Integration Work Group
Report to the Capacity Need Forum

September 29, 2005
Work Group Chairs

• John Dellas (517) 788-2251
  JJDELLAS@cmsenergy.com

• Paul Proudfoot (517) 241-6142
  PAPROUD@Michigan.gov
Presentation Points

• Define what the Integration Group was assigned to accomplish
• Describe how the Integration group accomplished its function
• Discuss the results of the integration process
Process Overview

• The Capacity Need Forum (CNF) was created as a collaborative industry-wide process to assess the projected need for electrical generating capacity in Michigan over the short-, intermediate-, and long-term future.
Proposed Integration Methodology

- Use MISO’s modeling capability to quantify capacity needs.
- Use New Energy’s Strategist to select a optimal resource addition plan.
- Use scenario based analysis to quantify Energy Conservation and Emissions issues.
- Regional modeling to reflect constraint issues.
Scenarios

• Traditional power sources
• Emissions
• Energy Conservation
• Non-Traditional sources
## Capacity Need Forum Proposed Integration Scenarios

<table>
<thead>
<tr>
<th>Resource Units</th>
<th>Traditional Power</th>
<th>Emissions</th>
<th>Energy Conservation</th>
<th>Non-Traditional</th>
</tr>
</thead>
<tbody>
<tr>
<td>PC Unit</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CT Unit</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>GCC Unit</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>IGCC Unit</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>IGCC C Seq.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nuclear Unit</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Waste Energy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wind Generation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cogeneration</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy Conservation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Sensitivities

<table>
<thead>
<tr>
<th>Sensitivity</th>
<th>Traditional Power</th>
<th>Emissions</th>
<th>Energy Conservation</th>
<th>Non-Traditional</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Load</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Low Load</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>High Gas Cost</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max Import</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Restricted Import</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Traditional with PC</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

### Assumptions

<table>
<thead>
<tr>
<th>Assumption</th>
<th>Traditional Power</th>
<th>Emissions</th>
<th>Energy Conservation</th>
<th>Non-Traditional</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal price driven energy conservation</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Carbon tax ($\text{$10.00} = 2010$-$\text{$30.00} = 2018$)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>85% Mercury Emissions Removal</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IGCC has CO2 sequestering</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max energy conservation options</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Maximum waste to energy</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum Cogeneration</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scale-up Renewables to Reflect RPS</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Assumed Transfer Capability (Normal)</td>
<td>3,000-3,500</td>
<td>3,000-3,500</td>
<td>3,000-3,500</td>
<td>3,000-3,500</td>
</tr>
</tbody>
</table>

---

1) Tier 1 transmission upgrades  
2) 1,500 MW transfer to OH  
3) Nominal dollars
New Energy’s Strategist

- For each year of the optimization Strategist generates all possible combinations of alternatives
- Each combination is tested against the constraints for that year and only those combinations that meet all the constraints are passed; these are the feasible states
- Cumulative Capital and operations costs are calculated for each feasible state
- Feasible states from year X are the starting points for generating new combinations for year X+1
- Repeat to end of Optimization Horizon
Integration Analysis Results

• Over 18 Unique runs
• Made up from the four scenarios and their associated sensitivities
• Today we will only be discussing a subset
Base Case Overview

- Base Expansion Plan

- Plan Specifics
  - No Specialties in base expansion plan

- Alternatives Considered
  - Combustion Turbine
  - Combined Cycle
  - Pulverized Sub-Critical Coal

- Alternatives Screened Out
  - Pulverized Super-Critical Coal
  - Fluidized Bed Coal
  - IGCC
  - IGCC – PRB Coal
  - Nuclear
Base Case Expansion Plan Results

- **2005 to 2014**
  - **Capacity Additions**
    - CT: 1,280 MW
    - CC: 1,500 MW
    - PC: 4,000 MW
    - Nuclear: 0 MW
    - IGCC-Seq: 0 MW
    - Other: 0 MW
  - **Total**: 6,780 MW
  - **Demand Growth**: 2.38%
  - **Reserve Margin**: 15.85%
  - **Plan Costs**
    - NPV Utility Cost: $29,640.7 M
    - NPV Emissions: $4,089.0 M
    - NPV CO2: $0.0 M

- **2005 to 2024**
  - **Capacity Additions**
    - CT: 2,880 MW
    - CC: 2,000 MW
    - Nuclear: 0 MW
    - PC: 12,000 MW
    - IGCC-Seq: 0 MW
    - Other: 0 MW
  - **Total**: 16,880 MW
  - **Demand Growth**: 2.17%
  - **Reserve Margin**: 15.03%
  - **Plan Costs**
    - NPV Utility Cost: $54,605.6 M
    - NPV Emissions: $7,638.6 M
    - NPV CO2: $0.0 M
Base Case

2005 to 2014

- Coal: 59%
- CC: 22%
- CT: 19%

2005 to 2024

- Coal: 71%
- CC: 12%
- CT: 17%

Capacity Need Forum 9/29, 2005
High Load Case Overview

• Base Expansion Plan
  – High Load Sensitivity

• Plan Specifics
  – Base Expansion Plan with high load case consistent with the LOLP study.

• Alternatives Considered
  – Combustion Turbine
  – Combined Cycle
  – Pulverized Sub-Critical Coal

• Alternatives Screened Out
  – Pulverized Super-Critical Coal
  – Fluidized Bed Coal
  – IGCC
  – IGCC – PRB Coal
  – Nuclear
High Load Case Expansion Plan Results

- **2005 to 2014**

  - **Capacity Additions**
    - CT 2,240 MW
    - CC 3,500 MW
    - PC 4,500 MW
    - Nuclear 0 MW
    - IGCC-Seq 0 MW
    - Other 0 MW
  - **Total** 10,240 MW

  - **Demand Growth** 3.35 %
  - **Reserve Margin** 15.14 %
  - **Plan Costs**
    - NPV Utility Cost $32,282.9 M
    - NPV Emissions $4,107.3 M
    - NPV CO2 $0.0 M

- **2005 to 2024**

  - **Capacity Additions**
    - CT 4,320 MW
    - CC 4,500 MW
    - PC 12,500 MW
    - Nuclear 0 MW
    - IGCC-Seq 0 MW
    - Other 0 MW
  - **Total** 21,320 MW

  - **Demand Growth** 2.63 %
  - **Reserve Margin** 15.00 %
  - **Plan Costs**
    - NPV Utility Cost $60,895.9 M
    - NPV Emissions $7,771.3 M
    - NPV CO2 $0.0 M
High Load Case Expansion Plan Results

2005 to 2014

- Coal: 44%
- CC: 34%
- CT: 22%

2005 to 2024

- Coal: 59%
- CC: 21%
- CT: 20%
Low Load Case Overview

- Base Expansion Plan
  - Low Load Sensitivity

- Plan Specifics
  - Base Expansion plan with low load case consistent with the LOLP Study

- Alternatives Considered
  - Combustion Turbine
  - Combined Cycle
  - Pulverized Sub-Critical Coal

- Alternatives Screened Out
  - Pulverized Super-Critical Coal
  - Fluidized Bed Coal
  - IGCC
  - IGCC – PRB Coal
  - Nuclear
Low Load Case Expansion Plan Results

- **2005 to 2014**
  - **Capacity Additions**
    - CT: 0 MW
    - CC: 1,000 MW
    - PC: 2,500 MW
    - Nuclear: 0 MW
    - IGCC-Seq: 0 MW
    - Other: 0 MW
  - Total: 3,500 MW

- Demand Growth: 1.30 %
- Reserve Margin: 16.40 %
- Plan Costs
  - NPV Utility Cost: $27,146.3 M
  - NPV Emissions: $4,051.2 M
  - NPV CO2: $0.0 M

- **2005 to 2024**
  - **Capacity Additions**
    - CT: 1,280 MW
    - CC: 2,000 MW
    - PC: 9,500 MW
    - Nuclear: 0 MW
    - IGCC-Seq: 0 MW
    - Other: 0 MW
  - Total: 12,780 MW

- Demand Growth: 1.66 %
- Reserve Margin: 15.42 %
- Plan Costs
  - NPV Utility Cost: $48,710.8 M
  - NPV Emissions: $7,536.0 M
  - NPV CO2: $0.0 M
Low Load Case Expansion Plan Results

2005 to 2014

- Coal: 71%
- CC: 29%
- CT: 0%

2005 to 2024

- Coal: 74%
- CC: 16%
- CT: 10%
High Gas Cost Case Overview

- Base Expansion Plan
  - High Gas Cost Sensitivity

- Plan Specifics
  - Base Expansion Plan with gas prices increased 20%.

- Alternatives Considered
  - Combustion Turbine
  - Combined Cycle
  - Pulverized Sub-Critical Coal

- Alternatives Screened Out
  - Pulverized Super-Critical Coal
  - Fluidized Bed Coal
  - IGCC
  - IGCC – PRB Coal
  - Nuclear
### High Gas Cost Case

#### 2005 to 2014
- **Capacity Additions**
  - CT: 1,280 MW
  - CC: 1,500 MW
  - PC: 4,000 MW
  - Nuclear: 0 MW
  - IGCC-Seq: 0 MW
  - Other: 0 MW
- **Total**: 6,780 MW
- **Demand Growth**: 2.38%
- **Reserve Margin**: 15.85%
- **Plan Costs**
  - NPV Utility Cost: $30,794.9 M
  - NPV Emissions: $4,049.5 M
  - NPV CO2: $0.0 M

#### 2005 to 2024
- **Capacity Additions**
  - CT: 2,880 MW
  - CC: 2,000 MW
  - PC: 12,000 MW
  - Nuclear: 0 MW
  - IGCC-Seq: 0 MW
  - Other: 0 MW
- **Total**: 16,880 MW
- **Demand Growth**: 2.17%
- **Reserve Margin**: 15.03%
- **Plan Costs**
  - NPV Utility Cost: $56,282.2 M
  - NPV Emissions: $7,568.1 M
  - NPV CO2: $0.0 M
High Gas Cost Case

2005 to 2014

CT 19%
CC 22%
Coal 59%

2005 to 2024

CT 17%
CC 12%
Coal 71%

Coal: 59% to 71%
CT: 19% to 17%
CC: 22% to 12%

Capacity Need Forum 9/29, 2005
High Import Case Overview

- Base Expansion Plan
  - High Import Sensitivity

- Plan Specifics
  - Base Expansion Plan with increased import capability
  - Tier I improvements are made to the system
  - Limits
    - into METC 4750
    - into ITC 1150
    - METC to ITC 3950
    - ITC to Ontario 0
    - All to MECS 4250

- Alternatives Considered
  - Combustion Turbine
  - Combined Cycle
  - Pulverized Sub-Critical Coal

- Alternatives Screened Out
  - Pulverized Super-Critical Coal
  - Fluidized Bed Coal
  - IGCC
  - IGCC – PRB Coal
  - Nuclear
### High Import Case

#### 2005 to 2014

- **Capacity Additions**
  - CT: 1,280 MW
  - CC: 1,500 MW
  - PC: 4,000 MW
  - Nuclear: 0 MW
  - IGCC-Seq: 0 MW
  - Other: 0 MW

- **Total**: 6,780 MW

- **Demand Growth**: 2.38%
- **Reserve Margin**: 16.85%
- **Plan Costs**
  - NPV Utility Cost\(^1\) $29,608.1 M
  - NPV Emissions $4,091.3 M
  - NPV CO2 $0 M

\(^1\) Does not include investment for Tier I improvements

#### 2005 to 2024

- **Capacity Additions**
  - CT: 2,400 MW
  - CC: 1,500 MW
  - PC: 13,000 MW
  - Nuclear: 0 MW
  - IGCC-Seq: 0 MW
  - Other: 0 MW

- **Total**: 16,900 MW

- **Demand Growth**: 2.17%
- **Reserve Margin**: 15.38%
- **Plan Costs**
  - NPV Utility Cost\(^1\) $54,242.0 M
  - NPV Emissions $7,746.7 M
  - NPV CO2 $0 M
High Import Case

2005 to 2014

- Coal: 59%
- CC: 22%
- CT: 19%

2005 to 2024

- Coal: 77%
- CC: 9%
- CT: 14%

Capacity Need Forum 9/29, 2005
Low Import Case Overview

• Base Expansion Plan
  – Low Import case

• Plan Specifics
  – Base Expansion Plan with limited import capability
  – 1500 MW of flow across the Michigan system going into Ontario Hydro reduces import capabilities for the Michigan System.
  – Michigan is not making sales to Ontario Hydro. The sales source is external to Michigan
  – Limits
    • into METC 1450
    • into ITC 200
    • METC to ITC 1800
    • ITC to Ontario 1500 unidirectional
    • All to MECS 1650

• Alternatives Considered
  – Combustion Turbine
  – Combined Cycle
  – Pulverized Sub-Critical Coal

• Alternatives Screened Out
  – Pulverized Super-Critical Coal
  – Fluidized Bed Coal
  – IGCC
  – IGCC – PRB Coal
  – Nuclear
Low Import Case

- **2005 to 2014**
  - **Capacity Additions**
    - CT 1,280 MW
    - CC 1,500 MW
    - PC 4,000 MW
    - Nuclear 0 MW
    - IGCC-Seq 0 MW
    - Other 0 MW
  - Total 6,780 MW

  - **Demand Growth** 2.38%
  - **Reserve Margin** 15.85%
  - **Plan Costs**
    - NPV Utility Cost $ 29,740.6 M
    - NPV Emissions $ 4,074.7 M
    - NPV CO2 $ 0 M

- **2005 to 2024**
  - **Capacity Additions**
    - CT 2,880 MW
    - CC 2,000 MW
    - PC 12,000 MW
    - Nuclear 0 MW
    - IGCC-Seq 0 MW
    - Other 0 MW
  - Total 16,880 MW

  - **Demand Growth** 2.17%
  - **Reserve Margin** 15.03%
  - **Plan Costs**
    - NPV Utility Cost $ 54,873.1 M
    - NPV Emissions $ 7,410.1 M
    - NPV CO2 $ 0 M
Low Import Case

2005 to 2014

- Coal: 59%
- CT: 19%
- CC: 22%

2005 to 2024

- Coal: 71%
- CT: 17%
- CC: 12%
Emissions Case Overview

• Plan Specifics
  – Hg emission allowance prices increased by 15%.
  – CO2 tax of 10 $/ton starting in 2010 and escalating to 30 $/ton in 2018 and constant thereafter.
  – IGCC has CO2 sequestering
  – IGCC without sequestration is not considered
  – Wind and Cogeneration capability is scheduled in

• Alternatives Considered
  – Combustion Turbine
  – Combined Cycle
  – Pulverized Super-Critical Coal
  – IGCC – CO2 Sequestered
  – Nuclear

• Alternatives Screened Out
  – Pulverized Sub-Critical Coal
  – Fluidized Bed Coal
## Emissions Case

### 2005 to 2015
- **Capacity Additions (Firm MW)**
  - CT: 2,080 MW
  - CC: 1,000 MW
  - PC: 3,000 MW
  - Nuclear: 0 MW
  - IGCC-Seq: 0 MW
  - Other: 600 MW
- **Total:** 6,680 MW

- **Demand Growth:** 2.38%
- **Reserve Margin:** 15.19%
- **Plan Costs (2005 $)**
  - NPV Utility Cost: $33,543.9 M
  - NPV Emissions: $7,851.0 M
  - NPV CO2: $3,724.5 M

### 2005 to 2024
- **Capacity Additions (Firm MW)**
  - CT: 2,720 MW
  - CC: 1,000 MW
  - PC: 4,500 MW
  - Nuclear: 8,000 MW
  - IGCC-Seq: 0 MW
  - Other: 600 MW
- **Total:** 16,820 MW

- **Demand Growth:** 2.17%
- **Reserve Margin:** 15.03%
- **Plan Costs (2005 $)**
  - NPV Utility Cost: $66,002.9 M
  - NPV Emissions: $20,195.6 M
  - NPV CO2: $12,751.3 M
Emissions Case

2005 to 2015

- Nuclear: 0%
- IGCC: 0%
- Coal: 41%
- CC: 14%
- Other: 16%

2005 to 2024

- Nuclear: 45%
- IGCC: 0%
- Coal: 25%
- CC: 6%
- Other: 9%
- CT: 15%
Conservation Case Overview

• Energy Conservation Plan

• Plan Specifics
  – Energy Conservation is scheduled in.
  – No direct load control
  – Landfill Gas, Digestion, and Wind technologies are scheduled in.
  – Cogeneration is not scheduled in
  – Gas Combined Cycles were considered

• Alternatives Considered
  – Combustion Turbine
  – Combined Cycle
  – Pulverized Sub-Critical Coal

• Alternatives Screened Out
  – Pulverized Super-Critical Coal
  – Fluidized Bed Coal
  – IGCC
  – IGCC – PRB Coal
  – Nuclear
Conservation Expansion Plan

- **2005 to 2014**
  - **Capacity Additions**
    - CT 1,280 MW
    - CC 1,000 MW
    - PC 3,500 MW
    - Nuclear 0 MW
    - IGCC-Seq 0 MW
    - Other 599 MW
  - **Total** 6,379 MW

- **Demand Growth** 2.38 %
- **Reserve Margin** 15.34 %
- **Plan Costs**
  - NPV Utility Cost 2 $29,802.9 M
  - NPV Emissions $4,054.5 M
  - NPV CO2 $0.0 M

- **2005 to 2024**
  - **Capacity Additions**
    - CT 3,040 MW
    - CC 2,500 MW
    - PC 10,000 MW
    - Nuclear 0 MW
    - IGCC-Seq 0 MW
    - Other 626 MW
  - **Total** 16,166 MW

- **Demand Growth** 2.17 %
- **Reserve Margin** 15.07 %
- **Plan Costs**
  - NPV Utility Cost 2 $54,066.4 M
  - NPV Emissions $7,509.6 M
  - NPV CO2 $0.0 M

2 Fixed costs for Energy Conservation are included.
Conservation Expansion Plan

2005 to 2014
- Other: 9%
- CT: 20%
- CC: 16%
- Coal: 55%

2005 to 2024
- Other: 4%
- CT: 19%
- CC: 15%
- Coal: 62%
Non –Traditional Case Overview

• Non-Traditional Plan

• Plan Specifics
  – Mandated renewable portfolio standard of 3% by 2008, 5% by 2010, and 7% by 2015 – Energy Based
  – Energy Conservation is not scheduled in.
  – Landfill Gas, Digestion, Wind, and Cogeneration technologies are scheduled in.
  – Renewable capabilities are scaled up to meet portfolio standards
  – No Coal Units nor Gas Combined Cycle units are allowed

• Alternatives Considered
  – Combustion Turbine
  – IGCC – PRB Coal

• Alternatives Screened Out
  – Fluidized Bed Coal
  – IGCC
  – Nuclear
Non–Traditional Case Expansion Plan Results

2005 to 2014

Capacity Additions

- CT: 1,760 MW
- CC: 1,000 MW
- PC: 0 MW
- Nuclear: 0 MW
- IGCC-PRB: 3,300 MW
- Other: 1,146 MW

Total: 7,206 MW

Demand Growth: 2.38%
Reserve Margin: 15.86%
Plan Costs
- NPV Utility Cost: $30,404.2 M
- NPV Emissions: $4,045.2 M
- NPV CO2: $0.0 M

2005 to 2024

Capacity Additions

- CT: 3,520 MW
- CC: 1,000 MW
- PC: 0 MW
- Nuclear: 0 MW
- IGCC-PRB: 11,550 MW
- Other: 1,507 MW

Total: 17,577 MW

Demand Growth: 2.17%
Reserve Margin: 15.57%
Plan Costs
- NPV Utility Cost: $57,480.9 M
- NPV Emissions: $7,451.2 M
- NPV CO2: $0.0 M
Non –Traditional Case

2005 to 2014

- IGCC: 46%
- CC: 14%
- Coal: 0%
- Other: 16%
- Nuclear: 0%
- CT: 24%

2005 to 2024

- IGCC: 65%
- CC: 6%
- Coal: 0%
- Nuclear: 9%
- Other: 9%
- CT: 20%

Capacity Need Forum 9/29, 2005
Non-Traditional with PC Case Overview

- **Non-Traditional Plan**
  - Coal Resource Sensitivity

- **Plan Specifics**
  - Mandated renewable portfolio standard of 3% by 2008, 5% by 2010, and 7% by 2015 – Energy Based
  - Energy Conservation is not scheduled in.
  - Landfill Gas, Digestion, Wind, and Cogeneration technologies are scheduled in.
  - Renewable capabilities are scaled up to meet portfolio standards
  - No Gas Combined Cycle units are allowed
  - Pulverized Coal is allowed

- **Alternatives Considered**
  - Combustion Turbine
  - Pulverized Sub-Critical Coal

- **Alternatives Screened Out**
  - Pulverized Super-Critical Coal
  - Fluidized Bed Coal
  - IGCC
  - IGCC – PRB Coal
  - Nuclear
Non-Traditional with PC Case

- **2005 to 2014**
  - **Capacity Additions**
    - CT 1,600 MW
    - CC 1,000 MW
    - PC 3,500 MW
    - Nuclear 0 MW
    - IGCC-PRB 0 MW
    - Other 1,146 MW
  - **Total 7,246 MW**
  - **Demand Growth** 2.38 %
  - **Reserve Margin** 16.06 %
  - **Plan Costs**
    - NPV Utility Cost $30,106.3 M
    - NPV Emissions $4,064.2 M
    - NPV CO2 $0.0 M

- **2005 to 2024**
  - **Capacity Additions**
    - CT 3,360 MW
    - CC 1,000 MW
    - PC 11,500 MW
    - Nuclear 0 MW
    - IGCC-PRB 0 MW
    - Other 1,507 MW
  - **Total 17,367 MW**
  - **Demand Growth** 2.17 %
  - **Reserve Margin** 15.00 %
  - **Plan Costs**
    - NPV Utility Cost $55,874.4 M
    - NPV Emissions $7,557.1 M
    - NPV CO2 $0.0 M
Non-Traditional with PC Case

2005 to 2014

- Coal: 48%
- CC: 14%
- CT: 22%
- Nuclear: 0%
- Other: 16%

2005 to 2024

- Coal: 66%
- CC: 6%
- CT: 19%
- Nuclear: 9%
- Other: 0%
- IGCC: 0%
<table>
<thead>
<tr>
<th>Plan Name</th>
<th>Total Capacity Added MW (Firm)</th>
<th>CT Capacity MW</th>
<th>CC Capacity MW</th>
<th>PC Capacity MW</th>
<th>Nuclear Capacity MW</th>
<th>IGCC Capacity MW</th>
<th>Other Capacity MW (Firm)</th>
<th>Ending Reserve Margin %</th>
<th>Ending Peak Demand MW</th>
<th>PVRR 2005 $M</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base</td>
<td>17,040</td>
<td>3,040</td>
<td>3,000</td>
<td>11,000</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>15.16%</td>
<td>34,880</td>
<td>$ 54,596.8</td>
</tr>
<tr>
<td>Base High Load</td>
<td>21,320</td>
<td>4,320</td>
<td>4,500</td>
<td>12,500</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>15.00%</td>
<td>38,368</td>
<td>$ 60,895.9</td>
</tr>
<tr>
<td>Base Low Load</td>
<td>12,780</td>
<td>1,280</td>
<td>2,000</td>
<td>9,500</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>15.42%</td>
<td>31,392</td>
<td>$ 48,707.3</td>
</tr>
<tr>
<td>Base High Gas</td>
<td>16,880</td>
<td>2,880</td>
<td>2,000</td>
<td>12,000</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>15.03%</td>
<td>34,880</td>
<td>$ 56,282.2</td>
</tr>
<tr>
<td>Base High Import</td>
<td>16,900</td>
<td>2,400</td>
<td>1,500</td>
<td>13,000</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>15.38%</td>
<td>34,880</td>
<td>$ 54,238.5</td>
</tr>
<tr>
<td>Base Low Import</td>
<td>16,880</td>
<td>2,880</td>
<td>2,000</td>
<td>12,000</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>15.03%</td>
<td>34,880</td>
<td>$ 54,870.9</td>
</tr>
<tr>
<td>Emissions</td>
<td>16,820</td>
<td>2,720</td>
<td>1,000</td>
<td>4,500</td>
<td>8,000</td>
<td>0</td>
<td>600</td>
<td>15.03%</td>
<td>34,880</td>
<td>$ 66,002.9</td>
</tr>
<tr>
<td>Emissions High Load</td>
<td>21,320</td>
<td>2,720</td>
<td>3,000</td>
<td>6,000</td>
<td>9,000</td>
<td>0</td>
<td>600</td>
<td>15.87%</td>
<td>38,368</td>
<td>$ 77,407.4</td>
</tr>
<tr>
<td>Emissions High Gas</td>
<td>17,660</td>
<td>2,560</td>
<td>1,000</td>
<td>4,500</td>
<td>9,000</td>
<td>0</td>
<td>600</td>
<td>17.55%</td>
<td>34,880</td>
<td>$ 67,779.9</td>
</tr>
<tr>
<td>Energy Conservation</td>
<td>15,799</td>
<td>3,040</td>
<td>2,500</td>
<td>10,000</td>
<td>0</td>
<td>0</td>
<td>259</td>
<td>15.07%</td>
<td>33,722</td>
<td>$ 54,066.4</td>
</tr>
<tr>
<td>Energy Conservation High Load</td>
<td>20,139</td>
<td>2,880</td>
<td>4,500</td>
<td>12,500</td>
<td>0</td>
<td>0</td>
<td>259</td>
<td>15.34%</td>
<td>37,210</td>
<td>$ 60,335.7</td>
</tr>
<tr>
<td>Energy Conservation Low Load</td>
<td>11,539</td>
<td>1,280</td>
<td>1,500</td>
<td>8,500</td>
<td>0</td>
<td>0</td>
<td>259</td>
<td>15.33%</td>
<td>30,234</td>
<td>$ 48,156.2</td>
</tr>
<tr>
<td>Energy Conservation High Gas</td>
<td>15,799</td>
<td>3,040</td>
<td>2,000</td>
<td>10,500</td>
<td>0</td>
<td>0</td>
<td>259</td>
<td>15.22%</td>
<td>33,722</td>
<td>$ 55,639.9</td>
</tr>
<tr>
<td>Non-Traditional</td>
<td>17,105</td>
<td>3,520</td>
<td>1,000</td>
<td>0</td>
<td>0</td>
<td>11,550</td>
<td>1,035</td>
<td>15.57%</td>
<td>34,880</td>
<td>$ 57,477.8</td>
</tr>
<tr>
<td>Non-Traditional High Load</td>
<td>21,395</td>
<td>4,160</td>
<td>3,000</td>
<td>0</td>
<td>0</td>
<td>13,200</td>
<td>1,035</td>
<td>15.28%</td>
<td>38,368</td>
<td>$ 67,023.5</td>
</tr>
<tr>
<td>Non-Traditional Low Load</td>
<td>12,535</td>
<td>1,600</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>9,990</td>
<td>1,035</td>
<td>15.51%</td>
<td>31,392</td>
<td>$ 53,523.5</td>
</tr>
<tr>
<td>Non-Traditional High Gas</td>
<td>17,105</td>
<td>3,520</td>
<td>1,000</td>
<td>0</td>
<td>0</td>
<td>11,550</td>
<td>1,035</td>
<td>15.57%</td>
<td>34,880</td>
<td>$ 59,149.8</td>
</tr>
<tr>
<td>Non-Traditional with PC as an option</td>
<td>16,895</td>
<td>3,360</td>
<td>1,000</td>
<td>11,500</td>
<td>0</td>
<td>0</td>
<td>1,035</td>
<td>15.00%</td>
<td>34,880</td>
<td>$ 55,864.4</td>
</tr>
</tbody>
</table>
Review of what was learned
• Substantial additions of new capacity are required to maintain the planning reserve margin and the associated LOL probability over the planning period.

• Capacity additions are required in the short term to maintain reserve margin targets.
• All scenarios add capacity during the planning period.
• The low growth sensitivity of the Energy Conservation Scenario adds 3,000 MWs of new capacity during the initial phase of the planning period (2005-2014).
• Additional base load capacity is part of the optimal resource plan and should be acquired in a timely manner.
• Optimal expansion plans were developed for four unique possible futures.
• These Scenarios were further analyzed with sensitivities analysis.
• All plans add base load capacity as soon as it is available.
• Resource plans that include energy conservation components and renewable options are comparable in cost to plans containing conventional resources.
• The Energy Conservation Scenario is only slightly more costly than the Base Case Scenario in the 2005-2015 period and is actually cheaper than the Base Case Scenario over the study period.

• 2005-2014
  – Conservation $ 29,802.9M
  – Base Case $ 29,640.7M

• 2005-2024
  – Conservation $ 54,066.4M
  – Base Case $ 54,605.6M
• The Non-Traditional with PC Scenario is only slightly more costly than the Base Case Scenario in the 2005-2015 period and is only 2% more costly than the Base Case Scenario over the study period.

• **2005-2014**
  – Non-Traditional with PC $ 30,106.3M
  – Base Case $ 29,640.7M

• **2005-2024**
  – Non-Traditional with PC $ 55,874.4M
  – Base Case $ 54,605.6M
• The cost of emissions control systems while significant are not the driving force for resource selection.
• Even a moderate tax on carbon will substantially increase the cost of electricity.
## Base Case

### Effluent Expense

<table>
<thead>
<tr>
<th>Year</th>
<th>NOX</th>
<th>SOx</th>
<th>CO2</th>
<th>Hg</th>
<th>Annual Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>$134,901</td>
<td>$227,876</td>
<td>$-</td>
<td>$-</td>
<td>$362,777</td>
</tr>
<tr>
<td>2006</td>
<td>$122,199</td>
<td>$246,143</td>
<td>$-</td>
<td>$-</td>
<td>$368,342</td>
</tr>
<tr>
<td>2007</td>
<td>$123,088</td>
<td>$267,581</td>
<td>$-</td>
<td>$-</td>
<td>$390,669</td>
</tr>
<tr>
<td>2008</td>
<td>$126,756</td>
<td>$291,232</td>
<td>$-</td>
<td>$-</td>
<td>$417,987</td>
</tr>
<tr>
<td>2009</td>
<td>$114,280</td>
<td>$317,870</td>
<td>$-</td>
<td>$-</td>
<td>$432,150</td>
</tr>
<tr>
<td>2010</td>
<td>$240,430</td>
<td>$340,821</td>
<td>$-</td>
<td>$125,350</td>
<td>$706,601</td>
</tr>
<tr>
<td>2011</td>
<td>$262,604</td>
<td>$366,247</td>
<td>$-</td>
<td>$130,224</td>
<td>$759,075</td>
</tr>
<tr>
<td>2012</td>
<td>$295,503</td>
<td>$395,470</td>
<td>$-</td>
<td>$136,486</td>
<td>$827,458</td>
</tr>
<tr>
<td>2013</td>
<td>$328,500</td>
<td>$423,855</td>
<td>$-</td>
<td>$141,991</td>
<td>$894,345</td>
</tr>
<tr>
<td>2014</td>
<td>$363,460</td>
<td>$454,359</td>
<td>$-</td>
<td>$147,676</td>
<td>$965,494</td>
</tr>
<tr>
<td>2015</td>
<td>$396,790</td>
<td>$487,130</td>
<td>$-</td>
<td>$152,505</td>
<td>$1,036,425</td>
</tr>
<tr>
<td>2016</td>
<td>$382,056</td>
<td>$517,255</td>
<td>$-</td>
<td>$155,737</td>
<td>$1,055,048</td>
</tr>
<tr>
<td>2017</td>
<td>$378,438</td>
<td>$543,849</td>
<td>$-</td>
<td>$158,972</td>
<td>$1,081,304</td>
</tr>
<tr>
<td>2018</td>
<td>$370,653</td>
<td>$570,419</td>
<td>$-</td>
<td>$225,393</td>
<td>$1,166,465</td>
</tr>
<tr>
<td>2019</td>
<td>$357,042</td>
<td>$579,403</td>
<td>$-</td>
<td>$224,786</td>
<td>$1,161,231</td>
</tr>
<tr>
<td>2020</td>
<td>$343,220</td>
<td>$582,718</td>
<td>$-</td>
<td>$222,222</td>
<td>$1,148,160</td>
</tr>
<tr>
<td>2021</td>
<td>$336,319</td>
<td>$614,563</td>
<td>$-</td>
<td>$225,760</td>
<td>$1,176,642</td>
</tr>
<tr>
<td>2022</td>
<td>$327,335</td>
<td>$637,994</td>
<td>$-</td>
<td>$227,558</td>
<td>$1,192,887</td>
</tr>
<tr>
<td>2023</td>
<td>$311,733</td>
<td>$637,780</td>
<td>$-</td>
<td>$219,653</td>
<td>$1,169,166</td>
</tr>
<tr>
<td>2024</td>
<td>$301,470</td>
<td>$671,634</td>
<td>$-</td>
<td>$221,005</td>
<td>$1,194,109</td>
</tr>
<tr>
<td>Year</td>
<td>NOX</td>
<td>SOx</td>
<td>CO2</td>
<td>Hg</td>
<td>Annual Total</td>
</tr>
<tr>
<td>------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>--------------</td>
</tr>
<tr>
<td>2005</td>
<td>$134,901</td>
<td>$227,876</td>
<td>$-</td>
<td>$-</td>
<td>$362,777</td>
</tr>
<tr>
<td>2006</td>
<td>$122,168</td>
<td>$246,127</td>
<td>$-</td>
<td>$-</td>
<td>$368,295</td>
</tr>
<tr>
<td>2007</td>
<td>$122,963</td>
<td>$267,496</td>
<td>$-</td>
<td>$-</td>
<td>$390,459</td>
</tr>
<tr>
<td>2008</td>
<td>$125,070</td>
<td>$289,479</td>
<td>$-</td>
<td>$-</td>
<td>$414,549</td>
</tr>
<tr>
<td>2009</td>
<td>$113,652</td>
<td>$316,665</td>
<td>$-</td>
<td>$-</td>
<td>$430,316</td>
</tr>
<tr>
<td>2010</td>
<td>$239,843</td>
<td>$338,358</td>
<td>$849,861</td>
<td>$143,823</td>
<td>$1,571,886</td>
</tr>
<tr>
<td>2011</td>
<td>$263,735</td>
<td>$364,619</td>
<td>$1,046,193</td>
<td>$150,137</td>
<td>$1,824,684</td>
</tr>
<tr>
<td>2012</td>
<td>$291,216</td>
<td>$391,617</td>
<td>$1,262,056</td>
<td>$155,443</td>
<td>$2,100,331</td>
</tr>
<tr>
<td>2013</td>
<td>$324,948</td>
<td>$421,729</td>
<td>$1,549,178</td>
<td>$162,409</td>
<td>$2,458,264</td>
</tr>
<tr>
<td>2014</td>
<td>$355,703</td>
<td>$451,715</td>
<td>$1,846,042</td>
<td>$167,710</td>
<td>$2,821,171</td>
</tr>
<tr>
<td>2015</td>
<td>$389,498</td>
<td>$483,143</td>
<td>$2,225,541</td>
<td>$173,568</td>
<td>$3,271,751</td>
</tr>
<tr>
<td>2016</td>
<td>$375,850</td>
<td>$514,763</td>
<td>$2,637,039</td>
<td>$177,322</td>
<td>$3,704,973</td>
</tr>
<tr>
<td>2017</td>
<td>$361,314</td>
<td>$539,262</td>
<td>$2,989,966</td>
<td>$177,824</td>
<td>$4,068,367</td>
</tr>
<tr>
<td>2018</td>
<td>$340,253</td>
<td>$553,176</td>
<td>$3,329,216</td>
<td>$242,894</td>
<td>$4,465,539</td>
</tr>
<tr>
<td>2019</td>
<td>$308,705</td>
<td>$540,159</td>
<td>$3,108,114</td>
<td>$228,484</td>
<td>$4,185,463</td>
</tr>
<tr>
<td>2020</td>
<td>$289,768</td>
<td>$552,074</td>
<td>$3,017,380</td>
<td>$224,493</td>
<td>$4,083,715</td>
</tr>
<tr>
<td>2021</td>
<td>$276,696</td>
<td>$576,938</td>
<td>$2,947,589</td>
<td>$222,759</td>
<td>$4,023,981</td>
</tr>
<tr>
<td>2022</td>
<td>$258,436</td>
<td>$592,226</td>
<td>$2,849,269</td>
<td>$217,432</td>
<td>$3,917,363</td>
</tr>
<tr>
<td>2023</td>
<td>$224,933</td>
<td>$564,858</td>
<td>$2,545,184</td>
<td>$191,727</td>
<td>$3,526,702</td>
</tr>
<tr>
<td>2024</td>
<td>$212,559</td>
<td>$597,821</td>
<td>$2,504,945</td>
<td>$190,513</td>
<td>$3,505,838</td>
</tr>
</tbody>
</table>
Where do we go from here?

- Continue to analyze the results
- Complete the Integration Work Group’s Final Report
- Provide assistance and recommendations to the Capacity Need Forum as the Forum moves forward to complete its tasks