Training Program:

Smart Metering Infrastructure and Application in Smart Grid

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Introduction:

Power systems and communications are close cousins. This may not be apparent at first, but that is how we will generally view these twin subtopics of electrical engineering. Communications and power systems are the same field with a different emphasis. Both transmit power. Communications seek to minimize power and maximize information content. Power systems seek to maximize power and minimize information content. It is particularly interesting to see what happens when these fields physically come together in technologies such as a power line carrier and wireless power transmission. Our goal is to explore both the theoretical and technological underpinnings of this shift in power systems, focusing upon the incorporation of communications and networking technology. There are those who suggest that the integration of communications into the power grid will enable a revolution in electric power distribution, perhaps thinking of the analogy with the explosive growth of the Internet.

Part one of this course covers power systems fundamentals; these are fundamentals that existed long before the smart grid and will exist long after, so they are well worth the time and effort to understand, although, as just mentioned, drawing the line between the pre- and post-smart grid is somewhat arbitrary and perhaps still ongoing, as we will see.

Part two defines what we mean by the term “smart grid” and focuses upon communications.

Part three goes on to explore what communications has enabled and could enable, including synchrophasor applications and machine intelligence.

Part four emphasis on the smart metering in smart grid system and provide many applications in this new area.

Who Should Attend?

Personnel working in all areas of electricity section who wish to understand the various aspects of smart metering and smart grid, Managers, network and distribution engineers, Instrumentation engineers, senior technical staff, plant designers, plant managers, Energy Management System, etc

Course Objectives:

The Smart Grid vision is to give much greater visibility to lower voltage networks and to enable the participation of customers in the operation of the power system, particularly through Smart Meters, smart grid and Smart Homes. The Smart Grid will support improved energy efficiency and allow a much greater utilization of renewable. Smart Grid research and development is currently well funded in the USA, the UK, China, Japan and the EU. It is an important research topic in all parts of the world and the source of considerable commercial interest. The aim of the course is to provide a basic discussion of the Smart Grid concept and then, in some detail, to describe the technologies that are required for its realization. Although the Smart Grid concept is not yet fully defined, the course will be valuable in describing the key enabling technologies and thus permitting the participant to engage with the immediate development of the power system and take part in the debate over the future of the Smart Grid.

Period: 10 days

Course Outline

MODULE (01) ELECTRIC POWER SYSTEMS: THE MAIN COMPONENT

- Introduction to Power Systems Before Smart Grid
- Generation
- Transmission
- Distribution
- Consumption
- Protection Techniques
- Conservation Voltage Reduction
- Distribution Line Carrier
- The Power Market
- Implications for Restructuring
- Frequency
- System Operation and Management
- Automation: Motivation for the “Smart Grid”
- Human Factors
- Variability in Consumption
- The Consumer Perspective
- Microgrids

- Flexibility for the Consumer
- Consumer Energy Management
- Plug-in Electric Vehicles

MODULE (02) COMMUNICATION AND NETWORKING: THE ENABLER

- What is Smart Grid Communication?
- Introduction
- Maxwell's Equations
- Eigensystems and Graph Spectra
- Energy and Information
- Back to the Physics of Information
- System View
- Power System Information Theory
- Complexity Theory
- Network Coding
- Information Theory and Network Science
- Network Science and Routing

- Compressive Sensing
- Communication Architecture
- Smart Grid Applications and Communication
- Active Network
- Wireless Communication Introduction
- Electromagnetic Radiation
- The Wave Equation
- What is the smart grid?
- Switching to smart grid technologies
- Objectives of smart grid roll-out
- Smart grid economics
- Smart grid road maps
- Challenges to meeting smart grid goals
- Deployment of Smart Meter Systems
- Selection of Smart Meter Systems
- Customer Care and Communications

- Meter and System Certification and Acceptance
- Logistics
- Smart Meter Installation
- Data Management

MODULE (03) DEMAND-RESPONSE AND THE ADVANCED METERING INFRASTRUCTURE

- Introduction
- Demand-Response
- Advanced Metering Infrastructure
- IEEE 802.15.4, 6LoWPAN, ROLL, and RPL
- Relationship between Power Line Voltage and Communication
- Introduction to IEEE 802
- Introduction to IEEE 802.15
- IEEE 802.15.4
- Introduction to IEEE 802.15.4g Smart Utility Networks
- Introduction to 6LoWPAN
- Introduction to Ripple Routing Protocol and Routing over

- Low-Power and Lossy Networks
- IEEE 802.11
- Definition of Metering Terminology and smart Meters
- Components of smart meters and metering systems
- Types of meters and electricity measurements
- Automatic Meter Reading (AMR) systems

MODULE (04) DISTRIBUTED GENERATION AND TRANSMISSION

- Introduction
- Distributed Generation
- Distributed Control
- Many Small Generators Working with the Grid
- Distributed Generation: Back to the Future
- Photovoltaics
- The Smart Power Transmission System
- The Flexible Alternating Current Transmission System
- Wireless Power Transmission

- Wide-Area Monitoring
- Networked Control

MODULE (05) STANDARDS OVERVIEW

- Introduction
- National Institute of Standards and Technology
- International Electrotechnical Commission
- International Council on Large Electric Systems
- Institute of Electrical and Electronics Engineers
- American National Standards Institute
- International Telecommunication Union
- Electric Power Research Institute
- Other Standardization-Related Activities
- Modbus
- Power Line Carrier
- Microsoft Power and Utilities Smart Energy Reference Architecture

MODULE (06) EMBEDDED AND DISTRIBUTED INTELLIGENCE FOR A SMARTER GRID: THE ULTIMATE GOAL

- Machine Intelligence in the Grid
- Computing Models for Smart Grid
- Machine Intelligence in the Grid
- Machine-to-Machine Communication in Smart Grid
- Dedicated and shared communication channels
- Switching techniques
- Circuit switching
- Message switching
- Packet switching
- Communication channels
- Wired communication
- Optical fibre
- Radio communication
- Cellular mobile communication

- Satellite communication
- Layered architecture and protocols
- The ISO/OSI model
- TCP/IP

MODULE (07) SYNCHROPHASOR APPLICATIONS

- Introduction
- Synchrophasors
- Phasors
- Timing and Synchronization
- Synchrophasor Compression
- Phasor Measurement Unit
- Phasor Data Concentrator
- Networking Synchrophasor Information
- Synchrophasor Applications

MODULE (08) SMART METERING COMMUNICATIONS AND ANALYSIS

- Smart meters: An overview of the hardware used

- Signal acquisition
- Signal conditioning
- Analogue to digital conversion
- Computation
- Input/output
- Communication
- Communications infrastructure and protocols for smart metering
- Home-area network
- Neighbourhood area network
- Data concentrator
- Meter data management system
- Protocols for communications
- Demand-side integration
- Services provided by DSI
- Implementations of DSI
- Hardware support to DSI implementations

- Flexibility delivered by prosumers from the demand side
- System support from DSI
- Smart Metering Communications Technologies
- Smart grid communication architecture
- Smart Metering Protocols (DLMS/COSEM, Smart Energy Profile, OSGP, etc.)
- Interoperability with other Standard and protocols; MEP, M-bus, OSGP,DLMS/COSEM functionality (including demonstration)

MODULE (09) ELECTRICITY METERING TARIFF STRUCTURES, DYNAMIC PRICING AND DEMAND SIDE MANAGEMENT (DSM) STRATEGIES

- Electricity tariff structures
- Electricity customer behaviour trials
- Technology trials and pre-payment systems
- Dynamic Pricing strategies for AMI
- Top 10 myths of Dynamic Pricing
- Setting of DSM targets
- Funding DSM programmes
- DSM programme execution

- DSM regulatory incentives
- Measurement and verification protocols

MODULE (10) PEAK LOAD AND WINTER/SUMMER SCHEMES

- Reasons for peak load reduction
- Structure of peak load reduction scheme
- Reliability payments to customers
- Energy payments to customers
- Sample power system infrastructure for peak demand metering

MODULE (X) SOFTWARE APPLICATIONS

Accreditation:

BTS attendance certificate will be issued to all attendees completing a minimum of 80% of the total course duration.