Case Studies

Accounting Framework for Biogenic CO_2 Emissions

Presentation to

EPA Science Advisory Board

October 26, 2011

What is the purpose of the case studies?

- Presented to accomplish two objectives:
  1. Demonstrate how the framework could be applied to stationary sources that typically emit biogenic CO_2
  2. Illustrate the implications of different policy choices on components of the framework (i.e., illustrative purposes only)
- Not an Exhaustive List:
  - Forest-Derived and Agricultural Biomass
- Treatment of Waste Materials:
  - BAF = 0 for waste decay at waste management systems, waste combustion at waste incinerators, or combustion of captured waste-derived CH_4
  - BAF would be calculated using approach described in Sections 4 and 5 if waste is harvested specifically for use at a stationary source

Case Studies: Summary

No.	Title	Points Illustrated
1	Roundwood to electricity – Spatial scale	• Importance of defining geographic extent of feedstock source location • Impact on NBE in the presence of declining carbon stocks (NH) vs. increasing carbon stocks (Northeast)
2	Roundwood to electricity – Different accounting approaches	• Accounting at the margin versus accounting at the average might lead to differences in net emissions
3	Pulp and paper mill	• Situation where bioenergy production is not entity's main function • Impact of carbon leaving the facility in form of products • Use of residues from the manufacturing process for energy • Leakage and indirect land-use change not applicable as biomass purchases are not for energy production
4	Corn stover to electricity	• Impact of sequestered carbon • Impact of soil sequestration loss due to feedstock removal • Impact of feedstock losses from haulage, handling and storage
5	Short Rotation Woody Crops (SRWC) to electricity	• Role of feedstock losses and sequestration in post-combustion materials • Impact of previous land-use on site sequestration gains and losses • Negative BAF

Case Study 1: Roundwood to electricity – Spatial scale

Description:

- Existing or proposed electricity generating plant in the Northeast with an output of 30 megawatts (MW) per year
- Consumes 250,000 BDT of wood from surrounding forests per year, i.e., PGE = 415,800 tCO_2e.
- Sources feedstock from harvest of low-grade roundwood, and does not compete with traditional timber and pulp markets

Illustrates:

- Impact of definition of geographic extent of the feedstock source location
- Effect of declining carbon stocks (New Hampshire) versus increasing carbon stocks (Northeast)

Case Study 1: Roundwood to electricity – Spatial scale (cont'd)

***Case 1*: Existing facility with either New Hampshire or the Northeast Region as the feedstock source region**

$$NBE = [PGE \times (1 + L) \times (1 - LAR) \times (1 - PRODC)] - [PGE \times SEQP] + SITE\_TNC \times (1 - PRODC)] + [LEAK \times (1 - PRODC)]$$

$$NBE = [415{,}800 \times (1 + 0) \times (1 - 1) \times (1 - 0)] - [415{,}800 \times 0] + [0 \times (1 - 0)] + [0 \times (1 - 0)]$$

$$NBE = 0\ tCO_2e$$

Case Study 1: Roundwood to electricity – Spatial scale (cont'd)

$$NBE = [PGE \times (1 + L) \times (1 - LAR) \times (1 - PRODC)] - [PGE \times SEQP] + [SITE\_TNC \times (1 - PRODC)] + [LEAK \times (1 - PRODC)]$$

***Case 2*: Proposed new facility, with the Northeast Region defined as the feedstock source region**

$$NBE = [415{,}800 \times (1 + 0) \times (1 - 1) \times (1 - 0)] - [415{,}800 \times 0] + [0 \times (1 - 0)] + [0 \times (1 - 0)]$$

$$NBE = 0\ tCO_2e$$

***Case 3*: Proposed new facility, with the state of New Hampshire defined as the source region**

$$NBE = [415{,}800 \times (1 + 0) \times (1 - 0.2507) \times (1 - 0)] - [415{,}800 \times 0] + [0 \times (1 - 0)] + [0 \times (1 - 0)]$$

$$NBE = 311{,}559\ tCO_2e$$

Results of Case Study 1: Roundwood to electricity – Spatial scale

Variable	Values			Units
	Case 1	Case 2	Case 3	
Net Biogenic Emissions (NBE)	0	0	311,559	tCO_2e
Potential Gross Emissions (PGE)	415,800	415,800	415,800	tCO_2e
Level of Atmospheric Reduction (LAR)	1	1	0.2507	Proportion (no units)
Biogenic Accounting Factor (BAF)	**0**	**0**	**0.749**	Proportion (no units)

Where:

Case 1: Existing facility with either New Hampshire or the Northeast Region as the feedstock source region

Case 2: Proposed new facility, with the Northeast Region defined as the feedstock source region

Case 3: Proposed new facility, with the state of New Hampshire defined as the source region

Case Study 2: Marginal versus Average Accounting

Description:

- Existing or proposed electricity generating plant in the Northeast has an output of 30 Megawatts (MW) per year
- Consumes 250,000 BDT of wood from surrounding forests per year, i.e., PGE = 415,800 tCO_2e.
- Sources feedstock from harvest of low-grade roundwood, and does not compete with traditional timber and pulp markets

Illustrates:

- In the context of annual harvest across the total landscape exceeds the annual rate of renewal across that landscape, how is responsibility apportioned:
  - Marginal accounting — attribute resource depletion to only the new feedstock users (who might have entered the market subsequent to the point in time when the resource depletion began)
  - Average accounting — attribute resource depletion to all users of the feedstock for energy, new and old, share responsibility, (perhaps in proportion to the magnitude of their harvests, size of entities using the resource, etc.).

Case Study 2: Marginal versus Average Accounting (cont'd)

***Case* : Emissions from a proposed new facility, using the state of New Hampshire as the source region and using MARGINAL accounting**

$$NBE = [PGE \times (1 + L) \times (1 - LAR) \times (1 - PRODC)] - [PGE \times SEQP] + SITE\_TNC \times (1 - PRODC)] + [LEAK \times (1 - PRODC)]$$

$$NBE = [415{,}800 \times (1 + 0) \times (1 - 0.2507) \times (1 - 0)] - [415{,}800 \times 0] + [0 \times (1 - 0)] + [0 \times (1 - 0)]$$

$$NBE = = 311{,}559\ tCO_2e$$

Case Study 2: Marginal versus Average Accounting (cont'd)

***Case* : Emissions from a proposed new facility, using the state of New Hampshire as the source region and using AVERAGE accounting**

$$NBE = [PGE \times (1 + L) \times (1 - LAR) \times (1 - PRODC)] - [PGE \times SEQP] + SITE\_TNC \times (1 - PRODC)] + [LEAK \times (1 - PRODC)]$$

$$NBE = [415{,}800 \times (1 + 0) \times (1 - 0.9304) \times (1 - 0)] - [415{,}800 \times 0] + [0 \times (1 - 0)] + [0 \times (1 - 0)]$$

$$NBE = 28{,}940\ tCO_2e$$

Results of Case Study 2: Marginal versus Average Accounting

Variable	Northeast		New Hampshire		Units
	Marginal	Average	Marginal	Average	
Net Biogenic Emissions (NBE)	0	0	311,559	28,940	tCO_2e
Potential Gross Emissions (PGE)	415,800	415,800	415,800	415,800	tCO_2e
Level of Atmospheric Reduction (LAR)	1	1	0.2507	0.9304	Proportion (no units)
Biogenic Accounting Factor (BAF)	**0**	**0**	**0.749**	**0.070**	Proportion (no units)

Case Study 5: SRWC to Electricity

Description:

- Electricity generation facility in the Midwest collects and converts short rotation woody crop (poplar) to electricity, with ash as a post-combustion byproduct
- Previous land use at production site was conventionally tilled cropland (switchgrass)
- Output of 100 MW per year, which requires 800,364 tons of poplar per year, resulting in Potential Gross Emissions (PGE) = 1,331,165 tCO_2e

Illustrates:

- Feedstock losses
- Sequestration in post-combustion material
- Soil and standing carbon change caused by direct land-use change
- Negative Biogenic Accounting Factor

Case Study 5: SRWC to Electricity

$$NBE = [PGE \times (1 + L) \times (1 - LAR) \times (1 - PRODC)] - [PGE \times SEQP] + [SITE\_TNC \times (1 - PRODC)] + [LEAK \times (1 - PRODC)]$$

$$NBE = [1{,}331{,}165 \times (1 + 0.045) \times (1 - 1) \times (1 - 0)] - [1{,}331{,}165 \times 0.01] + [-209{,}280 \times (1 - 0)] + [0 \times (1 - 0)]$$

NBE = $-222{,}593\ tCO_2e$

BAF = $-222{,}593\ tCO_2e / 1{,}331{,}165\ tCO_2e$

= −0.167

Results of Case Study 5: SRWC to Electricity

Variable	Midwest Values	Units
Net Biogenic Emissions (NBE)	−222,593	tCO_2e
Potential Gross Emissions (PGE)	1,331,165	tCO_2e
Level of Atmospheric Reduction (LAR)	1.000	Proportion (no units)
Carbon in Products (PRODC)	0.000	tCO_2e
Sequestered Fraction (SEQP)	0.010	Proportion (no units)
Net emissions gain on site (SITE_TNC)	−209,280	tCO_2e
Leakage (LEAK)	0	tCO_2e
Proportion of Feedstock Lost (L)	0.0452	Proportion (no units)
Biogenic Accounting Factor (BAF)	**−0.167**	Proportion (no units)

Case Studies

Forest-Derived Woody Biomass:

- **Case Study 1:** Calculating State versus Regional Net Biogenic Emissions from Electricity Generation using Harvested Roundwood in the Northeast United States.
- **Case Study 2:** Calculating Net Biogenic Emissions from Electricity Generation Using Roundwood Harvested in the Northeast United States, Comparing the Average versus Marginal Method for Level of Atmospheric Reduction.
- **Case Study 3:** Calculating Net Biogenic Emissions for a Pulp and Paper Mill Harvesting Roundwood in the Pacific Northwest.

Agricultural Biomass:

- **Case Study 4:** Calculating Net Biogenic Emissions from Converting Corn Stover to Electricity.
- **Case Study 5:** Calculating Net Biogenic Emissions from Converting Short-Rotation Woody Energy Crop (Poplar) to Electricity.

Questions?