Image credit: www.windpowerengineering.com

Battery Energy Storage: Unlocking Potential in India

05 September 2019

Presenter:
Vikas Singh Suhag
ICF Consulting India Pvt. Ltd.

Outline

- **Developments creating opportunities for deployment of energy storage**
- **Potential for energy storage deployment in India in the short and long-term**
- **Assessment of energy storage coupled at generator end:**
  - Benefits to cost ratio for individual applications
  - Benefits to cost ratio for stacked applications
- **Suggestions for unlocking storage's potential in India**

Opportunities for storage are arising from several developments

Increasing demand

National Electricity Plan (2018)		
	FY17	FY27
Electricity demand (BU)	1160	2047
Peak demand (GW)	161	298

↑ Generation capacity
↑ Network capacity

Rising VRE portfolio

2022 RE targets	
Solar	100 GW
Wind	60 GW

↑Stability needs
↑Balancing needs

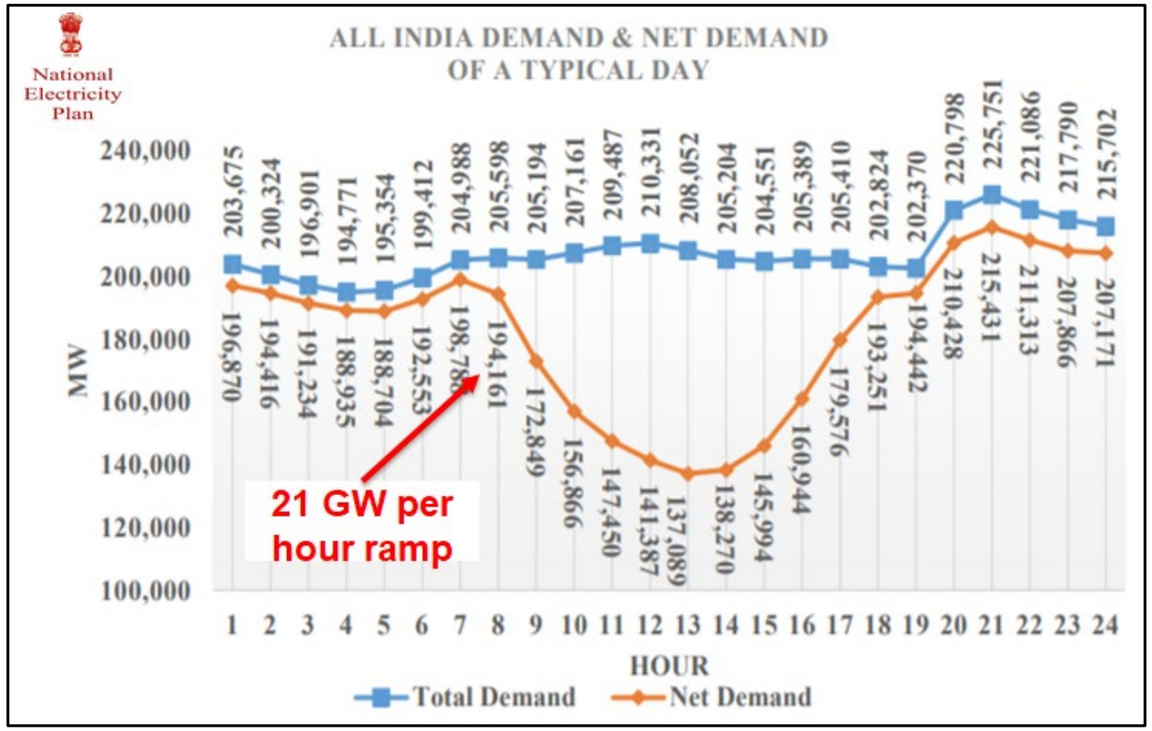
Electrification of transport

FAME scheme
State schemes

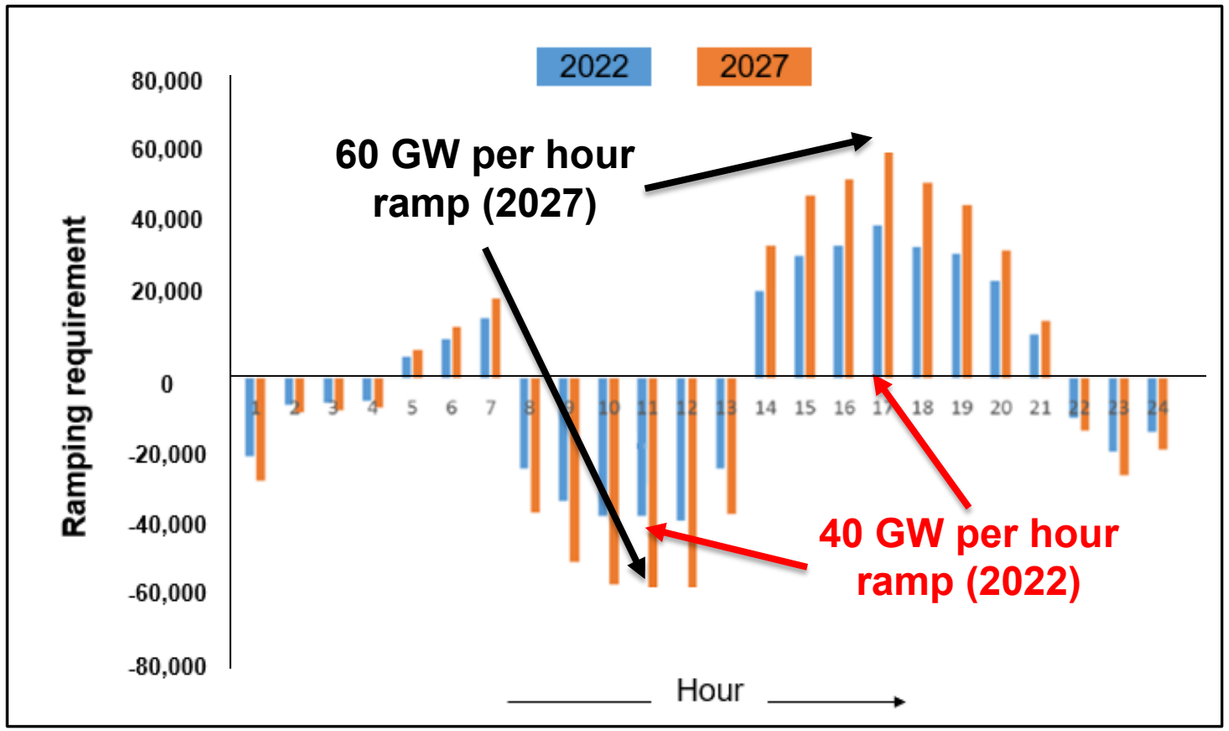
↑Battery needs

Opportunity for energy storage are higher in cost optimized dispatch scenario

Case 1: Ramping needs on typical day



Case 2: Ramping needs on typical day under cost optimized scenario

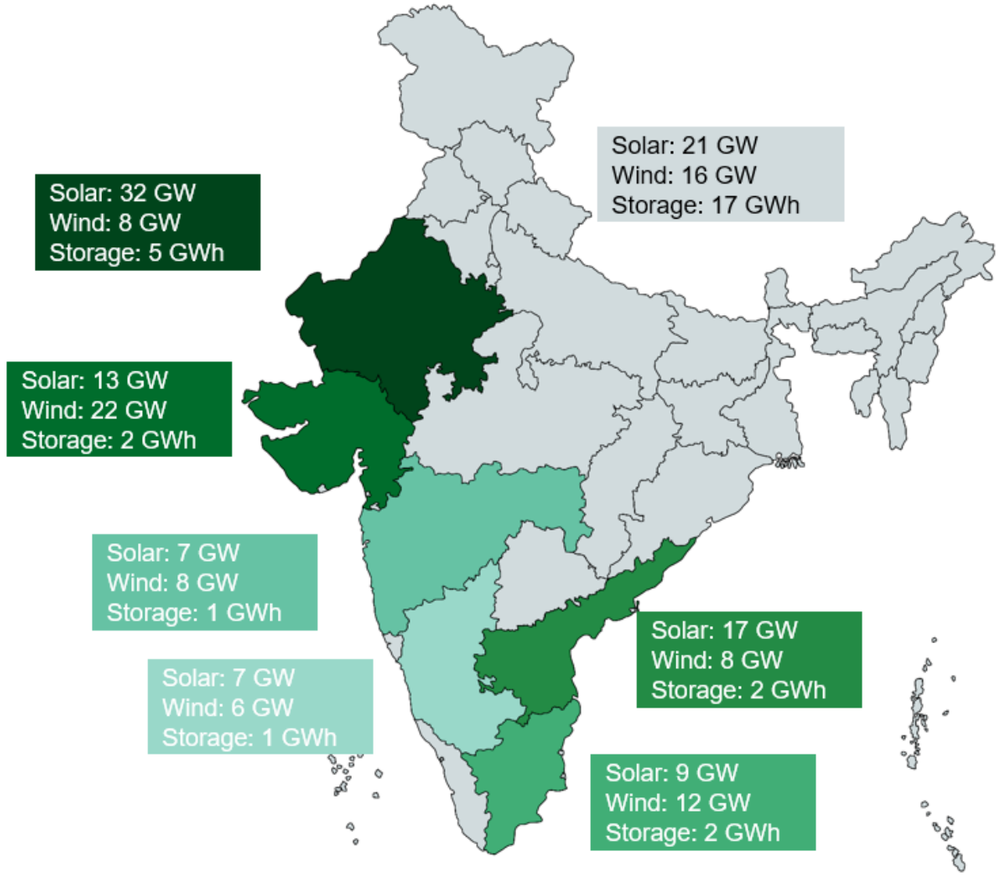


- Cost optimal dispatch leads to almost doubling of peak ramping needs
- Aggressive RE adoption will lead to ramping needs of 60 GW per hour by 2027

As batteries become cheaper, they are expected to play a greater role in VRE integration

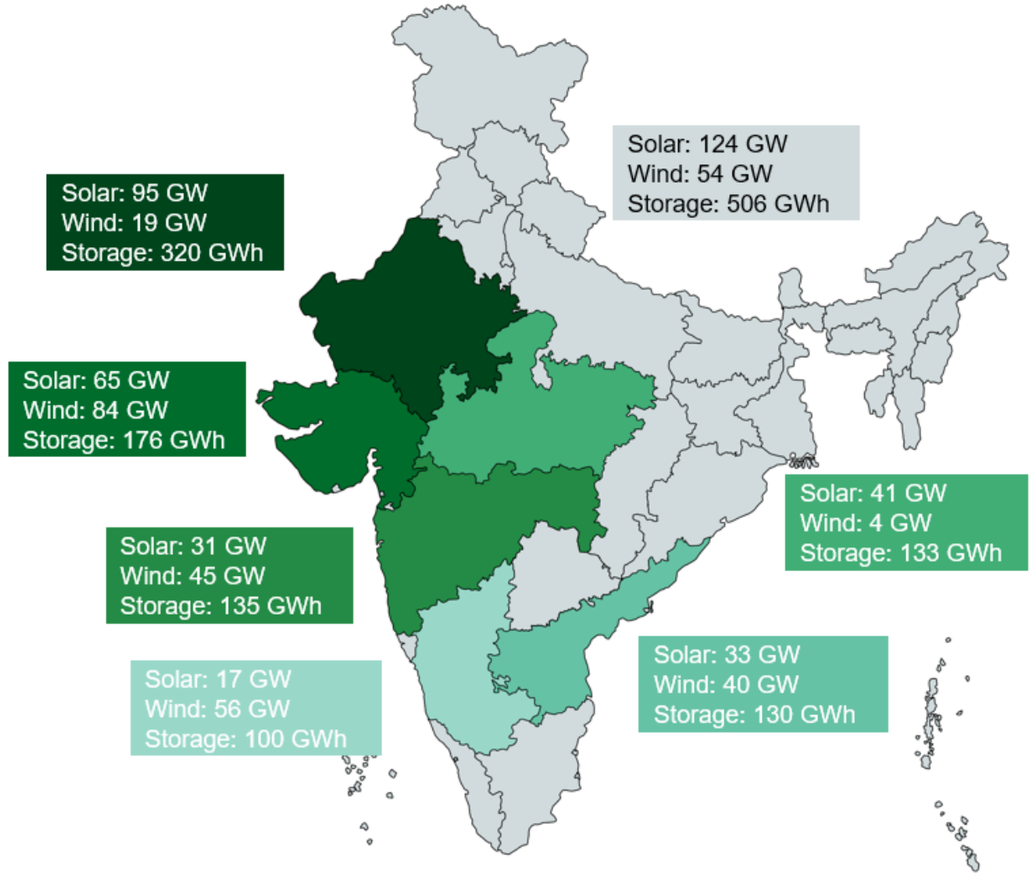
Energy storage potential in short-term (2027)

All India potential: 30 GWh



Energy storage potential in long-term (2041)

All India potential: 1,500 GWh



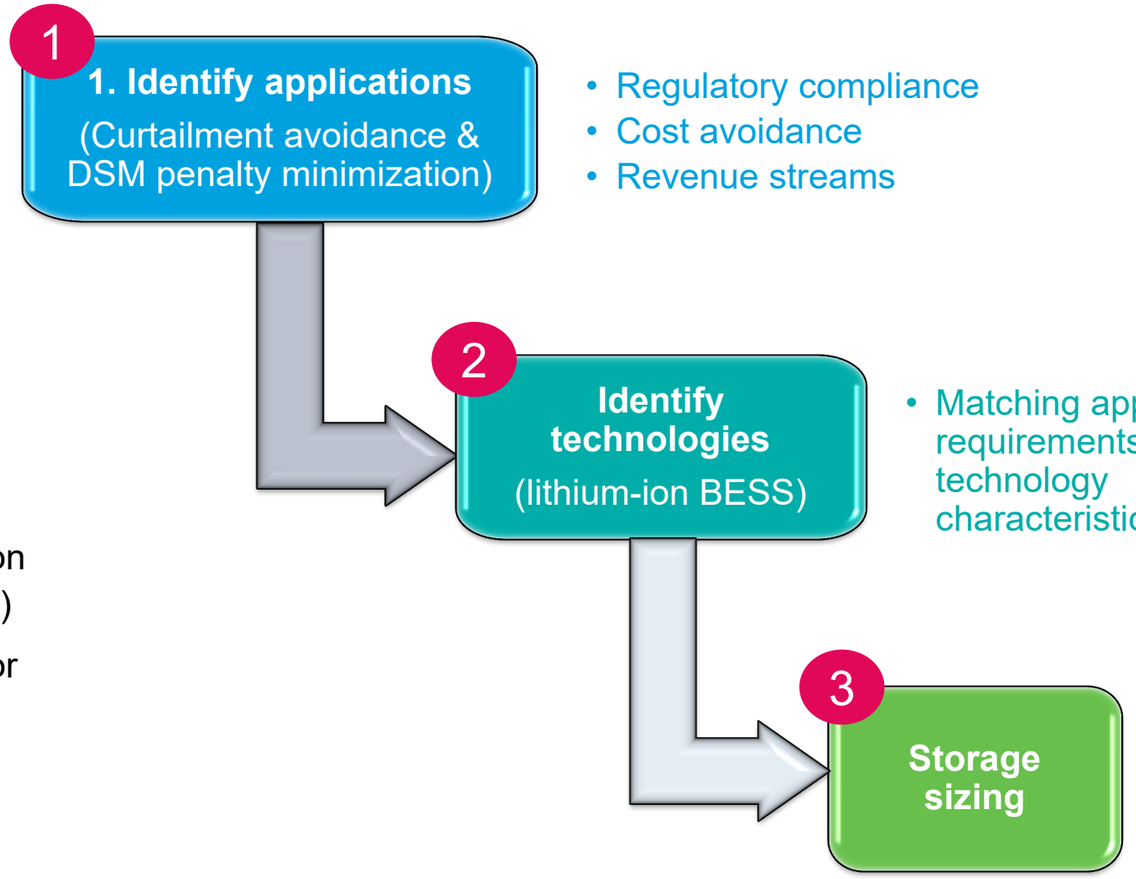
Key assumptions
- BESS cost assumption (BNEF estimates)
- Use cases modeled: Time shifting, Transmission optimization, Price arbitrage, Supply capacity
- Model is free to build new transmission lines and non-RE generator

Case study for BESS coupled at generator end

- **Wind-Solar hybrid plant in South-India**
  - 100+ MW solar
  - 50+ MW wind

- **Technical parameters:**
  - Wind generation curtailment ~3% of annual generation (conservative estimate)
  - No solar generation curtailment
  - Deviation Settlement Mechanism (DSM) penalty levied on both wind and solar generators (for absolute error >15%)
  - DSM penalty levied in incremental steps of absolute error

- **Financial implications in absence of storage**
  - Wind curtailment loss of ~ INR 12 crores
  - Annual DSM penalty of ~ 40 lakhs on wind generator
  - Annual DSM penalty of ~4 lakhs on solar generator

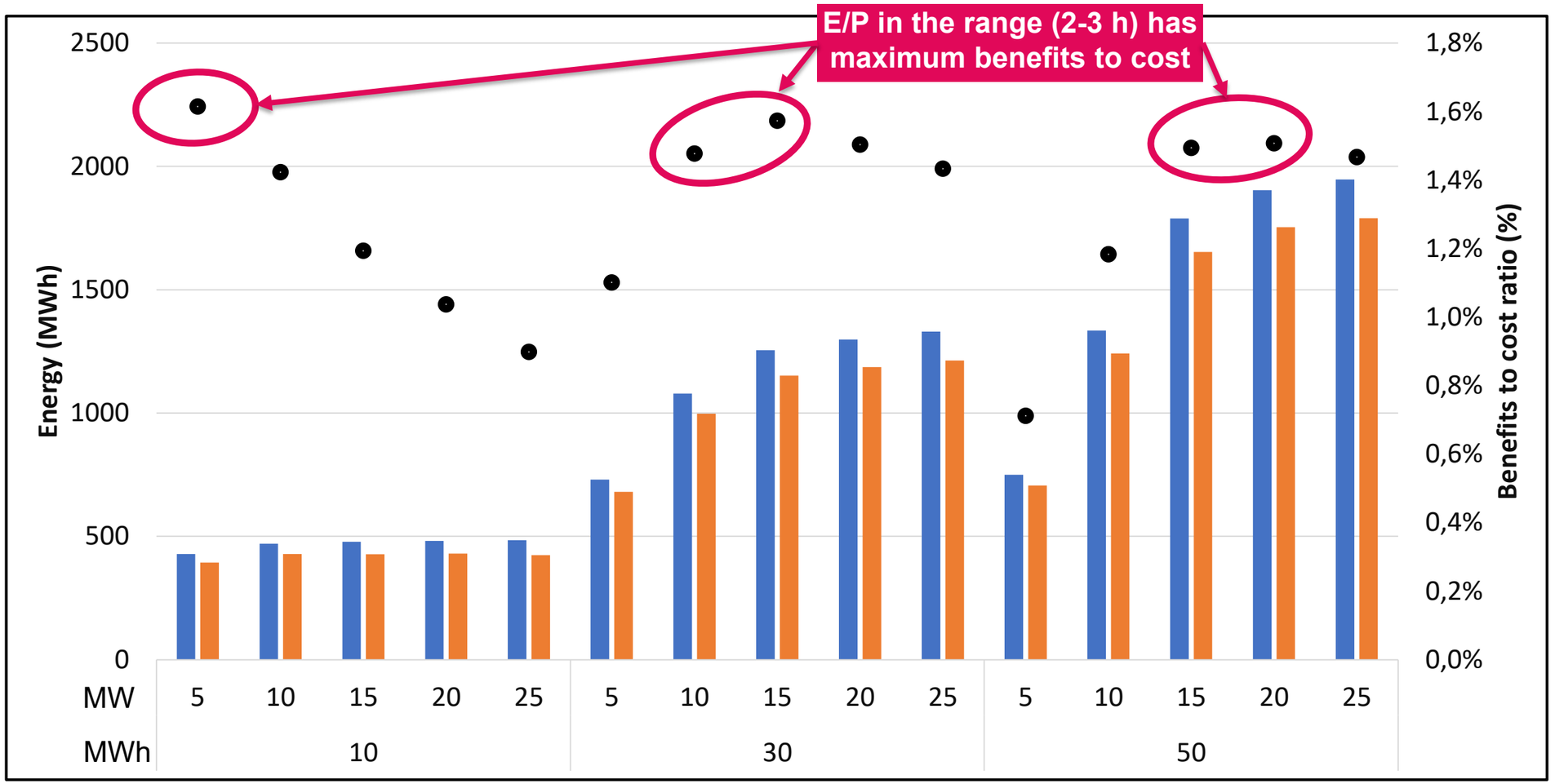


- Regulatory compliance
- Cost avoidance
- Revenue streams

- Matching applications requirements with technology characteristics

- Storage resource characteristics
- Cost avoidance parameters
- Market revenue parameters

Application 1: Curtailment avoidance (Benefits to cost assessment)



Annual Energy charged into the battery (MWh)

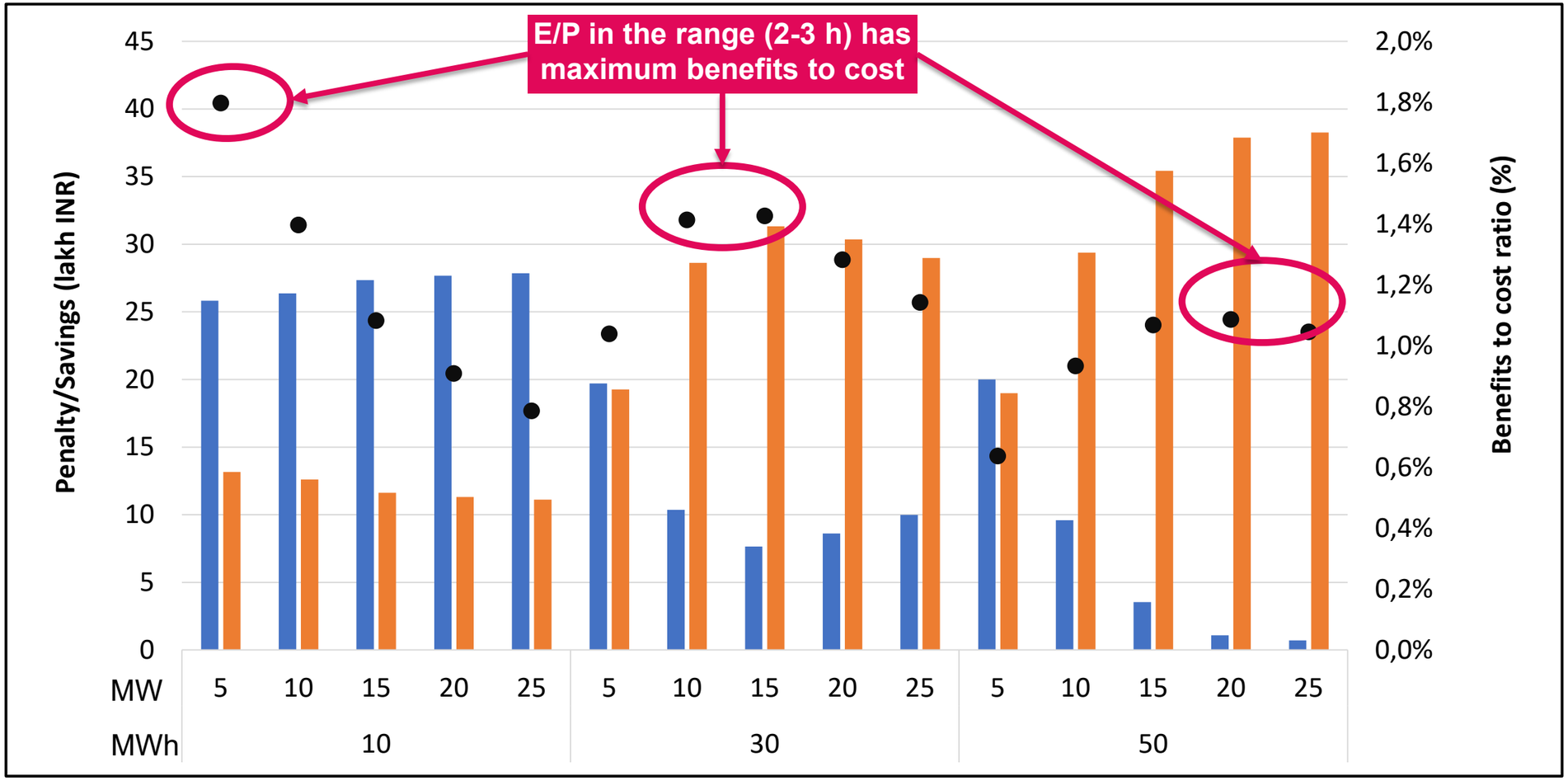
Annual Energy discharged from the battery (MWh)

Benefits to cost ratio decreases as battery capacity (MWh) increases

Benefits to cost ratio is maximum for energy to power (E/P) ratio in the range 2-3h

Note: Benefits to cost ratio considers annualized benefits and annualized costs of BESS. Analysis considers replacement of BESS after it has utilized its cycle life.

Application 2: Wind DSM penalty avoidance (Benefits to cost assessment)



Annual penalty incurred

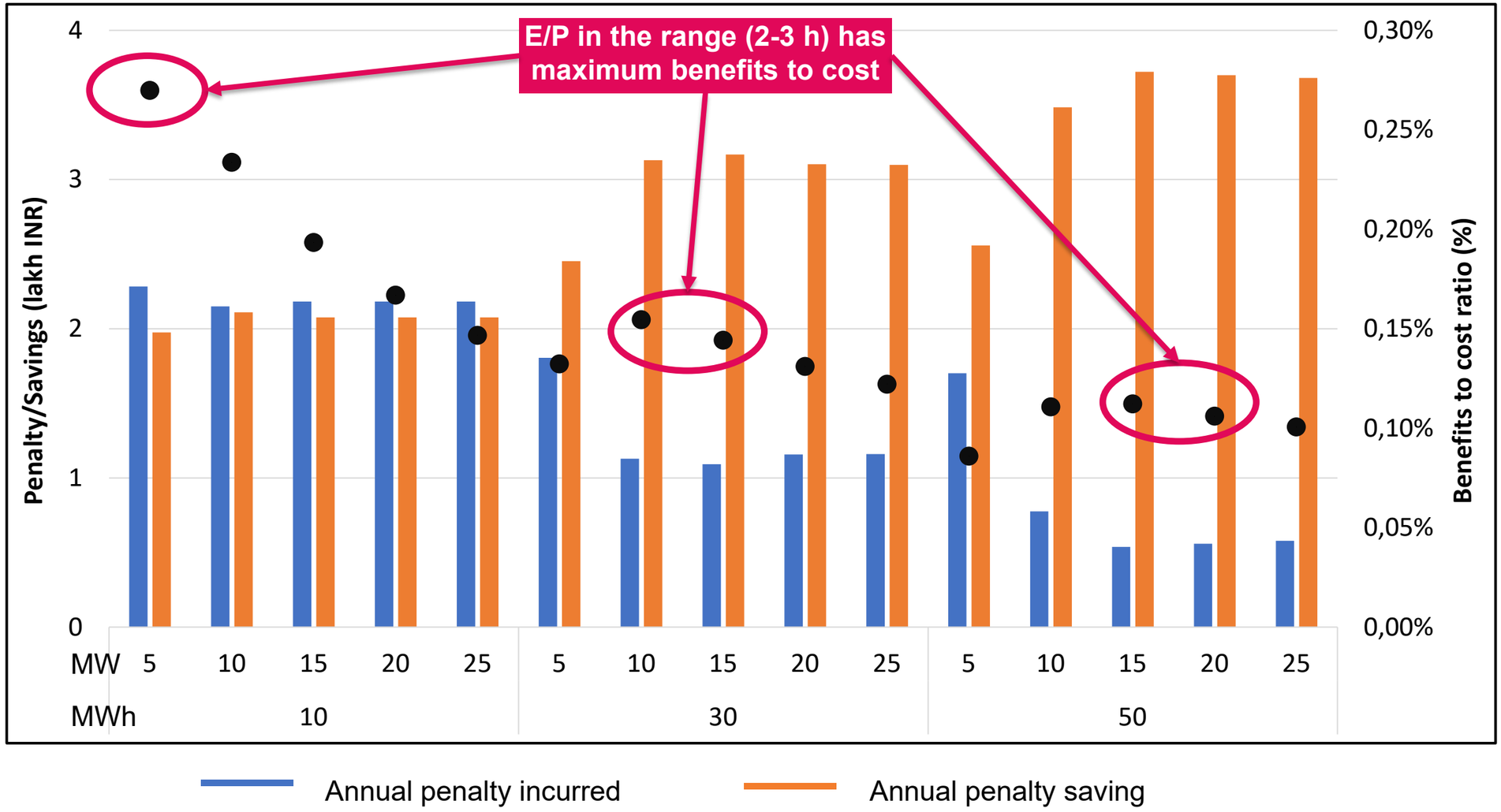
Annual penalty saving

Benefits to cost ratio decreases as battery capacity (MWh) increases

Benefits to cost ratio is maximum for energy to power (E/P) ratio in the range 2-3h

Note: Benefits to cost ratio considers annualized benefits and annualized costs of BESS. Analysis considers replacement of BESS after it has utilized its cycle life.

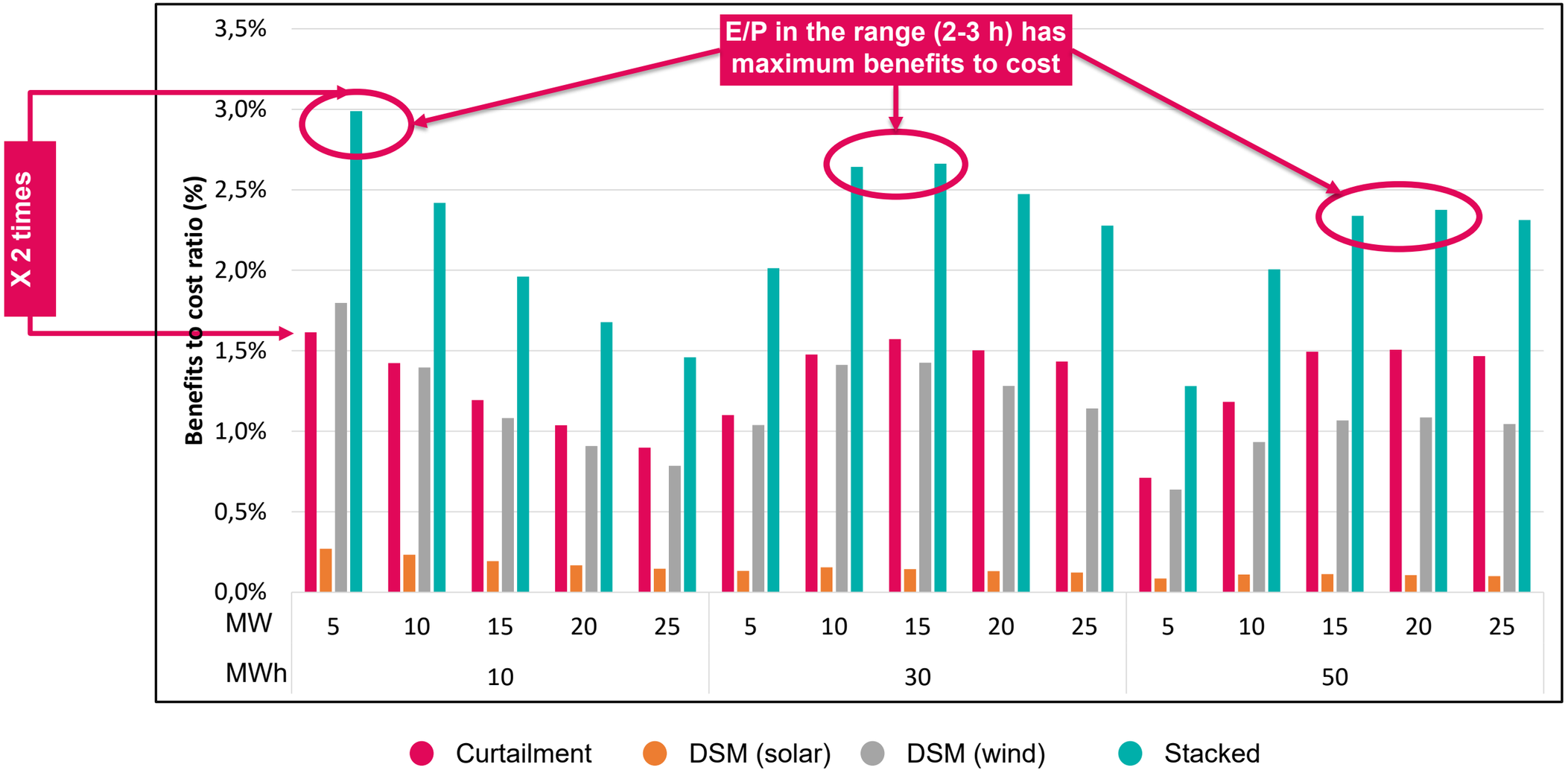
Application 2: Solar DSM penalty avoidance (Benefits to cost assessment)



Benefits to cost ratio decreases as battery capacity (MWh) increases

Benefits to cost ratio is maximum for energy to power (E/P) ratio in the range 2-3h

Stacking improves benefits to cost ratio by over 2 times but deploying storage at generator end does not look attractive



Stacking improves benefits to cost ratio

Benefits to cost ratio is maximum for energy to power (E/P) ratio in the range 2-3h

Suggestions for unlocking storage's potential in India

- The assumptions on curtailment level and DSM penalty as well as levels of absolute error are dependent on geographic location. Thus, **Policy makers, utilities and developers need to be prudent in storage site selection.**

- The assumptions on curtailment level and DSM penalty as well as band are on the conservative side, more realistic assumption will improve benefits to cost ratio.

- Wind and solar are natural complimentary resources, the penalties on wind and solar generators in isolation will be higher. Thus, **energy storage will realize higher benefits in isolated wind and solar projects.**

- Energy storage is modelled as a regulated asset tied by long term PPA. Thus, there is a case to focus on improving its utilization as well. This is possible through 'stacking' of applications. **Regulators, utilities and developers should work towards identifying 'Stacking' opportunities.**

- **Time of delivery based or Dynamic pricing** will enable storage to realize more benefits.

- Policy makers have to acknowledge **benefits of same storage resource to multiple stakeholders.**

For more information; please contact

Vikas Suhag
Author
Vikas.Suhag@icf.com

Pramod Singh
Co-author
Pramod.Singh2@icf.com