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Introduction to Biofuels

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Module 1: Current National Fuel Challenges

Learning Objectives

By the end of this section, you will be able to:

- **Evaluate** the strategic impact of petroleum dependency on national energy security and environmental stability.
- **Identify** the legislative mandates and production targets established by the Renewable Fuel Standard (RFS) and the 2008 Farm Bill.
- **Select** the appropriate supply-chain action areas required to transition advanced biofuel technologies from research to market competition.

Executive Summary: To mitigate energy security risks and a projected 40% increase in greenhouse gas emissions, federal mandates now require the production of 36 billion gallons of biofuels annually by 2022, necessitating a coordinated interagency approach to optimize the entire supply chain from feedstock production to end use.

Strategic Energy Context

The American economy remains heavily dependent on liquid transportation fuels primarily derived from petroleum. With 230 million automobiles—one-third of the global total—the U.S. consumes 25% of the world's oil. This reliance has created significant energy security concerns and environmental challenges.

Key projections in the absence of petroleum alternatives include:

- **Import Reliance:** Reliance on foreign oil producers is projected to increase 30% through 2030.
- **Emission Growth:** Greenhouse gas emissions from the transport sector are expected to grow by nearly 40%.

Administration Action and Legislative Mandates

Biofuels represent a primary near-term strategy to address these challenges. Federal initiatives have set aggressive benchmarks to reduce gasoline consumption and catalyze domestic production:

- **Advanced Energy Initiative (AEI):** Established in 2006 to increase research funding for cutting-edge production processes.
- **"Twenty-in-Ten" Initiative:** A 2007 plan to reduce gasoline consumption by 20% within 10 years.
- **Renewable Fuel Standard (RFS):** Enacted via the Energy Independence and Security Act (EISA) of 2007, requiring 36 billion gallons per year (BGY) of biofuels by 2022.
- **2008 Farm Bill:** Provided over \$1 billion in mandatory funding for renewable energy activities, including loan guarantees for cellulosic ethanol projects.

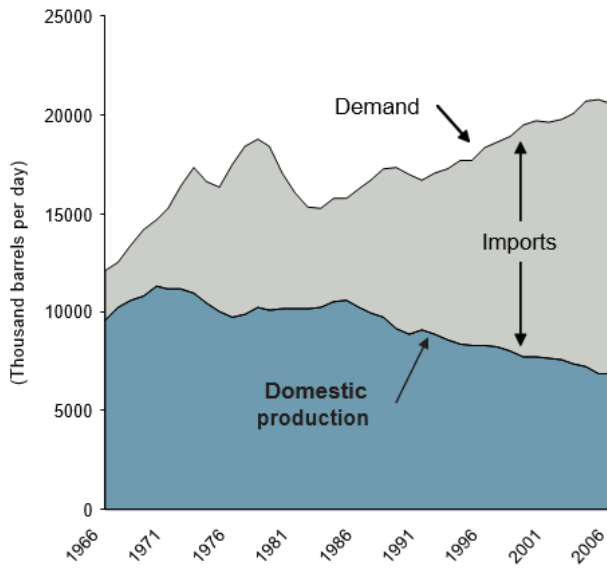


Figure 1: U.S. petroleum production capacity and demand

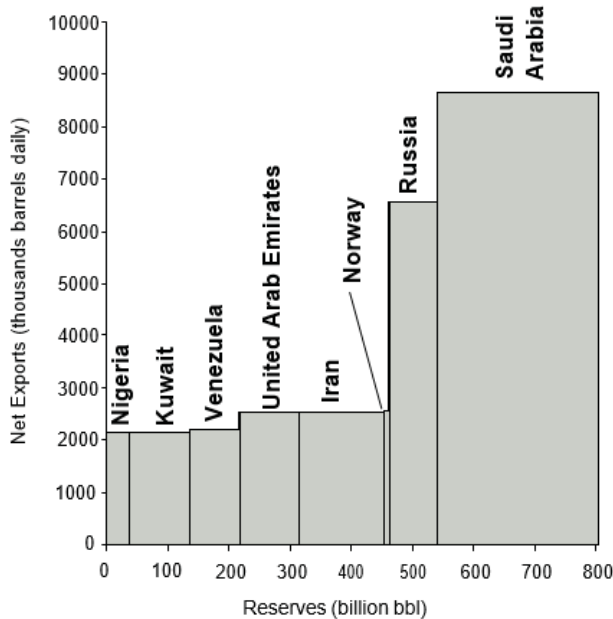


Figure 2: Top eight world-wide countries for petroleum reserves and net exports

The Biomass R&D Board

The Biomass Research and Development (R&D) Board coordinates programs across federal departments to promote bio-based fuels and products.

⚠ Safety Constraint: The Board must maximize the benefits of federal grants and bring coherence to strategic planning to ensure advanced technologies are deployed on an ecologically sustainable basis.

The Board is co-chaired by the Departments of Energy (DOE) and Agriculture (USDA) and includes senior decision-makers from the EPA, NSF, DoD, and Treasury, among other agencies.

The Biofuels Supply Chain Framework

The Board utilizes a five-part supply-chain framework to identify specific action areas for interagency cooperation.

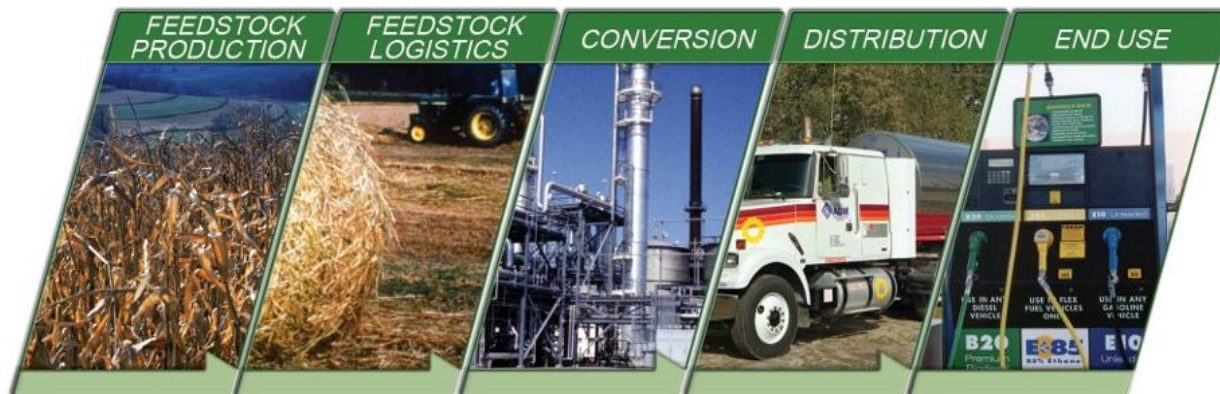


Figure 3: The biofuels supply chain

Supply Chain Action Areas

- **Feedstock Production:** Cultivation of biomass resources like corn and woody residues.
- **Feedstock Logistics:** Harvesting, processing, storing, and delivering feedstock to the biorefinery.
- **Conversion:** Transforming processed feedstock into liquid fuels; currently, cellulosic ethanol remains too costly for market competition.
- **Distribution:** Transferring fuel from biorefineries to retail points via trucks, trains, barges, and pipelines.
- **End Use:** Consumer purchase of biofuels for use in traditional or specially modified vehicles.

Crosscutting Action Areas

1. **Sustainability:** Meeting social, economic, and environmental requirements now and for the future.
2. **Environment, Health, and Safety:** Protecting the public and workers throughout all stages of the supply chain.

💡 Design Tip: When evaluating conversion technologies, engineers should prioritize R&D that addresses the inherent uncertainty of technological breakthroughs required to lower costs to competitive levels.

Checkpoint Quiz

1. What is the 2022 production target for biofuels as mandated by the Renewable Fuel Standard (RFS)?

- a) 20 BGY
- b) 35 BGY
- c) 36 BGY
- d) 40 BGY

Answer: (c). The Renewable Fuel Standard (RFS), as part of the Energy Independence and Security Act of 2007, specifically mandates the production of 36 billion gallons per year (BGY) of biofuels by 2022.

2. Which element of the biofuels supply chain involves harvesting and delivering biomass to the plant gate?

- a) Feedstock Production
- b) Feedstock Logistics
- c) Conversion
- d) Distribution

Answer: (b). Feedstock logistics is defined as the phase encompassing the harvesting or collection of feedstocks, its storage and storage, and its final delivery to the biorefinery plant gate.

3. According to projections, how much will the transport sector's greenhouse gas emissions grow by 2030 in the absence of petroleum alternatives?

- a) 20%
- b) 30%
- c) 40%
- d) 50%

Answer: (c). In the absence of viable alternatives, the Energy Information Administration (EIA) projects that greenhouse gas emissions from the transport sector will increase by nearly 40% through the year 2030.

Module 2: Board Action Area 1 – Sustainability

Learning Objectives

By the end of this section, you will be able to:

- **Identify** the science-based criteria and indicators used to evaluate the environmental, economic, and social performance of biofuels.
- **Evaluate** the four primary ways the EISA amendments to the RFS program promote sustainable biofuels production.
- **Identify** the specific roles and leading agencies of the Sustainability Interagency Working Group.

Executive Summary: The National Biofuels Action Plan seeks to maximize the environmental and economic benefits of biofuels by advancing sustainable practices and efficiency throughout the supply chain. This is achieved through interagency leadership, the establishment of science-based sustainability criteria, and compliance with mandatory EISA requirements to protect ecosystem and human health.

Sustainability Fundamentals

The production volumes specified by the Energy Independence and Security Act (EISA) are mandatory requirements necessary for national security, economic security, and environmental stewardship. To achieve these objectives, the Federal government is mobilizing interagency teams to advance sustainable practices from feedstock production to final use.

The Biomass R&D Board provides leadership to steer development through:

- **Compilation and evaluation** of biofuels sustainability criteria, benchmarks, and indicators.
- **Coordination** among federal and state agencies to identify best agricultural and land use practices.
- **Optimization** of production, conversion, transportation, and storage systems to ensure economic viability.

Historical Context

Sustainability is formally defined by Executive Order 13423 as creating and maintaining conditions under which humans and nature can exist in productive harmony to fulfill social and economic requirements for present and future generations.

The EISA amendments to the Renewable Fuel Standard (RFS) program promote this harmony through four specific mandates:

1. **Greenhouse Gas Reductions:** Directing that significant reductions be achieved across different feedstocks.



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