Climate Smart Agriculture in Alberta

Renewable Energy Potential

Actions that reduce greenhouse gas (GHG) emissions are increasingly important to consumers. These bring other "climate smart" benefits of improved productivity and increased adaptation to changing climates to your operations.

Renewable energy is generated from sources that can be restored indefinitely. Renewable energy technologies convert renewable resources into energy that complements or replaces conventional sources with reduced carbon dioxide emissions.

Wind, solar, and small-scale hydro systems have zero GHG emissions. Biomass sources of energy are considered GHG neutral because the carbon dioxide (CO2) generated by producing energy is offset by the CO2 used by the growing crop[1]. Table 1 outlines the various sources of energy in Alberta relative to fossil fuel sources (coal and natural gas), as well as costs and rates of emissions.

Renewable energy also provides opportunities to increase efficiencies by making use of a broader range of agricultural products. Adaptation to changing climates is improved by diversifying reliance on traditional, centralized energy sources.

TYPES

Wind turbines capture wind energy and convert it to electricity. Systems range from small 'off-grid' to utility-scale towers that contribute to the provincial power grid. Average annual wind speeds of greater than 15 kilometres per hour are required. Alberta has abundant wind energy resources (Table 2). There is over 1,479 megawatts (MW) connected to the grid or, enough to serve 625,000 homes[2].

Solar installations to generate heat or electricity include:

1. Passive - Collects and store solar energy and distribute it by natural processes such as convection and radiation.
2. Active - Uses collectors to heat water or air, and a pump to circulate it throughout the building. Canadian agricultural businesses using solar systems include dairy, swine and poultry producers.
3. Photovoltaic - Converts sunlight directly into electricity. Photovoltaic arrays (10 to 20 PV modules, of 40 cells) can provide enough power for a household. For large applications, hundreds of arrays can be connected to form a single PV system.

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Earth energy systems provide heating in winter, cooling in summer and year-round hot water for home use. Pumps move heat between the earth and buildings as needed. Installation costs are about twice as much as conventional, but operating costs are about two-thirds less than traditional systems. More than 30,000 heat pumps or "earth energy" installations are being used in in Canadian residential, commercial, institutional and industrial applications. They are considered to be the most energy-efficient, environmentally clean and cost-effective heating systems available.

Small-scale hydroelectric power uses free flowing water to produce electricity. Most are run-of-stream systems that divert water through a pipe or channel. Water is directed through a turbine and then allowed to flow back to the river or creek. Installations can be sited, built and operated with minimal environmental impact.

BIOMASS

Biomass resources are any plant-derived organic matter available on a renewable basis. This includes forestry and agricultural crops, in addition to animal, food-processing, and municipal wastes. Biomass is converted into energy by incineration (complete combustion), gasification or pyrolysis (absence of air and presence of extreme heat). Table 3 outlines the relative effectiveness of a range of biomass feedstock relative to fossil fuels.

Agriculture operations can benefit from sources that can be produced locally and either used on-farm or sold to producers of bio-energy products. Feedstock include wood, straw and switchgrass. Sustainable cropping practices that provide adequate protection from soil erosion are needed to ensure that this resource is renewable.

BIOGAS

Generated by the anaerobic (no oxygen) digestion of organic material such as manures and municipal wastes, biogas can be burned to produce heat, electricity or both. Liquid manure systems work best for anaerobic digestion. The installation and operation of an anaerobic digester requires considerable monetary and manpower investments. The feasibility of anaerobic digestors depends on type of livestock, type of manure management system, heat and electricity requirements. The cost and continuity of feedstock supply requires careful evaluation.

BIOFUELS

Biofuels include biogas, alcohols, ethers, esters and other chemicals made from biomass resources. Biofuels can be used as a supplement or an alternative to fossil fuel to produce electricity, heat and/or transportation fuel. In the short-term, biofuels can be used as blending agents to dilute CO2 emissions from fossil-based fuels. In the long-term, technological advances are expected to allow greater use of biofuels in vehicles.



Bioethanol (fuel alcohol) is made from starch (grain crops, corn); sugar (sugar beet or sugar cane); and, although still in the preliminary stages, from cellulose (wood, straw, grass or municipal solid waste). Bioethanol is widely used in Brazil and the USA today. Ethanol-blended fuels such as E85 (85 percent ethanol and 15 percent gasoline) can reduce net greenhouse gas emissions by as much as 37 percent, and E10 (10 percent ethanol and 90 percent gasoline) can reduce net greenhouse gas emissions by almost four percent.

Biodiesel is manufactured from most vegetable oils such as canola or soybean, animal fats, recycled grease, as well as low quality oilseeds and tall oil produced from wood pulp waste. Biodiesel can be blended with conventional diesel fuel or used 'straight' (100 percent biodiesel). It is typically added to petroleum diesel in 20 percent blends (B20) for diesel engines and is a direct fuel substitute for #2 petroleum diesel. Biodiesel used as a fuel or additive requires little or no engine modification and bio-diesel fueled engines deliver similar mileage, torque and horsepower. Compared to fossil fuels, it degrades quickly in the environment and is nontoxic.

The combination of improved technological efficiencies, scientific advances, increased environmental awareness and environmental protection regulations have turned biomass conversion into a cleaner, more efficient process. As the biomass energy market grows, so will the market for biomass resources, which may provide farms with another stream of income.

INCENTIVES FOR IMPROVEMENT

In addition to gains in efficiency and adaptation from reducing emissions, a number of programs are available to help you make improvements. There are also opportunities to learn more about environmental markets by selling carbon offsets.

For more information, see:
www.agriculture.alberta.ca/climatesmart

Sources

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[2]Canadian Wind Energy Association, https://canwea.ca/

[1]IPCC, 2005. IPCC Special Report on Carbon Dioxide Capture and Storage. Prepared by Working Group III of the Intergovernmental Panel on Climate Change [Metz, B., O. Davidson, H. C. de Coninck, M. Loos, and L. A. Meyer (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 442 pp. https://www.ipcc.ch/pdf/special-reports/srccs/srccs_wholereport.pdf

Kralovic and Mutysheva. 2006. The Role of Renewable Energy in Alberta's Energy Future. Canadian Energy Research Institute, Calgary, https://www.scribd.com/document/98721837/ABEnergyFutures-15

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Table 1. Estimated costs and emissions by technology in Alberta.

Technology	Cents/kWh[3]	Tonnes CO2e /MWh[4]
Coal, with Carbon Capture and Storage (CCS)	23.7	0.11
Coal, without CCS	4[5]	0.76
Natural gas, simple cycle	11	0.37
Natural gas, combined cycle	8.2	0.37
Cogeneration	6.9 to 10.6	0.37
Wind	8.9	0
Hydro	10.5	0
PV solar	17.6	0

[3] AESO Long Term Outlook 2014, [4] IPCC 2005, CO2e= Carbon dioxide equivalent, MWh = Megawatt hour, [5]Aydin et al. 2013

Table 2. Wind generation capacity in Alberta.

	Value	Units
Hours in the year	8760	hours
Capacity factor	0.34	%
Capacity of generating unit	1,100,000	kW
Electricity per year	3,276,240,000	kWh
Average Alberta residence electricity demand per year	7,200	kWh/year
Number of Alberta houses	455,033	count

Table 3. A comparison of Lower Heat Values (LHV) for different energy sources in Alberta.

Fuel	Lower Heat Values	
	BTU/lb	MJ/kg
Natural Gas	22865	53.18
Propane	19940	46.37
Gasoline	18831	43.80
Diesel (#2)	18401	42.80
Biodiesel	16251	37.80
Fuel Oil (#1)	15910	37.00
Ethanol	11479	26.70
Coal	10318	24.00
Coal (sub-bituminous)	9000	20.93
Flax straw (dry)	8587	19.97
Wood Pellets	8512	19.80
Wheat straw (dry)	7680	17.86
Corn straw (dry) *	7540	17.50
Shelled corn (15% moisture) *	7000	16.20
Flax straw (20% moisture)	6635	15.43
Wood (15% moisture)	6450	15.00
Wheat straw (20% moisture)	5908	13.74
Biogas	55159	17.25

Adapted from: PAMI Research Update #719. 1995
*OMAFRA Agdex #111.768. 1997

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