

The estimated and incomplete carbon exchange inventory of North America

revised: may 15 09

I. USA consumption of oil, natural gas and coal

USA oil consumption

(last update mar 4 09)

references:

<u>1 metric ton=</u>	1000 kilograms
1 short ton = 0.90718474 metric ton	
oil consumption=	20.68 million barrels per day (2007 estim.
carbon content of crude oil=	85 per cent
density of crude oil=	0.87
1 barrel= 42 gallons=	159 liters
1 barrel of water weighs=	159 kilograms
1 barrel of oil weighs=	138.33 kilograms
carbon in 1 barrel of oil=	117.6 kilograms
carbon content in one day's consumption of oil=	2,432 million kilograms of carbon
carbon content in one day's consumption of oil=	2,431,564,740 kilograms of carbon
carbon content in one day's consumption of oil=	<u>2,431,565 metric tons of carbon per day</u>

1 www.cia.gov/library/publications/the-world-factbook/print/us.html

2 <http://www.eia.doe.gov/oiaf/1605/archive/gg99rpt/tblb4.html>

2 <http://www.eia.doe.gov/oiaf/1605/archive/gg99rpt/tblb4.html>

I Coal annual consumption in USA

2007
coal consumption
annual in USA 1,128,800,000 short tons 3 www.eia.doe.gov/cneaf/coal/page/special/feature/html

1 short ton= 0.90718474 metric tonnes

2007
coal consumption
annual in USA 1,024,030,135 metric tonnes(1000kg)

percent carbon in coal, for the diffeent types of coal,=

lignite= 30 percent carbon 4 30%=MEDIAN VALUE, www.ket.org/Trips/Coal/AGSMM/agsmmtypes.html
lignite= 7 percent of the coal produced in the USA 5 www.eia.doe.gov/kids/energy_facts/sources/non-renewable/coal.html

subbituminous= 40 percent carbon 4 40%=MEDIAN VALUE, www.ket.org/Trips/Coal/AGSMM/agsmmtypes.html
subbituminous= 44 percent of the coal produced in the USA 5 www.eia.doe.gov/kids/energy_facts/sources/non-renewable/coal.html

bituminous= 65 percent carbon 4 65%=MEDIAN VALUE, www.ket.org/Trips/Coal/AGSMM/agsmmtypes.html
bituminous= approx 50 percent of the coal produced in the USA 5 www.eia.doe.gov/kids/energy_facts/sources/non-renewable/coal.html

anthracite= 91 percent carbon 4 91%=MEDIAN VALUE, www.ket.org/Trips/Coal/AGSMM/agsmmtypes.html
anthracite= less than 0.5 percent of the coal produced in the USA 5 www.eia.doe.gov/kids/energy_facts/sources/non-renewable/coal.html

average estimated
carbon percent
of the coal produced= 49 percent carbon (average used above numbers, omitted anthracite)

if the average carbon content of the coal consumed is 49 percent,

and if there is complete combustion of the coal, all of the carbon will turn into carbon dioxide,

and the amount of carbon that is annually emitted in the CO₂=

501,774,766 metric tons of carbon

and the daily amount is =

1,374,725 metric tons of carbon per day

.....
USA natural gas consumption:

2007 estimate= 653 billion cubic meters

daily consumption= 1.79 billion cubic meters

carbon content of
1 cubic meter of natural gas= 0.49 kilogram carbon

carbon content of one day's
consumption of natural gas= 0.876630137 billion kilograms

carbon content of one day's
consumption of natural gas= 876.630137 million kilograms

carbon content of one day's
consumption of natural gas= 876,630,137 kilograms

carbon content of one day's
consumption of natural gas= **876,630 metric tons of carbon per day**

reference:

1 www.cia.gov/library/publications/the-world-factbook/print/us.html

7 http://bioenergy.ornl.gov/papers/misc/energy_conv.html

USA
total estimated daily production of
carbon from the consumption of
oil, gas and coal =

4,682,920 metric tonnes of carbon per day

total estimated daily production of
carbon from the consumption of
oil, gas and coal =

4.68 million metric tons of carbon per day

II oil, coal, and natural gas consumption in Canada

feb 20 09

Oil Consumption in Canada

1 metric ton=

1000 kilograms

1 short ton = 0.90718474 metric ton

references:

oil consumption=

2.371 million barrels per day (2007 estimate)

10 www.nationmaster.com/graph/ene_oil_con-energy-oil-consumption

carbon content of crude oil=

85 per cent

2 <http://www.eia.doe.gov/oiaf/1605/archive/gg99rpt/tblb4.html>

density of crude oil=

0.87

3 <http://www.eia.doe.gov/oiaf/1605/archive/gg99rpt/tblb4.html>

1 barrel= 42 gallons=

159 liters

1 barrel of water weighs=

159 kilograms

1 barrel of oil weighs=

138.33 kilograms

carbon in 1 barrel of oil=

117.6 kilograms

carbon content in one day's
consumption of oil=

279 million kilograms of carbon

carbon content in one day's
consumption of oil=

278,783,366 kilograms of carbon

carbon content in one day's
consumption of oil=

278.783 metric tons of carbon per day

Consumption of coal in Canada(2006)

coal consumption
annual in canada(2006)=

58,000,000 metric tonnes(1000kg)

12 http://www.asiapacificpartnership.org/Coal%20Mining/Overview_Canada_Coal_Sector.pdf

percent carbon in coal, for the diffeent types of coal,=

lignite= 30 percent carbon
lignite= 7 percent of the coal produced in the USA

5 30%=MEDIAN VALUE, www.ket.org/Trips/Coal/AGSMM/agsmmtypes.html
6 www.eia.doe.gov/kids/energy_facts/sources/non-renewable/coal.html

subbituminous= 40 percent carbon
subbituminous= 44 percent of the coal produced in the USA

6 [40%=median value from www.eia.doe.gov/kids/energy_facts/sources/non-renewable/coal.html](http://www.eia.doe.gov/kids/energy_facts/sources/non-renewable/coal.html)
6 www.eia.doe.gov/kids/energy_facts/sources/non-renewable/coal.html

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6 www.eia.doe.gov/kids/energy_facts/sources/non-renewable/coal.html

average estimated
carbon percent
of the coal produced= 49 percent carbon

average used above numbers, omitted anthracite

if we assume that the average carbon content of coal consumed in Canada,
is the same carbon content of the coal used in the USA,
then we can use the same number of 49 percent carbon

if the average carbon content of the coal consumed is 49 percent,

and if there is complete combustion of the coal, all of the carbon will turn into carbon dioxide,

and the amount of carbon that is annually emitted in the CO2=

28,420,000 metric tons of carbon

and the daily amount
of carbon that is released to the
atmosphere from the consumption of coal=

77,863 metric tons of carbon per day

Canadian natural gas consumption:

Canada 2007 estimate=	92.9 billion cubic meters
daily consumption=	0.25 billion cubic meters
carbon content of 1 cubic meter of natural gas=	0.49 kilogram carbon
carbon content of one day's consumption of natural gas=	0.124715068 billion kilograms
carbon content of one day's consumption of natural gas=	125 million kilograms
carbon content of one day's consumption of natural gas=	124,715,068 kilograms
carbon content of one day's consumption of natural gas=	124,715 metric tons of carbon per day

reference:

13 www.cia.gov/library/publications/the-world-factbook/print/ca.html

7 http://bioenergy.ornl.gov/papers/misc/energy_conv.html

Canada,
total estimated daily production of
carbon from the consumption of
oil, gas and coal =

481,361 metric tonnes of carbon per day

total estimated daily production of
carbon from the consumption of
oil, gas and coal =

0.48 million metric tons of carbon per day

III. Total estimated carbon emitted from the consumption of oil, natural gas and coal in north america=

5.16 million metric tons of carbon per day

IV. USA forest absorption of Co2

references:

amount of carbon absorbed by an acre of forest in a year=

3,500 lbs per acre per year

10 ny times june 8 1993, A Forest Absorbs More Carbon Dioxide Than Was Predicted" by Tim Hilchey

amount of carbon absorbed by an acre of forest in a day=

9.59 lbs per acre per day

1 pound =

0.45359237 kilograms

amount of carbon absorbed by an acre of forest in a day=

4.35 kilograms per acre per day

acres of forest =

747 million acres

11 <http://www.sharplogger.vt.edu/virginiasfi/faq.html>

acres of forest =

747,000,000 acres

amount of carbon absorbed by all of the forests of the country in a day=

3,249,088,360 kilograms

amount of carbon absorbed by all of the forests of the country in a day=

3,249,088 metric tons

amount of carbon absorbed by all of the forests of the country in a day=

3.25 million metric tons

V.

Canada, forest absorption of Co2

amount of carbon absorbed by an acre of forest in a year= 3,500 lbs per acre per year

amount of carbon absorbed by an acre of forest in a day= 9.59 lbs per acre per day

1 pound = 0.45359237 kilograms

amount of carbon absorbed by an acre of forest in a day= 4.35 kilograms per acre per day

hectares of forest 417 million hectares of forest

1 hectare = 2.47105381 acres

acres of forest = 1030 million acres

acres of forest = 1,030,429,439 acres

amount of carbon absorbed by all of the forests of Canada in a day= 4,481,869,204 kilograms

amount of carbon absorbed by all of the forests of the Canada in a day= 4,481,869 metric tons

amount of carbon absorbed by all of the forests of Canada in a day= 4.48 million metric tons

references:

10 ny times june 8 1993, A Forest Absorbs More Carbon Dioxide Than Was Predicted" by Tim Hilchey

12 www.hpva.org/products/facts.asp

VI Carbon Absorbed by all of the crops in North America

Cropland in Canada= 34,951,977 hectares

1 hectare = 2.47105381 acres

Cropland in Canada= 86,368,216 acres

Cropland in USA= 922,095,840 acres

total cropland in North America= 1,008,464,056 acres

how much CO₂ or carbon is absorb by a crop in a year?
there are many different crops, to get an approximate number,
we can look at the carbon abosorbed by corn and wheat:

Corn, carbon absorbed:

22 metric tonnes of CO₂ absorbed by one
hectare of corn in one growing season

12 = molecular weight of carbon

44 = molecular wt of CO₂

27 percent of CO₂ is Carbon

6 metric tonnes of carbon is absorbed by one
hectare of corn in one growing season

1 hectare= 2.47 acres

2.43 metric tonnes of carbon is absorbed by one
acre of corn in one growing season

references:

22 www.hort.purdue.edu/newcrop/proceedings1999/v4-015a.html

23 2007 census of agriculture, www.agcensus.usda.gov

15 www.ontariocorn.org/envt/envclim.html

Wheat, carbon absorbed:

reference:

Carbon Dioxide removed from the air by a crop of wheat=

10,340 kilograms of CO2 per acre per crop 19 <http://mbm.net.au/b100/carbon.html>

Carbon removed from the air by a crop of wheat=

2,792 kilograms of Carbon per acre per crop of wheat

Carbon removed from the air by a crop of wheat=

2.8 metric tonnes of Carbon per acre per crop of wheat

Corn and wheat, carbon removed(ave):

2.61 metric tonnes of Carbon per acre per crop of wheat

to get a rough idea of the carbon needed by all crops, we can use this number which is the average of corn and wheat

total amount of carbon absorbed by all the crops in one growing season or one year:

2,632,570,104 metric tonnes of Carbon absorbed by all of the crops in north america in one year

total amount of carbon absorbed by all the crops in one day=

7,212,521 metric tonnes of Carbon absorbed by all of the crops in north america in one day

total amount of carbon absorbed by all the crops in one day=

7.21 million metric tonnes of Carbon absorbed by all of the crops in north america in one day



VII forest fires in the US and Canada

references:

US Forest fires for a 10 year period:

2007	9.3 million acres burned
2006	9.9
2005	8.7
2004	8.1
2003	4
2002	7.2
2001	3.6
2000	7.4
1999	5.6
1998	1.3

16 www.nifc.gov/fire/info/fire_acres.htm

average: 6.51 million acres burned per year

CO2 emitted from forest fires in the US= 290 million metric tons per year

17 www.nsf.gov/news/news_summ.jsp?cntn_id=110580

with a margin of error of 50 percent, the maximum estimated CO2 emitted from forest fires in the US= 435 million metric tons per year

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the maximum estimated carbon emitted from forest fires in the US= 117 million metric tons per year

the maximum estimated carbon emitted from forest fires in the US= 0.3 million metric tons per day

Canadian forest fires average land area per year= 2.5 million hectares

18 Pan-American Conference on Wildland fire, San Jose, Costa Rica, 23 October 2004

1 Hectare = 2.471 acres

Canadian forest fires average land area per year= 6.2 million acres

this amount of land burned by forest fires in Canada is roughly equal to the amount of land burned in the US so for our estimate of carbon emissions for north america, I will double the amount of carbon emissions from the forest fires in the US:

the estimated carbon emitted from forest fires in North America=

0.64 million metric tons per day

VII

Carbon emissions from solid waste:

references:

USA, solid waste generation per person per day, 2007=	4.62 lbs per person per day	24	www.infrastruxturereportcard.org/fact-sheet/solid-waste
percent recycled or composted,2007=	33 percent	24	
USA, solid waste per person per day, 2007 that is discarded= (to landfill or incinerator)	3.0954 lbs per person per day		
we will subtract the glass and metal because these will not emit carbon			
glass=	6.1 percent of the solid waste	25	www.epa.gov/osw/nonhaz/municipal/msw00.htm "characterization of MSW by weight"
metal=	8 percent of the solid waste	25	
for plastics, the amounts that go to landfills will not breakdown, will not emit carbon so we will subtract the portion of the plastics that go to landfills			
according to reference 24, of total generated msw,	33 percent recycled or composted,2007=	24	
	13 percent is burned in incinerators to recovever energy	24	
	54 percent goes to landfills	24	
in the generated municipal solid waste plastics =	12.1 percent	24	
in the generated municipal solid waste plastics =	0.55902 lbs per person per day		
if 13 percent of the plastics are burned, this is the carbon that will go to the atmosphere			
plastics that are incinerated are estimated to be=	0.0726726 lbs per day		

USA, solid waste
per person per day, 2007
that is discarded=
(to landfill or incinerator) 3.0954 lbs per person per day

how much plastics
go to landfills= 0.4863474 lbs per person per day

Subtract
how much plastics
go to landfills= 2.6090526 lbs msw/day

subtract the
glass and metal
as above= 0.367876417 lbs per day glass and metal

USA, solid waste
per person per day, 2007
that is discarded=
to landfill or incinerator
and will generate carbon
containing gas when
burned or decomposed= 2.241176183 lbs carbon per person per day

assuming that all of this
is organic matter such
as paper or wood or food
and we have already subtracted out
the moisture, the remaining should be
cellulose

the formula for cellulose is $(C_6 H_{10} O_5)_n$
and carbon is 35% of the weight

references:

of cellulose

therefore we will multiply the above number by 35%

and 0.784411664 lbs per day of
carbon generated per day per person from solid waste that
is discarded in the US and goes to landfills or incinerators
and this carbon could become carbon dioxide

assuming that the people of Canada generate the same types and quantities of MSW as the people in the USA,
we can add up the populations of the 2 countries, multiply by the above number for lbs per day
of carbon from MSW

USA population= 304,000,000 people, estimated for 2008 26 US census Bureau population division

Canada's population= 33,490,000 people, estimated for 2009 27 www.cia.gov/library/publications/the-world-factbook/print/ca.html

total population, N America= 337,490,000 people

total amount of carbon from
municipal solid waste
per day= 264,731,093 lbs of carbon per day

120,332,315 kilograms of carbon per day from solid waste

120,332 metric tonnes of carbon per day from solid waste

0.120 metric tonnes of carbon per day from solid waste

This estimation assumes that all of the paper and wood and other organic materials that go into a landfill are broken
down into carbon in the same year. This does not happen, but, the organic materials from previous years that is still breaking down this year
can let us use the estimation of counting just this years organics.

VIII Carbon emissions from volcanoes:

world wide CO2 emissions from volcanoes estimate=

200 million tons annually(short tons)

28 www.the-dailygreen.com/ptint-this/environmental-news/latest/volcanoes-global-warmi,,

total global release also estimated= 3-4x10E12 mol/yr

29 [terrence gerlach, 1991](#) present day co2 emissions from volcanoes, transactions of the american geophysical union v 72

a mole of co2 weighs: 48 grams

4x 10E12= 4,000,000,000,000

4x 10E12 x 48 grams= 192,000,000,000,000.00 grams

total co2 annual release from volcanoes world wide

total co2 annual release from volcanoes world wide= 192,000,000,000 kilograms

= 422,400,000,000 pounds

= 211,200,000 short tons

total co2 annual release from volcanoes world wide= 192,000,000 metric tonnes

total carbon from co2 annual release from volcanoes world wide= 51,840,000 metric tonnes

we are calculating estimated emissions for north america and this number is for the entire world so I will divide it by 7, because there are 7 continents in the world:

total carbon from co2 annual release from volcanoes in north america= 7,405,714 metric tonnes

total carbon from co2 annual release from volcanoes in north america= 7.4057 million metric tonnes

total carbon from co2 daily release from volcanoes in north america= 0.02029 million metric tonnes

IX Arctic Tundra Carbon absorption

In northern Canada and parts of Alaska there is land called tundra. This is where the ground has permafrost, it stays frozen all year. The upper layer of soil thaws out in the summer and plants grow. The reference that I found, has research on how much Carbon is absorbed by the plants in the tundra of Greenland. I will use this number to estimate how much carbon is absorbed by the tundra in Alaska and Canada.

		<u>reference:</u>
tundra, carbon absorption=	96 grams carbon per square meter per growing season(summer)	30 Ecosystem CO2 exchange from the Sahel to the Arctic- in a global change perspective by Henrik Soegaard www.tidsskrift.dk/visning.jsp?markup=&print=no&id=72553
1 square kilometer=	1,000,000 sq meters	
tundra, carbon absorption=	96,000,000 grams carbon per square kilometer per growing season(summer)	
tundra, carbon absorption=	96,000 kilograms carbon per square kilometer per growing season(summer)	
tundra, carbon absorption=	96 metric tonnes carbon per square kilometer per growing season(summer)	
tundra, carbon absorption=	0.26301 metric tonnes carbon per square kilometer per day, averaged out for the whole year	
tundra area of canada=	1,424,500 sq kilometers	31 http://en.wikipedia.org/wiki/canadian_arctic_archipeligo
tundra area of alaska=	230,000 sq kilometers	32 www.panda.org/about_ou_earth/ecoregions/alaskan_coastal_tundra.cfm
tundra area of Alaska and Canada=	1,654,500 sq kilometers	
carbon absorption by the tundra of Alaska and Canada=	435,156 metric tonnes carbon per day	
carbon absorption by the tundra of Alaska and Canada=	0.43516 million metric tonnes carbon per day	

Carbon emissions from the consumption of Oil,
Natural Gas, and coal in north America=

-5.16 million metric tonnes of carbon per day from the burning of fossil fuels

carbon emissions from forest fires
in North America=

-0.64 million metric tonnes of carbon per day from forest fires

carbon emissions from municipal solid waste
in N America=

-0.12 metric tonnes of carbon per day from solid waste

total carbon from co2 daily release
from volcanoes in north america=

-0.0203 million metric tonnes

Carbon absorbed by the forests in north america=

7.73 million metric tonnes of carbon per day absorbed by the forests

total amount of carbon absorbed by all the crops
in one day in N America=

7.21 million metric tonnes of carbon per day from all the crops

carbon absorption by the
tundra of Alaska and Canada=

0.435 million metric tonnes carbon per day

incomplete balance=

9.43 million metric tonnes of carbon per day

Carbon that is lost by the ecosystems(and enters the atmosphere) is a negative number and carbon that is gained by the ecosystems is a positive number