Opportunities and Challenges for deployment of energy storage, microgrids for RE Integration

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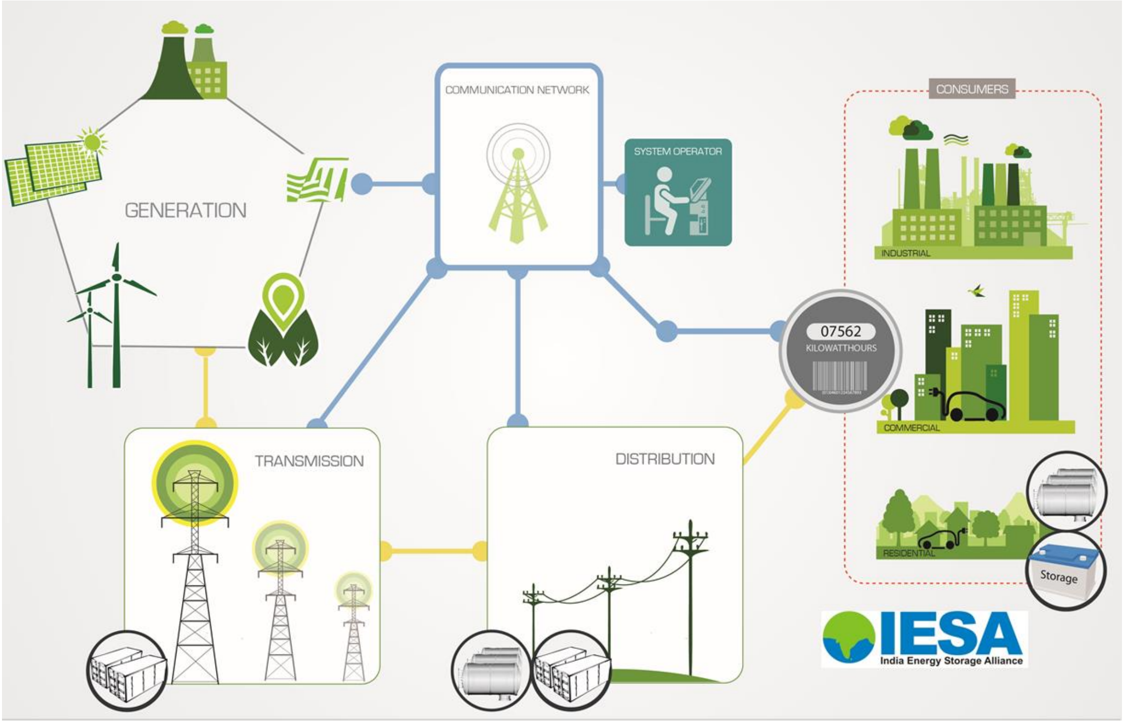
Role of Energy Storage in Modern Grid



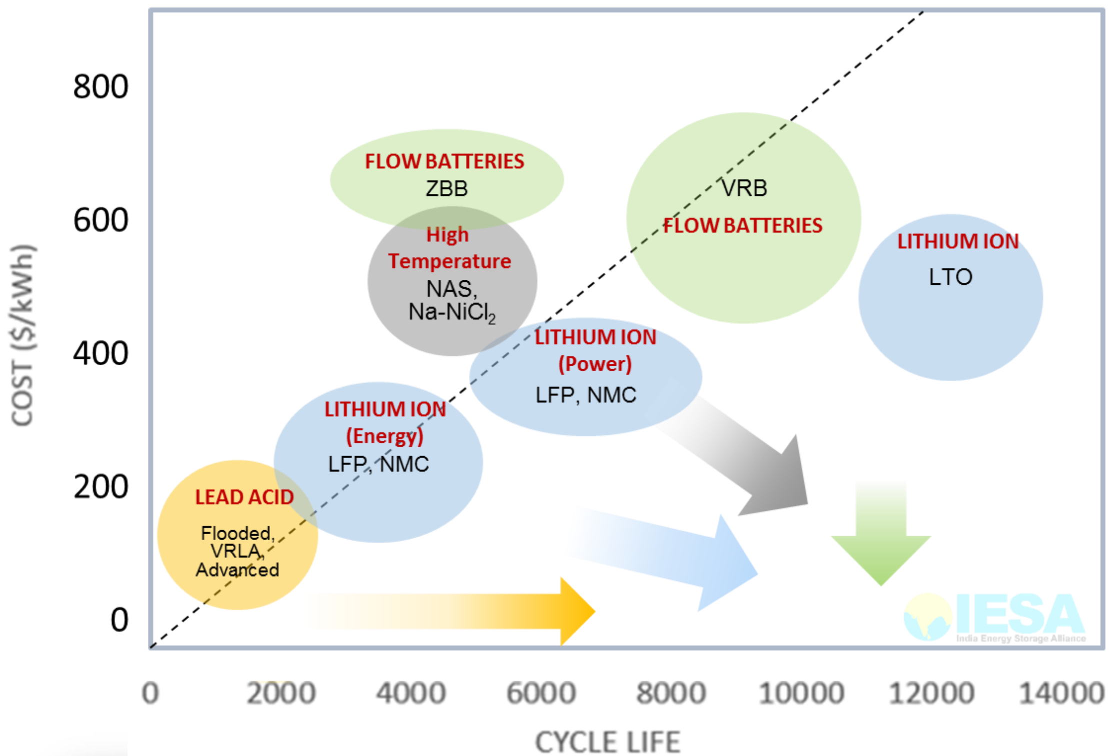
By supplying power when and where needed, Energy Storage will

- Improve the **reliability** of electricity supply
- Reduces variability and uncertainty, **increases stability**
- Better integration of renewables into the system
- **Increase the efficiency** (economic & utilization) of existing generation & transmission facilities
- Reduce the need for additional transmission assets
- Be the preferred supplier of **ancillary services**

Parameter	Fuel	Generation	Transmission	Distribution	Services
Challenges	Volatility	Low Utilization	Congestion	Disruptions	Dirty power
ESS Benefits	Hedge risk	Baseload arbitrage	Higher utilization	Stable power	Quality Power

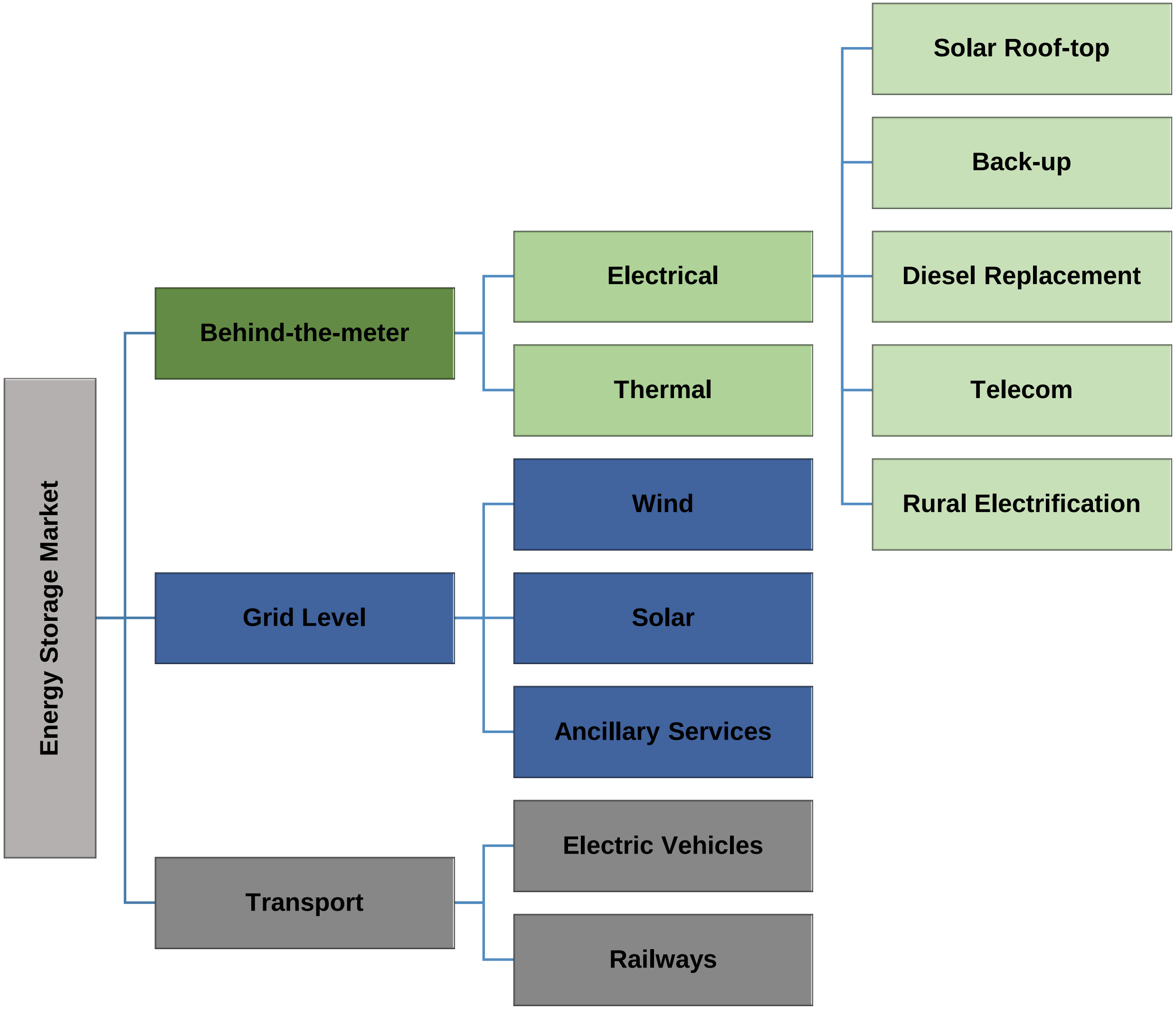
Cost ($/kWh) vs. Cycle Life

- Different battery types have different cycle life due to which generally the life cycle cost is considered ($/kWh/cycle)
- Lead acid batteries have a very low cost but comparatively low cycle life. Advanced lead acid batteries have a higher cycle life at a higher cost
- NAS batteries have an intermediate cycle life between lithium ion batteries and flow batteries.
- Flow batteries have a high cycle life and a moderately high cost
- Lithium ion battery systems may be designed for high power or long duration applications.
- LTO batteries can offer lowest marginal cost due to longer cycle life and high charge / discharge rates.



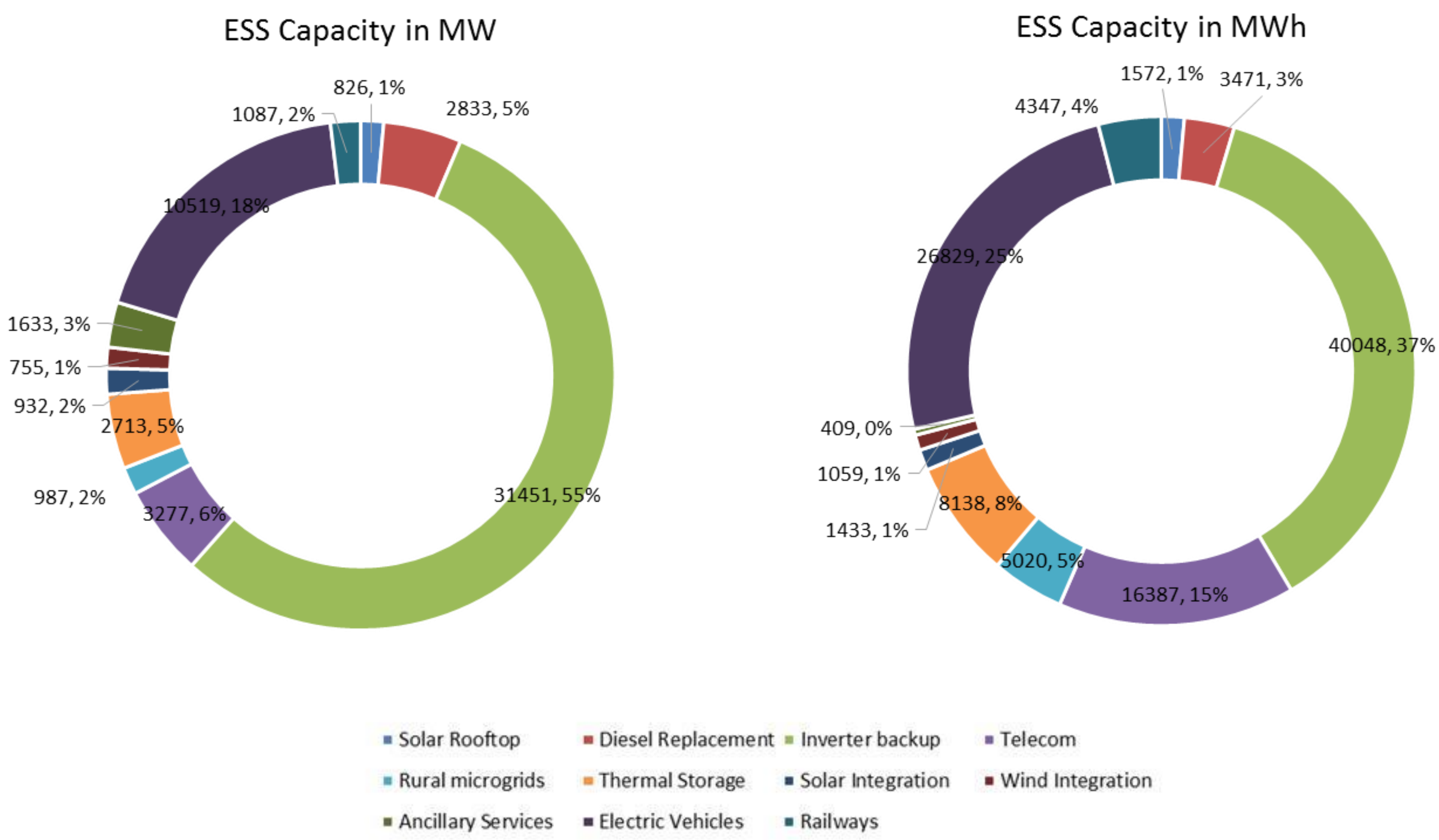
$$Cost\,per\,Storage\,Cycle(\$/kWh_e) = \frac{Energy\,Storage\,Cost(\$/kWh)}{Cycles(\#) \times Round\,Trip\,Efficiency(\%)}$$

Market segmentation of Energy Storage Market



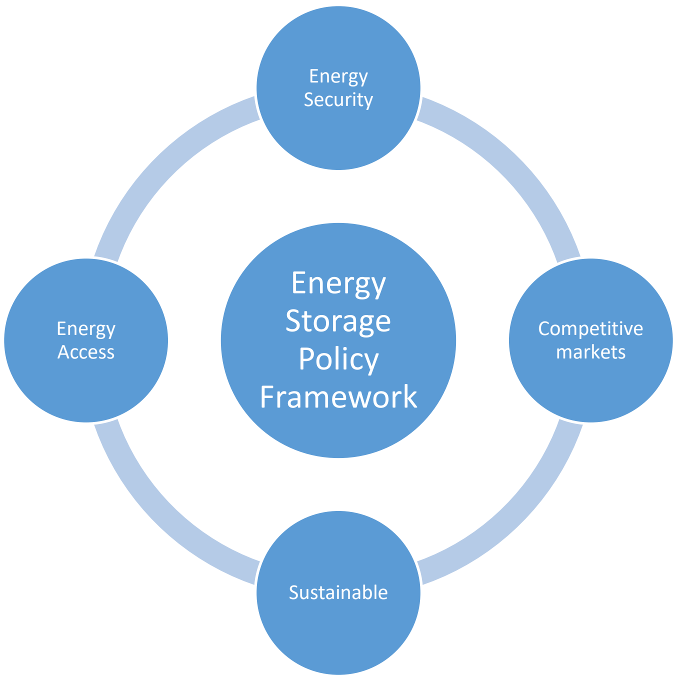
Growing need of RE integration, increasing need for energy access, diesel replacement, increasing usage of electric vehicles, energy sector de-carbonization etc., will further accelerate growth of Energy Storage

Application-wise ESS Market Potential



The ESS market potential between 2016-2022 would be around 57,000MW and 109,000MWh.

Limitation: Lack of Policy Framework



Existing Policy framework

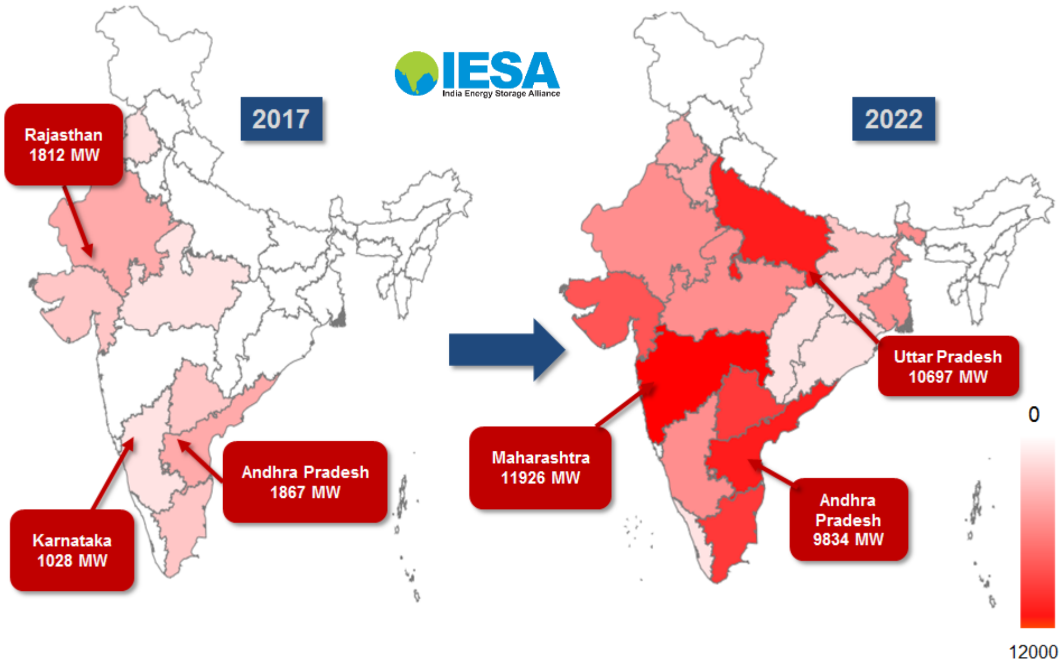
- National Electric Mobility Mission (6-7 million of EV by 2022)
- Renewable energy targets (175GW)
- Universal Energy Access – Power for all homes by 2019 National Smart Grid Mission – Quality power on demand for all by 2027
- Solar + storage projects
- Net metering policy (14+ states)

Lack of Policy framework

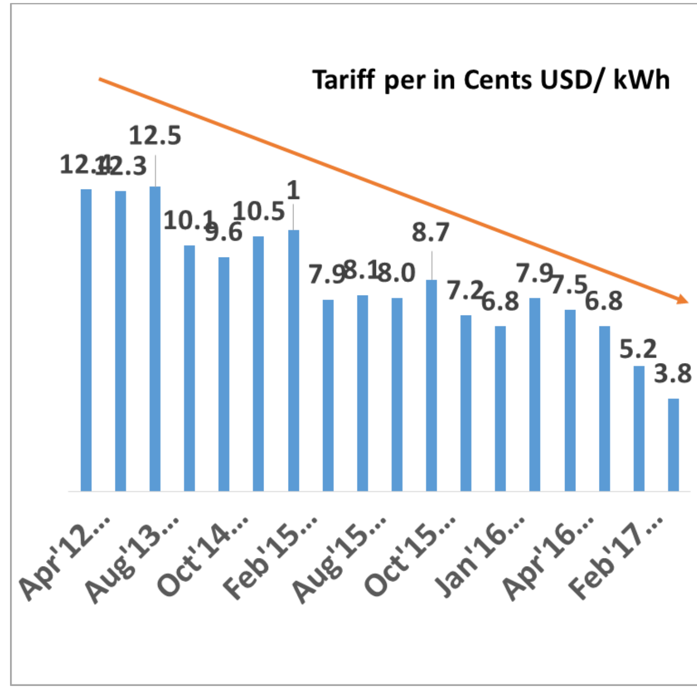
- ESS - Renewable integration policy including RE shifting / firming / smoothing / forecasting & scheduling / ramp rate control
- Framework for ESS in Frequency regulation ancillary services market & grid services
- Attractive Intra state deviation penalty mechanism for renewables
- Comprehensive EV charging policy for charging stations, TOD tariff & V2G
- Policy for distributed ESS- RE & micro grids integration
- Framework for reuse , recycle & disposal of batteries including 2nd life usage
- ESS policy for transmission for congestion management, reliability, investment deferral etc.,

To support effective implementation of storage technologies policy support is required for framing regulations, development of standards, integration of storage with renewables and raising awareness and defining storage as a asset class alongside Generation, transmission & distribution

Growth of Solar Power in India

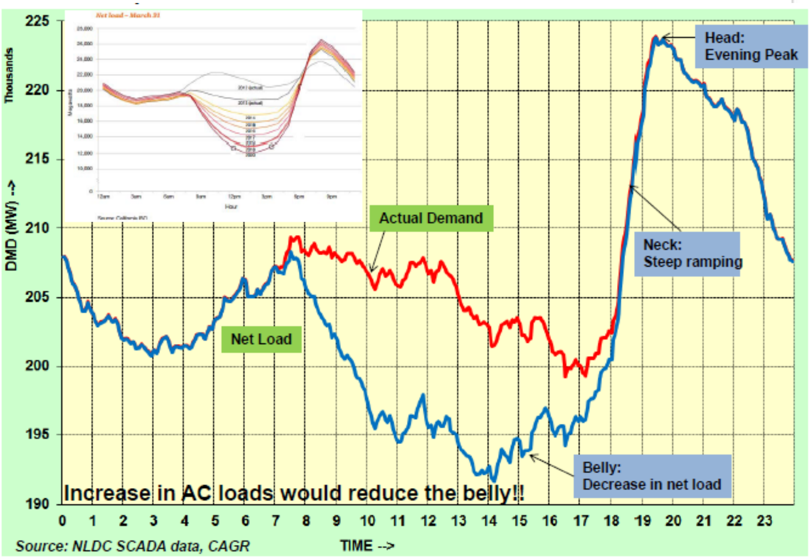


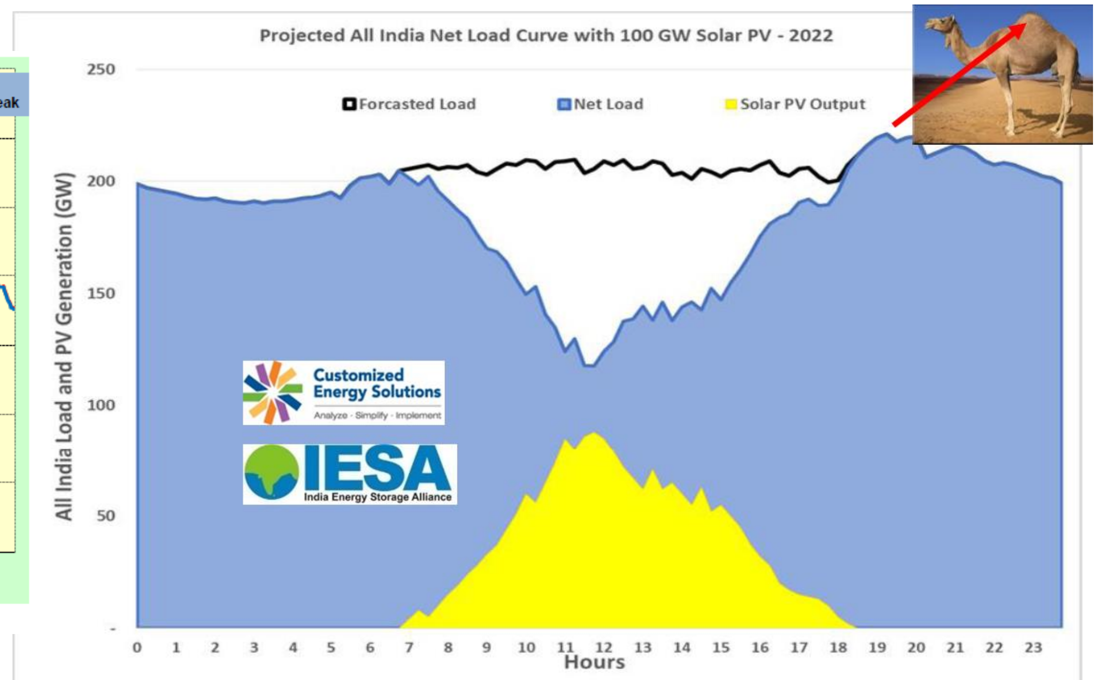
Solar Tariff Trends over past 5 Years



- India's cumulative installed capacity is nearly 13.5 GW
  - Capacity addition in the FY17 was over 5GW
  - Targeted capacity addition for FY 18 is 10GW

Expected India Net Load Curve 2022 (with 100 GW of solar generation)



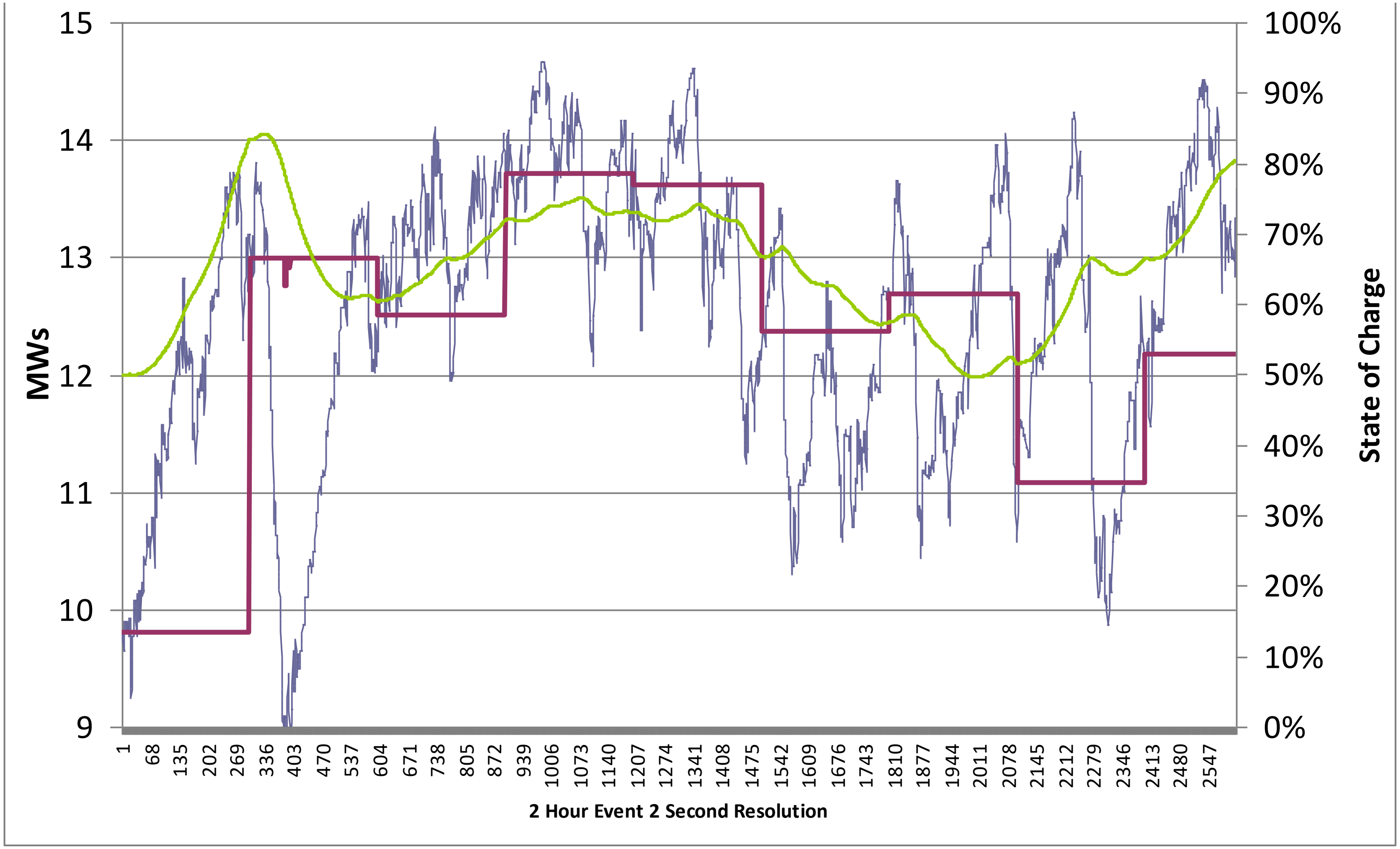


Impact of RE Integration into grid

a) Risk of over generation and wastage of resources, due to high RE uncertainty
b) The fluctuations of RE output affects transmission efficiency
c) High variability and uncertainty significantly complicates the demand-supply balancing system and requires additional flexibility in power systems
d) High uncertainty requires additional secondary and tertiary operating reserves, increased ramping
e) High intermittency of renewable energy make it difficult to forecast and schedule for dispatches.
f) Higher penetration (with rapid deployment) of RE resources may ultimately result in unstable grid

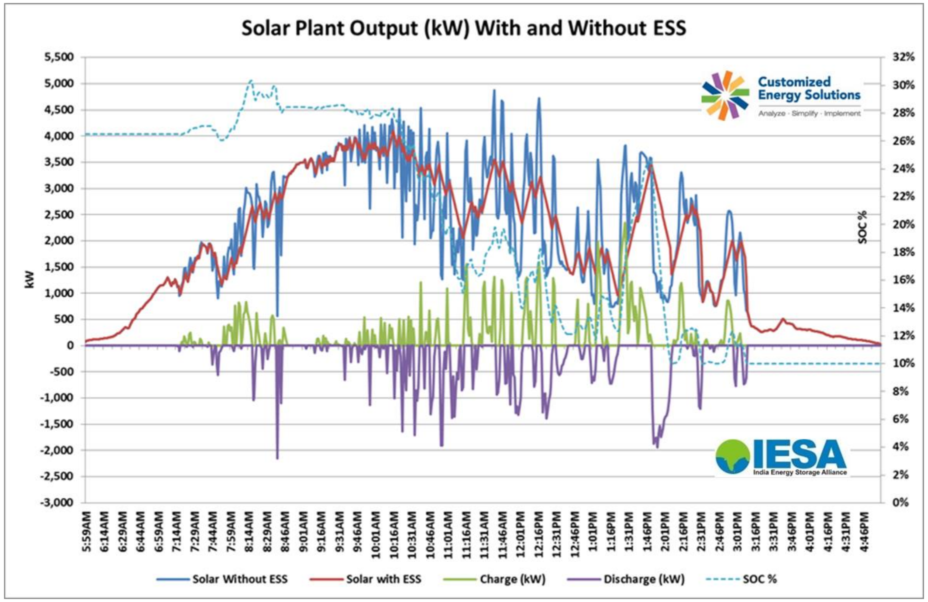
These challenges presents a historic opportunity to modernize the grid to smooth short-term variability and uncertainty with ESS, real time communication and control automation in grid systems

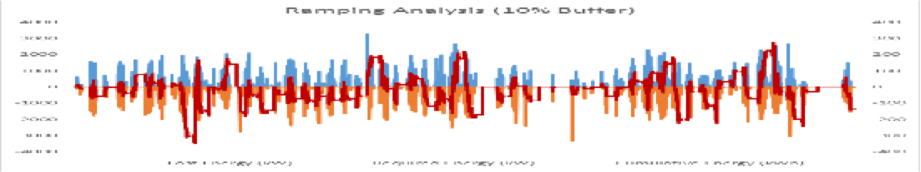
Energy Storage for Wind Smoothing



Energy Storage is the solution for RE integration challenges, which absorbs excess RE (ramp control), enables power producers provide the grid with consistent power and respond immediately and precisely to changes in load.

Solar + Storage Case Study on Port Blair, Andaman & Nicobar Island

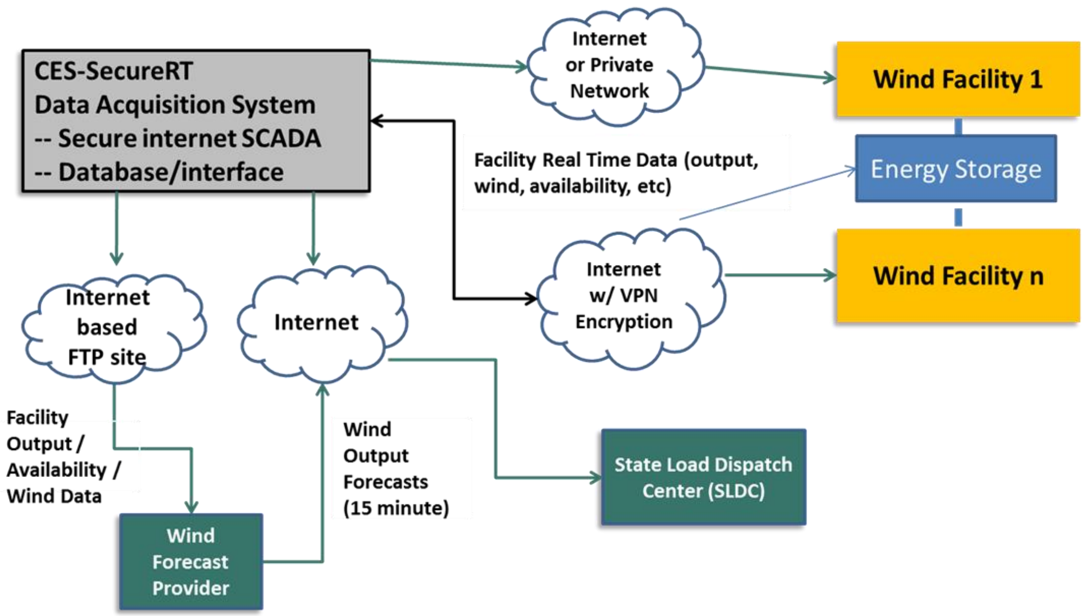




- Solar generation is inherently intermittent and supply may create very large instantaneous ramps.
- The problem will be accentuated in islands like Andaman and Nicobar, where currently diesel generators are used for providing base load as well as balancing service
- MNRE under Greening the Islands program is exploring deployment of 50+ MWh of energy storage with solar PV
- 1st project in this for 20 MW solar + 28 MWh storage is being retendered by NLC.

Island is dependent on diesel generators as primary source of electricity and balancing power, where solar variability is a major issue and opportunity for energy storage integration.

Examples of renewable and storage integration




Source: AES Energy Storage


Source: S&C Electric

Customized's Market Operations Center currently actively manages over 3000 MW of generation, energy storage and demand response resources to maximize profits for our clients.

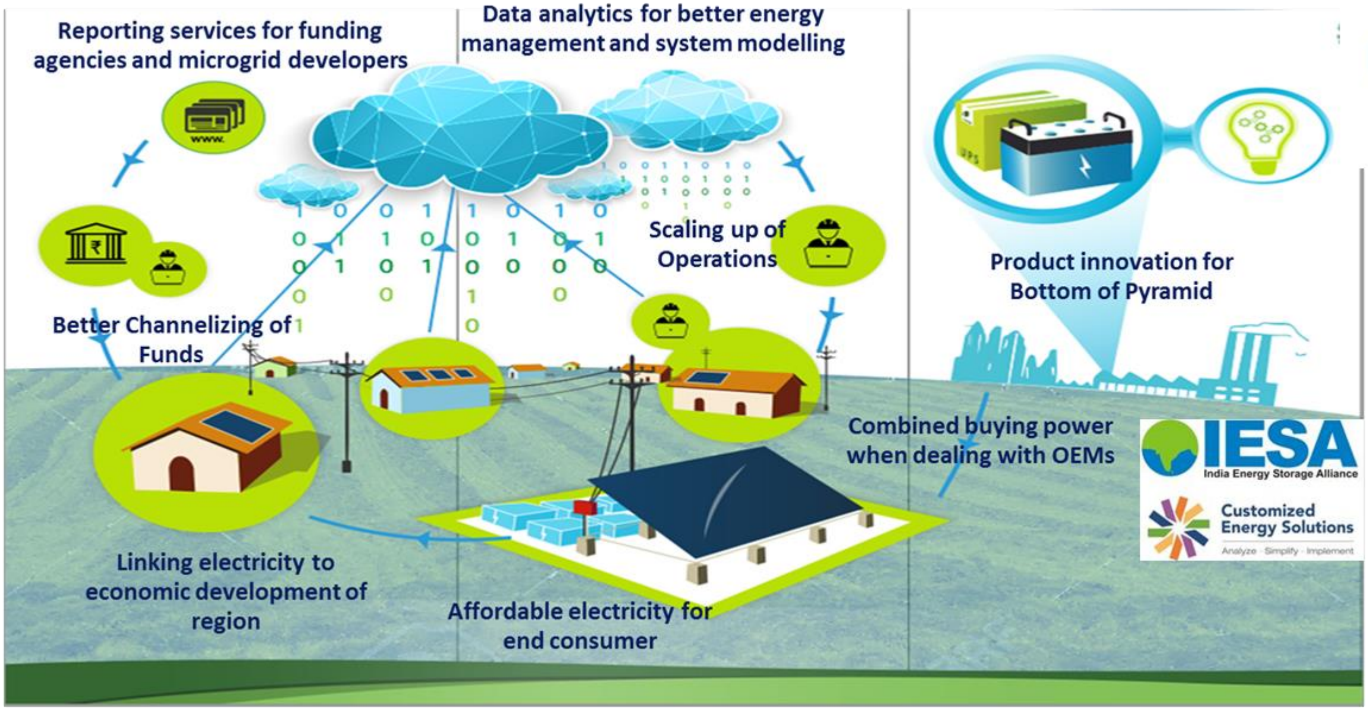
Grid Expansion vs Microgrids:

Microgrid Initiative for Campus & Rural Opportunities (MICRO)

Customized Energy Solutions — Analyze · Simplify · Implement

IESA — India Energy Storage Alliance

Over 300 Million people still need access to electricity and another 300 Million + people lack access to reliable grid power for 12+ hours / day.



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MICRO has set up goal of reducing cost of electricity from microgrids by 30-50% with in next 3 years.

Conclusion

- ✓ Energy storage technologies are required both for conventional as well as renewable resource optimization as well as for improving electric grid resiliency
- ✓ Solar + storage is already cost competitive with diesel and if there is a clear policy from MNRE, large scale deployments can start TODAY.
- ✓ Solar + Storage is expected to drive growth as grid parity will be reached with in next 12-18 months for such hybrid projects.
- ✓ Policy makers need to stop making just large announcements and focus on systematic scale up of deployments to build confidence and skill development.
- ✓ There is excellent opportunity for collaborations for R&D, manufacturing and exports

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IESA India Energy Storage Alliance

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