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Projections for agricultural and biofuel markets

FAPRI-MU Report #04-10

Providing objective analysis for over 25 years

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Foreword

FAPRI-MU 2010 biofuel and RIN stochastic baseline

The Food and Agricultural Policy Research Institute (FAPRI) provides analysis of agricultural and biofuel markets and policies for Congress and other decision makers. This report is an addendum to 2010 stochastic baseline projections for US agricultural and biofuel markets presented in the annual Baseline Briefing Book (FAPRI-MU Report #01-10). All data shown here are consistent with the baseline published in March 2010, and were generated as part of the stochastic model simulation results. These results summarize the 500 stochastic solutions characterized by random perturbations in crop yields, petroleum and energy prices and other external factors over the 10 year projection period.

Policy assumptions and scenario

The baseline is not a forecast of what will happen, but rather a projection of what could happen if current policies remain in place. The analysis incorporates provisions of the Food, Conservation and Energy Act (FCEA, the 2008 farm bill) and the Energy Independence and Security Act (EISA, the 2007 energy bill). In the baseline, we assume that tax credits given to blenders for every gallon of biofuel they use and the ethanol tariff are extended throughout the ten-year period. This includes the biodiesel blenders credit which expired on December 31st, 2009 and at the time of this publication had not been renewed. We assume that the cellulosic mandate is waived. Other assumptions and crop market results are discussed in the FAPRI baseline briefing book (available at www.fapri.missouri.edu).

We test what would happen if these policies are allowed to expire by simulating over the same period using the same set of 500 stochastic draws. We compare the results of these scenario to the baseline outcomes to estimate how the tax credit and tariff expiration affects biofuel and RIN markets.

Scenario : mandates in place, but other key biofuel policies allowed to expire:

- Biodiesel blender tax credit (\$1.00 per gallon) expires December 31st, 2009.
- Ethanol import tariff (\$0.54 per gallon) and blender tax credit (\$0.45 per gallon) expire December 31st, 2010.
- FCEA cellulosic ethanol producer credit (\$1.01 per gallon) expires December 31st, 2012.

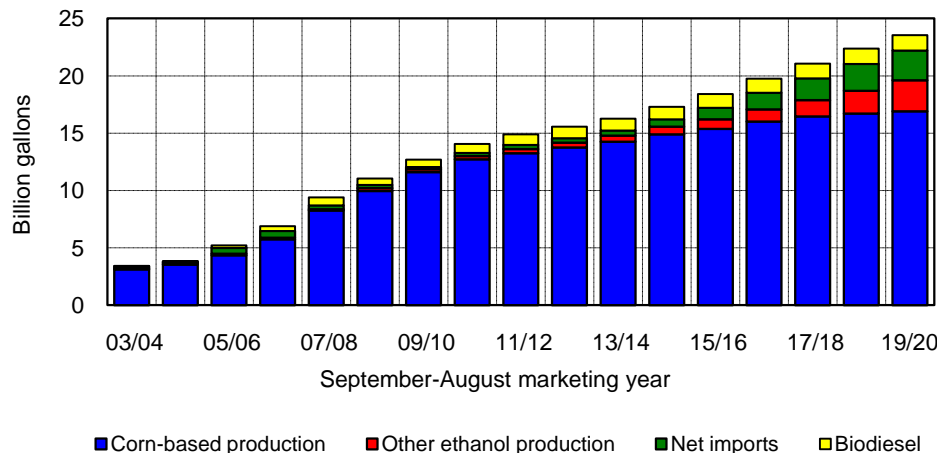
Key points

- Ethanol already largely saturates the E-10 market, further expansion must go to higher level blends (E-85).
 - Baseline and scenario assume no mid-level blends such as E-15.
 - Ethanol prices must fall to induce consumer purchases, but it's not clear how cheap ethanol must be relative to gasoline to fill the E-10 market and induce E-85 use.
- Biofuel use mandates can affect markets, but context matters, as market demand may exceed the mandate.
 - The overall mandate has modest effects in most years, peaking in 2015.
 - The biodiesel mandate has large effects until it peaks in 2012.
 - The advanced mandate has the most impact in later years.
 - Effects of policy changes can vary substantially depending on whether mandates are binding or not.
- Renewable Identification Numbers (RIN) are traded certificates assigned to each batch of biofuel and used by blenders to prove compliance with EISA biofuel use mandates.
 - A high RIN price indicates the corresponding mandate is or is likely to become binding.
 - Potentially billions of dollars in total mandate compliance costs to blenders depend on RIN prices.
- The cellulosic mandate is waived by assumption.
 - Prospective cellulosic ethanol production technology is highly uncertain over the projection period.
 - If waived, the EPA must offer cellulosic RINs at a fixed price that usually sets the market RIN price in simulations.
- The effects of eliminating the tax credit and tariffs are influenced by the presence of the mandate.
 - Mandates tend to limit quantity impacts, but mandate compliance costs change.

Baseline overview

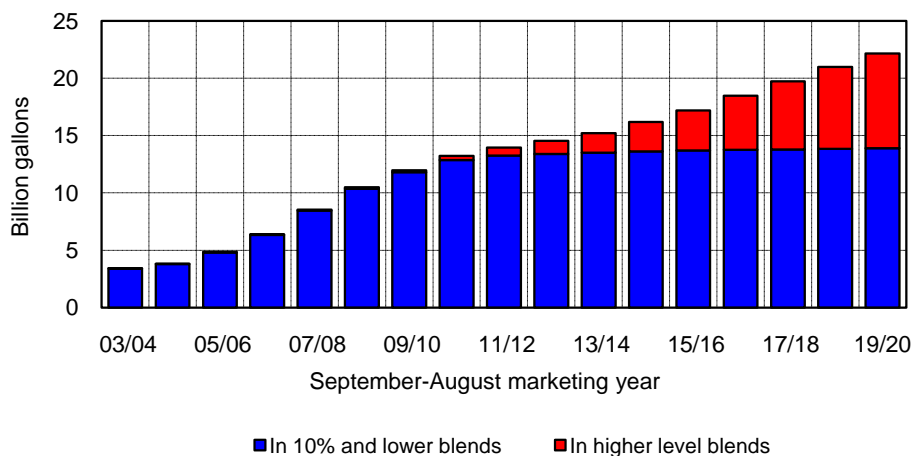
- Projected growth in corn-based ethanol slows, but production still reaches 15 billion gallons in 2015/16.
- Imported sugar-based ethanol is assumed to satisfy the advanced mandate not met by cellulosic ethanol or biodiesel.
- Future cellulosic ethanol production growth is waived by assumption. Projected supplies are well below the EISA levels.

Biofuel supplies increase



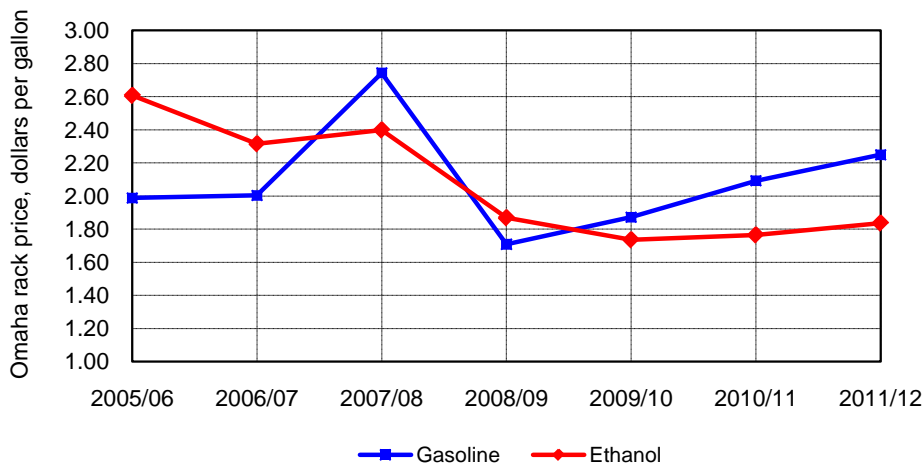
- Given projected levels of gasoline consumption, less than 14 billion gallons of ethanol can be used in 10% blends.
- To utilize the projected supplies of ethanol, use of higher level blends must increase rapidly after 2011/12.
- E-85 expansion requires more flex-fuel vehicles and distribution infrastructure. E-85 must be priced competitively.

Higher-level blends are required to use ethanol supplies



Ethanol increasingly priced by relative energy value

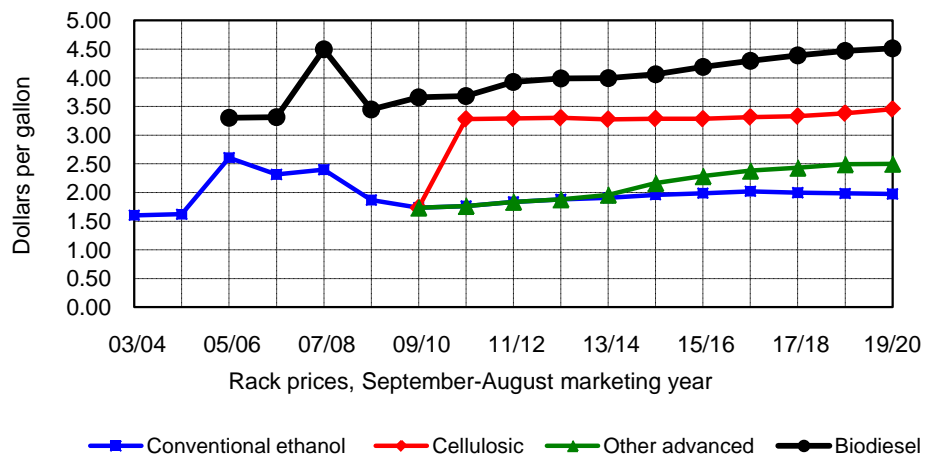
- Increases in gasoline prices support ethanol prices, but ethanol prices decline relative to gasoline to facilitate expanded use of ethanol in high level blends.
- The price of ethanol is pushed lower relative to gasoline in the future to reflect its energy value and its marginal use as a fuel replacement in E-85.
- Short-run obstacles to E-85 expansion are serious. The ethanol price could have to dip lower relative to the gasoline price to encourage needed investments.



Baseline overview

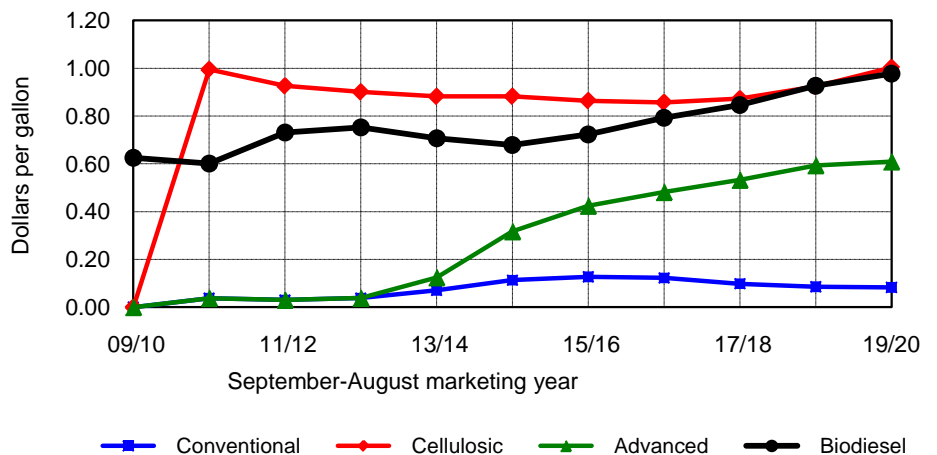
- Mandates by fuel type leads to different producer prices for different types of fuel.
- Producer prices for advanced ethanol can exceed prices for conventional ethanol to generate the supplies required.
- Cellulosic ethanol prices are effectively capped when the mandate is waived.

Because of EISA, prices differ across biofuel types



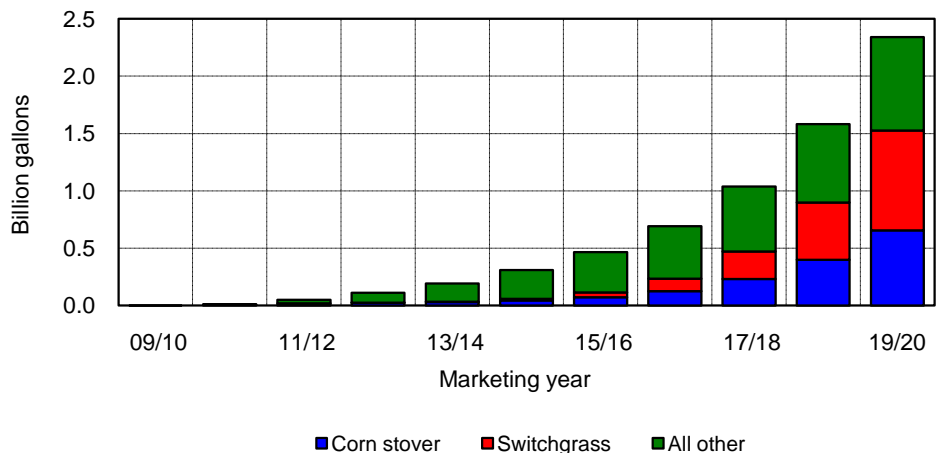
- Renewable Identification Numbers (RIN) take on value when mandates are binding.
- The nested nature of the mandates (see page 14) establishes four related RIN markets and a hierarchy of RIN prices.
- Biodiesel RINs are costly early on. The advanced RINs become more expensive as the advanced mandate rises.

RIN prices reflect binding mandates



- For the first time, the baseline includes market projections for corn stover and switchgrass as feedstocks for cellulosic ethanol production.
- Assuming production, collection and processing costs fall and the FCEA credit is extended, cellulosic ethanol production expands after 2015.

Cellulosic ethanol supplies increase



- Future technologies are unknown. Cellulosic biofuel projections are uncertain, but we assume the mandate is waived in this baseline.

Biofuel credits and tariff expire

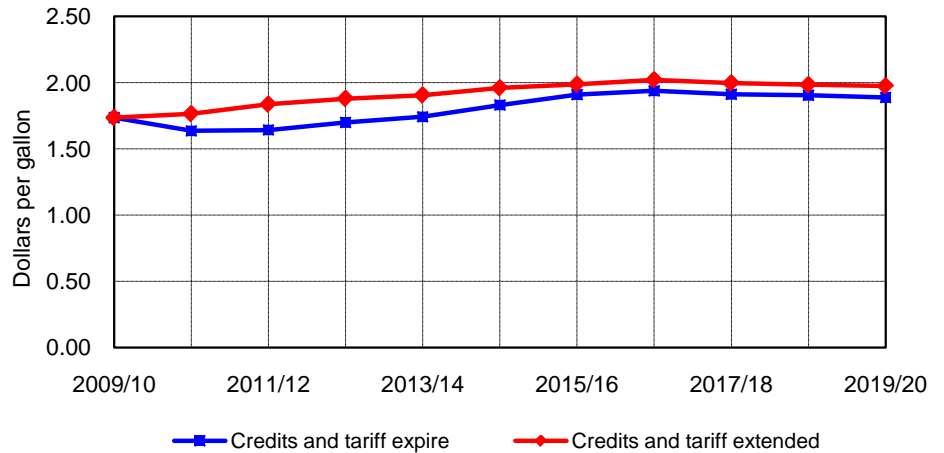
- Results shown are averages of 500 stochastic solutions. Individual results vary significantly depending on if mandates are binding or not.

- If blenders credits expire, blenders have less incentive to use biofuels. Ethanol tariff expiration makes it cheaper to import ethanol.

- Prices for domestically produced conventional (corn starch) ethanol fall on reduced demand.

- Effects are limited by the overall mandate, which must still be met.

Omaha conventional ethanol rack price falls

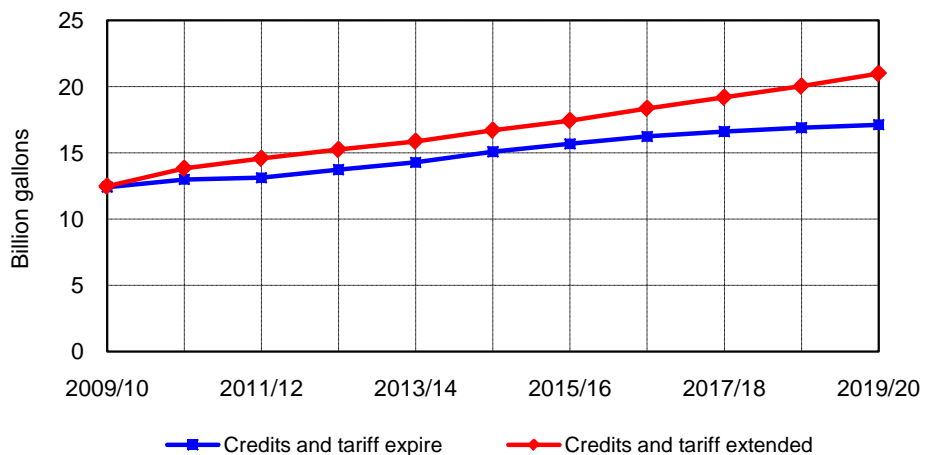


- Lower blender demand and more competition lead to less domestic biofuel production.

- If the FCEA cellulosic biofuel producer credit expires and the cellulosic mandate is waived, less cellulosic biofuel is made.

- Retail biofuel price effects are small because of high substitution with petroleum fuels.

Biofuel production is lower with lower prices



- Ethanol imports expand without the tariff, despite the blenders credit expiration.

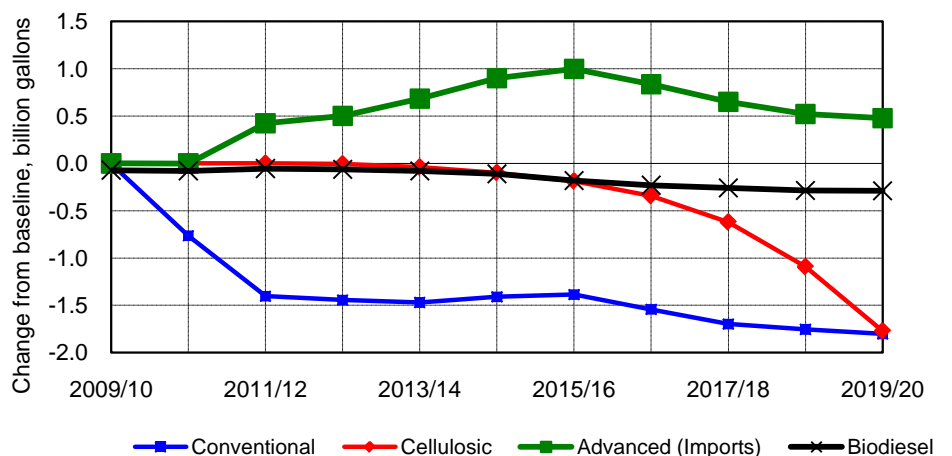
- Cellulosic ethanol production is lower without the blenders credit, a tariff on imports, or the production credit.

- Conventional (corn) ethanol production is lower without the blenders credit or a tariff.

- Biodiesel production is lower without the blenders credit.

- Effects are limited by the mandates.

Biofuel supply is different for each type



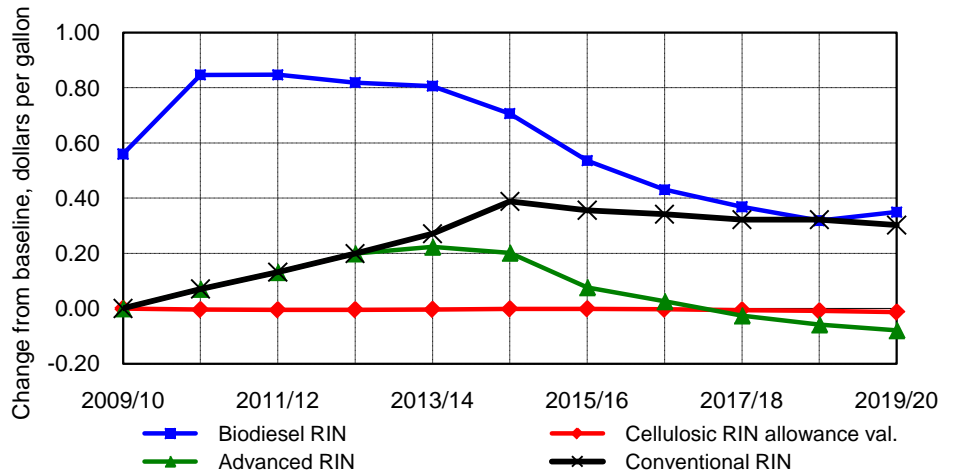
Biofuel credits and tariff expire

- Blenders credits encourage biofuel use. Their expiration makes it harder to meet mandates.

- The ethanol tariff discourages imports. Its expiration makes it easier to meet the advanced mandate.

- Conventional and biodiesel RIN prices rise, but advanced RIN prices fall. Cellulosic RIN prices are set because of the waiver.

RIN prices rise to offset credit loss

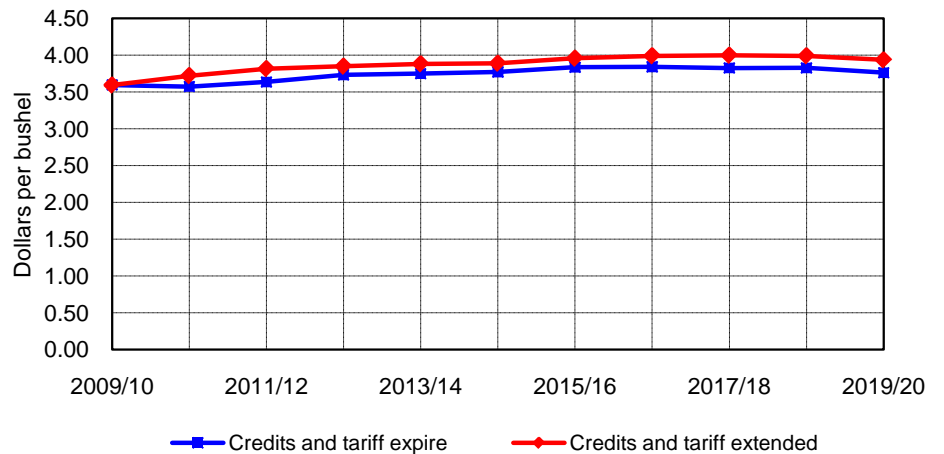


- Mandates disallow large reductions in biofuel use when credits and tariff expire. The results shown are averages over 500 stochastic outcomes and individual results are very different depending on whether mandates are binding or not.

- The eventual effect on feedstock markets is consequently also limited by mandates.

- It is a mistake to assess market effects of one policy change without taking into account other policies, petroleum prices, and other contextual factors.

Corn farm price declines modestly with reduced demand



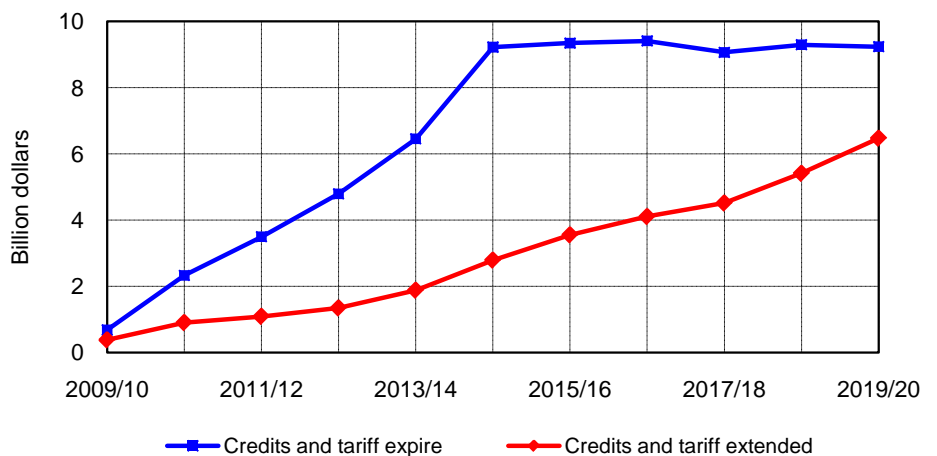
- RINs prove compliance with mandates. Higher RIN prices mean the mandate is more binding, and the compliance costs are also higher.

- The average compliance cost across 500 simulations in 2018/19 is about \$6.5 billion. Without credits or tariffs, the average rises to over \$9 billion.

- Eliminating the blenders credit does not affect quantities consumed if mandates are binding, but does affect RIN prices.

- We do not calculate total policy costs.

Aggregate compliance costs rise



Biofuel credits extended

Ethanol supply and use

September-August year	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20
Petroleum fuel prices											
	(Dollars per barrel)										
Petroleum, W. Texas interm.	66.07	74.07	80.72	85.50	88.54	92.99	97.20	99.42	101.20	101.68	101.16
Petroleum, refiners' acquis.	61.98	68.84	75.09	79.62	82.47	86.73	90.73	92.81	94.51	95.02	94.57
	(Dollars per gallon)										
Unl. gasoline, FOB Omaha	1.87	2.09	2.25	2.36	2.43	2.54	2.63	2.69	2.74	2.75	2.74
Unleaded gasoline, retail	2.50	2.73	2.88	3.00	3.08	3.19	3.30	3.36	3.42	3.43	3.43
Ethanol supply and use											
	(Million gallons)										
Production	11,848	13,005	13,604	14,184	14,784	15,570	16,219	17,077	17,873	18,679	19,618
From corn	11,599	12,716	13,244	13,743	14,246	14,900	15,384	16,009	16,459	16,722	16,901
Other conventional	248	281	309	329	344	359	368	376	376	374	376
Cellulosic	1	8	50	112	193	310	467	691	1,038	1,583	2,341
Imports (ethyl alcohol)	325	387	463	479	547	729	1,100	1,536	2,010	2,476	2,705
Domestic disappearance	11,956	13,220	13,947	14,540	15,210	16,171	17,193	18,469	19,729	20,991	22,148
In 10% and lower blends	11,808	12,872	13,257	13,394	13,497	13,627	13,705	13,750	13,782	13,825	13,900
In higher level blends	148	348	690	1,146	1,712	2,544	3,488	4,719	5,947	7,166	8,248
Exports (ethyl alcohol)	125	114	93	94	90	89	93	101	111	122	125
Ending stocks	722	780	807	835	866	904	937	980	1,023	1,067	1,116
Ethanol prices											
	(Dollars per gallon)										
Conventional rack, Omaha	1.74	1.77	1.84	1.88	1.91	1.96	1.99	2.02	2.00	1.98	1.97
AMS spot plant price, Iowa	1.57	1.60	1.66	1.70	1.72	1.77	1.80	1.83	1.81	1.79	1.78
Cellulosic rack	n.a.	3.28	3.29	3.30	3.28	3.29	3.29	3.32	3.33	3.38	3.46
Other advanced rack	1.74	1.77	1.84	1.88	1.96	2.16	2.28	2.38	2.43	2.49	2.50
Effective retail	1.91	1.91	1.99	2.03	2.03	2.05	2.07	2.12	2.12	2.13	2.13
Ethanol/gasoline retail	77%	70%	69%	68%	66%	64%	63%	63%	62%	62%	62%
RIN values											
Conventional ethanol	0.00	0.04	0.03	0.04	0.07	0.11	0.13	0.12	0.10	0.09	0.08
Advanced ethanol	0.00	0.04	0.03	0.04	0.12	0.32	0.42	0.48	0.53	0.59	0.61
Cellulosic ethanol	0.00	0.99	0.93	0.90	0.88	0.88	0.86	0.86	0.87	0.92	1.00

Biofuel policies

Calendar year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
(Million gallons)											
Renewable Fuel Standard	11,100	12,950	13,950	15,200	16,550	18,150	20,500	22,250	24,000	26,000	28,000
Advanced biofuels	600	950	1,350	2,000	2,750	3,750	5,500	7,250	9,000	11,000	13,000
Cellulosic ethanol	0	100	250	500	1,000	1,750	3,000	4,250	5,500	7,000	8,500
Biodiesel	500	650	800	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
(Dollars per gallon)											
Conventional ethanol credit	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
Biodiesel credit	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Cellulosic ethanol credit	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01
Ethanol specific tariff	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54
(Percent)											
Ethanol ad-valorem tariff	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5

Biofuel credits and tariff expire (change)

Ethanol supply and use

September-August year	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20
Petroleum fuel prices (Dollars per barrel)											
Petroleum, W. Texas interm.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Petroleum, refiners' acquis.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
(Dollars per gallon)											
Unl. gasoline, FOB Omaha	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.01	0.02
Unleaded gasoline, retail	0.00	0.01	0.02	0.02	0.03	0.04	0.04	0.04	0.04	0.04	0.04
Ethanol supply and use (Million gallons)											
Production	-1	-765	-1,403	-1,451	-1,510	-1,508	-1,573	-1,886	-2,318	-2,845	-3,571
From corn	-1	-751	-1,374	-1,406	-1,430	-1,373	-1,359	-1,521	-1,681	-1,740	-1,789
Other conventional	0	-14	-30	-38	-40	-37	-27	-21	-17	-14	-12
Cellulosic	0	0	0	-7	-40	-98	-187	-344	-620	-1,092	-1,769
Imports (ethyl alcohol)	0	-1	424	502	684	901	1,000	838	650	523	478
Domestic disappearance	-1	-797	-1,018	-1,012	-878	-647	-602	-1,078	-1,706	-2,383	-3,157
In 10% and lower blends	-1	-665	-649	-388	-87	-36	-83	-97	-108	-114	-118
In higher level blends	0	-133	-369	-624	-791	-611	-519	-981	-1,598	-2,269	-3,039
Exports (ethyl alcohol)	0	62	67	66	56	42	35	45	60	88	101
Ending stocks	0	-29	-57	-61	-65	-67	-74	-89	-111	-138	-173
Ethanol prices (Dollars per gallon)											
Conventional rack, Omaha	0.00	-0.13	-0.19	-0.18	-0.16	-0.13	-0.08	-0.08	-0.08	-0.08	-0.09
AMS spot plant price, Iowa	0.00	-0.12	-0.18	-0.16	-0.15	-0.12	-0.07	-0.07	-0.08	-0.07	-0.08
Cellulosic rack	n.a.	0.10	0.12	-0.61	-1.00	-1.08	-1.00	-0.99	-0.97	-0.97	-0.96
Other advanced rack	0.00	-0.13	-0.19	-0.18	-0.21	-0.32	-0.36	-0.40	-0.43	-0.46	-0.47
Effective retail	0.00	0.11	0.14	0.09	0.04	-0.03	0.05	0.06	0.07	0.08	0.08
Ethanol/gasoline retail	0%	4%	4%	2%	1%	-2%	1%	1%	1%	1%	2%
RIN values											
Conventional ethanol	0.00	0.07	0.13	0.20	0.27	0.39	0.36	0.34	0.32	0.32	0.30
Advanced ethanol	0.00	0.07	0.13	0.20	0.22	0.20	0.08	0.03	-0.03	-0.06	-0.08
Cellulosic ethanol	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01

Biofuel policies

Calendar year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Renewable Fuel Standard (Million gallons)											
Advanced biofuels	0	0	0	0	0	0	0	0	0	0	0
Cellulosic ethanol	0	0	0	0	0	0	0	0	0	0	0
Biodiesel	0	0	0	0	0	0	0	0	0	0	0
Tax credits and tariffs (Dollars per gallon)											
Conventional ethanol credit	0.00	0.00	-0.45	-0.45	-0.45	-0.45	-0.45	-0.45	-0.45	-0.45	-0.45
Biodiesel credit	0.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
Cellulosic ethanol credit	0.00	0.00	0.00	0.00	-1.01	-1.01	-1.01	-1.01	-1.01	-1.01	-1.01
Ethanol specific tariff	0.00	0.00	-0.54	-0.54	-0.54	-0.54	-0.54	-0.54	-0.54	-0.54	-0.54
(Percent)											
Ethanol ad-valorem tariff	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Biofuel credits extended

Biodiesel sector

October-September year	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20
Biodiesel supply and use											
	(Million gallons)										
Production	644	835	986	1,070	1,093	1,146	1,225	1,288	1,320	1,357	1,372
From soybean oil	303	435	517	546	536	566	623	668	687	714	723
From other fats and oils	341	400	469	524	557	580	602	620	633	644	649
Net exports	30	33	36	46	54	51	43	54	75	103	142
Domestic disappearance	614	802	950	1,024	1,039	1,095	1,182	1,234	1,246	1,255	1,230
Fuel prices and tax credit											
	(Dollars per gallon)										
Biodiesel, rack	3.66	3.79	4.01	4.10	4.12	4.16	4.25	4.35	4.44	4.53	4.59
#2 Diesel, refiner sales	1.92	2.15	2.31	2.41	2.49	2.59	2.69	2.75	2.80	2.81	2.80
#2 Diesel, retail	2.68	2.92	3.08	3.19	3.27	3.38	3.48	3.54	3.60	3.61	3.61
Biodiesel tax credit	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Costs and returns											
Biodiesel value	3.66	3.79	4.01	4.10	4.12	4.16	4.25	4.35	4.44	4.53	4.59
Glycerin value	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Soyoil cost	2.84	2.88	3.05	3.14	3.18	3.22	3.29	3.36	3.44	3.51	3.56
Other operating costs	0.55	0.56	0.56	0.56	0.57	0.57	0.58	0.58	0.59	0.60	0.60
Net operating return	0.30	0.39	0.43	0.43	0.40	0.40	0.41	0.43	0.44	0.46	0.46

Cellulosic biofuel feedstocks

Marketing year	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20
Cellulosic ethanol production											
	(Million gallons)										
From corn stover	1	8	50	112	193	310	467	691	1,038	1,583	2,341
From switchgrass	1	7	20	26	30	45	72	126	231	398	656
From switchgrass	0	0	0	0	2	13	43	108	239	500	870
All other	0	1	31	86	161	252	351	458	568	685	815
Corn stover											
Proportion harvested	0.0%	0.1%	0.0%	0.0%	0.1%	0.2%	0.2%	0.4%	0.7%	1.2%	2.0%
	(Million tons)										
Production	0.09	0.54	0.02	0.15	0.33	0.59	0.95	1.65	2.99	5.10	8.34
Ethanol use	0.01	0.10	0.27	0.34	0.40	0.60	0.94	1.63	2.97	5.06	8.27
Ending stocks	0.08	0.52	0.28	0.09	0.02	0.01	0.01	0.02	0.05	0.09	0.16
	(Dollars per ton)										
Farm price	28.79	30.10	35.28	41.01	43.71	44.90	45.42	45.93	46.54	47.60	48.41
Price delivered to plants	73.13	76.07	82.73	89.62	93.38	95.82	97.60	99.12	100.74	102.57	104.01
Switchgrass											
	(Million acres)										
Area harvested	0.01	0.00	0.00	0.00	0.02	0.09	0.24	0.52	1.03	2.00	2.85
	(Tons per acre)										
Yield per harvested acre	n.a.	n.a.	n.a.	n.a.	1.90	2.02	2.47	2.81	3.13	3.32	3.97
	(Million tons)										
Production	0.00	0.00	0.00	0.00	0.03	0.19	0.60	1.46	3.21	6.63	11.33
	(Dollars per ton)										
Farm price	n.a.	n.a.	n.a.	n.a.	16.40	26.13	35.38	43.03	49.02	57.89	68.75
Price delivered to plants	n.a.	n.a.	n.a.	n.a.	66.95	77.59	87.76	96.17	102.92	112.39	123.76

Biofuel credits and tariff expire (change)

Biodiesel sector

October-September year	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20
Biodiesel supply and use											
	(Million gallons)										
Production	-71	-78	-54	-62	-80	-110	-180	-230	-259	-286	-290
From soybean oil	-51	-52	-27	-32	-46	-67	-117	-148	-162	-178	-178
From other fats and oils	-20	-27	-27	-30	-34	-43	-63	-82	-96	-108	-112
Net exports	-30	-32	-35	-44	-52	-49	-41	-46	-57	-72	-93
Domestic disappearance	-42	-46	-19	-18	-28	-62	-139	-185	-202	-214	-197
Fuel prices and tax credit											
	(Dollars per gallon)										
Biodiesel, rack	-0.17	-0.13	-0.14	-0.17	-0.18	-0.25	-0.38	-0.45	-0.50	-0.55	-0.53
#2 Diesel, refiner sales	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01
#2 Diesel, retail	0.01	0.01	0.02	0.02	0.02	0.02	0.01	0.01	0.00	0.00	-0.01
Biodiesel tax credit	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Costs and returns											
Biodiesel value	-0.17	-0.13	-0.14	-0.17	-0.18	-0.25	-0.38	-0.45	-0.50	-0.55	-0.53
Glycerin value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Soyoil cost	-0.12	-0.10	-0.14	-0.16	-0.16	-0.23	-0.32	-0.39	-0.44	-0.48	-0.47
Other operating costs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Net operating return	-0.05	-0.03	-0.01	0.00	-0.01	-0.02	-0.05	-0.06	-0.07	-0.07	-0.06

Cellulosic biofuel feedstocks

Marketing year	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20
Cellulosic ethanol production											
	(Million gallons)										
From corn stover	0	0	0	-7	-40	-98	-187	-344	-620	-1,092	-1,769
From switchgrass	0	0	0	-2	-14	-30	-54	-106	-210	-375	-632
All other	0	0	0	-4	-23	-55	-90	-130	-172	-219	-271
Corn stover											
Proportion harvested	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	-0.2%	-0.3%	-0.7%	-1.2%	-1.9%
	(Million tons)										
Production	0.00	0.00	0.00	-0.03	-0.18	-0.41	-0.72	-1.39	-2.70	-4.79	-8.01
Ethanol use	0.00	0.00	0.00	-0.03	-0.19	-0.40	-0.71	-1.38	-2.69	-4.76	-7.96
Ending stocks	0.00	0.00	0.00	0.01	0.02	0.01	0.00	-0.01	-0.02	-0.04	-0.10
	(Dollars per ton)										
Farm price	0.00	0.00	0.01	-0.36	-2.20	-2.47	-1.84	-2.21	-3.11	-4.33	-5.39
Price delivered to plants	0.00	0.00	0.01	-0.36	-2.20	-2.47	-1.84	-2.21	-3.11	-4.33	-5.39
Switchgrass											
Area harvested	0.00	0.00	0.00	0.00	-0.02	-0.09	-0.24	-0.52	-1.02	-1.99	-2.84
	(Tons per acre)										
Yield per harvested acre	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
	(Million tons)										
Production	0.00	0.00	0.00	0.00	-0.03	-0.19	-0.60	-1.46	-3.19	-6.60	-11.29
	(Dollars per ton)										
Farm price	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Price delivered to plants	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

Biofuel credits extended

Corn processing

September-August year	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20
Corn food and industrial use											
	(Million bushels)										
Fuel alcohol	4,246	4,630	4,798	4,952	5,107	5,313	5,458	5,650	5,779	5,842	5,874
HFCS	477	469	469	473	476	479	480	481	483	485	487
Glucose and dextrose	237	234	234	235	236	237	238	239	240	241	242
Starch	234	236	237	240	242	244	246	248	251	253	256
Beverage alcohol	135	135	136	137	139	140	141	142	143	144	146
Cereals and other	194	195	197	198	200	202	203	205	207	209	211
Total	5,524	5,900	6,071	6,236	6,400	6,615	6,766	6,966	7,103	7,174	7,216
Corn dry milling											
Corn dry milled for ethanol	3,826	4,202	4,369	4,523	4,678	4,882	5,025	5,213	5,341	5,404	5,439
(Share fractionating)	9.5%	10.9%	12.6%	14.3%	15.9%	17.5%	19.0%	20.6%	22.0%	23.4%	24.8%
Yields per bushel of corn											
	(Units per bushel)										
Ethanol (gallons)	2.74	2.75	2.77	2.78	2.80	2.81	2.83	2.84	2.86	2.87	2.89
Distillers grains (pounds)	16.86	16.83	16.79	16.75	16.71	16.67	16.64	16.60	16.57	16.54	16.51
Costs and returns¹											
	(Dollars per gallon)										
Ethanol value	1.74	1.77	1.84	1.88	1.91	1.96	1.99	2.02	2.00	1.98	1.97
Distillers grains value	0.37	0.37	0.38	0.38	0.38	0.38	0.39	0.39	0.39	0.38	0.38
Corn cost	1.31	1.35	1.38	1.38	1.39	1.38	1.40	1.41	1.40	1.39	1.36
Fuel and electricity cost	0.17	0.16	0.19	0.20	0.20	0.21	0.23	0.25	0.26	0.26	0.27
Other operating costs	0.33	0.33	0.33	0.33	0.34	0.34	0.34	0.35	0.35	0.35	0.36
Net operating return	0.30	0.29	0.32	0.34	0.36	0.41	0.40	0.41	0.38	0.36	0.36
Corn wet milling											
	(Million bushels)										
Corn wet milled for ethanol	420	429	428	430	429	432	433	437	438	437	435
Other corn wet milling	948	938	940	948	954	960	965	969	974	979	986
Total corn wet milling	1,369	1,367	1,369	1,378	1,383	1,392	1,398	1,405	1,412	1,417	1,421
Yields per bushel of corn											
	(Units per bushel)										
Ethanol (gallons)	2.69	2.70	2.71	2.71	2.72	2.73	2.74	2.74	2.75	2.76	2.77
Gluten feed (pounds)	11.40	11.40	11.40	11.40	11.40	11.40	11.40	11.40	11.40	11.40	11.40
Gluten meal (pounds)	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Corn oil (pounds)	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67
Costs and returns											
	(Dollars per gallon)										
Ethanol value	1.74	1.77	1.84	1.88	1.91	1.96	1.99	2.02	2.00	1.98	1.97
Gluten feed value	0.18	0.18	0.18	0.18	0.18	0.18	0.19	0.19	0.19	0.19	0.18
Gluten meal value	0.25	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24
Corn oil value	0.23	0.23	0.24	0.25	0.25	0.25	0.25	0.26	0.26	0.27	0.27
Corn cost	1.34	1.38	1.41	1.42	1.43	1.43	1.45	1.46	1.45	1.45	1.42
Fuel and electricity cost	0.13	0.13	0.15	0.16	0.16	0.17	0.18	0.20	0.20	0.21	0.21
Other operating costs	0.52	0.52	0.53	0.53	0.53	0.54	0.54	0.55	0.55	0.56	0.56
Net operating return	0.41	0.38	0.42	0.45	0.46	0.51	0.50	0.51	0.48	0.47	0.47

¹ Dry mill costs and returns for a plant that does not use a fractionation process to extract corn oil.

Biofuel credits and tariff expire (change)

Corn processing

September-August year	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20
Corn food and industrial use											
	(Million bushels)										
Fuel alcohol	-1	-273	-497	-506	-512	-489	-482	-537	-590	-608	-622
HFCS	0	2	3	3	3	3	2	1	1	1	1
Glucose and dextrose	0	1	1	0	1	1	1	1	1	1	1
Starch	0	1	1	1	1	1	1	1	1	1	1
Beverage alcohol	0	1	1	0	0	0	0	0	1	0	1
Cereals and other	0	1	1	1	1	1	1	1	1	1	1
Total	-1	-268	-490	-501	-507	-485	-478	-533	-586	-604	-618
Corn dry milling											
Corn dry milled for ethanol (Share fractionating)	1 0.0%	-259 -0.1%	-469 -0.1%	-476 -0.2%	-479 -0.3%	-454 -0.4%	-444 -0.6%	-494 -0.7%	-544 -0.9%	-559 -1.1%	-572 -1.3%
Yields per bushel of corn											
	(Units per bushel)										
Ethanol (gallons)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Distillers grains (pounds)	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04
Costs and returns²											
	(Dollars per gallon)										
Ethanol value	0.00	-0.13	-0.19	-0.18	-0.16	-0.13	-0.08	-0.08	-0.08	-0.08	-0.09
Distillers grains value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Corn cost	0.00	-0.05	-0.07	-0.04	-0.05	-0.04	-0.04	-0.05	-0.06	-0.06	-0.06
Fuel and electricity cost	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other operating costs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Net operating return	0.00	-0.08	-0.13	-0.14	-0.12	-0.09	-0.03	-0.03	-0.02	-0.02	-0.02
Corn wet milling											
	(Million bushels)										
Corn wet milled for ethanol	-1	-15	-28	-30	-33	-36	-38	-42	-47	-49	-50
Other corn wet milling	0	4	5	4	4	4	3	3	3	3	3
Total corn wet milling	-1	-11	-23	-26	-29	-32	-35	-39	-43	-46	-47
Yields per bushel of corn											
	(Units per bushel)										
Ethanol (gallons)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gluten feed (pounds)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gluten meal (pounds)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Corn oil (pounds)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Costs and returns											
	(Dollars per gallon)										
Ethanol value	0.00	-0.13	-0.19	-0.18	-0.16	-0.13	-0.08	-0.08	-0.08	-0.08	-0.09
Gluten feed value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gluten meal value	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01
Corn oil value	-0.01	-0.01	-0.01	-0.01	-0.01	-0.02	-0.02	-0.03	-0.03	-0.03	-0.03
Corn cost	0.00	-0.06	-0.07	-0.04	-0.05	-0.04	-0.04	-0.05	-0.06	-0.06	-0.06
Fuel and electricity cost	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other operating costs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Net operating return	-0.01	-0.08	-0.14	-0.15	-0.13	-0.10	-0.05	-0.05	-0.05	-0.05	-0.05

² Dry mill costs and returns for a plant that does not use a fractionation process to extract corn oil.

Biofuel credits extended

Biofuel RIN supply and utilization: crop year

September-August year	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20
	(Million gallons)										
Renewable fuel standard	12,268	13,425	14,417	15,378	16,310	17,444	18,300	19,025	19,872	20,916	21,841
Advanced biofuels	768	1,025	1,417	1,778	2,110	2,644	3,300	4,025	4,872	5,916	6,841
Cellulosic ethanol (waived)	1	8	50	112	193	310	467	691	1,038	1,583	2,341
Biodiesel	600	750	933	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Biodiesel RFS RINs											
Production	614	802	950	1,024	1,039	1,095	1,182	1,234	1,246	1,255	1,230
Carry in	52	66	86	81	79	84	86	79	73	67	59
Use for biodiesel compliance	600	750	933	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Unused for this mandate	66	118	103	105	118	179	268	313	318	322	289
of which, carry out	66	86	81	79	84	86	79	73	67	59	55
of which, demoted	0	32	22	26	34	94	189	240	252	262	233
Advanced RFS RINs											
Production	1,188	1,741	2,137	2,385	2,600	3,002	3,578	4,275	5,093	6,097	7,007
Biodiesel (in ethanol gallons)	921	1,203	1,425	1,536	1,558	1,643	1,774	1,851	1,868	1,882	1,845
Cellulosic	1	8	50	112	193	310	467	691	1,038	1,583	2,341
Other advanced	265	327	403	419	487	669	1,040	1,476	1,950	2,417	2,645
Carry in	0	203	258	318	361	380	298	257	236	215	176
Use for advanced compliance	768	1,025	1,417	1,778	2,110	2,644	3,300	4,025	4,872	5,916	6,841
Unused for this mandate	420	717	720	607	490	358	278	250	222	181	166
of which, carry out	203	258	318	361	380	298	257	236	215	176	162
of which, demoted	217	459	402	246	110	60	22	14	7	4	3
Total RFS RINs											
Production	12,878	14,423	15,373	16,076	16,768	17,814	18,966	20,320	21,598	22,873	23,992
Biodiesel (in ethanol gallons)	921	1,203	1,425	1,536	1,558	1,643	1,774	1,851	1,868	1,882	1,845
Cellulosic	1	8	50	112	193	310	467	691	1,038	1,583	2,341
Other advanced	265	327	403	419	487	669	1,040	1,476	1,950	2,417	2,645
Conventional	11,690	12,885	13,493	14,009	14,529	15,192	15,686	16,302	16,741	16,991	17,162
Carry in	1,840	2,146	2,600	2,822	2,916	2,837	2,602	2,579	2,741	2,993	3,129
Use for total compliance	12,268	13,425	14,417	15,378	16,310	17,444	18,300	19,025	19,872	20,916	21,841
Unused for this mandate	2,450	3,144	3,555	3,520	3,373	3,207	3,268	3,874	4,467	4,950	5,280
of which, carry out	2,146	2,600	2,822	2,916	2,837	2,602	2,579	2,741	2,993	3,129	3,151
of which, expired	304	544	733	604	537	606	689	1,134	1,474	1,821	2,130
RIN value	(Dollars per gallon)										
Biodiesel RIN	0.62	0.60	0.73	0.75	0.71	0.68	0.72	0.79	0.85	0.93	0.98
Cellulosic RIN allowance val.	0.00	0.99	0.93	0.90	0.88	0.88	0.86	0.86	0.87	0.92	1.00
Advanced RIN	0.00	0.04	0.03	0.04	0.12	0.32	0.42	0.48	0.53	0.59	0.61
Conventional RIN	0.00	0.04	0.03	0.04	0.07	0.11	0.13	0.12	0.10	0.09	0.08
RIN compliance expend.	(Million dollars)										
Total	385	907	1,093	1,349	1,884	2,794	3,556	4,110	4,519	5,415	6,477

Biofuel credits and tariff expire (change)

Biofuel RIN supply and utilization: crop year

September-August year	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20
	(Million gallons)										
Renewable fuel standard	0	0	0	-7	-40	-98	-187	-344	-620	-1,092	-1,769
Advanced biofuels	0	0	0	-7	-40	-98	-187	-344	-620	-1,092	-1,769
Cellulosic ethanol (waived)	0	0	0	-7	-40	-98	-187	-344	-620	-1,092	-1,769
Biodiesel	0	0	0	0	0	0	0	0	0	0	0
Biodiesel RFS RINs											
Production	-42	-46	-19	-18	-28	-62	-139	-185	-202	-214	-197
Carry in	0	-42	-57	-56	-51	-51	-48	-37	-27	-21	-17
Use for biodiesel compliance	0	0	0	0	0	0	0	0	0	0	0
Unused for this mandate	-42	-88	-76	-75	-79	-113	-187	-222	-229	-235	-214
of which, carry out	-42	-57	-56	-51	-51	-48	-37	-27	-21	-17	-17
of which, demoted	0	-31	-20	-23	-28	-65	-150	-195	-208	-218	-197
Advanced RFS RINs											
Production	-62	-70	366	402	489	562	482	168	-276	-855	-1,537
Biodiesel (in ethanol gallons)	-62	-69	-29	-28	-42	-92	-209	-277	-303	-321	-296
Cellulosic	0	0	0	-7	-40	-98	-187	-344	-620	-1,092	-1,769
Other advanced	0	-1	424	502	684	901	1,000	838	650	523	478
Carry in	0	0	-29	-66	-113	-148	-121	-49	-3	34	50
Use for advanced compliance	0	0	0	-7	-40	-98	-187	-344	-620	-1,092	-1,769
Unused for this mandate	-62	-70	366	409	529	661	670	512	344	236	233
of which, carry out	0	-29	-66	-113	-148	-121	-49	-3	34	50	69
of which, demoted	-62	-41	432	522	677	782	719	515	310	186	164
Total RFS RINs											
Production	-64	-866	-1,047	-1,039	-920	-739	-811	-1,355	-2,009	-2,704	-3,453
Biodiesel (in ethanol gallons)	-62	-69	-29	-28	-42	-92	-209	-277	-303	-321	-296
Cellulosic	0	0	0	-7	-40	-98	-187	-344	-620	-1,092	-1,769
Other advanced	0	-1	424	502	684	901	1,000	838	650	523	478
Conventional	-1	-797	-1,443	-1,507	-1,522	-1,450	-1,414	-1,572	-1,736	-1,815	-1,866
Carry in	0	-2	-508	-933	-1,417	-1,798	-1,900	-1,916	-1,920	-2,001	-2,021
Use for total compliance	0	0	0	-7	-40	-98	-187	-344	-620	-1,092	-1,769
Unused for this mandate	-64	-868	-1,556	-1,965	-2,296	-2,438	-2,524	-2,928	-3,309	-3,613	-3,704
of which, carry out	-2	-508	-933	-1,417	-1,798	-1,900	-1,916	-1,920	-2,001	-2,021	-1,892
of which, expired	-62	-360	-623	-549	-499	-538	-608	-1,007	-1,308	-1,593	-1,813
RIN value	(Dollars per gallon)										
Biodiesel RIN	0.56	0.85	0.85	0.82	0.81	0.71	0.54	0.43	0.37	0.32	0.35
Cellulosic RIN allowance val.	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01
Advanced RIN	0.00	0.07	0.13	0.20	0.22	0.20	0.08	0.03	-0.03	-0.06	-0.08
Conventional RIN	0.00	0.07	0.13	0.20	0.27	0.39	0.36	0.34	0.32	0.32	0.30
RIN compliance expend.	(Million dollars)										
Total	297	1,425	2,407	3,449	4,573	6,433	5,794	5,304	4,549	3,882	2,762

Biofuel mandates

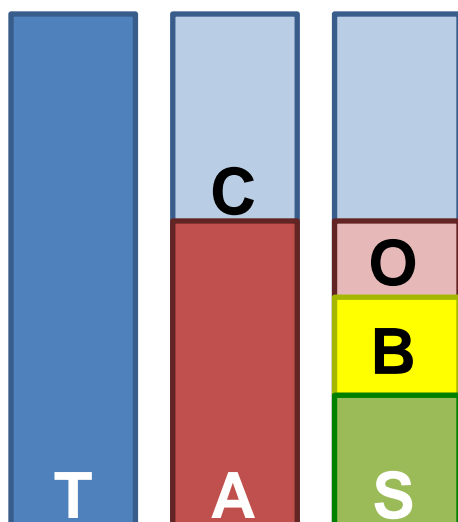
The biofuel mandates established in the Energy Independence and Security Act (EISA) of 2007 are not independent of each other but are hierarchical in nature. A mandate establishes the minimum quantity of use. A mandate is considered ‘binding’ in the market place if the market would result in use below the mandated quantity in its absence. Similar to its predecessor, the Energy Policy Act of 2005, the EISA establishes a minimum total quantity of biofuel (T in the figure below) to be used in a given calendar year. However, the new act goes on to specify minimum quantities that must come from specific feedstocks or biofuel types towards meeting that total. Another criterion is greenhouse gas (GHG) emission reductions.

Conventional biofuel (C) meets the lowest GHG target and counts toward the total mandate. Advanced biofuels (A) are biofuels produced from feedstocks that generate greater greenhouse gas emissions savings. Conventional ethanol (C) cannot be used to meet the advanced sub-mandate, but advanced biofuels do help to meet the total mandate (T). The legislation increases the share of advanced biofuels (A) in the mandate total (T) over time.

While it is often suggested that there is a corn ethanol mandate, in fact, no such mandate exists. Corn ethanol, a conventional ethanol according to the EISA, can be used to satisfy the difference between the total mandate and the advanced mandate ($T - A = C$) but must compete with all other biofuels, including any production of advanced biofuels in excess of the advanced mandate (A). The advanced biofuel mandate is further sub-divided. The two categories outlined are a mandated quantity for ethanol made from cellulosic or agricultural-waste-based feedstocks (S) and biodiesel (B). The remainder of the advanced ethanol mandate ($A - S - B = O$) can be met by additional cellulosic production, additional biodiesel production or from another source. Imported sugarcane ethanol, for example, is an advanced biofuel that is neither cellulosic nor biodiesel (thus, type O). The mandates only restrict minimum quantities and are nested within each other, creating a hierarchy of biofuel types which can be used for compliance.

Renewable Identification Numbers (RINs)

Renewable Identification Numbers or RINs are the currency of EISA compliance. Each gallon of renewable fuel produced or imported receives a RIN which classifies it by its vintage (year of creation) and the highest category of mandate to which it can be applied (cellulosic, bio-based diesel, advanced or conventional). The RIN is sold with the fuel by the producer or importer. Each blender is assigned a share of each of the annual mandates based upon their historic share of the fuel market and must obtain an equivalent number of RINs from domestically



consumed biofuels to show compliance. They can either blend the fuel themselves to obtain the RINs or obtain them from other blenders who have done so. This tradability establishes a market for RINs with each of the four RIN categories potentially having a different price. We assume the cellulosic mandate is waived, and cellulosic RIN prices are capped according to EISA provisions.

RIN values are linked to how ‘binding’ the mandates are. Because the mandates are nested, blending above that required to meet the mandate in one mandate category can be used to fulfill a broader mandate (*demotion*) or carried forward one year to meet up to 20% of next year’s obligation (*rollover*). The hierarchy of biofuel mandates creates a hierarchy in RIN pricing. Excess RIN production not used for lower level mandates nor rolled forward for next year’s obligations expire.

Renewable Identification Number (RINs) prices and mandate outcomes

The tables on the following pages summarize RIN price ranges and mandate outcomes for each year over all 500 stochastic simulations. The first table represents baseline results where all credits and tariffs are extended. The opposing table represents the results when blenders tax credits, the cellulosic biofuel producer credit, and ethanol tariff are allowed to expire.

Baseline table

The *overall mandate* is binding in over 60% of the outcomes in 2014/15 and 2015/16, when the volume of conventional ethanol that can be used to satisfy the overall mandate hits its plateau. It is less often binding when the mandate is still small in the early years or when growth in the other mandates at the end of the period makes this one somewhat easier to meet. *Conventional RIN prices* tend to be highest when the mandate is most likely to be binding, but is rarely more than \$0.30 and many conventional RINs often expire unused.

In the early years, the *advanced mandate* is often not binding and the *advanced RIN price* is usually set by the conventional price and advanced RINs are typically demoted to help meet the overall mandate, or else expire unused. The *advanced mandate* grows over time, and is binding in almost all the outcomes in the final years of the projection period. The average advanced RIN price is \$0.61, the 10th percentile price is \$0.37 (meaning that 50 of 500 outcomes were below this price), and the 90th price is \$0.83 percentile (meaning that 50 of 500 outcomes were above this price).

The *biodiesel mandate* grows to 1 billion gallons in 2012/13. Average *biodiesel RIN prices* range from \$0.40 to \$0.50 during this period and this mandate is frequently, but not always binding. After 2012/13, when the mandate is assumed to be flat at 1 billion gallons, the biodiesel RIN price is typically determined by the advanced RIN price and biodiesel RINs are often demoted to help to meet the broader advanced mandate.

We assume the *cellulosic mandate* is waived. The *cellulosic RIN price* is equal to the RIN credit value the EPA is compelled to offer in the event of a cellulosic mandate waiver. This value is set by the EISA as a function of the gasoline price or in any case no less than a minimum value.

Tax credits and tariff expire

It is a mistake to assess these policies in isolation because blenders must continue to use at least the mandated quantities. Without the tax credit for every gallon of biofuels they use, blenders would buy and sell less biofuel. But if a mandate is already binding, then eliminating the tax credit simply makes it more binding. The RIN price goes up, but there is no effect on the quantity. The ranges of results shown here reflect cases where mandates are binding – or become binding – as well as cases where they are not, so volumes change.

Cellulosic RIN prices are still set by the cap provided by the EISA in the event of a waiver.

Conventional and biodiesel RIN prices are higher on average because the overall and biodiesel mandates are binding more frequently and the average RIN price is higher. The effects at the 10th percentile tend to be smaller because the mandate is not binding or only just starts to be binding.

Advanced RIN prices would increase because of the tax credit expiration, but the absence of ethanol tariff cheapens sugarcane ethanol imports that help to meet this mandate. In net, there are more of these RINs and more are demoted, with the advanced RIN price more frequently set by the conventional RIN price.

Biofuel credits extended

Renewable identification number (RIN) prices and mandate outcomes

September-August year	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20
Conventional biofuel											
RIN prices						(Dollars per gallon)					
Average	0.00	0.04	0.03	0.04	0.07	0.11	0.13	0.12	0.10	0.09	0.08
10th percentile	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Median	0.00	0.00	0.00	0.00	0.04	0.07	0.08	0.03	0.00	0.00	0.00
90th percentile	0.00	0.13	0.11	0.14	0.19	0.28	0.32	0.34	0.30	0.28	0.28
Mandate outcomes						(Percent)					
Binding	2.4	43.0	31.4	42.8	59.6	61.0	63.8	55.6	47.4	41.2	42.2
Non-binding, demoted	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Non-binding, expired	97.6	57.0	68.6	57.2	40.4	39.0	36.2	44.4	52.6	58.8	57.8
Advanced biofuel											
RIN prices						(Dollars per gallon)					
Average	0.00	0.04	0.03	0.04	0.12	0.32	0.42	0.48	0.53	0.59	0.61
10th percentile	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.24	0.32	0.34	0.37
Median	0.00	0.00	0.00	0.00	0.12	0.35	0.44	0.49	0.54	0.61	0.63
90th percentile	0.00	0.13	0.11	0.14	0.27	0.54	0.66	0.69	0.75	0.81	0.83
Mandate outcomes						(Percent)					
Binding	0.0	0.0	0.0	1.0	54.2	85.6	94.4	96.8	98.8	99.2	99.4
Non-binding, demoted	2.4	43.0	31.4	42.6	21.4	3.6	2.0	1.6	0.6	0.2	0.2
Non-binding, expired	97.6	57.0	68.6	56.4	24.4	10.8	3.6	1.6	0.6	0.6	0.4
Bio-based diesel											
RIN prices						(Dollars per gallon)					
Average	0.42	0.40	0.49	0.50	0.47	0.45	0.48	0.53	0.56	0.62	0.65
10th percentile	0.41	0.00	0.00	0.00	0.00	0.00	0.15	0.24	0.32	0.35	0.37
Median	0.42	0.38	0.46	0.47	0.42	0.40	0.47	0.51	0.55	0.62	0.65
90th percentile	0.43	0.86	0.97	0.99	0.99	0.89	0.77	0.81	0.81	0.87	0.93
Mandate outcomes						(Percent)					
Binding	100.0	82.8	88.0	87.4	81.6	44.0	24.4	18.4	19.4	14.4	19.8
Non-binding, demoted	0.0	0.2	0.4	0.4	3.2	45.4	72.0	80.0	80.0	85.0	79.8
Non-binding, expired	0.0	17.0	11.6	12.2	15.2	10.6	3.6	1.6	0.6	0.6	0.4
Cellulosic ethanol											
RIN prices						(Dollars per gallon)					
Average	0.00	0.99	0.93	0.90	0.88	0.88	0.86	0.86	0.87	0.92	1.00
10th percentile	0.00	0.31	0.26	0.26	0.27	0.27	0.28	0.28	0.29	0.29	0.30
Median	0.00	1.17	0.99	0.96	0.96	0.93	0.86	0.86	0.86	0.93	1.05
90th percentile	0.00	1.42	1.46	1.46	1.48	1.48	1.49	1.51	1.55	1.62	1.71
RIN price outcomes						(Percent)					
Equal to legislated credit	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Less than legislated credit	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
All qualifying biofuel											
Mandate compliance costs						(Million dollars)					
Average	385	907	1,093	1,349	1,884	2,794	3,556	4,110	4,519	5,415	6,477
10th percentile	375	3	20	36	51	83	572	993	1,493	1,979	2,373
Median	384	539	741	943	1,578	2,259	2,776	2,699	3,128	3,945	5,046
90th percentile	397	2,484	2,845	3,272	4,165	6,062	7,435	8,527	9,352	10,733	12,505

Biofuel credits and tariff expire

Renewable identification number (RIN) prices and mandate outcomes

September-August year	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20
Conventional biofuel											
RIN prices						(Dollars per gallon)					
Average	0.00	0.11	0.16	0.24	0.34	0.50	0.48	0.46	0.42	0.41	0.39
10th percentile	0.00	0.00	0.00	0.03	0.09	0.10	0.16	0.10	0.06	0.03	0.00
Median	0.00	0.09	0.14	0.22	0.32	0.48	0.46	0.46	0.37	0.36	0.35
90th percentile	0.00	0.26	0.35	0.48	0.63	0.88	0.83	0.82	0.78	0.81	0.81
Mandate outcomes						(Percent)					
Binding	5.4	70.0	82.2	93.0	95.6	94.0	95.4	93.4	92.2	91.6	88.4
Non-binding, demoted	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Non-binding, expired	94.6	30.0	17.8	7.0	4.4	6.0	4.6	6.6	7.8	8.4	11.6
Advanced biofuel											
RIN prices						(Dollars per gallon)					
Average	0.00	0.11	0.16	0.24	0.35	0.52	0.50	0.51	0.51	0.54	0.53
10th percentile	0.00	0.00	0.00	0.03	0.11	0.17	0.22	0.22	0.26	0.29	0.28
Median	0.00	0.09	0.14	0.22	0.33	0.49	0.48	0.49	0.49	0.52	0.52
90th percentile	0.00	0.26	0.35	0.48	0.63	0.88	0.83	0.82	0.78	0.81	0.81
Mandate outcomes						(Percent)					
Binding	0.0	0.0	0.0	0.8	12.0	20.2	17.6	36.2	56.4	67.8	72.4
Non-binding, demoted	5.4	70.0	82.2	92.2	84.6	76.4	80.8	62.8	42.8	31.6	26.6
Non-binding, expired	94.6	30.0	17.8	7.0	3.4	3.4	1.6	1.0	0.8	0.6	1.0
Bio-based diesel											
RIN prices						(Dollars per gallon)					
Average	0.79	0.96	1.05	1.05	1.01	0.92	0.84	0.82	0.81	0.83	0.88
10th percentile	0.77	0.35	0.45	0.40	0.35	0.26	0.27	0.26	0.31	0.32	0.34
Median	0.79	0.97	1.02	1.01	0.95	0.90	0.81	0.77	0.74	0.78	0.84
90th percentile	0.81	1.59	1.67	1.73	1.71	1.60	1.46	1.47	1.45	1.43	1.50
Mandate outcomes						(Percent)					
Binding	100.0	98.6	98.8	97.8	94.0	79.0	75.6	71.6	72.6	72.0	80.2
Non-binding, demoted	0.0	0.0	0.2	1.0	4.8	18.4	23.0	27.4	26.8	27.4	19.2
Non-binding, expired	0.0	1.4	1.0	1.2	1.2	2.6	1.4	1.0	0.6	0.6	0.6
Cellulosic ethanol											
RIN prices						(Dollars per gallon)					
Average	0.00	0.99	0.92	0.90	0.88	0.88	0.86	0.85	0.87	0.92	0.99
10th percentile	0.00	0.31	0.26	0.26	0.27	0.27	0.28	0.28	0.29	0.29	0.30
Median	0.00	1.16	0.98	0.95	0.95	0.93	0.85	0.84	0.84	0.91	1.03
90th percentile	0.00	1.41	1.46	1.46	1.47	1.47	1.49	1.51	1.55	1.62	1.69
RIN price outcomes						(Percent)					
Equal to legislated credit	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Less than legislated credit	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
All qualifying biofuel											
Mandate compliance costs						(Million dollars)					
Average	683	2,332	3,501	4,797	6,457	9,227	9,350	9,414	9,068	9,297	9,238
10th percentile	666	441	747	1,203	1,964	2,162	3,660	2,558	2,062	2,254	2,015
Median	678	2,327	3,320	4,649	6,152	8,595	8,993	9,105	8,300	8,319	8,358
90th percentile	698	4,623	6,475	8,421	11,391	16,082	15,796	16,082	16,361	16,940	17,366