



NextSTEPS Sustainable Transportation Energy Pathways

Biofuel opportunities and transition costs

June 3, 2013

California Energy Commission

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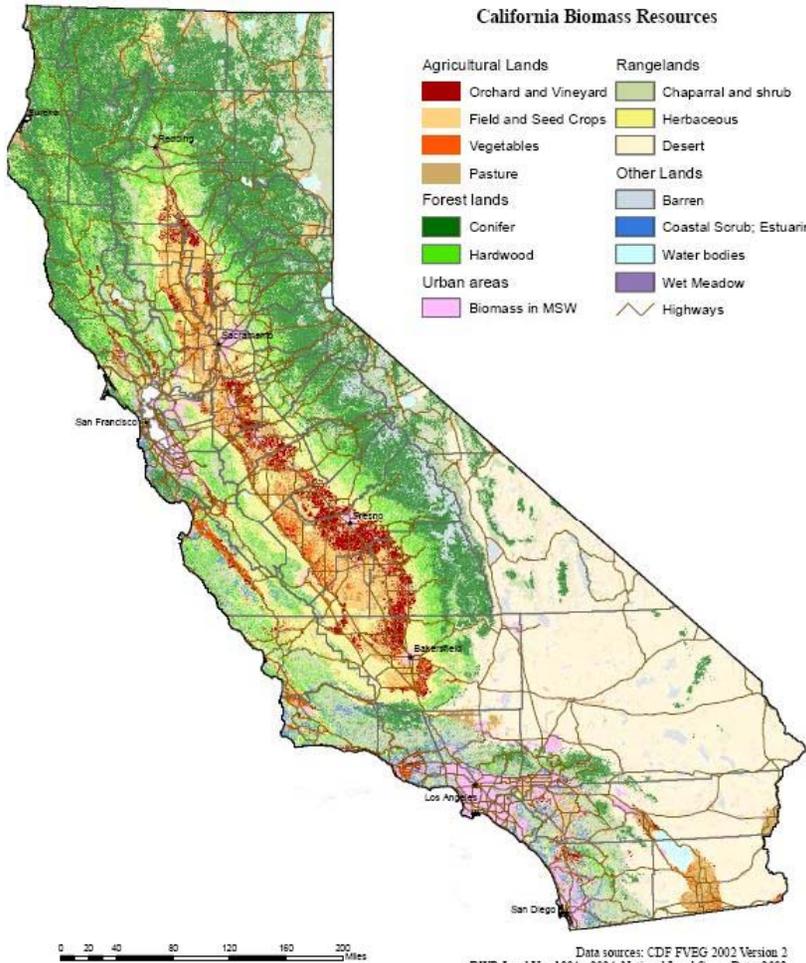
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California Biomass Resources Are Diverse

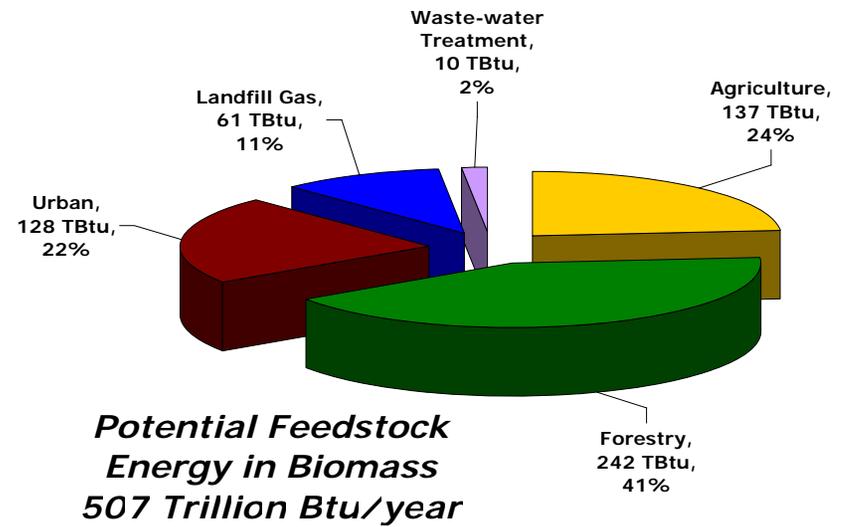
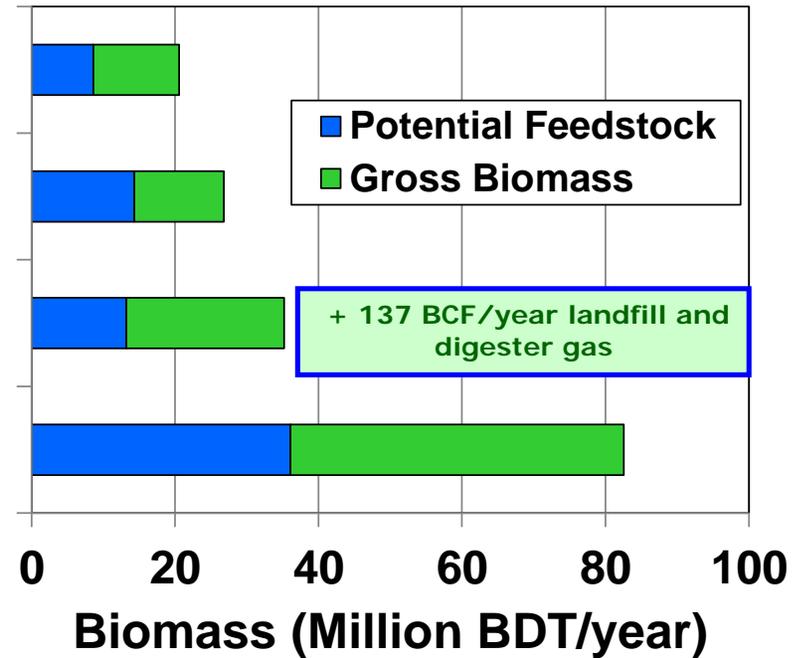


Agriculture

Forestry

Urban

Total

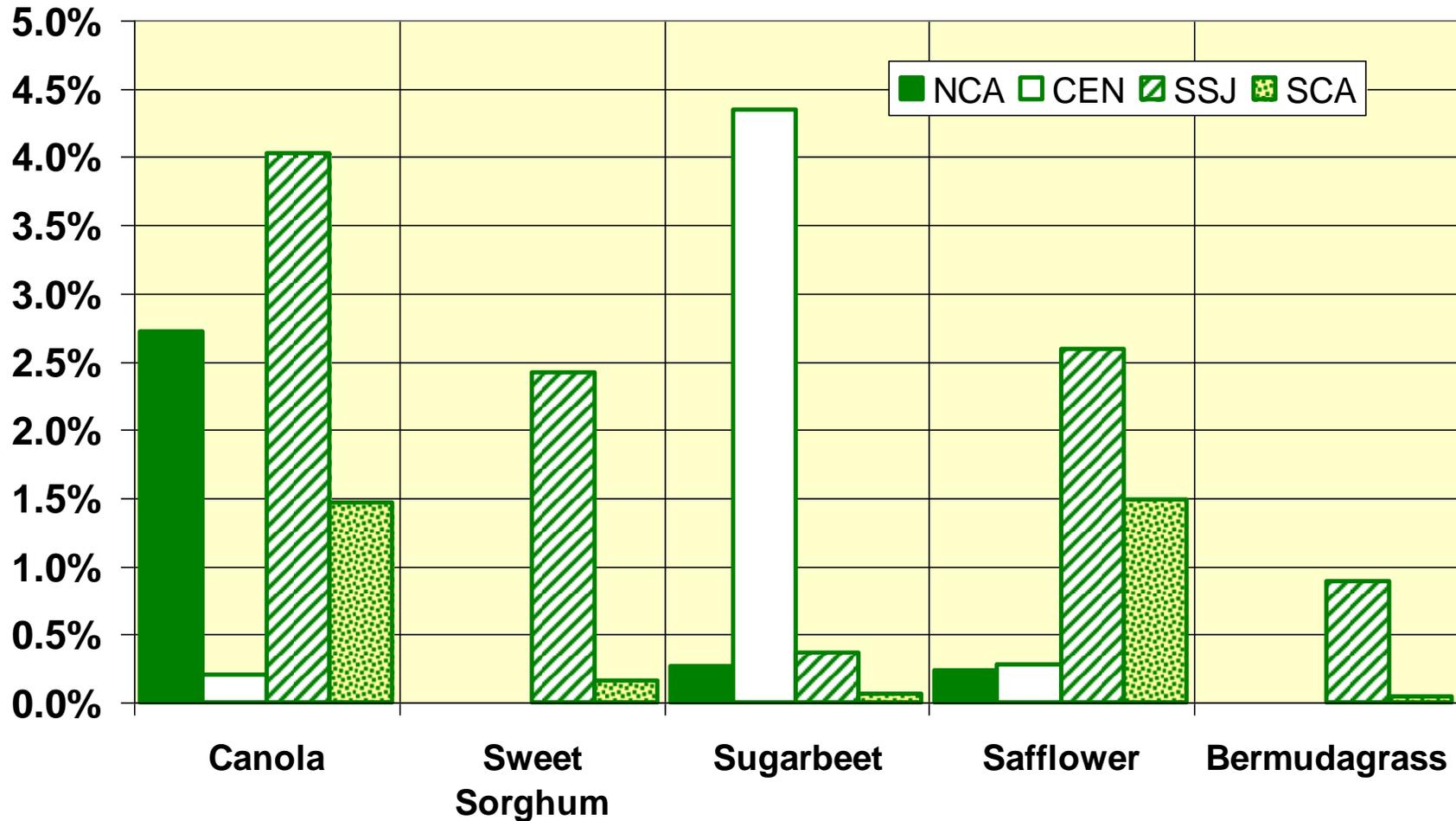


Jenkins et al. (2006) A roadmap for the development of biomass in California



- amounts are from: <http://www.calrecycle.ca.gov/Publications/General/2009023.pdf>)
- e. From EPA Region 9; Database for Waste Treatment Plants
 - f. Assumes 50% methane in gas
 - g. Assumes VS/TS= 0.83 and biomethane potential of 0.29g CH₄/g VS
 - h. Using 50 gge per dry ton (75 gallons EtOH per dry ton) yield. See, for example: Anex, R. P., et al. (2010). Techno-economic comparison of biomass-to-transportation fuels via pyrolysis, gasification, and biochemical pathways. [Article]. *Fuel*, 89, S29-S35. doi: 10.1016/j.fuel.2010.07.015
 - i. ~116 ft³ methane is equivalent to 1 gge (983 Btu/scf methane and 114,000 Btu/gallon gasoline, lower heating value basis)
 - j. 7.5 lbs FOG/ gallon biodiesel. Biodiesel has ~9% less energy per gallon than petroleum diesel, gives 50 M gallons diesel equivalent.
1 dge = 1.12 gge

Potential crop use for energy with favorable prices in different regions of the state (% of land in each region)



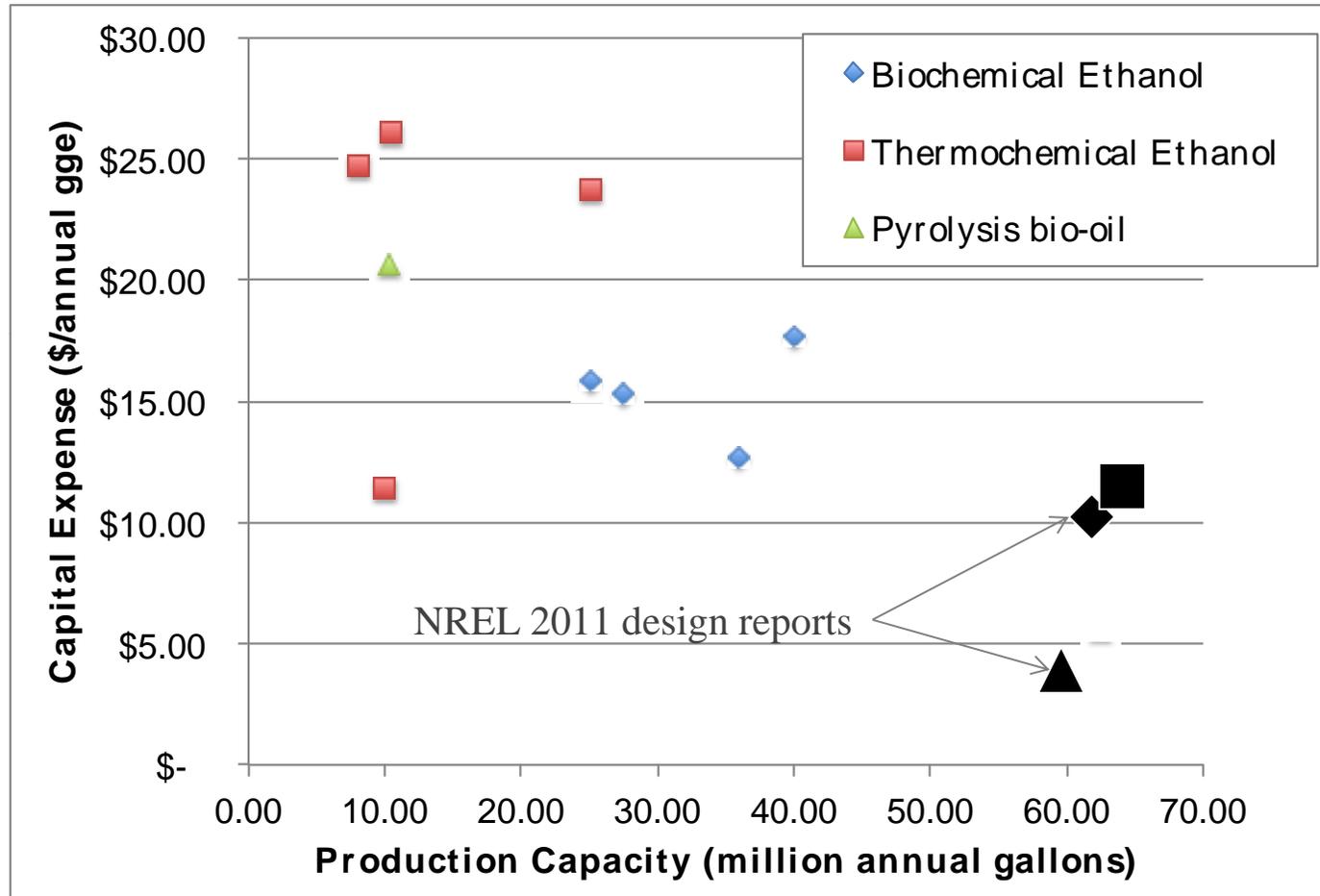
Multiple iterations of the Biomass Crop Adoption Model suggest that certain crops will be preferentially adopted in different parts of the state.

The vast majority of technically available biomass is lignocellulosic



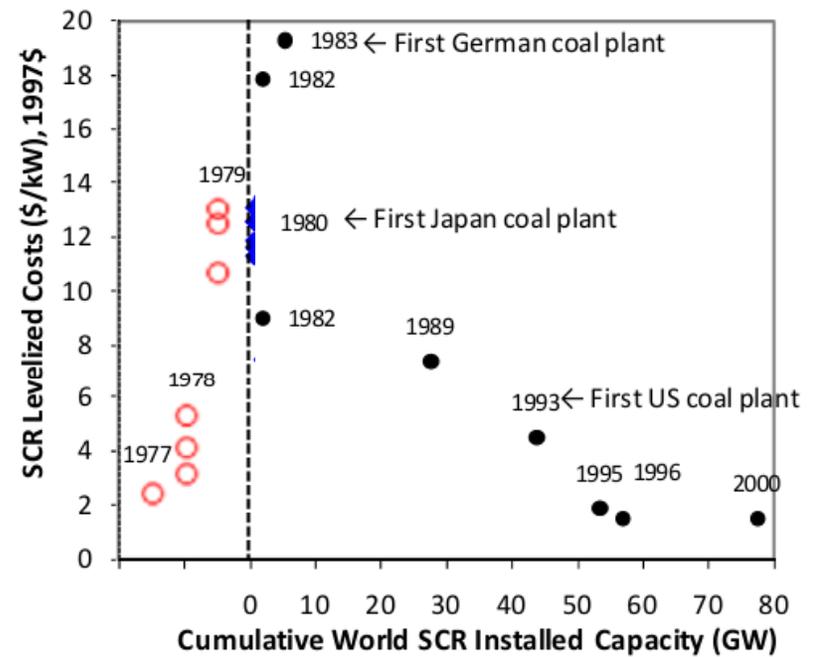
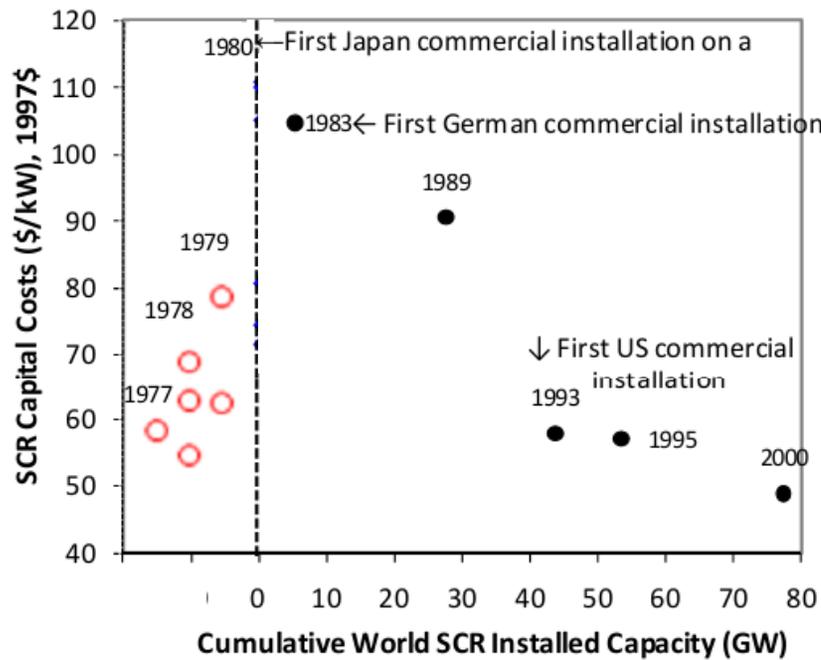
- There are no off the shelf technologies to utilize this resource for liquid fuels.
 - What technologies will prove commercially viable?
 - How do they get there?

High capital costs for 1st commercial biorefineries



Sample capital cost estimates as reported in media/loan programs/IPO fillings.

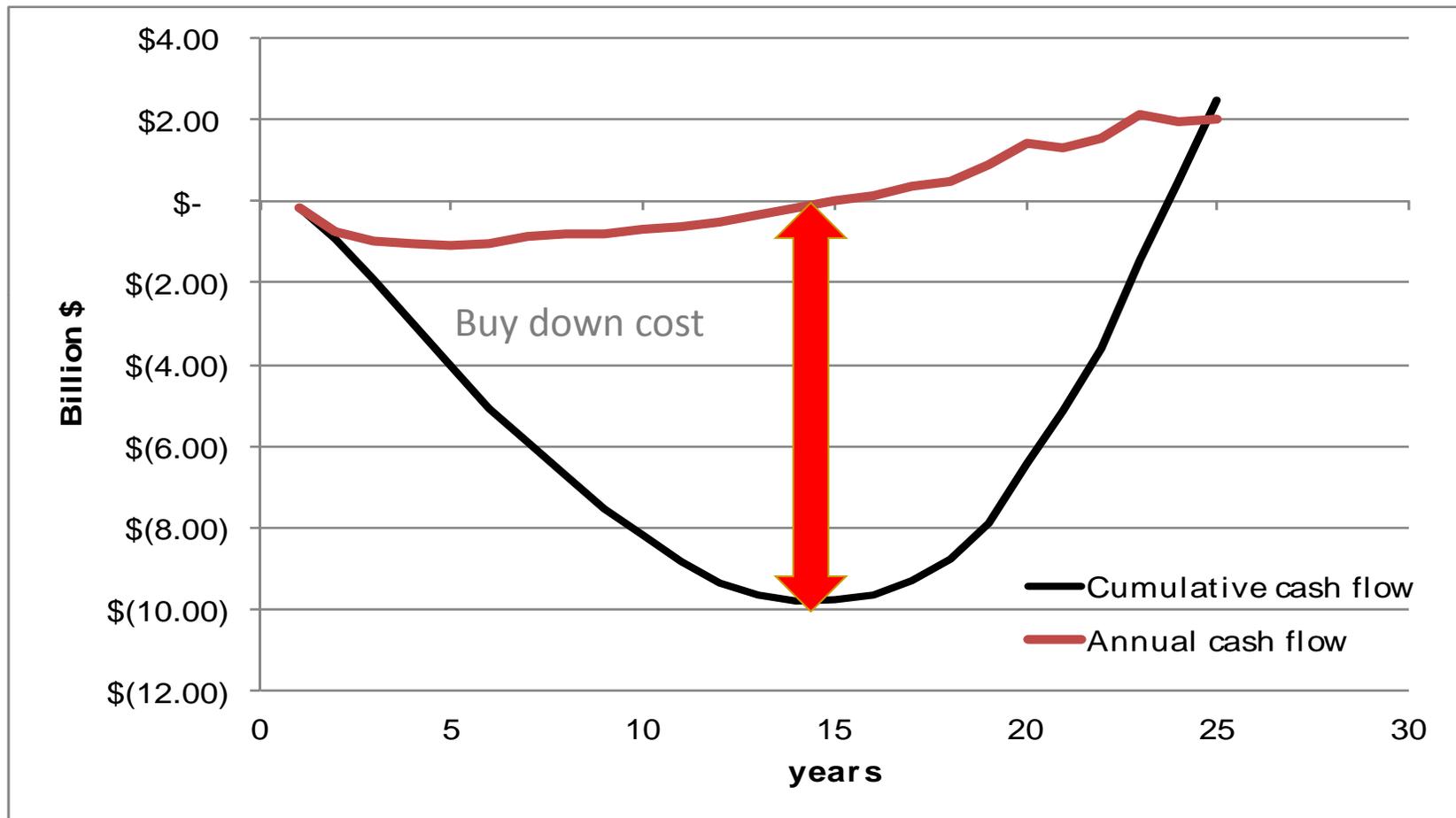
Cost path from cost estimates to mature technology



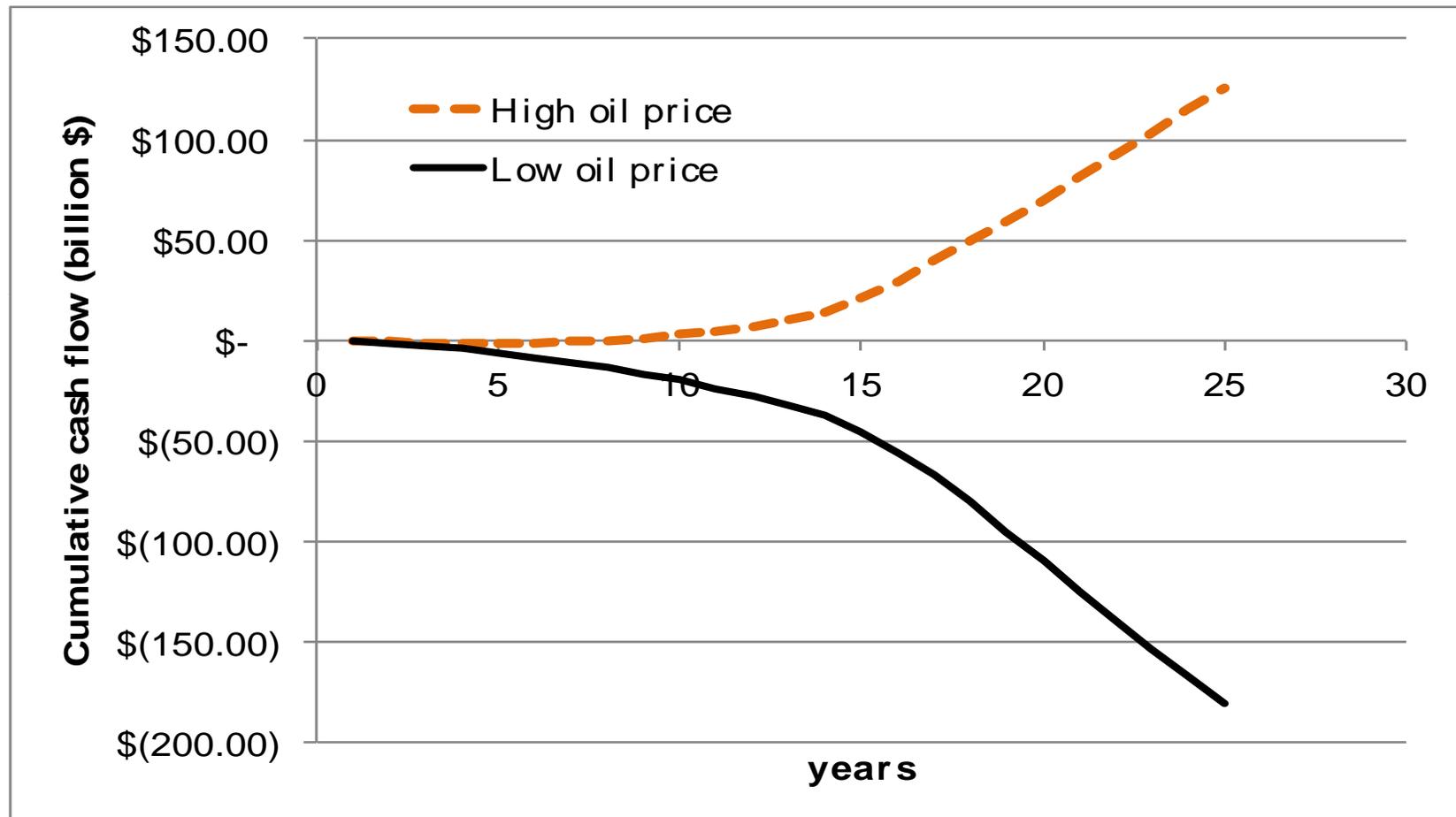
Illustrative example

Yeh, S. and E. Rubin. (2010) *Uncertainties in Technology Experience Curves for Energy-Economics Models.*

Transition cost reference case



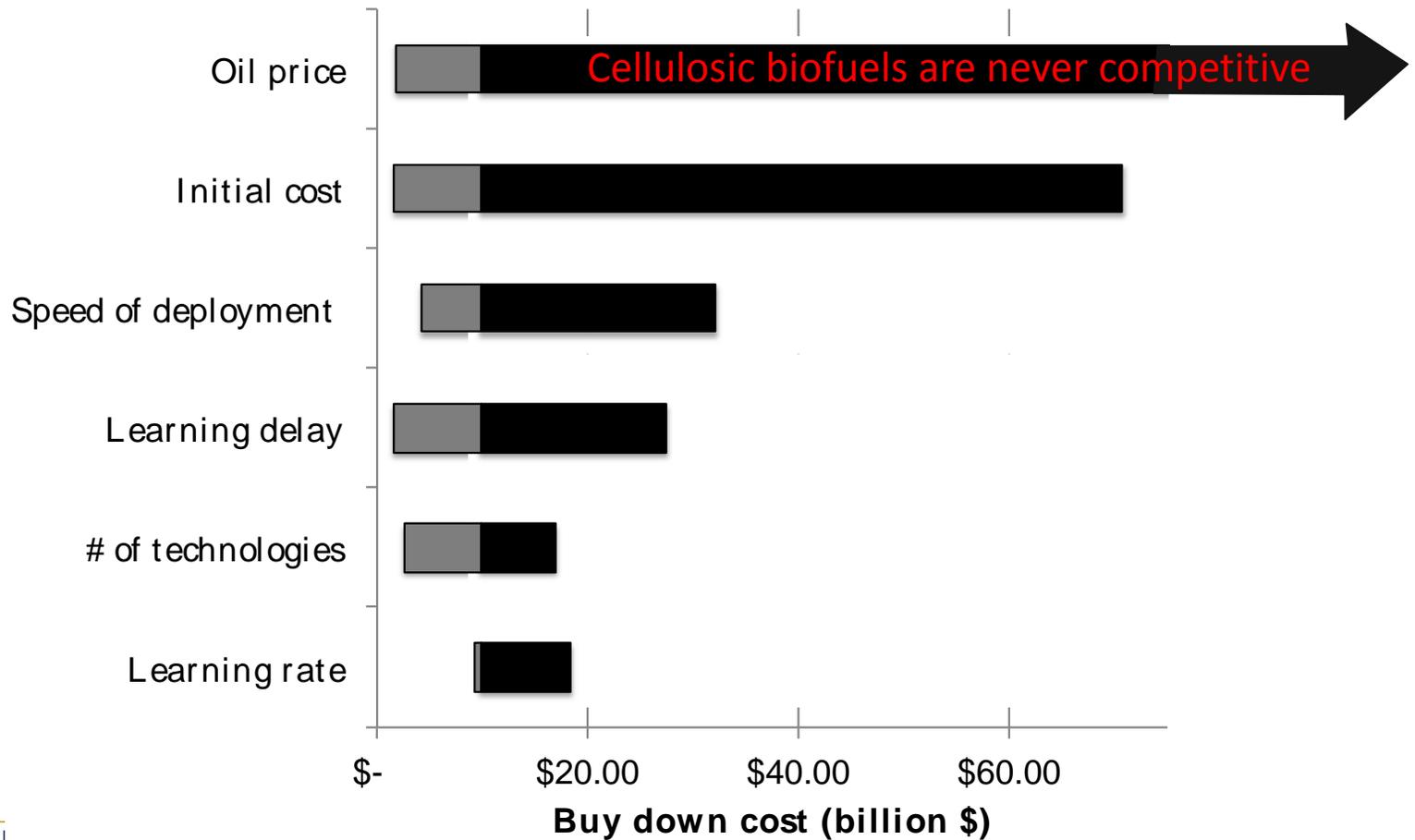
Extreme cases



The cost of transition is uncertain

- Take home messages

- Some scenarios do not lead to cost competitive biofuels
- For those that do, buy down cost are between \$2 and \$70 billion



Conclusion



- Lignocellulosic biomass remains the largest potential primary source for biofuels.
- Buy down cost for commercialization are estimated to be on the order of 10s of billions of dollars.
- Breakeven net present value for requires 10-40 years to occur.