
Proceedings for India Smart Utility Week 2019

7th India- EU Smart Grids Workshop | 13th March 2019| New Delhi

Introduction and Welcome: Reji Kumar Pillai, ISGF introduced about the workshop and elaborated upon the points:

- Importance of pilots that has been implemented and to be implemented in September 2019.
- ISGF and EU DG ENER office pilot role in pilot projects and the outcome of four year efforts and inputs have been fruitful and to utilized in the real time projects.
- Role of smart grids in Indian electric grids and increasing penetration of RE in India
- Role of entrepreneurs and requirement of scale up solutions in smart grids
- Match making among utilities and EU companies should be the primary takeaway from this workshop
- Joint India-EU 18 million euro project and role of new technologies.

Special Address:

1. ***Matthieu Craye, European Commission DG ENER,*** *The speaker focused upon the importance of the workshop in the current context of India and elaborated the need of smart grids on the backdrop current utility perspective in India and EU.*

- Role of ISGF in smart grids and role EU- India cooperation in implementation of smart grids
- Importance of distribution companies in EU India relationship
- Participation of EU role since 2015 workshop
- Transfer of technological solutions, business models, policies and implementation framework are the key benefits of this EU India relationship and also through this smart grids workshop
- Last Nov – EU Electricity markets and design workshop was benefitted various stakeholders
- 175 GW target of RE in India require smart utilities and technology providers. EU and India can leverage this partnership to implement the ambitious targets in a sustainable way
- Ongoing projects and projects to be implemented will be strengthened through this workshop
- Thanks to utilities and other stakeholders for showcasing the projects, learnings and success stories
- Initiation and development of new consortium from new idea through this workshop

2. ***C Shikha, Managing Director, BESCO (Absent)***

3. ***Debasish U Banerjee, Managing Director, CESC, Kolkata,*** *and The speaker highlighted the need of energy storage application in Utilities and the experiences and bottleneck is implementation of smart grids from energy storage perspective. The speaker discussed on the following areas:*

- Role of storage in DISCOM
- Challenges in utility-gap between peak demand and average load, capex are on the based on the peak load

- Optimization of load centers and storage
- Role of distributed storage leading to capex deferral
- Optimization of RoI in energy storage projects
- Storage at LT and 11Kv level
- Storage capacity based on the load centers
- Reducing AT&C losses through smart equipment and monitoring
- Storage at incoming and consuming side to improve returns on the storage investment
- Looking forward to work with EU and EU MS companies to implement projects and knowledge sharing

4. **Praveer Sinha, MD & CEO, Tata Power Company Limited**, the discussant focused on the need of smart grids and his learnings from the last workshops conducted by EU **and** potential areas in India to adopt various solutions in utilities. EU and India has come long way on the collaboration front and the learnings from pilot projects will enhance efficiency and investments in Indian utility sector. The speaker focused on the key points:

- Florence school 3 day workshop- played a key role in understanding the dynamics of different regulations in EU and best practices to leverage them in India
- India-EU relationship role in fostering investments in energy sector
- India a big potential market for EU
- IElectrix project and learnings
- EU and DST proposal role and opportunity to bridge the gap and challenges in distribution sector
- RE and storage role in Indian utilities
- EV penetration in distribution utility and intermittency
- Flexibility of distribution feeders and experience from EU will play a key role
- Lack of redundant capacity in Indian grids
- Balancing of power and stability of grids without adding much capex
- Looking forward to learn from EU and EU MS players and interested to implement much more projects in India
- Regulations are the key areas to develop a eco system and business models to implement the technologies in smart grids area
- Indian utilities are ready to collaborate with EU to improve efficiency and reduce AT&C losses

EU – India Projects Presentations

Moderator: Christophe Arnoult, Co-Moderator: Swetha Bhagwat

IELECTRIX: a project combining smart grid demonstrations in EU and Indian networks by ENEDIS and Tata Power Delhi Distribution Ltd

- **Rémy Garaude Verdier & Pierre-Jacques Le Quellec, ENEDIS**
- **Aastha Prashar & G Ganesh Das, Tata Power DDL**

- ✓ The legal framework – Energy Efficiency, valuating consumer commitment, Make EU a leader in RE
- ✓ Connection between legislation and EU projects
- ✓ Role of EU projects in Innovation (Horizon 2020, CEF, 27% RE energy 2030 etc.)
- ✓ H2020- 7 years and 79 billion investments
- ✓ Concrete examples –Smart grids, digital energy, EE, EV, RE, Demand side management
- ✓ **IElectrix- LV automation and digitization, energy islands and outage management, prosumer communities, upgradation of assets, space and capital**
- ✓ **15 EU partners, 1 Indian partner, 42 months duration and 10.7 million euros**
- ✓ **Germany (High RE, Lack of flexibility and storage), Austria (existing energy communities), Hungary (new voltage regulation limits, high peak load)**
- ✓ **Current status and way forward**

E-LAND: in particular its activities in India: Smart Innovation Norway and Indian partners in E-LAND
Project: *Jitendra Nahwaya, BSES Yamuna*

- ✓ *42 months, 6.2 million euros, 12 EU partners and 2 Indian Partners*
- ✓ *Multi vector energy management objectives – multi energy foundation on advanced data analytics and advanced ICT technologies with strong consumer engagement and business models*
- ✓ *Indian partner role in E-LAND project and relevance in India*
- ✓ *Pilots in India- Small, medium and community based storage and solar PV rooftop systems*

MUSE GRIDS: *Patrick Clerens, European Association for Storage of Energy (EASE)*

Multi energy management in rural areas

Efficient local energy technologies with RE sources

Connection between real and virtual demo sites were presented

Role of decentralized distribution in Universal household electrification in India

Q&A:

- 1. Tell us about the working of existing mini grids in West Bengal? How muse grids are different from the existing one?**
- 2. How simulations are in line to the real time project? How simulated pilots are precise to implement the real time projects?**

Jitendra: We have considered the past data for the last ten years and developed the model and we

- 3. E-Land: Does it have any impact on the overall PPA/Merit order dispatch?**

Since we have already have RPO: E-land will optimize the energy dispatch for EVs and demand side management. Peak load management with RE. Not going to impact any energy mandate portfolio?

- 4. How do you manage district energy storage system?**

Digitization of battery energy storage and management system will help in seamless bi-directional flow of power system with in the local community like net metering. Muse grids have that capability do that.

5. **How do you maintain gender equality?**

6. **Can we use ice based energy storage with solar PV? For storage in rural areas?**

Most of the thermal/ice based storage solutions are still at lab phase and we are ready take up if the landing cost of electricity generation should be economical.

7. **EV chargers: LV automation- How do you ensure auto closure at LV level?**

- ✓ Overloading projections need to be assessed and ToD need to be in place to optimize capacity
- ✓ Smart meters can do the job of giving real time data and help in overloading issues
- ✓ Charging station and grid always work with standard interfacing systems
- ✓ In UK- existing transformer are protected during EV charging
- ✓ Network planning need to be done for placement of EV chargers to optimally utilize the transformer capacity. TPDL has the work done other utilities should follow.

8. **How do you pick up the data from pilot projects? Why not implement real time project? How do you maintain the efficacy system?**

To scale up we need to have an understanding of the issues which can be identified at simulation stage to take preemptive actions.

Presentation on New Call for Joint EU – India Smart Grid Demonstration Projects

- **Matthieu Craye, European Commission DG ENER**
- **Arvind Kumar, Department of Science and Technology**

The speaker elaborated on the Joint EU-India smart grid demonstration projects and implementation plan for the upcoming pilot studies to be implemented jointly by DST, India and EU.

- *EU DG ENER and DST jointly calls for new proposals to implement projects under the mission innovation framework*
- *Aims at bringing together 9 million euros from each. (Decarbonize and smart utilities, integration of RE, distributed generation, demand response, EV integration at local level, business models (EU and India) - also focusing on R&D, capacity building etc.)*
- *For rural and urban areas will be considered*
- *Timeframe- Sep 2019 and Short listing in Jun 2020. Project implementation will begin in June 2020.*
- *Discussions are happening with DST on evaluation of the proposals*
- *One demo in India and EU each*
- *At least 3 participants from Indian and EU side*
- *EU partners will receive funding from H2020 and Indian partners from DST*

Smart and Optimized Local Energy Management: Technological Solutions and Business Models for Cost-Efficient Integration of Large Scale Distributed Renewable Electricity, EV, and Storage etc.

The Sessions are designed to have a discussions from DSOs and Technology providers to fill the gap and identify the challenges in utilities from technology and commercial perspective.

Panel Discussion on Possibilities for New EU - India Demo Projects: Point of View of the DSOs

- **TPDDL: Sanjay Banga**
- **BESCOM: C Shikha**
- **BSES Yamuna: Gaurav A Sharma, The speaker discussed on BSES evolution from high AT&C losses to more efficient and robust network and strategies behind the improvements. He also discussed on the technology focused areas like AI in utilities, digitization of LV network, fast EV charging and roadmap for smart meter program.**

CESC: Sanjoy Mukherjee

ENERGIAS DE Portugal: Ricardo Jorge Santos, The speaker discussed on implementation models in Portugal and the advantages of smart grids from consumer perspective in evolution in Quality of service, operational efficiency, RE integration, market facilitation.

CEZ : Eva Polanská, The discutant elaborated on the Electric mobility project in CEZ utility and their performance in the last decade. CEZ ranking and reasons behind the best performance in EU utilities.

The speaker highlighted the technology behind the fast charging and potential market opportunities for India and EU to collaborate in electric mobility and different market segments

ALLIANDER: Willem Van Den Reek and ENEDIS : Rémy Garaude Verdier & Pierre-Jacques Le Quellec, The speakers discussed on the 1.3 lakh kilometer MV and LV power line in EU- Lessons and challenges and way forward. RE support initiatives and success factors to adopt RE at utility scale. Role of R&D innovation and strategy for future

- Smart grids consistency with new users and applications
- Smart grids- installation and demo in France and Europe

Panel discussion on possibilities for new India EU demo projects: Point of View of the Technology and Service Providers

Technology providers elaborated on the solutions and case studies and scope for addressing the challenges highlighted by the DSOs:

Swedish Energy Agency: Mikael Rantil,

- *About Swedish smart grid forum, Swedish grids, Swedish energy agency*
- *India Sweden innovation accelerator*
- *ISIA Smart grid related companies*

SOCOMEK: Sumit Pundhir

- *Innovative power solutions for smart grids – Components (hardwares)*

TOTAL SAFT: Wasful Hasan

- *SAFT and TOTAL collaboration*

- *Innovative battery management systems*
- *Turnkey energy storage solutions*
- *Applications and modular battery packs for grid scale storage systems*

EASE: Patrick Clerens

- *Ease members and their role*

VaasaETT: Thomas Mikkelsen

Odit-e : Philippe Deschamps

- *Low voltage network management*
- *Analytics software and IoT in utility networks*
- *LV impact prediction, state estimation and cartography*

ETREL Slovenia : Sara Rudman

- *Commercial products for software for managing the charging infrastructure and charging stations*
- *R&D projects in e-mobility*

Schneider Electric : Anil Kadam

- *Asset management and its aspects*
- *How to leverage IoT and protect existing infrastructure*
- *Can we develop accurate digital model of T/F, switch gear etc?*
- *Network readiness for 175GW*

Q&A

The key points DSOs and Technology providers focused are upon:

- 1. Markets and business models for digitization of utilities**
- 2. Flexible energy modes**
- 3. Role of AI in utility segment**
- 4. Energy Storage- Have we tested enough?**
- 5. Applications and business models of energy storage**
- 6. Regulatory framework for seamless integration of RE through digitization and automation**

Q: Where the money should be invested in future from utility perspective?

A: EV charging with innovative regulatory framework

Q: Impact of EV charging on distribution network?

A: more pilots to understand the first results in India

Q: Future regulations for large scale RE integration on distribution side?

A: Focus should not be on technology only- it should be on viable business model, connecting framework, digitization of LV network.

Q: 30 percent of Indian population resides in cities, where there is less RE, future on rural minigrids+storage in india ? area to be explored.

Q: Economic sense for solar+storage in India need to be evaluated at different electricity nodes in the distribution network

Q: Future of distribution market?

A: The focus and momentum should shift from network driven to consumer driven market with distributed generation and storage in place.

Regulations should be in place to transform from network driven to consumer driven market

Q: Vehicle to Grid (V2G) will enhance the adoption of large scale RE?

Q: Grid stability if all the EV chargers are switch on at same time?

Q: Experience from EU perspective? Will benefit India

Q: Regulations support with all modes of charging compatibility in EV segment

Q: Easy implementation of EU grants in rural areas

Q: Can EV charger circuit electronics move towards grid? No inside the vehicle just the voltage?

Q: LV Network: Greater monitoring equipment (Digitization of LV networks)

Q: Low voltage is serious problem- How to automate LV? High degree of failure rates in Low voltage

Q: Forecasting at consumer level helps reduction in low voltage. Data visualization will play a key role in low voltage reduction

EU – India Workshop on Power Markets Design | 14th March

Power Market Regulation and Design enabling Cost-Efficient Flexibility Options to Integrate RES

Introduction and Welcome: *Reji Kumar Pillai, ISGF, introduced about the theme and pilot projects to be implemented in India. The role of EU-India workshop in gathering all stakeholders under one roof to fill the gaps and existing challenges.*

- *7 workshops on power market design so far*
- *Project announced with TPDDL*
- *About new project in sep 2019 under EU-India grant*
- *About florescence school workshop in last September ‘*
- *The current workshop- bridge the gaps in power markets from EU experience*

Special Address: -

PK Pujari, Chairman, CERC, The discussant elaborated the current electricity markets and the knowledge papers released by CERC and possibilities of EU India collaborative projects:

- *Transition of Indian power sector to RE is the need of the hour*
- *CERC and MoP working on the transition framework*
- *CERC white papers on regulations*
- *DSM and daily average price linking market mechanism*
- *Redesigning markets-optimization of RE integration*
- *Intraday market to continuous to option based markets*
- *Regulation for nationwide open access linkage*

Megan Richards, EC DG ENER, The discussant elaborated need of such events and strategy to adopt carbon free markets with enhanced consumer participation and adoption of RE. Few key points the speaker stressed upon are:

- *Success about last workshop and learnings from florescence school held in last September*
- *EU- India cooperation and market potential*
- *Stressed on consumer benefits and design of markets*
- *Integration of RE*
- *Distributed generation and regulatory landscape*
- *Demand response elements*
- *Digitization and consumer interaction*
- *Future long term strategy on carbon free market*
- *Energy union governance- EE new market design- RE revised RE directive*
- *Boost wholesale markets for flexibility and RE integration*

- *Promote regional cooperation and enable digitization*

Andris Piebalgs, Florence School of Regulations, The discussant elaborated on the real time challenges in EU markets and role of Florence school in mitigation and experiences from working on real time issues:

- *Real times issues and challenges*
- *Networks enabled with competition*
- *Energy revolution- RE in utilities*
- *New market dynamics*
- *Congestion management*

Theme 1: Functioning of Day Ahead Market in EU and India: Experiences and Way Ahead

Chair: PK Pujari, Chairman, CERC

Presenters:

- India Presentation on state-of-play Day Ahead Market **SK Chatterjee, Joint Chief, Regulatory Affairs, CERC**
- Power Exchange Operations and Day Ahead Price Discovery in India **Rajesh Mediratta, Director, Business Development, IEX**
 - *Indian power exchange markets and design*
 - *Market share and trading strategy and framework in India*
- Florence School of Regulations- **Tim Schittekatte, EU Presentation**
 - *(state of play, examples of functioning of day ahead markets in some EU member states, challenges/barriers to optimal functioning (for instance: issue of bidding zones), what is foreseen in the new electricity market design directives/regulation that will impact on day ahead markets)*

Theme 2: Intra-Day and Balancing Markets: Experiences in EU and India and Way Ahead

Chair: Anand Kumar, Chairman, GERC

Presenters:

- India experiences with balancing/intra-day markets and way ahead **Samir Saxena, General Manager, and POSOCO**
- EU Presentation -**Cristian Lanfranconi, ARERA, Italy**
 - *(State of play, examples of functioning of intra-day markets in some EU member states, challenges/barriers to optimal functioning, what is foreseen in the new electricity market design directives/regulation that will impact on intra-day markets)*

Q&A:

Q: Why UK is moving towards bilateral contracts? Mandatory pool under NETA and PETA and energy market reforms

A: It is not a mandatory pool in India. We are not asking to do away from bilateral contracts. We are optimizing the overall energy drawl.

Q: For competitive wholesale market of power does we need effective market of Fuel?

Q: What are the important point for shift away present energy situation to legacy contract?

Q: Why the benefits are not transferred for negative value at PUC?

Theme 3: Capacity Markets/Mechanisms Vs Energy-Only Markets; and Market Monitoring and Surveillance

Chair: Arbind Prasad, Chairman, JSERC

Presenters:

Options in India to ensure security of electricity supply in systems with large scale RES deployment- BB Mehta, Chief Engineer, GETCO

- *Capacity markets and energy markets*
- *Technological challenges*
- *RRAS implementation*
- *Fast response ancillary services*
- *Secondary response automatic generation control*
- *Role of national access registry*

Price Deregulation and Scarcity Prices: potential for energy only markets to deliver investments in back-up capacity and ensure security of electricity supply- Pradyumna Bhagwat, Florence School of Regulations

- *Centralized pooling-Hydro resources*
- *Capacity market regulations*
- *Power market design theory*
- *Intraday in practice- ancillary services-200MW auctioned out of batteries in EU*
- *Batteries in capacity mechanisms*
- *Energy banking between the states*
- *Pooling economy*

Theme 4: Value Streams and Business Case for Energy Storage: Impact of Power Market Design and Regulation

Chair: IS Jha, Member, CERC

Presenters:

EU Regulator Presentation (what is foreseen in new electricity market design; what is the experience in different EU countries; what are remaining challenges)

Cristian Lanfranconi, ARERA, Italy

- Evidences of requirement of ESS in EU utility markets
- Challenges with ESS
- Standards and current regulations
- Ownership models in EU
- Connection rules and network tariffs
- Pilots in Italy

Regulatory Options for Energy Storage in India Mahindra Singh, Secretary, DERC

- Need of energy storage system in India
- Battery test bed
- Architecture of 10MWh battery storage system
- Peak load management and ancillary markets (frequency regulation and spinning reserves)

EU Energy Storage Association Perspective Patrick Clerens, The European Association for Storage of Energy (EASE)

- Energy storage in Europe
- EU clean energy package – energy storage
- Issues for storage revenue streams
- Impact of regulations on storage business case

India Energy Storage Sector Perspective Nilesh Kane, Circle Head and In-charge of BESS, TPDDL Subir Sen, ED, PGCIL

- Indian power scenario
- BESS pilot in Puducherry
- Siting and sizing of BESS
- Awareness and capacity building

Q&A:

Key points discussed during the sessions are:

1. High ramping rates to integrate storage – 200MW/Minute
2. Sizing and specifications of ESS
3. Ownership issues of ESS and business models
4. Decrease in cost of the battery posing dent on investor confidence in the ESS market
5. Capacity required to integrate 175 GW RE?
6. Business for all source of generations

Q: How can ESS help in reducing harmonics in the grid?

A: case studies in railways BMRC have shown improved power quality with BESS

Q: How to ensure long term commitment of investors in battery storage markets?

A: U.K case study and regulations can be mapped with 4 year long term contracts for BESS services – stack of services for ESS for viability of future.

Q: analysis on feasibility of the pilot?

Q: different charges in EU for battery storage? Battery role and viability for utilities?

A: Battery mobility services is one option

Q: Do you include battery cost in ARR?

A: Based on the past under drawl and over drawl we can plan ESS for the future and include in the ARR calculation

Key takeaways from EU-India Smart Grids Workshop at ISUW 2019

The two day workshop on Smart grids and power markets design organized PwC at ISUW 2019 was attended by various stakeholders from EU and EU MS, Indian utilities, Regulators, technology providers, policy makers, academicians, government bodies etc. Below are the key areas discussed as part of the workshop and the scope for future interventions/opportunities from India and EU perspective can be carved out from the areas highlighted below:

1. Key areas for **pilot level interventions to understand full scale challenges in utilities from renewable energy integration perspective and experience from IElextrix, E-Land and Muse grids**
 - 1.1. **Energy storage business models-** The key challenges with Indian utilities with managing peak and base load. With increasing RE penetration utilities will face challenges in managing the stability of the grids. ESS of different capacities at different levels should be in place for smooth flow of bidirectional power. EU utilities have proven experience in this area which can be mapped in India from technical and regulatory perspective. To boost investor confidence a level playing field and sustainable tariff eco system should be in place. It is evident falling tariffs for solar and wind due to technological changes had slowed down investor confidence in long term returns from the project.
 - 1.2. **Storage at LT 11KV level:** Distributed energy storage will play key role to optimally utilize solar PV at 11 KV level and Indian electric utilities are keen to implement energy storage interventions at 11 KV feeder level and the initial feasibility studies are in place for most of utilities.
 - 1.3. **Smart equipment for monitoring bi-directional power and capex deferral for ESS projects:** Energy storage projects are capital intensive and often designed to meet peak load requirements and stabilize grids during high ramping periods. With increasing penetration of renewable energy in the Indian utilities grid scale storage has the immense market potential. The challenge is utilization of the energy storage capacities and robust regulatory system to adopt such practices. Although, there is technical feasibility for energy storage under current Indian energy mix, the market has to evolve on the economic viability perspective. Utilities are looking forward for small scale grid storage at LT levels with lower capex and viable business models.

From EU experience, there has been pilots and business models that has been implemented EU utilities, which can be mapped as per the Indian conditions.

- 1.4. **Optimization of load centers and storage:** It is crucial to identify load centers/zones where the ESS integration is technically feasible and tapping ESS application at the consumer end to improve stability and voltage profile. This integration will also help in improving overall efficiency of the distribution utility and reducing AT&C losses.

2. Key learnings from India-EU Project presentations:

The speakers and stakeholders stressed upon the need of digitization and the capability to enable utilities to optimize the Regulatory framework for RE, energy efficiency, customer satisfaction and improved transparency.

Optimization of renewable energy sources with demand side management will improve the utilization rate of renewables sources. Reduced AT&C losses and efficiency are the key outcomes of the pilot projects. The speakers stressed upon scaling up of similar projects and implementation at large scale.

Some of the key experiences that can be mapped in India from EU and EU MS DSOs:

Learnings from EU MS: Germany (High RE, Lack of flexibility and storage), Austria (existing energy communities to enable competitive participation among the consumers), Hungary (new voltage regulation limits to integrate RE, high peak load management with integration of renewable energy sources)

3. Presentation on new call for Joint EU- India smart grid demonstration projects: The workshop clarified on the Joint EU India program:

- EU DG ENER and DST jointly calls for new proposals to implement projects under the mission innovation framework
- Aims at bringing together 9 million euros from each. (Decarbonize and smart utilities, integration of RE, distributed generation, demand response, EV integration at local level, business models (EU and India) - also focusing on R&D, capacity building etc.)
- For rural and urban areas will be considered
- Timeframe- Sep 2019 and Short listing in Jun 2020. Project implementation will begin in June 2020.
- Discussions are happening with DST on evaluation of the proposals
- One demo in India and EU each
- At least 3 participants from Indian and EU side
- EU partners will receive funding from H2020 and Indian partners from DST

4. Discussions between the DSOs and Technology providers:

The discussions between the DSOs and Technology providers was thought provoking and some of the key challenges and solutions were part of the debate and hour long discussions are:

The technology providers should focus on Fast chargers for EV and DSOs should enable auto closure for last mile stability in Utilities. Digitization of LV networks in India- Markets in EU and relevant business models to be implemented in India and ESCOs models to be evolved from the digitization perspective. Impact studies of EV on distribution utilities (V2G models and EV has a driver for RE adoption) and grid stability with large scale EV penetration should be assed in India grids. Forecasting at consumer level and demand side management (network driven to consumer driven market with ESS and relevant regulations in place) with increasing role of Artificial intelligence in distribution utilities.

Markets and business models for digitization of utilities to adopt full scale solution to reduce AT&C losses and improve efficiency. Flexibility of energy nodes to integrate distributed renewable energy generation at the consumer end and at the 11 KV level.

Energy Storage- Have we tested enough? From the protection and flexibility perspective to utilize ESS solutions from grid stability perspective.

Regulatory framework for seamless integration of RE through digitization and automation

5. Ancillary markets and adoption of DSM to integrate RE at large scale in domestic segment

The speakers stressed upon increasing penetration of RE in the Indian electric grids and the sector is transforming with DSM enabled markets with daily average price linking mechanism. The stakeholders

discussed upon need of redesigning of markets-optimization of RE integration (Intraday market to continuous to option based markets).

Ancillary markets in India are at niche stage and a holistic regulation should be devised for nationwide open access linkage for seamless energy transfer between interstate and intrastate. With increasing intermittency in the grid due to influx of large scale RE, the need of energy storage will play a key role to meet the high ramping rates of 200, MW/minute. Detailed sizing and specifications as per the Indian grid conditions will be the need of the hour.

Ancillary markets in India are at niche stage and a holistic regulation should be devised for nationwide open access linkage for seamless energy transfer between interstate and intrastate. With increasing intermittency in the grid due to influx of large scale RE, the need of energy storage will play a key role to meet the high ramping rates of 200, MW/minute. Detailed sizing and specifications as per the Indian grid conditions will be the need of the hour.

Sizing of energy storage solution to integrate 175 GW of renewable energy. High capex for ESS is one the primary deterrent posed by utilities since the utilization of ESS at large scale integration. Utilities are keen to adopt capex deferral/distributed energy storage solutions to integrate RE.

The speakers are also stressed upon the role of **ownership of energy storage solutions** and issues of ESS and business model (three tier and two tier ownership model between utilities, generation companies and consumers).

Florence school has been actively working on the regulation for EU to enable ESS at large scale integration of energy storage at grid scale to adopt ancillary markets in EU and EU MS. The discussion and need was around Regulatory framework to protect investor confidence on the backdrop of falling technology prices and Business models for all sources of generation including conventional sources of generation.