Canadian Energy Systems 101

Part B. Canada's Green Advantage

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Some of the work presented here is from the PhD research project of
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Your Energy Future

Calgary, Alberta
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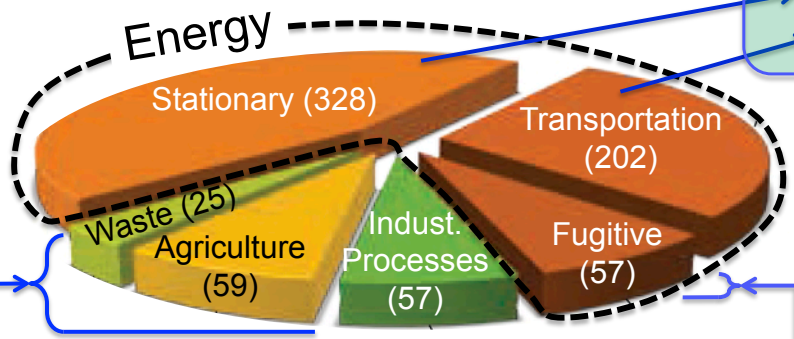
Cdn GHG Emissions (IPCC Categories) (722 $MtCO_2e/yr$ in 2015)

Biology:

Part of the Problem & *Part of the Solution*

BIOENERGY & BIOFUELS

Reduce fossil fuel demand:
- ✓ Wood to heat & power
- ✓ Ethanol & biodiesel



WASTE & AGRICULTURE

Microbial production of methane (CH_4) & nitrous oxide (N_2O):
- ❑ 84 Mt CO_2e/yr

ENERGY - FUGITIVE

Microbial production of CH_4 from tailings ponds:
- ❑ ? Mt CO_2e/yr

BIOLOGICAL CARBON MANAGEMENT

C stock increases in agriculture & managed forests (reported, but not counted)

Quantifying GHG Emissions & Removals

Sectors	Flows to Atmosphere			Carbon Stock Changes
	CO_2	CH_4	N_2O	
Energy production & use	✓	✓	✓	✗
Non-energy use (exc. Ag and for.)	✓	✓	✓	✗
Agriculture	✗	✓	✓	✓ (soil)
Forestry	✗	-	-	✓ (plant & soil)

-, not applicable

The C stock changes are quantified under the IPCC guidelines for 'Land Use, Land Use Change and Forestry' (LULUCF).

However, LULUCF changes are not counted in GHG national totals.

Canada's LULUCF Report for 2015 (March 2017)

Greenhouse Gas Categories		2005	2009	2010	2011	2012	2013	2014	2015
					Mt CO_2 equivalent				
TOTAL[1,2]		738	689	701	707	716	729	727	722
LAND USE, LAND-USE CHANGE AND FORESTRY		-37	-46	-28	-26	-30	-29	-33	-34
a.	Forest Land	-183	-166	-159	-160	-164	-163	-166	-164
b.	Cropland	-10	-12	-12	-12	-12	-11	-11	-11
c.	Grassland	1	0	0	1	2	1	1	1
d.	Wetlands	3	3	3	3	3	3	3	3
e.	Settlements	4	4	4	4	4	4	4	4
f.	Harvested Wood Products	149	125	136	138	137	138	137	135

NOTE:

Net removal of 34 Mt CO_2e/yr, due to:

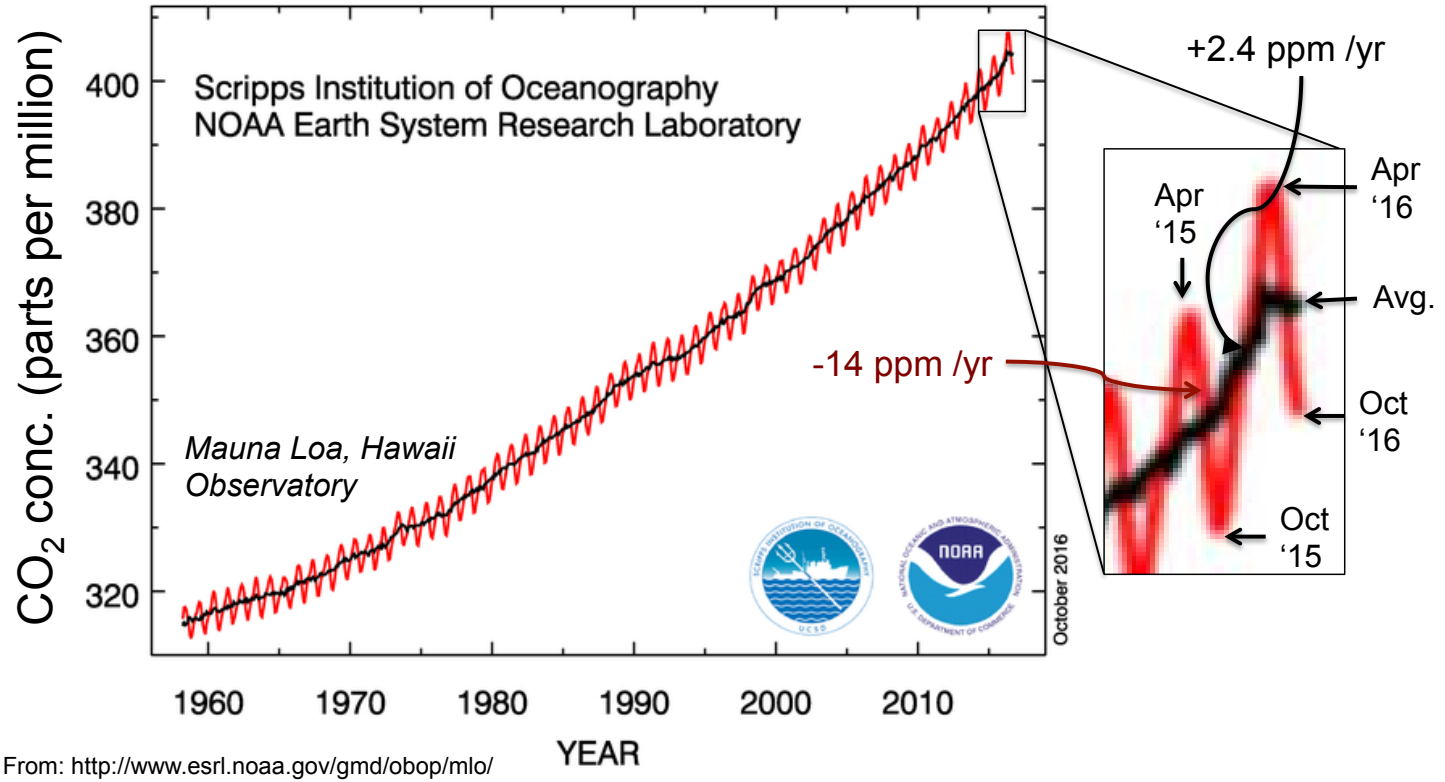
- Growing forests pulling more CO_2 from air than that added by forest fires and harvested wood products;
- Net CO_2 removal (-11 Mt CO_2e/yr) from no-till agriculture

If LULUCF were counted, Cdn emissions would be 722-34 = 688 Mt CO_2e/yr

But this C stock-change methodology is likely to miss the larger flows of Energy and C that could be useful in defining Climate Change Solutions.

ECCC 2017. National Inventory Report

Evidence for Large Bio-based Flows of Carbon

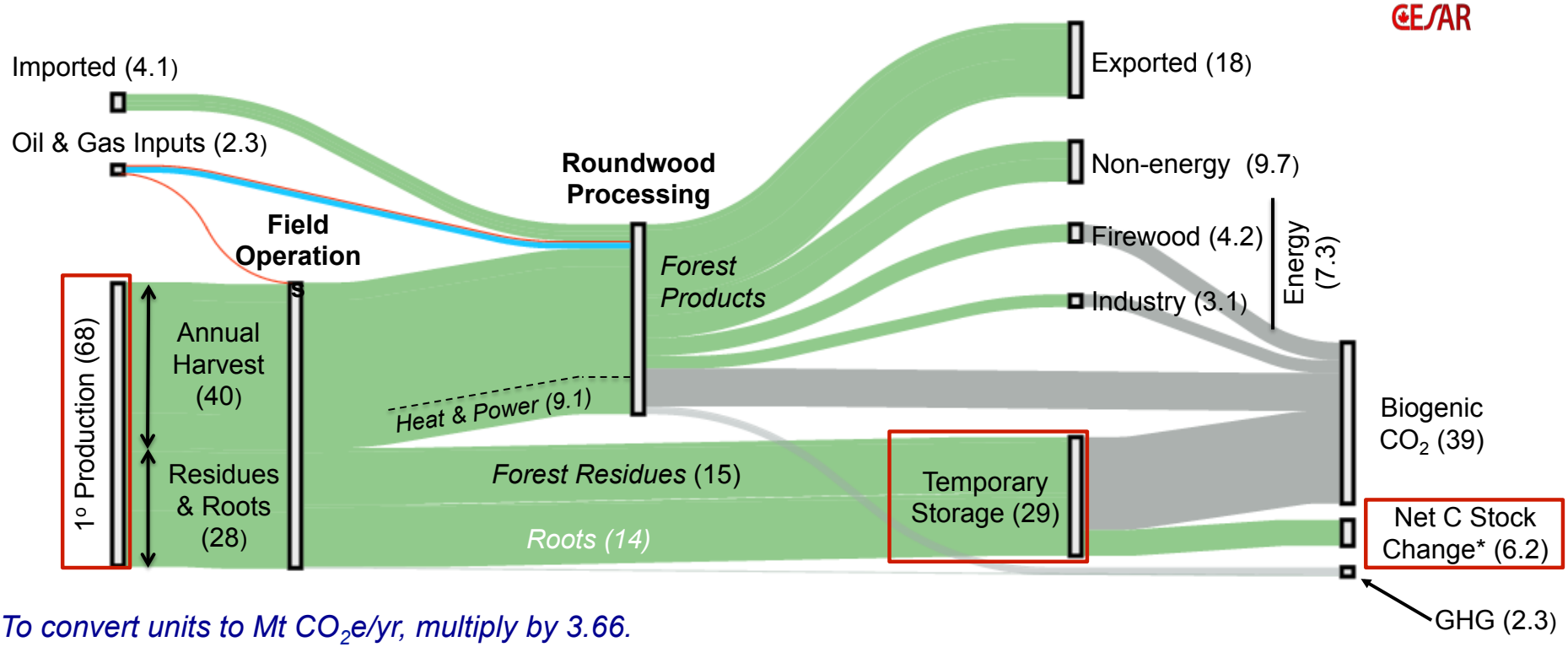


From: http://www.esrl.noaa.gov/gmd/obop/mlo/

In the summer months of every year, biological systems in the N hemisphere are able to remove from the air, 3X the additional CO_2 added through human activities

Forestry C Flows (Mt C/yr)

[For ~0.7 Mha harvested out of the 232 Mha managed forest]

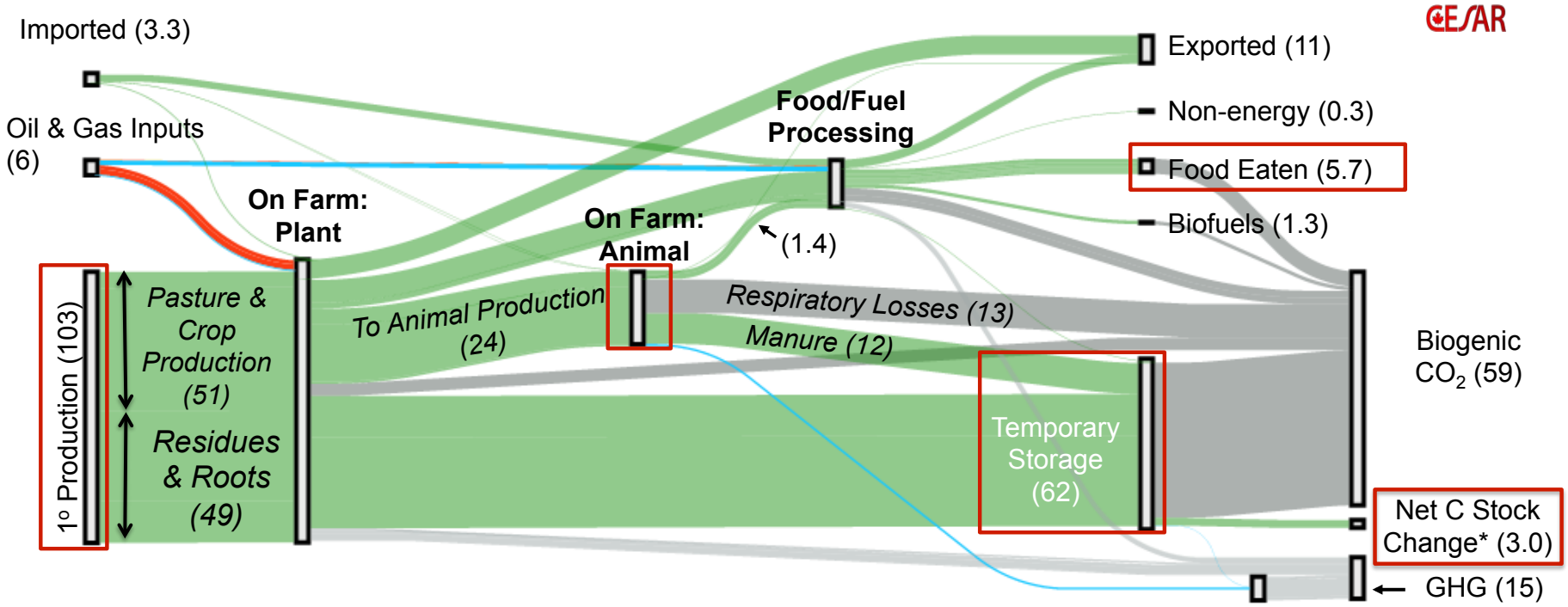


To convert units to Mt CO_2e/yr, multiply by 3.66.

Adetona & Layzell, 2017

* From Canada's Land Use, Land Use Change and Forestry Calculations. National Inventory Report (2017)

Agricultural C Flows (Mt C/yr)



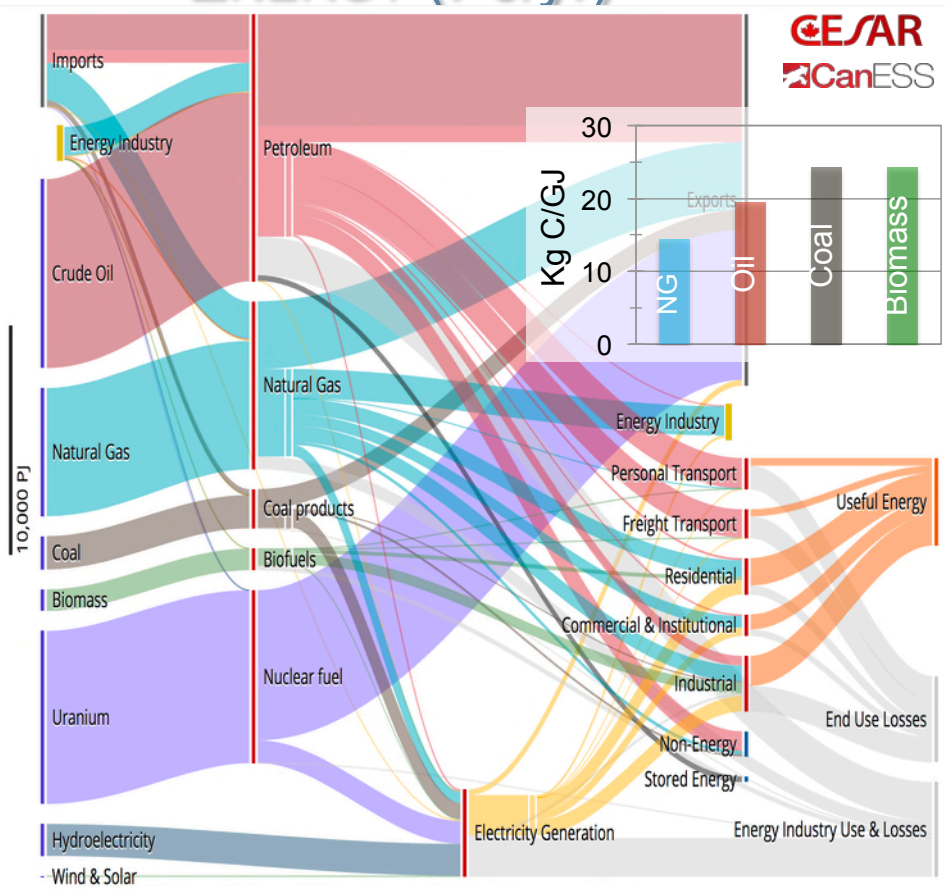
To convert units to Mt CO_2e/yr, multiply by 3.66.

Adetona & Layzell, 2017

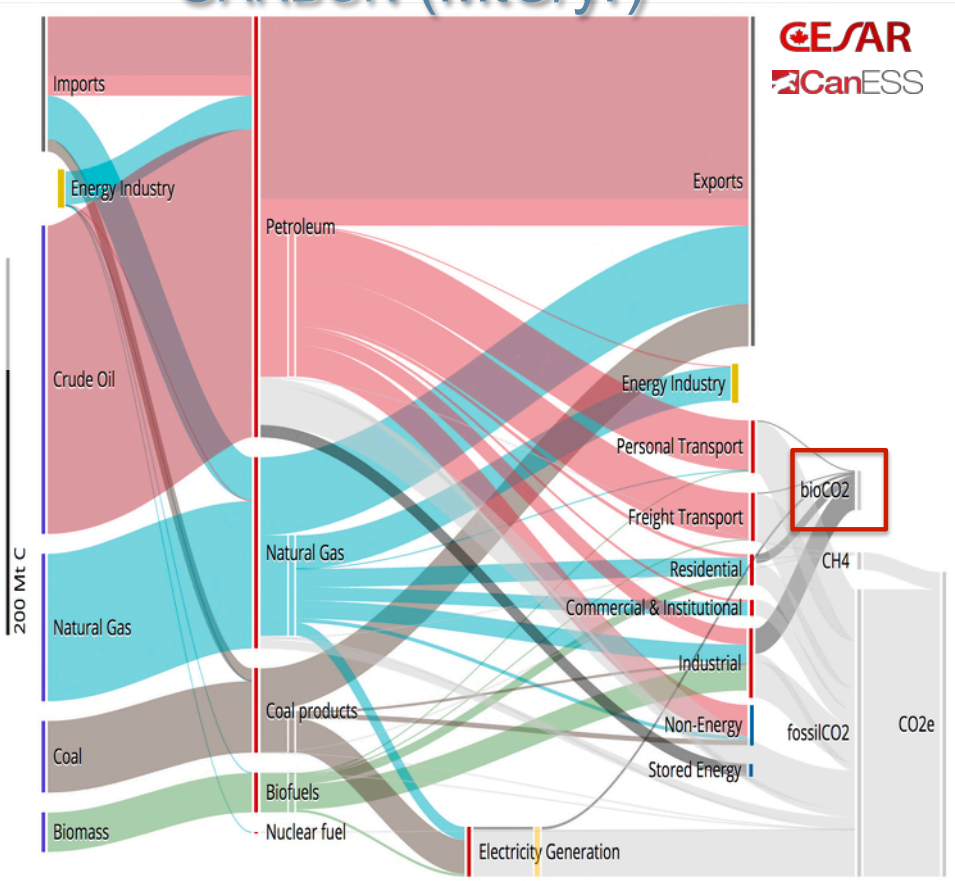
* From Canada's Land Use, Land Use Change and Forestry Calculations. National Inventory Report (2017)

Canada's Fuel and Electricity Flows (2013)

ENERGY (PJ/yr)

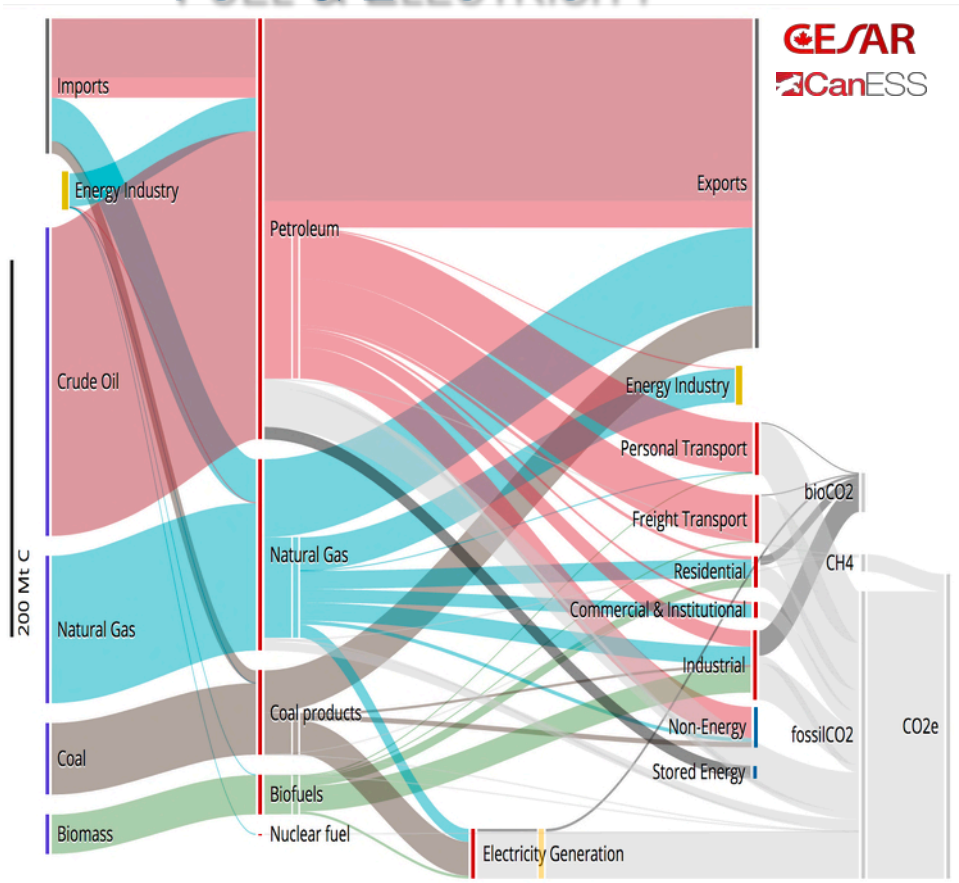


CARBON (MtC/yr)



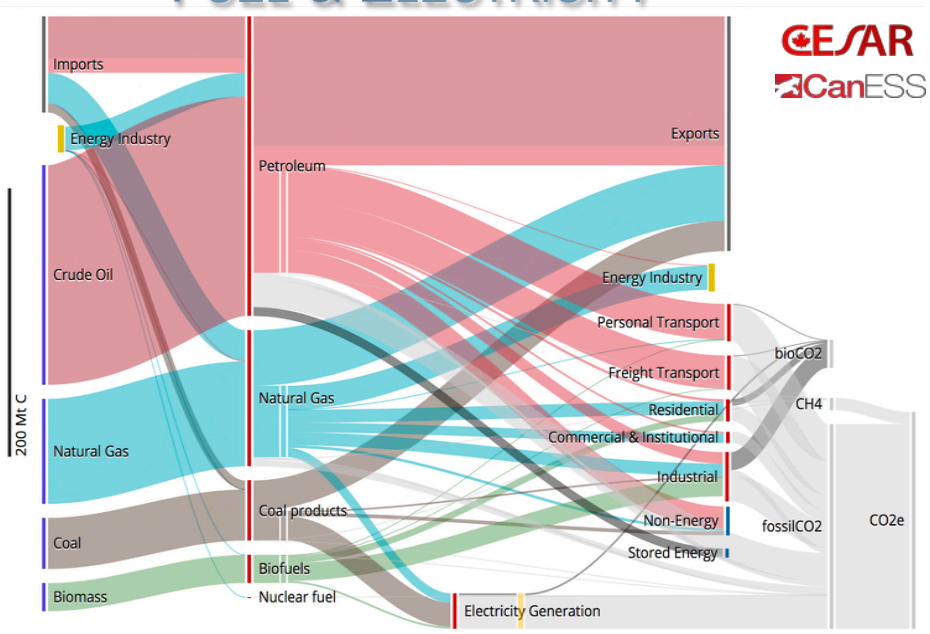
Canada's Anthropogenic Carbon Flows (2013)

FUEL & ELECTRICITY



Canada's Anthropogenic Carbon Flows (2013)

Fuel & Electricity

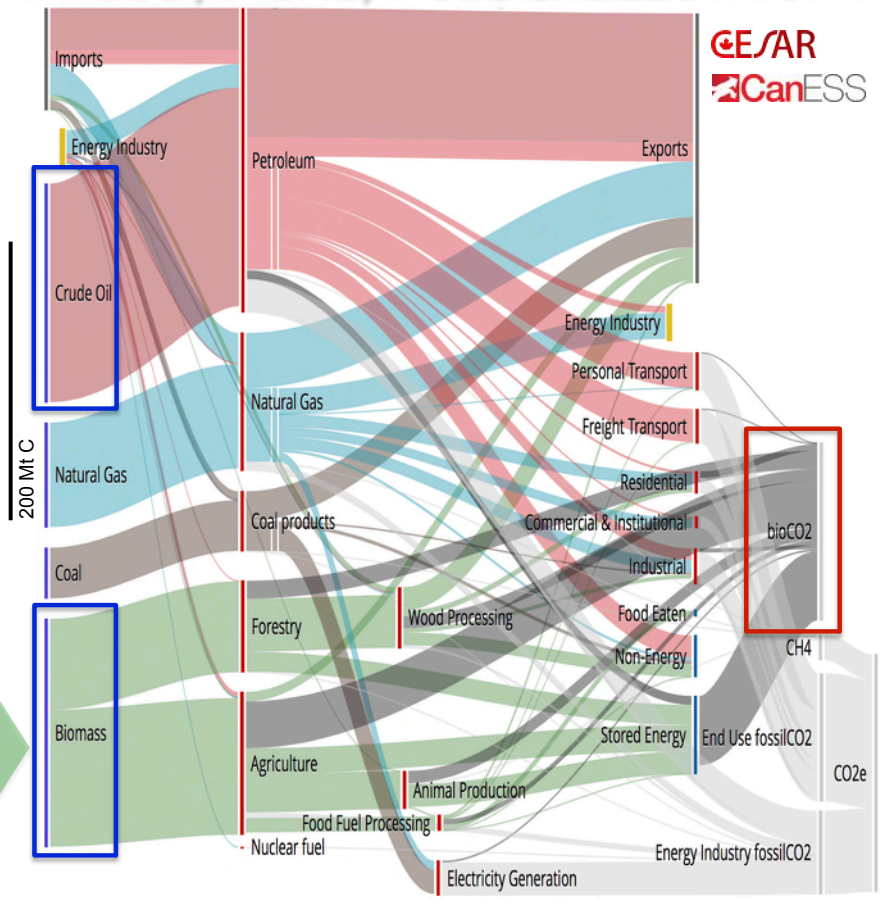


42% more 1° carbon flow

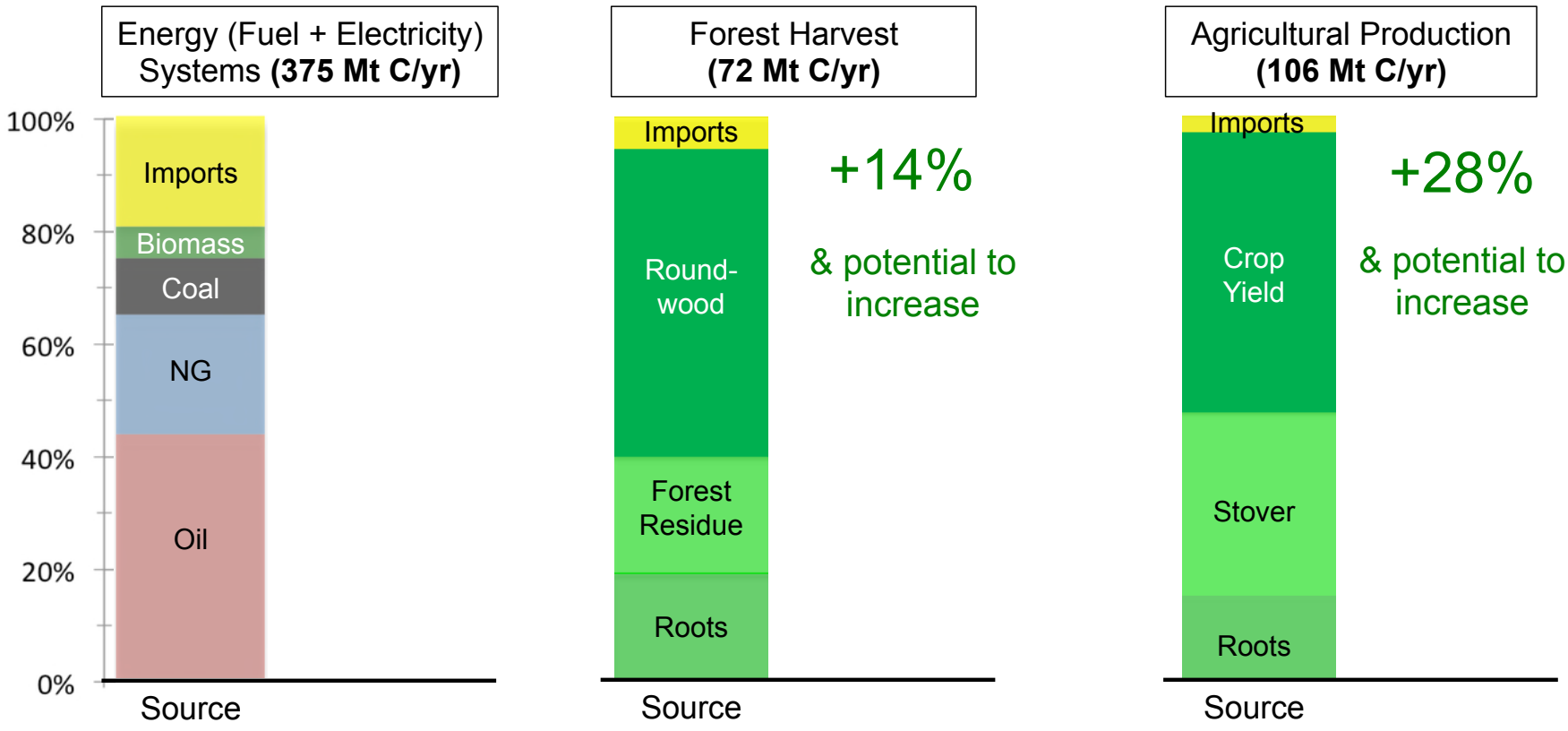
Sun

CO_2

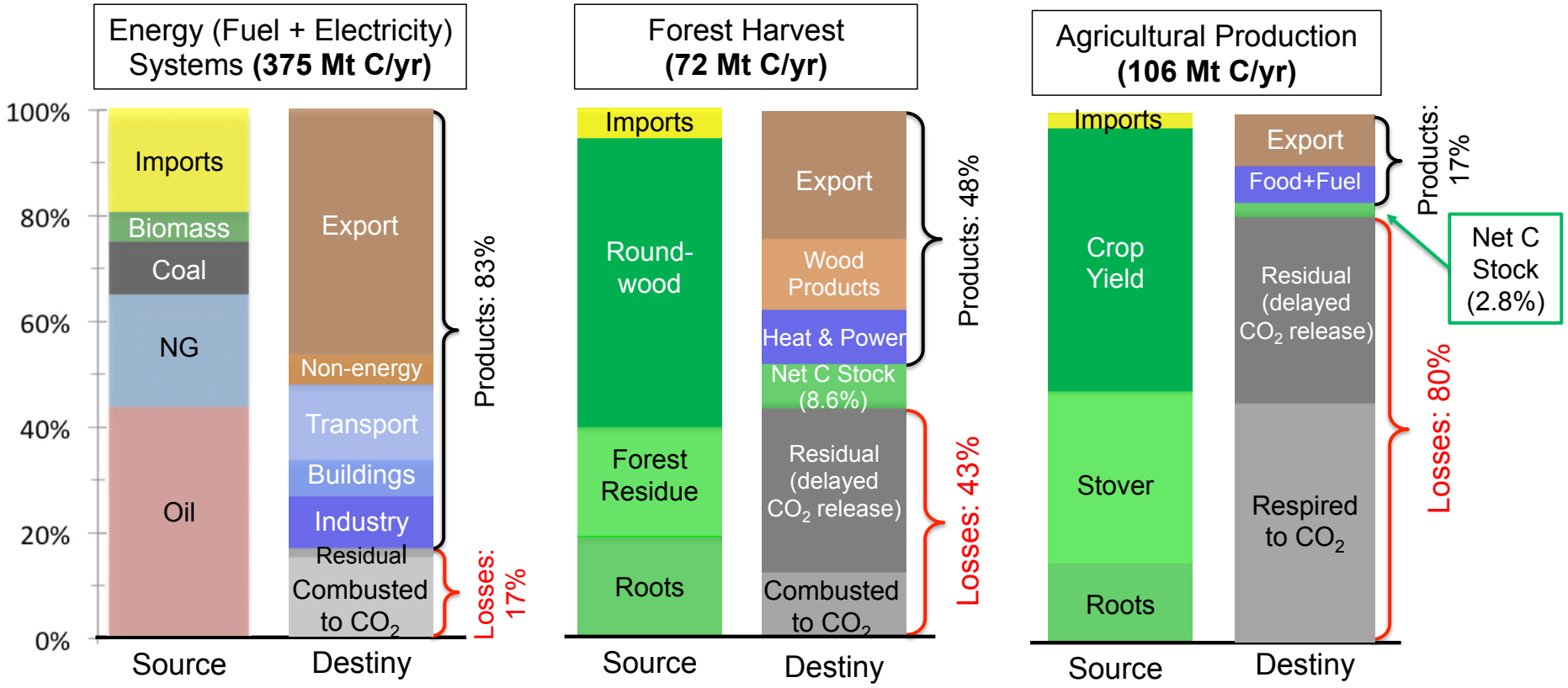
Food, Fibre, Fuel & Electricity



Primary Anthropogenic Carbon Flows in Canada (2013)



Primary Anthropogenic Carbon Flows in Canada (2013)



Biological Solutions

	1. N_2O and CH_4 emission reductions	2. Soil carbon sinks:	3. Forest carbon sinks
			
Problem (-) Solution (+) (Mt CO_2e/yr)	Landfills: -22 Crops/Soils: -30 Animals: -24 Wetlands: -3 -79	+11	+20-30
Potential (Mt CO_2e/yr)	Up to 40	Up to 30+ ?	Up to 100+ ?
Example Strategies	❑ Improved technol. & mgmt for landfills, manure, fertilizer, wetland & animal prod'n.	❑ Reduced tillage, ❑ New crop varieties ❑ Biochar ❑ Pasture mgmt	❑ Improved silviculture, pest & fire control ❑ New genotypes

Biological Solutions

	4. Heat and power	5. Transportation fuels	6. Bio-Products
			 From Peak oil Blog 2008
Problem (-) Solution (+) (Mt CO_2e/yr)	Power Gen: -79	Transportation: -173	Metal: -17 Cement: -9 | -26
Potential (Mt CO_2e/yr)	Up to 70 ?	Up to 50 ?	5 ?
Example Strategies	❑ Replace coal for power gen, or in cement making	❑ Supplement / replace gasoline or diesel with biofuels	❑ Replace steel and cement with wood in construction

Discussion

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