Overview

- Understanding electric load patterns
  - Aggregating loads
  - Categories of consumption
  - Sector (C, I, R) and appliance load patterns
- Load duration curve
  - Coincident peak
  - A ‘cumulative distribution function’
- Load management

Chronological Load Data - handout

- What is the load shape for one day with the following hourly load levels (in MW)?
- 12, 9, 8, 9, 10, 11, 12, 15, 20, 25, 27, 24, 22, 20, 22, 24, 25, 26, 23, 28, 20, 15

Load Duration Curve - handout

- Plot as a ‘cumulative distribution function’
- How is this version more helpful?
Basic Load Graph: Load Duration Curve (LDC)

- Given time series demand (load) data – represented as an LDC:
- How many hours does the building consume:
  - 8 MW?
  - 17 MW?
  - 25 MW?
- Why are these questions important?

Discussion: Electrical Consumption

- What are the categories of different types of consumers?
- What does each group use electricity for?
- Where/for what is the largest category of electricity consumption?

Electricity End-Use

[Pie chart showing electricity end-use in office buildings]

Cite: DOE EIA

Commercial/Industrial End-Use

[Pie chart showing commercial/industrial end-use]

Cite: Canadian Gov't, NRCAN
Time Series Consumption

- Think about electricity use over a 24 hour time period.
- For each category of consumer, when does their demand increase and when would it decrease?

See excel file on loadshapes_to_display.xls
Aggregating Load

Coincident Peak – Hand out

• Given the following 5 minute electrical demands, for three homes
  – When does the coincident peak occur?
  – What is the significance of the coincident peak?

Coincident Peak

Coincident Peak
Coincident Peak

Weekly Load Pattern

Annual Load Pattern

Annual Load Pattern

Fig. 1. Annual electric load curve
Load Duration Curve

• Load duration curves are profiles of system demand for specified periods of time (e.g., annual)
  – Graphed as a histogram, a CDF
  – Not graphed chronologically
• System load is plotted
  – x-axis: descending order of MW magnitude
  – y-axis: increasing number of hours
  – The curve indicates the number of hours load is above a given MW magnitude.

Creating an LDC from Hourly Data

Chronological Load Data

• What is the load duration for one day with the following hourly load levels (in MW)?
  • 12, 9, 8, 9, 10, 11, 12, 15, 20, 25, 27, 24, 22, 20, 22, 24, 25, 26, 23, 28, 20, 15

Load Duration Curve

• What is the load duration for one day with the following hourly load levels (in MW)?
  • 12, 9, 8, 9, 10, 11, 12, 15, 20, 25, 27, 24, 22, 20, 22, 24, 25, 26, 23, 28, 20, 15
Question: Load Duration Curve

- The two most basic pieces of information on an LDC are...?
  - System peak load level
    - A CAPACITY value, e.g., power
  - Total system energy demand
    - An energy value
- Where are these pieces of data displayed on the LDC?

Load Level Definitions

- Daily, Weekly and Seasonally
- Three typical “load level” identifications
  - These are relative values, not absolute
  - Peak: Intermediate: Base load
    - Sometimes see: super-peak, critical-peak...
- Where might these levels be on the next slide?
The power system load is typically divided into 3 categories:
1. Base-load (duration time 8760 hours)
2. Intermediate load (duration time from 2000 to 8760 hours)
3. Peak-load (duration time up to 2000 hours)

Each of these three categories represents a different type of generating technology
- Which characteristics are desirable for each type of generating technology?

Four types of load management are
- Peak shaving, peak shifting
- Energy conservation and efficiency

What are these programs? What are their benefits?
How would these be represented using the LDC?

Sketch an LDC and then sketch changes to the LDC if:
1) Baseload generation/demand is decreased by 10%
2) Intermediate generation/demand is decreased by 10%
3) Peaking gen/load is decreased by 10%
4) The top 20MW of peak is shifted to the intermediate load hours
Load Duration Curve

Future LDC Questions
- What if wind displaces 5% of baseload and 5% of intermediate generation, but does not generate at all during system peak load hours?
- For the same options on the previous slide
  - What is the change to total system energy demand
  - What is the change to system fossil fuel usage
  - What is the change to system capacity needs
- How do we achieve these decreases?

Future: System Design Issues
- How do you define “the grid?”
  - Characteristics
  - Pros and cons
- How would you characterize electricity demand?
  - What terms are used?
  - What do you need to know to understand electricity demand?
    - Individual? Regional?

Summary
- Aggregating load
  - Benefits
- Load duration curve, LDC
  - What it is and how you construct one
    - *Energy and capacity information*
  - Peak, intermediate and baseload categories
  - Representing demand management programs