
U.S. Renewable Fuel Standard Program (“RFS2”)

Global Bioenergy Partnership
Information Session on iLUC
18 November 2010



The RFS Program

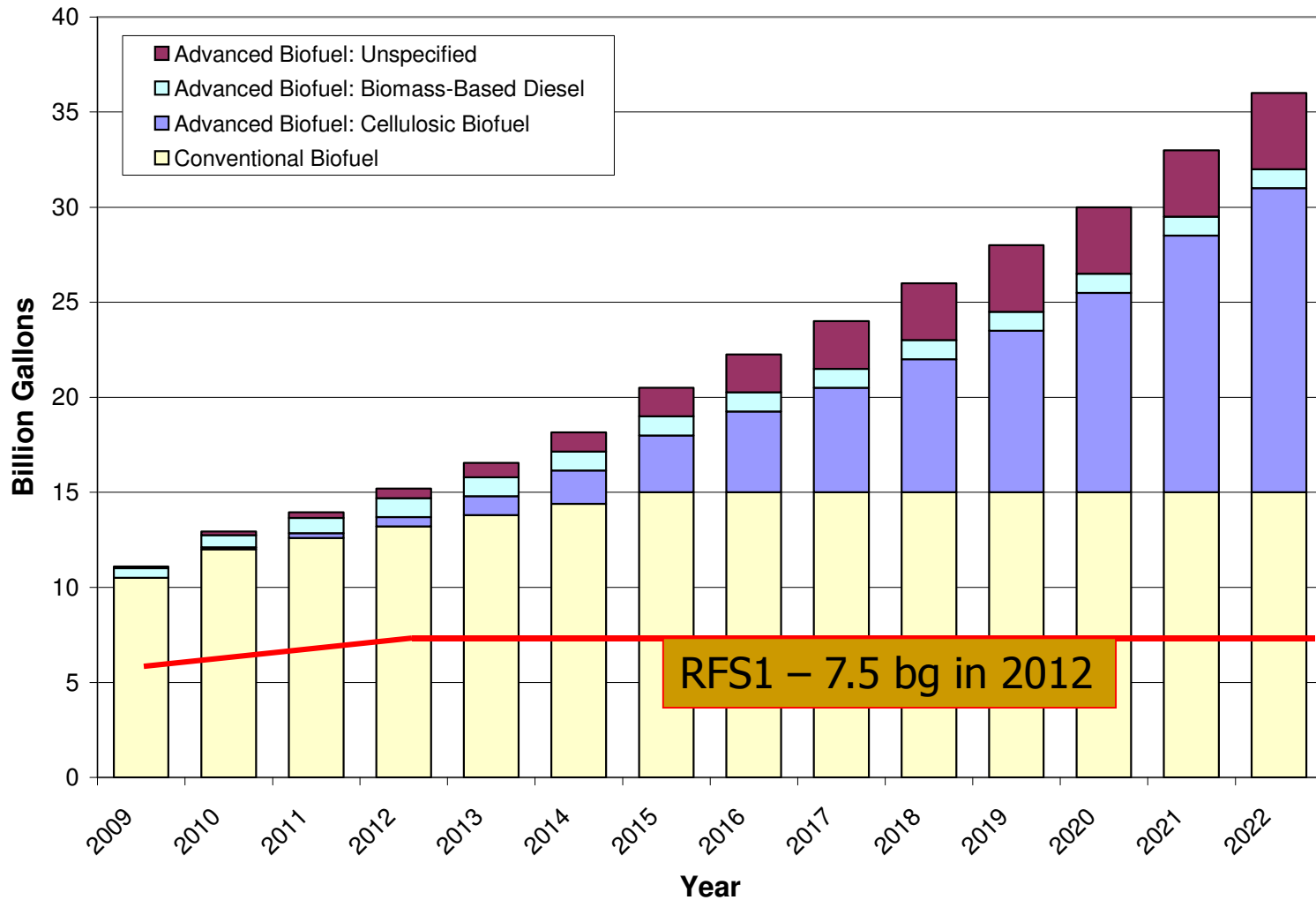
- **The Renewable Fuel Standard was revised in the Energy Independence & Security Act (EISA) of December 2007**

- **New provisions for the RFS-2 included:**
 - Significant increase in volumes (nearly 5X), for a total of 36 bgal by 2022
 - Separation of volume requirements into four categories, each of which must meet a lifecycle GHG threshold
 1. **Cellulosic biofuel** (60% lifecycle threshold)
 2. **Biomass-based diesel** (50% lifecycle threshold)
 3. **Advanced biofuel** (50% lifecycle threshold)
 - Includes cellulosic biofuel & biomass-based diesel, plus additional 4 Bgal of any biofuel (except for corn starch ethanol) that meets the 50% threshold
 4. **Total renewable fuel** (20% lifecycle threshold)
 - Ethanol derived from corn starch (or any other qualifying renewable fuel)
 - *Existing facilities (domestic /foreign) are “grandfathered” (not required to meet 20% threshold)*
 - Restrictions on types of feedstocks that can be used to make renewable fuel, and the types of land that can be used to grow those feedstocks

- **Final rulemaking was published on March 26, 2010**

RFS-2 program went into effect on July 1, 2010

RFS2 Volumes



Lifecycle GHG Emissions

- **Definition of lifecycle emissions (as included in EISA):**
 - “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.”

- **Definition of the petroleum baseline (as included in EISA):**
 - “The term ‘baseline lifecycle greenhouse gas emissions’ means the average lifecycle greenhouse gas emissions, as determined by the Administrator, after notice and opportunity for comment, for gasoline and diesel (whichever is being replaced by the renewable fuel) sold or distributed as transportation fuel in 2005.”

Lifecycle GHG Thresholds

- **Lifecycle definition of “direct emissions and significant indirect emissions such as significant emissions from land use changes” requires the use of a number of models and tools**
 - Typical lifecycle analysis tools are based on process modeling
 - However, the inclusion of direct and indirect impacts such as land use change requires analysis of markets
 - Need economic models in order to capture market impacts
 - Captures opportunity cost of different uses of crops/land
- **GHG thresholds are defined as the percent reduction in lifecycle GHGs for a renewable fuel in comparison to the 2005 baseline gasoline or diesel that it displaces**
 - Lifecycle GHG estimates are only used to categorize renewable fuels into the four standards, not to value them
 - While each renewable fuel pathway has a unique lifecycle GHG emissions impact in grams/mmBtu, for RFS-2 regulatory purposes these lifecycle emissions are used only to compare each pathway to the applicable threshold and assign it to one of the four renewable fuel categories

Land Use Change Analysis

Key Land Use Change Questions

How much land is converted?

Where is land newly converted to cropland?

What types of land are converted?

What are the GHG factors for each type of land conversion?

How to account for time dimension of GHG emissions?

Agricultural Production Questions

What are emissions trends of crop production?

Lifecycle Modeling Approach

- For the RFS-2, we developed a lifecycle GHG methodology that is consistent with the EISA statute
 - Methodology includes a suite of models that analyze all of the key pieces of the lifecycle of a particular renewable fuel, including indirect land use emissions
- RFS-2 Methodology includes:
 - **Domestic Agricultural Sector Modeling**
 - Includes interactions between cropland, pasture, and forest as well as impacts on GHG emissions from crops and livestock production
 - Measures changes in full agricultural sector emissions due to biofuels expansion
 - **International Agricultural Sector Modeling**
 - Includes detailed regional breakouts of agriculture & pasture land, including pasture/cropland interactions in Brazil
 - Calculates the impacts on world markets based on changes in use of feedstocks for biofuels
 - **Land Use Change Modeling**
 - Long-term satellite data (2001-2007) used to determine what types of land are impacted by international crop expansions
 - Data includes 9 land categories— in over 750 distinct regions— across 160 countries
 - **Biofuel Processing in Both Domestic & International Agricultural Sector Modeling**
 - Co-products are treated through an expansion of system boundaries to include co-product markets and replacement rates in the agricultural sector (e.g., DDGS from corn ethanol used as animal feed)
 - Includes the latest data on process energy use and projections for future efficiency gains

Updates to Lifecycle Modeling Relevant to LUC

Based on peer review results as well as other comments received we made several updates to our modeling for the final analysis

- **Updates to Domestic Agricultural Sector Modeling:**
 - Incorporated forestry model results in our analysis
 - Added new land classifications; cropland, cropland-pasture, rangeland, forest-pasture, forest, CRP, developed land
 - Reflected new data on projected switchgrass yields
 - Updated N₂O / soil carbon factors (Colorado State University DAYCENT/CENTURY models)
- **Updates to International Agricultural Sector Modeling:**
 - Incorporated a Brazil module into the international model framework
 - Regional breakout of agriculture and pasture land
 - Includes pasture / cropland interactions
 - Added price induced yield changes -- Based on work by CARD at Missouri and Iowa State that provides factors by crop and by country
 - Updated int'l agricultural GHG emission estimates based, in part, on new data from the International Fertilizer Industry Association (IFA)
- **Updates to Land Use Change Modeling:**
 - Increased geographic coverage of satellite data – increasing to 160 countries
 - Used longer time period of satellite data - 2001-2007
 - Used higher resolution satellite data from the latest MODIS V5 release, 500m² resolution
 - Augmented global satellite data with country / region specific data where available (e.g., data from Brazil on pasture intensification)

Land use change GHG emissions

- To determine the GHG emissions impacts of international land use changes, we followed the 2006 IPCC Agriculture, Forestry, and Other Land Use (AFOLU) Guidelines.
- Worked with Winrock to estimate land conversion emissions factors: (Winrock has years of experience developing and implementing the IPCC guidelines)
 - Land conversion emissions factors include 10 land categories in over 750 regions across 160 countries
 - Above and below ground biomass carbon stocks
 - Soil carbon stocks, including draining peat soils
 - Non- CO2 emissions from clearing with fire
 - Foregone forest sequestration (i.e., lost future growth in vegetation and soil carbon)

Addressing Uncertainty in Analysis

- **For the final rule analysis, we specifically addressed the uncertainty of the lifecycle results using three primary approaches:**
 1. Updated analysis with best currently available information to narrow uncertainty
 2. Performed sensitivity analysis around key factors to test the impact on the results
 3. Established reasonable ranges of uncertainty and used probability distributions within these ranges in threshold assessment

- **For key methodology choices we have selected approaches based on feedback from the comment process and peer review**
 - Where appropriate conducted sensitivity analysis around these decisions

Land Use Change –

- **Performed an uncertainty analysis and developed a range and distribution of results around the LUC emissions**
- **Two key drivers of land use change –**
 1. Types of land converted (satellite data)
 2. GHG emission factors associated with different types of land conversion

Compliance Determinations Included in Final Rule

- **For the final rule, after completing all of the necessary updates to our analysis, we made compliance determinations for a variety of renewable fuels**
 - In particular, these determinations accounted for the feedstock and fuel production pathways expected to form a significant portion of the volumes needed under the rule in 2022

- **Based upon our modeling results, we determined that the following fuel pathways meet the threshold requirements of the Act:**
 - Ethanol produced from corn starch at a new natural gas, biomass, or biogas fired facility using advanced efficient technologies meets 20% threshold (Coal fired does not)
 - Butanol from corn starch meets 20% threshold
 - Biodiesel (soy, wastes, algae) meets 50% threshold
 - Sugarcane ethanol (multiple pathways) meets 50% threshold
 - Cellulosic ethanol and diesel fuel (thermal and biochemical processes using stover, switchgrass) meet 60% threshold
 - Canola oil biodiesel qualifies as an advanced biofuel with a 50% reduction compared to petroleum diesel fuel. (Supplemental Rulemaking, September 2010)

- **For fuel pathways not yet modeled, EPA provides a petition process through which the fuel pathway can be analyzed and provided a compliance determination**

National Academies of Science Study

EPA is initiating a National Academy of Sciences (NAS) study to spur the continued advancement of lifecycle analysis for biofuels.

- In the final RFS-2 rule, EPA recognized that the state of scientific knowledge continues to evolve in the field of lifecycle analysis.

- EPA will request that over the next two years NAS
 - evaluate the current available models for LCA of GHG emissions due to biofuels, including the approach used for the RFS final rule,
 - make recommendations on continued enhancements to integrated modeling approaches to LCA for biofuels, especially with respect to indirect land use change,
 - identify data and research needs that would enhance the state of the science.

- EPA will consider NAS recommendations in its analyses for future RFS rulemakings.

Questions?

- For Additional information:
<http://www.epa.gov/otaq/renewablefuels/index.htm>
 - Includes Factsheets
 - RFS2 Rulemaking Package
 - Preamble
 - Regulations
 - Regulatory Impact Analysis
 - Links to Other Information
 - Frequently Asked Questions

- Send new questions to: EPAFuelsPrograms@epa.gov