

REGULATORY IMPACT STUDY FOR WATER AND GROUND SOURCE HEAT PUMPS

PREPARED BY:

ENERGY EFFICIENCY BRANCH,

BC MINISTRY OF ENERGY AND MINES

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AUGUST 31, 2012 – UPDATED SEPTEMBER 27, 2012

COMMENTS MUST BE RECEIVED BY OCTOBER 30TH, 2012

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SCOPE AND REQUIREMENTS

TYPE OF DEVICE	<p>Geothermal (Geoexchange) Heat Pumps (also referred to as Ground Source Heat Pump – GSHP) including:</p> <p>Water-to-air heat pumps used in both open (ground water) and closed loop (ground loop or closed lake, pond or ocean loop) configurations with a heating or cooling capacity up to and including 40 kW (135,000 Btu/hr).</p> <p>Water-to-water heat pumps used in both open (ground water) and closed loop (ground loop or closed lake, pond or ocean loop) configurations with a heating or cooling capacity up to and including 40 kW (135,000 Btu/hr).</p> <p>This proposed regulation will affect heat pump equipment only, not the ground loop installation and equipment or building air or water distribution systems.</p>																					
TEST STANDARD	<p>CAN/CSA-C13256-1-01 for Water-to-air and brine-to-air heat pumps</p> <p>CAN/CSA-C13256-2-01 for Water-to-water and brine-to-water heat pumps</p>																					
PROPOSED ENERGY PERFORMANCE STANDARD	<table border="1" data-bbox="451 905 1289 1331"> <thead> <tr> <th>Application</th> <th>COP_h</th> <th>COP_c (EER)</th> </tr> </thead> <tbody> <tr> <td colspan="3">Water-to-Air</td> </tr> <tr> <td>Closed Loop</td> <td>3.3 3.1</td> <td>4.1 (14.1) 3.93</td> </tr> <tr> <td>Open Loop</td> <td>3.6</td> <td>4.7 (16.2) 4.75</td> </tr> <tr> <td colspan="3">Water-to-Water</td> </tr> <tr> <td>Closed Loop</td> <td>3.0 2.8</td> <td>4.4 (15.1) 4.21</td> </tr> <tr> <td>Open Loop</td> <td>3.4</td> <td>5.6 (19.1)</td> </tr> </tbody> </table> <p>COP_h – Coefficient of Performance Heating</p> <p>COP_c – Coefficient of Performance Cooling</p> <p>COP is Coefficient of Performance is the ratio of net heating or cooling capacity to the power input.</p> <p>Energy Efficiency Ratio (EER) is total cooling capacity (Btu/hr) per electrical energy input (Kw) - Energy Star requirements are listed in EER.</p> <p><i>Note: these standards are consistent with the former voluntary ENERGY STAR[®] tier 1 requirements. The proposed standard has been updated to align with the proposed National Building Code equipment efficiency requirements.</i></p>	Application	COP _h	COP _c (EER)	Water-to-Air			Closed Loop	3.3 3.1	4.1 (14.1) 3.93	Open Loop	3.6	4.7 (16.2) 4.75	Water-to-Water			Closed Loop	3.0 2.8	4.4 (15.1) 4.21	Open Loop	3.4	5.6 (19.1)
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EFFECTIVE DATE	<p>Products manufactured and sold after September 1st, 2013</p>																					

<p>CERTIFICATION</p>	<p>Verification of compliance with the energy performance standard based on the noted “Test Standard(s)” is required.</p> <p>However, no new testing or labeling requirement is proposed, as products are already tested for the Natural Resources Canada (NRCAN) product database which could be used to verify compliance with the BC standards:</p> <p>http://oe.nrcan.gc.ca/pml-lmp/index.cfm?action=app.search-recherche&appliance=HP_GS</p>																																																																																																																				
<p>NEED FOR REGULATION</p>	<p>This energy efficiency standard is proposed for geothermal or ground source heat pump (GSHP) equipment. The standard will address the following:</p> <ul style="list-style-type: none"> Existing Energy Efficiency Regulations reference out of date test standards (CAN/CSA C-446-94) for both water-to-air and water-to-water GSHP. This amendment would reference the current Canadian and international test standards for geothermal heat pumps (CAN/CSA-C13256-1). The current performance specifications identified in the Energy Efficiency Regulations are lower than the National Standards published by NRCAN and California for water-to-air geothermal heat pumps. Minimum efficiencies for GSHP identified in CSA/CAN C13256 and adopted by NRCAN and California are for water-to-air but not for water-to-water heat pumps (Table 1). Water-to-water heat pumps are therefore currently excluded from energy efficiency standards. Market transformation has been supported by the United States Federal Tax Credits for Consumer Energy Efficiency program that requires heat pumps to meet current ENERGY STAR® efficiencies. The LiveSmart BC and previous NRCAN ecoENERGY grants were established prior to ENERGY STAR standards for geothermal heat pumps. Market forces have increased efficiencies of GSHPs above what is currently specified in the regulation and it is believed that all geothermal heat pumps sold in BC already meet the proposed efficiency standard. <p>Table 1 – Current and proposed energy efficiency standards for GSHP equipment (EWT – entering water temperature in testing standard). <i>Proposed requirements have been updated to align with proposed National Building Code equipment efficiency requirements.</i></p> <table border="1" data-bbox="451 1423 1459 1755"> <thead> <tr> <th rowspan="2">Testing Standard</th> <th colspan="4">Current Requirements</th> <th colspan="4">Proposed Requirements</th> <th colspan="4">Energy Star - Tier 3 - Voluntary</th> </tr> <tr> <th colspan="4">CAN/CSA C-446-94</th> <th colspan="4">CAN/CSA-C13256-1</th> <th colspan="4">CAN/CSA-C13256-1</th> </tr> <tr> <th></th> <th>Heating COP_h</th> <th>EWT °C</th> <th>Cooling COP_c (EER)</th> <th>EWT °C</th> <th>Heating COP_h</th> <th>EWT °C</th> <th>Cooling COP_c (EER)</th> <th>EWT °C</th> <th>Heating COP_h</th> <th>EWT °C</th> <th>Cooling COP_c (EER)</th> <th>EWT °C</th> </tr> </thead> <tbody> <tr> <td colspan="13">Water to Air Pumps</td> </tr> <tr> <td>Closed Loop</td> <td>2.8</td> <td>0</td> <td>3.8 (13)</td> <td>10</td> <td>3.1</td> <td>0</td> <td>3.93 (13.4)</td> <td>15</td> <td>3.6</td> <td>0</td> <td>5.0 (17.1)</td> <td>15</td> </tr> <tr> <td>Open Loop</td> <td>3.1</td> <td>10</td> <td>3.3 (11.5)</td> <td>25</td> <td>3.6</td> <td>10</td> <td>4.75 (16.2)</td> <td>25</td> <td>4.1</td> <td>10</td> <td>6.2 (21.1)</td> <td>25</td> </tr> <tr> <td colspan="13">Water to Water Pumps</td> </tr> <tr> <td>Closed Loop</td> <td>2.8</td> <td>0</td> <td>3.8 (13)</td> <td>10</td> <td>2.8</td> <td>0</td> <td>4.21 (14.4)</td> <td>15</td> <td>3.1</td> <td>0</td> <td>4.7 (16.1)</td> <td>15</td> </tr> <tr> <td>Open Loop</td> <td>3.1</td> <td>10</td> <td>3.3 (11.5)</td> <td>25</td> <td>3.4</td> <td>10</td> <td>5.6 (19.1)</td> <td>25</td> <td>3.5</td> <td>10</td> <td>5.9 (20.1)</td> <td>25</td> </tr> </tbody> </table>	Testing Standard	Current Requirements				Proposed Requirements				Energy Star - Tier 3 - Voluntary				CAN/CSA C-446-94				CAN/CSA-C13256-1				CAN/CSA-C13256-1					Heating COP _h	EWT °C	Cooling COP _c (EER)	EWT °C	Heating COP _h	EWT °C	Cooling COP _c (EER)	EWT °C	Heating COP _h	EWT °C	Cooling COP _c (EER)	EWT °C	Water to Air Pumps													Closed Loop	2.8	0	3.8 (13)	10	3.1	0	3.93 (13.4)	15	3.6	0	5.0 (17.1)	15	Open Loop	3.1	10	3.3 (11.5)	25	3.6	10	4.75 (16.2)	25	4.1	10	6.2 (21.1)	25	Water to Water Pumps													Closed Loop	2.8	0	3.8 (13)	10	2.8	0	4.21 (14.4)	15	3.1	0	4.7 (16.1)	15	Open Loop	3.1	10	3.3 (11.5)	25	3.4	10	5.6 (19.1)	25	3.5	10	5.9 (20.1)	25
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<p>HARMONIZATION</p>	<p>British Columbia’s current minimum efficiency for geothermal heat pumps is lower than current NRCan and California standards. Harmonization with these jurisdictions would not be advantageous as they are outdated and have not specified standards for Water-to-Water geothermal heat pumps, which are a growing segment of the equipment market.</p> <p>The proposed minimum efficiencies align with ENERGY STAR Tier 1 which was in effect between December 1, 2009 and December 31, 2010. The proposed standard has been updated to align with the proposed National Building Code equipment efficiency requirements. These standards partly align with NRCan and California standards for open loop Water-to-Air heat pumps, adopt a higher standard for closed loop and add standards for Water-to-Water geothermal heat pumps.</p> <p>Table 2 - Comparison of NRCan, California and proposed requirements for geothermal heat pumps <i>Proposed requirements have been updated to align with proposed National Building Code equipment efficiency requirements.</i></p> <table border="1"> <thead> <tr> <th></th> <th colspan="4">NRCan</th> <th colspan="4">California</th> <th colspan="4">Proposed Requirements</th> </tr> <tr> <th>Testing Standard</th> <th colspan="4">CAN/CSA-C13256-1</th> <th colspan="4">ISO 13256-1</th> <th colspan="4">CAN/CSA-C13256-1</th> </tr> <tr> <th></th> <th colspan="4">June 1, 2006</th> <th colspan="4">October 29, 2003</th> <th colspan="4"></th> </tr> <tr> <th></th> <th>Heating COP_h</th> <th>EWT °C</th> <th>Cooling COP_c (EER)</th> <th>EWT °C</th> <th>Heating COP_h</th> <th>EWT °C</th> <th>Cooling COP_c (EER)</th> <th>EWT °C</th> <th>Heating COP_h</th> <th>EWT °C</th> <th>Cooling COP_c (EER)</th> <th>EWT °C</th> </tr> </thead> <tbody> <tr> <td colspan="13">Water to Air Pumps</td> </tr> <tr> <td>Closed Loop</td> <td>3.1</td> <td>0</td> <td>3.93 (13.4)</td> <td>15</td> <td>3.1</td> <td>0</td> <td>3.93 (13.4)</td> <td>15</td> <td>3.1</td> <td>0</td> <td>3.93 (13.4)</td> <td>15</td> </tr> <tr> <td>Open Loop</td> <td>3.6</td> <td>10</td> <td>4.75 (16.2)</td> <td>25</td> <td>3.6</td> <td>10</td> <td>4.75 (16.2)</td> <td>25</td> <td>3.6</td> <td>10</td> <td>4.75 (16.2)</td> <td>25</td> </tr> <tr> <td colspan="13">Water to Water Pumps</td> </tr> <tr> <td>Closed Loop</td> <td colspan="4">no min COP Specified</td> <td colspan="4">no min COP Specified</td> <td>2.8</td> <td>0</td> <td>4.21 (14.4)</td> <td>15</td> </tr> <tr> <td>Open Loop</td> <td colspan="4">no min COP Specified</td> <td colspan="4">no min COP Specified</td> <td>3.4</td> <td>10</td> <td>5.6 (19.1)</td> <td>25</td> </tr> </tbody> </table>		NRCan				California				Proposed Requirements				Testing Standard	CAN/CSA-C13256-1				ISO 13256-1				CAN/CSA-C13256-1					June 1, 2006				October 29, 2003									Heating COP _h	EWT °C	Cooling COP _c (EER)	EWT °C	Heating COP _h	EWT °C	Cooling COP _c (EER)	EWT °C	Heating COP _h	EWT °C	Cooling COP _c (EER)	EWT °C	Water to Air Pumps													Closed Loop	3.1	0	3.93 (13.4)	15	3.1	0	3.93 (13.4)	15	3.1	0	3.93 (13.4)	15	Open Loop	3.6	10	4.75 (16.2)	25	3.6	10	4.75 (16.2)	25	3.6	10	4.75 (16.2)	25	Water to Water Pumps													Closed Loop	no min COP Specified				no min COP Specified				2.8	0	4.21 (14.4)	15	Open Loop	no min COP Specified				no min COP Specified				3.4	10	5.6 (19.1)	25
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<p>TRANSPARENT REGULATION DEVELOPMENT</p>	<p>Development of the proposed regulation included the following steps:</p> <ul style="list-style-type: none"> • Economic assessment by the Province of BC • Regulatory assessment by the Province of BC <p>Stakeholder consultation began in spring 2012, including a workshop and solicitation of written responses to this regulatory impact statement in September and October 2012. Additional stakeholder feedback sessions may be scheduled as required.</p>																																																																																																																																		

MARKET TRANSFORMATION STRATEGY	<p>Market transformation efforts have included provincial and federal consumer rebate programs, with the former operating between 2008 to present, and the latter ending in 2012. Both the LiveSmart BC and Federal ecoENERGY retrofit programs have required that ground source heat pumps systems be compliant with Canadian Standards CSA 448, an installation and design standard, and be certified by the Canadian Geoexchange Coalition. These programs have focused on the retrofit of existing residential heating systems and the total design and reliability of the system.</p> <p>The United States Federal Tax Credits for Consumer Energy Efficiency (30% of costs with no upper limit, expiring December 31, 2016) require that heat pumps installed meet current ENERGY STAR standards. As a result, most manufacturers' product lines conform to the current ENERGY STAR (tier 3) standard.</p> <p>The Canadian Geoexchange Coalition has developed, as part of its market transformation initiative, certification programs for GSHP designers, installers and drillers to ensure increase consumer confidence in the design and installation of ground source heat pump systems. Geoexchange BC has worked proactively to promote ground source heat pump systems in British Columbia and develop procurement and a series of professional guidelines highlighting concerns unique to British Columbia.</p> <p><i>Demand-Side Management Attribution</i></p> <p>This proposed regulation can be promoted by energy utilities through their Demand-Side Management (DSM) programs, leading to increased market share of compliant products prior to the effective date. In turn, part of the energy savings from the proposed regulation can be attributed back to those DSM programs as per Section 4 (Subsection 1.4) of the Demand-Side Measures Regulation under the <i>Utilities Commission Act</i>:</p> <p>http://www.bclaws.ca/EPLibraries/bclaws_new/document/ID/freeside/10_326_2008</p>
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ASSESSMENT FROM AN INDUSTRY PERSPECTIVE

RANGE OF PRODUCTS AFFECTED	<p>All water-to-water and water-to-air, ground or water source heat pumps used in an open or closed loop configuration up to 40 kW (135,000 Btu/hr).</p>
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COST IMPACT	<p>The regulation proposes to increase minimum energy efficiency standards of ground source heat pumps to align with the former ENERGY STAR tier 1 requirements (expired December 31, 2010). <i>The proposed standard has been updated to align with the proposed National Building Code equipment efficiency requirements.</i></p> <p>Manufacturers that have pursued ENERGY STAR certification since December 2009 for geothermal heat pumps will therefore already meet this standard and will not experience any further costs. Current ENERGY STAR tier 3 requirements will remain a voluntary measure.</p> <p>No new labelling of equipment will be required. Publication of net heating and cooling capacities and coefficient of performance specified in CAN/CSA-C13256-1 (section 8) is already an NRCAN requirement. Therefore, no additional costs are expected to be incurred by manufacturers.</p>
COMPETITIVE ANALYSIS	<p>The Federal Tax Credit program in the United States requires that eligible ground source heat pumps meet current ENERGY STAR requirements at the time of installation. This becomes a market force for increasing the energy efficiency of ground source heat pumps in North America. It was applied equally across all manufacturers, thus ensuring a level playing field.</p>
MARKET SHARE	<p>Over 6,680 geothermal heat pumps are identified as meeting current voluntary ENERGY STAR (tier3) requirements by NRCAN. All of the remaining 31 heat pumps listed by NRCAN meet the proposed regulation.</p>
WASTE MANAGEMENT	<p>Geothermal heat pumps have a serviceable life typically in excess of 20 years.</p>

COST ASSESSMENT FROM A CONSUMER PERSPECTIVE

CAPITAL / PURCHASE COSTS RESIDENTIAL	<p>Current models of ground source heat pumps from multiple manufacturers meet the proposed energy efficiency standards. Therefore incremental costs to consumers associated with meeting the proposed energy efficiency standard is zero. However, heat pumps not conforming to the proposed energy efficiency standards could be introduced in future. In this scenario it was estimated that non-conforming heat pumps would be \$174 less expensive than conforming ones.</p> <p>It is expected that costs of ground source heat pumps will decrease over time due to increase in market share. However, if the United States Federal Tax Credits for Consumer Energy Efficiency is not extended, there is a possibility that lower efficiency heat pumps may gain market share in North America after 2016. It is assumed that lower efficiency heat pumps could be marketed at a discount.</p>
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COST-BENEFIT ANALYSIS ENERGY SAVINGS FOR EACH CONSUMER	<p>A cost benefit analysis was performed with the following assumptions:</p> <ul style="list-style-type: none"> • A model of installations was developed based on historical data from Canadian Geoexchange Coalition with modest growth; • The baseline was assumed to be a non-compliant geoexchange system that meets current Energy Efficiency Act standards; • Installations were modelled for 10 years, with an additional 10 years of energy savings modeled for both Single Family Dwellings (SFD) and Multiple Unit Residential Buildings (MURB) scenarios; • The costing analysis is based on the 2011 rate structure, escalating by 8.0%, 7.1% and 1.44% through to 2014 (including the rate rider effective April 1, 2012), reflecting the BC Utilities Commission Order G-17-12, dated February 15, 2012, and the announcement of the provincial government’s direction to the Commission in May 2012 (http://www2.news.gov.bc.ca/news_releases_2009-2013/2012ENER0063-000720.htm); • An 8% discount rate was used; • Energy savings were modeled based on an average improvement in efficiency from current regulated efficiencies. The average takes into account the variation between water-to-air and water-to-water heat pumps and the ratio between open loop and closed loop configurations; • Heating loads were estimated from BC Hydro and Fortis BC end use studies; and • Average annual energy savings estimated were estimated as: <table border="1" data-bbox="516 953 1367 1064"> <thead> <tr> <th></th> <th>Single Family Dwelling</th> <th>Multi Unit Residential Building</th> </tr> </thead> <tbody> <tr> <td>Energy Savings/unit</td> <td>594 kWh/year</td> <td>332 kWh/year</td> </tr> </tbody> </table> <p>A positive benefit was calculated for consumers of \$22 with as simple payback of 4.25 years.</p> <p>Although the proposed energy efficiency standard has been updated, the economic model has not been revised. The change to the NBC-aligned standard will not materially impact the energy efficiency gains or consumer savings from the proposed regulation.</p>		Single Family Dwelling	Multi Unit Residential Building	Energy Savings/unit	594 kWh/year	332 kWh/year
	Single Family Dwelling	Multi Unit Residential Building					
Energy Savings/unit	594 kWh/year	332 kWh/year					
CAPITAL / PURCHASE COSTS COMMERCIAL	<p>An analysis of commercial applications indicated that the capacity of the majority of GSHP equipment installed was larger than the heating or cooling capacity up to and including 40 kW (135,000 Btu/hr) covered by this proposed regulation.</p>						

ASSESSMENT FROM A PROVINCIAL GOVERNMENT PERSPECTIVE

<p>ECONOMIC ASSESSMENT FROM A PROVINCIAL PERSPECTIVE</p> <p><i>(Aggregate energy, emission and net cost savings)</i></p>	<p>The effect of the proposed energy efficiency standards has been modeled to estimate the economic impact of implementation. The model was based on the consumer model with the following assumptions:</p> <ul style="list-style-type: none"> • A marginal cost of power with a 2% increase for 10 years, then flat for the remaining 10 years modeled; and • A 6% discount rate. <p>The cumulative electricity savings to 2020 and cost savings generated by this regulation from the proposed effective date to year 2032 are shown below:</p> <table border="1" data-bbox="518 583 1362 739"> <tr> <td>Cumulative Electricity Savings to 2020 in GWh/yr and million \$</td> <td>32,663 GWh/ \$4.76M</td> </tr> <tr> <td>Provincial NPV in million \$</td> <td>\$10.8M</td> </tr> </table> <p>Although the proposed energy efficiency standard has been updated, the economic model has not been revised. The change to the NBC-aligned standard will not materially impact the energy efficiency gains or consumer savings from the proposed regulation</p>	Cumulative Electricity Savings to 2020 in GWh/yr and million \$	32,663 GWh/ \$4.76M	Provincial NPV in million \$	\$10.8M
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Provincial NPV in million \$	\$10.8M				
<p>REGULATORY REQUIREMENTS AVOID OR ELIMINATE DUPLICATION WITH OTHER JURISDICTIONS</p>	<p>This regulation will correct the following deficiencies in the current Energy Efficiency Standards Regulation:</p> <ul style="list-style-type: none"> • The current regulations reference out of date testing protocols. This update is required to reference current national and international standards; • Efficiency regulations contained within CAN/CSA C13256 do not address water-to-water heat pumps so this regulation will address this omission by specifying minimum efficiencies; • Current minimum efficiencies for geothermal heat pumps are much lower than models currently on the market due to market transformation efforts; and • This regulation would bring British Columbia's requirements into alignment with ENERGY STAR tier 1 requirements. The proposed standard has been updated to align with the proposed National Building Code equipment efficiency requirements. 				
<p>ADMINISTRATIVE FEASIBILITY FOR COMPLIANCE AND ENFORCEMENT</p>	<p>The compliance and enforcement approach is based on product listings on the NRCan database and education of manufacturers, distributors, retailers, home builders and developers, and consumers with respect to energy efficiency standards and labelling requirements.</p>				

NOTES

<p>REGULATORY ASSESSMENT COMPLETED BY</p>	<p>Warren Walsh, M.Sc. P.Geo. British Columbia Ministry of Energy and Mines Email: Warren.Walsh@gov.bc.ca</p>
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DATE	August 31, 2012 – Update September 27, 2012
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