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The Future of Biofuels?

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April 30, 2013

Huge Uncertainty

- Future of biofuels is more uncertain today than at any time since I have been working in the area – 10 years.
- My plan is to discuss the major positive and negative drivers that exist today in the biofuels arena.
- Then I will focus on the uncertainties in second generation biofuels.

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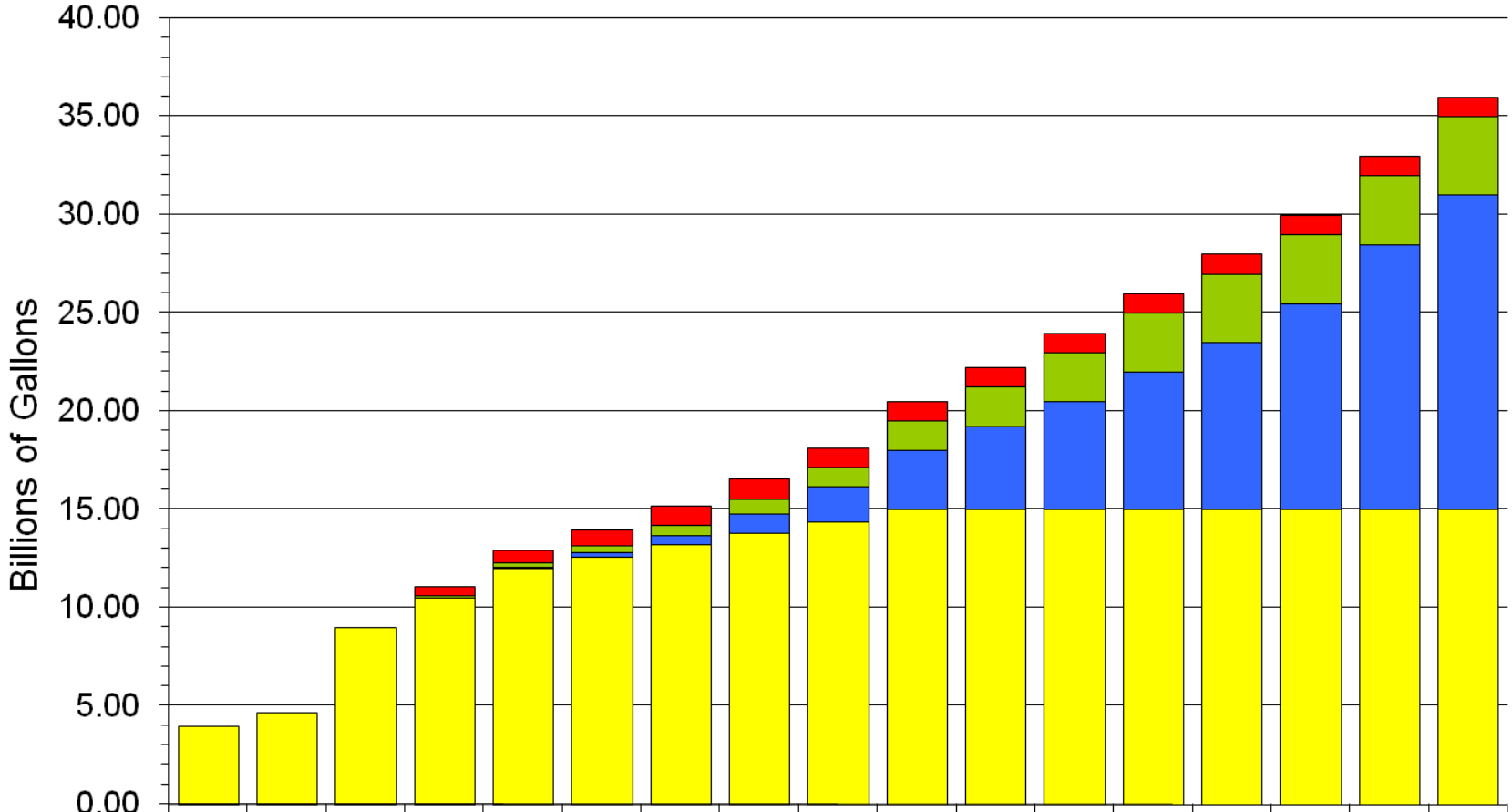
Renewable Fuel Standard



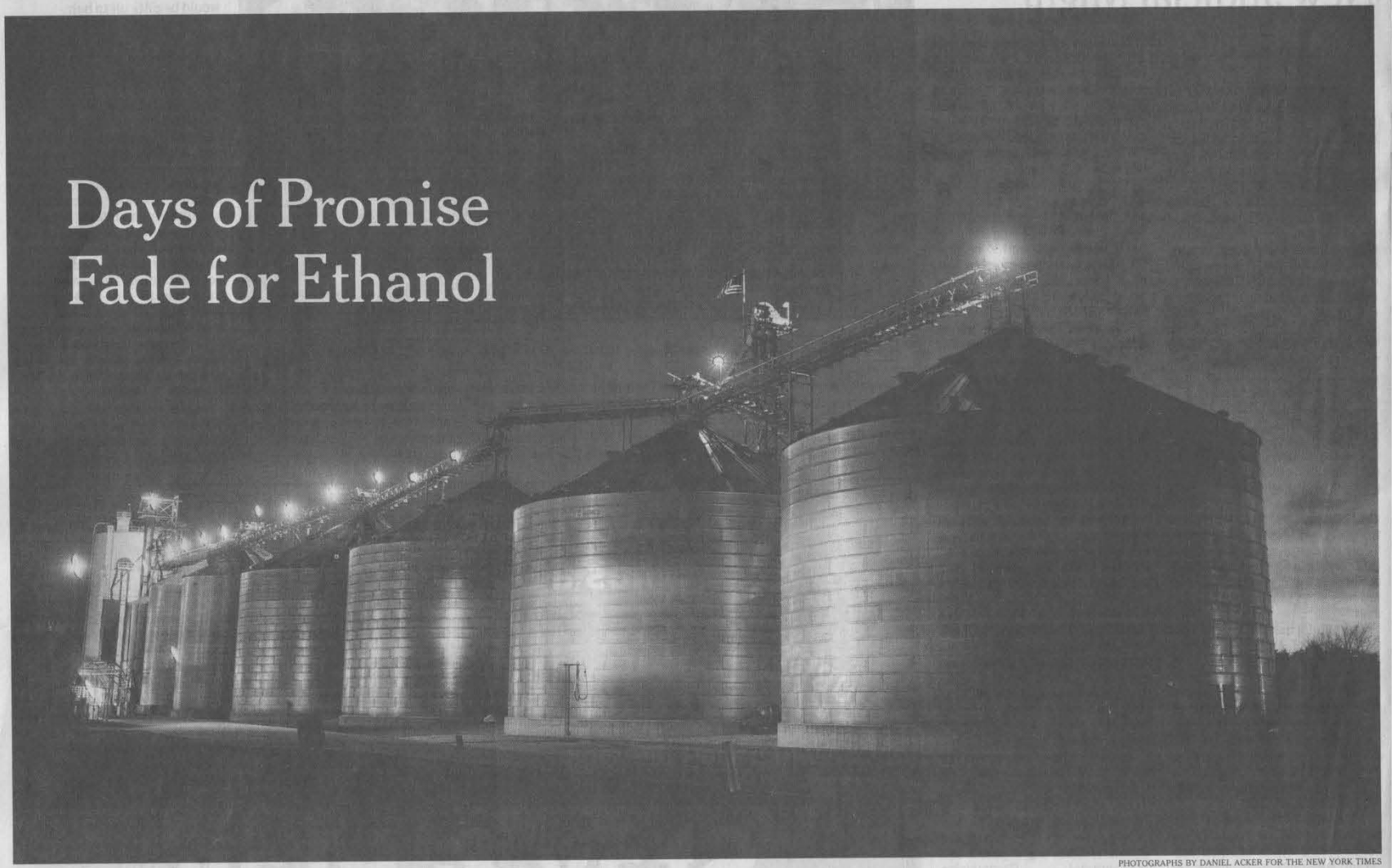
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Biomass-based Diesel				0.50	0.65	0.80	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Non-celulosic Advanced				0.10	0.20	0.30	0.50	0.75	1.00	1.50	2.00	2.50	3.00	3.50	3.50	3.50	4.00
Celulosic Advanced					0.10	0.25	0.50	1.00	1.75	3.00	4.25	5.50	7.00	8.50	10.5	13.5	16.0
Conventional Biofuels	4.00	4.70	9.00	10.5	12.0	12.6	13.2	13.8	14.4	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0

SUNDAY, MARCH 17, 2013

National

The New York Times

Days of Promise Fade for Ethanol



PHOTOGRAPHS BY DANIEL ACKER FOR THE NEW YORK TIMES

Corn storage at the ethanol plant in Macon, Mo., which stopped operating in January. Officials have vowed to reopen it, and it is undergoing renovations. More photos at nytimes.com/national.

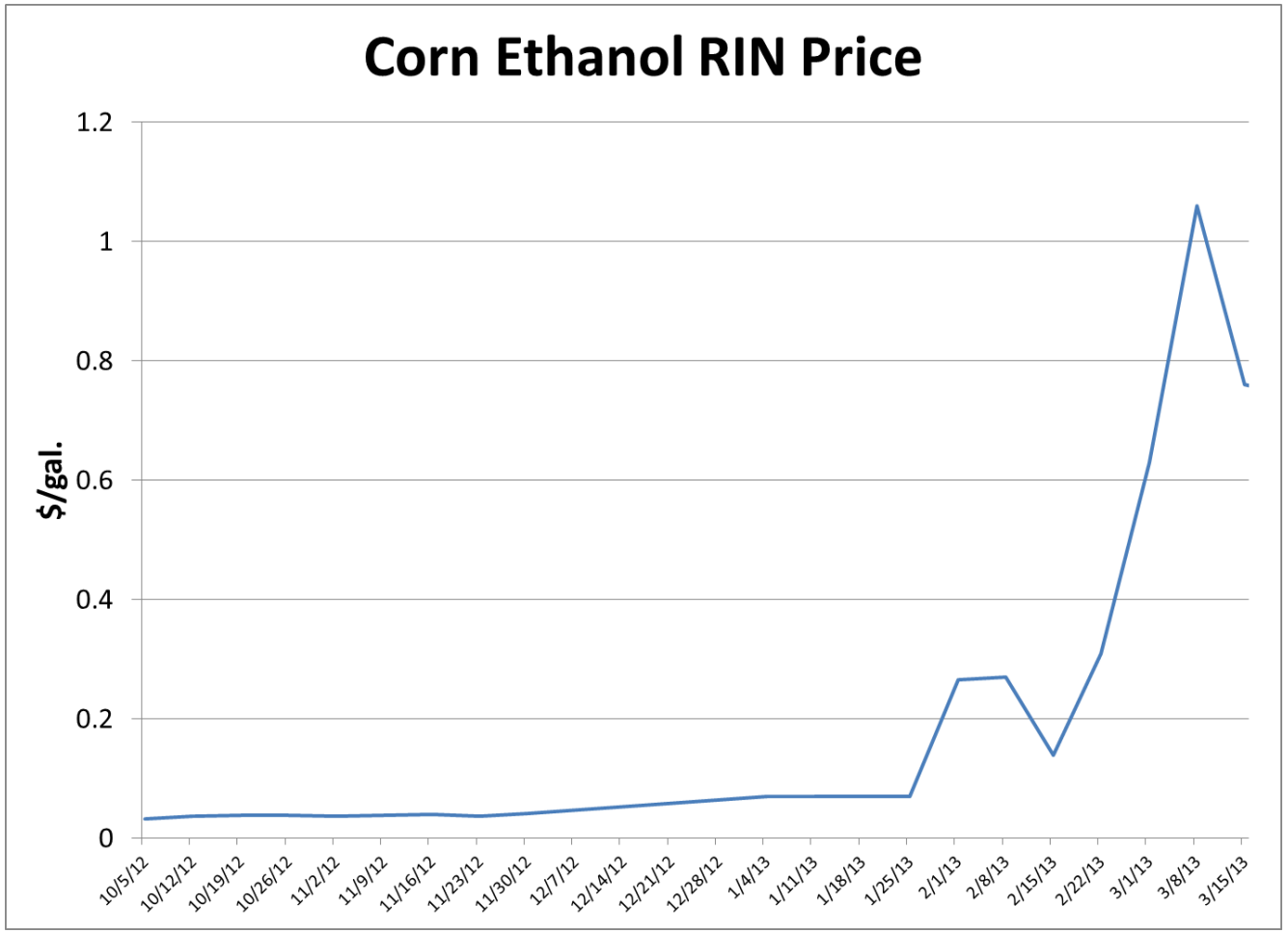
Blend Wall and RFS

Year	Conventional	Other Advanced
2012	13.2	0.50
2013	13.8	0.75
2014	14.4	1.00
2015	15.0	1.50

- Blend wall is about 13.3 BG, but sugarcane ethanol is part of that.
- Advanced will be met with biodiesel and sugarcane ethanol, so ethanol imports put pressure on blend wall.
- Market perceives carry-forward RINs being used up in 2014, and no adjustment of RFS by EPA.
- Today, corn ethanol price is rising due to high value of corn ethanol RINs. Corn ethanol is profitable again.

Negatives

- Blend wall is a huge issue for US ethanol



Blend Wall

- Exports provided a relief valve for the blend wall in 2011.

Year	Exports	Imports	Net Exports
2010	0	9.7	-9.7
2011	1,195	141	1,054
2012	739	555	184

- RIN prices previously much higher for biodiesel and advanced biofuels

RIN code	Fuel	RIN price 21 Mar
D6	Corn ethanol	0.71
D4	Biodiesel	0.80
D5	Advanced	0.77

Negatives

- Big oil and other opposition groups seem to be more aggressive in attacking biofuels and the RFS.

API, senators separately urge EPA to address rising RIN prices

WASHINGTON, DC, 03/21/2013, By Nick Snow, OGJ Washington Editor

The American Petroleum Institute and two Republican US senators separately asked the Environmental Protection Agency to address renewable identification number (RIN) costs, which have jumped by 1,400% since the beginning of 2012.

And from the RFA:

"So, the oil industry is howling about 'billions' in fictitious 'compliance costs,' when if they would just invest two one-hundreths of a penny of profit per gallon in infrastructure, no one would be talking about the 'blend wall' or high RIN prices today. And, more importantly, consumers would be enjoying greater choice and lower prices at the pump."

Negatives

- Federal and state budget issues may limit use of subsidies and biofuels research expenditures.
- Food/fuel issue attracting more attention.
- The EU is backing away from conventional biofuels and has provisionally capped the food crop component at 5% - half the renewable fuel target.
- With more US oil production and cheap natural gas, less interest in renewables.

Negatives

- EPA will be forced to waive some part of the cellulosic part of the RFS every year.
  - The RFS out clause automatically comes into play.
  - In that out clause, blenders can buy out of their blending obligation by purchasing a credit from EPA plus buying an advanced biofuel RIN.
  - The 2013 price for the credit is $0.42, and an advanced RIN currently is about $0.77.
  - The buy-out cost is about $1.19/gal.
  - With wholesale gasoline at $2.90, the cap on cellulosic is $4.09, less than its current cost.

Negatives

- The private sector seems less interested in biofuels today – projects being cancelled.
- Obtaining financing for advanced biofuels plants is very difficult.
- Changes in the RFS
  - There are legislative proposals to eliminate the RFS.
  - Other changes could weaken it further, but not eliminate it.

Positives

- Ethanol is now an important part of the US and Brazilian fuel systems
- This past summer, there were calls to suspend or reduce the RFS because of the drought.
  - However, ethanol is so well integrated in the fuel system, that a RFS change would have done little to change blending.
  - Ethanol is now less expensive than gasoline.

Positives

- Some advanced biofuel technologies are getting much closer to being economic
  - Envergent Technologies – RTP (pyrolysis)
  - CRI Catalyst – IH_2 – uses catalysts, H_2, and low heat and pressure to make drop-in fuels
  - Both project being commercial within 5 years.

Positives

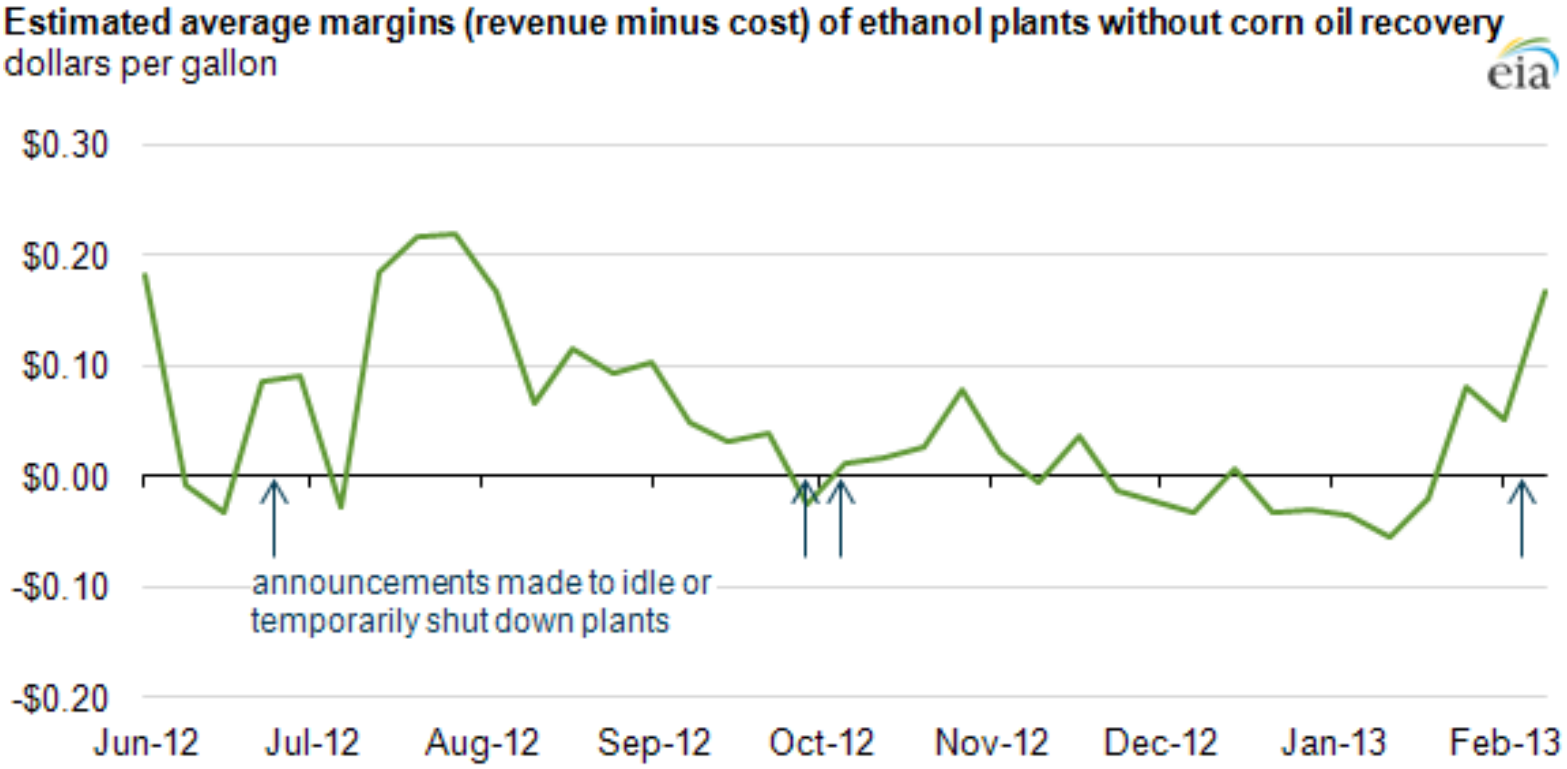
- The ethanol blend wall mainly affects the US and not other regions
- Climate change and GHG emissions seem to be getting more attention
- Aviation biofuels provide the best prospects for biofuels, and both the military and civil aviation are quite interested in biofuels.

Positives (continued)

- Changes in the RFS might help develop biofuels – removal of the out clause would benefit cellulosic biofuels.
- There is expansion in ethanol production in parts of Asia.
- Surge in RIN prices has pulled up corn ethanol price and increased profitability.

Positives (continued)

- Corn oil extraction is improving the profitability (or reducing the loss) of corn ethanol.

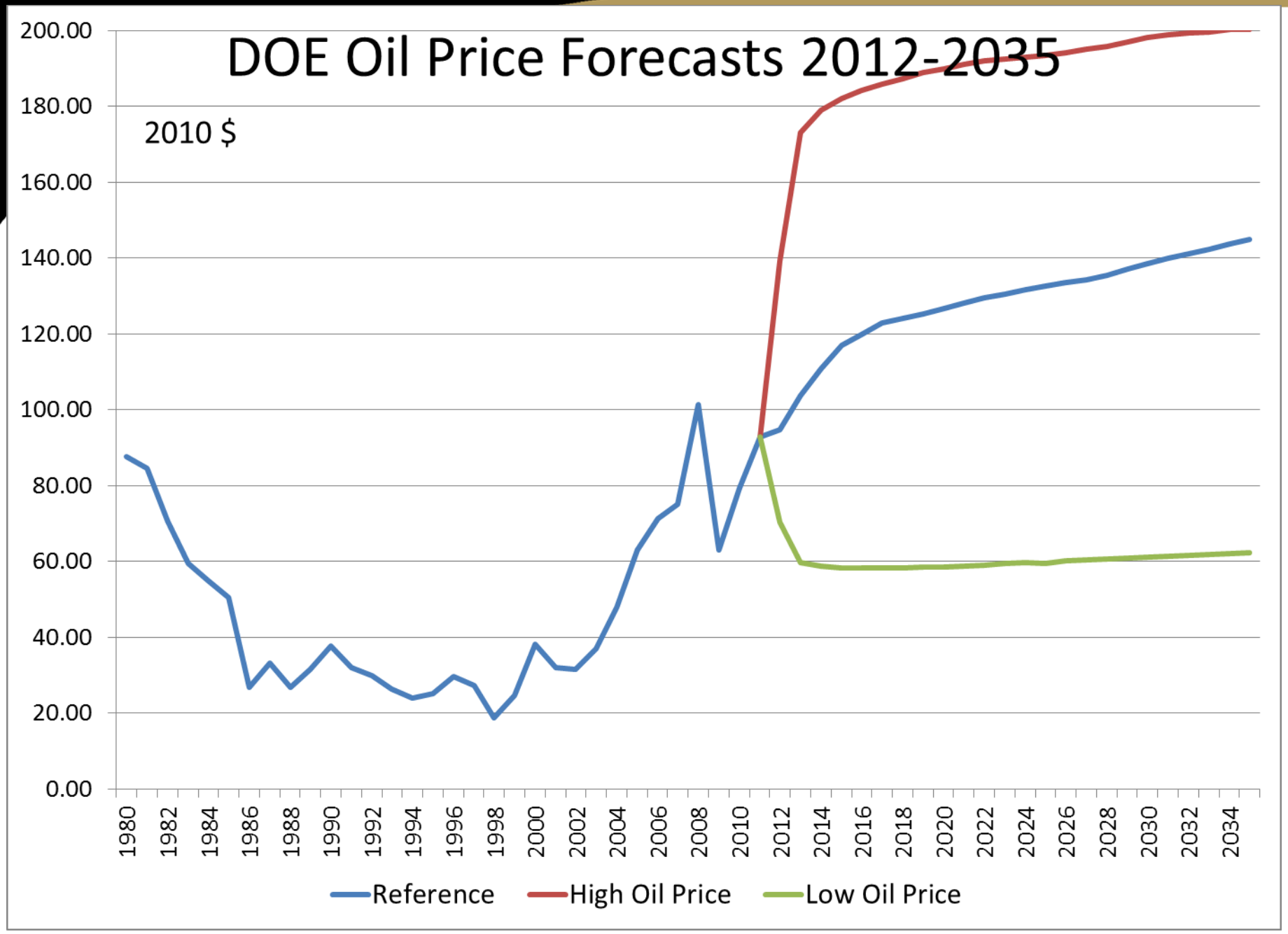


Positives

- Military remains interested in biofuels, and the DPA provisions could get 1-3 advanced biofuels plants built.
  - However, it appears the sequester, at least for now, has eliminated some of that funding.
- Reverse auction could get plants built, but no authority to implement today.

Second Generation Biofuel Uncertainties

- For cellulosic biofuels there are five major sources of uncertainty:
  - Future oil prices,
  - Feed stock costs and availability by region,
  - Conversion costs and efficiencies,
  - Environmental impacts,
  - Government policy.
- The combination of all of these uncertainties makes analysis of biofuels impacts highly uncertain.
- Add in the condition of the financial markets at present, and cellulosic biofuel investment becomes quite problematic.



Source: EIA, *Annual Energy Outlook 2012*

Feedstock Costs and Supply

- For many years, DOE used a cellulosic feedstock cost of $30/dry ton.
- Today we expect that corn stover may be more like $80 and dedicated energy crops closer to $110 or more per dry ton.
- Contracting mechanisms:
  - The production and delivery of biomass need long term contracts,
  - Contracts should meet the needs of farmers and conversion facilities.
  - The basic issue is how to index and share risks associated with the production and delivery.
- There is more than enough feedstock to meet the cellulosic RFS – the question is cost.

Technological Uncertainty

- All of the processes have a high degree of technical uncertainty.
- While in most cases, it is known that we can produce energy products using the technology, the question is at what cost.
- Thermochemical processes lead to “drop-in” fuels, which are attractive for many reasons.
- Biochemical processes go to ethanol

Conversion Costs

- Most estimates put the wholesale cost for biofuels from either biochemical or thermochemical conversion well over $4.00/gal. gasoline equivalent.
- Generally we need about $150 oil (Brent) or higher to make cellulosic biofuels competitive on a market basis with no government intervention.

Finding: Only in an economic environment characterized by high oil prices, technological breakthroughs, and a high implicit or actual carbon price would biofuels be cost-competitive with petroleum-based fuels.

- Biofuel Breakeven Model used to estimate:
  - The minimum price that biomass suppliers would be willing to accept for a dry ton of biomass delivered to the biorefinery gate.
  - The maximum price that processors would be willing to pay to at least break even.

Gap between supplier's price and processor's price is negative for all types of cellulosic biomass likely to be produced in 2022.

Price Gap Between Biomass Suppliers and Processors				
Cellulosic Feedstock	Supplier's Price	Processor's Price	**Price Gap (Per Dry Ton)**	Price Gap (Gallon of Ethanol)
Corn Stover in Corn-Soybean Rotation	$92	$25	**$67**	$0.96
Alfalfa	$118	$26	**$92**	$1.31
Switchgrass in the Midwest	$133	$26	**$106**	$1.51
Short Rotation Woody Crops	$89	$24	**$65**	$0.93
Forest Residues	$78	$24	**$54**	$0.77

Source: Examples from committee analysis in BioBreak model. Price of Oil $111/barrel. Biomass yield 70 gallons of ethanol per dry ton.

Finding: RFS2 cellulosic fuel mandate unlikely to be met in 2022

- No commercially viable biorefineries exist, to date, for converting lignocellulosic biomass to fuels.
- Aggressive deployment, in which the capacity build rate more than doubles the historic capacity build rate of corn-grain ethanol, necessary to produce 16 billion gallons of cellulosic biofuels by 2022.
- Policy uncertainties could deter investors from aggressive deployment.

Environmental Impacts

- The environmental impacts of cellulosic biofuels could be positive, as they create wildlife habitat and can reduce soil erosion.
- There has been some concern about possible local loss of biodiversity. This could arise if a biofuel plant were surrounded up to fifty miles by mostly miscanthus or switchgrass.

Government Policy

- RFS enforcement
- Blend wall – huge issue for ethanol
- Reverse auctions
- Cellulosic biofuel costs are higher than current market oil prices, but could be competitive if we priced energy security and/or GHG externalities.
- Key is to reduce uncertainty for private sector investors.

Conclusions

- Very difficult to go beyond identifying the key drivers
- There will be a big push to modify or end the RFS, given the blend wall, food/fuel issue, and other factors.
- Cellulosic biofuel seems closer than ever, but it is unlikely to be developed commercially in the current environment.

- “For my part I know nothing with any certainty, but the sight of the stars makes me dream.”

  Vincent Van Gogh

Thank you!

Questions and Comments

For more information:

http://www.agecon.purdue.edu

Click on faculty directory and then Tyner