

MEMORANDUM

To:	Caroline Garber, Chief, Environmental Studies Section, WI DNR Kris Krause, Co-Chair, GWTF Technical Advisory Committee George Edgar, Co-Chair, GWTF Technical Advisory Committee
From:	Glen Wood, ICF International (ICF), and Jeff Amlin, Systematic Solutions Inc. (SSI)
Date:	June 23 2008
Re:	<u>Policy Scenario 10 – Deep Reduction Scenario</u>

The following memorandum compares the ENERGY 2020 model outputs for Policy Scenario 10; referred to as the Deep Reductions Scenario to the original Reference Case as discussed in the memorandum dated April 16, 2008. Under this scenario 2,000 MW of generation is added in the state while all coal units under 150 MW in capacity are retired; all at the start of 2020. The new generation is assumed to have no associated carbon emissions, to operate at an 85% capacity factor and was priced at \$63/MWh (2005\$). This policy is assumed to be implemented in addition to Policy Case 01 (all policies except Cap and Trade).

More detailed results have been provided to the TAG in the form of Excel spreadsheets which summarize changes resulting from PC10 for Wisconsin, the surrounding states and the rest of the US and Canada.

The effects of the proposed policies were modeled for the states which were included in the Cap and Trade market for modeling purposes, the surrounding region and the rest of the U.S. and Canada. In the results which follow, these areas are referred to as:

- The Rest of the Market - this includes the neighbouring states which signed the MWGA Accord (Iowa, Illinois, Minnesota, and Michigan).
- The Rest of the Region – this includes the remaining states originally defined as the Region but which are assumed not to be included in the Cap and Trade market (Indiana, Missouri, and Ohio).
- The Rest of the US and Canada.

The results for these groups are additive, in that no state is included in more than one category. The only policies implemented in Wisconsin that were found to have an impact outside of the state are those which affected the electricity sector. Other policies had little or no impact beyond Wisconsin.

1. Introduction

The data is presented for a set of milestone years established after discussion with the TAG. ENERGY 2020 provides data for all years in the modelled period should that be required.

ENERGY 2020 outputs typically display the data for about 70 economic sectors and other categories. The data presented below has been consolidated by sector based on the following sectors as agreed to with the TAG:

- Residential
- Commercial
- Pulp and Paper
- Other Energy Intensive Industries (*these include Smelting and Refining, Iron and Steel, Chemicals, Cement, Petroleum Refining, & mining*)
- Other Industry (including construction)
- Passenger Transportation
- Freight Transportation (including off-road)
- Agricultural
- Forestry
- Waste and Wastewater
- Power Sector

2. Economic Data:

The economic data used in this scenario remains unchanged from prior modeling done for the Reference and prior policy cases. Iterative modeling of the Deep Reduction scenario was not completed using the REMI model as it was felt that the economic impacts would be relatively minor. Modeling of the effects of prior policies such as Policy Case 01 indicated that the overall impact on the economy of Wisconsin was less than 0.5% by 2024.

3. Power Sector Data:

The tables on the following pages show electricity sales and generation and the percentage change in these values under the Deep Reduction scenario.

Electricity sales are essentially unaffected by the changes in generation; showing a similar decrease from Reference Case levels as in PC01.

The addition of 2,000 MW of additional capacity and elimination of approximately 1,400 MW of coal generation results in 12% less coal generation and a 51% decrease in oil/gas generation by 2024. Total in-state generation increases by 6% relative to the Reference Case with the result that by 2015, Wisconsin becomes a net exporter of power, with over 8,000 GWh leaving the state in 2024.

As a result of the increased capacity in Wisconsin, gas/oil generation output falls within the rest of the market and the rest of the region, while in the rest of the US and Canada, coal generation decreases by about 19,000 GWh by 2024.

Wisconsin – Absolute Values:

Sales (GWh)	2010	2015	2020	2024
Residential	21,174	21,054	21,639	22,400
Commercial	22,559	22,555	23,687	25,136
Industrial	31,720	31,053	33,944	36,513
Street Lights/Misc.	400	400	400	400
Resale	-	-	-	-
Total Sales	75,853	75,062	79,670	84,449
Imports	1,344	(1,875)	(10,553)	(8,302)

Generation Output (GWh/year)	2010	2015	2020	2024
Gas/Oil	4,601	4,374	4,237	4,271
Coal	55,034	55,034	49,136	49,136
Nuclear	12,115	12,802	20,670	20,670
Hydro	1,184	1,184	8,647	8,647
Landfill Gas/EFW	137	539	1,196	1,520
Wind	1,351	2,737	6,026	8,188
Other	88	267	311	319
Total	74,509	76,937	90,223	92,751

Generation Capacity (MW)	2010	2015	2020	2024
Gas/Oil Combustn. Turbine	4,517	4,517	4,517	4,517
Gas/Oil Combined Cycle	2,679	2,679	2,679	2,679
Gas/Oil Steam	360	383	383	383
Coal	8,615	8,615	7,258	7,258
Nuclear	1,586	1,676	2,730	2,730
Hydro	435	435	1,435	1,435
Landfill Gas/EFW	52	103	186	227
Wind	507	968	1,983	2,640
Other	15	44	51	52
Total	18,766	19,420	21,223	21,922

- Notes: 1. EFW = Energy from Waste
 2. Other generation is primarily comprised of renewable generation sources.

Renewable Generation as a Percentage of Total Sales:	2015	2020	2024
Target	10%	20%	24%
Model Results	4.7	9.5	11.9

* Renewables defined as wind, solar, EFW, LFG and biomass.

Note – The model results represent in-state generation only. Approximately half of the generation to meet the RPS is expected to come from outside of Wisconsin.

Wisconsin: Change from Reference

Sales (GWh)	2010	2015	2020	2024
Residential	(611)	(1,883)	(3,125)	(3,995)
Commercial	(1,125)	(3,453)	(5,232)	(6,335)
Industrial	(1,363)	(4,201)	(6,944)	(8,562)
Street Lights/Misc.	-	-	-	-
Resale	-	-	-	-
Total Sales	(3,099)	(9,537)	(15,301)	(18,892)
Imports	(3,179)	(9,523)	(23,438)	(23,888)

Generation Output (GWh/year)	2010	2015	2020	2024
Gas/Oil	(46)	(37)	(3,301)	(4,503)
Coal	126	336	(6,361)	(6,361)
Nuclear	-	-	7,463	7,463
Hydro	0	(0)	7,463	7,463
Landfill Gas/EFW	-	(48)	346	(990)
Wind	-	(254)	2,508	2,204
Other	-	(12)	19	(280)
Total	80	(14)	8,136	4,996

Generation Capacity (MW)	2010	2015	2020	2024
Gas/Oil Combustn. Turbine	-	-	-	(160)
Gas/Oil Combined Cycle	-	-	-	(800)
Gas/Oil Steam	-	-	-	-
Coal	55	175	(1,405)	(1,405)
Nuclear	-	-	1,000	1,000
Hydro	-	-	1,000	1,000
Landfill Gas/EFW	-	(6)	44	(125)
Wind	-	(81)	772	680
Other	-	(2)	2	(47)
Total	55	85	1,413	143

Change in Rest of Market:

Sales (GWh)	2010	2015	2020	2024
Residential	(19)	(60)	(33)	96
Commercial	(15)	(59)	(38)	120
Industrial	(108)	(542)	(578)	(115)
Street Lights/Misc.	-	-	-	-
Resale	-	-	-	-
Total Sales	(142)	(661)	(649)	101

Generation Output (GWh/year)	2010	2015	2020	2024
Gas/Oil	(54)	(1,390)	(3,834)	(4,377)
Coal	(5)	(884)	(4,338)	(670)
Nuclear	-	-	-	-
Hydro	-	-	0	-
Landfill Gas/EFW	0	(4)	418	674
Wind	-	(20)	2,624	4,640
Other	-	(4)	149	188
Total	(59)	(2,302)	(4,982)	455

Change in Rest of Region:

Sales (GWh)	2010	2015	2020	2024
Residential	-	39	130	194
Commercial	-	45	185	286
Industrial	-	151	650	1,003
Street Lights/Misc.	-	-	-	-
Resale	-	-	-	-
Total Sales	-	235	965	1,483
Imports	265	1,339	2,512	3,048

Generation Output (GWh/year)	2010	2015	2020	2024
Gas/Oil	(265)	(1,116)	(1,236)	(1,711)
Coal	-	-	(326)	125
Nuclear	-	-	-	-
Hydro	-	-	-	-
Landfill Gas/EFW	-	9	9	9
Wind	-	4	4	4
Other	-	(1)	2	9
Total	(265)	(1,104)	(1,547)	(1,565)

Change in Rest of US and Canada

Sales (GWh)	2010	2015	2020	2024
Residential	(7)	9	48	133
Commercial	-	(1)	(3)	2
Industrial	(10)	23	107	370
Street Lights/Misc.	-	-	-	-
Resale	-	-	-	-
Total Sales	(17)	31	152	505
Imports	3,134	6,592	17,733	22,183

Generation Output (GWh/year)	2010	2015	2020	2024
Gas/Oil	(1,565)	(2,881)	(3,535)	(2,530)
Coal	(1,578)	(3,684)	(14,504)	(19,742)
Nuclear	-	-	-	-
Hydro	0	-	-	79
Landfill Gas/EFW	-	-	267	387
Wind	(8)	4	190	127
Other	-	-	1	1
Total	(3,151)	(6,561)	(17,581)	(21,678)

4. Transportation Data:

There was no change in the transportation sector relative to the “all policies” case (PC01) as a result of this policy.

5. Fuel Use data

Changes in fuel use largely reflect the changes seen in Policy Case 01. The key differences for Policy Case 10 relate to the decrease in natural gas and coal use after 2020. Power sector energy use drops by 78 tBtu in 2020, but starts to rise after that time. By 2024, power sector use is 49 tBtu below Reference Case levels.

Change from Reference Case – PC10

Total Energy Use (TBtu)	2010	2015	2020	2024
Residential	(7)	(22)	(37)	(48)
Commercial	(7)	(20)	(28)	(34)
Paper	(3)	(6)	(10)	(13)
Other Energy Intensive Industry	(3)	(7)	(11)	(13)
Other Industry	(6)	(15)	(23)	(28)
Agriculture / Forestry	(0)	(1)	(1)	(1)
Passenger Transport	(7)	(71)	(98)	(111)
Freight Transport	-	-	-	-
Power Sector	1	3	78	49
Total	(31)	(139)	(131)	(199)

Total Energy Use (TBtu)	2010	2015	2020	2024
Aviation Fuel	(0)	(3)	(5)	(6)
Biomass	(0)	(1)	(3)	(4)
Coal	1	2	(64)	(67)
Diesel	(0)	(2)	(2)	(3)
Ethanol	1	0	1	1
Electric	(11)	(33)	(52)	(64)
Landfill Gas	(0)	(1)	5	(14)
LPG	(0)	(0)	(0)	(0)
Gasoline	(8)	(67)	(92)	(104)
Natural Gas	(12)	(29)	(68)	(83)
Nuclear	-	-	82	82
Oil, Unspecified	(1)	(4)	(7)	(9)
Solar	(0)	(1)	(2)	(2)
Other	0	(0)	78	75
Total	(31)	(139)	(131)	(199)

6. Energy Price Data:

Prices for oil, gas, biomass and coal are specified exogenously. The model assumes that national and world supply prices are unaffected by changes within Wisconsin.

Delivered energy prices for electricity increase relative to the Reference Case but increases in energy efficiency as a result of policies included in PC01 result in lower overall energy costs. Rate increases in the “Deep Reduction” scenario are about 2% higher than in PC01 as the higher priced generation comes into the rate base after 2020.

Policy Case 10: Changes from Reference

Electricity Prices (2005 \$ per MWh)	2010	2015	2020	2024
Residential	8.8%	17.4%	11.6%	9.3%
Commercial	10.5%	20.7%	14.1%	11.4%
Industrial	12.3%	24.2%	16.3%	13.1%
Average Retail	10.5%	20.7%	14.1%	11.4%

Residential Energy Prices (Tbtu)	2010	2015	2020	2024
Electricity (2005 \$ per MWh)	8.8%	17.4%	11.6%	9.3%
Natural Gas (2007 \$ per mmBTu)	1.1%	2.0%	1.7%	1.5%
Gasoline (2007 \$ per gallon)	0.0%	0.0%	0.0%	0.0%

Total Cost of Energy	2010	2015	2020	2024
Residential Electricity	5.8%	7.7%	-2.4%	-7.3%
Commercial Electricity	-3.7%	-11.5%	-16.7%	-18.9%
Industrial Electricity	-4.1%	-11.9%	-17.0%	-19.0%
Gasoline Passenger	-1.9%	-21.5%	-30.8%	-34.9%

7. Emissions Data:

Under the “Deep Reductions” scenario emissions decrease by about 21 Mt compared to the Reference Case within Wisconsin. As the state changes from a net importer to a supplier of power within the region, emissions in the surrounding states decrease by about 4Mt while emissions in the rest of the US and Canada decrease by 20 Mt. Overall the implementation of the “Deep Reductions” policy results in a decrease of almost 45 Mt of emissions including changes within and outside of Wisconsin.

Absolute Values for Policy Scenario: Policy Case 10

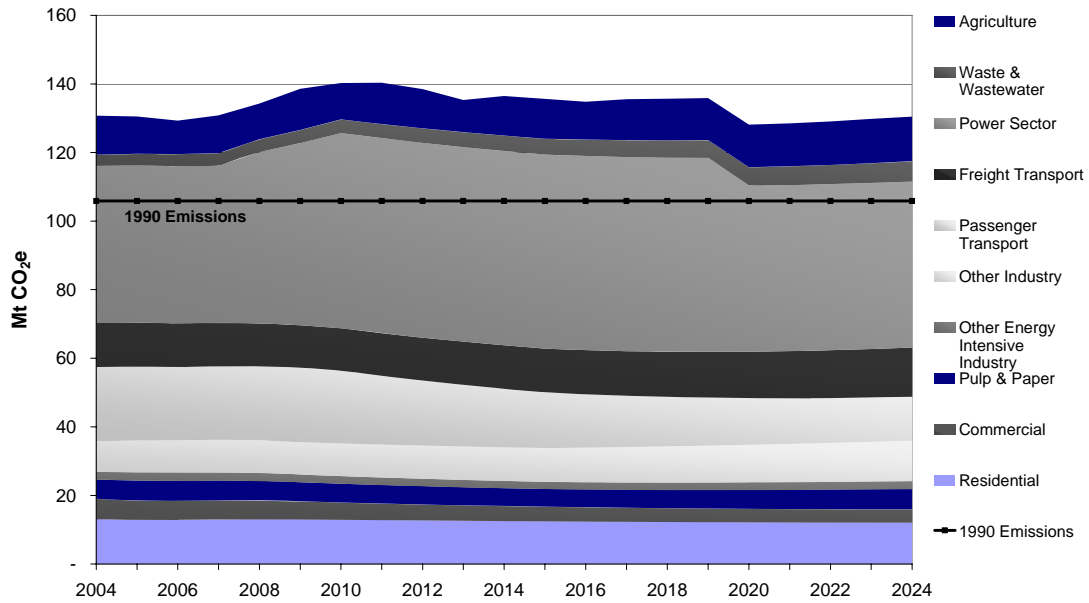
GHG Emissions (Mt)	2010	2015	2020	2024
Residential	12.9	12.5	12.2	12.1
Commercial	5.0	4.2	3.9	3.9
Pulp & Paper	5.5	5.1	5.6	5.9
Other Energy Intensive Industry	2.3	2.1	2.2	2.3
Other Industry	9.5	9.8	10.9	11.8
Agriculture	12.9	13.7	15.0	16.1
Passenger Transport	21.3	16.3	13.6	12.8
Freight Transport	12.4	12.8	13.6	14.4
Power Sector	56.8	56.6	48.4	48.4
Waste & Wastewater	3.9	4.6	5.3	5.9
Total Gross Emissions	142.5	137.7	130.7	133.6
Land Use - Forestry	(8.2)	(8.2)	(8.2)	(8.2)
Total Net Emissions	134.3	129.5	122.5	125.4

Change from Reference Case: Policy Case 10

GHG Emissions (Mt)	2010	2015	2020	2024
Residential	(0)	(1)	(1)	(2)
Commercial	(0)	(0)	(1)	(1)
Pulp & Paper	(0)	(0)	(0)	(1)
Other Energy Intensive Industry	(0)	(0)	(0)	(0)
Other Industry	(0)	(1)	(1)	(1)
Agriculture	(0)	(0)	(0)	(0)
Passenger Transport	(0)	(5)	(6)	(7)
Freight Transport	-	-	-	-
Power Sector	0	0	(9)	(9)
Waste & Wastewater	-	-	-	-
Total Gross Emissions	(1)	(7)	(19)	(21)
Land Use - Forestry	-	-	-	-
Total Net Emissions	(1)	(7)	(19)	(21)

GHG Emissions (Mt)	2010	2015	2020	2024
Residential	-2%	-6%	-11%	-14%
Commercial	-4%	-10%	-15%	-17%
Pulp & Paper	-2%	-5%	-8%	-10%
Other Energy Intensive Industry	-4%	-11%	-15%	-17%
Other Industry	-2%	-5%	-6%	-7%
Agriculture	0%	0%	0%	0%
Passenger Transport	-2%	-22%	-32%	-36%
Freight Transport	0%	0%	0%	0%
Power Sector	0%	1%	-15%	-16%
Waste & Wastewater	0%	0%	0%	0%
Total Gross Emissions	-1%	-5%	-13%	-14%
Land Use - Forestry	0%	0%	0%	0%
Total Net Emissions	-1%	-5%	-13%	-14%

Wisconsin GHG Emissions - Deep Reduction Scenario



Note – Graph shows Gross emissions and does not include sequestration.

Deep Reduction Scenario GHG Emissions - 2024

