Climate Change:
CO2 Projections – Alternative Resource Scenarios

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Outline

- Technology Comparisons
- Baseline CO2 Emissions
- Near-Term Illustration
- Resource Alternative Scenarios
  - CO2 Projections
## CO2 Emissions Comparisons for Resource Technologies

<table>
<thead>
<tr>
<th>Resource Technology</th>
<th>Average CO2 Emissions (metric tons / MWH)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing Coal Units</td>
<td>0.98</td>
<td>Number represents a projection of fleet-wide average for 2008</td>
</tr>
<tr>
<td>New Conventional Coal</td>
<td>0.86</td>
<td>APS' projection for a new, supercritical, pulverized coal unit using hybrid-cooling technology (size is approx. 470 MWs) and without CCS</td>
</tr>
<tr>
<td>Existing Gas Combined Cycle</td>
<td>0.43</td>
<td>Projection based upon APS' anticipated utilization patterns for Redhawk plant</td>
</tr>
<tr>
<td>Existing Gas Combustion Turbines</td>
<td>0.62</td>
<td>Projection based upon APS' anticipated utilization patterns for Sundance plant</td>
</tr>
<tr>
<td>Nuclear</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Energy Efficiency</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Renewable Sources (wind, solar, geothermal)</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>
Projected Power Production Sources of CO2 Emissions for 2008

- Mix Chart
  - Coal 73%
  - Gas Combined Cycle 25%
  - Gas Peaking 2%

- Table (MM tons)
  - Coal 12.0
  - Gas Combined Cycle 4.1
  - Gas Peaking 0.4
  - Total 16.4

- Includes projected emissions associated with meeting native load requirements,
- Includes projected emissions from energy purchases
Near-Term Illustration (Portfolio Re-Dispatch for 2012)

Supply Curve for 2012

Variable Cost ($/MWH)

Total Energy (GWH)

CO2 Metric Tons

Potential Cost:
- $490M (50% allocation)
- $985M (0% allocation)

Note – corrected error

Annual Gas Burn

CO2 Cost ($/Metric Ton)

Coal Energy

Gas Burn (MMBTU)

CO2 Cost ($/Metric Ton)

Coal Energy (GWHs)

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Resource Alternative Scenarios

• Four Alternative Resource Scenarios Presented in the Report:
  
  – Gas Scenario
    • Combination of Natural Gas Resources (combined cycle and peaking) Used to Meet Future Resource Needs
    • Assumptions common to all four scenarios include:
      – Renewable resources to meet RES targets
      – Energy efficiency based upon $25 M annual level (in 2007 $’s)
      – Existing generation portfolio is unchanged for forecast period
  
  – Renewable Scenario
    • Additional renewable resources included:
      – Ramp-up over the 2011 to 2020 time period
      – Assumes additional 200 MWs geothermal and 1,350 MWs solar thermal
      – Approximately 6,700 GWHs per year (added by 2020)
  
  – Nuclear Scenario
    • Total of 934 MWs of nuclear added (half in 2018, half in 2019)
  
  – Coal Scenario
    • Total of 934 MWs of coal added (half in 2017, half in 2018)
    • Conventional pulverized coal technology (supercritical units with hybrid cooling)

• Energy Efficiency Case:
  
  • EE investment increased to $75 M annual level (in 2007 $’s)
  • Compared to reference case without any future EE investment
    – Energy needs reduced by 1,908 GWHs in 2020
CO2 Projections – Alternative Resource Scenarios

(MM Tons)

- Includes projected emissions associated with meeting native load requirements,
- Includes projected emissions from energy purchases
Growth is a Key Driver

• All Four Scenarios Show a Net Increase in CO2 Emissions by 2020:
  – Even Renewable Scenario Shows 10% Increase in CO2 Emissions from 2008 to 2020:
    • Despite adding over 11,000 GWHs of clean energy sources (EE, RE + DE) by 2020
    • This scenario adds 1,350 MWs of solar thermal and 200 MWs of geothermal by 2020 (over and above
      the renewable resources assumed in the other scenarios)
CO2 Projections – Impact of Energy Efficiency

(MM Tons)


BAU (No EE)

With EE
**CO2 Projections – Emissions Intensity**

(Emissions Intensity)

* Calculation method is total emissions divided by BAU own load energy

Gas Scenario:
- Gas Increasing % of mix
- RES and EE Implementation

Gas Scenario:

Projected Impact of Lieberman-Warner Bill

Projected Emissions Gas Scenario

Gap for 2015 11.8 MM tons

Gap for 2025 19.0 MM tons

Projected Allocation Of Allowances

(MM Tons)
Projected Impact of Lieberman-Warner Bill

Cost and Timing of Technology Solutions ?????

Allowance Price ($/MM ton)

• Allowance price is based upon TAP price from Bingaman-Spector Bill (L-W did not include safety valve price provisions)
Summary

- **Near-Term CO2 Emissions are Set By the Composition of the Existing Resource Portfolio**
  - Very high emissions price required to create sizeable emissions reductions in the near-term

- **Wide Range of Potential Future CO2 Emissions Dependent Upon Future Resource Choices**
  - By 2020, the difference between the nuclear (or renewable) scenarios and the coal scenario is over 6 MM tons per year

- **Growth in Customer Energy Needs is a Key Driver**

- **Potential Costs Impacts are Significant**
  - Costs will be largely dependent upon:
    - Allocation schemes
    - Emissions allowance (or carbon tax) prices
    - Development and commercialization of new technologies