Technological Innovation on Smart Grids and Renewable Energy Sources

❖ ModuleObjectives

- To understand the need for a transition from the classical power system to smart grid technology.
- To understant the technical characteristics of smart grid.
- To analyze current electricity distribution networks and associated technologies.
- To describe the new test technologies associated with smart grid technologies.
- To evaluate the new methodologies for electric energy storage systems.
- To understand the impact of information and Data Acquisition systems.

❖ LearningOutcomes

At the end of the module, students will be able to:

- Identify the critical elements of smart grids and visualize the roadmaptowards next-gen electricity networks.
- Understand modern technologies and the smart grid challenges in distribution/transmission networks.
- Evaluate technology options about renewable energy generation, energy storage, data handling and for smart grids.
- Understanding of energy storage technology:
    - Know thetesting standards of different technologies used in smart grid.
    - Know the vision and strategy for the electricity networks of the future.

❖ Module Description

This Module covers technical characteristics of the smart grid, developing smart grids for a low-carbon future, microgrids and distributed energy future. Innovative renewable energy sources,Introducing the concepts of various components of the smart grid, and smart generation (resources and potentials) including renewables energy resource (wind & solar), and energy storage systems, Substations in Smart Grids, test technologies for the smart grid, for the smart grid, Data acquisition systems for Smart Grids,Dispatching center and energy management in Smart Grids.

❖ Module Content

Chapter1: Technical Characteristics of Smart Grid

- Developing Smart Grids for a Low-Carbon Future
- Microgrids and Distributed Energy Future

Chapter 2: Innovative renewable energy sources

- Solar Energy
- Wind Power
- Geothermal Energy
- Biomass
- Water and Maritime Power

Chapter 3: Smart Generation - Resources and Potentials

- New Trends and Requirements for Electricity Generation
- Volatile Renewable Energy Sources: Wind and Sun
- Cogeneration of Heat and Power Applying RenewableEnergy Sources
    - Bio Fuel Power Plants
    - Geothermal Power Plants
    - Fuel Cells

Chapter 4: Energy Storage Systems

- Introduction to sector coupling
- Electromechanical Storage
    - Pumped Water
    - Compressed Air
    - Springs, Torsion Bars and Flywheels
    - Capacitors, Ultra capacitors, and SuperconductingCoils
- Thermal Storage
    - Sensible and Latent Heat Storage
    - Heat Losses in Thermal Storage Systems
    - Storage of ‘‘Coolness’’ to Offset the Peak Power Demand

- Chemical Storage: Batteries
    - The Electrochemical Cell
    - Commonly Used Battery Types
- Hydrogen Storage: The Hydrogen Economy
- Fuel Cells
    - High-Temperature Fuel Cells
    - Thermodynamic Losses and Fuel Cell Efficiency
- Value added Products from Hydrogen and CO2 (Power-to-Gas/Liquid/Chemicals/…)

Chapter 5: Substations in Smart Grids

- Substation Automation Architecture and Technologies
- From Smart Substations to Smart Grid
- Implementation of Smart Grids In Substation

Chapter 6: Current Test Technologies for Smart Grid

- PV panel testing
- Introduction to testing technologies for smart grid
- Application of Advanced Magnetic Sensor in Smart Grid
- Application of Fiber Optic Sensor in Smart Grid
- Innovative Test Technologies For Smart Grid

Chapter 7: Data acquisition systems for Smart Grids

- Overview of Supervisory control and data acquisition (SCADA)
- Components of SCADA systems
- Types of data and signals in the power system
- Data acquisition and processing
- Digital data acquisition
- Analog data acquisition
- Data acquisition and communication (SCADA systems)

Chapter 8: Dispatching center and energy management in Smart Grids

- Datacenter Power Management Overview

- Geographical Load Balancing
- Temporal Load Balancing
- Data Center Demand Response

❖ References

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3. Buchholz, Bernd M., and Zbigniew Styczynski. Smart grids-fundamentals and technologies in electricity networks. Vol. 396. Heidelberg: Springer, 2014.
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5. Thomas, Mini S., and John Douglas McDonald. Power system SCADA and smart grids. CRC press, 2015.
6. Liu, Xue, and Fanxin Kong. "Datacenter power management in smart grids." Foundations and Trends® in Electronic Design Automation 9.1 (2015): 1-98.
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