Steps to Commercialization

The Future is Uncertain

Hard Realities (George Simons)

- $35 billion State deficit
- Huge benefits associated with ethanol
- Why rain on the parade?
- MTBE phase out created demand for ethanol—high stakes, benefits need to be realized
- Hear all the time about breakthroughs, but not ensured, situation won't tolerate failures
- Perceptions:
  - MTBE=great opportunity for ethanol
  - Cellulosic ethanol cheaper than sugar/starch
  - Phase out of MTBE was not done to create market for ethanol
  - Ethanol production will be economically driven
  - Available resources do not support 3-4 billion gallons
  - Midwest relatively cheap source of ethanol
  - Cellulosic ethanol $1/gallon more expensive
- No commercially available technologies for cellulosic ethanol
- Don't expect single step breakthroughs
  - Don't take things from the bench scale directly to commercial processes
- Cellulosic based processes will take longer than anticipated, development costs much higher, how do we come up with the money?
- Need deliberate pathways to ensure success in California

Technology Options (Jim McMillan)

- NREL trying to develop high quality data for scale-up
- Need to look at biomass resource itself
- Concentrated acid processes are working (Arkenol, Masada, Russian facilities)
- Good progress being made in reducing costs of enzymes
- Thermo-biochemical least studied system, gasification costs and gas quality may be limiting
- Challenges:
  - Processing solids
  - Understanding chemistry
  - Chicken-egg on co-products (need materials for research)

History (Loyd Forrest)

- To date none of proposed projects has been commercialized
- What are deal killing issues?
  - Cost of feedstock (Economically and environmentally viable)
  - Siting of facility (logistics)
  - Technology (economically efficient?)
  - Market (long term purchase agreement as basis for financing)
  - Development team (95% of expertise needed for business deal)
- Need to provide ethanol from biomass at price less than corn ethanol
- What is longevity?
- Does technology work in practice?
- Complex job to build industrial plant with off-the-shelf technology
- Complex job to build industrial plant with new technology
- Greater risk demands greater margin
- Don't assume you can sell product at current market price
- Close to commercialization (biodiesel, cellulosic ethanol, biomass to hydrogen)
- Only technology in our short time frame (3 years) is gasification
- Biogas not Syngas (sorry Loyd--biogas is still digester gas)

Forestry Supply (Doug Wickizer)

- Reduce costs and losses from damaging fires
- Need for fuels reduction
- Options
  - Burning (not acceptable)
  - Composting
  - Energy production
- Difficulties implementing fuels reduction (air quality, structural damage risk)
- Large public benefits in finding uses for this material
- Barriers:
  - Technological
  - Institutional
- Driving Green—fleet markets for fuel
- Dispersed Generation—smaller facilities (Washington Ridge)
- Bioenergy or Ashes?
- Don’t forget co-benefits that add benefits for public

Developers

- Bob Walker:
  - 30% rate of return to accommodate risk
- Michael Fatigati:
  - Success in working within existing framework (e.g. solid waste)
  - California not friendly for project development—issues (time and money will deal with those). More active role for State.
- Gene Jackson:
  - Ecalene, process can handle dirty synthesis gas.
- Don Brelsford:
  - Reverse interstage transfer. Commercial validation ready to start. See Don for a license.
- Greg Shipley:
  - Has already seen Don. Garbage in, ethanol out. Problems: trucking costs, labor costs, disposal costs, producing ethanol is solution to problems.
  - Utilize MRF infrastructure.
  - Suggestion: Single point permitting, coordinated policy.
- Laszlo Paszner:
  - Need co-product revenues. Cannot pay for feedstock on ethanol alone. Cannot make ethanol without subsidy. Need jobs.
- Lee MacLean:
  - Nitric acid is not sulfuric acid. Materials advantages, especially stainless steels.
- Daniel Musgrove:
  - Progressive scale-up is very important.

Case Studies (Fran Ferraro)

- State incentives justify small projects
- Obvious advantages where feedstocks already collected
- Lenders not necessarily familiar with products/stability of market
- No one has totally integrated pilot gasification system (might this also be said of more conventional routes?)
- Financing depends on reliability/feedstock guarantees

Theoretical California Biomass

- Solar energy = 2 MWh/m^2- year
- 1 % efficiency (agriculture)
- 16 tons/acre-year
- 100 million acres
- 160,000 MWe
- 112 billion gallons of ethanol
- Water?

Commercialization

Atlas | Reverse Dictionary | Rhyming Dictionary
Dictionary | Thesaurus | Unabridged Dictionary

Main Entry: **com·mer·cial·ize**
Pronunciation: k&-'m&r-sh&-"lIz
Function: *transitive verb*
Inflected Form(s): **-ized**; **-iz·ing**
Date: 1830
1 a : to manage on a business basis for profit **b :** to develop commerce in
2 : to exploit for profit <*commercialize* Christmas>
3 : to debase in quality for more profit
- **com·mer·cial·i·za·tion** /-"m&r-sh(&-)l&-'zA-sh&n/ *noun*

Commercialization

- Why are we here talking about “steps” to commercialization?
- There are a number of general models for commercializing technology
- Underlying sense of questioning why the technology is not already commercial

Needs/Incentives

- What needs does the industry have in commercializing the technology?
  - Continued research and development
  - Technology demonstration
  - Public/Government support
- What incentives can/should the State provide?

Needs

- Does California need ethanol?
- Does California need 1 billion gallons of ethanol?
- Does California need cellulosic ethanol?
- Does California ethanol need to come from California?
- Does California need a renewable fuels standard (RFS)?
- What policy does California need?
- What does the industry need?

Why fuel ethanol?

- Renewable, yes, with environmental and social (as fuel) advantages, but,
- Primary driving force for development is a liquid fueled transportation sector evolved from the ready availability of petroleum.
- Ethanol may be a transition fuel for the near to intermediate term, possibly longer if serving as energy storage (fuel cells).
- Sustained longer term use as a chemical intermediate.

Markets

- Replacement of MTBE gives ethanol a substantial market in California, but is it a necessary market?
  - Code does allow for oxygenates other than ethanol if no adverse impacts are demonstrated
  - non-oxygenated RFG?
- Transition to renewable fuels can also provide substantial ethanol market but other fuels also compete.
- High volumetric energy content and easy storage will remain major competitive advantages of liquid fuels.
- Ethanol will come under increasing competition from other fuels and propulsion technologies, including Hydrogen and Electricity, both capable of being produced from renewable resources.
- Continuing pressure to reduce production costs for the fuels market.

Why ethanol from cellulosics?

- Large resource with potentially improved economics and energy balance
  - 1 billion gallons from approximately 15 million tons of biomass, equivalent to estimated currently available annually in state from total of 65 million tons.
- Requires a more aggressive approach than for sugar and starch
- Elegant fundamental research
- Processes seemingly still in proof-of-concept stage
- Where is the technology?

Where is the technology?

"The conversion of cellulose to ethanol is not, at this point, rocket science."

David Morris, Institute for Local Self-Reliance

"...the world's most commercially advanced enzymatic process for making ethanol from biomass (bioethanol)."

Iogen Corporation Corporate Info
http://www.iogen.ca/2100.html

"Both units of the facility, the material recycling facility and the ethanol production plant, employ "proven" technologies with existing commercial operations. In fact, about 400 Material Recycling Facilities (MRF's) are currently operating in the United States, and more than 1.5 billion gallons of ethanol was produced in 1996."

Masada FAQ
http://www.ci.middletown.ny.us/cityhall/dpw/pmfaq.htm

Energy Grails?

- Tar-free gasifier
- Low-cost PV
- Effective hydrogen storage (is ethanol it?)
- Safe disposal/transformation of nuclear waste
- Fusion
- Sustainable carbon sequestration
- Paperless office
- US adoption of SI units and an end to the MMBtu
- Exergy (2^{nd} Law) based energy policies
- Cellulosic ethanol?

What incentives from the State?

- What responsibility does the State have for developing and demonstrating technology?
- Should the State encourage/dictate fuel/energy types and strategies or simply set the standards for protecting human health and welfare and the environment, leaving the industry to develop within that context?

Needs Driven Approach

- Identify needs and seek solutions.
- Weighted on potential industry capability to address perceived needs of State while simultaneously satisfying shorter term needs of industry for development funding.
- May become resource, process, or technology driven rather than result focused
  - e.g., Renewable Portfolio Standard
    Renewable Fuels Standard
    AB 939/AB 2770 definitions affecting conversion options
    Commodity specific credits/taxes

Incentives Driven Approach

- Provide incentives consistent with social value to (needs of) the State.
- Economic incentives for actual benefits generated.
- State has no particular role in technology.
- Industry proves technology for the purposes of obtaining financing and access to markets.
- Economic incentives intended for a sufficient period to justify commercial investment.
- Appropriate incentive mechanisms based on results
  - e.g., production/producer credits based on perceived environmental/social benefits.
- Economic subsidies should inherently decrease as industry need declines
  - e.g. production/producer credits paid from carbon taxes if environmental issues predominate.

Remaining Steps to Achieving Commercial Biomass-to-Ethanol Process Technology

- Deliver on the promise
- Demonstrate the technology
  - Technical
  - Economic
  - Financial
  - Social
  - Environmental

Steps to Commercialization

- What is State policy?
- What are industry needs?
- Determine role, if any, of government in supporting development.
  - Support fundamental research.
  - Motivate through regulation/incentives aimed at public/industry goals.
  - Can provide markets as appropriate to meet State goals (e.g. fleet fueling provisions).
- Education and Training to meet current and future personnel demands.
- For public support and financing, credible and independently verifiable information is critical.
  - demonstration to confirm technology and develop credible cost estimates for scale-up.

Remaining Steps to Achieving Commercial Biomass-to-Ethanol Process Technology

- Clear policies and well-informed legislation
- Well-defined needs
- Public education
- Collaborative infrastructure development planning
- Continued government and industry support of basic research
- Successful industry demonstration of integrated technology backed up by commercial financing
- Equitable production incentives to meet public objectives

Motivation?

- Remain optimistic, there is hope.
- Cooperative efforts are key.
- Research is unpredictable, serendipity happens (or not).
- Avoid adversarial models, maintain flexibility in approach, keep focus on important elements, freely disclose and learn from failures, there is success in learning.
- If something better comes along, that's good.

You get what you pay for?

One who knows, does not speak.

One who speaks, does not know.

…the Lao Tsu (Tao Te Ching)…

Or perhaps this translation?

One who knows, does not brag.

One who brags, does not know.

…the Laozi (Daodejing)…