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ISGF
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India SMART UTILITY Week 2025

18 - 22 March 2025 | The Lalit Hotel, New Delhi

OUTCOME REPORT

11th International Conference and Exhibition on Smart Energy and Smart Mobility

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INTRODUCTION

The 11th edition of India Smart Utility Week (ISUW) was conducted from 18 – 22 March 2025 in New Delhi, India as an International Conference and Exhibition on Smart Energy and Smart Mobility. ISUW 2025 included keynotes, thematic sessions, roundtables, bilateral workshops, technical sessions, technical paper presentations, V2G demonstration, tutorials and technical tours. Bi-lateral Smart Energy Workshops with US, Africa, UK, and Indonesia were held successfully. The 09th edition of ISGF Innovation Awards was organized as part of ISUW 2025 on 21st March 2025.

KEY HIGHLIGHTS OF ISUW 2025

- **2000+** Delegates
- **26** Countries
- **210** Speakers
- **5** Supporting Ministries
- **16** Supporting Organizations
- **20** Supporting Media Partners
- **33** Key Partners and **20** Exhibitors
- **14** Conference Session Partners
- **26** Thematic Sessions
- **7** Workshops and Roundtables
- **339** Utility Participants from 33 Utilities
- **68** Technical Papers Published, and 24 Technical Papers Presented
- **50** Winners for the **9th ISGF Innovation Awards** in 11 Categories

INAUGURAL SESSION

SUMMARY OF KEY POINTS FOR IMMEDIATE ACTION

- **Need for a Nationwide Campaign on the Benefits of Smart Metering**: Scaling-up smart metering program has been witnessing challenges in many states. The absence of a well-structured customer awareness campaign has limited the public acceptance, despite smart meter's role in improving efficiency, reducing losses, and supporting renewable energy integration. For successful AMI rollout and customer's participation in leveraging the full benefits of the AMI systems, it is essential to have customer engagement by DISCOMs right from the beginning of the project with a proper awareness campaign and periodical surveys. It is suggested that Ministry of Power (MOP) initiate a national level campaign on the benefits of smart metering immediately.

- **Concerns of Advanced Metering Infrastructure Service Providers (AMISPs)**: Inordinate delays in achieving Site Acceptance Test (SAT) milestones remain a serious concern for AMISPs and their ecosystem partners including funding agencies. This has adversely affected the cashflow and the debt service obligations of AMISPs. Direct debit proposed by MOP is not followed in most DISCOMs. Need immediate attention on this to make the AMI ecosystem sustainable in the country.

- **Issues with Prepaid Mode of Smart Metering:** The transition from postpaid to prepaid metering has created confusion, particularly in managing subsidies. A phased approach, starting with postpaid metering and gradually shifting to prepaid, has been suggested to mitigate this issue. **It is recommended to deploy all smart meters as post-paid (except government offices) and offer choice to customers to opt-in for pre-paid mode against a modest rebate.**
- **Need for New Billing Systems in some DISCOMs**: The integration of AMI with outdated billing systems in some of the DISCOMs is creating significant challenges. The scope of the AMISPs is to transfer data from meters to the Meter Data Management System (MDMS) and integrate the MDMS with the billing system, but not to overhaul existing billing systems. With each meter generating around 100 data sets daily, legacy billing systems struggle to handle this volume efficiently, causing delays in the project. ***New billing systems may be implemented in such DISCOMs on fast track***.
- **Selective Rollout of Smart Meters is a Serious Concern**: Targeting specific customers like new service connections, government connections and distribution transformers is adversely impacting the daily installation targets, reducing efficiency and increasing cost. To derive full benefits of smart metering it has to be rolled out full feeder-wise, not isolated installations.
- To ensure robust security in smart grid infrastructure, integrating a **Root of Trust directly into semiconductor chips is crucial**. This foundational security feature establishes a trusted hardware environment that secures communication, data storage, and system operations from potential cyber threats. By embedding security at the hardware level, utilities can protect their systems from malicious attacks, unauthorized access, and data manipulation. This proactive measure ensures that security is built into the grid ecosystem from the ground up, reducing vulnerabilities across the network.
- **Kerala Model of Solarization**: Despite having limited land availability for large scale projects, Kerala has shown success in rooftop solar deployment by focusing on consumer awareness and ecosystem development, including training of electricians and targeting vulnerable groups like widows and single mothers. Pradhan Mantri Awas Yojana (PMAY) homes with integrated solar rooftops and induction cooktops are being used to enhance clean energy adoption among the urban poor. The Kerala government has also solarized all government buildings in Trivandrum and installed EV charging stations which provide free power during high-solar hours.
- **Gujarat Model of Rooftop Solar (RTS):** Gujarat's proactive approach includes expanding the vendor base, online portals, timely disbursement of subsidy, augmentation of distribution network and setting targets—now achieving over 1 MW per day of rooftop capacity addition.

- **Reverse Power Flow Challenges with RTS**: Feeders with high concentration of RTS are experiencing reverse power flows, tripping of inverters due to voltage spikes, intra-day voltage variations, and grid instability which need engineering solutions like smart inverters, tap-changing transformers and reactors.
- **Evolution of Distribution System Operators (DSOs)**: DISCOM's shift towards DSOs is required for enabling rapid growth in rooftop solar and battery storage, smart grid management, enable prosumers to participate actively in the energy market, improve grid reliability and support net-zero and energy security goals.
- **Mandate Smart Inverters for all New DER Connections:** Enforce regulations for the installation of smart inverters conforming to IS 18968-2025 for all new RTS connections and other Distributed Energy Resources (DERs). Smart inverters have the capabilities for voltage regulation, frequency control, and reactive power management.
- **Grid Codes for DER Integration:** Update grid codes to accommodate the technical challenges posed by high penetration of rooftop PV and smart inverters.
- **SOPs for Disaster Management**: While smaller disasters are now managed more effectively, there is a pressing need for comprehensive Standard Operating Procedures (SOPs) to be developed for handling serious and large-scale disruptions.
- **Disaster Resilience Measures**: Utilities in cyclone-affected areas need to raise the height of substation platforms and deploy mobile substations and mobile transformers for disaster preparedness. Spun concrete and rebar lacing poles offer cyclone resilience and are cost-effective options for withstanding high wind speeds and storm events, especially in coastal states like Odisha.
- **Create Infrastructure Resilience Fund:** There is an urgent need to create an Infrastructure Resilience Fund to finance projects/interventions enhancing infrastructure durability and adaptability and use Resilience Cost-Benefit Analysis (RCBA) tool for eligibility of such funds.
- **Massive Growth in Rooftop Solar and Battery Energy Storage Systems (BESS):** The rooftop solar sector is witnessing exponential growth. As per the International Energy Agency (IEA), the global rooftop solar capacity is projected to reach 3,700 GW by 2035, up from the current 680 GW in 2024. Simultaneously, battery energy storage systems are expected to expand from 120 GW in 2024 to 850 GW by 2035. Notably, 180 GW of this capacity will be behind-the-meter (BTM), enabling consumers to actively participate in energy markets and enhancing energy resilience at the local level.
- **Unified Energy Interface (UEI) - Building the Digital Layer of the Future Grid:** To move beyond isolated pilots and create a scalable, interoperable ecosystem for decentralized energy trading, ISGF is leading the development of pilot demonstration of the Digital Energy Grid (DEG) based on Unified Energy Interface (UEI) architecture.

UEI serves as a cohesive digital layer that allows all energy stakeholders—utilities, prosumers, aggregators, EVs, and BESS operators—to interact through a common digital language. The UEI platform supports real-time, secure, and automated execution of energy and financial transactions, and aims to bridge legacy systems with new-age digital solutions. **The first UEI pilot project is being launched in Lucknow, Uttar Pradesh, to test and validate the UEI framework in a real-world setting**. The outcomes of this pilot are expected to influence national policies and lay the groundwork for large-scale replication across India.

- **Develop Robust Supply Chains for Nuclear:** Support the development of domestic and international supply chains for SMR components to reduce costs and enhance resilience.
- There is an urgent need for a well-defined regulatory and technical framework to enable DISCOMs to implement DERMS efficiently. Strengthening grid visibility, implementing demand response solutions, and ensuring energy storage mandates were identified as key priorities for future grid modernization efforts.
- **Identifying and replicating successful Artificial Intelligence (AI)/Machine Leaning (ML) use cases** will be crucial for a sustainable, future-ready power sector for which collaboration between utilities, technology providers, regulators and policymakers is essential.
- **Digitalization through Structured Roadmaps:** Utilities need to have a clear digitalization roadmap to guide their digital transformation. These roadmaps help prioritize technologies, align with regulatory needs, estimate investments, and ensure future readiness. The process begins with understanding industry requirements by identifying market threats, stakeholder objectives, and comprehensive use cases to define clear goals.
- **Digital Twins - A Game-Changer in Grid Management:** The concept of digital twins—virtual replicas of physical assets—is gaining traction. They help utilities simulate, analyze, and predict grid performance, especially in managing distributed energy resources. Predictive analytics using digital twins is proving valuable in proactive maintenance and improving system resilience.
- **Looming Threat of Grid Defection by C&I Customers**: As the cost of storage keeps falling steeply, many C&I customers might move to a new regime of self-generation and storage; or buy from the grid when the cost is cheap to charge the storage and run their business with stored power. Some customers might even completely defect from the grid and manage their needs with own generation and storage – example: schools and colleges; many private and government offices and campuses who operate only during the day. This will pose huge challenges for the present equilibrium

and should give impetus to more regulations to make utilities viable – a key challenge regardless of the ongoing transition.

- **Hydropower regulations** were identified as an area needing revision, particularly regarding return on investment (ROI) incentives to promote its expansion.
- **The transition from cost-based dispatch to carbon-emission-based dispatch was proposed as a necessary step toward a cleaner power grid**.
- A renewed focus was placed on Renewable Purchase Obligation (RPO) compliance, calling for stricter enforcement mechanisms. The shift towards performance-based regulation was also explored, aiming to enhance efficiency, accountability, and service quality in the power sector.
- **Growing Regulatory Assets**: The issue of accumulation of regulatory assets and its burden on consumers, who ultimately bear the cost of accumulating interest, was also debated as a major concern that requires immediate regulatory intervention.
- **Climate Finance** for the power sector is critically insufficient, despite the sector contributing over 55% of India's emissions. Trillions of dollars are needed for clean energy, grid upgrades, and emerging technologies. High cost of capital and limited leverage with existing instruments are major barriers to scaling clean energy investments. Recommended financing institutions to come forward and offer carbon financing solutions.
- **Security and Emission Constrained Economic Dispatch (SECED)** can help optimize dispatch based on both cost and emissions, potentially reducing carbon while maintaining grid security. Experts emphasized state-by-state or cluster-wise rollout of SECED, while cautioning against its high cost if implemented in silos.
- **New business models for Public Charging Stations (PCS)**: Need to integrate user amenities and recreational facilities to attract more EV drivers to PCS. Additionally, **PCS can be linked to peer-to-peer (P2P) energy trading platforms,** opening up new commercial opportunities
- **EV Only Corridors:** Specific routes around tourist, pilgrimage and heritage sites may be designated as green routes using electric vehicles only. This helps in eliminating pollution around cultural and environmentally sensitive areas. In Telangana, such a model has already been implemented, showcasing the feasibility and impact of green routes in protecting heritage zones
- **Scalability of Charging Infrastructure:** India needs to plan charging networks in advance, factoring in temperature and high-load demands—especially for MW-scale systems and super-fast charging suited for commercial EVs.
- **Standardization is Critical for Battery Swapping:** For battery swapping to scale, especially in 2/3-Wheeler segments, there must be uniform standards across batteries, connectors, and communication protocols.

- Need for creche facility in the utilities to promote gender equality
- Emphasizing on NITI Aayog initiative on pushing for gender-based budgeting incentivizes women's participation in various training and capacity-building programs.

A. THEMATIC SESSIONS

SESSION 1: SMART METERING PART A - GLOBAL AND INDIAN LESSONS

Panel 1: International Experiences

- The evolution of smart meter technology presents several key challenges and considerations for the energy sector. One significant concern is the effective utilization of vast amounts of data generated by smart meters. Extracting meaningful insights from this data and transforming it into actionable strategies is crucial for optimizing energy distribution. Developing predictive maintenance models, improving load forecasting, and enhancing demand-side management will require advanced data analytics capabilities.

- The transition from the first to third-generation smart meters has the potential to transform utility operations and customer services. These advanced meters offer superior data collection and integration capabilities, contributing to improved energy efficiency and customer engagement
- Customer engagement is equally important. By providing consumers with detailed insights into their energy consumption patterns, smart meters promote greater

awareness and facilitate personalized energy management services. This empowers consumers to make informed decisions, enhancing overall energy efficiency.

- Explore the use of Artificial Intelligence, machine learning, and predictive analytics for optimized energy management leveraging the time-stamped consumption data from smart meter reads.
- Ensuring accurate customer data is vital for the AMI project's success. This requires a comprehensive approach, starting with rigorous data validation of feeder codes, Distribution Transformer (DT) codes, pole numbers, and Lat-Long details of customers. Robust data quality checks, including manual reviews and system-level validation at Meter Data Management (MDM) stage are essential to prevent erroneous data entry.
- Accurate data directly impacts customer communication, ensuring timely notifications, preventing disconnections, and improving customer trust. Maintaining data integrity demands continuous improvement through Root Cause Analysis (RCA) for discrepancies and proactive firmware/software updates.
- For successful AMI rollout and customer's participation in leveraging the full benefits of the AMI systems, it is essential to have customer engagement by DISCOMs in the program right from the beginning with a proper awareness campaign and periodical surveys
- The failure of promised tariff reductions after a few years will not motivate the end customers
- Establish transparent data usage policies to build consumer trust

Panel 2: Indian Experiences

- India's smart metering rollout shows promising progress, with strong investor confidence reflecting its potential success. However, unlike initiatives like Swachh Bharat or Jan Dhan Yojana, customer awareness efforts are lacking in the smart metering program that is limiting customer acceptance despite the program's wide impact. Unclear accountability between Advanced Metering Infrastructure Service Providers (AMISPs) and DISCOMs has further hindered outreach strategies.
- Despite strong initial momentum and early success in Assam, scaling-up smart metering program nationwide has been challenging. The absence of a well-structured customer awareness campaign has limited public acceptance, despite smart meters' role in improving efficiency, reducing losses, and supporting renewable energy integration.
- Inordinate delays in achieving Site Acceptance Test (SAT) milestones remain a serious concern for AMISPs and their ecosystem partners.
- Delays in achieving the SAT, extending from 7 to 13 months, have disrupted revenue flow, strained AMISPs financially, and weakened lender confidence. Deviations from

the recommended installation strategy, legacy billing issues, and communication gaps have further slowed progress. A nationwide awareness campaign, streamlined SAT timelines, and clear accountability frameworks are crucial for the program's success.

- Policy ambiguity has added to the challenges, particularly regarding AMISPs' role in customer engagement. While Request for proposal (RFP) guidelines assign this responsibility to AMISPs, their limited influence compared to DISCOMs has led to communication gaps.

- The smart metering program is more of a social and economic transformation than a technical upgrade. Building consumer trust and ensuring active engagement with DISCOMs is crucial for its success.
- The program’s selective rollout strategy — targeting specific areas like new service connections, government connections and transformer zones — is also adversely impacting the daily installation targets, reducing efficiency and increasing cost.

- The integration of AMI system with outdated billing systems in some of the DISCOMs is creating significant challenges. The scope of the smart metering program is to transfer data from meters to the Meter Data Management System (MDMS) and integrate the MDMS with the Billing System, but not necessarily to overhaul existing billing systems. With each meter generating around 100 data sets daily, legacy billing systems struggle to handle this volume efficiently, causing delays in the project. In such DISCOMs the billing systems may be replaced ASAP.
- The transition from postpaid to prepaid metering has created confusion, particularly in managing subsidies. A phased approach, starting with postpaid metering and gradually shifting to prepaid, has been suggested to mitigate this issue.

- A critical starting point is data collection, which should extend beyond utility-provided information to include third-party sources such as Google Earth data for understanding topographical variations. Encouraging consumers to contribute accurate information via dedicated apps and financial incentives can further improve data reliability and enhance deployment planning.
- Equally important is the development of a flexible communication infrastructure. This requires deploying solutions that support multiple Radio Frequency (RF) technologies to address diverse geographic challenges — such as long-range systems for rural areas, short-range systems for densely populated regions, and adaptable networks for urban apartment complexes. While cellular networks will play a vital role, strategic planning is necessary to ensure stable and reliable coverage rather than assuming uniform connectivity.
- Foster feedback mechanisms for continuous improvement based on consumer experiences
- Explore innovative financing models to support widespread smart meter deployment

Video Link: https://www.youtube.com/watch?v=qS2xjuHgbhQ&list=PLgSiPGd4Nrcj3FFB-fg7OoFEK9ZEcjZ0o&index=15

SESSION 2: SMART METERING PART B - AMISPS AND DISCOMS, OEMS, SYSTEM INTEGRATORS

- Integrating smart meters with existing utility Information Technology (IT) systems has emerged as a persistent challenge. Utilities reported frequent issues such as bidirectional meter errors, negative meter readings, and inflated billing values — in some cases showing amounts as high as two lakh rupees. These technical issues have created confusion among consumers and hindered the progress of smart meter adoption. Addressing these integration gaps through improved testing, data validation, and streamlined system architecture is crucial for ensuring the smooth operation of AMI systems.
- The initial deployment of smart meters faced significant challenges when implemented in prepaid mode. Consumers experienced frequent disconnections, resulting in frustration and resistance. These issues prompted utilities to temporarily halt the rollout and transition to postpaid mode, which improved consumer acceptance and allowed the deployment process to regain momentum. This highlights the importance of carefully assessing consumer readiness and ensuring adequate support mechanisms are in place before mass rollout of prepaid solutions.

- While utilities possess significant expertise in power supply management, their IT capabilities have often lagged behind. This has presented a major hurdle in adopting smart metering systems, particularly when handling large volumes of data and integrating new technologies. The lack of sufficient IT personnel and expertise has contributed to delays and operational issues. Utilities need to prioritize IT capacity building to support the data-intensive nature of smart meter infrastructure effectively.

- The critical need to assess stakeholder readiness before deploying smart meters. This includes evaluating the preparedness of utility systems, vendor capabilities, and consumer awareness. Without proper planning, unexpected integration challenges and consumer pushbacks can derail deployment timelines. A well-coordinated strategy that aligns stakeholders and ensures readiness at every level is key to the successful rollout of smart meters.
- While technical glitches have posed challenges, the core smart meter technology itself has been reliable. The real issue lies in integration and operational readiness rather than the technology's functionality. To unlock the full potential of smart meters, utilities must focus on strengthening system integration, training personnel, and improving consumer communication.
- The importance of adopting internationally recognized security standards such as Global Platform Level 3, RPS Level 3, and standardized security applications widely implemented in Europe and the US. Aligning with these established frameworks enhances system resilience by ensuring consistent security protocols across various grid components. Utilities should prioritize integrating these best practices to maintain compatibility, improve data protection, and safeguard against evolving cyber risks.
- To ensure robust security in smart grid infrastructure, integrating a Root of Trust directly into semiconductor chips is crucial. This foundational security feature

establishes a trusted hardware environment that secures communication, data storage, and system operations from potential cyber threats. By embedding security at the hardware level, utilities can protect their systems from malicious attacks, unauthorized access, and data manipulation. This proactive measure ensures that security is built into the grid ecosystem from the ground up, reducing vulnerabilities across the network.

- A heterogeneous network architecture allows utilities to select the most suitable communication technologies for different environments. In rural areas, cellular networks can provide robust connectivity, while dense urban settings can leverage wireless mesh networks. This approach ensures that the communication infrastructure is optimized for the specific geographical and infrastructural challenges of each deployment area.
- A robust communication network architecture can support a wide range of services on a single infrastructure. Beyond meter data management, utilities can integrate distribution automation and even expand to smart city applications like water and gas distribution networks. This multi-service capability enables more efficient resource utilization and creates opportunities for cross-sector collaboration and utilities integration.

- **Holistic Planning:** Emphasize hardware sizing, system designing, and cybersecurity for scalable growth.
- **Integration with Smart Grids:** Design the smart metering systems being rolled out with capabilities to enhance to AMI 2.0 which involves integrating smart meters with other smart grid technologies like distributed energy resources (solar panels, electric vehicles) and energy storage systems.

- **IoT Integration:** It is expected that AMI 2.0 will integrate with Internet of Things (IoT) devices, enhancing grid automation and enabling advanced applications like automated demand response and real-time energy management.

Video Link: https://www.youtube.com/watch?v=g6WXHiPq6Ho&list=PLgSiPGd4Nrcj3FFB-fg7OoFEK9ZEcjZ0o&index=17

SESSION 3: ROOFTOP PV REVOLUTION IN INDIA AND IMPACT ON DISCOMs – NATIONAL REGISTRY OF DERs AND SMART INVERTERS

- A **National Registry for Rooftop Solar (RTS)** has been prepared by ISGF to track RTS installations DT-wise, Feeder-wise, Substation-wise, and DISCOM-wise, enhancing network planning.
- **Rooftop Solar Faces a Trilemma**: Supply-side constraints, demand-side challenges, and DISCOM-level policy and technical issues.
- **Supply-side bottlenecks** include the need to ramp up daily installations from about 2,200 to 12,000, with gaps in vendor capacity, material availability, and skilled workforce.

- **Demand-side barriers** involve lack of awareness, poor access to affordable finance for small households, and limited willingness to take loans when free electricity is expected.
- DISCOMs are challenged by cross-subsidization, integration costs, and the need for **smart metering** to implement Time-of-Day (ToD) tariffs, along with economic, technical, financial and monitoring issues.

➢ The rooftop solar program could unlock the vast potential in the residential sector, which has remained under-tapped compared to commercial and industrial (C&I) sectors. Deregulation and simplification of processes across states are necessary to accelerate adoption and reduce procedural bottlenecks.

➢ **Innovative Financing Options:** Promote green bonds, low-interest loans, and performance-based incentives for rooftop PV adoption, especially for residential and small commercial sectors to overcome the financial hurdles faced by low-income households. Collateral-free, easily accessible, and completely digital loan process is required to reduce friction and increase adoption, especially among lower-income households.

➢ Reaching the lower-income segment is critical as there's a risk of adoption plateauing around 30–40 lakh households unless the program targets the lower-income strata with tailored solutions. Utility-led aggregator models can pool smaller, un-bankable consumers to make rooftop solar viable and scalable in underserved segments.

➢ Despite having limited land availability for large scale projects, Kerala has shown success in rooftop solar deployment by focusing on consumer awareness and ecosystem development, including training of electricians and targeting vulnerable groups like widows and single mothers. Pradhan Mantri Awas Yojana (PMAY) homes with integrated solar rooftops and induction cooktops are being used to enhance clean energy adoption among the urban poor. The Kerala government has also solarized all government buildings in Trivandrum and installed DC charging stations which provide free power in the morning hours.

➢ **World Bank's Suprabha initiative** highlighted that residential rooftop solar must go beyond subsidy reliance, focusing on business model innovation and ecosystem strengthening.

- **Gujarat's proactive approach** includes expanding the vendor base, online portals, timely disbursement of subsidy, augmentation of distribution network and setting targets—now achieving 1 MW per day of rooftop capacity addition.

- Technical challenges such as reverse power flows, intra-day voltage variations, non-synchronized inverters, and grid instability need engineering solutions like tap-changing transformers and reactors.
- Rooftop solar helps manage rising residential and industrial demand, with some DISCOMs buying cheaper power from rooftop consumers during peak seasons. Peer-to-peer (P2P) energy trading is gaining traction, especially in housing societies—where prosumers can sell excess power to others.
- States require state specific customized incentive structures—what works in Gujarat may not work in Jharkhand due to economic and infrastructure differences.
- Going forward, India would need to work on several innovations such as having digital twin for decentralized grid, presence of digital twin at distribution level and strengthening of distribution infrastructure.
- The shift towards Distribution System Operators (DSOs) is required for enabling rapid growth in rooftop solar and battery storage, smart grid management, enable prosumers to participate actively in the energy market, improve grid reliability and support net-zero and energy security goals.
- **Standardize Data Collection:** Implement uniform data formats and protocols to ensure consistency and reliability across all states.
- **Integration of the Rooftop Registry with DISCOM Systems:** Ensure seamless data exchange between the rooftop registry and DISCOMs for better load forecasting and grid management.
- **Mandatory Smart Inverter Standards:** Enforce regulations for the installation of smart inverters conforming to IS 18968-2025 for all new rooftop PV systems, with capabilities for voltage regulation, frequency control, and reactive power management.
- **Grid Codes for DER Integration:** Update grid codes to accommodate the technical challenges posed by high penetration of rooftop PV and smart inverters.

Video Link: https://www.youtube.com/watch?v=4NIyuurP81A&list=PLgSiPGd4Nrcj3FFB-fg7OoFEK9ZEcjZ0o&index=18

SESSION 4: UNIFIED ENERGY INTERFACE (UEI) AND THE EVOLVING ERA OF ENERGY INTERNET

- **Massive Growth in Rooftop Solar and Battery Energy Storage Systems (BESS):** The rooftop solar sector is witnessing exponential growth. As per the International Energy Agency (IEA), the global rooftop solar capacity is projected to reach 3,700 GW by 2035, up from the current 680 GW in 2024. Simultaneously, battery energy storage systems are expected to expand from 120 GW in 2024 to 850 GW by 2035[1]. Notably, 180 GW of this capacity will be behind-the-meter (BTM), enabling consumers to actively participate in energy markets and enhancing energy resilience at the local level.
- **Need for Intelligent Grid Infrastructure and DER Integration:** With millions of rooftop solar (RTS) systems, BESS and electric vehicles expected to connect to the grid, utilities and grid operators face the challenge of managing a complex and dynamic network. There is an urgent requirement for:
  - Smart inverters capable of remote monitoring and control of DERs
  - Automation systems and real-time control capabilities
  - Network modeling tools and DER Management Systems (DERMS)
  - Scalable IT/OT platforms that can securely manage both energy and data flows

- **Peer-to-Peer (P2P) Energy Trading - India's Early Success Stories:** India is among the few countries actively piloting blockchain-based P2P energy trading projects. India Smart Grid Forum (ISGF) and its technology partners have already demonstrated three pilot projects enabling rooftop solar P2P transactions on blockchain platforms[2].

[1] This was the latest projections available in March 2025. Since we are publishing this Outcome Report in October 2025, the latest position of BESS are as follows: As of August 2025, there is 375 GWh of BESS of which 200 GWh was installed in the last one year. Out of this 200 GWh installed last year, 100 GWh was installed in China. Per latest estimates, BESS capacity by 2040 will be 4000 GWh.

[2] These pilot projects were implemented in UPPCL in Lucknow in 2020, TPDDL in Delhi in 2021 and CESC Kolkata in 2022.

These pilots have proven the technical and regulatory feasibility of the concept and have helped lay the foundation for future adoption. Three Indian states—Uttar Pradesh, Delhi, and Karnataka—have issued enabling regulatory guidelines to support the growth of P2P energy trading.

- **Unified Energy Interface (UEI): Building the Digital Layer of the Future Grid:** To move beyond isolated pilots and create a scalable, interoperable ecosystem for decentralized energy trading, ISGF is leading the development of the Unified Energy Interface (UEI) platform with UPPCL in Lucknow. UEI serves as a cohesive digital infrastructure that allows all energy stakeholders—utilities, prosumers, aggregators, EVs, and BESS operators—to interact through a common digital language. The UEI platform supports real-time, secure, and automated execution of energy and financial transactions, and aims to bridge legacy systems with new-age digital solutions.
  - **Example:** Under the UEI framework, a household sending surplus solar power to a neighbor's battery can receive automatic payments, unlocking new revenue streams for prosumers.
- **Key Components of the UEI Framework:** The architecture of UEI comprises three core layers:
  - **Transaction Layer:** A dynamic digital marketplace where buyers and sellers discover prices, negotiate contracts, and execute trades in real-time
  - **Data Trust Layer (Blockchain):** A decentralized ledger that records and secures all transactions, ensuring tamper-proof and transparent operations
  - **BAP/BPP Platforms:** These platforms facilitate Business Application Provider (BAP) and Business Process Provider (BPP) roles—essentially enabling real-time market functions such as energy matchmaking, settlement, and compliance checks
- **UEI Pilot Demonstration in Lucknow:** The first UEI pilot project is being launched in Lucknow, Uttar Pradesh, to test and validate the UEI framework in a real-world setting. This project will showcase:
  - Use of digital platforms including a blockchain for decentralized transactions
  - Real-time automated settlement mechanisms
  - Demonstration of a fully functional, decentralized energy marketplace within a DISCOM
- The outcomes of this pilot are expected to influence national policies and lay the groundwork for large-scale replication across India.
- **Challenges and Considerations:** Despite its promise, decentralized energy trading through UEI faces several challenges:
  - Interoperability across different technologies and platforms must be addressed through common standards and protocols
  - Cybersecurity becomes critical as the digital layer increases exposure to cyber threats

    - Regulatory frameworks need to evolve to support dynamic pricing, settlement, and prosumer participation
    - Consumer awareness and trust will be essential for the adoption of P2P and digital energy markets
- **Business Models, Utility Role, and Scalability:** UEI and P2P models open doors for innovative business models, such as:
    - Subscription-based services for energy trading platforms
    - Prosumer monetization through dynamic pricing and flexible demand management
    - Utility-operated digital service layers integrated with billing and Customer relationship management (CRM) systems
- **UEI as General-Purpose Infrastructure**: The Unified Energy Interface (UEI) aims to serve as a general-purpose digital energy infrastructure enabling seamless transactions between diverse energy participants. Principles like **"design for diversity"** and **"+1 thinking at the population level"** were emphasized to ensure equitable energy access and use.
- The concept of an **"Energy Internet"** is gaining traction, driven by decentralization, digitization, and the electrification of end uses.
- Blockchain is being integrated into energy trading operations to ensure data trust, transparency, and secure transactions.
- UEI helps in decreasing the costs of transactions for different players. It also democratizes access for multiple prosumers.
- Interoperability and standardization are crucial to UEI's success, with open digital protocols enabling integration across platforms and systems.
- Data quality, accessibility, usability, transparency, and standardization emerged as major themes for implementing UEI at scale
- The UEI model empowers prosumers – including those in remote villages – to participate in energy markets through a shared digital language. It enables P2P trading and allows this energy exchange to scale across a utility, state and beyond.
- UEI opens up new business models such as dynamic pricing, aggregator-led trading, and monetization of surplus rooftop solar. With rooftop solar capacity growing, behind-the-meter battery storage will be key to managing decentralized supply and demand.
- UEI cannot be just a digital overlay; it must integrate with the physical infrastructure of the grid. Any market or data layer must be sensitive to the operational realities of electricity flow

Video Link:

https://www.youtube.com/watch?v=mnCVnOGJwgM&list=PLgSiPGd4Nrcj3FFB-fg7OoFEK9ZEcjZ0o&index=19

SESSION 5: NUCLEAR RENAISSANCE AND THE ROLE OF SMR FOR THE NET ZERO POWER SYSTEMS (Session Partner: BSCE)

- The session reiterated the global commitment, in line with the COP28 Dubai resolutions, to triple nuclear energy capacity globally by 2050. This commitment underscores India's strategic focus on nuclear energy as a key pillar in its net-zero roadmap.
- Small Modular Reactor (SMR) needs to be licensed in several countries which require joint efforts from regulators and other stakeholders.
- The session provided a comprehensive overview of the current landscape and future prospects of nuclear energy, particularly focusing on the role of SMRs in achieving net-zero power systems. Discussions underscored the technological advancements, financial imperatives, and collaborative opportunities essential for integrating nuclear energy into India's decarbonization strategy.
- Our Session Partner, Brahma Shakti Clean Energy Systems (BSCE) introduced the concept of fusion of ancient Hindu wisdom with modern scientific thought. Using a symbolic visual of Brahma seated on a lotus — coincidentally matching the conference’s theme colors - advocated that reframing the nuclear narrative using indigenous, spiritual, and philosophical perspectives could counter the fear propagated by vested interests and help foster global acceptance of nuclear energy.

- India's ambitious nuclear energy targets, focusing on achieving 100 GW by 2047 and the development of five indigenous SMRs by 2033. Discussions delved into advancements in SMR technology, economic feasibility, regulatory frameworks, and the impact of the INR 20,000 crore Nuclear Energy Mission. Highlighted global collaborations, best practices, and the potential of thorium-based reactors in shaping the future of clean and reliable nuclear power.

- The primary concerns raised were the insufficiency of the national budget for nuclear energy expansion, necessitating global cooperation and private capital investment. Expert Speakers acknowledged that the pace of technology adoption would be exponential, leading to a rapid increase in energy demand.
- It was noted that even environmental protection initiatives, such as air and river water cleaning, require substantial energy inputs. Highlighted that nuclear energy, being land-efficient and highly intensive, is particularly well-suited for high-density urban settlements like metros and large cities where energy consumption is significant.
- This session included a presentation on molten salt research reactors and highlighted new developments in the field, such as fast neutron reactors, which enable nuclear plants to recycle their own fuel. Additionally, advancements in superconducting radiofrequency accelerator technologies and their applications were discussed. The issue of nuclear liability was also brought up, emphasizing the need for clear regulatory frameworks to ensure the sustainability of nuclear investments.
- **Need for Pilot Projects:** Launch demonstration projects globally to showcase SMR capabilities, build public trust, and attract private investment.
- **International Collaboration:** Foster global partnerships to harmonize regulatory standards, share best practices, and promote cross-border SMR deployment.
- **Hybrid Energy Systems and Grid Compatibility:** Design SMRs to operate flexibly with renewable energy sources, providing baseload power and grid stability, especially during low-renewable generation periods.
- **Develop Robust Supply Chains:** Support the development of domestic and international supply chains for SMR components to reduce costs and enhance resilience.

Video Link: https://www.youtube.com/watch?v=eSohmQe9XbQ&list=PLgSiPGd4Nrcj3FFB-fg7OoFEK9ZEcjZ0o&index=20

SESSION 6: BUILDING RESILIENT UTILITY ASSETS FOR CONGESTED CITIES AND CLIMATE RESILIENCE (Session Partner: CDRI)

- Urban utility infrastructure must adapt to climate risks. Cities in Odisha, Andra Pradesh, Gujarat and metro cities like Mumbai, Chennai and Delhi are facing increasing flood and cyclone risks, necessitating climate-resilient utility planning and infrastructure redesign.
- Case studies like California's water supply crisis and India's unexpected rain in summer months show how planning must evolve to meet unpredictable conditions.
- Utilities in cyclone-affected areas are raising substation platforms and deploying mobile substations and transformers for disaster preparedness. Spun concrete and rebar lacing poles offer cyclone resilience and are cost-effective options for

withstanding high wind speeds and storm events, especially in coastal states like Odisha.

- **Underground substations can help in addressing space constraints in cities. For example, Mumbai's underground substations and drain-top designs show how dense cities can accommodate large electrical infrastructure with minimal surface footprint**.

- Large infrastructure upgrades are capital intensive, and resilient infrastructure will impact electricity tariffs, especially in states with limited central government support for private DISCOMs.
- Right-of-Use models can enable Public-Private collaboration in building resilient utility assets. For example, Odisha's model of government-owned assets with usage rights granted to DISCOMs allows investment in climate-resilient infrastructure even when DISCOMs lack capital.
- Utilities are investing in digital monitoring systems to improve real-time asset management and damage prediction. There is also a shift from reactive to predictive maintenance, enabled by digitalization, IoT-enabled sensors and AI -ML tools. Real-time data can extend asset life and reduce unnecessary CAPEX by enabling smarter infrastructure management.
- **While there are many innovative solutions implemented by utilities, many digital and climate-resilient solutions are stuck at the pilot stage—scaling successful models is crucial and need immediate attention of authorities**.
- DISCOMs face hurdles in convincing regulators to approve climate-resilient infrastructure investments that require upfront capital. Including resilience metrics in standard concession documents can mainstream such investments, though excessive standardization can hinder innovation.
- Increased digitization introduces new vulnerabilities—IT/IoT systems, human error, and integration challenges increase cyber risk in utility operations. Personnel training,

standardized protocols, and preparedness drills are vital for both climate events and cyber threats.

- In countries such as Malaysia, Battery Energy Storage Systems (BESS) offer grid backup in case of failure. Malaysia is also focusing on trimming and managing tree cover near power lines to prevent grid disruptions during high wind events. The country is actively investing in resilient infrastructure by developing indoor gas-insulated substations, enhancing insulation systems, undergrounding critical power lines, and implementing robust post-impact recovery measures to ensure quicker restoration and long-term reliability.

- While smaller disasters are now managed more effectively, there is a pressing need for comprehensive Standard Operating Procedures (SOPs) to be developed for handling more advanced and large-scale disruptions.
- **Decentralized Systems:** Promote decentralized and distributed infrastructure solutions, such as microgrids and local water recycling systems, to reduce dependency on centralized assets.
- **Predictive Maintenance:** Utilize predictive analytics and AI for proactive asset maintenance, reducing downtime and extending the lifespan of critical infrastructure.
- **Cost-Benefit Analysis:** Conduct comprehensive economic analyses to demonstrate the long-term value of resilient infrastructure investments.
- **Capacity Building in Disaster Risk Reduction (DRR) and Disaster Risk Financing and Insurance Program (DRFI) with Toolkits and Training Programs** for government officials and private players.
- **Create Infrastructure Resilience Fund**: Finance projects/interventions enhancing infrastructure durability and adaptability and use Resilience Cost-Benefit Analysis (RCBA) tool for eligibility of such funds.
- **Defense in Depth:** No single security measure itself is foolproof as vulnerabilities and weaknesses could be identified at any time. **In order to reduce these risks, implementing multiple protections in series avoids single point of failure**.
- Implementing solutions around cyber security has to be a continuous process. It's not only important to protect a system from the current vulnerabilities but is also equally important to have mechanisms (technical and process) in place to quickly detect and effectively react to any incidents and isolate security breaches.

Video Link: https://www.youtube.com/watch?v=edTvv1rAQHs&list=PLgSiPGd4Nrcj3FFB-fg7OoFEK9ZEcjZ0o&index=22

SESSION 7: POWER SYSTEM FLEXIBILITY AND DERMS (Session Partner: AspenTech)

- This session focused on the critical role of Distributed Energy Resource Management Systems (DERMS) in enhancing grid flexibility, efficiency, and resilience. Discussions revolved around the key challenges DISCOMs face in integrating DERMS with existing IT and automation infrastructure, including interoperability issues, data management complexities, and the need for a structured approach for implementation.
- The session also showcased the major evolutionary stages of the power system, detailing how grid infrastructure has adapted over time to incorporate technological advancements and regulatory changes. This historical perspective helped frame the discussion on future challenges and opportunities in grid modernization.

- The issue of variability and intermittency in RE generation is a key concern, particularly in relation to solar power fluctuations due to cloud cover. Ensuring resource adequacy through enhanced visibility and monitoring of behind-the-meter generation was identified as a critical need.
- **The importance of a DER Registry as the foundation for effective DERMS deployment was highlighted including strategic roadmaps for cost-effective implementation, drawing lessons from successful global deployments.**
- The role of energy storage was also deliberated, with participants noting that storage systems should be available to store at least 10% of renewable energy. The government’s move to mandate 10% battery storage for new renewable energy projects is a significant step towards improving grid reliability.
- The potential of DER control mechanisms and demand response (DR) are the key measures for the transition from traditional analog grids to smart grids. Effective coordination between Transmission System Operators (TSOs) and Distribution System Operators (DSOs) was identified as essential for improving grid stability and congestion management.

- The session highlighted the importance of advanced network congestion management strategies to optimize grid performance and prevent bottlenecks as DER penetration increases.
- It is very important to have robust cybersecurity measures to safeguard grids that connect millions of DERs, electric vehicles, and smart meters. Emphasized the importance of workforce skill development to equip power sector professionals with the necessary expertise to manage evolving grid complexities.

- There is an urgent need for a well-defined regulatory and technical framework to enable DISCOMs to implement DERMS efficiently. Strengthening grid visibility, implementing demand response solutions, and ensuring energy storage mandates were identified as key priorities for future grid modernization efforts.
- Central Control Room (CCR) is at the forefront of enabling power system flexibility through intelligent DERMS solutions, ensuring a seamless transition to a resilient, low-carbon energy future. With India's strong telecom infrastructure and scalable workforce, the country is well-positioned to lead the adoption of smart energy management systems.

In USA, Federal Energy Regulatory Commission (FERC) Order 2222 allows aggregated DERs to participate in wholesale electricity markets; and promoting VPPs to enhance commercial viability and create a thriving market.

Video Link: https://www.youtube.com/watch?v=5eObrFvRy2g&list=PLgSiPGd4Nrcj3FFB-fg7OoFEK9ZEcjZ0o&index=23

SESSION 8: DEEP DIVE SESSION ON AI, ML AND ROBOTICS - USE CASES FOR UTILITIES

Some of the areas where AI-ML tools are being successfully deployed are described below:

- **Grid Optimization, Demand Forecasting, and Asset Management:** AI/ML models enhance demand forecasting accuracy, improving resource allocation. Real-time data analytics enable smarter grid management for renewable energy and EV integration. Advanced analytics reduce commercial losses and improve operational efficiency
- **AI's Role in Loss Identification and Theft Prevention:** AI-powered energy theft detection reduces losses by up to 30%. Consumption pattern analysis and anomaly detection improve billing accuracy and fraud detection. AI-driven real-time monitoring of transformers helps utilities tackle non-technical losses effectively.
- **Predictive Maintenance for Reliability and Cost Reduction:** AI-based predictive models identify equipment failures before breakdowns occur, reducing downtime. Implementation of deep learning and big data analytics enhances grid resilience. AI-ML powered enterprise analytics can improve DISCOM operations.
- **Web 3.0, Blockchain, and Immersive Technologies:** Blockchain applications ensure secure transactions, data integrity, and smart contracts in energy trading. Metaverse and AR/VR/XR technologies enable remote maintenance, workforce training, and enhanced grid visualization. AI-driven immersive technologies improve situational awareness and decision-making
- **Customer Service Enhancements:** AI-powered chatbots and voice assistants improve customer engagement. AI-driven analytics enable personalized service offerings and predictive billing solutions. Real-time customer insights improve response times and complaint resolution
- **Addressing Challenges and Ethical Considerations:** AI adoption faces hurdles such as data privacy, cybersecurity, and ethical risks of automated decisions. Strategies are needed to ensure fairness, transparency, and accountability in AI-powered utility services
- **Workforce Transformation and Skill Development:** AI and automation will reshape workforce roles, requiring upskilling and training programs. The utility sector must develop AI-literate professionals to harness these technologies effectively.

Successful Use Cases from Utilities who presented are:

- **Land Use Change Detection at Noida Power Company Ltd (NPCL):** NPCL uses satellite imagery and AI for GIS-based network planning. With urbanization and economic growth, consumers' electricity demand grows rapidly causing overload on the distribution network. Frequent grid augmentation is expensive and impractical. Mapping the Land Use and Land Cover (LULC) changes help in identifying suitable routes for laying the distribution power lines by analyzing land type and existing infrastructure.

- **AI-based Dispatch Optimization and Energy Trading by BSES Rajdhani:** AI models optimize power scheduling and trading
- **Alarm System via Optical Character Recognition at PGCIL:** AI-driven real-time monitoring and alarm identification
- **Deep Learning for Demand Forecasting at Tata Power Western Odisha:** AI models improve day-ahead load forecasting
- **Generative AI in REC Ltd**: Enhances document automation and workflow management
- **ML Models for PMU Data Analytics by MAHATRANSCO:** Improves grid visualization and situational awareness
- **Leveraging Data-Driven Insights by PT.PLN, Indonesia:** PLN strives towards data-driven insights to understand their operations and develop decision support systems
- **AI for Payment Default Prediction at Noida Power Corporation Limited (NPCL):** ML models assess consumer creditworthiness and reduce payment defaults

➢ **Important AI - ML Applications for Utilities to Adopt are:**
- Load and Generation (including RE) forecasting accuracy enhancement by using AI-ML Techniques
- Developing ML based data driven power system dynamic models and developing Dynamic Security Assessment (DSA)
- Improving performance of Energy Management Systems (EMS) using AI to predict Stability Accurately
- ML techniques can be applied to Phasor Measurement Unit (PMU) data to Classify Fault Types and suggest Corrective Actions
- ML models to improve Protection and Automation System Performance
- Utilities can employ AI capabilities to pinpoint exactly potential points of failures from asset inspection data and undertake preventive maintenance.

➢ It is important to identify the Right Use Cases by prioritizing which potential of AI as testbench and initiating next phase: migration to production.

- Identifying and replicating successful AI - ML use cases will be crucial for a sustainable, future-ready power sector for which collaboration between utilities, technology providers, regulators and policymakers is essential.

Video Link: https://www.youtube.com/watch?v=pZFg25hbM2k&list=PLgSiPGd4Nrcj3FFB-fg7OoFEK9ZEcjZ0o&index=24

SESSION 9: DIGITALIZATION OF UTILITIES, DIGITALIZATION ROADMAPS; DIGITAL TWINS

- **Digitalization Through Structured Roadmaps:** Utilities emphasized the importance of having a clear digitalization roadmap to guide their transition. These roadmaps help prioritize technologies, align with regulatory needs, estimate investments, and ensure future readiness. Developing a unified, secure, and sustainable digital infrastructure for utilities requires a structured systems approach and effective architecture modeling. The process begins with understanding industry requirements by identifying market threats, stakeholder objectives, and comprehensive use cases to define clear goals.

- The roadmap should focus on key transformation pillars such as customer engagement, grid operations, advanced metering infrastructure, renewable integration, cybersecurity, and data analytics
- **Driving Operational Excellence with Digital Technology:** Smart meters, automation, and IoT devices are at the forefront of improving real-time monitoring, reducing outages, and enhancing service delivery. Digital tools are enabling utilities to become more customer-centric by offering better visibility, faster issue resolution, and tailored services.

- **Digital Twins - A Game-Changer in Grid Management:** The concept of digital twins—virtual replicas of physical assets—is gaining traction. They are helping utilities simulate, analyze, and predict grid performance, especially in managing distributed energy resources and renewables. Predictive analytics using digital twins is proving valuable in proactive maintenance and improving system resilience.
- **Tapping into AI and ML for Smarter Decision-Making:** Advanced AI and ML tools are being actively adopted to process massive volumes of operational data. Use cases shared included asset performance optimization, load forecasting, and demand-side management, especially in complex urban networks.
- **Navigating Digital Transformation Challenges:** Common concerns include cybersecurity, regulatory compliance, and the high cost of technology upgrades. Utilities shared strategies such as phased implementation, workforce training, and strategic partnerships to overcome these hurdles.
- **Future Outlook Towards Data-Driven, Agile Utilities:** Presentations and panel discussions pointed towards a data-first approach, where utilities evolve into digital service providers rather than traditional power distributors. The role of customer data, real-time analytics, and integration with sectors like electric mobility was also highlighted as key trends shaping the future.
- **Insights from Global and Indian Leaders:** Speakers brought diverse perspectives from on-ground implementation in Indian DISCOMs to global best practices in digital utility transformation. Strong emphasis was placed on collaboration, innovation, and policy support to accelerate digital maturity in the sector.
- **A holistic system architecture** should follow a top-down approach that integrates multiple reference frameworks. Mapping existing standards, identifying gaps, and designing a layered structure - such as a 7-layer model covering devices, connectivity, and applications - ensures compatibility and efficiency.
- **Standardization is key to seamless integration**. Harmonizing data formats, establishing unified communication protocols, and creating common service layers with standardized gateways to enable smooth data flow across platforms
- **Harmonizing data standards and protocols** across diverse technology layers and vendors presents several challenges in enabling a seamless digital twin for utility operations. Technical challenges include the presence of multiple vendor solutions, each with distinct communication protocols and architectural complexities. Varying data formats and infrastructure differences further complicate integration. Systemic challenges arise from the absence of a unified data standardization approach, significant gaps between IoT and IT protocols, and vendors developing solutions in isolation without a common communication framework. Strategic challenges involve

breaking down functional silos, aligning engineering processes, and developing common service layers and standardized gateways to ensure smooth data exchange.

- **Organizational inertia is a major hurdle** in the adoption of new technologies, as deeply ingrained operational practices developed over the decades create strong resistance to new technologies and modern ways of working. Changing this long-standing mindset requires sustained effort and clear communication. The shift from a traditional consumer model to a prosumer model further complicates the landscape. Utilities must adapt their systems and processes to serve customers who actively produce and consume energy, requiring flexible technologies and service frameworks.
- To overcome these challenges, adopting a systematic change strategy is essential. **Tools like the Smart Grid Maturity Model (SGMM) can guide utilities** in assessing their current technological capabilities and mapping incremental steps for short, medium, and long-term transformation. Involving business experts in the technology integration process ensures that new solutions align with operational realities and customer needs.
- **A phased implementation approach ensures steady progress**. In the short term (0-12 months), focus on quick-win digital initiatives, basic data integration, skill development programs, and pilot projects. The medium term (1-3 years) should expand analytics capabilities, enhance grid monitoring, and strengthen workforce training. The long term (3-5 years) should target full digital transformation with predictive maintenance, AI-driven operations, and advanced renewable energy management.

Video Link: https://www.youtube.com/watch?v=sJUMg3xgYHo&list=PLgSiPGd4Nrcj3FFB-fg7OoFEK9ZEcjZ0o&index=28

SESSION 10: EMERGING DIGITAL TECHNOLOGIES FOR UTILITIES (Session Partners: DST and C-DAC)

- Efficient integration of large scale RE generation would require implementation of AI, ML, Blockchain and Metaverse solutions. Successful implementation of AI and ML solutions requires high quality data.

- The ongoing 250 million smart meter program is expected to generate the high quality digital data on the power consumption which could help DISCOMs in multiple ways. The implementation of these smart meters must be expedited.

- With the implementation of 10 million rooftop solar (RTS) systems under PM Surya Ghar Yojana, RTS generation would make a significant contribution to the power mix at distribution grid. This would require real time monitoring and digital tools to monitor and control in real time.
- Peer to Peer (P2P) trading and vehicle -to-grid (V2G) technology are becoming popular. V2G has the potential to encourage the automobile buyers for electric vehicles and complement the Battery Energy Storage System (BESS) for grid support.
- Flexible regulatory framework must be provided to facilitate the adoption of these cutting age technologies. Standardization and interoperability remain key concerns for large-scale deployments. Product developers and utilities adopting these technologies must give due consideration to these aspects at each stage.
- Utilities and regulators must have a forward-looking approach for these technologies and must give due consideration to the developing consumer aspirations.

Video Link: https://www.youtube.com/watch?v=W-H9BsK-p0w&list=PLgSiPGd4Nrcj3FFB-fg7OoFEK9ZEcjZ0o&index=29

SESSION 11: INNOVATIONS IN REGULATIONS FOR THE NEXT ROUND OF POWER SECTOR REFORMS

- There is not just decarbonization happening, but also digitalization and decentralization - the famous 3Ds. The fourth dimension is the rise of new market structures, including a reduction in costs-plus top-down regulations.
- This session underscored the necessity of a forward-looking regulatory framework that balances technological advancements, market mechanisms, consumer equity, and sustainability goals. Collaborative efforts among regulators, policymakers, industry stakeholders, and technology innovators will be key to ensuring that India's power sector reforms keep pace with global trends while addressing local challenges effectively.
- A major issue flagged and discussed at length was of trade-offs and multiple objective functions. E.g., electricity prices (which include subsidies, cross-subsidies, etc.). These are meant to not only signal costs, but cover social welfare redistribution, DISCOM viability, encourage efficiency, enable “greening”, etc.
- The range of historical and present instruments used in regulation, ranging from Renewable Purchase Obligations (RPOs), Renewable Energy Certificates (RECs), net metering (rooftop solar), etc., as well as new storage obligation and Round the Clock

(RTC)/Firm and Dispatchable Renewable Energy (FDRE) projects were discussed in detail. Some of these have served their purpose but may have outlived their practicality or may need to be updated. E.g., net-metering helps prosumers and grows the market for rooftop solar, but it comes at a cost to the DISCOMs. RE is no longer a toddler needing support; and should be treated similar to other generators or at least have better forecasting capabilities.

- Another key area of discussion was on costs. In the short run, there was consensus that RE doesn't raise costs – rather, it lowers costs. The challenge was scaling this through – after a point, that is not necessarily true. The good news remains that there is significant scope for higher RE without integration costs becoming non-linearly higher.
- One of the missing links in the way forward is the use of dynamic or time-of-use (ToU) pricing. This will promote smarter consumption as well as storage and demand response. Implementation of ToU tariff for all categories of consumers must be prioritized.
- There was some discussion of traditional models of reforms, including privatization, but there was a view that even without privatization, there is a strong role for the private sector to play, and the sector benefits from both competition and innovation. Some of this may emerge from edge-based solutions. In just a few years, storage prices will fall to the level that some consumers, especially the higher paying commercial users or industrial users, may see value in exiting from the current grid. That will pose challenges for the present equilibrium and should give impetus to more regulations to make utilities viable – a key challenge regardless of the ongoing transition.
- We have to find the middle ground – a balance between markets and regulation. Both have a role to play.
- The integration of vehicle-to-grid (V2G) technology, considering aspects such as pricing mechanisms, grid security, and equity in access. As more electric vehicles (EVs) enter the market, they will play a dual role as energy consumers and potential energy suppliers, necessitating regulations to manage bidirectional energy flows.

- There is need for appropriate economic incentives within regulatory frameworks. Tariff structures should encourage investments in DER, microgrids, small modular reactors (SMRs), BESS, and other emerging technologies.
- New sources of energy demand, such as EVs, data centres, AI and other digital services, were identified as key factors shaping future electricity demand.
- The rise of prosumers—consumers who both consume and produce electricity—leading to a shift from one-directional to bidirectional energy flows necessitates new regulatory mechanisms to address back feeding losses and ensure fair compensation structures for all stakeholders.
- Regulatory challenges in integrating RE were discussed, particularly the shift in peak load timing from afternoon to evening and the need to adjust the technical minimum for thermal plants to accommodate frequent ramping requirements. Additionally, the INR 10/kWh price cap on power markets and its implications on evening peak demand management were debated, especially in cases where costlier power is required to meet critical demand.
- Hydropower regulations were identified as an area needing revision, particularly regarding return on investment (ROI) incentives to promote its expansion.
- Similarly, nuclear power was recognized as a reliable baseload source, but concerns around safety, waste disposal, and high initial investment costs were highlighted as key regulatory challenges.
- The concept of a regulatory sandbox was discussed, allowing for controlled experimentation with new policies and technologies before full-scale implementation. Decentralized regulation was also emphasized, with suggestions to grant states more authority and responsibility in designing energy policies that suit their unique requirements.
- Another key recommendation was the implementation of Distribution System Operators (DSOs) in states, enabling a more efficient market-driven approach to power distribution. This led to a broader debate on the coexistence of regulation and market forces, emphasizing the need to avoid excessive market fragmentation while maintaining stability and affordability.
- The transition from cost-based dispatch to carbon-emission-based dispatch was proposed as a necessary step toward a cleaner power grid. Additionally, the impact of prosumer back feeding on DISCOM financials was discussed, emphasizing the need to account for these losses while planning transmission infrastructure and setting performance targets.
- Load forecasting improvements were identified as a critical factor in optimizing power purchase agreements (PPAs) and market price identification.
- A renewed focus was placed on Renewable Purchase Obligation (RPO) compliance, calling for stricter enforcement mechanisms. The shift towards performance-based

regulation was also explored, aiming to enhance efficiency, accountability, and service quality in the power sector.

- Discussed the peer-to-peer (P2P) electricity trading, emphasizing the need for platform regulations, consumer protection mechanisms, and equity considerations to ensure fair access to decentralized energy markets.
- Discussed the Maharashtra story, which includes a pioneering effort for decentralized Agri-solar, with thousands of MWs coming online in just a few years. This required policy clarity and political support.
- The issue of accumulation of regulatory assets and its burden on consumers, who ultimately bear the cost of accumulating interest, was also debated as a growing concern that requires regulatory intervention.

Video Link: https://www.youtube.com/watch?v=8w2ukmZrz7I&list=PLgSiPGd4Nrcj3FFB-fg7OoFEK9ZEcjZ0o&index=30

SESSION 12: GRID INTEGRATED BUILDINGS

- **Importance of Grid-Interactive Buildings (GIBs):** Buildings are among the largest consumers of electricity, accounting for nearly 50% of global energy consumption. This share is expected to increase due to rising cooling and heating demands, automation systems, and electronic devices. The transition towards Grid-Interactive Buildings (GIBs) offers a promising solution to improve energy efficiency, optimize energy usage, and enhance grid stability. According to IEA estimates, rooftop solar capacity is expected to grow from 688 GW to 3700 GW by 2035, indicating a significant shift towards decentralized power generation. With the integration of rooftop solar, BESS, and real-time automation technologies, buildings can act as active grid participants rather than just energy consumers.

- **Role of GIBs in Grid Flexibility and Stability:** GIBs enable real-time communication and coordination with the electric grid, optimizing energy consumption, generation, and storage. They provide much-needed grid flexibility through demand response, peak shaving, and frequency regulation. By integrating rooftop solar, BESS, EVs, and smart appliances, GIBs help stabilize energy supply and reduce dependency on fossil fuels. GIBs also provide resilience against grid outages, particularly during extreme weather events, by leveraging localized energy generation and storage solutions.
- **Technologies Driving Grid Interactivity:** GIBs leverage advanced technologies to ensure optimal energy management and seamless grid interaction, including:
  - **Smart Meters and Sensors**: Enable real-time energy monitoring and automated energy management.
  - **Battery Energy Storage Systems (BESS)**: Store energy when there is surplus on the grid for later use, reducing grid load during peak hours.
  - **Internet of Things (IoT) and AI-based Systems**: Facilitate real-time data analytics, predictive maintenance, and energy optimization.
  - **Vehicle-to-Grid (V2G) Systems**: Allow electric vehicles to act as energy storage units, aggregate EVs as virtual power plants (VPPs) supporting grid stability.
  - **Automated Demand Response (ADR) Systems**: Enable buildings to adjust power consumption based on grid signals.
  - **Decentralized Renewable Energy Integration:** A notable example is Nalanda University's triple net-zero campus, which integrates solar PV, biogas-based Combined Heat & Power (CHP) engines, and innovative cooling solutions like Desiccant-Enhanced Evaporative Air-Conditioning (DEVAP).
- **Economic and Environmental Benefits of GIBs:**
  - **Economic Benefits**
    - **Energy Cost Savings**: By optimizing energy use and reducing peak demand charges.
    - **Revenue Generation**: Through participation in energy trading markets, ancillary services, and demand response programs.
    - **Incentives and Carbon Credits**: Financial benefits from government incentives, net metering, and carbon trading mechanisms.
    - **Increased Asset Value**: GIBs enhance property value due to long-term energy savings and sustainability compliance.
  - **Environmental Benefits:**
    - **Decarbonization Potential**: Through the **electrification of heating, cooling, and transportation (EVs)**.
    - **Reduction in Carbon Footprint**: Buildings equipped with renewable energy can significantly cut GHG emissions.

- **Water and Waste Optimization**: Advanced net-zero waste, and water management solutions contribute to sustainability.
- **Air Quality Improvement**: Lower emissions from fossil fuel-based energy generation reduce air pollution. Nalanda University's Net-Zero Campus serves as an exemplary model, demonstrating the potential of GIBs in reducing deforestation, carbon emissions, and energy waste.

➢ **Policy and Regulatory Support for GIB Deployment:** For large-scale adoption of GIBs, strong policy frameworks and regulatory support are crucial. Key recommendations include:

- **Expansion of Net-Metering Policies**
  - Current 1MW capacity for captive consumers should be expanded to match their sanctioned demand
  - Hybrid net-metering should be allowed for all renewable energy sources, not just solar
- **Open Energy Trading for Captive Consumers**
  - Allow institutions, campuses, and government buildings to export excess renewable energy to the power grid
- **Mandatory Net-Zero Energy Targets**
  - All educational institutions, government campuses, and new urban developments should adopt net-zero policies.
  - Sustainability-focused construction approvals should be mandated for new projects
- **Financial Incentives and Carbon Trading**
  - Tax benefits, subsidies, and concessional financing should be introduced to make GIB investments attractive
  - Carbon credit trading mechanisms should be enhanced to incentivize sustainability

➢ **Integration of EV Charging Infrastructure with GIBs**

- With the increasing adoption of electric vehicles (EVs)**,** GIBs can serve as key enablers for smart EV charging
- Vehicle-to-Grid (V2G) systems allow bidirectional energy flow, enabling EVs to act as energy storage units

➢ **Challenges in Scaling GIBs:** Despite the great potential of GIBs, several challenges need to be addressed. Government incentives and financing mechanisms should help to reduce initial costs. Adoption of open standards for seamless interoperability of smart grid solutions is required; and strengthened cybersecurity measures for energy data protection. Also focus on capacity-building programs to upskill architects, engineers, facility managers, and policymakers

- **Case Study: Nalanda University – A Model for GIBs:** Nalanda University stands as a pioneering example of a Net-Zero, Grid-Integrated Campus**,** demonstrating:
  - **Hybrid Renewable Energy System**
  - **Advanced Cooling and Waste Management:** Use of Desiccant-Based Cooling (DEVAP), Geothermal Cooling, and Passive Architecture
  - Decentralized Wastewater Treatment (DEWAT) systems to recycle and reuse water
  - **Energy Optimization Strategies:** Smart building designs leveraging thick cavity walls, passive solar orientation, and three-layered vegetation for temperature control. Demand-side management using IoT-enabled smart appliances and sensors
- **Recommendations**
  - Strengthen policy frameworks for GIBs
  - Promote hybrid renewable energy solutions for buildings.
  - Encourage financial models like energy-as-a-service (EaaS) to drive adoption.
  - Scale successful case studies like Nalanda University to mainstream net-zero developments.

Video Link: https://www.youtube.com/watch?v=NofdyUAZFrs&list=PLgSiPGd4Nrcj3FFB-fg7OoFEK9ZEcjZ0o&index=31

SESSION 13: POWER MARKETS AND CARBON MARKETS

- Session outlined how Indian Carbon Credit Trading Scheme (CCTS) is well poised to include the power sector soon and emphasized on the early engagement and preparedness of the power sector stakeholders including topics related to equity and just transition.
- Provided an excellent overview of the integral and scaling aspects of climate finance and climate ambition by countries and the private sector and its increasing acceptance by the financing community. Also provided an overview of the transitioning of power projects to clean energy in Indonesia and highlighted the Singapore Government's The Transition Credits Coalition (TRACTION) initiative.

- Presented The World Bank study report on the Security Constrained Economic Dispatch (SCED) which was conducted in a detailed manner with simulations for different emission and cost scenarios. By carrying out simulations and the pilot, the study derived a range of the cost of carbon ($100/ton of CO_2 being the upper limit). State-wise analysis was also presented which showed renewable energy rich states can achieve a lower cost of carbon due to significant renewable energy and daytime power supply.

- Summarized various initiatives implemented towards reducing Green House Gas (GHG) emissions including solar pumping for agriculture and rooftop solar for domestic and other sectors besides evaluating the storage solutions with respect to fixed and variable costs. Emphasized the need for regulatory bodies to evaluate the DISCOM's ability to implement GHG emission reductions measures before designing mandates.
- India's CCTS should ensure liquidity for an active carbon market on the exchange platform(s) and highlighted the impact of floor and ceiling prices. The fungibility aspects and anticipated that pricing signals need to be established for compliance and voluntary offsets.
- Boston Consulting Group (BCG's) proprietary tool SWITCH-Green transition has been launched in Singapore and Indonesia assisting the corporates and Governments on the above areas. Also highlighted about just energy transition partnership in Indonesia which is based on people centric energy transition focused on the Article 6 of Paris Convention covering integration of voluntary and compliance market, prices, integrity related challenges besides emphasis on digital monitoring, reporting and verification.

- Referred to how SCED was implemented for the cement sector client and scenarios developed for optimizing the emissions.
- Discussed about implementing the CCTS in the PAT sectors. Government need to manage the expectations and have a hard look at enforcing compliance. Referred to the non-compliance designated consumers under different PAT regimes who weren't penalized for the same. Further stressed the need for a long term price signal (on carbon) for the private sector to decide and invest (high capital) now.
- **Climate finance for the power sector is critically insufficient, despite the sector contributing over 55% of India's emissions.** Trillions of dollars are needed for clean energy, grid upgrades, and emerging technologies. High cost of capital and limited leverage with existing instruments are major barriers to scaling clean energy investments. Recommended Financing Institutions to come forward and offer in carbon financing solutions.
- There is a strong need for integrated, unified carbon markets with robust MRV (Measurement, Reporting, and Verification) systems to ensure integrity and transparency. **Technological integration using blockchain, AI, and remote sensing can enhance credit quality and prevent greenwashing**.

- **Integrating power and carbon markets will create flexibility, improve cost efficiency, and help decarbonize India's energy system**
- **Security and Emission Constrained Economic Dispatch (SECED) can help optimize dispatch based on both cost and emissions, potentially reducing carbon while maintaining grid security**. Experts emphasized a state-by-state or cluster-wise rollout of SECED, while cautioning against its high cost if implemented in silos.
- Regulatory hurdles and low stakeholder awareness are major challenges in implementing carbon markets and need targeted interventions. The need for flexible, state-specific regulations was emphasized— Uttar Pradesh Power Corporation Limited (UPPCL) noted that uniform guidelines don't account for different states' load profiles and consumption patterns. They also emphasized the need for setting realistic targets which do not strain the finances of utilities.
- Non-compliance and oversupply are serious issues in India's existing schemes (like PAT), highlighting the need for stronger enforcement mechanisms. Enforcement, not the lack of penalties, was cited as the reason for high non-compliance rates in later PAT cycles.
- The power sector plays a critical role in carbon markets through existing frameworks like RPOs, co-location incentives, and the PAT scheme. **Future markets should enable fungibility across mechanisms to increase participation.**
- BSES's efforts in disclosing Scope 1, 2 and 3 emissions under its CSR reporting was discussed. BSES is advancing sustainability through 44% RE distribution, net metering, and overachieving PAT targets, alongside initiatives in green infrastructure.
- **Voluntary markets lack credibility unless backed by strong MRV frameworks. Pricing disparities between compliance and voluntary markets can be up to 10x.**
- In Asia, countries like Singapore, Indonesia, and the Philippines are providing innovative models—like upfront credits or advance financing to support renewable deployment.
- Industry experts suggested that carbon pricing should enable clean tech investments, not just trading. **Cement and heavy industry players are already investing without buying credits. Success of carbon markets depends on whether companies genuinely invest in low-carbon tech and whether finance flows follow**.

Video Link: https://www.youtube.com/watch?v=8hofbRP0v88&list=PLgSiPGd4Nrcj3FFB-fg7OoFEK9ZEcjZ0o&index=32

SESSION 14: EVOLVING TRENDS IN ELECTRIC MOBILITY AND V2G DEMO

Panel 1: Accelerating EV Adoption – Enabling Policies, Regulations and Programs

- The electrification of public transport, especially school buses, demands more than vehicle deployment—it also requires addressing safety and maintenance issues.

Manufacturers must take an active role in training drivers to handle electric buses efficiently and safely.

- Grid readiness and effective tariff structuring are critical for scaling EV charging. High-capacity hubs like bus depots may require dedicated substations, and time-of-day (ToD) tariff incentives could encourage charging during off-peak hours, facilitating better integration with renewable energy sources.
- **Charging infrastructure, particularly in bus depots, faces issues of underutilization during non-peak hours**. For instance, buses typically operate between 6 AM and 9 PM, leaving the infrastructure idle for long periods. **This idle capacity could be repurposed for charging electric trucks or other commercial vehicles to improve utilization**.
- The standardization of charging connectors is underway, with OEMs largely adopting Combined Charging System2 (CCS2) connectors for four-wheelers. However, the two-wheeler segment is still fragmented, and industry consensus is needed around connector types such as Type 6 and Type 7.

- Financing retrofitting solutions remains a challenge. Although retrofitted buses are approaching cost parity with diesel buses, policy inconsistencies between states hinder their broader adoption and limit potential applications such as converting older trucks to electric.
- **Localization of charging equipment is progressing steadily. Currently, about 50% of DC charger components and 75% of AC charger components are localized**. Efforts are ongoing to localize specific components like rectifiers to reduce reliance on imports.
- **New business models for public charging stations (PCS) are emerging, with an emphasis on integrating user amenities and recreational facilities to attract more users. Additionally, PCS can be linked to peer-to-peer (P2P) energy trading platforms, opening up new commercial opportunities**.

Video Link: https://www.youtube.com/watch?v=3ud9lHVc1Kw&list=PLgSiPGd4Nrcj3FFB-fg7OoFEK9ZEcjZ0o&index=34

Panel 2: Promotion of Intercity Operations of Electric Buses and Electric Trucks

- A key advantage of the electric buses—be it for city operations, university transport, or luxury coaches—is that they do not require any capital expenditure (capex) subsidy. Over a 10–12-year period, these e-buses are financially self-sustaining on a per-kilometer (PKM) basis, making them viable without upfront subsidies.

- **Developing reliable charging infrastructure along national and state highways is essential for the success of intercity electric bus and truck operations. This includes the co-planning of power corridors alongside highway development to ensure timely availability of grid connections for high-capacity charging stations.**

- **Specific routes around heritage sites and key tourist locations can be designated as green routes using electric buses**. This helps in eliminating pollution around cultural and environmentally sensitive areas. **In Telangana, such a model has already been implemented, showcasing the feasibility and impact of green routes in protecting heritage zones.**
- The current financing environment for electric buses has higher interest rates. A diesel bus investment ranges from INR 40–70 lakhs but electric bus investment is much higher, at INR 1.2 crore+. This increased financial burden makes adoption more difficult for private players. **Most private operators depend on loans from Non-Banking Financial Companies (NBFCs) and banks which offer loans a maximum of 5 years (~60 months). But given the high cost of EVs, there's a need for longer loan tenures to reduce EMI burden and make financing viable.**
- **Vehicle-to-grid (V2G) integration is more technically and economically feasible for school buses due to predictable schedules making them strong candidates for grid-balancing applications.**
- While retrofitting offers a short-term pathway for adoption, especially in the cargo segment, the cost and difficulties with certification for retrofitted vehicle model remain a significant barrier.

Video Link: https://www.youtube.com/watch?v=wo5bOmf6Dg8&list=PLgSiPGd4Nrcj3FFB-fg7OoFEK9ZEcjZ0o&index=35

Panel-3: Emerging Technologies in Electric Mobility – New EVs, MW-scale Charging, Wireless and Pantograph Charging, Battery Swapping, V2G and Green Mobility

- Recent technological advancements have significantly improved charging speeds, with some systems now offering 10–20 km of range per minute of charge. Even under current Indian market conditions, rapid charging technologies are already in use, showing significant progress in reducing charging time. These developments represent a major leap in EV charging efficiency, addressing one of the main barriers to EV adoption.

- **Scalability of Charging Infrastructure:** India needs to plan charging networks in advance, factoring in temperature and high-load demands—especially for MW-scale systems and super-fast charging suited for commercial EVs.
- **Smart Grid Readiness for V2G:** Vehicle-to-grid (V2G), vehicle-to-load (V2L), and vehicle-to-home (V2H) applications require robust smart grid infrastructure, which is still evolving in India.
- **Standardization is Critical for Battery Swapping:** For battery swapping to scale, especially in 2W and 3W segments, there must be uniform standards across batteries, connectors, and communication protocols.
- **Technologies like wireless and pantograph charging should be evaluated for Indian conditions, ensuring affordability and operational viability**. Government policies must actively support indigenous innovation and create space for startups and private players to lead technology development and deployment.

Video Link: https://www.youtube.com/watch?v=PbzwjMhEs2E&list=PLgSiPGd4Nrcj3FFB-fg7OoFEK9ZEcjZ0o&index=36

B. BI-LATERAL WORKSHOPS

1. UK - INDIA WORKSHOP ON ASPIRE PROGRAM

- The ASPIRE Programme, launched during the third India-UK Energy Dialogue in October 2021, was aimed at accelerating smart power and renewable energy in India covering critical areas such as electricity distribution, industrial energy efficiency, electric mobility, solar energy, offshore wind energy, energy storage, and green hydrogen.
- A strong emphasis was placed on gender equality and social inclusion, ensuring that the benefits of Accelerating Smart Power and Renewable Energy in India through the ASPIRE Programme initiatives are widespread and inclusive.
- Over the past three years, the ASPIRE Programme, a bilateral initiative implemented by the Foreign, Commonwealth and Development Office (FCDO) in association with the Government of India, has supported around 45 activities under 2 ministries across 8 states; and the notable achievements include:
    - Supported multiple states on the Revamped Distribution Sector Scheme (RDSS), including direct support to Andhra Pradesh for installing 2.7 million smart meters and working with Power Finance Corporation (PFC) to provide support to RDSS program in Delhi, Punjab, Odisha, Kerala, and Tripura
    - Demonstrated a unique AI and drone-based asset management solution for MSEDCL in Maharashtra
    - Developed and institutionalized the Digital Utility Manager course, a first-of-its-kind on digital upskilling of distribution companies, hosted on the IGOT-Karm Yogi platform
    - Created the knowledge-sharing platform IDEEKSHA, serving as a one-stop shop for all Industrial Energy Efficiency and Decarbonization needs of Indian energy-intensive industries and hard-to-abate sectors
    - Prepared the concept and design of a Future Mobility Park in Tamil Nadu
    - Developed a strategic roadmap for establishing the 'Intelligent Mobility Skill Centre,' adopted by the Government of West Bengal to address skill gaps in the EV value chain, and an employment backed scheme for training women drivers in the state, etc.
- The UK is committed to net zero by 2050 and aims to reduce greenhouse gas emissions by at least 81% from 1990 levels by 2035. The UK sources most of its electricity from renewables (46% renewable, 14% nuclear, 35% gas) and plans to double onshore wind, triple solar power, and quadruple offshore wind by 2030. Initiatives like the Contract for Difference (CFD) and the Great British Energy, with £8.3 billion in capital,

support clean energy deployment. The Global Clean Power Alliance (GCPA) aims to triple renewable energy capacity and double energy efficiency by 2030.

- The UK-India ASPIRE Programme supported India's offshore wind tenders, smart meter roll-out, industrial energy efficiency, and electric mobility. It aims to mobilize over £2.2 billion in investment and reduce CO_2 emissions by around 2 million tonnes.
- **A robust, smart grid infrastructure is crucial for renewable energy integration. The UK and India prioritize this in their collaboratio**n. The UK supports India Smart Utility Week, focusing on future-ready power grids and energy storage.

- It also focuses on promoting solar energy adoption through policy frameworks and innovative projects, such as solar cooking solutions in Kerala. Additionally, ASPIRE supported the deployment of green hydrogen by developing state policies and electrolyser manufacturing zones, and aims to expand offshore wind energy through grid integration and market development.
- Energy storage is another key area, with efforts to increase the penetration of next-generation technologies like sodium-ion batteries.
- Renewable energy adoption is increasing at an unprecedented rate to address the challenge of climate change. As a result, the electricity grid is changing at its core, which requires a change in the way power systems are engineered and taught in higher education institutions.
- The power sector is experiencing Vulnerability, Uncertainty, Complexity, and Ambiguity (VUCA). Factors such as renewable energy integration, solar expansion, EV charging, and green hydrogen adoption contribute to this complexity, making it difficult to prioritize new technologies and address sector requirements effectively.
- **Looking ahead, by 2032, India plans to integrate 600 GW of renewable energy (RE). The transmission plan is already in place, aiming for an installed capacity of around 2000 GW, with 1700 GW from non-fossil source**s.
- Expanding interconnectors with other countries will enhance grid flexibility, reliability, and help achieve clean energy targets.

Video Link:
https://www.youtube.com/watch?v=IUg6v5WOj_4&list=PLgSiPGd4Nrcj3FFB-fg7OoFEK9ZEcjZ0o&index=8

Session 1: Future Ready Power Grids - Practical Solutions for Grid Modernization

- UK is embarking on an ambitious journey to modernize its electricity grid, paving the way for a sustainable and efficient energy future. Facing delays caused by outdated 'first come, first served' policies, the country is adopting a 'first ready, first connected' approach to accelerate grid connections for prepared projects. With a £200bn investment plan and strategic guidance from the National Electricity System Operator (NESO)'s Beyond 2030 Report, the UK is laying the groundwork for transformative energy solutions
- Innovative technologies are taking center stage, including the use of AI and ML for smarter grids, as demonstrated by projects like the NESO's Virtual Power Plant (VPP). Large-scale battery storage systems, such as the Pillswood BESS, and expanded pumped hydro solutions are being deployed to balance energy supply and demand. Dynamic grid management is being revolutionized with smart meters, time-of-use tariffs, and cutting-edge tools like digital twins.
- The UK is strengthening its interconnections with neighboring countries through multi-purpose interconnectors, fostering cross-border electricity trade and improving pricing efficiency. Projects like the Viking Link and the NSL stand as milestones in this cross-national collaboration.
- With a strong focus on sustainable practices, the UK is embracing policies, business models, and innovation to ensure grid modernization aligns with environmental and economic goals. Public-private partnerships, R&D programs like the Flexibility Innovation Programme, and financing mechanisms such as green bonds play a vital role in driving this energy transformation.

- Power Grid Corporation of India Limited (PGCIL) has led the adoption of smart grid technologies in the transmission sector with several examples such as wide area monitoring system (WAMS) with PMUs, the first ever fully digital 400 kV substation and deployment of Analytics and AI for predictive maintenance.
- **Grid operations in India have transitioned from primarily manual decision-making to a technology-assisted system with high situational awar**eness – Technology intervention has made that possible. Key enablers of this transition and those for future such transitions as well, are:
  - Truly flexible tariffs that internalize real-time scenarios. Current time of Day (ToD) tariffs do not respond to changes in weather within the time slots.
  - Flexibility in regulations across the system allowing pilot scale technology adoption in a controlled environment
  - Preparedness of Indian utilities to adopt new technologies
  - The market has changed from supply driven to being demand driven – the sector stakeholders need to appreciate and respond accordingly
- The DNO/DSO system has encouraged competition in retail supply in the UK and a similar introduction in India can help. However, the scale of operation in India is comparatively much larger and therefore the system needs to be localized in the Indian context.
  - A dedicated business unit comprising of experts in relevant fields such as technology integration, commercial, operation etc. should be carved out to handle the supply related operations. This arrangement may not require commercial (wire and supply) separation of accounts.
  - **Currently, most utilities are analyzing data gathered from consumers but do not take actions based on such analyses**. For competition in retail supply to be implemented, actions based on data-led insights are crucial.
  - In most implemented cases, SLAs related to data quality are not being met. To encourage data led, insight-based actions, it is crucial to ensure data integrity.
- In India, the demand for electricity is surging at a galloping pace which will require technology adoption for effective grid operations. Policy and regulatory interventions are required to streamline the transition from PoC to implementation stage. Establishing a dedicated 'Digital Regulatory Authority' could be beneficial in achieving this. Regulations need to establish a clear and unambiguous compliance framework for utilities planning large scale technology adoption. Technology standardization through regulations can significantly streamline the transition by ensuring interoperability, consistency and scalability. **Utilities may streamline their procurement process by changing their vendor selection criteria from “lowest bid” to “highest impact” solutions.**

- The perspective of utilities regarding energy efficiency is changing. Unlike the past, utilities are now more amenable to energy efficient industries as a desirable consumer group. With this perspective change, technology adoption has scaled up.
- One of the main challenges UK technology providers encounter in India is the limited availability of operational data. However, this situation is rapidly improving.
- There is a need for a standardized framework to evaluate smart grids from an Environmental, Social, and Governance (ESG) perspective in assessing the sustainability and impact of technology adoption projects.
- The Services Model in smart metering is progressing well under the RDSS. This model can be extended to grid modernization projects, leveraging private sector efficiency and public sector support.
- The RDSS scheme has set up effective pre-qualification criteria and fund disbursement mechanisms. These criteria can serve as a model for future smart grid technology projects to ensure efficient and transparent funding.

  Video Link:
  https://www.youtube.com/watch?v=FoUpftVCa2U&list=PLgSiPGd4Nrcj3FFB-fg7OoFEK9ZEcjZ0o&index=9

Session 2: Empowering Women-Driving Change in the Power Sector

- Presented the key findings of the survey undertook in collaboration with PFC Ltd across 56 state-owned DISCOMs, which are as follows:
  - **Women's representation is 11.6% across the 33 respondent DISCOMs**
  - Women's representation is higher in regions such as Southern (14.4%) and Eastern (12.10%) compared to the national average of 11.6%
  - There is a significant drop in women's representation from lower to higher and leadership levels. Women constitute 17.2% at the entry level, leading to a drop-to-top ratio of 0.7.
  - Women have lower representation in technical/field-driven roles.
  - **Low gender diversity is seen in major functions such as O&M where only 8% women compared to 30% in IT department**.
- Key challenges include entry barriers (low female enrolment in STEM fields), cultural and societal expectations; workplace barriers (like safety, security, wage parity, lack of children facilities and inadequate Water, Sanitation, and Hygiene (WASH) policies); lack of women leaders and role models.
- Suggested strategic measures – Targeted training and skilling of the workforce; Inclusive policies and creating awareness; considering entry-level reservations; accelerating women's career progression to leadership roles; ensuring balanced

representation across functions; Implementing diverse and inclusive workplace practices.

- **Shared policies and practices that have helped increase gender diversity in the power sector, such as the Vidyut Sakhi program to involve women in revenue collection**.
- Highlighted the challenges a lady faced as a new mother joining the power sector, including lack of basic facilities like separate washrooms for women.
- Suggested ways to improve women's representation **– inclusive and gender-neutral recruitment practices;** employee-friendly policies like maternity leave and childcare support; training and development opportunities (especially in technical roles); positive reinforcement and creating an equal platform for men and women; ensuring women's participation in policymaking and implementation.

- **One example is provided to encourage women in power sector roles – women only Pink Substations**.
- **Need for creche facility in the utilities**
- Emphasizing on NITI Aayog initiative on pushing for gender-based budgeting incentivizes women's participation in various training and capacity-building programs.
- Highlighted the Gender Equality and Social Inclusion (GESI) report – like women representation in Kerala, Women's reservation bill etc.
- **Predictive maintenance wing can be carved out from O&M wing to accommodate more women.**
- EV policies should be made gender inclusive; and create safe and accessible EV charging infrastructure for women.
- Skilling / Reskilling women to encourage them to participate in the EV value chain.
- **Mentorship plays a key role for women to achieve development goals.**

Video Link: https://www.youtube.com/watch?v=D_dpuxUFvsE&list=PLgSiPGd4Nrcj3FFB-fg7OoFEK9ZEcjZ0o&index=10

2. UK - INDIA ROUNDTABLE ON ENERGY STORAGE SYSTEMS

➢ **Securing Raw Materials Through Domestic and International Sources**

- India has availability of some of the minerals but other critical minerals such as lithium are only available at "low degree of confidence", effectively limiting the potential production of these minerals in the near future.
- Dedicated programs should be designed to incentivise technology partners from across the globe to partner with Indian companies for refining of minerals. This will boost production and improve quality of minerals.
- Government to Government (G2G) collaborations must be established and promoted to align broader sectoral strategy and enhance knowledge sharing and industry partnerships

➢ **Advancing Innovations in Emerging Battery Technologies**

- Advancements are happening across the battery value chain, not just in technology but also across battery system design and software etc.
- Technology diversification should be prioritised by the government and other emerging alternatives such as sodium-ion batteries and flow batteries should also be promoted. Some of these batteries are likely to compete with lithium-ion batteries (LiBs) in terms of costs in the performance.

- Long Duration Energy Storage (LDES) technologies are increasingly gaining traction and pilot projects are being setup in various geographies. Advanced planning needs to be initiated for integration of such technologies in the grid.
- Emerging technologies will benefit from the increased market activity which has been led by decreasing costs of LIBs and there is a general openness to explore new technologies which can offer better performance vis-a-vis costs.

- The capital costs of LDES technologies are expected to come down significantly in the next five years and they can emerge as a viable alternative for multiple use-cases such as managing RE curtailment and intermittency.

➢ **Fostering the manufacturing of emerging battery technologies**

- India must look to tie-up with international technology providers such as those from UK to move up the battery manufacturing value chain. Lessons can be learned from UK's High-Value Manufacturing (HVM) Catapult which supports national research, focusing on the R&D process and battery material development, scale-up, and recycling support. HVM Catapult is a good example of industry-academia collaboration wherein academic institutions work with companies to boost UK's manufacturing performance and sustainability.

➢ **Establishing a Conducive Policy and Regulatory Framework**

- There is a need of a comprehensive storage strategy which needs to encompass plans and roadmaps for a range of different technologies, both existing and emerging technologies.

- Value stacking is critical to unlock more and better revenue streams for the BESS buyers. Lessons can be learned from successful projects in UK which are also tied-up through Corporate Power Purchase Agreements (PPAs) as a secondary revenue stream along with fixed term tariff-based contracts with utilities, which is the primary revenue driver.
- **Recent innovations such as allowing use of insurance surety bonds as an alternative to bank guarantees should be explored to improve Ease of Doing Business (EoDB) for investors as well as suppliers and developers**.
- The current focus of the energy storage market is on Round the Clock (RTC) and Firm and Dispatchable Renewable Energy (FDRE) models and there is limited uptake of other applications such as Behind the Meter (BTM) storage.

- Recently, the government has allowed distribution licensee to encourage adoption of energy storage in residential sector along with solar rooftop, however, policy and regulatory uncertainties still remain.
- **The government should establish clear policy guidelines on BTM applications of energy storage.** Clarity should also be provided on who will be investing in the energy storage asset- utility or consumer or third party aggregators.
- **Innovative energy storage applications such as reactive power compensation, Virtual Power Plant (VPP), energy shifting, frequency and voltage control are also gradually coming up**. Further policy support should be enabled to open up opportunities for new use-cases. These can be taken up as part of existing schemes such as PM-Surya Ghar: Muft Bijli Yojana.
- **Lessons can be learned from UK's Contracts for Difference (CfD) scheme which incentivises both manufacturing and deployment of energy storage.**

➢ **Improving the Battery Skilling Ecosystem in India**

- Skill development is required not just on the project side but also in manufacturing and supply chain, including mining side of the value chain. Country partnerships focusing on supply chain should also explore collaboration in skill development area.
- **Centre of Excellence (CoEs) may be established in each state which can act as an anchor for implementing the skill development activities**. States where currently the gigafactories are being planned can be prioritised for setting up these CoEs in the initial phase.

Video Link: https://www.youtube.com/watch?v=-e6DxQnSNjg&list=PLgSiPGd4Nrcj3FFB-fg7OoFEK9ZEcjZ0o&index=11

3. 11TH US – INDIA SMART ENERGY WORKSHOP (In Collaboration with US Commercial Services, and UL Standards and Engagement)

➢ The modernization of India's power sector hinges on transitioning to smart grids, which require robust and harmonized standards. **India needs harmonized standards to manage the increasing complexity introduced by Distributed Energy Resources (DERs) and enable reliable, secure power systems.**

➢ Human-centric design must be part of smartness of the grid, not just technological sophistication—smart systems should be intuitive, inclusive, and adaptable.

➢ **The adoption of IS 18968–2025 (based on IEEE 1547–2018) is a positive step, as it provides structured requirements for smart inverters to support voltage and frequency regulation**.

- Auto-disconnect protocols are crucial for DER safety, especially during grid disturbances—this help prevent islanding and protect utility workers and equipment.

- Standards for bidirectional power flow must be developed to support Vehicle-to-Grid (V2G) and Vehicle-to-Everything (V2X) use cases.
- With the implementation of PM Surya Ghar Yojana, P2P trading platforms also require clear protocols. Safe integration is needed in the events of voltage fluctuations, sudden loss of generation and cascading failures.
- Smart inverters must be able to align with grid profiles, and there is a need to mandate the mapping and communication protocols as regulatory requirements.
- User guides and minimum compliance toolkits are needed to help utilities, vendors, and consumers understand and adopt the standards in real-world settings.
- Collaborative action across stakeholders—including regulators, utilities, technical bodies, and solution providers—is essential to build a practical roadmap for standardization and DER deployment in India

Video Link: https://www.youtube.com/watch?v=7u0mEX8rTVg&list=PLgSiPGd4Nrcj3FFB-fg7OoFEK9ZEcjZ0o&index=12

4. FIRST AFRICA - INDIA SMART ENERGY ROUNDTABLE (In Collaboration with Association of Power Utilities of Africa (APUA))

- **International Solar Alliance (ISA) Program for Africa and Governance Strengthening**: The ISA has launched dedicated initiatives for Africa, aiming to enhance solar energy adoption and drive sustainable energy transitions. One of the key focuses is on strengthening institutional capacity, governance structures, and policy frameworks to enable effective implementation of renewable energy projects. Capacity-building programs, training, and knowledge-sharing efforts are essential to empower local governments, utilities, and stakeholders in managing large-scale solar deployments.

- **Technical Capacity Building in Africa**:

  A major challenge for Africa's energy sector is the shortage of skilled professionals and technical expertise. The discussion highlighted that several new colleges and Centers of Excellence (COEs) are being established across African nations to train engineers, policymakers, and technicians in modern energy technologies. These institutions will play a crucial role in developing a workforce capable of planning, building, and operating complex power infrastructure.

- **India's Experience as a Model for Africa's Energy Development**

  - **Gradual Growth and Capacity Building**: India's power sector started with just 1,362 MW in 1947, spread across several disconnected grids. Over the next three decades, it reached 43,000 MW by 1977, showcasing a steady but well-planned growth. Today it has reached 452 GW (January 2025)
  - **Investment in Institutions**: India strategically built its technical capacity through the establishment of key institutions such as Central Electricity Authority (CEA), Central Power Research Institute (CPRI), and leading organizations like Bharat Heavy Electricals Limited (BHEL), National Thermal Power Corporation (NTPC), National Hydro Power Corporation (NHPC), Nuclear Power Corporation Limited (NPCL), Power Grid Corporation of India Limited (PGCIL), and private sector players like Tata Power, CESC, Reliance, Adani, Torrent, and L&T.
  - **Government's Long-Term Planning**: Consistent policy direction and government-led initiatives enabled the expansion of India's electricity sector. Over time, this approach allowed India to add gigawatts of renewable and thermal capacity annually, supported by a vast and resilient transmission network.
  - **Lessons for Africa**: African nations should consider adopting a similar approach, establishing long-term planning agencies, developing domestic

expertise, and prioritizing grid expansion to ensure sustainable and inclusive electrification.

- **Need for a Continental-Level Energy Planning and Regulatory Body:** Africa, being a continent of multiple countries with diverse energy needs, requires a coordinated approach to grid planning and energy development. To facilitate structured growth, it was proposed that Africa establish its own high-level technical and planning institutions, such as:

  - African Central Electricity Authority (AfCEA) for overarching regulatory and policy planning
  - African Central Power Research Institute (AfCPRI) for technical research and equipment testing
  - AfPower-Grid to oversee interconnection and transmission expansion across African nations

- These institutions would help standardize grid equipment and operations, enhance cross-border electricity trade, and ensure long-term power sector resilience.

- **Key Priorities for Africa's Power Sector:**

  - **Grid Transmission and Distribution (GT&D) Development to Attract Industries:** A strong and stable power grid is crucial for industrial growth. Reliable electricity supply would encourage large-scale investments in manufacturing, processing, and other energy-intensive sectors, boosting economic development.
  - **Solar Microgrids for Remote Areas**: Given Africa's vast rural population, decentralized energy solutions such as solar microgrids are essential. These systems can power villages, schools, and businesses, enabling local economic activities.
  - **Standardization of Systems and Equipment**: Harmonizing energy standards across African countries will reduce costs, simplify project implementation, and facilitate cross-border energy trade.
  - **Building Transmission Interconnections and Power Pools**: Strengthening inter-country grid connections and expanding and interconnecting regional power pools (SAPP, WAPP, NAPP, CAPP and EAPP) will enhance energy security, stabilize electricity supply, and enable efficient utilization of renewable resources across borders.

Video Link: https://www.youtube.com/watch?v=3GkDMBsRk5A&list=PLgSiPGd4Nrcj3FFB-fg7OoFEK9ZEcjZ0o&index=13

5. FIRST INDONESIA - INDIA SMART ENERGY WORKSHOP

- **Indonesia's Renewable Energy (RE) Policy Evolution**

  Over the past few years, Indonesia has revised its renewable energy policies, but coal remains the dominant source of energy. The country acknowledges the need for a gradual energy transition while balancing affordability, reliability, and sustainability. Government-led initiatives are shaping policies to integrate more renewables, but coal will continue to play a central role in Indonesia's energy mix in the near future.

- **Optimizing Solar PV and Offshore Wind in the Energy Mix**

  Indonesia is currently reassessing its renewable energy policies to determine the most suitable mix of Solar PV and offshore wind energy. The government is exploring strategies to enhance the penetration of renewables while ensuring grid stability. Offshore wind energy, though still in its early stages, is being evaluated as a potential complement to solar PV, particularly in regions with strong wind resources.

- **Challenges and Opportunities for Solar PV Deployment on Small Islands** Indonesia has approximately 16,000 small islands, many of which rely on expensive and polluting diesel-based power generation. Due to limited inter-island grid connectivity, decentralized Solar PV systems, combined with energy storage solutions, are seen as viable options to provide clean and reliable electricity. This approach would reduce reliance on fossil fuels and improve energy security for remote communities.

- **Exploring Floating Solar as an Alternative**

  Given Indonesia's geography, floating solar projects are being considered for deployment in shallow coastal areas and inland lakes. This technology provides a promising solution for regions with limited land availability for conventional solar farms. Floating solar also has added benefits, such as reducing water evaporation and improving panel efficiency due to the cooling effect of water bodies.

- **New Capital Development in Kalimantan and Transmission Needs**

  Indonesia's new capital, Nusantara, being developed in East Kalimantan, will require a strong and reliable power supply. Given its location, it will need transmission infrastructure to connect with Java Island, which houses the largest electricity demand centers. Another potential source of power supply could be an interconnection with Malaysia's Sarawak grid, which has significant hydropower resources.

- **Policy Clarity Expected by December 2025**

  Indonesia is expected to finalize and clarify its renewable energy policies by the end of 2025. This includes setting clear targets, regulatory frameworks, and incentives to encourage investment in renewables. The anticipated policy updates will provide guidance on energy transition pathways, interconnection strategies, and potential collaborations between Indonesia and international partners, including India.

Partnership Opportunities:

- Smart metering as a service
- Solar and Wind Farm developments
- Island Microgrids
- National Registry for Rooftop Solar

Video Link:
https://www.youtube.com/watch?v=1IWXMSJAlAo&list=PLgSiPGd4Nrcj3FFB-fg7OoFEK9ZEcjZ0o&index=25

C. SPECIAL WORKSHOPS/ROUNDTABLE DISCUSSIONS

1. 9TH IEC-IEEE-BIS SMART ENERGY STANDARDIZATION COORDINATION WORKSHOP (In Collaboration with BIS, IEC and IEEE)

- There is an urgent need for global harmonization of standards for grid integration
- Another important task to be taken up is the development of a handbook/guide for grid integration of DER and its management
- National differences to be presented by active participation of members at the development stage of standards

- Some of the challenges to be addressed for safe and secure integration of DER are:
  - Variability and intermittency through storage and demand flexibility solutions
  - Grid modernization efforts, including the development of smart grids and improved transmission infrastructure
  - Maintaining system reliability and stability with advanced grid management technologies, such as real-time monitoring and control systems
  - Supportive policy frameworks and streamlining of regulatory processes
  - Rollout of Smart Inverters conforming to IS 18968-2025 for all new DERs
- New standards development topics identified:
  - Grid integration of renewable energy - Terms and Definitions
  - Renewable energy generation forecasting technology
  - Grid code compliance assessment methods for grid connection of wind and PV power plants
  - Grid Forming Inverters - IEEE 2800

Video Link: Part 1:

https://www.youtube.com/watch?v=cekwi5mSK3g&list=PLgSiPGd4Nrcj3FFB-fg7OoFEK9ZEcjZ0o&index=2

Part 2:

https://www.youtube.com/watch?v=JG4UF7dW8z8&list=PLgSiPGd4Nrcj3FFB-fg7OoFEK9ZEcjZ0o&index=3

Part 3:

https://www.youtube.com/watch?v=ZJaw1_BTgEA&list=PLgSiPGd4Nrcj3FFB-fg7OoFEK9ZEcjZ0o&index=4

2. OCPP TECHNICAL SESSION (In Collaboration with Open Charge Alliance)

- Strengthen the security features in Open Charge Point Protocol (OCPP) 2.0, particularly focusing on data encryption, secure communications, and authentication mechanisms
- Enhance OCPP 2.0 to better support Vehicle-to-Grid (V2G) integration by incorporating bidirectional charging protocols and enabling better communication between EVs, charging stations, and the grid
- Explore the inclusion of energy sharing and peer-to-peer (P2P) capabilities in OCPP 2.0, allowing users to share energy with one another or directly with the grid, fostering a more decentralized energy ecosystem
- Establish comprehensive safety guidelines and protocols in the OCPP standard for V2G to ensure that vehicles are safely integrated with the grid, considering both electrical safety and battery longevity

- Integrate features within OCPP to manage and track energy flow from EVs to the grid, including dynamic billing based on energy transactions, time-of-use pricing, and grid participation incentives.
- Implement real-time monitoring capabilities within OCPP to track V2G operations, such as the state of charge (SOC) of EV batteries, energy exchange, grid status, and the availability of EVs for power discharge.
- Align OCPP with existing and upcoming regulations related to V2G technology, energy storage, and grid operations, ensuring that it supports regulatory compliance in multiple regions.

Video Link: https://www.youtube.com/watch?v=rx8y4i8DNr4&list=PLgSiPGd4Nrcj3FFB-fg7OoFEK9ZEcjZ0o&index=5

3. FIRST GENERAL BODY MEETING OF ALL INDIA DISCOMS ASSOCIATION (AIDA)

- All India DISCOMs Association (AIDA) (www.aida-india.org) is a not-for-profit society formed by the DISCOMs. AIDA's objective is to bring all DISCOMs on a common platform to find solutions for several sectoral issues as well as help each other. The prime mandate of AIDA is:
  - An effective platform aimed at uniting all DISCOMs for experience sharing, capacity building, and finding collaborative solutions to sectoral challenges
  - Promotion of Public-Private Partnerships (PPP) and sharing of best practices in AT&C loss reduction, training, and IT systems compatibility
  - Development of a strategic vision for the power sector, standardization of equipment specifications, and sharing of cost data
  - Sharing of equipment, spares, specialized tools and crew during emergency situations for network restoration

- Apprised the members on the following key developments:
  - Office space has been leased at the CBIP Building, Malcha Marg, New Delhi, close to the Ministry of Power and ISGF
  - 18 DISCOMs have already submitted letters of consent to join AIDA as members
  - Application for PAN number has been submitted; and the Bank Account will be opened after PAN is allotted. The invoice for membership fee and corpus fund will be issued after Bank Account is made operational
  - Mr. Reji Pillai, President of ISGF has been made Acting Director General during the interim
  - Shri Alok Kumar, former Secretary, Ministry of Power, has kindly consented to join as the first Director General of AIDA from 1st April 2025

- **Some of the suggestions from the participants included:**
  - Inter-DISCOM Exposure Visits to learn the successful smart metering implementations; Functional Hierarchy Experimentation for improved consumer satisfaction; Formation of Working Groups on important topics; Learning from Private DISCOMs; Policy Implementation Gaps; Collaboration with Academia for pilot projects and technical research; Technology Pilots on Rooftop Solar, Dynamic Tariffs, Energy Storage; Preparation of one-year roadmap; Regular meetings with the Ministry of Power (MoP) and Forum of Regulators (FOR); Design data collection templates and launch the AIDA website.

Video Link: https://www.youtube.com/watch?v=4VOpZnlpD6I&list=PLgSiPGd4Nrcj3FFB-fg7OoFEK9ZEcjZ0o&index=7

4. WORKSHOP ON IMMERSIVE TECHNOLOGIES: AR/VR, DIGITAL TWINS, DRONES, AND ASSISTED REALITY FOR ENHANCED OPERATIONS AND EFFICIENCY

- **Transformative Impact of Immersive Technologies**
  - Immersive technologies (AR/VR, Digital Twins, Drones, and Assisted Reality) are revolutionizing operations across power generation, transmission, distribution, and the entire smart energy domains. These technologies enable significant improvements in efficiency, safety, and sustainability throughout the energy ecosystem

- **Technology-Specific Benefits**
  - **AR/VR Applications**
    - Provides immersive training environments for high-risk scenarios without operational disruption

  - Enhances maintenance procedures through guided visual instructions
  - Improves grid visualization, planning, and customer engagement
- **Digital Twins**
  - Enables predictive maintenance that reduces downtime and extends equipment life
  - Facilitates real-time performance monitoring and optimization across power infrastructure
  - Supports advanced scenario simulation for grid management, asset and power flow optimization
- **Drone Technology**
  - Transforms inspection capabilities for power lines, solar farms, and wind turbines
  - Improve safety by reducing human exposure to hazardous environments
  - Enhances vegetation management and enables AI-powered defect detection
  - Provides critical capabilities for emergency response and damage assessment
- **Assisted Reality**
  - Bridges knowledge gaps through remote expert assistance
  - Streamlines field operations with digital guided work instructions
  - Enables effective knowledge transfer and workforce augmentation

➢ **Implementation Considerations**

- Data security and privacy remain critical when deploying these technologies
- Integration with existing systems requires careful planning and phased implementation
- Cost-benefit analysis demonstrates positive ROI through reduced operational costs, improved efficiency, and enhanced safety
- Regulatory considerations must be addressed, particularly for drone operations

➢ **Future Outlook**

- These technologies will continue to evolve, creating new opportunities for operational efficiency
- Integration of AI with immersive technologies will further enhance predictive capabilities
- Cross-technology integration (combining digital twins with AR/VR, for example) represents the next frontier in power sector innovation
- Early adoption provides competitive advantages in workforce efficiency, operational excellence, and customer service

- **Call to Action**
  - DISCOMs should develop strategic roadmaps for immersive technology implementation
  - Start with high-impact use cases that address specific operational challenges
  - Invest in workforce training to maximize technological benefits
  - Collaborate with technology providers to develop customized solutions for the power sector

Video Link: https://www.youtube.com/watch?v=O1byors6COU&list=PLgSiPGd4Nrcj3FFB-fg7OoFEK9ZEcjZ0o&index=33

5. CAPACITY BUILDING IN UTILITIES FOR ENERGY TRANSITION (In Collaboration with Skill Council for Green Jobs)

- India's renewable energy ambitions are more than about installing gigawatts of capacity—they are about empowering people with the right skills needed to drive this transformation and make it sustainable. A skilled workforce is the backbone of our

clean energy future.

- The session shortlisted the Technical Skills requirements for following technologies/domains:
  - **Renewable Energy Technologies:** Expertise in solar PV systems, concentrated solar thermal systems, wind energy, hydropower, geothermal, green hydrogen and biomass. This includes design, installation, maintenance, and operation.
  - **Smart Grids:** Skills in power systems engineering, developing digital twins, grid design, renewable energy integration, smart grid technologies (IoT, data communication), and cybersecurity for energy infrastructure.

- **Energy Storage:** Knowledge of battery technologies (lithium-ion, etc.), pumped storage plants (PSP), thermal storage, and other energy storage solutions, including their design, installation, and management.
- **AI/ML in Energy Sector:** Proficiency in data analysis, interpretation, and visualization to optimize energy systems, predict demand, and improve efficiency. Knowledge of programming languages (Python, etc.) and automation systems (SCADA/DMS).
- **Cybersecurity:** Skills to protect energy infrastructure from cyber threats, ensuring the reliability and security of energy systems.

➢ **Soft Skills:** Strong communication, problem-solving, project management, teamwork, continuous learning, and adaptability are crucial for future energy systems.

➢ The Ministry of New and Renewable Energy (MNRE)'s targeted Skill Development Programs to build technical expertise in various renewable energy sectors are:
  - **Surya Mitra**: Focused on training technicians for solar plant installation, commissioning, and maintenance
  - **Varunmitra**: Developing skilled professionals in the bioenergy sector
  - **Vayumitra**: Preparing a workforce for wind energy projects, from installation to operations
  - **Jalurjamitra** – Enhancing skills in small hydro and water-based renewable energy solutions

➢ These initiatives, supported by institutions like National Institute of Solar Energy (NISE), Skill Council for Green Jobs (SCGJ) and state skill development centres, are bridging the skill gap and ensuring that India's renewable energy projects are executed efficiently, sustainably, and with local expertise. National Solar Energy Federation of India (NSEFI) is also striving to bridge the policy and regulatory gaps through assessing the right skill that are required throughout the value chain of all renewable energy domains. By investing in human capital through structured skilling programs, the sector will not only accelerate their timeline of project deployment but also create green jobs, foster entrepreneurship, and strengthen India's energy security.

Video Link: https://www.youtube.com/watch?v=Y4cOvivRReQ&list=PLgSiPGd4Nrcj3FFB-fg7OoFEK9ZEcjZ0o&index=37

D. TECHNICAL PAPERS AT ISUW 2025

Since 2016, ISGF has invited Technical Papers on the latest themes related to Power Sector to recognize the best Technical Papers in the industry. The authors of the top 25 technical papers selected by an expert jury panel get the opportunity to present their papers at ISUW which witnesses participation of Visionary Leaders, Utility CEOs, Regulators, Policy Makers and Subject Matter Experts from around the globe every year. The top 50-60 technical papers are published with renowned publishing house/ISGF. Springer published the top papers in 2017, 2018, 2019, 2020 and 2021.

For ISUW 2025 we received more than 186 Abstracts of which 122 were selected for full paper; and 68 papers were selected for publication and top 24 papers were presented.

Video Link Part 1:

https://www.youtube.com/watch?v=6Po-bOxH3zw&list=PLgSiPGd4Nrcj3FFB-fg7OoFEK9ZEcjZ0o&index=26

Part 2:

https://www.youtube.com/watch?v=FwOB3b-YIFo&list=PLgSiPGd4Nrcj3FFB-fg7OoFEK9ZEcjZ0o&index=27

E. TECHNICAL TOURS AT ISUW 2025

As part of ISUW 2025, ISGF organizes Technical Tours for the Conference Delegates. The ISUW 2025. Technical Tour comprised of:

Tour 1: Visit to Northern Regional Load Despatch Centre (NRLDC) + Renewable Energy

Management Centre (REMC) + Visit to Tata Power Delhi Distribution Limited (TPDDL) Smart Grid Laboratory

Tour 2: - 800 kV HVDC Station in AGRA & Taj Mahal

F. ISGF INNOVATION AWARDS 2025

ISGF Innovation Awards instituted in 2017 is aimed to recognize and to celebrate organizations (utilities and technology companies), projects, products and personalities that have set a new benchmark in Electricity, Gas, Water and E-Mobility domains. Till 2025, ISGF had selected and recognized more than 373 such organizations/ individuals.

In ISUW 2025, 282 projects submitted the nominations and out of which 36 projects were conferred with ISGF Innovation Award, and 14 projects were awarded with Certificate of Merit for the categories.

1. Best Smart Grid Project in India – Utility/Technology Company/Implementing Agency
2. Most Innovative Renewable Energy Programs/Projects in India
3. Smart Technology - Electricity – Distribution
4. Smart Technology - Electricity – Generation, Transmission, and Distribution
5. Smart Technology – Energy Storage Systems
6. Smart Technology - Smart Gas Distribution
7. Smart Technology - Smart Water Distribution
8. Emerging Innovation in Electric Mobility Domain - Electric Vehicle (2/3/4 Wheelers,

Buses, Trucks, Tractors, Boats/ Ferries, Drones etc.) and Battery for Electric Mobility/ EV and EVSE Rollouts including New Business Models

9. Adoption of Artificial Intelligence, Machine Learning and Robotic Solutions – Utility/Industry/Technology Provider
10. Smart Start-up of the Year
11. Smart Incubator of the Year
12. Innovative Financing for Energy Transition
13. Waste-to-Energy Projects (W2E)
14. Woman in Energy and Utilities

G. GLIMPSES OF EXHIBITION AT ISUW 2025

India Smart Grid Forum

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