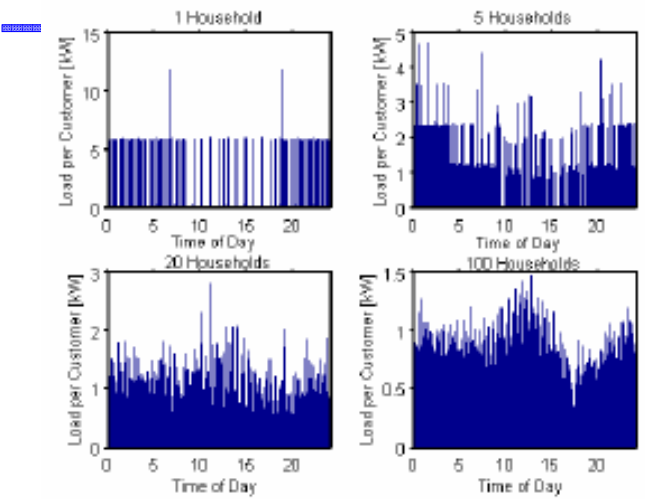


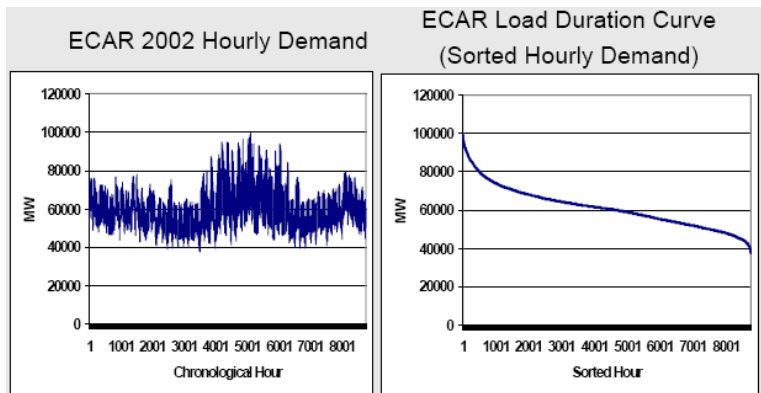
Overview

- Load duration curve recap
- Load management
- Production cost models
 - What they are
 - How they are used
 - Inputs and outputs
 - System planning

Aggregating Load



Creating an LDC from Hourly Data



Load Management

- Question 2 ...
- Three types of load management are “peak shaving,” “peak shifting” and “energy conservation.”
- What are these programs? What are their benefits?
- How would these be represented on the LDC?

5

More LDC Questions

- Sketch an LDC and then sketch changes to the LDC if:
 - Baseload generation is decreased by 10%
 - Intermediate generation is decreased by 10%
 - Peaking generation is decreased by 10%
 - The top 20MW of peak is shifted to the intermediate load hours
 - Wind displaces 5% of baseload and 5% of intermediate generation, but does not generate at all during system peak load hours₆

More LDC Questions

- 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
- What happens to the LDC if a generator is added or removed from the system?
- How are total system emissions effected by any of the above changes?

7

System Planning & Operations Production-Cost Models

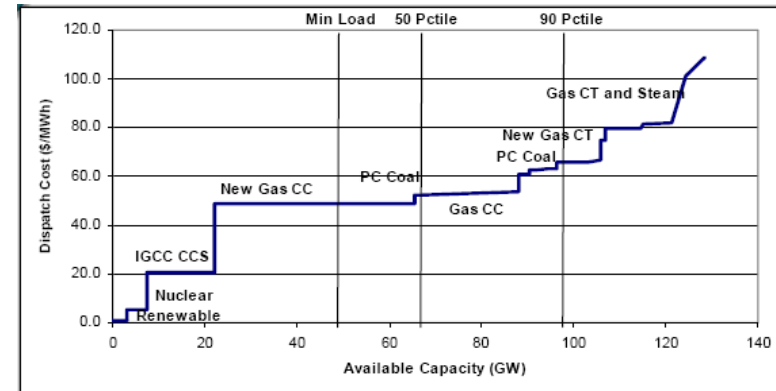
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System Planning

- How do we decide...
 - Which type of generating plant to build?
 - How much capacity of each type?
 - “The **technology mix**” is decided using a production cost model
- And also, how do we decide...
 - When to use these different plants to actually generate?
 - Economic dispatch model (linear programming) – Next week

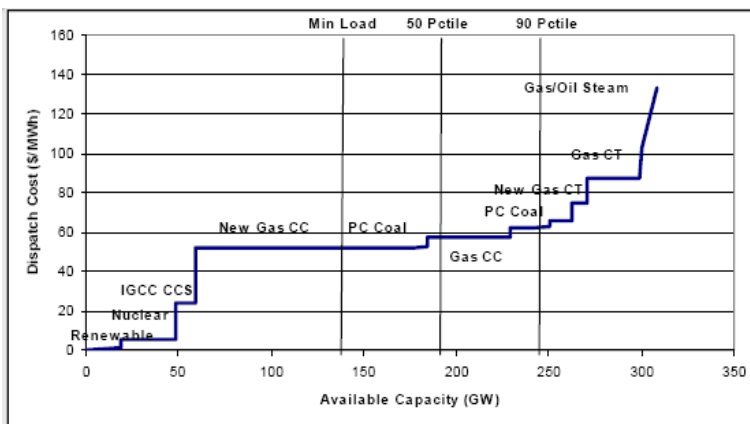
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Example: ERCOT Electric Supply Curve – Technology Mix



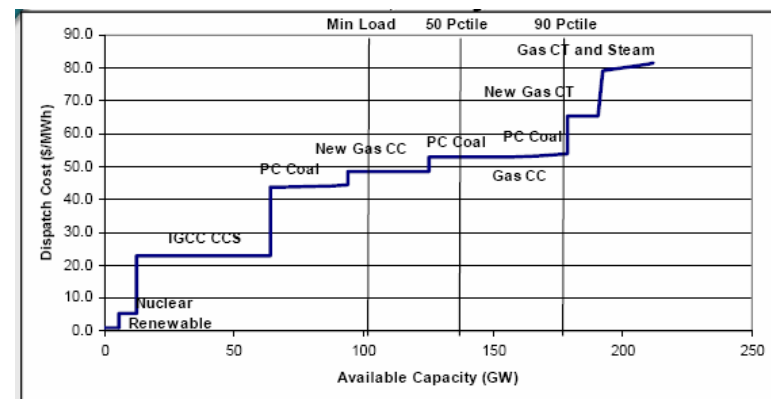
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Example: SERC Electric Supply Curve



11

Example: ECAR Electric Supply Curve



12

Analysis Tool: the Screening Curve

- The screening curve compares the costs of different technologies
- Two generating plant cost components plotted
 - Fixed, or capital cost
 - Variable or O&M costs (operating & maintenance)

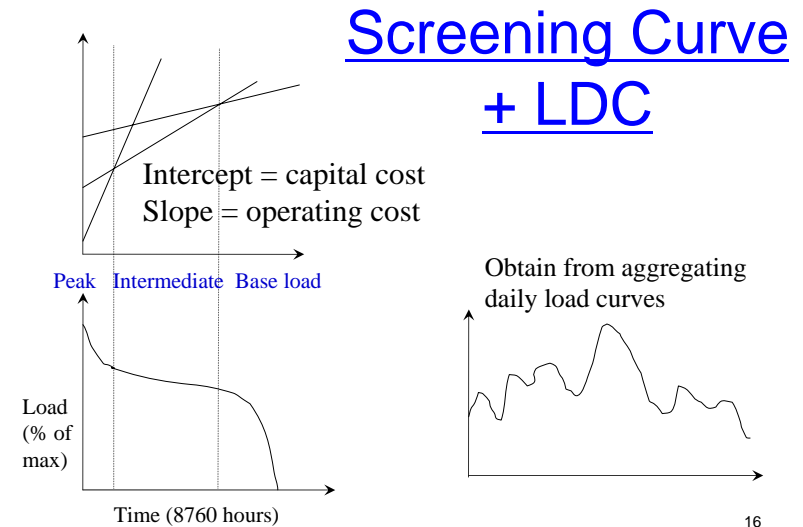
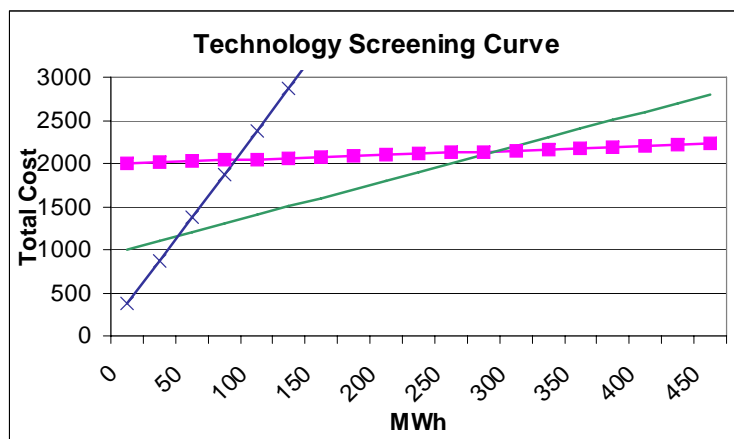
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The LDC & the Screening Curve

- A load duration curve specifies the nature of electrical demand in any system
- A screening curve compares the technologies available to meet that demand
- Combining these tools helps planners determine the best “technology mix”
- Activity...

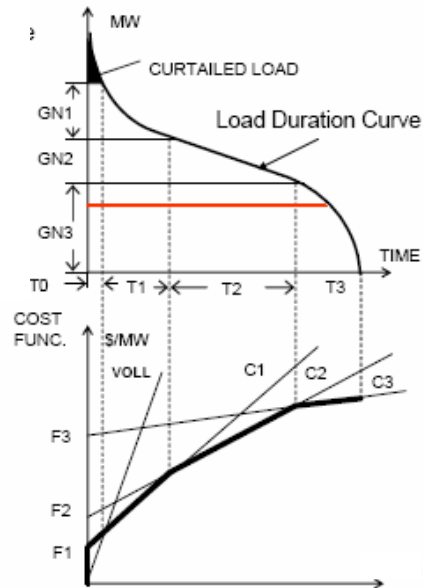
14

Sample Screening Curve



16

Determining Optimal Technology Mix



Production Cost Models

- A computer model to perform the task of the LDC + Screening curve
 - More complex input and output than the hand calculation
- Uses?
- Input data?
- Output information?

18

Load Management Programs

- Regulatory & Industry driven
 - DSM: Demand-side management
 - Conservation
 - Energy star..., purchasing efficient appliances based on rebates and/or penalties
- Market driven
 - Demand response – responding to ___?
 - Conservation based on price
 - Purchasing efficient appliances based on price

19

Using Production Cost Models

- How are load management programs modeled in the production cost model?
 - By adjusting the LDC
- How are environmental technologies modeled?
- What type of information is *not* provided as output from a production cost model?
 - Societal concerns, equity,
 - Transmission system expansion

20

Complex System Analysis

- Divide the full system into smaller sub-systems
- In power systems we can analyze...
 - By system sector: generation, transmission, distribution, customer...
 - By geographic region
 - **By time scale**
 - **Time scale separation of events**
 - By analysis question
 - Cost, environmental impacts...

21

Time Scale Separation

1. Decide what to build
2. Decide which plants to have warmed up and ready to go this month
3. Decide which plants to use to meet the expected load today, the next hour...
4. Decide how to maintain the supply and demand balance cycle to cycle (~17msec per cycle)

22

Time Scale Separation

- Long term system planning: Production cost
 - Decide what to build
- Hourly to monthly decisions: Unit commitment
 - Decide which plants to have warmed up and ready to go
 - Different technologies have different requirements
- Minutes to Hour: Economic dispatch
 - Decide which plants to use to meet the expected load now
 - 5 minutes to 1 hour
- Cycles to Minutes: Short term system operations and Load Flow Model
 - Maintain supply and demand balance moment to moment
 - ~17msec per cycle up to 5 minute control functions

23

Summary

- Understanding electrical load
- Analysis tools
 - Load duration curve
 - Technology screen curve
 - Production cost model
- System planning & operation
 - Operating at minimum cost to meet demand
 - Decide the optimal technology mix
 - Minimize emissions

24