State of Wisconsin Public Service Commission of Wisconsin

Focus on Energy Evaluation

Benefit-cost Analysis
CY09 Evaluation Report

Final: November 24, 2009

Evaluation Contractor: PA Consulting Group

Prepared by: Miriam L. Goldberg, Bobbi Tannenbaum, Ben Jones, Betty Seto, Matt Pettit, Nicole Buccitelli, and Brian Bak; KEMA Inc.

Bryan Ward and Eric Rambo, PA Consulting Group, Inc.

focus on energy℠
The power is within you.

State of Wisconsin Public Service Commission of Wisconsin

Focus on Energy Evaluation

Benefit-cost Analysis
CY09 Evaluation Report

Final: November 24, 2009

Liaison Contact: Dr. David Sumi
PA Consulting Group
6410 Enterprise Lane, Suite 300
Madison, WI 53719
Tel: +1 608 316 3700
Fax: +1 608 661 5181
E-mail: david.sumi@paconsulting.com

Prepared by: Miriam L. Goldberg, Bobbi Tannenbaum, Ben Jones, Betty Seto, Matt Pettit, Nicole Buccitelli, and Brian Bak; KEMA Inc.

Bryan Ward and Eric Rambo, PA Consulting Group, Inc.

Acknowledgment: Ralph Prahl, Prahl & Associates, contributed critical review and analysis.

This report is the property of the state of Wisconsin, Public Service Commission of Wisconsin, and was funded through the Wisconsin Focus on Energy Program.

TABLE OF CONTENTS

1. EXECUTIVE SUMMARY

1.1 PURPOSE OF THIS REPORT

This report provides a benefit-cost analysis of the Wisconsin Focus on Energy Program (Focus). The report is based on evaluation findings from the first eight years of program operations. The objective of this study is twofold: first, to provide relevant information to Wisconsin policymakers, regulators, utilities, and other stakeholders on the savings gained from the past, current and future investments in energy efficiency and renewable energy and second to objectively evaluate the costs and benefits of investing in achieving the potential savings described in the ECW Potential Report.[1]

The mission of Focus is to develop and operate a range of sustainable energy efficiency and renewable energy programs. In partnerships with consumers, utilities, businesses, non-profit organizations and government at all levels, these programs will:

- Reduce the amount of energy used per unit of production in Wisconsin while improving energy reliability.
- Enhance economic development and make Wisconsin firms more competitive.
- Reduce the environmental impact of energy use.
- Expand the ability of markets to deliver energy efficient and renewable goods and services to consumers and businesses.
- Deliver quantified financial returns on public investments in energy improvements.

The analysis presented here focuses on the value to the state of Wisconsin of energy-efficiency and renewable energy measures implemented as a result of Focus. This value includes savings on energy bills, associated benefits of the measures not related to energy bills, mitigation of environmental externalities, and economic impact.

This report is similar in structure and intent to a previous benefit-cost analysis completed in 2007.[2] The analysis draws on prior Focus evaluation work to quantify in monetary terms the benefits and costs attributable to Focus.

1.1.1 Timeframe

Focus includes many long-term initiatives directed toward lasting changes in the state's energy-efficiency markets. As a result, any meaningful assessment of the benefits and costs of Focus must consider a multi-year timeframe. For this report, the analysis assesses Focus for the first 10 years beginning in 2001 (FY02) through FY11. The total impact of these programs is measured for an additional 15 years after funding ends (FY26). Inputs

---

[1] Energy Center of Wisconsin. *Energy Efficiency and Customer-Sited Renewable Resource Potential in Wisconsin, For the Years 2012 and 2018 – Final Report*. August 2009.

[2] Miriam Goldberg, Chris Clark, and Sander Cohan, KEMA, Inc. *Focus on Energy Statewide Evaluation, Interim Benefit-cost Analysis: FY07 Evaluation Report, Final.* February 26, 2007.

and projections used for this analysis are based on evaluation findings through December 31, 2008, budgets through 2009, with projections through 2011.

The forward-look scenario assesses a 10-year program based on the results of the ECW Potential study. The ECW study estimated potential savings for an aggressive statewide program that replaces the existing program. The forward-look b/c analysis is for the savings identified in the ECW potential study and is not a projection of current program activities into future years. The forward-look scenario includes program activity from 2012 through 2021, with analysis out an additional 15 years after funding ends (FY36). Inputs and projections used for this analysis are based on ECW estimated energy savings and program costs and use many of the same general assumptions used for the historic scenario.

Limiting the analysis to 15 years beyond program activity allows for comparability across previous Focus on Energy benefit-cost reports. This approach understates the lifetime benefits of the program, but increases the level of certainty for the savings that are included.

1.2 APPROACH

1.2.1 Benefit-cost tests

This analysis takes a societal perspective to counting Focus benefits and costs. We completed both a simple and expanded test of cost-effectiveness. The “simple” b/c test presented here is more conservative than the expanded test. It counts as benefits only the avoided costs of well-documented direct energy savings and reasonably likely added market effects savings. These avoided costs include the value of avoided emissions for which active offset markets currently exist. The simple test is comparable to Total Resource Cost or Societal tests typically done in other states.

The “expanded” test is more liberal by including a broader range of effects. However, including this broader set of effects requires using estimates that have somewhat less empirical certainty and are not necessarily counted in other jurisdictions.

Both benefit-costs tests are reasonable and consistent with current commission policy in both their inputs and general approach. The simple test looks at the direct benefits of the program from a societal perspective. The expanded test also takes a societal perspective, but includes additional benefits that acknowledge the potential for positive externalities and positive statewide economic impacts.

Costs in both tests are program spending, excluding incentive payments, and customer incremental costs for measures attributable to the programs.

The expanded b/c test expands upon the simple test in several ways.

- Quantified non-energy benefits are included for all programs.
- Avoided emissions’ externality costs for expected future emissions offset markets are counted as a benefit.
- Benefits are valued in terms of their net impact on the economy, as determined from the economic impact analysis. The economic impacts take into account the

ripple effects on the Wisconsin economy of energy savings and associated non-energy and emissions effects.

1.3 OVERALL SUMMARY OF HISTORIC SCENARIO

1.3.1 Focus in total

The overall historic Focus on energy program has positive net benefits for the state in both the simple and expanded tests. The overall b/c ratio for the simple test is 2.5, with net benefits approaching $2 billion. For the expanded test, the projected net present value of 10 years of program operations over a 25-year horizon is a net benefit of $8 billion. The expanded test produces net benefits four times the value of the simple b/c test.

1.3.2 Summary across portfolios

For the simple b/c analysis both the Residential and Business Program Portfolios have net benefits and positive b/c ratios (see Figure 1-1). The Renewables program has net costs in excess of program benefits, but these are minor relative to the size of the Residential and Business programs. The Business programs are the largest contributor to net benefits for the overall portfolio and also have the highest simple b/c ratio (see Table 1-1).

Figure 1-1. Simple Benefits and Costs by Portfolio, Historic 25 Year NPV ($000,000)

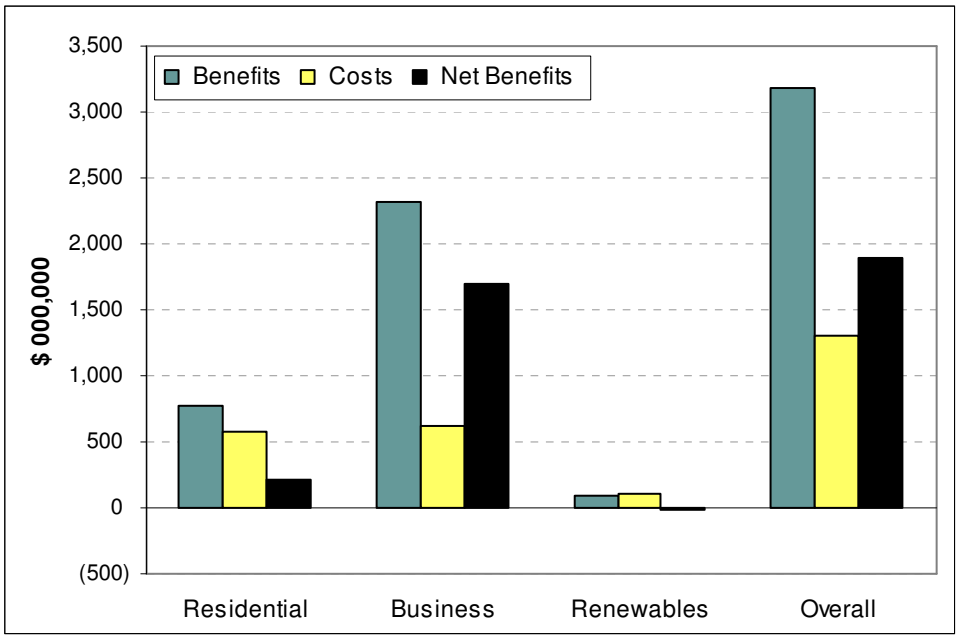


Table 1-1. Simple Benefits and Costs by Portfolio, Historic 25-Year NPV ($000,000)

Program Area	Benefits	Costs	Net Benefits	B/C Ratio
Residential	$778	$572	$206	1.4
Business	$2,320	$625	$1,695	3.7
Renewables	$92	$100	($8)	0.9
Overall	**$3,189**	**$1,297**	**$1,892**	**2.5**

For the expanded b/c test all programs have net benefits and positive b/c ratios. (See Figure 1-2.) The Business program continues to dominate net savings. The Renewables Program, however, achieves a positive b/c ratio that exceeds the b/c ratio for the residential program. (See Table 1-2).

Figure 1-2. Expanded Benefits and Costs by Portfolio, Historic 25 Year NPV ($000,000)

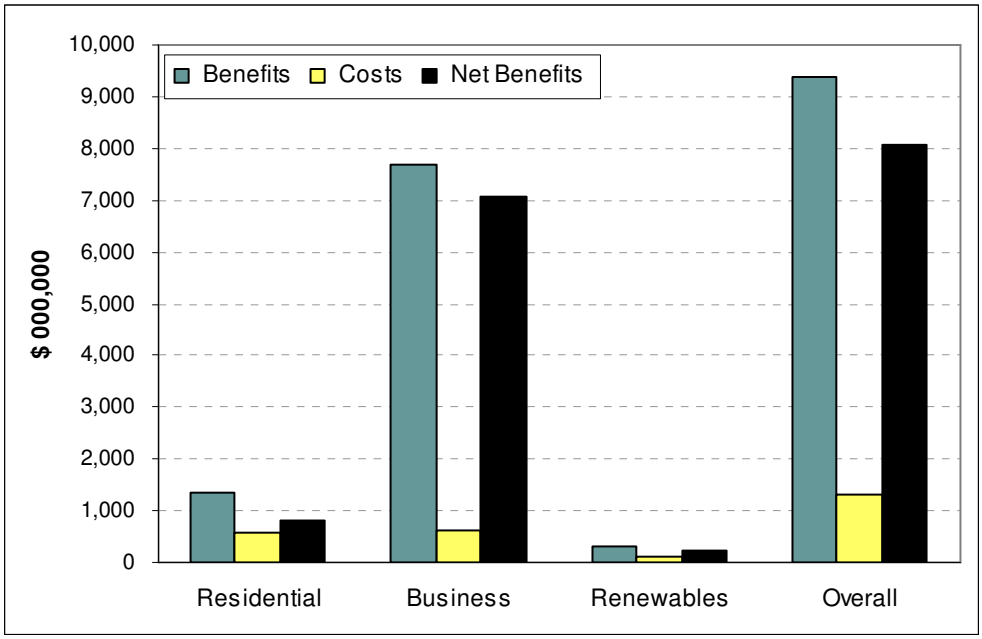


Table 1-2. Expanded Benefits and Costs by Portfolio, Historic 25 Year NPV ($000,000)

Program Area	Benefits	Costs	Net Benefits	B/C Ratio
Residential	$1,367	$572	$795	2.4
Business	$7,683	$625	$7,059	12.3
Renewables	$323	$100	$222	3.2
Overall	**$9,373**	**$1,297**	**$8,076**	**7.2**

1.3.3 Contributors to Focus benefits and costs

We show the value of each component of the benefits and costs in Figure 1-3 and list the exact values in Table 1-3. Overall, the total simple benefits are approximately one third of the expanded benefits. In other words, the expanded test results in benefits three times the value of the simple test benefits, mostly as a result of the economic impacts. Documented energy savings and economic impacts drive the benefits side of the equation. Incremental costs drive the costs.

Figure 1-3. Focus on Energy Overall Benefit Cost Components, Historic 25 Year NPV ($000,000)

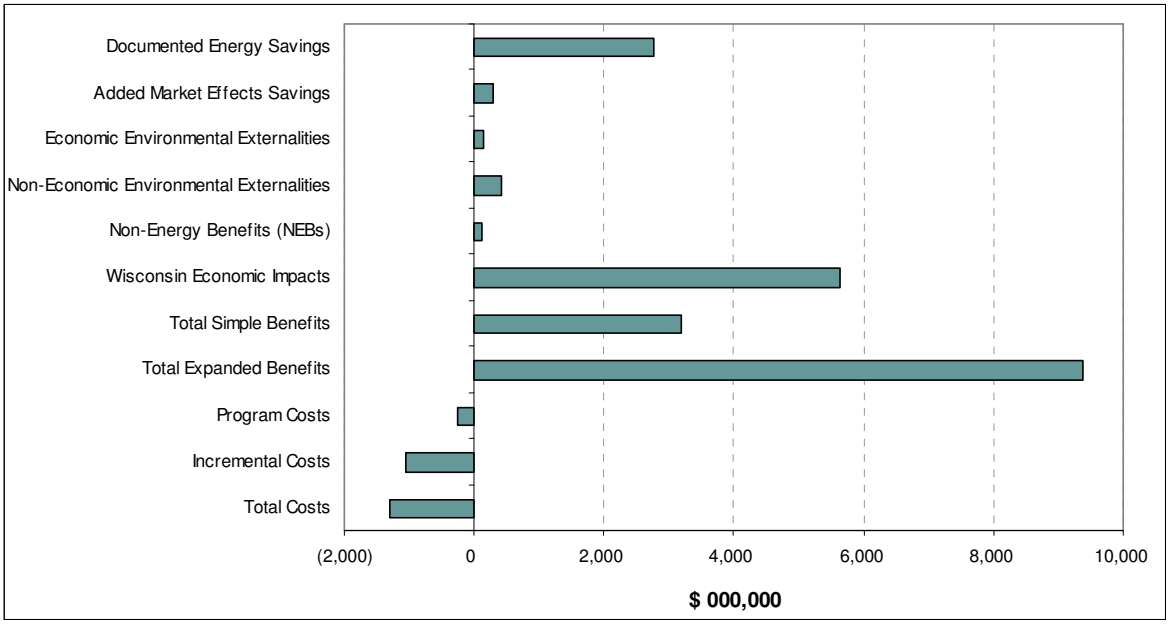


Table 1-3. Benefit Cost Components by Portfolio, Historic 25 Year NPV ($000,000)

B/C Component		Residential	Business	Renewables	Overall Focus on Energy
Simple Benefits	Documented Energy Savings	$666.5	$2,004.4	$90.0	$2,760.9
	Added Market Effects Savings	$73.1	$221.7	$0.0	$294.8
	Economic Environmental Externalities	$38.0	$93.4	$2.0	$133.5
Additional Expanded Benefits	Non-Economic Environmental Externalities	$92.3	$329.0	$10.7	$432.0
	Non-Energy Benefits (NEBs)	$75.9	$43.8	$9.9	$129.7
	Wisconsin Economic Impacts	$421.5	$4,990.7	$210.0	$5,622.2
Costs	Program Costs	$85.7	$151.0	$19.2	$255.9
	Incremental Costs	$486.3	$473.6	$81.0	$1,040.9
Total Simple Benefits		**$777.6**	**$2,319.5**	**$92.0**	**$3,189.1**
Total Expanded Benefits		**$1,367.3**	**$7,683.1**	**$322.6**	**$9,373.0**
Total Costs		**$572.0**	**$624.6**	**$100.2**	**$1,296.8**
				Net Benefits	**$8,076.2**
				B/C Ratio	**7.2**

1.4 OVERALL SUMMARY OF FORWARD-LOOK SCENARIO

1.4.1 Forward-look in total

The overall forward-look scenario has positive net benefits for the state in both the simple and expanded tests. The overall b/c ratio for this simple test is 1.9 with net benefits of $4.6 billion over the 25-year period of analysis. For the expanded test, the projected net present value of 10 years of program operations over a 25-year horizon is a net benefit of almost $28 billion. The expanded test produces net benefits almost six times the value of the simple b/c test.

1.4.2 Summary across portfolios

In the simple b/c analysis both the Residential and Business Portfolios have positive net benefits and b/c ratios greater than 1. (See Figure 1-4.) The Renewables Portfolio has costs in excess of program benefits, and approaches the Residential Portfolio in size. The Business Portfolio is the largest contributor to net benefits overall and has the highest b/c ratio of any of the Portfolios (see Table 1-4.)

Figure 1-4. Simple Benefits and Costs by Portfolio, Forward-look 25 Year NPV ($000,000)

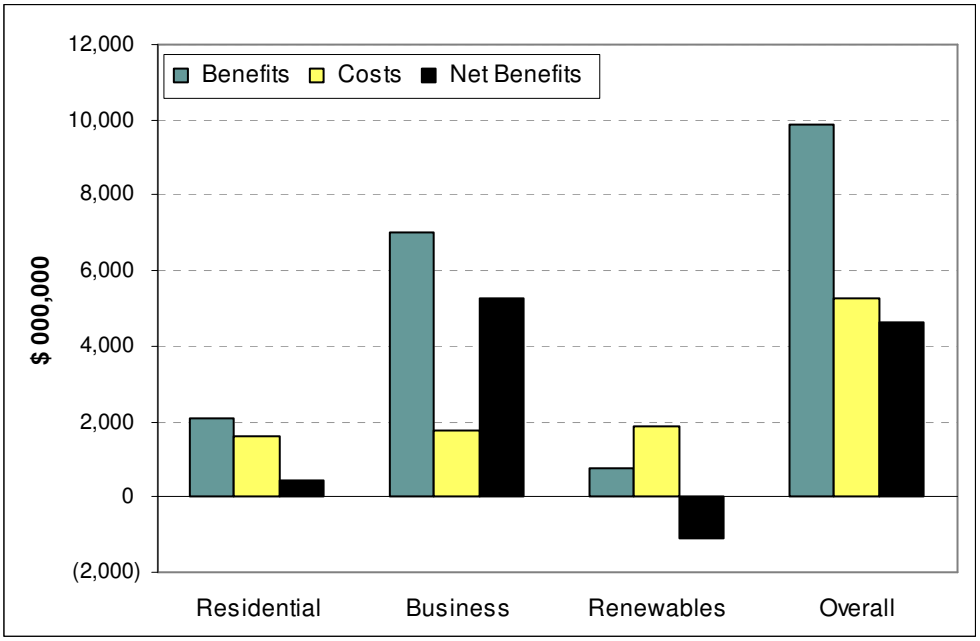


Table 1-4 Simple Benefits and Costs by Portfolio, Forward-look 25 Year NPV ($000,000)

Portfolio	Benefits	Costs	Net Benefits	B/C Ratio
Residential	$2,092	$1,626	$466	1.29
Business	$7,013	$1,772	$5,241	3.96
Renewables	$770	$1,873	($1,103)	0.41
Overall	**$9,875**	**$5,272**	**$4,604**	**1.87**

For the expanded b/c test all portfolios have net benefits and positive b/c ratios. (See Figure 1-5.) The Business portfolio continues to dominate net savings. The Renewables portfolio, achieves a positive b/c ratio. (See Table 1-5.)

Figure 1-5. Expanded Benefits and Costs by Portfolio Forward-look 25 Year NPV ($000,000)

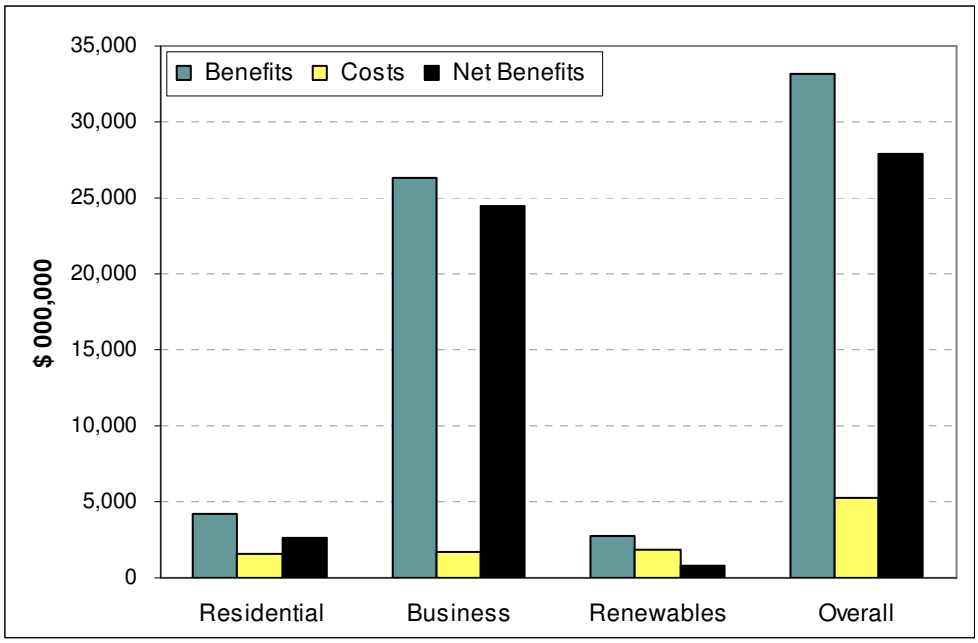


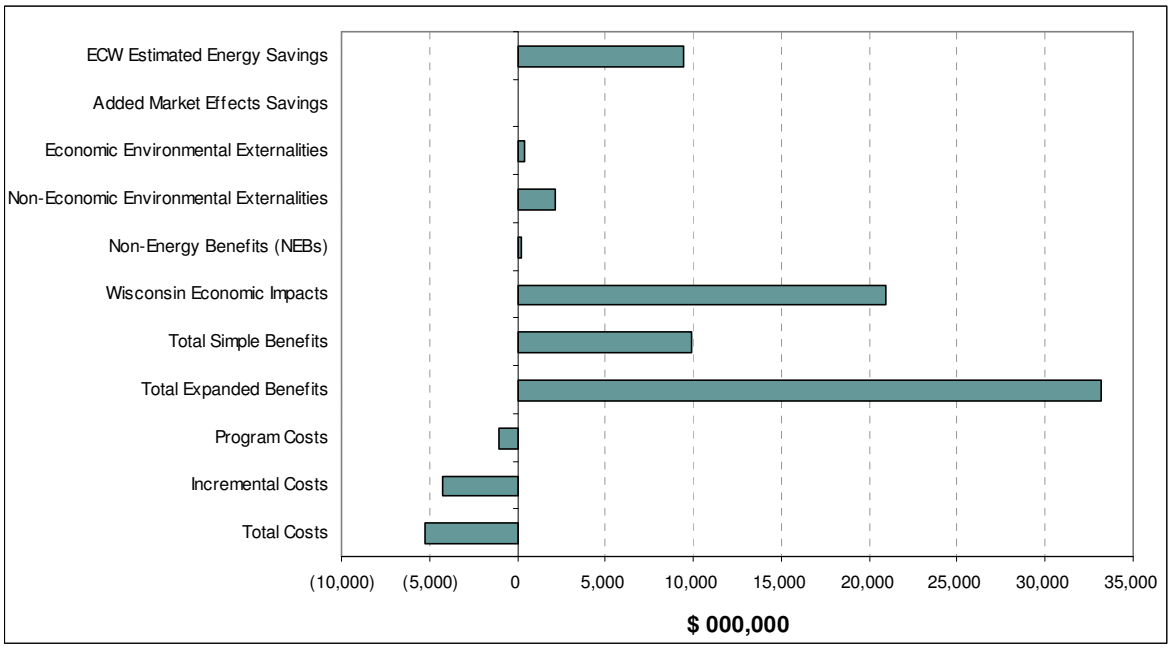
Table 1-5. Expanded Benefits and Costs by Portfolio Forward-look 25 Year NPV ($000,000)

Portfolio	Benefits	Costs	Net Benefits	B/C Ratio
Residential	$4,200	$1,626	$2,574	2.6
Business	$26,289	$1,772	$24,517	14.8
Renewables	$2,704	$1,873	$831	1.4
Overall	**$33,193**	**$5,272**	**$27,921**	**6.3**

1.4.3 Contributors to forward-look expanded test benefits and costs

We show the overall value of each component of the benefits and costs in Figure 1-6 and list a breakdown of the values by portfolio in Table 1-6. The total simple benefits are approximately 30 percent of the expanded benefits. Overall, the expanded test results in net benefits over three times the value of the simple test net benefits, largely because of the economic inputs.

Figure 1-6. Overall Benefit Cost Components, Forward-look 25 Year NPV ($000,000)



-

Table 1-6. Benefit Cost Components, by Portfolio Forward-look 25 Year NPV ($000,000)

B/C Component		Residential	Business	Renewables	Overall Focus on Energy
Simple Benefits	ECW Estimated Energy Savings	$2,003.1	$6,702.5	$733.9	$9,439.6
	Added Market Effects Savings	$0.0	$0.0	$0.0	$0.0
	Economic Environmental Externalities	$88.5	$310.7	$36.5	$435.7
Additional Expanded Benefits	Non-economic Environmental Externalities	$432.6	$1,493.9	$176.2	$2,102.7
	Non-Energy Benefits (NEBs)	$73.4	$160.5	$19.8	$253.8
	Wisconsin Economic Impacts	$1,602.0	$17,621.5	$1,737.6	$20,961.1
Costs	Program Costs	$340.1	$491.5	$184.1	$1,015.8
	Incremental Costs	$1,285.6	$1,280.9	$1,689.3	$4,255.8
	Total Simple Benefits	**$2,091.6**	**$7,013.3**	**$770.4**	**$9,875.2**
	Total Expanded Benefits	**$4,199.5**	**$26,289.2**	**$2,704.1**	**$33,192.9**
	Total Costs	**$1,625.7**	**$1,772.5**	**$1,873.4**	**$5,271.6**
				Net Benefits	**$27,921.3**
				B/C Ratio	**6.3**

2. INTRODUCTION

2.1 PURPOSE OF THIS REPORT

This report provides a benefit-cost analysis of the Wisconsin Focus on Energy Program (Focus). The report is based on evaluation findings from the first eight years of program operations. The objective of this study is twofold: first, to provide relevant information to Wisconsin policymakers, regulators, utilities, and other stakeholders on the savings gained from the past, current and future investments in energy efficiency and renewable energy and second to objectively evaluate the costs and benefits of investing in achieving the potential savings described in the ECW Potential Report.[3]

The mission of Focus is to develop and operate a range of sustainable energy efficiency and renewable energy programs. In partnerships with consumers, utilities, businesses, non-profit organizations and government at all levels, these programs will:

- Reduce the amount of energy used per unit of production in Wisconsin while improving energy reliability.
- Enhance economic development and make Wisconsin firms more competitive.
- Reduce the environmental impact of energy use.
- Expand the ability of markets to deliver energy efficient and renewable goods and services to consumers and businesses.
- Deliver quantified financial returns on public investments in energy improvements.

The analysis presented here focuses on the value to the state of Wisconsin of energy-efficiency and renewable energy measures implemented due to Focus programs. This value includes savings on energy bills, associated benefits of the measures not related to energy bills, mitigation of environmental externalities, and economic impact.

2.2 RELATIONSHIP TO OTHER FOCUS EVALUATION WORK

This report is similar in structure and intent to a previous benefit-cost analysis completed in 2007.[4] The analysis draws on prior Focus evaluation work to quantify in monetary terms the benefits and costs attributable to Focus. The prior work includes:

- Determination of verified energy and demand savings attributable to the programs
- Assessment of market effects and spillover
- Assessment of non-energy benefits

---

[3] Energy Center of Wisconsin. *Energy Efficiency and Customer-Sited Renewable Resource Potential in Wisconsin, For the Years 2012 and 2018 – Final Report*. August 2009.

[4] Miriam Goldberg, Chris Clark, and Sander Cohan, KEMA, Inc. *Focus on Energy Statewide Evaluation, Interim Benefit-cost Analysis: FY07 Evaluation Report, Final.* February 26, 2007.

- Assessment of emissions mitigation associated with energy savings
- Assessment of customer incremental costs.

Additional steps undertaken for the present analysis include:

- Translation of energy and demand savings into monetary values
- Translation of market effects observations into quantitative energy savings estimates
- Application of emissions factors to estimated savings
- Application of findings from the non-energy benefits work to estimate these benefits for the current programs
- Compilation of program spending information
- Projection of the historic benefit streams through the duration of the 25-year analysis period
- Specification and estimation of benefit-cost formulas.

In addition, the evaluation team is conducting an economic impact analysis in parallel with this work using most of the same data streams.[5] A key step in the benefit-cost analysis is to incorporate products of that analysis into a benefit-cost test. The combination of these results provides an overall assessment of program costs and benefits to the state.

2.3 SCENARIOS AND ASSUMPTIONS

The Focus program includes long-term initiatives that aim to create lasting changes in Wisconsin's energy efficiency markets. The assessment of the Program's cost and benefits, as a result, must take place over a similar timeframe. For this report, the analysis was conducted over two different timeframes, one for the "historic" scenario and one for the "forward-look" scenario.

- The historic scenario assumes that Focus will fund and manage the programs for 10 years beginning in 2001. The total impact of the programs is measured for an additional 15 years after funding ends (2026).
- In the forward-look scenario we assume that the future Focus programs follow the savings trends projected in the ECW Potential Report. In this scenario, the programs are funded for 10 years beginning in 2012. The total impact of the programs is measured for an additional 15 years after funding ends (2036).

This sort of temporal analysis of programs requires projections of program spending, direct impacts, market effects of energy savings, and associated customer costs over the analysis period.

---

[5] Lisa Petraglia, Tyler Comings and Glen Weisbrod, Economic Development Research Group. *Economic Development Benefits: CY09 Economic Impacts Report.* Forthcoming (early December 2009).

Inputs and projections used for both scenarios are based as much as possible on specific plans and evaluation findings. Direct energy savings impacts and participation are projected based on spending levels and findings to date. Non-energy benefits are projected in proportion to participation levels or energy savings. Calculation of program market effects, additional energy savings due to actions taken outside Focus programs but as a result of their effect, depend upon the program and the corresponding level of information available. In all cases, the projected effects are considered to be plausible, but are more uncertain than the direct energy savings.

2.4 APPROACHES

This analysis takes a societal perspective to counting Focus benefits and costs. We completed both a simple and expanded test of cost-effectiveness. Both benefit-costs tests are reasonable and consistent with current commission policy in both their inputs and general approach. The simple test looks at the direct benefits of the program from a societal perspective. The expanded test also takes a societal perspective, but includes additional benefits that acknowledge the potential for positive externalities and positive statewide economic impacts.

2.4.1 Simple b/c test

The simple benefit-cost test is comparable to types of analysis conducted for other programs. The methodology combines elements of a Total Resource Cost (TRC) and Societal Test approach. The analysis calculates the total benefit of the program based on the most basic measure of benefits, the avoided energy costs attributable to the program. These avoided costs include the value of avoided emissions for which active offset markets currently exist. Avoided energy costs are determined at the utility level. We included documented and quantified market effects and spillover savings that are counted in the annual impact results in “documented net savings.” We included additional market effects, considered likely but not previously quantified, in the “added market effects” for both the simple and expanded tests. Costs are the simple sum of program and customer costs.

2.4.2 Expanded b/c test

The expanded b/c test builds upon the simple test in several ways. In addition to the items in the simple test, the expanded test includes:

- Non-energy benefits for all programs that had them (although non-energy costs exist for most programs, they were not included in this analysis since we do not have quantitative estimates associated with them).
- Avoided emission externality costs for expected future emissions offset markets as a benefit.
- Total impact on the economy, as determined from the economic impact analysis. This accounts for the positive ripple impact on the Wisconsin economy of energy savings and associated non-energy and emissions effects.

2.4.3 Costs

The expanded b/c test includes the same costs as the simple test. These are the program costs, excluding incentive payments, and the net incremental customer spending attributable to the program. The incremental spending is the cost of efficiency measures above the costs that would have been incurred for the baseline equipment or system. *Net* incremental costs are counted only for measures that are attributed to the program, in the same way that net savings count only these measures.

2.5 SCENARIOS

The perspective of this report is that a multi-year period of program and post-program activity is needed to fully capture program effects. Consistent with the previous benefit-cost analysis, we based each of our scenarios on a ten-year period of program activity with an additional 15 years of program effects. The truncation of program effects 15 years after the end of program activity understates the lifetime benefits and to a lesser extent, lifetime costs, of the program.

2.5.1 Historic

This analysis, coming near the end of the initial decade of the Focus on Energy program, is primarily an assessment of the effects of actions already taken. The inputs to the benefit-cost analysis required one and one half year of projected program spending and two and one half years of savings and customer incremental costs. The projections used in the historical scenario assume a continuation of CY09 funding levels and use the relationship of net savings to program spending found in the 18 MCP impact evaluations to project savings.

The historic scenario counts only those market effects that prior program evaluation analyses have quantified or market effects considered highly likely. Additional market effects are also likely, but often difficult to quantify accurately. Thus, the historic scenario provides a conservative estimate of the cost-effectiveness of the programs based on empirical evidence.

2.5.2 Forward-look

The forward-look scenario relies upon the estimated potential program savings reported in the ECW Potential Study. ECW estimated potential savings for a more aggressive program with substantial additional funding. The forward-look scenario looks at these additional savings. It is not a projection of current program activities and is an assessment only of the potential identified in the ECW report.

The savings reported in the ECW potential study are net savings that include both program free-rider and spillover effects. Thus, the documented savings in the forward-look scenario implicitly include both documented and market affects savings. Therefore, we included no additional market effects during the program years.

The ECW study reported annual potential savings for 2012 and 2018. To develop savings estimates over a 10-year program period we extrapolated potential program savings for the years 2013 through 2017 and 2019 through 2021. This provides a 10-year time frame somewhat parallel to the historic scenario and previous benefit cost analyses.

2.6 LEVELS OF ANALYSIS

We conducted the benefit-cost analysis for the Focus program as a whole and separately for each portfolio. Portfolios are:

- Business Programs
- Residential Programs
- Renewable Energy.

We conducted the expanded b/c test only at the portfolio level. We conducted the simple b/c test for individual programs within each portfolio.

Table 2-1. Level of Analysis for Simple B/C Test –Historic Scenario*

Residential	Business	Renewables
ESP	Agriculture	Biogas
HPWES	Commercial	Biomass
WESH	Industrial	Solar Electric
EHCI	Schools and Government	Solar Hot Water
ACES		Wind
THPWES		Other
Other		

* For the Forward-look scenario we grouped the ECW measures into programs that are roughly comparable to the existing programs. See Appendix F for more details.

2.7 ORGANIZATION OF THE REPORT

The remainder of this report is in four additional sections.

Section 3: Elements of Costs and Benefits. In this section, we discuss the costs and benefits included in each of the benefit-costs tests, as well as the relationships between the various tests.

Section 4: Findings: Historic Scenario. This section presents the results of the simple and expanded b/c tests for the current Focus on Energy programs for FY02 through FY11.

Section 5: Findings: Forward-look Scenario. This section presents the results of simple and expanded b/c tests for a Forward-look Scenario based upon the ECW Potential study savings' estimates.

Section 6: Methodology. This section provides an overview of the methodology used to develop the b/c results.

The report also includes five appendices.

Appendices A, B, and C provide more detail on the development of inputs for the Residential, Business, and Renewable Programs Portfolios, respectively.

Appendix D discusses the development of emission factors and costs

Appendix E describes the development of the costing periods and prices associated with them.

Appendix F provides the program level results for the simple b/c analysis.

3. ELEMENTS OF COSTS AND BENEFITS

3.1 COSTS

3.1.1 Included costs

The costs counted in the analysis are:

- All spending by the program administration contractor, except for incentive payments
- Program-attributable customer incremental costs for measure implementation.

Incremental costs are the added cost of a measure compared to its baseline alternative. The benefit-cost analysis reflects the total customer incremental costs of measures implemented as a result of the program without deducting incentive payments to implementers for the measures.

The measure costs counted are both *net* and *incremental.* Incremental means we count only the cost above the baseline alternative. Net means we count these costs only for the fraction of measures attributable to the program.

In principle, non-energy costs associated with the measure implementation are also counted on the cost side. These are costs associated with the effect of the measure other than the direct costs of implementation. These costs include items such as reduced productivity, lower amenity value, or increased operating costs. In practice, non-energy costs have not been identified for these programs. The non-energy benefits analysis did explore costs as well as benefits. However, either non-energy costs were not found, or these negative effects were not separately reported. Instead, the negative and positive non-energy effects were combined into a single value, which is positive for all programs. Thus, to the extent non-energy costs are included in this analysis, they appear as a reduction to the non-energy benefits.

3.1.2 Excluded costs

Excluded from program costs are any costs incurred by the Department of Administration or Public Service Commission of Wisconsin (PSCW) for overseeing the program. The analysis assumes that regulators in the previous environment of utility program operation would have incurred similar cost. In other words, these costs are not exclusive to the Focus program.

Also excluded from the cost side are program incentive payments. They are considered a transfer payment. If the program induced a customer to implement an energy-efficiency project, this analysis counts the full incremental cost to the customer, including the portion covered by the incentives.

We excluded ongoing operational and maintenance costs associated with energy efficient and renewable energy equipment where the evaluation team has not quantified them.[6]. Most energy efficient equipment has ongoing costs comparable to that of standard efficiency equipment, and thus we assumed that the on-going incremental costs are zero. Renewables systems, however, may have substantial ongoing costs that are not included, such as the costs of operating a biogas system or replacing a PV inverter.

We excluded evaluation costs from the analysis.

3.2 BENEFITS

Benefits counted in this analysis are the following:

Documented energy savings. These are the energy savings from energy-efficiency measures attributable to the programs, based on the evaluation verified net savings reported in prior impact evaluations. Documented energy savings include in-program savings, excluding free-ridership, plus spillover and market effects savings to the extent these effects have been formally documented in past impact evaluations.[7] These energy savings are counted as benefits over the measure lifetime, or the 25-year horizon of the benefit-cost analysis, whichever is shorter. The dollar value assigned is the avoided cost to the Wisconsin utilities per kWh or therm of energy and kW of electricity demand.

Added market effects energy savings. Market effects savings are the energy savings due to additional measures implemented outside of the programs by either participants or non-participants that would not have occurred without the program. "Added" market effects energy savings are plausible projections of additional savings that have not been quantified in prior impact studies. These savings are also valued in terms of the avoided cost of the energy to the Wisconsin utilities over the measure lifetime.

Avoided externalities. The avoided externalities considered in this analysis are the avoided air emissions associated with reduced electricity (kWh) and natural gas (therms) consumption. Avoided externalities are divided into two categories:

> ***"Economic" externalities*** translate into dollar flows in the economy. These are externalities that have been "internalized" via trading markets or emissions caps. These externalities are counted in the simple b/c test as an additional avoided cost per unit of energy saved. They are also included in the economic impact model.
>
> Economic externalities in these analyses include SO_X, NO_X, and CO_2.
>
> ***"Non-economic" externalities*** have values set by regulatory policy or public willingness to pay, but do not translate into flows through the economy. We included these non-economic externalities in the expanded b/c test as an additional avoided cost per unit of energy saved, but do not include them in the economic impact model. Non-economic externalities include mercury (Hg).

---

[6] The ongoing fuel costs for biomass systems are included.

[7] Documentation of the market effects are in Appendices A through C.

Non-energy benefits. Non-energy benefits are benefits to the measure implementer, or in some cases the utility, other than avoided energy costs associated with the measure. For use with the economic impact model, non-energy benefits (and costs) are divided into two categories:

> ***"Economic" non-energy benefits and costs*** translate into dollar flows in the economy. Examples include reduced sick time and improved productivity. These effects are included in the economic impact model.
>
> ***"Non-economic" non-energy benefits and costs*** have perceived value to implementers or other parties, but do not result in monetary flows. Examples include residents' higher or lower satisfaction with lighting quality. These effects would not be included in the economic impact model. The present analysis does not count any non-economic non-energy effects outside the economic impact model.

3.2.1 Excluded benefits

We treated federal and state tax credits, as well as federal grants as transfer payments and did not include them in the stream of benefits. This is consistent with previous the previous B/C analyses that avoided counting federal incentives attracted by the program as a benefit to the state economy.

Table 3-1. Costs and Benefits by Analysis

	Simple B/C Test	Expanded B/C Test	Economic Impact
Costs			
Program Costs	x	x	x
Incentive payments	0	0	x
Measure Costs (net and incremental)	x	x	x
Benefits (avoided costs)			
Avoided energy (documented)	x	x	x
Avoided energy (added market effects)	x	x	x
Avoided economic externalities	x	x	x
Avoided non-economic externalities		x	
Economic non-energy benefits (NEBs)		x	x
Non-economic non-energy benefits (NEBs)	0	0	0

3.2.2 Simple b/c test

The simple b/c test counts as benefits only the avoided energy costs and associated avoided economic externalities associated with the energy savings (documented and added market effects). The expanded test also counts avoided non-energy benefits (NEBs), and non-economic externalities. The total economic value of the avoided energy is determined in the expanded b/c test as the output from the economic impact model. We refer to the difference between this total economic benefit and the direct sum of the benefit components as the "economic impact adder."

3.3 USE OF "NET" VALUES

In this report, the term "net" is used in four essentially distinct ways, arising from standard terminology that applies to different components of the analysis. While these multiple uses of the same term can lead to some confusion, we use "net" in these different senses so that these analysis components will each be understandable in terms of its usual framework. Following is an explanation of the kinds of "netting" that occurs in the analysis.

3.3.1 Net as program-attributable

Savings valued in this analysis are the *net* savings, meaning savings attributable to the program. Net savings include all savings that result from program activity, i.e. that occur only due to the program. These savings account for free-ridership, free-drivership, spillover, and some market effects. Since we have limited data for free-drivership, spillover and market effects, they may be understated in this analysis. Added market effects, included in both the simple and expanded tests, reduce this understatement of benefits.

Incremental customer costs counted in this analysis are also net or program-attributable incremental costs in this same sense. These costs are *incremental* in the sense that they represent the difference between the cost for the high-efficiency measure and the cost for the less efficient base case alternative. The incremental costs counted here are *net* incremental costs, meaning that the incremental costs are counted for all the program-attributable savings and not for measures or savings that would have occurred without the program. Essentially, the same attribution factors applied to gross savings to determine net savings are applied to the (gross) incremental costs to determine the attributable (net) incremental costs used in this analysis. (We do *not* subtract program incentive payments from the customer incremental costs, nor do we include them in program costs.)

Likewise, the non-energy benefits and avoided emissions valued in this analysis are those that correspond to the attributable savings. We do not apply the term "net" each time we reference these values, but they are net values in the same sense as are the savings and incremental costs.

3.3.2 Net benefits

In the context of a benefit-cost analysis, the "net benefit" is simply the difference between the benefits and the costs counted. This "netting" is distinct from the use of "net-to-gross" or attribution factors in the determination of the benefits and costs.

3.3.3 Net economic impacts

The economic impacts used as a measure of overall program benefit are "net" economic impacts. That is, these impacts are the effect of the program on the economy over and above the "multiplier" effect that would result if the same money were spent without any direct productive effects.

3.3.4 Net present value

The value today of a stream of future payments (or costs) based on a particular discount rate is the net present value (NPV). In this analysis, we determine streams of costs and

benefits over the timeframe of the analysis, and express these in terms of their net present value. Total benefits and costs are calculated in net present value terms.

In the simple test, we count, on a *net* (program-attributable) basis, the savings, avoided emissions, and incremental costs.

In the expanded test, the total program benefit is the *net* economic impact (i.e., impact beyond the base effect of program spending), plus the value of avoided emissions not captured in the economic model plus NEBs. Inputs to the economic model that determine this impact include the same *net* (program-attributable) values of savings, avoided emissions, and incremental costs used in the simple test.

For both tests, we translate each benefit and cost stream over the timeframe of the analysis into its $2009 *net present value*. *Net* benefits are the difference between total program benefit and total (societal) cost associated with the program, where both benefits and costs are expressed in NPV terms.

3.4 RELATIONSHIP OF BENEFIT-COST ANALYSIS AND ECONOMIC IMPACT ANALYSIS

This b/c analysis was conducted in conjunction with an economic impact analysis, separately reported. The two analyses use the same input streams of program spending and program effects. The expanded b/c test uses an output of the economic impact analysis as a measure of program benefits. (Both the simple and expanded b/c tests use the same measure of costs, as described under Section 3.1.)

In the simple analysis, documented and market effects energy savings are counted as benefits. Program costs excluding incentives and customer net (program-attributable) incremental costs are counted as costs. In the expanded analysis, NEBs are added to the list of benefits, and all benefits are valued based on the output of the economic impact model. “Non-economic” externalities are added to this benefit value. Table 3-2 indicates the relationship among these elements.

Table 3-2. Relationship of Elements in Economic Model and Simple and Expanded B/C Tests

Analysis Components Included in			General Category	Element	B/C Tests	
Simple Benefit–Cost	Expanded Benefit-cost	Economic Impact Analysis			"Benefit"	"Cost"
Yes	Yes	Yes	Direct costs and energy savings	Program operations		+
				Documented energy savings (avoided cost of energy)	+	
				Added market effects energy savings (avoided cost of energy)	+	
				End-user implementation costs for direct and market effects energy savings		+
				Internalized externalities (NO_x, SO_x, CO_2)	+	
No	Yes	Yes	Other direct effects on the state economy	Economic non-energy benefits	+	
				Economic non-energy costs	-	
No	Yes	Yes	Spin-off effects on the state economy	Business sales	+	
			Dynamic effects on the state economy	Business expansion and attraction	+	
No	Yes	No	Non-financial changes to WI households and businesses	Hg emission reductions	+	
No	No	Yes	Transfer payment	Program incentive payments	o	o

+ Added to the benefit or cost

- Subtracted from the benefit or cost

o Not included

The simple b/c test incorporates all of Focus' direct energy effects on the Wisconsin economy. This test does not include the spin-off and dynamic effects calculated by the economic impact model. These effects, along with economic non-energy benefits and non-economic emissions effects, are included in the more comprehensive expanded benefit-cost test. As indicated, the expanded b/c test counts all these effects listed.

The simple test treats incentive payments to end users from the program as a transfer. The incentive amount is not included as a cost to the program nor it is it counted as a benefit to the participants. It is simply a transfer from the program to end users. Customer incremental costs are *not* reduced by the incentive amounts. (Customer incremental costs *are* adjusted for program attribution to determine net incremental costs.) In the economic impact analysis, incentive amounts are taken into account as part of the dollar flows that affect the economy. There are secondary economic effects of these flows, but the incentive amounts themselves are neither an addition to nor a flow out of the state economy.

The benefits components counted in each test and considered in the economic analysis are displayed in condensed form in Table 3-3. The simple analysis counts only the energy savings and direct costs. The expanded test counts these direct effects; other direct effects

on the Wisconsin economy; the non-economic changes to state businesses and homes; and the economic "adders" that result from the economic impact model. The economic analysis described in a separate report determines the spin-off and dynamic effects on the economy that translate into economic adders. That analysis does not count the non-economic externalities and non-energy benefits. Transfer payments are not counted in either of the b/c tests, but are reflected in the economic analysis.

Table 3-3. Benefits Components Included in B/C Tests and Economic Analysis

Simple Benefit-cost Test	Expanded Benefit-cost Test	Economic Impact
Direct costs and energy savings		
	Other direct effects on the state economy	
	Spin-off effects on the state economy	
	Dynamic effects on the state economy	
	Non-financial changes to WI households and businesses	
		Transfer payment

These elements, their relationship, and how their values were determined are discussed further in Section 5.

3.5 VALUATION FACTORS

This benefit-cost analysis pulls together information from a number of sources. The projected streams of energy savings and costs were developed based on information provided largely by program-area evaluations. To monetize benefit and cost streams and to develop associated estimates of net present value, the following additional information was required:

- The real discount rate
- The energy escalation factor
- The unit avoided cost of energy
- The unit avoided cost of externalities.

We discuss the assumptions underlying each of the above valuation factors used in the benefit-cost analysis below.

Net present value discount rate. Consistent with the 2007 b/c analysis, we use a five percent real discount rate to calculate the present value of net benefits.

The public cost of raising money is lower than the private cost because it is subsidized by its special tax-free status and it has government backing. However, it brings an opportunity cost of forgone private sector financing. In fact, increasing public fundraising raises the real private cost of capital by further crowding the market. Thus, some argue that public decision-making should be consistent with decisions using the real private cost of capital, which is typically around five percent. This is the (real) discount rate used in this study.

The real discount rate reflects the time value of borrowing money over-and-above the rate of inflation. In the context of a benefit-cost study, it is an adjustment reflecting the opportunity cost of using money that could have been used for other endeavors. The five percent real discount rate used in this study is a central value within the common range of three to seven percent seen in studies around the country. US Office of Management and Budget recognizes three percent as the real cost of government borrowing, but recommends going up to seven percent as a discount rate for federal agencies evaluating public investments and regulations.[8]

Energy escalation. Over the past several years, the cost of energy in Wisconsin has escalated at a rate higher than the rate of inflation. To compensate, the PSCW recommended that we use an annual energy escalator (rate above inflation) of 2.0 percent to account for increases in the cost of all fuels used as inputs for electricity production.

The 2007 b/c study used a 1.0 percent energy escalator based on various forecasts from organizations such as the US Energy Information Administration and the PSCW. These sources estimated energy cost escalation factors from 0.3 to 1.5 percent above inflation, depending upon the assumptions used. Additionally, the PSC estimated that coal costs would increase at an average annual rate of 3.05 percent and natural gas a 3.55 percent, including inflation. Evidence since the 2007 analysis suggests that energy costs will increase faster than inflation by a more than the 2007 analysis assumed. This is the rationale for increasing the energy escalation rate to 2 percent from the 1 percent used in 2007.

Avoided costs. We developed avoided energy and demand costs for electricity and natural gas as described below.

- **kWh.** We used MISO day ahead locational marginal prices (LMPs) to determine avoided electricity costs. We used a combination of MISO LMPs and American Transmission Company (ATC) demand data for the Illinois hub to establish four peak pricing periods to value avoided electric energy costs. From these data, we developed the pricing periods and avoided costs listed in Table 3-4. Since customers experience the documented energy savings, we account for the eight percent line loss by increasing the amount of customer avoided electric energy by eight percent. This factors into the resulting avoided cost to the utility, as well as in the avoided emission estimates.

[8] OMB Circular A-94, Appendix C, rev January 2007 shows the government long-term cost of borrowing to be 3%. http://www.whitehouse.gov/omb/circulars/a094/a94_appx-c.html. OMB Circular A-94, Appendix C, update memo rev January 2007 http://www.whitehouse.gov/omb/memoranda/fy2007/m07-05.pdf, and http://www.whitehouse.gov/omb/circulars/a094/a094.html.

Table 3-4. kWh Pricing Periods

Period Name	Price per kWh	Months	Days	Hours Ending (24-hour clock)	Annual # of Hours
Summer Peak	.075	Jun, Jul, Aug	Every day	10–21	1,104
Winter AM Peak	.061	Dec, Jan, Feb, Mar	Weekdays	8–12	430
Winter PM Peak	.061	Dec, Jan, Feb, Mar	Weekdays	19–21	258
Off Peak	.036	Remaining	Remaining		6,974
					8,766

- **kW.** The cost of avoided kW has two components. The first component is the avoided cost of new generation capacity, valued at $94/kW. The second component is the avoided cost of transmission capacity, valued at $33/kW. This results in a value of $127 per kW avoided during the hours of 1–4 pm on a summer weekday afternoon. The PSCW provided these values for use in the b/c analysis.

- **Therms.** The avoided cost of natural gas also has two components. The first component is a value of $0.816/therm, the EIA estimate of the average cost of gas per therm delivered to Wisconsin from June 2006 through April 2009. We chose this date range to account for the high variability in year-to-year gas prices due to extreme weather conditions and economic shocks. We adjusted this amount to account for differences in costs of transport within Wisconsin across customer segments. To account for transportation costs, we used the average of published gas transport tariffs from We Energies[9] and Madison Gas and Electric[10] to determine sector level prices.

Table 3-5. Avoided Energy and Demand Costs

Sector	kW	kWh	Therms
Agriculture	$127	$0.043*	$1.005
Commercial			$1.005
Industrial			$0.871
Schools and Government			$0.900
Residential			$1.087

*kWh value is the hourly average per kWh price in FY09

[9] We Energies Gas Tariff Schedule (Accessed 7/14/2009)
http://www.we-energies.com/pdfs/tariffs_vol7/tariff_wRateOrder_WG.pdf

[10] Madison Gas and Electric Gas Rates (Accessed 7/14/2009)
http://www.mge.com/images/PDF/Gas/Rates/GasRates.pdf

Table 3-6. Electric Energy (kWh) Pricing Periods

Electric Energy Pricing Period	Months	Days	Start Time	End Time	Annual Number of Hours	Price per kWh
Summer Peak	Jun. 1 - Aug. 31	All Days	HE10	HE21	1,104	$0.075
Winter AM Peak	Dec. 1 - Mar. 31	Weekdays	HE8	HE12	430	$0.058
Winter PM Peak	Dec. 1 - Mar. 31	Weekdays	HE19	HE21	258	$0.065
Off Peak	ALL	All Remaining hours			6,974	$0.036
				Total	**8,766**	**$0.043**

*HE is an acronym for hour ending

3.6 AVOIDED EMISSIONS

We developed avoided emissions factors from data provided by the Environmental Protection Agency (EPA). We developed emission and cost factors for NO_x, SO_x, CO_2, and mercury. In the benefit/cost model we treated NOx, SO_x, and CO_2 as *economic emissions* because values are set in real markets. (In the case of CO_2, the values are zero until 2012). We treated mercury as a *non-economic emissions* because we had to impute the values.

3.6.1 Electricity emission factors

Emission factors are based on the EPA's Office of Air and Radiation "Acid Rain Hourly Emissions Data," which is derived from stack monitoring. Appropriate allowance prices are then used to place a monetary value on displaced emissions. This includes a forecast of future prices (2010–2055).

We have developed the concept of "use-rate" to identify marginal plants. Use-rate is the average length of time a generating unit remains on once it is online. Thus, peaking units, which are online for only a short time, have a low use-rate; base-load plants that remain on for hundreds of hours or more have a high use-rate. We define marginal emissions as those produced by the set of generating units in the lowest use-rate group that is operating in each hour. Table 3-7 shows the marginal emission factors in this b/c analysis.

Table 3-7. Marginal Plant Emission Factors for Wisconsin Energy Consumption

	Substance	Pounds per MWh
Marginal Plants	CO_2	1700
	NO_X	2.87
	SO_X	2.71
	Hg	0.0000163

3.6.2 Natural gas emission factors

The emission factors discussed above are for emissions savings at the electric generator. Other emissions savings occur when energy efficient projects reduce the use of non-electric fuels at the participant's site. The primary site-based fuel (burned at the participant's site rather than at the power generation plant) saved under the Focus program is natural gas. Combustion of natural gas produces a variety of pollutants

including CO_2, NO_x, N_2O, SO_x, PM10, VOC, and CO. With the exception of CO_2, these pollutants are emitted in fairly small quantities.

According to the EPA's Technology Transfer Network Clearinghouse for Inventories & Emission Factors, the emission factor for CO_2 is 11.76 pounds of CO_2 per therm. The Clearinghouse provides a single emission rate for SO_x and mercury, as it does for CO_2. (Both the SO_x and mercury values are quite small, particularly compared to coal, and as a result are often ignored.) The Clearinghouse provides a range of estimates for NO_x that depend on the size and configuration of the boiler. NO_x emissions are particularly sensitive to the size, design, and operating conditions of the boiler. Three representative emission rates for NO_x are presented in Table 3-8.

Table 3-8. Natural Gas On-Site Use Emission Factors

Substance	Pounds Per Therm
CO_2	11.76
SO_x	0.0000588
Mercury	0.00000002549
NO_x Lower Bound	0.003137
NO_x Mid-range	0.009804
NO_x Upper Bound	0.027451

Sources: (1) Compilation of Air Pollutant Emission Factors, AP-42, Fifth Edition, Volume I: Stationary Point and Area. (2) EPA Technology Transfer Network Clearinghouse for Inventories and Emission Factors.

3.7 ALLOWANCE PRICES

The historic and forecast allowance prices were provided by PA's Multi-Pollutant Optimization Model (M-POM). This model was designed to find optimal market-driven, environmental compliance options, given multi-pollutant compliance requirements. It is designed to explore emission costs and benefits in terms of fuel choice, capital investments in pollution control equipment, allowance market purchases, and generating unit operating decisions.

M-POM is a dynamic, inter-temporal model that simultaneously selects technology (new units and compliance technology) and dispatches units over a 30-year horizon. For this analysis, we have extended the horizon to 46 years, assuming prices beyond 30 years increase at a constant rate of 2.3 percent per year. This represents the inflation adjustment in the model. PA models two seasons and typically six load segments per season. M-POM is set up to operate with 23 US regions. Table 3-9 shows the allowance prices for four years throughout the analysis period. Table 3-10 shows the value of avoided emissions for the same four years.

Table 3-9. Emissions Allowance Prices

Externality Type	Avoided Pollutant	FY02 Allowance Price ($/ton)	FY11 Allowance Price ($/ton)	FY21 Allowance Price ($/ton)	FY36 Allowance Price ($/ton)
Economic	NO_x	$998	$1,467	$1,490	$1,473
	SO_x	$199	$773	$1,305	$1,450
	CO_2	$0	$0	$26	$28
Non-economic	Mercury	$4,713,568	$41,088,207	$73,074,126	$85,669,909

Table 3-10. Value of Avoided Emissions

Externality Type	Avoided Pollutant	$/kWh Summer Peak	$/kWh Winter AM Peak	$/kWh Winter PM Peak	$/kWh Remaining Hours	$/therm
FY02						
Economic	NO_x	$0.001297	$0.001039	$0.000992	$0.001558	$0.000029
	SO_x	$0.000064	$0.000328	$0.000174	$0.000563	$0.000976
	CO_2	$0.000000	$0.000000	$0.000000	$0.000000	$0.000000
Non-economic	Mercury	$0.000007	$0.000005	$0.000003	$0.000019	$0.000060
FY11						
Economic	NO_x	$0.001908	$0.001528	$0.001459	$0.002292	$0.000043
	SO_x	$0.000247	$0.001274	$0.000675	$0.002186	$0.003787
	CO_2	$0.000000	$0.000000	$0.000000	$0.000000	$0.000000
Non-economic	Mercury	$0.000061	$0.000045	$0.000024	$0.000169	$0.000524
FY21						
Economic	NO_x	$0.001937	$0.001552	$0.001481	$0.002327	$0.000044
	SO_x	$0.000418	$0.002152	$0.001141	$0.003694	$0.006399
	CO_2	$0.017930	$0.021708	$0.022166	$0.026862	$0.152317
Non-economic	Mercury	$0.000109	$0.000081	$0.000043	$0.000300	$0.000931
FY36						
Economic	NO_x	$0.001916	$0.001534	$0.001465	$0.002301	$0.000043
	SO_x	$0.000464	$0.002390	$0.001267	$0.004102	$0.007107
	CO_2	$0.019075	$0.023094	$0.023581	$0.028577	$0.162040
Non-economic	Mercury	$0.000128	$0.000095	$0.000051	$0.000352	$0.001092

3.8 COMPARISON WITH PRIOR B/C REPORT

The analysis in this report is similar to that of the 2007 benefit-cost report[11], but has some important differences. These differences and their likely effect on the benefit-cost ratios are as follows:

1. *We increased the energy cost escalator to two percent per year*. That is, energy costs rise two percent faster than inflation. The last analysis used a one percent escalator. This change increases future and decreases historical energy prices, resulting in an unknown overall impact on the b/c ratios.

2. *We based avoided electric energy (kWh) costs on the MISO forward-looking capacity market Locational Marginal Prices (LMP) at the Illinois hub.* The 2007 b/c analysis valued avoided electric energy at $0.052 per kWh. The current analysis uses prices that vary by time period. Avoided electric costs vary from $0.036 to $0.075 per kWh, with an average annual avoided cost of $0.043 per kWh. This decreases avoided energy costs and has a downward effect on the b/c ratio.

3. *We used pricing periods and savings load shapes to value avoided energy different over time periods.* This had differing impacts on estimated program savings depending upon the savings load shape. The net effect of this on the b/c ratio is unclear. For measures that save more energy at peak price times, the b/c ratio would increase, for those with little or no electric use at peak price times, the b/c ratio would decrease.

4. *The current analysis values all energy savings in terms of 2009 avoided costs.* The prior analysis valued all energy savings in terms of 2007 avoided costs. This resulted in lower avoided energy costs for kWh and therms, and higher avoided costs for kW. The overall effect on the b/c ratios is unclear.

5. *For all Portfolios, we calculated program costs in real 2009 dollars.* In the previous b/c analysis we erred by entering program costs as nominal dollars. This led to an overestimate of the b/c ratio in the 2007 analysis. Shifting from nominal to real dollars increases the value of historic costs and reduces the b/c ratio for the historic scenario.

6. *For all Portfolios, we calculated incremental costs in real 2009 dollars*. In the previous b/c analysis, we calculated Residential and Renewable program costs as nominal dollars. This led to an overestimate of the b/c ratio in the 2007 analysis. Shifting from nominal to real increases the value of historic costs and reduces the b/c ratio for the historic scenario in the 2009 analysis.

7. *We increased BP market effects due to the 2009 Channel Study[12] findings.* This increased the b/c ratio for some programs in the BP portfolio.

---

[11] Miriam Goldberg, Chris Clark, and Sander Cohan, KEMA, Inc. *Focus on Energy Statewide Evaluation, Interim Benefit-cost Analysis: FY07 Evaluation Report, Final.* February 26, 2007.

[12] See Appendix B for details.

8. *We corrected the calculation of environmental externalities.* This increased these values and thus, the b/c ratios in this report.

9. *We updated our prices for avoided emissions and calculated different emission factors for each electric cost periods.* This had differing impacts on program estimates of avoided emissions depending upon the savings load shape. The effect of these changes on the b/c ratios is unclear.

3.9 LIMITATIONS AND UNCERTAINTIES IN THE ANALYSIS

3.9.1 Addressing uncertainties in the 2007 b/c report

The 2007 b/c report identified sources of uncertainty in b/c inputs that contributed to uncertainties in the b/c ratio. The report pointed out that, "This analysis draws on many sources of data, and develops projections for several years into the future in an environment of many unknowns. The results are therefore subject to a variety of uncertainties." The report went on to identify these sources, as shown in the first three columns in Table 3-11. Before completing this b/c analysis, the evaluation team completed additional research or otherwise took action to mitigate these uncertainties. The final column in the table below identifies these improvements.

Table 3-11. Treatment of Identified Uncertainties in 2007 Analysis

2007 Sources of Uncertainty	2007 Issue/Treatment	Uncertainty Contributed to 2007 B/C Ratio	2009 Improvement
2007 B/C Future funding levels	Not a major factor in benefit–cost comparison, because projected benefits are scaled to projected spending. However, a major change in funding levels could result in added or lost economies of scale.	L	2009 b/c analysis requires only 1.5 years of projected budget.
Future program efficiency (savings per unit of program spending)	Future assumed similar to historic	M	Future assumed similar to 18 MCP, which is later in the program period, and applied to 2.5 additional years. 18 MCP contained program modifications likely to continue for several years.
Future energy savings	Scaled early results or near-term projections to future years based on assumed funding levels.	M	Future assumed similar to 18 MCP, which is later in the program period, and applied to 2.5 additional years. 18 MCP contained program modifications likely to continue for several years.
Future incentive payments	Scaled early results or near-term projections to future years based on assumed funding levels and any available information from the program on how it would be allocated	M	Future incentive payments based on the CY09 budget.

2007 Sources of Uncertainty	2007 Issue/Treatment	Uncertainty Contributed to 2007 B/C Ratio	2009 Improvement
End-user incremental costs	Often not tracked. Used combination of program tracking data and survey data	H	Renewable incremental costs (with the exception of biomass systems) continue to be based on project costs, as tracked by the program. The evaluation team completed incremental costs studies for the Business and Residential Programs, which informed values for this b/c analysis.
Historic energy savings	Savings values are always subject to estimation error. Used documented values from prior Focus evaluation work.	L	None. Used evaluation documented savings for all but 2.5 years.
Market effects	Limited documented effects to date. Used less solidly documented projections for the High Scenario.	M	Additional market-effects studies in Residential and Business programs informed the analysis.
Measure life and decay rate	Measure life by program/technology is based on available literature or DoA assumption. Projections assume exponential decay with the assumed measure life as the average lifetime.	M	Measure life study for Business programs informed the analysis.
Non-energy benefits	Estimates included for all sectors.	M	Refined Renewable and BP estimates.
Avoided Costs of Energy	Based on recent tariff filings and market data. Electric costs not specific to sector or measures	H	Developed electric avoided costs that vary according to the time of day of measure impacts. Used savings load shapes to apply varying avoided costs.
Externality values	Used trading credits for SO_x and NO_x and projected market values for CO_2 and mercury	M	Refined market analysis.

3.9.2 Uncertainties and limitations of the 2009 b/c report

The evaluation team conducted additional research and modified some estimation approaches to reduce uncertainty in the most recent b/c analysis. There always, however, exists some uncertainty in a study of this nature. We identify uncertainties that remain, but at a reduced level, and other limitations in the analysis.

Incremental costs. Establishing true incremental costs remains a challenge. The residential and business program research efforts to identify incremental costs represent an improvement over the previous estimates. The challenge is that they are difficult to obtain for all measures, and the changing nature of product markets means that the incremental costs are likely to change over time as the energy efficiency measures obtain greater penetration. The present study uses the same real payback period to estimate costs in each year. This approach is likely to understate costs in early years and overstate costs in later years. The effect of the static incremental costs assumption on the b/c ratio is ambiguous.

Ongoing incremental costs. Technologies that are additional (rather than in instead of) less efficient or non-renewable sources may incur ongoing maintenance or operational costs. These costs would be attributable to the program. These costs are no accounted for in the 2009 analysis (with the exception of biomass fuel costs). The exclusion of these

costs tends to overestimate the benefit-cost ratio for some measures, especially renewable technologies with substantial operational or maintenance costs.

Measure lives. The measure lives used in the study are reasonable and consistent with standard industry assumptions regarding the equipment. We could make additional improvements to some programs by establishing measure lives at a more detailed level, instead of across groups of similar measures.

Savings decay. The approximation of savings decay could also be improved, but would likely be expensive and result in little change to the overall impacts.

Analysis period. The analysis period is limited to 15 years beyond program delivery to be consistent with earlier b/c analysis. This approach truncates benefits (and ongoing costs) that accrue in future years. Determining the ideal analysis period that balances the inclusion of long-term costs and benefits and the needs of policy makers who operate on a more limited time horizon is an ongoing challenge in models that seek to approximate future impacts. Increasing the analysis period by 5 years would increase overall net benefits by roughly 17 percent. Increasing it by 10 years would increase net benefits by nearly 30 percent.

Discount rate. There is no "right" discount rate, but the choice of the discount rate can have a significant effect on the results of a study that includes effects more than 15 years from the present. A simple sensitivity analysis indicated that reducing or increasing the discount rate by 2 percent changes net benefits approximately 20 percent in the simple test.

Market effects. Additional research on market effects would improve these estimates. Market effect studies, however, are both expensive and assessing something that changes over time. Unless market effects are very large, they are unlikely to result in substantial changes to the overall b/c ratios. It is unclear whether the "added market effects" included in this report over or under estimate the program's effect on the market.

Persistence. Additional studies would be necessary to determine if, and how much credit the program should receive for participants continuing to use efficient technologies when the program measure is replaced. The current analysis does not explicitly give credit for this market effect, which may result in an underestimate of benefits.

NEBs. Non-energy benefits are very challenging to quantify. Current estimates are based on limited research and may underestimate these benefits.

Forward-look program costs. The ECW potential study included program costs that are, in general, lower that historic costs to achieve the same level of savings. This is especially true for the renewable program. It seems unlikely that the program could obtain substantial additional savings at costs at or below current costs.

Forward-look savings estimates. The forward-look scenario includes substantial increases in achievable savings. It is difficult to verify this level of potential and factors exogenous to the program could have a substantial effect on their magnitude.

4. FINDINGS: HISTORIC SCENARIO

4.1 GENERAL

For each Focus on Energy portfolio, we performed a series of simple and expanded benefit-cost tests for the historic scenarios. We performed a simple and expanded benefit-cost test for each portfolio as a whole. In addition, we conducted the simple benefit-cost test for individual programs or major components within each portfolio. We describe these results are described by portfolio in the following sections.

4.1.1 Program benefits

For each portfolio, we show the benefits for all programs for Years 1, 10, and 25 for the simple test. We show these benefits at the portfolio level only for the expanded test. Respectively, these are the first year of the program, (assumed) final year of the program, and the point 15 years after the assumed program close.

The benefits for each year are the total effects of all measures implemented resulting from the program up through that year. Thus, the documented energy savings for Year 1 would be the annual energy savings due to measures implemented through the programs and attributable to them (first-year net savings). The documented savings shown for Year 10 are the net (i.e. program-attributable) annual energy savings due to all measures implemented through the program in Years 1 through 10 and persisting until Year 10. The documented savings shown for Year 25 are the net annual energy savings due to measures implemented in Years 1 through 10, adjusted for persistence over the average measure life of the installed measures. For example, if the average measure life is 20 years, some measures will last longer, so that there are still savings in year 25 from measures installed under the program 15 or more years previously.

Market effects in Year 10 are the total annual savings of all measures implemented due to the program, but outside of it, in Years 1 through 10. Market effects in Year 25 include the total annual savings of all measures implemented due to the program, but outside of it, in Years 1 through 25, adjusted for persistence over the average measure life. As in the case of direct savings, there are still market effects savings in Year 25 from measures installed 15 or more years earlier. Thus, program activity in Years 1 through 10 contributes to market effects savings in Year 25, both through the persistence of market effects implementation that occurred during the program years, and potentially, through lasting market effects that led to implementation in the post-program years.

Under the simple benefit-cost test, only the avoided supply costs of documented savings impacts and added market effects are counted as benefits. For the expanded benefit-cost test, avoided environmental externalities (in the form of air emissions) that do not directly affect supply costs and NEBs are also counted as benefits. In addition for the expanded test, the total value benefit of energy savings, “economic” avoided emissions, and NEBs is determined as the output of an economic impact model with these streams as inputs.

4.1.2 Program costs

For each portfolio, the costs for all programs are shown for Years 1, 10, and 25 for the simple test. We show these costs at the portfolio level only for the expanded test.

Respectively, these are the first year of the program, (assumed) final year of the program, and the point 15 years after the assumed program close. For years after the program close, there is no program spending. The only cost in these later years are net (attributable) customer incremental costs associated with measures implemented in those years as a result of continuing market effects.

We use the same costs for both the simple and expanded tests. These include the program costs (excluding incentive payments) as well as the net incremental costs to the customer.

4.2 RESIDENTIAL PORTFOLIO

This section discusses the benefit-cost results associated with the Residential Portfolio. The Residential Portfolio covers six individual programs:

- ENERGY STAR® Products Program (ESP)
- Efficient Heating and Cooling Initiative (EHCI)
- Wisconsin ENERGY STAR Homes Program (WESH)
- Home Performance with ENERGY STAR (HPWES)
- Targeted Home Performance with ENERGY STAR Program (THPWES)
- Apartment and Condominium Efficiency Services Program (ACES).

For the Residential Portfolio, the documented net energy savings include evaluation-verified savings and quantified market effect (including spillover) that are included in evaluation reports. We separately estimated post program market effects, which are comprised of added market effects, where the evaluation team deemed them reasonably likely.

We projected documented savings by scaling historic savings levels to projected future funding levels. We assumed funding levels comparable to FY09 funding and scaled the programs according. Market effects, economic externalities, and non-economic externalities (NEBs) are projected and scaled similarly.

The small size of the programs relative to the markets they serve and the relative unknowns of the residential market introduce a level of uncertainty to the estimates of savings. We developed savings estimates on a program-by-program basis based on the project team's general knowledge of program activity, markets in which they operate, and other market intelligence gathered from a variety of industry and national sources.

Further details on the development of benefits and costs are provided in Appendix A.

4.2.1 Simple test – residential portfolio

Overall, the Residential Portfolio results in net benefits, with a b/c ratio of 1.4 over the 25-year period of analysis. Incremental participant and program costs are higher than benefits for the first 8 years of the program. In FY10, documented energy savings from measures installed through the program surpass these costs, resulting in overall net benefits. The program continues to have net benefits for the remainder of the analysis period. Added

market effects and avoided economic environmental externalities are small compared to documented savings.

At the portfolio level, the historic simple test yields a similar but slightly lower benefit-cost ratio than the high-funding results in the 2007 b/c study. This historic scenario results in a b/c ratio of 1.4, compared to 1.7 in the 2007 analysis.

In addition to changes in the general assumptions discussed in Section 3.8, we identified a change in the treatment of market effects that contributed to this slight decline. In the 2009 analysis we degraded the market effects for CFLs over time to account for changes in the market such as Wal-Mart promotions of CFL lamps, and changing federal standards for incandescent bulbs.

Figure 4-1. Residential Portfolio: Simple Benefit Cost Components, Historic

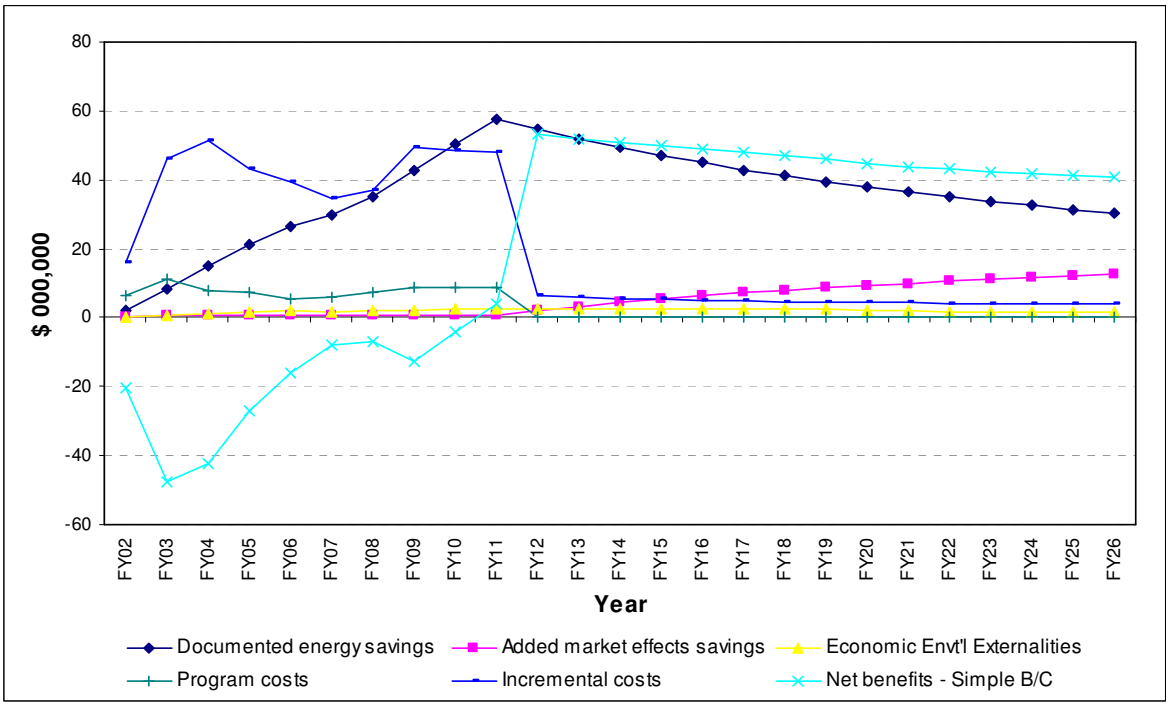


Table 4-1. Residential Portfolio: Simple Benefit Cost Components, Historic ($000,000)

B/C Component		FY02	FY11	FY26	NPV FY02 - FY26
Benefits	Documented Energy Savings	$2.0	$57.7	$30.4	$666.5
	Added Market Effects Savings	$0.1	$0.6	$12.8	$73.1
	Economic Environmental Externalities	$0.0	$2.8	$1.5	$38.0
Costs	Program Costs	$6.5	$8.9	$0.0	$85.7
	Incremental Costs	$15.9	$48.1	$4.0	$486.3
	Total Benefits	**$2.2**	**$61.0**	**$44.7**	**$777.6**
	Total Costs	**$22.4**	**$57.0**	**$4.0**	**$572.0**
				Net Benefits	**$205.6**
				B/C Ratio	**1.4**

4.2.2 Expanded test – residential portfolio

In the expanded analysis, the portfolio achieves net benefits starting in FY06 primarily due to the regional economic benefits. The overall net benefits in the 25-year analysis period exceed $713 million dollars, resulting in a Residential Portfolio b/c ratio of 2.4. We show the results of the expanded test for the Residential Program in Table 4-2.

We show the annual benefit and cost streams that drive the expanded benefit-cost calculations in Figure 4-2. The expanded test includes additional benefits, but no additional costs. Economic impacts associated with these benefits supplement the documented energy savings. Non-energy benefits and avoided environmental externalities are multipliers of the sum of documented savings and added market effect savings; their shapes are similar to that of the documented savings, but at a smaller level. Other components displayed in the figure are the same as shown for the simple b/c test.

The majority in the increase in the b/c ratio compared to the simple test comes from the Regional Economic Impacts, which add 54 percent to the simple test benefits. Non-economic environmental externalities and NEBs contribute an additional 12 and 10 percent, respectively. The inclusion of these additional benefits also increases the economic impact adder. Overall, the expanded test increases the overall benefits by 76 percent beyond the simple b/c test.

Figure 4-2. Residential Portfolio: Expanded Benefit Cost Components, Historic

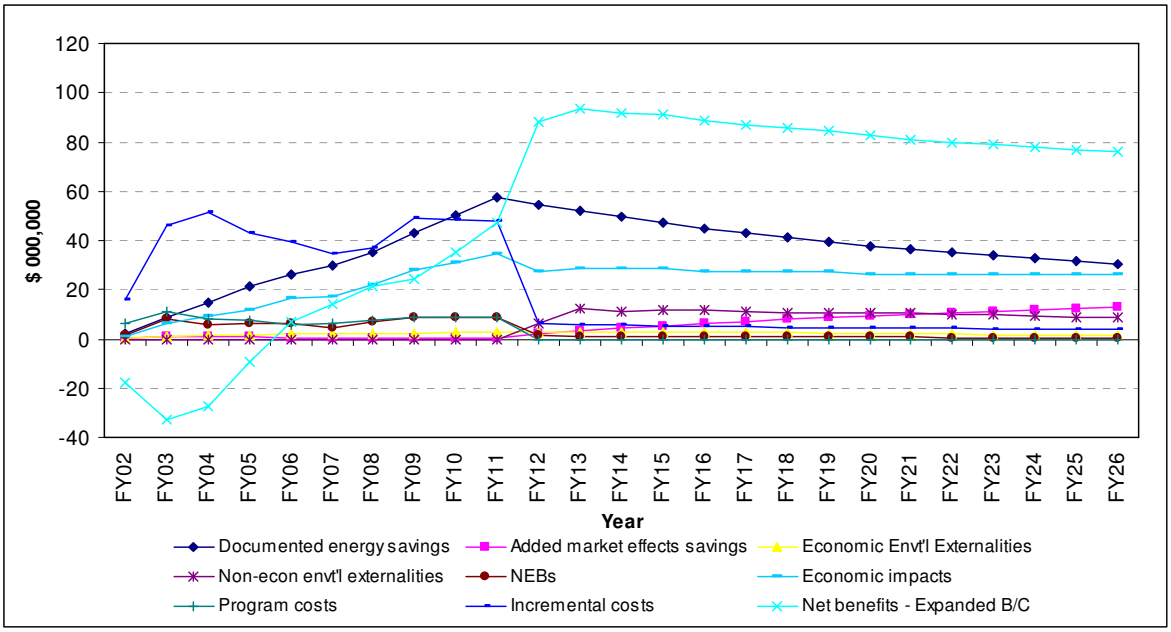


Table 4-2. Residential Portfolio: Expanded Benefit Cost Components, Historic ($000,000)

B/C Component		FY02	FY11	FY26	NPV FY02 - FY26
Benefits	Documented Energy Savings	$2.0	$57.7	$30.4	$666.5
	Added Market Effects Savings	$0.1	$0.6	$12.8	$73.1
	Economic Environmental Externalities	$0.0	$2.8	$1.5	$38.0
	Non-economic Environmental Externalities	$0.0	$0.0	$8.6	$92.3
	Non-Energy Benefits (NEBs)	$1.6	$8.7	$0.4	$75.9
	Regional Economic Impacts	$1.0	$34.6	$26.1	$421.5
Costs	Program Costs	$6.5	$8.9	$0.0	$85.7
	Incremental Costs	$15.9	$48.1	$4.0	$486.3
	Total Benefits	**$4.8**	**$104.3**	**$79.8**	**$1,367.3**
	Total Costs	**$22.4**	**$57.0**	**$4.0**	**$572.0**
				Net Benefits	**$795.3**
				B/C Ratio	**2.4**

4.2.3 Simple Test – individual program results

In this sub-section we report the results of the simple b/c test at the individual program level (see Table 4-3) ENERGY STAR Products, ACES, and Home Performance with ENERGY STAR all achieve a b/c ratio greater than 1 in the analysis period. WESH, EHCI, and Targeted Home Performance with ENERGY STAR achieve b/c ratios lower than one. This is consistent with the findings reported in the 2007 b/c report, with the exception of EHCI, which had a b/c ratio above 1 in 2007. The “Other” program achieves a high b/c ratio but is very small and has little impact on the overall Portfolio.

The ESP program is the greatest contributor to portfolio net benefits (providing more than one-half the net benefits) and has the highest benefit-cost ratio (except for "Other") of the Residential Programs, at 1.9. The Apartment and Condominium Efficiency Services (ACES) program contributes net benefits of around a third the level of ESP and Home Performance with ENERGY STAR (HPWES), and "Other" programs provide the rest of the net benefits.

Wisconsin ENERGY STAR Homes (WESH), Targeted Home Performance with ENERGY STAR (THPWES) and Efficient Heating and Cooling Initiative (EHCI) do not achieve positive net benefits. This is consistent with the 2007 benefit-cost report for WESH and THPwES. The 2007 report, however, showed positive net benefits for EHCI. Previous evaluation reports have shown limited electric savings and low gas savings for the WESH program. The Targeted Home Performance Program (THPWES) is essentially a low-income program. Program implementers and policy makers typically do not expect a b/c ratio above 1 for this type of based on avoided energy and associated emissions costs value alone, as is the basis in the simple test.

Table 4-3. Individual Residential Programs: Simple Benefit Cost Components, Historic 25 Year NPV ($000,000)

B/C Component	ESP	HPWES	WESH	EHCI	ACES	THPWES	Other
Documented Savings	$256.6	$118.2	$25.2	$99.4	$151.6	$15.1	$0.5
Market Effects	$30.6	$8.8	$6.2	$12.8	$14.6	$0.0	$0.0
Externalities	$25.3	$3.1	$0.4	$4.3	$4.6	$0.3	$0.0
Program Costs	$29.2	$14.2	$16.0	$2.8	$21.9	$1.4	$0.1
Incremental Costs	$133.8	$78.3	$24.2	$132.0	$95.5	$22.3	$0.1
Net Benefits	**$149.5**	**$37.5**	**($8.5)**	**($18.3)**	**$53.5**	**($8.4)**	**$0.3**
B/C Ratio	**1.9**	**1.4**	**0.8**	**0.9**	**1.5**	**0.6**	**2.5**

A. ENERGY STAR PRODUCTS PROGRAM (ESP)

The ESP program encompasses support for four separate technology categories: compact fluorescent lighting (CFL), clothes washers, other (non-CFL) lighting, and other appliances.

As shown in Table 4-4, the historic scenario achieves a benefit-cost ratio of 1.9. The program achieves the majority of its benefits from documented energy savings and the avoidance of associated economic environmental externalities. The program achieves additional, but minor benefits through market effects, which also contribute to incremental costs.

This b/c ratio is lower than the 2.7 b/c ratio in the 2007 high funding scenario. Since the last b/c analysis, there has been substantial growth in the CFL market nationally. This has accelerated the adoption of CFLs. We decreased the program market effects to account for this. Additionally, the evaluation team updated the incremental costs to based on the 2009 Study.[13] This may have reduced the b/c ratio as well.

[13] Steve Drake, Eric Rambo, Bryan Ward, PA Consulting Group. *Residential Technologies Incremental Cost Review.* Draft, November 13, 2009.

Table 4-4. ESP Program: Simple Benefit Cost Components, Historic ($000,000)

B/C Component		FY02	FY11	FY26	NPV FY02 - FY26
Benefits	Documented Energy Savings	$0.8	$24.9	$6.5	$256.6
	Added Market Effects Savings	$0.1	$0.6	$3.1	$30.6
	Economic Environmental Externalities	$0.0	$1.9	$0.7	$25.3
Costs	Program Costs	$2.0	$2.9	$0.0	$29.2
	Incremental Costs	$6.0	$8.9	$0.2	$133.8
	Total Benefits	**$1.0**	**$27.4**	**$10.4**	**$312.5**
	Total Costs	**$8.0**	**$11.8**	**$0.2**	**$163.0**
				Net Benefits	**$149.5**
				B/C Ratio	**1.9**

B. HOME PERFORMANCE WITH ENERGY STAR (HPWES)

The HPWES program promotes energy efficient home improvements through incentives, marketing, and education. HPWES consultants provide comprehensive assessments to homeowners who are either considering home retrofits or have concerns about high energy bills, comfort or safety issues (such as mold) in their home. The program provides financial incentives for the installation of measures recommended from the assessment. The program also provides training, mentoring, and education on best practices for both consultants and contractors who partner with HPWES. HPWES achieves a benefit/cost ratio of 1.4. As with the other Residential Programs, documented energy savings (on the benefit side), and participant incremental costs (on the cost side) dominate the b/c ratio. The program achieves net benefits by FY11 and the program continues to realize benefits associated with participants' continued savings and added market effects, with only minor associated costs.

We included market effects for the HPWES program. In developing these we assumed that home performance consultants, to some degree, rely upon program advertising and educational events to generate leads. The program also tries to achieve synergies with home remodelers and trade allies. These parties rely, in part, upon program incentives to convince customers to install energy-efficient options. There are indications that some savings attributable to the program will continue beyond the program life. Consultants have acquired a valuable skill set, which will carry forward after the program ends. Finally, given changes in price and interest in climate change, there is the potential for accelerated adoption of these measures.

Table 4-5. HPWES Program: Simple Benefit Cost Components, Historic ($000,000)

B/C Component		FY02	FY11	FY26	NPV FY02 - FY26
Benefits	Documented Energy Savings	$0.6	$7.8	$6.7	$118.2
	Added Market Effects Savings	$0.0	$0.0	$2.1	$8.8
	Economic Environmental Externalities	$0.0	$0.1	$0.2	$3.1
Costs	Program Costs	$1.1	$1.4	$0.0	$14.2
	Incremental Costs	$5.6	$2.7	$0.4	$78.3
	Total Benefits	**$0.6**	**$7.9**	**$9.0**	**$130.0**
	Total Costs	**$6.8**	**$4.1**	**$0.4**	**$92.5**
				Net Benefits	**$37.5**
				B/C Ratio	**1.4**

C. WISCONSIN ENERGY STAR HOMES (WESH)

The Wisconsin ENERGY STAR Homes program encourages the development of ENERGY STAR-certified energy-efficient homes.

In the simple test, as shown in Table 4-6, incremental and program costs exceed the direct energy savings they create. The program achieves a benefit-cost ratio of 0.8 with the simple test.

We incorporated market effects into these projections to account for continued WESH practices beyond program participation. Past evaluation work indicates that it is reasonable to expect a large percentage of current WESH builders to continue to build homes to WESH standards. Many of the changes provide health, safety, and comfort benefits to the end-user. The program also has changed the skill sets of trade allies (e.g., carpenters, HVAC technicians, insulators). WESH practices may also have an influence on the UDC in Wisconsin.

Table 4-6. WESH Program: Simple Benefit Cost Components, Historic ($000,000)

B/C Component		FY02	FY11	FY26	NPV FY02 - FY26
Benefits	Documented Energy Savings	$0.1	$1.8	$1.6	$25.2
	Added Market Effects Savings	$0.0	$0.0	$1.1	$6.2
	Economic Environmental Externalities	$0.0	$0.0	$0.0	$0.4
Costs	Program Costs	$1.9	$1.1	$0.0	$16.0
	Incremental Costs	$0.9	$1.3	$0.2	$24.2
	Total Benefits	**$0.1**	**$1.8**	**$2.8**	**$31.8**
	Total Costs	**$2.8**	**$2.4**	**$0.2**	**$40.3**
				Net Benefits	**($8.5)**
				B/C Ratio	**0.8**

D. EFFICIENT HEATING AND COOLING INITIATIVE (EHCI)

EHCI provides funding and assistance to encourage the proliferation of efficient heating and cooling equipment in Wisconsin. The program focuses on two key technologies: central air conditioning and electrically commutated motors (ECM).

Table 4-7 shows the results of the simple benefit-cost test of the program. The program achieves a benefit-cost ratio of 0.9, which is slightly below 1.0 and substantially lower than the 1.4 b/c ratio reported in 2007.

In the case of the EHCI program, incremental costs are very high relative to documented energy savings. This is primarily due to a change in federal standards establishing SEER 13 as the national minimum. The higher baseline (SEER 13) results in Incremental costs for air conditioners with a SEER 14 and higher being relatively higher relative to the incremental savings. For example, the ratio of incremental equipment cost to first-year avoided energy costs is approximately seven when increasing from SEER 11 to SEER 13. The same ratio for choosing a SEER 14 (the most common program unit) over a SEER 13 is approximately 12.

Added market effects provide roughly 13 percent increase in energy savings compared to the documented savings. These additional savings are also associated with some added costs. The market effects assume some additional promotion of higher SEER central air conditioners and ECM motors by contractors beyond the life of the program.

Table 4-7. EHCI Program: Simple Benefit Cost Components, Historic ($000,000)

B/C Component		FY02	FY11	FY26	NPV FY02 - FY26
Benefits	Documented Energy Savings	$0.0	$8.9	$7.3	$99.4
	Added Market Effects Savings	$0.0	$0.0	$3.1	$12.8
	Economic Environmental Externalities	$0.0	$0.3	$0.4	$4.3
Costs	Program Costs	$0.0	$0.6	$0.0	$2.8
	Incremental Costs	$0.0	$23.0	$2.3	$132.0
	Total Benefits	**$0.0**	**$9.2**	**$10.8**	**$116.5**
	Total Costs	**$0.0**	**$23.5**	**$2.3**	**$134.8**
				Net Benefits	**($18.3)**
				B/C Ratio	**0.9**

E. APARTMENT AND CONDOMINIUM EFFICIENCY SERVICES (ACES)

The ACES program provides energy efficiency information and services for owners and residents of apartments and condominiums. Benefit-cost results for the ACES program are shown in Table 4-8. The program achieves a benefit-cost ratio of 1.5, lower than the 1.7 b/c ratio in the 2007 results.

Documented program savings provide the majority of program benefits. We have included some, but limited market effects for the ACES program. While the program has been able to affect some change in how apartment and condominium owners see efficient lighting

and high-efficiency boilers, we anticipate that the elimination of program advertising and incentives will lead to a significant drop in the adoption of these efficiency measures.

Table 4-8. ACES Program: Simple Benefit Cost Components, Historic ($000,000)

B/C Component		FY02	FY11	FY26	NPV FY02 - FY26
Benefits	Documented Energy Savings	$0.5	$13.0	$7.2	$151.6
	Added Market Effects Savings	$0.0	$0.0	$3.3	$14.6
	Economic Environmental Externalities	$0.0	$0.3	$0.2	$4.6
Costs	Program Costs	$1.5	$2.7	$0.0	$21.9
	Incremental Costs	$3.4	$8.9	$0.9	$95.5
	Total Benefits	**$0.5**	**$13.4**	**$10.7**	**$170.9**
	Total Costs	**$4.8**	**$11.6**	**$0.9**	**$117.4**
				Net Benefits	**$53.5**
				B/C Ratio	**1.5**

F. TARGETED HOME PERFORMANCE WITH ENERGY STAR (THPWES)

The Focus Targeted Home Performance with ENERGY STAR Program (THPWES) is a weatherization program similar to the low-income Weatherization Assistance Program (WAP). Results of benefit-cost analysis for THPWES are shown in Table 4-9. There are no market effects assumed for this program. The program achieves a benefit-cost ratio of 0.6, comparable to the 0.8 b/c ratio reported in 2007.

Table 4-9. THPWES Program: Simple Benefit Cost Components, Historic ($000,000)

B/C Component		FY02	FY11	FY26	NPV FY02 - FY26
Benefits	Documented Energy Savings	$0.0	$1.2	$1.0	$15.1
	Added Market Effects Savings	$0.0	$0.0	$0.0	$0.0
	Economic Environmental Externalities	$0.0	$0.0	$0.0	$0.3
Costs	Program Costs	$0.0	$0.2	$0.0	$1.4
	Incremental Costs	$0.0	$3.3	$0.0	$22.3
	Total Benefits	**$0.0**	**$1.2**	**$1.0**	**$15.4**
	Total Costs	**$0.1**	**$3.5**	**$0.0**	**$23.8**
				Net Benefits	**($8.4)**
				B/C Ratio	**0.6**

G. OTHER PROGRAMS

"Other" programs is comprised of a program that distributes CFL incentives of $3.50 to parents of children enrolled in Head Start. The program follows up with a home inspection to ensure that the CFL installation occurred.

Table 4-10. Other Residential Programs: Simple Benefit Cost Components, Historic ($000,000)

B/C Component		FY02	FY11	FY26	NPV FY02 - FY26
Benefits	Documented Energy Savings	$0.0	$0.1	$0.0	$0.5
	Added Market Effects Savings	$0.0	$0.0	$0.0	$0.0
	Economic Environmental Externalities	$0.0	$0.0	$0.0	$0.0
Costs	Program Costs	$0.0	$0.1	$0.0	$0.1
	Incremental Costs	$0.0	$0.0	$0.0	$0.1
	Total Benefits	**$0.0**	**$0.1**	**$0.0**	**$0.6**
	Total Costs	**$0.0**	**$0.1**	**$0.0**	**$0.2**
				Net Benefits	**$0.3**
				B/C Ratio	**2.5**

4.3 BUSINESS PROGRAMS

4.3.1 Simple test – business portfolio

The Focus on Energy Business Programs help Wisconsin businesses, industries, farms, schools and local governments identify and install energy and cost-saving efficiency measures. We performed benefit-cost analysis for each of four business program areas: Agriculture, Commercial, Industrial, and Schools and Government. We summarize the benefit-cost results for these programs in Table 4-13 below.

In the simple test, shown in Table 4-11, the historic scenario achieves approximately $1.7 billion dollars in net benefits over the 25-year analysis period. This is substantially higher than the 2007 estimates for the high funding scenario, and results in an overall b/c ratio of 3.7.

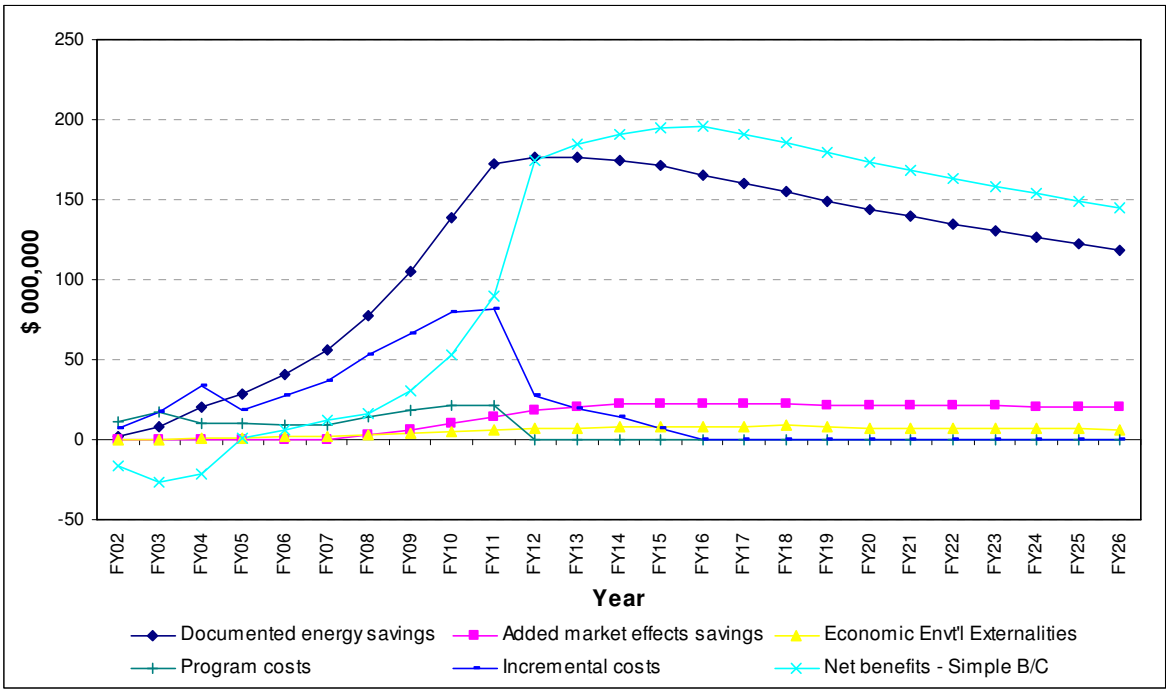
Table 4-11. Business Portfolio: Simple Benefit Cost Components, Historic ($000,000)

B/C Component		FY02	FY11	FY26	NPV FY02 - FY26
Benefits	Documented Energy Savings	$1.7	$172.5	$118.2	$2,004.4
	Added Market Effects Savings	$0.0	$14.6	$20.3	$221.7
	Economic Environmental Externalities	$0.0	$6.6	$6.4	$93.4
Costs	Program Costs	$11.1	$21.9	$0.0	$151.0
	Incremental Costs	$6.7	$81.7	$0.0	$473.6
	Total Benefits	**$1.8**	**$193.7**	**$145.0**	**$2,319.5**
	Total Costs	**$17.8**	**$103.5**	**$0.0**	**$624.6**
				Net Benefits	**$1,695.0**
				B/C Ratio	**3.7**

The Business Programs as a whole achieves positive net benefits in FY05—early in the program cycle. Documented energy savings dominate these benefits. Incremental costs

are high relative to the documented energy savings in the very early program years, but as the quantity of installed measures increases, the accumulated documented savings exceeds incremental and program benefits. We show the various benefit-cost components by year Figure 4-3.

Figure 4-3. Business Portfolio: Simple Benefit Cost Components, Historic



4.3.2 Expanded test – business portfolio

The expanded b/c tests for Business Programs take into account the total effects of program activities on the state economy. In addition to documented energy savings and economic environmental externalities, the economic impact analysis incorporates the effects of non-economic externalities, NEBs and most importantly, economic impacts. We combine the results of the economic impact analysis with non-economic externalities to arrive at total program benefits under the expanded benefit-cost test. In Table 4-12, we show the inputs to the economic impact model, as well as the results of the economic impact analysis for the Business Programs. The NPV of the net economic impact of the benefits streams is approximately 85 percent greater than the direct sum of these benefits. This is, the economic multiplier effect is about 1.85.

The b/c ratio for the expanded test is substantially higher than for the simple test, with overall net benefits of $7 billion over the analysis period and b/c ratio of 12.3. The majority of this increase comes from the economic impacts adder, that is, the effect of counting the full value of the benefits in the economy rather than only their direct effects.

The results reported here are substantially higher than those reported in 2007. Program costs are comparable to those included in the 2007 analysis (high scenario) with our estimates of incremental costs approximately 40 percent higher than estimated in 2007. We revised incremental cost estimates based on two additional program years of data and the recently completed Business Programs incremental cost study.

Our estimates of documented energy saving estimates for business programs are substantially higher than in 2007. This is due to better program performance in the two program years subsequent to the last analysis and the inclusion of E&T benefits documented in the E&T evaluation.[14] In addition, in this analysis we calculated substantially higher non-economic environmental externalities by correcting an error in the previous calculations. We also re-estimated NEBs, which reduced these savings. Previously, we calculated NEBs as recurring, when in most cases they were one-time benefits. The results of these two corrections roughly cancelled each other out.

We refined our savings estimates for lighting measures in the b/c analysis. In the 2007 analysis, we grouped all lighting measures together for measure life, attribution, and incremental costs. In this analysis, we separated CFLs from other lighting types. CFLs have a shorter measure life, lower incremental costs and a higher attribution level (resulting in higher net savings), relative to the other lighting measures. The impacts of this refinement on the overall Business Portfolio are positive, and affected different sectors to varying degrees.

Table 4-12. Business Portfolio: Expanded Benefit Cost Components, Historic ($000,000)

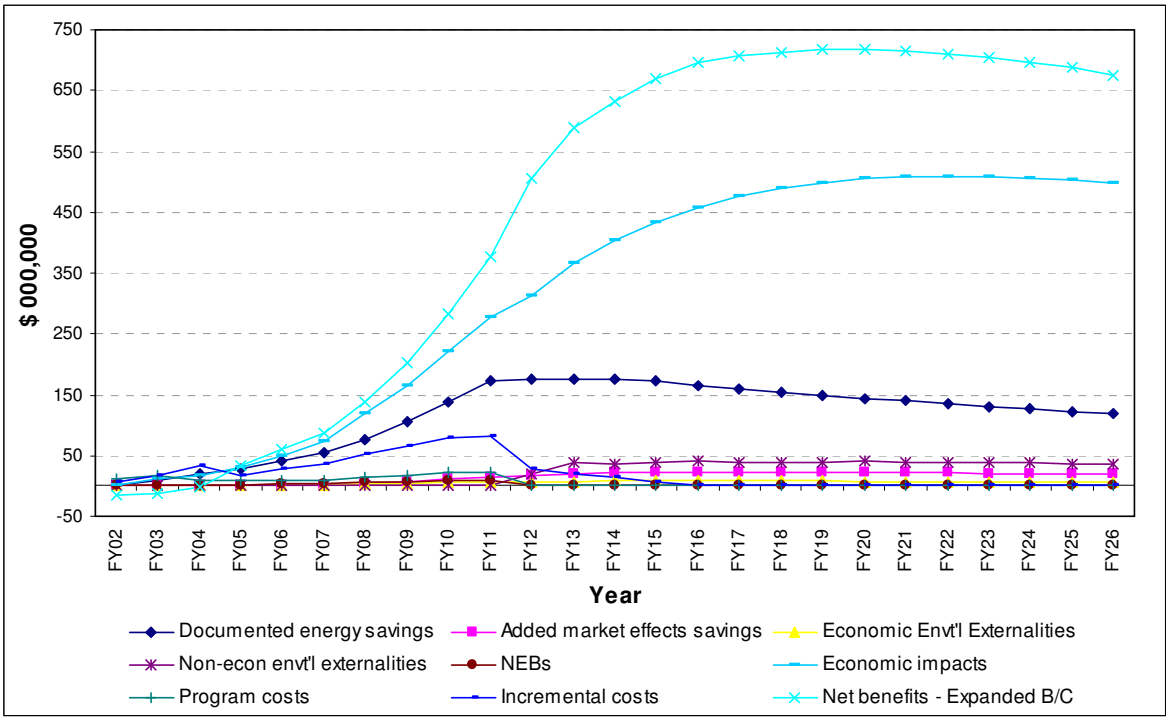
B/C Component		FY02	FY11	FY26	NPV FY02 - FY26
Benefits	Documented Energy Savings	$1.7	$172.5	$118.2	$2,004.4
	Added Market Effects Savings	$0.0	$14.6	$20.3	$221.7
	Economic Environmental Externalities	$0.0	$6.6	$6.4	$93.4
	Non-economic Environmental Externalities	$0.0	$0.0	$34.7	$329.0
	Non-Energy Benefits (NEBs)	$0.6	$8.4	$0.0	$43.8
	Regional Economic Impacts	$1.2	$277.5	$496.4	$4,990.7
Costs	Program Costs	$11.1	$21.9	$0.0	$151.0
	Incremental Costs	$6.7	$81.7	$0.0	$473.6
	Total Benefits	**$3.5**	**$479.6**	**$676.1**	**$7,683.1**
	Total Costs	**$17.8**	**$103.5**	**$0.0**	**$624.6**
				Net Benefits	**$7,058.5**
				B/C Ratio	**12.3**

We show the annual benefit and cost streams that drive the b/c calculation in Figure 4-4. In the post-program years, economic impacts increase substantially over documented energy savings and dominate the net benefits. Documented energy savings is also a large (but smaller) contributor to net savings. The net benefit is the economic impact, documented and market effect savings plus non-economic avoided externality minus program spending and customer incremental costs. In the post–program years, program spending is 0 and customer incremental costs are small. The non-economic avoided externality is a multiplier of the sum of documented savings and is small compared to total benefits in all years.

[14] Christopher Dyson, Ken Agnew, Miriam Goldberg, and Claire Palmgren, KEMA, Inc. *Focus on Energy Evaluation, Impact Evaluation of the Education and Training Program.* November 20, 2008.

NEBs are roughly a multiplier of the first-year savings and are very small in post-program years with limited annual market effect savings.

Figure 4-4. Business Portfolio: Expanded Benefit Cost Components, Historic



4.3.3 Simple test – individual program results

In this sub-section, we show the results for each of the individual Business programs. These results are based on the simple test, which counts only documented energy savings and added market effects as program benefits.

As shown in Table 4-13, all Business sectors contribute to the positive overall performance of the Business Portfolio. All four sectors have simple b/c ratios of at least 3.2. The Industrial sector contributes the greatest net savings to the Business Portfolio, with 57 percent of net savings. The commercial sector contributes an additional 28 percent of the net savings.

Table 4-13. Individual Business Programs: Simple Benefit Cost Components, Historic 25 Year NPV ($000,000)

B/C Component	Agriculture	Commercial	Industrial	Schools and Government
Documented Savings	$97.4	$504.5	$1,157.7	$244.9
Market Effects	$6.2	$63.6	$134.1	$17.8
Externalities	$6.6	$29.1	$47.2	$10.5
Program Costs	$18.1	$40.5	$62.3	$30.2
Incremental Costs	$14.0	$88.1	$316.9	$54.5
Net Benefits	**$78.1**	**$468.6**	**$959.7**	**$188.5**
B/C Ratio	**3.43**	**4.64**	**3.53**	**3.2**

A. AGRICULTURE SECTOR

Business Programs activities targeting the Agricultural sector help farmers and agricultural producers to reduce energy, increase profits, and enhance productivity.

The net benefits of the Agricultural sector program approach $80 million over the 25-year timeframe of analysis. This results in a b/c ratio of 3.4. Documented energy savings dominate program benefits. Unlike other programs, the program costs are comparable, but slightly higher than customer incremental costs. (For most other Focus programs customer incremental costs dominate the costs.)

Table 4-14. Agriculture Program: Simple Benefit Cost Components, Historic ($000,000)

B/C Component		FY02	FY11	FY26	NPV FY02 - FY26
Benefits	Documented Energy Savings	$0.0	$8.9	$5.8	$97.4
	Added Market Effects Savings	$0.0	$0.1	$0.9	$6.2
	Economic Environmental Externalities	$0.0	$0.5	$0.5	$6.6
Costs	Program Costs	$0.6	$2.7	$0.0	$18.1
	Incremental Costs	$0.1	$2.6	$0.0	$14.0
	Total Benefits	**$0.0**	**$9.5**	**$7.2**	**$110.2**
	Total Costs	**$0.7**	**$5.3**	**$0.0**	**$32.1**
				Net Benefits	**$78.1**
				B/C Ratio	**3.4**

B. COMMERCIAL SECTOR

The Commercial Sector activity supports small and large commercial business owners seeking to improve the energy efficiency of their facilities.

High documented savings contribute to the net benefits approaching $470 million, with a b/c ratio of 4.6. Market effects contribute eleven percent to program benefits, with economic environmental externalities contributing an additional five percent.

Table 4-15. Commercial Program: Simple Benefit Cost Components, Historic ($000,000)

B/C Component		FY02	FY11	FY26	NPV FY02 - FY26
Benefits	Documented Energy Savings	$0.6	$45.1	$29.2	$504.5
	Added Market Effects Savings	$0.0	$3.7	$6.6	$63.6
	Economic Environmental Externalities	$0.0	$2.1	$2.1	$29.1
Costs	Program Costs	$5.5	$5.2	$0.0	$40.5
	Incremental Costs	$2.3	$14.3	$0.0	$88.1
	Total Benefits	**$0.6**	**$50.8**	**$37.9**	**$597.2**
	Total Costs	**$7.8**	**$19.5**	**$0.0**	**$128.6**
				Net Benefits	**$468.6**
				B/C Ratio	**4.6**

C. INDUSTRIAL SECTOR

The Industrial program facilitates energy efficiency improvements for owners and mangers of industrial facilities of all sizes.

Consistent with the other Business sectors, simple b/c test results for the Industrial sector programs yield positive net benefits over the 25-year period of analysis. Documented energy savings three times program and incremental costs contribute to a b/c ratio of 3.5. Added market effects include sustained adoptions of premium efficiency motors, T8 replacements for HID in high-bay applications and pulp and paper efficiency improvements related to the Focus *Guidebook.*

Table 4-16. Industrial Program: Simple Benefit Cost Components, Historic ($000,000)

B/C Component		FY02	FY11	FY26	NPV FY02 - FY26
Benefits	Documented Energy Savings	$0.8	$95.5	$70.4	$1,157.7
	Added Market Effects Savings	$0.0	$10.1	$10.8	$134.1
	Economic Environmental Externalities	$0.0	$3.3	$3.2	$47.2
Costs	Program Costs	$4.1	$8.9	$0.0	$62.3
	Incremental Costs	$3.2	$56.4	$0.0	$316.9
	Total Benefits	**$0.8**	**$108.9**	**$84.4**	**$1,338.9**
	Total Costs	**$7.3**	**$65.3**	**$0.0**	**$379.2**
				Net Benefits	**$959.7**
				B/C Ratio	**3.5**

D. SCHOOLS AND GOVERNMENT

The Schools and Government sector activities help schools and local governments improve existing buildings and install energy-efficient lighting, heating, and cooling equipment.

Consistent with the other Business sectors, simple b/c test results for the Schools and Government sector program yields positive net benefits over the 25-year period of analysis. Documented energy savings approaching three times program and incremental costs contribute 90 percent of the benefits that result in a b/c ratio of 3.2. Added market effects and Economic Environmental Externalities comprise the remainder of the benefits.

Table 4-17. Schools and Government Program: Simple Benefit Cost Components, Historic ($000,000)

B/C Component		FY02	FY11	FY26	NPV FY02 - FY26
Benefits	Documented Energy Savings	$0.3	$22.9	$12.8	$244.9
	Added Market Effects Savings	$0.0	$0.8	$2.0	$17.8
	Economic Environmental Externalities	$0.0	$0.7	$0.7	$10.5
Costs	Program Costs	$0.9	$5.1	$0.0	$30.2
	Incremental Costs	$1.2	$8.4	$0.0	$54.5
	Total Benefits	**$0.3**	**$24.5**	**$15.6**	**$273.2**
	Total Costs	**$2.1**	**$13.4**	**$0.0**	**$84.7**
				Net Benefits	**$188.5**
				B/C Ratio	**3.2**

4.4 RENEWABLES PORTFOLIO

4.4.1 Simple test – renewables portfolio

We performed the benefit-cost analysis using the simple benefit-cost test at the Portfolio and technology level for each of six technology groups: photovoltaic (PV); wind; solar water heating (SWH); biogas; non-residential wood burning of bio-solids (Biomass); and Other. We summarize the disaggregated b/c results for these renewable technologies in Table 4-18 below.

The net present value (NPV) of Renewables Program benefits and costs for the 25-year period of analysis results in a b/c ratio of 0.9, with net benefits less than 0. Based on the results of the simple benefit-cost test applied here, the current portfolio of renewable energy programs is just short of being cost effective.

As shown in Figure 4-5 the Renewables Portfolio has positive net benefits only after the program is no longer operating. After program funding stops, there are no program costs. The only costs are fuel costs for the purchased biomass, which is offset by the steady stream of benefits from the installed renewable energy systems.

Since we do not expect the individual Renewables Programs to yield savings from market effects, the total benefits are attributable to documented energy savings and avoided emissions benefits only. The steady stream of energy savings from renewable energy projects does not completely offset the high customer incremental costs plus program costs during the analysis period. Only one of the individual programs, biomass, resulted in positive net benefits and a b/c ratio greater than 1 for the simple test.

Figure 4-5. Renewables Portfolio: Simple Benefit Cost Components, Historic

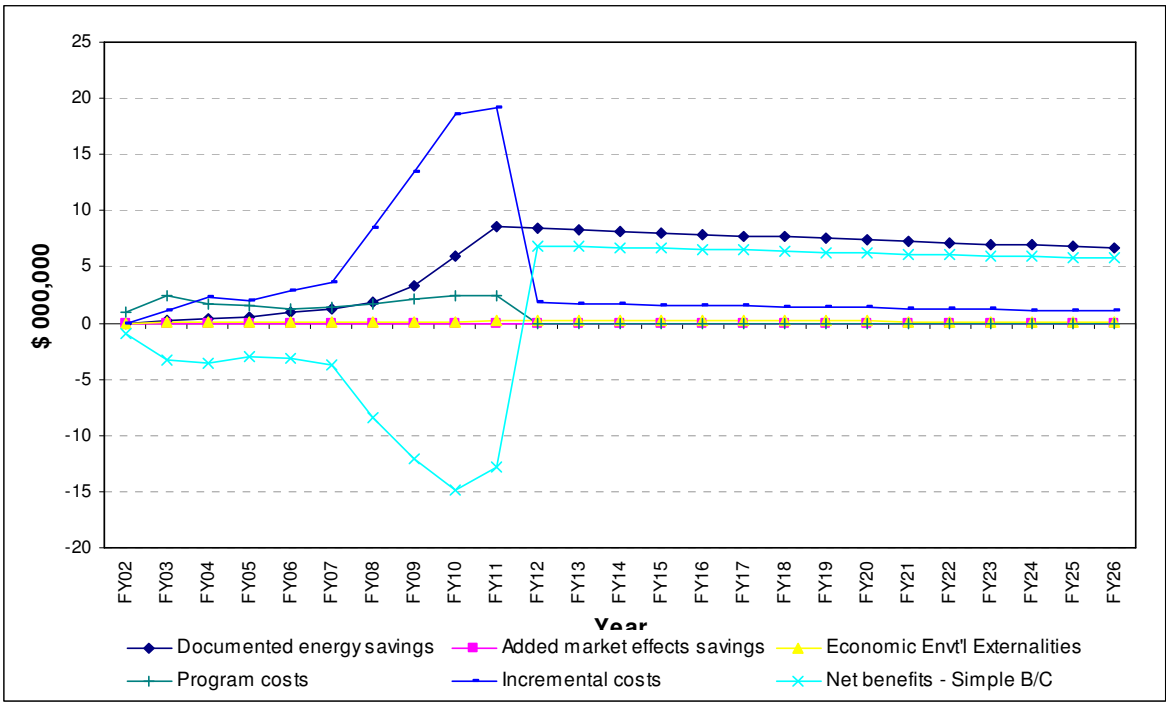


Table 4-18. Renewables Portfolio: Simple Benefit Cost Components, Historic ($000,000)

B/C Component		FY02	FY11	FY26	NPV FY02 - FY26
Benefits	Documented Energy Savings	$0.0	$8.6	$6.7	$90.0
	Added Market Effects Savings	$0.0	$0.0	$0.0	$0.0
	Economic Environmental Externalities	$0.0	$0.2	$0.1	$2.0
Costs	Program Costs	$1.0	$2.4	$0.0	$19.2
	Incremental Costs	$0.0	$19.2	$1.1	$81.0
	Total Benefits	**$0.0**	**$8.8**	**$6.8**	**$92.0**
	Total Costs	**$1.0**	**$21.6**	**$1.1**	**$100.2**
				Net Benefits	**($8.2)**
				B/C Ratio	**0.9**

These findings are substantially different (lower) than results reported in the 2007 b/c analysis for several reasons. In this analysis:

- We valued program and incremental costs in real 2009 dollars. The 2007 b/c used nominal values that resulted in an underestimation of costs.
- We included biomass fuel costs (in incremental costs) for biomass systems. We calculated these costs based on fuel costs incurred by biomass participants in the 18 MCP We assumed that all purchased biomass originated in Wisconsin and thus had economic multiplier effects in the expanded test. In the simple test, this

lowered the b/c ratio, while in the expanded test, the effect likely increased the b/c ratio.

- We had two years of additional program data (FY07, FY08, and one-half of FY09 are now based on evaluated program years). We only had to project two and one-half years based on the 2009 budget and 18 MCP program performance. In the 18 MCP attribution rates for biogas were substantially higher, which has the effect of increasing the net incremental costs.
- The overall mix of renewable energy technologies is different from 2007 projections. For example, PV received much more funding and became a larger share of the program. Because the PV program has far greater costs than benefits, this lowers the overall renewable b/c ratio.
- We based avoided kW costs on renewable system generation during the summer system peak. The 2007 b/c study based avoided kW costs on the renewable energy system capacity. This overrepresented avoided costs in the 2007 study.

4.4.2 Expanded Test – Renewables Portfolio

In the expanded analysis, the overall net benefits in the 25-year analysis period exceed $220 million dollars, resulting in a Renewable Portfolio b/c ratio of 3.2. The Regional Economic Benefits are 2.4 times the documented energy savings and alone exceed the program and participant incremental costs. During the program, much of the customer spending on renewable energy systems travels outside the state, leading to short term negative impacts on the state economy; Over the course of the analysis period, however, the avoided energy costs results in an positive economic impact on the state. We show the results of the expanded test for the Renewable Program in Table 4-19.

Table 4-19. Renewables Portfolio: Expanded Benefit Cost Components, Historic ($000,000)

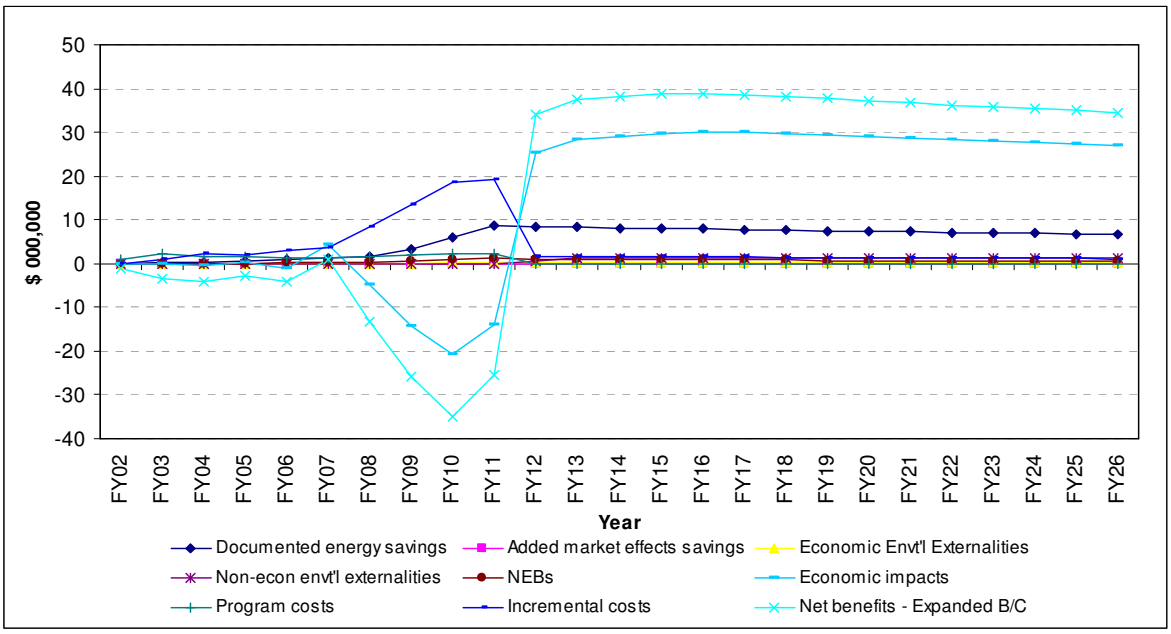
B/C Component		FY02	FY11	FY26	NPV FY02 - FY26
Benefits	Documented Energy Savings	$0.0	$8.6	$6.7	$90.0
	Added Market Effects Savings	$0.0	$0.0	$0.0	$0.0
	Economic Environmental Externalities	$0.0	$0.2	$0.1	$2.0
	Non-economic Environmental Externalities	$0.0	$0.0	$1.1	$10.7
	Non-Energy Benefits (NEBs)	$0.0	$1.1	$0.6	$9.9
	*Regional Economic Impacts**	$0.0	($13.8)	$26.9	$210.0
Costs	Program Costs	$1.0	$2.4	$0.0	$19.2
	Incremental Costs	$0.0	$19.2	$1.1	$81.0
	Total Benefits	**$0.0**	**($3.9)**	**$35.4**	**$322.6**
	Total Costs	**$1.0**	**$21.6**	**$1.1**	**$100.2**
				Net Benefits	**$222.4**
				B/C Ratio	**3.2**

* Negative regional impacts are possible for a given year when program expenditures (primarily incremental costs) are high and leave Wisconsin.

We show the annual benefit and cost streams that drive the expanded benefit-cost calculations in Figure 4-6. The program achieves net benefits starting in FY06 primarily due to the regional economic benefits. The expanded test includes additional benefits, but no additional costs. The documented energy savings are supplemented substantially by economic impacts associated with these benefits. Non-energy benefits and avoided externalities are multipliers of documented savings; their shapes are similar to that of the documented savings, but at a smaller level. Other components displayed in the figure are the same as shown for the simple b/c test.

The majority in the increase in the b/c ratio compared to the simple test comes from the Regional Economic Impacts, which adds 230 percent to the simple test net benefits. Non-economic environmental externalities and NEBs contribute an additional 11 percent each, respectively. The economic impact adder also increases by the inclusion of these additional benefits. Overall, the expanded test increases the overall net benefits by 250 percent beyond the simple b/c test.

Figure 4-6. Renewables Portfolio: Expanded Benefit Cost Components, Historic



4.4.3 Simple Test – individual program results

We show the benefit-cost results using the simple test for each of the individual renewable technologies in this section. The simple test counts documented energy savings, and avoided economic environmental externalities as program benefits.

Table 4-20 provides 25-year NPV for expected benefits and costs achieved for each renewable energy technology. Biogas, PV, solar thermal and wind all result in simple benefit-cost ratios below 1.0. In contrast, Biomass and "Other" achieve a simple benefit-cost ratio of greater than one. Biomass achieves a simple b/c ratio of 2.2, and is responsible for the bulk of the program's natural gas savings and for 75 percent of the value of all documented savings. It is this program that brings the simple b/c ratio for the Renewable Portfolio close to 1. The remaining programs (with the exception of "Other")

have incremental costs that alone exceed the combined benefits of documented energy savings and economic environmental externalities.

Table 4-20. Individual Renewables Programs: Simple Benefit Cost Components, Historic 25 Year NPV ($000,000)

B/C Component	Biogas	Thermal Biomass	PV	Solar Thermal	Wind	Other
Documented Savings	$15.9	$71.1	$3.8	$0.9	$0.7	$2.6
Market Effects	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Externalities	$1.3	$0.4	$0.2	$0.0	$0.1	$0.2
Program Costs	$2.6	$2.1	$7.6	$2.6	$3.2	$1.1
Incremental Costs	$22.2	$29.3	$22.7	$4.0	$2.6	$1.0
Net Benefits	**($7.6)**	**$40.1**	**($26.3)**	**($5.8)**	**($5.0)**	**$0.7**
B/C Ratio	**0.7**	**2.3**	**0.1**	**0.1**	**0.1**	**1.3**

A. BIOGAS

The Renewables Program provides financial assistance for commercial, industrial, and agricultural customers who install biogas digester systems. Benefit-cost analysis results shown in Table 4-21 indicate that the biogas program results in negative net benefits and achieves a benefit-cost ratio of less than 1.0. Energy savings associated with the program do not offset the substantial net incremental costs.

Table 4-21. Biogas Program: Simple Benefit Cost Components, Historic ($000,000)

B/C Component		FY02	FY11	FY26	NPV FY02 - FY26
Benefits	Documented Energy Savings	$0.0	$1.5	$1.0	$15.2
	Added Market Effects Savings	$0.0	$0.0	$0.0	$0.0
	Economic Environmental Externalities	$0.0	$0.1	$0.1	$1.2
Costs	Program Costs	$0.0	$0.4	$0.0	$2.6
	Incremental Costs	$0.0	$7.7	$0.0	$22.2
	Total Benefits	**$0.0**	**$1.6**	**$1.1**	**$16.4**
	Total Costs	**$0.0**	**$8.1**	**$0.0**	**$24.8**
				Net Benefits	**($8.4)**
				B/C Ratio	**0.7**

B. BIOMASS

The Renewables Program provides incentives for the development and installation of biomass systems for space and process heat. Benefit-cost analysis results shown in Table 4-22 indicate that the thermal biomass program yields positive net benefits for the 25-year timeframe under consideration. The table shows a benefit/cost ratio of 2.2. This is the highest benefit-cost ratio among the primary renewable energy technologies included in the Renewables Portfolio. Documented energy savings are more than two times customer incremental costs (even though the incremental costs include ongoing fuel costs over the system life).

Table 4-22. Biomass Program: Simple Benefit Cost Components, Historic ($000,000)

B/C Component		FY02	FY11	FY26	NPV FY02 - FY26
Benefits	Documented Energy Savings	$0.0	$6.5	$5.2	$67.2
	Added Market Effects Savings	$0.0	$0.0	$0.0	$0.0
	Economic Environmental Externalities	$0.0	$0.0	$0.0	$0.4
Costs	Program Costs	$0.0	$0.4	$0.0	$2.1
	Incremental Costs	$0.0	$5.3	$1.1	$28.5
	Total Benefits	**$0.0**	**$6.5**	**$5.2**	**$67.5**
	Total Costs	**$0.0**	**$5.7**	**$1.1**	**$30.6**
				Net Benefits	**$36.9**
				B/C Ratio	**2.2**

C. PHOTOVOLTAICS (PV)

The Renewables Program supports the installation of photovoltaic (PV) systems for residential and business customers. As shown in Table 4-23, net benefits for the PV program over the 25-year timeframe under consideration are negative. High program costs and especially high incremental costs far exceed documented energy savings. The result is benefit-cost ratios of 0.1. High customer incremental costs, indicative of the significant upfront capital costs of PV on a per kW basis, exceed documented energy savings by more than five times.

Table 4-23. PV Program: Simple Benefit Cost Components, Historic ($000,000)

B/C Component		FY02	FY11	FY26	NPV FY02 - FY26
Benefits	Documented Energy Savings	$0.0	$0.3	$0.3	$3.6
	Added Market Effects Savings	$0.0	$0.0	$0.0	$0.0
	Economic Environmental Externalities	$0.0	$0.0	$0.0	$0.2
Costs	Program Costs	$1.0	$0.5	$0.0	$7.6
	Incremental Costs	$0.0	$5.1	$0.0	$22.7
	Total Benefits	**$0.0**	**$0.3**	**$0.3**	**$3.8**
	Total Costs	**$1.0**	**$5.6**	**$0.0**	**$30.3**
				Net Benefits	**($26.5)**
				B/C Ratio	**0.1**

D. SOLAR HOT WATER

The Renewables Program provides incentives for the installation of solar water heating systems. Benefit-cost analysis results shown in Table 4-24 indicate that the SHW program yields negative net benefits for the 25-year period under consideration. The b/c ratio is 0.1 for the 25-year time horizon. Customer incremental costs exceed documented energy savings by 400 percent.

Table 4-24. Solar Hot Water Program: Simple Benefit Cost Components, Historic ($000,000)

B/C Component		FY02	FY11	FY26	NPV FY02 - FY26
Benefits	Documented Energy Savings	$0.0	$0.1	$0.1	$0.8
	Added Market Effects Savings	$0.0	$0.0	$0.0	$0.0
	Economic Environmental Externalities	$0.0	$0.0	$0.0	$0.0
Costs	Program Costs	$0.0	$0.7	$0.0	$2.6
	Incremental Costs	$0.0	$0.9	$0.0	$4.0
	Total Benefits	**$0.0**	**$0.1**	**$0.1**	**$0.8**
	Total Costs	**$0.0**	**$1.6**	**$0.0**	**$6.6**
				Net Benefits	**($5.8)**
				B/C Ratio	**0.1**

E. WIND

The Renewables Program supports the installation of wind turbines for residential and business customers. For the wind technology group, net benefits are negative for the simple b/c test. The simple benefit-cost ratio for the 25-year timeframe is 0.1. Combined program and incremental costs substantially outpace documented energy savings over the period under consideration. Participant incremental costs are greater than four times documented energy savings.

Table 4-25. Wind Program: Simple Benefit Cost Components, Historic ($000,000)

B/C Component		FY02	FY11	FY26	NPV FY02 - FY26
Benefits	Documented Energy Savings	$0.0	$0.0	$0.0	$0.6
	Added Market Effects Savings	$0.0	$0.0	$0.0	$0.0
	Economic Environmental Externalities	$0.0	$0.0	$0.0	$0.1
Costs	Program Costs	$0.0	$0.3	$0.0	$3.2
	Incremental Costs	$0.0	$0.2	$0.0	$2.6
	Total Benefits	**$0.0**	**$0.0**	**$0.0**	**$0.7**
	Total Costs	**$0.0**	**$0.5**	**$0.0**	**$5.8**
				Net Benefits	**($5.1)**
				B/C Ratio	**0.1**

F. OTHER

Under the Renewables Program, the “Other” technology category refers to projects that fall outside the other five technology groups. Examples include hydroelectric, a geothermal heat pump, solar space heating and projects that contained a mix of renewable technologies that could not be disaggregated.

As shown in Table 4-26, the “Other” technology category is shown to have positive net benefits for the program period with a benefit-cost ratio of 1.3.

Table 4-26. Other Renewables Programs: Simple Benefit Cost Components, Historic ($000,000)

B/C Component		FY02	FY11	FY26	NPV FY02 - FY26
Benefits	Documented Energy Savings	$0.0	$0.1	$0.1	$2.5
	Added Market Effects Savings	$0.0	$0.0	$0.0	$0.0
	Economic Environmental Externalities	$0.0	$0.0	$0.0	$0.2
Costs	Program Costs	$0.0	$0.0	$0.0	$1.1
	Incremental Costs	$0.0	$0.0	$0.0	$1.0
	Total Benefits	**$0.0**	**$0.1**	**$0.1**	**$2.7**
	Total Costs	**$0.0**	**$0.0**	**$0.0**	**$2.1**
				Net Benefits	**$0.6**
				B/C Ratio	**1.3**

4.5 OVERALL SUMMARY OF HISTORIC SCENARIO

4.5.1 Focus in total

The overall historic Focus on energy program has positive net benefits for the state in both the simple and expanded tests. The overall b/c ratio for the simple test is 2.5, with net benefits approaching $2 billion. For the expanded test, the projected net present value of 10 years of program operations over a 25-year horizon is a net benefit of $8 billion. The expanded test produces net benefits 4 times the value of the simple b/c test.

4.5.2 Summary across portfolios

For the simple b/c analysis both the Residential and Business Program Portfolios have net benefits and positive b/c ratios. (See Figure 4-7.) The Renewable program has net costs in excess of program benefits, but these are minor relative to the size of the Residential and Business programs. The Business programs are the largest contributor to net benefits for the overall portfolio and also have the highest simple b/c ratio (see Table 4-27).

The difference in performance between the three portfolios is consistent with benefit/cost results in other jurisdictions. It is a primarily a function of the incremental measure costs and lifetime savings. Non-residential programs generally have the highest b/c ratios due to the number of highly cost effective measures that have not fully penetrated the market. Renewable energy programs tend to have the lowest b/c ratios because of high incremental costs relative to generation or savings estimates. Renewable incremental costs are high because incremental costs are often full project costs, and because the technologies are relatively new and thus expensive. Residential energy efficiency measures vary in their cost effectiveness, and overall residential portfolios tend to have positive b/c ratios that are lower than non-residential portfolios. A substantial portion of residential savings is from CFLs, which are highly cost effective. Other measures range in their cost effectiveness.

Figure 4-7. Simple Benefits and Costs by Portfolio, Historic 25 Year NPV ($000,000)

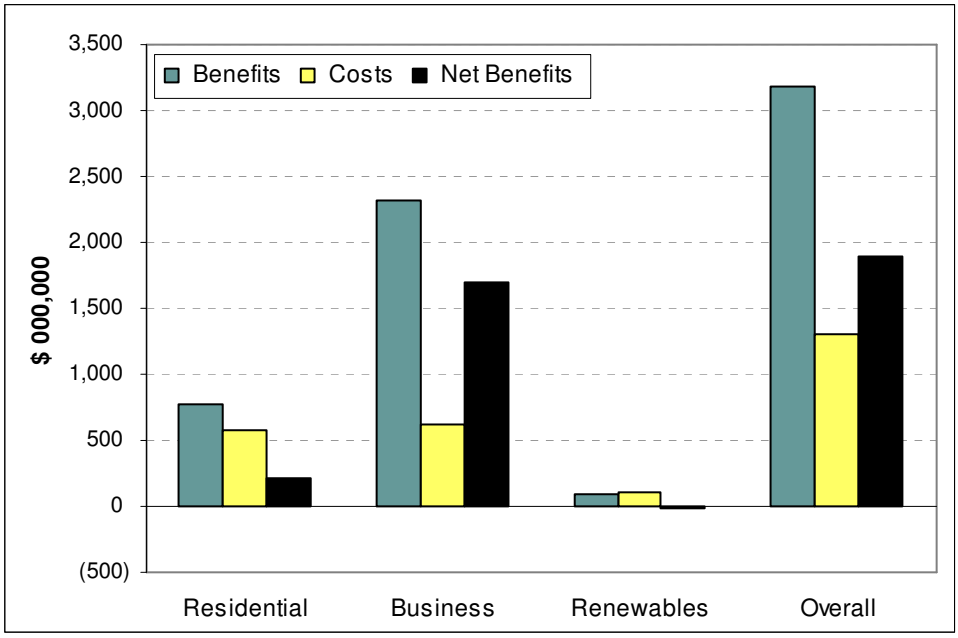


Table 4-27. Simple Benefits and Costs by Portfolio, Historic 25 Year NPV ($000,000)

Program Area	Benefits	Costs	Net Benefits	B/C Ratio
Residential	$778	$572	$206	1.4
Business	$2,320	$625	$1,695	3.7
Renewables	$92	$100	($8)	0.9
Overall	**$3,189**	**$1,297**	**$1,892**	**2.5**

For the expanded b/c test, all Portfolios have net benefits and positive b/c ratios (see Figure 4-8). The Business program continues to dominate net savings. The Renewable Program, however, achieves a positive b/c ratio that exceeds the b/c ratio for the residential program. (See Table 4-28).

Figure 4-8. Expanded Benefits and Costs by Portfolio, Historic 25 Year NPV ($000,000)

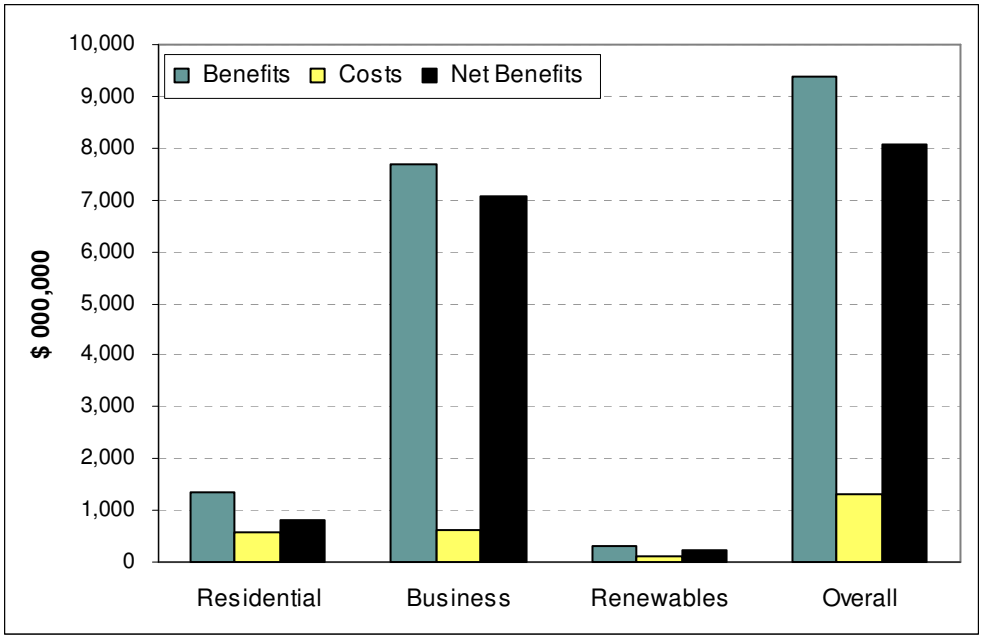


Table 4-28. Expanded Benefits and Costs by Portfolio, Historic 25 Year NPV ($000,000)

Portfolio	Benefits	Costs	Net Benefits	B/C Ratio
Residential	$1,367	$572	$795	2.4
Business	$7,683	$625	$7,059	12.3
Renewables	$323	$100	$222	3.2
Overall	**$9,373**	**$1,297**	**$8,076**	**7.2**

4.5.3 Contributors to Focus Benefits and Costs

We show the value of each component of the benefits and costs in Figure 4-9 and list the exact values in Table 4-29. Overall, the total simple benefits are approximately one third of the expanded benefits. In other words, the expanded test results in net benefits three times the value of the simple test net benefits, mostly resulting from the economic impacts. Overall, documented energy savings and economic impacts drive the benefits side of the equation. Incremental costs drive the costs.

Figure 4-9. Focus on Energy Overall Benefit Cost Components, Historic 25 Year NPV ($000,000)

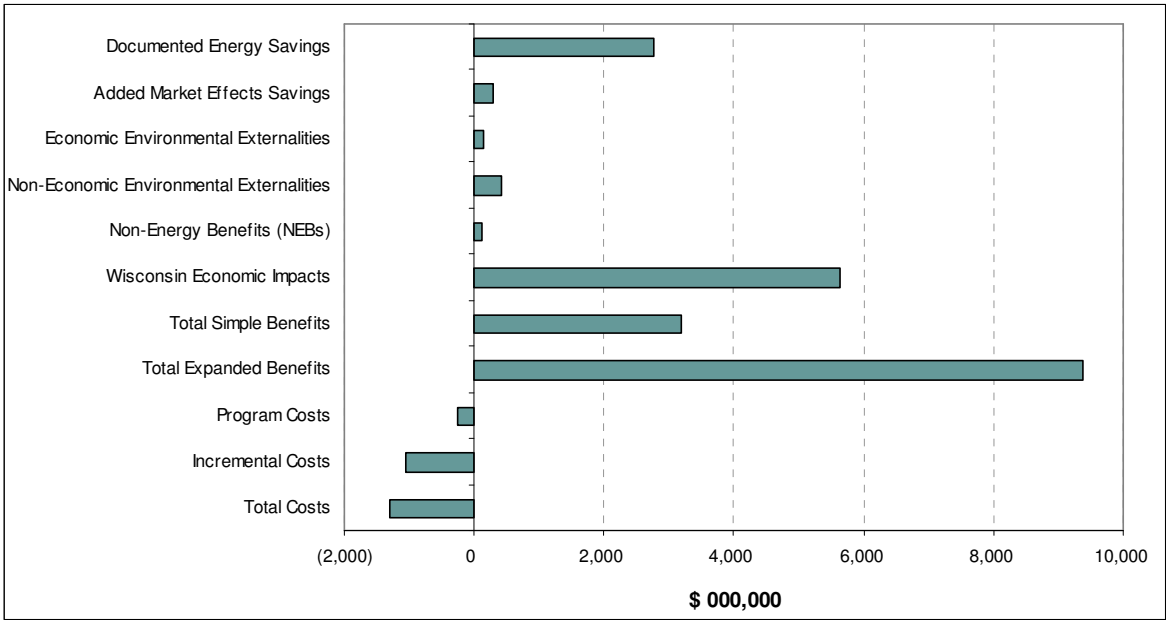


Table 4-29. Benefit Cost Components by Portfolio, Historic 25 Year NPV ($000,000)

B/C Component		Residential	Business	Renewables	Overall Focus on Energy
Simple Benefits	Documented Energy Savings	$666.5	$2,004.4	$90.0	$2,760.9
	Added Market Effects Savings	$73.1	$221.7	$0.0	$294.8
	Economic Environmental Externalities	$38.0	$93.4	$2.0	$133.5
Additional Expanded Benefits	*Non-economic Environmental Externalities*	$92.3	$329.0	$10.7	$432.0
	Non-Energy Benefits (NEBs)	$75.9	$43.8	$9.9	$129.7
	Wisconsin Economic Impacts	$421.5	$4,990.7	$210.0	$5,622.2
Costs	Program Costs	$85.7	$151.0	$19.2	$255.9
	Incremental Costs	$486.3	$473.6	$81.0	$1,040.9
	Total Simple Benefits	**$777.6**	**$2,319.5**	**$92.0**	**$3,189.1**
	Total Expanded Benefits	**$1,367.3**	**$7,683.1**	**$322.6**	**$9,373.0**
	Total Costs	**$572.0**	**$624.6**	**$100.2**	**$1,296.8**
				Net Benefits	**$8,076.2**
				B/C Ratio	**7.2**

5. FINDINGS: FORWARD-LOOK SCENARIO

5.1 GENERAL

The Public Service Commission of Wisconsin (PSCW) asked the evaluation team to evaluate objectively the costs and benefits associated with investing in the savings identified in the ECW Potential Report.[15] The intent of this analysis is to provide a b/c assessment of this potential that is roughly comparable to the historic assessment, in order to inform planning and future program funding.

In this section, we report the findings of this benefit/cost assessment. The ECW study estimated potential savings for an aggressive statewide program that replaces the existing program. The b/c analysis below is for the savings identified in the ECW potential study and is not a projection of current program activities into future years.

For each Focus on Energy Portfolio, we performed a series of simple and expanded benefit-cost tests for this forward-look scenario. We repeated the same simple and expanded benefit/cost test for each portfolio as a whole. In addition, we completed the simple benefit-cost test performed for individual programs or sectors within each portfolio. We grouped the ECW measures into program areas roughly comparable to the existing programs within the three Portfolios. We provide the results for the simple b/c tests for the forward-look scenario in Appendix F.

Appendices A through C provide details on the various inputs that went into both the historic and forward-look scenarios. Before reporting the results, we provide an overview of the approach and the major assumptions to put this analysis in context.

5.2 ASSUMPTIONS CONSISTENT WITH THE HISTORIC SCENARIO

Many of the basic assumptions used in the forward-look scenario are the same as those used in the historic analysis. These include:

- Discount rates
- Savings load shapes
- Incremental costs: Residential and Business Portfolios – estimated using the same simple paybacks applied to the historic scenario for the Residential and Business Portfolios
- Basic program configurations – we grouped ECW technologies into program groupings consistent with historic programs.
- Utility avoided costs – projected forward.

[15] Energy Center of Wisconsin. *Energy Efficiency and Customer-Sited Renewable Resource Potential in Wisconsin, For the Years 2012 and 2018 – Final Report*. August 2009.

- Avoided emissions costs – projected forward.
- NEBs were based on the same ratios as in the historic scenario.

5.3 ASSUMPTIONS FROM THE ECW STUDY

- *Incentive levels for measure.* These are based on the rates assumed in the ECW Potential study, applied to incremental costs as described above.
- *Measure savings.* The ECW study reports only *net* savings. The ECW team confirmed that net savings includes market effects (and spillover), as well as adjustments for free-ridership.
- *Incremental costs.* For renewable energy systems, we assumed incremental costs to be total project costs, as provided in the ECW report, Appendix B. For Business and Residential portfolio technologies, we applied the same payback ratios used in the historic scenario to the ECW measure costs to estimate incremental costs.

5.4 HYBRID APPROACH FOR PROGRAM COSTS

We used a hybrid approach for calculating the program costs associated with the savings identified by the ECW study. This approach combined values from the ECW study with historic data to estimate program administrative and incentive costs. ECW based the program costs on net savings values. Since the program incurs costs for all participants, this approach underestimates both administrative and incentive costs.

For this b/c analysis, we adjusted the ECW program costs to account for program attribution. Since the ECW report did not identify a specific attribution factor for the Residential and Business Portfolios, we applied the most recent (18 MCP) historic attribution factors to ECW program costs to make this adjustment. The resulting program costs are a slight overestimate for Residential and Business Portfolios because some net impacts not included in the 18MCP attribution factor are included in the ECW estimates. The ECW study includes non-documented market effects and spillover, “added market effects,” while the 18MCP estimates include only documented market effects. Because “added market effects” during the program are a small proportion of total net savings in the 18 MCP, this overestimation of program costs is slight.

The ECW report included a 50 percent attribution factor for the Renewables portfolio. We doubled ECW’s net program and incentive costs to account for this. The net savings in the ECW report are based on the 50 percent attribution assumptions.

5.5 DEVELOPMENT OF 10-YEAR PROGRAM SAVINGS

The ECW study estimated annual energy savings (and renewable generation) for the years 2012 and 2018. To be comparable to the historic scenario, we developed 10-year program estimates for a program operating from 2012 through 2021. To develop these estimates we assumed a linear relationship between the estimated annual savings in 2012 and 2018. We extended this relationship out through 2021 to develop annual estimated energy savings for 2012 through 2021.

We developed the linear relationship on a disaggregated basis for each of the three Portfolios.

- **Residential Portfolio.** First, we assigned each technology to a measure group (e.g., CFLs, clothes washers). Next, we allocated the savings associated with that measure group to a Residential program. We then extrapolated the line between 2012 and 2018 to develop annual estimates by measure group within a program through 2021. (For measures declining in potential, we established 0 as the minimum savings.)

- **Business Portfolio.** First, we assigned each technology to a measure group within a sector (e.g., industrial motors, commercial lighting). The ECW study identified technologies within two large groupings: Industrial and Commercial. We disaggregated Commercial into two groups: "Commercial" and "Schools and Government." All technologies associated with "education" and "public order and safety" were included in Schools and Government. The remainder we retained in the Commercial sector. We then extrapolated the line between 2012 and 2018 to develop annual estimates by measure group within a program through 2021. (For measures declining in potential, we established 0 as the minimum savings.)

- **Renewables Portfolio.** First, we assigned the technologies to one of the five existing technology groups (e.g., Biogas, Biomass). Then we allocated the savings into sectors (Residential and one of the four Business Program sectors) based on historical participation, information in the ECW Potential study report, and professional judgment. We then extrapolated the line between 2012 and 2018 to develop annual estimates by measure group within a program through 2021. (For measures declining in potential, we established 0 as the minimum savings.)

5.6 RESIDENTIAL PORTFOLIO

5.6.1 Simple test – residential portfolio

This section discusses the benefit-cost results associated with the forward-look scenario for the Residential Portfolio. We provide the results for the individual residential program areas on Appendix F. The forward-look Residential Portfolio includes six programmatic areas:

- ENERGY STAR Lighting and Appliances
- Residential HVAC
- New Construction
- Single Family Retrofit
- Multi-family Retrofit
- Water Heating and Thermostats

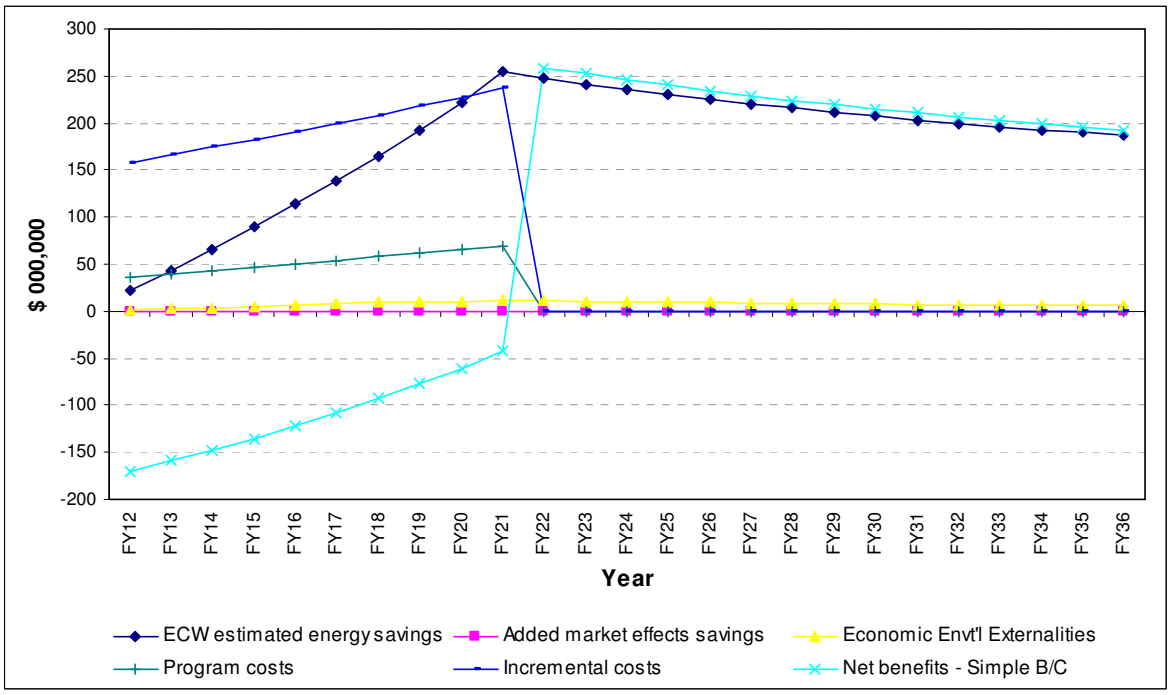
Overall, the forward-look Residential Portfolio results in net benefits, with a b/c ratio of 1.3 over the 25-year period of analysis (see Table 5-1). Incremental participant and program

costs are higher than benefits for the duration of the program (see Figure 5-1). Once the 10-year life of the program ends, the ECW Estimated Energy Savings from measures installed through the program continue, with no additional incremental or program costs, resulting in overall net benefits. Avoided economic externalities (NEBs) are small relative to ECW estimated energy savings, but also continue beyond the program life.

Table 5-1. Residential Portfolio: Simple Benefit Cost Components, Forward-look ($000,000)

B/C Component		FY12	FY21	FY36	NPV FY12 - FY36
Benefits	ECW Estimated Energy Savings	$21.7	$254.3	$186.9	$2,003.1
	Added Market Effects Savings	$0.0	$0.0	$0.0	$0.0
	Economic Environmental Externalities	$1.1	$11.6	$5.8	$88.5
Costs	Program Costs	$35.5	$69.8	$0.0	$340.1
	Incremental Costs	$157.4	$237.6	$0.0	$1,285.6
	Total Benefits	**$22.8**	**$265.9**	**$192.6**	**$2,091.6**
	Total Costs	**$192.9**	**$307.4**	**$0.0**	**$1,625.7**
				Net Benefits	**$465.9**
				B/C Ratio	**1.3**

Figure 5-1 Residential Portfolio: Simple Benefit Cost Components, Forward-look



5.6.2 Expanded test – residential portfolio

In the expanded analysis, the program achieves net benefits starting in FY15 due to the economic benefits and ECW estimated energy program savings. The overall net benefits in the 25-year analysis period exceed $2.5 billion dollars, resulting in a Residential Portfolio b/c ratio of 2.6. We show the results of the expanded test for the Residential Portfolio in Table 5-2.

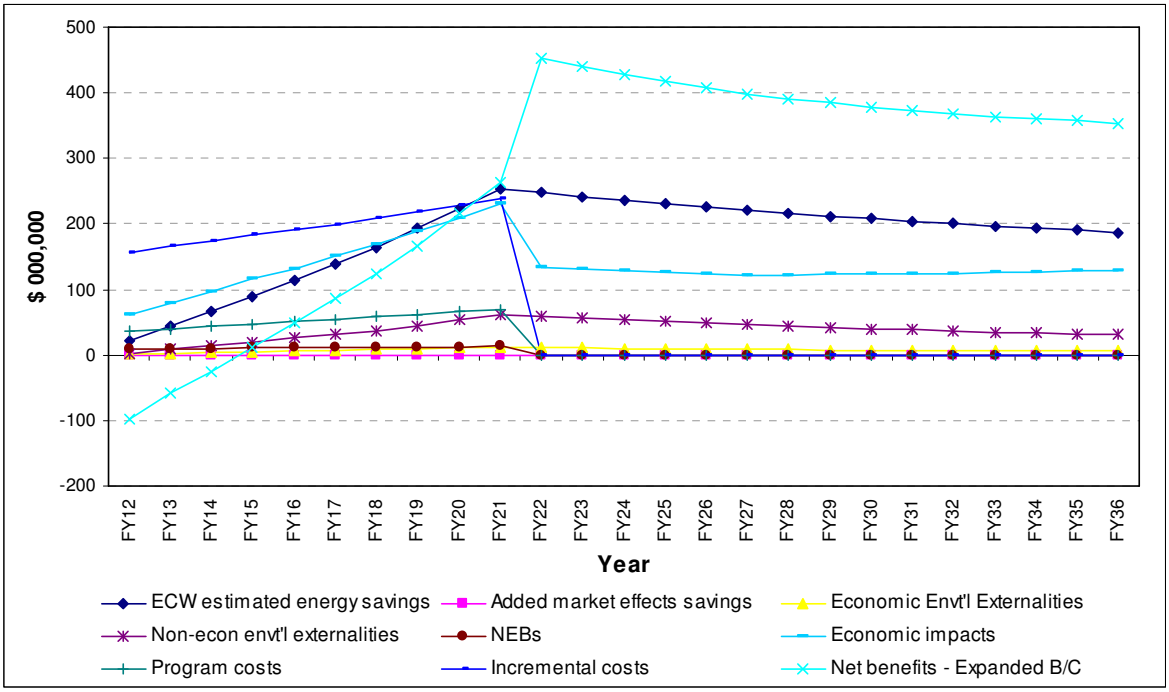
We show the annual benefit and cost streams that drive the expanded benefit-cost calculations in Figure 5-2. The expanded test includes additional benefits, but no additional costs. The ECW estimated energy savings are supplemented substantially by economic impacts associated with these benefits. Non-energy benefits and avoided externalities are multipliers of the sum of ECW estimated energy savings; their shapes are similar to that of the ECW estimated energy savings, but at a smaller level. Other components displayed in the figure are the same as shown for the simple b/c test.

The majority of the increase in the b/c ratio compared to the simple test comes from the regional Economic Impacts, which adds 62 percent to the simple test net benefits. Non-economic environmental externalities and NEBs contribute an additional 11 and 2 percent, respectively. The economic impact adder is also increased by the inclusion of these additional benefits. Overall, the expanded test increases the overall net benefits by 80 percent beyond the simple b/c test.

Table 5-2. Residential Portfolio: Expanded Benefit Cost Components, Forward-look ($000,000)

B/C Component		FY12	FY21	FY36	NPV FY12 - FY36
Benefits	ECW Estimated Energy Savings	$21.7	$254.3	$186.9	$2,003.1
	Added Market Effects Savings	$0.0	$0.0	$0.0	$0.0
	Economic Environmental Externalities	$1.1	$11.6	$5.8	$88.5
	Non-economic Environmental Externalities	$2.5	$60.6	$31.2	$432.6
	Non-Energy Benefits (NEBs)	$9.9	$13.4	$0.0	$73.4
	Wisconsin Economic Impacts	$60.7	$231.3	$130.0	$1,602.0
Costs	Program Costs	$35.5	$69.8	$0.0	$340.1
	Incremental Costs	$157.4	$237.6	$0.0	$1,285.6
	Total Benefits	**$95.9**	**$571.1**	**$353.8**	**$4,199.5**
	Total Costs	**$192.9**	**$307.4**	**$0.0**	**$1,625.7**
				Net Benefits	**$2,573.9**
				B/C Ratio	**2.6**

Figure 5-2. Residential Portfolio: Expanded Benefit Cost Components, Forward-look



5.7 BUSINESS PROGRAMS

5.7.1 Simple test – business portfolio

The Focus on Energy Business Programs help Wisconsin businesses, industries, farms, schools and local governments identify and install energy and cost-saving efficiency measures. We performed benefit-cost analysis for each of four business sectors: Agriculture. Commercial, Industrial, and Schools and Government based on the savings estimates projected in the ECW study. We summarize benefit-cost results for the Portfolio Table 5-3 below. We include sector level results in Appendix F. Figure 5-3 shows the annual stream of benefits and costs for the 25-year period of analysis.

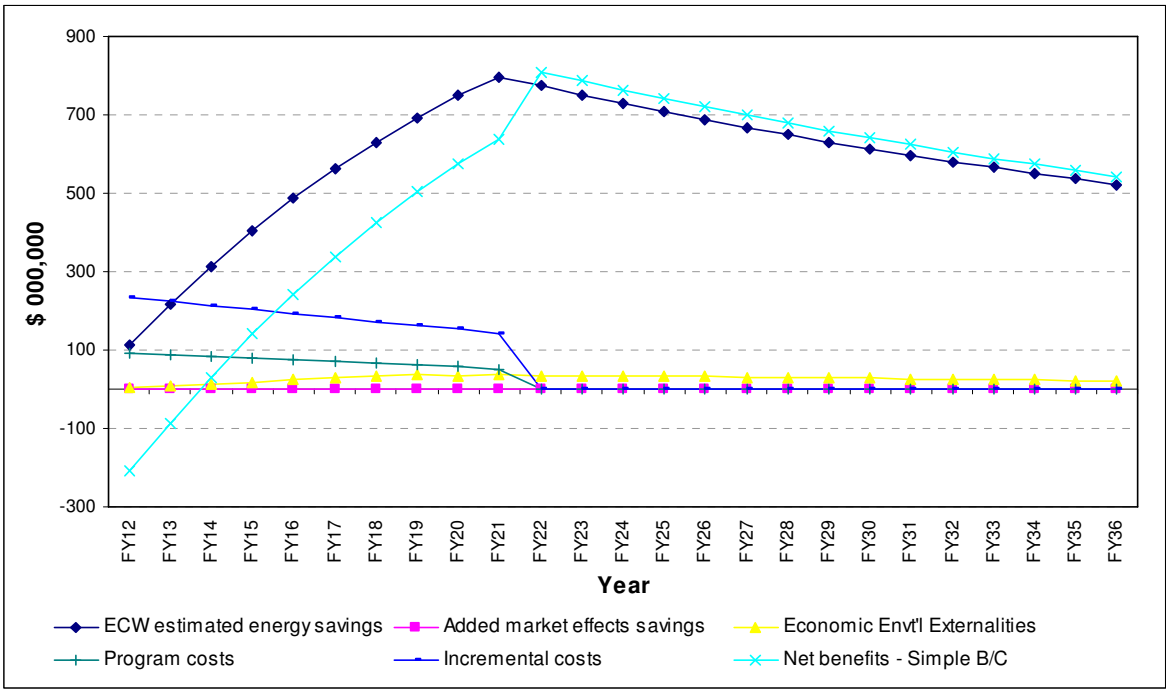
In the simple test, shown in Table 5-3, the historic scenario achieves approximately $7 billion dollars in net benefits over the 25-year analysis period. This is substantially higher than the historic program and results in an overall B/C ratio of 4.0.

Table 5-3. Business Portfolio: Simple Benefit Cost Components, Forward-look ($000,000)

B/C Component		FY12	FY21	FY36	NPV FY12 - FY36
Benefits	ECW Estimated Energy Savings	$111.8	$797.8	$521.6	$6,702.5
	Added Market Effects Savings	$0.0	$0.0	$0.0	$0.0
	Economic Environmental Externalities	$4.6	$35.8	$21.7	$310.7
Costs	Program Costs	$92.0	$52.0	$0.0	$491.5
	Incremental Costs	$233.8	$142.2	$0.0	$1,280.9
	Total Benefits	**$116.3**	**$833.6**	**$543.4**	**$7,013.3**
	Total Costs	**$325.7**	**$194.2**	**$0.0**	**$1,772.5**
				Net Benefits	**$5,240.8**
				B/C Ratio	**4.0**

The Business Program as a whole achieves positive net benefits in FY14, the projected 3rd year of the additional program operations. This is entirely due to the portfolio's ECW estimated energy savings and, to a lesser extent, the associated economic environmental externalities. Net benefits continue throughout the remainder of the analysis period, increasing slightly when the program ends and program costs reach 0.

Figure 5-3. Business Portfolio: Simple Benefit Cost Components, Forward-look



5.7.2 Expanded test – business portfolio

The expanded b/c test for Business Programs take into account the total effects of program activities on the state economy. In addition to ECW Estimated Energy Savings and economic environmental externalities, the economic impact analysis incorporates the effects of non-economic externalities, NEBs, and economic impacts.

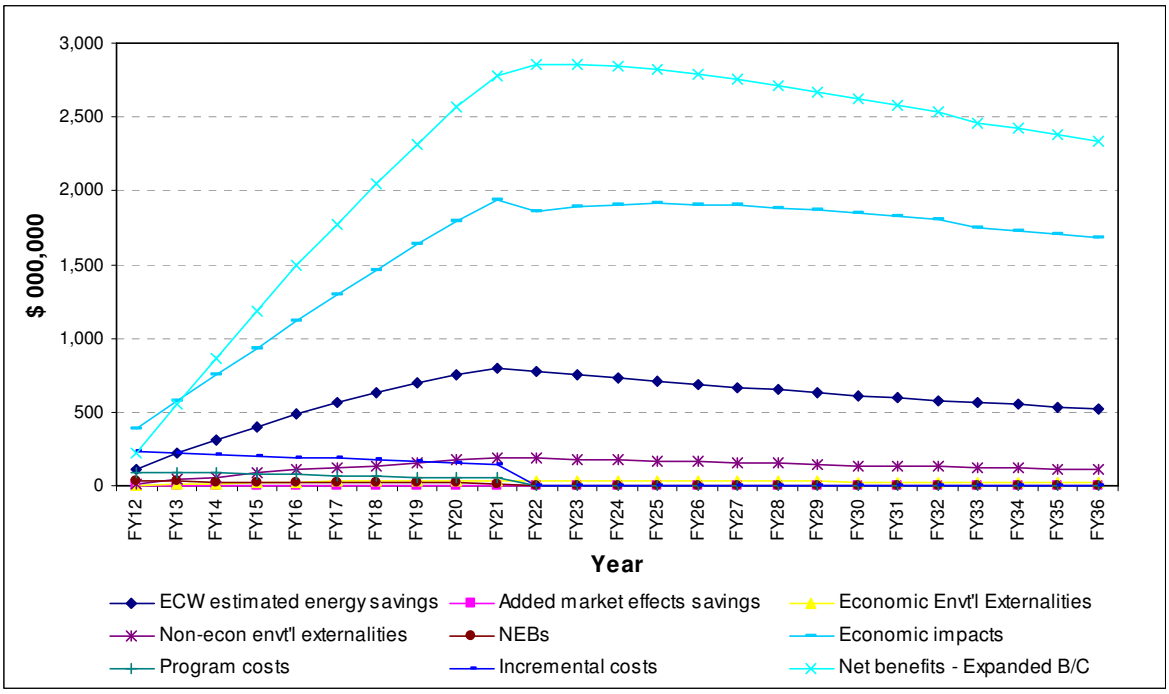
The b/c ratio for the expanded test is substantially higher than for the simple test, with overall net benefits of $24 billion over the 25-year analysis. The result is an expanded b/c ratio of 14.8 (see Table 5-4). The majority of this increase comes from the economic adder, that is, the effect of counting the full value of the benefits in the economy, rather than only the direct effects. Non-economic externalities also contribute to the increased net savings, as well as NEBs (but to a lesser degree).

Table 5-4. Business Portfolio: Expanded Benefit Cost Components, Forward-look ($000,000)

B/C Component		FY12	FY21	FY36	NPV FY12 - FY36
Benefits	ECW Estimated Energy Savings	$111.8	$797.8	$521.6	$6,702.5
	Added Market Effects Savings	$0.0	$0.0	$0.0	$0.0
	Economic Environmental Externalities	$4.6	$35.8	$21.7	$310.7
	Non-economic Environmental Externalities	$11.1	$187.6	$108.7	$1,493.9
	Non-Energy Benefits (NEBs)	$30.5	$16.5	$0.0	$160.5
	Regional Economic Impacts	$391.5	$1,940.3	$1,683.7	$17,621.5
Costs	Program Costs	$92.0	$52.0	$0.0	$491.5
	Incremental Costs	$233.8	$142.2	$0.0	$1,280.9
	Total Benefits	**$549.5**	**$2,978.1**	**$2,335.8**	**$26,289.2**
	Total Costs	**$325.7**	**$194.2**	**$0.0**	**$1,772.5**
				Net Benefits	**$24,516.7**
				B/C Ratio	**14.8**

We show the annual benefit and cost streams that drive the b/c calculation in Figure 5-4. In the expanded scenario to program achieves net benefits in the initial year, with the benefits increasing over the period of program delivery. At the end of the program, net benefits are decreasing, but remain positive. The remaining benefits are those from measures installed through the program, the associated economic adder and small avoided externality benefits.

Figure 5-4. Business Portfolio: Expanded Benefit Cost Components, Forward-look



5.8 RENEWABLES PORTFOLIO

We preformed the benefit-cost analysis using the simple b/c test and expanded test at the portfolio level. We also completed the simple b/c test at the technology level for each of the five technology groups: photovoltaic (PV); wind; solar water heating (SHW); biogas; and biomass-CHP. The grouping are similar to the historic scenario, but some of the technologies vary in size or application. These differences are:

- **Biogas combined heat and power (CHP).** Increasing the amount and types of anaerobic digesters included in the program. The historic program has primarily focused on agricultural applications, where anaerobic digestion of animal waste produces gas that is burned to generate electricity. These projects are included under Biogas.
- **Biogas – to natural gas pipeline.** These projects are included under biogas.
- **Biomass (CHP).** Biomass system will not only provide space and process heat, but some will include electricity generation. These technologies are most applicable to situations where space or process heat is needed and electricity is a by-product. These projects are included under Biomass-CHP.
- **Biomass thermal.** Increasing the applications for biomass thermal. The current program has focused on commercial and industrial space and process heating, primarily with wood. The ECW study identifies additional opportunities for residential space heating. These projects are included under Biomass-CHP.
- **Solar thermal.** These projects include solar hot water systems that augment small (residential size) natural gas and electric water heaters and are included in the existing program. The ECW study also identified opportunities for large-scale

solar hot water to augment larger commercial and industrial applications that have year-round demand for hot water. These projects are included in solar thermal.

- **Solar thermal.** This technology is not included in the current Renewable Energy program, but there are plans to test it in the WPS service territory. The technology uses the sun to preheat make-up air in open buildings (such as barns and warehouses) and enclosed buildings with high ventilation levels. These projects are included in the Solar Thermal program.
- **Solar electric (PV).** The current program includes PV systems for residences and business, with most systems under 20 kW. The ECW study identifies opportunities in commercial applications for large-scale PV (> 20 kW) as prices drop. These projects are included in the PV program.
- **Wind.** The ECW study includes of large-scale wind systems up 1.5 MW. Although usually considered utility-scale, the study identifies the opportunity to erect these size turbines as part of community wind projects.

5.8.1 Simple test – renewables portfolio

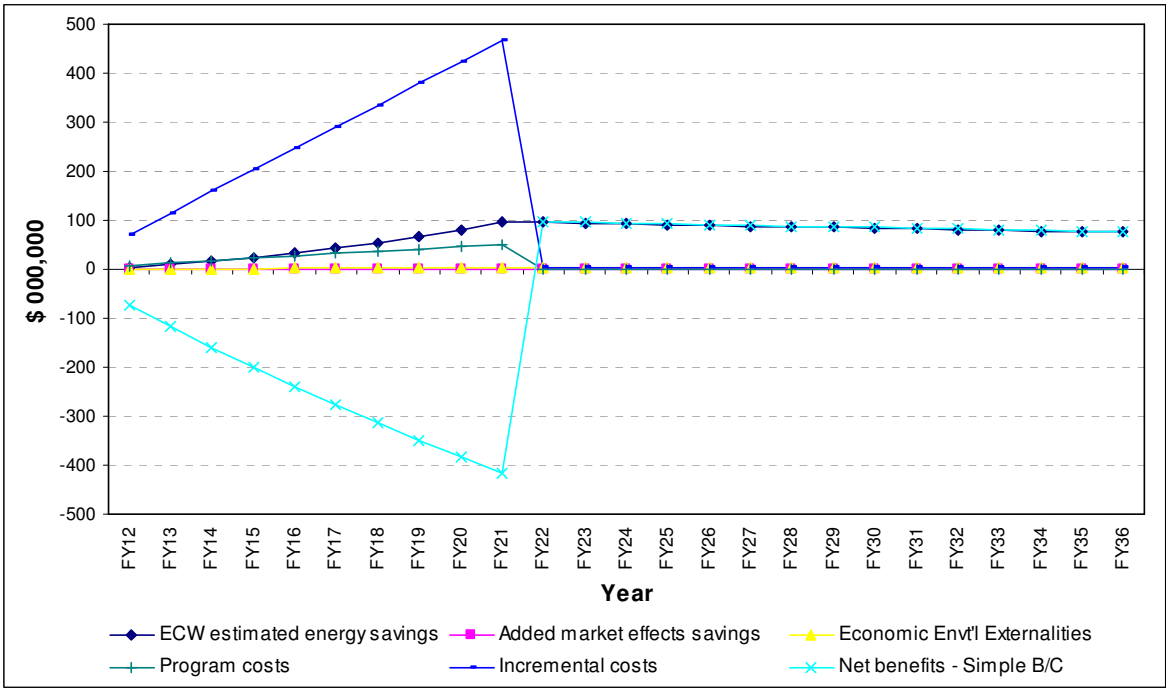
The net present value (NPV) of the forward-look Renewables Portfolio benefits and costs for the 25-year period of analysis results in a b/c ratio of 0.4, with net benefits less than 0. Very high incremental costs swamp the savings associated with the installation of these measures. The ratio of incremental costs to savings is higher in the Renewables forward-look scenario because the forward-look Renewables portfolio has a larger proportion of PV and wind activity. Historic program impacts are predominantly biogas and biomass, while forward-look impacts are dominated by PV and wind, which have lower b/c ratios due to high incremental costs. Program costs, which are minor relative to incremental project costs, have little impact on the b/c ratio.

Table 5-5. Renewables Portfolio:
Simple Benefit Cost Components, Forward-look ($000,000)

B/C Component		FY12	FY21	FY36	NPV FY12 - FY36
Benefits	ECW Estimated Energy Savings	$4.0	$97.2	$75.7	$733.9
	Added Market Effects Savings	$0.0	$0.0	$0.0	$0.0
	Economic Environmental Externalities	$0.2	$4.9	$3.0	$36.5
Costs	Program Costs	$7.8	$51.3	$0.0	$184.1
	Incremental Costs	$70.9	$466.8	$1.9	$1,689.3
	Total Benefits	**$4.2**	**$102.1**	**$78.8**	**$770.4**
	Total Costs	**$78.7**	**$518.1**	**$1.9**	**$1,873.4**
				Net Benefits	**($1,103.0)**
				B/C Ratio	**0.4**

As shown in Figure 5-5 the Renewable Energy Portfolio has positive net benefits only after the program has stopped operating. After program funding stops, there are no program costs and the benefits from the installed systems continue to accrue. The only ongoing costs are for the purchased biomass, which is offset by the steady stream of benefits.

Figure 5-5. Renewables Portfolio: Simple Benefit Cost Components, Forward-look



5.8.2 Expanded test – renewables portfolio

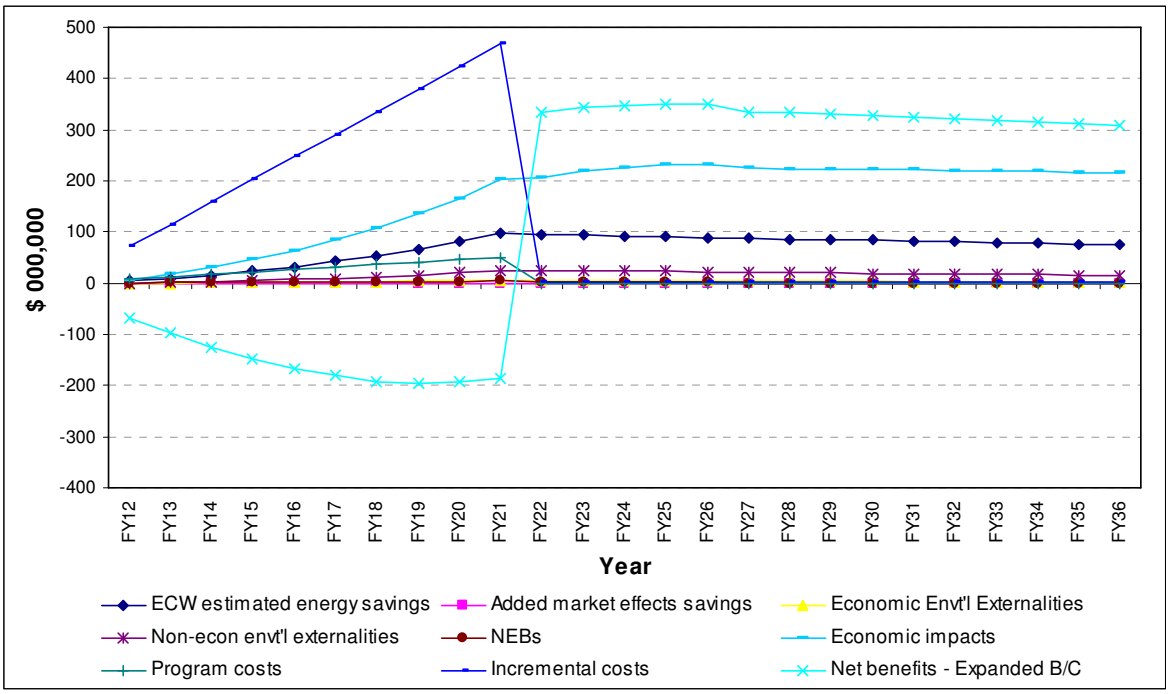
In the expanded analysis, the overall net benefits in the 25-year analysis period exceed $830 million, resulting in an expanded test b/c ratio of 1.4. The regional Economic Impacts are 2.4 times the ECW Estimated Energy Savings and alone exceed the program and participant incremental costs. We show the results for the expanded test for the Renewable program in Table 5-6.

Table 5-6. Renewables Portfolio: Expanded Benefit Cost Components, Forward-look ($000,000)

B/C Component		FY12	FY21	FY36	NPV FY12 - FY36
Benefits	ECW Estimated Energy Savings	$4.0	$97.2	$75.7	$733.9
	Added Market Effects Savings	$0.0	$0.0	$0.0	$0.0
	Economic Environmental Externalities	$0.2	$4.9	$3.0	$36.5
	Non-economic Environmental Externalities	$0.4	$25.1	$15.4	$176.2
	Non-Energy Benefits (NEBs)	$0.3	$3.8	$0.0	$19.8
	Regional Economic Impacts	$6.2	$202.5	$215.3	$1,737.6
Costs	Program Costs	$7.8	$51.3	$0.0	$184.1
	Incremental Costs	$70.9	$466.8	$1.9	$1,689.3
	Total Benefits	**$11.2**	**$333.5**	**$309.4**	**$2,704.1**
	Total Costs	**$78.7**	**$518.1**	**$1.9**	**$1,873.4**
				Net Benefits	**$830.7**
				B/C Ratio	**1.4**

We show the annual benefit and cost streams that drive the expanded b/c calculations in Figure 5-6. The program achieves net benefits starting the year after the program ends. The majority of the net benefits are associated with the economic impacts. The expanded test includes additional benefits, but no additional costs. The ECW estimated energy savings are supplemented substantially by economic impacts associated with these benefits. Non-energy benefits and avoided externalities are multipliers of ECW estimated energy savings; their shapes are similar to that of the ECW estimated energy, but at a smaller level.

Figure 5-6. Renewables Portfolio: Expanded Benefit Cost Components, Forward-look



5.9 OVERALL SUMMARY OF FORWARD-LOOK SCENARIO

5.9.1 Forward-look in total

The overall forward-look scenario has positive net benefits for the state in both the simple and expanded tests. The overall b/c ratio for this simple test is 1.9 with net benefits of $4.6 billion over the 25-year period of analysis. For the expanded test, the projected net present value of 10 years of program operations over a 25-year horizon is a net benefit of almost $28 billion. The expanded test produces net benefits almost six times the value of the simple b/c test.

5.9.2 Summary across portfolios

For the simple b/c analysis both the Residential and Business Portfolios have net benefits and positive b/c ratios. (See Figure 5-7) The Renewables program has net costs in excess of program benefits, but these are minor relative to the size of the Residential and Business programs. The Business portfolio is the largest contributor to net benefits overall and has the highest b/c ratio of any of the portfolios (see Table 5-7).

Figure 5-7. Simple Benefits and Costs by Portfolio
Forward-look 25 Year NPV ($000,000)

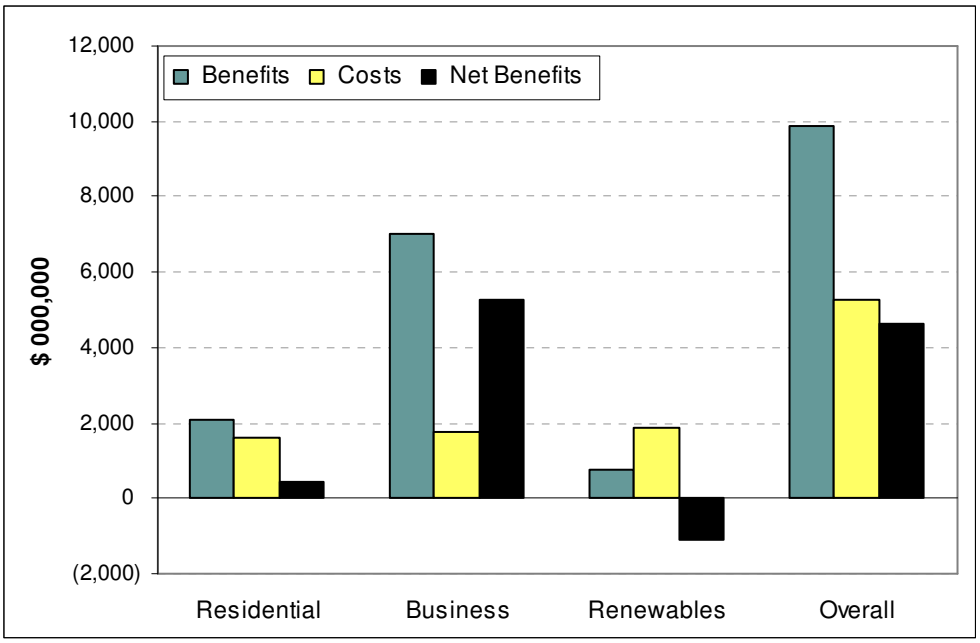


Table 5-7. Simple Benefits and Costs by Portfolio,
Forward-look 25 Year NPV ($000,000)

Portfolio	Benefits	Costs	Net Benefits	B/C Ratio
Residential	$2,092	$1,626	$466	1.29
Business	$7,013	$1,772	$5,241	3.96
Renewables	$770	$1,873	($1,103)	0.41
Overall	**$9,875**	**$5,272**	**$4,604**	**1.87**

For the expanded b/c test all portfolios have net benefits and positive b/c ratios (see Figure 5-8). The Business portfolio continues to dominate net savings. The Renewables portfolio achieves a positive b/c ratio in the expanded test (see Table 5-8).

Figure 5-8. Expanded Benefits and Costs by Portfolio Forward-look 25 Year NPV ($000,000)

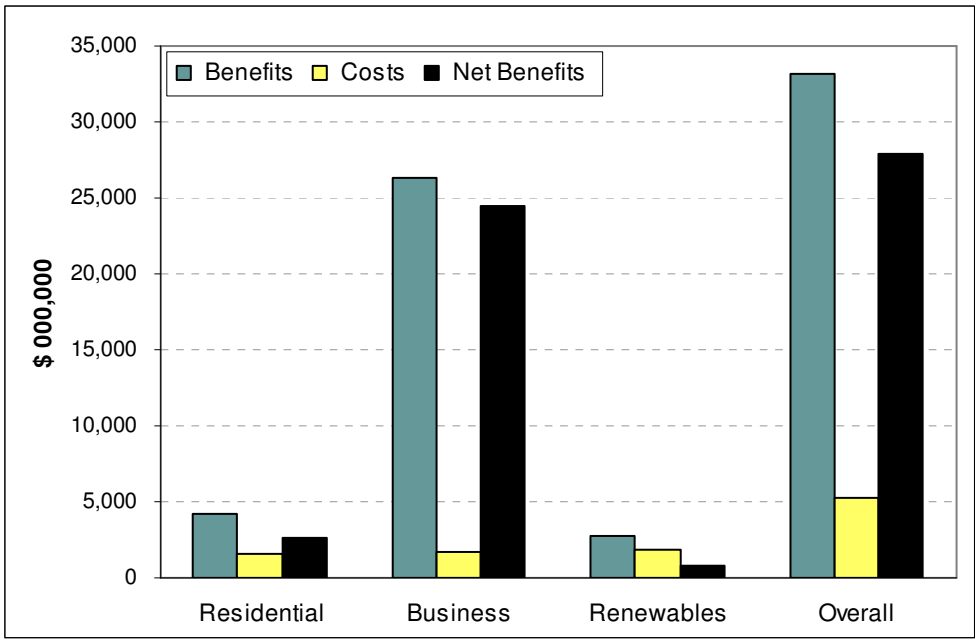


Table 5-8. Expanded Benefits and Costs by Portfolio Forward-look 25 Year NPV ($000,000)

Portfolio	Benefits	Costs	Net Benefits	B/C Ratio
Residential	$4,200	$1,626	$2,574	2.58
Business	$26,289	$1,772	$24,517	14.83
Renewables	$2,704	$1,873	$831	1.44
Overall	**$33,193**	**$5,272**	**$27,921**	**6.30**

5.9.3 Contributors to forward-look benefits and costs

We show the value of each component of the benefits and costs in Figure 5-9 and list the exact values in Table 5-9. Overall, the total simple benefits are approximately 40 percent of the expanded benefits. Overall, the expanded test results in net benefits 2.5 times the value of the simple test net benefits, largely because of the economic inputs.

Figure 5-9. Overall Simple and Expanded Benefit Cost Components, Forward-look 25 Year NPV ($000,000)

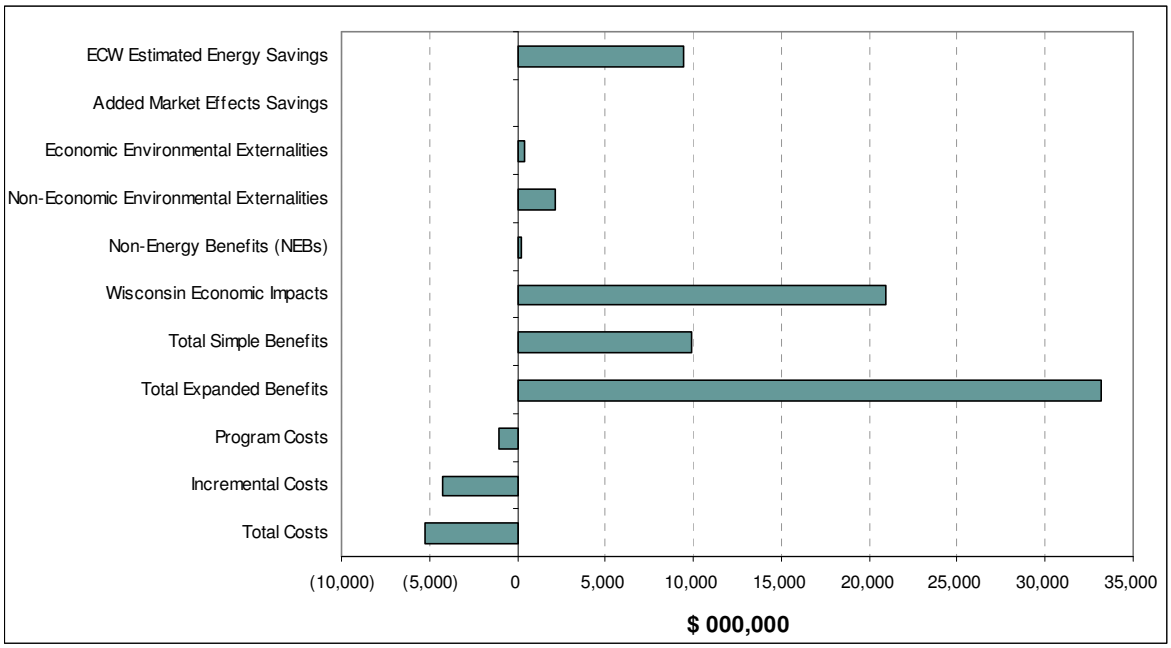


Table 5-9. Simple and Expanded Benefit Cost Components, by Portfolio Forward-look 25 Year NPV ($000,000)

B/C Component		Residential	Business	Renewables	Overall Focus on Energy
Simple Benefits	ECW Estimated Energy Savings	$2,003.1	$6,702.5	$733.9	$9,439.6
	Added Market Effects Savings	$0.0	$0.0	$0.0	$0.0
	Economic Environmental Externalities	$88.5	$310.7	$36.5	$435.7
Additional Expanded Benefits	Non-economic Environmental Externalities	$432.6	$1,493.9	$176.2	$2,102.7
	Non-Energy Benefits (NEBs)	$73.4	$160.5	$19.8	$253.8
	Wisconsin Economic Impacts	$1,602.0	$17,621.5	$1,737.6	$20,961.1
Costs	Program Costs	$340.1	$491.5	$184.1	$1,015.8
	Incremental Costs	$1,285.6	$1,280.9	$1,689.3	$4,255.8
	Total Simple Benefits	**$2,091.6**	**$7,013.3**	**$770.4**	**$9,875.2**
	Total Expanded Benefits	**$4,199.5**	**$26,289.2**	**$2,704.1**	**$33,192.9**
	Total Costs	**$1,625.7**	**$1,772.5**	**$1,873.4**	**$5,271.6**
				Net Benefits	**$27,921.3**
				B/C Ratio	**6.3**

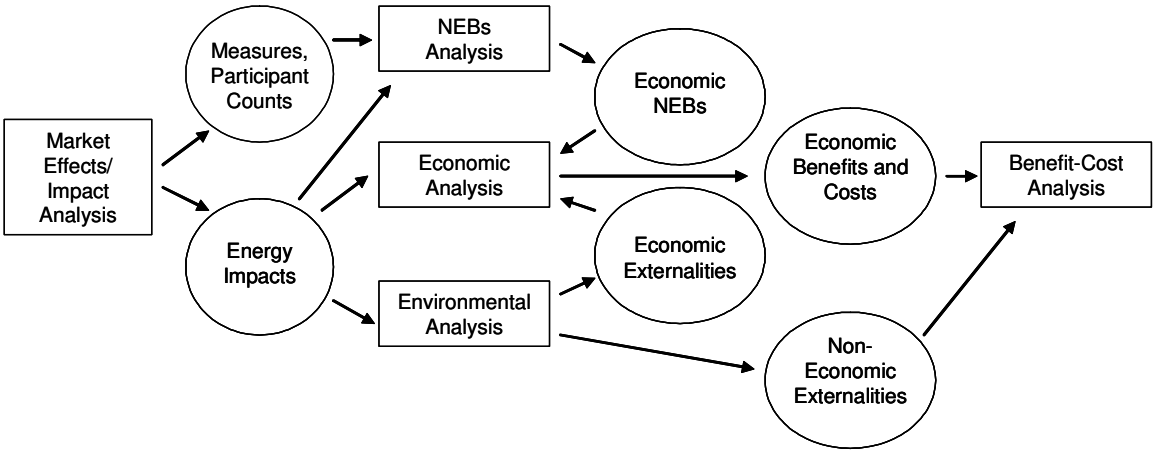
6. METHODOLOGY

This section describes the structure of the benefit-cost analysis. First, an overview of the key elements of the analysis is provided. The source of each of these elements is described in brief. The computation of the simple and economic development benefit-cost measures from these elements is then described.

6.1 ELEMENTS OF COSTS AND BENEFITS

The benefit-cost analysis combines quantified costs and benefits, as determined from a number of evaluation activities. These activities are referred to as "valuation" tasks because they assign values to distinct cost and benefit components. The relationship among the valuation tasks and cost and benefit components is illustrated in Figure 6-1.

Figure 6-1. Overview of Benefit-cost Components and Valuation Activities



For all components, we projected the results assuming program operation for a 10-year period, with additional projections made, as warranted for each program, over an additional 15-year timeframe extending beyond the end of the programs. The analysis components and benefit-cost elements provided by each valuation task are described more fully in the table below.

Table 6-1. Analysis Components Contributing to the Benefit-cost Analysis

Analysis Component	Input to B/C Analysis Provided	Provided by	Extensions Required for B/C	Level of Detail Used
Direct Impacts	Direct energy savings	Program Area Evaluation	Projection for future program years	Program – End-use
Market Effects	Market effects energy savings	Program Area Evaluation	Projection for future program years and Post-program effects	Program – End-use
Non-energy Benefits	Economic non-energy benefits multipliers	NEBs Evaluation	None	Portfolio
Economic Impact	Program net impact to state economy	Economic Evaluation	None	Portfolio
Environmental Externality	Environmental multipliers	Environmental Evaluation	None	All Focus on Energy
Costs	Program spending	Program Area Evaluation	Projection for future program years	Program
	Implementer's incremental project costs	Program Area Evaluation	Projection for future program years	Program

6.1.1 Energy impacts, documented energy savings

The impact analysis for each portfolio determines the documented energy savings attributed to the program to date. As part of the economic and benefit-cost analysis, energy savings for future years are projected based on the projected spending levels. This analysis also determines avoided costs per kWh, kW, and therm saved, which is used to translate energy savings into dollar values.

The present version of the benefit-cost analysis, uses utility avoided cost to develop energy impact estimates. That is, we calculated avoided energy from average utility spending per kWh and per therm delivered. In addition, the analysis includes a separate value for avoided demand (system peak day), or kW. In Focus benefit-cost analyses prior to the 2006 report, the demand cost was embedded in the customer's average cost per kWh.

6.1.2 Market effects

The most challenging projections to develop are the market effects of a program – the additional energy savings from actions taken outside of Focus but attributable to the Focus programs. The approach taken to projecting market effects varies by program, according to the level of information available at the time of the analysis. In all cases, the projected market effects are considered to be plausible, but are more uncertain than the direct energy savings.

To some extent, the market effect estimates used in the historic scenario incorporate empirical findings on the lasting effects of the programs after approximately five years of documented program activity. Were developed market effects estimates for each of the programs—Business, Residential, and Renewable—based in part on the results of their

respective program evaluations. Energy savings were translated into dollar values based on the previously discussed avoided cost factors.

Consistent with the 2006 low-funding scenario, no additional market effects have been assumed beyond a projected continuation of those that have already been documented in the evaluations. Each individual program evaluation team was responsible for the development of these inputs. Appendices A, B, and C describe the market effects projections in greater detail for each of the programs.

The forward-look scenario includes no market effects separate from the documented savings. The ECW Potentials study reported net savings that implicitly included both free rider effects and market effects.

6.1.3 Non-energy benefits

The non-energy benefits (NEBs) analysis provides multipliers in the form of incremental dollar value per unit of energy savings or participation for each of several non-energy benefits. NEBs are separated into “economic” and “non-economic” benefits. “Economic” NEBs result in dollar flows in the economy. These additional benefits are included in the economic input-output model, but not the simple model. “Non-economic” NEBs have value to customers, but do not affect dollar flows. These benefits are sometimes viewed as more subjective and less concrete than the “economic” NEBs. For this reason, non-economic NEBS have not been included in this benefit-cost analysis.

For the 2003 version of the benefit-cost analysis, we had reasonably well grounded NEBs estimates for the Residential and Low-income Programs. We had no NEBs estimates for the Business or Renewables Programs. Since then, the evaluation team has produced reports on NEBs for the latter two portfolios.[16] For the current benefit-cost analysis, economic NEBs have been incorporated for all portfolios.

NEBs were included in the forward-look scenario using identical methods to their inclusion in the historic scenario.

6.1.4 Environmental benefits (externalities)

Environmental benefits in the form of avoided emissions are included to varying degrees in the simple and expanded benefit cost tests. In the simple test, we include the well-documented value of avoided emissions based on existing cap and trading markets. These values are available for SO_x and NO_x. The current analysis also includes the projected cost of avoided carbon (CO_2) emissions (starting in 2012) in the simple test. These prices reflect the costs of mitigating these emissions associated with delivering electricity. For gas, the emissions mitigation cost is not an explicit cost of delivering the fuel. However, we take the trading price as the societal value of the avoided emissions from the gas consumption.

---

[16] *Non-energy Benefits to Implementing Partners from the Wisconsin Focus on Energy Program,* Final report October 20, 2003.

In the expanded test, we also count as benefits avoided mercury (Hg). These benefits are valued based on a projected market. Because these values are less well defined at this stage, we do not include them in the simple test.

Evaluation's environmental analysis developed emissions factors for electricity and gas saved in terms of pounds of emission per kWh and per therm. As described in Section 3, the emissions model used defined emissions factors for SO_x, NO_x, CO_2, and mercury emissions. The analysis also developed dollar values for each of these emissions based on current and projected emissions trading markets. For SO_x and NO_x, current emissions offset markets exist, and present emissions values were forecast through 2055.

For CO_2 regulatory markets are not expected to exist until 2012 and emissions values were projected to 2055. The previous version of the benefit-cost analysis did not include CO_2 in the simple test, instead including it in the expanded test as a non-economic environmental externality.

Mercury (Hg) emissions are included in the expanded test only. Projected emissions values for mercury were forecast to 2055. In addition, to enable valuation of avoided Hg emissions in program years FY02 to FY09, emissions values were developed based on a regression methodology developed expressly for this purpose. Since the economic impact benefit-cost test is a societal test, it was our intent to capture the value of mercury emissions in the expanded benefit-cost model irrespective of whether or not they have been prescribed a market value in an existing emissions trading marketplace.

SO_x, NO_x emissions, which are subject to active cap and trade regulations in Wisconsin and CO_2 emissions, which are expected to be regulated by 2012, are included in the simple benefit-cost test, as well as in the economic input-output analysis. The value of these avoided emissions would be monetized by the PSC and would ultimately be passed onto the customer in the form of reduced rates. Avoided SO_x, NO_x and CO_2 emissions are therefore representative of dollar flows in the economy. In contrast, emissions values for Hg are not currently regulated in Wisconsin and therefore are not captured in the economic input-output analysis. They are, however, included in the expanded benefit-cost tests.

6.1.5 Economic model

The economic input-output model counts the direct and indirect effects of all dollar flows into the Wisconsin economy resulting from Focus. The model counts the effects of direct energy and demand savings; market effects energy savings; economic NEBs; and any internalized externalities, namely avoided SO_x, NO_x and projected CO_2 emissions.

6.1.6 Costs

Both the benefit-cost analysis and input-output analysis required development of several cost elements:

- Program spending for each year
- Program incentive payments each year
- Incremental project costs.

A. PROGRAM SPENDING

For the historic scenario, program spending projections for FY09–FY11 were developed based on the projected CY09 program budgets. Consistent with the economic impact report, the current benefit-cost analysis assumes operation of the programs for a 10-year period (beginning in FY02) and includes impacts that extend 15 years beyond the end of the programs. Analysis for this timeframe requires projections of program spending, in addition to direct impacts, market effects, and associated customer costs several years forward.

The forward-look scenario projects program spending based on ratios found in the ECW potentials study.

B. PROGRAM INCENTIVE PAYMENTS

Incentive payments are not included in program costs counted in the denominator of the benefit-cost ratio. These payments are a transfer payment between parties, not a societal cost.

C. INCREMENTAL PROJECT COSTS

Incremental project costs are the incremental costs of the higher efficiency measure compared to cost of the baseline measure that would otherwise have been installed. The benefit-cost analysis counts the total incremental cost, not reduced by the amount of any incentive payment the customer may have received. However, the analysis counts only "attributable" incremental costs. These are incremental costs of measures that are attributable to the program. Essentially, the same attribution factor that goes into determining the net savings from the gross savings is applied to the incremental costs associated with the gross savings to determine attributable incremental costs. For example, if a program has an attribution rate of 80 percent, the evaluation verified gross savings are multiplied by 80 percent to determine attributable (or net) savings, and the total incremental costs associated with the gross savings are multiplied by 80 percent to determine attributable (net) incremental costs.

Incremental cost estimates represent a major source of uncertainty in any energy-efficiency program benefit-cost analysis. Procedures for estimating these costs are further described below for each program type.

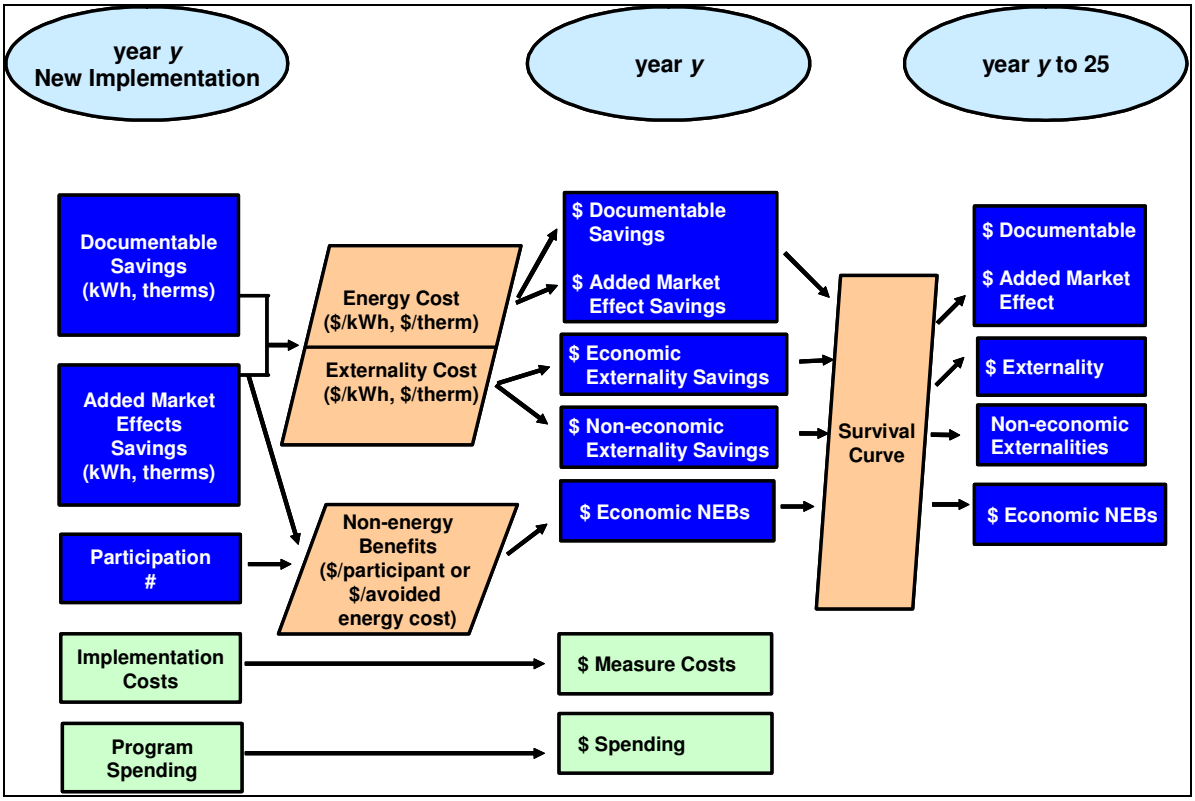
6.1.7 Relationship between the economic input-output model and the expanded benefit-cost analysis

The expanded benefit-cost analysis and the economic input-output analysis are closely related. Many of the inputs required for the two analyses are the same. Like the economic input-output model, the expanded benefit-cost analysis counts direct energy savings, market effects energy savings, economic non-energy benefits, and internalized environmental externalities. The expanded benefit-cost analysis also counts the value of non-internalized externalities. In the expanded benefit-cost analysis, the output of the economic input-output model provides the total value of the elements counted in that model.

6.1.8 Developing the input streams

Figure 6-2 shows how the benefit streams for 25 years are developed in the benefit-cost analysis. In each of Years 1 through 25, the projected new implementation of energy efficient measures due to both direct effects (in-program) and market effects are projected. Corresponding estimates of the numbers of program participants and their associated implementation costs are also projected. First-year dollar savings, in terms of avoided energy costs and avoided externalities are calculated from the first-year energy savings. For each year after Year *y*, these benefits are degraded according to an assumed decay curve. The decay curve is an exponential decay, with median lifetime equal to the savings-weighted average measure life for each program. This decay rate applies to all components of the benefits stream. The calculation and application of the decay curve is described further in Section 6.3.3.

Figure 6-2. Development of Benefit Streams



6.2 BENEFIT-COST MEASURES

The benefits and costs of a program like Focus can be compared in a variety of ways. This report presents the results of two approaches, which we have called the "simple" and "expanded" benefit-cost tests. The simple benefit-cost test we use is similar to a standard Total Resource Cost (TRC) or Societal Test approach. The expanded benefit-cost test incorporates additional benefits, including economic impacts, avoided air emissions, and non-energy benefits (NEBs). Both tests are based on a long-term time frame, rather than assessing program effectiveness for any single year.

6.2.1 Total Resource Cost test

The TRC test measures the net costs of a demand-side management program as a resource option based on the total program costs, both to the participants and the utility. The Societal Test, a variant of the Total Resource Cost Test, compares the avoided cost of energy supply with the combined program and participant costs. This framework has its origins in an Integrated Resource Planning process for regulated retail electricity supply. In this framework, investment in energy efficiency is justified if it is cheaper than investing in additional generation/energy supply. The Societal Test also counts avoided externalities among the benefits of energy efficiency and uses a societal discount rate (*California Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects,* July 2002.).

The benefits included in the TRC test are the avoided supply costs – the reduction in transmission, distribution, generation, and capacity costs valued at marginal costs for periods when there is a load reduction. Avoided supply costs are calculated using net program savings, or savings net of changes in energy use that would have happened in the absence of the program. The costs included in the TRC test are the program costs paid by both the program and the participants.

6.2.2 California Public Purpose test

The California Public Purpose test is an extension of the Societal Test (CEC, 2001b). The primary differences between the PPT and the Societal Test are that the PPT explicitly allows for counting of non-energy benefits and also allows for consideration of a multi-year timeframe for the analysis of costs and benefits. The PPT counts the following benefits and costs.

A. BENEFITS

- Customer avoided energy costs, based on direct net energy savings. Savings net of free-ridership are valued at the average cost per kWh or therm.
- Customer avoided energy costs, due to market effects energy savings. Market effects energy savings are valued at the same avoided cost as the direct energy savings.
- Customer non-energy benefits value, based on net energy savings. Non-energy benefit multipliers are applied to the net energy savings.
- Avoided externality value, based on net energy savings. Externality multipliers are applied to the net energy savings.

B. COSTS

- Program costs excluding incentive payments. Incentive payments are not counted as either a program benefit or a program cost. The incentives are a transfer payment, and represent a net difference of 0.
- Customer non-energy costs based on net energy savings. The PPT does not explicitly mention non-energy costs. However, consistent with considering non-energy benefits, non-energy costs should also be considered and would be assigned to the cost side of the equation.

- Customer incremental costs, net of free-ridership. The same attribution factor used to adjust energy savings for free-ridership is applied to the in-program customer incremental costs. Only the incremental costs of measures that would not have been implemented in the absence of the program are counted. Incremental costs for market effects implementation are also counted.

6.2.3 Simple benefit-cost test

The simple b/c test used in this study is based on the TRC or Societal Test, but with a multi-year time frame. Using this type of approach allows comparison of Focus programs with similar programs around the country. The test counts as benefits net (attributable to the program) energy and demand savings, and documented market effects savings only. The simple test also counts as benefits the avoided value of economic environmental externalities. NEBs, non-economic environmental externalities, and economic multiplier effects are excluded. On the cost side, program costs are included, exclusive of incentives. Net customer incremental costs, including any portion covered by incentives from Focus or anyone else, are also included.

The simple test is carried out for each program portfolio (e.g., Renewable, Residential, etc.), as well for each individual program within the program portfolio. The simple test is summarized below.

A. BENEFITS

- Utility avoided energy costs based on net (i.e., program-attributable) energy savings
- Avoided energy costs attributable to documented market effects
- Economic environmental externalities for SO_x, NO_x and CO_2.

B. COSTS

- Total program spending, excluding incentive payments
- Net (i.e., program-attributable) customer incremental costs.

C. RATIONALE FOR THE SIMPLE TEST

The simple test is based on direct valuation of energy savings in comparison with the total direct cost of achieving those savings.

6.2.4 Expanded benefit-cost test

The expanded benefit-cost test counts benefits more broadly than the simple test. The expanded test includes NEBs and the full range of environmental benefits in addition to the same benefit elements included in the simple test. In addition, whereas the simple b/c test counts the economic benefit by considering only the direct value of the benefit and cost components, the expanded benefit-cost test counts the total change to the state economy resulting from the benefits. This economic impact is calculated by running an economic input-output model for the state of Wisconsin with the expanded list of benefits as inputs.

The same costs are counted in the denominator for both the simple and expanded tests. Thus, the expanded test:

- Counts avoided non-economic externalities and NEBs in addition to the avoided energy benefits and economic externalities
- Values benefits in terms of the total economic impact of the benefits on the state economy
- Uses the same denominator (costs) as in the simple test.

The expanded benefit-cost test is performed at the portfolio level only and not for individual programs within each portfolio.

The total change to the state economy is measured by the economic impact as determined by the economic input-output model. This impact captures the effects of direct and market effects energy savings, as well as those environmental externalities and NEBs that result in dollar flows through the economy.

The economic impact model does not capture benefits that do not result in dollar flows through the economy. We refer to these benefits as "non-economic" benefits. These benefits are added to the economic impact calculated from the "economic" benefits to determine the total benefit for this test. In this analysis, SO_x, NO_x and CO_2 costs are internalized via emissions trading markets, and are counted in the economic model. Hg is not internalized and are not counted in the model; these benefits are added to the economic impact of the "economic" benefits to determine the total benefit. This analysis counts only "economic" NEBs.

The primary gains to the economy captured in the economic impact (but not in the sum of benefits in the simple test) include:

- Substitution of in-state purchases (such as for locally produced energy-efficiency products and services) for out-of-state purchases (such as for fossil fuel)
- Increased competitiveness of Wisconsin businesses as a result of increased in-state purchases.

The economic development benefits of interest to the analysis of Focus are:

1. Added worker earnings
2. Corporate net profits
3. Beneficial changes in the cost of living.

Program savings explicitly benefiting Wisconsin households are best evaluated using the real disposable income impact. This impact captures both the underlying earnings creation as the Wisconsin economy benefits under Focus, and the reduction in the cost of living to households. Thus, the measure of economic impact used to quantify the benefits for the Residential Programs for the expanded B/C test is the real disposable income impact.

Program savings explicitly benefiting Wisconsin businesses are best evaluated by examining the value-added impact. This impact captures both additional worker income created in the state and corporate net profits. Thus, for the Business and Renewables

Programs, the economic impact used to quantify benefits for the expanded b/c test is the value-added impact.

Although the economic impacts are quantified somewhat differently for the different portfolios, it is meaningful and appropriate to sum these economic impacts across portfolios to obtain the total Focus impact or benefit. The reader will find a consistent treatment of program-specific impacts in the separate report, entitled *Economic Development Benefits: FY07 Evaluation Report* (Focus Evaluation Team, 2006b). Distinct elements of the expanded benefit-cost test are summarized below.

A. BENEFITS

- Economic impacts from the Economic Input-Output Model, where the model inputs are:
  - Avoided energy costs attributable to documented market effects
  - Avoided energy costs attributable to additional, less rigorously measured market effects
  - Economic environmental externalities for SO_x, NO_x and CO_2
  - Economic NEBs
- Plus elements not included in the Economic Input-Output Model
  - Environmental externalities for mercury, which are not internalized in the Economic Input-Output Model.

B. COSTS

- Total program spending, excluding incentive payments
- Net customer incremental costs.

C. RATIONALE FOR THE EXPANDED TEST

The expanded test is intended to capture the full effects of the program on the state's economy. The test incorporates the flow-through effects of the program spending and savings in the economy. The test also looks at the broader array of benefits resulting from DSM programs, including well documented savings, as well as some effects that not necessarily possible to document as rigorously and/or are less widely accepted as belonging in such analysis.

i. Comparison of Tests

Table 6-2 compares key components of the standard TRC and Societal tests with those of the simple and expanded tests used here. Also shown are the elements included in the economic impacts. The TRC and Societal Test components are based on the definitions in the *California Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects,* July 2002.

All the tests considered count the avoided cost of energy supply as a benefit. The Societal Test also counts the value of all avoided emissions associated with the energy savings. The TRC test counts avoided emissions only to the extent that the cost of those emissions

has been internalized, for example through mitigation requirements or cap and trade markets.

Effectively, emissions costs for SO_x, NO_x, and CO_2 are internalized for electricity generation, but not for most gas consumption. Our simple test counts avoided SO_x, NO_x, and CO_2 values for both electricity and gas savings. Our expanded test also counts avoided mercury, which is not currently internalized.

Non-energy benefits resulting in monetary flows are counted in the Societal Test and in our expanded b/c test, but not in the TRC or simple test. The Societal Test would also count non-energy benefits that do not result in monetary flows. However, our expanded test considers only the more easily quantifiable monetary NEBs.

Secondary economic benefits related to the stimulus effects of program-related spending and savings are not explicitly identified in the SPM for the Societal Test, but are often counted in the form of "economic multiplier" effects as a form of non-energy benefit. Our expanded test includes these secondary economic effects as reflective of the overall impact of the program on the economy.

The TRC Test explicitly counts tax credits as a reduction to customer incremental costs. The Societal Test treats tax credits as a transfer payment and does not recognize a societal value. Both our simple and expanded test treat tax credits as a transfer and do not include their value in the benefits stream. The reason for this treatment is to avoid counting Federal tax credits attracted by the program as a benefit to the state economy.

The TRC test uses a non-societal discount rate, such as the utility's. The Societal Test uses a societal discount rate. Both our simple and expanded tests use a discount rate that we think of as a societal rate.

In total, we view both the simple and expanded tests as taking a societal perspective. The expanded test is more comprehensive, and includes some effects that cannot be as rigorously quantified. The expanded test is derived from the economic impact, together with the non-monetized externalities that are not reflected in the economic impact.

Table 6-2. Comparison of Test Components

Benefits Counted	TRC	Societal Test	Simple B/C Test	Expanded B/C Test	Economic Impact
Avoided supply costs of kWh, kW, therm	X	X	X	X	X
Avoided emissions costs included in electric delivery	X	X	X	X	X
Avoided externality value of market-valued emissions costs associated with customer gas use		X	X	X	X
Avoided externality value of projected market value of emissions costs associated with electricity delivery		X		X	
Avoided externality value of projected market value of emissions costs associated with customer gas use		X		X	
Non-energy benefits resulting in monetary flows ("economic")		X		X	X
Non-energy benefits not resulting in monetary flows ("non-economic")		X			
Secondary economic benefits		X		X	X
Tax credits treated as reduction in customer costs	X				
Discount rate	utility	societal	societal	societal	not applicable

6.2.5 Comparing benefits and costs

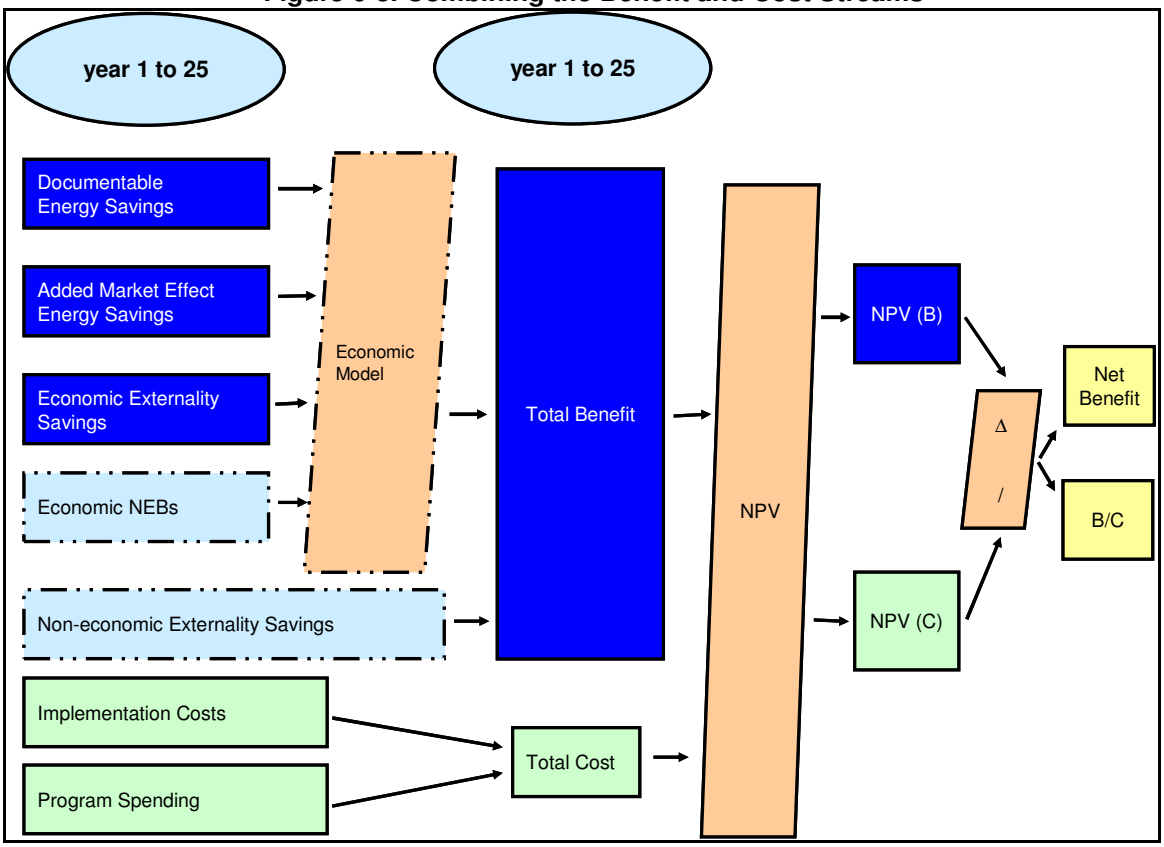
Benefits and costs are compared in this study in terms of the net benefit (total benefits minus total costs) and the benefit-cost ratio. Both the net benefit difference and benefit-cost ratio are calculated based on the net present value of a 25-year stream of costs and benefits. Results for both scenarios are presented in 2009 dollars. Savings and other projections assume that the programs continue for a period of 10 total years, FY02 through FY11 for the historic scenario and FY12 through FY21 for the forward-look scenario. A real discount rate of five percent is assumed, as discussed in Section 3.5.

Figure 6-3 illustrates how the benefits and costs are aggregated by the benefit-cost tests applied here. For each year of the analysis, simple or expanded test, the applicable benefits are combined. For the simple benefit-cost test, the combination is simply the sum of program benefits. For the expanded benefit-cost test, the benefit is the output of the economic impact model, using the expanded list of benefits as inputs, plus the non-internalized avoided externalities.

The costs are also combined for each analysis year. In both tests, the same cost elements are counted, and are summed to produce the total cost.

The 25-year net present value (NPV) is calculated for the total benefit and the total costs. The difference between total benefit and total cost yields the net benefit (also in NPV). The ratio is the benefit-cost ratio.

Figure 6-3. Combining the Benefit and Cost Streams



Because programs such as Focus are not likely to achieve meaningful penetration and/or results in a single year, benefit-cost results are calculated for a 25-year horizon. The projections used in the 25-year analysis of the historic scenario are grounded in the historic performance of the programs, FY02 to FY08. The forward-look scenario is projected based on the potential savings in the years 2012 and 2018 in the ECW Potentials study.

6.3 PROJECTIONS

This analysis required a 25-year stream of all the benefit and cost components. The general approach to developing these projections for each portfolio is described below. Specific analysis to develop the inputs for each portfolio is described in Appendices A, B, and C.

6.3.1 Program spending

For the historic scenario, program spending projections for FY09–FY11 were developed based on the projected CY09 program budgets. Consistent with the economic impact report, the current benefit-cost analysis assumes operation of the programs for a 10-year period and includes impacts that extend 15 years beyond the end of the programs.

Other assumptions used to develop the spending projections for the historic scenario are as follows:

- FY02–FY08 spending levels are based on actual invoices submitted to DOA and the PSC.
- CY09 budget numbers were provided by the program administrator.
- Unspent budget in each year is carried over to the following year.

For the foreword looking scenario, we estimated program spending for the first 10 years of the program based on the program spending estimation method described in the ECW Potentials study.

6.3.2 Documented savings

For the historic scenario, documented savings for the early program years are taken from the prior evaluation reports, in particular the most recent year-end report. Breakdowns into subcategories needed for the analysis were developed by each portfolio evaluation team. Projected savings for future years were based on projected spending levels together with the ratio of savings to spending observed to date.

For the forward-look scenario, documented savings are taken directly from the ECW Potentials study for FY12 and FY18. The intervening and subsequent years were estimated based on a linear projection of the values found in FY12 and FY18.

6.3.3 Measure life and decay rates

Measure life was assessed for each program component by the portfolio evaluators, primarily based on secondary sources. This measure life is interpreted as the median measure life. Measure lives for all program measures included in this analysis are provided in Appendices A through C. The savings implemented in each program year is extended into the future with an exponential decay rate, such that half the savings remains after the measure life.

That is, we interpret the measure life identified from the literature as the time until half the units would be expected to have failed or been removed. This interpretation is consistent with the persistence study framework used in California and elsewhere. Under those rules, the “expected useful life” is the median survival time, where “surviving” means remaining in place and operable.

With this interpretation and an assumed exponential decay, the fraction f of savings that survives from one year to the next is given by

$$f = 2^{-(1/L)}$$

where L is the measure life. For example, if the measure life is 15 years, the surviving fraction each year is

$$f = 2^{-1/15} = 95.5\%.$$

The decay rate is

$$d = 1-f = 4.5\%.$$

Thus, in this example, the surviving savings from the prior year is calculated as 95.5 percent of the prior year's amount; 4.5 percent of the prior year's savings is lost. Associated non-energy and environmental benefits decay at the same rate.

The exponential decay formula implies a constant failure rate over time. This assumption is not necessarily realistic for many measures. Experience from numerous persistence studies conducted in California indicates that the failure process is often a mixture of two phenomena—in the short term, removal due to defect or dissatisfaction, and in the longer term, more or less steady wear-out patterns. This mixture suggests a "hazard rate" that is high in the early years, then declines, becoming stable (exponential) or eventually rising again in much later years.

The Weibull function is commonly used for survival analysis. This form can give either an increasing or decreasing hazard rate, but not one that starts high, drops, then stabilizes or climbs. For a fixed median measure life, we considered a Weibull with shape parameter 1/2 (decreasing hazard) and one with shape parameter 2 (increasing hazard). The first gives 5-10 percent lower NPV and the second gives 5-10 percent higher NPV compared to the exponential. A mixture of the two distributions, representing a combination of the two contributing phenomena, would give NPV somewhere between, or close to that from the exponential itself. Thus, the exponential assumption, which is computationally convenient, appears to yield appropriate end results for purposes of this analysis.

6.3.4 Market effects savings

We count market effects savings that have been documented by the evaluation and are counted in the program achievement to date. These are projected to later program years similar to the projection of direct savings

6.3.5 Incentive payments

Incentive payment amounts were projected based on the CY09 projected budget.

6.3.6 Incremental project costs

The 2009 Business Programs incremental cost study[17] and the 2009 Residential incremental project cost study[18] developed and reported simple payback periods that we used to estimate incremental costs for each of these portfolios. For the renewables portfolio historic scenario, we assumed that the full project cost (tracked by the program) was the incremental costs (except for biomass systems). For the renewables forward-look

[17] Miriam Goldberg, J, Ryan Barry, Brian Dunn, Matt Pettit, KEMA, Inc. *Focus on Energy Evaluation, Business Programs: Incremental Cost Study. Final Report*. October 28, 2009.

[18] Steven Drake, Eric Rambo, Bryan Ward, PA Consulting Group. *Focus on Energy Evaluation: Residential Technologies Incremental Cost Review*. November 6, 2009.

scenario we used the project costs provided in the appendix to the ECW Potentials study as the incremental costs for all technologies.

6.3.7 Non-energy benefits

Non-energy benefits were estimated based on values provided in the non-energy benefits reports.[19] Each portfolio evaluator determined how best to apply these findings to the programs as they currently exist.

The residential and low-income NEBs reports identified some NEBs that do not result in dollar flows in the economy, but are based on customer reported value. For purposes of this analysis, only those NEBs that result in economic flows, or "economic" NEBs, are included. While customer perceived value was also used for the business NEBs assessments, the values reported involved financial effects on businesses.

[19] *Low-income Non-energy Benefits for Inclusion in Economic Analysis,* Final report April 3, 2006; *Non-energy Benefits Crosscutting Report Year 1 Efforts*, Final report January 30, 2003; *Non-energy Benefits to Implementing Partners from the Wisconsin Focus on Energy Program,* Final Report October 20, 2003; *The Non-energy Benefits of Wisconsin Low-income Weatherization Assistance Program,* Final report November 9, 2005; *Renewable Energy Program: Non-energy Effects,* Final report January 17, 2005.

APPENDIX A: DEVELOPMENT OF RESIDENTIAL PROGRAM INPUTS

A.1 HISTORIC SCENARIO

A.1.1 Documented savings

We base documented savings for FY02–FY08 on data developed for the CY09 Second-Quarter Semi-Annual Report. We held savings for FY09–FY11 constant at the level of FY08 under the assumption that program spending will remain constant. Energy consumption and demand savings are based on values developed by the evaluation team for individual measures and for measure categories. These deemed values have been published in a number of different reports, such as *Residential Deemed Savings Review*."[20]

For most residential programs, the evaluation team uses a market-based approach when assessing net program savings. This is especially true for those residential efforts, such as the ENERGY STAR Products, CFLs, and clothes washer initiatives that have accounted for the majority of residential sector savings. This market-based methodology does not lend itself to disaggregating net impacts into their component pieces (e.g., direct program savings, participant spillover, market effects, etc.). Rather, through the use of comparison areas or baseline data, the methodology provides a single point estimate of the probable impacts above and beyond what was likely to happen in the absence of program efforts. Given this methodology, it is important for the reader to realize that all program-year (FY02 to FY11) net savings numbers in the b/c modeling include such phenomena as direct attributable program savings, participant spillover, and market effects.

A.1.2 Market effects savings

For the period beyond 2011, each residential program included in the benefit-cost analysis is assigned future market effects wherever appropriate. In general, we assign market effects in a way consistent with the approach used in the 2007 b/c analysis.[21] We have assumed a fixed proportion of program effects will persist after the program has ended. There is, of course, a high degree of uncertainty surrounding these persisting program effects. For the current analysis, we generally used the proportions adopted previously. Thus, in the case of ECM furnace fans installed through EHCI, through a combination of supply-side and demand-side changes we estimate that 10 percent of FY11 direct program impacts will persist after the program has ended. Supply-side changes would include, for instance, continuation of ECM fan installations both among contractors who participated in Focus and among those who did not. Demand-side changes would include past program participants who continue to specify efficient fans and past program non-participants beginning to specify efficient fans due to their increased availability.

---

[20] Ron Swager, Patrick Engineering, Inc. *Focus on Energy Statewide Evaluation, Residential Deemed Savings Review*. February 2, 2009.

[21] Miriam L. Goldberg, Chris Clark, Sander Cohan, KEMA Inc. *Focus on Energy Statewide Evaluation Interim Benefit-cost Analysis*: *FY07 Evaluation Report.* February 26, 2007.

The market effects for CFLs have two changes since the 2007 analysis. First, we reduced the market effects of CFLs from 30 to 15 percent of FY08 savings. Second, we degraded the CFL market effects at a rate of 10 percent per year. In 2007, they were not degraded. These changes reflect the changing baseline of lighting technology and make the treatment of CFLs in the residential portfolio consistent with the business portfolio.

Among the seven residential programs in the analysis, only the Targeted Home Performance with ENERGY STAR® Program (THPWES) and Head Start have no documented market effects.

Most of the programs are small relative to the size of markets they are attempting to affect. This even applies to the CFL effort, which has been the largest Focus effort to date. More importantly, there are numerous unknowns in most residential markets, making any effort to estimate market effects highly speculative in both the short- and long-term. Nevertheless, we have attempted to project market effects based on our collective knowledge of program activity and the markets in which they operate.

For each of the programs/products discussed below, we outline the assumption of likely market effects that was incorporated into the modeling.

a. ENERGY STAR PRODUCTS PROGRAM (ESP)

Compact fluorescent Lighting: For this analysis, we assumed market effects that last beyond the end of program funding in FY11. As new federal lighting standards affect the market beginning in 2012, the baseline for incandescent energy consumption will move closer to CFL energy consumption, reducing the difference between lamps promoted through the program and substitute products. The effect on the market for CFLs will depend on factors presently unknown, such as the cost of the new incandescent lamps and snapback effects. In an effort to balance these unknowns we have estimated a market effect of 15 percent of FY11 energy savings, which degrades by 10 percent per year. This is consistent with the treatment of CFLs in the business portfolio.

Clothes Washers: For this analysis, we have assumed participant market effects that begin in FY08 and continue beyond the end of program funding in FY11. We assume that 40 percent of FY07 ENERGY STAR clothes washer impacts continued into FY08, after ESP ceased promoting them in favor of tier II and tier III equipment. Retailers and manufacturers view ENERGY STAR clothes washers as a premium product and will continue to market them heavily when program funding ends. These effects degrade at a rate of 20 percent per year.

b. EFFICIENT HEATING AND COOLING INITIATIVE (EHCI)

Central Air Conditioning: For this analysis, we have included participant market effects that last beyond the end of program funding in FY11. We estimate that 10 percent of SEER 14+ CAC impacts will continue into FY12 and subsequent years. Historically, HVAC contractors have been reluctant to promote highly efficient CAC products. Past ECW

Baseline efforts[22] indicated that contractors were reluctant to sell units above 10 SEER (the federal standard at the time) because of a long payback period, especially for those consumers who do not operate their CAC on a regular basis. Now that the federal standard has moved to 13 SEER, there is little reason to think (and no evaluation evidence to support) the contention that contractors will sell 14+ SEER units without a subsidy, given relatively low incremental savings and high incremental costs.

Electrically Commutated Motors (ECMs): For this analysis, we have included post-program participant market effects. We assume that 10 percent of ECM impacts will continue into FY12 and subsequent years. Our rationale is that a subset of HVAC contractors will continue to promote ECMs to a subset of residential customers, i.e. primarily those who operate their furnace fans continually. Under this scenario, Wisconsin contractors' exposure to EHCI results in a higher willingness to promote ECMs compared to contractors nationally (or in a suitable control area). This would appear to be plausible because Wisconsin contractors are currently having a net impact on this market, despite the fact that EHCI rewards cover a relatively small portion of the increased cost of an ECM furnace (i.e. a reward of $150 and an incremental cost of nearly $900).

c. WISCONSIN ENERGY STAR HOMES (WESH)

For this analysis, we have assumed participant market effects that last beyond the end of program funding in FY11. Our past evaluation work indicates that a large percentage of current WESH builders can be expected to continue to build homes to WESH standards. This is because many changes are health, safety, and comfort related and, more importantly, involve changing the skill sets of various trades people (e.g., carpenters, HVAC technicians, insulators) involved in the program. Given the acquired skills sets, it is plausible that they will continue to apply these skills to new projects. We estimate that 80 percent of the number of WESH homes certified in FY11 (the last year of program funding) will be built to WESH standards in FY12 and subsequent years. These market effects degrade by 20 percent per year.

d. HOME PERFORMANCE WITH ENERGY STAR (HPWES)

For this analysis, we have assumed participant market effects that last beyond the end of program funding in FY11. We expect progress in this market will continue to depend on program advertising and program incentives. Home performance consultants, home remodeling consultants, and trade allies who participate in the program to some degree, rely upon program advertising and educational events to generate leads. Similarly, these same parties rely upon program incentives to help them convince customers to take recommended energy-efficiency actions. While the advertising and incentives are important, we recognize that customers are currently paying a substantial portion of the cost of measures they install. We also recognize that consultants have acquired a valuable skill set and it would appear that these skills (and their application to the job at hand) will carry forward. Consultants, additionally, have acquired a valuable skill set, which will carry forward after the program ends.

---

[22] Tracking the *Heating, Ventilation, and Air Conditioning (HVAC)* Market for Energy Efficiency Services. Energy Center of Wisconsin (publication #143-1, 1996).

Taking all of the above into consideration, we estimate that in FY12 (and for all years beyond that) HPWES impacts will fall to 30 percent of the FY11 level. The removal of program advertising and program incentives will mean that only 30 percent of past (program-induced) activity levels will continue.

e. TARGETED HOME PERFORMANCE WITH ENERGY STAR (THPWES)

The targeted program operates very similar to Wisconsin's low-income weatherization program. Given the income constraints of participants, it is reasonable to assume that no lasting market effects will be realized through this program.

f. APARTMENT AND CONDOMINIUM EFFICIENCY SERVICES (ACES)

For this analysis, we have assumed participant market effects that last beyond the end of program funding in FY11. We believe this program has had a long-term effect on the lighting market, which was a major emphasis of the past program, as well as the high-efficiency boiler market. The lighting efforts were primarily resource acquisition in nature (i.e., direct install program administered by CSG); the high-efficiency boiler effort had a more market transformation-based approach.

We have estimated that in FY12 (and for all years beyond that) ACES impacts will fall to 10 percent of the FY11 level. Removal of program advertising and program incentives will mean that only 10 percent of past (program-induced) activity levels will continue. This seems reasonable in light of the fact that past multi-family programs nationally have had a difficult time, absent incentives, getting property owners to take action.

A.1.3 Incentive payments

Incentive payments for each year FY02 through FY08 are included as a line item in the Residential Program budget. Incentives for FY09–FY11 are held constant at the level of FY09 under the assumption that program spending will remain constant.

A.1.4 Incremental project costs

In the 2007 b/c analysis, incremental costs were derived from the Implementing Partner Short-Term Follow-up Surveys conducted as part of each round of impact evaluation. It was acknowledged that this was a significant source of uncertainty in the b/c analysis, so in 2009, we reviewed these costs.[23]

As a first step in evaluating incremental costs for Focus's Residential Programs, we identified the most important energy efficient technologies used in these programs from the standpoint of savings. We identified measures that accounted for at least 0.5 percent of total annual electric energy savings, peak demand reduction, or gas savings in the residential sector as reported in the 18MCP Focus on Energy Semiannual Report.[24] The PA team also identified a small number of technologies that did not meet the 0.5 percent

[23] Steven Drake, Eric Rambo, Bryan Ward, PA Consulting Group. *Focus on Energy Evaluation: Residential Technologies Incremental Cost Review.* November 6, 2009

[24] Focus Evaluation Team. Focus on Energy Evaluation. *Semiannual Report (18-month Contract Period).* October 19, 2009.

savings criterion but seemed an important part of residential energy efficiency programs. These measures included some ENERGY STAR appliances and equipment, such as dishwashers, refrigerators, and ceiling fans, as well as LED exit signs for multi-family units and high efficiency central air conditioning with a SEER rating 17 or above. Based on these criteria, the PA team targeted forty-five technologies for which to collect and analyze measure-level incremental cost data.[25] These measures, representing approximately 96 percent of total electric savings and 88 percent of total gas savings from residential programs, are shown in Table A-1.

We define incremental cost as the additional expense to the customer for installing an energy efficient technology instead of a less efficient, baseline technology. For most efficient technologies, the incremental cost is specified on a *replace-on-failure* basis. This assumes that the decision to choose high efficiency equipment over less efficient equipment is contingent on the failure of the existing measure. In these instances, the incremental cost is simply the difference in the material cost of the measure. For example, the incremental cost of replacing an inefficient air conditioner with an efficient air conditioner would be the added cost of purchasing the more efficient unit. The cost of installation for replace-on-failure measures would only be included where installation of the efficient measure is more expensive than installation of the baseline measure.

For some energy efficient technologies, however, the replace on failure condition is not appropriate, as individuals would not typically choose to install the high efficient versus less efficient equipment. In other words, one may think of these measures as having no baseline option. Examples of these types of measures include adding insulation to increase efficiency of a building shell, installing low-flow showerheads or aerators, and weatherization. In these instances, the incremental cost is the *full* cost of the energy efficient technology or the combined cost of the measure material and proper installation.

It is important to note that this analysis does not attempt to estimate incremental costs for *early replacement* installations, where high efficiency technologies are installed to replace less-efficient equipment prior to the existing equipment failing. Table A-1 shows the appropriate incremental cost definition for the energy efficient technologies from Focus Residential Programs included in this analysis.

[25] The energy savings criteria listed above identified two custom ACES measures—“cost of service” and “non-carpet flooring over radiant heat”—that we did not include in our analysis due to a lack of available cost data.

Table A-1. Measure Incremental Cost Definitions

Replace-on-Failure (Difference in Material Cost)	
Appliances	**Cooling Equipment *(continued)***
Ceiling fan	SEER 18
Clothes washers Tier 2	SEER 19
Clothes washers Tier 3	SEER 20
ENERGY STAR clothes washers	**Boilers**
ENERGY STAR clothes washers – common area	Boiler 90+ AFUE
ENERGY STAR dishwasher	Boiler 90+ AFUE – custom
ENERGY STAR dehumidifier	Boiler 90+ AFUE w/DHW – custom
ENERGY STAR refrigerator	Boiler 83-89 AFUE – custom
CFLs	**Heating Equipment**
CFL Fixtures	Furnace 90+ AFUE w/ ECM
CFL fixtures	**LED Lighting**
Torchiere	LED exit sign
Cooling Equipment	LED holiday lights
ENERGY STAR room AC	**Water Heating Equipment**
SEER 14	DHW sealed combustion
SEER 15	Power vent with EF of .80 or greater
SEER 16	Thermal (at least 80% AFUE)
SEER 17	
No Baseline (Full Material Cost and Installation Cost)	
Certified home	**Shell *(continued)***
Ground Source Heat Pumps	Foundation insulation
Heating Equipment	Home weatherization
Steam trap replacement	Sidewall insulation
Shell	Sill box insulation
Air sealing	**Water Saving Measures**
Attic insulation	Faucet aerator
Duct sealing	Showerhead
ENERGY STAR windows	**Water Heating Conversion**
Floor insulation	Water heating conversion
Flue Closure	Water heating conversion – custom

a. INCREMENTAL COST PER UNIT

The PA team reviewed data from several published sources to estimate the unit incremental cost of each energy efficient technology. For most technologies, PA researched simple dollar estimates of incremental costs for installing these energy efficient measures. For some custom measures, however, we researched incremental costs in dollars per unit of energy saved (in kWh or therms) instead of per measure, as the verified savings for these measures varied greatly across projects. This approach dampens the unknown effect of extraneous factors that may be responsible for the variance in energy savings for a given measure, such as the size and scope of individual projects. We then applied this dollar per unit of energy saved estimate to the average verified savings for each measure in the tracking database to calculate a dollar estimate. Specifically, the measures for which we used this approach include custom boilers, ground source heat pumps, and custom water heating conversions.

The sources used to develop our incremental cost estimates include California's Database for Energy Efficient Resources (DEER), the Department of Energy (DOE), the American Council for an Energy Efficient Economy (ACEEE), various market potential studies, conversations with local equipment dealers, and other secondary sources.

We used the most recent and local cost data available to construct our estimates. For example, for CFLs we relied upon Focus evaluation data from the *Second Annual Comprehensive CFL Market Effects Study* prepared by Glacier Consulting. Through this study, Glacier collected sales data from retailers in Wisconsin that accounted for 94 percent of all rewards paid in 2007. Using this data, we were able to estimate the average price of CFLs available in Wisconsin.

Where reliable local data was not available, we relied on several national sources, including DEER and DOE. Most recently updated in 2008, DEER provides detailed cost estimates for several energy efficient technologies based on extensive primary and secondary research. DEER uses data from retailer surveys, California program evaluations, manufacturer pricing, and other secondary sources for its cost estimates. The DOE's ENERGY STAR product website also reports cost estimates for several residential technologies, using recent national industry and retail pricing data ranging in date from 2007 to 2009.

b. AGGREGATING MEASURES INTO MEASURE CATEGORIES

In estimating incremental costs for the b/c analysis, we rolled individual measures together into measure categories on the basis of a savings-weighted average of incremental costs per first-year avoided cost. The incremental cost of a measure category is estimated to be this cost-per-savings value multiplied by the first-year savings.

A.1.5 Program administrative costs

This includes all program costs, except incentives.

A.1.6 Measure life and decay rates

The measure lives for individual measure types were based on estimates from the ECW Potential Study. For each year of the benefit-cost analysis, the life of the measures implemented within each individual Residential Program was calculated as a savings-weighted average of the associated measure lives.

Since decay rates are tied to measure life, they varied across the individual programs. Depending on the program, savings were assumed to degrade by a fixed percent per year for the life of the measure. With this assumed decrease, half the savings remain at the end of the measure life. Thus, each unit of first-year savings was degraded by a fixed percentage for each subsequent year of the measure lifer. The same measure lives and decay rates were applied to documented and market effects savings. The value of environmental externalities and economic NEBs was also subject to these measure life and decay rates. Further detail on this analysis is included in Section 6. The measure life assumptions are in Table A-2

Table A-2 Residential Program Measure Lives

Program Measure	Measure Life (in Years)
ESP	
CFL	6
Clothes Washers	12
Other Lighting	25
Other Appliances	12
HPES	
Air Sealing	25
Attic Insulation	25
Home Certification	50
Sidewall Insulation	25
CAC - 12 SEER	20
CAC - 13 SEER	20
CAC – 14+ SEER	20
ECM Furnace	23
Other Measures	25
EHCI	
CAC - 12 SEER	20
CAC - 13 SEER	20
CAC – 14+ SEER	20
ECM Furnace	13
Other Measures	20
ACES Measures	8.5
Targeted Measures	25

A.1.7 Electricity savings load shapes

For each measure category, we calculated a load shape that represents the percentage of annual consumption that falls within each of the kWh cost periods used in the b/c analysis. For heating and cooling load shape, for lighting, and for the total residential load shape, this information derives from research provided by the Wisconsin Energy Conservation Corporation.[26] For other appliances, we applied load shapes developed by the Bonneville Power Administration. The load shapes we applied are shown in Table A-3.

[26] Evaluation load curves were provided by Wayne DeForest, Senior Engineer, Strategic Planning & Research, Wisconsin Energy Conservation Corporation

Table A-3. Residential Load Shapes

Measure Category	Summer Peak	Winter AM Peak	Winter PM Peak	Off Peak
Residential Appliances	15%	5%	3%	77%
Residential Clothes Washers	18%	8%	4%	70%
Residential Cooling	53%	0%	0%	47%
Residential Heating	0%	10%	9%	82%
Residential Heating and Cooling	16%	5%	4%	75%
Residential Hot Water	14%	8%	4%	74%
Residential Lighting	13%	5%	4%	78%
Residential Total	20%	4%	3%	73%

A.1.8 Non-energy benefits

For the benefit cost-analysis, most of the residential program's NEBs estimates are based on NEBs factor applied to the utility avoided cost of each measure. These NEBs factors are reported in "A Reappraisal of NEBs Values for Residential Programs." NEBs for the "Targeted Hope Performance with ENERGY STAR" program are assumed to reflect the (Low Income) Weatherization Assistance Program (WAP). Therefore, the estimated NEB values in the FY03 NEB report[27] for low-income WAP have been used as proxy for THPES program.

A.2 FORWARD-LOOK SCENARIO

A.2.1 ECW estimated savings

ECW estimated savings were produced by the ECW potential study for 2012 and 2018. First, we grouped the measure level savings in the ECW potential study into the residential program and measure categories used for the historic scenario. Then we estimated savings for years other than 2012 and 2018 by assuming a linear growth or decline in savings. Measure categories for which ECW found no potential in 2018 were assumed to have no potential in subsequent years as well.

A.2.2 Market effects savings

The ECW Potentials study captured market effects in their estimates of potential net savings. No additional market effects were included beyond those already in ECW estimated savings.

[27] Low-income Non-Energy Benefits: Results of the revised benefit calculation approach for benefit-cost analysis. Memo dated May 1, 2003. Nick Hall and Johna Roth. TecMRKT Works.

A.2.3 Incentive payments

Incentive payments were based upon the rates assumed in the ECW Potential study: 50 percent of incremental costs for replace on burnout and new construction measures and 90 percent of incremental costs for early replacement retrofit measures.

A.2.4 Incremental project costs

Incremental project costs were estimated using the same simple paybacks (incremental costs divided by annual avoided costs) by program and measure category found in the Historic Scenario.

A.2.5 Program administrative costs

Overall program administration costs were calculated using cost factors provided by the ECW Potential Study. They were separated into labor, travel and office/equipment costs for the economic impacts analysis based on the distribution of these costs found in the projected FOE CY09 budget.

The ECW program administration cost factors are in terms of cost per unit of simple lifetime energy savings as shown in Table A-4. Estimating gross program administration costs required converting the ECW net savings into gross savings before applying the cost factors. Because no net-to-gross ratio was explicitly assumed for residential programs in the ECW study, we used the 18 MCP net-to-gross ratios to estimate gross energy savings. Gross energy savings were then multiplied times the measure life and the cost factor to get program administration costs.

Table A-4. ECW Potential Study:
Residential Program Administration Cost Factors

Measure Type	$ / lifetime kWh	$ / lifetime therm
Lighting	$0.005	$0.040
Appliances	$0.005	$0.040
New Construction	$0.009	$0.140
Building Shell	$0.009	$0.140

The full equation reads:

Overall Program Administration costs = (kWh Cost Factor) x (‘net kWh savings’ / ‘18MCP net-to-gross ratio for kWh’) x measure life + (therm Cost Factor) x (‘net therm savings’ / ‘18MCP net-to-gross ratio for therms’) x measure life.

A.2.6 Measure life

We used the same measure lives in both the Historic and Forward-look Scenarios.

A.2.7 Electricity savings load shapes

We used the same electricity savings load shapes in both the Historic and Forward-look Scenarios.

A.2.8 Non-energy benefits

We used the same methods to estimate NEBs in both the Historic and Forward-look Scenarios.

APPENDIX B: DEVELOPMENT OF BUSINESS PROGRAM INPUTS

B.1 HISTORIC SCENARIO

B.1.1 Structure of the projections

Projections were developed separately for each sector: Agriculture, Commercial, Schools and Government, and Industrial. Each sector is broken into nine end-use categories:

- Building Shell
- HVAC – Equipment
- HVAC – Service
- CFL
- Other Lighting
- Motor
- Manufacturing Process – Equipment
- Manufacturing Process – Service
- Other.

We chose to segregate the BP analysis by sector because each sector runs essentially as a unique unit with its own savings goals and targets. We report impact evaluation results by sector and, therefore, the savings breakdowns are already available at the sector level.

We chose to subcategorize the BP analysis into the same end-use categories used in BP reports that inform the Benefit-cost Analysis including Business Programs: Incremental Cost Study,[28] the Business Programs: Measure Life Study,[29] and Business Programs: End-use Specific Attribution Factors.[30] Structuring the study this way allowed for increased precision versus simply using the sector categories.

---

[28] Miriam Goldberg, J, Ryan Barry, Brian Dunn, Matt Pettit, KEMA, Inc. *Focus on Energy Evaluation, Business Programs: Incremental Cost Study, Final Report*. October 28, 2009.

[29] Miriam L. Goldberg, J. Ryan Barry, Brian Dunn, Mary Ackley, Darcy DeAngelo-Woolsey, KEMA Inc. *Focus on Energy Evaluation Business Programs: Measure Life Study.* August 25, 2009,

[30] Miriam L. Goldberg, J. Ryan Barry, Paula Ham-Su, and Aditya Chandraghatgi, KEMA Inc. *Focus on Energy Evaluation, Business Programs: End-use Specific Attribution Factors – Fiscal Year 2006, Final Report.* April 20, 2007.

B.1.2 Documented savings

Documented savings for FY02–FY08 are based on the Focus on Energy Evaluation Semiannual Report (18-month Contract Period).[31] Savings for FY08 are equal to two-thirds of the total savings in the 18-Month Contract Period. FY09 savings consist of one-third of the 18MCP savings plus one-half of the projected CY09 savings. We projected CY09 savings based on the ratio of savings per program spending dollar in the 18MCP applied to the projected budget for Contract Year 09. FY10 and FY11 are projected in the same way, based on the budget from CY09 remaining flat in real dollars through the end of the program.

a. EDUCATION AND TRAINING PROGRAM SAVINGS

We included savings based on the findings of the Focus on Energy Evaluation Impact Evaluation of the Education and Training Program (E&T Study) with documented savings.[32] E&T Study savings are based on a savings per participant estimation. We based our participant counts on detail provided by the program administrator for FY04–FY07. Participants were projected to later periods based on the ratio of participants to program spending found in the FY04–FY07 period. E&T Savings do not occur in the year of participation, rather they accrue in the four years after participation, leading to some documented savings in post-program years.

B.1.3 Market effects savings

a. CFLS

Beginning with the FY06 BP impact evaluation the net-to-gross analysis for CFLs in the residential portfolio has been applied to BP CFLs as well. This net-to-gross, which includes spillover and market effects as well as free-rider effects, is included for the documented savings in both scenarios.

Per the most recent analysis using this method, roughly 15 percent of in-program (tracked) sales are naturally occurring.[33] These are balanced by a roughly equal number outside the program but attributable to it. Thus, the sales outside the program and attributable to it are 15 percent of in-program tracked sales. We assume that these sales would continue after the close of the program, but would decline in the absence of an active program promoting a high level of demand. That is, the added market effects after the program close begins at 15 percent of the FY11 documented level. These effects are reduced by 10 percent per year throughout the analysis period.

---

[31] Focus Evaluation Team, *Focus on Energy Evaluation, Semiannual Report (18-month Contract Period), Final Revised Report.* August 14, 2009.

[32] Christopher Dyson, Ken Agnew, Miriam Goldberg, Claire Palmgren, KEMA Inc. *Focus on Energy Evaluation, Impact Evaluation of the Education and Training Program, Program Area: Business Programs, Final Report.* November 20, 2008.

[33] Rick Winch & Tom Talerico, Glacier Consulting Group LLC. *Focus on Energy Public Benefits Evaluation, Comprehensive CFL Market Effects Study – Final Report.* July 30, 2007.

b. NON-CFLS

The 2005 BP spillover report provides a basis for calculating the non-CFL spillover rate.[34] We calculate this rate as the new savings in the current year per unit of cumulative tracked savings in prior years. This rate represents first-year savings implemented in the current year due to all prior program years. This rate is:

0.08 percent for kWh

0.11 percent for kW

0.002 percent for therms.

Like CFL market effects, after program completion, these savings continue to accrue, but their effects are reduced by 10 percent per year.

The equation for non-CFL spillover during the program is:

rate * sum(program savings to date)

The equation for post-program non-CFL spillover is:

rate * sum(program savings to date)*$0.90^{(year-12)}$

c. HIGH BAY LIGHTING AND ROOFTOP UNITS

The FY08 BP Channel Studies Report found evidence of untracked attributable savings for specific high bay lighting and rooftop HVAC technologies.[35] The Channel Studies Report did not quantify these effects; however, we were able to apply the quantification methods developed for the CY09 Supply-Side Study to the data collected in the FY08 BP Channel study and 18 MCP tracking data to develop market projections for high bay and RTUs.[36]

B.1.4 Incentive payments

Historic incentive payments were determined from invoicing and budget records provided by the program administrators. Future incentive levels were projected based on the projected CY09 budget.

---

[34] Miriam Goldberg, Christopher Dyson, and Valy T. Goepfrich, KEMA Inc. *Focus on Energy Statewide Evaluation, Business Programs: Participant Spillover Savings Study, Final Report.* December 22, 2005.

[35] Ryan Barry, Mimi Goldberg, Mitch Rosenberg, Joshua Horton, and Karen Rothkin, KEMA Inc. *Focus on Energy Evaluation, Business Programs: Channel Studies – Fiscal Year 2008, Final Report.* January 17, 2009.

[36] Christopher Dyson, Ryan Barry, Miriam Goldberg, KEMA Inc., Ralph Prahl, Prahl and Associates. *Focus on Energy Evaluation: Research Plan for Supply-Side Research.* June 25, 2009.

B.1.5 Incremental project costs

Our primary source of incremental cost information is the Focus on Energy Evaluation Business Programs: Incremental Cost Study (IC Study).[37] This study provided payback periods for CFLs, other lighting and steam trap maintenance, which together make up a significant portion of program savings. For end-uses where the Incremental Cost Study found limited information, data collected as part of the Implementing Partner Short-Term Follow-up Survey is used.

Incremental cost data have been collected on every Implementing Partner Short-Term Follow-up Survey. These data were merged with reported gross savings data from the tracking databases. Savings values were translated to avoided costs by applying the avoided cost values used in the present report. From this combined database, we calculated the ratio of mean incremental cost to mean savings. This ratio can be thought of as the simple payback period.

Multiplying the payback period by the net savings (documented and market effects) gave the incremental cost. This calculation was done for each combination of sector, end-use, and year.

The payback period was calculated separately by end-use. The same end-use payback periods were used for each sector, since the available data were not sufficient to generate separate estimates by sector and end-use combined.

E&T Training savings required additional analysis. Some E&T Training savings fit within the end-use categories and are included as a part of the end-use savings. The remaining E&T Training savings were classified as operations and maintenance, a combination of service measures and behavior change based savings. Based on the mix of measures included, we estimated a simple payback period of slightly less than half that of pure service measures. This estimate is based on the assumption that “operations” changes are generally low to no cost since these often only entail revising set-points or other similar behavior changes. As a result, the payback period will be close to zero. We estimated the average payback period as approximately half that of service measures.

Table B-1 gives the payback periods calculated for each end-use as well as the source of the data. The total payback is divided into equipment and labor costs. These breakouts are used in the economic impact analysis, separately reported.

[37] Miriam L Goldberg, J. Ryan Barry, Brian Dunn, Matt Pettit, KEMA Inc. *Focus on Energy Evaluation, Business Programs: Incremental Cost Study, Draft Report.* September 8, 2009.

Table B-1. Business Programs Incremental Cost Payback Periods

End-use	Equipment	Labor	Total	Estimation Method
Building Shell	3.59	0.52	**4.11**	Implementing Partner Survey Method
HVAC-Equip	1.62	1.51	**3.13**	Implementing Partner Survey Method
HVAC-Service	0.20	0.46	**0.65**	Incremental Cost Study
Lighting	2.26	0.63	**2.89**	Incremental Cost Study combined with Implementing Partner Survey Method
MP-Equip	1.55	0.69	**2.24**	Implementing Partner Survey Method
MP-Service	0.20	0.46	**0.65**	Incremental Cost Study
Other	2.02	0.55	**2.57**	Implementing Partner Survey Method
CFL	0.04	0.00	**0.04**	Incremental Cost Study
Motor	1.10	0.39	**1.49**	Implementing Partner Survey Method
E&T O&M	0.10	0.20	**0.30**	Conservatively estimated based on service measure paybacks

a. SOURCE OF IMPLEMENTING PARTNER DATA

The incremental cost data used in the analysis is from the Implementing Partner Short-Term Follow-up Survey conducted as part of each round of impact evaluation. This survey established the purpose of the project for each participant. The response to these questions determined whether the participant was asked about the full cost of the project or the partial increase or decrease as a result of the energy efficiency improvements. In both cases the participant was asked to provide both a total for the costs as well as break out the total for equipment and/or labor. This sequence of questions was asked of participants for each different end-use they implemented.

b. PARTICIPANT LEVEL PAYBACK CALCULATION

The incremental cost data from the surveys was combined with energy savings from the tracking data and put in terms of 2009 dollars. Energy savings were transformed into a single avoided cost metric using 2009 energy prices. The incremental cost data from the surveys was inflated to 2009 dollars using the Consumer Price Index. The ratio of the 2009 incremental cost to 2009 avoided energy costs provides a participant level estimate of payback or the number of years it will take to break even on the project.

Incremental cost data is frequently difficult for participants to estimate, particularly when the efficiency measure was implemented in the context of a much larger project. We therefore screened the survey data to remove what appeared to be unreasonable responses. We used the participant level payback estimates to establish whether to include the data in the final estimates of overall payback. We accepted payback ranging from between one-half year and eight years. The median payback was similar with or without this screen.

Final incremental cost estimates were calculated using an unweighted ratio estimator.

$$\text{Payback} = \overline{IC_e} \Big/ \overline{AC_e}$$

where:

$\overline{IC_e}$ = mean incremental cost within an end-use.

$\overline{AC_e}$ = mean avoided energy cost within an end-use

For Other Lighting measures, we used portion of 18MCP tracked in the WISEERTS database to weight the results of the IC study (for those technologies where it applied) and the results of the Implementing Partner Survey Method where the IC Study was not applicable.

B.1.6 Measure life

The 2009 BP Measure Life Study[38] provided the measure lives for Business Programs in the b/c analysis at the end-use level by sector. Table B-2 shows the measure lives used.

Table B-2. Business Program Measure Lives

End-use Category	Measure Type	Sector			
		Agricultural	Commercial	Industrial	Schools and Government
Building Shell	Equip or Tech	19	19	19	19
HVAC	Equip or Tech	15	15	15	15
	Service	5	5	5	5
Lighting	Equip or Tech	12	12	12	12
Manufacturing Process	Equip or Tech	11	11	11	11
	Service	2	2	2	2
Other	Equip or Tech	12	12	12	12
CFL	Equip or Tech	7	5	4	5
Motors	Equip or Tech	16	16	16	16

B.1.7 Electricity savings load shapes

The savings load shapes shown in Table B-3 were used in the b/c analysis. A detailed discussion of how the savings load shapes were calculated can be found in the Focus evaluation memo, *Review of Business Programs Load Shapes—Draft*.

[38] Miriam L. Goldberg, J. Ryan Barry, Brian Dunn, Mary Ackley, Darcy Deangelo-Woolsey, KEMA Inc. *Focus on Energy Evaluation Business Programs: Measure Life Study.* August 25, 2009,

Table B-3. Business Programs Electricity Savings Load Shapes

Sector	End-use	Percent of Electric Energy Savings in Period				Average Avoided Cost per kWh
		Summer Peak	Winter AM Peak	Winter PM Peak	Remaining Hours	
Agriculture	Building Shell	19%	6%	5%	70%	$0.046
	HVAC	19%	6%	5%	70%	$0.046
	CFL	12%	2%	3%	83%	$0.042
	Other Lighting	12%	2%	3%	83%	$0.042
	Process	17%	5%	4%	74%	$0.045
	Motors	17%	5%	4%	74%	$0.045
	Other	17%	5%	4%	74%	$0.045
Commercial	Building Shell	32%	5%	2%	60%	$0.050
	HVAC	32%	5%	2%	60%	$0.050
	CFL	19%	12%	2%	67%	$0.047
	Other Lighting	19%	12%	2%	67%	$0.047
	Process	18%	6%	3%	73%	$0.045
	Motors	32%	5%	2%	60%	$0.050
	Other	18%	6%	3%	73%	$0.045
Industrial	Building Shell	30%	4%	2%	65%	$0.049
	HVAC	30%	4%	2%	65%	$0.049
	CFL	17%	9%	5%	69%	$0.046
	Other Lighting	17%	9%	5%	69%	$0.046
	Process	16%	6%	3%	75%	$0.044
	Motors	14%	6%	4%	75%	$0.044
	Other	16%	6%	3%	75%	$0.044
Schools and Government	Building Shell	38%	3%	1%	58%	$0.051
	HVAC	38%	3%	1%	58%	$0.051
	CFL	20%	13%	3%	65%	$0.047
	Other Lighting	20%	13%	3%	65%	$0.047
	Process	16%	6%	2%	76%	$0.044
	Motors	38%	3%	1%	58%	$0.051
	Other	16%	6%	2%	76%	$0.044

B.1.8 Non-energy benefits

Non-energy benefits (NEBs) were calculated by applying a fixed multiplier to the avoided energy costs. To develop this multiplier, we relied on results from the 2003 report on BP NEBs produced for Focus. (*Non-energy Benefits to Implementing Partners from the Wisconsin Focus on Energy Program: Final Report*, October 20, 2003).

The NEBs results produced in the report were reported on a per project basis. However, given the wide range of project sizes in the program, ranging from a few compact fluorescent bulbs to a major industrial plant changeover, it was important to develop a NEBs factor scaled to the project magnitude.

A participant-level ratio of NEBs to avoided energy cost using the original NEBs analysis was not feasible, because the magnitude of savings for the projects included in that study was not reported, and the data identifying the individual respondents are not readily available. Instead, an aggregate avoided cost estimate was calculated using the population

from which the NEBs analysis was drawn. That is, we scaled the average NEBs determined in the report by an estimate of average savings per project for the set of participants that served as the starting frame for the NEBs study sample.

To adjust for a possible different mix in project type and complexity between the starting frame and the completed sample, we determined the NEBs per unit avoided cost separately by measure category and weighted the results by the number of sample cases in each measure category. Participants in the NEBs population were assigned to detailed measure categories consistent with those used for the original NEBs analysis. Reported energy savings were transformed to avoided cost using 2009 energy prices and summed within the measure categories. Using the number of completed sample cases in each category as weights, we calculated a weighted average avoided cost for the NEBs population.

This aggregate avoided cost estimate was used to translate the NEBs results from the previous report into a NEBs value per dollar of avoided energy cost.

The original report offered three possible estimates depending on the interpretation of 0 responses and missing values in each NEBs category. We took the most conservative of these estimates. Using data presented in the report, we also constructed a version of that estimate based on median rather than mean values. The NEB value per dollar of avoided costs was found to be 0.33 using the median and 0.24 using the mean. We used a value of 0.3 for the benefit-cost analysis.

Based on the short term nature of the NEBs found in the 2003 BP NEBs report, BP NEBs in the b/c analysis were estimated based on first year savings rather than having them recur throughout the lifetime of the equipment.

B.2 FORWARD-LOOK SCENARIO

B.2.1 ECW estimated savings

ECW estimated Savings were produced by the ECW potential study for 2012 and 2018. First, we grouped the measure level savings in the ECW potential study into our sector and end-use categories. Then we estimated savings for years other than 2012 and 2018 by assuming a linear growth or decline in savings. We assumed end-uses for which ECW found no potential in 2018 have no potential in subsequent years as well.

B.2.2 Market effects savings

The ECW Potential study captured market effects in their estimates of potential net savings. No additional market effects were included beyond those already in ECW estimated savings.

B.2.3 Incentive payments

We based incentive payments upon the rates assumed in the ECW Potential study: 50 percent of incremental cost for replace on burnout and new construction measures and 90 percent of incremental costs for early replacement retrofit measures.

B.2.4 Incremental costs

We estimated incremental costs using the same simple paybacks that we applied in the Historic Scenario.

B.2.5 Program administrative costs

Overall Program Administration costs were calculated using cost factors provided by the ECW Potential Study. They were broken into Labor, Travel and office/equipment costs based on the distribution of these costs found in the projected FOE CY09 budget.

The ECW program administration cost factors are in terms of cost per unit of lifetime energy savings: 0.003 per lifetime kWh and .030 per lifetime therm. Estimating gross program administration costs required converting the ECW net savings into gross savings before applying the cost factors. Because no net-to-gross ratio was explicitly assumed for business programs in the ECW study, we used the 18MCP net-to-gross ratios to estimate gross energy savings. Gross energy savings were then multiplied times the measure life and the cost factor to get program administration costs. The full equation reads:

Overall Program Administration costs = $0.003 x (‘net kWh savings’ / ‘18MCP net-to-gross ratio for kWh’) x measure life + $0.030 x (‘net therm savings’ / ‘18MCP net-to-gross ratio for therms’) x measure life.

B.2.6 Measure life

We used the same measure lives in both the Historic and Forward-look Scenarios.

B.2.7 Electricity savings load shapes

We used the same electricity savings load shapes in both the Historic and Forward-look Scenarios.

B.2.8 Non-energy benefits

We used the same estimate of NEBs in both the Historic and Forward-look Scenarios.

APPENDIX C: DEVELOPMENT OF RENEWABLE ENERGY PROGRAM INPUTS

C.1 HISTORIC SCENARIO

C.1.1 Documented savings

Documented savings were calculated using historic Renewables Program tracking data and technology specific realization rates from annual impact evaluations.

C.1.2 Market effects savings

There have been no documented market effects savings for the Renewables Program to date.

C.1.3 Incentive payments

Where possible incentive payments prior to CY09 were based on program tracking data. For the few measures without known incentive payments, incentives were estimated based on the other incentives given in that year for similar projects.

C.1.4 Incremental project costs

For renewable projects, customer incremental costs are equal to the full project cost. Gross Incremental Costs prior to CY09 were based on program tracking data. For the few measures without known project costs, incremental costs were estimated based on the other incentives given in that year for similar projects.

To calculate the net incremental costs from the gross incremental costs, the annual technology specific net-to-gross ratio of the dominant energy savings type for the technology was used.

Biomass systems have an additional incremental cost that is ongoing and related to energy generation: fuel. The evaluation team found that across the program as a whole, biomass systems average $0.26 per therm in fuel costs. This value includes both systems who purchased fuel and those for which the fuel used had no cost. In the 2007 b/c fuel costs were not included.

C.1.5 Program administrative costs

Program administration costs were provided by the program.

C.1.6 Measure life

Measure lives used for renewable technologies are based on a review of measure lives used for other studies.

Table C-1. Renewable Technology Measure Lives

Technology	Measure Life
Biogas	15
Biomass	20
PV	20
Solar Hot Water	20
Wind	20
Other	20

C.1.7 Electricity savings load shapes

The b/c analysis uses MISO day ahead locational marginal prices (LMPs) to determine avoided electricity costs. A combination of MISO (LMPs) and American Transmission Company (ATC) data were used to establish four peak pricing periods to value avoided electric energy costs.

For each technology, we calculated a load shape that represents the percentage of annual generation that falls within each LMP period. The load shapes used are shown in Table C-2.

Table C-2. Renewable Programs Electricity Savings Load Shapes

Technology	Percent of Electric Energy Savings in Period				Average Avoided Cost per kWh
	Summer Peak	Winter AM Peak	Winter PM Peak	Remaining Hours	
Biogas	13%	5%	3%	80%	$0.043
Biomass	14%	7%	3%	75%	$0.044
PV	22%	16%	0%	62%	$0.048
Solar Hot Water	21%	17%	0%	62%	$0.048
Wind	8%	8%	5%	79%	$0.042
Other	13%	5%	3%	80%	$0.043

C.1.8 Non-energy benefits

We included Non-Energy Benefits for agricultural biogas systems. These estimates were developed based on a limited study done in Minnesota that reported savings values for the following NEBs: bedding, fertilizer, odor control, pest control, and herbicides.

C.2 FORWARD-LOOK SCENARIO

C.2.1 ECW estimated savings

ECW estimated savings were produced by the ECW potential study for 2012 and 2018. We estimated savings for years other than 2012 and 2018 by assuming a linear growth or decline in savings. Technologies for which ECW found no potential in 2018 were assumed to have no potential in subsequent years as well.

C.2.2 Market effects savings

The ECW Potential study captured market effects in their estimates of potential net savings. No additional market effects were included beyond those already in ECW estimated savings.

C.2.3 Incentive payments

Incentive payments were based upon the rates assumed in the ECW Potential study: 30 percent of incremental cost.

C.2.4 Incremental project costs

Incremental Project costs were estimated using based on the system costs reported in the ECW Potential Study.

C.2.5 Program administrative costs

Overall program administration costs were calculated using cost factors provided by the ECW Potential Study in the appendices. They were separated into labor, travel and office/equipment costs for the economic impacts analysis based on the distribution of these costs found in the projected FOE CY09 budget.

The ECW program administration costs were provided for each technology. We calculated the costs for each technology as a function of the dollars per unit of annual energy savings (per kWh and therms). Next we adjusted the ECW estimated net program costs into gross program costs by multiplying by two to account for the 50 percent attribution factor they assumed.

Table C-3. ECW Potential Study:
Renewable Program Administration Cost Factors

Technology	$ / kWh	$ / therm
Biogas	$0.00844	$0.07920
Biomass	$0.00202	$0.05688
Solar Electric	$0.24860	
Solar Hot Water	$0.38000	$8.90000
Wind	$0.08580	

The full equation reads:

Overall Program Administration costs = (kWh Cost Factor) x (‘net kWh savings’ / ‘attribution’) + (therm Cost Factor) x (‘net therm savings’ / ‘attribution’).

C.2.6 Measure life

We used the same measure lives in both the historic and forward-look scenarios.

C.2.7 Electricity savings load shapes

We used the same electricity savings load shapes in both the historic and forward-look scenarios.

C.2.8 Non-energy benefits

We used the same estimate of NEBs in both the historic and forward-look scenarios.

APPENDIX D: EMISSIONS FACTORS AND COSTS

D.1 EMISSION FACTORS

The Focus evaluation team uses emission factors to estimate environmental impacts from Focus on Energy net energy savings, in the form of displaced power plant emissions. Emission factors are used to accomplish basic conversions between energy inputs (i.e., fuels used to generate electricity) and generation of gases (e.g., CO_2, NO_x, SO_2, and mercury). We also strive to base our emission-factor calculations on generation data specific to the geography of the Focus energy efficiency programs. In addition, emission factors for Focus are estimated based on specific marginal generating plant(s), adding critical realism to the quantifications.[39]

As part of the inputs to the Focus benefit-cost analysis, the evaluation team provides updated emission factors based on the Environmental Protection Agency's (EPA) Office of Air and Radiation "Acid Rain Hourly Emissions Data," which derives from actual stack monitoring. Appropriate allowance prices for displaced emissions are then used for the benefit-cost and economic impact analyses, including a forecast of future prices (2007–2026). Focus on Energy estimates an annual net electric savings in 2008 of 756 GWh from activities since 2001.

In the Fiscal Year 2007 (FY07) emissions research, using 2005 EPA data, we noted significant changes in all factor estimates relative to an earlier analysis based on 2000 data. Between 2000 and 2005, our estimates indicated that NO_X had fallen from 5.7 to 3.2 lbs/MWh; SO_X had fallen from 12.2 to 4.8 lbs/MWh; mercury had fallen from 0.05 to 0.02 lbs/MWh. The rate for CO_2, conversely, had risen from 2,216 to 2,480 lbs/MWh. Change as dramatic as this demanded further investigation to determine whether it was real or an artifact of our estimation process. In particular, we wanted to know whether the change was a byproduct of the way we were defining marginal plants. If real, what caused the changes?

Recently, the Focus team has re-estimated emission factors on five years of EPA data, spanning from 2002 to 2006.[40] As before, we estimated the emission rate for all plants serving the grid that provides electricity to Wisconsin consumers. We define this grid by the two North American Reliability Corporation (NERC) reliability regions that cover the state: the Midwest Reliability Organization (MRO; prior to 2005 MAPP) and the Reliability First Corporation (RFC; prior to 2006 MAIN).

We have now adopted a new definition of emissions from generating units on the margin. In the past we have defined marginal generation in two different ways, i.e. as coming from:

---

[39] Using marginal emission factors will produce much more accurate estimates of emissions reductions than applying average rates taken from published data. This approach is also more accurate than one that relates avoided generation and emissions to a specific type of new power plant, since new capacity is often not dispatched as a marginal source.

[40] Eric Rambo, Bryan Ward, and David Sumi. *Focus on Energy Evaluation: Quantifying Environmental Benefits of Focus on Energy: Emission-rate Estimates 2002 to 2006.* October 28, 2008.

- The single unit in any hour with the greatest change in load from the previous hour, relative to the unit's maximum load, where that change is in the direction of the grid as a whole, up or down (referred to in this report as the "single greatest mover" approach); or,
- The set of plants that are increasing their load relative to their maximum load, by an amount that puts them in the top one percent of hourly change for the year (referred to in this report as the "99 percent gainers" approach).

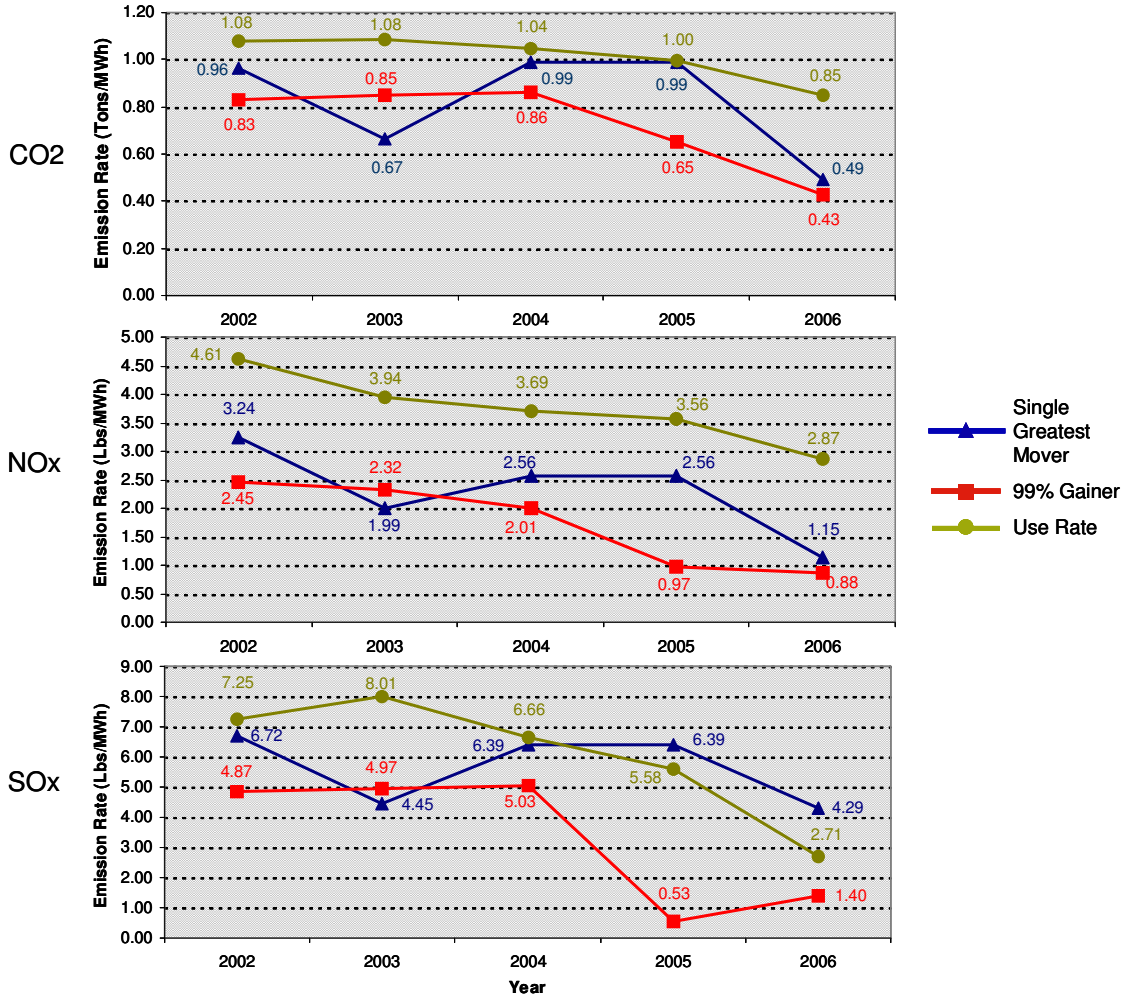
While both of those are reasonable approaches, each has its shortcomings. The single greatest mover approach is unstable because there are reasons other than demand changes that cause plants to increase or decrease load dramatically in an hour. The 99 percent gainers approach smoothes out some of this instability by averaging over several units; however the 99th percentile is an arbitrary cut-off and there are significant numbers of hours where there are no marginal plants under this definition.

We have now developed the concept of "use-rate" to identify marginal plants. Use-rate is the average length of time a generating unit remains on once it is brought online. Thus, peaking units, which are brought on for only a short time, have a low use-rate; base-load plants that remain on for hundreds of hours or more have a high use-rate. We define marginal emissions as those produced by the set of generating units in the lowest use-rate group that is operating in each hour, in each NERC region.

Another change from previous emissions estimates is the way we treat Wisconsin plants in the analysis. In FY07, we weighted emission factors to reflect in-state versus out-of-state generation. We no longer think this is appropriate. The Focus team has been working to align our emission rate estimation method with recommendations of the Greenhouse Gas Protocol Initiative. This protocol, developed by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD), has become the most broadly accepted accounting tool for understanding, quantifying, and managing greenhouse gas emissions. In July of 2007, the Greenhouse Gas Protocol Initiative published its "Guidelines for Quantifying GHG Reductions from Grid-Connected Electricity Projects" ("the Guidelines"). It is clearly stated in this protocol that the proper geographic region for estimating avoided emissions is the electrical grid. For this year, we do not introduce any weights to the analysis relative to where generation is occurring.

We have found that emission rate estimates are quite sensitive to the definition of what is a marginal plant. Compared to our current approach, the FY07 findings overstated the rate of change in emission factors. Figure D-1 compares marginal emission rates for the three definitions.

Figure D-1. Emission Rates under Three Definitions of Marginal Plant, 2002–2006



Source: EPA

Adopting a definition that we believe best captures the operating margin, we see more modest declines in CO_2, NO_X, and SO_X than we saw in our previous estimates. Table D-1 shows our current estimates of emission factors for 2002 to 2006.

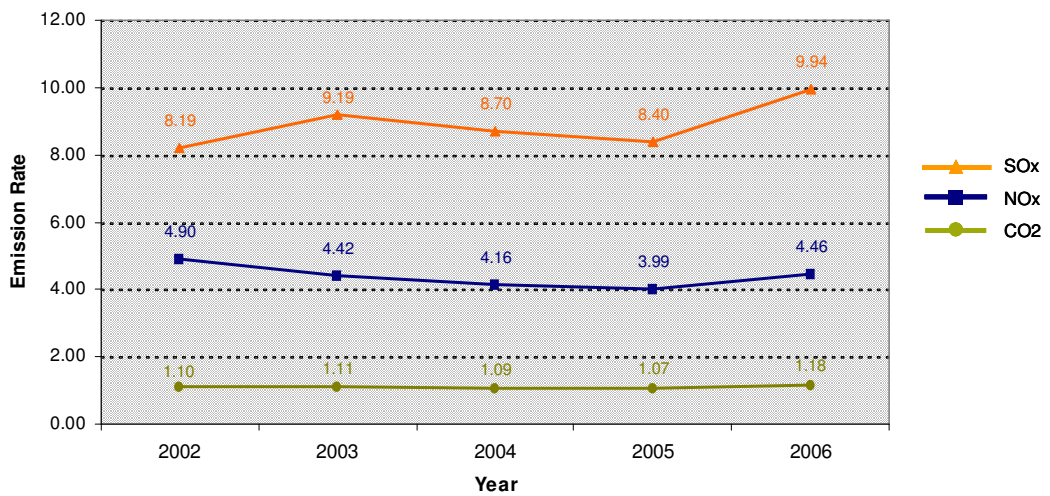
Table D-1. Emission Rates for Wisconsin NERC Regions, 2002–2006

		2002	2003	2004	2005	2006
Marginal Plants	CO_2	1.08	1.08	1.04	1.00	0.85
	NO_X	4.61	3.94	3.69	3.56	2.87
	SO_X	7.25	8.01	6.66	5.58	2.71
	Mercury	0.0000248	0.0000232	0.0000202	0.0000186	0.0000163
Total Generation	CO_2	1.10	1.15	1.13	1.15	1.22
	NO_X	4.49	4.31	4.28	4.24	3.74
	SO_X	8.80	9.03	8.86	7.69	11.03
	Mercury	0.0000257	0.0000258	0.0000261	0.0000246	0.0000529

Emission rates for CO_2 are in tons per MWh; emission rates for NO_X, SO_X, and mercury are in pounds per MWh.
Source: EPA

The decreases in emissions we see result from the substitution of gas-fired load for coal-fired load at the margins. We no longer see clear evidence that cleaner coal generation is contributing more than marginally to the reduction in emissions. We do note that among Wisconsin IOUs, MG&E has reduced its emissions from coal. Figure D-2 indicates the emission rates from coal fueled plants on the operating margin from 2002 to 2006.

Figure D-2. Emission Rates from Coal Fueled Plants on the Margin, 2002–2006

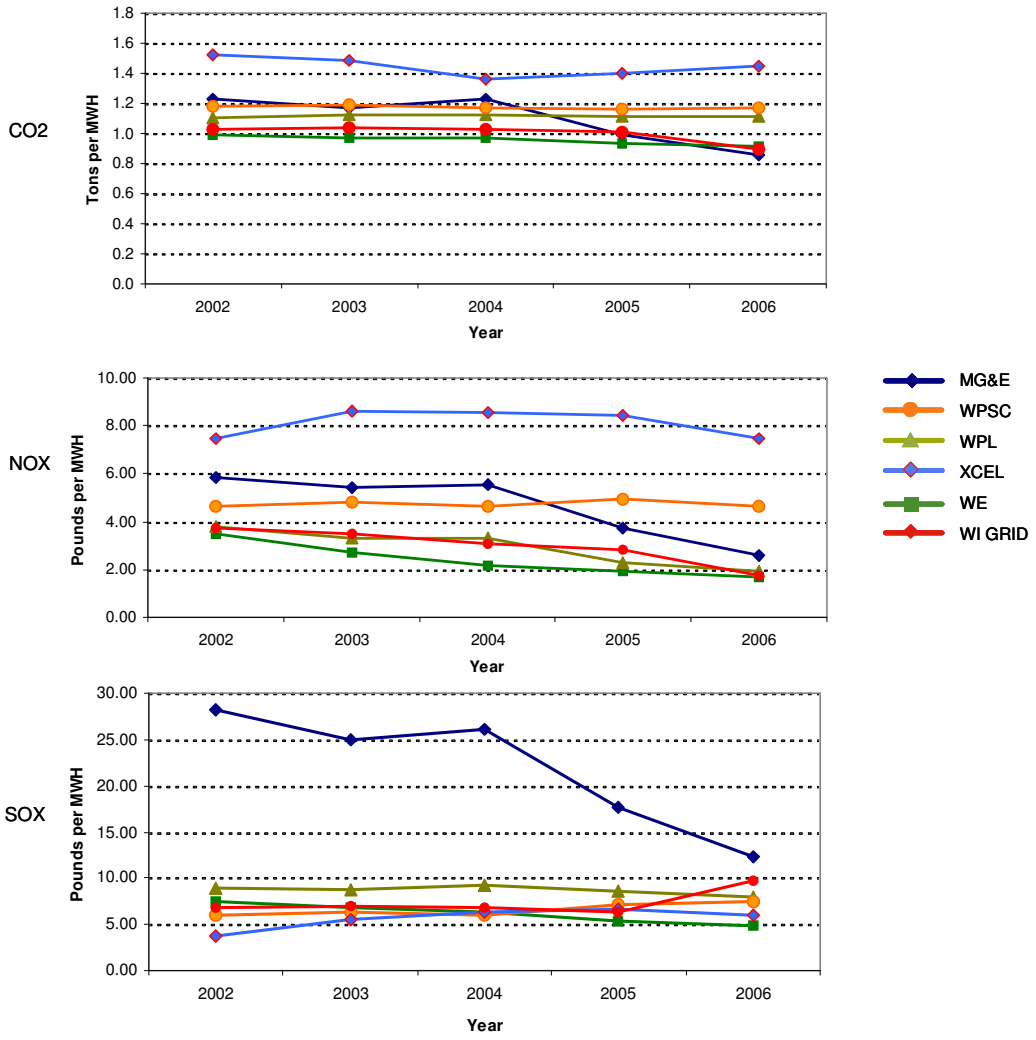


Note: CO_2 emissions expressed in tons per MWh; NO_X and SO_X expressed in pounds per MWh. Source: EPA

In our planning for this report, we anticipated providing separate emission estimates for individual Wisconsin IOUs. In the course of preparing the report, however, we have come to doubt that point of view. Nevertheless, we believe there is value in knowing how Wisconsin IOU emission rates compare with the grid as a whole. Given the predominance of base load in Wisconsin IOU generation, the comparison that seems most appropriate is for total emissions.

Figure D-3 shows the emission rates for CO_2, NO_X, and SO_X from Wisconsin IOUs' total generation. For CO_2, emission rates indicate some downward drift over the five-year study period, with the exception of WP&L. NO_X rates dropped for MG&E, We Energies, and WP&L. SO_X rates dropped significantly for MG&E.

Figure D-3. Emission Rates for Wisconsin IOUs' Total Generation, 2002–2006



Source EPA

D.2 ALLOWANCE PRICES

The historic and forecast allowance prices were provided by PA's Multi-Pollutant Optimization Model (M-POM). Table D-3 below presents the historic and forecast prices for the relevant emissions allowances for the years 2001–2036.

Table D-3. Forecast Prices for Emission Allowances, 2001–2036

	Allowance Type							
	SO_2 Acid Rain/ CAIR	NO_x SIP Call	NO_x CAIR - Annual	NO_x CAIR - Ozone	Mercury CAMR	CO_2 RGGI	CO_2 National	CO_2 Combined
Year	$/Ton, Nominal	$/Ton, Nominal	$/Ton, Nominal	$/Ton, Nominal	$M/Ton, Nominal	$/Ton, Nominal	$/Ton, Nominal	$/Ton, Nominal
2001	$185.55	$915.25			$-	$-	$-	$-
2002	$152.30	$778.33			$-	$-	$-	$-
2003	$175.89	$4,601.58			$-	$-	$-	$-
2004	$441.06	$2,236.00			$-	$-	$-	$-
2005	$901.21	$2,759.60			$-	$-	$-	$-
2006	$789.56	$2,068.70			$-	$-	$-	$-
2007	$637.37	$1,847.40			$-	$-	$-	$-
2008	$674.27	$1,693.47			$-	$-	$-	$-
2009	$712.53		$1,375.63	$392.74	$-	$6.44	$-	$6.44
2010	$772.66		$1,042.26	$425.88	$41.01	$6.99	$-	$6.99
2011	$843.90		$1,138.36	$465.15	$44.79	$7.63	$-	$7.63
2012	$918.01		$1,238.33	$505.99	$48.73	$8.30	$-	$8.30
2013	$995.08		$1,342.29	$548.47	$52.82	$9.00	$-	$9.00
2014	$1,075.20		$1,450.38	$592.63	$57.07	$9.72	$-	$9.72
2015	$1,158.49		$1,562.74	$638.54	$61.49	$-	$13.00	$13.00
2016	$1,260.60		$1,700.47	$694.82	$66.91	$-	$14.62	$14.62
2017	$1,366.79		$1,843.71	$753.35	$72.55	$-	$16.32	$16.32
2018	$1,477.20		$1,992.65	$814.20	$78.41	$-	$18.09	$18.09
2019	$1,569.53		$1,497.09	$884.41	$85.17	$-	$19.93	$19.93
2020	$1,665.34		$977.68	$957.41	$92.20	$-	$21.84	$21.84
2021	$1,764.72		$1,000.16	$979.43	$99.51	$-	$22.34	$22.34
2022	$1,867.79		$1,023.17	$1,001.96	$107.10	$-	$22.86	$22.86
2023	$1,974.67		$1,046.70	$1,025.00	$114.99	$-	$23.38	$23.38
2024	$2,085.48		$1,070.78	$1,048.58	$123.19	$-	$23.92	$23.92
2025	$2,133.44		$1,095.40	$1,072.69	$126.03	$-	$24.47	$24.47
2026	$2,182.51		$1,120.60	$1,097.36	$128.93	$-	$25.04	$25.04
2027	$2,232.71		$1,146.37	$1,122.60	$131.89		$25.61	$25.61
2028	$2,284.06		$1,172.74	$1,148.42	$134.92		$26.20	$26.20
2029	$2,336.60		$1,199.71	$1,174.84	$138.03		$26.80	$26.80
2030	$2,390.34		$1,227.30	$1,201.86	$141.20		$27.42	$27.42
2031	$2,445.32		$1,255.53	$1,229.50	$144.45		$28.05	$28.05
2032	$2,501.56		$1,284.41	$1,257.78	$147.77		$28.70	$28.70
2033	$2,559.09		$1,313.95	$1,286.71	$151.17		$29.35	$29.35
2034	$2,617.95		$1,344.17	$1,316.30	$154.65		$30.03	$30.03
2035	$2,678.17		$1,375.09	$1,346.58	$158.20		$30.72	$30.72
2036	$2,739.76		$1,406.71	$1,377.55	$161.84		$31.43	$31.43

APPENDIX E: ELECTRIC PRICING PERIODS

KEMA used MISO locational marginal prices (LMP) at the Illinois hub in combination with ATC load data to develop electric pricing periods. ATC load data were available for only one year. We had three years of LMPs for the Illinois hub, which showed high variability in prices. After determining that prices followed load, we relied on the LMPs to develop average pricing period prices.

The analysis was based on three years of data. In the analysis, the years are defined as:

- Year 1: June 2006 through May 2007
- Year 2: June 2007 through May 2008
- Year 3: June 2008 through May 2009.

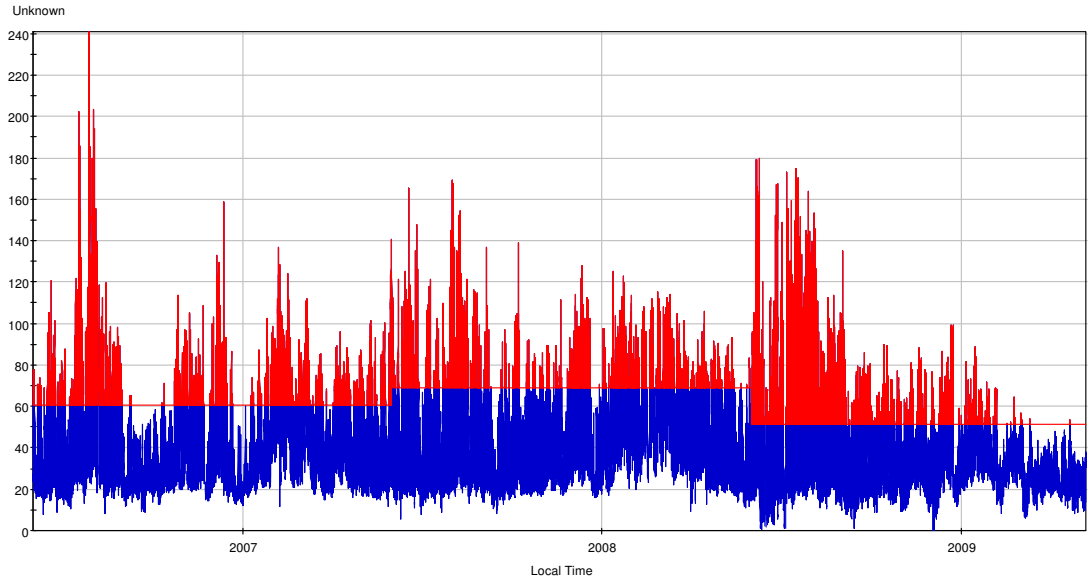
Peak price hours were defined as all hours above the 80th percentile for each analysis year. Table E-1 shows the 80th percentile by year. Note that Analysis Year 3 is substantially different that the previous two years. Figure E-1 illustrates the peak price hours in red. These periods typically occur in specific days of the week, "seasons" and hours of the day.

Table E-1. 80th Percentile for Prices (MW)

Analysis Year	Year	80th Percentile
1	2006–2007	$60.58
2	2007–2008	$69.17
3	2008–2009	$51.03

Figure E-1. Peak Price Hours

2006 - 2009



E.1.1 Day type

The percent of peak price hours were calculated by day of the week. Table E-2 shows that approximately 25 percent of the weekday hours are peak price hours. Approximately 10 percent of the weekend hours are peak price hours. The percentage of peak price hours is consistent over the analysis years. Accordingly, the day types were defined as weekdays and weekends.

Table E-2. Percent Peak Price Hours by Day of the Week

Day of the Week	All	2006–2007	2007–2008	2008–2009
Sunday	8%	7%	7%	10%
Monday	27%	26%	27%	26%
Tuesday	24%	23%	25%	24%
Wednesday	23%	23%	24%	22%
Thursday	25%	26%	26%	22%
Friday	21%	23%	20%	21%
Saturday	12%	11%	11%	14%
80th Percentile		$60.58	$69.17	$51.03

E.1.2 "Seasons"

"Seasons" are defined as grouping similar months. For the groupings by season were determined by choosing logical grouping of percentages of peak price hours. Table E-3 shows the percentages by month. The three months with the highest percentage are shown in pink. The next three months with the highest percentage are shown in peach. The third grouping is shown in light green. The months with the smallest percentage of price peak hours is shown in pale blue. This table shows that the first season is most consistent across years. The other three definitions are more variable on a yearly basis.

Table E-3. Percent Peak Price Hours by Month

Month	All	2006-2007	2007-2008	2008-2009
6	29%	22%	27%	38%
7	33%	33%	17%	50%
8	40%	38%	33%	48%
9	12%	1%	7%	27%
10	12%	8%	13%	14%
11	10%	10%	5%	13%
12	15%	13%	18%	14%
1	16%	10%	24%	14%
2	21%	32%	25%	4%
3	15%	16%	30%	1%
4	19%	28%	29%	0%
5	19%	31%	13%	0%
80th Percentile		$60.58	$69.17	$51.03

Accordingly, the seasons were initially defined as:

- Season 1: June, July, and August
- Season 2: September, October, and November
- Season 3: December, January, and March
- Season 4: February, April, and May.

E.1.3 On peak hours

The final categorization was to determine which hours had the highest percentage of peak price hours. The information was disaggregated by seasons and by day type. Any hour that had more than one third of all hours above the 80th percentile were identified as on peak hours. In Table E-4, these hours are highlighted in red. This table shows that there are two season day type combinations with no on-peak hours identified.

Table E-4. Percentage of Peak Price Hours by Season and Day Type

	Season 1		Season 2		Season 3		Season 4	
Months	June July August		September October November		December January March		February April May	
Daytype	Weekday	Weekend	Weekday	Weekend	Weekday	Weekend	Weekday	Weekend
Hour Ending								
1	2%	0%	0%	0%	0%	0%	0%	0%
2	1%	0%	0%	0%	0%	0%	0%	0%
3	0%	0%	0%	0%	0%	0%	0%	0%
4	0%	0%	0%	0%	0%	0%	0%	0%
5	0%	0%	0%	0%	0%	0%	0%	0%
6	0%	0%	1%	0%	4%	0%	1%	0%
7	1%	0%	13%	0%	24%	0%	25%	0%
8	3%	1%	14%	0%	50%	1%	44%	3%
9	16%	2%	13%	2%	42%	5%	49%	9%
10	43%	12%	16%	2%	37%	11%	56%	17%
11	61%	21%	16%	6%	37%	11%	59%	14%
12	72%	35%	17%	7%	29%	7%	54%	14%
13	82%	38%	22%	6%	19%	2%	49%	1%
14	89%	41%	22%	6%	8%	1%	36%	0%
15	91%	45%	20%	7%	0%	0%	25%	0%
16	92%	60%	21%	10%	0%	0%	21%	0%
17	89%	63%	18%	10%	1%	0%	19%	1%
18	77%	59%	23%	10%	31%	17%	13%	3%
19	63%	37%	54%	29%	59%	37%	27%	13%
20	54%	34%	43%	14%	59%	33%	56%	24%
21	60%	37%	15%	4%	39%	24%	52%	24%
22	31%	20%	2%	1%	21%	9%	14%	10%
23	8%	4%	1%	0%	5%	1%	3%	1%
24	3%	0%	0%	0%	1%	1%	3%	0%

E.1.4 Average price per period

Using the defined day type, season, and hour grouping, there were a total of 14 categories identified. Table E-5 shows the average price and the percentage of peak hours in each category. Table E-6 presents a description of the 14 pricing periods. Figure E-2 illustrates the pricing periods.

Table E-5. Average Price and Percentage of Peak Prices by Season, Day Type, and Hour Category

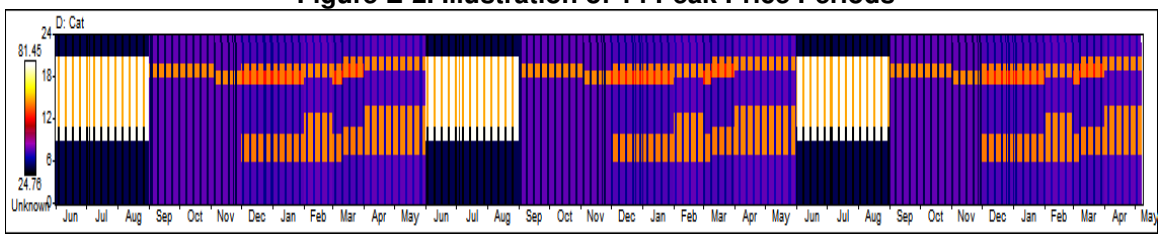
			All Years		Year 1		Year 2		Year 3	
Season	Day Type	Period	Price	Peak	Price	Peak	Price	Peak	Price	Peak
1	Weekday	Off Peak	$ 29.01	5%	$ 30.67	5%	$ 29.03	2%	$ 27.29	9%
1	Weekday	On Peak	$ 81.45	73%	$ 75.46	67%	$ 77.19	58%	$ 91.87	94%
1	Weekend	Off Peak	$ 24.76	4%	$ 25.78	4%	$ 23.52	1%	$ 25.02	8%
1	Weekend	On Peak	$ 63.21	45%	$ 59.70	39%	$ 58.32	33%	$ 71.20	64%
2	Weekday	Off Peak	$ 37.49	11%	$ 35.19	6%	$ 41.19	8%	$ 36.08	18%
2	Weekday	On Peak	$ 60.85	49%	$ 58.19	38%	$ 65.11	41%	$ 59.25	67%
2	Weekend	Off Peak	$ 28.80	5%	$ 26.84	2%	$ 30.98	4%	$ 28.56	9%
3	Weekday	Off Peak	$ 36.88	8%	$ 34.88	7%	$ 45.94	14%	$ 30.06	4%
3	Weekday	On Peak	$ 59.91	46%	$ 58.74	41%	$ 75.35	66%	$ 46.09	32%
3	Weekend	Off Peak	$ 31.46	4%	$ 26.68	3%	$ 40.73	9%	$ 26.49	1%
3	Weekend	On Peak	$ 53.57	35%	$ 45.25	24%	$ 70.38	48%	$ 44.18	32%
4	Weekday	Off Peak	$ 37.75	10%	$ 42.49	17%	$ 42.18	10%	$ 25.35	1%
4	Weekday	On Peak	$ 61.38	51%	$ 68.84	73%	$ 72.20	63%	$ 36.64	5%
4	Weekend	Off Peak	$ 33.77	6%	$ 38.68	11%	$ 35.33	4%	$ 24.44	0%

Table E-6. Category Pricing Periods

Season		Day Type		Hour Periods	
1	June, July, and August	Weekday	M-F	Off Peak	22 to 9
1	June, July, and August	Weekday	M-F	On Peak	10 to 21
1	June, July, and August	Weekend	S-S	Off Peak	22 to 11
1	June, July, and August	Weekend	S-S	On Peak	12 to 21
2	September, October, and November	Weekday	M-F	Off Peak	22 to 18
2	September, October, and November	Weekday	M-F	On Peak	19 to 20
2	September, October, and November	Weekend	S-S	Off Peak	1 to 24
3	December, January and March	Weekday	M-F	Off Peak	22 to 7 and 12 to 18
3	December, January and March	Weekday	M-F	On Peak	8 to 11 and 19 to 21
3	December, January and March	Weekend	S-S	Off Peak	21 to 18
3	December, January and March	Weekend	S-S	On Peak	19 to 20
4	February, April and May	Weekday	M-F	Off Peak	22 to 7 and 15 to 19
4	February, April and May	Weekday	M-F	On Peak	8 to 14 and 20 to 21
4	February, April and May	Weekend	S-S	Off Peak	1 to 24

Figure E-2 shows the 14 categories that were further aggregated into the categories show in Figure E-3.

Figure E-2. Illustration of 14 Peak Price Periods



E.1.5 Final pricing period

We developed the final categories to be roughly consistent with Wisconsin utility definitions of summer peak periods and to include sufficient categories that represent substantial differences in avoided costs. Table E-7 shows the average price per category. These categories are significantly differentiated, and are consistent across years.

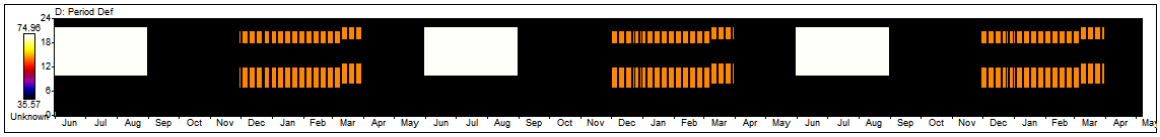
Table E-7. Average Prices across Four Pricing Periods

Cat	Description	Months	Day Types	Hours	All Years		Year 1		Year 2		Year 3	
					Price	Peak	Price	Peak	Price	Peak	Price	Peak
1	Summer On Peak	Jun-Aug	All Day Types	HE 10 to HE 21	$74.96	63%	$70.01	58%	$70.54	49%	$84.28	83%
2.1	Winter On Peak	Dec-Mar	Week Days	HE 8 to HE 12	$57.99	43%	$58.86	44%	$72.84	65%	$42.44	20%
2.2	Winter On Peak	Dec-Mar	Week Days	HE 19 to 21	$65.46	55%	$68.35	56%	$80.58	71%	$47.66	37%
3	Off Peak	All Others	All Others	All Others	$35.57	10%	$35.95	11%	$40.31	11%	$29.94	8%

Table E-8. Final Pricing Categories for All Years

Cat	Year 1	Year 2	Year 3	All Years	Percent
1	1,092	1,104	1,104	3,300	13%
2.1	420	420	425	1,265	5%
2.2	252	252	255	759	3%
3	6,972	7,008	6,382	20,362	79%

Figure E-3. Final Pricing Categories for All Years



Color	Category
	Summer On Peak
	Winter On Peak
	Off Peak

The final kWh Pricing Periods are shown in Table E-9. We used these periods and average price per kWh in the b/c analysis for determining avoided costs across time periods as defined, based on load shapes for end-uses and measures.

Table E-9. Electric Energy (kWh) Pricing Periods

Electric Energy Pricing Period	Months	Days	Start Time[41]	End Time	Annual Number of Hours	Price per kWh
Summer Peak	Jun. 1 - Aug. 31	All Days	HE10	HE21	1,104	$0.075
Winter AM Peak	Dec. 1 - Mar. 31	Weekdays	HE8	HE12	430	$0.058
Winter PM Peak	Dec. 1 - Mar. 31	Weekdays	HE19	HE21	258	$0.065
Off Peak	All others	All others			6,974	$0.036
				Total	**8,766**	**$0.043**

[41] HE is an acronym for "Hour Ending."

APPENDIX F: FORWARD LOOK PROGRAM LEVEL RESULTS

In this appendix, we provide the program level results for the simple b/c analysis. For the forward-look scenarios we grouped the energy efficiency measures (and renewable energy technologies) into program areas that are approximate the current programs.

F.1 RESIDENTIAL FORWARD-LOOK – INDIVIDUAL PROGRAM RESULTS

- ENERGY STAR Lighting and Appliances
- HVAC equipment
- New Construction
- Residential (Whole House) Retrofit
- Multi-family Retrofit
- Water Heating and Thermostats.

F.1.1 Simple test

In this sub-section, we report the results of the simple b/c test for the forward-look scenario at the individual program level ENERGY STAR Lighting and Appliances, Single Family Whole house and Multi-Family, Home Performance with ENERGY STAR and Residential New Construction all achieve a b/c ratio greater than 1 in the analysis period. Residential HVAC has a b/c ratio that rounds up to 1 and Targeted Home Performance with ENERGY STAR has a b/c ratio lower than one. This is consistent with the findings reported in Section 4 of this report for the historic programs.

The Multi-Family program is the greatest contributor to portfolio net benefits (providing 47 percent of the positive benefits. ENERGY STAR Lighting and Appliances is also a large contributor (providing 44 percent of the positive net benefits) and with the highest b/c ratio. Single Family Whole House provides approximately nine percent of the positive net benefits, with Residential New Construction contributes a positive but minor amount.

Table F-1. Individual Residential Programs: Simple Benefit Cost Components, Forward-look 25 Year NPV ($000,000)

25 Year NPV	ENERGY STAR Lighting and Appliances	Whole House Retrofit	Residential New Construction*	Residential HVAC	Multi-Family*	Water Heating and Thermostats
ECW Estimated Energy Savings	$258.3	$1,020.0	$5.6	$199.7	$382.4	$137.1
Market Effects	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Externalities	$18.7	$42.6	$0.2	$9.4	$13.4	$4.1
Program Costs	$5.1	$238.5	$1.2	$35.8	$49.6	$10.0
Incremental Costs	$46.8	$779.2	$2.9	$181.0	$106.2	$169.6
Net Benefits	**$225.1**	**$45.0**	**$1.8**	**($7.7)**	**$240.0**	**($38.3)**
Benefit/Cost Ratio	**5.3**	**1.0**	**1.4**	**1.0**	**2.5**	**0.8**

* All measures identified in the ECW study as new construction are included in this program group.

** All measures identified in the ECW study as multi-family are included in this program group.

a. *ENERGY STAR LIGHTING AND APPLIANCES*

The ENERGY STAR Lighting and Appliances Program provides support for four separate technology categories: compact fluorescent lighting (CFL), clothes washers, other (non-CFL) lighting, and other appliances.

As shown in Table F-2, the forward-look scenario achieves a benefit-cost ratio of 5.3. The program achieves the majority of its benefits from ECW Estimated Energy Savings, with additional savings from the avoidance of associated economic environmental externalities.

Table F-2. ENERGY STAR Lighting and Appliances Program: Simple Benefit Cost Components, Forward-look ($000,000)

B/C Component		FY12	FY21	FY36	NPV FY12 - FY36
Benefits	ECW Estimated Energy Savings	$5.4	$35.8	$12.5	$258.3
	Added Market Effects Savings	$0.0	$0.0	$0.0	$0.0
	Economic Environmental Externalities	$0.4	$2.6	$0.5	$18.7
Costs	Program Costs	$1.0	$0.5	$0.0	$5.1
	Incremental Costs	$8.0	$7.7	$0.0	$46.8
	Total Benefits	**$5.8**	**$38.4**	**$13.0**	**$277.1**
	Total Costs	**$9.0**	**$8.2**	**$0.0**	**$51.9**
				Net Benefits	**$225.1**
				B/C Ratio	**5.3**

b. *SINGLE FAMILY RETROFIT*

The single family retrofit program has substantial ECW estimated energy savings, with comparable program and incremental costs associated with these savings. The net

benefits are relatively small, but result in a b/c ratio of close to 1.0 over the 25-year period of analysis.

Table F-3. Single Family Retrofit Program: Simple Benefit Cost Components, Forward-look ($000,000)

B/C Component		FY12	FY21	FY36	NPV FY12 - FY36
Benefits	ECW Estimated Energy Savings	$7.2	$126.8	$112.6	$1,020.0
	Added Market Effects Savings	$0.0	$0.0	$0.0	$0.0
	Economic Environmental Externalities	$0.3	$5.3	$3.8	$42.6
Costs	Program Costs	$21.7	$52.5	$0.0	$238.5
	Incremental Costs	$75.8	$165.8	$0.0	$779.2
	Total Benefits	**$7.5**	**$132.2**	**$116.4**	**$1,062.6**
	Total Costs	**$97.5**	**$218.3**	**$0.0**	**$1,017.6**
				Net Benefits	**$45.0**
				B/C Ratio	**1.0**

c. *RESIDENTIAL NEW CONSTRUCTION*

In the forward-look scenario, we included all residential measures for new construction under the residential new construction heading. This resulted in a program with relatively small ECW estimated energy savings and small associated costs to achieve these savings. The net benefits are very small relative to the Residential Portfolio as a whole, but result in a b/c ratio of 1.4 over the 25-year period of analysis.

Table F-4. Residential New Construction Program: Simple Benefit Cost Components, Forward-look ($000,000)

B/C Component		FY12	FY21	FY36	NPV FY12 - FY36
Benefits	ECW Estimated Energy Savings	$0.0	$0.7	$0.6	$5.6
	Added Market Effects Savings	$0.0	$0.0	$0.0	$0.0
	Economic Environmental Externalities	$0.0	$0.0	$0.0	$0.2
Costs	Program Costs	$0.1	$0.2	$0.0	$1.2
	Incremental Costs	$0.3	$0.6	$0.0	$2.9
	Total Benefits	**$0.0**	**$0.7**	**$0.6**	**$5.8**
	Total Costs	**$0.5**	**$0.8**	**$0.0**	**$4.1**
				Net Benefits	**$1.8**
				B/C Ratio	**1.4**

d. *RESIDENTIAL HVAC*

The residential HVAC program results in a b/c ratio close to 1, but with minor negative net benefits. This is consistent with the historic program, which also resulted in a b/c ratio of slightly less than 1. Wisconsin households, in general contain relatively high efficiency heating systems, which limits the opportunities for achieving savings. The greatest opportunities exist for measures that have small incremental savings, but likely high

incremental costs. Increased federal standards for central air conditioning limit the incremental benefits of installing a system more efficient than the standards, especially given Wisconsin's low number of cooling degree days and customer usage habits.

Table F-5. Residential HVAC Program: Simple Benefit Cost Components, Forward-look ($000,000)

B/C Component		FY12	FY21	FY36	NPV FY12 - FY36
Benefits	ECW Estimated Energy Savings	$1.9	$24.4	$20.4	$199.7
	Added Market Effects Savings	$0.0	$0.0	$0.0	$0.0
	Economic Environmental Externalities	$0.1	$1.2	$0.8	$9.4
Costs	Program Costs	$4.5	$6.4	$0.0	$35.8
	Incremental Costs	$22.9	$32.2	$0.0	$181.0
	Total Benefits	**$2.0**	**$25.5**	**$21.2**	**$209.1**
	Total Costs	**$27.4**	**$38.6**	**$0.0**	**$216.7**
				Net Benefits	**($7.7)**
				B/C Ratio	**1.0**

e. MULTI-FAMILY

The multi-family program analysis shows substantial net benefits and a b/c ratio of 2.5. The measures within the apartment building sector appear to have substantial ECW estimated energy savings relative to incremental and program costs. This sector has traditionally lagged behind other sectors in energy efficiency equipment and practices due to split incentives—where the energy bill payer is often not the equipment or building owner.

Table F-6. Multi-Family Program: Simple Benefit Cost Components, Forward-look ($000,000)

B/C Component		FY12	FY21	FY36	NPV FY12 - FY36
Benefits	ECW Estimated Energy Savings	$4.9	$51.4	$28.6	$382.4
	Added Market Effects Savings	$0.0	$0.0	$0.0	$0.0
	Economic Environmental Externalities	$0.2	$2.0	$0.4	$13.4
Costs	Program Costs	$6.1	$9.4	$0.0	$49.6
	Incremental Costs	$14.4	$18.5	$0.0	$106.2
	Total Benefits	**$5.1**	**$53.3**	**$29.0**	**$395.8**
	Total Costs	**$20.5**	**$27.9**	**$0.0**	**$155.8**
				Net Benefits	**$240.0**
				B/C Ratio	**2.5**

f. WATER HEATING AND THERMOSTATS

The Water Heating and Thermostats consists primarily of water heating measures. Results of benefit-cost analysis for Single Family Water Heating and Thermostats are shown in Table F-7.

Table F-7. Single Family Water Heating and Thermostats Program: Simple Benefit Cost Components, Forward-look ($000,000)

B/C Component		FY12	FY21	FY36	NPV FY12 - FY36
Benefits	ECW Estimated Energy Savings	$2.3	$15.3	$12.2	$137.1
	Added Market Effects Savings	$0.0	$0.0	$0.0	$0.0
	Economic Environmental Externalities	$0.1	$0.5	$0.3	$4.1
Costs	Program Costs	$2.1	$0.8	$0.0	$10.0
	Incremental Costs	$36.0	$12.7	$0.0	$169.6
	Total Benefits	**$2.3**	**$15.7**	**$12.5**	**$141.2**
	Total Costs	**$38.1**	**$13.5**	**$0.0**	**$179.5**
				Net Benefits	**($38.3)**
				B/C Ratio	**0.8**

F.2 BUSINESS PROGRAMS FORWARD LOOK – INDIVIDUAL PROGRAM RESULTS

F.2.1 Simple test – individual program results

In this sub-section, we show the results for each of the individual Business programs. These results are based on the simple test, which counts only ECW Estimated Energy Savings in the forward-look scenario.

As shown in Table F-8, all Business sectors contribute to the positive overall performance of the projected Business Portfolio. All four sectors have simple b/c ratios of at least 3.3. The commercial sector contributes the largest net benefits to the portfolio, with 48 percent of the net benefits. The industrial sector comes close with 45 percent of net savings and the highest expanded b/c ratio at 4.8. Schools and Government contributes 6 percent to the net benefits, and agriculture the final 2 percent.

Table F-8. Individual Business Programs: Simple Benefit Cost Components, Forward-look 25 Year NPV ($000,000)

25 Year NPV	Agriculture	Commercial	Industrial	Schools and Government
ECW Estimated Energy Savings	$122.8	$3,340.4	$2,834.4	$404.8
Market Effects	$0.0	$0.0	$0.0	$0.0
Externalities	$9.0	$144.9	$142.7	$14.1
Program Costs	$12.1	$251.2	$192.9	$35.4
Incremental Costs	$22.0	$732.1	$433.2	$93.6
Net Benefits	**$97.8**	**$2,502.0**	**$2,351.0**	**$290.0**
Benefit/Cost Ratio	**3.9**	**3.5**	**4.8**	**3.3**

a. AGRICULTURE SECTOR

The net benefits of the agriculture approach $100 million over the 25-year period of analysis. This results in a simple b/c ratio of 3.9.

Table F-9. Agriculture Program: Simple Benefit Cost Components, Forward-look ($000,000)

B/C Component		FY12	FY21	FY36	NPV FY12 - FY36
Benefits	ECW Estimated Energy Savings	$1.9	$14.4	$10.4	$122.8
	Added Market Effects Savings	$0.0	$0.0	$0.0	$0.0
	Economic Environmental Externalities	$0.1	$1.0	$0.6	$9.0
Costs	Program Costs	$2.3	$1.3	$0.0	$12.1
	Incremental Costs	$4.1	$2.4	$0.0	$22.0
	Total Benefits	**$2.0**	**$15.5**	**$11.1**	**$131.9**
	Total Costs	**$6.3**	**$3.6**	**$0.0**	**$34.1**
				Net Benefits	**$97.8**
				B/C Ratio	**3.9**

b. COMMERCIAL SECTOR

The Commercial Sector activity helps small and large commercial business owners improve the energy efficiency of their facilities. High documented savings compared to relatively low incremental and program costs result in a b/c ratio of 3.5 (see Table F-12).

Table F-12. Commercial Program: Simple Benefit Cost Components, Forward-look ($000,000)

B/C Component		FY12	FY21	FY36	NPV FY12 - FY36
Benefits	ECW Estimated Energy Savings	$50.5	$398.6	$276.4	$3,340.4
	Added Market Effects Savings	$0.0	$0.0	$0.0	$0.0
	Economic Environmental Externalities	$2.1	$16.7	$10.2	$144.9
Costs	Program Costs	$44.6	$29.5	$0.0	$251.2
	Incremental Costs	$126.9	$89.3	$0.0	$732.1
	Total Benefits	**$52.6**	**$415.3**	**$286.7**	**$3,485.3**
	Total Costs	**$171.5**	**$118.8**	**$0.0**	**$983.3**
				Net Benefits	**$2,502.0**
				B/C Ratio	**3.5**

c. INDUSTRIAL SECTOR

The Industrial program facilitates energy efficiency improvements for owners and managers of industrial facilities of all sizes. Consistent with the other Business sector program areas, the forward-look b/c test results in high net benefits (~$2.4 billion) and a b/c ratio of 4.8 (see Table F-13).

Table F-13. Industrial Program: Simple Benefit Cost Components, Forward-look ($000,000)

B/C Component		FY12	FY21	FY36	NPV FY12 - FY36
Benefits	ECW Estimated Energy Savings	$53.3	$336.2	$201.5	$2,834.4
	Added Market Effects Savings	$0.0	$0.0	$0.0	$0.0
	Economic Environmental Externalities	$2.1	$16.4	$9.8	$142.7
Costs	Program Costs	$38.8	$17.2	$0.0	$192.9
	Incremental Costs	$86.6	$39.0	$0.0	$433.2
	Total Benefits	**$55.5**	**$352.6**	**$211.3**	**$2,977.2**
	Total Costs	**$125.4**	**$56.2**	**$0.0**	**$626.1**
				Net Benefits	**$2,351.0**
				B/C Ratio	**4.8**

d. SCHOOLS AND GOVERNMENT SECTOR

The Schools and Government sector activities help schools and local governments improve existing buildings and install energy-efficient lighting, heating and cooling equipment. The forward-look scenario results in net benefits of $290 million (see Table F-14).

Table F-14. Schools and Government Program: Simple Benefit Cost Components, Forward-look ($000,000)

B/C Component		FY12	FY21	FY36	NPV FY12 - FY36
Benefits	ECW Estimated Energy Savings	$6.0	$48.6	$33.3	$404.8
	Added Market Effects Savings	$0.0	$0.0	$0.0	$0.0
	Economic Environmental Externalities	$0.2	$1.6	$1.0	$14.1
Costs	Program Costs	$6.3	$4.1	$0.0	$35.4
	Incremental Costs	$16.2	$11.5	$0.0	$93.6
	Total Benefits	**$6.2**	**$50.3**	**$34.3**	**$418.9**
	Total Costs	**$22.5**	**$15.5**	**$0.0**	**$128.9**
				Net Benefits	**$290.0**
				B/C Ratio	**3.3**

F.3 RENEWABLES PROGRAMS FORWARD LOOK – INDIVIDUAL PROGRAM RESULTS

F.3.1 Simple test – individual program results

We show the benefit-cost results using the simple test for each of the individual technologies in the forward-look scenario. The simple test counts ECW Estimated Energy Savings and avoided economic environmental externalities as program benefits.

We provide 25-year NPV for the expected benefits and costs for each renewable technology in Table F-15. Both Biogas and Biomass contribute positive net benefits to the

portfolio and result in b/c ratios of 1.8 and 1.9, respectively. PV, SHW and Wind do not perform as well under the simple b/c test, with b/c ratios substantially lower than 1. PV has very high incremental costs—more than five times the ECW estimated energy savings. Solar hot water has incremental costs almost twice the ECW estimated energy savings, and program costs that exceed ECW estimated energy savings.

Table F-15. Individual Renewables Programs: Simple Benefit Cost Components, Forward-look 25 Year NPV ($000,000)

B/C Component	Biogas	Biomass-CHP	PV	Solar Hot Water	Wind
ECW Estimated Energy Savings	$122.6	$115.0	$230.4	$32.0	$234.0
Market Effects	$0.0	$0.0	$0.0	$0.0	$0.0
Externalities	$7.1	$0.8	$9.0	$0.2	$19.4
Program Costs	$2.5	$1.1	$78.8	$49.6	$52.2
Incremental Costs	$68.3	$60.4	$1,132.9	$62.0	$365.7
Net Benefits	**$58.9**	**$54.3**	**($972.2)**	**($79.5)**	**($164.6)**
B/C Ratio	**1.8**	**1.9**	**0.2**	**0.3**	**0.6**

a. BIOGAS

The Renewables Program provides financial assistance for commercial, industrial, and agricultural customers who install biogas digester systems. The forward-look scenario includes additional savings associated with anaerobic digesters that generate gas that goes into natural gas pipelines.

The results of the b/c analysis using ECW estimated savings and adjusted program and incremental costs results in a simple b/c ratio of 1.83. This is substantially higher than the 0.7 b/c ratio in the historic program. ECW estimated incremental costs are substantially lower relative to energy savings, in part due to the higher estimated attribution. Program costs are roughly comparable to historic program costs, despite the higher anticipated savings.

Table F-16. Biogas-CHP Program: Simple Benefit Cost Components, Forward-look ($000,000)

B/C Component		FY12	FY21	FY36	NPV FY12 - FY36
Benefits	ECW Estimated Energy Savings	$1.2	$16.1	$10.8	$122.6
	Added Market Effects Savings	$0.0	$0.0	$0.0	$0.0
	Economic Environmental Externalities	$0.1	$0.9	$0.5	$7.1
Costs	Program Costs	$0.3	$0.5	$0.0	$2.5
	Incremental Costs	$7.5	$13.5	$0.0	$68.3
	Total Benefits	**$1.2**	**$17.0**	**$11.3**	**$129.6**
	Total Costs	**$7.8**	**$14.0**	**$0.0**	**$70.7**
				Net Benefits	**$58.9**
				B/C Ratio	**1.8**

b. BIOMASS-CHP

The historic Renewables Program provides incentives for the installation of biomass systems for space and process heat. The ECW study identified additional potential for Biomass CHP and for residential application. The resulting b/c ratio of 1.9 is due to high ECW estimated energy savings relative to incremental cost (and minor program costs). The ECW estimates energy savings are more than seven times the savings of the existing program, with incremental costs only three times greater and less than 50 percent of the historic program costs.

Table F-17. Biomass-CHP Program:
Simple Benefit Cost Components, Forward-look ($000,000)

B/C Component		FY12	FY21	FY36	NPV FY12 - FY36
Benefits	ECW Estimated Energy Savings	$1.2	$14.1	$11.3	$115.0
	Added Market Effects Savings	$0.0	$0.0	$0.0	$0.0
	Economic Environmental Externalities	$0.0	$0.1	$0.1	$0.8
Costs	Program Costs	$0.1	$0.2	$0.0	$1.1
	Incremental Costs	$5.0	$9.4	$1.9	$60.4
	Total Benefits	**$1.2**	**$14.2**	**$11.4**	**$115.8**
	Total Costs	**$5.1**	**$9.6**	**$1.9**	**$61.5**
				Net Benefits	**$54.3**
				B/C Ratio	**1.9**

c. PHOTOVOLTAICS (PV)

The Renewables Program supports the installation of PV systems for residential and business customers. The ECW study identified substantial potential for increasing the penetration of PV systems, and for increasing the size of customer-sited systems in commercial applications. The PV program described in the ECW study is a much greater portion of the Renewables portfolio costs and savings than that in the historic program.

The simple b/c ratio for the PV program is 0.2, with a net cost of almost $1 billion. The net costs incurred by the program are due to high incremental costs based on the price per kWh found in Appendix B of the ECW study. We assumed that prices would stay constant in real dollars.

Table F-18. Solar Electric Program:
Simple Benefit Cost Components, Forward-look ($000,000)

B/C Component		FY12	FY21	FY36	NPV FY12 - FY36
Benefits	ECW Estimated Energy Savings	$0.5	$31.6	$25.3	$230.4
	Added Market Effects Savings	$0.0	$0.0	$0.0	$0.0
	Economic Environmental Externalities	$0.0	$1.3	$0.8	$9.0
Costs	Program Costs	$2.3	$23.2	$0.0	$78.8
	Incremental Costs	$33.0	$333.4	$0.0	$1,132.9
	Total Benefits	**$0.5**	**$32.9**	**$26.1**	**$239.4**
	Total Costs	**$35.3**	**$356.6**	**$0.0**	**$1,211.6**
				Net Benefits	**($972.2)**
				B/C Ratio	**0.2**

d. SOLAR THERMAL

The existing Renewables program provides incentives for the installation of solar hot water systems. The ECW study also identified opportunities for large-scale solar hot water to augment larger commercial and industrial applications that have year-round demand for hot water. (The existing Focus program has begun promoting these types of systems and completed one installation in the 18 MCP.)

The simple b/c ratio for the forward-look Solar Thermal Program is 0.3. Both incremental and program costs contribute to the high costs relative to ECW estimated savings. The estimated savings are 40 times what we projected for the historic Solar Hot Water program, but with only 15 times the additional incremental costs.

Table F-19. Solar Thermal Program:
Simple Benefit Cost Components, Forward-look ($000,000)

B/C Component		FY12	FY21	FY36	NPV FY12 - FY36
Benefits	ECW Estimated Energy Savings	$0.1	$4.3	$3.5	$32.0
	Added Market Effects Savings	$0.0	$0.0	$0.0	$0.0
	Economic Environmental Externalities	$0.0	$0.0	$0.0	$0.2
Costs	Program Costs	$1.9	$14.0	$0.0	$49.6
	Incremental Costs	$2.6	$17.3	$0.0	$62.0
	Total Benefits	**$0.1**	**$4.4**	**$3.5**	**$32.2**
	Total Costs	**$4.6**	**$31.3**	**$0.0**	**$111.7**
				Net Benefits	**($79.5)**
				B/C Ratio	**0.3**

e. WIND

The current Renewables Program supports the installation of wind turbines for residential and business customers. The ECW study identified additional opportunity for larger "customer-sited" systems (1.5 MW) installed for community projects. The wind program

described in the ECW study is a much greater portion of the Renewables portfolio costs and savings than that in the historic program. The simple b/c ratio for the forward-look wind program is 0.6, with net costs of $165 million.

The system incremental costs alone are higher than the ECW Estimated Energy Savings. The relationship of estimated energy savings to the combined program and incremental costs are projected to be better than the historic experience. The existing Focus program has combined incremental and program costs that are roughly six times the estimated savings. The forward-look program has a combined incremental and program costs that are less than two times the estimated savings.

Table F-20. Wind Program: Simple Benefit Cost Components, Forward-look ($000,000)

B/C Component		FY12	FY21	FY36	NPV FY12 - FY36
Benefits	ECW Estimated Energy Savings	$1.1	$31.0	$24.8	$234.0
	Added Market Effects Savings	$0.0	$0.0	$0.0	$0.0
	Economic Environmental Externalities	$0.1	$2.6	$1.7	$19.4
Costs	Program Costs	$3.2	$13.4	$0.0	$52.2
	Incremental Costs	$22.8	$93.2	$0.0	$365.7
	Total Benefits	**$1.2**	**$33.7**	**$26.5**	**$253.4**
	Total Costs	**$25.9**	**$106.6**	**$0.0**	**$417.9**
				Net Benefits	**($164.6)**
				B/C Ratio	**0.6**