Amirkabir Univ. of Technology
(Tehran Polytechnic)
Graduate School

A Course on

Energy Planning

(Section-8)

M.S. Program
Power and Energy Management Division
Department of Electrical Engineering

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Integrating Supply and Demand Sides

- **An integrated resource planning (IRP) process brings together, on a common basis of comparison, programs for energy efficiency and load management with options for electricity supply, including both utility and non-utility sources.**
- **Utility sources: Power generation from various energy resources such as gas, nuclear, coal, etc.**
- **Non-utility resource: Materials and processes required.**
- **Example: Combined cycle power plants with higher efficiency use less energy input (gas as utility source) and less materials and processes (non-utility sources) to provide same amount of electricity, as compared with conventional gas and steam power plants.**

Integrating Supply and Demand Sides

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- Ideally, the basis of comparison should have a societal perspective and should include environmental and social costs.
- This part of course explains how IRP can be used to bring new elements such as energy efficiency programs and environmental constraints into electricity supply planning.

Fundamentals of Electric Power Planning

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- It is useful to begin with a brief description of the type of planning process into which IRP would be "integrated," and to define some of the terms that will be used throughout the rest of this study.

- The traditional electric planning model includes:
  - 1. Projections of demand growth
  - 2. Expansion planning to determine available resources and when they are needed
  - 3. Production-cost analysis to rank supply-options by cost
  - 4. Calculation of required revenues and rates

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- The principal goal of traditional power planning is to meet the projected demand for electricity at the least-cost.
- This goal is modified in the IRP context to meet the demand for energy services, which allows for the inclusion of DSM and energy efficiency programs.
- In other words, under IRP, if it is cheaper to meet the demand for energy services by improving energy efficiency rather than by building additional supply capacity, then the energy efficiency resource would be selected.

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- **In both traditional utility planning and in IRP, expansion planning analysis is used to determine the least-cost plan for increasing the power supply capacity.**

- **The main cost criterion in expansion planning is the revenue requirements, which must be sufficient to cover all utility costs and an acceptable return to investors.**

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- **Although costs of past investments contribute to revenue requirements, they cannot be reversed, so the planning process should concentrate on being forward-looking to minimize future investments.**

- **These future investments should be discounted to their present worth to reflect the time value of money, and they should be compared according to their long-run marginal costs.**

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- Because different resources are available in different (and often quite large) size-increments, the marginal costs are usually normalized for comparison on the basis of the marginal cost of energy ($/kWh) or marginal cost of capacity ($/kW).

- The ratio between the marginal costs of energy and capacity depends on the extent to which a resource runs at full capacity, reflected by the capacity factor.

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- This is related to the load factor, which measures the variability of demand and can be estimated from the load-duration curve.

- All of these concepts are applicable in both traditional planning and IRP processes.

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- **Knowing the marginal costs as a function of capacity factor or load factor, the planner can screen the potential supply options to determine the least-cost expansion plan that meets the projected demand.**
- **Of course, this plan must be periodically reviewed and updated as more information about demand growth and supply resources and costs becomes available.**

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- **In addition to the conventional thermal and hydroelectric power supply options, the IRP process can include options such as DSM, supply-side loss reductions, utility of heat and power, and intermittent renewable resources (solar, wind, etc.).**

- **The fundamental comparison between these options is generally made on the basis of the (long-run) marginal cost of energy, although other measures will be presented as well.**

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- **While the long-run marginal cost governs the planning of new resources, the choice of which existing resources to operate, or dispatch, at a given time depends on short-run marginal costs (variable costs for fuel, operations and maintenance).**

- **A traditional economic dispatch strategy ranks supply resources by variable costs to determine the dispatch order.**

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- The most expensive source operating at a given time is the marginal resource, and this varies with the system load.
- Another approach is environmental dispatch, which considers the emissions from available sources and ranks them according to a combination of cost and emission rates, depending on how the pollution is valued.
- In IRP, the environmental impacts can also be used to rank new supply resources according to the cost of avoided emissions, or by adding emission charges or externality values to the economic cost values.

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- To establish electricity rates (tariffs) requires the summation of present revenue requirements and the allocation of these costs to the electricity sales in each customer category.
- In traditional power planning, the least-cost plan should also have the lowest tariffs.
- In IRP, however, the extensive use of DSM can increase tariffs while decreasing total costs.

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- **In other words, with a cost-effective DSM plan, electricity rates might increase on a per-kWh basis, but electricity bills should decline because the reduction in energy consumption would more than compensate for the increase in the per-kWh price.**
- **All of the concepts introduced here are explained more fully in the following sections.**