Overview

• A bit of history
• Future power systems
  – Distributed generation and The Distributed Utility
  – Micro-Grids
  – The Super Grid
  – The Smart Grid
  – A role for energy conservation and demand response?

System Evolution History

• 1960s – Economies of scale and scope
• 1970s
  – OPEC – fuel prices
  – Generation – new (aero, CHP) technologies
  – Demand – slowed growth
  – Society – environmental awareness (R. Carson)
  – Regulatory – PURPA, EPACT & FERC Orders
• Industry restructuring (worldwide)
  ➔ Changing system purpose and design “architecture”
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A Distributed Utility → microGrid

Microgrid

• A group of interconnected controllable loads and distributed energy resources (DER)
  • …with clearly defined electrical boundaries
  • …that acts as a single controllable entity with respect to the grid
  • …[and can] connect and disconnect from the grid to enable it to operate in both grid-connected or island mode.
Microgrid

• Cogeneration
  – Focus on providing energy close to the load to allow for co-generation of heat & electricity
  – For northern regions
• Photovoltaic systems (& solar hot water…)
  – Warm, sunny climates
• Islanding of the micropower system → improved reliability
• Total energy efficiency objective
The Supergrid Concept

- A network of underground, DC superconductors
  - energy flow of electricity and hydrogen
  - hydrogen could replace gas for transportation
  - the ability to store H\textsubscript{2} would allow much greater use of resources such as wind and solar
  - one promising material is magnesium diboride (MgB\textsubscript{2}), which is superconducting at 39K
Smart Grid

- Definition?
- Elements/Components?
- …More on Wednesday and Friday

Renewable Energy

- Dispatchable renewable energy
  - Hydroelectric
  - Hydrogen (depending on how generated)
- Non-dispatchable renewable energy
  - Wind; solar
  - System integration issues
- Policy measures
  - Renewables portfolio standards
  - Environmental regulations (EPA)

Energy Conservation?

- The future role for the demand side – the active/interactive customer
  - Competitive markets currently are one-sided, supply-side only
  - How can we get demand-side participation in energy markets?
  - What is the impact of our non-involvement?

Energy Conservation

- Six factors for the reduction in load:
  (1) Role of the media and the Internet in increasing public awareness of the crisis;
  (2) Fossil fuel prices;
  (3) Utility energy efficiency programs;
  (4) Rebate programs (appliance purchases);
  (5) Independent System Operator (ISO) load management/demand response programs; and
  (6) Other state programs
    - Such as energy use reduction by Federal, state, and local government facilities and partnerships with the private sector.
Summary

• Different views on power system evolution
  – Methods to promote a favorite technology
• DU – system level evolution
• Microgrid – localized improvement in energy efficiency
• Supergrid – a way to promote nuclear power?
• The Smart Grid – adds communications technologies and demand response