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Conducting a business case analysis for Net Zero Plus--Joint Concept Technology Demonstration (JCTD)

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THESIS

CONDUCTING A BUSINESS CASE ANALYSIS FOR NET ZERO PLUS – JOINT CONCEPT TECHNOLOGY DEMONSTRATION (JCTD)

by

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December 2007

Thesis Advisor: Dan Nussbaum
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13. ABSTRACT (maximum 200 words)

The Net Zero Plus (NZP) is an approved Fiscal Year 2007 Joint Capability Technology Demonstration (JCTD) initiative by the United States Rapid Equipping Force (REF). The purpose of JCTD is to identify significant military needs and match them to mature technologies or technology demonstration programs, so that the military needs can be addressed rapidly.

The operational issue that underlies this research is how to reduce the risk to logistics forces by lowering the re-supply requirement of fuel by forward / remote operating bases. The achievement of this reduction in external fuel requirements reduces costs and diminishes the number of fuel convoys required. Fewer convoys reduce the opportunity for an enemy to target and attack our forces in vulnerable convoys. Net Zero Plus looks into mainly three categories, namely: energy supply, energy demand and brilliant distribution of energy to the forward operating bases.

The purpose of this study is to analyze the cost and benefits of implementing the following proposed alternative energy solutions, namely:

1) External Spray Foam Insulation

2) Transportable Hybrid Electric Power Station (THEPS)

3) Tactical Garbage to Energy Refinery (TGER)

This research will:

- Develop a Business Case to analyze the alternative solutions. The objective is to identify the costs and benefits of the alternative solutions. The goal is provide the decision makers the financial information so they can make better informed decisions.
- Examine DoD's proposed alternatives to reduce its demand for oil and understand the financial aspect of the alternatives proposed.

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CONDUCTING A BUSINESS CASE ANALYSIS FOR NET ZERO PLUS – JOINT CONCEPT TECHNOLOGY DEMONSTRATION (JCTD)

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ABSTRACT

Net Zero Plus (NZP) is an approved Fiscal Year 2007 Joint Capability Technology Demonstration (JCTD) initiative by the United States Rapid Equipping Force (REF). The purpose of JCTD is to identify significant military needs and match them to mature technologies or technology demonstration programs, so that the military needs can be addressed rapidly.

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EXECUTIVE SUMMARY

Net Zero Plus (NZP) is an approved Fiscal Year 2007 Joint Capability Technology Demonstration (JCTD) initiative by the United States Rapid Equipping Force (REF). The purpose of JCTD is to identify significant military needs and match them to mature technologies or technology demonstration programs, so that the military needs can be addressed rapidly.

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The results of the Net Zero Plus business case analysis are as follows:

Initiatives	Annualized ROI	Payback Period
Spray Foam Insulation	32.9%	Less than 1 year
THEPS	43.8%	Less than 1 year
TGER	28.5%	Less than 1 year

Table 1. Annualized ROI and Payback Period for the Initiatives

- THEPS has the highest annualized return on investment (ROI) among the three initiatives and has a payback period of less than 1 year.
- Sensitivity analysis shows that THEPS is the least sensitive to changes in operations and support (O&S) costs. Its ROI is reduced by 0.3% for every 1% increase in O&S costs. On the other hand, THEPS's ROI is the most sensitive towards the change in discount rate, but remains above 40% with the discount rate ranging from 5% to 15%.
- TGER achieves an annualized ROI of 28.5%, with a payback period of less than 1 year. It is more sensitive to a change in the O&S costs as compared to THEPS and spray foam insulation. It is observed from the sensitivity analysis that TGER's ROI is very sensitive to the quantity of waste produced by the theatre. For TGER to achieve an annualized ROI of more than 20%, the quantity of waste produced per day must be more than 7 tons.
- The spray foam insulation achieves an annualized ROI of 32.9% with a payback period of less than 1 year. Its investment does not give a return as high as THEPS; however, its technology has already been developed and it is a commercial off-the-shelf (COTS) product currently on the market. Its technology can be implemented as soon as possible if time is a constraint.
- From the learning curve analysis, it is observed that higher economies of scale can be achieved for producing THEPS and TGER. For every unit of THEPS produced, there is an increase of approximately 0.5% annualized ROI. On the other hand, for every unit of TGER produced, there is an increase of approximately 0.55% annualized ROI.
- The three initiatives are very attractive financial solutions to NZP, with high annualized ROIs, short payback periods and opportunities to leverage economies of scale.

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I would like to personally express my gratitude to Professor Dan Nussbaum and COL (Ret) Edward Lesnowicz for their guidance and advice in writing this thesis. Their support has made writing my thesis a wonderful experience. Thank you.

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I. INTRODUCTION

A. PURPOSE AND BACKGROUND OF THE STUDY

The United States consumes 20.5 million barrels of oil per day (bbl/d). Extrapolated out, this rate of usage consumes 25% of the world's annual oil supply, and three times that of the second largest consumer, China. The Department of Defense's (DoD's) oil consumption requirement represents 1.2% of total U.S. oil consumption. This percentage, though small, becomes financially significant in light of recent 25% cost increases ($2.7B experienced between FY05 to FY06)[1] as well as politically significant when DoD's capabilities and operational costs are devoted to maintaining lines of oil supply overseas.

This research will examine DoD's proposed alternatives to reduce its demand for oil with an understanding of the financial aspects of the alternatives proposed. The purpose of this study is to analyze the cost and benefits of implementing the proposed alternative energy solutions. This research will:

- Develop a Business Case to analyze the alternative solutions. The objective is to identify the costs and benefits of the alternative solutions. The goal is provide the decision makers the financial information so they can make better informed decisions.
- Examine DoD's proposed alternatives to reduce its demand for oil and understand the financial aspect of the alternatives proposed.

The operational issue that underlies this study is how to reduce the risk to logistics forces by lowering the re-supply requirement of fuel by forward/remote operating bases. The achievement of this reduction in external fuel requirements reduces costs and diminishes the number of fuel convoys required. Fewer convoys reduce the opportunity for an enemy to target and attack our forces in vulnerable convoys.

The alternatives considered in this study have a tactical significance, since they were initiated to meet the Joint Urgent Operational Need Statement (JUONS) submitted

[1] Al Shaffer, (May 22, 2007), *DoD Energy Security Task Force*, Retrieved August 6, 2007 from http://proceedings.ndia.org/jsem2007/Shaffer.pdf.

by the operational commander in Iraq. The JUONS states, "By reducing the need for Class III (petroleum) at our outlying bases, we can decrease the frequency of logistics convoys on the road, thereby reducing the danger to our Marines, Soldiers, Sailors and Airmen." The Army Rapid Equipping Force (REF), in response to the JUONS, set up a Power Surety Task Force (PSTF) to look into the energy demand from, energy supply, and distribution of energy to the forward operating bases (FOBs).

B. ORGANIZATION OF THE POWER SURETY EFFORT

The REF was established with a broad mission to rapidly increase mission capability while reducing the risk to soldiers. The REF accomplishes this mission in three ways:

- **Equip** operational commanders with commercial off-the-shelf (COTS) and government off-the-shelf (GOTS) solutions in order to increase effectiveness and reduce risk.
- **Insert** future force technologies and surrogates to validate concepts and speed capabilities to the warfighter.
- **Assess** Army business practices, desired capabilities, and acquisition techniques to effect institutional Army change

More information on REF can be found at: https://www.ref.army.mil/nonflash/default.asp.

The PSTF was established by the REF to foster the development of power surety projects and programs that are deployable within 18 months and that will reduce fuel requirements of FOBs by 40%. The measures of effectiveness of PSTF are:

- Increase soldier safety by reducing logistics signature
- Seek the most efficient energy-using devices and conservation tools
- Improve power production/distribution effectiveness
- Rapidly foster fuels/power storage programs
- Develop a model power system to support a FOB

More information on PSTF can be found at: https://www.ref.army.mil/powersurety/default.asp.

The objective of the Net Zero Plus (NZP) program is to reduce energy demand by brilliant distribution of appropriate alternative energy supplies.[2] NZP is a Joint Capability Technology Demonstration (JCTD) that looks into three categories, namely:

- **Energy Supply**: Renewable and alternative power generation reduces fuel consumption by generating power through a combination of renewable, traditional and alternative power generation.
- **Brilliant Distribution**: A system of distribution that precisely connects power consuming and producing devices. Such a system has real-time or near real-time knowledge of the available power supply and load demands and uses that knowledge and an automated power manager to properly schedule and deliver available energy supplies to intelligent energy consuming devices. This power manager precisely matches supply with demand while minimizing excessive production, shaving peak demands or minimizing unnecessary losses of energy.
- **Energy Demand**: Energy efficient structures and technologies reduce energy consumption through minimized air infiltration, low-power devices and efficient environmental control.

C. PROBLEM STATEMENT

In an environment of uncertainty about the price of fossil fuels and the availability of traditional energy sources, DoD is facing increasing demands for fuel consumption that it must meet in order to meet its operational requirements, including providing increased mobility for the forces.

The distribution system for fuel is both a significant effort, as well as an increasing burden on the armed forces. The logistics costs to deliver fuel include people, training, platforms (for example, oilers, trucks, and tanker aircraft), and other hardware and infrastructure. The exact costs, though significant, are not fully quantified. However, it is believed that the actual costs of delivering fuel for operations are dramatically higher than the decision makers realize.[3]

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[2] Dan Nolan, Power Surety Task Force, Power Surety for Enduring Operations, Retrieved August 7, 2007 from https://www.ref.army.mil/powersurety/background.asp.

[3] Scott C. Buchanan, (3rd Quarter 2006), *Energy and Force Transformation*, Retrieved August 7, 2007 from http://www.army.mil/professionalwriting/volumes/volume5/april_2007/4_07_4,html#12.

For the reasons above, DoD seeks alternative ways of supplying energy resources to the armed forces. Additional reasons include:

1. Vulnerability of Fuel Convoys to Enemy Attacks

The supply of fuel to the FOBs often requires lengthy logistic supply lines to transport the fuel to meet the needs of the troops in the FOBs. These supply lines have become a favorite target for guerilla-style asymmetrical warfare against U.S. troops. Military operations highlight both the requirement for and vulnerability of military fuel convoys.

Current military operations are very reliant on petroleum-derived fuels. These needs impose large logistical burdens, operational constraints and liabilities, and vulnerabilities to the fuel convoys that are exposed to attacks while delivering fuel along supply routes supporting the FOBs.

2. National Security

Recent oil prices have been volatile and unpredictable, with relatively small disruptions in supply causing significant price fluctuations. Recent events have led to volatility in both supply and demand, and the result has been increased oil prices. Most of the petroleum-based fuel resources are located in the Middle East, Africa, Latin America, and Central Asia. This reliance on foreign oil supply to meet its energy demands requires strong trade partners willing to provide oil to the United States. Hence, the U.S.'s reliance on other countries to supply energy resources has national security implications that cannot be easily disregarded.

II. BACKGROUND

A. JOINT/ADVANCED CONCEPT TECHNOLOGY DEMONSTRATION PROCESS

Budget constraints, significant changes in threats, and an accelerated pace of technology development have challenged the ability of the Component Commanders (COCOMs) to respond adequately to rapidly evolving military needs. Part of the DoD response to these challenges has been to initiate the Advanced Concept Technology Demonstration (ACTD) program in early 1994 to get new technologies into the hands of the warfighter as quickly as possible.

The ACTD program was designed to assist the DoD acquisition process to adapt to today's economic and threat environments. ACTDs identify significant military needs and match them to mature technologies or technology demonstration programs. These technologies are then combined and integrated into a complete military capability to provide decision makers an opportunity to understand fully the operational potential offered by a proposed new military capability before making an acquisition or sustainment decision.

This goal is met by developing fieldable prototypes of the proposed capability and providing those prototypes to the warfighter for evaluation of that capability. The warfighter evaluates the capability in real military exercises and at a scale sufficient to fully assess military utility. During the ACTD, the warfighter also evolves the broad statement of need, which existed at the start of the ACTD, into a definitive set of operational requirements that can support a follow-on acquisition. At the completion of the ACTD, the prototypes used in the evaluation process are left with the warfighter to provide an interim capability or, in some cases, to fulfill the total current need.[4]

[4] Gadala E. Kratzer, (October 2005), *NPS Thesis on a Methodological Approach for Conducting a Business Case Analysis for Advanced Technology Ordnance Surveillance (AOTS).*

B. JOINT CAPABILITY TECHNOLOGY DEMONSTRATIONS PROCESS

Beginning in Fiscal Year (FY) 2006, a new ACTD business process was initiated which will take the successful ACTD program and update it to meet the Department's transformational goal of becoming capability-based vice threat-based in its focus. The program will be referred to as the Joint Capability Technology Demonstration (JCTD) program. The JCTD program will include many of the positive aspects of the ACTD program, but will be revamped to meet the defense challenges of the 21st century. The new process will integrate the ACTD program with the new Joint Capabilities Integration and Development System (JCIDS) developed by the Joint Chiefs of Staff (JCS).

Beginning in FY 2006, the Department estimated a three- to five-year transition period from the current ACTD process to the improved JCTD program. Eventually, JCTDs will replace ACTDs, providing an even faster process that focuses on joint and transformational technologies that are initiated in science and technology (S&T) and carried through the difficult transition stage to a full "program of record." This transition has, in the past, been marked by many failures, so much so that it is sometimes referred to as the "S&T valley of death."

The new JCTD business model includes a Defense Acquisition Executive (DAE) pilot program which will take a limited number of "joint peculiar" JCTDs past milestone B, through engineering and manufacturing, and into procurement, followed by initial sustainment—a "cradle to grave" approach. The piloted program envisions using joint acquisition activities like the Joint Precision Strike Demonstration (JPSD) program office, or even U.S. Special Operations Command (USSOCOM), to provide the necessary acquisition compliance and program management functions. The DAE pilot program will give overall programmed oversight of JCTDs that are deemed uniquely joint/combined (i.e., the capability directly supports more than one Military Service)

and/or transformational. The new JCTD demonstration model will specifically address congressional concerns and recommendations made by the General Accountability Office (GAO) regarding the ACTD program.[5]

C. PROPOSED NET ZERO PLUS INITIATIVES

In the NZP program, three initiatives are proposed to reduce the fuel demand and increase the energy supply to the FOBs. These proposed initiatives are all underpinned by mature technologies that can lead to accelerated procurement, so that the capabilities can be delivered to the warfighters quickly.

1. External Spray Foam Insulation

a. System Description

The main idea of this technology is to provide an insulating layer on the tents to keep the outside air out and the air-conditioning in. The spray foam insulation used is a product from Gaco Western Polyform™ System 193. It is sprayed onto the tents, and will fill every nook and cranny, creating a uniform monolithic barrier. Figure 1 shows the tents and Containerized Living Units before and after the spraying of foam insulation. It is a hydrofluorocarbon (HFC) blown (zero-ozone depleting) liquid spray system that cures to a low-density rigid polyurethane insulation material. It contains material derived from naturally renewable resources and does not contain chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs) or other gases harmful to the environment. This system can be sprayed on clean, dry substrates down to 35^{o}F (1.66 ^{o}C).

[5] Advanced Systems & Concepts, (October 14, 2006), *Joint Capability Technology Demonstration (JCTD)*, Retrieved on August 17, 2007 from http://www.acq.osd.mil/jctd/index,htm.

Once the spray foam is applied, it is allowed to cure into a barrier approximately two inches thick. Finally, a top coat of acrylic elastomeric coating is applied to provide enhanced protection against environmental conditions. At this point, the tent becomes a semi-permanent structure that remains in place and cannot be relocated for other uses.

Potential safety hazards have been identified for this product and measures are taken to mitigate their severity. More details can be obtained from the owner's manual[6] prepared by REF for the users.

Tents

Containerized Living Unit (CLU)

Standard Noninsulated, Air-infiltrated GP Tent

Standard GP Tent with Exterior Foam Insulation

Figure 1. Tents and CLU Before and After Applying External Spray Foam Insulation. From: COL Dan Nolan, U.S. Army (Ret.), 2007.

[6] Rapid Equipping Force, (May 2007), *Owner's Manual for External Insulated Temporary Structures*, Obtained from Rapid Equipping Force on September 25, 2007.

b. Status

The spray foam insulation product is readily available, as it is a COTS product. REF engaged Exponent, Inc.® in March 2007 to examine a current proposal to insulate U.S. Army general purpose (GP) tents installed at FOBs with spray foam insulation.[7] Exponent is required to perform the following tasks:

1) Quantify the air exchange rate for a foam-insulated GP tent and compare it with a traditional (non-insulated) GP tent;

2) Perform heating and cooling load calculations for the foam-insulated GP tent and estimate energy consumption for different potential air conditioning units;

3) Assess the relative fire safety of foam-insulated tents as compared with traditional non-insulated tents.

The main finding from the study is that the thermal resistance of walls and roofs in the foam-insulated tents is comparable with the thermal resistance of walls and roofs in permanent building structures. This represents a vast improvement towards reducing energy consumption for air conditioning, when compared with a non-insulated tent.

Another finding is that a high-efficiency heating, ventilation, and air conditioning (HVAC) unit (for example, an "Energy Star" labeled unit) should be used to reduce the energy consumption-per-unit cooling or heating output and it should be sized according to the "recommended unit size" calculation for the maximum number of soldiers that will be in the tent.

Another important finding to reduce fire risk inside the tents is to include:

1) Fixed smoke alarms;
2) Installation of door hardware that facilitates emergency egress;
3) Portable fire extinguishers for occupant use;
4) Training for the occupants in firefighting techniques.

[7] Exponent, Inc., (March 2007), *Tent Foam Insulation Report*, Obtained from Rapid Equipping Force on September 15, 2007.

Currently, the spraying of foam insulation is ongoing in the U.S. Central Command (USCENTCOM) area of responsibility (AOR).

2. Transportable Hybrid Electric Power Stations

The Transportable Hybrid Electric Power Station (THEPS) is a mobile power station that can make use of renewable energy sources to generate power output. DoD had contracted Skybuilt Power to make two variants for the Army: one mobile power station that can be towed by a High-Mobility Multipurpose Wheeled Vehicle (HMMWV), and one tactical operations center that can act as a manned or unmanned operations center. Figure 2 shows the THEPS variant that is used as a tactical operations center, and Figure 3 shows the THEPS variant that can be towed by a HMMWV. Figure 4 shows an artist's rendering of a THEPS Tactical Operations Center.

THEPS TOC v2.0

THEPS TOC v2.0

Figure 2. THEPS Variant Used as a Tactical Operations Center. From COL Dan Nolan, U.S. Army (Ret.) 2007.

THEPS MEP v1.0

THEPS MEP v2.0

Figure 3. THEPS Variant Towed by HMMWV. From: COL Dan Nolan, U.S. Army (Ret.) 2007.

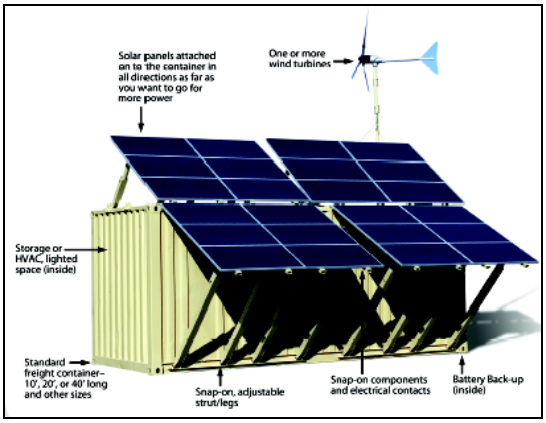

Figure 4. THEPS TOC (artist rendering). From: COL Dan Nolan, U.S. Army (Ret.). 2007.

While hybrid vehicle technology and fuel cell programs are still in research and development, new, more mature programs, such as wind- and solar-powered generators are being touted as quick, mobile power solutions by the REF. Dan Nolan, head of the effort at REF, said, "We want to do nothing to diminish mission capability but, rather, decrease the fuel need."[8]

a. System Description

THEPS can make use of various renewable energy sources, like wind and solar, to generate power. The power generated from renewable energy can be integrated with power generated from fuel, such as diesel, propane, natural gas, JP-8 or storage batteries to provide reliable power. Wind turbines, photovoltaics, absorbed glass mat batteries and diesel generators can fit inside a ¾-ton trailer or a 20-foot storage container.

A test was carried out on the effectiveness of THEPS at converting renewable energy into power at the National Training Center (NTC).[9] It was observed that THEPS's power output averaged at 0.355 kilowatts (kW) from data taken on an hourly basis over a week-long period. The maximum and minimum power output is 0.931 kW and 0 kW, respectively. The power output varies depending on the weather (wind speed) conditions and time of the day.

THEPS is suitable for FOBs of all sizes, for example, bare bases, observation posts, border checkpoints and humanitarian efforts where JP-8 re-supply is costly.

b. Status

THEPS's technology is currently being evaluated at NTC. The implementation timeline is awaiting Spiral 2 concepts from the USMC DREAM program, a United States Marine Corps (USMC) technological initiative that makes use

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[8] Breanne Wagner, (April 2007), *Alternative power sources sought for remote bases*, Retrieved on October 5, 2007 from http://www.nationaldefensemagazine.org/issues/2007/April/Alternativepower,htm.

[9] Rapid Equipping Force, *Data sets for testing THEPS at National Training Center,* Obtained from Rapid Equipping Force on October 7, 2007.

of renewable energy sources. REF is considering conducting additional spirals for THEPS in coordination with the National Renewable Energy Laboratory.

3. Tactical Garbage-to-Energy Refinery (TGER)

All organic waste contains energy. Oil, coal, wood, and garbage all contain heat energy that is released when burned. The amount of heat energy in each substance determines how much energy is released. While it costs more to generate electricity at a waste-to-energy plant than it does at a coal, nuclear, or hydropower plant, providing electricity is not the major advantage of waste-to-energy plants. For example, the major advantage of burning waste in a large-scale domestic incinerator is that it reduces the amount of garbage buried in landfills. (National Energy Education Development Project, 2006)

A study done by the Logistics Management Institute for Defense Advanced Research Projects Agency (DARPA)[10] found that:

- approximately 87 percent of the waste is potentially convertible into fuel;
- much of the waste is made up of wood, cardboard, plastic, and food; and
- a deployed soldier generates an average of 7.2 pounds of convertible solid waste per day.

The biorefinery could alleviate the expense and potential danger associated with transporting waste and fuel. Also, by eliminating garbage remnants—known in the military as a unit's "signature"—a biorefinery could protect the unit's security by destroying clues that such refuse could provide to enemies. Researchers tested the first tactical biorefinery prototype in November 2006 and found that it produced approximately 90 percent more energy than it consumed, said Jerry Warner, founder of Defense Life Sciences LLC, a private company working with Purdue researchers on the project.[11] The biorefinery generator initially runs on diesel oil for several hours until the

[10] Logistics Management Institute, (February 2004), *An Analysis of the Energy Potential of Waste in the Field*, Obtained from Rapid Equipping Force on September 25, 2007.

[11] Douglas M. Main, (February 1, 2007), *Scientists develop portable generator that turns trash into electricity*, Retrieved on October 5, 2007 from http://news.uns.purdue.edu/x/2007a/070201LadischBio.html.

gasifier and the bioreactor begin to produce fuel, according to Warner. In the initial commissioning test, the efficiency of the TGER was calculated by measuring the amount of diesel oil burned during the initial start-up and the electricity produced. Refer to the system description below on how a TGER works.

The TGER machine produces a very small amount of its own waste, mostly in the form of ash that the Environmental Protection Agency has designated as "benign," or non-hazardous. Any leftover materials from the bioreactor are put into the gasifier, which has to be emptied every two to three days. The remaining waste is about enough to fill a regular-sized trash bag, and it represents about a 30-to-1 volume reduction.

TGER is skid mounted and can be employed on military 5-ton flatbed trailer. It has a tare weight of 7,128lbs and dimensions: 160"L x 96"W x 90"H. Figure 5 shows a TGER.

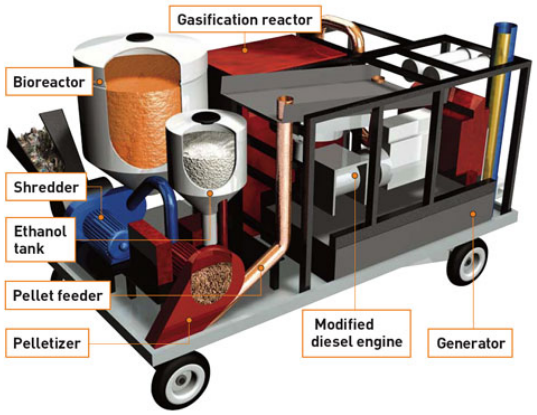

Figure 5. TGER. From: COL Dan Nolan, U.S. Army (Ret.). 2007.

a. System Description

The TGER incorporates two complementary technologies:

1) Bioreactor to convert carbohydrates, sugars, some cellulosic waste into vaporous ethanol

2) Thermochemical gasifier to convert bioreactor residuals into "fuel gas"

How it works:

1) The shredder rips up waste and soaks it in water.

2) The sludge is pumped into the bioreactor, and enzymes break it down into carbohydrates and then into simple sugars, which yeast metabolizes into ethanol.

3) The pelletizer compresses undigested waste pellets and feeds them into a gasification reactor that burns them in a low-oxygen, high-temperature environment to produce a composite gas.

4) The ethanol is combined with the composite gas and injected into a 60-kW diesel generator, where it is mixed with 10 percent diesel fuel to generate electricity.

The TGER will start on JP-8 or diesel fuel, and then, within six to twelve hours, convert to running 98 percent on trash-derived energetics. It will turn 1 ton of waste into energy, while conserving 115 gallons of JP-8 or diesel fuel. Excess thermal energy can be used for field sanitation, showers or laundry use. Another major potential saving comes from the avoidance of the disposal costs of trash.

D. POSSIBLE BENEFITS OF THE PROPOSED INITIATIVES

There are two main benefits for the proposed NZP initiatives:

1) **Reduced fuel transport saves money and reduces the frequency of vulnerable fuel convoys being exposed to enemy attacks.** Spray foam insulation on tents will reduce the demand for fuel in generating power to air-condition the tents. THEPS make use of renewable energy sources to generate power supply and less fuel is required. TGER converts waste to energy, and it conserves diesel fuel. Each month, a TGER will save enough gasoline to fill a mid-sized tanker truck. Fewer fuel trucks means fewer convoys subjected to improvised explosive devices (IEDs) along the transportation route.

2) **Reduced waste disposal costs.** The estimated waste disposal cost of a division in a Middle Eastern Operating Theater is $629 per ton of waste.[12] There will be substantial savings on disposal costs if the waste can be converted into electricity.

[12] Exponent, Inc., (March 2007), *Tent Foam Insulation Report*, Obtained from Rapid Equipping Force on September 15, 2007.

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III. NET ZERO PLUS BUSINESS CASE ANALYSIS

A. WHAT IS BUSINESS CASE ANALYSIS?

A Business Case Analysis (BCA) is a financial tool that helps decision makers to evaluate alternative solutions and to present economical arguments for carrying out alternatives over the life cycle to achieve stated business objectives. It is a structured and systematic methodology to examine the all proposed alternatives and to evaluate them on the same baseline.

In this thesis, the specific BCA is modeled after the approach in a Naval Postgraduate School (NPS) thesis that was completed in December 2006.[13]

The BCA's general framework consists of the following elements:

- Define objectives of the action being considered.
- Specify assumptions and constraints.
- Identify possible alternatives and status quo.
- Estimate costs and benefits of each alternative.
- Conduct sensitivity and risk analysis.
- Draw conclusion and make recommendations.

A BCA is an iterative process that is conducted, revised and reviewed throughout the life cycle of the program. As the program plans change over time due to changes in the business and operational environments, the BCA will have to be revised accordingly.

Figure 6 shows a BCA process proposed by the Defense Acquisition University[14] for DoD personnel in conducting a BCA:

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[13] Lim Hang Sheng, (December 2006), *NPS Thesis on A Methodological Approach For Conducting A Business Case Analysis For the Joint Distance Support and Response (JDSR) Advanced Concept Technology Demonstration (ACTD)*, Retrieved on August 23, 2007 from http://bosun.nps.edu/uhtbin/cgisirsi.exe/4yeMQ0C51I/SIRSI/16300008/503/182.

[14] Defense Acquisition University, (2007), *Business Case Analysis*, Retrieved on August 24, 2007 from https://acc.dau.mil/CommunityBrowser.aspx?id=32524.

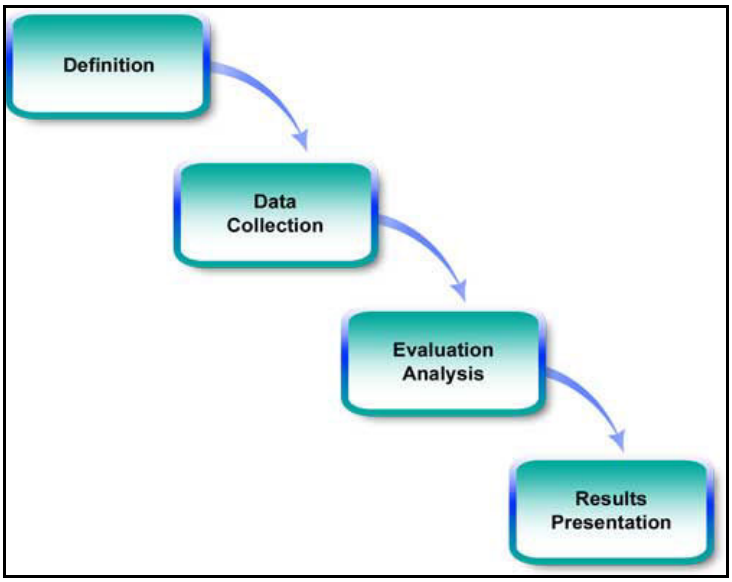

Figure 6. Business Case Analysis Process. From: Defense Acquisition University, 2007.

1. Phase 1: Definition

In Phase 1, the objective and scope of the analysis is defined along with assumptions and constraints to guide the analysis.

2. Phase 2: Data Collection

In Phase 2, a plan is outlined to collect the various types of data required for the analysis. These are categorized and potential data sources identified for the collection. Spreadsheets and databases need to be created to store and organize the data after it is collected. Often, the data required is not available. In this event, an estimate is made with the approach for calculating the estimate clearly explained and documented. The data collected is checked for accuracy and completeness. Data normalization is carried out to adjust for inflation or deflation to account for the time value of money.

3. Phase 3: Evaluation Analysis

In Phase 3, the actual computation occurs and a BCA is built for each alternative, using both quantitative and qualitative data. Each alternative is then compared with the

baseline, which is the status quo, to determine which one offers the best value for money. A sensitivity analysis is carried out to explain what happens if the assumptions change or are proven wrong. It is also important to examine the risks associated with each alternative, along with the potential risk mitigation strategies for each identified risk.

4. Phase 4: Results Presentation

In the last phase, the results of the analysis are presented in appropriate graphs and charts to the decision makers. The presentation should include the key information from the previous three phases. Lastly, the conclusion and recommendations for a suitable course of action are presented to the decision maker.

B. WHAT IS A WORK BREAKDOWN STRUCTURE?

A Work Breakdown Structure (WBS) has a hierarchical tree structure that captures all the work of a project in an organized way. A WBS can be product or process oriented on the ultimate end-items of the project. DoD Handbook MIL-HDBK-881[15] has defined WBS as:

> A WBS displays and defines the product, or products, to be developed and/or produced. It relates the elements of work to be accomplished to each other and to the end product. A WBS can be expressed down to any level of interest. However the top three levels are as far as any program or contract need go unless the items identified are high cost or high risk. Then, and only then, is it important to take the work breakdown structure to a lower level of definition.

There are several benefits to having a WBS planned out properly for a project. A WBS helps to keep track of the schedule, resource allocation, cash flow, expenditures, and performance of the project. In our Business Case analyzing three proposed initiatives, we will consider the life-cycle costs, namely from Investment, O&S to Disposal. The WBS will consist of three top-level components, as follows.

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[15] Department of Defense Handbook, (January 2, 2007), *Work Breakdown Structure*, Retrieved on August 26, 2007 from http://www.srs.gov/general/EFCOG/03OtherAgencies/MilHdbk881.pdf.

1. Investment Cost

Investment cost consists of the estimated cost of the investment phase, including total cost of procuring the prime equipment, related support equipment, training, initial and war reserve spares, pre-planned product improvements and military construction.

2. Operations and Support Cost

The O&S cost consists of the estimated cost of operating and supporting the fielded system, including all direct and indirect costs incurred in using the system, e.g., personnel, maintenance, and sustaining investment (replenishment spares). It is a recurring cost that is incurred to maintain the operational readiness of the system throughout the life cycle of the system.

3. Disposal Cost

The disposal cost is the estimated cost to dispose of the system after its useful life.

C. "AS-IS" COST (WITHOUT PROPOSED INITIATIVES)

1. Defense Energy Support Center

The Defense Energy Support Center (DESC)[16] is the organization within the Defense Logistics Agency (DLA) that is in charge of procurement and sales responsibility for crude oil for the Department of Energy's Strategic Petroleum Reserve, a program used to store crude oil as a buffer against potential national energy emergencies. The mission of DESC is to provide DoD and other government agencies with comprehensive energy support in the most effective and economical way. DESC acts as DoD's energy market consolidator and wholesale agent.

DESC directs the DoD organization responsible for purchasing and managing all petroleum resources used by the U.S. military. In addition, DESC guides the growing mission of total energy support by developing strategies to buy and sell deregulated

[16] DESC Middle East, Retrieved on October 15, 2007 from http://www.globalsecurity.org/military/agency/dod/desc-me.htm.

electricity and natural gas to DoD and other federal agency customers. DESC also directly supports DoD's initiative to privatize the military base infrastructure that distributes those utilities (in addition to lighting, heating, air conditioning and water/wastewater systems).

DESC has a presence in the Middle East to support fuel-related operations. Fuel storage is a primary need within the Middle East. To meet U.S. requirements, DESC-Middle East uses commercial contractors to store and issue fuel stocks to U.S. and allied nations throughout the region. Storage capacity nears 5.5 million barrels and accommodates JP-5 jet fuel; F-76 Navy distillate fuel; and Jet A-1, a commercial jet fuel.

DESC is divided into four Commodity Business Units (CBU),[17] each specializing in a specific product or process. By taking advantage of an integrated teaming concept, DESC's customers enjoy "one-stop shopping" for all of their needs. The four CBUs are:

- **Alternative Fuels CBU** procures natural gas, electricity and coal, and assists with utility privatization and energy demand management for DoD and federal civilian agencies in the continental U.S. and Alaska.
- **Facilities and Distribution Management CBU** is the advisor on matters concerning worldwide fuel terminal operations, storage and acquisition programs. This CBU also directs plans and programs for operation and maintenance of Government Owned-Contractor Operated (GOCO) and Contractor Owned-Contractor Operated (COCO) facilities.
- **Direct Delivery Fuels CBU** is responsible for the worldwide acquisition and integrated materiel management of fuels delivered directly to using activities by contracted vendors as required to support the Military Services, DoD Activities and designated Federal agencies.
- **Bulk Fuels CBU** provides contracting, distribution, transportation, inventory control and quality support for bulk fuels (for example, jet fuels, distillate fuels, residual fuels, automotive gasoline [for overseas locations only], specified bulk lubricating oils, aircraft engine oils, and fuel additives such as fuel system icing inhibitor, and crude oil in support of the Department of Energy Strategic Petroleum Reserve Program) worldwide, accounting for about three-fourths of all fuel supplied by the Center.

[17] Defense Energy Support Center (DESC), Retrieved October 15, 2007 from http://www.globalsecurity.org/military/agency/dod/desc.htm.

2. Burdened Cost of Fuel

DoD's current bulk fuel supply chain is shown in Figure 7.

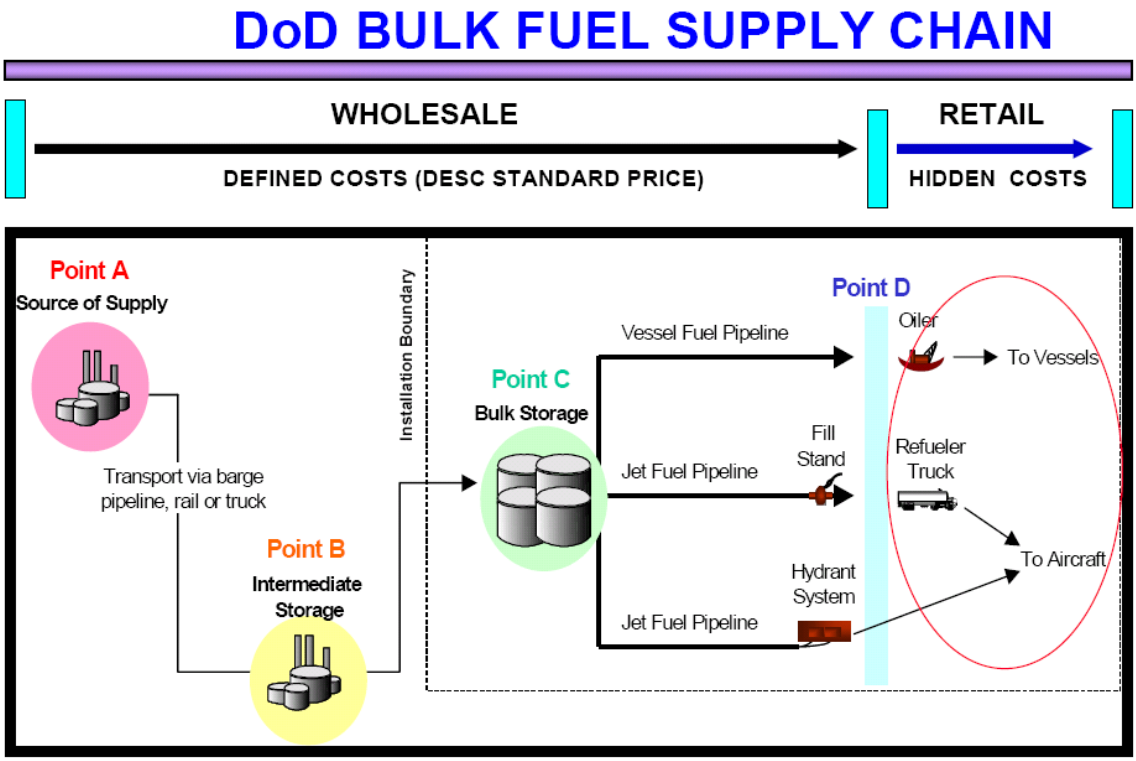

Figure 7. DoD Bulk Fuel Supply Chain. From: OSD(PA&E). 2006.

DESC delivery points are storage locations owned either by DESC or the Services, and are typically located on or near DoD installations. DESC also maintains some large tank farms from which it dispenses fuel. To simplify accounting, OSD establishes a "standard fuel price" annually. This price includes the cost for purchasing the fuel from the world market, plus DESC operating costs. The DESC price does not reflect the cost to the Services of moving the fuel from the DESC supply point to the ultimate consumer.[18]

[18] Defense Science Board Task Force, (January 2001), *More Capable Warfighting through Reduced Fuel Burdened*, Retrieved on October 15, 2007 from http://www.acq.osd.mil/dsb/reports/fuel,pdf.

The standard price of fuel[19] is a tool that was created by DoD's fiscal managers to insulate the Military Services from the normal ups and downs of the fuel marketplace. It provides the Military Services and the Office of the Secretary of Defense (OSD) with budget stability despite commodity market swings, with gains or losses being absorbed by a revolving fund known as the Defense Working Capital Fund (DWCF). In years that the market price of fuel is higher than the standard price, the DWCF loses money. In years that the market price is lower than the standard price, it makes money. This gain or loss can be made up by adjusting future standard prices. Figure 8 shows the trend of the standard fuel price of JP8 from FY 2000 to FY2008.

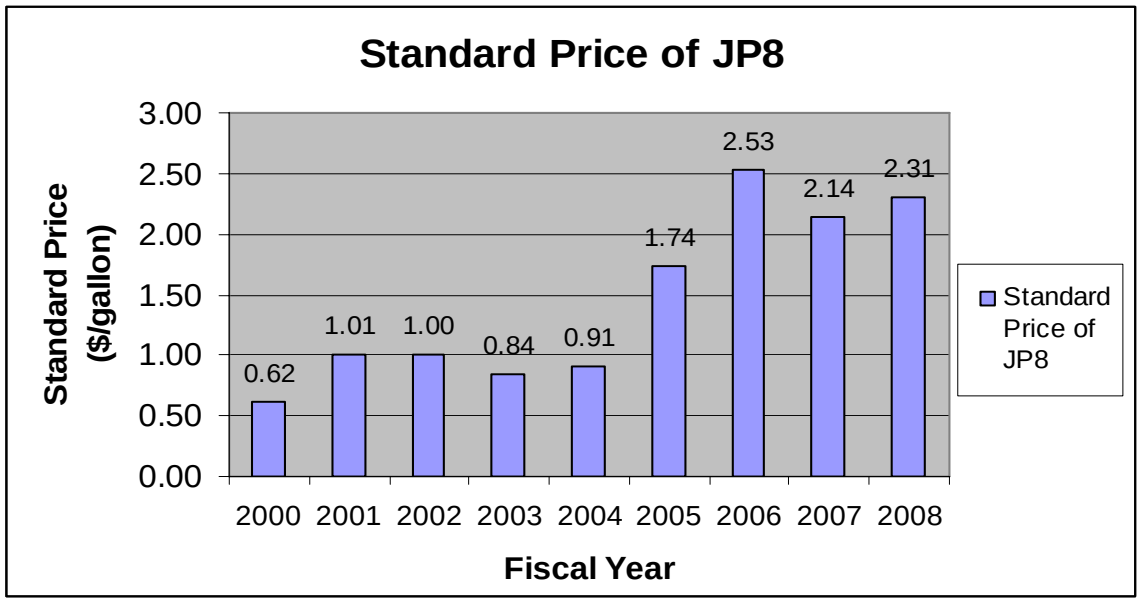

Figure 8. Trend of Standard Fuel Price from FY 2000 to FY 2008. From DESC. 2008.

It is observed that there are ups and downs in the fuel price over the years, with the lowest in FY 2000, and the highest in FY 2006. Although there is a drop in the fuel price in FY 2007, it shows a trend of increasing again in FY 2008, an increment of about 8%.

[19] Defense Energy Support Center, (November 2, 2007), *What the Standard Fuel Price is,* Retrieved on October 16, 2007 from http://p2web.desc.dla.mil/pls/p2wp/std_price_pkg,std_price_list.

With reference to Figure 7, the standard fuel price is the DESC standard price for the source of supply from Point A to Point D.

Beyond Point D, there are other hidden costs involved, such as O&S of fuel trucks, truck depreciation, etc. The Task Force set up by Defense Science Board for the fuel efficiency study concluded that:

> The DoD currently prices fuel based on the wholesale refinery price and does not include the cost of delivery to its customers. This prevents an end-to-end view of fuel utilization in decision making and it does not reflect the DoD's true fuel costs, masks energy efficiency benefits, and distorts platform design choices.

The true cost of fuel delivery should include the cost from Point D and beyond. The burdened fuel cost for the Army JP8 is $20.00 per gallon, inclusive of the DESC standard price and other costs involved during the fuel delivery to the ultimate consumer.[20]

In this thesis, $20.00 per gallon will be used as the burdened cost of fuel in the computations. This is the most current burdened cost of fuel that the author can find from the open sources.

3. "As-Is" Cost (without Proposed Initiatives)

The current area of operations of concern is in Camp Le Monier, Djibouti. The Republic of Djibouti is a small country (8,250 sq miles), located at the junction of the Red Sea and the Gulf of Aden. It has been cooperating with the U.S.-led war against terrorism, and American troops have been stationed at Camp Le Monier barracks since April 2002. The facility is an ex-French military barracks, located near the Djibouti airport.

Currently, 90% of the total fuel (approximately 10,000 gallons per day) supplied to Camp Le Monier is used for making power to generate air-conditioning to cool the barracks (e.g., sleeping tents, containerized living units) at 90^{o}F ambient environment.

[20] Under Secretary of Defense for Acquisition, Technology and Acquisition, (September 2007), *Burdended Cost of Fuel*, Obtained from REF on November 18, 2007.

Figure 9 shows the projection of cash outflows for the baseline scenario without the implementation of any proposed initiatives. The cash outflows consist of the cost of fuel used for generating power to air-condition the non-insulated tents and the O&S cost of HVAC and generators over a life cycle of 10 years. An assumption made is that the cost of fuel increased at a rate of 10% annually.

Data

- Amount of fuel used per day = 10,000 gallons
- 90% of the fuel is used to generate power to air-condition the non-insulated tents
- Cost of fuel used for generating power to air-condition non-insulated tents per year = (10,000*0.9*365*$20) = $65.7M

Assume that the O&S cost of HVAC units and generator is 5% of the total cost of fuel used for generating power to air-condition non-insulated tents, i.e. = 0.05*$65.7M

Therefore, total Cash Outflow for the "As-Is" Cost = $65.7M + (0.05*$65.7M) = $69M for the first year.

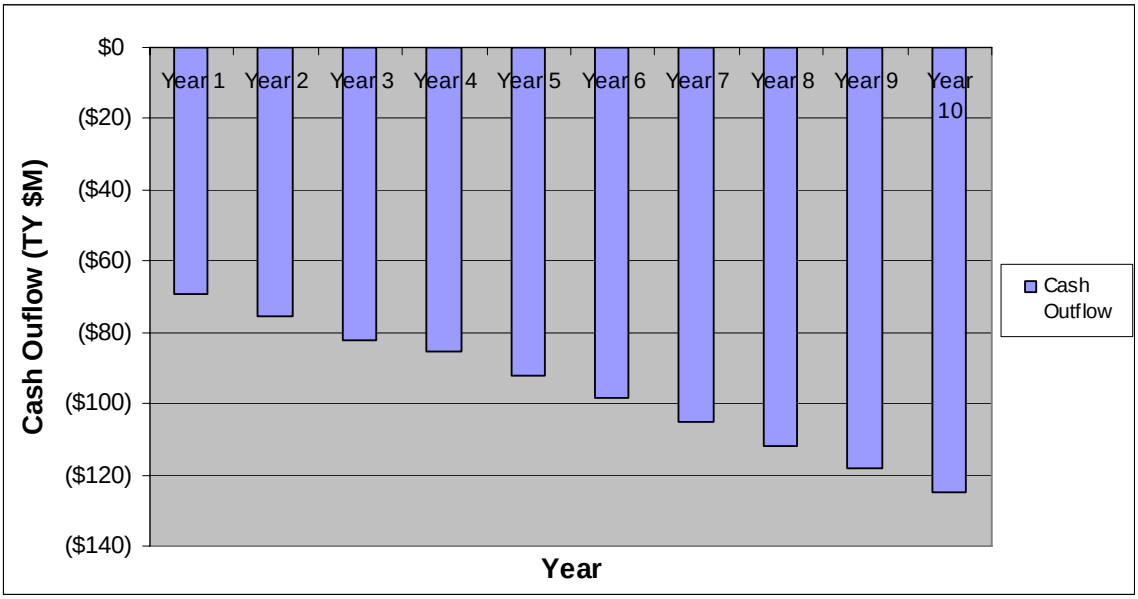

Figure 9. Projection of Cash Outflows for "As-Is" Cost (without proposed initiatives)

D. "TO-BE" COST (WITH PROPOSED INITIATIVES)

Each of the three proposed initiatives will be evaluated on three financial metrics.

Net Present Value (NPV) of an investment is defined as the sum of the present values of the annual cash flows. The annual cash flows are the Net Benefits (revenues minus costs) generated from the investment during its lifetime. These cash flows are discounted or adjusted by incorporating the uncertainty and time value of money. An investment with a larger NPV is a better option. The formula for calculating NPV is as follows:

$$NPV = \sum_{t=1}^{n} \frac{C_t}{(1+r)^t}$$

where

t – the time of the cash flow

n – the total time of the project

r – the discount rate

C_t – the net cash flow at time

Discount rate is the rate used to discount future cash flows to their present values. An approach to choosing the discount rate factor is to decide the rate which the capital needed for the project could return if invested in an alternative venture. A discount rate of 5% is chosen for the baseline computation, because that is the current return of 10-year U.S. Treasury notes.[21]

Return on Investment (ROI) measures the ratio of money gained or lost on an investment relative to the amount of money invested. An annualized ROI is used here to calculate the investment over a certain period. For our case, we are interested in an annualized ROI over a period of 10 years. An investment with a higher annualized ROI is a better investment option than an investment with a lower annualized ROI.

Payback period answers the question, "When does the investment pay for itself?" It occurs at the point where the cumulative cash inflows are equal to the cumulative cash outflows, i.e., no net loss or gain.

[21] Discount Rate, (October 31, 2007), Retrieved on November 2, 2007 from http://www.rateempire.com/indexes/discountrate.html.

1. "To-Be" Cost (with Spray Foam Insulation)

For the spray foam insulation work breakdown structure, the cash outflows for a 10-year life cycle include:

- Investment cost: $5.3M to procure insulation for tents in Djibouti. This includes the insulation material cost, transportation cost and labor cost.[22]
- O&S cost: 10% of the investment cost is estimated annually for O&S to repair the tents' insulation due to wear and tear. The useful life of a tent is approximately six years, after which it might be given away to a host nation or disposed of. A replacement cost of the tents (complete with insulation) is estimated in Year 7 of the life cycle.
- Disposal cost: A disposal cost is estimated in Year 7 to dispose of the tents after their useful life of six years. Disposal costs are estimated as about $2,500 per tent.

The benefits for the spray foam insulation comes from the cash inflows from the energy savings achieved through reduced fuel usage for air-conditioning the tents. It is assumed that the fuel price increased by 10% annually and that 50% energy savings (compared to the non-insulated case) are achieved. Figure 10 shows the cash flow projections over 10 years for 50% energy savings.

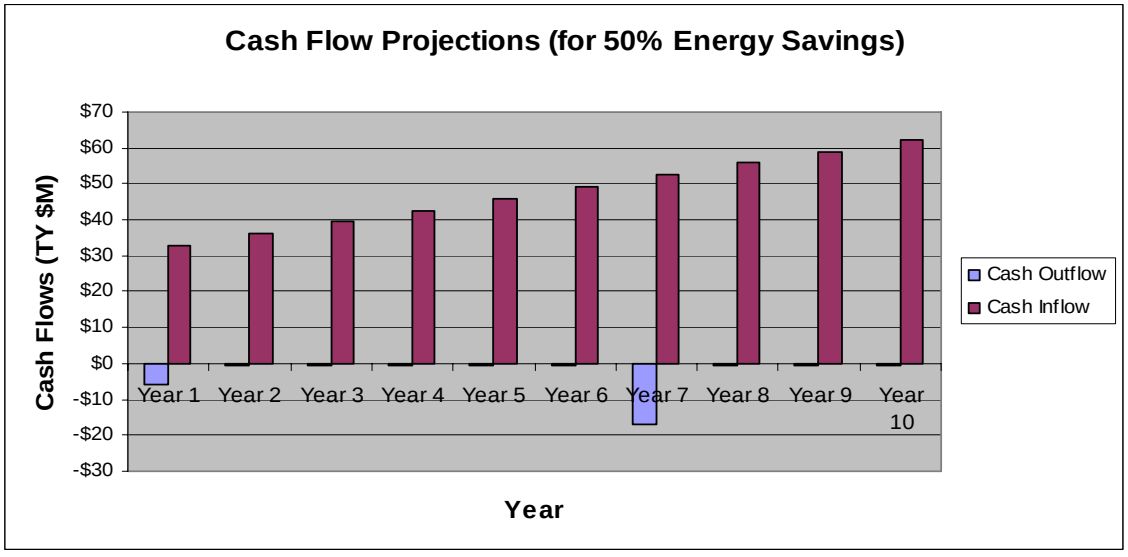

Figure 10. Cash Flow Projections for Spray Foam Insulation over 10 years for 50% Energy Savings

[22] Rapid Equipping Force, (February 23, 2007), Power Surety, Obtained from REF on March 7, 2007.

Figures 11 and 12, respectively, show the cumulative undiscounted and discounted cash inflow and outflow over 10 years for the investment. We observe from Figures 11 and 12 that the break-even point occurs at Year 1 and the payback period starts after Year 1. This represents a very attractive financial solution. An NPV of $357.6M savings can be gained over a 10-year period with a corresponding $20.8M invested.

The cumulative ROI is computed as:

$$\frac{\text{NPV of Energy Savings - NPV of Investment}}{\text{NPV of Investment}}$$

For the case of spray foam insulation, the cumulative ROI is $\frac{41.8 - 20.8}{20.8} \times 100\% = 1{,}618\%$, or 32.9% annual, compounded ROI.

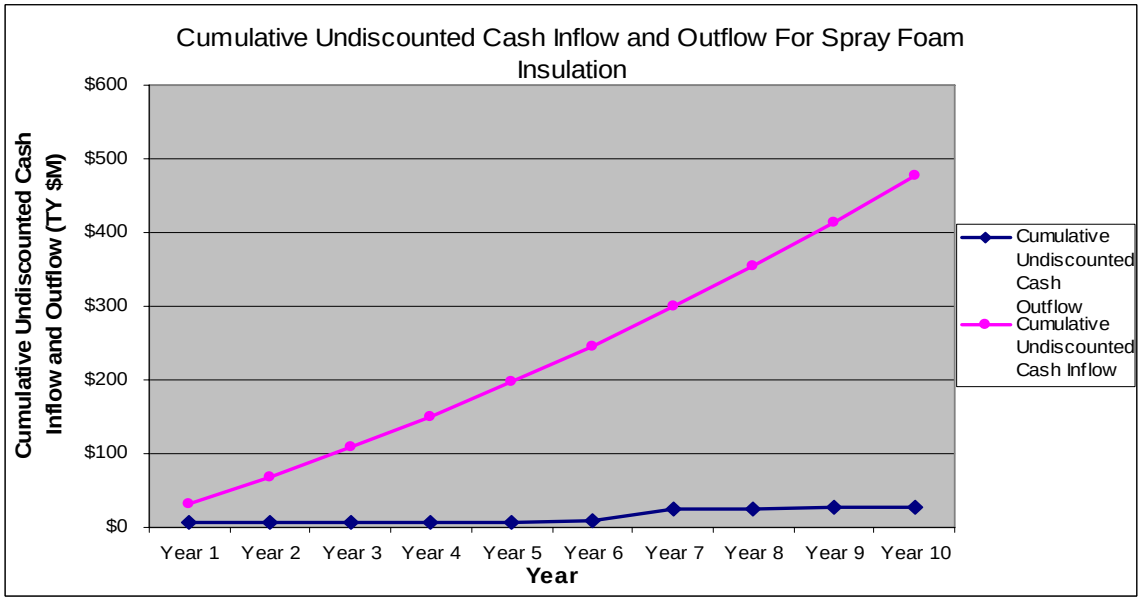

Figure 11. Cumulative Undiscounted Cash Inflow and Outflow for Spray Foam Insulation over 10 years

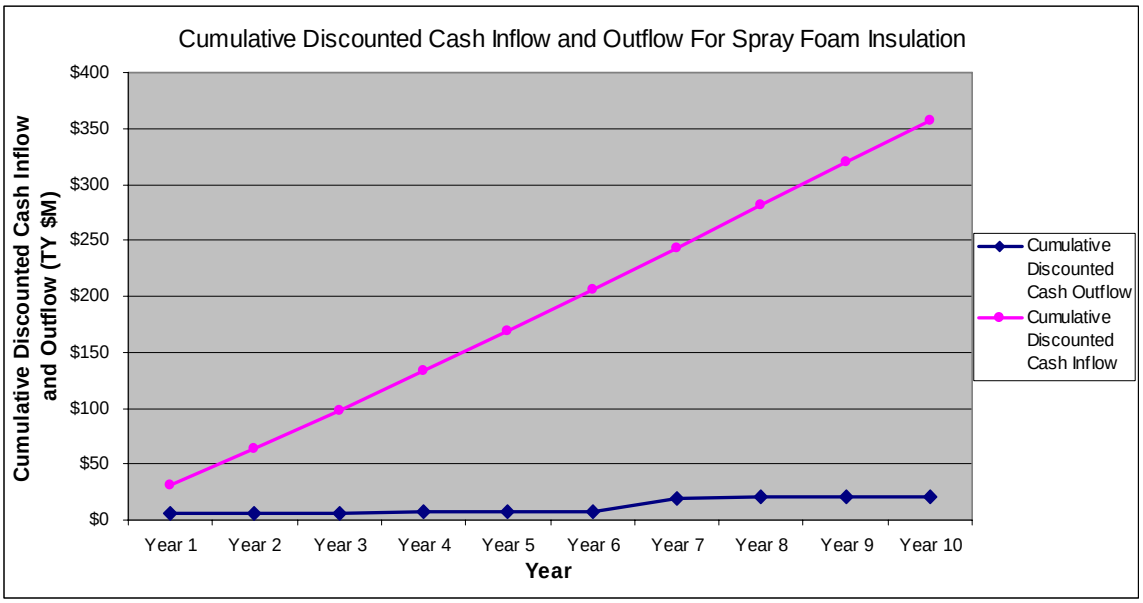

Figure 12. Cumulative Discounted Inflow and Outflow for Spray Foam Insulation over 10 years

2. "To-Be" Cost (with Transportable Hybrid Electric Power Stations)

For the THEPS work breakdown structure, the cash outflows for a 10-year life cycle include:

- Investment cost: There are two variants being developed, namely: THEPS Mobile Electric Power (MEP) – HMWVV towable (two units), and THEPS Tactical Operations Center (TOC) – container express (CONEX)-mounted (two units). The total investment cost of $3.85M includes the development of THEPS, test and evaluation and on-site support.[23]
- O&S cost: 10% of the investment cost is estimated annually for O&S.
- Disposal cost: The disposal cost is estimated at 100% of the total investment cost. THEPS make use of photovoltaics, which is a solar power technology that uses solar cells or solar photovoltaic arrays to convert light from the sun into electricity. The use of solar panels in THEPS might lead to some pollution during disposal, and so a proper disposal method is necessary.

The cash inflow for THEPS comes from the energy savings through reduced fuel usage for air-conditioning the tents. It is assumed that the fuel price increased by 10%

[23] THEPS Quad, (July 5, 2007), Obtained from REF on October 22, 2007.

annually. In on-site testing conducted by the NTC in March 2007, THEPS obtained an efficiency of 7.1% for each THEPS (compared to a 5-kW TQG) in converting renewable energy to power. Hence, energy savings are calculated from the reduced fuel usage. Figure 13 shows the cash flow projections over 10 years for 4 THEPS.

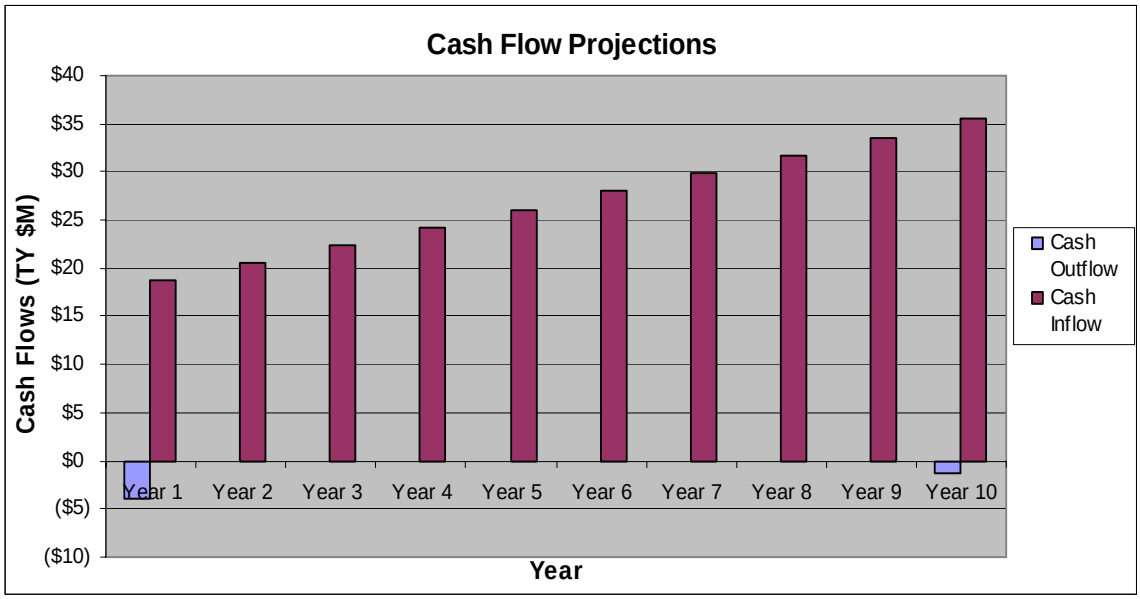

Figure 13. Cash Flow Projections for THEPS over 10 years

Figures 14 and 15, respectively, show the cumulative undiscounted and discounted cash inflow and outflow over 10 years for the investment.

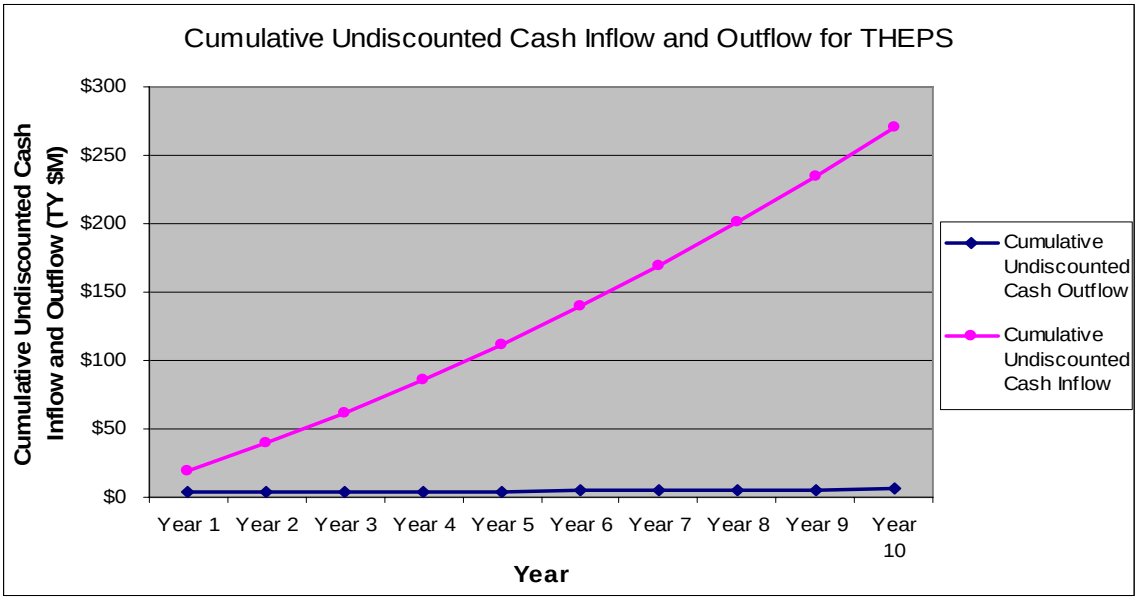

Figure 14. Cumulative Undiscounted Cash Inflow and Outflow for THEPS over 10 years

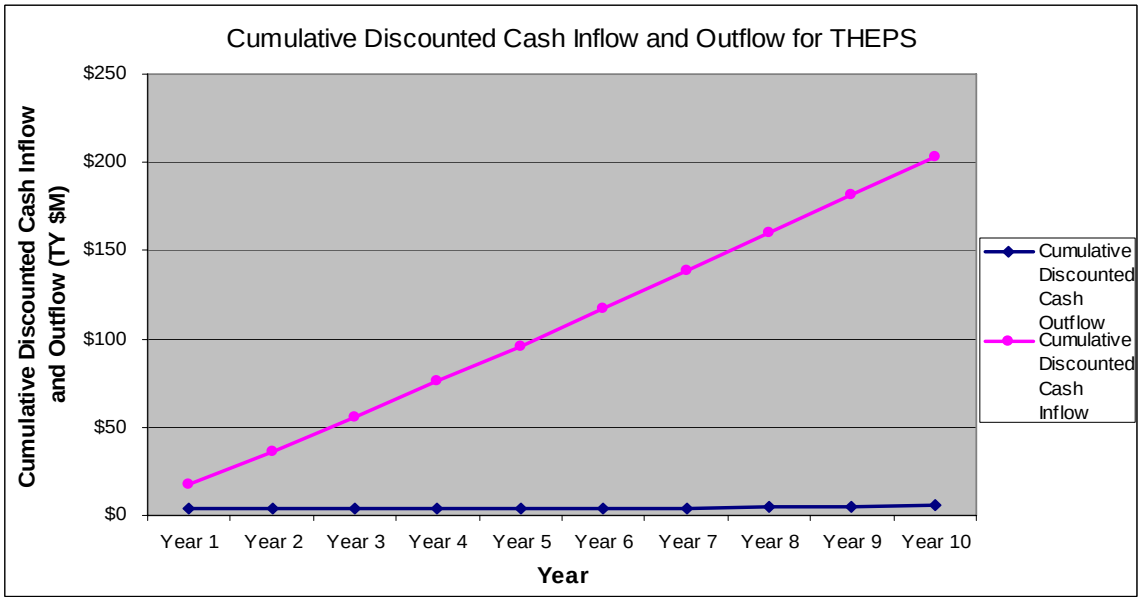

Figure 15. Cumulative Discounted Cash Inflow and Outflow for THEPS over 10 years

We observe from Figures 14 and 15 that the break-even point occurs at less than a year. The payback period starts in Year 1. An NPV of $203.1M in savings can be gained over a 10-year period with a corresponding $5.3M invested. The ROI for THEPS is 3680.5%, or about 43.8% annual, compounded ROI.

3. "To-Be" Cost (with Tactical Garbage to Energy Refinery)

For the TGER work breakdown structure, the cash outflows for a 10-year life cycle include:

- Investment cost: This includes the development of two units of TGER, test and evaluation and engineering support. The total investment cost of TGER is $2.2M.
- O&S cost: Assume that 10% of the investment cost is estimated annually for O&S.
- Disposal cost: Assume that the disposal cost is 100% of the total investment cost.

The cash inflow for TGER comes from the following:

- Avoided cost of waste disposal
- Avoided cost of waste transport
- Avoided cost of transport fuel
- Avoided personnel cost
- Value of fuel produced

Figure 16 shows the cash flow projections over 10 years. Figures 17 and 18, respectively, show the cumulative undiscounted and discounted cash inflow and outflow over 10 years for the investment.

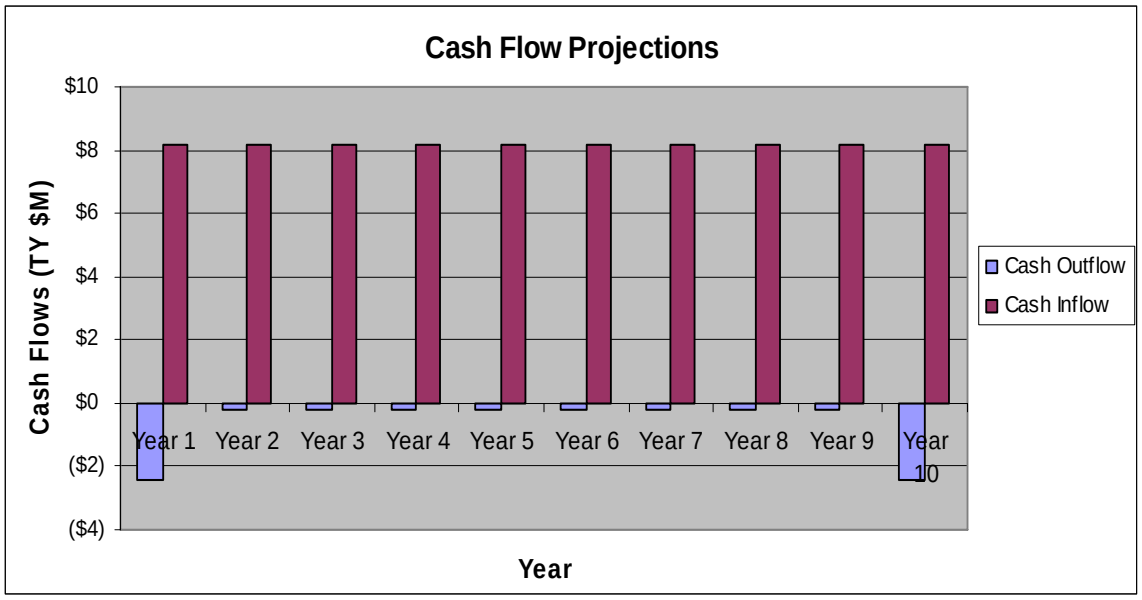

Figure 16. Cash Flow Projections for TGER over 10 years

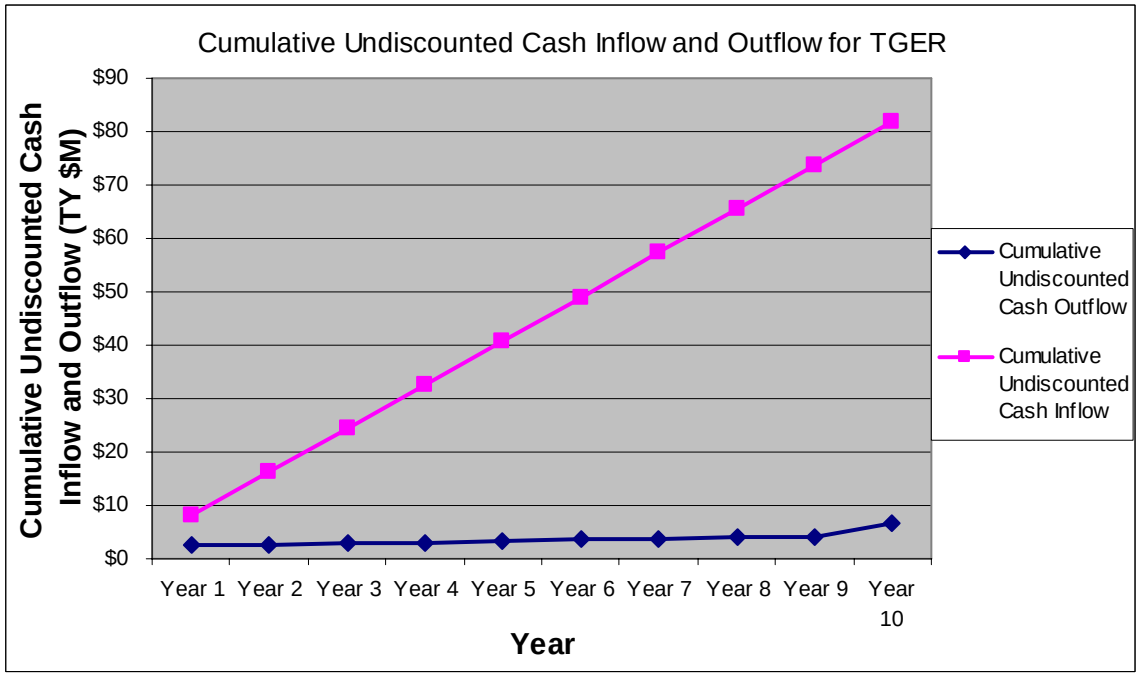

Figure 17. Cumulative Undiscounted Cash Inflow and Outflow for TGER over 10 years

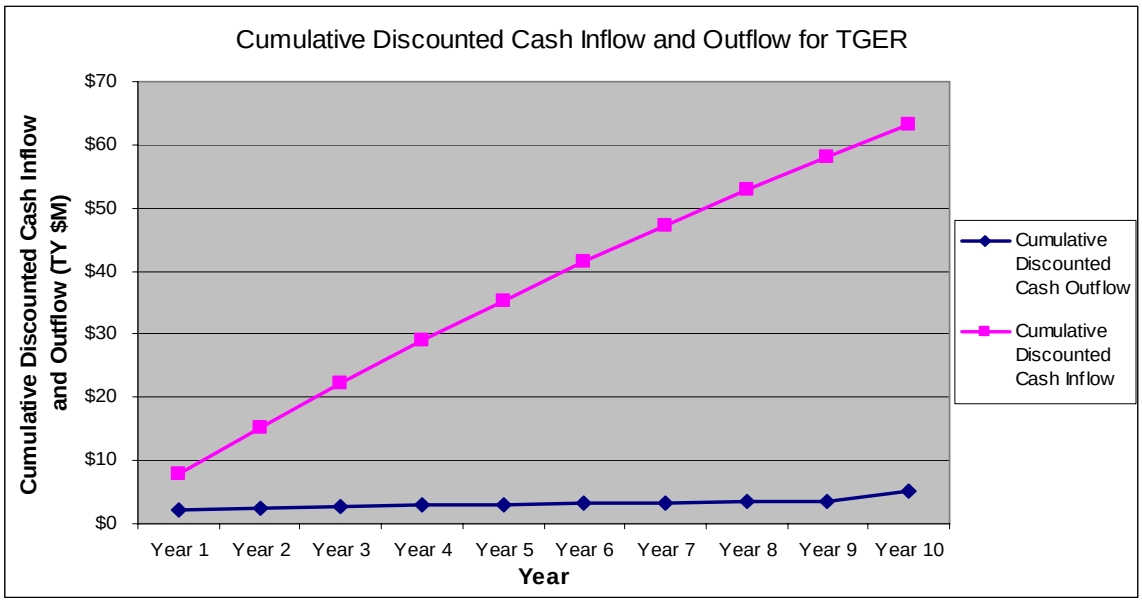

Figure 18. Cumulative Discounted Cash Inflow and Outflow for TGER over 10 years

We observe from Figures 17 and 18 that the break-even point occurs at less than Year 1. The payback period starts in Year 1. An NPV of $63.1M in savings can be gained over a 10-year period with a corresponding $5.1M invested. The ROI for TGER is 1127.3%, or about 28.5% annual, compounded ROI.

4. Summary of "To-Be" Cost for Three Proposed Initiatives

The table below provides a summary of the annualized ROI and payback period for the baseline cases for the three proposed initiatives:

Initiatives	Annualized ROI	Payback Period
Spray Foam Insulation	32.9%	Less than 1 year
THEPS	43.8%	Less than 1 year
TGER	28.5%	Less than 1 year

Table 2. Annualized ROI and Payback Period for the Initiatives

The annualized ROI and payback period for the three initiatives represent very attractive financial solutions for NZP.

E. SENSITIVITY ANALYSIS

A sensitivity analysis is a process used to understand the uncertainty in a model. The objective is to identify critical input parameters to the model, vary them over a reasonable range and observe how the variability impacts the output result. A small change in the value of the input parameter that results in large change in the outcome implies that the outcome is very sensitive to the input parameter. On the other hand, small changes in the outcome indicate a stable, or robust, solution.

In this thesis, the cost estimates that were used in the ROI computations are based on feedback and input from subject matter experts, as well as personal professional judgment. This is because the required data are not available for analysis. Sensitivity analyses varying the percentage of energy savings, O&S costs and discount rate for each initiative, while keeping the other variables constant, is a useful analytical tool for understanding the financial behavior of these projects.

When the proposed initiatives are actually implemented, the energy savings and the O&S cost data can be collected and validated with the computations used in this thesis.

1. Varying Percentage of O&S Costs Sensitivity Analysis

The aim is to observe how sensitive ROI is to changes in O&S costs. In the model, the percentage of O&S cost is assumed to be 10% of the investment cost of the initiatives. This parameter is varied from 5% to 15% as a larger percentage of O&S costs will lower the ROI. Figure 19 shows the plot of ROI versus the percentage of O&S cost from the range of 5% to 15% for the three proposed initiatives.

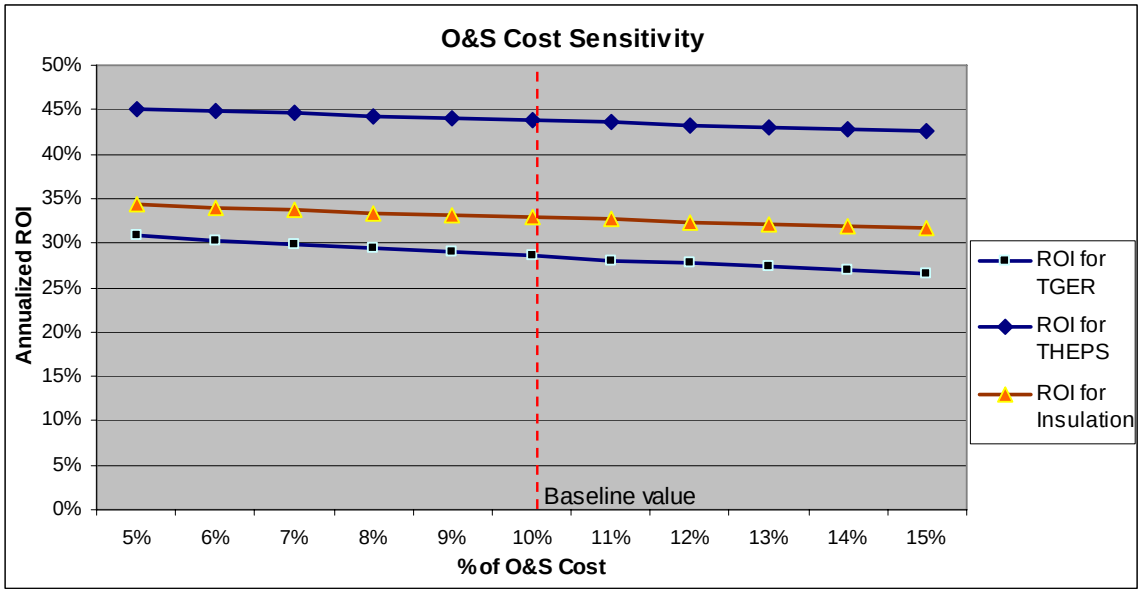

Figure 19. Plot of Annualized ROI versus Percentage of O&S Costs

From Figure 19, we observe that TGER is most sensitive to changes in the percentage of O&S costs. The ROI reduced by about 0.5% for every increase in 1% of O&S costs. THEPS is the least sensitive to changes in the percentage of O&S costs. Its ROI is reduced by 0.3% for every 1% increase in O&S costs. In any case, the annualized ROI remains at very attractive levels across the range of relevant O&S costs.

2. Varying Percentage of Energy Savings Sensitivity Analysis

In the model, it is assumed that there are 50% energy savings for spray foam insulation in terms of the reduced fuel usage required to generate power to operate the air-conditioning for tents. For THEPS, it is assumed that there is a conversion efficiency of 7.1% to convert renewable energy to electrical energy.

TGER's energy savings mainly come from the avoidance of waste disposal and the ability to convert waste to energy. Therefore, its ROI is largely dependent on the amount of waste that is generated by the theater.

Figure 20 shows the plot of ROI versus the percentage of energy savings from the range of 10% to 90% for the spray foam insulation and THEPS.

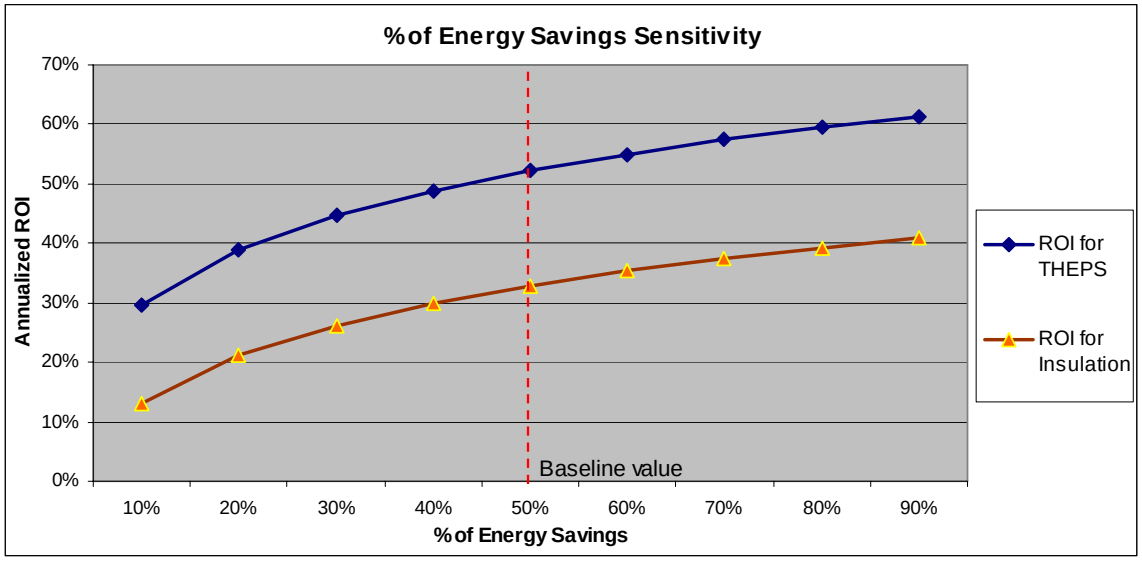

Figure 20. Plot of Annualized ROI versus % of Energy Savings

We observe from Figure 20 that the THEPS's ROI is more sensitive to the energy savings than spray foam insulation. From an increase of 20% to 30% change in energy savings, the THEPS's ROI increases by 5.75%, whereas spray foam insulation's ROI increases by 5.02%.

Figure 21 shows the plot of ROI versus the quantity of waste produced per day from the range of 2 to 20 tons for TGER.

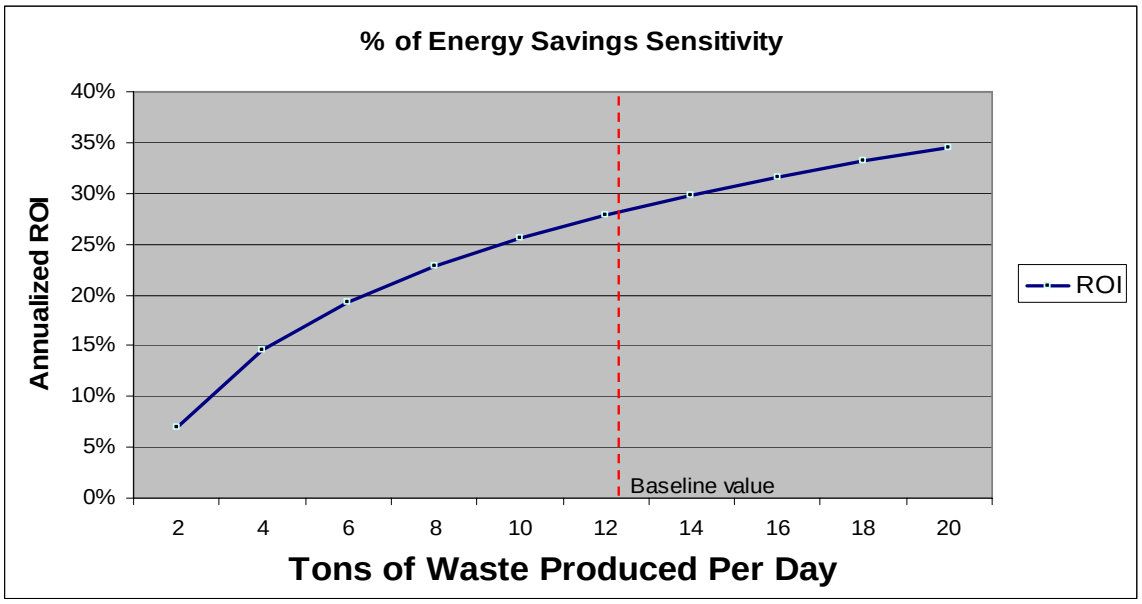

Figure 21. Plot of Annualized ROI versus Quantity of Waste Produced Per Day

As observed from Figure 21, the ROI of TGER is very sensitive to the quantity of waste produced by the theater. Compare a theater which produces six tons of waste per day to a theater which produces 12 tons of waste per day, the ROI of the TGER in the latter theater is able to achieve an increase ROI of about 8.56%.

3. Varying Discount Rate Sensitivity Analysis

The discount rate is a financial concept used to convert future cash flows into present value of the cash flow. A large discount rate will reduce the potential benefits of the proposed initiatives. This factor is varied from 5% to 15% in the sensitivity analysis.

Figure 22 shows that plot of annualized ROI versus the discount rate for the three proposed initiatives.

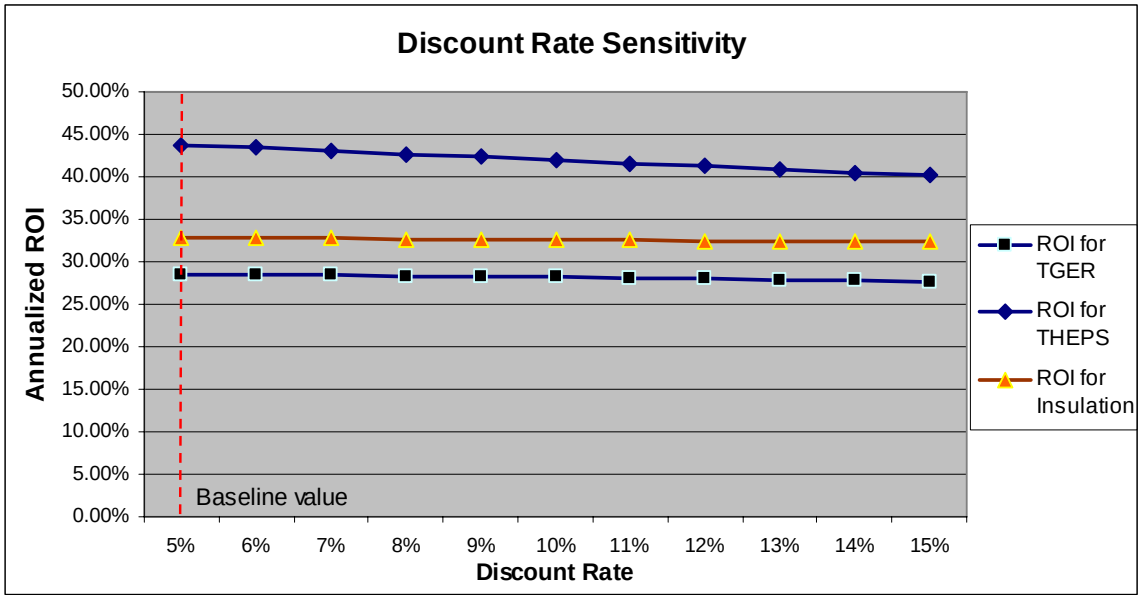

Figure 22. Plot of Annualized ROI versus the Discount Rate

From Figure 22, we observe that TGER's ROI is the least sensitive to the discount rate, while THEPS's ROI is most sensitive to the discount rate. For TGER, its ROI is reduced by 0.05% for every 1% discount rate increase, whereas for THEPS, its ROI is reduced by 0.37% for every 1% discount rate increase.

ROI for THEPS and TGER still manage to maintain a level above 25% with the discount rate ranging from 5% to 15%. The observation from Figure 22 is that the annualized ROI has very low sensitivity to the discount rate.

F. LEARNING CURVE FOR THEPS AND TGER'S PRODUCTION

We assume that there is learning associated with the increased number of THEPS or TGER units being produced for deployment. The concept of learning curve (also called cost improvement) observes that the production cost of a unit is decreased by a constant percentage each time the number of units produced doubles. Learning occurs because of production improvement in areas such as tooling and engineering, although it is not limited to these areas.

There are 2 variations of learning theory, which are:

- **Cumulative Average Theory** which is defined as:

  As the *cumulative quantity* of units produced doubles, the *average cost* of *all units produced to date* is decreased by a constant percentage

- **Unit Theory** which is defined as:

  If there is learning in the production process, the cost of some *doubled unit* equals the cost of the un-doubled unit times the slope of the learning curve

In our model, we are using the unit theory, and we assume the rate of learning to be 90%, i.e., the cost of producing the second unit is 90% of the cost of producing the first unit.

The formula used for calculating the cost of the first N production units of THEPS is:

$$CT_N \cong \frac{A(N)^{b+1}}{b+1}$$

where CT_N = the cumulative cost of the first N units

A = cost of unit #1

N = # of units

b = a constant representing the slope of the learning curve

In our case, b = ln(0.9)/ln(2).

The cumulative cost formula is normally applied in the production phase to estimate lot costs. For the current sensitivity analysis on learning curves, we apply the following process:

- Apply the cumulative cost formula to the four research and development (R&D) units to compute the cost of R&D unit #1.
- "Step down" by 50% from the cost of R&D unit #1 computed in the step above to the cost of production unit #1.
- Apply the cumulative cost formula to the first N production units and display the results for various N.

Computation

N = 4

CT_4 = \$3.75M

Assume 90% rate of learning, b = ln(0.9)/ln(2)

Therefore, cost of unit #1, A = \$0.982M

Cost of Production unit #1 = A/2 = \$0.49M

Production cost of THEPS = $CT_N = \frac{A}{2}\frac{(N)^{b+1}}{b+1}$

Figure 23 shows the plot of annualized ROI versus the quantity of THEPS produced.

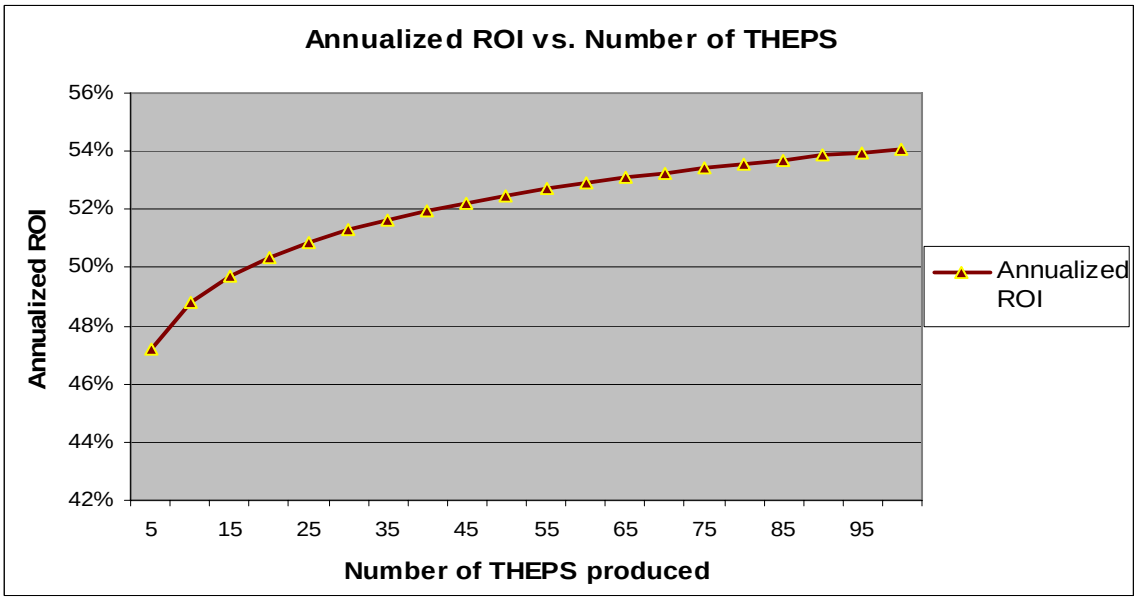

Figure 23. Plot of Annualized ROI versus Number of THEPS produced

From Table 2, where four THEPS are produced, an annualized ROI of 43.8% is achieved. From Figure 23, we observed that the annualized ROI increased with the number of THEPS produced. For every unit of THEPS produced, there is an increase of approximately 0.5% annualized ROI. Hence, by producing more THEPS, the ROI is made more attractive by taking advantage of economies of scale.

Similarly, we plot the annualized ROI versus the number of TGER produced as shown in Figure 24. From Table, where two TGERs are produced, an annualized ROI of 28.5% is achieved. From Figure 24, for every unit of TGER produced, there is an increase of approximately 0.55% annualized ROI. This shows that the ROI is more attractive in producing more TGERs due to economies of scale.

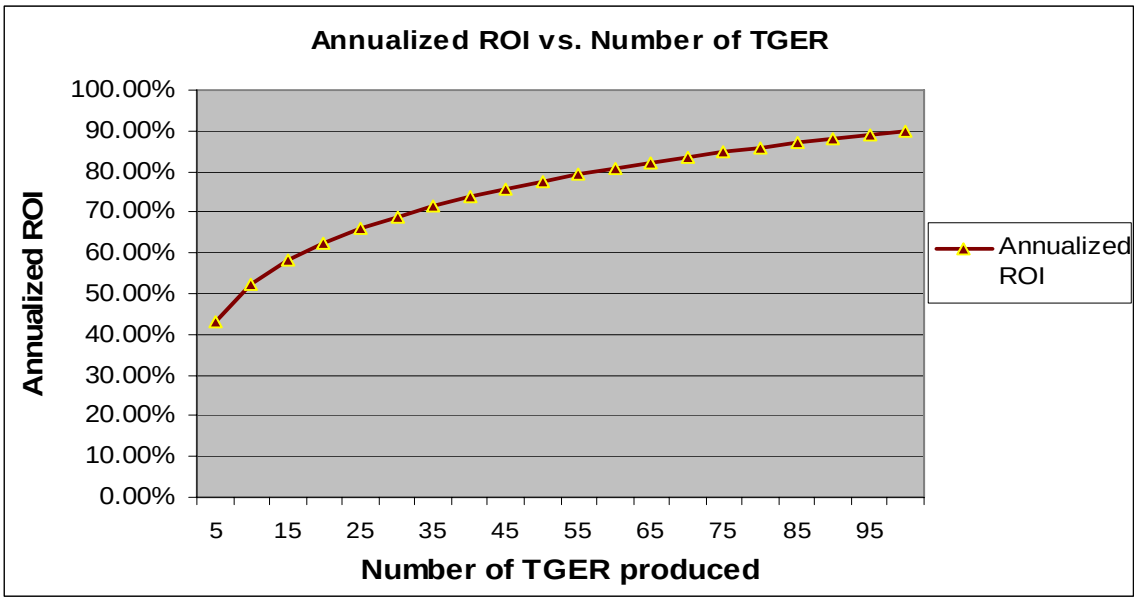

Figure 24. Plot of Annualized ROI versus Number of TGER produced

From Figure 24, we observe that if, for example, 30 units of TGER are produced (costing about $7.5M), the ROI can be raised to a very attractive level, in the range of 68%.

IV. CONCLUSIONS AND RECOMMENDATIONS

A business case analysis was performed on the three proposed initiatives to evaluate their ROI over a 10-year life-cycle cost. The results of the baseline analysis are summarized as follows:

Initiatives	Annualized ROI	Payback Period
Spray Foam Insulation	32.9%	Less than 1 year
THEPS	43.8%	Less than 1 year
TGER	28.5%	Less than 1 year

Table 3. Annualized ROI and Payback Period for the Initiatives

THEPS has the highest annualized ROI among the three initiatives and has a payback period of less than one year. This means that THEPS gives the largest return on benefits (in terms of energy savings) as compared to the other two initiatives. It takes less than one year for THEPS to repay its original investment.

The technology required to implement THEPS had been developed using renewable energy sources, like solar and wind energy, to generate electricity. The prototype had been tested at the NTC, and the power output is generally dependent on the weather conditions, e.g., the availability of wind and sunlight.

Sensitivity analysis shows that THEPS is the least sensitive to changes in O&S costs. Its ROI is reduced by 0.3% for every 1% increase in O&S costs. On the other hand, THEPS's ROI is the most sensitive to changes in the discount rate, but still manages to maintain an ROI above 40% with the discount rate ranging from 5% to 15%.

TGER is another initiative which can achieve a high annualized ROI, of 28.5%, with a payback period of less than one year. It is more sensitive to a change in the O&S costs as compared to THEPS and spray foam insulation. We observe from the sensitivity analysis that TGER's ROI is very sensitive to the quantity of waste produced by the theater. For TGER to fully exploit its technological capability, it must be deployed to a

theater which can produce a substantial amount of waste per day. For it to achieve an annualized ROI of more than 20%, the quantity of waste produced per day must be more than seven tons. On the whole, TGER is still a new technology which has not been proven in the field, but it will be a very attractive investment if it can perform according to its specifications.

From the learning curve analysis, it is observed that there are economies of scale by producing more THEPS and TGER. For every unit of THEPS produced, there is an increase of approximately 0.5% annualized ROI. On the other hand, for every unit of TGER produced, there is an increase of approximately 0.55% annualized ROI. For example, a modest investment of 30 units of TGER (costing about $7.5M), the ROI can be raised to a very attractive level, in the range of 68%.

The spray foam insulation achieves an annualized ROI of 32.9%, with a payback period of less than one year. Its investment does not give a return as high as THEPS; however, its technology had been developed and is a COTS product currently on the market. Its technology can be implemented as soon as possible if time is a constraint.

In conclusion, all three initiatives are very attractive financial solutions to NZP, with high annualized ROIs, short payback period and opportunities to leverage economies of scale.

APPENDIX

The following data sets are obtained from testing THEPS from September 18–27, 2007.

TIMESTAMP (GMT) Time	Record #	LoggerID Sample	Day Of Week Sun=1 Sample	JulianDay Sample	Solar Radiation Horizontal W/m2 Average	Speed Wind mph Average	Speed Wind mph Max	Temperature PV deg F Average	Voltage PV volts Average
09/18/07 22:00	0	Yorktown	3	261	537.8	1.9	11.9	7999.00	0.01
09/18/07 23:00	1	Yorktown	3	261	613.5	5.4	12.2	7999.00	0.01
09/19/07 0:00	2	Yorktown	4	262	416.9	3.3	13.9	7999.00	18.51
09/19/07 1:00	3	Yorktown	4	262	204.4	4.0	12.5	7999.00	39.97
09/19/07 2:00	4	Yorktown	4	262	33.3	8.9	15.6	7999.00	33.76
09/19/07 3:00	5	Yorktown	4	262	0.1	5.6	9.8	7999.00	0.98
09/19/07 4:00	6	Yorktown	4	262	0.0	4.7	8.5	7999.00	0.01
09/19/07 5:00	7	Yorktown	4	262	0.0	5.2	12.9	7999.00	0.01
09/19/07 6:00	8	Yorktown	4	262	0.0	7.9	12.2	7999.00	0.01
09/19/07 7:00	9	Yorktown	4	262	0.0	8.0	17.6	7999.00	0.01
09/19/07 8:00	10	Yorktown	4	262	0.0	4.3	11.9	7999.00	0.01
09/19/07 9:00	11	Yorktown	4	262	0.0	4.2	10.5	7999.00	0.01
09/19/07 10:00	12	Yorktown	4	262	0.0	3.2	7.5	-7999.00	0.01
09/19/07 11:00	13	Yorktown	4	262	0.0	8.0	15.2	-7999.00	0.01
09/19/07 12:00	14	Yorktown	4	262	0.0	9.9	15.6	7999.00	0.01
09/19/07 13:00	15	Yorktown	4	262	0.0	10.8	15.9	7999.00	0.02
09/19/07 14:00	16	Yorktown	4	262	11.4	6.5	16.2	-7999.00	22.20
09/19/07 15:00	17	Yorktown	4	262	150.4	4.3	12.5	-7999.00	36.08
09/19/07 16:00	18	Yorktown	4	262	364.5	11.2	16.6	-7999.00	43.88
09/19/07 17:00	19	Yorktown	4	262	569.7	10.3	16.6	-7999.00	42.77
09/19/07 18:00	20	Yorktown	4	262	730.7	7.9	15.2	-7999.00	40.54
09/19/07 19:00	21	Yorktown	4	262	835.0	9.9	23.9	7999.00	38.39
09/19/07 20:00	22	Yorktown	4	262	871.0	17.5	27.6	7999.00	37.05
09/19/07 21:00	23	Yorktown	4	262	843.0	15.2	25.3	7999.00	36.94
09/19/07 22:00	24	Yorktown	4	262	745.9	16.9	28.3	7999.00	33.70
09/19/07 23:00	25	Yorktown	4	262	584.6	18.2	28.0	-7999.00	2.01
09/20/07 0:00	26	Yorktown	5	263	355.1	20.6	29.0	-7999.00	0.06
09/20/07 1:00	27	Yorktown	5	263	1.4	23.9	33.0	-7999.00	27.48
09/20/07 2:00	28	Yorktown	5	263	0.1	22.5	32.0	-7999.00	32.81
09/20/07 3:00	29	Yorktown	5	263	0.0	13.2	28.0	-7999.00	0.57
09/20/07 4:00	30	Yorktown	5	263	0.0	9.1	26.0	7999.00	0.07
09/20/07 5:00	31	Yorktown	5	263	0.0	15.8	27.6	-7999.00	0.07
09/20/07 6:00	32	Yorktown	5	263	0.0	7.3	22.3	-7999.00	0.07
09/20/07 7:00	33	Yorktown	5	263	0.0	6.1	13.9	-7999.00	0.07
09/20/07 8:00	34	Yorktown	5	263	0.0	1.1	5.1	7999.00	0.07
09/20/07 9:00	35	Yorktown	5	263	0.0	1.7	7.2	7999.00	0.07
09/20/07 10:00	36	Yorktown	5	263	0.0	0.5	3.1	-7999.00	0.07
09/20/07 11:00	37	Yorktown	5	263	0.0	1.6	7.8	7999.00	0.07
09/20/07 12:00	38	Yorktown	5	263	0.0	0.5	5.8	7999.00	0.07

TIMESTAMP (GMT) Time	Record #	LoggerID Sample	Day Of Week Sun=1 Sample	JulianDay Sample	Voltage Battery volts Average Battery Voltage	Current PV amps Average	Current Wind Turbine amps Average	Current Wind Turbine amps Max	Current Battery amps Average
09/18/07 22:00	0	Yorktown	3	261	24.77	0.00	0.00	0.00	-26.24
09/18/07 23:00	1	Yorktown	3	261	24.66	0.00	0.00	0.00	-38.30
09/19/07 0:00	2	Yorktown	4	262	24.64	3.39	0.00	0.00	-35.98
09/19/07 1:00	3	Yorktown	4	262	24.80	8.09	0.00	0.00	-13.63
09/19/07 2:00	4	Yorktown	4	262	24.95	1.13	0.00	0.00	-0.86
09/19/07 3:00	5	Yorktown	4	262	24.94	0.00	0.00	0.00	-2.04
09/19/07 4:00	6	Yorktown	4	262	24.93	0.00	0.00	0.00	-2.04
09/19/07 5:00	7	Yorktown	4	262	24.91	0.00	0.00	0.00	-2.04
09/19/07 6:00	8	Yorktown	4	262	24.90	0.00	0.00	0.00	-2.04
09/19/07 7:00	9	Yorktown	4	262	24.90	0.00	0.00	0.00	-2.04
09/19/07 8:00	10	Yorktown	4	262	24.90	0.00	0.00	0.00	-2.04
09/19/07 9:00	11	Yorktown	4	262	24.91	0.00	0.00	0.00	-2.03
09/19/07 10:00	12	Yorktown	4	262	24.91	0.00	0.00	0.00	-2.03
09/19/07 11:00	13	Yorktown	4	262	24.90	0.00	0.00	0.00	-2.01
09/19/07 12:00	14	Yorktown	4	262	24.89	0.00	0.00	0.00	-2.01
09/19/07 13:00	15	Yorktown	4	262	24.89	0.00	0.00	0.00	-2.02
09/19/07 14:00	16	Yorktown	4	262	24.88	0.13	0.00	0.00	-1.77
09/19/07 15:00	17	Yorktown	4	262	24.95	3.79	0.00	0.00	2.03
09/19/07 16:00	18	Yorktown	4	262	25.17	16.06	0.00	0.00	13.98
09/19/07 17:00	19	Yorktown	4	262	25.61	31.36	0.00	0.00	29.15
09/19/07 18:00	20	Yorktown	4	262	25.94	39.47	0.00	0.00	37.15
09/19/07 19:00	21	Yorktown	4	262	26.19	43.73	0.00	0.00	41.38
09/19/07 20:00	22	Yorktown	4	262	26.55	46.75	0.00	0.00	44.30
09/19/07 21:00	23	Yorktown	4	262	27.30	44.42	0.00	0.00	34.09
09/19/07 22:00	24	Yorktown	4	262	25.56	35.15	0.00	0.00	-6.19
09/19/07 23:00	25	Yorktown	4	262	24.95	0.00	0.00	0.00	-41.88
09/20/07 0:00	26	Yorktown	5	263	24.82	0.00	0.00	0.00	-40.65
09/20/07 1:00	27	Yorktown	5	263	24.89	12.53	0.00	0.00	-18.00
09/20/07 2:00	28	Yorktown	5	263	25.13	2.48	0.00	0.00	2.19
09/20/07 3:00	29	Yorktown	5	263	25.09	-0.26	0.00	0.00	-0.43
09/20/07 4:00	30	Yorktown	5	263	25.08	-0.27	0.00	0.00	-1.47
09/20/07 5:00	31	Yorktown	5	263	25.09	-0.27	0.00	0.00	-0.35
09/20/07 6:00	32	Yorktown	5	263	25.10	-0.27	0.00	0.00	-0.45
09/20/07 7:00	33	Yorktown	5	263	25.10	-0.27	0.00	0.00	-0.34
09/20/07 8:00	34	Yorktown	5	263	25.09	-0.27	0.00	0.00	-0.43
09/20/07 9:00	35	Yorktown	5	263	25.08	-0.27	0.00	0.00	-0.44
09/20/07 10:00	36	Yorktown	5	263	25.06	-0.27	0.00	0.00	-0.35
09/20/07 11:00	37	Yorktown	5	263	25.06	-0.27	0.00	0.00	-0.42
09/20/07 12:00	38	Yorktown	5	263	25.07	-0.27	0.00	0.00	-0.34

TIMESTAMP (GMT) Time	Record #	LoggerID Sample	Day Of Week Sun=1 Sample	JulianDay Sample	Power PV kW Average	Power Wind Turbine kW Average	Power Battery kW Average	Power Generator kW Average	Power Load kW Average Load (kW)
09/18/07 22:00	0	Yorktown	3	261	0.000	0.000	-0.648	0.000	0.448
09/18/07 23:00	1	Yorktown	3	261	0.000	0.000	-0.943	0.000	0.712
09/19/07 0:00	2	Yorktown	4	262	0.084	0.000	-0.885	0.000	0.723
09/19/07 1:00	3	Yorktown	4	262	0.201	0.000	-0.335	0.000	0.371
09/19/07 2:00	4	Yorktown	4	262	0.028	0.000	-0.021	0.000	0.000
09/19/07 3:00	5	Yorktown	4	262	0.000	0.000	-0.051	0.000	0.000
09/19/07 4:00	6	Yorktown	4	262	0.000	0.000	-0.051	0.000	0.000
09/19/07 5:00	7	Yorktown	4	262	0.000	0.000	-0.051	0.000	0.000
09/19/07 6:00	8	Yorktown	4	262	0.000	0.000	-0.051	0.000	0.000
09/19/07 7:00	9	Yorktown	4	262	0.000	0.000	-0.051	0.000	0.000
09/19/07 8:00	10	Yorktown	4	262	0.000	0.000	-0.051	0.000	0.000
09/19/07 9:00	11	Yorktown	4	262	0.000	0.000	-0.051	0.000	0.000
09/19/07 10:00	12	Yorktown	4	262	0.000	0.000	-0.051	0.000	0.000
09/19/07 11:00	13	Yorktown	4	262	0.000	0.000	-0.050	0.000	0.000
09/19/07 12:00	14	Yorktown	4	262	0.000	0.000	-0.050	0.000	0.000
09/19/07 13:00	15	Yorktown	4	262	0.000	0.000	-0.050	0.000	0.000
09/19/07 14:00	16	Yorktown	4	262	0.003	0.000	-0.044	0.000	0.000
09/19/07 15:00	17	Yorktown	4	262	0.095	0.000	0.051	0.000	0.000
09/19/07 16:00	18	Yorktown	4	262	0.405	0.000	0.352	0.000	0.000
09/19/07 17:00	19	Yorktown	4	262	0.804	0.000	0.747	0.000	0.000
09/19/07 18:00	20	Yorktown	4	262	1.024	0.000	0.964	0.000	0.000
09/19/07 19:00	21	Yorktown	4	262	1.146	0.000	1.084	0.000	0.000
09/19/07 20:00	22	Yorktown	4	262	1.241	0.000	1.176	0.000	0.000
09/19/07 21:00	23	Yorktown	4	262	1.212	0.000	0.941	0.000	0.156
09/19/07 22:00	24	Yorktown	4	262	0.902	0.000	-0.154	0.000	0.762
09/19/07 23:00	25	Yorktown	4	262	0.000	0.000	-1.045	0.000	0.778
09/20/07 0:00	26	Yorktown	5	263	0.000	0.000	-1.008	0.000	0.752
09/20/07 1:00	27	Yorktown	5	263	0.312	0.000	-0.445	0.067	0.585
09/20/07 2:00	28	Yorktown	5	263	0.063	0.000	0.055	0.000	0.000
09/20/07 3:00	29	Yorktown	5	263	-0.007	0.000	-0.011	0.000	0.000
09/20/07 4:00	30	Yorktown	5	263	-0.007	0.000	-0.037	0.000	0.004
09/20/07 5:00	31	Yorktown	5	263	-0.007	0.000	-0.009	0.000	0.000
09/20/07 6:00	32	Yorktown	5	263	-0.007	0.000	-0.011	0.000	0.000
09/20/07 7:00	33	Yorktown	5	263	-0.007	0.000	-0.009	0.000	0.000
09/20/07 8:00	34	Yorktown	5	263	-0.007	0.000	-0.011	0.000	0.000
09/20/07 9:00	35	Yorktown	5	263	-0.007	0.000	-0.011	0.000	0.000
09/20/07 10:00	36	Yorktown	5	263	-0.007	0.000	-0.009	0.000	0.000
09/20/07 11:00	37	Yorktown	5	263	-0.007	0.000	-0.011	0.000	0.000
09/20/07 12:00	38	Yorktown	5	263	-0.007	0.000	-0.009	0.000	0.000

TIMESTAMP (GMT) Time	Record #	LoggerID Sample	Day Of Week Sun=1 Sample	JulianDay Sample	Flow Fuel Supply gal Total	Flow Fuel Return gal Total	Flow Fuel Use gal Total	Time GPS hhmmss Sample	Latitude GPS deg Sample
09/18/07 22:00	0	Yorktown	3	261	0	0	0	220117	35
09/18/07 23:00	1	Yorktown	3	261	0	0	0	230117	35
09/19/07 0:00	2	Yorktown	4	262	0	0	0	117	35
09/19/07 1:00	3	Yorktown	4	262	0	0	0	10117	35
09/19/07 2:00	4	Yorktown	4	262	0	0	0	20116	35
09/19/07 3:00	5	Yorktown	4	262	0	0	0	30117	35
09/19/07 4:00	6	Yorktown	4	262	0	0	0	40117	35
09/19/07 5:00	7	Yorktown	4	262	0	0	0	50117	35
09/19/07 6:00	8	Yorktown	4	262	0	0	0	60117	35
09/19/07 7:00	9	Yorktown	4	262	0	0	0	70117	35
09/19/07 8:00	10	Yorktown	4	262	0	0	0	80117	35
09/19/07 9:00	11	Yorktown	4	262	0	0	0	90117	35
09/19/07 10:00	12	Yorktown	4	262	0	0	0	100117	35
09/19/07 11:00	13	Yorktown	4	262	0	0	0	110117	35
09/19/07 12:00	14	Yorktown	4	262	0	0	0	120117	35
09/19/07 13:00	15	Yorktown	4	262	0	0	0	130117	35
09/19/07 14:00	16	Yorktown	4	262	0	0	0	140116	35
09/19/07 15:00	17	Yorktown	4	262	0	0	0	150116	35
09/19/07 16:00	18	Yorktown	4	262	0	0	0	160116	35
09/19/07 17:00	19	Yorktown	4	262	0	0	0	170116	35
09/19/07 18:00	20	Yorktown	4	262	0	0	0	180116	35
09/19/07 19:00	21	Yorktown	4	262	0	0	0	190116	35
09/19/07 20:00	22	Yorktown	4	262	0	0	0	200117	35
09/19/07 21:00	23	Yorktown	4	262	0	0	0	210116	35
09/19/07 22:00	24	Yorktown	4	262	0	0	0	220116	35
09/19/07 23:00	25	Yorktown	4	262	0	0	0	230116	35
09/20/07 0:00	26	Yorktown	5	263	0	0	0	116	35
09/20/07 1:00	27	Yorktown	5	263	0	0	0	10116	35
09/20/07 2:00	28	Yorktown	5	263	0	0	0	20116	35
09/20/07 3:00	29	Yorktown	5	263	0	0	0	30116	35
09/20/07 4:00	30	Yorktown	5	263	0	0	0	40116	35
09/20/07 5:00	31	Yorktown	5	263	0	0	0	50116	35
09/20/07 6:00	32	Yorktown	5	263	0	0	0	60116	35
09/20/07 7:00	33	Yorktown	5	263	0	0	0	70116	35
09/20/07 8:00	34	Yorktown	5	263	0	0	0	80116	35
09/20/07 9:00	35	Yorktown	5	263	0	0	0	90116	35
09/20/07 10:00	36	Yorktown	5	263	0	0	0	100116	35
09/20/07 11:00	37	Yorktown	5	263	0	0	0	110116	35
09/20/07 12:00	38	Yorktown	5	263	0	0	0	120116	35

TIMESTAMP (GMT) Time	Record #	LoggerID Sample	Day Of Week Sun=1 Sample	JulianDay Sample	Latitude GPS min Sample	Latitude GPS sec Sample	N-S Hemisphere GPS Sample	Longitude GPS deg Sample	Longitude GPS min Sample
09/18/07 22:00	0	Yorktown	3	261	15	5.292	N	116	24.00
09/18/07 23:00	1	Yorktown	3	261	15	5.31	N	116	24.00
09/19/07 0:00	2	Yorktown	4	262	15	5.304	N	116	24.00
09/19/07 1:00	3	Yorktown	4	262	15	5.346	N	116	24.00
09/19/07 2:00	4	Yorktown	4	262	15	5.322	N	116	24.00
09/19/07 3:00	5	Yorktown	4	262	15	5.364	N	116	24.00
09/19/07 4:00	6	Yorktown	4	262	15	5.364	N	116	24.00
09/19/07 5:00	7	Yorktown	4	262	15	5.292	N	116	24.00
09/19/07 6:00	8	Yorktown	4	262	15	5.358	N	116	24.00
09/19/07 7:00	9	Yorktown	4	262	15	6.756	N	116	24.00
09/19/07 8:00	10	Yorktown	4	262	15	6.348	N	116	24.00
09/19/07 9:00	11	Yorktown	4	262	15	3.696	N	116	24.00
09/19/07 10:00	12	Yorktown	4	262	15	1.524	N	116	24.00
09/19/07 11:00	13	Yorktown	4	262	15	3.504	N	116	24.00
09/19/07 12:00	14	Yorktown	4	262	15	6.414	N	116	24.00
09/19/07 13:00	15	Yorktown	4	262	15	8.68	N	116	24.00
09/19/07 14:00	16	Yorktown	4	262	15	5.196	N	116	24.00
09/19/07 15:00	17	Yorktown	4	262	15	5.322	N	116	24.00
09/19/07 16:00	18	Yorktown	4	262	15	5.364	N	116	24.00
09/19/07 17:00	19	Yorktown	4	262	15	5.334	N	116	24.00
09/19/07 18:00	20	Yorktown	4	262	15	5.304	N	116	24.00
09/19/07 19:00	21	Yorktown	4	262	15	5.292	N	116	24.00
09/19/07 20:00	22	Yorktown	4	262	15	5.262	N	116	24.00
09/19/07 21:00	23	Yorktown	4	262	15	5.316	N	116	24.00
09/19/07 22:00	24	Yorktown	4	262	15	5.256	N	116	24.00
09/19/07 23:00	25	Yorktown	4	262	15	5.316	N	116	24.00
09/20/07 0:00	26	Yorktown	5	263	15	5.388	N	116	24.00
09/20/07 1:00	27	Yorktown	5	263	15	5.184	N	116	24.00
09/20/07 2:00	28	Yorktown	5	263	15	5.346	N	116	24.00
09/20/07 3:00	29	Yorktown	5	263	15	5.25	N	116	24.00
09/20/07 4:00	30	Yorktown	5	263	15	5.25	N	116	24.00
09/20/07 5:00	31	Yorktown	5	263	15	5.316	N	116	24.00
09/20/07 6:00	32	Yorktown	5	263	15	5.292	N	116	24.00
09/20/07 7:00	33	Yorktown	5	263	15	5.262	N	116	24.00
09/20/07 8:00	34	Yorktown	5	263	15	5.316	N	116	24.00
09/20/07 9:00	35	Yorktown	5	263	15	5.268	N	116	24.00
09/20/07 10:00	36	Yorktown	5	263	15	5.274	N	116	24.00
09/20/07 11:00	37	Yorktown	5	263	15	5.298	N	116	24.00
09/20/07 12:00	38	Yorktown	5	263	15	5.256	N	116	24.00

TIMESTAMP (GMT) Time	Record #	LoggerID Sample	Day Of Week Sun=1 Sample	JulianDay Sample	Longitude GPS sec Sample	E-W Hemisphere GPS Sample	Altitude GPS meters Sample	Received String GPS Sample	Temperature Logger Panel meters Average	Voltage Logger Battery volts Average
09/18/07 22:00	0	Yorktown	3	261	13.37	W	489.00	GPGGA,2	86.10	13.09
09/18/07 23:00	1	Yorktown	3	261	13.39	W	485.90	GPGGA,2	88.30	13.13
09/19/07 0:00	2	Yorktown	4	262	13.39	W	488.00	GPGGA,0	87.60	13.08
09/19/07 1:00	3	Yorktown	4	262	13.40	W	490.80	GPGGA,0	88.10	13.13
09/19/07 2:00	4	Yorktown	4	262	13.39	W	487.90	GPGGA,0	90.70	13.07
09/19/07 3:00	5	Yorktown	4	262	13.36	W	487.40	GPGGA,0	92.10	13.09
09/19/07 4:00	6	Yorktown	4	262	13.38	W	487.30	GPGGA,0	92.60	13.09
09/19/07 5:00	7	Yorktown	4	262	13.38	W	487.30	GPGGA,0	92.20	13.08
09/19/07 6:00	8	Yorktown	4	262	13.35	W	485.00	GPGGA,0	91.70	13.05
09/19/07 7:00	9	Yorktown	4	262	11.32	W	646.40	GPGGA,0	90.90	13.11
09/19/07 8:00	10	Yorktown	4	262	9.19	W	410.00	GPGGA,0	89.60	13.08
09/19/07 9:00	11	Yorktown	4	262	12.26	W	190.70	GPGGA,0	88.50	13.14
09/19/07 10:00	12	Yorktown	4	262	14.23	W	239.40	GPGGA,1	87.10	13.10
09/19/07 11:00	13	Yorktown	4	262	17.23	W	448.20	GPGGA,1	86.00	13.16
09/19/07 12:00	14	Yorktown	4	262	17.27	W	628.80	GPGGA,1	84.80	13.12
09/19/07 13:00	15	Yorktown	4	262	14.95	W	596.60	GPGGA,1	83.80	13.18
09/19/07 14:00	16	Yorktown	4	262	13.30	W	494.60	GPGGA,1	82.70	13.15
09/19/07 15:00	17	Yorktown	4	262	13.36	W	488.90	GPGGA,1	81.80	13.20
09/19/07 16:00	18	Yorktown	4	262	13.36	W	488.10	GPGGA,1	81.30	13.15
09/19/07 17:00	19	Yorktown	4	262	13.34	W	487.00	GPGGA,1	81.60	13.20
09/19/07 18:00	20	Yorktown	4	262	13.41	W	488.10	GPGGA,1	82.70	13.14
09/19/07 19:00	21	Yorktown	4	262	13.36	W	489.60	GPGGA,1	84.20	13.17
09/19/07 20:00	22	Yorktown	4	262	13.35	W	489.60	GPGGA,2	86.20	13.11
09/19/07 21:00	23	Yorktown	4	262	13.37	W	487.50	GPGGA,2	87.90	13.13
09/19/07 22:00	24	Yorktown	4	262	13.32	W	491.00	GPGGA,2	88.20	13.11
09/19/07 23:00	25	Yorktown	4	262	13.33	W	488.00	GPGGA,2	87.10	13.11
09/20/07 0:00	26	Yorktown	5	263	13.34	W	490.20	GPGGA,0	86.10	13.15
09/20/07 1:00	27	Yorktown	5	263	13.36	W	485.20	GPGGA,0	85.80	13.11
09/20/07 2:00	28	Yorktown	5	263	13.40	W	486.10	GPGGA,0	86.00	13.15
09/20/07 3:00	29	Yorktown	5	263	13.36	W	491.60	GPGGA,0	85.90	13.12
09/20/07 4:00	30	Yorktown	5	263	13.40	W	490.70	GPGGA,0	84.90	13.13
09/20/07 5:00	31	Yorktown	5	263	13.43	W	483.40	GPGGA,0	83.40	13.18
09/20/07 6:00	32	Yorktown	5	263	13.41	W	488.70	GPGGA,0	81.60	13.15
09/20/07 7:00	33	Yorktown	5	263	13.41	W	483.70	GPGGA,0	80.10	13.21
09/20/07 8:00	34	Yorktown	5	263	13.38	W	487.00	GPGGA,0	78.74	13.19
09/20/07 9:00	35	Yorktown	5	263	13.36	W	486.90	GPGGA,0	77.45	13.20
09/20/07 10:00	36	Yorktown	5	263	13.42	W	488.60	GPGGA,1	76.30	13.25
09/20/07 11:00	37	Yorktown	5	263	13.36	W	488.20	GPGGA,1	74.94	13.22
09/20/07 12:00	38	Yorktown	5	263	13.33	W	490.00	GPGGA,1	73.68	13.28

TIMESTAMP (GMT)	Record #	LoggerID	Day Of Week Sun=1	JulianDay	Solar Radiation Horizontal W/m2	Speed Wind mph	Speed Wind mph	Temperature PV deg F	Voltage PV volts
		Sample	Sample	Sample	Average	Average	Max	Average	Average
Time									
09/20/07 13:00	39	Yorktown	5	263	0.0	0.1	0.8	-7999.00	0.07
09/20/07 14:00	40	Yorktown	5	263	0.0	0.4	8.2	-7999.00	21.45
09/20/07 15:00	41	Yorktown	5	263	0.1	0.2	4.5	-7999.00	37.49
09/20/07 16:00	42	Yorktown	5	263	0.5	0.8	2.8	-7999.00	43.94
09/20/07 17:00	43	Yorktown	5	263	1.0	1.9	10.5	-7999.00	44.30
09/20/07 18:00	44	Yorktown	5	263	0.4	1.1	5.1	7999.00	45.92
09/20/07 19:00	45	Yorktown	5	263	0.5	2.1	7.2	7999.00	47.25
09/20/07 20:00	46	Yorktown	5	263	0.6	2.0	6.8	7999.00	48.20
09/20/07 21:00	47	Yorktown	5	263	0.6	2.1	6.8	7999.00	47.25
09/20/07 22:00	48	Yorktown	5	263	0.6	2.5	8.5	-7999.00	50.91
09/20/07 23:00	49	Yorktown	5	263	0.7	2.3	9.2	-7999.00	50.39
09/21/07 0:00	50	Yorktown	6	264	1.9	2.0	7.2	7999.00	51.24
09/21/07 1:00	51	Yorktown	6	264	1.6	1.9	4.1	-7999.00	50.87
09/21/07 2:00	52	Yorktown	6	264	0.0	1.7	2.1	-7999.00	36.65
09/21/07 3:00	53	Yorktown	6	264	0.0	1.4	2.1	7999.00	0.31
09/21/07 4:00	54	Yorktown	6	264	0.0	1.5	9.8	7999.00	0.01
09/21/07 5:00	55	Yorktown	6	264	0.0	2.0	14.2	7999.00	0.01
09/21/07 6:00	56	Yorktown	6	264	0.0	1.3	7.2	7999.00	0.01
09/21/07 7:00	57	Yorktown	6	264	0.0	2.6	8.5	7999.00	0.01
09/21/07 8:00	58	Yorktown	6	264	0.0	2.8	10.9	7999.00	0.00
09/21/07 9:00	59	Yorktown	6	264	0.0	0.9	7.2	7999.00	0.00
09/21/07 10:00	60	Yorktown	6	264	0.0	0.6	1.5	7999.00	0.00
09/21/07 11:00	61	Yorktown	6	264	0.0	0.7	1.5	7999.00	0.00
09/21/07 12:00	62	Yorktown	6	264	0.0	0.5	7.5	7999.00	0.00
09/21/07 13:00	63	Yorktown	6	264	0.0	0.6	5.5	7999.00	0.03
09/21/07 14:00	64	Yorktown	6	264	0.0	0.4	1.8	7999.00	15.32
09/21/07 15:00	65	Yorktown	6	264	0.0	0.7	1.5	7999.00	30.46
09/21/07 16:00	66	Yorktown	6	264	0.1	0.8	1.8	7999.00	32.21
09/21/07 17:00	67	Yorktown	6	264	0.2	1.1	1.8	7999.00	24.48
09/21/07 18:00	68	Yorktown	6	264	0.0	1.0	1.8	7999.00	32.05
09/21/07 19:00	69	Yorktown	6	264	0.0	7.5	16.6	7999.00	42.33
09/21/07 20:00	70	Yorktown	6	264	0.0	1.0	9.5	7999.00	41.16
09/21/07 21:00	71	Yorktown	6	264	0.0	0.9	1.5	7999.00	40.49
09/21/07 22:00	72	Yorktown	6	264	0.0	0.6	1.8	7999.00	40.49
09/21/07 23:00	73	Yorktown	6	264	0.0	8.4	14.9	7999.00	44.04
09/22/07 0:00	74	Yorktown	7	265	0.1	4.2	14.2	7999.00	44.01
09/22/07 1:00	75	Yorktown	7	265	0.5	3.0	10.2	7999.00	40.50
09/22/07 2:00	76	Yorktown	7	265	0.0	6.7	14.9	7999.00	32.52
09/22/07 3:00	77	Yorktown	7	265	0.0	4.9	13.9	7999.00	0.09
09/22/07 4:00	78	Yorktown	7	265	0.0	1.5	9.5	7999.00	0.00
09/22/07 5:00	79	Yorktown	7	265	0.0	1.2	5.1	7999.00	0.01
09/22/07 6:00	80	Yorktown	7	265	0.0	0.9	1.8	7999.00	0.01
09/22/07 7:00	81	Yorktown	7	265	0.0	0.7	6.5	7999.00	0.01
09/22/07 8:00	82	Yorktown	7	265	0.0	0.5	1.8	7999.00	0.00
09/22/07 9:00	83	Yorktown	7	265	0.0	0.8	1.5	7999.00	0.01
09/22/07 10:00	84	Yorktown	7	265	0.0	0.6	7.2	7999.00	0.00
09/22/07 11:00	85	Yorktown	7	265	0.0	1.8	10.9	7999.00	0.00
09/22/07 12:00	86	Yorktown	7	265	0.0	1.6	10.5	7999.00	0.00
09/22/07 13:00	87	Yorktown	7	265	0.0	0.3	3.1	7999.00	0.01
09/22/07 14:00	88	Yorktown	7	265	0.0	0.4	1.5	7999.00	18.18
09/22/07 15:00	89	Yorktown	7	265	0.2	1.3	2.1	7999.00	34.16
09/22/07 16:00	90	Yorktown	7	265	0.4	1.7	2.1	7999.00	44.93
09/22/07 17:00	91	Yorktown	7	265	0.9	2.0	2.1	7999.00	42.79

TIMESTAMP (GMT) Time	Record #	LoggerID Sample	Day Of Week Sun=1 Sample	JulianDay Sample	Voltage Battery volts Average Battery Voltage	Current PV amps Average	Current Wind Turbine amps Average	Current Wind Turbine amps Max	Current Battery amps Average
09/20/07 13:00	39	Yorktown	5	263	25.07	-0.27	0.00	0.00	-0.44
09/20/07 14:00	40	Yorktown	5	263	25.07	0.06	0.00	0.00	-0.03
09/20/07 15:00	41	Yorktown	5	263	25.29	10.05	0.00	0.00	9.72
09/20/07 16:00	42	Yorktown	5	263	26.12	38.53	0.00	0.00	37.85
09/20/07 17:00	43	Yorktown	5	263	27.52	55.83	0.00	0.00	54.86
09/20/07 18:00	44	Yorktown	5	263	28.60	31.00	0.00	0.00	30.43
09/20/07 19:00	45	Yorktown	5	263	28.78	25.35	0.00	0.00	23.74
09/20/07 20:00	46	Yorktown	5	263	21.39	23.16	0.00	0.00	16.85
09/20/07 21:00	47	Yorktown	5	263	27.65	20.14	0.00	0.00	12.66
09/20/07 22:00	48	Yorktown	5	263	25.16	2.27	0.00	0.00	-28.50
09/20/07 23:00	49	Yorktown	5	263	25.05	1.94	0.00	0.00	-29.43
09/21/07 0:00	50	Yorktown	6	264	24.97	4.99	0.00	0.00	-26.65
09/21/07 1:00	51	Yorktown	6	264	24.84	1.18	0.00	0.00	-30.60
09/21/07 2:00	52	Yorktown	6	264	24.70	-0.22	0.00	0.00	-37.08
09/21/07 3:00	53	Yorktown	6	264	24.65	-0.08	0.00	0.00	-35.18
09/21/07 4:00	54	Yorktown	6	264	24.73	-0.05	0.00	0.00	-18.06
09/21/07 5:00	55	Yorktown	6	264	24.64	-0.04	0.00	0.00	-28.14
09/21/07 6:00	56	Yorktown	6	264	25.23	-0.08	0.00	0.00	20.39
09/21/07 7:00	57	Yorktown	6	264	25.78	-0.27	0.00	0.00	33.78
09/21/07 8:00	58	Yorktown	6	264	25.96	-0.27	0.00	0.00	33.72
09/21/07 9:00	59	Yorktown	6	264	26.11	-0.27	0.00	0.00	32.41
09/21/07 10:00	60	Yorktown	6	264	26.29	-0.27	0.00	0.00	32.56
09/21/07 11:00	61	Yorktown	6	264	26.48	-0.27	0.00	0.00	32.15
09/21/07 12:00	62	Yorktown	6	264	26.81	-0.27	0.00	0.00	31.26
09/21/07 13:00	63	Yorktown	6	264	28.06	-0.24	0.00	0.00	28.34
09/21/07 14:00	64	Yorktown	6	264	26.50	-0.25	0.00	0.00	-2.19
09/21/07 15:00	65	Yorktown	6	264	25.29	-0.05	0.00	0.00	-13.61
09/21/07 16:00	66	Yorktown	6	264	25.43	12.78	0.00	0.00	-1.50
09/21/07 17:00	67	Yorktown	6	264	25.52	12.87	0.00	0.00	-2.90
09/21/07 18:00	68	Yorktown	6	264	25.37	12.19	0.00	0.00	-2.82
09/21/07 19:00	69	Yorktown	6	264	25.36	12.07	0.00	0.00	-3.11
09/21/07 20:00	70	Yorktown	6	264	25.22	6.63	0.00	0.00	-8.62
09/21/07 21:00	71	Yorktown	6	264	25.17	8.36	0.00	0.00	-12.45
09/21/07 22:00	72	Yorktown	6	264	25.21	10.74	0.00	0.00	-6.17
09/21/07 23:00	73	Yorktown	6	264	25.38	18.52	0.00	0.00	2.85
09/22/07 0:00	74	Yorktown	7	265	25.55	19.43	0.00	0.00	3.65
09/22/07 1:00	75	Yorktown	7	265	25.51	19.35	0.00	0.00	4.22
09/22/07 2:00	76	Yorktown	7	265	25.28	3.07	0.00	0.00	-7.72
09/22/07 3:00	77	Yorktown	7	265	25.03	-0.27	0.00	0.00	-14.81
09/22/07 4:00	78	Yorktown	7	265	24.96	-0.27	0.00	0.00	-20.04
09/22/07 5:00	79	Yorktown	7	265	24.90	-0.27	0.00	0.00	-22.51
09/22/07 6:00	80	Yorktown	7	265	24.83	-0.27	0.00	0.00	-23.81
09/22/07 7:00	81	Yorktown	7	265	24.86	-0.27	0.00	0.00	-13.24
09/22/07 8:00	82	Yorktown	7	265	24.83	-0.27	0.00	0.00	-14.33
09/22/07 9:00	83	Yorktown	7	265	24.79	-0.27	0.00	0.00	-14.64
09/22/07 10:00	84	Yorktown	7	265	24.76	-0.27	0.00	0.00	-15.08
09/22/07 11:00	85	Yorktown	7	265	24.73	-0.27	0.00	0.00	-15.77
09/22/07 12:00	86	Yorktown	7	265	24.71	-0.27	0.00	0.00	-16.88
09/22/07 13:00	87	Yorktown	7	265	24.56	-0.27	0.00	0.00	-36.17
09/22/07 14:00	88	Yorktown	7	265	24.49	0.07	0.00	0.00	-39.34
09/22/07 15:00	89	Yorktown	7	265	24.70	11.38	0.00	0.00	-9.85
09/22/07 16:00	90	Yorktown	7	265	25.30	48.36	0.00	0.00	31.71
09/22/07 17:00	91	Yorktown	7	265	26.08	87.00	0.00	0.00	69.76

TIMESTAMP (GMT) Time	Record #	LoggerID Sample	Day Of Week Sun=1 Sample	JulianDay Sample	Power PV kW Average	Power Wind Turbine kW Average	Power Battery kW Average	Power Generator kW Average	Power Load kW Average Load (kW)
09/20/07 13:00	39	Yorktown	5	263	-0.007	0.000	-0.011	0.000	0.000
09/20/07 14:00	40	Yorktown	5	263	0.001	0.000	-0.001	0.000	0.000
09/20/07 15:00	41	Yorktown	5	263	0.256	0.000	0.247	0.000	0.000
09/20/07 16:00	42	Yorktown	5	263	1.008	0.000	0.991	0.000	0.000
09/20/07 17:00	43	Yorktown	5	263	1.547	0.000	1.520	0.000	0.000
09/20/07 18:00	44	Yorktown	5	263	0.887	0.000	0.870	0.000	0.000
09/20/07 19:00	45	Yorktown	5	263	0.730	0.000	0.684	0.000	0.000
09/20/07 20:00	46	Yorktown	5	263	0.667	0.000	0.485	0.038	0.001
09/20/07 21:00	47	Yorktown	5	263	0.573	0.000	0.371	0.115	0.045
09/20/07 22:00	48	Yorktown	5	263	0.058	0.000	-0.717	0.000	0.687
09/20/07 23:00	49	Yorktown	5	263	0.049	0.000	-0.737	0.000	0.694
09/21/07 0:00	50	Yorktown	6	264	0.125	0.000	-0.665	0.000	0.699
09/21/07 1:00	51	Yorktown	6	264	0.029	0.000	-0.760	0.000	0.697
09/21/07 2:00	52	Yorktown	6	264	-0.005	0.000	-0.916	0.000	0.715
09/21/07 3:00	53	Yorktown	6	264	-0.002	0.000	-0.867	0.000	0.629
09/21/07 4:00	54	Yorktown	6	264	-0.001	0.000	-0.447	0.000	0.233
09/21/07 5:00	55	Yorktown	6	264	-0.001	0.000	-0.692	0.000	0.466
09/21/07 6:00	56	Yorktown	6	264	-0.002	0.000	0.522	1.203	0.330
09/21/07 7:00	57	Yorktown	6	264	-0.007	0.000	0.871	1.607	0.308
09/21/07 8:00	58	Yorktown	6	264	-0.007	0.000	0.875	1.682	0.368
09/21/07 9:00	59	Yorktown	6	264	-0.007	0.000	0.846	1.462	0.168
09/21/07 10:00	60	Yorktown	6	264	-0.007	0.000	0.856	1.666	0.359
09/21/07 11:00	61	Yorktown	6	264	-0.007	0.000	0.852	1.631	0.323
09/21/07 12:00	62	Yorktown	6	264	-0.007	0.000	0.838	1.488	0.180
09/21/07 13:00	63	Yorktown	6	264	-0.007	0.000	0.795	1.431	0.128
09/21/07 14:00	64	Yorktown	6	264	-0.007	0.000	-0.031	0.418	0.125
09/21/07 15:00	65	Yorktown	6	264	-0.001	0.000	-0.344	0.000	0.126
09/21/07 16:00	66	Yorktown	6	264	0.326	0.000	-0.037	0.000	0.141
09/21/07 17:00	67	Yorktown	6	264	0.332	0.000	-0.071	0.000	0.169
09/21/07 18:00	68	Yorktown	6	264	0.309	0.000	-0.071	0.000	0.163
09/21/07 19:00	69	Yorktown	6	264	0.307	0.000	-0.078	0.000	0.168
09/21/07 20:00	70	Yorktown	6	264	0.167	0.000	-0.217	0.000	0.176
09/21/07 21:00	71	Yorktown	6	264	0.211	0.000	-0.312	0.000	0.305
09/21/07 22:00	72	Yorktown	6	264	0.271	0.000	-0.155	0.000	0.211
09/21/07 23:00	73	Yorktown	6	264	0.472	0.000	0.075	0.000	0.174
09/22/07 0:00	74	Yorktown	7	265	0.497	0.000	0.094	0.000	0.170
09/22/07 1:00	75	Yorktown	7	265	0.496	0.000	0.110	0.000	0.162
09/22/07 2:00	76	Yorktown	7	265	0.078	0.000	-0.194	0.000	0.164
09/22/07 3:00	77	Yorktown	7	265	-0.007	0.000	-0.371	0.000	0.164
09/22/07 4:00	78	Yorktown	7	265	-0.007	0.000	-0.499	0.000	0.323
09/22/07 5:00	79	Yorktown	7	265	-0.007	0.000	-0.559	0.000	0.355
09/22/07 6:00	80	Yorktown	7	265	-0.007	0.000	-0.590	0.000	0.368
09/22/07 7:00	81	Yorktown	7	265	-0.007	0.000	-0.329	0.000	0.125
09/22/07 8:00	82	Yorktown	7	265	-0.007	0.000	-0.356	0.000	0.151
09/22/07 9:00	83	Yorktown	7	265	-0.007	0.000	-0.363	0.000	0.192
09/22/07 10:00	84	Yorktown	7	265	-0.007	0.000	-0.373	0.000	0.214
09/22/07 11:00	85	Yorktown	7	265	-0.007	0.000	-0.389	0.000	0.228
09/22/07 12:00	86	Yorktown	7	265	-0.007	0.000	-0.416	0.000	0.266
09/22/07 13:00	87	Yorktown	7	265	-0.007	0.000	-0.887	0.000	0.750
09/22/07 14:00	88	Yorktown	7	265	0.002	0.000	-0.962	0.000	0.823
09/22/07 15:00	89	Yorktown	7	265	0.282	0.000	-0.240	0.000	0.412
09/22/07 16:00	90	Yorktown	7	265	1.226	0.000	0.805	0.000	0.182
09/22/07 17:00	91	Yorktown	7	265	2.272	0.000	1.821	0.000	0.171

TIMESTAMP (GMT) Time	Record #	LoggerID Sample	Day Of Week Sun=1 Sample	JulianDay Sample	Flow Fuel Supply gal Total	Flow Fuel Return gal Total	Flow Fuel Use gal Total	Time GPS hhmmss Sample	Latitude GPS deg Sample
09/20/07 13:00	39	Yorktown	5	263	0	0	0	130116	35
09/20/07 14:00	40	Yorktown	5	263	0	0	0	140116	35
09/20/07 15:00	41	Yorktown	5	263	0	0	0	150116	35
09/20/07 16:00	42	Yorktown	5	263	0	0	0	160116	35
09/20/07 17:00	43	Yorktown	5	263	0	0	0	170116	35
09/20/07 18:00	44	Yorktown	5	263	0	0	0	180116	35
09/20/07 19:00	45	Yorktown	5	263	0	0	0	190116	35
09/20/07 20:00	46	Yorktown	5	263	0	0	0	200116	35
09/20/07 21:00	47	Yorktown	5	263	0	0	0	210116	35
09/20/07 22:00	48	Yorktown	5	263	0	0	0	220116	35
09/20/07 23:00	49	Yorktown	5	263	0	0	0	230116	35
09/21/07 0:00	50	Yorktown	6	264	0	0	0	116	35
09/21/07 1:00	51	Yorktown	6	264	0	0	0	10116	35
09/21/07 2:00	52	Yorktown	6	264	0	0	0	20116	35
09/21/07 3:00	53	Yorktown	6	264	0	0	0	30116	35
09/21/07 4:00	54	Yorktown	6	264	0	0	0	40116	35
09/21/07 5:00	55	Yorktown	6	264	0	0	0	50116	35
09/21/07 6:00	56	Yorktown	6	264	0	0	0	60116	35
09/21/07 7:00	57	Yorktown	6	264	0	0	0	70116	35
09/21/07 8:00	58	Yorktown	6	264	0	0	0	80116	35
09/21/07 9:00	59	Yorktown	6	264	0	0	0	90116	35
09/21/07 10:00	60	Yorktown	6	264	0	0	0	100116	35
09/21/07 11:00	61	Yorktown	6	264	0	0	0	110116	35
09/21/07 12:00	62	Yorktown	6	264	0	0	0	120116	35
09/21/07 13:00	63	Yorktown	6	264	0	0	0	130116	35
09/21/07 14:00	64	Yorktown	6	264	0	0	0	140116	35
09/21/07 15:00	65	Yorktown	6	264	0	0	0	150116	35
09/21/07 16:00	66	Yorktown	6	264	0	0	0	160116	35
09/21/07 17:00	67	Yorktown	6	264	0	0	0	170116	35
09/21/07 18:00	68	Yorktown	6	264	0	0	0	180116	35
09/21/07 19:00	69	Yorktown	6	264	0	0	0	190116	35
09/21/07 20:00	70	Yorktown	6	264	0	0	0	200116	35
09/21/07 21:00	71	Yorktown	6	264	0	0	0	210116	35
09/21/07 22:00	72	Yorktown	6	264	0	0	0	220116	35
09/21/07 23:00	73	Yorktown	6	264	0	0	0	230116	35
09/22/07 0:00	74	Yorktown	7	265	0	0	0	116	35
09/22/07 1:00	75	Yorktown	7	265	0	0	0	10116	35
09/22/07 2:00	76	Yorktown	7	265	0	0	0	20116	35
09/22/07 3:00	77	Yorktown	7	265	0	0	0	30116	35
09/22/07 4:00	78	Yorktown	7	265	0	0	0	40116	35
09/22/07 5:00	79	Yorktown	7	265	0	0	0	50116	35
09/22/07 6:00	80	Yorktown	7	265	0	0	0	60116	35
09/22/07 7:00	81	Yorktown	7	265	0	0	0	70116	35
09/22/07 8:00	82	Yorktown	7	265	0	0	0	80116	35
09/22/07 9:00	83	Yorktown	7	265	0	0	0	90116	35
09/22/07 10:00	84	Yorktown	7	265	0	0	0	100116	35
09/22/07 11:00	85	Yorktown	7	265	0	0	0	110116	35
09/22/07 12:00	86	Yorktown	7	265	0	0	0	120116	35
09/22/07 13:00	87	Yorktown	7	265	0	0	0	130116	35
09/22/07 14:00	88	Yorktown	7	265	0	0	0	140116	35
09/22/07 15:00	89	Yorktown	7	265	0	0	0	150116	35
09/22/07 16:00	90	Yorktown	7	265	0	0	0	160116	35
09/22/07 17:00	91	Yorktown	7	265	0	0	0	170116	35

TIMESTAMP (GMT) Time	Record #	LoggerID Sample	Day Of Week Sun=1 Sample	JulianDay Sample	Latitude GPS min Sample	Latitude GPS sec Sample	N-S Hemisphere GPS Sample	Longitude GPS deg Sample	Longitude GPS min Sample
09/20/07 13:00	39	Yorktown	5	263	15	5.226	N	116	24.00
09/20/07 14:00	40	Yorktown	5	263	15	5.25	N	116	24.00
09/20/07 15:00	41	Yorktown	5	263	15	5.28	N	116	24.00
09/20/07 16:00	42	Yorktown	5	263	15	5.19	N	116	24.00
09/20/07 17:00	43	Yorktown	5	263	15	5.214	N	116	24.00
09/20/07 18:00	44	Yorktown	5	263	15	5.148	N	116	24.00
09/20/07 19:00	45	Yorktown	5	263	15	5.256	N	116	24.00
09/20/07 20:00	46	Yorktown	5	263	15	5.274	N	116	24.00
09/20/07 21:00	47	Yorktown	5	263	15	5.244	N	116	24.00
09/20/07 22:00	48	Yorktown	5	263	15	5.304	N	116	24.00
09/20/07 23:00	49	Yorktown	5	263	15	5.226	N	116	24.00
09/21/07 0:00	50	Yorktown	6	264	15	5.442	N	116	24.00
09/21/07 1:00	51	Yorktown	6	264	15	5.16	N	116	24.00
09/21/07 2:00	52	Yorktown	6	264	15	5.382	N	116	24.00
09/21/07 3:00	53	Yorktown	6	264	15	5.328	N	116	24.00
09/21/07 4:00	54	Yorktown	6	264	15	5.232	N	116	24.00
09/21/07 5:00	55	Yorktown	6	264	15	5.292	N	116	24.00
09/21/07 6:00	56	Yorktown	6	264	15	5.28	N	116	24.00
09/21/07 7:00	57	Yorktown	6	264	15	5.316	N	116	24.00
09/21/07 8:00	58	Yorktown	6	264	15	5.334	N	116	24.00
09/21/07 9:00	59	Yorktown	6	264	15	5.304	N	116	24.00
09/21/07 10:00	60	Yorktown	6	264	15	5.262	N	116	24.00
09/21/07 11:00	61	Yorktown	6	264	15	5.268	N	116	24.00
09/21/07 12:00	62	Yorktown	6	264	15	5.262	N	116	24.00
09/21/07 13:00	63	Yorktown	6	264	15	5.106	N	116	24.00
09/21/07 14:00	64	Yorktown	6	264	15	5.244	N	116	24.00
09/21/07 15:00	65	Yorktown	6	264	15	5.274	N	116	24.00
09/21/07 16:00	66	Yorktown	6	264	15	5.232	N	116	24.00
09/21/07 17:00	67	Yorktown	6	264	15	5.268	N	116	24.00
09/21/07 18:00	68	Yorktown	6	264	15	5.178	N	116	24.00
09/21/07 19:00	69	Yorktown	6	264	15	5.28	N	116	24.00
09/21/07 20:00	70	Yorktown	6	264	15	5.28	N	116	24.00
09/21/07 21:00	71	Yorktown	6	264	15	5.172	N	116	24.00
09/21/07 22:00	72	Yorktown	6	264	15	5.268	N	116	24.00
09/21/07 23:00	73	Yorktown	6	264	15	5.298	N	116	24.00
09/22/07 0:00	74	Yorktown	7	265	15	5.364	N	116	24.00
09/22/07 1:00	75	Yorktown	7	265	15	5.16	N	116	24.00
09/22/07 2:00	76	Yorktown	7	265	15	4.878	N	116	24.00
09/22/07 3:00	77	Yorktown	7	265	15	5.184	N	116	24.00
09/22/07 4:00	78	Yorktown	7	265	15	5.154	N	116	24.00
09/22/07 5:00	79	Yorktown	7	265	15	5.682	N	116	24.00
09/22/07 6:00	80	Yorktown	7	265	15	5.274	N	116	24.00
09/22/07 7:00	81	Yorktown	7	265	15	5.304	N	116	24.00
09/22/07 8:00	82	Yorktown	7	265	15	5.298	N	116	24.00
09/22/07 9:00	83	Yorktown	7	265	15	5.256	N	116	24.00
09/22/07 10:00	84	Yorktown	7	265	15	5.304	N	116	24.00
09/22/07 11:00	85	Yorktown	7	265	15	5.328	N	116	24.00
09/22/07 12:00	86	Yorktown	7	265	15	5.19	N	116	24.00
09/22/07 13:00	87	Yorktown	7	265	15	5.226	N	116	24.00
09/22/07 14:00	88	Yorktown	7	265	15	5.214	N	116	24.00
09/22/07 15:00	89	Yorktown	7	265	15	5.298	N	116	24.00
09/22/07 16:00	90	Yorktown	7	265	15	5.28	N	116	24.00
09/22/07 17:00	91	Yorktown	7	265	15	5.274	N	116	24.00

TIMESTAMP (GMT) Time	Record #	LoggerID Sample	Day Of Week Sun=1 Sample	JulianDay Sample	Longitude GPS sec Sample	E-W Hemisphere GPS Sample	Altitude GPS meters Sample	Received String GPS Sample	Temperature Logger Panel meters Average	Voltage Logger Battery volts Average
09/20/07 13:00	39	Yorktown	5	263	13.34	W	491.60	GPGGA,1	72.63	13.24
09/20/07 14:00	40	Yorktown	5	263	13.40	W	492.10	GPGGA,1	71.67	13.31
09/20/07 15:00	41	Yorktown	5	263	13.39	W	486.80	GPGGA,1	70.76	13.26
09/20/07 16:00	42	Yorktown	5	263	13.39	W	487.50	GPGGA,1	70.56	13.32
09/20/07 17:00	43	Yorktown	5	263	13.26	W	492.80	GPGGA,1	71.66	13.24
09/20/07 18:00	44	Yorktown	5	263	13.40	W	487.40	GPGGA,1	73.56	13.28
09/20/07 19:00	45	Yorktown	5	263	13.37	W	488.40	GPGGA,1	75.30	13.21
09/20/07 20:00	46	Yorktown	5	263	13.40	W	485.90	GPGGA,2	76.54	13.25
09/20/07 21:00	47	Yorktown	5	263	13.34	W	491.00	GPGGA,2	78.13	13.18
09/20/07 22:00	48	Yorktown	5	263	13.48	W	486.60	GPGGA,2	78.34	13.24
09/20/07 23:00	49	Yorktown	5	263	13.40	W	494.40	GPGGA,2	76.71	13.19
09/21/07 0:00	50	Yorktown	6	264	13.41	W	489.60	GPGGA,0	77.11	13.24
09/21/07 1:00	51	Yorktown	6	264	13.34	W	488.70	GPGGA,0	78.09	13.18
09/21/07 2:00	52	Yorktown	6	264	13.53	W	483.50	GPGGA,0	78.42	13.23
09/21/07 3:00	53	Yorktown	6	264	13.35	W	493.20	GPGGA,0	76.95	13.20
09/21/07 4:00	54	Yorktown	6	264	13.38	W	491.70	GPGGA,0	76.77	13.22
09/21/07 5:00	55	Yorktown	6	264	13.46	W	484.80	GPGGA,0	77.21	13.23
09/21/07 6:00	56	Yorktown	6	264	13.33	W	488.40	GPGGA,0	76.20	13.20
09/21/07 7:00	57	Yorktown	6	264	13.42	W	484.10	GPGGA,0	76.19	13.25
09/21/07 8:00	58	Yorktown	6	264	13.38	W	487.30	GPGGA,0	75.87	13.20
09/21/07 9:00	59	Yorktown	6	264	13.46	W	484.30	GPGGA,0	75.54	13.23
09/21/07 10:00	60	Yorktown	6	264	13.40	W	487.50	GPGGA,1	76.09	13.23
09/21/07 11:00	61	Yorktown	6	264	13.40	W	489.80	GPGGA,1	75.81	13.20
09/21/07 12:00	62	Yorktown	6	264	13.34	W	487.60	GPGGA,1	75.82	13.25
09/21/07 13:00	63	Yorktown	6	264	13.21	W	496.80	GPGGA,1	76.56	13.19
09/21/07 14:00	64	Yorktown	6	264	13.40	W	480.90	GPGGA,1	77.11	13.24
09/21/07 15:00	65	Yorktown	6	264	13.38	W	489.30	GPGGA,1	77.23	13.20
09/21/07 16:00	66	Yorktown	6	264	13.38	W	489.20	GPGGA,1	76.56	13.24
09/21/07 17:00	67	Yorktown	6	264	13.28	W	487.90	GPGGA,1	76.45	13.20
09/21/07 18:00	68	Yorktown	6	264	13.40	W	488.60	GPGGA,1	76.62	13.23
09/21/07 19:00	69	Yorktown	6	264	13.37	W	488.30	GPGGA,1	77.07	13.22
09/21/07 20:00	70	Yorktown	6	264	13.29	W	487.30	GPGGA,2	76.87	13.21
09/21/07 21:00	71	Yorktown	6	264	13.43	W	488.80	GPGGA,2	76.97	13.23
09/21/07 22:00	72	Yorktown	6	264	13.42	W	491.50	GPGGA,2	76.40	13.21
09/21/07 23:00	73	Yorktown	6	264	13.45	W	492.60	GPGGA,2	76.33	13.24
09/22/07 0:00	74	Yorktown	7	265	13.34	W	486.50	GPGGA,0	76.26	13.21
09/22/07 1:00	75	Yorktown	7	265	13.32	W	489.20	GPGGA,0	76.64	13.25
09/22/07 2:00	76	Yorktown	7	265	13.55	W	508.00	GPGGA,0	77.35	13.18
09/22/07 3:00	77	Yorktown	7	265	13.35	W	488.20	GPGGA,0	77.54	13.24
09/22/07 4:00	78	Yorktown	7	265	13.30	W	489.80	GPGGA,0	77.46	13.20
09/22/07 5:00	79	Yorktown	7	265	13.70	W	461.30	GPGGA,0	77.50	13.23
09/22/07 6:00	80	Yorktown	7	265	13.38	W	489.40	GPGGA,0	77.20	13.21
09/22/07 7:00	81	Yorktown	7	265	13.26	W	490.80	GPGGA,0	76.52	13.21
09/22/07 8:00	82	Yorktown	7	265	13.39	W	484.70	GPGGA,0	76.54	13.25
09/22/07 9:00	83	Yorktown	7	265	13.40	W	487.20	GPGGA,0	76.57	13.21
09/22/07 10:00	84	Yorktown	7	265	13.46	W	486.70	GPGGA,1	76.57	13.24
09/22/07 11:00	85	Yorktown	7	265	13.39	W	487.90	GPGGA,1	76.72	13.21
09/22/07 12:00	86	Yorktown	7	265	13.31	W	490.70	GPGGA,1	76.69	13.20
09/22/07 13:00	87	Yorktown	7	265	13.30	W	492.60	GPGGA,1	77.36	13.24
09/22/07 14:00	88	Yorktown	7	265	13.38	W	477.40	GPGGA,1	79.82	13.17
09/22/07 15:00	89	Yorktown	7	265	13.40	W	490.10	GPGGA,1	80.70	13.21
09/22/07 16:00	90	Yorktown	7	265	13.46	W	485.50	GPGGA,1	80.20	13.15
09/22/07 17:00	91	Yorktown	7	265	13.35	W	485.70	GPGGA,1	79.45	13.21

TIMESTAMP (GMT) Time	Record #	LoggerID Sample	Day Of Week Sun=1 Sample	JulianDay Sample	Solar Radiation Horizontal W/m2 Average	Speed Wind mph Average	Speed Wind mph Max	Temperature PV deg F Average	Voltage PV volts Average
09/22/07 18:00	92	Yorktown	7	265	0.4	1.7	2.1	7999.00	39.59
09/22/07 19:00	93	Yorktown	7	265	0.4	2.1	2.1	7999.00	41.49
09/22/07 20:00	94	Yorktown	7	265	0.4	2.1	2.1	7999.00	45.26
09/22/07 21:00	95	Yorktown	7	265	0.4	2.1	3.5	7999.00	47.77
09/22/07 22:00	96	Yorktown	7	265	0.3	2.1	7.2	7999.00	42.03
09/22/07 23:00	97	Yorktown	7	265	0.2	2.8	10.9	7999.00	38.46
09/23/07 0:00	98	Yorktown	1	266	0.2	5.1	14.9	7999.00	41.40
09/23/07 1:00	99	Yorktown	1	266	0.1	13.2	27.0	7999.00	38.31
09/23/07 2:00	100	Yorktown	1	266	0.0	13.1	27.0	-7999.00	27.31
09/23/07 3:00	101	Yorktown	1	266	0.0	10.4	20.9	-7999.00	0.18
09/23/07 4:00	102	Yorktown	1	266	0.0	4.7	17.6	-7999.00	0.01
09/23/07 5:00	103	Yorktown	1	266	0.0	6.8	16.6	-7999.00	0.01
09/23/07 6:00	104	Yorktown	1	266	0.0	6.3	17.9	-7999.00	0.01
09/23/07 7:00	105	Yorktown	1	266	0.0	1.7	13.2	7999.00	0.01
09/23/07 8:00	106	Yorktown	1	266	0.0	0.4	3.8	-7999.00	0.01
09/23/07 9:00	107	Yorktown	1	266	0.0	3.6	11.2	-7999.00	0.01
09/23/07 10:00	108	Yorktown	1	266	0.0	1.8	9.5	-7999.00	0.00
09/23/07 11:00	109	Yorktown	1	266	0.0	1.6	11.2	-7999.00	0.00
09/23/07 12:00	110	Yorktown	1	266	0.0	4.4	12.9	7999.00	0.01
09/23/07 13:00	111	Yorktown	1	266	0.0	1.2	5.5	-7999.00	0.02
09/23/07 14:00	112	Yorktown	1	266	0.0	1.0	5.1	-7999.00	20.66
09/23/07 15:00	113	Yorktown	1	266	0.2	5.2	15.6	-7999.00	37.06
09/23/07 16:00	114	Yorktown	1	266	0.4	3.9	12.2	7999.00	44.91
09/23/07 17:00	115	Yorktown	1	266	1.0	7.0	15.6	7999.00	43.53
09/23/07 18:00	116	Yorktown	1	266	0.4	3.3	11.5	7999.00	41.49
09/23/07 19:00	117	Yorktown	1	266	0.4	2.3	7.5	7999.00	40.58
09/23/07 20:00	118	Yorktown	1	266	0.3	2.5	9.8	7999.00	43.64
09/23/07 21:00	119	Yorktown	1	266	0.2	2.3	7.2	-7999.00	46.75
09/23/07 22:00	120	Yorktown	1	266	0.2	2.3	5.8	7999.00	50.22
09/23/07 23:00	121	Yorktown	1	266	0.4	2.4	12.2	-7999.00	50.82
09/24/07 0:00	122	Yorktown	2	267	1.5	6.5	15.9	-7999.00	47.23
09/24/07 1:00	123	Yorktown	2	267	1.0	6.8	13.5	-7999.00	32.47
09/24/07 2:00	124	Yorktown	2	267	0.1	4.0	13.5	-7999.00	29.06
09/24/07 3:00	125	Yorktown	2	267	0.0	2.5	6.8	-7999.00	0.19
09/24/07 4:00	126	Yorktown	2	267	0.0	1.8	2.1	-7999.00	0.02
09/24/07 5:00	127	Yorktown	2	267	0.0	1.8	2.1	-7999.00	0.02
09/24/07 6:00	128	Yorktown	2	267	0.0	1.3	2.1	-7999.00	0.02
09/24/07 7:00	129	Yorktown	2	267	0.0	1.5	5.8	7999.00	0.02
09/24/07 8:00	130	Yorktown	2	267	0.0	1.4	10.5	7999.00	0.02
09/24/07 9:00	131	Yorktown	2	267	0.0	1.0	2.1	-7999.00	0.02
09/24/07 10:00	132	Yorktown	2	267	0.0	0.7	1.8	-7999.00	0.01
09/24/07 11:00	133	Yorktown	2	267	0.0	0.5	1.5	7999.00	0.01
09/24/07 12:00	134	Yorktown	2	267	0.0	0.4	1.5	-7999.00	0.01
09/24/07 13:00	135	Yorktown	2	267	0.0	0.3	1.5	-7999.00	0.01
09/24/07 14:00	136	Yorktown	2	267	0.0	0.2	1.5	-7999.00	19.23
09/24/07 15:00	137	Yorktown	2	267	0.1	1.2	2.1	-7999.00	34.44
09/24/07 16:00	138	Yorktown	2	267	0.4	2.0	2.1	7999.00	43.02
09/24/07 17:00	139	Yorktown	2	267	1.0	2.0	2.5	-7999.00	42.40
09/24/07 18:00	140	Yorktown	2	267	0.4	2.2	6.5	7999.00	44.58
09/24/07 19:00	141	Yorktown	2	267	0.4	4.9	14.5	7999.00	48.95
09/24/07 20:00	142	Yorktown	2	267	0.3	7.6	16.2	-7999.00	51.27
09/24/07 21:00	143	Yorktown	2	267	0.2	5.3	13.2	7999.00	51.61
09/24/07 22:00	144	Yorktown	2	267	0.2	5.4	13.9	7999.00	50.29

TIMESTAMP (GMT) Time	Record #	LoggerID Sample	Day Of Week Sun=1 Sample	JulianDay Sample	Voltage Battery volts Average Battery Voltage	Current PV amps Average	Current Wind Turbine amps Average	Current Wind Turbine amps Max	Current Battery amps Average
09/22/07 18:00	92	Yorktown	7	265	26.82	109.20	0.00	0.00	91.10
09/22/07 19:00	93	Yorktown	7	265	28.74	98.50	0.00	0.00	80.10
09/22/07 20:00	94	Yorktown	7	265	28.86	64.50	0.00	0.00	46.32
09/22/07 21:00	95	Yorktown	7	265	27.61	66.28	0.00	0.00	26.23
09/22/07 22:00	96	Yorktown	7	265	26.65	54.76	0.00	0.00	11.15
09/22/07 23:00	97	Yorktown	7	265	25.54	24.42	0.00	0.00	-10.26
09/23/07 0:00	98	Yorktown	1	266	26.00	22.46	0.00	0.00	6.54
09/23/07 1:00	99	Yorktown	1	266	25.35	3.25	0.00	0.00	-11.84
09/23/07 2:00	100	Yorktown	1	266	25.28	1.48	0.00	0.00	-13.69
09/23/07 3:00	101	Yorktown	1	266	25.23	-0.27	0.00	0.00	-15.35
09/23/07 4:00	102	Yorktown	1	266	25.19	-0.27	0.00	0.00	-15.48
09/23/07 5:00	103	Yorktown	1	266	25.11	-0.27	0.00	0.00	-20.08
09/23/07 6:00	104	Yorktown	1	266	25.02	-0.27	0.00	0.00	-24.13
09/23/07 7:00	105	Yorktown	1	266	24.94	-0.27	0.00	0.00	-26.95
09/23/07 8:00	106	Yorktown	1	266	24.90	-0.27	0.00	0.00	-24.49
09/23/07 9:00	107	Yorktown	1	266	24.81	-0.27	0.00	0.00	-29.19
09/23/07 10:00	108	Yorktown	1	266	24.72	-0.27	0.00	0.00	-31.94
09/23/07 11:00	109	Yorktown	1	266	24.63	-0.27	0.00	0.00	-36.67
09/23/07 12:00	110	Yorktown	1	266	24.66	-0.27	0.00	0.00	-26.38
09/23/07 13:00	111	Yorktown	1	266	24.58	-0.27	0.00	0.00	-32.00
09/23/07 14:00	112	Yorktown	1	266	24.60	0.10	0.00	0.00	-25.74
09/23/07 15:00	113	Yorktown	1	266	24.61	11.81	0.00	0.00	-20.07
09/23/07 16:00	114	Yorktown	1	266	25.06	50.79	0.00	0.00	19.84
09/23/07 17:00	115	Yorktown	1	266	25.72	91.60	0.00	0.00	56.88
09/23/07 18:00	116	Yorktown	1	266	26.37	115.60	0.00	0.00	93.70
09/23/07 19:00	117	Yorktown	1	266	27.76	118.50	0.00	0.00	102.80
09/23/07 20:00	118	Yorktown	1	266	28.84	97.80	0.00	0.00	67.95
09/23/07 21:00	119	Yorktown	1	266	28.20	75.70	0.00	0.00	37.48
09/23/07 22:00	120	Yorktown	1	266	27.07	60.22	0.00	0.00	21.05
09/23/07 23:00	121	Yorktown	1	266	27.06	55.65	0.00	0.00	16.59
09/24/07 0:00	122	Yorktown	2	267	27.34	48.75	0.00	0.00	15.02
09/24/07 1:00	123	Yorktown	2	267	27.38	22.13	0.00	0.00	11.13
09/24/07 2:00	124	Yorktown	2	267	25.37	2.66	0.00	0.00	-27.94
09/24/07 3:00	125	Yorktown	2	267	25.41	-0.27	0.00	0.00	-10.71
09/24/07 4:00	126	Yorktown	2	267	25.29	-0.27	0.00	0.00	-18.00
09/24/07 5:00	127	Yorktown	2	267	25.30	-0.27	0.00	0.00	-12.22
09/24/07 6:00	128	Yorktown	2	267	25.28	-0.27	0.00	0.00	-10.82
09/24/07 7:00	129	Yorktown	2	267	25.22	-0.27	0.00	0.00	-13.81
09/24/07 8:00	130	Yorktown	2	267	25.18	-0.27	0.00	0.00	-14.57
09/24/07 9:00	131	Yorktown	2	267	25.17	-0.27	0.00	0.00	-10.99
09/24/07 10:00	132	Yorktown	2	267	25.14	-0.27	0.00	0.00	-11.32
09/24/07 11:00	133	Yorktown	2	267	24.98	-0.27	0.00	0.00	-26.47
09/24/07 12:00	134	Yorktown	2	267	25.02	-0.27	0.00	0.00	-18.41
09/24/07 13:00	135	Yorktown	2	267	24.94	-0.27	0.00	0.00	-22.89
09/24/07 14:00	136	Yorktown	2	267	24.94	-0.02	0.00	0.00	-17.32
09/24/07 15:00	137	Yorktown	2	267	24.93	11.22	0.00	0.00	-16.39
09/24/07 16:00	138	Yorktown	2	267	25.21	46.37	0.00	0.00	9.90
09/24/07 17:00	139	Yorktown	2	267	26.45	83.60	0.00	0.00	71.93
09/24/07 18:00	140	Yorktown	2	267	28.51	86.10	0.00	0.00	75.26
09/24/07 19:00	141	Yorktown	2	267	28.85	54.25	0.00	0.00	43.89
09/24/07 20:00	142	Yorktown	2	267	27.61	36.01	0.00	0.00	25.78
09/24/07 21:00	143	Yorktown	2	267	27.05	26.45	0.00	0.00	16.67
09/24/07 22:00	144	Yorktown	2	267	27.05	32.54	0.00	0.00	12.92

TIMESTAMP (GMT) Time	Record #	LoggerID Sample	Day Of Week Sun=1 Sample	JulianDay Sample	Power PV kW Average	Power Wind Turbine kW Average	Power Battery kW Average	Power Generator kW Average	Power Load kW Average Load (kW)
09/22/07 18:00	92	Yorktown	7	265	2.929	0.000	2.444	0.000	0.173
09/22/07 19:00	93	Yorktown	7	265	2.827	0.000	2.298	0.000	0.177
09/22/07 20:00	94	Yorktown	7	265	1.861	0.000	1.337	0.000	0.178
09/22/07 21:00	95	Yorktown	7	265	1.825	0.000	0.728	0.000	0.733
09/22/07 22:00	96	Yorktown	7	265	1.468	0.000	0.306	0.000	0.825
09/22/07 23:00	97	Yorktown	7	265	0.626	0.000	-0.257	0.000	0.615
09/23/07 0:00	98	Yorktown	1	266	0.591	0.000	0.177	0.000	0.163
09/23/07 1:00	99	Yorktown	1	266	0.083	0.000	-0.300	0.000	0.165
09/23/07 2:00	100	Yorktown	1	266	0.037	0.000	-0.346	0.000	0.170
09/23/07 3:00	101	Yorktown	1	266	-0.007	0.000	-0.387	0.000	0.170
09/23/07 4:00	102	Yorktown	1	266	-0.007	0.000	-0.390	0.000	0.173
09/23/07 5:00	103	Yorktown	1	266	-0.007	0.000	-0.503	0.000	0.278
09/23/07 6:00	104	Yorktown	1	266	-0.007	0.000	-0.603	0.000	0.372
09/23/07 7:00	105	Yorktown	1	266	-0.007	0.000	-0.671	0.000	0.436
09/23/07 8:00	106	Yorktown	1	266	-0.007	0.000	-0.609	0.000	0.382
09/23/07 9:00	107	Yorktown	1	266	-0.007	0.000	-0.724	0.000	0.487
09/23/07 10:00	108	Yorktown	1	266	-0.007	0.000	-0.789	0.000	0.551
09/23/07 11:00	109	Yorktown	1	266	-0.007	0.000	-0.902	0.000	0.656
09/23/07 12:00	110	Yorktown	1	266	-0.007	0.000	-0.649	0.000	0.516
09/23/07 13:00	111	Yorktown	1	266	-0.007	0.000	-0.785	0.000	0.650
09/23/07 14:00	112	Yorktown	1	266	0.002	0.000	-0.631	0.000	0.518
09/23/07 15:00	113	Yorktown	1	266	0.291	0.000	-0.491	0.000	0.654
09/23/07 16:00	114	Yorktown	1	266	1.274	0.000	0.499	0.000	0.624
09/23/07 17:00	115	Yorktown	1	266	2.357	0.000	1.466	0.000	0.611
09/23/07 18:00	116	Yorktown	1	266	3.049	0.000	2.473	0.000	0.262
09/23/07 19:00	117	Yorktown	1	266	3.284	0.000	2.852	0.000	0.176
09/23/07 20:00	118	Yorktown	1	266	2.819	0.000	1.960	0.000	0.659
09/23/07 21:00	119	Yorktown	1	266	2.139	0.000	1.063	0.000	0.854
09/23/07 22:00	120	Yorktown	1	266	1.630	0.000	0.570	0.000	0.855
09/23/07 23:00	121	Yorktown	1	266	1.506	0.000	0.449	0.000	0.861
09/24/07 0:00	122	Yorktown	2	267	1.328	0.000	0.413	0.000	0.730
09/24/07 1:00	123	Yorktown	2	267	0.616	0.000	0.314	0.000	0.177
09/24/07 2:00	124	Yorktown	2	267	0.068	0.000	-0.706	0.000	0.639
09/24/07 3:00	125	Yorktown	2	267	-0.007	0.000	-0.272	0.000	0.164
09/24/07 4:00	126	Yorktown	2	267	-0.007	0.000	-0.455	0.000	0.345
09/24/07 5:00	127	Yorktown	2	267	-0.007	0.000	-0.309	0.000	0.209
09/24/07 6:00	128	Yorktown	2	267	-0.007	0.000	-0.273	0.000	0.185
09/24/07 7:00	129	Yorktown	2	267	-0.007	0.000	-0.348	0.000	0.253
09/24/07 8:00	130	Yorktown	2	267	-0.007	0.000	-0.366	0.000	0.268
09/24/07 9:00	131	Yorktown	2	267	-0.007	0.000	-0.277	0.000	0.191
09/24/07 10:00	132	Yorktown	2	267	-0.007	0.000	-0.285	0.000	0.195
09/24/07 11:00	133	Yorktown	2	267	-0.007	0.000	-0.659	0.000	0.539
09/24/07 12:00	134	Yorktown	2	267	-0.007	0.000	-0.459	0.000	0.349
09/24/07 13:00	135	Yorktown	2	267	-0.007	0.000	-0.569	0.000	0.456
09/24/07 14:00	136	Yorktown	2	267	0.000	0.000	-0.431	0.000	0.314
09/24/07 15:00	137	Yorktown	2	267	0.280	0.000	-0.406	0.000	0.510
09/24/07 16:00	138	Yorktown	2	267	1.173	0.000	0.260	0.000	0.706
09/24/07 17:00	139	Yorktown	2	267	2.215	0.000	1.906	0.000	0.164
09/24/07 18:00	140	Yorktown	2	267	2.448	0.000	2.140	0.000	0.162
09/24/07 19:00	141	Yorktown	2	267	1.565	0.000	1.266	0.000	0.165
09/24/07 20:00	142	Yorktown	2	267	0.998	0.000	0.716	0.000	0.160
09/24/07 21:00	143	Yorktown	2	267	0.716	0.000	0.451	0.000	0.150
09/24/07 22:00	144	Yorktown	2	267	0.880	0.000	0.349	0.000	0.394

TIMESTAMP (GMT) Time	Record #	LoggerID Sample	Day Of Week Sun=1 Sample	JulianDay Sample	Flow Fuel Supply gal Total	Flow Fuel Return gal Total	Flow Fuel Use gal Total	Time GPS hhmmss Sample	Latitude GPS deg Sample
09/22/07 18:00	92	Yorktown	7	265	0	0	0	180116	35
09/22/07 19:00	93	Yorktown	7	265	0	0	0	190116	35
09/22/07 20:00	94	Yorktown	7	265	0	0	0	200116	35
09/22/07 21:00	95	Yorktown	7	265	0	0	0	210116	35
09/22/07 22:00	96	Yorktown	7	265	0	0	0	220116	35
09/22/07 23:00	97	Yorktown	7	265	0	0	0	230116	35
09/23/07 0:00	98	Yorktown	1	266	0	0	0	116	35
09/23/07 1:00	99	Yorktown	1	266	0	0	0	10116	35
09/23/07 2:00	100	Yorktown	1	266	0	0	0	20116	35
09/23/07 3:00	101	Yorktown	1	266	0	0	0	30116	35
09/23/07 4:00	102	Yorktown	1	266	0	0	0	40116	35
09/23/07 5:00	103	Yorktown	1	266	0	0	0	50116	35
09/23/07 6:00	104	Yorktown	1	266	0	0	0	60116	35
09/23/07 7:00	105	Yorktown	1	266	0	0	0	70116	35
09/23/07 8:00	106	Yorktown	1	266	0	0	0	80116	35
09/23/07 9:00	107	Yorktown	1	266	0	0	0	90116	35
09/23/07 10:00	108	Yorktown	1	266	0	0	0	100116	35
09/23/07 11:00	109	Yorktown	1	266	0	0	0	110116	35
09/23/07 12:00	110	Yorktown	1	266	0	0	0	120116	35
09/23/07 13:00	111	Yorktown	1	266	0	0	0	130116	35
09/23/07 14:00	112	Yorktown	1	266	0	0	0	140116	35
09/23/07 15:00	113	Yorktown	1	266	0	0	0	150116	35
09/23/07 16:00	114	Yorktown	1	266	0	0	0	160116	35
09/23/07 17:00	115	Yorktown	1	266	0	0	0	170116	35
09/23/07 18:00	116	Yorktown	1	266	0	0	0	180116	35
09/23/07 19:00	117	Yorktown	1	266	0	0	0	190116	35
09/23/07 20:00	118	Yorktown	1	266	0	0	0	200116	35
09/23/07 21:00	119	Yorktown	1	266	0	0	0	210116	35
09/23/07 22:00	120	Yorktown	1	266	0	0	0	220116	35
09/23/07 23:00	121	Yorktown	1	266	0	0	0	230116	35
09/24/07 0:00	122	Yorktown	2	267	0	0	0	116	35
09/24/07 1:00	123	Yorktown	2	267	0	0	0	10116	35
09/24/07 2:00	124	Yorktown	2	267	0	0	0	20116	35
09/24/07 3:00	125	Yorktown	2	267	0	0	0	30116	35
09/24/07 4:00	126	Yorktown	2	267	0	0	0	40116	35
09/24/07 5:00	127	Yorktown	2	267	0	0	0	50116	35
09/24/07 6:00	128	Yorktown	2	267	0	0	0	60116	35
09/24/07 7:00	129	Yorktown	2	267	0	0	0	70116	35
09/24/07 8:00	130	Yorktown	2	267	0	0	0	80116	35
09/24/07 9:00	131	Yorktown	2	267	0	0	0	90116	35
09/24/07 10:00	132	Yorktown	2	267	0	0	0	100116	35
09/24/07 11:00	133	Yorktown	2	267	0	0	0	110116	35
09/24/07 12:00	134	Yorktown	2	267	0	0	0	120116	35
09/24/07 13:00	135	Yorktown	2	267	0	0	0	130116	35
09/24/07 14:00	136	Yorktown	2	267	0	0	0	140116	35
09/24/07 15:00	137	Yorktown	2	267	0	0	0	150116	35
09/24/07 16:00	138	Yorktown	2	267	0	0	0	160116	35
09/24/07 17:00	139	Yorktown	2	267	0	0	0	170116	35
09/24/07 18:00	140	Yorktown	2	267	0	0	0	180116	35
09/24/07 19:00	141	Yorktown	2	267	0	0	0	190116	35
09/24/07 20:00	142	Yorktown	2	267	0	0	0	200116	35
09/24/07 21:00	143	Yorktown	2	267	0	0	0	210116	35
09/24/07 22:00	144	Yorktown	2	267	0	0	0	220116	35

TIMESTAMP (GMT) Time	Record #	LoggerID Sample	Day Of Week Sun=1 Sample	JulianDay Sample	Latitude GPS min Sample	Latitude GPS sec Sample	N-S Hemisphere GPS Sample	Longitude GPS deg Sample	Longitude GPS min Sample
09/22/07 18:00	92	Yorktown	7	265	15	5.226	N	116	24.00
09/22/07 19:00	93	Yorktown	7	265	15	5.286	N	116	24.00
09/22/07 20:00	94	Yorktown	7	265	15	5.292	N	116	24.00
09/22/07 21:00	95	Yorktown	7	265	15	5.232	N	116	24.00
09/22/07 22:00	96	Yorktown	7	265	15	5.256	N	116	24.00
09/22/07 23:00	97	Yorktown	7	265	15	5.274	N	116	24.00
09/23/07 0:00	98	Yorktown	1	266	15	5.418	N	116	24.00
09/23/07 1:00	99	Yorktown	1	266	15	5.07	N	116	24.00
09/23/07 2:00	100	Yorktown	1	266	15	4.974	N	116	24.00
09/23/07 3:00	101	Yorktown	1	266	15	5.274	N	116	24.00
09/23/07 4:00	102	Yorktown	1	266	15	5.244	N	116	24.00
09/23/07 5:00	103	Yorktown	1	266	15	5.286	N	116	24.00
09/23/07 6:00	104	Yorktown	1	266	15	5.244	N	116	24.00
09/23/07 7:00	105	Yorktown	1	266	15	5.328	N	116	24.00
09/23/07 8:00	106	Yorktown	1	266	15	5.256	N	116	24.00
09/23/07 9:00	107	Yorktown	1	266	15	5.298	N	116	24.00
09/23/07 10:00	108	Yorktown	1	266	15	5.28	N	116	24.00
09/23/07 11:00	109	Yorktown	1	266	15	5.334	N	116	24.00
09/23/07 12:00	110	Yorktown	1	266	15	5.208	N	116	24.00
09/23/07 13:00	111	Yorktown	1	266	15	5.232	N	116	24.00
09/23/07 14:00	112	Yorktown	1	266	15	5.352	N	116	24.00
09/23/07 15:00	113	Yorktown	1	266	15	5.334	N	116	24.00
09/23/07 16:00	114	Yorktown	1	266	15	5.256	N	116	24.00
09/23/07 17:00	115	Yorktown	1	266	15	5.346	N	116	24.00
09/23/07 18:00	116	Yorktown	1	266	15	5.256	N	116	24.00
09/23/07 19:00	117	Yorktown	1	266	15	5.262	N	116	24.00
09/23/07 20:00	118	Yorktown	1	266	15	5.394	N	116	24.00
09/23/07 21:00	119	Yorktown	1	266	15	5.196	N	116	24.00
09/23/07 22:00	120	Yorktown	1	266	15	5.322	N	116	24.00
09/23/07 23:00	121	Yorktown	1	266	15	5.31	N	116	24.00
09/24/07 0:00	122	Yorktown	2	267	15	5.31	N	116	24.00
09/24/07 1:00	123	Yorktown	2	267	15	5.124	N	116	24.00
09/24/07 2:00	124	Yorktown	2	267	15	5.112	N	116	24.00
09/24/07 3:00	125	Yorktown	2	267	15	5.346	N	116	24.00
09/24/07 4:00	126	Yorktown	2	267	15	5.226	N	116	24.00
09/24/07 5:00	127	Yorktown	2	267	15	5.226	N	116	24.00
09/24/07 6:00	128	Yorktown	2	267	15	5.244	N	116	24.00
09/24/07 7:00	129	Yorktown	2	267	15	5.25	N	116	24.00
09/24/07 8:00	130	Yorktown	2	267	15	5.274	N	116	24.00
09/24/07 9:00	131	Yorktown	2	267	15	5.232	N	116	24.00
09/24/07 10:00	132	Yorktown	2	267	15	5.304	N	116	24.00
09/24/07 11:00	133	Yorktown	2	267	15	5.28	N	116	24.00
09/24/07 12:00	134	Yorktown	2	267	15	5.184	N	116	24.00
09/24/07 13:00	135	Yorktown	2	267	15	5.184	N	116	24.00
09/24/07 14:00	136	Yorktown	2	267	15	5.244	N	116	24.00
09/24/07 15:00	137	Yorktown	2	267	15	5.37	N	116	24.00
09/24/07 16:00	138	Yorktown	2	267	15	5.316	N	116	24.00
09/24/07 17:00	139	Yorktown	2	267	15	5.334	N	116	24.00
09/24/07 18:00	140	Yorktown	2	267	15	5.232	N	116	24.00
09/24/07 19:00	141	Yorktown	2	267	15	5.286	N	116	24.00
09/24/07 20:00	142	Yorktown	2	267	15	5.328	N	116	24.00
09/24/07 21:00	143	Yorktown	2	267	15	5.208	N	116	24.00
09/24/07 22:00	144	Yorktown	2	267	15	5.268	N	116	24.00

TIMESTAMP (GMT) Time	Record #	LoggerID Sample	Day Of Week Sun=1 Sample	JulianDay Sample	Longitude GPS sec Sample	E-W Hemisphere GPS Sample	Altitude GPS meters Sample	Received String GPS Sample	Temperature Logger Panel meters Average	Voltage Logger Battery volts Average
09/22/07 18:00	92	Yorktown	7	265	13.40	W	487.60	GPGGA,1	80.60	13.13
09/22/07 19:00	93	Yorktown	7	265	13.42	W	491.60	GPGGA,1	82.70	13.17
09/22/07 20:00	94	Yorktown	7	265	13.45	W	489.40	GPGGA,2	84.20	13.13
09/22/07 21:00	95	Yorktown	7	265	13.38	W	486.50	GPGGA,2	85.40	13.15
09/22/07 22:00	96	Yorktown	7	265	13.44	W	491.40	GPGGA,2	84.60	13.13
09/22/07 23:00	97	Yorktown	7	265	13.40	W	488.70	GPGGA,2	83.90	13.16
09/23/07 0:00	98	Yorktown	1	266	13.26	W	485.60	GPGGA,0	83.40	13.14
09/23/07 1:00	99	Yorktown	1	266	13.25	W	486.50	GPGGA,0	83.30	13.18
09/23/07 2:00	100	Yorktown	1	266	13.52	W	503.00	GPGGA,0	83.00	13.14
09/23/07 3:00	101	Yorktown	1	266	13.33	W	491.90	GPGGA,0	82.70	13.16
09/23/07 4:00	102	Yorktown	1	266	13.33	W	492.00	GPGGA,0	81.90	13.18
09/23/07 5:00	103	Yorktown	1	266	13.42	W	488.20	GPGGA,0	81.00	13.16
09/23/07 6:00	104	Yorktown	1	266	13.45	W	489.70	GPGGA,0	80.20	13.21
09/23/07 7:00	105	Yorktown	1	266	13.46	W	488.30	GPGGA,0	79.58	13.18
09/23/07 8:00	106	Yorktown	1	266	13.39	W	493.20	GPGGA,0	79.34	13.22
09/23/07 9:00	107	Yorktown	1	266	13.46	W	483.50	GPGGA,0	79.34	13.17
09/23/07 10:00	108	Yorktown	1	266	13.37	W	489.40	GPGGA,1	79.14	13.21
09/23/07 11:00	109	Yorktown	1	266	13.38	W	487.60	GPGGA,1	79.39	13.19
09/23/07 12:00	110	Yorktown	1	266	13.34	W	488.00	GPGGA,1	80.50	13.17
09/23/07 13:00	111	Yorktown	1	266	13.30	W	493.50	GPGGA,1	82.80	13.19
09/23/07 14:00	112	Yorktown	1	266	13.36	W	487.60	GPGGA,1	82.60	13.15
09/23/07 15:00	113	Yorktown	1	266	13.39	W	487.10	GPGGA,1	82.80	13.18
09/23/07 16:00	114	Yorktown	1	266	13.36	W	492.90	GPGGA,1	84.00	13.13
09/23/07 17:00	115	Yorktown	1	266	13.43	W	486.50	GPGGA,1	85.40	13.16
09/23/07 18:00	116	Yorktown	1	266	13.43	W	486.10	GPGGA,1	86.80	13.10
09/23/07 19:00	117	Yorktown	1	266	13.38	W	491.00	GPGGA,1	86.60	13.15
09/23/07 20:00	118	Yorktown	1	266	13.35	W	488.90	GPGGA,2	86.80	13.09
09/23/07 21:00	119	Yorktown	1	266	13.40	W	490.90	GPGGA,2	85.70	13.15
09/23/07 22:00	120	Yorktown	1	266	13.38	W	489.90	GPGGA,2	83.90	13.12
09/23/07 23:00	121	Yorktown	1	266	13.41	W	488.50	GPGGA,2	82.50	13.18
09/24/07 0:00	122	Yorktown	2	267	13.43	W	491.50	GPGGA,0	81.30	13.14
09/24/07 1:00	123	Yorktown	2	267	13.29	W	486.50	GPGGA,0	81.70	13.19
09/24/07 2:00	124	Yorktown	2	267	13.25	W	496.10	GPGGA,0	83.10	13.14
09/24/07 3:00	125	Yorktown	2	267	13.43	W	493.00	GPGGA,0	82.30	13.15
09/24/07 4:00	126	Yorktown	2	267	13.37	W	493.80	GPGGA,0	81.80	13.19
09/24/07 5:00	127	Yorktown	2	267	13.45	W	490.60	GPGGA,0	81.00	13.15
09/24/07 6:00	128	Yorktown	2	267	13.34	W	487.30	GPGGA,0	80.30	13.21
09/24/07 7:00	129	Yorktown	2	267	13.32	W	492.40	GPGGA,0	79.98	13.16
09/24/07 8:00	130	Yorktown	2	267	13.25	W	492.30	GPGGA,0	79.17	13.18
09/24/07 9:00	131	Yorktown	2	267	13.39	W	485.20	GPGGA,0	78.79	13.21
09/24/07 10:00	132	Yorktown	2	267	13.48	W	488.20	GPGGA,1	78.37	13.18
09/24/07 11:00	133	Yorktown	2	267	13.40	W	491.10	GPGGA,1	78.00	13.23
09/24/07 12:00	134	Yorktown	2	267	13.46	W	486.40	GPGGA,1	78.52	13.18
09/24/07 13:00	135	Yorktown	2	267	13.26	W	494.60	GPGGA,1	78.66	13.21
09/24/07 14:00	136	Yorktown	2	267	13.42	W	487.40	GPGGA,1	78.95	13.19
09/24/07 15:00	137	Yorktown	2	267	13.34	W	491.90	GPGGA,1	78.28	13.22
09/24/07 16:00	138	Yorktown	2	267	13.42	W	488.20	GPGGA,1	78.19	13.19
09/24/07 17:00	139	Yorktown	2	267	13.29	W	487.30	GPGGA,1	79.01	13.21
09/24/07 18:00	140	Yorktown	2	267	13.45	W	486.10	GPGGA,1	80.70	13.16
09/24/07 19:00	141	Yorktown	2	267	13.30	W	490.90	GPGGA,1	82.70	13.17
09/24/07 20:00	142	Yorktown	2	267	13.33	W	488.00	GPGGA,2	84.80	13.13
09/24/07 21:00	143	Yorktown	2	267	13.47	W	491.20	GPGGA,2	86.20	13.14
09/24/07 22:00	144	Yorktown	2	267	13.37	W	491.40	GPGGA,2	87.60	13.11

TIMESTAMP (GMT) Time	Record #	LoggerID Sample	Day Of Week Sun=1 Sample	JulianDay Sample	Solar Radiation Horizontal W/m2 Average	Speed Wind mph Average	Speed Wind mph Max	Temperature PV deg F Average	Voltage PV volts Average
09/24/07 23:00	145	Yorktown	2	267	0.4	3.8	11.5	-7999.00	48.49
09/25/07 0:00	146	Yorktown	3	268	1.7	3.1	10.9	-7999.00	48.73
09/25/07 1:00	147	Yorktown	3	268	1.3	2.2	4.8	-7999.00	42.81
09/25/07 2:00	148	Yorktown	3	268	0.0	2.4	5.8	-7999.00	30.44
09/25/07 3:00	149	Yorktown	3	268	0.0	2.7	9.5	7999.00	0.15
09/25/07 4:00	150	Yorktown	3	268	0.0	4.3	8.5	7999.00	0.03
09/25/07 5:00	151	Yorktown	3	268	0.0	3.0	9.5	7999.00	0.02
09/25/07 6:00	152	Yorktown	3	268	0.0	1.9	3.8	-7999.00	0.03
09/25/07 7:00	153	Yorktown	3	268	0.0	1.7	3.1	-7999.00	0.03
09/25/07 8:00	154	Yorktown	3	268	0.0	1.3	2.8	-7999.00	0.02
09/25/07 9:00	155	Yorktown	3	268	0.0	1.5	3.5	7999.00	0.02
09/25/07 10:00	156	Yorktown	3	268	0.0	0.9	2.1	7999.00	0.02
09/25/07 11:00	157	Yorktown	3	268	0.0	1.6	5.1	7999.00	0.01
09/25/07 12:00	158	Yorktown	3	268	0.0	1.2	5.1	7999.00	0.01
09/25/07 13:00	159	Yorktown	3	268	0.0	2.1	5.5	7999.00	0.01
09/25/07 14:00	160	Yorktown	3	268	0.1	1.5	4.1	7999.00	19.50
09/25/07 15:00	161	Yorktown	3	268	0.2	2.8	6.5	7999.00	35.12
09/25/07 16:00	162	Yorktown	3	268	0.4	2.3	6.2	7999.00	42.34
09/25/07 17:00	163	Yorktown	3	268	1.1	2.4	6.2	7999.00	42.43
09/25/07 18:00	164	Yorktown	3	268	0.4	3.6	9.2	-7999.00	40.23
09/25/07 19:00	165	Yorktown	3	268	0.3	3.8	10.5	-7999.00	40.63
09/25/07 20:00	166	Yorktown	3	268	0.2	2.8	9.2	-7999.00	45.60
09/25/07 21:00	167	Yorktown	3	268	0.2	2.9	11.5	-7999.00	48.33
09/25/07 22:00	168	Yorktown	3	268	0.2	3.1	13.2	7999.00	49.96
09/25/07 23:00	169	Yorktown	3	268	0.4	2.5	9.2	7999.00	49.58
09/26/07 0:00	170	Yorktown	4	269	1.7	2.4	9.8	7999.00	40.55
09/26/07 1:00	171	Yorktown	4	269	1.3	2.1	2.5	7999.00	41.72
09/26/07 2:00	172	Yorktown	4	269	0.0	2.1	2.5	7999.00	31.02
09/26/07 3:00	173	Yorktown	4	269	0.0	2.1	2.5	-7999.00	0.11
09/26/07 4:00	174	Yorktown	4	269	0.0	2.1	5.5	7999.00	0.02
09/26/07 5:00	175	Yorktown	4	269	0.0	2.1	3.1	-7999.00	0.03
09/26/07 6:00	176	Yorktown	4	269	0.0	1.8	2.1	-7999.00	0.03
09/26/07 7:00	177	Yorktown	4	269	0.0	1.4	2.1	-7999.00	0.04
09/26/07 8:00	178	Yorktown	4	269	0.0	0.8	2.1	-7999.00	0.04
09/26/07 9:00	179	Yorktown	4	269	0.0	1.1	2.1	7999.00	0.04
09/26/07 10:00	180	Yorktown	4	269	0.0	1.1	7.2	7999.00	0.03
09/26/07 11:00	181	Yorktown	4	269	0.0	2.4	8.2	7999.00	0.02
09/26/07 12:00	182	Yorktown	4	269	0.0	0.7	5.5	7999.00	0.02
09/26/07 13:00	183	Yorktown	4	269	0.0	0.9	7.5	7999.00	0.01
09/26/07 14:00	184	Yorktown	4	269	0.0	1.4	7.8	7999.00	18.58
09/26/07 15:00	185	Yorktown	4	269	0.2	1.8	5.1	7999.00	34.07
09/26/07 16:00	186	Yorktown	4	269	0.4	2.1	2.5	7999.00	42.33
09/26/07 17:00	187	Yorktown	4	269	1.2	2.1	2.5	7999.00	41.95
09/26/07 18:00	188	Yorktown	4	269	0.4	2.1	2.5	7999.00	41.17
09/26/07 19:00	189	Yorktown	4	269	0.3	2.1	2.5	7999.00	46.90
09/26/07 20:00	190	Yorktown	4	269	0.2	2.1	4.1	7999.00	46.73
09/26/07 21:00	191	Yorktown	4	269	0.2	2.3	7.5	7999.00	49.16
09/26/07 22:00	192	Yorktown	4	269	0.2	2.3	8.5	7999.00	49.38
09/26/07 23:00	193	Yorktown	4	269	0.4	2.5	11.2	7999.00	49.20
09/27/07 0:00	194	Yorktown	5	270	1.4	2.5	9.2	7999.00	47.16
09/27/07 1:00	195	Yorktown	5	270	1.0	2.2	7.2	7999.00	42.28
09/27/07 2:00	196	Yorktown	5	270	0.0	2.1	2.5	7999.00	28.63
09/27/07 3:00	197	Yorktown	5	270	0.0	2.1	2.5	7999.00	0.07

TIMESTAMP (GMT) Time	Record #	LoggerID Sample	Day Of Week Sun=1 Sample	JulianDay Sample	Voltage Battery volts Average Battery Voltage	Current PV amps Average	Current Wind Turbine amps Average	Current Wind Turbine amps Max	Current Battery amps Average
09/24/07 23:00	145	Yorktown	2	267	27.04	49.73	0.00	0.00	10.67
09/25/07 0:00	146	Yorktown	3	268	27.03	47.23	0.00	0.00	9.22
09/25/07 1:00	147	Yorktown	3	268	26.07	32.87	0.00	0.00	-5.63
09/25/07 2:00	148	Yorktown	3	268	25.27	2.60	0.00	0.00	-31.90
09/25/07 3:00	149	Yorktown	3	268	25.40	-0.27	0.00	0.00	-11.34
09/25/07 4:00	150	Yorktown	3	268	25.35	-0.27	0.00	0.00	-11.91
09/25/07 5:00	151	Yorktown	3	268	25.26	-0.27	0.00	0.00	-18.40
09/25/07 6:00	152	Yorktown	3	268	25.27	-0.27	0.00	0.00	-11.00
09/25/07 7:00	153	Yorktown	3	268	25.18	-0.27	0.00	0.00	-17.67
09/25/07 8:00	154	Yorktown	3	268	25.18	-0.27	0.00	0.00	-12.74
09/25/07 9:00	155	Yorktown	3	268	25.14	-0.27	0.00	0.00	-13.79
09/25/07 10:00	156	Yorktown	3	268	25.04	-0.27	0.00	0.00	-21.41
09/25/07 11:00	157	Yorktown	3	268	24.98	-0.27	0.00	0.00	-21.67
09/25/07 12:00	158	Yorktown	3	268	24.87	-0.27	0.00	0.00	-30.53
09/25/07 13:00	159	Yorktown	3	268	24.75	-0.27	0.00	0.00	-40.85
09/25/07 14:00	160	Yorktown	3	268	24.66	-0.02	0.00	0.00	-45.43
09/25/07 15:00	161	Yorktown	3	268	24.75	11.29	0.00	0.00	-27.15
09/25/07 16:00	162	Yorktown	3	268	25.06	49.90	0.00	0.00	9.66
09/25/07 17:00	163	Yorktown	3	268	26.13	86.50	0.00	0.00	75.22
09/25/07 18:00	164	Yorktown	3	268	26.72	112.50	0.00	0.00	90.60
09/25/07 19:00	165	Yorktown	3	268	28.23	110.80	0.00	0.00	73.99
09/25/07 20:00	166	Yorktown	3	268	28.74	79.90	0.00	0.00	42.63
09/25/07 21:00	167	Yorktown	3	268	27.82	63.72	0.00	0.00	25.29
09/25/07 22:00	168	Yorktown	3	268	27.07	57.48	0.00	0.00	15.79
09/25/07 23:00	169	Yorktown	3	268	27.05	51.81	0.00	0.00	11.95
09/26/07 0:00	170	Yorktown	4	269	27.05	50.51	0.00	0.00	9.54
09/26/07 1:00	171	Yorktown	4	269	25.94	33.71	0.00	0.00	-8.63
09/26/07 2:00	172	Yorktown	4	269	25.30	2.35	0.00	0.00	-30.36
09/26/07 3:00	173	Yorktown	4	269	25.43	-0.27	0.00	0.00	-10.97
09/26/07 4:00	174	Yorktown	4	269	25.37	-0.27	0.00	0.00	-13.02
09/26/07 5:00	175	Yorktown	4	269	25.33	-0.27	0.00	0.00	-13.05
09/26/07 6:00	176	Yorktown	4	269	25.29	-0.27	0.00	0.00	-13.51
09/26/07 7:00	177	Yorktown	4	269	25.24	-0.27	0.00	0.00	-13.95
09/26/07 8:00	178	Yorktown	4	269	25.20	-0.27	0.00	0.00	-14.34
09/26/07 9:00	179	Yorktown	4	269	25.19	-0.27	0.00	0.00	-11.63
09/26/07 10:00	180	Yorktown	4	269	25.15	-0.27	0.00	0.00	-12.68
09/26/07 11:00	181	Yorktown	4	269	25.06	-0.27	0.00	0.00	-20.29
09/26/07 12:00	182	Yorktown	4	269	24.99	-0.27	0.00	0.00	-23.62
09/26/07 13:00	183	Yorktown	4	269	24.86	-0.27	0.00	0.00	-34.59
09/26/07 14:00	184	Yorktown	4	269	24.82	-0.06	0.00	0.00	-29.87
09/26/07 15:00	185	Yorktown	4	269	24.87	10.88	0.00	0.00	-19.42
09/26/07 16:00	186	Yorktown	4	269	25.37	48.36	0.00	0.00	20.17
09/26/07 17:00	187	Yorktown	4	269	26.30	85.60	0.00	0.00	69.90
09/26/07 18:00	188	Yorktown	4	269	27.79	101.20	0.00	0.00	90.10
09/26/07 19:00	189	Yorktown	4	269	28.74	73.15	0.00	0.00	49.01
09/26/07 20:00	190	Yorktown	4	269	28.19	68.74	0.00	0.00	27.19
09/26/07 21:00	191	Yorktown	4	269	27.06	57.66	0.00	0.00	15.40
09/26/07 22:00	192	Yorktown	4	269	27.06	52.78	0.00	0.00	11.79
09/26/07 23:00	193	Yorktown	4	269	27.04	49.33	0.00	0.00	9.38
09/27/07 0:00	194	Yorktown	5	270	27.03	47.84	0.00	0.00	7.73
09/27/07 1:00	195	Yorktown	5	270	25.84	30.97	0.00	0.00	-10.62
09/27/07 2:00	196	Yorktown	5	270	25.23	2.12	0.00	0.00	-39.62
09/27/07 3:00	197	Yorktown	5	270	25.15	-0.27	0.00	0.00	-40.24

TIMESTAMP (GMT) Time	Record #	LoggerID Sample	Day Of Week Sun=1 Sample	JulianDay Sample	Power PV kW Average	Power Wind Turbine kW Average	Power Battery kW Average	Power Generator kW Average	Power Load kW Average Load (kW)
09/24/07 23:00	145	Yorktown	2	267	1.345	0.000	0.288	0.000	0.870
09/25/07 0:00	146	Yorktown	3	268	1.277	0.000	0.249	0.000	0.862
09/25/07 1:00	147	Yorktown	3	268	0.863	0.000	-0.140	0.000	0.839
09/25/07 2:00	148	Yorktown	3	268	0.066	0.000	-0.805	0.000	0.721
09/25/07 3:00	149	Yorktown	3	268	-0.007	0.000	-0.288	0.000	0.190
09/25/07 4:00	150	Yorktown	3	268	-0.007	0.000	-0.302	0.000	0.203
09/25/07 5:00	151	Yorktown	3	268	-0.007	0.000	-0.463	0.000	0.352
09/25/07 6:00	152	Yorktown	3	268	-0.007	0.000	-0.278	0.000	0.182
09/25/07 7:00	153	Yorktown	3	268	-0.007	0.000	-0.444	0.000	0.340
09/25/07 8:00	154	Yorktown	3	268	-0.007	0.000	-0.321	0.000	0.224
09/25/07 9:00	155	Yorktown	3	268	-0.007	0.000	-0.346	0.000	0.252
09/25/07 10:00	156	Yorktown	3	268	-0.007	0.000	-0.535	0.000	0.444
09/25/07 11:00	157	Yorktown	3	268	-0.007	0.000	-0.540	0.000	0.453
09/25/07 12:00	158	Yorktown	3	268	-0.007	0.000	-0.757	0.000	0.602
09/25/07 13:00	159	Yorktown	3	268	-0.007	0.000	-1.010	0.000	0.767
09/25/07 14:00	160	Yorktown	3	268	-0.001	0.000	-1.120	0.000	0.865
09/25/07 15:00	161	Yorktown	3	268	0.280	0.000	-0.669	0.000	0.698
09/25/07 16:00	162	Yorktown	3	268	1.254	0.000	0.250	0.000	0.746
09/25/07 17:00	163	Yorktown	3	268	2.263	0.000	1.967	0.000	0.161
09/25/07 18:00	164	Yorktown	3	268	3.006	0.000	2.420	0.000	0.418
09/25/07 19:00	165	Yorktown	3	268	3.123	0.000	2.083	0.000	0.822
09/25/07 20:00	166	Yorktown	3	268	2.296	0.000	1.225	0.000	0.859
09/25/07 21:00	167	Yorktown	3	268	1.777	0.000	0.708	0.000	0.868
09/25/07 22:00	168	Yorktown	3	268	1.556	0.000	0.428	0.000	0.931
09/25/07 23:00	169	Yorktown	3	268	1.401	0.000	0.323	0.000	0.886
09/26/07 0:00	170	Yorktown	4	269	1.366	0.000	0.258	0.000	0.892
09/26/07 1:00	171	Yorktown	4	269	0.881	0.000	-0.217	0.000	0.883
09/26/07 2:00	172	Yorktown	4	269	0.060	0.000	-0.767	0.000	0.683
09/26/07 3:00	173	Yorktown	4	269	-0.007	0.000	-0.279	0.000	0.182
09/26/07 4:00	174	Yorktown	4	269	-0.007	0.000	-0.330	0.000	0.229
09/26/07 5:00	175	Yorktown	4	269	-0.007	0.000	-0.330	0.000	0.230
09/26/07 6:00	176	Yorktown	4	269	-0.007	0.000	-0.342	0.000	0.239
09/26/07 7:00	177	Yorktown	4	269	-0.007	0.000	-0.352	0.000	0.251
09/26/07 8:00	178	Yorktown	4	269	-0.007	0.000	-0.361	0.000	0.238
09/26/07 9:00	179	Yorktown	4	269	-0.007	0.000	-0.293	0.000	0.205
09/26/07 10:00	180	Yorktown	4	269	-0.007	0.000	-0.319	0.000	0.189
09/26/07 11:00	181	Yorktown	4	269	-0.007	0.000	-0.507	0.000	0.398
09/26/07 12:00	182	Yorktown	4	269	-0.007	0.000	-0.589	0.000	0.451
09/26/07 13:00	183	Yorktown	4	269	-0.007	0.000	-0.858	0.000	0.611
09/26/07 14:00	184	Yorktown	4	269	-0.001	0.000	-0.739	0.000	0.508
09/26/07 15:00	185	Yorktown	4	269	0.271	0.000	-0.481	0.000	0.513
09/26/07 16:00	186	Yorktown	4	269	1.229	0.000	0.517	0.000	0.447
09/26/07 17:00	187	Yorktown	4	269	2.253	0.000	1.840	0.000	0.128
09/26/07 18:00	188	Yorktown	4	269	2.809	0.000	2.501	0.000	0.128
09/26/07 19:00	189	Yorktown	4	269	2.102	0.000	1.409	0.000	0.500
09/26/07 20:00	190	Yorktown	4	269	1.941	0.000	0.770	0.000	0.904
09/26/07 21:00	191	Yorktown	4	269	1.560	0.000	0.417	0.000	0.919
09/26/07 22:00	192	Yorktown	4	269	1.428	0.000	0.319	0.000	0.915
09/26/07 23:00	193	Yorktown	4	269	1.334	0.000	0.254	0.000	0.887
09/27/07 0:00	194	Yorktown	5	270	1.293	0.000	0.209	0.000	0.895
09/27/07 1:00	195	Yorktown	5	270	0.806	0.000	-0.269	0.000	0.911
09/27/07 2:00	196	Yorktown	5	270	0.054	0.000	-0.999	0.000	0.902
09/27/07 3:00	197	Yorktown	5	270	-0.007	0.000	-1.012	0.000	0.863

TIMESTAMP (GMT) Time	Record #	LoggerID Sample	Day Of Week Sun=1 Sample	JulianDay Sample	Flow Fuel Supply gal Total	Flow Fuel Return gal Total	Flow Fuel Use gal Total	Time GPS hhmmss Sample	Latitude GPS deg Sample
09/24/07 23:00	145	Yorktown	2	267	0	0	0	230116	35
09/25/07 0:00	146	Yorktown	3	268	0	0	0	116	35
09/25/07 1:00	147	Yorktown	3	268	0	0	0	10116	35
09/25/07 2:00	148	Yorktown	3	268	0	0	0	20116	35
09/25/07 3:00	149	Yorktown	3	268	0	0	0	30116	35
09/25/07 4:00	150	Yorktown	3	268	0	0	0	40116	35
09/25/07 5:00	151	Yorktown	3	268	0	0	0	50116	35
09/25/07 6:00	152	Yorktown	3	268	0	0	0	60116	35
09/25/07 7:00	153	Yorktown	3	268	0	0	0	70116	35
09/25/07 8:00	154	Yorktown	3	268	0	0	0	80116	35
09/25/07 9:00	155	Yorktown	3	268	0	0	0	90116	35
09/25/07 10:00	156	Yorktown	3	268	0	0	0	100116	35
09/25/07 11:00	157	Yorktown	3	268	0	0	0	110116	35
09/25/07 12:00	158	Yorktown	3	268	0	0	0	120116	35
09/25/07 13:00	159	Yorktown	3	268	0	0	0	130116	35
09/25/07 14:00	160	Yorktown	3	268	0	0	0	140116	35
09/25/07 15:00	161	Yorktown	3	268	0	0	0	150116	35
09/25/07 16:00	162	Yorktown	3	268	0	0	0	160116	35
09/25/07 17:00	163	Yorktown	3	268	0	0	0	170116	35
09/25/07 18:00	164	Yorktown	3	268	0	0	0	180116	35
09/25/07 19:00	165	Yorktown	3	268	0	0	0	190116	35
09/25/07 20:00	166	Yorktown	3	268	0	0	0	200116	35
09/25/07 21:00	167	Yorktown	3	268	0	0	0	210116	35
09/25/07 22:00	168	Yorktown	3	268	0	0	0	220116	35
09/25/07 23:00	169	Yorktown	3	268	0	0	0	230116	35
09/26/07 0:00	170	Yorktown	4	269	0	0	0	116	35
09/26/07 1:00	171	Yorktown	4	269	0	0	0	10116	35
09/26/07 2:00	172	Yorktown	4	269	0	0	0	20116	35
09/26/07 3:00	173	Yorktown	4	269	0	0	0	30116	35
09/26/07 4:00	174	Yorktown	4	269	0	0	0	40116	35
09/26/07 5:00	175	Yorktown	4	269	0	0	0	50116	35
09/26/07 6:00	176	Yorktown	4	269	0	0	0	60116	35
09/26/07 7:00	177	Yorktown	4	269	0	0	0	70116	35
09/26/07 8:00	178	Yorktown	4	269	0	0	0	80116	35
09/26/07 9:00	179	Yorktown	4	269	0	0	0	90116	35
09/26/07 10:00	180	Yorktown	4	269	0	0	0	100116	35
09/26/07 11:00	181	Yorktown	4	269	0	0	0	110116	35
09/26/07 12:00	182	Yorktown	4	269	0	0	0	120116	35
09/26/07 13:00	183	Yorktown	4	269	0	0	0	130116	35
09/26/07 14:00	184	Yorktown	4	269	0	0	0	140116	35
09/26/07 15:00	185	Yorktown	4	269	0	0	0	150116	35
09/26/07 16:00	186	Yorktown	4	269	0	0	0	160116	35
09/26/07 17:00	187	Yorktown	4	269	0	0	0	170116	35
09/26/07 18:00	188	Yorktown	4	269	0	0	0	180116	35
09/26/07 19:00	189	Yorktown	4	269	0	0	0	190116	35
09/26/07 20:00	190	Yorktown	4	269	0	0	0	200116	35
09/26/07 21:00	191	Yorktown	4	269	0	0	0	210116	35
09/26/07 22:00	192	Yorktown	4	269	0	0	0	220116	35
09/26/07 23:00	193	Yorktown	4	269	0	0	0	230116	35
09/27/07 0:00	194	Yorktown	5	270	0	0	0	116	35
09/27/07 1:00	195	Yorktown	5	270	0	0	0	10116	35
09/27/07 2:00	196	Yorktown	5	270	0	0	0	20116	35
09/27/07 3:00	197	Yorktown	5	270	0	0	0	30116	35

TIMESTAMP (GMT) Time	Record #	LoggerID Sample	Day Of Week Sun=1 Sample	JulianDay Sample	Latitude GPS min Sample	Latitude GPS sec Sample	N-S Hemisphere GPS Sample	Longitude GPS deg Sample	Longitude GPS min Sample
09/24/07 23:00	145	Yorktown	2	267	15	5.28	N	116	24.00
09/25/07 0:00	146	Yorktown	3	268	15	5.328	N	116	24.00
09/25/07 1:00	147	Yorktown	3	268	15	5.268	N	116	24.00
09/25/07 2:00	148	Yorktown	3	268	15	5.28	N	116	24.00
09/25/07 3:00	149	Yorktown	3	268	15	5.322	N	116	24.00
09/25/07 4:00	150	Yorktown	3	268	15	5.28	N	116	24.00
09/25/07 5:00	151	Yorktown	3	268	15	5.346	N	116	24.00
09/25/07 6:00	152	Yorktown	3	268	15	5.214	N	116	24.00
09/25/07 7:00	153	Yorktown	3	268	15	5.31	N	116	24.00
09/25/07 8:00	154	Yorktown	3	268	15	5.262	N	116	24.00
09/25/07 9:00	155	Yorktown	3	268	15	5.328	N	116	24.00
09/25/07 10:00	156	Yorktown	3	268	15	5.298	N	116	24.00
09/25/07 11:00	157	Yorktown	3	268	15	5.328	N	116	24.00
09/25/07 12:00	158	Yorktown	3	268	15	5.208	N	116	24.00
09/25/07 13:00	159	Yorktown	3	268	15	5.22	N	116	24.00
09/25/07 14:00	160	Yorktown	3	268	15	5.274	N	116	24.00
09/25/07 15:00	161	Yorktown	3	268	15	5.304	N	116	24.00
09/25/07 16:00	162	Yorktown	3	268	15	5.364	N	116	24.00
09/25/07 17:00	163	Yorktown	3	268	15	5.256	N	116	24.00
09/25/07 18:00	164	Yorktown	3	268	15	5.304	N	116	24.00
09/25/07 19:00	165	Yorktown	3	268	15	5.25	N	116	24.00
09/25/07 20:00	166	Yorktown	3	268	15	5.31	N	116	24.00
09/25/07 21:00	167	Yorktown	3	268	15	5.19	N	116	24.00
09/25/07 22:00	168	Yorktown	3	268	15	5.334	N	116	24.00
09/25/07 23:00	169	Yorktown	3	268	15	5.286	N	116	24.00
09/26/07 0:00	170	Yorktown	4	269	15	5.238	N	116	24.00
09/26/07 1:00	171	Yorktown	4	269	15	5.178	N	116	24.00
09/26/07 2:00	172	Yorktown	4	269	15	5.232	N	116	24.00
09/26/07 3:00	173	Yorktown	4	269	15	5.262	N	116	24.00
09/26/07 4:00	174	Yorktown	4	269	15	5.328	N	116	24.00
09/26/07 5:00	175	Yorktown	4	269	15	5.256	N	116	24.00
09/26/07 6:00	176	Yorktown	4	269	15	5.262	N	116	24.00
09/26/07 7:00	177	Yorktown	4	269	15	5.34	N	116	24.00
09/26/07 8:00	178	Yorktown	4	269	15	5.256	N	116	24.00
09/26/07 9:00	179	Yorktown	4	269	15	5.274	N	116	24.00
09/26/07 10:00	180	Yorktown	4	269	15	5.328	N	116	24.00
09/26/07 11:00	181	Yorktown	4	269	15	5.25	N	116	24.00
09/26/07 12:00	182	Yorktown	4	269	15	5.238	N	116	24.00
09/26/07 13:00	183	Yorktown	4	269	15	5.262	N	116	24.00
09/26/07 14:00	184	Yorktown	4	269	15	5.142	N	116	24.00
09/26/07 15:00	185	Yorktown	4	269	15	5.208	N	116	24.00
09/26/07 16:00	186	Yorktown	4	269	15	5.31	N	116	24.00
09/26/07 17:00	187	Yorktown	4	269	15	5.484	N	116	24.00
09/26/07 18:00	188	Yorktown	4	269	15	5.28	N	116	24.00
09/26/07 19:00	189	Yorktown	4	269	15	5.334	N	116	24.00
09/26/07 20:00	190	Yorktown	4	269	15	5.262	N	116	24.00
09/26/07 21:00	191	Yorktown	4	269	15	5.25	N	116	24.00
09/26/07 22:00	192	Yorktown	4	269	15	5.274	N	116	24.00
09/26/07 23:00	193	Yorktown	4	269	15	5.298	N	116	24.00
09/27/07 0:00	194	Yorktown	5	270	15	5.364	N	116	24.00
09/27/07 1:00	195	Yorktown	5	270	15	5.418	N	116	24.00
09/27/07 2:00	196	Yorktown	5	270	15	5.25	N	116	24.00
09/27/07 3:00	197	Yorktown	5	270	15	5.214	N	116	24.00

TIMESTAMP (GMT) Time	Record #	LoggerID Sample	Day Of Week Sun=1 Sample	JulianDay Sample	Longitude GPS sec Sample	E-W Hemisphere GPS Sample	Altitude GPS meters Sample	Received String GPS Sample	Temperature Logger Panel meters Average	Voltage Logger Battery volts Average
09/24/07 23:00	145	Yorktown	2	267	13.39	W	488.30	GPGGA,2	87.50	13.13
09/25/07 0:00	146	Yorktown	3	268	13.37	W	483.90	GPGGA,0	87.30	13.11
09/25/07 1:00	147	Yorktown	3	268	13.46	W	489.80	GPGGA,0	86.40	13.13
09/25/07 2:00	148	Yorktown	3	268	13.28	W	488.20	GPGGA,0	85.00	13.12
09/25/07 3:00	149	Yorktown	3	268	13.41	W	493.80	GPGGA,0	84.00	13.15
09/25/07 4:00	150	Yorktown	3	268	13.46	W	487.40	GPGGA,0	83.80	13.16
09/25/07 5:00	151	Yorktown	3	268	13.45	W	482.90	GPGGA,0	83.50	13.14
09/25/07 6:00	152	Yorktown	3	268	13.33	W	490.00	GPGGA,0	82.70	13.19
09/25/07 7:00	153	Yorktown	3	268	13.48	W	488.80	GPGGA,0	81.90	13.15
09/25/07 8:00	154	Yorktown	3	268	13.39	W	490.50	GPGGA,0	81.00	13.19
09/25/07 9:00	155	Yorktown	3	268	13.45	W	486.30	GPGGA,0	80.20	13.17
09/25/07 10:00	156	Yorktown	3	268	13.42	W	488.50	GPGGA,1	80.30	13.19
09/25/07 11:00	157	Yorktown	3	268	13.38	W	480.10	GPGGA,1	80.70	13.17
09/25/07 12:00	158	Yorktown	3	268	13.39	W	487.40	GPGGA,1	81.70	13.19
09/25/07 13:00	159	Yorktown	3	268	13.33	W	492.60	GPGGA,1	83.10	13.14
09/25/07 14:00	160	Yorktown	3	268	13.43	W	480.50	GPGGA,1	84.30	13.17
09/25/07 15:00	161	Yorktown	3	268	13.40	W	490.80	GPGGA,1	83.90	13.13
09/25/07 16:00	162	Yorktown	3	268	13.45	W	484.90	GPGGA,1	83.90	13.17
09/25/07 17:00	163	Yorktown	3	268	13.33	W	491.60	GPGGA,1	84.40	13.13
09/25/07 18:00	164	Yorktown	3	268	13.42	W	489.00	GPGGA,1	85.30	13.16
09/25/07 19:00	165	Yorktown	3	268	13.37	W	491.10	GPGGA,1	85.30	13.11
09/25/07 20:00	166	Yorktown	3	268	13.28	W	489.30	GPGGA,2	85.60	13.15
09/25/07 21:00	167	Yorktown	3	268	13.46	W	490.20	GPGGA,2	85.80	13.10
09/25/07 22:00	168	Yorktown	3	268	13.41	W	490.30	GPGGA,2	86.20	13.15
09/25/07 23:00	169	Yorktown	3	268	13.38	W	489.50	GPGGA,2	86.50	13.09
09/26/07 0:00	170	Yorktown	4	269	13.40	W	493.20	GPGGA,0	87.10	13.15
09/26/07 1:00	171	Yorktown	4	269	13.30	W	491.60	GPGGA,0	87.10	13.10
09/26/07 2:00	172	Yorktown	4	269	13.33	W	491.40	GPGGA,0	85.70	13.15
09/26/07 3:00	173	Yorktown	4	269	13.36	W	497.50	GPGGA,0	85.00	13.12
09/26/07 4:00	174	Yorktown	4	269	13.42	W	486.20	GPGGA,0	84.40	13.13
09/26/07 5:00	175	Yorktown	4	269	13.34	W	490.30	GPGGA,0	83.60	13.17
09/26/07 6:00	176	Yorktown	4	269	13.39	W	489.00	GPGGA,0	82.50	13.14
09/26/07 7:00	177	Yorktown	4	269	13.39	W	487.30	GPGGA,0	81.30	13.20
09/26/07 8:00	178	Yorktown	4	269	13.36	W	490.40	GPGGA,0	80.10	13.16
09/26/07 9:00	179	Yorktown	4	269	13.31	W	492.10	GPGGA,0	78.90	13.18
09/26/07 10:00	180	Yorktown	4	269	13.46	W	490.80	GPGGA,1	78.43	13.22
09/26/07 11:00	181	Yorktown	4	269	13.43	W	495.80	GPGGA,1	78.03	13.18
09/26/07 12:00	182	Yorktown	4	269	13.34	W	482.50	GPGGA,1	78.63	13.23
09/26/07 13:00	183	Yorktown	4	269	13.31	W	493.30	GPGGA,1	79.74	13.17
09/26/07 14:00	184	Yorktown	4	269	13.38	W	491.20	GPGGA,1	81.10	13.21
09/26/07 15:00	185	Yorktown	4	269	13.33	W	488.70	GPGGA,1	82.20	13.15
09/26/07 16:00	186	Yorktown	4	269	13.36	W	487.10	GPGGA,1	82.40	13.17
09/26/07 17:00	187	Yorktown	4	269	13.39	W	482.80	GPGGA,1	83.20	13.15
09/26/07 18:00	188	Yorktown	4	269	13.44	W	486.50	GPGGA,1	84.70	13.14
09/26/07 19:00	189	Yorktown	4	269	13.41	W	491.00	GPGGA,1	87.10	13.12
09/26/07 20:00	190	Yorktown	4	269	13.37	W	491.70	GPGGA,2	87.30	13.12
09/26/07 21:00	191	Yorktown	4	269	13.41	W	489.10	GPGGA,2	88.10	13.12
09/26/07 22:00	192	Yorktown	4	269	13.41	W	490.70	GPGGA,2	88.80	13.08
09/26/07 23:00	193	Yorktown	4	269	13.34	W	488.90	GPGGA,2	89.60	13.12
09/27/07 0:00	194	Yorktown	5	270	13.44	W	488.10	GPGGA,0	90.20	13.07
09/27/07 1:00	195	Yorktown	5	270	13.50	W	487.90	GPGGA,0	90.50	13.12
09/27/07 2:00	196	Yorktown	5	270	13.31	W	491.60	GPGGA,0	90.10	13.08
09/27/07 3:00	197	Yorktown	5	270	13.36	W	490.90	GPGGA,0	88.30	13.13

TIMESTAMP (GMT) Time	Record #	LoggerID Sample	Day Of Week Sun=1 Sample	JulianDay Sample	Solar Radiation Horizontal W/m2 Average	Speed Wind mph Average	Speed Wind mph Max	Temperature PV deg F Average	Voltage PV volts Average
09/27/07 4:00	198	Yorktown	5	270	-0.1	2.1	2.5	-7999.00	0.02
09/27/07 5:00	199	Yorktown	5	270	0.0	2.3	5.1	-7999.00	0.02
09/27/07 6:00	200	Yorktown	5	270	0.0	2.7	6.5	-7999.00	0.03
09/27/07 7:00	201	Yorktown	5	270	0.0	2.4	6.5	7999.00	0.04
09/27/07 8:00	202	Yorktown	5	270	0.0	2.2	6.8	7999.00	0.04
09/27/07 9:00	203	Yorktown	5	270	0.0	3.0	8.2	-7999.00	0.04
09/27/07 10:00	204	Yorktown	5	270	0.0	2.2	5.5	-7999.00	0.04
09/27/07 11:00	205	Yorktown	5	270	0.0	1.9	3.8	-7999.00	0.03
09/27/07 12:00	206	Yorktown	5	270	0.0	1.7	4.5	-7999.00	0.02
09/27/07 13:00	207	Yorktown	5	270	0.0	1.7	4.1	-7999.00	0.02
09/27/07 14:00	208	Yorktown	5	270	0.0	1.6	4.8	-7999.00	16.44
09/27/07 15:00	209	Yorktown	5	270	0.1	1.7	5.1	-7999.00	32.92
09/27/07 16:00	210	Yorktown	5	270	0.3	2.0	2.5	7999.00	44.63

TIMESTAMP (GMT) Time	Record #	LoggerID Sample	Day Of Week Sun=1 Sample	JulianDay Sample	Voltage Battery volts Average	Current PV amps Average	Current Wind Turbine amps Average	Current Wind Turbine amps Max	Current Battery amps Average
					Battery Voltage				
09/27/07 4:00	198	Yorktown	5	270	25.30	-0.27	0.00	0.00	-12.30
09/27/07 5:00	199	Yorktown	5	270	25.25	-0.27	0.00	0.00	-13.16
09/27/07 6:00	200	Yorktown	5	270	25.21	-0.27	0.00	0.00	-13.40
09/27/07 7:00	201	Yorktown	5	270	25.18	-0.27	0.00	0.00	-13.26
09/27/07 8:00	202	Yorktown	5	270	25.11	-0.27	0.00	0.00	-16.83
09/27/07 9:00	203	Yorktown	5	270	25.05	-0.27	0.00	0.00	-19.33
09/27/07 10:00	204	Yorktown	5	270	25.02	-0.27	0.00	0.00	-17.35
09/27/07 11:00	205	Yorktown	5	270	24.97	-0.27	0.00	0.00	-19.09
09/27/07 12:00	206	Yorktown	5	270	24.92	-0.27	0.00	0.00	-19.50
09/27/07 13:00	207	Yorktown	5	270	24.88	-0.27	0.00	0.00	-20.26
09/27/07 14:00	208	Yorktown	5	270	24.88	-0.10	0.00	0.00	-16.14
09/27/07 15:00	209	Yorktown	5	270	24.71	10.11	0.00	0.00	-36.72
09/27/07 16:00	210	Yorktown	5	270	25.16	45.47	0.00	0.00	10.35

TIMESTAMP (GMT) Time	Record #	LoggerID Sample	Day Of Week Sun=1 Sample	JulianDay Sample	Power PV kW Average	Power Wind Turbine kW Average	Power Battery kW Average	Power Generator kW Average	Power Load kW Average Load (kW)
09/27/07 4:00	198	Yorktown	5	270	-0.007	0.000	-0.311	0.000	0.211
09/27/07 5:00	199	Yorktown	5	270	-0.007	0.000	-0.332	0.000	0.245
09/27/07 6:00	200	Yorktown	5	270	-0.007	0.000	-0.338	0.000	0.268
09/27/07 7:00	201	Yorktown	5	270	-0.007	0.000	-0.334	0.000	0.240
09/27/07 8:00	202	Yorktown	5	270	-0.007	0.000	-0.422	0.000	0.280
09/27/07 9:00	203	Yorktown	5	270	-0.007	0.000	-0.483	0.000	0.369
09/27/07 10:00	204	Yorktown	5	270	-0.007	0.000	-0.433	0.000	0.355
09/27/07 11:00	205	Yorktown	5	270	-0.007	0.000	-0.476	0.000	0.348
09/27/07 12:00	206	Yorktown	5	270	-0.007	0.000	-0.485	0.000	0.366
09/27/07 13:00	207	Yorktown	5	270	-0.007	0.000	-0.503	0.000	0.281
09/27/07 14:00	208	Yorktown	5	270	-0.003	0.000	-0.401	0.000	0.193
09/27/07 15:00	209	Yorktown	5	270	0.250	0.000	-0.907	0.000	0.900
09/27/07 16:00	210	Yorktown	5	270	1.147	0.000	0.267	0.000	0.611

TIMESTAMP (GMT) Time	Record #	LoggerID Sample	Day Of Week Sun=1 Sample	JulianDay Sample	Flow Fuel Supply gal Total	Flow Fuel Return gal Total	Flow Fuel Use gal Total	Time GPS hhmmss Sample	Latitude GPS deg Sample
09/27/07 4:00	198	Yorktown	5	270	0	0	0	40116	35
09/27/07 5:00	199	Yorktown	5	270	0	0	0	50116	35
09/27/07 6:00	200	Yorktown	5	270	0	0	0	60116	35
09/27/07 7:00	201	Yorktown	5	270	0	0	0	70116	35
09/27/07 8:00	202	Yorktown	5	270	0	0	0	80116	35
09/27/07 9:00	203	Yorktown	5	270	0	0	0	90116	35
09/27/07 10:00	204	Yorktown	5	270	0	0	0	100116	35
09/27/07 11:00	205	Yorktown	5	270	0	0	0	110116	35
09/27/07 12:00	206	Yorktown	5	270	0	0	0	120116	35
09/27/07 13:00	207	Yorktown	5	270	0	0	0	130116	35
09/27/07 14:00	208	Yorktown	5	270	0	0	0	140116	35
09/27/07 15:00	209	Yorktown	5	270	0	0	0	150116	35
09/27/07 16:00	210	Yorktown	5	270	0	0	0	160116	35

TIMESTAMP (GMT) Time	Record #	LoggerID Sample	Day Of Week Sun=1 Sample	JulianDay Sample	Latitude GPS min Sample	Latitude GPS sec Sample	N-S Hemisphere GPS Sample	Longitude GPS deg Sample	Longitude GPS min Sample
09/27/07 4:00	198	Yorktown	5	270	15	5.292	N	116	24.00
09/27/07 5:00	199	Yorktown	5	270	15	5.178	N	116	24.00
09/27/07 6:00	200	Yorktown	5	270	15	5.178	N	116	24.00
09/27/07 7:00	201	Yorktown	5	270	15	5.28	N	116	24.00
09/27/07 8:00	202	Yorktown	5	270	15	5.256	N	116	24.00
09/27/07 9:00	203	Yorktown	5	270	15	5.286	N	116	24.00
09/27/07 10:00	204	Yorktown	5	270	15	5.238	N	116	24.00
09/27/07 11:00	205	Yorktown	5	270	15	5.238	N	116	24.00
09/27/07 12:00	206	Yorktown	5	270	15	5.196	N	116	24.00
09/27/07 13:00	207	Yorktown	5	270	15	5.28	N	116	24.00
09/27/07 14:00	208	Yorktown	5	270	15	5.232	N	116	24.00
09/27/07 15:00	209	Yorktown	5	270	15	5.268	N	116	24.00
09/27/07 16:00	210	Yorktown	5	270	15	5.262	N	116	24.00

TIMESTAMP (GMT) Time	Record #	LoggerID Sample	Day Of Week Sun=1 Sample	JulianDay Sample	Longitude GPS sec Sample	E-W Hemisphere GPS Sample	Altitude GPS meters Sample	Received String GPS Sample	Temperature Logger Panel meters Average	Voltage Logger Battery volts Average
09/27/07 4:00	198	Yorktown	5	270	13.48	W	481.10	GPGGA,0	86.70	13.11
09/27/07 5:00	199	Yorktown	5	270	13.23	W	495.60	GPGGA,0	86.30	13.13
09/27/07 6:00	200	Yorktown	5	270	13.33	W	489.00	GPGGA,0	85.90	13.13
09/27/07 7:00	201	Yorktown	5	270	13.33	W	489.40	GPGGA,0	84.80	13.14
09/27/07 8:00	202	Yorktown	5	270	13.36	W	489.30	GPGGA,0	83.90	13.16
09/27/07 9:00	203	Yorktown	5	270	13.41	W	486.70	GPGGA,0	83.00	13.14
09/27/07 10:00	204	Yorktown	5	270	13.41	W	494.70	GPGGA,1	83.20	13.17
09/27/07 11:00	205	Yorktown	5	270	13.36	W	494.80	GPGGA,1	83.00	13.15
09/27/07 12:00	206	Yorktown	5	270	13.31	W	492.10	GPGGA,1	83.10	13.18
09/27/07 13:00	207	Yorktown	5	270	13.35	W	489.50	GPGGA,1	82.80	13.15
09/27/07 14:00	208	Yorktown	5	270	13.40	W	493.10	GPGGA,1	82.20	13.19
09/27/07 15:00	209	Yorktown	5	270	13.38	W	489.40	GPGGA,1	80.60	13.17
09/27/07 16:00	210	Yorktown	5	270	13.34	W	492.10	GPGGA,1	81.30	13.20

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