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: 27 June 2008

Re: **High Energy Price Sensitivity Run – Reference Case**

The following describes the ENERGY 2020 model outputs for a sensitivity run in which energy supply prices were increased by 50% from levels used in the Reference Case. These cost increases were applied to the world price of oil, the well head price for natural gas, as well as coal and biomass prices. For this scenario, the model was set up to assume that new generation would be built to meet reserve margin requirements.

Two policy cases were modeled under this high price scenario: 1) the Reference Case, which includes the impacts of the Energy Independence and Security Act (EISA), and 2) Policy Case 01 which includes all policies approved for modeling by the Task Force except for the Cap & Trade policy. The results presented below compare the Reference Case with 50% higher energy prices to the original Reference Case. The original Reference Case used for comparison was consistent with the case described in the memo dated April 16, 2008 but using model results prior to feedback from the REMI model. More detailed results have been provided to the TAG in the form of Excel spreadsheets which summarize changes resulting for Wisconsin, the surrounding states and the rest of the US and Canada. The results of modeling Policy Case 01 with high energy prices are presented in a separate memorandum.

The data inputs and assumptions underlying this Reference Case are described in the Assumptions Book.

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 Case and Policy Case 01.

3. **Power Sector Data:**

The tables on the following pages show electricity sales and generation under the “high price” reference case and the percentage change in these values from the original reference case.

The increase in fuel prices leads to a slight (1%) increase in electricity sales in Wisconsin but a slight decrease (1-2%) in electricity sales in areas outside the state.

Renewable generation becomes more competitive, with the result that wind and other forms of renewables grow both within Wisconsin and in the rest of the U.S.. Wind generation declines in the immediate area as more of the renewable generation required to meet the RPS is built within Wisconsin than in the Reference Case. In-state renewable generation rises to almost 12% of Wisconsin electricity sales by 2024.

Generation fuelled by natural gas and oil declines by over 20% by 2024. Coal generation is largely unchanged from reference case levels.

Wisconsin – Absolute Values:

Sales *(GWh)*	**2010**	**2015**	**2020**	**2024**
Residential	21,850	22,966	24,773	26,373
Commercial	23,883	26,299	29,312	31,896
Industrial	33,279	35,537	41,358	45,636
Street Lights/Misc.	400	400	400	400
Resale	-	-	-	-
Total Sales	***79,412***	***85,202***	***95,843***	***104,305***
Imports	4,702	8,417	16,203	17,104

Generation Output *(GWh/year)*	**2010**	**2015**	**2020**	**2024**
Gas/Oil	4,928	4,893	6,212	6,852
Coal	54,908	54,020	54,226	53,997
Nuclear	12,115	12,802	12,802	12,802
Hydro	1,184	1,184	1,184	1,184
Landfill Gas/EFW	137	592	860	3,005
Wind	1,351	3,015	4,066	8,763
Other	88	278	291	598
Total	***74,710***	***76,785***	***79,641***	***87,201***

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	8,560	8,441	8,441	8,441
Nuclear	1,586	1,676	1,676	1,676
Hydro	435	435	435	435
Landfill Gas/EFW	52	110	143	415
Wind	507	1,056	1,379	2,806
Other	15	46	48	98
Total	***18,711***	***19,343***	***19,702***	***21,450***

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

Wisconsin – Change from Reference:

Sales *(GWh)*	**2010**	**2015**	**2020**	**2024**
Residential	0%	0%	0%	0%
Commercial	1%	1%	1%	1%
Industrial	1%	1%	1%	1%
Street Lights/Misc.	0%	0%	0%	0%
Resale	0%	0%	0%	0%
Total Sales	***1%***	***1%***	***1%***	***1%***
Imports	4%	10%	11%	-1%

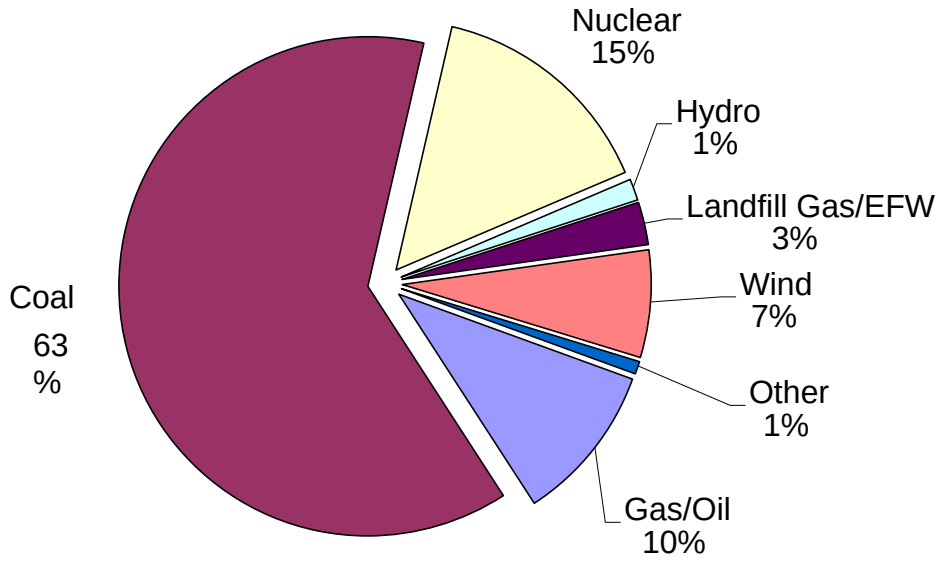
Generation Output *(GWh/year)*	**2010**	**2015**	**2020**	**2024**
Gas/Oil	6%	11%	-18%	-22%
Coal	0%	-1%	0%	0%
Nuclear	0%	0%	0%	0%
Hydro	0%	0%	0%	0%
Landfill Gas/EFW	0%	1%	1%	20%
Wind	0%	1%	16%	46%
Other	0%	0%	-1%	0%
Total	***0%***	***0%***	***-1%***	***1%***

Generation Capacity *(MW)*	**2010**	**2015**	**2020**	**2024**
Gas/Oil Combustn. Turbine	0%	0%	0%	-3%
Gas/Oil Combined Cycle	0%	0%	0%	-23%
Gas/Oil Steam	0%	0%	0%	0%
Coal	0%	0%	0%	0%
Nuclear	0%	0%	0%	0%
Hydro	0%	0%	0%	0%
Landfill Gas/EFW	0%	1%	1%	18%
Wind	0%	1%	14%	43%
Other	0%	0%	-1%	-1%
Total	***0%***	***0%***	***1%***	***0%***

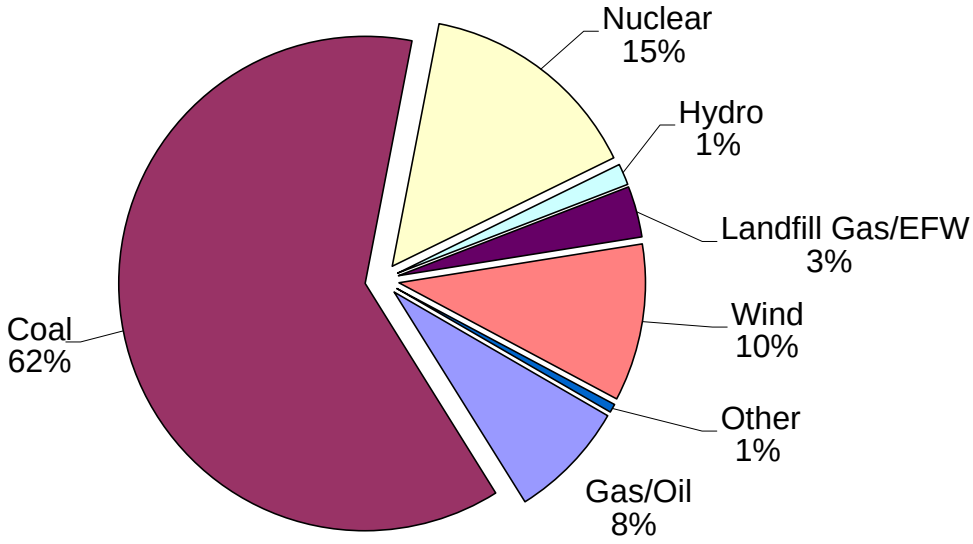
Renewable Generation as a Percentage of Total Sales:	2015	2020	2024
Target	10%	10%	10%
Model Results	4.6	5.4	11.9
* Renewables defined as wind, solar, EFW, LFG and biomass.			

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 Power Generation
Reference Case - 2024



Wisconsin Power Generation
High Energy Price Reference Case - 2024



4. **Transportation Data:**

The following tables show the change in average vehicle efficiency and distance traveled in response to the increase in energy prices. Average vehicle efficiency, already rising as a result of the CAFÉ standards in the Reference Case, increase slowly in response to higher prices as the vehicle stock is turned over. Passenger VMT decreases as travel becomes more expensive but this decrease is moderated as vehicle efficiency increases partially offset the increase in costs. Freight transportation, which is unaffected by other policies, shows a greater response to the price increase.

Average Passenger Vehicle Efficiency *(mpg)*	**2010**	**2015**	**2020**	**2024**
Light Gas Vehicles	1.9%	2.1%	1.2%	0.7%
Medium Gas Vehicles	1.9%	2.0%	1.1%	0.7%
Heavy Gas Vehicles	0.9%	0.4%	0.2%	0.1%
Heavy Gas Vehicles	0.9%	0.4%	0.2%	0.1%
Ethanol as a Percentage of Passenger Gasoline Use	-1.3%	-4.2%	-5.8%	-6.4%

Distance Travelled *(millions of VMT)*	**2010**	**2015**	**2020**	**2024**
Passenger	-0.2%	-0.4%	-0.6%	-0.6%
Freight	-1.8%	-4.8%	-6.5%	-7.3%
Passenger *(miles per person)*	-0.2%	-0.4%	-0.6%	-0.6%

5. **Fuel Use data:**

Overall fuel use declines in response to the increase in prices. The greatest increases occur in the sectors where efficiency has not been increased by prior policies, such as freight, and in the sectors where energy costs represent a significant portion of energy costs, such as the Pulp and Paper sector.

The increase in fuel prices results in increases in renewable forms of energy as they become more competitive. Electricity also becomes more competitive, as only the fossil-fuelled portion of electricity costs are affected by the price change.

Total energy use in the state drops by just over 3% as a result of the price increase. Similar decreases occur in the Region and the rest of the U.S.

Wisconsin – Change from Reference:

Total Energy Use *(TBtu)*	**2010**	**2015**	**2020**	**2024**
Residential	-0.5%	-1.7%	-2.6%	-3.2%
Commercial	0.0%	-0.3%	-0.4%	-0.4%
Paper	-1.1%	-3.2%	-4.7%	-5.3%
Other Energy Intensive Industry	-0.9%	-2.5%	-3.4%	-3.8%
Other Industry	-0.8%	-2.4%	-3.2%	-3.6%
Agriculture / Forestry	-0.3%	-0.8%	-1.1%	-1.3%
Passenger Transport	-1.5%	-2.0%	-1.9%	-2.0%
Freight Transport	-2.0%	-5.7%	-7.8%	-8.8%
Power Sector	0.3%	1.7%	-2.2%	-2.2%
Total	***-0.5%***	***-0.9%***	***-2.8%***	***-3.1%***

Total Energy Use *(TBtu)*	**2010**	**2015**	**2020**	**2024**
Aviation Fuel	-0.9%	-2.0%	-2.6%	-2.9%
Biomass	-1.3%	-3.3%	-4.1%	-4.4%
Coal	-0.1%	-2.0%	-1.4%	3.7%
Diesel	-2.0%	-6.0%	-8.4%	-9.4%
Ethanol	-2.9%	-6.1%	-7.6%	-8.3%
Electric	0.6%	0.7%	1.1%	1.4%
Landfill Gas	0.0%	331.6%	197.0%	0.4%
LPG	-1.3%	-3.6%	-5.0%	-5.7%
Gasoline	-1.6%	-1.9%	-1.7%	-1.7%
Natural Gas	-0.6%	-4.0%	-12.3%	-14.7%
Nuclear	0.0%	0.0%	0.0%	0.0%
Oil, Unspecified	-0.9%	-2.8%	-4.6%	-5.8%
Solar	1.2%	1.0%	2.0%	3.1%
Other	0.0%	14.0%	10.2%	3.9%
Total	***-0.5%***	***-0.9%***	***-2.8%***	***-3.1%***

6. Energy Price Data:

Electricity prices rise moderately as a result of the increase in fuel prices.

Electricity Prices *(2005 $ per MWh)*	**2010**	**2015**	**2020**	**2024**
Residential	3.6%	11.5%	10.6%	10.2%
Commercial	3.5%	13.0%	11.9%	11.5%
Industrial	3.7%	14.9%	13.5%	13.0%
Average Retail	3.5%	13.0%	11.9%	11.5%

Natural gas and gasoline prices rise as the increase in supply prices are reflected in delivered energy prices.

The second portion of the table below presents the effective change in actual electricity and gasoline costs, taking into account changes in both price and volumes.

Residential Energy Prices	**2010**	**2015**	**2020**	**2024**
Electricity *(2005 $ per MWh)*	3.6%	11.5%	10.6%	10.2%
Natural Gas *(2007 $ per mmBtu)*	24.8%	24.8%	24.8%	24.8%
Gasoline *(2007 $ per gallon)*	21.1%	23.2%	24.5%	25.2%

Total Cost of Energy	**2010**	**2015**	**2020**	**2024**
Residential Electricity	3.9%	11.7%	10.7%	10.5%
Commercial Electricity	25.9%	26.2%	26.7%	27.1%
Industrial Electricity	21.8%	24.1%	26.3%	27.4%
Gasoline Passenger	18.6%	20.1%	22.4%	23.5%

7. **Emission Data:**

The decrease in energy use and increase in renewable energy supply results in a decrease in GHG emissions of about 4Mt by 2024 relative to the Reference Case, bringing net emissions to 142.7 Mt. The pattern of these reductions reflects the changes in energy use described above.

Similar decreases in energy use occur outside of Wisconsin in response to the changed price signal. The exception to this is in the surrounding states where the level of renewable generation declined relative to the Reference Case. As more of this generation is built within Wisconsin rather than in these states, their emission levels increase.

Wisconsin Absolute Emissions:

GHG Emissions *(Mt)*	**2010**	**2015**	**2020**	**2024**
Residential	13.1	13.0	13.1	13.3
Commercial	5.1	4.6	4.5	4.5
Pulp & Paper	5.5	5.2	5.7	6.2
Other Energy Intensive Industry	2.3	2.3	2.5	2.7
Other Industry	9.6	10.0	11.2	12.2
Agriculture	12.9	13.7	15.0	16.1
Passenger Transport	21.4	20.5	19.7	19.8
Freight Transport	12.1	12.0	12.5	13.1
Power Sector	56.8	54.8	54.3	57.3
Waste & Wastewater	3.9	4.6	5.3	5.9
Total Gross Emissions	***142.8***	***140.8***	***143.9***	***150.9***
Land Use - Forestry	(8.2)	(8.2)	(8.2)	(8.2)
Total Net Emissions	***134.6***	***132.6***	***135.7***	***142.7***

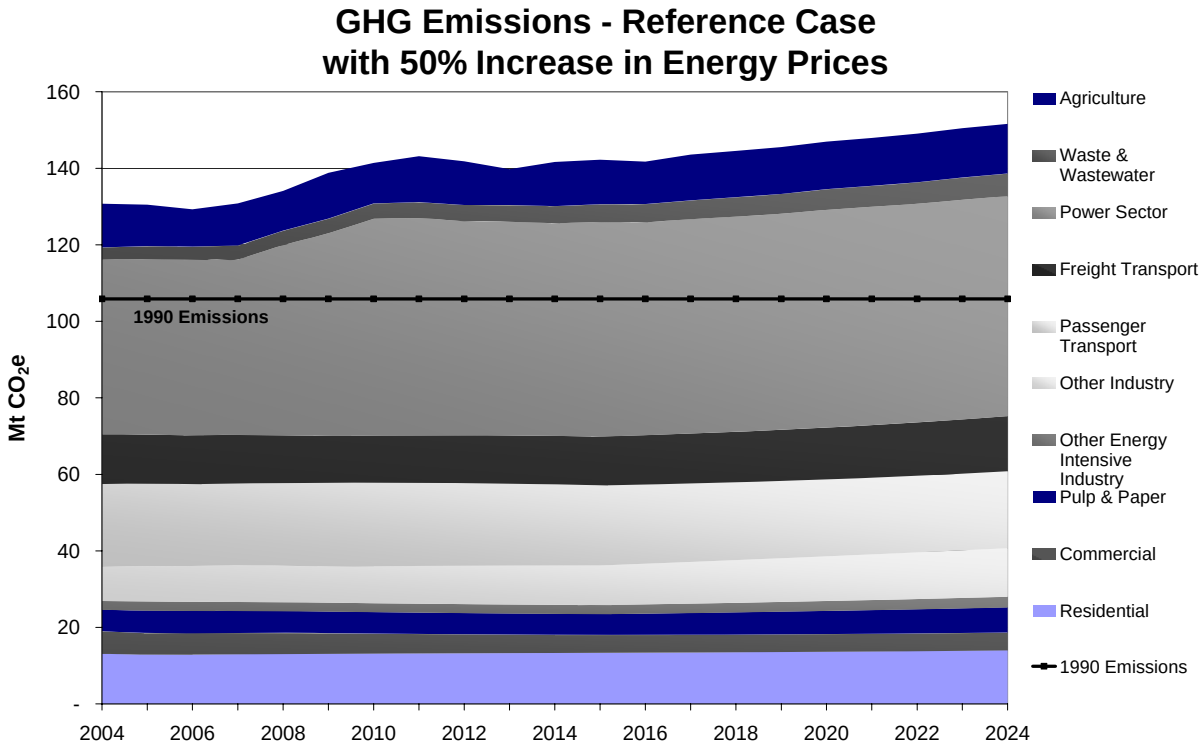
Wisconsin - Change from Reference:

GHG Emissions *(Mt)*	**2010**	**2015**	**2020**	**2024**
Residential	(0)	(0)	(1)	(1)
Commercial	(0)	(0)	(0)	(0)
Pulp & Paper	(0)	(0)	(0)	(0)
Other Energy Intensive Industry	(0)	(0)	(0)	(0)
Other Industry	(0)	(0)	(0)	(1)
Agriculture	(0)	(0)	(0)	(0)
Passenger Transport	(0)	(0)	(0)	(0)
Freight Transport	(0)	(1)	(1)	(1)
Power Sector	0	(1)	(3)	(0)
Waste & Wastewater	-	-	-	-
Total Gross Emissions	***(1)***	***(3)***	***(6)***	***(4)***
Land Use - Forestry	-	-	-	-
Total Net Emissions	***(1)***	***(3)***	***(6)***	***(4)***

GHG Emissions *(Mt)*	**2010**	**2015**	**2020**	**2024**
Residential	-1%	-3%	-4%	-5%
Commercial	-1%	-2%	-3%	-3%
Pulp & Paper	-2%	-4%	-6%	-6%
Other Energy Intensive Industry	-1%	-4%	-5%	-5%
Other Industry	-1%	-3%	-4%	-4%
Agriculture	0%	0%	0%	0%
Passenger Transportation	-2%	-2%	-2%	-2%
Freight Transport	-2%	-6%	-8%	-9%
Power Sector	0%	-2%	-5%	0%
Waste & Wastewater	0%	0%	0%	0%
Total Gross Emissions	***-1%***	***-2%***	***-4%***	***-2%***
Land Use - Forestry	0%	0%	0%	0%
Total Net Emissions	***-1%***	***-3%***	***-4%***	***-3%***

Notes:

- *Carbon sequestration from land use is based on the estimate of carbon sequestration in forestry lands presented in the report prepared for the Task Force by Winrock International. This sink was not included in the WRI inventory.*



NOTE – Graph shows gross emissions without sequestration (8.2 Mt/year)

High Energy Price Reference Case Emissions - 2024