

**Global Warming Task Force – Technical Advisory Group
Final Report Summarizing Power Sector Modeling Runs
July 17, 2008**

I. Abstract

The purpose of this report is to document the modeling runs done by the Technical Advisory Group (TAG) at the direction of the Global Warming Task Force (Task Force). ICF Consulting assisted the TAG by performing the modeling simulations using ENERGY 2020 and REMI. The World Resources Institute assisted in monitoring the study and interpreting the results.

The modeling results represent projections of what may happen in the future under a certain set of assumptions. As such, results are highly sensitive to these assumptions. The results are indicative of what could be achieved if all of the policies were adopted and implemented promptly in Wisconsin, but they do not guarantee the exact outcome. All results reported below should be viewed with these points in mind.

For all sectors, significant issues were discussed before the various work groups' Policy Templates were developed. Each of the Policy Templates identify these issues in great detail. Even when there were substantive policy differences in the discussion on developing the Policy Templates, the final policy templates for all of the work groups ended up being fairly straight forward from a modeling perspective. The Transportation Work Group identified some concerns and they worked with the TAG to review the travel response feedback in the Energy 2020 modeling.

While the Power Sector Work Group templates were clearly established, there was a need for the TAG to insure that the assumptions regarding the Electric Power Sector were accurately reflected in the modeling by ICF, the modeling contractor. As a result, the TAG spent considerable time and effort working with the contractor to achieve this result. Thus, unlike the other work group templates that ended up being straight-forward from a modeling perspective, the Electric Power Sector requires further explanation of the TAG efforts so that the modeling results can be better understood. The following report on the Electric Power Sector modeling effort was written by the TAG to provide the documentation and information to more fully understand its efforts and insights in modeling the Electric Power Sector templates.

The Power Sector modeling effort identified the following major findings:

- A. For the “business as usual” (BAU – Reference Case) Wisconsin’s increase in greenhouse gas (GHG) emissions is driven by Power Sector GHG emission increases.

- B. Policy Scenario 01 included the following GHG reduction policies for the Power Sector:
1. Enhanced Energy Efficiency
 2. Expanded renewable portfolio standard (RPS)
- C. Policy Scenario 01 resulted in a 0.6 million metric ton and 3.8 million metric ton reduction in Power Sector GHG emissions in 2015 and 2024 respectively.
- D. Policy Scenario 01 impact on Wisconsin Power Sector GHG emission reductions do not account for the total GHG emission reductions achieved by Policy Scenario 01 due to:
1. Wisconsin's imports are reduced due to Policy Scenario 01 that means the GHG emissions are reduced in the Power Sector outside of Wisconsin. This is known as "leakage".
 2. Approximately ½ of Wisconsin's expanded RPS is made up of renewable projects developed outside of Wisconsin. These projects affect Wisconsin electric rates but do not directly reduce Wisconsin Power Sector GHG emissions. However, these out-of-state renewable projects do reduce the GHG emissions for the Power Sector outside of Wisconsin.
- E. Policy Scenario 01 has the following impacts on Power Sector electric rates (\$/Mwh) and industrial customer bills (\$):

Parameter	2015	2024
% Change In Industrial Electric Rates (\$/Mwh 2007\$)	26.0	10.0
% Change In Average Retail Electric Rates (\$/Mwh 2007\$)	22.0	8.5
% Change In Industrial Energy Cost (2007\$) - Note 1	8	-12
Note 1: Calculation assumes industrial customer can achieve the energy savings associated with the enhanced energy efficiency program.		

- F. A 50% increase in energy costs (coal, natural gas, oil and biomass) results in a small reduction in Power Sector GHG emissions for both the Reference and the Policy Scenario 01 cases.

- G. A 50% increase in energy costs has the following impacts on Power Sector electric rates and industrial customer bills in 2015:

Case =	Reference Case - High Energy Cost	Policy Scenario 01 - High Energy Cost
With Respect To Case =	Reference Case	Reference Case - High Energy Cost
Parameter		
Industrial Energy Rate - % Change	14.9	20.8
Average Retail Rate - % Change	13.0	18.1
Industrial Bill - % Change	24.1	-11.6

- H. Deep Reductions Scenario included the following GHG reduction policies and actions for the Power Sector:

1. Enhanced energy efficiency
 2. Expanded renewable portfolio standard (RPS)
 3. 2,000 Mw of zero carbon electric resources in January 2020 (1,000 Mw Canadian hydro imported into Wisconsin, 1,000 Mw new electric generating resource in Wisconsin)
 4. Replacement of older Wisconsin coal units less than 150 Mw (approximately 1,400 Mw) in January 2020
- I. Deep Reductions Scenario resulted in a 10.9 million metric ton reduction in Power Sector GHG emissions in 2024.
- J. Deep Reductions Scenario results in a 24 million metric ton reduction in the GHG emissions for the Power Sector outside of Wisconsin in 2024.
- K. Deep Reductions Scenario results in a combined Power Sector GHG reduction (Wisconsin and outside world) of 35 million metric tons in 2024. If this total reduction is accounted for and accredited to Wisconsin, the Deep Reductions Scenario would reduce Wisconsin's total 2024 GHG emissions to 101.4 million metric tons which is approximately equal to Wisconsin's 2005 GHG emissions being reduced by 19%.
- L. Deep Reductions Scenario raises electric rates by 3 percentage points compared to the Policy Scenario 01.
- M. Modeling Cap and Trade identified numerous issues that need to be addressed in future design and modeling of a Midwest Cap and Trade system being

studied by the Midwest Governor's Association (MGA) climate change initiative.

II. Summary

A. Reference Case

The Reference Case reflects business as usual for the various sectors of the Wisconsin economy:

Relative to 2005 GHG emissions, Wisconsin's Power Sector GHG emissions for 2015 increased by 12.4 million metric tons whereas Wisconsin's total GHG emissions increased by 11.6 million metric tons for the same time frame. Wisconsin's Power Sector GHG emissions for 2024 increased by 14.3 million metric tons whereas Wisconsin's total GHG emissions increased by 22.4 million metric tons for the same time frame.

Between 2005 and 2015, subject to modeling accuracy, Wisconsin's increase in GHG emissions is forecasted to be driven by the Power Sector. Between 2005 and 2024 approximately 64% of Wisconsin's increase in GHG emissions is forecasted to be driven by the Power Sector.

The Power Sector's forecasted increase in GHG emissions is driven by: 1. the output from new coal fueled generating unit additions already permitted in Wisconsin and new natural gas fueled generating unit additions selected by the model 2. increased electric sales and 3. changes in Wisconsin's use of electric power imports needed to meet electric energy sales.

Wisconsin's reliance on electric power imports varies significantly during the study period. Wisconsin is modeled as importing 16.7% of its electric energy needs in 2006 to being a net exporter of approximately 1.4% of its electric energy needs in 2010.

The fact that there is so much variation in Wisconsin's electric power imports for changes in the Power Sector makes it difficult to accurately account for the total reduction in GHG emissions associated with the proposed policies.

A significant portion of the electric resource supply in the Midwest Independent System Operator (MISO) market is coal fueled. As a result there are times when imports into Wisconsin could be generated from coal fueled units that are on the margin. During peak load times natural gas fueled combined cycle units could be on the margin. As a result,

depending on system conditions, there could be a wide variation in CO₂ emissions that are associated with Wisconsin electric power imports. This attribute makes it difficult to estimate in real time what the impact of changes in Wisconsin electric power imports are on total CO₂ emissions.

B. All Policies Except Cap & Trade (Policy Scenario 01)

Policy Scenario 01 reflects the GHG emission reduction policies listed in Appendix A.

The GHG emission reduction policies modeled for the Power Sector include: 1. enhanced energy efficiency and 2. expanded renewable portfolio standard (RPS)

Relative to 2005 GHG emissions, Wisconsin's Power Sector GHG emissions for 2015 increased by 11.8 million metric tons whereas Wisconsin's total GHG emissions increased by 4.0 million metric tons for the same time frame. Wisconsin's Power Sector GHG emissions for 2024 increased by 10.5 million metric tons whereas Wisconsin's total GHG emissions increased by 6.7 million metric tons for the same time frame.

Due to GHG reductions in other sectors of the Wisconsin economy in 2015 and 2024, subject to modeling accuracy, Wisconsin's increase in Power Sector GHG emissions is forecasted to exceed Wisconsin's total GHG emission increase.

The Power Sector's GHG reduction policies do not result in material reductions in GHG emissions for the Wisconsin Power Sector. In 2015 the policies result in a 0.6 million metric ton reduction in Power Sector GHG emissions, whereas, in 2024 the policies result in a 3.8 million metric ton reduction in Power Sector GHG emissions.

There are two reasons for the small change in Wisconsin Power Sector GHG emissions:

1. The enhanced energy efficiency results in lower electric sales, however, these reductions in sales are offset by reductions in electric power imports (In 2015 85% of the energy efficiency savings translated into reduced electric power imports. In 2024 70% of the energy efficiency savings translated into reduced electric power imports).
2. The expanded RPS (the increase in RPS starts after 2015) resulted in a net increase in Wisconsin 2024 renewable generation of approximately 2,565 Gwh. This renewable generation displaced natural gas fueled generation and reduced GHG emissions by

approximately 1 million metric tons assuming natural gas generation emits 375 metric tons CO₂/Gwh. The assumption that ½ of the expanded RPS is generated from out-of-state renewable projects also contributes to the small reduction in Wisconsin Power Sector GHG emissions since the affect of out-of-state renewable resources is not accounted for.

The results from the model suggest that renewable electric resources (wind generation) tend to mostly displace natural gas fueled electric resources. This could be an outcome of the level of detail in the model's dispatch algorithm. More detailed, hourly simulations of additional renewable electric resources (wind) may show a different mix (coal and natural gas fueled electric resources as well as Wisconsin imports) of electric resources being affected by the renewable electric resource additions. To the extent that actual wind power displaces greater amounts of coal generation than shown in the model the model results will underestimate the carbon dioxide benefit of wind power.

The impacts of Wisconsin's Power Sector GHG reduction policies on the rest of the world in 2024 resulted in a GHG reduction of approximately 11 million metric tons. The combined affect of Wisconsin's Power Sector GHG reduction policies for the three markets (Wisconsin, Region and rest of the US) is to reduce GHG emissions by 14.7 million metric tons.

The Power Sector cost impacts associated with Policy Scenario 01, are expressed in % change in electric rates and in % change in customer's electric bill. For instance as shown in the Results section, in 2015 industrial electric rate increase due to Policy Scenario 01 is forecasted to be 26%. If the industrial customer is able to realize reductions in energy usage due to the enhanced energy efficiency policy, the industrial customer's actual bill would increase by 8% in 2015.

C. Reference Case – High Energy Prices

“Reference Case – High Energy Prices” is identical to the original “Reference Case” with the exception that the energy supply prices (coal, natural gas, oil and biomass) are increased by 50%. The following summarizes a comparison of the “Reference Case – High Energy Prices” to the original “Reference Case”.

Relative to the “Reference Case”, the Wisconsin's Power Sector GHG emissions for 2015 in the “Reference Case – High Energy Prices” are reduced by approximately 2.6 million metric tons. In 2024 the reduction in GHG emissions for the Power Sector is 2.0 million metric tons.

The Power Sector cost impacts associated with the Reference Case – High Energy Prices”, are expressed in % change in electric rates and in % change in customer’s electric bill. For instance as shown in the Results section, in 2015 industrial electric rate increase due to Reference Case – High Energy Prices” is forecasted to be 14.9%. The industrial customer’s actual bill would increase by 24.1% in 2015.

D. All Policies Except Cap & Trade – High Energy Prices (Policy Scenario 01 – High Energy Prices)

“Policy Scenario 01 – High Energy Prices” reflects the GHG emission reduction policies listed in Appendix A along with a 50% increase in energy prices (coal, natural gas, oil and biomass) relative to the original “Reference Case” energy prices.

The GHG emission reduction policies modeled for the Power Sector include: 1. enhanced energy efficiency and 2. expanded renewable portfolio standard (RPS)

Relative to 2005 GHG emissions, Wisconsin’s Power Sector GHG emissions for 2015 increased by 10.3 million metric tons whereas Wisconsin’s total GHG emissions increased by 1.5 million metric tons for the same time frame. Wisconsin’s Power Sector GHG emissions for 2024 increased by 9.9 million metric tons whereas Wisconsin’s total GHG emissions increased by 4.1 million metric tons for the same time frame.

Due to GHG reductions in other sectors of the Wisconsin economy in 2015 and 2024, subject to modeling accuracy, Wisconsin’s increase in Power Sector GHG emissions is forecasted to exceed Wisconsin’s total GHG emission increase.

The Power Sector’s GHG reduction policies and high energy prices do not result in material reductions in GHG emissions for the Wisconsin Power Sector (relative to the original Reference Case). In 2015 the policies and high energy prices result in a 2.1 million metric ton reduction in Power Sector GHG emissions, whereas, in 2024 the policies and high energy prices result in a 4.4 million metric ton reduction in Power Sector GHG emissions.

There are two reasons for the small change in Wisconsin Power Sector GHG emissions:

1. The enhanced energy efficiency results in lower electric sales, however, these reductions in sales are offset by reductions in electric power imports (In 2015 43% of the energy efficiency savings translated into reduced electric power imports. In 2024

63% of the energy efficiency savings translated into reduced electric power imports).

2. The expanded RPS (the increase in RPS starts after 2015) resulted in a net increase in Wisconsin 2024 renewable generation of approximately 2,702 Gwh. This renewable generation generally displaces natural gas fueled generation and reduces GHG emissions by approximately 1 million metric tons assuming natural gas generation emits 375 metric tons CO₂/Gwh. The assumption that ½ of the expanded RPS is generated from out-of-state renewable projects also contributes to the small reduction in Wisconsin Power Sector GHG emissions since the affect of out-of-state renewable resources is not accounted for.

The impacts of Wisconsin’s Power Sector GHG reduction policies and high energy prices on the rest of the world in 2024 resulted in a GHG reduction of approximately 14 million metric tons. The combined affect of Wisconsin’s Power Sector GHG reduction policies for the three markets (Wisconsin, Region and rest of the US) is to reduce GHG emissions by 18.4 million metric tons.

The Power Sector cost impacts associated with Policy Scenario 01 with high energy prices compared to the “Reference Case – High Energy Prices”, are expressed in % change in electric rates and in % change in customer’s electric bill. For instance as shown in the Results section, in 2015 industrial electric rate increase due to Policy Scenario 01 and high energy prices is forecasted to be 20.8%. If the industrial customer is able to realize reductions in energy usage due to the enhanced energy efficiency policy, the industrial customer’s actual bill would decrease by 11.6% in 2015.

- E. Deep Reductions (Policy Scenario 01 w. 2,000 Mw zero carbon electric resources)

The Deep Reductions Scenario includes the Policy Scenario 01 GHG emission reduction policies, as well as, replacement of 1,400 Mw of older coal units and the addition of 2,000 Mw of new zero carbon electric resources in 2020. The 2,000 Mw of new zero carbon electric resources consist of 1,000 Mw of Canadian hydro that is imported into Wisconsin and a 1,000 Mw zero carbon electric resource that is built in Wisconsin.

The “Deep Reductions” scenario modeled for the Power Sector include: 1. enhanced energy efficiency, 2. expanded renewable portfolio standard (RPS), 3. replacement of older coal units, less than 150 Mw (approximately 1,400 Mw total), in January 2020, and 4. addition of 2,000

Mw of zero carbon electric resources priced as new nuclear units (real levelized cost \$63/Mwh 2005\$) in January 2020.

The only difference between the “Deep Reductions” scenario and “Policy Scenario 01” occurs in 2020 when the changes in electric supply are assumed to be made in the “Deep Reductions” scenario. The following summary for the “Deep Reductions” scenario will focus on the study results for 2024.

Relative to 2005 GHG emissions, Wisconsin’s Power Sector GHG emissions for 2024 increased by 3.4 million metric tons in the Deep Reduction Scenario whereas Wisconsin’s total GHG emissions decreased by 0.1 million metric tons for the same time frame.

Due to GHG reductions in other sectors of the Wisconsin economy in 2024, subject to modeling accuracy, Wisconsin’s Power Sector GHG emissions are forecasted to increase while Wisconsin’s total GHG emissions are forecasted to return to 2005 levels in 2024.

The Power Sector’s GHG reduction policies and addition of 2,000 Mw of zero carbon resources result in material reductions in GHG emissions for the Wisconsin Power Sector. In 2024 the combined policies result in a 10.9 million metric ton reduction in Power Sector GHG emissions relative to the original “Reference Case”.

There are three reasons for the change in Wisconsin Power Sector 2024 GHG emissions:

1. The enhanced energy efficiency results in lower electric sales. In 2024 enhanced energy efficiency results in a 20% reduction in electric sales relative to the original Reference Case.
2. The expanded RPS (the increase in RPS starts after 2015, ½ of the renewable requirement is met with out-of-state renewable resources) and the 1,000 Mw Canadian hydro import resulted in a net increase in Wisconsin 2024 renewable generation of approximately 9,975 Gwh. In addition, the assumption that ½ of the expanded RPS is generated from out-of-state renewable projects results in out-of-state GHG emission reductions that are not accounted for in the forecasted Wisconsin GHG emissions.
3. The enhanced energy efficiency and expanded RPS along with the addition of 2,000 Mw of zero carbon electric resources and the replacement of approximately 1,400 Mw of older coal units resulted in a 14,595 Gwh reduction in Wisconsin natural gas and coal fueled electric resource generation. In addition Wisconsin

switched from being a net importer to being a net exporter of electric energy to the outside world. In 2024 Wisconsin went from being an importer of 16,169 Gwh in the original “Reference Case” to a net exporter of 8,302 Gwh in the “Deep Reductions” scenario. This results in a net reduction of 24,471 Gwh of electric generation by electric resources in the rest of the world.

The impacts of Wisconsin’s Power Sector GHG reduction policies (Policy Scenario 01) and replacement of 1,400 Mw of older coal units with 2,000 Mw of zero carbon electric resources resulted in a 24 million metric ton reduction in the GHG emissions of the rest of the world in 2024. The combined affect of Wisconsin’s Power Sector GHG reduction policies and new zero carbon resources for the three markets (Wisconsin, Region and rest of the US) is to reduce GHG emissions by approximately 35 million metric tons.

It should be noted that if Wisconsin were to be credited with the GHG emission reductions that occur in the rest of the outside world due to the “Deep Reductions” scenario, Wisconsin’s 2024 GHG emissions would be approximately 101.4 million metric tons or approximately 81% of Wisconsin’s 2005 GHG emission level (19% reduction).

The Power Sector cost impacts associated with the “Deep Reductions” scenario, are expressed in % change in electric rates and in % change in customer’s electric bill. For instance as shown in the Results section, in 2024 industrial electric rate increase due to the “Deep Reductions” scenario is forecasted to be 13.1%. If the industrial customer is able to realize reductions in energy usage due to the enhanced energy efficiency policy, the industrial customer’s actual bill would decrease by 19% in 2024.

F. Cap and Trade Observations

Cap and Trade design and modeling issues prevented a complete analysis of Cap and Trade as a policy for reducing GHG emissions.

The major observations are:

1. If the Cap and Trade program is not national in scope, “leakage” can be a significant problem for a smaller regional Cap and Trade program under the existing regulatory framework for electrical generation dispatch.

“Leakage” defined as an attribute of the Power Sector where, due to constraints on GHG emissions in the Cap and Trade region, electric energy is produced from GHG emitting electric resources

outside of the Cap and Trade region in order to export electric energy into the Cap and Trade region so that GHG emitting electric resources inside the Cap and Trade region can reduce their generation and as a result reduce their GHG emissions. The result is a transfer of GHG emissions from inside the Cap and Trade region to the outside world. The observed reduction in GHG emissions in the Cap and Trade region is overstated due to the transfer of GHG emissions to the outside world.

2. To avoid leakage in a regional Cap and Trade program there has to be a balance between the level of GHG emission reductions and the available GHG reduction policies and GHG offsets, as well as, an accounting for and proper treatment of electric power imports into the Cap and Trade region.
3. In the absence of any regulatory changes to the Regional Transmission Operator (RTO) rules, the regional Cap and Trade program needs to be designed to match as closely as possible the existing independent transmission system operators (like Midwest Independent System Operator MISO) in order to be effective. This will provide for consistent dispatch to insure that GHG emission reductions are achieved and leakage is minimized.
4. To avoid extremely high CO₂ allowance costs there has to be a balance between the level of GHG emission reductions and the availability of cost effective GHG reduction policies and GHG offsets.
5. All states in a regional Cap and Trade program should have comparable access to GHG emission reduction policies and GHG offsets in order to insure that one state is not burdened with an unequal share of the GHG emission reduction goal.

III. Results

A. Reference Case

Reference Case reflects continued growth in Wisconsin electric energy sales. This increase in electric energy sales is met with the construction of new natural gas fueled generating units assumed to be built by the model's new unit expansion algorithm and the completion of coal fueled generating units already permitted in Wisconsin, as well as, varying degrees of reliance on imports of electric power from outside of Wisconsin. The following table shows the changes in Power Sector GHG emissions and electric rates for the Reference Case.

Reference Case - Key Power Sector Parameters

Parameter	2005	2015	2024
GHG Emissions In Million Metric Tons	45.0	57.4	59.3
Industrial Electric Rates (\$/Mwh 2007\$)	Note 1	51.52	55.17
Average Retail Electric Rates (\$/Mwh 2007\$)	Note 1	63.25	66.19
Note 1: 2006 Industrial Electric Rate = \$57.68/Mwh 2006 Average Retail Electric Rate = \$70.05/Mwh			

B. All Policies Except Cap & Trade (Policy Scenario 01)

Policy Scenario 01 reflects continued growth in Power Sector GHG emissions in spite of the GHG reduction policies that were deployed in the Power Sector (Refer to Summary section for explanation). The following table shows the changes in Power Sector GHG emissions, electric rates (expressed as a % change with respect to the electric rates for the Reference Case in the year of interest) and total electric bill (expressed as a % change with respect to the electric bill for the Reference Case in the year of interest)

Policy Scenario 01 - Key Power Sector Parameters

Parameter	2005	2015	2024
GHG Emissions In Million Metric Tons	45.0	56.8	55.5
% Change In Industrial Electric Rates (\$/Mwh 2007\$) – $\{[(\text{Policy 01})/(\text{Reference Case})]-1\} * 100\%$	N/A	26.0	10.0
% Change In Average Retail Electric Rates (\$/Mwh 2007\$) – $\{[(\text{Policy 01})/(\text{Reference Case})]-1\} * 100\%$	N/A	22.0	8.5
% Change In Industrial Energy Cost (2007\$) – $\{[(\text{Policy 01})/(\text{Reference Case})]-1\} * 100\%$ - Note 1	N/A	8	-12
Note 1: Calculation assumes industrial customer can achieve the energy savings associated with the enhanced energy efficiency program.			

C. Reference Case – High Energy Prices

“Reference Case – High Energy Prices” reflects Power Sector GHG emissions that are relatively flat in the 2010 – 2024 time period due to high energy prices relative to growth observed in the original “Reference Case”. The following table shows the changes in Power Sector GHG emissions, electric rates (expressed as a % change with respect to the

electric rates for the Reference Case in the year of interest) and total electric bill (expressed as a % change with respect to the electric bill for the Reference Case in the year of interest)

Reference Case – High Energy Prices
- Key Power Sector Parameters

Parameter	2005	2015	2024
GHG Emissions In Million Metric Tons	45.0	54.8	57.3
% Change In Industrial Electric Rates (\$/Mwh 2007\$) – {[(Reference w High Energy Cost)/(Reference Case)]-1}*100%	N/A	14.9	13.0
% Change In Average Retail Electric Rates (\$/Mwh 2007\$) – {[(Reference w High Energy Cost)/(Reference Case)]-1}*100%	N/A	13.0	11.5
% Change In Industrial Energy Cost (2007\$) – {[(Reference w High Energy Cost)/(Reference Case)]-1}*100% - Note 1	N/A	24.1	27.4
Note 1: Calculation assumes industrial customer sees a slight increase in electric energy use (approximately 1%)			

D. All Policies Except Cap & Trade – High Energy Prices (Policy Scenario 01 – High Energy Prices)

Policy Scenario 01 with high energy prices reflects no material growth in Power Sector GHG emission due to the combination of the GHG reduction policies that were deployed in the Power Sector (Refer to Summary section for explanation) and high energy prices. The following table shows the changes in Power Sector GHG emissions, electric rates (expressed as a % change with respect to the electric rates for the “Reference Case – High Energy Prices” in the year of interest) and total electric bill (expressed as a % change with respect to the electric bill for the “Reference Case – High Energy Prices” in the year of interest)

Policy Scenario 01 – High Energy Prices
- Key Power Sector Parameters

Parameter	2005	2015	2024
GHG Emissions In Million Metric Tons	45.0	55.3	54.9
% Change In Industrial Electric Rates (\$/Mwh 2007\$) – {[(Policy 01) / (Reference Case)] - 1 } * 100%	N/A	20.8	7.4
% Change In Average Retail Electric Rates (\$/Mwh 2007\$) – {[(Policy 01) / (Reference Case)] - 1 } * 100%	N/A	18.1	6.5
% Change In Industrial Energy Cost (2007\$) – {[(Policy 01) / (Reference Case)] - 1 } * 100% - Note 1	N/A	-11.6	-18.0
Note 1: Calculation assumes industrial customer can achieve the energy savings associated with the enhanced energy efficiency program.			

E. Deep Reductions (Policy Scenario 01 w. 2,000 Mw zero carbon electric resources)

The “Deep Reductions” scenario reflects some growth in Power Sector GHG emission in spite of the GHG reduction policies that were deployed in the Power Sector and the addition of 2,000 Mw of zero carbon electric resources that replace approximately 1,400 Mw of older coal (Refer to Summary section for explanation). The following table shows for the year 2024 a comparison of the “All Policies Except Cap and Trade” (Policy Scenario 01) compared to the “Deep Reductions” scenario. The comparison includes: changes in Power Sector GHG emissions, electric rates (expressed as a % change with respect to the electric rates for the Reference Case in the year of interest) and total electric bill (expressed as a % change with respect to the electric bill for the Reference Case in the year of interest).

“All Policies Except Cap and Trade (Policy Scenario 01)”
vs. “Deep Reductions” Scenario
Key Power Sector Parameters

Parameter		Policy Scenario 01	Deep Reductions
	2005	2024	2024
Wisconsin GHG Emissions In Million Metric Tons	45.0	55.5	48.4
Outside of Wisconsin GHG emission reductions due to scenario (in million metric tons)		11	24
% Change In Industrial Electric Rates (\$/Mwh 2007\$) – $\{[(\text{Policy Scenario})/(\text{Reference Case})]-1\} * 100\%$	N/A	10.0	13.1
% Change In Average Retail Electric Rates (\$/Mwh 2007\$) – $\{[(\text{Policy Scenario})/(\text{Reference Case})]-1\} * 100\%$	N/A	8.5	11.4
% Change In Industrial Energy Cost (2007\$) – $\{[(\text{Policy Scenario})/(\text{Reference Case})]-1\} * 100\%$ - Note 1	N/A	-12	-19.0
Note 1: Calculation assumes industrial customer can achieve the energy savings associated with the enhanced energy efficiency program.			

The “Deep Reductions” scenario relative to the “All Policies Except Cap and Trade” results in the Wisconsin GHG emissions being 7.1 million metric tons lower. Including the impact on the outside world, the “Deep Reductions” scenario reduces GHG emissions by an additional 20.1 million metric tons compared to the “All Policies Except Cap and Trade”. The “Deep Reductions” scenario results in electric rates being approximately 3 percentage points higher than the electric rates associated with the “All Policies Except Cap and Trade”.

IV. Background

For modeling it was assumed that ½ of new renewable resources to meet the RPS would come from out-of-state renewable projects. This assumption reflects what utilities are currently doing. The practice of purchasing renewable resources from outside of Wisconsin may under estimate the impact of RPS on GHG emission reductions if the renewable generation avoids out-of-state fossil generation

because the model's tracking system only reports emissions from Wisconsin based generation resources.

A. Reference Case

The major Power Sector attributes that contribute to GHG emissions are shown in the following table.

Major Power Sector Attributes
Reference Case

Attribute	2006	2015	2024
Electric Sales %/Yr			
2006 - 2015	1.6		
2015 - 2024		2.4	
Generation Supply (% of Electric Sales)			
Coal & Natural Gas	62.5	74.2	64.4
Imports	16.7	4.5	15.3
Total	79.2	78.7	79.7
WI RPS Target (Total) - %		10	10
WI In-State Renewables as % Of Total Sales	4.2	4.9	7.1

Approximately 79 – 80% of Wisconsin's electric energy requirement is met by a combination of fossil fueled generation and power imports.

B. All Policies Except Cap & Trade (Policy Scenario 01)

The major Power Sector attributes that contribute to GHG emissions are shown in the following table.

Major Power Sector Attributes
Policy Scenario 01

Attribute	2006	2015	2024
Electric Sales %/Yr			
2006 - 2015	0.2		
2015 - 2024		1.4	
Generation Supply (% of Electric Sales)			
Coal & Natural Gas	62.5	82.5	69.2
Imports (Negative is Export)	16.7	-6.1	2.8
Total	79.2	76.4	72.0
WI RPS Target (Total) - %		10	24
WI In-State Renewables as % Of Total Sales	4.2	5.0	12

Approximately 72 – 79% of Wisconsin’s electric energy requirement is met by a combination of fossil fueled generation and power imports.

C. Reference Case – High Energy Prices

The major Power Sector attributes that contribute to GHG emissions are shown in the following table.

Major Power Sector Attributes
Reference Case

Attribute	2006	2015	2024
Electric Sales %/Yr			
2006 - 2015	1.6		
2015 - 2024		2.3	
Generation Supply (% of Electric Sales)			
Coal & Natural Gas	62.5	69.1	58.3
Imports	16.7	9.9	16.4
Total	79.2	79.0	74.7
WI RPS Target (Total) - %		10	10
WI In-State Renewables as % Of Total Sales	4.2	4.6	11.9

Approximately 75 – 79% of Wisconsin’s electric energy requirement is met by a combination of fossil fueled generation and power imports.

D. All Policies Except Cap & Trade – High Energy Prices (Policy Scenario 01 – High Energy Prices)

The major Power Sector attributes that contribute to GHG emissions are shown in the following table.

Major Power Sector Attributes
Policy Scenario 01 – High Energy Prices

Attribute	2006	2015	2024
Electric Sales %/Yr			
2006 - 2015	0.3		
2015 - 2024		1.4	
Generation Supply (% of Electric Sales)			
Coal & Natural Gas	62.5	77.2	67.3
Imports (Negative is Export)	16.7	-0.4	4.6
Total	79.2	76.8	71.9
WI RPS Target (Total) - %		10	24
WI In-State Renewables as % Of Total Sales	4.2	4.7	11.9

Approximately 72 – 79% of Wisconsin’s electric energy requirement is met by a combination of fossil fueled generation and power imports.

E. Deep Reductions (Policy Scenario 01 w. 2,000 Mw zero carbon electric resources)

The major Power Sector attributes that contribute to GHG emissions are shown in the following table.

Major Power Sector Attributes
 “All Policies Except Cap and Trade (Policy Scenario 01)”
 vs. “Deep Reductions” Scenario

		Policy Scenario 01	Deep Reductions
Attribute			
Electric Sales %/Yr			
2006 - 2015		0.2	0.2
2015 - 2024		1.4	1.3
	2006	2024	2024
Generation Supply (% of Electric Sales)			
Coal & Natural Gas	62.5	69.2	63.2
Imports (Negative is Export)	16.7	2.8	-9.8
Total	79.2	72.0	53.4
WI RPS Target (Total) - %		24	24
WI In-State Renewables as % Of Total Sales	4.2	12	11.9

The “Deep Reductions” scenario relies on natural gas and coal fueled electric resources to meet approximately 53.4% of its electric supply need. The “All Policies Except Cap and Trade” scenario relies on natural gas and coal fueled electric resources to meet approximately 72.0% of its electric supply need.

The “Deep Reductions” scenario does not count the 1,000 Mw Canadian hydro purchase toward Wisconsin’s expanded RPS requirement.

Power Sector Policy Assumptions

Policy Title	Revision Date	Modeling Assumptions																																																																																																												
C&EE 01 - Enhanced Energy Efficiency Program	2/4/08	<p>Policy increases spending and targets for EE and Conservation programs. Targets are set as a percentage of total sales to all sectors. Existing spending on EE programs set at 1.2% annually. <i>Annual kWh savings from existing programs estimated as 0.5% annually for electric load and 0.3% annually for natural gas.</i></p> <p>Spending as a % of revenues:</p> <table border="1" data-bbox="500 722 1442 1041"> <thead> <tr> <th rowspan="2">Year</th> <th colspan="2">Electric</th> <th colspan="2">Natural Gas</th> </tr> <tr> <th>Total</th> <th>Incremental</th> <th>Total</th> <th>Incremental</th> </tr> </thead> <tbody> <tr><td>2009</td><td>2.0%</td><td>0.8%</td><td>2.0%</td><td>0.8%</td></tr> <tr><td>2010</td><td>2.5%</td><td>1.3%</td><td>2.5%</td><td>1.3%</td></tr> <tr><td>2011</td><td>3.0%</td><td>1.8%</td><td>3.0%</td><td>2.8%</td></tr> <tr><td>2012</td><td>3.5%</td><td>2.3%</td><td>3.0%</td><td>2.8%</td></tr> <tr><td>2013</td><td>3.75%</td><td>2.55%</td><td>3.0%</td><td>2.8%</td></tr> <tr><td>2014</td><td>3.75%</td><td>2.55%</td><td>3.0%</td><td>2.8%</td></tr> <tr><td>2015</td><td>4.25%</td><td>3.05%</td><td>3.0%</td><td>2.8%</td></tr> <tr><td>2016-2020</td><td>4.25%</td><td>3.05%</td><td>3.0%</td><td>2.8%</td></tr> </tbody> </table> <p>Target Savings:</p> <table border="1" data-bbox="500 1100 1442 1482"> <thead> <tr> <th rowspan="2">Year</th> <th colspan="2">Electric</th> <th colspan="3">Natural Gas</th> </tr> <tr> <th>(GWh/year)</th> <th>% of Sales</th> <th>Incremental</th> <th>% of Sales</th> <th>Incremental</th> </tr> </thead> <tbody> <tr><td>2009</td><td>575</td><td>0.75%</td><td>0.25%</td><td>2.0%</td><td>1.70%</td></tr> <tr><td>2010</td><td>775</td><td>1.00%</td><td>0.50%</td><td>2.5%</td><td>2.20%</td></tr> <tr><td>2011</td><td>950</td><td>1.25%</td><td>0.75%</td><td>3.0%</td><td>2.70%</td></tr> <tr><td>2012</td><td>1150</td><td>1.50%</td><td>1.00%</td><td>3.0%</td><td>2.70%</td></tr> <tr><td>2013</td><td>1325</td><td>1.75%</td><td>1.25%</td><td>3.0%</td><td>2.70%</td></tr> <tr><td>2014</td><td>1325</td><td>1.75%</td><td>1.25%</td><td>3.0%</td><td>2.70%</td></tr> <tr><td>2015</td><td>1525</td><td>2.0%</td><td>1.50%</td><td>3.0%</td><td>2.70%</td></tr> <tr><td>2016-2020</td><td>1525</td><td>2.0%</td><td>1.50%</td><td>3.0%</td><td>2.70%</td></tr> </tbody> </table> <ul style="list-style-type: none"> Above spending assumed to represents utility investments only For modeling purposes assume that utility costs represent 25% on average of total investments to implement efficiency measures. <p><i>Note – from G.Edgar by e-mail 17 Jan 2008 - the Conservation & EE work group template for "Enhanced EE program" indicates that annual kWh savings will be 0.5% annually for electric load and 0.3% annually for natural gas load.</i></p>	Year	Electric		Natural Gas		Total	Incremental	Total	Incremental	2009	2.0%	0.8%	2.0%	0.8%	2010	2.5%	1.3%	2.5%	1.3%	2011	3.0%	1.8%	3.0%	2.8%	2012	3.5%	2.3%	3.0%	2.8%	2013	3.75%	2.55%	3.0%	2.8%	2014	3.75%	2.55%	3.0%	2.8%	2015	4.25%	3.05%	3.0%	2.8%	2016-2020	4.25%	3.05%	3.0%	2.8%	Year	Electric		Natural Gas			(GWh/year)	% of Sales	Incremental	% of Sales	Incremental	2009	575	0.75%	0.25%	2.0%	1.70%	2010	775	1.00%	0.50%	2.5%	2.20%	2011	950	1.25%	0.75%	3.0%	2.70%	2012	1150	1.50%	1.00%	3.0%	2.70%	2013	1325	1.75%	1.25%	3.0%	2.70%	2014	1325	1.75%	1.25%	3.0%	2.70%	2015	1525	2.0%	1.50%	3.0%	2.70%	2016-2020	1525	2.0%	1.50%	3.0%	2.70%
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Power Sector Policy Assumptions

Policy Title	Revision Date	Modeling Assumptions
EG 01 - Enhanced Renewable Portfolio Standard	2/8/08	<p>Policy expands targets for renewable energy's contribution to <u>electricity sales</u>:</p> <ul style="list-style-type: none"> • 10% renewable content by 2015 • Approximately 20% by 2020 Target increasing until 2025 target reached (growth more rapid in 2015-2020 period than in last 5 years of period). • 25% renewable content by 2025. • For modeling purposes, REC's are not included (Note: they remain part of proposed policy after 2015 but group decided not to include in modeling). • Capital costs for wind as specified in Appendix H of the Assumptions Book (same values as for Reference Case). • Expand definition of renewables to include biogas produced in Wisconsin and thermal energy produced by solar or biomass. All non-electric energy would be converted to equivalent quantities of electricity. • Values to be used for converting non-electric energy to electric equivalent: <ul style="list-style-type: none"> ○ Biogas – use 7,000 Btu/kWh ○ Solar/Biomass used for thermal energy use 3412 Btu/kWh. • New hydro less than 60MW qualifies as renewable. Assume any up-rating less than 60MW qualifies as renewable.