Appendix I: Illustrative Forestry and Agriculture Case Studies Using a Retrospective Reference Point Baseline

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1. Introduction

This appendix presents three illustrative case studies to demonstrate how values for biogenic landscape and process attributes could be combined to calculate the net biogenic emissions (*NBE*) and biogenic assessment factor (*BAF*) using a retrospective reference point baseline. Nested within each case study section are various sensitivity analyses. These analyses highlight the influence of alternative scenarios on the base case. The three illustrative case studies and associated sensitivity analyses focus on:

- Roundwood in the Southeast;
- Logging residues in the Pacific Northwest; and
- Corn stover in the Corn Belt.

These case studies use the biogenic assessment equation from the main report:

$$\boldsymbol{NBE} = (\boldsymbol{PGE})(\boldsymbol{GROW} + \boldsymbol{AVOIDEMIT} + \boldsymbol{SITETNC})(\boldsymbol{L})(\boldsymbol{P}) \qquad \textbf{(EQ. I.1)}$$

This appendix uses the illustrative biogenic landscape attributes (*GROW*, *AVOIDEMIT*, and *SITETNC*) as calculated using the retrospective reference point baseline approach in Appendix H. For simplicity, feedstock carbon losses during storage, transport, and processing (*L*) are held constant at 1.1, feedstock carbon embodied in products (*P*) is also constant at 1 (both of these biogenic process attributes are discussed in Appendix G). Assessment of potential leakage effects associated with feedstock production (*LEAK*) is not included in this case study application.

2. Roundwood in the Southeast

This case study calculates the net biogenic CO_2 emissions from a hypothetical electricity facility with an electricity generating unit (EGU) that uses roundwood from the Southeast region as a biogenic feedstock. This case study also examines alternative scenarios as sensitivities:

- A regional aggregation of roundwood in both the Southeast (SE) and South Central (SC) regions;
- Increased roundwood removals, as reflected in increased removals in multiples of one billion cubic feet of removals (by 1, 2, 5, and 10);
- Equation term analysis (i.e., investigation of the impact of removing terms on the assessment factor calculation);
- Varied land bases in the Southeast (i.e., all forestland, all timberlands, private timberlands, all working timberlands, private working timberlands); and
- A temporal scale analysis for all timberland.

2.1. Base Case

For all of the case study scenarios, it was assumed that the electricity facility has an output of 30 MW, a capacity factor of 95%, and efficiency of 26% (consumes 1 bone dry ton [BDT] of roundwood per MWh of electricity produced), thus requiring an input of 250,000 BDT of roundwood per year. If we assume that 50% of the 250,000 BDT of feedstock is carbon and convert the short tons to tonnes and carbon to CO_2, we end up with a *PGE* of 0.42 $mmtCO_2$ for the hypothetical 30 MW plant.

Table I-1. Biogenic Landscape Attributes: Roundwood in the Southeast.

Feedstock/Region	Growth (G) (cu ft/yr)	Removals (R) (cu ft/yr)	*GROW*	*AVOIDEMIT*	*SITETNC*
Roundwood/Southeast	7.6	4.4	−0.74	0	−0.02

Table I-2. Process Attributes: Roundwood in the Southeast.

Feedstock/Process	*P*	*L*
Roundwood/EGU	1	1.1

This case study then uses the main biogenic assessment factor equation from the main report:

$$\boldsymbol{NBE = (PGE)(GROW + AVOIDEMIT + SITETNC)(L)(P)} \qquad \textbf{(EQ. I.2)}$$

Inserting the illustrative values for the relevant equation terms, this equation is now:

$$\boldsymbol{NBE = (0.42\ mmtCO_2e)(-0.74 + 0 + -0.02)(1.1)(1)}$$

And the result is:

$$\boldsymbol{NBE = -0.35\ mmtCO_2}$$

For this case study application:

$$\boldsymbol{PGE = 0.42\ mmtCO_2e}$$

Therefore:

$$\boldsymbol{BAF = NBE/PGE}$$

$$\boldsymbol{BAF = -0.35\ mmtCO_2e/0.42\ mmtCO_2e}$$

$$\boldsymbol{BAF = -0.84}$$

GROW is less than 0 because the Southeast is currently experiencing greater forest growth compared with removals. Because *AVOIDEMIT* is 0 in this application, and *SITETNC* has a small value, *GROW* is the driving factor and causes the *BAF* to be negative.

2.2. Regional Aggregation

To evaluate the sensitivity of estimates to the geographic domain, the *GROW* terms for the SE region and the SC region were computed separately and as an aggregated southern region to demonstrate the impact of using larger spatial scales to develop the *BAF* estimates. Table I-3 contains the growth and removals values (from the 2010 FIA survey period, which includes data collected between 2006 and 2010) for private timberlands for the SE and SC regions and then for the South as a whole.

The process attributes—*P* and *L*—remain the same as for the base case.

Table I-3. Biogenic Attributes for the Southeast and South Central Regions.

Feedstock/Region	Growth (*G*) (billion cu ft/yr)	Removals (*R*) (billion cu ft/yr)	*GROW*	*AVOIDEMIT*	*SITETNC*
Roundwood/Southeast	7.60	4.38	−0.74	0	−0.024
Roundwood/South Central	9.58	5.38	−0.78	0	−0.020
Roundwood/Combined Southeast and South Central	17.16	9.76	−0.76	0	−0.022

Inserting the illustrative values for the relevant equation terms into the main biogenic assessment factor equation from the main report, this equation is now:

$$\boldsymbol{NBE = (0.42\ mmtCO_2e)(-0.76 + 0 + -0.02)(1.1)(1)} \quad \textbf{(EQ. I.3)}$$

And the result is:

$$\boldsymbol{NBE = -0.36\ mmtCO_2e}$$

For this case study application:

$$\boldsymbol{PGE = 0.42\ mmtCO_2e}$$

Therefore:

$$\boldsymbol{BAF = NBE/PGE}$$

$$\boldsymbol{BAF = -0.36\ mmtCO_2e/0.42\ mmtCO_2e}$$

$$\boldsymbol{BAF = -0.86}$$

Combining the Southeast and South Central regions results in a very slight change to the *GROW* term for the Southeast region, though overall growth still exceeds removals in the combined region.

2.3. Increased Removals

Increased removal scenarios were analyzed for roundwood in the SE region to demonstrate the potential impact of changing future roundwood harvests as a biogenic feedstock on the assessment factor under the reference point baseline. This analysis changes the removals term in isolation and thus does not mimic growth responses associated with land use change to meet increased demand or enhanced growth due to changes in management to accommodate increased removals. This variation represents the base case removals increased by different multiples of 1 billion cubic feet (Table I-4). In each case, *GROW* and *SITETNC* are calculated using the methods described in Appendix H, so the "*REMOVALS*" volume in the denominator of Equations H.2 and H.4 increases with each increased removal case. For *SITETNC*, the numerator of Equation H.4 stays constant, so the estimated ratio decreases with the level of removals. For GROW, the *"REMOVALS – GROWTH"* difference in Equation H.2 changes with greater removals, ultimately causing the sign of the *GROW* term to switch from negative to positive.

Table I-4. Increased Removals by Multiples of 1 Billion Cubic Feet.

Region	Growth (*G*) (billion cu ft/yr)	Incremental Removal Increases (cu ft)	Removals (*R*) (billion cu ft/yr)	*GROW*	*AVOIDEMIT*	*SITETNC*	*BAF*
Southeast	7.60	Base	4.38	−0.74	0	−0.024	−0.84
Southeast	7.60	1 billion	5.38	−0.41	0	−0.020	−0.48
Southeast	7.60	2 billion	6.38	−0.19	0	−0.017	−0.23
Southeast	7.60	5 billion	9.38	0.19	0	−0.010	0.20
Southeast	7.60	10 billion	14.38	0.47	0	−0.007	0.51

The calculations below step through the equation to generate the *BAF* values in Table I-4. In the increased removal scenarios presented below, as the *GROW* term increases and everything else stays the same, the *BAF* increases.

Scenario 1: Incremental Removals by 1 Billion

One billion cubic feet increase: Inserting the values for *L*, *P*, and *SITETNC* into the equation results in:

$$\boldsymbol{NBE = (0.42\ mmtCO_2e)(-0.41 + 0 - 0.02)(1.1)(1)} \qquad \textbf{(EQ. I.4)}$$

And the result is:

$$\boldsymbol{NBE = -0.20\ mmtCO_2e}$$

For this case study application:

$$\boldsymbol{PGE = 0.42\ mmtCO_2e}$$

Therefore:

$$\boldsymbol{BAF = NBE/PGE}$$

$$\boldsymbol{BAF = -0.20\ mmtCO_2e/0.42\ mmtCO_2e}$$

$$\boldsymbol{BAF = -0.48}$$

Scenario 2: Incremental Removals by 2 Billion

Two billion cubic feet increase: Inserting the values for *L*, *P*, and *SITETNC* into the equation results in:

$$\boldsymbol{NBE = (0.42\ mmtCO_2e)(-0.19 + 0 - 0.02)(1.1)(1)} \qquad \textbf{(EQ. I.5)}$$

And the result is:

$$\boldsymbol{NBE = -0.10\ mmtCO_2e}$$

For this case study application:

$$\boldsymbol{PGE = 0.42\ mmtCO_2e}$$

Therefore:

$$BAF = NBE/PGE$$

$$BAF = -0.10\ mmtCO_2e/0.42\ mmtCO_2e$$

$$BAF = -0.23$$

Scenario 4: Incremental Removals by 5 Billion

Five billion cubic feet increase: Inserting the values for *L*, *P*, and *SITETNC* into the equation results in:

$$NBE = (0.42\ mmtCO_2e)(0.19 + 0 - 0.01)(1.1)(1) \qquad \textbf{(EQ. I.6)}$$

And the result is:

$$NBE = 0.08\ mmtCO_2e$$

For this case study application:

$$PGE = 0.42\ mmtCO_2e$$

Therefore:

$$BAF = NBE/PGE$$

$$BAF = 0.08\ mmtCO_2e/0.42\ mmtCO_2e$$

$$BAF = 0.20$$

Scenario 5: Incremental Removals by 10 Billion

Ten billion cubic feet increase: Inserting the values for *L*, *P*, and *SITETNC* into the equation results in:

$$NBE = (0.42\ mmtCO_2e)(0.47 + 0\ -\ 0.01)(1.1)(1) \qquad \textbf{(EQ. I.7)}$$

And the result is:

$$NBE = 0.21\ mmtCO_2e$$

For this application:

$$PGE = 0.42\ mmtCO_2e$$

Therefore:

$$BAF = NBE/PGE$$

$$BAF = 0.21\ mmtCO_2e/0.42\ mmtCO_2e$$

$$BAF = 0.51$$

As shown in Table I-4 above, increased removals generate changes to the *GROW* term because removals increase while growth does not. Removals begin to exceed growth—and result in a net atmospheric contribution of biogenic CO_2 emissions from our hypothetical EGU using roundwood—

when current removals are increased by more than 3.3 billion cubic feet. However, it should be noted that current removals are already at a high level (4.8 billion cu ft/yr) relative to net growth compared with other regions nationwide.

2.4. Equation Term Analysis

For the equation term analysis, the assessment factor was calculated using base levels of the biogenic landscape attributes (Table I-5) with and without certain equation variables (e.g., *GROW* and *SITETNC*). As for the base case above, for roundwood, L = 1.1 and P = 1, while *AVOIDEMIT* is equal to 0. By calculating the assessment factor with and without certain variables in the equation, this analysis illustrates the relative importance of those terms.

Table I-5. Biogenic Attributes for Term Analysis.

Feedstock/Region	Growth (G) (billion cu ft/yr)	Removals (R) (cu ft/yr)	*GROW*	*AVOIDEMIT*	*SITETNC*
Roundwood/Southeast	7.60	4.38	−0.74	0	−0.024

Scenario 1: Without the *GROW* Term

In this equation term analysis, *GROW* is excluded from the equation to evaluate its impact on the assessment factor.

$$\boldsymbol{NBE = (PGE)(AVOIDEMIT + SITETNC)(L)(P)} \qquad \textbf{(EQ. I.8)}$$

Inserting the illustrative values for relevant equation terms into this equation results in:

$$\boldsymbol{NBE = (0.42\ mmtCO_2e)(0 - 0.024)(1.1)(1)}$$

And the result is:

$$\boldsymbol{NBE = -0.01\ mmtCO_2e}$$

For this application:

$$\boldsymbol{PGE = 0.42\ mmtCO_2e}$$

Therefore:

$$\boldsymbol{BAF = NBE/PGE}$$

$$\boldsymbol{BAF = -0.01\ mmtCO_2e/0.42\ mmtCO_2e}$$

$$\boldsymbol{BAF = -0.03}$$

Excluding the *GROW* term results in an increase in the negative assessment factor compared with the base case because only the changes in non-tree pools represented in the *SITETNC* term are represented in the *BAF*. The resulting assessment factor remains negative, however, because the *SITETNC* term pools have been increasing through the reference period.

Scenario 2: Without the *SITETNC* Term

In this equation term analysis, *SITETNC* is excluded from the equation to evaluate its impact on the assessment factor.

$$\boldsymbol{NBE = (PGE)(GROW + AVOIDEMIT)(L)(P)} \qquad \textbf{(EQ. I.9)}$$

Inserting the illustrative values for relevant equation terms into this equation results in:

$$\boldsymbol{NBE = (0.42\ mmtCO_2e)(-0.74 + 0)(1.1)(1)}$$

And the result is:

$$\boldsymbol{NBE = -0.34\ mmtCO_2e}$$

For this application:

$$\boldsymbol{PGE = 0.42\ mmtCO_2e}$$

Therefore:

$$\boldsymbol{BAF = NBE/PGE}$$

$$\boldsymbol{BAF = -0.34\ mmtCO_2e/0.42\ mmtCO_2e}$$

$$\boldsymbol{BAF = -0.81}$$

Excluding the *SITETNC* term also results in an increase in the assessment factor compared with the base case because only the changes in tree biomass pools that are represented in the *GROW* term are represented in the *BAF*. The resulting assessment factor remains negative because the *GROW* term pools have been increasing through the reference period.

2.5. Working Forest

Forest inventory estimates (such as growth and removals) can be expressed for different land areas or definitions of forest. In general, FIA distinguishes between forestland (all land covered with forest as defined by FIA) and timberland (forest meeting certain minimum productivity thresholds and not reserved from timber harvest by law). Forest owned by public entities can be further differentiated from forest owned by private entities (because, for example, private timberland accounts for 98.8% of all removals or harvests within the Southeast). The land under consideration can be further restricted to the "working forest," which can be defined as accessible lands not constrained by steep slopes or wet soils or other criteria that would serve to limit the ability of these lands to produce commercial wood fiber.

For the purposes of this working forest analysis, *GROW* estimates are developed for six categories of land for the Southeast United States:

1. All forest lands (all lands meeting the FIA definition of forest);
2. All timberlands (forest land above productivity thresholds not reserved from harvest);
3. Private forest lands (#1 above for private ownerships);
4. Private timberlands (#2 above for private ownerships);

5. Working timberlands (#2 above, further screened to eliminate steep slopes, wet soils, etc.); and
6. Private working timberlands (#4 above, further screened to eliminate steep slopes, wet soils, etc.).

These categories are summarized in Table I-6.

Table I-6. Land Base Categorization for the Working Forest Definition Case Study.

Land Base	Public Lands	Private Lands	Reserved Land	Low Productivity Land	Steep Slopes, Hydric Soils, etc.
All Forest Lands	Yes	Yes	Yes	Yes	Yes
All Timberlands	Yes	Yes	No	No	Yes
Private Forest Lands	No	Yes	Yes	Yes	Yes
Private Timberlands	No	Yes	No	No	Yes
All Working Timberlands	Yes	Yes	No	No	No
Private Working Timberlands	No	Yes	No	No	No

Applying these different land definitions to the southeastern U.S. FIA data from the 2010 survey period, we obtained different values for growth/removals ratios as depicted in Table I-7.

Table I-7. Biogenic Attributes for the Working Forest Definition Case Study Sensitivity.

Roundwood/Southeast	Growth (G) (billion cu ft/yr)	Removals (R) (billion cu ft/yr)	*GROW*	*AVOIDEMIT*	*SITETNC*	*BAF*
All Forest Lands	8.24	4.43	−0.86	0	−0.022	−0.97
All Timberlands	8.14	4.45	−0.83	0	−0.024	−0.94
Private Forest Lands	7.6	4.4	−0.75	0	−0.022	−0.85
Private Timberlands	7.6	4.4	−0.74	0	−0.024	−0.84
All Working Timberlands	7.2	4.1	−0.74	0	−0.024	−0.84
Private Working Timberlands[1]	6.8	4.1	−0.66	0	−0.024	−0.76

[1]Because the private "working forests" tend to incur harvests more frequently (they account for 91.6% of harvest removals) and yet account for only 82% of growth, the *GROW* term decreases as the land base used in the computation becomes more restrictive.

This section calculates one of the above alternative land base equation as an example, using the All Forest Land category.

$$\boldsymbol{NBE = (PGE)(GROW + AVOIDEMIT + SITETNC)(L)(P)} \qquad \textbf{(EQ. I.10)}$$

Inserting the illustrative values for the relevant equation terms into this equation:

$$\boldsymbol{NBE = (0.42\ mmtCO_2e)(-0.86 + 0 - 0.02)(1.1)(1)}$$

And the result is:

$$NBE = -0.40\ mmtCO_2e$$

For this application:

$$PGE = 0.42\ mmtCO_2e$$

Therefore:

$$BAF = NBE/PGE$$

$$BAF = -0.40\ mmtCO_2e/0.42\ mmtCO_2e$$

$$BAF = -0.97$$

2.6. Temporal Scale

Because forest growth and removals are dynamic processes, the *GROW* term can be expected to change over time. Some of this change may be due to sampling error, some due to changes in inventory processes over long spans of time, and some due to changing rates of utilization and changing age-class distributions of forests. Because of its small value and the potential for variation due to inventory methodology, *SITETNC* is held constant across the temporal scales evaluated. To demonstrate the levels of change in *GROW* that have occurred in the past in these measures, we can use data from the periodic assessments of the U.S. forest land base conducted under the Resources Planning Act (RPA) by the USDA Forest Service. From Smith et al. (2009; tables 33, 34, and 35), growth, mortality, and removals data were extracted for the southeastern United States for RPA years prior to 2010, and FIA data were used for 2010. All estimates are based on all timberlands (see analysis for Working Forest in Section 2.5).

Table I-8 shows that the growth estimate has fluctuated from a minimum of 5,587 million cu ft/yr in 1986 to a maximum of 8,142 million cu ft/yr in 2010—a 46% increase in the Southeast—while the removals estimate has fluctuated from a minimum of 3,031 million cu ft/yr in 1976 to a maximum of 4,449 million cu ft/yr in 2010—a 47% increase. The ratio of growth/removals has also fluctuated, decreasing from a maximum of 1.98 in 1976 to a minimum of 1.34 in 1996, followed by an increasing trend to 1.83 in 2010. As previously mentioned, growth/removals is expected to change over time for a variety of reasons and will reflect changing rates of roundwood utilization and changing age-class distributions of forests, among other factors.

Table I-8. Biogenic Attributes over Forest Inventory Time Frames for the Temporal Scale Case Study.

Roundwood/Southeast/ All Timberlands	Growth (*G*) (billion cu ft/yr)	Removals (*R*) (billion cu ft/yr)	*GROW*	*AVOIDEMIT*	*SITETNC*	*BAF*
1976	5.99	3.03	−0.98	0	−0.024	−1.10
1986	5.59	3.67	−0.52	0	−0.024	−0.60
1996	5.96	4.46	−0.34	0	−0.024	−0.40
2006	7.31	4.31	−0.70	0	−0.024	−0.79
2010	8.14	4.45	−0.83	0	−0.024	−0.94

Scenario 1: Changed Time Frame 1966–1976

Inserting the illustrative values for relevant equation terms into the equation results in:

$$NBE = (0.42\ mmtCO_2e)(-0.98 + 0 - 0.02)(1.1)(1) \qquad \textbf{(EQ. I.11)}$$

And the result is:

$$NBE = -0.46\ mmtCO_2e$$

For this application:

$$PGE = 0.42\ mmtCO_2e$$

Therefore:

$$BAF = NBE/PGE$$

$$BAF = -0.46\ mmtCO_2e/0.42\ mmtCO_2e$$

$$BAF = -1.10$$

Scenario 2: Changed Time Frame 1977–1986

Inserting the values for L and P into this equation results in:

$$NBE = (0.42\ mmtCO_2e)(-0.52 + 0 - 0.02)(1.1)(1)$$

And the result is:

$$NBE = -0.25\ mmtCO_2e$$

For this application:

$$PGE = 0.42\ mmtCO_2e$$

Therefore:

$$BAF = NBE/PGE$$

$$BAF = -0.25\ mmtCO_2e/0.42\ mmtCO_2e$$

$$BAF = -0.60$$

Scenario 3: Changed Time Frame 1987–1996

Inserting the illustrative values for relevant equation terms into the equation results in:

$$NBE = (0.42\ mmtCO_2e)(-0.34 + 0 - 0.02)(1.1)(1) \qquad \textbf{(EQ. I.12)}$$

And the result is:

$$NBE = -0.17\ mmtCO_2e$$

For this application:

$$PGE = 0.42\ mmtCO_2e$$

Therefore:

$$BAF = NBE/PGE$$

$$BAF = -0.17\ mmtCO_2e/0.42\ mmtCO_2e$$

$$BAF = -0.40$$

Scenario 4: Changed Time Frame 1997–2006

Inserting the illustrative values for relevant equation terms into the equation results in:

$$NBE = (0.42\ mmtCO_2e)(-0.70 + 0 - 0.02)(1.1)(1) \quad \textbf{(EQ. I.13)}$$

And the result is:

$$NBE = -0.33\ mmtCO_2e$$

For this application:

$$PGE = 0.42\ mmtCO_2e.$$

Therefore:

$$BAF = NBE/PGE$$

$$BAF = -0.33\ mmtCO_2e/0.42\ mmtCO_2e$$

$$BAF = -0.79$$

Scenario 5: Changed Time Frame 2010

Inserting the values into this equation results in:

$$NBE = (0.42\ mmtCO_2e)(-0.83 + 0 - 0.02)(1.1)(1) \quad \textbf{(EQ. I.14)}$$

And the result is:

$$NBE = -0.39\ mmtCO_2e$$

For this application:

$$PGE = 0.42\ mmtCO_2e$$

Therefore:

$$BAF = NBE/PGE$$

$$BAF = -0.39\ mmtCO_2e/0.42\ mmtCO_2e$$

$$BAF = -0.94$$

3. Logging Residues in the Pacific Northwest

This case study calculates the net biogenic CO_2 emissions from a hypothetical electricity facility with an EGU that uses logging residues from the Pacific Northwest as a biogenic feedstock. The case study illustrates how estimated values for biogenic attributes and facility-specific attributes would be combined to calculate the *NBE* and *BAF* using a reference point baseline. This case study also examines alternative scenarios including (1) equation term analysis (i.e., investigation of the impact of various terms on the final result as they are added or subtracted from the assessment factor calculation); and (2) alternative fate (i.e., investigation of the impact of assuming either a decay or combustion fate if the logging residues were not removed as biogenic feedstock).

As with the SE roundwood case study, feedstock carbon losses during storage, transport, and processing (L) are held constant at 1.1, feedstock carbon embodied in products (P) is also constant at 1, and leakage associated with feedstock production (*LEAK*) values are not included in this case study application.

3.1. Base Case

For all of the case study scenarios, it was assumed that the electricity facility has an output of 30 MW, a capacity factor of 95%, and efficiency of 26% (consumes 1 BDT of roundwood per MWh of electricity produced), thus requiring an input of 250,000 BDT of roundwood per year. If we assume that 50% of the 250,000 BDT of feedstock is carbon and convert the short tons to tonnes and carbon to CO_2, we end up with a *PGE* of 0.42 mmtCO_2 for the hypothetical 30 MW plant.

In Appendix H, *SITETNC* for logging residues in the Pacific Northwest was estimated as 1 mtCO_2e per ton of feedstock removed. *GROW* is 0 and *AVOIDEMIT* represents an alternative fate of decomposition on site.

Table I-9. Biogenic Landscape Attributes: Logging Residues in the Pacific Northwest.

Feedstock/Region	*GROW*	*AVOIDEMIT*	*SITETNC*
Logging Residues/Pacific Northwest	0	−0.98	1

Table I-10. Process Attributes: Logging Residues in the Pacific Northwest.

Feedstock/Process	PRODC	L
Logging Residues/EGU	1	1.1

Inserting the illustrative values for relevant equation terms into the equation results in:

$$\boldsymbol{NBE = (0.42\ mmtCO_2e)(0 - 0.98 + 1)(1.1)(1)} \qquad \textbf{(EQ. I.15)}$$

And the result is:

$$\boldsymbol{NBE = 0.01\ mmtCO_2e}$$

For this application:

$$\boldsymbol{PGE = 0.42\ mmtCO_2e}$$

Therefore:

BAF = NBE/PGE

$$BAF = 0.01\ mmtCO_2e/0.42\ mmtCO_2e$$

$$BAF = 0.02$$

SITETNC equals 1 in the base case to represent a ton of logging residues being removed or emitted from the feedstock production site. As described in Appendix H, the *AVOIDEMIT* value of −0.98 represents the percentage of emissions that would have occurred on the production site had those logging residues remained on site rather than been combusted at a stationary facility less the 2% that would have remained sequestered in the soil pool long term. In other words, using logging residues that would have been left at the production site following a harvest would result in a loss (or emission) of the 2% of that feedstock that would have remained on site in the long run.

4. Corn Stover in the Corn Belt

This case study calculates the net biogenic CO_2 emissions from a hypothetical electricity facility with an EGU that uses corn stover from the Corn Belt as a biogenic feedstock. The case study illustrates how estimated values for biogenic attributes, and process attributes would be combined to calculate the *NBE* and *BAF* using a reference point baseline.

This case study also examines alternative scenarios including (1) equation term analysis (i.e., investigation of the impact of various terms on the final result as they are added or subtracted from the assessment factor calculation); and (2) the influence of including fluxes of nitrous oxide (N_2O) at sites where corn stover is removed.

4.1. Base Case

For all of the case study scenarios, it was assumed that the electricity facility has an output of 30 MW per year, a capacity factor of 95% efficiency, converts 1.1 BDT of corn stover per MWh of electricity produced, and would consume an input of 275,000 BDT of corn stover per year. Note, this estimate of BDT has been revised upward from the estimates presented in the roundwood and logging residue case studies to account for the lower carbon fraction in corn stover (0.44) compared with roundwood/logging residue (0.50). Converting the 275,000 BDT of feedstock to carbon and converting the short tons to metric tonnes and carbon to CO_2 we end up with a *PGE* of 0.44 $mmtCO_2$ for the hypothetical 30 MW plant.

In Appendix H, *SITETNC* for corn stover in the Corn Belt was estimated as +0.0026 $mtCO_2e$ per ton of feedstock removed. *GROW* is set to 0 because the ratio of net growth to removals is 0. *AVOIDEMIT* is also 0 because all emissions would have occurred anyway in the absence of residue removals. Therefore:

Table I-11. Biogenic Landscape Attributes: Corn Stover in the Corn Belt.

Feedstock/Region	*SITETNC*	*GROW*	*AVOIDEMIT*
Corn Stover/Corn Belt	.0026	0	0

Table I-12. Process Attributes: Corn Stover in the Corn Belt

Feedstock/Process	*P*	*L*
Corn Stover/EGU	1	1.1

To investigate the relative impact of each of the variables on the assessment factor result, the assessment factor was calculated with and without certain equation variables (i.e., *SITETNC*).

Inserting the illustrative values for the relevant equation terms into the main biogenic assessment factor equation from the main report, this equation is now:

$$\boldsymbol{NBE = (0.44\ mmtCO_2e)(0 + 0.0026 + 0)(1.1)(1)} \qquad \textbf{(EQ. I.16)}$$

And the result is:

$$\boldsymbol{NBE = 0.0013\ mmtCO_2e}$$

For this case study application:

$$\boldsymbol{PGE = 0.44\ mmtCO_2e}$$

Therefore:

BAF = NBE/PGE

$\boldsymbol{BAF = 0.0013\ mmtCO_2e/0.44\ mmtCO_2e}$

***BAF* = 0.0029**

4.2. *NBE* Results with N_2O Emissions

In Appendix H, *SITETNC* for corn stover in the Corn Belt with N_2O emissions was estimated as +0.0123 mtCO_2 equivalent (e) per ton of feedstock removed.[1,2] Once again, *GROW* is set to 0 because the ratio of net growth to removals is 0. *AVOIDEMIT* is also 0 because all emissions would have occurred anyway in the absence of residue removals. Therefore:

Table I-13. Biogenic Landscape Attributes: Corn Stover in the Corn Belt with N_2O Emissions.

Feedstock/Region	*SITETNC*	*GROW*	*AVOIDEMIT*
Corn Stover/Corn Belt	.0123	0	0

Inserting the illustrative values for the relevant equation terms into the main biogenic assessment factor equation from the main report, this equation is now:

$$\boldsymbol{NBE = (0.44\ mmtCO_2e)(0 + 0.00123 + 0)(1.1)(1)} \qquad \textbf{(EQ. I.17)}$$

And the result is:

[1] A detailed methodology for estimating *SITETNC* for soil carbon and N_2O emissions changes can be found in Appendix H.
[2] CO_2 equivalence is used for *SITETNC* as N_2O emissions are converted to CO_2 terms.

$$NBE = 0.006\ mmtCO_2e$$

For this case study application:

$$PGE = 0.44\ mmtCO_2e$$

Therefore:

BAF = NBE/PGE

BAF = $\mathbf{0.006\ mmtCO_2e/0.44\ mmtCO_2e}$

***BAF =* 0.0135**

5. References

Smith, W.B., P.D. Miles, C.H. Perry, and S.A. Pugh. 2009. *Forest Resources of the United States, 2007*. Gen. Tech. Rep. WO-78. Washington, DC: U.S. Department of Agriculture, Forest Service, Washington Office. 336 p.