

Distributed Biodiesel Refining

Made possible by the

OAT™

Optimized Anaerobic
Treatment Process

United States Fossil Fuel Annual Sales

- 💧 Consisting of heating oil, jet fuel, natural gas, diesel fuel, LP gas, and gasoline total about 300 billion gallons according to the American Petroleum Institute.
- 💧 100% of these sales may be theoretically and technically replaced by **biodiesel**.

Existing US Vegetable Oil Production

- 💧 Can produce but 0.2% of the 300 billion gallon biodiesel demand.
- 💧 Land required to produce 100% of the demand is approximately 80 million acres or about 1-1/2 times the size of the state of Rhode Island.
- 💧 Additional vegetable oil farming is therefore required to satisfy the sustainable and renewable biodiesel market.

Inexpensive Land Sources

- 💧 Closed landfills.
- 💧 Active landfills.
- 💧 Closed + active landfills and their ancillary buffer zones add up to about 80,000,000 acres.

Inexpensive Land Or A Liability?

- 💧 The OAT™ process permits the total elimination of closed and active landfills.
- 💧 If owned or leased by WaterSmart, these landfills represent a significant resource rather than a significant liability.
- 💧 Once eliminated, the former landfill site may be developed as a vegetable oil farm.
- 💧 It is entirely possible that WaterSmart can be paid to accept a landfill site or its lease.

Soybeans

- ☹ Are already the most widely grown protein/oilseed crop in the world.
- ☹ Can be grown in a **controlled environment** or greenhouse similar in appearance and structure type to a twelve story concrete parking garage.
- ☹ Require a two meter deep soil to establish a one meter plant height for maximum oil production.
- ☹ Under a controlled environment four harvests per year can be achieved which would reduce the stories from twelve to two. Additional stories can always be added to satisfy future growth.

A Controlled Environment

- 💧 Requires irrigation water for plant growth and boiler water make-up.
- 💧 Requires electricity for the fluorescent lights.
- 💧 Requires a soil amendment to provide micronutrients.
- 💧 Requires carbon dioxide gas to enhance plant growth.
- 💧 Requires phosphates and potash for maximum plant growth.
- 💧 Requires heating and cooling to optimize plant growth.
- 💧 In short, requires **all** of the co-products of the OAT™ process.

A Controlled Environment

- 💧 Can significantly reduce plant insects.
- 💧 Can significantly reduce plant disease.
- 💧 Reduces or completely eliminates pesticides.
- 💧 Reduces or completely eliminates weeds.
- 💧 Completely eliminates drought conditions.
- 💧 Completely eliminates excessively wet soils.
- 💧 Completely eliminates loss of moisture due to transpiration.
- 💧 Can significantly increase vegetable oil yields.

Vegetable Oils

- 💧 Can be extracted by crushing.
- 💧 Can be extracted with hexane.
- 💧 Can be extracted with steam (recommended).
- 💧 Leave solid residues after extraction.
- 💧 Leave glycerine and fatty acids after refining.

Biodiesel Refining

- 💧 Requires energy in the forms of steam and electricity.
- 💧 Energy requirements add to refining costs.
- 💧 Use of solid residues can reduce refining costs by marketing as animal feed (common practice).
- 💧 Use of solid residues, glycerine, and fatty acids can significantly reduce refining costs by conversion into energy through anaerobic digestion (not yet attempted).
- 💧 If converted into energy would **more than satisfy** biodiesel refining steam and electricity requirements thus reducing production costs.

Fate Of OAT™ Process Co-Products

- 💧 Digestate (digester solids) are returned to greenhouse soil thereby accomplishing 100% recycling of micronutrients.
- 💧 Phosphorus and Potassium salts returned to greenhouse soil thereby accomplishing 100% recycling of macronutrients.
- 💧 Carbon dioxide used to enhance soybean plant growth.
- 💧 Methane converted into steam and electricity for biodiesel refining process.
- 💧 Reverse osmosis permeate water used for plant irrigation.
- 💧 Stripped ammonia sold as fertilizer thus further reducing biodiesel refining costs.

Distributed Electricity Generation

- 💧 Can be accomplished using excess methane gas.
- 💧 Can be accomplished using biodiesel fuel.
- 💧 Should be accomplished using combined cycle generation technology for increased efficiency.
- 💧 Can utilize steam turbine discharge for vegetable oil extraction steam (common practice in palm oil industry).
- 💧 Beneficial use of steam turbine discharge for extraction steam further reduces biodiesel refining costs.

A 100 Acre Two-Story Soybean Greenhouse

- ◆ Can produce about 38,000 GPY or 100 GPD of vegetable oil.
- ◆ This amount oil production can support about 40 kW of simple cycle electricity generation from biodiesel at an 80% yield.
- ◆ Anaerobic digestion of the crop residuals and biodiesel refining wastes to methane gas further increases the electricity generation potential to over 210 kW.
- ◆ Converting from simple to combined cycle increases electricity generation output to over 250 kW.
- ◆ Adding 10 stories further increases power output potential to 1.5 MW and biodiesel yield to 225,000 GPY.
- ◆ Some or all of the biodiesel may be used for domestic air and ground transportation, domestic heating requirements, and as a quite valuable fuel export product.
- ◆ Building a several thousand acre multi-story greenhouse is technically achievable utilizing currently available reinforced concrete construction technology.

Each Greenhouse

- 💧 May be expanded to increase distributed biodiesel production.
- 💧 Distributed biodiesel generation reduces biodiesel market costs.
- 💧 Landfills are located on a distributed basis.

Each Greenhouse

- 💧 May be expanded to increase biodiesel production for the purpose of increasing distributed electricity generation.
- 💧 Distributed electricity generation reduces distribution line losses due to conductor resistance.
- 💧 Generated electricity fully qualifies as **green energy**.

Biodiesel Refining Process

- 💧 Produces biodiesel for sale to the marketplace.
- 💧 Produces aqueous ammonia fertilizer for sale to the marketplace.
- 💧 Can produce electricity for sale to the marketplace.
- 💧 Can produce CNG for sale to the marketplace.
- 💧 Can produce steam for sale to the marketplace.
- 💧 Generates **zero wastes**.

A Holistic Biodiesel Refining Processes Which Uses The OAT™ Process

- Is competitively capable of completely replacing fossil based fuels worldwide.

For Project Feasibility Studies and Proposals

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