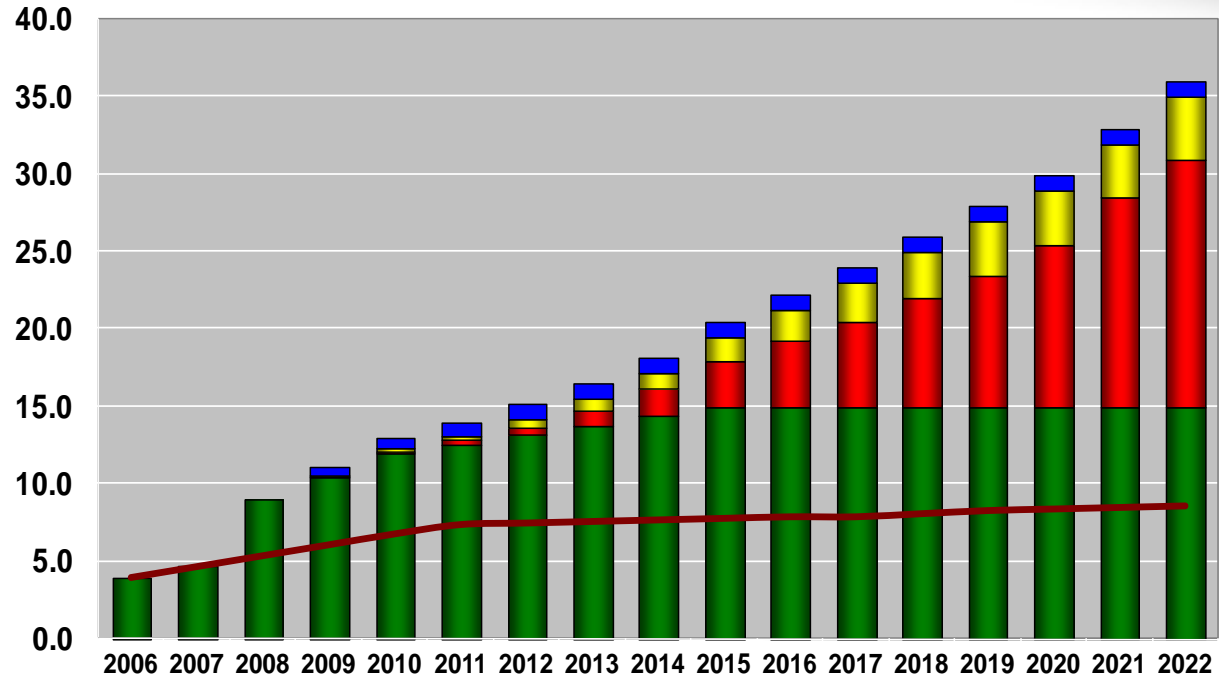


# **Is the Renewable Fuel Standard Sufficient to Motivate Cellulosic Biofuel Production?**

**2011 Asilomar Conference  
Rethinking Energy & Climate Strategies  
for Transportation**

**John Kneiss  
Hart Energy Consulting**

# RFS2 Requirements Under EISA



	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
<b>Biomass Based Diesel</b>				0.5	0.7	0.8	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
<b>Advanced not classified</b>				0.1	0.2	0.3	0.5	0.8	1.0	1.5	2.0	2.5	3.0	3.5	3.5	3.5	4.0
<b>Cellulosic Advanced</b>					0.1	0.25	0.5	1.0	1.8	3.0	4.25	5.5	7.0	8.5	10.5	13.5	16.0
<b>Conventional Biofuels</b>	4.0	4.7	9.0	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
<b>Previous RFS - PL 109-58</b>	4.0	4.7	5.4	6.1	6.8	7.4	7.5	7.6	7.7	7.8	7.9	7.9	8.1	8.3	8.4	8.5	8.6
<b>Total New RFS Requirement</b>	4.0	4.7	9.0	11.1	13.0	14.0	15.2	16.6	18.2	20.5	22.3	24.0	26.0	28.0	30.0	33.0	36.0

# Advanced Biofuel vs. Cellulosic Biofuel

**EISA sets different GHG reduction levels for biofuels**

- **Advanced Biofuels – 50% below baseline**
- **Cellulosic Biofuels – 60% below baseline**

**Advanced biofuel – from any renewable feedstock other than corn-starch**

**Renewable Biomass includes:**

- **Planted crops (grasses) and crop residues (stover)**
- **Planted trees and tree residues (some restrictions apply)**
- **Animal wastes**
- **Clearings, yard wastes**
- **Algae**

# RFS2 Volume Requirements

## 2011 RFS 2 Requirements

Category	Actual Volume (gallons)	Percentage Standard (RVO)	EISA Volume Requirement
Cellulosic Biofuel	0.006 billion	0.003	0.25 billion
Biomass-Based Diesel	0.80 billion	0.69	0.80 billion
Advanced Biofuel	1.35 billion	1.35	1.35 billion
Renewable Fuel	13.95 billion	8.01	14.0 billion

## 2012 Proposed RFS 2 Requirements

Category	Actual Volume (gallons)	Percentage Standard (RVO)	EISA Volume Requirement
Cellulosic Biofuel	0.00345 to 0.0129 billion	0.002 to 0.01	0.50 billion
Biomass-Based Diesel	1.0 billion	0.91	1.0 billion
Advanced Biofuel	2.0 billion	1.21	2.0 billion
Renewable Fuel	15.2 billion	9.21	15.2 billion

# EPA - 2012 Potential Cellulosic Biofuel Volume

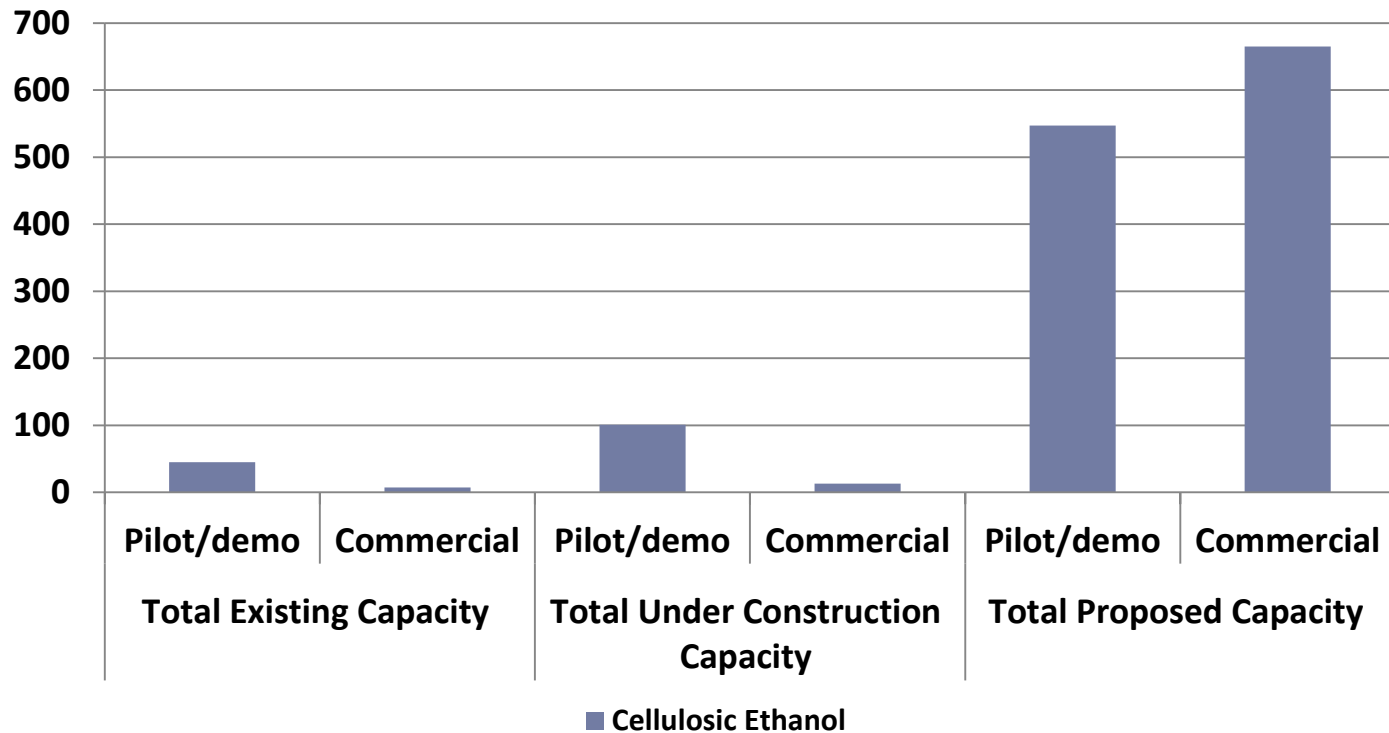
Company	Location/Status	Feedstock	Fuel Made	Volume
DuPont Danisco	Tennessee (online)	Corn Stover	Ethanol	0.25 million gal.
Fiberright	Iowa (online)	MSW	Ethanol	3 million gal.
Fulcrum Bioenergy	Nevada (2012)	MSW	Ethanol	0.5 million gal.
INEOS Bio	Florida (2012)	Ag Residue	Ethanol	3 million gal.
KiOR	Texas	Ag Residue	Gasoline/ Diesel	0.2 million gal.
KiOR	Mississippi (2012)	Pulp Wood	Gasoline/ Diesel	4 million gal.
KL energy	Wyoming (online)	Wood Waste	Ethanol	1 million gal.
Terrabon	Texas (2012)	MSW	Gasoline	0.7 million gal.
ZeaChem	Oregon (2011)	Tree Harvest	Ethanol	0.25 million gal.

# Next-Generation Biofuels Facilities in North America

(U.S. and Canada in parenthesis)

Product	Total number of facilities			Total annual production capacity (million gallons)		
	Pilot/demo	Commercial	Total	Pilot/demo	Commercial	Total
Biobutanol	1	2	3	-	19.5	19.5
Cellulosic Ethanol	32 (5)	9 (2)	41 (7)	251	170 (34)	421 (34)
FT Liquids / Hydrocarbon	3	4	7	0.2	126	126
Synthetic Gasoline	2	0	2	0.01	0	0.01
Non-FT Hydrocarbon Diesel/Jet Fuel	3	3	6	5.1	232	237
<b>Total</b>	<b>41 (5)</b>	<b>18 (2)</b>	<b>59 (7)</b>	<b>257</b>	<b>547 (34)</b>	<b>804 (35)</b>

# Global Cellulosic Ethanol Facilities (in million gallons)



# Refinery Industry Investments in Advanced Biofuels

- **BP – Verenum/Qteros/Synthetic Genomics/DuPont (\$1.6 Bn since 2006)**
- **Chevron – Solazyme/LS9 (undisclosed in 2010)**
- **ConocoPhillips – ADM/Tyson Foods (\$25 MM est)**
- **ExxonMobil – Synthetic Genomics (\$300 MM)**
- **Neste Oil – NExBTL facilities (\$3.2 BN)**
- **Marathon Oil – Mascoma (\$10 MM)**
- **Shell Oil – Iogen/Codexis/Choren/Solana (\$500 MM est.)**
- **Total – Gevo (\$40 MM)**
- **Valero – Terrabon/Qteros/Solix (undisclosed)**



# Other Facility Investments

- **Abengoa Bioenergy (Kansas &**
  - **commercial scale of 12 million gal/yr**
  - **DOE grant - \$76 million; loan guarantee - \$134 million**
  - **planned start in 2013**
- **Poet LLC (Iowa)**
  - **commercial scale of 25 million gal/yr**
  - **USDA loan guarantee - \$105 million**
  - **construction to start this year; operations in 2013**
- **BlueFire Renewables (California)**
  - **Commercial scale of 19 million gal/yr**
  - **site preparation started; start-up planned for 2013**
  - **USDA loan guarantee application pending**

# Recent Developments

- **DOE – Lawrence Berkeley Nat'l Lab demonstration research facility**
- **USDA expansion of Biomass Crop Assistance Program project areas**
- **DOE updated “billion-ton biomass supply” study confirms biomass availability to displace up to 30% of current petroleum use**
- **DOE/USDA/Dept. of Navy issue Request for Information (RFI) – seek input on needs to bring Advance Biofuel industry to commercialization (focus on aviation & marine diesel biofuels)**

# Challenges to Cellulosic Biofuel Production

- **Most significant impediment – access to capital funding & investment for commercial scale development**
- **Technology – ability to scale up operations & maintain efficiencies & yields**
- **Construction & operation costs – infrastructure, enzymes, feedstocks, storage-transport-delivery**
- **Competition with power generation (co-fired) for cellulosic feedstock**
- **Coordination of entire supply chain to ensure efficiency & economic competitiveness**
- **Energy return on energy invested – land use change & lifecycle GHG reductions**

# Policy Issues

- **Likely expiration of VEETC (blender tax credit) & alternative fuels mixture credit after Dec. 2011**
- **Cellulosic biofuels production tax credit expires after Dec. 2012**
- **Risk of government funding losses due to budget deficit cutbacks**
- **Farm bill reauthorization due in 2012**
- **E15 implementation**
- **Next year is Presidential election**

# Outlook for Cellulosic Biofuels

- **Industry & research centers can improve cooperation to identify technology hurdles & solutions**
- **“Biorefining” concept of multiple (or at least several) product lines – low volume with high value (pharmaceuticals); high volume with low value (fuels)**
- **Oil industry expected to be major investor – policy makes them the main ‘consumer’ of renewable fuels**
- **Aviation industry can be significant support of advanced biofuels, especially in EU**
- **Continuation of RFS2 program as established – no RFS3, for now**

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