Energy Efficiency and Renewable Energy Improvements for New Homes in Dawson Creek

Version 3 – June 2007

Emanuel Machado
emachado@dawsoncreek.ca
250.784.3661

Matt Horne
matth@pembina.org
604.874.8558 ext 223

Introduction

This paper analyzes several opportunities available to Dawson Creek to reduce electricity and natural gas consumption in new houses with energy efficiency improvements and solar water heating systems[1]. The analysis is intended to support Dawson Creek's Community Action on Energy Efficiency (CAEE) initiative to ensure all new housing is achieving an EnerGuide rating of 80 before 2010. It is also directly relevant to climate policy in British Columbia and the 2007 Speech from the Throne's reference to a BC Green Building Code.

All of the options discussed in this report are well established technologies that are in use throughout BC and internationally. In general, the energy efficiency improvements present better opportunities for economic return and environmental benefit, while solar hot water heating still has a slightly negative economic return even in the best-case scenario. That said, both types of improvements offer real environmental benefits and help insulate homeowners from the risks of fluctuating energy costs. The combined effect of pursuing all of the improvements offers a positive economic return in all scenarios. In Dawson Creek, these improvements have the potential to reduce greenhouse gas emissions by between 35% and 41% compared to standard building practices today. In addition, due to reduced energy consumption, they could provide a net benefit of between $2,000 and $5,000 to homeowners.

The first two sections of this discussion paper describe the improvements in more detail, and the third section follows with a summary of their economic and environmental implications. The paper closes with some next steps that are intended to help progress to the point where the energy efficiency and solar improvements presented in the report become the norm in new housing developments.

The next steps are designed to make this a "living document" that will be updated as the progress is made, and subsequent versions will provide updates as needed. This is the second version.

[1] The same technologies would be applicable to existing housing and commercial buildings, but the economics of those applications are different enough that they are not covered within the scope of this analysis.

Energy Efficiency Improvements

In 2004, the Ministry of Energy, Mines, and Petroleum Resources conducted a series of studies to research improved energy efficiency in new and existing buildings in British Columbia. Of particular relevance to this paper, "Life Cycle Analysis for New Low-Rise Buildings" by SAR Engineering Ltd. and Innes Hood Consulting (January 2004) analyzes the costs and associated energy savings of a variety of improvements for new detached and row housing. The results are presented relative to typical current building practices, and also separated according to heating type (gas or electricity) and geographic location (Lower Mainland, Vancouver Island, Southern Interior, and Northern Interior)[2].

Two of the options explored for detached housing in the Northern Interior (with a total floor space of 264 m^2 or 2,842 ft^2) were found to achieve an EnerGuide rating of 80 or higher. These two options are very similar with the only difference being that Option 1 includes a heat recovery ventilator (HRV) that is integrated with the furnace and hot water heater, as opposed to Option 2, which relies on a separate HRV unit. The full list of improvements considered for homes in the Northern Interior region include the following:

- Insulation and framing – Increasing the levels of insulation and changing framing practices relative to typical construction practice. For the walls: 2x6 wood frame construction with 24" stud spacing, and RSI 3.85 / R22 batt insulation plus 38mm expanded polystyrene (EPS) insulation. For the basement: 2x4 wood frame construction with 24" stud spacing, and RSI 2.1 / R12 batt insulation plus 38 mm extruded polystyrene (XTPS) to 600mm below ground. Additional cost: $935 for walls and $326 for basement.
- Windows – Using windows that are double-glazed, low E (emissivity), and argon filled, with a vinyl frame and insulating spacers between panes of glass. Additional cost: $761
- Ventilation – Replacing principal exhaust fans with heat recovery ventilators connected to the forced air ducts to capture some of the heat leaving the house. Additional cost: $903
- Air Tightness – Reducing the amount of air leakage to 1 to 1.5 (Tight to Somewhat Tight in comparison with a reference value of 0.75 for an R2000 home) Additional cost: $138
- Space and Domestic Hot Water Heating – Installing integrated condensing space heat and hot water system with a variable speed, electronically commutated motor (ECM). Additional cost: $1,600

For options 1 and 2, energy consumption for new homes was reduced by between 73 and 74 GJ per year. This is equivalent to between a 36% and 37% reduction or an improvement to an EnerGuide rating of 81 from a base value of 72 for typical new housing. These improvements were expected to add approximately $4,700 to the cost of a home and reduce energy prices by between $800 and $850 per year based on current natural gas and electricity prices.[3]

[2] The Northern Interior region was modeled using climate conditions for Fort St. John.

[3] It should be noted that although the added cost of each separate improvement could be identified individually, it is not as easy to identify the energy savings that each improvement is responsible for. This is due to the fact that buildings work as a system, with all of the buildings features interacting to determine what the ultimate energy requirements are.

Solar Water Heating Improvements

A solar thermal domestic hot water system traps and uses heat from the sun to raise the temperature of water for showers, washing dishes and laundry. Solar water heating can be used to supply 36% and 65% of water requirements in the home. A conventional hot water tank draws pre-heated water from the solar storage tank thus reducing the amount of natural gas needed to heat water for household use. These systems are safe, reliable and emission-free. Solar collectors are typically installed on the rooftop, taking up otherwise unused space, and resemble low-profile sky-lights, as shown below.

Roof-mounted Solar Collectors for domestic hot water system[4]

To install a typical residential system, the average total cost would be about $5,300, and energy savings would range between $110 and $230 per year based on current natural gas prices in Dawson Creek. The installation is much easier (and cheaper) if the house is built 'Solar Ready', meaning the pipe and sensor wire (for automatic control of the system) are in place from the roof to the mechanical room. If the house is Solar Ready, the installation costs are reduced by $200 to $800 due to the reduced labour requirements.

The expected life of a well-maintained system is 20-25 years. Properly maintained solar collectors should outlast the life of the storage tank. When the storage tank needs replacing, the existing collectors can be connected to the new tank. The life-cycle economics and environmental benefits of solar hot-water systems are discussed in the next section.

Economic and Environmental Implications

The following three tables summarize the key economic and environmental implications of:

- Requiring improved energy efficiency in new homes so that they achieve an EnerGuide rating of 80 or better.
- Requiring new homes to be solar ready or requiring them to have pre-installed solar hot-water systems.
- Requiring a combination of energy efficiency and solar hot water improvements on new homes.

[4] Image courtesy Sedmek Inc. Renewable Energy Systems (www.sedmek.com)

It is important to note that this analysis does not account for the fact that some housing is already using various energy efficiency and renewable energy improvements, and many of those improvements will become somewhat more commonplace regardless of the action Dawson Creek takes. The implication of these statements is that the per-home costs and benefits are most representative of a home that would have otherwise followed "typical" building practices. For a home that was already going to incorporate some of the improvements (e.g. a high efficiency furnace), the incremental costs discussed here will be lower, as will the savings.

The results for energy efficiency improvements show that in both cases an additional cost of $4,700 results in an annual savings of between $800 and $850. These actions would reduce the greenhouse gas emissions from a typical home by between 31% and 33%. On a community scale, seeing these improvements in over 750 homes during the next 20 years would be equivalent to eliminating the greenhouse gas emissions from between 520 and 550 vehicles.

Anticipated costs and benefits for energy efficiency improvements on new homes

	Option 1	Option 2
Extra construction cost per home resulting from improvements	$4,663	$4,661
Energy savings per year	$801	$852
Net benefit over 20 years	$6,434	$7,143
Percentage reduction in household GHG emissions	31%	33%
Equivalent number of vehicles off the road if 768 homes are improved	518	552

The results for solar energy installations show that making a house solar ready adds $300 to the construction cost of a home, while the full cost of a system ranges from $4,700 to $6,070. These actions would reduce the greenhouse gas emissions from a typical home by between 4% and 9%. On a community scale, seeing these improvements in over 750 homes during the next 20 years would be equivalent to eliminating the greenhouse gas emissions from between 70 and 150 vehicles.

Anticipated costs and benefits for solar energy improvements on new homes

	Best-Case Scenario		Mid-Case Scenario		Worst-Case Scenario	
	Solar Ready Required	Solar Installation Required	Solar Ready Required	Solar Installation Required	Solar Ready Required	Solar Installation Required
Extra construction cost per home resulting from improvements	$300	$4,700	$300	$5,385	$300	$6,070
Energy savings per year if solar system is installed	$229		$168		$106	
Net benefit over 20 years if solar system is installed	-$1,524		-$3,064		-$4,604	
Percentage reduction in household GHG emissions	9%		7%		4%	
Equivalent number of vehicles off the road if 768 homes are improved	148		108		68	

The results for energy efficiency improvements in combination with solar energy installations show that the added cost to a new home would be between $9,300 and $10,700 (the cost would be $4,900 if only solar-readiness and energy efficiency improvements were required). These actions would reduce the greenhouse gas emissions from a typical home by between 35% and 41%. On a

community scale, seeing these improvements in over 750 homes during the next 20 years would be equivalent to eliminating the greenhouse gas emissions from between 580 and 680 vehicles.[5]

Anticipated costs and benefits for

	Best-Case Scenario		Mid-Case Scenario		Worst-Case Scenario	
	Solar Ready Required	Solar Installation Required	Solar Ready Required	Solar Installation Required	Solar Ready Required	Solar Installation Required
Extra construction cost per home resulting from improvements	$4,961	$9,361	$4,962	$10,047	$4,963	$10,733
Energy savings per year if solar system is installed	$1,043		$975		$907	
Net benefit over 20 years if solar system is installed	$5,090		$3,460		$1,830	
Percentage reduction in household GHG emissions	41%		38%		35%	
Equivalent number of vehicles off the road if 768 homes are improved	675		631		586	

In summary, the energy efficiency improvements present better opportunities for economic return and environmental benefit, while solar hot water heating still costs slightly more than the savings that will be generated in the best-case scenario. That said, both types of improvements offer real environmental benefits and help insulate homeowners from the risks of fluctuating energy costs. In addition, the combined effect of pursuing all of the improvements offers a positive economic return in all scenarios.

Road Map Forward

Seven steps have been identified to help advance this technical analysis to a point where all new residential developments in Dawson Creek are more energy efficient and are using more renewable energy. The following table summarizes progress on those steps, and the specifics are described in greater detail below. Subsequent versions of this report will update this table and revise scope of the steps where appropriate.

Step #	1	2	3	4	5	6	7
Description	Review document	Select desired improvements	Consider how improvements will best be specified	Consider how to best achieve the improvements	Engage with stakeholders	Engage with Ministry of Community Services	Implement Finalized Policy
Status	☑	☑	☑	☑	☑	☑	❑
Notes	Completed in December 2006	Completed in January 2006	Completed in January 2006	Completed in January 2006	Completed in January 2006	Commenced in March 2007 and ongoing	Will depend on outcome of BC Green Building Code Process

[5] The results for solar and energy efficiency improvements are not additive because the improved water heating efficiency reduces some potential use for the solar system.

The seven steps are:

1. *Review this document with Pembina staff*

   Given the relatively important changes that are being considered for new housing in Dawson Creek, it is critical that key staff understand the technologies being considered, and their economic and environmental implications.

   (Completed December 2006)

2. *Select the improvements that are desired to be standard practice in new homes*

   Dawson Creek needed to decide which of the improvements offered strong enough benefits (e.g. reduced energy costs, reduced greenhouse gas emissions, and reduced risk from energy price fluctuations) to justify any increased costs. The City has decided that there is a strong enough economic and environmental rationale to:

   a. Require all new housing to incorporate the types of energy efficiency improvements discussed in this report, such that they can achieve an EnerGuide rating of 80.

   b. Require all new housing to be built solar-ready to ensure all future owners have the flexibility to install a solar hot water system as inexpensively as possible if they choose to do so. The City will also consider various approaches to ensure that solar systems are installed on those solar-ready homes.

   (Completed January 2007)

3. *Consider how those improvements will be specified to builders and homeowners*

   In this paper, the improvements have been specified in terms of specific technologies that are focused entirely on energy. Dawson Creek has decided that the current specifications are not ideal, and that the policy requiring the improvements specified in step 2 would be more effective if the improvements were specified as follows:

   a. In terms of performance based standards (as opposed to technology prescriptions), so that developers have greater flexibility to find the best way to meet energy performance goals. In terms of energy performance, an EnerGuide rating of 80 seems appropriate.

   b. In terms of more broadly defined sustainability criteria (as opposed to a narrow energy focus), so that development never compromises other priorities in the pursuit of efficiency (indoor air quality for example). The BuiltGreen system is a good example of a broader system, with the only problem being that the energy performance requirement for the Gold rating falls short of EnerGuide 80.

   (Completed January 2007)

4. *Consider strategies to achieve desired changes in building practices*

   There are a variety of approaches available to make the improvements selected in steps 2 and 3 standard practice in Dawson Creek. Dawson Creek has identified the following options as being viable, with the order of preference being ‘a’ (highest) to ‘c’ (lowest).

Dawson Creek would prefer to see the standard maintained and updated by a provincial level body because it would help share the effort across the province and create a level playing field for all developers.

a. A building code change by the Provincial government that would apply to all municipalities. The building code should be developed collaboratively with municipal governments and ideally include provisions for municipalities to exceed province wide standards (e.g. levels of on-site renewable energy requirements).

b. A building code change by the Provincial government that municipalities would have the option of adopting. The building code should be developed collaboratively with municipal governments and ideally include provisions for municipalities to exceed province wide standards (e.g. levels of on-site renewable energy requirements).

c. A bylaw implemented by Dawson Creek with permission from the Minister of Community Services under the Community Charter's concurrent authority clause.

(Completed January 2007)

5. *Engage with stakeholders*

This step will use the results of steps 2, 3, and 4 to facilitate discussions with stakeholders, with the intention being to build a broader base of support.

Stakeholders already contacted:

a. Local developers were met with in January 2007 to gain their perspectives on potential increased development costs and possible training needs. In general, they were supportive of the direction and felt that most of the improvements discussed in this report were already standard practice in their developments. Some concerns were expressed regarding the additional costs for housing and the training needs of local sub-contractors.

Stakeholders still to be contacted:

b. Local suppliers who can provide their perspectives on the potential impacts of increased and decreased demands for various products.

c. Other municipal governments that would be interacting with the same buildings and/or have a specific interest in similar types of housing improvements. Examples would include Bowen Island and North Vancouver.

d. Homeowner associations and realtors who can provide their perspectives on potential increased housing prices and impacts on the real estate market.

6. *Engage with Provincial Government*:

This step is currently ongoing and is using the results of steps 2 through 5 to communicate a position to the Provincial Government with as much support from local stakeholders as possible. More specifically, Dawson Creek is engaging with the Buildings Policy Branch and the Ministry of Energy, Mines, and Petroleum Resources to discuss the desired improvements and explore ways of making them happen that will work at the local and

provincial levels. The political context for this step was dramatically changed by the 2007 Throne Speech, which promised the development of a Green Building Code. As a result, Dawson Creek has been participating in these discussions with the intent of securing strong energy efficiency and renewable energy provisions in the new code.

7. *Implement finalized policy*

   The exact nature of this step will depend on the outcome of the green building code process that is expected to be complete by late 2007 or early 2008. Dawson Creek will continue to participate in this process and evaluate what additional steps (if any) need to be taken once it is complete.

Supporting Documentation and Analysis

- The expected energy savings and incremental capital costs for energy efficiency improvements were obtained from "Life Cycle Analysis for New Low-Rise Buildings". The report was prepared by SAR Engineering Ltd. and Innes Hood Consulting in January 2004 and is available from the Ministry of Energy, Mines, and Petroleum Resources.
- The expected energy savings and material and installation costs for solar hot water heating systems were calculated by the Pembina Institute. Contact Matt Horne for additional information (604.874.8558 ext 223 / matth@pembina.org).
- The cost effectiveness and environmental benefits of energy efficiency and solar improvements at a household and community scale were calculated by the Pembina Institute. Contact Matt Horne for additional information (604.874.8558 ext 223 / matth@pembina.org).