



# Diversified Energy Corporation

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## Advanced Biofuels Opportunities and Challenges Southwest Energy Innovation Forum 18 Oct 2010

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# Who is Diversified Energy?

- Alternative and Renewable Energy Technology Company – HQ Phoenix, Arizona, USA
- 5 Yrs Working in Two Major Energy Areas:
  - “Clean Carbon” Gasification
  - Advanced “Drop-In” Biofuels
- Focused on Development and Commercial Introduction of Promising Technologies
- Core Team in Place and Key Partnerships Established to Support Development
- Millions in Revenue -Technologies Funded by Private \$\$, Five Separate U.S. Government Agencies, and Commercial Partners



*Headquarters – Gilbert, Arizona*

***“Develop and mature alternative energy technologies, systems, and projects to economically address United States and World energy demand”***



# Diversified Energy Beliefs/Principles

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- Founding Beliefs:
  - “Peak Oil” has Arrived or Will Shortly
  - Global Energy Demand Will Continue Strong Growth
  - Energy and Fuel Costs Will Rise
  - Major Transportation Energy Crisis Continues to Build Long-Term
- Founding Principles:
  - Be Technology Diverse
  - Processes Ideally Use Multiple Input Feedstocks
  - Multiple Output Products, All “Fungible” Drop-In Replacements
  - Focus on Low Conversion Cost and Realistic Commercialization Scenarios
  - Be a Leader in Alternative/Renewable Liquid Transportation Fuels



# The Problem Is Staggering.... (Optimist: What an Opportunity!)

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- 840 Million Gallons Per Day of US Petro Fuel Use
    - 90 Day Supply In Pipeline for Country On any Given Day
    - Highly Bottlenecked Supply System, Very Vulnerable
    - Over 75% of World In-Ground Supply controlled by NOCs
      - Big Oil Majors Really Just Truckers and Refiners.....
  - US Domestic and Military Fleets Near 100% Petro-Fueled
    - 215 Million Automobiles
    - 85 Million Light Trucks
    - 6 Million Long-Haul 18-Wheelers
    - 6000 Long-Haul Aircraft
    - Major Railroads Each Using over 1 Billion Gallons Diesel Per Year
    - Hundreds of Thousands of Military Vehicles – Largest Single User
  - The Era of Low-Cost Plentiful Petro Supply is Over
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# Review of Scale For 10 MMGY Outdoors

- For a 10 MMGY Fuels Farm (Cyanobacteria Example)
  - 1500 acres of land
  - 250,000,000 gallons of water - standing
  - 150,000,000 linear feet closed tubes – 126,000,000 lbs plastic
  - 13,000,000 linear feet troughs
  - 750,000 gallons per day lost to evaporation (open system in AL)
  - >3" diameter make-up water piping to fields
  - 722 tons CO<sub>2</sub> consumed per day
  - 20,000,000 L/hr CO<sub>2</sub> gas flow rate to farm (>10 MW compression)
  - 10,000 GPM flow rate through extraction (16 MW pumping)
  - 155 tons of fatty acid produced every day
- Material & Energy Requirements for only 1500 Acres HUGE
- Approaches \$100 Million CAPEX for this Small Farm



# Extending Prior Example to NATIONAL Scale (Worst Case - Doing it All)

- Need 20 Million bbls per day
  - 840 Million gallons per day
  - 306,600,000,000 gallons per year
  - Need 30,660 Algae Farms like the One Just Described @ 10 MMGPY
  - Requires 45.9 Million Acres of Flat, Sunny, Temperate Land
- Requires 7.6 Trillion Gallons of Standing Water
  - Open System Loses 22.9 Billion Gallons Water/Day to Evaporation
- Requires 3.8 Trillion Lbs of Plastic (Replaced Periodically)
  - (We Just Ran Out of Oil and Gas to Make it All)
- Gobbles Up 22 Million Tons of CO<sub>2</sub> Per Day!
  - CO<sub>2</sub> Crowd Will Like THAT!
- Consumes 490 Gigawatts of Electricity To Pump the Water
  - Probably Generates More CO<sub>2</sub> To Pump the Water than Saved....



# Thompson's Prediction and Question

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- Obviously Won't Work, Country Will Not Go to This Scale
  - Only A 10% Supply Contribution Would Help
  - We Will See a Smorgasboard of Future Fuel Offerings
- Food Crops Will Eventually Be Outlawed as a Fuel Source
- Cellulosic Ethanol Costs Too Much In Infrastructure Mods
  - Near- Broke Country Can't Afford \$5 Trillion Infrastructure Change
- Future Fuels MUST be 100% Drop-In Replacements
  - Preserve the 300 Million Vehicles in the US Domestic Fleet
  - Military Vehicles Must Have Drop-in Replacements - \$Trillion Cost
  - Demand/Supply Inversion and Costs Ahead will Park Many Vehicles
- US has the Science and Technologies to Jump the Crevasse
  - Will We Move Fast Enough To Implement It??

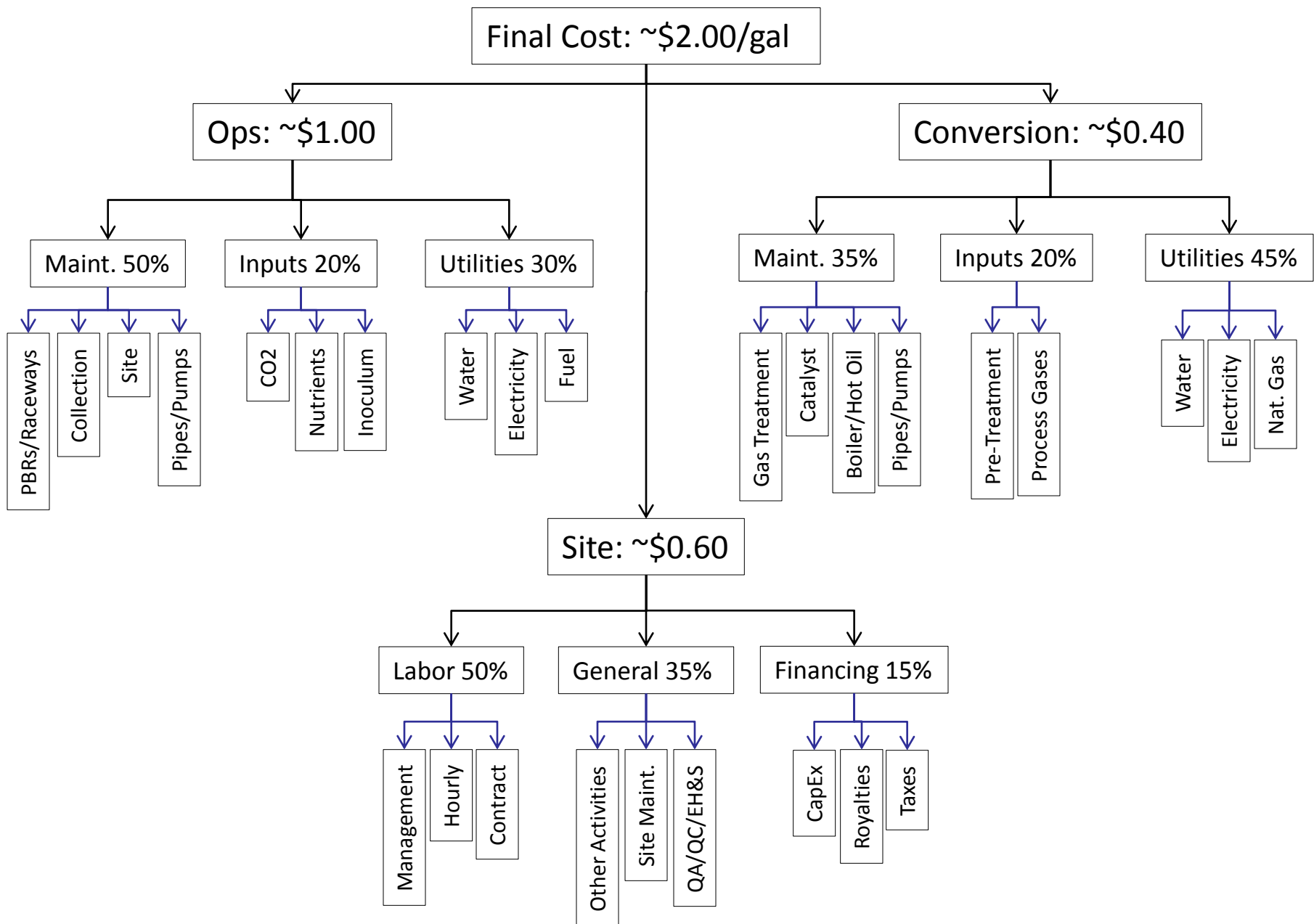


# Drivers for Algae-Derived Fuels

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- AFTER We Find the Right Strain.....
- Cost of Containment (Plastics or Other Barriers)
- Achieving Proper Solar Access
- Amount of Water Handling Required
- Efficiently Moving That Water
- Feeding It the CO<sub>2</sub> (Capturing, Compressing, Transporting)
- Dewatering Energy....Or Eliminate
- Oil Extraction Energy....Or Eliminate
- What to Do With Leftover Biomass ...Or Don't Make Much
- Cost Efficient Biorefineries to Convert to Drop-In Fuels







# Conclusions

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- We Really Have a Lot Of Work To Do Collectively
  - Country is Not Prepared for Coming Fuel Changeover
  - Answer is Going to Have to Be a Smorgasboard
  - Serious Threats to National Security/Finances Ahead
  - Much More Money Will Have to Be Spent, And Quickly
  - Clean Coal, Nuclear, Wind.....all will Play a Part
  
  - Good News is That America Has a Lot of Very Smart People
  - We Have the Science and Technologies to Solve It
  - Bumpy Road Ahead as National Strategy Jells
  - Many Excellent Opportunities for Entrepreneurs
  - Whole World Will Follow Our Answer
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