



BC FARM ENERGY ASSESSMENT FACT SHEET 1 – Vegetable & Floriculture Greenhouses



photo courtesy of Investment Agriculture Foundation

The Farm Energy Assessment Pilot Project

Increasing on farm energy efficiency provides a “win-win” opportunity through the potential for energy and cost savings, as well as greenhouse gas emission reductions. The BC Farm Energy Assessment Pilot Project was initiated to explore key energy efficiency opportunities on BC farms, as well as to develop a specialized tool to assess agricultural energy use (and make energy savings recommendations).

During the summer of 2010, 27 farms from across the province participated in high level energy assessments of all fuel types; these pilot assessments enabled the testing and development of the BC Farm Energy Assessment (BCFEA) tool. The BC Greenhouse Growers Association was committed to increasing the number of greenhouses participating in the project and was able to secure additional funding for this purpose. In total, eight vegetable greenhouse and three floriculture greenhouse operations were included in the pilot project. Each participant received a high level energy assessment and an individual report on energy use and potential efficiency opportunities.

Findings for the greenhouse sector

Greenhouses are the largest consumers of energy per farm of the seven farm types included in the project. Multiple boilers (typically natural gas) are used to provide greenhouse heating, as well as carbon dioxide (CO₂) to stimulate plant growth. Several farms use bottled CO₂ depending on price in comparison to natural gas. Electricity is used for supplemental lighting in some greenhouses, in addition to heating and irrigation pumps. Some greenhouses use fans for forced ventilation and air mixing.

A broad range of efficiency opportunities were identified for the vegetable and floriculture greenhouse operations included in the BC Farm Energy Assessment pilot project. For a number of operations, a high level of efficiency has already been achieved and very few improvements could be recommended. For some there were moderate to significant energy savings opportunities identified.

Approximate combined savings for the 11 greenhouses assessed using the BCFEA Tool:

- 57,000 eGJ/yr (elec + fuels)

- \$500,000 /yr in savings
- 2,800 tons/yr CO₂ emissions
- Energy savings varied considerably from site to site (<1 to 28% of overall energy use)

The overall potential savings identified do not incorporate some of the areas with greatest savings potential because these areas require further exploration before they can be recommended with confidence. Although general payback period information was provided, energy assessment participants were still required to determine cost-effectiveness in the context of their operation.

- Average 2009 energy use intensity for vegetable greenhouses of 1.94 eGJ/m² (all energy types)
- Average 2009 energy use intensity for floriculture greenhouses of 1.27 eGJ/m² (all energy types)

Energy savings opportunities

Listed below are all of the opportunities that were identified throughout the greenhouse sector assessments.

Greenhouse Construction

- Repair greenhouse glazing leaks where possible to avoid unnecessary heat loss.
- Insulate the perimeter walls below the height of the bench to avoid heat loss.

Greenhouse Heating Systems

- If possible, ensure standby boilers are isolated by shutting off supply and return valves when not in use. If standby boilers cannot be isolated, consider reducing flow through the standby boiler in order to save pumping energy.
- Conduct boiler flue gas tests and tuning at least annually.
- Install a flue-gas economizer (condenser) to recover heat from the primary boiler exhaust.

- If CO₂ is fed into the greenhouse(s) during the daytime, install a hot water storage tank to capture the heat generated by the boiler so it can be released when heating is required. According to recent studies, this holds large savings potential of 15–20% of total heating energy consumption.
- Shut off zone pumps unless there is a need for heating in the zone. If a central control system is used to control zone pumps and valves, use a simple software modification to disable each zone pump when the zone heating valve is closed (i.e. no zone heating requirement).
- When replacing pumps at end of life, ensure new pumps use high efficiency motors.
- If possible, shift primary heating pipes to a vertical level at or below the bottom of the crop.
- Ensure temperature sensors are shaded from direct sunlight for accurate readings and improved control.
- Ensure heating distribution pipes are well insulated.
- Install a retractable thermal curtain to retain the heat at night. Many growers claim up to 30% reduction in heating consumption with the use of a thermal curtain.
- (Vegetable greenhouses only) Install a retractable shade curtain to provide shade to the crop at times of peak solar radiation (crop dependent). This protects the crop, as well as reducing the ventilation cooling load on the greenhouse. A reduced ventilation load in turn reduces the loss of CO₂ and thus boiler/bottled CO₂ consumption.

Lighting

- Investigate the possibility of staging supplemental lighting to take advantage of periods when only partial light is sufficient, or when accumulated light energy during the day has reached a maximum threshold.
- Photosynthesis in plants does not begin until approximately 30 minutes after the plant senses light. Staging lights for this period of time will result in energy savings.



photo courtesy of Investment Agriculture Foundation

- When light levels are moderate outside, lights should be staged:
 - Full lights when outside light less than 100 lux;
 - Half lights when outside light 100–300 lux;
 - And no lights when outside light greater than 300 lux (lux levels approximate).

Ventilation Fans

- Consider installing variable speed drives on base-load fans and use staging for the remainder.
- When replacing fans use high efficiency motors.
- Ensure fans are balanced and in good condition.
- Use external wind covers on fan openings to prevent draughts during cooler periods.
- Repair or upgrade fan louvers to ensure they seal properly when closed.

Additional opportunities/considerations

Some of the most promising efficiency opportunities for greenhouses that were identified through the pilot project are not currently included in BCFEA tool. This is due to their complexity, or barriers preventing implementation. Nonetheless, it is important to make note of these opportunities because they have the potential to result in significant efficiencies.

Co-Generation

Use of combined heat and power (cogeneration) is common in greenhouses in other jurisdictions, particularly in Europe. Cogeneration's efficiency value is in its potential to generate both heat and electricity simultaneously in close proximity to its use. Compared with separate heat and electricity production, energy savings of up to 25% can be realized. As most greenhouses need far more heat than electricity, the economic diversification benefit comes with the potential to sell energy to the grid. At present this technology is challenging from an economic feasibility point of view in BC.

Bio-gasification

An alternative use of biomass not yet used in the greenhouse sector in BC is bio-gasification. This technology uses a thermo-chemical process whereby indirect heat is applied to biomass and a clean burning gas (syngas) is produced. Syngas is composed primarily of carbon monoxide, hydrogen and methane, and unlike direct incineration of many waste fuels, is a clean burning fuel that can be used as a substitute for natural gas. The opportunity therefore exists to run a co-generation plant from syngas derived from biomass, and as such meet the requirements of the recently proposed BC Hydro feed-in tariff policy.

The University of British Columbia has ordered a bio-gasification/co-generation plant which is scheduled to

be commissioned in 2011. While costly, this technology is worthy of further investigation with regards to applications in the greenhouse sector.

Semi-closed greenhouses

The concept of a semi-closed greenhouse is not new in BC. A semi-closed greenhouse involves minimal use of roof vents to provide cooling by natural ventilation. In this case natural gas savings are achieved by reducing the amount of boiler use for CO₂ production in summer, since opening roof vents allows CO₂ to escape the greenhouse.

To provide cooling in a semi-closed greenhouse, reverse-cycle heat pumps are used to cool and dehumidify the air within the greenhouse. As an additional step, the heat extracted from the greenhouse can be stored either long-term from season to season,

or short term (from day to night) in holding tanks for use when greenhouse heating is required.

Semi-closed greenhouses have additional benefits including improved control of the greenhouse climate (in particular humidity levels) and in turn improved crop quality, reduced pesticide use, and reduced irrigation water consumption. To assess the potential savings of retrofitting an existing greenhouse to a semi-closed design requires detailed engineering and can be site/crop specific. The opportunity holds significant potential in BC for reducing natural gas and greenhouse gas emissions.



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The Climate Action Initiative is facilitating a proactive approach to climate change issues within the BC agriculture and food sector. By developing climate action resources, the Initiative raises awareness and assists the industry in meeting the challenges, and acting upon the opportunities, presented by climate change. For more information about the Climate Action Initiative, please contact Initiative Coordinator, Emily MacNair at 250-356-1666 or Emily@BCAgClimateAction.ca.

other project partners



funding provided by



Currently available incentives

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Environmental Farm Plan & Beneficial Management Practices

Agricultural producers who have successfully completed the Environmental Farm Plan Program may apply for cost sharing for changes to farm practices specified within the Beneficial Management Practices (BMP) Program. * Energy-related practices have been incorporated into the (cost-share) incentives and new for 2011 is the availability of up to \$2,500 toward the cost of consultative services for a farm energy assessment. Please note: Only two BMPs may be completed per farm, per year.

Each BMP has eligibility parameters which are described in the full list available at: www.bcefp.ca

2011/2012 Beneficial Management Practices: Carbon Dioxide Emission Reduction

3301 (up to \$2.5K per plan – limit of one plan per eligible farm operation)

Consultative services for on-farm energy efficiency assessment.

3302-1 (30% of eligible costs) Maximum of \$10,000
Replacement of fossil-fuel driven motors with electrical motors.

3303 (30% of eligible costs) Maximum of \$30,000
Alternative energy technology (wind, solar, on-farm hydro) for powering previously fossil-fuel dependent equipment and replacement of diesel generators.

3304 (30% of eligible costs) Maximum of \$50,000
Replacement of fossil-fuel dependent space heating with renewable heating including: solar-thermal infrastructure, geothermal infrastructure, heat pumps, biomass boilers, heat exchangers and heat conveyance infrastructure, warm water tanks, assessment design and construction costs are eligible.

3307 (30% of eligible costs) Maximum of \$30,000
Thermal energy efficiency improvements that increase insulation: thermal curtains and other dividers, improved insulation, management optimization systems, high priority items as specified in plan developed under 3301.

3308 (30% of eligible costs) Maximum of \$10,000
Lighting efficiency improvements: Low energy lighting equipment, high priority items specified in energy plan developed under 3301.

3309 (30% of eligible costs) Maximum of \$30,000
Engineering design work or technical feasibility studies. This practice code will stand alone if project does not proceed for economic, technical or environmental reasons.

* The Canada-British Columbia Environmental Farm Plan Program (EFP) is a voluntary, confidential program that agricultural producers can use to identify environmental strengths and any potential risks on their farms. The objective of the program is to help agricultural operations develop and implement a practical plan that uses beneficial management practices to protect and enhance the environment. Both the EFP and BMP Programs are delivered by the BC Agricultural Research & Development Corporation.

Utility Provider Incentive Programs

Various incentives are available from BC Hydro for energy efficiency projects. For most greenhouse operations, the incentives fall into BC Hydro's

Industrial category, and are calculated on a case-by-case basis. For smaller operations product specific incentives are available.

FortisBC (formerly Terasen Gas) at this point in time provides incentives for efficient boiler upgrades, with the incentive amount calculated on a case-by-case basis for larger boilers above 6,000 MBH, subject to approval.

FortisBC Incentive Programs: Efficient Boiler Program

- Condensing Boilers < 6,000 MBH: \$6,000 per boiler + \$9 per MBH plant input.
- Condensing or near-condensing boilers > 6,000 MBH: incentive calculated on a case-by-case basis.

Contact FortisBC for more info.
www.fortisbc.com/EfficientBoiler

BC Hydro Incentive Programs: Industrial (most greenhouses)

Maximum of 75% of project costs to limit of \$500,000

For greenhouses with Key Account Managers (KAM), incentives fall into the Industrial category. Incentive amounts are customized for each project. If you have an energy project in mind, talk to your KAM to find out more, and see: www.bchydro.com/powersmart/industrial.html

Project examples include:

- Lighting Optimization (Redesign) → For customers who use more than \$200,000 of electricity per year. Incentive towards detailed analysis and upgrade to more efficient lighting.
- Lighting Optimization (Retrofit) → For customers who use \$50,000 to \$200,000 of electricity per year. Incentive towards basic analysis and upgrade to more efficient lighting.

BC Hydro Incentive Programs: Commercial (smaller greenhouses)

For smaller greenhouses with no Key Account Manager, projects may be eligible for rebates under the Commercial Product Incentive Program (PIP). To qualify, products must be listed in BC Hydro's e.Catalogue (available online). If products are not listed, they may also be eligible for incentives on a case-by-case basis if the project has estimated savings greater than 50,000 kWh/yr. For more details see: www.bchydro.com/powersmart/commercial.html

Examples of e.Catalogue products include:

- Lighting → Replacement of a 4' T12 lamp + magnetic ballast with a 32W T8 lamp + electronic ballast – rebate of \$10/lamp.
- Pumps → Replacement of a standard pump with variable speed ECM pump (1–2 hp) – rebate of \$2,000/pump.



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