



Growing Forward 2

A federal-provincial-territorial initiative

Farm Upgrade: High-Efficiency Boilers

There are many heating requirements on any Albertan farm, many of which are met using boiler heating systems. An Albertan colony farm near Calgary with hog, dairy, crop, egg and various poultry operations, relies on boiler systems to supply heat/hot water for production operations. Using grants from the *Growing Forward 2* On-Farm Energy Management Program, they added sub-meters to their systems in 2013 and in 2015 upgraded their old inefficient boilers to new high-efficiency boilers, as well as adding other efficiency improving system components. With the upgraded system, they also added high efficiency hot water heaters for egg grading that require an average of 31 GJ per month to operate. This added about 34% to their boilers' heating load.

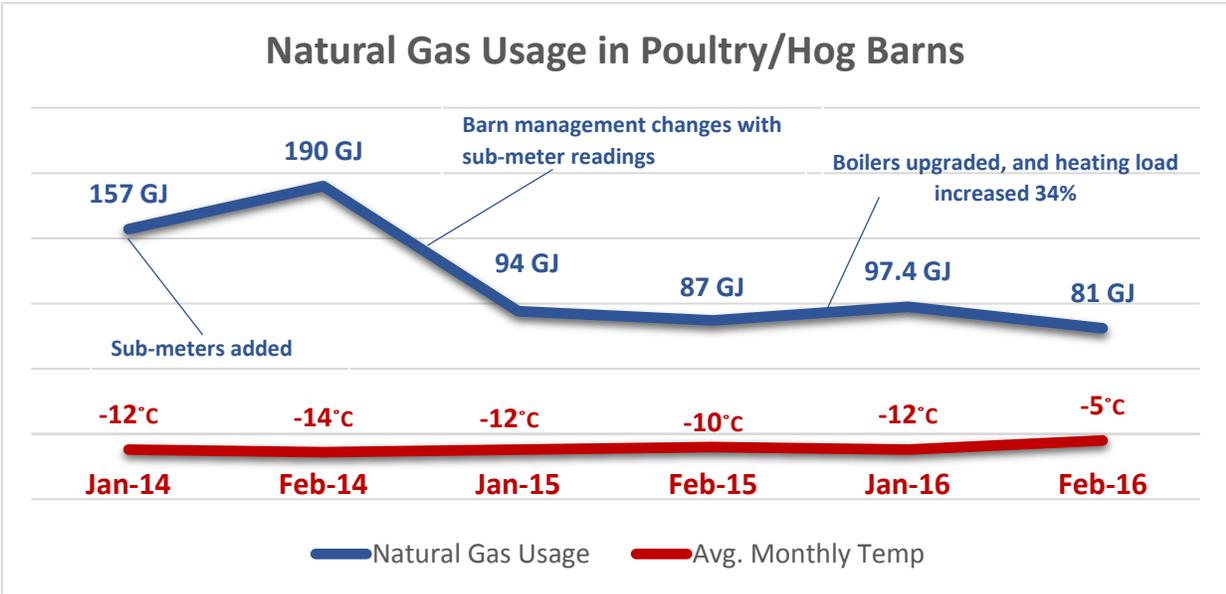


Figure 1: 22 year-old 800,000btu Superhot



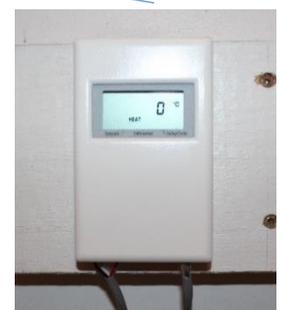
Figure 2: Two High Efficiency Lochinvar FTXL 400,000btu (800,000btu combined) Annual Fuel Utilization Efficiency (AFUE) 95%

Month	Barn Usage	Load/Weather Description	Cost Approximation <i>Jan & Feb @ \$4.07/GJ</i>
January 2014	157 GJ	<ul style="list-style-type: none"> Avg. Monthly Temp: -14°C Heated by two 400,000btu Superhot boilers, sub-meters added in the summer of 2013 	\$1,412.29
February 2014	190 GJ		
Barn Management changes (ventilation altered) due to information gained from installing sub-meters			
January 2015	94 GJ	<ul style="list-style-type: none"> Avg. Monthly Temp: -12 °C Boilers unchanged but barn management altered with the use of sub-meters to maximize efficiency Hot water heater and egg grading systems added in summer of 2015, 50 cases/hour once a day year round. Increasing the boiler load about 34% 	\$736.67
February 2015	87 GJ		
High Efficiency Boiler Installed and boiler load increased about 34% due to added egg grader/water heater.			
January 2016	97.4 GJ	<ul style="list-style-type: none"> Avg. Monthly Temp: -11 °C Old boilers replaced with two 400,000btu Lochinvar Condensing boilers in Sept. 2015 as well as other efficiency improving devices added to the boiler system of AFUE 95% 	\$726.09
February 2016	81 GJ		



The boiler upgrade consisted of two old 400,000btu Super-Hot boilers (AFUE of 75%-80%) being replaced by two high efficiency 400,000btu condensing and modulating Lochinvar FTXL boilers with AFUE ratings of 95%. AFUE ratings represent how efficiently the heat from the burning natural gas is transferred into the boiler water. The Lochinvar boilers also have a 10:1 turn down ratio, allowing them to modulate the burner temperatures proportional to the barn's needed heat.

Along with the boilers being upgraded, there were other components added to the system to increase efficiency: high efficiency pumps, pipe insulation, hydro-separator, and out-door thermometers.



Growing Forward 2 offers cost share grants for eligible boiler equipment. A detailed funding list and application form can be found at www.growingforward.alberta.ca under the On-Farm Energy Management Program.

There are many things that contribute to having an efficient boiler system. Everything from piping, boiler pumps, to the boilers themselves have a large effect on the overall efficiency of the boiler system in any application. Below is information about different components that contribute to making an energy efficient boiler system. When designing your own system, speak with a professional about the options available that will be most effective for your farm system.

Modulating and Condensing Boilers (AFUE $\geq 95\%$)

A modulating and condensing boiler is usually 15-20 percent more efficient than non-condensing boilers.

The **Modulating** aspect of the boiler means that it can vary the burner intensity to match the heat needed in that moment. This modulating feature prevents short cycling and more effectively delivers the proper amount of heat needed. Short cycling is when there are multiple start-ups and shut-downs in a short period of time, significantly lowering efficiency.

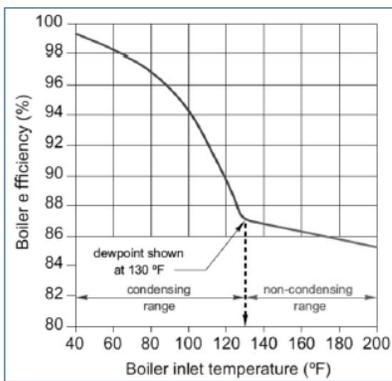


Figure 3: Characteristic curve for return water temperature and boiler efficiency

The **Condensing** aspect of the boiler means that it removes heat from the exhaust before it is vented outside. This feature relies on a cooler inlet stream to condense the combustion exhaust, transferring heat that would have been lost out the chimney into the boiler's inlet stream.

NOTE: The inlet water stream must be sufficiently cool in order for the boiler to reach maximum efficiency. Therefore managing the order in which boiler water travels through your heating systems can help you provide high enough temperatures for your barns, while returning low enough temperatures to the boiler. For instance: circulating water first through your pullet barn fin-pipe (where higher water temperatures are needed to sufficiently transfer heat into barn), then through the in-floor heating (which requires a lower temperature) before returning to the boiler can ensure that the return line is cool enough for the condensing boiler to operate properly and efficiently.



High Efficiency Circulating Water Pumps

Most boiler systems on Alberta farms use single-speed or manual three speed circulating water pumps. These pumps are commonly left on year round, circulating water through the system whether heat is required or not; this is a large unnecessary draw on electricity as well as wear and tear to the pumps when heat isn't needed.

A much more efficient option is variable speed high efficiency circulating pumps. An example of one of these pumps is the Grundfos Magna3 Variable Speed Circulator with ECM technology. This pump monitors water pressure and temperature, slowing down the circulation speed to save power when heat is not required. The electrical savings of changing from a single speed circulator to a variable speed ECM circulator pump is estimated at 40-65 percent electricity usage savings.



Tekmar Boiler Controller



The Tekmar 256 is a boiler controller with outdoor thermometers and warm weather shutdown capability. By monitoring the outdoor temperature and water temperatures in your system it can determine the most appropriate supply temperature and boiler firing rate. This prevents the system from running if the outdoor temperatures are equal or greater than the desired temperature and modulates the burners proportionally to the heat requirement.