

# **Bio-Energy & Chemicals: Follow The Money**



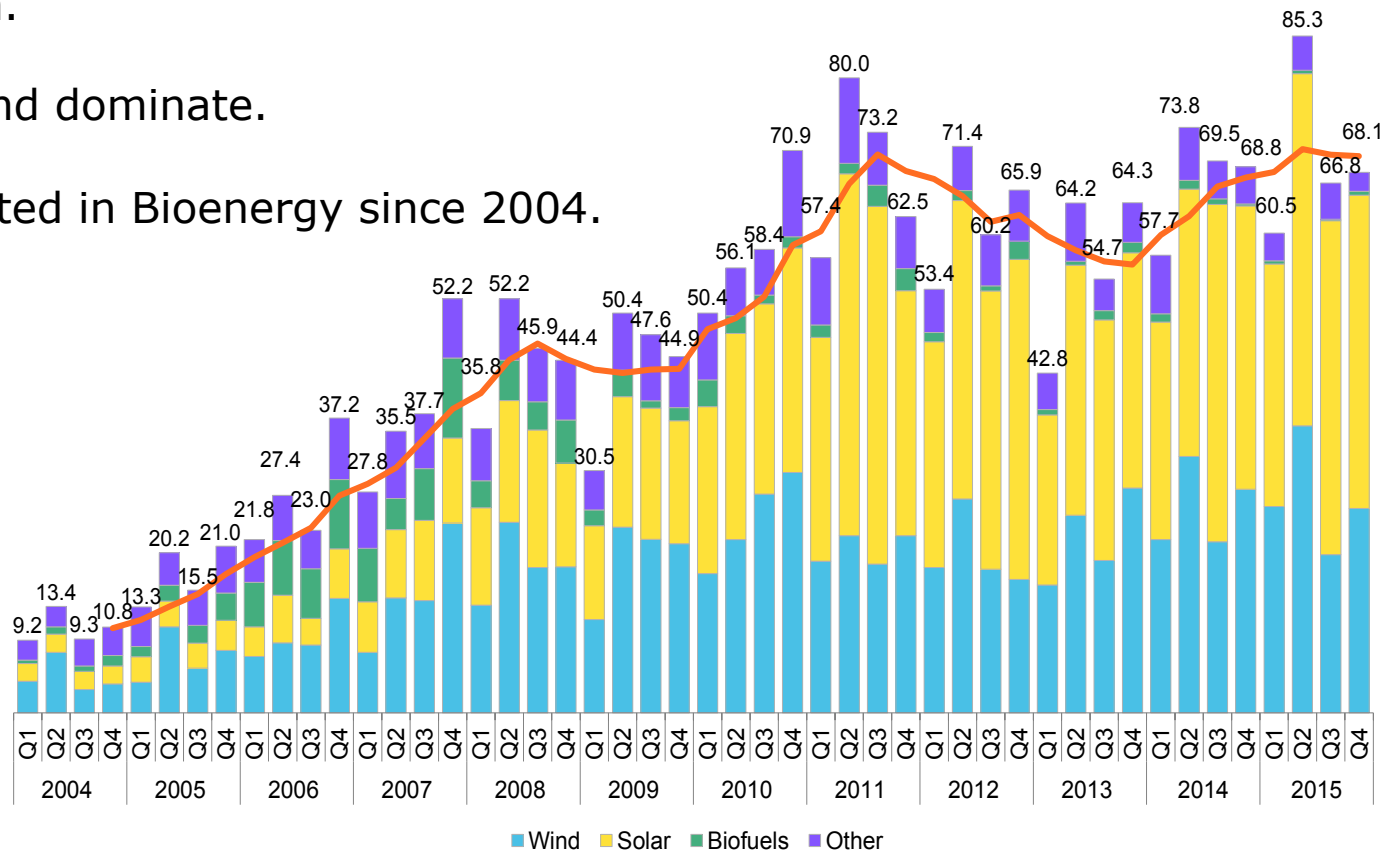
**by  
Don Roberts  
CEO, Nawitka Capital Advisors Ltd.**



**June 2016  
Prince George, British Columbia**

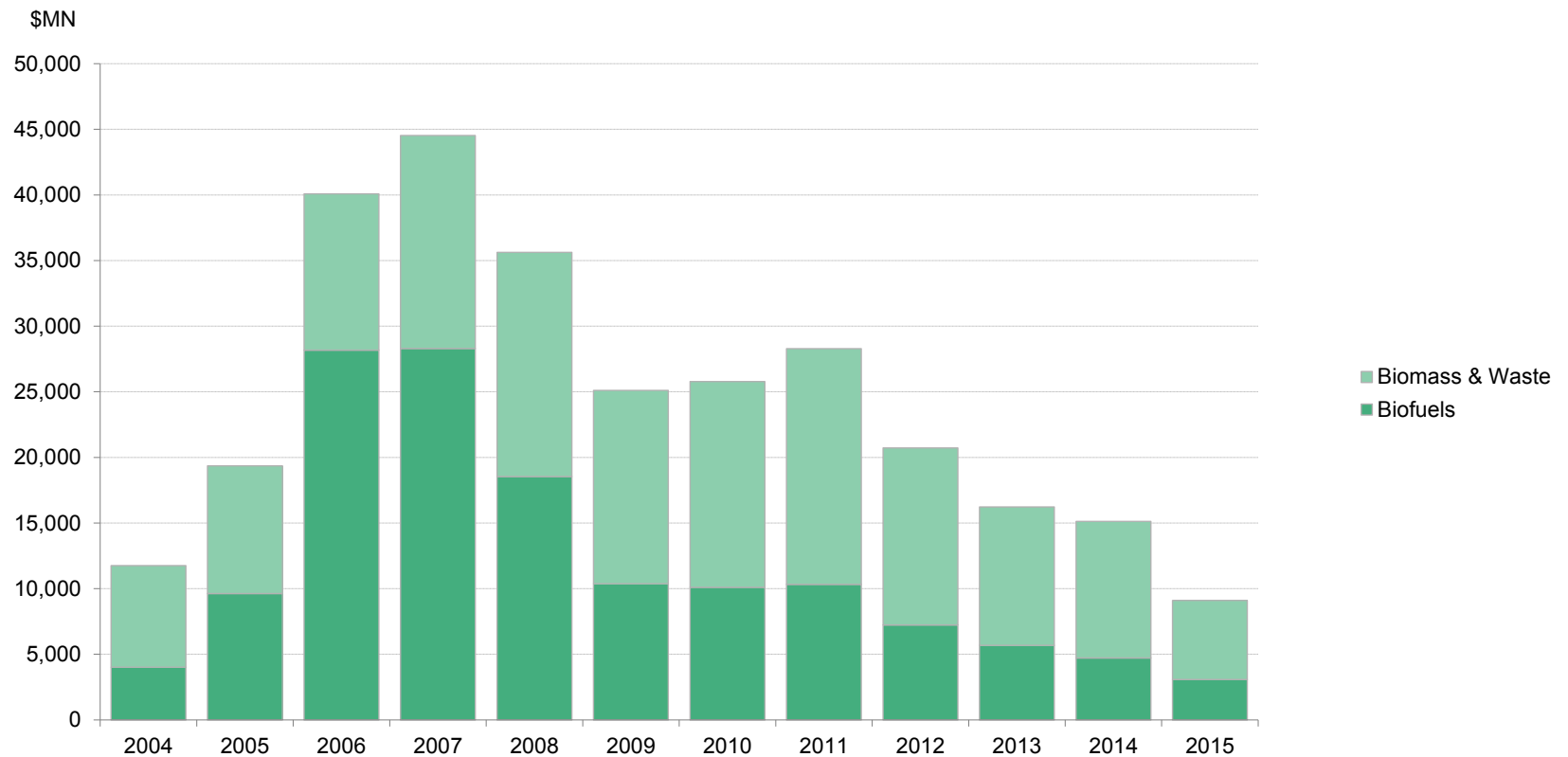
## New Investment in Clean Energy by Sector 2004-2015 (\$BN)

- Global New Investment in Clean Energy reached ~\$330 billion in 2015 - a new record high.
- Solar & Wind dominate.
- <1% invested in Bioenergy since 2004.



Source: Bloomberg New Energy Finance, Nawitka

## Global Bioenergy Investment (2004-2015): Asset Finance, R&D, Public Markets, VC/PE



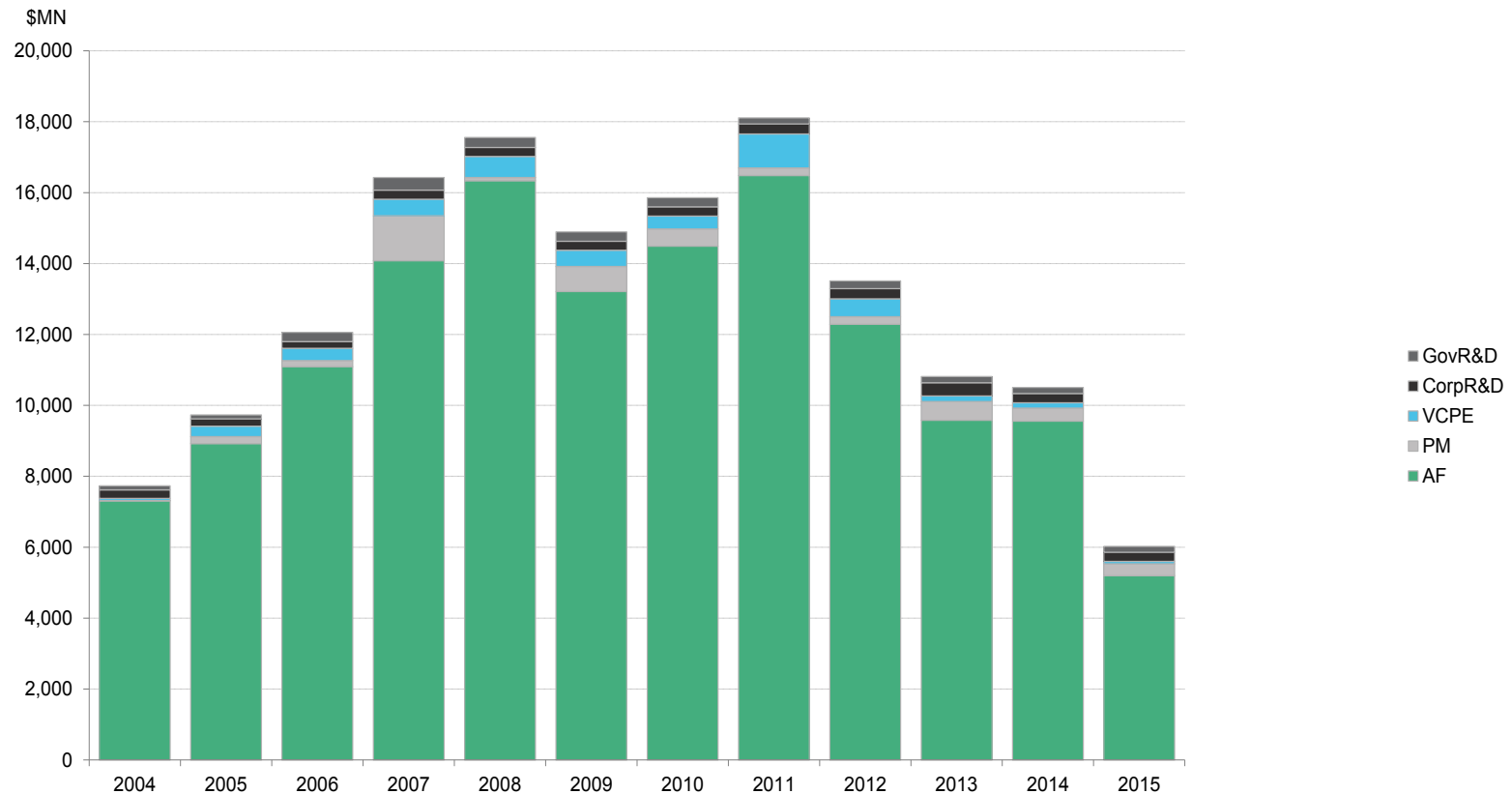
- At the global level, aggregate investment in bio-energy has been declining since 2007 – down ~80% in 2015 to ~\$10 billion.



Investments generally focus on Biofuels in North/South America, and Biomass for Power in Europe/Asia.

Source: Bloomberg New Energy Finance, Nawitka

# Global Investment in Bio-Based Power, by Asset Class 2006–2015 (\$BN)



- ~\$6 Billion in 2015; down ~2/3 since 2011



> 90% in the form of Project Finance, with an overwhelming focus on conventional technologies.

~40% in Asia, ~40% Europe, and ~20% the Americas.

Source: Bloomberg New Energy Finance, Nawitka

## Relative Attractiveness of Bio-Power Going Forward?

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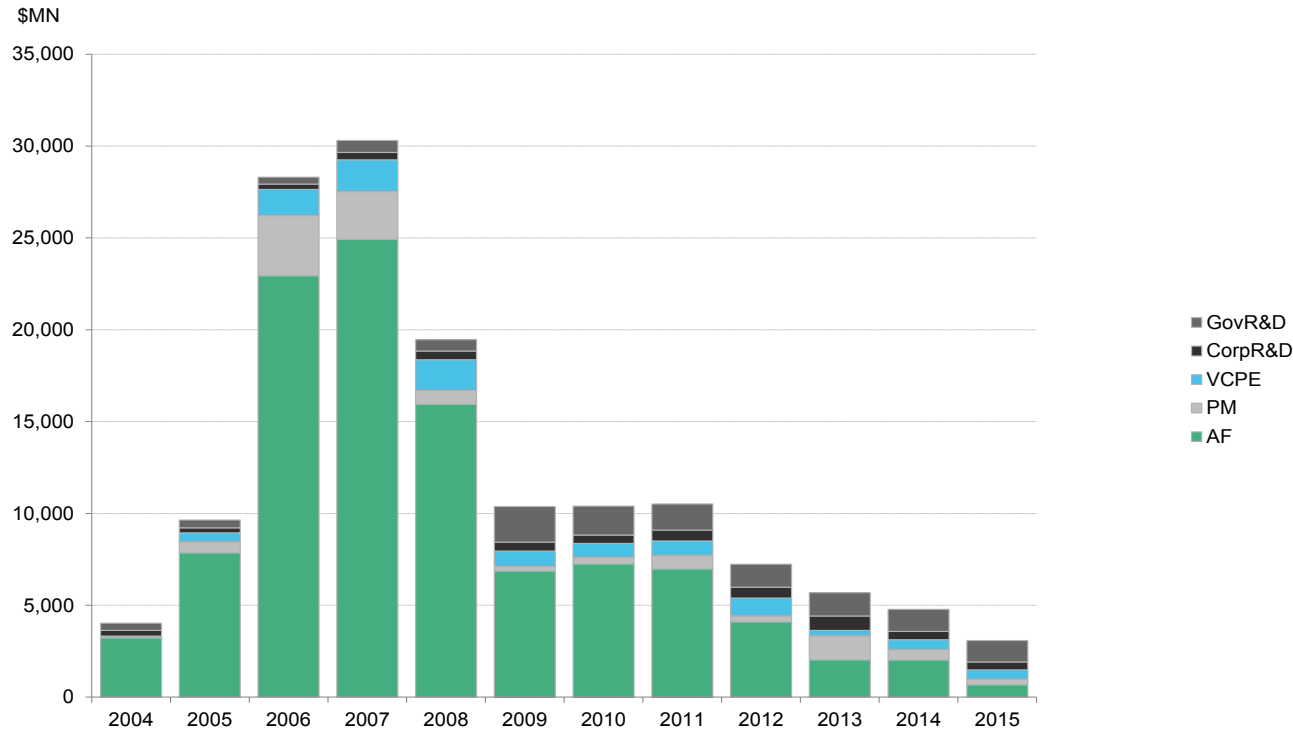
We expect the relative attractiveness of bio-based electricity to continue to decrease over time.

Due to:

- Continuing availability of low cost natural gas;
- Declining costs for other renewable resources (especially wind & solar);
- Improvements in power storage technologies
- Difficulty in reducing the delivered cost of biomass; and,
- On-going uncertainty in public policy.



## Global Investment in Biofuels, by Asset Class: Q1 2006 – Q4 2015 (\$B)



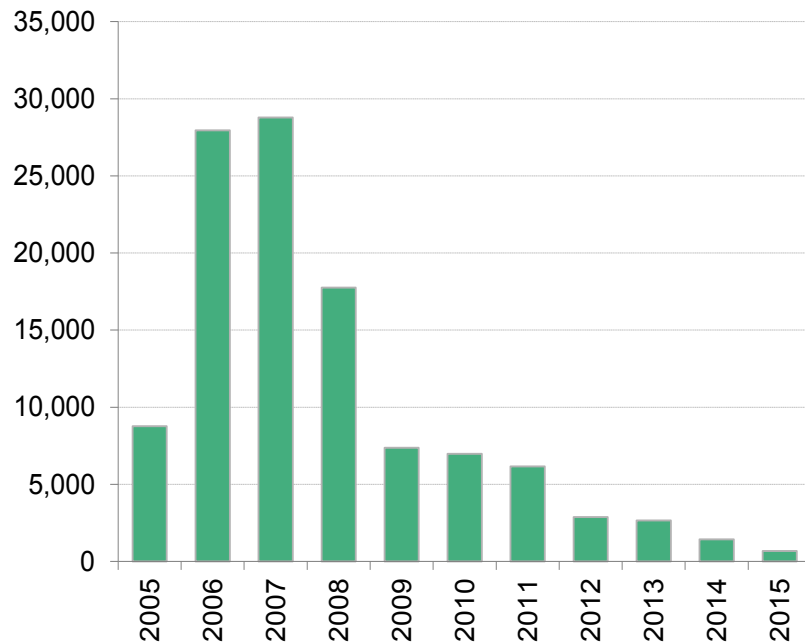
- In 2015, global investment in Biofuels hit its lowest level since at least 2004 (~\$3 billion)
  - Reflects lower oil & gas prices, perceived blend wall for ethanol, uncertainty in public policy.
- But is the aggregate data hiding some positive trends?



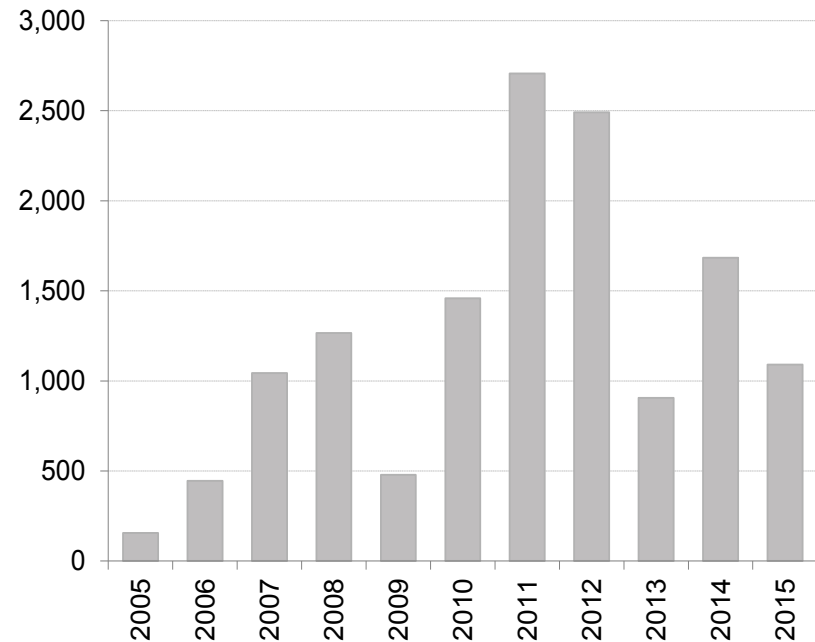
Source: Bloomberg New Energy Finance, Nawitka

# Global Investment in Biofuels by Technology, Q1 2005–Q2 2015 (\$m)

GLOBAL INVESTMENT IN FIRST-GENERATION  
BIOFUELS,



GLOBAL INVESTMENT IN NEXT-GENERATION  
BIOFUELS,



- Investors are switching from First-Generation to Next-Generation Biofuels.
- Investment in Next-Generation Biofuels is smaller and quite volatile, but the trend is clearly better.



# Main Next-Generation Biofuel and Biochemical Fundraising in 2016



Privately raised  
\$9.27m



Publicly raised \$20m, and  
signed a product offtake  
worth \$9m



terraviva™

Raised \$28m publicly after changing  
its name from Solazyme

January 2016

February 2016

March 2016



Privately raised  
\$18.7m



Mitsui paid \$19.35m for  
an additional 10% in its  
JV with BioAmber



An equity raise of \$24m



Publicly raised  
\$4.25m





## **Biggest Private Investors in Advanced Biofuels/Chemicals?**

### 5 Biggest Financial Investors:

- Khosla Ventures
- KPCB
- Flagship Ventures
- Riverstone
- Sofinnova

### 5 Biggest Strategic Investors:

- DuPont
- Poet DSM
- Abengoa
- UPM-Kymmene
- Stora Enso



## **Leading Forest Companies in the New Bio-Economy**

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Forest Companies leading the transformation to a bio-economy, by continent:

- Europe: UPM-Kymmene
- Asia: Oji
- South America: Fibria
- North America: Georgia Pacific/Koch



# Public Sector Support in Canada

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Governments have played a direct role in supporting the development of next-generation biofuels and chemicals in Canada.

## Federal level:

- SDTC has been the largest provider of early stage capital for bioenergy investments in Canada. (~\$265 million in 61 bio-related projects with total value of ~\$880 million)
- IFIT Program has helped carry the ball. (~\$190 million targeted at forest sector transformation)

## Provincial Level:

- Quebec has arguably thought the most re the forest sector transformation agenda. Developed a formal strategy in 2012, and supported with the 5 year \$170 million *Fonds Valorisation Bois*
- B.C.'s Low Carbon Fuel Standard is very interesting – and not well known.



## State of Commercialization?

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- Almost \$9 billion has been invested in developing Next Generation biofuels over the past five years. The industry is emerging beyond the initial stage.
- Globally, there is roughly 150 million gallons of cellulosic biofuels capacity already on line.
  - 12 plants are up, but only 4 have at least 20 million gallons of capacity (small-scale commercial).
  - The largest plant has 30 million gallons of cellulosic ethanol capacity, and was commissioned by DuPont in October 2015 – roughly five years after the project was first announced.
  - Several more plants are approaching start-up in 2016/17.
  - The bulk of the capacity is targeting the U.S. market.
- We have the opportunity to learn more about what is commercially feasible over the next 12-24 months than we have in the previous 20 years.



## Global Cellulosic Biofuels Capacity, Q1 2016

Company	Location	Commissioning date	Million gallons/year	Technology pathway and final product	Registered for RFS2?
Ensyn	Renfrew, Canada	Q4 2007	5	Biomass pyrolysis Cellulosic bio-oil	RFS2
Beta Renewables	Crescentino, Italy	Q3 2013	18	Enzymatic hydrolysis cellulosic ethanol	
Ineos Bio	Vero Beach, Florida, USA	Q3 2013	8	Gasification Fermentation cellulosic ethanol	RFS2
Shandong Longlive	Yucheng, China	2013	5	Enzymatic hydrolysis cellulosic ethanol	
Quad County	Galva, Iowa, USA	Q2 2014	2	Enzymatic hydrolysis cellulosic ethanol	RFS2
Henan Tianguan	Zhenping, China	Q2 2014	4	Enzymatic hydrolysis cellulosic ethanol	
GranBio	Alagoas, Brazil	Q3 2014	22	Enzymatic hydrolysis cellulosic ethanol	RFS2
Poet DSM	Emmetsburg, Iowa, USA	Q3 2014	20	Enzymatic hydrolysis cellulosic ethanol	RFS2
Abengoa	Hugoton, Kansas, USA	Q3 2014	23	Enzymatic hydrolysis cellulosic ethanol	RFS2
Raizen	Piracicaba, Brazil	Q4 2014	11	Enzymatic hydrolysis cellulosic ethanol	
Enerkem	Edmonton, Canada	Q2 2015	10	Gasification Fermentation cellulosic methanol	N/A (making a chemical)
DuPont	Nevada, Iowa, USA	Q4 2015	30	Enzymatic hydrolysis cellulosic ethanol	RFS2



Source: Bloomberg New Energy Finance, Nawitka

## Within Bio-Products, Where Should We Focus?

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- ◆ Need to focus on what is truly unique about biomass – its ability to produce things other than electrons (eg., liquids, chemicals & advanced materials).
  - Drop-in fuels that use existing infrastructure, with a path to qualify under RFS2 and California LCFS
    - Fast Pyrolysis and Hydro-thermal processes most promising
    - Ethanol less attractive because of the “blend wall”.
  - Bio-chemicals with a sizeable market
    - Strategic off-take partner is critical.



## Major Next-Generation Biofuel and Biochemical Partnership Announcements



Tesoro announced in January plans to support the development of turning biomass into biocrude, which it could co-process with crude oil in its refineries. **Tesoro partnered with Fulcrum BioEnergy, Virent and Ensyn.** Fulcrum BioEnergy will supply Tesoro with biocrude at its Martinez, California, refinery from Fulcrum's Reno biofuels plant that should be operational in 2018. The California Air Resources Board has approved Ensyn's pathway to co-process its biocrude in Tesoro's refinery.



Off the back of a \$28m raise, Solazyme announced it had a new name and a new focus. Terravia, as it's now called, will focus on production of specialty food ingredients, consumer food products and specialty personal care. **Unilever and Terravia have signed a five year contract for supply** of algal oils to be used in personal care products. This change of focus is likely due in large part to the low price of petroleum.



**Newlight** - a bioplastic producer using biomethane feedstock - announced that **IKEA** would be off-taking half of its 23,000 tonne per annum US production capacity, as well as paying for an exclusive license of its technology for the home furnishings industry. **Both companies will work towards deploying up to 453,000 tonnes of Newlight bioplastic capacity** in the coming years.



## Value of the RFS2 and California LCFS?

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Assume:

- \$30 Crude Oil price
- 0.20 gCO<sub>2</sub>/MJ Carbon Intensity of the consumer ready fuel.
- Fuel is consumed in California
- Technology qualifies to generate RINs under the RFS2 and Credits under the California LCFS.
- RIN and Credit prices as of May 2016

The bio-crude is worth ~\$143/barrel, \$113 of which is environmental value.

- Fuel Value = \$30 barrel;
- RFS2 = \$79/barrel;
- California LCFS = \$28/barrel
- California Cap & Trade Credit = \$6/barrel





## Value of the RFS2 and California LCFS? (cont.)

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- The company producing the final “consumer-ready” biofuel is the one which is formally awarded the RINS/credits.
- If a technology company produces an intermediate bio-crude oil which must be further processed into gasoline/diesel at an oil refinery, it must negotiate with the refinery for its share of the environmental value created.
- Assuming a 50/50 split in the \$113/barrel environmental value, the technology company would receive an estimated \$86.50/barrel (\$30 + \$56.50).



## Need To Mitigate Risk To Get the Capital

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- Currently an abundance of capital in global financial markets (and on many corporate balance sheets). However, it is very risk averse.
  
- To attract this capital, it is necessary to identify & mitigate the key sources of risk:
  - Fiber Supply Risk
  - Technology Risk
  - Operating Risk
  - Output Market Risk
  - Financing Risk
  - Business Model Risk
  - Regulatory Risk
  
- Partnerships are critical, as is government support for the right hosting conditions.



## Key Questions Asked by Investors

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**1. Has the management team commercialized a new technology/ developed a project before? How strong are they?**

**2. What is the value proposition?**

1. If proven technology with secure fiber supply & off-take, need 6-8% yield;
2. For drop-in products, need ~25% cost advantage over best available technology;
3. For new products, need significant performance advantage (2-10x?) over current solution.

**3. If it is a new technology, how strong is the IP protection?**

**4. Is there a clear market for the output? Is there a big enough opportunity to matter?**

- Have you engaged with real industry commercial players who can assist with production and distribution?
- Are off-takers in place, and under what terms?



**APPENDIX 1:  
DRIVERS OF BIO-BASED POWER**



## Bio-Based Power

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- ▲ Fewer large plants – particularly coal-to-biomass conversions in Europe - are now being financed. Reflecting:
  - Low fossil fuel prices (natural gas & coal)
  - Falling prices of solar & wind energy and power storage
  - Government efforts to rein in spending on renewables,
  - Debate over the environmental sustainability of burning millions of tonnes of wood to produce electricity.
- ▲ Smaller CHP plants are still being funded – especially where power prices are relatively high.
- ▲ Japan, South Korea, Denmark and the UK will likely drive the majority of medium-term growth.



## Demand for Pellets in Asia

- China, Japan & S. Korea have all stated objective of reducing carbon emissions by reducing their use of coal.
- If they substitute biomass for coal, the impact on biomass demand would be significant – especially in China.
- But they lack supportive policies to meet the bio-energy targets. Expect them to rely more on wind, solar and nuclear.

### Change in Biomass Demand Associated with Replacing 1% of Coal Consumption (for Power)

Country	Wood Pellets (million ODMT)	Equivalent Biomass Demand from a 550,000 tpy Kraft Pulp Mill (# of mills)
S. Korea	1.4	2/3
Japan	2.0	1
China	50.2	25



Source: Asian Market for Wood Pellets, Biomass Magazine, Allen Brackley , April 2013

# Japanese Biomass Projects Awarded FITs

Number of projects:  
July 2012 – Dec 2015



- Commissioned projects
- Uncommissioned approved FIT applications

Capacity (GW)  
July 2012 – Dec 2015

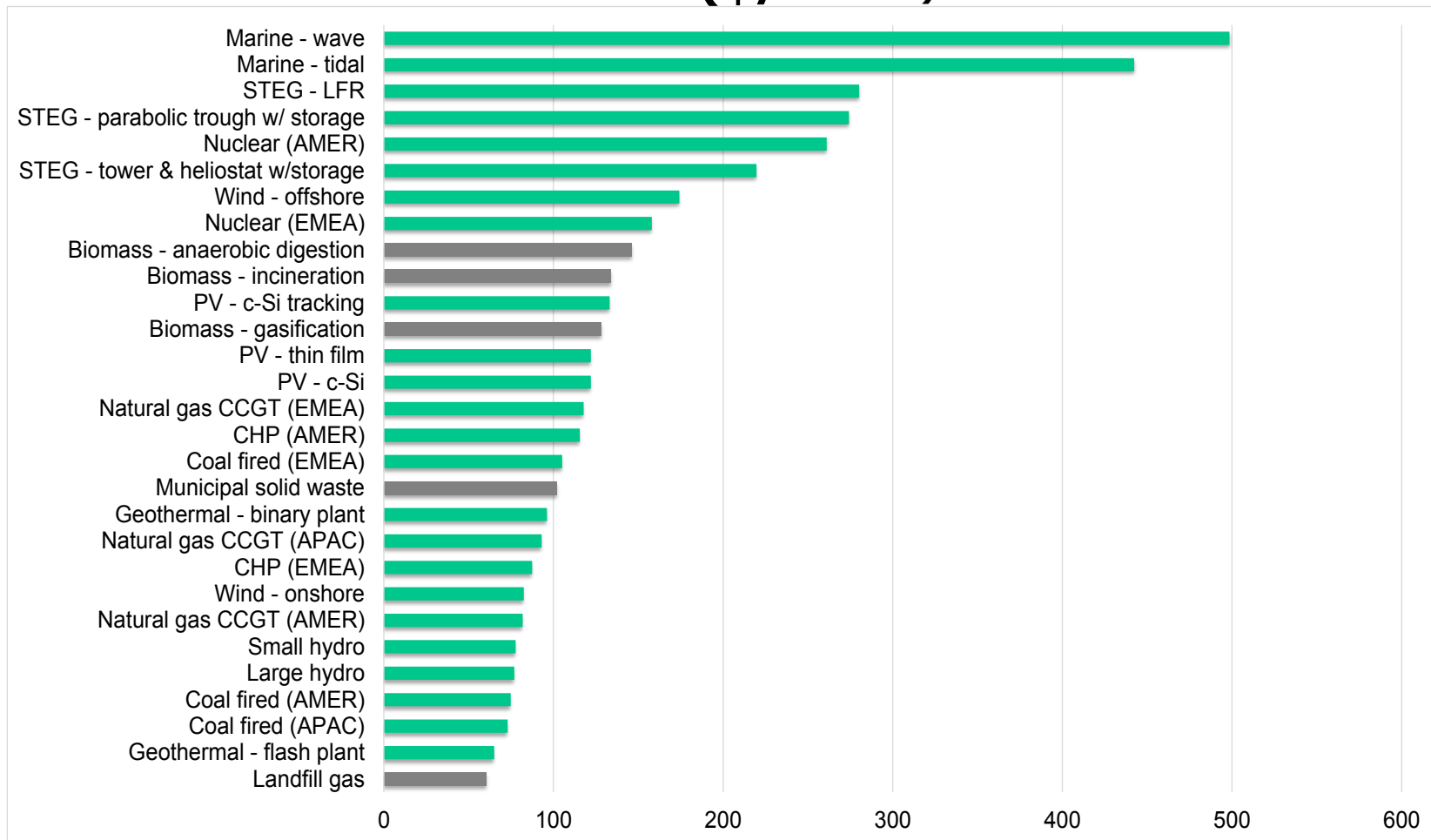


- Commissioned projects
- Uncommissioned approved FIT applications



Source: Japan's Ministry of Economy, Trade and Industry.

## Levelized Cost of Electricity: H2 2015 (\$/MWH)



- Biomass-based power is generally in the middle of the electricity cost curve, but it looks better if existing coal plants can be utilized and we account for the cost of intermittency of solar and wind.

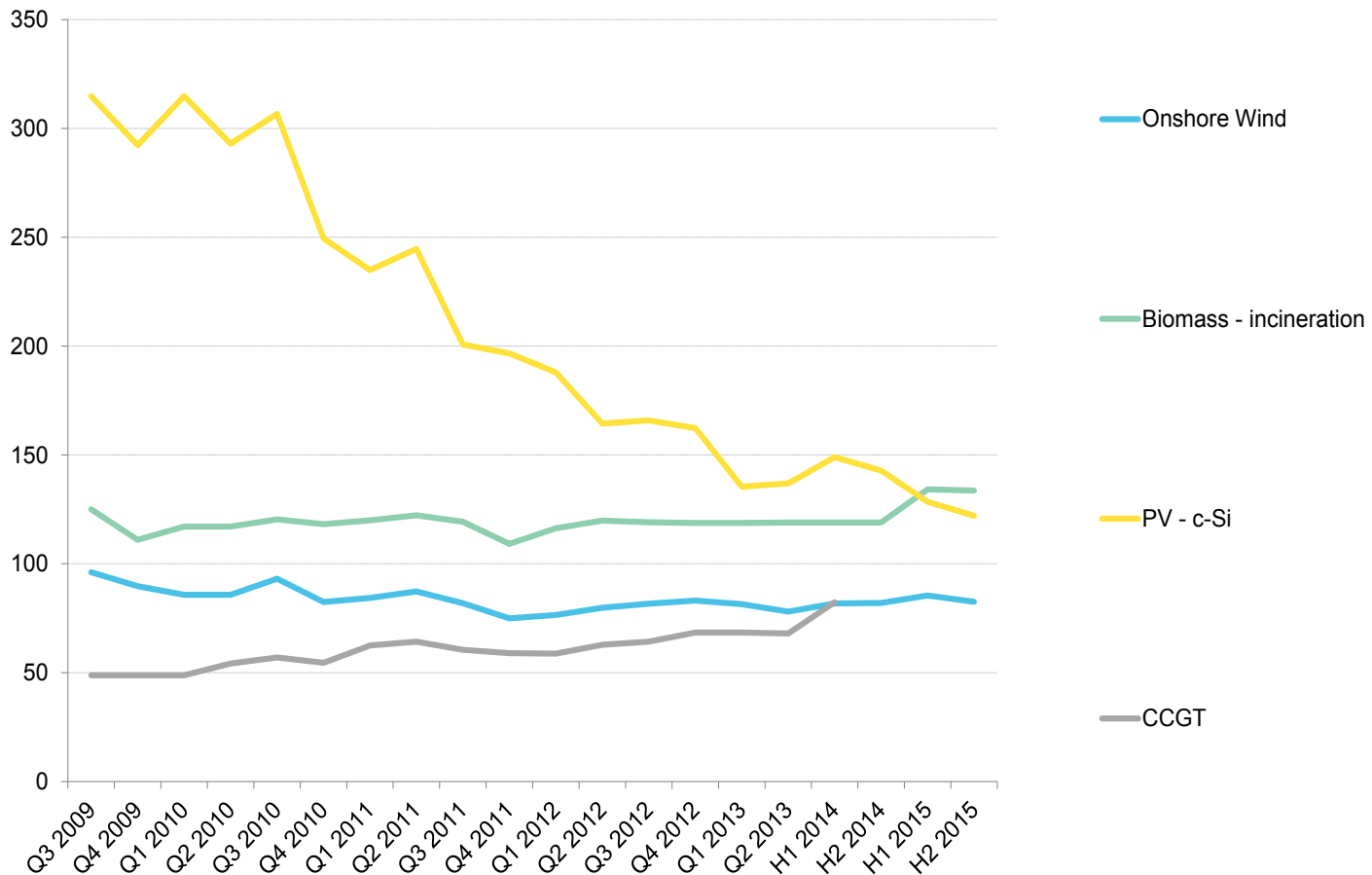


- But will it be competitive in the future?

Source: Bloomberg New Energy Finance, Nawitka



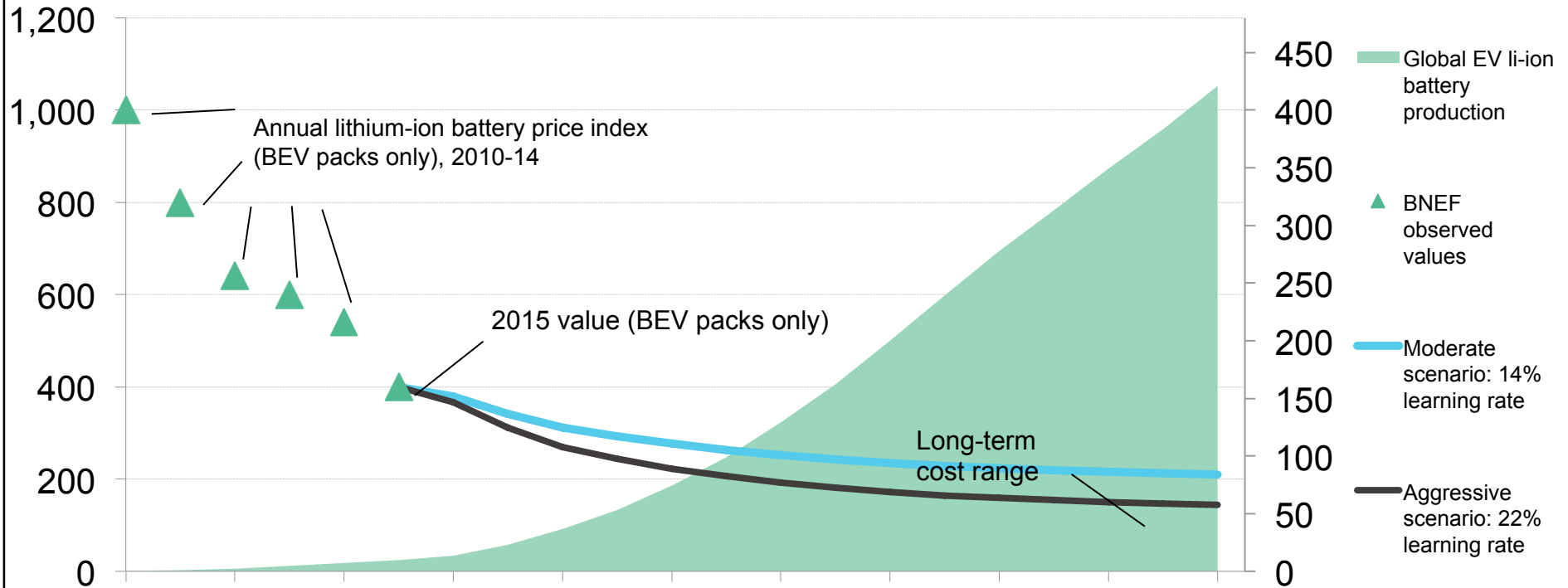
## Levelized Cost of Electricity: Q3 2009-Q4 2015 (\$/MWH)



- The relative cost of bio-power has been deteriorating. Now typically higher than not only gas, but also wind and solar.

Source: Bloomberg New Energy Finance, Nawitka

# Lithium-ion Battery Experience Curve (\$/kWh) and Cumulative Capacity 2010-2030E (GWh)



- Cost of power storage fell by more than 50% from 2010-2015, and is expected to fall another ~50% between 2015-2030.
- This is improving the value proposition for intermittent sources of power, and reducing the relative competitive advantage of biomass



Source: BNEF, Nawitka

**APPENDIX 2:  
U.S. LOW CARBON FUEL MANDATES**



## Focus on Fuel Standards

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Renewable and Low Carbon Fuel Standards can play an important role in stimulating investment in advanced biofuels (and reducing Greenhouse Gas Emissions from the Transportation Sector).

- Globally, the U.S.'s Renewable Fuel Standard 2 is the most important and effective Fuel Standard.
- California and British Columbia are the only two sub-national jurisdictions with similar Low Carbon Fuel Standards.
- Policy uncertainty exists around the implementation of the RFS2 in the U.S., but the Standard is unlikely to disappear. Grid-lock in Congress actually hampers change to the existing U.S. law.
- Fuel Standards can be viewed as a "Compliance Tool" as opposed to an "Incentive Tool". Anecdotal evidence suggests the former are more stable than the latter, and thus tend to be more effective in driving investment due to lower regulatory risk over time.



## Renewable Fuel Standard 2 (RFS2)

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In 2007, the U.S. Congress passed legislation creating the Renewable Fuel Standard 2 to stimulate the consumption of renewable and low carbon fuels in the United States.

- The RFS2 legislation was initially implemented in 2008, and required oil companies to blend up to 36 billion gallons of biofuel by 2022.
- If oil refineries do not meet their mandated targets, they face significant regulatory compliance costs. There is no cost to the public purse.
- The cost of not complying with the mandates (which is represented by the value of Renewable Identification Numbers – RINs), has been designed to provide a stable incentive over time. Low oil prices trigger a rise in the price of RINs
- The value of the RINs varies with the type of biofuel produced.
- A plant-by-plant review suggests that over 80% of the global capacity in cellulosic biofuels has been built in response to the RFS2 – including those plants in Canada and Brazil.



## Other Notable Mandates

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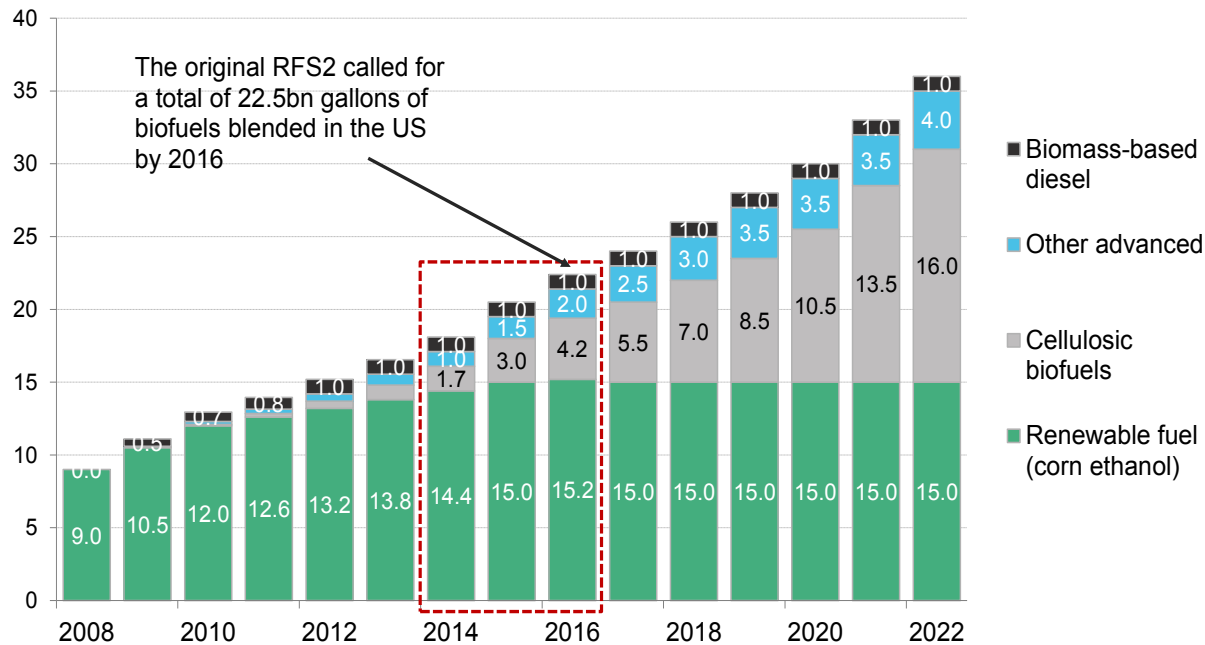
California and British Columbia are the only two sub-national jurisdictions with Low Carbon Fuel Standards.

- Both Standards are less prescriptive than the RFS2 regime.
- The California regime was first introduced in 2006, and then over hauled and re-launched in late 2015. It aims to reduce California's greenhouse gas emissions to 1990 levels by the year 2020, a 25% reduction statewide.
- British Columbia has more recently rolled out a program similar in concept to the LCFS, the Renewable and Low Carbon Fuel Requirements Regulation (RLCFRR). The credit market in B.C. is very nascent.
- Under both Standards, the project developer must demonstrate that:
  - The product will be used as a transportation fuel;
  - The "well-to-wheels" GHG footprint yields an attractive Carbon Intensity score (gCO<sub>2</sub>/MJ);
  - The ability to demonstrate the existence of an established physical pathway for delivering the fuel to that jurisdiction.



# Original Mandates Under the RFS2

**Original RFS2 Schedule, 2008-2022**  
(bn gallons per year)



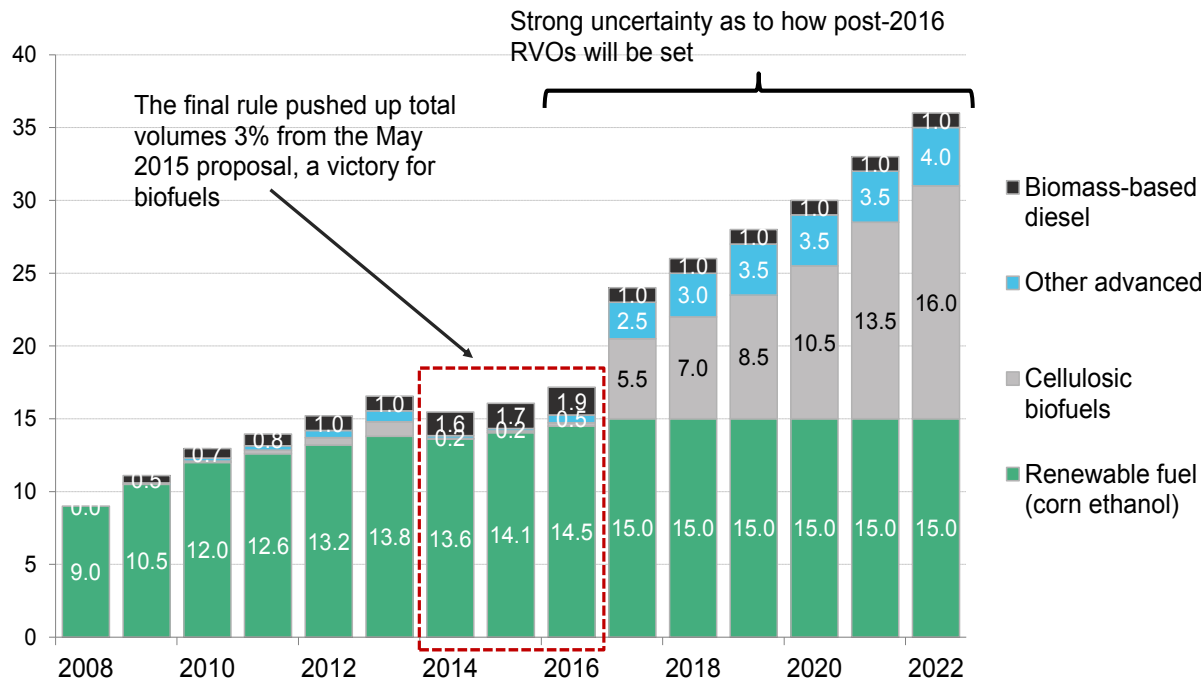
- By 2013 it became clear the RFS2 could not be complied with beyond 2014 because of low production volumes of cellulosic biofuel, and the perceived “ethanol blend wall” which prevents more than 10% of ethanol to be blended with gasoline.

- The EPA did not issue a final rule for biofuels blending in the US for 2014 and 2015, creating regulatory uncertainty and raising legal challenges as to the EPA’s authority to stall on administering a law voted by Congress.



# Revised Mandates Under the RFS2

## Finalised RFS2 schedule in November 2015, 2008-2022 (bn gallons per year)



Source: Bloomberg New Energy Finance, Nawitka

- In late 2015 the EPA slashed the Cellulosic Biofuel mandate for 2016 from 4.2 bn to 0.2 bn gallons – a 95% reduction due to the lack of supply.

- It also reduced the corn ethanol Renewable Volume Obligations (RVOs) for 2016 from 15.2 bn to 14.5 bn gallons to reflect the perceived blend wall for most vehicles.

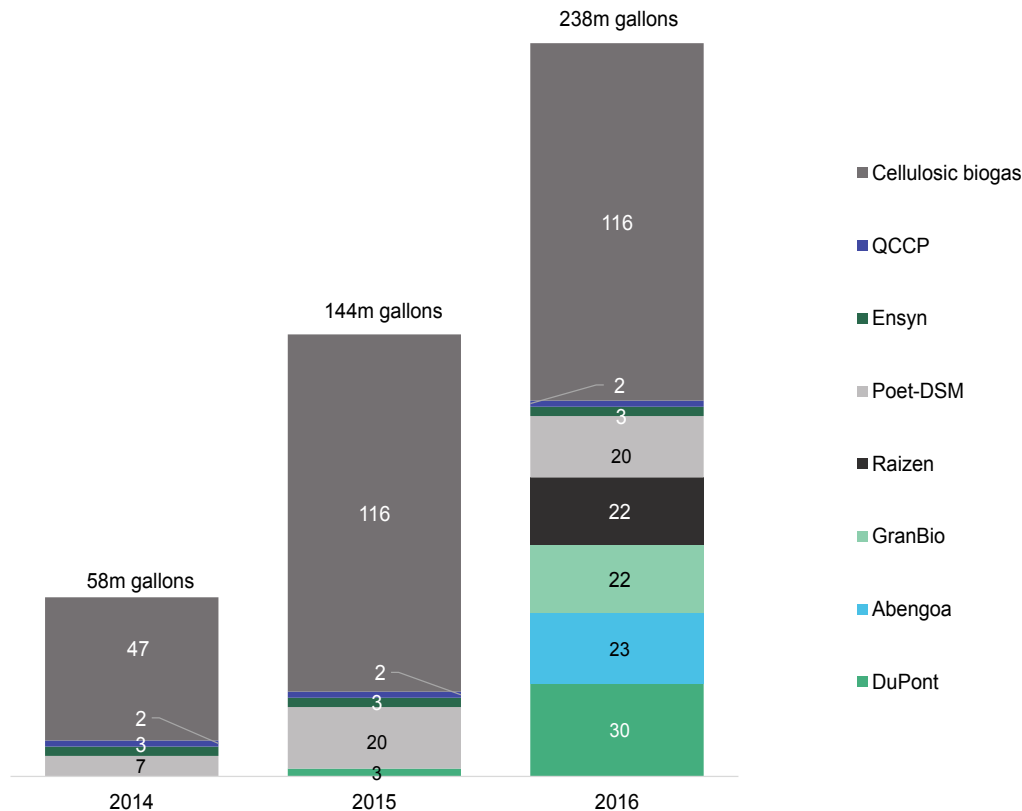


- The original RVO for Cellulosic Biofuel in 2017 is 5.5 bn gallons. However, we expect the EPA will reduce this amount to better reflect the installed capacity.



# Total Cellulosic Biofuel Supply in the U.S. Market

## Cellulosic Biofuel Supply Under the RFS2: 2014-2016



Source: Bloomberg New Energy Finance, Nawitka

- The estimated cellulosic biofuel supply that qualifies as D3 RIN stands at 238m gallons in 2016, including cellulosic biogas.
- This approximates the EPA's Renewable Volume Obligations (RVO) for cellulosic biofuels, of 230m gallons.



Note: EPA considers Cellulosic biogas as an RFS2 fuel if it is made through an approved pathway. The biogas capacities are the volumes that generated RINs in 2014 and BNEFs estimate for 2015 RIN generation. The 2016 cellulosic biogas volume is the same as 2015, although it could be higher if more plants break their supply agreements with heat and power companies.

## California LCFS Credit Prices, October 2014 – May 2016 (\$/credit) (US\$/Credit)



- LCFS prices held steady at around \$121 a credit in Q1 2016, up from an average of \$45 in 2015.
- Credit prices are capped at \$200 by legislation, and they are expected to approach this level as the Carbon Intensity targets are reduced over time for the State's fuel suppliers.



Source: Bloomberg New Energy Finance, ANP, Nawitka

## Focus on Fuel Standards

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- Should we look closer at adopting something similar to the RFS2 and California/BC LCFS across Canada?
- Ontario recently announced it will introduce a LCFS. A patchwork of regulatory regimes across N. America is a barrier to business & investment. Alignment is important, so long as it encourages “a race to the top” and not the lowest common denominator.
- Without something similar to an RFS2 regime in Canada, there will be a strong incentive for any advanced biofuel plants built in Canada to ship all their output to the U.S.
- Canadian oil refiners could not complain that adopting a modified RFS2/LCFS in Canada would put them at a competitive disadvantage. It would simply put them on a level playing field with U.S.-based refiners who are already subject to these mandates.
- If Canada is to meet its announced GHG targets, it must take specific action which focuses on reducing emissions from Road Transport.
  - ✓ Road Transport is one of the fastest growing sources of GHG emissions, and generated an estimated 137 million tonnes of CO<sub>2</sub> equivalent in 2013 – making it the single largest emissions sub-category
  - ✓ By comparison Oil Sands emissions are estimated to be 62 Million tonnes<sup>34</sup> in 2013.



**APPENDIX 3:  
NAWITKA CAPITAL ADVISORS**



## Nawitka Capital/Don Roberts

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Mr. Roberts is CEO of Nawitka Capital Advisors Ltd, a firm which provides advice on strategic direction and raising capital for companies in the Renewable Energy, Clean Technology & Forest Products Industries.

In 2012, Mr. Roberts was chosen by Corporate Knights Magazine as the individual in the Financial Services sector who contributed the most to sustainable development in Canada.

Prior to starting Nawitka in 2013, Mr. Roberts was a Vice-Chair of Wholesale Banking, and Managing Director in Investment Banking with CIBC World Markets Inc. In this position he founded and led the Bank's cross-functional Renewable Energy & Clean Technology Team. He also provided senior coverage for companies in the global forest products industry.

Mr. Roberts was recognized in 2006 by Forbes Magazine as one of the Best Brokerage Analysts in North America. From 1995-2009, investor surveys consistently ranked him among the top equity research analysts covering the North American forest products industry. Prior to joining the financial sector, Mr. Roberts was Chief Economist for the Canadian Forest Service.

Mr. Roberts is a certified Board Director with the Institute of Corporate Directors, and sits on the boards of four organizations.

Mr. Roberts has a Bachelor's degree in Agricultural Economics from the University of British Columbia, a Master's degree in Forestry Economics from the University of California at Berkeley, and both an MBA and doctoral studies in International Finance and Economics from the University of Chicago.

