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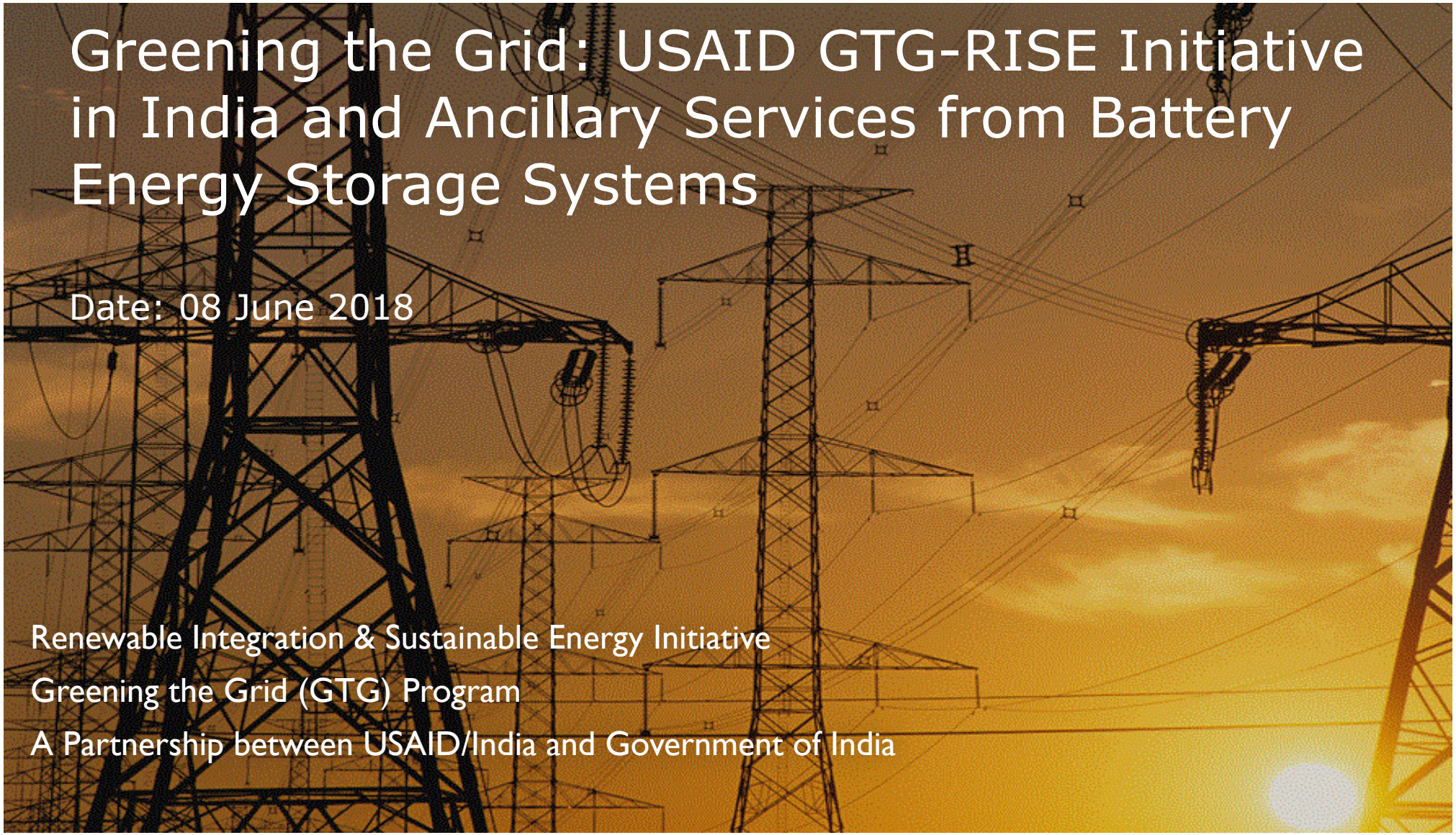
GOVERNMENT OF INDIA
MINISTRY OF POWER
सत्यमेव जयते

Greening the Grid: USAID GTG-RISE Initiative in India and Ancillary Services from Battery Energy Storage Systems



Date: 08 June 2018

Renewable Integration & Sustainable Energy Initiative

Greening the Grid (GTG) Program

A Partnership between USAID/India and Government of India

Greening the Grid - U.S.-India Joint Partnership

Goal: Enhance efforts to manage large-scale RE grid integration

- Robust analysis of challenges and solutions
- Integration pilots to validate scalable reforms
- Sharing of knowledge and best practices

U.S.-INDIA PARTNERSHIP TO ADVANCE CLEAN ENERGY DEPLOYMENT

EXTERNAL ACTORS

DONOR TO DONOR COORDINATION
(with GiZ, DFID, ADB, etc)

UNITED STATES GOVERNMENT COORDINATION

INDUSTRY ADVISORY COUNCIL (IAC)

USAID's GREENING THE GRID (GTG) PROGRAM

POWER SYSTEM PLANNING REFORMS (DOE LABORATORIES)

- National Grid Integration Study
- Regional Grid Integration Plans
- TA to Large-scale RE Parks
- Analysis - Grid Integration Pilots

PILOTING REFORMS (DELOITTE CONSULTING LLP)

- Co-financing & TA for Pilots
- Stakeholder Mobilization
- Integrate GTG Components
- Special Activity Fund

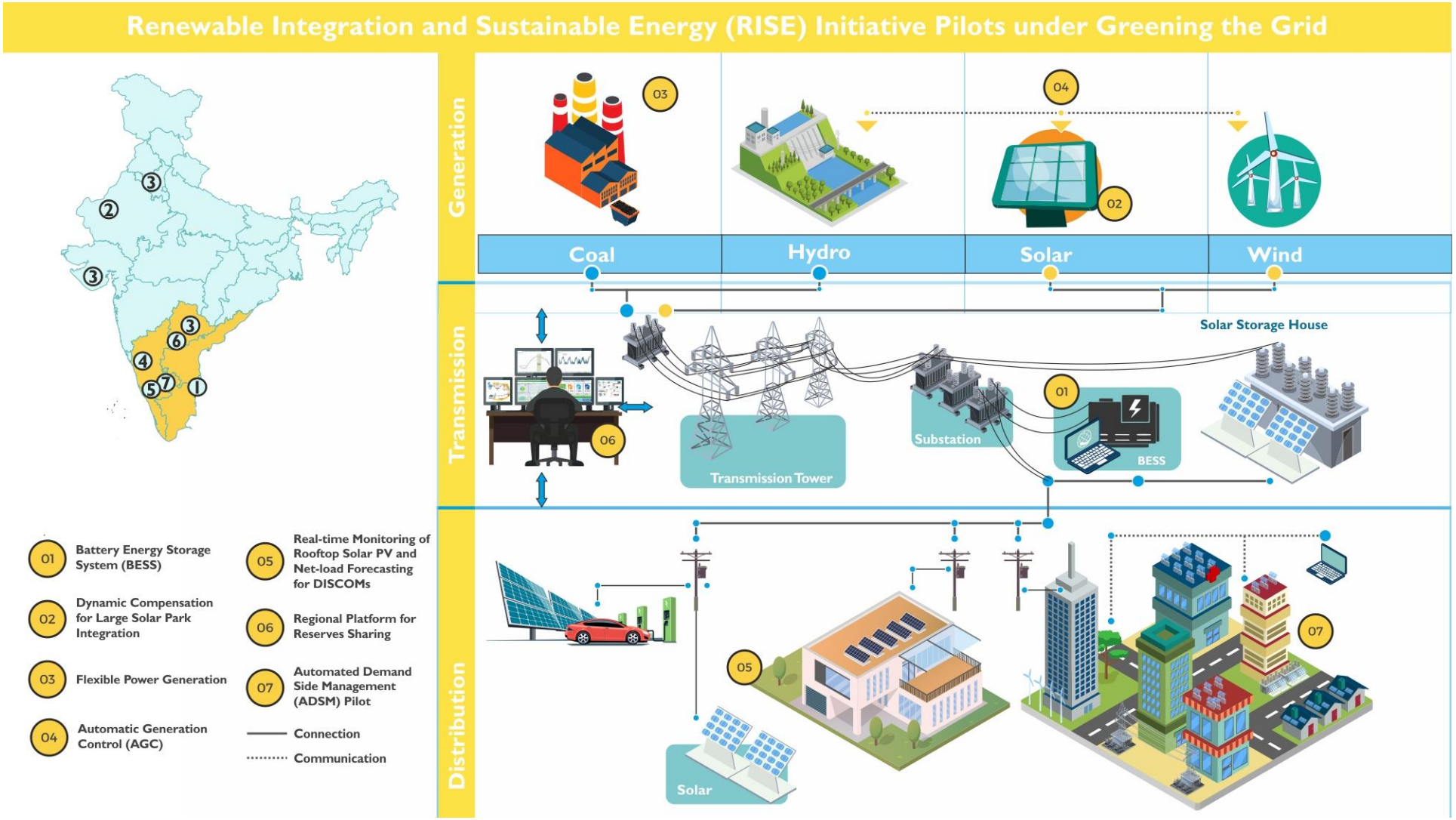
U.S.-INDIA SYSTEM OPERATORS PARTNERSHIP (USEA)

- Capacity Building of SLDCs, ISOs Utilities
- Peer to Peer Exchanges
- Training and Workshops
- India - U.S. Private Sector Exchange

INDIA REGULATORY PARTNERSHIP (NARUC)

- Assistance to Forum of Regulators
- Twinning with State Regulators
- Training and Capacity Building
- Peer to Peer Exchanges

Renewable Integration and Sustainable Energy (RISE)



Economics of Grid Connected Battery Energy Storage System (BESS) with PGCIL

Scope & Outcome

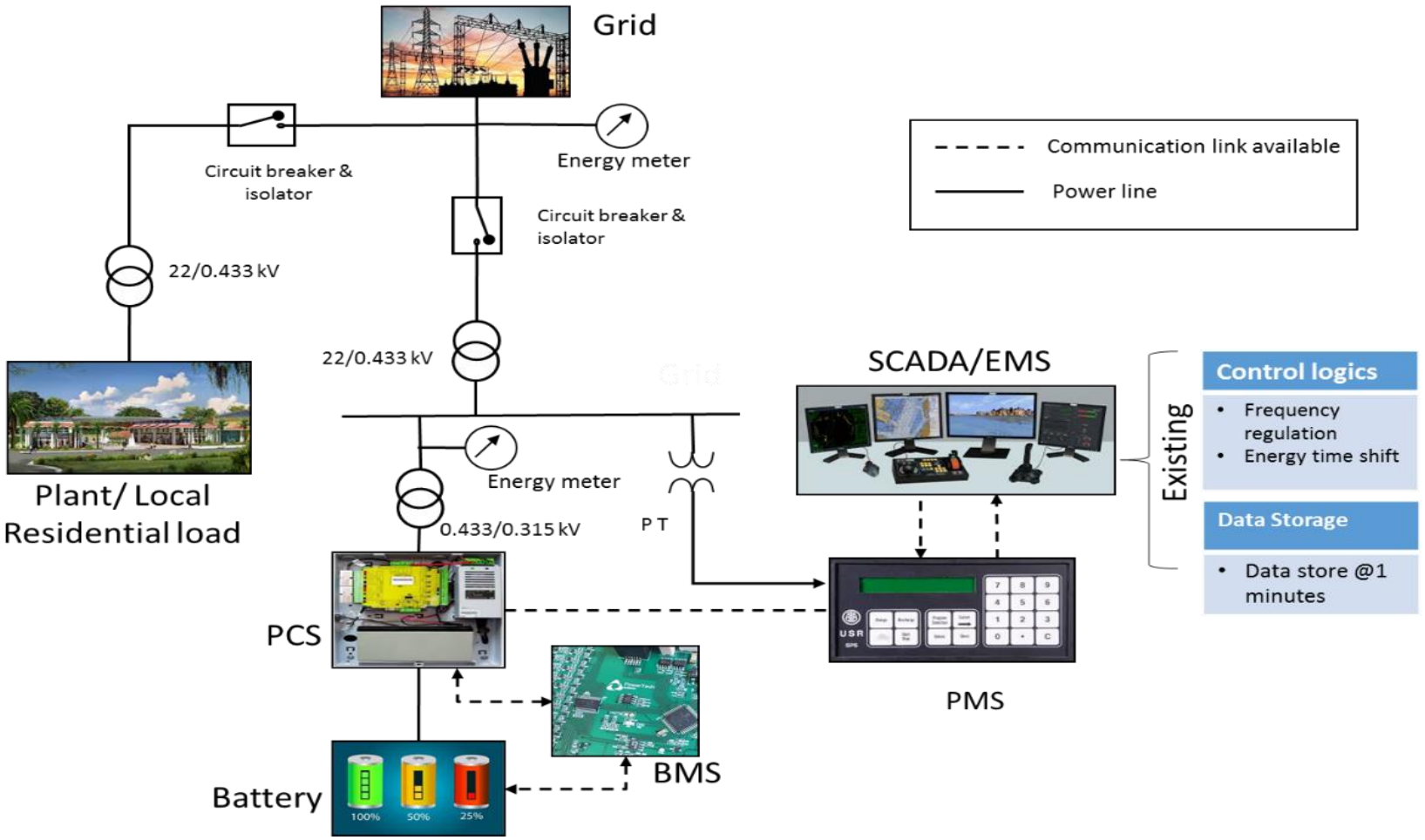
Pilot Scope

- Enhancement of existing BESS facility Puducherry and assessment of economic value of storage systems.
- Technical design and demonstration of array of BESS applications viz. dynamic frequency regulation, Renewable energy time shift, capacity firming etc. in providing grid support.
- Detailed modelling study on the need, quantity and location of storage systems in India in sub-15 minute time scale.

Outcomes

- Specific recommendations for operation of battery energy storage system and required enhancements based on Indian grid conditions
- Optimize usability of BESS under the capacity and limitation of the battery.
- Economic evaluation of BESS operation in grid support.
- Development of a scalable roadmap for policy makers and regulators

Schematic diagram of the BESS integrated to the grid



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Progress so far

Milestones achieved	Timeline
Concept Note submitted and approved by PGCIL	May, 2017
Logical Outline / Functional Specifications (DPR) for additional Use Cases framed and finalized with PGCIL	April, 2018
Selection of Systems Implementer for additional Use Cases implementation initiated	May 2018

Way forward

Milestones Planned	Timeline
Assess/evaluate the proposals received against the RFAs	June, 2018
Finalize the grantee subcontract and start pilot implementation	July, 2018
Implementation of Use Cases planned over 4 months + 3 months of demonstration and data support.	Jan, 2019
Systemic Value modelling to be taken up	FY20
Guidance note to policy makers, regulators based on findings of the systemic valuation of storage in Indian context	FY20

Demonstration of various BESS applications

Following applications are proposed on three different battery technologies (Advance Lead Acid, Lithium ion and Flow), at PGCIL's Sub-station, Puducherry

1. **Dynamic frequency regulation**
2. **Voltage/reactive power support**
3. Load following
4. Peak shaving
5. Renewable energy capacity firming
6. Renewable energy time shift
7. **Integrated applications- A combination of two or more of the above applications**

Summary and Takeaways

- Higher penetration of RE will change the economics of battery storage: Battery energy storage systems would provide critical ancillary service support
- Storage will compete with other flexible resources. Best practice is to define technology neutral needs of the system and allow different resources to compete to efficiently meet system needs.
- **In power systems with increasing levels of variable RE, deploy utility scale storage…..**
  - ❑ Of **TYPES** that will deliver services that are underprovided and/or likely to diminish as the power grid evolves.
  - ❑ **WHEN** storage technologies are more cost effective than other sources of power system flexibility
  - ❑ **IF** storage is cost effective and policy, regulatory and market frameworks clearly monetize value stream(s)
  - ❑ In **QUANTITIES** commensurate with the market share for the particular service(s) storage can cost-effectively provide
  - ❑ **WHERE** it can provide the most value at the system level, or strategically as a hybrid with other generators (not just RE)

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