

## DRAFT INFOSHEET

### **OSCIA Infosheet Series - Part 1 - Introduction to modern cordwood hydronic heaters and new firelogs (aka briquettes) available on the market**

OSCIA has received funding by OMAFRA to demonstrate a new type of small hydronic heating appliance at Forman Farms (<http://formanfarms.ca/>) located in Gananoque, ON near the City of Kingston. Forman Farms was the ideal partner to locate a demonstration site because of their knowledge and experience on solid biofuel production and combustion to heat agricultural operation. Currently, a solid biofuel hydronic heater heats their tomato greenhouse. They also operate a pellet mill and produce switchgrass and wood pellets.



The hydronic heating appliances are based on new design concepts to control how and when solid biofuels such as cordwood, agricultural and forestry briquettes are burned. Also, modern hydronic heating technology has been installed to demonstrate how a small greenhouse and a small office can be heated without causing emissions typically released by traditional outdoor wood boilers.

Monitoring equipment typically not used in residential or light commercial heating systems has been installed to monitor the performance between two models. A hot water meter, similar to a potable water meter located in your house if you are on a municipal drinking water supply, is used in this demonstration site. Two sets of thermometers are inserted in the hot water going to the heat load and coming back. They are attached to a calculating unit to measure how much heat is used or has been produced over a period of time.



*This infosheet is part of a series of 2 written by OSCIA to summarize the observations and results of a demonstration project funded by OMAFRA to promote knowledge and technology transfer for cleaner air. OSCIA, Forman Farms and the School of Engineering, University of Guelph would like to thank the Ontario Ministry of Agriculture Food and Rural Affairs for financial and technical support to realize this demonstration project. The information presented is that of OSCIA. The technology demonstrated is actively used in areas of rural British Columbia, Quebec, PEI, New Brunswick, Vermont, Maine and New York State. This series of infosheets showcases manually fed domestic, and small commercial size hydronic heating appliances that emit less air emissions compared to traditional outdoor wood boilers. They also showcase their ability to efficiently combust other types of solid biofuels such as agriculture and forestry based residues in briquette, brick or firelog format now available on the market.*

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### Model #1 (Fabricated in North America)

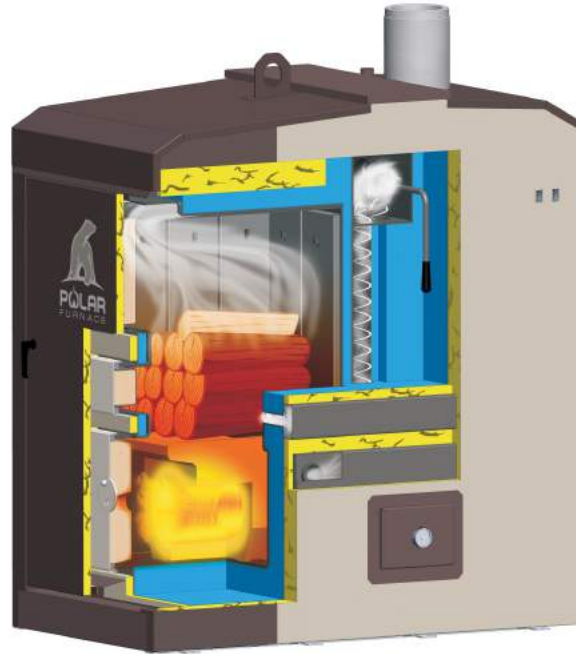
The model #1 demonstrated at Forman Farms is fabricated in Western Canada by Polar Manufacturing Inc. and distributed by multiple dealers in Ontario. They can be used inside a building or located outside. The model G2 was selected due to a medium size firebox and secondary burn chamber.



Based on the manufacturer's calculation examples, the firebox allows the operator to load wood twice a day to sufficiently heat a normal size house and provide some domestic hot water. The secondary burn chamber allows the reintroduction of secondary combustion air to combust unburnt wood gases or smoke before it exits the heating appliance. A large bright yellow flame is

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present in this chamber when in operation. These hot gases are in contact with the heat exchanger area present in the back of the heating appliances.



This model is simple to operate and does not use advanced combustion control that could be seen in the automotive sector. When the hot water has reached its set point temperature via a thermostat installed in the appliance, the air supply is shut-down. The hot water is constantly circulated to the heat load (house or shop), but for our demonstration project at Forman Farms, it is sent to a hydronic heating shed where hot water storage tanks and hot water meters are installed to store and monitor the performance of this model.

Hot water storage tanks are installed to increase the thermal performance of the hydronic heating appliance and to minimize its emissions released. The tanks allow the unit to completely burn the whole batch of cordwood or briquette fed in the primary firebox. This unit is manually adjusted at the factory to burn wood efficiently using the two stage combustion principle, but when it stops due to the thermostat inside the unit, it will stop burning efficiently and will release some smoke until it cools down. The amount of smoke released by two stage combustion units is significantly less than typical outdoor wood boilers that use a single combustion chamber and combustion air supply. To read more on emissions and performance test comparing single stage combustion and two-stage combustion heaters, please consult the testing report completed by New York State Energy Research and Development Authority in 2012 titled *Environmental, Energy Market, and Health Characterization of Wood-Fired Hydronic Heater Technologies*.

### ***Model #2 (Fabricated in Austria, European Union)***

The second model of solid biofuel hydronic heater used in this demonstration project at Forman Farms is fabricated in Austria by Fröling xyz GmbH and distributed by Biothermic in Ontario, Canada ([www.biothermic.ca](http://www.biothermic.ca)). It is very similar in size and design compared to the G2 series appliance manufactured in Western Canada by Polar Manufacturing.

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Fröling has tested the performance of these units according to a standard used in European Countries titled EN303-5:2015 *Heating boilers for solid fuels, manually and automatically stoked, nominal heat output of up to 500 kW. Terminology, requirements, testing and marking*. Their results show that a minimum of thermal and emissions performance can be met by burning seasoned cordwood. This appliance may look similar in shape in color, but has a multitude of differences between each other.

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First, it is not designed to be used outside in the cold weather elements. Secondly, it has more combustion and temperature controls that are very similar to larger industrial combustion units on the market in North America and European Union. Since these two types of appliances were not compared on a side-by-side basis by other less automated two-stage combustion hydronic heaters in the 2012 New York State Energy Research and Development Authority testing report, it is one of the main objectives of the demonstration project at Forman Farms.

### Solid biofuels

A wide supply of solid biofuels are available in Ontario to burn in typical wood stoves, fireplaces, outdoor wood boilers and modern hydronic heaters with two-stage combustion, such as the two units demonstrated at Forman Farms. Solid biofuels can be sourced from various operations including the forestry, agriculture, aquaculture sector. When supplied by the forestry sector, they are mainly manufactured using wood based fibres, either sourced by a local pulp and paper mill. There is also a wide supply of post-consumer wood residues derived from the commercial and industrial sector or the construction and demolition sector. These wood based fibers can be found as wood pallets, other shipping crates or containers and waste lumber from the construction or

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demolition debris. Certain sources of wood fibre are cleaner and require significantly less handling and processing before being produced in a clean and marketable product. In Canada, international biofuels standards have recently been adopted to standardize their source, size, quality and heating value by the Canadian Standards Association. To read more about the adoption of international solid biofuels standards in Canada, please consult the *Solid Biofuels Bulletin No3. CAN/CSA-ISO Solid Biofuels Standard* by Natural Resource Canada at [www.nrcan.gc.ca](http://www.nrcan.gc.ca)

### Agricultural Solid Biofuels

In Ontario, field residues have been collected as part of various biomass trials. Cereal and soybean straw and corn stover are the most discussed. Unfortunately, large scale use of these residues as bio-product are still in development and competes with more traditional uses of straws such as bedding for livestock and the mushroom composting market. The Ontario Biomass Producers Cooperative Inc. represent a group of farmers that are diversifying their production by cultivating purpose grown crops like Miscanthus and switchgrass. Please visit this website for more information about this cooperative and to discuss availability of crops in your area <http://ontariobiomassproducersgroup.wildapricot.org> .

In this demonstration project with Forman Farms, we contracted the densification of miscanthus and switchgrass at the West Nova Agro Commodities Ltd. in Nova Scotia. These two briquettes are currently being produced and will be tested in the spring of 2016. Another interesting aspect of agricultural solid biofuels is by-products from transformation to commodities. This is the case with the flax briquette that is densified in Carman, Manitoba. Right next to the flax processing plant, a second business was formed to produce this clean burning briquette. To obtain more information about this fuel, contact the Eastern Canada distributor <http://www.ecolutioncanada.com>



### Forestry Solid Biofuels

Wood based briquettes have been on the market for many years. Typically, sawmills or other wood manufacturing facilities that had access to a dry and clean supply of sawdust ventured in the densification of wood by-products in wood pellets or wood briquette. They are available either in a box of a couple of logs or can be ordered by the pallet and delivered to your home. Wood briquettes from Milson Forestry in Timmins, ON and Groupe Savoie, New Brunswick have been used and demonstrated at Forman Farms.

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To obtain more general information on wood based briquettes, please consult the *Solid Biofuels Bulletin No. 5 Graded Wood Briquettes* by Natural Resource Canada at [www.nrcan.gc.ca](http://www.nrcan.gc.ca)

### Solid Biofuel Analysis

The Bio-Renewable Innovation Lab, School of Engineering of the University of Guelph have completed the solid biofuel analysis and emissions testing of many solid biofuels during the course of this demonstration project. Some of the analyses were done directly at the lab and other done on-site at Forman Farms, such as the emissions testing using a portable gas analyser.

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Other data and analyses conducted by the operator such as the hot water metering and solid biofuel consumption are shown in the second series titled *OSCIA Infosheet Series - Part 2 – Comparison of the performance between modern cordwood hydronic heaters and traditional models on the North American market.*

### Results of the Solid Biofuels Analysis

Table 1 Ultimate Analysis of burned biomass in percentage (unless otherwise specified)

Sample	Carbon	Hydrogen	Nitrogen	Sulphur	Oxygen	Ash	HHV (MJ/kg)	LHV (MJ/kg)
Hardwood 2lbs logs	46.73	6.13	0.13	0.00	46.61	0.4049	18.50	16.01
Cedar kindling	47.93	6.04	0.33	0.00	45.40	0.2926	19.00	16.87
CANWICK Bricks	46.78	6.07	0.23	0.00	46.41	0.5149	18.52	17.27



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SPF lumber waste	46.70	6.21	0.00	0.00	46.80	0.2907	18.48	16.60
CANWICK octagonal logs	46.66	6.17	0.00	0.00	46.65	0.5211	18.46	17.23
Re-Treeved logs	46.54	5.90	0.53	0.00	44.19	2.8304	18.44	17.15
Flax logs	47.48	5.89	0.63	0.02	42.70	3.2750	18.83	17.07
Miscanthus logs	-	-	-	-	-	-	-	-
Switchgrass logs	-	-	-	-	-	-	-	-

\* Miscanthus and switchgrass logs are in fabrication as this infosheet is distributed

Table 2 Proximate Analysis of burned biomass in percentage wet basis (unless otherwise specified)

Sample	Moisture	Volatile Matter	Fixed Carbon	Ash
Hardwood 2lbs logs	12.01%	89.61%	9.98%	0.40%
Cedar kindling	10.02%	91.96%	7.75%	0.29%
CANWICK Bricks	6.04%	88.39%	11.10%	0.51%
SPF lumber waste	9.09%	87.34%	12.37%	0.29%
CANWICK octagonal logs	5.95%	86.73%	12.75%	0.52%
Re-Treeved logs	6.26%	84.80%	12.37%	2.83%
Flax logs	8.32%	81.46%	15.27%	3.28%
Miscanthus logs	-*	-	-	-
Switchgrass logs	-*	-	-	-

\* Miscanthus and switchgrass logs are in fabrication as this infosheet is distributed

If you are interested to learn more on how you can modify your current hot water heating system or outdoor wood boiler, please consult the last infosheet of this series titled *OSCIA Infosheet Series - Part 3 - (title TBD)*.

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