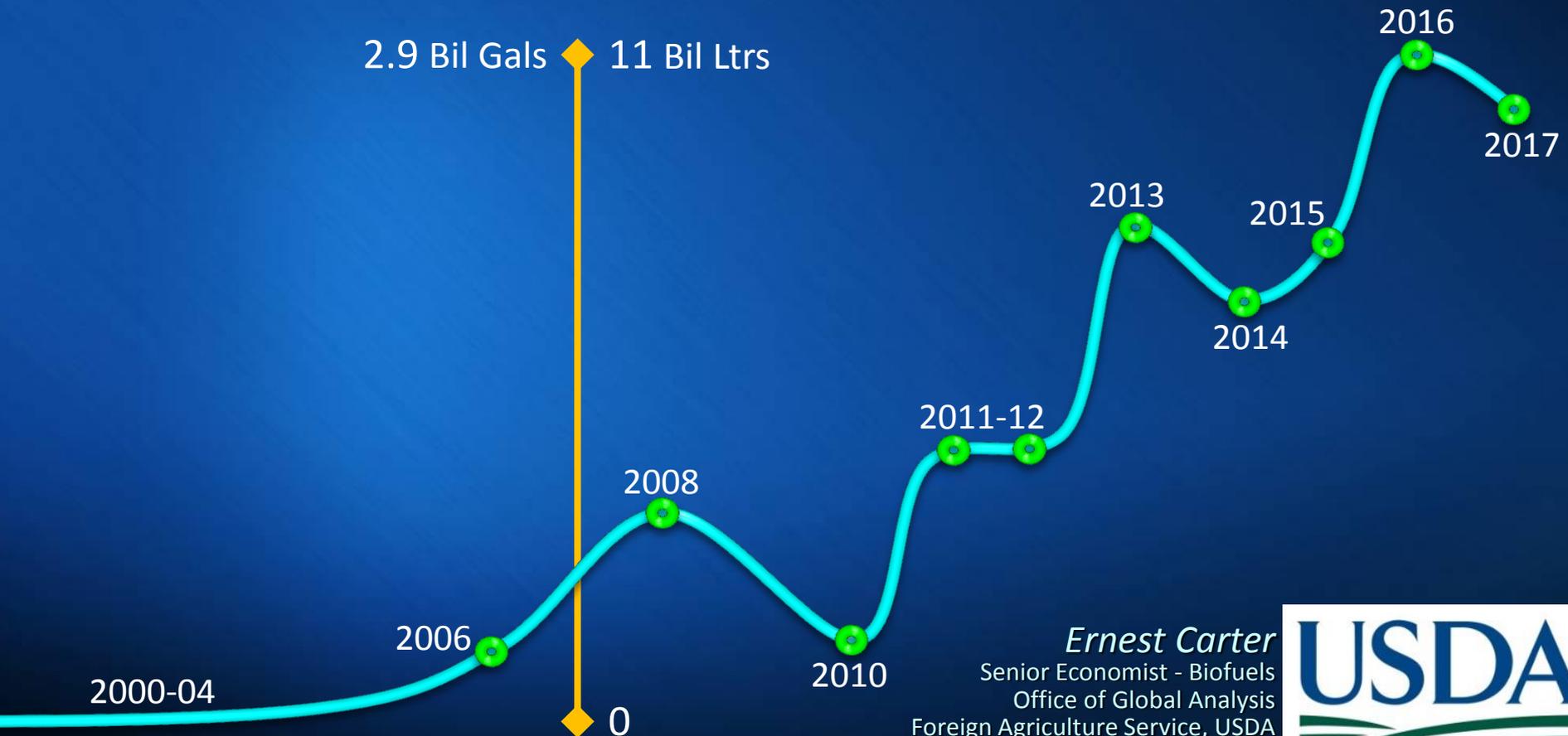


The U.S. Biodiesel/Renewable Diesel Market

Factors Driving Change Through 2017



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USDA's Interest in Biofuels

USDA Programs and Activities Support Industry

USDA Interests

- ❑ Advance the biomass economy to support rural communities.
- ❑ Report on biofuel markets & demand for grains & oilseeds to support market efficiency.

USDA Programs & Activities

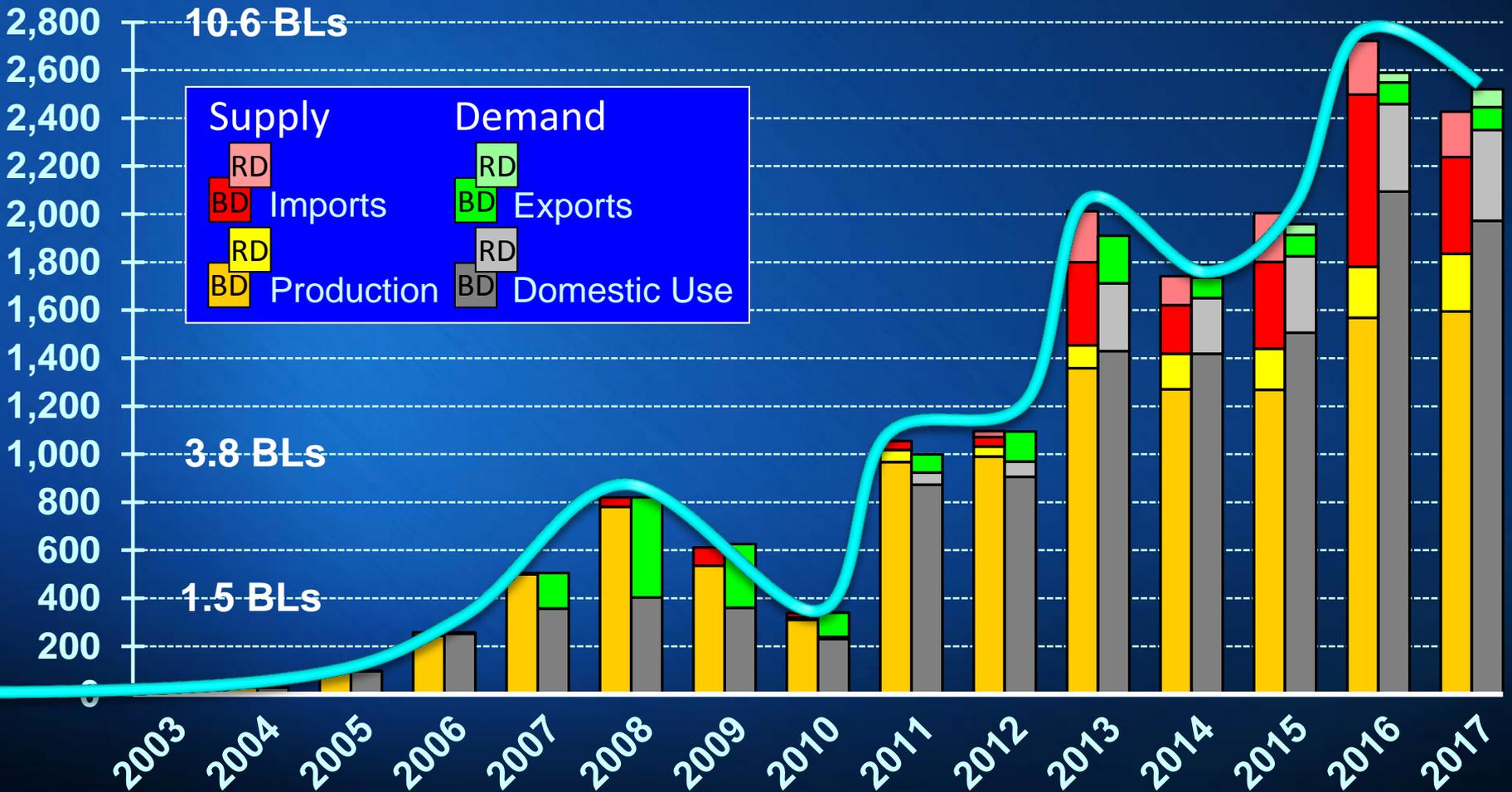
- ❑ 2014 Farm Bill Energy Title IX has \$694 million in 'mandatory' funding (loans & payments) covering crop **research** & biomass handling technologies for cellulosic fuels, **biorefinery redesign** to produce advanced fuels and bio-based products, and **education**. Additional 'discretionary' funding supports research. Grants to build **market infrastructure** to expand delivery of high ethanol blends.
- ❑ Office of the Chief Economist supports biofuel **market studies & research**.
- ❑ FAS **market reports** on the EU and 14 other countries; interagency monthly, **near-term forecasts on US corn & soyoil use in biofuels**, and annual, **long-term projections on US and foreign agricultural markets**.
- ❑ FAS **overseas market promotion** to expand the global ethanol market.
- ❑ FAS **foreign policy engagement** on barriers to biofuel trade.



US Biodiesel & Renewable Diesel Market 2000-17: Uneven Start Followed by Growth

The Renewable Fuel Standard sets long-term policy. EPA rulings setting annual volumes drove BBD use above statutory minimum while state mandate & tax policy support local demand. Legal challenges, federal tax policy, and trade policy create risk.

MGals



BBD = BD + RD. BD = biodiesel (fatty acid methyl ester); RD = renewable diesel (only HVO is commercialized) + small amount of biojet fuel; MGs (million gallons); BLs (billion liters).

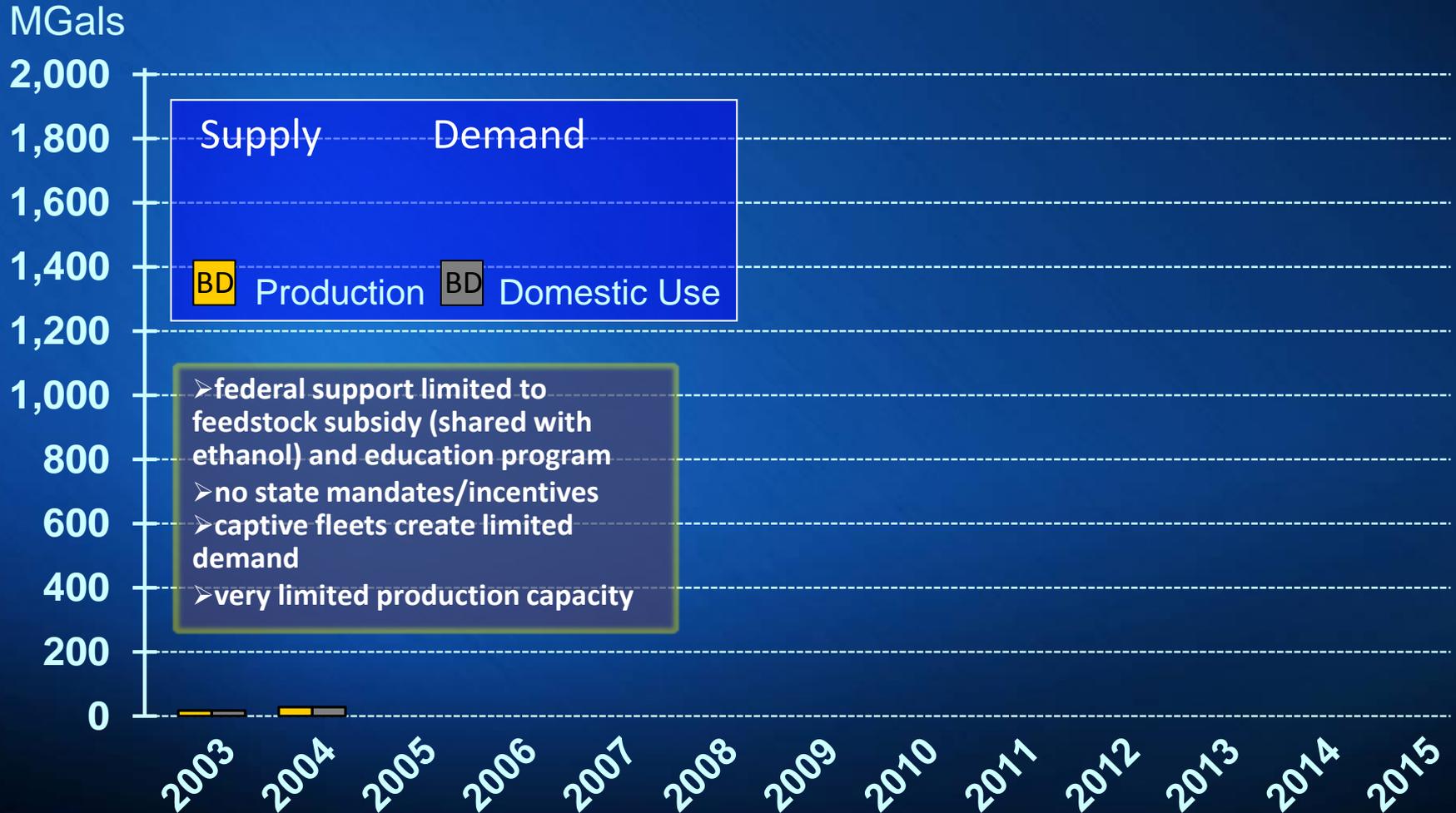


Early Years

2000-04: Limited Production and Use; No Trade

CCC Bioenergy Prog (2000-6) →

Nat Biodiesel Ed. Prog (2003 – today) →



- > federal support limited to feedstock subsidy (shared with ethanol) and education program
- > no state mandates/incentives
- > captive fleets create limited demand
- > very limited production capacity

BBD = BD + RD. BD = biodiesel (fatty acid methyl ester); RD = renewable diesel (only HVO is commercialized) + small amount of biojet fuel; MGs (million gallons); BLs (billion liters).



Expansion & Collapse

2005-10: Exports are Key Driver; Domestic Use is Unstable

CCC Bioenergy Prog (2000-6) →

Nat Biodiesel Ed. Prog (2003 – today) →

Federal tax credit (2005 – today) →

State mandates/incentives (2005 – today) →

MGals

2,000

1,800

1,600

1,400

1,200

1,000

800

600

400

200

0



Domestic Use Rises

- \$1/gal federal tax credit
- state mandates/incentives
- production shifts from mainly soyoil to multi-feedstock production in 2008 to control costs



3.0 BLs

1.5 BLs

BBD = BD + RD. BD = biodiesel (fatty acid methyl ester); RD = renewable diesel (only HVO is currently commercialized); MGs (million gallons); BLs (billion liters).



Expansion & Collapse

2005-10: Exports are Key Driver; Domestic Use is Unstable

CCC Bioenergy Prog (2000-6) →

Nat Biodiesel Ed. Prog (2003 – today) →

Federal tax credit (2005 – today) →

State mandates/incentives (2005 – today) →

MGals

2,000

1,800

1,600

1,400

1,200

1,000

800

600

400

200

0



Exports Drive
Two-thirds of
Production
Expansion

- 50% of production exported by 2008 (mostly Europe)
- production capacity swells to 2.5 BGs

3.0 BLs

1.5 BLs

2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015

BBD = BD + RD. BD = biodiesel (fatty acid methyl ester); RD = renewable diesel (only HVO is commercialized) + small amount of biojet fuel; MGs (million gallons); BLs (billion liters).



Expansion & Collapse

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MGals

2,000

1,800

1,600

1,400

1,200

1,000

800

600

400

200

0

Supply

BD Imports

BD Production

Demand

BD Exports

BD Domestic Use

Exports Collapse

➤ Europe imposes Cv/AD duties

Domestic Use Collapses

➤ RFS2 ruling delayed 20 months to June 2010

➤ 12-month lapse in blenders credit (2009)

➤ Financial Crises of 2008 freezes credit markets, and ensuing severe recession causes on-road diesel use to drop 9% from 2008 to 2009

3.0 BLs

1.5 BLs

2003

2004

2005

2006

2007

2008

2009

2010

2011

2012

2013

2014

2015

BBD = BD + RD. BD = biodiesel (fatty acid methyl ester); RD = renewable diesel (only HVO is commercialized) + small amount of biojet fuel; MGs (million gallons); BLs (billion liters).



Expansion Resumes on Surer Footing

2011-12: RFS 2 Builds Domestic Use; Trade is Limited

CCC Bioenergy Prog (2000-6) →

Nat Biodiesel Ed. Prog (2003 – today) →

Federal tax credit (2005 – today) →

State mandates/incentives (2005 – today) →

RFS2, EPA rulings, RINs (2009 – today) →

MGals

2,000

1,800

1,600

1,400

1,200

1,000

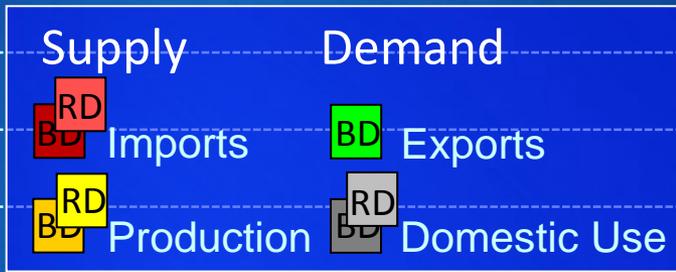
800

600

400

200

0



➤ First RFS2 rulings impacting BD and RD use are finalized in June 2010 (20 months late); BBD & UAB obligations (mandates) reach 1 BGs & 490 MGs by 2012, respectively.

3.8 BLs

1.5 BLs

2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015

BBD = biomass-based diesel (BD+RD); UAB = undifferentiated (non-cellulosic) advanced biofuels (measured in ethanol vols).



Renewable Fuel Obligations - Energy Acts of 2005 & 2007

Comparing Original RFS Schedules with EPA Final Rules

Renewable Fuel Obligations Under the Energy Acts of 2005 & 2007 for RFS1 (2006-08) & RFS2 (2009-22)

Billions of Gallons

Year	Conventional Biofuel 1/ 2/		Advanced Biofuel								Total Renewable Fuel 1/	
			Cellulosic Biofuel 1/		Biomass-based Diesel (BBD) 3/4/		Other Advanced Biofuel 1/5/		Total Advanced 1/			
	Original Schedule	Final Rule	Original Schedule	Final Rule	Original Schedule	Final Rule	Original Schedule	Final Rule	Original Schedule	Final Rule	Original Schedule	Final Rule
2006	4.0	4.00									4.00	4.00
2007	4.7	4.70									4.70	4.70
2008	5.4	9.00	Biodiesel & Renewable Diesel Fill These Categories								5.40	9.00
2009	10.5	10.50	n/a	n/a	0.50	0.50	0.10	0.10000	0.60	0.60	11.10	11.10
2010 6/	12.0	12.00	0.10	0.00500	0.65	0.65	-0.13	-0.03000	0.95	0.95	12.95	12.95
2011	12.6	12.60	0.25	0.00600	0.80	0.80	-0.10	0.14400	1.35	1.35	13.95	13.95
2012	13.2	13.20	0.50	0.01045	1.00	1.00	0.00	0.48955	2.00	2.00	15.20	15.20
2013	13.8	13.80	1.00	0.00600	1.00	1.28	0.25	0.82400	2.75	2.75	16.55	16.55
2014	14.4	13.61	1.75	0.03300	1.00	1.63	0.50	0.19200	3.75	2.67	18.15	16.28
2015	15.0	14.05	3.00	0.12300	1.00	1.73	1.00	0.16200	5.50	2.88	20.50	16.93
2016	15.0	14.50	4.25	0.23000	1.00	1.90	1.50	0.53000	7.25	3.61	22.25	18.11
2017	15.0	15.00	5.50	0.31100	1.00	2.00	2.00	0.96900	9.00	4.28	24.00	19.28
2018	15.0	15.00	7.00	0.28800	1.00	2.10	2.50	0.85200	11.00	4.29	26.00	19.29
2019	15.0		8.50		1.00	2.10	3.00		13.00		28.00	
2020	15.0		10.50		1.00		3.00		15.00		30.00	
2021	15.0		13.50		1.00		3.00		18.00		33.00	
2022	15.0		16.00		1.00		3.50		21.00		36.00	

- 1/ Volumes are in ethanol-equivalent. Actual volumes blended will be lower if any portion contains fuels with energy content greater than ethanol.
- 2/ Not published by EPA. "Implied" volumes are calculated by subtracting total advanced by total renewable fuel. Nearly all is corn ethanol.
- 3/ BBD values are actual vols, not ethanol-equivalent vols. Multiply biodiesel & renewable diesel values by 1.5 and 1.7 to find ethanol-equivalent vols.
- 4/ Starting in 2012, BBD volumes may be no less than 1 billion gallons.
- 5/ Not published by EPA. Known as "undifferentiated (non-cellulosic) advanced biofuel." Equals total advanced minus cellulosic biofuel minus (BBD x 1.5). Negative values for 2010 and 2011 indicate that obligations for BBD were set high enough so that when met no additional advanced biofuel was needed to meet obligation for Total Advanced.
- 6/ Delay in EPA rule-making resulted in combining BBD 2009 & 2010 obligations into a single BBD obligation for 2010.

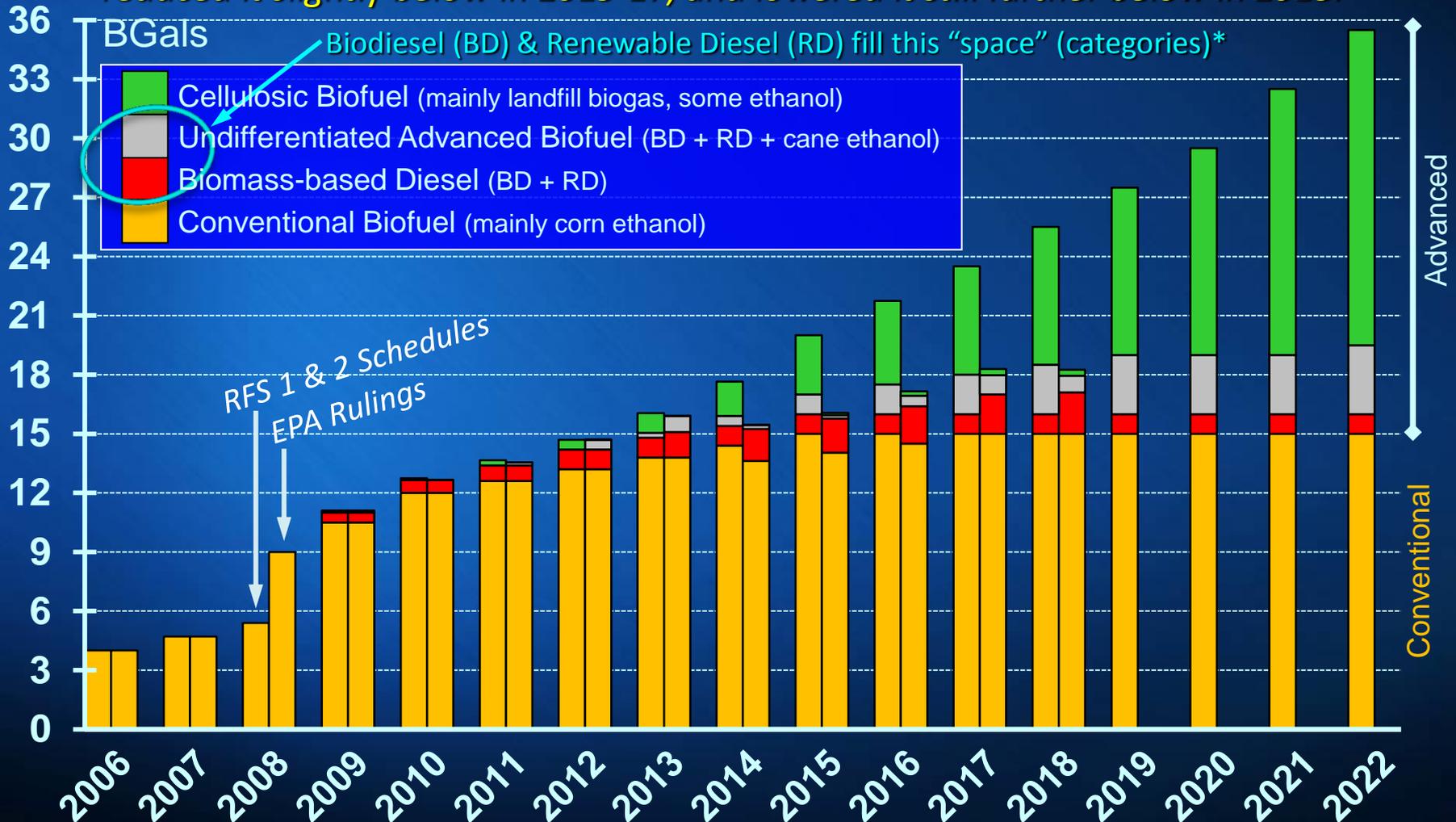
Updated: ECarter, OGA/FAS/USDA, May 2018.



Renewable Fuel Obligations - Energy Acts of 2005 & 2007

Comparing Original RFS Schedules with EPA Final Rules

Advanced biofuels remain far behind original schedule due to lack of cellulosic fuels. EPA rulings increased the “space” for BD/RD above the original schedule thru 2014, reduced it slightly below in 2015-17, and lowered it still further below in 2018.



*BBD can also fill the “conventional” biofuel category but this is rare. Schedule for RFS 2 ends in 2022.



Expansion Continues

2013-17: EPA Rulings & California's LCFS Build Domestic BBD Use; Renewable Diesel Arrives; Biodiesel Imports Surge Then Retreat

CCC Bioenergy Program 2000-6

Nat Biodiesel Ed. Prog (2003 – today)

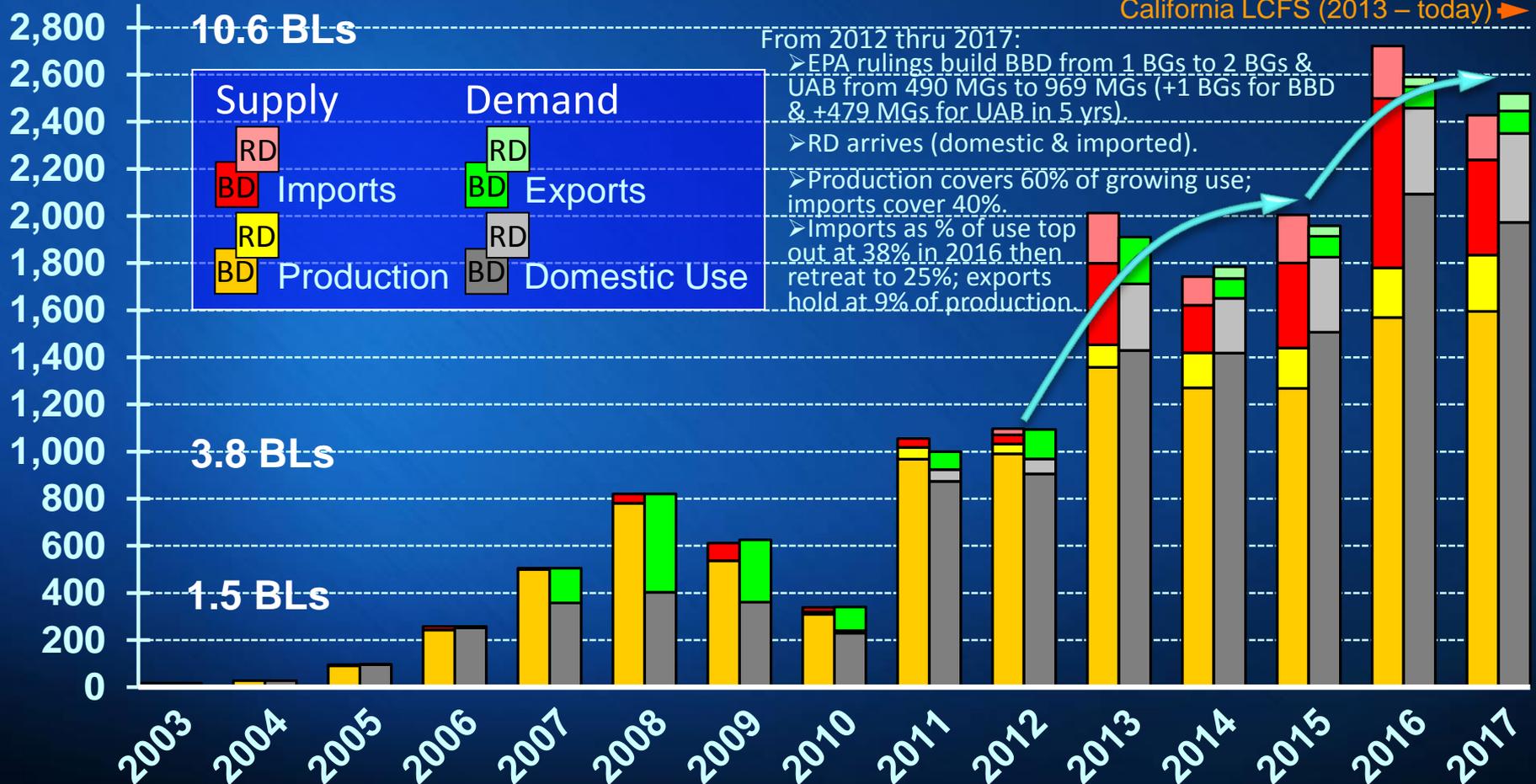
Federal tax credit (2005 – today)

State mandates/incentives (2005 – today)

RFS2, EPA rulings, RINs (2009 – today)

California LCFS (2013 – today)

MGals



BBD = biomass-based diesel (BD+RD). BD = mostly road transport biodiesel, some off-road transport and heating oil; RD = mostly drop-in road transport renewable diesel, but some biojet starting 2016. UAB = undifferentiated (non-cellulosic) advanced biofuels (ethanol vols).



US Biodiesel & Renewable Diesel Market

Annual Supply/Demand Balances

US Biomass-based Diesel (BBD) Supply/Demand, MGals

BBD = Biodiesel (FAME) + Renewable Diesel (RD); RD = drop-in renewable diesel (transport & heating oil) + biojet fuel

Year	SUPPLY									DEMAND									Reliance		Reliance	
	BEGIN STOCKS			PRODUCTION			IMPORTS			DOMESTIC USE			EXPORTS			END STOCKS			Exp	Imp	Exp	Imp
	FAME	RD	TOTAL	FAME	RD	TOTAL	FAME	RD	TOTAL	FAME	RD	TOTAL	FAME	RD	TOTAL	FAME	RD	TOTAL	FAME	FAME + RD		
2000				2.0		2.0				2.0		2.0										
2001				8.1		8.1				8.1		8.1										
2002				13.8		13.8				13.8		13.8										
2003				17.6		17.6				17.6		17.6										
2004				28.0		28.0				28.0		28.0										
2005				91.2		91.2	4.2		4.2	95.0		95.0	0.5		0.5			0%	4%	0%	4%	
2006				243.4		243.4	14.4		14.4	252.4		252.4	5.5		5.5			2%	6%	2%	6%	
2007				499.7		499.7	5.0		5.0	357.3		357.3	147.3		147.3			29%	1%	29%	1%	
2008				780.6		780.6	40.3		40.3	402.8		402.8	418.1		418.1			54%	10%	54%	10%	
2009	44.0	0.0	44.0	536.3		536.3	74.8		74.8	360.9		360.9	264.2		264.2	29.9		49%	21%	49%	21%	
2010	29.9	0.0	29.9	310.4	9.7	320.1	18.5		18.5	229.4	9.7	239.2	101.1		101.1	28.2	0.0	33%	8%	32%	8%	
2011	28.2	0.0	28.2	967.5	50.3	1,017.8	37.5		37.5	873.3	50.0	923.3	75.7		75.7	84.2	0.3	8%	4%	7%	4%	
2012	84.2	0.3	84.5	990.0	42.0	1,032.0	39.3	25.4	64.7	905.6	63.7	969.3	124.6		124.6	83.3	3.9	13%	4%	12%	7%	
2013	83.3	3.9	87.3	1,358.0	95.4	1,453.4	346.1	212.9	559.0	1,428.9	283.2	1,712.0	198.5		198.5	160.0	29.0	15%	24%	14%	33%	
2014	160.0	29.0	189.0	1,271.0	147.7	1,418.7	202.7	120.7	323.4	1,418.6	232.3	1,650.9	83.6	50.4	134.0	131.5	14.7	7%	14%	9%	20%	
2015	131.5	14.7	146.2	1,268.0	171.4	1,439.4	361.3	203.7	564.9	1,506.5	318.8	1,825.3	88.7	44.4	133.1	165.6	26.6	7%	24%	9%	31%	
2016	165.6	26.6	192.2	1,569.0	211.5	1,780.5	718.4	222.8	941.2	2,093.5	364.6	2,458.1	90.8	41.1	131.9	268.7	55.2	6%	34%	7%	38%	
2017	268.7	55.2	323.9	1,595.0	239.4	1,834.4	403.4	189.4	592.8	1,972.5	378.0	2,350.5	95.1	74.4	169.5	199.5	31.6	6%	20%	9%	25%	

Prepared by: Ernest Carter, Office of Global Analysis, Foreign Agricultural Service/USDA, Washington, DC.

Export reliance = exports/production

Sources: Fame Production: 2000-05 (CCC Bioenergy Program, USDA); 2006-10 DOC Industry Survey (Rpt M311K); 2011-forward (DOE/EIA)

Import reliance = imports/dom. use

Fame Trade: DOC/US Census Bureau, B30-100 Chapt. 38 HTS codes (assume B100) plus Petroleum Oils Containing Biodiesel (>B30) Chapter. 27 HTS codes (assume average B5 content) beginning 2012. Include errata updates thru 2017

RD Production and Exports (includes biojet): Ryan Ruikka of PRX (ProExporter Network) using EPA RIN & company reports (REG Geismar Dynamic Fuels, Darling Corp Diamond Green, AltAir Fuels, UOP Honeywell), updated March 2018.

RD Imports: DOE/EIA "Company Level Imports" from Petroleum and Other Liquids, product code = 205

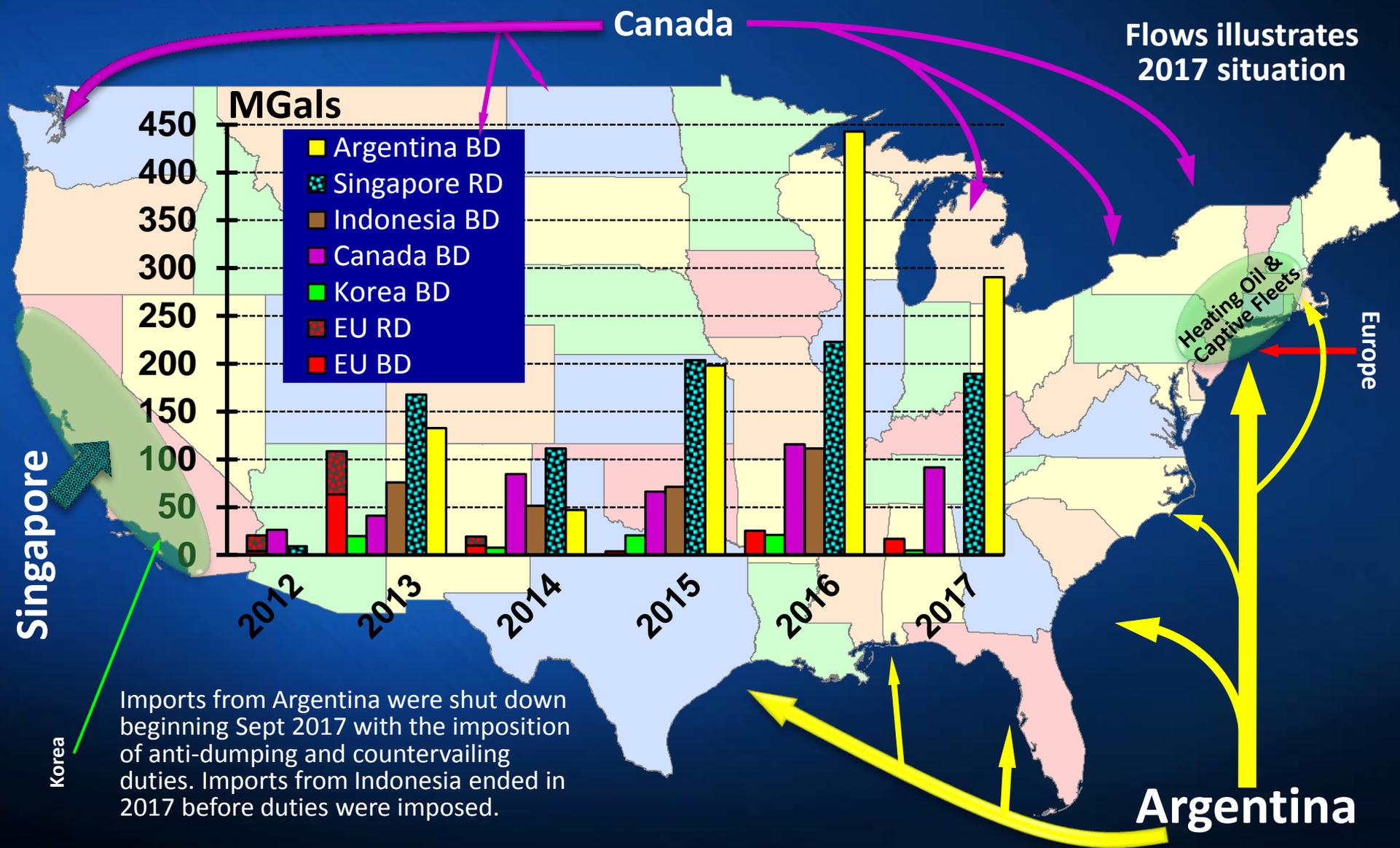
Fame & RD Domestic Use: derived by balancing all other elements of supply and demand.

Fame Stocks: DOE/Energy Information Agency (EIA), Monthly Energy Review (MER), Table 10.4 RD Stocks: EIA Monthly Petroleum Supply Report (PSM) minus MER



US Biodiesel (BD) & Renewable Diesel (RD) Imports

Imports Target California & Other Coastal Deficit Regions





US Biodiesel/Renewable Diesel Market

Final Observations for This 2.35 Billion Gallon Market (2017)

State Policies Create Regional Pools of Demand

- ✓ Beginning 2013, California's LCFS & carbon market have raised the use of BBD, and pushed the state's blending rate to three times the national average or 13% by 2017. As an aside, biogas rose to 67% of the state's LNG/CNG market in 2017. Oregon has more recently adopted a similar program .
- ✓ Other state tax credits and blend mandates create regional pools of demand. Following California, in descending order of size, are Texas, Illinois, Oregon, Minnesota, New York (residential/commercial heating), Iowa, and Pennsylvania.

Earlier BBD Trade Surplus Has Become a Trade Deficit

- ✓ Small trade deficit in 2005-6, was followed by a surplus in 2007-12 which was especially large (140-380 MGs) in 2007-9 with biodiesel exports to EU peaking prior to the EU imposition of AD/Cv duties.
- ✓ Since 2013, the trade balance has remained negative peaking at (-)810 MGs in 2016 due to 1) little overall growth in exports (EU duties applied in 2009 were extended in 2015), and 2) expanding imports, mainly biodiesel from Argentina (Indonesia as well) and renewable diesel from Singapore.
- ✓ From 2016 to 2017, the deficit fell by half as imports declined due to the imposition of US AD/Cv duties on Argentina & Indonesia.

Future Market Expansion Through Higher Blending, Not Fuel Pool Growth

- ✓ Distillate fuel oil use was 60.8 BGs in 2016, of which 40.2 BGs was used on-highway and 5.6 BGs for heating oil. EIA projects the on-highway pool will decline thru 2035 assuming fleet efficiency gains.
- ✓ Biodiesel use of 2.35 BGs (2017) equals a national average blend rate close to B4 for markets now blending, so there is a lot of room to expand from a technical standpoint since nearly all OEMs approve the use of B20. By comparison, Brazil, Argentina & Indonesia are near or just above B10.
- ✓ B10 for US nationwide on-highway plus the Northeast heating oil market currently equals about 4.4 BGs of biofuel; extending B10 to the entire distillate market raises the figure to 6 BGs.