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Economic and Financial Implications of the ZEROS Technology

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ECONOMIC AND FINANCIAL IMPLICATIONS OF THE ZEROS TECHNOLOGY

Contract Report
to the State Energy Conservation Office

Contract CM918

by

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ECONOMIC AND FINANCIAL IMPLICATIONS OF THE ZEROS TECHNOLOGY

Table of Contents

Table of Contents, continued

List of Tables

ECONOMIC AND FINANCIAL IMPLICATIONS OF THE ZEROS TECHNOLOGY

Abstract

A conceptual understanding of the complexity of the ZEROS technology is realized and incorporated into both a base (i.e., benchmark) and a robust scenario analyzed and discussed in this report. The calculated economic and financial feasibility results, based on engineering and chemical factors, suggest that for these scenarios the technology has substantial potential for being profitable. A set of extensive sensitivity results are presented, reinforcing the base conclusions regarding the potential profitability of the ZEROS technology, but also identifying the possibility that variations in values for a combination of the numerous input factors could negatively affect the apparent potential of the technology. Alternatively, energy prices could increase, resulting in a more favorable prospect for the technology. The reported results for the robust scenario materially demonstrate the importance of considering financing, federal taxation, and incentives in detail when considering capital investment projects. Given the data available for the Killeen ZEROS project and the extent of the analyses reported, the ZEROS technology appears to have potential merit as a profitable investment. Additional economic and financial investigations are warranted where system locations or fuel differences or other issues are different than that analyzed in this report.

ECONOMIC AND FINANCIAL IMPLICATIONS OF THE ZEROS TECHNOLOGY

Introduction

This project analysis is targeting the conversion of biomass and/or other renewable carbon-based feedstock for energy production. There are alternatives for biomass conversion, but to date, the cost of conversion makes the final energy output more costly than conventional energy sources, in the absence of significant government subsidies. Preliminary engineering and economics studies suggest that the Zero-emission Energy Recycling Oxidation System (ZEROS) may have an advantage in converting biomass to different energy forms, ranging from electricity to gasoline to diesel, as well as higher alcohols, and doing it with a broad array of feedstock. However, there is a dearth of an objective, unbiased third-party assessment of this emerging technology; therefore, the technology needs to have a detailed economic and financial evaluation whereby a model is developed that allows multi-uses relative to feedstock and types of output. If indeed the technology is feasible, then it opens the door to distributed generation of energy based on location of feedstock. In addition, what previously has been a waste stream could be used as a valuable feedstock. There is a need for a detailed economic and financial analysis of the technology to determine breakeven points and overall implications. Expected clienteles for these results include federal, state, and local government entities, as well as the private sector.

Project Objectives

- Perform an economic/financial study of the ZEROS technology**,** considering alternative feedstocks (i.e., inputs) and potential output products such as electricity, gasoline, diesel, and water, developing per unit costs of products produced.

- Conduct sensitivity analyses across several factors involved with ZEROS such as capital investment costs, operating costs, length of life of components, and amount of marketable products and byproducts.

- Examine the impacts of critical institutional factors potentially affecting the economic and financial feasibility of ZEROS, including financing terms, taxation, and subsidy incentives.

With work initiated under this project and related Texas AgriLife research, it is anticipated there may be future opportunities to apply this paradigm to evaluations of using alternative feedstocks in a ZEROS plant, including dedicated biofuels feedstock, waste streams, and crop residues, as well as interest by communities for protection against grid blackouts or system enhancements during peak electricity demand periods.

Background

There are contemporary dramatic needs and issues that relate to energy, natural resources, waste disposal, and the environment. There is an economic implication related to the need for generation of energy, potable water, and reduction in the waste stream for communities, industries, and the military. Technologies which may be more efficient and effective than current alternatives are evolving that have the potential to address these needs of society. ZEROS is one of these technologies with promise.

As communicated in Jones, "ZEROS (Zero-emission Energy Recycling Oxidation System) is an innovative "oxy-fuel" technology that uses pure oxygen to completely oxidize a variety of organic/hydrocarbon fuels with no air or waste emissions and with complete sequestration of CO_2. ZEROS technology was developed, patented, and commercialized in the late 1980s and early 1990s by Mr. Steve L. Clark to clean up oilfield waste without producing atmospheric emissions or water pollution." The feasibility of the ZEROS technology has been chronicled in several proprietary engineering and economic analyses reports prepared for potential investors in both public and private sectors. Consistent conclusions of such prospectuses are that a ZEROS plant would be very profitable because of its potential multiple sources of income, including tipping fees and sale of synthetic diesel fuel and pure CO_2, N_2, Ar_2, and H_2O, among other possible byproducts. The magnitude of investment required is substantial and a deterrent to adoption of the technology. Also, U.S. institutional requirements that implementation of improved technology by public utilities occur uniformly across all of an entity's generation plants once the initial investment has occurred further impedes adoption of the ZEROS technology. Several efforts are ongoing to "sell" the technology, but related economic studies are confidential in nature and generally conducted in-house and provided only to prospective clients. This project seeks to provide an objective third-party assessment of the economic and financial feasibility of investment in and operation of a commercial ZEROS plant. Mr. Clark of ZEROS, Inc. is the primary source of the confidential data used in the analyses. A broad spectrum of sensitivity analyses involving variations in several critical data factors is employed to investigate the absolute and relative stability of feasible economic and financial investment in the ZEROS technology.

As described by Steve Clark (2007), who is founder of ZEROS, Inc. and Systems International, Inc. and holder of seven intellectual properties related to the ZEROS technology:

- "ZEROS is a two-stage process. First stage is gasification and second stage is oxidation. It is this second stage and the fact that ZEROS has no smokestack that makes ZEROS unique to all other processes.

- Air separation units (ASU) can be energy intensive, but not so in ZEROS. ZEROS has a [large amount] of high temperature waste heat and it is primarily this high heat that is the energy source for the ASU. A 50 megawatt plant has a gross megawatt output of approximately 55 megawatts per hour. The system ASU has a parasitic draw of approximately 4 megawatts for a net plant output of 50 to 51 megawatts. This is in line with coal-fired plants running their feed water pumps, cooling towers and smokestack gas cleaning apparatus. The net result is ZEROS has at least equal efficiency."

ZEROS is an innovative technology that uses pure oxygen to create high temperatures needed to completely oxidize hazardous organic wastes as well as biomass. This process can be fueled by a variety of materials, including: municipal solid waste, agricultural biomass and manure, coal, paper or plastic trash, car tires, natural gas, waste oil, and woody materials. The potential resulting products from this process include electrical energy, process steam, liquid fuels, sulfur, sulfuric acid, oxygen, hydrogen, argon and nitrogen, slag/char/rock wool, pure carbon dioxide, and distilled water. An exceptional trait of this process is that there are no atmospheric emissions or exhaust stacks constructed at a ZEROS facility, it emits net negative carbon dioxide when powered by renewable biomass and zero carbon dioxide when powered by fossil fuels. The resulting pure carbon dioxide from the process may be marketed for injection in deep geologic formations or other industrial processes.

The ZEROS technology is especially unique because it cannot be categorized as just one type of facility. A ZEROS unit could be categorized as a power plant, a waste disposal facility, an environmental remediation project, or a manufacturing plant. In evaluating ZEROS for its energy production capability, there are several characteristics that separate this technology from the typical power plant. The first is the potential for multiple revenue streams from the resulting multiple by-products. A traditional power plant relies on one source of revenue, energy, whereas a ZEROS plant can generate sales for a number of products (i.e., distilled water, liquid fuels, electricity, etc.). Secondly, due to the two-step energy release in the oxidation process for ZEROS, the total energy released per pound of fuel is greater than more traditional combustion processes, with 35-80% of the nominal heating value of the fuel released. Generating electricity using ZEROS generates Renewable Energy Credits (Green Tags) and Carbon Emission Reduction Certificates (CER) which could be sold on a national and international market. Further, since a ZEROS facility is considered a "closed" system and has zero airborne emissions or liquid discharges, it is an environmentally-friendly system and is exempt from requiring any air emission permits (Clark 2007).

Considering the role of ZEROS in waste removal while generating the set of output products, the system has proven to demonstrate 100% Destruction Removal Efficiency (DRE) which is the ratio of the number of molecules of the targeted compound destructed and removed relative to the number of molecules entering the system.

As described in Jones (2011),

> "ZEROS (Zero-emission Energy Recycling Oxidation System) is an innovative "oxy-fuel" technology that uses pure oxygen to completely oxidize a variety of organic/hydrocarbon fuels with no air or water emissions and with complete sequestration of CO_2.
>
> ZEROS technology was developed, patented, and commercialized in the late 1980s and early 1990s by Mr. Steve L. Clark to clean up oilfield waste without producing atmospheric emissions or water pollution. The ZEROS process is currently being commercialized by The Chambers Fuel & Energy Project to produce up to 100 million gallons of diesel fuel per year and/or up to 50 MWhr per gross (gross) of base load electrical energy. All CO_2 produced by the facility will be captured for sale/sequestration, mostly for enhanced crude oil recovery in mature oil fields or perhaps to produce algae for liquid fuel. In addition, commercial quantities of pure N_2, Ar_2, distilled H_2O, and several minor products will be sold through existing markets. The Chambers County facility will produce no air or water emissions, including the greenhouse gas CO_2.
>
> ZEROS combines several well-known technologies into a unique system with many advantages. Fuels are oxidized with pure oxygen from a co-located air separation unit.

Initial gasification—partial oxidation of the fuels—is accomplished in the primary reaction vessel, a rotary kiln. The synthesis gas that is produced in the rotary kiln (primarily CO, CO_2, CH_4, H_2, and H_2O) moves to either

- a secondary reaction vessel where it is completely oxidized with pure oxygen to CO_2 and H_2O (which are captured as pure liquid (or solid) CO_2 and distilled water) and the heat released is used to drive a steam turbine and electrical generator or
- a steam reformer and a modified, carbon-recycling Fischer-Tropsch reaction vessel to produce diesel fuel.

By using pure oxygen as the oxidant, the system can use low quality fuels that would not normally be considered for traditional incineration technologies. A variety of organic materials—including coal, lignite, municipal solid waste, wood waste, scrap tires, agricultural and forestry biomass, animal manure, sewage sludge, and a number of hazardous organic wastes—can be used as feedstocks to power the system. Finally, a ZEROS facility has no smokestack and has no air or water emissions; it captures and renders harmless all oxides of nitrogen and sulfur, heavy metals, organic compounds, and other potential contaminants, including asbestos."

Numerous patents are associated with the ZEROS technology. Refer to Appendix A for a brief discussion of those patents (Jones 2011).

Methodology

The methodology used to analyze the economic and financial feasibility of ZEROS technology combines standard Capital Budgeting-Net Present Value (NPV) analysis with the calculation of annuity equivalent measures. Calculating NPV values of dollars allows for comparing alternatives (i.e., other energy sources) with differing cash flows and energy production output, while the use of annuity equivalents facilitates comparisons of projects with different useful lives. This combined approach integrates expected years of useful life with related annual costs and outputs, as well as other financial realities, into comparative, comprehensive annual life-cycle costs. These financial measures are augmented by development of corresponding cash flow and income *pro forma* budgets, allowing the calculation and reporting of several financial measures of interest, e.g., Benefit-Cost ratio, ROI, EBIDTA.

A spreadsheet-based model, ZEROSECONOMICS©, was developed to estimate economic and financial implications of the ZEROS technology. In the spreadsheet model, specific cost items are included for the initial investment including land, foundation, storage units, electrical service, equipment components, and such. In a similar fashion, continuing operating costs are divided into individual functional areas such as administrative (i.e., overhead, insurance, labor, maintenance, vehicles) and Operations and Maintenance (i.e., chemical, power, oxygen, maintenance, vehicles, feedstock, other). Furthermore, the model includes the projected revenues for each of the end products (i.e., electrical energy, liquid fuels, water, other). This spreadsheet model facilitates calculating estimates of economic costs per year and per unit of energy. The model will also provide a breakdown of costs by type, (i.e., initial construction, recurring costs), segment (i.e., individual functional areas of the system), and item (i.e., oxygen, chemicals). Due to brevity concerns, such detailed results are not presented in this report. Refer to Appendix B for a listing of the data required in ZEROSECONOMICS©.

Sensitivity analyses are used to evaluate alternative values of major factors . Doing so allows testing the stability (or instability) of key input values and demonstrates how sensitive results are to variances in input factors. Key variables subject to sensitivity analysis include (a) the initial capital investment, (b) annual operating costs, (c) length of useful life of the capital components, and (d) marketable sales of products and byproducts.

Net Present Value (NPV)

The basic elements of determining if a proposed capital investment project is worthwhile are represented in the net present value (NPV) equation:

$$BNPV_0 = \quad -\sum[CI_j / \{(1+r)^j\}] + \sum[R_i / \{(1+r)^I\}] - \sum[E_i / \{(1+r)^I\}] + NSV_{z+1} / (1+r)^{z+1},$$

where,

BNPV: basic net present value of the project;

0: time zero, at the beginning of the project investment stream;

CI: capital investment expenditures;

R: revenue inflows, from sale of products;

j: year of investment, commencing in time 0 and extending through z to account for recurring intermediate capital replacement items;

i: year of realization, with years extending from 1 through z;

r: interest rate used for discounting;

E: expense outflows, for operating expenses;

NSV: net salvage value of project, at end of its expected useful life; and

z: last year of project's use ful life.

Identifying the respective elements of a capital investment project and calculating the noted NPV results in an assessment of the project which accounts for the time value of money according to the basic tenets of finance; refer to Rister et al. (2009) for a discussion of the relevant issues. Calculated BNPVs greater than zero are suggestive the related capital investment projects are economically feasible, capable of realizing net returns in excess of the costs of the investments. Alternatively, projects for which the BNPVs are less than zero are generally deemed infeasible in that the projected net returns (over the course of its expected life term) are insufficient to merit the initial capital costs.

While the above model representation captures the general aspects of capital investment ventures, the addition of several critical features facilitates a more comprehensive consideration of capital investment projects often available to investors:

$$RNPV_0 = -\sum[CI_j / \{(1+r)^j\}] + \sum[R_i / \{(1+r)^I\}] - \sum[E_i / \{(1+r)^I\}] + NSV_{z+1} / (1+r)^{z+1} + \sum[TC_i / \{(1+r)^I\}] + \sum[INCT_i / \{(1+r)^I\}] - \sum[TX_i / \{(1+r)^I\}] - \sum[INT_i / \{(1+r)^I\}] + \sum[IINC_i / \{(1+r)^I\}] ,$$

where,

RNPV:	robust net present value of the project;
TC:	federal, state, and local tax credits associated with capital investment ventures;
INCT:	incentives associated with capital investment projects;
TX:	federal, state, and local taxes levied against taxable income;
INT:	interest costs associated with capital and short-term financing and
IINC:	interest income associated with investment accounts.

The fundamental purposes of the additional noted terms are to account for the various incentives and financing features associated with large capital investment projects, including the effects of income taxes. The resulting robust present value is to be interpreted similarly to the prior noted net present value; that is, capital investment projects with RNPVs exceeding zero are economically feasible, whereas those having RNPVs less than zero are not feasible.

Benefit-Cost Ratio (B-C)

Many analysts and investors are interested in comparing the ratio of all benefits to all costs. Ratios in excess of 1.00 are preferred, with higher magnitudes of the ratio representing favorable projects.

Return on Investment (ROI)

Another measure of a capital investment venture project is its return on investment (ROI). That is, what rate of return is being earned by the capital investment venture project? An approximation of this measure is afforded by using the above-noted RNPV paradigm and solving for the r discount rate that realizes a RNPV of zero. That is, for this ROI discount rate, the net returns generated throughout the life of the capital venture project are sufficient to exactly offset the requisite capital assets, both initial and intermediate recurring capital replacement items. The worth of knowing this value is that investors can compare it to their preferred rate of return or their opportunity costs that could be earned in alternative investments and decide if the proposed capital investment project is an appropriate choice. One qualification for this measure is that the calculations are based on the earnings in each year being successively reinvested in future years at that same rate of return.

Annuity Equivalent (AE)

For some capital investment projects, differences in projected useful lives and unevenness in flows of net returns over years often begs for a common denominator for comparison purposes. Calculation of an annuity equivalent (AE) measure provides such a basis of comparison (Rister et al. 2009):

$$AE = RNPV / \{[1 - (1 + r)^{-T}] \div [r]\},$$

where AE refers to annuity equivalent value and other terms are as previously defined above. The AE measure reflects the annual stream of net returns (in present dollars) into perpetuity for the designated project, assuming constant technology prevails into perpetuity, that the capital project is continually replaced at the end of each planning horizon period, and that all other projected revenues and operating costs continue as originally specified.

Breakeven Analysis (BE)

An interesting perspective regarding the stability of analytical results is afforded by “breakeven” analysis. This method of evaluation involves selecting several critical factors (e.g., magnitude of capital investment costs, amount of operating costs, level of revenues, etc.) and individually, holding all other things constant (HAOTC), identifying the numeric value for that factor which would result in the proposed project ‘breaking even’, i.e., having a RNPV of zero. The calculation methods for these types of analyses are similar to those followed in identifying the ROI.

Pro forma Analyses

The afore going measures are all useful in appraising the economic merits of capital investment venture projects, but all are characterized by the same shortcoming in that they each fail to explicitly illustrate the ebb and flow in the timing of cash flows, an issue of substantial interest to most investors and their financiers. Two *pro forma* (i.e., *ex ante* budgeting) budgeting tools often used to project annual flow of funds are the Income Statement and the Cash Flow Budget.

Income Statement

The Income Statement relates the flow of annual receipts and operating expenses while expensing the capital investment expenditures through time based on annual measures of depreciation. The influences of capital expensing, as allowed by tax codes, are considered, as are the deductible measures of capital and short-term financing interest expenses. Net Business Income is calculated on the basis of before and after income taxes. Various secondary measures are calculated to relate the magnitude of this measure to capital debt service associated with financing of the capital assets aspects of the capital investment venture project.

Cash Flow Budget

The Cash Flow Budget illustrates all of the capital investment venture project's cash inflows and outflows, including revenue, operating expenses, debt services, and tax payments. Annual reconciliation of the cash flows is used to identify needs for short-term financing, and to indicate when such financial obligations may be repaid. In addition, distributions of dividends may be reflected, if appropriate.

Sensitivity Analyses

Seldom, if ever, is one analysis of one set of data sufficient to appraise the economic and financial merits of a capital investment venture project. The number of factors involved in determining the bottom line performance of a project and the extended temporal nature of a capital project contribute to a vast complexity of interrelated issues that are often obscured and perhaps inappropriately simplified in conducting only one analysis. Sensitivity scenario analyses are a means of overcoming this deficiency inherent in only one analysis. Select, critical, key factors and related assumptions should be varied both singly and in combinations, with the associated analyses results compared to that for a base, benchmark analysis to enable identification of the relative impact of such factors.

Data

Case analyses are used in this report to evaluate the potential for the ZEROS technology. The base analysis and several sensitivity analyses are framed for an ongoing development of ZEROS for Killeen, TX (Killeen Daily Herald 2008; Clark 2009). In addition, several sensitivity scenarios are performed to evaluate the stability of the base analysis solution and to demonstrate the relative impact of several factors considered critical to determining the economic and financial feasibility of the ZEROS technology. Data for the base, benchmark situation are presented here, representing the nature and magnitude of capital investment and associated operating costs required to produce one technically feasible stream of principal product (i.e., electricity) and selected byproducts using the ZEROS technology.

Base, Benchmark Scenario

The base situation is the Killeen/Fort Hood Municipal Solid Waste ("MSW") to Synthetic Diesel / Power Plant project (hereafter referred to as the Killeen ZEROS Project). Data assimilation for this project commenced in 2008 and is considered bonafide for a 2010 construction start date assumed in this analysis. A three-year construction period (2010-2012) is assumed, with 50% production assumed to occur in the fourth year (2013). A forty-year productive life is assumed for the plant facility. As discussed in the Killeen Daily Herald (2008), financing difficulties have delayed this project, but the data remain appropriate for analysis within the purpose of this economic and financial feasibility analysis project.

The analysis presented for this base, benchmark situation presumes no financing, no federal taxation, and no incentives. That is, the analysis is consistent with the base NPV calculations presented in the Methodology section.

ZEROS Facility

The Killeen ZEROS Project consists of a ZEROS facility designed to produce the equivalent of 50 MWhr of electricity daily, operating at an annual efficiency of 85%, with the regulator-specified QSE factor set at 8,760 (Clark 2009). The various capital assets comprising the facility are designated in **Table 1**. It is assumed that 25% of the Killeen ZEROS project is salvageable at the end of its useful life and that the rate of appreciation on that value is similar to the 1.000% appreciation rate assumed to be occurring for the revenue stream items.

Table 1. Capital Assets Required for the Killeen ZEROS Project, 2009.

Category	Item	Cost
BASIC COSTS		
	System Design and Detailed Engineering	$ 3,500,000
	OEM Zeros RK Equipment Package	36000000
	OEM License and Engineering Package	4000000
	Fuel Handling & Storage Equipment	3280000
	Conceptual Project Design	300000
	Project Controls / Project Management Oversight	8748426
	Installation ~	29895097
	Development Startup Fees	500000
Generation Equipment		
	HRSGs	6150000
	Turbine Generators	10660000
	Control System / Computers / DAS	1100000
	Condenser / Cooling Tower / Flash Distillation Unit	3690000
	Environmental Monitoring Equipment	551000
	Storage Tanks (Water)	4058000
	Storage Tanks & Loading Equipment (Gases)	10000000
	Storage Tanks Diesel	500000
	Air Separation Unit (ASU)	11480000
	Hydrogen Processing Unit	-
	Electrical Auxiliary Equipment	2460000
	Plant Water Treatment	2500000
	Main Power Transformer & Auxiliary Power Transformer	1394000
	Black Start Diesels - 2X	715000
	UPS System/Battery	385000
	Capital Spare Parts	1000000
Site Improvements and Support Structures		
	Buildings & Structures & Receiving Building	3147500
	Fischer-Tropsch Equipment	24850000
	Road Improvements	1450000
	Transmission Interconnect and Switchyard	6000000
	Other Plant Equipment / Tools	1000000
	Consumables	300000

Table 1. Capital Assets Required for the Killeen ZEROS Project, 2009.

Category	Item	Cost
Land Acquisition Cost		
	100 acres[a]	1000000
Project Development, Financing, & Implementation Costs		
	Contingency	10.0%
	Project Performance Bond	1.0%
	Development Fee	10.0%
	Legal and other soft costs	500000
	Equipment Insurance	1.0%
	Financing Fees (for full $250,000,000 USD equity participation)	5.0%
	Working Capital	5000000
	Maintenance Reserve	1000000
	Startup Costs	2750000
	Maintenance, Operating, Safety and Environmental Procedures Development	550000
	Surveys, Fees, Permits and Applications	750000
	Total Capital Costs	$243,399,108

Source: Clark (2009).

[a] Land costs were not specified in the original Clark (2009) data set. For this project, costs of $10,000 per acre for 100 acres are assumed.

Feedstock Material

The principal feedstock assumed for the Killeen ZEROS Project is municipal solid waste (MSW), with daily throughput at 100% operating capacity expected to be 2,400 tons, i.e., 100 tons per hour. Accounting for the expected 85% annual operating capacity and a proprietary modification of the hourly throughput based on fuel source (Clark), annual feedstock requirements are 332,836 tons, i.e., 1,073 tons per day. As noted in the next section, it is assumed that the current tipping fees[1] of $15 per ton will continue and be considered as a revenue stream for the ZEROS facility.

[1] "Tipping fees" are the charges levied by waste management facilities for the receipt of waste materials.

Revenue Product and Byproducts

The designated revenue items are conservative in nature, identified according to those proportions of possible products that can contractually be sold at the time of the analysis. **Table 2** is a listing of the revenue items considered for the Killeen ZEROS Project. These items and the respective products are identified by Clark (2009) using proprietary software. Considerations in identifying the product mix include the fuel source (i.e., feedstock) and the prevailing market prices; that is, this product mix could be dynamic over time as plant management responded to market opportunities and changes in the fuel source and quality thereof. The market prices used in this project are based on regional market analysis by Clark (2009).

Table 2. Revenue Items Considered for Killeen ZEROS Project, 2009.

Product/ ByProduct	Unit	Net Production	% Sold	Price per unit
Electricity	MWhr	372300	100	$ 120.00
Metal	Ton	3328	100	65
Nitrogen	Ton	176250	10	46
Hydrogen	Ton	2882	100	2600
Argon	Ton	2882	100	400
Ash	Ton	33284	100	5
CO2	Ton	351352	100	45
Synthetic Diesel	Gallon	28217914	100	2.95
"Clean" demineralized water for industry	Gallon	72592537	100	0.005
MSW Tipping Fees	Ton	332836	100	15

Source: Clark (2009).

Operating Expenses

Several annual expenditures are required to operate a ZEROS facility and maintain it in operating condition. Such costs are specified in **Table 3** as designated by Clark (2009), as defined by Department of Energy published/posted standards (Clark 2011).

Table 3. Annual Operating Costs for Killeen ZEROS Project, 2009.

Category	Item	Unit	Amount
Variable	Management Fees	% annual rate	1.00%
	Labor Costs	$	$ 9,092,544
	Labor Overtime	%	10.00%
	Training	$	800000
	Fuel Costs	$	-
	Natural Gas Fuel	$	100000
	Leased Equipment	$	125000
	Plant Maintenance:		
	Synthetic Fuels System	$	1864000
	Air Separation System	$	100000
	Power System	$	150000
	Hydrogen System	$	-
	Zeros System	$	380000
	General Facility	$	300000
	Professional Fees	$	360000
	QSE Fees	%	2.00%
	Office Expenses	$	360000
Pseudo-Fixed	Insurance	%	1.00%
	Property Taxes	%	1.50%
	Royalties	$	3000000
Contingency	Contingency	%	5.00%

In **Table 3**, the annual maintenance costs are specified at a level sufficient to keep the facility within 85% of "new" capacity, thereby avoiding the need for intermittent intermediate replacement of selected capital asset components (Clark 2011). Additional details regarding the annual labor cost amount of $9,092,544 are detailed in **Table 4**.

Table 4. Detailed specifics regarding annual labor costs for the Killeen ZEROS Project, 2009.

Job Function	# Workers	Base Rate / hr	Hours / Week	Benefits	Avg Weeks Worked/ Year	Annual Cost
Operator - Group 2	40	$ 28.00	40	41.15%	52	$ 3,288,230
Operator - Group 3	40	22	40	41.15%	52	2583610
Security	5	15	40	41.15%	52	220194
Fuel Handlers	14	20	40	41.15%	52	822058
Site Maintenance	5	15	40	41.15%	52	220194
By-Product Logistics	8	20	40	41.15%	52	469747
Plant Manager	1	50	40	41.15%	52	146796
Control Operators	6	33	40	41.15%	52	581312
Plant Engineers	3	33	40	41.15%	52	290656
Warehouse / Office	5	17	40	41.15%	52	249553
Training / Safety	3	25	40	41.15%	52	220194
Totals	130					$ 9,092,544

Operating Capital

A minimal annual balance of $5,000,000 is required for operating capital. The annual interest rate for short term fund needs is 0.000% in the base analysis, consistent with the intention to ignore implications of financing in the benchmark.

Financing

For the base benchmark analysis, it is assumed the full capital investment cost of the Killeen ZEROS project is paid with cash in time 0, i.e., there are no financing considerations. That is, the project is evaluated strictly on the merits of the anticipated revenues versus the initial capital investment costs and annual operating costs.

Federal Taxes

For the base benchmark analysis, the effects of federal income tax provisions on the Killeen ZEROS project are ignored. That is, the project is evaluated strictly on the merits of the anticipated revenues versus the initial capital investment costs and annual operating costs.

Incentives

For the base benchmark analysis, it is assumed there are no federal, state, or local incentive/ subsidy programs for the Killeen ZEROS project. That is, the project is evaluated strictly on the merits of the anticipated revenues versus the initial capital investment costs and annual operating costs.

Discounting

The three components of the discount rate for the base, benchmark situation are defined as follows:

- societal time preference – 4.0% (Griffin and Chowdhury 2003);
- inflation – 2.04% (Rister et al. 2009); and
- risk – arbitrarily set at 5% due to a dearth of information existing regarding actual operations of a ZEROS facility, i.e., all data are predicated on professional speculation on how the plant would perform and the related capital investment and operating costs and associated revenue streams are projections absent actual performance data.

The multiplicative format (Rister et al. 2009) is used at arriving at the overall discount rate, resulting in a calculated rate of 11.431%.

Robust Scenario

The analysis presented for this robust scenario presumes the presence of financing, federal taxation, and incentives. That is, the analysis is consistent with the robust NPV calculations presented in the Methodology section. The particular assumptions made in regard to each of these areas and incorporated into a revised ZEROSECONOMICS© analysis are noted below.

Financing

For the robust scenario analysis, it is assumed the full capital investment cost of the Killeen ZEROS project is incurred in time 0, and that the total amount is financed according to the following terms. The terms are intended to be representative of what might occur in reality, as well as to demonstrate the financing features incorporated into ZEROSECONOMICS©.

Downpayment. The assumed downpayment amount is $0.

Financing Costs - Percent of Loan. It is assumed a financing fee equivalent to 10% of the cost of capital assets is incurred. Rather than be paid at the time of purchase, this financing fee is capitalized into the loan.

Financing Costs - Flat Cost. It also is assumed a flat cost financing fee equivalent to $1 million is incurred and paid at the time of purchase. Note that ZEROSECONOMICS© does allow for this type of financing fee to also be capitalized into the loan.

Capital Loan Payment Moratorium Period. In recognition of the requisite construction period and allowance for the commencement of operations, it is assumed no principal payment will be required on the capital loan for five years.

Interest Rate During Capital Loan Payment Moratorium Period. The assumed applicable annual interest rate during this moratorium period is 8%. Such interest is assumed to be compounded and all due in the first year that a principal payment is made on the capital loan (as opposed to being paid annually during the moratorium period; such annual payments are facilitated within ZEROSECONOMICS©).

Capital Loan Amortization Period. The capital loan is assumed to be repaid over a seven year period in equal, amortized payments, commencing after the conclusion of the moratorium period.

Balloon Payment. A balloon payment of $50 million is segregated from the amortized capital loan amount and assumed due at the time of the final amortized payment.

Interest on Balloon Payment. An annual 8% interest rate is levied against the capital loan, with such interest being payable during each year of the amortized loan payment period (as opposed to being compounded and due at the time of the balloon payment; such a one-time compounded payment of this interest is facilitated within ZEROSECONOMICS©).

Other Financing Factors. As before, a minimum cash balance of $5 million must be maintained for working capital. The short-term borrowing interest rate is 7%. All cash accumulated in excess of the minimal required balance of $5 million is invested and earns an annual interest rate of 1.5%. No cash dividends are distributed.

Federal Taxes

For the robust scenario analysis, a 35% marginal tax rate is assumed applicable to annual taxable income. As before, the 15-year MACRS method of depreciation on the capital assets is assumed.

Incentives

For the robust analysis, two proxy incentive/subsidy programs are recognized. First, a 0% federal tax investment credit is allowed against the capital asset purchases, i.e., no federal tax credit. Secondly, a 50% abatement of local property taxes is allowed for ten years.

Results

The baseline, benchmark results are used to validate the calculating behavior of ZEROSECONOMICS©, to demonstrate the type of results generated, and to establish a foundation for use in comparing to the results associated with the various sensitivity analyses. The extensive paradigm of ZEROSECONOMICS© facilitates development of a wealth of information useful to potential investors and other stakeholders associated with ZEROS projects under consideration. The results presented in this report are a capsulated summary version of the details represented in the spreadsheet.

Base, Benchmark Scenario – No Financing, No Federal Taxes, No Incentives

This relatively naive, simplified form of analysis presumes:

- all of the requisite capital investment funds are available and expended in time zero;
- the investing entity is of a public sector nature and thus not subject to federal taxation; and

- no federal, state, and/or local cost-sharing or other forms of incentives/subsidies are available to induce the investment activity.

Net Present Value (NPV)

The basic NPV equation previously noted (i.e., BNPV) is representative of this situation. The bottom line calculated BNPV for the base situation is $607,485,536. This value is suggestive that, in time zero, at the beginning of 2010, the proposed Killeen ZEROS project has a net present value in excess of $600 million. This BNPV is calculated considering the cost of the initial investment and the annual operating costs, while presuming the realization of the annual revenue streams and net salvage value one year after (i.e., 2054) the termination of the project in 2053 (allows for three years of construction [2010-2012], and 50% production in the first year [2013] and last year [2053] of the project's expected 40-year useful life). Revenue streams are expected to increase 1% per year while operating costs increase at an expected rate of 2.04%. The discount rate used for calculating the BNPV is 11.431%. Detailed breakdown of the net present calculations can be summarized as indicated in **Table 5**. For illustrative purposes, both nominal (i.e., non-discounted) and real (i.e., discounted for time, inflation, and risk) values are reported.

Table 5. Basic Net Present Value Calculations for Base, Benchmark Killeen ZEROS Project, 2011.

Item	Nominal	Real
Capital Investment	$ - 243,399,108	$ - 243,399,108
Revenues	+ 8,125,138,494	+ 1,070,774,1445
Operating Costs	-1975280812	-220598167
Net Salvage Value	+ 92,418,026	+ 708,666
BNPV	$ 5,998,876,600	$ 607,485,536

How should this result be interpreted? "Very carefully!!!" If this value were the only measure available, the interpretation is that the project appears highly favorable. As noted in the Methodology section, however, no one analysis or one measure of evaluation should be used to appraise the worth of a capital investment project. This warning is especially warranted for a project of the magnitude of investment associated with the ZEROS technology. The following calculated measures provide additional insights into the merits of the proposed project.

Benefit-Cost Ratio (B-C)

The Benefit-Cost (B-C) ratio of the proposed investment project is 3.50. This ratio's value is suggestive that for every $1 of the original investment, $3.50 of net returns, in 2010 dollars, will be realized. The quality of this financial measure in comparison to the previous reported BNPV is associated with the B-C ratio framing the projected net returns as a relative measure (i.e., net returns versus the initial investment) whereas the BNPV is more of an absolute measure. That said, the noted B-C ratio is favorable.

Return on Investment (ROI)

The calculated Return on Investment (ROI) for the base, benchmark project is 25.79%. That is, assuming all net returns are reinvested at this rate, the project realizes a rate of return in excess of 25%. This value is in excess of double the discount rate used in calculating the BNPV.

Annuity Equivalent (AE)

The calculated annuity equivalent corresponding to the BNPV is $70,041,667. A lay interpretation of this value is that should the initial investment of $243,399,108 be made in the Killeen ZEROS project and the plant be constructed and operate according to the revenue stream, annual operating costs, and net salvage value expectations delineated in the Data section, as well as be repeatedly replaced at the end of each 40-year expected useful life period, the investment would generate an annual net return, in 2010 dollars, in the amount of $70+ million. In effect, this is the net annuity return on the investment.

Breakeven Analyses (BE)

The numerous factors involved in a ZEROS project are almost overwhelming when one attempts to anticipate what factors are "driving" the results and what the implications might be if the projections for such "drivers" are in error. Here, several such factors are isolated in an attempt to test the stability of the base, benchmark results. In each case, the original assumption for the selected parameter is altered such that the BNPV is $0.

Magnitude of Capital Investment Costs. The magnitude of requisite capital investments could increase from $243,399,108 to $749,053,049, a factor of 319.0% (i.e., an increase of 219.0%), and realize a BNPV of $0, HAOTC.

Amount of Operating Costs. The amount of annual operating costs could increase by 250.90%, and realize a BNPV of $0, HAOTC.

Level of Revenues. Annual revenue streams could be decreased to 42.0% of expected levels, and realize a BNPV of $0, HAOTC.

Project Expected Life. An iterative evaluation of the project's productive useful life indicates the BNPV would realize a $0 value during year 3 of production, HAOTC.

Risk Discount Premium. Accepting the 4% time value discount rate and the 2.043% inflation discount rate, the risk premium discount rate could be increased to 18.531%, HAOTC, and a BNPV of $0 realized (with the multiplicative format as outlined in Rister et al. 2009).

These measures all are suggestive of similar margin of possible "errors" in the original projected values. That is, the greater the allowed changes, the greater the "comfort zone" for the results. It is important to realize that the validity and usefulness of such breakeven values, similar to the case for all of the previous and subsequent values, are contingent on the reliability of the original stated values.

Pro forma Analysis

Illustrative tables of the pro forma statements produced within ZEROSECONOMICS© are presented below, with attention directed toward important features of and results reflected in such tables. Only the first eleven years of the total 45-year[2] planning horizon are presented, for brevity's sake.

Income Statement. **Table 6** provides for an evaluation of the Killeen ZEROS project on the basis of its annual income performance, using standard accounting formatting. Although Year 0 is included in the table for consistency purposes relative to the Cash Flow Budget (**Table 7**), there is no relevant income statement information in that column of **Table 6**. Earnings Before Interest, Taxes, Depreciation, and Amortization (EBITDA) are first calculated as Revenues less Operating Expenses.

Next, Earnings before Interest and Taxes (EBIT) are calculated by subtracting depreciation and first year expensing (allowed under the federal tax code). In the base, benchmark analysis, the 15-year option of the Modified Accelerated Cost Recovery System (MACRS) depreciation method is used for depreciation purposes and no first year expensing is considered (although allowances for this feature are incorporated into ZEROSECONOMICS©).

Another feature incorporated into ZEROSECONOMICS© is that of allowing temporary waiving of local property taxes by the local taxing authority. Recognition of such abatement results in calculation of an adjusted EBIT. In the base, benchmark analysis, no such property tax reduction is considered.

Thereafter, Earnings Before Income Taxes (EBT) are calculated, with the principal calculations involving reduction of earnings due to all facets of interest expenses paid (i.e., capital debt and short-term operating financing) and addition of any interest earned on accumulated cash earnings/savings. Inasmuch as all financing aspects of ZEROSECONOMICS© are disengaged in this base, benchmark analysis, there are no such adjustments reflected in **Table 6**.

Although federal taxation is disregarded in this base, benchmark analysis, **Table 6** includes several accounting rows tracking relevant information in that regard. Cumulative EBT losses are recorded for use in reducing taxable income in subsequent years. That is, it is assumed that any losses incurred during the construction years and early years of facility operations may be carried

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[2] The 45-year planning horizon is comprised of (a) three years of construction; (b) 41 years of production, with 50% production during the first and last years; and (c) the facility being salvaged during the 45th year, with the net salvage proceeds realized at the end of that year.

over and use as an offset against future earnings, thereby reducing taxes paid. Annual federal taxes payable are calculated based on a user-specified marginal rate of taxation, and subsequently reduced by any earned/allowed investment tax credits.

After accounting for income taxes paid, the income statement includes several rows which are focused on calculating net cash flow for the year. Tax-deductible non-cash depreciation and capital asset expensing are credited (i.e., added), capital principal payments are debited (i.e., subtracted), and net salvage value of the facility (less applicable federal taxes) are credited; the latter adjustment occurs only in the year following the end of the facility's expected productive life.

The Income Statement represented in **Table 6** also includes three rows of monitoring information representing financial ratios of interest. The first two rows are the nominal and real perspectives of the Debt Service Coverage ratio, calculated by dividing the annual EBIDTA by either the nominal or real amount of the original total capital investment outlay; these values are the same in **Table 6** for the base, benchmark analysis since the total capital investment is assumed to occur in time zero, resulting in the nominal and real amounts of the investment being the same. For the base, benchmark analysis, once full production is occurring (in year 5 and after of the planning horizon), the noted Debt Service Coverage ratios exceed 50%. The third ratio monitoring row is a similar Debt Service Coverage ratio, but reflecting in this case the EBIDTA divided by the annual debt service (i.e., the total of principal and interest payments associated with capital debt). Inasmuch as all capital investment was presumed paid at time zero in the base, benchmark analysis, there is no capital debt and no values are reported for this row.

Cash Flow Budget. **Table 7** is illustrative of the annual flow of cash funds, commencing with the acquisition of capital assets in year zero. Use of long-term capital loans for such capital acquisitions are monitored in detail, addressing initial downpayments, loan principal payments, and associated interest payments. Cash outflows for federal taxes are noted as are credits for abatement of property taxes. Interest expenses on short-term operating loans and interest earnings on accumulated cash are also recognized. A projected end-of-year cash balance is identified. In the event the expected cash balance is insufficient to meet a user-specified minimum level of working capital, short-term borrowings are executed to cover the deficiency. If expected funds exceed the minimal desired level, the excess funds are segregated among either cash dividends to investors and/or retained in a cash investment account assumed to be earning interest at some user-defined interest rate.

Table 6. *Pro Forma* Income Statement for Base, Benchmark Analysis of Killeen ZEROS Project, 2011.

Year Number	0	1	2	3	4	5	6	7	8	9	10	11
Year Date	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Revenue		$ -	$ -	$ -	$ 82,688,839	$ 167,031,455	$ 168,701,769	$ 170,388,787	$ 172,092,675	$ 173,813,602	$ 175,551,738	$ 177,307,255
Operating Expenses		$ -	$ -	$ -	$ 17,989,629	$ 30,223,862	$ 30,930,093	$ 31,654,210	$ 32,396,715	$ 33,158,130	$ 33,938,993	$ 34,739,857
EBITDA (Earnings Before Interest, Taxes, Depreciation, and Amortization)		$ -	$ -	$ -	$ 64,699,210	$ 136,807,593	$ 137,771,676	$ 138,734,577	$ 139,695,960	$ 140,655,471	$ 141,612,745	$ 142,567,398
Depreciation (15 years)		$ 11,998,756	$ 22,797,636	$ 20,517,873	$ 18,478,084	$ 16,630,276	$ 14,950,450	$ 14,158,532	$ 14,158,532	$ 14,182,529	$ 14,158,532	$ 14,182,529
Expensing of Capital Assets in Year of Purchase		$ 3,423,991	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
EBIT (Earnings Before Interest and Taxes)		$ (15,422,747)	$ (22,797,636)	$ (20,517,873)	$ 46,221,126	$ 120,177,318	$ 122,821,226	$ 124,576,046	$ 125,537,428	$ 126,472,942	$ 127,454,213	$ 128,384,868
Abatement of Property Taxes		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Adjusted EBIT (Earnings Before Interest and Income Taxes)		$ (15,422,747)	$ (22,797,636)	$ (20,517,873)	$ 46,221,126	$ 120,177,318	$ 122,821,226	$ 124,576,046	$ 125,537,428	$ 126,472,942	$ 127,454,213	$ 128,384,868
Interest Expense on Capital Debt		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Interest Expense on Short-Term Debt		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Interest Earnings on Investment Account		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
EBT (Earnings Before Income Taxes)		$ (15,422,747)	$ (22,797,636)	$ (20,517,873)	$ 46,221,126	$ 120,177,318	$ 122,821,226	$ 124,576,046	$ 125,537,428	$ 126,472,942	$ 127,454,213	$ 128,384,868
Cumulative Total of Negative EBT Assumed Available in Subsequent Years to Reduce Ordinary Taxable Income		$ (15,422,747)	$ (38,220,383)	$ (58,738,256)	$ (12,517,129)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Net Taxable EBT for Current year, After Accounting for Carryover Losses from Prior Years		$ -	$ -	$ -	$ -	$ 107,660,188	$ 122,821,226	$ 124,576,046	$ 125,537,428	$ 126,472,942	$ 127,454,213	$ 128,384,868
Annual Income Taxes Payable		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Tax Credits Earned During the Current Year		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Tax Credits Applied Against Taxes Due During the Current Year		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cumulative Tax Credits Earned During the Current Year and Unused from Prior Years		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Net Income Taxes Paid on Operating Income		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Net Income After Income Taxes on Operating Income		$ (15,422,747)	$ (22,797,636)	$ (20,517,873)	$ 46,221,126	$ 120,177,318	$ 122,821,226	$ 124,576,046	$ 125,537,428	$ 126,472,942	$ 127,454,213	$ 128,384,868
Add Back Depreciation and Expensing of Capital Assets		$ 15,422,747	$ 22,797,636	$ 20,517,873	$ 18,478,084	$ 16,630,276	$ 14,950,450	$ 14,158,532	$ 14,158,532	$ 14,182,529	$ 14,158,532	$ 14,182,529
Less Principal Payment on Capital Debt		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Plus Net Recoverable Salvage of Facility		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Less Ordinary and Capital Gain Taxes		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Net Cash Flow		$ -	$ -	$ -	$ 64,699,210	$ 136,807,593	$ 137,771,676	$ 138,734,577	$ 139,695,960	$ 140,655,471	$ 141,612,745	$ 142,567,398
DSCR (Debt Service Coverage Ratio), i.e., EBDITA divided by		0.000	0.000	0.000	0.266	0.562	0.566	0.570	0.574	0.578	0.582	0.586
DSCR (Debt Service Coverage Ratio), i.e., EBDITA divided by Real		0.000	0.000	0.000	0.266	0.562	0.566	0.570	0.574	0.578	0.582	0.586
DSCR (Debt Service Coverage Ratio), i.e., EBDITA divided by		NO DEBT	NO DEBT	NO DEBT	NO DEBT	NO DEBT	NO DEBT	NO DEBT	NO DEBT	NO DEBT	NO DEBT	NO DEBT

Table 7. *Pro Forma* Cash Flow Budget for Base, Benchmark Analysis of Killeen ZEROS Project, 2011.

Year Number	0	1	2	3	4	5	6	7	8	9	10	11
Year Date	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Beginning of Year Cash Balance	$ 5,000,000	$ (238,399,108)	$ 5,000,000	$ 5,000,000	$ 5,000,000	$ 5,000,000	$ 5,000,000	$ 5,000,000	$ 5,000,000	$ 5,000,000	$ 5,000,000	$ 5,000,000
Revenue		-	-	-	82688839	167031455	168701769	170388787	172092675	173813602	175551738	177307255
Operating Expenses		-	-	-	17989629	30223862	30930093	31654210	32396715	33158130	33938993	34739857
Capital Investments, Depreciable Amount, Including Capitalizing Financing Expenditures	$ 239,975,117	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Capital Investments, Expensed Amount included in Capital Loans	$ 3,423,991	$ -	$ -	$ -	$ -	$ -						
Expensed Financing Expenditures, which are handled out of available cash flow	$ -	$ -	$ -	$ -	$ -	$ -						
Salvage Value of Facility		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Capital Loans/Bonds	$ -	$ -	$ -	$ -	$ -	$ -						
Down Payments		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Loan Principal Payments		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Interest on Capital Loans		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Net Income Taxes Paid on Operating Income		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Income Taxes Paid on Salvaging of Facility		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Abatement of Property Taxes		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Interest Expense on Short Term Loans		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Interest Income on Investment Account		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Projected End of Year Cash Balance	-238399108	-238399108	5000000	5000000	69699210	141807593	142771676	143734577	144695960	145655471	146612745	147567398
Short-Term Loan Payments		$ -	$ -	$ -	$ 64,699,210	$ 136,807,593	$ 41,892,304	$ -	$ -	$ -	$ -	$ -
Investment Account Withdrawals		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Short-Term Loan Borrowings		$ 243,399,108	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Dividends Paid Out		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Investment Account Infusions		$ -	$ -	$ -	$ -	$ -	$ 95,879,372	$ 138,734,577	$ 139,695,960	$ 140,655,471	$ 141,612,745	$ 142,567,398
"Actual" End-of-year Cash Balance	$ (238,399,108)	$ 5,000,000	$ 5,000,000	$ 5,000,000	$ 5,000,000	$ 5,000,000	$ 5,000,000	$ 5,000,000	$ 5,000,000	$ 5,000,000	$ 5,000,000	$ 5,000,000
Short-Term Loan Balance	$ -	$ 243,399,108	$ 243,399,108	$ 243,399,108	$ 178,699,898	$ 41,892,304	$ -	$ -	$ -	$ -	$ -	$ -
Capital Loan Balance	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Investment Account Balance	$ -	$ -	$ -	$ -	$ -	$ -	$ 95,879,372	$ 234,613,949	$ 374,309,909	$ 514,965,380	$ 656,578,125	$ 799,145,523
Cumulative Dividends Paid out	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -

Sensitivity Analyses

As suggested in the Methodology section, sensitivity analyses are an important feature of sound economic and financial feasibility analyses of proposed capital investment projects. It is considered premature to conduct such sensitivity analyses (beyond the breakeven results already reported), however, in that the absence of financing, federal taxation, and incentives/subsidies considerations in the base, benchmark situation provides for an overly-optimistic perspective of the Killeen ZEROS project. Once these features are implemented in the following more robust scenario, one or more sets of selected key factors will be varied in combinations to enable identification of the relative impact of such factors, e.g., amount and price of electricity to be marketed.

Robust Scenario – With Financing, Federal Taxes, and Incentives

This enhance form of analysis presumes the basic data contained in the base, benchmark scenario plus:

- while all of the requisite capital investment funds are expended in time zero, they are financed according to the terms indicated in the corresponding sub-section of the Data section;
- the investing entity is of a private sector nature and thus is subject to federal taxation at a 35% marginal rate; and
- two proxy forms of incentives/subsidies are available to induce the investment activity.

In the results discussions which follow, the revised "robust" estimates are identified, compared, and contrasted to the base, benchmark results.

<u>Net Present Value (NPV)</u>

The bottom line calculated RNPV for the robust scenario is $296,517,017 versus the BNPV for the base situation of $607,485,536. As for BNPV, this RNPV is calculated considering the cost of the initial investment and the annual operating costs while presuming the realization of the annual revenue streams and net salvage value one year after (i.e., 2054) the termination of the project in

2053 (allows for three years of construction [2010-2012], and 50% production in the first year [2013] and last year [2053] of the project's expected 40-year useful life). Revenue streams are expected to increase 1% per year while operating costs increase at an expected rate of 2.04%. The discount rate used for calculating the BNPV is 11.431%. Detailed breakdown of the BNPV and RNPV net present calculations can be summarized as indicated in **Table 8**. As in **Table 5**, both nominal (i.e., non-discounted) and real (i.e., discounted) values are reported. Several additional rows are added to identify the impacts of considering the financing, federal taxes, and incentives aspects of the investment decision.

Table 8. Robust and Basic Net Present Value Calculations for Killeen ZEROS Project, 2011.

Item	Basic Scenario		Robust Scenario	
	Nominal	Real	Nominal	Real
Capital Investment	$ - 243,399,108	$ - 243,399,108	$ - 267,739,019	$ - 265,242,093
Revenues	+ 8,125,138,494	+ 1,070,774,1445	+ 8,125,138,494	+ 1,070,774,1445
Operating Costs	-1,975,280,812	-220,598,167	-1,975,280,812	-220,598,167
Property Tax Abatement	n/a[a]	n/a	+ 14,734,117	+ 7,008,519
Interest Expense (-) and Earnings (+)	n/a	n/a	+ 932,857,802	-59,060,666
Net Annual Taxes	n/a	n/a	-2,387,614,713	-236,825,355
Net Salvage Value (after taxes)	+ 92,418,026	+ 708,666	+ 60,071,717	+ 460,633
NPV	$ 5,998,876,600	$ 607,485,536	$ 4,505,167,587	$ 296,517,017

[a] n/a refers to nonapplicable in that these provisions were not considered for the Base Scenario.

Several basic differences are apparent in these results. First, capital investment costs are higher. This result is attributable to the assumed cost of acquiring financing. Neither revenues nor operating costs are affected by the new assumptions embodied in the robust scenario. The local property tax abatement provides some measure of lessened cost/additional returns in the real amount of $7+ million. Financing interest is at first suspicious because of the negative value for the nominal column and positive value for the real column. The positive nominal value results from the investment account interest earnings accumulated over the 45-year planning horizon (and growing in magnitude throughout) offsetting and "dwarfing" the interest expenses associated with capital loans and short-term borrowing during the early years of the planning horizon. The negative real value results from the discounting feature of the NPV analysis which places reduced weight on the distant earnings relative to much higher weights on the interest expenses in the early years of the planning period. Finally, the consideration of federal taxes obviously diminishes the expected magnitude of the positive nature of the investment project (from the investors' perspectives) in that a considerable amount of the returns accrue to the federal government as opposed to the investors.

The comprehensive real assessment remains positive, however, in the nature of a positive $296+ million. The reduction of slightly over $300 million between the BNPV and RNPV estimates are attributable to the assumed up-front costs of acquiring financing of the capital investments, the net interest expenses, and the federal tax liability, with a slight benefit noted for the local property abatement program.

Benefit-Cost Ratio (B-C)

The robust Benefit-Cost (B-C) ratio of the proposed investment project is 2.12 in comparison to the base estimate of 3.50. Although smaller in nature (due to the issues noted in the NPV section above), the noted robust B-C ratio remains favorable, i.e., for every $1 of the original investment, $2.12 of net returns, in 2010 dollars, will be realized.

Return on Investment (ROI)

The calculated Return on Investment (ROI) for the robust scenario is 18.6% in comparison to the base, benchmark scenario estimate of 25.79%. That is, assuming all net returns are reinvested at this rate and federal taxes and interest expenses are paid along with the other revised assumptions embedded in the robust scenario, the project realizes a rate of return equivalent to in excess of 18%.

Annuity Equivalent (AE)

The calculated annuity equivalent corresponding to the RNPV is $34,187,721 in comparison to the $70,041,667 estimate calculated for the BNPV. A lay interpretation of this value is that should the initial investment of $243,399,108 be made in the Killeen ZEROS project and the plant be constructed and operate according to the revenue stream, annual operating costs, and net salvage value expectations delineated in the Data section (including the revised provisions of the robust scenario), as well as be repeatedly replaced at the end of each 40-year expected useful life period, the investment would generate an annual net return, in 2010 dollars, in the amount of $34+ million. In effect, this is the net annuity return on the investment.

Breakeven Analyses (BE)

The numerous factors involved in a ZEROS project are almost overwhelming when one attempts to anticipate what factors are "driving" the results and what the implications might be if the projections for such "drivers" are in error. Here, several such factors are isolated in an attempt to test the stability of the base, benchmark results. In each case, the original assumption for the selected parameter is altered such that the BNPV is $0.

Magnitude of Capital Investment Costs. The magnitude of requisite capital investments could increase from $243,399,108 to $453,230,711, a factor of 190.9% (i.e., an increase of 90.9%), and realize a RNPV of $0, HAOTC. This appraised breakeven value infers an allowed increase in capital costs approximately one-half of that suggested by the breakeven factor of 319.0% identified for the base, benchmark scenario.

Amount of Operating Costs. The amount of annual operating costs could increase by 283.7%, and realize a RNPV of $0, HAOTC. This appraised breakeven value infers an allowed increase in capital costs slightly above that suggested by the breakeven factor of 250.9% identified for the base, benchmark scenario. This contrasting result to that achieved with respect to allowed increases in capital costs above is most likely attributed to the tax-deductible characteristic of operating expenses and their relative influence on the overall costs being less than in the base, benchmark scenario.

Level of Revenues. Annual revenue streams could be decreased to 60.4% of expected levels, and realize a RNPV of $0, HAOTC. This appraised breakeven value infers an allowed decrease in revenues approximately two-thirds of that suggested by the breakeven factor of 42.0% identified for the base, benchmark scenario.

Project Expected Life. An iterative evaluation of the project's productive useful life indicates the RNPV would realize a $0 value during year 7 of production, HAOTC. This appraised breakeven value infers the need for the plant to be productive more than twice as long as suggested by the breakeven factor of 3 years identified for the base, benchmark scenario.

Risk Discount Premium. Accepting the 4% time value discount rate and the 2.043% inflation discount rate, the risk premium discount rate could be increased to 11.761%, HAOTC, and a RNPV of $0 realized. This appraised breakeven value infers an allowed increase in the risk premium approximately one-half of that suggested by the breakeven factor of 18.531% identified for the base, benchmark scenario.

These measures identified for the robust scenario, similar to those identified for the base, benchmark scenario, all are suggestive that there is a "comfort margin" in the original projected estimates of capital investment and operating costs and revenue streams for the proposed Killeen ZEROS project. This subjective assessment of the existence of such a "comfort margin" is associated with the realization of positive RNPV and BC ratios for the robust scenario, combined with "reasonable' allowed variations in the cost and revenue aspects of the project before the RNPV falls to $0. As stated before, it is important to realize that the validity and usefulness of such breakeven values, similar to the case for all of the previous and subsequent values, are contingent on the reliability of the original stated values.

***Pro forma* Analysis**

Pro forma statement Tables **9 and 10** are presented below, with attention directed toward the apparent changes in the results reflected in comparison to **Tables 6 and 7**, with such changes associated with the consideration of the financing, federal taxes, and incentives considerations embedded in the robust scenario. As before, only the first eleven years of the total 45-year planning horizon are presented, for brevity's sake.

Income Statement. The notable changes appearing in **Table 9** relative to **Table 6** are associated with the financing, federal taxation, and incentives issues embedded in the robust scenario. The first difference that appears is the expensing of capital assets during the first year. The $4,423,991 expensed amount originates from the $1,000,000 flat cost of the financing arrangement plus 1% of the capital assets which are assumed expensed in the first year of the business. Some short-term interest expense is incurred during years two-four while construction is occurring/being completing and short-term borrowing is required to maintain the stipulated $5 million of working capital. Negative EBT are accumulated during years one-four and used to offset positive taxable EBT in year five. A negative EBt is experienced in year six as the compounded interest associated with the moratorium period for capital loan repayments is paid in that year.

Federal taxes are due for years five and seven and beyond. Investment tax credits are realized in year one and used in year five, the first year of positive tax liability after offsets for accumulated EBT losses have been credited. Accumulated interest expenses realized in year six on the construction period financing result in a negative taxable income for that year. Capital loan principal payments commence in year six. Net cash flows are zero in year one, negative in years two-three, and positive in years four and thereafter. The Debt Service Coverage ratios with respect to the Total Original Investment Cost of the project are 0.24 during year four during which operations occur at a 50% level and slightly in excess of 50% in years five and thereafter when production reaches 100% of expected levels. The Debt Service Ratio with respect to principal and interest payments are 0.74 in year six (when the compounded interest for the capital loan payment moratorium period is due) and in excess of 3.0 in years seven and thereafter.

The wealth of information apparent in **Table 9** is a testimony to the apparent validity of the performance of ZEROSECONOMICS© when the added features of financing, federal taxation, and incentives are considered in the robust scenario. Potential investors and other stakeholders in ZEROS investment projects should find the information contained in **Table 9** very useful in their decision-making processes.

Cash Flow Budget. **Table 10** offers an enhanced perspective of *pro forma* cashflows relative to **Table 7**. The impacts of financing, federal taxation, and incentives are evident in **Table 10**, specifically with respect to (a) loan principal and interest payments; (b) payment of income taxes on operating income; (c) abatement of property taxes; (d) interest expenses on short-term operating loans; (e) interest income associated with the accumulated earnings investment account; (f) short-term loan borrowings and repayments; and (g) accumulated earnings investment account contributions and withdrawals (the latter are allowed before short-term borrowings are instigated whenever there is a need for cash to meet the minimal working capital requirements and the accumulated earnings investment account balance is positive). Finally, several monitoring rows are included in **Table 10** reflecting the temporal balances of (a) short-term loans; (b) capital loans; (c) the earnings investment account; and (d) cumulative dividends distributed to date. Again, it is intended that the information contained in **Table 10** be useful to potential investors and other stakeholders in ZEROS investment projects during their decision-making processes.

Sensitivity Analyses

Two formats of sensitivity analyses are presented for the robust scenario: (a) two-way data tables and (b) scenario analyses (Walkenbach). The development and consideration of two-way data tables allows for visualizing the joint, combined impacts of varying two individual input factors simultaneously to be determined with respect to a single output measure. As noted in the Methodology section, there are numerous output measures of relevance in measuring the potential of a capital investment project. For brevity's sake, the demonstration of the usefulness of two-way data tables is limited to the RNPV measure and to the following three sets of two-way comparisons:

- capital investment and operating costs levels (**Table 11**);
- revenue streams and discount rates (**Table 12**); and
- sales level and market price for the principal product, electricity (**Table 13**).

Certainly, more output measures and/or two-way pairs of comparisons could be developed as deemed appropriate. The results displayed in these three tables are indicative, however, of the superior information forthcoming from such sensitivity analyses.

Table 9. *Pro Forma* Income Statement for Robust Scenario Analysis of Killeen ZEROS Project, 2011.

Year Number	0	1	2	3	4	5	6	7	8	9	10	11
Year Date	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Revenue	[redacted]	$ -	$ -	$ -	$ 82,688,839	$ 167,031,455	$ 168,701,769	$ 170,388,787	$ 172,092,675	$ 173,813,602	$ 175,551,738	$ 177,307,255
Operating Expenses		$ -	$ -	$ -	$ 17,989,629	$ 30,223,862	$ 30,930,093	$ 31,654,210	$ 32,396,715	$ 33,158,130	$ 33,938,993	$ 34,739,857
EBITDA (Earnings Before Interest, Taxes, Depreciation, and Amortization)		$ -	$ -	$ -	$ 64,699,210	$ 136,807,593	$ 137,771,676	$ 138,734,577	$ 139,695,960	$ 140,655,471	$ 141,612,745	$ 142,567,398
Depreciation (15 years) MACRS schedule	[redacted]	$ 13,215,751	$ 25,109,928	$ 22,598,935	$ 20,352,257	$ 18,317,031	$ 16,466,826	$ 15,594,587	$ 15,594,587	$ 15,621,018	$ 15,594,587	$ 15,621,018
Expensing of Capital Assets in Year of Purchase		$ 4,423,991	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
EBIT (Earnings Before Interest and Taxes)		$ (17,639,742)	$ (25,109,928)	$ (22,598,935)	$ 44,346,953	$ 118,490,562	$ 121,304,850	$ 123,139,991	$ 124,101,373	$ 125,034,453	$ 126,018,158	$ 126,946,380
Abatement of Property Taxes	[redacted]	$ -	$ -	$ -	$ 1,979,328	$ 2,019,771	$ 2,061,040	$ 2,103,153	$ 2,146,126	$ 2,189,977	$ 2,234,724	$ -
Adjusted EBIT (Earnings Before Interest and Income Taxes)		$ (17,639,742)	$ (25,109,928)	$ (22,598,935)	$ 46,326,281	$ 120,510,332	$ 123,365,890	$ 125,243,143	$ 126,247,499	$ 127,224,430	$ 128,252,882	$ 126,946,380
Interest Expense on Capital Debt		$ -	$ -	$ -	$ -	$ -	$ 161,129,155	$ 19,466,919	$ 17,358,540	$ 15,081,490	$ 12,622,277	$ 9,966,327
Interest Expense on Short-Term Debt		$ -	$ 70,000	$ 74,900	$ 80,143	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Interest Earnings on Investment Account		$ -	$ -	$ -	$ -	$ 981,802	$ 2,578,665	$ 1,931,860	$ 3,005,331	$ 3,903,272	$ 4,807,936	$ 5,718,139
EBT (Earnings Before Income Taxes)		$ (17,639,742)	$ (25,179,928)	$ (22,673,835)	$ 46,246,138	$ 121,492,135	$ (35,184,601)	$ 107,708,085	$ 111,894,290	$ 116,046,212	$ 120,438,541	$ 122,698,192
Cumulative Total of Negative EBT Assumed Available in Subsequent Years to Reduce Ordinary Taxable Income		$ (17,639,742)	$ (42,819,670)	$ (65,493,505)	$ (19,247,367)	$ -	$ (35,184,601)	$ -	$ -	$ -	$ -	$ -
Net Taxable EBT for Current year, After Accounting for Carryover Losses from Prior Years		$ -	$ -	$ -	$ -	$ 102,244,768	$ -	$ 72,523,484	$ 111,894,290	$ 116,046,212	$ 120,438,541	$ 122,698,192
Annual Income Taxes Payable	[redacted]	$ -	$ -	$ -	$ -	$ 35,785,669	$ -	$ 25,383,219	$ 39,163,002	$ 40,616,174	$ 42,153,489	$ 42,944,367
Tax Credits Earned During the Current Year		$ 2,433,991	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Tax Credits Applied Against Taxes Due During the Current Year		$ -	$ -	$ -	$ -	$ 2,433,991	$ -	$ -	$ -	$ -	$ -	$ -
Cumulative Tax Credits Earned During the Current Year and Unused from Prior Years		$ 2,433,991	$ 2,433,991	$ 2,433,991	$ 2,433,991	$ 2,433,991	$ -	$ -	$ -	$ -	$ -	$ -
Net Income Taxes Paid on Operating Income		$ -	$ -	$ -	$ -	$ 33,351,678	$ -	$ 25,383,219	$ 39,163,002	$ 40,616,174	$ 42,153,489	$ 42,944,367
Net Income After Income Taxes on Operating Income		$ (17,639,742)	$ (25,179,928)	$ (22,673,835)	$ 46,246,138	$ 88,140,457	$ (35,184,601)	$ 82,324,865	$ 72,731,289	$ 75,430,038	$ 78,285,051	$ 79,753,825
Add Back Depreciation and Expensing of Capital Assets		$ 17,639,742	$ 25,109,928	$ 22,598,935	$ 20,352,257	$ 18,317,031	$ 16,466,826	$ 15,594,587	$ 15,594,587	$ 15,621,018	$ 15,594,587	$ 15,621,018
Less Principal Payment on Capital Debt		$ -	$ -	$ -	$ -	$ -	$ 24,402,535	$ 26,354,738	$ 28,463,117	$ 30,740,166	$ 33,199,379	$ 35,855,329
Plus Net Recoverable Salvage of Facility		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Less Ordinary and Capital Gain Taxes Associated with Sale of Facility		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Net Cash Flow	[redacted]	$ -	$ (70,000)	$ (74,900)	$ 66,598,395	$ 106,457,489	$ (43,120,309)	$ 71,564,715	$ 59,862,759	$ 60,310,890	$ 60,680,259	$ 59,519,514
DSCR (Debt Service Coverage Ratio), i.e., EBDITA divided by Nominal Total Original Investment Cost		-	-	-	0.24	0.51	0.51	0.52	0.52	0.53	0.53	0.54
DSCR (Debt Service Coverage Ratio), i.e., EBDITA divided by Real Total Original Investment Cost		-	-	-	0.24	0.51	0.51	0.52	0.52	0.53	0.53	0.54
DSCR (Debt Service Coverage Ratio), i.e., EBDITA divided by Annual Debt Service (principal plus interest)		NO DEBT SERVICE	NO DEBT SERVICE	NO DEBT SERVICE	NO DEBT SERVICE	NO DEBT SERVICE	0.74	3.03	3.05	3.07	3.09	3.11

Table 10. *Pro Forma* Cash Flow Budget for Robust Scenario Analysis of Killeen ZEROS Project, 2011.

Year Number	0	1	2	3	4	5	6	7	8	9	10	11
Year Date	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Beginning of Year Cash Balance	$ 5,000,000	$ 4,000,000	$ 5,000,000	$ 5,000,000	$ 5,000,000	$ 5,000,000	$ 5,000,000	$ 5,000,000	$ 5,000,000	$ 5,000,000	$ 5,000,000	$ 5,000,000
Revenue		-	-	-	82688839	167031455	168701769	170388787	172092675	173813602	175551738	177307255
Operating Expenses		-	-	-	17989629	30223862	30930093	31654210	32396715	33158130	33938993	34739857
Capital Investments, Depreciable Amount, Including Capitalizing Financing Expenditures	$ 264,315,028	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Capital Investments, Expensed Amount included in Capital Loans	$ 3,423,991	$ -	$ -	$ -	$ -	$ -	0	0	0	0	0	0
Expensed Financing Expenditures, which are handled out of available cash flow	$ 1,000,000	$ -	$ -	$ -	$ -	$ -	0	0	0	0	0	0
Salvage Value of Facility		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Capital Loans/Bonds	$ 267,739,019	$ -	$ -	$ -	$ -	$ -						
Down Payments		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Loan Principal Payments		$ -	$ -	$ -	$ -	$ -	$ 24,402,535	$ 26,354,738	$ 28,463,117	$ 30,740,166	$ 33,199,379	$ 35,855,329
Interest on Capital Loans		$ -	$ -	$ -	$ -	$ -	$ 161,129,155	$ 19,466,919	$ 17,358,540	$ 15,081,490	$ 12,622,277	$ 9,966,327
Net Income Taxes Paid on Operating Income		$ -	$ -	$ -	$ -	$ 33,351,678	$ -	$ 25,383,219	$ 39,163,002	$ 40,616,174	$ 42,153,489	$ 42,944,367
Income Taxes Paid on Salvaging of Facility		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Abatement of Property Taxes		$ -	$ -	$ -	$ 1,979,328	$ 2,019,771	$ 2,061,040	$ 2,103,153	$ 2,146,126	$ 2,189,977	$ 2,234,724	$ -
Interest Expense on Short Term Loans		$ -	$ 70,000	$ 74,900	$ 80,143	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Interest Income on Investment Account		$ -	$ -	$ -	$ -	$ 981,802	$ 2,578,665	$ 1,931,860	$ 3,005,331	$ 3,903,272	$ 4,807,936	$ 5,718,139
Projected End of Year Cash Balance	4000000	4000000	4930000	4925100	71598395	111457489	-38120309	76564715	64862759	65310890	65680259	64519514
												0
Short-Term Loan Payments		$ -	$ -	$ -	$ 1,144,900	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Investment Account Withdrawals		$ -	$ -	$ -	$ -	$ -	$ 43,120,309	$ -	$ -	$ -	$ -	$ -
Short-Term Loan Borrowings		$ 1,000,000	$ 70,000	$ 74,900	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Dividends Paid Out		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Investment Account Infusions		$ -	$ -	$ -	$ 65,453,495	$ 106,457,489	$ -	$ 71,564,715	$ 59,862,759	$ 60,310,890	$ 60,680,259	$ 59,519,514
"Actual" End-of-year Cash Balance	$ 4,000,000	$ 5,000,000	$ 5,000,000	$ 5,000,000	$ 5,000,000	$ 5,000,000	$ 5,000,000	$ 5,000,000	$ 5,000,000	$ 5,000,000	$ 5,000,000	$ 5,000,000
Short-Term Loan Balance	$ -	$ 1,000,000	$ 1,070,000	$ 1,144,900	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Capital Loan Balance	$ 267,739,019	$ 267,739,019	$ 267,739,019	$ 267,739,019	$ 267,739,019	$ 267,739,019	$ 243,336,484	$ 216,981,747	$ 188,518,630	$ 157,778,464	$ 124,579,085	$ 88,723,756
Investment Account Balance	$ -	$ -	$ -	$ -	$ 65,453,495	$ 171,910,984	$ 128,790,674	$ 200,355,389	$ 260,218,148	$ 320,529,038	$ 381,209,297	$ 440,728,810
Cumulative Dividends Paid out	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -

Table 11 is demonstrative of the synergism existing between capital investment costs and annual operating costs and the joint effects on the RNPV of simultaneous changes in those factors. In **Table 11**, both of these factors are individually varied between 90-300% of the levels identified in the Data section for the base, benchmark scenario (and also for the robust scenario). The values appearing at the respective intersections of the noted levels represent the RNPV for that combination of levels of the respective factors. For example, the $296,517,017 value appearing in the white-backgrounded cell for the intersection of the two 100% expectation levels is the RNPV previously noted as the expected RNPV for the robust scenario. Those cells with green backgrounds represent positive-valued RNPVs whereas those with the amber/orange backgrounds have negative-valued RNPVs. As one should have expected, the lower the levels of the combined alternative, the higher the RNPV, and, conversely, the higher the levels, the lower the RNPVs. Another perspective of this phenomena is that RNPVs are the highest in the upper-left (northwest) corner of **Table11**, e.g., a RNPV of $342,803,172 for the 90%-90% combination. RNPVs decline as the combinations move to higher levels toward the lower-right (southeast) corner of the table, e.g., a RNPV of ($1,549,233,733) for the 300%-300% combination.

Table 11. Two-Way Table for Robust Scenario Examining Variations in Robust Net Present Value as Magnitudes of Capital Investments in and Operating Costs for the Killeen ZEROS Project are Varied, 2011.

		Level of Capital Investments Relative to Base, Benchmark Scenario Amount					
RNPV—>	$ 296,517,017	90.0%	100.0%	125.0%	150.0%	200.0%	300.0%
Level of Annual Operating Costs Relative to Base, Benchmark Scenario Amount	90.0%	$ 342,803,172	$ 310,903,034	$ 231,127,640	$ 150,782,808	$ (12,984,879)	$ (400,609,841)
	100.0%	$ 328,723,996	$ 296,517,017	$ 215,974,522	$ 134,749,653	$ (31,310,694)	$ (429,231,248)
	125.0%	$ 292,770,756	$ 259,778,247	$ 177,271,926	$ 93,795,319	$ (79,116,884)	$ (506,029,765)
	150.0%	$ 255,738,515	$ 221,934,149	$ 137,214,643	$ 51,596,064	$ (129,801,026)	$ (592,519,190)
	200.0%	$ 178,437,032	$ 142,929,975	$ 53,363,972	$ (38,261,852)	$ (247,116,623)	$ (837,956,178)
	300.0%	$ 10,333,662	$ (29,445,610)	$ (136,665,734)	$ (267,521,040)	$ (666,582,046)	$(1,549,233,733)

Table 12 similarly is an indication of the relationship existing between the revenue stream and the discount rate and the joint effects on the RNPV of simultaneous changes in those factors. In **Table 12**, the revenue stream is varied between 40-200% of the levels identified in the Data section for the base, benchmark scenario (and also for the robust scenario). The discount rate is likewise varied between 6% and 30% about the expected 11.431%. The values appearing at the respective intersections of the noted levels represent the RNPV for that combination of levels of the

respective factors. For example, the $296,517,017 value appearing in the white-backgrounded cell for the intersection of the 100% expectation level for the revenue stream and the 11.431% for the discount rate is the RNPV previously noted as the expected RNPV for the robust scenario. As for **Table 11**, those cells with green backgrounds represent positive-valued RNPVs whereas those with the amber/orange backgrounds have negative-valued RNPVs. The higher the levels of the revenue stream in combination with lower discount rates, the higher the RNPV, and, conversely, the lower the revenue stream and the higher the discount rate, the lower the RNPVs. Another perspective of this phenomena is that RNPVs are the highest in the upper-right (northeast) corner of **Table12**, e.g., a RNPV of $2,673,266,631 for the 200%-6% combination. RNPVs decline as the combinations move to lower revenue streams and higher discount rates in the lower-left (southwest) corner of the table, e.g., a RNPV of ($256,623,889) for the 40%-30% combination.

Table 12. Two-Way Table for Robust Scenario Examining Variations in Robust Net Present Value as Magnitudes of Revenue Streams and Discount Rates for the Killeen ZEROS Project are Varied, 2011.

		Level of Revenue Stream Relative to Base, Benchmark Scenario Amount					
RNPV—>	$ 296,517,017	40.0%	50.0%	75.0%	100.0%	125.0%	200.0%
Level of Discount Rate Relative to Base, Benchmark Scenario Amount	6.000%	$ (56,879,270)	$ 158,295,240	$ 586,912,004	$ 1,004,985,714	$ 1,422,750,875	$ 2,673,266,631
	10.000%	$ (171,148,739)	$ (46,116,906)	$ 188,351,650	$ 412,904,629	$ 637,096,462	$ 1,306,247,872
	11.431%	$ (192,349,215)	$ (86,075,458)	$ 110,028,791	$ 296,517,017	$ 482,636,072	$ 1,037,429,045
	15.000%	$ (224,418,065)	$ (149,947,091)	$ (16,301,364)	$ 108,571,336	$ 233,071,250	$ 602,807,288
	20.000%	$ (244,642,009)	$ (195,563,120)	$ (108,844,678)	$ (29,645,809)	$ 49,199,651	$ 281,941,460
	30.000%	$ (256,623,889)	$ (231,612,023)	$ (186,863,150)	$ (147,400,480)	$ (108,221,601)	$ 5,881,488

Table 13 is a reporting of the RNPV results occurring as the marketable level of the primary product, electricity, and the level of market price for that product (i.e., electricity) are simultaneously varied. In **Table 13**, the marketable level of electricity is varied between 0-100% of the levels identified in the Data section for the base, benchmark scenario (and also for the robust scenario). The market price for electricity is likewise varied between $60-200 per MWhr about the expected $120. The values appearing at the respective intersections of the noted levels represent the RNPV for that combination of levels of the respective factors. For example, the $296,517,017 value appearing in the white-backgrounded cell for the intersection of the 100% expectation level for the marketable level of electricity and the expected $120 market price is the RNPV previously

noted as the expected RNPV for the robust scenario. As for **Tables 11 and 12**, those cells with green backgrounds represent positive-valued RNPVs, whereas those with the amber/orange backgrounds have negative-valued RNPVs. The higher the marketable level of electricity in combination with higher market prices, the higher the RNPV, and, conversely, the lower the marketable level of electricity and the lower the market price for electricity, the lower the RNPVs. Another perspective of this phenomena is that RNPVs are the highest in the lower-right (southeast) corner of **Table13**, e.g., a RNPV of $433,231,657 for the 100%-$200 combination. RNPVs decline as the combinations move to lower marketable sales level and lower market prices for electricity in the upper-left (northwest) corner of the table, e.g., a RNPV of ($91,051,816) for the 0%-$60 combination. An additional interesting result apparent in this table is that with no electricity sales (i.e., the 0% market sales level), all RNPVs are positive; that is, the expected sales of the byproducts are sufficient to justify the project's investment.

Table 13. Two-Way Table for Robust Scenario Examining Variations in Robust Net Present Value as Magnitudes of Market Sales Level of Electricity and Market Price for Electricity for the Killeen ZEROS Project are Varied, 2011.

		Market Sales Level of Electricity Relative to Base, Benchmark Scenario Amount					
RNPV—>	$ 296,517,017	0.0%	25.0%	50.0%	75.0%	90.0%	100.0%
Level of Market Price for Electricity Relative to Base, Benchmark Scenario Amount	$ 60.00	$ 91,051,816	$ 116,901,741	$ 142,713,047	$ 168,347,042	$ 183,727,439	$ 193,981,037
	$ 80.00	$ 91,051,816	$ 125,518,382	$ 159,802,377	$ 193,981,037	$ 214,488,233	$ 228,159,697
	$ 100.00	$ 91,051,816	$ 134,135,024	$ 176,891,707	$ 219,615,032	$ 245,249,027	$ 262,338,357
	$ 120.00	$ 91,051,816	$ 142,713,047	$ 193,981,037	$ 245,249,027	$ 276,009,821	$ 296,517,017
	$ 150.00	$ 91,051,816	$ 155,530,044	$ 219,615,032	$ 283,700,019	$ 322,151,012	$ 347,785,007
	$ 200.00	$ 91,051,816	$ 176,891,707	$ 262,338,357	$ 347,785,007	$ 399,052,997	$433,231,657

Scenario analyses within Excel (Walkenbach) allow for more expansive sensitivity investigations in that numerous input factors may simultaneously be varied while also reporting the results for numerous output factors. As for two-way data tables, the possibilities for scenario analyses are extensive for capital investment projects such as the ZEROS technology. For brevity's sake and to relate the results to those presented in the two-way data tables, variances in the same select set of input factors are considered in regards to how changes in their assumed levels affect the RNPV and B-C ratio are considered as designated in **Table 14**.

Table 14. Input Factors Altered in Scenario Analyses for the Killeen ZEROS Project, 2011.

Input Factors	Scenario				
	1	2	3	4	5
Capital Investment Costs	100%	150%	150%	90%	90%
Annual Operating Costs	100%	150%	150%	90%	90%
Revenue Stream	100%	75%	100%	125%	100%
Discount Rate	11.431%	15%	15%	10%	10%
Marketable Sales Level of Electricity	100%	100%	50%	100%	100%
Market Price of Electricity	$120	$120	$80	$120	$200

Table 15 is an illustration of the type of results that can be achieved with Scenario Analyses in Excel. The five sets of scenarios identified in **Table 14** were subjected to analysis, with the results indicated in **Table 15**. For each scenario, the values for the respective input factors are repeated, followed by the calculated values for the targeted output variables. Repeating of the Base Assumptions allows for anchoring the analysis and also reassuring the analyst that Excel can indeed replicate the base solution (similar to why the base assumptions are included in the two-way data tables with those results identified in **Tables 11-13** in cells with white backgrounds). The two pessimistic scenarios represent variations of increasing costs, lowering revenues, and increasing the discount rate. Not surprising (hopefully), the RNPVs and B-C ratios for these scenarios are substantially lower than those determined for the base assumptions. In fact, the results are largely negative, indicating that a "perfect storm" with the attributes in these scenarios would result in a largely unprofitable investment for the Killeen ZEROS project. In contrast, the two optimistic scenarios exemplify variations of decreasing costs, higher revenues, and decreasing the discount rate. Again, not unexpectedly, the RNPVs and B-C ratios for these scenarios are higher than those determined for the base assumptions. Recognition of the slight alterations in the base assumptions and the calculated implications for the results underscore the value of accuracy in projecting costs and returns for capital investment projects such as the ZEROS technology.

Table 15. Scenario Analyses RNPV and B-C Ratio Results for Selected Input Factors, for the Killeen ZEROS Project, 2011.

Input Factor	Base Assumptions	Pessimistic 1	Pessimistic 2	Optimistic 1	Optimistic 2
Cap_Inv_Costs_Level	100.0%	150.0%	150.0%	90.0%	90.0%
Annual_Op_Costs_Level	100.0%	150.0%	150.0%	90.0%	90.0%
Rev_Stream_Level	100.0%	75.0%	100.0%	125.0%	100.0%
Discount_Rate	11.431%	15.000%	15.000%	10.000%	10.000%
Mkt_Sales_of_Electricty	100.0%	100.0%	50.0%	100.0%	100.0%
Mkt_Price_of_Electricity	$ 120.00	$ 120.00	$ 80.00	$ 120.00	$ 200.00
Output Value					
RNPV	$ 296,517,017	$ (237,619,360)	$ (195,893,760)	$ 687,242,418	$ 627,835,150
BC_Ratio	2.12	0.39	0.5	3.86	3.61

Limitations

Although the spreadsheet model ZEROSECONOMICS© is extensive in scope and due diligence was taken in acquiring and validating the data used in the reported feasibility analysis of the Killeen ZEROS project and associated ZEROS technology, there are restrictions on the results that must be recognized and addressed in the future. Identifying these limitations does not nullify the results provided in this report, but rather provide a pathway for future improvements in assessing the economic and financial potential of the technology.

Foremost, the absence of an existing operational ZEROS production facility contributes to an absence of bonafide historic operational data for the ZEROS technology. Recognizing this issue is not intended to cast unreasonable doubt on the projected data used. Substantial groundtruthing has occurred in the past several years in regards to the projected capabilities of the technology and its underlying chemical and engineering aspects. Within the context of such intense scrutiny by a host of reputable engineers and others, the data used appears valid and justified for projection purposes. A confidential report by Annamalai and Hall (2007) provides support for this conclusion.

The complex nature of the ZEROS technology is both a strength of its potential and an obstacle for evaluating that potential. The flexibility of the technology lends itself to capabilities for handling a broad spectrum of feedstocks, with the principal product and byproducts forthcoming from disposal of such feedstocks contingent on the facility manager's "tweaking" of controls in reaction to prevailing spot and/or contractual market prices. Consequently, as is the case for evaluating other proposed capital projects, the quality of appraisal of the ZEROS technology can be improved over time as more proposed project situations are considered and evaluated with a consistent approach such as that afforded in ZEROSECONOMICS©.

This being the first application of ZEROSECONOMICS©, the extent of sensitivity analyses is purposefully constrained so as to allow feedback on this report and further refinement of the model before producing a plethora of additional results. It is perceived the information contained herein more than adequately provides an initial third-party appraisal of the ZEROS technology within the constraints of this project. Opportunities to subsequently evaluate additional ZEROS projects will serve to enhance the quality of the appraisal and the acceptance of the paradigm embedded in ZEROSECONOMICS©.

Conclusions

As Texas looks at energy alternatives for the future, it is important that new innovative technologies such as ZEROS be carefully evaluated for engineering and economic feasibility and SECO is commended for studies such as these.

The first objective of this project is to:

> "Perform an economic/financial study of the ZEROS technology considering alternative feedstock and potential products such as electricity, gasoline, diesel, and water, developing cost per unit of products produced."

With the concurrent development of the ZEROSECONOMICS© spreadsheet model, a conceptual understanding of the complexity of the ZEROS technology was realized and incorporated into the base, benchmark and robust scenarios discussed in this report. The calculated economic and financial feasibility results for these scenarios are suggestive that the technology has substantial potential for being profitable.

The second objective of this project is to:

> "Conduct sensitivity analyses across several factors involved with ZEROS such as capital investment costs, operating costs, length of life of components, and amount of marketable products and byproducts."

The ZEROSECONOMICS© spreadsheet model was employed to satisfy this objective, with the extensive results presented reinforcing the base conclusions regarding the potential profitability of the ZEROS technology, but also identifying the possibility that variations in values for a combination of the numerous input factors could negatively affect the apparent potential of the technology.

The third objective of this project is to:

> "Examine impact of critical institutional factors potentially affecting the economic and financial feasibility of ZEROS, including financing terms, taxation, and subsidy incentives."

The reported results for the robust scenario respond directly to this objective, materially demonstrating the importance of considering these issues in detail. The flexibility incorporated into ZEROSECONOMICS© allows for consideration of a myriad of possible features representing these investment attributes.

Implications

Recognizing the above-expressed limitations, given the data available for the Killeen ZEROS project and the extent of analyses produced through the use of ZEROSECONOMICS©, the ZEROS technology appears to have potential merit as a profitable investment, but sensitive to several key data-input values. Additional economic and financial investigations are warranted to either further confirm the results reported herein or to identify contradictory conclusions.

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Appendix A – ZEROS Patents

As indicated in Jones (2011), "The ZEROS process is protected by the following U.S. patents and patent applications:

U.S. 5,906,806 — Reduced Emission Combustion Process with Resource Conservation and Recovery Options "ZEROS" Zero-emission Energy Recycling Oxidation System. A system and a process for combusting hydrocarbons to recover energy and the CO_2 resulting from the combustion is provided. The process utilizes a two-stage combustion process, each stage utilizing water injection and a recirculation stream to increase the efficiency of combustion to generate larger proportions of CO_2. An energy recovery boiler is used to recover heat energy from the combustion product. Combustion product is then cleaned and the CO_2 is separated and condensed into a useable liquid CO_2 product.

U.S. 6,024,029 — Reduced Emission Combustion System. The invention is a combustion process which maximizes the ratio of CO_2 level to the level of all other combustion gas constituents in the post combustion chamber gas stream and facilitates the efficient capture and liquiefication of the CO_2 produced by the hydrocarbon fuels combustion process for use as a commercial product. When optimally employed the process yields only CO_2, water vapor and oxygen as constituents of the combustion gas stream. All of these constituents may be segregated, captured, contained and reused in the process, filtered and discharged as liquid or sold to other interests as a commercial product for beneficial use. In less than optimum applications the hydrocarbon fuels being combusted might contain chemical impurities such as sulphur, chlorine, nitrogen, and inorganic refractory constituents. To facilitate the employment of the process in these less than optimum circumstances various means of removal, neutralization and containment of the combustion byproducts from the fuel impurities are included in the invention. When practical these "undesirable" combustion byproducts may be converted into usable commercial products.

U.S. 6,119,606 — Reduced Emission Combustion Process. The invention is a combustion process which maximizes the ratio of CO_2 level to the level of all other combustion gas constituents in the post combustion chamber gas stream and facilitates the efficient capture and liquefication of the CO_2produced by the hydrocarbon fuels combustion process for use as a commercial product. When optimally employed the process yields only CO_2, water vapor and oxygen as constituents of the combustion gas stream. All of these constituents may be segregated, captured, contained and reused in the process, filtered and discharged as liquid or sold to other interests as a commercial product for beneficial use. In less than optimum applications the hydrocarbon fuels being combusted might contain chemical impurities such as sulphur, chlorine, nitrogen, and inorganic refractory constituents. To facilitate the employment of the process in these less than optimum circumstances various means of removal, neutralization and containment of the combustion byproducts from the fuel impurities are included in the invention. When practical these "undesirable" combustion byproducts may be converted into usable commercial products.

U.S. 6,137,026 — ZEROS Bio-Dynamics, A Zero-Emission Non-Thermal Process for Cleaning Hydrocarbon from Soils. A combination of parallel processes is disclosed to provide optimal remediation operations for contaminated soil. Soils with high levels of heavy petroleum hydrocarbons are directed to a thermal process for destruction in a combustion process. CO_2 generated and recovered in the thermal process is employed as a solvent in a solvent process to clean other soils of petroleum hydrocarbons and certain chlorinated hydrocarbon compounds. In the solvent process, contaminated soils are run through a closed soil separator where the soils are washed with CO_2. The $CO_2$is then dried from the soil and the soil is sent for segregation. Soils with the lightest forms of hydrocarbon contamination (gasoline, etc.) are subjected to a vaporization process utilizing heat energy generated in the thermal process to heat the soil, under a partial vacuum, and the vapors generated are captured, condensed, and recovered as product.

U.S. 6,688,318 B1 — Process for Cleaning Hydrocarbons from Soils. The present invention is a combination of parallel processes that provide optimal remediation operations for contaminated soil. Soils with high levels of heavy petroleum hydrocarbons are directed to a thermal process for destruction in a combustion process. CO_2 generated and recovered in the thermal process is employed as a solvent in a solvent process to clean soils having moderate contamination with petroleum hydrocarbons and chlorinated hydrocarbon compounds. In this solvent process, contaminated soils are run through a closed soil separator where the soils are washed with CO_2. The CO_2 is then dried from the soil and the soil is sent for segregation. Additionally, soils with the lightest forms of hydrocarbon contamination, such as gasoline, etc., are subjected to a vaporization process utilizing heat energy generated from the thermal process to heat the soil under a partial vacuum. The vapors generated are captured, condensed, and recovered as product.

U.S. 7,338,563 B2 — Process for Cleaning Hydrocarbons from Soils. The present invention is a combination of parallel processes that provide optimal remediation operations for contaminated soil. Soils with high levels of heavy petroleum hydrocarbons are directed to a thermal process for destruction in a combustion process. CO_2 generated and recovered in the thermal process is employed as a solvent in a solvent process to clean soils having moderate contamination with petroleum hydrocarbons and chlorinated hydrocarbon compounds. In this solvent process, contaminated soils are run through a closed soil separator where the soils are washed with CO_2. The CO_2 is then dried from the soil and the soil is sent for segregation. Additionally, soils with the lightest forms of hydrocarbon contamination, such as gasoline, etc., are subjected to a vaporization process utilizing heat energy generated from the thermal process to heat the soil under a partial vacuum. The vapors generated are captured, condensed, and recovered as product.

U.S. Patent 7,833,296 — Reduced-Emission Gasification and Oxidation of Hydrocarbon Materials for Power Generation. A system and process for maximizing the generation of electrical power from a variety of hydrocarbon feedstocks. The hydrocarbon feedstocks are first gasified and then oxidized in a two-chamber system and process using oxygen gas rather than ambient air. Intermediate gases generated in the system and process are recirculated and recycled to the gasification and oxidation chambers in order to maximize energy production. The energy produced through the system and process is used to generate steam and produce power through conventional steam turbine technology. In addition to the release of heat energy, the hydrocarbon feedstocks are oxidized to the pure product compounds of water and CO_2, which are subsequently purified and marketed. The system and process minimizes environmental emissions

U.S. Patent Application 20080078122 A1 — Reduced-Emission Gasification And Oxidation Of Hydrocarbon Materials for Hydrogen And Oxygen Extraction. A system and process for maximizing the generation of marketable products from a variety of hydrocarbon feedstocks. The hydrocarbon feedstocks are first gasified and then oxidized in a two-chamber system and process using oxygen gas rather than ambient air. Intermediate gases generated in the system and process are recirculated and recycled to the gasification and oxidation chambers in order to maximize both energy generation and the resulting stoichiometric reaction products. The energy produced through the system and process is used to generate steam and produce power through conventional steam turbine technology. In addition to the release of heat energy, the hydrocarbon feedstocks are oxidized to the pure product compounds of water and CO_2. The CO_2 is subsequently purified and marketed. The water recovered from the system and process is collected and electrolyzed to generate oxygen and hydrogen gases. These gases are separated using conventional gas separation technologies and also marketed. The system and process minimizes environmental emissions.

U.S. Patent Application 20080184621 — Reduced-Emission Gasification and Oxidation of Hydrocarbon Materials for Power Generation. A system and process for maximizing the generation of electrical power from a variety of hydrocarbon feedstocks. The hydrocarbon feedstocks are first gasified and then oxidized in a two-chamber system and process using oxygen gas rather than ambient air. Intermediate gases generated in the system and process are recirculated and recycled to the gasification and oxidation chambers in order to maximize energy production. The energy produced through the system and process is used to generate steam and produce power through conventional steam turbine technology. In addition to the release of heat energy, the hydrocarbon feedstocks are oxidized to the pure product compounds of water and CO_2, which are subsequently purified and marketed. The system and process minimizes environmental emissions.

U.S.Patent Application 20080275278 — Reduced-Emission Gasification and Oxidation of Hydrocarbon Materials for Liquid Fuel Production. A system and process are disclosed for the controlled combustion of a wide variety of hydrocarbon feedstocks to produce thermal energy, liquid fuels, and other valuable products with little or no emissions. The hydrocarbon feeds, such as coal and biomass, are first gasified and then oxidized in a two-chamber system/process using pure oxygen rather than ambient air. A portion of the intermediate gases generated in the system/process are sent to a Fischer-Tropsch synthesis process for conversion into diesel fuel and other desired liquid hydrocarbons. The remaining intermediate gases are circulated and recycled through each of the gasification/oxidation chambers in order to maximize energy production. The energy produced through the system/process is used to generate steam and produce power through conventional steam turbine technology. In addition to the release of heat energy, the hydrocarbon fuels are oxidized to the pure product compounds of water and CO_2, which are subsequently purified and marketed. The system/process minimizes environmental emissions."

Appendix B – Data Requirements

This Appendix identifies the respective data input items required to be specified to facilitate an analysis of the ZEROS technology. The noted numeric numbers correspond to Excel spreadsheet row numbers within the model.

General. Case Analysis Description

5. Case Location and Related Information
7. Case Study Description
9. Feedstock Description
11. Date of origination for data
13. Most recent date of analysis

A. Facility Design and Operating Capacity Details

104. Number of Online Units in Plant
105. Description of "One Unit"
106. Daily Operating Hours, at full capacity (ignoring downtime)
107. Number of Days Operating per Year, at full capacity (ignoring downtime)
108. Daily Feedstock Throughput per Design Specs for One Unit at Designated Operating Regime
110. Average Annual Availability per Unit
114. Modified Total Average Hourly Feedstock Throughput for this Plant, function of actual feedstock type and quality
121. Heat Content of Feedstock designated in row 9
125. Year of Data Origination
126. Year of Project Design/Construction Initiation, i.e., t=0
128. Number of Years Required for Project Design/Construction Before Production Begins, i.e., no production occurs during t=0 nor during years 1, 2, …, through this year of the planning horizon; this includes no partial production in this year
129. Percent of Year Production Occurs During First Year of Production
130. Number of Production Years in Planning Horizon, Commencing with First year of Production and Accounting for Partial Years, e.g., 25% in first year and 75% in last year equals one year of production; i.e., model adjusts for and handles partial production in year one and extends production beyond defined production period to account for remainder of a full year's production in last year of plant's operation

B. Sale of Products and By-Products and Other Revenue Items

1) Electricity

205. QSE factor set by regulators regarding amount of productions that can be sold, i.e., a certain % of total production for a % of available days and hours

207. Portion of Net MWhr Electricity Produced for Sale Assumed Contracted for Sale

208. Net Sales Price per MWhr of Electricity

209. Base (a.k.a. origination) year for electricity sales price quote

210. Heat Rate for Electricity Produced

212. Total Electrical Production in MW/hr (Gross Generation)

213. Electricity Available for Sale (Net Generation)

214. BTU per MWhr of Electricity Produced for Sale

2) Sulphur

216. Percentage of Sulphur in feedstock

218. Portion of Total Tons of Sulphur Produced for Sale Assumed Contracted for Sale

219. Sales Price per Ton of Sulphur

220. Base (a.k.a. origination) year for sulphur sales price quote

221. BTU per lb of Sulphur Produced for Sale

3) Metal

223. Percentage of Metal in feedstock

225. Portion of Total Tons of Metal Produced for Sale Assumed Contracted for Sale

226. Sales Price per Ton of Metal

227. Base (a.k.a. origination) year for metal sales price quote

228. BTU per ton of Metal Produced for Sale

4) Nitrogen

231. Portion of Total Tons of Nitrogen Produced for Sale -- produced from ASU Assumed Contracted for Sale

232. Sale Price per Ton of Nitrogen

233. Base (a.k.a. origination) year for nitrogen sales price quote

234. BTU per lb of Nitrogen Produced for Sale

5) Hydrogen

236. Total Tons of Hydrogen Produced for Sale -- - produced from ceramic membrane separation

237. Portion of Total Tons of Hydrogen Produced for Sale -- - produced from ceramic membrane separation Assumed Contracted for Sale

238. Sale Price per Ton of Hydrogen

239. Base (a.k.a. origination) year for hydrogen sales price quote

240. BTU per lb of Hydrogen Produced for Sale

6) Argon

242. Total Tons of Argon Produced for Sale- produced from ASU with equipment additions

243. Portion of Total Tons of Argon Produced for Sale- produced from ASU with equipment additions Assumed Contracted for Sale

244. Sale Price per Ton of Argon

245. Base (a.k.a. origination) year for argon sales price quote

246. BTU per lb of Argon Produced for Sale

7) Ash

248. Percentage of Ash in feedstock

249. Total Tons of Ash Produced for Sale

250. Portion of Total Tons of Ash Produced for Sale Assumed Contracted for Sale

251. Sale Price per Ton of Ash

252. Base (a.k.a. origination) year for ash sales price quote

253. BTU per lb of Ash Produced for Sale

8) CO_2

255. Tons of $C0_2$ Produced per Ton of feedstock per Day

257. Portion of Total Tons of CO2 Produced for Sale Assumed Contracted for Sale

258. Sale Price per Ton of $C0_2$

259. Base (a.k.a. origination) year for CO_2 sales price quote

260. BTU per lb of CO2 Produced for Sale

9) Distilled Water

262. Gallons of Distilled Water Produced per Day

263. Total Gallons of Distilled Water Produced for Sale

264. Portion of Total Gallons of Distilled Water Produced for Sale Assumed Contracted for Sale

265. Sale Price per Gallon of Distilled Water

266. Base (a.k.a. origination) year for distilled water sales price quote

267. BTU per gal of Distilled Water Produced for Sale

10) Synthetic Diesel

269. Total Gallons of Synthetic Diesel Produced for Sale

270. Portion of Total Gallons of Synthetic Diesel Produced for Sale Assumed Contracted for Sale

271. Sales Price per Gallon of Synthetic Diesel

272. Base (a.k.a. origination) year for synthetic diesel sales price quote

273. Ratio of Wholesale Diesel Price to WTI Cushing

275. BTU per gal of Synthetic Diesel Produced for Sale

11) Clean Process Water

277. Net Excess Gallons of Clean Process Water Produced for Sale

278. Portion of Net Excess Gallons of Clean Process Water Produced for Sale Assumed Contracted for Sale

279. Sale Price per Gallon of Clean Process Water

280. Base (a.k.a. origination) year for clean process water sales price quote

281. BTU per gal of Clean Process Water Produced for Sale

12) Another Sales Product Extra #1

283. Net Excess of TBDefined 1 of Another Sales Product Extra #1 Produced for Sale

284. Portion of Net Excess of TBDefined 1 of Another Sales Product Extra #1 Produced for Sale Assumed Contracted for Sale

285. Sale Price per TBDefined 1 of Another Sales Product Extra #1

286. Base (a.k.a. origination) year for Another Sales Product Extra #1 sales price quote

287. BTU per TBD1 of Another Sales Product Extra #1 Produced for Sale

13) Another Sales Product Extra #2

289. Net Excess of TBDefined 2 of Another Sales Product Extra #2 Produced for Sale

290. Portion of Net Excess of TBDefined 2 of Another Sales Product Extra #2 Produced for Sale Assumed Contracted for Sale

291. Sale Price per TBDefined 2 of Another Sales Product Extra #2

292. Base (a.k.a. origination) year for Another Sales Product Extra #2 sales price quote

293. BTU per TBD2 of Another Sales Product Extra #2 Produced for Sale

14) Another Sales Product Extra #3

295. Net Excess of TBDefined 3 of Another Sales Product Extra #3 Produced for Sale

296. Portion of Net Excess of TBDefined 3 of Another Sales Product Extra #3 Produced for Sale Assumed Contracted for Sale

297. Sale Price per TBDefined 3 of Another Sales Product Extra #3

298. Base (a.k.a. origination) year for Another Sales Product Extra #3 sales price quote

299. BTU per TBD3 of Another Sales Product Extra #3 Produced for Sale

15) Another Sales Product Extra #4

301. Net Excess of TBDefined 4 of Another Sales Product Extra #4 Produced for Sale

302. Portion of Net Excess of TBDefined 4 of Another Sales Product Extra #4 Produced for Sale Assumed Contracted for Sale

303. Sale Price per TBDefined 4 of Another Sales Product Extra #4

304. Base (a.k.a. origination) year for Another Sales Product Extra #4 sales price quote

305. BTU per TBD4 of Another Sales Product Extra #4 Produced for Sale

16) Another Sales Product Extra #5

307. Net Excess of TBDefined 5 of Another Sales Product Extra #5 Produced for Sale

308. Portion of Net Excess of TBDefined 5 of Another Sales Product Extra #5 Produced for Sale Assumed Contracted for Sale

309. Sale Price per TBDefined 5 of Another Sales Product Extra #5

310. Base (a.k.a. origination) year for Another Sales Product Extra #5 sales price quote

311. BTU per TBD5 of Another Sales Product Extra #5 Produced for Sale

17) Another Sales Product Extra #6

313. Net Excess of TBDefined 6 of Another Sales Product Extra #6 Produced for Sale

314. Portion of Net Excess of TBDefined 6 of Another Sales Product Extra #6 Produced for Sale Assumed Contracted for Sale

315. Sale Price per TBDefined 6 of Another Sales Product Extra #6

316. Base (a.k.a. origination) year for Another Sales Product Extra #6 sales price quote

317. BTU per TBD6 of Another Sales Product Extra #6 Produced for Sale

18) Tipping Fees

319. Portion of Input Materials subject to Tipping Fees

320. Total Tons of Input Materials subject to Tipping Fees

321. Portion of Total Tons of Input Materials subject to Tipping Fees Assumed Contracted for Sale

322. Tipping Fees per Ton of Input Materials subject to Tipping Fees

323. Base (a.k.a. origination) year for clean process water sales price quote

C. Capital Asset Costs – portion eligible for investment tax credit; portion depreciable versus expensed in year of purchase, and annual inflation factor for purchases after time 0

1) Basic Costs

406. System Design and Detailed Engineering

407. OEM Zeros RK Equipment Package

408. OEM License and Engineering Package

409. Fuel Handling & Storage Equipment

410. Conceptual Project Design

411. Project Controls / Project Management Oversight

412. Installation ~

413. Development Startup Fees

414. Extra

415. Extra

2) Generation Equipment

422. HRSGs

423. Turbine Generators

424. Control System / Computers / DAS

425. Condenser / Cooling Tower / Flash Distillation Unit

426. Environmental Monitoring Equipment

427. Storage Tanks (Water)

428. Storage Tanks & Loading Equipment (Gases)

429. Storage Tanks Diesel

430. Air Separation Unit (ASU)

431. Hydrogen Processing Unit

432. Electrical Auxiliary Equipment

433. Plant Water Treatment

434. Main Power Transformer & Auxiliary Power Transformer

435. Black Start Diesels - 2X

436. UPS System/Battery

437. Capital Spare Parts

438. Extra

439. Extra

3) Site Improvements and Support Structures

446. Buildings & Structures & Receiving Building

447. Fischer-Tropsch Equipment

448. Road Improvements

449. Transmission Interconnect and Switchyard

450. Other Plant Equipment / Tools

451. Consumables

452. Extra

453. Extra

4) Land Acquisition Cost

460. +/- 100 acres

461. Extra

462. Extra

5) Project Development, Financing, & Implementation Costs

471. Contingency

472. Project Performance Bond

473. Development Fee

474. Legal and other soft costs

475. Equipment Insurance

476. Financing Fees (for full $250,000,000 USD equity participation)

477. Working Capital

478. Maintenance Reserve

479. Startup Costs

480. Maintenance, Operating, Safety and Environmental Procedures Development

481. Surveys, Fees, Permits and Applications

482. Other #1, e.g., within year financing to calibrate all purchases as if at end of noted year

483. Financing Costs Associated with Capital Loans

484. Other #3

485. Other #4

486. Other #5

6) Financing Terms by Time/Year of Purchase

496. Cash Downpayment on Respective Capital Investment Block of Funds

502. Financing Costs -- % of Financed Amount

503. Amount (%) of this cost to be capitalized into the loan

505. Financing Costs -- Flat $ cost

506. Amount (%) of this cost to be capitalized into the loan

509. Number of Years with No Principal Payments

511. Annual Interest Rate During No Principal Payment Period

513. Interest for Years with No Principal Payment Paid Annually (1) or All in First Year of Amortization Payments (2)

515. Amortized Payment Period (Years)

517. Balloon Payment Amount Due at End of Amortization Period (same year as last amortized payment due)

521. Annual Interest Rate on Balloon Payment Financed Amount

523. Annual Interest Rate on Amortized Financed Amount

525. Balloon Payment Interest Paid Annually (1) or All in Final Year (2)

7) Facility Salvage Value Information

527. What % of the plant's total investment, ignoring appreciation in value from time of purchase, is net recoverable one year after ceasing of operations?

529. What annual rate of appreciation in value is expected on the full capital investment, commencing in the first year of operating and extending through one year after ceasing of operations? Note that for this purpose, initial value is assumed to be sum of capital investments in time 0 through year 5 without any further adjustment in value during this time period

531. What marginal federal tax rate is assumed applicable to any recovered value in excess of the original investment amount? i.e., up to the original investment amount, the realized market value is ordinary income since it is in essence recaptured depreciation and expensing; any excesses realized are capital gains

D. Operating Costs – amount and base year of respective amounts

605. Management Fees

606. Labor Costs

607. Labor Overtime

608. Training

609. Fuel Costs

610. Natural Gas Fuel

611. Leased Equipment

612. Plant Maintenance – for all systems, or specifically:

613. Synthetic Fuels System

614. Air Separation System

615. Power System

616. Hydrogen System

617. Zeros System

618. General Facility

619. Professional Fees

620. QSE Fees

621. Office Expenses

622. Additional Operating VC 1

623. Additional Operating VC 2

624. Additional Operating VC 3

625. Additional Operating VC 4

626. Additional Operating VC 5

627. Additional Operating VC 6

628. Additional Operating VC 7

629. Additional Operating VC 8

630. Additional Operating VC 9

631. Additional Operating VC 10

634. Insurance

635. Property Taxes

636. Royalties

638. Contingency

1) Details on labor costs – job function, number of workers, Base $/hr, Hrs/wk, benefits %, average hours worked per week

645. Operator - Group 2

646. Operator - Group 3

647. Security

648. Fuel Handlers

649. Site Maintenance

650. By-Product Logistics

651. Plant Manager

652. Control Operators

653. Plant Engineers

654. Warehouse / Office

655. Training / Safety

E. Macroeconomics and Fiscal Factors

1) Revenue & Cost Indices

805. Overall General CPI Escalator - Estimated Fixed Rate; used if no individual index nor no category index

806. General Revenue Price Index

807. Electricity

808. Sulphur

809. Metal

810. Nitrogen

811. Hydrogen

812. Argon

813. Ash

814. CO2

815. Distilled Water

816. Synthetic Diesel

817. Clean Process Water

818. Another Sales Product Extra #1

819. Another Sales Product Extra #2

820. Another Sales Product Extra #3

821. Another Sales Product Extra #4

822. Another Sales Product Extra #5

823. Another Sales Product Extra #6

824. Tipping Fees

825. Extra

826. Extra

827. Extra

828. General Operating Costs Index

829. Management Fees

830. Labor Costs

831. Labor Overtime

832. Training

833. Fuel Costs

834. Natural Gas Fuel

835. Leased Equipment

836. Plant Maintenance:

837. Synthetic Fuels System

838. Air Separation System

839. Power System

840. Hydrogen System

841. Zeros System

842. General Facility

843. Professional Fees

844. QSE Fees

845. Office Expenses

846. Additional Operating VC 1

847. Additional Operating VC 2

848. Additional Operating VC 3

849. Additional Operating VC 4

850. Additional Operating VC 5

851. Additional Operating VC 6

852. Additional Operating VC 7

853. Additional Operating VC 8

854. Additional Operating VC 9

855. Additional Operating VC 10

856. Insurance

857. Property Taxes

858. Royalties

859. Contingency

2) Federal Tax Marginal Rate and Depreciation

863. Estimated Effective Annual Marginal Tax Rate

864. Desired MACRS Federal Tax Depreciation Useful Life: 3, 5, 7, 10, 15, 20

3) Federal Tax Credits

889. Federal Investment Tax Credit Rate (%) Applicable to Qualified Capital Investments

a) A federal tax credit series applicable to a specified span of years, at an annual flat rate

892. Annual flat rate amount of credit ($)

893. First year of credit, i.e., 1, 2, 3, …

894. Last year of credit, i.e., 2, 3, 4, …

b) A federal tax credit series applicable to a specified span of years, based on a percentage of annual gross revenue

897. Annual % rate of credit ($)

898. First year of credit, i.e., 1, 2, 3, …

899. Last year of credit, i.e., 2, 3, 4, …

c) A federal tax credit series applicable to a specified span of years, based on a percentage of annual operating income

902. Annual % rate of credit ($)

903. First year of credit, i.e., 1, 2, 3, …

904. Last year of credit, i.e., 2, 3, 4, …

906. Incorporate Allowance for Production Tax Credits (Alternative Fuels)

907. Production Tax Credits (Alternative Fuels)

908. First year of credit, i.e., 1, 2, 3, …

909. Last year of credit, i.e., 2, 3, 4, …

910. Incorporate Allowance (Yes=1 and No=0) for Green Energy Credits per Mwhr Net

912. Green Energy Credits per Mwhr Net

913. First year of credit, i.e., 1, 2, 3, …

914. Last year of credit, i.e., 2, 3, 4, …

917. Incorporate Allowance (Yes=1 and No=0) for Methane Offset Factor for Municipal Solid Waste (MSW)

918. Methane Offset Factor for Municipal Solid Waste (MSW)

919. First year of credit, i.e., 1, 2, 3, …

920. Last year of credit, i.e., 2, 3, 4, …

922. Incorporate Allowance for Carbon Credits

923. Carbon Credits per Metric Ton

924. First year of credit, i.e., 1, 2, 3, …

925. Last year of credit, i.e., 2, 3, 4, …

927. Another Tax Credit #1

928. % Amount Allowed of Another Tax Credit Extra #1

929. First year of credit, i.e., 1, 2, 3, …

930. Last year of credit, i.e., 2, 3, 4, …

932. Another Tax Credit #2

933. % Amount Allowed of Another Tax Credit Extra #2

934. First year of credit, i.e., 1, 2, 3, …

935. Last year of credit, i.e., 2, 3, 4, …

4) Discount Factors

937. Inflation discount factor

938. Risk disk factor

939. Time value discount factor

940. Multiplicative (1) or Additive (2) formulation of discount factor

942. Composite Discount Factor Used in Calculations -- either manually specified or determined using Goal Seek

5) Property Tax Abatement

944. Property Tax Abatement

945. If there is property tax abatement, number of years, including both construction and general operating period

946. Proportion of Charged Property Taxes That are Abated

6) Cash Flow Balance Maintenance

948. Minimal End-of-Year Cash Balance Requirement

949. Interest Rate for Short-Term borrowing to maintain Cash Flow Balance

950. Proportion of Excess Cash (after Short-term Loan Payments are made) Paid Out as Dividends

951. Interest Earnings on Investment Account (%)