State Utility Forecasting Group Studies

2008 Indiana Renewable Resources Study
Indiana Electricity Projections: The 2007 Forecast
The Projected Impacts of Carbon Dioxide Emissions Reduction Legislation on Indiana Electricity Prices

Presented by:
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State Utility Forecasting Group
Purdue University

Presented to:
Regulatory Flexibility Committee
Indiana General Assembly

September 25, 2008
Renewable Resources Study
2008 Renewable Resources Study

• Renewable energy trends
• Barriers and incentives
• Individual renewable resources
  – wind
  – energy crops
  – organic waste
  – solar/photovoltaics
  – fuel cells
  – Hydropower
• Appendix - Intermittent resources
Historical Renewable Energy in the U.S.

Data for geothermal, wind and solar was not available before 1960, 1982 and 1983 respectively.  Source: EIA
2007 U.S. Total Energy Consumption by Energy Source

Source: EIA
Renewables Share of Indiana Total Energy Consumption

Source: EIA
Barriers to Renewables

• Major barrier is cost
  – most renewable technologies have high capital costs
  – Indiana had the 10th lowest electricity rates in the country in 2006, according to the Energy Information Administration (6.46 cents/kWh vs. national average 8.90 cents/kWh)

• Limited resources are also a problem for some technologies
  – solar/photovoltaics, hydropower, wind
Incentives for Renewables

• Federal
  – tax credits and exemptions (production tax credit)
  – grant programs

• State
  – net metering rule
  – grant programs
  – tax credits
  – emissions credits

• Utilities
  – green pricing programs
# Wind Developments

<table>
<thead>
<tr>
<th>Project Name</th>
<th>Counties</th>
<th>Developer</th>
<th>Rated Capacity (MW)</th>
<th>Construction Schedule</th>
<th>Status</th>
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<tbody>
<tr>
<td>Benton County Wind Farm</td>
<td>Benton</td>
<td>Orion Energy</td>
<td>130</td>
<td>Completed Spring 2008</td>
<td>Completed</td>
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<tr>
<td>Fowler Ridge Phase 1</td>
<td>Benton</td>
<td>BP Alternative Energy &amp; Dominion</td>
<td>400</td>
<td>To be completed by end of 2008</td>
<td>Under construction</td>
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<tr>
<td>Hoosier Wind Project</td>
<td>Benton</td>
<td>enXco</td>
<td>100</td>
<td>2009</td>
<td>Pending w/ PPA</td>
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<tr>
<td>Fowler Ridge Phase 2</td>
<td>Benton</td>
<td>BP Alternative Energy &amp; Dominion</td>
<td>350</td>
<td>Begin early 2009</td>
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<tr>
<td>Tri-County Wind Energy Center</td>
<td>Tippecanoe, Montgomery, Fountain</td>
<td>Invenergy</td>
<td>300-500</td>
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<td>Meadow Lake Wind Farm</td>
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<td>Horizon Energy</td>
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<td>Randolph</td>
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<td>Howard</td>
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## Indiana Utility Wind PPAs

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<th>MW</th>
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<td>SIGECO</td>
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<td>IN</td>
<td>30</td>
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<td>WVPA</td>
<td>AgriWind</td>
<td>IL</td>
<td>8</td>
<td>Operational</td>
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<td>Indiana Michigan</td>
<td>Fowler Ridge</td>
<td>IN</td>
<td>100</td>
<td>Approved</td>
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<tr>
<td>NIPSCO</td>
<td>Buffalo Ridge</td>
<td>SD</td>
<td>50</td>
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<td>NIPSCO</td>
<td>Barton Windpower</td>
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<td>IPALCO</td>
<td>Hoosier Wind</td>
<td>IN</td>
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<td>Pending</td>
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</table>
Intermittent Resources

• Some renewable resources are only available on an intermittent basis
  – Wind
  – Solar, PV

• This causes resource planning and operational challenges/costs
Mitigating Intermittency

- Dispatchable/backup generators
- Demand response
- Wind forecasting
- Energy storage
  - Hydroelectricity
  - Compressed air
  - Batteries
  - Hydrogen
- Geographic diversity
SUFG Forecast

Indiana Electricity Projections:
The 2007 Forecast

State Utility Forecasting Group Purdue University, West Lafayette, Indiana
December 2007
SUFG Forecast Highlights

- Significant real electricity price increase through 2012, then leveling off
- Electricity requirements and peak demand projections are similar to the previous forecast in the first half of the forecast
- Electricity requirements and peak demand projections are higher than the previous forecast in the later years of the forecast
- Industrial electricity consumption is projected to grow faster than previously projected
- Resource requirements are down in the early years primarily due to new purchase contracts
Indiana Electricity Requirements

- Retail sales by investor owned and not-for-profit utilities
- Includes estimated transmission and distribution losses
- Growth rates
  - 2007 forecast: 2.46%
  - 2005 forecast: 2.22%
  - 2003 forecast: 2.16%
Indiana Resource Requirements

• Resources may be provided by conservation measures, contractual purchases, purchases of existing assets, or new construction

• Existing resources are adjusted into the future for retirements, contract expirations, and IURC approved new resources
  – Does not include Duke IGCC, NIPSCO purchase of Sugar Creek, and most wind purchases
### Indiana Resource Requirements

<table>
<thead>
<tr>
<th>Year</th>
<th>Uncontrolled Peak Demand 1</th>
<th>Interruptible Demand 2</th>
<th>Net Peak Demand 2</th>
<th>Existing/Approved Capacity 3</th>
<th>Incremental Change in Capacity 4</th>
<th>Projected Additional Resource Requirements 5</th>
<th>Total Resources 6</th>
<th>Reserve Margin</th>
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<td>19,874</td>
<td>22,166</td>
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<td>90</td>
<td>930</td>
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<td>1,062</td>
<td>20,331</td>
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<tr>
<td>2007</td>
<td>21,865</td>
<td>1,063</td>
<td>20,803</td>
<td>22,779</td>
<td>260</td>
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<td>2008</td>
<td>22,163</td>
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<td>2009</td>
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<td>21,541</td>
<td>22,719</td>
<td>165</td>
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<td>2012</td>
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<td>1,073</td>
<td>23,104</td>
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<td>23,756</td>
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<td>1,096</td>
<td>27,921</td>
<td>21,909</td>
<td>-163</td>
<td>2,530</td>
<td>2,430</td>
<td>10,180</td>
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<td>2020</td>
<td>29,746</td>
<td>1,100</td>
<td>28,647</td>
<td>21,909</td>
<td>0</td>
<td>2,700</td>
<td>2,520</td>
<td>11,040</td>
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<td>2021</td>
<td>30,504</td>
<td>1,104</td>
<td>29,400</td>
<td>21,869</td>
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<td>2,940</td>
<td>2,600</td>
<td>11,940</td>
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<td>1,108</td>
<td>30,112</td>
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<td>3,100</td>
<td>2,700</td>
<td>12,920</td>
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<td>2023</td>
<td>31,954</td>
<td>1,112</td>
<td>30,843</td>
<td>21,709</td>
<td>0</td>
<td>3,290</td>
<td>2,820</td>
<td>13,750</td>
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<td>2024</td>
<td>32,678</td>
<td>1,116</td>
<td>31,562</td>
<td>21,628</td>
<td>-81</td>
<td>3,470</td>
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<td>2025</td>
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<td>32,191</td>
<td>21,559</td>
<td>-163</td>
<td>3,640</td>
<td>3,070</td>
<td>15,620</td>
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</table>

1. Uncontrolled peak demand is the peak demand with DSM in place but without any interruptible loads being called upon.
2. Net peak demand is the peak demand after interruptible loads are taken into account.
3. Existing/approved capacity includes installed capacity plus approved new capacity plus firm purchases minus firm sales.
4. Incremental change in capacity is the change in existing/approved capacity from the previous year. The change is due to new, approved capacity becoming operational, retirements of existing capacity, and changes in firm purchases and sales.
5. Projected additional resource requirements is the cumulative amount of additional resources needed to meet future requirements.
6. Total resource requirements are the total statewide resources required including existing/approved capacity and projected additional resource requirements.
Indiana Real Price Projections (2005 $)

- Effect of inflation removed
- Includes the cost of meeting CAIR and CAMR
- Does not include costs associated with CO2 or RPS
- Includes the cost of new resources
Alternative Scenarios

- Any forecast contains uncertainty
- CEMR provides alternative low and high growth econometric forecasts
- Low and high growth scenarios are intended to give a plausible bound to uncertainty
CO2
Electricity Price Impact Study

The Projected Impacts of Carbon Dioxide Emissions Reduction Legislation on Electricity Prices in Indiana
Background

• Analysis based on then proposed Lieberman-Warner Climate Security Act

• Focuses on price impacts of CO2 limitations on Indiana’s electric utility industry
  – does not address benefits

• Uses the traditional regulation forecasting model developed by the State Utility Forecasting Group (SUFG)

• Collaboration with the Purdue Climate Change Research Center
Lieberman-Warner Act

- “Cap and trade” reduction of six greenhouse gases
  - we focus on CO2
- Declining cap from 2012 to 2050
- Emissions allowances can be traded, banked, or borrowed from the future
- An increasing percentage of allowances are auctioned over time
- Offsets can be purchased from non-covered sources
Methodology

- Reduce utility CO2 emissions at the overall national rate specified by the proposed legislation
- Incorporate emission allowance purchase costs
- Incorporate emission offset purchase costs
- Adjust fossil fuel price projections
- Other model inputs kept the same as in SUFG 2007 forecast
Compliance Strategy

- Purchase the maximum amount of offsets allowable
- Switch the basis for new baseload resources from pulverized coal-fired to a combination of wind and natural gas
- Retire older coal units that have not been retrofitted with equipment to remove SO2 and NOx
- Bank allowances in the early years for use in the later years
Other Resource Options

- Nuclear
- IGCC with carbon capture and storage
- Carbon capture from existing facilities
- Fuel switching
- Energy efficiency programs
Results

S. 2191 2007 Base History
Electricity Price Changes

Indiana Real Electricity Prices in 2012 (2005 cents/kWh)

<table>
<thead>
<tr>
<th>Sector</th>
<th>2007 Base</th>
<th>S. 2191</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>8.766</td>
<td>9.915</td>
<td>13.1 %</td>
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<tr>
<td>Commercial</td>
<td>7.896</td>
<td>8.946</td>
<td>13.3 %</td>
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<tr>
<td>Industrial</td>
<td>5.294</td>
<td>6.662</td>
<td>25.1 %</td>
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<tr>
<td>Total</td>
<td>6.972</td>
<td>8.213</td>
<td>17.8 %</td>
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Indiana Real Electricity Prices in 2015 (2005 cents/kWh)

<table>
<thead>
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</thead>
<tbody>
<tr>
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<td>16.1 %</td>
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<td>Commercial</td>
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<td>Industrial</td>
<td>5.280</td>
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<td>25.9 %</td>
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<td>Total</td>
<td>6.745</td>
<td>8.158</td>
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# Electricity Price Changes

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<th>Sector</th>
<th>2007 Base</th>
<th>S. 2191</th>
<th>Change</th>
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<tbody>
<tr>
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<td>10.101</td>
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<tr>
<td>Commercial</td>
<td>7.204</td>
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<tr>
<td>Industrial</td>
<td>5.318</td>
<td>7.315</td>
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<tr>
<td>Total</td>
<td>6.507</td>
<td>8.695</td>
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<table>
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<th>2007 Base</th>
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<td>39.7%</td>
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<td>Industrial</td>
<td>5.513</td>
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<tr>
<td>Total</td>
<td>6.525</td>
<td>9.437</td>
<td>44.6%</td>
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Caveats

• Large-scale wind development
  – 3,400 MW needed by 2012
  – 9,800 MW needed by 2025
  – significant transmission investment
  – operational issues due to intermittency
  – ability of turbine manufacturers to meet demand
  – analysis does not include federal production tax credit
Caveats

• Demand-side management (DSM)
  – higher cost makes DSM more attractive
  – quantifying amount and cost not feasible for this study

• Price elasticity
  – SUFG modeling system uses historical observations to project the future
  – price increases are greater than previously experienced
Caveats

• Macroeconomic effects
  – SUFG model captures microeconomic effects of price increases
    • customer switches from electricity to another resource
    • customer uses electricity more efficiently
  – SUFG model does not capture macroeconomic effects of price increases
    • customer shuts down business
    • customer elects not to open facility in the state
Caveats

- Technological innovations
  - Restrictions are likely to provide incentives for new developments
    - better carbon capture methods for fossil-fuel generators
    - better energy storage for wind intermittency
  - It is not possible to predict what developments will occur and when
Caveats

• Compliance strategy
  – least cost options have been chosen when possible, but should not be construed to be optimal

• Modeling of Lieberman-Warner bill
  – Analysis is based on the proposed legislation, but does not model it exactly
    • allowance allocation
    • carbon capture bonus allowances
    • fuel, allowance, and offset prices from analysis of earlier bill
Further Information

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http://www.purdue.edu/dp/energy/SUFG/

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