

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: 16 April 2008

Re: **Reference Case Outputs – Including REMI Feedback**

The following describes the ENERGY 2020 model outputs for the Reference Case including the impacts of the Energy Independence and Security Act (EISA). The ENERGY 2020 and the REMI macro-economic models were run iteratively to capture the impacts of the Act and in order to establish a new economic reference case for use as a baseline in comparing the impact of future policies.

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:

A forecast of population growth and economic activity was provided from the REMI macro-economic model. This forecast projects future population growth, employment, personal income, and economic output (gross output).

The REMI forecast was provided by the Wisconsin Department of Transportation and was reviewed by the Technical Advisory Group. The TAG noted that growth in some sectors, such as pulp and paper and other energy intensive industries, appeared to be somewhat optimistic in their view, however adjusting the macro-economic model was not felt to be feasible within the available time and resources for this project.

A discussion of the REMI economic forecast is included in the Assumptions Book. The discussion which follows focuses on modeling results from the ENERGY 2020 model.

ENERGY 2020 projected future housing types based on historic trends and economic activity. Housing in Wisconsin is dominated by single family dwellings. Over the next twenty years, the model projects a little change in the split between household types.

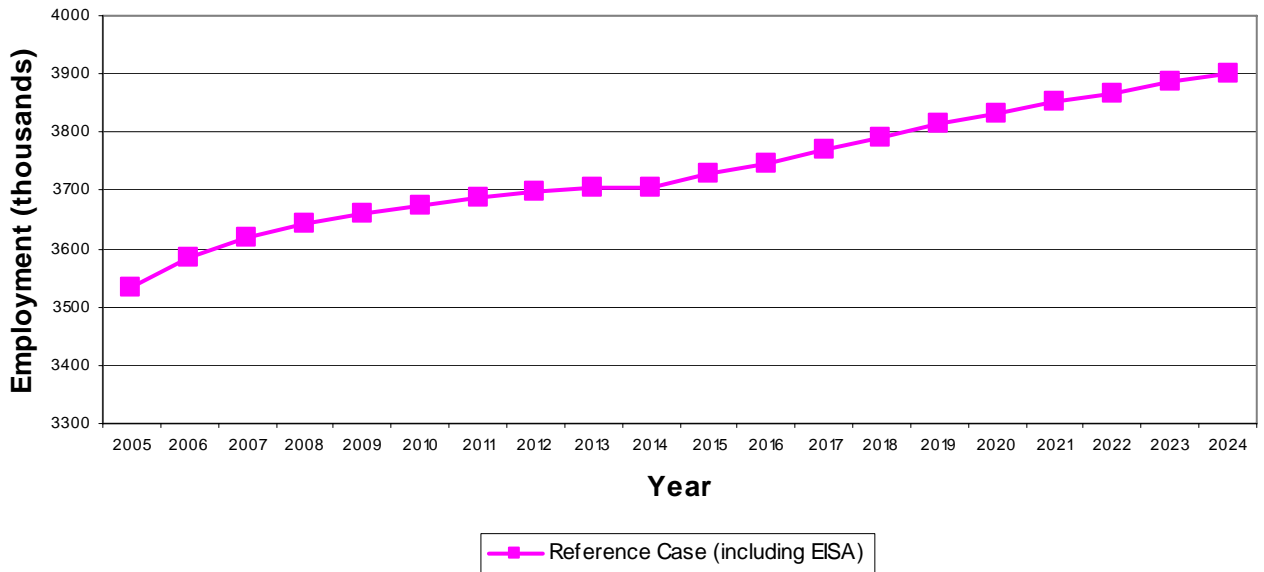
The implementation of the Energy Independence and Security Act (EISA) will result in a number of changes that will affect the cost of new vehicles, buildings and equipment and fuels. In order to isolate these impacts and create a new economic baseline, the ENERGY 2020 and REMI models were re-run to calculate the effect of these changes. The resulting economic baseline will be used as the point of reference for calculating the impacts of policy scenarios modeled for the Task Force.

The overall effect of the EISA changes were found to be relatively minor in terms of the overall economy. The models predicted very slight (less than 0.3%) decreases in employment, state product and disposable income relative to what they would otherwise have been. Given the uncertainties around the costs and savings associated with these policies these effects are felt to be well within the uncertainty band around these future values.

The following tables show the economic conditions for the Reference Case including the changes due to the EISA.

Base Case:	2005	2010	2015	2020	2024
Employment (thousands)	3,532	3,673	3,729	3,830	3,900
Gross State Product (Billions 2000 \$)	201	234	273	314	347
Real Personal Disposable Income (Billions 2000 \$)	149	164	177	193	206

Total Employment



Employment by Sector (thousands)	2005	2010	2015	2020	2024
Paper	39	37	35	37	39
Other Energy Intensive Industry	74	70	65	68	69
Other Industry	633	725	698	719	728
Commercial	2,231	2,388	2,462	2,536	2,590

3. Power Sector Data:

- Capacity (MW) by plant type
- Generation (GWh) by plant type
- Change in Capacity over period by plant type
- Change in Generation over period by plant type
- Sales (GWh) by sector
- Imports/exports to state
- Reserve margin

The model has been calibrated with historic information wherever possible. It should be noted, however, that the available data sources exhibit some differences due to differing definitions, reporting methods and other issues. The table below compares data from the model with some of the available data sources.

Comparison with Actual/Reported Values:

For 2004	Model Results	WI Stats^{1,2}	WI Stat Description
Total Generation Capacity (MW)	14,259	12,573 (a) 15,056 (b)	a) Owned generation used for Wisconsin loads, b) Total including owned & merchant
Total Generation Output (GWh)	60,445	57,987	Utility gen. inc. IPP, but excluding imports and losses.
Sales (GWh)	69,861	67,976	Sales to ultimate customers
Peak Load (MW)	12,958	13,001 - Peak 12,149 - Adjusted	Adjusted value is net of Interruptible and DR, capacity sales/purchases, etc..
For 2006	Model Results	WI Stats^{1,2}	WI Stat Description
Total Generation Capacity (MW)	15,983	12,762 (a) 16,238 (b)	a) Owned generation used for Wisconsin loads, b) Total including owned & merchant
Total Generation Output (GWh)	61,644	58,822	Utility gen. inc. IPP, but excluding imports and losses.
Sales (GWh)	74,046	69,809	Sales to ultimate customers
Peak Load (MW)	13,616	15,166 – Peak 14,022 - Adjusted	Adjusted value is net of Interruptible and DR, capacity sales/purchases, etc..

1. Demand (MW) data from: Strategic Energy Assessment Energy 2012: Final Report, Public Service Commission, February 2007, Table 2-01.

2. Energy (GWh) data from: 2007 Wisconsin Energy Statistics Report, page 46.

- Sales, total generation and capacity are in 2004 and 2006 are unchanged from prior results.
- Total capacity has been calibrated to the NEEDS database and compared with the Strategic Energy Assessment report for 2004 and 2006.
- Generation output has been calibrated to reported production by the Energy Information Administration and is slightly higher than values reported in the Wisconsin Energy Statistics.
- Peak loads shown from the model are unadjusted for demand reduction or interruptible loads. Modeled peak demand matches well for 2004 but is below the reported value for 2006. This is one of the reasons why the reserve margins shown for 2006, 2010 and 2015 shown in the following table appears to be high. Variations in the peak load are expected due to changing weather conditions at the time of the system peak but are not captured in the modeling.

Electricity Sales (GWh)						
Sector	2004	2006	2010	2015	2020	2024
Residential	19,203	20,148	21,805	23,086	25,063	26,806
Commercial	21,800	22,272	23,722	26,371	29,592	32,333
Industrial	28,438	31,226	33,137	35,625	41,716	46,133
Street Lights/Misc.	400	400	400	400	400	400
Resale	20	-	-	-	-	-
Total Sales	69,861	74,046	79,064	85,482	96,771	105,672
Net Imports to Region	9,416	12,402	(1,140)	3,866	12,720	16,169

Generation Output (GWh/year)						
Plant Type	2004	2006	2010	2015	2020	2024
Gas/Oil	3,146	6,226	10,509	9,431	9,967	13,776
Coal	42,141	40,043	54,909	54,020	54,226	54,226
Nuclear	11,888	12,234	12,115	12,802	12,802	12,802
Hydro	1,981	1,679	1,184	1,184	1,184	1,184
Landfill Gas/EFW	114	110	133	419	944	1,283
Wind	1,175	1,349	1,283	3,374	4,014	4,967
Other	-	4	72	386	913	1,265
Total	60,445	61,644	80,204	81,616	84,051	89,503

Generation Capacity (MW)						
Plant Type	2004	2006	2010	2015	2020	2024
Gas/Oil Combustn. Turbine	5,248	6,793	4,517	4,517	4,517	4,517
Gas/Oil Combined Cycle			2,679	2,680	2,881	4,482
Gas/Oil Steam			360	383	383	383
Coal	6,882	6,984	8,560	8,441	8,441	8,441
Nuclear	1,583	1,586	1,586	1,676	1,676	1,676
Hydro	447	447	447	447	447	447
Landfill Gas/EFW	60	52	52	88	154	197
Wind	39	121	484	1,166	1,363	1,653
Other	-	-	12	63	149	206
Total	14,259	15,983	18,697	19,460	20,011	22,001

Notes: 1. EFW = Energy from Waste

2. Other generation is primarily comprised of renewable generation sources.

Peak Loads (MW)	2004	2006	2010	2015	2020	2024
Annual Peak Load	12,958	13,616	14,483	15,666	17,653	19,234
Reserve Margin Calculation						
Adjusted Peak Load (net of Demand Reduction and Interruptible Load)	12,103	12,761	13,628	14,811	16,798	18,379
Adjusted Generation Capacity (Including out-of-state generation devoted to WI & 15% of wind capacity)	15,062	16,716	19,122	19,305	19,689	21,432
Estimated Reserve Margin -	23%	29%	38%	29%	16%	16%

- The reserve margin rises above target levels in 2010 to 2015 period and remains above target levels as planned new capacity and generation to meet

the RPS is added. As mentioned above, the model does not attempt to reflect annual variations in peak demand due to weather variations or other factors. These variations in the peak load are not expected to have a material impact on GHG emissions from the power sector.

- Gas generation capacity rises as the contribution of wind increases, reflecting the assumed limited contribution of wind power at the time of the system peak.
- For modeling purposes adjustments to reflect demand reduction, interruptible loads and out-of-state resources are assumed to remain at current levels.

The TAG and PSC provided a consolidated forecast of energy and demand growth for the state based on a weighted average of the compound growth rates submitted by utilities serving the state as part of their Strategic Energy Assessment (SEA) submissions.

These are the weighted averages of the compound growth rates requested for demand and energy in the SEA docket, the Commission’s biennial energy assessment for the years 2007 through 2014.

PEAK DEMAND compound annual growth rate of 2.1%

TOTAL ENERGY compound annual growth rate of 1.8%

Note: Numbers are preliminary and may be subject to minor revisions

The model projects growth in peak demand over the period to 2024 at the same rate as the PSC forecast. Growth in energy sales in the model is slightly higher (by 0.3%) than the forecast by the PSC. It should be noted that the PSC forecast only extends to 2014, whereas the model projection runs to 2024. Inclusion of the EISA lowers electricity growth rates to below the PSC forecast.

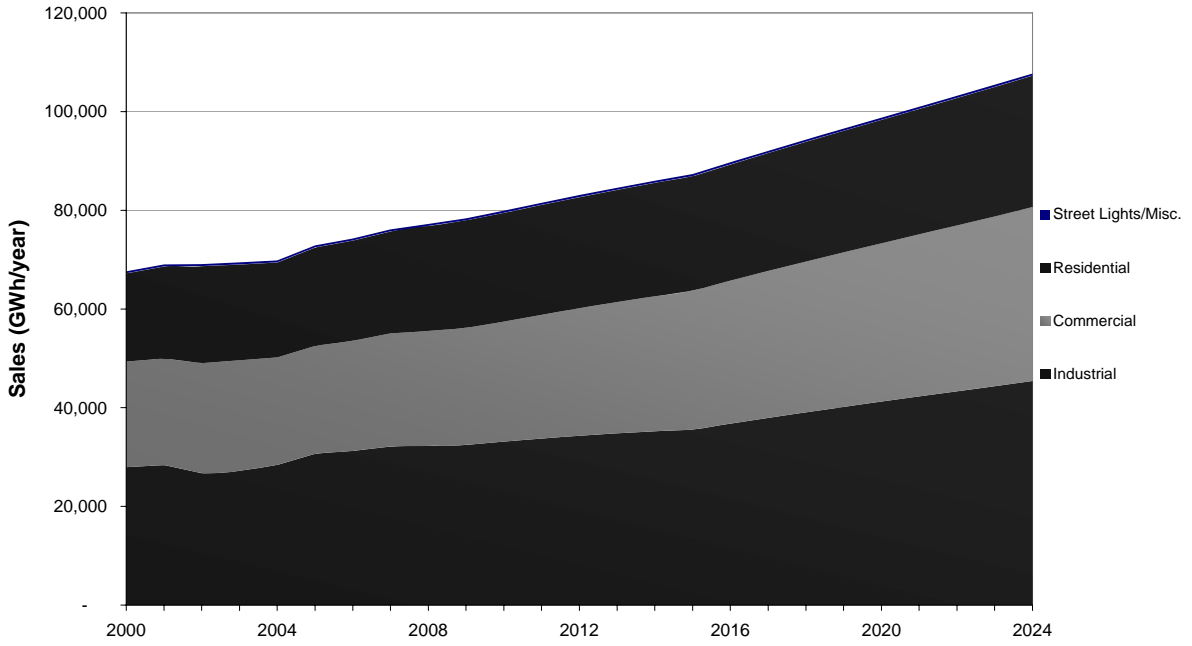
In-State Renewables	2015	2020	2024
- as % of Total Sales	4.9	6.1	7.1

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

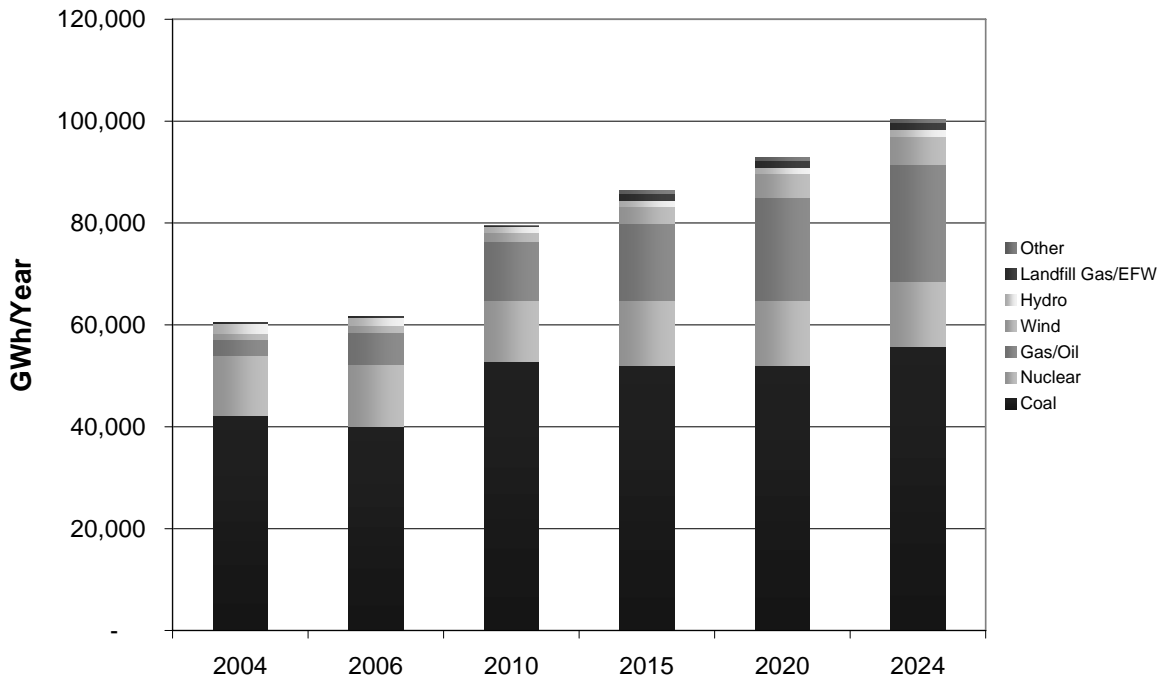
Note – The model results represent in-state generation only. Approximately half of the generation to meet the RPS is expected to come from outside of Wisconsin.

The RPS provisions are met by wind, energy-from-waste, landfill gas and biomass by 2010; with the majority of the new supply from wind. Some solar is added in the latter part of the period. Approximately half of the renewable generation required to meet the target of 10% of sales is assumed to be developed out-of-state.

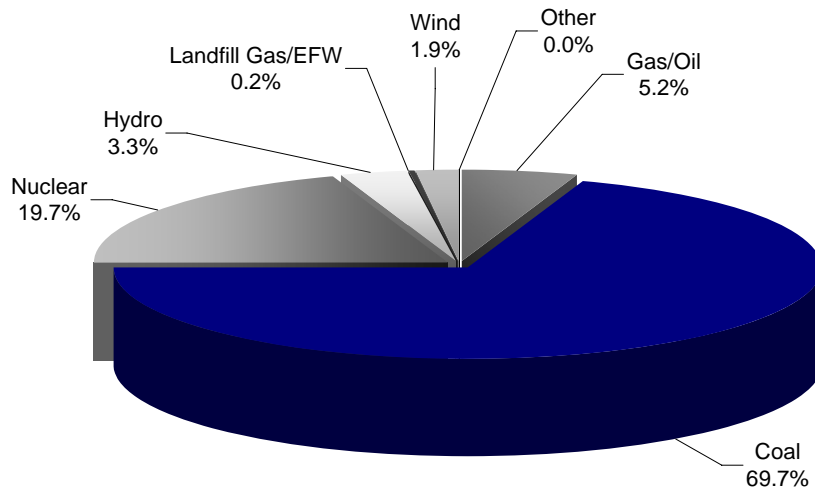
Electricity Sales Reference Case



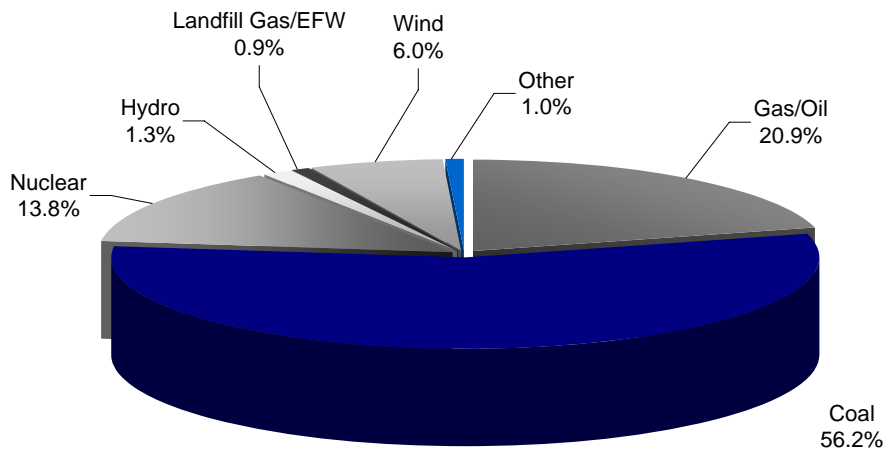
Generation Output



Generation by Type - 2004 Share of Generation (GWh) Output



Generation by Type - 2024 Share of Generation (GWh) Output



- Regional and national sales and generation have also been modeled but have not been subject to the same level of review as data for Wisconsin. These regional and national results will be used to indicate directional changes in generation and emissions as a result of modeled policies.
- Generation results were checked for reasonableness using available data for the ECAR, MAIN and MAPP regions from the Energy Information Administration's Energy Outlook 2007. The modeling results were judged to be reasonable however it must be noted that the "region" as defined for this analysis does not align with the reliability districts reported in the AEO.

4. Transportation Data:

- Demand for transportation by type (passenger, freight, off road)
- Energy use for transportation by type (passenger, freight, off road)
- Vehicle efficiency (fleet average for passenger and freight)
- Ethanol as % of total passenger transportation fuel use

ENERGY 2020 models passenger, freight and off-road transportation separately based on different underlying drivers. Passenger and freight transportation are modeled by mode and vehicle type. The figure below shows the projected increase in transportation demand, in terms of passenger miles traveled and tonne-miles of freight, for the historic and forecast period.

Growth in transportation demand and energy use was reviewed against available information from the Wisconsin Department of Transportation. The WI DoT forecast for the period 2005 to 2030 projects that passenger vehicle miles travelled (VMT) will increase at 1.32% per year, while commercial/freight VMT will grow at 2.00% per year. The BAU baseline provided by the DoT indicates 2005 personal vehicle miles travelled of about 64.7 billion and commercial/freight VMT of 11.4 billion.

- Initial levels of VMT use for passenger transportation are below reported actual values however growth rates are higher than projected by the DOT.
- Initial levels of freight VMT are higher than DOT expectations but growth rates are lower than the DOT forecast.
- The efficiency of new vehicles rises by approximately 19% as a result of the requirements of the Energy Act.

Marginal Vehicle Efficiency (miles/gallon)						
	2004	2006	2010	2015	2020	2024
Light Gas Vehicles	30.9	32.1	33.7	36.9	41.9	45.4
Medium Vehicles	26.8	28.2	30.0	33.0	37.7	41.0
Heavy Vehicles	20.7	21.1	21.6	23.3	25.2	25.9
Heavy Diesel	20.7	21.2	21.8	23.6	25.5	26.3
	2004	2006	2010	2015	2020	2024
Ethanol as a % of Gasoline Used for Passenger Transportation*	2.8%	2.8%	4.2%	6.5%	9.0%	10.7%

*This represents total statewide use of ethanol.

Six of the counties in southeastern Wisconsin are covered by a requirement under the Clear Air Act¹ which requires that ethanol comprise at least 10% of all gasoline sold. According to information provided by the Transportation Working Group these counties represent approximately 25-30% of gasoline sales in the state.

Information on historic levels of ethanol use is also available from the Wisconsin Energy Statistics. According to the 2007 report, 8.7 trillion Btu's of ethanol were used in the state in 2004². Modeled levels of ethanol use are very close to reported values for the historic period.

Ethanol use increases from just under 3% of total fuel use to almost 11% by 2024 as a result of Energy Act requirements.

5. Fuel Use data:

- Demand by sector
- Energy use by fuel type

Total Energy Use (TBtu/year)						
Sector	2004	2006	2010	2015	2020	2024
Residential	275	278	291	300	316	330
Commercial	174	170	168	168	176	186
Paper	108	108	102	98	107	116
Other Energy Intensive Industry	75	78	78	80	88	95
Other Industry	138	146	150	157	177	192
Passenger Transportation	332	329	334	326	318	322
Freight Transportation	185	181	175	180	191	203
Agriculture	9	9	9	10	10	11
Power Sector	656	662	767	759	780	813
Total	1,952	1,959	2,074	2,077	2,164	2,269

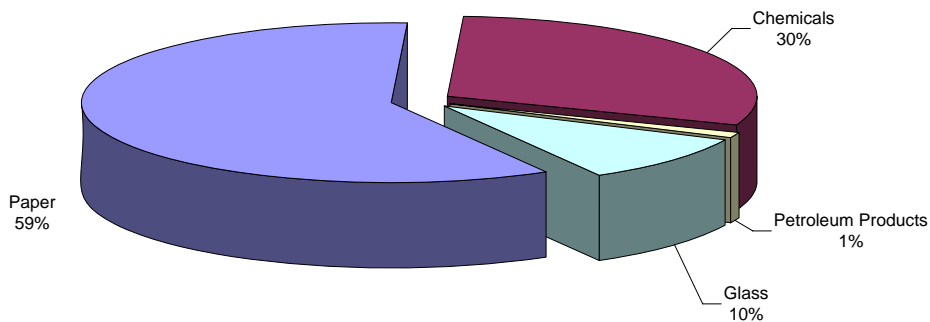
¹ EPA fuel oxygenate rules designed to reduce VOC emissions in ozone non-attainment areas.

² 2007 Wisconsin Energy Statistics, page 60.

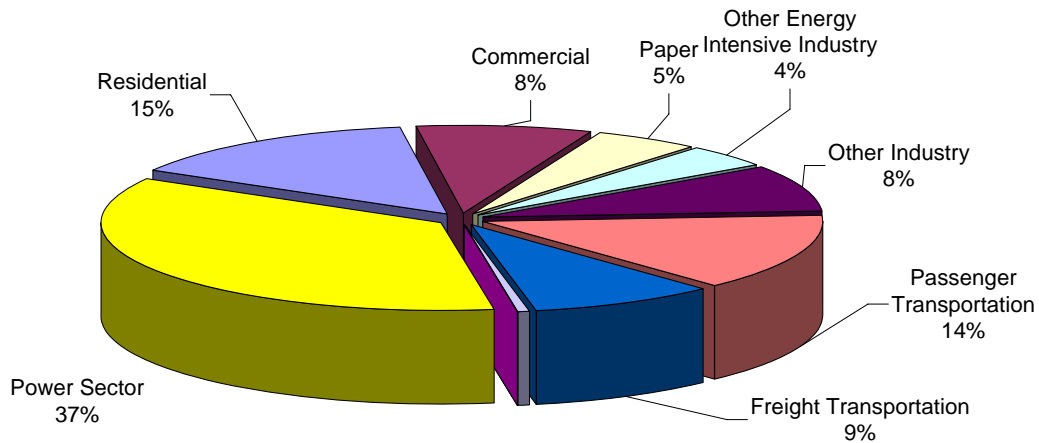
Total Energy Use (TBtu/year)						
Fuel Type	2004	2006	2010	2015	2020	2024
Aviation Fuel	12.9	13.3	14.1	14.9	16.2	17.4
Biomass	45.9	45.3	45.4	45.5	47.9	49.4
Coal	510.2	516.0	609.3	597.6	604.9	609.3
Diesel	176.7	175.3	169.2	171.7	181.0	191.0
Ethanol	8.6	8.6	12.9	19.5	26.4	31.5
Electric	236.9	251.3	268.4	290.3	328.8	359.2
Landfill Gas	-	1.8	1.8	5.7	12.9	17.5
LPG	2.3	2.2	2.2	2.2	2.4	2.5
Gasoline	316.2	312.4	312.8	297.6	283.7	282.4
Natural Gas	415.3	425.0	429.3	413.6	434.1	476.3
Nuclear	121.9	122.4	122.4	129.4	129.4	129.4
Oil, Unspecified	85.6	72.5	71.0	69.4	69.7	70.8
Solar	7.8	8.9	10.2	11.7	13.4	14.7
Other	11.2	4.0	5.4	8.1	13.7	17.5
Total -	1,952	1,959	2,074	2,077	2,164	2,269

- Historic levels of energy use were calibrated with actual energy use reported in the Wisconsin Energy Statistics.
- Where possible end use efficiencies were also calibrated to available data for Wisconsin.

Energy Intensive Industries 2004 Energy Use



Energy Use by Sector - 2024



6. Energy Price Data:

- Prices by fuel type by sector
- Energy prices based on high price scenario as defined by the TAG.

Energy Prices (2007 \$'s)		2004	2006	2010	2015	2020	2024
Electricity Units							
Residential	MWh	\$76.34	\$84.10	\$80.81	\$76.45	\$77.70	\$79.25
Commercial	MWh	\$68.33	\$70.05	\$67.09	\$63.25	\$64.63	\$66.19
Industrial	MWh	\$57.00	\$57.68	\$54.90	\$51.52	\$53.45	\$55.17
Average Retail	MWh	\$68.33	\$70.05	\$67.09	\$63.25	\$64.63	\$66.19
Natural Gas							
Residential	Mcf	\$13.44	\$16.63	\$16.73	\$15.50	\$15.84	\$15.84
Commercial	Mcf	\$11.91	\$14.85	\$14.21	\$14.21	\$14.21	\$14.21
Industrial	Mcf	\$11.08	\$12.83	\$13.33	\$13.33	\$13.33	\$13.33
Transportation Fuels							
Gasoline	gallons	\$2.34	\$3.29	\$3.29	\$3.55	\$3.74	\$3.83
Diesel	gallons	\$2.37	\$3.55	\$3.56	\$3.84	\$4.06	\$4.16
Biomass							
Residential	MBtu	\$5.20	\$11.53	\$11.50	\$13.53	\$15.10	\$15.84
Commercial	MBtu	\$3.76	\$10.09	\$10.06	\$12.09	\$13.66	\$14.40
Industrial	MBtu	\$3.76	\$10.09	\$10.06	\$12.09	\$13.66	\$14.40
Coal							
Power	MBtu	\$2.68	\$3.27	\$3.33	\$3.28	\$3.30	\$3.35
Industrial	MBtu	\$1.68	\$2.03	\$2.07	\$2.02	\$2.04	\$2.09

- Energy prices for natural gas, oil, biomass and coal are specified exogenously based on the high energy price scenario.
- Electricity prices rise between 2004 and 2006 but remain relatively flat in real terms to 2024.

7. Emission Data:

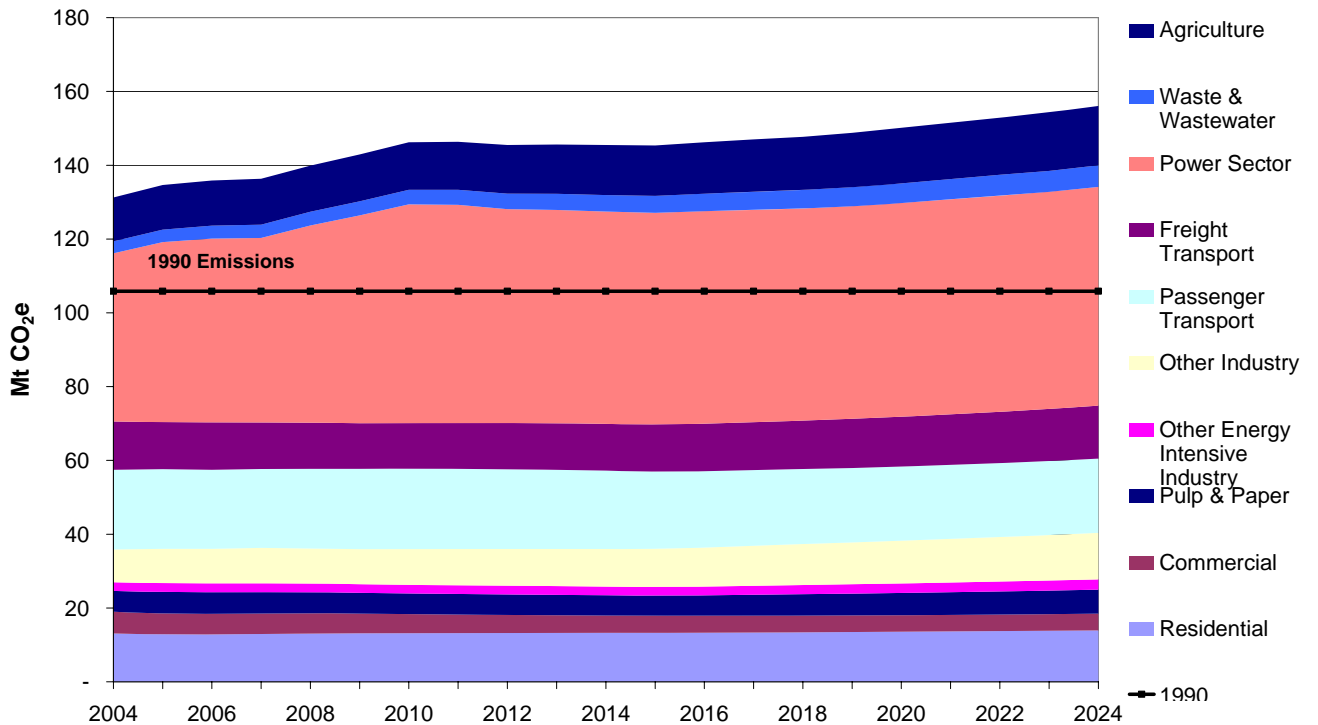
Wisconsin:

GHG Emissions (Mt)	2004	2006	2010	2015	2020	2024	Average Annual % Change
Residential	13.1	12.9	13.2	13.3	13.6	13.9	0.3%
Commercial	5.9	5.6	5.2	4.7	4.5	4.5	-1.3%
Pulp & Paper	5.6	5.8	5.6	5.4	6.0	6.5	0.7%
Other Energy Intensive Industry	2.3	2.4	2.4	2.4	2.6	2.8	0.8%
Other Industry	8.9	9.4	9.7	10.3	11.6	12.6	1.7%
Agriculture	11.9	12.2	12.9	13.7	15.0	16.1	1.5%
Passenger Transport	21.6	21.4	21.8	20.9	20.1	20.1	-0.4%
Freight Transport	13.1	12.7	12.4	12.7	13.5	14.3	0.5%
Power Sector	45.6	49.9	59.3	57.4	57.9	59.3	1.3%
Waste & Wastewater	3.2	3.5	3.9	4.6	5.3	5.9	3.0%
Total Gross Emissions	131.3	135.8	146.2	145.3	150.1	156.1	0.9%
Land Use - Forestry	(8.2)	(8.2)	(8.2)	(8.2)	(8.2)	(8.2)	0.0%
Total Net Emissions	123.1	127.6	138.0	137.1	141.9	147.9	0.9%

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.
- The WRI inventory for 2003 estimated emissions at 123.1 Mt. The model results show gross emissions of 130 Mt in 2004, excluding sinks.
- Emissions for the Region and the balance of the US have also been modeled, but have not been subject to the same level of review as data for Wisconsin or calibrated to actual reported values. These results will be used to indicate directional changes in emissions as a result of modeled policies.
- The EPA reported gross GHG emissions for the US as a whole in 2005 at 7,260 Mt of CO₂e. Total gross emissions reported by the model for 2006 total 7,661 Mt CO₂e.

GHG Emissions - Reference Case



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

GHG Reference Case Emissions 2024

