Comparing Anthropogenic Carbon Flows:

Opportunities for Climate Change Solutions in Canada

UNIVERSITY OF CALGARY

CESAR CANADIAN ENERGY SYSTEMS ANALYSIS RESEARCH

Adekunbi B. Adetona, MSc, PAg
PhD Candidate, CESAR & Dept. of Biological Sciences
(adekunbi.adetona@ucalgary.ca)

David B. Layzell, PhD, FRSC
Professor & Director, CESAR & Dept. of Biological Sciences
(dlayzell@ucalgary.ca)

INTRODUCTION

Humans have influenced global energy & carbon (C) flows in their production & use of:

- Fuels & electricity (**Energy**);
- Fibre (**Forestry**); &
- Food (**Agriculture**).

Image Sources: See Refs [1-3]

While all the three sectors have impacted climate change [4,5], the focus for mitigation has been on the energy sector, which accounts for 81% of Canada's greenhouse gas (GHG) emissions.

This study quantifies all anthropogenic flows of C in the hope of identifying new opportunities to address the challenges of climate change mitigation.

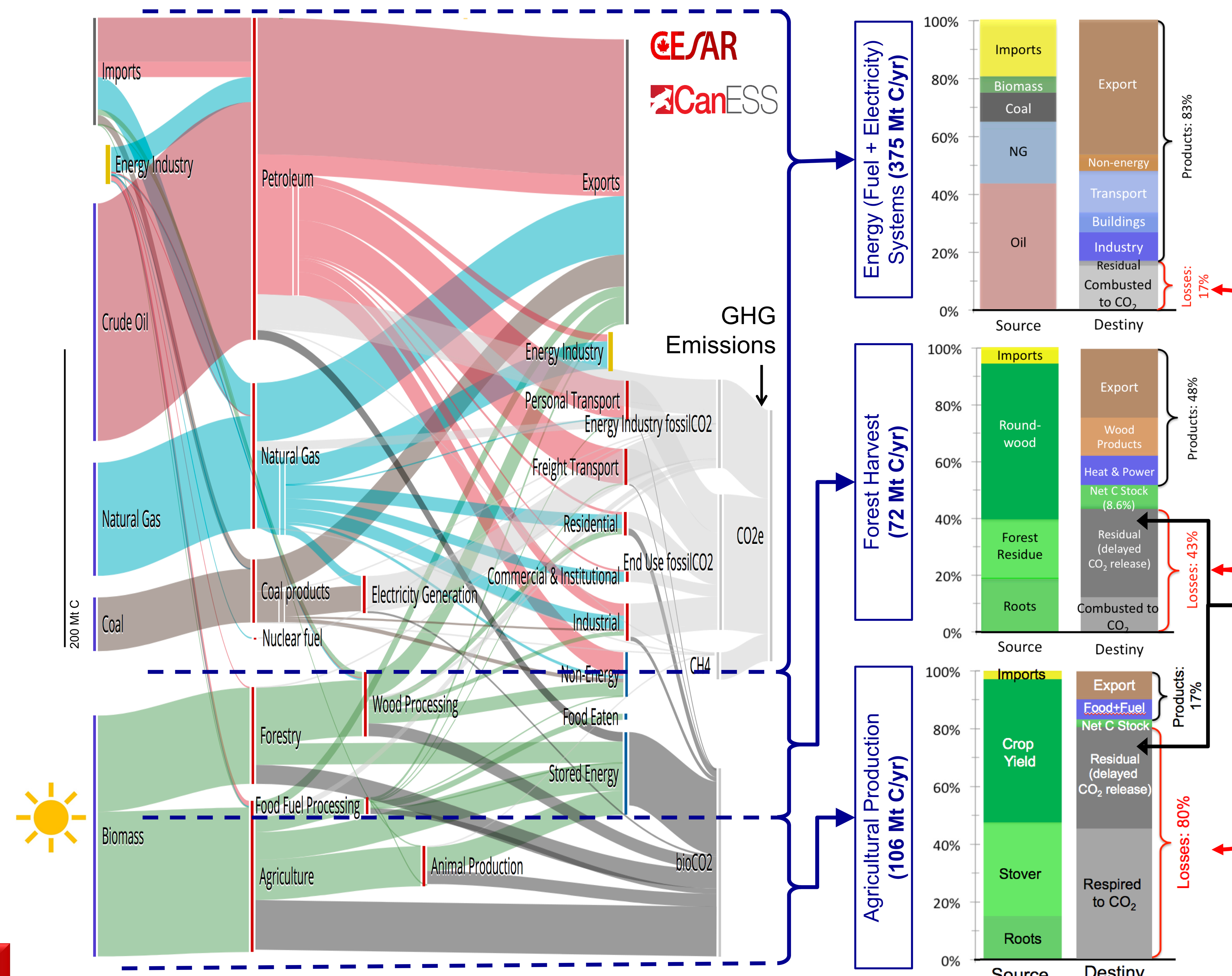
METHODS

Government data sources [e.g., 6] were used to obtain information on the production & use of forestry & agricultural products. The data were then converted to megatonnes (Mt) of C using conversion factors from the literature [e.g., 7,8].

The C flows for fuels & electricity were obtained from the CanESS [9] & CESAR [10] models, and the results were used to generate Sankey diagrams using software developed for the www.cesarnet.ca website.

RESULTS AND DISCUSSION

Food, Fibre, Fuel, & Electricity Carbon Flows (2013)



NOTE:

- ❑ Annual biological C flows are similar in size to C flows though Canada's oil industry (incl. exports), and they could be increased.
- ❑ C in biological flows originate from the atmosphere, so end use emissions are not typically counted as GHGs.
- ❑ Conversion losses are much higher in the biological sectors than in the energy sector.
- ❑ The biological sectors generate millions of tonnes/yr of unused (residual) by-products that could be:
  - ➢ Left to decompose;
  - ➢ Used as bioenergy to reduce fossil fuel demand; &
  - ➢ Converted to biochar for long term storage.

  See **Table 1** for pros & cons.
- ❑ Systems level analyses are needed to determine the optimal strategies for using forestry and agricultural residues.

Table 1. Options to manage residues to reduce greenhouse gas emissions in Canada [8,11]

Options	Pros	Cons
Leave to decompose *(Business as usual)*	▪ Retains nutrients in ecosystems ▪ Provide food for microbes	▪ Fuels for forest fires ▪ Inconvenient for agricultural production ▪ No net contribution to GHG management
Bioenergy/biofuels *(Reduce fossil fuel demand)*	▪ Reduces fossil fuel demand & GHG emissions ▪ Promotes rural economic development	▪ Nutrients are lost from ecosystem ▪ Carbon debt – net CO_2 released in conversion & use ▪ Inefficient conversion efficiencies relative to fossil fuels.
Biochar *(Create carbon sink)*	▪ Resistant to decomposition ▪ Builds soil carbon ▪ Potential use for water/air purification	▪ May remove nutrients from the ecosystem ▪ Carbon debt – net CO_2 released in conversion & use

CONCLUSIONS

Three main insights were gained from this study:

- ❑ Canada has the ability to manage biological systems to capture more C from the atmosphere.
- ❑ However, to reduce GHGs, the captured C needs to be better managed.
- ❑ Some of the by-products & residues could be converted to biochar to enhance C storage or to bioenergy to reduce GHG emissions associated with the production & use of fuels & electricity.

In summary, forestry & agricultural systems have a major untapped potential to address some of the challenges of climate change in Canada.

Recommendations

Technology-rich, systems level modeling is needed to explore various pathways for the use of biological systems to reduce GHG emissions.

Climate change policies and programs need to recognize these opportunities and remove barriers while creating incentives.

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EDMONTON COMMUNITY FOUNDATION

CanESS

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