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The Renewable Fuel Standard: 2014 and Beyond

Presentation at Resources for the Future

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Overview

- The Energy Security and Independence Act (EISA) sets rising requirements for including renewable fuels in the supply of transportation fuels
- Full compliance with the Renewable Fuel Standard (RFS) mandates stated in EISA will be challenging
- Food prices would be similar whether the RFS was continued or repealed
- Meeting EISA requirements would have significant effects on the prices of transportation fuels
- Reductions in greenhouse gas (GHG) emissions under EISA would be small in the near term but could be larger over the longer term depending on technology development

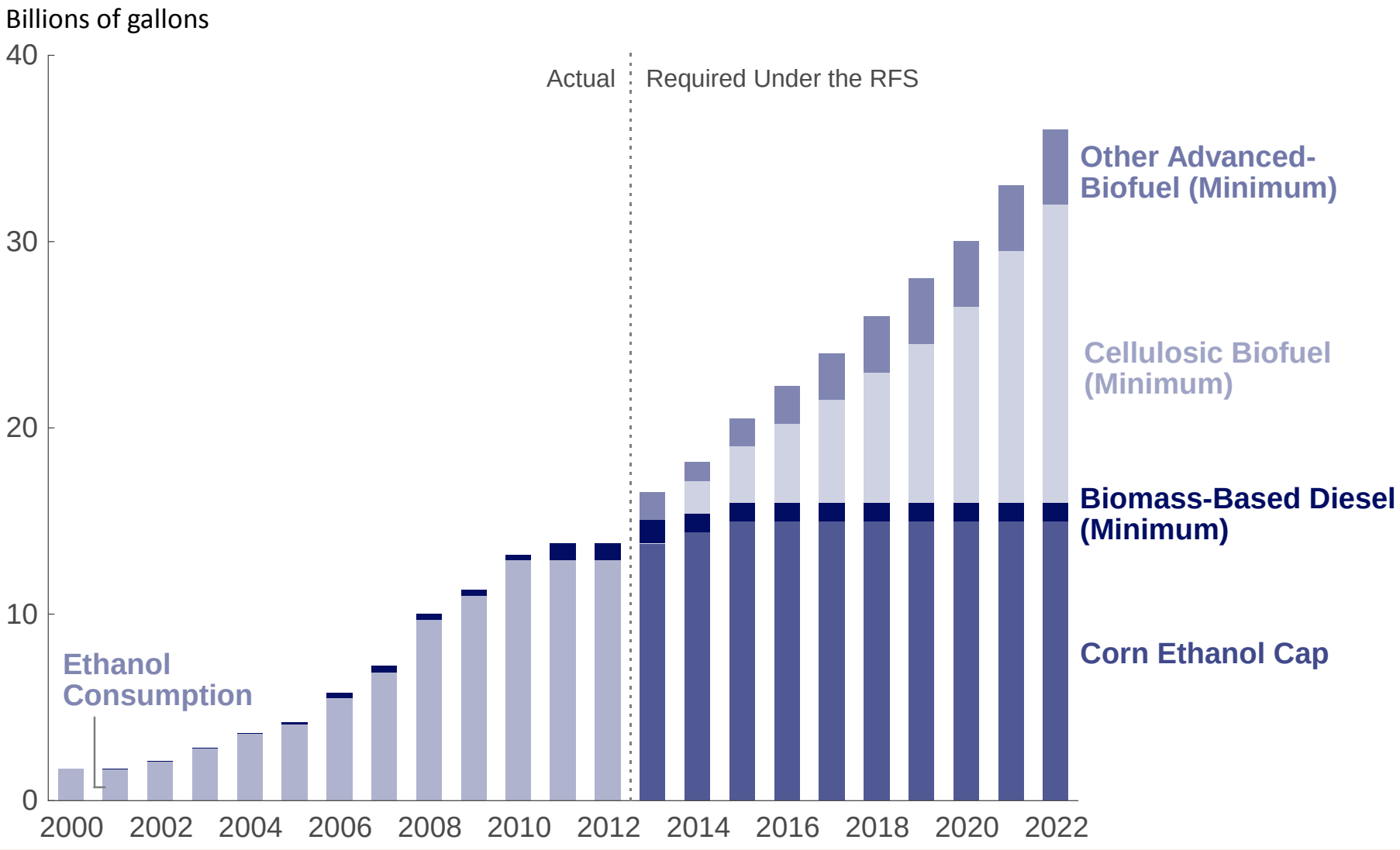
RFS Requirements

- The RFS was enacted in 2005 and expanded in 2007 under EISA
- Stated goals include reducing dependence on foreign oil and reducing GHG emissions
- EISA sets minimum volume requirements for amounts of renewable fuels that must be blended into transportation fuel; the requirements are nested. EISA sets a:
  - Minimum amount of cellulosic biofuels
  - Minimum amount of biomass-based diesel (BBD)
  - Minimum amount of advanced biofuels, inclusive of cellulosic biofuels and BBD
  - Minimum amount of renewable fuels, inclusive of advanced fuels
  - Maximum limit on use of corn ethanol for compliance purposes

RFS Requirements (Continued)

- EISA sets minimum requirement for amount by which renewable fuels must reduce GHG emissions relative to the fuels they replace
  - 20 percent for all renewable fuels
  - 50 percent for advanced fuels
  - 60 percent for cellulosic fuels
- EPA certifies qualifying fuels with a renewable identification number (RIN) attached to each gallon
  - Ethanol produced at plants built prior to or under construction in 2007 is exempt; it automatically receives RINs
- Fuel suppliers must submit the required number of RINs based on their use of petroleum-based fuels
- RINs can be traded and banked

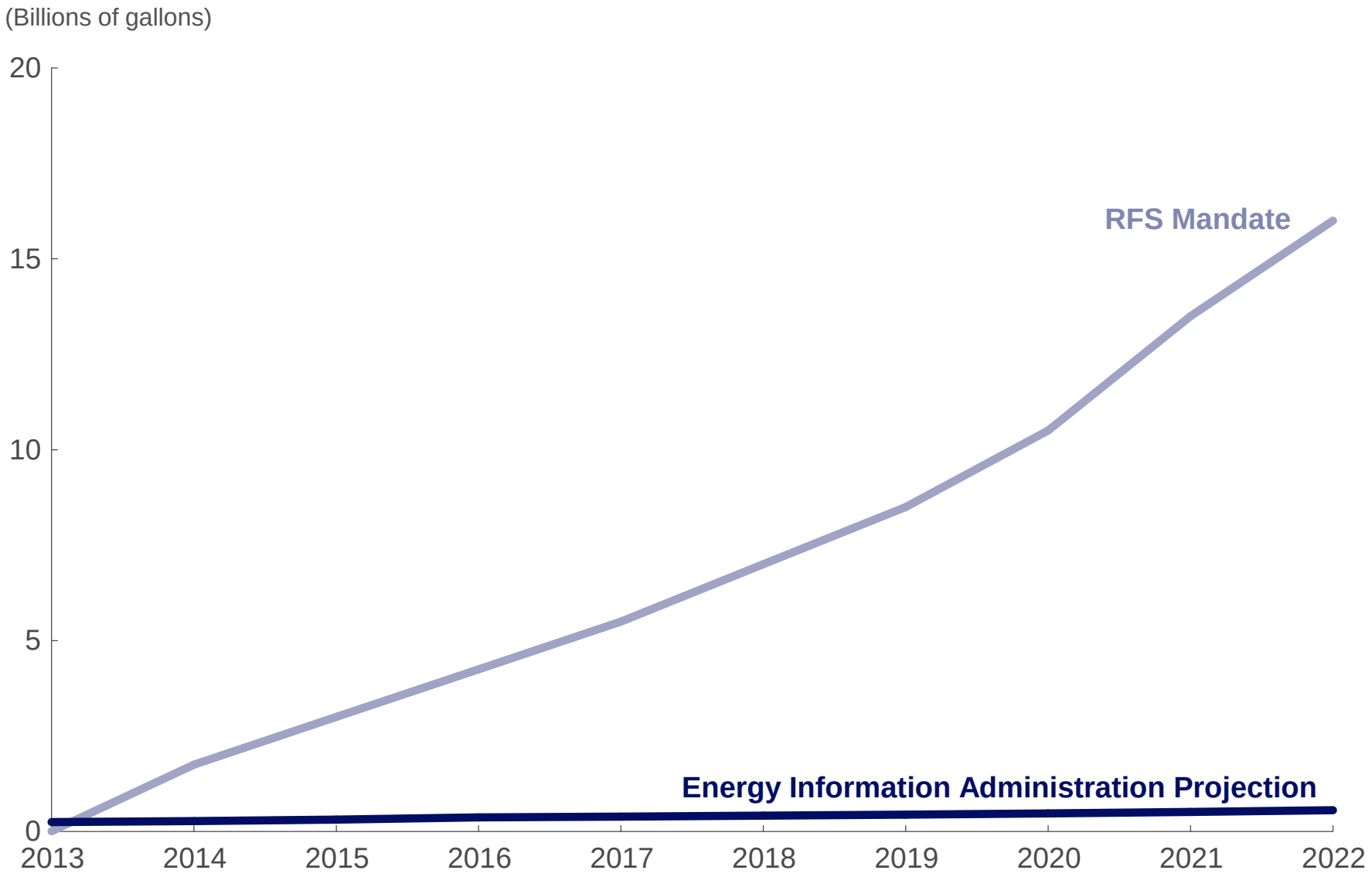
Past Use of Renewable Fuels and Future Requirements of the Renewable Fuel Standard



The Supply of Cellulosic Biofuels is Limited

- EISA requirements for cellulosic biofuels began in 2010
- First commercial production began in 2013 with two plants
- More commercial production is expected, but far less than is required
- Production is complex, entails logistical challenges, and is costly

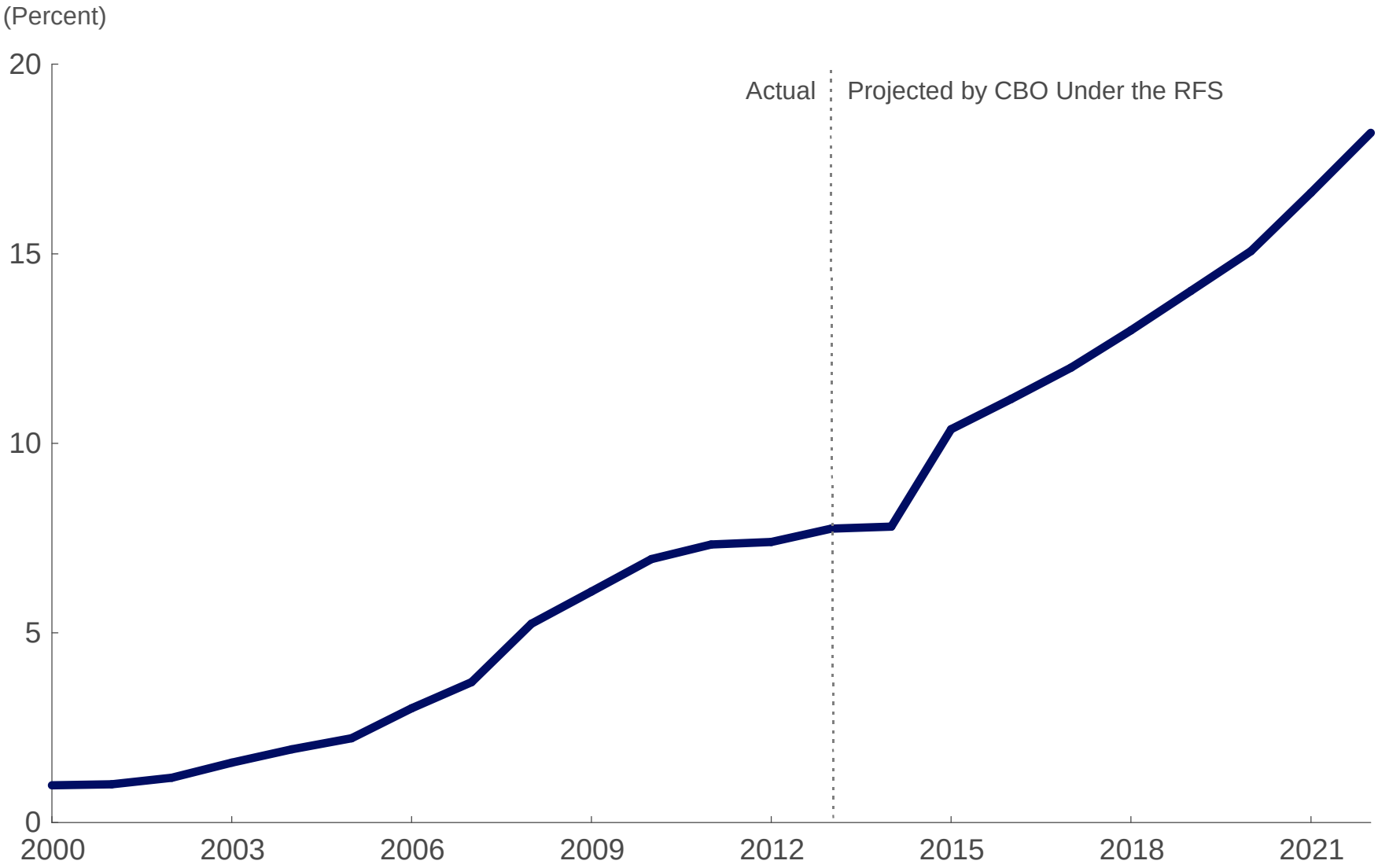
Projected Use of Cellulosic Biofuels, Compared With the Use Mandated by the Renewable Fuel Standard



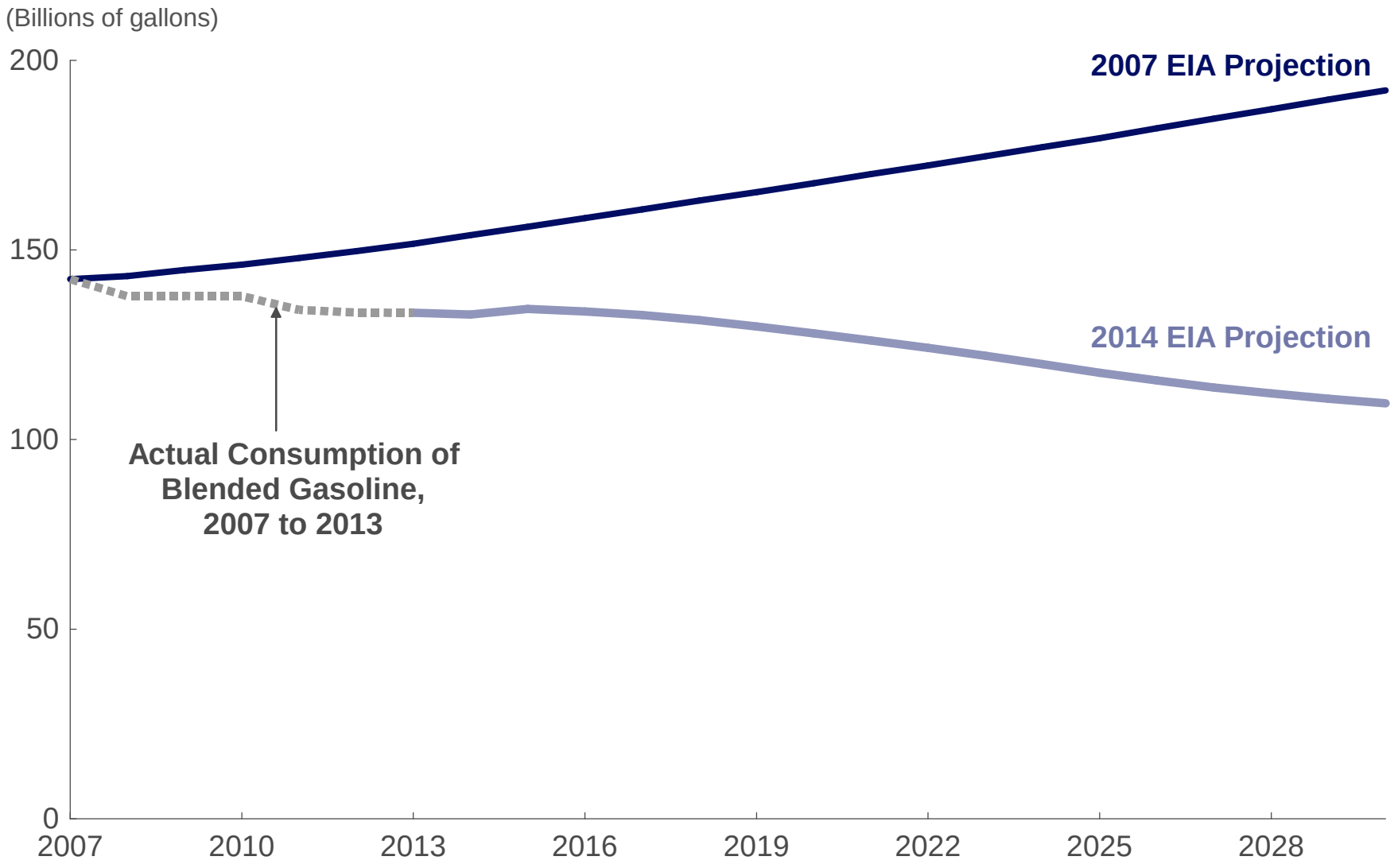
Using the Required Volume of Renewable Fuels Is Difficult

- 10 percent is the maximum ethanol content for blended fuel that can be used by most vehicles on the road
  - Protects the engines and fuel systems of cars built before 2001
  - Many states prohibit higher blends, except for in flex-fuel vehicles that are able to use fuels containing up to 85 percent ethanol
- Increases in required volume will push ethanol content past the 10 percent "blend wall"
- Challenges posed by the blend wall are exacerbated by a decrease in the consumption of blended gasoline

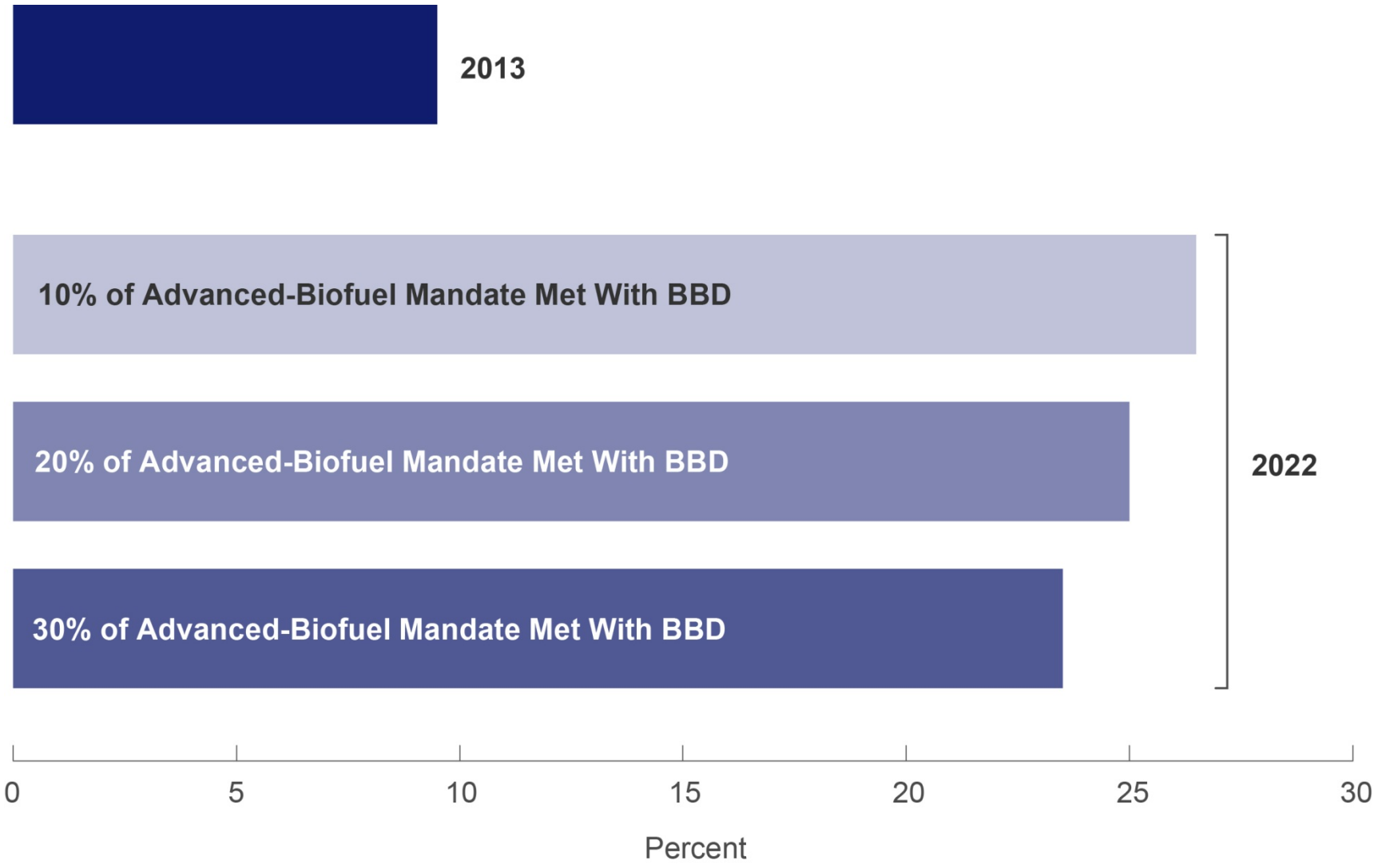
Renewable Fuels as a Share of the Total U.S. Supply of Transportation Fuels



Changing Expectations About the Future Consumption of Blended Gasoline



Ethanol as a Percentage of Blended Gasoline Under Different Assumptions About the Future Use of Biomass-Based Diesel



Ways Around the Blend Wall: Increasing the Use of E85 in Flex-Fuel Vehicles

- Flex-fuel technology is relatively inexpensive
- Many flex-fuel vehicles are now on the road
- Increasing the use of E85 in existing flex-fuel vehicles is more challenging
  - Only 2 percent of stations offer E85
  - Lower energy content means users demand lower prices
- Use of E85 is growing, but at its current rate, it would reach only 1 billion gallons in 2022 (out of a projected 125 billion gallons of blended gasoline)

E85 is blended fuel that contains up to 85 percent ethanol

Ways Around the Blend Wall: Increasing the Use of E15

- There is disagreement about the risk of damage with use of E15
  - EPA has certified that vehicles built since 2001 (60 percent of current vehicles) can run on E15 without damage
  - Many automakers disagree with EPA and discourage the use of E15
  - Ford and GM have stated that vehicles built since 2012 can use E15
- Until mid-2012 no stations offered E15
  - A small number of stations now have pumps
  - Offering both E10 and E15 would require new pumps and storage tanks, and would raise liability concerns if E15 was put in vehicles built before 2012

E10 is blended fuel that contains up to 10 percent ethanol
E15 is blended fuel that contains up to 15 percent ethanol

Ways Around the Blend Wall: Drop-In Fuels

- Drop-in fuels can be made from cellulose and are chemically identical to gasoline and diesel and can serve as direct substitutes
- The technology is new and production is costly

EPA's Response to Compliance Challenges

- EPA used waiver authority to reduce the required use of cellulosic biofuels
  - Eliminated the requirements for 2011 and 2012
  - Reduced the 2013 mandate from 1 billion to 1 million gallons, reflecting production capacity
  - Fuel suppliers are required to use additional biodiesel, sugarcane ethanol, or other advanced fuels instead of using less cellulosic biofuel

EPA's Response to Compliance Challenges (Continued)

- EPA's proposals for 2014
  - Reduce the cellulosic requirement from 1.75 billion gallons to 17 million gallons
  - Reduce advanced biofuel requirement by 1.5 billion gallons
  - Reduce total renewable fuel requirement by nearly 3 billion gallons
- EPA waivers have probably contributed to the slowing growth of cellulosic production capacity

The Effects of the RFS

- CBO considered the effects of the RFS on the prices of food and transportation fuels as well as the effects on emissions
  - Focus on the near term (2017) for food and fuel prices
  - Qualitative discussion of emission effects
- Effects are heavily dependent on decisions made by EPA
- CBO considered three alternative scenarios
  - ESIA Volumes Scenario: Requires compliance with total renewable fuel and advanced-fuel mandates and the corn-ethanol cap as stated in EISA
  - 2014 Volumes Scenario: Holds volume requirements at levels proposed for 2014
  - Repeal Scenario: No volume requirements

Use of Renewable Fuels in 2017 Under CBO's Alternative Scenarios for the Renewable Fuel Standard

	EISA Volumes Scenario		2014 Volumes Scenario		Repeal Scenario
	Volume Requirement (Billions of gallons)	Blend Requirement (Percent)	Volume Requirement (Billions of gallons)	Blend Requirement (Percent)	Estimated Volume (Billions of gallons)
Advanced Biofuels					
Biomass-based diesel	2.0	1.3	1.9	1.2	Less than 1
Other advanced biofuels	7.0	4.0	0.3	0.1	
Subtotal	9.0	5.3	2.2	1.3	Less than 1
Corn Ethanol	15.0		13.0		13
Total Renewable Fuels	24.0	14.5	15.2	9.2	13 to 14

Effects on Prices and Spending for Food: The 2014 Volumes Scenario vs. the Repeal Scenario

- Ethanol accounts for 40 percent of the corn produced in the U.S.
- Ethanol use in 2017 is likely to be the same if mandates are held at 2014 levels or if the RFS is repealed
  - Fuel suppliers continue to use a 10 percent blend because ethanol is projected to cost less per gallon than gasoline in 2017
  - Some demand is probably prompted by ethanol's effect on octane and carbon monoxide emissions
- Imposing 2014 mandates in 2017 would probably have little to no effect on food prices and spending

Effects on Prices and Spending for Food: The 2014 Volumes Scenario vs. the Repeal Scenario (Continued)

- Repeal could lead to a larger decrease in corn ethanol use over the long run
  - The price of corn ethanol could rise above the price of gasoline
  - Less expensive additives could be developed

Production and Price of Corn in 2017 Under CBO's Alternative Scenarios for the Renewable Fuel Standard

	2014 Volumes Scenario and Repeal Scenario	EISA Volumes Scenario	Difference Between the EISA Volumes Scenario and the Other Two Scenarios
Projected U.S. Corn Production in 2017 (Billions of bushels)	14.1	14.4	2%
Projected Average Price of Corn in 2017 (Dollars per bushel)	4.25	4.50	6%

Effects of the EISA Volumes Scenario on Food Prices and Spending in 2017

	Change Under the EISA Volumes Scenario
Estimated Change in the Average Price of Corn (Dollars per bushel)	0.25
Change in Spending on Food (Billions of dollars)	
Food products that contain corn	0.4
Meat, poultry, and dairy products	1.3
Soybeans	1.8
Total	3.5
Projected 2017 Food Expenditures (Billions of dollars)	1,770
Percentage Change in Spending on Food	0.2

Effects of the EISA Volumes Scenario on Fuel Prices Relative to the 2014 Volumes Scenario

- The EISA Volumes Scenario would require 7 billion gallons of advanced biofuel in addition to the 2 billion gallons used to meet the BBD mandate
  - To date, no more than 500 million gallons of advanced biofuel (beyond required use of BBD) has been used for compliance

Effects of the EISA Volumes Scenario on Fuel Prices Relative to the 2014 Volumes Scenario (Continued)

- Illustrative examples of the challenge of using 7 billion additional gallons of advanced biofuel:
  - Using 2 billion additional gallons by further increasing use of BBD would require production to double relative to EIA projections
  - Using 4 billion additional gallons by importing sugarcane ethanol from Brazil would require a 45-percent increase in Brazil's 2017 projected production
  - Those increases in BBD and sugarcane ethanol would still leave suppliers 1 billion gallons short of 7 billion gallons

Existing Studies Do Not Address the Effects of Meeting EISA Mandates on 2017 Fuel Prices

- Some studies find that the RFS would cause only a small increase—or even a decrease—in the price of E10
  - A decrease is possible through the effect on the world price of oil
  - CBO anticipates no change in the world price of oil because a decrease in global demand would be small and could be offset by suppliers' strategic behavior

Existing Studies Do Not Address the Effects of Meeting EISA Mandates on 2017 Fuel Prices (Continued)

- Existing studies do not apply to the EISA Volumes Scenario because they
  - Allow the market 10 to 15 years to adjust
  - Assume that up to 20 percent ethanol could be blended into gasoline with no changes in fueling infrastructure or decrease in demand for blended fuel because of its lower energy content
  - Do not account for the cross-subsidy needed to encourage additional use of E85
  - Do not model compliance with all EISA requirements (they do not account for the fact that gasoline suppliers have to submit BBD RINs)

CBO's Method of Estimating Effects on Fuel Prices Under the EISA Volumes Scenario

- CBO determined what fuel suppliers' RIN requirements would be based on EISA volumes and fuel projections
- For each 100 gallons of gasoline or diesel they sell, suppliers are required to submit
  - 1.3 biomass-based diesel RINs
  - 4.0 additional advanced biofuel RINs
  - 9.2 additional renewable fuel RINs (met with corn ethanol)

CBO's Method of Estimating Effects on Fuel Prices Under the EISA Volumes Scenario (Continued)

- CBO estimated RIN prices based on an illustrative example of how advanced biofuel requirements would be met:
  - 2 billion gallons of BBD
  - 4 billion gallons of sugarcane ethanol
  - 1 billion gallons of other advanced biofuels
- CBO determined the effects of RIN requirements on marginal costs for suppliers of E10, E85, and diesel

Price of Renewable (Corn Ethanol) RINs Under the EISA Volumes Scenario

- CBO's renewable RIN price estimate is $1.55 to $2.10
- A price premium of 10 cents per gallon would be needed to increase the supply of corn ethanol by 2 billion gallons
- Cost of getting the market to absorb 6 billion more gallons of ethanol than can be used in E10
  - 10 cents per gallon to cover stations' capital costs for new E85 tanks and pumps
  - Subsidy of $1.35 to $1.90 per gallon to achieve sufficient increase in demand for E85

CBO's Method for Calculating the Subsidy Needed to Stimulate Sufficient Demand for E85

- The subsidy compensates drivers for
  - Refueling more often
  - Driving farther to find a station that offers E85
- In Brazil, the fuel cost of driving with E85 would have to be 40 percent lower than the cost of driving with E10 for the market to absorb an additional 6 billion gallons of ethanol in E85
  - The study assumed that vehicle owners would drive 10 miles out of their way to refuel with E85
- CBO calculated the subsidy that would put U.S. consumers' fuel cost of driving with E85 30 percent to 50 percent below the cost of driving with E10: $1.35 to $1.90 per gallon of ethanol

Price of Advanced Biofuel RINs Under the EISA Volumes Scenario

- CBO's price estimate for advanced biofuel RINs is $3.00 to $6.00
- Cost of absorbing 6 billion more gallons of ethanol than can be used in E10 (same as for renewable RINs):
  - 10 cents per gallon to cover stations' capital costs
  - $1.35 to $1.90 per gallon subsidy to increase demand for E85
- Increasing the supply of advanced biofuels by 7 billion gallons would require a $1.50 to $4.00 per gallon price premium
  - Lower end of the range: 50 cents more than the average spot price premium for BBD RINs in 2011 and 2012 (when RFS compliance was not constrained by a blend wall)
  - Upper end of the range: set at $4.00 to reflect the fact that the price premium might need to be much higher than in the past because of the large required increase in supply

The Price of BBD RINs Under the EISA Volumes Scenario

- The price of BBD RINs would be the same as the price of advanced biofuel RINs:
  - Fuel suppliers would over-comply with the BBD requirement to meet the advanced biofuel requirement
  - BBD RINs would trade at the same price as advanced biofuel RINs ($3.00 to $6.00)

Estimated Effects on Fuel Prices Based on Blend Ratios Associated with the EISA Volumes Scenario

- For each 100 gallons of petroleum-based fuel (gasoline or diesel) they use, suppliers would be required to submit
  - 1.3 biomass-based diesel RINs
  - 4 additional advanced biofuel RINs
  - 9.2 additional renewable fuel RINs (met with corn ethanol)
- RIN requirements per 100 gallons of specific fuels
  - Petroleum-based diesel: RIN requirement for 100 gallons of petroleum-based fuel
  - E10 (90 percent petroleum): 0.9 × [RIN requirement for 100 gallons of petroleum-based fuel]
  - E85 (25-percent petroleum, on average): 0.25 × [RIN requirement for 100 gallons of petroleum-based fuel]

Effects of RIN Requirements on the Marginal Cost for Each Fuel

- Net effect of RIN transactions
  - Fuel suppliers would acquire RINs with biofuel purchases and could use or sell them at market price, with sales reducing marginal costs
  - Fuel suppliers not using biofuel would buy RINs at market price
- Example: For each 100 gallons of E10 produced, a supplier
  - Buys 10 gallons of corn ethanol and acquires 10 renewable RINs
  - Uses 8.28 renewable RINs to meet its own compliance requirements: 8.28 = 0.9 (petroleum share of its fuel) × 9.2 (renewable RIN requirement for each 100 gallons of petroleum based fuel)
  - Sells 1.72 renewable RINs (10 – 8.28) at market price
  - Buys (0.9 × 1.3) BBD RINs at market price
  - Buys (0.9 × 4.0) advanced biofuel RINs at market price

Estimated Effects of RFS on 2017 Fuel Prices: EISA Volumes Scenario

- Price of E10 would increase
  - $0.13 to $0.26 per gallon
  - 4 percent to 9 percent
- Price of petroleum-based diesel would increase
  - $0.30 to $0.51 per gallon
  - 9 percent to 14 percent
- Price of E85 would decrease
  - $0.91 to $1.27
  - 37 percent to 51 percent

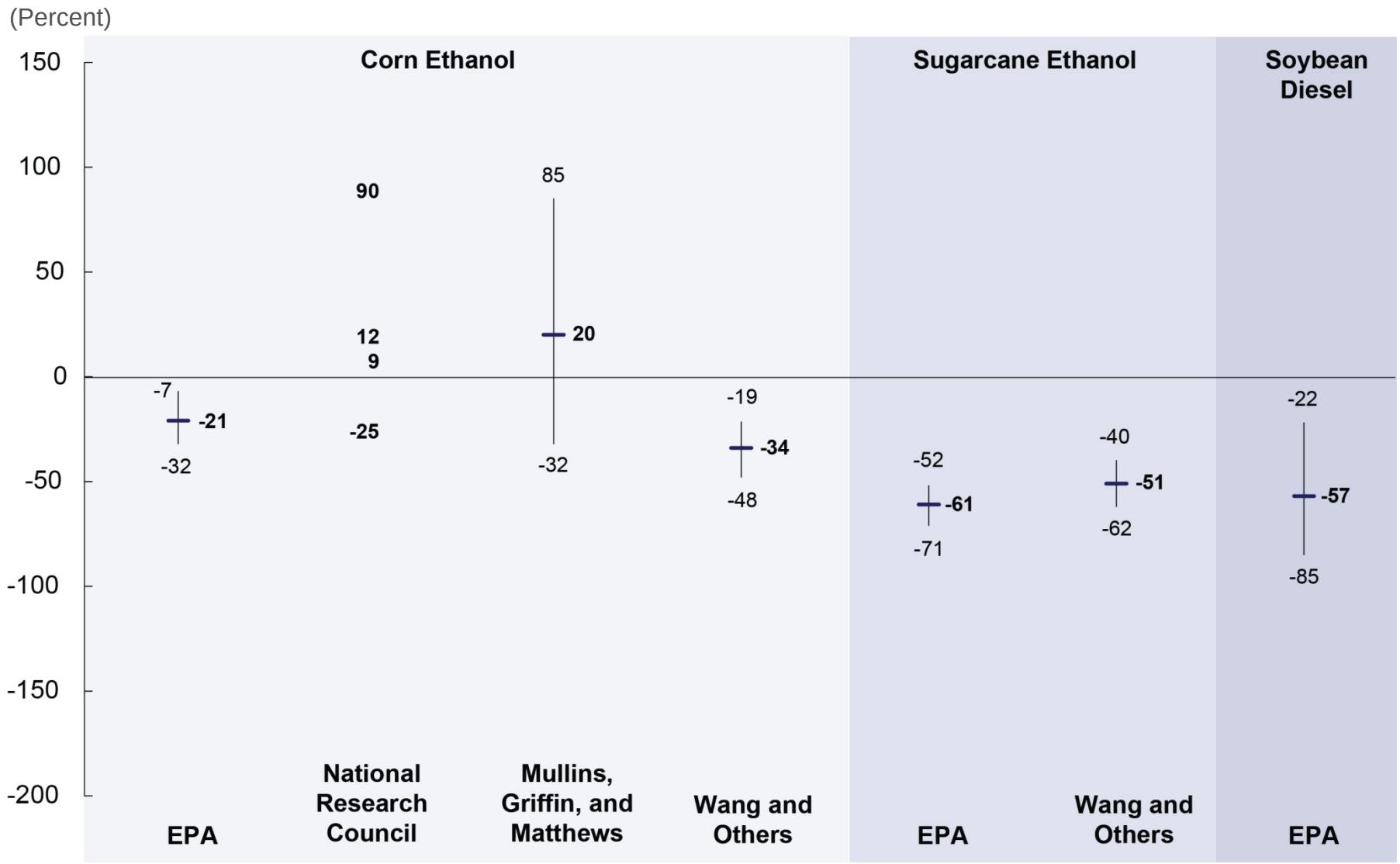
RFS Emission Requirements

- The RFS sets fuel-specific emission reduction requirements relative to emissions from the fuel being replaced
  - Cellulosic fuels must reduce emissions by 60 percent
  - Advanced biofuels (sugarcane ethanol and BBD) must reduce emissions by 50 percent
  - All other renewable fuels (primarily corn ethanol) must reduce emissions by 20 percent unless produced at a plant in operation or under construction by end of 2007
- EPA's emissions estimates determine which fuels qualify for compliance purposes; other researchers produce different estimates

Key Factors Affecting Emission Estimates

- Crop yields
- Fertilizer use
- Changes in land use and amounts of carbon in the soil
  - Includes direct and indirect effects
  - Potentially large and uncertain sources of emissions
- Efficiency of the feedstock-to-fuel conversion process
- Generation of electricity credits with cellulosic production
  - Use of residual material (lignin) to generate electricity
  - Assumptions about fuel used to generate displaced electricity
- Rebound effect
  - Most emission studies do not take a rebound effect into account; it would reduce potential emission reductions

Estimated Difference Between the GHG Emissions Associated With Biofuels and the Emissions Associated With the Gasoline or Diesel They Replace



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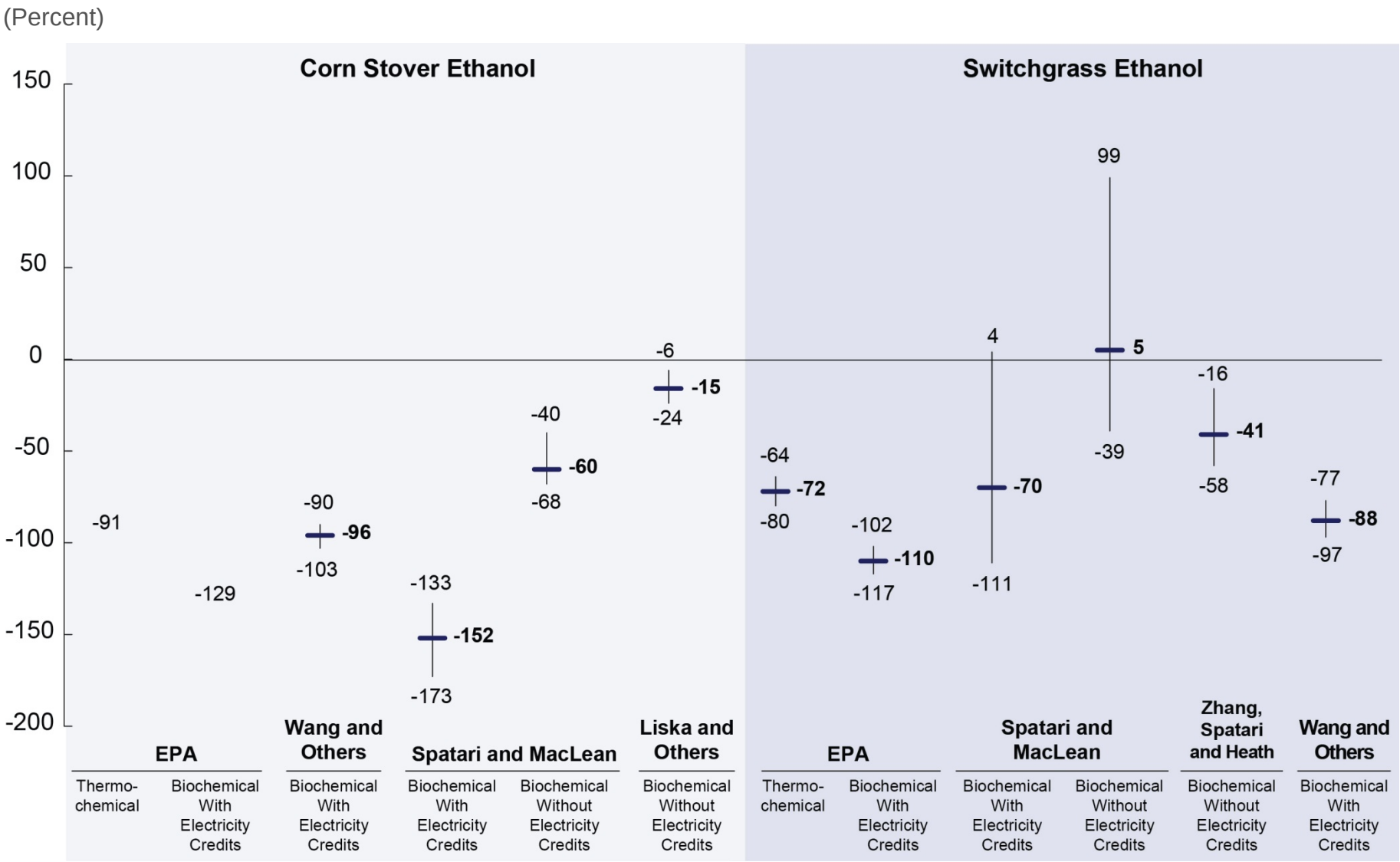

Conclusions About Emissions

- Emission reductions are uncertain; estimates differ
  - Changes in land use and soil carbon
  - Assumptions about electricity credits
- Reductions in 2017 emissions under the EISA Volumes Scenario would be small
  - Limited use of cellulosic biofuels
  - Continued use of corn ethanol from grandfathered facilities
- Reductions over the longer term will depend on the development and deployment of new technologies

Summing Up

- To date, RIN prices have typically been low
  - Fuel suppliers have complied by using corn ethanol in E10
  - EPA has waived cellulosic requirements
- In the future, meeting EISA mandates will be challenging
  - Cellulosic production capacity likely to remain well below mandated levels
  - Substituting other advanced fuels for cellulosic biofuels would entail large and rapid increases in their supply
  - Overcoming the blend wall will require capital investments in fueling stations and significant subsidies to encourage use of E85

Summing Up (Continued)

- The EISA Volumes Scenario
  - Small effects on food prices
  - Significant effects on transportation fuel prices
  - Small effects on emissions
- Potential for significant emission reductions in the longer term depends on technology development
- The RFS illustrates the trade-off between the use of waivers to contain costs and the effectiveness of the policy in forcing technologies