Northern Forest Wood Pellet Heat Greenhouse Gas Emissions Analysis Methods Summary

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Thomas Buchholz, Ph.D., Senior Scientist, Spatial Informatics Group and Affiliate, Gund Institute, University of Vermont. tbuchholz@sig-gis.com

John Gunn, Ph.D., Executive Director, Spatial Informatics Group – Natural Assets Laboratory and Research and Extension Assistant Professor, Department of Natural Resources and the Environment, University of New Hampshire. jgunn@sig-nal.org

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1 METHODS

1.1 LCA tool

1.1.1 ForGATE - A Forest Sector Greenhouse Gas Assessment Tool for Maine

ForGATE is a publicly available life cycle assessment (LCA) tool that calculates greenhouse gas (GHG) balances associated with the harvest, processing, and use of wood products including bioenergy applications (Hennigar et al. 2013). Aiming at a trade-off between user friendliness and the greater complexity of representing ecological and management dynamics of forest carbon, ForGATE provides predefined forest management options, inventory, as well as growth and yield data on the forest sector side. The user can define allocation of acreage by silvicultural management regime, wood products processing GHG emissions, wood products in-use and post-use assumptions, GHG emissions from electricity production and consumption, and wood product substitution. Being built for Maine's forest conditions using FIA data as a starting point, it has application across the Northern Forest because of the regional nature of the forest sector data included in the tool and the foundation of growth and yield projections that come from the Northeast Variant of the Forest Vegetation Simulator.

1.1.2 Pellet module

We modified the ForGATE tool to track changes in GHG emissions when producing and consuming pellets sourced from a defined forest landscape. The module allows the user to identify economic scenarios, predefined state-specific grid electricity data (updated to 2015 data), feedstock mix, transport distances of biomass to and pellets from the plant (assuming empty returns as default), energy source for plant processing heat, alternative heating technologies and associated annual fuel utilization efficiencies. We derived default pellet processing GHG emissions from Hansson et al. (6). For sawmill residue (i.e., sawdust) currently not directed to pellets or energy use, we assumed complete decomposition in less than one year (e.g., use for animal bedding, landscaping, etc.). For harvest residues, we applied northeastern US specific annual coarse woody debris decomposition rates of 5.3% and 6.9% for residues (EPA 2014c).

The fossil fuel heating alternatives analyzed included #2 heating oil, propane, and natural gas with a global warming indicator (GWI) of 357, 290, and 267g CO_2e/kWh, respectively. The GWIs for #2 heating oil, propane, and natural gas were derived from Hennigar et al. (2013) and an annual fuel utilization efficiency of 90% (80% for pellets) which includes cradle to gate primary and upstream emissions.

1.2 Study Area

One representative wood supply area in Maine was chosen to evaluate the impacts of adding a pellet manufacturing facility to the forest landscape. The wood supply areas each were defined by an 83 km (50 mile) radius centered on an existing wood pellet manufacturing facility. We queried USDA Forest Service Forest Inventory and Assessment (FIA) data to categorize the current acreage within the radius based on forest cover type, tree diameter size class, and stand density (as required in the ForGATE tool , section 1.1.1 above). FIA data also allowed us to categorize forest acreage as available or unavailable for harvest. FIA "forest land" total acreage minus FIA "timberland" acreage represents the area categorized as "reserve" and unavailable for harvest. Timberland acreage was then allocated to a silvicultural regime.

ForGATE requires baseline forest sector and alternative future pellet sector silvicultural regimes for each forest cover type and size/density class combination. The Maine Forest Service Silvicultural Activities reports provided the most comprehensive assessment of actual harvest activities conducted each year within the region. We designated baseline silvicultural regimes for the study area based on the 2014 report for Maine (MFS 2015) (Table 1). We assumed these silvicultural regimes could be applied to a managed forest area elsewhere in the region because of the statewide nature of the data and the broad classes of silvicultural activities defined in the model.

Table 1. Harvest acreage allocation to silvicultural regimes as a percentage of total harvestable land base (excluding reserve acreage). The total study area forested landscape was 504,081 ha (1,245,612 ac.).

Harvest Regime	Reserve (% of Total Landscape)[1]	Partial Harvest[2]	Heavy Harvest[3]	Selection Harvest[4]	Shelterwood Harvest[5]	Clearcut Harvest[6]
Current Harvest Level	3%	17%	17%	17%	43%	7%

See Hennigar et al. 2013 for more details on the silvicultural regimes described below.

[1]Baseline reserve percentage of total forested land base was determined from USFS FIA acreage summary of study areas.

[2] Partial Harvest regime involves a thin from above (remove larger dbh trees first) harvest entry every 30 years or more when stands reach 100 sq. ft. of Basal Area (BA). Target BA removal was </= 30%.

[3] Heavy Harvest regime is a thin from above harvest of =/> 60% of BA every 50 years or more. Harvest entry threshold was 2,500 merchantable ft.^{3}

[4]Selection Harvest regime is a thin from below (remove small merchantable dbh trees first) harvest to create uneven-aged stands with entries every 30 years or more that reduce no more than 30% of the BA.

[5]Shelterwood Harvest regime is two stage process that involves an initial thin from below every 70 years or more that removes </= 60% of the BA. The second harvest entry is a 100% overstory removal 10 years after the first entry.

[6]Clearcut Harvest regime is a 100% removal when merchantable volume reaches 2,500 ft.^{3} (generally every 60 years).

1.3 Pellet plants

We surveyed the 10 existing wood pellet plants in Northern Forest states of Maine, New Hampshire, Vermont, and New York in January 2015 to understand operational scale, feedstock inputs, and energy use of wood pellet production in the region. Contacts at all existing pellet facilities were emailed a link to an online survey followed up by a phone call. Nine of the 10 facilities responded to the 16-question survey (three from New York, three from Maine, one from New Hampshire, and two from Vermont). Survey questions addressed feedstock consumption and composition, information about forester involvement and third party certification, transport distance (to and from mill), delivery mechanism, production capacity, electricity source, and process heat energy source. Responses were tabulated and summarized at both a facility-level and for the sector as a whole. Results are reported here anonymously and in aggregate to protect proprietary information. Results were used to develop ForGATE scenario inputs (see 1.3.1).

1.3.1 Pellet forest sector assumptions

Pellet mill inputs for the ForGATE scenarios used insight from the survey data to frame the input parameters and assumptions. Based on the survey results, pellet mills in the region fall into three categories of feedstock inputs: 1) 100% pulpwood and small diameter trees; 2) 100% sawmill residue; and 3) some combination of pulpwood/small diameter trees and sawmill residue. While individual facilities vary in terms of feedstock inputs, 55.7% of total feedstock consumption by the nine facilities came from forest harvesting operations, 43.8% from sawmill residues (primary and secondary), and 0.5% from other sources such as municipal waste and landscaping/yard trimming.

Of the feedstock from forestry operations, only 2% of the volume came from tops and limbs (i.e., “harvest residues”), the remainder was classified as pulpwood (76%) or small diameter trees (22%). All nine facilities across the Northern Forest consumed a combined 1,097,000 green tons of wood in calendar year 2014. Hardwood feedstock represented 65.9% of the total green weight of inputs, the remainder was softwood feedstock. Total production in 2014 was 490,000 metric tons (MT), which is 79% of the stated total capacity of the nine facilities. Mean production per facility for 2014 was 57,152 bone dry metric tons (BDMT) and ranged from 10,886 BDMT to 105,233 BDMT. For the analysis, we assumed a single 45,359 BDMT/year of output pellet facility was added to the landscape, which is slightly lower than the average production based on the survey results but within the typical range for the region. Most facilities use wood for process heat (one uses natural gas and another uses a mix of electricity, oil, and wood). All facilities use electricity from the grid.

1.3.2 Analytical Scenario

Our study analyzed current harvest levels and pellet production to provide a baseline result for the GHG impact of using wood pellets for heat. Our study also analyzed different potential scenarios in which harvest levels and pellet production change. The Northern Forest Center developed a fact sheet summarizing the results of the baseline scenario that represents current harvest levels and pellet production. The other scenarios are presented in a manuscript being developed for peer-reviewed publication.

For this scenario, we assumed a “Market Shift” where pulpwood consumption in the region is reduced below recent levels and creates a surplus of low-grade material. This “Market Shift” scenario assumes that recent harvest levels of low-grade material such as pulpwood are maintained and the harvested material is used to make pellets instead of pulp and paper and engineered wood products (e.g., oriented strand board). The annual harvest volume does not change between the baseline forest sector and the alternative future pellet forest sector and therefore there are no changes in the forest carbon stocks (live and dead) between the “Baseline” and the “Alternative Future” forest sector greenhouse gas emissions comparison.

In the case of this Market Shift scenario, where pellets are made instead of pulp and paper or fiberboard building material (e.g., oriented strand board), the baseline forest sector emissions include the tracking of wood disposition and fate throughout the 50 year study period. However, wood product production emissions are not assumed to be avoided because global production is increasing or at least stable (Prestemon et al. 2015; Renner 2015). By conducting the LCA in this manner, we seek to address the impact of leakage emissions from our analysis boundary. The scenario was forecast using a 50 year time horizon to evaluate long-term trends, though forest growth and yield projections do not include climate change factors and natural disturbances.

Feedstock inputs were simplified to a 50% pulpwood to 50% sawmill residue ratio to closely mimic the regional average feedstock use for the pellet mills surveyed.

2 REFERENCES

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