Northern California Rice Field

Alcohol Fuels from Biomass – Assessment of Production Technologies

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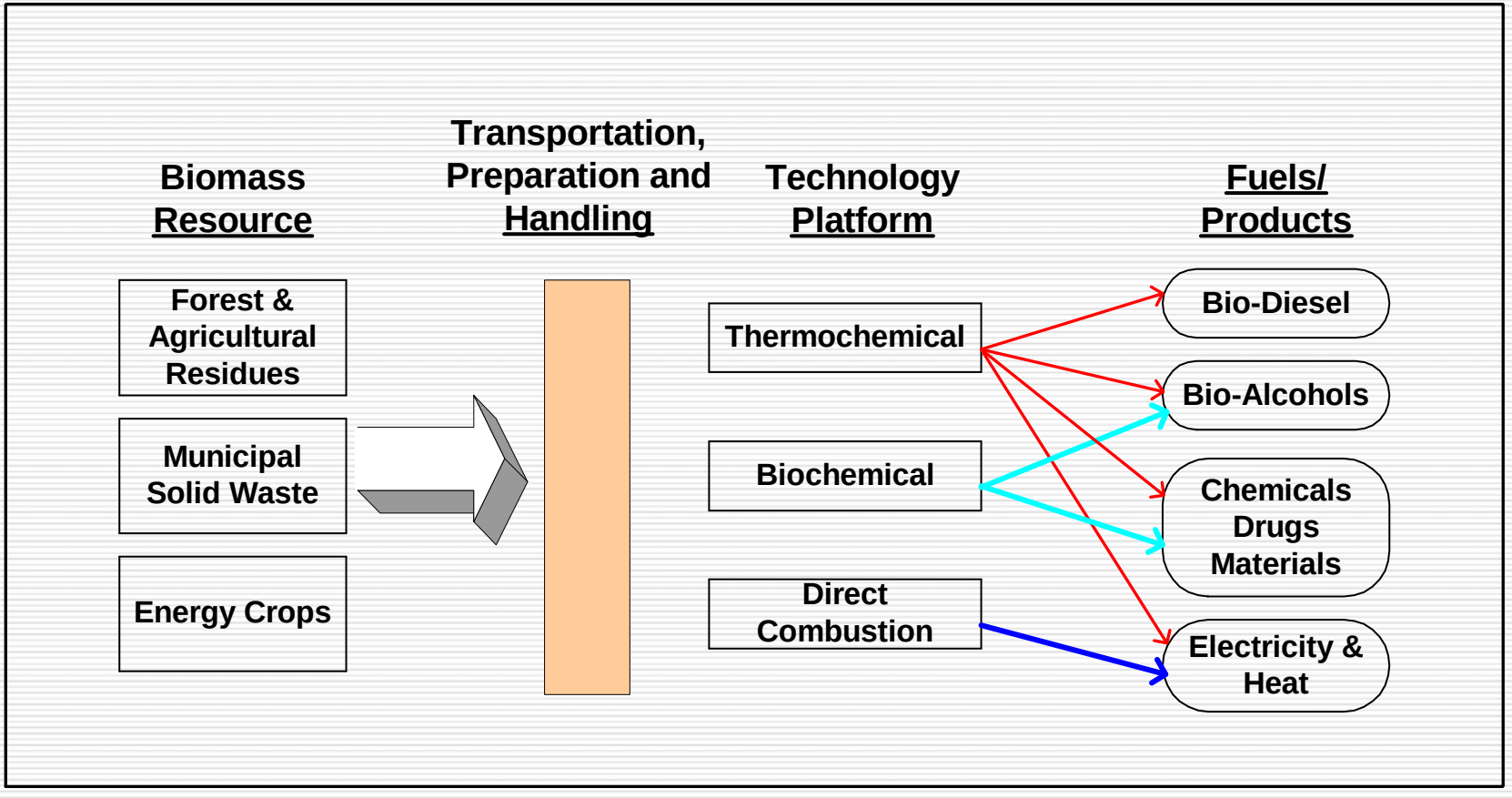
Introduction

- Who was behind it?
- Purpose of Study
- Cellulose-to-Bioalcohols technologies examined
- Study approach
- Findings, conclusions, and path forward

Purpose of Study

- Review and evaluate candidate technologies for producing ethanol and other alcohols from cellulosic biomass feedstocks, describing development progress to date and future prospects for these technologies.
- Review and summarize relevant past bioalcohol production technology projects studied or proposed in California.
- Identify opportunities for new projects involving applications of candidate bioalcohol production technologies using California's cellulosic biomass resources.
- Identify remaining regulatory, economic and institutional obstacles to bioalcohol project development and describe state and federal government roles in addressing these challenges.

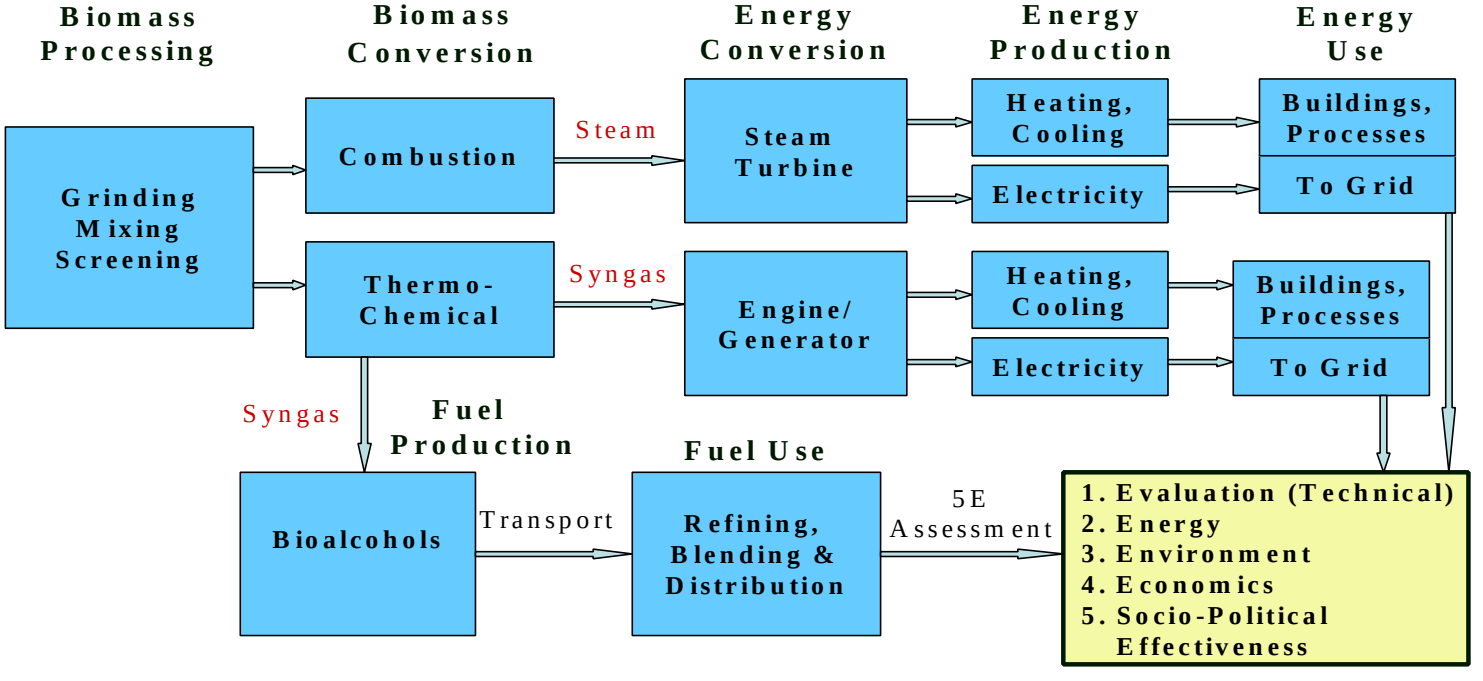
Potential Biofuels and Bioenery Pathways



Technologies Examined – Thermochemical Processes

- Pyrolysis/Steam Reforming – no air or oxygen
- Gasification – with air or oxygen
- High Temperature Gasification >3500 F with air or oxygen
- Thermal Pyrolysis – no oxygen or air
- Thermal Oxidation – combustion at or near stochiometry
- Integrated Thermochemical Conversion/Oxidation)
- 13 Developers Examined

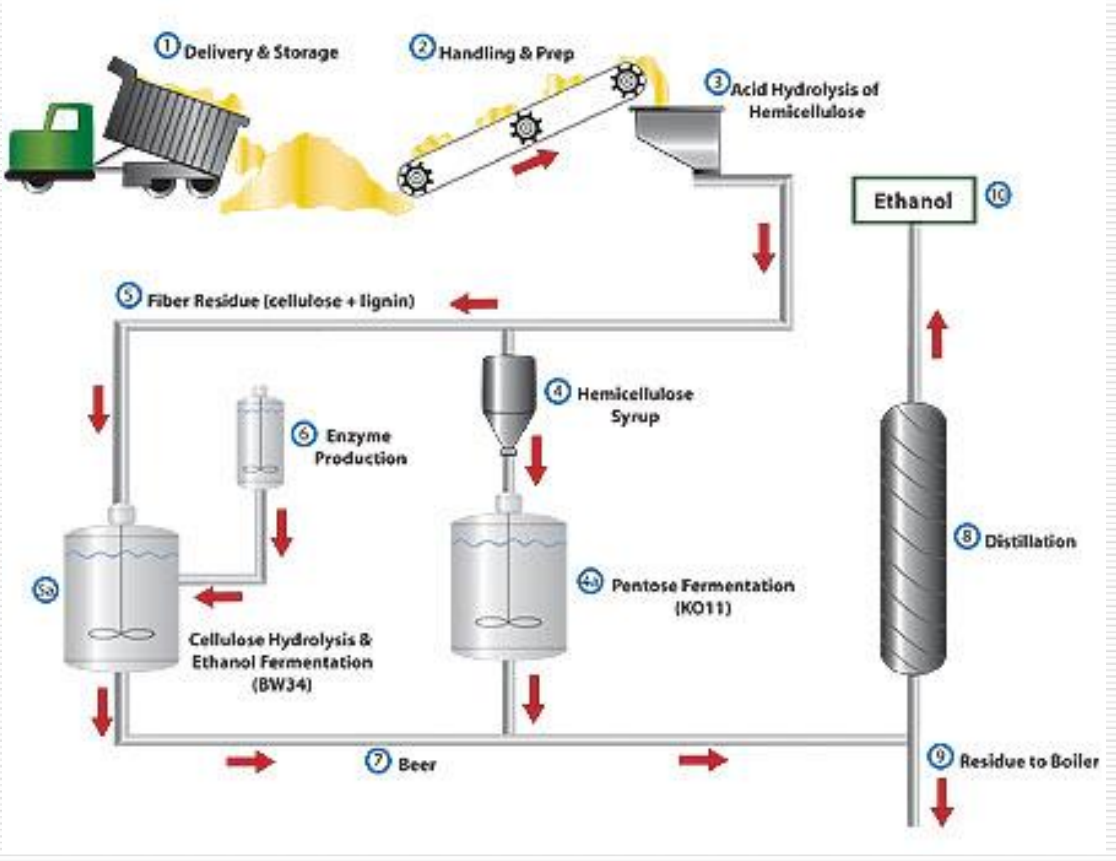
Thermochemical Technology



Technologies Examined – Biochemical Processes

- Acid Hydrolysis/Fermentation
- Enzymatic Hydrolysis/Fermentation
- Other Biological Processes
- 25 Developers Examined

Biochemical Technology



Credit: Celunol Corp.

“5E” Assessment

- E1 – Technology Evaluation
- E2 – Energy Efficiency
- E3 – Environmental Impacts
- E4 – Economic Viability
- E5 – Socio-political Effectiveness

Comparison of Thermochemical and Biochemical Systems

	A) Thermochemical Conversion Mixed Alcohols & Electricity	B) Biochemical Conversion Ethanol & Electricity	C) Thermochemical Conversion Electricity Only
Plant Size DT/day	500	2,205	500
Products (E1)			
Ethanol Fuel (gallons/DT)	80	59	N/A
Electricity (kWh/DT)	550	205	1400
Total Net Energy Efficiency (E2)	50%	33%	28%
Plant Emissions (E3)	see report	see report	see report
Economics (E4)			
Capital Cost, $M	66	205	60
Operating Cost, $M/yr	14.9	107.0	16.4
Electricity Production Cost ($/kWh)	$0.071	N/A	$0.071
Alcohol Production Cost ($/gallon)	$1.12	$2.24	N/A

N/A: Not applicable; E1, E2 and E4 values are given with ±15% uncertainty

Opportunities and Challenges

- U.S. Biomass Potential – the "Billon Ton Study"
- CA Biomass Potential – 33 million tons
- Technical Challenges
- Environmental and Regulatory Challenges
- Economic and Institutional Challenges
- Market-Related Challenges

Government Roles and Initiatives

- California Government
  - Energy Commission's Public Interest Energy Program (PIER)
  - Governor's Executive Order S-06-06
  - Bioenergy Action Plan
  - Bioenergy Interagency Working Group
  - AB 32 – Global Warming Solutions Act
- Federal Government
  - U.S. DOE Biomass Research and Development Initiative
  - U.S. Dept. of Agriculture
  - U.S. Defense Advanced Research Projects Agency

Federal Funding Efforts - 2007

8/27 - DOE offers up to $33.8 Million to Support Cellulosic Biofuel Processes

11/5 - Ground Broken for First Commercial Cellulosic Biomass Plant in the U.S.

5/1 - DOE Offers $200 Million for Small-Scale Cellulosic Biorefineries

10/1 - DOE Invests $30 Million to Launch Bioenergy Research Centers

9/26 - DOE and USDA Offer $18 Million for Biomass Research

6/26 - DOE Awards $375 Million for Three Bioenergy Research Centers

Conclusions and Recommendations

- Thermochemical technology with the highest probability of near-term commercial success is an integrated pyrolysis/steam reforming process – possibly as low as $1.12/gallon production cost
- Biochemical technology – hydrolysis and fermentation was estimated to be approximately $2.24/gallon production cost at present time
- Projected improvements could lower this cost to below $1.50/gallon

Conclusions and Recommendations (cont'd)

- Ethanol and bioalcohols from cellulosic biomass has several promising technologies
- Still need for significant research, development, demonstration, and deployment
- Demonstration and commercial scale plants need to be built, validated, and improved
- Government still needed to implement regulations, provide increased RDD&D support and grant incentives to promote tech advancement
- However, government should not mandate the type(s) of technology they believe to be the future winners, but support all promising technologies

Questions/Comments?

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