Thinking About Energy...

- Where does it come from?

- Where does it go?
**Converting Fuels to “Energy”**

- Lots of Turbines and Tea Kettles...

<table>
<thead>
<tr>
<th>Type of Generation</th>
<th>Combustion Type</th>
<th>Turbine Type</th>
<th>Primay Power</th>
<th>Electrical Conversion</th>
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<tbody>
<tr>
<td>Traditional Boiler</td>
<td>External</td>
<td>Gas</td>
<td>Shaft Generator</td>
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<tr>
<td>Fluidized Bed Combustion</td>
<td>External</td>
<td>Steam</td>
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<tr>
<td>Integrated Gasification</td>
<td>Both</td>
<td>Water</td>
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<td>Combined-Cycle</td>
<td>Internal</td>
<td>Aero</td>
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<tr>
<td>Combined Cycle</td>
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<td>Nuclear</td>
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<td>Diesel Genset</td>
<td>Internal</td>
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<tr>
<td>Micro-Turbines</td>
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<td>Fuel Cells</td>
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<td>Direct Inverter</td>
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<td>Biomass &amp; WTE Windpower</td>
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<td>Direct Inverter</td>
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<tr>
<td>Ocean Thermal</td>
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<td>Shaft Generator</td>
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</tr>
</tbody>
</table>

**Electricity from the Wind**

- Texas
- Vermont
- Denmark
Windpower’s Getting BIG!!!

• Comparative Size/Height

Where is it Windy?

• Trees and Hills, Matter!!!
Wind in Space and Time

Electricity Demand

Generation from Wind

Pop Quiz !!!

• Is the wind blowing?
Solar Energy - Many Flavors

• Photovoltaics

(Source: NREL)

• Some “Large” Systems in Boston (Northeastern, MIT)

(Source: solarpower.mit.edu)

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Solar Energy - Many Flavors

• Solar Tower – Solar Electric

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Where and When is it Sunny?
(Definitely more than just latitude)

Fuels from Plants! (Biomass)

- Ethanol
  » Which feedstock? (sugar, seed, plant)
  » Implicit feedstock variability/product stability issues
  » Thousands of assumptions regarding agricultural practices, biorefinery performance, etc.

- Similar assumptions for Biodiesel

- How good is it?
  » From the seed, or the whole plant?
  » Do you come out ahead or behind?
Efficiency Too in Space & Time

• Redefining “Energy Efficiency”
  » Energy Conversion Efficiency
    • Historically Synonymous with “Energy Efficiency”
    • Leading Example: Efficient Light Bulbs
  » Energy Utilization Efficiency
    • Look at “Duty Cycles” and “Driving Cycles”
    • The “Efficiency of turning things off”
  » Integrated Energy Efficiency
    • Look at “Two Birds/One Stone” Energy Services
    • Leading Example: Combined Heat and Power

• Focus also on “Technology Development, Deployment and Use”
  • “Every Market’s A Niche Market”
  • “Some Niches Are Just Bigger Than Others”
  • Niches Will Grow in Size, and Expand in Number as Technologies Improve and Markets Evolve

Thanks for Listening…
Thanks for Your Questions…

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