Generation & Transmission of Electricity

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Electric generation is the first process in generating electric power from primary energy sources.

Electricity is most often generated at a power plant by electromechanical generators, primarily driven by heat engines fueled by combustion or nuclear fission but also by other means such as the kinetic energy of flowing water and wind. Other energy sources include solar photovoltaics and geothermal power.

Each type of generation has a portfolio that provides companies with information on how much capacity each type can generate.
TYPES OF GENERATION

- Coal: Favorite among U.S utilities. Most coal fired generation uses steam turbine technology. Range from 250 – 1500 MW
- Nuclear: Range from 600 to over 1200 MW. No new units have been brought online since 1996.
- Natural Gas: High percentage of generation are being built. Range from 1 MW to over 500 MW
- Hydro: Backbone of many electric generation. 100 KW to 500 MW. Good at managing peak loads and power regulation purposes.
- Fuel Oil: Usually seen in regions where natural gas supply is limited, or utilities have the capability of fuel oil generation.
- Renewables: Includes: Biomass, geothermal, hydro, solar, wave and wind
COAL

- Low cost
- Ranges from 250 – 1500 MW
- Capital cost for these units are high.
- O & M are low
- Limited operational flexibility
- High environmental impact
- High transportation cost.
NUCLEAR

- Range from 600 to 1,200 MW.
- Capital cost are high
- Maintenance
- Used as baseload
- Issues involve disposal for fuel and risk for major nuclear accidents or terrorist attacks.
- No new units have been created.
NATURAL GAS

- High percentage of generation build in the U.S.
- Range from small 1 MW to 500 MW.
- Uses fuel on site cogeneration unit and back up generators.
- Capital cost is fairly low
- O & M are low.
- The market value determines the price of the fuel.
- Operationally flexible depending on which technology is used.
HYDRO

- Backbone of many generations.
- Range from 100 kW to 500 MW
- Capital cost are mediocre.
- O&M cost are low and no fuel cost since water is the main source of fuel.
- Operationally flexible – Can manage peak loads
RENEWABLES

- Amount of energy varies depend on the technology
- Varies per technology for capital cost – technically high for things like solar and wind.
- O & M varies as well
- No on-going fuel cost (wind and solar)
- Little to non environmental
DISTRIBUTED GENERATION

- Employs small-scale technology to produce electricity close to the end use of the power.
- Consists of generators driven by gas or internal combustion engines
- Distributed generation has two levels: Local level and end point level
- Local level: involves renewable energy technology. They are more energy, cost efficient and more reliable.
- End point level: Uses internal combustion engine. Can operate as isolated island of electric energy production.
ELECTRIC GENERATION CONCERNS

• Concerns involving environmental impact with generation.
• Air pollution, gas emission, ecosystem and land disruption are occurred.
• Location surrounding by electric generation are concerned about acid rain, smog, health issue, radiation and global warming.
Operators must match generation output demand instantaneously across the day since they have limited economic means of storing energy.

Storing electricity helps balance fluctuations in electricity supply and demand is to store electricity during periods of relatively high production and low demand then it get release it back to the grid during periods of lower production.
LOAD CURVE

• Understanding the load curve is crucial for generation because it shows which generation unit are dispatched at what times.
• Generation units are typically scheduled hourly based on least cost supply.
• Separated into 3 categories: Baseload, intermediate and peaking
FUTURE GENERATION
What is transmission?
Transmission is the movement of large amounts of electricity over long distances.
Typically larger than 60kV.
It can carry AC or DC, but not both.

In US, AC is transmitted over the lines because it is more stable and has low cost of maintenance and repair.
How do we transmit electricity using transmission lines?
Operation and Planning
Operation and planning depends on the **customers demand** and the **electricity generation resource**.

How much **capacity** the transmission line can handle depends on:-

1) Thermal Constraint
2) Voltage Constraint
3) System Operating Constraint
Cost
Main cost is the **manufacturing cost**:-

1) $130,000/mile for a 115kV line
2) $500,000/mile for a 230kV line
3) $1,000,000/mile for 345+ kV line

For underground transmission lines the cost may go up 10 times.

**Secondary cost** is seen as the **maintenance cost**.
Construction Issues
Public opposition:-

1) Land use issues
2) Impact on property value
3) Environmental issues
4) Electro Magnetic Field (EMF) threat

Regulatory issues:-

1) Plan for recovery of costs and profits in the electric rates
2) How projects that cross state line can be effectively planned?
3) Construction permits
The U.S. Power Grid
Federal Energy Regulatory Commission

- Regulates the **transmission** and **wholesale sales of electricity** in interstate commerce
- Regulates the transmission and sale of natural gas for resale in interstate commerce
- Reviews the siting application for electric transmission projects under limited circumstances
- Protects the **reliability** of the **high voltage interstate transmission** system through mandatory reliability standards
- **Monitors** and **investigates** energy markets
Transmission Line Ownership for Arizona
• Arizona Public Services
• Salt River Project
• Southwest Transmission Cooperative
• Tucson Electric Power
• Western Area Power Administration
Future Scope
Visualization and monitoring:-
1) Phase Measurement Units (PMU)

Power quality and flow control devices:-
1) Flexible AC Transmission Systems (FACTS)
2) Phase Angel Regulators (PAR)
3) Static Variable Compensators (SVC)

Substation automation and monitoring:-
1) Intelligent Electronic Devices (IED)
2) Remote Terminal Units (RTU)
3) Programable Logic Controllers (PLC)
Thank you!!