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SUMMARY OF CARBON EMISSION IMPACTS OF MODERN WOOD HEATING IN NORTHEASTERN US

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INTRODUCTION

The purpose of this document is to provide greater clarity on the very complicated issue of carbon emission impacts of switching from fossil heating to wood fuel. It is extremely important to keep in mind that this is a very complex issue and any attempt to explain it will be an over-simplification and will require making numerous broad generalities.

KEY FACTORS IN DETERMINING CARBON IMPACTS

For decades biomass energy has been deemed by energy policy makers, regulators, and experts around the world as "net neutral" in terms of carbon emissions – meaning the amount of gross CO_2 emissions from burning renewable biomass materials like wood are directly offset by the sequestration of atmospheric carbon as forests regrow new wood over time. While the "net neutral" characterization is over-simplified and has been called into question over the last ten years, the basic concept is solid and remains the energy policy position of many European countries where sustainable forest management laws have been in place for hundreds of years.

Sustainable Forest Management

In the US, there has been more debate on this issue due, in part, to the fact that sustainable forest management is highly encouraged by state and federal government – not mandated by law like it is in Europe. One of the biggest variables influencing the carbon impacts of wood energy is the sustainability of the forest management from where the wood fuels are sourced. If wood fuels are sourced from forest conversions (i.e. clearing forests for developing a shopping mall), it is hard to claim that the carbon emissions of burning the wood for energy will be directly offset by the regrowth of wood over time because that footprint of land can no longer re-sequester carbon. On the other hand, when wood fuels are sourced from periodic harvesting as part of long-term sustainable forest management, it is reasonable to say that the carbon emissions from burning the wood fuel will be offset by carbon sequestration as the forest regrows over time. For many decades in Vermont, New Hampshire, Massachusetts and Maine, the amount of wood harvested each year has been considerably less than the amount of wood grown in our forests and, while there are always exceptions, the management and harvesting activities have been by and large in accordance with "best practices" for silviculture.

Accounting for "Upstream" Carbon Emissions

Most studies that examine the carbon emission impacts of biomass energy look at the life-cycle emissions along the supply-chain or the total carbon emissions from stump to stack. When wood fuels are harvested and transported using heavy equipment that run on diesel fuel (harvesters, skidders/forwarders, chippers, and trucks) there are carbon emissions that need to be accounted for in addition to the amount of carbon released when the wood fuel is burned at the boiler plant. Numerous studies in recent years have concluded that the total amount of carbon emissions for upstream supply-chain activities is only 2-4% of total gross carbon emissions from wood fuel combustion.[1]

Temporal Scale

Another critical factor in assessing the carbon emission impacts of wood energy is ***time***. Over what length of time are the impacts of wood energy being measured? Forests take time to grow, so any assessment that only considers a short-time frame (1 to 10 years) may conclude there are actually net increases to atmospheric levels of CO_2 caused by switching to wood fuel. However, assessments that examine longer time periods (10-100 years) often conclude there are significant reductions of atmospheric CO_2 levels over time caused by switching to wood fuels from local, well-managed forests.

Another key factor related to timeframe is the assumed level of harvest intensity. Heavy intensity harvesting will require more time to regrow and sequester an equal amount of carbon stored in the forest as existed prior to the harvest. Light intensity harvests require less time to regrow an equal amount of wood. However, the reality is that harvest intensity is not an indicator of good or even sustainable forest management – but it does impact the timeframe needed to achieve forest carbon equilibrium.

Several recent studies looking at the carbon emission impacts of wood energy have made the assumption that wood fuel would be sourced from new, independent harvesting directly caused by the increased market demand for wood fuels. The reality in the Northeastern US is that wood fuels are sourced as just a small part of integrated timber harvesting where numerous types and grades of timber products are harvested at the same time. So, while a single harvest operation may remove a large volume of wood from a stand, only a relatively

[1] http://www.biomasscenter.org/images/stories/SE_Carbon_Study_FINAL_2-6-12.pdf

small increment might be used as wood fuel. If only the wood fuel harvest increment is counted, the typical time period to regrow that amount of wood is greatly shortened.

Spatial Scale

Yet another critical variable is the spatial scale of the carbon analysis framework. Several controversial carbon impact studies (such as the Manomet study[2]) examined the impacts at the forest-stand (or group of trees) level. Stand-level analysis looks at the before and after carbon stocks of a harvested stand of trees over time and compares this against the amounts of CO_2 emitted by the wood energy activity. While stand-level analysis is an important piece of the picture, it does not provide the full story – the reality is that for every stand of trees that is harvested in the Northeastern US, there are hundreds of stands that are not harvested and their growth of new wood annually exceeds the amount of wood that is harvested. So, when the carbon impacts are examined at the landscape-level factoring both the harvested and unharvested footprints of managed forests, there is a very different and more favorable carbon impact outcome for wood energy.

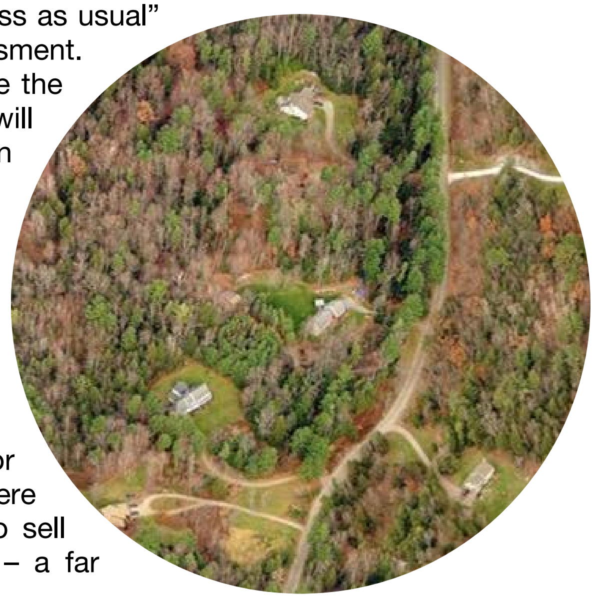
Product Substitution

Any quality carbon emissions impact assessment also needs to account, not just for the impacts of the wood energy activities, but also for the avoided emissions from the products or energy replaced by using wood. For buildings constructed using wood, the assessment must also account for the avoided carbon emissions associated with the production and use of the typical building materials that would be used otherwise (steel, concrete, glass, plastic, etc.). For wood fuels used for heating, the avoided emissions from using fossil heating fuels (like oil, propane, or natural gas) must be factored. One important point worth noting is that several of the recent carbon studies have focused on the impacts of using wood for stand-alone wood fired power generation which is a very low-efficiency use of wood fuels and would often be replacing low-carbon sources of electricity like nuclear or hydro-power. By contrast, using wood fuels for thermal energy is much higher efficiency and tends to more often directly replace carbon-intense fuels like heating oil.

[2] https://www.manomet.org/sites/default/files/publications_and_tools/Manomet_Biomass_Report_ExecutiveSummary_June2010.pdf

Choosing the BAU

The last major factor worth highlighting is what "business as usual" (BAU) scenario is applied in a carbon impact assessment. Numerous past carbon impact assessments have made the assertion that if wood energy is not used, forests will continue to grow and sequester greater levels of carbon than if they are periodically harvested for wood fuel. However, this is not grounded in reality. The working forests of the Northeast are predominately privately owned and will continue to be managed and periodically harvested for a wide range of forest management objectives including generating revenue from timber production. Very few studies have accounted for the fact that without local wood energy markets to help generate some supplemental income for private forestland owners to pay property taxes, there would be strong economic pressure on landowners to sell forestland for residential or commercial development – a far worse carbon impact.



DETERMING A CO_2 EMISSION FACTOR

Burning wood actually emits slightly higher (gross) amounts of CO_2 per unit of energy than burning oil. However, burning wood for heat emits ***biogenic*** carbon that has been constantly cycling between forests and the atmosphere over time as part of the natural carbon cycle. By contrast, burning oil emits ***geologic*** sources of carbon – taking this fossil carbon stored beneath the surface of the earth for millions of years and creating a one way path to the atmosphere. Put simply, burning wood emits CO_2 that was previously in the atmosphere 20-100 years ago, whereas burning oil emits carbon that was in the atmosphere 20-100 ***million*** years ago. Even though a molecule of CO_2 from burning wood has the same warming affect in the atmosphere as a molecule of CO_2 from burning oil, there is still an important and fundamental distinction that needs to be made. After three years of research and debate, the US EPA has stated they will treat biogenic carbon emissions from wood energy distinctly more favorably than geologic carbon from burning fossil fuels.[3]

Despite all the variables and complexities, most environmentally-minded institutions considering a fuel switch want to be able to reasonably quantify the potential carbon emission reduction benefits of replacing heating oil with wood fuel. To that end, we recommend the following values and applied assumptions to yield a useable emission rate for wood fuel:

[3] http://www.epa.gov/climatechange/Downloads/ghgemissions/Biogenic-CO2-Accounting-Framework-Report-Sept-2011.pdf

Process for Determining an Emission Factor	Pounds of CO2 equivalents per MMBtu[4]
Start with gross emissions produced at the biomass boiler plant[5]	206.7
Include the "Upstream" emissions in the harvesting, processing, and transport of wood fuel[6]	8.1
Total emissions (Gross + Upstream)	214.8
Apply a conservative assumption of the minimum percentage of total wood fuel sourced that is from forest management where the harvested stand's carbon stores will be regenerated within a 20-100 timeframe	90%
Use the resulting carbon emission rate to address the remaining 10% not sourced from forest management where full regrowth is achieved within a 20-100 year time frame.	21.48
Recommended emission rate	**29.58**

This 29.58 value is derived by adding the upstream emissions factor of 8.1 with 21.48 (10% of the total 214.8 emissions factor). The approach presented above intends to err on the side of being conservative because, in addition to factoring the upstream emissions, it also acknowledges the possibility that not all wood fuel sourced for any given project may come from forest management that achieves full regeneration within 20-100 years.

While the recommended carbon emission factor of 29.58 pounds per million Btu is far from the historic "carbon neutral" stance, when compared to the carbon emissions (165.5 pounds per MMBtu[7]) from burning heating oil, ***it represents an 82% reduction in CO_2 emissions***.

PARTING THOUGHTS

There is a long-standing scientific and energy policy recognition that using wood fuel to substitute other fossil fuel energy sources (also using wood products to replace concrete, steel and plastics as building materials) has significant, long-term ***net*** carbon emission mitigation benefits. Over the past few decades in Northeastern US, we have practiced sustainable forest management and we harvest less wood than is grown each year. So, assuming we continue to manage our forests sustainably and continue to cut less wood than we grow in the years ahead, using wood fuel to replace heating oil and using wood products to replace carbon intensive materials like plastic, steel, and concrete is an EXCELLENT carbon emission mitigation strategy for our region.

When considering the merits of modern wood heating, it is important to acknowledge and communicate the key factors (like timeframe of analysis, the spatial scale of analysis, and the baseline that the researchers choose to compare wood energy scenarios against) that make

[4] Carbon dioxide emission equivalents (factoring the greenhouse gas potential for other emissions like N_2O) per Million British thermal units of energy produced.
[5] http://www.epa.gov/climateleadership/documents/emission-factors.pdf
[6] http://www.biomasscenter.org/images/stories/SE_Carbon_Study_FINAL_2-6-12.pdf
[7] http://www.epa.gov/climateleadership/documents/emission-factors.pdf

this issue so complicated, but it is also important to not lose sight of a few basic but key points to help dispel common misconceptions:

- People tend to think of forests as perpetual carbon sinks—continually growing and sequestering carbon from atmosphere at a steady rate. However, forests are complex and dynamic systems that are always releasing some carbon and at certain points in time they can emit more CO_2 than they absorb (i.e. major disturbances like forest fires, pest infestations, and wind storms).
- It is a common belief that wood energy will destroy our forests, but for many decades northeastern states have consistently grown more new wood in our forests than we have harvested.
- People tend to believe that in the absence of a local market for wood fuel, forests would be left alone to just continually grow and sequester carbon without any human intervention. However, northeastern forests are predominately privately owned – they will still be managed and periodically harvested for other timber products as part of good forest management and as a means to pay landowner's property taxes. Also, in the absence of local wood markets, more forestland would be prone to the economic pressures to fragment and convert for development.
- Many people focus on debating whether various forms of biomass energy are ***"carbon neutral***" or not – but this really misses the point. The point is that modern wood heating is ***"carbon better***" than the alternative for space heating – fossil fuels like oil and gas.