Cabazon Band of Mission Indians

FINAL REPORT

Strategic Energy Planning For a Renewable Energy Demonstration Center

Present to:
U.S. Department of Energy
Tribal Energy Program
Contract # DE-EE0005059

Project Officer: Lizana Pierce
lizana.pierce@go.doe.gov

Prepared by:

Cabazon Band of Mission Indians
Planning Department
84-245 Indio Springs Pkwy
Indio, CA 92203

Technical Contact: Becky Ross
bross@cabazonindians-nsn.gov

December 2013
Updated April 2014

Project Data

Awardee:	Cabazon Band of Mission Indians
Location:	Indio, CA
Type of Award:	First Steps Grant
DOE Grant Number:	DE-EE000050509
Project Amounts:	DOE: Awardee: Total:
Project Period:	Start: September 1, 2011 End: December 31, 2013
Project Officer	Lizana Pierce, Manager U.S.D.O.E. Tribal Energy Program Golden Field Office Phone: (303) 275-4727 Fax: (303) 275-4753 lizana.pierce@go.doe.gov
Tribal Contacts:	*Technical:* Ms. Becky Ross Phone: (760) 342-5000, ext. 84784 bross@cabazonindians-nsn.gov *Business:* Ms. Leilani Gomez Phone: (760) 342-5000, ext. 85788 lgomez@cabazoninidans-nsn.gov Cabazon Band of Mission Indians 84-245 Indio Springs Pkwy Indio, CA 92203

Table of Contents

Figures & Tables

Referenced:

1. ‘Baseline Assessment for Strategic Energy Plan’, dated July 2013, prepared by Technikon, Inc. (Improperly reference as ‘Final Report’, when it was the final draft).
2. ‘Action Plan – Strategic Energy Planning for a Renewable Energy Demonstration Center’, dated December 2013, prepared by Cabazon Band of Mission Indians Planning Department.

Executive Summary

Project Overview

The Cabazon Band of Mission Indians was awarded a grant under the U.S. Department of Energy's ("DOE") Tribal Energy Program to develop a comprehensive Tribal Strategic Energy Plan. The grant, awarded under DOE's First Steps program, supported the development of a strategic energy plan that would include the development of an Action Plan for the addition of a Renewable Energy Demonstration Center ("REDC") at the Tribe's Cabazon Resource Recovery Park ("CRRP').

The strategic energy plan would be integrated into the Tribe's long-range goals to become energy self-sufficient, foster economic diversity, grow jobs and improve the well-being of Tribal members as well as citizens in the Coachella Valley of Southern California. At the same time, the Tribe does not want to sacrifice its long-time commitment to the careful stewardship of the environment.

Project Objectives

The goal of the project was to determine if the addition of a REDC at the CRRP would benefit the Tribal Strategic Energy Plan. To accomplish this project goal, the following took place:

- Perform a baseline assessment of the REDC concept which included these tasks:
    - A vision statement;
    - Needs forecast (demand analysis);
    - Energy resource options (supply analysis);
    - Preliminary choices; and
    - Setting priorities.
- Develop an Action Plan based on the findings of the assessment.

Descriptions of Activities Performed

After the completion of the first draft of the baseline assessment, the Tribal Staff and the consultant held a series of conference calls and meetings to discussion the draft assessment as it was unclear if the REDC concept for waste conversion technologies was viable for inclusion in the Tribe's Strategic Energy Plan and long-term goals for the CRRP. The consultant took the findings and concerns from these calls and meetings to produce a second draft. After receiving and reviewing the second baseline assessment draft and research by the Tribal Staff, it was concluded that the assessment lacked available data and information on waste conversion technologies in the United States to determine the viability of the REDC concept.

Even though the viability of the REDC concept could not be shown, the Tribe believes that waste conversion technologies will play a role in the development of the CRRP and in turn benefit the Tribe's Strategic Energy Plan. The Planning Department and other Tribal Staff members were tasked with formulating actions that could be used by the Tribe to evaluate the technologies.

Conclusions and Recommended Actions

So that waste conversion technologies can play a role in the development of the CRRP and benefit the Tribe's Strategic Energy Plan, the Tribal Staff formulated action tasks that could be used by the Tribe to review and evaluate these technologies. The recommended actions were organized into the categories of "near-term initiation/execution," "future study" and "continued monitoring" for prioritizing as it was recognized for practical reasons that Tribal Staff time and resources would prevent execution of all of the actions at once. (See page 10).

Actions for Near-Term Initiation/Execution

- **Recommendation #1: Development of a Conversion Technology Informational Checklist.** A checklist could serve as a convenient tool for use when reviewing/evaluating technology for inclusion in the Tribe's CRRP or for future study. Topics to be considered are:

- **Recommendation #2: Attend Conversion Technology Related Conferences /Training Events.** Conferences and training events relating to conversion technology could serve as an avenue to either learn about emerging commercial technology or serve as a venue to present the CRRP concept to attract interested companies.

- **Recommendation #3: Perform a Study of the Waste Streams of the Coachella Valley.** Though the draft assessment discussed the increasing challenge in the United States for the disposal of waste, it did not address if a sustainable waste stream can be found in the Coachella Valley.

Actions for Further Study/Longer-Term Initiation

- **Recommendation #4: Partner with a University/College Involved in Conversion Technology Research/Development.** Many universities/colleges involved in the research and/or the development of conversion technology do not have the available land to build a commercial sized unit of a proven pilot.

Actions for Continued/Future Monitoring

Recommendation #5: Continue Monitoring for Studies, Assessments, Reports on Waste Conversion Technology. Tribal Staff should continue to monitor for studies, assessments and report on waste conversion technology to educate themselves and the Tribe on technology being considered for the CRRP.

Background

In the early 1990s, the Cabazon Band of Mission Indians designated 590 acres in the southern section of their Reservation as an Eco Industrial Park that would support recycling and renewable technologies in the Coachella Valley of the Southern California deserts without sacrificing the Tribe's long-time commitment to the careful stewardship of the environment. This park was called the Cabazon Resource Recovery Park ("CRRP").

In 1999, a Programmatic Environmental Impact Statement ("PEIS") was developed and approved for the CRRP. The PEIS identified twenty-six (26) different waste streams that had the potential to be converted or recycled into a higher value product by one or more of the sixteen (16) facilities types/processes identified. A majority of these waste streams were being transported to a landfill for final disposal. If a process to convert or recycle a waste stream had not been set-out in the PEIS, there was a contingency for an Environmental Assessment of the process or addendum approval.

The major challenge faced by the CRRP since its inception has been the ability to attract additional technology to the park, especially in the waste to energy or fuel technology sector. The addition of a 47 MW biomass (woody waste) to electricity plant in 1992 was the last such addition in the waste conversion technology sector.

The concept of a Renewable Energy Demonstration Center ("REDC") had been presented to the Tribe as a means to attract waste conversion technology to CRRP. For the Tribe to consider the addition of a REDC to the CRRP, an assessment of the concept needed to be performed to determine its viability.

The Tribe was awarded a grant under the U.S. Department of Energy's ("DOE") Tribal Energy Program to develop a comprehensive Tribal Strategic Energy Plan. The grant, awarded under DOE's First Steps program, supported the development of a strategic energy plan that would include an assessment of the addition of a Renewable Energy Demonstration Center ("REDC") at the CRRP that would lead to the development of an Action Plan for the REDC. The assessment was performed by an outside consultant.

During the assessment development phase of the grant, the Tribal Staff used the time to educate themselves on waste conversion technology from information found during research utilizing the internet. Topics researched and reviewed ranged from basic understanding of the different technology processes to industry presentations to assessments/reports prepared for other organizations/governments. The knowledge learned during this time aided the Tribal Staff in assessing the REDC assessment.

Each draft version of the REDC assessment reviewed by the Tribal Staff was found to lack performance or independent testing data that could verify the data presented. The Staff also was concerned that the assessment drafts lacked data or information regarding the economic viability of the demonstration concept. Key elements of the REDC assessment review are set-out in the 'Review Process' section below.

Even though the Tribal Staff concluded that the REDC concept was not presently viable for the CRRP, the Staff concluded that waste conversion technologies considered for the REDC concept could play a role in the development of the CRRP and benefit the Tribe's Strategic Energy Plan. Instead of developing an Action Plan for the REDC Concept, the Tribal Staff formulated action tasks that could be used by the Tribe to review and evaluate waste conversion technologies.

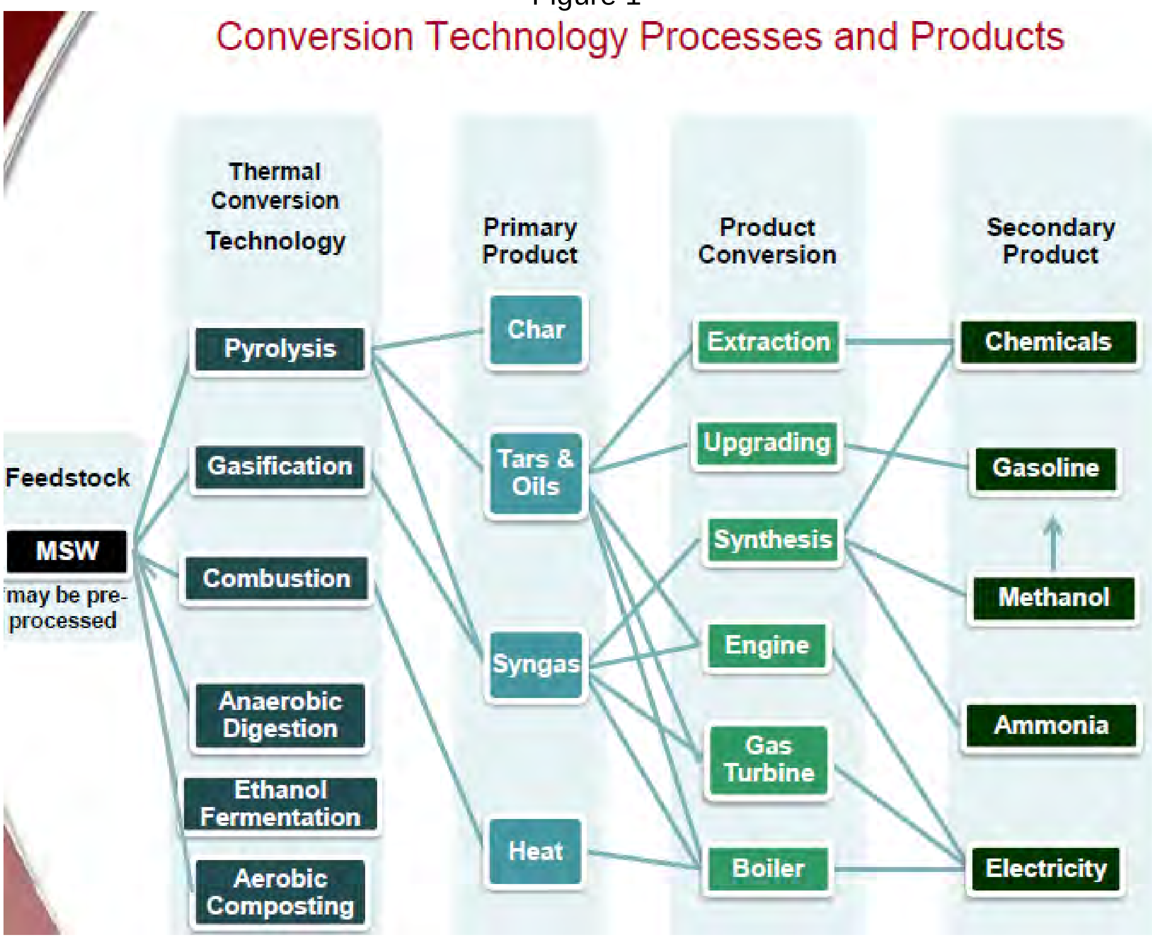
Process Review

The following section includes some of the key elements looked at and addressed during the Tribal review of the REDC concept assessment. They also were used in the development of the Action Plan.

Types of Waste Conversion Technology

A basic understanding of the different types and products of waste conversion technology was needed by Tribal Staff involved in the review of the REDC concept assessment. The illustration depicted in Figure 1 shows the general overview the Staff needed to understand.

Figure 1



Pg. 17, GBB Solid Waste Management Consultants presentation entitled "Waste-to-Energy and Alternative Conversion Technologies – Experience & Opportunities", Municipal Waste Management Association 2012 Fall Summit.

Though technologies shown in Figure 1 used to produce electricity, pyrolysis, gasification and combustion, have been around for a long time (gasification of coal and peat for over 180 years), the use of municipal solid waste ("MSW") as a feedstock is relatively new and was the proposed feedstock for the REDC. Anaerobic Digestion ("AD") should also be included as a technology that can be considered for the production of electricity through the use of biogas.

The Tribal Staff already had a basic understanding of the conversion technology except for pyrolysis and gasification.

- Gasification is a process that converts organic or fossil based carbonaceous materials into carbon monoxide, hydrogen and carbon dioxide. This is achieved by reacting the material at high temperatures (>700 °C), without combustion, with a controlled amount of oxygen and/or steam. The resulting gas mixture is called syngas (from synthesis gas or synthetic gas) or producer gas and is itself a fuel. The power derived from gasification and combustion of the resultant gas is considered to be a source of renewable energy if the gasified compounds were obtained from biomass. *Wikipedia.*
- Pyrolysis is a thermochemical decomposition of organic material at elevated temperatures in the absence of oxygen (or any halogen) that produces gas and liquid products and leaves a solid residue richer in carbon content, char. It involves the simultaneous change of chemical composition and physical phase, and is irreversible. It is a type of thermolysis, and is most commonly observed in organic materials exposed to high temperatures. *Wikipedia*

Though gasification and pyrolysis technologies both use high temperatures in their conversion process, gasification is aerobic, uses oxygen, while pyrolysis is anaerobic, does not use oxygen.

Stages of Technical Development

Because of the interest in waste conversion technology not only in the United States but internationally as well, the REDC concept focused on developing technology that would meet the requirements of DOE's Readiness Levels TRL 6 and TRL 7 (Table 1). Since TRL 6 included the engineering development of the technology as an operational system and TRL 7 the actual operation of the technology in a relevant commercial environment, the Tribal Staff posed the following questions during the draft REDC assessment review they felt needed to be addressed:

- What was the attrition rate between TRL 5 and TRL 6 – could not make the transition from the laboratory to a pilot?
- What was the attrition rate between TRL 6 and TRL 7 – inability to operate in a relevant commercial environment?
- What was the average length of time it took successful technology to transition from TRL 6 to TRL 7?
- Do one or more types of waste conversion technology have a better success to transition from TRL 6 to TRL 7?
- Were the failures to obtain an operational system due to environmental issues like emissions? (Environmental stewardship concern.)

Neither the consultant nor Tribal Staff could find any performance or independent data that could be used to validate or answer these questions.

Table 1

Technology Readiness Levels

Relative Level of Technology Development	Technology Readiness Level	TRL Definition	Description
System Operations	TRL 9	Actual system operated over the full range of expected conditions.	The technology is in its final form and operated under the full range of operating conditions. Examples include using the actual system with the full range of wastes in hot operations.
System Commissioning	TRL 8	Actual system completed and qualified through test and demonstration.	The technology has been proven to work in its final form and under expected conditions. In almost all cases, this TRL represents the end of true system development. Examples include developmental testing and evaluation of the system with actual waste in hot commissioning. Supporting information includes operational procedures that are virtually complete. An ORR has been successfully completed prior to the start of hot testing.
	TRL 7	Full-scale, similar (prototypical) system demonstrated in relevant environment.	This represents a major step up from TRL 6, requiring demonstration of an actual system prototype in a relevant environment. Examples include testing full-scale prototype in the field with a range of simulants in cold commissioning1. Supporting information includes results from the full-scale testing and analysis of the differences between the test environment, and analysis of what the experimental results mean for the eventual operating system/environment. Final design is virtually complete.
Technology Demonstration	TRL 6	Engineering/pilot-scale, similar (prototypical) system validation in relevant environment.	Engineering-scale models or prototypes are tested in a relevant environment. This represents a major step up in a technology's demonstrated readiness. Examples include testing an engineering scale prototypical system with a range of simulants.1 Supporting information includes results from the engineering scale testing and analysis of the differences between the engineering scale, prototypical system/environment, and analysis of what the experimental results mean for the eventual operating system/environment. TRL 6 begins true engineering development of the technology as an operational system. The major difference between TRL 5 and 6 is the step up from laboratory scale to engineering scale and the determination of scaling factors that will enable design of the operating system. The prototype should be capable of performing all the functions that will be required of the operational system. The operating environment for the testing should closely represent the actual operating environment.
Technology Development	TRL 5	Laboratory scale, similar system validation in relevant environment.	The basic technological components are integrated so that the system configuration is similar to (matches) the final application in almost all respects. Examples include testing a high-fidelity, laboratory scale system in a simulated environment with a range of simulants1 and actual waste2. Supporting information includes results from the laboratory scale testing, analysis of the differences between the laboratory and eventual operating system/environment, and analysis of what the experimental results mean for the eventual operating system/environment. The major difference between TRL 4 and 5 is the increase in the fidelity of the system and environment to the actual application. The system tested is almost prototypical.
	TRL 4	Component and/or system validation in laboratory environment	The basic technological components are integrated to establish that the pieces will work together. This is relatively "low fidelity" compared with the eventual system. Examples include integration of ad hoc hardware in a laboratory and testing with a range of simulants and small scale tests on actual waste2. Supporting information includes the results of the integrated experiments and estimates of how the experimental components and experimental test results differ from the expected system performance goals. TRL 4-6 represent the bridge from scientific research to engineering. TRL 4 is the first step in determining whether the individual components will work together as a system. The laboratory system will probably be a mix of on hand equipment and a few special purpose components that may require special handling, calibration, or alignment to get them to function.
Research to Prove Feasibility	TRL 3	Analytical and experimental critical function and/or characteristic proof of concept.	Active research and development (R&D) is initiated. This includes analytical studies and laboratory-scale studies to physically validate the analytical predictions of separate elements of the technology. Examples include components that are not yet integrated or representative tested with simulants.1 Supporting information includes results of laboratory tests performed to measure parameters of interest and comparison to analytical predictions for critical subsystems. At TRL 3 the work has moved beyond the paper phase to experimental work that verifies that the concept works as expected on simulants. Components of the technology are validated, but there is no attempt to integrate the components into a complete system. Modeling and simulation may be used to complement physical experiments.
Basic Technology Research	TRL 2	Technology concept and/or application formulated.	Once basic principles are observed, practical applications can be invented. Applications are speculative, and there may be no proof or detailed analysis to support the assumptions. Examples are still limited to analytic studies. Supporting information includes publications or other references that outline the application being considered and that provide analysis to support the concept. The step up from TRL 1 to TRL 2 moves the ideas from pure to applied research. Most of the work is analytical or paper studies with the emphasis on understanding the science better. Experimental work is designed to corroborate the basic scientific observations made during TRL 1 work.
	TRL 1	Basic principles observed and reported.	This is the lowest level of technology readiness. Scientific research begins to be translated into applied R&D. Examples might include paper studies of a technology's basic properties or experimental work that consists mainly of observations of the physical world. Supporting information includes published research or other references that identify the principles that underlie the technology.

[1] Simulants should match relevant physical and chemical properties.

[2] Testing with as wide a range of actual waste as practicable; and consistent with waste availability, safety, ALARA, cost, and project risk is highly desirable

Conversion Comparison

During the review of the draft REDC assessment, the Tribal Staff had expected to see some kind of comparison of waste conversion technologies performance and/or cost. Staff research did find in the 2012 assessment entitled *State of Practice for Emerging Waste Conversion Technologies*, prepared for the U.S. EPA, that "(i)t is difficult to directly compare the cost and performance of pyrolysis, gasification, and AD technologies directly due to differences in feedstocks and primary products" (See Table 2). "Pyrolysis technologies typically process only plastics; gasification technologies typically process plastics and biodegradable fractions of MSW but avoid inerts (e.g., glass, metals, aggregate); and AD typically processes highly putrescible (decayable) fractions of food, yard, and paper wastes. The difference in suitable feedstocks creates differences in feedstock energy values as well as in product energy value and related beneficial offsets."

Table 2
Overview of Conversion Technology Characteristics[1]

Conversion Technologies	Pyrolysis	Gasification	Anaerobic Digestion
Feedstock	Plastics	MSW[2]	Food, yard, and paper wastes
Primary End Product(s)	Synthetic Oil, Petroleum Wax	Syngas, Electricity, Ethanol	Biogas, Electricity
Conversion Efficiency[1]	62–85%	69–82%	60–75%
Facility Size (Capacity)	10–30 tons per day	75–330[3] tons per day	10–100[5] tons per day
Product Energy Value	15,000–19,050 BTU/lb	11,500[4]-18,800 BTU/lb	6,000–7,000[5] BTU/lb (estimated)

[1] Conversion efficiency is defined as the percentage of feedstock energy value (e.g., btu/lb) that is transformed to and contained in the end product (e.g., syngas, oil, biogas).
[2] Only certain MSW fractions can be input to a gasifier. Glass, metals, aggregate, and other inerts are not desirable and may cause damage to the reactor.
[3] Total capacity permitted based on vendor communications. Geoplasma's St. Lucie, FL plasma gasification plant is permitted up to 686 tons/day, but the vendor could not be reached for confirmation. [Note: as of September 2012, the St. Lucie facility is no longer in development]
[4] LHV of ethanol.
[5] Estimated. AD facilities can span a wide range of sizes, input feedstocks, and designs.

So before there can be any kind of cost comparison of the technologies, there needs to be a comparison and/or evaluation of the feedstock.

Feedstock

The draft REDC assessment proposed the use of MSW, municipal solid waste, diverted from landfilling as feedstock. MSW in the United States is considered to be those everyday items discarded by the public as trash/garbage. Since discarded items can easily vary by location within the United States, city vs. rural, farm vs. industrial, it may be best to look at the typical waste classifications:

- Biodegradable waste: food and kitchen waste, green waste, paper (can also be recycled).
- Recyclable material - paper, glass, bottles, cans, metals, certain plastics, fabrics, clothes, batteries etc.
- Inert waste - construction and demolition waste, dirt, rocks, debris.
- Electrical and electronic waste (WEEE) - electrical appliances, TVs, computers, screens, etc.
- Composite wastes - waste clothing, Tetra Packs, waste plastics such as toys.
- Hazardous waste - including most paints, chemicals, light bulbs, fluorescent tubes, spray cans, fertilizer and containers.
- Toxic waste - including pesticide, herbicides, fungicides, and
- Medical waste.

Even though waste management in the United States has instituted programs like recycling or alternative hazardous disposal to separate out many of the above waste classifications for both the general public and industry prior to landfilling, none of the programs have achieved 100 percent diversion. This being stated may require additional presorting before use by conversion technology.

Summary

Because there were many unanswered questions left from the review of the draft REDC concept assessment, the viability of concept could not be determined. Since the REDC concept had been proposed as a means to help the development of the CRRP, the Tribal Staff developed an Action Plan for waste conversion technology.

The Action Plan – Proposed Actions

So that waste conversion technologies can play a role in the development of the CRRP and benefit the Tribe's Strategic Energy Plan, the Planning Department and other Tribal Staff members formulated action tasks that could be used by the Tribe to review and evaluate these technologies. The recommended actions were organized into the categories of "near-term initiation/execution", "future study" and "continued monitoring" for prioritizing as it was recognized for practical reasons that Tribal Staff time and resources would prevent execution of all of the actions at once.

The foundation for prioritization included factors such as potential for greatest impact/value, need of further analysis, and the ease/complexity of implementation. When factoring in a timeline, factors such as lead times, study periods monitoring of ongoing industry advances were also considered. Incorporating these factors, the recommended actions for (i) near-term initiation/execution, (ii) future study and (iii) continued monitoring are presented below.

Actions for Near-Term Initiation/Execution

Recommendation #1: Development of a Conversion Technology Informational Checklist.

A checklist could serve as a convenient tool for use when reviewing/evaluating technology for inclusion in the Tribe's CRRP or for future study. Topics to be considered are:

- Technology Type.
- Permitting – whether or not the technology had been permitted by a federal, state or foreign agency or meets a DOE Technology Readiness Level of 7, 8 or 9.
- Environmental Impacts – air emissions, solid residues, liquid residues, and nuisance factors.
- Feedstock – availability, storage and pre-use preparation.
- End Products – Residues – Wastes.
- Plans.
- Timeline.
- Staffing.
- Regulatory compliance.

Recommendation #2: Attend Conversion Technology related Conferences/Training Events.

Conferences and training events relating to conversion technology could serve as an avenue to either learn about emerging commercial technology or serve as a venue to present the CRRP concept to attract interested companies. These events are:

- Sponsored by industry related associations.
- Put on by federal/state agencies having an interest in the technology like DOE and EPA.

Recommendation #3: Perform a Study of the Waste Streams of the Coachella Valley.

Though the draft assessment discussed the increasing challenge in the United States for the disposal of waste, it did not address how this challenge was being addressed in the area surrounding the Tribe's Reservation – the Coachella Valley. If a sustainable waste stream can be found in the Coachella Valley that can be utilized as feedstock for a conversion technology, it will help in lowering the production costs for the technology.

Actions for Further Study/Longer-Term Initiation

Recommendation #4: Partner with a University/College Involved in Conversion Technology Research/Development.

Many universities/colleges involved in the research and/or the development of conversion technology do not have the available land to build a commercial sized unit of a proven pilot. This partnership would be similar to the REDC concept except the technology would come from academia.

Actions for Continued/Future Monitoring

Recommendation #5: Continue Monitoring for Studies, Assessments, Reports on Waste Conversion Technology.

Even though there are no technical experts like engineers/chemists on the Tribal Staff at this time, Staff members have used studies, assessments and reports found on the internet or in association/agency newsletters to educate themselves on waste conversion technology. Documents found by the Staff ranged from "*Conversion Technology Evaluation Report"* prepared for The County of Los Angeles Department of Public Works and the Los Angeles County Solid Waste Management Committee/Integrated Waste Management Task Force's Alternative Technology Advisory Subcommittee, August 18, 2005, to the "*State of Practice for Emerging Waste Conversion Technologies"* prepared for the U.S. Environmental Protection Agency, October, 2012. Tribal Staff should continue to monitor for studies, assessments and report on waste conversion technology to educate themselves and the Tribe on technology being considered for the CRRP, especially performance or independent testing data that could be used to validate technology claims.

Implementation and Timeline

Based upon the Tribal Business Committee's (BC) consideration of the recommendations contained in this Action Plan and their subsequent guidance, Tribal Staff will prepare detailed implementation plans and schedules for those recommended actions the BC decides to pursue.

Lessons Learned

Though the waste conversion technologies summarized/discussed above have been around for quite some time, recent increased interest in the technologies can be contributed to:

- Federal renewable energy policy and funding;
- Local governments desire to be greener and to divert more from landfills;
- Source for local jobs; and
- Increase in disposal fees and transportation costs.

Tribal Staff research also found that though there was recent increased interest in the technologies, the interest might be limited until there is a widespread landfill disposal crisis in the United States.

Resources:

Beck, R.W., 2007, Comparative Evaluation of Waste Export Conversion Technologies Disposal Options, Report prepared for King County, Washington, Department of Natural Resources and Parks, Solid Waste Division.

California Integrated Waste Management Staff Report, 2007, New and Emerging Conversion Technologies, Report to the Legislature.

GBB Solid Waste Management Consultants, 2012, Waste-to-Energy and Alternative Conversion Technologies – Experience & Opportunities, Presentation from the Municipal Waste Management Association 2012 Fall Summit.

Penn, Ian T., 2002, Resource Manual on Infrastructure for Eco-Industrial Development, prepared for the Economic Development Administration under the auspices of Leonard Mitchell, Esq., Director: USC Center for Economic Development, School of Policy, Planning, and Development, University of Southern California.

RTI International, 2012, State of Practice for Emerging Waste Conversion Technologies, Prepared for the United States Environmental Protection Agency.

URS Corporation, 2005, Conversion Technology Report, Prepared for The County of Los Angeles Department of Public Works and the Los Angeles County Solid Waste Management Committee / Integrated Waste Management Task Force’s alternative Technologies advisory Subcommittee.

U.S. DOE (Department of Energy), Office of Environmental Management, 2008, Technology Readiness Assessment (TRA) / Technology Maturation Plan (TMP) Process Guide.

U.S. EPA (Environmental Protection Agency), 2008, Municipal Solid Waste Generation, Recycling and Disposal in the United States: Facts and Figures for 2008.

Cabazon Band of Mission Indians

Baseline Assessment for Strategic Energy Plan

July 2013

Final Report

Present to:
U.S. Department of Energy
Tribal Energy Program
Contract # DE-EE00005059

Project Officer:
Lizana Pierce
lizana.pierce@go.doe.gov

Prepared by:
Technikon Inc
1170 National Drive, Suite 70
Sacramento, CA 95834

Technical Contact: George Crandell
gcrandell@technikon.us

Page Intentionally Blank

Project Data

Awardee:	Cabazon Band of Mission Indians
Location:	Indio, CA
Type of Award	First Steps Grant
DOE Grant Number:	DE-EE00005059
Project Amounts:	DOE: Awardee: Cabazon Band of Mission Indians Total: XXXXX
Project period:	Start: July 2012 End: July 2013
Project Officer:	Lizana Pierce, Manager U.S.D.O.E. Tribal Energy Program Golden Field Office Phone: (303) 275-4727 Fax: (303) 275-4753 lizana.pierce@go.doe.gov
Tribal Contacts:	*Technical:* Ms. Becky Ross Phone (760) 342-5000 ext 84784 bross@cabazonindians-nsn.gov *Business:* Ms Leilani Gomez Phone (760) 342-5000 ext XXXX lgomez@cabazonindians-nsn.gov
Consultant:	*Technical Contact:* Mr. George Crandell Technikon Inc 1170 National Drive, Suite 70 Sacramento, CA 95834 (916)-929-8001 – ext 223

Contents

Figures and Tables

DOE Grant Award Number DE-EE00005059

To the

Cabazon Band of Mission Indians

Baseline Assessment for Strategic Energy Planning

1.0 Executive Summary

This report is the deliverable for DOE Grant Award Number DE-EE00005059 to the Cabazon Band of Mission Indians (CBMI) to develop a: *strategic planning effort that defines a comprehensive energy plan that addresses: "where you are" (baseline assessment), "where you want to go" (a vision), and "how you're going to get there" (priorities)*.

The CBMI has chosen to focus the Grant efforts at the CBMI's Cabazon Resource Recovery Park (CRRP). The CRRP is an existing 590 acre Eco Industrial Park that was built in the early 1990s to support recycling and renewable technologies in the Coachella Valley of Southern California.

In 1999 the CBMI developed and approved a Programmatic Environmental Impact Statement (PEIS) for the CRRP trust land. The PEIS identified twenty-six different waste streams that had the potential to be converted into a higher value product; a majority of these streams would otherwise be transported to a landfill. The PEIS is currently being updated and to further support renewable energy technologies at the CRRP.

The major problem that the CRRP has faced since its inception has been attracting additional tenants to the property. The CRRP has had little growth of companies that have focused on waste to energy or fuel technology, after the start up of the 47 MW wood-waste to electricity plant in 1992. The goal of this report document is to provide a baseline assessment useful in attracting renewable energy tenants to the CRRP. The report summarizes the types of companies and the feedstocks targeted for the Park.

The major concept being proposed for the Park that would attract the type of targeted tenants is to install a Renewable Energy Demonstration Center (REDC). The REDC is an expansion of the U. S. DoD's "Renewable Energy Testing Center" located in Sacramento, CA. The REDC would allow for companies on the verge of going commercial to have a location that supplies technical support and reduces cost for their technology demonstration facility. Eventually, these technology companies could be integrated directly into the Cabazon Resource Recovery Park (CRRP) on a commercial scale and become part of the eco industrial partnership being created.

The Renewable Energy Demonstration Center will be a one of a kind facility that fills the mission of advancing renewable energy and fuels technologies by providing a lower cost solution for technology demonstration. Having the REDC located on Indian Lands is additionally unique and demonstrates that the CBMI is supportive of improving the environment, creating local jobs and reducing the country's dependence on foreign resources.

Another factor that will encourage companies to locate at the CRRP is the supply of feedstocks in the area. There is an abundance of biomass resources and municipal solid waste (MSW) in proximity to the CRRP. California annually produces a gross of 83 million bone dry tons of waste per year based on figures from a 2007 research study done by the California Emission Commission. 25% of this waste was agricultural, 31% forestry, and the remaining 44% MSW. The CRRP is in a central location that has access to adequate biomass and other waste streams for considerable growth of renewable companies in the area of electrical energy and bio fuels.

The Los Angeles County's Puente Hills Landfill will be shut down at the end of 2013 due to an expiring permit. This creates a large problem for the Los Angeles County Waste District that would force the waste to be transported to remote landfills, such as the Mesquite Regional Landfill in the Imperial Valley. One concept proposed is a Waste to Rail system and it would run approximately 5,500 tons of waste per day directly by the CRRP site to a new landfill 80 miles further away. The CRRP not only provides a better solution to the problem of high transportation costs, but it also could convert organic wastes into valuable resources instead of landfilling them.

Based on the biomass and waste available, preliminary choices for potential types of renewable energy companies that would be attracted to the REDC are identified in this report. The criteria that would be used to evaluate individual companies' qualification for the REDC include; a) the company being well capitalized outside federal contracts/grants or tribal funding, b) technology readiness level, c) potential for renewable energy or fuel production, d) space requirements (small footprint), e) the ability to create local jobs, f) the availability of the feedstock required for sustainable operation of the facility, g) the potential to meet the eco industrial park goals of the CRRP, and h) synergy with other companies to be located at the REDC or the CRRP.

The REDC's ultimate goal would be to; a) help reduce United States dependence on foreign oil, b) support recycling as a means to reduce environmental impact, c) create sustainable jobs for California, d) increase economic opportunities for the CRRP, e) support the clean tech economy, f) create renewable energy education and job sector in a high unemployment, low education region, and g) provide critical mass for the demonstration of technologies. The synergy of the sites will help reduce the cost of advancement of early-stage technologies from start up through commercialization.

The priorities for completion of this project are based on getting national and local groups involved in the concept. Once the REDC concept is closer to finalization, such as the design phase in the unfunded part of this grant, the marketing of the proposal will start. Funding sources will need to be identified to make the vision of adding the REDC to the existing Cabazon Resource Recovery Park a reality. The CRRP is the ideal location for the first REDC to be constructed, because the CBMI had the vision 25 years ago that establish its eco industrial park. The CBMI believe that the REDC is a first step in adding alternative revenue sources to other Indian Nations.

2.0 Project Overview

This Grant was awarded to the Cabazon Band of Mission Indians (CBMI) in July 2012. Following is the scope of work wording and task listing from the award document.

"Results of a strategic planning effort should define a comprehensive energy plan that addresses: "where you are" (baseline assessment), "where you want to go" (a vision), and "how you're going to get there" (priorities).

Strategic energy plans should address both "supply-side" and "demand-side" options and possible energy sources including conventional and non-conventional sources, but <u>must</u> include renewable energy and energy efficiency options. This effort is intended to result in a long-term sustainable plan for energy sufficiency or energy development on Tribal Lands."

Approved Task Listing from DOE to the CBMI:

<u>Task 1.0 Program Management</u>

Tracking Costs, Schedule, Technical Progress, DOE Communications

<u>Task 2.0 Baseline Assessment:</u>

Task 2.1: Develop Vision Statement

Task 2.2: Needs and Forecasts (Demand Analysis)

Task 2.3: Energy Resource Options (Supply Analysis)

Task 2.4: Preliminary Choices

Task 2.5: Setting Priorities

The focus of this project is to support the addition of renewable energy technologies to the existing CBMI resource recovery park, known as the Cabazon Resource Recovery Park (CRRP) in Mecca, California. The concept approved for this project was to determine if the resources and the needs existed for the addition of a Renewable Energy Demonstration Center (REDC) at the CRRP. The REDC concept is envisioned to support the need of startup renewable companies for a demonstration site that reduces their development costs. The REDC at the CRRP will be designed to attract companies by providing: critical common infrastructure, laboratories, permitting support, local feedstock and a prime location for graduation to a full commercial plant location. The REDC would be an expansion and evolution of the pilot testing function occurring at The Renewable Energy Testing Center (RETC) in Sacramento, CA. that is operated by Technikon.

Once companies develop their first demonstration plant at the CRRP, with the support of the REDC, the hope is that many will be successful, expand their operations and become permanent residents at the CRRP.

Page Intentionally Blank

3.0 Project Objectives

The project objectives under this grant were to develop a "Strategic Energy Plan" that would support the CBMI goal of expanding renewable energy at its 590 acre resource recovery park. This plan was to be focused around the addition of renewable energy operations by determining a Baseline Assessment of the CRRP and the surrounding areas.

The first step in developing this plan was to get agreement on a vision statement of what the CBMI wanted to do with its resource recovery park. The team could then use this vision statement to address the priorities in moving the CRRP in that direction. The approved grant application captured the general vision concept for the CRRP of developing a renewable energy demonstration facility as a means of attract technology companies.

A DOE requirement was that the strategic energy plans should also address both "supply-side" and "demand-side" options and possible energy sources including conventional and renewable energy and energy efficiency options.

4.0 Description of Activities Performed

The activities under this project were designed to meet the requirements of a strategic energy plan by supplying analysis and data in the following categories:

- Develop Vision Statement - details in Section 5.0
- Needs and Forecasts (Demand Analysis) - details in Section 6.0
- Energy Resource Options (Supply Analysis) - details in Section 7.0
- Preliminary Choices - details in Section 8.0
- Setting Priorities - details in Section 9.0

Technikon Inc, a nonprofit company, is a subcontractor on this grant and collected much of the data utilized in this report. CBMI and Technikon had multiple meetings and reviews of the information assembled in this report. The Renewable Energy Demonstration Center concept developed because of the CBMI visits to the U.S. Army's Renewable Energy Testing Center (RETC) that Technikon operates in Sacramento. The direction the team proposed and that was written into grant application was the expansion of the RETC model to provide a location for larger commercial demonstration facilities at the CRRP.

The actual activities for the above topic areas where:

1. On Vision Statement the CBMI and Technikon had multiple meeting to determine the direction of the project. The CBMI advocated that the addition of the Renewable Energy Demonstration Center to the existing CRRP was the key element to attract green technologies to the park. The CBMI also envisioned that this model could be transferred to other tribes that were interested in creating income from a resource recovery park at their reservations.

2. Once the REDC concept was selected as the direction the CBMI were interested in pursuing, the team reviewed the demand for such a facility. It was decided that the demand for the REDC was based on multiple needs that included: a) industry and supplier demand for a low cost location to demonstrate their renewable technology, b) the CRRP and local utilities needs for renewable power, c) government agencies needs for successful renewable energy projects, and d) the CRRP needs for viable long term renewable energy tenants. The team documented each of these demand areas separately in Section 6.

   Appendices One thru Six were created to support this section and are a compilation of renewable energy suppliers that potentially could be interested in a demonstration facility at the CRRP. Meetings were held with many of these suppliers to share the REDC concept and to get added details on technology. Additional data was gathered from websites, magazine articles and trade association publications.

3. The team reviewed reports from the California Energy Commission, (CEC), the California Biomass Collaborative and Los Angeles County on the amount of biomass (wood and agricultural waste) and organic municipal solid wastes (MSW) that were located in the nearest counties around the location of the CRRP. The team had multiple meetings on biomass supply with different groups in the area, including:
   a. Two meetings with the County of Los Angeles Department of Public Works about the issues with a major LA landfill closing at the end of 2013 and added transportation costs the local communities may incur.

   b. Met with biomass plant owner and supervisors that move over 1000 tons per day of biomass to the CRRP site and the availability of those materials locally.
   c. Met with two MSW and biomass hauling companies about the availability of feed-stock and local disposal and hauling costs.

4. In the Preliminary Choice area the team attempted to get to a short list of companies that would be the most interested in locating at the REDC and try to determine their Technology Readiness Level (TRL). This was done by having meetings and conversations with many companies and reviewing their pilot plant operations data.

5. In the area of Setting Priorities the team looked at ongoing activities that the CBMI is doing that would support the goals of establishing the REDC such as the updating of the PEIS, completion of the ISO 14000; based on Environmental Health and Safety Management Program, for the CRRP, and new agreements with South Coast Air Quality Management District.

   Next , a priority listing was developed on the items needing future development in the next phase of the grant. General explanations of these items are in the priorities section and include:

   1. Outreach to and input by local community leaders and concerned citizens
   2. Design REDC
   3. Finding Partners
      a. Industrial
      b. Government
      c. Educational Institutions
   4. Establish Funding
   5. Construction of the REDC
   6. Qualify technology companies to install equipment at the REDC

5.0 Vision Statement

The Renewable Energy Demonstration Center (REDC) will provide a unique commercial demonstration site for waste to energy/fuels renewable energy technology companies. The addition of the REDC at the Cabazon Band of Mission Indian's (CBMI) Cabazon Resource Recovery Park (CRRP) will make the CRRP an attractive and strategic location for these companies. The primary mission for the REDC is to provide services and infrastructure to support the commercialization of renewable energy technologies.

5.1 Vision Details

5.1.1 Background

Cabazon Band of Mission Indians Resource Recovery Park

Recognizing the need for a well-conceived, environmentally sound industry to diversify its economy, the CBMI set aside a portion of its reservation for a resource recovery park, known as the Cabazon Resource Recovery Park (CRRP) in Mecca, California. The CRRP has an approved Programmatic Environmental Impact Statement (PEIS) that, with appropriate regulatory review and permitting, can accept a wide range of waste materials for conversion to reusable materials and energy. Presently the major tenant at the site is the Desert View Power Plant that operates a 900 ton/day wood waste to electricity (47 MW) power plant.

Technikon, Inc., a Non-Profit Corporation: Located in Sacramento, California, Technikon operates the Renewable Energy Testing Center ("RETC") and is a leader in renewable energy technology advocacy in the area of waste and biomass to energy and clean fuels. The RETC program functions as an independent technology commercialization accelerator for evaluating the performance of green technologies with respect to robustness, energy efficiency, safety, environmental effectiveness, and other key specifications. The RETC has focused on promising post-research, early-stage technologies, primarily related to thermo-chemical gasification and anaerobic digestion to electricity or renewable fuels. The ultimate goal of the RETC is to provide technology developers a location for pilot plants, testing services and assistance in commercializing their technology.

Technikon and the CBMI (the Team) have a common vision of supporting the growth of clean and green technologies to reduce U.S. dependence on foreign oil and mining of raw materials, including fossil fuels. The CRRP was designed in the early 1990's before the concept of an Eco Industrial Park actually was formalized. The existing approved PEIS lists nine renewable conversion activities that could occur on the CRRP, pending CBMI and USEPA permitting approval. Since the start up of the 47 MW Colmac Energy Inc., (presently the Green Leaf Desert View Power Plant) in 1992, the CRRP has had little growth of companies that have focused on waste to energy or fuel technology.

5.1.2 Renewable Energy Demonstration Center Vision

Companies that are developing renewable energy technologies need a location that allows demonstration of waste conversion, accelerates commercialization and reduces costs to market. Other interested parties, including DOE, California Energy Commission (CEC), Department of Defense and investors need to see successful demonstrations of renewable energy technologies. The DOE continues to invest in Energy Efficiency and Renewable Energy; $2.3 Billion is proposed in the DOE 2013 Budget[1], an increase of 29% over the 2012 budget.

The Renewable Energy Demonstration Center (REDC) concept is envisioned to support this need. The REDC at the CRRP will be designed to attract companies by providing critical common infrastructure, laboratories, permitting support, local feedstock and a prime location for graduation to a full commercial plant location. The REDC concept is an evolution of the Renewable Energy Testing Center (RETC) concept operated by Technikon.

The CBMI is interested in placing additional renewable technologies to the CRRP and has recently formed a Tribal Corporation to accelerate that effort and to manage the CRRP. The CBMI have a long range vision of sharing the concept of resource recovery parks with other Indian Nations as a way to diversify, create jobs, provide educational opportunities and improve the environment. The REDC is an important element to developing additional renewable resource recovery parks by being a magnet to attract companies to the new facilities. Besides additional income, the concept will promote green technologies, be a center for educational opportunities and create jobs for tribes and local communities.

5.1.3 Advantages of Concept

The U.S. Government has been funding the development and demonstration of renewable energy technologies in the biomass area (waste to energy/fuels) through individual grants for many years; $180 Million was expended in 2011[2] from the Energy Efficiency Renewable Energy (EERE) budget just for biomass and biorefinery R&D. However, in many of these grants a high percentage of the grant funding is spent on infrastructure improvements and environmental permitting, prior to equipment installation. The REDC concept would reduce many of these redundant costs and provide an incentive for companies to locate their first larger scale system at the demonstration center.

The REDC will employ a phased approach that allows renewable energy technology companies to have a short-term site for the development of near commercial scale equipment: Technology Readiness Level (TRL) of 6 and above (please refer to Table 5 for TRLs). The CRRP would be a future location for some commercial systems that graduate from the REDC and that would generate revenue for the Tribe. Complementary emerging technologies will also be demonstrated at the REDC that later could be integrated into the commercial plants that locate at the CRRP. As an example, a gasification company could be producing a quality synthetic gas and making electricity. The REDC site would allow a fuel technology company, requiring carbon monoxide and hydrogen, to test its equipment, utilizing the gasification company's synthetic gas. If the demonstration is successful, the companies could combine efforts at the CRRP and improve the value proposition of the biomass waste stream. Both companies then would have their first successful demonstration project, facilitated by the existence of the REDC being located at the CRRP.

Major Advantages of the REDC Concept:

1. Accelerates promising renewable energy technology demonstrations
2. Reduces cost for commercialization of renewable technologies for developers
3. Supportive of DOE goals to bring renewable energy and renewable fuels to the market
4. Common infrastructure design of the REDC reduces cost for private and government supported projects and grants

1 U.S. DEPARTMENT OF ENERGY - FY 2013 Statistical Table by Appropriation, page 1
2 U.S. DEPARTMENT OF ENERGY - FY 2013 Statistical Table by Appropriation, Volume 3 page 11

5. Provides location for green job training and for higher level college and university participation
6. Provides unbiased 3rd party testing and reporting data on technologies that are needed for investors to commercialize technology and install additional facilities

Major Advantages of the REDC location at the CRRP:

1. Ideal location for feedstock availability
2. Permitting and construction timing may be reduced for companies wishing to locate
3. The CRRP provides a location for expansion of technology to commercial scale
4. Provides future revenue sources for the CBMI
5. Creates local jobs, both skilled and non-skilled, in a high unemployment area

The REDC also aligns the goals of the DOE with the goals of the CBMI, as shown in Table 1.

Table 1- REDC supports Common Energy and Environmental Goals

Goal	CBMI	Federal Government
Reduce Dependence on Foreign Oil	Yes	Yes
Creations of Jobs in high unemployment area	Yes	Yes
Expansion of Renewable Energy Technologies	Yes	Yes
Lower Air Emissions and reduced impact on Environment	Yes	Yes

6.0 Needs and Forecasts (Demand Analysis)

6.1 Renewable Energy Demonstration Center (REDC) Demand Analysis

The demand analysis for a unique concept such as the REDC actually has two major components to be developed: a) electrical demand – what power can be expected to be generated at the REDC and b) technology providers' demand (how many companies would be interested in locating at the REDC). This is a different analysis compared to traditional DOE Strategic Energy Planning grants. Both the electrical and the technology provider's demands will be covered in this section plus some additional demands for the REDC from the perspective of DOE, Industry and CRRP. Important in defining these demands is the relationship of the proposed REDC and the Cabazon Resource Recovery Park (CRRP).

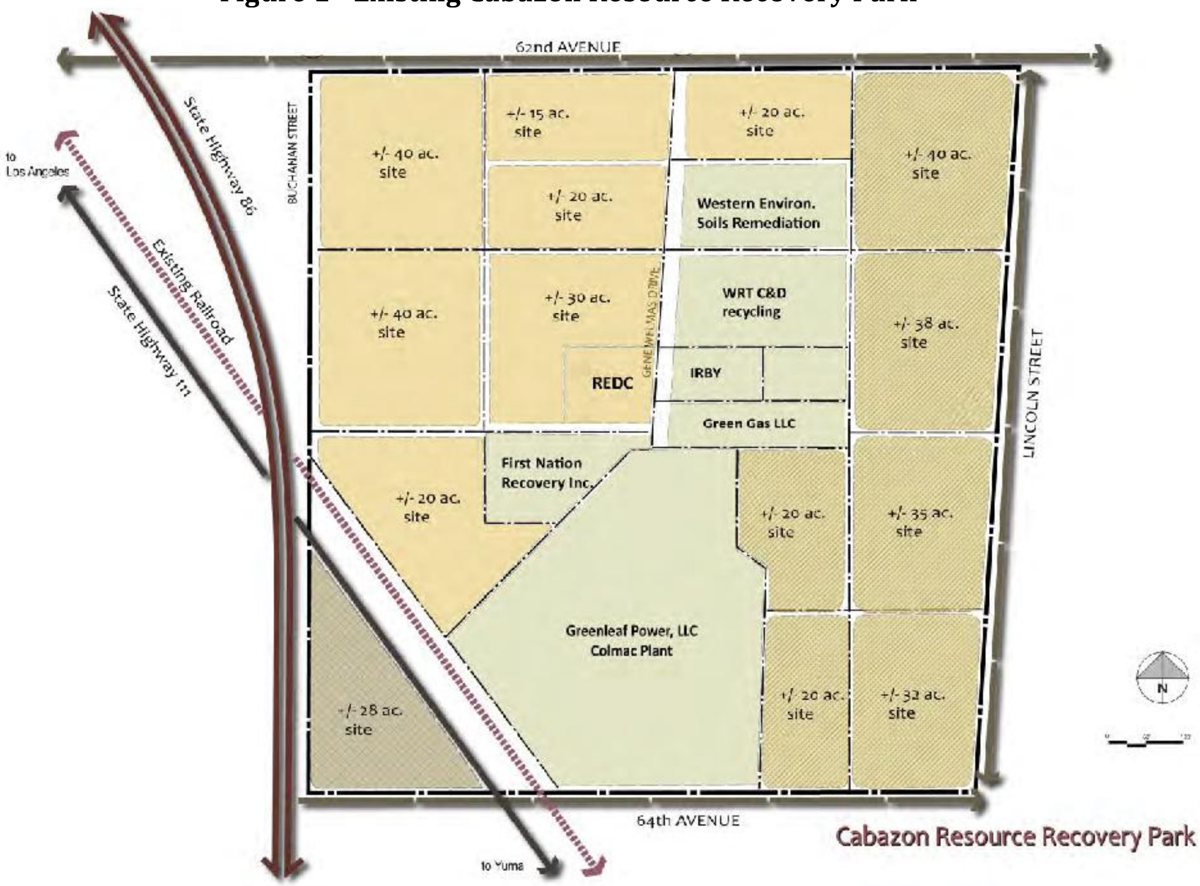
The REDC concept is an expansion of the smaller Renewable Energy Testing Center (RETC) located in Sacramento, CA. The RETC is funded by a combination of government and private funding for testing pilot technologies, particularly ones in the waste to energy or fuels area. When companies successfully complete pilot testing, either at the RETC or at other locations, they need to scale up their technology. The RETC site is not large enough to support this scaling up so these companies are left looking for a larger location that can supply feedstock, permits, and economic benefit. The RETC only sees a fraction of the companies (4 out of 28 listed in Appendixes) looking for the proper site for their first demonstration plant, so there is a large demand for the REDC services. The Team came together when one company that has equipment at the RETC identified the CRRP location for its larger system.

It is important to understand the CRRP history and mission to better understand the reasons why the REDC should be located at such a facility.

6.1.1 CRRP's Programmatic Environmental Impact Statement and Explanation of the Types of Operations Originally Envisioned for the CRRP

In 1999 the CBMI's Programmatic Environmental Impact Statement (PEIS) for the CRRP was developed and approved. Presently the PEIS is being updated reflect the latest regulatory requirements and opportunities for the CRRP. A PEIS document was prepared to describe the positive and negative environmental impacts of proposed recycling and renewable energy activities, and ways to mitigate impacts. The fact that the CRRP has an approved PEIS and is proactively updating it can shorten the permitting processes for companies wishing to locate at the park. The CRRP has multiple existing tenants but has at unoccupied acres that could easily support added renewable company sites and provide space for the REDC. See Figure 1 for site plan of the CRRP with one proposed REDC site.

Figure 1 - Existing Cabazon Resource Recovery Park [3]

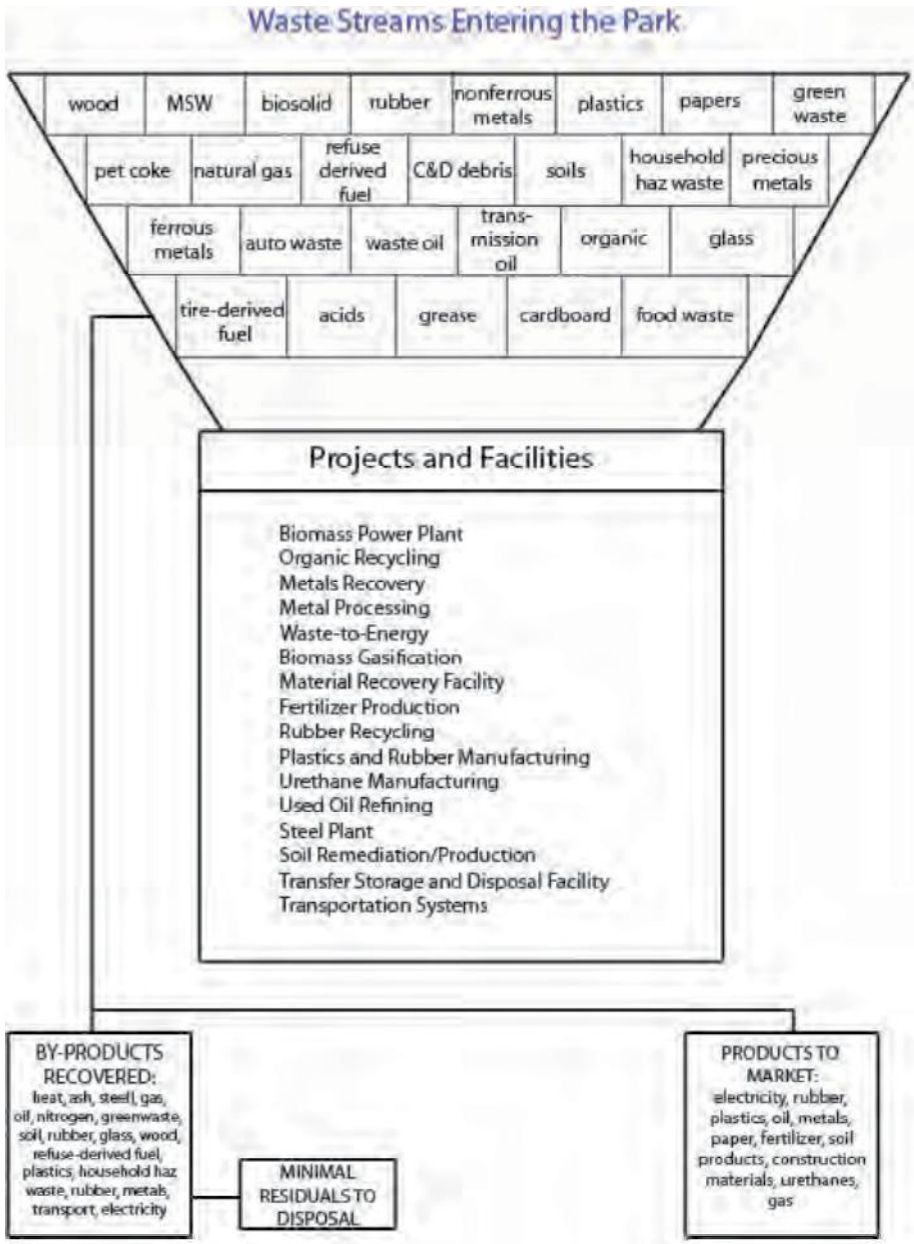


The original authors of the PEIS had the foresight to identify industries that support CBMI's recycling, reuse and material recovery goals. The PEIS identified twenty-six (26) different waste streams that can be converted into a usable product, such as waste plastic to die injection pellets or used oil into fuel oil. Many of these materials would otherwise be landfilled (See Figure 2). The PEIS is in the process of being reviewed for potential amendment to strengthen the document and support renewable technologies at the CRRP.

---

3 Cabazon Resource Recovery Park, Programmatic Environmental Impact Statement, June 1999

Figure 2 - Potential Approved Waste Streams [4]



4 Cabazon Resource Recovery Park, Programmatic Environmental Impact Statement, June 1999

6.1.2 Targeted Renewable Energy Technologies for the REDC

The CRRP design is based on advancing the traditional eco-industrial park model by combining the synergy of new green technologies with Native American values. A traditional eco-industrial park (EIP) is a community of manufacturing and service businesses located together because the waste of one business becomes the resource of another. The goal of an EIP is to improve the economic performance of the participating companies while minimizing their environmental impact. Components of this approach include pollution prevention and energy/water efficiency. Compared to a traditional industrial park, the emphasis of an EIP is on materials, energy, and water efficiency that reduce both pollution and demands for natural resources typically used as raw materials.

The CRRP model, as presented in the PEIS, utilizes the EIP model but with a focus on material conversion and recycling. The logical renewable technologies for the REDC should closely match the mission of the CRRP. Solar and wind renewable technologies are not being proposed in this report for the REDC, because of that reason and the fact the CBMI wish to create more than construction jobs for the local community.

The proposed method to add renewable technologies to the REDC and CRRP will parallel the traditional EIP approach. The major differences between conventional EIP and this proposal are the following distinct features: a) the addition of the Renewable Energy Demonstration Center to the CRRP, b) the focus on utilizing local agricultural, green wood and municipal wastes for renewable energy / fuel and c) taking advantage of the location of the CRRP on Indian Lands.

The benefits to REDC graduates for locating their commercial operations at the CRRP include: a) the 20 year history of the CRRP being in operation; b) the CBMI sovereign nation status that reduces some of the permitting issues while still meeting all the requirements; c) the CRRP's location and access to a variety of green waste and other feedstocks; d) the synergistic relationships with other tenants; and e) a demonstration site for potential customers. The addition of the REDC will only add to reasons why companies should locate their green technology at the CRRP. The green technologies to be targeted for the REDC and CRRP are companies seeking enhanced environmental and economic performance opportunities through collaboration in the management of waste, energy, water, and raw materials.

Since the CRRP is an existing operation, the focus of the technologies being considered at the REDC is based on them complementing the mission of the CRRP. Most of the renewable and recycling technologies being reviewed utilize biomass or waste to generate: a) liquid fuel, b) power and heat, c) recoverable resources that can be recycled and, d) green chemicals. Many of the technologies utilize a thermo-chemical conversion (gasification) as the front end of the process.

Appendices One thru Six were developed to support the Demand Analysis of technologies providers for consideration for the REDC. Appendices One thru Six have more detailed description of technologies by category, and identify companies that are commercial or near commercial. Thiese appendices are meant to be a guidance document only and no scientific data are supplied that are not available on websites or news releases. As such, many of the claims for the technologies status have not been independently verified.

Appendices One thru Six are broken into (6) technology sections:

1. Integrated gasification to liquid fuel processes (companies have pilot or production plants)
2. Pyrolysis catalytic reforming processes that produce oil or fuel (bio oil reforming)
3. Other chemical conversion processes (alternative approaches utilizing syngas for products like fertilizer)
4. Syngas to fuel only technology companies (require syngas or industrial gas source)

5. Electrical power generation from biomass or waste technologies companies
6. Waste and biomass recycling companies, which would be perfect feedstock providers for the REDC.

6.2 Demand for the REDC

The demand for the construction of the REDC is based on multiple needs, including; a) industry and supplier demand for a low cost location to demonstrate renewable technologies, b) the CRRP and local utilities needs for renewable power, c) government agencies needs for successful renewable energy projects, and d) the CRRP needs for viable renewable energy tenants.

6.2.1 Industry and Supplier Demand:

Data on number of technology developers looking to advance their technology from the pilot scale to a demonstration scale are difficult to accurately report because many of these companies do not actively publicize their status. Based on various DOE and media reports, there is an ever increasing variety of new companies entering the renewable energy market with technologies focused on biomass/waste to energy or fuel. As an example, in the 2012 Advanced Biofuel Market Report[5], 74 companies are listed; two of these have done their pilot testing at the RETC in Sacramento.

In Appendices One thru Six we identified companies that have demonstration projects built or in the planning stages. This is not a complete listing because some of the companies are avoiding publicity, referred to as being in stealth mode, until pilot testing data are available. The Team has been in contact with multiple companies that are interested in locating at the CRRP if the REDC was built. An active marketing plan will be developed in the next phase of the project to line up suppliers for the CRRP and to get their input on design needs that will be incorporated in the REDC engineering study.

6.2.2 Electrical Demand:

Power production from the REDC will not be consistent because technologies at the REDC will be in various states of development, including installation, ramping up, production and testing, and ultimately moving out. The availability of electrical power may never be dependable, but it may find uses in the CRRP or be sold to the local utility under a Power Purchase Agreement.

It is estimated that current tenants at the CRRP could utilize up to 1.2 MW of power, supplied by the Imperial Irrigation District (IID), if the tire recycling plant was in full operation. The IID operates hydroelectric, gas turbine power plants, and provides electricity to more than 145,000 customers in Southern California's Imperial Valley. If funded in the future, a design phase of this grant would provide breakdown of electrical usage at the CRRP by the tenants will completed including time phased power demand.

Presently the three main power users at the CRRP include: 1) FNRI, 2) Western Environmental, and Desert View Power.

The CBMI-owned First Nation Recycling Inc. (FNRI) is a tire recycling plant that can produce crumb rubber. The FNRI building and equipment are shown in Figure 3. The main tire recycling plant is 33,000 sq. ft. plus a separate a scale-house with offices. The FNRI facility was built in 1999 and currently has a peak power requirement of 600KW.

5 Advance Bofuel Market Report, by E2, Mary Solecki, Anisa Dougherty, Bob Epstein

Figure 3- FNRI Buildings and Tire Recycling Plant

Western Environmental operates soil and construction debris recycling facilities at the park. It has two office trailers, scales, and other miscellaneous equipment, that utilize power from the grid. The operations have a peak summer power requirement of 18,000 kwh per month that drops to 7,000 kwh per month in the winter months.

Desert View Power is a 47 MW power plant that produces its own power for most of its requirements, but would not be interested in REDC generated power. It has a separate outgoing power line to the local grid that is not part of the CRRP service.

6.2.3 Government Demand:

The DOE and the California Energy Commission support renewable energy demonstration projects through grant funding. There is a demand to reduce costs and generate success stories from grant funds. The REDC represents a means to reduce costs by having the basic infrastructure in place that could be reutilized in these projects. The State of California has identified this need in the Electric Power Investment Charge (EPIC) program, which identifies testing centers as a major funding area for the state.

In DOE Report[6] DOE/FE-0447, it is stated as a goal to: “establish a government-sponsored full-scale demonstration plant that includes slip streams specifically designed for testing new technologies in a “plug and play” fashion. The evaluation of gasification technologies and feedstocks needs to be done in test facilities that are as close as possible to commercial-scale. Ideally, such facilities should be accessible by more than one company.”

6.2.4 CRRP Demand

The REDC will be supportive of the CRRP goals and add to the tenant opportunities. As companies graduate from the REDC they will have knowledge of the local conditions and hopefully will find the CRRP as the natural location for a full commercial facility. This will increase employment in the area and increase revenues for the park.

6.3 Explanation of the REDC Model

The REDC model expands on the successful application of the approach at the existing RETC in Sacramento. In the past 4 years, the RETC has built the infrastructure and skill sets to provide specialized and unique support for a pilot technology testing site. This approach has attracted fourteen

6 DOE Report number: DOE/FE-0447 page 49

startup companies to the RETC since 2009. Of these, seven companies have obtained over $35 million in State and Federal grant funding to advance their technologies. Two companies have graduated from the RETC to commercial demonstration projects, one as far away as Toledo, Ohio. Four companies are presently at the RETC doing testing; a turnover rate of about 3 years to move companies in and out.

The concept of creating a demonstration facility located at the CRRP that is associated with the RETC will allow a lower cost alternative site and a tribal partner for technology companies that need a commercialization and demonstration site. Having the major infrastructure and laboratory equipment at the REDC reduces demonstration costs by an estimated 30 to 40%.

The REDC complements the test and validation function of the Sacramento RETC. It allows the most successful pilot renewable technologies to scale-up and locate to the REDC facility, enabling performance demonstration at a commercial scale in a real world environment. Other sources of technologies, like universities or incubators, will also supply the REDC. While the RETC tests and validates "pilot" renewable energy technologies, the REDC will be a unique facility to prove technology operation at a "commercial" demonstration scale. Companies applying for the REDC must be independently well capitalized, outside of government or tribal funding, supply equipment and have some environmental and parametric testing data.

The combined goals of these two renewable energy centers function to: a) help reduce United States dependence on foreign oil, b) support recycling as a means to reduce environmental impact, c) create sustainable jobs for California, d) increase economic opportunities for the CRRP, e) support California's clean tech economy, f) create renewable energy education and job sector in a high unemployment, low education region, g) provide critical mass for the demonstration of technologies and ability for interested parties to come to the site for investigation and purchase. The synergy of the sites will help reduce the cost of advancement of early-stage technologies from start up through commercialization.

The REDC would both leverage the knowledge of the existing testing center in Sacramento as well as jump to the next level: *demonstrating renewable energy technologies*. It would also attract other renewable energy technology developers not associated with the RETC, who are prepared to scale up from pilot scale to commercial scale. Each technology provider would supply its own equipment and add some of its own technical and engineering support to the REDC's pool of resources, benefiting all participants. The REDC would provide access to shared infrastructure including connections to the common utility grid, offices, laboratories and support in obtaining the required permitting.

The Team believes that constructing the REDC at its CRRP would allow it to: become a leader in renewable energy technologies; create high quality jobs in one of the highest unemployment areas in the country; and diversify the CBMI economic base beyond gaming. Ultimately, this project could become a template for tribes in the US, allowing all to share similar benefits.

Figure 4 is a rough conceptual layout that captures the vision of this site. The REDC project would contain one central high tech laboratory, classrooms and a common office complex (foreground) and, as companies are added, additional buildings would surround the common demonstration courtyard.

Figure 4 - Conceptual Layout of REDC

Additional advantages for the REDC concept at the CRRP site include:

1. The CRRP has the advantage for renewable companies of shortened permitting time while still requiring compliance with California and Federal regulations, lower development fees, and special tribal tax incentives.
2. The CRRP has an established twenty plus years for waste conversion/recycling and can be easily adapted for new technology demonstrations.
3. Multiple types and large volumes of feedstocks for waste to energy or fuel technology companies are available in the area of the CRRP.
4. Companies locating at the CRRP must meet Federal and California environmental regulations, including California's CO2 cap and trade regulations. In addition, companies that qualify could potentially sell carbon offsets.
5. Companies that take waste from California sources could potentially assist generators in qualifying for diversion credits, since the CRRP is on Tribal land. The Team has posed this question to CalRecycle and is awaiting an answer.
6. The Renewable Energy Demonstration Center will provide the demonstration and testing results necessary for technology transition and deployment at the CRRP and other locations.
    a. REDC will supply the data needed for federal or state air (or other) permits and establishing credibility for the technology and its effects on the environment.
    b. The REDC will have a team of experts in energy conversion technologies that will support renewable energy companies' development.
7. The REDC will provide location for hands on green jobs training from operator level to undergraduate education. Working with local universities and colleges, the REDC will provide

a training ground for a new generation of renewable energy technology scientists, engineers, and various specialists.

8. The REDC will expose promising renewable energy technologies to the government and the public allowing successful companies to expand beyond the REDC demonstration facility to full commercial plants at the CRRP or other sites.

6.4 Forecasting types of commercial renewable technologies

In a time where U.S. has become largely dependent on fossil fuels such as oil, coal, and natural gas, renewable energy provides a start to a feasible alternative energy source. The main goal of the creation of the REDC is to promote and increase the number of renewable energy companies that are successful. By creating a network of companies at the REDC that match the PEIS vision for the CRRP, it is possible to produce a multiple end products from a variety of incoming feedstocks. Some of the projected outputs would include green gasoline, fertilizer, diesel fuel, and electricity.

Examples of renewable energy outputs that could be produced at the REDC:

1. Electrical power and heat production by gasification of biomass or waste materials.
2. Bio Fuels, such as diesel fuel, ethanol, gasoline, from biomass or waste materials. Processes could include gasification to Fischer Tropsch (FT) fuels, pyrolysis oils, biochemical conversion.
3. Fertilizer production from organic waste. Many technologies utilize gasification to produce synthetic gas that can be converted to ammonia and other fertilizers.
4. Anaerobic Digestion System that would produce methane for organic wastes.
5. Pyrolysis gasification systems that would produce steam for power and a carbon by-product know as biochar, which can be utilized as a soil additive.
6. Cellulosic Ethanol Plants – using agricultural wastes to produce ethanol fuels.
7. Companies using natural gas for energy, such as natural gas to FT liquid fuels. A natural gas line runs through the property.

7.0 Energy Resource Options (Supply Analysis)

In the next two sections, biomass resources, such as wood and agricultural waste, and municipal solid waste (MSW) in proximity to the CRRP will be discussed. In order to discuss them clearly, we must create a division between these two categories that are often grouped together. For the sake of the clarity of this section, we will consider biomass to be agricultural waste, wood waste, construction and demolition (C&D) waste, and paper. Municipal Solid Waste (MSW) encompasses all of the other varieties of waste such as garbage, plastics, and metals picked up at curbside and transferred to be reclaimed or landfilled.

The Team envisions that the REDC will make contact with multiple suppliers and transporters of biomass, MSW and other feedstocks, but it will be up to the individual companies utilizing the REDC to negotiate for and supply their specific feedstock needs.

7.1 Biomass Resources in proximity to REDC/CRRP

There is an abundance of biomass resources in proximity to the CRRP. As an example, nearly 1000 tons of wood waste is being brought into the park daily by the Desert View Power Plant. In a 2007 research report funded by the California Energy Commission (CEC)[7], California was estimated to generate a gross annual resource of 83 million bone dry tons of waste. Of this total, 25% was agricultural waste, 31% was forestry waste, and the remaining 44% was municipal solid waste. This analysis for feed stock for the CRRP will target waste streams from the Los Angeles and Riverside areas to reduce transportation costs.

Table 2 shows data compiled from the 2007 report and provides the different varieties of biomass and MSW available in the counties surrounding the CRRP. The table shows that there is a large amount of biomass generated that is being landfilled in the counties surrounding the Coachella Valley. According to representatives from CEC and CalRecycle, these specific, county by county, data have not been systematically updated since the report was published, but projections presented in the report confirm that these data are representative and appropriate for planning purposes.

7 Williams, Robert B, An Assessment of Biomass Resources in California, 2007. California Energy Commission, PIER Collaborative Report, Contract No. 500-01-016

Table 2- Biomass Feedstock by County [8]

Units: Dry Tons/Year	Total Feedstock Produced	Feedstock that can be effectively utilized	Southern California (Dry Tons/Yr)	Imperial (Dry Tons/Yr)	Los Angeles (Dry Tons/Yr)	Orange (Dry tons/Yr)	Riverside (Dry Tons/Yr)	San Bernadino (Dry Tons/Yr)	San Diego (Dry Tons/Yr)
Total Biomass	83,362,000	40,885,000	9,996,277	478,444	1,958,671	1,481,252	1,268,195	1,624,861	1,745,033
Total Municipal	36,000,000	18,000,000	7,893,027	94,184	2,828,811	1,469,412	871,505	814,491	1,442,803
BioSolids Landiflled	123,000	0	0	0	0	0	0	0	0
Biosolids Diverted	698,000	558,400	175,250	1,200	82,250	22,000	20,050	13,550	26,000
Total USW Biomass Landfilled	18,300,000	9,077,190	2,860,353	28,803	1,261,291	483,750	290,975	261,083	428,353
Paper and Carboard	8,000,000	3,993,100	1,230,400	13,200	567,475	184,900	119,525	109,050	187,550
Food	1,900,000	925,500	285,125	3,050	131,500	42,850	27,700	25,275	43,475
Leaves and Grass	710,000	354,930	109,365	1,173	50,443	16,435	10,623	9,693	16,673
Other Organics	1,800,000	892,350	274,000	2,950	127,825	41,325	26,700	24,375	41,925
C&D Lumber	3,600,000	1,784,800	549,000	5,900	253,650	82,650	53,425	48,750	83,825
Stumps	2,256,000	1,126,510	410,513	2,530	131,398	115,590	53,003	43,940	54,905
Total MSW Biomass Diverted	16,600,000	0	0	0	0	0	0	0	0
Plastic	4,100,000	2,050,000	1,787,301	12,252	911,393	284,668	116,026	132,887	263,999
Textiles	1,600,000	800,000	537,094	2,735	219,556	174,407	27,473	31,744	65,527
Other C&D	5,100,000	2,550,000	1,451,188	11,937	693,992	245,782	112,020	122,837	219,126
Metal	3,300,000	1,650,000	1,017,265	6,526	500,236	167,165	70,391	79,210	155,867
Other Mixed & Mineralized	3,300,000	1,650,000	832,351	6,641	411,283	130,662	60,087	68,780	123,971
Glass	1,000,000	500,000	626,945	4,153	304,861	99,712	46,149	51,035	97,537

Southern California generates a large amount of biomass. This provides an opportunity for the REDC and potentially the CRRP to provide diversion opportunities to the Los Angeles County Waste District.

The area around the CRRP has a sizable amount of farmland, which could contribute greatly to the amount of biomass brought in. From Table 2, we see that about 0.7 million dry tons of leaves and grass and 1.8 million dry tons of other organics can be effectively utilized for conversion into energy per year. If the CRRP were able to harness all of the crop waste and agricultural waste from the surrounding communities and match that to the appropriate technology, over 300 MW of power could be generated. Obviously, the REDC does not require that volume of feedstocks for demonstra-

8 from 2005 research study done by the California Energy Commission

tion projects. But the type of companies that would utilize the REDC would be attracted by the variety and accessibility of these biomass sources.

Table 2 shows approximately 8 million dry tons of paper and cardboard wastes are produced a year, with around 4 million dry tons available to be utilized for reuse. Paper and cardboard are prime feedstocks for technologies that convert waste, such as gasification processes, anaerobic digestion (AD) systems and liquid fuel technologies.

The existing tire recycling plant at the CRRP, First Nation Recycling Inc. (FNRI) can supply shredded tires and tire fluff as feedstock to renewable companies. One company identified in Appendices converts tires in bio-crude oil.

7.2 MSW Resources in Proximity to CRRP

Los Angeles County Waste District has seven major landfills, the smallest of them being permitted to receive 500 tons of MSW per day. Puente Hill Landfill (PHL), at 5,500 tons per day is one of the largest. PHL's permit will expire by the end of 2013 and will not be renewed.

As shown in Table 3, the average total daily disposal of MSW to the seven in county major landfills was 20,795 tons in 2011. At 5500 tons per day, PHL accounts for 26.5% of the total MSW disposal into all of the major landfills in the Los Angeles County.

Table 3 - LA Waste District Tonnages for 1st and 2nd Quarter 2011

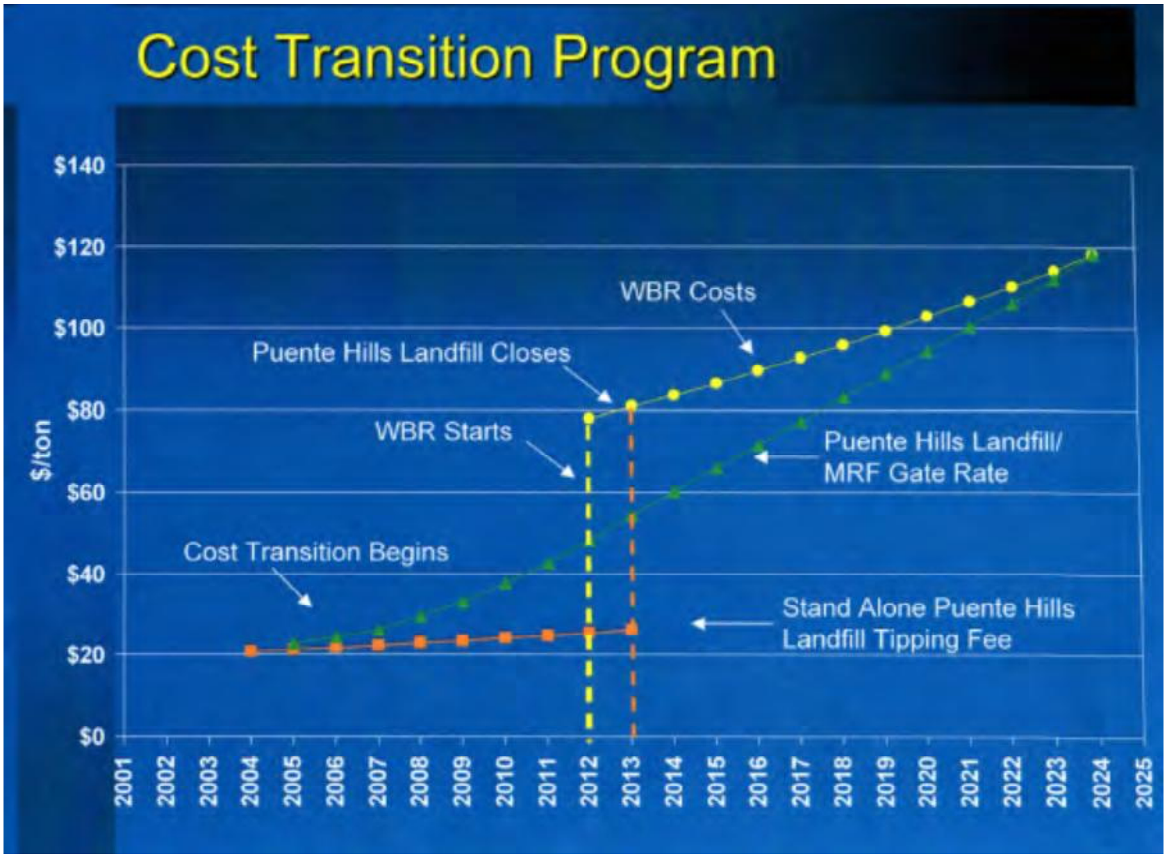
Item	Disposal (tons)	Average Daily Disposal (Based on six operating days)
In-Country Class III Landfills*	3,202,421	20,795
Transformation Facilities	244,920	1,590
Exports to Out-Of-Country Landfills**	985,131	6,397
Total Disposed	4,432,472	28,782

* Data from Solid Waste Disposal Summary Reports by Facilities, County of Los Angeles Department of Public Works, September 27, 2011. Assumes 154 operating days in first and second quarters 2011.
** Data from Solid Waste Disposal Reports from Ventura, Riverside, Orange, Kings, Kern, San Diego, and San Bernardino Counties.

The Los Angeles County Waste District is faced with the task of replacing the space where 26.5% of the daily MSW is being disposed. One proposed solution for this problem is called a Waste by Rail system, where waste that is taken to the Puente Hills Landfill is sorted and then sent by rail to the Mesquite Regional Landfill that is located 175 miles east of Los Angeles. Transporting 5,500 tons of MSW to a distant landfill is expensive and will have extensive environmental impacts.

Transportation costs are on the rise and the Los Angeles County Waste District could feel the pain of these hikes. In Figure 5, the Waste by Rail costs are compared with the current Puente Hills tipping fee as well as the MRF gate rate. It is shown that year-by-year the transportation costs that the Waste by Rail program will face will continually grow if alternative solutions are not developed.

Figure 5 - Estimated Landfill Costs for Los Angeles [9]



Landfilling, which is still employed at the overwhelming majority of global waste management facilities in developed nations, generally performs well in terms of throughput, public health, and safety. But many current and widespread waste management practices are mediocre or even poor performers in terms of energy efficiency and environmental performance. For instance, moderate to long haul distances, which generate substantial greenhouse gas emissions, followed by long-term storage in a landfill, releasing methane and other pollutants, commonly characterizes the conventional municipal solid waste chain.

The REDC at the CRRP is an attractive location to demonstrate technologies that could utilize MSW as feedstock. The REDC location would reduce transportation costs to more remote landfills and the MSW could be converted into renewable fuel and energy. Rather than move the MSW from the closed landfill to more remote landfills, the REDC and ultimately the CRRP would be a model for resource recovery parks that would produce renewable energy from this waste.

In the "Hauled Offsite" column, Table 4 shows how little of the waste that is taken to the PHL is being utilized for renewable energy technologies. The yearly total of around 1.8 million tons of MSW disposed can be theoretically turned into renewable energy. The REDC location at the CRRP could

9 From Los Angeles County Waste District Presentation by Janet Coke, Waste by Rail Manager

provide an easy and already accessible place to turn the MSW coming from the PHL into renewable energy. Diversion of the organic components coming from PHL and turning them into renewable energy avoids many of the problems associated with landfills and makes them profitable and renewable resources.

Table 4- Volume of Waste Disposed by Type from July 2011 to June 2012 in Puente Hills Landfill [10]

Month & Year	On-Site Diversion/Reuse (tons)				Hauled Offsite for Reuse/Recycling (tons)			Hauled Offsite	Disposal (tons)
	Dirt	Asphalt	Ash Crete	Green Waste Received	Green Waste Hauled Offsite	Metallic Discards	Elec-tronics	Tires	Refuse
Jul-11	63,116	23,095	16,808	24,329	0	8.78	0.00	10.51	125,275
Aug-11	60,902	10,624	18,365	23,895	0	19.80	0.00	0.00	131,120
Sep-11	35,431	8,241	17,091	22,367	0	27,73	0.00	12.56	124,158
Oct-11	38,461	6,782	17,202	21,364	0	1.51	0.00	0.00	128,333
Nov-11	75,712	11,193	15,679	21,658	0	1.89	0.00	29.25	118,594
Dec-11	105,759	17,731	16,798	25,618	0	1.51	0.00	0.00	125,404
Jan-12	123,149	13,098	15,564	22.049	0	7.68	0.00	14.00	114,036
Feb-12	121,856	14,235	15,904	18,971	0	1.47	0.00	0.00	168.840
Mar-12	144.938	20,177	16,984	20,347	0	8.65	0.00	0.00	185,749
Apr-12	142,429	12,037	9,472	21,377	0	8.96	0.00	32.47	187,941
May-12	171,527	14,576	13,166	22,887	0	6.32	0.00	12.02	199,479
Jun-12	158,062	24,179	16,780	21,232	0	21,42	0.00	0.00	195,294
Yearly Total	1,241,342	175,968	189,814	266,093	0	117.1	0.0	110.9	1,804,304

The vision of the REDC location at the CRRP is to increase the renewable options for waste streams (MSW, wood waste, and C&D waste) that are readily available in the area.

7.3 The Opportunity of Siting a MRF at the CRRP

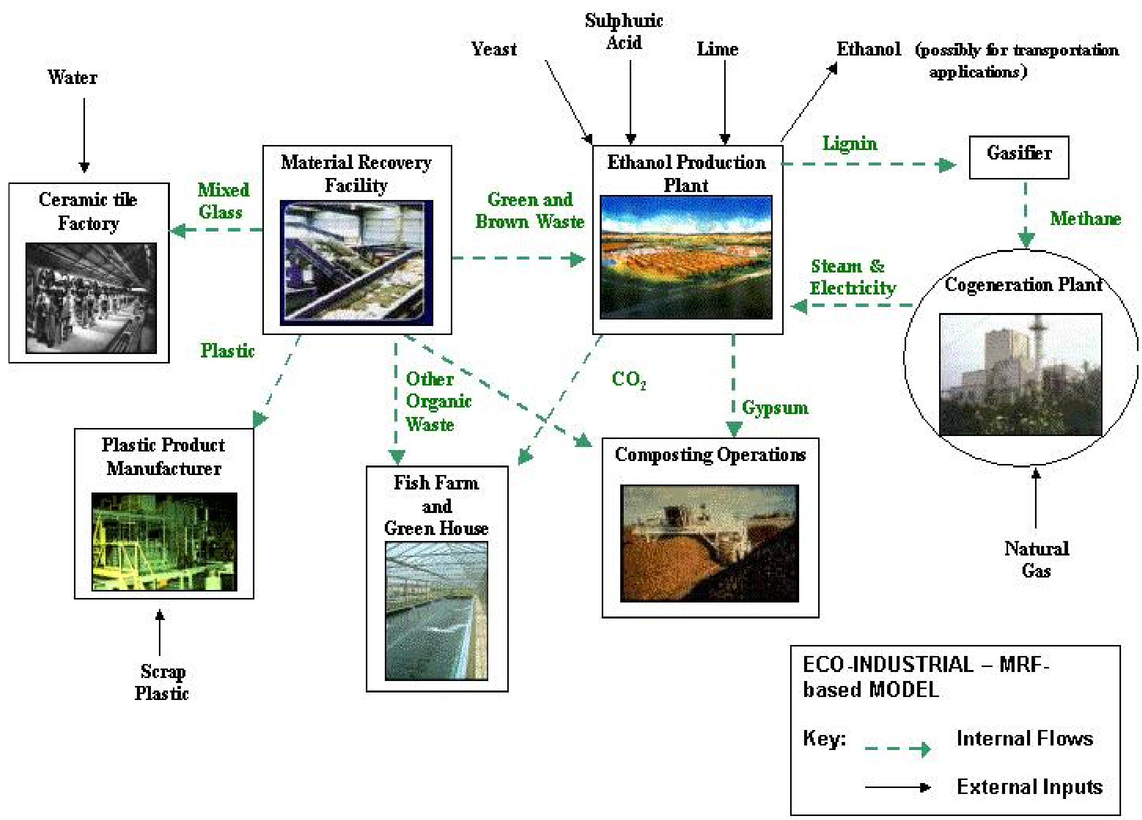
The first stage for any waste conversion technology, when MSW is the input, is separation into recyclables, non recyclable organics (food, cellulosic, plastics) and inorganic materials (sand, rock, etc.). The facility used to separate this waste is known as a MRF. MRFs accept both non-recyclable and recyclable commodities for processing into energy or other products or for sale for re-use or landfilling. Commodities can include fibers such as cardboard, newspaper and office paper, three colors of glass, plastics such as milk jugs and laundry detergent bottles (#2 HDPE), plastic soda bottles (#1 PETE), plus tin and aluminum cans. MRFs can be privately or publicly owned and operated; example being at the Puente Hills location which is owned by LA County.

The 1999 PEIS of the CRRP had a focal point on building a Material Recovery Facility (MRF) for supplying input materials for other resource recovery companies. This concept still makes sense today, considering the increasing costs of landfilling. The REDC would also benefit from a MRF being located at the CRRP because of the readable available feedstock being generated for renewable companies.

10 Puente Hills Landfill Annual Report (see Appendix 2)

The materials recovery process is largely a vertical process, involving the collection, sorting, and processing of organics and recyclable materials. The approach of adding an advanced MRF at the CRRP supports the model being created of green technologies anchored around the notion of discarded materials and byproducts being turned into viable new products and green energy feedstock materials. This will attract other material processors, service providers and manufacturing companies that operate or utilize byproducts of the resource recovery process. The type of tenant companies associated with a material recovery facility is displayed in Figure 6.

Figure 6 - Basic MRF Outputs



Assuming a MRF facility could be located at the CRRP, it would generate a variety of renewable feedstocks for the REDC and other technology companies that convert these materials to power or fuels. The CRRP already has a 47 MW green waste to electricity facility that could utilize the wood wastes generated at the MRF. Major opportunities exist for the REDC companies in conversion of these separated organic materials into a liquid fuel.

8.0 Preliminary Choices

This section will provide the list of typical renewable companies that the Team proposes would be good candidates for operation at the REDC or alternatively directly at the CRRP. The criteria used to evaluate individual company included: a) the company being well capitalized outside federal contracts/grants or tribal funding, b) technology readiness level, c) potential for renewable energy or fuel production, d) space requirements (small footprint), e) the ability to create local jobs, f) the availability of the feedstock required for sustainable operation of the facility, g) the potential to meet the eco industrial park goals of the CRRP, and h) synergy with other companies located at the REDC or the CRRP.

Table 5 is a measurement system (rubric) developed by the Department on Energy that categorizes a technology's readiness level (TRL) based on specific factors. This rubric will be used to judge the status of the technology for each company being considered for the REDC.

Table 5- DOE Technology Readiness Level Definitions

Technology Readiness Level	Description
TRL 1.	Scientific research begins translation to applied R&D - Lowest level of technology readiness. Scientific research begins to be translated into applied research and development. Examples might include paper studies of a technology's basic properties.
TRL 2.	Invention begins - Once basic principles are observed, practical applications can be invented. Applications are speculative and there may be no proof or detailed analysis to support the assumptions. Examples are limited to analytic studies.
TRL 3.	Active R&D is initiated - Active research and development is initiated. This includes analytical studies and laboratory studies to physically validate analytical predictions of separate elements of the technology. Examples include components that are not yet integrated or representative.
TRL 4.	Basic technological components are integrated - Basic technological components are integrated to establish that the pieces will work together.
TRL 5.	Fidelity of breadboard technology improves significantly - The basic technological components are integrated with reasonably realistic supporting elements so it can be tested in a simulated environment. Examples include "high fidelity" laboratory integration of components.
TRL 6.	Model/prototype is tested in relevant environment - Representative model or prototype system, which is well beyond that of TRL 5, is tested in a relevant environment. Represents a major step up in a technology's demonstrated readiness. Examples include testing a prototype in a high-fidelity laboratory environment or in simulated operational environment.
TRL 7.	Prototype near or at planned operational system - Represents a major step up from TRL 6, requiring demonstration of an actual system prototype in an operational environment.
TRL 8.	Technology is proven to work - Actual technology completed and qualified through test and demonstration.
TRL 9.	Actual application of technology is in its final form - Technology proven through successful operations.

Utilizing the DOE TRL definitions against the companies that potentially could be a fit for the REDC, the team developed the listing of the following companies (Table 6) as examples. Appropriate candidates for the REDC are between TRL 6 and 8. Companies with TRLs below 6 are not considered ready for demonstration at the REDC. The RETC in Sacramento is designed to assist companies with TRLs between 3 and 6. Companies that are at the TRL level of 9 would not be interested in the REDC but may be candidates for the CRRP as tenants.

Table 6- Examples of Targeted Companies for the REDC/CRRP

Company	Approach	Feedstock and Output Volume per day	Technology Readiness Level
OEC	MRF – separation of recyclable materials	2000 tons per day	TRL 8.
Omega Oil with WRT Indio and US Fuel Oils	Used Oil Recovery	7500 gallons per day	TRL 9.
Concord Blue	MSW gasification to Electrical Power	400 tons per day	TRL 8.
BioNitrogen	Farm Biomass Gasification to UREA fertilizer	Feedstock: Agricultural Waste 340 tons per day	TRL 8.
Green Distillation Technologies (GDT)	Tire Pyrolysis and Distillation to Carbon, Oil, and Steel	Feed Stock: Tires, output 21 tons of carbon per year 8 tons of steel per day 18 tons of oil per day	TRL 8.
CORE BioFuel Inc.	Biomass Gasification to Green Gasoline, Water, and Electricity	Feedstock: Wood, output 54,800 liters of water per day 183,000 liters of green gasoline per day	TRL 8.
Envergent Technologies	Biomass Pyrolysis to Green Fuel	137,000 gallons per year	TRL 8.

See Appendices One thru Six for more detailed information on the above companies as well as other companies that were identified during this study. Since this is a Baseline Assessment not all the companies on the listing were contacted. Additionally many unidentified companies will move from pilot testing stage to needing the REDC by the time the REDC would be constructed.

9.0 Setting Priorities

The CRRP is a unique but underdeveloped waste conversion location, although it was designed around the concept of the eco industrial park model. Some of the elements of such a park are in place, such as the 47 MW wood waste power plant, but the park has stalled in attracting any other renewable energy companies.

The CBMI and its subcontractor, Technikon Inc., have been reviewing options for the addition of new tenant companies at the CRRP. The concept of expanding on the Sacramento based Renewable Energy Testing Center (RETC) to the CRRP is considered one of the best options, and therefore the top priority for renewable energy at the CRRP. The expansion of the RETC model to larger, near commercial demonstration projects would supply a low cost location for such projects and evolve tenants for the CRRP when the companies need a commercial location.

9.1 Ongoing Activities

The goal of the REDC at the CRRP would be to add renewable energy technologies to the CRRP both to create clean tech jobs for the local community, have a positive impact on the environment, validate renewable energy technologies, and provide educational opportunities in green technologies. To achieve these goals some new approaches and infrastructure changes will be necessary to make the park attractive for the REDC and renewable companies. Many activities are ongoing or being planned that will make the CRRP attractive to future tenants and the REDC pending future funding. These activities listed below, are all supportive of the next phase of the project leading to the construction of the REDC.

1. The CBMI has contracted with the company that completed the original 1999 PEIS, Reese Chambers, to update the PEIS. This will require coordination with the Bureau of Indian Affairs (BIA) and other agencies,
2. The CBMI has been developing agreements with the South Coast Air Quality Management District and the California Department of Toxic Substances Control on monitoring and coordinating Park environmental issues,
3. The CBMI and its contractor, Technikon, developed an environmental health and safety management program (based on ISO 14000 and OSHAS 18000) for tenant companies on the Park to assure compliance with applicable regulations and requirements (CBMI, EPA and other rules as appropriate). This program will require training with tenant groups and the CBMI Environmental Department,
4. The Team has been contacting renewable energy companies about the advantages of locating a facility at the CRRP and has identified a few that meet the criteria of being ready for installation and contributing to the long range vision of the Park.

Prior to and as part of this grant the Team also has been reviewing the state of development of renewable energy companies. This information is presented in Appendix 1 of this report. From these contacts with technology companies it became obvious that there would be two categories of companies that are interested in locating at the REDC.

1. The first group is focused on recycling operations and would be complementary to the REDC. They tend to be the kind of companies that could supply a feedstock to a renewable technology they would be an important addition to the REDC. As an example, a company that would operate a municipal solid waste (MSW) recycling operation (municipal recycling facility or MRF) would be a plus in attracting a company interested in organic waste steams for gasification.

2. The second group that is targeted includes biomass or waste conversion companies that are looking for a location for their technology, either for a first demonstration plant or as a full scale operation. This group of companies is very interested in the REDC concept and many believe that if the center existed that they would be a candidate for the services and benefits that CRRP and REDC can offer. In the case of these emerging renewable technology companies, they are usually underfunded and the REDC facility would be a low cost solution for a demonstration site. The ultimate goal would be to get them graduated from the REDC and make them a permanent tenant of the CRRP.

9.2 Priorities

Since the establishment of the REDC was a given direction in the grant award, the priority listing is focused on items needed to achieve success. The priorities for the future development of the REDC are listed below and explained as individual subtasks.

1. Outreach to and input by local community leaders and concerned citizens
2. Design REDC
3. Finding Partners
    a. Industrial
    b. Government
    c. Educational Institutions
4. Establish Funding
5. Construct REDC
6. Qualify technology companies to install equipment at the REDC

9.2.1 Outreach to and input by local community

A major priority for the REDC would be in obtaining community involvement in the project. It is important to get the local educational institutions, community leaders and neighbors involved in the concept of the REDC. They need to understand the mission of the facility is to advance green technologies, create jobs and supply educational opportunities for the area. In the second phase of this grant it is planned to involve University of California Riverside, and College of the Desert in discussion on how to utilize the REDC in educational and vocational training programs.

The CBMI is very involved in educating the community, community leaders and elected officials about the goals and plans for the CRRP, and this activity will continue in the future.

9.2.2- Design of the REDC

The REDC will be designed to supply selected renewable energy companies a location, offices, laboratories and permitting, which would reduce the companies' infrastructure costs and give them a stepping stone location to expand into a full scale production facility. Design of the REDC will allow for tenants to be added either in the main building or to adjacent concrete pad areas. The initial construction will be a 40,000 square-foot building with about two acres of paved yard space. The proposed building will include the following: (1) a clear span with minimum ceiling height of 30 feet; (2) six to eight exterior loading docks; (3) an evaporative air ventilation system for the entire building; and (4) a 10,000 square foot area for office, lab, common area and meeting room with a complete HVAC system. This would require 440-voltage, three-phase electrical service, natural gas, central dust collection, and a small waste water treatment plant. In the second phase of this project, detailed engineering drawings and cost estimates for building the REDC will be supplied. Resources to operate the REDC also will be specified in that analysis. A rough estimate is that the

REDC would cost $20 million to build and about $2 million per year to operate. This cost estimate includes a new 40,000 sq. ft. building at $100 per sq. ft., including machine shop, laboratories, instruments, offices and classrooms. Additionally the site will have a 2 acre concrete slab area for future tenant equipment installation, and utilities hook ups for plug and play installation.

9.2.3 Finding Partners

The REDC is going to need to have strategic partners in the energy arena to be a sustainable project. Once built the ability to find partners in projects such as the California Energy Commission (CEC), the Electric Power Research Institute (EPRI), Chevron, the American Council of Renewable Energy (ACORE), will be critical. The Team has been in contact with all these organizations and has their support for a project like the REDC, especially on Indian Lands. The opportunity of reducing costs for both companies and in government grants by having a large proving grounds is attractive to all potential partners.

9.2.4 Establishing Funding

Once the engineering design of the REDC is completed, which is a currently unfunded phase of this grant, the Team will have a detailed estimate of the funding required to launch project. The Team has begun identifying sources that could fund the construction and operation of the REDC. Some of the early concepts include:

- DOE – Tribal Energy Program Grants
- Other Federal Grants
- State Grants – such as CEC's new EPIC program
- Congressional funding
- Private Funding, such as Endowments
- Electric Power Research Institute (EPRI), which is looking for a waste to energy test center

It is planned that each REDC test company would pay the cost of having its equipment installed and pay a monthly service charge for use of the facility. REDC staffing costs would be built into the overhead of the operation and partially or fully paid for by testing companies.

The major benefit for the CBMI would be the successful tenants that would decide to locate permanently at the CRRP. After completing a testing regime at the REDC the test company and the CBMI would both be more confident that the commercial facility would be successful. Potentially some of the income from the new tenants could be utilized to support the next group of testing companies utilizing the REDC, making the program sustainable without government funding.

9.2.5 Construction of the REDC

Construction of the REDC will follow the designs completed during the design phase and approved by Team. Local engineering and construction contractors will be utilized as feasible, to retain work for the community. The construction will include sites designed for easy expansion. Demonstration projects will each have unique requirements that will have to be determined at the time of their application and modifications to the REDC will be at the company's expense. Once a company graduates from demonstration program, the site will be cleared and made ready for the next technology.

9.2.6 Qualify Technology Companies to locate Equipment at the REDC

The REDC will need to develop a standardized application manual for companies to apply to locate at the facility. The Team identified the type of companies that most likely fit the REDC goals but the team has not actively marketed the concept. A Matrix of qualities will be developed for acceptance into program that will include items such as shown in Table 7:

Table 7 – Qualification Questionnaire and Ranking

Item	Response	Ranking
Company Name & Location		
Technology Description		
Status of Pilot Technology		
TRL Level Assessment		
Companies Financial Assessment		
Environmental Data		
Safety Analysis		
Testing Plan		
Feedstock requirement		
Space Requirements		
Services Required; power, water, gas, etc.		

10.0 Conclusion and Recommendations

The Renewable Energy Demonstration Center will be a one of a kind facility that fills the mission of advancing renewable energy and fuels technologies by providing a lower cost solution for technology demonstration. Having the REDC located on Indian Lands is additionally unique and demonstrates that the CBMI are supportive of improving the environment, creating local jobs and reducing the country's dependence on foreign resources.

This study has identified that there is more than adequate biomass and other waste materials (Supply) near the CRRP to support the REDC. Potential tenant companies interested in wastes materials will have no issues locating these feedstocks.

The team has reviewed a variety of companies that are in the pilot stage or in the near commercial stages of testing. These companies are listed in Appendices One thru Six. Most of these companies would have been very interested in the REDC as a location for demonstration projects (Demand).

The priorities for completion of this project are based on getting national and local groups involved in the concept. Once the REDC concept is closer to finalization such as the design phase in the unfunded part of this grant, the marketing of the proposal will start. Funding sources will need to be identified to make the vision of adding the REDC to the existing Cabazon Resource Recovery Park a reality.

The CRRP is the ideal location for the first REDC to be constructed, because the CBMI had the vision 25 years ago that establish their eco industrial park. The CBMI believe that the REDC is a first step in adding alternative revenue sources to other Indian Nations.

Recommendation: Immediately start a marketing effort to sell the concept of the Renewable Energy Demonstration Center at the CRRP. The project will need to be marketed to the local community, universities and companies. The tribe will also need to find state and federal supporters for the project to make it a reality.

11.0 Lessons Learned

The greater Riverside and Los Angeles counties area population density represent one of the best biomass and organic supply sources on the west coast of the United States.

Los Angeles County Department of Public Works has a serious problem with the closure of the Puente Hills Landfill at the end of 2013. This is going to require added costs to the County and the Public in finding replacements landfill space. Waste to Energy projects would be a solution to this issue.

The 590 acre Cabazon Resource Recovery Park is an ideal location to process these materials into renewable energy power or fuel.

Opportunities and technologies exist to turn these waste products that otherwise destined to be land filled, in renewable energy or fuel. But in many cases the technology for renewable energy conversion is still in the early stage development phase. Many companies have pilot demonstration plants but our struggling to find financing and location for first demonstration plants.

The concept of a having a Renewable Energy Demonstration Center located at the CRRP is very attractive to technologies companies because of reduced facility costs, less permitting issues and feedstock availability.

Page Intentionally Blank

Appendices

These appendices were written to summarize the technology approach of commercial companies involved in conversion of biomass and waste to energy. Since the Cabazon Resource Recovery Park (CRRP) is an existing operation, the focus of the technologies being reviewed is to complement the mission of the park. Most of the technologies being reviewed utilize biomass or waste to generate either a) liquid fuel, b) power and heat, c) recoverable resource that can be recycled and d) green chemicals. Many of technologies utilize thermo-chemical conversion (gasification) as the front end of the process.

This document is meant to be guidance only and no scientific data are supplied that aren't available on websites or news releases. As such many of the claims for the technologies status have not been independently verified.

Technologies are placed into one of six categories each organized in Appendices One thru Six:

Integrated gasification and fuel processes (companies have pilot or production plants)

Pyrolysis catalytic reforming processes (bio-oil reforming)

Other Chemical Conversion processes (alternative approaches utilizing syngas)

Syngas to Fuel only technology companies (require syngas or industrial gas source)

Electrical Power Generation from biomass or waste

Waste and Biomass recycling companies

The Team working on this grant is in discussion with most of these companies and will be down selecting to companies whose technologies are the most advanced and show interest at being located at the CRRP or interest in utilizing the Renewable Energy Demonstration Center (REDC) services. See the full report for more information on the CRRP and the REDC.

Page Intentionally Blank

Appendix 1: Integrated Gasification and Fuel Processes

Fulcrum Bioenergy, Inc. – www.fulcrum-bioenergy.com - Pleasanton, CA

Fulcrum Bioenergy system is focused on the Biofuels market and uses a Gasifier System with a downdraft gasifier followed by the InEnTec purchased PEM (Plasma Enhanced Melter) and Ther-Thermal Residence Chamber (TRC). The company focuses only on the conversion of municipal solid waste (MSW) as a feedstock to ethanol.

Fulcrum Pilot Plant

Fulcrum is currently building a plant, Sierra BioFuels, in McCarran, Nevada, with an expected online date of 2014. The company states it will provide 10 million gallons of ethanol per year from 145,000 tons of sorted MSW from Waste Management and Waste Connections.

On August 6, 2012, Fulcrum BioEnergy, Inc. announced that the U.S. Department of Agriculture ("USDA") has awarded Fulcrum's Sierra BioFuels Plant a conditional commitment for a $105 million loan guarantee. With the loan guarantee finalized, the company will secure bank financing, which when combined with private equity capital provided by Fulcrum, will fully fund construction of the municipal solid waste to renewable transportation fuel facility. There is a final 112-page US DOE Energy Information Administration report, dated June 2011, available on the evaluation for the Loan Guarantee for this Plant, which is not a Grant. These loans were a part of the Energy Policy Act 2005 (Energy Act) Loan Guarantee Program for innovative renewable energy programs.

The Sierra BioFuels Plant will be located approximately 20 miles east of Reno, Nevada in Storey County. The plant will produce 10 million gallons of ethanol annually as well as renewable energy, which seems to be consumed by the plant and not sold. The company states that it would create 53 full-time and more than 430 engineering and construction jobs. Fulcrum has secured long-term MSW feedstock contracts and an ethanol off-take contract for the Sierra BioFuels Plant. The company is in the final stages of completing engineering work on the project and will proceed with procurement and construction when the loan guarantee is finalized and the financing is secured.

The plant requires use of all 16.8 acres of the available land, and requires 3 separate lines in parallel, each including a gasifier + PEM + TRC. The design cannot process commercial, industrial or hazardous waste. The Plant requires 16 MW of parasitic load to operate. The Return on Investment (ROI) on a 10m gal per year ethanol plant; at 90 to 100 gallons per ton, versus a diesel plant, at 40 to 50 gallons per ton, needs to be reviewed. Fulcrum's technology platform utilizes its proprietary catalytic alcohol synthesis process.

Plasma2Energy – www.plasma2energy.com - Edinburg, TX

This is a subsidiary of Plasma Gasification Corporation in Edinburg Texas. Its Pilot Plant in Monterrey Mexico has been operating for 3 years at a production capacity of 10 tons per day (TPD).

The technology uses microwave induced plasma gasification, meaning it uses microwave irradiation with superheated steam to produce the plasma cloud, versus plasma torches, for this process. There is a video of the ABA Microwave Plasma Gasification Process (http://vimeo.com/27772698) that explains the system but in summary:

Illustration of Plasma2Energy Gasifier

The major component is a large vertical gasifier called the Thermal Reduction Unit (TRU) with 2 separate gasifier zones at the top and bottom and the central exhaust chamber in the middle. The pre-sorted MSW-only waste is inserted into the top zone. It is them bombarded with microwaves from what they call Plasmatron Array Rings. There are 2 rings with 4 Plasmatron "guns" that start and sustain the reaction. Microwaves cause molecular movement and friction that causes ionization of the carbonic matter. This causes molecular disassociation, but when the molecules recombine, they form not just H + CO + CO2 but also long chain hydrocarbons. The syngas rises and is then sent down to the bottom through a 2nd gasifier zone where 2 more rings of 4 Plasmatron guns reprocess the gas. It then flows to the central exhaust chamber where another single set of 4 Plasmatron guns processes it again. It is a different process than plasma with torches. The company is negotiating with McAllen Texas for a first commercial plant site.

The website claims that the gas is then purified and some of it can be re-fed into through the reactor to achieve a complete transformation into carbon monoxide (CO) and hydrogen (H2). The synthesis gas formed is H2 (50-54%) + CO (20%) +some hydrocarbons. The company claims it constitutes an excellent substitute for natural gas for power generation using gas or steam turbines. The company claims it can generate at least 2.2 MW of electricity per metric ton of processed feedstock. In the October 2011 Biofuels Digest article it is stated that Plasma2Energy is a modular system with the basic full scale unit handling up to 300 tons of biomass per day (there are also 10-150 ton modules available). The 300 ton per day plant produces 15 million gallons of ethanol and 2 million gallons of diesel fuel per year, and costs $10.5 million to operate per year (inclusive of capital expenditure, amortized over 20 years). The company claims a $32.60 per barrel of oil equivalent cost.

Solena Fuels – www.solenafuels.com – Washington DC

Solena Fuels' proprietary "biomass-to-liquids" (BTL) solution encompasses three major processing blocks. The first is Solena's patented high temperature, single phase gasification technology, which has the ability to process heterogeneous waste feedstock (such as MSW) with what it claims has the highest efficiencies in the industry. This process produces a clean, bio-based synthetic gas that is then conditioned and fed into a Fischer-Tropsch (FT) reactor. This second FT processing block transforms the Syngas into a renewable form of hydrocarbons such as light FT liquids and FT wax. The third block is the upgrading of the light FT liquids and FT wax into certified, sustainable liquid fuels such as jet and marine diesel. The design also utilizes heat and tail gases to produce electricity and sustainably operate the facility while importing no electricity. Solena Fuels' BTL design can be optimized for any combination of jet, diesel (road or marine) and naphtha.

Solena Group is developing projects in Australia and the UK, in cooperation with British Airways and Qantas Airlines. The company also announced in June 2012 a new project with SAS in Sweden. It claims it could build a project in every major airport hub in the world, using municipal solid waste and other urban and agricultural residues.

Solena is focusing on high end jet fuel and military fuels. Dr. Robert T. Do, President & CEO of Solena Fuels Corporation, was recently invited by the American Council On Renewable Energy (ACORE)'s President and CEO Vice-Admiral Dennis V. McGinn, to Co-chair the organization's Transportation Initiative.

Dr. Do is the inventor of this proprietary technology. In 1995, Dr. Do partnered with Dr. Salvador Camacho, the NASA plasma scientist and "father of the plasma technology", to found Global Plasma Systems for the commercialization of plasma processes. Dr. Do then put in place an organization with a team of technical experts and business development executives in conjunction with venture capital investment to create Solena, Inc. for the development of green bioenergy facilities using Solena Plasma Gasification Vitrification (SPGV) technology in 2001. Solena Fuels was subsequently created to focus on the commercialization of the core technology in the liquid fuels arena. Dr. Do, with graduate degrees in Physics and Medicine from Georgetown University, is the lead author and inventor of the current SPGV technology patent filed and issued worldwide.

Vice President Mr. Motycka joined Solena in 2006 and is responsible for developing BTL plants, and the related technologies, processes and operations. He is also responsible for the engineering, procurement and construction of Solena's patented plasma gasification island that is integrated with biomass to liquids and/or power plants. Prior to working with Solena, Mr. Motycka worked at the Institute of Plasma Physics, Academy of Sciences of the Czech Republic, where he modeled plasma torches' jet instabilities. He also worked for a US-based company, SurfX Technologies, where he developed plasma reactors, and is co-inventor of a patent filed to the United States Patent Office.

ThermoChem Recovery International (TRI) - www.tri-inc.net - (2) Wisconsin sites

After a rigorous testing process, Department of Energy project partners at (TRI) have validated a process that converts wood waste and forest residue into clean, renewable fuel. Pilot validation is a key milestone for biofuels companies like TRI. With critical engineering data in hand and the testing phase complete, TRI is moving toward full-scale commercialization of this technology.

TRI Plant

With the support of Department of Energy funding, TRI has done substantial testing of a thermal gasification and gas-to-liquids process at its pilot plant in Durham, North Carolina. Through its operations, TRI converted several hundred tons of 100% woody biomass feedstock into diesel fuel and paraffin waxes. TRI has collected over 1,000 hours of operational data that validates the process, while meeting or exceeding all of their operational and product yield targets.

They claim that this achievement will directly benefit two biorefinery projects in Wisconsin that are cost-shared by the DOE: 1) "Project Independence," in Wisconsin Rapids and, 2) 9,000,000 gallons per year) in Park Falls. TRI's data will help inform final engineering design of its future biorefineries. The gasification and gas-to-liquids technology will be integrated into their its pulp and paper mills to produce clean, renewable, marketable diesel fuel and paraffin waxes, and will also provide additional renewable energy by supplying steam and hot water to the co-located paper mill.

Per DOE, TRI's thousand hours of runtime is key to the success of the New Page and Flambeau projects, and a notable milestone on the way to a clean energy economy. It's an important achievement in the Department's portfolio of efforts to deploy advanced bioenergy and bioproducts that replace foreign oil, reduce the greenhouse gas impacts of transportation fuels, and open up new economic opportunities for rural America.www.tri-inc.net

TRI developed the gasifier and steam reforming system. The Fischer-Tropsch (FT) system was supplied by Emerging Fuels Technology (EFT) of Tulsa, OK, founded in 2008 by Kenneth Agee with partners Dr. Kym Arcuri and Dr. Rafael Espinoza. EFT offers a broad range of catalyst development, catalyst testing, analytical services, and engineering and consulting services. These services are generally associated with EFT's core competency in the areas of Fischer-Tropsch and related synthesis gas and hydroprocessing chemistry. www.emfuelstech.com

Specifically, EFT is providing engineering, mass and energy integration, FT catalyst, procurement, construction, analysis, and operations support for the Wisconsin demonstration projects. The resources at EFT can be used to develop catalyst systems, evaluate their performance in a laboratory reactor system, analyze product yields, convert products to transportation fuels and develop an engineering design for a final commercial plant.

*Rentech / Clearfuels – **www.rentechinc.com** - Commerce City, Colorado Plant*

Rentech Plant

Built with funds from the American Recovery and Reinvestment Act, the pilot-scale facility converts wood waste, agricultural residue, and bagasse—the unused portion of sugarcane-- into renewable diesel and jet fuel. ClearFuels has developed a process to thermo-chemically convert a variety of feedstock types—utilizing a combination of heat and chemicals to produce fuel. The "drop-in" biofuels produced at the facility will provide a direct replacement to petroleum-based diesel and jet fuel, without any need for changes to existing fuel distribution networks or engines. That flexibility will allow commercial and military planes to transition to a clean, domestic fuel source that not only reduces their environmental impact but also boosts national security by providing them with a domestic alternative supply. In early 2013 Rentech has shut down their testing center and fate of renewable energy effort is not resolved.

This project was built at pilot scale, processing 20 tons of feedstock per day, which is an important step in scaling up the technology. Estimated production is 151,000 gallons per year of biofuel. The facility will lead to a final engineering design that can potentially be duplicated, which could result in multiple, large commercial-scale projects throughout the southeastern United States and Hawaii – creating jobs and fostering energy independence across the nation. The biorefinery was expected to begin producing certified renewable fuels, but that is on hold. .

Rentech has developed its own FT system. It has purchased interest in two gasifier companies. Clearfuels is focused on wood waste. The most critical component of the Rentech Process is its proprietary iron-based Rentech catalyst. Rentech is the only United States based company that uses an iron-based catalyst to produce synthetic transportation fuels and chemicals.

SynTerra Energy – www.synterraenergy.com - McClellan Park, CA & Toledo Ohio

The SynTerra Energy team, in collaboration with partner organization (REII), was awarded a $25 million US DOE grant that began in 2010 to further demonstrate and commercialize the Syntrex™ technologies. SynTerra is a JV partnership of Pacific Renewable Fuels, Sacramento, CA [pilot system at the Renewable Energy Testing Center (RETC)] and Red Lion Bio-Energy of Toledo, Ohio.

SynTerra Energy's Syntrex™ Commercial Facility in Toledo, Ohio

RETC has worked with PRF on the Pilot FT system during construction and testing. PRF is a partner of SyntTerra is only focused on working with Red Lion and has not shown interest in other gasification partners. The 25 tpd Toledo facility is in start-up mode as of fall 2012.

Following six years of development the Syntrex™,Synterra claims that the platform is ready for widespread commercial deployment. SynTerra Energy's Syntrex™ platform was designed specifically to address the distributed fuel production market by meeting key requirements:

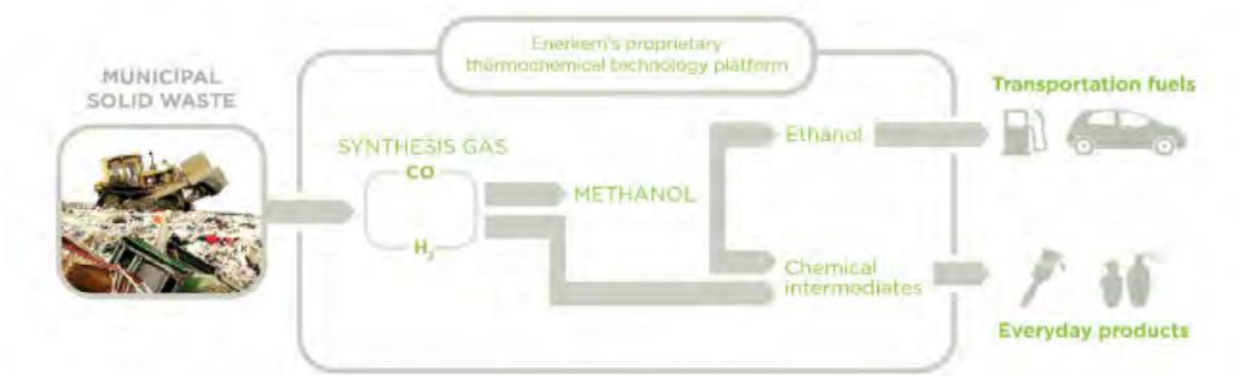
- A solution scaled for varied and distributed feedstock
- "Large scale" economics at small scale
- Infrastructure compatible, hydrocarbon fuels
- Energy efficient, simple operation with excellent environmental profile

The "Syntrex™ Reforming Process" uses a proprietary reforming catalyst in the presence of heat, pressure, and steam to efficiently convert almost any carbonaceous resource into high-quality syngas that contains primarily hydrogen (H2) and carbon monoxide (CO). Syngas is produced directly with the ideal stoichiometric ratio of hydrogen and carbon monoxide and does not required extensive conditioning, compared to other systems, which reduces both plant capital and operating costs. Feedstocks that are ideal for the Syntrex™ Reforming Process include natural gas, waste CO2, natural gas liquids, municipal solid waste and biomass.

The process involves steam reformation with pyrolysis (Red Lion system) that is followed by a Fischer Tropsch process (PRF system) that converts the syngas with a catalyst designed by SynTerra into synthetic diesel. The process, known as the Syntrex process, creates a syngas with a low volume of contaminants, which helps lower the cost of downstream purification, according to the company. The synthetic diesel contains zero sulfur and has a 50 percent higher cetane level compared to conventional diesel fuel, all with a 50 percent greenhouse gas reduction compared to diesel. Nearly one ton of dry biomass can be converted to 54 gallons of renewable diesel. Because the early research and development efforts utilized rice hulls and rice straw, the future plants will focus on using those same feedstocks, but the process can use nearly any waste biomass.

Enerkem – www.enerkem.com - Montreal, Canada

Enerkem develops biofuels and chemicals from waste. With its proprietary thermochemical technology, Enerkem converts abundantly available municipal solid waste (mixed textiles, plastics, fibers, wood and other non-recyclable waste materials) into chemical-grade syngas, and then methanol, ethanol and other chemical intermediates that form everyday products. By using waste instead of fossil fuels, Enerkem can address the growing demand for renewable energy sources and chemicals, while reducing landfill volumes and greenhouse gas emissions. Headquartered in Montreal, Canada, the company currently operates both a pilot and a commercial demonstration facility in Québec, has its first waste-to-biofuels full-scale commercial plant under construction in Edmonton, Alberta, and is developing several similar facilities in the U.S. and Canada that will convert municipal solid waste into biofuels and chemicals.



Enerkem's proprietary thermochemical process converts waste into biofuels and chemicals.

Westbury, Quebec (Canada)

Type: Commercial Demonstration
Status: Commissioned since 2009
Feedstock: Used electricity poles
Products: Syngas, Biomethanol (Cellulosic Ethanol in the future)
Capacity: 5 million litres /1.3 million gallons per year
Read more >

Edmonton, Alberta (Canada)

Type: Commercial
Status: Under construction
Feedstock: Post-sorted Municipal Solid Waste
Planned Products: Methanol, Ethanol
Expected Capacity: 38 million litres /10 million gallons per year
Read more >

Pontotoc, Mississippi (United States)

Type: Commercial
Status: Under development
Feedstock: Post-sorted municipal solid waste and wood residues
Planned Products: Ethanol
Expected Capacity: 38 million litres/ 10 million gallons per year
Read more >

Varennes, Québec (Canada)

Type: Commercial
Status: Under development
Feedstock: Sorted industrial, commercial and institutional waste
Planned Product: Cellulosic ethanol
Expected Capacity: 38 million litres/ 10 million gallons per year
Read more >

Enerkem's Westbury facility is the company's first commercial biofuels and biochemicals facility. This demonstration-scale facility seeks to be the world's first ethanol and biochemicals plant to use negative-cost and unconventional materials - treated wood from used electricity poles as a feedstock.

Operations started in 2009 with the production of conditioned syngas. Methanol production has been underway at the Westbury facility since 2011 and cellulosic ethanol since spring 2012.

The plant, located in a rural area near a sawmill, recycles used electricity and telephone poles. Enerkem employs the non-usable portion of these poles and creates value from it.

Pilot FT Reactor at Sherbrooke

According to Enerkem, there are in excess of 500 municipalities in the United States that have sufficient MSW available to feasibly install an Enerkem solution, and the company has received "dozens of calls" from municipalities looking to investigate construction of an Enerkem facility. Depending on the range of MSW available per facility, the potential production capacity of these systems as a whole would be between 4.7 and 19 billion gallons of ethanol capacity. At the upper limit, that's 90 percent of the amount of advanced biofuels required under the Renewable Fuel Standard by 2022.

Refuse-derived fuel (RDF) is a fuel produced by shredding and dehydrating solid waste (MSW) with a Waste converter technology. RDF consists largely of combustible components of municipal waste such as plastics and biodegradable waste.

Enerkem is processing RDF – the municipality must "manufacture" its RDF to the plant's spec – for example, a 20% cap on moisture and 15% on inert materials such as glass. The RDF is fed into the Enerkem facility on a continuous basis by a screw process.

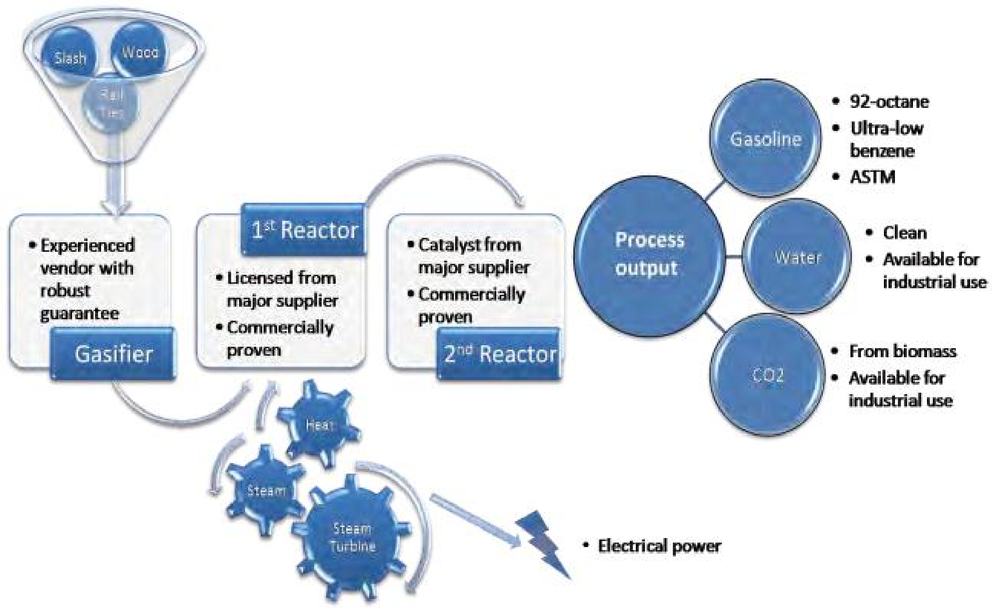
The Enerkem approach has been to develop, for the first commercial plant, a complete supply chain based on pre-assembled modules, shipped on skids, with local operations limited to site prep and pipefitting. The design package is based on 10 million gallon modules – so that the plant can be expanded on a modular basis to produce more product where more MSW is available. According to the company, it has been designed as a system for rapid scale-up.

In the case of the Edmonton project, cement is being poured and site prep will be completed this year, with pipefitters on site in mid 2013 to complete the plant.

Core Bio Fuels Inc. – www.corebiofuels.com - A Canadian Company – testing in Houston, TX

CORE BioFuels Inc. was formed in 2008 with the purpose of commercializing its biomass-to-gasoline process, a patent-pending variant of ExxonMobil's methanol-to-gasoline (MTG) process. CORE claim it has modified and improved the process, bypassing the production of methanol, to produce engine-ready Green Gasoline™. CORE's process is scalable, efficient, and cost effective. CORE's process uses commercial equipment and is *insurable and bankable.*

CORE's biomass-to-gasoline process was developed in response to the burgeoning demand for renewable alternatives to petroleum based vehicle fuels. It is a highly efficient process that uses proven, commercially available equipment combined in a novel, efficient method to produce a unique product from biomass – Green Gasoline™.



Core BioFuels Process Flow Diagram

Core's Biomass-to-Gasoline process is reportedly environmentally benign and is designed to use biomass feedstock, so facilities can be located on land zoned as Industrial (Subclass Chemical Manufacturing) where renewable, sustainably harvestable, cost effective supplies of biomass are available. Unlike other biofuel production processes which require a supply of water, the plant location decisions for Green Gasoline™ facilities can be made independent of water availability requirements since the process produces large quantities of clean water.

Claims:

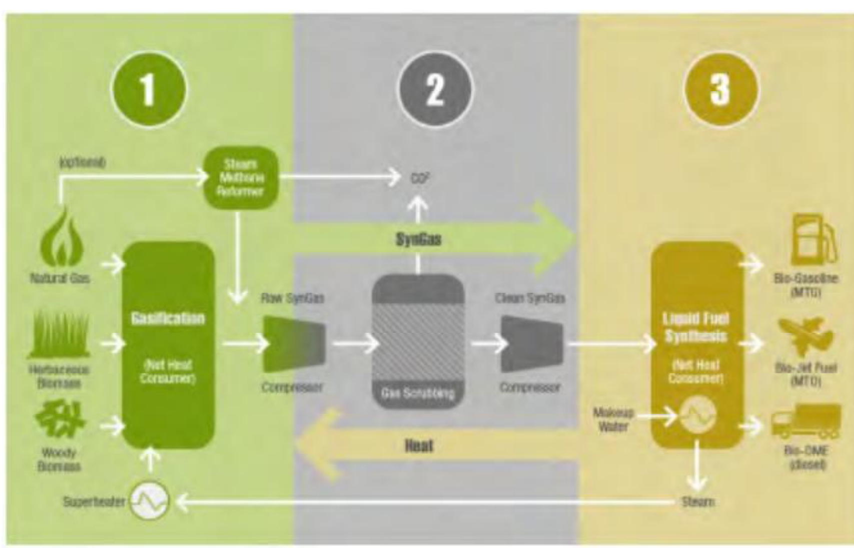
- Uses widely available, non-food, waste biomass that may have no other commercial use. Employs commercially available industrial scale equipment and requires no technology development. Uses EPI gasifier.
- Produces carbon neutral, ultra-low benzene, 94 octane gasoline, which will be ASTM certified as a "drop-in" replacement for conventional gasoline, and emit little or no criteria air pollutants.
- Takes advantage of the existing fuel marketing and distribution infrastructure.
- Will have a production cost of 38 cents/liter ($1.44/gallon).
- Is energy self sufficient and could be a net contributor of renewable electricity onto the electrical grid.
- Produces water (while most other commercial biofuel processes consume water).
- Does not produce toxic waste. The ash produced by the Green Gasoline™ process is chemically inert. CORE is investigating its use as a soil amendment which could improve the growing conditions for reforestation activities.

References indicate that Core is in process of starting up $100 Million Plant.. It has selected Technip, a world leader in engineering, construction and project management in the energy industry, to complete the construction engineering of its first wood to gasoline biorefinery. The Green Gasoline plant will produce 67 million liters of renewable gasoline and generate over 20 million litres of water annually from wood waste.

Primus Green Energy – www.primusge.com - Hillsborough, NJ

According to the web site, Primus' innovative thermo-chemical conversion process and proprietary technology produces gasoline that is cost-competitive with petroleum without subsidies. By developing proprietary enhancements to well-established commercial processes, Primus enables the best of both worlds– breakthrough conversion efficiency combined with low technological risk. Being an evolutionary improvement over an existing process, not a revolutionary development, enables a faster track to construction capital to build industrial-scale refineries.

Based on a proprietary variant of the ExxonMobil methanol-to-gasoline (MTG) process, the process is simplified to produce standard gasoline without need for separation or further treatment. The result is a highly efficient process (converting 35% or more of feedstock to gasoline) producing



Primus Process Flow

a drop-in fuel ready for immediate distribution, sale and consumption using existing infrastructure.

Primus has raised $40 million from its main investor (Israel Corp), and an $8 Million demonstration project is producing gas (but not yet in commercial quantities).

Plans are to build an approximately $200 million commercial plant in partnership with Bechtel, an engineering giant with a history of scaling up new technology (40,000 tpy and 3.2 million gallons).

INEOS Bio - www.ineosbio.com - Lisle, IL

INEOS is one of the world's largest petrochemical companies. It is a leading manufacturer of commodity chemicals, specialty chemicals, biofuels, and oil products. INEOS Bio is one of the global businesses in INEOS. INEOS Bio has developed a highly innovative thermo-chemical and biochemical technology for the production of advanced biofuel and renewable energy from a wide range of low-cost carbon materials. The company's initial focus is to commercialize and license the world's leading advanced bioethanol process technology to serve the global renewable transport fuels market.

INEOS Bio and its joint venture partner,
NPE Florida commercial plant
Indian River BioEnergy Center

In 1989, a small team of researchers led by Dr. James Gaddy developed an innovative biochemical process in Arkansas, which has become the heart of the INEOS Bio technology platform. During experiments using bacteria, the team detected their ability to produce ethanol from gases. This discovery was honed for many years and eventually culminated in the construction of a pilot fermenter in Fayetteville, Arkansas in 1994. The team in Arkansas joined with INEOS Bio to create a multi-disciplinary global team with the capabilities to quickly commercialize this technology. The INEOS Bio process consists of four steps to generate clean fuel and renewable power: gasification, fermentation, distillation and power generation.

Front end gasification is used to convert as much of the carbon in the feed material as possible to carbon monoxide, which has valuable chemical energy. The oxygen-blown gasification technology used in the INEOS Bio process suppresses the formation of dioxins and furans thanks to the reducing environment in the gasifier, and destroys any dioxins and furans formed through exposure to high temperature and residence time in the upper part of the gasifier. In addition, the carry-over of volatile metals into the syngas is minimized. This clever front-end design reduces the burden on, and cost of, the syngas clean-up stage.

It is the use of the thermo-chemical gasification step which gives the whole process its feed flexibility. It is this feed flexibility that enables almost any biomass material almost anywhere in the World to be converted to syngas for onward, high yield conversion by the INEOS Bio biocatalyst to bio-ethanol.

In November 2011, INEOS Bio selected AMEC (www.amec.com), an international engineering company, to be its global license support engineering firm, as the company rolls out its licensing program for the INEOS Bio advanced bioenergy technology. AMEC will work with INEOS Bio in developing engineering design packages for future INEOS Bio technology licensees. In this role, AMEC will ensure the engineering designs for bioenergy facilities using INEOS Bio's advanced waste-to-bioenergy technology are optimized and customized for each site location. AMEC was selected following an extensive evaluation process of qualified global engineering firms.

According to its web site, AMEC is one of the world's leading international engineering, procurement and construction management firms with deep expertise in the clean energy, environment and infrastructure markets. AMEC's experience in similar markets, along with its dedication to sustainable business practices makes it an ideal license support contractor for INEOS Bio. The two companies are currently working together on the first commercial-scale facility to deploy this advanced waste-to-bioenergy technology. Slated to come online in the 2nd quarter of 2012, the Indian River BioEnergy Center in Vero Beach, Florida will produce eight million gallons of advanced cellulosic ethanol and six megawatts (gross) of renewable power, while providing a solution for dealing with waste that would normally end up in a landfill.

Sundrop Fuels – www.sundropfuels.com - Longmont, CO

Sundrop is a gasification development company that has signed a deal to utilize technology from ThyssenKrupp Uhde. Sundrop claims its gasifier is similar to conventional biomass gasification except for one major difference, it uses radiation heat transfer to rapidly drive the extremely high temperatures needed to create the syngas. At the center of the patented approach is the Sundrop Fuels *RP Reactor™*, a radiation-driven biomass gasifier that generates temperatures of more than 1,300 degrees Celsius (2,372 degrees Fahrenheit).

In May 2012, Sundrop Fuels, Inc., a drop-in advanced biofuels company, announced a partnership with technology and engineering supplier ThyssenKrupp Uhde for what will be the nation's first bona fide commercial "green gasoline" production facility.

The company's inaugural plant near Alexandria, Louisiana, will yield up to 50 million gallons of renewable gasoline annually while also serving as proving ground for Sundrop Fuels' proprietary biomass conversion technologies that will be used for future large-scale facilities.

The collaboration follows signing of a comprehensive "Front End Engineering and Licensing Agreement" between Sundrop Fuels and Uhde Corporation of America, a unit of ThyssenKrupp USA Inc. More than 70 engineers from the two companies are now working together to complete designs for the Sundrop Fuels plant, which should begin construction late this year.

Sundrop Fuels will convert sustainable forest residues and thinning as feedstock combined with natural gas into bio-based "green gasoline" by using a commercially-proven production path that integrates gasification, gas purification, methanol synthesis and a methanol-to-gasoline (MTG) process. The clean, affordable biofuel is ready for immediate use in today's combustion engines and will be delivered to the marketplace via the nation's existing fuels distribution infrastructure. The company's first production plant will have a capacity of about 3,500 barrels of renewable gasoline per day.

As a key element to its first facility, Sundrop Fuels will deploy ThyssenKrupp Uhde's High Temperature Winkler (HTW) gasification process, coupled with other well-established technologies for gas cleanup, methanol synthesis, and the MTG conversion.

ThyssenKrupp Uhde is a world leader in coal and biomass gasification. Its proprietary HTW fluidized-bed and PRENFLO entrained-flow gasification technologies convert almost any feedstock including biomass into a wide variety of products including fuels and industrial chemicals.

Significant backing for Sundrop Fuels comes from Chesapeake Energy Corporation, the largest producer of natural gas in northern Louisiana's Haynesville Shale Field and second-largest producer in the nation. Chesapeake invested $155 million in Sundrop Fuels in mid-2011. The company's investors also include two of the world's premier venture capital firms, Oak Investment Partners and Kleiner Perkins Caulfield & Byers.

ThyssenKrupp Uhde is among the world leaders in coal and biomass gasification and has over 70 years of experience in coal gasification. Due to the current energy market situation, Uhde Corporation of America sees a significant increase in the demand for biomass and natural gas for alternative energy projects. The Sundrop Fuels plant is one that will demonstrate the suitability of biomass as a reliable and cost-effective source for generation of highly valuable transportation fuels.

Coal-to-Liquids
Wesseling, Germany
Capacity: 100 barrels per day

With its proprietary solids gasification technologies HTW (fluidised-bed gasification) and PRENFLO (entrained-flow gasification), ThyssenKrupp Uhde is able to take almost all available feedstocks, such as hard coal and lignite, high-ash coal, petcoke, various biomasses or household waste, and convert them into highly lucrative products. PRENFLO and HTW have already been selected by a number of customers in the recent past for worldwide projects for the generation of electricity, hydrogen, gasoline, diesel, chemical products and for direct reduction in the steel industry.

Page Intentionally Blank

Appendix 2: Pyrolysis Catalytic Reforming Processes

Envergent Technologies Company and Honeywell UOP - www.envergenttech.com www.ensyn.com- Kapolei, Hawaii

Envergent Technologies LLC is a joint venture of Honeywell's UOP and Ensyn Corp. combining nearly 100 years of refining and process technology development from UOP and more than 25 years of commercial RTP experience from Ensyn Corp. RTP™ ("Rapid Thermal Process"). The RTP technology is currently in use in seven commercial biomass processing plants in the U.S. and Canada.

Ensyn is a producer of renewable liquid fuels and chemicals from non-food biomass with more than 30 million gallons produced to date. Honeywell's UOP is a leading supplier and licensor of process technology catalysts, adsorbents and services to the petroleum refining, petrochemical, gas processing and biofuels industries. The RTP pyrolysis process is based on the application of a hot "transported" bed (typically sand) that is circulating between two key vessels. Feedstocks, such as wood residues, are subjected to fast, intimate contact with the hot sand for under a few seconds, resulting in the thermal cracking of the feedstock to gases and vapors. Product vapors are rapidly quenched, or cooled, and recovered as a light liquid product.

Ensyn's RTP process is an analogue to Fluid Catalytic Cracking, or FCC, a very common and mature process used in most refineries around the world. An FCC system circulates catalyst in a closed loop between two key vessels in order to convert vacuum gas oil to gasoline. Ensyn uses a similar mechanical process, but typically circulates readily-available sand while converting wood residues to high yields of a light liquid product.

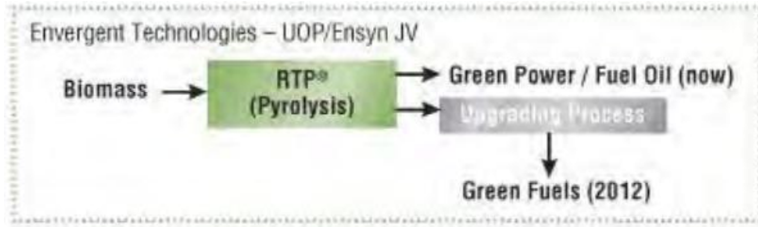
U.S. Energy Secretary Steven Chu visited Kapolei, Hawaii in November 2011) to check in on the progress of an integrated biorefinery project that promises to help increase the domestic production of advanced biofuels. Once complete, the pilot-scale facility will convert cellulosic biomass, like wood waste and algae, into clean, renewable gasoline, diesel, and jet fuel at 60,000 gallons per year.

Honeywell UOP, the company leading the project, was awarded $25 million through the Recovery Act to construct the facility—part of the Department's efforts to bolster America's advanced biofuels industry and reduce our dependence on foreign oil.

The project leverages into an integrated platform: pyrolysis of biomass from Ensyn Corporation and hydro-conversion from UOP. The pyrolysis process rapidly heats the biomass to form a vapor that is then rapidly cooled, creating a liquid bio-oil. The hydro-conversion process cleans and stabilizes the bio-oil to make it suitable for storage and processing into finished transportation fuels. The integrated biorefinery will demonstrate the technology's viability, test the fuels produced, and evaluate the fuels and the processing technology's environmental footprint.

Once the technology has been successfully demonstrated at this scale, UOP intends to make the technology available to license at the commercial scale. Each commercial application would produce as much as 50 million gallons of drop-in green transportation fuels per year and create up to 1,000 permanent jobs. Initial production at UOP's Hawaii facility is scheduled to begin in 2012. The facility is expected to be fully operational by 2014.

Envergent Technologies and Ensyn Corporation have more than 20 years of commercial experience with RTP technology for producing renewable oil for various natural chemical and fuel products. RTP™ converts non-food-based feed-stocks into RTP green fuel. It is a fast thermal process whereby bio-mass is heated rapidly by contact with hot sand; the biomass is first vaporized and then rapidly cooled. The process occurs in less than two seconds. This product can then be used in the generation of electricity and for the production of process heat. Development is underway to upgrade RTP green fuel into green gasoline, green diesel and green jet fuel. Honeywell UOP is the catalyst and fuel partner. The team claim that a 400 bone dry metric ton per day greenfield RTP unit (with a feedstock cost of $US 40 per ton), would produce RTP green fuel at $US 0.41 per gallon. They list a price of $38 Million for their hardware uninstalled.

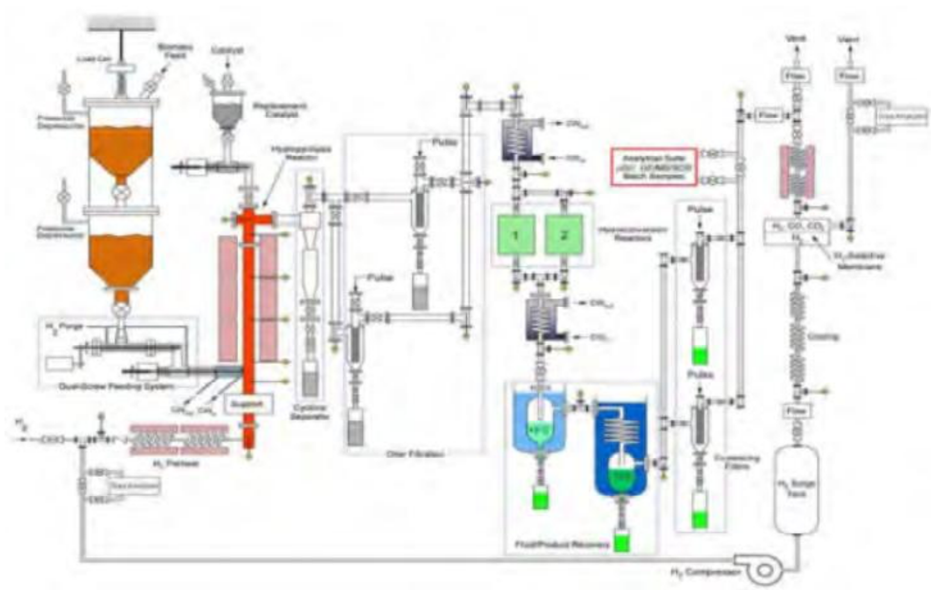


CRI Catalyst Company (CRI) – www.cricatalyst.com – Houston, TX

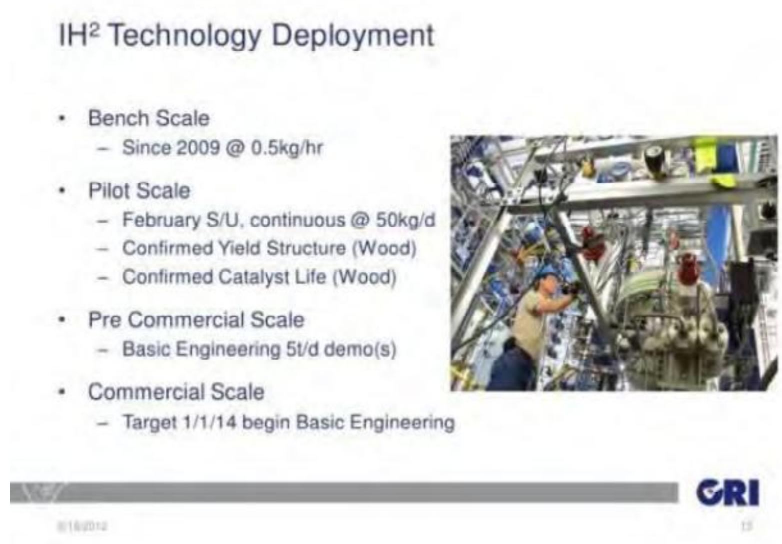
CRI is a license holder of a process developed by Gas Technology Institute (GTI). GTI scientist Dr. Martin Linck an update (August '12) on the progress toward commercializing the GTI Integrated Hydro-pyrolysis and Hydro-conversion (IH2) process, with a presentation of new data on IH2 de-veloped from a continuous 50 kg/day pilot plant

IH2 is a new thermochemical process that employs a catalyzed fluidized bed hydropyrolysis step followed by an integrated hydroconversion step to directly convert biomass into high-quality, fungible hydrocarbon fuels. IH2 derived fuels contain less than 1% oxygen and are completely compatible with petroleum-derived fuels. National Renewable Energy Laboratory (NREL) modeling predicted $1.76 per gallon of renewable fuel from a 2000 ton per biomass wood plant (assume $72 per ton purchase price).

IH2 technology involves use of internally generated hydrogen and a series of proprietary catalysts. The process uses as its feedstock virtually any kind of nonfood biomass material—including wood, cornstalks and cobs, algae, aquatic plants and municipal solid waste—and produces gasoline, jet fuel or diesel fuel.



IH2 Process Flow Diagram



Linck and colleagues had earlier published a paper in a journal with experimental data from their 0.45 kg/h semi-continuous IH2 pilot plant. The smaller plant can produce 72-157 gallons of fuel per ton of dry, ash-free feedstock, depending on feedstock type.

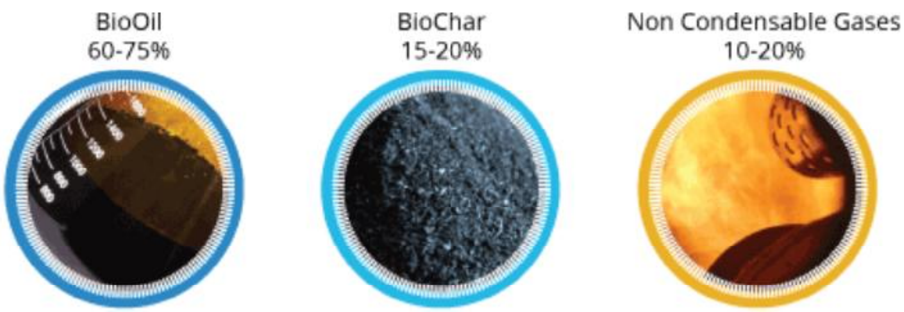
GTI has licensed the IH2 technology to CRI Catalyst Company (CRI), in Houston, Texas. CRI has exclusive sub-licensing rights to the process and is working with multiple customers, planning to build several demonstration units that can convert between 40 and 200 tons of biomass a day.

Dynamotive – www. Dynamotive.com -Vancouver, Canada

Dynamotive's patented fast pyrolysis proces involves the rapid heating of a biomass feedstock in the absence of oxygen. Prepared feedstock (<10% moisture and 1-2 mm particle size) is fed into the bubbling fluidized bed reactor, which is heated to 450-500°C in the absence of oxygen. This is lower than other pyrolysis systems and, therefore, has the benefit of higher overall energy conversion efficiency. The resulting gases pass into a cyclone where solid particles (char) are extracted. The gases enter a quench tower where they are quickly cooled using BioOil already made in the process.

The BioOil condenses and falls into the product tank, while non-condensable gases are returned to the reactor as fuel to maintain process heating. The entire reaction from injection to quenching takes only two seconds.

Fast Pyrolysis Outputs



Three products are produced: BioOil (60-75% by weight), char (15-20% by weight) and non-condensable gases (10-20% by weight). Yields vary depending on the feedstock composition.

A fourth product, BioOil Plus, can be produced by adding back the separated char into the BioOil, in a finely ground form of about 8 microns in size.

Dynamotive's pyrolysis upgrades bio-oil in a two stage process involving hyrdo-reforming, and hydro-treating:

Stage One: Hydro-Reforming

Hydrogen is added to the pyrolysis oil in a reactor that incorporates an industrial catalyst. Water, methanol and acetic acid are removed from the pyrolysis oil and the energy density of the remaining oil is substantially increased. The resulting hydrocarbon liquid is completely miscible with other hydrocarbon fuels and has an energy content that is almost 90% of diesel.

Stage Two: Hydro-Treating

A second processing stage is called hydro-treating, and further upgrades this fuel. Additional hydrogen is added and additional oxygen is removed. The characteristics of the final upgraded product can be varied via the reaction conditions, however the general outcome is to produce a hydrocarbon liquid with characteristics the same as a mixture of jet fuel, gasoline and diesel. The various fuels may then be separated via standard distillation equipment.

Upgrading Outputs

Three products are produced: Jet Fuel (30% by weight), Diesel (35% by weight) and Naphtha (35% by weight). By products including Acetic Acid, Methanol and Water are also produced in the first stage of the upgrading process.

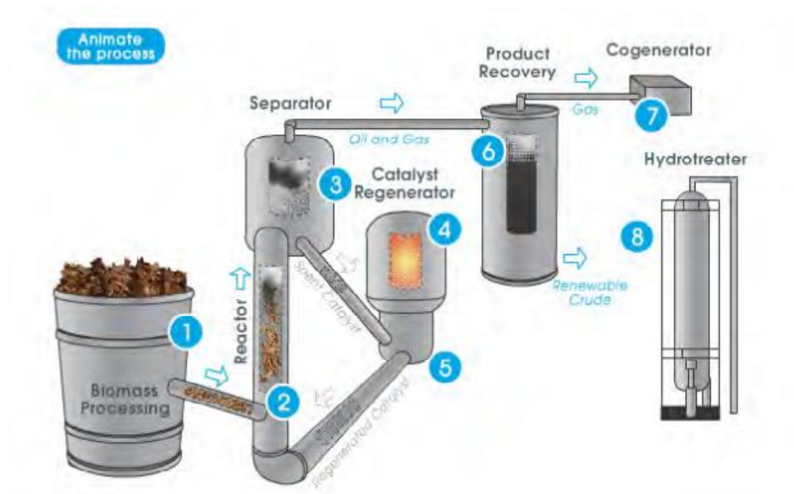
Commercial Status:

Through its 14 years of participation in the biofuel sector, Dynamotive developed two processes that, when combined, can deliver 1 gallon of Jet / Gasoline and Diesel for between ($1.82 and $3.25) depending on feedstock (focus is cellulosic feedstocks). The Patented Technology is proven with 4 Plants (2 Pilot & 2 Commercial) in operation. Commercial plants are located in West Lorne, Ontario at 130 TPD and Guelph, Ontario at 200 TPD.

Lorne, ON 200 tpd plant

KIOR- www.kior.com – Pasadena, TX

KIOR is a next-generation that has developed a proprietary to convert into renewable crude oil. KiOR's renewable crude oil is processed using standard refinery equipment into and that are compatible with the existing fuel infrastructure. KiOR strives to help ease dependence on foreign oil, reduce lifecycle greenhouse gas emissions and create high-quality jobs and economic across rural communities. In 2007, KiOR was founded by Khosla Ventures and a group of catalyst scientists who shared a vision of making renewable fuels from cellulosic biomass through a one-step catalytic process.



KiOR's Process Flow Diagram

KIOR has developed a proprietary technology platform to convert sustainable, low-cost, non-food biomass into a hydrocarbon-based renewable crude oil. Using standard refining equipment, the company processes its renewable crude into gasoline and diesel blend stocks that can utilize the existing transportation fuel infrastructure for use in vehicles on the road today. In essence, KIOR'S technology simply reduces the time it takes to produce oil from millions of years to a matter of seconds. The company's technology platform combines its proprietary catalyst systems with a process based on existing Fluid Catalytic Cracking (FCC) technology, a standard process used for over

60 years in oil refining. The efficiency of KIOR'S process, called Biomass Fluid Catalytic Cracking (BFCC), and the proven nature of catalytic cracking technologies, allow for significant cost advantages, including lower capital and operating costs, versus traditional biofuels producers.

KIOR systems use a two step BFCC that is continuous process. KIOR has a Pilot unit that has logged 9000 hours, at 0.025 BDT/day, which was used to test 250 catalyst systems. Its demonstration unit has operated 3000 hours at 10 BDT/day.

Its first Commercial Unit – 500 BDT/day, was supposed to operational by mid 2012.

Appendix 3: Other Chemical Conversion Approaches

BioNitrogen - www.bionitrogen.com -Doral, FL

BioNitrogen is an American company focused on building fully operational, turnkey manufacturing facilities to produce urea utilizing Gasification as the front end process. BioNitrogen is headquartered in Doral, Florida.

On 8/25/12, BioNitrogen Corporation, announced a 3 year agreement whereby PRM Energy Systems, Inc. (PRME) of Hot Springs, Arkansas, will build updraft gasifiers for BioNitrogen's patent-pending biomass-to-urea production facilities.

PRME was originally incorporated in 1973 under the laws of Arkansas. The technology for the biomass fired reactor/gasifier was developed and patented under the direction of Mr. Ron Bailey, Sr. while President of Producers Rice Mill Inc., (1967-88). The first two gasifiers were installed in 1982 to gasify rice husks to produce process heat and steam for a large rice parboiling facility. The energy from the gasification of rice husks in the PRME gasifier displaces natural gas in the dryers and boiler. The reactor is a vertical, cylindrical steel vessel that is lined with castable refractory. The proprietary shape of the reactor produces negligible entrained particulate matter and promotes mixing of volatilized combustibles. Residence time of the biomass fuels within the reactor can be precisely controlled. Multi-zoned Sub-stoichiometric air is admitted into the reactor via one or more zones and is controlled to volatilize the biomass while partially combusting the solids, producing low BTU gases.

Urea is a white, crystalline solid containing 46% Nitrogen and is principally used in the agricultural industry as a crop fertilizer. BioNitrogen's innovative, patent-pending technologies will transform residual agricultural waste and other biomass materials into high-quality bulk urea for sale to agricultural wholesalers and retailers. plants will be modular and substantially smaller than traditional urea production plants. The company claims its facilities will be capable of manufacturing 15 tons of urea fertilizer per hour for a total annual production of approximately 124,200 tons per plant. Nitrogen fertilizer is basically modified natural gas, with natural gas forming the main feedstock and accounting for 75 to 85 per cent of the production cost in the manufacture of the fertilizer. Traditionally, nitrogen fertilizer prices have moved in tandem with natural gas prices.

Instead of building more large-scale nitrogen production facilities, Frank Segredo, corporate development officer for BioNitrogen Corporation, believes small local plants could reduce fertilizer costs for farmers. "Transportation costs add at least $65 to $75 per ton of nitrogen fertilizer," Segredo says. "If fertilizer was produced locally, these transportation costs could be reduced." Until now, this would have required the building of pipelines to move natural gas to each small plant, greatly increasing capital and operating costs.

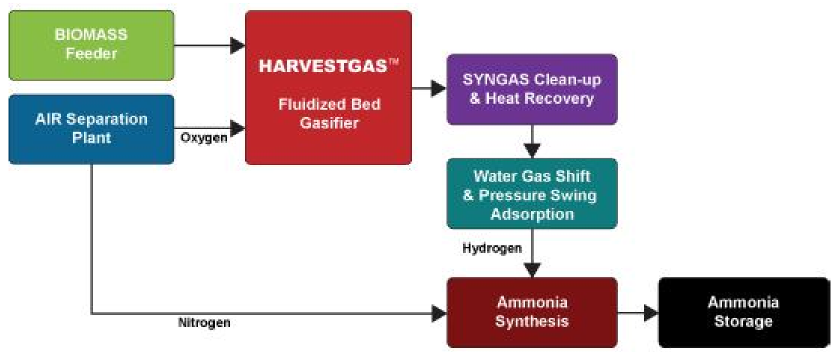
BioNitrogen has sidestepped this problem by replacing natural gas as the feedstock, using farm biomass sources instead. Three researchers at Texas Tech developed a process whereby agricultural waste such as corn stover is pelleted and then gassified to turn the pellets into syngas, which can then be used to make nitrogen fertilizers. Based on this technology, BioNitrogen has engineered small modular processing and production facilities which can be built in agricultural areas where there is an abundance of biomass which could be converted back to fertilizer. An individual plant would produce up to 124,000 tons of fertilizer per year.

On August 28th BioNitrogen announced signing an agreement with the Development Authorities of for its proposed Florida conversion facility. The pledge of support comes just days after BioNitrogen secured a 3-year agreement for from PRM Energy. Subject to final approval, the Memorandum of Understand (MOU) provides $2 million for building a railroad spur onto the Florida Fertilizer property where the urea plant will be constructed. The County has also agreed to provide tax credits and other incentives for the plant's construction. BioNitrogen converts low value non-food biomass first into synthetic gas, then through catalysis turns the syngas into urea, a high-nitrogen fertilizer compound usually produced from petroleum. Bill Lambert, Director of Hardee County Economic Development, said, "The County is focused on fostering economic development in the region and we believe that the BioNitrogen plant will be a significant step in that direction by bringing both jobs and revenue to the area.

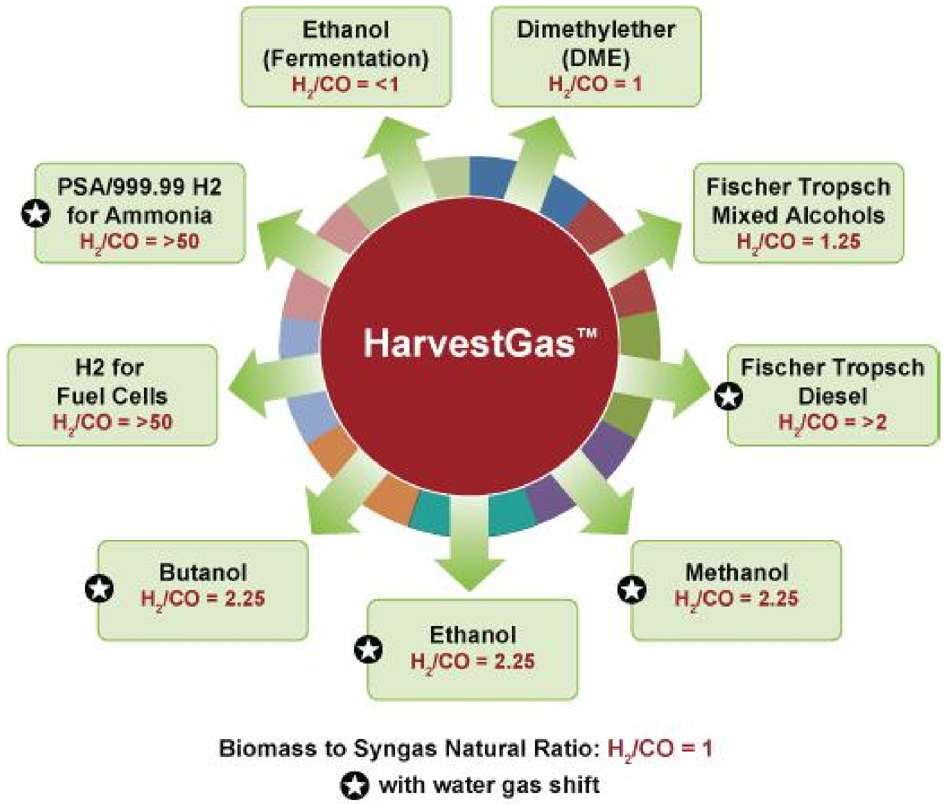
SynGest – wwwsyngest.com – San Francisco, CA

SynGest Inc. has announced plans to build its first commercial scale facility to convert crop waste such as corn stalks and cobs into anhydrous ammonia, an advanced biofuel and nitrogen fertilizer. The company intends to become the dominant player in the production and distribution of anhydrous ammonia made from biomass. Typical plants will cost $100 million, employee 200 and utilize up to 130,000 tons per year of waste biomass.

The heart of the SynGest process involves a pressurized oxygen-blown biomass gasifier designed for operation in an expanding bed fluidized mode. The HarvestGas™ system converts the biomass into a mixture of hydrogen and carbon monoxide, and is optimized to minimize the formation of methane. After the gas stream is cleaned, the carbon monoxide is "shifted" to maximize hydrogen. The hydrogen is purified and catalytically reacted with nitrogen to make ammonia. The plant includes an air separation system to provide oxygen for the gasifier and pure nitrogen for ammonia synthesis. Waste heat is recovered, thereby minimizing the need for external energy supplies. Two major patents are pending.



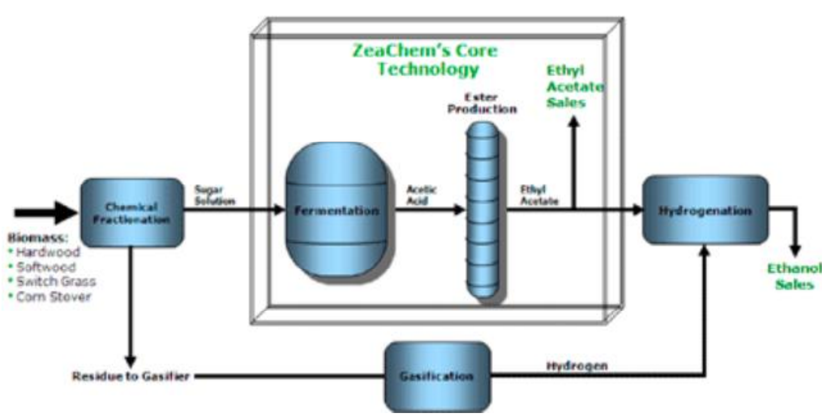
SynGest Process



HarvestGas "Wheel of Fortune" Applications: In addition to anhydrous ammonia, the same oxy-gasification process that produces the syngas can be coupled with a variety of downstream processes to produce any of several different fuel products.

ZeaChem- www.zeachem.com – Lakewood, CO

ZeaChem is pioneering advanced cellulosic ethanol, fuels and chemical technology using a hybrid combination of biochemical and thermochemical processing steps. ZeaChem uses biomass feedstocks that contain high levels of cellulose, which is the rigid structural compound found in all plants. Cellulosic biomass is an ideal choice for biorefining because it grows abundantly throughout the world and replenishes quickly and easily in poor quality soil. Another significant benefit of using cellulosic biomass is that it effectively ends the "food vs. fuel" debate that has drawn so much negative publicity to corn based ethanol plants.



ZeaChem utilizes a hybrid process of biochemical and thermochemical processing that preserves the best of both approaches from yield and efficiency perspectives. ZeaChem's process, although tightly protected by Intellectual Property (IP), utilizes no new organisms or process.

After fractionating the biomass, the sugar stream (both xylose [C5] and glucose [C6]) are sent to fermentation where an acetogenic process is utilized to ferment the sugars to acetic acid without CO2 as a by-product. In comparison, traditional yeast fermentation creates one molecule of CO2 for every molecule of ethanol. Thus the carbon efficiency of the ZeaChem fermentation process is nearly 100% vs. 67% for yeast. The acetic acid is converted to an ester which can then be reacted with hydrogen to make ethanol. To get the hydrogen necessary to convert the ester to ethanol, ZeaChem takes the lignin residue from the fractionation process and gasifies it to create a hydrogen-rich syngas stream. The hydrogen is separated from the syngas and used for ester hydrogenation and the remainder of the syngas is burned to create steam and power for the process. The net effect of combining the two processes is that about 2/3 of the energy in the ethanol comes from the sugar stream and 1/3 comes from the lignin steam in the form of hydrogen. At an expected plant yield of 135 gallons per bone dry ton (gal/BDT), the process is nearly balanced with the necessary steam and power generated from the non-hydrogen portion of the syngas stream.

On July 26, 2012, ZeaChem Inc. announced it had been awarded part of a $6 million grant by the U.S. Department of Agriculture (USDA) and U.S. Department of Energy (DOE) for the development of advanced biofuels utilizing tropical grasses. ZeaChem is part of a consortium led by the University of Hawaii that includes Oregon State University, Washington State University, Hawaiian Commercial and Sugar Company, and Hawaii BioEnergy LLC.

Boardman OR, 250,000 gal per year Demonstration Plant

ZeaChem's technology has great potential to reduce Hawaii's dependence on imported fossil fuels, which the state depends on for over 90 percent of its energy needs. The project will focus on the production of bio-based jet and diesel fuel from tropical grasses grown in Hawaii. Because its process can use any type of non-food biomass, ZeaChem will be able to optimize its sustainable and economical high yield fermentation process for local feedstocks grown in Hawaii, specifically tropical grasses. The four-year project will enable lab and engineering scale production of bio-based jet and diesel fuels.

Appendix 4: Syngas to Fuels Only Technologies Companies

Oxford Chemical/Velocys, Inc – www.velocys.com - Oxford, U.K and Columbus, OH

Velocys, Inc. is one of the two operating subsidiaries of the Oxford Catalysts Group, the second being Oxford Catalysts Limited. Each specializes in different aspects of the technology. Together, the combined group has a total patent portfolio of over 750 patents and over $250 million has been invested in the technology, primarily by commercial partners.

Velocys, Inc. is based near Columbus, Ohio, and specializes in the design and development of for the production of synthetic fuels, chemicals, emulsions and other materials. It owns, or has licenses to, the largest microchannel patent portfolio in the world, and supports a large microchannel development team. Velocys merged with Oxford Catalysts in 2008.

The company claims The use of microchannel processing will make it possible to greatly intensify chemical reactions to enable them to occur at rates 10 to 1000 times faster than in conventional systems. This means that microchannels are able to be used economically at much smaller scale than analogous conventional systems and so are uniquely suited to the distributed production of fuels and other materials on a small and decentralized scale.

Oxford Catalysts Ltd, based in Milton Park near Oxford, UK, designs and develops specialty catalyst technologies for the generation of clean fuels from gas, biomass, coal and waste, through steam methane reforming, Fischer-Tropsch and hydro-processing.

The company focuses on a series of key catalyst platform technologies. Among these is the patented (OMX) method. OMX makes it possible to produce catalysts with high activity and selectivity, while being more stable than those produced through conventional processes. Such catalysts are particularly well suited to microchannel reactors, which are able to exploit superactive catalysts most efficiently.

Microchannel reactors are compact reactors that have channels with diameters in the millimetre range. These small channels dissipate heat more quickly than conventional reactors with larger channel diameters in the 2.5 – 10 cm (1 – 4 inch) range, so more active catalysts can be used, such as those developed by Oxford Catalysts. Mass and heat transfer limitations reduce the efficiency of the large conventional reactors used for and reactions. The use of microchannel processing makes it possible to greatly intensify chemical reactions enabling them to occur at rates 10 to 1000 times faster than in conventional FT systems.

Microchannel Fischer-Tropsch reactors, developed by Velocys and using a new highly active FT catalyst developed by Oxford Catalysts, are now available for the small scale distributed production of fuels. These reactors exhibit conversion efficiencies in the range of 70% per pass, and are designed for economical production on a small scale. A single microchannel reactor block produces some 30 barrels (bbls) of synthetic fuel per day. In contrast, conventional FT plants are designed to work at minimum capacities of 5,000 bbls/day, and function well and economically at capacities of 30,000 bbls/day or higher. They typically exhibit conversion efficiencies in the range of 50% or less per pass. Microchannels have a smaller footprint, can be scaled up or down more flexibly as they can be 'numbered up', and have efficiencies superior to those achievable using conventional process technology. Microchannel reactors, therefore, have the potential to unlock the distributed production of fuels and other materials on a small, decentralized scale.

Velocys has been on the cusp of commercial rollout of their technologies for some time - two demonstration programs are underway:

- A demonstration at Güssing, Austria in operation since mid-2010
- A demonstration at Fortaleza, Brazil expected in operation Q4-2011

Manufacturing partners are engaged and the supply chain is established. They claim to be ready for commercial orders for Fischer-Tropsch reactors for synthetic fuels plants:

- First commercial order for commercial scale FT reactor received in December 2010 and completed in March 2011
- A number of orders, to multiple partners, expected during 2011

Velocys is also partner with Sierra Energy (pilot gasifier at the RETC) on a $5 M California Energy grant for a 25 ton per day auto fluff to liquid fuel demonstration project for West Sacramento.

LanzaTech – www.lanzatech.co.nz -New Zealand

LanzaTech has visited the RETC in Sacramento and were trying to work with one of the gasifier companies on site. One of its engineers visited the pilot plant which was running off the exhaust gas of steel mill melting furnace. Its technology converts CO and Hydrogen through microbes to ethanol. It has had multiple deals with a Chinese Baosteel company (100,000 gal per year demonstration plant) and recently purchased the Soperton, GA Range Fuel site from the federal government (a failed DOE gasification project). It has one MSW project in India with Concord Enviro.

The LanzaTech Process can convert carbon monoxide containing gases produced by industries such as steel manufacturing, oil refining and chemical production, as well as gases generated by gasification of forestry and agricultural residues, municipal waste, and coal into valuable fuel and chemical products. The robust process is flexible to the hydrogen content in the input gas and tolerant of typical gas contaminants.

Pilot Plant at BlueScope Steel, New Zealand

The carbon monoxide containing gas enters the process at the bottom of the bioreactor, and is dispersed into the liquid medium where it is consumed by LanzaTech's proprietary microbes as the reactor contents move upward in the reactor vessel. The net product is withdrawn and sent to the product recovery section.

The product recovery section makes use of an advanced hybrid separation system to recover the valuable products and co-products from the fermentation broth. The water is recovered and returned to the reactor system, minimizing water discharge from the process. The products and co-products are collected for downstream use.

In some cases, these products can be used directly as fuel or chemical products. In many cases it is also possible to convert products from the LanzaTech process into common chemicals or 'drop in' fuels that are normally derived from petroleum.

The LanzaTech process provides a route from waste gases and solids to valuable fuel and chemical products, reusing carbon along the way to minimize environmental impact.

In January 2012, LanzaTech announced that it has closed its Series C round with new investment totaling US $55.8 million led by the Malaysian Life Sciences Capital Fund. New investors include Petronas Technology Ventures Sdn Bhd, the venture arm of Petronas, the national oil company of Malaysia, and Dialog Group, a leading Malaysian integrated specialist technical services provider to the oil, gas and petrochemical industry. Specific investments in the round were not disclosed by the company.

Existing investors Khosla Ventures, Qiming Venture Partners and K1W1 also participated in the round. To date, the company has raised more than $85 million.

LanzaTech CEO Jennifer Holmgren told the Digest "we managed a pretty large C round despite the fact that the funds are not for building production facilities. The funds are for R&D and continuing to develop our waste gas to fuels and chemicals platform. So the money is to grow our R&D base. Some of the money will also go to further develop Soperton as a chemicals platform launch site.

Coskata – www.coskata.com - Warrenville, Illinois

Coskata is a technology leader in the production of alternative fuels and chemicals utilizing microbes. Its proprietary three-step process has been demonstrated at scale and offers high yields, low costs and feedstock flexibility.

Step 1: Gasification **-** In the first process step, the technology converts carbon-containing feedstock into synthesis gas, or syngas, which is a mixture of carbon monoxide, hydrogen, and carbon dioxide. The feedstock material decomposes into a syngas that Coskata can then convert into fuels or chemicals, without releasing harmful emissions or byproducts.

For natural gas conversion, the technology uses commercial natural gas reformers to convert the feedstock into syngas. Natural gas reforming is a common process used in the production of fertilizers and chemicals. For industrial gases such as steel mill gases, no reforming is required.

For solid feedstocks such as wood or coal, the technology produces syngas through gasification. Gasification has been widely used in industrial settings and has a long operating history in coal-based applications. Modern gasification technologies are highly efficient and have years of operating history.

Whether using natural gas or solid feedstocks, the syngas stream is cleaned to remove any materials that may be harm-

Coskata's fermentor (right tower) at

ful to the downstream process. The hot syngas stream is also used as a heat source to generate the steam necessary to drive distillation; this recovered heat greatly reduces operating costs of the facility.

Step 2: Fermentation **-** After the syngas is cleaned and cooled, it is fed to Coskata's innovative bioreactors where proprietary microorganisms convert the syngas into fuels and chemicals.

Coskata's microorganisms convert nearly all of the chemical energy of the syngas into the desired end product, leading to high yields. The fermentation process operates at lower pressure and lower temperatures, delivering cost and energy advantages over thermochemical pathways.

Step 3: Separation **-** The third step of the Coskata process is product separation. This step utilizes commercially-available distillation and dehydration technologies to efficiently separate the final product from the water stream exiting the bioreactor. The separation step has several cost-savings measures as part of its design, including heat recovery and water recycling. These measures reduce the need for external energy sources and minimize water consumption.

Coskata recently announced that it was going to focus on the Natural Gas conversion market because it was less capital intensive for building commercial plants. Its pilot plant is located at the old Westinghouse Plasma test plant in Pennsylvania and $25 million was spent to build it. Testing had been done with the Alter NRG gasifier syngas plus natural gas. The facility has amassed over 15,000 run hours of operation and successfully converted wood biomass and municipal solid waste into fuel-grade ethanol.

"The data and operating experience cultivated at this pre-commercial scale facility have conclusively demonstrated that the Coskata technology is ready for commercial production today," said Coskata President and Chief Executive Officer Bill Roe. "With an industry leading yield of more than 100 gallons of ethanol coming from a dry ton of wood biomass, we look forward to working with industry partners to rapidly deploy this leading conversion technology and help the country meet the Renewable Fuels Standard."

The integrated biorefinery, which utilizes plasma gasification technology provided by Westinghouse Plasma Corporation, a wholly owned subsidiary of Alter NRG, was built to demonstrate the commercial readiness of the Coskata technology. It is the largest scale facility that has utilized syngas fermentation into ethanol technology.

Maverick Bio-Fuels – www.maverickbiofuels.com – Chapel Hill, NC

Maverick claims its process represents a paradigm shift in syngas to mixed-alcohol technologies. Conventional syngas-to-mixed alcohol technologies convert syngas directly to a mixture of alcohols predominantly containing methanol and ethanol. This mixture has significantly lower energy than gasoline. In the best case scenario, producing only ethanol (i.e., no methanol), the energy content would still be less than 70% that of gasoline.

Maverick Biofuels Pilot Plant

In contrast, Maverick uses a modified Fischer-Tropsch synthesis to produce an intermediate olefin product, which is then converted to a mixture of alcohols. Since olefins must include two or more carbons, methanol cannot be produced and the resultant mixed alcohol product has significantly higher energy content than ethanol.

The energy content of Maverick's mixed-alcohol fuel is approximately 85% that of gasoline. Catalytic addition of water across the olefin double bonds produces branched chain (secondary) alcohols that have a higher octane value than the straight chain (i.e., un-branched or primary) alcohols formed using direct syngas to alcohol technologies and adds significantly to the product yield per ton of feedstock.

Unlike competitive syngas to alcohol technologies, which pass syngas through a catalyst bed at extremely high pressure (i.e., between 1,100 and 1,800 PSI), Maverick's Fischer-Tropsch (F-T) olefin synthesis is conducted at lower pressures, making this process more technologically feasible and the production facility less expensive to build, maintain, and operate. The competitive technologies that convert syngas to alcohol have a very low product yield per pass through the catalyst bed (i.e., around 20% per pass). In contrast, Maverick's F-T synthesis produces high product yields per pass. Because the reaction is carried out at a relatively low pressure, it is economically feasible to recompress any unreacted syngas and to recycle it through the reactor to increase the overall syngas conversion.

Maverick's mixed-alcohol biofuel is a mixture of ethanol, propanol, butanol, and a small percentage of higher carbon content alcohols. This mixture of alcohols will have an energy content that is approximately 85% that of gasoline, will have an octane rating higher than gasoline, and will have general handling characteristics that are more compatible than ethanol with gasoline.

Maverick Biofuels and Enerjetik, LLC, a manufacturer of advanced gasification technology, have entered into a joint technology development agreement to design and build a pilot-scale facility in Denver Colorado for the production of high-value, olefin-derived products from solid waste. Maverick's business model is to license technology to other gasification companies and partner on opportunities.

Comparison to Other Mixed Alcohol Processes: Several companies are trying to directly convert syngas into a mixture of alcohols. These efforts include separating ethanol from the methanol and the higher alcohols by distillation. Limitations include a) significant methanol production, b) requirement for very high pressures, c) product mix has a relatively low energy content, d) extremely low syngas conversion per pass (around 20-25%), and e) no history of proven scalability.

Maverick High-Energy Biofuel Comparison

Major Product	Production Technology	Energy Content (% of Gasoline)	Feedstock	Yield per Ton of Feedstock*
Mixed Alcohols (Ethanol, Propanol, & Butanol Blend)	Gasification	85	Biomass	~90 gallons + ~31 gallons of bio-LPG gas

Other Biofuels

Major Product	Production Technology	Energy Content (% of Gasoline)	Feedstock	Yield per Ton of Feedstock*
Methanol	Gasification	50	Biomass	~186 gallons
Ethanol	Fermentation (first generation)	68	High sugar content biomass	~100 gallons
	Fermentation (Cellulosic ethanol)	68	Cellulosic biomass	~100 gallons
	Gasification	68	Biomass	~85 gallons
	Combination	68	Biomass	~100 gallons
Butanol	Fermentation	92	Biomass	~46 gallons
Methanol & Ethanol Blend	Gasification	59	Biomass	~105 gallons

*Yield is based upon the feedstock, not the biomass from which the feedstock is produced (i.e. 1 ton of corn grain, not one ton of corn plant, to produce corn starch ethanol).

Appendix 5: Electrical Power Generation from biomass or waste technologies companies

Advanced Plasma Power – www.advancedplasmapower.com – Swindon, UK

Advanced Plasma Power's (APP) technology is called Gasplasma® which is a patented two-step process that gasifies carbon rich municipal, commercial, industrial and hazardous waste (without incineration) and then cleans the resultant synthetic gas by funneling it though a plasma arc chamber. Per APP "the process is energy efficient (it uses for internal operations only a small fraction of the energy it generates for export), compact in size (it fits within a standard industrial warehouse), richer in calorific value than any alternative gasification, clean (it meets the most stringent emission regulations and has no residual ash) and lower cost than incineration facilities with the same volume of processing capacity."

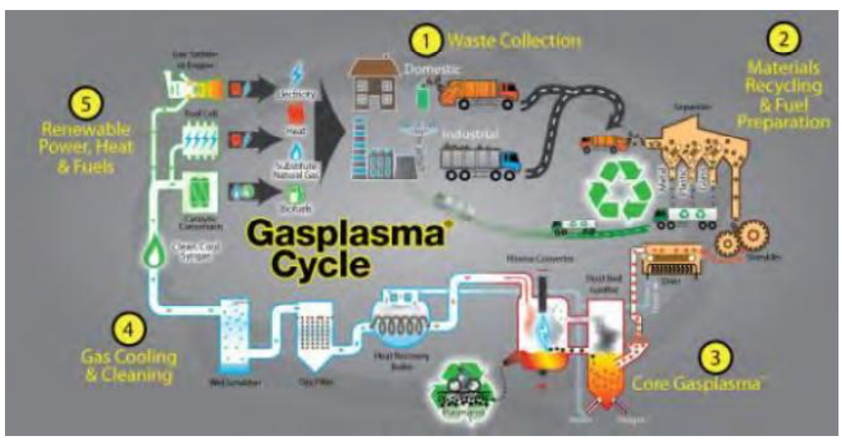
The RETC did test of this technology in June of 2012 and we measure the cleanest and highest Hydrogen content syngas of any gasifier tested to date.

Advanced Plasma Power (APP) is a spinoff company, formed in 2005, of Tetronics which is a major designer and supplier of plasma systems since 1965. APP was created to develop and commercialize a technology specifically for waste to energy, utilizing the Tetronics plasma technology as part of the process. APP developed the Gasplasma® waste to energy system that combines proven subsystems in a unique, internationally patented process:

- A fluid bed gasifier supplied by Energy Products of Idaho, recently acquired by a Finnish company "Outotec Ojy", which has over 5 million hours of proven commercial scale gasification in operation and over 100 operational sites globally
- A plasma converter provided by Tetronics which has a 45 year pedigree in direct current (DC) plasma solutions and 80+ installations globally

A full Gasplasma® plant would have four main components: 1) Materials Recycling Facility (MRF), if material is not pre-processed; 2) The core APP Gasplasma® technology consisting of the fluidized bed gasifier and plasma convertor; 3) Gas cleaning equipment to cool, clean and condition the synthesis gas (syngas); and 4) Power island to generate renewable power and recover residual heat.

If a MRF is part of the process it is sized to typically accept 150,000 tons of residual Municipal Solid Waste (MSW) or commercial and industrial (C and I) waste per year. The waste is first sorted to remove any oversized objects. The remainder is then sorted in the MRF to recover any metal, glass and hard plastics. The residue, which would normally go to landfill, is finally shredded and dried to make around 90,000 tons of Refuse Derived Fuel (RDF) a year.



APP Process Flow Diagram

Per APP, the Gasplasma® process can accept a vast diversity of organic wastes (raw municipal, commercial, industrial, hazardous and military) and transform them into a purified, calorie rich, standardized fuel in full compliance with the most stringent regulations. The various waste streams can be delivered to the Gasplasma® facility and homogenized on site. This capability gives Gasplasma® fundamental processing and economic advantages over competing technologies.

APP claims the Gasplasma® process produces super clean Syngas because all of the complex organic compounds are first gasified in a reduced-oxygen environment and then further cracked by the extreme temperatures and extensive ultraviolet exposure of the plasma arc. In contrast to an incineration process, Gasplasma® eliminates chars/tars and particulates rather than concentrating them in ash.

The ratio of Hydrogen to Carbon Monoxide (2 to 1) and the reduced tars in the Gasplasma® syngas, with further cleaning for sulfur compounds should work well in a Fischer Tropsch converter to make liquid fuels.

The core APP technology is a two-stage advanced conversion technology, which combines two long-standing and well-proven technologies to convert waste into a very clean, hydrogen-rich syngas.

The first stage is a Fluidized Bed Gasifier, which transforms the organic materials in the RDF into a crude syngas containing long chain hydrocarbons such as tars and chars. It does this by heating the RDF to approximately 800 degrees Celsius in a highly controlled, reduced oxygen environment. The crude syngas is then passed into a separate, secondary Plasma Converter. The intense heat from the plasma arc, in excess of 8,000° C, and the strong ultraviolet light of the plasma arc, 'cracks' the crude syngas. The cracking creates a clean syngas, while the bottom ash from the gasifier is vitrified into a slag that can be used as a building material or aggregate.

A typical APP plant is 16-20MW in size and generates about 150,000 MWh per year of electricity from around 150,000 tons of waste. APP claims that the process is based on proven systems and "compares favorably to the cost of other thermal processes" such as waste incinerators. Additionally the hydrogen-rich synthesis gas, or syngas, produced is clean enough to be further refined for a Fischer Tropsch process to make a range of biofuels and a very clean hydrogen that can be used in fuel cells.

PHG Energy – www.phgenergy.com – Nashville, TN

PHG Energy's modern downdraft gasification technology allows the use of existing waste streams or a flexible array of feedstock for conversion to combustible gaseous fuel for kilns, boilers or electrical generation. The choice of feedstock is a critical element in the economic analysis of any installation, and in the design and construction of the mechanical and control equipment to fuel the recommended gasification equipment.

Examples of feedstock alternatives for PHG systems:

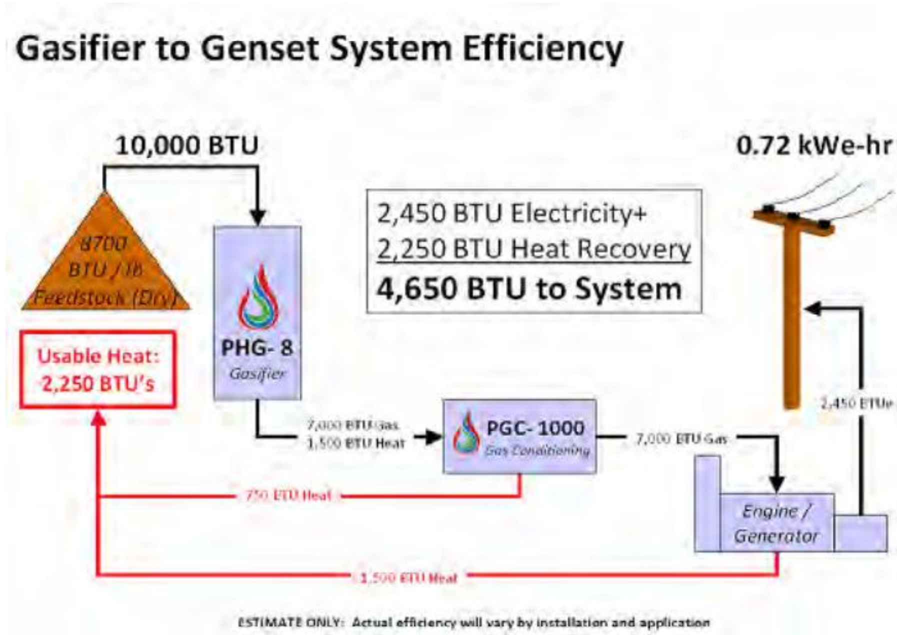
- Wood Chips – bark or other forest product waste
- Manufacturing Scrap – pallets, and other by-products
- Agricultural Biomass and Waste
- Purpose-grown renewable crops
- Processed Municipal Solid Waste
- Scrap Tires and Rubber Products
- Coal

PHG Pilot System

In July 2012, PHG announced that a biomass gasification waste-to-energy system will be built adjacent to the wastewater treatment plant on city of Nashville owned property. The waste to be used, approximately 12 tons per day, is primarily composed of woody biomass from the city's collections. The use of biosolids from the treatment plant is also being investigated as a possible fuel for the gasifiers.

PHG's technology combines a state-of-the-art downdraft gasification system with thermal oxidation equipment and a 125 kilowatt Organic Rankine Cycle (ORC) power generator, manufactured by General Electric, to produce electric power. ORC generators offer low operating and maintenance costs while running without the need for constant attendance by an operator. Combustion of producer gas within the thermal oxidizer provides heat to power the system while maintaining emission levels comparable to the use of natural gas.

Direct Electrical Generation:



Further refinement of the Producer Gas through the PGC-1000 processing skid technology allows direct injection into internal combustion generator engines. Securing feedstock at $30/ton will provide customers with a three-year equipment payback based on offsetting delivered electric costs of 14.2 cents per kilowatt hour. This estimate also considers maintenance and operating costs of the gasification system.

Concord Blue – www.concordblueenergy.com – Jacksonville, FL

Concord Blue is a waste to Energy Company offering turnkey solutions to disposal of wastes from a wide range of sources. As a comprehensive waste-solution innovator, Concord Blue delivers environmentally friendly, economically viable, turnkey, waste-to-energy solutions. Concord Blue Energy is an American daughter company of CONCORD BLUE ENGINEERING GmbH. Corporate headquarters are in Düsseldorf, Germany, with U.S. office in Jacksonville, FL. The Concord Blue System is not only environmentally friendly, fulfills all International, EPA and European regulations in regards to the renewable energy laws and air emissions, but is also the most economically viable waste and sewage sludge disposal solution.

The Concord Blue systems offer the following features:

1. Accommodate small to very large volumes of waste. This is a scalable system that is economically viable and self-sustaining. Smallest size is 100kg (220 lbs) per hour up to 40 metric tons per hour per single reformer; off the shelf power modules of 1MW, 2MW and 4MW are available;
2. Decentralized system – capable of working in remote / extreme conditions;
3. Stand-alone system – no special infrastructure or utility requirements;
4. Self-Sustaining system – no additional fuel sources needed (only for start up);
5. Fully automated system – easy and cost-effective to operate;
6. Environmentally friendly – meets or exceeds U.S., European and other International regulatory standards;
7. Tailor-made scalability and flexibility – Is able to handle different throughput feedstock volumes and varying multi-waste input;
8. High efficiency – regardless of scale, the system is highly efficient;
9. High flexibility – total control of plant in order to maximize desired output depending on current economics, i.e. produce maximum electricity during peak hours and then produce maximum amounts of biochar during off-peak hours.

Due to the tower-like structure of Concord Blue reformers, a 20MW Concord Blue plant running on approximately 150,000 tons of fresh/wet MSW per year typically only requires around 2.5 acres or 10,000m2 / 107,000ft2 for the entire system including storage, gen-sets, interconnect, etc.


Test Plant in Herten, Germany

Typical Concord Blue Unit requires area of 2 acres with a 10,000 sq. ft. office, storage and maintenance building. Plant would be sized for 80 tons per day of tire derived fuel, MSW, or wood wastes. Electrical output would be 4 MW that would be available for park tenants or sales into the grid. Staffing would be 25 people for 3 shifts and 7 day a week operation.

Appendix 6: Recycling Technology Companies

The CRRP provides an ideal location for fully enclosed recycling facilities that would provide segregated feedstocks for the renewable energy technology companies. This could include a state-of-the-art advanced Municipal recycling Facility (MRF), a construction and demolition recycling center and a used oil collection and conversion company. Following are companies that could provide these services.

Organic Energy Corporation – [www.organicenergycorp.com -Sacramento](www.organicenergycorp.com), CA

Organic Energy Corporation (OEC) has a patent pending MRF design that is a highly automated, mechanized, integrated and extremely efficient for Municipal Solid Waste (MSW) mining. The OEC System is designed to first, mine or recover all recyclable commodities that have a market value exceeding capture and/or disposal costs and second, covert all remaining low or negative value wet and dry organic residue to fuel, energy and soil amendments.

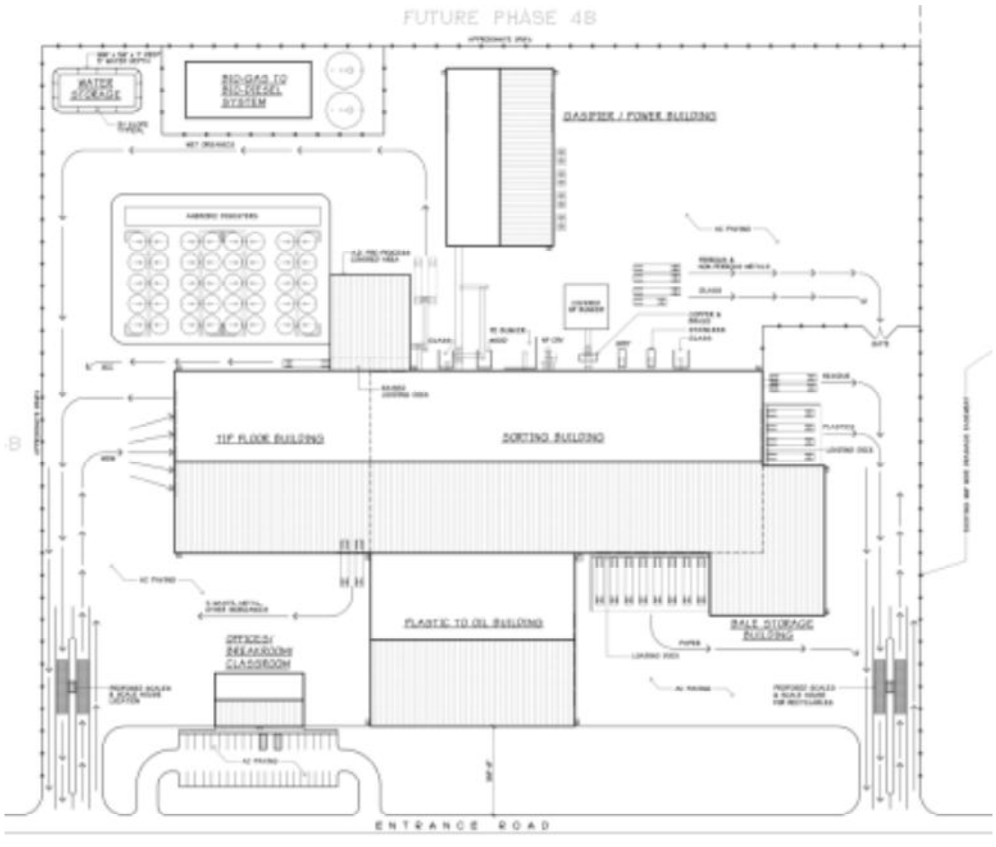
OEC has, as its cornerstone, its multi-Patent-Pending Mining Recyclables Facility™. The idea is to classify and homogenize the various elemental streams contained within the inbound MSW. Once this occurs, these streams are guided toward the technology to maximize the recovery efficiency of individual commodities, even if they are only present in fractions of a percent within the MSW. All separation and recovery occurs through a custom designed and engineered front-end system that incorporates conveyors, shredders, disc screens, ballistic separators, metal detectors, vibratory screens and feeders, magnets, eddy current separators, air separation and density classification technology, optical sorting technology (infrared, X-ray, camera), material storage systems and baling systems. The front-end is highly efficient, with operating costs of a few dollars per ton, while providing throughputs of up to 100 tons per hour per system module.

The OEC system offers maximum recyclables recovery and conversion rates of 90% or more on typical "black bin" landfill bound waste, at an extremely low operating cost and high efficiency. All of the components are field proven and established technologies that are configured in a unique way to produce extraordinary results. OEC has secured and will arrange financing for all of its development projects, based upon a minimum 20% Internal Rate of Return (IRR) for its investors.

OEC Plant Design Parameters: 2,000 TPD In-bound Commercial and Residential Material

- 1,260 TPD Recycled Recovery
- OCC, Mixed Paper, FE, Mixed NF, Aluminum Cans, Copper & Brass, Stainless Steel, PETE, HDPE, Film Plastic, #3-7 Plastic, Glass
- 100 TPD Full Scale (Dry Organics) EOF™ = 3.5 MW of Electricity
- 434 TPD Full Scale (Wet Organics) EOF™ = 6,000 Gallons of CNG (DGE)
- 200 TPD Class A Solid Digestate/Compost
- 90% + Diversion from Landfill
- $85 Million Investment
- 42% Simple ROI

OEC land requirements for plant would be 20 acres, with main building being 160,000 square foot under roof and would require 100 full time employees.



OEC Plant Layout

OEC Material Flow

EcoTec Fuels – [www.ecotecfuels.com-](http://www.ecotecfuels.com) Reno, NV

EcoTec Fuels (German and US Patents Pending) produces equipment that utilizes a Catalytic Fractionated Conversion (CFC) process to convert waste to liquid fuels. EcoTec has a pilot test unit located in Reno, Nevada.

- The CFC process is claimed to utilize a wide range of waste and low-no cost renewable organic streams as its prime resource and feedstock. Feedstock include but are not limited to: fats, oils, greases (plant, animal, fossil), plastics, paper, wood, plant / animal material, (prepared) municipal, agricultural and industrial streams, hospital waste, refinery residue, tank bottoms, sludge, tar, bitumen, and a wide range of organic materials are production-scale process-able.
- The product is a very high quality fractionated middle distillate fuel oil, similar to diesel, kerosene or jet fuel, with room for an attractive profit margin and return on investment.
- A Single ECOTEC 700L unit will process 1.4 tons/hour of biomass waste, or 33.6 tons in 24 hours and operate on continuous basis.
    - Estimated Single Unit output is 700 liters/hour. or 186 gals/hour
- A 6-Unit plant will process 200 tons 24/7 at 5% moisture content.
- Estimated 6-Unit plant output is 26,628 gallons/24 hour/day; or 8,321,250 gals per year, based on 7,500 hour/year (312.5 days).
- One ton (1,000 kg) of biomass waste will yield 500 liters (132 gallons) of fuel oil that complies with ASTM D-975, known as highway diesel for cars and trucks. Based on an expected yield of 9.21 gallons of diesel from conventional processing of crude oil, 1 ton of biomass converted into EcoTec Fuel yields the same amount of diesel as 14.3 barrels of crude.


Typical Ecotec Fuels Plant Pictures

The above pictured Ecotec Fuels Plant requires an area of 2 acres with a 20,000 sq. ft. building for plant conversion modules, material storage, office, and maintenance area. The initial installation would be 3 modules or 100 tons per day input, with room for expansion to three additional modules. 100 ton per day input will produce 143 barrels of oil per day or approximately 4,000,000 gallons per year.

The building would have a clear span with minimum ceiling height of 26 feet, 4 three exterior loading doors, and a small, interior office area with an HVAC system. It would also have 3-phase electrical service. Additional units could be added without requiring additional building space. Plant would be sized for 100 tons per day of used oil (10%), and MSW (90%). Staffing would be 25 people for 3 shifts and 7 day a week operation.

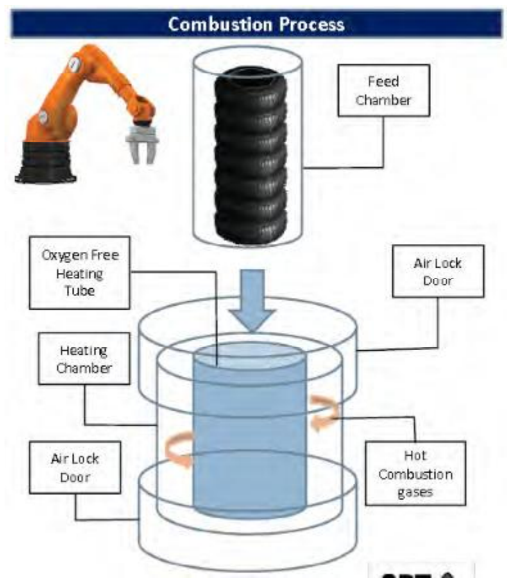
Green Distillation Technologies Pty, Ltd; New Zealand

Green Distillation Technologies (GDT) is commercializing an innovative process to resolve the long standing, global environmental problem of tire disposal, to produce oil and recover steel from end of life tires.

GDT has a pilot plant already in operation which has been extensively tested by potential buyers of its commodity outputs as well as the Australian Government, Department of Innovation, Industry Science and Research ("AUSIndustry"). GDT has a pipeline of seven (7) commercial plant opportunities in Australia of which two are ready to commence development immediately.

GDT distillation process is a quasi-continuous batch pyrolysis process which has been adapted to ELT feed stock. GDT's plant design has the following key elements:

- A series of reactor chambers, or 'tubes';
- An integrated combustion chamber/reactor housing assembly;
- A vapor condensing unit; and
- A CO2 and sulfur removal unit.



For each batch, the heating tube is loaded with a mix of used car and truck tires from a feed chamber located at the top of the vessel. a key feature of the technology is that the feed stock requires no pre-processing. (Hot combustion gases are circulated through the cavity surrounding each heating tube to heat ELTs to the maintained distillation temperature range. Total processing time for each batch, including ELT loading, the process cycle time and unloading operations is claimed to be 1 hour.

Two gaseous streams feed the process; a) Organic Vapor Stream that is condensable oils and b) a combustion exhaust stream. The product vapor stream is sent to a condenser, where the condensable fraction (oil) is captured. The residual heat is removed to the cooler/scrubber, where it is reacted with calcium hydroxide $Ca(OH)_2$, where CO_2 and sulfur oxides(SO_x) from the exhaust stream are adsorbed and precipitated as calcium carbonate ($CaCO_3$) and calcium sulphate ($CaSO_4$).

The cleaned gases leaving the scrubber are returned to the atmosphere. Solid products from the conversion process, including steel wire and carbon are removed from the bottom of the reactor for further processing and isolation as commodity for resale.

WRT Indio LLC and Omega Refining Corporation –Indio, CA and Marrero, LA

WRT Indio in partnership with Omega Refining wish to use CRRP to build an oil recovery plant that would convert up to 25,000,000 gallons of used oils into lubrication oils, motor oils and other petroleum products. The Proposed plant would need a 20 acre site and would gross $100 million per year employee 50 employees. The Park's existing Programmatic Environmental Impact Statement for the park presently allows oil recycling but volume limit would have to be increased and issues with DSTC resolved.

Omega Refining Corporation (Omega) is a major United States stakeholder in the used motor oil (UMO) re-refining industry. Since 1994, Omega and its predecessors in southeastern Louisiana have established themselves as leaders in operating re-refining facilities. Omega currently operates the second largest UMO re-refining facility in the United States.

The transportation and industrial sectors in the United States generate approximately 230 billion gallons of UMO annually, but only about five percent is re-refined. While more re-refining facilities are coming on-line, the number is few; and compared to Europe, our nation lags dramatically. Used lubricating oil is a renewable resource and a valuable commodity.

By adding a plant at the CRRP, WRT and Omega will be building stronger economies in the local Mecca community. This facility would create good-paying jobs, generating local and state taxes and increasing the amount of local goods and services purchased. By increasing the amount of re-refined UMO in the marketplace, this plant will also assist in reducing dependence on foreign oil and better protect the environment.

T2eEnergy – www.T2eEnergy.com-Carlsbad, CA

T2eEnergy has submitted grant requests that would allow testing of its patented Algae technology that would utilize CO2 from large steam turbine power plants. The approach involves underground tanks that feed CO2 from a power plant, artificial grow lighting, and a patented enzyme that increases Algae production by factor of 4 to 10 over conventional approaches. Algae will be harvested for its bio-oil and sent to refiner to produce bio-diesel fuel.

Cabazon Band of Mission Indians

ACTION PLAN

Strategic Energy Planning For a Renewable Energy Demonstration Center

Present to:
U.S. Department of Energy
Tribal Energy Program
Contract # DE-EE0005059

Project Officer: Lizana Pierce
lizana.pierce@go.doe.gov

Prepared by:

Cabazon Band of Mission Indians
Planning Department
84-245 Indio Springs Pkwy
Indio, CA 92203

Technical Contact: Becky Ross
bross@cabazonindians-nsn.gov

December 2013

Project Data

Awardee:	Cabazon Band of Mission Indians
Location:	Indio, CA
Type of Award:	First Steps Grant
DOE Grant Number:	DE-EE000050509
Project Amounts:	DOE: Awardee: Total:
Project Period:	Start: September 1, 2011 End: December 31, 2013
Project Officer	Lizana Pierce, Manager U.S.D.O.E. Tribal Energy Program Golden Field Office Phone: (303) 275-4727 Fax: (303) 275-4753 lizana.pierce@go.doe.gov
Tribal Contacts:	*Technical:* Ms. Becky Ross Phone: (760) 342-5000, ext. 84784 bross@cabazonindians-nsn.gov *Business:* Ms. Leilani Gomez Phone: (760) 342-5000, ext. 85788 lgomez@cabazoninidans-nsn.gov Cabazon Band of Mission Indians 84-245 Indio Springs Pkwy Indio, CA 92203

Table of Contents

Executive Summary

Project Overview

The Cabazon Band of Mission Indians was awarded a grant under the U.S. Department of Energy's ("DOE") Tribal Energy Program to develop a comprehensive Tribal Strategic Energy Plan. The grant, awarded under DOE's First Steps program, supported the development of a strategic energy plan that would include the development of an Action Plan for the addition of a Renewable Energy Demonstration Center ("REDC") at the Tribe's Cabazon Resource Recovery Park ("CRRP').

The strategic energy plan would be integrated into the Tribe's long-range goals to become energy self-sufficient, foster economic diversity, grow jobs and improve the well-being of Tribal members as well as citizens in the Coachella Valley of Southern California. At the same time, the Tribe does not want to sacrifice its long-time commitment to the careful stewardship of the environment.

Project Objectives

The goal of the project was to determine if the addition of a REDC at the CRRP would benefit the Tribal Strategic Energy Plan. To accomplish this project goal, the following took place:

- Perform a baseline assessment of the REDC concept which included these tasks:
  - A vision statement;
  - Needs forecast (demand analysis);
  - Energy resource options (supply analysis);
  - Preliminary choices; and
  - Setting priorities.
- Develop an Action Plan based on the findings of the assessment.

Descriptions of Activities Performed

After the completion of the first draft of the baseline assessment, the Tribal Staff and the consultant held a series of conference calls and meetings to discuss the draft assessment as it was unclear if the REDC concept for waste conversion technologies was viable for inclusion in the Tribe's Strategic Energy Plan and long-term goals for the CRRP. The consultant took the findings and concerns from these calls and meetings to produce a second draft. After receiving and reviewing the second baseline assessment draft and research by the Tribal Staff, it was concluded that the assessment lacked available data and information on waste conversion technologies in the United States to determine the viability of the REDC concept.

Even though the viability of the REDC concept could not be shown, the Tribe believes that waste conversion technologies will play a role in the development of the CRRP and in turn benefit the Tribe's Strategic Energy Plan. The Planning Department and other Tribal Staff members were tasked with formulating actions that could be used by the Tribe to evaluate the technologies.

The Action Plan – Proposed Actions

So that waste conversion technologies can play a role in the development of the CRRP and benefit the Tribe's Strategic Energy Plan, the Planning Department and other Tribal Staff members formulated action tasks that could be used by the Tribe to review and evaluate these technologies. The recommended actions were organized into the categories of "near-term initiation/execution", "future study" and "continued monitoring" for prioritizing as it was recognized for practical reasons that Tribal Staff time and resources would prevent execution of all of the actions at once.

The foundation for prioritization included factors such as potential for greatest impact/value, need of further analysis, and the ease/complexity of implementation. When factoring in a timeline, factors such as lead times, study periods monitoring of ongoing industry advances were also considered. Incorporating these factors, the recommended actions for (i) near-term initiation/execution, (ii) future study and (iii) continued monitoring are presented below.

Actions for Near-Term Initiation/Execution

Recommendation #1: Development of a Conversion Technology Informational Checklist.

A checklist could serve as a convenient tool for use when reviewing/evaluating technology for inclusion in the Tribe's CRRP or for future study. Topics to be considered are:

- Technology Type.
- Permitting – whether or not the technology had been permitted by a federal, state or foreign agency or meets a DOE Technology Readiness Level of 7, 8 or 9.
- Environmental Impacts – air emissions, solid residues, liquid residues, and nuisance factors.
- Feedstock – availability, storage and pre-use preparation.
- End Products – Residues – Wastes.
- Plans.
- Timeline.
- Staffing.
- Regulatory compliance.

Recommendation #2: Attend Conversion Technology related Conferences/Training Events.

Conferences and training events relating to conversion technology could serve as an avenue to either learn about emerging commercial technology or serve as a venue to present the CRRP concept to attract interested companies. These events are:

- Sponsored by industry related associations.
- Put on by federal/state agencies having an interest in the technology like DOE and EPA.

Recommendation #3: Perform a Study of the Waste Streams of the Coachella Valley.

Though the draft assessment discussed the increasing challenge in the United States for the disposal of waste, it did not address how this challenge was being addressed in the area surrounding the Tribe's Reservation – the Coachella Valley. If a sustainable waste stream can be found in the Coachella Valley that can be utilized as feedstock for a conversion technology, it will help in lowering the production costs for the technology.

Actions for Further Study/Longer-Term Initiation

Recommendation #4: Partner with a University/College Involved in Conversion Technology Research/Development.

Many universities/colleges involved in the research and/or the development of conversion technology do not have the available land to build a commercial sized unit of a proven pilot. This partnership would be similar to the REDC concept except the technology would come from academia.

Actions for Continued/Future Monitoring

Recommendation #5: Continue Monitoring for Studies, Assessments, Reports on Waste Conversion Technology.

Even though there are no technical experts like engineers/chemists on the Tribal Staff at this time, Staff members have used studies, assessments and reports found on the internet or in association/agency newsletters to educate themselves on waste conversion technology. Documents found by the Staff ranged from "*Conversion Technology Evaluation Report"* prepared for The County of Los Angeles Department of Public Works and the Los Angeles County Solid Waste Management Committee/Integrated Waste Management Task Force's Alternative Technology Advisory Subcommittee, August 18, 2005, to the "*State of Practice for Emerging Waste Conversion Technologies"* prepared for the U.S. Environmental Protection Agency, October, 2012. Tribal Staff should continue to monitor for studies, assessments and report on waste conversion technology to educate themselves and the Tribe on technology being considered for the CRRP, especially performance or independent testing data that could be used to validate technology claims.

Implementation and Timeline

Based upon the Tribal Business Committee's (BC) consideration of the recommendations contained in this Action Plan and their subsequent guidance, Tribal Staff will prepare detailed implementation plans and schedules for those recommended actions if the BC decides to pursue.