Overview of EPA Life Cycle Modeling for EISA

EISA Renewable Fuel Standard

Year	Advanced Biofuel			Total Renewable Fuel
	Biomass-Based Diesel	Cellulosic Biofuel	Total Advanced Biofuel	
2006				4.0
2007				4.7
2008				9.0
2009	0.5		0.6	11.1
2010	0.65	0.1	0.95	12.95
2011	0.80	0.25	1.35	13.95
2012	1.0	0.5	2.0	15.2
2013	1.0	1.0	2.75	16.55
2014	1.0	1.75	3.75	18.15
2015	1.0	3.0	5.5	20.5
2016	1.0	4.25	7.25	22.25
2017	1.0	5.5	9.0	24.0
2018	1.0	7.0	11.0	26.0
2019	1.0	8.5	13.0	28.0
2020	1.0	10.5	15.0	30.0
2021	1.0	13.5	18.0	33.0
2022	1.0	16.0	21.0	36.0

EISA Requires Lifecycle Assessment

- Each fuel category required to meet mandated GHG performance thresholds (reduction compared to baseline petroleum fuel replaced)
  - **Conventional Biofuel** (ethanol derived from corn starch)
    - Must meet 20% lifecycle GHG threshold
    - Only applies to fuel produced in new facilities
  - **Advanced Biofuel**
    - Essentially anything but corn starch ethanol
    - Includes cellulosic ethanol and biomass-based diesel
    - Must meet a 50% lifecycle GHG threshold
  - **Biomass-Based Diesel**
    - E.g., Biodiesel, “renewable diesel” if fats and oils not co-processed with petroleum
    - Must meet a 50% lifecycle GHG threshold
    - 20-50% still counts as renewable fuel
  - **Cellulosic Biofuel**
    - Renewable fuel produced from cellulose, hemicellulose, or lignin
    - E.g., cellulosic ethanol, BTL diesel
    - Must meet a 60% lifecycle GHG threshold
- EISA language permits EPA to adjust the lifecycle GHG thresholds by as much as 10%
- Baseline fuel for comparison is gasoline and diesel fuel in 2005

Definition of Lifecycle GHG Emissions

‘‘(H) LIFECYCLE GREENHOUSE GAS EMISSIONS.—The term ‘lifecycle greenhouse gas emissions’ means the aggregate quantity of greenhouse gas emissions (including direct emissions and significant indirect emissions such as significant emissions from land use changes), as determined by the Administrator, related to the full fuel lifecycle, including all stages of fuel and feedstock production and distribution, from feedstock generation or extraction through the distribution and delivery and use of the finished fuel to the ultimate consumer, where the mass values for all greenhouse gases are adjusted to account for their relative global warming potential.

Methodology for Life Cycle Analysis

- Integrating a number of models and analysis
- Including direct and indirect impacts such as land use change as specified by legislation requires analysis of markets
  - Typical life cycle analysis tools are based on process modeling
  - To capture market impacts need to use economic models
- Doing our own process and emissions modeling as part of rulemaking
- Considering results of many modeling efforts and data sources
  - Emission factors (GREET, Winrock, Woods Hole)
  - Fertilizer N_2O modeling (CSU DAYCENT/CENTURY)
  - Agricultural sector models (FASOM, FAPRI, GTAP, BESS)
  - Land use changes (FASOM, FAPRI, GTAP)
  - Fuel production process models (GREET, USDA & NREL ASPEN models, BESS)
  - Tailpipe emissions (MOVES)
  - Energy sector modeling (NEMS)

Land Use Change Modeling

- Agricultural sector models provide total amount of land converted
  - FASOM and FAPRI established partial equilibrium agricultural sector models
  - GTAP general equilibrium model including agricultural sector
  - Models capturing
    - Changes in crop production patterns e.g., more corn less soybeans
    - Change in demand e.g., higher corn prices reduce livestock production
    - Net additional land needed for crop production
- GHG emissions based on types of land converted
  - FASOM has domestic land competition, e.g., pasture vs. forest converted to crop production
  - FAPRI does not have international land competition
  - Purdue GTAP model has land competition
  - Also looking at recent trends in land conversion (satellite data)
- GHG factors for different land types (GHG/acre)
  - Winrock International developing factors
  - Woods Hole has factors (used in Science Article)
- EPA is considering data from a number of sources

Land Use Change Questions and Potential Models / Data Sources

FAPRI (Domestic and International)

IPCC
Woods Hole (Houghton)
Winrock

FASOM (Domestic)

GTAP (Domestic and International)

How much land is converted?
- Demand response
- Co-product use
- Market shifts
- Baseline yield improvements
- Price induced yield changes

Where is land converted?
- Global trade of commodities
- Growing conditions
- Availability of land

What type of land is converted?
- CRP in US
- Pasture vs. forest
- Managed vs. unmanaged
- Impacts on livestock market
- Impacts on timber market
- Recent trends

What are the emissions from conversion?
- Above ground and soil carbon
- Foregone sequestration
- Fate of carbon removed (timber vs. burned) and offsets
- Type of forest and grassland
- Regional vs. country specific

Timing of Emissions
- Net present value
- Amortize
- Discount rate
- Payback period

Ongoing GTAP Work

- Develop future reference case
  - Crop yields
  - Demand increase
  - Energy prices
- Assess future case assumptions including land supply curves and land values
- Capture the dynamic nature of assumptions specifically in forestry sector
- Include unmanaged land types

Life Cycle Work Plan

- Currently updating our input assumptions and rerunning models
  - New baseline / reference case runs
  - New mandated volumes
  - New biofuels only runs - to isolate impacts
    - Corn ethanol
    - Biodiesel
    - Imported ethanol
    - Cellulosic ethanol

- We plan to continue to reach out to all stakeholders throughout the summer as we get further along in our analysis