Biofuels and Chemicals: Market Realities, Finance, Applications

Brian M. Baynes, Ph.D.

December 2015

FLAGSHIP VENTURES

Flagship Ventures Overview

- Founded in 2000, based in Cambridge, MA, USA
- Managing US$1.5B in venture capital funds
- Focus on early-stage technology breakthroughs in healthcare (70%) and sustainability (30%)
- VentureLabs™: in-house proprietary platform for founding and building new ventures, to which 30% of funds are directed
- 9 IPOs and 3 acquisitions of portfolio companies since Jan 2013.
  Top quartile performance in 3 of 4 funds
- Closed $537M Flagship Fund V in 2015
- Sector partners: AstraZeneca (pharma), Nestle (health science), Bayer (crop science)

Sustainability Portfolio Overview

	Formation	Growth	Realization
Biofuels and Chemicals	RED ROCK BIOFUELS	NOVOMER, JOULE	LS9, MASCOMA, Celexion
Agriculture and Nutrition	SYMBIOTA	Midori	
Other Sustainability	Be Power	ECOSENSE, OASYS WATER	

Personal Perspective

- Ph.D. Chemical Engineering
- Early career in oil industry
- Most recently startup Founder/Chairman/CEO/CTO/investor

- Current roles
  - CEO, Joule
  - Executive Chairman, Midori
  - Partner of Flagship funds III, IV, V

The Main Challenges

Macro

- Oil and natgas price level and volatility
- High profile failures. Specious claims by many companies
- Do customers really care? Differentiated product or not? Sustainability / carbon intensity, supply security, etc.

Micro

- Intermediate stage valuation
- Feedstock cost level and volatility
- Experience of team vs key proof points
  - Research vs scale up vs project development
  - Fundraising

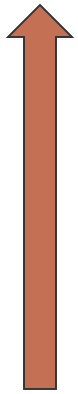
Development Cost and Risk

Development Phase	Cost	Time	Success Probability
Laboratory Research	$10M	2 years	50%
Pilot Plant	$20M	2 years	80%
Demo Plant	$60M	2 years	80%
Commercial Plant	$300M	2 years	60%

- Cost of 1 commercial plant success ~ $700M
- Sensitivity to failure is very high in the later stages. Derisking is critical.
- Important tradeoff between unit cost and risk in “scaling up” vs “scaling out” (replicating proven units)

Risk-adjusted return expectations

• VC/PE	30%/yr
• Strategic Partner	10-15%/yr
• Project Finance	5-10%/yr
• Development Bank Loan	3-5%/yr



Higher risk tolerance
Higher return expectations

For an Nth plant (no tech risk): needs 10%/yr return

For a 1st plant (tech risk): 30%/yr / 60% (risk adjustment) need a 50%/yr "success case return"

This spread (10-50%/yr) creates the "valley of death".
If a whole $300M 1st plant project was equity, this means >$150M/yr cash flow required… basically impossible for all but the highest value products.

→ Must minimize the VC/PE requirement with (1) grants, (2) bank debt/bonds, and/or (3) participation of strategics

Non-Equity Sources of Capital Help Cross the Valley of Death

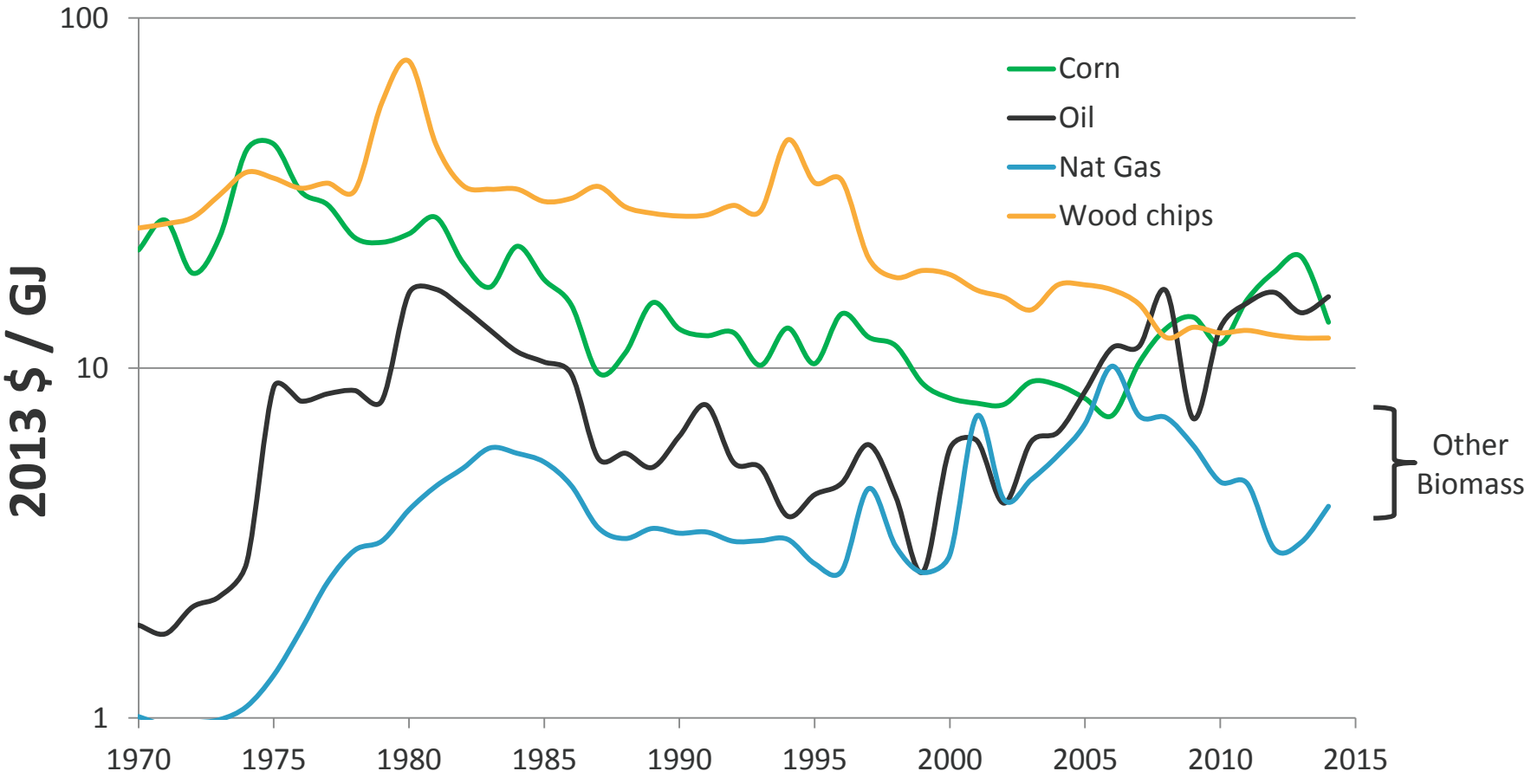
		Equity only	Multi-source
Equity		$10/(gal/yr)	$2/(gal/yr)
Grant			$3/(gal/yr)
Bank Debt/Bonds			$5/(gal/yr)
Product value		$3/gal	$3/gal
Debt service			$0.59/gal
Cash production cost	-	$1.5/gal	$1.5/gal
Cash flow to equity		$1.5/gal	$0.91/gal
Equity IRR, assuming success		13%	38%
Equity IRR, risk adjusted		6%	24%

What it takes to raise money for a deployment

- Proven technology or insurance/wrap/loan guarantee
- Long-term feedstock supply and product offtake contracts with creditworthy parties
- Sound project financials with minimal volatility
- Strong independent engineering report and feedstock study
- Investment grade Engineering-Procurement-Construction (EPC) contract
- Experienced operator

(it's all about reducing perceived risks)

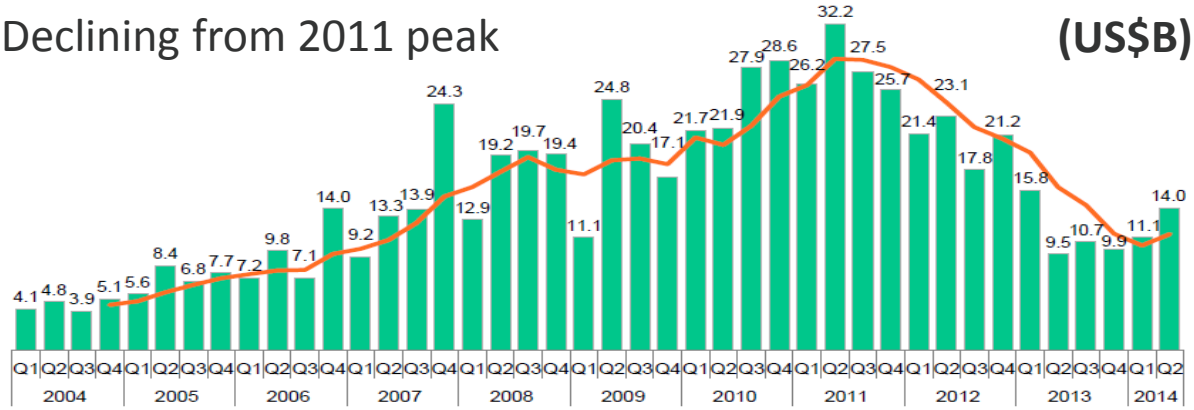
Input Commodity Values (USA)



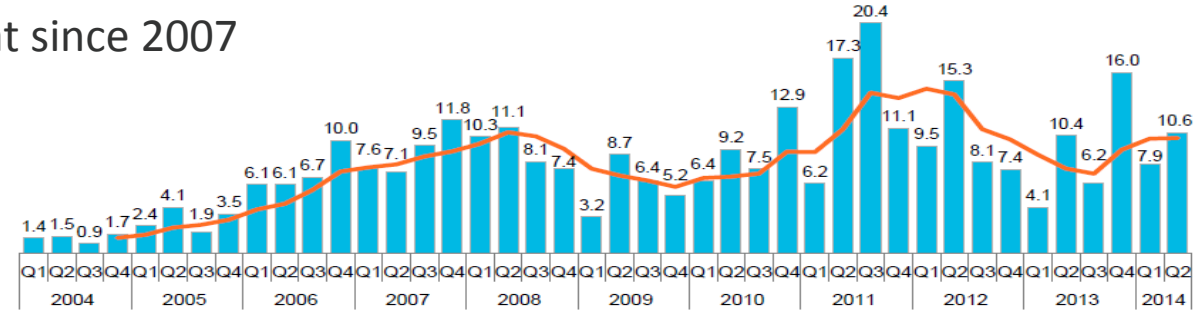
How to convince yourself of expected economics <u>over ~20 yr life</u> of a project?

Clean Energy Investment: Plenty of Capital Available for Deployment

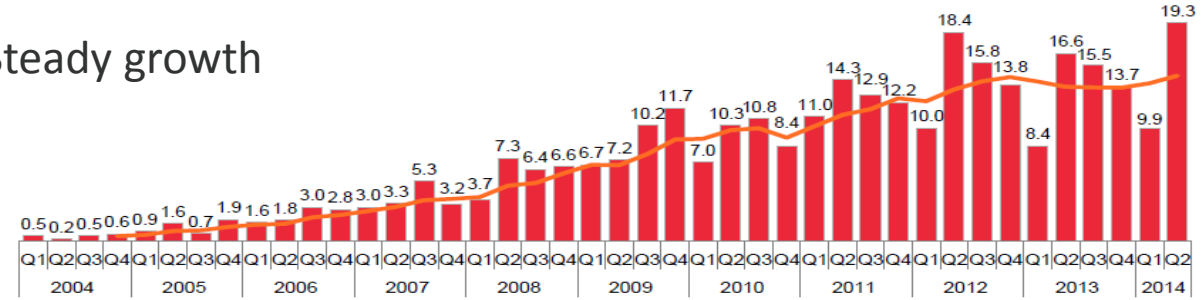
Europe. Declining from 2011 peak **(US$B)**



USA. Flat since 2007

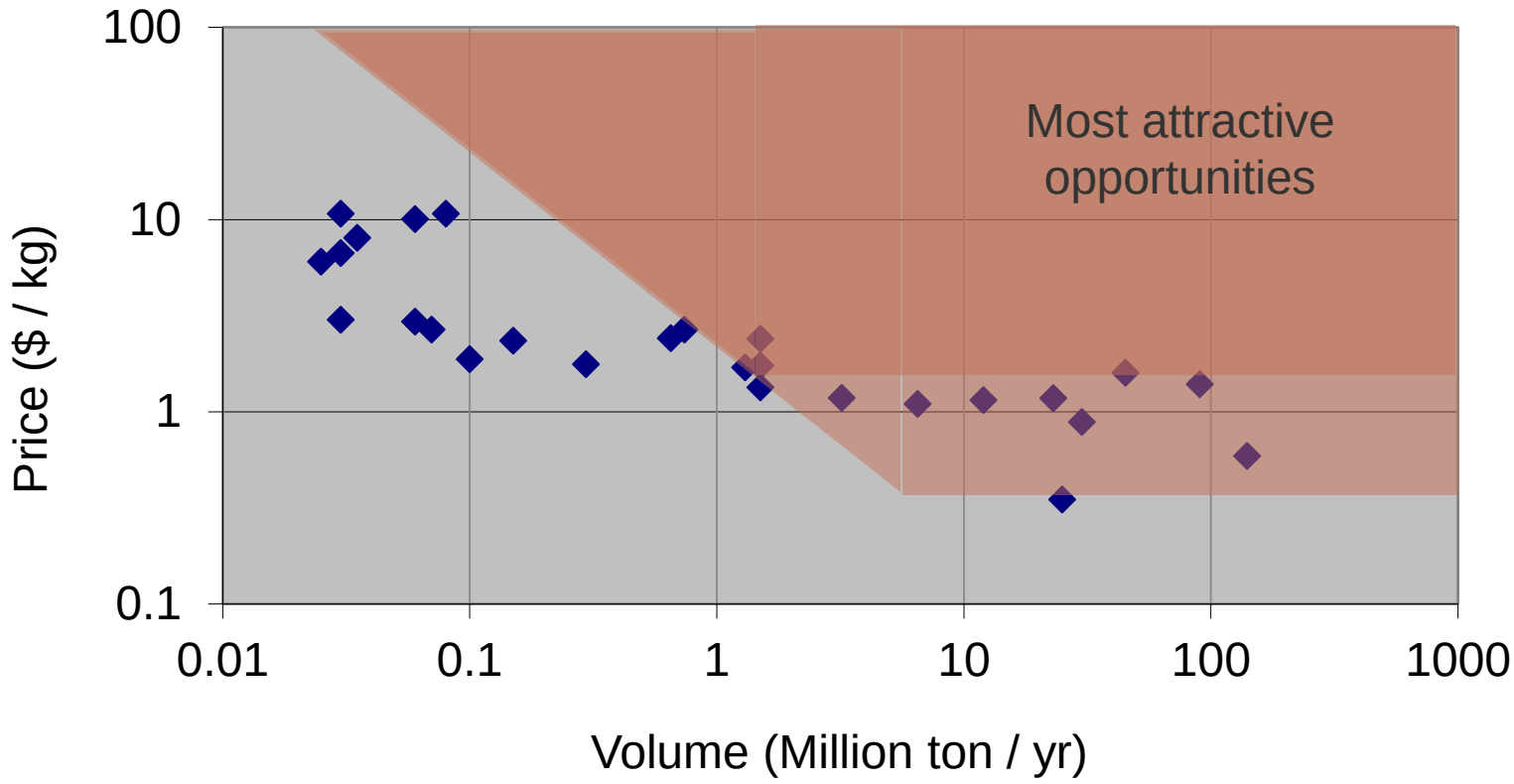


China. Steady growth



Source: Bloomberg New Energy Finance. Total values in $B and include estimates for undisclosed deals. Excludes corporate and government R&D and spending for digital energy and energy storage projects

Choosing Markets: Price and Volume Constraints



- Costs of development (diagonal line) and production (horizontal lines) define the opportunities
- Market creation is also possible (e.g. putting a new dot on the map), but requires much more capital and time

Cost of Energy in a Feedstock

Sun		$0 / GJ
Natural Gas (N America)		$2 – 4 / GJ
Coal:		$3 – 6 / GJ
Biomass (15 GJ/dt)	$50-100/dt =	$3 – 7 / GJ
Oil (6.2 GJ/bbl)	$50/bbl =	$8 / GJ
Natural Gas (Europe, Asia)		$10 – 15 / GJ
Corn	$4/bu=	$16 – 20 / GJ

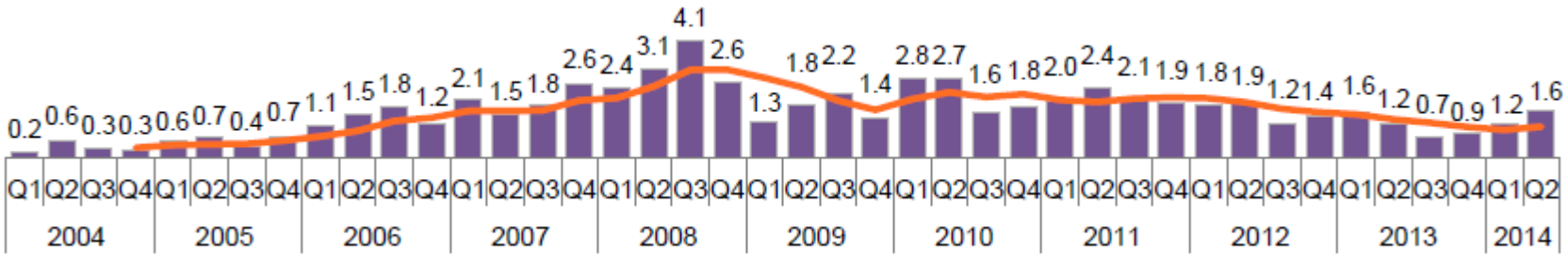
- Significant untapped potential from sun and biomass
- Further potential in coal and natgas, but require a CO_2 solution

What it takes to raise money for development

- Disruptive or game changing idea, $B+ opportunity
- Durable competitive advantage, enabled by patents or similar
- Early proof points that materially de-risk the venture
- Team has a competitive advantage in mitigating key risks– entrepreneurship, technology, commercial, financial
- Potential for 10x return in ~5 years

Clean Energy Investment from VC/PE: Still a Good Amount of Money for Development

VC/PE. Declining from 2008 peak **(US$B)**



Source: Bloomberg New Energy Finance.

Conclusions

- Still plenty of opportunity and worthy problems to solve!
- Impact will come only through scale, which requires capital, so understanding how investors think and how to raise money is critical
  - Avoid the valley of death by beginning with the end in mind
- The money is there, if the project makes financial sense