Program

Asignatura 1:	Distributed generation
Asignatura 2:	Generation and storage technologies
Asignatura 3:	Control techniques and renewable energy integration systems
Asignatura 4:	Power grid analysis
Asignatura 5:	Smart grids
Asignatura 6:	Standards and electric markets
	Project

Subject 1

Distributed generation

Learning Outcomes

Due to the different backgrounds of the students, in this first subject basic theory and practical knowledge about the electric energy is taught in order to unify their starting point and making it easier for them to apply later concepts. Distribution, stability and power grid quality concepts are revised as well as the effects of renewable energy into the grid. The concept of distributed generation is as well introduced..

Credits: 2

Program

1.1.- Power System Operation: Electric grid introduction. Supply guarantee and power quality. Stability. Effects of renewable energy into the grid. Boundaries of the actual grid configuration. Consumption models and patterns. Demand Side Management.

1.2.- Distributed Generation Definition: Integration in power systems. Distributed generation advantages and needs.

Subject 2

Generation and Storage technologies

Learning Outcomes

Some of the basic aspects of renewable energy generation are shown. Furthermore, storage technologies will be explained for considering their development essential for the success of distributed generation.

Credits: 4,5

Program

2.1.- Wind Power: Wind power generation profiles. Wind power generation advantages and disadvantages. Wind power generation electric features.

2.2.- Photovoltaic and Thermo-solar Power: Types of PV technologies. Building integrate PV systems. Performance indicators in PV installations (kWh/kW, Wp/m^2, ERF, IRR, etc ....). Aspects for the design of PV systems. The solar PV installation and the net metering. Best practices in integration of PV systems.

2.3.- Biomass Power: General view.

2.4.- Hydraulic Power: Hydroelectric centrals with asynchronous machine. Hydroelectric centrals with synchronous machine. Secondary regulation. Hydraulic central visit.

2.5.- Hydrogen Technologies: State of the art (generation, transport and storage). Hydrogen applications and Walqa visit.

2.6.- Power Storage: Battery types. Ultra-capacitors based energy storage systems. Flywheel.

2.7.- Electric Vehicles: EV interests. Random generation forecast corrections. EV needs according to users and grid exigencies. Dimension and security according to EV needs. Batteries and chargers. Standard UNE 61851.

Subject 3

Control techniques and renewable energy integration systems

Learning Outcomes

To study the power electronic basic concepts as a tool for highly efficient process of electric power by means of electronic states. To know the converters and electronic devices developed for the integration of renewable energies.

Credits: 5,5

Program

3.1.- AC/DC Drives Control: Introduction to basic analysis and operation techniques on power electronic systems. Basic commutation cell. Functional analysis of power converters main topologies. Power conversion schemes between electric machines and the grid. Power systems control using power converters. High power electronic converters. Tendencies, topologies and basic functional principles. Multilevel converter with 3 stages. Electronic conversion systems application to renewable energy generation systems. Basic schemes and functional advantages. Wind Power and Photovoltaic Power applications.

3.2.- Predictive direct power control of systems connected into the grid.

3.3.- Technological aspects of power electronic systems connection to the grid: PLL. Sampling effect, commutation frequency, etc. Modulation types. Dimensioning LC filters. Harmonic cancellation by modulation.

3.4.- Active Network Devices, Control and FACTS Technology: Theory and operation principle of FACTS. Implementation and FACTS technologies (Series / Shunt compensation).

3.5.- Micro-Grids: Resources evaluation and needs. Dimensioning integration systems. Optimizing integration systems. Integration systems control. Case of study: multi-generation buildings.

Subject 4

Power grid analysis and studies systems

Learning Outcomes

This subject will present the different studies to undertake in electric grids to assure a correct planning and operation.

The modelling of electric grid elements will be shown in a general way, and in a more specific way for each kind of study, that could be for steady state, dynamic or transient regimes.

The features for power supply quality will be exposed, as well as the measure and verification tools used to verify the quality levels to apply in the grid studies.

Credits: 6

Program

4.1.- Electric Systems Modelling: Modelling and simulation of electric systems introduction. Electric systems modelling for permanent regime studies. Simulation grid studies and used tools. Nodes method. Per Unit systems. Steady state simulation studies. Load flow. Line, cable, transformer, generator and load models. Short-circuit and sequence networks. Electric systems modelling for simulation in dynamic regime. Transient regime simulation studies. Transient regime electric systems modelling. Generation systems modelling.

4.2.- Power Supply Quality: Background and poor quality of electricity supply effects. Frequency variators. Slow voltage variations. Flicker voltage fluctuations. Voltage gaps and brief voltage cuts. Voltage boosts. Harmonic distortion. Voltage unbalances. Wind Power Central or MEGHA visit.

4.3.- Optimization and Grid Planning: Integral planning of primary-secondary distribution systems using mixed integer linear programming. A probabilistic methodology for distribution substation location. A linear programming methodology for the optimization of electric power-generation schemes. Grid planning, considering DG and electric vehicles.

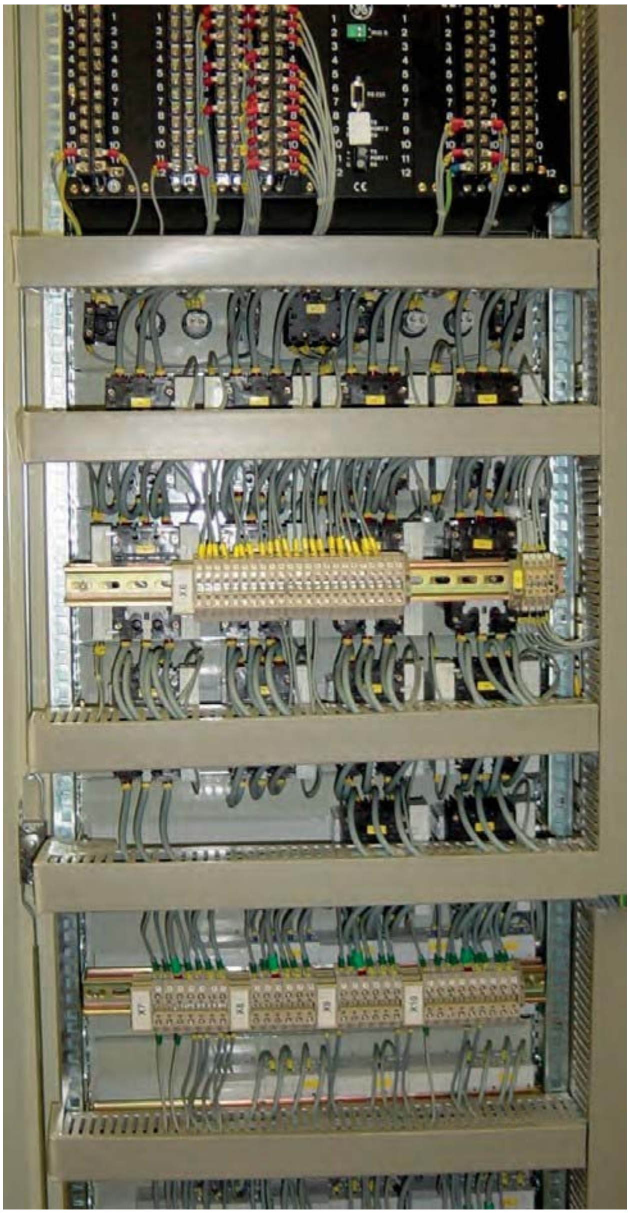
Subject 5

Smart Grids

Learning Outcomes

Provide students with knowledge in smart grids programming and protection. Present experiences will be shown as well as technologies and devices being used.

Credits: 4,5



Program

5.1.- Smart Grids Programming: Virtual Power Producer. Intelligent reconfiguration including SCADA distributed generators.

5.2.- Protective Devices: Introduction. Overcurrent protection. Distance protection. Differential protection. Protection coordination. Renewable energies protection. IEC 61850. REE control centre and RREE centre visit.

5.3.- Case of Study: Distributed Generation Protection: Distributed grids protection. Problems in distributed grids. Solutions.

5.4.- *Smart grids:* Integration of mini- and micro-generation in distribution grids. V2G integration. Control devices. IEDs. Measurement and control communications.

Subject 6

Standards and electric markets

Learning Outcomes

To know the different law and economic regulations concerning distributed generation for the deregulated markets, and to identify boundaries and opportunities in those fields.

Credits: 2,5

Program

6.1.- Electric Market: The electric sector: structures and models. Economics in distributed generation. Remuneration. Regulation comparison with other international electric markets experiences. Regulation of the electric sector impact on distributed generation. New activities regulation proposals.

6.2.- Standards: State of the art. Power supply quality generic standards. Renewable energies specific standards.

Subject 7

End of section project

Learning Outcomes

At the end of the course it will be complimentary for every student to hand in an End of Section Project.

Credits: 5

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