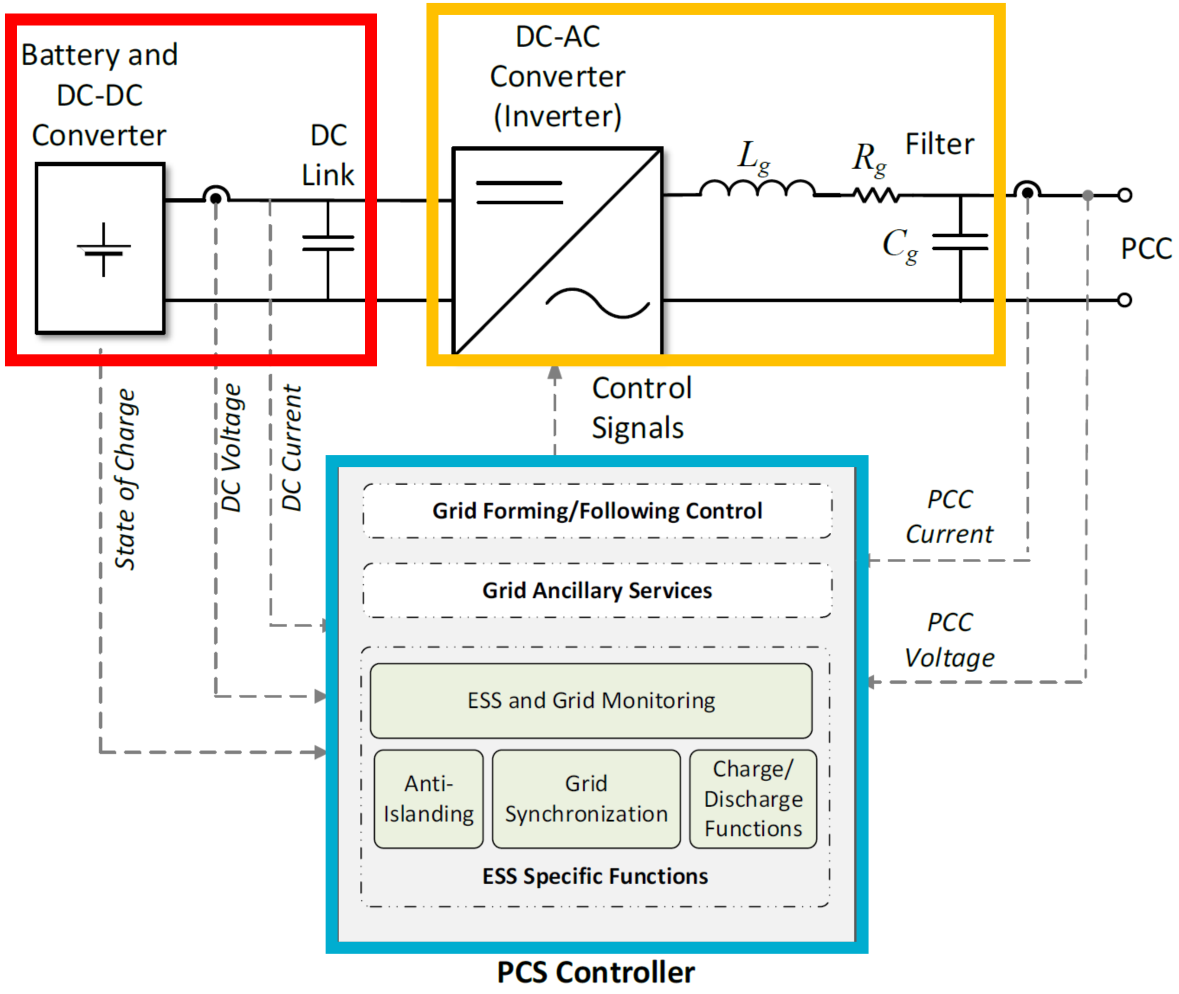


Figure 7. Schematic diagram of a grid-interfaced energy storage system along with its PCS controller

LDES NATIONAL CONSORTIUM

Source: https://www.sandia.gov/ess/publications/doe-oe-resources/eshb

Key Findings

- National energy policy/lack of policy on the best usage of solar/wind and other renewable energy resources.
- From low TRL laboratory prototype to high TRL deployable solution – How to infer high TRL performance and characteristics from the low TRL one and at what confidence level? How would it look like? What will be the implications on thermal management, round trip efficiency, **scalability, life-cycle assessment** and operations and maintenance cost?
- It is the energy storage technology that needs to be adapted to LDES requirement to have favorable RTE.
- Storage mobility considerations - containerized (transportable) versus im-mobile.
- Assessment of EV charging stations to support solar firm capacity is needed. One aspect is the DC-level integration of nearby solar generation facility with LDES and EV charging stations. Such a solution can potentially avoid AC interconnection needs and associated queues.

Key Findings Contd.

- Thermal management in lead-acid batteries and Li-Ion batteries has been brought up.
- Interests to know supercapacitors' scalability and commercial availability for LDES have shown up. Specifically, how different would be the long duration supercapacitor from the short one? Is it just in terms of the quantity of modules or something else?
- For LDES application, can the supercapacitor be charged fast and discharged slowly? Different rate in charging and discharging – What would be the requirements and challenges of the power conversion system?
- Graphene capacitor or supercapacitor as buffer to solar farm and as a support of EV charging station.
- Need to explore whether a byproduct from the operation of certain energy storage technology can offer another storage mechanism, thereby a potential hybrid energy storage system.

Key Findings Contd.

- Capacity limitation of existing hardware (upto 15 MW) is forcing to implement multi-level DC-DC conversion and hence introducing more degradation in efficiencies.
- Existing Power Conversion Systems (PCS) are not energy storage technology agnostic – their power quality and other performance varies across capacity as well as ES technology applied. For example, the harmonics injection from PCS with chemical storage may be more adverse than those with mechanical storage system.
- ESS has been demonstrated to receive AGC and respond to regulation need, but seamless integration with Utility's Energy Management System of such service is still being addressed.
- Turbine as well as pump operation range extension at existing PSH needs to be addressed: Viable options are either making electrical couple of another storage with conventional PSH or upgrading to advanced PSH (via power electronic converter integration and/or penstock modifications). Techno-economic tradeoffs among these options need to be investigated.

THANK YOU!