Woody Biomass Economic Study

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Executive Summary

Florida is made up of nearly 16 million acres of timberland, of which approximately 10 million acres are held by private forest landowners. Over 16 billion dollars of economic return is generated annually by the management and utilization of our state's forest.

In 2008, the Florida Legislature passed legislation requiring the Department of Agriculture and Consumer Services, in conjunction with the Department of Environmental Protection to conduct an economic impact analysis on the effects of granting financial incentives to energy producers who use woody biomass as fuel, including an analysis of the effects on wood supply and prices and impacts on current markets and forest resource sustainability.

The University of Florida's School of Forest Resources and Conservation and the Food and Resource Economics Department were contracted to complete the needed analyses and prepare detailed technical reports. A public forum was held on April 14, 2009, in order to allow conservation groups, forest industry, land managers and other stakeholders to provide input on the methodology for the studies proposed by the UF researchers. These two studies focused on the use of woody biomass fuels for electrical generation and evaluated the potential for Florida's private timberland contributions to supplying biomass feedstocks under varying scenarios. Private lands were chosen due to individual landowners' ability to quickly adapt their management practices to meet market changes.

The study conducted by the UF Food and Resource Economics Department (FRED) analyzed the economic impacts in the state from expanded use of woody biomass as a feedstock for energy production under selected policies and incentives. This study concluded that financial incentives such as renewable energy production tax credits and subsidies for forestry biomass producers would increase state GDP, employment and forest sector output while reducing fossil fuel imports, provided feedstock availability can be secured. The existing wood products manufacturing sector would face higher competition for timber products resulting in higher prices for raw material, while timberland owners would benefit from higher timber prices.

The study conducted by the UF School of Forest Resources and Conservation (SFRC) utilized the Sub-regional Timber Supply (SRTS) model to analyze woody biomass demand, supply and timber prices resulting from implementation of a hypothetical renewable portfolio standard (RPS) in Florida. Currently in Florida, electricity generation from wood and wood waste contributes 0.6% of total capacity. To sustainably achieve 1% to 3% of electricity production from wood sources, logging residues and urban wood waste have to be utilized in addition to merchantable timber along with an enhanced reforestation program. Reforestation must at least keep pace with forest harvest removals. Beyond 3% of electricity generation from wood sources, short rotation energy crops need to make up a larger share of the fuel mix in addition to all other feedstock sources mentioned above. The study concluded that a 7% RPS (equivalent of 1% to 3% electricity production from wood sources over time) would have little impact to the existing forest products industry and Florida's forest would remain sustainable.

Therefore, it appears that a 7% RPS as modeled in the SFRC study would be both feasible without much disruption of timber supply to existing forest products industry, and economically beneficial to the economy of the state, and especially to timber producers and forestry in general. A modest mandate of this kind would facilitate increases in stumpage timber prices landowners receive for their products and increase chances of keeping “forests in forest”. Any clean portfolio standard or RPS mandate should also incentivize tree planting including short rotation energy crops establishment on acreage proportional to the magnitude of the mandate. With increased reforestation, afforestation and planting of high-yielding short rotation woody crops on up to 15% of non-forested lands, a 12% and higher RPS could be achieved without depletion of the forest resources of the state, or significant impacts to the existing forest industries.

Introduction

The current report was mandated by the 2008 legislature in House Bill 7135 and signed into law by Governor Crist (Laws of Florida, Chapter 2008-227, Section 113, pages 125-126). The relevant excerpt of the law reads: "Woody biomass economic study. – The Department of Agriculture and Consumer Services, in conjunction with the Department of Environmental Protection, shall conduct an economic impact analysis on the effects of granting financial incentives to energy producers who use woody biomass as fuel, including an analysis of effects on wood supply and prices and impacts on current markets and forest sustainability. The departments shall prepare and submit a report on the results of the analysis to the Governor, the President of the Senate, and the Speaker of the House of Representatives no later than March 1, 2010."

The Florida Division of Forestry (DOF) was designated within the Florida Department of Agriculture and Consumer Services (DACS) as the lead agency for this report. This report focuses on the forest resources of the state, current forest products use, and how granting of financial incentives to energy producers may affect Florida's forest resources and forest industries. The DOF contracted with two teams of researchers at the University of Florida (UF), one at the Food and Resource Economics Department (FRED), and the other at the School of Forest Resources and Conservation (SFRC) to conduct the needed analyses. A public meeting was held in Tallahassee on April 14, 2009, during which forestland owners, forest products industry representatives, conservation organizations, other stakeholders and the public had an opportunity to provide input on the methodology for the studies proposed by the UF researchers. Further stakeholder input was received via a dedicated website between April 15 and May 15, 2009. This report summarizes results of the two technical reports (Hodges et al 2010, and Rossi et al 2010) prepared at the University of Florida at our request. The readers interested in background details, in depth methodology, and results are encouraged to visit www.fl-dof.com where the two technical reports are posted.

Florida has abundant forest resources which are predominantly in private ownership. As of 2007, forests covered 49% of Florida, or 16.9 million acres. Ninety-four percent of that area, or 15.9 million acres is considered available for timber production and classified as timberland. The remainder is largely reserved (e.g., parks and preserves) or unproductive. Softwood forest types occupy 46% of Florida's timberlands, while hardwoods comprise 51%, and non-stocked areas make up the remaining 3%. The longleaf-slash pine forest-type group predominates with 5.6 million acres, or 35% of the timberland. The oak-gum-cypress type group is second in abundance with nearly 3.1 million acres or 19% of the timberland. Non-industrial private forest (NIPF) owners control 63%, or 10.1 million acres, public ownerships are 28%, or nearly 4.5 million acres, while forest products industry ownership is 9% or 1.4 million acres of timberland according to 2007 data. The NIPF ownership is almost equally split between family-owned forests (4.8 million acres) and corporate ownership (5.0 million acres). The NIPF corporate ownership is comprised mainly of Timber Investment Management Organizations (TIMOs) and Real Estate Investments Trusts (REITs).

Florida has thriving forestry and forest products industry sectors with considerable contributions to the state's economy. There are 77 sawmills, pulpwood mills and other primary wood-processing plants operating in the state. The forest products industry uses approximately 20 million green tons of merchantable timber annually. Production of that timber has more than doubled in Florida within the last 60 years, growing from 218 million cubic feet in 1948 to 491 million cubic feet in 2007. Pulpwood, saw logs, veneer logs, composite boards, posts, pilings, and more recently wood pellets are the primary wood products in Florida. The forestry and forest products industry are leading economic sectors in many rural counties in the northern part of the state. Revenue from forestry and related activities is the largest, while the total value added is second only to environmental horticulture among seven leading agricultural industries in Florida. The forestry, wood and paper products industry in Florida has an annual economic impact of $16.7 billion and employs 89,000 persons.

While the legislation referenced the impact of financial incentives to energy producers, such incentives can take various forms, all of which would arguably increase the demand for woody biomass. For purposes of this report, state and federal renewable electricity production tax credits, and the federal biomass crop assistance program (BCAP) were considered in the context of a hypothetical Renewable Portfolio Standard (RPS) for electricity production in Florida. The objective of the report was to answer two questions: (1) what level of biomass utilization for power generation is sustainable in Florida, and (2) what effects do financial incentives to energy producers who use woody biomass as fuel have on the Florida economy, forestry and the existing forest products industry.

In 2007, Florida had 1,048 MW of renewable electricity generation capacity, which was 1.9% of the total, wood and wood waste contributed 354 MW, or 0.6% to that capacity (USDOE 2009b). If a 7% RPS was adopted in Florida today, woody biomass would need to contribute between 1% and 3% of total electricity consumption, for a 12% RPS that share would grow to between 6% and 8%, while for a 20% RPS woody biomass would need to contribute from 14% to 16% of total electricity consumption for the period beginning in 2013 until 2040 (Table 1). However, to sustainably achieve 1% to 3% levels of electricity production from wood sources, logging residues and urban wood waste have to also be utilized in addition to merchantable timber, and reforestation has to keep pace with harvest removals. Beyond 3% of electricity generation from wood sources, short rotation energy crops (SREC) need to fulfill an increasingly larger share of the fuel mix beside all other feedstock sources mentioned above, as described in this report.

Table 1. Woody biomass and base other renewable energy sources (ORES) contributions to electricity production in Florida under a hypothetical 7%, 12% or 20% renewable portfolio standard (RPS) in 2025.

	7% RPS		12% RPS		20% RPS	
Woody Biomass contribution	6.3 TWh	2%	20.4 TWh	7%	43.0 TWh	15%
ORES contribution	13.5 TWh	5%	13.5 TWh	5%	13.5 TWh	5%
Total renewable electricity	19.8 TWh	7%	33.9 TWh	12%	56.5 TWh	20%
Total electricity production	282.5 TWh	100%	282.5 TWh	100%	282.5 TWh	100%

The amount of woody biomass needed to produce renewable electricity in Florida increases with time due to the projected increases in demand for electricity (Figure 1). Florida currently harvests approximately 20 million green tons of merchantable timber annually. By 2025, a 2% contribution from wood to electricity generation would require an additional 10 million green tons, a 7% contribution would require an additional 30 million green tons, while a 15% contribution would require an additional 60 million green tons of woody biomass beyond what the current forest products industry may need. Assuming current harvest levels for traditional wood products remain the same, such changes would require anywhere from 1.5 to more than four-fold increase in wood output by forestry and allied activities. The four-fold increase would require landscape-scale adjustments in timber and other woody biomass production methods, high and sustained reforestation and afforestation, and infrastructure changes to plant, grow, harvest and transport short rotation woody crops on up to 1.4 million acres of currently non-forested lands.

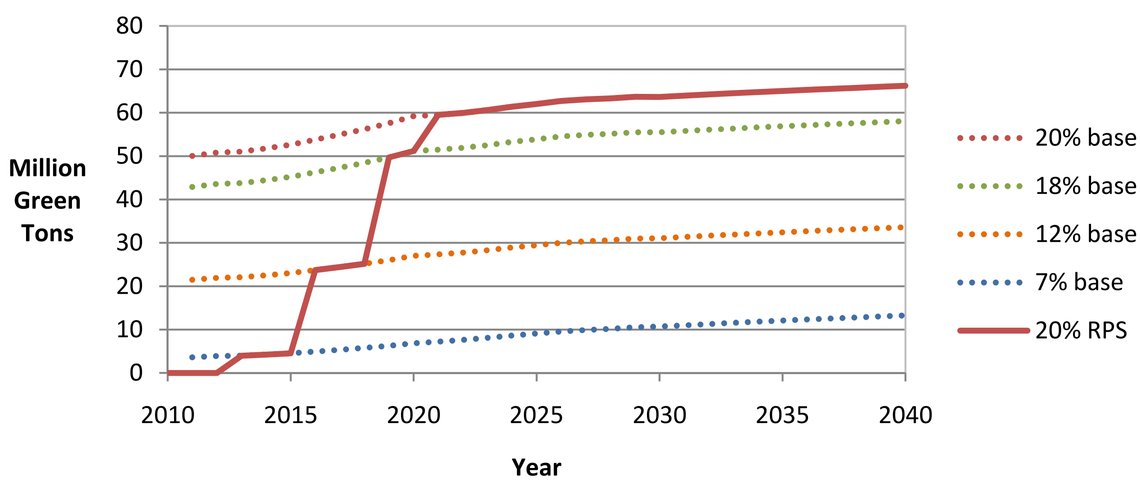

Figure 1. Projected change in demand for woody biomass above 2007 harvest levels of 20 million green tons resulting from a theoretical 20% renewable portfolio standard (solid line), assuming "base" other renewable energy sources (ORES) projection and a step-wise portfolio adoption. Also shown projected amount of woody biomass needed for a hypothetical 7%, 12% or 18% RPS with base ORES assumptions.

The subsequent two chapters of this report summarize the University of Florida's FRED report by Hodges et al 2010, and SFRC report by Rossi et al 2010. The FRED report describes economic impacts which may result from increased wood utilization for renewable electricity production. However, that report did not look at the availability of the woody biomass feedstocks. This task was accomplished by SFRC researchers who modeled woody biomass demand, supply and timber prices scenarios resulting from increased wood utilization for electricity production in Florida as exemplified by a hypothetical adoption of 7%, 12%, or 20% RPS in Florida. The DOF in conjunction with the Department of Environmental Protection (DEP) prepared this final report for the Florida Governor, the President of the Senate, and the Speaker of the House of Representatives, as requested.

University of Florida FRED Report Methods and Findings

Introduction

This study evaluated the economic impacts in the state of Florida from expanded use of woody biomass as feedstock for energy production under selected policies and incentives, as mandated by the Florida legislature in 2008 (HB 7135). The study focused on use of woody biomass fuels for electric power generation, since this is a mature technology with a potential for some expansion under enabling legislation. The models used in this study represent a "snapshot" in time, and do not incorporate a time dimension. However, it is assumed that the estimated economic impacts would occur within a relatively short period of a year or less.

Methods

The analysis was conducted using Input-Output analysis and Social Accounting Matrices (I-O/SAM) for Florida, together with a Computable General Equilibrium (CGE) model of the state's economy. The *Impact Analysis for Planning* (IMPLAN) Professional software and associated databases (Minnesota IMPLAN Group 2007) provided regional information on industry output, value added, employment, personal income, commodity supply and demand, state-local and federal government taxes and spending, capital investment, business inventories, and domestic and foreign trade. The I-O/SAM model was used to generate a snapshot of the Florida economy that served as the starting point for implementation of the CGE model, which finds a solution where all markets are in equilibrium, i.e. supply equals demand. The model was customized to reflect the makeup of the forestry sector (timber production, logging and support services), wood products manufacturing (sawmills, pulp and paper, etc.), and use of biomass fuels as a substitute to fossil fuels (coal, natural gas, oil) for electric power generation. It was assumed that biomass fuels could be provided from domestic and international imports as well as Florida resources, since commodity trade is a feature of the CGE model. Forestry sector production is assumed to include sources such as merchantable timber resources, logging residues, urban wood waste as well as short rotation energy crops.

The impact of increasing biomass fuel supply for electric power generation was simulated over a range of 1 to 80 million green tons annually, at an average composite delivered price of $30 per ton. The upper end of this range represents approximately 26% of current electricity production in Florida, and about 21% of projected generation in the year 2025. These levels can be related to a "clean portfolio standard" considered by the legislature, which would mandate a certain minimum percentage of clean and/or renewable electric power generation sold to final consumers by a given date. Simulations were also conducted to test the effect of a $0.010 to $0.011 per kilowatt-hour state or federal renewable electricity production tax credit, and a 100 percent federal subsidy for biomass fuel producers under the *Biomass Crop Assistance Program* (BCAP). Assumptions about mobility of capital to meet changes in industry output and intermediate commodity demand were tested with different model settings. It may be expected that the results for the mobile capital scenario would hold in the long run, say 10 years or more, while fixed capital would prevail in the short run, subject to limitations on capital movement, especially for highly fixed assets such as forest inventories.

Projected electric power generation in Florida was taken from USDOE Annual Energy Outlook (2009a). The share of generation from conventional efficiency represents 25% thermal efficiency for conversion from wood fuel to electricity with typical stoker-grate furnace technology; high efficiency represents 35% thermal efficiency for advanced gasification combined-cycle technology (Figure 2).

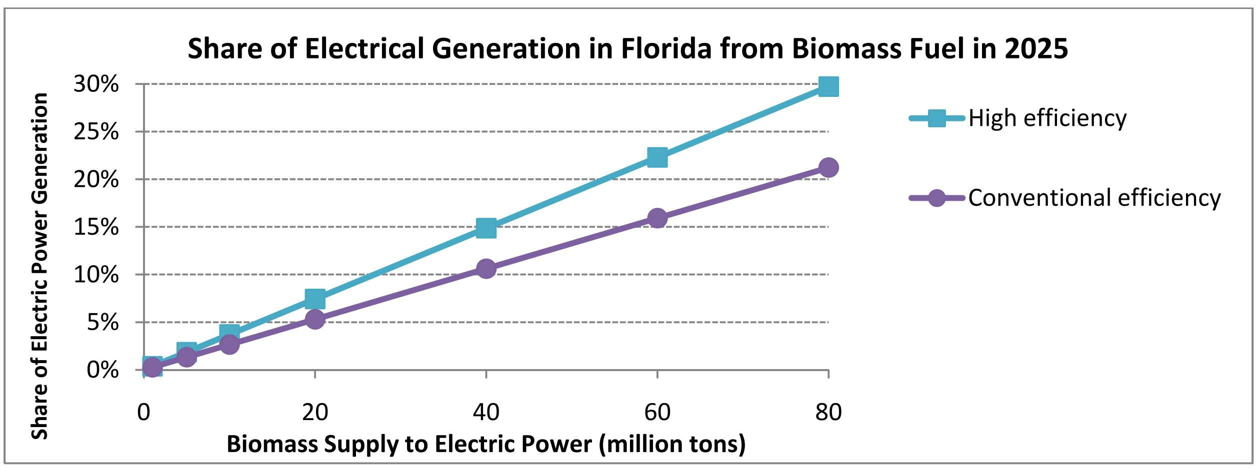

Figure 2. Share of electrical power generation in Florida from biomass fuels under conventional (25%) and high (35%) thermal efficiencies at different levels of biomass supply to power plants in 2025.

Economic Impact Results

It was estimated that increasing biomass use for electric power generation would bring about a relatively small increase in Gross Domestic Product (GDP) of Florida (Figure 3), overall employment, and state government revenues, while modestly decreasing imports of fossil fuels. At the biomass supply level of 40 million tons, with capital assumed to be mobile, GDP would increase by 0.32% above the base level, representing $2.2 billion. Output or sales of the forestry sector would be increased dramatically, about

69% above current levels, to meet new demand for woody biomass fuels. Output of the electric power sector would decrease by up to 0.33% as a result of marginally higher costs for biomass fuels. Under the fixed capital scenario, output of the forest products manufacturing sector would decrease by 6.7% due to competition for the forest resources, and prices for forest commodities may increase by up to 18% in the short run due to competition, but would likely be much lower in the long run as capital resources are reallocated to biofuel production. The relatively modest effects on forest commodity prices observed in the fixed capital CGE analysis, even in the face of a threefold increase in demand, may be attributed to the moderating effect of increased imports, substitution effects, the diverse mix of different biomass resources available, and the fact that commercial timber production in the CGE model represents less than 25% of the total forestry sector.

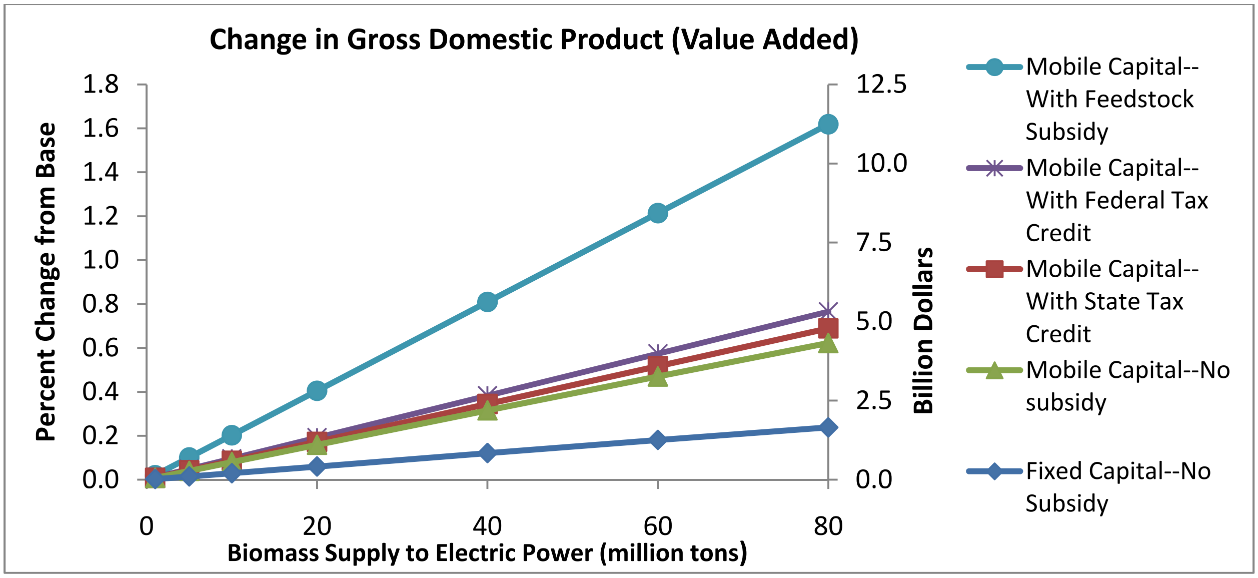

Figure 3. Change in Florida's Gross Domestic Product (GDP) at different levels of biomass supply for electric power generation under differing capital mobility and financial incentives assumptions.

When the CGE model was modified to disaggregate timber production and logging/forestry support services, much larger price effects were observed, with composite prices for timber increasing by 42%, and prices for logging/support services increasing by 143%, for the scenario with 40 million tons biomass supply and fixed capital. The price response was greater for logging/support services than for timber production in this case because logging is the direct supplier to the electric power sector and timber production becomes an indirect input. When the model was further modified to restrict imports of timber and logging/support services, prices for forestry products increased by 150%, and prices for logging/support services increased by 280%. The CGE model predicted also price increases for manufactured wood products anywhere from 0.03% to 4.6% under various model settings.

Imports of fossil fuels would decrease by 2.5%, representing a savings in import purchases of $1.14 billion, while imports of forestry commodities would increase. Employee income would increase by $1.61 billion. Tax revenues to state government would increase by 0.06 percent ($108 million).

Effects of Financial Incentives

Incentives such as a renewable energy production tax credit for electricity generated from biomass, and a subsidy to forestry biomass producers, would further increase forest sector output and state GDP and employment, and reduce imports of fossil fuels. In particular, an electricity production tax credit equivalent to $0.010-0.011 per kilowatt-hour would substantially increase output of the electric power sector, and decrease imports of fossil fuels, while reducing the negative impact of higher electricity prices on all other sectors. However, assuming that the tax credit is unlimited, the state-sponsored incentive would significantly reduce state government revenues by nearly $200 million at the 40 million ton biomass supply level. The 100 percent biomass feedstock federal subsidy to forestry producers would dramatically increase both electric power and forestry commodity output, but would not appreciably affect state government revenues (Figure 4).

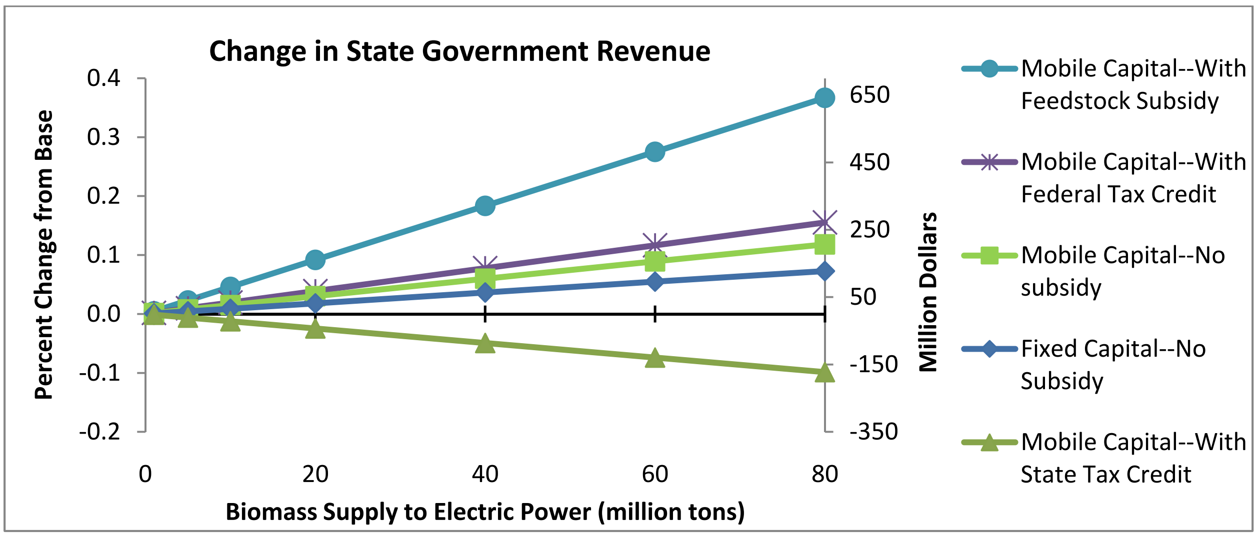

Figure 4. Change in state government revenue at different levels of biomass supply for electric power generation under differing capital mobility and financial incentives assumptions.

Conclusions on Economic Impact and Financial Incentives

Based on these findings, it is concluded that provided feedstock availability can be secured, the various policies and incentives for bioenergy development would have an overall positive impact on the economy of Florida in terms of increased GDP, employment and state government revenues, and decreased imports of fossil fuels. The forestry sector would particularly benefit from increased demand and prices. However, the forest product manufacturing sector would be adversely affected by competition for wood resources and higher prices for material inputs.

The I-O/ SAM and CGE models with mobile capital do not explicitly incorporate any physical capacity limitations on production of a commodity such as biomass fuels. This stands in contrast to bioeconomic models such as the Sub-regional Timber Supply (SRTS) model used in a companion study described below, which dynamically represents timber inventories, forest growth and harvest removals, although without consideration of the effects of domestic or international trade.

University of Florida SFRC Report Methods and Findings

Introduction

This study analyzed woody biomass demand, supply and timber prices resulting from implementation of a hypothetical 20% renewable portfolio standard (RPS) in Florida. Lower RPS mandates at 7% and 12% were also considered. It was assumed that 20% RPS, if passed by the legislature, would be phased-in over time using interim targets of 7% by January 1, 2014, 12% by January 1, 2017, 18% by January 1, 2020, and would be fully implemented at the 20% level by January 1, 2022. It was further assumed that wood resources from Florida and selected counties in southern Alabama and southern Georgia would meet that share of the RPS-imposed demand for electricity generation which cannot be satisfied by other renewable energy sources (ORES) such as solar, wind, hydropower, and biogenic municipal waste. According to U.S. Department of Energy projections, technological constraints and cost would limit the amount of renewable electricity that could be generated from ORES in Florida (Table 1).

Methods

The study estimated bio-economic impacts that a 7%, 12% or 20% RPS mandate would have on the forestry sector in Florida by simulating increased demand for timber resources and modeling the resulting effect on timber stumpage prices, harvests, and inventories of merchantable timber derived from private timberland using Sub-regional Timber Supply (SRTS) model (Abt et al 2000). This study was limited to private timberlands only, partly because of the model employed, which does not model for other types of forest ownership, and partly out of conviction that private landowners could respond quickly to market demands and would not be restrained by other factors influencing forest management decisions on public lands. In order to meet large volume demands of the modeled RPS mandates the pine roundwood category was defined to include pulpwood and small sawtimber size trees between 5.0 and 12.9 inches in diameter. The information generated by SRTS model runs was used to project the allocation of harvested merchantable timber between the forest products industry (FPI) sector and the electric power industry in Florida.

As part of the analysis, several different possible scenarios that represent different woody biomass feedstock source combinations were developed. The SFRC report concluded that for merchantable timber (MT) simulations all hypothetical RPS scenarios modeled had negative impacts on the forest products industry. Therefore, it was assumed that MT alone would not be utilized to satisfy any of the RPS mandates. The first scenario considered in this report is one where MT is augmented with urban wood waste (UWW) and logging residues (LR) as additional sources of woody biomass being used as electricity generation feedstock. The UWW is comprised mainly of large diameter trees typically removed from urban areas. However, this category may also be referred to as "yard trash" in the DEP records. Although the SFRC report used a per capita factor of 0.203 tons per person per year to estimate UWW, the resulting tonnage corresponds very well with a five year average of 3.76 million green tons of "yard trash" received in the DEP registered facilities
http://www.dep.state.fl.us/waste/categories/recycling/SWreportdata/07_data.htm

The LR are derived from the discarded tree tops and tree limbs that are generated during the harvest of MT, and currently mostly left behind in the woods in slash piles or scattered throughout harvested tracts. The next two scenarios are those in which short rotation energy crops (SREC) were added to the first scenario either in "low" or "high" quantities. Given the uncertainty in projecting the amount of Florida's non-forested land that could be converted to SREC in the near future and different potential productivity of these woody crops, the following was assumed. The "SREC_low" scenario is based on unimproved varieties of eucalyptus species planted on up to 0.568 million acres, while "SREC_high" scenario assumed deployment of high-yielding varieties of eucalyptus species tested previously in Florida (Rockwood et al 2006) planted on 1.441 million acres.

Impacts of an RPS on Forest Sustainability

This report considers forest sustainability only in terms of changes to merchantable timber volumes and does not take into account changes in timberland acreage that may take place in the modeled area. This is due to the features of the SRTS model used. As such, these assessments do not provide insights into other aspects of forest sustainability. However, the changes in merchantable timber volume would be crucial to assessments of forest sustainability under any definition.

Comparisons of the simulated effects of the 7% RPS, 12% RPS and 20% RPS and no RPS scenario reveal that only 7% RPS does not lead to merchantable timber volumes decline below 2006 baseline in the modeled time period between 2010 and 2040 (Figure 5). The 12% RPS would diminish the merchantable timber inventory below the 2006 baseline around 2035, while the 20% RPS would do the same starting in approximately 2025. In these runs wood fueled electricity was assumed to be produced from merchantable timber supplemented by urban wood waste and logging residues (no short rotation energy crops), and all runs were under "base" other renewable energy sources assumptions. The negative effects of various RPS mandates on pine roundwood inventory are more pronounced and come sooner (Figure 6) compared with effects on combined merchantable timber inventory discussed before. Still, in the case of the 7% RPS, the pine roundwood inventory does not decline below the 2006 baseline until 2040. However, the levels of pine harvests under 20% or 12% RPS would be below 2006 baseline, and unsustainable, starting in approximately 2022, and 2027, respectively, if only merchantable timber, urban wood waste and logging residues were used for wood-fueled electricity generation.

A closer look at the pine roundwood merchantable timber inventory under the 20% RPS reveals only one sustainable feedstock source combination scenario. Only when merchantable timber augmented with urban wood waste, logging residues and "high" short rotation energy crops are all employed to meet the 20% RPS demand under the "high" ORES assumptions, the pine roundwood inventory stays above the

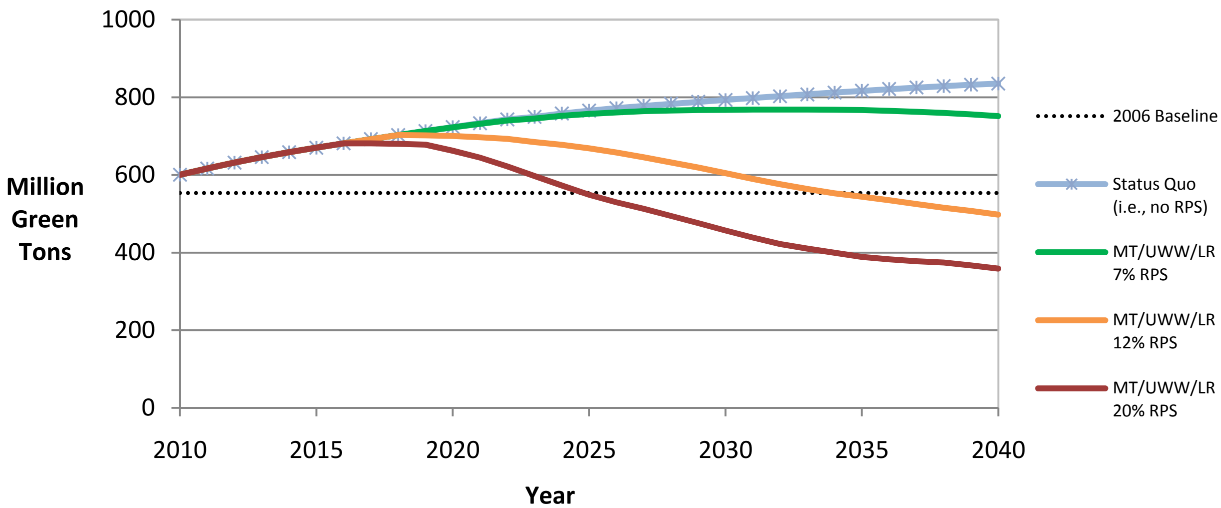

Figure 5. The SRTS model-generated pine and hardwood (combined) merchantable timber inventory. Merchantable timber (MT), urban wood waste (UWW) and logging residue (LR) are used to meet woody biomass demand of a 7%, 12%, or 20% RPS under "base" other renewable energy sources (ORES) assumptions. Also shown are changes in combined pine and hardwood merchantable timber inventory without an RPS mandate and a 2006 baseline.

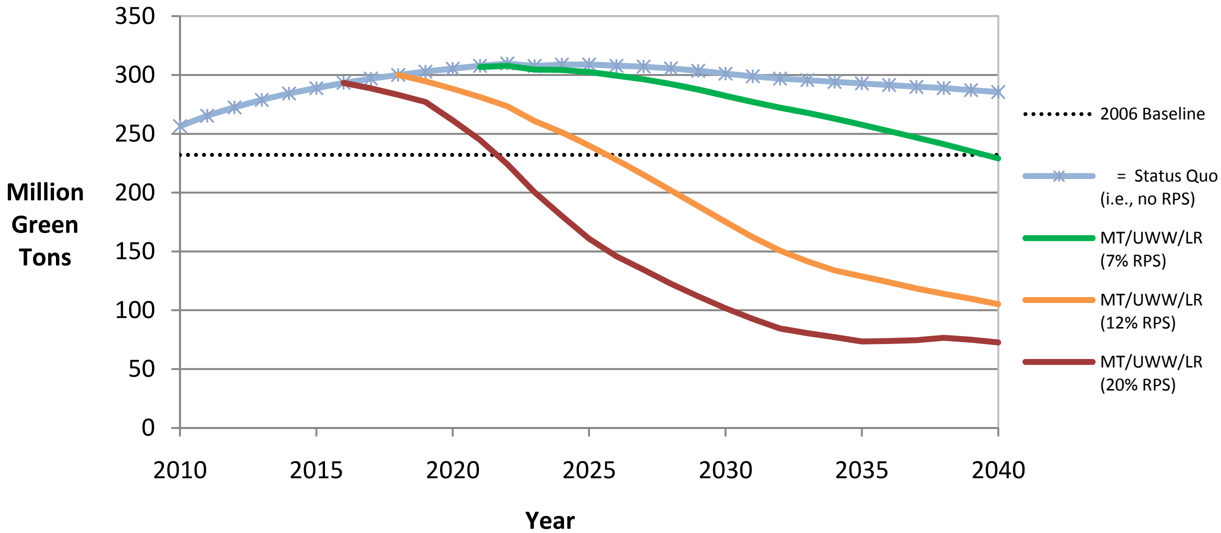

Figure 6. The SRTS model-generated pine roundwood inventory. Merchantable timber (MT), urban wood waste (UWW) and logging residue (LR) are used to meet woody biomass demand of a 7%, 12%, or 20% RPS under "base" other renewable energy sources (ORES) assumptions. Also shown are changes in pine roundwood inventory without an RPS mandate and a 2006 baseline.

2006 baseline level (Figure 7). In that case the amount of biomass feedstock generated in high acreage, high yielding short rotation woody crops plantations plus high contribution of other than wood renewable energy sources (ORES) creates a situation where pine roundwood is unnecessary to meet the 20% RPS demand. In all other considered feedstock combination scenarios, pine roundwood inventory falls quickly below the 2006 baseline and decreases precipitously. In the cases of base ORES without "high" version of short rotation energy crops, pine roundwood inventory declines below the 2006 baseline as early as 2022. This is the year when fully implemented 20% RPS would take effect. Our analyses also showed that reaching the 20% RPS would require very significant redirection of harvested merchantable timber to electricity generation from existing forest products industry under most considered scenarios, as shown for pine roundwood in Figure 8.a-f.

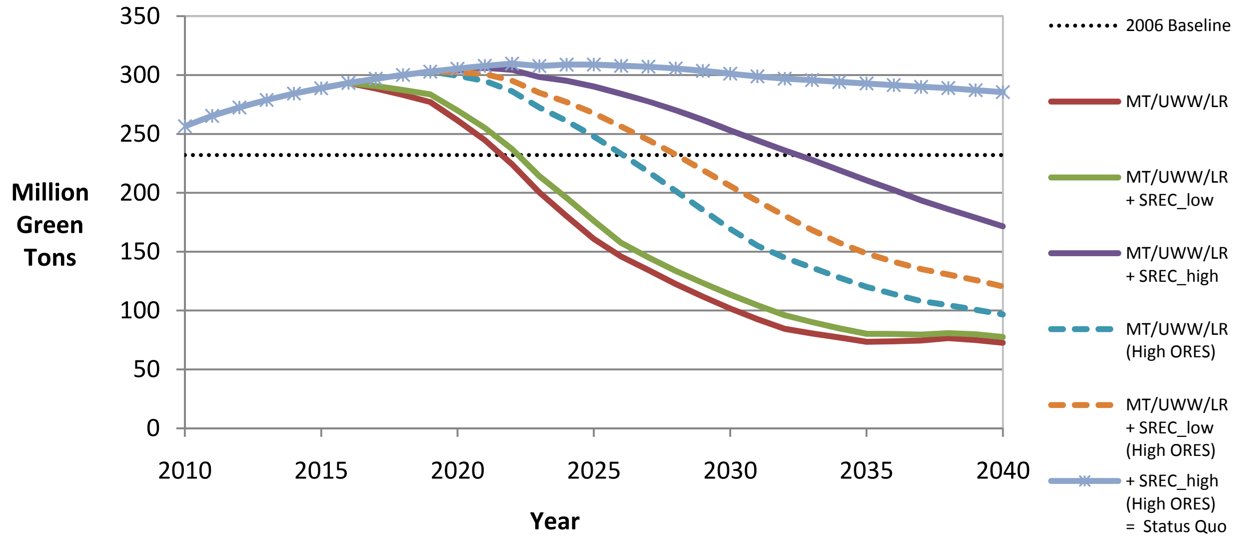

Figure 7. The SRTS model-generated pine roundwood inventory under the 20% RPS mandate. Merchantable timber (MT), urban wood waste (UWW) and logging residue (LR) are augmented with short rotation energy crops (SREC) as indicated in the legend. Base level of other renewable energy sources (ORES) assumed unless otherwise indicated. Changes in pine roundwood inventory without an RPS mandate are equivalent to feedstock scenario of MT/UWW/LR+SREC_high under high ORES assumptions (denoted as Status Quo). Also shown is 2006 pine roundwood baseline.

Generally it was found, that a 12% RPS would also adversely impact the existing forest products industry for all of the base ORES simulations that do not include the SREC_low or SREC_high assumptions as part of that particular feedstock mix. There are little, if any, impacts observed for the high ORES simulations under a 12% RPS. The SREC_high scenario precludes the need for harvesting merchantable timber whatsoever under either a 7% or a 12% RPS in the base or high ORES simulations. Finally, except for the preliminary "merchantable timber only" simulation, all of the 7% RPS projections modeled impart a relatively benign impact on the forest products industry with those under the high ORES assumptions having little, if any, impact at all.

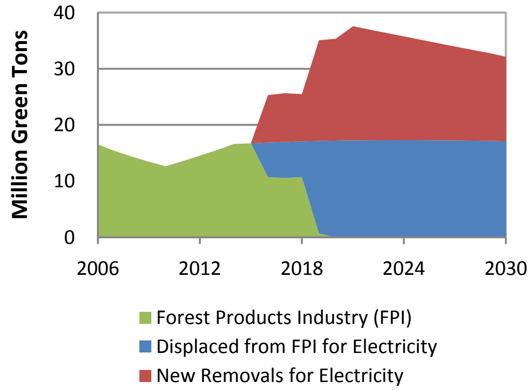

Figure 8.a. Allocation of *Pine Roundwood* 20% RPS, feedstock: MT/UWW/LR.

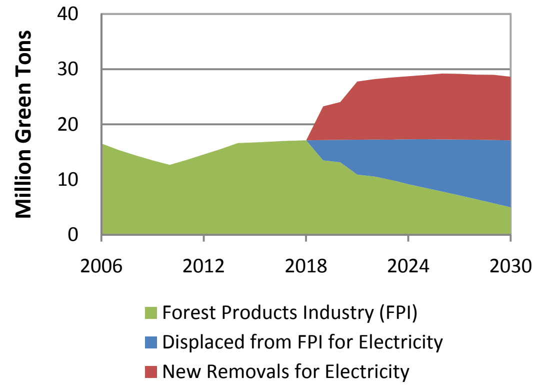

Figure 8.b. Allocation of *Pine Roundwood* RPS, High ORES, feedstock: MT/UWW/LR.

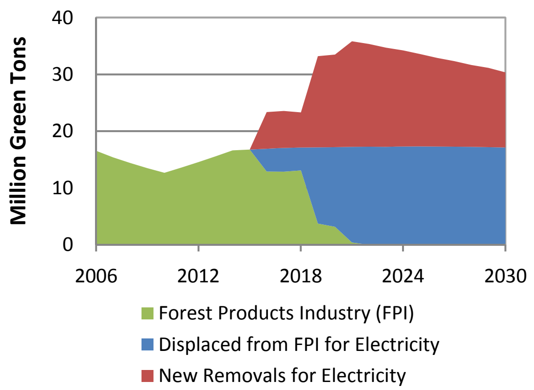

Figure 8.c. Allocation of *Pine Roundwood* 20% RPS, feedstock: MT/UWW/LR+SREC_low.

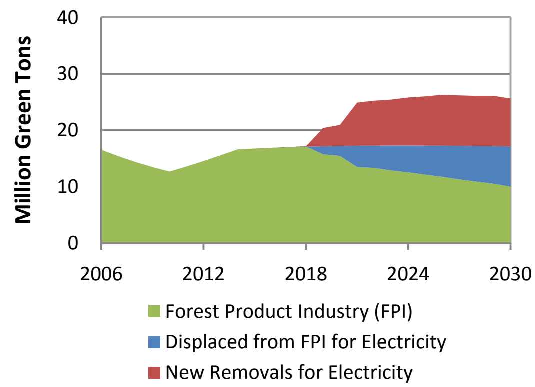

Figure 8.d. Allocation of *Pine Roundwood* 20% RPS, High ORES, feedstock: MT/UWW/LR +SREC_low.

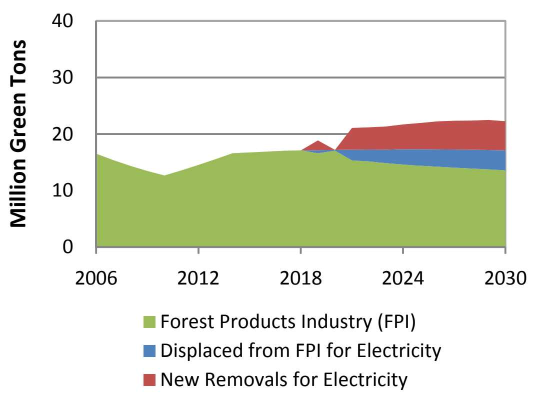

Figure 8.e. Allocation of *Pine Roundwood* 20% RPS, feedstock:MT/UWW/LR+SREC_high.

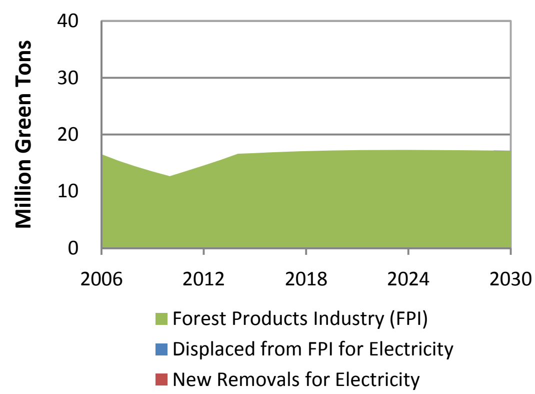

Figure 8.f. Allocation of *Pine Roundwood* 20% RPS, High ORES, feedstock: MT/UWW/LR +SREC_high.

Impact of an RPS on Timber Prices

This study has shown that the effects on stumpage timber prices of a 20% RPS could be quite dramatic, but depend to a large degree on how much short rotation energy crops (SREC) contribute to energy feedstocks, and to a lesser degree on the other renewable energy sources (ORES) development. For example, in the case of MT/UWW/LR+SREC_low feedstock combination scenario with "base" ORES assumptions, by 2025 the stumpage prices for pine pulpwood and small diameter sawtimber were modeled to increase by 500% compared with the prices recorded in 2006. In the same model run pine large sawtimber prices increased by 100% and those of hardwood pulpwood by 150%. In the analogous simulations where SREC_high under base ORES assumptions were used, pine pulpwood and small diameter sawtimber prices increased only slightly by 2025, and there was virtually no effect on prices for pine large sawtimber or hardwood pulpwood compared with 2006 prices. However, in a model run where ORES were assumed "high" and SREC were set to "low", by 2025 prices for pine pulpwood and small sawtimber increased by 100%, prices for large pine sawtimber were virtually unaffected, and prices for hardwood pulpwood increased by 50% compared with 2006 prices. Although price volatility could be disruptive to the existing forest products industry, some of the modeled effects might not be as dramatic in real life. This is mostly due to the fact that the SRTS model employed does not allow for timber imports from outside of Florida and pre-determined neighboring counties in Alabama and Georgia, nor does it account for capital mobilization and substitution effects. It is also worth noting that timberland owners would welcome return of timber prices to their historically much higher levels. With greater returns on investment, more timberland owners would be interested in reforestation of harvested tracts and managing their forests for various uses including bioenergy.

Conclusions on Woody Biomass Supply and Demand

We conclude that in order to achieve a 20% RPS the renewable energy supply intended to meet this demand includes: a strong reforestation and afforestation program, the planting of high-yielding SREC on 15% of Florida farmland or other non-forested lands, and/or other sources of woody biomass not considered here, and/or additional (and significant) amounts of other sources of renewable energy (e.g., wind, solar, biogenic municipal waste) similar to our high ORES scenarios. We projected this latter case by assuming 2.5 times the original estimate of other than woody biomass renewable energy sources. This projection is somewhat hypothetical as the opinions to how much ORES could contribute to the overall RPS differ among experts. The findings from the high ORES scenarios indicate that SREC would still be required to mitigate the impacts of 20% RPS demand on merchantable timber resources. In this case, however, the SREC_high scenario would preclude the need for using any merchantable timber in order to reach the 20% RPS. While the SREC_low scenario appears to approach feasibility as well, the impact on the forest products industry would likely still be adverse in terms of the impact on the price and inventory of pine pulpwood, and the price of pulpwood derived from hardwoods. However, as mentioned before, except for the "merchantable timber only" simulations, all of the 7% RPS projections modeled in this study impart a relatively benign impact on the forest products industry with those under the high

ORES assumptions having little, if any, impact at all. Increases in stumpage prices for timber and other woody biomass would benefit forest landowners and other producers.

Overall Conclusions

The conclusions presented below should be viewed qualitatively rather than quantitatively as many assumptions had to be made in the modeling process, and because of limited predictive powers of models in general, including those employed in the course of preparing the studies for this report.

We conclude that provided woody biomass feedstock availability is secured as discussed in this report, increased woody biomass use for electric power generation in Florida would bring about a modest increase in the state's Gross Domestic Product, employment, and state government revenues, while decreasing total imports, particularly of fossil fuels. For example in 2025, a woody biomass supply level of 40 million tons (equivalent to approximately 10% of electrical power generation, Figure 2), GDP could be increased by 0.32%, representing a $2.2 billion addition to Florida's economy. Such an outcome would require tripling of Florida's wood harvest from the current levels of about 20 million tons. Depending on the level of woody biomass use for electricity generation, output of the forestry sector would have to be increased significantly to meet new demand for woody biomass fuels. This could represent a great economic opportunity for the forestry sector in the state as this would require increased reforestation and afforestation efforts to sustain the bioenergy industry, and would increase the opportunities for existing forest producers and related industries. The largest adverse impact of these policies would be a decrease in output of the forest products manufacturing sector by up to 6.7%, because of competition and increased prices for forest resources.

According to modeling by IMPLAN and CGE (global models), prices for forest timber products may increase approximately 18% in the short-run due to competition for the resource, but would likely be much lower in the long-run if capital is allowed to move freely. However, when CGE model was modified to disaggregate timber production from logging/forestry support services, or further modified to restrict timber and services imports, a 43% to 150% timber price increases were observed. This is somewhat similar to the regional SRTS timber supply model, which predicted timber price increases anywhere from 0% to 150% in some instances, but also 500% in other cases for various timber products depending on the demand and supply assumptions. The CGE model predicted also price increases for manufactured wood products anywhere from 0.03% to 4.6% under various model settings. Imports of fossil fuels into the state would be decreased by up to 2.5%, representing a savings in import purchases of $1.14 billion annually. Employee income would increase by up to $1.61 billion. State government tax revenues would increase by 0.06 percent ($108 million).

The modeling also showed that incentives, such as a state and federal renewable energy production tax credits for electricity generated from biomass equivalent to $0.010 and $0.011 per KWh, respectively, and a 100 percent subsidy to forestry woody biomass producers, would marginally further increase state GDP and employment. The electricity production tax credit would substantially increase output of the electric power sector, and decrease imports of fossil fuels, while reducing the negative impact of higher electricity prices on all other sectors. The federally sponsored renewable production tax credit would not adversely affect state government revenues. The biomass feedstock federal subsidy to forestry producers would dramatically increase both electric-power and forestry timber output, but would not appreciably affect fossil fuel imports or state government revenues.

Given that physical woody biomass availability is secured as discussed before, it is concluded that the various policies and incentives for bioenergy development that were examined would have an overall positive impact on the economy of Florida in terms of increased GDP, employment and state government revenues, and decreased imports of fossil fuels. The forestry sector would particularly benefit from increased demand and timber prices. However, the forest product manufacturing sector would be subject to increased competition for wood resources with resulting higher prices for material inputs.

Overall, it appears that a 7% RPS as modeled in the SFRC study would be both feasible without much disruption of timber supply to existing forest products industry, and economically beneficial to the economy of the state, and especially to timber producers and forestry in general. A modest mandate of this kind would facilitate increases in stumpage timber prices landowners receive for their products and increase chances of keeping “forests in forest”. Any clean portfolio standard or RPS mandate should also incentivize tree planting including short rotation energy crops establishment on acreage proportional to the magnitude of the mandate. With increased reforestation, afforestation and planting of high-yielding short rotation woody crops on up to 15% of non-forested lands, a 12% and higher RPS could be achieved without depletion of the forest resources of the state, or significant impacts to the existing forest industries.

References

Abt, R., F. Cubbage, and G. Pacheco. 2000. Southern forest resource assessment using the subregional timber supply (SRTS) model. Forest Products Journal 50(4):25-33.

Hodges, A.W., T.J. Stevens, and M. Rahmani. Economic Impacts of Expanded Woody Biomass Utilization on the Bioenergy and Forest Products Industries in Florida. Final report to Florida Department of Agriculture and Consumer Services – Division of Forestry, University of Florida, 36 pages, Revised February 23, 2010.

Minnesota IMPLAN Group (MIG). 2007. IMPLAN Professional, version 2, Economic Impact and Social Accounting Software and Data for Florida Counties. Stillwater, MN.

Rockwood, D.L., D.R. Carter, M.H. Langholtz and J.A. Stricker. 2006. *Eucalyptus* and *Populus* short rotation woody crops for phosphate mined lands in Florida USA. Biomass & Bioenergy 30:728-734.

Rossi, F.J., D.R. Carter and R.C. Abt. Woody Biomass for Electricity Generation in Florida: Bioeconomic Impacts under a Proposed Renewable Portfolio Standard (RPS) Mandate. Final report to Florida Department of Agriculture and Consumer Services – Division of Forestry, University of Florida, 99 pages, March 1, 2010.

USDOE. 2009a. Annual Energy Outlook. United States Department of Energy, Energy Information Administration. April 2009.

USDOE. 2009b. State Renewable Electricity Profiles 2007, Florida. June 2009.

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