THE ECONOMIC AND ENVIRONMENTAL IMPACTS OF CLEAN ENERGY DEVELOPMENT IN ILLINOIS

Prepared for

The Illinois Department of Commerce and Economic Opportunity

June 2005

ENERGY RESOURCES CENTER
UNIVERSITY OF ILLINOIS AT CHICAGO
ESTABLISHED 1973

Energy Resources Center, 851 South Morgan Street, 12th Floor, Chicago, Illinois 60607
Phone (312) 996-4490 • Fax (312) 996-5620 • http://www.erc.uic.edu

THE ECONOMIC AND ENVIRONMENTAL IMPACTS OF CLEAN ENERGY DEVELOPMENT IN ILLINOIS

Prepared by:

Athanasios D. Bournakis, Ph.D.
John J. Cuttica,
Steffen Mueller, Ph.D.
The Energy Resources Center
University of Illinois at Chicago

and

Geoffrey J.D. Hewings, Ph.D.
The Regional Economics Application Laboratory
University of Illinois at Urbana-Champaign

Submitted to:

The Illinois Department of Commerce
and Economic Opportunity

June 2005

LEGAL NOTICE

This report was prepared by the Energy Resources Center of the University of Illinois at Chicago (UIC) and the Regional Economics Application Laboratory of the University of Illinois at Urbana-Champaign (UIUC). This work was performed under an agreement with the Illinois Department of Commerce and Economic Opportunity (DCEO) and its contents are solely the responsibility of the authors and do not necessarily represent the official views of the DCEO, UIC, UIUC, officers, trustees, or staff of these organizations, nor any person acting on their behalf:

1. Makes any warranty or representation, expressed or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any apparatus, methods, or process disclosed in this report may not infringe upon privately owned rights; or
2. Assumes any liability with respect to the use of, or for damages resulting from the use of, any information, apparatus, method, or process disclosed in this report.

ACKNOWLEDGMENTS

The authors gratefully acknowledge the significant contribution provided by the personnel of the Illinois Environmental Protection Agency, the Illinois Department of Commerce and Economic Opportunity, Bureau of Energy and Recycling, the Illinois Department of Commerce and Economic Opportunity, Office of Coal Development, the Energy Resources Center of the University of Illinois at Chicago, and the Regional Economics Application Laboratory of the University of Illinois at Urbana-Champaign in creating this report.

TABLE OF CONTENT

LEGAL NOTICE iv
ACKNOWLEDGMENTS v
TABLE OF CONTENT vi
LIST OF TABLES vii
LIST OF FIGURES ix
EXECUTIVE SUMMARY 1
CHAPTER 2 - ILLINOIS ENERGY OUTLOOK 3
CHAPTER 3 - RENEWABLE ENERGY 6
WIND RESOURCES 8
SOLAR RESOURCES 10
GEOTHERMAL RESOURCES 12
HYDROPOWER RESOURCES 12
BIOMASS RESOURCES 13
Biomass Resource: Landfill Gas 13
Biomass Resource: Mill Wastes, Forest Residues, Agricultural Residues, and Switchgrass 15
Biomass Resource: Animal Manure 17
PROPOSED RENEWABLE RESOURCES PORTFOLIO 20
CHAPTER 4 - ENERGY EFFICIENCY MEASURES 28
RESIDENTIAL ENERGY EFFICIENCY ELECTRICITY SAVINGS 29
COMMERCIAL ENERGY EFFICIENCY ELECTRICITY SAVINGS 34
INDUSTRIAL ENERGY EFFICIENCY ELECTRICITY SAVINGS 39
TOTAL ENERGY EFFICIENCY SAVINGS 49
CHAPTER 5 – OTHER ENVIRONMENTALLY BENIGN GENERATION 52
NATURAL GAS-FIRED COMBINED HEAT AND POWER SYSTEMS FOR COMMERCIAL APPLICATIONS 52
COAL-FIRED INTEGRATED GASIFICATION COMBINED CYCLE (IGCC) TECHNOLOGY 56
CHAPTER 6 - EMISSIONS ANALYSIS 58
RENEWABLE RESOURCES 59
Emissions from Renewable Resources 59
Emission Savings from Renewable Resources 64
ENERGY EFFICIENCY 69
Emissions from Energy Efficiency Measures 69
Emissions Savings from Energy Efficiency Measures 69
NATURAL GAS-FIRED CHP 70
Emissions from Natural Gas-Fired CHP in the Commercial Sector 70
Emissions Savings from Natural Gas Fired CHP 71
IGCC CLEAN COAL TECHNOLOGY 72
Emissions from IGCC Clean Coal Technology 72
Emissions Savings from IGCC Clean Coal Technology 73
COMPARISON OF EMISSION SAVINGS TO REGULATORY MANDATES 74
CHAPTER 7 - ECONOMIC IMPACTS 77
The Model 78
Local Vs. Non-Local Impacts 78
Assumptions 80
Results 80
REFERENCES 93
APPENDICES 97
APPENDIX A: RESIDENTIAL ENERGY EFFICIENCY IMPACTS 99
APPENDIX B: COMMERCIAL ENERGY EFFICIENCY IMPACTS 108
APPENDIX C: INDUSTRIAL ENERGY EFFICIENCY IMPACTS 117
APPENDIX D: EMISSIONS REDUCTIONS ANALYSIS BY INDIVIDUAL MEASURE 126
APPENDIX E: THE ILLINOIS REGIONAL ECONOMETRIC INPUT-OUTPUT MODEL 128
APPENDIX F: ECONOMIC IMPACTS - DETAILED RESULTS 132

LIST OF TABLES

Table 2- 1: Electricity Consumption Growth Rates 3
Table 2- 2: Projected Illinois Electricity Consumption (MWh) 4
Table 2- 3: Projected Illinois Electric Generating Capacity and Electricity Generation 5

Table 3- 1: Estimated Illinois Renewable Energy Procurement Requirement Targets 6
Table 3- 2: Estimated Energy from Renewable Resources (MWh) and Installed Nameplate Generation Capacity (MW) 7
Table 3- 3: Class 4 Wind Power Assumptions 9
Table 3- 4: Class 3 Wind Power Assumptions 10
Table 3- 5: Solar Power Assumptions 11
Table 3- 6: Landfill Gas Electricity Generation Assumptions 15
Table 3- 7: Biomass Co-Firing Electricity Generation Assumptions 17
Table 3- 8: Biomass Gasification Electricity Generation Assumptions 17
Table 3- 9: Manure Biomass Electricity Generation Assumptions 19
Table 3- 10: Renewable Resources Energy Procurement Requirements 20
Table 3- 11: Illinois Potential Installed Generation Capacity 21
Table 3- 12: Cost of Electricity per kWh ($/kWh) 22
Table 3- 13: Incremental New Generating Capacity Installations 23
Table 3- 14: Annual Incremental Delivered Energy from Renewable Resources 24
Table 3- 15: Annual Delivered Energy from Renewable Resources 25
Table 3- 16: Renewable Generation Annual Investment – Capital Cost 26
Table 3- 17: Conventional Electric Power System Costs 26
Table 3- 18: Renewable Generation Annual O&M Costs 27

Table 4- 1: Energy Efficiency Targets for Electricity Consumption Savings in 2020 (kWh) 28
Table 4- 2: Estimated Illinois Residential Electricity Use 29
Table 4- 3: Residential Energy Efficiency Savings 30
Table 4- 4: Cost of Residential Energy Efficiency Measures ($/kWh) 31
Table 4- 5: Net Savings for Residential Consumers ($/kWh) 32
Table 4- 6: Residential Energy Efficiency Electricity Savings, Investments, and Consumer Savings 32
Table 4- 7: Estimated Illinois Commercial Electricity Use 35
Table 4- 8: Commercial Energy Efficiency Savings 35
Table 4- 9: Cost of Commercial Energy Efficiency Measures ($/kWh) 36
Table 4- 10: Net Savings for Commercial Consumers ($/kWh) 37
Table 4- 11: Commercial Energy Efficiency Electricity Savings, Investments, and Consumer Savings 38
Table 4- 12: Estimated Illinois Industrial Electricity Use 44
Table 4- 13: Industrial Energy Efficiency Savings 44
Table 4- 14: Cost of Industrial Energy Efficiency Measures ($/kWh) 46
Table 4- 15: Net Savings for Industrial Consumers 47
Table 4- 16: Industrial Energy Efficiency Electricity Savings, Investments, and Consumer Savings 47
Table 4- 17: Total Energy Efficiency Electricity Savings, Investments, and Consumer Savings 49
Table 4- 18: Outage Costs 51

Table 5- 1: Commercial Natural Gas-Fired CHP Assumptions 53
Table 5- 2: Commercial Natural Gas CHP Delivered Capacity, Investment, Electricity Generation, and Consumer Energy Savings 53
Table 5- 3: Coal-Fired IGCC Assumptions 56
Table 5- 4: IGCC Delivered Capacity, Investment, and Cost of Electricity Generated 57

Table 6- 1: Emission Estimates from Commercial Gas Turbines at Landfills 60
Table 6- 2: Emission Estimates from Co-firing Biomass at Coal Plants 61
Table 6- 3: Emission Estimates from Biomass Gasification Electric Generating Technologies 62

Table 6- 4: Emission Estimates from Digester Gas Fired Combustion Turbines 63
Table 6- 5: SOx Emissions Savings from Renewable Resources 65
Table 6- 6: NOx Emissions Savings from Renewable Resources 66
Table 6- 7: CO2 Emissions Savings from Renewable Resources 67
Table 6- 8: Hg Emissions Savings from Renewable Resources 68
Table 6- 9: Emissions Savings from Energy Efficiency Measures 69
Table 6- 10: Emissions from Natural Gas-Fired CHP 70
Table 6- 11: Emissions Savings from Natural Gas Fired CHP 71
Table 6- 12: Emissions from IGCC Clean Coal Technology 72
Table 6- 13: Emissions Savings from IGCC Clean Coal Technology 73
Table 6- 14: CAIR and Mercury Rule Emissions Budgets for Illinois 74
Table 6- 15: Compliance Contributions from RE/EE/CHP/IGCC Measures 75

Table 7- 1: Direct Impact by Type of Expenditure 81
Table 7- 2: Total (Direct and Indirect) Impact by Type of Expenditure 82
Table 7- 3: Impacts as a Percentage of Baseline Forecasts 85
Table 7- 4: Total Impact by Residential Investment and Savings 88
Table 7- 5: Total Impact by Commercial Investment and Savings 89
Table 7- 6: Total Impact by Industrial Investment and Savings 90
Table 7- 7: Total Impact by Renewable Generation 91
Table 7- 8: Total Impact by IGCC Clean Coal Power & Commercial CHP 92

LIST OF FIGURES

Figure 1- 1: Projected Illinois Electricity Consumption (MWh) 1

Figure 3- 1: Illinois Wind Maps 9
Figure 3- 2: Illinois Solar Maps for Flat-Plate Collectors 11
Figure 3- 3: U.S. Hydropower Resource Potential 12
Figure 3- 4: Estimated Total Animal Units 18
Figure 3- 5: Cost of Electricity Generated from Renewable Resources 22
Figure 3- 6: Installed Power Generating Capacity from Renewable Resources 24
Figure 3- 7: Renewable Generation Annual O&M Cost 27

Figure 6- 1: SOx Emissions Savings from Renewable Resources 65
Figure 6- 2: NOx Emissions Savings from Renewable Resources 66
Figure 6- 3: CO2 Emissions Savings from Renewable Resources 67
Figure 6- 4: Hg Emissions Savings from Renewable Resources 68
Figure 6- 5: SO_x Emissions Reductions from RE/EE/CHP/IGCC Compared to CAIR Requirements 76
Figure 6- 6: NO_x Emissions Reductions from RE/EE/CHP/IGCC Compared to CAIR Requirements 76
Figure 6- 7: Hg Emissions Reductions from RE/EE/CHP/IGCC Compared to Mercury Rule Requirements 76

Figure 7- 1: Distribution of Impacts for 2020 83
Figure 7- 2: Distribution of Impacts by Sector for 2020 86
Figure 7- 3: Employment Impacts over Time by Program 87

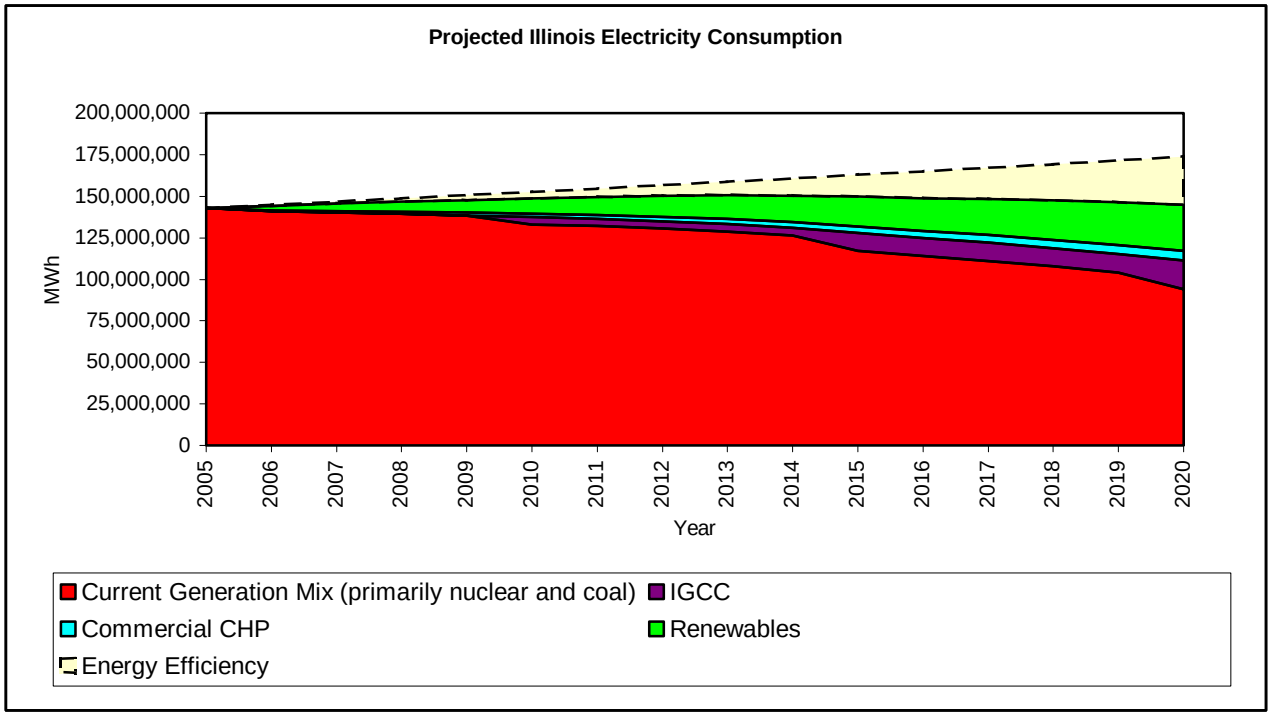
EXECUTIVE SUMMARY

This study examines the economic, employment and environmental benefits that Illinois could realize by increasing investment in

- renewable energy to 8% of electricity generated in Illinois in 2012[1], 16% by 2020
- energy efficiency to reduce electricity consumption in Illinois by about 16% in 2020
- combined heat and power (CHP) resulting in 1,570 MW by 2020
- coal-fired Integrated Gasification Combined Cycle (IGCC) resulting in 2,000 MW by 2020

Under this scenario, Illinois' electricity consumption is projected to remain approximately constant during the 2006 to 2020 period. The energy efficiency portfolio evaluated in this report would reduce electricity consumption, offsetting growth in demand and decreasing overall consumption by more than 28,000,000 MWh by 2020. Electricity generated from renewable energy sources, CHP, and IGCC in the 2006 – 2020 period will diversify Illinois' electricity generation portfolio, which currently consists of primarily nuclear and coal-fired generation.

Figure 1- 1: Projected Illinois Electricity Consumption (MWh)



[1] This mirrors the renewable energy targets proposed in Governor Blagojevich's 2005 Sustainable Energy Plan.

The study uses modeling that allows estimations of both direct and indirect economic impacts from the scenarios under review. The study finds that increasing investment in renewable energy resources, energy efficiency, CHP, and IGCC would increase total economic output in Illinois by $4.7 billion by 2012 and by $18 billion by 2020, and would increase income for Illinois residents by $5.5 billion by 2020. It would also result in the creation of 191,000 new jobs in Illinois by 2020, including:

- approximately 7,800 new jobs by 2012 from renewable energy development, including 1,800 jobs directly in renewable energy business sectors; and
- approximately 7,400 new jobs by 2012 as a result of improved industrial energy efficiency, including 1,800 jobs directly in industrial sectors.

The study also shows that increased use of renewables, efficiency and CHP could help Illinois make significant progress toward air pollution reductions needed in the next State Implementation Plan (SIP) in order to comply with new federal requirements to reduce power plant emissions of sulfur dioxide, nitrogen oxides and mercury. The study also finds that implementing just the renewable energy scenario would reduce sulfur dioxide and nitrogen oxides pollution by 2012 by the equivalent of four typical mid-size power plants operating today.

CHAPTER 2 - ILLINOIS ENERGY OUTLOOK

In recent years, the relationship between electricity consumption and economic growth in the United States has changed markedly. During the 1960s, U.S. electricity demand grew by more than 7 percent per year, nearly twice the rate of economic growth. By the 1990s, the relationship was reversed – with economic growth increasing by 3.7 percent per year and annual growth in electricity consumption at just under 2 percent. Several factors have contributed to this trend, including increased market saturation of electric appliances, improvements in equipment efficiency, and more stringent efficiency standards.

U.S. electricity sales are expected to grow an average of 1.8 percent per year between 2001 and 2025.[2] Residential demand for electricity is expected to grow by 1.6 percent annually between 2001 and 2025, a slower rate than in the recent past. Commercial and industrial electricity demand is expected to grow 2.2 and 1.6 percent per year, respectively.

Based on historical consumption patterns, Illinois electricity use during 2001 – 2025 is expected to grow somewhat less than the national growth rate:

Table 2- 1: Electricity Consumption Growth Rates[3]

	United States	**Illinois**	**United States**	**Illinois**
	(1991-2002)	**(1991-2002)**	**EIA Forecast**	**Estimate**
	(1)	(2,3)	**2001-2025** (4)	**2001-2025**
Residential	2.599%	2.065%	1.60%	1.27%
Commercial	3.268%	2.990%	2.20%	2.01%
Industrial	0.243%	-0.938%	1.60%	0.42%
Transportation	0.751%	0.727%	0.75%	0.73%
Total	2.076%	1.500%	1.80%	1.30%

Sources:

1. Energy Information Administration, "Monthly Energy Review", Table 7.5 Electricity End-Use. DOE/EIA-0035 (2004/12), December 2004.
2. Energy Information Administration/State Electricity Profiles 2002, pp 62.
3. Energy Information Administration/State Energy Data 2001: Consumption, pp. 104-107.
4. Energy Information Administration/Energy Annual Outlook 2003, pp 66.

[2] Annual Energy Outlook 2003 (Energy Information Administration, "Energy Annual Outlook 2003", January 2003, DOE/EIA-0383(2003).

[3] The Illinois growth rate was estimated based on the "Annual Energy Outlook 2003" projections of U.S. annual electricity consumption growth, adjusted by the differential in the annual electricity growth rate of U.S. and Illinois during the 1991-2002 period.

Based on the estimated electricity consumption growth rates for Illinois, we forecast electricity consumption for the 2006-2020 period as follows:

Table 2- 2: Projected Illinois Electricity Consumption (MWh)

Year	Residential MWh	Commercial MWh	Industrial MWh	Total MWh
2006	47,364,000	61,057,000	36,406,000	144,971,000
2007	47,966,000	62,286,000	36,559,000	146,857,000
2008	48,575,000	63,540,000	36,712,000	148,767,000
2009	49,193,000	64,819,000	36,866,000	150,702,000
2010	49,818,000	66,124,000	37,021,000	152,662,000
2011	50,452,000	67,455,000	37,176,000	154,647,000
2012	51,093,000	68,813,000	37,332,000	156,659,000
2013	51,742,000	70,198,000	37,488,000	158,696,000
2014	52,400,000	71,611,000	37,646,000	160,760,000
2015	53,066,000	73,053,000	37,803,000	162,851,000
2016	53,741,000	74,523,000	37,962,000	164,969,000
2017	54,424,000	76,023,000	38,121,000	167,115,000
2018	55,116,000	77,553,000	38,281,000	169,288,000
2019	55,816,000	79,115,000	38,441,000	171,490,000
2020	56,526,000	80,707,000	38,603,000	173,721,000

In 2002, electric generating capacity in Illinois totaled 44,713 MW, and generated 188,054,449 MWh of electricity. Illinois is a net exporter of electricity, with installed power generating capacity (and actual electricity generation) above its electricity requirements. Over the 1993-2002 period, the state's electric generating capacity has been growing at more than twice Illinois' electric consumption growth.

By 2020, projected electricity consumption of about 174,000,000 MWh per year will utilize about all of the current electricity generated (188,000,000 MWh in 2002) from the 44,713 MW of generating capacity. Illinois power producers would require significant power plant additions (about 12,000 MW capacity) to meet projected electricity demand for both Illinois customers and to continue exports to customers in other states. The following table shows estimated generating capacity and electricity generation to 2020 using the state's 1.30% growth rate in electricity consumption and maintaining the same level of exports to out-of-state customers:

Table 2- 3: Projected Illinois Electric Generating Capacity and Electricity Generation

Year	Generating Capacity MW	Electricity Generation MWh
2002	44,713	188,054,449
2003	45,295	190,500,334
2004	45,884	192,978,031
2005	46,480	195,487,954
2006	47,085	198,030,522
2007	47,697	200,606,158
2008	48,318	203,215,295
2009	48,946	205,858,366
2010	49,583	208,535,814
2011	50,228	211,248,085
2012	50,881	213,995,633
2013	51,543	216,778,916
2014	52,213	219,598,399
2015	52,892	222,454,553
2016	53,580	225,347,855
2017	54,277	228,278,788
2018	54,983	231,247,842
2019	55,698	234,255,512
2020	56,422	237,302,300

(1 MWh = 1000 kWh)

CHAPTER 3 - RENEWABLE ENERGY

The renewable portfolio standard analyzed in this report[4] requires that, by 2006, at least 2% of the electricity sold to Illinois customers be generated from renewable resources. The amount of electricity required from renewable resources increases by 1% annually until, in 2012, at least 8% of total electricity supplied to Illinois customers is generated by renewable resources and, in 2020, at least 16% is generated by renewable resources. Meeting the 8% target by 2012, and the 16% target by 2020 would require construction of renewable facilities capable of delivering about 12,500,000 MWh in 2012 and about 28,000,000 MWh in 2020. The table below shows the estimated electricity consumption requirements in MWh per year.

Table 3- 1: Estimated Illinois Renewable Energy Procurement Requirement Targets

Year	Projected Electricity Consumption MWh	Renewable Share	Total Renewable Requirement MWh	Wind Power Requirement (75%) MWh	Other Renewable (25%) MWh
2006	144,971,000	2.00%	2,899,423	2,174,567	724,856
2007	146,857,000	3.00%	4,405,700	3,304,275	1,101,425
2008	148,767,000	4.00%	5,950,669	4,463,002	1,487,667
2009	150,702,000	5.00%	7,535,081	5,651,311	1,883,770
2010	152,662,000	6.00%	9,159,701	6,869,776	2,289,925
2011	154,647,000	7.00%	10,825,307	8,118,980	2,706,327
2012	156,659,000	8.00%	12,532,690	9,399,517	3,133,172
2013	158,696,000	9.00%	14,282,655	10,711,991	3,570,664
2014	160,760,000	10.00%	16,076,021	12,057,016	4,019,005
2015	162,851,000	11.00%	17,913,621	13,435,216	4,478,405
2016	164,969,000	12.00%	19,796,302	14,847,226	4,949,075
2017	167,115,000	13.00%	21,724,926	16,293,694	5,431,231
2018	169,288,000	14.00%	23,700,369	17,775,277	5,925,092
2019	171,490,000	15.00%	25,723,524	19,292,643	6,430,881
2020	173,721,000	16.00%	27,795,297	20,846,473	6,948,824

Under the 1997 Energy Law, several electric generating technologies qualify as renewable resources. These are technologies that utilize wind, solar, certain hydro, geothermal, and certain biomass resources. For this study, landfill gas is also included in the renewable portfolio standard recommended for Illinois.

As described above, a renewable portfolio scenario, where 16% of all electricity consumption in the state is generated by renewable resources within the state by 2020, will require the construction of new wind

[4] The renewable energy targets for 2006 - 2012 mirror the targets proposed by Governor Blagojevich in the Sustainable Energy Plan process of 2005.

power generation facilities with a nameplate generation capacity of 6,838 MW, generating 20,850,000 MWh, or 75% of the total generation of 27,800,000 MWh from all renewable sources in 2020.

Table 3- 2: Estimated Energy from Renewable Resources (MWh) and Installed Nameplate Generation Capacity (MW)

Year	Total Renewable Energy (MWh)	Wind Energy (75%) (MWh)	Wind Nameplate Generation Capacity Installed (MW)	Other Renewable Energy (25%) (MWh)	Other Renewable Nameplate Generation Capacity Installed (MW)
2006	2,897,336	2,172,480	681	724,856	85
2007	4,403,945	3,302,520	1,032	1,101,425	129
2008	5,946,507	4,458,840	1,387	1,487,667	175
2009	7,533,970	5,650,200	1,748	1,883,770	221
2010	9,157,765	6,867,840	2,114	2,289,925	269
2011	10,826,847	8,120,520	2,489	2,706,327	318
2012	12,532,652	9,399,480	2,869	3,133,172	368
2013	14,284,144	10,713,480	3,329	3,570,664	419
2014	16,081,525	12,062,520	3,798	4,019,005	472
2015	17,916,245	13,437,840	4,274	4,478,405	526
2016	19,797,275	14,848,200	4,762	4,949,075	593
2017	21,724,831	16,293,600	5,262	5,431,231	669
2018	23,699,132	17,774,040	5,774	5,925,092	746
2019	25,722,287	19,291,406	6,299	6,430,881	825
2020	27,799,510	20,850,686	6,838	6,948,824	905

Illinois electricity consumption is expected to grow by approximately 30,600,000 MWh during the 2005-2020 period. Assuming that power generators are committed to maintain their current levels of electricity exports, it is expected that even with the new renewable generation capacity installed to meet the requirements for a 16% renewable portfolio scenario by 2020, additional generation capacity will be required to meet Illinois consumers' growing electricity requirements (an additional 2,800,000 MWh above the 27,800,000 MWh from renewable sources) by 2020.

In this study, we assumed that approximately 2,600 MW of delivered generation capacity will have to be installed to meet potential retirement of older power generation facilities and growth in the Illinois consumer electricity consumption beyond the electricity generated from renewable resources. In the study, the 2,600 MW of delivered power generation capacity is met with technologies that, while not included in the 1997 Energy Law as renewable resources, are nevertheless environmentally benign. Two technologies are suggested to meet the additional 2,600 MW of capacity; integrated gasification combined cycle technology (IGCC) and natural gas fired combined heat and power technology (CHP). In the following chapter, each of the technologies that constitute the renewable portfolio is discussed. The key technologies that provide capacity for additional load growth (IGCC and CHP) are discussed in the

environmentally benign generation section. The available Illinois renewable resources and their capability to meet the renewable energy requirements is described below:

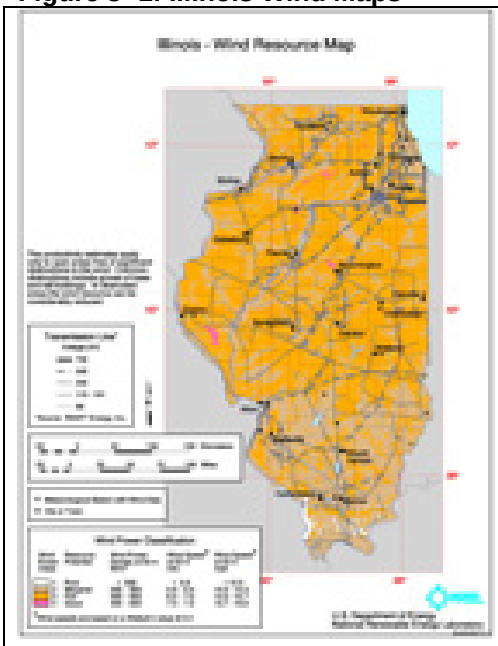
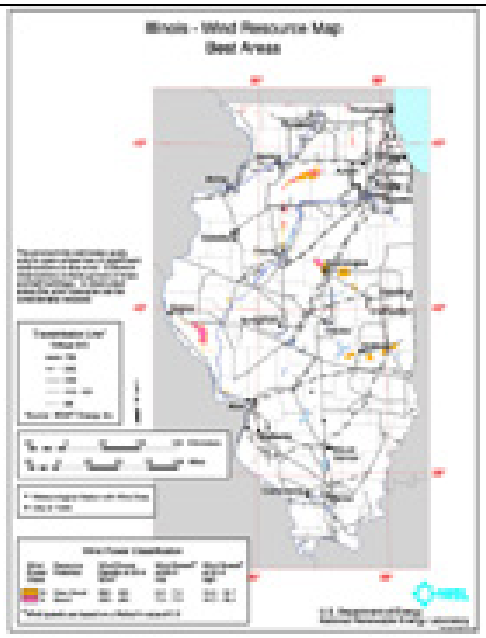
WIND RESOURCES

Over the past 15 years, significant experience has been gained from domestic wind farms in California, Hawaii, Iowa, Minnesota, Texas, and Vermont. Considerable advances have been made in the ability to design, site, install, operate, and maintain turbines, both on a single-unit level as well as part of an entire wind farm. Continued significant improvements in cost and performance of wind turbines are likely in the future.

Wind resources can be used for wholesale utility applications as well as for on-site generation. As a renewable resource, wind is classified according to wind power classes, which are based on annual average available wind energy. These classes range from class 1 (the lowest) to class 7 (the highest). In general, wind power classes from the upper range of Class 3 or higher can be useful for generating wind power with large (utility-scale) turbines.

New wind resource maps of Illinois have been produced by the Department of Energy's Wind Program and National Renewable Energy Laboratory (Energy Efficiency and Renewable Energy, U.S. Department of Energy, Wind & Hydropower Technology Program, “Illinois Wind Maps”, Updated November 17, 2004). The new information shows that Illinois has at least 3,000 MW in potential wind capacity from Class 4 wind resource areas and an additional 6,000 MW in upper-range Class 3 resources. Because the map is compiled more from topographical extrapolations than from specific tower data, the aggregate wind resource projections can be expected to be accurate, though individual sites may have a stronger or lesser resource than the map indicates.

Figure 3- 1: Illinois Wind Maps

	
This map of Illinois shows the wind resource at all levels.	This map of Illinois highlights the best areas suitable for utility-scale wind energy development.

Assumptions for wind capital costs and O&M costs were based on information from the National Renewable Energy Laboratory ("*Projected Benefits of Federal Energy Efficiency and Renewable Energy Programs (FY 2005-FY 2050)", Table 3, Appendix L, page L-4).* Wind capacity factors were modified to reflect Illinois Class 4 wind resources. The Illinois Class 4 wind capacity factor was reduced between 0.02 and 0.06 in the 2005 to 2020 period compared to the national Class 4 capacity factor projected by the National Renewable Energy Laboratory[5].

Table 3- 3: Class 4 Wind Power Assumptions

Class 4:	**2005**	**2010**	**2015**	**2020**
Capital Cost (2003 $/KW)*	$1,231	$1,017	$936	$936
Total O&M Costs (2003 $/kW-year)*	$13.4	$8.0	$7.6	$7.6
Capacity Factor for Illinois	0.36	0.38	0.39	0.40

* Source: Wind Energy Program, as reflected in *Wind Energy Program Multi Year Technical Plan, 2004–2010 (November 2003).*

For Class 3 wind turbines, we maintained the same cost information as with Class 4 wind turbines, but we reduced the capacity factor by 0.06 to 0.07 compared to Class 4 wind capacity factor, and maintained the same capacity factor throughout the 2015-2020 period (not accounting for any potential technology

[5] Most Illinois Class 4 resource is in the lower ranges of Class 4 and the capacity factor was therefore adjusted downward, and then reduced again to estimate the Illinois capacity factor for high-end Class 3 resources. Other factors will also likely impact future wind energy installation costs: technology improvements reducing costs; and higher steel prices and increasing reliance on less optimal sites (as the best sites are utilized first) increasing costs, among other influences.

efficiency improvements for a more conservative analysis). This reduced capacity factor assumption is based on the current differential in the capacity factor between Class 5 and Class 4 wind locations reported by NREL, although the capacity factor differences between these two wind class locations is eliminated by 2015.

Table 3- 4: Class 3 Wind Power Assumptions

Class 3:	**2005**	**2010**	**2015**	**2020**
Capital Cost (2003 $/KW)	$1,231	$1,017	$936	$936
O&M Costs (2003 $/kW-year)	$13.4	$8.0	$7.6	$7.6
Capacity Factor for Illinois	0.30	0.32	0.33	0.33

The discount rate for the economic analysis of wind generators is set at 8 percent (instead of the utility average of 10 percent) to reflect the accelerated depreciation schedule available for renewable-generation technologies (*Projected Benefits of Federal Energy Efficiency and Renewable Energy Programs (FY 2005-FY 2050)", page 5-29).*

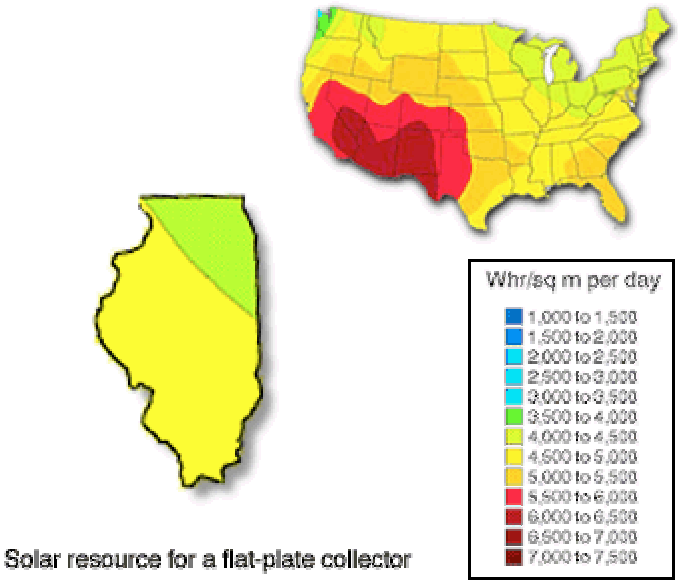
It is anticipated, that in order to meet the 16% renewable threshold (with 75% from wind energy), Illinois would install wind systems with 2,380 MW of delivered generation capacity. This can be accomplished with the installation of 6,838 MW of installed wind capacity across the state. Class 4 wind sites will be utilized initially, with Class 3 wind sites utilized after 2012.

SOLAR RESOURCES

Renewable energy technologies can convert solar energy into electricity, heating, and even cooling. But solar energy varies by location and by the time of year. Different solar technologies convert that energy in different ways, and not all of that can be converted directly into useful energy. Solar resources are greatest in the middle of the day — the same time that utility customers have the highest demand, especially during the summer months. Different types of solar technologies are available for power generation.

Flat-plate solar technologies, flat panels that collect sunlight and convert it to either electricity or heat, include solar water-heating technologies and photovoltaic (PV)-based electricity generation. This reports focuses on PV systems for electricity generation. The map below shows how much solar radiation reaches a flat-plate collector, which is installed in a tilted position, for example, on a roof. Because of their simplicity, flat-plate collectors are often used for residential and commercial building applications. They can also be used in large arrays for utility applications. In addition, Illinois could make use of certain types of solar concentrator technologies, mainly in the southwestern region of the state. Because these systems require tracking mechanisms, solar concentrators are generally used for large-scale applications such as utility or industrial use (Energy Efficiency and Renewable Energy, U.S. Department of Energy, "Illinois Solar Resources", Updated July 21, 2004).

Figure 3- 2: Illinois Solar Maps for Flat-Plate Collectors[6]



Decentralized units reflect the Million Solar Roofs installation goals for reducing end-use electricity demand from the central grid. However, this analysis concentrates on centralized generating systems to compete with conventional fossil fuel-based power plants.

Capital cost and O&M costs for centralized PV power systems were based on information from the National Renewable Energy Laboratory (*Projected Benefits of Federal Energy Efficiency and Renewable Energy Programs (FY 2005-FY 2050))*. The analysis assumes discount rates of these technologies at 8 percent (instead of the industrial average of 10 percent) to reflect the accelerated depreciation schedule available for renewable-generation technologies. Capacity factor is assumed constant, at 19.56% in average-insolation locations for flat-plate thin photovoltaics and 22.74% in average solar energy sites for PV concentrators in the East North Central Census Region (Energy Efficiency and Renewable Energy, U.S. DOE, and EPRI, "Renewable Energy Technology Characterization", TR-109496, December 1997, Appendix E). This analysis utilizes an average capacity factor of 21.15% for Illinois. The cost and performance characteristics for PV systems are shown in the table below:

Table 3- 5: Solar Power Assumptions

	2005	2010	2015	2020
Capital Cost (2003 $/KW)*	$4,607	$3,345	$2,708	$2,071
O&M Costs (2003 $/kW-year)*	$52	$34	$22	$10
Capacity Factor for Illinois	0.2115	0.2115	0.2115	0.2115

** Projected Benefits of Federal Energy Efficiency and Renewable Energy Programs (FY 2005-FY 2050)", page 5-22.*

[6] Solar resources are expressed in watt-hours per square meter per day (Wh/m^2/day).

Currently, solar power is the most expensive of the available Illinois renewable sources, and it is anticipated to be the last of the renewable sources to be installed. The high cost of solar power generation, on a $/kWh basis, makes solar power less attractive option to the other renewable resources available in Illinois. Although, other renewable sources offer better economics in electricity generation, in this analysis we have assumed that Illinois could install some (about 109 MW) solar generating capacity, with a delivered power generating capacity of 23 MW by 2020.

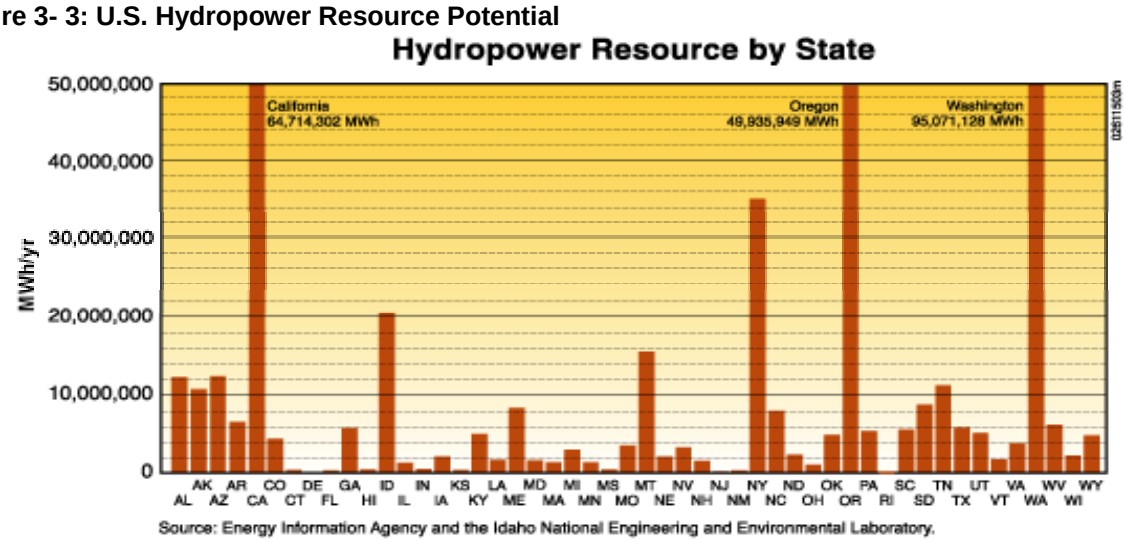
GEOTHERMAL RESOURCES

Available geothermal resources in Illinois do not meet the state's definition of renewable resources for electricity generation and were not considered for this study. Electricity generation is not possible with the current geothermal resources in Illinois (Energy Efficiency and Renewable Energy, U.S. Department of Energy, "Illinois Geothermal Resources", Updated 7/21/2004). Therefore, geothermal power is not considered in the renewable power generation portfolio for Illinois.

HYDROPOWER RESOURCES

The amount of hydropower resource varies widely among states. To have a usable hydropower resource, a state must have both a large volume of flowing water and a significant change in elevation. Illinois has a relatively low hydropower resource as a percentage of the state's electricity generation. Illinois could produce an estimated 1,485,897 MWh (see Figure 3-3) of electricity annually from hydropower. The chart below, by the Energy Information Administration and the Idaho National Engineering and Environmental Laboratory, shows the overall likely hydropower resource by state (Conner, A.M, Francfort, J.E, Idaho National Engineering Laboratory, U.S. Department of Energy "U.S. Hydropower Resource Assessment for Illinois", DOE/ID-10430(IL), January 1997). This includes both current hydropower generation as well as an estimate of potential additional resources. This estimate factored in the many legal, social, and environmental constraints on hydropower development. For Illinois, the hydropower potential represents less than 2% of the electricity generated from all sources in 2002 in Illinois.

Figure 3- 3: U.S. Hydropower Resource Potential



The “U.S. Hydropower Resource Assessment for Illinois” report identified a total of 49 sites in Illinois and assessed their undeveloped hydropower potential. The majority of the sites (59%) have potential capacities of greater than 1 MW, but less than 10 MW. The undeveloped hydropower potential total for Illinois was identified as 594 MW. The 49 identified sites are located within 9 major river basins and 1 minor river basin.

However, DOE’s Hydropower Program analysts expect that future hydroelectric capacity and generation may decrease due to environmental concerns as facilities undergo relicensing. The *AEO2003* projected relatively constant hydropower, implying that the technology was assumed to be deployed already or that the issue had not been examined. For these reasons, this analysis assumes that no new hydropower capacity will be constructed as part of the renewable energy procurement requirements for Illinois.

BIOMASS RESOURCES

Based on the differences in the conditioning of the feedstock for electricity production, this report groups biomass resources in three main categories:

- Landfill Gas
- Mill Wastes, Forest Residues, Agricultural Residues, and Switchgrass
- Animal Manure

In the following, electricity production from each of these biomass resources will be discussed in more detail.

Biomass Resource: Landfill Gas

Technology Introduction

Landfills provide a substantial opportunity for energy generation in Illinois. Decomposing solid waste produces biogas, which can be recovered at relatively low cost for energy production. Using biogas for electricity generation reduces odor from landfills and it reduces emissions of volatile organic compounds and methane, a powerful global warming gas. A wide variety of commercially available electric generating technologies can be fueled by biogas. These technologies include stationary gas turbines (including microturbines), reciprocating engines, and sterling engines.

Fuel Availability and Capacity Potential

Municipal solid waste landfills in Illinois are required to report to the Illinois Environmental Protection Agency (IEPA) annually the amount of waste they receive (Illinois Environmental Protection Agency, Nonhazardous Solid Waste Management and Landfill Capacity in Illinois, November 2004). In its 2003 annual report IEPA showed that the 50 active landfills in Illinois accepted a total of 17.3 million tons of solid waste, an increase of 4.4% from 2002.

The total electricity capacity potential from Illinois landfills was calculated as follows:

- The EPA's "First Order Decay Model" allows estimating the annual amount of biogas generated at landfills (see U.S. Environmental Protection Agency, Landfill Methane Outreach Program. Turing a Liability into an Asset: A Landfill Gas-to-Energy Project Development Handbook, EPA 430-B-96-004, September 1996, referred to as the "Landfill Methane Outreach Program Report"):

  $LFG = 2L_0 R(e^{-kc}-e^{-kt})$
  where:
  LFG = Total amount of landfill gas generated during current year (cf)
  L_0 = Methane generation potential of the waste
  (2.72 cf/lb default value, see Landfill Methane Outreach Program Report, page 2-6)
  R = the annual waste acceptance rate (lb)
  t,c = the number of years a landfill is open or closed, respectively (years)
  k= rate at which methane is released from each pound of waste
  (0.05/year default value, see Landfill Methane Outreach Program Report, page 2-6)

  This study employs the "First Order of Decay Model" to calculate the total available biogas from the 50 currently active landfills in Illinois as follows:

  Utilizing the default values for "k" and "L_0" an annual waste acceptance rate of 17.3 million tons for Illinois' landfills, and an estimated average landfill age of 15 years for landfills in Illinois, the resulting amount of landfill gas estimated to be generated each year on Illinois' 50 landfills amounts to approximately 99.3 billion cf.

- Adjusting for inefficiencies of the biogas collection process (EPA recommends applying a collection efficiency factor of between 0.75 and 0.85 (see Landfill Methane Outreach Program Report, page 2-8), and applying a Btu content ratio of 450 Btu/cf to landfill biogas results in 35,800,000 MMBtu of collectable gas per year at Illinois landfills. These gas assumptions are relatively conservative since only gas from the currently active landfills is taken into considerations, when recently closed landfills may still produce usable gas. Also, while the total waste delivered to Illinois' landfills has been steadily increasing over the years, no increase of waste was assumed till 2020; all biogas calculations are based on the reported waste numbers for 2003, a relatively conservative assumption.

- Assuming a series of 68% efficient microturbine CHP systems, the calculated heat content of 35,800,000 MMBtu in landfill biogas could fuel a total of 813 MW electric generating capacity. Utilizing 30% efficient electric generating only equipment (without waste heat recovery) would result in approximately 360 MW of capacity.

- However, according to EPA's Landfill Methane Outreach Program database, a total of 146 MW of capacity is already installed at Illinois' landfills.[7] As a result, the remaining electric generating capacity in Illinois should approximately range between 200 and 650 MW depending on the assumed efficiency of the installed generating equipment.

[7] See U.S. EPA Landfill Methane Outreach Program "Energy Projects and Candidate Landfills" http://www.epa.gov/lmop/.

Financial Assumptions

Capital cost and O&M assumptions consist of two parts: a cost component for the electric generating equipment and a cost component for the biogas collection system. The capital cost assumptions for the generating equipment assumes broad deployment of microturbine technologies with heat recovery (see U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy Programs. Projected Benefits of Federal Energy Efficiency and Renewable Energy Programs FY 2005 – FY 2050, prepared by the National Renewable Energy Laboratory, May 2004, Table 5-11, adjusted by GDP implicit price deflator). Biomass collection system capital cost were taken from the Landfill Methane Outreach Program Report for average collection system cost of a typical landfill with 1 million metric tons of waste in place and these cost were adjusted to 2003 dollars using the GDP implicit price deflator (Bureau of Economic Analysis, U.S. Department of Commerce. "Survey of Current Business", January 2005). Adding a substantial capital component for biogas collection systems as part of this study should be a relatively conservative approach since many landfills already have collection systems in place to flare landfill gas for environmental purposes.

Variable O&M costs for the generating system were taken from the MAC CHP Guidebook (Midwest CHP Application Center in Partnership with the U.S. Department of Energy, Combined Heat and Power Resource (CHP) Guide, September 2003). O&M cost for the collection system were again taken from the Landfill Methane Outreach Program Report but were adjusted to 2003 dollars using the GDP implicit price deflator. A CHP system with a combined efficiency of 68% gradually increasing to 72% was assumed consistent with DOE Table 5-11.[8]

Table 3- 6: Landfill Gas Electricity Generation Assumptions

Landfill-based Generation	2005	2010	2015	2020
Capital Cost ($/kW)	1,450	622	622	622
O&M Cost ($/kWh)	0.015	0.015	0.015	0.015
Capacity Factor	95%	95%	95%	95%

In this study, we have estimated that in order to meet the 16% renewable requirement by 2020, Illinois has to install landfill gas power generation that can deliver 365 MW of power. This is can be accomplished with the installation of 384 MW of installed generation capacity across the state by 2020.

Biomass Resource: Mill Wastes, Forest Residues, Agricultural Residues, and Switchgrass

Technology Introduction

The literature on electricity generation from mill wastes, forest residues, agricultural residues, and switchgrass generally cites three technology options (EPRI and U.S. Department of Energy. Renewable Energy Technology Characterization, December 1997): 1) Electricity generation from co-firing biomass with coal, 2) direct combustion of biomass utilizing the heat from the combustion process to generate electricity via steam turbines, and 3) gasification of biomass and subsequent combustion of the biogas

[8] The 1980 "Retail Rate Law" requires utility companies to purchase energy from landfill gas collection systems at rates above retail and then gives them a tax credit to offset the price difference. Due to uncertainties regarding proposals to eliminate the "Retail Rate Law" the impacts of the law on cost are not considered here.

utilizing combustion turbine technologies, generally with heat recovery. While biomass-gasification is a relatively new technology it is past the development stage, and this technology is now becoming commercially available. However, biomass co-firing constitutes the "nearest term low-cost option" (EPRI and U.S. Department of Energy. Renewable Energy Technology Characterization, December 1997, p. 2-2). Therefore, during the early years of the RPS timeframe, co-firing the available biomass feedstock in coal power plants takes priority over other technology options. However, in later years available biomass will be utilized in modern, biomass gasification plants, which by then will be widely commercially available. This approach (utilizing available feedstock for biomass and coal-gasification) is consistent with recent studies (Haq, 2004).

Fuel Availability and Capacity Potential

Fuel availability from mill wastes, forest residues, agricultural residues, and switchgrass was derived from a study by Oak Ridge National Laboratory "ORNL Study" (Marie Walsh, 2000). This study determines the available biomass feedstock at various delivered price levels taking into account different harvesting and transportation costs. The available biomass quantities cited in the ORNL study for Illinois were reduced to reflect biomass that is already used productively (i.e. which is already used for energy generation, for fertilizer, or other purposes), with the remaining biomass available for additional energy generation. As a result, at $30 per dry ton of biomass, an estimated amount of 7,683 dry tons are available for energy production. At $40/dry ton, an estimated amount of 25,708,441 dry tons of biomass are available for energy production in Illinois. There is a large difference in the quantity of biomass that is available at the two price levels. This is due to the fact that the higher price level offers a financial incentive for dedicated production of switchgrass. Utilizing an average heat content of 17,180 Btu/dry ton (Haq, 2004) the available biomass at $40 per dry ton could provide 441,671,016 MMBtu of energy. However, at a proven co-firing rate of 15% (DOE/EPRI, 1997), the biomass needed to co-fire 15% of the heat input of current installed Illinois coal plants is far less than the available amount, namely 147,928,545 MMBtu, or 1,484 MW of co-fired capacity (assuming an average efficiency of 34 % for current Illinois coal plants).[9] Assuming that 80% of Illinois' coal plants retrofit co-firing capabilities, there is a probable biomass co-firing capacity limit of around 1,200 MW.

Co-firing 147,928,545 MMBtu of the total available biomass in Illinois would leave approximately 293,742,472 MMBtu for other biomass electric generation technologies -- such as biomass gasification. Assuming an average heat rate for biomass gasification of 8,911 Btu/kWh (per Haq, 2004) this would result in a theoretical potential for 3,763 MW of gasification capacity. However, due to uncertainties associated with studies that assess biomass availability, the actual capacity limit may be only 1,500 MW, based on conservative assumptions that biomass is only available to serve 50% of the probable capacity, of which only 80% gets installed.

Financial Assumptions

Biomass co-firing can be employed in existing coal plants as well as new power plants. The financial assumptions for biomass co-firing used in this study are based on co-firing in new power plants. This is a relative conservative approach since the capital cost assumptions includes the cost of constructing a new coal plant with a biomass feed system as opposed to retrofitting a fully depreciated existing coal plant.

[9] An analysis of biomass feedstock available at $30 results in a very small amount of co-firing capacity of less than 50 MW. Therefore, the impact of biomass feedstock at the higher price level was explored in more detail.

Capital costs for constructing a new coal plant were assumed to be $1,083/kWh (U.S. DOE/NREL, "Technical Facts", Coal and Environmental Systems, 9/2001; cost escalated by the GDP implicit price deflator). Further, at an assumed 15% co-firing rate the plant would need to require installing a separate feed system at a cost of $223/biomass-kW, as opposed to a less expensive blended feed system at $50/biomass-kW, which is generally used for co-firing levels around 5% (see DOE/EPRI 1997 Report, page 2-38, cost figures adjusted by GDP implicit price deflator). Capital costs are assumed to decline by 1.5% per year due to economies of scale in the production and installation of this technology. Variable costs are assumed to consist of one additional operator per 10 MW of biomass capacity (per DOE/EPRI, 1997) in addition to a general variable O&M rate of $0.0031/kWh (Haq, 2004, adjusted by GDP implicit price deflator).

Table 3- 7: Biomass Co-Firing Electricity Generation Assumptions

Biomass Co-Firing	2005	2010	2015	2020
Capital Cost ($/kW)	1,306	1,211	1,123	1,041
O&M Cost ($/kWh)*	0.03	0.03	0.03	0.03
Capacity Factor**	100%	100%	100%	100%

*O&M Cost include variable, fixed, and fuel cost

**assumes 15 % co-firing of current coal capacity on a heat-input basis

Cost assumptions for biomass gasification were taken from Haq (2004, escalated by GDP implicit price deflator) with current capital costs of $1,828/kW declining to $1,381/kW by 2020 and current variable O&M cost at $0.0031/kWh and fixed O&M cost at $47.65/kW. The discount rate for biomass generators is set at 8 percent (instead of the utility average of 10 percent) to reflect current renewable incentives.

Table 3- 8: Biomass Gasification Electricity Generation Assumptions

Biomass Gasification	2005	2010	2015	2020
Capital Cost ($/kW)	1,828	1,679	1,530	1,381
O&M Cost ($/kWh)*	0.029	0.029	0.029	0.029
Capacity Factor	95%	95%	95%	95%

*O&M Cost include variable, fixed, and fuel cost

Biomass Resource: Animal Manure

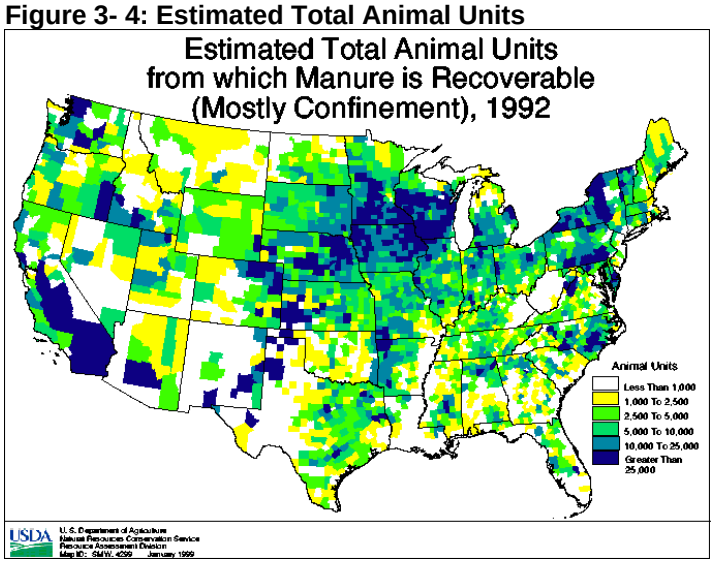
Technology Introduction

Animal manure can be converted into electricity using an anaerobic digester integrated with a combined heat and power system. An anaerobic digester utilizes a bacterial process to convert complex molecules contained in animal manure into simple molecules like methane and water. The methane can be combusted with proven engine or microturbine technology. The waste heat from the combustion process can, in turn, be used to control the temperature of the anaerobic digester and thus optimize the methane production process. Other uses for the recovered heat from CHP systems at farms include, for example, space heating of farrowing operations. Utilizing anaerobic digesters integrated with CHP provides an efficient way to generate electricity based on an otherwise unused resource (i.e., methane gas from manure), and has the added advantage of substantially reducing the odor from concentrated animal operations and providing nutrient management for the soil.

Capacity Potential

This study estimates a total electric generating capacity of 2,200 MW available from animal manure in Illinois. This number is based on available manure from 7,022,301 animals consisting of swine, cattle, poultry, and sheep, which in turn produce approximately 19,000,000 tons of manure.[10] The potential capacity of 2,200 MW assumes that all animal manure can be utilized for electricity generation. However, engines and microturbines, generally, cannot be sized to produce electricity at small farms with less than 500 animal units. While Illinois tends to be among the states with the largest animal feeding operations (see Map below), detailed information on total size distribution is not available. Therefore the potential capacity of 2,200 MW from all manure was conservatively reduced to a more realistic, capacity of 877 MW. This capacity estimate assumes that only 50% of the expected biomass is actually available from animal operations large enough to install an anaerobic digester system. Furthermore, while 50% of farms could install a digester system, only 80% can actually be expected to install a generating system.

Figure 3- 4: Estimated Total Animal Units



Financial Assumptions

Capital cost assumptions are based on published information by the Department of Energy's CHP Application Center program of actual CHP systems that utilize methane recovered from animal manure (Midwest CHP Application Center Project Profiles on Colorado Pork LLC, 2004, and Afxantiou Farms, 2004). For the purpose of this study capital costs include the cost of the CHP prime mover, the heat recovery equipment, and the anaerobic digester system. Including the digester in the capital cost assumptions results in relatively high capital cost estimates of $4,564/kW ($1,400/kW for the CHP system plus $3,164/kW for the anaerobic digester). However, this approach is relatively conservative since some animal feeding operations may already use anaerobic digesters for odor control and therefore may only incur the incremental capital cost of installing a CHP system. The efficiency of the CHP systems is assumed to be 40%; this efficiency estimate assumes that most of the waste heat is required for digester heating, i.e. biogas production, which is not credited towards the overall system efficiency. O&M cost are assumed to be on the high side of the surveyed literature for CHP applications, with $0.015/kWh (MAC CHP Guidebook), taking into account possibly increased maintenance requirements due to impurities

[10] Utilizing North Carolina Agricultural Chemicals Manual's Livestock Fresh Manure Characteristics and USDA 1997 Animal Census for Illinois.

inherent to biogas. The discount rate for animal manure biomass generators is set at 8 percent (instead of the utility average of 10 percent) to reflect current renewable incentives.

Table 3- 9: Manure Biomass Electricity Generation Assumptions

Manure Biomass	2005	2010	2015	2020
Capital Cost ($/kW)	4,564	4,232	3,924	3,638
O&M Cost ($/kWh)*	0.015	0.015	0.015	0.015
Capacity Factor	95%	95%	95%	95%

*O&M Cost include variable, fixed, and fuel cost

PROPOSED RENEWABLE RESOURCES PORTFOLIO

The study examines a renewable portfolio standard which requires that, by 2006, at least 2% of the electricity sold to Illinois customers is generated from renewable resources, increasing by 1% annually until, in 2012, at least 8% of total electricity supplied to Illinois customers is generated by renewable resources. 75% of the renewable energy requirements will be met using wind resources. For this study, we further assume that electricity required from renewable resources will continue to increase by 1% annually until, in 2020, at least 16% of total electricity supplied to Illinois customers is generated by renewable resources.

The table below shows the annual electricity power requirements from renewable resources and by each of the available renewable sources, separately. Wind power comprises 75% of the renewable requirements each year; with landfill gas and biomass-cofiring the most often used alternative renewable options. The table shows the electricity consumption requirements in both MWh per year and the nameplate generating capacity in MW required to meet the renewable targets, including targets for wind power and other renewable sources.

Table 3- 10: Renewable Resources Energy Procurement Requirements

Year	Projected Electricity Consumption (MWh)	Renewable Share	Total Renewable Requirements (MWh)	Wind Power 75% (MWh)	Other Renewable 25% (MWh)	Wind Nameplate Generation Capacity (MW)	Other Renewable Nameplate Generation Capacity (MW)	Total Renewable Nameplate Generation Capacity (MW)
2006	144,971,000	2.00%	2,899,423	2,174,567	724,856	681	85	766
2007	146,857,000	3.00%	4,405,700	3,304,275	1,101,425	1,032	129	1,161
2008	148,767,000	4.00%	5,950,669	4,463,002	1,487,667	1,387	175	1,561
2009	150,702,000	5.00%	7,535,081	5,651,311	1,883,770	1,748	221	1,969
2010	152,662,000	6.00%	9,159,701	6,869,776	2,289,925	2,114	269	2,383
2011	154,647,000	7.00%	10,825,307	8,118,980	2,706,327	2,489	318	2,806
2012	156,659,000	8.00%	12,532,690	9,399,517	3,133,172	2,869	368	3,236
2013	158,696,000	9.00%	14,282,655	10,711,991	3,570,664	3,329	419	3,748
2014	160,760,000	10.00%	16,076,021	12,057,016	4,019,005	3,798	472	4,270
2015	162,851,000	11.00%	17,913,621	13,435,216	4,478,405	4,274	526	4,800
2016	164,969,000	12.00%	19,796,302	14,847,226	4,949,075	4,762	593	5,355
2017	167,115,000	13.00%	21,724,926	16,293,694	5,431,231	5,262	669	5,931
2018	169,288,000	14.00%	23,700,369	17,775,277	5,925,092	5,774	746	6,520
2019	171,490,000	15.00%	25,723,524	19,292,643	6,430,881	6,299	825	7,124
2020	173,721,000	16.00%	27,795,297	20,846,473	6,948,824	6,838	905	7,743

The table below summarizes the conclusions from throughout the chapter relating to capacity potential for each of the reviewed renewable technologies (and the environmentally benign technologies reviewed in chapter 5).

Table 3- 11: Illinois Potential Installed Generation Capacity

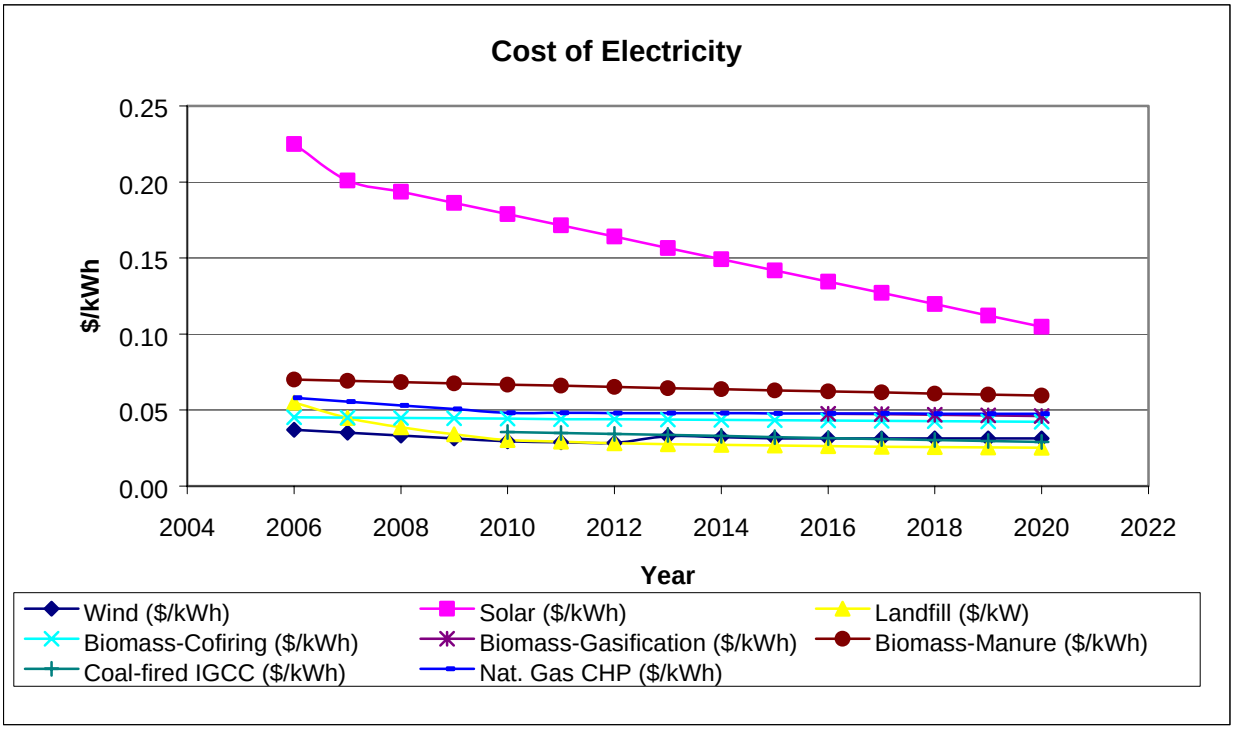
Technology	Potential Generation Capacity (MW)	Potential Electric Generation (MWh)	Comments
Wind	9,000	27,000,000	Nameplate Capacity (3,150 MW Delivered Capacity)
Solar	No Limit	No Limit	Limited by Available Land and Cost
Hydro	0	0	Limited by Environmental Concerns
Geothermal	0	0	No Hydrothermal Fluid Resources
Landfill Gas	200-650	1,800,000-5,700,000	Depending on Generator Efficiency
Biomass Co-Firing	1,200	11,000,000	
Biomass Gasification	1,500	13,000,000	
Biomass Manure	870	7,600,000	
Environmentally Benign Technologies			
Natural Gas-Fired CHP	2,600 1,800	23,000,000 16,000,000	Commercial Sector Industrial Sector
IGCC	2,000	18,000,000	Possibly More

To select the most cost-effective renewable power generation options, we mapped the annual cost of electricity per kWh generated for the different renewable resources, including landfill gas (see table and graph below). Wind power (from Class 4 wind resources) is the least expensive renewable resource on a $/kWh generated, with solar power the most expensive. Landfill gas and biomass-cofiring are the two most cost-efficient renewable resources after wind power.

Table 3- 12: Cost of Electricity per kWh ($/kWh)

Renewable Portfolio							Environmentally Benign Technologies	
Year	Wind ($/kWh)	Solar ($/kWh)	Landfill ($/kWh)	Biomass-Cofiring ($/kWh)	Biomass-Gasification ($/kWh)	Biomass-Manure ($/kWh)	Coal-fired IGCC ($/kWh)	Natural Gas CHP ($/kWh)
2006	0.037	0.225	0.055	0.045		0.070		0.058
2007	0.035	0.201	0.045	0.045		0.069		0.056
2008	0.033	0.194	0.039	0.045		0.068		0.053
2009	0.031	0.186	0.034	0.045		0.068		0.051
2010	0.030	0.179	0.030	0.044		0.067	0.0356	0.048
2011	0.029	0.171	0.029	0.044		0.066	0.0350	0.048
2012	0.028	0.164	0.028	0.044		0.065	0.0343	0.048
2013	0.033	0.157	0.028	0.044		0.064	0.0336	0.048
2014	0.032	0.149	0.027	0.043		0.064	0.0330	0.048
2015	0.031	0.142	0.027	0.043		0.063	0.0323	0.048
2016	0.031	0.134	0.026	0.043	0.048	0.062	0.0316	0.048
2017	0.031	0.127	0.026	0.043	0.047	0.062	0.0310	0.048
2018	0.031	0.120	0.026	0.043	0.047	0.061	0.0303	0.048
2019	0.031	0.112	0.025	0.043	0.047	0.060	0.0297	0.048
2020	0.031	0.105	0.025	0.042	0.046	0.060	0.0290	0.047

Figure 3- 5: Cost of Electricity Generated from Renewable Resources



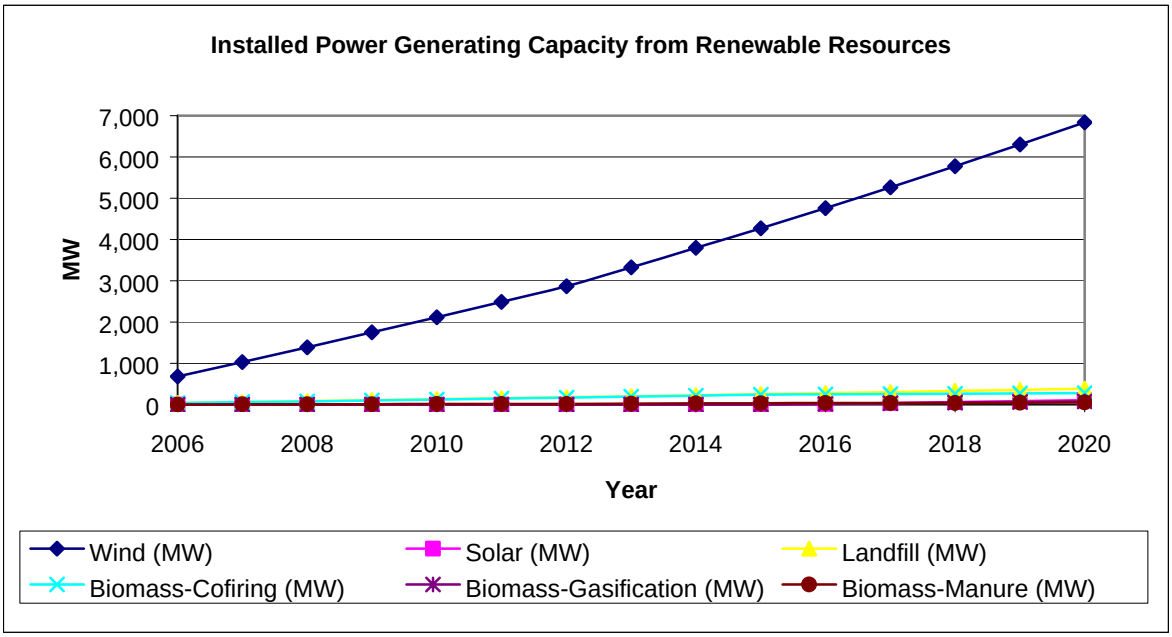
To meet the 27,800,000 MWh of electricity requirements from renewable resources, and utilizing the appropriate capacity factors, Illinois utilities would have to install 7,743 MW of installed power generating capacity. The following table presents the annual incremental new generation capacity installations for the different renewable resources utilized in this study. The high difference between installed and delivered generation capacity is due mainly to the low capacity factors of both wind and solar power.

Table 3- 13: Incremental New Generating Capacity Installations

Year	Wind (MW)	Solar (MW)	Landfill (MW)	Biomass-Cofiring (MW)	Biomass-Gasification (MW)	Biomass-Manure (MW)	Total Installed Generating Capacity (MW)	Cumulative Installed Generating Capacity (MW)
2006	681	0	42	40	0	3	766	766
2007	351	0	21	20	0	3	395	1,161
2008	355	0	22	21	0	2	400	1,561
2009	362	0	23	20	0	3	408	1,969
2010	366	0	23	22	0	2	413	2,383
2011	374	0	24	23	0	2	423	2,806
2012	380	0	24	23	0	3	430	3,236
2013	460	0	24	23	0	4	511	3,748
2014	470	0	24	24	0	4	522	4,270
2015	476	0	25	24	0	5	530	4,800
2016	488	14	25	8	16	4	555	5,355
2017	500	24	26	8	16	2	576	5,931
2018	512	24	26	8	16	4	589	6,520
2019	525	24	26	8	16	5	604	7,124
2020	539	24	26	8	16	6	620	7,743
SUM	6,838	109	384	280	79	53	7,743	

To chart below shows the installed renewable power requirements for Illinois: 7,743 MW of new wind and other renewable generating capacity will be required by 2020, with 6,838 MW of installed power generation capacity from wind power installations and 905 MW from other renewable sources.

Figure 3- 6: Installed Power Generating Capacity from Renewable Resources



The table below presents the incremental delivered energy from renewable resources (in MWh per year), including annual delivered energy from wind power, solar, landfill gas and biomass resources. Wind power comprises 75% of the renewable requirements; with landfill gas and biomass-cofiring, the most cost effective alternative options, comprising a large percentage of the remaining 25% of the delivered energy from renewable resources. We have included some biomass-manure energy, and some biomass-gasification and solar energy after 2015.

Table 3- 14: Annual Incremental Delivered Energy from Renewable Resources

Year	Wind (MWh)	Solar (MWh)	Landfill Gas (MWh)	Biomass-Cofiring (MWh)	Biomass-Gasification (MWh)	Biomass-Manure (MWh)	Total Delivered Energy (MWh)
2006	2,172,480	0	350,400	350,400	0	24,056	2,897,336
2007	1,130,040	0	175,200	175,200	0	26,169	1,506,609
2008	1,156,320	0	183,960	183,960	0	18,322	1,542,562
2009	1,191,360	0	192,720	175,200	0	28,183	1,587,463
2010	1,217,640	0	192,720	192,720	0	20,715	1,623,795
2011	1,252,680	0	201,480	201,480	0	13,441	1,669,081
2012	1,278,960	0	201,480	201,480	0	23,886	1,705,806
2013	1,314,000	0	201,480	201,480	0	34,531	1,751,491
2014	1,349,040	0	201,480	210,240	0	36,622	1,797,382
2015	1,375,320	0	210,240	210,240	0	38,920	1,834,720
2016	1,410,360	26,280	210,240	70,080	131,400	32,670	1,881,030
2017	1,445,400	43,800	219,000	70,080	131,400	17,876	1,927,556

Table 3- 14: Annual Incremental Delivered Energy from Renewable Resources

Year	Wind (MWh)	Solar (MWh)	Landfill Gas (MWh)	Biomass-Cofiring (MWh)	Biomass-Gasification (MWh)	Biomass-Manure (MWh)	Total Delivered Energy (MWh)
2018	1,480,440	43,800	219,000	70,080	131,400	29,581	1,974,301
2019	1,517,366	43,800	219,000	70,080	131,400	41,509	2,023,155
2020	1,559,280	43,800	219,000	70,080	131,400	53,663	2,077,223
SUM	20,850,686	201,480	3,197,400	2,452,800	657,000	440,144	27,799,510

The table below presents the annual delivered energy from renewable resources (in MWh per year) required to meet the renewable targets, including annual delivered energy from wind power, solar, landfill gas and biomass resources.

Table 3- 15: Annual Delivered Energy from Renewable Resources

Year	Wind (MWh)	Solar (MWh)	Landfill Gas (MWh)	Biomass-Cofiring (MWh)	Biomass-Gasification (MWh)	Biomass-Manure (MWh)	Total Delivered Energy (MWh)
2006	2,172,480	0	350,400	350,400	0	24,056	2,897,336
2007	3,302,520	0	525,600	525,600	0	50,225	4,403,945
2008	4,458,840	0	709,560	709,560	0	68,547	5,946,507
2009	5,650,200	0	902,280	884,760	0	96,730	7,533,970
2010	6,867,840	0	1,095,000	1,077,480	0	117,445	9,157,765
2011	8,120,520	0	1,296,480	1,278,960	0	130,887	10,826,847
2012	9,399,480	0	1,497,960	1,480,440	0	154,772	12,532,652
2013	10,713,480	0	1,699,440	1,681,920	0	189,304	14,284,144
2014	12,062,520	0	1,900,920	1,892,160	0	225,925	16,081,525
2015	13,437,840	0	2,111,160	2,102,400	0	264,845	17,916,245
2016	14,848,200	26,280	2,321,400	2,172,480	131,400	297,515	19,797,275
2017	16,293,600	70,080	2,540,400	2,242,560	262,800	315,391	21,724,831
2018	17,774,040	113,880	2,759,400	2,312,640	394,200	344,972	23,699,132
2019	19,291,406	157,680	2,978,400	2,382,720	525,600	386,481	25,722,287
2020	20,850,686	201,480	3,197,400	2,452,800	657,000	440,144	27,799,510

The total cost of installing 7,743 MW of renewable generation (delivered capacity of 3,173 MW) is about $8.1 billion (table below) over the 2006-2020 period. On a capital cost basis, this is considerably more investment than would be required to install either pulverized coal or combined cycle natural gas to achieve equivalent delivered power generation[11]. However, when fuel costs are considered, wind power

[11] U.S. Department of Energy, National Energy Technology Laboratory, "Technical Facts", Coal and Environmental Systems, titled "Coal Plays Key Role in Electric Power Generation", 9/2001.

is less expensive on a $/kWh basis of delivered electricity power than either pulverized coal or combined cycle natural gas (Table 3-17, shown below). Also, wind power compares favorably, on a $/kWh basis of delivered electricity power, to integrated gasification combined cycle technology and is less expensive than combined heat and power technology.[12]

Table 3- 16: Renewable Generation Annual Investment – Capital Cost

Year	Wind ($)	Solar ($)	Landfill ($)	Biomass-Cofiring ($)	Biomass-Gasification ($)	Biomass-Manure ($)	Total Investment ($)
2006	$809,542,857	$0	$56,403,600	$51,456,400	$0	$12,994,848	$930,397,705
2007	$401,512,500	$0	$25,877,284	$25,342,277	$0	$13,924,601	$466,656,662
2008	$391,245,161	$0	$23,394,337	$26,210,250	$0	$9,602,949	$450,452,697
2009	$383,331,915	$0	$20,562,758	$24,587,711	$0	$14,549,582	$443,031,966
2010	$372,007,895	$0	$16,727,811	$26,640,785	$0	$10,533,780	$425,910,270
2011	$374,645,026	$0	$17,382,547	$27,433,953	$0	$6,732,585	$426,194,112
2012	$374,353,125	$0	$17,382,547	$27,022,444	$0	$11,784,478	$430,542,594
2013	$445,582,822	$0	$17,382,547	$26,617,107	$0	$16,781,096	$506,363,573
2014	$447,069,512	$0	$17,382,547	$27,357,757	$0	$17,529,931	$509,339,748
2015	$445,309,091	$0	$18,037,284	$26,947,391	$0	$18,350,707	$508,644,473
2016	$456,654,545	$36,602,881	$18,037,284	$8,847,727	$23,687,368	$15,172,917	$559,002,723
2017	$468,000,000	$57,992,219	$18,692,021	$8,715,011	$23,216,842	$8,177,549	$584,793,642
2018	$479,345,455	$54,979,637	$18,692,021	$8,584,286	$22,746,316	$13,329,083	$597,676,797
2019	$491,301,605	$51,967,054	$18,692,021	$8,455,521	$22,275,789	$18,423,168	$611,115,159
2020	$504,872,727	$48,954,471	$18,692,021	$8,328,689	$21,805,263	$23,460,554	$626,113,725
SUM	$6,844,774,237	$250,496,262	$323,338,632	$332,547,308	$113,731,579	$211,347,829	$8,076,235,846

Table 3- 17: Conventional Electric Power System Costs[13]

	State-of-the-Art (2000)		Future (2010)	
	Pulverized Coal	Natural Gas Combined Cycle	Pulverized Coal	Natural Gas Combined Cycle
Capital Cost 1999 $/kW	$1,000	$550	$950	$500
Cost of Electricity 1999 $/kWh	$0.035	$0.040 - $0.068	$0.034	$0.035 - $0.060

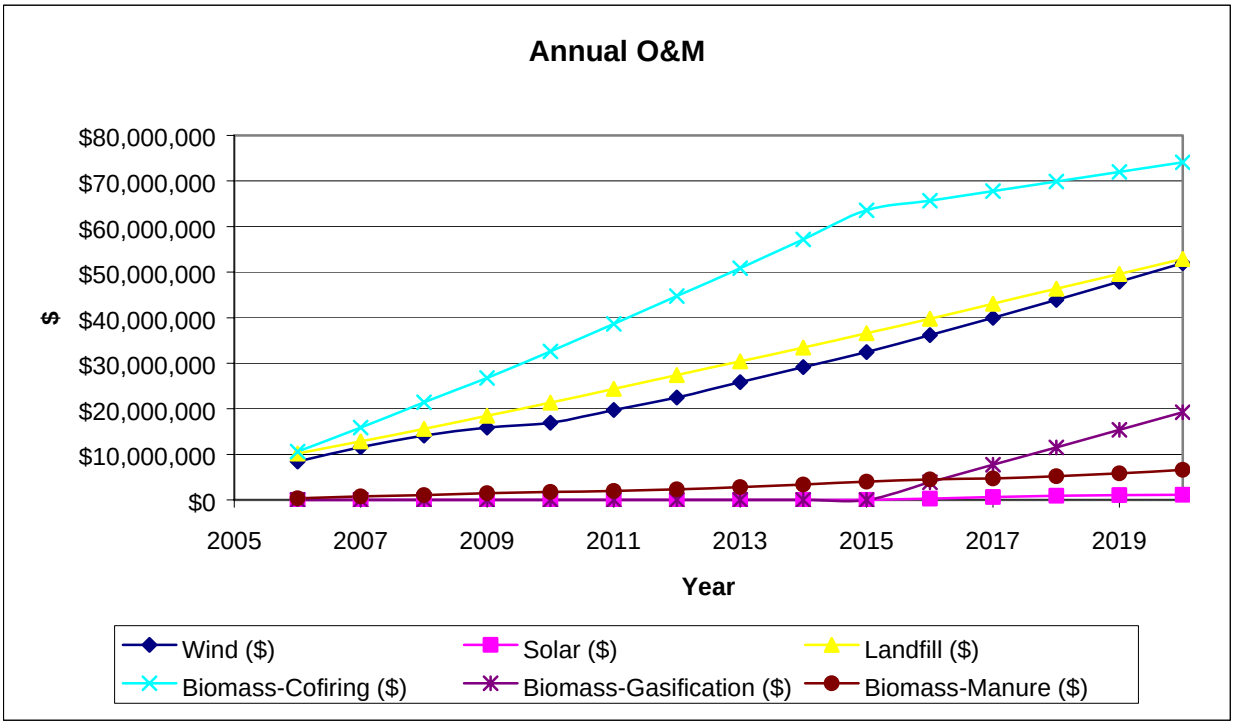
The table and graph below show annual O&M costs for renewable power. Although wind power represents 75% of all new MW of delivered power, the O&M cost of wind power is lower than the O&M costs for landfill gas and biomass.

[12] Chapter 6 presents information on integrated gasification combined cycle technology (IGCC) and natural gas fired combined heat and power technology (CHP) for commercial applications.
[13] U.S. Department of Energy, National Energy Technology Laboratory, "Technical Facts", Coal and Environmental Systems, titled "Coal Plays Key Role in Electric Power Generation", 9/2001.

Table 3- 18: Renewable Generation Annual O&M Costs

Year	Wind ($)	Solar ($)	Landfill ($)	Biomass-Cofiring ($)	Biomass-Gasification ($)	Biomass-Manure ($)	Total O&M Cost ($)
2006	$8,393,846	$0	$10,195,500	$10,588,445	$0	$360,835	$29,538,626
2007	$11,598,131	$0	$12,823,500	$15,882,667	$0	$753,374	$41,057,672
2008	$14,088,881	$0	$15,582,900	$21,441,601	$0	$1,028,208	$52,141,589
2009	$15,875,499	$0	$18,473,700	$26,735,823	$0	$1,450,953	$62,535,976
2010	$16,913,540	$0	$21,364,500	$32,559,468	$0	$1,761,678	$72,599,186
2011	$19,709,221	$0	$24,386,700	$38,647,824	$0	$1,963,300	$84,707,045
2012	$22,490,971	$0	$27,408,900	$44,736,180	$0	$2,321,586	$96,957,637
2013	$25,832,024	$0	$30,431,100	$50,824,535	$0	$2,839,556	$109,927,215
2014	$29,171,568	$0	$33,453,300	$57,177,602	$0	$3,388,878	$123,191,348
2015	$32,483,455	$0	$36,606,900	$63,530,669	$0	$3,972,678	$136,593,702
2016	$36,191,334	$282,430	$39,760,500	$65,648,358	$3,848,296	$4,462,732	$150,193,649
2017	$39,991,334	$662,768	$43,045,500	$67,766,047	$7,696,592	$4,730,872	$163,893,113
2018	$43,883,455	$930,135	$46,330,500	$69,883,736	$11,544,887	$5,174,585	$177,747,299
2019	$47,872,656	$1,084,530	$49,615,500	$72,001,425	$15,393,183	$5,797,216	$191,764,510
2020	$51,972,050	$1,125,953	$52,900,500	$74,119,114	$19,241,479	$6,602,164	$205,961,260

Figure 3- 7: Renewable Generation Annual O&M Cost



CHAPTER 4 - ENERGY EFFICIENCY MEASURES

This chapter evaluates an energy efficiency portfolio that would reduce electricity use 16% by 2020 (the same reduction achieved with the renewable portfolio discussed in the previous chapter)[14]. By implementing these energy efficiency measures, electricity use in Illinois could be reduced by about 28,000,000,000 kWh in 2020:

Table 4- 1: Energy Efficiency Targets for Electricity Consumption Savings in 2020 (kWh)

End-Use	Energy Efficiency Savings Targets kWh
Residential Energy Efficiency Savings Target	9,000,000,000
Commercial Energy Efficiency Savings Target	12,900,000,000
Industrial Energy Efficiency Savings Target	6,100,000,000
Total Energy Efficiency Savings Target	28,000,000,000

A wide range of energy efficiency measures could be used to meet these targets. In the sections that follow, we discuss specific efficiency measures for each customer sector and calculate the energy savings that could be achieved through their implementation. The estimates of energy savings are largely based on data from the US Department of Energy's "5-Lab Study"[15] with adjustments for customer mix, climate and other Illinois-specific factors.

[14] Governor Blagojevich, in the Sustainable Energy Plan process of 2005, calls for an Energy Efficiency Portfolio Standard that would reduce electricity consumption in Illinois by the following amounts each year: 10% of Projected Annual Load Growth in years 2006 to 2008; 15% of Projected Annual Load Growth in years 2009 to 2011; 20% of Projected Annual Load Growth in years 2012 to 2014; and 25% of Projected Annual Load Growth in years 2015 to 2017. Assuming that Illinois electricity consumption grows by 30,600,000,000 kWh during the 2005-2020 period, electricity savings would amount to 7,650,000,000 kWh in 2020 (assuming 25% savings of projected annual load growth in year 2020) with the Governor's plan, compared to an electricity consumption savings target of 28,000,000,000 kWh in 2020 with the energy efficiency portfolio evaluated in this study.

[15] "Scenarios of U.S. Carbon Reductions: Potential Impacts of Energy Technologies by 2010 and beyond", U.S. Department of Energy (PB98107659*CA, September 1997).

RESIDENTIAL ENERGY EFFICIENCY ELECTRICITY SAVINGS

Electricity used in the residential sector provides a variety of services such as lighting, space heating and cooling, water heating, refrigeration, and electricity for electronics and other equipment. In developing scenarios for reducing electricity consumption in the residential sector, we used data from the 5-Lab study to identify cost-effective energy efficiency technologies and developed a spreadsheet-based analysis of estimated investments, potential energy savings, and consumer benefits from residential energy efficiency measures installed in Illinois from 2006 to 2020.

Energy efficiency is highly cost-effective. Installing and operating energy efficiency measures cost significantly less per kWh saved than the cost to consumers from generating, transmitting and distributing electricity -- sometimes by a factor of two or more. Some customers recognize the economic advantages of energy efficiency and adopt improvements on their own. However, most of the potential for energy efficiency improvements in the residential sector has yet to be realized.

In the residential sector, the greatest potential for electricity savings is more efficient lighting. Compact fluorescent lamps (CFL) produce the same amount of light as conventional incandescent light bulbs, but use only one-quarter as much electricity and last 12 times longer. Residential water heating is the area with the second greatest potential for household energy savings.

The following steps were taken to estimate the energy efficiency savings for the residential sector:

Step 1:
The residential electricity sector represents about 32.7% (in 2002) of the total electricity consumption in the state of Illinois. Specific end-use data is not available for the residential sector in Illinois – but we were able to estimate consumption shares for each end-use, based on data recently collected in Iowa,[16] shown below:

Table 4- 2: Estimated Illinois Residential Electricity Use

Residential Electricity End-Uses	Percent of Total Electricity Use
Space Heating	8%
Space Cooling	11%
Water Heating	9%
Refrigeration	11%
Cooking	3%
Clothes Drying	6%
Freezers	4%
Lighting	9%
Other Uses	39%
Total	100%

[16] Hadley, S.W., Oak Ridge National Laboratory, "The Potential for Energy Efficiency in the State of Iowa" (The Iowa Energy Center, June 2001) p. 19.

The “Other” category incorporates personal computers (CPU and monitor), color televisions, furnace fans, other household electronics, heating coils (such as toasters or coffeepots), and small motors.

Based on the above percentages, and assuming that the percentages remain constant over time, we estimated the annual electricity consumption for each residential end-use (space heating, space cooling, etc.) for the 2006-2020 period. For example, space heating electricity consumption in 2020 is calculated as follows:

Space Heating Electricity Consumption	=	56,526 million kWh	X	8%	=	4,522 million kWh

Step 2:
Next, we evaluated energy savings from efficiency measures that target a range of residential end-uses. Potential energy savings for the various end-uses, expressed as a percentage of current consumption, is shown below:

Table 4- 3: Residential Energy Efficiency Savings

Residential Electricity End-Uses	**Potential Savings**
Space Heating	10%
Space Cooling	14%
Water Heating	29%
Refrigeration	13%
Lighting	51%
Other	30%

In addition, we project a technology implementation rate starting at 2% in 2006 and reaching 75% of the residential sector by 2020. The incremental annual savings generated from these energy efficiency measures is estimated as follows:

Incremental Annual Energy Savings	=	Annual Electricity Consumption for each End-Use	X	Percent Savings for each End-Use	X	Incremental Implementation for each Energy Efficiency Measure

Step 3:
In this step, we evaluate the annual investment for these energy efficiency measures. We multiply the incremental electricity saved annually (step 2) for each end-use by the investment required to obtain each kWh of annual savings. The investment per kWh is derived from the present value of the Cost of Conserved Electricity ($/kWh) in the 5-Lab Study. The cost of conserved electricity (CCE) in the 5-Lab Study was converted to 2003$ using the GDP implicit price deflator. Utilizing the CCE, we estimate the present value investment per kWh needed to achieve the electricity savings.

Annual Investment	=	Incremental Annual Energy Savings for each End-Use	X	Present Value of the Cost of Saved Energy ($/kWh)

The service life of the energy efficiency measures and the discount rate (7%) from the 5-Lab study were used to calculate the PV of the cost of the efficiency measures. The table below shows the cost of energy efficiency measures that target each of the major residential end-uses:

Table 4- 4: Cost of Residential Energy Efficiency Measures ($/kWh)

Residential Electricity End-Uses	**Lifetime (Years)**	**Cost of Conserved Electricity (2003$/kWh)**	**PV of Cost of Conserved Electricity (2003$/kWh)**
Space Heating	16	$0.034	$0.317
Space Cooling	16	$0.034	$0.317
Water Heating	10	$0.039	$0.274
Refrigeration	19	$0.039	$0.403
Lighting	1	$0.030	$0.028
Other	10	$0.048	$0.335

Step 4:

In the final step, we evaluate net consumer savings from investing in residential energy efficiency measures. To calculate consumer savings we multiply the electricity saved annually for each end-use (from step 2) by the difference between the retail cost of electricity and the cost of conserved electricity.

Annual Net Consumer Savings	=	Annual Electricity Savings (kWh/year)	X	Retail Cost of Residential Electricity ($/kWh) – Cost of Conserved Energy ($/kWh)

For purposes of this calculation, we assume that the retail cost of electricity for Illinois residential consumers will remain unchanged (in constant dollars) at $0.0838/kWh, from 2003 to 2020.[17] The table below shows the net consumer savings for each residential end-use.

[17] Energy Information Administration, “Electric Power Annual 2003 – Spreadsheets”, January 2005, DOE/EIA-0348(2003).

Table 4- 5: Net Savings for Residential Consumers ($/kWh)

Residential Electricity End-Uses	Cost of Conserved Electricity (2003$/kWh)	Net Consumer Savings (2003$/kWh)
Space Heating	$0.034	$0.0502
Space Cooling	$0.034	$0.0502
Water Heating	$0.039	$0.0448
Refrigeration	$0.039	$0.0448
Lighting	$0.030	$0.0535
Other	$0.048	$0.0362

Net consumer savings total about $4.8 billion (above investment cost[18]) throughout the service life of all energy efficiency measures installed by 2020. The table below presents a summary of residential energy savings, investment in energy efficiency measures, annual electricity cost savings, and net consumer savings generated over the life of the energy efficiency measures.

The internal rate of return for investments in residential energy efficiency measures is 15.0%.[19] More detailed results are available in Appendix A.

Table 4- 6: Residential Energy Efficiency Electricity Savings, Investments, and Consumer Savings

Year	Penetration Rate of Efficiency Measures	Incremental Electricity Savings kWh	Annual Electricity Savings kWh	Estimated Annual Investment	Annual Electricity Cost Savings	Annualized Net Consumer Savings
2006	2%	242,028,437	242,028,437	$67,217,241	$20,281,983	$10,210,363
2007	4%	245,105,064	487,133,501	$69,303,870	$40,821,787	$20,550,518
2008	6%	248,220,800	735,354,301	$71,417,023	$61,622,690	$31,022,116
2009	9%	377,064,215	1,112,418,516	$108,463,703	$93,220,672	$46,929,183
2010	12%	343,671,655	1,456,090,171	$101,109,415	$122,020,356	$61,427,530
2011	15%	377,043,717	1,833,133,888	$112,127,299	$153,616,620	$77,333,732
2012	18%	477,295,795	2,310,429,683	$141,889,304	$193,614,007	$97,469,231
2013	23%	604,203,878	2,914,633,561	$179,564,723	$244,246,292	$122,958,553
2014	29%	764,855,527	3,679,489,088	$227,257,651	$308,341,186	$155,225,227
2015	36%	968,222,809	4,647,711,897	$287,631,643	$389,478,257	$196,071,279
2016	44%	1,078,583,772	5,726,295,670	$373,730,562	$479,863,577	$241,573,088
2017	50%	908,590,472	6,634,886,141	$332,652,549	$556,003,459	$279,903,454

[18] The energy efficiency measures required to reach the 2006 – 2020 residential reduction targets will cost about $3.4 billion through 2020.
[19] Internal Rate of Return (IRR) is the discount rate at which the net present value of the cash flows generated from an investment is zero. The IRR is a method of evaluating capital expenditure proposals and projects.

Table 4- 6: Residential Energy Efficiency Electricity Savings, Investments, and Consumer Savings

Year	Penetration Rate of Efficiency Measures	Incremental Electricity Savings kWh	Annual Electricity Savings kWh	Estimated Annual Investment	Annual Electricity Cost Savings	Annualized Net Consumer Savings
2018	58%	1,058,161,378	7,693,047,519	$379,468,087	$644,677,382	$324,543,711
2019	66%	1,232,354,439	8,925,401,958	$460,126,993	$747,948,684	$376,532,586
2020	75%	1,243,859,864	10,169,261,822	$462,626,102	$852,184,141	$429,006,836
2021			8,035,824,023		$673,402,053	$296,213,628
2022			7,625,595,757		$639,024,924	$286,012,326
2023			7,111,903,975		$595,977,553	$273,380,483
2024			6,467,310,121		$541,960,588	$257,675,428
2025			5,719,099,834		$479,260,566	$236,567,301
2026			5,082,863,298		$425,943,944	$210,699,075
2027			4,347,235,960		$364,298,373	$182,005,212
2028			3,479,403,459		$291,574,010	$156,448,109
2029			2,595,446,833		$217,498,445	$126,831,520
2030			1,315,417,258		$110,231,966	$92,147,951
2031			1,185,457,763		$99,341,361	$55,862,936
2032			1,034,413,669		$86,683,865	$48,559,211
2033			885,042,538		$74,166,565	$41,414,759
2034			704,382,262		$59,027,234	$32,793,951
2035			498,222,594		$41,751,053	$22,944,036
2036			305,713,121		$25,618,760	$13,700,132
2037			214,185,268		$17,948,725	$9,598,432
2038			107,590,227		$9,016,061	$4,821,515
2039			0		$0	$0
2040			0		$0	$0
SUM		10,169,261,822	115,282,424,113	$3,374,586,165	$9,660,667,141	$4,818,433,412

COMMERCIAL ENERGY EFFICIENCY ELECTRICITY SAVINGS

Electricity used in the commercial sector provides a variety of services such as lighting, space heating and cooling, ventilation, refrigeration, and electricity for electronics and other equipment. In developing scenarios of reducing electricity consumption in the commercial sector, we used data from the 5-Lab study to identify cost-effective energy efficiency technologies and developed a spreadsheet-based analysis of estimated investments, potential energy savings, and consumer benefits from commercial energy efficiency measures installed in Illinois from 2006 to 2020.

Energy efficiency is highly cost-effective. Installing and operating energy efficiency measures cost significantly less per kWh saved than the cost to consumers from generating, transmitting and distributing electricity -- sometimes by a factor of two or more. Some customers recognize the economic advantages of energy efficiency and adopt improvements on their own. However, most of the potential for energy efficiency improvements in the commercial sector has yet to be realized. The 5-Lab study did not evaluate commercial energy efficiency savings from integrated systems that combine heating and water heating, or heating, cooling, and water heating. Also, no savings were included for district heating and cooling systems with combined heat and power. In this study, Combined Heat and Power in commercial applications was evaluated, separately, to complement the energy efficiency measures recommended by the 5-Lab study. CHP offers commercial customers that produce at least a portion of the electric requirements of their building/facility a cost-effective method to recycle the otherwise wasted heat from the electric generation equipment and utilize it for process heating, space heating, cooling, or dehumidification, thus improving the overall efficiency of their energy generation system.

In the commercial sector, the greatest potential for electricity savings is efficient lighting technologies and space cooling. Installing modern energy-efficient lighting ballasts in new commercial buildings, or through retrofits of existing buildings, produces rapid paybacks and operating cost savings in almost all settings. Lighting use is characterized by a tremendous diversity of applications and needs, and an equivalent diversity of sources, fixtures, controls, and designs. Thus, energy efficiency can best be achieved by an array of new and existing technologies intelligently matched to the appropriate lighting needs. Unlike other aspects of the building infrastructure, most lighting system components are replaced at a relatively high turnover rate within ten years, and thus provide opportunities to introduce more efficient technologies on a regular basis.

The following steps were taken to estimate the energy efficiency savings for the commercial sector:

Step 1:
The commercial electricity sector represents about 41% (in 2002) of the total electricity consumption in the state of Illinois. Specific end-use data is not available for the commercial sector in Illinois – but we were able to estimate consumption shares for each end-use, based on data recently collected in Iowa,[20] shown below:

[20] Hadley, S.W., Oak Ridge National Laboratory, "The Potential for Energy Efficiency in the State of Iowa" (The Iowa Energy Center, June 2001) pp. 40.

Table 4- 7: Estimated Illinois Commercial Electricity Use

Commercial Electricity End-Uses	Percent of Total Electricity Use
Space Heating	4.12%
Space Cooling	7.51%
Ventilation	5.08%
Water Heating	2.91%
Lighting	30.02%
Cooking	0.24%
Refrigeration	3.39%
Office Equipment	13.80%
Other Uses	32.93%
Total	100%

Based on the above percentages, and assuming that the percentages remain constant over time, we estimated the annual electricity consumption for each commercial end-use (space heating, space cooling, etc.) for the 2006-2020 period. For example, space heating electricity consumption in 2020 is calculated as follows:

Space Heating Electricity Consumption	=	80,707 million kWh	X	4.12%	=	3,325 million kWh

Step 2:

Next, we evaluated energy savings from efficiency measures that target a range of commercial end-uses. Potential energy savings for the various end-uses, expressed as a percentage of current consumption, is shown below:

Table 4- 8: Commercial Energy Efficiency Savings

Commercial Electricity End-Uses	Potential Savings
Space Heating	25%
Space Cooling	27%
Ventilation	26%
Water Heating	7%
Lighting	21%
Cooking	33%
Refrigeration	25%
Office Equipment	33%
Other	33%

In addition, we project a technology implementation rate starting at 2% in 2006 and reaching 75% of the commercial sector by 2020. The incremental annual savings generated from these energy efficiency measures is estimated as follows:

Incremental Annual Energy Savings	=	Annual Electricity Consumption for each End-Use	X	Percent Savings for each End-Use	X	Incremental Implementation for each Energy Efficiency Measure

Step 3:
In this step, we evaluate the annual investment for these energy efficiency measures. We multiply the incremental electricity saved annually (step 2) for each end-use by the investment required to obtain each kWh of annual savings. The investment per kWh is derived from the present value of the Cost of Conserved Electricity ($/kWh) in the 5-Lab Study. The cost of conserved electricity (CCE) in the 5-Lab Study was converted to 2003$ using the GDP implicit price deflator. Utilizing the CCE, we estimate the present value investment per kWh needed to achieve the electricity savings.

Annual Investment	=	Incremental Annual Energy Savings for each End-Use	X	Present Value of the Cost of Saved Energy ($/kWh)

The service life of the energy efficiency measures and the discount rate (7%) from the 5-Lab study were used to calculate the PV of the cost of the efficiency measures. The table below shows the cost of energy efficiency measures that target each of the major commercial end-uses:

Table 4- 9: Cost of Commercial Energy Efficiency Measures ($/kWh)

Commercial Electricity End-Uses	Lifetime (Years)	Cost of Conserved Electricity (2003$/kWh)	PV of Cost of Conserved Electricity (2003$/kWh)
Space Heating	18	$0.016	$0.163
Space Cooling	18	$0.016	$0.163
Ventilation	18	$0.016	$0.163
Water Heating	9	$0.037	$0.241
Lighting[21]	12	-$0.040	$0.257
Cooking	7	$0.040	$0.218
Refrigeration	15	$0.019	$0.169
Office Equipment	7	$0.040	$0.218
Other	7	$0.040	$0.218

[21] The cost of conserved electricity for lighting is negative (-$0.040/kWh in 2003$) due to the O&M savings from labor costs associated for avoiding changing lighting bulbs. To evaluate the investment in lighting, we eliminated the O&M savings by assuming that the commercial lighting CCE is the same to the residential lighting CCE.

Step 4:
In the final step, we evaluate net consumer savings from investing in commercial energy efficiency measures. To calculate consumer savings we multiply the electricity saved annually for each end-use (from step 2) by the difference between the retail cost of electricity and the cost of conserved electricity.

Annual Net Consumer Savings	=	Annual Electricity Savings (kWh/year)	X	Retail Cost of Commercial Electricity ($/kWh) – Cost of Conserved Energy ($/kWh)

For purposes of this calculation, we assume that the retail cost of electricity for Illinois commercial consumers will remain unchanged (in constant dollars) at $0.0722/kWh, from 2003 to 2020.[22] The table below shows the net consumer savings for each commercial end-use.

Table 4- 10: Net Savings for Commercial Consumers ($/kWh)

Commercial Electricity End-Uses	**Cost of Conserved Electricity (2003$/kWh)**	**Net Consumer Savings (2003$/kWh)**
Space Heating	$0.016	$0.0560
Space Cooling	$0.016	$0.0560
Ventilation	$0.016	$0.0560
Water Heating	$0.037	$0.0352
Lighting[23]	-$0.040	$0.1127
Cooking	$0.040	$0.0317
Refrigeration	$0.019	$0.0537
Office Equipment	$0.040	$0.0317
Other	$0.040	$0.0317

Net consumer savings total about $9.7 billion (above investment cost[24]) throughout the service life of all energy efficiency measures installed by 2020. The table below presents a summary of commercial energy savings, investment in energy efficiency measures, annual electricity cost savings, and net consumer savings generated over the life of the energy efficiency measures.

The internal rate of return for investments in commercial energy efficiency measures is 17.3%. More detailed results are available in Appendix B.

[22] Energy Information Administration, "Electric Power Annual 2003 – Spreadsheets", January 2005, DOE/EIA-0348(2003).

[23] Commercial lighting measures have negative costs (i.e., net savings) due to reduced labor costs associated with less frequent light bulb replacement.
[24] The energy efficiency measures required to reach the 2006 – 2020 commercial reduction targets will cost about $3.9 billion through 2020.

Table 4- 11: Commercial Energy Efficiency Electricity Savings, Investments, and Consumer Savings

Year	Penetration Rate of Efficiency Measures	Incremental Electricity Savings kWh	Annual Electricity Savings kWh	Estimated Annual Investment	Annual Electricity Cost Savings	Annualized Net Consumer Savings
2006	2%	332,567,489	332,567,489	$72,147,910	$24,011,373	$18,316,251
2007	4%	339,261,862	671,829,351	$73,600,201	$48,506,079	$37,001,197
2008	6%	346,090,987	1,017,920,338	$75,081,726	$73,493,848	$56,062,259
2009	9%	529,586,368	1,547,506,706	$114,889,611	$111,729,984	$85,229,382
2010	12%	486,221,944	2,033,728,649	$105,482,039	$146,835,208	$112,008,197
2011	15%	537,343,389	2,571,072,039	$116,572,436	$185,631,401	$141,602,540
2012	18%	685,199,712	3,256,271,751	$148,648,706	$235,102,820	$179,340,114
2013	23%	873,740,433	4,130,012,184	$230,844,477	$298,186,880	$227,461,622
2014	29%	1,114,160,340	5,244,172,524	$283,832,899	$378,629,256	$288,824,327
2015	36%	1,420,734,599	6,664,907,123	$351,789,536	$481,206,294	$367,071,699
2016	44%	1,594,266,391	8,259,173,514	$412,231,729	$596,312,328	$454,876,384
2017	50%	1,352,834,121	9,612,007,635	$354,482,852	$693,986,951	$529,384,117
2018	58%	1,587,075,683	11,199,083,318	$431,779,831	$808,573,816	$616,792,772
2019	66%	1,861,875,883	13,060,959,201	$510,074,587	$943,001,254	$719,336,127
2020	75%	1,893,023,079	14,953,982,280	$582,034,100	$1,079,677,521	$823,594,924
2021			14,015,941,573		$1,011,950,982	$687,144,536
2022			12,965,295,778		$936,094,355	$648,016,732
2023			12,015,328,240		$867,506,699	$604,348,035
2024			10,827,923,177		$781,776,053	$557,799,373
2025			9,430,542,864		$680,885,195	$502,070,632
2026			7,940,027,797		$573,270,007	$435,026,539
2027			4,465,894,820		$322,437,606	$357,462,584
2028			4,033,216,423		$291,198,226	$309,550,178
2029			3,520,417,936		$254,174,175	$267,064,941
2030			2,935,051,943		$211,910,750	$217,124,447
2031			2,306,763,431		$166,548,320	$158,028,493
2032			1,727,316,058		$124,712,219	$96,358,650
2033			1,449,511,362		$104,654,720	$80,913,662
2034			1,135,255,829		$81,965,471	$63,446,924
2035			858,846,882		$62,008,745	$48,102,132
2036			603,687,490		$43,586,237	$33,811,213
2037			304,347,564		$21,973,894	$17,045,840
2038			0		$0	$0
2039			0		$0	$0
2040			0		$0	$0
SUM		14,953,982,280	175,090,563,269	$3,863,492,639	$12,641,538,668	$9,740,216,822

INDUSTRIAL ENERGY EFFICIENCY ELECTRICITY SAVINGS

The industrial sector is extraordinarily complex and heterogeneous. By definition, it includes all manufacturing, as well as agriculture, mining, and construction activities. The manufacturing industries range from those that transform raw materials into more refined forms (e.g., the primary metals and petroleum refining industries) to those that produce highly finished products (e.g., the food processing, pharmaceuticals, and electronics industries). In the industrial sector, the greatest efficiency opportunities are found in the metals fabrication, rubber and plastics, primary metals, and agricultural industry sectors by deploying more efficient industrial motors and drives, more advanced heating, ventilating and cooling (HVAC) techniques, and better lighting technologies.

In developing scenarios for reducing electricity consumption in the industrial sector, we used data from the 5-Lab study to identify cost-effective energy efficiency technologies and business practices, and developed a spreadsheet-based analysis of estimated investments, potential energy savings, and consumer benefits from industrial energy efficiency measures installed in Illinois from 2006 to 2020.[25] Industries are characterized using data collected by the Bureau of the Census from establishments (plants) that are classified in a particular industry based on the value of the production of the plant and the industry that is identified as the origin of that product. This classification system is known as the Standard Industrial Classification (SIC) -- superceded now by the North American Industry Classification System (NAICS).

The forecast savings that were expected in each application/sector were drawn from a variety of sources of new technologies and business practices. Currently-available technologies that were integrated to provide the industrial savings include:

Cross-Cutting Technologies

There are a variety of cross-cutting technologies that are not process- or product-specific in industry operations. Some include lighting and HVAC technologies that are also commercial applications. Others include sensors and computer control systems, which have a common underlying technology, but have a variety of configurations and benefits depending on the industry. There are two major ways that all of industry can benefit from improved efficiency: combined heat and power and improved motor systems.

- **Combined Heat and Power:** Combined heat and power (CHP) is the joint production of useful heat and electricity, either for on-site use or sale back to the electric grid. There are substantial thermodynamic advantages to the joint production of heat and power that could greatly reduce generation losses from traditional power production and would reduce carbon emissions system-wide. The advantage of such an approach is that little additional fuel is required for the electricity generation over that required for simple steam production. Thus, the efficiency for use of the thermal energy available from the fuel is higher than with separate electricity generation and steam production.
- **Motor Systems:** Energy-efficiency opportunities associated with electric motor drives derive not so much from the replacement of motors with high-efficiency motors as from energy-conscious

[25] The 5-Lab study identifies overall energy savings and investments for industrial sector end-uses from cost-effective energy efficiency technologies and business practices. The study did not attempt to identify or quantify energy savings from specific operation and maintenance (O&M) measures that could improve efficiency without capital costs. O&M measures are often low-cost or no-cost, so industries can achieve significant energy savings at lower cost than presented in this study.

design throughout the system employing the motor drive. The system includes power supply lines, controls, motor feed cables, the electric motor, the drive and transmission system, and the driven load.

Pulp and Paper

Paper manufacturing was one of the most energy-intensive industries in the United States in 1994. Large amounts of steam and power are used to debark and chip the wood, digest the wood, bleach the pulp, and dry the paper products. In paper manufacturing, any technology that will economize the use of steam, reduce the need for heat, better utilize the biomass fuel sources available, or help to balance both steam and power needs will improve the performance of the industry. The most promising near-term options are:

- **Impulse Drying**: Impulse drying reduces the huge energy requirements of evaporative drying by removing more water in the pressing section and reducing the amount of water, which must be evaporated. Impulse drying methods allow papermaking machines to run at higher speeds, thereby increasing production rates. This drying method reduces energy use by one-third.
- **Multiport Cylinder Drying**: The evaporative drying in a paper mill is accomplished by winding the continuous sheet of paper serpentine over a series of rollers. The multiport cylinder drying concept uses an alternative method to remove the condensate from the drier, which reduces the condensate film thickness inside the drier to 25-30% of conventional technology. This improves heat transfer and increases drying.
- **On-Machine Sensors for Paper Properties**: The development of new sensors to provide real-time feedback on whether the process and product are within specification can save the energy of reprocessing off-grade material and allow the use of greater amounts of recycled fiber
- **Biomass Gasification Cogeneration:** The pulp and paper industry is about 57% energy self-sufficient, due to the use of wood residues (i.e., hog fuel and bark, pulping wastes, and cogenerated electricity). The gasification of biomass and electricity generation through a combined cycle would increase the electricity output of the paper industry, further reducing purchased electricity needs.

Chemicals

The chemical industry is almost too complex to characterize as a single industry. Promising technologies for the near-term are those that economize on the use of heat or cooling or bring the two in better balance. Examples are:

- **Pinch Analytical Techniques**: The “pinch” technique was originally a method for optimizing heat recovery in thermal processes and has more recently been applied as a general optimization tool. Energy savings occur because of the heat recovery process (waste heat from one process is used to provide needed heat to another). Energy savings of 50% in new plants and retrofit paybacks of six months can be achieved.
- **Advanced Distillation Control Techniques**: Distillation columns commonly use 30% to 50% more energy than is necessary to meet the product specifications. It has been estimated that an overall average 15% reduction of distillation energy consumption can be attained if better column controls are applied.

Petroleum Refining

The most energy-intensive processes are: distillation; catalytic hydrocracking, reforming and hydrotreating; alkylation; and hydrogen production. Efficiency improvements can be achieved in the

following ways: (1) introduction of more efficient equipment; (2) reducing process activation energies (through improved catalysts); (3) improving equipment integration to recover more heat; and/or (4) adopting improved process control.

- **Monitoring Overall Energy Performance:** Refineries could promote energy efficiency by rigorously pursuing a program to monitor equipment/process/overall refinery energy performance to identify when a system or piece of equipment begins to become inefficient so that corrective actions can be initiated.
- **Utility System Improvements:** The principal utility systems in a refinery are the cooling, steam power, and fuel-gas systems; they are integrated with virtually every process subsystem. While their impact on the overall refinery operating profit margin is relatively small, the potential for energy savings is substantial.
    - **Process/Equipment Modifications:** Major opportunities to reduce energy usage also exist through retrofitting and/or replacement of existing equipment nearing the end of its useful life. Examples of such opportunities include: 1) the application of advanced oxy-fuel combustion systems such as Dilute Oxygen Combustion can result in net fuel savings of 25%; 2) improving boiler efficiency is through improved sensors and controls. For example, balancing the burners in a multi-burner boiler and reducing excess air can cut fuel use by 10% to 25%.
- **Fluid Catalytic Cracking:** Fluid catalytic cracking (FCC) is currently the most energy-efficient and widely used of the cracking processes. Improved computer simulations of cracking kinetics should result in an improved commercial technology by the year 2008 according to the 5-Lab study.
- **Fouling Mitigation in Heat Exchangers:** Seven percent of the total energy consumed in petroleum refining is due to extra energy needed to run heat exchangers that have a fouling build-up. Improved operations and retrofits can reduce fouling build-up.

Glass

The glass industry is comprised of several major product segments, each with their own processes for producing final products. The segments include container, flat glass, wool and textile fiber, specialty, lighting, and hand glass. The major common energy-intensive stage of the glass industry is the glass furnace. While there are other stages of product finishing which also require significant amounts of energy, the examples below focus on the glass furnace as the primary area of concern for energy efficiency.

- **Oxy-Fuel Process:** In the oxy-fuel process, oxygen or oxygen-enriched air is used in combustion in the melting furnace. Fuel savings from oxy-fuel conversions are typically 10-15% for well designed soda-lime regenerative furnaces, and at least 30-40% for direct fired or regenerative boro-silicate or lead glasses (Ross 1996). Oxy-fuel technology also increases furnace productivity by 25%, reduces defects, and eliminates the need for heat recovery (DOE/OIT Impacts, December 1996). There is also a waste-heat-driven thermal swing absorption (TSA) process for producing low-cost oxygen for this process. This low-cost absorption system selectively absorbs oxygen from air at a cost 30% lower than the best conventional system. This new technology increases productivity dramatically, reduces fuel use by 60%, nitrogen oxides (NOx) emissions by 50%, and particulate emissions by 30%.
- **Advanced Burner Technology:** Adoption of newly developed burners in the oxy-fuel process further improves the energy efficiency of the process. Some recent burner designs have shown as much as a 30% decrease in fuel use, as well as improvement of product quality.

- **Glass Batch/Cullet Preheater Technology:** The dual batch/cullet preheater uses the oxy-gas furnace's waste heat to preheat cullet and batch before feeding it to the furnace. Preheating cullet and batch reduces the amount of energy and oxygen required in the overall melting process (*GRID* 1996).

Aluminum

Aluminum smelting is highly capital-intensive. A variety of technologies exist, however, that have the potential to incrementally reduce energy intensity in the aluminum industry in the time frame to 2010.

- **Improving Hall-Heroult Cell Efficiency:** Performance in the range of 13 to 15 kWh/kg has been achieved in domestic smelters through a variety of techniques including enhanced potline controls, better anode rod connections, improved cathode block materials, and increases in anode size resulting in lower current density (Newsted et al. 1992, Jeltsch and Franklin 1992).
- **Materials Recycling:** Remelting aluminum scrap requires only a small fraction of the energy required to smelt aluminum from alumina. Remelting is also far less capital-intensive than smelting, which reduces barriers to modernizing.
- **Improve Furnace Efficiency:** Improving energy efficiency of melting and holding furnaces offers potential for energy savings in the secondary aluminum industry. Several commercially available technologies exist for reducing energy use in furnaces, including heat recuperators and regenerators and the use of oxygen-assisted combustion.

Iron and Steel

Iron and steel industry comprises the ore-based integrated steel plants, scrap-based “minimills,” and specialty steel mills. Steel production via integrated plants has been decreasing, while that of the electric arc furnace (EAF) based mini-mills has been increasing. Mini-mills are more energy-efficient, since they use scrap or directly-reduced iron or hot-briquetted iron. If the mini-mill relies mainly on scrap, the range of products that can be produced is somewhat limited by scrap quality issues.

- **Direct Smelting/Direct Reduction:** This technology eliminates the production of coke and reduces the need for ore preparation by integrating three steel processes into one. This technology reduces energy consumption by 20-30% and capital costs by 25-50% compared to conventional blast furnace technology.
- **Scrap Preheating:** Energy consumption in EAF operations can be reduced by preheating scrap to approximately 400°C with EAF offgases. For a DC Fuchs shaft furnace, compared to a conventional DC furnace, energy savings of 13.5% and reduced electrode consumption of 29% are estimated. Preheating also reduces furnace tap-to-tap time (normally about an hour) by 12 to 15 minutes (Scheidig 1995), resulting in increased raw steel production capacity.
- **Hot Connection:** Depending on plant layout, moving forms from the continuous casting operation to the rolling operation with minimal cooling may provide energy savings. Reheat furnaces are generally employed to bring the cast forms back to rolling temperature.
- **Near Net Shape Casting:** Near net shape casting provides an example of an innovative and energy-efficient technology that has experienced rapid penetration in a capital- and energy-intensive industry. Near net shape casting uses 25% less energy than the current best practice conventional technology.

Metal Casting

Metal casting is not a single industry segment according, but covers a diverse group of products and metals. Products range from cast pipes, motor vehicle components, and tools. Iron, steel, aluminum, copper and zinc are all metals used by the industry. Over half of the energy use is in melting metal. Technologies, which improve the melting stage or reduce waste/recasting have important energy implications.

- **Computer-Aided Casting Design:** Rapid advances in computer modeling of the casting process and in computer-aided drafting of castings have led to an increased use of computers in foundries, and hence, an increased need for integration in casting design systems. Increased integration in the casting design functions is needed to realize the full potential for improving both casting designs and production lead time. With computer modeling, an average of 25% improvement was found in casting yield (Lensen 1996, Lensen et al. 1995), which would comparably reduce energy use for metal remelting.
- **Optimized Coreless Induction Melting:** Foundries can dramatically reduce a major portion of their energy through optimization of their induction melting equipment. It has been estimated that foundries are operating their induction furnaces at 50-80% of their optimal efficiency (Horwath et al. 1996). A foundry melting 1,000 tons/month could reduce its monthly melting costs by $5/ton by installing sensors and computer optimization of its melting practice. Four major variables are important in determining the power required for melting: (1) charge makeup, (2) furnace cover, (3) power application, and (4) furnace condition. Use of a furnace cover can reduce energy consumption by 12%. Maintaining the furnace in hot condition can result in 15.4% less energy consumption for melting the metal.

The following steps were taken to estimate the energy efficiency savings for the industrial sector:

Step 1:

The industrial electricity sector represents about 26% (in 2002) of the total electricity consumption in the state of Illinois. Specific electricity end-use data is not available for the industrial sector in Illinois – but we were able to estimate Illinois electricity consumption shares for each industrial end-use, based on U.S. Census data on industrial electricity consumption by SIC code, combined with information on the monetary value of shipments by each SIC end-use for U.S. and Illinois. Illinois' electricity consumption shares for each industrial SIC end-use is estimated by assuming equivalent industrial electric consumption per dollar of shipment/production between U.S. and Illinois.[26] The table below shows the estimated breakdown of industrial electricity uses by SIC application in Illinois.

---

[26] U.S. Census Bureau, Census 2000

U.S. Census Bureau, 1997 Economic Census, Construction, Table 1-US, Table 2-Illinois, (US, January 2000. Illinois, March 2000)

USDA, National Agricultural Statistical Service, 1997 Census of Agriculture, State Data, Table 1, State Summary Highlights

U.S. Census Bureau, 1997 Economic Census, Comparative Statistics, Mineral Industries (for United States and Illinois)

U.S. Census Bureau, 1997 Economic Census, Comparative Statistics, Manufacturing (for United States and Illinois)

Table 4- 12: Estimated Illinois Industrial Electricity Use

Industrial Electricity End-Uses	United States Percent of Total Electricity Use	Illinois Percent of Total Electricity Use
Food	6.69%	8.21%
Paper	7.64%	6.18%
Chemicals	16.97%	17.96%
Petroleum Refining	4.07%	4.45%
Rubber & Plastics	5.66%	7.61%
Stone, Glass, Clay	4.26%	3.18%
Primary Metals	14.13%	17.34%
Metals Fabrication	4.88%	7.22%
Other mfg.	25.1%	19.3%
Agriculture	1.71%	1.46%
Mining	1.52%	0.34%
Construction	7.35%	6.74%

Based on the above percentages, and assuming that the percentages remain constant over time, we estimated the annual electricity consumption for each industrial end-use (food, paper, etc.) for the 2006-2020 period. For example, the food industry electricity consumption in 2020 is calculated as follows:

Food Industry Electricity Consumption	=	38,603 million kWh	X	8.2%	=	3,170 million kWh

Step 2:
Next, we evaluated energy savings from efficiency measures that target a range of industrial end-uses. Potential energy savings for the various end-uses, expressed as a percentage of current consumption,[27] is shown below:

Table 4- 13: Industrial Energy Efficiency Savings

Industrial Electricity End-Uses	Potential Savings (2010)
Food	14.80%
Paper	6.80%
Chemicals	6.80%

[27] The 5-Lab study evaluated electricity savings achieved by 2010 from a variety of energy efficiency measures for the different industrial end-uses (by SIC code). In this study, we assume the same percent savings by 2020.

Table 4- 13: Industrial Energy Efficiency Savings

Industrial Electricity End-Uses	Potential Savings (2010)
Petroleum Refining	6.80%
Rubber & Plastics	25.00%
Stone, Glass, Clay	5.70%
Primary Metals	8.70%
Metals Fabrication	17.70%
Other mfg.	17.20%
Agriculture	17.10%
Mining	16.50%
Construction	17.20%
Total Reduction	13.40%

In addition, we project a technology implementation rate starting at 2% in 2006 and reaching 75% of the industrial sector by 2020. The incremental annual savings generated from these energy efficiency measures is estimated as follows:

Incremental Annual Energy Savings	=	Annual Electricity Consumption for each End-Use	X	Percent Savings for each End-Use	X	Incremental Implementation for each Energy Efficiency Measure

Step 3:

In this step, we evaluate the annual investment for these energy efficiency measures. We multiply the incremental electricity saved annually (step 2) for each end-use by the investment required to obtain each kWh of annual savings. The investment per kWh is derived from the present value of the Cost of Conserved Electricity ($/kWh) in the 5-Lab Study. The cost of conserved electricity (CCE) in the 5-Lab Study was converted to 2003$ using the GDP implicit price deflator. Utilizing the CCE, we estimate the present value investment per kWh needed to achieve the electricity savings.

Annual Investment	=	Incremental Annual Energy Savings for each End-Use	X	Present Value of the Cost of Saved Energy ($/kWh)

A 20-year service life for the energy efficiency measures and the discount rate (15%) from the 5-Lab study were used to calculate the PV of the cost of the efficiency measures. The table below shows the cost of energy efficiency measures that target each of the major industrial end-uses:

Table 4- 14: Cost of Industrial Energy Efficiency Measures ($/kWh)

Industrial Electricity End-Uses	Lifetime (Years)	Cost of Conserved Electricity (2003$/kWh)	PV of Cost of Conserved Electricity (2003$/kWh)
Food	20	$0.026	$0.163
Paper	20	$0.026	$0.163
Chemicals	20	$0.026	$0.163
Petroleum Refining	20	$0.026	$0.163
Rubber & Plastics	20	$0.026	$0.163
Stone, Glass, Clay	20	$0.026	$0.163
Primary Metals	20	$0.026	$0.163
Metals Fabrication	20	$0.026	$0.163
Other mfg.	20	$0.026	$0.163
Agriculture	20	$0.026	$0.163
Mining	20	$0.026	$0.163
Construction	20	$0.026	$0.163

Step 4:

In the final step, we evaluate net consumer savings from investing in industrial energy efficiency measures. To calculate consumer savings we multiply the electricity saved annually for each end-use (from step 2) by the difference between the retail cost of electricity and the cost of conserved electricity.

Annual Net Consumer Savings	=	Annual Electricity Savings (kWh/year)	X	Retail Cost of Industrial Electricity ($/kWh) – Cost of Conserved Energy ($/kWh)

For purposes of this calculation, we assume that the retail cost of electricity for Illinois industrial consumers will remain unchanged (in constant dollars) at $0.0491/kWh, from 2003 to 2020.[28] The table below shows the net consumer savings for each industrial end-use.

[28] Energy Information Administration, "Electric Power Annual 2003 – Spreadsheets", January 2005, DOE/EIA-0348(2003).

Table 4- 15: Net Savings for Industrial Consumers

Industrial Electricity End-Uses	Cost of Conserved Electricity (2003$/kWh)	Net Consumer Savings (2003$/kWh)
Food	$0.026	$0.0231
Paper	$0.026	$0.0231
Chemicals	$0.026	$0.0231
Petroleum Refining	$0.026	$0.0231
Rubber & Plastics	$0.026	$0.0231
Stone, Glass, Clay	$0.026	$0.0231
Primary Metals	$0.026	$0.0231
Metals Fabrication	$0.026	$0.0231
Other mfg.	$0.026	$0.0231
Agriculture	$0.026	$0.0231
Mining	$0.026	$0.0231
Construction	$0.026	$0.0231

Net consumer savings total about $1.7 billion (above investment cost[29]) throughout the service life of all energy efficiency measures installed by 2020. The table below presents a summary of industrial energy savings, investment in energy efficiency measures, annual electricity cost savings, and net consumer savings generated over the life of the energy efficiency measures.

Table 4- 16: Industrial Energy Efficiency Electricity Savings, Investments, and Consumer Savings

Year	Penetration Rate of Efficiency Measures	Incremental Electricity Savings kWh	Annual Electricity Savings kWh	Estimated Annual Investment	Annual Electricity Cost Savings	Annualized Net Consumer Savings
2006	2%	93,310,157	93,310,157	$15,180,210	$4,581,529	$2,156,316
2007	4%	93,701,407	187,011,564	$15,243,861	$9,182,268	$4,321,674
2008	6%	94,094,297	281,105,861	$15,307,778	$13,802,298	$6,496,110
2009	9%	141,733,251	422,839,112	$23,057,945	$20,761,400	$9,771,442
2010	12%	128,094,785	550,933,897	$20,839,165	$27,050,854	$12,731,600
2011	15%	139,351,210	690,285,108	$22,670,422	$33,892,999	$15,951,885
2012	18%	174,919,387	865,204,495	$28,456,849	$42,481,541	$19,994,119
2013	23%	219,566,030	1,084,770,526	$35,720,210	$53,262,233	$25,068,097
2014	29%	275,608,339	1,360,378,864	$44,837,481	$66,794,602	$31,437,165
2015	36%	345,954,955	1,706,333,819	$56,281,856	$83,780,991	$39,431,881
2016	44%	382,146,099	2,088,479,918	$62,169,631	$102,544,364	$48,262,943
2017	52%	425,611,903	2,514,091,822	$69,240,887	$123,441,908	$58,098,462

[29] The energy efficiency measures required to reach the 2006 – 2020 industrial reduction targets will cost about $0.6 billion through 2020.

Table 4- 16: Industrial Energy Efficiency Electricity Savings, Investments, and Consumer Savings

Year	Penetration Rate of Efficiency Measures	Incremental Electricity Savings kWh	Annual Electricity Savings kWh	Estimated Annual Investment	Annual Electricity Cost Savings	Annualized Net Consumer Savings
2018	60%	384,656,845	2,898,748,667	$62,578,092	$142,328,560	$66,987,545
2019	67%	355,368,134	3,254,116,801	$57,813,244	$159,777,135	$75,199,791
2020	75%	366,374,411	3,620,491,212	$59,603,806	$177,766,118	$83,666,383
2021			3,620,491,212		$177,766,118	$83,666,383
2022			3,620,491,212		$177,766,118	$83,666,383
2023			3,620,491,212		$177,766,118	$83,666,383
2024			3,620,491,212		$177,766,118	$83,666,383
2025			3,620,491,212		$177,766,118	$83,666,383
2026			3,527,181,054		$173,184,590	$81,510,067
2027			3,433,479,648		$168,583,851	$79,344,710
2028			3,339,385,351		$163,963,821	$77,170,273
2029			3,197,652,099		$157,004,718	$73,894,941
2030			3,069,557,314		$150,715,264	$70,934,783
2031			2,930,206,104		$143,873,120	$67,714,498
2032			2,755,286,717		$135,284,578	$63,672,264
2033			2,535,720,686		$124,503,886	$58,598,286
2034			2,260,112,348		$110,971,516	$52,229,218
2035			1,914,157,392		$93,985,128	$44,234,502
2036			1,532,011,293		$75,221,755	$35,403,440
2037			1,106,399,390		$54,324,210	$25,567,922
2038			721,742,545		$35,437,559	$16,678,839
2039			366,374,411		$17,988,984	$8,466,592
2040			0		$0	$0
SUM		3,620,491,212	72,409,824,236	$589,001,436	$3,555,322,370	$1,673,327,661

The internal rate of return for investments in industrial energy efficiency measures is 17.2%. More detailed results are available in Appendix C

TOTAL ENERGY EFFICIENCY SAVINGS

The residential, commercial and industrial energy efficiency measures described in this chapter would reduce overall consumption of electricity in Illinois by 165,000,000,000 kWh from 2006 through 2020. Electricity savings will continue beyond 2020, throughout the life of the projects, without further investments in energy efficiency. Total electricity savings throughout the life of the energy efficiency measures will amount to 363,000,000,000 kWh (from 2006 through 2039).

Electricity cost savings from reduced electricity use, over the service life of the energy efficiency measures, total $25.9 billion. Consumer net savings from the energy efficiency measures (using the difference between the price of electricity and the cost of conserved electricity) is about $16 billion (above the investment cost) throughout the service life of all the energy efficiency measures installed by 2020. Overall, the energy efficiency program is estimated to require a $7.8 billion investment through 2020. The internal rate of return of investing in residential, commercial and industrial energy efficiency measures is 15.5%.

The table below presents a summary of annual energy savings, investment in energy efficiency measures, and consumer net savings generated over the life of the energy efficiency measures.

Table 4- 17: Total Energy Efficiency Electricity Savings, Investments, and Consumer Savings

Year	Incremental Electricity Savings kWh	Annual Electricity Savings kWh	Estimated Annual Investment	Annual Electricity Cost Savings	Annualized Net Consumer Savings
2006	667,906,084	667,906,084	$154,545,360	$48,874,885	$30,682,930
2007	678,068,332	1,345,974,416	$158,147,931	$98,510,134	$61,873,389
2008	688,406,084	2,034,380,500	$161,806,528	$148,918,837	$93,580,485
2009	1,048,383,834	3,082,764,334	$246,411,259	$225,712,056	$141,930,007
2010	957,988,384	4,040,752,718	$227,430,618	$295,906,419	$186,167,327
2011	1,053,738,316	5,094,491,034	$251,370,156	$373,141,020	$234,888,157
2012	1,337,414,895	6,431,905,929	$318,994,858	$471,198,369	$296,803,463
2013	1,697,510,342	8,129,416,271	$446,129,410	$595,695,405	$375,488,273
2014	2,154,624,205	10,284,040,476	$555,928,032	$753,765,044	$475,486,719
2015	2,734,912,364	13,018,952,840	$695,703,035	$954,465,542	$602,574,859
2016	3,054,996,263	16,073,949,102	$848,131,922	$1,178,720,269	$744,712,415
2017	2,687,036,496	18,760,985,599	$756,376,288	$1,373,432,318	$867,386,032
2018	3,029,893,905	21,790,879,504	$873,826,010	$1,595,579,757	$1,008,324,028
2019	3,449,598,455	25,240,477,959	$1,028,014,823	$1,850,727,073	$1,171,068,505
2020	3,503,257,354	28,743,735,313	$1,104,264,008	$2,109,627,780	$1,336,268,143
2021	0	25,672,256,808		$1,863,119,153	$1,067,024,547
2022	0	24,211,382,747		$1,752,885,398	$1,017,695,441
2023	0	22,747,723,427		$1,641,250,371	$961,394,902
2024	0	20,915,724,510		$1,501,502,760	$899,141,183
2025	0	18,770,133,910		$1,337,911,879	$822,304,316
2026	0	16,550,072,150		$1,172,398,541	$727,235,681

Table 4- 17: Total Energy Efficiency Electricity Savings, Investments, and Consumer Savings

Year	Incremental Electricity Savings kWh	Annual Electricity Savings kWh	Estimated Annual Investment	Annual Electricity Cost Savings	Annualized Net Consumer Savings
2027	0	12,246,610,428		$855,319,830	$618,812,505
2028	0	10,852,005,233		$746,736,056	$543,168,560
2029	0	9,313,516,868		$628,677,338	$467,791,402
2030	0	7,320,026,515		$472,857,981	$380,207,180
2031	0	6,422,427,298		$409,762,800	$281,605,927
2032	0	5,517,016,444		$346,680,663	$208,590,125
2033	0	4,870,274,586		$303,325,171	$180,926,706
2034	0	4,099,750,439		$251,964,221	$148,470,092
2035	0	3,271,226,868		$197,744,926	$115,280,670
2036	0	2,441,411,905		$144,426,751	$82,914,786
2037	0	1,624,932,222		$94,246,830	$52,212,193
2038	0	829,332,772		$44,453,620	$21,500,353
2039	0	366,374,411		$17,988,984	$8,466,592
2040	0	0		$0	$0
SUM	28,743,735,313	362,782,811,619	$7,827,080,240	$25,857,528,179	$16,231,977,896

In addition to consumer savings, energy efficiency measures will free transmission and distribution capacity. Based on a 1994 conference paper by the engineering firm Black & Veatch, installing new transmission and distribution lines to meet increasing consumer energy demand costs over one million dollars per mile[30]. Also, as reliable as the U.S. and Illinois utility system may be, an overloaded T&D system could cause outages. When an outage occurs, customers experience damages. A residential customer may experience food spoilage, personal discomfort, loss of leisure time, and loss of working time. A retail store will lose sales and a restaurant will lose sales and stored food. An industrial customer will lose production and may lose the value of work in progress as well. For some customers, like hospitals, the potential outage costs relate to health and safety and are extremely high. Determining outage costs per kilowatt-hour of unserved load for different customer classes can be difficult. Review of the outage cost literature by EPRI (table below) shows that commercial customers have the highest outage costs, followed by industrial, and finally residential customers (Customer Demand for Service Reliability: A Synthesis of the Outage Cost Literature, EPRI P-6510, 1989)[31].

[30] U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, “Nature's Power on Demand: Renewable Energy Systems as Emergency Power Sources”, October 1995.
[31] Market Assessment of Combined Heat and Power in the State of California. California Energy Commission, P700-00-009, October 2000, pp 2-29.

Table 4- 18: Outage Costs

Customer Class	Average Outage Costs ($/kWh)
Residential	$1-10
Commercial	$25-60
Industrial	$10-20

A more in depth analysis of the current status of the Illinois electricity transmission and distribution system and future T&D needs is needed to better evaluate the impacts of energy efficient measures on the T&D system, effects on the economy, productivity, jobs, etc.

CHAPTER 5 – OTHER ENVIRONMENTALLY BENIGN GENERATION

Illinois electricity consumption is expected to grow by approximately 30,600,000 MWh during the 2005-2020 period. Assuming that power generators are committed to maintain their current levels of electricity exports, it is expected that even with the new renewable generation capacity to meet the requirements for a 16% renewable portfolio scenario by 2020, an additional 320 MW of delivered capacity will be required to meet Illinois consumers' growing electricity requirements (an additional 2,800,000 MWh above the 27,800,000 MWh from renewable sources) by 2020.

This study assumes that approximately 2,600 MW of delivered capacity will have to be installed to meet potential retirement of older power generation facilities and growth in the Illinois consumer electricity consumption beyond the electricity generated from renewable resources. In the study, the 2,600 MW capacity requirement is met with technologies that, while not included in the 1997 Energy Law as renewable resources, are nevertheless environmentally benign. The two technologies that are suggested to supply the additional 2,600 MW of capacity are integrated gasification combined cycle technology (IGCC) and natural gas fired combined heat and power technology (CHP).

NATURAL GAS-FIRED COMBINED HEAT AND POWER SYSTEMS FOR COMMERCIAL APPLICATIONS

Natural gas fired combined Heat and Power systems generate electricity and recycle the otherwise wasted heat from the generator for process heating, space heating, cooling, or dehumidification. There is a total of approximately 4,531 MW of additional CHP capacity potential in Illinois consisting of 2,661 MW in the commercial sector and 1,870 in the industrial sector.[32,33,34] Assuming an actual implementation rate of 25%, a conservative estimate, this will result in CHP capacity additions of 1,133 MW by 2020 (0.25*4,531 MW), consisting of 665 MW in the commercial sector and 468 MW in the industrial sector. However, since industrial sector CHP systems are already included as an industrial energy efficiency measure discussed in Chapter 4, only commercial CHP is discussed in this section.[35]

The installed cost for a 100 kW microturbine CHP facility is currently $1,450/kW, and is projected to be $622/kW in 2010 thru 2020 (U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy Programs. Projected Benefits of Federal Energy Efficiency and Renewable Energy Programs FY 2005 – FY 2050, prepared by the National Renewable Energy Laboratory, May 2004, Table 5-11, cost

[32] A DOE-sponsored study by Onsite Sycom Energy Corporation estimates the capacity potential for CHP in the commercial/institutional sector to be about 2,773 MW (Onsite Energy, 2000). Subtracting from this capacity potential the amount of already installed CHP capacity in this market sector of 112 MW (per Midwest CHP Application Center, CHP/BCHP Baseline Analysis for the Illinois Market – 2002 Update) results in a net capacity potential of 2,661 MW of CHP in the commercial/institutional sector in Illinois.

[33] In the industrial sector, the Midwest CHP Application Center estimates that about 935 MW of CHP capacity are installed in Illinois (Midwest CHP Application Center, CHP/BCHP Baseline Analysis for the Illinois Market – 2002 Update). Onsite Sycom, in a DOE-sponsored study reports that about 33% of the total CHP capacity potential has been installed nationwide in the industrial sector (Onsite Sycom, 2001, page 2-3). If the installed CHP capacity in Illinois of 935 MW represents 33% saturation, then an additional CHP capacity of 1,870 MW should be available in the industrial market sector in the State.

[34] CHP capacity potential in the residential sector is considered to be zero, a conservative estimate.

[35] Total additional CHP by 2020 is 1,570 MW, including 384 MW from landfill gas and 53 MW from biomass-manure.

numbers adjusted by GDP implicit price deflator).[36] The combined efficiency for these CHP systems is currently 68%, gradually increasing to 72% by 2020. Variable O&M costs are estimated to be $0.015/kWh.[37] The discount rate for natural gas-fired CHP generators is set at 10 percent, consistent with the utility average.

Table 5- 1: Commercial Natural Gas-Fired CHP Assumptions

Natural Gas CHP	2005	2010	2015	2020
Capital Cost ($/kW)	1,450	622	622	622
O&M Cost ($/kWh)*	0.04	0.039	0.039	0.039
Capacity Factor	95%	95%	95%	95%

*O&M Cost include variable, fixed, and fuel cost

The use of natural gas CHP in the commercial sector, at the levels shown below, will require about $0.5 billion investment through 2020. Energy cost savings amount to $3.9 billion over the service life of the CHP equipment. Net consumer savings from CHP applications (above the CHP investment cost) from reduced electricity costs (using the difference between the utility cost of electricity and the cost of electricity generated with CHP) is about $2.8 billion throughout the service life of the CHP equipment installed by 2020. For purposes of this calculation, we assume that the retail cost of electricity for Illinois commercial consumers will remain unchanged (in constant dollars) at $0.0722/kWh, from 2003 to 2020.[38] The internal rate of return in investing in CHP energy efficiency installations is 15.4%.

The table below presents a summary of electricity generation, investment in CHP, and consumer savings generated over the life of the CHP projects.

Table 5- 2: Commercial Natural Gas CHP Delivered Capacity, Investment, Electricity Generation, and Consumer Energy Savings

Year	Delivered Capacity (MW)	Capital Cost ($)	Electricity Generation (kWh)	Cost of Electricity Generated $/kWh	Annual Energy Cost Savings[39]	Annualized Net Consumer Savings
2006	44	$59,938,667	388,360,000	$0.0581	$12,525,064	$5,484,691
2007	89	$52,210,667	776,720,000	$0.0556	$25,162,793	$12,897,502
2008	133	$44,482,667	1,165,080,000	$0.0531	$37,911,232	$22,236,480
2009	177	$36,754,667	1,553,440,000	$0.0506	$50,768,473	$33,499,715
2010	222	$29,026,667	1,941,800,000	$0.0482	$63,732,650	$46,685,343
2011	266	$29,026,667	2,330,160,000	$0.0481	$76,641,020	$56,184,252
2012	310	$29,026,667	2,718,520,000	$0.0480	$89,602,265	$65,736,035
2013	355	$29,026,667	3,106,880,000	$0.0480	$102,615,934	$75,340,243
2014	399	$29,026,667	3,495,240,000	$0.0479	$115,681,583	$84,996,431

[36] The current cost estimates of the NREL-EREE 2004 Report are generally close to other published cost estimates (see MAC CHP Guidebook).
[37] MAC CHP Guidebook.
[38] Energy Information Administration, "Electric Power Annual 2003 – Spreadsheets", January 2005, DOE/EIA-0348(2003).
[39] Annual Energy Cost Savings = Electricity Cost Savings – CHP O&M Costs.

Table 5- 2: Commercial Natural Gas CHP Delivered Capacity, Investment, Electricity Generation, and Consumer Energy Savings

Year	Delivered Capacity (MW)	Capital Cost ($)	Electricity Generation (kWh)	Cost of Electricity Generated $/kWh	Annual Energy Cost Savings[39]	Annualized Net Consumer Savings
2015	443	$29,026,667	3,883,600,000	$0.0478	$128,798,774	$94,704,160
2016	488	$29,026,667	4,271,960,000	$0.0477	$141,967,071	$104,462,996
2017	532	$29,026,667	4,660,320,000	$0.0477	$155,186,045	$114,272,509
2018	576	$29,026,667	5,048,680,000	$0.0476	$168,455,272	$124,132,274
2019	621	$29,026,667	5,437,040,000	$0.0475	$181,774,332	$134,041,873
2020	665	$29,026,667	5,825,400,000	$0.0475	$195,142,809	$144,000,889
2021			5,825,400,000	$0.0475	$195,142,809	$144,000,889
2022			5,825,400,000	$0.0475	$195,142,809	$144,000,889
2023			5,825,400,000	$0.0475	$195,142,809	$144,000,889
2024			5,825,400,000	$0.0475	$195,142,809	$144,000,889
2025			5,825,400,000	$0.0475	$195,142,809	$144,000,889
2026			5,437,040,000	$0.0475	$182,617,745	$134,400,829
2027			5,048,680,000	$0.0475	$169,980,016	$124,800,770
2028			4,660,320,000	$0.0475	$157,231,577	$115,200,711
2029			4,271,960,000	$0.0475	$144,374,337	$105,600,652
2030			3,883,600,000	$0.0475	$131,410,159	$96,000,592
2031			3,495,240,000	$0.0475	$118,501,789	$86,400,533
2032			3,106,880,000	$0.0475	$105,540,544	$76,800,474
2033			2,718,520,000	$0.0475	$92,526,875	$67,200,415
2034			2,330,160,000	$0.0475	$79,461,226	$57,600,355
2035			1,941,800,000	$0.0475	$66,344,036	$48,000,296
2036			1,553,440,000	$0.0475	$53,175,738	$38,400,237
2037			1,165,080,000	$0.0475	$39,956,764	$28,800,178
2038			776,720,000	$0.0475	$26,687,537	$19,200,118
2039			388,360,000	$0.0475	$13,368,477	$9,600,059
2040						
SUM		$512,680,000			$3,902,856,183	$2,846,686,054

Distributed Generation systems such as CHP can offer additional savings beyond those quantified in Table 5-2. Facilities operating distributed generating systems can experience enhanced reliability since the distributed generating system can continue to operate during outages on the distribution system. Furthermore, distributed generation systems reduce current load on the distribution and transmission system thus slowing the need for upgrades and expansion of these facilities. Based on a 1994 conference paper by the engineering firm Black & Veatch, installing new transmission and distribution lines to meet increasing consumer energy demand costs over one million dollars per mile.[40] Distributed

[40] U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, “Nature's Power on Demand: Renewable Energy Systems as Emergency Power Sources”, October 1995.

generating systems also do not incur the transmission and distribution system line losses typical of central power plants (4% to 12%). A more in depth analysis of the current status of the Illinois electricity transmission and distribution system and future T&D needs is needed to better evaluate the impacts of distributed generation on the T&D system, effects on the economy, productivity, jobs, etc.

COAL-FIRED INTEGRATED GASIFICATION COMBINED CYCLE (IGCC) TECHNOLOGY

Technology Introduction

IGCC technology uses a gasifier to convert coal into a synthetic gas, referred to as "syngas." The syngas from the gasifier is combusted in a combustion turbine. Heat from the turbine exhaust gas is extracted in a heat recovery steam generator to produce steam to drive a steam turbine generator. One of the unique characteristics that make IGCC a relatively clean form of electricity production is the ability to break down coal into its basic elements, which allows the separation of the pollutants prior to combustion of the syngas in the combustion turbine. Additional emissions reductions could be possible since Illinois has favorable settings for geological CO_2 sequestration (Rostam-Abadi, 2004).

Fuel availability and capacity potential

Illinois has one of the largest coal reserves in the country totaling 199 billion tons of which 30% are economically minable (Rostam-Abadi, 2004). While fuel availability has not been an obstacle for coal-fired IGCC installations in Illinois, relatively high capital costs have impeded IGCC deployment. However, recent developments such as the availability of packaged IGCC technologies (such as ConocoPhillips coal gasification units) may reduce the capital requirements for this technology in the future. Currently, Madison Power Corporation is in advanced development stages for its 540 MW Southern Illinois Clean Energy Center located in Williamson County, Illinois; this plant is scheduled to start commercial operation before 2010. This study assumes that IGCC can play a significant role for Illinois' electricity portfolio: by 2020 a total of 2,000 MW of coal-fired IGCC are projected for the state.

Financial Assumptions

Capital cost assumptions are based on recent industry estimates with current capital costs of $1,200/kW to $1,300/kW gradually declining to $850/kW by 2020. The Department of Energy estimates efficiency increases for IGCC from the current 40-42% to 50-60% by 2020 (Miller, 2004). Variable O&M costs are assumed to be $0.01/kWh (Madison Power Corporation). Coal costs are based on the average delivered coal price of $1.19/MMBtu in Illinois (per EIA State Energy Profiles 2002). The discount rate for IGCC generators is set at 8 percent (instead of the utility average of 10 percent) to reflect potential incentives for coal-fired IGCC in the State (see Hoback, 2004).

Table 5- 3: Coal-Fired IGCC Assumptions

Coal-Fired IGCC	2005	2010	2015	2020
Capital Cost ($/kW)	No Installation	1,250	1,050	850
O&M Cost ($/kWh)*	No Installation	0.019	0.018	0.017
Capacity Factor	No Installation	85%	85%	85%

*O&M Cost include variable, fixed, and fuel cost

Overall, the installation of 2,000 MW of coal-fired IGCC will require about $2.4 billion investment through 2020. The table below presents a summary of delivered generation capacity, investment, and cost of electricity generated from IGCC.

Table 5- 4: IGCC Delivered Capacity, Investment, and Cost of Electricity Generated[41]

Year	Incremental IGCC Delivered Capacity (MW)	Cumulative Delivered Capacity (MW)	Capital Cost ($)	Cost of Electricity Generated ($/kWh)
2010	500	500	$735,294,118	$0.0356
2011		500	$0	$0.0350
2012		500	$0	$0.0343
2013		500	$0	$0.0336
2014		500	$0	$0.0330
2015	750	1,250	$926,470,588	$0.0323
2016		1,250	$0	$0.0316
2017		1,250	$0	$0.0310
2018		1,250	$0	$0.0303
2019		1,250	$0	$0.0297
2020	750	2,000	$750,000,000	$0.0290
SUM	2,000		$2,411,764,706	

[41] The IGCC analysis does not include net consumer savings, because net consumer savings are accrued only by end-users.

CHAPTER 6 - EMISSIONS ANALYSIS

The analysis in this section quantifies the air emission reductions that could be obtained by investing in energy efficiency and substituting electricity generated from renewable and benign technologies (such as IGCC and CHP) for electricity generated using nonrenewable resources. The analysis focuses on the following pollutants: Sulfur Oxides (SO_x), Nitrogen Oxides (NO_x), Mercury (Hg), and Carbon Dioxide (CO_2).

According to data published by the Energy Information Administration (EIA State Electricity Profile 2002, Table 7) more than 90% of all SOx, NO_x, and CO_2 emitted by Illinois' electric power plants comes from coal-fired resources. These coal-fired resources burn predominantly western coal. In this study, efficiency measures and electricity from renewables and environmentally benign resources such as IGCC technologies and natural gas fired CHP are assumed to displace electricity from these coal-fired power plants.[42] Therefore, emissions from IGCC and CHP facilities are compared against emissions associated with a mainly western coal-fired business as usual scenario.

Inherent in this methodology is the assumption that all of the emissions reductions resulting from the renewable energy, energy efficiency, CHP, and IGCC scenarios would occur in Illinois. Illinois is however a significant exporter of power, and a deregulated state where existing power generators may potentially choose to sell power to regional markets beyond Illinois' borders rather than ramping down their generation in state. The actual decisions of individual power generators will therefore depend on a broad variety of market factors outside of Illinois that are beyond the scope of this study[43]. Relevant to this study, to the extent that predicted emissions reductions actually occur outside of the Illinois airshed, the Illinois emissions reductions are overestimated.

It should furthermore be noted that uncertainties exist when estimating emissions associated with electric power generation and that the following analysis need always be viewed in the context of the individual assumptions. The following general sources were used for emission estimation purposes:

- Some renewable technologies utilize internal combustion sources. Wherever possible, emission estimates for these renewable technologies rely on AP-42 emission factors published by the Environmental Protection Agency's Office of Air Quality and Standards (Fifth Edition, Volume 1, Chapter 3, Stationary Internal Combustion Sources). AP-42 Emission Factors represent typical emissions for certain classes of electric generating equipment. For example, one set of factors represents the emissions for each pollutant from stationary gas turbines fueled by landfill gas; another set of factors represents emissions for gasoline engines less than 600 horsepower.

[42] Studies that compare emissions from renewable energy resources against business as usual scenarios generally distinguish between peaking resources and baseload generating resources. Oftentimes peaking resources use different types of fuel (i.e. natural gas) than baseload resources (i.e. coal, nuclear) and therefore have different emission characteristics. However, in Illinois both a substantial amount of baseload capacity as well as peaking capacity is fueled by coal (EPA eGrid 2000 data shows only 2.7% natural gas-fired resources). Therefore, no distinction between peaking and baseload resources was deemed necessary.

[43] The Illinois EPA and Illinois DCEO are currently beginning a comprehensive assessment to more fully determine the likely location of emissions reductions with the intent of developing a reasonable approach to include and account for those reductions in Illinois' State Implementation Plan per the Clean Air Act.

- Since AP-42 emission factors for certain technologies (such as Clean Coal Gasification Technologies) are not available, other sources of information were tapped. One such source includes the EPA's Region V Air Permit Database of air permit applications; these documents provide a good indication of estimated emissions for various technologies.

- Emissions estimates for existing coal-fired electric generation in Illinois are based on data from the EPA eGrid Database. This database provides output emission rates in lb/MWh for each of the pollutants assessed in this study.[44]

Finally, published reports and personal conversations with emissions experts complement these sources of emission information.[45]

In the following sections the total emissions and the emissions savings are calculated for: a) the renewable portfolio technologies; b) the energy efficiency measures; c) IGCC clean coal technologies, and d) natural gas fired CHP. Then, the calculated emissions and emissions savings are compared against emission mandates under the Clean Air Interstate Rule and the Clean Air Mercury Rule.

RENEWABLE RESOURCES

Emissions from Renewable Resources

This section analyzes expected emissions and emissions reductions for each of the renewable electric generating technologies: Wind, solar, landfill gas, biomass co-firing, biomass gasification, and biomass manure.

Emissions from Wind and Solar Technologies

Wind and solar-based electric generating technologies are not expected to produce any SO_x, NO_x, Hg, and CO_2 as part of the electricity generating process. Pollution from the equipment manufacturing process is not considered in this study.

Emissions from Landfill-Gas Fueled Electric Generating Technologies

For the purpose of this analysis landfill gas is assumed to be combusted in small (100 kW), commercially available microturbines with heat recovery systems. Emission estimates for landfill-gas fired electric

[44] This study uses emission rates based on eGrid's Year 2000 State Level Data for Illinois.
[45] The employed methodology does not account for net carbon reductions from renewable technologies that convert methane (CH4) to carbon dioxide (CO2). Because uncaptured methane emissions are a potent global warming gas that is 21 times more powerful than carbon, and because landfill gas combustion and animal manure biogas combustion are both methane sources, the net carbon-ton-equivalent reductions for those technologies are much greater than indicated by this study (see EPA's "Global Warming Homepage" at http://www.epa.gov/methane/scientific.html).

generating technologies for SO_x, CO_2, and NO_x are based on AP-42 Emissions Factors.[46] Mercury emissions were deemed negligible. Since these emission factors are based on fuel input (lb/MMBtu) the factors were converted to lb/MWh assuming a heat rate of 5,019 Btu/kWh. The table below lists the emissions factors used for landfill gas-based electricity generation.

Emissions Factor (lb/MWh)			
SO_x	NO_x	CO_2	Hg
0.23	0.70	250.95	0.00

With these assumptions the emissions contributions from landfill-gas fired technologies under the renewable portfolio scenario were calculated. The table below shows the delivered capacity from landfill gas based generation in each of the renewable portfolio years, followed by the expected total emissions from each pollutant during that year.

Table 6- 1: Emission Estimates from Commercial Gas Turbines at Landfills

Year	*Capacity (MW)*	*SO_x (tpy)*	*NO_x (tpy)*	*CO_2 (tpy)*	*Hg (tpy)*
2006	40	40	123	43,966	0.000
2007	60	59	185	65,950	0.000
2008	81	80	249	89,032	0.000
2009	103	102	317	113,214	0.000
2010	125	124	385	137,395	0.000
2011	148	146	455	162,676	0.000
2012	171	169	526	187,957	0.000
2013	194	192	597	213,237	0.000
2014	217	215	668	238,518	0.000
2015	241	238	742	264,898	0.000
2016	265	262	816	291,278	0.000
2017	290	287	893	318,757	0.000
2018	315	312	969	346,236	0.000
2019	340	336	1,046	373,715	0.000
2020	365	361	1,123	401,194	0.000

Emissions from Biomass Co-Firing Electric Generating Technology

The "Renewable Energy Technology Characterization" report (Energy Efficiency and Renewable Energy, U.S. DOE, and EPRI, TR-109496, December 1997) models SO_2 emissions for a 100 MW coal-fired power plant with biomass co-firing. The analysis shows that SO_2 emissions are 10% lower for a power plant co-firing 15% biomass and 85% coal (assuming biomass sulfur content of 0.02% and coal sulfur content of 1.9%) than from a coal-only system.

[46]Fifth Edition, Volume I - Chapter 3: Stationary Internal Combustion Sources, Tables 3.1-2b and Table 3.1-1 subsection "Landfill-Gas Fired Turbines"

For CO_2 the analysis assumes a “net-zero” scenario with no additional CO_2 emissions created from biomass co-firing. A “net-zero” scenario is based on the premise that plants absorb CO_2 during growth and release CO_2 during combustion; therefore, if crops are dedicated solely for biomass co-firing no net emissions are being created. Since the financial analysis of this study is based on the more expensive feedstock from dedicated biomass-crops, it is only consistent that the emissions analysis is based on dedicated biomass, hence “net-zero” CO_2 emissions are assumed.

NO_x emissions are assumed to be the same as expected from coal only plants. This is a conservative assumption since NO_x emissions from co-fired systems should actually be lower than NO_x emissions from coal only plants “due to the lower nitrogen content of biomass and the lower flame temperatures associated with combustion of high-moisture content biomass feedstocks” (DOE/EPRI, 1997, page 2-38). Mercury emissions from biomass systems are assumed to be negligible. The table below lists the emissions factors used for biomass co-firing based electricity generation.

Emissions Factor (lb/MWh)			
SO_x	NO_x	CO_2	Hg
0.106	5.73	0	0

With these assumptions the emissions contributions from biomass co-fired technologies under the renewable portfolio scenario were calculated. The table below shows the delivered capacity from biomass co-fired generation (15% biomass and 85% coal) in each of the renewable portfolio years, followed by the expected total emissions from each pollutant during that year.

Table 6- 2: Emission Estimates from Co-firing Biomass at Coal Plants

Year	*Capacity (MW)*	*SO_x (tpy)*	*NO_x (tpy)*	*CO_2 (tpy)*	*Hg (tpy)*
2006	40	186	1,004	0	0
2007	60	279	1,506	0	0
2008	81	377	2,033	0	0
2009	101	470	2,535	0	0
2010	123	572	3,087	0	0
2011	146	679	3,664	0	0
2012	169	786	4,241	0	0
2013	192	893	4,819	0	0
2014	216	1,005	5,421	0	0
2015	240	1,116	6,023	0	0
2016	248	1,154	6,224	0	0
2017	256	1,191	6,425	0	0
2018	264	1,228	6,626	0	0
2019	272	1,265	6,826	0	0
2020	280	1,302	7,027	0	0

Emissions from Biomass-Gasification based Electric Generating Technology

Estimates for SO_2 and NO_x form biomass-gasification are taken from a study utilizing the EPRI Biopower model.[47] The model is based on a 100 MW atmospheric pressure biomass gasification power plant (consisting of a gasifier, gas cleaning, combustion turbine, and steam turbine) with a net heat rate of 11,190 Btu/kWh. The model plant is assumed to fire a blend of urban wood, mill residue, in-forest residue, and agricultural crop residue.

Similar to the approach for biomass co-firing technologies, "net-zero" CO_2 emissions are assumed for biomass-gasification technologies. Mercury emissions from biomass gasification are also assumed to be negligible. The tables below show the employed emission factors for a biomass-gasification facility and the total emissions expected from biomass gasification generating facilities under the renewable portfolio standard.

Emissions Factor (lb/MWh)			
SO_x	NO_x	CO_2	Hg
1.4397	0.1826	0.0000	0

Table 6- 3: Emission Estimates from Biomass Gasification Electric Generating Technologies

Year	*Capacity (MW)*	*SO_x (tpy)*	*NO_x (tpy)*	*CO_2 (tpy)*	*Hg (tpy)*
2006	0	0	0	0	0
2007	0	0	0	0	0
2008	0	0	0	0	0
2009	0	0	0	0	0
2010	0	0	0	0	0
2011	0	0	0	0	0
2012	0	0	0	0	0
2013	0	0	0	0	0
2014	0	0	0	0	0
2015	0	0	0	0	0
2016	15	95	12	0	0
2017	30	189	24	0	0
2018	45	284	36	0	0
2019	60	378	48	0	0
2020	75	473	60	0	0

[47] Charles McGowin, Evan Hughes & Neville Holt, EPRI, Economic and Risk Evaluation for the Brazil Biomass Gasification/Gas Turbine Demonstration Project, published by Worldbank, 2004

Emissions from Biomass Manure

The emissions assumptions for biomass manure fired electric generating technologies are based on AP-42 emission factors for uncontrolled digester gas-fired turbines.[48] Since the recovered waste heat from the combustion process is assumed to be used for digester heating (i.e. the production of digester gas) no further emissions reductions can be expected from the recovered heat.[49] Therefore, conversion from the fuel-input based emission factors to output based emission factors is based on the generator-only heat rate of 11,000 Btu/kWh. Mercury emissions from biomass manure are considered negligible. The table below lists the emission factors for biomass manure-fired generation, followed by a table with the total emissions expected from manure based electric generating capacity for each of the portfolio years.

Emissions Factor (lb/MWh)			
SO_x	NO_x	CO_2	Hg
0.0715	1.7600	297.0000	0

Table 6- 4: Emission Estimates from Digester Gas Fired Combustion Turbines

Year	*Capacity (MW)*	*SO_x (tpy)*	*NO_x (tpy)*	*CO_2 (tpy)*	*Hg (tpy)*
2006	3	0.9	21	3,572	0
2007	6	1.8	44	7,458	0
2008	8	2.5	60	10,179	0
2009	11	3.5	85	14,364	0
2010	13	4.2	103	17,441	0
2011	15	4.7	115	19,437	0
2012	18	5.5	136	22,984	0
2013	22	6.8	167	28,112	0
2014	26	8.1	199	33,550	0
2015	30	9.5	233	39,330	0
2016	34	10.6	262	44,181	0
2017	36	11.3	278	46,836	0
2018	39	12.3	304	51,228	0
2019	44	13.8	340	57,392	0
2020	50	15.7	387	65,361	0

[48] Fifth Edition, Volume I - Chapter 3: Stationary Internal Combustion Sources, Tables 3.1-1 and 3.1-2b
[49] This is a conservative assumption since some of the recovered heat may be used for space heating or cooling on farms, thus displacing emissions from other sources.

Emission Savings from Renewable Resources

The analysis below shows a comparison of emissions by pollutant over the 15-year study horizon that would be expected if 3,173 MW of delivered capacity under a renewable portfolio standard were added to the system vs. a business as usual scenario. The renewable portfolio emissions are the total pollutants emitted from the sum of the delivered capacities of the renewable portfolio technologies (i.e. wind, solar, landfill gas, biomass co-firing, biomass gasification, biomass manure). The business as usual scenario assumes average emissions from coal technologies installed in the state.[50] Emissions estimates for coal-fired electric generation in Illinois are based on data from the EPA eGrid Database. This database provides output emission rates in lb/MWh for each of the pollutants assessed in this study. [51]

[50] While the employed emissions factors for the business as usual scenario reflect current emissions rates, these rates may be lower in the future as generators comply with more stringent environmental regulations. This may overstate the emissions savings from renewable generation technologies. However, high uncertainties exist if and how existing generating sources reduce their emissions and any such assumptions would be highly speculative.

[51] The employed emission factors (lbs/MWh) for the business as usual scenario are:

SOx	NOx	CO2	Hg
10.62	5.73	2308.12	8.32E-05

Table 6- 5: SOx Emissions Savings from Renewable Resources

Year	SOx Emissions: "Business As Usual" Generation Mix (tpy)	SOx Emissions: Renewable Generation Mix (tpy)	SOx Emissions Avoided By Switching to Renewable Resources (tpy)
2006	15,385	226	15,158
2007	23,385	340	23,045
2008	31,576	459	31,117
2009	40,005	575	39,430
2010	48,628	700	47,928
2011	57,491	830	56,660
2012	66,548	961	65,588
2013	75,849	1,092	74,757
2014	85,393	1,227	84,165
2015	95,135	1,364	93,771
2016	105,124	1,521	103,603
2017	115,359	1,678	113,681
2018	125,842	1,836	124,007
2019	136,585	1,994	134,592
2020	147,615	2,152	145,463

Figure 6- 1: SOx Emissions Savings from Renewable Resources

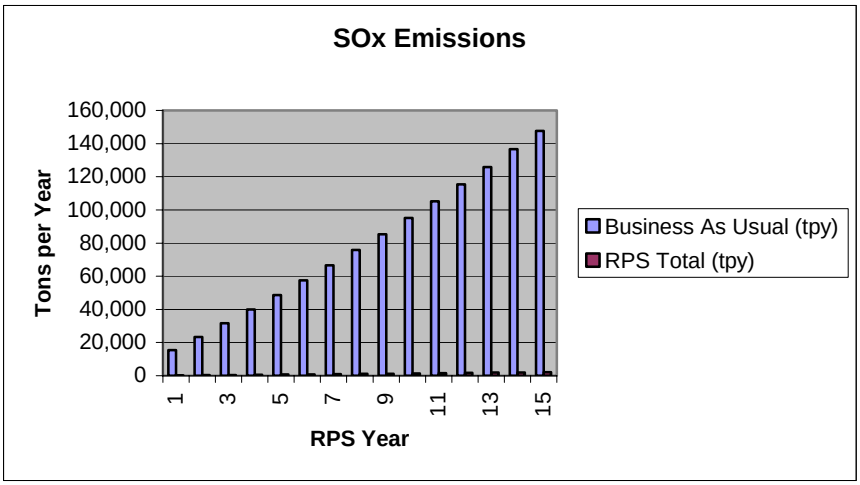


Table 6- 6: NOx Emissions Savings from Renewable Resources

Year	NOx Emissions: "Business As Usual" Generation Mix (tpy)	NOx Emissions: Renewable Generation Mix (tpy)	NOx Emissions Avoided By Switching to Renewable Resources (tpy)
2006	8,301	1,148	7,153
2007	12,617	1,735	10,883
2008	17,037	2,343	14,694
2009	21,585	2,937	18,648
2010	26,237	3,575	22,662
2011	31,019	4,235	26,784
2012	35,906	4,904	31,002
2013	40,924	5,582	35,342
2014	46,074	6,288	39,786
2015	51,330	6,998	44,332
2016	56,719	7,314	49,406
2017	62,242	7,619	54,623
2018	67,898	7,935	59,963
2019	73,694	8,261	65,433
2020	79,646	8,598	71,048

Figure 6- 2: NOx Emissions Savings from Renewable Resources

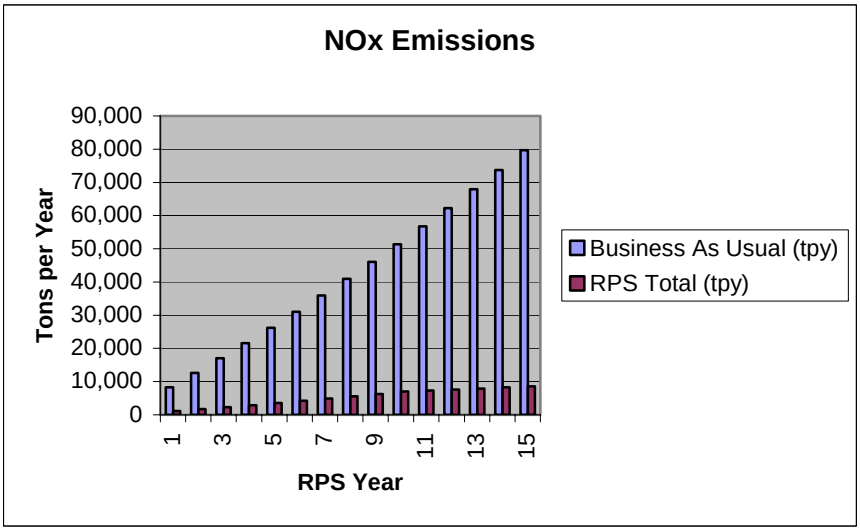


Table 6- 7: CO2 Emissions Savings from Renewable Resources

Year	CO2 Emissions: "Business As Usual" Generation Mix (tpy)	CO2 Emissions: Renewable Generation Mix (tpy)	CO2 Emissions Avoided By Switching to Renewable Resources (tpy)
2006	3,343,699	47,539	3,296,160
2007	5,082,417	73,408	5,009,009
2008	6,862,626	99,211	6,763,415
2009	8,694,654	127,578	8,567,076
2010	10,568,611	154,836	10,413,775
2011	12,494,831	182,113	12,312,718
2012	14,463,433	210,940	14,252,493
2013	16,484,759	241,349	16,243,410
2014	18,559,045	272,068	18,286,977
2015	20,676,422	304,227	20,372,195
2016	22,847,244	335,459	22,511,785
2017	25,071,759	365,592	24,706,167
2018	27,350,221	397,464	26,952,757
2019	29,685,063	431,107	29,253,956
2020	32,082,303	466,555	31,615,748

Figure 6- 3: CO2 Emissions Savings from Renewable Resources

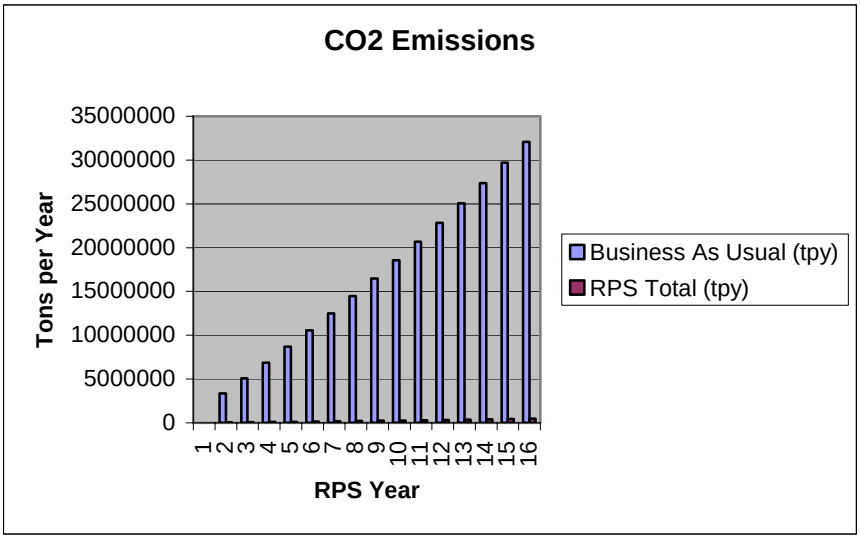
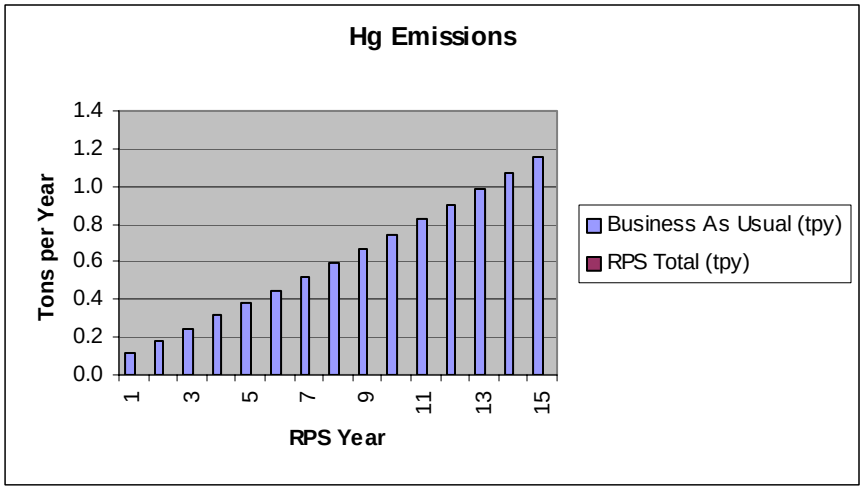


Table 6- 8: Hg Emissions Savings from Renewable Resources

Year	Hg Emissions: "Business As Usual" Generation Mix (tpy)	Hg Emissions: Renewable Generation Mix (tpy)	Hg Emissions Avoided By Switching to Renewable Resources (tpy)
2006	0.12	0	0.12
2007	0.18	0	0.18
2008	0.25	0	0.25
2009	0.31	0	0.31
2010	0.38	0	0.38
2011	0.45	0	0.45
2012	0.52	0	0.52
2013	0.59	0	0.59
2014	0.67	0	0.67
2015	0.75	0	0.75
2016	0.82	0	0.82
2017	0.90	0	0.90
2018	0.99	0	0.99
2019	1.07	0	1.07
2020	1.16	0	1.16

Figure 6- 4: Hg Emissions Savings from Renewable Resources



ENERGY EFFICIENCY

Emissions from Energy Efficiency Measures

In general, energy efficiency measures create no additional emissions.

Emissions Savings from Energy Efficiency Measures

This table below shows the expected emissions savings achieved from the combined energy efficiency measures in the residential, commercial, and industrial sectors against the business as usual scenario.[52]

Table 6- 9: Emissions Savings from Energy Efficiency Measures

Year	Cumulative Consumption (MWh)	SOx (tpy)	NOx (tpy)	CO2 (tpy)	Hg (tpy)
2005					
2006	667,906	3,547	1,914	770,804	0.03
2007	1,345,974	7,147	3,856	1,553,335	0.06
2008	2,034,381	10,803	5,829	2,347,797	0.08
2009	3,082,764	16,369	8,832	3,557,695	0.13
2010	4,040,753	21,456	11,577	4,663,271	0.17
2011	5,094,491	27,052	14,596	5,879,348	0.21
2012	6,431,906	34,153	18,427	7,422,805	0.27
2013	8,129,416	43,167	23,291	9,381,834	0.34
2014	10,284,040	54,608	29,464	11,868,400	0.43
2015	13,018,953	69,131	37,299	15,024,653	0.54
2016	16,073,949	85,353	46,052	18,550,302	0.67
2017	18,760,986	99,621	53,750	21,651,303	0.78
2018	21,790,880	115,710	62,431	25,147,982	0.91
2019	25,240,478	134,027	72,314	29,129,026	1.05
2020	28,743,735	152,629	82,351	33,171,995	1.20

[52] Business as usual scenario assumes eGrid output based emission factors for coal.

NATURAL GAS-FIRED CHP

Emissions from Natural Gas-Fired CHP in the Commercial Sector

For the purpose of this analysis CHP systems installed in the commercial sector utilize small (100 kW), natural gas fired microturbines with heat recovery systems. Emission estimates for natural-gas fired combustion turbine technologies are again based on AP-42 factors.[53] Mercury emissions are deemed negligible. Since these emission factors are based on fuel input (lb/MMBtu) the factors were converted to lb/MWh assuming a heat rate of 5,019 Btu/kWh. The table below lists the emission factors used for natural gas fired CHP systems.

Emissions Factor (lb/MWh)			
SO_x	NO_x	CO_2	Hg
0.017	0.652	552.090	0

Assuming a penetration of natural gas fired CHP totaling 665 MW by year 2020 the following emissions can be expected.

Table 6- 10: Emissions from Natural Gas-Fired CHP

Year	*Capacity (MW)*	*SO_x (tpy)*	*NO_x (tpy)*	*CO_2 (tpy)*	*Hg (tpy)*
2006	44	3.314	127	107,205	0
2007	89	6.627	253	214,410	0
2008	133	9.941	380	321,615	0
2009	177	13.254	507	428,819	0
2010	222	16.568	633	536,024	0
2011	266	19.882	760	643,229	0
2012	310	23.195	887	750,434	0
2013	355	26.509	1,014	857,639	0
2014	399	29.822	1,140	964,844	0
2015	443	33.136	1,267	1,072,048	0
2016	488	36.450	1,394	1,179,253	0
2017	532	39.763	1,520	1,286,458	0
2018	576	43.077	1,647	1,393,663	0
2019	621	46.390	1,774	1,500,868	0
2020	665	49.704	1,900	1,608,073	0

[53] Fifth Edition, Volume I - Chapter 3: Stationary Internal Combustion Sources, Table 3.1-1 for NOx, and Table 3.1-2a for SOx and CO2.

Emissions Savings from Natural Gas Fired CHP

Emissions Savings from Natural Gas Fired CHP against a business as usual scenario.

Table 6- 11: Emissions Savings from Natural Gas Fired CHP

Year	Capacity (MW)	SO2 (tpy)	NOx (tpy)	CO2 (tpy)	Hg (tpy)
2006	44	2,059	986	340,986	0.016
2007	89	4,118	1,972	681,972	0.032
2008	133	6,177	2,958	1,022,958	0.048
2009	177	8,236	3,944	1,363,944	0.065
2010	222	10,294	4,930	1,704,930	0.081
2011	266	12,353	5,916	2,045,915	0.097
2012	310	14,412	6,902	2,386,901	0.113
2013	355	16,471	7,888	2,727,887	0.129
2014	399	18,530	8,874	3,068,873	0.145
2015	443	20,589	9,860	3,409,859	0.162
2016	488	22,648	10,846	3,750,845	0.178
2017	532	24,707	11,831	4,091,831	0.194
2018	576	26,765	12,817	4,432,817	0.210
2019	621	28,824	13,803	4,773,803	0.226
2020	665	30,883	14,789	5,114,789	0.242

IGCC CLEAN COAL TECHNOLOGY

Emissions from IGCC Clean Coal Technology

Emissions factors for coal gasification technology were calculated based on the air quality construction permit application prepared by Sargent & Lundy LLC for the Southern Illinois Clean Energy Center (Sargent & Lundy, LLC. Southern Illinois Clean Energy Center, Integrated Gasification Combined Cycle and Substitute Natural Gas Methanation Plant, Air Quality Construction Permit Application, prepared for Steelhead Energy Co., LLC, October 2004); the SICEC is in advanced development stages with a scheduled operation date of 2009. Based on a capacity of 540 MW and the stated emission potentials for each pollutant in the air quality permit application the emission factors in lb/MWh were calculated. Since the emission factors are based on the potential to emit, this approach constitutes a conservative scenario. For a lack of better information, CO_2 emissions factors for the 2010-2014 timeframe were assumed to the same as average Illinois coal. However starting 2015 carbon sequestration was assumed. This assumption is consistent with current studies that show good potential for carbon sequestration integrated with IGCC in the Illinois Basin (Massoud Rostam-Abadi, 2004). The table below lists the employed emission factors followed by a table that shows the total emissions from each pollutant by year and installed capacity.

Emissions Factor (lb/MWh)			
SO_x	NO_x	CO_2	Hg
0.297142	0.661086	2308.12	4.74E-06

Table 6- 12: Emissions from IGCC Clean Coal Technology

Year	*Capacity (MW)*	*SO_x (tpy)*	*NO_x (tpy)*	*CO_2 (tpy)*	*Hg (tpy)*
2006	0				
2007	0				
2008	0				
2009	0				
2010	500	650.741	1,447.778	5,054,783	0.010
2011	500	650.741	1,447.778	5,054,783	0.010
2012	500	650.741	1,447.778	5,054,783	0.010
2013	500	650.741	1,447.778	5,054,783	0.010
2014	500	650.741	1,447.778	5,054,783	0.010
2015	1250	1,626.852	3,619.444	0.000	0.026
2016	1250	1,626.852	3,619.444	0.000	0.026
2017	1250	1,626.852	3,619.444	0.000	0.026
2018	1250	1,626.852	3,619.444	0.000	0.026
2019	1250	1,626.852	3,619.444	0.000	0.026
2020	2000	2,602.963	5,791.111	0.000	0.041

Emissions Savings from IGCC Clean Coal Technology

The table below details the emissions savings from IGCC against a business as usual scenario for each year of the study time frame.

Table 6- 13: Emissions Savings from IGCC Clean Coal Technology

Year	Capacity (MW)	SO2 (tpy)	NOx (tpy)	CO2 (tpy)	Hg (tpy)
2005					
2006	0	0	0	0	0.000
2007	0	0	0	0	0.000
2008	0	0	0	0	0.000
2009	0	0	0	0	0.000
2010	500	22,607	11,101	0	0.172
2011	500	22,607	11,101	0	0.172
2012	500	22,607	11,101	0	0.172
2013	500	22,607	11,101	0	0.172
2014	500	22,607	11,101	0	0.172
2015	1250	56,518	27,752	12,636,957	0.430
2016	1250	56,518	27,752	12,636,957	0.430
2017	1250	56,518	27,752	12,636,957	0.430
2018	1250	56,518	27,752	12,636,957	0.430
2019	1250	56,518	27,752	12,636,957	0.430
2020	2000	90,428	44,404	20,219,131	0.687

COMPARISON OF EMISSION SAVINGS TO REGULATORY MANDATES

On March 10, 2005 EPA finalized the Clean Air Interstate Rule (CAIR). CAIR addresses emissions reductions for SO_2 and NO_x across 28 eastern states including Illinois. Furthermore, on March 15, 2005, EPA issued the Clean Air Mercury Rule ("Mercury Rule") to reduce mercury emissions from coal-fired power plants. Under CAIR and the Mercury Rule, EPA has assigned each state an emissions "budget" for the pollutants and each state must submit a State Implementation Plan (SIP) detailing how it will meet its budget for reducing these pollutants. The following table shows the emissions budgets for Illinois under CAIR and the Mercury Rule (source: Illinois Environmental Protection Agency, email exchange). States must achieve the required emission reductions using one of two compliance options: 1) meet the state's emission budget by requiring power plants to participate in an EPA-administered interstate cap and trade system that caps emissions in two stages, or 2) meet an individual state emissions budget through measures of the state's choosing.

Table 6- 14: CAIR and Mercury Rule Emissions Budgets for Illinois

	SOx	*NOx*	*Hg*
Year	tpy	tpy	tpy
2002	353,696	174,239	3.70*
2009		76,230	
2010	192,671		1.59
2015	134,869	63,525	0.63

* Illinois EPA estimate from U.S. EPA year 1999 budget of 2.99 tpy.

EPA also developed a guideline ("Guideline") that details how states can achieve the emissions budgets through the above-mentioned "measures of the state's choosing" (U.S. EPA Air Quality and Standards Division, August 2004). These measures include potential credits towards achieving the emission budget from electric-sector energy efficiency and renewable energy measures. The Guideline consists of a four step procedure for quantifying the potential credits: 1) Estimate the energy savings from an energy efficiency/renewable energy measure, 2) estimate the emissions reductions from these measures, 3) determine the impact from the estimated emission reductions on air quality, and 4) provide a mechanism to validate or evaluate the effectiveness of the project or initiative.

The following analysis provides an estimation of the emissions savings associated with investments in renewable energy resources, energy efficiency, natural gas fired CHP, and IGCC ("RE/EE/CHP/IGCC"). The analysis will also show what contribution implementing the proposed RE/EE/CHP/IGCC measures can provide towards compliance with CAIR/Mercury Rule emission reduction requirements. Any contribution towards CAIR/Mercury Rule compliance then will reduce otherwise necessary investments in traditional pollution control technologies. This analysis can be viewed as a first approximation towards the estimation of emission reductions required under "Step 2" of the Guideline.[54]

[54] It should be noted that this analysis looks at statewide emissions whereas the Guideline focuses on non-attainment areas.

The table below shows the expected emissions (in tons per year) from Illinois electric power producers after implementation of RE/EE/CHP/IGCC measures against the budget established by CAIR/Mercury Rule.[55] As can be seen over time implementing RE/EE/CHP/IGCC measures rapidly narrow the gap between the emissions allowed under the CAIR/Mercury Rule and the expected emissions in the state.

Table 6- 15: Compliance Contributions from RE/EE/CHP/IGCC Measures

	*2002**	*2009*	*2010*	*2015*	*2018*	*2020*
SOx	tpy		tpy	tpy	Tpy	tpy
Expected Total IL Emissions with RE/EE/CHP/IGCC	353,696		300,343	209,126	156,843	82,212
CAIR Budget	353,696		192,671	134,869	134,869	134,869
NOx						
Expected Total IL Emissions with RE/EE/CHP/IGCC	174,239	164,161		106,087	78,935	41,054
CAIR Budget	174,239	76,230		63,525	63,525	63,525
Hg						
Expected Total IL Emissions with RE/EE/CHP/IGCC	3.7		3.28		2.15	
Mercury Rule	3.7		1.59		0.63	

*Base Year Actual Emissions

Based on Table 6-15, the graphs below compare the expected emission reductions (in percent) from implementing the RE/EE/CHP/IGCC measures with the emission reductions required under CAIR/Mercury Rule. Implementing the proposed RE/EE/CHP/IGCC measures can provide a significant contribution towards compliance with the emission reduction requirements: By 2018 the emissions reductions achieved from RE/EE/CHP/IGCC alone are close to compliance with CAIR reduction requirements and exceed CAIR reduction requirements by 2020. Mercury reductions from RE/EE/CHP/IGCC by 2018 constitute approximately half of the required reductions under the Mercury Rule. Thus RE/EE/CHP/IGCC measures prove to be a practical alternative to conventional pollution control retrofits at existing power plants.

[55] The analysis shown in the table assumes that the capacity additions provided by renewable energy resources will substantially cover all of Illinois' projected load growth. Therefore, the emissions generated from renewable energy resources are net additions to the base year emission budget. Furthermore, this analysis assumes that emission reductions from energy efficiency measures, CHP, and IGCC will come from capacity retirements from existing western coal burning power plants (business as usual technologies); the associated emission savings are subtracted from the base year emission budget. These emission adjustments result in a revised emission budget (or expected emissions), which can be compared against the emission budgets set by CAIR/Mercury Rule for the years addressed in these mandates.

Figure 6- 5: SO_x Emissions Reductions from RE/EE/CHP/IGCC Compared to CAIR Requirements

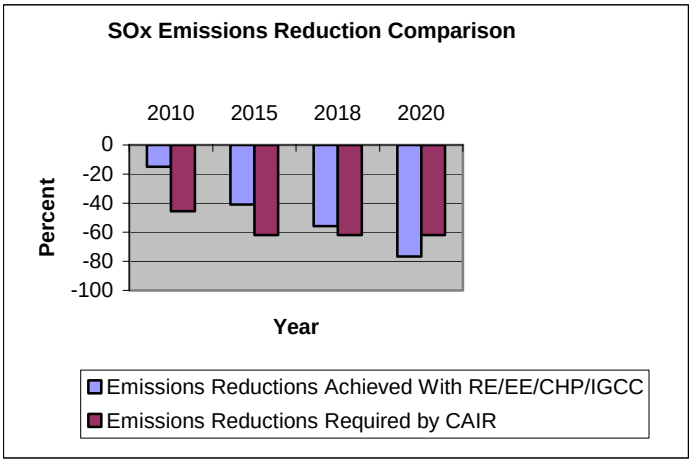


Figure 6- 6: NO_x Emissions Reductions from RE/EE/CHP/IGCC Compared to CAIR Requirements

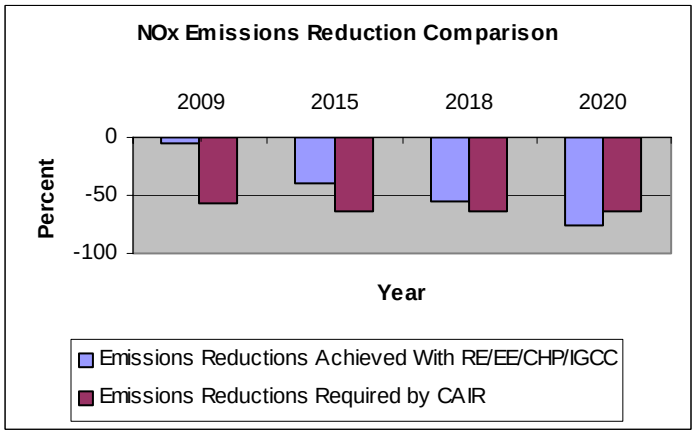
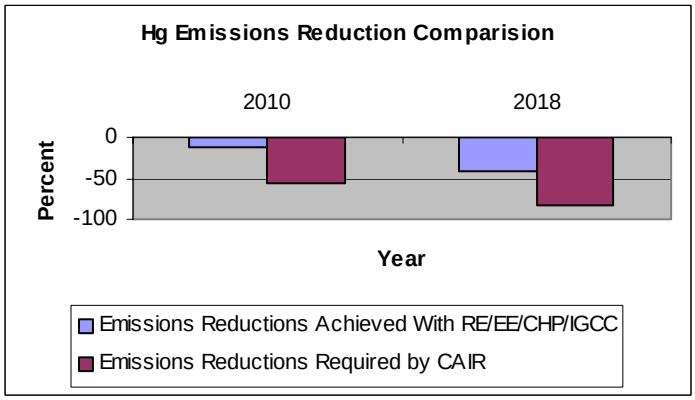


Figure 6- 7: Hg Emissions Reductions from RE/EE/CHP/IGCC Compared to Mercury Rule Requirements



An analysis that compares the expected emission savings achieved with each measure individually (investments in renewable energy resources, energy efficiency, natural gas fired CHP, and IGCC) against emissions reductions required under CAIR can be found in Appendix D.

CHAPTER 7 - ECONOMIC IMPACTS

This chapter examines the employment and overall economic impacts of Renewable and Energy Efficiency Deployment in Illinois. The economic impact analysis explores two major components: a renewable energy plan and an energy efficiency plan. The foci of the programs are described earlier in this report. The goal of this chapter is to present the findings of the economic analysis of the implementation of these programs. For example, energy efficiency savings will free up resources in the participating sectors and allow income, consumption, and investment to be redirected and increase employment in Illinois. The energy efficiency proposal will also generate economic benefits by enhancing opportunities for manufacturers of efficiency equipment and appliances. Some direct negative effects are expected for some energy sectors as the demand for electricity may decline as a result of these savings. However, these negative effects are predicted to be relatively small within Illinois because most of the reduced energy sources are imported from outside of the state. The renewable resources scenario is designed to replace the conventional technologies with renewable energy technologies in generating energy for the state. The study also examines new technologies including IGCC and CHP for commercial applications. As opposed to the existing technologies, the renewable, clean coal, and CHP technologies will generate clean energy and use local resources for their energy generation. The proposed programs are designed to be implemented over the next 15 years, although its positive impacts will last far beyond this period. However, in this chapter, attention will be focused on a sample of years, 2010, 2012, 2015 and 2020.

Analysis of implementing these scenarios based simply on *direct* impacts would increase economic output in Illinois by $2 billion by 2012 and by $7 billion by 2020, and would increase income for Illinois residents by $1.5 billion by 2020 (See Table 7-1). Implementing these scenarios will also result in the creation of 43,000 *direct* new jobs in Illinois by 2020, including:

- approximately 1,800 new jobs from renewable energy development by 2012;
- over 6,500 new jobs from renewable energy development and clean coal gasification development by 2020;
- over 1,800 new jobs created by 2012 and over 7,000 jobs created by 2020 as a result of improved industrial energy efficiency.

Furthermore, under the modeling employed for this report, additional *indirect* economic benefits and job creation are estimated and added to direct impacts (see Table 7-2). Combined direct and indirect economic output in Illinois would increase by over $4.5 billion by 2012 and by over $18 billion by 2020; income for Illinois residents would increase by about $5.5 billion by 2020. Analysis of combined total direct and indirect job creation produces even larger estimated job creation, totaling 191,000 new net jobs created by 2020, including:

- over 7,000 total jobs from renewable energy development by 2012, and over 12,000 new jobs by 2020;
- over 6,000 new jobs from Commercial CHP and clean coal gasification development by 2012, and over 32,000 new jobs by 2020;
- over 7,000 new jobs resulting from increased industrial energy efficiency by 2012, and almost 31,000 such jobs by 2020.

Although this analysis focuses on economic and employment impacts over the next 25 years, positive impacts would last beyond this time period.

The Model

The economic effects were estimated using the Illinois Regional Economic Input-Output Model (ILREIM). The state model estimates the direct and indirect economic effects on the local economy with respect to different economic sectors. The model links the regional input-output components (industrial linkages between suppliers and customers and vice versa) with macroeconomic and demographic variables at both the local and the national levels. The model provides a framework to examine the feedback effects of economic events within the different sectors and with the rest of the economy (for a detailed description of the REIM Input-Output model, see Appendix E). The results of the economic impacts are presented in terms of the generated employment, economic output and income. The reader should use great caution when comparing the models' results with other studies analyzing the economic impact of the investment in energy efficiency because each study differs in its technological scope, methodology and working assumptions.

Local Vs. Non-Local Impacts

The scenarios involve a large investment in efficiency equipment and efficient appliances to achieve energy efficiency savings and a concomitant investment in facilities to achieve a targeted renewable energy portfolio. It is likely that some portions of the efficiency equipment will be manufactured in Illinois (i.e., generating equipment in Peoria). Similarly, part of the saved energy will come from imported energy. The state's economy will experience an economic adjustment comprised of the interplay between the reduced local production of energy and the increased production of efficiency equipment. The non-local economic impacts will not affect the local economy, but will affect the economies in which the equipment and energy are manufactured. Further, more detailed analysis would be needed to measure the anticipated direct, local (i.e. in-state) impacts. Overall, large investment in energy efficiency and renewables utilizing Illinois manufacturers, engineering firms, and labor will have a greater impact on the employment, output, and income. The following case studies illustrate how consumers and the economy will benefit from investments in energy efficiency and renewables.

CASE STUDIES[56]

Energy Efficiency Measures

The University of Illinois at Chicago's Industrial Assessment Center performed an energy audit of **Pactiv Corporation**'s Lake Forest plant to identify energy conservation measures. Pactiv Corporation is a leading producer of specialty packaging products. The total energy budget for the plant is approximately $1.65 million per year, the bulk of which is electricity usage and the remainder natural gas consumption. The energy audit showed that the largest electricity users of the plant are motors and pumps, consuming 58% of the total electricity, and the compressed air system, consuming 21% of total electricity. Opportunities for saving electricity included the installation of several devices to control motor, pump, compressed air, chilled water, and lighting usage. The recommendations reduced electricity consumption by more than 3,000,000 kWh/year, reduced the annual electrical demand by 8,927 kW, reduced natural gas usage by more than 8,800 MMBtu/year, and saved $220,000 per year in energy costs.

Biomass-based Electricity Generation

Antioch Community High School utilizes biogas from a near-by landfill to produce electricity. The High School installed a CHP system consisting of twelve 30 kW Capstone microturbine generators with heat recovery capabilities. The system runs 24/7 supplying as much of the school's electrical load as possible. A gas clean-up and compression system was installed to transfer the gas from the landfill to the school for combustion in the microturbines. The landfill currently generates enough methane to supply the twelve microturbines and the remaining gas is flared off. The equipment generates 360 kW of electric energy and 3.48 MMBtu of thermal energy, saving more then $165,000 in annual energy costs. The twelve microturbines reduce the annual amount of pollution (greenhouse gasses) equivalent to removing nearly 3,400 cars from the road for a year, or planting 4,570 acres of trees.

Natural Gas-Fired CHP Applications

Adkins Energy LLC was formed by farmer led cooperatives in northwestern Illinois to develop an ethanol plant with a capacity of approximately 43 million gallons per year. The plant, which has been in operation since August 2002, is located in Lena, Illinois. Approximately 99% of the electrical energy requirements of the ethanol plant are supplied by a 5 MW combustion turbine-based CHP system. The turbine was manufactured by Solar Turbines, a Caterpillar Company (IL). The CHP system incorporates a heat recovery steam generator that recycles the waste heat from the turbine that satisfies approximately 32% of the thermal requirements of the ethanol production process. During the conception of the ethanol plant project, Adkins Energy LLC learned that feed mills in the surrounding area pay as much as $0.17 per kWh (electricity and demand charge combined). Faced with these high electric rates, Adkins Energy evaluated the installation of an on-site electric generating system, and concluded that a CHP system would provide the perfect fit for its energy needs. Based on its current natural gas cost of $5.50 per MMBtu, Adkins Energy's $3 million CHP investment is able to produce approximately $903,000 in savings per year.

High electric utility costs and frequent power interruptions inspired **Lake Forest Hospital** of Lake Forest, Illinois to consider generating its own electricity. The hospital experienced 50-60 instantaneous interruptions on average each year. These interruptions impact patient care, including diagnostic equipment resets, scheduling backups, and inconvenienced patients (i.e. it takes 45-60 minutes to reset the logic on radiographic and other sensitive, computer-controlled equipment.). These factors motivated Lake Forest Hospital to contract with LaSalle Associates (located in Glen Ellyn, IL) to install a combined heat and power plant consisting four 820 kW Caterpillar 3516 natural gas reciprocating engines equipped with heat recovery units. The CHP plant now meets 90% of the campus electricity needs and 30% of its steam load. In its first year alone, the CHP plant saved the hospital $640,000 in energy costs. Power interruptions were reduced from 50 down to two, which improves patient care and reduces operating costs.

[56] Case studies were conducted by DOE's Midwest CHP Application Center and DOE's Industrial Assessment Center at the University of Illinois at Chicago.

Assumptions

The assumptions discussed in detail for renewables (chapter 3), efficiency (chapter 4), and other environmentally benign generation (chapter 5) were "translated" into a form suitable for use in ILREIM. Savings related to consumer activity were assumed to be redirected from energy to non-energy products on a proportional basis; in other words, the savings were used to increase consumption of other goods and services according to a schedule of average propensities to consume. In reality, there would be a tendency for consumers to follow a schedule of marginal propensities to consume, reflecting that fact that incremental savings are likely to be spent on goods and services that have more discretionary characteristics. However, over a twenty-year time horizon, the energy savings will likely become absorbed into characteristic expenditure patterns. For industries, savings in energy costs can be re-allocated in many ways – increase in returns to factors (labor and capital), increase in production, increase in R&D expenditures, or some combination of all of the above. For the current analysis, it was assumed that the savings were allocated equally among returns to factors and increased production.

Results

In this section, the main results will be presented; the detailed results are available in Appendix F. The direct impacts – those associated with each program – are shown in table 7-1; a distinction is made between investment or capital costs and annualized savings; the reason for this stems from the fact that capital expenditures, for example, may place demands on different sectors and a different basket of goods than annual operation expenditures or consumer savings. However, when the results of these direct effects are run through the model, the distinction is dropped. Table 7-2 provides a summary of the impacts by major category – Residential, Commercial, Industrial, Renewable Generation and IGCC and Commercial CHP. Recall that even though the analysis was conducted annually through 2039, only the selected years shown in the tables will be highlighted. The results will focus on three economic characteristics – output (the value of production, in millions of dollars); income (the value of wages and salaries, also in millions of dollars) and employment (essentially, full-time equivalent jobs shown in thousands of persons). The same data are presented in figure 7-1 to provide a sense of the proportional contributions to the overall economic impacts.

Table 7- 1: Direct Impact by Type of Expenditure

Output ($million)	2010	2012	2015	2020
Residential	284.56	432.97	873.18	1,743.82
(Investment)	101.11	141.89	287.63	462.63
(Consumer & Cost Savings)	183.45	291.08	585.55	1,281.19
Commercial	364.33	563.09	1,200.07	2,485.31
(Investment)	105.48	148.65	351.79	582.03
(Consumer & Cost Savings)	258.84	414.44	848.28	1,903.27
Industrial	60.62	90.93	179.49	321.04
(Investment)	20.84	28.46	56.28	59.60
(Consumer & Cost Savings)	39.78	62.48	123.21	261.43
Renewable Generation	498.51	527.50	645.24	832.07
(Capital Cost)	425.91	430.54	508.64	626.11
(Annual O&M Cost)	72.60	96.96	136.59	205.96
IGCC Clean Coal Power	640.07	80.10	990.39	1,054.58
(Capital Cost)	558.82	0.00	794.12	750.00
(Annual O&M Cost)	81.25	80.10	196.28	304.58
Commercial CHP	215.91	291.04	404.13	593.62
(Capital Cost)	29.03	29.03	29.03	29.03
(Annual O&M Cost)	76.47	106.67	151.60	225.45
(Cost Savings)	63.73	89.60	128.80	195.14
(Consumer Savings)	46.69	65.74	94.70	144.00
Total	2,064.00	1,985.64	4,292.50	7,030.43

Employment (in thousands)	2010	2012	2015	2020
Residential	1.89	2.87	5.62	11.29
(Investment)	0.38	0.51	0.95	1.35
(Consumer & Cost Savings)	1.50	2.36	4.66	9.94
Commercial	2.52	3.89	7.92	16.46
(Investment)	0.40	0.53	1.17	1.70
(Consumer & Cost Savings)	2.12	3.35	6.75	14.77
Industrial	1.17	1.80	3.52	7.05
(Investment)	0.13	0.17	0.33	0.33
(Consumer & Cost Savings)	1.04	1.63	3.19	6.71
Renewable Generation	1.71	1.80	2.21	2.89
(Capital Cost)	1.46	1.47	1.75	2.17
(Annual O&M Cost)	0.25	0.33	0.47	0.71
IGCC Clean Coal Power	2.20	0.27	3.40	3.66
(Capital Cost)	1.92	0.00	2.73	2.60
(Annual O&M Cost)	0.28	0.27	0.67	1.06
Commercial CHP	0.74	0.99	1.39	2.06
(Capital Cost)	0.10	0.10	0.10	0.10
(Annual O&M Cost)	0.26	0.36	0.52	0.78
(Cost Savings)	0.22	0.31	0.44	0.68
(Consumer Savings)	0.16	0.22	0.32	0.50
Total	10.23	11.63	24.06	43.41

Income ($million)	2010	2012	2015	2020
Residential	60.53	90.99	178.44	348.07
(Investment)	18.17	24.77	48.09	72.02
(Consumer & Cost Savings)	42.37	66.22	130.35	276.05
Commercial	78.73	120.23	247.65	500.70
(Investment)	18.95	25.95	58.82	90.61
(Consumer & Cost Savings)	59.78	94.28	188.83	410.09
Industrial	44.22	68.42	134.67	273.10
(Investment)	4.44	5.95	11.46	11.66
(Consumer & Cost Savings)	39.78	62.48	123.21	261.43
Renewable Generation	100.72	104.70	126.10	158.71
(Capital Cost)	86.05	85.45	99.41	119.43
(Annual O&M Cost)	14.67	19.24	26.70	39.29
IGCC Clean Coal Power	129.32	15.90	193.56	201.15
(Capital Cost)	112.91	0.00	155.20	143.06
(Annual O&M Cost)	16.42	15.90	38.36	58.10
Commercial CHP	43.62	57.76	78.98	113.23
(Capital Cost)	5.86	5.76	5.67	5.54
(Annual O&M Cost)	15.45	21.17	29.63	43.00
(Cost Savings)	12.88	17.78	25.17	37.22
(Consumer Savings)	9.43	13.05	18.51	27.47
Total	457.15	458.00	959.41	1,594.96

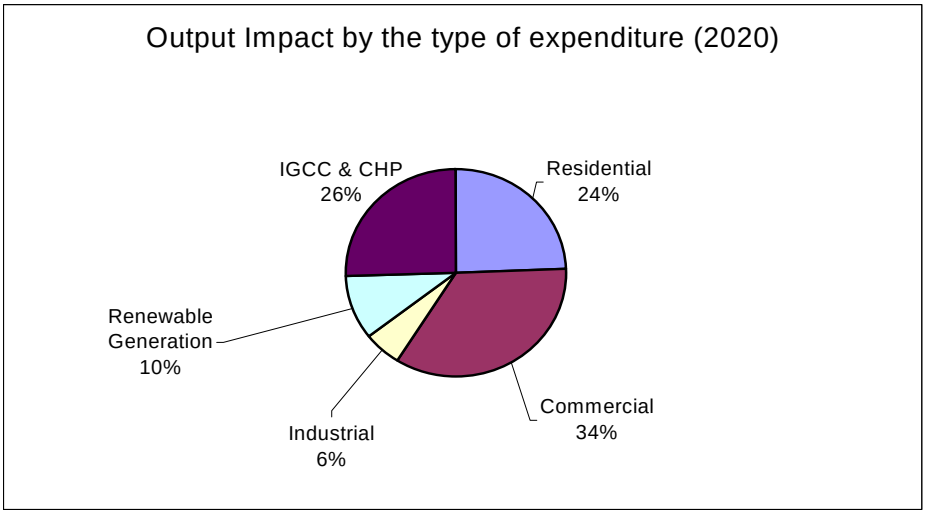
Table 7- 2: Total (Direct and Indirect) Impact by Type of Expenditure

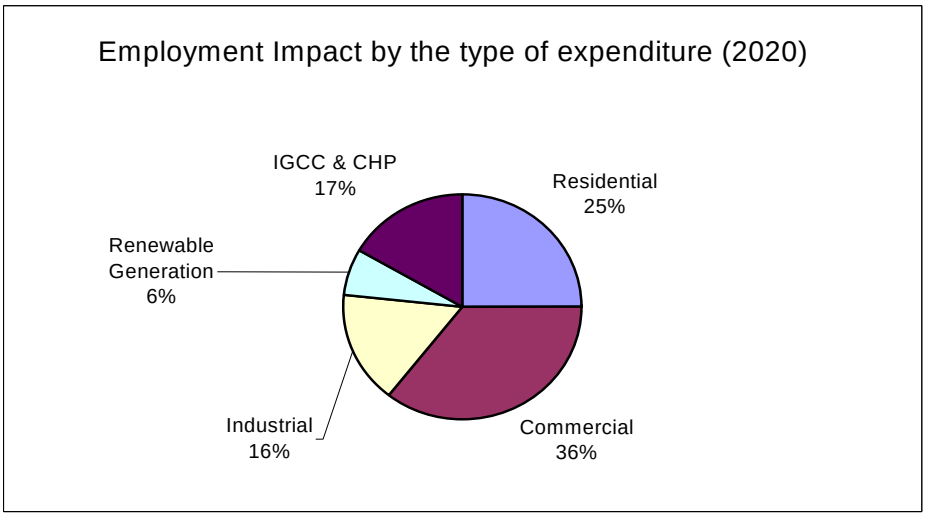
Output ($million)	2010	2012	2015	2020
Residential	682.73	1,060.29	2,141.17	4,473.08
Commercial	891.69	1,412.98	2,874.36	6,297.47
Industrial	180.78	276.04	545.20	1,039.23
Renewable Generation	1,074.26	1,142.68	1,394.91	1,806.52
IGCC & Commercial CHP	2,422.27	881.16	4,016.35	4,699.67
Total	5,251.74	4,773.16	10,971.99	18,315.97

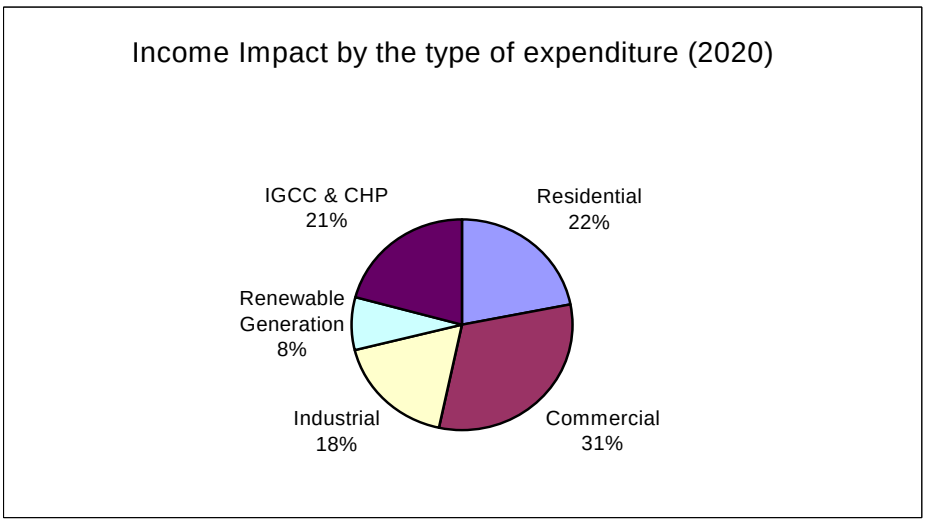
Employment (in thousands)	2010	2012	2015	2020
Residential	6.85	10.84	22.04	47.90
Commercial	8.89	14.34	29.85	67.80
Industrial	4.73	7.44	14.78	30.93
Renewable Generation	7.40	7.84	9.54	12.33
IGCC & Commercial CHP	16.68	6.05	27.47	32.08
Total	44.55	46.51	103.67	191.04

Income ($million)	2010	2012	2015	2020
Residential	186.53	289.61	578.22	1,208.33
Commercial	244.58	387.33	783.45	1,714.93
Industrial	152.82	239.72	475.65	987.42
Renewable Generation	272.78	287.22	346.26	439.99
IGCC & Commercial CHP	615.08	221.49	996.99	1,144.63
Total	1,471.79	1,425.37	3,180.57	5,495.30

Figure 7- 1: Distribution of Impacts for 2020







The results can be considered net additional impacts to the state's economy; of course, a full project appraisal would require consideration of alternative expenditures so that one might gain a sense of the degree to which these allocations generate the largest impact on any particular economic characteristic (such as employment). Table 7-3 does provide a sense of the impacts in terms of REAL's baseline forecasts for the state. While the percentage contributions to the baseline forecasts may seem small, the numbers need to be considered in the context of year-to-year changes in the state's economy. To put these results in more recent context, for calendar year 2004, partly as a result of the robust economic development policies pursued by the Illinois Department of Commerce and Economic Opportunity during a period of stagnant national job growth, the state's economy added 40,000 net jobs. The economic impact of the programs analyzed here in 2010 (creation of over 44,000 direct and indirect jobs) can therefore be considered to be significant and complimentary to other economic development initiatives. Hence, a program that could contribute to enhancing state economic performance by approximately 2% (in 2020) should be seen as significant. A further dimension that is important is the fact that, in 2020, over one third of the additional jobs would be created in durable and nondurable manufacturing sectors (see figure 7-2); for the most part, these jobs would be created in programs (such as energy efficiency retrofitting of building heating and cooling systems or adopting or more widespread use of energy efficient building codes) that would require the use of local (in-state) skilled labor.

With all the programs, the more dramatic impacts begin to be noticeable in the late 2010s; for example, there is only a modest increase in employment from 2010 to 2012 but a more than two-fold increase between 2010 and 2015 and a four-fold increase from 2010 to 2020. Turning to figure 7-1, the output impacts are dominated by IGCC and CHP, Residential and Commercial; however, Industrial plays a much bigger role in employment and income generation.

Table 7- 3: Impacts as a Percentage of Baseline Forecasts

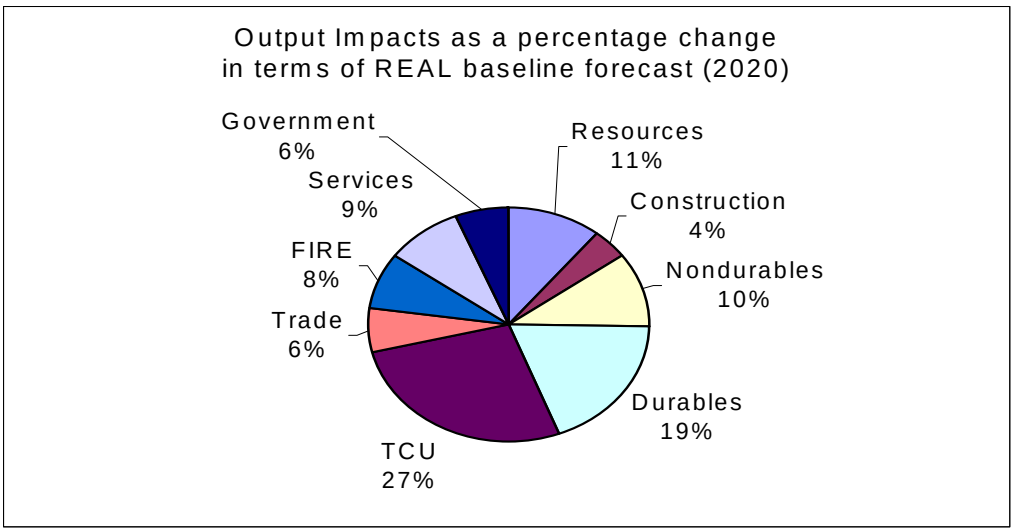
Output ($million)	2010	2012	2015	2020
Resources	0.74%	0.59%	1.32%	1.99%
Construction	0.26%	0.22%	0.49%	0.74%
Nondurables	0.49%	0.52%	1.08%	1.89%
Durables	0.81%	0.96%	1.98%	3.41%
TCU*	2.75%	1.68%	4.09%	4.91%
Trade	0.31%	0.30%	0.64%	1.10%
FIRE**	0.44%	0.40%	0.86%	1.41%
Services	0.44%	0.44%	0.94%	1.63%
Government	0.33%	0.31%	0.67%	1.12%
Total	0.71%	0.62%	1.36%	2.12%

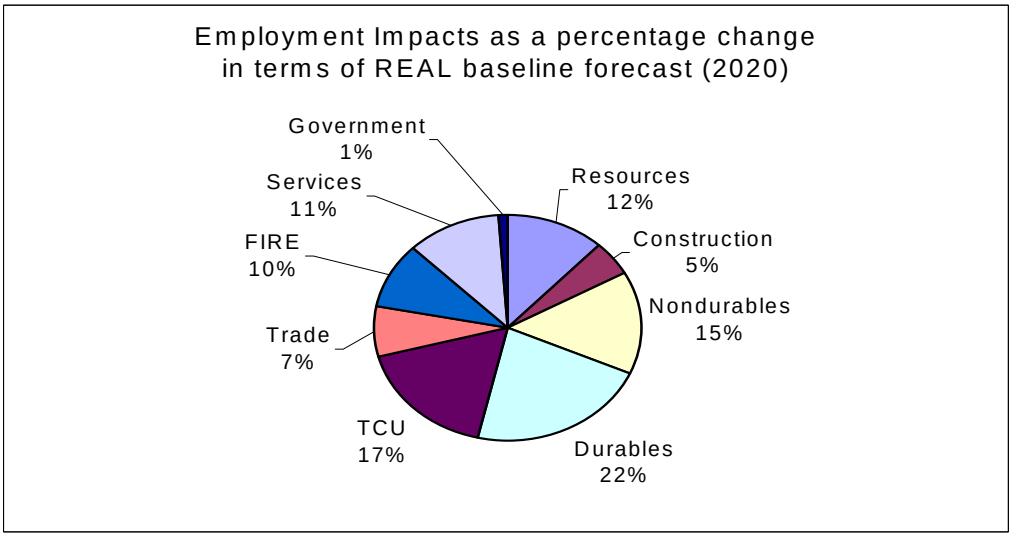
Employment (in thousands)	2010	2012	2015	2020
Resources	0.59%	0.61%	1.28%	2.23%
Construction	0.29%	0.27%	0.59%	0.94%
Nondurables	0.61%	0.73%	1.49%	2.77%
Durables	0.96%	1.17%	2.38%	4.10%
TCU*	1.53%	1.01%	2.44%	3.21%
Trade	0.33%	0.35%	0.74%	1.32%
FIRE**	0.49%	0.48%	1.04%	1.78%
Services	0.50%	0.54%	1.15%	2.14%
Government	0.05%	0.05%	0.11%	0.20%
Total	0.49%	0.50%	1.07%	1.85%

Income ($million)	2010	2012	2015	2020
Resources	0.69%	0.64%	1.36%	2.24%
Construction	0.29%	0.27%	0.57%	0.90%
Nondurables	0.61%	0.72%	1.46%	2.69%
Durables	0.90%	1.09%	2.23%	3.91%
TCU*	2.10%	1.32%	3.20%	4.02%
Trade	0.33%	0.34%	0.73%	1.28%
FIRE**	0.45%	0.42%	0.90%	1.48%
Services	0.47%	0.49%	1.03%	1.84%
Government	0.06%	0.06%	0.12%	0.21%
Total	0.55%	0.52%	1.12%	1.83%

* TCU is Transportation, Communications, and Utilities
** FIRE is Finance, Insurance, and Real Estate

Figure 7- 2: Distribution of Impacts by Sector for 2020





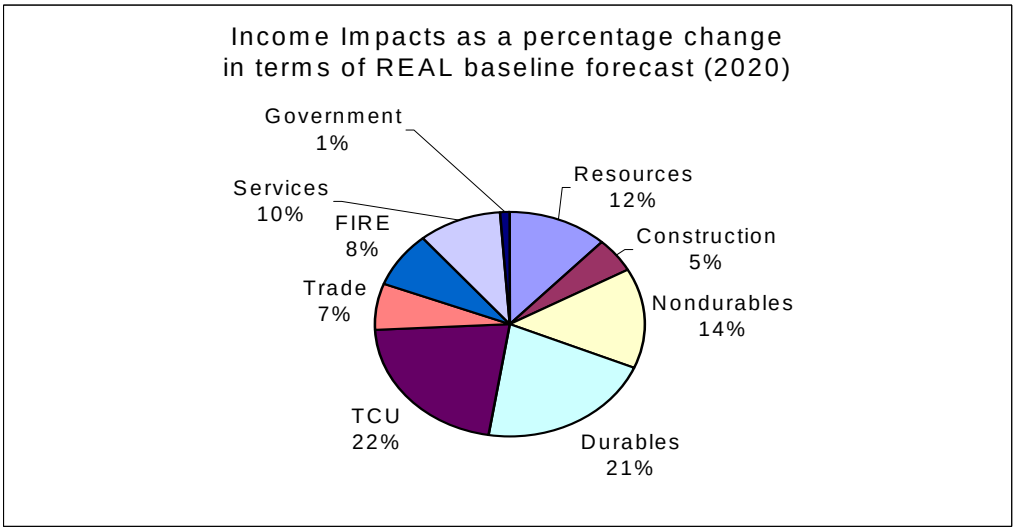
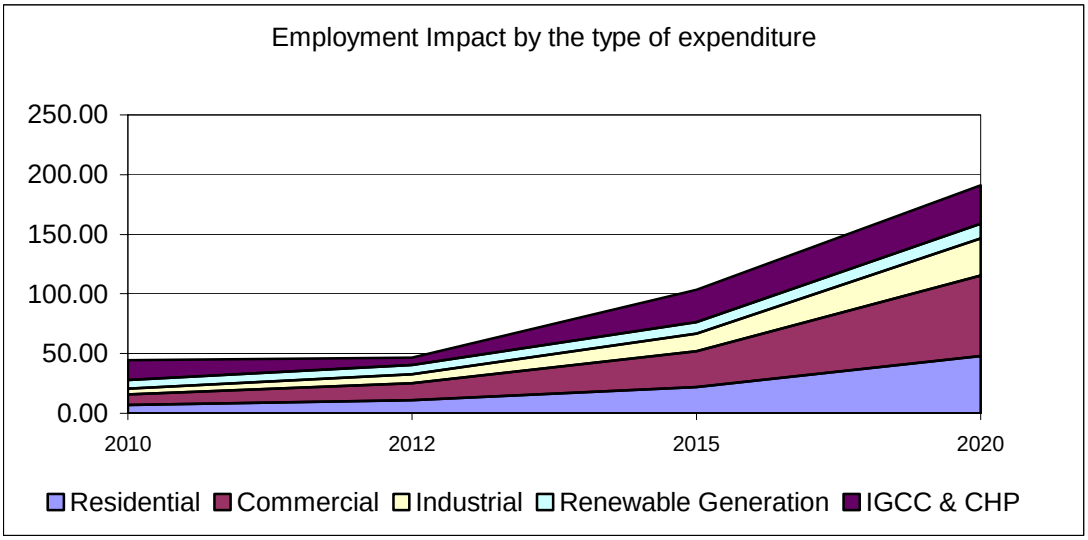


Figure 7-3 provides a program and time summary of the employment impacts, illustrating the dramatic upsurge in impacts towards 2020. Commercial turns out to have the largest employment impact, but industrial's share grows over time. This is particularly important news given the declines in absolute and relative employment in the industrial sector in the last three decades.

Figure 7- 3: Employment Impacts over Time by Program



Tables 7-4 through 7-8 provide a summary of the impacts by sector for the major programs. The sectors have been aggregated from 53 to nine. Resources include agriculture, forestry and fishing; manufacturing is divided into durable and nondurable; TCU is transportation, communications and utilities and FIRE is finance, insurance and real estate. Essentially, what is presented in these tables is a disaggregation of the entries in table 7-1. For example, in table 7-4 the entries for Total Residential shown in table 7-1 have been broken down by sector; the 2020 employment impact of 47,900 jobs may be seen to be heavily concentrated in services (24,920), but over 9,000 jobs have been created in manufacturing (durable and nondurable together). Note that when one examines the output or income tables in table 7-4, the distributions change. While services accounted for over half the employment, they account for just over a third of the income and over a fifth of production. This differences stem from variations in employment/production ratios (i.e., how many jobs are associated with each one million dollars worth of production) as well as differences in wage rates paid across industrial sectors. Thus, manufacturing production accounts for over half the production impact but only a fifth or so of the employment impact. A similar distinction can be seen in table 7-5 for Commercial but the distinctions are less apparent in table 7-6 for Industrial. Here, output by manufacturing accounts for 50% of the total while employment in this same sector is just under a third of the total.

Table 7- 4: Total Impact by Residential Investment and Savings

Output ($million)	2010	2012	2015	2020
Resources	4.38	6.69	12.58	25.65
Construction	8.29	14.82	29.50	70.00
Nondurables	105.17	167.56	338.78	748.01
Durables	305.34	456.61	916.67	1,746.17
TCU*	32.30	50.83	102.28	221.53
Trade	44.76	70.72	142.92	311.53
FIRE**	55.59	88.35	178.79	395.91
Services	122.36	197.58	405.26	923.00
Government	4.53	7.15	14.40	31.27
Total	682.73	1,060.29	2,141.17	4,473.08

Employment (in thousands)	2010	2012	2015	2020
Resources	0.15	0.23	0.45	0.95
Construction	0.13	0.24	0.51	1.25
Nondurables	0.43	0.67	1.32	2.76
Durables	1.47	2.11	4.02	6.93
TCU*	0.25	0.39	0.79	1.69
Trade	0.74	1.17	2.33	4.93
FIRE**	0.55	0.87	1.76	3.82
Services	3.05	5.03	10.57	24.92
Government	0.09	0.15	0.30	0.65
Total	6.85	10.84	22.04	47.90

Income ($million)	2010	2012	2015	2020
Resources	1.63	2.52	4.78	9.67
Construction	3.63	6.55	13.18	31.51
Nondurables	16.29	25.43	50.41	107.24
Durables	58.89	85.87	166.65	299.10
TCU*	8.82	13.70	27.18	57.20
Trade	15.96	24.83	49.00	102.77
FIRE**	15.45	24.57	49.45	107.67
Services	63.02	101.63	208.34	472.88
Government	2.84	4.52	9.22	20.31
Total	186.53	289.61	578.22	1,208.33

* TCU is Transportation, Communications, and Utilities
** FIRE is Finance, Insurance, and Real Estate

Table 7- 5: Total Impact by Commercial Investment and Savings

Output ($million)	2010	2012	2015	2020
Resources	6.50	10.09	18.61	39.34
Construction	11.37	20.43	41.33	102.24
Nondurables	152.29	246.75	490.90	1,126.18
Durables	355.55	539.20	1,120.98	2,226.77
TCU*	45.09	72.32	144.45	326.76
Trade	62.19	100.20	201.28	458.61
FIRE**	79.21	128.21	256.37	591.39
Services	173.20	285.64	580.13	1,380.05
Government	6.29	10.13	20.30	46.14
Total	891.69	1,412.98	2,874.36	6,297.47

Employment (in thousands)	2010	2012	2015	2020
Resources	0.20	0.33	0.65	1.39
Construction	0.17	0.31	0.68	1.76
Nondurables	0.58	0.92	1.83	3.96
Durables	1.62	2.35	4.76	8.56
TCU*	0.32	0.51	1.07	2.39
Trade	1.00	1.59	3.22	7.07
FIRE**	0.74	1.18	2.43	5.48
Services	4.14	6.95	14.79	36.27
Government	0.12	0.20	0.41	0.92
Total	8.89	14.34	29.85	67.80

Income ($million)	2010	2012	2015	2020
Resources	2.35	3.69	6.95	14.55
Construction	4.89	8.86	18.28	45.44
Nondurables	22.93	36.34	71.68	158.06
Durables	67.04	98.95	201.10	375.84
TCU*	12.08	19.10	37.98	83.26
Trade	21.98	34.80	68.77	150.23
FIRE**	21.55	34.84	69.97	158.29
Services	87.88	144.47	295.87	699.71
Government	3.88	6.28	12.86	29.55
Total	244.58	387.33	783.45	1,714.93

* TCU is Transportation, Communications, and Utilities
** FIRE is Finance, Insurance, and Real Estate

Table 7- 6: Total Impact by Industrial Investment and Savings

Output ($million)	2010	2012	2015	2020
Resources	3.43	5.12	9.76	17.97
Construction	8.17	12.99	25.76	51.46
Nondurables	45.86	68.91	136.17	241.81
Durables	50.07	74.88	146.40	258.25
TCU*	9.32	14.24	28.02	54.47
Trade	11.65	17.87	35.03	68.17
FIRE**	12.10	18.64	36.98	72.16
Services	38.48	60.68	121.62	262.79
Government	1.72	2.73	5.46	12.15
Total	180.78	276.04	545.20	1,039.23

Employment (in thousands)	2010	2012	2015	2020
Resources	0.26	0.39	0.76	1.45
Construction	0.24	0.40	0.83	1.80
Nondurables	0.66	1.03	2.02	4.18
Durables	0.87	1.33	2.55	5.05
TCU*	0.19	0.31	0.62	1.34
Trade	0.42	0.65	1.28	2.64
FIRE**	0.31	0.49	0.99	2.09
Services	1.72	2.74	5.55	11.98
Government	0.06	0.09	0.19	0.40
Total	4.73	7.44	14.78	30.93

Income ($million)	2010	2012	2015	2020
Resources	3.73	5.61	10.67	19.40
Construction	7.76	12.54	25.34	52.16
Nondurables	30.15	47.15	93.26	194.90
Durables	35.67	55.01	107.21	215.82
TCU*	8.22	12.86	25.45	53.29
Trade	11.07	17.23	33.73	68.64
FIRE**	10.38	16.51	33.07	69.93
Services	43.75	69.48	140.18	298.82
Government	2.09	3.33	6.75	14.46
Total	152.82	239.72	475.65	987.42

* TCU is Transportation, Communications, and Utilities
** FIRE is Finance, Insurance, and Real Estate

Table 7- 7: Total Impact by Renewable Generation

Output ($million)	2010	2012	2015	2020
Resources	14.52	14.47	16.28	18.59
Construction	27.51	32.18	38.25	52.11
Nondurables	89.24	94.71	115.03	146.93
Durables	104.15	110.45	133.76	171.53
TCU*	566.81	599.83	733.47	946.36
Trade	50.08	53.61	65.98	86.83
FIRE**	81.41	86.84	106.74	140.00
Services	134.38	144.03	177.40	233.82
Government	6.16	6.55	7.99	10.34
Total	1,074.26	1,142.68	1,394.91	1,806.52

Employment (in thousands)	2010	2012	2015	2020
Resources	0.21	0.21	0.24	0.28
Construction	0.36	0.43	0.53	0.76
Nondurables	0.29	0.30	0.36	0.44
Durables	0.45	0.47	0.54	0.64
TCU*	2.07	2.18	2.68	3.49
Trade	0.66	0.69	0.83	1.05
FIRE**	0.65	0.68	0.82	1.05
Services	2.59	2.75	3.40	4.44
Government	0.11	0.11	0.14	0.18
Total	7.40	7.84	9.54	12.33

Income ($million)	2010	2012	2015	2020
Resources	3.69	3.60	3.87	4.11
Construction	11.26	13.27	15.86	21.68
Nondurables	12.78	13.33	15.84	19.71
Durables	20.01	20.78	24.39	29.83
TCU*	117.37	122.10	147.01	185.13
Trade	16.49	17.30	20.67	25.90
FIRE**	22.97	24.48	29.81	38.42
Services	64.46	68.37	83.90	108.79
Government	3.75	4.00	4.92	6.42
Total	272.78	287.22	346.26	439.99

* TCU is Transportation, Communications, and Utilities
** FIRE is Finance, Insurance, and Real Estate

Table 7- 8: Total Impact by IGCC Clean Coal Power & Commercial CHP

Output ($million)	2010	2012	2015	2020
Resources	32.74	11.16	46.87	48.36
Construction	62.03	24.82	110.13	135.57
Nondurables	201.23	73.03	331.21	382.25
Durables	234.85	85.18	385.14	446.25
TCU*	1,278.07	462.56	2,111.88	2,461.95
Trade	112.91	41.34	189.98	225.89
FIRE**	183.57	66.97	307.34	364.20
Services	303.01	111.07	510.79	608.29
Government	13.88	5.05	23.02	26.91
Total	2,422.27	881.16	4,016.35	4,699.67

Employment (in thousands)	2010	2012	2015	2020
Resources	0.48	0.17	0.70	0.73
Construction	0.81	0.33	1.53	1.97
Nondurables	0.66	0.23	1.03	1.14
Durables	1.02	0.36	1.55	1.67
TCU*	4.68	1.68	7.71	9.08
Trade	1.48	0.53	2.39	2.73
FIRE**	1.46	0.53	2.37	2.74
Services	5.84	2.12	9.79	11.56
Government	0.24	0.09	0.39	0.46
Total	16.68	6.05	27.47	32.08

Income ($million)	2010	2012	2015	2020
Resources	8.32	2.77	11.15	10.69
Construction	25.40	10.23	45.66	56.39
Nondurables	28.82	10.28	45.60	51.28
Durables	45.12	16.02	70.23	77.59
TCU*	264.64	94.15	423.29	481.62
Trade	37.19	13.34	59.50	67.38
FIRE**	51.80	18.88	85.84	99.96
Services	145.34	52.72	241.56	283.02
Government	8.45	3.09	14.15	16.70
Total	615.08	221.49	996.99	1,144.63

* TCU is Transportation, Communications, and Utilities
** FIRE is Finance, Insurance, and Real Estate

REFERENCES

Anderson, Conrad. Madison Power Corporation, Personal Conversation, February, 2005.

Antares Group Inc. Biomass Residue Supply Curves for the United States. Prepared for U.S. Department of Energy Biomass Program and the National Renewable Energy Laboratory, June 1999.

Bureau of Economic Analysis, U.S. Department of Commerce. Economic Profile of Illinois.

Bureau of Economic Analysis, U.S. Department of Commerce. "Survey of Current Business", January 2005.

California Energy Commission, "Market Assessment of Combined Heat and Power in the State of California", P700-00-009, October 2000.

Conner, A.M, Francfort, J.E, Idaho National Engineering Laboratory, U.S. Department of Energy "U.S. Hydropower Resource Assessment for Illinois", DOE/ID-10430(IL), January 1997

Energy Efficiency and Renewable Energy, U.S. Department of Energy, "Illinois Solar Resources", Updated 7/21/2004.

Energy Efficiency and Renewable Energy, U.S. Department of Energy, "Illinois Hydropower Resources", Updated 7/21/2004.

Energy Efficiency and Renewable Energy, U.S. Department of Energy, "Illinois Geothermal Resources", Updated 7/21/2004.

Energy Efficiency and Renewable Energy, U.S. Department of Energy, "Illinois Bioenergy Resources", Updated 7/21/2004.

Energy Efficiency and Renewable Energy, U.S. Department of Energy, Wind & Hydropower Technology Program, "Illinois Wind Maps", Updated 11/17/2004.

Energy Efficiency and Renewable Energy, U.S. Department of Energy, Scenarios of U.S. Carbon Reductions: Potential Impacts of Energy Technologies by 2010 and beyond", PB98107659*CA. September 1997.

Energy Efficiency and Renewable Energy, U.S. DOE, and EPRI, "Renewable Energy Technology Characterization", TR-109496, December 1997.

Energy Information Administration, "Monthly Energy Review", Table 7.5 Electricity End-Use. DOE/EIA-0035 (2004/12), December 2004.

Energy Information Administration, "Electric Power Annual 2003 – Spreadsheets", January 2005, DOE/EIA-0348(2003).

Energy Information Administration, “Energy Annual Outlook 2003”, January 2003, DOE/EIA-0383(2003).

Energy Information Administration, “Renewable Energy 2000: Issues and Trends”, February 2001, DOE/EIA-0628(2000).

Energy Information Administration, “State Energy Data 2001: Consumption”.

Energy Information Administration, State Electricity Profiles, 2002 Summary Statistics for Illinois.

EPRI and U.S. Department of Energy. Renewable Energy Technology Characterization, December 1997.

Haq, Zia. Biomass for Electricity Generation, Energy Information Administration, www.eia.doe.gov, 2005.

Hadley, S.W., Oak Ridge National Laboratory, "The Potential for Energy Efficiency in the State of Iowa”. Sponsored by The Iowa Energy Center, June 2001.

Hoback, Bill, Chief, Illinois Office of Coal Development, Illinois Department of Commerce and Economic Opportunity. Coal Gasification Conference, presented at the “Illinois Gasification Symposium” December 2, 2004 at the Gas Technology Institute, Des Plaines, Illinois.

Illinois Environmental Protection Agency, Bureau of Land. Nonhazardous Solid Waste Management and Landfill Capacity in Illinois. November 2004.

Lusk, P. Methane Recovery from Animal Manures. The Current Opportunities Casebook, Resource Development Associates prepared for National Renewable Energy Laboratory, September 1998.

McGowin, Charles et al., EPRI, Economic and Risk Evaluation for the Brazil Biomass Gasification/Gas Turbine Demonstration Project, published by Worldbank, 2004.

Midwest CHP Application Center in Partnership with the U.S. Department of Energy, Combined Heat and Power Resource (CHP) Guide, September 2003.

Midwest CHP Application Center in Partnership with U.S. Department of Energy, Colorado Pork LLC, 85 kW CHP Application, Project Profile, 2004.

Midwest CHP Application Center in Partnership with U.S. Department of Energy, Afxantiou Farm, 205 kW CHP Application, Project Profile, 2004.

Miller, C. Lowell, Director, U.S. Department of Energy, Office of Sequestration, Hydrogen, and Clean Coal Fuels. Converting Coal into Gas is Key. presented at the “Illinois Gasification Symposium” December 2, 2004 at the Gas Technology Institute, Des Plaines, Illinois.

Murphy, Michael, Energy Products of Idaho. Repowering Options: Retrofit of Coal-Fired Power Boilers using Fluidized Bed Biomass Gasification, May 2001.

National Energy Technology Laboratory, U.S. Department of Energy, “Technical Facts”, Coal and Environmental Systems, titled “Coal Plays Key Role in Electric Power Generation”, 9/2001.

National Renewable Energy Laboratory, U.S Department of Energy, “Projected Benefits of Federal Energy Efficiency and Renewable Energy Programs (FY 2005-FY 2050)”, May 2004.

Onsite Sycom Energy Corporation. The Market and Technical Potential for Combined Heat and Power in the Commercial/Institutional Sector. Prepared for U.S Department of Energy, Energy Information Administration, January 2000, Revision 1.

Onsite Energy Corporation. Assessment of On-Site Power Opportunities in the Industrial Sector. Prepared for U.S. Department of Energy Office of Industrial Technology. March 2001.

Parsons, B., Wind Applications National Wind Technology Center, “Wind Workshop for State Lands” National Renewable Energy Laboratory, April 29, 2003.

Rostam-Abadi, Massoud, Illinois State Geological Survey. An Assessment of Geological Carbon Sequestration Options in the Illinois Basin, presented at the “Illinois Gasification Symposium” December 2, 2004 at the Gas Technology Institute, Des Plaines, Illinois.

Sargent & Lundy, LLC. Southern Illinois Clean Energy Center, Integrated Gasification Combined Cycle and Substitute Natural Gas Methanation Plant, Air Quality Construction Permit Application, prepared for Steelhead Energy Co., LLC, October 2004.

Scorecard.org, Illinois 1997 Animal Waste Summary, www.scorecard.org.

Sugalski, Tony, McKinsey and Associates, “Responsive Demand the Opportunity in California,” presentation at Energy Commission Demand Response Workshop, Sacramento, California, March 15, 2002).

U.S. Census Bureau, Census 2000.

U.S. Census Bureau, 1997 Economic Census, Construction, Table 1-US, Table 2-Illinois, (US, January 2000. Illinois, March 2000).

U.S. Census Bureau, 1997 Economic Census, Comparative Statistics, Mineral Industries (for United States and Illinois).

U.S. Census Bureau, 1997 Economic Census, Comparative Statistics, Manufacturing (for United States and Illinois).

USDA, National Agricultural Statistical Service, 1997 Census of Agriculture, State Data, Table 1, State Summary Highlights.

U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy Programs. Projected Benefits of Federal Energy Efficiency and Renewable Energy Programs FY 2005 – FY 2050. Prepared by the National Renewable Energy Laboratory, May 2004.

U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, "Nature's Power on Demand: Renewable Energy Systems as Emergency Power Sources", October 1995.

U.S. Environmental Protection Agency, Air Quality and Standards Division, Office of Air Quality Planning and Standards. Guidance on State Implementation Plant (SIP) Credits for Emission Reductions from Electric Sector Energy Efficiency and Renewable Energy Measures. August, 2004

U.S. Environmental Protection Agency, Office of Air Quality and Standards. AP-42 Emission Factors, Fifth Edition, Volume 1, Chapter 3, Stationary Internal Combustion Sources. http://www.epa.gov/ttn/chief/ap42

U.S. Environmental Protection Agency, Landfill Methane Outreach Program. Turing a Liability into an Asset: A Landfill Gas-to-Energy Project Development Handbook, EPA 430-B-96-004, September 1996.

U.S. Environmental Protection Agency, eGrid Database, Version 2.01, Fossil Fuel Emission Rates.

U.S. Environmental Protection Agency. Landfill Methane Outreach Program, Landfill and Project Database, http://www.epa.gov/lmop/proj/index.htm#1, 2005.

Walsh, Marie E. et al. Biomass Feedstock Availability in the United States: 1999 State Level Analysis, Oak Ridge National Laboratory, 2000.

APPENDICES

APPENDIX A: RESIDENTIAL ENERGY EFFICIENCY IMPACTS

Year	Average Res. Electric Consumption	Residential Electricity Consumption (million kWh/year) Space Heating	Space Cooling	Water Heating	Refri-geration	Range	Freezers	Clothes Drying	Lighting	Other	ECM Penetration Rate
	million kWh/year	8%	11%	9%	11%	3%	6%	4%	9%	39%	
	(1)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	
2000	40,146	3,212	4,416	3,613	4,416	1,204	2,409	1,606	3,613	15,657	0%
2001	41,820	3,346	4,600	3,764	4,600	1,255	2,509	1,673	3,764	16,310	0%
2002	45,030	3,602	4,953	4,053	4,953	1,351	2,702	1,801	4,053	17,562	0%
2003	45,602	3,648	5,016	4,104	5,016	1,368	2,736	1,824	4,104	17,785	0%
2004	46,182	3,695	5,080	4,156	5,080	1,385	2,771	1,847	4,156	18,011	0%
2005	46,769	3,742	5,145	4,209	5,145	1,403	2,806	1,871	4,209	18,240	0%
2006	47,364	3,789	5,210	4,263	5,210	1,421	2,842	1,895	4,263	18,472	2%
2007	47,966	3,837	5,276	4,317	5,276	1,439	2,878	1,919	4,317	18,707	4%
2008	48,575	3,886	5,343	4,372	5,343	1,457	2,915	1,943	4,372	18,944	6%
2009	49,193	3,935	5,411	4,427	5,411	1,476	2,952	1,968	4,427	19,185	9%
2010	49,818	3,985	5,480	4,484	5,480	1,495	2,989	1,993	4,484	19,429	12%
2011	50,452	4,036	5,550	4,541	5,550	1,514	3,027	2,018	4,541	19,676	15%
2012	51,093	4,087	5,620	4,598	5,620	1,533	3,066	2,044	4,598	19,926	18%
2013	51,742	4,139	5,692	4,657	5,692	1,552	3,105	2,070	4,657	20,180	23%
2014	52,400	4,192	5,764	4,716	5,764	1,572	3,144	2,096	4,716	20,436	29%
2015	53,066	4,245	5,837	4,776	5,837	1,592	3,184	2,123	4,776	20,696	36%
2016	53,741	4,299	5,911	4,837	5,911	1,612	3,224	2,150	4,837	20,959	44%
2017	54,424	4,354	5,987	4,898	5,987	1,633	3,265	2,177	4,898	21,225	50%
2018	55,116	4,409	6,063	4,960	6,063	1,653	3,307	2,205	4,960	21,495	58%
2019	55,816	4,465	6,140	5,023	6,140	1,674	3,349	2,233	5,023	21,768	66%
2020	56,526	4,522	6,218	5,087	6,218	1,696	3,392	2,261	5,087	22,045	75%
SUM		83,427	114,713	93,856	114,713	31,285	62,571	41,714	93,856	406,708	

1. Energy Information Administration/State Electricity Profiles 2002, pp 62.
2. "The Potential for Energy Efficiency in the State of Iowa, Table 4-1: Iowa Base Case Total Residential Energy Use" pp. 19. Percent of total electricity.
3. Table D3. Appliances in East North Central Households, Selected Years, 1980-2001.
4. Five Lab Study

Year	Space Heating	Space Cooling	Water Heating	Refri-geration	Range	Freezers	Clothes Drying	Lighting	Other	TOTAL Consumption Savings	Cumulative Consumption Savings
	Residential Incremental Electricity Consumption Savings (kWh/year)										
	10%	14%	29%	13%	30%	13%	30%	51%	30%		
	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)		
2000	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0	0
2006	7,578,190	14,588,015	24,723,844	13,546,014	8,525,464	7,388,735	11,367,285	43,479,864	110,831,026	242,028,437	242,028,437
2007	7,674,523	14,773,456	25,038,130	13,718,209	8,633,838	7,482,659	11,511,784	44,032,573	112,239,892	245,105,064	487,133,501
2008	7,772,080	14,961,254	25,356,411	13,892,593	8,743,590	7,577,778	11,658,120	44,592,308	113,666,668	248,220,800	735,354,301
2009	11,806,316	22,727,158	38,518,106	21,103,790	13,282,105	11,511,158	17,709,474	67,738,738	172,667,370	377,064,215	1,112,418,516
2010	10,760,756	20,714,456	35,106,968	19,234,852	12,105,851	10,491,737	16,141,134	61,739,839	157,376,061	343,671,655	1,456,090,171
2011	11,805,674	22,725,923	38,516,012	21,102,642	13,281,383	11,510,532	17,708,511	67,735,055	172,657,984	377,043,717	1,833,133,888
2012	14,944,682	28,768,514	48,757,026	26,713,620	16,812,768	14,571,065	22,417,024	85,745,115	218,565,981	477,295,795	2,310,429,683
2013	18,918,321	36,417,768	61,721,022	33,816,499	21,283,111	18,445,363	28,377,482	108,543,867	276,680,445	604,203,878	2,914,633,561
2014	23,948,510	46,100,881	78,132,013	42,807,961	26,942,073	23,349,797	35,922,764	137,404,574	350,246,953	764,855,527	3,679,489,088
2015	30,316,174	58,358,635	98,906,518	54,190,161	34,105,696	29,558,270	45,474,261	173,939,049	443,374,046	968,222,809	4,647,711,897
2016	33,771,703	65,010,529	110,180,182	60,366,920	37,993,166	32,927,411	50,657,555	193,765,147	493,911,160	1,078,583,772	5,726,295,670
2017	28,449,017	54,764,357	92,814,917	50,852,617	32,005,144	27,737,791	42,673,525	163,226,234	416,066,870	908,590,472	6,634,886,141
2018	33,132,254	63,779,590	108,093,980	59,223,905	37,273,786	32,303,948	49,698,382	190,096,310	484,559,222	1,058,161,378	7,693,047,519
2019	38,586,440	74,278,898	125,888,262	68,973,262	43,409,745	37,621,779	57,879,661	221,389,701	564,326,690	1,232,354,439	8,925,401,958
2020	38,946,689	74,972,375	127,063,571	69,617,206	43,815,025	37,973,021	58,420,033	223,456,625	569,595,319	1,243,859,864	10,169,261,822
SUM	318,411,329	612,941,808	1,038,816,961	569,160,251	358,212,745	310,451,046	477,616,994	1,826,885,000	4,656,765,687	10,169,261,822	

Year	Residential Electricity Consumption Savings (kWh/year)									
	Space Heating	**Space Cooling**	**Water Heating**	**Refri-geration**	**Range**	**Freezers**	**Clothes Drying**	**Lighting**	**Other**	**Annual Residential Electricity Savings kWh**
	10%	14%	29%	13%	30%	13%	30%	51%	30%	
	16	16	10	19	10	19	10	1	10	
	(1,2,4)	(1,2,4)	(1,2,4)	(1,2,4)	(1,2,4)	(1,2,4)	(1,2,4)	(1,2,4)	(1,2,4)	
2000	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0
2006	7,578,190	14,588,015	24,723,844	13,546,014	8,525,464	7,388,735	11,367,285	43,479,864	110,831,026	242,028,437
2007	15,252,712	29,361,471	49,761,974	27,264,223	17,159,301	14,871,395	22,879,069	87,512,437	223,070,918	487,133,501
2008	23,024,792	44,322,725	75,118,385	41,156,816	25,902,891	22,449,172	34,537,188	132,104,745	336,737,586	735,354,301
2009	34,831,108	67,049,883	113,636,490	62,260,606	39,184,997	33,960,330	52,246,662	199,843,483	509,404,956	1,112,418,516
2010	45,591,864	87,764,339	148,743,458	81,495,458	51,290,848	44,452,068	68,387,797	261,583,322	666,781,018	1,456,090,171
2011	57,397,539	110,490,262	187,259,470	102,598,100	64,572,231	55,962,600	86,096,308	329,318,377	839,439,001	1,833,133,888
2012	72,342,221	139,258,775	236,016,496	129,311,720	81,384,999	70,533,665	108,513,331	415,063,493	1,058,004,982	2,310,429,683
2013	91,260,542	175,676,543	297,737,518	163,128,219	102,668,110	88,979,028	136,890,813	523,607,360	1,334,685,427	2,914,633,561
2014	115,209,052	221,777,424	375,869,531	205,936,180	129,610,183	112,328,825	172,813,578	661,011,934	1,684,932,381	3,679,489,088
2015	145,525,226	280,136,060	474,776,049	260,126,341	163,715,879	141,887,095	218,287,839	834,950,983	2,128,306,426	4,647,711,897
2016	179,296,929	345,146,588	584,956,231	320,493,261	201,709,045	174,814,506	268,945,393	1,028,716,130	2,622,217,586	5,726,295,670
2017	207,745,946	399,910,946	677,771,148	371,345,878	233,714,189	202,552,297	311,618,919	1,191,942,364	3,038,284,456	6,634,886,141
2018	240,878,200	463,690,535	785,865,128	430,569,783	270,987,975	234,856,245	361,317,300	1,382,038,674	3,522,843,678	7,693,047,519
2019	279,464,641	537,969,433	911,753,390	499,543,045	314,397,721	272,478,025	419,196,961	1,603,428,375	4,087,170,368	8,925,401,958
2020	318,411,329	612,941,808	1,038,816,961	569,160,251	358,212,745	310,451,046	477,616,994	1,826,885,000	4,656,765,687	10,169,261,822
2021	318,411,329	612,941,808	990,059,935	569,160,251	341,399,977	310,451,046	455,199,970	0	4,438,199,707	8,035,824,023
2022	310,833,139	598,353,793	928,338,912	569,160,251	320,116,866	310,451,046	426,822,488	0	4,161,519,262	7,625,595,757
2023	303,158,617	583,580,337	850,206,899	569,160,251	293,174,793	310,451,046	390,899,724	0	3,811,272,308	7,111,903,975
2024	295,386,537	568,619,083	751,300,382	569,160,251	259,069,097	310,451,046	345,425,463	0	3,367,898,262	6,467,310,121
2025	283,580,221	545,891,925	641,120,200	555,614,236	221,075,931	303,062,311	294,767,908	0	2,873,987,102	5,719,099,834

Year	Residential Electricity Consumption Savings (kWh/year)									
	Space Heating	**Space Cooling**	**Water Heating**	**Refri-geration**	**Range**	**Freezers**	**Clothes Drying**	**Lighting**	**Other**	**Annual Residential Electricity Savings kWh**
	10%	14%	29%	13%	30%	13%	30%	51%	30%	
	16	16	10	19	10	19	10	1	10	
	(1,2,4)	(1,2,4)	(1,2,4)	(1,2,4)	(1,2,4)	(1,2,4)	(1,2,4)	(1,2,4)	(1,2,4)	
2026	272,819,465	525,177,469	548,305,283	541,896,027	189,070,787	295,579,651	252,094,383	0	2,457,920,233	5,082,863,298
2027	261,013,790	502,451,547	440,211,302	528,003,435	151,797,001	288,001,873	202,396,001	0	1,973,361,011	4,347,235,960
2028	246,069,108	473,683,033	314,323,041	506,899,645	108,387,255	276,490,715	144,516,341	0	1,409,034,321	3,479,403,459
2029	227,150,787	437,265,265	187,259,470	487,664,793	64,572,231	265,998,978	86,096,308	0	839,439,001	2,595,446,833
2030	203,202,277	391,164,384		466,562,151		254,488,446		0		1,315,417,258
2031	172,886,103	332,805,749		439,848,531		239,917,380		0		1,185,457,763
2032	139,114,400	267,795,220		406,032,032		221,472,017		0		1,034,413,669
2033	110,665,383	213,030,863		363,224,071		198,122,220		0		885,042,538
2034	77,533,129	149,251,273		309,033,910		168,563,951		0		704,382,262
2035	38,946,689	74,972,375		248,666,990		135,636,540		0		498,222,594
2036	0	0		197,814,373		107,898,749		0		305,713,121
2037				138,590,468		75,594,801		0		214,185,268
2038				69,617,206		37,973,021		0		107,590,227
2039				0		0		0		0
2040										0
SUM	5,094,581,265	9,807,068,935	11,633,931,496	10,814,044,763	4,011,700,516	5,898,569,871	5,348,934,021	10,521,486,542	52,152,106,706	115,282,424,113

Year	Residential Annual Electricity Cost Savings from Energy Efficiency Measures (2003)									
	Space Heating	**Space Cooling**	**Water Heating**	**Refri-geration**	**Range**	**Freezers**	**Clothes Drying**	**Lighting**	**Other**	**Annual Electricity Cost Savings**
	$0.084	$0.084	$0.084	$0.084	$0.084	$0.084	$0.084	$0.084	$0.084	
	16	16	10	19	10	19	10	1	10	
	(4,1)	(4,1)	(4,1)	(4,1)	(4,1)	(4,1)	(4,1)	(4,1)	(4,1)	
2000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2001	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2002	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2003	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2004	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2005	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2006	$635,052	$1,222,476	$2,071,858	$1,135,156	$714,434	$619,176	$952,578	$3,643,613	$9,287,640	$20,281,983
2007	$1,278,177	$2,460,491	$4,170,053	$2,284,742	$1,437,949	$1,246,223	$1,917,266	$7,333,542	$18,693,343	$40,821,787
2008	$1,929,478	$3,714,244	$6,294,921	$3,448,941	$2,170,662	$1,881,241	$2,894,216	$11,070,378	$28,218,610	$61,622,690
2009	$2,918,847	$5,618,780	$9,522,738	$5,217,439	$3,283,703	$2,845,876	$4,378,270	$16,746,884	$42,688,135	$93,220,672
2010	$3,820,598	$7,354,652	$12,464,702	$6,829,319	$4,298,173	$3,725,083	$5,730,897	$21,920,682	$55,876,249	$122,020,356
2011	$4,809,914	$9,259,084	$15,692,344	$8,597,721	$5,411,153	$4,689,666	$7,214,871	$27,596,880	$70,344,988	$153,616,620
2012	$6,062,278	$11,669,885	$19,778,182	$10,836,322	$6,820,063	$5,910,721	$9,093,417	$34,782,321	$88,660,817	$193,614,007
2013	$7,647,633	$14,721,694	$24,950,404	$13,670,145	$8,603,588	$7,456,443	$11,471,450	$43,878,297	$111,846,639	$244,246,292
2014	$9,654,519	$18,584,948	$31,497,867	$17,257,452	$10,861,333	$9,413,156	$14,481,778	$55,392,800	$141,197,334	$308,341,186
2015	$12,195,014	$23,475,402	$39,786,233	$21,798,587	$13,719,391	$11,890,139	$18,292,521	$69,968,892	$178,352,079	$389,478,257
2016	$15,025,083	$28,923,284	$49,019,332	$26,857,335	$16,903,218	$14,649,456	$22,537,624	$86,206,412	$219,741,834	$479,863,577
2017	$17,409,110	$33,512,537	$56,797,222	$31,118,785	$19,585,249	$16,973,882	$26,113,665	$99,884,770	$254,608,237	$556,003,459
2018	$20,185,593	$38,857,267	$65,855,498	$36,081,748	$22,708,792	$19,680,953	$30,278,390	$115,814,841	$295,214,300	$644,677,382
2019	$23,419,137	$45,081,838	$76,404,934	$41,861,707	$26,346,529	$22,833,658	$35,128,705	$134,367,298	$342,504,877	$747,948,684
2020	$26,682,869	$51,364,524	$87,052,861	$47,695,629	$30,018,228	$26,015,798	$40,024,304	$153,092,963	$390,236,965	$852,184,141
2021	$26,682,869	$51,364,524	$82,967,023	$47,695,629	$28,609,318	$26,015,798	$38,145,757	$0	$371,921,135	$673,402,053
2022	$26,047,817	$50,142,048	$77,794,801	$47,695,629	$26,825,793	$26,015,798	$35,767,725	$0	$348,735,314	$639,024,924
2023	$25,404,692	$48,904,032	$71,247,338	$47,695,629	$24,568,048	$26,015,798	$32,757,397	$0	$319,384,619	$595,977,553
2024	$24,753,392	$47,650,279	$62,958,972	$47,695,629	$21,709,990	$26,015,798	$28,946,654	$0	$282,229,874	$541,960,588
2025	$23,764,023	$45,745,743	$53,725,873	$46,560,473	$18,526,163	$25,396,622	$24,701,551	$0	$240,840,119	$479,260,566

Year	Residential Annual Electricity Cost Savings from Energy Efficiency Measures (2003)									
	Space Heating	**Space Cooling**	**Water Heating**	**Refri-geration**	**Range**	**Freezers**	**Clothes Drying**	**Lighting**	**Other**	**Annual Electricity Cost Savings**
	$0.084	$0.084	$0.084	$0.084	$0.084	$0.084	$0.084	$0.084	$0.084	
	16	16	10	19	10	19	10	1	10	
	(4,1)	(4,1)	(4,1)	(4,1)	(4,1)	(4,1)	(4,1)	(4,1)	(4,1)	
2026	$22,862,271	$44,009,872	$45,947,983	$45,410,887	$15,844,132	$24,769,575	$21,125,509	$0	$205,973,715	$425,943,944
2027	$21,872,956	$42,105,440	$36,889,707	$44,246,688	$12,720,589	$24,134,557	$16,960,785	$0	$165,367,653	$364,298,373
2028	$20,620,591	$39,694,638	$26,340,271	$42,478,190	$9,082,852	$23,169,922	$12,110,469	$0	$118,077,076	$291,574,010
2029	$19,035,236	$36,642,829	$15,692,344	$40,866,310	$5,411,153	$22,290,714	$7,214,871	$0	$70,344,988	$217,498,445
2030	$17,028,351	$32,779,575	$0	$39,097,908	$0	$21,326,132	$0	$0	$0	$110,231,966
2031	$14,487,855	$27,889,122	$0	$36,859,307	$0	$20,105,076	$0	$0	$0	$99,341,361
2032	$11,657,787	$22,441,239	$0	$34,025,484	$0	$18,559,355	$0	$0	$0	$86,683,865
2033	$9,273,759	$17,851,986	$0	$30,438,177	$0	$16,602,642	$0	$0	$0	$74,166,565
2034	$6,497,276	$12,507,257	$0	$25,897,042	$0	$14,125,659	$0	$0	$0	$59,027,234
2035	$3,263,732	$6,282,685	$0	$20,838,294	$0	$11,366,342	$0	$0	$0	$41,751,053
2036	$0	$0	$0	$16,576,844	$0	$9,041,915	$0	$0	$0	$25,618,760
2037	$0	$0	$0	$11,613,881	$0	$6,334,844	$0	$0	$0	$17,948,725
2038	$0	$0	$0	$5,833,922	$0	$3,182,139	$0	$0	$0	$9,016,061
2039	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2040	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
SUM	$426,925,910	$821,832,377	$974,923,459	$906,216,951	$336,180,503	$494,300,155	$448,240,671	$881,700,572	$4,370,346,542	$9,660,667,141

These figures represent the consumers $ savings from reduced electricity use. These are amount of money they would have paid to utilities without the energy efficiency measures.

It is calculated using: Annual Electricity Saved X Residential Utility Cost of Electricity.

Residential Annual Investment in Electricity Energy Efficiency Measures (2003)

Year	Space Heating	Space Cooling	Water Heating	Refri-geration	Range	Freezers	Clothes Drying	Lighting	Other	TOTAL Annual Investment	Cumulative Residential Investment
	$0.317	$0.317	$0.274	$0.403	$0.335	$0.403	$0.335	$0.028	$0.335		
	16	16	10	19	10	19	10	1	10		
	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)		
2000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2001	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2002	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2003	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2004	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2005	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2006	$2,403,337	$4,626,423	$6,769,971	$5,458,322	$2,853,244	$2,977,267	$3,804,326	$1,232,174	$37,092,177	$67,217,241	$67,217,241
2007	$2,433,887	$4,685,233	$6,856,030	$5,527,708	$2,889,514	$3,015,113	$3,852,686	$2,480,012	$37,563,687	$69,303,870	$136,521,110
2008	$2,464,827	$4,744,791	$6,943,182	$5,597,975	$2,926,245	$3,053,441	$3,901,661	$3,743,711	$38,041,190	$71,417,023	$207,938,134
2009	$3,744,239	$7,207,659	$10,547,164	$8,503,703	$4,445,165	$4,638,384	$5,926,887	$5,663,357	$57,787,146	$108,463,703	$316,401,837
2010	$3,412,651	$6,569,354	$9,613,114	$7,750,621	$4,051,504	$4,227,611	$5,402,006	$7,412,999	$52,669,554	$101,109,415	$417,511,252
2011	$3,744,035	$7,207,268	$10,546,591	$8,503,241	$4,444,923	$4,638,132	$5,926,565	$9,332,541	$57,784,004	$112,127,299	$529,638,551
2012	$4,739,536	$9,123,606	$13,350,822	$10,764,166	$5,626,783	$5,871,363	$7,502,378	$11,762,468	$73,148,182	$141,889,304	$671,527,855
2013	$5,999,730	$11,549,480	$16,900,669	$13,626,248	$7,122,887	$7,432,499	$9,497,183	$14,838,488	$92,597,537	$179,564,723	$851,092,578
2014	$7,594,997	$14,620,369	$21,394,385	$17,249,329	$9,016,791	$9,408,725	$12,022,387	$18,732,391	$117,218,277	$227,257,651	$1,078,350,229
2015	$9,614,429	$18,507,776	$27,082,934	$21,835,749	$11,414,263	$11,910,409	$15,219,018	$23,661,643	$148,385,422	$287,631,643	$1,365,981,872
2016	$10,710,311	$20,617,349	$36,939,899	$24,324,654	$15,568,540	$13,267,993	$20,758,053	$29,152,746	$202,391,017	$373,730,562	$1,739,712,434
2017	$9,022,282	$17,367,892	$32,270,939	$20,490,897	$13,600,779	$11,176,853	$18,134,372	$33,778,408	$176,810,128	$332,652,549	$2,072,364,983
2018	$10,507,517	$20,226,970	$36,541,859	$23,864,080	$15,400,784	$13,016,771	$20,534,378	$39,165,539	$200,210,188	$379,468,087	$2,451,833,070
2019	$12,237,250	$23,556,706	$45,018,335	$27,792,552	$18,973,245	$15,159,574	$25,297,659	$45,439,493	$246,652,179	$460,126,993	$2,911,960,063
2020	$12,351,499	$23,776,635	$44,406,112	$28,052,027	$18,715,220	$15,301,106	$24,953,626	$51,772,022	$243,297,856	$462,626,102	$3,374,586,165
SUM	$100,980,526	$194,387,513	$325,182,007	$229,341,273	$137,049,888	$125,095,240	$182,733,184	$298,167,992	$1,781,648,542	$3,374,586,165	

Residential Annual Net Consumer Savings from Electricity Energy Efficiency Measures (2003)

Year	Space Heating	Space Cooling	Water Heating	Refri-geration	Range	Freezers	Clothes Drying	Lighting	Other	Annual Electricity Consumer Net Savings	Cumulative Electricity Consumer Net Savings
	$0.050	$0.050	$0.045	$0.045	$0.036	$0.045	$0.036	$0.053	$0.036		
	16	16	10	19	10	19	10	1	10		
	(4,1)	(4,1)	(4,1)	(4,1)	(4,1)	(4,1)	(4,1)	(4,1)	(4,1)		
2000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2001	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2002	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2003	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2004	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2005	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2006	$380,641	$732,733	$1,107,967	$607,047	$308,196	$331,116	$410,928	$2,325,186	$4,006,548	$10,210,363	$10,210,363
2007	$766,120	$1,474,781	$2,230,018	$1,221,810	$620,310	$666,442	$827,080	$4,679,930	$8,064,028	$20,550,518	$30,760,881
2008	$1,156,500	$2,226,262	$3,366,332	$1,844,389	$936,391	$1,006,030	$1,248,522	$7,064,607	$12,173,085	$31,022,116	$61,782,998
2009	$1,749,513	$3,367,812	$5,092,470	$2,790,127	$1,416,540	$1,521,888	$1,888,720	$10,687,092	$18,415,021	$46,929,183	$108,712,180
2010	$2,290,009	$4,408,267	$6,665,743	$3,652,112	$1,854,167	$1,992,061	$2,472,223	$13,988,773	$24,104,175	$61,427,530	$170,139,710
2011	$2,882,990	$5,549,755	$8,391,787	$4,597,799	$2,334,290	$2,507,890	$3,112,387	$17,611,062	$30,345,772	$77,333,732	$247,473,443
2012	$3,633,638	$6,994,753	$10,576,769	$5,794,935	$2,942,073	$3,160,874	$3,922,764	$22,196,480	$38,246,946	$97,469,231	$344,942,673
2013	$4,583,876	$8,823,961	$13,342,716	$7,310,377	$3,711,459	$3,987,478	$4,948,611	$28,001,114	$48,248,961	$122,958,553	$467,901,227
2014	$5,786,772	$11,139,537	$16,844,100	$9,228,760	$4,685,416	$5,033,869	$6,247,222	$35,349,142	$60,910,410	$155,225,227	$623,126,453
2015	$7,309,507	$14,070,801	$21,276,465	$11,657,220	$5,918,339	$6,358,484	$7,891,119	$44,650,934	$76,938,409	$196,071,279	$819,197,732
2016	$9,005,807	$17,336,179	$26,214,046	$14,362,485	$7,291,794	$7,834,083	$9,722,393	$55,012,974	$94,793,328	$241,573,088	$1,060,770,821
2017	$10,434,757	$20,086,908	$30,373,424	$16,641,378	$8,448,782	$9,077,115	$11,265,043	$63,741,874	$109,834,172	$279,903,454	$1,340,674,275
2018	$12,098,939	$23,290,458	$35,217,514	$19,295,420	$9,796,232	$10,524,774	$13,061,643	$73,907,714	$127,351,018	$324,543,711	$1,665,217,986
2019	$14,037,077	$27,021,372	$40,859,031	$22,386,366	$11,365,497	$12,210,745	$15,153,996	$85,747,040	$147,751,462	$376,532,586	$2,041,750,572
2020	$15,993,308	$30,787,119	$46,553,218	$25,506,169	$12,949,413	$13,912,456	$17,265,884	$97,696,900	$168,342,369	$429,006,836	$2,470,757,408
2021	$15,993,308	$30,787,119	$39,887,475	$25,506,169	$11,095,246	$13,912,456	$14,793,661	$0	$144,238,193	$296,213,628	$2,766,971,036
2022	$15,612,668	$30,054,385	$38,161,431	$25,506,169	$10,615,123	$13,912,456	$14,153,497		$137,996,597	$286,012,326	$3,052,983,362
2023	$15,227,188	$29,312,337	$35,976,449	$25,506,169	$10,007,340	$13,912,456	$13,343,120		$130,095,423	$273,380,483	$3,326,363,845
2024	$14,836,809	$28,560,857	$33,210,502	$25,506,169	$9,237,954	$13,912,456	$12,317,273		$120,093,408	$257,675,428	$3,584,039,273
2025	$14,243,796	$27,419,307	$29,709,119	$24,899,123	$8,263,997	$13,581,340	$11,018,662		$107,431,958	$236,567,301	$3,820,606,574

Year	Space Heating	Space Cooling	Water Heating	Refri-geration	Range	Freezers	Clothes Drying	Lighting	Other	Annual Electricity Consumer Net Savings	Cumulative Electricity Consumer Net Savings
	Residential Annual Net Consumer Savings from Electricity Energy Efficiency Measures (2003)										
	$0.050	$0.050	$0.045	$0.045	$0.036	$0.045	$0.036	$0.053	$0.036		
	16	16	10	19	10	19	10	1	10		
	(4,1)	(4,1)	(4,1)	(4,1)	(4,1)	(4,1)	(4,1)	(4,1)	(4,1)		
2026	$13,703,300	$26,378,852	$25,276,753	$24,284,359	$7,031,074	$13,246,014	$9,374,765		$91,403,959	$210,699,075	$4,031,305,649
2027	$13,110,319	$25,237,364	$20,339,173	$23,661,781	$5,657,618	$12,906,426	$7,543,491		$73,549,040	$182,005,212	$4,213,310,861
2028	$12,359,671	$23,792,366	$16,179,794	$22,716,042	$4,500,631	$12,390,568	$6,000,841		$58,508,197	$156,448,109	$4,369,758,970
2029	$11,409,433	$21,963,158	$11,335,704	$21,854,057	$3,153,181	$11,920,395	$4,204,241		$40,991,351	$126,831,520	$4,496,590,490
2030	$10,206,536	$19,647,582	$5,694,187	$20,908,370	$1,583,916	$11,404,566	$2,111,888		$20,590,906	$92,147,951	$4,588,738,441
2031	$8,683,801	$16,716,318	$0	$19,711,234	$0	$10,751,582	$0		$0	$55,862,936	$4,644,601,377
2032	$6,987,501	$13,450,940		$18,195,792		$9,924,978				$48,559,211	$4,693,160,588
2033	$5,558,551	$10,700,211		$16,277,410		$8,878,587				$41,414,759	$4,734,575,346
2034	$3,894,369	$7,496,661		$13,848,949		$7,553,972				$32,793,951	$4,767,369,297
2035	$1,956,232	$3,765,746		$11,143,685		$6,078,373				$22,944,036	$4,790,313,334
2036	$0	$0		$8,864,791		$4,835,341				$13,700,132	$4,804,013,466
2037				$6,210,750		$3,387,682				$9,598,432	$4,813,611,897
2038				$3,119,804		$1,701,711				$4,821,515	$4,818,433,412
2039				$0		$0				$0	$4,818,433,412
2040										$0	$4,818,433,412
SUM	$255,892,935	$492,593,899	$523,882,187	$484,617,219	$145,724,980	$264,336,665	$194,299,973	$562,660,821	$1,894,424,735	$4,818,433,412	

Annual Net Consumer Savings = (Annual Electricity Savings in kWh/year) X (Retail Cost of Residential Electricity per kWh – Cost of Conserved Energy per kWh).

The Cost of Conserved Electricity includes the annualized investment cost and O&M cost over the service life of the energy efficiency measures.

APPENDIX B: COMMERCIAL ENERGY EFFICIENCY IMPACTS

Year	Commercial Electricity Consumption (million kWh/year)										
	Com. Electric Consumption	Space Heating	Space Cooling	Ventilation	Water Heating	Lighting	Cooking	Refri-geration	Office Equipment	Other	ECM Penetration Rate
	million kWh/year	4.12%	7.51%	5.08%	2.91%	30.02%	0.24%	3.39%	13.80%	32.93%	
	(1)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	
2000	53,152	2,190	3,992	2,700	1,547	15,956	128	1,802	7,335	17,503	0%
2001	55,460	2,285	4,165	2,817	1,614	16,649	133	1,880	7,653	18,263	0%
2002	56,379	2,323	4,234	2,864	1,641	16,925	135	1,911	7,780	18,566	0%
2003	57,514	2,370	4,319	2,922	1,674	17,266	138	1,950	7,937	18,939	0%
2004	58,672	2,417	4,406	2,981	1,707	17,613	141	1,989	8,097	19,321	0%
2005	59,853	2,466	4,495	3,041	1,742	17,968	144	2,029	8,260	19,709	0%
2006	61,057	2,516	4,585	3,102	1,777	18,329	147	2,070	8,426	20,106	2%
2007	62,286	2,566	4,678	3,164	1,813	18,698	149	2,112	8,596	20,511	4%
2008	63,540	2,618	4,772	3,228	1,849	19,075	152	2,154	8,769	20,924	6%
2009	64,819	2,671	4,868	3,293	1,886	19,459	156	2,197	8,945	21,345	9%
2010	66,124	2,724	4,966	3,359	1,924	19,850	159	2,242	9,125	21,775	12%
2011	67,455	2,779	5,066	3,427	1,963	20,250	162	2,287	9,309	22,213	15%
2012	68,813	2,835	5,168	3,496	2,002	20,658	165	2,333	9,496	22,660	18%
2013	70,198	2,892	5,272	3,566	2,043	21,073	168	2,380	9,687	23,116	23%
2014	71,611	2,950	5,378	3,638	2,084	21,498	172	2,428	9,882	23,582	29%
2015	73,053	3,010	5,486	3,711	2,126	21,930	175	2,476	10,081	24,056	36%
2016	74,523	3,070	5,597	3,786	2,169	22,372	179	2,526	10,284	24,540	44%
2017	76,023	3,132	5,709	3,862	2,212	22,822	182	2,577	10,491	25,034	50%
2018	77,553	3,195	5,824	3,940	2,257	23,282	186	2,629	10,702	25,538	58%
2019	79,115	3,260	5,942	4,019	2,302	23,750	190	2,682	10,918	26,052	66%
2020	80,707	3,325	6,061	4,100	2,349	24,228	194	2,736	11,138	26,577	75%
SUM	1,397,908	57,594	104,983	71,014	40,679	419,652	3,355	47,389	192,911	460,331	

1) Energy Information Administration/State Electricity Profiles 2002, pp. 62; 2) The Potential for Energy Efficiency in the State of Iowa, pp. 40;

3) 5-Lab Study (reported on Repowering the Midwest, pp. 20.); and 4) 5-Lab Study.

Year	Commercial Incremental Electricity Consumption Savings (kWh/year)										
	Space Heating	Space Cooling	Ventilation	Water Heating	Lighting	Cooking	Refri-geration	Office Equipment	Other	TOTAL Consumption Savings	Cumulative Consumption Savings
	25%	27%	26%	7%	21%	33%	25%	33%	33%		
	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)		
2000	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0	0
2006	12,577,826	24,761,221	16,128,925	2,487,479	76,983,622	967,149	10,349,231	55,611,087	132,700,949	332,567,489	332,567,489
2007	12,831,010	25,259,649	16,453,590	2,537,550	78,533,254	986,617	10,557,554	56,730,503	135,372,135	339,261,862	671,829,351
2008	13,089,290	25,768,110	16,784,790	2,588,629	80,114,078	1,006,477	10,770,071	57,872,452	138,097,090	346,090,987	1,017,920,338
2009	20,029,153	39,430,208	25,683,986	3,961,105	122,590,085	1,540,106	16,480,298	88,556,081	211,315,345	529,586,368	1,547,506,706
2010	18,389,095	36,201,521	23,580,889	3,636,756	112,551,971	1,413,996	15,130,833	81,304,793	194,012,089	486,221,944	2,033,728,649
2011	20,322,527	40,007,755	26,060,188	4,019,125	124,385,701	1,562,664	16,721,691	89,853,191	214,410,548	537,343,389	2,571,072,039
2012	25,914,508	51,016,357	33,230,953	5,125,034	158,611,883	1,992,650	21,322,860	114,577,348	273,408,120	685,199,712	3,256,271,751
2013	33,045,188	65,054,104	42,374,839	6,535,247	202,255,799	2,540,950	27,190,094	146,104,646	348,639,565	873,740,433	4,130,012,184
2014	42,137,958	82,954,503	54,034,772	8,333,497	257,908,850	3,240,123	34,671,766	186,307,050	444,571,822	1,114,160,340	5,244,172,524
2015	53,732,710	105,780,405	68,903,072	10,626,556	328,875,489	4,131,680	44,212,109	237,571,615	566,900,963	1,420,734,599	6,664,907,123
2016	60,295,747	118,700,667	77,319,052	11,924,508	369,045,097	4,636,333	49,612,278	266,589,159	636,143,550	1,594,266,391	8,259,173,514
2017	51,164,689	100,724,893	65,610,021	10,118,687	313,157,702	3,934,217	42,099,101	226,217,470	539,807,340	1,352,834,121	9,612,007,635
2018	60,023,792	118,165,285	76,970,315	11,870,725	367,380,573	4,615,422	49,388,509	265,386,747	633,274,317	1,587,075,683	11,199,083,318
2019	70,416,838	138,625,458	90,297,630	13,926,126	430,992,067	5,414,576	57,940,068	311,338,135	742,924,985	1,861,875,883	13,060,959,201
2020	71,594,836	140,944,514	91,808,213	14,159,095	438,202,104	5,505,156	58,909,343	316,546,490	755,353,327	1,893,023,079	14,953,982,280
SUM	565,565,167	1,113,394,649	725,241,235	111,850,121	3,461,588,275	43,488,118	465,355,805	2,500,566,766	5,966,932,145	14,953,982,280	

Year	Commercial Electricity Consumption Savings (kWh/year)									
	Space Heating	**Space Cooling**	**Ventilation**	**Water Heating**	**Lighting**	**Cooking**	**Refri-geration**	**Office Equipment**	**Other**	**Annual Commercial Electricity Savings kWh**
	25%	27%	26%	7%	21%	33%	25%	33%	33%	
	18	18	18	9	12	7	15	7	7	
	(1,2,4)	(1,2,4)	(1,2,4)	(1,2,4)	(1,2,4)	(1,2,4)	(1,2,4)	(1,2,4)	(1,2,4)	
2000	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0
2006	12,577,826	24,761,221	16,128,925	2,487,479	76,983,622	967,149	10,349,231	55,611,087	132,700,949	332,567,489
2007	25,408,836	50,020,870	32,582,515	5,025,029	155,516,876	1,953,767	20,906,785	112,341,590	268,073,084	671,829,351
2008	38,498,125	75,788,980	49,367,305	7,613,658	235,630,954	2,960,244	31,676,856	170,214,042	406,170,174	1,017,920,338
2009	58,527,279	115,219,187	75,051,291	11,574,764	358,221,039	4,500,350	48,157,154	258,770,123	617,485,519	1,547,506,706
2010	76,916,373	151,420,709	98,632,180	15,211,520	470,773,010	5,914,346	63,287,987	340,074,916	811,497,608	2,033,728,649
2011	97,238,900	191,428,463	124,692,368	19,230,645	595,158,711	7,477,011	80,009,677	429,928,107	1,025,908,157	2,571,072,039
2012	123,153,408	242,444,820	157,923,321	24,355,679	753,770,595	9,469,660	101,332,537	544,505,455	1,299,316,277	3,256,271,751
2013	156,198,595	307,498,924	200,298,160	30,890,926	956,026,394	12,010,610	128,522,631	690,610,101	1,647,955,842	4,130,012,184
2014	198,336,554	390,453,427	254,332,932	39,224,423	1,213,935,244	15,250,733	163,194,397	876,917,150	2,092,527,664	5,244,172,524
2015	252,069,264	496,233,832	323,236,004	49,850,980	1,542,810,732	19,382,413	207,406,506	1,114,488,766	2,659,428,627	6,664,907,123
2016	312,365,011	614,934,499	400,555,055	61,775,488	1,911,855,830	24,018,747	257,018,784	1,381,077,924	3,295,572,177	8,259,173,514
2017	363,529,701	715,659,392	466,165,076	71,894,175	2,225,013,532	27,952,963	299,117,885	1,607,295,394	3,835,379,517	9,612,007,635
2018	423,553,493	833,824,677	543,135,391	83,764,899	2,592,394,105	32,568,385	348,506,393	1,872,682,141	4,468,653,834	11,199,083,318
2019	493,970,330	972,450,135	633,433,022	97,691,026	3,023,386,171	37,982,961	406,446,461	2,184,020,276	5,211,578,818	13,060,959,201
2020	565,565,167	1,113,394,649	725,241,235	111,850,121	3,461,588,275	43,488,118	465,355,805	2,500,566,766	5,966,932,145	14,953,982,280
2021	565,565,167	1,113,394,649	725,241,235	105,314,873	3,349,036,304	39,356,437	455,006,574	2,262,995,151	5,400,031,182	14,015,941,573
2022	565,565,167	1,113,394,649	725,241,235	96,981,376	3,224,650,603	34,720,104	444,449,020	1,996,405,992	4,763,887,632	12,965,295,778
2023	565,565,167	1,113,394,649	725,241,235	86,354,820	3,066,038,720	30,785,887	433,678,949	1,770,188,522	4,224,080,292	12,015,328,240
2024	552,987,341	1,088,633,428	709,112,310	74,430,311	2,863,782,920	26,170,466	417,198,651	1,504,801,775	3,590,805,975	10,827,923,177
2025	540,156,331	1,063,373,779	692,658,720	64,311,625	2,605,874,070	20,755,889	402,067,818	1,193,463,640	2,847,880,991	9,430,542,864

Year	Commercial Electricity Consumption Savings (kWh/year)									
	Space Heating	Space Cooling	Ventilation	Water Heating	Lighting	Cooking	Refri-geration	Office Equipment	Other	Annual Commercial Electricity Savings kWh
	25%	27%	26%	7%	21%	33%	25%	33%	33%	
	18	18	18	9	12	7	15	7	7	
	(1,2,4)	(1,2,4)	(1,2,4)	(1,2,4)	(1,2,4)	(1,2,4)	(1,2,4)	(1,2,4)	(1,2,4)	
2026	527,067,041	1,037,605,669	675,873,930	52,440,900	2,276,998,582	15,250,733	385,346,127	876,917,150	2,092,527,664	7,940,027,797
2027	507,037,888	998,175,462	650,189,944	38,514,774	1,907,953,484		364,023,268			4,465,894,820
2028	488,648,793	961,973,940	626,609,055	24,355,679	1,594,795,782		336,833,174			4,033,216,423
2029	468,326,267	921,966,186	600,548,867		1,227,415,209		302,161,407			3,520,417,936
2030	442,411,759	870,949,829	567,317,914		796,423,143		257,949,298			2,935,051,943
2031	409,366,571	805,895,725	524,943,075		358,221,039		208,337,021			2,306,763,431
2032	367,228,613	722,941,222	470,908,303				166,237,920			1,727,316,058
2033	313,495,903	617,160,817	402,005,231				116,849,411			1,449,511,362
2034	253,200,155	498,460,150	324,686,180				58,909,343			1,135,255,829
2035	202,035,466	397,735,257	259,076,159				0			858,846,882
2036	142,011,674	279,569,972	182,105,844							603,687,490
2037	71,594,836	140,944,514	91,808,213							304,347,564
2038	0	0	0							0
2039										0
2040										0
SUM	10,180,173,000	20,041,103,681	13,054,342,231	1,175,145,170	42,844,254,946	412,936,975	6,980,337,069	23,743,876,070	56,658,394,129	175,090,563,269

Year	Commercial Annual Electricity Cost Savings from Energy Efficiency Measures (2003)									
	Space Heating	**Space Cooling**	**Ventilation**	**Water Heating**	**Lighting**	**Cooking**	**Refri-geration**	**Office Equipment**	**Other**	**Annual Electricity Cost Savings**
	$0.072	$0.072	$0.072	$0.072	$0.072	$0.072	$0.072	$0.072	$0.072	
	18	18	18	9	12	7	15	7	7	
	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	
2000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2001	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2002	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2003	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2004	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2005	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2006	$908,119	$1,787,760	$1,164,508	$179,596	$5,558,218	$69,828	$747,214	$4,015,120	$9,581,009	$24,011,373
2007	$1,834,518	$3,611,507	$2,352,458	$362,807	$11,228,318	$141,062	$1,509,470	$8,111,063	$19,354,877	$48,506,079
2008	$2,779,565	$5,471,964	$3,564,319	$549,706	$17,012,555	$213,730	$2,287,069	$12,289,454	$29,325,487	$73,493,848
2009	$4,225,670	$8,318,825	$5,418,703	$835,698	$25,863,559	$324,925	$3,476,947	$18,683,203	$44,582,454	$111,729,984
2010	$5,553,362	$10,932,575	$7,121,243	$1,098,272	$33,989,811	$427,016	$4,569,393	$24,553,409	$58,590,127	$146,835,208
2011	$7,020,649	$13,821,135	$9,002,789	$1,388,453	$42,970,459	$539,840	$5,776,699	$31,040,809	$74,070,569	$185,631,401
2012	$8,891,676	$17,504,516	$11,402,064	$1,758,480	$54,422,237	$683,709	$7,316,209	$39,313,294	$93,810,635	$235,102,820
2013	$11,277,539	$22,201,422	$14,461,527	$2,230,325	$69,025,106	$867,166	$9,279,334	$49,862,049	$118,982,412	$298,186,880
2014	$14,319,899	$28,190,737	$18,362,838	$2,832,003	$87,646,125	$1,101,103	$11,782,635	$63,313,418	$151,080,497	$378,629,256
2015	$18,199,401	$35,828,083	$23,337,639	$3,599,241	$111,390,935	$1,399,410	$14,974,750	$80,466,089	$192,010,747	$481,206,294
2016	$22,552,754	$44,398,271	$28,920,075	$4,460,190	$138,035,991	$1,734,153	$18,556,756	$99,713,826	$237,940,311	$596,312,328
2017	$26,246,844	$51,670,608	$33,657,119	$5,190,759	$160,645,977	$2,018,204	$21,596,311	$116,046,727	$276,914,401	$693,986,951
2018	$30,580,562	$60,202,142	$39,214,375	$6,047,826	$187,170,854	$2,351,437	$25,162,162	$135,207,651	$322,636,807	$808,573,816
2019	$35,664,658	$70,210,900	$45,733,864	$7,053,292	$218,288,482	$2,742,370	$29,345,434	$157,686,264	$376,275,991	$943,001,254
2020	$40,833,805	$80,387,094	$52,362,417	$8,075,579	$249,926,673	$3,139,842	$33,598,689	$180,540,920	$430,812,501	$1,079,677,521
2021	$40,833,805	$80,387,094	$52,362,417	$7,603,734	$241,800,421	$2,841,535	$32,851,475	$163,388,250	$389,882,251	$1,011,950,982
2022	$40,833,805	$80,387,094	$52,362,417	$7,002,055	$232,819,774	$2,506,792	$32,089,219	$144,140,513	$343,952,687	$936,094,355
2023	$40,833,805	$80,387,094	$52,362,417	$6,234,818	$221,367,996	$2,222,741	$31,311,620	$127,807,611	$304,978,597	$867,506,699
2024	$39,925,686	$78,599,333	$51,197,909	$5,373,868	$206,765,127	$1,889,508	$30,121,743	$108,646,688	$259,256,191	$781,776,053
2025	$38,999,287	$76,775,587	$50,009,960	$4,643,299	$188,144,108	$1,498,575	$29,029,296	$86,168,075	$205,617,008	$680,885,195

Year	Commercial Annual Electricity Cost Savings from Energy Efficiency Measures (2003)									
	Space Heating	**Space Cooling**	**Ventilation**	**Water Heating**	**Lighting**	**Cooking**	**Refri-geration**	**Office Equipment**	**Other**	**Annual Electricity Cost Savings**
	$0.072	$0.072	$0.072	$0.072	$0.072	$0.072	$0.072	$0.072	$0.072	
	18	18	18	9	12	7	15	7	7	
	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	
2026	$38,054,240	$74,915,129	$48,798,098	$3,786,233	$164,399,298	$1,101,103	$27,821,990	$63,313,418	$151,080,497	$573,270,007
2027	$36,608,136	$72,068,268	$46,943,714	$2,780,767	$137,754,242	$0	$26,282,480	$0	$0	$322,437,606
2028	$35,280,443	$69,454,518	$45,241,174	$1,758,480	$115,144,255	$0	$24,319,355	$0	$0	$291,198,226
2029	$33,813,156	$66,565,959	$43,359,628	$0	$88,619,378	$0	$21,816,054	$0	$0	$254,174,175
2030	$31,942,129	$62,882,578	$40,960,353	$0	$57,501,751	$0	$18,623,939	$0	$0	$211,910,750
2031	$29,556,266	$58,185,671	$37,900,890	$0	$25,863,559	$0	$15,041,933	$0	$0	$166,548,320
2032	$26,513,906	$52,196,356	$33,999,579	$0	$0	$0	$12,002,378	$0	$0	$124,712,219
2033	$22,634,404	$44,559,011	$29,024,778	$0	$0	$0	$8,436,528	$0	$0	$104,654,720
2034	$18,281,051	$35,988,823	$23,442,342	$0	$0	$0	$4,253,255	$0	$0	$81,965,471
2035	$14,586,961	$28,716,486	$18,705,299	$0	$0	$0	$0	$0	$0	$62,008,745
2036	$10,253,243	$20,184,952	$13,148,042	$0	$0	$0	$0	$0	$0	$43,586,237
2037	$5,169,147	$10,176,194	$6,628,553	$0	$0	$0	$0	$0	$0	$21,973,894
2038	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2039	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2040	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
SUM	$735,008,491	$1,446,967,686	$942,523,509	$84,845,481	$3,093,355,207	$29,814,050	$503,980,336	$1,714,307,852	$4,090,736,056	$12,641,538,668

These figures represent the consumers $ savings from reduced electricity use. These are amount of money they would have paid to utilities without the energy efficiency measures.

It is calculated using: Annual Electricity Saved X Commercial Utility Cost of Electricity.

Year	Space Heating	Space Cooling	Ventilation	Water Heating	Lighting	Cooking	Refri-geration	Office Equipment	Other	TOTAL Annual Investment	Cumulative Commercial Investment
	Commercial Annual Investment in Electricity Energy Efficiency Measures (2003)										
	$0.163	$0.163	$0.163	$0.241	$0.257	$0.218	$0.169	$0.218	$0.218		
	18	18	18	9	12	7	15	7	7		
	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)		
2000	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0	0
2006	2,048,659	4,033,075	2,627,058	599,814	19,801,650	210,994	1,744,314	12,132,171	28,950,174	72,147,910	72,147,910
2007	2,089,898	4,114,258	2,679,939	611,888	20,200,245	215,241	1,779,426	12,376,384	29,532,923	73,600,201	145,748,111
2008	2,131,966	4,197,075	2,733,884	624,205	20,606,863	219,574	1,815,244	12,625,513	30,127,402	75,081,726	220,829,837
2009	3,262,322	6,422,340	4,183,373	955,155	31,532,499	335,991	2,777,676	19,319,485	46,100,771	114,889,611	335,719,448
2010	2,995,191	5,896,455	3,840,824	876,944	28,950,505	308,479	2,550,230	17,737,536	42,325,875	105,482,039	441,201,486
2011	3,310,106	6,516,410	4,244,649	969,146	31,994,365	340,912	2,818,361	19,602,463	46,776,023	116,572,436	557,773,922
2012	4,220,920	8,309,476	5,412,613	1,235,817	40,797,990	434,718	3,593,867	24,996,311	59,646,994	148,648,706	706,422,628
2013	5,382,356	10,595,926	6,901,957	1,575,867	52,024,034	765,331	4,582,761	44,006,510	105,009,736	230,844,477	937,267,104
2014	6,863,374	13,511,518	8,801,111	2,009,485	66,339,056	922,110	5,843,761	53,021,320	126,521,163	283,832,899	1,221,100,004
2015	8,751,912	17,229,371	11,222,840	3,162,233	84,593,023	1,120,946	7,451,741	64,454,378	153,803,092	351,789,536	1,572,889,539
2016	9,820,891	19,333,806	12,593,624	3,487,286	94,925,410	1,347,458	8,361,913	77,478,847	184,882,494	412,231,729	1,985,121,269
2017	8,333,636	16,405,936	10,686,472	3,064,159	80,550,110	1,166,772	7,095,603	67,089,370	160,090,793	354,482,852	2,339,604,120
2018	9,776,595	19,246,604	12,536,822	3,817,584	114,298,913	1,347,817	8,324,198	77,499,506	184,931,792	431,779,831	2,771,383,952
2019	11,469,400	22,579,129	14,707,557	4,234,999	131,059,592	1,615,968	9,765,523	92,918,155	221,724,264	510,074,587	3,281,458,539
2020	11,661,271	22,956,854	14,953,599	4,383,377	133,320,769	1,966,341	9,928,890	113,064,614	269,798,386	582,034,100	3,863,492,639
SUM	92,118,498	181,348,232	118,126,323	31,607,959	950,995,023	12,318,653	78,433,508	708,322,562	1,690,221,882	3,863,492,639	

Year	Commercial Annual Net Consumer Savings from Electricity Energy Efficiency Measures (2003)										
	Space Heating	Space Cooling	Ventilation	Water Heating	Lighting	Cooking	Refri-geration	Office Equipment	Other	Annual Electricity Consumer Net Savings	Cumulative Electricity Consumer Net Savings
	$0.056	$0.056	$0.056	$0.035	$0.113	$0.032	$0.054	$0.032	$0.032		
	18	18	18	9	12	7	15	7	7		
	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)		
2000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	0
2001	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	0
2002	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	0
2003	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	0
2004	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	0
2005	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	0
2006	$704,456	$1,386,822	$903,346	$87,533	$8,674,551	$30,678	$555,698	$1,763,957	$4,209,211	$18,316,251	18,316,251
2007	$1,423,093	$2,801,559	$1,824,875	$176,827	$17,523,716	$61,973	$1,122,582	$3,563,421	$8,503,150	$37,001,197	55,317,448
2008	$2,156,196	$4,244,775	$2,764,955	$267,919	$26,551,009	$93,898	$1,700,877	$5,399,108	$12,883,523	$56,062,259	111,379,707
2009	$3,277,985	$6,453,174	$4,203,458	$407,308	$40,364,518	$142,749	$2,585,781	$8,208,064	$19,586,345	$85,229,382	196,609,089
2010	$4,307,917	$8,480,742	$5,524,172	$535,282	$53,046,928	$187,600	$3,398,226	$10,787,013	$25,740,315	$112,008,197	308,617,286
2011	$5,446,138	$10,721,489	$6,983,746	$676,712	$67,062,769	$237,167	$4,296,091	$13,637,114	$32,541,315	$141,602,540	450,219,826
2012	$6,897,552	$13,578,803	$8,844,939	$857,059	$84,935,232	$300,373	$5,441,014	$17,271,452	$41,213,690	$179,340,114	629,559,940
2013	$8,748,341	$17,222,341	$11,218,261	$1,087,029	$107,725,512	$380,971	$6,900,976	$21,905,822	$52,272,370	$227,461,622	857,021,563
2014	$11,108,396	$21,868,441	$14,244,630	$1,380,279	$136,786,805	$483,746	$8,762,664	$27,815,392	$66,373,975	$288,824,327	1,145,845,890
2015	$14,117,847	$27,792,969	$18,103,740	$1,754,220	$173,844,652	$614,801	$11,136,617	$35,351,050	$84,355,802	$367,071,699	1,512,917,589
2016	$17,494,880	$34,441,134	$22,434,211	$2,173,835	$215,428,831	$761,863	$13,800,531	$43,807,130	$104,533,971	$454,876,384	1,967,793,973
2017	$20,360,502	$40,082,514	$26,108,884	$2,529,904	$250,715,591	$886,655	$16,061,027	$50,982,640	$121,656,401	$529,384,117	2,497,178,089
2018	$23,722,303	$46,700,693	$30,419,823	$2,947,626	$292,112,210	$1,033,054	$18,712,925	$59,400,580	$141,743,559	$616,792,772	3,113,970,861
2019	$27,666,196	$54,464,801	$35,477,195	$3,437,676	$340,676,602	$1,204,801	$21,823,996	$69,276,077	$165,308,783	$719,336,127	3,833,306,988
2020	$31,676,065	$62,358,794	$40,619,172	$3,935,925	$390,053,425	$1,379,422	$24,987,112	$79,316,780	$189,268,229	$823,594,924	4,656,901,913
2021	$31,676,065	$62,358,794	$40,619,172	$3,078,866	$349,688,907	$895,676	$24,431,413	$51,501,388	$122,894,254	$687,144,536	5,344,046,449
2022	$31,676,065	$62,358,794	$40,619,172	$2,848,895	$337,006,497	$764,621	$23,864,529	$43,965,730	$104,912,427	$648,016,732	5,992,063,181
2023	$31,676,065	$62,358,794	$40,619,172	$2,555,646	$322,990,657	$617,559	$23,286,234	$35,509,650	$84,734,258	$604,348,035	6,596,411,216
2024	$30,971,609	$60,971,972	$39,715,826	$2,181,705	$305,118,194	$492,768	$22,401,331	$28,334,140	$67,611,828	$557,799,373	7,154,210,589
2025	$30,252,972	$59,557,235	$38,794,297	$1,762,090	$282,327,913	$346,369	$21,588,886	$19,916,199	$47,524,670	$502,070,632	7,656,281,220

Year	Commercial Annual Net Consumer Savings from Electricity Energy Efficiency Measures (2003)										
	Space Heating	**Space Cooling**	**Ventilation**	**Water Heating**	**Lighting**	**Cooking**	**Refri-geration**	**Office Equipment**	**Other**	**Annual Electricity Consumer Net Savings**	**Cumulative Electricity Consumer Net Savings**
	$0.056	$0.056	$0.056	$0.035	$0.113	$0.032	$0.054	$0.032	$0.032		
	18	18	18	9	12	7	15	7	7		
	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)		
2026	$29,519,870	$58,114,019	$37,854,218	$1,406,021	$253,266,620	$174,621	$20,691,021	$10,040,703	$23,959,446	$435,026,539	8,091,307,759
2027	$28,398,081	$55,905,620	$36,415,714	$988,299	$216,208,773	$0	$19,546,098	$0	$0	$357,462,584	8,448,770,343
2028	$27,368,148	$53,878,052	$35,095,000	$498,248	$174,624,594		$18,086,135			$309,550,178	8,758,320,521
2029	$26,229,928	$51,637,305	$33,635,426	$0	$139,337,835		$16,224,447			$267,064,941	9,025,385,462
2030	$24,778,513	$48,779,991	$31,774,233		$97,941,216		$13,850,494			$217,124,447	9,242,509,909
2031	$22,927,724	$45,136,453	$29,400,911		$49,376,823		$11,186,581			$158,028,493	9,400,538,401
2032	$20,567,670	$40,490,353	$26,374,542		$0		$8,926,085			$96,358,650	9,496,897,052
2033	$17,558,218	$34,565,825	$22,515,432				$6,274,187			$80,913,662	9,577,810,714
2034	$14,181,186	$27,917,661	$18,184,961				$3,163,116			$63,446,924	9,641,257,637
2035	$11,315,564	$22,276,280	$14,510,288				$0			$48,102,132	9,689,359,769
2036	$7,953,763	$15,658,101	$10,199,349							$33,811,213	9,723,170,982
2037	$4,009,870	$7,893,993	$5,141,977							$17,045,840	9,740,216,822
2038	$0	$0	$0							$0	9,740,216,822
2039										$0	9,740,216,822
2040										$0	9,740,216,822
SUM	$570,169,178	$1,122,458,294	$731,145,098	$37,574,904	$4,733,390,380	$11,091,364	$374,806,673	$637,753,410	$1,521,827,521	$9,740,216,822	

Annual Net Consumer Savings = (Annual Electricity Savings in kWh/year) X (Retail Cost of Commercial Electricity per kWh – Cost of Conserved Energy per kWh).

The Cost of Conserved Electricity includes the annualized investment cost and O&M cost over the service life of the energy efficiency measures.

APPENDIX C: INDUSTRIAL ENERGY EFFICIENCY IMPACTS

	Industrial Electricity Consumption (million kWh/year)													
Year	Electric Consumption million kWh/year (1)	Food 8.2% (2)	Paper 6.2% (2)	Chemicals 18.0% (2)	Petroleum Refining 4.4% (2)	Rubber & Plastics 7.6% (2)	Stone, Glass, Clay 3.2% (2)	Primary Metals 17.3% (2)	Metals Fabrication 7.2% (2)	Other mfg. 19.3% (2)	Agriculture 1.5% (2)	Mining 0.3% (2)	Construction 6.7% (2)	ECM Penetration Rate
2000	40,939	3,361	2,532	7,354	1,822	3,115	1,301	7,100	2,956	7,900	598	140	2,759	0%
2001	37,948	3,116	2,347	6,817	1,689	2,888	1,206	6,581	2,740	7,323	555	130	2,558	0%
2002	35,802	2,940	2,214	6,432	1,593	2,724	1,137	6,209	2,585	6,909	523	122	2,413	0%
2003	35,952	2,952	2,223	6,459	1,600	2,736	1,142	6,235	2,596	6,938	526	123	2,423	0%
2004	36,103	2,964	2,233	6,486	1,606	2,747	1,147	6,261	2,607	6,967	528	123	2,433	0%
2005	36,254	2,977	2,242	6,513	1,613	2,759	1,152	6,287	2,618	6,996	530	124	2,443	0%
2006	36,406	2,989	2,252	6,540	1,620	2,770	1,157	6,313	2,629	7,026	532	124	2,454	2%
2007	36,559	3,002	2,261	6,568	1,627	2,782	1,161	6,340	2,640	7,055	534	125	2,464	4%
2008	36,712	3,014	2,270	6,595	1,634	2,794	1,166	6,367	2,651	7,085	537	125	2,474	6%
2009	36,866	3,027	2,280	6,623	1,640	2,805	1,171	6,393	2,662	7,115	539	126	2,485	9%
2010	37,021	3,040	2,290	6,651	1,647	2,817	1,176	6,420	2,673	7,144	541	126	2,495	12%
2011	37,176	3,052	2,299	6,678	1,654	2,829	1,181	6,447	2,685	7,174	543	127	2,505	15%
2012	37,332	3,065	2,309	6,706	1,661	2,841	1,186	6,474	2,696	7,204	546	128	2,516	18%
2013	37,488	3,078	2,318	6,735	1,668	2,853	1,191	6,501	2,707	7,235	548	128	2,527	23%
2014	37,646	3,091	2,328	6,763	1,675	2,865	1,196	6,528	2,718	7,265	550	129	2,537	29%
2015	37,803	3,104	2,338	6,791	1,682	2,877	1,201	6,556	2,730	7,295	553	129	2,548	36%
2016	37,962	3,117	2,348	6,820	1,689	2,889	1,206	6,583	2,741	7,326	555	130	2,558	44%
2017	38,121	3,130	2,358	6,848	1,696	2,901	1,211	6,611	2,753	7,357	557	130	2,569	52%
2018	38,281	3,143	2,367	6,877	1,703	2,913	1,216	6,639	2,764	7,388	560	131	2,580	60%
2019	38,441	3,156	2,377	6,906	1,711	2,925	1,221	6,666	2,776	7,419	562	131	2,591	67%
2020	38,603	3,170	2,387	6,935	1,718	2,938	1,226	6,694	2,788	7,450	564	132	2,602	75%
SUM	785,415	64,488	48,574	141,095	34,948	59,769	24,953	136,204	56,715	151,571	11,482	2,683	52,934	

1) Energy Information Administration/State Electricity Profiles 2002, pp 62; 2) U.S. Census Data; .3) 5-Lab Study (reported on Repowering the Midwest, pp. 22.); and 4) 5-Lab Study.

Year	Food	Paper	Chemicals	Petroleum Refining	Rubber & Plastics	Stone, Glass, Clay	Primary Metals	Metals Fabrication	Other Mfg.	Agriculture	Mining	Construction	TOTAL Consumption Savings kWh
	Industrial Incremental Electricity Consumption Savings (kWh/year)												
	14.80%	6.80%	6.80%	6.80%	25.00%	5.70%	8.70%	17.70%	17.20%	17.10%	16.50%	17.20%	
	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	
2000	0	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0	0	0	0
2006	8,848,029	3,062,082	8,894,608	2,203,124	13,852,262	1,318,553	10,985,408	9,306,388	24,168,607	1,820,176	410,459	8,440,459	93,310,157
2007	8,885,129	3,074,922	8,931,904	2,212,362	13,910,345	1,324,082	11,031,470	9,345,410	24,269,946	1,827,808	412,180	8,475,850	93,701,407
2008	8,922,384	3,087,815	8,969,355	2,221,638	13,968,671	1,329,634	11,077,725	9,384,595	24,371,710	1,835,472	413,908	8,511,390	94,094,297
2009	13,439,694	4,651,143	13,510,445	3,346,431	21,040,862	2,002,813	16,686,260	14,135,917	36,710,851	2,764,753	623,465	12,820,617	141,733,251
2010	12,146,442	4,203,581	12,210,385	3,024,416	19,016,178	1,810,090	15,080,603	12,775,670	33,178,302	2,498,711	563,472	11,586,936	128,094,785
2011	13,213,819	4,572,974	13,283,382	3,290,189	20,687,239	1,969,153	16,405,822	13,898,341	36,093,870	2,718,287	612,987	12,605,147	139,351,210
2012	16,586,531	5,740,185	16,673,849	4,129,981	25,967,476	2,471,762	20,593,265	17,445,771	45,306,514	3,412,106	769,447	15,822,500	174,919,387
2013	20,820,098	7,205,317	20,929,703	5,184,122	32,595,447	3,102,658	25,849,516	21,898,652	56,870,606	4,283,016	965,841	19,861,055	219,566,030
2014	26,134,246	9,044,411	26,271,826	6,507,324	40,915,149	3,894,584	32,447,379	27,488,091	71,386,330	5,376,219	1,212,364	24,930,416	275,608,339
2015	32,804,784	11,352,918	32,977,480	8,168,261	51,358,383	4,888,643	40,729,288	34,504,186	89,607,067	6,748,451	1,521,809	31,293,686	345,954,955
2016	36,236,568	12,540,573	36,427,330	9,022,762	56,731,102	5,400,055	44,990,073	38,113,748	98,981,068	7,454,423	1,681,009	34,567,390	382,146,099
2017	40,358,163	13,966,954	40,570,623	10,049,023	63,183,772	6,014,264	50,107,303	42,448,856	110,239,306	8,302,298	1,872,209	38,499,131	425,611,903
2018	36,474,646	12,622,966	36,666,662	9,082,043	57,103,832	5,435,534	45,285,663	38,364,160	99,631,385	7,503,399	1,692,053	34,794,502	384,656,845
2019	33,697,378	11,661,822	33,874,773	8,390,514	52,755,807	5,021,659	41,837,502	35,443,019	92,045,209	6,932,072	1,563,216	32,145,164	355,368,134
2020	34,741,035	12,023,006	34,923,925	8,650,380	54,389,732	5,177,187	43,133,271	36,540,742	94,895,985	7,146,768	1,611,631	33,140,747	366,374,411
SUM	343,308,948	118,810,669	345,116,251	85,482,569	537,476,256	51,160,672	426,240,547	361,093,543	937,756,757	70,623,961	15,926,047	327,494,991	3,620,491,212

Year	Industrial Electricity Consumption Savings (kWh/year)												
	Food	**Paper**	**Chemicals**	**Petroleum Refining**	**Rubber & Plastics**	**Stone, Glass, Clay**	**Primary Metals**	**Metals Fabrication**	**Other mfg.**	**Agriculture**	**Mining**	**Construction**	**Annual Electricity Savings kWh**
	15%	7%	7%	7%	25%	6%	9%	18%	17%	17%	17%	17%	
	20	20	20	20	20	20	20	20	20	20	20	20	
	(1,2,4)	(1,2,4)	(1,2,4)	(1,2,4)	(1,2,4)	(1,2,4)	(1,2,4)	(1,2,4)	(1,2,4)	(1,2,4)	(1,2,4)	(1,2,4)	
2000	0	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0	0	0	0
2006	8,848,029	3,062,082	8,894,608	2,203,124	13,852,262	1,318,553	10,985,408	9,306,388	24,168,607	1,820,176	410,459	8,440,459	93,310,157
2007	17,733,158	6,137,004	17,826,512	4,415,486	27,762,607	2,642,635	22,016,877	18,651,797	48,438,554	3,647,985	822,638	16,916,310	187,011,564
2008	26,655,542	9,224,819	26,795,867	6,637,125	41,731,278	3,972,269	33,094,602	28,036,392	72,810,264	5,483,457	1,236,546	25,427,699	281,105,861
2009	40,095,236	13,875,962	40,306,312	9,983,555	62,772,141	5,975,082	49,780,862	42,172,309	109,521,115	8,248,210	1,860,012	38,248,316	422,839,112
2010	52,241,678	18,079,543	52,516,697	13,007,971	81,788,319	7,785,172	64,861,466	54,947,978	142,699,417	10,746,921	2,423,483	49,835,252	550,933,897
2011	65,455,498	22,652,516	65,800,079	16,298,160	102,475,558	9,754,326	81,267,288	68,846,320	178,793,287	13,465,208	3,036,470	62,440,399	690,285,108
2012	82,042,029	28,392,701	82,473,928	20,428,140	128,443,033	12,226,088	101,860,553	86,292,091	224,099,801	16,877,314	3,805,917	78,262,899	865,204,495
2013	102,862,127	35,598,018	103,403,631	25,612,263	161,038,480	15,328,746	127,710,069	108,190,743	280,970,407	21,160,331	4,771,758	98,123,954	1,084,770,526
2014	128,996,373	44,642,429	129,675,457	32,119,586	201,953,629	19,223,330	160,157,448	135,678,833	352,356,738	26,536,549	5,984,121	123,054,370	1,360,378,864
2015	161,801,157	55,995,347	162,652,937	40,287,848	253,312,012	24,111,973	200,886,736	170,183,019	441,963,804	33,285,001	7,505,930	154,348,056	1,706,333,819
2016	198,037,725	68,535,920	199,080,268	49,310,610	310,043,114	29,512,027	245,876,808	208,296,767	540,944,872	40,739,423	9,186,939	188,915,446	2,088,479,918
2017	238,395,888	82,502,874	239,650,891	59,359,633	373,226,886	35,526,292	295,984,111	250,745,623	651,184,178	49,041,722	11,059,147	227,414,577	2,514,091,822
2018	274,870,534	95,125,840	276,317,553	68,441,675	430,330,718	40,961,825	341,269,774	289,109,783	750,815,563	56,545,121	12,751,200	262,209,080	2,898,748,667
2019	308,567,912	106,787,663	310,192,326	76,832,189	483,086,524	45,983,485	383,107,276	324,552,801	842,860,772	63,477,193	14,314,416	294,354,244	3,254,116,801
2020	343,308,948	118,810,669	345,116,251	85,482,569	537,476,256	51,160,672	426,240,547	361,093,543	937,756,757	70,623,961	15,926,047	327,494,991	3,620,491,212
2021	343,308,948	118,810,669	345,116,251	85,482,569	537,476,256	51,160,672	426,240,547	361,093,543	937,756,757	70,623,961	15,926,047	327,494,991	3,620,491,212
2022	343,308,948	118,810,669	345,116,251	85,482,569	537,476,256	51,160,672	426,240,547	361,093,543	937,756,757	70,623,961	15,926,047	327,494,991	3,620,491,212
2023	343,308,948	118,810,669	345,116,251	85,482,569	537,476,256	51,160,672	426,240,547	361,093,543	937,756,757	70,623,961	15,926,047	327,494,991	3,620,491,212
2024	343,308,948	118,810,669	345,116,251	85,482,569	537,476,256	51,160,672	426,240,547	361,093,543	937,756,757	70,623,961	15,926,047	327,494,991	3,620,491,212
2025	343,308,948	118,810,669	345,116,251	85,482,569	537,476,256	51,160,672	426,240,547	361,093,543	937,756,757	70,623,961	15,926,047	327,494,991	3,620,491,212

Year	Industrial Electricity Consumption Savings (kWh/year)												
	Food	Paper	Chemicals	Petroleum Refining	Rubber & Plastics	Stone, Glass, Clay	Primary Metals	Metals Fabrication	Other mfg.	Agriculture	Mining	Construction	Annual Electricity Savings kWh
	15%	7%	7%	7%	25%	6%	9%	18%	17%	17%	17%	17%	
	20	20	20	20	20	20	20	20	20	20	20	20	
	(1,2,4)	(1,2,4)	(1,2,4)	(1,2,4)	(1,2,4)	(1,2,4)	(1,2,4)	(1,2,4)	(1,2,4)	(1,2,4)	(1,2,4)	(1,2,4)	
2026	334,460,919	115,748,587	336,221,642	83,279,445	523,623,994	49,842,119	415,255,139	351,787,155	913,588,150	68,803,785	15,515,589	319,054,532	3,527,181,054
2027	325,575,790	112,673,665	327,289,739	81,067,083	509,713,649	48,518,037	404,223,670	342,441,746	889,318,203	66,975,976	15,103,409	310,578,681	3,433,479,648
2028	316,653,405	109,585,850	318,320,384	78,845,445	495,744,978	47,188,403	393,145,945	333,057,151	864,946,493	65,140,504	14,689,501	302,067,292	3,339,385,351
2029	303,213,711	104,934,707	304,809,939	75,499,014	474,704,116	45,185,589	376,459,685	318,921,234	828,235,642	62,375,751	14,066,036	289,246,675	3,197,652,099
2030	291,067,270	100,731,126	292,599,553	72,474,598	455,687,938	43,375,499	361,379,082	306,145,565	795,057,340	59,877,040	13,502,564	277,659,739	3,069,557,314
2031	277,853,450	96,158,153	279,316,172	69,184,409	435,000,699	41,406,346	344,973,259	292,247,224	758,963,470	57,158,753	12,889,577	265,054,592	2,930,206,104
2032	261,266,919	90,417,968	262,642,323	65,054,429	409,033,223	38,934,584	324,379,994	274,801,452	713,656,956	53,746,647	12,120,131	249,232,092	2,755,286,717
2033	240,446,820	83,212,651	241,712,620	59,870,307	376,437,776	35,831,926	298,530,478	252,902,801	656,786,350	49,463,630	11,154,290	229,371,037	2,535,720,686
2034	214,312,574	74,168,240	215,440,794	53,362,983	335,522,627	31,937,342	266,083,100	225,414,710	585,400,019	44,087,412	9,941,926	204,440,621	2,260,112,348
2035	181,507,790	62,815,322	182,463,313	45,194,721	284,164,244	27,048,699	225,353,812	190,910,524	495,792,953	37,338,960	8,420,118	173,146,935	1,914,157,392
2036	145,271,223	50,274,749	146,035,983	36,171,959	227,433,143	21,648,644	180,363,739	152,796,776	396,811,885	29,884,538	6,739,109	138,579,545	1,532,011,293
2037	104,913,060	36,307,795	105,465,360	26,122,937	164,249,370	15,634,380	130,256,436	110,347,920	286,572,579	21,582,239	4,866,900	100,080,414	1,106,399,390
2038	68,438,413	23,684,829	68,798,698	17,040,894	107,145,539	10,198,846	84,970,773	71,983,761	186,941,194	14,078,840	3,174,847	65,285,911	721,742,545
2039	34,741,035	12,023,006	34,923,925	8,650,380	54,389,732	5,177,187	43,133,271	36,540,742	94,895,985	7,146,768	1,611,631	33,140,747	366,374,411
2040	0	0	0	0	0	0	0	0	0	0	0	0	0
SUM	6,866,178,954	2,376,213,379	6,902,325,016	1,709,651,384	10,749,525,124	1,023,213,436	8,524,810,946	7,221,870,864	18,755,135,141	1,412,479,221	318,520,949	6,549,899,820	72,409,824,236

Industrial Annual Electricity Cost Savings from Energy Efficiency Measures (2003)

Year	Food	Paper	Chemicals	Petroleum Refining	Rubber & Plastics	Stone, Glass, Clay	Primary Metals	Metals Fabrication	Other mfg.	Agriculture	Mining	Construction	Annual Electricity Cost Savings
	$0.0491	$0.0491	$0.0491	$0.0491	$0.0491	$0.0491	$0.0491	$0.0491	$0.0491	$0.0491	$0.0491	$0.0491	
	20	20	20	20	20	20	20	20	20	20	20	20	
	(4,5,1)	(4,5,1)	(4,5,1)	(4,5,1)	(4,5,1)	(4,5,1)	(4,5,1)	(4,5,1)	(4,5,1)	(4,5,1)	(4,5,1)	(4,5,1)	
2000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2001	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2002	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2003	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2004	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2005	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2006	$434,438	$150,348	$436,725	$108,173	$680,146	$64,741	$539,384	$456,944	$1,186,679	$89,371	$20,154	$414,427	$4,581,529
2007	$870,698	$301,327	$875,282	$216,800	$1,363,144	$129,753	$1,081,029	$915,803	$2,378,333	$179,116	$40,392	$830,591	$9,182,268
2008	$1,308,787	$452,939	$1,315,677	$325,883	$2,049,006	$195,038	$1,624,945	$1,376,587	$3,574,984	$269,238	$60,714	$1,248,500	$13,802,298
2009	$1,968,676	$681,310	$1,979,040	$490,193	$3,082,112	$293,377	$2,444,240	$2,070,660	$5,377,487	$404,987	$91,327	$1,877,992	$20,761,400
2010	$2,565,066	$887,706	$2,578,570	$638,691	$4,015,806	$382,252	$3,184,698	$2,697,946	$7,006,541	$527,674	$118,993	$2,446,911	$27,050,854
2011	$3,213,865	$1,112,239	$3,230,784	$800,240	$5,031,550	$478,937	$3,990,224	$3,380,354	$8,778,750	$661,142	$149,091	$3,065,824	$33,892,999
2012	$4,028,264	$1,394,082	$4,049,470	$1,003,022	$6,306,553	$600,301	$5,001,353	$4,236,942	$11,003,300	$828,676	$186,871	$3,842,708	$42,481,541
2013	$5,050,530	$1,747,863	$5,077,118	$1,257,562	$7,906,989	$752,641	$6,270,564	$5,312,165	$13,795,647	$1,038,972	$234,293	$4,817,886	$53,262,233
2014	$6,333,722	$2,191,943	$6,367,065	$1,577,072	$9,915,923	$943,865	$7,863,731	$6,661,831	$17,300,716	$1,302,945	$293,820	$6,041,970	$66,794,602
2015	$7,944,437	$2,749,372	$7,986,259	$1,978,133	$12,437,620	$1,183,898	$9,863,539	$8,355,986	$21,700,423	$1,634,294	$368,541	$7,578,490	$83,780,991
2016	$9,723,652	$3,365,114	$9,774,841	$2,421,151	$15,223,117	$1,449,041	$12,072,551	$10,227,371	$26,560,393	$2,000,306	$451,079	$9,275,748	$102,544,364
2017	$11,705,238	$4,050,891	$11,766,859	$2,914,558	$18,325,440	$1,744,341	$14,532,820	$12,311,610	$31,973,143	$2,407,949	$543,004	$11,166,056	$123,441,908
2018	$13,496,143	$4,670,679	$13,567,192	$3,360,486	$21,129,238	$2,011,226	$16,756,346	$14,195,290	$36,865,044	$2,776,365	$626,084	$12,874,466	$142,328,560
2019	$15,150,684	$5,243,274	$15,230,443	$3,772,460	$23,719,548	$2,257,789	$18,810,567	$15,935,543	$41,384,464	$3,116,730	$702,838	$14,452,793	$159,777,135
2020	$16,856,469	$5,833,604	$16,945,208	$4,197,194	$26,390,084	$2,511,989	$20,928,411	$17,729,693	$46,043,857	$3,467,636	$781,969	$16,080,004	$177,766,118
2021	$16,856,469	$5,833,604	$16,945,208	$4,197,194	$26,390,084	$2,511,989	$20,928,411	$17,729,693	$46,043,857	$3,467,636	$781,969	$16,080,004	$177,766,118
2022	$16,856,469	$5,833,604	$16,945,208	$4,197,194	$26,390,084	$2,511,989	$20,928,411	$17,729,693	$46,043,857	$3,467,636	$781,969	$16,080,004	$177,766,118
2023	$16,856,469	$5,833,604	$16,945,208	$4,197,194	$26,390,084	$2,511,989	$20,928,411	$17,729,693	$46,043,857	$3,467,636	$781,969	$16,080,004	$177,766,118
2024	$16,856,469	$5,833,604	$16,945,208	$4,197,194	$26,390,084	$2,511,989	$20,928,411	$17,729,693	$46,043,857	$3,467,636	$781,969	$16,080,004	$177,766,118
2025	$16,856,469	$5,833,604	$16,945,208	$4,197,194	$26,390,084	$2,511,989	$20,928,411	$17,729,693	$46,043,857	$3,467,636	$781,969	$16,080,004	$177,766,118

Industrial Annual Electricity Cost Savings from Energy Efficiency Measures (2003)

Year	Food	Paper	Chemicals	Petroleum Refining	Rubber & Plastics	Stone, Glass, Clay	Primary Metals	Metals Fabrication	Other mfg.	Agriculture	Mining	Construction	Annual Electricity Cost Savings
	$0.0491	$0.0491	$0.0491	$0.0491	$0.0491	$0.0491	$0.0491	$0.0491	$0.0491	$0.0491	$0.0491	$0.0491	
	20	20	20	20	20	20	20	20	20	20	20	20	
	(4,5,1)	(4,5,1)	(4,5,1)	(4,5,1)	(4,5,1)	(4,5,1)	(4,5,1)	(4,5,1)	(4,5,1)	(4,5,1)	(4,5,1)	(4,5,1)	
2026	$16,422,031	$5,683,256	$16,508,483	$4,089,021	$25,709,938	$2,447,248	$20,389,027	$17,272,749	$44,857,178	$3,378,266	$761,815	$15,665,578	$173,184,590
2027	$15,985,771	$5,532,277	$16,069,926	$3,980,394	$25,026,940	$2,382,236	$19,847,382	$16,813,890	$43,665,524	$3,288,520	$741,577	$15,249,413	$168,583,851
2028	$15,547,682	$5,380,665	$15,629,531	$3,871,311	$24,341,078	$2,316,951	$19,303,466	$16,353,106	$42,468,873	$3,198,399	$721,255	$14,831,504	$163,963,821
2029	$14,887,793	$5,152,294	$14,966,168	$3,707,002	$23,307,972	$2,218,612	$18,484,171	$15,659,033	$40,666,370	$3,062,649	$690,642	$14,202,012	$157,004,718
2030	$14,291,403	$4,945,898	$14,366,638	$3,558,503	$22,374,278	$2,129,737	$17,743,713	$15,031,747	$39,037,315	$2,939,963	$662,976	$13,633,093	$150,715,264
2031	$13,642,604	$4,721,365	$13,714,424	$3,396,954	$21,358,534	$2,033,052	$16,938,187	$14,349,339	$37,265,106	$2,806,495	$632,878	$13,014,180	$143,873,120
2032	$12,828,206	$4,439,522	$12,895,738	$3,194,172	$20,083,531	$1,911,688	$15,927,058	$13,492,751	$35,040,557	$2,638,960	$595,098	$12,237,296	$135,284,578
2033	$11,805,939	$4,085,741	$11,868,090	$2,939,632	$18,483,095	$1,759,348	$14,657,846	$12,417,528	$32,248,210	$2,428,664	$547,676	$11,262,118	$124,503,886
2034	$10,522,747	$3,641,661	$10,578,143	$2,620,122	$16,474,161	$1,568,123	$13,064,680	$11,067,862	$28,743,141	$2,164,692	$488,149	$10,038,035	$110,971,516
2035	$8,912,033	$3,084,232	$8,958,949	$2,219,061	$13,952,464	$1,328,091	$11,064,872	$9,373,707	$24,343,434	$1,833,343	$413,428	$8,501,515	$93,985,128
2036	$7,132,817	$2,468,490	$7,170,367	$1,776,043	$11,166,967	$1,062,948	$8,855,860	$7,502,322	$19,483,464	$1,467,331	$330,890	$6,804,256	$75,221,755
2037	$5,151,231	$1,782,713	$5,178,349	$1,282,636	$8,064,644	$767,648	$6,395,591	$5,418,083	$14,070,714	$1,059,688	$238,965	$4,913,948	$54,324,210
2038	$3,360,326	$1,162,925	$3,378,016	$836,708	$5,260,846	$500,763	$4,172,065	$3,534,403	$9,178,813	$691,271	$155,885	$3,205,538	$35,437,559
2039	$1,705,785	$590,330	$1,714,765	$424,734	$2,670,536	$254,200	$2,117,844	$1,794,150	$4,659,393	$350,906	$79,131	$1,627,211	$17,988,984
2040	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
SUM	$337,129,387	$116,672,077	$338,904,158	$83,943,883	$527,801,684	$50,239,780	$418,568,217	$354,593,859	$920,877,135	$69,352,730	$15,639,379	$321,600,081	$3,555,322,370

These figures represent the consumers $ savings from reduced electricity use. These are amount of money they would have paid to utilities without the energy efficiency measures.

It is calculated using: Annual Electricity Saved X Industrial Utility Cost of Electricity.

Industrial Annual Investment in Electricity Energy Efficiency Measures (2003)

Year	Food	Paper	Chemicals	Petroleum Refining	Rubber & Plastics	Stone, Glass, Clay	Primary Metals	Metals Fabrication	Other Mfg.	Agriculture	Mining	Construction	TOTAL Annual Investment
	$0.163	$0.163	$0.163	$0.163	$0.163	$0.163	$0.163	$0.163	$0.163	$0.163	$0.163	$0.163	
	20	20	20	20	20	20	20	20	20	20	20	20	
	(4, 5)	(4, 5)	(4, 5)	(4, 5)	(4, 5)	(4, 5)	(4, 5)	(4, 5)	(4, 5)	(4, 5)	(4, 5)	(4, 5)	
2000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2001	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2002	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2003	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2004	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2005	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2006	$1,439,446	$498,156	$1,447,024	$358,416	$2,253,562	$214,509	$1,787,167	$1,514,014	$3,931,882	$296,116	$66,776	$1,373,140	$15,180,210
2007	$1,445,482	$500,245	$1,453,091	$359,919	$2,263,011	$215,409	$1,794,660	$1,520,363	$3,948,368	$297,358	$67,056	$1,378,898	$15,243,861
2008	$1,451,543	$502,343	$1,459,184	$361,428	$2,272,500	$216,312	$1,802,185	$1,526,738	$3,964,924	$298,605	$67,337	$1,384,680	$15,307,778
2009	$2,186,443	$756,674	$2,197,954	$544,416	$3,423,043	$325,829	$2,714,613	$2,299,709	$5,972,323	$449,785	$101,429	$2,085,728	$23,057,945
2010	$1,976,050	$683,862	$1,986,453	$492,029	$3,093,656	$294,475	$2,453,396	$2,078,416	$5,397,629	$406,504	$91,669	$1,885,027	$20,839,165
2011	$2,149,697	$743,957	$2,161,014	$535,266	$3,365,514	$320,353	$2,668,989	$2,261,059	$5,871,949	$442,226	$99,724	$2,050,675	$22,670,422
2012	$2,698,388	$933,845	$2,712,593	$671,888	$4,224,532	$402,120	$3,350,226	$2,838,174	$7,370,713	$555,100	$125,178	$2,574,091	$28,456,849
2013	$3,387,128	$1,172,201	$3,404,959	$843,382	$5,302,807	$504,757	$4,205,342	$3,562,593	$9,252,023	$696,785	$157,128	$3,231,106	$35,720,210
2014	$4,251,663	$1,471,395	$4,274,045	$1,058,647	$6,656,302	$633,592	$5,278,718	$4,471,914	$11,613,521	$874,633	$197,234	$4,055,817	$44,837,481
2015	$5,336,863	$1,846,955	$5,364,958	$1,328,858	$8,355,264	$795,311	$6,626,065	$5,613,331	$14,577,771	$1,097,875	$247,576	$5,091,029	$56,281,856
2016	$5,895,164	$2,040,169	$5,926,199	$1,467,873	$9,229,328	$878,511	$7,319,233	$6,200,554	$16,102,785	$1,212,726	$273,476	$5,623,613	$62,169,631
2017	$6,565,688	$2,272,221	$6,600,252	$1,634,830	$10,279,084	$978,434	$8,151,732	$6,905,814	$17,934,337	$1,350,664	$304,581	$6,263,251	$69,240,887
2018	$5,933,896	$2,053,574	$5,965,134	$1,477,517	$9,289,966	$884,283	$7,367,321	$6,241,293	$16,208,582	$1,220,694	$275,273	$5,660,561	$62,578,092
2019	$5,482,075	$1,897,209	$5,510,935	$1,365,015	$8,582,605	$816,951	$6,806,355	$5,766,065	$14,974,421	$1,127,748	$254,313	$5,229,552	$57,813,244
2020	$5,651,863	$1,955,969	$5,681,616	$1,407,291	$8,848,421	$842,253	$7,017,158	$5,944,649	$15,438,201	$1,162,676	$262,189	$5,391,519	$59,603,806
SUM	$55,851,389	$19,328,773	$56,145,411	$13,906,775	$87,439,595	$8,323,100	$69,343,158	$58,744,685	$152,559,430	$11,489,495	$2,590,937	$53,278,688	$589,001,436

Year	Food	Paper	Chemicals	Petroleum Refining	Rubber & Plastics	Stone, Glass, Clay	Primary Metals	Metals Fabrication	Other Mfg.	Agriculture	Mining	Construction	Annual Electricity Consumer Net Savings
	Industrial Annual Net Consumer Savings from Electricity Energy Efficiency Measures (2003)												
	20	20	20	20	20	20	20	20	20	20	20	20	
	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	
2000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2001	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2002	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2003	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2004	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2005	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2006	$204,470	$70,762	$205,547	$50,912	$320,114	$30,471	$253,863	$215,062	$558,515	$42,063	$9,485	$195,052	$2,156,316
2007	$409,798	$141,821	$411,955	$102,038	$641,570	$61,069	$508,791	$431,027	$1,119,373	$84,302	$19,010	$390,921	$4,321,674
2008	$615,986	$213,177	$619,229	$153,378	$964,373	$91,796	$764,787	$647,896	$1,682,581	$126,718	$28,576	$587,612	$6,496,110
2009	$926,566	$320,661	$931,444	$230,711	$1,450,609	$138,079	$1,150,392	$974,565	$2,530,937	$190,609	$42,983	$883,885	$9,771,442
2010	$1,207,259	$417,802	$1,213,615	$300,603	$1,890,056	$179,909	$1,498,892	$1,269,800	$3,297,659	$248,352	$56,005	$1,151,649	$12,731,600
2011	$1,512,619	$523,480	$1,520,582	$376,636	$2,368,120	$225,414	$1,878,016	$1,590,978	$4,131,756	$311,169	$70,170	$1,442,943	$15,951,885
2012	$1,895,919	$656,130	$1,905,900	$472,076	$2,968,206	$282,534	$2,353,908	$1,994,135	$5,178,750	$390,020	$87,951	$1,808,587	$19,994,119
2013	$2,377,054	$822,639	$2,389,567	$591,877	$3,721,458	$354,234	$2,951,268	$2,500,193	$6,492,980	$488,997	$110,271	$2,267,559	$25,068,097
2014	$2,980,993	$1,031,647	$2,996,686	$742,256	$4,666,972	$444,234	$3,701,098	$3,135,419	$8,142,656	$613,236	$138,288	$2,843,679	$31,437,165
2015	$3,739,083	$1,294,003	$3,758,767	$931,017	$5,853,819	$557,207	$4,642,317	$3,932,781	$10,213,397	$769,187	$173,455	$3,566,848	$39,431,881
2016	$4,576,478	$1,583,805	$4,600,571	$1,139,525	$7,164,825	$681,997	$5,681,998	$4,813,556	$12,500,763	$941,452	$212,302	$4,365,671	$48,262,943
2017	$5,509,120	$1,906,569	$5,538,122	$1,371,749	$8,624,947	$820,982	$6,839,934	$5,794,512	$15,048,296	$1,133,311	$255,567	$5,255,352	$58,098,462
2018	$6,352,017	$2,198,275	$6,385,457	$1,581,627	$9,944,566	$946,592	$7,886,446	$6,681,074	$17,350,691	$1,306,708	$294,669	$6,059,422	$66,987,545
2019	$7,130,734	$2,467,769	$7,168,273	$1,775,525	$11,163,707	$1,062,638	$8,853,274	$7,500,131	$19,477,775	$1,466,902	$330,794	$6,802,269	$75,199,791
2020	$7,933,569	$2,745,611	$7,975,334	$1,975,427	$12,420,606	$1,182,278	$9,850,046	$8,344,556	$21,670,738	$1,632,058	$368,037	$7,568,123	$83,666,383
2021	$7,933,569	$2,745,611	$7,975,334	$1,975,427	$12,420,606	$1,182,278	$9,850,046	$8,344,556	$21,670,738	$1,632,058	$368,037	$7,568,123	$83,666,383
2022	$7,933,569	$2,745,611	$7,975,334	$1,975,427	$12,420,606	$1,182,278	$9,850,046	$8,344,556	$21,670,738	$1,632,058	$368,037	$7,568,123	$83,666,383
2023	$7,933,569	$2,745,611	$7,975,334	$1,975,427	$12,420,606	$1,182,278	$9,850,046	$8,344,556	$21,670,738	$1,632,058	$368,037	$7,568,123	$83,666,383
2024	$7,933,569	$2,745,611	$7,975,334	$1,975,427	$12,420,606	$1,182,278	$9,850,046	$8,344,556	$21,670,738	$1,632,058	$368,037	$7,568,123	$83,666,383
2025	$7,933,569	$2,745,611	$7,975,334	$1,975,427	$12,420,606	$1,182,278	$9,850,046	$8,344,556	$21,670,738	$1,632,058	$368,037	$7,568,123	$83,666,383
2026	$7,729,099	$2,674,849	$7,769,788	$1,924,515	$12,100,492	$1,151,808	$9,596,183	$8,129,493	$21,112,223	$1,589,995	$358,552	$7,373,071	$81,510,067

Year	Food	Paper	Chemicals	Petroleum Refining	Rubber & Plastics	Stone, Glass, Clay	Primary Metals	Metals Fabrication	Other Mfg.	Agriculture	Mining	Construction	Annual Electricity Consumer Net Savings
	Industrial Annual Net Consumer Savings from Electricity Energy Efficiency Measures (2003)												
	20	20	20	20	20	20	20	20	20	20	20	20	
	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	
2027	$7,523,772	$2,603,790	$7,563,379	$1,873,389	$11,779,036	$1,121,209	$9,341,255	$7,913,529	$20,551,365	$1,547,756	$349,027	$7,177,201	$79,344,710
2028	$7,317,583	$2,532,433	$7,356,105	$1,822,049	$11,456,233	$1,090,483	$9,085,259	$7,696,659	$19,988,156	$1,505,340	$339,462	$6,980,511	$77,170,273
2029	$7,007,003	$2,424,949	$7,043,891	$1,744,716	$10,969,997	$1,044,199	$8,699,654	$7,369,991	$19,139,801	$1,441,449	$325,054	$6,684,238	$73,894,941
2030	$6,726,310	$2,327,808	$6,761,720	$1,674,825	$10,530,549	$1,002,370	$8,351,154	$7,074,756	$18,373,079	$1,383,706	$312,032	$6,416,474	$70,934,783
2031	$6,420,950	$2,222,131	$6,454,752	$1,598,791	$10,052,485	$956,864	$7,972,030	$6,753,578	$17,538,982	$1,320,889	$297,867	$6,125,180	$67,714,498
2032	$6,037,650	$2,089,480	$6,069,434	$1,503,351	$9,452,400	$899,744	$7,496,138	$6,350,421	$16,491,988	$1,242,038	$280,086	$5,759,536	$63,672,264
2033	$5,556,516	$1,922,972	$5,585,767	$1,383,550	$8,699,148	$828,044	$6,898,778	$5,844,362	$15,177,758	$1,143,061	$257,766	$5,300,564	$58,598,286
2034	$4,952,576	$1,713,963	$4,978,648	$1,233,172	$7,753,634	$738,044	$6,148,948	$5,209,137	$13,528,082	$1,018,821	$229,749	$4,724,444	$52,229,218
2035	$4,194,486	$1,451,607	$4,216,567	$1,044,410	$6,566,787	$625,072	$5,207,729	$4,411,775	$11,457,341	$862,871	$194,582	$4,001,274	$44,234,502
2036	$3,357,091	$1,161,805	$3,374,764	$835,902	$5,255,781	$500,281	$4,168,048	$3,531,000	$9,169,975	$690,606	$155,735	$3,202,452	$35,403,440
2037	$2,424,449	$839,041	$2,437,212	$603,678	$3,795,659	$361,297	$3,010,112	$2,550,044	$6,622,441	$498,747	$112,470	$2,312,771	$25,567,922
2038	$1,581,552	$547,336	$1,589,878	$393,800	$2,476,040	$235,686	$1,963,600	$1,663,482	$4,320,047	$325,350	$73,368	$1,508,700	$16,678,839
2039	$802,835	$277,841	$807,061	$199,903	$1,256,899	$119,640	$996,772	$844,425	$2,192,963	$165,156	$37,243	$765,854	$8,466,592
2040	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
SUM	$158,671,386	$54,912,211	$159,506,690	$39,508,547	$248,412,117	$23,645,567	$197,000,920	$166,891,115	$433,414,758	$32,641,159	$7,360,740	$151,362,452	$1,673,327,661

Annual Net Consumer Savings = (Annual Electricity Savings in kWh/year) X (Retail Cost of Industrial Electricity per kWh – Cost of Conserved Energy per kWh).

The Cost of Conserved Electricity includes the annualized investment cost and O&M cost over the service life of the energy efficiency measures.

APPENDIX D: EMISSIONS REDUCTIONS ANALYSIS BY INDIVIDUAL MEASURE

The graphs below compare the expected emission savings associated with each measure individually (investments in renewable energy resources, energy efficiency, natural gas fired CHP, and IGCC) against emissions reductions required under CAIR. The emissions savings for each measure are calculated against the business as usual scenario (i.e. mainly western coal fired technologies). As an example Figure D-1 below shows that in year 2020 emissions reductions achieved from implementing a renewable portfolio standard while retiring an equivalent amount of western coal fired generating capacity could provide a 41% SOx reduction from the 2002 base year emissions budget while CAIR would require a 62% reduction from the 2002 base year budget.

Figure D-1: SOx Emissions Reductions by Individual Measure

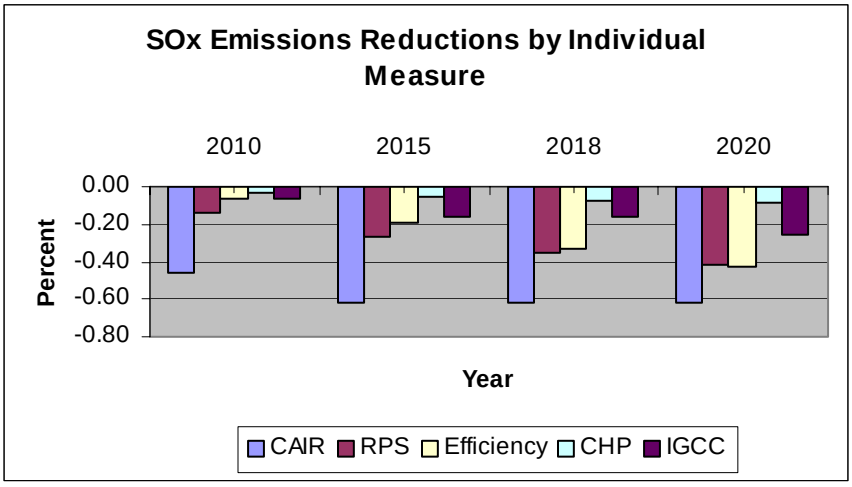


Figure D-2: NOx Emissions Reductions by Individual Measure

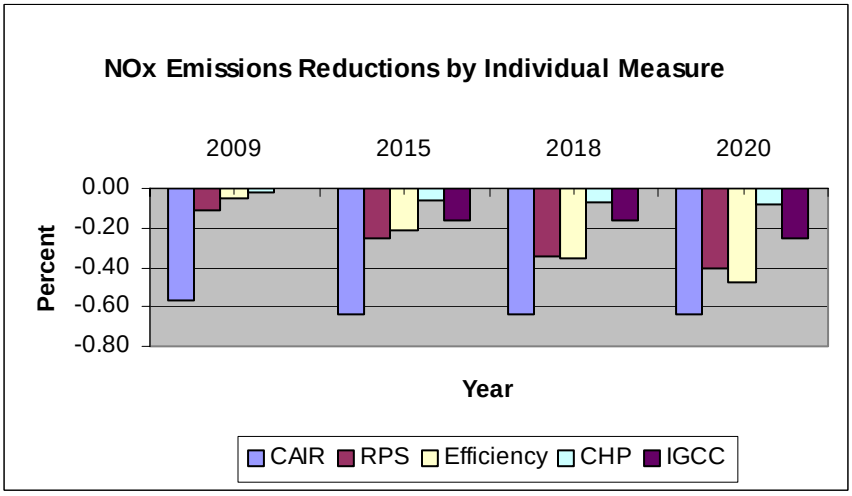
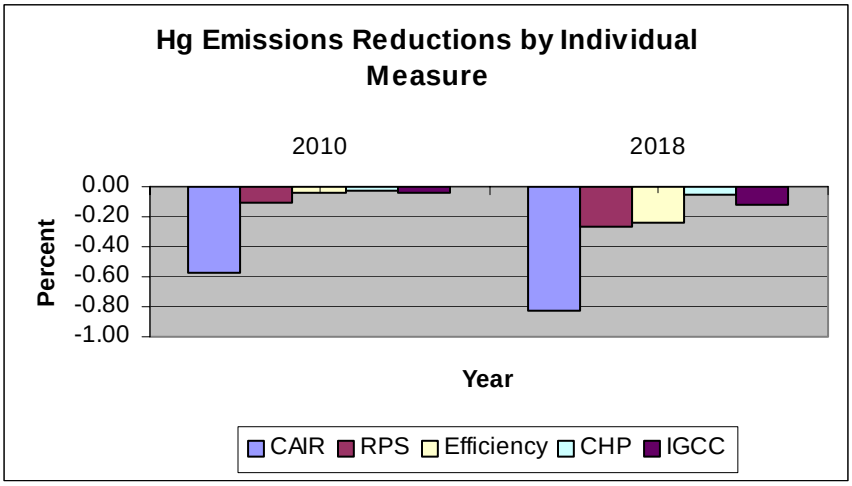


Figure D-3: Hg Emissions Reductions by Individual Measure



APPENDIX E: THE ILLINOIS REGIONAL ECONOMETRIC INPUT-OUTPUT MODEL

General Structure

The Regional Econometric Input-output Model generates forecasts of the regional economy on an annual basis, with the forecast horizon extending up to 25 years. The model is comprised of two major components, an input-output module and an econometric module. Figure E-1 summarizes the main features of the model. It is a system of linear equations formulated to predict the behavior of 151 endogenous variables, and consists of 123 behavioral equations, 28 accounting identities, and 68 exogenous variables. The model identifies 53 industries and three government sectors. For each industry (see table E-1 for sector definitions), there are projections of output, employment, and earnings.

Among the other variables depicted by the model are Gross State Product, personal consumption expenditures, investment, state and local government expenditures, exports, labor force, unemployment rate, personal income, net migration, population, and the consumer price index.

The Input-Output Module

This module was constructed from establishment-level data obtained from the U.S. Bureau of the Census. Three models have been developed, based on 1982, 1987, 1992 and 1997 data. The earlier two models were developed at the 36-sector level, while the ones for 1992 and 1997 contained 53 sectors

Since survey-based systems are prohibitively expensive, researchers developing regional input-output models have relied on a variety of adjustments of national level data. There are many problems with this approach; first, the latest available benchmark national table is for 1997. While updates have been made annually, the reliability of these updates is not known. Secondly, the adjustment process in developing regional from national tables relies on a large number of assumptions; the most critical being the one that assumes that the technology at the regional and national levels is identical. Since there has been little survey work done to test this assumption, it often reverts to an assertion. Preliminary analysis with the Census data suggests that differences between national and regional technologies may be significant.

REAL's approach to table construction avoids many of these problems, since survey data is used to build the manufacturing portions of the tables. Since the data has already been collected by the Bureau of the Census, the tables are constructed at a fraction of the time and expense usually associated with survey-based methods. Once constructed, the input-output table reveals the linkages that exist between the sectors in the region. For instance, fifty-three sectors were identified for the Illinois regional model - essentially, the two-digit SIC manufacturing sectors and somewhat more aggregated sectors for non-manufacturing.

Table E-1 describes the sectoring scheme used. While data are available at the individual establishment level, Federal Disclosure Rules preclude the publication of data that would reveal the transactions of individual firms or would enable reasonable estimation from information presented.

In addition to the transactions between sectors, the table also records the purchases made from labor (wages and salaries), capital (profits and undistributed dividends) and imports from outside the state. Complementing the sales made to other sectors are sales to households (consumers), government, investment and exports outside of the model's region. With this table one has, in essence, an economic photograph of the state in question, captured at one point in time. Adding the econometric component enables the analyst to extend this photograph back in time to test the reliability of the system in tracking the changes that have been observed in the economy (this process is known as backcasting) and to redevelop this photograph each year for the next twenty to twenty-five years producing the annual forecasts.

Solving the Model

The model is solved in a number of ways; in this example, assume that US exports increase as a result of a stimulus generated by increased demand in Eastern Europe or the Former Soviet Union. In Stage I, the model first allocates a share of these exports to the region and these provide the first stimulus to an increase in local production. In figure E-1, the stimulus would be shown as entering the system through the US economy model (in this case DRI's model) to generate an increase in the region's exports.

In Stage II, production of local exports generates a set of internal demands - i.e., the regional interindustry demands. The individual output equations capture these internal demands using the input-output relationships. Unlike many other models that use national input-output coefficients, the model uses region-specific input-output transactions. In addition, input-output coefficients are adjusted for changing supply-demand relationships, thus creating the possibilities for changes in interindustry dependencies on an annual basis. This equilibrium adjustment process - that includes a complex system of interacting equations - avoids one of the major criticisms of the input-output models, namely their static nature.

In Stage III, forecasts of output (obtained using national data and exports) are combined with forecasts of labor productivity and wage rates to predict employment and earnings by industry. These projections are further combined with projections of the labor force participation rate and the unemployment rate to obtain population forecasts. Meanwhile, total earnings are obtained by predictions of property income, transfer payments, residence adjustments and personal contributions to social insurance.

Total earnings are then combined with population forecasts to obtain estimates of personal income in Stage IV. This completes the path of the first set of demands - those originating initially outside the system. Personal income and population now expand internal demands, the final demand sectors, comprised of consumption, investment, and government (Stage V). Very briefly, four types of consumption expenditures and three types of investment expenditures are considered, along with one type of state and local government expenditure.

Until now, the entire stimulus to the region's economy has come from external demand (in this case, exports). Tracing through the effects, one arrived at increases in personal income, the expenditures of these increases in personal income give rise to the second set of demands that drive the model. These are the internal demands and, in some cases, these can account for the more significant part of the total changes in the regional economy.

In the final stage, Stage VI, the model is brought to closure as the above final demands feed into the input-output sectors. This time, though, the output increases that result come not in response to exports but in response to increased internal demand for goods and services, both public and private. This increased demand works its way through the input-output module in exactly the same way as the export stimulus did - resulting in another chain of increases in output, employment, earnings, population, income, and again, final demand. This is a slice of the ripple or multiplier effect; it will continue to work its way through the system but each time around the impact will become smaller and smaller until the effects are negligible. The model mimics this process through a series of iterations until convergence is obtained for each year the model is run. Several alternative stimuli can be handled - a change in federal government expenditures, location of new firms or closure of existing ones, as well as the effects of increased or decreased exports. One of the major advantages of the model is its ability to track impacts throughout the economy and through time. Thus, the effects of a one-shot change can be calculated in comparison to a change that was made permanent. This distinction is very important in differentiating between the construction and operating phases of a major project.

Figure E-1: Structure of the Macro Model

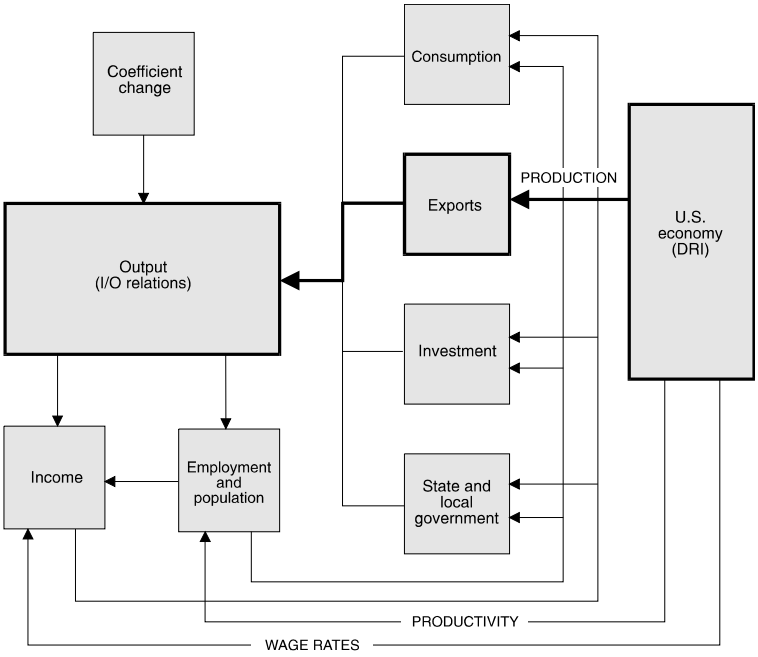


Table E-1: Sectoring Scheme in the Regional Model

	Title	SIC
1	Livestock, Livestock Products, and Agricultural Products	01, 02
2	Agriculture, Forestry, and Fisheries	07, 08, 09
3	Mining	10, 12, 13, 14
4	Construction	15, 16, 17
5	Food and Kindred Products	20
6	Tobacco	21
7	Apparel and Textile Products	22, 23
8	Lumber and Wood Products	24
9	Furniture and Fixtures	25
10	Printing and Publishing	27
12	Chemicals and Allied Products	28
13	Petroleum and Coal Products	29
14	Rubber and Misc. Plastics Products	30
15	Leather and Leather Products	31
16	Stone, Clay, and Glass Products	32
17	Primary Metals Industries	33
18	Fabricated Metal Products	34
19	Industrial Machinery and Equipment	35
20	Electronic and Electric Equipment	36
21	Transportation Equipment	37
22	Instruments and Related Products	38
23	Miscellaneous Manufacturing Industries	39
24	Railroad Transportation and Transportation	40, 47
25	Local and Interurban Passenger Transit	41
26	Trucking and Warehousing	42
27	Water Transportation	44
28	Transportation by Air	45
29	Pipelines, Except Natural Gas	46
30	Communications	48
31	Electric, Gas, and Sanitary Services	49
32	Wholesale Trade	50, 51
33	Retail Trade	52-57, 59
34	Banking and Other Credit Agencies	60, 61, 67
35	Security and Commodity Brokers	68
36	Insurance Carriers	63
37	Insurance Agents, Brokers, and Service	64
38	Real Estate	65
39	Eating and Drinking Places	58
40	Hotels and Other Lodging Places	70
41	Personal Services	72
42	Business, Engineering, and Management Services	73, 87, 89
43	Auto Repair, Services, and Parking	75
44	Miscellaneous Repair Services	76
45	Motion Pictures	78
46	Amusement and Recreation Services	79
47	Health Services	80
48	Legal Services	81
49	Educational Services	82
50	Social Services	83
51	Membership Organizations and Households	84, 86, 88
52	Federal Government Enterprises	
53	State and Local Government Enterprises	

APPENDIX F: ECONOMIC IMPACTS - DETAILED RESULTS

Units for all tables are: $ million for output and income; Thousands persons for employment.

Table F-1: Direct Impact by residential investment and savings

Output

Residential Annual Investment in Electric Energy Efficiency Measures	2010	2012	2015	2020
Space Heating	3.41	4.74	9.61	12.35
Space Cooling	6.57	9.12	18.51	23.78
Water Heating	9.61	13.35	27.08	44.41
Refrigerator	7.75	10.76	21.84	28.05
Range	4.05	5.63	11.41	18.72
Freezers	4.23	5.87	11.91	15.30
Clothes Drying	5.40	7.50	15.22	24.95
Lighting	7.41	11.76	23.66	51.77
Other	52.67	73.15	148.39	243.30
Total	**101.11**	**141.89**	**287.63**	**462.63**

Residential Annual Net Consumer Savings from Electric Energy Efficiency Measures	2010	2012	2015	2020
Space Heating	6.11	9.70	19.50	42.68
Space Cooling	11.76	18.66	37.55	82.15
Water Heating	19.13	30.35	61.06	133.61
Refrigerator	10.48	16.63	33.46	73.20
Range	6.15	9.76	19.64	42.97
Freezers	5.72	9.07	18.25	39.93
Clothes Drying	8.20	13.02	26.18	57.29
Lighting	35.91	56.98	114.62	250.79
Other	79.98	126.91	255.29	558.58
Total	**183.45**	**291.08**	**585.55**	**1281.19**

Employment

Residential Annual Investment in Electric Energy Efficiency Measures	2010	2012	2015	2020
Space Heating	0.01	0.02	0.03	0.04
Space Cooling	0.02	0.03	0.06	0.07
Water Heating	0.04	0.05	0.09	0.13
Refrigerator	0.03	0.04	0.07	0.08
Range	0.02	0.02	0.04	0.05
Freezers	0.02	0.02	0.04	0.04
Clothes Drying	0.02	0.03	0.05	0.07
Lighting	0.03	0.04	0.08	0.15
Other	0.20	0.26	0.49	0.71
Total	**0.38**	**0.51**	**0.95**	**1.35**

Residential Annual Net Consumer Savings from Electric Energy Efficiency Measures	2010	2012	2015	2020
Space Heating	0.06	0.09	0.17	0.37
Space Cooling	0.11	0.17	0.33	0.71
Water Heating	0.16	0.26	0.51	1.08
Refrigerator	0.09	0.14	0.28	0.59
Range	0.05	0.07	0.14	0.30
Freezers	0.05	0.08	0.15	0.32
Clothes Drying	0.06	0.09	0.19	0.40

Residential Annual Net Consumer Savings from Electric Energy Efficiency Measures	2010	2012	2015	2020
Lighting	0.34	0.54	1.06	2.26
Other	0.59	0.92	1.83	3.90
Total	**1.50**	**2.36**	**4.66**	**9.94**

Figure F-1: Residential Annual Investment Impact on Employment, 2020

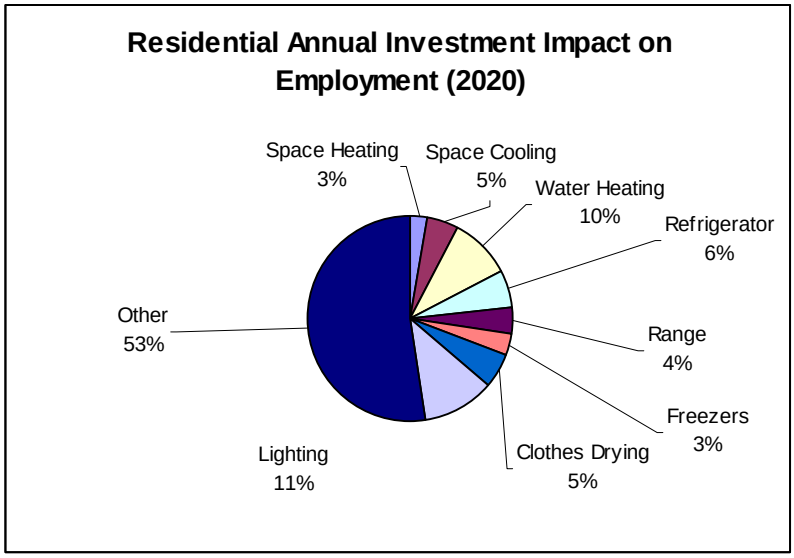
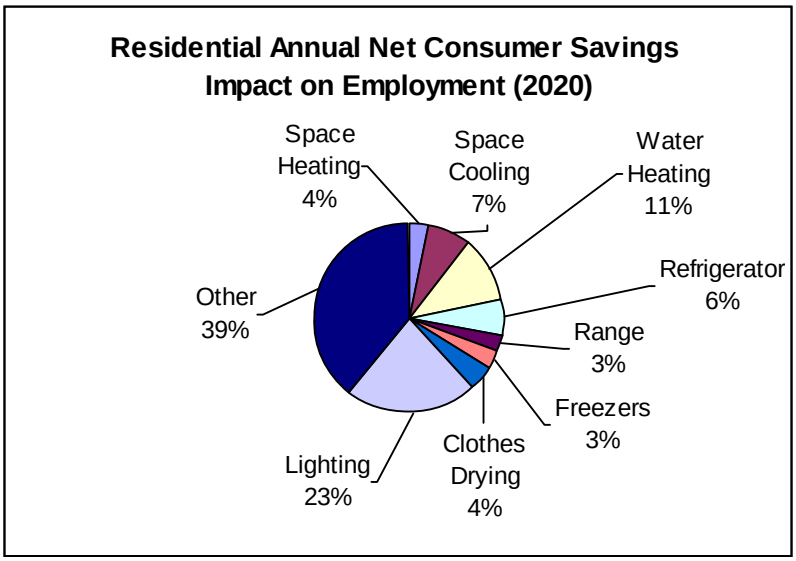


Figure F-2: Residential Annual Net Consumer Savings Impact on Employment, 2020



Income

Residential Annual Investment in Electric Energy Efficiency Measures	2010	2012	2015	2020
Space Heating	0.61	0.83	1.61	1.92
Space Cooling	1.18	1.59	3.09	3.70
Water Heating	1.73	2.33	4.53	6.91
Refrigerator	1.39	1.88	3.65	4.37
Range	0.73	0.98	1.91	2.91
Freezers	0.76	1.03	1.99	2.38
Clothes Drying	0.97	1.31	2.54	3.88
Lighting	1.33	2.05	3.96	8.06
Other	9.46	12.77	24.81	37.88
Total	**18.17**	**24.77**	**48.09**	**72.02**

Residential Annual Net Consumer Savings from Electric Energy Efficiency Measures	2010	2012	2015	2020
Space Heating	1.58	2.47	4.86	10.29
Space Cooling	3.04	4.75	9.35	19.81
Water Heating	4.60	7.19	14.14	29.96
Refrigerator	2.52	3.94	7.75	16.41
Range	1.28	2.00	3.93	8.33
Freezers	1.37	2.15	4.23	8.95
Clothes Drying	1.71	2.66	5.25	11.11
Lighting	9.65	15.08	29.68	62.86
Other	16.62	25.98	51.15	108.32
Total	**42.37**	**66.22**	**130.35**	**276.05**

Table F-2: Direct Impact by commercial investment and savings

Output

Commercial Annual Investment in Electric Energy Efficiency Measures	2010	2012	2015	2020
Space Heating	3.00	4.22	8.75	11.66
Space Cooling	5.90	8.31	17.23	22.96
Water Heating	3.84	5.41	11.22	14.95
Refrigerator	0.88	1.24	3.16	4.38
Range	28.95	40.80	84.59	133.32
Freezers	0.31	0.43	1.12	1.97
Clothes Drying	2.55	3.59	7.45	9.93
Lighting	17.74	25.00	64.45	113.06
Other	42.33	59.65	153.80	269.80
Total	**105.48**	**148.65**	**351.79**	**582.03**

Commercial Annual Net Consumer Savings from Electric Energy Efficiency Measures	2010	2012	2015	2020
Space Heating	9.86	15.79	32.32	72.51
Space Cooling	19.41	31.08	63.62	142.75
Water Heating	12.65	20.25	41.44	92.98
Refrigerator	1.63	2.62	5.35	12.01
Range	87.04	139.36	285.24	639.98
Freezers	0.61	0.98	2.01	4.52
Clothes Drying	7.97	12.76	26.11	58.59
Lighting	35.34	56.58	115.82	259.86
Other	84.33	135.02	276.37	620.08
Total	**258.84**	**414.44**	**848.28**	**1903.27**

Employment

Commercial Annual Investment in Electric Energy Efficiency Measures	2010	2012	2015	2020
Space Heating	0.01	0.02	0.03	0.03
Space Cooling	0.02	0.03	0.06	0.07
Water Heating	0.01	0.02	0.04	0.04
Refrigerator	0.00	0.00	0.01	0.01
Range	0.11	0.15	0.28	0.39
Freezers	0.00	0.00	0.00	0.01
Clothes Drying	0.01	0.01	0.02	0.03
Lighting	0.07	0.09	0.21	0.33
Other	0.16	0.21	0.51	0.79
Total	**0.40**	**0.53**	**1.17**	**1.70**

Commercial Annual Net Consumer Savings from Electric Energy Efficiency Measures	2010	2012	2015	2020
Space Heating	0.08	0.13	0.26	0.57
Space Cooling	0.16	0.25	0.51	1.12
Water Heating	0.10	0.17	0.33	0.73
Refrigerator	0.01	0.02	0.03	0.07
Range	1.00	1.59	3.20	6.99
Freezers	0.00	0.01	0.01	0.02
Clothes Drying	0.06	0.10	0.20	0.45
Lighting	0.20	0.32	0.65	1.42
Other	0.49	0.77	1.55	3.39
Total	**2.12**	**3.35**	**6.75**	**14.77**

Figure F-3: Commercial Annual Investment Impact on Employment, 2020

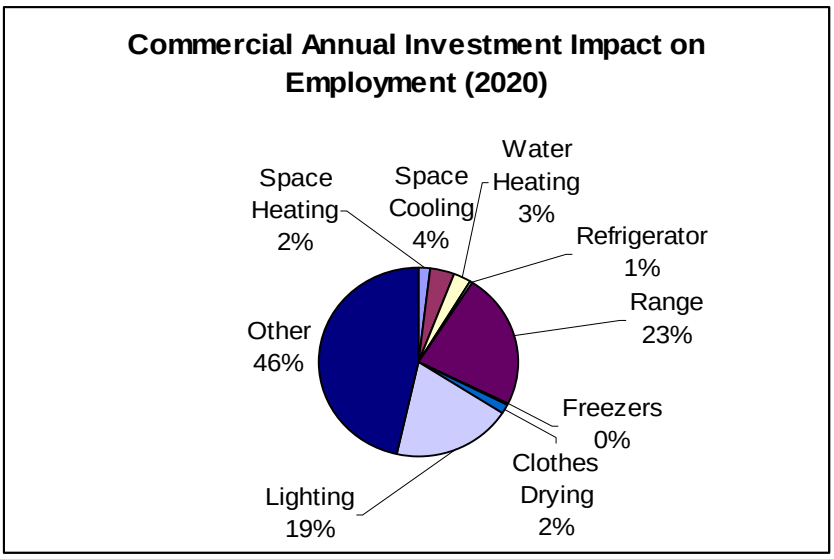
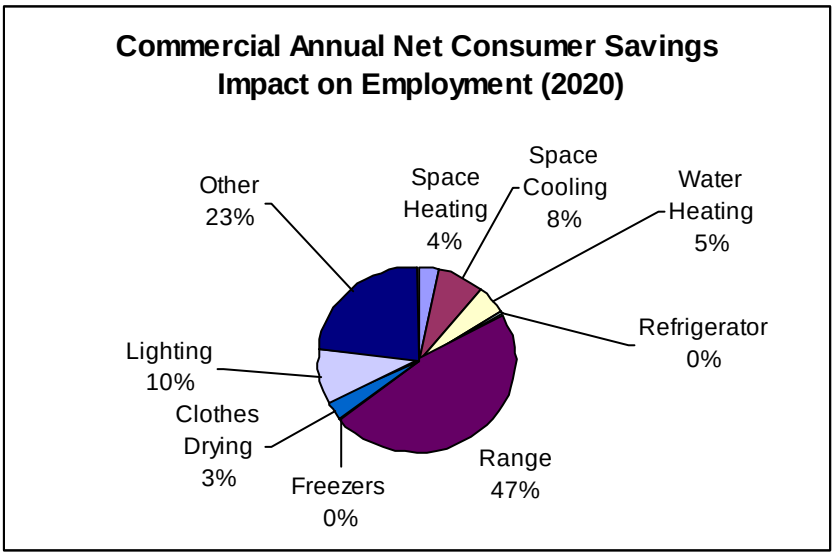


Figure F-4: Commercial Annual Net Consumer Savings Impact on Employment, 2020



Income

Commercial Annual Investment in Electric Energy Efficiency Measures	2010	2012	2015	2020
Space Heating	0.54	0.74	1.46	1.82
Space Cooling	1.06	1.45	2.88	3.57
Water Heating	0.69	0.94	1.88	2.33
Refrigerator	0.16	0.22	0.53	0.68
Range	5.20	7.12	14.14	20.76
Freezers	0.06	0.08	0.19	0.31
Clothes Drying	0.46	0.63	1.25	1.55
Lighting	3.19	4.36	10.78	17.60
Other	7.60	10.41	25.72	42.00
Total	**18.95**	**25.95**	**58.82**	**90.61**

Commercial Annual Net Consumer Savings from Electric Energy Efficiency Measures	2010	2012	2015	2020
Space Heating	2.30	3.63	7.26	15.77
Space Cooling	4.53	7.14	14.30	31.05
Water Heating	2.95	4.65	9.31	20.23
Refrigerator	0.29	0.45	0.90	1.96
Range	28.31	44.65	89.43	194.22
Freezers	0.10	0.16	0.32	0.69
Clothes Drying	1.81	2.86	5.73	12.44
Lighting	5.76	9.08	18.19	39.49
Other	13.74	21.67	43.40	94.24
Total	**59.78**	**94.28**	**188.83**	**410.09**

Table F-3: Direct Impact by Industrial investment and savings

Output

Industrial Annual Investment in Electric Energy Efficiency Measures	2010	2012	2015	2020
Food	1.98	2.70	5.34	5.65
Paper	0.68	0.93	1.85	1.96
Chemicals	1.99	2.71	5.36	5.68
Petroleum Refining	0.49	0.67	1.33	1.41
Rubber & Plastics	3.09	4.22	8.36	8.85
Stone, Glass, Clay	0.29	0.40	0.80	0.84
Primary Metals	2.45	3.35	6.63	7.02
Metals Fabrication	2.08	2.84	5.61	5.94
Other Mfg.	5.40	7.37	14.58	15.44
Agriculture	0.41	0.56	1.10	1.16
Mining	0.09	0.13	0.25	0.26
Construction	1.89	2.57	5.09	5.39
Total	**20.84**	**28.46**	**56.28**	**59.60**

Industrial Annual Net Consumer Savings from Electric Energy Efficiency Measures	2010	2012	2015	2020
Food	3.77	5.92	11.68	24.79
Paper	1.31	2.05	4.04	8.58
Chemicals	3.79	5.96	11.75	24.92
Petroleum Refining	0.94	1.48	2.91	6.17
Rubber & Plastics	5.91	9.27	18.29	38.81
Stone, Glass, Clay	0.56	0.88	1.74	3.69
Primary Metals	4.68	7.36	14.51	30.78
Metals Fabrication	3.97	6.23	12.29	26.07
Other Mfg.	10.30	16.18	31.91	67.71
Agriculture	0.78	1.22	2.40	5.10
Mining	0.17	0.27	0.54	1.15
Construction	3.60	5.65	11.15	23.65
Total	**39.78**	**62.48**	**123.21**	**261.43**

Employment

Industrial Annual Investment in Electric Energy Efficiency Measures	2010	2012	2015	2020
Food	0.00	0.01	0.01	0.01
Paper	0.00	0.00	0.01	0.01
Chemicals	0.01	0.01	0.01	0.01
Petroleum Refining	0.00	0.00	0.00	0.00
Rubber & Plastics	0.01	0.02	0.04	0.04
Stone, Glass, Clay	0.00	0.00	0.00	0.00
Primary Metals	0.01	0.01	0.02	0.02
Metals Fabrication	0.01	0.02	0.04	0.04
Other Mfg.	0.03	0.04	0.08	0.07
Agriculture	0.02	0.02	0.05	0.05
Mining	0.00	0.00	0.00	0.00
Construction	0.02	0.03	0.07	0.08
Total	**0.13**	**0.17**	**0.33**	**0.33**

Industrial Annual Net Consumer Savings from Electric Energy Efficiency Measures	2010	2012	2015	2020
Food	0.10	0.16	0.32	0.67
Paper	0.03	0.05	0.11	0.23
Chemicals	0.05	0.08	0.16	0.32
Petroleum Refining	0.02	0.03	0.05	0.11
Rubber & Plastics	0.16	0.26	0.50	1.05
Stone, Glass, Clay	0.02	0.02	0.05	0.10
Primary Metals	0.10	0.16	0.31	0.65
Metals Fabrication	0.11	0.17	0.33	0.70
Other Mfg.	0.28	0.43	0.83	1.70
Agriculture	0.05	0.07	0.14	0.31
Mining	0.01	0.01	0.03	0.07
Construction	0.12	0.18	0.37	0.83
Total	**1.04**	**1.63**	**3.19**	**6.71**

Figure F-5: Industrial Annual Investment Impact on Employment, 2020

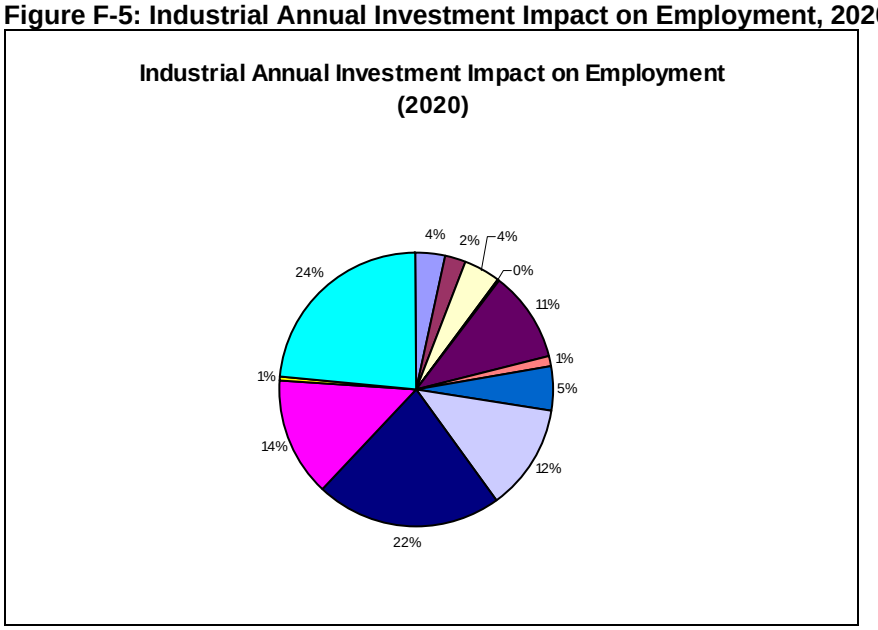
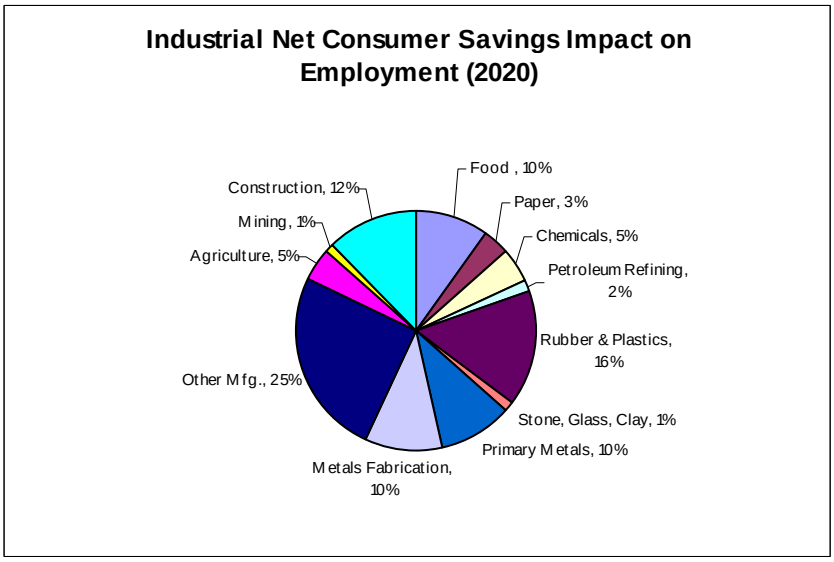


Figure F-6: Industrial Annual Net Consumer Savings Impact on Employment, 2020



Income

Industrial Annual Investment in Electric Energy Efficiency Measures	2010	2012	2015	2020
Food	0.18	0.24	0.45	0.44
Paper	0.12	0.16	0.31	0.31
Chemicals	0.39	0.53	1.03	1.07
Petroleum Refining	0.02	0.03	0.05	0.06
Rubber & Plastics	0.52	0.69	1.32	1.33
Stone, Glass, Clay	0.06	0.08	0.16	0.16
Primary Metals	0.36	0.47	0.86	0.79
Metals Fabrication	0.54	0.74	1.46	1.54
Other Mfg.	1.14	1.51	2.89	2.92
Agriculture	0.31	0.41	0.79	0.76
Mining	0.02	0.02	0.05	0.04
Construction	0.77	1.06	2.11	2.24
Total	**4.44**	**5.95**	**11.46**	**11.66**

Industrial Annual Net Consumer Savings from Electric Energy Efficiency Measures	2010	2012	2015	2020
Food	3.77	5.92	11.68	24.79
Paper	1.31	2.05	4.04	8.58
Chemicals	3.79	5.96	11.75	24.92
Petroleum Refining	0.94	1.48	2.91	6.17
Rubber & Plastics	5.91	9.27	18.29	38.81
Stone, Glass, Clay	0.56	0.88	1.74	3.69
Primary Metals	4.68	7.36	14.51	30.78
Metals Fabrication	3.97	6.23	12.29	26.07
Other Mfg.	10.30	16.18	31.91	67.71
Agriculture	0.78	1.22	2.40	5.10
Mining	0.17	0.27	0.54	1.15
Construction	3.60	5.65	11.15	23.65
Total	**39.78**	**62.48**	**123.21**	**261.43**

Table F-4: Direct Impact by Renewable Generation Investment and Savings

Output

Annual Investment-Capital Cost	2010	2012	2015	2020
Wind	372.01	374.35	445.31	504.87
Solar	0.00	0.00	0.00	48.95
Landfill	16.73	17.38	18.04	18.69
Biomass-Cofiring	26.64	27.02	26.95	8.33
Biomass-Gasification	0.00	0.00	0.00	21.81
Biomass-Manure	10.53	11.78	18.35	23.46
Total	**425.91**	**430.54**	**508.64**	**626.11**

Annual O&M Cost	2010	2012	2015	2020
Wind	16.91	22.49	32.48	51.97
Solar	0.00	0.00	0.00	1.13
Landfill	21.36	27.41	36.61	52.90
Biomass-Cofiring	32.56	44.74	63.53	74.12
Biomass-Gasification	0.00	0.00	0.00	19.24
Biomass-Manure	1.76	2.32	3.97	6.60
Total	**72.60**	**96.96**	**136.59**	**205.96**

Employment

Annual Investment-Capital Cost	2010	2012	2015	2020
Wind	1.28	1.28	1.53	1.75
Solar	0.00	0.00	0.00	0.17
Landfill	0.06	0.06	0.06	0.06
Biomass-Cofiring	0.09	0.09	0.09	0.03
Biomass-Gasification	0.00	0.00	0.00	0.08
Biomass-Manure	0.04	0.04	0.06	0.08
Total	**1.46**	**1.47**	**1.75**	**2.17**

Annual O&M Cost	2010	2012	2015	2020
Wind	0.06	0.08	0.11	0.18
Solar	0.00	0.00	0.00	0.00
Landfill	0.07	0.09	0.13	0.18
Biomass-Cofiring	0.11	0.15	0.22	0.26
Biomass-Gasification	0.00	0.00	0.00	0.07
Biomass-Manure	0.01	0.01	0.01	0.02
Total	**0.25**	**0.33**	**0.47**	**0.71**

Figure F-7: Renewable Generation Annual Investment Impact on Employment, 2020

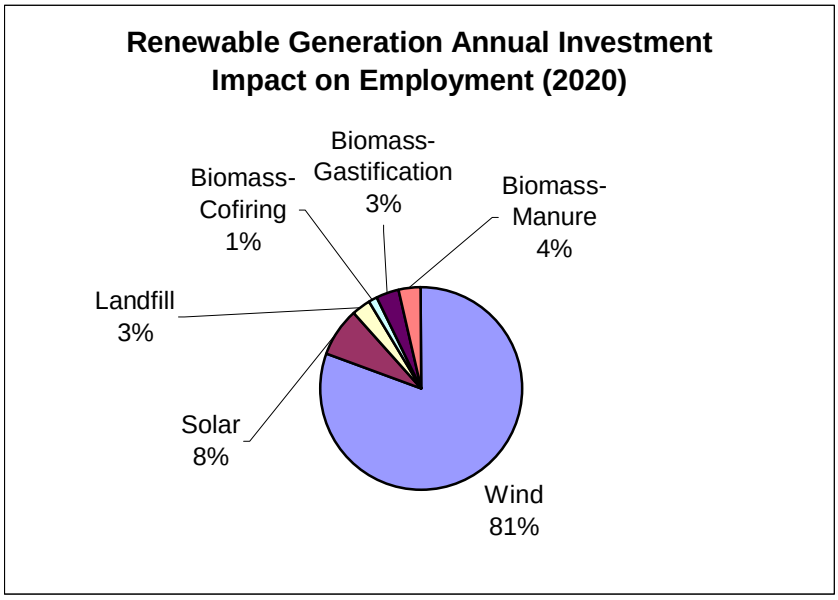
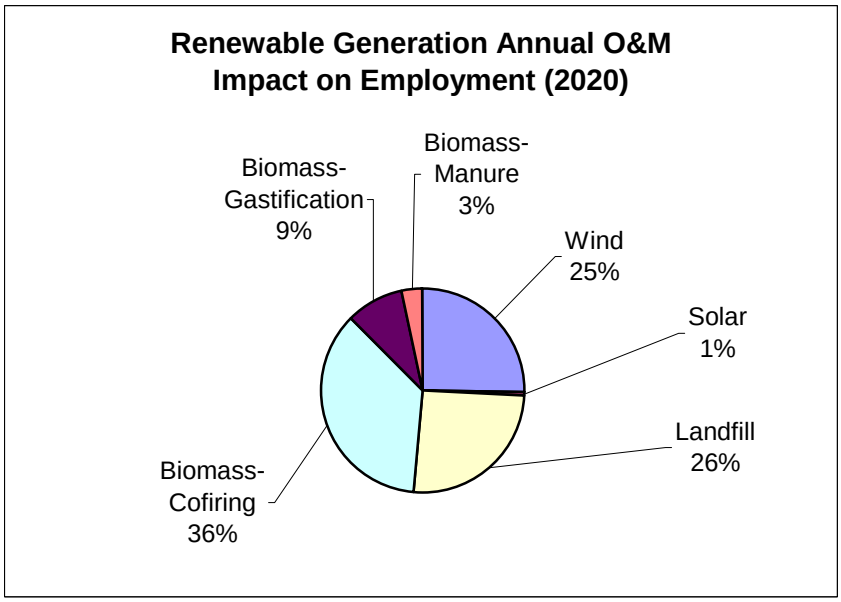


Figure F-8: Renewable Generation Annual O&M Impact on Employment, 2020



Income

Annual Investment-Capital Cost	2010	2012	2015	2020
Wind	75.16	74.30	87.03	96.30
Solar	0.00	0.00	0.00	9.34
Landfill	3.38	3.45	3.53	3.57
Biomass-Cofiring	5.38	5.36	5.27	1.59
Biomass-Gasification	0.00	0.00	0.00	4.16
Biomass-Manure	2.13	2.34	3.59	4.47
Total	**86.05**	**85.45**	**99.41**	**119.43**

Annual O&M Cost	2010	2012	2015	2020
Wind	3.42	4.46	6.35	9.91
Solar	0.00	0.00	0.00	0.21
Landfill	4.32	5.44	7.15	10.09
Biomass-Cofiring	6.58	8.88	12.42	14.14
Biomass-Gasification	0.00	0.00	0.00	3.67
Biomass-Manure	0.36	0.46	0.78	1.26
Total	**14.67**	**19.24**	**26.70**	**39.29**

Table F-5: Direct Impact by IGCC & CHP Investment and Savings

Output

IGCC Clean Coal Power Generation	2010	2012	2015	2020
Capital Cost	558.82	0.00	794.12	750.00
O&M Cost	81.25	80.10	196.28	304.58
Total	**640.07**	**80.10**	**990.39**	**1054.58**

Consumer Savings from Commercial CHP	2010	2012	2015	2020
Capital Cost	29.03	29.03	29.03	29.03
O&M Cost	76.47	106.67	151.60	225.45
Cost Savings	63.73	89.60	128.80	195.14
Consumer Savings	46.69	65.74	94.70	144.00
Total	**215.91**	**291.04**	**404.13**	**593.62**

Employment

IGCC Clean Coal Power Generation	2010	2012	2015	2020
Capital Cost	1.92	0.00	2.73	2.60
O&M Cost	0.28	0.27	0.67	1.06
Total	**2.20**	**0.27**	**3.40**	**3.66**

Consumer Savings from Commercial CHP	2010	2012	2015	2020
Capital Cost	0.10	0.10	0.10	0.10
O&M Cost	0.26	0.36	0.52	0.78
Cost Savings	0.22	0.31	0.44	0.68
Consumer Savings	0.16	0.22	0.32	0.50
Total	**0.74**	**0.99**	**1.39**	**2.06**

Figure F-9: IGCC Clean Coal Power Generation Impact on Employment, 2020

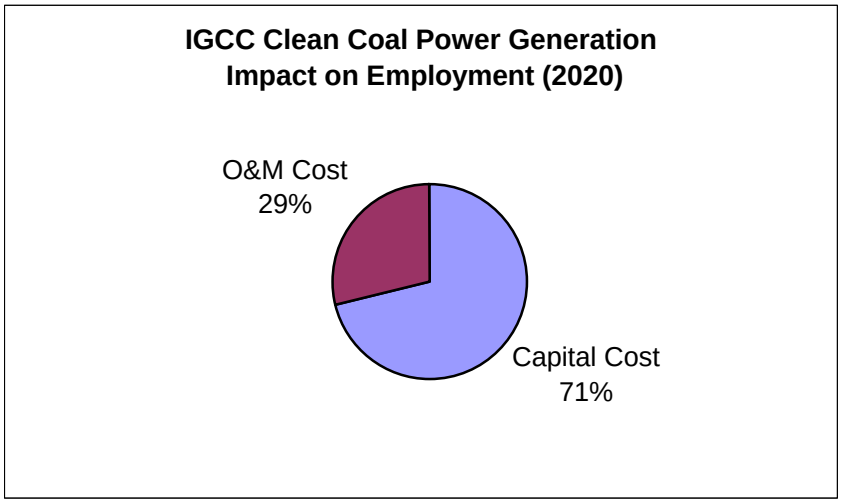
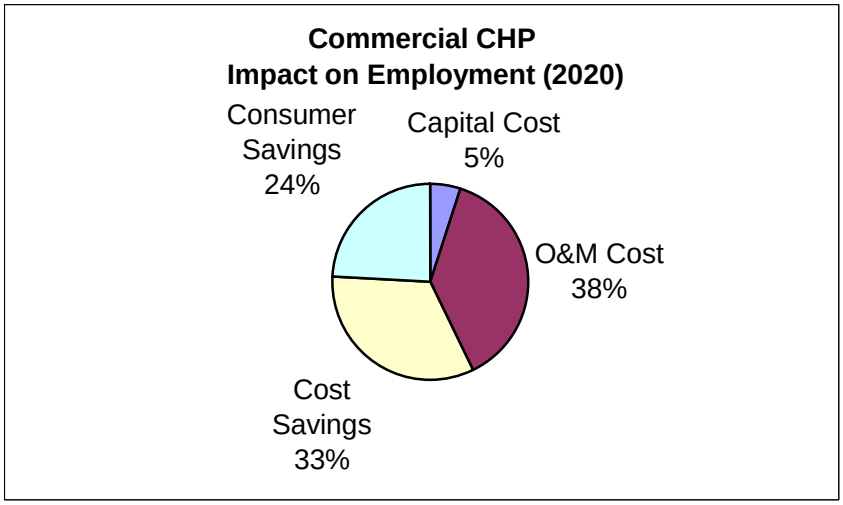


Figure F-10: Commercial CHP Impact on Employment, 2020



Income

IGCC Clean Coal Power Generation	2010	2012	2015	2020
Capital Cost	112.91	0.00	155.20	143.06
O&M Cost	16.42	15.90	38.36	58.10
Total	**129.32**	**15.90**	**193.56**	**201.15**

Consumer Savings from Commercial CHP	2010	2012	2015	2020
Capital Cost	5.86	5.76	5.67	5.54
O&M Cost	15.45	21.17	29.63	43.00
Cost Savings	12.88	17.78	25.17	37.22
Consumer Savings	9.43	13.05	18.51	27.47
Total	**43.62**	**57.76**	**78.98**	**113.23**