



Bioenergy Supply, Land Use, and Environmental Implications

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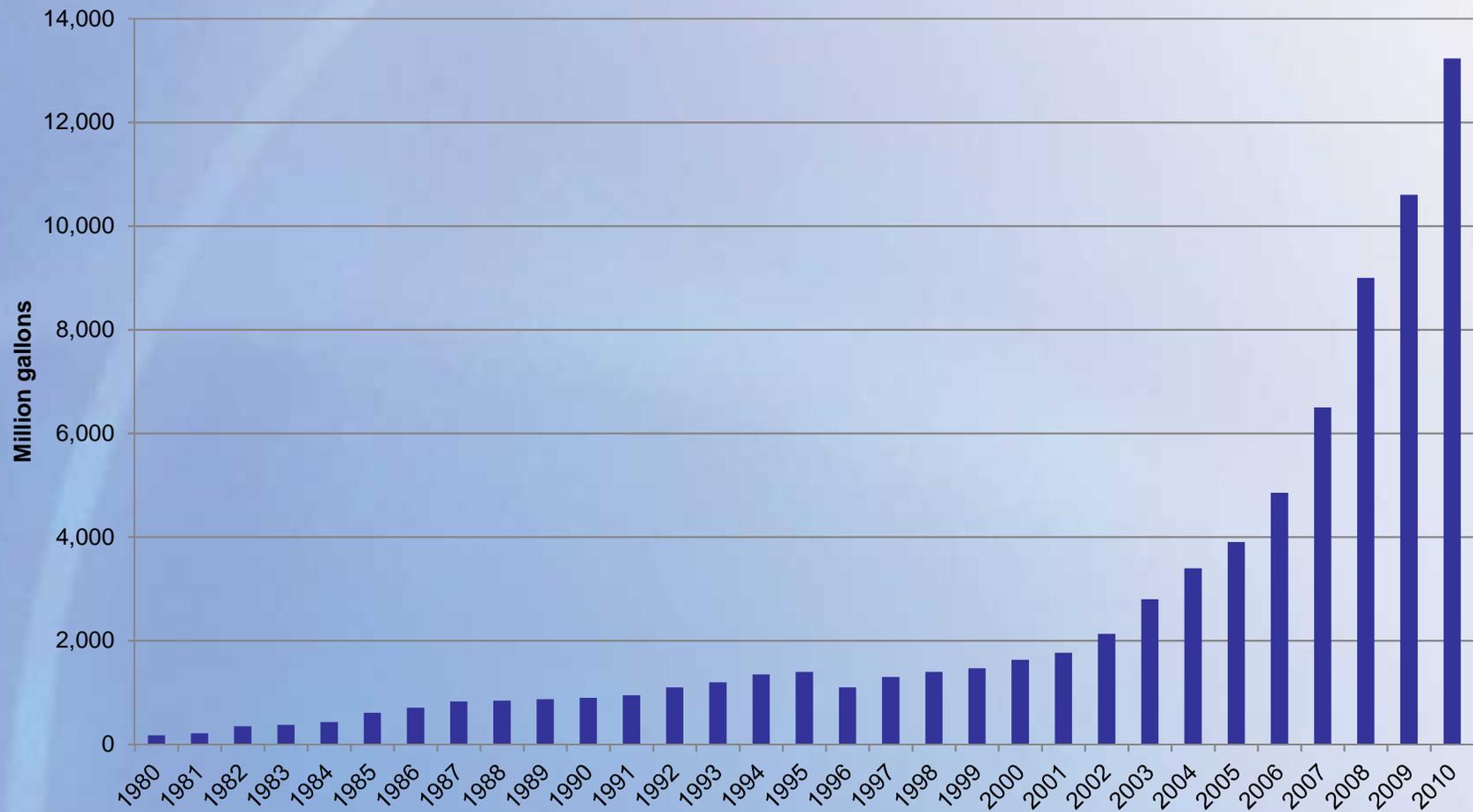
Bioenergy

- Potential reductions in GHG emissions along with domestic energy security have been drivers of rapid global bioenergy expansion
- Relatively little concern regarding potential negative impacts of biofuels prior to efforts to expand volumes in the last few years
 - Details emerged and studies followed pointing out issues of land use change, water use, agricultural commodity prices (food vs. fuel), and net GHG impacts with full life cycle accounting
 - Similarly, concerns about sustainability and environmental impacts of forest biomass to energy have been raised
 - Timing of biomass emissions vs. sequestration
 - Challenges over smoke, toxics, forest cover, biodiversity, etc
- Increased competition for agricultural outputs will impact production practices, crop mix, commodity markets, land use, and net GHG emissions

Selected US Policies Affecting Bioenergy

- Existing
 - Energy Independence and Security Act of 2007
 - State-level Renewable Portfolio Standards
 - 2008 Farm Bill
 - Multiple programs encouraging and providing funding for renewable energy development
 - American Recovery and Reinvestment Act of 2009
 - Funding for clean energy
- Potential Future Policies
 - National Renewable Electricity Standard or Clean Electricity Standard
 - GHG mitigation policies

US Ethanol Production, 1980-2010



Energy Independence and Security Act of 2007

- Revisions to the U.S. National Renewable Fuel Standard program (RFS)
 - Increases in required volumes of biofuels
 - Expand beyond gasoline to transportation fuels more broadly
 - Specific volume standards for cellulosic biofuels, biomass-based diesel, advanced biofuels, and total renewable fuels used in transportation
 - New definitions and criteria for renewable fuels, including minimum GHG reduction thresholds

RFS2 Volume Requirements (billion gallons)

Year	Cellulosic biofuels	Biomass-based diesel	Advanced biofuels	Total renewable fuels
2008	n/a	n/a	n/a	9.0
2009	n/a	0.50	0.60	11.10
2010	0.10 (6.5 mgy)	0.65	0.95	12.95
2011	0.25 (5.0-17.1 mgy)	0.80	1.35	13.95
2012	0.50 (3.45-12.9 mgy)	1.00	2.00	15.00
2014	1.75	TBD, 1.00	3.75	18.15
2016	4.25	TBD, 1.00	7.25	22.25
2018	7.00	TBD, 1.00	11.00	26.00
2020	10.50	TBD, 1.00	15.00	30.00
2022	16.00	TBD, 1.00	21.00	36.00

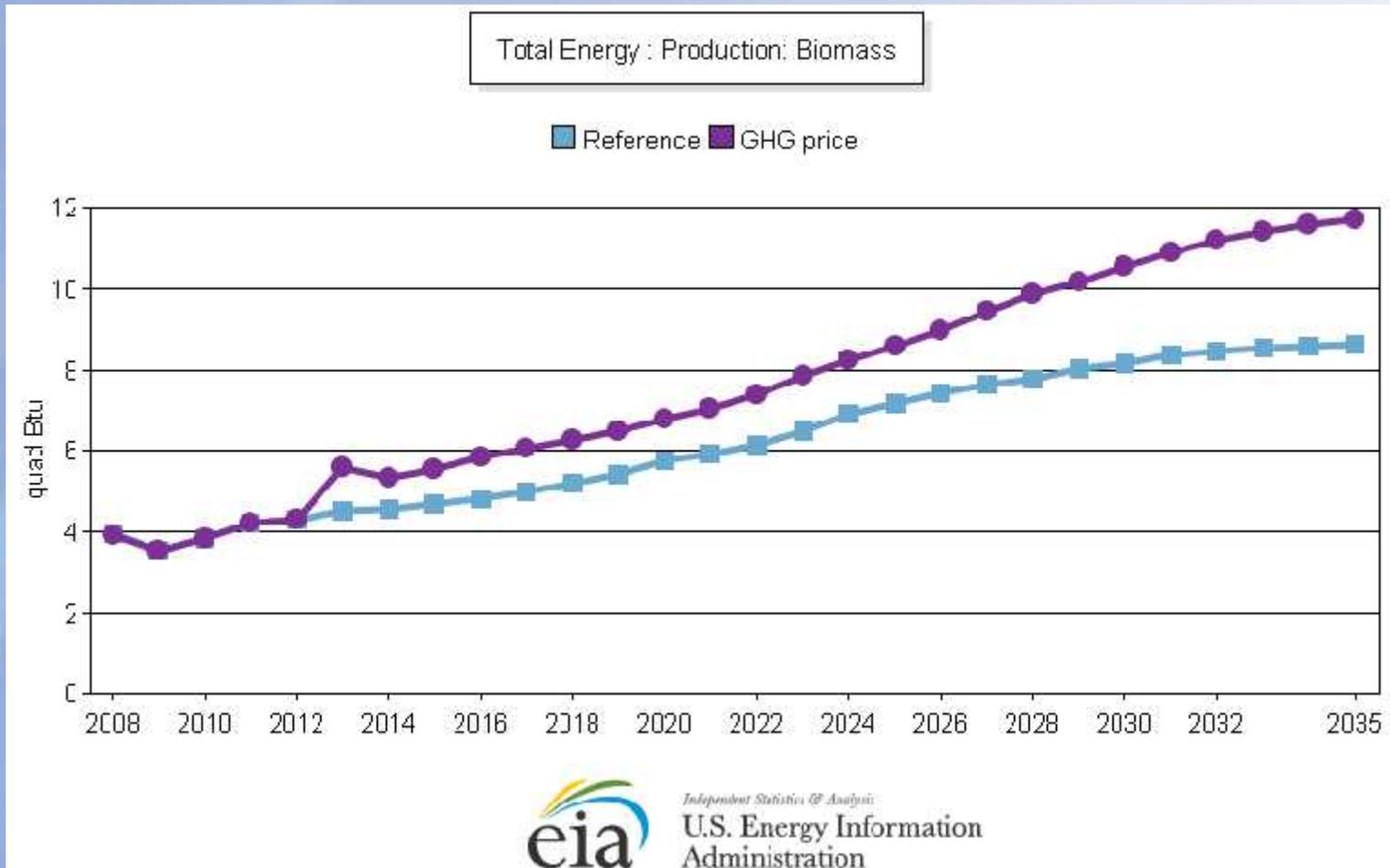
Share of Gasoline or Diesel Volume, 2012

Renewable Fuel Category	Standards for 2011	Proposed Standards for 2012
Renewable fuel	7.95%	9.21%
Advanced biofuel	0.77%	1.21%
Biomass-based diesel	0.68%	0.91%
Cellulosic biofuel	0.004%-0.015%	0.002%-0.010%

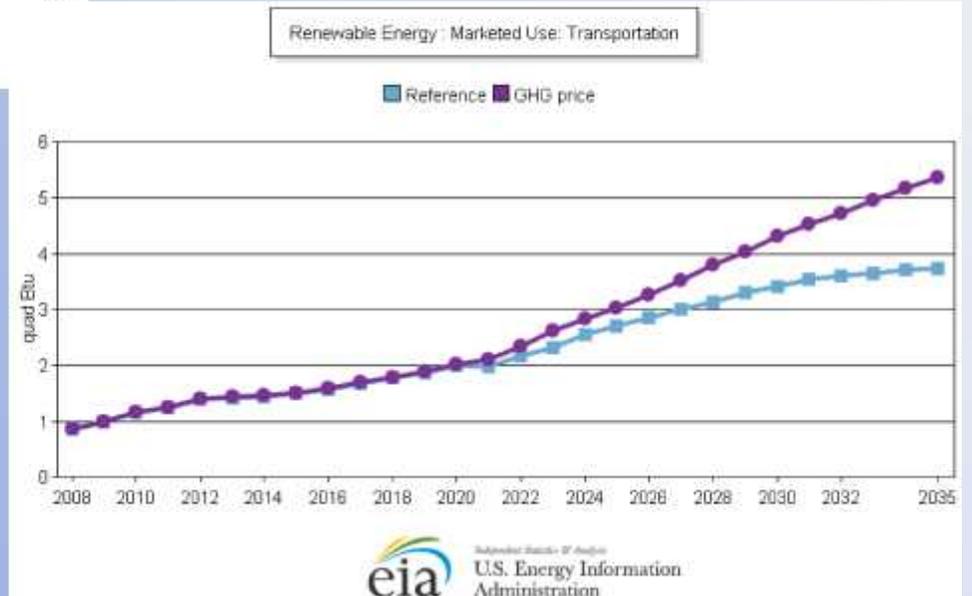
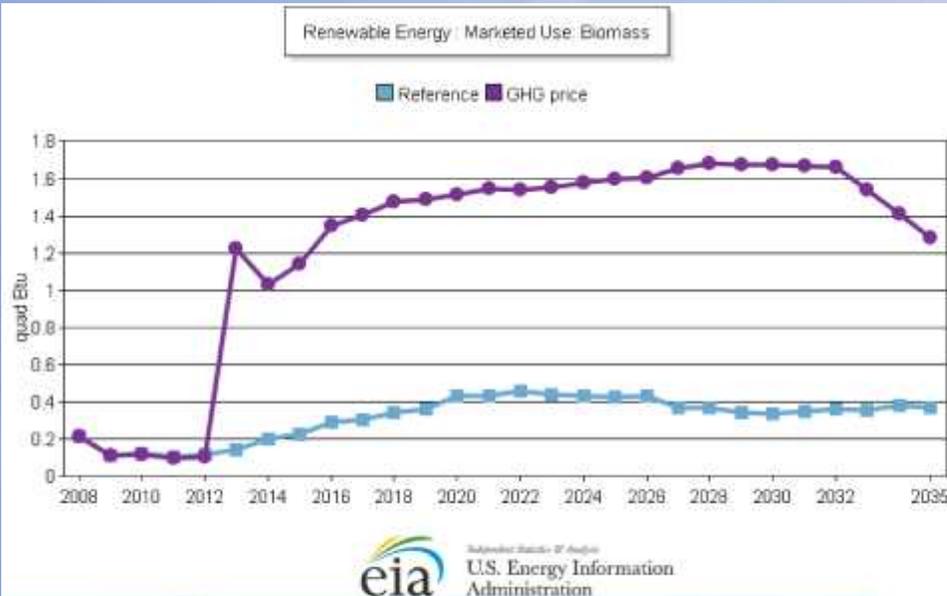
Notes:

Percentage requirements are based on RFS2 volume requirements as a share of EIA gasoline and diesel volume projections. These percentages represent the minimum fraction of each refiner's or importer's gasoline and diesel volume that must fall into each renewable fuel category.

AEO2011 – Bioenergy Projections



AEO2011 Bioelectricity and Biofuels



State Renewable Portfolio Standards

- 27 States plus the District of Columbia have RPS, another 4 states have an alternative energy portfolio standard, and 7 have voluntary goals (the other 12 states have no renewable energy standards or goals)
- Standards range from 8% to 33% when fully phased in, with full requirement taking effect in years between 2013 and 2030 across states
- Generally do not require biomass energy specifically, but seen as a likely major source in many states

US Clean (or Renewable) Electricity Standard

- Currently about 10% of US electricity produced from renewable sources
- Based on CBO (2011), recent studies (EIA, NREL, RFF) have generally concluded that the bulk of the increase in renewable energy would come from:
 - Wind generation in the west and plains
 - Biomass feedstocks in the southeast
- Studies looking at 20%-25% CES or RES estimated increases in biomass generation of 14-410 billion kWh by 2030 or 2035 depending on the study and policy specification
- This is up to about 418 million dry tons of biomass

International Bioenergy

- Far broader than US
 - IEA (2011) identifies 33 countries and the EU that now have biofuel blending targets and mandates
 - Project more than 10 times the 2010 biofuel demand by 2050 with increases taking place across all regions of the world
- Bioelectricity with CCS
 - Major potential to contribute to low-carbon future in US and elsewhere

Questions to Consider

- Modeling bioenergy supply over space and time
 - Land competition
 - Technology assumptions
 - Global trade assumptions
 - Biomass supply constraints
 - Climate change effects on productivity and land competition
- Impacts of increased reliance on bioenergy
 - GHG implications and uncertainties
 - Land use implications and uncertainties
 - Food security implications
- Emerging bioenergy pathways