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BUILDING A FUTURE FOR BIOMASS COMBUSTION

Transforming crop residue into valuable, clean burning energy

"Maximizing value" is a business buzz word farmers hear a lot in today's competitive environment. But what does it really mean?

When it comes down to it, many of the catchphrases fired around agriculture these days could be summed up with a simple principle: "Make the most of what you've got."

And agriculture has got a lot.

Case in point is the 15.8 million tonnes of cereal and canola straw Alberta produces most years as a by-product of crop farming. After deducting the volumes of these residues required for current levels of livestock production and sustainable soil erosion protection, it's estimated that 7.7 to 13.2 million tonnes of cereal and canola straw could be sustainably recovered for other uses.

That's a lot of straw. It's also a lot of opportunity, says Kelly Lund, a research engineer with Alberta Agriculture and Rural Development (ARD).

"In agriculture today, there is more focus than ever on looking at the by-products that are left over from our current practices, and findings ways to make productive use of these by-products, to make production more efficient and potentially generate additional sources of income," says Lund. "When it comes to managing straw and other crop residues, one of the most promising opportunities is to use these residues as an energy source for heating, through the process of biomass combustion."

Better furnaces, new processing options

A key development driving this opportunity is technology advances – not only in combustion furnaces that can better handle crop residues, but in processing options that turn raw biomass into pellets or briquettes for use in these systems.

Using these forms of processed biomass and modern systems, producers have options to produce energy for heating their own facilities and residences or, potentially, to sell to other industries. In Canada, a leading example of the latter is in Ontario, where the greenhouse

...continued on page 2

Alberta

"Biomass combustion is considered a carbon-neutral process. This makes it an attractive option from an environmental perspective."

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industry now uses biomass combustion of agro-pellets as its main heat source, supplied by local farmers.

"This type of opportunity is a growing possibility for Alberta and other provinces to also develop," says Lund. "Quality biomass combustion systems are now available for a range of scales. With processing, agriculture can be a good producer, user and supplier of fuel for these systems."

What Alberta can do

So, how can producers and industry take advantage of the biomass combustion opportunity?

There are a couple pathways, says AgTech Centre's Kelly Lund.

For on-farm use, getting into biomass combustion is a matter of investment and implementing the right approach and system for a specific operation. For supplying energy off site, a key to developing the potential is to find or encouraging the right markets.

"For larger scale opportunities like the greenhouse industry example in Ontario, there are often advantages to pursuing them at industry level," says Lund. "They take time and resources to develop, but can in the end can be quite profitable and offer many additional benefits."

The process of biomass combustion, which by definition involves burning plant-based organic material to create energy, is growing in popularity worldwide as demand increases for alternative energy sources that are renewable, more environmentally friendly, more cost effective and less susceptible to fluctuating global energy markets.

In the case of industries such as forestry and agriculture, biomass combustion also offers a way to make use of by-products or residues that might otherwise go unused or represent a significant cost to manage.

Pellet power. The ability to efficiently process agricultural biomass into pellets, like the ones shown above, is one of the key developments that is making biomass combustion a more viable option.

While straw and other residues can be a great source for biomass fuel, farmers also have the option to focus a portion of their production specifically on growing energy, by producing non-food energy crops such as switchgrass or a similar crop better suited to western Canada, notes Lund. "This can be a good way to make productive use of marginal land."

Two major studies

Lund is part of an ARD team that has commissioned and provided technical oversight support to two major studies examining the opportunity for creating an ag residue-based bioheat industry in Alberta. The studies, which provide a window on the opportunity for Canada as a whole, were conducted by Resource Efficient Agricultural Production (REAP), a Canadian agency focused on developing bioenergy opportunities for rural development and greenhouse gas mitigation.

The first study was an assessment of the agri-fibre biomass residue resources available in the province. The second study added to that investigation with an assessment of the technology options available for turning these resources into more viable energy sources.

The studies found positive results on both fronts, says Lund. "The findings indicated that Alberta has substantial agri-fibre biomass residue that could be used as fuel for bio-energy," says Lund. "They also showed that, with the technology improvements now coming on stream, this opportunity is much closer to reality for both producers and industry."

New 'agro-pellet' potential

Much of the optimism surrounding the findings is based on new opportunities for processing agriculture biomass into pellet or briquette form, for use in small and medium scale biomass combustion systems in commercial facilities. Biomass combustion is most common using wood biomass – ag materials are tougher to handle and don't burn as clean in raw form, but processing is a way to overcome those obstacles.

"A big challenge with using agricultural biomass, as opposed to wood biomass, is that it has a lot more mineral content, which is harder on the equipment," says Lund. "Agricultural biomass also tends to be a lot more variable or lower quality, which doesn't give you the consistency and performance of wood. Going to pellets or briquettes is a way to address both problems."

According to the studies, a key opportunity in Alberta for small and medium scale biocombustion systems is to use agro-pellet biomass combustion as a space heating technology that can provide an alternative to natural gas.

"The findings showed that agro-pellets produced by Alberta farmers could represent a competitively priced fuel option to compete with natural gas in commercial heating applications," says Lund. "The challenge is to have the infrastructure in place to provide a reliable resource for producing the pellets. That's an opportunity for the various industry and government players to consider closely as we look to the future."

Questions to be answered

How big will biomass combustion be? What types of scale will be involved? Will on-farm systems take off, or is supplying to broader systems the way to go? All of these questions are yet to be answered.

To get an initial understanding of the broad potential Alberta Agriculture and Rural Development commissioned and provided technical oversight to two major studies by REAP Canada. One thing is for certain: Biomass combustion using densified agri-fuels is an area with real potential that is worth keeping an eye on.

Quality biomass combustion systems are now available for a range of scales. Pelleting technology is also advancing. The photo here shows a new pelleting system.

For those interested in the specific options available today, best approach is to contact one of the handful of major suppliers of combustion technology or pelleting technology in Canada. Contact information for several of these companies is available through the REAP Canada Web site, at www.reap-canada.com.

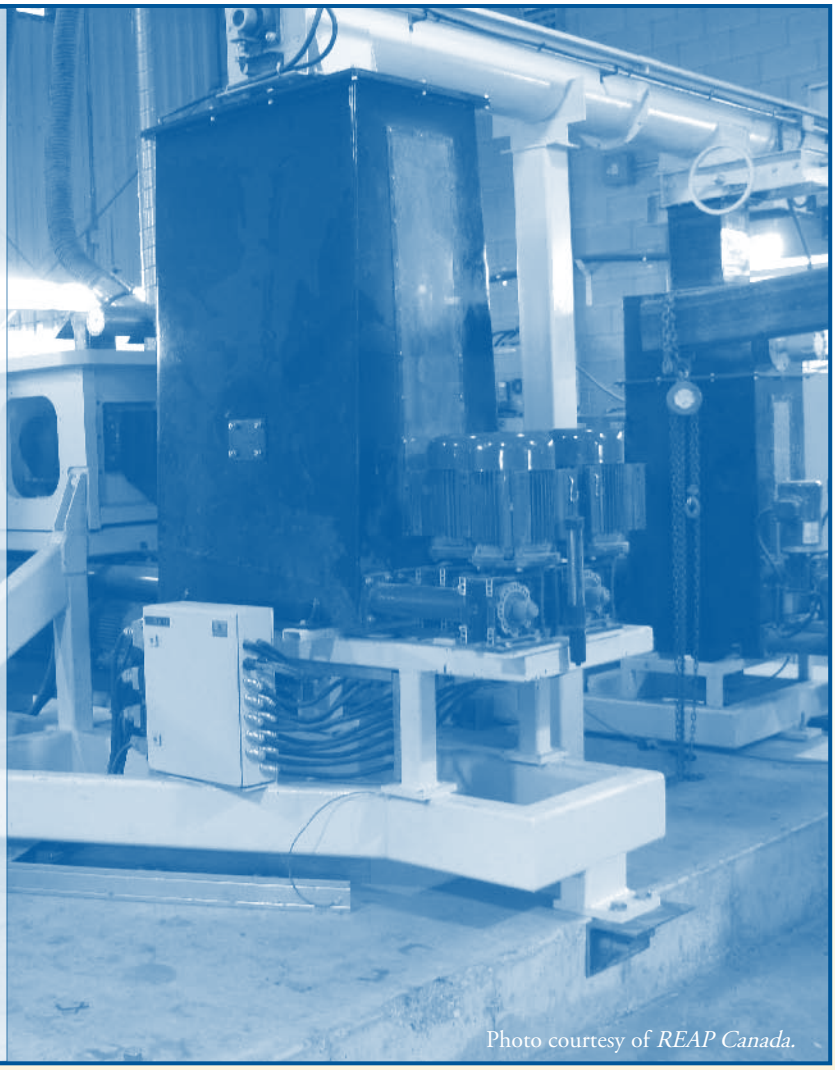

Photo courtesy of *REAP Canada.*

Compared to 15.8 million tonnes of cereal and canola straw Alberta produces annually, crop milling residues from cereal grain production represents a much smaller volume of available residues in Alberta.

However, the studies observed, these could still be important feedstocks for initiating the agro-pellet industry in Alberta. With current capacity for wheat and oat processing in Alberta, an estimated 161,000 tonnes of wheat mill feed and 46,000 tonnes of oat hulls and pin oats could likely be available in the province on an annual basis. Other residues that may have some potential for development in the province include barley hulls and off-specification canola meal.

Cost-competitive option

Outside of North America, the biomass pellet industry is now in rapid development, with over 400 biomass pellet plants globally, which has stimulated a pellet machine manufacturer sector, especially in Europe.

Now interest is growing on this continent. For instance, as cited in the REAP studies, within Canada's farming sector, there is a growing popularity for round upright fixed bed stoker systems, as well as sloping grate boilers for large greenhouses.

At the same time, incremental improvements in efficiency, convenience, and lower particulate loads are being made with a series of technological innovations in the combustion chamber design and air control systems for these commercial systems.

"As more systems are implemented, there is greater opportunity for agricultural biomass as a fuel for these systems," says Lund.

The understanding of design features that are necessary to be incorporated in the combustion technologies to burn agro-pellets is now well grounded in the manufacturing sector, the studies report.

"The studies point out that an important development on the horizon is to gain practical field experience in large numbers of small scale systems, to make the use of agro-pellet technology as convenient and reliable as the use of wood pellets," says Lund.

The potential represents a leadership opportunity for Alberta, and Canada, within the North American context, the studies observe. According to the findings, when compared to other biofuel options, bioheat from fuel pellets has potential as one of the most economically efficient and environmentally friendly means to displace fossil fuels.

Based on ballpark estimates of prices in 2008 and experience in other districts, the studies estimated crop milling residues could be produced for about $100/tonne or the equivalent of $5.55/GJ in Alberta.

Because biomass combustion is considered a carbon-neutral process, increasing the adoption of this energy source can also help reduce greenhouse gas emissions and provide an asset in carbon trading scenarios, the studies report.

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BIOMASS COMBUSTION BASICS

Burning crop material can produce many forms of useful energy including hot air, hot water, steam and electricity.

Biomass combustion is a concept as old as they come. Making a campfire to keep warm or cook food is one example. Using a wood burning furnace, stove or boiler for the same purposes is another.

But in the modern sense at a commercial scale, biomass combustion is a sophisticated area of equipment and technology, geared toward energy efficiency and low emissions.

Most biomass combustion systems have been designed to handle wood and wood residues, but more are now coming on stream that can handle agricultural biomass, either independently or in a system built to handle different types of biomass.

Variety of scale and systems

There is a range of scale in biomass combustion systems. Some large biomass combustion plants have been implemented by municipalities, bio-energy companies and large commercial enterprises, both for on site use or for supplying energy off site. Smaller systems have been adopted by a range of commercial facilities for on site use, often specially designed to handle byproducts produced by those operations or by nearby industries.

Whatever the system – from a simple furnace or boiler to multi-component, large scale sophisticated equipment – the process centres around several key steps: feeding biomass into the system either manually or automatically, burning the biomass in some form of combustion chamber, capturing the heat and filtering the emissions, and then distributing the heat.

In some systems, the biomass used may be in raw form. This is more common using wood material, which is relatively consistent, or in situations where the system uses by-products produced on site and is designed to handle raw forms. But for less consistent materials or those supplied or sold commercially to external facilities, processing is more common, with the typical preferred forms being chips or pellets.

Most biomass combustion systems are designed to burn a single type of biomass, but some can be used or adjusted to burn multiple forms. Some also allow biomass to be co-fired with another fuel, such as coal.

Ultimately, the process of biomass combustion can be used to convert the biomass into many forms of useful energy including hot air, hot water, steam and electricity.

Opening the door for agriculture

To date, biomass combustion systems designed for and implemented in commercial facilities have focused heavily on using forest industry biomass resources such as wood and wood residues.

However, research, technology advances and increasing interest in recent years has opened the door to greater opportunity for using agricultural biomass.

Europe has lead the way, with a substantial number of agricultural operations either implementing biomass combustion systems or supplying biomass in various forms for external facilities and markets.

Now there is rising interest in North America for adopting similar technologies and approaches for biomass combustion, and Canadian agriculture has the potential to provide a good fit for this option. ✦

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