Renewable Portfolio Standard in the Electricity Industry and Its Impact on Agriculture in the United States

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Introduction

Renewable Portfolio Standard (RPS)

- Requirement to generate a predetermined fraction of electricity from renewable energy sources such as wind, solar, biomass, landfill gas, geothermal, etc.

Policy proposals affecting electricity industry

- RPS in 33 U.S. states (March 2009) and proposal for a federal renewable portfolio standard
- EPA regulation under the Clean Air Act of biomass power plants postponed for three years

Research question:

- Impact of a RPS on biomass industry and electric utilities in terms of prices, supply, and demand in a dynamic setting
- Assessing land-use change and greenhouse gas emissions from RPS policies
Previous Analysis

Energy Information Agency (2007): 25% RPS and 25% RFS by 2025
- Increase of biomass supply from 30 to 571 million tons
- Price increase from $30/ton to $88/ton
- Doubling of corn price
- Exhaustion of biomass supply

Brechbill & Tyner (2008): Biomass supply in Indiana for electricity generation
- Three power plants with different name plate capacities
- Corn stover and switchgrass

Contribution of the project
- Dynamic framework including yield growth
- National coverage (48 contiguous states)
Model: Supply of Biomass

Three sources of biomass fuel

- **Agricultural residues (corn stover and wheat straw)**
  - Spatial issue: Availability of agricultural residues in the Midwest
  - Compensation for harvesting/collection of residues
  - Soil and climate specific tradeoff between residue and soil erosion
  - Participation rate of farmers and landowners willing to supply biomass to an electric power plant

- **Forest residues from logging**
  - Spatial issue: Forest residues in the Southeast, Northeast, and Northwest

- **Energy crops (hybrid poplar/willow and switchgrass)**
  - Land-use change
  - Possibility of using Conservation Reserve Program land
Existing coal power plants:
- Importance of location and name plate capacity of coal power plants
- Positive relationship between capacity and transportation costs
- Location of power plant (Geographic Information System Data)
- Possibility of retrofitting a coal power plant

Power plant location as the single most important determinant for the demand of biomass (Brechbill & Tyner)
- Potential competition among power plants
- Power plants situated in regions with low supply of biomass
Crop Residues

Biomass Resources of the United States
Crop Residues

The following crops were included in this analysis: corn, wheat, soybeans, cotton, sorghum, barley, oats, rice, rye, canola, dry edible beans, dry edible peas, peanuts, potatoes, safflower, sunflower, sugarcane, and flaxseed. The quantities of crop residues that can be available in each county are estimated using total grain production, crop to residue ratio, moisture content, and taking into consideration the amount of residue left on the field for soil protection, grazing, and other agricultural activities. Source: USDA, National Agricultural Statistics Service; 5-year average, 2003-2007 data.

For more information on the data development, please refer to http://www.nrel.gov/docs/fy09/39161.pdf. Although, the document contains the methodology for the development of an earlier assessment, the information is applicable to this assessment as well. The difference is only in the data's time period.

Author: Billy Roberts - September 23, 2009

This map was produced by the National Renewable Energy Laboratory for the U.S. Department of Energy.
Forest Residues

Biomass Resources of the United States
Forest Residues

Thousand Dry Tonnes/Year
- >100
- 50 - 100
- 25 - 50
- 10 - 25
- 5 - 10
- <5
- Not Estimated

Forest residues include logging residues and other removable material left after carrying out silvicultural operations and site conversions. Logging residue comprises unused portions of trees, cut or killed by logging and left in the woods. Other removable materials are the unutilized volume of trees cut or killed during logging operations. Source: USDA, Forest Service’s Timber Product Output Database, 2007.

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Data

Biomass supply

- Agricultural residues
  - County level area and yield (NASS)
- Forest residues from logging and other removals (e.g., clearings not associated with timber production)
  - U.S. Forest Service for forest residues
- Energy crops
  - Historical participation rates

Biomass demand

- Coal power plant location and characteristics
  - Energy Information Agency
  - National Renewable Energy Laboratory (NREL)

County-level agricultural model for the United States
Model and Scenario

Assessing the resources of biomass and demand

- Dynamic competitive equilibrium model for biomass
- Input parameters
  - Level of biomass demand by power plants based on RPS
  - Participation rate of landowners and farmers
- Possibility of land-use change growing of energy crops

Output

- Spatial and temporal information about biomass supply and demand
- Prices necessary to induce participation and market clearing
- Greenhouse gas emissions from electricity production thorough biomass