

Biofuels: Think outside the Barrel

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Assertions

- We don't need oil for cars & light trucks
- We definitely don't need hydrogen!
- We don't need new car/engine designs
- We don't need new distribution systems
- We can start to transform our infrastructure at little cost radically within 3-5 years!

Not so Magic Answer: Ethanol

Why Ethanol

- Today's cars & today's fuel distribution
- Today's liquid fuel infrastructure
- Already part of fuel market through “blending”
 - just add E85 fuel category
 - Existing ethanol market in the billions & growing!
 - Incremental introduction possible
- If scaled many improvements possible:
 - Crops
 - Crop yield
 - Process technology
 - Bioengineered crops, enzymes,....
- Significant “economic/environmental/land use” improvements possible thru technology/scale/...
- NRDC Estimate 2050: \$20b/yr in fuel cost savings & 80% reduction in today's transportation-related emissions

Why Now

- Brazil has “proven” model of ethanol
 - Low risk auto conversion model to FFV
 - Initial fuel markets thru blending- reduced “production” risk
 - Excess supply for “kick start” available from Brazil
- High oil prices accommodate “startup” costs of ethanol
- Breakeven at scale likely to be ~\$35/barrel
- Carbon considerations will further improve “economics”
- 20% increase/yr of US ethanol production already in process
- Significant increase in farm profits now feasible
- 4m US FFV vehicles, 5b gals ethanol supply, blending in place,....
- Many US cars available at same price (FFV or gasoline)

Objections

- Land Use
 - Traditional numbers cited are for “corn” ethanol
 - NRDC 2050 estimate: 114m acres required for our needs
 - Further improvements beyond NRDC estimates possible
 - Conversion of 73m acres to soybeans “proves” ability to switch land use through incentives
- Energy Balance (Energy IN vs. OUT)
 - “Corn” ethanol numbers ~1.2-1.8X
 - Cellulosic ethanol ~4-8X
- Environmental pollution
 - E85 better in all respects
 - E10 equivalent to gasoline or better
 - “mid-blends” (E15+) increase some emissions (NOX...)

Interest Groups

- **US Automakers:** less investment than hydrogen; compatible with hybrids
- **Agricultural Interests:** more income, less pressure on subsidies; new opportunity for Cargill, ADM, farmers co-operatives,...
- **Environmental Groups:** faster & lower risk to renewable future; aligned with instead of against other interests
- **Oil Majors:** equipped to build/own ethanol “factories”& distribution; lower geopolitical risk, financial wherewithal to own ethanol infrastruct.; diversification
- **Distribution (old & New):** no significant infrastructure change; potential new distribution sources (e.g. Walmart)

Interest Groups: Action Items

- **US Automakers:** trade 100% flex-fuel new car requirement for “CAFÉ pressure” relief
- **Agricultural Interests:** 100% flex-fuel new cars but no tax on imported ethanol; “transfer” subsidies from row crops to energy crops (equivalent \$/acre)
- **Environmental Groups:** tax-credit for “cellulosic ethanol” & debt guarantees for new cellulosic ethanol technologies
- **Oil Majors:** new business opportunity?
- **Distribution (old & New):** assist “ethanol third pump” strategy; promote ethanol distribution at destination sites (e.g. Walmart) & fleets

Prioritized Action Items

- Require all cars to be Flex Fuel Vehicles (FFV's)
- Assist debt financibility of first 10 of cellulosic ethanol plants with any “new technology” (behind investor risk)
- Allow/require fleets to import ethanol without tax burden
- Require E85 ethanol distribution at 30% of gas stations
- Remove tax on Brazilian ethanol imports
- Establish early demand by creating “strategic ethanol reserve”
- Switch subsidies (same \$/acre) from existing to energy crops
- Allow carbon credits for cellulosic ethanol
- Require automakers to promote ethanol usage to get CAFÉ credit

RISK: Oil vs. Hydrogen vs. Ethanol

	Oil	Hydrogen	Biofuels
Energy Security Risk	High	Low	Low
Cost per Mile	High	?	Low
Infrastructure Cost	Low	Very High	Low
Technology Risk	Very Low	Very High	Low
Environmental Cost	Very High	?	Low
Implementation Risk	Very Low	Very High	Low
Interest Group Opposition	Very High	High	Low
Political Difficulty	?	High	Low
Time to Impact	-	Very high	Low

Land Use

- NRDC: 114m acres meets our transportation fuel needs in 2050
 - Assumes 2X switch grass yield improvement (vs. Corn has had >5X yield improvement)
 - Assumes ethanol production @ 100 gals/dry ton of feedstock (not very aggressive)
 - Woolsey/Shultz estimate lower land use requirements
- Currently 73m acres under soybean for animal proteins – can be used for co-production of ethanol & animal protein
- Use agricultural waste products & animal waste

Technology Improvements

- Enzymes
- Plant based Co-production of Enzymes
- Consolidated bioprocessing for C5 & C6 sugars (CBP)
- Feedstock Crop Yields
 - Dry tons/acre
 - Feedstock Variety: Sugarcane bagasse, rice husk, corn stover, wheat straw, forest clippings, sorghum, papermill waste, coal, animal waste....
- Energy crops
 - Switch grass
 - Poplar
 - Willow
- Co-production of animal protein & cellulose/hemi-cellulose
- Process & Process Yields
 - Process Cost
 - Process Yield gals/dry ton
 - Co-production of industrial chemicals to reduce net fuel costs
- Other: “out of the box” technologies

Flex Fuel Vehicles (FFV)

- Almost no incremental cost to produce & low risk
- Confidence on fuel availability to consumers
- Easy switchover for automobile manufacturers
- 4 million FFV cars in the US today (to earn CAFÉ credits)
- Consumer choice: use EITHER ethanol or gasoline (no risk)
- Fully compatible with Hybrid cars
- Brazil “Proof”: new car sales from 4% FFV to ~50% in 3 years!
- Growth in ethanol use driven by low prices of ethanol
- Brazil: \$50b on oil imports “savings”

Fuel Issues

- E10
 - Usable in today's engine
- E85
 - Easy switch
 - Exceeds hydrogen fuel cell carbon reductions today and in 2015!
- Other: “mid-fuels” possible, reduced pressure on oil prices

Switch Grass as Feedstock

- Natural prairie grass in the US
- Enriches soil carbon content; less fertilizer; less pesticide
- Less water pollution (nitrogen runoff)
- Dramatic reduction in CO₂ , NO₂, Sulphurs,...
- More biodiversity in switchgrass fields (vs. corn)
- Dramatically less topsoil loss compared to corn fields
- High potential for co-production of animal feed
 - Currently ~50% of all agricultural land use
 - Minimal extra land required for fuel production

Hydrogen vs. Ethanol

- Ethanol: US automakers balance sheets ill-equipped for gasoline to hydrogen infrastructure change
- Ethanol: No change infrastructure in liquid fuels vs. gaseous fuels
- Ethanol: Current engine/manufacturing/maintenance infrastructure
- Ethanol switchover requires little capital
- Ethanol: Agricultural Subsidies are leveraged for social good
- Ethanol: Faster switchover- 3-5 years vs 15-25yrs
- Ethanol: Low technology risk
- Ethanol: Incremental introduction of new fuel
- Ethanol: Early carbon emission reductions

Strategy & Tactics

- Choice: Oil imports or ethanol imports?
- GDP – “beyond food to food & energy “ rural economy
- Add \$5-50B to rural GDP
- Avoid international pressure to remove agricultural subsidies through “energy crops”
- Rely on entrepreneurs to increase capacity
- Rely on biotechnology & process technology to increase yields in crops/process/enzymes,....
- Increased ethanol use mandates already in place – 20% /yr production capacity increase plans already in process!

Environmental issues

- Carbon emission reduction ~1 ton/ton of biomass used
- Carbon emission reduction of 80% of current transportation related emissions (\$1.7b tons/yr)
- Zero sulphur, low carbon monoxide, particulate & toxic emissions
- Switchgrass: low nitrogen runoff, soil carbon enrichment, increased biodiversity, low soil erosion (compared to row crops)
 - 2-8X lower nitrogen run-off
 - 75-120X lower topsoil erosion (compared to corn)
 - 2-5X more bird species
 - Resistant to infestation & disease; lower pesticide use
- Co-production of animal protein & cellulosic biomass allows existing cropland to produce our energy needs
- Potential for coal ethanol as supplementary source

The Numbers

- Ethanol cost today: ~\$0.75/gal (Brazilian ethanol)
- E85 “gasoline equivalent” blended cost: ~\$1.30/gal
- Gasoline cost ~\$2.00/gal
- Long term ethanol price potential of \$0.39/gal (\$0.59 “gasoline equivalent” price)
- NRDC 2050 Forecast: 165 billion gals of ethanol from existing cropland while meeting current agricultural needs!
- \$40/ton of extra income for farmers for waste biomass – lower government subsidies for price support (5-12 tons/acre yield)
- Today’s corn stover itself can produce 20b gallons of ethanol production & new income to corn farmers

Example: Pennsylvania

- Ethanol off-take contracts at \$1.25/gal for 10 years
(vs. today's gasoline @ ~\$2/gal)
- Providing Demand aggregation
- Providing debt to assist biofuel plant financing
- Providing feedstock price guarantees / contracts

References

- NRDC Report: “Growing Energy” (Dec 2004)
- George Schultz & Jim Woolsey white paper “Oil & Security”
- Rocky Mountain Institute: “Winning the Oil Endgame”

Comments?

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