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Andrea Colnes

Biomass Energy Resource Center

Kamalesh Doshi

Biomass Energy Resource Center

Hillary Emick

Biomass Energy Resource Center

Dr. Alexander Evans

Forest Guild

Robert Perschel

Forest Guild

Dr. Tim Robards

Spatial Informatics Group

Dr. David Saah

Spatial Informatics Group

Adam Sherman

Biomass Energy Resource Center

The study was conducted on behalf of the National Wildlife Federation and Southern Environmental Law Center, whose project team included:

David Carr

Southern Environmental Law Center

Eric Palola

National Wildlife Federation

Frank Rambo

Southern Environmental Law Center

Julie Sibbing

National Wildlife Federation

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Colin High

Resource Systems Group

Daniel Markowitz

Warnell School of Forestry and Natural Resources, The University of Georgia

William Schlesinger

Cary Institute

John Gunn

Manomet Center for Conservation Sciences

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EXECUTIVE SUMMARY

It is important to note that due to the emphasis in the Southeast on biomass electric power production, this study examines only the use of biomass for large-scale electric power generation (and electric-led combined heat and power, or CHP).

As climate change policy develops, forest biomass is consistently recognized as an alternative fuel with the potential to replace fossil fuels and mitigate the build-up of atmospheric carbon. In response to these issues, the southeastern United States has seen recent interest in significantly expanding the biomass energy sector, including building new power plants, co-firing with coal power in existing plants, pellet manufacture for export to Europe, and producing cellulosic ethanol. While some look to these developments and see promise, others look with great concern at pressures on the region's forests, implications for forest health and sustainable wood supply, and impacts on cumulative greenhouse gas emissions.

Until recently, governmental policies have almost unanimously reflected the opinion that energy from biomass is beneficial from a greenhouse gas (GHG) perspective. Biomass typically is included in energy portfolios as a renewable energy source in the same classification as wind and solar and is eligible for the same public incentives and subsidies. Starting in the early to mid 1990s, however, a number of studies looked more closely at the net GHG benefits of burning biomass and resulted in refined calculations of benefits depending on site factors, forest growth modeling, and timing of emissions and sequestration (Manomet, 2010). In the past few years, direct challenges to the accuracy of accounting approaches spurred a rethinking of carbon accounting for biomass (Searchinger, 2009).

As part of this emerging research, the US Environmental Protection Agency (EPA) is revisiting the premise that burning biomass for energy is carbon neutral in the context of the natural carbon cycle of the earth

(EPA, 2011) and is considering regulating carbon emissions from biomass combustion. This study provides an example of how the “comparative” approach can be used for a specific region. It can be further evaluated by EPA to inform its criteria for an “accounting framework for biogenic CO₂ emissions from stationary sources.”

KEY QUESTIONS

To address these complex issues as relevant to southeastern forests, this study seeks to address two key questions relevant to the biomass electric power sector in this region of the country:

- How much biomass (primarily wood) is available on a sustainable basis to source the expanding southeastern biomass electric power sector? And, what is the potential of public policy to create demands that exceed sustainable supply levels?
- How will the increased use of forest biomass for electric power generation in the Southeast affect atmospheric carbon over time, and how does biomass energy compare to several fossil fuel energy alternatives in terms of cumulative GHG emissions over time?

It is important to note that due to the emphasis in the Southeast on biomass electric power production, this study examines only the use of biomass for large-scale electric power generation (and electric-led combined heat and power, or CHP). Thermal energy pathways were not examined and due to their much higher efficiencies, these thermal technologies would have significantly shorter carbon payback periods and different overall impact on atmospheric carbon levels when compared to fossil fuel technologies (Manomet, 2010).

WOOD SUPPLY REVIEW

To assess the potential for sustainably harvested biomass (primarily wood) to fuel an expanded biomass energy sector in the Southeast, the study presents a literature review of several key biomass resource assessments conducted to date, examines the current and possible future energy policies that could drive the expansion of biomass energy development, and compares the supply with this potential demand. This portion of the study has three main parts:

1. assessment of the biomass resource literature for the seven-state region
2. examination of the energy policies in the seven-state region
3. comparison of the resource supply to the potential demand

The study does not present new primary fuel-supply analysis, but is based on a review of existing information. Main findings include the following points:

- Most studies conducted in the past six years quantify the gross or total amount of woody biomass material generated on an annual basis and do not quantify how much is already being used. Most of these studies focus on residues produced from other primary activities while evidence suggests nearly all the mill and urban wood residues are already used by existing markets.
- The evidence clearly suggests that any expanded biomass energy in the Southeast will come from harvested wood (either tops and limbs left behind from timber harvesting, whole trees, or pulpwood sourced from the main stem of a harvested tree).
- Whether logging slash, whole trees, or pulpwood will be used in the expansion of biomass energy in the Southeast will depend on the following:

1. Which market the wood is going to (pellet mills need high-quality fiber from pulpwood while biomass plants are less particular about quality)
2. How much demand increases within the pellet and power market sectors over time
3. What happens with the pulp and paper industry in the southeast region in the future

- Prior to 2009, most fuel availability studies presented estimates of supply without any acknowledgment of the influence price has on the availability of these woody biomass resources. Since then, different studies have examined the economics using different indicators—making it difficult to compare results among the studies. For a clear assessment of the economics of woody biomass resources, the total delivered price paid by the receiving facilities is the best indicator to use.
- Various studies reviewed in this chapter used widely divergent assumptions regarding what percentage of the total amount of logging residue can be recovered from a harvested area. While the range observed in the literature was from roughly 50-100 percent, it should be noted that there is a difference between how much residue *can* be recovered and how much *should* be recovered when ecological factors are taken into account. While examining how much wood fuel could be generated if 100 percent of this material was recovered is useful for academic purposes, it is unrealistic to assume that such a high level can and should be realized. Ideally, studies would look at two critical issues when factoring the overall recovery rate—percentage of recovered residues on individual harvest operations and percentage of harvest operations where residues can be recovered.

It should be noted that there is a difference between how much [logging] residue can be recovered and how much *should* be recovered when ecological factors are taken into account.

EXECUTIVE SUMMARY (cont'd)

While some believe that biomass power demand will likely transition to procuring roundwood and displacing wood from the pulp and paper industry, it is actually more likely that growth in pellet markets—which demand higher fiber quality found in roundwood (not slash)—will be the market that most immediately displaces pulpwood.

- The availability of logging residues will largely depend on extraction methods. Where whole-tree harvesting systems can be used, these residues can be cost effectively accessed, however, the potential ecological effects of whole-tree logging need to be considered. Where mechanized cut-to-length and manual stem-only harvesting are used, these residues will not be easily accessible. Further analysis that determines how much whole-tree harvesting systems versus stem-only harvesting systems are used across this region would be very useful.
 - Of all the states in the seven-state study region, North Carolina has had the most in-depth and sophisticated level of study of its biomass energy potential. In contrast, Alabama and Tennessee both had very little publicly available reports estimating biomass resources.
 - Evidence suggests that there is likely enough wood to meet a 15 percent federal Renewable Energy Standard (RES) applied to each of the seven states (with the exception of Florida) when woody biomass sourced from local forests accounts for no more than 20 percent of the overall renewable electric generation target (or 3 percent of electricity supplied). It also appears, however, that adequate wood fuel resources are quite sensitive to the RES allocation. For example, if 30 percent of a 15 percent RES was allocated to forest biomass, it is likely there would not be enough wood fuel available within the region. A more aggressive RES standard for biomass leads to a higher likelihood of shortages and a greater probability of pulpwood displacement.
 - Capacity to access and utilize residues is also a function of how much roundwood harvest occurs. More demand for roundwood generates more residues. The extent to which biomass power plants transition their wood procurement away from residues and toward roundwood is governed by the strength of the rest of the forest products industry. If the forest products industry strengthens as a result of greater lumber demand, it will increase its wood fiber consumption and as a result, biomass power plants would procure more residues at a lower cost and less pulpwood at a higher cost. If the forest products industry as a whole continues to contract, however, biomass power plants will likely transition toward procurement of chipped fuel from whole trees assuming they can absorb the higher cost associated with that transition.
- While some believe that biomass power demand will likely transition to procuring roundwood and displacing wood from the pulp and paper industry, it is actually more likely that growth in pellet markets—which demand higher fiber quality found in roundwood (not slash)—will be the market that most immediately displaces pulpwood. Therefore, pellet mills and biomass power plants have somewhat complementary (almost symbiotic) procurement needs. Pellet production, especially the export market to Europe, will continue to play the wild card role in future wood fuel markets.

- The supply review performed as part of this study does not directly address potential ecological impacts of biomass energy sourcing. Additional analysis will be necessary to assess these impacts on other forest resources and values.
- The potential recovery rate for harvest residue is a key variable in determining the quantity of available wood fuel. Further research is needed to assess both the current achievable residue recovery rates and reasonable future recovery rates. Projected recovery rates need to consider woody biomass retention rates to meet wildlife and biodiversity, water quality, and soil productivity needs.

While this report has identified and probed some of the issues regarding the forest resource's capacity to produce more energy in the Southeast, there are numerous areas where key information is missing. More specific research is needed in the areas of: existing forest residue utilization, use of different harvesting systems, a comprehensive wood fiber assessment for the entire seven-state region, the price elasticity of demand between fuel chips and pulpwood, and the likely impacts of federal renewable energy standards on the economic incentives that drive project development.

ATMOSPHERIC CARBON ANALYSIS

To examine the atmospheric effects of biomass electric power generation in the Southeast, this study developed a new carbon accounting framework that integrates life-cycle carbon accounting with forest carbon accounting and utilizes forest growth, forest management practices, and supply data related to the specific situation in the Southeast. The framework is based on what we will call a “landscape-woodshed approach” where actual supply zones for specific facilities across the landscape are defined and aggregated as the basis for the study. Essentially, the study framework is designed to answer policy questions related to how atmospheric carbon would be affected if certain activities were promoted. It develops a “business-as-usual” baseline and then projects the atmospheric carbon effect of different future scenarios of creating electricity from woody biomass versus creating it from fossil fuels.

Given the dynamics of the southeastern forestry sector, this study assumes that most of the trees modeled would eventually be harvested for pulp or other management objectives (such as to initiate the new stand under even-aged management) versus being left untouched if not harvested for biomass energy. The study excludes all public lands and 21 percent of private lands as not available for harvesting.

This is a more dynamic approach than was recommended in EPA's accounting framework for biogenic sources released in September 2011. Although, EPA acknowledged the “comparative” approach used in this study as a more comprehensive accounting method, it chose a “reference point” approach because of the perceived difficulties and challenges in applying a more dynamic approach to actual situations in the field.

The framework [for this study] is based on what we will call a “landscape-woodshed approach” where actual supply zones for specific facilities across the landscape are defined and aggregated as the basis for the study.

EXECUTIVE SUMMARY (cont'd)

This study provides an example of how more dynamic accounting can be accomplished and should be considered by EPA in its carbon accounting deliberations. The results are consistent with other studies from other states or regions using similar analytical methods (Manomet, 2010 and McKechnie, 2011). Others have recently voiced opinions over which accounting methods are most appropriate. The SAF Task Force Report, *Managing Forests because Carbon Matters: Integrating Energy, Products, and Land Management Policy* (Malmshiemer et al., 2011), recommends a reference-point approach to establish forest biomass as carbon neutral. The European Environment Agency's Scientific Committee on Greenhouse

Gas Accounting (European Environmental Agency, 2011) recently offered an opinion championing a comparative approach to fix a serious flaw in current GHG accounting.

Carbon Modeling Results

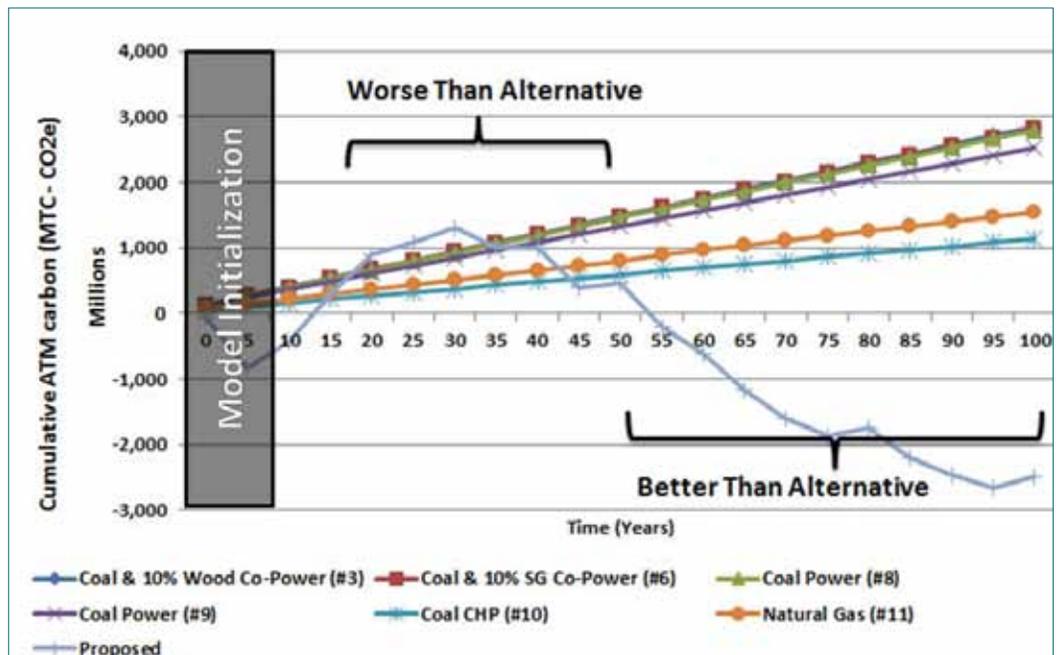
- The study modeled 22 new power plants as proposed to be developed over the next several years (1014 MW and 3.05 million tons of pellet production) added to an existing base of 17 power plants. The list of proposed plants is a snapshot compiled in May 2011 by the Southern Environmental Law Center. Additional large plants have since been proposed and are under development. As biomass demand increases with more facilities beyond the

Figure 22.

The study found that using southeastern forests for an expansion of electric power generation produced a significant long-term atmospheric benefit, but at short-term atmospheric cost.

The expanded biomass scenario creates a carbon debt that takes 35-50 years to recover before yielding ongoing carbon benefits relative to fossil fuels after this time period. (The initial apparent sequestration in the graph is a modeling artifact. It is a function of the simulation resolution and is due to the 5-year cycle with harvests mid-decade. This creates a 5-year growth period before harvest simulation.)

Figure 22. Cumulative atmospheric carbon balance over 100 years using coal and natural gas technologies to meet energy demand of proposed biomass facilities.



22 modeled, the ability of the forested landscape to provide biomass supply and store carbon may become more limited, particularly in localized areas with strong demand.

- The results indicated that the 17 existing biomass facilities were now generating and would continue to generate an improved atmospheric carbon benefit relative to fossil fuel technologies.
- The study found that using southeastern forests for the modeled expansion of power generation produced a significant long-term atmospheric benefit, but at short-term atmospheric cost. The expanded biomass scenario creates a carbon debt that takes 35-50 years to recover before yielding ongoing carbon benefits relative to fossil fuels after this time period (see Figure 22 on page 95). This outcome depends on the fossil fuel pathway used for comparison and assumes forests re-occupy the site through planting or natural regeneration, with no forest land conversion. This finding is consistent with other recent studies and naturally creates tension between climate scientists who assert that the next 20-30 years are a critical time for reducing carbon additions to the atmosphere and those who are more focused on long-term cumulative atmospheric carbon levels. This tension can only be resolved by well-informed energy and climate policy decisions.
- The efficiency of combustion technology was shown to be a critical factor influencing carbon emissions over time. The study used a mid-range value of 6,800 Bone Dry Tons (BDT) per megawatt hour per year. Using less-efficient combustion technology that requires more biomass per unit of power (e.g., using 8,000 BDT per megawatt hour per year) extends the payback period to 53 years. Using more efficient technologies would shorten this payback period. This study does not address biomass for thermal applications. While less common in the study area, strictly thermal applications or CHP applications are significantly more efficient and have much shorter carbon payback periods (in the range of 5-10 years in similar studies) than conventional combustion for base-load electrical generation that produces significant amounts of unused “waste” heat. The study also found that there is wide variability in carbon outcomes for different fuel types across different combustion systems.
- The use of logging residuals, when available from current harvests, leads to an improved carbon balance versus using standing roundwood because of the higher relative carbon storage of pulpwood versus residuals. The availability of harvest residue, however, is highly dependent on other parts of the wood products economy to generate sufficient demand for harvesting that creates residue material.
- The study did not model the use of dedicated energy crops for feedstock or crops that could be grown on fallow land and not jeopardize current sequestration and carbon stocks in existing forests. It attempted to analyze switchgrass based on information from a literature review, but this did not provide adequate or comparable information to what was available from our forest biomass modeling. Hence, a switchgrass analysis was dropped from the carbon modeling.

EXECUTIVE SUMMARY (cont'd)

One central issue to recognize is that [carbon] policy discussions include two competing perspectives—one long term and one short term—that will need to be assessed and weighed in the development of effective climate and energy policy.

DISCUSSION

The complex flux of forest-based carbon and the 35-50 year payback periods for the electric generation technologies modeled present both an intellectual and policy challenge. One central issue to recognize is that policy discussions include two competing perspectives—one long term and one short term—that will need to be assessed and weighed in the development of effective climate and energy policy. The long-term perspective focuses on the much lower amounts of atmospheric carbon that will eventually be realized if biomass is substituted for fossil fuels and the related beneficial effects for climate change and future generations. From this perspective, the 35-50 year payback period of biomass is less consequential. The short-term perspective, by contrast, believes near-term emission reductions are critical. This perspective is concerned with near-term “tipping points”—climate events that might be triggered by near-term increases in atmospheric carbon. From that perspective, the 35-50 year payback periods for biomass electric power are considered unacceptable climate and energy policy.

To further inform this discussion, it is useful to note that the carbon debt period shown in this study is consistent with other studies (Manomet, 2010, McKechnie, 2011) that have used life-cycle analysis, forest carbon accounting, and a business-as-usual baseline to compare biomass to other forms of energy production. As shown schematically in Figure 1 on the following page based on the Manomet study, there is an initial carbon “debt” relative to fossil fuels in the combustion of biomass for energy. Following a variable “payback” period, this debt is recovered and beyond that point biomass energy results in lower atmospheric carbon than fossil fuel alternatives.

The Manomet modeling produced a 42-year payback period for biomass- versus coal-generated electricity and the McKechnie modeling indicated 17-38 year payback periods for generating electricity with biomass instead of coal. Although these patterns are basically consistent, there are differences in debt periods, which are attributable to different forest types and harvest scenarios. In addition, our framework includes a more precise modeling of actual harvesting methods in real stands across the study region and linked to specific facilities.

Also there are significant differences between this study and the Manomet study in the time it takes to re-sequester all the emitted carbon and reach the point commonly called “carbon neutral.” Our modeling indicates 53 years are required for this southeastern study region while the Manomet results for Massachusetts indicate more than 100 years are required.

Beyond the tension between this long- and short-term perspective, analyzing the climate implications of the biomass technologies modeled in this report is informed by several additional issues. First, recent climate studies indicate that whatever the ultimate peak in atmospheric carbon, it will take much longer than previously thought—hundreds or thousands of years—for the earth’s systems to bring it back down to what are considered safe levels. This further complicates the understanding of how to address the short- versus long-term atmospheric carbon implications of biomass energy.

Second, it is possible to imagine future scenarios where technology leaps allow the retirement of such major sources of combustion as coal and biomass within 50 years. If realized, this would significantly shorten the payback period for biomass since facilities would be retired, biomass harvesting would stop, and re-sequestration would accelerate to shorten the payback periods. Conversely, it is possible to imagine land-use changes that would adversely affect the availability of biomass and negatively affect the payback periods. Concern over land-use change is well documented in the Southeast.

Third, it is necessary to fully consider any negative climate implications or events that could be triggered by the carbon debts created by the biomass scenarios. One should also consider whether these climate effects would eventually be triggered by continuation of the fossil fuel scenarios in the absence of biomass or other alternative fuels. Evaluating the cumulative costs and benefits to ecosystems and society of these factors over time is the task in front of policy makers in the southeastern region and at the national level.

Fourth, much of the carbon accounting debate for biomass centers on assumptions of baseline conditions. It is not uncommon to see studies that rely on generic “growth-to-removal” ratios as the key indicator of carbon accounting. The rationale is that as long as overall carbon stocks are being maintained in some specified area, then any biomass removal in that area is considered carbon neutral. This approach oversimplifies the accounting and can overlook very significant changes in forest carbon stock at the local level. They also do not accurately portray the foregone tons of new sequestration that would continue to accrue if those forests were not harvested for biomass.

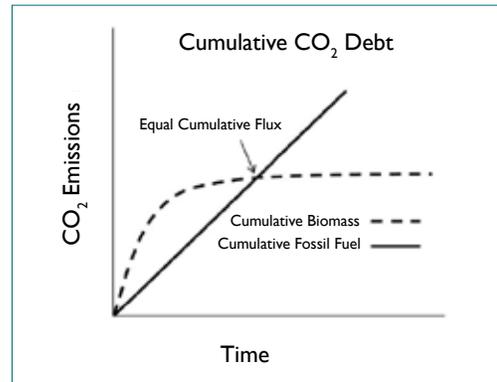


Figure 1.
Landscape-Scale
Cumulative Carbon
Debts and Dividends
(Walker, 2012).

This study relies on a comparative approach that realistically estimates both the level of forest harvesting and the level of forest sequestration going forward in the absence of new biomass harvesting as a more accurate baseline approach. The approach used in this study can be applied to a region or an individual facility and should be useful for EPA as it develops regulations for GHG emissions.