The Institution of Engineers (India)

"A Century of Service to Nation"

Two-Day National Seminar

on

Smart Grid : Current Trends and Future

6 th & 7 th September 2024

Organized by

The Institution of Engineers (India)

PALGHAT LOCAL CENTRE

Under the Aegis of

Electrical Engineering Division Board, IEI

Jointly with,

N|S|S COLLEGE OF ENGINEERING
Palakkad, Kerala, India

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

And

IE(I) ELECTRICAL STUDENTS CHAPTER
NSS COLLEGE OF ENGINEERING

Venue : NSS College of Engineering, Palakkad

Two-Day
National Seminar on

SMART GRID : CURRENT TRENDS AND FUTURE

September 6th and 7th , 2024

SOUVENIR

Organised By

The Institution of Engineers (India)

Palghat Local Centre

In Collaboration with

Department of Electrical and Electronics Engineering, NSSCE

And

IE(I) ELECTRICAL STUDENTS' CHAPTER, NSSCE

ACKNOWLEDGEMENTS

We are extremely delighted to bring out a Souvenir of the "Two-Day National seminar on Smart Grid: Current Trends and Future" organized by the Institution of Engineers (India), Palghat Local Centre jointly with the Department of Electrical and Electronics Engineering and IE(I) Electrical Chapter, NSS College of Engineering, Palakkad on 6 and 7 September, 2024.

"Smart Grid: Current Trends and Future" is a two-day event designed to explore the rapidly evolving landscape of Smart Grid technology. As the energy sector undergoes significant transformations, Smart Grids are emerging as a key innovation for sustainability. This seminar will feature presentations, panel discussions, and interactive sessions with leading experts and industry stalwarts. Attendees will gain insights into enhancing energy efficiency, grid resilience, integrating renewable energy sources, and enabling demand response. The event will also showcase cutting-edge research and real-world applications of Smart Grid technology. Participants will have the opportunity to engage with experts, explore the latest trends, and contribute to discussions shaping the future of the energy landscape. The seminar aims to inspire attendees to participate in the ongoing evolution of this transformative technology. By bridging the gap between academia and industry, the event fosters collaboration and knowledge exchange. Attendees will leave well-versed in the current state of Smart Grids and equipped with ideas to drive future advancements. This seminar promises to be a pivotal experience for anyone involved in the energy sector.

This National Seminar will give an insight on:

-Renewable Energy Integration

-Demand Response and Energy Management

-Energy Storage Solutions

We are grateful to the speakers who have handled the technical sessions of relevant topics for the benefit of practicing industrialists, technicians and academicians attending the workshop.

We express our warm gratitude to the sponsors and delegates who have extended their support for the smooth conduct of the workshop and in bringing out this souvenir. Our appreciation to all the members of the Organizing committee and well wishers for their whole hearted cooperation and assistance.

CHAIRMAN

Rajappan, FIE
IEI Palghat Local Centre

HON. SECRETARY

Dr. Rajesh Menon B, FIE
IEI Palghat Local Centre

CHAIRMAN

Dr. Saju N, HOD ,EEE
Technical Committee

CONVENOR
ORGANISING COMMITTEE
Dr. Nisha A S

CONVENOR
TECHNICAL COMMITTEE
Dr. Leena N

FORWARD

Smart Grid : Current Trends and Future is a two-day event that seeks to illuminate the path forward in the dynamic world of Smart Grid technology. With the energy sector undergoing profound transformations, Smart Grids have emerged as a beacon of innovation and sustainability. This seminar will bring together an illustrious gathering of experts, thought leaders, and enthusiasts who are at the forefront of Smart Grid research and implementation. Through a series of engaging presentations, panel discussions, and interactive sessions, attendees will embark on a journey to uncover the latest trends and envision the future of Smart Grids. From enhancing energy efficiency and grid resilience to integrating renewable energy sources and enabling demand response, the seminar will delve deep into the diverse aspects of Smart Grids. Industry stalwarts will share their practical experiences and insights, providing a valuable perspective on the real-world applications of Smart Grid technology. Attendees will have the chance to interact with experts, explore cutting-edge research, and engage in stimulating discussions that can shape the future of the energy landscape. By the end of this seminar, participants will not only be well-versed in the current state of Smart Grids but will also be inspired to contribute to the ongoing evolution of this transformative technology Furthermore, the seminar aims to bridge the gap between academia and industry, fostering collaboration and knowledge exchange.

Sub themes (Technical Sessions):

1) Renewable Energy Integration: Challenges and solutions for integrating solar and wind power into the grid. Microgrids and their role in renewable energy integration.

2) Demand Response and Energy Management: The role of demand response programs in optimizing grid operations. Smart meters and energy management systems for consumers.

3) Energy Storage Solutions: Advancements in energy storage technologies (batteries, flywheels, etc.). Storage as a means to balance supply and demand in the grid.

4) Case Studies and Success Stories: Real-world examples of successful smart grid implementations. Lessons learned from smart grid projects around the world.

MESSAGE

K. K. Gopalakrishnan Nair.
Chairman, ELDB

I'm glad to hear that the Palghat Local Center of The Institution of Engineers (India) is organizing a National Seminar on "Smart Grids: Current Trends and Future." It's indeed a highly relevant topic, considering the rapid advancements in smart grid technologies and their impact on energy management and sustainability. I hope the seminar provides valuable insights to the participants on recent developments in the field.

Wishing you all the best for a successful event!

The Institution of Engineers (India)

A Century of Service to the Nation

(Established 1920, Incorporated by Royal Charter 1935)

Kerala State Centre

Visvesvaraya Bhavan, Opposite to Kanakakunnu Palace, Thiruvananthapuram 695033

Er.P.Balakrishnan Nair, FIE
Chairman
Mobile : 8547859168

Prof (Dr.) M. Jayaraju, FIE
Chairman (I/C), Immediate Past Chairman
Mobile : 9846369478

Phone : 0471 2322991
Mobile : 8078027563
email : keralasc@ieindia.org
ieitvm@gmail.com

Website : www.ieitvm.org
GSTIN : 32AAATT3439Q3Z1

MESSAGE

4th September 2024

Er.P.Balakrishnan Nair, FIE
Chairman, IEI Kerala State Centre

I am very glad to note that The Institution of Engineers (India), Palghat Local Centre is a holding two-day National Seminar on 6th and 7th September 2024 with the theme "Smart Grid: Current Trends and Future".

Today, in the world where everyone looks out for smart objectives and methods involving smart technology, this two-day event seems designed to explore the rapidly evolving landscape of Smart Grid technology. Smart grids are electricity network that use digital technologies, sensors and software to better match the supply and demand of electricity in real time while minimizing costs and maintaining the stability and reliability of the grid. The smart grid is an enhancement of the20th century electrical grid, using two-way communications and distributed so-called intelligent devices. The changes that take place in the energy sector are likely to be deliberated during the event and I hope it would be very beneficial to all especially the young engineers who should participate and gather vital information for improving the transformations in electrical field as Smart Grids are emerging as a key innovation for sustainability.

I wish the seminar all the very best and success.

Er.P.Balakrishnan Nair,
FIE Chairman
The Institution of Engineers (India)
Kerala State Centre

PROGRAMME SCHEDULE

Day 1 (06-09-2024), Friday		
9:00 am to 10:00 am	REGISTRATION	
10:00 am to 12:00 am	**Inauguration and Key note by Er. C Rethi Nair, General Manager at SRLDC, Grid Controller of India Limited**	
12:00 pm to 1:00 pm	**LUNCH**	
1:00 pm to 2:15 pm	**SESSION 1**	**Speaker: Er. R Ramar, Deputy Director, National Power Training Institute, Alappuzha** **Session On : Recent Trends in Smart Grid Systems ,Overview of distribution management**
2:15 pm to 2:30 pm	**TEA BREAK**	
2:30 pm to 3:45 pm	**SESSION 2**	**Speaker: Er. Ajit Paul, Founder, Digital i2o** **Session On : Digital Twin Capabilities for smart grid transformation**
Day 2 (07 -09-2024), Saturday		
10:00 am to 11.30 am	**SESSION 1**	**Speaker : Dr. Manas Kumar, IIT Palakkad** **Session on : Impact on High Penetration of Inverter based Generation on Power System Dynamics, Control & Protection**
11:30 am to 11.45 am	**TEA BREAK**	
11:45 am to 1:00 pm	**SESSION 2**	**Speaker : Er. Madhana Mohan, Retd. Dy.Chief Electrical Engineer Railways** **Session on : Role of Synchro phasor technology in wide area monitoring , protection & control**
1:00 pm to 2:00 pm	**LUNCH**	
2:00 pm to 3:00 pm	**SESSION 3**	**Speaker Er. Nobin Mathew, Director Energy IoT Division at Kalkitech** **Session on : Orchestration of Distributed Energy Resources for Grid Support"**
3:00 pm to 3:15 pm	**TEA BREAK**	
3:15 pm to 3:45 pm	**PANEL DISCUSSION**	
3:50 pm to 4:10 pm	**VALEDICTORY**	

ABOUT INSTITUTION OF ENGINEERS (INDIA)

The Institution of Engineers (India) or IEI is the largest multidisciplinary professional body that encompasses 15 engineering disciplines and gives engineers a global platform to share professional interest. IEI has a membership strength of over 1 million. Established in 1920, with its headquarters at Kolkata. IEI has served the engineering fraternity for over ten decades. In this period, it has been inextricably linked with the history of modern-day engineering. In 1935, IEI was incorporated by Royal Charter and remains the only professional body in India to be accorded this honor. Today, its quest for professional excellence has given it a place of pride in almost every prestigious and relevant organization across the globe. It provides a vast array of technical, professional and supporting services to the Government, Industries, Academia and the Engineering fraternity, operating from 124 Centers located across the country. The Institution has established R&D Centers at various locations in the country and provides grant-in-aid to its members to conduct research and development on engineering subjects. IEI has been recognized as Scientific and Industrial Research Organization (SIRO) by the Ministry of Science & Technology, Government of India and besides conducting its own research, provides Grant-in-Aid to UG/PG/ PhD students of Engineering Institutes & Universities. IEI holds the International Professional Engineers (IntPE) Register for India under the global International Professional Engineers Alliance (IntPEA). The Institution also awards the Professional Engineers (PE) Certification. The Palghat Local Centre was established in 1981 and became a full-fledged Local Centre in 1988.

ABOUT IE(I) PALGHAT LOCAL CENTRE

Palghat Local Centre of IEI was established as a Paper Centre in 1981 and was given the status of a Local Centre in 1988 with Palakkad and Malappuram districts within its jurisdiction. Presently it has a membership of 1435 (Fellows: 146; Members: 389; Associate members: 900) corporate members in 14 Engineering Divisions. The Local Centre is functioning in our own building situated in Nerukakkad, Kalleppully, Palakkad (Ph:04912972137). The Centre has a library with a collection of 2006 books of all disciplines of Engineering, Technical journals and other IEI publications, accessible to corporate members and students. The Centre organizes national seminars, regular technical meetings and observes all statutory days advised by IEI HeadQuarters.

ABOUT DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING, NSSCE

The Department of Electrical & Electronics Engineering was started in 1960. The department has established itself as one of the best and prestigious departments of NSS College of Engineering. The department has well experienced and committed faculty having specialization in different areas in Electrical and Electronics Engineering.The National Board of Accreditation AICTE has given a National Level recognition by accrediting the department with Grade B. The department of EEE is offering B.Tech and M.Tech (Power Electronics) programmes. The department has a number of well equipped laboratories and provides excellent facilities for learning, research and development and consultancy works. Department periodically organizes seminars, conferences, workshops, industrial visits and guest lectures for the benefit of both the students and the faculty.

ABOUT IE(I) ELECTRICAL STUDENTS' CHAPTER, NSSCE

Established in 1990's IE(I) Electrical Chapter NSSCE is one of the long-standing societies in NSSCE. In recent years, IE(I) Electrical Chapter NSSCE has been one of the active chapters of IE(I). The chapter has a well-organized core team and more than 300 active members who together act as a driving force. IE(I) Electrical Chapter NSSCE has organized countless activities, including workshops, industrial visits, talk sessions, webinars, bootcamps, hackathons, etc., which have helped to uplift the skillsets of more than 1000 students. Currently, the chapter mobilizes activities on a weekly basis to help students enhance their skills and personalities.IE(I) Electrical Chapter NSSCE will continue to contribute to the process of moulding the students into socially responsible engineers.

INAUGURATION AND KEYNOTE

by Dr. C Rethi Nair

General Manager at SRLDC, Grid Controller of India Limited

C Rethi Nair is currently the General Manager at the Southern Regional Load Dispatch Center (SRLDC) under the Grid Controller of India Limited in Bangalore, overseeing the integrated operation of India's power grid. With 32 years of experience, his career spans various roles in power system operations, market management, and grid control across multiple locations, including Bangalore, Mumbai, and Indore. His technical expertise includes managing market operations, commercial settlements, and transmission systems. Nair has also presented research on India's electricity market at CIGRE Paris 2024 and has contributed to publications on power quality monitoring.

Smart Grids and Their Development in India

Introduction to Smart Grids

Smart grids represent a significant evolution from traditional electricity networks. A smart grid integrates advanced communication, automation, and information technologies to enhance the efficiency, reliability, and sustainability of the electricity supply chain. The shift to smart grids is not merely a technological upgrade; it is a fundamental transformation that allows for better management of the demand and supply of electricity, more integration of renewable energy sources, and greater engagement of consumers in energy management.

Transition from Traditional SCADA to PMU and WAMS

In traditional power systems, Supervisory Control and Data Acquisition (SCADA) systems have been the backbone of grid monitoring and control. SCADA systems allowed utilities to monitor and control grid components over large geographical areas in real-time. However, these systems were limited in their ability to provide detailed, high-resolution data, which became increasingly necessary as grids became more complex.

Phasor Measurement Units (PMUs) have emerged as a key technology in modern power systems. PMUs provide real-time, time-synchronized measurements of electrical quantities across the grid, enabling operators to have a precise view of the system's dynamic behavior. The deployment of PMUs has led to the development of Wide-Area Monitoring Systems (WAMS), which allow for comprehensive monitoring of the grid over large areas, improving situational awareness and enabling more accurate and timely decision-making.

Evolution from SEM Meters to Smart Meters

In the context of metering, traditional Special Energy Meters (SEM) have served the purpose of recording energy consumption for billing purposes. However, these meters lacked the capability to provide real-time data or support advanced functionalities, which became crucial as energy systems grew more complex and consumer participation in energy management became more important.

Smart meters represent a significant advancement in metering technology. These devices not only measure energy consumption but also communicate this data in real-time to both consumers and utilities. This real-time data enables better demand-side management, supports dynamic pricing models, and enhances the ability of utilities to detect and respond to issues such as outages or energy theft.

Role of AI and IoT in Modern Grid Management

Artificial Intelligence (AI) and the Internet of Things (IoT) are playing transformative roles in the operation of modern power grids. AI algorithms can analyze vast amounts of data generated by smart meters, PMUs, and other sensors to optimize grid operations, predict demand patterns, and improve the integration of renewable energy sources. AI-driven predictive analytics can also enhance the reliability of the grid by identifying potential issues before they lead to outages.

The IoT enables the seamless connectivity of devices across the grid, from household appliances to large industrial equipment, facilitating real-time monitoring and control. This interconnectedness allows for more responsive and efficient grid management, where every component, from generation to consumption, can be optimized to improve overall system performance.

Development of Smart Grids in India

India has been at the forefront of adopting smart grid technologies, recognizing their potential to address the challenges of a rapidly growing and increasingly complex power sector. The Indian government has launched several initiatives aimed at modernizing the grid infrastructure, such as the National Smart Grid Mission (NSGM) and various pilot projects across the country.

The transition to smart grids in India involves several key elements:

- Implementation of PMUs and WAMS: India has been deploying PMUs across the grid, which are connected through WAMS to enhance the monitoring and control capabilities of the grid. The WAMS- (Wide Area Monitoring System) project in India named as the URTDSM (Unified Real Time Dynamic State Measurement) is implemented in two phases. Phase-I has been in operation since 2016 with over 300 PMUs installed in the Southern Region. The project also has several analytical applications for Visualization, Oscillation Monitoring and Dynamics analysis.
- Smart Metering Initiatives: The government has initiated large-scale smart metering projects, aiming to replace traditional meters with smart meters to improve billing accuracy, reduce losses, and empower consumers with real-time energy usage information.
- Integration of Renewable Energy: With India's ambitious renewable energy targets, smart grids are crucial for

managing the variability and uncertainty associated with solar and wind power. Smart grid technologies facilitate better integration of these renewable sources into the grid. Better RE forecasting is crucial for secure grid operation.

- Use of AI and IoT: Indian utilities are increasingly adopting AI and IoT solutions to improve grid management, from predictive maintenance to demand forecasting and beyond.

Conclusion

The development of smart grids in India represents a significant leap forward in the country's journey toward achieving a reliable, efficient, and sustainable power infrastructure. As India continues to urbanize and industrialize, the demand for electricity is expected to rise exponentially. Traditional power grids, with their limitations in handling complex and dynamic energy needs, are increasingly inadequate for meeting these demands. Smart grids, with their ability to integrate advanced communication, automation, and IT technologies, offer a robust solution that not only addresses the challenges of energy management but also enhances the overall efficiency and resilience of the power system.

One of the critical drivers for the adoption of smart grids in India has been the integration of renewable energy sources. As the country strives to meet its ambitious renewable energy targets, the variability and unpredictability associated with renewable energy generation present significant challenges. Smart grids, with their advanced monitoring and control capabilities, provide a platform for the seamless integration of renewable energy into the grid, ensuring stability and reliability. The deployment of technologies such as Phasor Measurement Units (PMUs) and Wide-Area Monitoring Systems (WAMS) plays a pivotal role in this integration, enabling real-time monitoring and precise control over the grid’s operations.

Furthermore, smart grids are set to revolutionize the way electricity is consumed and managed at the consumer level. The shift from traditional meters to smart meters is empowering consumers with greater control over their energy usage, promoting energy efficiency, and facilitating demand-side management. This not only helps in reducing energy consumption but also in flattening peak demand curves, thereby easing the load on the grid. The advent of AI and IoT in grid management further enhances the capabilities of smart grids, enabling predictive maintenance, automated fault detection, and quicker restoration of services.

In conclusion, the ongoing development of smart grids in India is a testament to the country's commitment to building a future-ready power infrastructure. By embracing cutting-edge technologies and fostering innovation in grid management, India is paving the way for a more resilient, sustainable, and efficient energy ecosystem. However, the journey is far from complete. Continued investment in technology, regulatory support, and capacity-building initiatives will be essential to fully realize the potential of smart grids and to address the evolving challenges of the energy sector in the coming decades. As smart grids evolve, they will not only transform India's energy landscape but also serve as a model for other developing nations in their pursuit of energy security and sustainability.

THEME PAPER

on

RECENT TRENDS IN SMART GRID SYSTEMS:

OVERVIEW OF DISTRIBUTION MANAGEMENT SYSTEM

by Er. R Ramar,

Deputy Director, National Power Training Institute, Allapuzha

ABOUT THE SPEAKER :

R. Ramar has 22 years of experience in both industrial and academic sectors, currently serving as Deputy Director (Tech/Faculty) at the National Power Training Institute since November 2008. His expertise encompasses Power System, Thermal Power Plant Engineering, Transmission & Distribution, Power System Optimization techniques, and Generator Design. In his present role, he coordinates long, medium, and short-term training programs, oversees electrical maintenance and lab operations, and serves as the Estate Officer Incharge. Additionally, he delivers lectures on various electrical topics, guides projects, evaluates question papers, manages vehicle operations, and oversees the stores section for stock maintenance. Notably, he presented a paper titled “Honey Badger Algorithm optimized dual-mode fractional order controller for two area hybrid power system” at the International Conference on Innovative and Cutting Edge Technologies in Electrical, Electronics, Computer Engineering, and Information Technology (ICICEECI - 2022).

ABSTRACT OF TALK :

The twenty-first century has been marked by big technological progress. With the development of new technologies, pressing issues related to the re-equipment of the energy sector have become more prominent. The implementation of up-to-date electricity-powered devices such as battery-powered vehicles and high-tech equipment has increased the energy demand, but existing engineering management tools cannot provide the required level of reliability and safety of the energy distribution process. There are several cases able to explain the current situation:

1.Aging workforce and infrastructure.

2.Absence of wide-dimension software which would provide different functionalities unified in one program solution.

3.Modern electricity equipment implementation.

4.Appearance of distributed generation.

To solve the above referenced problems smart grid technologies and ADMS are being increasingly developed. The ADMS (advanced distribution management system) technology and its features will be described in this paper.

Problem statement

What is an ADMS?

“An advanced distribution management system (ADMS) is the software platform that supports the full suite of distribution management and optimization. An ADMS includes functions that automate outage restoration and optimize the performance of the distribution grid.

The ADMS is a decision support system that helps control room and field operating personnel to monitor and control the electric distribution system effectively while improving safety, reliability, asset protection and quality of service. ADMS delivers a single environment and user experience. This enables the streamlining of decision making and enhances emergency response performance. It resolves the critical barrier issues of real-time integration and enables the creation of high-performance network models. By providing a unified environment for control and dispatch, ADMS also allows for a more comprehensive view of the distribution system during an outage. The Advanced DMS is the utility dependent on technology that is why it should be interconnected with the existing Energy Management or Network Management System and OMS. Data sharing between these systems maximizes the efficiency of operation within your control room or control centers.

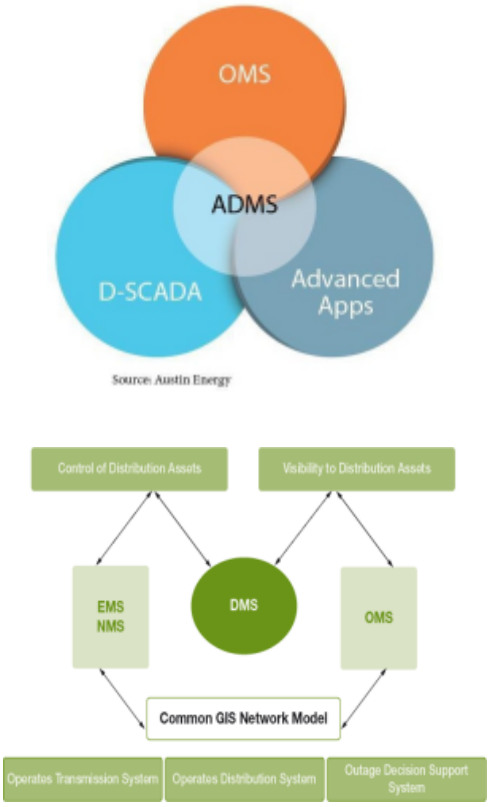

Figure 1. The structure of the distribution management system.

Moreover, with the increase of energy consumers it is mandatory to enlarge the hardware structure in order to keep up the processed data. For

this reason, new open structures are being implemented with ADMS. It allows increasing the accuracy level of the system analysis, data calculation and network representation.

The ADMS includes monitoring, analysis, control, optimization, training and planning tools that all function on a common representation of the entire electric distribution network. This allows system operators, dispatchers, reliability analysts, planning engineers and managers to work as a team accessing the same as-operated representation of network information for efficient and reliable management of grid operations.

With the ADMS there is the possibility to visualize the current state of the network based on SCADA telemetry combined with state estimation for all non-telemetered equipment to provide systems operators with greater network awareness.

The ADMS benefits:

- Demand management.
- Energy loss prevention.
- Peak shaving.
- Reduced peak power purchases.
- Improved operational efficiency
- Support for regulatory compliance
- Better assets utilization
- Standards-based integration

Furthermore, these benefits can contribute to significant savings for utilities and customers.The foundation of the ADMS

The major ADMS capability is to accurately define the network model and to process an unbalanced load flow algorithm, based upon this model with telemetered data, acquired from the network.

The network model

The ADMS must be able to represent all aspects of the distribution networks, including a variety of conductor types, transformers, switches, fuses, etc. and monitor the status of these ones.

The dynamic data

In order to make ADMS load flow algorithm more exact it is necessary to provide telemetered data from the distribution network. Data is usually obtained from SCADA (Supervisory Control and Data Acquisition) systems. The AMI (advanced metering infrastructure) and OMS (Outage Management) are subsystems, which allow assembling and transferring data. ADMS requires a lot of data which changes quickly. For this reason high-performance data management is indispensable. This data provides a lot of information (Voltage, current) and device status to enable the load flow algorithm to promote more reliable results.

The unbalanced load flow algorithm

The ADMS must have a significantly fast load flow algorithm to solve unbalanced distribution networks.

Main ADMS components

Control system

The ADMS typically includes a SCADA system, an OMS and advanced applications.

Data is significantly important

The ADMS requires data to understand the full potential of its function. Data is gathered from intelligent field devices and enterprise systems. Besides, AMI grids can render the last gasp information to enforce outage management processing within ADMS as well as the capability to perform output meter pings to test for voltage potential at the meter base endpoint.

Mobility

Mobile systems can be used to directly view and operate the network on mobile data terminals. OMSs get enforced abilities through mobility by implementing the digital ticket system for team dispatch and tracking, occurrence/cause/repair reporting and up to date customer outage information.

These applications are interconnected with each other. The relay protection analysis application accomplishes analytical studies on the network. If a system is complemented by adaptive protection,it can determine the correct relay setting to support new configurations. As soon as the new configuration is recognized with a closed loop application, the system will automatically reconfigure without the need for operator interruption.

Switch order management

This application provides the user with the option to create switching orders manually or automatically. The application allows the user to customize the switching order to reflect current in- house templates. The business benefit is that all relevant factors are analyzed on a single platform providing improved safety, reliability and operating effectiveness.

Fault Location Isolation Service Restoration (FLISR)

This application enhances the Fault Location process. Customer restoration is improved by having better information and the ability to direct field crews more accurately to the faulted location. Using information obtained from the relay IED and fault detectors location in the field will avoid lengthy line patrols and sectionalizing efforts. Some DMS solutions also provide means whereby data administrators can input historical failures for the feeder in the application. This historical information can be used as one of the mechanisms for determining faulted locations as well. The Isolation and Service Restoration piece of FLISR is the next step. Once the faulted section is known, remotely

controlled devices can restore customer load either manually (via remote control) or automatically (without operator intervention).

The business benefits include improved field resource utilization, reduced customer interruptions and less “windshield time” for field forces.

Topology Analyzer

The Topology Analyzer application displays voltages, phasing, and the state of the system (energized or de-energized) using different color schemes as determined by the utility. This application is applicable to single line schematic displays and geographic displays. Some DMS solutions can create single line displays on the fly by the user selecting the feeders and substations they wish displayed in isolation of other superfluous equipment. From a user perspective this is very powerful as it provides simplicity and clarity for the task at hand.

The business benefit is somewhat obvious. Without a method to simplify the electrical connectivity, the visual diagrams would be extremely cluttered and not useful. A lot of work has been done by the vendor community to ensure optimum flexibility provided for the user.

The ADMS's analytical functionality.

The ADMS has multifaceted functions. In this part it should be mentioned about some of them.

Volt/VAR Optimization (VVO)

The Volt/VAR Optimization (VVO) application in its simplest form reduces the distribution system voltage, thereby reducing the overall demand. Today, there are a number of devices that can be utilized to manage the network at a lower voltage profile, including:

- Substation – under load tap changers
- Capacitors – large and small

- Distribution stations – under load tap changers
- Other DER devices

The VVO application has been designed to optimize the use of all of the mentioned devices to minimize the overall load on the system. Typically, the VVO applications are rule-based to determine the order and use of these devices.

The business benefit is the reduction of power consumption. This will offset the need for capital upgrades such as additional generating facilities and network upgrades to meet increased load demands.

Network reconfiguration

This application allows network optimization in case of new devices/customers deployment, fault or power imbalance occurrence. The objectives are minimizing line losses, providing optimum phase balancing while maintaining adequate voltage profiles.

State estimation

In power network state estimation validates observable data and calculates all non- telemetered points in order to derive a complete network view.

The collected data quality is not very precise due to problems in devices or telecommunication networks. To solve this issue and provide an advanced analysis, the obtained data must be pre- processed in order of elimination of bad data points.

Distribution state estimation is much more advanced than simple load calibration. For this reason,the distribution state estimation should have the highest precision as it is the basis of all advanced functions.

Peak shaving

Near-term load forecasting is a great tool to identify the potential for a peak load event during the course of the day. Combining this forecast capability with Volt/VAR Optimization is a great way to continue managing the demand on the network without affecting any customers. Load tap changers, voltage regulators, and capacitors can be automatically or manually controlled to maintain voltage profiles, within regulatory limits, in order to manage demand. This can be done only during peak events or as a normal mode of operation as desired.

Conclusion:

Demand response is the main function that drives utilities to Smart Grid programs and to the implementation of advanced DMS software. The complex system of demand response offers a lot of options that can be accomplished to reduce demand in case of increasing demand, and the potential of rising costs and network instability.

Some demand response actions depend on customers to react on their own. Utilities operationally require electricity consumers to change their consumption patterns when supply is short. Regulators are also able to create rate structures that encourage similar conduct through normal attention to energy costs. However, since these approaches do not provide enough reduction, additional demand response options are rendered, and the ADMS can support the prioritized application of these options.

THEME PAPER

on

DIGITAL TWIN CAPABILITIES FOR SMART GRID TRANSFORMATION

by Er.Ajit Paul,

Founder, Digital i2o (Insights-to-Outcomes), Global EDISON Alliance nominee for Industry 4.0 initiatives.

ABOUT THE SPEAKER :

Ajit has over 25 years of experience in business transformation, strategic technology management, and C-level engagements for major corporations. He has held leadership roles at Tech Mahindra, Philips, and Honda.

Since 2015, Ajit has founded two successful startups:

- Giftolexia Solutions: An AI-powered dyslexia screening and intervention platform. Recognized by the World Economic Forum as a Tech Pioneer, Giftolexia has been deployed widely and supported by various government agencies and tech giants.
- Digital i2o: A boutique consulting firm specializing in digital strategy, ESG governance, and digital twin initiatives. Clients include Rakuten Group, Transworld Group, Barclays Bank, and others.

Ajit is a Stanford Seed Program mentor and has been recognized for his expertise in industry 4.0, digital strategy, and cloud services. He holds degrees from TKM College of Engineering and IMI Delhi, and has certifications in enterprise architecture, cloud security, and independent directorship.

ABSTRACT OF TALK:

Introduction

The concept of a Digital Twin has emerged as a transformative technology across various industries, including energy. A Digital Twin refers to a virtual replica of a physical asset, process, or system that can be used for real-time monitoring, simulation, and optimization. In the context of Smart Grids, Digital Twins offer unprecedented capabilities to enhance grid management, reliability, and efficiency. As the global energy landscape evolves towards decarbonization, decentralization, and digitalization, Digital Twin technology becomes essential for modernizing energy infrastructure and achieving sustainable energy goals.

Why is Digital Twin Capability Essential for Smart Grids?

Smart Grids represent the next generation of electricity networks, integrating advanced communication and automation technologies with the traditional grid to enable two-way communication between utilities and consumers. The primary aim of Smart Grids is to enhance the efficiency, reliability, and sustainability of power delivery. Digital Twin capabilities are crucial in achieving these goals for several reasons:

1. Real-time Monitoring and Predictive Maintenance: Digital Twins provide a dynamic, real-time digital replica of the physical grid, enabling operators to monitor the network's status continuously. This real-time visibility helps in identifying potential faults or inefficiencies before they escalate into significant issues, thereby reducing downtime and improving grid reliability. Predictive maintenance powered by Digital

Twins allows for the early detection of equipment wear and tear, optimizing maintenance schedules and extending the lifespan of grid components.

2. Enhanced Decision-Making and Optimization: By simulating different scenarios and analyzing their impact on the grid, Digital Twins enable utilities to make more informed decisions. For instance, they can model the integration of renewable energy sources, assess the impact of new policies or market conditions, and optimize the operation of distributed energy resources (DERs). This capability is particularly vital in a Smart Grid environment where decisions must account for complex variables and the need for real-time responses.

3. Improved Resilience and Fault Management: Digital Twins enable advanced fault detection and isolation techniques, helping utilities quickly identify and mitigate faults in the grid. By simulating fault conditions and response strategies, Digital Twins can support the development of more robust grid architectures and emergency response plans, enhancing overall grid resilience against natural disasters, cyberattacks, and other disruptions.

4. Customer Engagement and Demand Response: Digital Twins can also model consumer behavior and energy usage patterns, allowing utilities to develop more effective demand response programs. By understanding how different factors influence consumption, utilities can better manage peak loads, reduce energy costs, and enhance customer satisfaction through personalized services.

Global Major Implementations of Digital Twins for Smart Grids

Several countries have made significant strides in implementing Digital Twins for Smart Grids, leading the way in digital transformation in the energy sector:

1. United States: The U.S. has been at the forefront of Smart Grid transformation, with several utilities adopting Digital Twin technology. For example, GE Digital has implemented Digital Twin technology with utilities like Southern California Edison and Florida Power & Light. These Digital Twins are used for predictive maintenance, load forecasting, and optimizing the integration of renewable energy sources into the grid.

2. United Kingdom: National Grid ESO, the electricity system operator in the UK, has developed a Digital Twin to manage the country's electricity system more efficiently. The Digital Twin helps simulate different scenarios, such as increased renewable energy penetration or new demand patterns, enabling the grid operator to anticipate challenges and optimize the network accordingly.

3. China: State Grid Corporation of China (SGCC), the world's largest utility company, has embraced Digital Twin technology to enhance its grid management capabilities. SGCC uses Digital Twins to model and analyze the performance of its extensive grid infrastructure, improve fault detection, and enhance grid resilience in response to natural disasters and rapid urbanization.

4. Germany: In Germany, Digital Twin technology is being integrated into the country's "Energiewende" (energy transition) strategy. TenneT, a leading European electricity transmission system operator, has deployed Digital Twins to model the impact of renewable energy sources on the grid and optimize cross-border energy flows between Germany and neighboring countries.

Why India Needs Similar Digital Twin Capabilities for Smart Grid Projects?

India is rapidly advancing towards a more digital and sustainable energy future. With its ambitious targets for renewable energy integration, electrification, and Smart Grid development, India needs Digital Twin capabilities to manage its complex energy landscape effectively. Here's why:

1. Growing Energy Demand and Grid Complexity: As India's economy grows, so does its energy demand. The integration of various energy sources, including renewables, into the grid adds complexity that requires advanced tools like Digital Twins to manage efficiently. Digital Twins can help optimize the balance between supply and demand, reduce losses, and enhance grid stability.

2. Need for Improved Grid Resilience: India faces unique challenges, such as extreme weather events and an aging infrastructure, which make grid resilience a critical priority. Digital Twin technology can enhance fault detection, predictive maintenance, and emergency response, helping India build a more resilient grid.

3. Support for Renewable Energy Integration: India has set ambitious targets for renewable energy capacity. Digital Twins can model the impact of renewables on the grid, optimize their integration, and manage variability, supporting India's transition to a cleaner energy mix.

4. Urbanization and Smart City Development: With rapid urbanization and the development of smart cities, there is a need for advanced grid management solutions. Digital Twins can support smart city initiatives by enabling real-time monitoring, demand-side management, and energy optimization.

5. Enhancing Customer Engagement and Demand Response: Digital Twin technology can help Indian utilities better understand customer behavior and develop more effective demand response programs, improving customer satisfaction and reducing peak demand pressures on the grid.

6. Data-Driven Decision Making: In a dynamic and evolving energy market, Digital Twins can provide Indian utilities with the tools needed for data-driven decision-making. This capability is essential for adapting to regulatory changes, market dynamics, and technological advancements.

Conclusion:

Digital Twin capabilities are crucial for transforming Smart Grids and achieving energy goals. While global implementations have demonstrated significant benefits, such as improved operational efficiency, enhanced grid resilience, and better decision-making, challenges like high initial costs and data management persist. For India, adopting Digital Twin technology is essential to managing its growing energy demand, supporting renewable integration, enhancing grid resilience, and fostering sustainable development in a rapidly evolving energy landscape.

THEME PAPER

on

Impact of High Penetration of Inverter based Generation on Power System Dynamics, Control and Protection

by Dr. Manas Kumar,

IIT Palakkad

ABOUT THE SPEAKER :

Dr. Manas Kumar Jena received his Ph.D. in Power System Engineering from the Department of Electrical Engineering, Indian Institute of Technology Delhi, India. He is currently serving as an assistant professor in the Department of Electrical Engineering, Indian Institute of Technology, Palakkad, India. Before joining IIT Palakkad, he served as a Subject Matter Expert (SME), at General Electric (GE-Power). He is the recipient of the Indian National Academy of Engineers (INAE) Innovative Student Projects Award 2018- Doctoral Level, POSOCO Power System Award (PPSA)-2019, GE-Impact Award-2019 for the development and delivery of PhasorAnalytics Software Solution to ONS-Brazil and Indian National Academy of Engineers (INAE) Young Engineer Award 2021. He is an associate editor of the IET Generation Transmission and Distribution Journal.

ABSTRACT OF TALK:

The global push to reduce carbon emissions in the environment has led to a search for alternative energy sources that are less polluting and less expensive to harness than traditional primary energy sources that are currently widely used, such as fossil fuel sources. This has resulted in the widespread use of renewable energy sources (RES) as an alternative future energy source. In the process of integrating RES generation into the electrical grid while it offers many benefits, it is not without drawbacks. Not all RES are inverter-based resources (IBRs), but the most majority are, and this is projected to have a substantial impact on how the power grid is operated. The loss of natural inertia given by conventional synchronous machines on the grid is a major challenge with the introduction of inverter-based generation on the grid. The inertia provided by the synchronous generators limits the rate of change of frequency (ROCOF) and maintains system frequency within the limits of stable operation. Switching from synchronous generation to inverter based resources IBRs reduces system inertia and affects power system frequency stability. Similar impacts on legacy protection schemes are also anticipated on IBR dominated power systems. The issues faced by the current/future grid with significant renewables penetration, as well as potential solutions, are examined in this talk, with an emphasis on real-world examples.

THEME PAPER

on

Role of Synchro phasor technology in wide area monitoring, Protection and Control

by Er.Madhana Mohan,

Retd. Dy.Chief Electrical Engineer Railways

ABOUT THE SPEAKER:

Er K. Madhana Mohan IRSEE, Retd. Dy. Chief Electrical Engineer, Railways. graduated in Electrical Engineering from NSS College of Engineering, Palakkad in 1978. He joined Integral Coach Factory (Chennai)/ Railways in June 1979 and worked there in various capacities like AEE/ designs, Works Manager and Dy. CEE/ Production in manufacturing of AC EMUs / DC EMUs / DEMUs and other special coaches.

He had a stint of 10 years as programmer cum System Analyst in EDP Centre, System Development Group of Indian Railways stationed at Chennai ICF , responsible for developing application programs for production planning & control and inventory management for the production units of IR (ICF,CLW & DLW) in main frame computers ICL/2957 & IBM /370.

He had also worked as Chief safety officer for the Factory for a period of 4 years and was instrumental in implementing ISO 14001 EMS and OHSAS18001 (now upgraded to ISO 45001) in ICF.

He had worked as Dy.CEE/Contracts & Developments for the procurement of rolling stock items and also worked in plant & machinery maintenance of ICF besides maintaining 7 wind Turbines of 1.5 MW

Capacity each at Tirunelveli Dist. owned by ICF.

He had been to Holland, France and Germany for training in 3 phase technology for EMU traction and Traction converters with V V V F (variable voltage and variable frequency) controls for traction motors.

He is also FIE (electrical) of Institution of Engineers India Ltd (IEI) and former Chairman of IEI Palakkad local Centre. Presently working as a consultant for EV manufacturing units.

ABSTRACT OF TALK:

Brief on "synchro phasor technology in wide area monitoring, protection and control system (WAMPCS) for smart grids ".

Synchro phasor technology is a cutting -edge solution for real time monitoring and analysis of power grid operations. Synchro phasor technology uses precise time stamped (GPS provided precise timings for synchronization) measurements of voltage and current phasors across the grid covering a wide area of the network to monitor and analyze power grid operations in real time.

It enables real time monitoring of the power grid across large geographical areas by analyzing synchro phasor data to assess grid stability and predict potential disturbances. It significantly assists in rapid fault detection, identifying and locating faults on the grid. State estimation or estimating the state of the grid in real time including voltage, current and power flow enhances the situational awareness with a comprehensive understanding of grid conditions.

Usage of the synchro phasor data allows to optimize grid operations and control, thereby reducing the energy losses and improved resource allocation. Moreover, the enhanced monitoring and analysis capabilities reduce the risk of blackouts and power outages.

Advanced techniques using machine learning and AI for data analytics of the synchro phasor data from the phasor measurement units (PMU) connected across the grid ensures grid stability by predicting the potential grid disturbances well in advance. Leveraging synchro phasor technology to manage the integration of renewable energy sources such as wind and solar power is an added advantage. This could be extended to microgrid environments for monitoring and control of such small scale local energy systems as well.

The synchro phasor technology enhances grid cybersecurity by detecting and responding to cyber threats in real time. The role of synchro phasor technology in wide area monitoring , protection and control of power grid is very significant in improving reliability, stability and resilience of the power grid and also making the grid smarter.

Synchro phasor technology is being increasingly adopted in the Indian power grids and over 1400 PMUs (phasor measurement units) have been installed at various substations and power plants covering more than 80% of India's power grid.

In summary, synchro phasor technology is a critical component of smart grids, enabling real-time monitoring, analysis and control of grid operations to improve reliability, efficiency and sustainability and also making the grid smarter.

THEME PAPER

on

Orchestration of Distributed Energy Resources for Grid Support

by Er. Nobin Mathew,

Director Energy IoT Division at Kalkitech

ABOUT THE SPEAKER :

Nobin Mathew is in-charge of Kalkitech's Energy IoT Solutioning and drives DER Integration solutions with over 22 years of global diverse experience in Smart grids and DER integration. His areas of expertise include various communication protocol standards used in Smart Grid and DER Integration, he is a member of various standardization committees such as DER API TWG for CSIP AUS(AS 5385:2023), Behind the meter interoperability(AS P-004209), CSIP AUS test specification(SA HB 218:2023), Bureau Of Indian Standards LITD 28 Smart infrastructure Sectional committee, E4S Alliance Edge software working group. He has presented technical papers forums such as CIRED2011 , CEPSI2018, AESIEAP-TC4-2023.

ABSTRACT OF TALK :

Orchestration of Distributed Energy Resources for Grid Support

As energy transition accelerates disruption in the network operations & energy markets, orchestration of Distributed Energy Resource (DER) including solar PV, battery energy storage and controllable loads such as air conditioning, hot water systems and EV chargers becomes a critical part of DSOs and Retailers operations strategy. The objective of DER orchestration is to enable generation and demand flexibility to mitigate intermittencies of DER as well as to mitigate network constraints.

The presentation outlines industry trends on DER Orchestration for integration of DER sites with ESS and EV Charger site with PV & Battery Energy Storage based on IEEE 2030.5 protocol for achieving centralisation of communication and interaction between DER management backend applications at Distribution System Operator (DSO/DISCOM) as well as Market facing application and remote DER from multiple Original Equipment Manufacturers (OEMs). The standards based DER Orchestration enables broad coverage of required capabilities for remote monitoring and control of DER assets while simplifying the process for OEMs to integrate and connect and provides a consistent pathway for future third party integrators to align with grid support and market services. The presentation outlines key considerations for handling primacy of control commands, cybersecurity considerations at the edge and cloud, message models for market participation and grid support flexibility services, framework requirements for seamless integration, process for registration, onboarding and end-to-end test, performance & scalability requirements.

PANEL DISCUSSION

"One Grid-One Nation One-Price Prospects" is a transformative initiative in India's energy sector, aiming to create a unified power distribution network across the country. This concept envisions a single, integrated electricity market where power flows seamlessly from regions with surplus to those with deficits, ensuring uniform pricing and optimal resource utilization. A 30-minute panel discussion on this topic will bring together leaders from the electrical and power sectors to explore key issues such as energy security, enhancing grid reliability, boosting economic efficiency, and reducing regional disparities in power tariffs.