

ECE 444 / ECE 544 /
CS 444 / CS 544

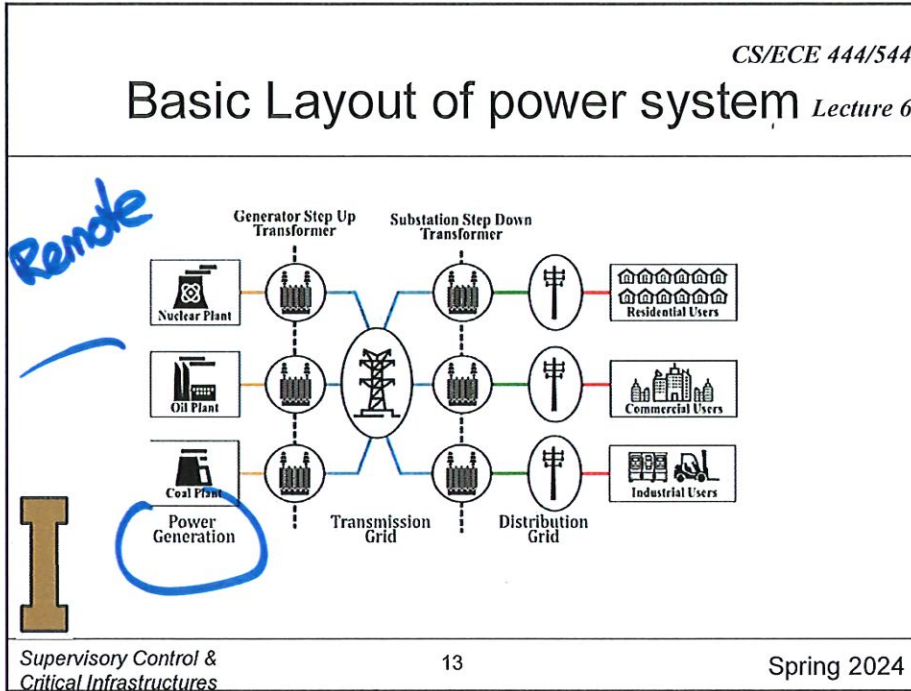
Supervisory Control and Critical Infrastructure Systems

Session 8

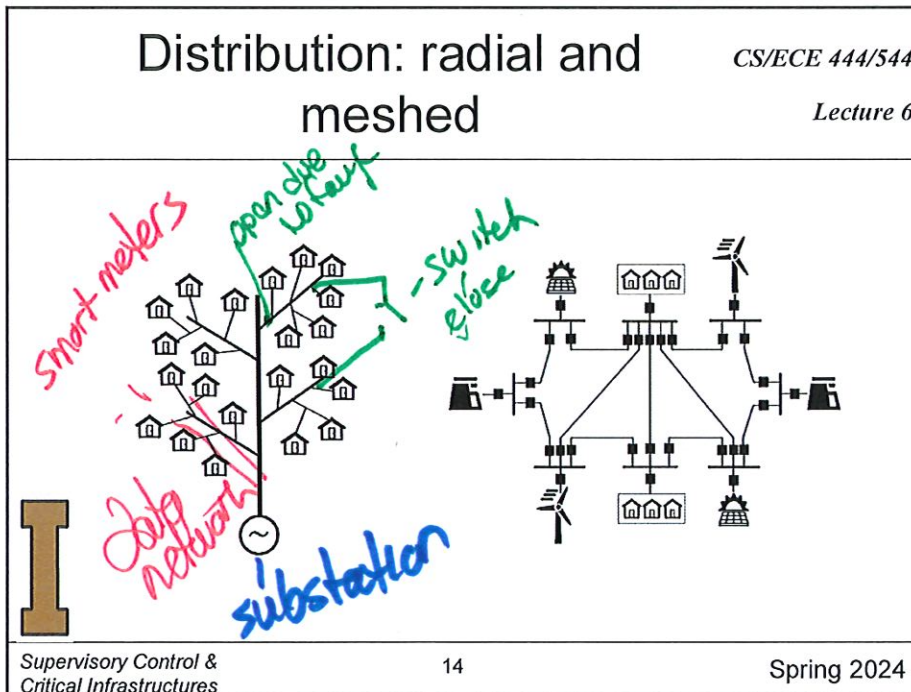
Handwritten blue scribble at the top of the page.

Handwritten blue text: 1/6, 8, 7

Handwritten blue notes: Remde, Wind, PV



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14

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What is the objective of the power System?

- Transfer power from generation to end users
- Balance generation and load
 - Load varies
 - Variable generation sources - wind, photovoltaic } forecasts

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Performance Expectations

- Maintain frequency to tight tolerance
- Maintain voltage magnitude
- Reliability
 - So successful that taken for granted
- Low cost/losses
 - Others...

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What is the objective of the power System? CS/ECE 444/544
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Performance Expectations CS/ECE 444/544
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- Frequency maintained to tight tolerance
- Voltage magnitude
- Reliability
- Low costs

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- EMISSIONS/pollution

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HISTORICAL POWER SYSTEM ARCHITECTURE

- same company owned generation, transmission + distribution
- regulated monopoly
- provided efficiencies + reliability
- Deregulate - reregulate.

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TECHNOLOGY CHANGES

- communication technology
 - supervisory control (SCADA)
 - running system closer to limits
- computing technology
 - more accurate planning studies
 - automation

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control actions too fast for human.

- Power Electronics

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WHAT IS CONTROLLED? AND HOW?

- Generators owned by utilities
 - Power output
 - voltage/reactive power
- voltage control devices
- Demand response

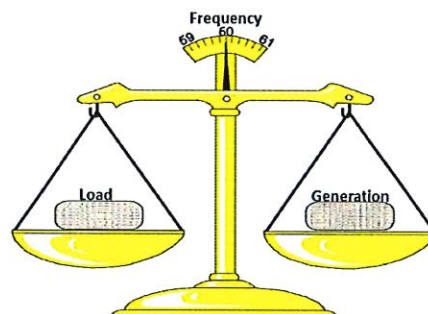


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FREQUENCY INDICATES ENERGY BALANCE



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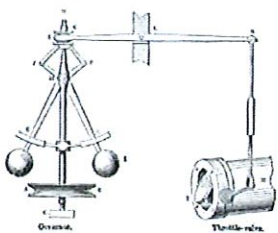
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GENERATOR GOVERNOR



- modern solid state
- speed/freq control
- operate on local measurements
 - increase/decrease P_{gen} to control freq

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- communicated setpoint to optimize system

1. Automatic Generation Control (AGC)

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REAL-TIME OPERATIONS

- most of energy is used as it is generated
- real time is somewhat application dependent
- multiple time scales

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↳ comms & automation allow faster responses

2. Human Operation