

## Electrical energy GHG emission factors for BC

Calculating greenhouse gas (GHG) emissions in the process of generating electrical energy is a problem. The energy comes from many different sources, each with its own emission factor (EF), but because power supply systems are integrated across North America, it is not possible to identify which particular source is supplying any particular customer. A solution to this accounting problem has to provide useful information, yet be simple enough that the calculation can easily be repeated by others.

Approximately 88% of BC Hydro (BCH)'s installed capacity is hydroelectric and emits no GHG. The remaining 12% is fossil fuelled and is used for meeting peak demand in winter and supplying remote off-grid locations. Installed generating capacity however does not accurately reflect usage. Burrard thermal generating plant is a good example. It only produces expensive and "dirty" power and so is used as seldom as possible even though it remains on BCH's books as an available generator. Installed capacity is thus a poor indicator of GHG emissions.

A better way is to look at energy statistics. There are two sources of data on energy usage, namely *energy production* and *energy consumption*. These two are exactly equal when all sources of production and all sources of consumption are considered in a self-contained system. However, for a selected area within the system, the two numbers will only rarely balance, the difference being made up of the selected area's imports and exports.

Imports are hugely beneficial because imports allow a geographical area to handle its peak demand without having to build generating capacity that would, at other than peak times, not be required. Equally, exports make good use of any available spare generating capacity that would otherwise be idle. Unfortunately for the environment however, once the infrastructure for transmitting energy back and forth exists, decisions as to whether to import or export are made with an eye to making money on the trade, not minimizing GHG emissions.

From a GHG accounting perspective, the difficulty is that the emission factors (EF in kilotonnes of CO<sub>2</sub> equivalent per GWh) of imports and exports are not the same. In BC, we like to use an accounting system that uses only the EF of energy produced in BC because at 17 kt/GWh it is low. Albertans on the other hand object, with reason, to being held responsible for emissions resulting from the generation of electrical power for out-of-province users because at 882 kt/GWh, their EF is very high. They would prefer an accounting system where only the EF of energy consumed is considered. With an accounting system that counts GHG only where it is emitted, it would be better for Alberta to ship fossil fuel to its customers rather than use it to generate electrical energy on their behalf, because that way they avoid having the GHG on their account. BC does exactly this when it exports coal.

My suggested solution to this problem is as follows. It counts all the energy produced in BC by BCH and Independent Power Producers (IPPs) for the benefit of consumers in BC as having the average EF of BCH using its own facilities. IPPs are mostly if not entirely green and so probably match BCH's mix fairly closely. The proposed indicator counts the *net* energy imported into BC for the benefit of consumers in BC as having the weighted average Canadian EF. This indicator has the following advantages: reducing imports brings the indicator EF closer to BCH's EF; increasing imports makes the indicator EF closer to the Canadian EF; improving BCH's EF improves the indicator EF; improving the Canadian average improves the indicator EF; and it is not assumed that all imported energy has a high EF.

Here's the calculations for 2001–10 using re-interpreted data from BCH Annual Reports.

## BCH BALANCE SHEET 2011

### USED IN BC(GWh)

Electricity sold, domestic total	50607	
Line loss and system use	<u>4701</u>	
<b>TOTAL</b>	55073	<u>55308</u>

### ACQUIRED (GWh)

Electricity purchased, long-term contracts	15295	
Electricity purchased, short-term contracts	26340	
Less electricity sold, trade	-26253	
Energy exchange net	<u>372</u>	
<b>TOTAL</b>	15754	15754

### GENERATED IN BC

Burrard thermal generation	58	
Other thermal	<u>193</u>	
Total thermal	251	251
Hydro generation	<u>39303</u>	
<b>TOTAL</b>	39554	<u>39554</u>

### ACQUIRED AND GENERATED

55308

### BCH emission factor 2010

<u>GWh</u>		<u>kt/GWh</u>	<u>Mt</u>
58	@ BCH thermal generation rate	523	30.3
193	@ BCH thermal generation rate	640	123.5
39303	@ BCH hydroelectric generation rate	0	0
<u>15754</u>	@ Canadian average rate*	220	<u>3465.9</u>
55308			3619.7
	BCH average for BC 2011	<u>65.4</u> kt/GWh	

\* assumed to be constant over the decade because it has not been researched.

## BCH BALANCE SHEET 2010

### USED IN BC(GWh)

Electricity sold, domestic total	50233	
Line loss and system use	<u>4840</u>	
<b>TOTAL</b>	55073	<u>55073</u>

### ACQUIRED (GWh)

Electricity purchased, long-term contracts	13403	
Electricity purchased, short-term contracts	27217	
Less electricity sold, trade	-28210	
Energy exchange net	<u>-1092</u>	
<b>TOTAL</b>	11318	11318

### GENERATED IN BC

Burrard thermal generation	233	
Other thermal	<u>315</u>	
Total thermal	548	548
Hydro generation	<u>43207</u>	
<b>TOTAL</b>	43755	<u>43755</u>

### ACQUIRED AND GENERATED

55073

### BCH emission factor 2010

<u>GWh</u>		<u>kt/GWh</u>	<u>Mt</u>
233	@ BCH thermal generation rate	523	121.9
315	@ BCH thermal generation rate	640	201.6
43207	@ BCH hydroelectric generation rate	0	0
<u>11318</u>	@ Canadian average rate*	220	<u>2490.0</u>
55073			2813.5
BCH average for BC 2010		<u>51.1</u>	kt/GWh

\* assumed to be constant over the decade because it has not been researched.

## BCH BALANCE SHEET 2009

### USED IN BC(GWh)

Electricity sold, domestic total	52512	
Line loss and system use	<u>5241</u>	
<b>TOTAL</b>	<b>57753</b>	<u><b>57753</b></u>

### ACQUIRED (GWh)

Electricity purchased, long-term contracts	12359	
Electricity purchased, short-term contracts	33237	
Less electricity sold, trade	-32504	
Energy exchange net	<u>537</u>	
<b>TOTAL</b>	<b>13629</b>	<b>13629</b>

### GENERATED IN BC

Burrard thermal generation	116	
Other thermal	<u>196</u>	
Total thermal	312	312
Hydro generation	<u>43812</u>	
<b>TOTAL</b>	<b>44124</b>	<u><b>44124</b></u>

### ACQUIRED AND GENERATED

57753

### BCH emission factor 2009

<u>GWh</u>		<u>kt/GWh</u>	<u>Mt</u>
116	@ BCH thermal generation rate	523	60.7
196	@ BCH thermal generation rate	640	125.4
43813	@ BCH hydroelectric generation rate	0	0
<u>13628</u>	@ Canadian average rate*	220	<u>2998.2</u>
57753			3184.3
	BCH average for BC 2009	<u>55.1</u> kt/GWh	

\* assumed to be constant over the decade because it has not been researched.

## BCH BALANCE SHEET 2008

### USED IN BC(GWh)

Electricity sold, domestic total	53300	
Line loss and system use	<u>5676</u>	
<b>TOTAL</b>	<b>58976</b>	<u>58976</u>

### ACQUIRED (GWh)

Electricity purchased, long-term contracts	11878	
Electricity purchased, short-term contracts	32281	
Less electricity sold, trade	-37450	
Energy exchange net	<u>-486</u>	
<b>TOTAL</b>	<b>6223</b>	<b>6223</b>

### GENERATED IN BC

Burrard thermal generation	260			
Other thermal	<u>353</u>			
Total thermal	613	613		
Hydro generation		<u>52140</u>		
<b>TOTAL</b>		<b>52753</b>		<u>52753</u>

**ACQUIRED AND GENERATED** 58976

### BCH emission factor 2008

<u>GWh</u>		<u>kt/GWh</u>	<u>Mt</u>
260	@ BCH thermal generation rate	523	136.0
353	@ BCH thermal generation rate	640	225.9
52140	@ BCH hydroelectric generation rate	0	0
<u>6223</u>	@ Canadian average rate*	220	<u>1369.3</u>
58976			1731.2
	BCH average for BC 2008	<u>29.4</u> kt/GWh	

\* assumed to be constant over the decade because it has not been researched.

## BCH BALANCE SHEET 2007

### USED IN BC(GWh)

Electricity sold, domestic total	52911	
Line loss and system use	<u>5329</u>	
<b>TOTAL</b>	<b>58240</b>	<u><b>58240</b></u>

### ACQUIRED (GWh)

Electricity purchased, long-term contracts	10306	
Electricity purchased, short-term contracts	35360	
Less electricity sold, trade	-33372	
Energy exchange net	<u>410</u>	
<b>TOTAL</b>	<b>12704</b>	<b>12704</b>

### GENERATED IN BC

Burrard thermal generation	727	
Other thermal	<u>333</u>	
Total thermal	1060	1060
Hydro generation	<u>44476</u>	
<b>TOTAL</b>	<b>45536</b>	<u><b>45536</b></u>

**ACQUIRED AND GENERATED** **58240**

### BCH emission factor 2007

<u>GWh</u>		<u>kt/GWh</u>	<u>Mt</u>
727	@ BCH thermal generation rate	523	380.2
333	@ BCH thermal generation rate	640	213.1
44476	@ BCH hydroelectric generation rate	0	0
<u>12704</u>	@ Canadian average rate	220	<u>2794.9</u>
58240			3388.2
	BCH average for BC 2007	<u>58.2</u> kt/GWh	

## BCH BALANCE SHEET 2006

### USED IN BC(GWh)

Electricity sold, domestic total	52440	
Line loss and system use	<u>5356</u>	
<b>TOTAL</b>	<b>57796</b>	<u>57796</u>

### ACQUIRED (GWh)

Electricity purchased, long-term contracts	11275	
Electricity purchased, short-term contracts	29831	
Less electricity sold, trade	-29906	
Energy exchange net	<u>-629</u>	
<b>TOTAL</b>	<b>10571</b>	10571

### GENERATED IN BC

Burrard thermal generation	39		
Other thermal	<u>336</u>		
Total thermal	375	375	
Hydro generation		<u>46580</u>	
<b>TOTAL</b>		<b>47225</b>	<u>47225</u>

### ACQUIRED AND GENERATED

57796

### BCH emission factor 2006

<u>GWh</u>		<u>kt/GWh</u>	<u>Mt</u>
39	@ BCH thermal generation rate	523	20.4
336	@ BCH thermal generation rate	640	215.0
46580	@ BCH hydroelectric generation rate	0	0
<u>10571</u>	@ Canadian average rate	220	<u>2325.6</u>
58976			2561.0
	BCH average for BC 2006	<u>44.3</u> kt/GWh	

## BCH BALANCE SHEET 2005

### USED IN BC(GWh)

Electricity sold, domestic total	51205	
Line loss and system use	<u>4660</u>	
<b>TOTAL</b>	<b>55865</b>	<u>55865</u>

### ACQUIRED (GWh)

Electricity purchased, long-term contracts	10992	
Electricity purchased, short-term contracts	32637	
Less electricity sold, trade	-29706	
Energy exchange net	<u>-440</u>	
<b>TOTAL</b>	<b>13483</b>	<b>13483</b>

### GENERATED IN BC

Burrard thermal generation	456	
Other thermal	<u>325</u>	
Total thermal	781	781
Hydro generation	<u>41601</u>	
<b>TOTAL</b>	<b>42382</b>	<u>42382</u>

### ACQUIRED AND GENERATED

55865

### BCH emission factor 2005

<u>GWh</u>		<u>kt/GWh</u>	<u>Mt</u>
456	@ BCH thermal generation rate	523	238.5
325	@ BCH thermal generation rate	640	208.0
41601	@ BCH hydroelectric generation rate	0	0
<u>13483</u>	@ Canadian average rate	220	<u>2966.3</u>
58976			3412.8
	BCH average for BC 2005	<u>61.1</u> kt/GWh	



## BCH BALANCE SHEET 2004

### USED IN BC(GWh)

Electricity sold, domestic total	50151	
Line loss and system use	<u>4969</u>	
<b>TOTAL</b>	<b>55120</b>	<b><u>55120</u></b>

### ACQUIRED (GWh)

Electricity purchased, long-term contracts	10681	
Electricity purchased, short-term contracts	29402	
Less electricity sold, trade	-28373	
Energy exchange net	<u>-1218</u>	
<b>TOTAL</b>	<b>10132</b>	<b>10132</b>

### GENERATED IN BC

Burrard thermal generation	136	
Other thermal	<u>312</u>	
Total thermal	448	448
Hydro generation	<u>44540</u>	
<b>TOTAL</b>	<b>44988</b>	<b><u>44988</u></b>

### ACQUIRED AND GENERATED

**55120**

### BCH emission factor 2004

<u>GWh</u>		<u>kt/GWh</u>	<u>Mt</u>
136	@ BCH thermal generation rate	523	71.1
312	@ BCH thermal generation rate	640	199.7
44540	@ BCH hydroelectric generation rate	0	0
<u>10132</u>	@ Canadian average rate	220	<u>2229.0</u>
58976			2499.8
	BCH average for BC 2004	<u>45.4</u> kt/GWh	

## BCH BALANCE SHEET 2003

### USED IN BC(GWh)

Electricity sold, domestic total	48677	
Line loss and system use	<u>4689</u>	
<b>TOTAL</b>	53366	<u>53366</u>

### ACQUIRED (GWh)

Electricity purchased, long-term contracts	7518	
Electricity purchased, short-term contracts	30560	
Less electricity sold, trade	-31182	
Energy exchange net	<u>-1605</u>	
<b>TOTAL</b>	5291	5291

### GENERATED IN BC

Burrard thermal generation	110	
Other thermal	<u>300</u>	
Total thermal	410	410
Hydro generation	<u>47665</u>	
<b>TOTAL</b>	48075	<u>48075</u>

### ACQUIRED AND GENERATED

53366

### BCH emission factor 2003

<u>GWh</u>		<u>kt/GWh</u>	<u>Mt</u>
110	@ BCH thermal generation rate	523	57.5
300	@ BCH thermal generation rate	640	190.0
47665	@ BCH hydroelectric generation rate	0	0
<u>5291</u>	@ Canadian average rate	220	<u>1164.0</u>
58976			1413.5
	BCH average for BC 2003	<u>26.5</u> kt/GWh	

## BCH BALANCE SHEET 2002

### USED IN BC(GWh)

Electricity sold, domestic total	47801	
Line loss and system use	<u>5033</u>	
<b>TOTAL</b>	52834	<u>52834</u>

### ACQUIRED (GWh)

Electricity purchased, long-term contracts	7512	
Electricity purchased, short-term contracts	22608	
Less electricity sold, trade	-20666	
Energy exchange net	<u>-283</u>	
<b>TOTAL</b>	9171	9171

### GENERATED IN BC

Burrard thermal generation	2731		
Other thermal	<u>447</u>		
Total thermal	3178	3178	
Hydro generation		<u>40485</u>	
<b>TOTAL</b>		43663	<u>43663</u>

### ACQUIRED AND GENERATED

52834

### BCH emission factor 2002

<u>GWh</u>		<u>kt/GWh</u>	<u>Mt</u>
2731	@ BCH thermal generation rate	523	1428.3
447	@ BCH thermal generation rate	640	286.1
40485	@ BCH hydroelectric generation rate	0	0
<u>9171</u>	@ Canadian average rate	220	<u>2017.6</u>
58976			3732.0
	BCH average for BC 2002	<u>70.6</u> kt/GWh	

## BCH BALANCE SHEET 2001

### USED IN BC(GWh)

Electricity sold, domestic total	48131	
Line loss and system use	<u>5200</u>	
<b>TOTAL</b>	53331	<u>53331</u>

### ACQUIRED (GWh)

Electricity purchased, long-term contracts	6304	
Electricity purchased, short-term contracts	21655	
Less electricity sold, trade	-23900	
Energy exchange net	<u>-613</u>	
<b>TOTAL</b>	3446	3446

### GENERATED IN BC

Burrard thermal generation	3974			
Other thermal	<u>464</u>			
Total thermal	4438	4438		
Hydro generation		<u>45447</u>		
<b>TOTAL</b>		49885		<u>49885</u>

### ACQUIRED AND GENERATED

53331

### BCH emission factor 2001

<u>GWh</u>		<u>kt/GWh</u>	<u>Mt</u>
3974	@ BCH thermal generation rate	523	2078.4
464	@ BCH thermal generation rate	640	297.0
45447	@ BCH hydroelectric generation rate	0	0
<u>3446</u>	@ Canadian average rate	220	<u>758.1</u>
58976			3133.5
	BCH average for BC 2001	<u>58.8</u> kt/GWh	