

## 1. United States

- a. Energy Panorama in the United States
  - U.S. energy resources
  - A look backward - how did we get here?
  - Renewable energy resources
    - Biomass
    - Geothermal
    - Hydroelectric
    - Photovoltaic
    - Thermal
    - Wind
  - Research strategies
    - Government focus
    - Industry approach
  - Energy policy issues
    - US resource utilization
    - Climate change
    - Emerging market sector - nanomanufacturing
  - Visions of the future - 2020 and beyond
- b. Resource materials
  - US Department of Energy studies on energy resources, research strategies
  - Energy policy
    - Federal and local issues
    - Special interest groups
    - Other

## 2. Energy policy in Navarre

- a. Situation of the energy sector in Navarre, Spain.
  - Fuels used.
  - Balance of final energy
  - Fuel consumption
  - Energy sources used
  - Degree of energy dependence
  - Changes that have occurred
- b. Energy policy since 1990:
  - Resource evaluation
  - Measuring sun and wind parameters
  - Biomass potential study
  - Study of hydroelectricity in Navarre
  - Energy savings and efficiency
  - Energy audits
  - Aid available for investment in energy savings
  - Energy infrastructures: Oil products and natural gas

- c. Development of renewable energies. History
  - Wind power development start
  - Wind power plan and expansion in Navarre
  - Photovoltaic solar power development
  - CENER Foundation
  - CENIFER: Renewable Energies Training Centre.

### 3. Wind power:

- Origin of Wind
  - Global Winds
  - Local Winds
- Wind Resource
  - Measurement, methods and measured parameters.
  - Wind measurement equipment.
  - Wind Resource Assessment.
  - Evaluation of the wind energy.
  - Main parameters for a wind farm site assessment.
  - Wind Atlas.
- Wind Farms
  - Wind farm planning and design.
  - Wind farm site search criteria.
  - Choosing the suitable wind turbine for a wind farm site.
  - Impacts of a Wind Farm.
  - Standards and best practice guidelines.
  - Bibliography and word glossary.
- Wind Turbine Generators
  - Brief history of wind turbines and development.
  - Types of wind turbines.
  - State of the art wind turbines and Evolution.
  - The power curve. Energy produced by a wind turbine.
  - Wind turbine components: Mechanical and Electrical.
  - Wind farm planning and design.
- Systems of regulation and control
  - Power and speed control
  - Guidance systems
- Sustainability and environment:
  - Environmental and socioeconomic aspects
  - Operation and maintenance of wind farms
- Wind Turbine standards
- Brief introduction to offshore wind farms.

#### 4. Geothermal power:

- Introduction:
- General characteristics.
- What is a heat pump?.
- Heating and cooling with radiant surfaces.
- C.O.P variation.
- Selecting and Installing a heat pump.
- Benefits of using geothermal energy.
- High temperature, geothermal energy.
- Low temperature, geothermal energy.
- Types and examples of installations.
  - Ground exchanger.
    - Horizontal.
    - Vertical.
  - Inside installation.
    - Heat pump.
    - Piping.
    - Regulation.
    - Maintenance.
- Practical example.
  - Initial data.
  - Different options.
  - Evaluation of the selected option

#### 5. Biomass:

- Introduction:
  - What is biomass?.
  - Global Carbon Cycle.
  - Why use biomass?.
  - General characteristics.
  - Benefits of using biomass.
- Types of biomass and evaluation of sources.
- Solid biomass.
  - Pellets, Wood Chips, Dry waste from industry, etc.
  - Definition.
  - Prime materials on producing solid and dry biomass.
  - Applications.
  - Main characteristics.
- Liquid Biomass.
  - Biodiesel.
  - Bioetanol.
  - Definition.
  - Prime materials on producing solid liquid biomass.
  - General characteristics in this industry and process.
  - Applications.
  - Main characteristics.

- Biogas.

- Biogas.
  - Definition.
  - Prime materials and sources on producing biomass gas.
  - Applications.
  - Main characteristics.
- Forest biomass.
  - Field operations.
  - Sustainable use of forest biomass.
  - Transforming forest biomass.
- Agricultural biomass.
  - Farming biomass.
  - Different possibilities.
- Food industry biomass.
  - Waste biomass.
  - Urban solid waste.
  - Other kinds of waste.
- Technology of changing biomass into energy.
  - Introduction.
  - General characteristics.
  - Technology of direct combustion
  - Equipments and process.
  - Boilers.
  - Biomass into energy Technology.
    - Gasification.
    - Biofuels.
    - Ethanol.
    - Biodiesel.
    - Combustion and Co-combustion.
    - Biogas.
- Heat generation.
  - Technologies of combustion.
- Electricity generation.
- Organic Rankine Cycle.
- ORC.
- Technology of gasification and subsequent combustion.
  - Equipments and process.
  - Digestors.
  - Heat generation.
  - Electricity generation.
  - External combustion engine.
  - Stirling Engine.
- Technology of co - combustion.
- Practical example.
  - Initial data.
  - Biomass source.
  - Different options.
  - Evaluation of the selected option

## 6. Mini-hydroelectric plants: Technology, uses and applications

- Introduction
- Hydroelectric Power in the world.
- Examples.
- Characteristics of hydroelectric energy
- Types of mini-hydroelectric plants
- Design of a hydroelectric plant
- Civil engineering installations
- Electromechanical equipment
- Economic, administrative and environmental factors
- Advantages of mini-hydroelectric plants: Environmental and socioeconomic benefits

## 7. Photovoltaic solar power:

- Introduction
- Basic Concepts and elements
  - DC and AC voltage
  - Voltage and Current sources
  - Basic Electronic Components
- General concepts of Power Electronics
- Power Semiconductors
- DC-DC Converters
- DC-AC Converters.
- Converter Stage on Photovoltaic Systems
  - Inverter topologies for grid-tie Photovoltaic Systems.
  - Inverter topologies for Stand-alone Photovoltaic Systems.
- Solar radiation
- Solar Cell and Photovoltaic Module
- Operation Principles

## 8. Thermal solar power:

- Solar thermal sensors: Types and characteristics
- Components of a thermal installation: Operating scheme
- Applications for ACS and air conditioning