



NextSTEPS Sustainable Transportation Energy Pathways

Biofuel development and commercialization

April 10, 2014

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Outline

- State of California biofuels
- Understanding cost and potential
- How is the industry developing?
- Looking for an Incremental path to reduce risk
- Policy incentives: what is being communicated to the market through prices?

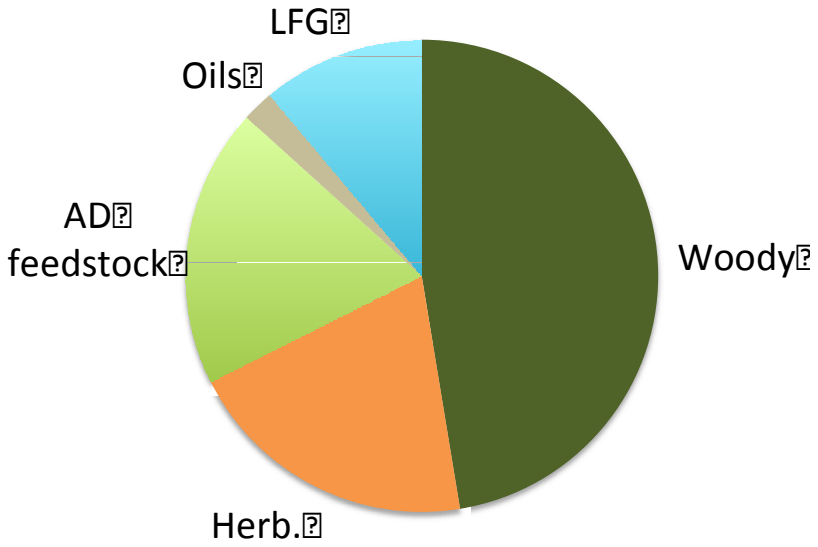
California a major player in biofuel knowledge base
But not a major player in production

Snapshot of California's biofuel industry

Product	Firms	Production Capacity (MGY)	# Plants (demo/comm.)
Corn ethanol	7	164	4
Biodiesel	24	165	10
Sugar beet ethanol	1	0	0
Cellulosic ethanol	6	25**	3
Drop-in	11	0	0
Renewable Jet	3	30***	2
Biomethane	7	In progress	0
Other*	16	0	0
Total	**75**	**384****	**19**

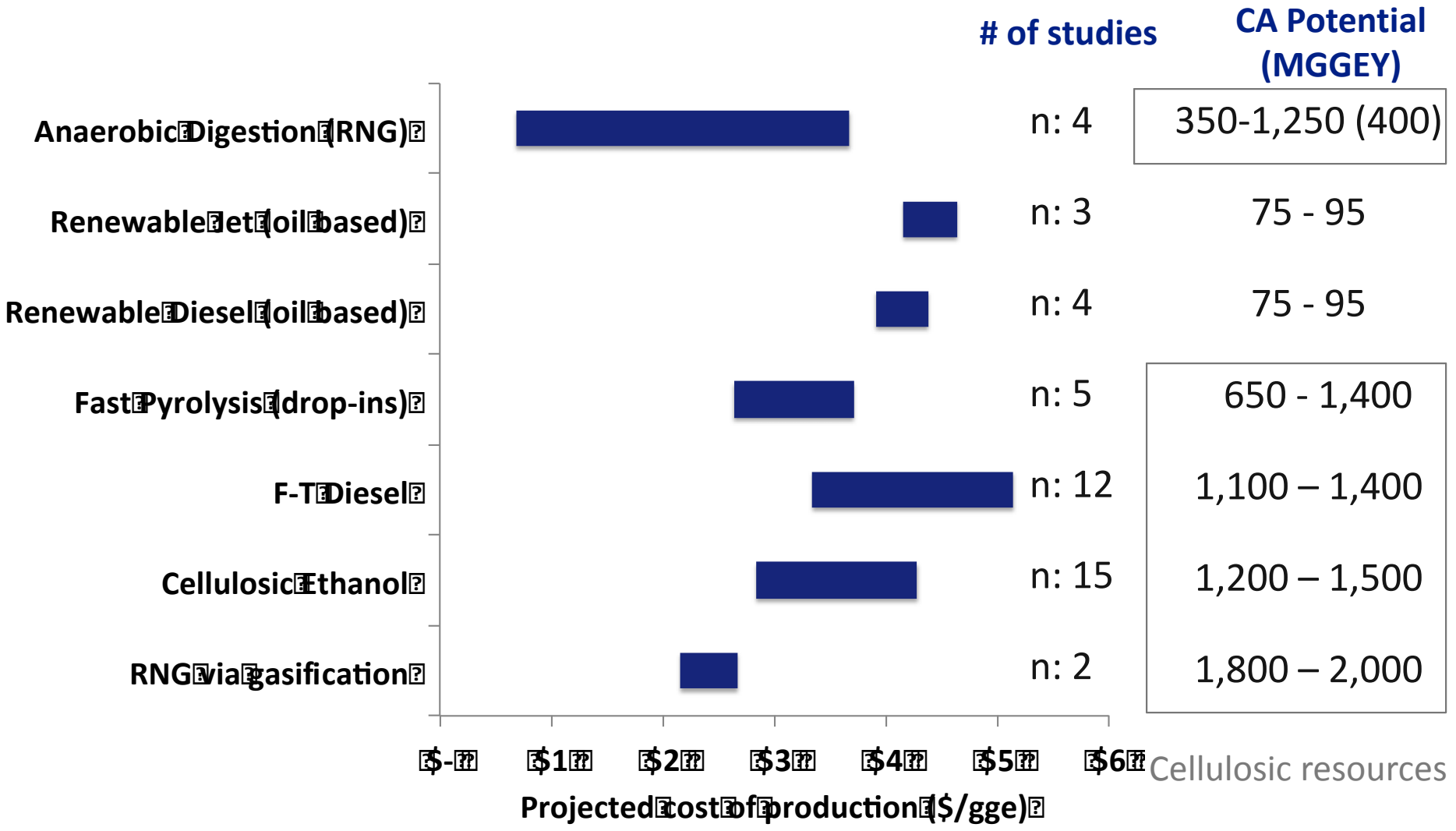
*Other includes biochemicals, biobutanol, or multiple products
**Planned production (Canergy in 2016)
***Planned production (AltAir in 2014; Alipha Jet, no date specified)
****US Biofuel production ~15 BGY/year (mostly ethanol)

California's biomass resource base without energy crops is roughly 0.5 EJ (~1.5-2.0 BGGE).



Source: CA Biomass Collaborative, Biomass Resource Assessment, 2014

Wide range of costs and potential for advanced technology biofuels from waste (nth Plant)



Cellulosic technologies face large capital costs and risk

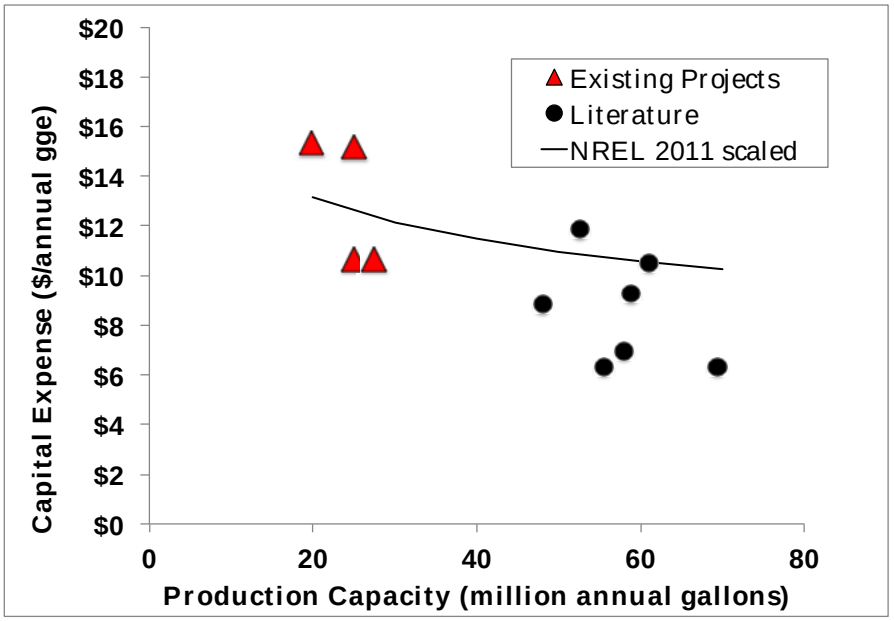
Research Design

- Literature review and meta-model to standardize inputs and financial assumptions
- Compare with reported values from industry

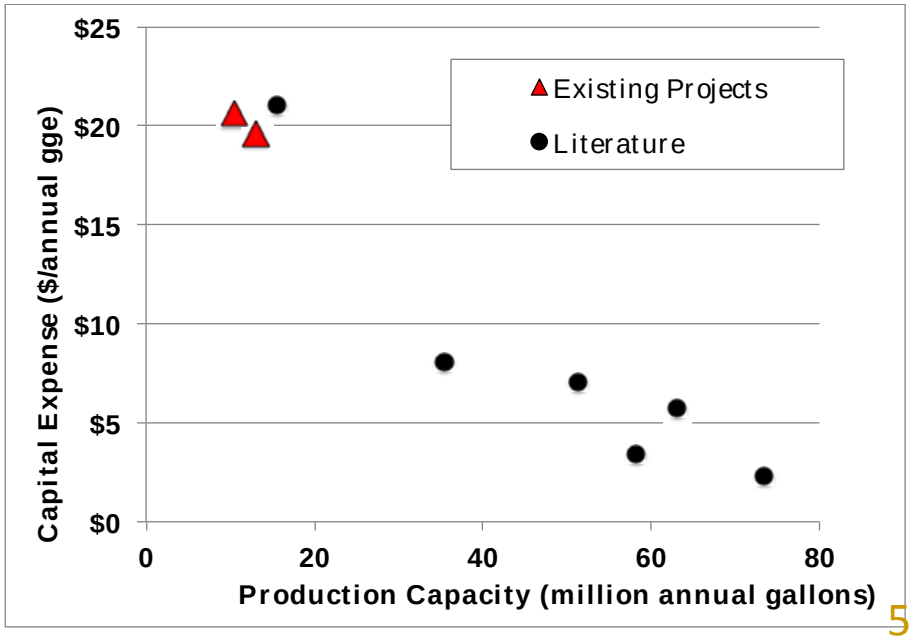
Take home messages

- Existing projects are smaller scale and higher capital intensity than what is evaluated in academic literature.
- Reported plant costs are in line with scaled literature values.

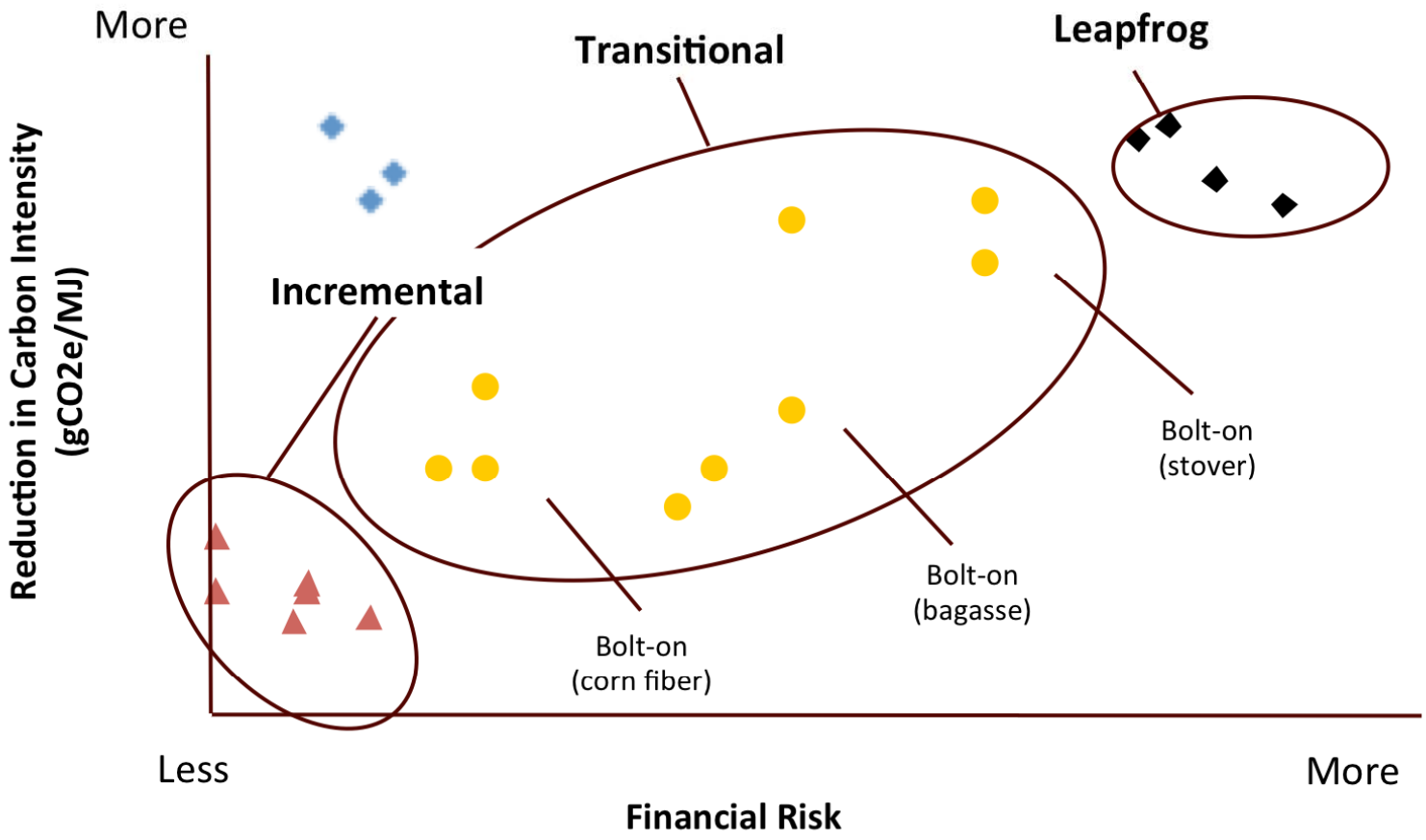
Capital Expenditure for Cellulosic Ethanol



Capital Expenditure for Pyrolysis-based Drop-in Biofuels

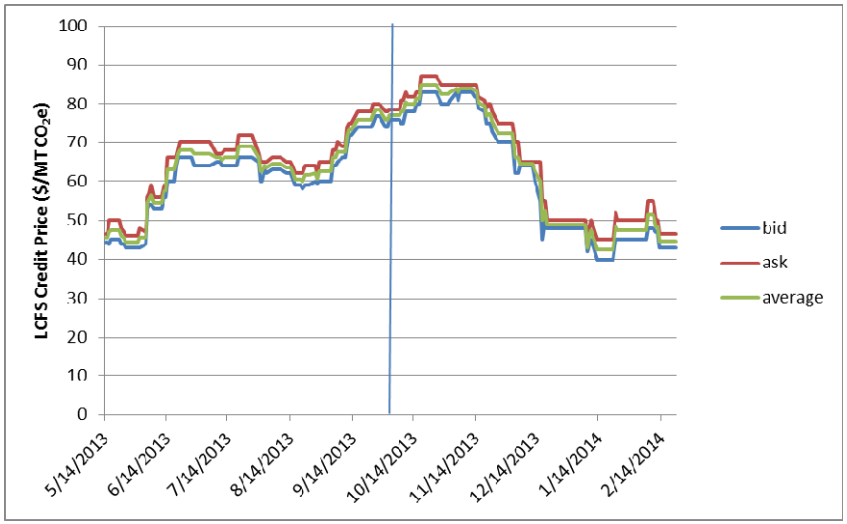


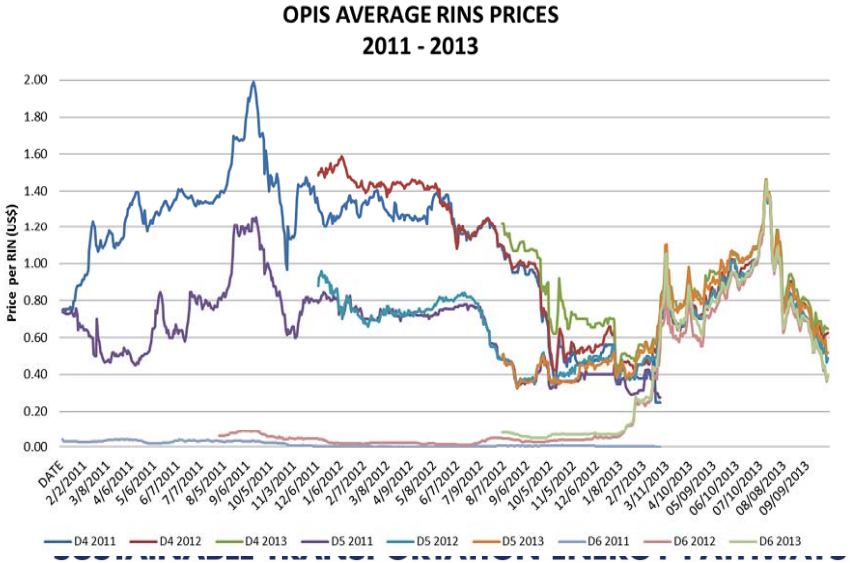
Is there a path with lower risk at each step that leads to the large resources?



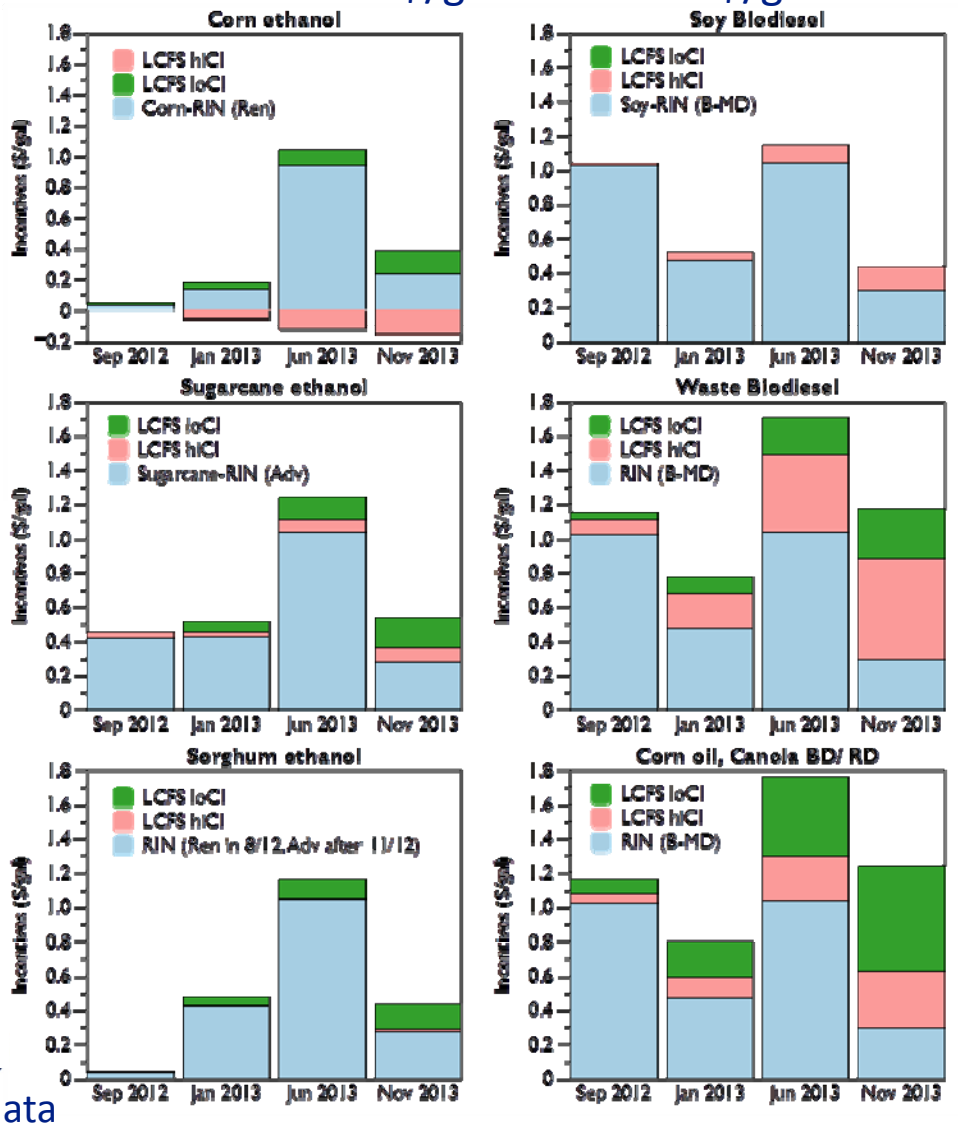
LCFS v. RFS Price Volatility Means Shifting Incentives

LCFS Credit Price Trends





LCFS $/gal v. US RFS2 $/gal



Sources: OPIS price data, CARB carbon intensity data

Summary of points

- Waste oil supplies are limited but important for near term reductions
- Need to get to cellulosic or algae resource base
- Path there with a good business case is unclear