# Carbon Friendly Communities through Biochar-based Bioenergy System in Northern Ontario


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## Introduction

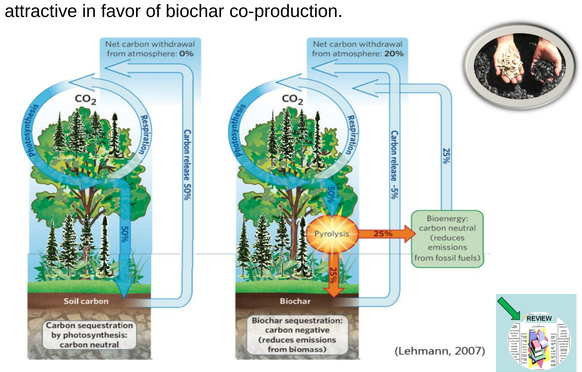
Climate change and related environmental disasters are continuously posing threats to sustainable livelihood of forest and natural resources dependent communities in northern Ontario. Current efforts in changing forest tenure systems and involvement of local communities in forest resources management can create some opportunities to mitigate and adapt from adverse effects by creating carbon friendly communities. Reduction of greenhouse gas (GHG) emissions by replacing fossil fuels with biomass derived energy was identified by the United Nation's intergovernmental panel on climate change (IPCC) as one of four forest sector climate change mitigation options. Vast availability of woody biomass in the region and growing concerns in biomass energy coincides with the Ontario government's decision to eliminate coal-fired energy generation by the end of 2014. Bioenergy is considered as the carbon neutral solution of the current environmental crisis. Biochar is a by-product of bioenergy, which can sequester carbon for a longer time if applied in the soil and it is claimed to be carbon negative in the life cycle. Fossil fuel related emissions are often blamed to be one of the biggest contributors of the current environmental greenhouse gas mix and subsequent global warming. Fossil fuel makes a significant proportion in the current power supply mix in Ontario. There are a lot of other bioenergy initiatives in different scales including community pellet initiatives and combined heat and power (CHP) plants. The use of biomass feedstock for producing biochar and bioenergy not only has the potential to address the environmental problems related to air pollution and climate change, but also ensures job and energy security for local communities. Recently established local forest management corporations (LFMCs) in Ontario can incorporate biochar-based bioenergy in their forest and carbon management plans.

## Objectives

This poster is a part of a big project on modeling of the life cycle environmental impact of biochar-based bioenergy production and conducting its economic analysis in northern Ontario. Here we present a brief synopsis of results on review of the status of peer reviewed and published papers (i) to analyze the availability and sustainable supply of woody biomass for future biochar-based bioenergy system; (ii) to compare the efficient use of woody biomass for bioenergy production systems using biochar with conventional methods; (iii) to study environmental impacts of biochar production, its land application and carbon management potential; and (iv) to identify the research needs and potential environmental impact assessment methods for woody biomass utilization for bioenergy production in northwestern Ontario in a sustainable basis.

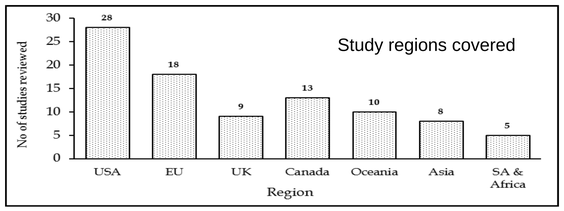
## Why Biochar?

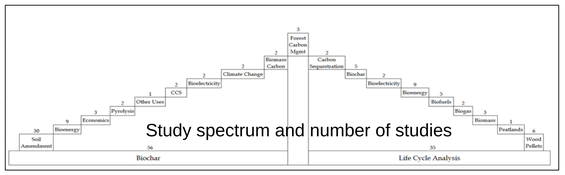
Biochar is a stable, recalcitrant organic carbon compound co-produced from the heating of biomass under low or zero oxygen condition (Pyrolysis) along with bioenergy. Bioenergy is carbon neutral and biochar is considered as carbon negative if managed properly in the long run. The co-production of biochar from a portion of the biomass feedstock may reduce the total amount of bioenergy that is produced by the technology, but even at today's energy and fertilizer prices, the net gain in soil productivity is worth more than the value of the energy that would otherwise have been derived from the bioenergy. As the cost of carbon emissions rises and the value of $CO_2$ extraction from the atmosphere is also considered, the balance becomes overwhelmingly attractive in favor of biochar co-production.




## Method

Selected papers from ISI web of science database with the combinations of keywords like "biochar", "life cycle assessment", "bioenergy", "soil amendment", and "northwestern Ontario" and related other grey literatures were reviewed. Similar keyword search combinations were used to find more published articles from Google Scholar and Proquest. The extent of papers reviewed is more or less universal with most are published in the USA. However, the proportion of reviewed papers for Canada was 1/7 of which only 3 papers were directly related to northwestern Ontario.



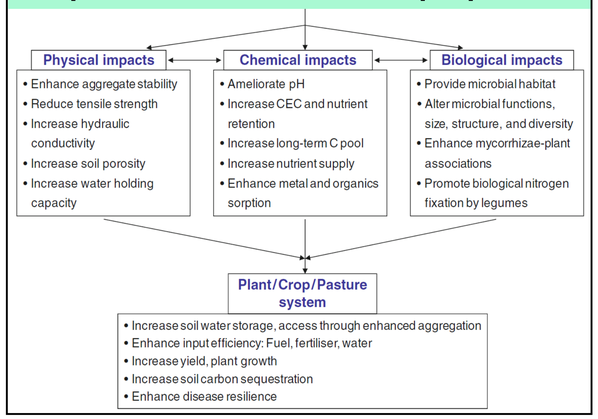




## Results

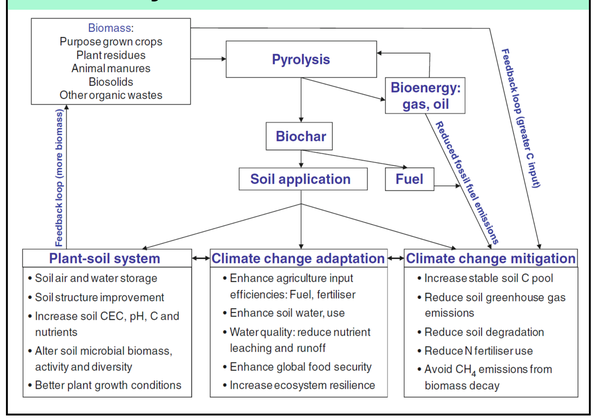
Woody biomass availability (Million tonnes per year) in northern Ontario

| Source | Quantity available per year | Reference | Remarks |
|---|---|---|---|
| Forest harvest residue and underutilized tree species | 7.9 million green tonnes | Alam et al. (2012) | Northwestern Ontario |
| Woody and agri based biomass | 34 million dry tonnes | (Hacatoglu et al. 2011) | Includes Canadian side of Great lakes region |
| Harvest residue, sawmill residue and underutilized hardwoods | 2.3 million dry tonnes | Kennedy et al. (2011) | Parts of Northeastern Ontario |
| Traditionally unmerchantable, unused and available trees | 7.6 to 7.9 million green tonnes | MNR (2011) | All over Ontario but harvest and Saw mill residue not included |
| Harvest residue and sawmill residue and residual trees | 3.8 million dry tonnes | Wood and Layzell (2003) | Factored @ 5% for NW Ontario from 77 million dry tonnes for all Canada |

### Impacts of Biochar on Soil properties




### Ecosystem Benefits of Biochar




## Benefits of biomass

- ✓ **Renewable –** Sustainably-managed sources of biomass can provide fuel indefinitely.
- ✓ **Readily available –** A significant amount of biomass fuel is available in most regions of North America in the form of agricultural crops and waste, forestry, and municipal waste.
- ✓ **Dispatchable –** A biomass-fired generation plant can increase or decrease electricity production in response to demand. This is an important factor in incorporating a variety of energy sources in the overall system.
- ✓ **Part of the natural carbon cycle –** Drawing energy from biomass utilizes the carbon within the natural carbon cycle. Biomass draws carbon from the atmosphere during its growth cycle and releases carbon when it is combusted.
- ✓ **Local resource –** Biomass energy is typically fuelled by local sources of biomass, creating local economic development opportunities.

**(Source: OPG, 2011)**

## Biomass Vs Conventional Coal

**Emissions comparison based on 100% wood pellet trials at Atikokan GS in July 2008:**

| | Lignite Coal | Biomass Wood-Pellet |
|---|---|---|
| $SO_2$ emissions | 4.2 kg/MWh | Negligible |
| $NO_x$ emissions | 1.5 kg/MWh | 0.6 kg/MWh |

## Conclusion and Future Steps

Review shows very promising potential environmental benefits of biochar-based bioenergy system in general. Most of the studies were limited to non-boreal region and the broader applicability of these findings needs area specific study. Long term biochar trial plots in the boreal region need to be established and life cycle environmental and cost assessment of the overall system need to be conducted so that communities can manage their resources and become carbon friendly.