



Biological Solutions to Climate Change: *An Energy Systems Perspective*

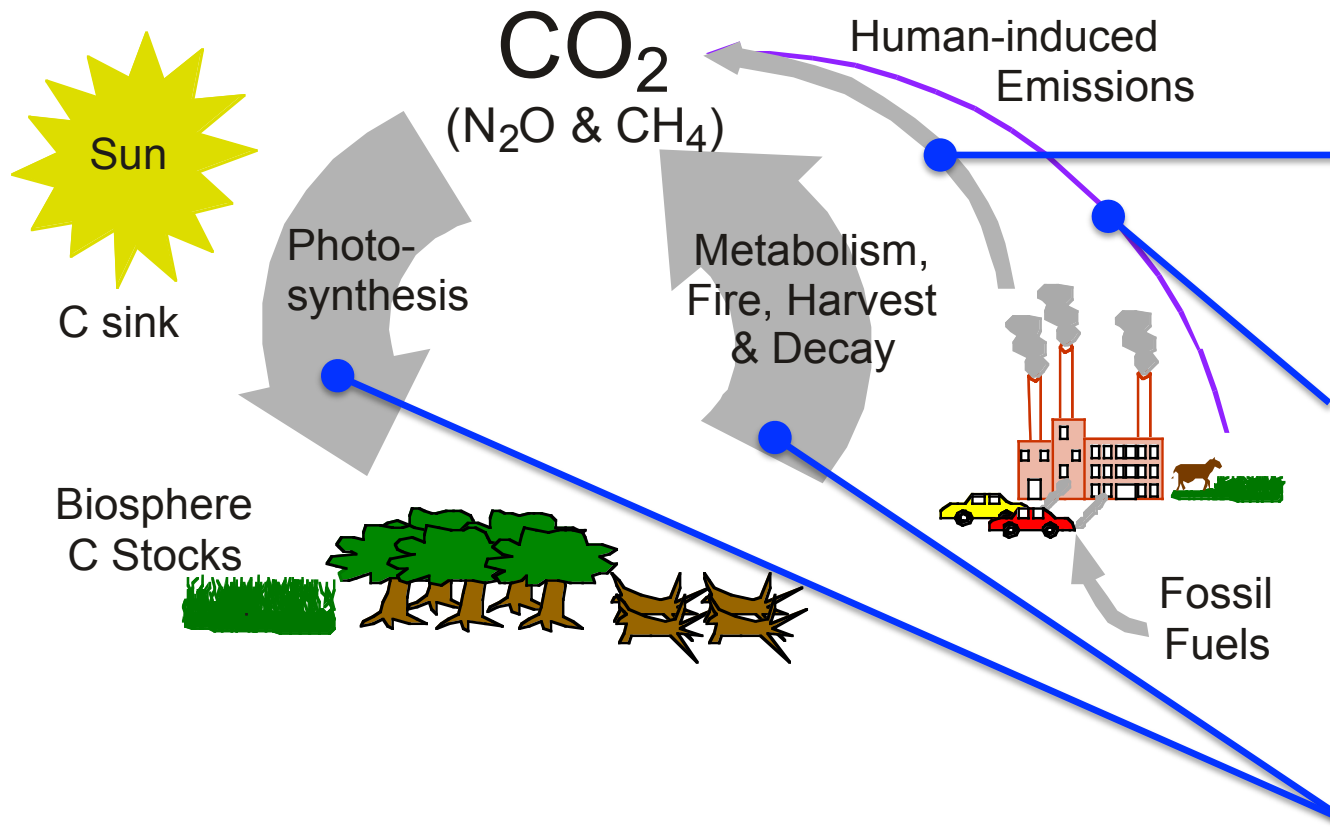
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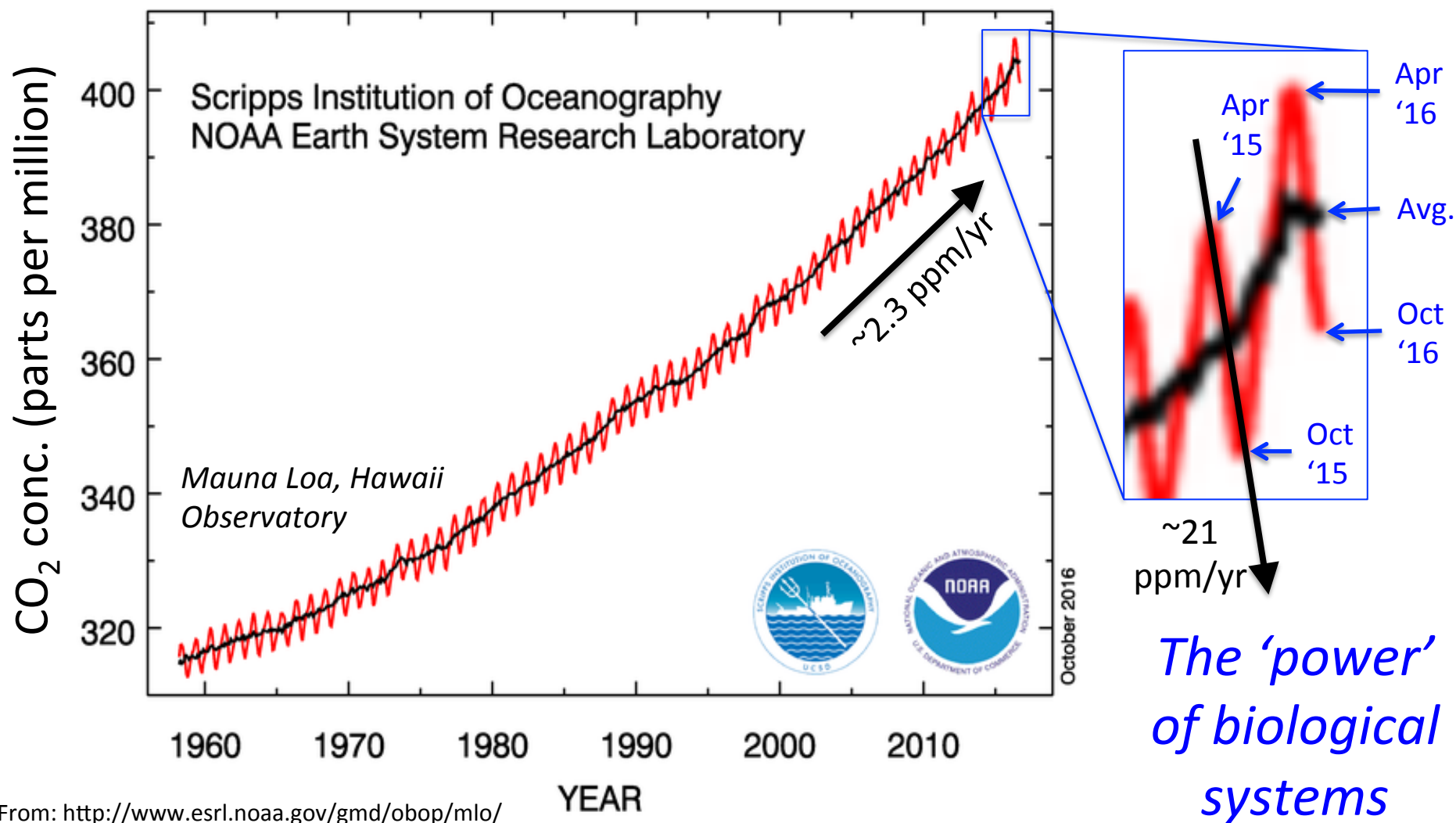
Canada's GHG Emissions vs. the Biological C Cycle

Note:



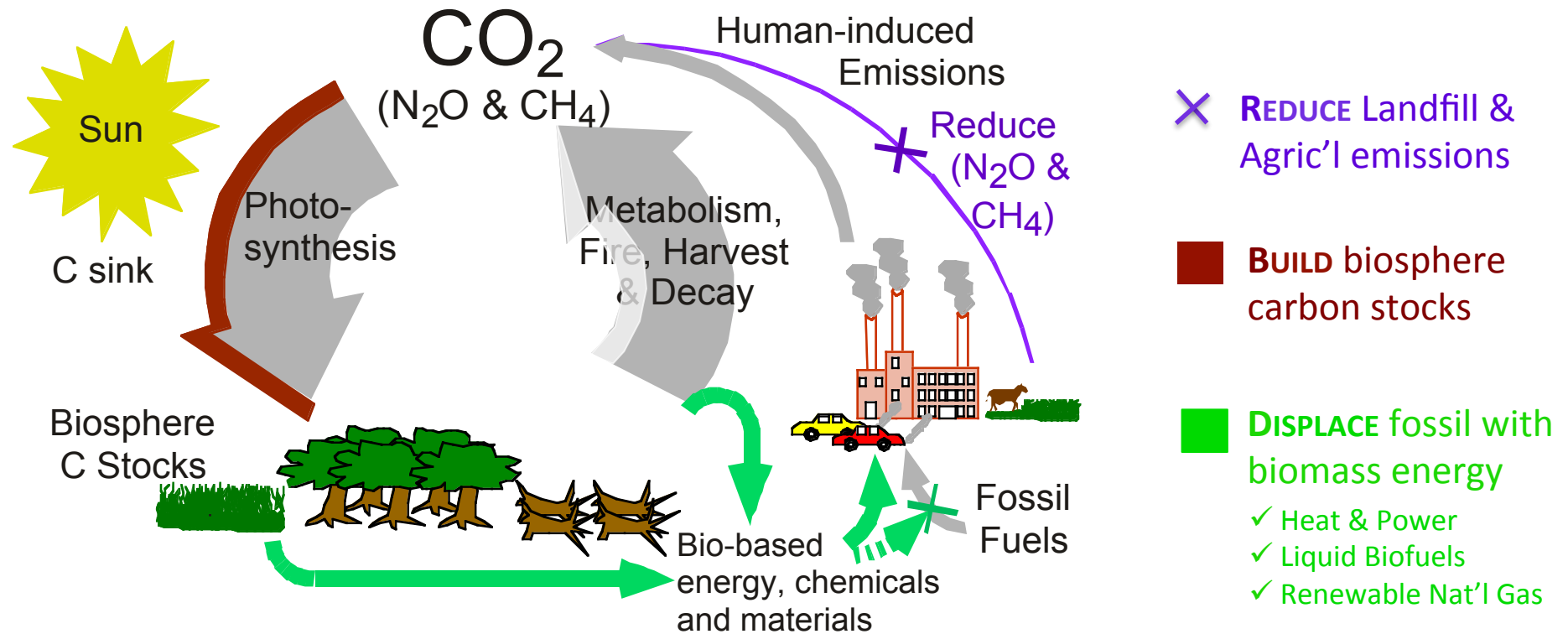
1. Fossil CO₂ emissions account for over 80% of GHGs.
2. Anthropogenic CH₄ & N₂O from:
 - Landfill sites
 - Animal prod'n
 - Fertilizer N
 - ...
3. Biological CO₂ cycle is 10-14X fossil CO₂ emissions.

Rising Atmospheric CO₂ Driving Climate Change



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

Biological Solutions to Climate Change



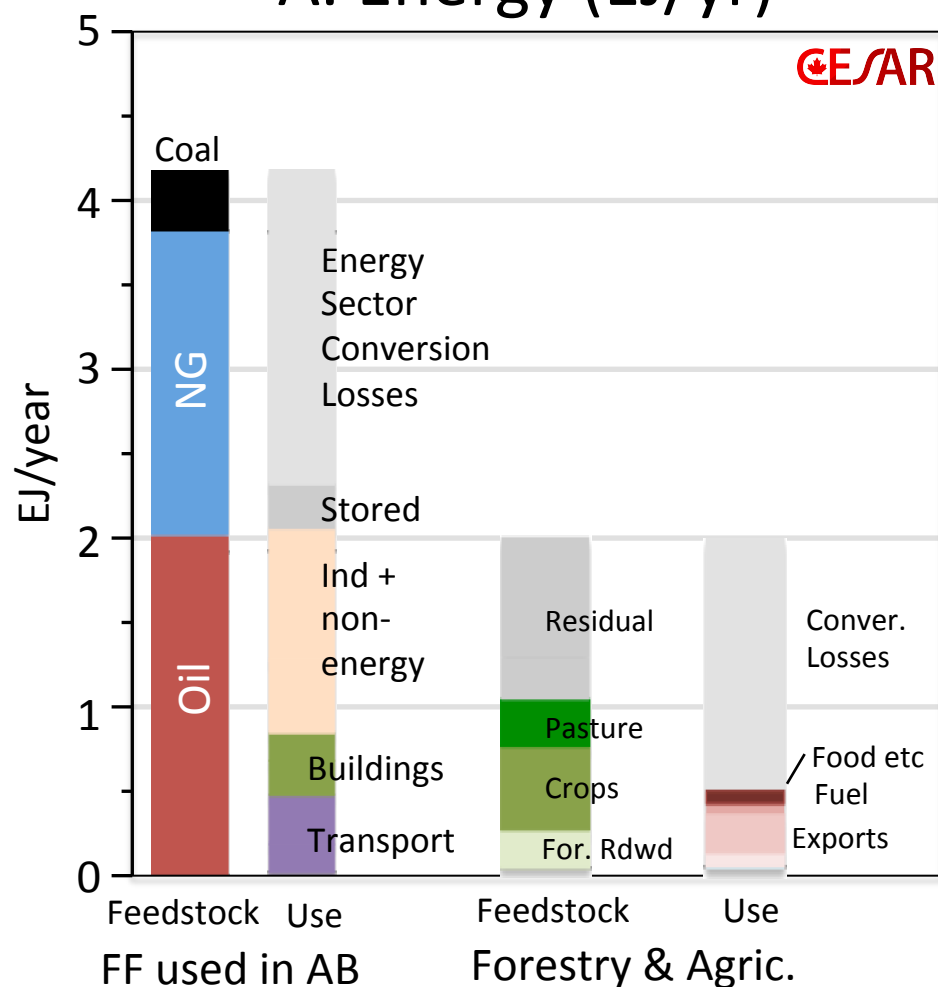
Fossil Energy
(Electricity + Fuels)
Systems

Can we compare Energy & C flows?

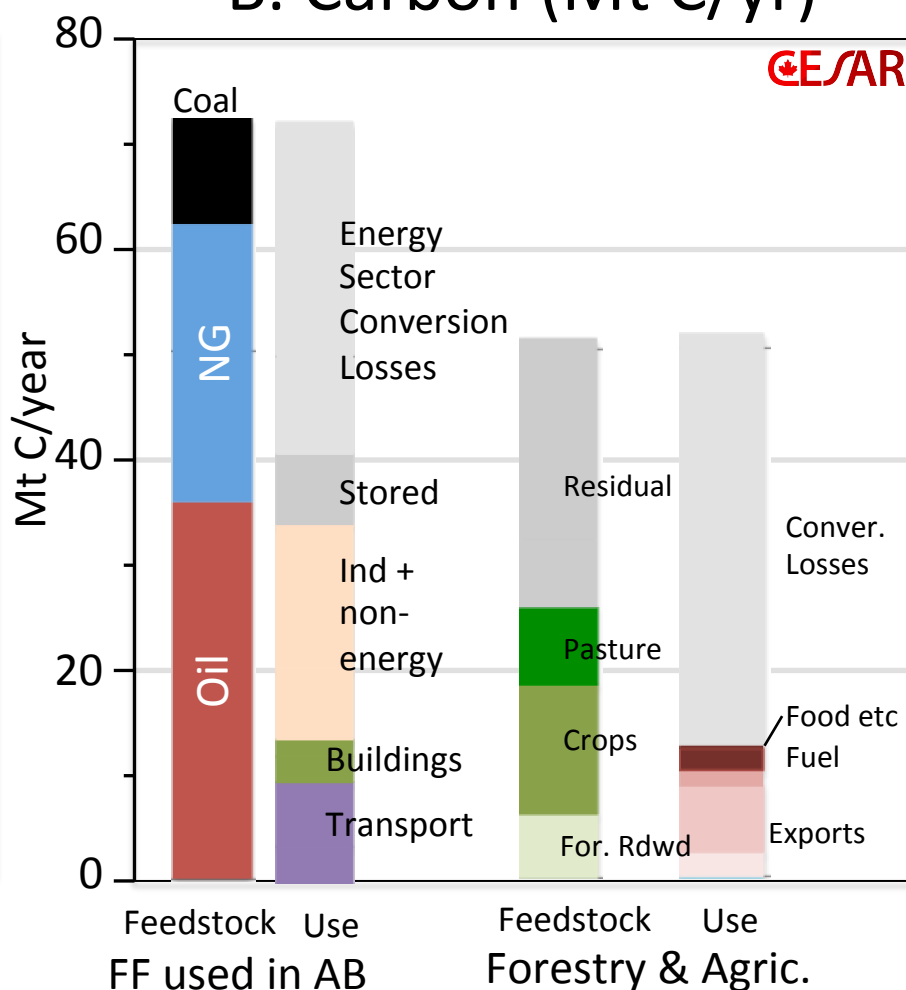
**Agriculture
& Forestry**
Systems

Alberta's Energy & C Flows (2013)

A. Energy (EJ/yr)



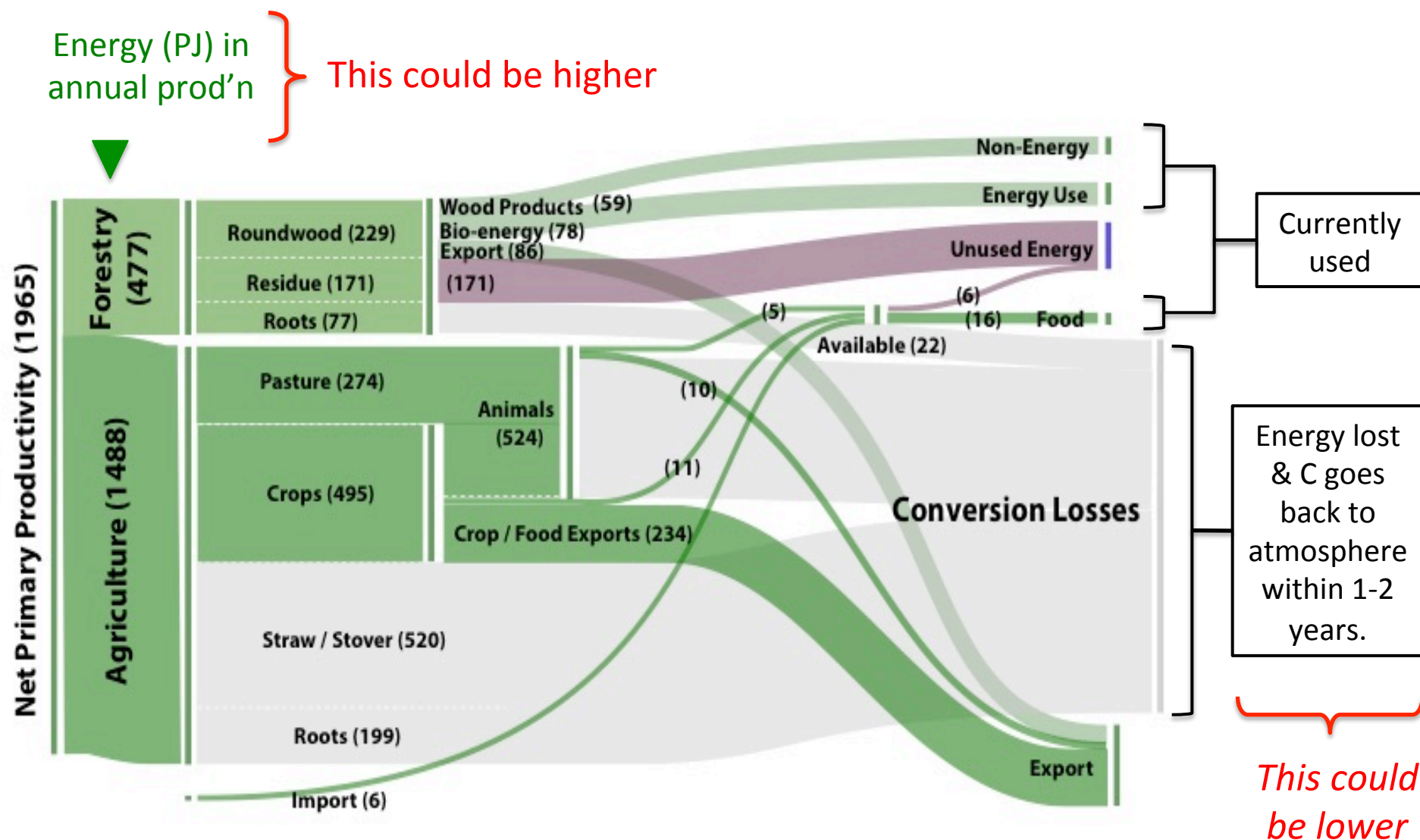
B. Carbon (Mt C/yr)



In a climate change world, biosphere C stocks need more attention.

Alberta's Bio-based Energy System

(work of Kunbi Adetona, PhD candidate)



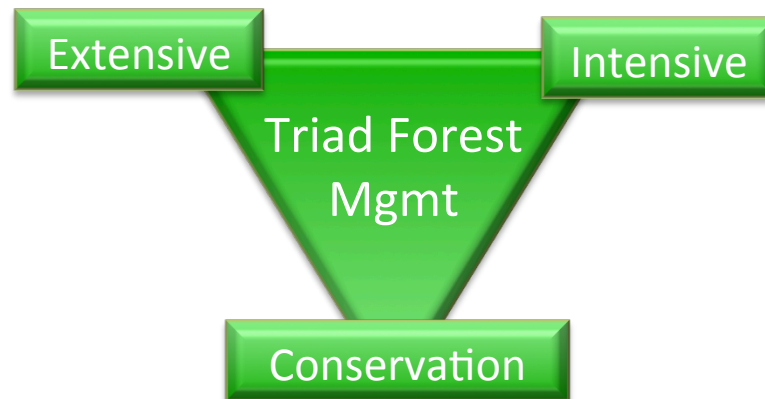
How to Build Biological Carbon Stocks?

1. Afforestation and Reforestation. (Planting trees on lands without, or with sub-optimal tree cover)

- ☐ *Using genotypes adapted to future, not past climate!*

2. Improve Silviculture

- ☐ *Fertilization, pre-commercial thinning,*
- ☐ *Pest and fire control*



- Many Canadian Forests are severely limited by nutrient availability (N, P, Ca, B);
- Relieving those limitations could increase the growth in biosphere carbon (and energy) stock by 50% or more.

How to Build Biological Carbon Stocks?

<http://frame.icapemay.com/wooden-building-frames/>

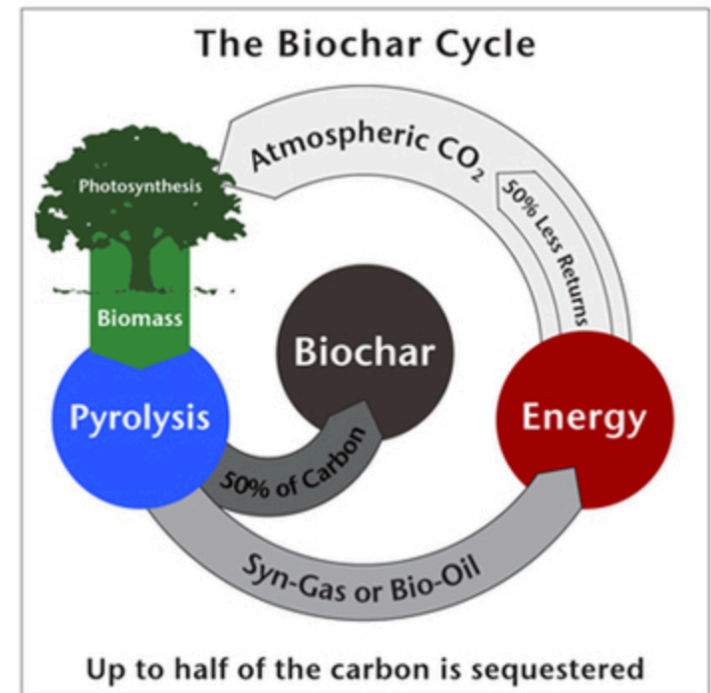


3. Encourage more use of wood in buildings

- ☐ *Stores bio-carbon for 50-100 years*
- ☐ *Decreases demand for GHG intense steel & cement*

4. Convert agric'l/forest residues to biochar (resistant to degradation)

- ☐ *Bio-carbon stable for 100's of years*
- ☐ *When added to soil, enhances fertility*
- ☐ *'Activated carbon' can remove toxins from water & air*



<http://albertabiochar.ca/biochar/>

Conclusions

1. Bio-based energy has an important role to play in the transformation of our energy systems to sustainability;
2. However, if biomass use for energy/fuels depletes biosphere C stocks, the case for sustainability is severely undermined;
3. A coordinated, multi-decade strategy is needed to build biosphere C stocks AND bio-based energy pathways. Only then will we have truly achieved
Biological Solutions to Climate Change.

Thank you



*In CESAR, we analyze and model
past, present and possible future energy systems
to inform policy and investment decisions
on climate change solutions*

www.cesarnet.ca

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