Corn Furnace Program Feasibility Study for Wisconsin

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Prepared by:

GLOBAL ENERGY OPTIONS
Energy Consulting

Prepared for:

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Executive Summary

Introduction

This study summarizes research related to the potential for corn furnaces and stoves to reduce fossil fuel usage in Wisconsin. National recognition of significant increases in electricity and gas costs to homeowners has prompted renewed interest in investigating options for heating homes in more cost effective and environmentally friendly ways. In 2005 the Governor of Wisconsin and the State Legislature agreed that energy efficiency and renewable energy were a priority for Wisconsin. The resulting legislation, Wisconsin Act 141, included a provision requiring Focus on Energy to commission a feasibility study of corn burning furnaces for Wisconsin homes. This report is the outcome of that directive.

Methodology

A variety of approaches were used to obtain the information summarized in this report. Interviews were conducted with all of the industry stakeholder groups – from manufacturers, to farmers, to homeowners who have installed corn burning furnaces.

In addition, several homeowners who have corn burning furnaces were visited to discuss installation and operating experiences, costs and to obtain billing data for analysis.

While the study was initially focused on corn furnaces (which provide whole house heating), it was expanded to include corn stoves (which provide zone heating) and wood pellets – when it became clear that these were major components of the market.

Findings

This study was charged with summarizing findings relative to three issues:

- A profile of corn furnaces and corn fuel available in Wisconsin
- The net impact of corn furnaces on household electric and natural gas use
- The feasibility of a Focus on Energy initiative to promote corn furnaces

Key findings are summarized below with more detailed discussion in the next section of this report.

With respect to the current market for corn furnaces:

- The corn fueled heater market in Wisconsin is less than 1% of Wisconsin's overall furnace market with approximately:
  - 1,000 – 2,000 furnaces installed to date and
  - 4,000 – 8,000 stoves installed to date
- A typical corn furnace installation is one where the corn unit supplements (rather than replaces) a fossil fuel heating system.
- Corn furnace efficiencies have not been studied but are expected to be between 75% and 85% for current models. We used an average AFUE estimate of 80% for this study.

- The cost of corn is higher than historic levels this year but it is not clear that this is a trend, and it is difficult to predict the future cost of corn and biomass fuels accurately – or fossil fuels for that matter. The current cost of about $4.00 per bushel is lower than past spikes.
- The equipment and accessories to burn corn are readily available from manufacturers and dealerships that sell this equipment are opening in Wisconsin.
- The corn for use in burners is very available and will not limit the use of this technology.
- Corn furnaces cost on average about $5,055 to install while stoves are less expensive at $3,255 on average.
- No conclusive emissions data exist for corn burners as the technology has yet to capture significant market share. As a result, it is difficult to compare emissions from burning corn to burning natural or liquid propane (LP) gas.

With respect to potential energy savings:

- Corn fueled furnaces are cost effective in select situations, such as:
  - when displacing LP gas
  - when the heating use of natural gas is high – as in older, less efficient homes
  - when the cost of corn is low due to abundant local supplies
- The natural gas consumption of a typical older existing home may be reduced by about 900 therms and $506 per year through use of a corn burning furnace
- Corn fueled stoves are more cost effective than furnaces due to their lower cost
- The long term cost effectiveness of corn stoves and furnaces is difficult to predict given volatile prices for both fossil fuels and corn in recent years

With respect to the feasibility of a Focus initiative to promote corn furnaces, it is important to note that Focus is funded through a surcharge on electric and natural gas rates and is charged with reducing electric and natural gas usage, not LP usage.[1] That said, the Focus eligible customers best suited for this technology are those who have high natural gas heating bills. This would include older homes that are large, not well insulated and leaky. The program feasibility test results are tool low and the payback is too long for homes using less heating energy.

The following table summarizes the results of evaluating the cost-effectiveness of four installation options for corn furnaces. The Total Resource Cost Test (TRC) measures cost-effectiveness from a total program and customer cost perspective, while payback is a simple measure of cost-effectiveness from the customer's perspective.[2]

[1] Historically Focus has supported measures that reduce LP usage (because it was assumed that reduced LP usage would ultimately reduce natural gas costs) but it is not clear that this policy will continue in the future under the new funding mechanism. This analysis focuses on the feasibility of reducing natural gas usage rather than LP usage.

[2] A few more scenarios are discussed in the report and significantly more scenarios are discussed in the Technical Research Supplement.

Scenario:	Natural Gas[3]	
	TRC (B/C Ratio	Customer Payback (Years)
Cost Conscious (Existing Home with 80% AFUE furnace) [4]	1.07	5
Cost Conscious (New Home with 92% AFUE furnace)	0.58	17
Value Conscious (Existing Home with 80% AFUE furnace)	0.66	-15
Value Conscious (New Home with 92% AFUE furnace)	0.43	-52

If Focus on Energy were to decide to promote corn burning furnaces, it is reasonable that the program be an information only initiative that would help homeowners understand the pros and cons of installing corn furnaces and stoves and easily assess whether this technology meets their needs. It should be noted, though, that the manufacturers and dealers are already doing consumer education successfully in limited markets. If Focus becomes involved the program it should do this in cooperation with the industry actors. Otherwise Focus might interfere with the existing success and possibly reduce the market share for corn furnaces, thereby losing the environmental benefits inherent in this technology. Focus should commit to increasing the market share for corn burning furnaces or not include this technology in its menu of programs.

These findings are discussed in more detail in this report.

[3] Passing the TRC test requires the benefit-cost ratio to be >1.00.

[4] "Cost Conscious" refers to a situation where the homeowner has access to lower-cost corn from a farmer or grain drying facility. "Value Conscious" refers to instances where the homeowner will likely purchase higher-cost corn from a retail outlet in bags.

Background

On March 17, 2006, the 2005 Wisconsin Act 141 was passed and signed into law. This Act modified a number of energy related statutes in the state, including those pertaining to Focus on Energy, the state's public benefits energy efficiency and renewable energy program. One of the provisions of Act 141 was a requirement that Focus personnel investigate the feasibility of burning corn for the purpose of heating homes. The statute states:

> The department of administration shall conduct a pilot program under section 16.957 (2) (b) 1. b. of the statutes during the winter heating season between November 1, 2006, and March 1, 2007, to determine the feasibility and cost effectiveness of the use of residential space heating equipment in this state that is fueled by biomass, as defined in section 196.378 (1) (a) of the statutes, from corn plants. The Department of Administration shall report to the legislature the results of the pilot program in the report required under section 16.957 (2) (d) 4. of the statutes.

This report was prepared in response to the statutory requirement cited above.

The accelerated inflation of fossil fuel costs in the last couple of years has resulted in many homeowners looking for ways to cut their home heating costs. One of the obvious options is to improve the efficiency of their homes. Another is to investigate using less expensive renewable energy for heating their homes. Corn burning in stoves and furnaces is a newly popular renewable energy option.

Consistent with the scope of work, this study is organized into three sections. The first is a profile of the corn and corn furnace and stove markets. The second discusses the energy and environmental impacts of corn burning for heating homes. The final section discusses the feasibility of Focus promoting corn stoves and furnaces as part of its efforts. This includes recommendations for program design if one is added to the Focus program menu. This report also references a longer supplement, the Technical Research Supplement to the Corn Furnace Feasibility Study in Wisconsin, which provides more technical information about some of the calculations used in this study.

Corn and Corn Burning Appliance Markets

It is important to understand the corn commodity markets and the corn burning appliance markets in the context of the potential for developing a program to increase the penetration of corn burning technologies. The potential of pellet burning appliances for displacing natural gas for heating homes is another important and related issue.

Corn Markets

The price for corn has been relatively stable for the last twenty or more years. This price has primarily floated between $2.00 and $2.50 per bushel with periodic fluctuations as high as $5.55 and below $1.50 per bushel. Obviously the cost effectiveness of burning corn instead of fossil fuels is sensitive to the price of the corn the homeowner can access.

The cost of corn this winter has increased significantly above the long term average of $2.25 per bushel. The price breached $4.00 per bushel in January 2006 – driving some homeowners to cut back on their corn burning this year.

The long term cost of corn (as well as fossil fuels) is uncertain. Price drivers such as the increase in production of corn based ethanol, peak oil possibilities, and potential climate change impacts of corn growing complicate any projection of corn prices into the future. There are also downward pressures on price that suggest the current highs may not be maintained. The federal government is already discussing the possibility of investing in research to develop biomass based ethanol, which might take the place of corn ethanol. Also, there is talk of opening Conservation Reserve Program set-aside land for growing corn. Finally, current prices will ultimately impact supply. If the high corn prices persist, for example, the farmers who use corn as feedstock are likely shift to other types of feed for their cattle, chickens and other livestock. Given this uncertainty, this analysis assumes that corn prices will stabilize at $2.50 per bushel going forward.

Corn Burning Appliances

The corn burning appliances have become increasingly more available in the last couple of years. While corn burning started taking root in the 1990s, it is in the last few years that development of corn burning furnaces has increased to complement corn burning stoves. The accelerated cost of natural gas, LP gas and fuel oil in the last couple of years has increased demand for alternative heating fuels such as corn and wood pellets.

Wood pellet burning has been slowly crowding out cordwood burning since the 1980s. Indeed, most of the appliances sold in recent years to homeowners interested in alternatives to fossil fuels have been pellet stoves. The proliferation of pellet appliances prompted the expansion of this analysis to include wood pellet burning. Only in the last few years has corn burning started challenging the wood pellet market. Several types of equipment are included in this analysis—outdoor corn boilers, indoor corn furnaces as well as corn stoves. More information about these equipment options is included in the Technical Research Supplement to the Corn Furnace Feasibility Study in Wisconsin.

Based on estimates from a variety of sources, there are about 1,000 to 2,000 corn burning furnaces installed in Wisconsin. There are another 4,000 to 8,000 corn burning stoves installed. This data is imprecise because there is a lack of tracking of corn burning appliance sales. The industry is not large enough for anyone to be concerned about sales tracking. More, the corn furnace market is still quite new; most corn furnaces installed in Wisconsin were sold in the last few years. That is in part why there are significantly more stoves.

The Potential Study conducted by Focus last year suggests annual sales of natural gas furnaces in Wisconsin of about 90,000 units per year. Thus the total number of corn burning furnaces and stoves installed in Wisconsin is less than 5% of the annual sales of fossil fueled furnaces. If corn furnaces were to displace even 1% of the natural gas furnaces sold each year, this would be 9,000 units per year, which is probably unrealistic both from a programmatic and manufacturer supply perspective.

The average cost of a corn burning furnace is about $5,055 per year – including the accessories needed for handling and cleaning corn and the ash from the furnace. Where the homeowner chooses to install a stove, the cost for the burner and accessories will be about $3,255. In the situation where the existing furnace or stove is over 20 years old, the cost of the corn furnace could be discounted to about half the investment cost because replacement of the fossil fuel furnace would be delayed significantly. Under this scenario, the incremental cost of the furnace would be considered about $2,530. In other circumstances, though, the corn burning appliance is supplementing an existing fossil fuel furnace and, as a result, the full cost of the corn burning appliance is considered the incremental cost to the homeowner.

It is notable that corn burning technology does not exist in isolation of other biomass burners. Indeed, the industry has a variety of burners for heating the home that will burn corn *or* pellets. This allows the customer to burn the fuel that is both most accessible and most cost effective. And, the industry continues to move toward more flexible biomass burners that will burn a variety of fuels – including cherry pits and other locally available fuels.

Finally it is important to note that corn and wood burning appliances require more maintenance from homeowners than do their fossil fuel counterparts. Homeowners with a natural gas furnace are responsible for occasionally changing the filter while homeowners with a corn burning furnace need to empty ashes, haul corn to the furnace and perform other tasks on a regular basis. While these tasks are not insurmountable, it is the case that even the corn burning sales staff is quick to point out that this technology is not suitable for everyone.

A variety of other cost scenarios are discussed in the Technical Research Supplement to the Corn Furnace Feasibility Study, including scenarios related to burning wood pellets.

Energy and Environmental Impacts of Corn Burning for Heating Homes

Focus interest in the feasibility of corn burning for heating is premised on its charge to reduce electric and natural gas consumption and the environmental impacts associated with that energy usage. Burning corn to heat homes provides benefits to the Focus on Energy program.

Energy and Energy Cost Savings

The natural or LP gas energy savings from corn burning for heating homes is significant. However, while there are significant energy *cost* savings from displacing LP gas, the cost savings from displacing natural gas are limited. The difference is driven by the costs of the fuels.[5] These savings differences result in divergent payback periods from corn burning.

For an existing home that has significant current natural gas use, using a corn burning furnace will displace about 900 therms per year. The same home that is currently using LP gas will see a displacement of about 980 gallons per year. Efficient and new homes that use less gas will see less energy savings.

Given usage reductions and fuel costs, it is easy to understand why homes that burn LP gas are a better candidate for corn burning furnaces and stoves. (In both cases the savings are based on the home having an 80% efficient atmospheric furnace.) An existing home using natural gas and reducing usage by 900 therms per year will save about $506 per year if the corn costs $2.50 per bushel, assuming that corn is purchased at $2.50 per bushel. A similar home using LP gas and saving 980 gallons per year will save about $1,282 per year in heating costs. The payback period for displacing natural gas heat by burning corn where the existing furnace is older will be in the order of *five* years ($2,530/$506). For the same home where LP gas is being displaced the payback period will be about *two* years ($2,530/$1,282). Where the home is new or small and efficient the payback period basically triples in each case – 15 years where displacing natural gas and six years where displacing LP gas.

As noted above, this analysis assumes the corn is purchased at market rates of about $2.50 per bushel. We call this the “cost conscious” market. There is a second market selling corn that we call the “value conscious” market (discussed in the Technical Research Supplement to the Corn Furnace Feasibility Study). This constitutes corn currently being sold in primarily retail outlets for about $4.00 per 40# bag. This is equivalent to about $5.00 per bushel. For homeowners who would use this channel to purchase corn and currently purchase natural gas, the payback periods would be too long to be considered cost effective. However, burning corn at this price may be justified where the homeowner is displacing LP gas at a price of $1.65 per gallon.

[5] The current average price of delivered natural gas to residential customers in Wisconsin is about $1.10 per therm. The current average cost of LP gas is about $1.65 per gallon. This makes LP gas significantly more expensive on a cost per million BTU basis ($18.07 vs. $11.00).

The analysis also assumes an average annual efficiency of corn burning furnaces to be about 80% (AFUE equivalent). This is a weak estimate based on researcher and manufacturer-published estimates of efficiencies. There has been no standardized measurement of corn furnace efficiencies yet – but some promise of imminent effort in this area and in emissions testing.

The following table is a summary of customer perspective payback periods for several of the scenarios analyzed and discussed in the Technical Supplement.

Payback Periods (in years) for Selected Scenarios - FURNACE

Scenario:	Natural Gas			LP Gas		
	Savings	Cost	Payback	Savings	Cost	Payback
Cost Conscious (Existing Home 80%)	$506	$2,528	5	$1,282	$2,528	2
Cost Conscious (New Home 92%)	$293	$5,055	17	$749	$5,055	7
Value Conscious (Existing Home 80%)	-$155	$2,310	-15	$662	$2,310	4
Value Conscious (New Home 92%)	-$90	$4,620	-52	$366	$4,620	13
Wood Pellets (Existing Home 80%)	$1	$2,300	2,412	$778	$2,300	3
Wood Pellets (New Home 92%)	$1	$4,600	8,322	$456	$4,600	10

Payback Periods (in years) for Selected Scenarios - STOVE

Scenario:	Natural Gas			LP Gas		
	Savings	Cost	Payback	Savings	Cost	Payback
Cost Conscious (Existing Home 80%)	$499	$1,628	3	$1,187	$1,628	1
Cost Conscious (New Home 92%)	$289	$3,255	11	$688	$3,255	5
Value Conscious (Existing Home 80%)	-$79	$1,410	-18	$609	$1,410	2
Value Conscious (New Home 92%)	-$46	$2,820	-62	$355	$2,820	8
Wood Pellets (Existing Home 80%)	$57	$1,400	24	$745	$1,400	2
Wood Pellets (New Home 92%)	$33	$2,800	84	$432	$2,800	6

For both tables above: Natural Gas @ $1.10/therm, LP Gas at $1.65 per gallon, Cost Conscious Corn @ $2.50/bu, Cost Value Corn @ $3.57 per 40# bag, Pellets @ $180 per ton. New and Existing in the first column indicate new homes or existing homes. Efficiencies in the first column are assumed for the fossil-fuel furnaces. Cells shaded in green suggest acceptable payback periods.

In summary, there is a limited market for corn burning in homes that currently use natural gas for heating—which is the market that Focus on Energy is charged with serving. And burning wood pellets in homes heated with natural gas is not a good option. While there are better economics for LP gas customers, it is uncertain if future Focus funding will cover homes that are heated with LP gas. This analysis does suggest, though, that there is a good opportunity to reduce LP gas usage.

There are significantly more energy saving scenarios discussed in the Technical Supplement to this report.

Environmental Impacts

Burning corn to heat the home offers some environmental benefits although these are difficult to quantify. No research was found that catalogs the emissions of pollutants from corn burning appliances. Some experts argue that burning corn results in nearly zero CO_2 emissions compared to fossil fuels. These experts would assert that any CO_2 emitted by burning corn is equivalent to the CO_2 absorbed from the atmosphere half a year earlier in growing the corn. While there are CO_2 emissions related to the embodied energy to produce and deliver the corn, there are also CO_2 emission related to extraction, processing and delivery of the displaced natural and LP gas. No research was found to compare these embodied energies. Similarly, it is not possible to quantify the emissions of other pollutants such as SO_2, NO_X and Hg resulting from burning corn, although the deferred emission from the displaced fossil fuels can be quantified. As a result, it is impossible to make an apples-to-apples comparison of emissions.

Feasibility of a Focus on Energy Initiative to Promote Corn Burning Furnaces and Stoves

Focus on Energy staff must consider a variety of issues when deciding whether to include a technology or program in its menu of services. These include conducting a benefit/cost analysis, assessing available budget as well as weighing the economic and environmental benefits of the new opportunity.

In addition to this public benefits perspective, any program design must consider the current market infrastructure and the benefits and costs to homeowners likely to install the targeted technology. This was discussed above, in part, as the payback period. Other benefits and costs beyond the payback are also important and are discussed further in the research supplement.

A plethora of benefit/cost analyses of technology and program scenarios were conducted and are discussed in the research supplement. The most relevant scenarios are discussed here.

For a program to be viable from the public benefits perspective it must have a Focus Total Resource Cost (TRC) benefit/cost ratio of 1.00 or greater.[6] Typically priority is given to programs with the highest benefit/cost ratio so that the program can deliver maximum benefits. With regard to displacing natural gas, only one scenario both has a benefit/cost ratio greater than 1.00 and provides positive environmental benefits. This, then, is the only scenario appropriate for Focus on Energy consideration.

[6] The Focus on Energy program utilizes a Total Resource Cost test to analyze benefit/cost ratios. This test is one of the standard benefit/cost tests utilized in the energy industry and takes into account benefits and costs from both the program and the participant perspective.

The only natural gas scenario that passes the public benefit tests for corn burning furnaces is one where the program targets homes with high heating load and 80% efficient atmospheric natural gas furnaces. However, this expands slightly if the customer is considering installing a corn burning stove. That technology option passes the public benefits tests even if the customer has a 92% efficient condensing furnace as long as they have a high heating load. More, this option becomes even more cost effective if these households have access to corn at below market prices. (This suggests that the ideal corn burning furnace customer is a farmer with an older, inefficient home and his own supply of corn for burning.)

Two other available fuels were analyzed: corn sold in bags at retail and other outlets, and wood pellets. Neither of these options passed the benefit/cost test where natural gas is being burned.

The following table is a summary of customer perspective payback periods for several of the scenarios analyzed and discussed in the Technical Supplement.

Payback Periods (in years) for Selected Scenarios - FURNACE

Scenario:	Natural Gas			LP Gas		
	TRC	CO_2 Reduction	Customer Payback	TRC	CO_2 Reduction	Customer Payback
Cost Conscious (Existing Home 80%)	1.07	10,343	5	2.29	11,967	2
Cost Conscious (New Home 92%)	0.58	5,996	17	1.25	6,937	7
Value Conscious (Existing Home 80%)	0.66	10,343	-15	1.42	11,967	4
Value Conscious (New Home 92%)	0.43	5,996	-52	0.93	6,937	13
Wood Pellets (Existing Home 80%)	0.84	10,343	2,412	1.81	11,967	3
Wood Pellets (New Home 92%)	0.51	5,996	8,322	1.10	6,937	10

Payback Periods (in years) for Selected Scenarios - STOVE

Scenario:	Natural Gas			LP Gas		
	TRC	CO_2 Reduction	Customer Payback	TRC	CO_2 Reduction	Customer Payback
Cost Conscious (Existing 80%)	1.19	10,343	3	2.52	11,967	1
Cost Conscious (New 92%)	0.70	5,996	11	1.49	6,937	5
Value Conscious (Existing 80%)	0.71	10,343	-18	1.51	11,967	2
Value Conscious (New 92%)	0.50	5,996	-62	1.06	6,937	8
Wood Pellets (Existing 80%)	0.92	10,343	24	1.96	11,967	2
Wood Pellets (New 92%)	0.61	5,996	84	1.30	6,937	6

Cells that are shaded green pass the column test. Those not shaded do not pass the test. Passing the TRC test requires the B/C ratio to be >1.00. Passing the emissions test requires a positive CO_2 savings. Passing from the customer perspective requires a payback of 17 years or less. All scenarios show significant CO_2 reductions.

There are significantly more scenarios discussed in the Technical Supplement to this report.

The analysis looked at several program administration and incentive options:

- Awareness (and education) only
- Awareness and rebate
- Awareness complemented with infrastructure support
- Awareness and rebate complemented with infrastructure support

Each of these options, based on the current benefit/cost analysis approach, provided similar results – for displacement of natural gas using corn for heating, the program would target high heating load homes.

While some of the organizations interviewed would like to see a rebate offered, others asserted that unless the rebate is at least 10% to 20% of the cost or the burner, the money could be better spent building awareness.

The 2005 Energy Bill passed by the federal government has a mechanism for providing significant financial incentives for burning biomass. However, this mechanism has not yet been funded. It appears prudent for Focus on Energy to refrain from offering a financial incentive as part of an early program to see if this federal program will be funded. Additionally, it is reasonable that a program should initially be designed without an incentive to test the necessity of an incentive.

Conclusions and Recommendations

It is clear from this research that displacing natural gas by burning corn has limited market potential while there are more opportunities to displace LP gas. Targeting either fuel may provide environmental benefits. The analysis shows that based on the current approach to the public benefits benefit/cost test any program to increase the penetration of corn burning appliances should be targeted to older homes with high heating loads. There is likely a large market of homes in Wisconsin that either are not good candidates for cost effective conservation upgrades or whose owners would rather install a corn burning appliance than try to significantly insulate their homes.

If Focus decides to develop a program to increase the penetration of corn burning appliances, it should target its efforts in rural towns and cities that are served by natural gas. These areas would likely allow access to inexpensive corn.

There are likely tens of thousands of homes in rural Wisconsin which might be good candidates for this technology although it is not clear how many of these homes are eligible for Focus programs.

Properly targeting and managing this currently nascent and complex market will take some special effort in the first couple of years. While the market players would accept an increase in awareness building, given the limited market of interest to Focus, it might be difficult to target the message without potentially negatively impacting the existing marketing efforts. This might be best managed by appointing a program manager to develop this program for the first couple of years.

And given the potential incentive program from the federal government, it is prudent that Focus elect not to offer a rebate for this technology. If the federal legislation remains unfunded, Focus could offer an incentive at a later date with a better understanding of the market and program potential.

Also, a phased approach to growing the program would be prudent because of the instability of both the cost of corn and natural gas.

In the event that Focus on Energy decides to develop a corn burning appliance program for heating homes our recommendations are to go slow, conducting a limited program without rebates that focuses on increasing consumer awareness of corn burning furnaces and stoves and on building market infrastructure. The market support might include collaboration with dealers and corn sellers, for example. This approach would enable Focus to continue to learn about this market and adapt its program offerings as the market—and Focus' understanding—evolved.

There is more discussion of these recommendations in the Technical Research Supplement.