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Load Forecasting of Electrical Network

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Load Forecasting

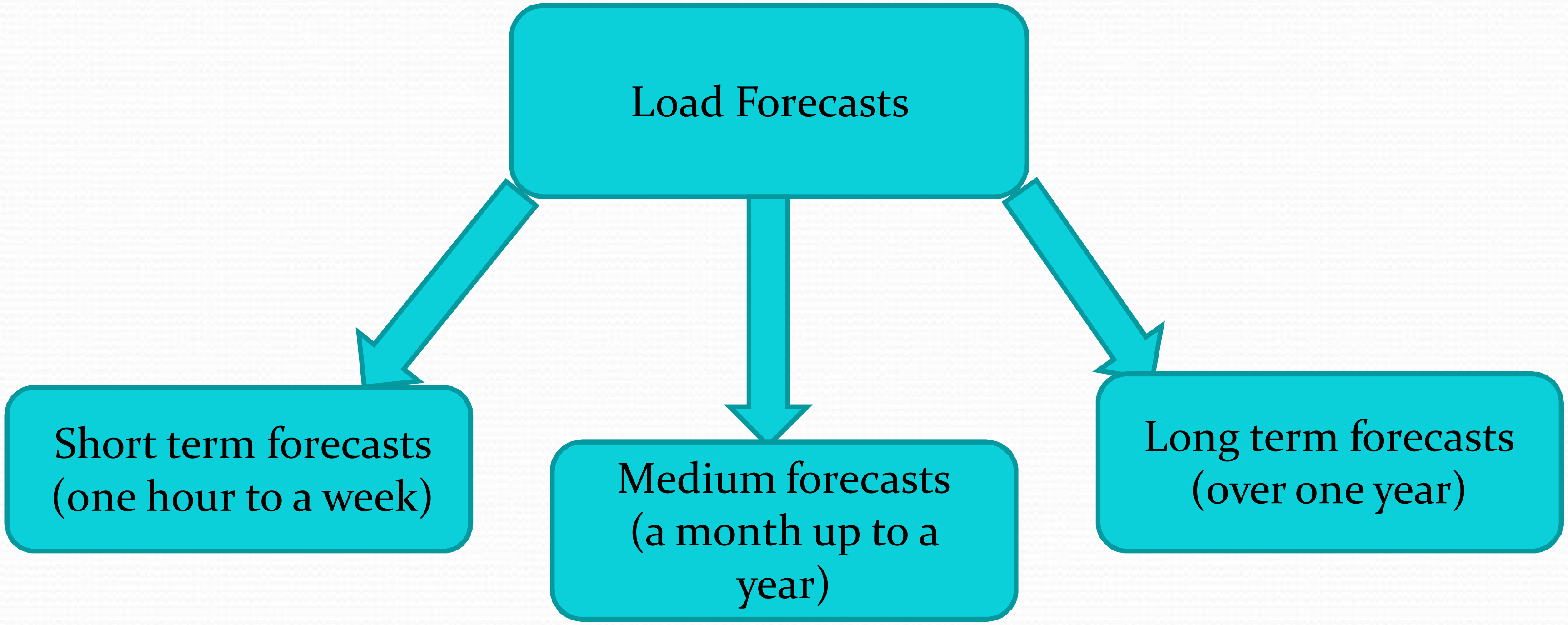
1- Introduction:

- Load forecasting has always been important for planning and operational decision conducted by utility companies.
- With supply and demand fluctuating and the changes of weather conditions and energy prices increasing by a factor of ten or more during peak situations , load forecasting is vitally important for utilities can help to estimate load flows and to make decisions that can prevent overloading.
- Timely implementations of such decisions lead to the improvement of network reliability and to the reduced occurrences of equipment failures and

Importance of Load Forecasting in Deregulated Markets :.

1-Purchasing, generation, sales
2-Contracts
3-Load switching
4-Area planning
5-Infrastructure development/capital expenditure decision making

2- Types of Forecasting :.



3- Factors for accurate forecasts

The accuracy of load forecasting depends not only on the load forecasting techniques, but also on the accuracy of forecasted weather scenarios.

A. ***Weather influence***
B. Time factors
C. Customer classes

A .Weather Influence

Electric load has an obvious correlation to weather. The most important variables responsible in load changes are:

1) Dry and wet bulb temperature
2) Dew point
3) Humidity
4) Wind Speed / Wind Direction
5) Sky Cover
6) Sunshine

B) Time factors :.

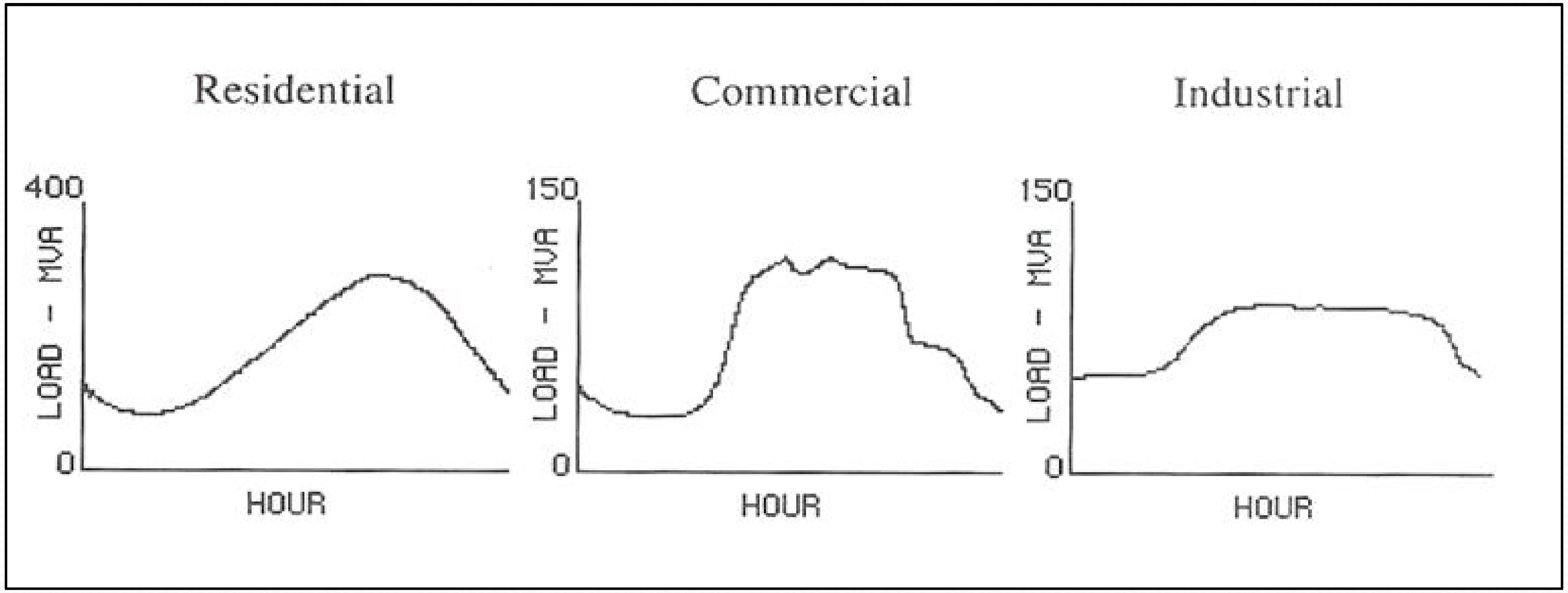
In the forecasting model, we should also consider time factors such as:

- The time of the year
- The day of the week
- The hour of the day
- Holidays

C)Customer Class:

Electric utilities usually serve different types of customers such as residential, commercial, and industrial. The following graphs show the load behavior in the above classes by showing the amount of peak load per customer, and the total energy.

Load Curves:



Residential
400
LOAD - MVA
0
HOUR
Commercial
150
LOAD - MVA
0
HOUR
Industrial
150
LOAD - MVA
0
HOUR

4) Mathematical Methods:

1- Medium- and long-term forecasting: End-use and Econometric approach.
2- Short-term forecasting: Similar day approach, Regression models ,Time series, Neural networks, Expert systems, Fuzzy logic, and Statistical learning algorithms.

Statistical approach:

Statistical approaches usually require a mathematical model that represents load as function of different factors such as time , weather, and customer class. The two important categories of such mathematical models are: additive models and multiplicative models.

Additive models:

L= Ln+Lw+Ls+Lr

where L: is the total load,

Ln: represents the "normal" part of the load, which is a set of standardized load shapes for each "type" of day that has been identified as occurring throughout the year,

Lw: represents the weather sensitive part of the load,

Ls: is a special event component that create a substantial deviation from the usual load pattern,

Lr: is a completely random term, the noise.

Multiplicative models:

L = Ln .Fw .Fs .Fr

- Where Ln: is the normal (base) load and the correction factors Fw, Fs, and Fr are positive numbers that can increase or decrease the overall load.
- These corrections are based on current weather (Fw), special events (Fs),
- random fluctuation (Fr).
- Factors such as electricity pricing (Fp) and load growth (Fg) can also be included.

Medium-Long Term Forecasting:

End-use approach:

* Directly estimates energy consumption.
* Descriptions of appliances used by customers, the sizes of the houses, the age of equipment, technology changes, customer behavior, and population.

•Focus on the various uses of electricity in the residential, commercial, and industrial sector.

* Explain energy demand as a function of the number of appliances in the market.
* Requires less historical data but more information about customers and their equipment.

Econometric models:

* Combines economic theory and statistical techniques for forecasting electricity demand.
* The relationships are estimated by the least-squares method or time series methods.
* Economic factors such as weather.

Short Term Forecasting:

A large variety of statistical and artificial intelligence techniques have been developed for short-term load forecasting.

1-Similar-day approach:

* This approach is based on searching historical data for days within one, two, or three years with similar characteristics to the forecast day. Similar characteristics include weather, day of the week, and the date.
* The load of a similar day is the trend coefficients can be used for similar days in the previous years.

2-Regression methods:

* Regression is the one of most widely used statistical techniques.
* regression methods are usually used to model the relationship of load consumption and other factors such as weather, day type, and customer class.

3-Time series:

Time series methods are based on the assumption that

*the data have an internal structure, such as autocorrelation, trend, or seasonal variation.

*Time series forecasting methods detect and explore such a structure. Time series have been used for decades in such fields as economics, digital signal processing, as well as electric load forecasting.

*In particular, ARMA (autoregressive moving average), ARIMA (autoregressive integrated moving average), ARMAX (autoregressive moving average with exogenous variables), and ARIMAX (autoregressive integrated moving average with exogenous variables) are the most often used classical time series methods. ARMA models are usually used for stationary processes while ARIMA is an extension of ARMA to stationary processes.

*ARMA and ARIMA use the time and load as the only input parameters.

*Since load generally depends on the weather and time of the day, ARIMAX is the most natural tool for load forecasting among the classical time series models.

4-Neural networks (ANN or simply NN): since1990

*The use of artificial neural networks (ANN or simply NN) has been a widely studied electric load forecasting technique since 1990 Neural networks are essentially non-linear circuits that have the demonstrated capability to do non-linear curve fitting.

*The outputs of an artificial neural network are some linear or nonlinear mathematical function of its inputs. The inputs may be the outputs of other network elements as well as actual network inputs. In practice network elements are arranged in a relatively small number of connected layers of elements between network inputs and outputs. Feedback paths are sometimes used.

Thank you for Listening