Duke NICHOLAS INSTITUTE FOR ENVIRONMENTAL POLICY SOLUTIONS
Celebrating 10 Years

Policy Brief
NI PB 15-02

March 2015

www.nicholasinstitute.duke.edu

Environmental and Economic Implications of Regional Bioenergy Policy

Christopher S. Galik, Nicholas Institute for Environmental Policy Solutions
Robert C. Abt, North Carolina State University
Gregory Latta, Oregon State University
Tibor Vegh, Nicholas Institute for Environmental Policy Solutions

The unique generation, landownership, and resource attributes of the southeastern United States make the region a ripe and important test bed for implementation of novel renewable energy policy. This policy brief describes the environmental and economic implications of one policy intervention: a hypothetical region-wide renewable portfolio standard (RPS) with separate biomass targets or "carve-outs." A study of this intervention shows that over time the dominant contributor to such an RPS would be forest biomass and that existing resource conditions would influence patterns of biomass harvesting, resulting in a spatially and temporally diverse forest carbon response. Net forest carbon storage in the Southeast would be greater with the hypothetical RPS than without it in all but the final years of the modeled time period, but when displaced fossil fuel emissions are accounted for net greenhouse gas (GHG) reductions over the period could be substantial. The methods and findings presented here are also relevant to a broader array of policies that could increase biomass demand from the region, including pellet exports from the United States to the European Union and regulation of greenhouse gases under the Clean Air Act.

Background and Approach

Policy interventions are commonplace in emerging markets. They have been used in the United States to encourage production and use of bioenergy and bio-based fuels but have been met with mixed success. This analysis focuses on the role of regional renewable energy policy in encouraging the development of a sustainable regional bioenergy market in the southeastern United States. The hypothetical regional policy is based on existing state Renewable Portfolio Standard (RPS) policies. The majority of U.S. states now have an RPS, but only one state in the Southeast (North Carolina) has a state-level renewable energy mandate. Given this gap, would a multistate renewable energy policy help establish a sustainable bioenergy market in the region? And what would such a policy's local and national environmental and economic effects be?

Overview of the Regional RPS

The hypothetical regional energy policy is based on an evaluation of existing state RPS policies and involves three key considerations or assumptions. First: the regional renewable energy target is set at 3% of total energy sales in year 1. This target would increase by the average rate for existing RPS policies—4.1%—every 5 years, reach a 15% maximum in the 16th year of the policy, and be maintained through 2050, the end of the modeled scenario. Energy sales are themselves estimated from year 2010 data and are assumed to grow at a rate of 0.3% per year.[1] Second: biomass must satisfy an annual carve-out of 5% of the renewable energy target in each year. Third: demand for renewable energy imposed by the hypothetical RPS could be met with biomass from anywhere in the region. In practice this flexibility approximates the use of tradable renewable energy credits (RECs) to meet state-level compliance obligations.

[1] Energy Information Administration (EIA). 2012. State electricity profiles 2010. DOE/EIA-0348(01)/2. EIA. 2014. Annual Energy Outlook 2013, Data Tables, East South Central Residential Total Delivered Energy 2012–2040 growth rate.

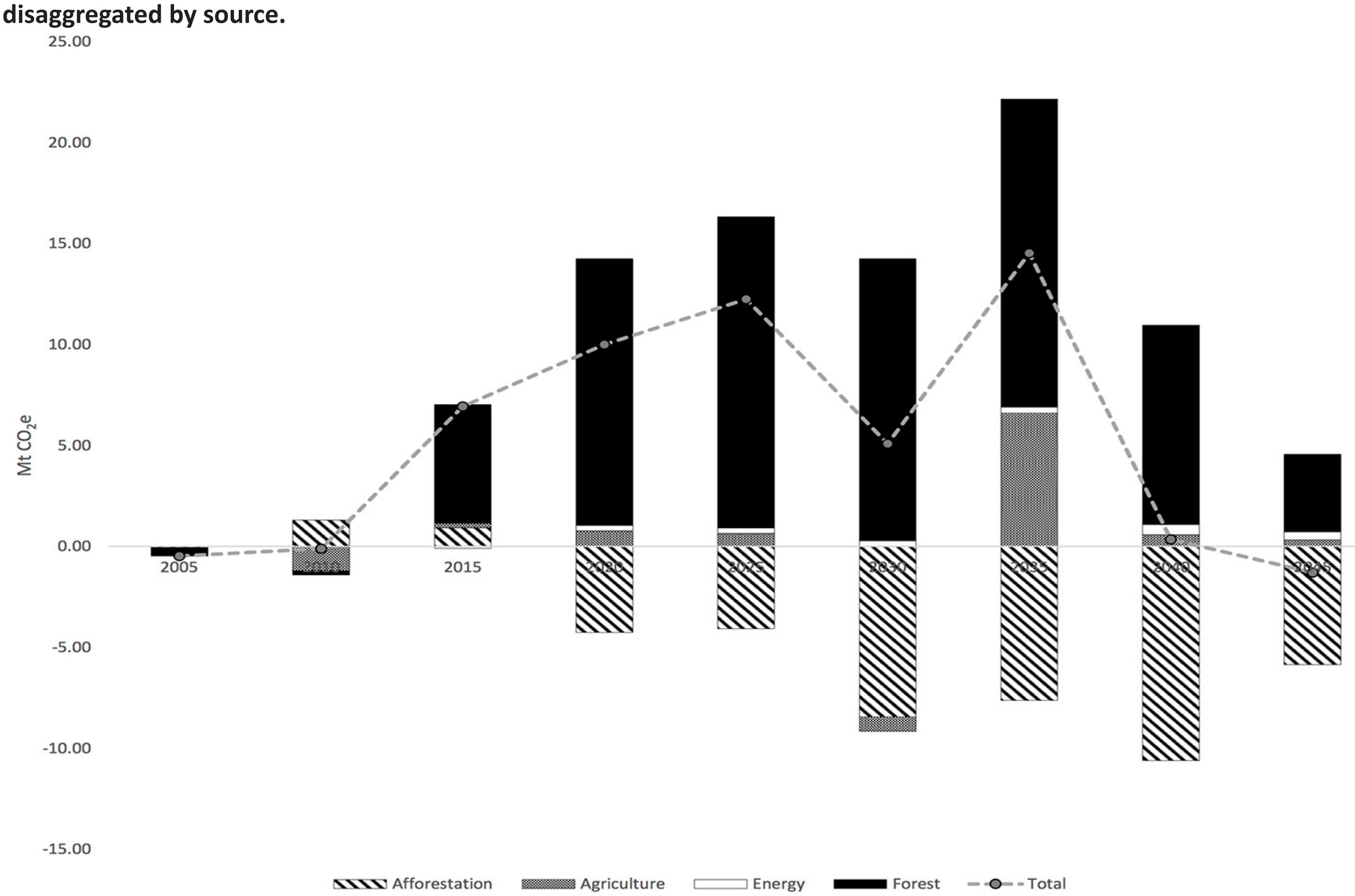
Overview of the Modeling Framework

Understanding the regional and national effects of a regional RPS requires modeling the dynamics of local forest product supply and demand. In this analysis, the regional and national harvest effects of the hypothetical RPS policy are first estimated within a multi-sector model of the United States and then downscaled to the sub-regional level for observation of localized responses. The analysis utilizes the Forest and Agriculture Sector Optimization Model with Greenhouse Gases (FASOMGHG) to assess the multi-sector and interregional allocation of increased harvest activity to meet the RPS target. The FASOMGHG model is an intertemporal optimization model; therefore, it simulates agriculture, forestry, and bioenergy decisions in a way that allocates resources in the most efficient fashion to achieve the greatest benefits over time. Once output is generated by FASOMGHG at the regional and national levels, data are passed to the Sub-Regional Timber Supply (SRTS) model to assess how regional estimates are further allocated within the southeastern United States. Because SRTS estimates forest resource dynamics, harvest response, and market consequences at a sub-regional (e.g. multi-county) level, it can indicate comparative advantages within the southeastern United States that would not be possible with FASOMGHG alone.

Modeling Results

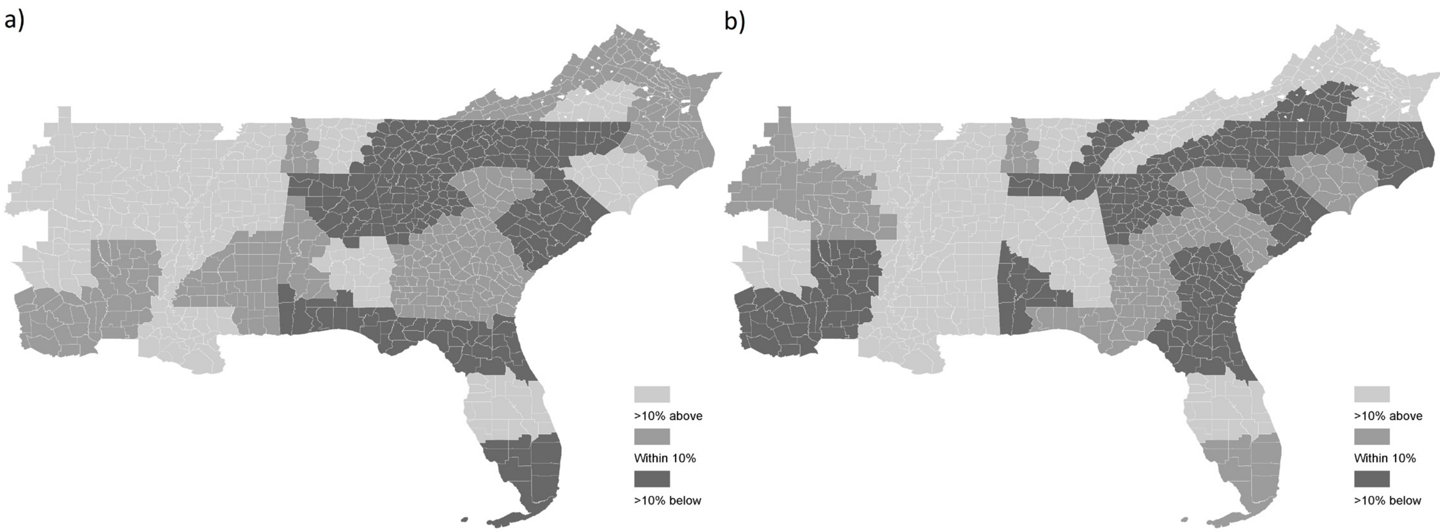
The analysis indicates that a regional RPS in the Southeast would primarily draw from forest biomass in the form of logging residues to meet imposed targets. Moreover, national output data from FASOMGHG suggest that forest carbon storage is greater with the RPS than without it in all but the final years of the model run (Figure 1). This increased storage is in part due to increased investment in pine plantations. At the national level, harvest activity is reallocated across southern, western, and northern portions of the country. The western United States steps up lumber production to meet demands in the forest and agriculture sectors as harvests are reallocated to account for the imposition of the RPS targets in the South. The southern United States slows near-term harvests of planted pine to boost harvests in the long run. This shift triggers the northern United States to reduce hardwood harvests to allow its long-term hardwood inventories to increase. The end result of this reallocation is a net gain in forest carbon storage at the national level in all years of the analysis.

Figure 1. Cumulative change in carbon storage in the South attributable to implementation of the regional RPS, disaggregated by source.



The analysis paints a similar story of spatial and temporal heterogeneity within the Southeast. Within the region, implementation of the regional bioenergy policy results in a small price increase relative to a no-RPS baseline, leading to changes in land use, management, and harvest activities. The increased demand for biomass leads to an increase in harvests from plantations, decreasing in-forest carbon storage. Countering this trend, the increased value of woody biomass also increases the value of forestland relative to other uses, leading to an increase in carbon storage. These patterns of harvest, inventory, and land use change are not consistent across the region. Rather, areas of regional comparative advantage, largely driven by previous planting and harvest cycles, are evident. For example, the coastal plains of South Carolina and northern Florida experience lower-than-average softwood pulp removals due to a recent decline in planting activity. The end result is that changes in forest carbon within the Southeast exhibit a large degree of spatial heterogeneity (Figure 2).

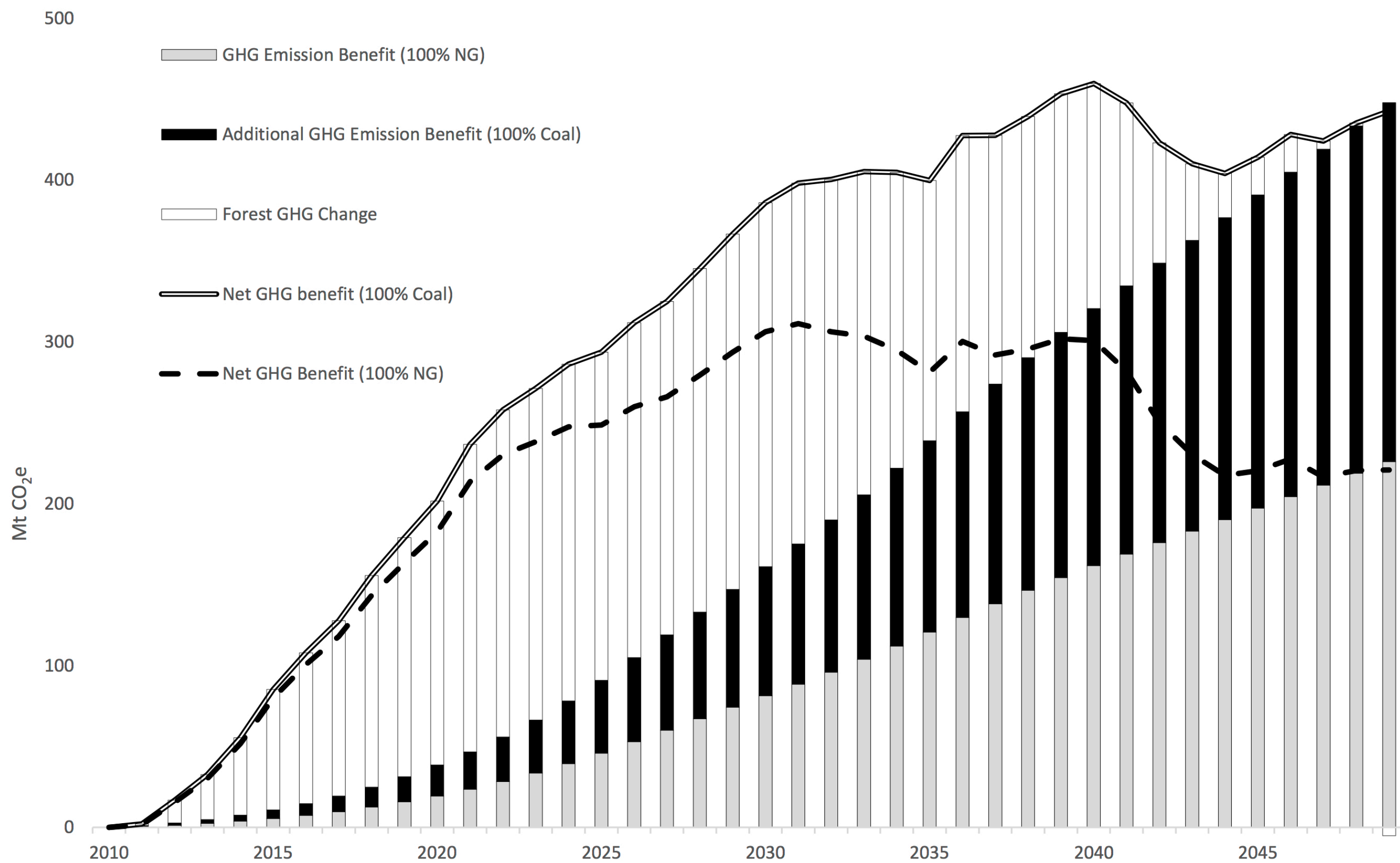
Figure 2. Change in forest carbon stock by survey unit attributable to the regional RPS in (a) 2029 and (b) 2049.



Assuming that the production of bioenergy will be higher under a RPS than it would have been otherwise, the net GHG implications of the policy are a function of both the change in forest and agriculture carbon storage and the emissions displaced from alternative fossil-fuel sources. Absent an integrated modeling exercise that simultaneously captures utility investment decisions made in response to the regional RPS and subsequent feedback effects to forest and agriculture sectors, it is difficult to estimate how the policy will affect existing and planned electricity generation infrastructure. Instead, net emissions reductions can be calculated under two extreme scenarios: that all additional bioenergy capacity replaces existing coal and that all additional bioenergy capacity replaces new natural gas. Owing to the higher per-MWh GHG emissions associated with coal (2,249 lbs CO_2/MWh) as compared to natural gas (1,135 lbs CO_2/MWh), the former scenario would be expected to generate the highest level of GHG reductions, whereas the latter would generate the lowest (Figure 3).[2] The actual amount of GHG reductions would likely fall somewhere in between.

[2] Conversion rates indicate the U.S. average for each fuel and are derived from http://www.epa.gov/cleanenergy/energy-and-you/affect/air-emissions.html (last accessed August 28, 2014).

Figure 3. Cumulative change in forest carbon storage in response to imposition of a regional RPS along with estimate of displaced emissions.



Note: The upper, double line indicates the carbon benefits of switching fuels and replacing 100% coal; the lower, dashed line indicates replacement of 100% natural gas-fired generation.

Other Policy Drivers of Renewable Energy Demand

The demand attributed here to a regional RPS can also be thought of as arising from a variety of other policy drivers. For example, EU renewable energy goals could promote wood pellets exports to European markets, increasing demand for biomass in the Southeast region at a magnitude consistent with that estimated here.[3] The extent to which pellets from the U.S. South are utilized to meet EU renewable energy goals will depend on the continued evolution of EU energy policy and the ultimate eligibility of U.S. producers to meet sustainability and chain of custody requirements.[4]

Another potential driver of renewable energy demand is impending regulation of greenhouse gases under the Clean Air Act (CAA). The U.S. Environmental Protection Agency (EPA) is in the process of regulating carbon dioxide (CO_2) emissions from the power sector through section 111 of the CAA. In June 2014, it proposed its Clean Power Plan, which would regulate CO_2 emissions from existing power plants. To comply, states can choose from a wide variety of strategies, including co-firing with biomass.[5] States may also work with other states to meet a joint emissions performance level. The agency recognizes that states may wish to cooperate with one another to increase emissions reduction opportunities and capture low-cost reductions. In this manner, implementation of the Clean Power Plan could create incentives to use biomass at a scale and magnitude similar to the regional RPS scenario modeled here.

[3] Lamers, P., R. Hoefnagels, M. Junginger, C. Hamelinck, and A. Faaij. 2014. "Global Solid Biomass Trade for Energy by 2020: An Assessment of Potential Import Streams and Supply Costs to North-West Europe under Different Sustainability Constraints." GCB Bioenergy doi: 10.1111/gcbb.12162; Cocchi, M., L. Nikolaisen, M. Junginger et al. 2011. "Global Wood Pellet Industry Market and Trade Study." IEA Bioenergy Task 40: Sustainable International Bioenergy Trade.

[4] See, e.g., Bullein, R., 2014. "EC Plans Biomass Sustainability Review by Summer." ENDSEurope. See also Kittler, B., W. Price, W. McDow, and B. Larson. 2012. "Pathways to Sustainability: An Evaluation of Forestry Programs to Meet European Biomass Supply Chain Requirements." New York: Environmental Defense Fund.

[5] When it comes to guidance on quantifying the carbon intensity of biogenic fuel sources, however, the proposals defer to the agency's pending biogenic accounting framework.

Acknowledgments
Funding for this work was provided under USDA NIFA Grant Number 2012-67009-1991. Material in this brief is drawn from Nicholas Institute Working Paper 14-10, "Environmental and Economic Effects of a Regional Renewable Portfolio Standard with Biomass Carve-outs." We thank Andreanne Meley for assistance in the preparation of this brief.

Citation
Christopher S. Galik, Robert C. Abt, Gregory Latta, and Tibor Vegh. 2015. "The Environmental and Economic Implications of Regional Bioenergy Policy." NI PB 15-02. Durham, NC: Duke University.
www.nicholasinstitute.duke.edu/publications

Nicholas Institute for Environmental Policy Solutions
The Nicholas Institute for Environmental Policy Solutions at Duke University is a nonpartisan institute founded in 2005 to help decision makers in government, the private sector, and the nonprofit community address critical environmental challenges. The Nichols Institute responds to the demand for high-quality and timely data and acts as an "honest broker" in policy debates by convening and fostering open, ongoing dialogue between stakeholders on all sides of the issues and providing policy-relevant analysis based on academic research. The Nicholas Institute's leadership and staff leverage the broad expertise of Duke University as well as public and private partners worldwide. Since its inception, the Nicholas Institute has earned a distinguished reputation for its innovative approach to developing multilateral, nonpartisan, and economically viable solutions to pressing environmental challenges.

Contact
Nicholas Institute, Duke University
P.O. Box 90335
Durham, North Carolina 27708

1201 New York Avenue NW, Suite 1110
Washington, D.C. 20005

Duke Marine Lab Road
Beaufort, North Carolina 28516

919.613.8709 phone
919.613.8712 fax

nicholasinstitute@duke.edu
www.nicholasinstitute.duke.edu