FINAL TECHNICAL REPORT FOR THE US DEPARTMENT OF ENERGY

Project Title: Costilla County Biodiesel Pilot Project

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Recipient:
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Subcontractors: N/A

Other Partners: N/A

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EXECUTIVE SUMMARY

The Costilla County Biodiesel Pilot Project was first conceived by the Costilla County Commissioners' Office and the Costilla County Economic Development Council, Inc in 2002. Construction of the building facility began in 2004 and testing of production equipment began in 2006. Ben Doon, Project Manager, began work on a CDP DOE funding application in February 2007. A one page project summary was submitted to DOE in January 2008. A "Cost Share and Application Requirements" letter from DOE was sent to Costilla County in February 2008. The Notice of Financial Assistance Award for the Costilla County Biodiesel Pilot Project was signed by DOE on February 9, 2009 and was signed by Costilla County Biodiesel on March 3, 2009. The first draw down of funds occurred on April 1, 2009.

Costilla County is located in south-central Colorado in the San Luis Valley, which is the world's largest high alpine valley in agricultural production. Elevations for agricultural lands in Costilla County range from 7,500'-8,200'. Costilla County has about 3,500 residents and 2.9 people per square mile. The median household income is $24,758 compared to $55,735 for Colorado according to the 2010 census.

Costilla County began construction of a pilot biodiesel facility in 2005. DOE project funds allowed Costilla County to complete the development of a semi-automated, community-scale, vertically integrated oil seed crush and biodiesel production facility that includes blending capabilities. Community-scale production facilities allow for a relatively independent, local solution to renewable fuels production utilizing locally sourced feedstocks and making available fuel and co-products into local markets. Local residents manage and operate the facility and

local farmers provide the feedstock. The biodiesel and co-products are utilized locally with little to no marketing and transportation needs.

The project is not a turn-key facility by any means. Small-scale production and storage equipment were procured from the United States, Canada, Costa Rica, Argentina, India and China and pieced together to create a semi-automated production line. The facility has the ability to process a variety of oil seed feedstock crops. No process water is used for production, nor is a water wash used to purify the biodiesel. The facility also does not use any steam, or natural gas. All biodiesel produced at the facility is used by the County's Road and Bridge Department diesel fleet and maintenance equipment. The cake meal co-product of crushing seeds for oil is marketed by a local non-profit organization to local ranchers for use as a high protein livestock feed. The glycerol co-product is used as a heating fuel in the facility and distributed to local residents, mechanic shops and universities for a variety of uses.

The total project budget was $544,374. DOE contributed $270,600 towards the project, while cost share for the project came to $272,774. A one year no-cost time extension was granted which extended the completion date from April 2010 to April 2011. Most of the tasks identified in the Statement of Work were completed, however a few tasks were abandoned due to budget issues and a low priority assigned to those tasks. Despite the fact that some tasks were not completed, which will be discussed in more detail in the "Compare Actual Accomplishments with Goals and Objectives" section, a fully operational, small-scale seeds to diesel vertically integrated biodiesel production facility has been developed.

The following processes have been successfully implemented at the facility:

1. Feedstock crop storage and handling
2. Oil seed crushing
3. Oil seed meal cake storage and handling
4. Vegetable oil filtering
5. Transesterification (conversion of vegetable oil to biodiesel)
6. Fuel and vegetable oil bulk tank systems with blending capabilities
7. Ion resin biodiesel dry wash system
8. Glycerol utilization as a heating fuel
9. Laboratory equipment and infrastructure development
10. Truck scale installation for feedstock crops and meal cake
11. Fencing, office and auxiliary equipment installation

1. <u>How the research adds to the understanding of the area investigated</u>

The Costilla County Biodiesel Pilot Project used DOE project funds to acquire and install additional equipment to reduce labor requirements and maximize production capacity for a vertically integrated, community-scale oil seed crush and biodiesel production facility. The use of project funds covered upgrades and improvements for a number of processes at the facility. The production line has been primed and tested and blends of up to B80 have been successfully tested in the Costilla County diesel fleet. Locally made biodiesel has been successfully integrated into Costilla County diesel vehicles and maintenance equipment. Prior to this project Costilla County had virtually no experience, or familiarity with biofuels of any kind. Local farmers are producing the feedstock crops for production, local residents with no previous experience or formal training are operating the production equipment and Costilla County truck drivers and machine operators are utilizing the biodiesel without any negative impact to performance. The project has fostered great acceptance of biodiesel in the local area and has created significant interest in similar types of facilities throughout the region. Three different oil seed crops have been successfully tested as a feedstock for biodiesel production at the facility; canola, sunflower and camelina. Canola has proven to be the most efficient crop regarding production capacity and yield potential.

The project has added to the understanding of the equipment needs of developing a small-scale, vertically integrated biodiesel production facility. For most processes the facility utilizes multiple small-scale units, rather than one large one. This allows the facility to almost always be able to operate at some level of production despite breakdowns, equipment failures and significant maintenance requirements. Small-scale production and storage equipment were sourced from a variety of countries and companies and many pieces of equipment required modifications to the motors, pumps, electrical and general configuration. In some cases equipment that was anticipated to be needed such as a hammer mill ultimately was not needed. In other situations electrical infrastructure requirements were underestimated such as with the meal cake storage and handling system. This will be discussed in more detail in the "Compare Actual Accomplishments with Goals and Objectives" section.

The project has fostered a better understanding of equipment needs and capabilities of a small-scale biodiesel facility. The project has demonstrated that a variety of processes, everything from crop storage and handling to final blending of diesel and biodiesel fuels, can be housed under one roof on a relatively low budget. The project established that various types of processes with equipment manufactured from around the world can be brought together to create a reliable, semi-automated biodiesel facility in a remote and rural part of the United States. The project has also emphasized the fact that locally available feedstock crops are critical to a successful small-scale facility as are local markets for the biodiesel fuel and the cake meal co-product of crushing seeds for oil.

2. <u>The technical effectiveness and economic feasibility of the methods, or techniques investigated or demonstrated</u>

The basic method, or technique investigated and demonstrated during the life of the project has been the technical and economic feasibility of small-scale, vertically integrated biodiesel production co-located with oil seed crushing. As will be discussed in the "Compare Actual Accomplishments with Goals and Objectives" section, for the most part we have successfully completed the build-out of a seeds to diesel biodiesel facility that can reliably produce good quality fuel in 100-gallon batches. The pieces of equipment utilized at the facility are designed for small-scale biodiesel production, as well as storage and handling of grain crops, vegetable oils and fuel. Large industrial machines requiring significant capital outlays are not required for this type of facility. However, oil extraction percentages of crushing seeds for oil and conversion ratios for the transesterification process remain on par with large industrial machines.

The oil seed crushing process involves mechanical expellers, rather than hexane extraction. While mechanical expellers cannot compete with the oil extraction rates of the hexane process, the facility's small scale Chinese-made 6YL-95 screw type presses have been producing oil seed cake meal with residual oil contents of 9-10%, which is on par with much larger and more expensive screw type expeller machines.

The facility's small-scale batch biodiesel reactors utilize a high temperature, high pressure protocol that produces conversion rates very similar to large-scale, continuous flow industrial sized units that are significantly more expensive. One way to measure biodiesel conversion rates is to measure the mass percent of monoglycerides remaining in a sample of biodiesel. Monoglycerides result due to incomplete reaction of fats and oils in making biodiesel. Low monoglyceride levels have resulted from the biodiesel batch process employed at the Costilla County facility.

The most critical aspect to the economic feasibility of the project and the sustainability of the facility is the availability of locally produced oil seed feedstock crops. Costilla County's economy is largely dominated by small to mid-sized agriculture producers. Small to mid-sized producers can have more flexibility when it comes to crop rotation choices than very large farms which are often tied to contracts with large corporations for food, grain and feed products. The biodiesel project has had good acceptance with local agriculture producers. These local producers have shown that they are willing and able to produce feedstock crops for biodiesel production. Oil seed crops such as canola and sunflower have proven to work well with local grain rotations, such as barley and wheat, as well as with alfalfa rotations and the oil seed feedstock crops have proven to be an economically feasible option for local farmers.

Higher fuel and crude oil prices allow better prices to be offered for biodiesel feedstock crops. As the price of diesel falls, prices for feedstock crops will need to fall in order to remain competitive with the price of diesel fuel. At the same time general patterns exist in the agriculture industry that when oil prices are high, crop prices are high and when oil prices fall, crop prices typically fall as well. Therefore the economic feasibility of the project is practically in constant motion determined by the prices of oil, diesel fuel and grain crops. However, local farmers have demonstrated that the facility's proximity to their fields is a definite advantage to the project when they are choosing their crop options. Especially in times of high diesel fuel prices, local farmers want to take advantage of a local market with minimum transportation requirements even if the base price for the crop is slightly less than a market located at a more significant distance from their fields.

3. How the project is otherwise of benefit to the public

The Costilla County Biodiesel Pilot Project has demonstrated that small-scale, vertically integrated biodiesel production is possible without massive investment dependent on large industrial applications. The project utilizes small-scale technology and equipment from around the world and has developed a unique production system that that can be replicated anywhere there is available feedstock crops and markets for biodiesel fuel and oil seed cake meal. Equipment manufactured in the United States, Canada, Costa Rica, Argentina, China and India have been brought together to create a unique semi-automated production line capable of processing multiple feedstocks into high quality biodiesel.

Smaller scale biodiesel production models offer some distinct opportunities and advantages for the adoption and utilization of biodiesel in rural areas. It ensures that the development of biodiesel will benefit rural communities and restore some prosperity to areas much in need of income. Small-scale biodiesel production spreads the wealth potential from biodiesel around much further than one very large plant that requires most of the oil seed production from an entire region. Using locally sourced feedstocks and putting the fuel into local markets significantly reduces transportation and marketing costs that are incurred at larger plants.

Locally based renewable fuel production plays a role in decreasing the demand for foreign oil products, enhances domestic energy security, decreases greenhouse gas emissions by offsetting the use of petroleum diesel fuel and provides another market option for local agriculture producers.

COMPARE ACTUAL ACCOMPLISHMENTS WITH GOALS & OBJECTIVES

The Costilla County Biodiesel Pilot Project identified thirteen tasks labeled A-M for the project.

The tasks are as follows:

- Task A – Feedstock Storage and Delivery System
- Task B – Oil Press System Set-up

- Task C – Meal Cake Storage and Handling System
- Task D – Vegetable Oil Delivery and Filtering System
- Task E – Transesterification and Settling System Set-up
- Task F – Bulk Storage Tanks System Set-up
- Task G – Ion Resin Biodiesel Dry Wash System
- Task H – Methanol Recovery System
- Task I – Glycerin Storage and Handling System
- Task J – Laboratory Equipment Set-up
- Task K – Truck Scale
- Task L – Fence and Auxiliary Equipment Set-up
- Task M – Project Management and Reporting

<u>Task A – Feedstock Storage and Delivery System</u>

<u>Goal</u> - Task A.1, complete installation of the grain bin system.
<u>Accomplishment</u> - Two 3,200-bushel, cone-bottom grain bins and two 2,200-bushel, flat-bottom grain bins have been installed.

Task A.1

Task A.1.1

<u>Goal</u> - Task A.1.1, procure and install a portable grain auger to feed grain bins.
<u>Accomplishment</u> – A Hutchinson/Mayrath 10" X 72' Swing Away Portable Auger has been installed and tested.

<u>Goal</u> - Task A.1.2, procure and install a grain vacuum to unload the two flat-bottom grain bins.
<u>Accomplishment</u> - the purchase of a grain vacuum has been abandoned due to budget constraints and a low priority assigned to this subtask. Abandonment of this subtask does not negatively affect any other elements of Task A.

Goal - Task A.2, install flex-flo auger lines from the two cone bottom grain bins to the seed cleaner unit.
Accomplishment - This task is complete. Flex-flo auger lines are a unique type of auger system where the auger casing is made from PVC pipe, thereby allowing 30 and 60-degree elbow bends in the line in order to create curves in the auger line. A spring-like coil is inserted in the PVC tubing and attached to a motor at the drop end of the auger line. Only the cone-bottom grain bins are connected to the production line via the flex-flo augers.

Task A.2

Task A.3

Goal - Task A.2.1, supply power and install a breaker box for the motor on the auger line and A.2.2 is to install a Variable Frequency Drive (VFD) in order to control the speed of the auger motor and supply power to the VFD.
Accomplishment - Both tasks are complete.

Goal - Task A.3, install a flex-flo auger line from the outlet of the seed cleaning machine to an indoor day bin, which holds clean feedstock seed prior to crushing.
Accomplishment – complete.

Goal - Tasks A.3.1 and A.3.2, install a breaker box and supply power to the auger motor and install and supply power to a VFD for the auger motor.
Accomplishment – complete.

Tasks A.3.1 and A.3.2

Task A.4

Goal - Task A.4, procure a second seed conditioner. Seed conditions are used to add heat and moisture to the feedstock seed prior to crushing to maximize oil extraction.
Accomplishment - a second seed conditioning unit has been procured from Goyum Screw Press of India and Nebraska Renewable Energy Systems, Goyum's US Sales Representative.

Goal – Task A.5, fabricate a steel stand, approximately 7' tall for the conditioning unit.
Accomplishment – complete.

Goal - Task A.6, mount and install seed conditioner and stand in place along the production line and Task A.6.1, install motor and gear head to power the mixing paddle on the seed conditioner.
Accomplishment – complete.

Goal - Task A.6.2, supply power to the motor and heater elements on the seed conditioner and Task A.6.3, install and supply power to a VFD for the motor on the conditioning unit.
Accomplishment – complete.

Goal - Task A.7, install two auger lines from the indoor seed day bin to each of the seed conditioning units and mount the motors along the drop point.
Accomplishment – complete.

Task A.7

Task A.7.1

Goal - Task A.7.1, install a breaker box and supply power to the auger motors and Task A.7.2, to install and supply power to two VFDs for the two auger motors.
Accomplishment – complete.

Goal - Task A.8, install a mist or drip system to automatically add moisture to the seed in the conditioners to create optimal conditions for extracting oil from seed.
Accomplishment – complete.

Goal - Task A.9, the Project Investigator, Dan Quintana, and Project Manager, Ben Doon, will visually inspect and verify that all installation projects are complete.
Accomplishment – complete.

Task B – Oil Press System Set-up

Goal - Task B.1, mount and install the first seed conditioner in place along the production line.
Accomplishment - The first seed conditioner procured from Goyum Screw Press and Nebraska Renewable Energy Systems has been installed.

Goal - Task B.1.1, install motor and gear head for the mixing paddle on the seed conditioner.
Accomplishment – complete.

Goal - Task B.1.2, install breaker boxes and supply power to the motor and heater elements on the seed conditioner.
Accomplishment – complete.

Goal - Task B.1.3, install and supply power to a VFD for the motor on the conditioning unit.
Accomplishment – complete.

Goal - Task B.2, procure a 6-ton Chinese-made 6YL-95 screw type presses seed crushing unit.
Accomplishment – complete.

Goal - Tasks B.3 and B.4, fabricate and install a stand for the crushing unit and fabricate and install guards for the pulleys on the crusher unit.
Accomplishment – complete

Goal - Task B.5, mount and secure the four seed crushing units along the production line.
Accomplishment – complete.

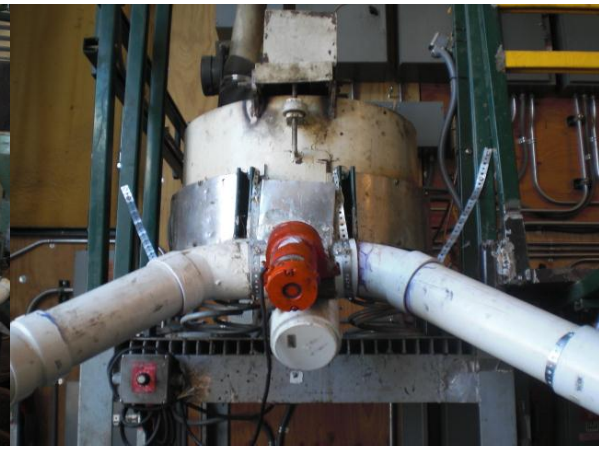
Task B.5 with view of seed conditioner, Flex-flo auger, seed chutes and electricals

Goal - Task B.5.1, install motors, pulleys and start/stop buttons on each of the screw type press seed crushing units.
Accomplishment - 10 HP motors were installed on the 4-ton per day crushing units cost and a 20 HP motor with base were installed on the 6-ton per day crushing units.

Goal - Task B.5.2, install breaker boxes and supply power to the seed crushers.
Accomplishment – complete.

Goal - Task B.6, install chutes to deliver seed from the seed conditioners to the hoppers of seed press units.
Accomplishment – complete.

Goal - Task B.7, install vibrator motors with VFD on the seed delivery chutes. The vibrator motors allow improved flow of seed from the conditioning units into the hoppers of the oil press crushing units.
Accomplishment – complete.

Task B.5.1, Task B.6 Task B.7

Goal - Task B.8, the Project Investigator, Dan Quintana, and Project Manager, Ben Doon, will visually inspect and verify that all installation projects are complete.
Accomplishment – complete.

Task C – Meal Cake Storage and Handling System

Goal - Task C.1, procure a hammer mill to grind the oil seed cake meal co-product into small dime-sized pieces.
Accomplishment - Meadows Mills model #5 hammer mill has been procured.

Goal - Task C.2, mount, secure and install the hammer in place along the production line.
Accomplishment – Task abandoned. We discovered that the Flex-flo auger systems that deliver the cake meal into a surge bin and an outdoor storage bin do a nice job of grinding the cake meal into small pieces as it passes through the auger. We did not anticipate this. As a result, in order to save floor space, infrastructure costs and energy costs, we opted against installing the hammer mill along the production line.

Goal – Task C.2.1, supply 3-phase 480-volt power and a breaker box for the hammer mill.
Accomplishment - Task abandoned. Since the Flex-flo augers are able to grind the cake meal into small pieces as it delivers the product into storage bins, we opted against installing and supplying power to the hammer mill in order to save infrastructure costs and energy costs.

Goal – Task C.3, procure a conveyance system to deliver the meal cake from the outlet ends of the crushing units and into the hammer mill.
Accomplishment – This task has been slightly modified but is complete. An M500 Flex-flo auger hopper sits on the floor adjacent to the seed crushing units. The cake meal is manually collected from the outlet ends of the seed crushing units and transferred to the Flex-flo auger hopper where it is conveyed by the M500 Flex-flo auger and into an indoor storage bin. This auger along with the auger system for Task C.5 has replaced the need for a hammer mill.

Task C.1

Task C.3

Goal – Task C.4, procure a bulk bin for the meal cake.
Accomplishment – a 12' diameter, 3-ring bulk bin has been procured.

Goal - Task C.5, procure a flex-flo auger line to deliver the meal cake from the outlet of the hammer mill up and into the bulk meal bin.
Accomplishment – this task has been slightly modified, but is complete. An indoor surge bin that collects the meal cake has been installed in place of the hammer mill along the production line. An M300 Flex-flo auger system has been installed to deliver the cake meal from the indoor surge bin to the outdoor bulk bin. An auger hopper for the Flex-flo line has been installed directly below the surge bin. A small sliding door can be manually opened to allow the cake meal to drop into the Flex-flo hopper when it is time to transfer the meal from the surge bin to the outdoor bulk bin.

Task C.4

Task C.5 and Task C.5.1

Goal – Task C.5.1, install the flex-flo auger to deliver the cake meal to the outdoor bulk bin.
Accomplishment – complete.

Goal – Task C.5.2, mount the motors to deliver the cake meal to the outdoor bulk bin.
Accomplishment – A ¾ HP, 230v, 60Hz, 3-Phase has been installed.

Goal – Task C.5.3, install a breaker box and supply power to the flex-flo auger motor and install and supply power to a VFD to control the auger speed.
Accomplishment – complete.

Task D – Vegetable Oil Delivery and Filtering System

Goal - Task D.1, fabricate two 70-gallon collection tanks to capture the crude vegetable oil as it is expelled from the crushing units.
Accomplishment – complete.

Goal - Task D.1.1, install floats to the collection tanks to provide for automatic liquid transfer.
Accomplishment – complete.

Goal - Task D.1.2, supply power to the floats.
Accomplishment – complete.

Goal - Task D.2, install pipes, valves, a pump and in-line filter cartridges to deliver the crude vegetable oil from the 70-gallon collection tanks to a 450-gallon tank. The oil along this line will pass through one 200-micron filter cartridge and one 100-micron filter cartridge before it is deposited in the 450-gallon tank.

Accomplishment – this task has been slightly modified, but is complete. The two in-line cartridge filters were changed to a 50-micron filter, followed by a 25-micron filter.

Task D.1

Task D.3, D.3.1 and D.3.2

Goal - Task D.2.1, install a breaker box and supply power to the motor and pump to deliver the crude oil to the 450-gallon collection tank.
Accomplishment – complete.

Goal - Task D.3, install the 450-gallon tank in place.
Accomplishment – complete.

Goal - Tasks D.3.1 and D.3.2, install floats in the 450-gallon tank for automatic liquid transfer and supply power to the floats.
Accomplishment – complete.

Goal - Task D.4, install a pre-filter system for the oil. The pre-filter consists of a 50-micron and a 25-micron cartridge filter and a ¾ HP pump and motor.
Accomplishment – this task has been slightly modified, but is complete. A 10-micron cartridge filter followed by a 5-micron cartridge filter was installed.

Goal - Task D.4.1, install a breaker box and supply power to the pump and motor to deliver oil from the 450-gallon tank, through the pre-filter system and into a 150-gallon tank.
Accomplishment – complete.


Task D.4


Task D.6

Goal - Task D.5, procure a second filter press unit for final oil filtering from Goyum Screw Press and Nebraska Renewable Energy Systems.
Accomplishment – a 12" X 12" filter press with 1,200-liters per day capacity has been procured.

Goal – Task D.6, fabricate a stand for the filter press.
Accomplishment – complete.

Goal - Task D.7, install two filter press units used for final filtering of vegetable oil prior to transesterification. Each filter press unit will be installed with a diaphragm air pump along with air lines from the compressor, breaker box and power supply.
Accomplishment – complete.

Goal - Task D.8, install a 40-gallon tank to capture the clean oil as it drains from the filter press.
Accomplishment – complete.


Task D.7


Task D.8

Goal – Tasks D.9 and D.9.1, install floats in the 40-gallon tanks to automatically transfer the oil and supply power to the floats.
Accomplishment – complete.

Goal - Task D.10, install pipes, a pump and valves from the two 40-gallon collection tanks to the two 1,500-gallon vegetable oil storage tanks located in the indoor containment area and install a breaker box and supply power to the ¾ HP pump and motor to deliver the clean vegetable oil to the 1,500 gallon storage tanks.
Accomplishment – complete.

Goal - Task D.11, the Project Investigator, Dan Quintana, and Project Manager, Ben Doon, will visually inspect and verify that all installation projects are complete.
Accomplishment – complete.

Task D.11

Task E – Transesterification and Settling System Set-up

Goal - Task E.1, mount and secure two batch transesterification units and one oil pre-heat unit along the transesterification platform.
Accomplishment – complete.

Goal - Task E.1.1, mount and install electrical control boxes for the three units in task E.1.
Accomplishment – complete.

Goal - Task E.1.2, install and supply power to a VFD box for each of the units in task E.1.
Accomplishment – complete.

Goal - Task E.1.3, install flow switches on each of the three units in E.1. The flow switches will be tied to the pump and heater elements on the units. The flow switches provide a safety mechanism in the event that a broken pump or closed valve prevents circulation of liquid, the heater elements will shut down if no liquid is circulating, thereby preventing the heater elements from burning-out in the absence of liquid circulating through the units.
Accomplishment – completed.

Goal – Task E.1.4, supply power to the three units in E.1 with connections to the control boxes, flow switches and VFDs.
Accomplishment – completed.

Goal – Task E.1.5, install pipes, valves, hydraulic hoses and air lines from the oil pre-heat unit to the transesterification units.
Accomplishment – completed.

Goal - Task E.2, procure and install two settling tanks along the transesterification platform.
Accomplishment – complete. Two 400-liter BioAdd settling tanks were procured from Central Biodiesel HTP.

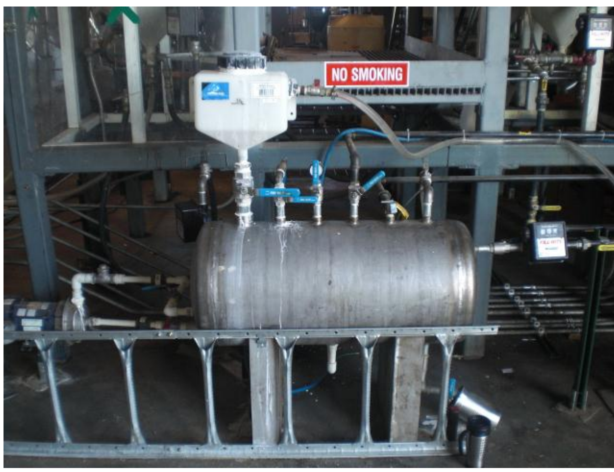
Task E.1.3

Task E.2

Goal - Task E.2.1, install pipes, valves, hydraulic hoses and air lines to deliver the biodiesel/glycerin mixture from the transesterification units to the methanol recovery unit.
Accomplishment – this task has been modified. Task H – methanol recovery has been abandoned and will be discussed in detail in the Task H section of the “Goals and Accomplishments” report. The biodiesel/glycerin mixture is moved from the reactor tank to the settling tank with compressed air and is allowed to gravity settle overnight in the settling tank. Then the glycerin is drained into a 55-gallon drum, once the phase change between the glycerin and biodiesel becomes apparent, the biodiesel is pumped into a 1,500-gallon bulk storage tank.

Goal – Task E.3, install an explosion proof heater in the sodium methylate room to keep the liquid from freezing in cold weather.
Accomplishment – complete.

Goal - Task E.4, install a gravity fed hose line from the sodium methylate tote to the stainless steel sodium methoxide mix pot, which sits adjacent to the reactors in the transesterification area.
Accomplishment – complete.



Task E.4


Task E.7

Goal - Task E.5, install pipes, a pump and valves from the outdoor bulk methanol tank to the sodium methoxide mix pot.
Accomplishment – complete.

Goal - Task E.5.1, install a breaker box and supply power to the pump, motor, emergency shut-off and alarm to deliver methanol from the outdoor bulk tank to the sodium methoxide mix pot.
Accomplishment – complete.

Goal - Task E.6, install pipes, a pump and valves to deliver liquid from the sodium methoxide mix pot to the transesterification batch reactor units.
Accomplishment – complete.

Goal – Tasks E.6.1 and E.6.2, install a VFD on the sodium methoxide mix pot motor and supply power to the VFD, pump and motor and emergency shut-off to deliver the methoxide solution to transesterification units.
Accomplishment – complete.

Goal - Task E.7, install an explosion proof vent fan above transesterification area.
Accomplishment – completed.

Goal – Task E.7.1, supply power to the vent fan.
Accomplishment – completed.

Goal - Task E.8, the Project Investigator, Dan Quintana, and Project Manager, Ben Doon, will visually inspect and verify that all installation projects are complete.
Accomplishment – complete.

Task E.8

Task F – Bulk Storage Tanks System Set-up

Goal - Task F.1, install the bulk storage tanks in the indoor and outdoor containment areas.
Accomplishment – complete.

Goal – Task F.1.1, install pipes, valves, sight glasses, flow meters, overflow protection and liquid level indicators for the following tanks: B100, biodiesel/diesel mix, vegetable oil 1, vegetable oil 2, petroleum diesel, biodiesel blend and methanol.
Accomplishment – completed with a slight modification. Vegetable oil tank 1 is being used for crude, unwashed biodiesel. There are two 1,500-gallon bulk tanks for the biodiesel and one 1,500-gallon bulk tank for vegetable oil.

Goal - Task F.1.2, supply electrical power, breaker boxes, motors and pumps, alarms and emergency shut-off for the following tanks B100, biodiesel/diesel mix, vegetable oil 1, vegetable oil 2, petroleum diesel, biodiesel blend and methanol.
Accomplishment – completed with a slight modification. Vegetable oil tank 1 is being used for crude, unwashed biodiesel. There are two 1,500-gallon bulk tanks for the biodiesel and one 1,500-gallon bulk tank for vegetable oil.

Goal - Task F.2, install pipes, pumps and valves from the vegetable oil storage tanks 1 and 2 to the oil pre-heat tank.
Accomplishment – completed with a slight modification. Vegetable oil tank 1 is being used for crude, unwashed biodiesel. There are two 1,500-gallon bulk tanks for the biodiesel and one 1,500-gallon bulk tank for vegetable oil.

Goal - Task F.2.1, install breaker boxes and supplying power for the motors, start/stop buttons, alarms and VFDs to deliver oil from the two vegetable oil storage tanks to the oil pre-heat unit in the transesterification area.
Accomplishment – completed with a slight modification. Vegetable oil tank 1 is being used for crude, unwashed biodiesel. There are two 1,500-gallon bulk tanks for the biodiesel and one 1,500-gallon bulk tank for vegetable oil.

Task F.2

Task F.2.1

Goal - Task F.3, install pipes, pumps and valves from the outside petroleum diesel tank and the inside B100 tank to the inside biodiesel/diesel mix tank.
Accomplishment – completed.

Goal - Task F.3.1, install a breaker box and supply power for the motors, start/stop buttons and alarms from the petroleum diesel and B100 tanks to the biodiesel/diesel mix tank.
Accomplishment – completed.

Goal - Task F.4, install pipes, pumps and valves from the indoor biodiesel/diesel mix tank to the outdoor biodiesel blend tank.
Accomplishment – completed.

Goal - Task F.4.1, supply power and install breaker boxes to the motors, start/stop buttons and alarms from the biodiesel/diesel mix tank to the biodiesel blend storage tank.
Accomplishment – completed.

Task F.4

Task F.4.1

Goal - Task F.5, install an explosion proof vent fan above the biodiesel/diesel mix tank in the indoor tank containment area.
Accomplishment – completed.

Goal – Task F.5.1, supply power to the vent fan and tie the vent fan motor to the pump and motor on the biodiesel/diesel mix tank.
Accomplishment – completed.

Goal - Task F.6, obtain the final inspection from the Colorado Department of Labor and Employment, Oil Inspection Section for Above Ground Storage Tanks.
Accomplishment – completed.

Task F.6

Goal - Task F.7, the Project Investigator, Dan Quintana, and Project Manager, Ben Doon, will visually inspect and verify that all installation projects are complete.
Accomplishment – completed.

Task F.7

Task G – Ion Resin Biodiesel Dry Wash System

Goal - Task G.1, procure an ion resin biodiesel dry wash system.
Accomplishment – completed. Two dual tower ion resin biodiesel dry wash systems have been procured each with a 60 gallon per hour capacity.

Goal - Task G.2, mount and secure the unit along the production line.
Accomplishment – completed.

Task G.2

Goal – Task G.2.1, install the pipes, valves and pump from the settling tanks to the ion resin unit to deliver the unwashed biodiesel into the unit for task G.2.1.
Accomplishment – completed with minor modifications. The unwashed biodiesel is transferred from the settling tanks into a 1,500-gallon bulk tank. The unwashed biodiesel is pumped from the tank through the two column dry wash system and into a second 1,500-gallon bulk tank which stores the washed biodiesel.

Task G.2.1

Goal – Task G.2.2, install a breaker box and supply power to the motor and emergency shut-off to deliver the unwashed biodiesel from the settling tanks to the ion resin system.
Accomplishment – completed with minor modifications. The unwashed biodiesel is transferred from the settling tanks into a 1,500-gallon bulk tank. The unwashed biodiesel is pumped from the tank through the two column dry wash system and into a second 1,500-gallon bulk tank which stores the washed biodiesel.

Goal - Task G.3, install pipes, a pump and valves to deliver the washed biodiesel from the ion resin unit to the 1,500-gallon B100 storage tank located in the indoor containment area.
Accomplishment – complete.

Goal – Task G.3.1, install a breaker box and supply power to the motor, start/stop button and alarm to deliver the washed biodiesel from the ion resin system to the B100 storage tank.
Accomplishment – complete.

Goal – Task G.4, load the resin beads in the dry wash towers.

Accomplishment – completed. Two different filtering mediums are used in each tower of the dry wash system. The first tower contains Purolite PD206 resin, while the second tower contains a medium called Eco2Pure.

Goal - Task G.5, the Project Investigator, Dan Quintana, and Project Manager, Ben Doon, will visually inspect and verify that all installation projects are complete.
Accomplishment – complete.

Task H – Methanol Recovery System

Goal - Task H.1, procure a methanol recovery unit.
Goal – Task H.2, mount and secure the unit along the production line for task H.2.
Goal – Task H.2.1, install pipes, valves and a pump from the transesterification units to the methanol recovery unit to deliver the biodiesel/glycerin mixture to the recovery unit.
Goal - Task H.2.2, install a breaker box and supply power to the motor and emergency start/stop to deliver the biodiesel/ glycerin mixture from the transesterification units to the methanol recovery system.
Goal – Task H.3, Install pipes, valves and pump from methanol recovery unit to the settling tanks.
Goal – Task H.3.1, Supply power to motor and emergency shut-off to deliver biodiesel and glycerin to the settling tanks.
Goal – Task H.4, install the chiller unit on the recovery system.
Goal - Task H.5, the Project Investigator, Dan Quintana, and Project Manager, Ben Doon, will visually inspect and verify that all installation projects are complete.

Accomplishment - Task H – Methanol Recovery System has been abandoned due to budget constraints and a low priority assigned to this task. The low priority was assigned to this task based on recommendations from our Principal Investigator and our engineer consultant. Details regarding the abandonment of this task are discussed in the "Problems encountered and departure from planned methodology and assessment of their impact on the project results" section.

Task I – Glycerin Storage and Handling System

Goal - Task I.1, procure a glycerin burning furnace.
Accomplishment – completed. An HW250 furnace unit with a draft inducer has been procured. The unit has a compressed air requirement and it has a fuel flow rate of 1.4 gallons per hour.

Goal - Task I.2, mount and install the unit in place.

Accomplishment – complete.

Goal – Task I.2.1, install ducts and dampers to deliver heat throughout the facility.
Accomplishment – complete.

Goal - Task I.2.2, supply power to the furnace unit and automatic dampers.
Accomplishment – complete.

Tasks I.1, I.2, I.2.1 and I.2.2

Goal – Task I.3, install the pipes, pump and valves to deliver the glycerin from the batch reaction settling tanks to the 1,500-gallon glycerin storage tank located on the south-side of the indoor tank containment area.
Goal - Task I.3.1, install a breaker box and supply power to the pump and motor and emergency shut-off to deliver the glycerin from the settling tanks to the indoor glycerin storage tank.
Goal – Task I.4, install heater elements in the glycerin storage tank to keep the glycerin from gelling in cold temperatures.
Goal – Task I.5, install pipes, a pump and valves from the glycerin storage tank to the glycerin burning furnace.
Goal – Task I.5.1, supply power and install a breaker box for the pump and motor and start/stop button to deliver glycerin from the indoor storage tank to the furnace storage tank.

Accomplishment - Task I – Glycerin Storage and Handling has been partially completed. Subtasks I.1 - I.2.2 involving the glycerin burning furnace are complete. However, subtasks I.3 – I.5.1 involving the piping of the glycerin to a bulk storage tank and then to the furnace has been abandoned due to problems encountered with gelling issues with the crude glycerin.

Detailed information about subtasks I1.3-I1.5.1 is discussed in the "Problems encountered and departure from planned methodology and assessment of their impact on the project results."

Task J – Laboratory Equipment Set-up

Goal – Task J.1, procure the following lab equipment: Flash Point Tester, Capillary Viscometer with constant temp bath, Hydrometer, Centrifuge, Fume Hood, Recirculator Bath and a Potentiometric Titration Cell.
Goal – Task J.1.1, install equipment in the lab room.
Goal – Task J.1.2, supply power to each piece of lab equipment.
Goal – Task J.2, install fume hood.
Goal – Task J.2.1, install ducts and dampers for the fume hood.
Goal - Task J.2.2, supply power to the fume hood and dampers.

Task J.2

Task J.2.2

Accomplishment - Laboratory Equipment Set-up has been partially completed. Subtasks J.2 – J.2.2 involving procurement and installation of a fume hood is complete. In addition a portion of subtask J.1.2, which involves the electrical infrastructure for additional pieces of lab equipment, has been installed including a breaker panel and a transformer. However, subtasks J.1 – J.1.2, the purchase and installation of additional lab equipment have been abandoned. Detailed information about subtasks I1.3-I1.5.1 is in the "Problems encountered and departure from planned methodology and assessment of their impact on the project results" section.

Task K – Truck Scale

Goal - Task K.1, procure a truck scale.

Accomplishment – complete. A 70’ x 10’ truck scale has been procured from Mid-America Scales. The scale has a gross capacity of 120 tons and includes steel decking with a 14” profile, load cells, bump bolts, j-box, conduit system, digital readout and ticket printer.

Task K.3

Task K.3.1

Goal – Task K.2, frame and pour a concrete slab for the truck scale pad.
Accomplishment – complete.

Goal – Task K.3, install the truck scale frame and equipment, which includes placement and proper installation of scale modules, proper anchoring to concrete piers and wiring of the scale.
Accomplishment – complete.

Goal – Task K.3.1, supply electrical power to the truck scale.
Accomplishment – complete.

Goal - Task K.4, the Project Investigator, Dan Quintana, and Project Manager, Ben Doon, will visually inspect and verify that all installation projects are complete.
Accomplishment – complete. Calibration and certification of the scale are complete.

Task K.4

Task L – Fence and Auxiliary Equipment Set-up

Goal - Task L.1, install a commercial grade, chain link fence with three strands of barbed wire around the outdoor tank containment area. The fence is required by the Colorado Department of Labor and Employment, Oil Inspection Section for Above Ground Storage Tanks.
Accomplishment – complete.

Task L.1

Goal - Task L.2, procure and install new computer equipment and software. The equipment included an HP desktop, a Canon FAXPHONE, a 17" monitor and a Toshiba Notebook PC.
Accomplishment – complete.

Goal - Task L.3, procure and install Wild Blue satellite internet system.
Accomplishment – complete. Jade Communications LLC provided the hardware and installation service. No other high speed internet options were available at the time in Mesita, Colorado.

Task L.3

Goal - Task L.4, the Project Investigator, Dan Quintana, and Project Manager, Ben Doon, visually inspected and verified that all installation projects for task L are complete.
Accomplishment – complete.

Task M – Project Management and Reporting

Goal - Task M.1, hire bookkeeping assistance and complete all DOE required project management and reporting.
Accomplishment – complete.

SUMMARIZE PROJECT ACTIVITIES

1. Original hypothesis

The Costilla County Biodiesel Pilot Project planned to use project funds to acquire and install additional equipment to reduce labor requirements and maximize production for its existing vertically integrated, oil seed crush and biodiesel pilot production facility. The intended use of project funds was to cover upgrades and improvements for a number of processes at the facility. Funding would be used to improve the oil seed feedstock storage and handling system, upgrade the vegetable oil filtering system, improve the oil seed meal cake storage and handling system, upgrade the biodiesel wash and filtering system, upgrade the glycerin storage system, procure a heating system that can use glycerin as a fuel, add a methanol recovery unit and add lab equipment to the facility.

2. Approaches used

Small-scale production, storage and handling equipment for the project was identified and procured from over a dozen companies manufactured in six different nations. Individual pieces of equipment were temporarily installed in the facility often with temporary electrical power to test the unit capabilities and production capacities. Foreign made equipment such as the oil seed crushing machines and the oil filter press units needed replacements, or modifications to the pump and motor systems. Most pieces of equipment such as the seed cleaner, oil seed crushers, and oil filter press and batch transesterification units needed to have stands and platforms fabricated in-house in order to accommodate the units as part of a production line. These factors were significant for the project taking longer than planned.

Each individual piece of equipment was tested “by hand.” The production line is not a turn-key operation; rather it had to be connected together piece by piece. As we gained an understanding of the capabilities and parameters of each piece of equipment, it was mounted in its permanent position along the production line and hard wired with all required electrical infrastructure. As each piece of equipment was installed along the production we began to move away from operating the machine "by hand" and started to connect each work station and piece of equipment to create a semi-automated production line.

For example, rather than continuing to feed the seed cleaner by hand, Flex-flo auger systems connected the outdoor grain bins to the seed cleaner, the clean seed then dropped into another Flex-flo auger system, which delivered it to an indoor day bin. Another set of Flex-flo augers pull the seed from the day bin and drop it into one of two seed conditioning kettles. The seed is warmed and moistened in the kettles where it then flows down a chute and into one of five seed crushing expeller units.

As the oil exits the expeller machines, it flows through a screen and into a 70-gallon, two chambered collection tank with a float system. At the same time the oil seed cake co-product of crushing seeds for oil is exits the expeller machines, drops into a small bin and is manually delivered to a Flex-flo hopper. An M500 Flex-flo auger system delivers the cake from the hopper into an indoor surge bin. An M300 Flex-flo auger delivers the cake into an outdoor storage bin with a discharge auger where it gets loaded into trucks or totes for use by local ranchers as a high protein livestock feed.

When the 70-gallon, two chambered collection tanks become full, a pump is triggered, which sends the oil through a 50-micron and then a 25-micron cartridge filter. The oil then collects and settles into a 450-gallon tank. When the 450-gallon tank is full a float system triggers a pump which sends the oil through a 10-micron and then a 5-micron cartridge filter and into a 150-gallon tank. Two air diaphragm pumps pull the oil out of the 150-gallon tank and then push the seed oil through one of two oil filter press units which cleans the oil to a level where it is ready for transesterification into biodiesel. The clean oil flows into a 40-gallon collection tank with a float system which when full triggers a pump which sends the oil into a 1,500-gallon bulk tank located in the indoor tank containment area.

Biodiesel is made in one of two 400-liter reactor vessels utilizing a high temperature, high pressure protocol. 100-gallons of oil are pumped from the 1,500-gallon bulk tank into an oil pre-warm tank where the oil is heated to 45-degrees Celsius. 11.9-gallons of methanol are pumped from a bulk methanol tank located in the outdoor tank containment area to a 40-gallon stainless steel sodium methoxide mix pot. 1.5-gallons of sodium methylate catalyst are gravity fed from a 250-gallon tote located in an outdoor shed with an explosion proof heater to prevent the solution from freezing in the winter. The methanol and methylate are mixed via a ¾ HP pump in the 40-gallon stainless steel mixing pot. After 5-minutes of mixing, the methanol and sodium methylate are pushed into one of two biodiesel reactor tanks using compressed air where it is heated to 45-degrees Celsius. When the oil reaches temperature it is pushed into a reactor tank which already contains the pre-warmed methanol and sodium methylate. The mixture of oil, alcohol and catalyst is then heated to 80-degrees Celsius with strong agitation in the tank. When the batch reaches temperature, which takes about 30 minutes, compressed air is used to push the liquid mixture into a settling tank where gravity settles the glycerol to the bottom and allows the biodiesel to float to the top. The batch settles overnight. The glycerol is drained and manually transferred to a tank where it is used as a heating fuel and the biodiesel is pumped into a 1,500-gallon storage tank.

The crude biodiesel is pumped from the 1,500-gallon storage tank through two towers that are part of an ion resin dry wash system which removes residual soaps, salts, glycerol and other impurities. The cleaned biodiesel then drains into a second 1,500-gallon storage tank for purified biodiesel. The purified biodiesel gets pumped into a 500-gallon tank where it is mixed with petroleum diesel in custom blends from B1-B99. The blend is mixed for about 10-minutes and transferred to an outdoor tank with a fuel pump. Water is not used in any stage of the process and therefore neither waste water nor effluent is created at the facility.

3. <u>Problems encountered and departure from planned methodology and assessment of their impact on the project results</u>

Task I – Glycerin Storage and Handling has been partially completed. Subtasks I.1 – I.2.2 involving the glycerin burning furnace are complete. However, subtasks I.3 – I.5.1 involving the piping of the glycerin to a bulk storage tank and then to the furnace has been abandoned due to viscosity issues with the glycerin. The biodiesel glycerin co-product produced at the facility begins to gel rather quickly when exposed to ambient temperatures of 65° Fahrenheit and less. This has caused concern that the pipes and pumps will become clogged with glycerin unless the entire line is heat traced and even then we would anticipate problems. Therefore we have abandoned subtasks I.3 – I.5.1 in favor of a more manual delivery system for the glycerin.

Task J – Laboratory Equipment Set-up has also been partially completed. Subtasks J.2 – J.2.2 involving procurement and installation of a fume hood is complete. In addition a portion of subtask J.1.2, which involves the electrical infrastructure for additional pieces of lab equipment have been installed including a breaker panel and a transformer. However, the purchase and installation of additional lab equipment has been abandoned as part of the project due to budget constraints and a low priority assigned to the remainder of subtasks J.1 – J.1.2. Because the Costilla County Biodiesel facility uses locally grown feedstock crops and virgin feedstock oil, the quality of the biodiesel produced is very consistent and repeatable. A facility that uses experimental or waste product feedstocks will produce less consistent biodiesel fuel, and will therefore require more regular quality testing of the biodiesel being produced. Currently it is more cost efficient for the Costilla County facility to send a few samples a year to a lab for quality control testing, rather than develop an in-house testing lab as our testing needs are currently minimal. However, a lab room infrastructure has been built at the facility with chemical resistant counters and cabinets, drain traps, fume hood, ducts and dampers and electrical infrastructure. In this way if additional lab equipment is desired in the future, set-up and installation can be simple and relatively inexpensive.

Task H – Methanol Recovery System has been abandoned due to budget constraints and a low priority assigned to this task. The low priority was assigned to this task based on recommendations from our Principal Investigator and our engineer consultant. The following is a recommendation from our project engineer, Dale Lessig of MKEC Engineering Consultants. This recommendation was made on November 1, 2010.

"The methanol and sodium methylate are mixed together and preheated to 113°F before going to the biodiesel reactor. As the methanol is preheated the vapor pressure of the solution will increase and there will be some additional methanol vapor losses. Also there is excess methanol in the biodiesel reactor to assure that there is complete reaction. This is heated up to 185°F, so there will be even more methanol vapor losses.

If we are talking about a large scale biodiesel production plant, where hundreds or thousands of gallons of methanol could be lost daily, it makes common sense to install some sort of a vapor recovery system. This becomes economically feasible to install such equipment to reduce operating raw material costs.

Here at this plant when current operations is typically 2 batches of 100 gal biodiesel. Methanol losses are only 1-2 gals per batch. If we base operations at 5 days per week and methanol cost at $1.83/gal. Then annual loss recoverable revenue would be approximately:

2 batches/day x 2 gals/batch x 5 days/wk x 52 weeks/yr x $1.83/gal = $1,900

Equipment only quotes for a methanol recovery unit at 25 GPH is $17,950 and for a 50 GPH is $25,950. Add to this the installation cost and electrical operating cost, this has a very long economic payback. Unless there are other requirements to reduce emissions loading from this plant, the economic incentive for adding capital improvement of a vapor recovery system is not justifiable. (See also the need for methanol to be left in glycerin, if you try to burn the byproduct as a fuel for heating)."

Task I – Ion Resin Biodiesel Dry Wash System has been enhanced beyond the original scope due to a recommendation from the project engineer. Our project engineer, Dale Lessig of MKEC Engineering Consultants made the following recommendation on November 1, 2010 regarding our existing biodiesel dry wash system.

"The original biodiesel operation called for a water wash of the biodiesel followed by a vacuum pump dehydration step. Since water is so scarce, and precious to be used in a process in the southern part of Colorado, an alternate option of filtering and ion exchange resin system to purify the biodiesel has been implemented. This has worked quite well from a cleaning standpoint, but will be very limiting on any future expansion capacity improvements. It is recommended that a second parallel ion exchanger resin system to be install, not only as a spare unit, but can be used for higher biodiesel production rates."

- Assumptions used to support the conclusions

The Costilla County Biodiesel Pilot Project is now a fully operational, vertically integrated, semi-automated seeds to diesel biodiesel production facility. The facility is able to process a wide variety of oil seed feedstocks and our goal of reducing labor requirements while increasing production have been met.

The Costilla County Biodiesel Pilot Project has demonstrated the compatibility of biodiesel technology and economics on a local scale. The project has been committed to making homegrown biodiesel a viable form of community economic development. The project has benefitted by reducing risks by building the facility gradually and avoiding large initial outlays of money for facilities and technologies. A primary advantage of this type of community-scale biodiesel production is that it allows for a relatively independent, local solution to fuel production. Successfully using locally sourced feedstocks and putting the fuel into local use emphasizes the feasibility of different business models under the biodiesel tent and that there is more than just a one size fits all template for successful biodiesel production.

IDENTIFY PRODUCTS DEVELOPED

- Publications

Biofuels Journal, May/June 2009

- Networks, or collaborations fostered

The Costilla County Biodiesel Pilot Project has been collaborating with Colorado State University at Pueblo's Department of Chemistry on glycerol related projects. The university has been taking samples of the glycerol produced at the Costilla County facility with soaps from the glycerol layer being used to synthesize additional biodiesel, crude glycerol being used for capture of atmospheric carbon dioxide, and conversion of carbon dioxide to methanol.

The following is a list of projects that Colorado State University at Pueblo's Department of Chemistry is undertaking with glycerol donated by Costilla County Biodiesel. In addition

Costilla County Biodiesel is working to assist the university with funding applications for the projects.

- **Determine overall yield of soaps from yield of glycerol (Costilla County)**

Working with the biodiesel producers, the overall yield of soaps in the biodiesel process can be calculated from the yields of glycerol and biodiesel fractions produced.

- **Conversion of carboxylic acids from soaps to methyl esters**

Carboxylic acids can be converted to esters by acid-catalyzed esterification. Carboxylic acids made from the soaps in crude bioglycerol will be converted to methyl esters and characterized as "biodiesel".

- **Efficiency of CO_2 capture**

Carbon dioxide (CO_2) is easily absorbed by strongly alkaline solutions such as aqueous sodium hydroxide (NaOH). We propose to use alkaline solutions to absorb CO_2 by bubbling ordinary air through the solutions. To absorb the maximum quantity of CO_2 from air where the concentration of CO_2 is low will take hours or days of aeration. During long aeration processes, evaporative loss of water from aqueous solutions will be high. To minimize the loss of liquid volume, we propose to use crude glycerol from biodiesel production. Glycerol has a very low vapor pressure and does not evaporate significantly at reasonable atmospheric outdoor temperatures. In addition, aqueous solutions of glycerol have sufficiently low freezing points (depending on the relative concentrations of water and glycerol in solution) that they will not freeze at ordinary outdoor temperatures in most parts of the United States. Bioglycerol obtained from biodiesel production is ideal in that it also contains soaps. Even after removal of most of the soaps, residual traces of soaps will remain and will promote foaming during aeration processes. Foam will increase the residence time of air containing CO_2 inside a surface of NaOH-containing solution thus promoting efficiency of absorption.

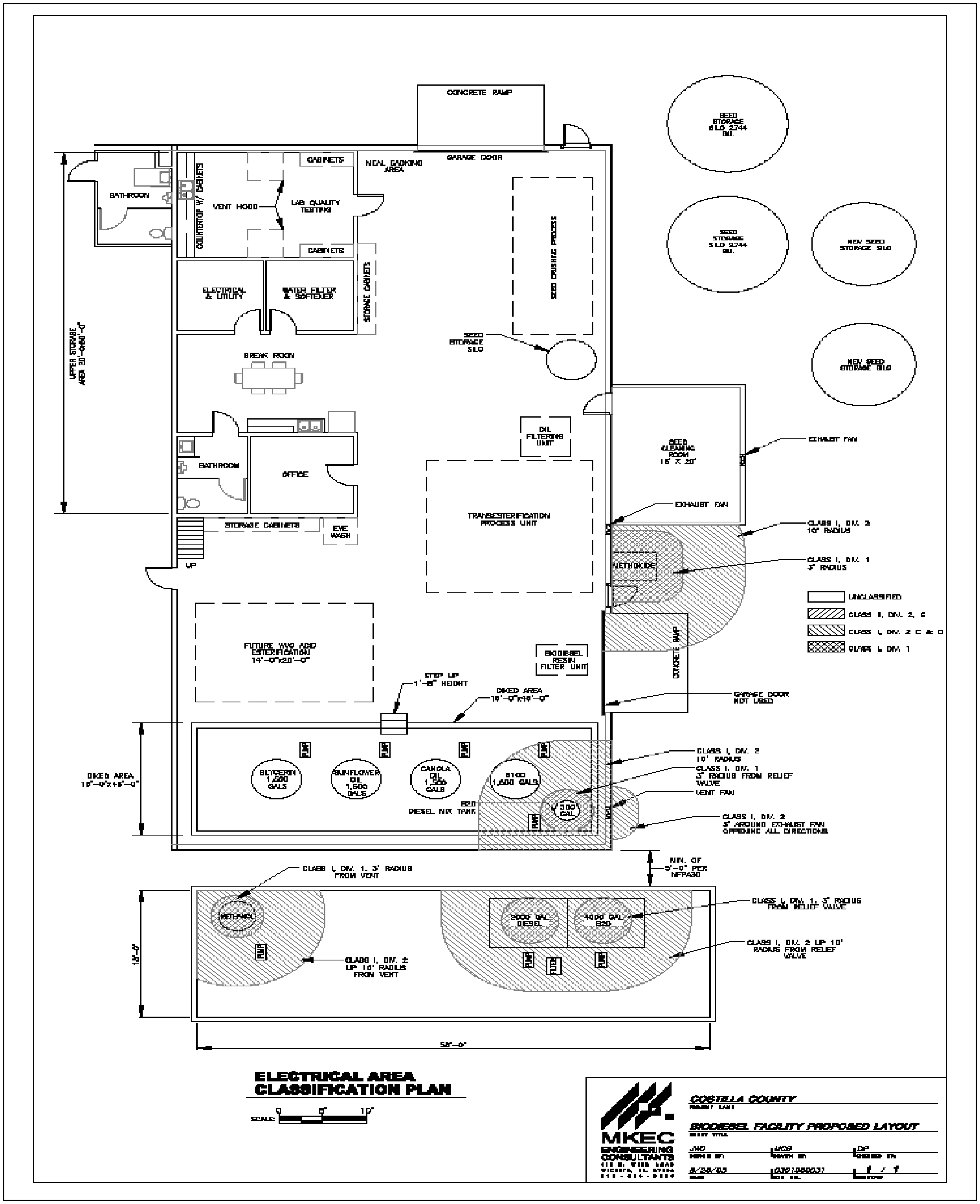
- **Feedstock chamber**

Engineering students will work with chemistry students to design and build a chamber for storage of crude glycerol containing trapped CO_2.

- **Release chamber**

Engineering students will work with chemistry students to design and build a reaction chamber in which glycerol will be acidified to release and hold CO_2 from the glycerol solution.

Facility Layout



Government Biodiesel

Costilla County-Owned, Operated Plant Produces Fuel, Jobs

With a declining population and ag-based economy, how does a county create new jobs?

For Costilla County, CO, the answer was to build a biodiesel plant.

The south central Colorado county now is operating an integrated canola/sunflower-crush and biodiesel plant producing 300,000 gallons per year from locally-grown feedstocks.

The biodiesel currently is being used as a fuel blend in the county's fleet of 40 diesel vehicles.

"Part of what attracted the county to the project is that even if the operation is a wash financially, we are paying our own workers to create fuel rather than sending money out of the county to a petroleum company," said Project Manager Ben Doon.

Plant History

The plant, which as of mid-June was still in its final phases of construction, was the brainchild of County Commissioner Joe Gallegos who took office in 2001 but is no longer county commissioner.

Gallegos, who was a former petroleum industry engineer, was looking for ideas to stimulate the rural economy of Costilla County, which has approximately 3,600 people.

"Our county is very low-income," Doon said. "One thing people kept asking is because we are ag-based, what about renewable energy supporting our ag infrastructure?"

The county did a feasibility study, and biodiesel rose to the top of the study for two primary reasons:

- Feedstock are available due to the long history of canola being raised in the area.

"In this valley, canola was never grown commercially, but it grows well," Doon said. "It loves our climate."

- The county utilizes a large amount of diesel fuel in its operations.

"Even with such a small population, the

"Even with such a small population, the county has large road maintenance duties. In our region, we maintain more roads than most larger populated counties."

- Ben Doon, Project Manager

Facility Feature

Costilla County Biodiesel
719-672-0320 | Mesita, CO
www.costillacounty-co.gov

Ben Doon, Project Manager
Dan Quintana, Chemist
Crestina Martinez, Business Manager

Employees: 3 full-time, 2 part-time
Capacity: 300,000 gpy
Feedstock: Canola, sunflower

Lab Technician Willie Medina examines a fuel sample.

county has large road maintenance duties. In our region, we maintain more roads than most larger populated counties."

The vehicles utilize B40 blended at the plant in cooler weather and B80 in warmer weather, Doon said.

The plant is owned jointly by the county government and a nonprofit group—Costilla County Economic Development Council.

"It sure took some real political will, especially early on, for the county board keep the momentum going," Doon said. "Politics really played a big role when getting permits. A lot of people didn't like government getting involved in business."

The county-owned and operated biodiesel plant was funded from several sources including a $150,000 U.S. Department of Agriculture (USDA) Rural Development Grant, $50,000 from the Environmental Protection Agency (EPA), $25,000 from the state energy office, $270,000 from the U.S. Department of Energy (DOE), a $35,000 USDA resource conservation service grant, a $12,500 grant from the local El Pomar private foundation, and a $4,500 grant from the Walcott family.

Construction on the plant began in 2003 but now is just being completed at a total cost approximately $1 million, Doon said.

Fuel has been produced in small amounts at the plant since 2006.

Construction Challenges

Rather than hire a construction firm, the plant was designed and built by county employees over the six-year construction period.

"We are a totally integrated plant—we take the seed crops and crush them for processing into biodiesel," Doon said. "Every step in the process we had to figure out on our own."

According to Doon, equipment for the plant came from all across the globe.

"That is part of the reason it took so long to build the plant," said Doon.

"For example, we had some bizarre wiring," he said. "For the crusher, the manual was in Chinese. We had to figure out how to do it ourselves."

Currently, the system is being operated without computer automation.

In the next phase, computer automation and other devices will be installed, to make the operation more efficient, Doon noted.

The crush will be automated, and methanol recovery also will be automated.

"Once we get comfortable, we will tie all the machines together and automate them," Doon said.

Co-Products

Crude glycerin produced as a co-product of the biodiesel process currently is being stored for future use.

"Moving foward," said Doon, "we plan to replace propane as our fuel source with the glycerin."

Another co-product produced is canola meal or sunflower meal, through the crush operation.

"There are a lot of family farms here with 20 to 50 head of cattle, horses, and other livestock," Doon said. "In the winter, we can't keep up with the demand. Our biggest customers are the cattle folks in the winter."

According to Doon, the farmers come to the plant to pick up the feed, and there is no formal marketing operation associated with the feed.

"It's just word of mouth," he said.

Plant Storage Capacity

The plant's storage capacity consists of:

- A 1,500 gallon B100 tank.
- Outdoor fuel tanks that hold 4,000 gallons of B40 in the winter and B80 in the summer.

"There's not enough fuel being produced for the entire county fleet," Doon said.

The plant has no rail access, only truck access, Doon noted. ▶

County worker Dave Guerra fuels a dump truck with B40. At present the biodiesel fuel produced at the plant is utilized in the county's diesel vehicles.

The plant, piecemealed together by county employees from 2003 to 2009, is now in operation. The next phase is to automate it, including the crush operation.

Marketing

All the plant's fuel is being utilized for county vehicles. According to Doon the plant is not allowed to sell fuel to other users.

However, the El Pomar Foundation is investigating privitization options for the plant such as a non-profit, farmer cooperative structure, which would allow it to market fuel to the public.

Lessons Learned

Doon said that despite the challenges the county had in developing the plant, it was a wise move.

"It took longer than we anticipated," Doon said. "The closest thing we had to engineers were the electricians here. We were doing everything from storing crops to producing fuel."

He said if the county had to do it now, the plant would take half the time to construct.

"The biodiesel is good quality, and the feed meal is in high demand," Doon said. "We haven't heard one word of complaint from our drivers and mechanics about biodiesel fuel in 2.5 years of use."

Myke Feinman, editor