ENERGY CENTER
OF WISCONSIN

ENERGY EFFICIENCY AND CUSTOMER-SITED RENEWABLE RESOURCE POTENTIAL IN WISCONSIN
For the years 2012 and 2018

RENEWABLE ENERGY APPENDICES

List of Appendices, Renewable Energy

APPENDIX A

VALUING RENEWABLE RESOURCE FLEXIBILITY

As discussed in Chapter RE-1, the total resource cost (TRC) structure used to compare benefits to costs for renewable resources is essentially an application of the discounted cash flow (DCF) model. Many people, including those with some exposure to finance principles, believe that the DCF model result is *the* valuation tool for all projects, but this is not the case. Renewable resources are prime examples of resources for which the DCF approach is incomplete.

Consider the following quote from MIT financial economist Stewart Myers:

> DCF is readily applied to "cash cows" – relatively safe businesses held for the cash they generate rather than strategic value. *It also works for "engineering investments," such as machine replacements where the main benefit is reduced cost in a clearly-defined activity.*[1](Emphasis added.)

Nearly all energy efficiency investments, including those in the home, are essentially engineering investments of the type Myers identifies. We need to light a space. We replace an incandescent bulb with a CFL. We reduce the cost of achieving a clearly-defined task.

We are therefore justified by finance principles to use the DCF approach, *i.e.*, the approach that underlies the TRC framework, for energy efficiency resources. Note that if we can value environmental externalities, we can still use the DCF model. It is in estimating those values where the difficulty lies. If we can do that, we know how to include them in the analysis.

The question, though, is whether we can use the DCF model to value all the benefits of renewable resources. To find that answer, let us continue with Myers' quote:

> DCF is less helpful in valuing businesses with *substantial growth opportunities* or *intangible assets*. In other words, it is not the whole answer when options account for a large fraction of a business's value.[2](Emphasis added.)

Do renewable resources have substantial growth opportunities? Yes. This point requires some clarification. If we know with reasonable certainty that a resource will follow a high-growth trajectory, then we can use the DCF model. If the high-growth path is more of a possibility than a certainty, however, we will undervalue the resource if we use the DCF approach.

Renewable resources have the potential for high growth, but no one would claim that they are necessarily on a high-growth path. In fact, most renewable resource advocates suggest that if Wisconsin does not develop policies that support renewable resource acquisition, the growth of this resource base will be limited. Therefore, we can be safe in assuming that the DCF model will not work for these resources.

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[1] Stewart C. Myers, "Finance Theory and Financial Strategy," in *The Revolution in Corporate Finance*, Basil Blackwell (2003), p. 61.
[2] *Ibid*.

This finding leads to an unequivocal conclusion: Strict reliance on the standard cash flow analysis used in the TRC framework will not work well with renewable resources. This result is due to the high-growth possibilities and the intangible benefits associated with these resources. (Note that this finding has little to do with environmental benefits. We can value those with the DCF model.)

The proper way one *should* value renewable resources is fundamentally different from the way we value energy efficiency investments. Yet, in potential studies similar to this one, analysts generally use the same mathematical models for analyzing renewable resources that they do for the energy efficiency analysis. This approach is incomplete.

It is not that the DCF model is *irrelevant* to the valuation of renewable resources; it is that it is *incomplete*. The correct models for valuing energy efficiency and renewable resources are shown below:

<u>Energy Efficiency Resources</u>

net benefit = present value of avoided costs (including externalities) –

technology cost[3]

<u>Renewable Resources</u>

net benefit = present value of avoided costs (including externalities) +

***real option value** – technology cost*

We see that renewable resources offer a benefit that is over and above the present value of the avoided utility costs and avoided externalities. They offer option value. Another term for option value is strategic opportunity.

Option value is either positive or zero; it can never be negative. Therefore, we see that *the traditional approach to valuing renewable resources, which does not consider option value, will always understate the true value of renewable resources*.

What is the option value for renewable resources? Interestingly, those who are involved in renewable resource projects intuitively know what option value is, although most have never heard of the term. Option value is that associated with the *dynamic* aspects associated with renewable resources.

For the most part, option values do not include environmental factors and economic development benefits. While improved environmental quality and local economic development are often not explicitly quantified in assessments of renewable resources, such effects can be estimated and addressed in the standard DCF model.

[3] This assumes that all costs are incurred upfront. If additional costs are incurred over the life of the measure, they are netted out from the energy savings benefits in the year the cost is incurred.

Those benefits are substantial for renewable resources, and should be included as externalities, but as we will discuss, they do not create option value. Let us review those benefits before we explain why there is no option value there.

- **Environmental Quality:** The most obvious environmental benefit is the reduction of carbon emissions and criteria pollutants generated by the combustion of fossil fuels if renewable sources are used instead. This would also reduce mercury contamination of lakes and rivers, and it would lessen levels of acid deposition, as well as reduce particulate pollution that limits visibility through ozone-induced smog. Public health would benefit as well, perhaps eliminating the issuance of fish advisories and warnings to asthma sufferers about pollution levels, and preventing loss of work days to pollution-induced illnesses. Reduction of carbon emissions will have the long term benefit of slowing climate change with its unpredictable potential for disrupting Wisconsin nature, agriculture and weather patterns.
- **Local Economic Development:** Such resources create a variety of economic opportunities available at the local level. Wind turbines and anaerobic digesters have already produced a positive economic impact on rural communities in the state. In some areas, farmers and their local governments are both deriving income from leasing land to wind farm developers. Anaerobic digesters on large dairy farms are generating electricity as well as improving the economics of farming operations as a whole by adding value to the animal waste, keeping the farms viable within the local economy. In addition to the on-site value of renewable energy resources, there is potential for creation of local jobs to manufacture, install and maintain renewable energy equipment. Most of these jobs cannot be exported. This includes both new businesses and expansion of existing trades such as plumbing and electrical businesses that learn new skills.

While these benefits are real, they also apply in one way or another to energy efficiency investments. Both reduce emissions. Both lead to job creation, albeit in different ways. As we note above, if these benefits can be estimated, they, too, can be valued using standard DCF techniques.

However, there are two key components of renewable resources that cannot be valued using the DCF approach: increased energy security and the expanded opportunity to transition Wisconsin to the new energy economy.

- **Energy Supply Security:** Renewable resources are local in nature. An energy system that relies on local resources is less likely to fall victim to widespread power outages or rapidly fluctuating, world market fuel prices. It is quite possible that recent unpredictable weather patterns will continue, with floods, violent summer storms and heavy winter snows becoming regular features of the Wisconsin climate. Moving toward a system based on micro-grid distributed generation that includes both customer and utility-sited renewable energy can reduce potential for outages during weather emergencies as well as limit reliance on imported fuels with their rising costs. Renewable energy also has the advantage of built-in price stability, providing a hedge against rising fossil fuel prices.

- **Preparing for a Possible Transition to a New Energy Economy:** Internationally, clean energy technologies and resources are seen by many economists as offering among the greatest opportunities for world economic growth for the foreseeable future. This is in response to the challenges of climate change and carbon emissions reduction, and the peaking supply of easily accessible fossil fuels. Now that national policy appears to be moving the United States toward participation in the world market for renewable energy, Wisconsin has the potential to reinvigorate its manufacturing base and engage its academic research capabilities in response to this demand, making a place for itself in the new energy economy.

Note that these are the *strategic* aspects of renewable resources. Energy efficiency does not offer these benefits to the degree that renewable resources do. Energy efficiency improvements may help reduce our dependence on outside energy sources, but energy efficiency, in and of itself, is not an energy source.

Furthermore, unlike energy efficiency, which is well entrenched, renewable resources are largely undeveloped. Even if we can identify security-related benefits from the expected levels of energy efficiency resources, since that resource expansion path is better developed, we can value those benefits with the DCF approach.

This point is critically important and therefore deserves attention. The option value of a resource is the greatest when the resource sits in a tenuous position. That is, the option value is highest when we have some ability to use the resource, but we have flexibility as to the amount we use in the future.

Option value accrues from having the ability to use more of a resource, *if the conditions warrant*. The more of the resource we use, the less option value that remains. If we were currently using renewable technologies in all possible applications, then we would not have the option of further expanding its use. The option value then would be zero.

At the other end of the spectrum, if we have no renewable resource infrastructure, we again have no option value, at least in the short run, because we have no way of garnering those resources. If we focus on developing the infrastructure to deliver increased levels of renewable resources as a *strategic alternative* to staying on a fossil-fuel-dominated path, we have the greatest option value.

Having a renewable resource infrastructure in place provides intangible supply-side security benefits because that structure offers us the possibility of doing something we do not now do *should conditions change*. Options value is not determined by what is most likely to happen, which is how the DCF model works, but rather depends on the full range of possible future events. It is a measure of the flexibility of the resource base.

This leads to what is at first a counterintuitive point. While increased uncertainty about the future *decreases* the present value of future savings under the DCF model, it *increases* the corresponding option value.

Assume that one has in place a renewable resource program that has some scalability. When is that scalability most valuable, when fossil fuel prices are fairly stable, or when they are volatile? The answer is that the flexibility afforded by the scalability is greatest when the future is uncertain. That is when we could rely on that flexibility. Flexibility is a form of option value. Therefore, as uncertainty increases, so does option value.

The exact opposite conclusion holds under the DCF approach. An expected cash flow stream decreases in value when uncertainty increases, as the discount rate used in the denominator rises to reflect the greater risk. This provides one of the reasons that the DCF model cannot be used to value the strategic aspects of any resource.

Figure RE-1 shows the hypothetical impact of increasing uncertainty on the components that drive the full value of renewable resources. As uncertainty increases, the present value of all *expected benefits*, both economic and environmental, decline. In contrast, the value of the *flexibility to expand the resource base* increases with uncertainty.

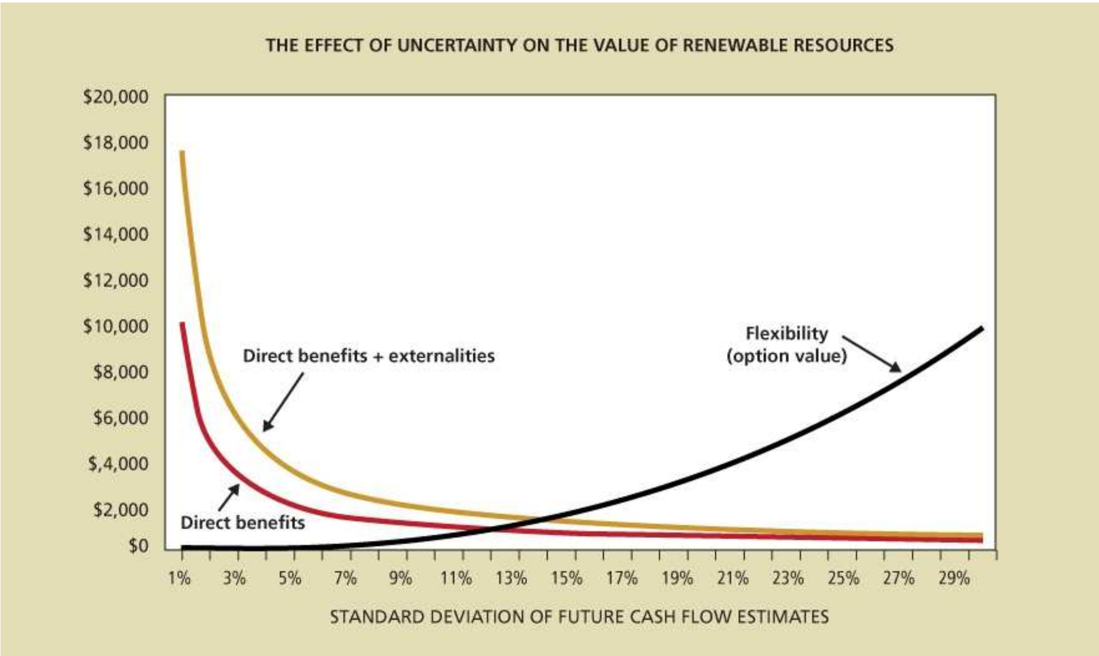

Figure A-1: The Effect of Uncertainty on the Value of Renewable Resources

Note how this issue plays out in a cumulative sense. As Figure A-2 demonstrates, increasing uncertainty initially begins to cause the benefits of renewable resources to decline. As uncertainty ramps up, however, the values of the direct benefits and the externalities are driven toward zero, but the option value begins to increase exponentially.

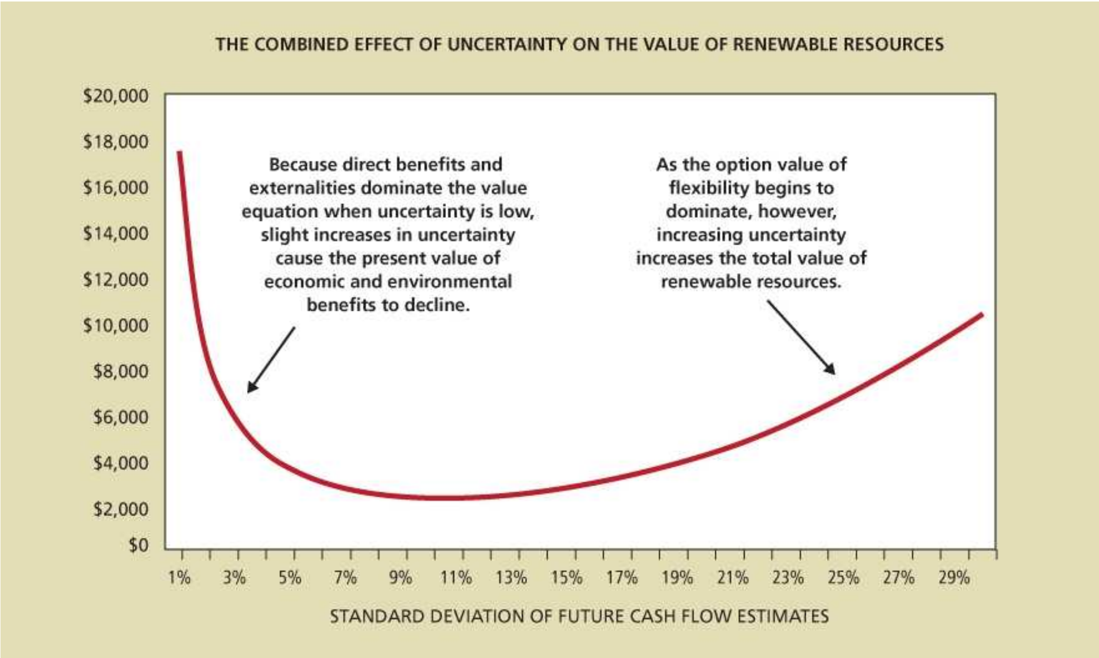

Figure A-2: The Combined Effect of Uncertainty on the Value of Renewable Resources

The policy implications of this analysis are important. If the case for renewable resources rests on the notion of an uncertain world, it is the flexibility benefits, not the environmental benefits, that make renewable resources attractive.

By developing the infrastructure to promote renewable resources, Wisconsin creates the option of expanding the acquisition of those resources should conditions change. If conditions change in such a way that renewable resources are more valuable, then we could expand the acquisition of those resources. If another future takes hold—for example, one in which some other technology is developed that makes renewable resources less valuable—then Wisconsin does not have to exercise the option to expand its renewable energy initiatives.

That is why option value increases with uncertainty. If circumstances change in your favor, you have the *right* to take advantage of the situation. On the other hand, if circumstances go against you, you have no *obligation* to take any action that would hurt you.

It is clear that we need to move beyond the TRC–based DCF approach to valuing renewable resources. Given the intangible benefits associated with renewable resources, a proper economic model for evaluating renewable resource investments should have an options component.

Developing a real options pricing model to analyze the cost-effectiveness of renewable energy resources is a complex undertaking that is beyond the scope of this study. Instead, we assessed two resource strategies and developed a range of renewable energy potential estimates based on these strategies. The "conservative renewable strategy," representing the low end of the range, targets only those customer-sited renewable energy resources that are currently cost-effective using a standard TRC-based DCF approach. The "aggressive renewable strategy" includes additional renewable resources that are not currently cost-effective. The objective of the aggressive strategy is not to maximize the acquisition of renewable resources, but rather to maximize the option value of capturing those resources later, should the right conditions arise.

We suggest further investigation of this issue as an area for future research. Real options models, while not for the quantitatively faint of heart, are being applied in major corporations across the world, including Du Pont, Hewlett-Packard, Amgen, Consolidated Edison, Boeing, and Wisconsin Public Service Corporation.[4]

[4] A. Triantis and A, Borrison (2003). "Real Options: State of the Practice," in *The Revolution in Corporate Finance*, Basil Blackwell, p. 107.

APPENDIX B

RENEWABLE TECHNOLOGY INPUTS FOR COST-EFFECTIVENESS ANALYSIS

TABLE B-1: SMALL-SCALE WIND (<=20 KW)

Technology System Costs	
Estimated System Lifetime, years	20
Average System Cost (initial cost), $	$43,081
Average System Cost per kW, $/kW	$4,952
Technology Federal Tax Credit	30%
System Capacity Factor	0.162
System Capacity, kW	8.7
Annual Electricity Savings, kWh	12,346
Annual Natural Gas Savings, therm	0
Program Administrative Costs	
Total Administrative Cost for Technology, $	$272,208
2008 Energy Savings for Technology, adj. gross kWh	3,172,600
Program Admin Cost Factor, $/kWh	0.0858
Average Program Admin Cost per System, $	$1,059
Lifetime Net Present Value of Costs, $	**$39,751**
Benefits	
Present Value of Lifetime Capacity Savings, $/kW	$3,253
Present Value of Lifetime Electricity Savings, $/kWh	$8,401
Present Value of Lifetime Natural Gas Savings, $/therm	$0
Lifetime Net Present Value of Benefits, $	**$11,654**
Simple TRC B/C	**0.29**

TABLE B-2: MID-SIZED WIND (>20 KW TO 100 KW)

Technology System Cost	
Estimated System Lifetime, years	20
Average System Cost (initial cost), $	$360,019
Average System Cost per kW, $/kW	$5,334
Technology Federal Tax Credit	30%
System Capacity Factor	0.169
System Capacity, kW	67.5
Annual Electricity Savings, kWh	100,115
Annual Natural Gas Savings, therm	0
Program Administrative Cost	
Total Administrative Cost for Technology, $	$272,208
2008 Energy Savings for Technology, adj. gross kWh	3,172,600
Program Admin Cost Factor, $/kWh	0.0858
Average Program Admin Cost per System, $	$8,590
Lifetime Net Present Value of Costs, $	**$360,921**
Benefits	
Present Value of Lifetime Capacity Savings, $/kW	$25,236
Present Value of Lifetime Electricity Savings, $/kWh	$68,122
Present Value of Lifetime Natural Gas Savings, $/therm	$0
Lifetime Net Present Value of Benefits, $	**$93,358**
Simple TRC B/C	**0.26**

TABLE B-3: LARGE-SCALE WIND (1.5 MW)

Technology System Cost	
Estimated System Lifetime, years	20
Average System Cost (initial cost), $	$3,400,000
Average System Cost per kW, $/kW	$2,267
Technology Federal Tax Credit	0.021
System Capacity Factor	0.220
System Capacity, kW	1,500
Annual Electricity Savings, kWh	2,890,800
Annual Natural Gas Savings, therm	0
Program Administrative Cost	
Total Administrative Cost for Technology, $	$272,208
2008 Energy Savings for Technology, adj. gross kWh	3,172,600
Program Admin Cost Factor, $/kWh	0.0858
Average Program Admin Cost per System, $	$248,030
Lifetime Net Present Value of Costs, $	**$2,645,295**
Benefits	
Present Value of Lifetime Capacity Savings, $/kW	$560,799
Present Value of Lifetime Electricity Savings, $/kWh	$1,967,006
Present Value of Lifetime Natural Gas Savings, $/therm	$0
Lifetime Net Present Value of Benefits, $	**$2,527,806**
Simple TRC B/C	**0.96**

TABLE B-4: SMALL-SCALE SOLAR ELECTRIC (<=20 KW)

Technology System Cost	
Estimated System Lifetime, years	25
Average System Cost (initial cost), $	$44,966
Average System Cost per kW, $/kW	$9,066
Technology Federal Tax Credit	30%
System Capacity Factor	0.147
System Capacity, kW	4.96
Annual Electricity Savings, kWh	6,370
Annual Natural Gas Savings, therm	0
Program Administrative Cost	
Total Administrative Cost for Technology, $	$336,693
2008 Energy Savings for Technology, adj. gross kWh	1,354,375
Program Admin Cost Factor, $/kWh	0.24860
Average Program Admin Cost per System, $	$1,583
Lifetime Net Present Value of Costs, $	**$30,715**
Benefits	
Present Value of Lifetime Capacity Savings, $/kW	$1,854
Present Value of Lifetime Electricity Savings, $/kWh	$4,334
Present Value of Lifetime Natural Gas Savings, $/therm	$0
Lifetime Net Present Value of Benefits, $	**$6,999**
Simple TRC B/C	**0.23**

TABLE B-5: LARGE-SCALE SOLAR ELECTRIC (>20 KW)

Technology System Cost	
Estimated System Lifetime, years	25
Average System Cost (initial cost), $	$234,425
Average System Cost per kW, $/kW	$7,947
Technology Federal Tax Credit	30%
System Capacity Factor	0.122
System Capacity, kW	29.5
Annual Electricity Savings, kWh	31,527
Annual Natural Gas Savings, therm	0
Program Administrative Cost	
Total Administrative Cost for Technology, $	$336,693
2008 Energy Savings for Technology, adj. gross kWh	1,354,375
Program Admin Cost Factor, $/kWh	0.24860
Average Program Admin Cost per System, $	$7,838
Lifetime Net Present Value of Costs, $	**$161,408**
Benefits	
Present Value of Lifetime Capacity Savings, $/kW	$11,029
Present Value of Lifetime Electricity Savings, $/kWh	$21,452
Present Value of Lifetime Natural Gas Savings, $/therm	$0
Lifetime Net Present Value of Benefits, $	**$36,734**
Simple TRC B/C	**0.23**

TABLE B-6: SMALL-SCALE SOLAR HOT WATER (<=7,300 KWH/YR)

Technology System Cost	
Estimated System Lifetime, years	25
Average System Cost (initial cost), $	$10,320
Average System Cost per kWh, $/kWh	$3.43
Technology Federal Tax Credit	30%
System Capacity Factor	
System Capacity, kW	
Annual Electricity Savings, kWh	3,013
Annual Natural Gas Savings, therm	0
Program Administrative Cost	
Total Administrative Cost for Technology, $	$437,153
2008 Energy Savings for Technology, adj. gross kWh/yr	1,151,446
Program Admin Cost Factor, $/kWh	0.380
Average Program Admin Cost per System, $	$1,143.90
Lifetime Net Present Value of Costs, $	**$11,271**
Benefits	
Present Value of Lifetime Capacity Savings, $/kW	$0
Present Value of Lifetime Electricity Savings, $/kWh	$2,050
Present Value of Lifetime Natural Gas Savings, $/therm	$0
Lifetime Net Present Value of Benefits, $	**$2,319**
Simple TRC B/C	**0.21**

TABLE B-7: LARGE-SCALE SOLAR HOT WATER (>7,300 KWH/YR)

Technology System Cost	
Estimated System Lifetime, years	25
Average System Cost (initial cost), $	$44,431
Average System Cost per kWh, $/kWh	$6.81
Technology Federal Tax Credit	30%
System Capacity Factor	0.147
System Capacity, kW	5.08
Annual Electricity Savings, kWh	6,524
Annual Natural Gas Savings, therm	0
Program Administrative Cost	
Total Administrative Cost for Technology, $	$437,153
2008 Energy Savings for Technology, adj. gross kWh/yr	1,151,446
Program Admin Cost Factor, $/kWh	0.380
Average Program Admin Cost per System, $	$2,477
Lifetime Net Present Value of Costs, $	**$48,467**
Benefits	
Present Value of Lifetime Capacity Savings, $/kW	$1,899
Present Value of Lifetime Electricity Savings, $/kWh	$4,439
Present Value of Lifetime Natural Gas Savings, $/therm	$0
Lifetime Net Present Value of Benefits, $	**$7,168**
Simple TRC B/C	**0.15**

TABLE B-8: BIOGAS CHP (ANAEROBIC DIGESTER)

Technology System Cost	
Estimated System Lifetime, years	20
Average System Cost (initial cost), $	$1,246,263
Average System Cost per kW, $/kW	$3,443
Technology Federal Tax Credit	$0.01
System Capacity Factor	0.744
System Capacity, kW	362
Annual Electricity Savings, kWh	2,359,313
Annual Natural Gas Savings, therm	0
Program Administrative Cost	
Total Administrative Cost for Technology, $	341,910
2008 Energy Savings for Technology, adj. gross kWh/yr	40,513,175
Program Admin Cost Factor, $/kWh	0.00844
Average Program Admin Cost per System, $	$19,911
Lifetime Net Present Value of Costs, $	**$1,103,679**
Benefits	
Present Value of Lifetime Capacity Savings, $/kW	$135,340
Present Value of Lifetime Electricity Savings, $/kWh	$1,605,363
Present Value of Lifetime Natural Gas Savings, $/therm	$0
Lifetime Net Present Value of Benefits, $	**$1,740,703**
Simple TRC B/C	**1.58**

TABLE B-9: BIOMASS CHP

Technology System Cost	
Estimated System Lifetime, years	20
Average System Cost (initial cost), $	$24,000,000
Average System Cost per kW, $/kW	$2,000
Technology Federal Tax Credit	$0.01
System Capacity Factor	0.85
System Capacity, kW	12,000
Annual Electricity Savings, kWh	89,352,000
Annual Natural Gas Savings, therm	2,900,000
Program Administrative Cost	
Total Administrative Cost for Technology, $	$284,013
2008 Energy Savings for Technology, adj. gross kWh/yr	140,572,366
Program Admin Cost Factor, $/kWh	0.00202
Average Program Admin Cost per System, $	$180,527
Lifetime Net Present Value of Costs, $	**$19,796,013**
Benefits	
Present Value of Lifetime Capacity Savings, $/kW	$4,486,396
Present Value of Lifetime Electricity Savings, $/kWh	$60,798,379
Present Value of Lifetime Natural Gas Savings, $/therm	$30,357,944
Lifetime Net Present Value of Benefits, $	**$95,642,719**
Simple TRC B/C	**4.83**

TABLE B-10: SMALL-SCALE SOLAR HOT WATER (<=5,000 THERMS/YR)

Technology System Cost	
Estimated System Lifetime, years	25
Average System Cost (initial cost), $	$25,438
Average System Cost per kW, $/kW	$40.57
Technology Federal Tax Credit	30%
System Capacity Factor	0
System Capacity, kW	0
Annual Electricity Savings, kWh	0
Annual Natural Gas Savings, therm	627
Program Administrative Cost	
Total Administrative Cost for Technology, $	$437,153
2008 Energy Savings for Technology, adj. gross therms/yr	49,109
Program Admin Cost Factor, $/therm	$8.90
Average Program Admin Cost per System, $	$5,581
Lifetime Net Present Value of Costs, $	**$31,475**
Benefits	
Present Value of Lifetime Capacity Savings, $/kW	$0
Present Value of Lifetime Electricity Savings, $/kWh	$0
Present Value of Lifetime Natural Gas Savings, $/therm	$6,564
Lifetime Net Present Value of Benefits, $	**$7,423**
Simple TRC B/C	**0.24**

TABLE B-11: LARGE-SCALE SOLAR HOT WATER (>5,000 THERMS/YR)

Technology System Cost	
Estimated System Lifetime, years	25
Average System Cost (initial cost), $	$291,000
Average System Cost per therm, $/therm	$24.65
Technology Federal Tax Credit	30%
System Capacity Factor	
System Capacity, kW	
Annual Electricity Savings, kWh	
Annual Natural Gas Savings, therm	11,807
Program Administrative Cost	
Total Administrative Cost for Technology, $	$437,153
2008 Energy Savings for Technology, adj. gross therms/yr	49,109
Program Admin Cost Factor, $/therm	$8.90
Average Program Admin Cost per System, $	$105,102
Lifetime Net Present Value of Costs, $	**$387,850**
Benefits	
Present Value of Lifetime Capacity Savings, $/kW	$0
Present Value of Lifetime Electricity Savings, $/kWh	$0
Present Value of Lifetime Natural Gas Savings, $/therm	$123,599
Lifetime Net Present Value of Benefits, $	**$139,782**
Simple TRC B/C	**0.36**

TABLE B-12: SOLAR THERMAL AIR

Technology System Cost	
Estimated System Lifetime, years	25
Average System Cost (initial cost), $	$19,872
Average System Cost per therm, $/therm	$18
Technology Federal Tax Credit	30%
System Capacity Factor	0.0
System Capacity, kW	0
Annual Electricity Savings, kWh	0
Annual Natural Gas Savings, therm	1,123
Program Administrative Cost	
Total Administrative Cost for Technology, $	$437,153
2008 Energy Savings for Technology, adj. gross therms/yr	49,109
Program Admin Cost Factor, $/therm	8.90
Average Program Admin Cost per System, $	$9,997
Lifetime Net Present Value of Costs, $	**$20,967**
Benefits	
Present Value of Lifetime Capacity Savings, $/kW	$0
Present Value of Lifetime Electricity Savings, $/kWh	$0
Present Value of Lifetime Natural Gas Savings, $/therm	$11,756
Lifetime Net Present Value of Benefits, $	**$11,756**
Simple TRC B/C	**0.56**

TABLE B-13: BIOGAS RNG (ANAEROBIC DIGESTER TO NATURAL GAS PIPELINE)

Technology System Cost	
Estimated System Lifetime, years	20
Average System Cost (initial cost), $	$1,221,000
Average System Cost per therm, $/therm	$2.23
Technology Federal Tax Credit	
System Capacity Factor	0
System Capacity, kW	0
Annual Electricity Parasitic Load, kWh	-725,328
Annual Natural Gas Savings, therm	547,500
Program Administrative Cost	
Total Administrative Cost for Technology, $	341,910
2008 Energy Savings for Technology, adj. gross therms/yr	4,319,717
Program Admin Cost Factor, $/therm	0.0792
Average Program Cost per System, $	$43,335
Lifetime Net Present Value of Costs, $	**$1,085,953**
Benefits	
Present Value of Lifetime Capacity Savings, $/kW	$0
Present Value of Lifetime Electricity Savings, $/kWh	($493,540)
Present Value of Lifetime Natural Gas Savings, $/therm	$5,731,371
Lifetime Net Present Value of Benefits, $	**$5,237,831**
Simple TRC B/C	**4.82**

TABLE B-14: RESIDENTIAL-SCALE BIOMASS THERMAL

Technology System Cost	
Estimated System Lifetime, years	20
Average System Cost (initial cost), $	$15,496
Average System Cost per therm, $/therm	$8.50
Technology Federal Tax Credit	0%
System Capacity Factor	0
System Capacity, kW	0
Annual Electricity Savings, kWh	0
Annual Natural Gas Savings, therm	1,824
Program Administrative Cost	
Total Administrative Cost for Technology, $[5]	$284,013
2008 Energy Savings for Technology, adj. gross therms/yr	4,993,254
Program Admin Cost Factor, $/therm	0.05688
Average Program Cost per System, $	$104
Lifetime Net Present Value of Costs, $	**$14,834**
Benefits	
Present Value of Lifetime Capacity Savings, $/kW	$0
Present Value of Lifetime Electricity Savings, $/kWh	$0
Present Value of Lifetime Natural Gas Savings, $/therm	$19,094
Lifetime Net Present Value of Benefits, $	**$19,094**
Simple TRC B/C	**1.29**

[5] This market includes program costs for all thermal biomass projects.

TABLE B-15: COMMERCIAL/INSITUTIONAL-SCALE BIOMASS THERMAL

Technology System Cost	
Estimated System Lifetime, years	20
Average System Cost (initial cost), $	$397,397
Average System Cost per therm, $/therm	$3.70
Technology Federal Tax Credit	0%
System Capacity Factor	0
System Capacity, kW	0
Annual Electricity Savings, kWh	0
Annual Natural Gas Savings, therm	107,293
Program Administrative Cost	
Total Administrative Cost for Technology, $[6]	$284,013
2008 Energy Savings for Technology, adj. gross therms/yr	4,993,254
Program Admin Cost Factor, $/therm	0.05688
Average Program Cost per System, $	$6,103
Lifetime Net Present Value of Costs, $	**$267,957**
Benefits	
Present Value of Lifetime Capacity Savings, $/kW	$0
Present Value of Lifetime Electricity Savings, $/kWh	$0
Present Value of Lifetime Natural Gas Savings, $/therm	$1,123,171
Lifetime Net Present Value of Benefits, $	**$1,123,171**
Simple TRC B/C	**4.19**

[6] This market includes program costs for all thermal biomass projects.

APPENDIX C

DETAILED RESULTS

As discussed in Chapter RE-1, the Energy Center's estimates of achievable potential for customer-sited renewable energy technologies are based on information provided by Wisconsin renewable energy experts who participated in a Delphi process. Delphi participants were asked to project future installations of specific renewable energy technologies under four scenarios: (1) a continuation of the status quo with respect to program design and funding, and the current status quo for market barrier reduction; (2) optimal program design and funding, but a continuation of the current status quo for market barrier reduction; (3) a continuation of the status quo with respect to program design and funding, but optimal market barrier reduction; and (4) optimal program design and funding, and optimal market barrier reduction. The Energy Center's point estimate for renewable energy potential represents the geometric mean of maximum and minimum values provided by Delphi participants. Detailed results are presented in the tables below.

TABLE C-1: ACHIEVABLE RENEWABLE ELECTRIC POTENTIAL ESTIMATES BY TECHNOLOGY, 2012

	Energy Center Achievable Potential Estimate		Delphi Status Quo Scenario		Delphi Optimal Program Scenario		Delphi Optimal Barrier Reduction Scenario		Delphi Optimal Program & Barrier Reduction Scenario	
	kWh	kW	kWh	kW	kWh	kW	kWh	kW	kWh	kW
Small wind	441,341	265	374,490	225	416,100	250	457,710	275	520,125	313
Large wind	18,017,659	10,825	10,402,500	6,250	20,805,000	12,500	20,805,000	12,500	31,207,500	18,750
Small solar electric	3,277,143	2,878	1,423,500	1,250	7,473,375	6,563	1,850,550	1,625	7,544,550	6,625
Large solar electric	1,327,752	1,166	825,630	725	1,423,500	1,250	1,138,800	1,000	2,135,250	1,875
Small solar hot water	103,025	90	64,657	57	67,921	60	67,921	60	164,160	144
Large solar hot water	23,502	21	6,466	6	6,792	6	6,792	6	85,425	75

	Energy Center Achievable Potential Estimate		Delphi Status Quo Scenario		Delphi Optimal Program Scenario		Delphi Optimal Barrier Reduction Scenario		Delphi Optimal Program & Barrier Reduction Scenario	
	kWh	**kW**	**kWh**	**kW**	**kWh**	**kW**	**kWh**	**kW**	**kWh**	**kW**
Biogas CHP	12,614,324	1,694	2,606,100	350	32,948,550	4,425	28,387,875	3,813	61,057,200	8,200
Biomass CHP	138,053	19	102,383	14	139,613	19	186,150	25	186,150	25
TOTAL	**35,942,799**	**16,958**	**15,805,726**	**8,877**	**63,280,851**	**25,073**	**52,900,798**	**19,304**	**102,900,360**	**36,007**

TABLE C-2: ACHIEVABLE RENEWABLE THERMAL POTENTIAL ESTIMATES BY TECHNOLOGY, 2012

	Energy Center Achievable Potential Estimate	Delphi Status Quo Scenario	Delphi Optimal Program Scenario	Delphi Optimal Barrier Reduction Scenario	Delphi Optimal Program & Barrier Reduction Scenario
	Therms	**Therms**	**Therms**	**Therms**	**Therms**
Small solar hot water	6,159	4,061	5,406	5,406	9,340
Large solar hot water	92,426	30,000	44,844	50,000	284,750
Solar thermal air	5,303	3,750	5,625	5,625	7,500
Biogas RNG	370,810	110,000	625,000	625,000	1,250,000

	Energy Center Achievable Potential Estimate	Delphi Status Quo Scenario	Delphi Optimal Program Scenario	Delphi Optimal Barrier Reduction Scenario	Delphi Optimal Program & Barrier Reduction Scenario
	Therms	Therms	Therms	Therms	Therms
Residential-scale biomass thermal	39,528	25,000	37,500	50,000	62,500
Commercial-scale biomass thermal	1,177,922	925,000	1,125,000	1,250,000	1,625,000
TOTAL	**1,692,148**	**1,097,811**	**1,843,375**	**1,986,031**	**3,239,090**

TABLE C-3: ACHIEVABLE RENEWABLE ELECTRIC POTENTIAL ESTIMATES BY TECHNOLOGY, 2018

	Energy Center Achievable Potential Estimate		Delphi Status Quo Scenario		Delphi Optimal Program Scenario		Delphi Optimal Barrier Reduction Scenario		Delphi Optimal Program & Barrier Reduction Scenario	
	kWh	kW	kWh	kW	kWh	kW	kWh	kW	kWh	kW
Small wind	526,329	316	416,100	250	582,540	350	499,320	300	665,760	400
Large wind	57,656,507	34,641	33,288,000	20,000	66,576,000	40,000	66,576,000	40,000	99,864,000	60,000
Small solar electric	24,737,793	21,723	14,235,000	12,500	37,011,000	32,500	20,213,700	17,750	42,989,700	37,750
Large solar electric	7,889,838	6,928	2,277,600	2,000	5,694,000	5,000	5,694,000	5,000	27,331,200	24,000

	Energy Center Achievable Potential Estimate		Delphi Status Quo Scenario		Delphi Optimal Program Scenario		Delphi Optimal Barrier Reduction Scenario		Delphi Optimal Program & Barrier Reduction Scenario	
	kWh	**kW**	**kWh**	**kW**	**kWh**	**kW**	**kWh**	**kW**	**kWh**	**kW**
Small solar hot water	967,890	850	85,673	75	98,083	86	98,093	86	10,934,784	9,602
Large solar hot water	311,211	273	8,567	8	9,808	9	9,808	9	11,305,030	9,927
Biogas CHP	19,477,375	2,616	4,281,450	575	47,282,100	6,350	41,883,750	5,625	88,607,400	11,900
Biomass CHP	166,498	22	148,920	20	186,150	25	186,150	25	186,150	25
TOTAL	**111,733,441**	**67,369**	**54,741,310**	**35,428**	**157,439,681**	**84,320**	**135,160,821**	**68,795**	**281,884,024**	**153,604**

TABLE C-4: ACHIEVABLE RENEWABLE THERMAL POTENTIAL ESTIMATES BY TECHNOLOGY, 2018

	Energy Center Achievable Potential Estimate	Delphi Status Quo Scenario	Delphi Optimal Program Scenario	Delphi Optimal Barrier Reduction Scenario	Delphi Optimal Program & Barrier Reduction Scenario
	Therms	**Therms**	**Therms**	**Therms**	**Therms**
Small solar hot water	55,504	6,721	13,279	13,279	458,366
Large solar hot water	309,839	96,000	463,272	463,272	1,000,000

	Energy Center Achievable Potential Estimate Therms	Delphi Status Quo Scenario Therms	Delphi Optimal Program Scenario Therms	Delphi Optimal Barrier Reduction Scenario Therms	Delphi Optimal Program & Barrier Reduction Scenario Therms
Solar thermal air	141,421	100,000	150,000	150,000	200,000
Biogas RNG	547,723	150,000	1,000,000	1,000,000	2,000,000
Residential-scale biomass thermal	42,426	30,000	40,000	50,000	60,000
Commercial-scale biomass thermal	1,456,022	1,325,000	1,100,000	1,500,000	1,600,000
TOTAL	**2,552,935**	**1,707,721**	**2,766,551**	**3,176,551**	**5,318,366**

APPENDIX D

DELPHI QUESTIONNAIRE

Delphi Questionnaire for Renewable Energy Technologies

This Delphi questionnaire addresses the following renewable energy technology:

- **Technology Evaluated**: ____

The Delphi process is an important part of the 2009 Wisconsin efficiency potential study, and we greatly appreciate your thoughtful participation.

Delphi responses are due November 19, 2008. Please return your completed questionnaire via email to Karen Koski at the Energy Center of Wisconsin: kkoski@ecw.org.

If you have any questions, please contact Claire Cowan at the Energy Center of Wisconsin: ccowan@ecw.org or by phone at (608) 238-8276 x117.

Qualitative Questions

This questionnaire is an effort to gather two kinds of informed opinion – both qualitative and quantitative. The first five questions are to establish qualitative context for data entered in the quantitative tables at the end. Use as much space as you wish after each question.

Technology Evaluated: ____

1. Describe briefly and generally how you characterize this renewable technology in terms of geographic and seasonal applicability, specific physical barriers or constraints, and the scope of physical adoption opportunities that remain.

2. Describe briefly and qualitatively, in your opinion, what market sectors are currently and potentially adopting this technology and why, and what adoption trends will look like within the next four years (2009-2012), and within the following five years (2013-2017).

3. In your opinion, what are the primary barriers to the growth of the industry for this technology in Wisconsin? Characterize whether programmatic or barrier reduction approaches will be needed to address each one.

4. In your opinion, what trends in the current energy economy or environmental legislation arena will prove advantageous or disadvantageous to this technology?

5. Are there any other factors that need to be considered within the context of studying achievable potential for this technology in Wisconsin?

Quantitative Questions

Technology Evaluated: ____

1. Program Impacts
“Program” refers to publicly or privately funded efforts to promote renewable energy technologies through voluntary programs. There are two steps to filling out this table. First is to rank the typical program components in order of their importance to promoting the technology, and second, estimating the percentage of a total program effort each measure represents. For example, you might start with choosing *Financial incentives* as number one and *Project facilitation* as number two (and so forth) in importance for promoting this technology. You might then estimate that 40% of program efforts should be dedicated to *Financial incentives*, while 18% should be focused on *Project facilitation*. If you feel that a component is unnecessary, enter N/A (not applicable). If there is an additional program component you feel is necessary but not listed, you may add that. Program components are considered here in general terms rather than in reference to any existing program initiatives.

Based on your perspective, rank each program component in order of its importance for significantly increasing adoption of this technology in Wisconsin. Then estimate the percentage of total importance each component will represent for this technology over the next four years, and then within the following five years.

Program Component	**Rank (1 being highest)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Financial incentives			
Consumer information			
Project facilitation			
Training of industry professionals			
Industrial economic development			
Regulatory and legislative policy support			
Other program component (specify)			
TOTAL		100%	100%

2. Impacts of Barriers

Like the Program Impacts table above, this table requires two steps – choosing applicable barriers and ranking them in order of their impact at the present time, and estimating a percentage that represents their impact among all identified barriers within the next four years, and then the following five years. For example, Say you choose *Low buy-back rates* as number 1 and *Lack of trained installers* as number 2, then estimate that *Low buy-back rates* represent 22% of the problem, and *Lack of trained installers*, 21 %. The situation may change as time advances, so you might enter lower numbers in the 2013-2017 column. If you feel that a barrier doesn't apply, enter N/A (not applicable). If there is an additional barrier (or more) you feel should be listed, you may add it (or them).

Select the significant barriers to this technology from the following list and rank them in order of their impact (enter N/A if not applicable). Then estimate the percentage of total impact you feel each barrier will represent for this technology within the next four years, and within the following five years.

Barrier	**Rank (1 being the greatest)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Low buy-back rates consistently applied statewide			
Lack of interconnection agreement for methane			
Absence of production tax credit			
Low net metering rate			
High cost of equipment/installation			
Expensive/difficult local permitting processes			
Low awareness among local officials			
Low awareness among potential adopters			
Lack of trained installers			
Reliability of available equipment/components			
NIMBYism			
Accessibility to/inadequacy of transmission/distribution system			
Lack of market for green credits			
Lack of coordination within fuel supply chain			
Lack of coordination within methane distribution system			
Transportation costs			
Availability of/competition for fuel			
Other Barrier (specify):			
TOTAL		100%	100%

3. Installation Estimates

This table requires estimates of potential installation levels in Wisconsin under four different scenarios.

- The first scenario is continuation of the status quo both with existing programs and the current status of barrier reduction, taking into account the incremental changes that will occur, in your opinion.
- The second scenario would reflect the level of installation you feel would occur if program funding allowed optimal implementation of program components you identified under Program Impacts, and barrier reduction activity remained at the status quo.
- The third scenario reverses this, assuming optimal support for barrier reduction priorities per your response to Impacts of Barriers, while program activity remains the same.
- The fourth assumes optimal program implementation and barrier reduction.

From your knowledge of the industry, what is your projected estimate of therms and/or kWs that would be installed in Wisconsin within the next four years, and within the following five years, under the following scenarios?

Scenario	**Therms installed within 4 years (2009-2012)**	**Therms installed within following 5 years (2013-2017)**	**kWs installed within the next 4 years (2009-2012)**	**kWs installed within following 5 years (2013-2017)**
Current program levels and barrier reduction efforts (status quo)				
Optimal program implementation				
Optimal support in reducing barriers				
Total optimal level (program support and barrier reduction)				

APPENDIX E

DELPHI RESPONSES

Biomass Combined Heat and Power

Qualitative Questions

1. Describe briefly and generally how you characterize this renewable technology in terms of geographic and seasonal applicability, specific physical barriers or constraints, and the scope of physical adoption opportunities that remain.

Respondent 1: On a seasonal basis, I don't believe there are any limitations to its use. The only issues that I have seen related to the use of solid fuel biomass is the occasional restrictions related to road bans in the springs. This time however, if it is known in advance can be used at the power plants as maintenance outages so as to minimize its impacts. Geographical limitations are based on transportation issues, largely costs to transport the fuel and road bans on the size of the loads. The potential adoption opportunities are still numerous in the state. The technology appears to be limited to projects of about 50 MWe in size due to fuel transportation issues. A limitation I see is in the potential urbanized area where biomass markets may have to be combined to fully feed a large biomass generating plant, i.e., a 50 MWe plant. There are other constraints, however, that are critical. There are potentially competing uses of the biomass resources, resistance by some to utilizing the biomass resources from existing forest due to nutrient cycle impacts, biodiversity issues, and water quantity and quality issues. (need to manage biomass extraction based on sustainability principles).

Respondent 2: I really view nuclear power as a better alternative to biomass combustion for the generation of electricity. If that's not an option, I view this as viable 12 months of the year. Some sources are more difficult to harvest during warmer months (e.g., marshlands access have to be frozen). Some big barriers are 1) capital investment needed to make a fuel switch; 2) transportation logistics for supply of biomass as well as removal of residues (ash); 3) environmental permitting aspects due to fuel switching, and the unintended consequences that may result, such as BACT or MACT requirements; 4) a huge barrier to this will be future cost, and that is due to the increasing demand for biomass in utility generation portfolios associated with RPS, while at the same time industrial users will want to increase biomass utilization to "go green" and the result will be price pressure making this far more costly than fossil fuels.

2. Describe briefly and qualitatively, in your opinion, what market sectors are currently and potentially adopting this technology and why, and what adoption trends will look like within the next four years (2009-2012), and within the following five years (2013-2017).

Respondent 1: Right now I see two major market sectors utilizing biomass for electricity purposes. Mostly it is the utilities that have or are looking to expand the use of biomass to produce electricity. Some companies in the paper industry have in the produced electricity for their own use, but are not looking at expanding there generation capacity in response to the potential for biorefining. I see continued expansion of the utility sector in through 2012. Xcel Energy has announced an expansion of biomass and WE Energies has committed to siting a 50 MWe biomass plant. In addition, I expect that as energy prices continue to rise and remain volatile, biomass opportunities will increase for electric utilities through 2017. Paper companies will continue to look at the use of biomass for generating electricity, but I believe it will be dependent upon the bio-refining concept, i.e., if bio-refining does not become a reality, the paper companies will not develop electric generation facilities. I do not believe there will be a large expansion of the bio-refining concepts between now and 2017. Fuel prices are too volatile and the risk of investing in an industry that swings wildly will deter many. Most of the bio-refining will occur as part of government lead efforts.

Respondent 2: For sure, I see pulp and paper and electric utility sectors adopting this technology due to RPS, climate change initiatives, etc. The trends in the time periods shown will largely be influenced by the current economic crisis plus the degree to which national and global pressures are put on climate change.

3. In your opinion, what are the primary barriers to the growth of the industry for this technology in Wisconsin? Characterize whether programmatic or barrier reduction approaches will be needed to address each one.

Respondent 1: The primary barriers to the growth of biomass for electric generation or CHP are four:
1. Transportation cost related to the fuel will limit the size of the individual projects and drive up production costs. There is no way to overcome this limitation other than to provide some sort of tax break or subsidy for the transportation of the biomass fuel.
2. Buy back rates are to low for green field opportunities, and support for subsidies or tax breaks to foster green field plants is lacking. Furthermore, shifting of costs for green field plants to the broader electric customer base is not accepted or at least does not have strong support at this time.
3. Lack of CHP infrastructure. Typically, successful CHP operations have multiple steam customers. The existing heating and cooling systems in Wisconsin do not support CHP systems and the cost of locating a CHP operation for one or two firm customers is difficult especially for regulated utilities. The revenue from the steam customers can help justify a green field plant, but gaining approval through the regulatory process can be difficult because of the risk of cost shifting if a steam customer shutters a plant or an office building. This is a barrier that is difficult to overcome unless there is a cheap source of financing for the utility or the municipality sponsoring the steam customers.
4. Environmental concerns as mentioned earlier. Education of the public can help over come this barrier.

Respondent 2: The primary barriers are cost of capital improvements, cost of transportation from source to user, and cost of consequences of environmental permitting (PSD, Title V, BACT, etc.).

4. In your opinion, what trends in the current energy economy or environmental legislation arena will prove advantageous or disadvantageous to this technology?

Respondent 1: Establishing hard, inflexible regulations related to water use, air emissions, or sustainable management guidelines will act as a deterrent to the technology. The volatility of the fossil fuel market will also serve as a deterrent, i.e., the risk of an investment will be hard to price. Serving as an advantage would be higher stable energy prices. In addition, government programs to support the transition of some marginal row crop land to energy plantations will be beneficial.

Respondent 2: Competition for forest and agricultural resources will I believe prove disadvantageous. Environmental legislation will force only “compliance” driven changes.

5. Are there any other factors that need to be considered within the context of studying achievable potential for this technology in Wisconsin?

Respondent 1: Yes, competing uses and the resulting political pressure to select 'winners' in the use of the biomass supplies will be extremely intense. In appropriate state policies will not only hamper the expansion of the biomass to electricity industry, but it could actually do away with it completely. Federal and state policy supporting the use of biomass to generate electricity, i.e., making sure the supply markets are free and unfettered, will be critical to expand the industry.

Respondent 2: Yes – namely, the impact of price volatility in fossil fuels as a driver in motivating renewable energy projects. Example, when natural gas is $14/mmBtu there is high motivation, when it drops to $8/mmBtu, industry focuses on actually being able to keep their doors open for another quarter of a year.

Quantitative Questions
1. Program Impacts

Respondent 1:

Program Component	**Rank (1 being highest)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Financial incentives	2	20	40
Consumer information	4	5	5
Project facilitation	5	3	3
Training of industry professionals	6	2	2
Industrial economic development	3	10	20
Regulatory and legislative policy support	1	50	30
Other program component (specify)			
TOTAL		100%	100%

Respondent 2:

Program Component	**Rank (1 being highest)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Financial incentives	1	30	40
Consumer information	7	2	2
Project facilitation	5	5	5
Training of industry professionals	6	3	3
Industrial economic development	4	10	10
Regulatory and legislative policy support	2	40	30
Other program component (specify) Development/deployment of emerging technologies, like Organic Rankine	3	10	10
TOTAL		100%	100%

2. Impacts of Barriers

Respondent 1:

Barrier	**Rank (1 being the greatest)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Low buy-back rates consistently applied statewide	4	15	10
Lack of interconnection agreement for methane	N/A		
Absence of production tax credit	N/A		
Low net metering rate	N/A		
High cost of equipment/installation	3	15	10
Expensive/difficult local permitting processes	N/A		
Low awareness among local officials	8	4	2
Low awareness among potential adopters	9	4	2
Lack of trained installers	N/A		
Reliability of available equipment/components	N/A		
NIMBYism	5	10	10
Accessibility to/inadequacy of transmission/distribution system	7	6	10
Lack of market for green credits	N/A		
Lack of coordination within fuel supply chain	6	6	6
Lack of coordination within methane distribution system	N/A		
Transportation costs	1	20	30
Availability of/competition for fuel	2	20	20
Other Barrier (specify):			
TOTAL		100%	100%

Respondent 2:

Barrier	Rank (1 being the greatest)	% of importance during the next 4 years (2009-2012)	% of importance during the following 5 years (2013-2017)
Low buy-back rates consistently applied statewide	3	10	10
Lack of interconnection agreement for methane	11	0	0
Absence of production tax credit	4	10	10
Low net metering rate	10	0	0
High cost of equipment/installation	1	30	20
Expensive/difficult local permitting processes	2	30	20
Low awareness among local officials	9	0	0
Low awareness among potential adopters	12	0	0
Lack of trained installers	13	0	0
Reliability of available equipment/components	14	0	0
NIMBYism	15	0	0
Accessibility to/inadequacy of transmission/distribution system	8	0	0
Lack of market for green credits	7	0	0
Lack of coordination within fuel supply chain	16	0	0
Lack of coordination within methane distribution system	17	0	0
Transportation costs	5	10	20
Availability of/competition for fuel	6	10	20
Other Barrier (specify):			
TOTAL		100%	100%

3. Installation Estimates

Respondent 1:

Scenario	Therms installed within 4 years (2009-2012)	Therms installed within following 5 years (2013-2017)	kWs installed within the next 4 years (2009-2012)	kWs installed within following 5 years (2013-2017)
Current program levels and barrier reduction efforts (status quo)	N/A	N/A	110	200
Optimal program implementation	N/A	N/A	150	250
Optimal support in reducing barriers	N/A	N/A	200	250
Total optimal level (program support and barrier reduction)	N/A	N/A	200	250

Biogas Combined Heat and Power

Qualitative Questions

1. Describe briefly and generally how you characterize this renewable technology in terms of geographic and seasonal applicability, specific physical barriers or constraints, and the scope of physical adoption opportunities that remain.

Respondent 1: Methane digesters are just now starting to take off, but only on large farms. I think they can and should be used on any farms 100 cows and up; a farm with 100 cows would still produce about 20 Kw of electricity 24X 7. Digesters not only produce electricity for the farm but also support the electrical grid by having the generation more diversified. One of the obstacles is the price paid for the electricity produced. Presently some companies are paying over 20 cents a kilowatt for solar, but only 6 cents for digester produced energy. Another problem is the perception that electricity has to be produced from 100 % digester gas. To buy a generator of that type is very expensive, but a diesel engine running on 85% methane and 15% diesel will operate just fine and cost less then 20% of a methane only engine. The price of digesters and their components are a problem. I don't believe in community digesters because when you put "wheels under the manure" it just takes the profits out of the project. The farm has uses for the excess heat where you would have a hard time making use of the heat from a community digester. So I would see a partnership with the farm and a digester company sharing the profits and the risk. The digester company would also perform the maintenance and be responsible for keeping the system running. In that way the digester company would design and use parts that are in common as much as possible. I think the possibilities are endless right now but we need to think of the whole picture, not just energy in the form of electricity but also heat. On smaller farms the gas could be used to heat greenhouses and fish farm ponds. I think we have only scratched the surface of using the waste off the press separator to produce elegy that would produce biodiesel.

Respondent 2: You need a large enough gas production to justify an anaerobic digestion system. Sites need space and a connection to the electrical grid or natural gas pipeline. Systems consume less energy in summer.

Respondent 3: Anaerobic digestion can be installed in almost any geographic region and is designed as a year-round system. The main barriers to the advancement of this technology are the low buy-back rates for the energy produced by these systems to justify the relatively high capital costs. The market is currently stalled in an area waiting for revenue from these systems to improve. It is my opinion that once the revenues improve, larger scale development will lead to lower capital and operating costs. In the short-term, improved buy-back rates would bridge the gap of achieving a critical mass to reduce capital and operating costs to the point where these systems are self sustaining without the requirement of special incentives. The anaerobic digestion market is still immature with only about 17 farms of a potential 250 farms utilizing this technology. With the addition of organic substrates, the economics could improve to increase the number of farms that could utilize this technology to over 500. There are also many opportunities that exist in the industrial sector. I would estimate that there are over 100 industrial food processors that could utilize anaerobic digestion systems.

Respondent 4: Anaerobic digestion can be applied statewide and must be applied year-round. Anaerobic digestion is applicable to larger municipal wastewater treatment facilities, moderate to larger farming operations and food processing facilities. Anaerobic digestion is implemented year round. The largest barriers to anaerobic digestion are its large capital expenditure, high operating costs and low biogas or power buyback rates. This tends to make anaerobic digestion more applicable to larger facilities. Operating costs for food processing facilities include disposal of resultant post-digestion solids and post-digestion effluent (liquid). Typically, the post-digestion effluent requires a further treatment step prior to disposal and the solids are either land applied or land filled. Operating costs include the high cost of maintaining cogeneration equipment. Considerable adoption opportunities remain in the State of Wisconsin. The largest potential exists in farming. There are approximately 200 dairy operations in the State that do not have anaerobic digestion. Opportunities also exist for community digesters, where several farming operations could haul manure to a central digestion facility. Food processing facilities, including ethanol facilities, offer significant opportunities for anaerobic digestion. Opportunities include constructing new digesters at the larger food processing facilities or hauling high-strength wastes to existing digestion facilities to produce more biogas. Municipally, opportunities for new digesters in the State are rare. Opportunities do exist for smaller generation projects (30 KW range) at existing municipal digesters and to add feed stocks to municipal digesters to produce additional biogas. Feed stocks could include hauled-in high strength wastes from food processing facilities.

Respondent 5: This is a sound technology with many years of development and proven effectiveness. The technology has been applied in all regions within the US. All that is needed is a reliable source of liquid biomass, and demand for the power, and preferably a use for the heat that is released from the combustion engine or turbine used to power the electric generator.

2. Describe briefly and qualitatively, in your opinion, what market sectors are currently and potentially adopting this technology and why, and what adoption trends will look like within the next four years (2009-2012), and within the following five years (2013-2017).

Respondent 1: CAFO's farms (700 cows and up) have different regulations as to their manure management. So only these large farms are installing digesters at this time because they are looking at it as a manure management tool, and energy is just one part of the equation to finance the project. I have been talking to farmers with 350 to 500 cows, and they would like to install such a system, but they need help with the financing either at a state level or federal level. It really is all about money! If the farmer knew it would not jeopardize his farming operation financially, I don't think there would be much hold up to the development and adoption of digesters. I think most farms will have a digester in the next 10-15 years. Just like milking parlors were not common in the 60's, by the 90's most farms that were business orientated had this system installed.

Respondent 2: Market sectors: wastewater, agriculture (dairy), and industrial. Wastewater is adopting it for process needs, dairy is adopting to assist in manure handling and produce energy, and industries are adopting either for processing needs or as a renewable energy resource. I see the wastewater market continuing as is has historically. I see rapid growth in the dairy industry, and the industrial market growth will be bottom line dependent.

Respondent 3: Presently, farms are mainly adopting this technology with the main drivers being odor control and assistance with nutrient management. Since these factors are difficult to financially quantify, the payback typically comes from the energy generation. Given the current utility rates, the market will continue this slow rate of development over the next 4 years. If energy prices increase significantly over the next four years, the following five years will see more significant development. Until the economics of these systems improve to the point of providing a reasonable rate of return given the relatively large financial risk, the development of this technology will continue to grow at a slow pace. The other sectors include municipal and industrial. Municipal systems are already installed is the city has a large enough population to support the technology. The growth in this sector will follow the growth in population. The industrial sector offers significant opportunities with the continued success of the food processing industry. The developing ethanol industry also offers an opportunity for growth of anaerobic digestion systems. Again, the development of these sectors will follow the economics. As energy rates continue to increase, this technology becomes more attractive. In the next 4 years, I believe this market will continue to wait for the economics to improve. The following five years offer greater potential assuming the energy costs increase to the point of making these system viable investments.

Respondent 4: On-farm digesters are at the beginning stages of adopting this technology. Drivers include nutrient management requirements and odor minimization, especially as urban sprawl continues. In my opinion, I see on-farm digestion growth continuing at its current slow pace for the next 3 years. Industrially, several drivers may promote anaerobic digestion. Higher energy costs will have facilities taking a second look at anaerobic digestion to process high strength wastes for recovery of energy in the form of biogas. Land spreading of high strength wastes will become more difficult as nutrient management plans become more prevalent. In addition, it appears that winter spreading of wastes will be discontinued in the next 5-years. In my opinion, anaerobic digestion will grow slowly industrially in the next four years and will increase as land spreading is more restrictive in the following five years.

Respondent 5: The technology is most commonly applied in the US by local government for digestion of wastewater bio-solids and by agriculture for digestion of animal manure. There is increasing interest in processing food scrap, either in dedicated digesters or in conjunction with the digestion of municipal wastewater Biosolids. There is some discussion about the ability to digest the Organic Fraction of Municipal Solid Waste, however, not much progress has been made in this area.

3. In your opinion, what are the primary barriers to the growth of the industry for this technology in Wisconsin? Characterize whether programmatic or barrier reduction approaches will be needed to address each one.

Respondent 1: The major barrier is financing. Farmers are keenly aware of what can happen when the price of milk goes down, and the price of their supplies goes up. Consequently they are unwilling to take that risk right now. Some utility companies are unwilling to pay much for the electricity produced and make it very hard for customers to even hook up. I am referring to the Co-ops; there are a lot of farmers in these areas, but the coops don't want the power. There are also many different rules as to what is needed for equipment. Some of it is so redundant as well as pricey with no real need for it. So I would recommend a state wide application and standardization of equipment.

Respondent 2: Energy buyback rates are a barrier that could be overcome with programmatic changes. Permitting complications when manure and other wastes are mixed are a barrier. I see these being overcome currently. The agriculture sector needs qualified operators and more established byproduct markets. These could be overcome with programmatic and barrier reduction approaches.

Respondent 3: The primary barrier is the system economics. Given the current technology costs and electric buy-back rates, the returns are not much better than break-even. Given the risk of the investment, most investors will choose to wait rather than move forward on projects. A programmatic approach will be the most effective for this issue. Having a mandated renewable portfolio standard that is more aggressive than the current mandates or having a feed-in tariff that is high enough to provide these plants a reasonable return will be required to move this market. Another barrier is the 10% limit set the Wisconsin Department of Natural Resources for off-farm substrate addition to a digester. Eliminating this barrier would significantly improve the economics of these projects. If they want a limit, closer to 50% would provide more flexibility to system operators in achieving the desired economics.

Respondent 4: The primary barrier is cost. At current renewable energy buyback rates, the rate of return on anaerobic digestion is minimal. In addition, being a biological process, there is greater risk for the minimal return. Higher renewable energy buyback rates, utility buy-ins or grants, or other grant opportunities are needed to make anaerobic digestion more feasible. Another barrier is the risks or fear of being the first to implement anaerobic digestion on a unique feedstock. Significant opportunities exist in the ethanol industry to dramatically off-set natural gas usage through anaerobic digestion, although this has not been implemented full-scale. Utility or State funding of a demonstration digester would provide a needed “jump start” to the industry.

Respondent 5: The cost of constructing the digester vessels. Newer design concepts applied in the southwest and in Europe will be needed to reduce the construction cost and the associated payback period. The complexity of interconnect requirements. A recent project we worked on had new requirements being applied at the end of construction. A market for generated power that cannot be used at the point of generation (e.g. landfills). Food scrap, and the organic fraction of municipal solid waste are not identified as sources of biomass (e.g. not identified as renewable fuels) in current energy legislation.

4. In your opinion, what trends in the current energy economy or environmental legislation arena will prove advantageous or disadvantageous to this technology?

Respondent 1: It is my hope that we stop talking about it and make it a reality for farmers to put in digesters and take down the financial barriers. My grandfather had a saying “use it up wear it out, make it do or do with out”. If we don’t implement new technologies while also being restricted on the use of coal, we will be the first people in history to be sitting on all kinds of energy and freezing to death. I don’t see any draw backs to this technology; it is the part of the answer to our future.

Respondent 2: Green energy promotion will help this sector grow as will higher energy prices.

Respondent 3: Almost all the trends will be advantageous for this technology. With increased environmental concerns, this technology has the ability to assist in managing some of these issues such as odor control, spreading requirements, phosphorus loading rates, etc. Another benefit would be the adoption of a carbon cap and trade program. Since these projects capture and mitigate methane which is 21 times more potent than carbon dioxide, they provide a means to reduce our carbon emissions while producing clean energy. Finally, as energy prices continue to escalate, the economics of this technology continue to improve. Eventually, it will come to the point of feasibility on a larger scale.

Respondent 4: Advantageous trends include carbon cap trading, high renewable energy buybacks and nutrient management plan requirements.

Respondent 5: First, the cost of electric energy must be at least $0.07 per kWh to have this method of producing electricity make sense. Continued support of renewable energy credits is important. A stable market for REC's so that the developer can predict the value will be necessary. Improvement of uniformity and clarity of interconnect requirements. Facilitating the air permitting process. Uniform application of building code requirements.

5. Are there any other factors that need to be considered within the context of studying achievable potential for this technology in Wisconsin?

Respondent 1: We need to take advantage of all the components that digesters can bring to the table. We will be better able to control the Phosphorus levels in our water sheds. We would be able to irrigate with the remaining liquid in the summer when the crops need it, and not have to think about spring and fall run off polluting our lake and rivers. We would be able to use the heat in green houses so we can have locally grown fruits and vegetables all year around. We need to research the technology of growing elegy that will produce bio-diesel. We would have the perfect conditions with the heat being produced by the digester and the liquid emitted from the press separator. Not to mention the possibilities of revitalizing the fish industry by growing yellow perch in water that is tempered by the heat from the digester produced on a farm with only 50 cows or with 1500 cows.

Respondent 3: With much of the potential market located in rural areas, access to the 3-phase grid can be a barrier. Currently, the cost to interconnect a project to the grid can stop a project from moving forward. There are no cost control measures in place to allow these systems to connect to the grid at a reasonable cost. If the utility does not favor the project, they can offer an attractive buy-back rate, but kill it with an inflated interconnect cost. An example of this was one of the projects we recently completed where a private transmission contractor provided a quote of $7,500 to extend the lines 250' and the Utility charged us almost $40,000 for the same 250' extension. To facilitate development of this technology, the utility should provide the connection to the system at no cost to the installer. This would make the feasibility more predictable and favorable in all areas of the State. Since the Utility and ratepayers are deriving a benefit from the renewable energy, this cost should be justifiable.

Respondent 4: For farming operations, a quantitative analysis of environmental benefits is needed, including nutrient removal through digestion processes. Industrially, the ability to "mine" or remove nutrients, such as phosphorus, following digestion needs to become a recognized practice. Two manufacturers claim to have this ability, although a demonstration project would help quantify removal efficiencies and costs. Removing nutrients could open the door for water reuse opportunities at food processing facilities. In addition this could alleviate concerns with overloading existing wastewater treatment facilities with phosphorus at either food processing facility's plant or where they would discharge the digester effluent to municipal wastewater plants. Mining nutrients after digestion would also be valuable for farm operations, where nutrient management plans can dictate the number of animals an operation can support. This would not only increase the growth of on-farm anaerobic digestion, but can also increase farming operations in general.

Respondent 5: No insights to add.

Quantitative Questions

1. Program Impacts

Respondent 1:

Program Component	**Rank (1 being highest)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Financial incentives	1	50	50
Consumer information	4	10	5
Project facilitation	2	20	15
Training of industry professionals	5	5	10
Industrial economic development	6	5	10
Regulatory and legislative policy support	3	10	10
Other program component (specify)			
TOTAL		100%	100%

Respondent 2:

Program Component	**Rank (1 being highest)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Financial incentives	1	25	25
Consumer information	6	10	10
Project facilitation	4	15	15
Training of industry professionals	3	20	20
Industrial economic development	5	10	10
Regulatory and legislative policy support	2	20	20
Other program component (specify)			
TOTAL		100%	100%

Respondent 3:

Program Component	**Rank (1 being highest)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Financial incentives	1	60	40
Consumer information	3	5	10
Project facilitation	4	5	10
Training of industry professionals	5	5	10
Industrial economic development	6	5	10
Regulatory and legislative policy support	2	20	20
Other program component (specify)			
TOTAL		100%	100%

Respondent 4:

Program Component	**Rank (1 being highest)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Financial incentives	1	50	60
Consumer information	6	2	1
Project facilitation	4	2	2
Training of industry professionals	5	2	1
Industrial economic development	2	15	15
Regulatory and legislative policy support	3	29	21
Other program component (specify)			
TOTAL		100%	100%

Respondent 5:

Program Component	**Rank (1 being highest)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Financial incentives	2	40	40
Consumer information	5	5	5
Project facilitation	6	5	5
Training of industry professionals	3	10	10
Industrial economic development	4	10	10
Regulatory and legislative policy support	1	30	30
Other program component (specify)	0	0	0
TOTAL		100%	100%

2. Impacts of Barriers

Respondent 1

Barrier	**Rank (1 being the greatest)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Low buy-back rates consistently applied statewide	1	25	10
Lack of interconnection agreement for methane	4	5	15
Absence of production tax credit	6	5	5
Low net metering rate	5	5	15
High cost of equipment/installation	3	25	15
Expensive/difficult local permitting processes	2	15	5
Low awareness among local officials	8	3	3
Low awareness among potential adopters	7	5	5
Lack of trained installers	13	2	5
Reliability of available equipment/components	12	2	2
NIMBYism	10	2	3
Accessibility to/inadequacy of transmission/distribution system	9	2	2
Lack of market for green credits	11	2	10
Transportation costs	14	2	5
TOTAL		100%	100%

Respondent 2:

Barrier	**Rank (1 being the greatest)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Low buy-back rates consistently applied statewide	1	20	20
Lack of interconnection agreement for methane	4	20	20
Low net metering rate	3	20	20
High cost of equipment/installation	2	20	20
Expensive/difficult local permitting processes	5	20	20
TOTAL		100%	100%

Respondent 3:

Barrier	**Rank (1 being the greatest)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Low buy-back rates consistently applied statewide	1	60	50
Absence of production tax credit	3	5	5
Low net metering rate	10	1	1
High cost of equipment/installation	4	2	2
Expensive/difficult local permitting processes	9	1	5
Low awareness among local officials	11	1	1
Low awareness among potential adopters	12	1	1
Lack of trained installers	8	1	2
Reliability of available equipment/components	7	1	1
NIMBYism	13	1	1
Accessibility to/inadequacy of transmission/distribution system	5	5	10
Lack of market for green credits	2	20	20
Availability of/competition for fuel	6	1	1
TOTAL		100%	100%

Respondent 4:

Barrier	**Rank (1 being the greatest)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Low buy-back rates consistently applied statewide	1	42	42
Lack of interconnection agreement for methane	10	1	1
Absence of production tax credit	6	2	2
Low net metering rate	14	1	1
High cost of equipment/installation	2	15	15
Expensive/difficult local permitting processes	11	1	1
Low awareness among local officials	13	1	1
Low awareness among potential adopters	12	1	1
Lack of trained installers	15	1	1
Reliability of available equipment/components	3	17	17
NIMBYism	9	2	2
Accessibility to/inadequacy of transmission/distribution system	5	3	3
Lack of market for green credits	4	7	7
Lack of coordination within fuel supply chain	16	1	1
Lack of coordination within methane	17	1	1

Barrier	Rank (1 being the greatest)	% of importance during the next 4 years (2009-2012)	% of importance during the following 5 years (2013-2017)
distribution system			
Transportation costs	7	2	2
Availability of/competition for fuel	8	2	2
TOTAL		100%	100%

Respondent 5:

Barrier	Rank (1 being the greatest)	% of importance during the next 4 years (2009-2012)	% of importance during the following 5 years (2013-2017)
Low buy-back rates consistently applied statewide	1	10	20
Lack of interconnection agreement for methane	1	20	
Absence of production tax credit	2	10	
Low net metering rate	3	10	
High cost of equipment/installation	3	10	10
Expensive/difficult local permitting processes	1	20	20
Low awareness among local officials	5		
Low awareness among potential adopters	5		
Lack of trained installers	5		
Reliability of available equipment/components	6		
NIMBYism	5		
Accessibility to/inadequacy of transmission/distribution system	4		10
Lack of market for green credits	3	20	20
Lack of coordination within fuel supply chain	6		
Lack of coordination within methane distribution system	3		
Transportation costs	6		10
Availability of/competition for fuel	3		10
TOTAL		100%	100%

3. Installation Estimates

Respondent 1:

Scenario	Therms installed within 4 years (2009-2012)	Therms installed within following 5 years (2013-2017)	kWs installed within the next 4 years (2009-2012)	kWs installed within following 5 years (2013-2017)
Current program levels and barrier reduction efforts (status quo)	600 Kw	1500 Kw	1500 Kw	1500 Kw
Optimal program implementation	800 Kw	2000Kw	2000 Kw	2000 Kw
Optimal support in reducing barriers	1000 Kw	2500 Kw	2500 Kw	2500 Kw
Total optimal level (program support and barrier reduction)	1200 Kw	3000 Kw	3000 Kw	3000 Kw

Respondent 2: I don't have enough knowledge about the current situation to answer this question. I know that you will see a general increase in therms and kWs as you move from the upper left hand corner to the lower right hand corner of the chart.

Respondent 3:

Scenario	Therms installed within 4 years (2009-2012)	Therms installed within following 5 years (2013-2017)	kWs installed within the next 4 years (2009-2012)	kWs installed within following 5 years (2013-2017)
Current program levels and barrier reduction efforts (status quo)			5 MW	10MW
Optimal program implementation			70 MW	125 MW
Optimal support in reducing barriers			60 MW	110 MW
Total optimal level (program support and barrier reduction)			130 MW	235 MW

Biogas Renewable Natural Gas

Qualitative Questions

1. Describe briefly and generally how you characterize this renewable technology in terms of geographic and seasonal applicability, specific physical barriers or constraints, and the scope of physical adoption opportunities that remain.

Respondent 1: Anaerobic digestion can be installed in almost any geographic region and is designed as a year-round system. The main barriers to the advancement of this technology are the high cost of the gas processing equipment, the interconnection to the pipeline system, and the fluctuating prices of natural gas. Another significant barrier is the limited natural gas infrastructure near the main produces of biogas. Many farms are many miles for the nearest natural gas pipeline and the extension costs make these projects not feasible. With no defined gas quality standards, it can be a moving target when trying to discuss with pipeline owners. This makes project feasibility analysis difficult and make it unique to each project. Having a set standard statewide gas quality standard and a statewide interconnection requirement similar to PSC 119 would eliminate this barrier. The anaerobic digestion market is still immature with only about 17 farms of a potential 250 farms utilizing this technology. Of the 250 farms, I would estimate that only about 25% of them are within 1 mile of a natural gas pipeline.

2. Describe briefly and qualitatively, in your opinion, what market sectors are currently and potentially adopting this technology and why, and what adoption trends will look like within the next four years (2009-2012), and within the following five years (2013-2017).

Respondent 1: Farms that have access to the natural gas pipeline system have expressed interest. The feasibility of projects are better utilizing the biogas as renewable natural gas rather than generating electricity since electric generation is only about 30-40% efficient in converting the Btu's to electricity. The largest potential for this is in the industrial and municipal sectors. Since most industrial and municipal operations are connected to the natural gas system, this significantly reduces this barrier. The other opportunity is that they are able to utilize much of the gas themselves with minimal compression and only compressing a portion of their production for export into the system. In the next 4 years, I would estimate about 5-10 projects developed for injection of renewable natural gas into the pipeline. One of the main factors for the growth in this field is the price paid to the producer for the renewable natural gas. If the price of natural gas remains around $10/MMBTU, this technology is relatively feasible and will develop quickly as more installations will lead to more comfort with the technology and pricing will be reduced through increased competition.

3. In your opinion, what are the primary barriers to the growth of the industry for this technology in Wisconsin? Characterize whether programmatic or barrier reduction approaches will be needed to address each one.

Respondent 1: The primary barrier is having a standard gas quality and interconnection standard. This hinders the project feasibility and delays projects while the developer and utility attempt to identify the requirements. This barrier could be eliminated with a statewide gas quality and interconnection standard. The other barrier is having a predictable rate for the renewable natural gas. The fluctuating and seasonal pricing makes securing financing for these projects more difficult since the revenue over a long term is at risk. Following market trends, it should continue to increase or at least hold steady, but there is no guarantee for this revenue stream. A buy-back program for renewable natural gas would reduce this barrier, making project economics more predictable and providing greater security to investors.

4. In your opinion, what trends in the current energy economy or environmental legislation arena will prove advantageous or disadvantageous to this technology?

Respondent 1: The continued increase in natural gas pricing will continue to improve the project economics. The addition of a cap and trade program would also help in developing this market. If a large inexpensive deposit of natural gas was found in North America that caused the price to drop significantly, this market would be negatively affected.

5. Are there any other factors that need to be considered within the context of studying achievable potential for this technology in Wisconsin?

Respondent 1; Clarifying that the renewable natural gas injected into the system can be pulled out at any location on the system and used as renewable natural gas. It should not require direct use of the gas produced to qualify as renewable.

Quantitative Questions

1. Program Impacts

Respondent 1:

Program Component	**Rank (1 being highest)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Financial incentives	2	30	50
Consumer information	6	5	5
Project facilitation	3	5	5
Training of industry professionals	5	5	10
Industrial economic development	4	5	20
Regulatory and legislative policy support	1	50	10
Other program component (specify)			
TOTAL		100%	100%

2. Impacts of Barriers

Respondent 1:

Barrier	**Rank (1 being the greatest)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Low buy-back rates consistently applied statewide	2	24	40
Lack of interconnection agreement for methane	1	35	5
Absence of production tax credit	13	1	1
High cost of equipment/installation	7	1	1
Expensive/difficult local permitting processes	4	5	5
Low awareness among local officials	14	1	1
Low awareness among potential adopters	11	1	1
Lack of trained installers	12	1	1
Reliability of available equipment/components	10	1	1
NIMBYism	15	1	1
Accessibility to/inadequacy of transmission/distribution system	3	20	34
Lack of market for green credits	8	5	5
Lack of coordination within fuel supply chain	9	1	1
Lack of coordination within methane distribution system	5	1	1
Transportation costs	16	1	1
Availability of/competition for fuel	6	1	1
TOTAL		100%	100%

3. Installation Estimates

Respondent 1:

Scenario	**Therms installed within 4 years (2009-2012)**	**Therms installed within following 5 years (2013-2017)**	**kWs installed within the next 4 years (2009-2012)**	**kWs installed within following 5 years (2013-2017)**
Current program levels and barrier reduction efforts (status quo)	880,000	1,500,000		
Optimal program implementation	5,000,000	10,000,000		
Optimal support in reducing barriers	5,000,000	10,000,000		
Total optimal level (program support and barrier reduction)	10,000,000	20,000,000		

Large-Scale Solar Electric (larger than 20 kW)

Respondent 3: A comment that I want to include: Today the need for safety and quality requires an installer to attend classes, do installs, be capable of designing, understanding the dangers of both the AC and the DC involved and safety of installer climbing on roofs and attaching equipment. I think the future will be many systems installs that have a tracking system (capable of generating 40% more electricity per year with the same amount of roof top panels) that are installed in two days by normal workmen with normal skills. They dig and pour a base pad. They assemble an engineered tracking system with good instructions. They attend classes to assure they know the dangers of the system and pass a test to gain a “limited certification” that does not authorize them to do any installs except tracking and fixed pole mount systems. The do no AC wiring. They prove their skills by doing installs under supervision. This would in a very short time create many skilled installers that would go into this business and compete giving a great value and dramatically increasing the installed base. See dhsolar.net

Qualitative Questions

1. Describe briefly and generally how you characterize this renewable technology in terms of geographic and seasonal applicability, specific physical barriers or constraints, and the scope of physical adoption opportunities that remain.

Respondent 1: Photovoltaics will produce energy year-round – if optimized for best annual production, will produce about half as much in November and December as it does in the best months, which can be May, July, June or even March. It only requires year round and day long open access to the sun, so there are no other geographic limitations here. Physical barriers are mainly open roof or ground space to implement the technology. Adoption opportunities are tremendous.

Respondent 2: Can be used nearly anywhere where there is unshaded space with the caveat that some roofs may not be able to structurally hold the weight of a system. A better understanding of this needs to be communicated. Solar power works better in the summer and in the day while wind power works better in the winter and at night. This may add additional value to solar by diversifying renewable energy generation. Although solar resources are not optimal in Wisconsin, the state’s electricity load is actually well matched with PV output, i.e. the coincidence of peak demand matches the solar resource fairly well.

Respondent 3: As a manufacturer of a sun tracker we have constructed 20 KW systems and they are both easy and relatively simple to build and install. We feel this is a business with great future potential.

2. Describe briefly and qualitatively, in your opinion, what market sectors are currently and potentially adopting this technology and why, and what adoption trends will look like within the next four years (2009-2012), and within the following five years (2013-2017).

Respondent 1: Current and potential adopters are mainly companies/organizations that are looking for energy savings, have potentially already taken other significant actions, and have a strong feeling that adopting the technology is the right thing to do either for long term energy cost savings, environmental or energy independence reasons. I expect that adoption over the next 4 years will present significant growth, though possibly less than otherwise would have occurred due to national economic and credit issues. The following 4 years will hopefully see significantly increased adoption building on mainstreaming success of prior 4 years, and prior resolution of economic and credit barriers.

Respondent 2: The 8-year extension of the federal Investment Tax Credit (ITC) through 2016 along with likely installed price decreases in this time frame will possibly lead to great adoption of solar in commercial markets. Utility prices are likely to continue an upward trend over this time as well. PV is becoming cost competitive with grid power in some markets and could reach parity in Wisconsin between 2012-2015. Increasingly PV will be recognized as a hedge against higher electric rates.

Respondent 3: With the benefits of incentives they can be financially logical. The two reasons to install them is when they make financial sense and also because of the wish to be “green” or create the image you are.

3. In your opinion, what are the primary barriers to the growth of the industry for this technology in Wisconsin? Characterize whether programmatic or barrier reduction approaches will be needed to address each one.

Respondent 1: Primary barriers are up-front cost and lack of awareness of this energy option. This combines with current economic and credit issues as they may or may not exist in Wisconsin. A state organized program that utilizes public or private investors to mitigate up front costs would be effective.

Respondent 2: The 3 primary barriers today are costs, costs, and costs. The industry needs to reduce the price of the product. State incentives would help short term until prices drop. Wisconsin needs a competitive solar market for both product and installations. There are not enough experience installers in the state and few, if any, with experience with larger systems, i.e. 100 kW and up. Another need is for better knowledge and understanding on the part of code inspectors. Lack of adequate financing may be a barrier going forward.

Respondent 3: Cost of panels that will be reduced in the future and the difficulty of finding certified installers.

4. In your opinion, what trends in the current energy economy or environmental legislation arena will prove advantageous or disadvantageous to this technology?

Respondent 1: Rising utility energy costs will do the most to promote adoption, which will especially be enhanced when environmental/climate change costs are reflected in utility costs, along with the recently extended federal tax credits, will provide advantages. The current potential credit and economic concerns are expected to be a disadvantage without specific actions to mitigate these concerns. The current 20kW limit for net metering in WI is also a disadvantage for adoption of systems at greater than 20kW. An advantage would be provided by adopting a statewide consistent feed-in tariff for solar.

Respondent 2: PV will very likely grow without mandates, e.g. a solar set-aside in the state RPS or a federal RPS with a solar carve out requirement. Of course, either of these would increase the amount of solar deployment. Other factors include the potential impact of future carbon costs on electricity rates from a regional or national carbon cap and trade program.

Respondent 3: Government subsidies make them be financially logical.

5. Are there any other factors that need to be considered within the context of studying achievable potential for this technology in Wisconsin?

Respondent 1: How to insure that the many people and forms that are now “getting into solar” are actually qualified and provide high quality and high performing system designs, installations and operation. The current perceived barrier that only regulated utilities can sell energy, makes 3rd party ownership a legal and therefore costly challenge.

Respondent 2: A constrained capital market with a lack of financing needs to be considered.

Respondent 3: The present procedure for certifying installers is logical and needed. It is designed for roof top installation. A tracking self contained system does not require the needed training and a limited certification that only authorized tracking installation with training only in that area that authorized installers to install to engineered drawings and do no AC connections would instantly create a large base of sellers who would then become competitive to each other resulting in a big increase in systems.

Quantitative Questions

1. Program Impacts

Respondent 1:

Program Component	**Rank (1 being of highest importance)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Financial incentives	1	55%	25%
Consumer information	4	5%	20%
Project facilitation	6	5%	5%
Training of industry professionals	3	10%	20%
Industrial economic development	5	5%	25%
Regulatory and legislative policy support	2	20%	5%
TOTAL		100%	100%

Respondent 2:

Program Component	**Rank (1 being of highest importance)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Financial incentives	1	35	25
Consumer information	3	25	30
Project facilitation	5	5	10
Training of industry professionals	2	25	25
Industrial economic development			
Regulatory and legislative policy support	4	10	10
TOTAL		100%	100%

Respondent 2:

Program Component	**Rank (1 being of highest importance)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Financial incentives	30		
Consumer information	20		
Project facilitation			
Training of industry professionals	30		
Industrial economic development			
Regulatory and legislative policy support	20		
TOTAL		100%	100%

2. Impacts of Barriers

Respondent 1: In all tables, I assumed that an issue identified as important in the first period, was resolved and so of no or little impact in the second period.

Barrier	**Rank (1 being the greatest)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Low buy-back rates consistently applied statewide	2	20%	10%
Absence of production tax credit	5	5%	5%
Low net metering rate	3	15%	5%
Lack of market for green credits	6	5%	5%
Expensive/difficult local permitting processes	13	0%	0%
Low awareness among local officials/neighborhood associations	9	5%	5%
Low awareness among builders and developers	7	5%	10%
Low awareness among consumers	8	5%	20%
High cost of equipment/installation	1	20%	15%
Lack of trained installers	11	5%	15%
Shortage of equipment/components	12	0%	0%
NIMBYism	14	0%	0%
Accessibility to/inadequacy of transmission/distribution system	10	5%	5%
Other Barrier (specify): Low net metering cap	4	10%	5%
TOTAL		100%	100%

Respondent 2:

Barrier	**Rank (1 being the greatest)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Low awareness among local officials/neighborhood associations	5	5	15
Low awareness among builders and developers	4	10	15
Low awareness among consumers	2	10	20
High cost of equipment/installation	1	65	40
Lack of trained installers	3	10	10
TOTAL		100%	100%

Respondent 3:

Barrier	**Rank (1 being the greatest)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Low net metering rate	6	10	10
Low awareness among local officials/neighborhood associations	4	10	10
Low awareness among builders and developers	5	10	10
High cost of equipment/installation	3	20	
Lack of trained installers	1	30	35
Shortage of equipment/components	2	20	15
TOTAL		100%	100%

3. Installation Estimates

Respondent 1: Not clear on which actions would fall into which categories, program or barrier.

Scenario	**kW installed within the next 4 years (2009-2012)**	**kW installed within the following 5 years (2013-2017)**
Current program levels and barrier reduction efforts (status quo)	5,000	20,000
Optimal program implementation	8,000	50,000
Optimal support in reducing barriers	8,000	50,000
Total optimal level (program support and barrier reduction)	15,000	240,000

Respondent 2:

Scenario	**kW installed within the next 4 years (2009-2012)**	**kW installed within the following 5 years (2013-2017)**
Current program levels and barrier reduction efforts (status quo)	6,000	10,0000 incremental
Optimal program implementation	10,000	50,000 incremental
Optimal support in reducing barriers	10,000	50,000 incremental
Total optimal level (program support and barrier reduction)	15,000	80,000 incremental

Commercial/Institutional-Scale Solar Hot Water

Qualitative Questions

1. Describe briefly and generally how you characterize this renewable technology in terms of geographic and seasonal applicability, specific physical barriers or constraints, and the scope of physical adoption opportunities that remain.

Respondent 1: Solar thermal is a good fit in every geographical location, regardless of seasonal differences. Good system design can account for seasonal differences. With good design and flexibility ALL physical barriers can be overcome.

Respondent 2: This technology is useful statewide, but tends to work better during the summer. The other specific physical barrier with this technology is that there needs to be a hot water load on-site, meaning if you don't use much, you don't gain much from the system. The hot water load will determine the scope of commercial solar thermal's adoption within the various market sectors.

Respondent 3: Non-Residential solar water heating systems are applicable in all parts of Wisconsin. The climate in Wisconsin dictates that all solar water heating is of a design that protects them from freezing. The Focus program only allows proven system types that accomplish this goal (pressurized glycol antifreeze or drainback [with glycol] systems). The largest physical barrier of installation of systems is the availability of appropriate collector mounting locations. Solar collectors must be placed in a location that receives at least 4 hours of direct sunlight throughout the year. Solar thermal collectors are somewhat forgiving in that partial shading does not significantly reduce output. Nevertheless, shading from trees and adequate roof space for collectors is a significant barrier. On the other side of the coin, most locations do have enough room for proper collector mounting.

Respondent 4: Applicable across the state in a wide range of opportunities, starting with a consistent demand of 50 gallons of hot water per day. Has twice the resource in the 6 highest sun months than the lowest sun months. Is mostly coincident with summer electrical peak. Need about one square foot of collector area to match one gallon per day of hot water needs in summer. Has weight limits on roofs. Has major aesthetic issues to integrate with existing buildings, including collector angle and piping. Huge energy opportunities. Current application is likely less than one percent of the potential.

2. Describe briefly and qualitatively, in your opinion, what market sectors are currently and potentially adopting this technology and why, and what adoption trends will look like within the next four years (2009-2012), and within the following five years (2013-2017).

Respondent 1: The biggest market looking at the advantages of solar are healthcare, schools, hotel/motel, and multifamily. This trend will continue to grow with increased fuels costs and the positive PR it produces for the complex.

Respondent 2: Hot water demand necessary. Hospitality, health care, laundries, food processing and other material production, restaurants, car washes, gyms, pools, etc. Adoption trends will depend on conventional fuel prices, but we will see a 'green marketing' effect over the next 4 years, with some companies adopting solar as an image. Seriously large users of hot water want to see this affect their bottom line, and that will only come with higher fuel prices, so the trend will lean towards the highest end users of the various sectors.

Respondent 3: The subject of this questionnaire revolves around non-residential solar water heating systems. Non-Residential systems have been occurring diversely throughout the State. In areas where both the general atmosphere is more positive about renewable energy systems and where the local utilities are more positive about renewable energy systems, we see accelerated growth in the market. A good example of this is in the WE Energies territory of the State. Within the last 18 months WE Energies has begun to put out positive messages regarding solar water heating and we have seen a surge of interest in that territory directly correlating with the positive message put forth by the utility. We have seen a significant increase in installations in the non-residential sector over the whole State. Contributing factors for this growth include enhanced financial characteristics that result from the federal incentive credits, Focus on Energy incentives, economies of scale and a desire to be green. Another factor in the growth in non-residential solar water heating in Wisconsin has been the start-up of a major solar thermal component distributor in Wisconsin. This distributor is aggressive and is moving the market, particularly the non-residential market. We are also seeing the long awaited entry (re-entry) of conventional plumbing distributors into the solar thermal arena. This change in the marketing of solar thermal components is by no means completed but this is the sign of a market that is taking the right steps toward maturity. Overall the non-residential solar water heating market in Wisconsin has seen accelerated growth recently. Non-Residential systems, like most renewable energy systems have a high upfront cost. We see surges in sales whenever fossil fuel prices spike upward. Also, like other renewable energy technologies, when fossil fuel prices rise, so do the costs of the raw materials used in constructing solar water heating systems. I predict continued moderate growth in the non-residential market over the next 4 years. The extension of the non-residential federal tax credits for solar water heating systems was a critically important factor in ensuring this growth. A stable Focus incentive program will also help this anticipated growth. A lot depends on the support both the State and the Federal Government gives to solar water heating, the more support, the greater the growth. The rate of growth will be dependant on two factors, fossil fuel prices and potential increases in incentives. If fossil fuel prices rise strongly, we will see a surge in solar water heater installations. The same is true if incentive levels are raised. On the other side of the coin, if financing is harder to get, then installations will not rise as quickly. I see the long-term growth as very positive because I anticipate steady and potentially drastic fossil fuel price increases in the long run, especially the cost of natural gas.

Respondent 4: To be honest, no C/I market segment are adopting solar water heating in any significant way. The few C/I solar hot water systems being installed are at “green” municipal fire stations, school indoor swimming pools, motels and a few car washes and industrial uses. Almost all of these applications are occurring based on “green” imaging. There are few if any applications where owners decisions were based on a least cost solution. The current cost effectiveness of the technology has not reached the point where it is being adopted to save money, the driver of most energy decisions in the C/I markets. 2009-2012: The adoption trend will likely track natural gas costs. As natural gas costs increase, so will adoption of solar water heating. Commodity costs for copper and aluminum will also have an influence as will other policies affecting carbon and the ability to monetize solar water heating carbon savings. There was a large percent increase in adoption in 2008 from 2007, owing much to the extremely small installations before 2008. I would expect the annual growth rates to be in the 15-25 % range unless natural gas costs are increasing more than this, while commodity costs hold steady. 2013-2017 will likely witness much higher growth rates as natural gas availability begins to wane due to resource constraints and much higher use in electric power production, which should have a strong influence on moving natural gas prices higher.

3. In your opinion, what are the primary barriers to the growth of the industry for this technology in Wisconsin? Characterize whether programmatic or barrier reduction approaches will be needed to address each one.

Respondent 1: ECOMONY: Investment is difficult at this time.
AVAILABLE GRANTS: We need to show quicker payback periods
EDUCATION: Installations have to be better than in the 1970's, they need to stand the test of time.
POLITICS: Education and awareness

Respondent 2: Economics (barrier). Strong professional industry (programmatic & barrier).

Respondent 3: As long as this country continues to subsidize the fossil fuels industry, solar water heating will only see modest growth. As mentioned above, fossil fuel pricing is a major driver in the adoption of this technology. Certainly, the acceptance of the concept of global climate change has had a positive effect in the acceptance of the technology. Another barrier to growth in rural areas is the fact that Focus no longer gives incentives for systems offsetting propane gas water heaters. In the past Focus did incentivize these systems and when the policy changes in 2007 we saw a marked decrease in rural installations. This would be a programmatic issue that I would suggest be changed. In these uncertain economic times with the ensuing tightening of the credit industry, this may pose a significant barrier. A programmatic solution to this barrier may be to offer attractive financing options. It is interesting to note that financing programs through Focus have not been successful in the past, but note that those were times of easy and plentiful financing options. A successful model to address this barrier is a program in San Francisco where the cost of the solar water heating system is financed by the city and annual payments are added to the annual property taxes for that location. The financing stays with the property and is transferable if/when the property is sold. Long term financing typically creates a positive cash-flow situation making heating water with solar less expensive than using fossil fuels. Another barrier has been in the supply chain. Wisconsin, like the rest of the country, has suffered because the solar water heating industry is still immature. We have not had adequate qualified installers and the plumbing industry has not adequately supplied/stocked the specialized solar products needed by the solar industry. In addition, the plumbing suppliers do not have adequate knowledge to successfully supply these products to the industry. This is changing in Wisconsin and we see a surge currently in the plumbing industry seeking training. The plumbers and HVAC installers are leading this surge but the plumbing wholesale houses are still severely lacking. The Focus program has been aggressive in training these people, but there is still a long way to go in creating a somewhat mature industry. The limited Focus budget has hampered our ability to be very aggressive in this area. There has also been reluctance among plumbing wholesalers to enter this market. More aggressive tactics could improve this situation.

Respondent 4: The primary barrier is cost effectiveness. There will not be large growth and adoption unless the payback for C/I customers is less than five years. Current paybacks of 7-10 years even with the first cost reductions of 60-75 percent indicate that this technology is no where near being cost effective without large price declines in the technology or in large cost increases in competing natural gas applications. For large scale adoption, the program would need to provide incentives to meet a five year payback or provide other services that reduce installation costs. Permit barriers are also a significant transaction cost that increase the cost and time for installations. This could be addressed through training, learning and/or by having the program provide a third party contractor that would provide this service. There needs to be innovation that can develop systems that reduce installation costs and reduce the first cost for customers. Solar Mining Co. addressed some of these barriers by building larger factory made panels and looking at ways to reduce costs. They also developed the third party ownership models, which eliminated the upfront costs for customers. However, they did not have the resources to fully develop the technology innovations and financial model. There still exists a lack of trust by potential owners of the technology working in a reliable and low maintenance way for 20 to 30 years. Well built, professionally installed systems that have routine maintenance should be able to last for long periods of time (40-50 years). Systems may need to be insured by the program to develop confidence by owners that system guarantees will be honored. Word of mouth success stories are needed to develop buzz about the technology in order to increase adoption rates.

4. In your opinion, what trends in the current energy economy or environmental legislation arena will prove advantageous or disadvantageous to this technology?

Respondent 1: As fuel prices continue to rise, so does people's interest in saving money. Through good education the general public can make informed decisions.

Respondent 2: Extension of the federal tax credit will prove advantageous. RPS and new construction mandates would be advantageous.

Respondent 3: As mentioned above, as long as fossil fuels are subsidized as heavily as they currently are, the solar thermal industry will suffer. We can see in other parts of the world where this is not the case that solar water heating is much more successful. For instance, in most of Europe where fossil fuel prices are higher than here that solar water heating is literally everywhere but even in these parts of the world it takes aggressive subsidies to get the public on-board with solar thermal. It is unrealistic to expect solar thermal to compete in the energy marketplace if it is not subsidized as aggressively as it's competition (fossil fuels). If we had a level playing field, then we would see the solar industry thrive. Therefore, as long as fossil fuels are subsidized as they are today, we need aggressive subsidies for the solar industry too in order to compete. In addition, if we intend to jump-start the aggressive growth of this industry, then we need to increase subsidies for the solar industry to a greater extent. The original federal tax credit legislation of the 1980's was structured as sunset legislation where the subsidies were stable for a certain time period and then were reduced yearly over an extended period of time. This allowed the industry to grow while everyone understood that they would be weaned from the incentives in a predictable timeframe. Again, stability of the incentive programs is essential or the support industries will not participate (this is why the plumbing supply chain is still reluctant to participate as they got burnt when the original federal legislation was stopped in mid stream). In order for a subsidizing program to be successful in the long term, we heed oversight of the industry. Fortunately, this is a major component of the Focus program. This oversight will ensure that the systems being subsidized are of high quality.

Respondent 4:
Advantageous:
a. Likely higher natural gas prices as North America begins to feel the impact of resource constraints.
b. The eight year extension of the ITC signals that significant incentives will be available for a long enough period that there can be supply chain investment with a higher probably of potential return.

c. Likely carbon policies will increase the cost of alternatives
d. Increasing supply chain development since the Focus program has developed. Major plumbing and HVAC firms are already investing resources in having a SWH component, although they are at the beginning of this expansion and learning process.
e. There are some examples of regulatory approaches that require SWH in new buildings and process changes.
Disadvantages
a. In an economic slow down, with decreasing natural gas prices, there may be reluctance to invest in longer payback technologies
b. There is not a well documented history of successful applications nor the hope of better and cheaper technology (like PV). This reduces buzz, capital and creativity from entering this market to the same extent as other RE technologies.

5. Are there any other factors that need to be considered within the context of studying achievable potential for this technology in Wisconsin?

Respondent 1: Consistent enforcement of regulations. More training/education.

Respondent 3: We need more positive signals from both the utility sector and the State government to see aggressive growth in this sector. We have seen where positive signals from utilities have happened that more systems have been installed. This tactic would have a very small cost but would have a major impact on growth. The signals have been very modest up to this time and there is a lot that could be done in this area. The Governor as well as State legislators could be more aggressive in the message they are putting out there. The same holds true for the utilities. Streamlining the permitting process for solar water heating would certainly have a very positive effect. Implementation of solar water heating technologies on State, County, schools and local government facilities is essential. This both has a positive impact on operating costs as well as giving positive signals to the general population. The news media could also be proactive in promoting renewable energy. Options here would be to give renewable energy installations more press. Again, this concept of positive signals would not cost much money but could potentially be a major factor in achieving the potential of this technology.

Respondent 4: Identifying all the potential applications would give developers and others a reason to get interested. This could include looking at the Navigant PV study, which evaluated roof areas in Wisconsin. The impact that could occur if progressive building codes were adopted that required use of solar water heating as a permit requirement or at point of sale of existing building.

Quantitative Questions

1. Program Impacts

Respondent 1:

Program Component	Rank (1 being highest)	% of importance during the next 4 years (2009-2012)	% of importance during the following 5 years (2013-2017)
Financial incentives	2	50	50
Consumer information	3	12	12
Project facilitation	6	16	6
Training of industry professionals	4	10	10
Industrial economic development	5	7	7
Regulatory and legislative policy support	1	15	15
TOTAL		100%	100%

Respondent 2:

Program Component	Rank (1 being highest)	% of importance during the next 4 years (2009-2012)	% of importance during the following 5 years (2013-2017)
Financial incentives	1	50	45
Consumer information	3	5	10
Project facilitation	4	10	5
Training of industry professionals	2	20	10
Industrial economic development	6	5	10
Regulatory and legislative policy support	5	10	20
TOTAL		100%	100%

Respondent 3:

Program Component	Rank (1 being highest)	% of importance during the next 4 years (2009-2012)	% of importance during the following 5 years (2013-2017)
Financial incentives	1	50	40
Consumer information	3	10	10
Project facilitation	2	20	25 **
Training of industry professionals	5	10	10
Industrial economic development	6	*	5
Regulatory and legislative policy support	4	10	10
TOTAL		100%	100%

* This will happen naturally as the other factors mature. Industry will respond to demand. Programs like Focus on Energy helps create demand.

** The easy applications will come first. The harder ones will require more work.

Respondent 4:

Program Component	**Rank (1 being highest)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Financial incentives	1	40	30
Consumer information	5	5	5
Project facilitation	4	10	10
Training of industry professionals	3	10	10
Industrial economic development	6	5	5
Regulatory and legislative policy support	2	30	40
TOTAL		100%	100%

2. Impacts of Barriers

Respondent 1;

Barrier	**Rank (1 being the greatest)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Low buy-back rates consistently applied statewide	4	20	20
High cost of equipment/installation	5	10	10
Expensive/difficult local permitting processes	1	30	25
Low awareness among local officials	2	10	15
Low awareness among potential adopters	3	10	10
Lack of trained installers	6	10	10
Reliability of available equipment/components	7	10	10
TOTAL		100%	100%

Respondent 2:

Barrier	**Rank (1 being the greatest)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Absence of production tax credit	8		
High cost of equipment/installation	1	90	75
Expensive/difficult local permitting processes	6		
Low awareness among local officials	7		
Low awareness among potential adopters	3	5	15
Lack of trained installers	2	5	15
Reliability of available equipment/components	4		
NIMBYism – what about not in their own yard'ism?	9		
Lack of market for green credits	5		
Transportation costs	10		
TOTAL		100%	100%

Respondent 3:

Barrier	**Rank (1 being the greatest)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
High cost of equipment/installation	1	30	30
Expensive/difficult local permitting processes	6	5	5
Low awareness among local officials	4	7	7
Low awareness among potential adopters	2	17	16
Lack of trained installers	5	10	7
Reliability of available equipment/components	9	3	3
NIMBYism	10	2	2
Lack of market for green credits	7	5	7
Transportation costs	8	5	8
Availability of/competition for fuel	3	16	15
TOTAL		100%	100%

Respondent 4:

Barrier	**Rank (1 being the greatest)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
High cost of equipment/installation	1	48	43
Expensive/difficult local permitting processes	3	7	10
Low awareness among local officials	5	6	5
Low awareness among potential adopters	2	15	10
Lack of trained installers	6	5	3
Reliability of available equipment/components	4	10	8
NIMBYism	9	1	5
Lack of market for green credits	7	2	5
Lack of coordination within supply chain	9	2	5
Availability of/competition for fuel			
Other Barrier (specify): Aesthetics	7	4	6
TOTAL		100%	100%

3. Installation Estimates

Respondent 1:

Scenario	**Therms installed within 4 years (2009-2012)**	**Therms installed within following 5 years (2013-2017)**	**kWs installed within the next 4 years (2009-2012)**	**kWs installed within following 5 years (2013-2017)**
Current program levels and barrier reduction efforts (status quo)	1 million	2-3 million		
Optimal program implementation	1.5 million	3-4 million		
Optimal support in reducing barriers	3 million	6-7 million		
Total optimal level (program support and barrier reduction)	5 million	10 million		

Respondent 2:

Scenario	Therms installed within 4 years (2009-2012)	Therms installed within following 5 years (2013-2017)	kWs installed within the next 4 years (2009-2012)	kWs installed within following 5 years (2013-2017)
Current program levels and barrier reduction efforts (status quo)	40,000	50,000		
Optimal program implementation	50,000	55,000		
Optimal support in reducing barriers	50,000	55,000		
Total optimal level (program support and barrier reduction)	55,000	75,000		

Respondent 3:

Scenario	Therms installed within 4 years (2009-2012)	Therms installed within following 5 years (2013-2017)	kWs installed within the next 4 years (2009-2012)	kWs installed within following 5 years (2013-2017)
Current program levels and barrier reduction efforts (status quo)	228,184	729,598	51,725	85,672
Optimal program implementation	358,750	4,632,724	54,336	98,082
Optimal support in reducing barriers	358,750	4,632,724	54,336	98,082
Total optimal level (program support and barrier reduction)	2,278,000	378,351,000	683,400	113,050,300

Notes on table above:
This is conservative and is dependant on factors that are unknown at this time. If the federal government embarks on an aggressive program to reduce greenhouse gas emissions as well as to create significant jobs, these numbers could triple. We have seen growth rates in European countries in excess of 700% where the particular federal government embarked on an aggressive solar thermal program (Spain instituting mandatory solar thermal on all new construction). Another unknown that potentially may have a large impact on this market is the commercialization of space cooling systems powered by solar thermal energy systems. If this technology is successfully brought to market as anticipated, then this will significantly add to the numbers above. I believe it is impossible to separate program and barrier reduction scenarios. Many components of the program address reducing barriers. If there were only 3 options (status, program/barrier, optimal, I would fill in the table differently.

Respondent 4:

Scenario	**Therms installed within 4 years (2009-2012)**	**Therms installed within following 5 years (2013-2017)**	**kWs installed within the next 4 years (2009-2012)**	**kWs installed within following 5 years (2013-2017)**
Current program levels and barrier reduction efforts (status quo)	240,000	960,000		
Optimal program implementation	320,000	1,200,000		
Optimal support in reducing barriers	400,000	1,600,000		
Total optimal level (program support and barrier reduction)	480,000	2,000,000		

Large-Scale Wind (> 100 kW to 15 MW)

Qualitative Questions

1. Describe briefly and generally how you characterize this renewable technology in terms of geographic and seasonal applicability, specific physical barriers or constraints, and the scope of physical adoption opportunities that remain.

Respondent 1: Wind turbines will provide WI with most of its renewable energy into the future. While WI does not have the best or most wide spread wind sites, turbine and rotor technologies have improved to make it economical in the state. The best wind sites are located in the eastern part of the state on the Niagara Escarpment which has been the target of the developers of larger projects. Once the best sites have been "picked over" by the large projects other developers will shift to trying to locate smaller sized projects to serve local loads. The seasonal variations in wind are well known in WI; low in the summer, better most other times. The "physical barriers" now are manifested in the resistance of some individuals towards allowing wind turbines in their viewshed. These people state they are "for renewable energy, just not here" and go on about health and safety concerns as the reason for locating projects in North Dakota or somewhere else where they can't see them. This results in townships or counties spending countless hours reading material, recreating wind turbine siting ordinances and running up high attorney fees. While many of these local officials claim they want local control over wind turbines, it is suspected that none signed on to their positions with this in mind and that they would rather have these siting ordinances handled at the state level. It is hoped that the installation of the new wind farms in the state will provide people an opportunity to go and visit these locations and observe firsthand wind turbines in operation. This will allow them to judge for themselves what is fact and fiction in the wind turbine discussions held in public forums. Once people see that the sky is not falling it is expected that the opposition ranks will diminish. Another possible impediment is the revenue uncertainty townships/counties face by hosting wind turbines. Each developer is likely to strike their own deal. It is possible that if local jurisdictions could generate a more certain revenue through the ownership of local wind projects, many of the opposition hurdles would fall.

Respondent 2: This technology can be used throughout the state, although it is more difficult to site in urban, suburban, and exurban residential areas. The main non-siting constraint is wind speed, but this may be less of a constraint in the future as fossil fuel energy becomes more expensive. It is less productive in summer than in other seasons, but it may increasingly matter less because of the increasing adoption of PV solar by the same entities that adopt wind. Wind and solar have a natural seasonal diversity in availability which is beneficial if both are used. I see this size range as the community wind range, with likely adopters ranging from large farms to schools to local governments to federal installations to industrial companies and the state. While this market has not yet developed, I predict it will in the next five years to a very significant degree. Potential market size within five years exceeds 100 MW and could ultimately approach 1000 MW.

Respondent 3: Wind is very good fit for a renewable resource in Wisconsin, there are many windy sites in the state in open ag areas near transmission lines. Wind generates more energy in winter or at night when utilities have less power needs, but it also can offset carbon emissions at these times. Barriers are mainly permitting, and power sales. Permitting is tough at times with local government, a vocal minority can easily stop a project by having Town or County adopt restrictive ordinances (even though WI has a law on the books to try and prevent this). Power sales is issue that WI utilities are buying inexpensive wind out of state, or building and owning their own projects in State, so it can be difficult to get power sales contract at price needed to get project financing

2. Describe briefly and qualitatively, in your opinion, what market sectors are currently and potentially adopting this technology and why, and what adoption trends will look like within the next four years (2009-2012), and within the following five years (2013-2017).

Respondent 1: For the range of 100kW to 15MW, the market is still early adopters. There are a couple of schools that are investigating turbine installations or that have made the commitment to install turbines on the low end of the range. WPPI is trying to install a few community-based wind projects in the 4.5 to 7.5MW size. Other than that the wind market is dominated by the larger wind farms owned by the developer or investor-owned utility. In the near future, communities and more schools will look to own their own wind turbines. In addition, larger businesses may also add a wind turbine to enhance their corporate image and help them compete in a carbon constrained market. This adoption will take time with the present incentives and legislation. Hopefully, during that time those rules will change so that the following five-years will see much greater growth.

Respondent 2: All six of the above-referenced market segments (question 1 response) are within the client groups I have worked with on wind assessments in the last few years. I believe all of these segments are ripe to adopt wind technology on this scale, basically all for the same reason, to reduce their carbon footprints. In the case of large farms, there may be an additional reason, to control wind development on the farm and in the neighborhood, to avoid ceding control of such development to large wind developers and wind farms. In the next four years, I expect to see at least 50 MW of community wind development, in the following four at least 200 MW.

Respondent 3: Mainly large wind farms these days with electricity sold to large utilities, trend seems to be that more utilities will build and own wind projects now that they can use the Federal tax credit. Longer term there is interest by a few companies to own wind and get value from carbon emissions credits.

3. In your opinion, what are the primary barriers to the growth of the industry for this technology in Wisconsin? Characterize whether programmatic or barrier reduction approaches will be needed to address each one.

Respondent 1: The primary barriers to growth were stated in the answer to question one – local turbine siting rules create the largest uncertainty for someone looking to install wind turbines. While some of these local ordinances have been drafted in short order with favorable siting rules, many are written to basically place a moratorium on wind turbine installation. Why should there be a difference from community to community, town to town or county to county? Are people in one location more sensitive or susceptible than others? I doubt it. Again, as much as the local officials say they want to have local control out, they are likely quietly hoping the state takes it out of their hands so that they can focus their attention on taking care of roads and voting on subdivisions. Programmatic changes are likely required to resolve this. Another barrier is the revenue that townships and counties receive when a wind project is installed. For the projects over 50MW the rules are legislated about what percentage of the Payment In Lieu Of Taxes goes where. Even though it is spelled out, the towns and counties often feel as though they should be getting the larger share. It seems the best resolution may be to split it 50-50. For projects <50MW, there are no requirements on the project owner to provide any revenue, however most try to follow the rules above. If wind turbine siting reform does not happen, then perhaps the percentage split should go in favor of the group that has the siting control. That is, if the county has the authority to approve projects they should get the larger percentage and vice versa. A better programmatic approach might be for the State of Wisconsin to adopt Community-Based Energy Development (C-BED) legislation that is similar to the State of Minnesota. This legislation encourages local ownership of wind projects which would help lower the opposition barriers ("Your own cows don't stink" philosophy). This legislation also requires utilities to develop and offer C-BED tariffs. These front-end loaded tariffs help the project get a better return in the early years. Since January 2007, Minnesota has installed 115MW of C-BED wind projects. Minnesota has legislated that wind projects 5MW and greater are sited at the state level. However, there is a provision that projects 5-25MW can be sited by the county provided the county notices the Public Utility Commission that they will assume the permitting responsibility. This requires a county resolution. The county may adopt more restrictive standards than the PUC, although it is unknown if any have. Finally, projects smaller than 5MW are subject to local jurisdiction and review. It is interesting to note that MN has not experienced the opposition to wind development that WI has. In short, it seems that more of a programmatic (legislative?) approach might work best to alleviate the barriers and encourage smaller projects. Once these barriers are down and demand for wind technology increases, it is likely that economic development would follow to support those demands. Another barrier is the availability of wind turbines in the range defined above. There are a few remanufactured wind turbines on the low end of the range, but those are nearly as expensive as new ones of similar size. Perhaps there is a market niche opportunity there to get more used turbines relocated. The megawatt class wind turbines are just as hard to find as most are tied up in large frame agreements with the major developers or financiers of large wind projects. There are few manufacturers that will provide turbines in smaller quantities with responsible lead times. These material shortages require barrier reduction approaches to solve.

Respondent 2: A major barrier is the failure of Focus on Energy to support this sector to a significant degree, even though this sector is potentially bigger—and can produce wind energy at lower net cost per kWh--than the small wind sector which Focus does support.
I believe Focus should support community wind. A program approach could solve this problem. Another barrier has been the failure of wind manufacturers to make intermediate-scale wind technology and small numbers of commercial-scale wind turbines available to the community-wind sector. I believe this will start changing in 2009 for reasons related to the global financial crisis. That will reduce the demand for private debt-financed projects and wind turbines in general, and community wind in general and publicly-owned and financed wind in particular will surge, in part due to strong support from the Obama Administration and in part due to greatly increased availability of turbines for community wind projects. Another major barrier is low buyback rates and low electricity rates offered by utilities. The major corrective required here is to shake up the entrenched rate-making sub-bureaucracy at the PSC with some new people who have had a few new ideas in the last 30 years.

Respondent 3: Permitting and Power Sales. Permitting issue can be solved with some legislation introduced last year (permitting siting reform). Power Sales is tougher, a feed-in tariff type system would solve the problem. Permitting is tough at times with local government, a vocal minority can easily stop a project by having Town or County adopt restrictive ordinances (even though WI has a law on the books to try and prevent this). Power sales is issue that WI utilities are buying inexpensive wind out of state, or building and owning their own projects in State, so it can be difficult to get power sales contract at price needed to get project financing.

4. In your opinion, what trends in the current energy economy or environmental legislation arena will prove advantageous or disadvantageous to this technology?

Respondent 1: Clearly climate change policy will drive this technology (and others). If businesses will be accountable for their carbon emissions they will need to find ways to offset those emissions. Generating some of their energy needs with wind generated energy will help. The cost of energy continues to rise which will help renewable technologies compete against fossil fuel generated energy. It is unknown the extent to which the cost of fossil fuels will rise as result of any climate change legislation, but this too will help renewables. Unfortunately, as energy costs rise it will cost more to produce wind turbines and the parts that go into them. This could result in business development to build needed parts locally to avoid long transportation costs. It is possible that some companies may not want to install and own wind turbines and rather just buy credits out on the market instead.

Respondent 2: The renewable energy infrastructure initiatives of the new administration could be highly advantageous. The reduction of demand for wind-farm turbines likely in 2009 due to the global economic slowdown and tight credit markets will free up supply of turbines for community wind projects very significantly. There may be new entrants in the wind turbine business in intermediate size ranges. This could also be advantageous. Turbine prices will likely drop in 2009, which will be advantageous. Less clear in terms of whether it will happen in 2009 is an increase in fossil fuel prices due to global agreement or U.S. legislation requiring reductions of GHG emissions. While this would stimulate the community wind market, it may not happen in 2009 due to general economic distress. Also disadvantageous to community wind is the PSC's continued foot-dragging in the area of electric rate reform.

Respondent 3: Carbon emissions trading will help immensely, industry needs to have more weight put on the electricity being carbon free.

5. Are there any other factors that need to be considered within the context of studying achievable potential for this technology in Wisconsin?

Respondent 1: There should be some type of economic incentives to get wind technology businesses to locate in WI. The State of Iowa has this down pat and has lured a number of businesses to their state in the last 12-months.

Respondent 2: Utilities need to be more uniformly pro-active in encouraging community wind. Too many utilities are not supportive. If utilities had a financial incentive to foster community wind to reduce their carbon footprints, it would be easier for those projects to get developed. Utilities need to get a "piece of the action," some reward, for fostering community wind. All renewable energy installations are inhibited by hide-bound utility rate regulation which under prices electric energy and over prices peak demand. The PSC needs to clean house and start over in its rate regulation of gas and electric rates and to adopt new, higher, energy rates which give consumers clearer signals to reduce electric use. As part of reform, buyback rates should be increased also. Rate reform will foster community wind.

Respondent 3: There is a lot of windy, developable areas in ag fields in this state. There are a number of projects partially developed that could be constructed if a few barriers (permitting and/or power sales) are addressed. This energy is reasonable in price, falling in the 7-9 cent/kwhr range for a 20 year fixed price. Coal is cheaper but no one is assessing it the environmental and health costs. Wind provides WI with a lot, it gives tax revenues, landowner payments, construction jobs, operations jobs, to all the folks that need that in this State.

Quantitative Questions

1. Program Impacts

Respondent 1:

Program Component	**Rank (1 being of highest importance)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Financial incentives	2	35	25
Consumer information	5	4	8
Project facilitation	4	7	13
Training of industry professionals	6	4	9
Industrial economic development	3	10	20
Regulatory and legislative policy support	1	40	25
Other program component (specify)			
TOTAL		100%	100%

Respondent 2:

Program Component	**Rank (1 being of highest importance)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Financial incentives	1	60	50
Consumer information	3	10	15
Project facilitation	4	5	3
Training of industry professionals	6	1	2
Industrial economic development	5	4	2
Regulatory and legislative policy support	2	25	28
Other program component (specify)			
TOTAL		100%	100%

Respondent 3:

Program Component	**Rank (1 being of highest importance)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Financial incentives	2	4	4
Consumer information	3	3	3
Project facilitation			
Training of industry professionals			
Industrial economic development			
Regulatory and legislative policy support	1	1	2
Other program component (transmission infrastructure)	4	2	1
TOTAL		100%	100%

The ones above I did not rank play no role in whether large wind moves forward.

2. Impacts of Barriers

Respondent 1:

Barrier	**Rank (1 being the greatest)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Low buy-back rates consistently applied statewide	3	20	15
Absence of production tax credit	4	10	5
Low net metering rate	6	9	15
Expensive/difficult local permitting processes	1	20	5
Low awareness among local officials/neighborhood associations	9	1	5
Low awareness among builders and developers	N/A	-	2
Low awareness among consumers	8	1	5
High cost of equipment/installation	5	8	10
Lack of trained installers	10	1	10
Shortage of equipment/components	7	9	15
NIMBYism	2	20	8
Accessibility to/inadequacy of transmission/distribution system	11	1	5
TOTAL		100%	100%

Respondent 2:

Barrier	**Rank (1 being the greatest)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Low buy-back rates consistently applied statewide	1	50	45
Absence of production tax credit	9	0	0
Low net metering rate	2	30	40
Lack of market for green credits	4	4	3
Expensive/difficult local permitting processes	8	1	1
Low awareness among local officials/neighborhood associations	11	0	0
Low awareness among consumers	N/A		
High cost of equipment/installation	5	3	2
Lack of trained installers	10	0	1
Shortage of equipment/components	6	1	2
NIMBYism	3	10	5
Accessibility to/inadequacy of transmission/distribution system	7	1	1
TOTAL		100%	100%

Respondent 3:

Barrier	**Rank (1 being the greatest)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Low buy-back rates consistently applied statewide	2	1	2
Absence of production tax credit	3	6	
Lack of market for green credits	5	5	4
Expensive/difficult local permitting processes	1	2	3
NIMBYism	4	4	5
Accessibility to/inadequacy of transmission/distribution system	6	3	1
TOTAL		100%	100%

3. Installation Estimates

Respondent 1:

Scenario	**kW installed within the next 4 years (2009-2012)**	**kW installed within the following 5 years (2013-2017)**
Current program levels and barrier reduction efforts (status quo)	25,000	30,000
Optimal program implementation	60,000	80,000
Optimal support in reducing barriers	40,000	60,000
Total optimal level (program support and barrier reduction)	100,000	140,000

The above table is based on the wind project size ranging between 100kW and 15MW.

Respondent 2:

Scenario	**kW installed within the next 4 years (2009-2012)**	**kW installed within the following 5 years (2013-2017)**
Current program levels and barrier reduction efforts (status quo)	50,000	200,000
Optimal program implementation	100,000	400,000
Optimal support in reducing barriers	100,000	400,000
Total optimal level (program support and barrier reduction)	150,000	600,000

Respondent 3:

Scenario	**kW installed within the next 4 years (2009-2012)**	**kW installed within the following 5 years (2013-2017)**
Current program levels and barrier reduction efforts (status quo)	300,000	750,000
Optimal program implementation	400,000	1,000,000
Optimal support in reducing barriers	650,000	1,500,000
Total optimal level (program support and barrier reduction)	750,000	1,750,000

Biomass Thermal, Commercial/Institutional Scale

Qualitative Questions

1. Describe briefly and generally how you characterize this renewable technology in terms of geographic and seasonal applicability, specific physical barriers or constraints, and the scope of physical adoption opportunities that remain.

Respondent 1: The smaller scale systems the technology is well developed on the bio-refinery level break through are still needed. The wood biomass supply infrastructure is the major barrier. The lack of current information on wood residues within all industries and in some areas of the state the lack of collection structure to obtain the material from the woods.

Respondent 2: Wood fuel resources are generally more available in the northern part(s) of WI. For commercial/institutional facilities, the heating demands are much higher during the winter months. Because the heating demand is seasonal, it is difficult to justify capital costs for a wood combustion system that is used seasonally (unless wood fuel is available for free or low cost). Many facilities have a perception that a wood combustion system will be difficult to operate and will be much less convenient than a natural gas system. Costs savings have to be significant to make up for the additional O&M effort.

Respondent 3: Wood combustion projects are located across Wisconsin, but are more predominant in Northern Wisconsin and clustered around the wood industry (primary and secondary wood processing). For those companies with continual heating needs (kilns) there is little or no seasonal variation in the heating demand. Those using wood for space heating only would be utilizing the wood resource during the fall, winter and spring. The major barriers or constraints are related to wood supply (for those not generating their own wood waste) and characteristics (size, moisture content, etc.). Many of these issues are being addressed by technology vendors or incorporated into ongoing initiatives such as the biomass commodities exchange that is under development.

Respondent 4: Applicable in all rural areas of Wisconsin, in rural communities and in some applications in larger cities. Mostly available for space heating with some potential for electricity, water heating, cooling and a combination of everything. Major barriers include: immature fuel extraction, process and delivery infrastructure; low value of biomass energy compared to other biomass fiber markets; competition from non-energy and other energy (utility scale electricity and biofuels) markets and the need for emission control in the combustion process. Large opportunity for adoption if barriers are overcome and the proper price signals are in place.

Respondent 5: I view this as viable 12 months of the year. Some sources are more difficult to harvest during warmer months (e.g., marshlands access have to be frozen). Some big barriers are 1) capital investment needed to make a fuel switch; 2) transportation logistics for supply of biomass as well as removal of residues (ash); 3) environmental permitting aspects due to fuel switching, and the unintended consequences that may result, such as BACT or MACT requirements; 4) a huge barrier to this will be future cost, and that is due to the increasing demand for biomass in utility generation portfolios associated with RPS, while at the same time industrial users will want to increase biomass utilization to “go green” and the result will be price pressure making this far more costly than fossil fuels.

2. Describe briefly and qualitatively, in your opinion, what market sectors are currently and potentially adopting this technology and why, and what adoption trends will look like within the next four years (2009-2012), and within the following five years (2013-2017).

Respondent 1: House holds and small industrial users are adopting the use of wood pellets and the availability of wood pellet is improving. The larger users such as utilities and pulp industry are proceeding with the development of major projects that could strain the ability of the forest to supply if all of the projects occur. Most of these projects are in the planning stage put to occur by 2013.

Respondent 2: Facilities/personnel experienced with wood handling have adopted this technology. I expect that future adoption trends will be driven primarily by natural gas prices.

Respondent 3: The adoption of the technology will depend on natural gas prices and wood availability. Many companies are either retrofitting/expanding existing wood systems with better control technologies or putting in new systems. Currently, there are a few CHP systems being discussed, but it is likely that this sector will expand in the future (late in the first time period or in the second time period).

Respondent 4: The major market sectors include rural commercial and industrial customers with heat demands: includes heat processing (drying and steam needs), space heating needs and smaller commercial markets with a desire to reduce their carbon footprint. These customers are driven by expectations of significant energy cost savings and are able to justify high up front costs and constant O&M costs by fuel savings per therm of 50% or more, depending on the biomass fuel being used and the fossil fuel being replaced. Some customers have their own fuel source or are very close to a source of low cost biomass supplies. Adoption trends in the next four years could be in the 15-30% increase, depending on natural gas cost trends. 15% per year growth for natural gas well head prices in the $6-9 per million Btu range and 30% per year growth for well head prices in the $9-12 per million range. Growth in the 2013-2017 period could be more modest due to more biomass competition, which will increase biomass energy costs and limit traditional biomass supplies. However, higher prices are likely to promote new technologies and supply production innovation, leading to increased supply and utilization. Decreasing supplies of natural gas and increasing natural gas prices will also encourage utilization of alternatives, including biomass. I suggest an annual growth range of 10% to 20% for the 2013-2017 period.

Respondent 5: For sure, I see pulp and paper and electric utility sectors adopting this technology due to RPS, climate change initiatives, etc. The trends in the time periods shown will largely be influenced by the current economic crisis plus the degree to which national and global pressures are put on climate change.

3. In your opinion, what are the primary barriers to the growth of the industry for this technology in Wisconsin? Characterize whether programmatic or barrier reduction approaches will be needed to address each one.

Respondent 1: Current wood residue supply information the last study done was 1994. This needs to be replicated. The Wisconsin Timber Product Output study for 2008 will start in January which will provided needed numbers from the forest industry but the lack of wood residue information from all industries. The amount of wood being ground by communities also needs to be tracked. Resources are need to track this so the information is available for companies wanting to use this material.

Respondent 2: There is no easy way for facilities considering wood combustion to assess availability and costs for wood fuel. Low natural gas prices could also be a significant barrier.

Respondent 3: Some of the most significant barriers will be related to wood supply and the ability to cost-effectively extra wood resources from the forest. However, the wood products industry is also fairly low margin and under stress economically, so large capital investments are often problematic. This has been one of the biggest benefits of having funding from Focus to reduce the capital costs. For larger CHP projects, significant financial resources are required (which may be outside the realm of Focus), but Focus still plays in integral role in moving projects forward in the other industry sectors.

Respondent 4: The barriers were described in question 1: immature fuel extraction process and delivery infrastructure, low value of biomass energy compared to other biomass markets, competition from non energy and other energy (utility scale electricity and biofuels) markets and the need for emission control in the combustion process. The current Focus program is based on a catalyst, multi-dimension, barrier reduction theory, which applies programmic and barrier reduction methods simultaneously. For all of these barriers, a combination of programmatic, market signals activities and time will lead to the barriers being overcome or at least mitigated.

Respondent 5: The primary barriers are cost of capital improvements, cost of transportation from source to user, and cost of consequences of environmental permitting (PSD, Title V, BACT, etc.).

4. In your opinion, what trends in the current energy economy or environmental legislation arena will prove advantageous or disadvantageous to this technology?

Respondent 1: For Wisconsin policies that would incentives the integration of renewable energy production would provide the greatest impact. If you put the electrical generation or transportation fuels in conjunction with a pulp or paper mill you get 4 times more jobs maintained and a 10 fold increase in the economic impact to the state economy over a standalone facility. On the other hand if you provide to many incentives to the stand alone facility you run the risk of loosing some or all of the 37,000 paper industry jobs.

Respondent 2: Low natural gas prices will be a disadvantage. Carbon footprint legislation or State mandate regarding carbon management could be advantageous. Grant money available from the State is also advantageous.

Respondent 3: The lack of a renewable portfolio standard for thermal energy (natural gas) is a major barrier to moving this forward in a larger way. It should also be noted that natural gas prices are very low at the moment, which reduces the economic incentive to install a large wood system. However, this situation is not likely to remain this way for long.

Respondent 4:
Energy economy
- Advantageous: need for replacement to natural gas, high natural gas prices, carbon policy that could reward biomass as a closed loop, no net carbon gain technology, technological advances and innovation, market diffusion
- Disadvantageous: high capital cost, O&M costs, lack of loaning mechanisms (this is recent), competition from other markets including the RPS and biofuels
Environmental legislation

- Advantageous: Carbon cap and trade
- Disadvantageous: PM 10 problems, potential additional cost of pollution abatement equipment, transaction costs of permits.
- Costs and limitations to comply with sustainable harvesting permitting

Respondent 5: Competition for forest and agricultural resources will I believe prove disadvantageous. Environmental legislation will force only "compliance" driven changes.

5. Are there any other factors that need to be considered within the context of studying achievable potential for this technology in Wisconsin?

Respondent 1: We must get a handle on what is available and where it is and what it costs for this to make an impact.

Respondent 2: State forest lands have traditionally been managed for timber and/or pulp wood….not as a fuel source. With the timber and paper industry in decline, more emphasis should be placed on using wood and forestland as a fuel source.

Respondent 3: Perhaps the largest issue moving forward will be related to wood availability. Even one or two large CHP projects has the potential to utilize a significant amount of the available wood, which would then require better resource extraction/utilization of forest resources. Excel Energy is proposing an expansion of their wood use at the Ashland facility by several hundred thousand tons annually, which may be the first real test in terms of how much wood is available and at what price.

Respondent 4: Potential for very high growth of energy crop yields. Use of IC engines to use simplified gasification processes for CHP applications. Absorption cooling potential

Respondent 5: Yes – namely, the impact of price volatility in fossil fuels as a driver in motivating renewable energy projects. Example, when natural gas is $14/mmBtu there is high motivation, when it drops to $8/mmBtu, industry focuses on actually being able to keep their doors open for another quarter of a year.

Quantitative Questions

1. Program Impacts

Respondent 1:

Program Component	**Rank (1 being highest)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Financial incentives	4	20	30
Consumer information	6	10	10
Project facilitation	3	10	10
Training of industry professionals	5	10	10
Industrial economic development	1	30	30
Regulatory and legislative policy support	2	20	10
TOTAL		100%	100%

Respondent 2:

Program Component	**Rank (1 being highest)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Financial incentives	1	30	25
Consumer information	5	10	10
Project facilitation	2	25	25
Training of industry professionals	4	10	10
Industrial economic development	6	10	10
Regulatory and legislative policy support	3	15	20
TOTAL		100%	100%

Respondent 3:

Program Component	**Rank (1 being highest)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Financial incentives	1	60	60
Consumer information	7		
Project facilitation	2	25	25
Training of industry professionals	6		
Industrial economic development	3	10	5
Regulatory and legislative policy support	5		
Other program component (specify) Thermal RPS	4	5	10
TOTAL		100%	100%

Respondent 4:

Program Component	**Rank (1 being highest)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Financial incentives	1	35	30
Consumer information	7	10	10
Project facilitation	3	10	10
Training of industry professionals	4	10	10
Industrial economic development	6	5	10
Regulatory and legislative policy support	2	20	20
Other program component (specify) -R&D	5	10	10
TOTAL		100%	100%

Respondent 5:

Program Component	**Rank (1 being highest)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Financial incentives	1	35	35
Consumer information	6	5	5
Project facilitation	4	5	5
Training of industry professionals	5	5	5
Industrial economic development	3	15	15
Regulatory and legislative policy support	2	35	35
TOTAL		100%	100%

2. Impacts of Barriers

Respondent 1:

Barrier	**Rank (1 being the greatest)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Lack of coordination within fuel supply chain	2	20	20
Transportation costs	3	30	30
Availability of/competition for fuel	1	50	50
TOTAL		100%	100%

Respondent 2:

Barrier	**Rank (1 being the greatest)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Low awareness among builders and developers	5	5	0
Low awareness among consumers	7	0	0
High cost of equipment/installation	1	40	50
Expensive/difficult local permitting processes	8	0	0
Low awareness among local officials/neighborhood associations	9	0	0
Lack of trained installers	10	0	0
Lack of market for green credits	6	5	0
NIMBYism	11	0	0
Shortage of equipment/components	12	0	0
Lack of coordination within fuel supply chain	3	10	10
Transportation costs	4	10	10
Availability of/competition for fuel	2	30	30
TOTAL		100%	100%

Respondent 3:

Barrier	**Rank (1 being the greatest)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Low awareness among builders and developers	9		
Low awareness among consumers	8		
High cost of equipment/installation	1	40	40
Expensive/difficult local permitting processes	10		
Low awareness among local officials/neighborhood associations	12		
Lack of trained installers	7		
Lack of market for green credits	5	10	
NIMBYism	11		
Shortage of equipment/components	6		
Lack of coordination within fuel supply chain	2	30	20
Transportation costs	4	10	10
Availability of/competition for fuel	3	10	30
TOTAL		100%	100%

Respondent 4:

Barrier	**Rank (1 being the greatest)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Low awareness among builders and developers	7	4	3
Low awareness among consumers	11	2	1
High cost of equipment/installation	1	29	24
Expensive/difficult local permitting processes	5	6	6
Low awareness among local officials/neighborhood associations	11	2	1
Lack of trained installers	10	2	2
Lack of market for green credits	8	4	5
NIMBYism	9	4	5
Shortage of equipment/components	5	6	6
Lack of coordination within fuel supply chain	3	10	8
Transportation costs	4	8	9
Availability of/competition for fuel	2	24	30
TOTAL		100%	100%

Respondent 5:

Barrier	Rank (1 being the greatest)	% of importance during the next 4 years (2009-2012)	% of importance during the following 5 years (2013-2017)
Low awareness among builders and developers	10	1	1
Low awareness among consumers	11	1	1
High cost of equipment/installation	3	10	10
Expensive/difficult local permitting processes	4	20	10
Low awareness among local officials/neighborhood associations	12	1	1
Lack of trained installers	9	1	1
Lack of market for green credits	5	2	1
NIMBYism	6	2	1
Shortage of equipment/components	8	1	1
Lack of coordination within fuel supply chain	7	1	3
Transportation costs	2	30	35
Availability of/competition for fuel	1	30	35
Other Barrier (specify):			
Other Barrier (specify):			
TOTAL		100%	100%

3. Installation Estimates

Respondent 1:

Scenario	Therms installed within the next 4 years (2009-2012)	Therms installed within the following 5 years (2013-2017)
Current program levels and barrier reduction efforts (status quo)	500,000 dry tons?	200,000 dry tons?

I do not know with the data I have currently if we can support current and proposed demand now. And we do not have the infrastructure in the woods to get it out at this time. Also you can convert the number to therms. 8,000 btu's per dry pound of wood.

Respondent 2:

Scenario	Therms installed within the next 4 years (2009-2012)	Therms installed within the following 5 years (2013-2017)
Current program levels and barrier reduction efforts (status quo)	8,000,000	10,000,000
Optimal program implementation	9,000,000	11,000,000
Optimal support in reducing barriers	12,000,000	15,000,000
Total optimal level (program support and barrier reduction)	13,000,000	16,000,000

Respondent 3:

Scenario	Therms installed within the next 4 years (2009-2012)	Therms installed within the following 5 years (2013-2017)
Current program levels and barrier reduction efforts (status quo)	4,000,000	6,000,000
Optimal program implementation	6,000,000	8,000,000
Optimal support in reducing barriers	6,000,000	8,000,000
Total optimal level (program support and barrier reduction)	8,000,000	10,000,000

It should be noted that support of only one small-medium CHP project could have a huge impact on these numbers when compared with the smaller projects that have historically been funded by Focus.

Respondent 4:

Scenario	Therms installed within the next 4 years (2009-2012)	Therms installed within the following 5 years (2013-2017)
Current program levels and barrier reduction efforts (status quo)	6.8 million	16.5 million
Optimal program implementation	9 million	21 million
Optimal support in reducing barriers	10 million	23 million
Total optimal level (program support and barrier reduction)	13.6 million	33 million

Residential-Scale Solar Hot Water

Qualitative Questions

1. Describe briefly and generally how you characterize this renewable technology in terms of geographic and seasonal applicability, specific physical barriers or constraints, and the scope of physical adoption opportunities that remain.

Respondent 1: This technology is useful statewide, but tends to work better during the summer. Shading and roof condition are the primary physical barriers, as the majority of neighborhoods have not been planned from a solar production prospective, and the roof structure was probably not designed to accommodate the additional load. Finding a pipe chase and room for the storage tank are secondary to solar access. The scope can be considered at almost 100% adoption in new construction, if mandated, as solar access can be part of the plan. The retrofit market will depend on the age of the neighborhood, as tree growth and improved building codes over time make younger neighborhoods more accessible. The other specific physical barrier with this technology is that there needs to be a hot water load on-site, meaning if you don't use much, you don't gain much from the system. Production is also best in the summer, when you arguably use the least amount of hot water in a home.

Respondent 2: Residential solar water heating systems are applicable in all parts of Wisconsin. The climate in Wisconsin dictates that all solar water-heating systems (hereinafter called "systems") be of a design that protects them from freezing. The Focus program only allows proven system types that accomplish this goal (pressurized glycol antifreeze or drainback [with glycol] systems). There is also a small opportunity for seasonal solar water heating systems in Wisconsin. This type of system would be applicable to the recreation industry, specifically for solar water heating at campgrounds (both public and private) as well as for seasonal homes. The largest physical barrier of installation of systems is the availability of appropriate collector mounting locations. Solar collectors must be placed in a location that receives at least 4 hours of direct sunlight throughout the year. Solar thermal collectors are somewhat forgiving in that partial shading does not significantly reduce output. Nevertheless, shading from trees and adequate roof space for collectors is a significant barrier. On the other side of the coin, most locations do have enough room for proper collector mounting.

2. Describe briefly and qualitatively, in your opinion, what market sectors are currently and potentially adopting this technology and why, and what adoption trends will look like within the next four years (2009-2012), and within the following five years (2013-2017).

Respondent 1: Currently: the green-minded and those looking to control their heating bills. The next 4 years: the above, plus new construction. As solar electric prices decline, solar hot water will lose its edge as being the most cost-effective (unless there is a significant water heating load within the home). Hopefully, there will be some sort of solar mandate on new construction within the next presidency. Adoption will occur in this sector otherwise because it will help builders, developers gain an edge in what will be left of this market, and it is equipment that should be considered during the design of the roof so that the appropriate structural integrity is established.
2013-17: the above, plus multifamily with shared water-heating systems, particularly the new construction market.

Respondent 2: The subject of this questionnaire revolves around residential solar water heating systems. Residential systems have been occurring diversly throughout the State. In areas where both the general atmosphere is more positive about renewable energy systems and where the local utilities are more positive about renewable energy systems, we see accelerated growth in the market. A good example of this is in the WE Energies territory of the State. Within the last 18 months WE Energies has begun to put out positive messages regarding solar water heating and we have seen a surge of interest in that territory directly correlating with the positive message put forth by the utility. Overall the residential solar water heating market in Wisconsin has seen rather slow growth recently. Residential systems, like most renewable energy systems have a high upfront cost. We see surges in sales whenever fossil fuel prices spike upward. Also, like other renewable energy technologies, when fossil fuel prices rise, so do the costs of the raw materials used in constructing solar water heating systems. I predict continued moderate growth in the residential market over the next 4 years. The extension of the residential federal tax credits for residential solar water heating systems was a critically important factor in ensuring this growth. A stable Focus incentive program will also help this anticipated growth. A lot depends on the support both the State and the Federal Government give to solar water heating, the more support, the greater the growth. I would note that while some renewable technologies benefited by the removal of the $2,000 cap on federal tax credits, solar water heating did not receive that benefit in the recent legislation. That will slow growth potential. The rate of growth will be dependant on two factors, fossil fuel prices and potential increases in incentives. If fossil fuel prices rise strongly, we will see a surge in solar water heater installations. The same is true if incentive levels are raised. On the other side of the coin, if financing is harder to get, then installations will not rise as quickly. I see the long term growth as very positive because I anticipate steady and potentially drastic fossil fuel price increases in the long run, especially the cost of natural gas.

3. In your opinion, what are the primary barriers to the growth of the industry for this technology in Wisconsin? Characterize whether programmatic or barrier reduction approaches will be needed to address each one.

Respondent 1: Understanding of our building, plumbing code applications within this industry and with permit officials/ inspectors. Barrier reduction approaches possible via training, but this issue will require considerable time and research that may not be at the contractor's expense. We will likely have to take this one on as a program, state-wide.

Respondent 2: As long as this country continues to subsidize the fossil fuels industry, solar water heating will only see modest growth. As mentioned above, fossil fuel pricing is a major driver in the adoption of this technology. Certainly, the acceptance of the concept of global climate change has had a positive effect in the acceptance of the technology. Another barrier to growth in rural areas is the fact that Focus no longer gives incentives for systems offsetting propane gas water heaters. In the past Focus did incentivize these systems and when the policy changes in 2007 we saw a marked decrease in rural installations. This would be a programmatic issue that I would suggest be changed. In these uncertain economic times with the ensuing tightening of the credit industry, this may pose a significant barrier. A programmatic solution to this barrier may be to offer attractive financing options. It is interesting to note that financing programs through Focus have not been successful in the past, but note that those were times of easy and plentiful financing options. A successful model to address this barrier is a program in San Francisco where the cost of the solar water heating system is financed by the city and annual payments are added to the annual property taxes for that location. The financing stays with the property and is transferable if/when the property is sold. Long term financing typically creates a positive cash-flow situation making heating water with solar less expensive than using fossil fuels. Another barrio has been in the supply chain. Wisconsin, like the rest of the country, has suffered because the solar water heating industry is still immature. We have not had adequate qualified installers and the plumbing industry has not adequately supplied/stocked the specialized solar products needed by the solar industry. In addition, the plumbing suppliers do not have adequate knowledge to successfully supply these products to the industry. This is changing in Wisconsin and we see a surge currently in the plumbing industry seeking training. The plumbers and HVAC installers are leading this surge but the plumbing wholesale houses are still severely lacking. The Focus program has been aggressive in training these people, but there is still a long way to go in creating a somewhat mature industry. The limited Focus budget has hampered our ability to be very aggressive in this area. There has also been a reluctance among plumbing wholesalers to enter this market. More aggressive tactics could improve this situation.

4. In your opinion, what trends in the current energy economy or environmental legislation arena will prove advantageous or disadvantageous to this technology?

Respondent 1: Federal tax credit extension will provide some additional interest, but because it is capped at $2000, the space heating market will not improve. The legislation didn't consider that systems installed in northern climates will be larger and will require significant freeze protection, and can cost 30-50% more to install.
The current economy will limit growth in this market, undoubtedly.

Respondent 2: As mentioned above, as long as fossil fuels are subsidized as heavily as they currently are, the solar thermal industry will suffer. We can see in other parts of the world where this is not the case that solar water heating is much more successful. For instance, in most of Europe where fossil fuel prices are higher than here that solar water heating is literally everywhere. It is unrealistic to expect solar thermal to compete in the energy marketplace if it is not subsidized as aggressively as it's competition (fossil fuels). If we had a level playing field, then we would see solar thrive. Therefore, as long as fossil fuels are subsidized as they are today, we need aggressive subsidies for the solar industry too in order to compete. In addition, if we intend to jump-start the aggressive growth of this industry, then we need to increase subsidies for the solar industry to a greater extent. In order for a subsidizing program to be successful in the long term, we heed oversight of the industry. Fortunately, this is a major component of the Focus program. This oversight will ensure that the systems being subsidized are of high quality. As mentioned above, if the $2,000 cap was removed from the federal tax credit legislation for solar water heating systems, then this would have significant positive impact on the solar water heating industry in the country as a whole, including here in Wisconsin.

5. Are there any other factors that need to be considered within the context of studying achievable potential for this technology in Wisconsin?

Respondent 1: Natural gas prices. Large portion of the state does not qualify for these incentives because propane is used for heating.

Respondent 2: We need more positive signals from both the utility sector and the State government to see aggressive growth in this sector. We have seen where positive signals from utilities have happened that more systems have been installed. This tactic would have a very small cost but would have a major impact on growth. The signals have been very modest up to this time and there is a lot that could be done in this area. The Governor as well as State legislators could be more aggressive in the message they are putting out there. The same holds true for the utilities. Streamlining the permitting process for solar water heating would certainly have a very positive effect. Implementation of solar water heating technologies on State, County, schools and local government facilities is essential. This both has a positive impact on operating costs as well as giving positive signals to the general population. The news media could also be proactive in promoting renewable energy. Options here would be to give renewable energy installations more press. Again, this concept of positive signals would not cost much money but could potentially be a major factor in achieving the potential of this technology.

Quantitative Questions

1. Program Impacts

Respondent 1:

Program Component	**Rank (1 being highest)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Financial incentives	1	40	30
Consumer information	5	10	15
Project facilitation	6	15	5
Training of industry professionals	3	25	25
Industrial economic development	4	5	20
Regulatory and legislative policy support	2	5	10
TOTAL		100%	100%

Respondent 2:

Program Component	**Rank (1 being highest)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Financial incentives	1	50	40
Consumer information	3	10	10
Project facilitation	2	20	25 **
Training of industry professionals	5	10	10
Industrial economic development	6	*	5
Regulatory and legislative policy support	4	10	10
Other program component (specify)			
TOTAL		100%	100%

* This will happen naturally as the other factors mature. Industry will respond to demand. Programs like Focus on Energy helps create demand.
** The easy applications will come first. The harder ones will require more work.

2. Impacts of Barriers

Respondent 1:

Barrier	**Rank (1 being the greatest)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Absence of production tax credit	4		
High cost of equipment/installation	1	65	55
Expensive/difficult local permitting processes	3	20	5
Low awareness among local officials	6	10	5
Low awareness among potential adopters	2	10	5
Lack of trained installers	7	5	5
Reliability of available equipment/components	5		25
NIMBYism	11		
Lack of market for green credits	8		
Lack of coordination within fuel supply chain	9		
Transportation costs	10		
TOTAL		100%	100%

Respondent 2:

Barrier	**Rank (1 being the greatest)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
High cost of equipment/installation	1	30	30
Expensive/difficult local permitting processes	6	5	5
Low awareness among local officials	4	7	7
Low awareness among potential adopters	2	17	16
Lack of trained installers	5	10	7
Reliability of available equipment/components	9	3	3
NIMBYism	10	2	2
Lack of market for green credits	7	5	7
Transportation costs	8	5	8
Availability of/competition for fuel (fuel costs)	3	16	15
TOTAL		100%	100%

3. Installation Estimates

Respondent 1:

Scenario	**Therms installed within 4 years (2009-2012)**	**Therms installed within following 5 years (2013-2017)**	**kWs installed within the next 4 years (2009-2012)**	**kWs installed within following 5 years (2013-2017)**
Current program levels and barrier reduction efforts (status quo)	20,000	25,000		
Optimal program implementation	30,000	40,000		
Optimal support in reducing barriers	30,000	40,000		
Total optimal level (program support and barrier reduction)	40,000	55,000		

Respondent 2:

Scenario	**Therms installed within 4 years (2009-2012)**	**Therms installed within following 5 years (2013-2017)**	**kWs installed within the next 4 years (2009-2012)**	**kWs installed within following 5 years (2013-2017)**
Current program levels and barrier reduction efforts (status quo)	44,975	109,420	517,257	856,726
Optimal program implementation	56,489	225,579	543,367	980,828
Optimal support in reducing barriers	56,489	225,579	543,367	980,929
Total optimal level (program support and barrier reduction)	109,440	9,112,320	1,313,280	109,347,840

Notes on table above:
This is conservative and is dependant on factors that are unknown at this time. If the federal government embarks on an aggressive program to reduce greenhouse gas emissions as well as to create significant jobs, these numbers could triple. We have seen growth rates in European countries in excess of 700% where the particular federal government embarked on an aggressive solar thermal program (Spain instituting mandatory solar thermal on all new construction). Another unknown that potentially may have a large impact on this market is the commercialization of space cooling systems powered by solar thermal energy systems. If this technology is successfully brought to market as anticipated, then this will significantly add to the numbers above.

Small-Scale Wind (20 kW or smaller)

Qualitative Questions

1. Describe briefly and generally how you characterize this renewable technology in terms of geographic and seasonal applicability, specific physical barriers or constraints, and the scope of physical adoption opportunities that remain.

Respondent 1: Technology will produce energy year-round, with more in the Spring and Fall, and least in July and August. Geographic limitations are significant, as wind resource varies considerably by site. Significant physical barriers include above noted siting, as well as government siting restrictions, and need for adequate space.

2. Describe briefly and qualitatively, in your opinion, what market sectors are currently and potentially adopting this technology and why, and what adoption trends will look like within the next four years (2009-2012), and within the following five years (2013-2017).

Respondent 1: Adopters are looking for cost savings and many also have environmental and climate change concerns. Adoption should increase to some extent with rising energy costs over the entire time frame.

3. In your opinion, what are the primary barriers to the growth of the industry for this technology in Wisconsin? Characterize whether programmatic or barrier reduction approaches will be needed to address each one.

Respondent 1: Primary barriers are system hardware and installation costs, site requirements and restrictions, and lack of installers and ability for them to be profitable.

4. In your opinion, what trends in the current energy economy or environmental legislation arena will prove advantageous or disadvantageous to this technology?

Respondent 1: Trend disadvantages are more locations restricting implementation, and rising equipment costs. Trend advantage is rising utility rates.

5. Are there any other factors that need to be considered within the context of studying achievable potential for this technology in Wisconsin?

Respondent 1: Can large companies be engaged that would help to reduce equipment costs, and local companies to reduce shipping costs.

Quantitative Questions

1. Program Impacts

Respondent 1: Assumed important issues in first period are resolved in the second, and so have little to no importance.

Program Component	**Rank (1 being of highest importance)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Financial incentives	1	25%	20%
Consumer information	4	10%	30%
Project facilitation	6	5%	10%
Training of industry professionals	5	10%	15%
Industrial economic development	3	25%	15%
Regulatory and legislative policy support	2	25%	10%
TOTAL		100%	100%

2. Impacts of Barriers

Respondent 1:

Barrier	**Rank (1 being the greatest)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Low buy-back rates consistently applied statewide	5	5%	10%
Lack of market for green credits	6	5%	10%
Expensive/difficult local permitting processes	2	20%	5%
Low awareness among local officials/neighborhood associations	4	10%	5%
Low awareness among builders and developers	NA	5%	NA
Low awareness among consumers	7	5%	15%
High cost of equipment/installation	1	30%	20%
Lack of trained installers	9	5%	15%
Shortage of equipment/components	8	5%	15%
NIMBYism	3	10%	5%
TOTAL		100%	100%

3. Installation Estimates

Respondent 1: Program/barrier split unclear.

Scenario	**kW installed within the next 4 years (2009-2012)**	**kW installed within the following 5 years (2013-2017)**
Current program levels and barrier reduction efforts (status quo)	1,800	2,500
Optimal program implementation	2,000	3,500
Optimal support in reducing barriers	2,200	3,000
Total optimal level (program support and barrier reduction)	2,500	4,000

Biomass Thermal, Residential Scale

1. Describe briefly and generally how you characterize this renewable technology in terms of geographic and seasonal applicability, specific physical barriers or constraints, and the scope of physical adoption opportunities that remain.

Respondent 1: Best net energy utilization of biomass belongs in thermo energy.

Respondent 2: Non-residential small scale wood combustion projects are located across Wisconsin in more rural areas, principally due to the emergence of the pellet fuel industry and pellet availability. Most small scale projects are for space heating and are seasonal in nature. The major barrier to widespread adoption has been the relatively long paybacks when compared to heating with natural gas, especially with the recent falling prices. The adoption of the pellet burning stoves has also been delayed due to development of more equipment vendors.

2. Describe briefly and qualitatively, in your opinion, what market sectors are currently and potentially adopting this technology and why, and what adoption trends will look like within the next four years (2009-2012), and within the following five years (2013-2017).

Respondent 1: Potential grows but is directly related to fossil fuel costs which either spur or limit implementation.

Respondent 2: The widespread adoption of the technology will depend on price differential between natural gas and wood chips or pellets. A potential emerging market may be for small scale institutions, such as public schools. These institutions are able to implement projects with longer financial payback periods than commercial or industrial facilities.

3. In your opinion, what are the primary barriers to the growth of the industry for this technology in Wisconsin? Characterize whether programmatic or barrier reduction approaches will be needed to address each one.

Respondent 1: Access to biomass on a level playing field. Both electric & liquid development /utilization are subsidized.

Respondent 2: Large investments are required to manufacture wood pellets. Consequently, new production facilities have been slow to develop. Demand for the wood pellets depends on the savings realized. The grants offered by Focus on Energy have helped with the economics of installing systems and moving the market.

4. In your opinion, what trends in the current energy economy or environmental legislation arena will prove advantageous or disadvantageous to this technology?

Respondent 1: Due to above, equivalent incentives need to be developed.

Respondent 2: Fluctuations in the price of natural gas are a disadvantage to this technology. Small businesses want to be confident in the economics and with falling prices, decisions are delayed. A commitment to saving thermal energy, similar to portfolio standards for electrical power generation, would be helpful.

5. Are there any other factors that need to be considered within the context of studying achievable potential for this technology in Wisconsin?

Respondent 1: Long term biomass sustainable management on fed, state, county, private & crp lands that are logical & not overly cumbersome.

Respondent 2: Wood availability and industries (paper) competing for the same resources.

Quantitative Questions

1. Program Impacts

Respondent 1:

Program Component	Rank (1 being highest)	% of importance during the next 4 years (2009-2012)	% of importance during the following 5 years (2013-2017)
Financial incentives	1	50	50
Consumer information	2	30	30
Regulatory and legislative policy support	3	20	20
TOTAL		100%	100%

Respondent 2:

Program Component	Rank (1 being highest)	% of importance during the next 4 years (2009-2012)	% of importance during the following 5 years (2013-2017)
Financial incentives	1	50	50
Consumer information	5		
Project facilitation	3	25	25
Training of industry professionals	6		
Industrial economic development	2	25	25
Regulatory and legislative policy support	4		
Other program component (specify)	7		
TOTAL		100%	100%

2. Impacts of Barriers

Barrier	**Rank (1 being the greatest)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Low awareness among builders and developers	2	20	10
Low awareness among consumers	3	15	10
High cost of equipment/installation	1	40	30
Expensive/difficult local permitting processes	4	10	5
Low awareness among local officials/neighborhood associations		5	
Lack of trained installers			10
Shortage of equipment/components	5		10
Lack of coordination within fuel supply chain	5	5	5
Transportation costs	5	5	5
Availability of/competition for fuel	5		5
Other Barrier (specify): Sustainable raw material equal access.	5		10
TOTAL		100%	100%

Respondent 2:

Barrier	**Rank (1 being the greatest)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Low awareness among builders and developers	5	10	10
Low awareness among consumers	6		
High cost of equipment/installation	1	40	35
Expensive/difficult local permitting processes	9		
Low awareness among local officials/neighborhood associations	12		
Lack of trained installers	4	10	10
Lack of market for green credits	11		
NIMBYism	10		
Shortage of equipment/components	8		
Lack of coordination within fuel supply chain	7		

Barrier	**Rank (1 being the greatest)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Transportation costs	3	10	10
Availability of/competition for fuel	2	30	35
TOTAL		100%	100%

3. Installation Estimates

Respondent 2:

Scenario	**Therms installed within the next 4 years (2009-2012)**	**Therms installed within the following 5 years (2013-2017)**
Current program levels and barrier reduction efforts (status quo)	200,000	300,000
Optimal program implementation	300,000	400,000
Optimal support in reducing barriers	400,000	500,000
Total optimal level (program support and barrier reduction)	500,000	600,000

Small-Scale Solar Electric (20 kW or smaller)

Qualitative Questions

1. Describe briefly and generally how you characterize this renewable technology in terms of geographic and seasonal applicability, specific physical barriers or constraints, and the scope of physical adoption opportunities that remain.

Respondent 1: PV is an appropriate and promising technology for the entire state of Wisconsin. The scope of physical adoption opportunities for small-scale PV is similar to the potential in many other states, with some limitations due to more snow and tree cover and higher latitude than southern states. Urban areas in Wisconsin offer more opportunities for rooftop and parking lot applications. PV can help meet summer peak demand which is more of a concern here, while there is very little electric heating load in winter.

Respondent 2: I am only qualified to speak to this technology in terms of how it performs in Southern WI. In terms of seasonal applicability, my systems produce 45% of their annual energy during June, July, August and September, from November through February they produce 20%, with the remaining months producing 35%. The only physical barriers or constraints are shade related. It is imperative that these projects are out of the shade. The scope of physical opportunities is unlimited. This technology can be applied on every new home once orientation is addressed. Any business with a flat roof should also be able to apply this technology.

Respondent 3:
• Geographic applicability – very similar statewide, see slide 2 of the attached document
• Seasonable applicability – better in the summer and mid-days, see slides 3 and 4 of the attached document
• Specific physical barriers
a. Orientation impact energy production, should be roughly south facing, see slide 5
b. for conventional solar module generates about 1200 kWh/85 sq. ft. of modules, see slide 2
c. Shading (snow and obstacle) impacts energy production
d. If building mounted
    i. structure must be able to support weight of system and snow loading
    ii. if mounted over roofing, roofing should have over 10 years remaining life
• Scope of physical adoption opportunities
a. Basically unlimited if ground mounted applications are included
b. A 20 kW solar electric system will require about 1,700 sq feet of roof area or less. Today average systems sizes being installed in WI are about __ kW (slide 6 of the attached document)
c. A GIS study of the city of Milwaukee shows large potential of suitable roof areas (that study is attached) but it includes only the large commercial roof tops.
d. There is a very significant residential rooftop resource

2. Describe briefly and qualitatively, in your opinion, what market sectors are currently and potentially adopting this technology and why, and what adoption trends will look like within the next four years (2009-2012), and within the following five years (2013-2017).

Respondent 1: Commercial and residential building applications, community and municipal buildings. These are the market sectors that we see offering the most opportunity for future expansion of PV, with the possible addition of farms, depending on what policy mechanisms exist to encourage the growth of the PV industry in Wisconsin. These sectors are leaders for PV development because the technology is best suited for small, distributed systems on houses and other buildings. Large heavy industrial users, many of whom compete in a global market with lower cost countries, are too price sensitive to readily adopt PV without incentives. In our view, the next four years will see PV costs decrease as the market develops, spurring expansion into new sectors and greater numbers of systems installed, depending (in part) on state and federal energy policies.

Respondent 2: I see environmentally concerned home and business owners installing this technology. It will remain this way until the simple paybacks reach 2 years. I use 2 years because that is the benchmark most used by the business community. If paybacks are not lowered to the 2 year threshold for business and perhaps 5 years for residential, I don't see any customers other than environmentally concerned ones installing this technology regardless of the time frame you use.

Respondent 3:
Sectors

- Residential, single and multi family (under ~10 unit buildings)
- Small commercial
- Medium and large commercial doing smaller systems to leverage public education and public relations benefits
- Other small but potentially significant markets
    - Off grid energy systems such as sign lighting systems, security lighting, monitoring systems (weather, traffic, water levels, garbage can fill status, etc.)
    - Telephone solar electric systems that maintain charge for their battery back up systems
    - Etc.
- Why do they adopt technology
    - RES and Small Commercial
        - Today mainly installed due to ethics (Prius crowd)
        - Future will increasing be installed because it is also cost effective
            - Navigant Study shows cost effectiveness around 2015 for We Energies customers (see Slide 6)
            - Cost effectiveness depends on three key variables: system cost, cost of power and incentives
            - Different customer classes are eligible for different incentives (Slide 7)
        - The average single family home requires a 8 kilowatt solar electric system.
    - Medium and Small Commercial
        - Today mainly installer for educational and PR benefits
        - When systems become cost effective, these owners will tend to go to larger systems (greater and 20 kW)
- Rates of installations
    - The WI solar electric market has been growing at about 80 per year for the last six years (see Slide 5)
    - I would assume these rates would continue, unless the current economic slow down extend into 2010. If this become a real depression than who knows.

        - It will be interesting to watch federal action in this space during the first months of the new administration. (Could investments in renewable and solar electric infrastructure be accelerated to get the economy moving?)
    - As Utilities will soon be eligible for Federal solar tax credits they could become large players (for example owning solar electrics systems on their customers roof tops (or land) and leasing that space from their customers)
        - Will first happen, after ~2010, with projects that are well over 20 kW (rather they are likely to be in the 300 to 2000 kW range)
        - Then after ~2014, utilities may lease space (or offer lease to own options) from solar electric systems from homeowners
    - When cost parity is achieved, say 2015, then the market could grow as quickly as providers are available to supply the needed goods and services. An important provider is the finance community – to finance these systems.

3. In your opinion, what are the primary barriers to the growth of the industry for this technology in Wisconsin? Characterize whether programmatic or barrier reduction approaches will be needed to address each one.

Respondent 1: The primary barriers are cost (installation, cost of panels, financing) as well as institutional (available outreach, site assessment, and trained installation assistance). Wisconsin's Focus on Energy program has done a good job of providing information and resources about small PV to utility customers, and we hope that increased funding for Public Benefits will allow that program to expand and reach more potential PV owners. Utilities could be more helpful in providing information to their customers, and financial incentives (buyback rates, grants, rebates) are an important tool.

Respondent 2: The only barrier is economic. Unless the PV industry becomes competitive with the grid or folks can use other people's money to make their projects pay off, this technology will not see mainstream adoption.

Respondent 3:
Price Barrier – will be reduced by

    - Global issue, solved by the global PV industry and global R&D and venture capital
    - Installer efficiency gains will made by local installers as the industry gets increasingly competitive
        - Large national firms are already looking to site in WI, for example REC Solar
    - Long term financing (e.g., rolling system cost into mortgages) and third party ownership (utility or finance company)
        - For large systems review what SunEdison is doing www.sunedison.com
    - New incentives, could be solar renewable credits, carbon credits, R&D support, financing incentives, European-style fed in tariffs, workforce training, Smart grid, etc…
    - Cost of other energy sources
        - This includes transportation fuels when solar is used to charge electric vehicles rather than offsetting convention building loads.

- Institutional Barriers
    - Limit on net metering currently 20 kW – may become problematic as customer's want larger systems

    - A few local zoning departments have been unsure how to respond to solar systems (relatively minor and currently working through this)
    - Can the Focus on Energy incentive program continue to provide cost share in a market that is growing so rapidly. A solar electric program budget of $80 million would co-fund 45 MW of solar electric systems at the current incentive level.

- Market Barriers
    - Sufficient high quality goods and service providers to safely grow the market (again Focus are working on this, for example in 2009 solar electric installer class offering will increase by 200% in 2009 compared to 2008).

- Information Barrier
    - Should be reduced as the numbers of highly qualified providers enter the market
    - Focus on Energy working on initial stages of customer education
        - Fact sheets, call center, site assessor program, conference and workshops, email lists, etc.
    - Customer education should largely be transferred to the industry over the 2012 to 2015 time period.

4. In your opinion, what trends in the current energy economy or environmental legislation arena will prove advantageous or disadvantageous to this technology?

Respondent 1: Increasing capital and fuel costs for fossil and uranium fueled generation makes the relative cost of PV and other renewables much more competitive. Greater public awareness and concern about global warming and clean air and water are already motivating more people to consider clean energy options. Legislation to address global climate change, such as carbon cap & trade, carbon portfolio standards, etc. and the Renewable Portfolio Standard will expand PV opportunities. PV may also have an advantage over other renewable energy sources in that it can be unobtrusive, is quiet, is not thought to kill birds or cause seizures, etc.

Respondent 2: The extension of the federal tax credits will help environmentally concerned people continue to install these projects. If there is implementation of carbon taxes, this should provide an incentive to this technology by raising the grid power price and thus making this technology more economically attractive.

Respondent 3:
Advantageous

- Energy security
- Job creation
- Climate change (carbon trading or carbon taxes)
- Renewable portfolio standards
- Solar meeting share of green power customer’s supply (MGE and WE solar buyback rates)
- Need for the US to maintain it’s high tech leadership role
- Polling shows that people like solar energy over any other energy source

Disadvantageous

- Cost of economic bailout – will funds remain to do other needed Federal programs and what priority is solar or renewables?

5. Are there any other factors that need to be considered within the context of studying achievable potential for this technology in Wisconsin?

Respondent 1: PV innovation in technological development more closely resembles that of the semiconductor and computational industries than to electric generation technologies that have followed progressions in mechanical and chemical engineering fields. For example, conventional Rankine (steam) cycles used in coal and nuclear plants have made only marginal increases in efficiency over the past decades. Also, when comparing the achievable potential for PV the levelized cost of electricity from different sources may be used. Large scale generation currently shows lower levelized costs than PV, but the life expectancy and therefore the amortization timeframe for capital costs for large scale projects is 40 to 50 years. Thus, many of these comparisons assume that there will not be any major developments or rapid technological progress for PV. In fact, the opposite is true: experience has shown that there is likely to be faster technological advancement for PV and other small scale renewables, thus, the achievable potential for PV is likely to be much greater than anticipated.

Respondent 2: There are not any technology barriers, the only barrier is economic.

Respondent 3:
Solar electric technology – the technology is young, many significant technological advances are possible and I believe very likely to reduce cost and improve efficiency over the study period. Game changing events are likely. Several game changes are currently in the process of coming to the market. For one example see nanosolar.com

- The forecasts that I present here are based on assuming a business as usual situation

Solar electric technology will benefit greatly from advances in electricity storage, a smart grid and perhaps by the penetration of electric vehicles. Daytime solar power production and night vehicle charging will tend to flatten utility load shapes.

Quantitative Questions

1. Program Impacts

Respondent 1:

Program Component	**Rank (1 being of highest importance)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Financial incentives	1	50	30
Consumer information	3	15	20
Project facilitation	5	10	10
Training of industry professionals	4	10	10
Industrial economic development	6	5	10
Regulatory and legislative policy support	2	10	20
TOTAL		100%	100%

Respondent 3: Comments:

- In the next four year incentives will encourage installations. And the installations pull along all other program components (i.e., training of professionals, consumer education, policy support, etc.)
- I assume that "Regulatory and legislative policy support" includes all institutional barriers
- Legislative and Regulatory support could offer massive support to the industry but it seems unlikely. For example if the Legislature required electric utilities to generate 5% of their power from solar electric systems. Or the PSCW could change how electric utilities determine solar farm economics, to make them much more competitive sooner.

Program Component	**Rank (1 being of highest importance)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Financial incentives	1	50	30
Consumer information	3	15	25
Project facilitation	5	7	>5
Training of industry professionals	2	15	30
Industrial economic development	6	5	10
Regulatory and legislative policy support	4	8	>5
TOTAL		100%	100%

2. Impacts of Barriers

Respondent 1:

Barrier	**Rank (1 being the greatest)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Low buy-back rates consistently applied statewide	3	10	10
Expensive/difficult local permitting processes	6		5
Low awareness among local officials/neighborhood associations	7		10
Low awareness among builders and developers	2	20	10
Low awareness among consumers	4	10	10
High cost of equipment/installation	1	50	40
Lack of trained installers	5	10	10
Shortage of equipment/components	8		5
NIMBYism	9	0	0
TOTAL		100%	100%

Respondent 3:

Barrier	Rank (1 being the greatest)	% of importance during the next 4 years (2009-2012)	% of importance during the following 5 years (2013-2017)
Low buy-back rates consistently applied statewide	7 will all fill within 18 months	<1%	0
Lack of market for green credits	9	<1%	15%
Expensive/difficult local permitting processes	5	1%	<1%
Low awareness among local officials/neighborhood associations	8	<1%	<1%
Low awareness among builders and developers	4	3%	5%
Low awareness among consumers	3	5%	5%
High cost of equipment/installation	1	80%	25%
Lack of trained installers	6	<1%	5%
Shortage of equipment/components	NA	0	0
NIMBYism	Very minor	0	0
Accessibility to/inadequacy of transmission/distribution system		NA	5%
Other Barrier (specify): Low net metering cap	6	<1%	15%
Lack of trained service providers – financing, engineering, maintenance, loan officers, etc.	2	10%	25%
TOTAL		100%	100%

3. Installation Estimates

Respondent 1:

Scenario	kW installed within the next 4 years (2009-2012)	kW installed within the following 5 years (2013-2017)
Current program levels and barrier reduction efforts (status quo)	15 mw	100 mw
Optimal program implementation	100 mw	500 mw
Optimal support in reducing barriers	20 mw	200 mw
Total optimal level (program support and barrier reduction)	100 mw	600 mw

Respondent 3:

Scenario Residential Solar Electric Projects	**kW installed within the next 4 years (2009-2012)**	**kW installed within the following 5 years (2013-2017)**
Current program levels (50 kW cap) and barrier reduction efforts (status quo)	5 MW	150 MW
Optimal program implementation (removing 50 kW cap and other program caps)	5 MW	150 MW
Optimal support in reducing barriers (I think we are working on barriers in a fairly optimal way now… this assumes the budget to reduce barriers would increase as the program grows) Wisconsin's ability to decrease system cost is minor!	6 MW	155 MW
Total optimal level (program support and barrier reduction)	6 MW	155 MW

Solar Thermal Air

*Qualitative Questions*1. Describe briefly and generally how you characterize this renewable technology in terms of geographic and seasonal applicability, specific physical barriers or constraints, and the scope of physical adoption opportunities that remain.

Respondent 1: This is a small market as compared to either residential solar water and/or space heating systems using hydronic technologies and especially non-residential solar thermal water and/or space heating systems using hydronic technologies. During the 1970's and 80's solar air heating systems were popular. At this time this technology is seeing very little activity. The only area we see activity of any significance is in transpired air systems used to pre-heat make-up air for non-residential applications. This technology is used to provide space heat for buildings. The most successful applications have been with systems that were direct (provided heat only when the sun was shinning, no storage). Heat storage associated with air collectors experienced problems that revolved around air quality because the heat storage systems, typically rock bins and bricks were good mediums for mould growth. These systems work well in all areas of Wisconsin. The collectors were typically vertically mounted on south facing walls so they performed very well during the winter but did not work during the summer when no space heat was needed (no overheating problems). As these systems can be much lower in initial cost than the other solar heating alternatives, the potential is very high overall. They are usually lower cost systems as compared to hydronic based systems but they pose more challenges in installing the balance of system components because they use ductwork instead of copper piping (ductwork is much larger than copper pipe). If this technology is to come back around to play a significant role in the whole solar field, then it will have to reinvent itself. There are very few manufacturers producing this type of product so the industry is in its infancy. However this technology has good potential if heating fuel prices remain high and/or if Focus on Energy would include space-heating systems in its programs.

Respondent 2:

- Solar air heating can be described in two ways: passive solar air heating and active collector air heating.
- Passive solar air heating is the most cost effective application and is called direct solar heating. However, it is most effective when designed into residential applications in the construction of a home with about 10 percent of the floor square footage in south facing windows, which have thermal curtains that can be closed at night, either manually or automatically. Estimates of useful heat are about 0.5 to 1 therm per square foot of window.
- Active solar heating primarily is used in Wisconsin with active solar water heating collectors, where the heat is stored seasonally or in large tanks and run through the floor or through a water to air heat exchanger. I will not comment on this technology in this response as I do not consider myself to be an expert. Active solar heating can also institute the use of air collectors, vents and fans, to provide zone heating or make-up air heating.
- Solar make up air heating is the solar energy application that will be discussed in this response, and there are two technologies that can address a building's heating needs. The collectors may be framed units that are added to a building's façade, or they may integrated into building façade in the south wall. Framed air collectors are similar in size & construction to solar water heating collectors, but the solar derived heat is transferred to the air rather than through a liquid.. Transpired solar consists of pre-heating outside

air through a simple passage of air drawn through metal slits, which is heated by the sun in a vertical or south facing sloped collector. Most of the applications use a product made by Solar Wall, which holds several patents on the concept. The technology is limited to winter applications in buildings that have a high degree of outside air due to the nature of their business: laboratories with fume hoods, hospitals, animal shelters, schools, community centers, athletic facilities, places with engine exhaust, agriculture operations, etc. The technology is essentially unknown in the state and has one known application in the State of Wisconsin, at UW-Green Bay's Mary Coffrin Hall. Another south side wall application has been recently been funded at the City of Stevens Point Air Port Hanger. A roof top application will also be supported at the Glenwood City Elementary school.

- The major barrier to adoption is lack of information about the technology, how it works and its cost effectiveness. Another barrier to transpired solar technology is the patent held by one company on the technology. The inventors have patents on the idea and the design.
- There appears to be a large potential for cost effective applications although I have not seen an analysis of the potential.

2. Describe briefly and qualitatively, in your opinion, what market sectors are currently and potentially adopting this technology and why, and what adoption trends will look like within the next four years (2009-2012), and within the following five years (2013-2017).

Respondent 1: This technology is applicable for both residential and non-residential applications. The biggest opportunity for this technology is for heating warehouses and shops where consistent temperatures are not required. These facilities typically have large south facing walls that have few windows that are excellent candidates for wall-mounted collectors. Because virtually all collectors available today are modular, this can work well when there are no obstructions on the walls that would restrict collector installation. As mentioned above, these systems are typically set-up to dump heat into a building whenever it is sunny. This can pose problems if a consistent temperature inside the building is mandatory. This is not the case in warehouses and many shops.

Respondent 2:

- There is essentially no adoption of this technology in the state.
- The appropriate markets are ID'ed above: laboratories with fume hoods, hospitals, animal shelters, schools, community centers, athletic facilities, places with engine exhaust, agriculture operations, etc.
- It will take many years of dynamic demonstration and information dissemination for this technology to catch on to any significant level.
- There could be an annual doubling of applications for the period in this forecast before this technology starts to make a dent in energy consumption. An annual doubling rate would produce 32 operational systems by 2012 and about 1,000 applications by the end of 2017.

3. In your opinion, what are the primary barriers to the growth of the industry for this technology in Wisconsin? Characterize whether programmatic or barrier reduction approaches will be needed to address each one.

Respondent 1: Residential buildings typically have a large number of doors and windows on all walls, especially south facing walls, so mounting standardized collectors is difficult because there is usually just not enough room for the collectors (typically 4'x8' each). In the 1970's and 80's there were companies that manufactured site-assembled collectors. These site assembled collectors were custom designed for each building so they could be fabricated to go around windows and doors. There are no manufacturers that I am aware of at this time that offers this type of product. Therefore, the biggest barrier for residential applications of this technology is the lack of manufacturers and products that are adaptable to residential homes. The major barrier for non-residential applications is the lack of affordable collectors. The products that are on the market today are only available from small manufacturers and are not taking advantages of mass manufacturing (high prices). Another barrier is the lack of customer knowledge about this technology as well as a lack of qualified installation contractors offering this technology. Certainly a major barrier is the fact that Focus on Energy offers no programs or incentives for space heating of any kind. Focus did offer a special grant recently (fall 2008) specifically targeted toward systems that preheat make-up air for commercial buildings. This grant generated modest interest. A barrier to growth in the transpired collector sector is the fact that one company holds the patent on the concept of transpired collectors. With only one manufacturer of this product, there is no competition in the marketplace. If Focus on Energy would include both information and incentives for space heating systems, then I am confident that this technology would see significant growth in Wisconsin.

Respondent 2:

- Lack of information on the technology
- Lack of cost competitiveness due to a monopoly in the design.
- Lack of installers and lack of training for installers.
- Lack of performance data from Wisconsin applications
- Not eligible for the ITC
- No standards for equipment

4. In your opinion, what trends in the current energy economy or environmental legislation arena will prove advantageous or disadvantageous to this technology?

Respondent 1: If Focus on Energy would include this technology in it's programs and incentives, then we could see a significant increase in activity in this technology. This technology is eligible for the federal tax credits, so with the addition of support from Focus on Energy, I believe this technology would grow significantly. Right now there is essentially no promotion of this technology in Wisconsin. Another opportunity for the advancement of this technology would be some sort of support to attract or help a start-up manufacturer here in Wisconsin for this type of collector. This type of collector does not require sophisticated manufacturing. These are relatively simple collectors. I manufactured site assembled air collectors during the 1980's and was very successful. In that ear there was state support of this technology as well as federal support. I'm sure that if Focus would support the technology, then it would grow significantly.

Respondent 2:

- Advantageous
    a. Increased gas costs
    b. Lack of natural gas availability
    c. Possible regulations calling for mandatory solar for identified applications
    d. LEED standards which rate renewable energy higher than current ratings
- Disadvantages
    a. Added first costs with out reducing the need for a back-up

b. Not eligible for the IRS Investment Tax Credit

5. Are there any other factors that need to be considered within the context of studying achievable potential for this technology in Wisconsin?

Respondent 1: As stated above, this technology will never have the impact that solar hydronic heating systems will have, but nonetheless this technology has the potential to offset a significant amount fossil fuel that is currently used for space heating.

Quantitative Questions

1. Program Impacts

Respondent 1:

Program Component	**Rank (1 being highest)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Financial incentives	2	30	40
Consumer information	3	10	20
Project facilitation	4	10	20
Training of industry professionals	6	1	5
Industrial economic development	5	9	5
Regulatory and legislative policy support (Focus support)	1	40	10
TOTAL		100%	100%

Respondent 2:

Program Component	**Rank (1 being highest)**	**% of importance during the next 4 years (2009-2012)**	**% of importance during the following 5 years (2013-2017)**
Financial incentives	2	20	20
Consumer information	1	30	10
Project facilitation	2	20	20
Training of industry professionals	4	15	20
Industrial economic development	6	5	10
Regulatory and legislative policy support	5	10	20
TOTAL		100%	100%

2. Impacts of Barriers

Respondent 1:

Barrier	Rank (1 being the greatest)	% of importance during the next 4 years (2009-2012)	% of importance during the following 5 years (2013-2017)
Low awareness among builders and developers	4	17	17
Low awareness among consumers	3	18	18
High cost of equipment/installation	6	5	5
Expensive/difficult local permitting processes	8	3	3
Low awareness among local officials/neighborhood associations	10	1	1
Lack of trained installers	7	5	5
Lack of market for green credits	9	2	2
Shortage of equipment/components	5	10	10
Other Barrier (specify): lack of Focus support	1	20	20
Other Barrier (specify): lack of Focus incentives	2	20	20
TOTAL		100%	100%

Respondent 2:

Barrier	Rank (1 being the greatest)	% of importance during the next 4 years (2009-2012)	% of importance during the following 5 years (2013-2017)
Low awareness among builders and developers	2	20	10
Low awareness among consumers	1	26	15
High cost of equipment/installation	5	10	20
Expensive/difficult local permitting processes	9	5	5
Low awareness among local officials/neighborhood associations	4	10	5
Lack of trained installers	3	15	15
Lack of market for green credits	8	5	5
Shortage of equipment/components	6	8	20
Other Barrier (specify): Aesthetics	7	6	5
TOTAL		100%	100%

3. Installation Estimates

Respondent 1: There is not any current way to track what is happening in this technology currently so there is nothing for me to work with in coming up with numbers for this table within the timeframe available.

Respondent 2:

Scenario	**Therms installed within the next 4 years (2009-2012)**	**Therms installed within the following 5 years (2013-2017)**
Current program levels and barrier reduction efforts (status quo)	30,000 therms	1 million therms
Optimal program implementation	45,000 therms	1.5 million therms
Optimal support in reducing barriers	45000 therms	1.5 million therms
Total optimal level (program support and barrier reduction)	60,000 therms	2 million therms