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# Electric Energy Price Arbitrage Using Battery Energy Storage 

Feasibility study

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#### Abstract

The following thesis is a study into the feasibility of exploiting the inefficiencies of an openly traded electricity market by buying low cost electricity storing it in electric car batteries and reselling it to the market. To assess the feasibility a hypothetical project with all necessary equipment, infrastructure and personnel is set up and 15 years of daily electricity trading operation are calculated using the Discounted Cash Flow method and Net Present Value then used to determine the feasibility of the project. 29 energy systems on five power markets were tested and the result of the research is that it is feasible to conduct electric energy price arbitrage on four of the twenty nine systems: - SoCal - San Diego - SP-15 - Long Island

The present value of the cash generated in the operation on these systems was higher than the value of the cash needed to set it up, i.e. it is economical to spend the money in setting up the facilities and the operations because the cash generated by the business more than compensates the initial investment, even with opportunity costs, risk and time value of money taken into account.


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## 1 Introduction

This thesis studies the feasibility of buying electricity on an openly traded electricity market, storing it in electric car batteries and reselling it to the market. The approach used for assessing the feasibility is to set up a hypothetical project with all necessary equipment, infrastructure and personnel and then evaluate 15 years of daily electricity trading operation with the Discounted Cash Flow (DCF) method. The Net Present Value (NPV) of the project is calculated and if the outcome is positive the project is feasible.

The study deliberately ignores important aspects of a potential energy storage project which will be addressed in the "Model Limitations" chapter of this thesis. The issues left out of the study are:

- Cost of batteries
- Environmental impact
- Recycling of batteries
- Reduction of fossil fuel usage
- Political importance

This is done for simplicity's sake - if trading turns out to be feasible then then these important aspects can be further investigated and quantified, if not then there is unlikely any need to.

The idea behind this thesis is to benefit from the limitations of electricity as energy source and the inherent inefficiencies of its market though breakthroughs in Battery Energy Storage technology to conduct "virtual arbitrage" on the electric spot market ${ }^{1}$.

Electric energy price arbitrage exploits wholesale electricity price volatility and diurnal variability. Benefits accrue when storage is charged using lowpriced off-peak energy, for sale when energy price is high (Schoenung \& Eyer, 2008, p. 28).

[^0]The business idea is to buy electricity at low prices during off-peak hours, store it in a battery storage systems using batteries from Battery Electric Vehicles (BEV) and then selling it again for a higher price at peak hours.

This thesis is put forward in 12 chapters. The main topic is a feasibility study on electric arbitrage, based on energy storage. In order to investigate if it is financially feasible to trade energy you must first determine if it is technologically possible before the economic assumptions are applied and tested. Therefore electricity and its physical attributes will be examined as well as previous research on energy storage and technologies. The most widely used technologies will be studied to figure out which one would best fit the project. By a process of elimination battery storage technology is deemed the best and most relevant process and the lithium ion battery is chosen by applying one of the prerequisites for the idea and by looking at the global trend of automobile manufacturers.

The feasibility study ignores important inputs and these limitations and the reasons for them will be explained before the research is introduced. The data gathering, the setup and scenarios is then explained as well as all the underlying assumptions that the results are based on. Consequently, the results are further analyzed to see how sensitive the conclusions are to variations in the most relevant underlying assumptions. Finally findings were discussed, a course of action recommended and the thesis concluded.

The first chapter is an introduction to the basic idea and the structure of the thesis is described therein. The second chapter reviews common knowledge on electricity, where electricity itself, the history behind it and how men have gradually gained control over harnessing it is investigated. The different types of generation methods are explained and also the mismatch between efficient production of electricity and electricity usage. This mismatch is the underlying precondition for the research and is explained in the thesis as the "peak power problem". Following the discussion of the peak power problem a quick look is made into the different technologies man has created to store electricity and the most common technologies were discussed to find out which would best fit the project.

The topic of the third chapter is the electric car, its history and how recent trends suggest that it will rise in popularity over the next few years.

The two basic prerequisites for this research are detailed in chapter four, as well as how they will be fulfilled. Chapter five includes a list of the limitations of the model and a discussion on why certain critical political and environmental aspects were purposefully left out.

Chapter six is devoted to the research which is explained in details. The electrical markets and the 29 systems that operate within these markets are introduced as well as the process of data gathering and its setup. This chapter also contains a discussion on the two scenarios that are presented in the research.

The next two chapters address the core of the feasibility study as they introduce and explain the intricacies and conditions of the financial model. In chapter seven the model is presented and its numerous inputs are thoroughly explained. Chapter eight, on the other hand, deals with the assumptions of the financial model. Because the assumptions are the pillars on which the result is based on it is of paramount importance to explain these assumptions attentively, therefore all eight categories of assumptions are introduced, explained and justified in this chapter.

Chapter nine includes the major findings of the study and the results of all 29 systems in both scenarios are explained in details. Chapter ten contains a sensitivity analysis of the assumptions introduced in chapter eight. First the assumptions are tested to find out which ones have the most influence on the outcome and then three of the most influential ones are taken and the main results from chapter nine are tested with two of them varying at the same time.

A discussion on the outcome of the thesis is conducted in chapter eleven. It starts with a short and concise passage on the core findings, followed with a general discussion of the thesis and its results. In this chapter the limitations of the model are explained and potential action plane introduced.

Finally there is a short chapter where it is concluded that the venture is feasible on 4 of the 29 systems investigated and that additional steps should be taken to insure that the idea will be taken forward.

## 2 Electricity

The existence of electricity is a well-known fact in the modern day life. Different phenomena such as lightning, static electricity, and electric current do all result from the presence and flow of electric charge that fall under our definition of electricity. The modern man recognizes the feeling of getting a small electric shock from a door knob when he walks on his carpet with socks on, most of us have seen lightning bolts in the sky, and we take for granted that we can power our stereos and TV sets (and charge our phones) from the electric socket in the wall.

But the existence of electricity has been known by men for millennia. Around 2500 BC, the ancient Egyptians spoke of the "Thunderer of the Nile" that was "the protector" of all fish and the Greeks, Romans and Arabics also referenced these electric eels centuries later (Moeller \& Kramer, 1991). Around 600 BC Thalus of Miletus started experimenting with static electricity and found that amber, when rubbed, would shoot sparks and attract small (and light) objects. The term electricity, however, wasn't adopted into the English language until 1646, following William Gilbert's research on electricity and magnetism (Stewart, 2001). Further research was conducted in the following years and in the early $18^{\text {th }}$ century Alessandro Volta invented the battery and Michael Faraday the electric motor (Kirby, 1990). In the late $19^{\text {th }}$ century, following the works of men like Tomas Alva Edison, Nikola Tesla, Werner von Siemens and Alexander Graham Bell electricity was elevated from being a scientific research project into being the driving force of the Second Industrial Revolution.

Today, electricity is both commonplace and necessary. The majority of the human race is completely dependent on electricity. It powers our cities, our households and our businesses, and most of our industries are powered by (and dependent on) electricity. In the USA alone the electricity usage was little shy of 4 Terawatt hours (4 billion kWh) in 2009 (us energy Information Administration, 2009). To put that into perspective the electricity used in the USA in 2009 alone could power a normal 45 watt light bulb for 10 billion years ${ }^{2}$.

[^1]However, electricity has its limitations. It is a secondary energy source, and as such it has to be produced or created from another source of energy. The most common ways of producing electricity is by coal, which represents more than $40 \%$ of the world's electricity generation. Other methods include gas, hydro, nuclear, oil and other renewables (in a descending order, see Fig. 1)


Figure 1 - Global Electricity Generation by Source

Once generated, electricity is impossible to store in its current form, it has to be converted to a different energy form for storage and then reconverted into electricity. This means that electricity has to be produced when it is to be used. If one looks at the modes of electricity production one can see that a vast majority of electricity production is performed by large scale power plants, generating tens and often hundreds of megawatts (MW) of power. Such large plants represent enormous capital investment with fairly low operational costs. Therefore, it is most economical to run such facilities as close to full capacity as possible to minimize waste and inefficiencies. It is true that capital versus operational cost inequalities are more blatant with hydro and nuclear power plants than with fossil fuel plants. Nonetheless, it holds true that it is most economical for all facilities to run at capacity. In short, the supply part of the electricity market prefers stable output with minimal variations. However, this does not hold true with the demand part of the market.

The demand part can be divided into two brackets, a) the power intensive/dependent users and b) the general users. In the first bracket you would find heavy industries such as metal smelting and forging, chemical industry, data storage, etc. Quite often these industries utilize their energy almost every hour of every day of the year ( 8760 hours/year) and thus are the backbone (and obvious favorites) of the power producers. In the second bracket you find basic consumers and everyday
industries: supermarkets, offices, households, etc. The players in the second bracket do not have a flat utility rate of electricity, i.e. they neither use the same amount of energy constantly throughout the year nor within a single day. The second bracket represents fractional (and very cyclical) demand dictated by everyday life. Because of this, power demand spikes around 6:00-7:00 when people are waking up, turning on their lights, toasting their bread and shaving their faces, when offices come to life and stores are opened. And then there is another spike in the demand around 18:00-19:00 when people come home and start cooking dinner and turning on their TV's and computers.

### 2.1 Peak Power Problem

This fractional demand of electricity creates the issue that can be referred to as peak power problem. The demand for electricity is not constant through the course of the day or between different times of year, it fluctuates. Very little electricity is consumed during the night when the majority of the population is asleep and activity is at a minimum whereas the consumption shoots up during the day as the world comes alive to create a peak in the demand. The supply, however, is kept relatively stable (for it is most efficient to run a power plant at a stable load), and because electricity does not store easily there has to be enough production to meet these peaks in demand

Let's draw a small picture of this problem with a fictional example and create the small town of Kraftstadt with 50.000 inhabitants. The maximum energy consumption of each individual in this town has grown from 1.000 Wh a few years ago to 1.249 Wh $(1,25 \mathrm{kWh})$ today, i.e. during the peak hour of the day every person in Kraftstadt consumes $1,25 \mathrm{kWh}$ of electricity. Let's also assume that the people of Kraftstadt follow a general consumption cycle of electricity, consuming between $50-60 \%$ of the max load between the hours of 00:00 and 6:00, going up to about 80\% in the morning and during the day, and peaking over dinner with consumption around $70-80 \%$ for the TV hours of the night. We will also create the Kraftwerk power company (located in Kraftstadt), an old utility with a generation capacity of about 55MW of power.

Because of the recent increase in energy consumption of the townspeople, Kraftwerk has to expand their generation capacity. Now they can supply the town with 50MW of
power very easily but that is not enough. But how should they go about expanding? It is obvious from the discussion above that it is most economical for Kraftwerk to run at close to full capacity, but what kind of inefficiencies and waste does that entail?

To visualize the problem, the supply curve of Kraftwerk's power supply can be drawn (see Fig. 2). The current generation is at 50 MW and as mentioned above


Figure 2 - Supply Curve for Kraftwerk Power Company it is most economical for Kraftwerk to keep their output constant.

The demand curve for the town of Kraftstadt can also be drawn up (see Fig. 3). It is at a minimum during the depth of night, rising during the day and reaching maximum around dinner time and through the TV hours on the evening.

If these charts are combined it is easy to see how the supply and demand of power differs through the course of the day (see Fig 4). In the morning the stable production of power plant far exceeds the needs of the town, while during the day and afternoon the supply and demand harmonize rather well but late afternoon and early evening the need for power is far more than the power company produces.

But what do these curves mean as regards


Figure 4 - Supply and Demand Curves Matched Together
to the inefficiencies of the system? To make it easier to comprehend one needs to look at the areas below the respective lines. As the lines represent the supply and demand of power (in MW), the area below them depict the energy produced and consumed (see Fig. 5).

The area below the blue line but still above the red line is light blue and represents a surplus of power in the system and the area under the red line in salmon pink


Figure 5 - Surplus and Deficit of Power with 50MW Production represents the power that is traded in the system. Finally, the area under the red line but above the blue line is green and represents a deficit of power in the system.

During the night Kraftwerk is generating a lot of energy with which is wasted, during the majority of the day Kraftwerk is able to meet the demand of the people of Kraftstadt but between the hours of 17:00 and 21:00 there is a serious lack of power to meet the peak demand.

At the moment the people of Kraftstadt are relying on their neighboring town of Machtburg to supply them with power during the peak hours. In addition to be hurting their pride it is also emptying their wallets because the Machtburgers are charging them triple for the peak power. All the while, the overproduction of Kraftwerk is 99MWh/day (the sum of the light blue colored area) but because electricity cannot be stored, this energy goes to waste.

Initially the board of Kraftwerk introduced a solution to the town council of Kraftstadt. Kraftwerk would raise production capacity to 60 MW and thus cover the complete electricity demand of the day, save for the hour beginning at 18:00 (see Fig. 6).


Figure 6 - Surplus and Deficit of Power with 60MW Production

This solution would save Kraftwerk substantial investment cost and even though they could not supply power over the dire peak hours they pointed out that with this solution (even without generation to cover the peak hours) energy wasted would amount to $337 \mathrm{MWh} /$ day (blue shaded area). The town council did not like this idea one bit, they were not going to let the Machtburgers overcharge them for energy. So a second solution was devised, one where Kraftwerk would raise its capacity to 65ME to cover ALL demand, including the peak hours (see Fig. 7).

The second solution was accepted and today Kraftwerk produces 65 MW of power and is able to supply the whole town of Kraftstadt, even during peak hours. This


Figure 7 - Surplus and Traded Power with 65 MW Production solution results in Kraftwerk wasting 395MWh of energy every day.

This highly simplified example explains the peak power problem. Of course power generators are able to vary their production to some extent, and of course other factors come into play in a major electricity market. But the principle maintains that there are inefficiencies in the power market because of the mismatch of preferences between the producers and off takers. This is the underlying precondition for this research. Because there are different levels of demand for electricity through the course of the day while it is economical to keep the supply relatively stable price swings are created on the market. If it is possible to store electricity, one can buy it when demand is small and prices are low and resell it at higher price when demand soars.

As can be seen the electricity market has inherent inefficiencies and people have been studying energy storage for number of years to try to mitigate and minimize these inefficiencies. Much research has been done on the subject, and many possible technologies have been explored and tested. These researches are giving increasingly better results and applications are slowly getting closer to be economically viable. The solution to cost effectively store energy therefore looks to be close at hand.

### 2.2 Energy storage

Storing energy is by no means novel or new, and in fact it is an inherent part of nature. Energy is stored in all living organisms, plants convert the energy from the sun and store it in chains of carbohydrates and humans convert the energy from carbohydrates and store it in fat. Even for industrial or commercial applications, energy storage is ancient and records dating back to the $11^{\text {th }}$ century talk of flywheel applications (waterwheel) for harnessing and storing energy.

In modern day vocabulary however, energy storage is referred to when energy is collected for later use.

The fundamental idea of the energy storage is to transfer the excess of power (energy) produced by the power plant during the weak load periods to the peak periods (Ibrahim, Ilincia \& Perron, 2007, p. 393).

The problem with electricity (as mentioned above) is that it is a secondary power source and cannot be stored in its current state.

Initially electricity must be transformed into another form of storable energy (chemical, Mechanical, electrical, or potential energy) and to be transformed back when needed (Ibrahim et al., 2007, p. 393).

To understand how energy storage works it is helpful to remember that energy can take on many forms and any of those forms can potentially be used to store electric energy. This is exactly what scientists are doing all over the world, they are exploring methods of converting electricity into one of the many forms for storage and then reconverting it back to electricity.

The different techniques of storage can be divided into categories based on the form of energy they exploit. One of the most elemental of energy storage is the one mentioned in the openings of this chapter, the biological energy storage. Nature found a way to preserve solar energy through photosynthesis, i.e. capture solar energy and store it as hydrocarbons. This principle can be utilized in storing energy. No one has yet figured out a way to convert sunlight directly into a storable energy form but instead other forms of energy can be used and converted into hydrocarbons. The most common types of Biological Energy Storage are:

- Starch
- Glycogen
- Methanol
- Ethanol

Just as biological energy storage is a key aspect of biological functioning, so too has mechanical energy storage become a key aspect of the functioning of human society. Ever since we have understood the causal connection between energy and its effects we have explored ways to mechanically control and store it. In simple terms mechanical energy is the energy associated with the motion and position of an object, and the applications of this were discovered fairly quickly. Men found out that if they stuck a paddled wheel in a running stream, the energy of the water would turn the wheel, which in turn could turn a device (e.g. a millstone for wheat and corn). They also figured out that if they carried a large (heavy) stone up and kept it at an elevated position, the position of the stone and the velocity of its decent would release great energy when released. The most common types of Mechanical Energy Storage are:

- Compressed air energy storage
- Flywheel energy storage
- Hydraulic accumulator
- Hydroelectric energy storage
- Spring
- Gravitational potential energy

Once mankind developed a little more sophistication in its approach to science a whole new world opened up, the world of chemistry. Following in the footsteps of

Boyle, Lavoisier and Dalton in the $17^{\text {th }}$ and $18^{\text {th }}$ century, chemists started to apply scientific method to a concentration of a set system of elements that all are composed of atoms. Advances were rapidly made and one discovery was the chemical bonds that keep atoms together to create elements or compounds. It was also discovered that making or breaking these bonds involves energy that can be absorbed or evolved. This opened up the possibility of storing energy within chemicals. The most common types of Chemical Energy Storage are:

- Hydrogen
- Biofuels
- Liquid nitrogen
- Oxyhydrogen
- Hydrogen peroxide

The 18th and 19th century also saw huge advances in the fields of electric- and magnetic science, and in the middle of the 18th century the first electrostatic generator was constructed. Static electricity could be stored in a jar and released when needed. Further research into the matter revealed that an electric field could be created to store energy. The most common types of Electrical Energy Storage are:

- Capacitor
- Supercapacitor
- Superconducting magnetic energy storage

Parallel to research into electric energy, chemists and physicists would look into possibilities of storing energy by combining the principles of chemistry and electricity. In 1800 Alexander Volta introduced the first battery (voltaic pile) and John F. Daniell improved the technology with his new design (Daniell Cell). Obviously modern technology has advanced the design and sophistication of electrochemical storage but the principle remains, it is a device that creates current from chemical reactions (or reversed, creates chemical reactions by a flow of current). The most common types of Electrochemical Energy Storage are:

- Batteries
- Flow batteries
- Fuel cells

The last storage technique mentioned in this thesis is thermal energy storage. Thermal energy is the energy that dictates the temperature within a system. If a system (say a room) is at a stable temperature, you need additional energy to increase/decrease the temperature of an object within that system. This principle can be applied to energy storage. If you know that you need to cool a system in the future and you also know that energy will be scarce and expensive at that time, you can use the abundant energy that you currently have to create ice, you then store that ice in an insulated container until you apply it to cool the system. The most common types of Thermal Energy Storage, apart from Ice Storage are:

- Ice Storage
- Molten salt
- Cryogenic liquid air or nitrogen
- Seasonal thermal store
- Solar pond
- Hot bricks
- Graphite accumulator
- Steam accumulator
- Fireless locomotive
- Eutectic system

This list of storage systems is neither detailed nor exhaustive, but is intended to give a good indication of the vast possibilities for energy storage. But even though storage technologies are numerous, some are better (and/or more) researched than others and some have been applied and have been in use for decades. The most commonly studied and commercially applied technologies are:

- Battery Energy Storage (BES)
- Compressed Air Energy Storage (CAES)
- Superconducting Magnetic Energy Storage (SMES)
- Pumped Hydro Energy Storage (PHES)
- Flywheel Energy Storage (FES) systems

These are the most popular and advanced technologies for energy storage but their characteristics and physical scope are quite different as are the applications that apply
to them. To take a decision on which of them best fits for electricity arbitrage a short investigation of the technologies needs to take place.

### 2.2.1 Battery Energy Storage Systems

As the name suggests, BES systems consist of a number of batteries stacked together as a unit to store energy. There are many different types of batteries (different chemistries used for the storage process) but they can be divided into two categories: Electrochemical batteries and Flow batteries. In this thesis the emphasis will be on electrochemical batteries.

The electrochemical batteries comprise of electrochemical cells that use chemical reaction to create electric current. The primary elements of these cells are the container, the anode and cathode (electrodes), and some sort of electrolyte material that is in contact with the electrodes. Within the cell there is a chemical reaction between the electrolyte and electrodes which creates the current needed. During the discharge phase, oxidation occurs when electrically charged ions in the electrolyte close to one of the


Figure 8 - Picture of a Battery Energy Storage System electrodes supply electrons and to complete the process reduction occurs with ions near the other electrode accept electrons. To recharge the battery this process is reversed and the electrodes are ionized.

There are numerous different chemistries used for this process, including lead-acid, lithium-ion (Li-ion), nickel-cadmium (NiCad) and sodium/sulfur ( $\mathrm{Na} / \mathrm{S}$ ) and others (Eyer \& Corey, 2010; Divya \& Østergaard, 2008; Kinter-Meyer et al., 2010; Davidson et al., 1980; Krupka et al, 1979).

### 2.2.2 Compressed Air Energy Storage Systems

As the name suggests CAES involves using low cost energy to compress air that is later used to regenerate electricity. The compressed air is converted into electricity by a combustion turbine, i.e. the air is released and heated and then sent through the turbine to generate electricity. The storage vessel for the


Figure 9 - Diagram of a Compressed Air Storage System compressed air varies depending on the scale of the project. For smaller projects the air can be stored in tanks or large on-site pipes (e.g. high-pressure natural gas transmission pipes) while in larger projects you would need underground geologic formations, like natural gas fields, aquifers or salt formations (Schilte, Fritelli, Holst \& Huff, 2012; Agrawal et al., 2011; Eyer \& Corey, 2010; Davidson et al., 1980; Krupka et al., 1979).

### 2.2.3 Superconducting Magnetic Energy Storage Systems

In a SMES system energy is stored in a magnetic field that is created by a flow of direct current in a cryogenically cooled superconducting coil. The system contrives of three elements: the cryogenically cooled refrigerator, a superconducting coil, and a power conducting system. If the coil is kept at a temperature lower than its superconducting critical temperature the


Figure 10 - Diagram of Superconducting Magnetic
Storage System current will not degrade and the energy can be stored indefinitely (Sander \& Gehring, 2011; Eyer \& Corey, 2010; Davidson et al., 1980; Krupka et al., 1979).

### 2.2.4 Pumped Hydro Energy Storage Systems

The idea behind PHES is to reverse the generating process of a hydroelectric plant to store the energy contained within the water's mass. Hydro electricity is produced by collecting water into reservoirs and then running it through turbines to generate electricity. In order to have a PHS system as part of your plant, the only addition to an ordinary hydropower station is a second reservoir to collect the water running through the


Figure 11 - Diagram of Pumped Hydro Storage System turbines. At times when energy is inexpensive the turbines can be reversed to pump the water from the lower reservoir into the elevated one. There it stays until it is feasible to run it through the turbines again to generate electricity (Agrawal et al., 2011; Eyer \& Corey, 2010; Davidson et al., 1980; Krupka et al., 1979)

### 2.2.5 Flywheel Energy Storage Systems

The FES system stores energy through the kinetic energy in rotating masses. The mechanism of a FES system consists of a fast spinning cylinder with shaft within an enclosed vessel. Modern engineering include a magnet to levitate the cylinder and minimize friction and wear. The shaft is connected to a generator that converts electric energy into kinetic energy


Figure 12 - Diagram of a Flywheel Energy Storage System (increases the speed of the cylinder). The
stored energy can be converted back to electricity via the generator, slowing the flywheel's rotational speed (Eyer \& Corey, 2010; Eyer, 2009; Davidson et al., 1980; Krupka et al., 1979)

### 2.3 Energy Storage Legacy

With the introduction of new power previous production methods (wind, solar, tide, etc.) the need for a simple solution to energy storage has become increasingly important. The incompatibilities of the new environmentally friendly power production and the cyclical nature of power demand creates a need for an equalizing solution on the power grid. The new green power solutions are incapable of producing energy to meet fluctuations in demand, their production capabilities are completely dependent on existence of the primary power source (sun light, wind, waves, etc.). And for this reason the systems operators and governing bodies are looking towards energy storage as a possible solution (Srivastava, Kumar \& Schulz, 2012). But although utilities and transmission systems operators are increasingly interested in new advances in energy storage to balance systems and fight inefficiencies, this topic has been researched and developed for quite some time.

In 1979 the Los Alamos Scientific Laboratory of the University of California issued a paper on energy storage technologies where
...the energy storage technologies under study included: advanced lead-acid battery, compressed air, underground pumped hydroelectric, flywheel, superconducting magnet and various thermal systems (Krupka et al., 1979, p. 2)

And later that year another paper was issued by the Central Electricity Generating Board where the same technologies (with the addition of compressed air) were studied (Davidson et al., 1980). It is therefore evident that the history of modern day energy storage technologies dates back decades.

As mentioned above, the inherent inefficiencies of the electric system is what sparks most research into energy storage. Scholars, scientists and engineers are curious to find ways to make generation, transmission and distribution of this most popular energy source more economical and less wasteful. To that end, every angle of
the problem is diagnosed. Different types of applications have been identified for different needs, whether it is to balance the supply capacity or for voltage support or to relief transmission congestion. Different applications apply to different problems and this involves different types of storage solutions. The various storage technologies are not all equally suited for all storage applications. The applications where you only need to store small amounts of energy but need high power output for relatively short periods of time can be thought of as "power applications", whereas applications where you need more energy capacity for a larger periods of time can be called "energy applications". The technologies that fit the former applications are SMES and FES systems, while PHES, CAES and most BES systems are more suited for the latter (Eyer \& Corey, 2010).

In this thesis the intention is to focus on energy applications, i.e. different technologies to store relatively large quantities of energy ( 75 MWh ) for a considerable time (1-19 hours), and that the technology be geographically independent, i.e. that the solution can be mobile and does not depend on geography such as rivers or old gas fields. By a process of elimination this leaves batteries as the ideal technology, because CAES is geographically dependent (for this scale of operations) as is PHES, and FES and SMES is better suited for power applications.

In 2007 a study was conducted on energy storage system to explore the benefits of relieving operational challenges on the electricity grid through energy storage. In the study NAS batteries were used to store (a modest amount) of energy (7,2MWh), they were fitted within a shipping container and connected to the PJM power market. The results of the study were positive: there is a definite, quantifiable lifetime value of storage (Nourai, 2007).

Large scale energy storage with batteries can be done, and it can be done on an economic merit. For it to be successful there are three criteria that need to be fulfilled:

1. The storage system has to be efficient, i.e. energy losses have to be minimal (this includes charging, storing and discharging).
2. The storage system has to be durable, i.e. it has to have a long service life and maintenance has to be at minimum.
3. The storage system has to be inexpensive, i.e. has to represent modest capital cost relative to the operation (Prost, 2009).

The increased effort into research and development on lithium ion batteries gives hope that these criteria can be fulfilled. The technology for storing electricity in batteries is rapidly improving and in large parts it is due to the increased focus on the electric car. Batteries are getting smaller, more powerful and cheaper. But although the technology is driven towards the electrification of the common car there are numerous other applications for this new technology. One application is to utilize the storage possibilities on a large scale.

The notion of using electric car batteries to fight inefficiencies of the electrical systems has been studied. Electric cars are plugged in while not in use and the condition of the electricity market dictates whether the car buys electricity (and charges) or sells electricity to the market (discharges), allowing energy markets to be regulated and demand peaks mitigated to some extent. This way "peak shaving" can be obtained through the sophistication of the grid (Sousa, Roque \& Casimiro, 2011). But there is another application, to use the batteries to utilize the variance between demand and supply of electricity and conduct arbitrage on the electrical market.

The idea in this research is to collect batteries into "battery islands" where relatively large quantities of energy ( 75 MWh ) can be stored for a considerable time (1-19 hours). The batteries are charged during the low cost, off-peak hours and then discharged at peak hours for a much higher price. But what types of batteries would be best suited for such an operation? The answer can be found within a global trend fueled by environmental awareness, the electrification of the common car.

## 3 The Electric Car

### 3.1 Term

There are many types of vehicles that use electricity for propulsion, and therefore have claim for the name 'electric car'. In this thesis the term will, however, be assigned only to high performance cars that derive their power from an a on-board battery pack, and not small, low performance vehicles like golf carts or electric wheelchairs; solar powered cars that use photo voltaic technology to convert sunlight into electricity; or hybrid cars that merge internal combustion engine and electric powered propulsion.

### 3.2 History

The electric car was big in the late $19^{\text {th }}$ and early $20^{\text {th }}$ century, and in fact it was the preferred choice of automobile. Electricity was the driving force of the second industrial revolution and its popularity as an energy source extended outside the home and factories. The electric car was also considered simpler and more enjoyable to use, it had neither the noise nor smell of a gasoline car, it did not vibrate and shake, there was no changing of gears (one of the most difficult part of operating a gasoline car of that time), and it did not require the manual effort of cranking of the engine to start (Sperling \& Gordon, 2009; Sandalow, ed., 2009)

However, with Ford Motor Company's new methods of production the cost of a gasoline car was slashed to less than half of that of an electric one and advances in internal combustion engines, gave them increased range, quicker refilling time and made them more enjoyable to ride overall. (Sperling \& Gordon, 2009; Sandalow, ed., 2009; Georgano, 2000)

In the oil crises of the 70 's and 80 's the eyes of the world quickly gazed toward the electric car, but only for a brief moment. And it wasn't until the global downturn in the early 2000's when car makers steered away from fuel-inefficient SUV's toward smaller cars. Recently the concerns about environmental impact are playing a bigger role and eyes have shifted toward the electric car again (Sperling \& Gordon, 2009; Sandalow, ed., 2009)

### 3.3 Race to popularity

The debate on whether car ownership is a necessity or luxury is ongoing but fact remains that car ownership is widespread in the USA, with more than 137 million passenger cars on the streets in 2008 (Bureau of Transportation, 2011). It is therefore safe to say that cars are a commodity.

The typical consumer goes through a cost/benefit analysis when he purchases a commodity. More often than not he does not realize that such an analysis has taken place, he simply buys what he is used to buying and the benefits of getting something that he knows, plus the benefit of not having to bother with the alternatives outweigh the cost of having to evaluate other options. But when it comes to cars the analysis tends to be more thorough. And if the electric car is to be able to substitute the gasoline car it will have to win this cost/benefit comparison.

One of the most critical factors in the auto industry's fight for the consumer is the distance the car can travel with its potential purchaser. Traditional car makers (those focusing on gasoline) have conceded that look and feel can be matched with electric cars but the range cannot, and are therefore highlighting this fact to their advantage. As with a typical internal combustion engine vehicle, the range of an electric car is a determined by four factors:

- Energy source
- Weight of vehicle
- Resistance
- Performance demand of driver

The last three factors are simply limitations governed by the laws of physics. Newton's $1^{\text {st }}$ law of motion tells us that the speed (or velocity) of an object remains constant until a force acts upon it and the $2^{\text {nd }}$ law says that the acceleration of an object is directly proportional to the force acting on it and inversely to its mass (the heavier the object the bigger the force needed).

Applying these laws one sees that heavy vehicle depletes its energy faster driving from $A$ to $B$, than in a lighter one (all other things kept equal) and a car with high resistance has a harder time propelling forward and therefore requires more energy
than a car with lower resistance. The performance constraint is also dictated by the law of motion because a driving style of rapid acceleration demands more energy than a constant speed type of driving (Zimba, 2009).

In the race toward wide-spread commercial electric car it is relatively easy to keep the last three factors on par with the internal combustion one. The weight is similar because the battery pack replaces a heavy engine and the car manufacturers are looking at new alloys and carbon fiber for the body in white (BIW). Both car types are built on comparable bodies and chassis so the wind resistance and tire friction should be very similar (or the same). And the performance demand is subject to the individual driver which will act the same in both car types, a fast driving teenager that drives the car to its maximum can travel less distance with the energy stored in the car than a veteran truck driver. And will do so regardless of the type of car.

The first factor, the energy source, is most difficult and will determine the outcome of the race. It seems that battery technology is on the right track. Electric car makers today usually focus on lithium based batteries for energy storage and major advances have been made in this area with today's electric vehicles are sporting ranges in excess of 300 km pr/charge (GreenCar Magazine, 2009). As previously mentioned governments (local and national) are assisting private entities in research and development of batteries and major car manufacturers have announced their version of an electric car for the coming years (see Fig. 15 and 16).

To win the race toward commercialization the electric car will also have to overcome a bigger challenge, the cost. It can be argued that a typical


Figure 13 - Nissan Leaf Electric Car
 additional value to the fact that her car is environmentally friendly and has no $\mathrm{CO}_{2}$ emission. It is true the electric car has no tailpipe pollution and depending on the power source used to generate the electricity it emits less than half, down to a quarter, of the $\mathrm{CO}_{2}$ of an
conventional gasoline powered car (Kromer \& Haywood, 2007), but nonetheless, the first thing that affects consumer is the direct cost, i.e. how much she has to pay. Today the price of an electric car is considerably higher than of a gasoline car, primarily because of the high cost of electric batteries. To address this issue, both private and governmental entities are pouring money into research and development of batteries to enhance their capabilities and reduce the cost, with the aim of market parity in the coming years. Governments around the world are also spending considerable money in promoting electric cars, including incentives of up to $\$ 7,500$ for buyers of electric vehicle (IRS, 2011). New advances are also being made in the production of batteries and production costs are gradually shrinking, making new batteries better and cheaper.

The outlook for the electric vehicle looks promising and if all goes as planned there will be more than one million electric cars on the streets within a few years. And with each car comes a battery and with each battery comes possibilities.

## 4 Prerequisites

In order to operate a project that uses battery storage for electric arbitrage many obstacles have to be overcome and numerous conditions have to be met. One obvious condition is that energy storage is technologically possible, another is the condition of economics.

The technological requirements were addressed in chapters two and three. It has been established that energy storage is possible and has been done, and if the results from the research prove promising a more thorough investigation into the technological aspects are in order. As for the commercial and economic concerns, they will be addressed in the research. There are, however, two basic prerequisites that need to be fulfilled:

- There needs to be access to an open electricity market
- There needs to be access to a sufficient number of batteries


### 4.1 Open electricity market

For the project to be successful one has to be able to connect to the electricity transmission system, buy of it at one price during a particular time and sell into it at another time. This demands the following of the electric system and its market:

- The transmission system has to be open, i.e. anyone can connect to the system and negotiate purchase out of it / sale into it (given the necessary competencies and licenses)
- The market for prices on the system must be open, i.e. one can negotiate purchases/sales in real time (with delayed delivery)
- The market for prices on the system must be active, i.e. it follows the laws of supply and demand, making off-peak electricity cheaper than peak

The US electrical markets and the transmission systems on them fulfill all the conditions above.

### 4.2 Access to batteries

Based on the abovementioned trend in the auto industry it is assumed that electric car batteries will be used for energy storage. The size of project defined in this thesis will
need roughly 5.000 batteries so it is obvious that quite a few electric cars would have to be on the streets to accommodate such a large number of batteries.

Today's outlook is that a considerable amount of battery electric vehicles will be in operation within few years, as many large car manufacturers (e.g. Mitsubishi, Nissan, BMW, Renault, and Ford) have announced their electric vehicles and proposed rollout in the coming years (see Fig. 13 and 14).


Figure 15 - Ford Focus Electric Car


Figure 16 - BMW i3 Electric Car

The US government has also been vocal about their support toward the electric car and president Obama announced in his State of the Union Address in January 2011 plans to see 1 million electric vehicles on American streets in 2015 (The White House, 2011). Therefore we believe there will be enough batteries for this kind of operation without it representing the bulk of the total number of batteries on the market.

## 5 Model Limitations

With the two prerequisites met, it is possible to calculate the commercial viability and the economic benefits of trading electricity on an open market. The viability is ascertained through a feasibility study that uses a DCF method to calculate the NPV of a project that trades electricity for 15 years.

As mentioned in chapter one, this research ignores a few important aspects of a potential energy storage project. The research is conducted only to determine if electric energy price arbitrage is profitable based on the operation of such project including all operation cost, investment cost of equipment, financing cost and depreciation. The study, however, neither includes the cost of batteries nor the political and environmental impact of the operation.

These omissions are purposely done for the sake of simplicity. This thesis is a feasibility study and not a business plan. If the results of the feasibility study are positive and it turns out that electric arbitrage is feasible then steps can be taken to create a business plan around the idea with the focus of setting up and running an actual business. Such a business plan will have to take into account acquisition of car batteries, and various environmental- and political impacts such as the benefits of reducing $\mathrm{CO}_{2}$, stabilizing the electric grid and the disposal of the batteries.

All these issues can be incorporated into a business plan in many inventive ways that create value for both the project and its customers, but a positive outcome from this feasibility study needs to be in place for this work to take place (otherwise it will be in vain).

### 5.1 Terminal value

Because of the abovementioned limitations it was decided not to calculate terminal value in this study. The goal was to determine if the cash flow from an electric arbitrage would suffice to cover the investment (and opportunity) cost of setting up such an operation. And lacking important cost and benefits inputs related to batteries, politicaland environmental aspects, it did not seem right to attribute a perpetual growth to the substantial cash flow the operation produces without including part of the basis of what constitutes a going concern project.

## 6 Research

### 6.1 Finding data

The aim of this study is to determine if it is feasible to actively trade electricity on an electricity market in the United States. The Federal Energy Regulatory Commission (FERC) is an independent agency that regulates the interstate transmission of electricity, natural gas and oil. It also collects real time data on day to day electricity prices. All data for this research was collected from the FERC's website ${ }^{3}$.

The electrical power market in the USA is broken down into ten independent markets (see Fig. 17):


Figure 17 - Geographical location of US Power Markets
Of the ten markets, FERC has collected detailed and comprehensive data on five of them, and then issued the data reports for the years 2009, 2010 and 2011:

- California (CAISO)
- Midwest (MISO)
- New England (ISO-NE)
- New York (NYISO)
- PJM

There are several independent transmission systems that are traded within each market. The five markets that were the focus of this research had 29 systems between them:

[^2]| California | Midwest | New England | New York | PJM |
| :---: | :---: | :---: | :---: | :---: |
| Pacific G\&E | Cinergy | CT | Capital | Western |
| SoCal | First Energy | NEMass | Hudson | Baltimore |
| San Diego | Illinois | NH | Long Island | Commonwealth |
| NP-15 | Michigan | ME | NY | Dominion |
| SP-15 | Minnesota | Internal | North | NJ |
| Palo Verde | Wisconsin |  | West | Pepco |

Table 1 - All Five Markets and 29 Systems
The data for these five markets was found in monthly reports. Each report gave a daily overview for each of the transmission system for that month and each day was broken down to 24 individual one hour intervals, giving prices quoted for each hour of the day. The reports had two sets of pricing information, "Day-Ahead Prices" and "RealTime Prices". The Day-Ahead prices are prices that are forecasted the previous day and Real-Time prices are the actual prices that were traded (see Exhibit 1).

### 6.2 Arranging the data

All the information was exported into Excel, one month at a time (see Exhibit 2) and then rearranged for each transmission system (see Exhibit 3).

The aim of the project is to investigate the feasibility of buying electricity when the price is low and reselling it to the market at peak prices. It was decided to fix the amount of energy to 75 MWh , i.e. buying and selling 75 MWh at different times. After consulting with electrical engineers at Orkuveita Reykjavíkur (Guðleifur Kristmundsson \& Porsteinn Sigurjónsson, Orkuveita Reykjavíkur, personal communication, March $2^{\text {nd }}$, 2011) and VJI Engineering (Eymundur Sigurðsson, VJI Engineering, personal communication, March $3^{\text {rd }}, 2011$ ) it was decided to limit the power load to 25 MW . A power load of 25 MW offers less expensive equipment solutions and this was further confirmed at a meeting at Smith \& Norland, the Siemens distributers in Iceland (Ólafur Marel Kjartansson \& Ólaf Sveinsson, Smith\&Norland, personal communication, March $11^{\text {th }}, 2011$ ). With a power load at 25 MW it is obvious that in order to achieve 75 MWh it is necessary to buy power for three hours (at full load) and sell it for another three hours. With these basic conditions in mind the sum of each consecutive three hour
period in the day was calculated, i.e. from 0:00-2:00, 1:00-3:00, 2:00-4:00, etc. Each day was treaded as standalone and therefore calculations were made on the cost between days (e.g. 23:00-1:00). This gave 22 unique sums for each day (see Exhibit 4). These sums were calculated for both sets of prices provided by the daily reports. The "Day-Ahead Prices" sums were called "Projected" and "Real-Time Prices" sums were called "Actual". The lowest and highest sums were then found ${ }^{4}$.

### 6.3 Two scenarios

Having two sets of numbers, the projections (best guess) of what prices would be the following day and the actual prices of that day gave the opportunity to calculate outcomes with and without the presence of intellect (human or artificial). In order to do that, two scenarios were created. One called Actual; being the theoretical maximum (always buying at the lowest possible and selling at the highest possible price) the other called Projected; being the intellectual minimum (relying purely on day-ahead predictions). And even though the fundamental principle of the two scenarios is the same the approach for calculating the outcomes for Projected and Actual are very different.

In the Actual scenario the lowest of the 22 daily sums were multiplied with 25 (MW) to get the price of buying 75 MWh of electricity at the lowest possible cost for that day $(25 \mathrm{MW} \times 3$ hours $=75 \mathrm{MWh})$. The same was done with the highest price, thus getting the highest possible revenue for the day. Subtracting the cost from the revenue gave the maximum gross margin of the day. This was done for every day of every month (see Exhibit 5). The daily gross margin was then used to calculate the gross margin for each month and consequently each year. The same calculation was done for all transmission systems and the data compiled to a simple overview (see Exhibit 6).

The calculation for Projected was more complicated. The "Day-Ahead Prices" is a base for what the market projects will be next day prices. The idea was to use these

[^3]forecasts and apply them to the actual numbers. By finding the lowest (and highest) three consecutive hours of the "Day-Ahead Prices" it was possible to mirror them to the actual prices, i.e. buying and selling at real prices on the hours the market predicted would be the best. If the "Day-Ahead Prices" were lowest between 2:004:00 and highest between 18:00-20:00, energy would be bought at 2:00-4:00 and sold at 18:00-20:00 irrespective of the actual prices.

The major difference between the applications of the two scenarios is that for Actual you would require human intelligence monitoring and reacting to the market in real time. Traders would have to be hired who would strive toward the theoretical maximum of always buying at the lowest possible price and selling at the highest. Ideally the compensation structure for these traders would reflect the proximity of the actual trading to that theoretical maximum goal, i.e. the closer you get to the maximum the higher your compensation. The Projected scenario is the simplest setup where the equipment is merely connected to a computer that buys and sells solely on predictions from the day before. This scenario assumes no intelligence.

With revenue, cost and gross margin numbers for all years on each of the transmission systems calculated, the data sets could then be merged into a single model. Each year was considered unique and each system was filed individually, giving a total of 86 individual sub datasets (see Exhibit 7). The numbers were then arranged in an overview with numbers for Projected scenario and Actual scenario in separate columns, and top five values for gross margin and increase percentage were highlighted to enable visual comparison.

Table 2 gives a visual representation of the gross margin of all the systems in California. After having calculated gross margin for all three years for each of

| Pacific G\&E | Gross margin |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Projected |  |  |  |  |  | Actual |  |  |
|  |  | 2009 |  | 2010 |  | 2011 | 2009 | 2010 | 2011 |
|  | \$ | 826.899 |  | 904.278 | \$ | 885.983 | \$1.404.274 | \$1.618.872 | \$1.724.483 |
| SoCal | \$ | 954.318 |  | 1.207.066 | \$ | 961.644 | \$1.643.958 | \$2.085.359 | \$1.934.894 |
| San Diego | \$ | 958.977 |  | 1.283.706 | \$1 | 1.123.566 | \$1.815.862 | \$2.124.199 | \$2.391.214 |
| NP-15 | \$ | 777.676 |  | 853.698 | \$ | 813.826 | \$1.369.337 | \$1.552.692 | \$1.640.471 |
| SP-15 | \$ | 947.408 |  | 1.158.756 | \$ | 930.238 | \$1.739.558 | \$1.974.152 | \$1.926.366 |
| Palo Verde | \$ | 700.196 | \$ | 918.903 | \$ | 756.434 | \$1.432.841 | \$1.738.897 | \$1.779.699 |

Table 2 - Gross Margin for all 6 Systems in California the 29 systems, the highest results were identified and shaded (different shades of blue for the Projected scenario and red for the Actual scenario). When focusing on the Actual
scenario it is interesting to see that in the years 2010 and 2011 four of the five highest outcomes were in California.

The increase in gross margin for all the 29 systems was also calculated for each

| Western | Increase |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Projected |  |  | Actual |  |  |
|  | 09 to '10 | 10 to '11 | Overall | 09 to '10 | 10 to '11 | Overall |
|  | 41,70\% | 5,97\% | 50,16\% | 42,35\% | 0,03\% | 42,38\% |
| Baltimore | 69,50\% | -1,44\% | 67,06\% | 64,12\% | -5,13\% | 55,71\% |
| Commonwealth | 28,37\% | 2,03\% | 30,97\% | 25,26\% | 0,55\% | 25,94\% |
| Dominion | 63,76\% | -1,47\% | 61,35\% | 65,78\% | -8,55\% | 51,60\% |
| NJ | 59,70\% | 8,25\% | 72,87\% | 56,54\% | 4,05\% | 62,87\% |
| Pepco |  | 12,23\% | 12,23\% |  | 8,30\% | 8,30\% |

Table 3 - Increase for all 6 Systems on the PJM Market scenario and five highest values were identified and shaded (light green for the Projected scenario, green for the Actual scenario. Table 3 depicts the percentage increase in gross margin for the PJM market and just as the gross margin numbers are dominated by the California market, the increase in gross margin is nowhere higher than in the North East with four of the five highest (in both scenarios) outcomes.

## 7 Financial Model

In this study the DCF analysis was used to value the project. The model calculates free cash flow from buying electricity at low prices, storing it in electric car batteries and reselling it at peak prices. It is assumed that trading occurs every day of the year and that transmission losses are incurred. The model projects 15 years of operation.

The model uses the historical data and projects it into the future based on a set of assumptions. The assumptions inputs are all located on a single sheet for the user of the model to manipulate at will (see Exhibit 8). All changes made to the assumption inputs will immediately be incorporated into the model and the outcome will change accordingly. An example of the revenue inputs can be seen in Table 4.

The outcome of this model is two sets of numbers. The first set consists of two numbers, the Internal Rate of Return (IRR) and the NPV of the investment as a whole. To arrive at these numbers the total cash flow of each year is calculated and is then discounted against the


Table 4 - Revenue Inputs entire investment of the project. The goal is to find the cash available to repay loans, pay out as dividends and/or plow back into the project. And because the objective is to use this cash to service both debt and equity it is discounted with the weighted average cost of capital (WACC), i.e. the cost of both debt and equity. These two numbers are referred to as "IRR of Investment" and "NPV of Investment" (see Table 5).

|  | Traded | Projected |
| :--- | :---: | :---: |
| IRR of Investment | $\mathbf{1 5 , 0 0 \%}$ | $\mathbf{7 , 5 0 \%}$ |
| NPV of Investment | $\mathbf{\$ 1 . 0 0 0 . 0 0 0}$ | $\mathbf{\$ 5 0 0 . 0 0 0}$ |

Table 5 - IRR and NPV of Investment

The second set of numbers consists of the IRR and NPV of the equity. The total cash flow that was calculated for the whole project is taken and the cost of servicing loans is deducted. The resulting cash flow is then discounted against the equity contributions of the project. The goal is to find the cash available to pay out as dividends or plow back into the project. In this instance, because the objective is to find the cash earmarked for equity it is discounted with the cost of equity. These two numbers are referred to as "IRR of equity" and "NPV of equity" (see Table 6).

The model provides the option of calculating for each transmission system independently. One system is chosen and corresponding revenue and cost numbers is

|  | Traded | Projected |
| :--- | :---: | :---: |
| IRR of Equity | $\mathbf{1 0 , 0 0 \%}$ | $\mathbf{5 , 0 0 \%}$ |
| NPV of Equity | $\mathbf{\$ 5 0 0 . 0 0 0}$ | $\mathbf{\$ 3 2 5 . 0 0 0}$ |

Table 6 - IRR and NPV of Equity pulled from the data set and used as a base for the projections. The mode allows for two kinds of growth, short term and long term. The user denotes the increase percentage and the length of the short term period (in years) and then appoints the long term growth percentage (see Table 7).

| Increase in power prices | $15 \%$ | first | 5 |
| :--- | :---: | :---: | :---: |
|  | yrs |  |  |
| Long term increase | $5 \%$ |  |  |

Table 7 - Short- and Long Term Increase

Revenue and cost will rise according to the short term growth rate, for the determined number of years, and then at the long term rate for the remainder of the 15 years. When a transmission system is chosen as a base for calculations, its corresponding increase numbers appears on the screen. This is done so that the user can


Table 8 - Actual
Increase on System

The two different set of data Actual and Projected are used to create two independent sets of outcome. The Actual data assumes that traders use insight and intelligence to achieve results close to the "theoretical maximum" and the model allows the user to predict the accuracy level. All deviation from the "theoretical maximum" is treated as cost of goods sold and comes as a deduction to the gross margin. This is done to maintain logic in the compensation system for the traders. The traders receive salary for their work but also bonuses based on performance. The bonuses are tied to the gross margin, i.e. the higher the gross margin the higher the bonuses. By tying the accuracy level of the traders with cost of goods sold it creates an increased incentive for results as a lower accuracy decreases the gross margin which in turn decreases bonuess. The Projected data assumes no intelligence and therefore neither salary (and bonus payments) nor accuracy costs are included in the calculations.

The operational costs for the project, aside from salaries and bonuses are overhead, maintenance, selling expense and 'other expenses'.

Overhead is assumed to be minimal as the only thing needed is an office for the traders with telephone- and internet connection, computers, mobile- and landline phones, and appropriate furniture and amenities. Maintenance of the electric system will be outsourced to a third party on a long term contract, terminable by both parties once a year.

Selling expense is assumed to be modest, because all trading is done online in real time. However, traders need to have the possibility to develop and maintain their network of business relations and therefore a small ratio of revenues is allocated as selling expense. Other expenses are for any kind of contingencies that might occur when running a business. A lump sum is also allocated as startup cost, and is intended to cover unexpected costs that often pile up when starting a business. Even though the settlement system for online electrical trading is done through a clearing house, contingencies are built into the model and working capital is assumed to increase for a defined number of years (determined by the user). It is assumed that initial capital raised will finance the first year of working capital, and internally generated cash flow will service the consequent years. All inputs for operation costs can be modified by the user of the model (see Table 9).

| Salaries | $\$ 75.000$ |
| :--- | :---: |
| Bonus payments | $2 \%$ |
| Nr of traders | 2 |
| Traider accuracy | $95 \%$ |
| Overhead | $\$ 30.000$ |
| Maintenance | $\$ 120.000$ |
| Other | $\$ 100.000$ |
| Working capital | $\$ 200.000$ |
| Selling expense | $0,2 \%$ |
| Start-up expense | $\$ 300.000$ |
|  |  |

Table 9-Operational Cost Inputs


Figure 18-2MW Storage Unit in Bluffton, Ohio

Capital expenditures for the project will consist of acquisition of land (buying or leasing), constructing (or buying) a building, and purchasing electrical equipment. The piece of land needed under the project is modest in size. The batteries can easily fit into a few shipping containers and the electrical equipment is of a similar size. Figures 18 and 19 depict a 2 MW and 8 MW battery storage units (respectively) currently found in the USA. A land of $10,000 \mathrm{~m}^{2}$ (1 hectare) would be ample, and easily provide space for possible future expansions.

The purchase of electrical equipment would take place either through local distributors or directly through vendors. The leading European electrical equipment providers $A B B$ and Siemens both have readymade solutions, on shelf, at $\$ 10,000,000$ with lead time of 12 to 24 months. The need of shelter for both batteries and electrical equipment depends on location


Figure 19-8MW Storage Unit in Johnson City, NY (local weather conditions) and would consist of a simple structure. The batteries and electrical equipment together cover about $500 \mathrm{~m}^{2}$, so a $700 \mathrm{~m}^{2}$ house would be erected, giving room for storage and maintenance facilities. The model allows for additional unforeseen capital expenditure of $\$ 300.000$ (see Table 10).

The fixed assets will be depreciated in accordance with applicable laws and legislations (depending on location). The model assumes that assets can only be depreciated by $90 \%$, i.e. $10 \%$ residual value must remain in the books ${ }^{5}$

| Land | $\$ 300.000$ |
| :--- | ---: |
| Building | $\$ 1.000 .000$ |
| Equipment | $\$ 10.000 .000$ |
| Other | $\$ 300.000$ |
| Total | $\$ 11.600 .000$ |
|  |  |

Table 10 - Investment Inputs

| Leverage of equipment | $70 \%$ |
| :--- | :---: |
| Equipment loan |  |
| Bank I | $\$ 7.000 .000$ |
| Interest rate | $6,25 \%$ |
| Payback in years | 8 |
| Short term financing |  |
| Bank II | $\$ 500.000$ |
| Interest rate | $8 \%$ |
| Payback in years | 3 |
| Total capital needed | $\$ 12.100 .000$ |
| Equity ratio | $38 \%$ |
| Equity | $\$ 4.600 .000$ |
| Debt | $\$ 7.500 .000$ |
|  |  |

Table 11 - Financing Input

The equipment will be financed with export financing from the country of origin (Sweden or Germany). The model assumes that the equipment cost will be leveraged through either the vendor himself or an export financing program within the vendor's home country, at local rates plus a premium. A smaller, short term loan of $\$ 500,000$ to cover the initial outflow of cash is also included in the model. Interest rates and payback years are adjustable by the user of the model (see Table 11).

Income taxes are levied on Earnings before Tax (EBT) with losses carried over for a maximum of 10 years. Property tax is calculated on all real estate, i.e. both land and building.

[^4]All in all, the total capital needed for the project is $\$ 12,100,000$, with $\$ 7,500,000$ as debt and $\$ 4,600,000$ provided as equity. This corresponds to an equity ratio of roughly $38 \%$.

The model calculates the cost of equity using the Capital Asset Pricing Model (CAPM; French, 2003) and derives a discount rate for the project by applying the Weighted Average Cost of Capital (WACC; Miles \& Ezzel, 1980) method. Both rates are used to calculate the NPV of the investment. The WACC is used to discount the leveraged project, i.e. the cash flow that can be used to service debt and pay out dividends. The cost of equity is used to discount the cash flow after debt has been serviced.

## 8 Assumptions for Financial Model

A financial model is only as strong as the assumptions it is built on, and therefore it is imperative to scrutinize each assumption thoroughly. The model is set up with 39 different assumptions that fall into 8 different categories. The categories are:

- Revenue
- Capital expenditure
- Operational expenditure
- Depreciation
- Debt
- WACC
- Tax
- Batteries

A decision on each different assumption was arrived at through a rigorous process. Information on each point was gathered through interviews ${ }^{6}$, the above mentioned research, and the author's experience and common sense. The data was then matched to real examples and the results double checked with industry experts (see Exhibit 9).

### 8.1 Revenue

Hours in/out is the only assumption in the whole model that is fixed and cannot be altered by the user. After meetings with electrical engineers and distributors of the electrical equipment it was decided to divide the flow of total electricity purchased/sold over 3 hours. This is done to decrease the strain on the batteries and to some extent the electrical equipment (see Table 12).


Table 12 - All Revenue Inputs

[^5]MW hours in/out was arrived at following the advice from electrical experts at Orkuveita Reykjavikur and VJI Engineering. To have a sizeable operation, it was the aim to have at least 25 GWh of energy traded per year. To achieve this minimum requirements one would have to have at least $22,83 \mathrm{MW}$ of installed power (keeping in mind the fixed precondition of 3 hours in/out).
$25 \mathrm{GWh}=25.000 \mathrm{MWh}$. The goal is to buy/sell 3 hours of energy every day of the year (3h/day * 365 days 1095 hours). To arrive at the necessary power load, the total amount of energy is divided by the total hours bought/sold:

$$
\frac{25.000 \mathrm{MWh}}{1095 \mathrm{~h}}=22,83 \mathrm{MW}
$$

$22,83 \mathrm{MW}$ of power is needed to trade 25 GWh of energy pr/year, this number was then rounded up to 25 MW of installed power, resulting in $27,375 \mathrm{GWh}$ of energy traded per year.

In this model power losses are assumed 3\% in the model based on the Icelandic grid operator Landsnet which publishes $3 \%$ as their power losses. The same level of sophistication is assumed with American operators.

Increase in power prices dictates how much revenues and COGS increase between years, i.e. the percentage by which the previous year will increase. The model assumes a

|  |  |  |
| :--- | :---: | :---: |
|  | Projected | Actual |
| New England | $28,06 \%$ | $19,09 \%$ |
| California | $5,99 \%$ | $21,16 \%$ |
| Midwest | $16,43 \%$ | $10,97 \%$ |
| New York | $24,15 \%$ | $-3,69 \%$ |
| PJM | $49,11 \%$ | $41,13 \%$ |
| Overall | $\mathbf{2 4 , 6 3 \%}$ | $\mathbf{1 7 , 6 8 \%}$ |

Table 14 - Average Increase $15 \%$ increase. This looks high, but it is imperative that one realizes that this number does not correspond to an increase in consumer prices (or spot prices); this is the percentage by which the gross margin of buying at lowest prices and selling at peak prices increases over the course of one year. For the the average increase between the years 2009 and 2011, over all the 29 systems was 17,68\% (median $16,33 \%$ ), and for the Projected scenario the respect matching numbers were $24,63 \%$ and 20,85\% (average and medium, respectively; see

|  | Projected | Actual |
| :--- | :---: | :---: |
|  | $22,54 \%$ | $23,37 \%$ |
| California | $5,90 \%$ | $21,30 \%$ |
| Midwest | $18,43 \%$ | $12,58 \%$ |
| New York | $24,50 \%$ | $-0,65 \%$ |
| PJM | $55,75 \%$ | $46,99 \%$ |
| Overall | $\mathbf{2 0 , 8 5 \%}$ | $\mathbf{1 6 , 3 3 \%}$ |

Table 13 - Median Increase Tables 13 and 14).

The next assumption deals with the length of the short term power price growth, i.e. it determines how many years the short term growth will last. After consulting with experts in corporate banking at Arion Bank it was agreed that 5 years would be an appropriate period.

Finally the long term increase is set at 5\%, which represents roughly one third of the average increase between 2009 and 2011.

### 8.2 Capital expenditure

There are two sets of assumptions in this category. First the prices of the assets are assumed and second, the speed of acquisition (or construction; see Table 15).

The project assumes a purchase of 1 hectare of land. This will be ample for current operations as well as any future expansions. The batteries needed for this project will fit within 8 normal 40 foot containers, so that the area needed for the batteries is about $350 \mathrm{~m}^{2}$. With


Table 15 - Investment Inputs the electrical equipment allocated $150 \mathrm{~m}^{2}$ of space the total area of building would be $500 \mathrm{~m}^{2}$. Provided that the utility ratio of the land is $50 \%$ (maximum half of the land can be occupied for building) the maximum size of buildings on the land is $5.000 \mathrm{~m}^{2}$. This means that the operations can expand ten times without further acquisition of land. The price of land is assumed to be $\$ 300.000 \mathrm{pr} /$ hectare, which is on par with prices of industrial land in Iceland. The land is assumed to be purchased all at once (100\% phasing during first year).

The building would be a simple construction, large enough to shelter batteries and electrical equipment, plus a small storage space and maintenance facility. The model assumes $\$ 1.000 .000$ as the cost of the building, the cost of a simple shell house with specialized wiring and utilities is assumed to be $\$ 1,666 \mathrm{pr} / \mathrm{m}^{2}$ and a size around $600 \mathrm{~m}^{2}$. The building will be erected in year 1 and finished in year two, $75 \%$ phasing in first year)

Equipment is assumed to cost $\$ 10.000 .000$. This number was quoted at a meeting with an electrical engineering expert (Eymundur Sigurðsson, personal communication, March $3^{\text {rd }}, 2011$ ) and then confirmed by the distributers of Siemens in Iceland (Ólafur M. Kjartansson \& Ólaf Sveinsson, personal communications, March $11^{\text {th }}, 2011$ ). All the equipment will be installed during first year.

The model allows for unforeseen additional capital expenditure of $\$ 300.000$, half of which is allocated to first year, the other half to the second.

### 8.3 Operational expenditure

The first four assumptions regarding operational expenditure are associated with the professionals that buy and sell electricity out of and into the electric system (see Table 16). The yearly salary is set at $\$ 75.000$. It is assumed that active traders on the utility market could be contracted to add this responsibility to their portfolio of trading activities. The trading bonuses are then defined as a percentage of gross margin, thus tying the effectiveness of their trading directly to the compensation they receive. Based on the analysis a $2 \%$ bonus would match the traders' salaries after three years on the most profitable systems. The model assumes two traders to be employed, due to the fact that electricity will be traded 24 hours of the day, every day of the year. Finally the model predicts on the accuracy of the traders. The benchmark is always the defined "theoretical maximum", i.e. buying at the lowest possible price and selling at the highest and the traders will strive to reach as high a percentage of that maximum as possible. $95 \%$ is believed to be a reachable goal, based on the fact that a simple algorithm with no integrated intelligence (based on day-ahead projections) achieved 65\% accuracy.

Overhead is set at $\$ 30.000$ a year. The overhead consists of running computers, telephones and internet connections. This amount is to cover these costs in addition to licenses and access to the electricity market exchange where the electricity is traded.

Maintenance on the electrical equipment and building will be outsourced. We assume to pay $\$ 10.000$ a month to a service provider that offers full maintenance service.

There is a build-in contingency of $\$ 100.000$ for operational cost. This will cover any other expenditure that derives directly from operating the business.

We assume that working capital needs to be funded for a set number of years. It is assumed that $\$ 200.000$ will be the addition to the working capital for the first two years. In the first year it will be funded with equity, but in the second with internally generated cash flow.

The traders will have a budget to secure deals and maintain normal customer relations. The budget is set as $0,2 \%$ of revenues.

A leeway of $\$ 300.000$ is given for any unforeseen circumstances and additional cost of starting up the business during the initial year.

### 8.4 Depreciation

It is assumed that Building, Equipment and Other can only be depreciated by $90 \%$, i.e. that a $10 \%$ residual value remains. The building is depreciated by $4 \%$, a standard practice in most cases. The equipment is depreciated by $12,5 \%$, giving them an 8 years lifetime and other items are assumed to


Table 17 - Depreciation Inputs have a lifetime of 4 years (see Table 17).

### 8.5 Debt

The model assumes that $70 \%$ of the equipment cost will be financed with an export credit loan offered in both Germany (Siemens) and Sweden (ABB). Experts assume the cost of this loan to be the rate of local 10 year treasury bonds plus a premium (Erlendur Davíđsson, Arion Bank, personal communication, September 8 ${ }^{\text {th }}, 2011$ \& Jóhann Ingi Kristjánsson, Akurey Investments, personal communications,
 September $15^{\text {th }}, 2011$ ). In the model the German 10 year bond (1,75\%; Bloomberg, 2012) with a 400 point premium is assumed, or $5,75 \%$ interest rate. The length of the loan is directly tied to the depreciation of the collateralized asset, and therefore, it is assumed that it will be paid back in 8 years (see Table 18).

An additional short term loan of $\$ 500.000$ will be taken to finance initial burning of cash. It is assumed to carry 8\% interests and be paid up in 3 years, when the business generates enough cash to easily sustain its operation.

The equity ratio is set at $38.02 \%$ which corresponds with the required equity capital of $\$ 4.600 .000$.

### 8.6 WACC

In order to discount the cash flow from the project and arrive at a meaningful NPV of the investment it is necessary to calculate the cost of the equity for the project, as well as the cost of debt (see Table 19).

In the model we assumed the risk free rate to be the long term (more than 10 years) US treasury bills, 2,71\% (US Department of Treasury, 2012) and we mirrored a standard practice of many corporate bankers in using the work of Aswath Damodaran, Professor at Stern Business School, in assuming the risk premium at 6,19\% (Damodaran, 2012). The beta ( $\beta$ ) for this project is impossible to calculate because it is a correlation between the volatility of the project and the market. The way to calculate it is to find the correlation

| Total capital needed | $\$ 12.100 .000$ |
| :--- | :---: |
| Equity ratio | $38 \%$ |
| Equity | $\$ 4.600 .000$ |
| Debt | $\$ 7.500 .000$ |


| WACC input |  |
| :--- | :---: |
| CAPM |  |
| Risk free rate | $2,71 \%$ |
| Market risk premium | $6,19 \%$ |
| $\beta$ for project | 2,79 |
| $r_{E}$ | $20,00 \%$ |
| $r_{D}$ | $5,90 \%$ |
| WACC (discount rate) | $10,02 \%$ |

Table 19 - WACC Inputs between a set of returns of the project and a set of returns of the market, i.e. find out how much the two change together. So, instead of trying to chase the beta, we decided to fix the rate of equity. The normal expected (desired) return of a risky, startup project is $20 \%$, i.e. an investor would need a return of $20 \%$ to invest in the project. With the rate of equity fixed at $20 \%$, the beta coefficient turns out to be 2,79

Applying the CAPM formula:

$$
r_{e}=r_{f}+\beta\left(r_{m r p}\right)
$$

```
re}=\mathrm{ Return on Equity
rf}=\mathrm{ Risk free rate
rmrp = Market risk premium
```

We fix the $r_{e}$ at $20 \%$ and solve for the $\beta$ :

$$
\begin{aligned}
& 20=2,71+\beta(6,19) \\
& \beta=\frac{20-2,71}{6,19}=2,79
\end{aligned}
$$

The cost of debt is simply the weighted average of the rates on the loans assumed, or $5,90 \%$, and with an equity ratio of $38 \%$ and a tax rate of $34 \%$, we arrive at a cost of capital for the project at $10,21 \%$

Simply applying the WACC formula:

$$
\mathrm{WACC}=\frac{\text { Equity }}{(E q u i t y+D e b t)} \times r_{e}+\frac{D e b t}{(E q u i t y+D e b t)} \times r_{d} \times(1-t a x)
$$

We get:

$$
\mathrm{WACC}=\frac{\$ 4.600 .000}{\$ 12.100 .000} \times 20 \%+\frac{\$ 7.500 .000}{\$ 12.100 .000} \times 5,9 \% \times 66 \%=10,02 \%
$$

### 8.7 Tax

The model assumes 34\% income tax. In 2011 the marginal tax rate in the USA produced a flat $34 \%$ tax rate on income between $\$ 335.000$ to $\$ 10.000 .000$. The projected income of the project falls within these limits. Taxes are calculated on EBT (earnings before tax) and losses are carried over for up to 10 year. The model also calculates $1.65 \%$ property tax on book value of building and land.

### 8.8 Batteries

The battery calculations are only to give the user a sense of physical scope of the project, i.e. how much space it will require. Ford Motor Company will introduce their new electric car, Ford Focus Electric in 2012. This car will have a battery pack that holds 21 kWh of electricity. If it is assumed that these batteries will be used, and that the recharge of these batteries has dropped to $60 \%$ by the time received by this project 5.435 batteries would be needed to store 75 MWh of electricity and they would fit easily into 8 normal 40 foot containers.

## 9 Results

The results of the research are that the project in this form is only to some extent feasible. It should, however, be taken further and a thorough investigation of the most critical assumptions should be conducted. It is also evident that some markets are more ideal for this kind of venture than others and that four of the 29 electrical systems should be focused on and investigated further (see Exhibit 10).

The systems in question are: SoCal, San Diego, SP-15 and Long Island. Those were the only four systems that produced sufficient return on both investment and equity (see Table 20).
 was applied in buying

Table 20 - Four Systems with Sufficient Return on Investment and Equity and selling, a day-ahead projections given by the market was used blindly (Projected); and another where human intelligence was used to actively trade on the market, using real time data to identify the best possible time to buy and sell (Actual).

### 9.1 Projected

This scenario turns out not to be feasible given the assumptions we applied (see Exhibit 11). None of the 29 systems achieved the required $20 \%$ return of equity investment and only in six systems (San Diego, Long Island, NY, Commonwealth, NJ and Pepco) was the investment's IRR above the required rate of $10,02 \%$ (see Table 21). In fact, the average rate of return for the 29 systems was only $6,00 \%$ and $5,40 \%$ of project and equity (respectively), and the average NPV was $\$-2.806 .973$ for the investment and $\$$-4.643.864 for equity. One market did stand out, PJM, but even though the returns there were dramatically better than the other markets (NPV of investment was $\$ 2.387 .333$ on the Baltimore system) it was still quite far from the
defined target rates of return for equity (\$-1.510.370 was the NPV of equity for the Baltimore system).

The accuracy in the day-ahead projections was only about 65\% (on average), i.e. the gross margin

|  | NPV investment | IRR investment | NPV equity | IRR equity |
| :--- | :---: | :---: | :---: | :---: |
| San Diego | $\mathbf{\$ 5 7 7 . 3 3 0}$ | $\mathbf{1 0 , 7 7 \%}$ | $-\$ 2.579 .222$ | $12,01 \%$ |
| Long IsI | $\mathbf{\$ 2 . 5 0 7 . 7 4 3}$ | $\mathbf{1 3 , 1 7 \%}$ | $-\$ 1.434 .188$ | $15,59 \%$ |
| NY | $\mathbf{\$ 7 4 7 . 1 1 6}$ | $\mathbf{1 0 , 9 8 \%}$ | $-\$ 2.477 .387$ | $12,33 \%$ |
| Baltimore | $\mathbf{\$ 2 . 3 7 8 . 3 3 3}$ | $\mathbf{1 3 , 0 2 \%}$ | $-\$ 1.510 .370$ | $15,35 \%$ |
| Dominion | $\mathbf{\$ 8 6 1 . 0 0 0}$ | $\mathbf{1 1 , 1 3 \%}$ | $-\$ 2.409 .444$ | $12,55 \%$ |
| NJ | $\mathbf{\$ 1 . 1 3 6 . 4 7 0}$ | $\mathbf{1 1 , 4 8 \%}$ | $-\$ 2.245 .098$ | $13,06 \%$ |

Table 21 - Six Systems with Sufficient Return on Investment in the projected scenario was only about $65 \%$ of the theoretical max gross margin. All markets had a trading surplus in all years (2009, 2010 and 2011), and in fact all months in all years were traded in a surplus, in all of the 29 markets. However, there were quite a few days that resulted in a trading loss, sometimes in excess of $\$ 7.000$. The biggest problem with the day-ahead projection was that they were completely unable to predict extraordinary activity on the market, i.e. large spikes/drops in power prices. This was often costly, not only because the model missed these opportunities but often times because it traded on the wrong side of it (sold at negative prices, bought at souring prices).

In this form and with the given assumptions this scenario should not be pursued. Nevertheless, with the extensive and detailed data available a more sophisticated algorithm can easily be created, one that learns from its mistakes and is fed real time data from the market. The scenario is not feasible, but should not be totally disregarded.

### 9.2 Actual

The results from the second scenario were somewhat more positive, although with the given assumptions the idea is only feasible on specific systems (see Exhibit 12). 12 of the 29 systems had an IRR of investment higher than the required $10,02 \%$ but only 4 of them achieved a positive NPV of equity. The average rate of return for all 29 systems was 9,14\% and 9,98\% of investment and equity (respectively) and the average NPV was $\$-349.145$ for the investment and $\$-3.245 .572$ for equity. Again California stands out,
with New York and PJM showing some potential. In California all systems resulted in a positive NPV of investment and half of them (SoCal, San Diego and SP-15) also had a positive value of equity, in fact the average IRR of equity in the whole market of California was $1,55 \%$ over the required rate of $20 \%$. Both the New York and PJM markets had three systems that traded with a positive NPV of investment, but only in the Long Island system in New York was the IRR of equity above the 20\% mark. The single highest score of all the systems (by far) was in San Diego, with a NPV of investment of $\$ 10.652 .938$ and an IRR of $21,81 \%$, and the comparable numbers for equity were $\$ 3.153 .378$ and $29,26 \%$ (see Table 22).

The PJM market, as well as New York, had three systems with positive NPV of investment, and although no system in PJM gave a high enough return on equity it is a market worth

|  | NPV investment | IRR investment | NPV equity | IRR equity |
| :--- | :---: | :---: | :---: | :---: |
| Pacific G\&E | $\mathbf{\$ 4 . 3 4 8 . 5 8 1}$ | $\mathbf{1 5 , 2 7 \%}$ | $-\$ 419.696$ | $18,74 \%$ |
| SoCal | $\mathbf{\$ 6 . 3 3 6 . 7 4 2}$ | $\mathbf{1 7 , 4 5 \%}$ | $\mathbf{\$ 7 2 1 . 1 5 7}$ | $\mathbf{2 2 , 1 5 \%}$ |
| San Diego | $\mathbf{\$ 1 0 . 6 5 2 . 9 3 8}$ | $\mathbf{2 1 , 8 1 \%}$ | $\mathbf{\$ 3 . 1 5 3 . 3 7 8}$ | $\mathbf{2 9 , 2 6 \%}$ |
| NP-15 | $\mathbf{\$ 3 . 5 5 5 . 0 0 5}$ | $\mathbf{1 4 , 3 6 \%}$ | $-\$ 880.149$ | $17,35 \%$ |
| SP-15 | $\mathbf{\$ 6 . 2 8 0 . 1 2 6}$ | $\mathbf{1 7 , 3 9 \%}$ | $\mathbf{\$ 6 8 8 . 7 7 8}$ | $\mathbf{2 2 , 0 6 \%}$ |
| Palo Verde | $\mathbf{\$ 4 . 9 3 4 . 7 8 5}$ | $\mathbf{1 5 , 9 3 \%}$ | $-\$ 80.624$ | $19,76 \%$ |
| Hudson | $\mathbf{\$ 4 6 4 . 0 5 8}$ | $\mathbf{1 0 , 6 1 \%}$ | $-\$ 2.707 .849$ | $11,76 \%$ |
| Long IsI | $\mathbf{\$ 6 . 6 8 2 . 1 4 3}$ | $\mathbf{1 7 , 8 2} \%$ | $\mathbf{\$ 9 1 8 . 6 9 2}$ | $\mathbf{2 2 , 7 4 \%}$ |
| NY | $\mathbf{\$ 2 . 7 1 0 . 5 2 6}$ | $\mathbf{1 3 , 3 8 \%}$ | $-\$ 1.372 .855$ | $15,85 \%$ |
| Baltimore | $\mathbf{\$ 2 . 4 9 8 . 9 3 9}$ | $\mathbf{1 3 , 1 2 \%}$ | $-\$ 1.497 .413$ | $15,47 \%$ |
| Dominion | $\mathbf{\$ 1 . 0 3 1 . 2 4 2}$ | $\mathbf{1 1 , 3 3 \%}$ | $-\$ 2.367 .274$ | $12,81 \%$ |
| NJ | $\mathbf{\$ 1 . 1 3 2 . 9 2 8}$ | $\mathbf{1 1 , 4 6 \%}$ | $-\$ 2.306 .608$ | $13,00 \%$ |

Table 22- Twelve Systems with Sufficient Return on Investment looking at. PJM was the market with considerably largest increase in gross margin between the years 2009 and 2011. As mentioned in the Assumptions for financial model chapter, the increase in gross margin is the percentage by which the gross margin of buying at lowest prices and selling at peak prices increases over the course of one year and the average for all markets was $25,39 \%$ (median $18,91 \%$ ). In the six systems within the PJM market this average was roughly $47,7 \%$ and the three systems what showed positive NPV of investment (Baltimore, Dominion and NJ) had 55,71\%, 51,60\% and 62,87\% increase in their gross margin between the years 2009 and 2011 (respectively). If these increase numbers are applied to the model (for only 2 years) and then the long term $5 \%$ growth rate for the consecutive 13 years both systems would show quite different results (see Table 23).

outcome and that
Table 23-- Three PJM Systems with Actual Increase Applied for Two Years
Baltimore, Dominion and NJ had huge growth between 2009 and 2011, the California market turns out to be most feasible. All systems in that market had a positive NPV of investment and 3 systems had a positive NPV for equity as well, and the calculated growth rate was healthy $31,68 \%$ and $17,7 \%$ in SoCal and San Diego (respectively).

The results from the research were that it is feasible to conduct electrical trading on 4 of the 29 systems, SoCal, San Diego, SP-15 and Long Island. Based on these findings some further calculations were made on the four systems to assess the vulnerability of the outcome and to identify the effect a variance in the assumptions have on the results.

## 10 Sensitivity

The results of the research are that electrical arbitrage is feasible on four systems if the assumptions the model is based on hold true. To assess the level of depth to the results and how strong a foundation they are built on, a sensitivity analysis was made on these underlying assumptions. First a single dimension analysis was made to gauge what assumptions are most vulnerable to variation, i.e. change to what assumptions have the most severe effect to the change of the outcome. Once the assumptions had been assessed and the most critical ones identified, a two dimensional analysis was performed. The most critical assumptions were tested interacting with each other (and not only as stand-alone) and the effect on the outcome calculated.

For the single dimension analysis two types of output were created, a "Spider chart" and a "Tornado chart", and based on the results from that analysis a two dimensional "two-variable matrix data table" was created .

The analysis was carried out on the basis of both the investment as a whole as well as the equity part of it, and thus the same set of calculations was made for both NPV of investment and NPV of equity.

### 10.1 Single dimension analysis

The reason this analysis is called single dimension is because only one variable is tested at a time, all other assumptions are kept at their initial value.

For the single dimension analysis ten assumptions were tested:

- Cost of Investment/Equity
- Increase in power prices
- Equipment
- Power losses
- Salaries
- Trader accuracy
- Maintenance
- Start-up expense
- Working capital
- Corporate tax rate

As mentioned above both "Spider charts" and "Tornado charts" are the output of a single dimension analysis. It means that they are the results of a set of tests where a single assumption at a time is tested, keeping all other assumptions fixed. In our analysis the 10 assumptions were tested with a variation of $20 \%$ to both sides, i.e. each assumption was treated as a variable and given extreme values of $20 \%$ better and $20 \%$ worse. Thus we get an output of three data points for each of the variable tested. E.g. when the first variable (Cost of Investment/Equity) was tested, all the other variables were fixed (i.e. they kept their initial value). Then the NPV was calculated with three values of Cost of Investment/Equity, a) the initial value (Base Case); b) 20\% lower value (Best Case); and c) 20\% higher value (Worst Case). This gave three different outcomes for NPV. The same calculations were made for all other assumptions.

### 10.1.1 Spider charts

The 10 assumptions that were thought to be the most influential on the outcome were chosen, and a worst and a best case was assigned (see Table 24).



Figure 20 - Spider chart for Long Island, Linear representation of each assumption's effect on NPV of Investment

The lines represent each assumption and the steeper the slope of the line, the bigger effect the assumption has on the outcome. Based on the pictures it was evident that five of the assumptions had considerable effect on the outcome (large incline) while the effect of the other five was limited.

This calculation was made for NPV of investment and equity on all 4 systems, 8 sets of calculations in total. All 8 spider charts were uniform and indicated that there were potentially five assumptions that had major effect on the outcome, i.e. had the steepest incline (see Exhibit 13):

- Discount rate (WACC or cost of equity)
- Increase in power prices
- Equipment
- Trader accuracy
- Corporate tax rate

To find out if all these assumptions had the same effect on the outcome, or if there was a level to their influence a tornado charts were created. This helped with gauging the scope and the volume of the influence each of the assumptions had on the results.

### 10.1.2 Tornado charts

Like the Spider charts, Tornado charts are an output of a single dimension analysis and the same principle is applied to both methods, i.e. varying one assumption while fixing all the others. The Tornado is a visual representation but unlike the Spider it gives a better sense of the volume of financial variation the change in each assumption has on the outcome. So to investigate further whether the five most influential assumptions
had the same effect on the outcome, Tornado charts was created to see the absolute number effect on the end result (see Fig. 18).

The calculation for a tornado chart is the same as for a spider chart, but the tornado chart visualizes the change in absolute numbers of the outcome, instead of the relative change. The tornado chart confirmed the results of the spider


Figure 21 - Absolute Value of each Assumption's Effect on NPV of Investment chart. There are five variables that have the greatest effect on the outcome, but the tornado also calculates how the difference between the expected value and the certain equivalent is affected by the uncertainty of a specific input variable, i.e. how much each variable influences the outcome based on the uncertainty of the input (see Table. 25).

The table shows the three values each assumption is given (base, worst- and best

| Input Variable | NPV of Investment |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Low Output | Base Case | High Output | Low | Base | High | Swing | Swing ${ }^{2}$ |
| WACC | 12,02\% | 10,02\% | 8,02\% | \$4.492.557 | \$6.678.480 | \$9.330.276 | \$4.837.719 | 37,1\% |
| Increase in power prices | 12\% | 15\% | 18\% | \$4.731.864 | \$6.678.480 | \$8.811.187 | \$4.079.323 | 26,3\% |
| Equipment | \$12.000.000 | \$10.000.000 | \$8.000.000 | \$5.124.660 | \$6.678.480 | \$8.207.462 | \$3.082.803 | 15,0\% |
| Trader accuracy | 90\% | 95\% | 100\% | \$5.189.258 | \$6.678.480 | \$8.155.547 | \$2.966.289 | 13,9\% |
| Corporate tax rate | 41\% | 34\% | 27\% | \$5.601.841 | \$6.678.480 | \$7.755.119 | \$2.153.278 | 7,3\% |

case) and gives the corresponding number value of the outcome if all other assumptions are kept fixed at their base value. The table also shows how much the outcome varies between the two extremes, i.e. how much the outcome "swings" between the worst case and the best. Finally the table shows how much influence each assumption has on the outcome based on its uncertainty in a metric called "Percent Swing". The results in all eight calculation sets were uniform, the Percent Swing ${ }^{2}$ indicated that there were three assumptions that were the most relevant and had the largest impact on the
outcome (even though the order of the second and third assumption alternated between power systems). The most influential assumptions were:

- Discount rate (WACC or cost of equity)
- Increase in power prices
- Equipment

Knowing that three assumptions had by far the most effect on the outcome a two dimensional analysis was performed. This allowed us to see how the change in two assumptions at the same time would affect the outcome.

### 10.2 Two dimensional analysis

### 10.2.1 Matrix data tables

Having determined the three most significant assumptions a two dimensional matrix data tables were created to see the effect changes in two of the variables at the same time have on the outcome. Three tables were created for each of the four systems for the total investment and three for equity, resulting in 24 individual tables (see Exhibit 14).

The variables are arranged with a range of values from bad to good with the base value in the middle, e.g. "Increase in power prices" were arranged with $15 \%$ in the middle with $10 \%$ on the "bad" end and $20 \%$ on the "good" one. One variable is arranged vertically the other horizontally, thus creating a matrix. The outcome is then calculated based on the matching value of both variables (see Table. 26)

not particularly sensitive to changes in any of the assumptions while the NPV of equity is much more vulnerable to change.

The one dimensional analysis exposed the order in which the assumptions affect the outcome, both calculated for the total investment as well as equity. When calculated for
total investment the "WACC" (discount rate) is by far the most influential variable with "Increase in power prices" a dominant runner up. When it comes to calculations for equity the front runner is also "Return on equity" but the runner up is "Equipment" in all but one system (San Diego) where "Increase in power prices" edges in front (see Table 27).

| that five |  |  |  |  |  | Return on eq |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | 3.153.378 | 23\% | 22\% | 21\% | 20\% | 19\% | 18\% | 17\% |
| variables have | $\begin{aligned} & \text { D } \\ & \stackrel{\rightharpoonup}{\partial} \\ & \stackrel{\rightharpoonup}{W} \\ & \stackrel{W}{0} \end{aligned}$ | 17,25\% | 2.684.710 | 3.126.157 | 3.605.835 | 4.127.861 | 4.696.874 | 5.318.103 | 5.997.452 |
|  |  | 16,50\% | 2.405.702 | 2.830 .865 | 3.292.885 | 3.795.737 | 4.343.895 | 4.942 .405 | 5.596.966 |
|  |  | 15,75\% | 2.132.746 | 2.542.019 | 2.986.810 | 3.470.952 | 3.998.764 | 4.575.110 | 5.205.490 |
| the greatest | 3 | 15,00\% | 1.865.735 | 2.259.504 | 2.687.486 | 3.153.378 | 3.661.341 | 4.216.069 | 4.822 .862 |
|  |  | 14,25\% | 1.604.565 | 1.983.209 | 2.394 .795 | 2.842 .884 | 3.331.488 | 3.865.131 | 4.448 .923 |
| impact on the | - | 13,50\% | 1.349.130 | 1.713 .022 | 2.108.616 | 2.539.344 | 3.009.069 | 3.522.151 | 4.083.514 |
|  |  | 12,75\% | 1.099.328 | 1.4488 .834 | 1.828.833 | 2.242 .631 | 2.693.949 | 3.186.984 | 3.726.480 |
| overall out- | Table 27 - Matrix Data Table Long Island Equity with Return on Equity and Increase in Power Prices |  |  |  |  |  |  |  |  |
| come and |  |  |  |  |  |  |  |  |  |

three of them play a crucial role. However, in both cases (project and equity) the sensitivity of the outcome is small enough to sustain a change of $10 \%$ in two assumptions at the same time, and for the NPV of investment it can easily sustain 15\% negative variation in any two of the three most influential variables at the same time.

## 11 Discussion

In this thesis the feasibility of buying electricity on an openly traded electricity market, storing it in electric car batteries and reselling it to the market was investigated. The result of the research is that it is feasible to conduct electric energy price arbitrage on four of the twenty nine systems tested:

- SoCal
- San Diego
- SP-15
- Long Island

The present value of the cash generated in the operation on these systems was higher than the value of the cash needed to set it up, i.e. it is economical to spend the money in setting up the facilities and the operations because the cash generated by the business more than compensates the initial investment, even with opportunity costs, risk and time value of money taken into account.

These findings suggest that a further investigation should be conducted on the conditions of those four systems, a thorough due diligence on the assumptions of the model should be made and a business plan created.

### 11.1 Groundwork

The research is based on a simple idea: to exploit the inherent inefficiencies of an electrical energy system to conduct electrical arbitrage. It is understood that for this to be possible a basic understanding of electricity and its physical attributes, challenges and opportunities, is paramount. The thesis, therefore, started out by taking a look at electricity itself, the history behind it and how men have gradually gained control over harnessing it. The different types of generation methods were reviewed and also the mismatch between the efficient production of electricity and the demand for it, i.e. the "peak power problem", which is the underlying precondition for the research.

Having established that there are inherent inefficiencies in the electric market and that the volatility has diurnal cycles, solutions to store electricity to exploit these inefficiencies were investigated. It turns out that energy storage has been conducted for
decades and after exploring the most commonly used technologies a decision was made to focus on BES systems. The decision was taken by a process of elimination, batteries were the only option that served the quantity and mobility we needed, i.e. was a geographically independent energy application.

To decide what types of batteries would best suit the project recent technology advances and potential accessibility in the future were taken into account. The latest trends within the auto industry and the electrification of the common car made lithium ion batteries a logical choice. The reason was twofold:

- Considerable corporate and official resources (money and brain power) are being allocated to finding new advances in Li-ion battery technology
I.e. lithium ion batteries are good and steadily improving, and the second reason was because they fulfill the second prerequisites for the project (access).

There were two other prerequisites that needed to be fulfilled in order to test the economics of the project once all the all the technological issues have been adequately dealt with (i.e. having determined that energy storage was indeed possible):

- Access to an open electricity market
- Access to a sufficient number of batteries

A short look at the US electrical markets suffices to satisfy the first premise, but to answer the second one a better look at the electric car and the plans of major auto manufacturers was needed. Many large car manufacturers have announced their electric vehicles for rollout in the coming years and the US government plans to have over a million electric cars on the streets by 2015. Most of these electric cars will be powered by lithium-ion batteries, hence the increase in number of batteries will be dramatic and thus the access to them.

Having defined the technological scope of the project and with all the prerequisites satisfied a feasibility study was conducted on a 15 years operation. The calculations were based on a free cash flow method, but no terminal value was assigned at the end of the 15 years. The reason for the absence of terminal value calculations are explained in chapter 4, "Model Limitations".

### 11.2 Research

After consulting with industry experts it was decided to investigate the feasibility of trading 75MWh of energy using 25MW equipment. This means that the operation must buy and sell 3 hours of electricity each day on a continuous cycle, i.e. energy has to be bought and sold for 3 consecutive hours. Each day was treaded as isolated (you could not buy/sell between two days) and thus 22 unique cost data for 75 MWh of energy each day was calculated.

Detailed, hourly price data was collected from five of the ten independent electrical US markets for the years 2009, 2010 and 2011, and uploaded into our model. Each market had 5-6 electricity systems resulting in 29 systems, and each system was treated as independent. The data collected contained two sets of information, projected prices (estimations from the previous day) and actual prices. The data was used to construct two scenarios:

- Projected - where the day old estimates were used to buy electricity (representing theoretical minimum)
- Actual - where energy was bought at lowest prices and sold at highest (representing theoretical maximum)

Having two sets of 22 unique cost data made it possible to calculate cost and revenue of buying and selling energy in two different scenarios. In the Projected scenario, energy was bought at the time the predicted price would be lowest and sold at a time predicted as being highest giving a theoretical minimum, because no intelligence was applied only extrapolation of the previous day's data. In the Actual scenario, energy was bought at the cheapest price and sold at the highest, thus providing the theoretical maximum. The accuracy of the projections turned out to be about $65 \%$, i.e. trading on predictions gave $65 \%$ lower gross margin than was the theoretical maximum.

With all the data arranged and cost, revenues and gross margin of each day calculated it could be imported into the model. The model calculates NPV and IRR of a 15 year project, based on 39 different assumptions in eight categories. Each assumption was arrived at through a rigorous process of research, interviews, experience and common sense and then verified by industry experts. Applying all the
assumptions to the data gave results for all the 29 systems. The results were then categorized into two categories

- Investment - results applying to the whole project, i.e. cash that can be used to pay debt, distribute as dividends and/or plowed back into the project
- Equity - results applying to the equity of the project, i.e. cash that can be used to distribute as dividends and/or plowed back into the project

NPV and IRR was calculated for both categories and the results were that 12 systems had positive NPV in the first category but only four of systems had positive NPV of equity. These four systems were investigated further to ascertain how sensitive the outcome was to change in the most important underlying assumptions. Three sets of analysis were done and it turns out that in the investment category the outcome of all of the four systems can sustain considerable negative variation in two of the most critical assumptions at the same time In the equity category the results are strong enough to handle mild negative variation in two assumptions simultaneously. The results are therefore that four systems show clear signs of arbitrage feasibility and should be further investigated.

### 11.3 Limitations

Because this research is conducted only to determine if electric energy price arbitrage is feasible based on the operation of such a project, it ignores important aspects of a potential energy storage venture. The study does not include the acquisition cost of batteries, the political and/or environmental impact of the operation (such as the benefits of reducing $\mathrm{CO}_{2}$, stabilizing the electric grid, and disposing of the batteries), and because of the absence of these important factors a terminal value is not assigned at the end of the 15 year operation.

This was done for the sake of simplicity. The thesis is a feasibility study and not a business plan and because a positive outcome of a feasibility study is needed to justify the efforts of a full blown business plan it was therefore, decided to conduct such a study first. The positive outcome of this research, however, begs the question of what steps should be taken next.

### 11.4 Next steps

Because it is feasible to conduct electrical arbitrage on four of the systems investigated in the research it would be a terrible waste not to investigate those systems further and see if the assumptions hold true and profit can be made from such a venture. A number of things would have to be done before the theoretical idea becomes a physical project, but because we have investigated the feasibility of the venture we can justify the effort of examining it further. The next steps would fall into three categories:

- Fixing the underlying cost assumptions
- Designing and engineering
- Acquiring batteries


### 11.4.1 Fixing underlying cost assumptions

For the first category a number of steps can be taken to get a firmer grip on the parameters of the operation. Most of these steps involve interaction with a person or company in order to create trust, build a relationship and secure a contract. A few examples of possible steps include:

### 11.4.1.1 Electric equipment contracts

Electric equipment manufacturers should be identified and engaged. The large suppliers Siemens, ABB and GE would be an obvious choice as well as other European and East-Asian companies. The goal here would be a signed memorandum of understanding (MOU) or letter of intent (LOI) on price, conditions and financing of equipment for the project. If the companies are unable (or unwilling) to assist in financing local state regimes, e.g. European export credit or the China Development Bank should be approached.

### 11.4.1.2 Contacting CALED and ESD

The California Association for Local Economic Development (CALED) and the Empire State Development (ESD) should be contacted. They are economic development agencies for the state of California and New York (respectively) and would be a valuable ally in preparing and managing the setup of a project in their states. They possess valuable information and statistics on local business environment and
economic affairs and have connections into local businesses as well as governmental agencies and institutions.

### 11.4.1.3 EPC contract

EPC contractors should be contracted to oversee the entire engineering, procurement and construction of the physical project. The local Icelandic engineering firms should initially be approached as they could provide assistance and (perhaps) act as subcontractor. CALED and ESD could assist with finding a EPC contractor in their respective areas.

### 11.4.1.4 HR information

Headhunting agencies and local traders should be visited and interviewed to get a better idea of price and the salary structure of electricity traders. CALED and ESD could provide valuable assistance on this issue.

### 11.4.1.5 Electric grid operator

The electrical grid operator in California should be approached and a MOU should be signed. It is imperative to understand the rules, regulations, limitations and conditions there regarding operation on the California- and New York electric grid. Information on grid security, power losses and incentives for non-fossil solutions would provide important information to the assumptions. The Icelandic grid operator Landsnet, and CALED and ESD could assist with identifying the appropriate contact(s).

### 11.4.2 Designing and engineering

Parallel to establishing business relationships with potential vendors, partners and customers and gathering information into the business model, considerable work can be done on the designing and engineering front, e.g.:

### 11.4.2.1 Computer system

A computer system can be designed that applies artificial intelligence to the historical data in order to better predict future prices. In this thesis the simplest possible algorithm is used to extrapolate when to buy and when to sell based on historical data, and this simple algorithm resulted in 65\% accuracy. A computer engineer should be able to come up with a program that learns from its mistakes in order to increase
the accuracy. This could easily be done in a graduate level academic setting, as a project or thesis.

### 11.4.2.2 Battery system

The interaction between thousands of batteries and the interconnection of an integrated battery system needs to studied and designed. The chemical and physical properties of the batteries need to be understood, e.g. charge and discharge time, durability, lifetime, effect of expedite charging, etc., as well as the limitations and challenges of having thousands of batteries interconnected. Such a study is also ideal for academic work on a graduate level.

### 11.4.3 Acquiring batteries

The final category deals with how to acquire the batteries, who should bear the cost and how it should be split. A number of possible solutions are available for tying environmental- and political aspects into the equation as well as focusing on the purely commercial aspect.

### 11.4.3.1 Partnership with auto manufacturer

A partnership with car manufacturer would provide considerable value to both parties as it would provide the venture with the batteries for storage while providing the auto manufacturer ways to relieve perceived risk, thus lowering the risk for the buyer, making the electric car more sellable.

One of the challenges the car manufacturers face when introducing the electric car is the psychological barrier the consumer has to overcome regarding the perception of maintenance. It is a common perception that an electric car demands extensive maintenance and replacing the battery pack every few years acts as a deterrent from purchasing such vehicle.

Partnership can supply a solution, for by partnering with an energy storage project the auto manufacturer can offer deals on new cars, where the buyer would be able to return the used battery and be replaced with a new one. The auto company will offset the cost of this service through the increased sales and the revenues of the electricity arbitrage.

### 11.4.3.2 Recycling intermediate

One business model would be to act as an intermediate between the consumer and the recycling plant. An owner of an electric car needs to replace the primary battery of his car every few years, because the performance demand on cars are such that when the car's range has dropped below a certain point the battery of that car will be replaced. These replaced batteries are not unusable and even though they are unfit for cars they still have $60-70 \%$ of their charge left. An intermediate would collect these batteries, use them while they still maintain charge and then have them recycled. This venture would provide an additional value to the community because it would be responsible for collecting used batteries and recycling them, and not letting them be thrown away. There is a possibility of an environmental incentive as well as a political backing for such a project.

### 11.4.3.3 Environmental incentives

The project set up for electric arbitrage is inherently $\mathrm{CO}_{2}$ friendly. It exploits the cyclical nature of power prices and by doing so it evens out the imbalances on the grid (reduces the spikes), which otherwise would be met with by increasing output from fossil fuel power plants. Evening out the spikes means reduction of $\mathrm{CO}_{2}$ on the electric grid and for such projects you can get environmental incentives in California and New York.

### 11.4.3.4 Political incentives

One of the bigger issues in US politics is energy security as Americans are by far the largest consumers of energy in the world. Their electric grid is however old and outdated and because this project acts as a regulator on the electric system (reducing imbalance) there is a possibility of getting political incentives in the name of energy security.

Of course this list is by no means exhaustive, but it gives a good indication of the possibilities of an energy storage project. And once the project preparation reaches this stage with all these important aspects already included into the model, terminal value must be assigned at the end of the operation horizon for a comprehensive valuation of the project.

## 12 Conclusion

Electric price arbitrage using battery energy storage is feasible and the idea should be pursued further.

The research in this thesis demonstrates the feasibility of conducting energy arbitrage on four of the 29 systems studied. Each of those four systems produced positive NPV for the total investment as well as the equity part of it, based on calculations from historical data. The results were tested and all systems could withstand considerable negative variation on two of the most important assumptions simultaneously without producing negative NPV.

Having established the feasibility, considerable effort should be put into actualizing the underlying idea. The four performing systems should be further investigated and the other 25 discarded. The grid operators on the four systems should be contacted as well as local economic development agencies. Financial- and human capital should be allocated to fixing the underlying assumptions and designing the necessary battery- and computer systems as well as creating an extensive business plan, which includes acquisition of batteries, political importance and environmental impact.

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| Preliminary Real-Itme Prices with Forecasted and Actual System Load |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | Avg. | Hr \$ |
| Hour Ending: | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | All | On Pk |
| Pacific G\&E | 25.62 | 26.28 | 23.08 | 22.26 | 18.86 | 26.89 | 23.31 | 18.31 | 33.67 | 41.99 | 34.04 | 38.85 | 37.33 | 38.42 | 34.24 | 39.94 | 40.47 | 40.47 | 37.08 | 31.25 | 31.20 | 28.07 | 33.57 | 26.28 | 31.31 | 34.29 |
| SoCal Edison | 24.96 | 25.32 | 22.21 | 21.40 | 18.17 | 26.02 | 23.01 | 18.06 | 26.31 | 29.60 | 32.04 | 39.69 | 41.10 | 40.00 | 43.21 | 41.87 | 42.30 | 42.10 | 38.35 | 32.01 | 31.71 | 28.46 | 30.97 | 26.06 | 31.04 | 34.36 |
| San Diego G\&E | 24.93 | 25.24 | 22.16 | 21.34 | 18.14 | 26.01 | 23.06 | 18.15 | 26.40 | 29.63 | 32.04 | 39.71 | 41.15 | 40.00 | 43.26 | 41.97 | 42.38 | 42.07 | 38.25 | 31.94 | 31.61 | 28.43 | 30.91 | 25.94 | 31.03 | 34.38 |
| NP-15 | 24.72 | 25.34 | 22.23 | 21.48 | 18.32 | 26.12 | 22.43 | 17.77 | 27.73 | 32.17 | 31.16 | 37.06 | 35.69 | 36.65 | 32.47 | 38.25 | 38.71 | 38.83 | 35.61 | 30.05 | 29.83 | 26.82 | 30.42 | 25.35 | 29.38 | 31.95 |
| SP-15 | 24.41 | 24.76 | 21.73 | 20.94 | 17.78 | 25.46 | 22.63 | 17.75 | 25.80 | 28.98 | 31.31 | 38.74 | 40.13 | 39.03 | 42.23 | 40.84 | 41.27 | 41.05 | 37.43 | 31.30 | 31.03 | 27.90 | 30.20 | 25.44 | 30.34 | 33.59 |
| Palo Verde | 24.05 | 24.41 | 21.42 | 20.66 | 17.52 | 25.06 | 22.19 | 17.35 | 25.26 | 28.42 | 30.71 | 38.08 | 39.62 | 38.56 | 41.78 | 40.40 | 40.85 | 40.59 | 36.97 | 30.85 | 30.43 | 27.28 | 29.79 | 25.10 | 29.89 | 33.08 |
| DA Forecast (GW) | 26.66 | 25.10 | 24.12 | 23.63 | 23.86 | 24.93 | 26.27 | 28.38 | 30.39 | 32.20 | 33.93 | 35.26 | 36.23 | 37.46 | 38.46 | 39.14 | 39.36 | 38.80 | 37.64 | 36.28 | 36.15 | 34.94 | 31.89 | 28.76 |  |  |
| Forecast Error \% | -9.1\% | -9.0\% | -9.0\% | -9.0\% | -8.7\% | -8.1\% | -7.1\% | -6.6\% | -6.1\% | -5.9\% | -5.4\% | -5.5\% | -6.2\% | -6.3\% | -6.7\% | -6.8\% | -6.6\% | -6.4\% | -6.7\% | $-6.7 \%$ | -7.0\% | -7.7\% | -8.1\% | -8.4\% |  |  |


DA

| -4.9\% | 5-9.9\% | 10\% |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | On |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Pactic | Ending: | - ${ }^{17,05}$ | 32,42 | 29,17 | 28,59 | 27,91 | 30,98 | 31,35 | 34,9 | 36,76 | $\frac{10}{41,01}$ | 44,1 | 46,52 | $\stackrel{13}{46,89}$ | ${ }_{49,51}^{14}$ | 57,04 | $\frac{16}{60,76}$ | 67,57 | 51,48 | 50,83 | -47,69 | 47,34 | 44,87 | ${ }_{39,44}^{23}$ | 35,54 | A2,49 | - ${ }_{\text {47,41 }}$ |
| SoCal | Edison | 36,16 | 31,53 | 28,26 | 27,56 | 27,01 | 30,05 | 30,86 | 34,36 | 36,47 | 40,97 | 44,64 | 47,44 | 49,31 | 51,26 | 58,96 | 69,44 | 69,7 | 52,99 | 51,92 | 48,46 | 47,7 | 45,53 | 39,11 | 35,03 | 43,11 | 48,75 |
| San | Diego | 36,13 | ${ }^{31,56}$ | 28,24 | 27,58 | 27,02 | 30,03 | 31,01 | 34,48 | 36,67 | 41,01 | 44,49 | 47,12 | 48,95 | 50,76 | 58,37 | 68,77 | 68,85 | 52,33 | 51,2 | 48,2 | 47,42 | 45,36 | 38,91 | 35,1 | 42,9 | 48,44 |
| NP-15 |  | 36,15 | 31,63 | 28,44 | 27,91 | 27,26 | 30,21 | 30,57 | 33,94 | 35,45 | 39,6 | 42,58 | 44,96 | 45,28 | 47,84 | 55,07 | 58,48 | 65,21 | 49,75 | 49,19 | 46,17 | 45,78 | 43,45 | 38,3 | 34,6 | 41,16 | 45,83 |
| SP-15 |  | 35,41 | 30,9 | 27,71 | 27,03 | 26,48 | 29,42 | 30,36 | 33,72 | 35,76 | 40,13 | 43,63 | 46,29 | 48,12 | 49,94 | 57,39 | 67,61 | 67,8 | 51,64 | 50,7 | 47,42 | 46,71 | 44,62 | 38,15 | 34,31 | 42,14 | 47,62 |
| Palo | Verde | 34,76 | ${ }^{30,36}$ | 27,25 | 26,63 | 26,07 | 28,93 | 29,63 | 32,93 | 34,9 | 39,11 | 42,55 | 45,24 | 47,14 | 49 | 56,39 | 66,47 | 66,64 | 50,74 | 49,72 | 46,45 | 45,59 | 43,49 | 37,42 | 33,6 | 41,29 |  |
| A | Forecast | Load | (GW) | 26,7 | 25,1 | 24,1 | 23,6 | 23,9 | 24,9 | 26,3 | 28,4 | 30,4 | 32,2 | 33,9 | 35,3 | 36,2 | 37,5 | 38,5 | 39,1 | 39,4 | 38,8 | 37,6 | 36,3 | 36,1 | 34,9 | 31,9 | 28,8 |




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| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Revenus | 20.208 | ${ }_{1}^{165.256}$ | ${ }^{127.843}$ | ${ }_{1059}^{10.982}$ | ${ }^{187.018}$ | ${ }_{178}^{17833}$ | 232.415 | 204.279 | 169.899 | 106.118 6.850 | 126.33 <br> 755 | 196.991 108915 | ${ }^{2.005 .155}$ |
|  | coas | 101.277 | 81.042 | 57.230 | ${ }^{61.253}$ | 76.139 | ${ }^{73,456}$ | 83.918 | 77702 | 71.384 | 60.850 | 74.555 | 108.415 | 927.217 |
|  | GM | 103.931 | 84.214 | 70.614 | 44.730 | 110.879 | 104887 | 148.988 | 126.578 | 98.425 | 45.268 | 51.838 | 88.076 | 1.077 .938 |
| NEMass |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Revenues | 198.176 | 157.588 | 122.015 | 119.508 | 174.394 | 171.175 | 22.025 | 197.75 | 169.583 | 102.509 | ${ }^{123.003}$ | 189.053 | 1.946 .787 |
|  | coas | 99.800 | 79.017 | 56.098 | 59.740 | 74.680 | 72.603 | 82.780 | 76.564 | 71.206 | 61.287 | 74.713 | 106.808 | 915.294 |
|  | ¢M | 98.376 | 78.51 | 65.917 | 59.768 | 99.714 | 98.571 | 139.245 | 1221.194 | 98.378 | ${ }^{41.222}$ | 48.291 | 82.245 | 1.031 .493 |
| NH |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | ${ }^{\text {Revenues }}$ | ${ }^{199.646}$ | ${ }_{\text {120, }}^{1587}$ | ${ }^{120.354}$ | 94.800 | 170.955 | 169.569 | ${ }^{221.452}$ | 196.950 | 165.267 | 103.240 | ${ }^{122.085}$ | 187.042 | 1.900 .998 |
|  | $\frac{\text { coas }}{6 m}$ | $\frac{98.646}{98.000}$ | ${ }^{78.191}$ | ${ }_{5}^{56.360}$ | ${ }_{58.539}^{36261}$ | $\frac{74.294}{96.661}$ | $\frac{72.294}{97275}$ | ${ }_{8}^{82.616}$ | 7.169 | $\frac{71.272}{03,066}$ | $\frac{61.340}{11900}$ | 74.005 | 105.530 | 908.233 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| ME |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Revenues coas | ${ }_{\text {971.938 }}^{195}$ | 157.383 75.548 | ${ }_{55 \text { c.352 }}^{129.53}$ | 89.250 56.099 | ${ }_{71.639}^{159.31}$ | 164.376 70.629 | ${ }_{\substack{210.757 \\ 80.279}}$ | ${ }_{\substack{190.457 \\ 74.15}}$ | 161.140 70.116 | ${ }_{\substack{10.149 \\ 60.263}}$ | $\xrightarrow{118.743}$ | 181.588 102893 | ${ }_{\text {l }}^{1.858 .460} 88.671$ |
|  | $\underline{6 m}$ | 98.556 | 81.835 | ${ }_{7} 7.2511$ | ${ }^{33.151}$ | ${ }_{87} 8.713$ | ${ }_{93,777}$ | ${ }_{1}^{80.478}$ | ${ }_{116.342}$ | ${ }_{9} 9.1024$ | ${ }_{39,886}$ | ${ }_{46.141}$ | ${ }_{7} 78.705$ | 97.1 |
| Internal |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Revenues | 198.679 | 157.941 | ${ }_{122.861}$ | 100.170 | 177.740 | 172.836 | 224.146 | 198.966 | 166.538 | 103.225 | 123.846 | 190.659 | 1.937.607 |
|  | coos | 100.414 | 79.756 | 56.595 | 60.239 | 75.574 | 73.17 | 84.628 | 78.075 | 71.494 | ${ }_{61.437}$ | 75.072 | 1007828 | 924.288 |
|  | ¢M | 98.265 | 78.885 | 66.266 | 39.932 | 102.166 | 99.659 | 139.518 | 120.891 | 95.044 | 41.788 | 48.774 | 82.831 | 1.013 .320 |
| Pacficicge |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | ${ }_{\text {Reverues }}$ | 155.090 76096 | ${ }_{\text {17 }}^{114.725}$ | ${ }_{\substack{123.760}}^{54015}$ |  | ${ }_{1}^{179.897}$ | ${ }^{289345}$ | ${ }^{130.922}$ | 129.228 | 169.83 | ${ }^{219.567}$ | ${ }^{210,747}$ | 20.5510 | 2.089 .636 |
|  | cocs | 76.966 88095 | 57.467 | $\frac{54.015}{697}$ | $\frac{39.227}{110816}$ | ${ }^{13.711}$ | ${ }^{6} \mathbf{6}$ 29577 | $\frac{23.877}{107005}$ | ${ }_{\text {c }}^{33.339}$ | ${ }^{33.150}$ | 55.974 | ${ }_{\text {5, }}^{5}$ | 35.459 | ${ }^{470.764}$ |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| socal | Revenues | 248.924 | 209.884 | 161.515 | 159.096 | 161.781 | 278.912 | 241.45 | 195.159 | 180.080 | 235.682 | 217.077 | 240.571 | 2.530 .127 |
|  | cocs | 70.527 | 57.04 | 52.650 | 38.341 | 11.813 | ${ }^{-6.181}$ | 23.314 | 31.678 | 31.319 | 51.661 | 48.989 | 33.653 | 444.768 |
|  | ¢ | 178.398 | 152.880 | 108.865 | 120.755 | 199.969 | 285.093 | 218.131 | 163.881 | 148.761 | 184.021 | 168.088 | 206.918 | 2.085.359 |
| San Diego |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Revenues coos | 164.736 68795 | 136.390 56.465 | ${ }_{\substack{147.505 \\ 52774}}$ | ${ }_{\substack{175.734 \\ 38.278}}$ | ${ }_{\substack{162.871 \\ 11.688}}$ | $\underset{\substack{282.144 \\ \text { c. } \\ \hline 191}}{ }$ | ${ }_{\substack{212.370}}^{23282}$ |  | 年30.913 | ( | ${ }_{\text {ckich }}^{257.375}$ | ${ }_{\substack{42.712 \\ 33719}}$ | ${ }_{\text {2.565.196 }}^{\text {40097 }}$ |
|  | ¢9 | 95.941 | ${ }_{79.925}$ | 99.731 | 133.457 | 151.233 | 288.134 | 189.088 | 160.999 | 191.23 | 189.747 | 208.728 | ${ }_{366.93}$ | ${ }^{2.124 .199}$ |
| Np.15 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | ${ }^{\text {Reverues }}$ | 160.178 765097 | ${ }_{\text {1 }}^{110.003}$ | ${ }^{119.996}$ | 145.491 | 175.125 | 27.530 | ${ }^{124.41}$ | ${ }^{123.399}$ | ${ }^{162.636}$ | 216.948 | 203.573 | 200.723 | 2.014 .094 |
|  | coas |  | 56.542 | 53.057 | 38.427 |  | ${ }^{-6.501}$ | 22.881 |  | ${ }^{32.547}$ |  |  |  | 461.102 |
|  | GM | 84.081 | 53.861 | 66.939 | 107.065 | 1161.946 | 278.031 | 101.260 | 90.816 | 130.089 | 161.92 | 150.628 | 165.985 | ${ }^{1.552 .692}$ |
| sp-15 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Revenues coos | ${ }_{\substack{226.666 \\ 69020}}$ | 187.924 55885 |  | 154.979 37.849 | 157.390 11.507 | ${ }_{\substack{\text { c.0.72 }}}^{27.72}$ | ${ }_{\text {22, }}^{223888}$ | ${ }_{\substack{188.877}}^{31123}$ |  | $\underset{\substack{234.315 \\ 50.732}}{ }$ | ${ }_{48.035}^{210.614}$ | 232.29 33,268 | ${ }_{\text {2, }}^{2.411 .116}$ 43.965 |
|  | ¢M | ${ }_{159.646}$ | ${ }_{\text {132.039 }}$ | ${ }_{10}^{10.3088}$ | ${ }_{117.730}$ | ${ }_{1455.884}$ | $\stackrel{\text { 270.757 }}{ }$ | ${ }_{202.10 .085}$ | ${ }_{151.754}$ | ${ }_{\text {che }}^{1309996}$ | ${ }_{1}^{58.3538}$ | ${ }_{162.579}$ | ${ }^{3929.238}$ | ${ }_{\text {1.9394.152 }}$ |
| Palo verde |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Revenues | 151.180 | 119.484 | 124.916 | 14.1933 | 155.673 | 269.569 | 224.875 | 184.559 | 162.408 | ${ }^{223.726}$ | ${ }_{190.123}$ | ${ }_{175.053}$ | 2.123.501 |
|  | coas | 61.493 | 54.330 | 46.173 | 36.342 | 11.347 | -6.165 | 22.378 | 30.308 | 29.758 | 49.095 | 41314 | 8.232 | 384.604 |
|  | ¢M | 89.887 | 65.154 | 78.744 | 105.591 | 144.326 | 275.734 | 202.49 | 154.251 | 132.650 | 174.631 | 148.810 | 166.821 | 1.783 .897 |
| Cinergy |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Revenues cogs | 134.434 52.192 | 116.044 5.509 | ${ }_{45 \text { 4,092 }}^{110.368}$ | 55.409 179.910 | ${ }_{38.213}^{128.152}$ | ${ }_{40.295}^{124.492}$ | 183.490 43.170 |  | ${ }_{1}^{117.529}$ | ${ }_{\text {cher }}^{92.127}$ | ${ }_{42,411}^{110.402}$ | ${ }_{\substack{133.761 \\ 52.266}}$ | ${ }^{1.4993 .348}$ |
|  | 609 | ${ }_{8} 82.1242$ | ${ }_{65.536}$ | ${ }^{65.249}$ | ${ }^{137.499}$ | ${ }_{\text {89.939 }}$ | ${ }_{\text {102.297 }}$ | ${ }_{1}^{40.3} \mathbf{1 2 1}$ |  | ${ }_{10.4114}^{10.14}$ | ${ }_{5}^{54.954}$ | ${ }_{\text {4, }}^{67.971}$ | ${ }_{8}^{52.496}$ | ${ }_{\text {1.015.0.06 }}$ |
| First Energy |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Revenues | 166.243 | ${ }^{118.421}$ | ${ }^{111.108}$ | ${ }^{56.695}$ | 127.746 | 143.887 | 192.095 | ${ }^{174.150}$ | ${ }^{122.644}$ | ${ }^{96.789}$ | ${ }^{110.438}$ | ${ }^{130.828}$ | 1.549 .045 |
|  | coas | 54.378 | 54.651 | 46.030 | 17.342 | 37.846 | 41.246 | 41.935 | 38.600 | 13.185 | 39332 | ${ }^{43.095}$ | 41.716 | 469.353 |
|  | GM | 109.866 | 63.770 | 65.078 | ${ }^{39.353}$ | 89.900 | 102.641 | 150.160 | ${ }_{135.51}$ | 10.459 | 57.457 | 67.344 | 89.112 | 1.079.692 |
| Illinois |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | ${ }^{\text {Reverues }}$ | ${ }_{1}^{128.977}$ | ${ }_{112}^{12.401}$ | ${ }^{98,290}$ | ${ }_{5}^{52883}$ | ${ }^{134.088}$ | 16.116 | 192.55 | 165.072 | 98.579 | ${ }^{81.012}$ | 89.572 | 117.67 | ${ }^{1.437 .168}$ |
|  | coas | 43,739 | 44.296 | 27.615 | 10.441 | 31.190 | 21.272 | 39.391 | 36.940 | ${ }^{-1.628}$ | 22.782 | 2.331 | ${ }_{-626}$ | ${ }_{27}^{27.732}$ |
|  | $\underline{\text { ¢m }}$ | ${ }^{85.238}$ | 68.104 | 70.675 | 42.392 | 102.898 | 144.84 | 133.161 | ${ }_{128.132}$ | 100.206 | 58.230 | 87.252 | 118.303 | ${ }^{1.159 .436}$ |
| Michigan |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Revenues | 130.977 | 119.180 | ${ }^{113.760}$ | 55.807 | 147.048 | 150.078 | 177.153 | 178.182 | 128.943 | ${ }^{131.473}$ | 126.915 | 139.878 | 1.599 .396 |
|  | coas | 48.189 | 55.016 | 47.097 | 16.157 | 42.382 | 43.211 | 45.616 | 42.161 | 16.251 | 37776 | 45.078 | 48.541 | 487.475 |
|  | ¢M | ${ }^{82.789}$ | 64.164 | ${ }^{66.664}$ | ${ }^{39.650}$ | 104.66 | 10.8 .86 | ${ }^{131.537}$ | 136.022 | 112.692 | ${ }^{93.697}$ | ${ }^{81.837}$ | ${ }^{91.337}$ | 1.111.921 |
| Minnesta |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Revenu | ${ }^{130.611}$ | ${ }^{126.746}$ | ${ }^{96.003}$ | ${ }_{53.619}$ | ${ }^{121.389}$ | 107.645 | ${ }^{152721}$ | 162.863 | 94.571 | 99.889 | ${ }^{126.171}$ | 129.991 | 1.401 .720 |
|  | co6s | 32.440 | ${ }^{44.261}$ | 20.452 | 4.027 | 26.665 | 4.754 | 21.195 | 21.579 | -11237 | 3.771 | 10.005 |  |  |
|  | $\underline{\text { GM }}$ | 98.171 | ${ }_{82.485}$ | 75.551 | ${ }^{49.592}$ | 94.724 | 102.892 | ${ }_{131.527}$ | 141.284 | 105.89 | 96.118 | ${ }_{116.166}$ | 102.473 | ${ }^{1.196 .790}$ |
| Wisconsin |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Reverues cocs | 122.190 34.699 | 105.225 48.020 | ( 98.220 | ${ }_{\substack{5.075 \\ 7.302}}$ | 130.118 22.843 | ${ }^{113.423}$ | ${ }_{\text {l }}^{172.227}$ | 153.583 24.729 | ${ }_{\substack{92.872 \\-9.82}}^{\text {a }}$ | 87.70 14.985 |  | 15.969 26.551 | ${ }_{\text {l }}^{1.402 .247}$ |
|  | $\underline{6065}$ | $\xrightarrow{34,999}$ | 48.020 57.205 | ${ }_{6}^{34.351}$ | $\xrightarrow{75.3574}$ | ${ }_{102887}^{20.275}$ | ${ }_{122756}$ | ${ }_{1}^{245.5214}$ | ${ }_{128.854}^{2124}$ | 102514 | ${ }_{\text {l2, }}^{12485}$ | ${ }_{1}^{10.1818}$ | ${ }_{\text {20, }}^{12.948}$ | ${ }_{\text {1.154.6.606 }}$ |
| Capital |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | ${ }^{\text {Revenues }}$ | ${ }_{2}^{262.251}$ | ${ }_{2}^{221.130}$ | ${ }_{1}^{150.723}$ | ${ }_{66.328}^{6232}$ | ${ }_{1}^{122.026}$ | ${ }_{151856}^{1586}$ | 215.688 | ${ }^{181.437}$ | ${ }_{1}^{150.735}$ | ${ }^{103.275}$ | ${ }^{171.278}$ | ${ }_{2}^{258.627}$ | ${ }_{1}^{1.884 .056}$ |
|  | $\frac{\text { coas }}{6 \mathrm{~m}}$ | ${ }_{54971}^{207.280}$ | ${ }^{57.084} 160.046$ | ${ }_{4}^{40.164}$ | $\frac{23.732}{42596}$ | ${ }_{\text {4, }}^{4.546}$ | ${ }_{\text {S }}^{56.810}$ |  | ${ }_{\text {64.070 }}^{117.367}$ |  | $\frac{12373}{20.902}$ |  | $\frac{88.222}{170.005}$ | 599.305 1.288 .751 |
| Husson |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Revenues | 24.899 | 196.331 | 154.539 | ${ }_{68.234}$ | 119.988 | 288.162 | 267.244 | 206.423 | 197.823 | 114.949 | 192.422 | 26.269 | 2.11 .861 |
|  | coas | 55.052 | 56.951 | 44.784 | ${ }^{24.465}$ | 44.308 | 64.621 | 91.363 | 71.942 | 61.267 | 13.515 | 106.928 | 89.330 | 617.697 |
|  | GM | 191.847 | 139.380 | 109.755 | 43.769 | 75.680 | 217.541 | 175.881 | 134.481 | ${ }_{1}^{136.566}$ | 100.435 | 85.514 | 172.839 | 1.4999 .164 |
| Long st |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Revenues | 405.175 | ${ }^{239.352}$ | 180.378 | 88.96 | 192.659 | ${ }^{330.536}$ | ${ }^{343.023}$ | 310.580 | 228.132 | 155.858 | 256.489 | 347.591 | 2.881 .378 |
|  | coas | 70.915 | 60.807 | 48.714 | ${ }^{26.098}$ | 46.515 | 7.403 | 9.8504 | 7.920 | ${ }^{62.106}$ | 14.058 | 129.147 | 95.419 | ${ }^{667.756}$ |
|  | ¢ | 334.260 | ${ }^{178.545}$ | 131.64 | 61.988 | 146.144 | 260.133 | 247.220 | 233.60 | 166.026 | 141.801 | ${ }_{127.342}$ | 258.172 | ${ }^{2.153 .623}$ |
| nv |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Revenues | ${ }^{258.434}$ | ${ }^{212.422}$ | 170.114 | 74.808 | 165.267 | 324.619 | ${ }^{313.370}$ | 198.576 | 225.569 | 125.244 | 214.42 | 290.988 | ${ }^{2.359 .411}$ |
|  | coos | 56.228 | 57.988 | ${ }_{4}^{46.476}$ | 25.522 | ${ }^{4.7564}$ | ${ }^{22.170}$ | ${ }^{99.088}$ | ${ }^{73,793}$ | ${ }_{6}^{66.401}$ | ${ }_{\text {13, }}^{13274}$ | ${ }_{\text {117.929 }}$ | ${ }^{91.674}$ | $\underline{639.576}$ |
|  |  |  |  |  |  |  |  |  |  |  |  |  | 仡 | ${ }^{1.779 .836}$ |
| North |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | (eoce $\begin{gathered}\text { Revenues } \\ \text { coos }\end{gathered}$ | ${ }_{36555}^{19540}$ | ${ }_{128.49}^{11.795}$ | ${ }_{\text {l }}^{10.05139}$ | ${ }_{\substack{56.034 \\ 19.951}}^{\text {a }}$ | 92.144 37.296 | ${ }_{4}^{137.957}$ | ${ }_{1}^{189.394}$ | 162.725 62.180 | ${ }_{\substack{134.808 \\ 57.845}}$ | ${ }_{\text {che }}^{96.143}$ 10.761 | ${ }_{\substack{134.797 \\ 35.935}}$ | 200.229 | ${ }_{4}^{1.488 .762}$ |
|  | ¢M | 155.915 | ${ }_{88,317}$ | 74.682 | 36.084 | 54.849 | 88.521 | 104.229 | 100.545 | 76.564 | 85.382 | 98.862 | 130.62 | 994.109 |
| west |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Revenues coos | 173.282 31.352 | ${ }_{4}^{113.164}$ | ${ }_{\substack{103.921 \\ 3485}}$ | 57.694 21.992 | 94.113 <br> 38.25 | ${ }_{45.585}^{13.51}$ | ${ }_{\text {180, }}^{189.066}$ | ${ }_{\substack{160.051 \\ 59.057}}$ | ${ }_{\substack{117.556 \\ 52781}}$ | ¢ 9 9.043 11.984 | 128.230 75.615 |  | ${ }_{\text {l }}^{1.410 .537 .580}$ |
|  | GM | 141.930 | 72.296 | 69.086 | 35.702 | 55.848 | 87.916 | 108.817 | 100.994 | 64.775 | 82.059 | 52.615 | 103.528 | 922.953 |
| Weste |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Reverues coas | ${ }_{7}^{178.916}$ | ${ }_{\substack{133.155 \\ 69.784}}$ | ${ }_{\substack{127.907 \\ 61.980}}$ | (124.273 ${ }_{5}^{1}$ | ${ }_{42,483}^{126.488}$ | (182.941 | ${ }_{\text {254.711 }}^{258}$ | (20.445 | ${ }_{\substack{167.621 \\ 55.928}}$ | (12.084 | ${ }_{\substack{126.019 \\ 62.788}}$ | 182.519 77.23 | ${ }_{\substack{1.931 .069 \\ 754.784}}$ |
|  | $\underline{\text { ¢m }}$ | 99.689 | 63.371 | 65.927 | 67.93 | 83.995 | 124.169 | 186.94 | 13.403 | 111.693 | 65.265 | 63.271 | 105.315 | ${ }_{\text {1.176.285 }}$ |
| Batimore |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Reverues coos | ${ }^{230.557} 88.731$ | 159.889 75.001 | ${ }_{64.521}^{141217}$ | 144.567 58.727 | 155.948 44.977 | 246.800 62.980 | 345.154 72.723 | 266.640 69.30 | 257.140 58.590 | 155.095 56.594 |  | 224.819 83.786 | 2.479 .812 801.465 |
|  | GM | 141.826 | 84.889 | ${ }^{76.996}$ | 85.840 | 110.971 | ${ }^{183.821}$ | 272.432 | 197.300 | 198.550 | ${ }^{98.501}$ | 86.507 | ${ }^{141.033}$ | ${ }^{1.678 .365}$ |
| Commonweatt |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Revenues | 135.495 | ${ }^{113.448}$ | 100.730 | 91.866 | ${ }^{93.020}$ | 135.601 | 183.685 | 167.403 | 93.214 | ${ }^{86.523}$ | 89.227 | 102.148 | ${ }^{1.392 .361}$ |
|  | coas | 54.003 | 52.895 | 28.608 | 9.252 | 23.237 | 39.174 | 47.301 | 47.125 | 11.112 | 26.131 | 6.576 | 28.54 | 373.996 |
|  | $\underline{6 m}$ | 81.492 | 60.54 | ${ }^{72.122}$ | 82.614 | 69.783 | ${ }^{96,427}$ | ${ }^{136.384}$ | ${ }_{120.278}$ | ${ }^{82.103}$ | 60.393 | 82.652 | 73.564 | 1.018.364 |
| Dominion |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Revenues | 238.760 | 158.328 | 130.918 | 159.849 | 155.334 | 253.65 | ${ }^{313.361}$ | 231.685 | 220.634 | 151.835 | 133.364 | 213.515 | ${ }^{2.359 .745}$ |
|  | coas | 84.23 | 73.080 | 61.923 | 57.502 | 44.212 | 62.031 | 72.012 | 67.660 | 57.392 | 61.029 | 60.912 | 83.20 | 784.994 |
|  | $\underline{6 M}$ | 152.538 | 85.248 | ${ }^{68.996}$ | 102346 | 111.622 | ${ }^{191.631}$ | ${ }^{241.349}$ | 164.025 | 163.242 | 90.807 | ${ }^{72.452}$ | ${ }^{130.495}$ | ${ }^{1.574 .751}$ |
| N |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Reverues coss | ${ }_{\substack{210.055 \\ 85.195}}$ | ${ }_{\substack{146.1887}}$ |  | 128.378 58.586 | ${ }_{44.4262}^{14.232}$ | $\underset{\substack{20.063 \\ 63.239}}{ }$ | ${ }_{\substack{335.086 \\ 73.517}}$ | ${ }_{\substack{21.871 \\ 69.143}}$ | ${ }_{\substack{\text { che } \\ 59.000 \\ \hline 100}}$ |  | ${ }_{65.148}^{14.717}$ | $\substack{\text { 215.409 } \\ \text { 81023 }}_{\text {20, }}$ | 2.189 .830 794.360 |
|  | ${ }_{6}^{\text {coas }}$ | ${ }^{124.859}$ | ${ }_{7} 7.15895$ | ${ }_{\text {73.471 }}^{64.38}$ |  | ${ }_{9}^{49.8966}$ | ${ }_{10}^{60.2395}$ | ${ }_{261.569}$ | ${ }_{1} 15.7278$ | ${ }_{118.109}$ | ${ }_{66.734}$ | ${ }^{\text {79.599 }}$ | ${ }_{134.382}$ | ${ }_{\text {1.3995.470 }}$ |
| Pepoo |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | ${ }^{\text {Reverues }}$ | $\bigcirc$ | 0 | 0 | 0 | ${ }^{35.133}$ | 239.446 | ${ }^{332779}$ | ${ }^{2477.423}$ | ${ }_{2}^{245.319}$ | ${ }^{154.000}$ | ${ }_{1}^{152.72}$ | ${ }^{226.683}$ | ${ }^{1.633 .464}$ |
|  | GM | 0 | 0 | 0 | 0 | ${ }_{22,897}^{12.86}$ | 177.107 | 26.574 | ${ }_{178.811}$ | ${ }_{1} 187.265$ | ${ }^{59.032}$ | ${ }_{8}^{87.738}$ | ${ }_{1}^{13.35151}$ | 1.156.574 |


| Average Increase |  |
| :---: | :---: |
| Projected | Actual |
| $28,06 \%$ | $19,09 \%$ |
| $5,99 \%$ | $21,16 \%$ |
| $1,93 \%$ | $10,97 \%$ |
| $24,15 \%$ | $-3,69 \%$ |
| $49,11 \%$ | $41,13 \%$ |
| $\mathbf{2 4 , 6 3 \%}$ | $\mathbf{1 7 , 6 8 \%}$ |
|  |  |
| Median Increase |  |
| Projected | Actual |
| $22,54 \%$ | $23,37 \%$ |
| $5,90 \%$ | $21,30 \%$ |
| $18,43 \%$ | $12,58 \%$ |
| $24,50 \%$ | $-0,65 \%$ |
| $55,75 \%$ | $46,99 \%$ |
| $\mathbf{2 0 , 8 5 \%}$ | $\mathbf{1 6 , 3 3 \%}$ |


|  |  |
| :---: | :---: |






| Projected |  |  |  |  |  |  |  |  |  | Actual |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 0 09 to '10 | 10 to '11 | Overall |  | 09 to ' 10 | 10 to '11 | Overall |  |  |  |  |  |  |
| $24,23 \%$ | $-10,83 \%$ | $10,77 \%$ |  | $-7,02 \%$ | $-10,78 \%$ | $-17,04 \%$ |  |  |  |  |  |  |
| $25,63 \%$ | $4,62 \%$ | $31,44 \%$ |  | $6,18 \%$ | $-7,64 \%$ | $-1,93 \%$ |  |  |  |  |  |  |
| $32,50 \%$ | $-11,28 \%$ | $17,56 \%$ |  | $14,09 \%$ | $-5,41 \%$ | $7,92 \%$ |  |  |  |  |  |  |
| $27,93 \%$ | $3,22 \%$ | $32,05 \%$ |  | $7,13 \%$ | $-6,08 \%$ | $0,62 \%$ |  |  |  |  |  |  |
| $56,73 \%$ | $-4,47 \%$ | $49,73 \%$ |  | $23,78 \%$ | $-6,02 \%$ | $16,33 \%$ |  |  |  |  |  |  |
| $12,80 \%$ | $-8,36 \%$ | $3,37 \%$ |  | $-18,69 \%$ | $-11,52 \%$ | $-28,06 \%$ |  |  |  |  |  |  |


| Increase |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Projected |  |  | Actual |  |  |
| 09 to '10 | 10 to '11 | Overall | 09 to '10 | 10 to '11 | Overall |
| 41,70\% | 5,97\% | 50,16\% | 42,35\% | 0,03\% | 42,38\% |
| 69,50\% | -1,44\% | 67,06\% | 64,12\% | -5,13\% | 55,71\% |
| 28,37\% | 2,03\% | 30,97\% | 25,26\% | 0,55\% | 25,94\% |
| 63,76\% | -1,47\% | 61,35\% | 65,78\% | -8,55\% | 51,60\% |
| 59,70\% | 8,25\% | 72,87\% | 56,54\% | 4,05\% | 62,87\% |
|  | 12,23\% | 12,23\% |  | 8,30\% | 8,30\% |


| Gross margin |  |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Projected |  |  |  |  |  | Actual |  |  |  |  |  |
|  | 2009 |  | 2010 |  | 2011 |  | 2009 |  | 2010 |  | 2011 |
| \$ | 572.623 | \$ | 798.485 | \$ | 720.330 | \$ | 781.347 | \$ | 1.077.938 | \$ | 992.396 |
| \$ | 529.262 | \$ | 753.029 | \$ | 639.609 | \$ | 734.474 | \$ | 1.031.493 | \$ | 906.130 |
| \$ | 519.790 | \$ | 722.073 | \$ | 616.462 | \$ | 724.350 | \$ | 908.253 | \$ | 879.562 |
| \$ | 382.498 | \$ | 663.167 | \$ | 583.298 | \$ | 857.280 | \$ | 971.789 | \$ | 851.767 |
| \$ | 519.301 | \$ | 726.920 | \$ | 636.363 | \$ | 718.005 | \$ | 1.013.320 | \$ | 892.247 |






Wisconsin


| Revenue input |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Grid to be used | - |  |  |  |  |
| Hours in/out | 3 |  | Increase | rom 2009 |  |
| MW pr/hour in | 0 |  | Grid | Increase |  |
| Power losses | 0,00\% |  | - | 0,00\% |  |
| MW pr/hour out | 0 |  |  |  |  |
| Increase in power prices | 0\% | first | 0 | yrs |  |
| Long term increase | 0\% |  |  |  |  |
| Capex input |  |  |  |  |  |
|  |  |  |  | Phasing |  |
| Cost |  |  | yr 1 | yr 2 | yr 3 |
| Land | \$0 |  | 100\% | 0\% | 0\% |
| Building | \$0 |  | 100\% | 0\% | 0\% |
| Equipment | \$0 |  | 100\% | 0\% | 0\% |
| Other | \$0 |  | 100\% | 0\% | 0\% |
| Total | \$0 |  |  |  |  |
| Opex input |  |  |  |  |  |
| Opex cost |  |  |  |  |  |
| Salaries | \$0 | $\mathrm{pr} / \mathrm{yr}$ |  |  |  |
| Bonus payments | 0\% | of GM |  |  |  |
| Nr of traders | 0 |  |  |  |  |
| Traider accuracy | 0\% |  |  |  |  |
| Overhead | \$0 | $\mathrm{pr} / \mathrm{yr}$ |  |  |  |
| Maintenance | \$0 | $\mathrm{pr} / \mathrm{yr}$ |  |  |  |
| Other | \$0 | $\mathrm{pr} / \mathrm{yr}$ |  |  |  |
| Working capital | \$0 | for | 0 | yrs |  |
| Selling expense | 0,0\% | of revenue |  |  |  |
| Start-up expense | \$0 |  |  |  |  |
| Depreciation input |  |  |  |  |  |
|  | \% | Factor |  |  |  |
| Building | 0\% | 0\% |  |  |  |
| Years of depreciation | 0,00 |  |  |  |  |
| Equipment | 0,0\% | 0\% |  |  |  |
| Years of depreciation | 0,00 |  |  |  |  |
| Other | 0\% | 0\% |  |  |  |
| Years of depreciation | 0,00 |  |  |  |  |


| Debt input |  |  |
| :---: | :---: | :---: |
| Leverage of equipment | 0\% |  |
| Equipment loan |  |  |
| Bank I | \$0 |  |
| Interest rate | 0,00\% |  |
| Payback in years | 0 |  |
| Short term financing |  |  |
| Bank II | \$0 |  |
| Interest rate | 0\% |  |
| Payback in years | 0 |  |
| Total capital needed | \$0 |  |
| Equity ratio | 0\% |  |
| Equity | \$0 |  |
| Debt | \$0 |  |
| WACC input |  |  |
| Risk free rate | 0,00\% |  |
| Market risk premium | 0,00\% |  |
| $\beta$ for project | 0,00 |  |
| $\mathrm{r}_{\mathrm{E}}$ | 0,00\% |  |
| ${ }^{\text {r }}$ | 0,00\% |  |
| WACC (discount rate) | 0,00\% |  |
| Tax input |  |  |
| Corporate tax | 0\% |  |
| Property Tax | 0,00\% |  |
|  | Traded | Projected |
| IRR of Investment | 0,00\% | 0,00\% |
| NPV of Investment | \$0 | \$0 |
| IRR of Equity | 0,00\% | 0,00\% |
| NPV of Equity | \$0 | \$0 |
| Battery input |  |  |
| Type of batteries used | Ford |  |
| Recharge of batteries | 0\% |  |
| \# of batteries | 0 |  |
| \# of containers | 0 |  |


| Revenue input |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Grid to be used | North |  |  |  |  |
| Hours in/out | 3 |  | Increase | from 2009 |  |
| MW pr/hour in | 25 |  | Grid | Increase |  |
| Power losses | 3,00\% |  | North | 16,33\% |  |
| MW pr/hour out | 24,25 |  |  |  |  |
| Increase in power prices | 15\% | first | 5 | yrs |  |
| Long term increase | 5\% |  |  |  |  |
| Capex input |  |  |  |  |  |
|  |  |  |  | Phasing |  |
| Cost |  |  | yr 1 | yr 2 | yr 3 |
| Land | \$300.000 |  | 100\% | 0\% | 0\% |
| Building | \$1.000.000 |  | 75\% | 25\% | 0\% |
| Equipment | \$10.000.000 |  | 100\% | 0\% | 0\% |
| Other | \$300.000 |  | 50\% | 50\% | 0\% |
| Total | \$11.600.000 |  |  |  |  |
| Opex input |  |  |  |  |  |
| Opex cost |  |  |  |  |  |
| Salaries | \$75.000 | $\mathrm{pr} / \mathrm{yr}$ |  |  |  |
| Bonus payments | 2\% | of GM |  |  |  |
| Nr of traders | 2 |  |  |  |  |
| Traider accuracy | 95\% |  |  |  |  |
| Overhead | \$30.000 | $\mathrm{pr} / \mathrm{yr}$ |  |  |  |
| Maintenance | \$120.000 | $\mathrm{pr} / \mathrm{yr}$ |  |  |  |
| Other | \$100.000 | $\mathrm{pr} / \mathrm{yr}$ |  |  |  |
| Working capital | \$200.000 | for | 2 | yrs |  |
| Selling expense | 0,2\% | of revenue |  |  |  |
| Start-up expense | \$300.000 |  |  |  |  |
| Depreciation input |  |  |  |  |  |
|  | \% | Factor |  |  |  |
| Building | 4\% | 90\% |  |  |  |
| Years of depreciation | 22,75 |  |  |  |  |
| Equipment | 12,5\% | 90\% |  |  |  |
| Years of depreciation | 7,20 |  |  |  |  |
| Other | 25\% | 90\% |  |  |  |
| Years of depreciation | 4,10 |  |  |  |  |


| Debt input |  |  |
| :---: | :---: | :---: |
| Leverage of equipment | 70\% |  |
| Equipment loan |  |  |
| Bank I | \$7.000.000 |  |
| Interest rate | 5,75\% |  |
| Payback in years | 8 |  |
| Short term financing |  |  |
| Bank II | \$500.000 |  |
| Interest rate | 8\% |  |
| Payback in years | 3 |  |
| Total capital needed | \$12.100.000 |  |
| Equity ratio | 38\% |  |
| Equity | \$4.600.000 |  |
| Debt | \$7.500.000 |  |
| WACC input |  |  |
| Risk free rate | 2,71\% |  |
| Market risk premium | 6,19\% |  |
| $\beta$ for project | 2,79 |  |
| ${ }_{\text {r }}^{\text {E }}$ | 20,00\% |  |
| $\underline{r_{\text {D }}}$ | 5,90\% |  |
| WACC (discount rate) | 10,02\% |  |
| Tax input |  |  |
| Corporate tax | 34\% |  |
| Property Tax | 1,65\% |  |
| IRR of Investment | Traded 4,47\% | Projected $-0,11 \%$ |
| NPV of Investment | -\$4.017.060 | -\$6.910.815 |
| IRR of Equity | 3,21\% | -2,67\% |
| NPV of Equity | -\$5.438.057 | -\$7.165.756 |
| Battery input |  |  |
| Type of batteries used | Ford |  |
| Recharge of batteries | 60\% |  |
| \# of batteries | 5.435 |  |
| \# of containers | 8 |  |



|  | Projected |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
|  | NPV project | IRR project | NPV equity | IRR equity |
| CT | -\$3.961.310 | 4,45\% | -\$5.342.668 | 3,16\% |
| NEMass | -\$4.911.106 | 3,00\% | -\$5.929.177 | 1,24\% |
| NH | -\$5.186.484 | 2,58\% | -\$6.099.501 | 0,69\% |
| ME | -\$5.587.274 | 1,95\% | -\$6.347.565 | -0,12\% |
| Internal | -\$4.949.847 | 2,94\% | -\$5.953.139 | 1,17\% |
| Average | -\$4.919.204 | 2,99\% | -\$5.934.410 | 1,23\% |
| Pacific G\&E | -\$2.055.618 | 7,23\% | -\$4.173.875 | 6,96\% |
| SoCal | -\$1.207.131 | 8,40\% | -\$3.656.897 | 8,61\% |
| San Diego | \$577.330 | 10,77\% | -\$2.579.222 | 12,01\% |
| NP-15 | -\$2.872.006 | 6,06\% | -\$4.673.025 | 5,35\% |
| SP-15 | -\$1.559.048 | 7,92\% | -\$3.871.318 | 7,93\% |
| Palo Verde | -\$3.528.881 | 5,10\% | -\$5.076.149 | 4,03\% |
| Average | -\$1.774.226 | 7,58\% | -\$4.005.081 | 7,48\% |
| Cinergy | -\$4.034.970 | 4,34\% | -\$5.388.098 | 3,01\% |
| First Energy | -\$3.535.757 | 5,09\% | -\$5.080.369 | 4,02\% |
| Illinois | -\$4.235.445 | 4,04\% | -\$5.511.742 | 2,61\% |
| Michigan | -\$3.951.091 | 4,47\% | -\$5.336.366 | 3,18\% |
| Minnesota | -\$2.737.985 | 6,25\% | -\$4.590.777 | 5,61\% |
| Wisconsin | -\$3.661.828 | 4,90\% | -\$5.157.961 | 3,76\% |
| Average | -\$3.692.846 | 4,85\% | -\$5.177.552 | 3,70\% |
| Capital | -\$5.058.612 | 2,78\% | -\$6.020.411 | 0,95\% |
| Hudson | -\$1.319.568 | 8,25\% | -\$3.725.404 | 8,39\% |
| Long IsI | \$2.507.743 | 13,17\% | -\$1.434.188 | 15,59\% |
| NY | \$747.116 | 10,98\% | -\$2.477.387 | 12,33\% |
| North | -\$6.910.815 | -0,11\% | -\$7.165.756 | -2,67\% |
| West | -\$7.063.705 | -0,37\% | -\$7.256.665 | -2,99\% |
| Average | -\$2.849.640 | 5,78\% | -\$4.679.969 | 5,27\% |
| Western | -\$1.250.775 | 8,34\% | -\$3.683.489 | 8,53\% |
| Baltimore | \$2.378.333 | 13,02\% | -\$1.510.370 | 15,35\% |
| Commonwealth | -\$2.998.933 | 5,88\% | -\$4.750.920 | 5,09\% |
| Dominion | \$861.000 | 11,13\% | -\$2.409.444 | 12,55\% |
| NJ | \$1.136.470 | 11,48\% | -\$2.245.098 | 13,06\% |
| Pepco | -\$383.778 | 9,51\% | -\$3.159.305 | 10,19\% |
| Average | -\$42.947 | 9,89\% | -\$2.959.771 | 10,79\% |
| Average Over All | -\$2.655.773 | 6,22\% | -\$4.551.356 | 5,69\% |


|  | Traded |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
|  | NPV project | IRR project | NPV equity | IRR equity |
| CT | -\$3.653.948 | 5,00\% | -\$5.214.107 | 3,92\% |
| NEMass | -\$4.561.893 | 3,65\% | -\$5.774.164 | 2,14\% |
| NH | -\$4.842.509 | 3,23\% | -\$5.947.728 | 1,59\% |
| ME | -\$5.123.409 | 2,81\% | -\$6.121.467 | 1,04\% |
| Internal | -\$4.725.992 | 3,41\% | -\$5.875.661 | 1,82\% |
| Average | -\$4.581.550 | 3,62\% | -\$5.786.625 | 2,10\% |
| Pacific G\&E | \$4.348.581 | 15,27\% | -\$419.696 | 18,74\% |
| SoCal | \$6.336.742 | 17,45\% | \$721.157 | 22,15\% |
| San Diego | \$10.652.938 | 21,81\% | \$3.153.378 | 29,26\% |
| NP-15 | \$3.555.005 | 14,36\% | -\$880.149 | 17,35\% |
| SP-15 | \$6.280.126 | 17,39\% | \$688.778 | 22,06\% |
| Palo Verde | \$4.934.785 | 15,93\% | -\$80.624 | 19,76\% |
| Average | \$6.018.029 | 17,04\% | \$530.474 | 21,55\% |
| Cinergy | -\$2.925.111 | 6,05\% | -\$4.766.573 | 5,35\% |
| First Energy | -\$2.143.507 | 7,15\% | -\$4.288.169 | 6,86\% |
| Illinois | -\$2.168.704 | 7,11\% | -\$4.303.522 | 6,81\% |
| Michigan | -\$1.673.290 | 7,79\% | -\$4.001.669 | 7,75\% |
| Minnesota | -\$925.593 | 8,80\% | -\$3.546.582 | 9,17\% |
| Wisconsin | -\$2.478.872 | 6,68\% | -\$4.492.716 | 6,21\% |
| Average | -\$2.052.513 | 7,26\% | -\$4.233.205 | 7,02\% |
| Capital | -\$1.873.520 | 7,52\% | -\$4.123.667 | 7,37\% |
| Hudson | \$464.058 | 10,61\% | -\$2.707.849 | 11,76\% |
| Long IsI | \$6.682.143 | 17,82\% | \$918.692 | 22,74\% |
| NY | \$2.710.526 | 13,38\% | -\$1.372.855 | 15,85\% |
| North | -\$4.017.060 | 4,47\% | -\$5.438.057 | 3,21\% |
| West | -\$5.288.532 | 2,56\% | -\$6.223.597 | 0,71\% |
| Average | -\$220.397 | 9,39\% | -\$3.157.889 | 10,27\% |
| Western | -\$1.598.662 | 7,90\% | -\$3.956.198 | 7,90\% |
| Baltimore | \$2.498.939 | 13,12\% | -\$1.497.413 | 15,47\% |
| Commonwealth | -\$2.824.231 | 6,19\% | -\$4.704.663 | 5,54\% |
| Dominion | \$1.031.242 | 11,33\% | -\$2.367.274 | 12,81\% |
| NJ | \$1.132.928 | 11,46\% | -\$2.306.608 | 13,00\% |
| Pepco | -\$731.081 | 9,06\% | -\$3.429.183 | 9,54\% |
| Average | -\$81.811 | 9,84\% | -\$3.043.556 | 10,71\% |
| Average Over All | -\$183.648 | 9,43\% | -\$3.138.160 | 10,33\% |

Senslt
Spider Analysis

## Long Island

|  | Corresponding Input Value |  |  | Input Value as \% of Base |  |  | NPV of Investment Output Value |  |  | Swing |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Input Variable | Low Output | Base Case | High Output | Low \% | Base \% | High \% | Low | Base | High |  |
| WACC | 12,25\% | 10,21\% | 8,17\% | 120\% | 100\% | 80\% | \$4.270.995 | \$6.455.134 | \$9.112.327 | \$4.841.332 |
| Increase in power prices | 12\% | 15\% | 18\% | 80\% | 100\% | 120\% | \$4.535.788 | \$6.455.134 | \$8.557.543 | \$4.021.755 |
| Equipment | \$12.000.000 | \$10.000.000 | \$8.000.000 | 120\% | 100\% | 80\% | \$4.897.667 | \$6.455.134 | \$7.987.476 | \$3.089.808 |
| Trader accuracy | 90\% | 95\% | 100\% | 94,7\% | 100\% | 105,3\% | \$4.984.179 | \$6.455.134 | \$7.913.789 | \$2.929.610 |
| Corporate tax rate | 41\% | 34\% | 27\% | 120\% | 100\% | 80\% | \$5.396.527 | \$6.455.134 | \$7.513.741 | \$2.117.214 |
| Salaries | \$90.000 | \$75.000 | \$60.000 | 120\% | 100\% | 80\% | \$6.301.775 | \$6.455.134 | \$6.607.540 | \$305.765 |
| Maintenance | \$144.000 | \$120.000 | \$96.000 | 120\% | 100\% | 80\% | \$6.332.447 | \$6.455.134 | \$6.577.292 | \$244.845 |
| Working capital | \$240.000 | \$200.000 | \$160.000 | 120\% | 100\% | 80\% | \$6.405.258 | \$6.455.134 | \$6.504.199 | \$98.941 |
| Start-up expense | \$360.000 | \$300.000 | \$240.000 | 120\% | 100\% | 80\% | \$6.415.891 | \$6.455.134 | \$6.493.990 | \$78.099 |
| Power losses | 4\% | 3\% | 2\% | 120\% | 100\% | 80\% | \$6.455.134 | \$6.455.134 | \$6.455.134 | \$0 |



Senslt
Spider Analysis

## SP-15

|  | Corresponding Input Value |  |  | Input Value as \% of Base |  |  | NPV of Investment Output Value |  |  | Swing |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Input Variable | Low Output | Base Case | High Output | Low \% | Base \% | High \% | Low | Base | High |  |
| WACC | 12,25\% | 10,21\% | 8,17\% | 120\% | 100\% | 80\% | \$3.922.064 | \$6.058.127 | \$8.656.513 | \$4.734.449 |
| Increase in power prices | 12\% | 15\% | 18\% | 80\% | 100\% | 120\% | \$4.180.642 | \$6.058.127 | \$8.118.343 | \$3.937.701 |
| Equipment | \$12.000.000 | \$10.000.000 | \$8.000.000 | 120\% | 100\% | 80\% | \$4.495.919 | \$6.058.127 | \$7.594.103 | \$3.098.184 |
| Trader accuracy | 90\% | 95\% | 100\% | 94,7\% | 100\% | 105,3\% | \$4.989.302 | \$6.058.127 | \$7.121.969 | \$2.132.667 |
| Corporate tax rate | 41\% | 34\% | 27\% | 120\% | 100\% | 80\% | \$5.038.186 | \$6.058.127 | \$7.078.068 | \$2.039.882 |
| Salaries | \$90.000 | \$75.000 | \$60.000 | 120\% | 100\% | 80\% | \$5.904.769 | \$6.058.127 | \$6.211.485 | \$306.717 |
| Maintenance | \$144.000 | \$120.000 | \$96.000 | 120\% | 100\% | 80\% | \$5.935.441 | \$6.058.127 | \$6.180.814 | \$245.373 |
| Working capital | \$240.000 | \$200.000 | \$160.000 | 120\% | 100\% | 80\% | \$6.008.251 | \$6.058.127 | \$6.108.003 | \$99.752 |
| Start-up expense | \$360.000 | \$300.000 | \$240.000 | 120\% | 100\% | 80\% | \$6.018.885 | \$6.058.127 | \$6.097.370 | \$78.485 |
| Power losses | 4\% | 3\% | 2\% | 120\% | 100\% | 80\% | \$6.058.127 | \$6.058.127 | \$6.058.127 | \$0 |



Senslt
Spider Analysis

## San Diego




Senslt
Spider Analysis

## SoCal




Senslt
Spider Analysis

## Long Island Equity

| Input Variable | Corresponding Input Value |  |  | Input Value as \% of Base |  |  | NPV of Investment Output Value |  |  | Swing |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Low Output | Base Case | High Output | Low \% | Base \% | High \% | Low | Base | High |  |
| Cost of Equity | 24,00\% | 20,00\% | 16,00\% | 120\% | 100\% | 80\% | -\$355.999 | \$918.692 | \$2.734.378 | \$3.090.376 |
| Equipment | \$12.000.000 | \$10.000.000 | \$8.000.000 | 120\% | 100\% | 80\% | -\$295.731 | \$918.692 | \$2.098.583 | \$2.394.315 |
| Increase in power prices | 12\% | 15\% | 18\% | 80\% | 100\% | 120\% | -\$86.688 | \$918.692 | \$2.006.438 | \$2.093.125 |
| Trader accuracy | 90\% | 95\% | 100\% | 94,7\% | 100\% | 105,3\% | \$66.833 | \$918.692 | \$1.753.409 | \$1.686.576 |
| Corporate tax rate | 41\% | 34\% | 27\% | 120\% | 100\% | 80\% | \$444.938 | \$918.692 | \$1.392.447 | \$947.509 |
| Salaries | \$90.000 | \$75.000 | \$60.000 | 120\% | 100\% | 80\% | \$819.389 | \$918.692 | \$1.016.669 | \$197.280 |
| Start-up expense | \$360.000 | \$300.000 | \$240.000 | 120\% | 100\% | 80\% | \$826.152 | \$918.692 | \$1.010.694 | \$184.542 |
| Working capital | \$240.000 | \$200.000 | \$160.000 | 120\% | 100\% | 80\% | \$835.780 | \$918.692 | \$1.000.476 | \$164.696 |
| Maintenance | \$144.000 | \$120.000 | \$96.000 | 120\% | 100\% | 80\% | \$839.250 | \$918.692 | \$997.398 | \$158.149 |
| Power losses | 4\% | 3\% | 2\% | 120\% | 100\% | 80\% | \$918.692 | \$918.692 | \$918.692 | \$0 |



Senslt
Spider Analysis

## SP-15 Equity

| Input Variable | Corresponding Input Value |  |  | Input Value as \% of Base |  |  | NPV of Investment Output Value |  |  | Swing |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Low Output | Base Case | High Output | Low \% | Base \% | High \% | Low | Base | High |  |
| Cost of Equity | 24,00\% | 20,00\% | 16,00\% | 120\% | 100\% | 80\% | -\$548.622 | \$688.778 | \$2.453.044 | \$3.001.665 |
| Equipment | \$12.000.000 | \$10.000.000 | \$8.000.000 | 120\% | 100\% | 80\% | -\$531.716 | \$688.778 | \$1.873.734 | \$2.405.450 |
| Increase in power prices | 12\% | 15\% | 18\% | 80\% | 100\% | 120\% | -\$294.675 | \$688.778 | \$1.757.900 | \$2.052.576 |
| Trader accuracy | 90\% | 95\% | 100\% | 94,7\% | 100\% | 105,3\% | \$69.799 | \$688.778 | \$1.300.809 | \$1.231.010 |
| Corporate tax rate | 41\% | 34\% | 27\% | 120\% | 100\% | 80\% | \$235.400 | \$688.778 | \$1.142.156 | \$906.756 |
| Salaries | \$90.000 | \$75.000 | \$60.000 | 120\% | 100\% | 80\% | \$589.474 | \$688.778 | \$788.081 | \$198.607 |
| Start-up expense | \$360.000 | \$300.000 | \$240.000 | 120\% | 100\% | 80\% | \$596.238 | \$688.778 | \$781.318 | \$185.081 |
| Working capital | \$240.000 | \$200.000 | \$160.000 | 120\% | 100\% | 80\% | \$605.865 | \$688.778 | \$771.691 | \$165.825 |
| Maintenance | \$144.000 | \$120.000 | \$96.000 | 120\% | 100\% | 80\% | \$609.335 | \$688.778 | \$768.221 | \$158.886 |
| Power losses | 4\% | 3\% | 2\% | 120\% | 100\% | 80\% | \$688.778 | \$688.778 | \$688.778 | \$0 |



Senslt
Spider Analysis

## San Diego Equity

|  | Corresponding Input Value |  |  | Input Value as \% of Base |  |  | NPV of Investment Output Value |  |  | Swing |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Input Variable | Low Output | Base Case | High Output | Low \% | Base \% | High \% | Low | Base | High |  |
| Cost of Equity | 24,00\% | 20,00\% | 16,00\% | 120\% | 100\% | 80\% | \$1.502.892 | \$3.153.378 | \$5.487.720 | \$3.984.828 |
| Increase in power prices | 12\% | 15\% | 18\% | 80\% | 100\% | 120\% | \$1.952.621 | \$3.153.378 | \$4.467.458 | \$2.514.836 |
| Equipment | \$12.000.000 | \$10.000.000 | \$8.000.000 | 120\% | 100\% | 80\% | \$1.986.447 | \$3.153.378 | \$4.302.449 | \$2.316.002 |
| Trader accuracy | 90\% | 95\% | 100\% | 94,7\% | 100\% | 105,3\% | \$2.432.708 | \$3.153.378 | \$3.873.132 | \$1.440.424 |
| Corporate tax rate | 41\% | 34\% | 27\% | 120\% | 100\% | 80\% | \$2.464.177 | \$3.153.378 | \$3.842.579 | \$1.378.402 |
| Salaries | \$90.000 | \$75.000 | \$60.000 | 120\% | 100\% | 80\% | \$3.059.387 | \$3.153.378 | \$3.247.369 | \$187.982 |
| Start-up expense | \$360.000 | \$300.000 | \$240.000 | 120\% | 100\% | 80\% | \$3.065.557 | \$3.153.378 | \$3.241.199 | \$175.643 |
| Working capital | \$240.000 | \$200.000 | \$160.000 | 120\% | 100\% | 80\% | \$3.076.497 | \$3.153.378 | \$3.230.259 | \$153.762 |
| Maintenance | \$144.000 | \$120.000 | \$96.000 | 120\% | 100\% | 80\% | \$3.078.185 | \$3.153.378 | \$3.228.571 | \$150.386 |
| Power losses | 4\% | 3\% | 2\% | 120\% | 100\% | 80\% | \$3.153.378 | \$3.153.378 | \$3.153.378 | \$0 |



Senslt
Spider Analysis

## SoCal Equity

| Input Variable | Corresponding Input Value |  |  | Input Value as \% of Base |  |  | NPV of Investment Output Value |  |  | Swing |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Low Output | Base Case | High Output | Low \% | Base \% | High \% | Low | Base | High |  |
| Cost of Equity | 24,00\% | 20,00\% | 16,00\% | 120\% | 100\% | 80\% | -\$521.494 | \$721.157 | \$2.492.664 | \$3.014.159 |
| Equipment | \$12.000.000 | \$10.000.000 | \$8.000.000 | 120\% | 100\% | 80\% | -\$498.482 | \$721.157 | \$1.905.400 | \$2.403.881 |
| Increase in power prices | 12\% | 15\% | 18\% | 80\% | 100\% | 120\% | -\$265.384 | \$721.157 | \$1.792.902 | \$2.058.286 |
| Trader accuracy | 90\% | 95\% | 100\% | 94,7\% | 100\% | 105,3\% | \$92.226 | \$721.157 | \$1.342.209 | \$1.249.982 |
| Corporate tax rate | 41\% | 34\% | 27\% | 120\% | 100\% | 80\% | \$264.909 | \$721.157 | \$1.177.405 | \$912.496 |
| Salaries | \$90.000 | \$75.000 | \$60.000 | 120\% | 100\% | 80\% | \$621.854 | \$721.157 | \$820.461 | \$198.607 |
| Start-up expense | \$360.000 | \$300.000 | \$240.000 | 120\% | 100\% | 80\% | \$628.617 | \$721.157 | \$813.697 | \$185.081 |
| Working capital | \$240.000 | \$200.000 | \$160.000 | 120\% | 100\% | 80\% | \$638.244 | \$721.157 | \$804.070 | \$165.825 |
| Maintenance | \$144.000 | \$120.000 | \$96.000 | 120\% | 100\% | 80\% | \$641.714 | \$721.157 | \$800.600 | \$158.886 |
| Power losses | 4\% | 3\% | 2\% | 120\% | 100\% | 80\% | \$721.157 | \$721.157 | \$721.157 | \$0 |



Senslt 1.45
Long Island
Tornado Analysis

|  | NPV of Investment |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Input Variable | Low Output | Base Case | High Output | Low | Base | High | Swing | Swing^2 |
| WACC | 12,02\% | 10,02\% | 8,02\% | \$4.492.557 | \$6.678.480 | \$9.330.276 | \$4.837.719 | 37,1\% |
| Increase in power prices | 12\% | 15\% | 18\% | \$4.731.864 | \$6.678.480 | \$8.811.187 | \$4.079.323 | 26,3\% |
| Equipment | \$12.000.000 | \$10.000.000 | \$8.000.000 | \$5.124.660 | \$6.678.480 | \$8.207.462 | \$3.082.803 | 15,0\% |
| Trader accuracy | 90\% | 95\% | 100\% | \$5.189.258 | \$6.678.480 | \$8.155.547 | \$2.966.289 | 13,9\% |
| Corporate tax rate | 41\% | 34\% | 27\% | \$5.601.841 | \$6.678.480 | \$7.755.119 | \$2.153.278 | 7,3\% |
| Salaries | \$90.000 | \$75.000 | \$60.000 | \$6.523.579 | \$6.678.480 | \$6.832.439 | \$308.860 | 0,2\% |
| Maintenance | \$144.000 | \$120.000 | \$96.000 | \$6.554.559 | \$6.678.480 | \$6.801.878 | \$247.318 | 0,1\% |
| Working capital | \$240.000 | \$200.000 | \$160.000 | \$6.628.562 | \$6.678.480 | \$6.727.597 | \$99.035 | 0,0\% |
| Start-up expense | \$360.000 | \$300.000 | \$240.000 | \$6.639.248 | \$6.678.480 | \$6.717.329 | \$78.081 | 0,0\% |
| Power losses | 4\% | 3\% | 2\% | \$6.678.480 | \$6.678.480 | \$6.678.480 | \$0 | 0,0\% |



Senslt 1.45
SP-15
Tornado Analysis

|  | NPV of Investment |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Input Variable | Low Output | Base Case | High Output | Low | Base | High | Swing | Swing^2 |
| WACC | 12,02\% | 10,02\% | 8,02\% | \$4.138.762 | \$6.276.543 | \$8.869.625 | \$4.730.863 | 39,2\% |
| Increase in power prices | 12\% | 15\% | 18\% | \$4.372.382 | \$6.276.543 | \$8.366.353 | \$3.993.971 | 28,0\% |
| Equipment | \$12.000.000 | \$10.000.000 | \$8.000.000 | \$4.718.029 | \$6.276.543 | \$7.809.117 | \$3.091.088 | 16,8\% |
| Trader accuracy | 90\% | 95\% | 100\% | \$5.194.444 | \$6.276.543 | \$7.353.716 | \$2.159.272 | 8,2\% |
| Corporate tax rate | 41\% | 34\% | 27\% | \$5.239.107 | \$6.276.543 | \$7.313.979 | \$2.074.873 | 7,5\% |
| Salaries | \$90.000 | \$75.000 | \$60.000 | \$6.121.642 | \$6.276.543 | \$6.431.443 | \$309.801 | 0,2\% |
| Maintenance | \$144.000 | \$120.000 | \$96.000 | \$6.152.622 | \$6.276.543 | \$6.400.463 | \$247.841 | 0,1\% |
| Working capital | \$240.000 | \$200.000 | \$160.000 | \$6.226.625 | \$6.276.543 | \$6.326.461 | \$99.836 | 0,0\% |
| Start-up expense | \$360.000 | \$300.000 | \$240.000 | \$6.237.312 | \$6.276.543 | \$6.315.774 | \$78.463 | 0,0\% |
| Power losses | 4\% | 3\% | 2\% | \$6.276.543 | \$6.276.543 | \$6.276.543 | \$0 | 0,0\% |



Senslt 1.45
San Diego
Tornado Analysis

|  | NPV of Investment |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Input Variable | Low Output | Base Case | High Output | Low | Base | High | Swing | Swing^2 |
| WACC | 12,02\% | 10,02\% | 8,02\% | \$7.976.952 | \$10.648.459 | \$13.892.296 | \$5.915.344 | 41,6\% |
| Increase in power prices | 12\% | 15\% | 18\% | \$8.294.232 | \$10.648.459 | \$13.238.536 | \$4.944.303 | 29,1\% |
| Equipment | \$12.000.000 | \$10.000.000 | \$8.000.000 | \$9.127.997 | \$10.648.459 | \$12.157.549 | \$3.029.552 | 10,9\% |
| Corporate tax rate | 41\% | 34\% | 27\% | \$9.172.094 | \$10.648.459 | \$12.124.823 | \$2.952.729 | 10,4\% |
| Trader accuracy | 90\% | 95\% | 100\% | \$9.358.999 | \$10.648.459 | \$11.937.323 | \$2.578.324 | 7,9\% |
| Salaries | \$90.000 | \$75.000 | \$60.000 | \$10.497.186 | \$10.648.459 | \$10.799.732 | \$302.546 | 0,1\% |
| Maintenance | \$144.000 | \$120.000 | \$96.000 | \$10.527.441 | \$10.648.459 | \$10.769.477 | \$242.037 | 0,1\% |
| Working capital | \$240.000 | \$200.000 | \$160.000 | \$10.602.625 | \$10.648.459 | \$10.694.293 | \$91.669 | 0,0\% |
| Start-up expense | \$360.000 | \$300.000 | \$240.000 | \$10.612.423 | \$10.648.459 | \$10.684.495 | \$72.072 | 0,0\% |
| Power losses | 4\% | 3\% | 2\% | \$10.648.459 | \$10.648.459 | \$10.648.459 | \$0 | 0,0\% |



Senslt 1.45
So Cal
Tornado Analysis

|  | NPV of Investment |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Input Variable | Low Output | Base Case | High Output | Low | Base | High | Swing | Swing^2 |
| WACC | 12,02\% | 10,02\% | 8,02\% | \$4.188.587 | \$6.333.148 | \$8.934.499 | \$4.745.912 | 39,2\% |
| Increase in power prices | 12\% | 15\% | 18\% | \$4.423.009 | \$6.333.148 | \$8.429.000 | \$4.005.991 | 27,9\% |
| Equipment | \$12.000.000 | \$10.000.000 | \$8.000.000 | \$4.775.295 | \$6.333.148 | \$7.865.217 | \$3.089.921 | 16,6\% |
| Trader accuracy | 90\% | 95\% | 100\% | \$5.233.650 | \$6.333.148 | \$7.427.059 | \$2.193.409 | 8,4\% |
| Corporate tax rate | 41\% | 34\% | 27\% | \$5.290.191 | \$6.333.148 | \$7.376.105 | \$2.085.915 | 7,6\% |
| Salaries | \$90.000 | \$75.000 | \$60.000 | \$6.178.248 | \$6.333.148 | \$6.488.049 | \$309.801 | 0,2\% |
| Maintenance | \$144.000 | \$120.000 | \$96.000 | \$6.209.228 | \$6.333.148 | \$6.457.069 | \$247.841 | 0,1\% |
| Working capital | \$240.000 | \$200.000 | \$160.000 | \$6.283.230 | \$6.333.148 | \$6.383.066 | \$99.836 | 0,0\% |
| Start-up expense | \$360.000 | \$300.000 | \$240.000 | \$6.293.917 | \$6.333.148 | \$6.372.380 | \$78.463 | 0,0\% |
| Power losses | 4\% | 3\% | 2\% | \$6.333.148 | \$6.333.148 | \$6.333.148 | \$0 | 0,0\% |



|  | NPV of Investment |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Input Variable | Low Output | Base Case | High Output | Low | Base | High | Swing | Swing^2 |
| Return on Equity | 24,00\% | 20,00\% | 16,00\% | -\$355.999 | \$918.692 | \$2.734.378 | \$3.090.376 | 40,6\% |
| Equipment | \$12.000.000 | \$10.000.000 | \$8.000.000 | -\$295.731 | \$918.692 | \$2.098.583 | \$2.394.315 | 24,4\% |
| Increase in power prices | 12\% | 15\% | 18\% | -\$86.688 | \$918.692 | \$2.006.438 | \$2.093.125 | 18,6\% |
| Trader accuracy | 90\% | 95\% | 100\% | \$66.833 | \$918.692 | \$1.753.409 | \$1.686.576 | 12,1\% |
| Corporate tax rate | 41\% | 34\% | 27\% | \$444.938 | \$918.692 | \$1.392.447 | \$947.509 | 3,8\% |
| Salaries | \$90.000 | \$75.000 | \$60.000 | \$819.389 | \$918.692 | \$1.016.669 | \$197.280 | 0,2\% |
| Start-up expense | \$360.000 | \$300.000 | \$240.000 | \$826.152 | \$918.692 | \$1.010.694 | \$184.542 | 0,1\% |
| Working capital | \$240.000 | \$200.000 | \$160.000 | \$835.780 | \$918.692 | \$1.000.476 | \$164.696 | 0,1\% |
| Maintenance | \$144.000 | \$120.000 | \$96.000 | \$839.250 | \$918.692 | \$997.398 | \$158.149 | 0,1\% |
| Power losses | 4\% | 3\% | 2\% | \$918.692 | \$918.692 | \$918.692 | \$0 | 0,0\% |



| Input Variable | NPV of Investment |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Low Output | Base Case | High Output | Low | Base | High | Swing | Swing^2 |
| Return on Equity | 24,00\% | 20,00\% | 16,00\% | -\$548.622 | \$688.778 | \$2.453.044 | \$3.001.665 | 42,0\% |
| Equipment | \$12.000.000 | \$10.000.000 | \$8.000.000 | -\$531.716 | \$688.778 | \$1.873.734 | \$2.405.450 | 26,9\% |
| Increase in power prices | 12\% | 15\% | 18\% | -\$294.675 | \$688.778 | \$1.757.900 | \$2.052.576 | 19,6\% |
| Trader accuracy | 90\% | 95\% | 100\% | \$69.799 | \$688.778 | \$1.300.809 | \$1.231.010 | 7,1\% |
| Corporate tax rate | 41\% | 34\% | 27\% | \$235.400 | \$688.778 | \$1.142.156 | \$906.756 | 3,8\% |
| Salaries | \$90.000 | \$75.000 | \$60.000 | \$589.474 | \$688.778 | \$788.081 | \$198.607 | 0,2\% |
| Start-up expense | \$360.000 | \$300.000 | \$240.000 | \$596.238 | \$688.778 | \$781.318 | \$185.081 | 0,2\% |
| Working capital | \$240.000 | \$200.000 | \$160.000 | \$605.865 | \$688.778 | \$771.691 | \$165.825 | 0,1\% |
| Maintenance | \$144.000 | \$120.000 | \$96.000 | \$609.335 | \$688.778 | \$768.221 | \$158.886 | 0,1\% |
| Power losses | 4\% | 3\% | 2\% | \$688.778 | \$688.778 | \$688.778 | \$0 | 0,0\% |



|  | $\begin{array}{lc}\text { Corresponding Input Value } & \text { NPV of Investment } \\ \text { Output Value }\end{array}$ |  |  |  |  |  |  | Percent |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Input Variable | Low Output | Base Case | High Output | Low | Base | High | Swing | Swing^2 |
| Return on Equity | 24,00\% | 20,00\% | 16,00\% | \$1.502.892 | \$3.153.378 | \$5.487.720 | \$3.984.828 | 50,2\% |
| Increase in power prices | 12\% | 15\% | 18\% | \$1.952.621 | \$3.153.378 | \$4.467.458 | \$2.514.836 | 20,0\% |
| Equipment | \$12.000.000 | \$10.000.000 | \$8.000.000 | \$1.986.447 | \$3.153.378 | \$4.302.449 | \$2.316.002 | 16,9\% |
| Trader accuracy | 90\% | 95\% | 100\% | \$2.432.708 | \$3.153.378 | \$3.873.132 | \$1.440.424 | 6,6\% |
| Corporate tax rate | 41\% | 34\% | 27\% | \$2.464.177 | \$3.153.378 | \$3.842.579 | \$1.378.402 | 6,0\% |
| Salaries | \$90.000 | \$75.000 | \$60.000 | \$3.059.387 | \$3.153.378 | \$3.247.369 | \$187.982 | 0,1\% |
| Start-up expense | \$360.000 | \$300.000 | \$240.000 | \$3.065.557 | \$3.153.378 | \$3.241.199 | \$175.643 | 0,1\% |
| Working capital | \$240.000 | \$200.000 | \$160.000 | \$3.076.497 | \$3.153.378 | \$3.230.259 | \$153.762 | 0,1\% |
| Maintenance | \$144.000 | \$120.000 | \$96.000 | \$3.078.185 | \$3.153.378 | \$3.228.571 | \$150.386 | 0,1\% |
| Power losses | 4\% | 3\% | 2\% | \$3.153.378 | \$3.153.378 | \$3.153.378 | \$0 | 0,0\% |



Senslt 1.45
So Cal Equity
Tornado Analysis

|  | $\begin{array}{cc}\text { Corresponding Input Value } & \text { NPV of Investment } \\ \text { Output Value }\end{array}$ |  |  |  |  |  |  | Percent |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Input Variable | Low Output | Base Case | High Output | Low | Base | High | Swing | Swing^2 |
| WACC | 24,00\% | 20,00\% | 16,00\% | -\$521.494 | \$721.157 | \$2.492.664 | \$3.014.159 | 42,0\% |
| Equipment | \$12.000.000 | \$10.000.000 | \$8.000.000 | -\$498.482 | \$721.157 | \$1.905.400 | \$2.403.881 | 26,7\% |
| Increase in power prices | 12\% | 15\% | 18\% | -\$265.384 | \$721.157 | \$1.792.902 | \$2.058.286 | 19,6\% |
| Trader accuracy | 90\% | 95\% | 100\% | \$92.226 | \$721.157 | \$1.342.209 | \$1.249.982 | 7,2\% |
| Corporate tax rate | 41\% | 34\% | 27\% | \$264.909 | \$721.157 | \$1.177.405 | \$912.496 | 3,9\% |
| Salaries | \$90.000 | \$75.000 | \$60.000 | \$621.854 | \$721.157 | \$820.461 | \$198.607 | 0,2\% |
| Start-up expense | \$360.000 | \$300.000 | \$240.000 | \$628.617 | \$721.157 | \$813.697 | \$185.081 | 0,2\% |
| Working capital | \$240.000 | \$200.000 | \$160.000 | \$638.244 | \$721.157 | \$804.070 | \$165.825 | 0,1\% |
| Maintenance | \$144.000 | \$120.000 | \$96.000 | \$641.714 | \$721.157 | \$800.600 | \$158.886 | 0,1\% |
| Power losses | 4\% | 3\% | 2\% | \$721.157 | \$721.157 | \$721.157 | \$0 | 0,0\% |



| Variation | $10 \%$ |
| :--- | :---: |
| System used | Long IsI |
| WACC | $10,02 \%$ |
| Increase | $15 \%$ |
| Equipment | 10.000 .000 |


| 6.678 .480 |  | Long Island |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | $\triangle$ WACC |  |  |  |  |  |  |  |  |  |  |
|  |  | 12,53\% | 12,02\% | 11,52\% | 11,02\% | 10,52\% | 10,02\% | 9,52\% | 9,02\% | 8,52\% | 8,02\% | 7,52\% |
|  | 18,75\% | 6.248 .369 | 6.816 .366 | 7.411 .477 | 8.035.305 | 8.689 .560 | 9.376 .071 | 10.096.791 | 10.853.813 | 11.649.373 | 12.485.868 | 13.365.866 |
|  | 18,00\% | 5.779 .383 | 6.330.047 | 6.906.957 | 7.511.661 | 8.145.815 | 8.811 .187 | 99.509.668 | 10.243.279 | 11.014.185 | 11.824 .704 | 12.677 .320 |
| 亏 | 17,25\% | 5.321.079 | 5.854 .834 | 6.413 .988 | 7.000.038 | 7.614.584 | 8.259 .336 | 8.936.122 | 9.646 .899 | 10.393.758 | 11.178.941 | 12.004.848 |
| ® | 16,50\% | 4.873 .264 | 5.390.527 | 5.932.362 | 6.500 .217 | 7.095.639 | 7.720 .281 | 8.375 .909 | 9.064.416 | 9.787 .823 | 10.548.297 | 11.348.158 |
| $\stackrel{\text { \% }}{\text { ¢ }}$ | 15,75\% | 4.435.749 | 4.936 .928 | 5.461.874 | 6.011.986 | 6.588 .758 | 7.193 .789 | 7.828 .787 | 8.495.577 | 9.196 .116 | 9.932.497 | 10.706.962 |
| $\stackrel{3}{8}$ | 15,00\% | 4.007.031 | 4.492 .557 | 5.001 .066 | 5.533 .910 | 6.092.533 | 6.678 .480 | 7.293 .399 | 7.939.057 | 8.617.342 | 9.330.276 | 10.080.027 |
| § | 14,25\% | 3.587.001 | 4.057 .295 | 4.549.810 | 5.065.852 | 5.606.815 | 6.174.192 | 6.769.575 | 7.394.670 | 8.051.301 | 8.741.422 | 9.467 .125 |
| $\stackrel{\square}{0}$ | 13,50\% | 3.176.740 | 3.632 .188 | 4.109 .113 | 4.608 .778 | 5.132 .529 | 5.681 .807 | 6.258 .150 | 6.863.205 | 7.498 .733 | 8.166.621 | 8.868.889 |
| 궁. | 12,75\% | 2.776.067 | 3.217 .046 | 3.678 .779 | 4.162 .485 | 4.669.463 | 5.201.104 | 5.758.893 | 6.344.420 | 6.959.386 | 7.605 .610 | 8.285.044 |
| \% | 12,00\% | 2.384.805 | 2.811 .686 | 3.258 .616 | 3.726.771 | 4.217 .407 | 4.731 .864 | 5.271 .577 | 5.838 .079 | 6.433 .011 | 7.058.130 | 7.715.317 |
|  | 11,25\% | 2.002.778 | 2.415.923 | 2.848.432 | 3.301.439 | 3.776.154 | 4.273 .872 | 4.795 .976 | 5.343 .945 | 5.919.363 | 6.523.924 | 7.159.443 |


|  |  | Long Island |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | $\triangle$ WACC |  |  |  |  |  |  |  |  |  |  |
|  | 6.678 .480 | 12,53\% | 12,02\% | 11,52\% | 11,02\% | 10,52\% | 10,02\% | 9,52\% | 9,02\% | 8,52\% | 8,02\% | 7,52\% |
|  | 7.500.000 | 5.967.076 | 6.442 .685 | 6.941.025 | 7.463 .441 | 8.011.367 | 8.586.339 | 9.189.998 | 9.824 .101 | 10.490 .525 | 11.191.283 | 11.928 .532 |
|  | 8.000.000 | 5.578.210 | 6.055.719 | 6.556 .006 | 7.080.417 | 7.630.391 | 8.207.462 | 8.813.275 | 9.449 .587 | 10.118 .278 | 10.821.364 | 11.561 .001 |
|  | 8.500 .000 | 5.185.744 | 5.665.250 | 6.167.585 | 6.694 .096 | 7.246.223 | 7.825.505 | 8.433.585 | 9.072.223 | 9.743 .303 | 10.448 .840 | 11.190.994 |
|  | 9.000 .000 | 4.793 .278 | 5.274.781 | 5.779.163 | 6.307.775 | 6.862 .056 | 7.443 .547 | 8.053 .894 | 8.694 .860 | 9.368 .327 | 10.076.316 | 10.820.988 |
|  | 9.500 .000 | 4.400 .812 | 4.884.312 | 5.390 .742 | 5.921.453 | 6.477 .888 | 7.061 .589 | 7.674 .204 | 8.317.496 | 8.993.352 | 9.703 .792 | 10.450.981 |
|  | 10.000.000 | 4.007.031 | 4.492 .557 | 5.001.066 | 5.533.910 | 6.092.533 | 6.678.480 | 7.293.399 | 7.939.057 | 8.617.342 | 9.330 .276 | 10.080.027 |
|  | 10.500.000 | 3.608.351 | 4.096.016 | 4.606 .720 | 5.141.819 | 5.702 .758 | 6.291 .083 | 6.908.447 | 7.556 .616 | 8.237.482 | 8.953 .069 | 9.705 .547 |
|  | 11.000.000 | 3.209.672 | 3.699 .475 | 4.212.374 | 4.749 .728 | 5.312 .982 | 5.903 .686 | 6.523 .494 | 7.174.174 | 7.857 .622 | 8.575.862 | 9.331 .068 |
|  | 11.500 .000 | 2.810 .993 | 3.302.934 | 3.818 .029 | 4.357 .636 | 4.923 .207 | 5.516 .290 | 6.138 .541 | 6.791 .733 | 7.477.761 | 8.198.655 | 8.956.588 |
|  | 12.000.000 | 2.407 .586 | 2.901.751 | 3.419.134 | 3.961.095 | 4.529 .086 | 5.124.660 | 5.749.474 | 6.405 .304 | 7.094.047 | 7.817.735 | 8.578 .546 |
|  | 12.500 .000 | 2.001.612 | 2.498.050 | 3.017.771 | 3.562.139 | 4.132.608 | 4.730 .733 | 5.358 .174 | 6.016.710 | 6.708.240 | 7.434.801 | 8.198.571 |


|  |  | Long Island |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | $\Delta$ Increase in power prices |  |  |  |  |  |  |  |  |  |  |
|  | 6.678 .480 | 11,25\% | 12,00\% | 12,75\% | 13,50\% | 14,25\% | 15,00\% | 15,75\% | 16,50\% | 17,25\% | 18,00\% | 18,75\% |
|  | 7.500.000 | 6.195.794 | 6.651 .631 | 7.118 .695 | 7.596.356 | 8.085.409 | 8.586.339 | 9.099.371 | 9.624 .732 | 10.162 .652 | 10.713.363 | 11.277.100 |
|  | 8.000.000 | 5.813 .837 | 6.269 .673 | 6.736 .737 | 7.215 .243 | 7.705 .412 | 8.207.462 | 8.721 .440 | 9.246 .801 | 9.784 .720 | 10.335.431 | 10.899.169 |
|  | 8.500 .000 | 5.431.879 | 5.887.715 | 6.354.779 | 6.833 .286 | 7.323.454 | 7.825.505 | 8.339 .662 | 8.866.154 | 9.405 .209 | 9.957.060 | 10.521.238 |
|  | 9.000.000 | 5.048 .665 | 5.505.758 | 5.972 .821 | 6.451 .328 | 6.941 .496 | 7.443 .547 | 7.957.705 | 8.484.196 | 9.023 .251 | 9.575.103 | 10.139.986 |
| m | 9.500 .000 | 4.661.269 | 5.119.261 | 5.588 .500 | 6.069.203 | 6.559 .538 | 7.061 .589 | 7.575 .747 | 8.102.238 | 8.641 .293 | 9.193.145 | 9.758 .029 |
| ㄷ.. | 10.000.000 | 4.273 .872 | 4.731 .864 | 5.201.104 | 5.681 .807 | 6.174.192 | 6.678 .480 | 7.193.789 | 7.720 .281 | 8.259.336 | 8.811 .187 | 9.376 .071 |
| \% | 10.500.000 | 3.883.710 | 4.344.467 | 4.813 .707 | 5.294 .410 | 5.786 .795 | 6.291 .083 | 6.807.499 | 7.336.269 | 7.877 .378 | 8.429.230 | 8.994.113 |
| $\stackrel{ }{-}$ | 11.000.000 | 3.489.783 | 3.951.298 | 4.424.111 | 4.907.013 | 5.399 .398 | $5.903 .68 \overline{6}^{6}$ | 6.420 .102 | 6.948.872 | 7.490 .227 | 8.044.399 | 8.611 .624 |
|  | 11.500.000 | 3.095.855 | 3.557.371 | 4.030.184 | 4.514 .511 | 5.010 .572 | 5.516.290 | 6.032 .705 | 6.561475 | 7.102.830 | 7.657.002 | 8.224.227 |
|  | 12.000.000 | 2.697 .685 | 3.163.444 | 3.636 .257 | 4.120 .584 | 4.616 .644 | 5.124.660' | 5.644.854 | 6.174.079 | 6.715 .433 | 7.269.605 | 7.836.831 |
|  | 12.500.000 | 2.296.428 | 2.763.130 | 3.241.228 | 3.726.657 | 4.222.717 | 4.730 .733 | 5.250.927 | 5.783.530 | 6.328.037 | 6.882.209 | 7.449.434 |


| Variation | $10 \%$ |
| :--- | :---: |
| System used | SP-15 |
| WACC | $10,02 \%$ |
| Increase | $15 \%$ |
| Equipment | 10.000 .000 |

SP-15

|  | SP-15 |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | $\triangle$ WACC |  |  |  |  |  |  |  |  |  |  |
| 6.276 .543 | 12,53\% | 12,02\% | 11,52\% | 11,02\% | 10,52\% | 10,02\% | 9,52\% | 9,02\% | 8,52\% | 8,02\% | 7,52\% |
| 18,75\% | 5.860.479 | 6.415.926 | 6.997.875 | 7.607 .890 | 8.247 .642 | 8.918.917 | 9.623 .625 | 10.363.810 | 11.141 .657 | 11.959.508 | 12.819 .870 |
| 18,00\% | 5.401.721 | 5.940.214 | 6.504 .358 | 7.095.666 | 7.715 .756 | 8.366.353 | 9.049.307 | 9.766 .592 | 10.520.323 | 11.312.764 | 12.146 .341 |
| इ 17,25\% | 4.953 .412 | 5.475 .365 | 6.022 .140 | 6.595 .201 | 7.196 .110 | 7.826 .537 | 8.488 .270 | 9.183 .218 | 9.913 .427 | 10.681.084 | 11.488.536 |
| त $16.50 \%$ | 4.515.015 | 5.020 .843 | 5.550.686 | 6.105.957 | 6.688 .168 | 7.298.934 | 7.939.980 | 8.613 .154 | 9.320.433 | 10.063.932 | 10.845 .917 |
| ~. 15,75\% | 4.084.496 | 4.574 .649 | 5.088.031 | 5.626 .009 | 6.190 .044 | 6.781 .696 | 7.402 .633 | 8.054.641 | 8.739.629 | 9.459 .643 | 10.216.872 |
| ${ }_{5}$ | 3.663.892 | 4.138 .762 | 4.636 .095 | 5.157.213 | 5.703.526 | 6.276 .543 | 6.877 .876 | 7.509 .248 | 8.172.506 | 8.869.625 | 9.602.721 |
| \% 14,25\% | 3.253.023 | 3.712 .993 | 4.194 .681 | 4.699.362 | 5.228.401 | 5.783.253 | 6.365.476 | 6.976.734 | 7.618 .811 | 8.293.613 | 9.003 .186 |
| 13,50\% | 2.851 .709 | 3.297.157 | 3.763.595 | 4.252.257 | 4.764 .459 | $5.301 .6 \overline{7}$ | 5.865 .205 | 6.456.860 | 7.078.294 | 7.731 .349 | 8.417.997 |
| ]. 12,75\% | 2.459.775 | 2.891.069 | 3.342 .647 | 3.815.698 | 4.311.492 | 4.831 .388 | 5.376.837 | 5.949.390 | 6.550.710 | 7.182 .573 | 7.846.885 |
| $\sim$ 12,00\% | 2.077.047 | 2.494 .550 | 2.931 .647 | 3.389 .487 | 3.869.295 | 4.372 .382 | 4.900 .149 | 5.454 .092 | 6.035.815 | 6.647 .033 | 7.289.585 |
| 11,25\% | 1.702.755 | 2.106.833 | 2.529.836 | 2.972 .870 | 3.437.118 | 3.923.845 | 4.434.401 | 4.970 .232 | 5.532.883 | 6.124 .010 | 6.745.385 |


|  |  | SP-15 |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | $\triangle$ WACC |  |  |  |  |  |  |  |  |  |  |
|  | 6.276 .543 | 12,53\% | 12,02\% | 11,52\% | 11,02\% | 10,52\% | 10,02\% | 9,52\% | 9,02\% | 8,52\% | 8,02\% | 7,52\% |
|  | 7.500 .000 | 5.630.899 | 6.095.681 | 6.582 .667 | 7.093.172 | 7.628.596 | 8.190.440 | 8.780 .306 | 9.399.908 | 10.051.081 | 10.735.792 | 11.456.145 |
|  | 8.000 .000 | 5.239.174 | 5.705.933 | 6.194 .947 | 6.707 .530 | 7.245 .086 | 7.809 .117 | 8.401.226 | 9.023.131 | 9.676 .668 | 10.363.805 | 11.086 .648 |
|  | 8.500 .000 | 4.846 .708 | 5.315.464 | 5.806.525 | 6.321 .208 | 6.860 .919 | 7.427.159 | 8.021.536 | 8.645.767 | 9.301 .692 | 9.991 .281 | 10.716 .641 |
|  | 9.000 .000 | 4.454.242 | 4.924 .995 | 5.418.104 | 5.934 .887 | 6.476 .751 | 7.045.202 | 7.641 .845 | 8.268.404 | 8.926 .717 | 9.618 .757 | 10.346.635 |
| m | 9.500 .000 | 4.061.776 | 4.534.526 | 5.029.683 | 5.548.566 | 6.092 .584 | 6.663 .244 | 7.262 .155 | 7.891 .040 | 8.551 .741 | 9.246 .233 | 9.976 .628 |
| ㄷ.. | 10.000.000 | 3.663.892 | 4.138.762 | 4.636.095 | 5.157.213 | 5.703.526 | 6.276.543 | 6.877 .876 | 7.509 .248 | 8.172.506 | 8.869 .625 | 9.602 .721 |
| \% | 10.500.000 | 3.265.213 | 3.742 .220 | 4.241 .749 | 4.765.121 | 5.313 .750 | 5.889 .146 | 6.492 .923 | 7.126.807 | 7.792 .646 | 8.492 .418 | 9.228 .241 |
| $\stackrel{+}{+}$ | 11.000.000 | 2.866.533 | 3.345.679 | 3.847.403 | 4.373 .030 | 4.923 .975 | $5.501 .749^{-}$ | 6.107 .970 | 6.744.366 | 7.412 .786 | 8.115.210 | 8.853 .761 |
|  | 11.500.000 | 2.465 .177 | 2.946.510 | 3.450.482 | 3.978.419 | 4.531.739 | 5.111.956 | 5.720.688 | 6.359.666 | 7.030.743 | 7.735.901 | 8.477.264 |
|  | 12.000.000 | 2.059.204 | 2.542 .809 | 3.049.119 | 3.579 .463 | 4.135 .261 | 4.718 .029 | 5.329 .388 | 5.971.072 | 6.644.937 | 7.352 .967 | 8.097.289 |
|  | 12.500.000 | 1.653 .231 | 2.139.108 | 2.647.756 | 3.180.507 | 3.738 .782 | 4.324.102 | 4.938.088 | 5.582.479 | 6.259.131 | 6.970.032 | 7.717.314 |

SP-15


| Variation | $10 \%$ |
| :--- | :---: |
| System used | San Diego |
| WACC | $10,02 \%$ |
| Increase | $15 \%$ |
| Equipment | 10.000 .000 |


|  |  | San Diego |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | $\triangle$ WACC |  |  |  |  |  |  |  |  |  |  |
|  | 10.648 .459 | 12,53\% | 12,02\% | 11,52\% | 11,02\% | 10,52\% | 10,02\% | 9,52\% | 9,02\% | 8,52\% | 8,02\% | 7,52\% |
|  | 18,75\% | 10.103.518 | 10.797.228 | 11.524.194 | 12.286 .385 | 13.085.904 | 13.924.999 | 14.806.074 | 15.731 .699 | 16.704.628 | 17.727.808 | 18.804.395 |
|  | 18,00\% | 9.534 .064 | 10.206.624 | 10.911.380 | 11.650 .238 | 12.425.231 | 13.238 .536 | 14.092.477 | 14.989.543 | 15.932.396 | 16.923.888 | 17.967.074 |
| 亏 | 17,25\% | 8.977.610 | 9.629 .536 | 10.312.626 | 11.028.720 | 11.779.789 | 12.567 .935 | 13.395 .408 | 14.264 .616 | 15.178 .132 | 16.138.716 | 17.149.321 |
| กั๊ | 16,50\% | 8.433.921 | 9.065.721 | 9.727 .677 | 10.421 .569 | 11.149 .302 | 11.912 .910 | 12.714 .569 | 13.556.606 | 14.441 .510 | 15.371.950 | 16.350.782 |
| $\stackrel{\sim}{\sim}$ | 15,75\% | 7.902.767 | 8.514.939 | 9.156.283 | 9.828.523 | $10.53 \overline{3} .499$ | 11.273 .178 | 12.049 .663 | 12.865.204 | 13.722 .208 | 14.623.254 | 15.571.104 |
| $\stackrel{5}{0}$ | 15,00\% | 7.383.921 | 7.976.952 | 8.598 .198 | 9.249 .325 | 9.932 .112 | 10.648.459 | 11.400 .399 | 12.190.106 | 13.019.908 | 13.892.296 | 14.809.939 |
| ¢ | 14,25\% | 6.877.156 | 7.451.526 | 8.053.178 | 8.683.721 | 9.344 .875 | 10.038 .476 | 10.766 .488 | 11.531.012 | 12.334.296 | 13.178 .747 | 14.066.946 |
| $\stackrel{\square}{0}$ | 13,50\% | 6.382.252 | 6.938.429 | 7.520.981 | 8.131.460 | 8.771 .527 | 9.442 .956 | 10.147 .645 | 10.887.623 | 11.665.061 | 12.482.284 | 13.341 .785 |
| 궁. | 12,75\% | 5.898 .987 | 6.437.434 | 7.001.369 | 7.592 .293 | 8.211 .809 | 8.861 .630 | 9.543.590 | 10.259 .646 | 11.011 .897 | 11.802 .587 | 12.634.122 |
| $\stackrel{\sim}{\sim}$ | 12,00\% | 5.427.147 | 5.948.315 | 6.494 .108 | 7.065 .976 | 7.665.466 | 8.294 .232 | 8.954 .044 | 9.646 .792 | 10.374 .501 | 11.139.339 | 11.943.627 |
|  | 11,25\% | 4.966.516 | 5.470 .848 | 5.998.966 | 6.552 .267 | 7.132.246 | 7.740 .500 | 8.378.734 | 9.048 .775 | 9.752 .576 | 10.492.229 | 11.269.974 |


|  |  | San Diego |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | $\triangle$ WACC |  |  |  |  |  |  |  |  |  |  |
|  | 10.648 .459 | 12,53\% | 12,02\% | 11,52\% | 11,02\% | 10,52\% | 10,02\% | 9,52\% | 9,02\% | 8,52\% | 8,02\% | 7,52\% |
|  | 7.500.000 | 9.316 .910 | 9.900.775 | 10.512 .626 | 11.154.121 | 11.827.029 | 12.533 .246 | 13.274 .793 | 14.053.838 | 14.872 .698 | 15.733 .855 | 16.639.969 |
|  | 8.000.000 | 8.931.819 | 9.517.470 | 10.131 .152 | 10.774.524 | 11.449.358 | 12.157 .549 | 12.901 .123 | 13.682 .248 | 14.503.242 | 15.366 .590 | 16.274 .954 |
|  | 8.500 .000 | 8.546 .728 | 9.134.165 | 9.749 .678 | 10.394.927 | 11.071 .687 | 11.781.853 | 12.527 .454 | 13.310 .657 | 14.133.786 | 14.999.325 | 15.909.938 |
|  | 9.000.000 | 8.159.444 | 8.748.736 | 9.366 .150 | 10.013.348 | 10.692 .106 | 11.404.322 | 12.152.024 | 12.937.385 | 13.762 .726 | 14.630 .537 | 15.543.481 |
| \% | 9.500 .000 | 7.771 .683 | 8.362.844 | 8.982.174 | 9.631 .337 | 10.312.109 | 11.026 .390 | 11.776 .212 | 12.563.746 | 13.391.317 | 14.261.416 | 15.176.710 |
| ㄷ.. | 10.000.000 | 7.383.921 | 7.976.952 | 8.598.198 | 9.249.325 | 9.932 .112 | 10.648.459 | 11.400.399 | 12.190.106 | 13.019.908 | 13.892.296 | 14.809.939 |
| \% | 10.500.000 | 6.996.159 | 7.591 .060 | 8.214.222 | 8.867.314 | 9.552.115 | 10.270 .528 | 11.024 .586 | 11.816 .467 | 12.648 .499 | 13.523 .176 | 14.443.168 |
| $\stackrel{+}{+}$ | 11.000.000 | 6.607 .599 | 7.204.391 | 7.829 .492 | 8.484.571 | 9.171 .410 | 9.891 .913 | 10.648 .115 | 11.442.196 | 12.276 .485 | 13.153.478 | 14.075 .848 |
|  | 11.500.000 | 6.215.133 | 6.813.922 | 7.441.071 | 8.098.250 | 8.7877.243 | 9.509.955 | 10.268 .425 | 11.064.832 | 11.901.509 | 12.780.954 | 13.705 .841 |
|  | 12.000.000 | 5.822 .667 | 6.423 .453 | 7.052 .649 | 7.711.928 | 8.403 .075 | 9.127 .997 | 9.888 .735 | 10.687.469 | 11.526 .534 | 12.408 .430 | 13.335.835 |
|  | 12.500.000 | 5.430.201 | 6.032.984 | 6.664.228 | 7.325.607 | 8.018.908 | 8.746 .040 | 9.509 .044 | 10.310.105 | 11.151.558 | 12.035.906 | 12.965.828 |

San Diego

|  | $\Delta$ Increase in power prices |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  |  |  |  |  |  |
| 10.648 .459 | 11,25\% | 12,00\% | 12,75\% | 13,50\% | 14,25\% | 15,00\% | 15,75\% | 16,50\% | 17,25\% | 18,00\% | 18,75\% |
| 7.500 .000 | 9.627.566 | 10.180 .842 | 10.747.784 | 11.328.654 | 11.923 .718 | 12.533 .246 | 13.157 .509 | 13.796 .785 | 14.451.354 | 15.121.499 | 15.807.506 |
| 8.000 .000 | 9.251.869 | 9.805 .146 | 10.372 .088 | 10.952 .958 | 11.548 .022 | 12.157 .549 | 12.781 .813 | 13.421 .089 | 14.075 .658 | 14.745 .803 | 15.431 .810 |
| 8.500 .000 | 8.874.294 | 9.428 .027 | 9.995.424 | 10.576 .750 | 11.172.270 | 11.781.853 | 12.406 .117 | 13.045 .393 | 13.699 .962 | 14.370.107 | 15.056.114 |
| 9.000 .000 | 8.496.363 | 9.050 .095 | 9.617 .493 | 10.198.819 | 10.794.339 | 11.404.322 | 12.029.041 | 12.668.773 | 13.323 .798 | 13.994 .398 | 14.680 .418 |
| \% 9.500.000 | 8.118.431 | 8.672 .164 | 9.239 .562 | 9.820 .887 | 10.416 .407 | 11.026 .390 | 11.651 .110 | 12.290.842 | 12.945 .866 | 13.616 .467 | 14.302.931 |
| ㅇ. 10.000 .000 | 7.740 .500 | 8.294 .232 | 8.861 .630 | 9.442 .956 | 10.038.476 | 10.648.459 | 11.273 .178 | 11.912.910 | 12.567 .935 | 13.238.536 | 13.924.999 |
| 3 10.500.000 | 7.359.152 | 7.914 .224 | 8.482 .968 | 9.065.025 | 9.660.544 | 10.270 .528 | 10.895.247 | 11.534 .979 | 12.190.004 | 12.860 .604 | 13.547.068 |
| $\rightarrow 11.000 .000$ | 6.977.195 | 7.532 .267 | 8.101 .010 | 8.683.688 | 9.280 .565 | 9.891 .913 | 10.517 .316 | 11.157 .048 | 11.812.072 | 12.482 .673 | 13.169.136 |
| 11.500 .000 | 6.595.237 | 7.150.309 | 7.719.052 | 8.301 .730 | 8.898 .608 | 9.509 .955 | 10.136 .045 | 10.777.154 | 11.433 .561 | 12.104.741 | 12.791 .205 |
| 12.000.000 | 6.212 .847 | 6.768 .351 | 7.337.095 | 7.919.772 | 8.516 .650 | 9.127.997 | 9.754.087 | 10.395.196 | 11.051.603 | 11.723.593 | 12.411 .452 |
| 12.500.000 | 5.825.451 | 6.383 .148 | 6.954.541 | 7.537.815 | 8.134.692 | 8.746 .040 | 9.372 .129 | 10.013.238 | 10.669.646 | 11.341 .635 | 12.029.494 |


| Variation | $10 \%$ |
| :--- | :---: |
| System used | SoCal |
| WACC | $10,02 \%$ |
| Increase | $15 \%$ |
| Equipment | 10.000 .000 |


|  |  | SoCal |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | $\triangle$ WACC |  |  |  |  |  |  |  |  |  |  |
|  | 6.333.148 | 12,53\% | 12,02\% | 11,52\% | 11,02\% | 10,52\% | 10,02\% | 9,52\% | 9,02\% | 8,52\% | 8,02\% | 7,52\% |
|  | 18,75\% | 5.915 .106 | 6.472 .321 | 7.056.123 | 7.668.083 | 8.309.878 | 8.983.299 | 9.690.262 | 10.432 .818 | 11.213 .159 | 12.033.636 | 12.896.764 |
| $\triangleright$ | 18,00\% | 5.454.908 | 5.995.115 | 6.561.057 | 7.154.251 | 7.776.321 | 8.429.000 | 9.114.140 | 99.833.724 | 10.5899.874 | 11.384.861 | 12.221.119 |
| $\bar{\square}$ | 17,25\% | 5.005.191 | 5.528.806 | 6.077.325 | 6.652 .215 | 7.255 .044 | 7.887 .489 | 8.551 .342 | 9.248 .519 | 9.981 .072 | 10.751.198 | 11.561 .249 |
| $\stackrel{\text { ²0 }}{ }$ | 16,50\% | 4.565.767 | 5.073.199 | 5.604.724 | 6.161 .760 | 6.745 .823 | 7.358.535 | 8.001 .627 | 8.676 .951 | 9.386 .492 | 10.132.371 | 10.916.864 |
| $\stackrel{\sim}{\circ}$ | 15,75\% | 4.134.141 | 4.625 .843 | 5.140.850 | 5.680 .532 | 6.246 .356 | 6.839 .887 | 7.462 .800 | 8.116.884 | 8.804.057 | 9.526 .370 | 10.286.020 |
| ミ | 15,00\% | 3.712.217 | 4.188 .587 | 4.687.494 | 5.210 .263 | 5.758 .310 | 6.333.148 | 6.936.394 | 7.569.779 | 8.235.153 | 8.934.499 | 9.669.940 |
| $\stackrel{\square}{\circ}$ | 14,25\% | 3.300.057 | 3.761 .481 | 4.244.694 | 4.750 .976 | 5.281 .694 | 5.838 .310 | 6.422 .386 | 7.035.593 | 7.679.719 | 8.356.679 | 9.068.523 |
| $\stackrel{1}{7}$ | 13,50\% | 2.897.484 | 3.344.339 | 3.812 .255 | 4.302.467 | 4.816 .295 | 5.355.151 | 5.920 .544 | 6.514 .086 | 7.137.505 | 7.792 .649 | 8.481 .497 |
| ) | 12,75\% | 2.504.319 | 2.936.977 | 3.389 .985 | 3.864 .536 | 4.361 .906 | 4.883.456 | 5.430.642 | 6.005 .023 | 6.608 .264 | 7.242.150 | 7.908.592 |
| $\bigcirc$ | 12,00\% | 2.120.389 | 2.539.213 | 2.977 .695 | 3.436 .987 | 3.918 .320 | 4.423 .009 | 4.952 .457 | 5.508.169 | 6.091 .752 | 6.704.928 | 7.349.541 |
|  | 11,25\% | 1.745 .520 | 2.150 .866 | 2.575.197 | 3.019.625 | 3.485.336 | 3.973 .599 | 4.485.768 | 5.023.295 | 5.587.729 | 6.180.733 | 6.804 .083 |


|  |  | SoCal |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | $\triangle$ WACC |  |  |  |  |  |  |  |  |  |  |
|  | 6.333.148 | 12,53\% | 12,02\% | 11,52\% | 11,02\% | 10,52\% | 10,02\% | 9,52\% | 9,02\% | 8,52\% | 8,02\% | 7,52\% |
|  | 7.500 .000 | 5.678.243 | 6.144.550 | 6.633.135 | 7.145.317 | 7.682.503 | 8.246.195 | 8.838 .003 | 9.459.647 | 10.112 .969 | 10.799.940 | 11.522.672 |
|  | 8.000.000 | 5.286.921 | 5.755.194 | 6.245 .795 | 6.760.044 | 7.299.349 | 7.865.217 | 8.459 .256 | 9.083 .189 | 9.738.861 | 10.428.243 | 11.153.452 |
|  | 8.500 .000 | 4.894 .455 | 5.364.725 | 5.857.374 | 6.373 .723 | 6.915 .182 | 7.483 .259 | 8.079 .565 | 8.705 .826 | 9.363 .885 | 10.055.719 | 10.783.445 |
|  | 9.000 .000 | 4.501 .989 | 4.974.256 | 5.468.952 | 5.987 .401 | 6.531 .014 | 7.101.301 | 7.699.875 | 8.328.462 | 8.988.910 | 9.683 .195 | 10.413.438 |
| m | 9.500 .000 | 4.109.523 | 4.583 .787 | 5.080.531 | 5.601.080 | 6.146.847 | 6.719 .343 | 7.320 .184 | 7.951 .098 | 8.613.934 | 9.310.671 | 10.043.432 |
| ㄷ. | 10.000.000 | 3.712.217 | 4.188 .587 | 4.687.494 | 5.210 .263 | 5.758 .310 | 6.333.148 | 6.936.394 | 7.569 .779 | 8.235.153 | 8.934.499 | 9.669.940 |
| 3 | 10.500 .000 | 3.313.537 | 3.792 .046 | 4.293 .148 | 4.818 .172 | 5.368.535 | 5.945.752 | 6.551 .442 | 7.187.337 | 7.855.293 | 8.557.292 | 9.295.461 |
|  | 11.000.000 | 2.914.858 | 3.395.505 | 3.898.803 | 4.426 .081 | 4.978 .759 | 5.558 .355 | 6.166.489 | 6.804 .896 | 7.475 .433 | 8.180.085 | 8.920.981 |
|  | 11.500 .000 | 2.514 .240 | 2.997.060 | 3.502 .592 | 4.032 165 | 4.587202 | 5.169.222 | 5.779.849 | 6.420.820 | 7.093.992 | 7.801 .355 | 8.545 .040 |
|  | 12.000.000 | 2.108.267 | 2.593.359 | 3.101.228 | 3.633.209 | 4.190.724 | 4.775 .295 | 5.388.549 | 6.032.226 | 6.708.186 | 7.418.421 | 8.165.065 |
|  | 12.500 .000 | 1.702.294 | 2.189.658 | 2.699 .865 | 3.234.252 | 3.794.245 | 4.381.368 | 4.997.250 | 5.643 .632 | 6.322.379 | 7.035.486 | 7.785 .090 |

SoCal

|  | $\Delta$ Increase in power prices |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 6.333 .148 | 11,25\% | 12,00\% | 12,75\% | 13,50\% | 14,25\% | 15,00\% | 15,75\% | 16,50\% | 17,25\% | 18,00\% | 18,75\% |
| 7.500 .000 | 5.898.401 | 6.345.696 | 6.804.007 | 7.273 .548 | 7.754.531 | 8.246.195 | 8.749.614 | 9.265.131 | 9.792.971 | 10.333.362 | 10.886.536 |
| 8.000 .000 | 5.516 .443 | 5.963.738 | 6.422 .050 | 6.891.590 | 7.372.573 | 7.8665.217 | 8.369.740 | 8.8866.366 | 9.415 .039 | 9.955.431 | 10.508.605 |
| 8.500 .000 | 5.134.486 | 5.581 .780 | 6.040 .092 | 6.509 .632 | 6.990 .616 | 7.483 .259 | 7.987.782 | 8.504 .408 | 9.033 .362 | 9.574.873 | 10.129.172 |
| 9.000 .000 | 4.748 .392 | 5.197.802 | 5.658 .134 | 6.127.675 | 6.608 .658 | 7.101.301 | 7.605.824 | 8.122.450 | 8.651 .405 | 9.192 .915 | 9.747 .214 |
| 9.500 .000 | 4.360 .995 | 4.810 .405 | 5.270.852 | 5.742.548 | 6.225.706 | 6.719 .343 | 7.223 .867 | 7.740.493 | 8.269.447 | 8.810 .958 | 9.365 .256 |
| 10.000.000 | 3.973.599 | 4.423 .009 | 4.883.456 | 5.355.151 | 5.838 .310 | 6.333.148 | 6.839.887 | 7.358.535 | 7.887.489 | 8.429 .000 | 8.983.299 |
| 10.500.000 | 3.579.743 | 4.032 .610 | 4.496 .059 | 4.967.754 | 5.450.913 | 5.945.752 | 6.452 .490 | 6.971 .352 | 7.502.563 | 8.046.351 | 8.601 .341 |
| + 11.000.000 | 3.185.816 | 3.638.683 | 4.102 .637 | 4.577 .889 | 5.063 .516 | 5.558 .355 | 6.065 .094 | 6.583.956 | 7.115.166 | 7.658 .954 | 8.215 .551 |
| 11.500 .000 | 2.790 .530 | 3.244.756 | 3.708 .710 | 4.183.961 | 4.670 .726 | 5.169.222 | 5.677 .697 | 6.196 .559 | 6.727.770 | 7.271 .558 | 7.828.154 |
| 12.000.000 | 2.389.273 | 2.847.229 | 3.314.783 | 3.790.034 | 4.276 .799 | 4.775 .295 | 5.285.742 | 5.808.365 | 6.340.373 | 6.884.161 | 7.440.757 |
| 12.500.000 | 1.988.016 | 2.445 .973 | 2.915.113 | 3.395 .650 | 3.882.872 | 4.381 .368 | 4.891 .815 | 5.414 .438 | 5.949.461 | 6.496.764 | 7.053.360 |


| Variation | $10 \%$ |
| :--- | :---: |
| System used | Long IsI |
| Return on equity | $20,00 \%$ |
| Increase | $15 \%$ |
| Equipment | 10.000 .000 |


| 918.69 |  | Long Island Equity |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | $\Delta$ Return on equity |  |  |  |  |  |  |  |  |  |  |
|  |  | 25\% | 24\% | 23\% | 22\% | 21\% | 20\% | 19\% | 18\% | 17\% | 16\% | 15\% |
|  | 18,75\% | 425.192 | 739.501 | 1.080.487 | 1.450 .957 | 1.854.057 | 2.293.331 | 2.772 .763 | 3.296.854 | 3.870 .683 | 4.500 .001 | 5.191.324 |
| $\triangleright$ | 18,00\% | 208.865 | 511.215 | 839.271 | 1.195.739 | 1.583 .656 | 2.006 .438 | 2.467 .931 | 2.972 .476 | 3.524 .976 | 4.130 .979 | 4.796.775 |
| 亏 | 17,25\% | -2.900 | 287.777 | 603.212 | 946.014 | 1.319 .112 | 1.725.799 | 2.169 .786 | 2.655 .259 | 3.186 .946 | 3.770 .200 | 4.411 .089 |
| \% | 16,50\% | -210.182 | 69.102 | 372.220 | 701.686 | 1.060.322 | 1.451 .305 | 1.878 .210 | 2.345.074 | 2.856 .456 | 3.417 .518 | 4.034.110 |
| $\stackrel{\text { \% }}{\sim}$ | 15,75\% | -413.059 | -144.893 | 146.206 | 462.659 | 807.186 | 1.182.847 | 1.593 .088 | 2.041 .799 | 2.533.374 | 3.072.788 | 3.665.681 |
| - | 15,00\% | -613.331 | -355.999 | -76.610 | 227.167 | 557.952 | 918.692 | 1.312.707 | 1.743 .744 | 2.216.036 | 2.734.378 | 3.304.203 |
| ${ }^{\circ}$ | 14,25\% | -810.977 | -564.199 | -296.216 | -4.785 | 312.618 | 658.830 | 1.037.047 | 1.450 .879 | 1.904.401 | 2.402.233 | 2.949.608 |
| $\bigcirc$ | 13,50\% | -1.004.414 | -767.931 | -511.074 | -231.683 | 72.670 | $40 \overline{4.714}$ | 767.528 | 1.164 .583 | 1.599.806 | 2.077.642 | 2.603.131 |
| ) | 12,75\% | -1.193.717 | -967.275 | -721.267 | -453.616 | -161.989 | 156.243 | 504.038 | 884.739 | 1.302.123 | 1.760 .468 | 2.264.624 |
| $\stackrel{\sim}{\sim}$ | 12,00\% | -1.378.960 | -1.162.308 | -926.879 | -670.676 | -391.454 | -86.688 | 246.469 | 611.229 | 1.011 .226 | 1.450.574 | 1.933.940 |
|  | 11,25\% | -1.560.215 | -1.353.109 | -1.127.993 | -882.948 | -615.819 | -324.178 | -5.289 | 343.935 | 726.989 | 1.147.826 | 1.610.934 |


|  |  | Long Island Equity |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | $\Delta$ Return on equity |  |  |  |  |  |  |  |  |  |  |
|  | 918.692 | 25\% | 24\% | 23\% | 22\% | 21\% | 20\% | 19\% | 18\% | 17\% | 16\% | 15\% |
|  | 7.500 .000 | 791.664 | 1.060 .667 | 1.352 .322 | 1.668 .999 | 2.013.364 | 2.388 .411 | 2.797 .510 | 3.244.463 | 3.733.566 | 4.269.677 | 4.858 .302 |
|  | 8.000 .000 | 515.203 | 781.800 | 1.070 .923 | 1.384 .936 | 1.726.495 | 2.098 .583 | 2.504 .562 | 2.948.221 | 3.433 .843 | 3.966.273 | 4.551 .002 |
|  | 8.500 .000 | 233.501 | 497.778 | 784.463 | 1.095 .912 | 1.434.772 | 1.804.017 | 2.206.997 | 2.647.493 | 3.129.773 | 3.658.671 | 4.239.663 |
|  | 9.000 .000 | -48.202 | 213.755 | 498.003 | 806.888 | 1.143.049 | 1.509.450 | 1.909 .432 | 2.346 .764 | 2.825.703 | 3.351 .069 | 3.928.325 |
| $\stackrel{\square}{8}$ | 9.500 .000 | -329.904 | -70.267 | 211.543 | 517.864 | 851.325 | 1.214 .883 | 1.611 .868 | 2.046.036 | 2.521 .634 | 3.043.468 | 3.616.986 |
| ㅊ. | 10.000.000 | -613.331 | -355.999 | -76.610 | 227.167 | 557.952 | 918.692 | 1.312.707 | 1.743.744 | 2.216.036 | 2.734.378 | 3.304.203 |
| \% | 10.500.000 | -903.177 | -648.094 | -371.062 | -69.755 | 258.438 | 616.455 | 1.007.607 | 1.435 .632 | 1.904.752 | 2.419.748 | 2.986.044 |
|  | 11.000.000 | -1.193.024 | -940.190 | -665.514 | -366.677 | -41.077 | $314.2 \overline{7}$ | 702.507 | 1.127.520 | 1.593 .467 | 2.105.119 | 2.667 .885 |
|  | 11.500 .000 | -1.482.870 | -1.232.285 | -959.965 | -663.599 | -340.591 | 11.980 | 397.407 | 819.407 | 1.282 .182 | 1.790.489 | 2.349.725 |
|  | 12.000.000 | -1.778.296 | -1.529.956 | -1.259.981 | -966.065' | -645.620' | -295.731 | 86.885 | 505.937 | 965.617 | 1.470.672 | 2.026.487 |
|  | 12.500 .000 | -2.076.749 | -1.830.653 | -1.563.016 | -1.271.539 | -953.641 | -606.413 | -226.580 | 189.559 | 646.186 | 1.148.039 | 1.700 .493 |


|  |  | Long Island Equity |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | $\Delta$ Increase in power prices |  |  |  |  |  |  |  |  |  |  |
|  | 918.692 | 11,25\% | 12,00\% | 12,75\% | 13,50\% | 14,25\% | 15,00\% | 15,75\% | 16,50\% | 17,25\% | 18,00\% | 18,75\% |
|  | 7.500 .000 | 1.165.769 | 1.400.218 | 1.640 .080 | 1.884.153 | 2.133.427 | 2.388.411 | 2.649.209 | 2.915 .929 | 3.188.676 | 3.467.560 | 3.752 .690 |
|  | 8.000.000 | 871.202 | 1.105.652 | 1.345 .513 | 11.590.887 | 1.841 .876 | 2.098 .588 | 2.360.836 | 2.627 .555 | 2.9000 .303 | 3.179.187 | 3.464.317 |
|  | 8.500 .000 | 576.635 | 811.085 | 1.050 .946 | 1.296.321 | 1.547.310 | 1.804.017 | 2.066 .546 | 2.335.005 | 2.609 .499 | 2.890.138 | 3.175.944 |
|  | 9.000.000 | 280.297 | 516.518 | 756.380 | 1.001.754 | 1.252 .743 | 1.509.450 | 1.771 .980 | 2.040 .438 | 2.314 .932 | 2.595 .571 | 2.882.464 |
| m | 9.500.000 | -21.940 | 215.550 | 458.480 | 706.952 | 958.176 | 1.214 .883 | 1.477 .413 | 1.745.872 | 2.020.366 | 2.301.004 | 2.587.897 |
| ㄷ. | 10.000.000 | -324.178 | -86.688 | 156.243 | 404.714 | 658.830 | 918.692 | 1.182 .847 | 1.451.305 | 1.725.799 | 2.006.438 | 2.293.331 |
| \% | 10.500.000 | -629.991 | -388.925 | -145.995 | 102.477 | 356.592 | 616.455 | 882.169 | 1.153.841 | 1.431 .232 | 1.711 .871 | 1.998.764 |
|  | 11.000.000 | -940.673 | -698.627 | -451.076 | -199.760 | 54.355 | $31 \overline{4} \overline{2} \overline{17}$ | 579.932 | 851.604 | 1.129.341 | 1.413.252 | 1.703 .448 |
|  | 11.500 .000 | -1.251.354 | -1.009.308 | -761.757 | -508.599 | -249,731 | 11.980 | 2777694 | 549366 | 827.104 | 1.111.015 | 1.401 .210 |
|  | 12.000.000 | -1.567.067 | -1.319.990 | -1.072.439 | -819.281 | -560.413 | -295.731 | -25.130 | 247.129 | 524.866 | 808.778 | 1.098.973 |
|  | 12.500.000 | -1.886.438 | -1.638.244 | -1.384.427 | -1.129.962 | -871.095 | -606.413 | -335.812 | -59.185 | 222.629 | 506.540 | 796.735 |


| Variation | $10 \%$ |
| :--- | :---: |
| System used | SP-15 |
| Return on equity | $20,00 \%$ |
| Increase | $15 \%$ |
| Equipment | 10.000 .000 |


|  |  | SP-15 Equity |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | $\triangle$ Return on equity |  |  |  |  |  |  |  |  |  |  |
|  | 688.778 | 25\% | 24\% | 23\% | 22\% | 21\% | 20\% | 19\% | 18\% | 17\% | 16\% | 15\% |
|  | 18,75\% | 223.034 | 528.353 | 859.656 | 1.219 .677 | 1.611 .486 | 2.038 .536 | 2.504 .716 | 3.014.413 | 3.572 .582 | 4.184 .832 | 4.857 .520 |
| $\triangleright$ | 18,00\% | 11.425 | 305.046 | 623.701 | 970.026 | 1.346 .982 | 1.757.900 | 2.206 .532 | 2.697 .110 | 3.234 .415 | 3.823 .858 | 4.471 .575 |
| 亏 | 17,25\% | -195.722 | 86.481 | 392.790 | 725.747 | 1.088.207 | 1.483 .382 | 1.914 .890 | 2.386.811 | 2.903.757 | 3.470 .948 | 4.094.302 |
| - | 16,50\% | -398.940 | -127.878 | 166.387 | 486.303 | 834.624 | 1.214.444 | 1.629 .250 | 2.082.977 | 2.580.070 | 3.125.563 | 3.725.161 |
| $\stackrel{\sim}{\sim}$ | 15,75\% | -600.730 | -340.514 | -57.973 | 249.253 | 583.815 | 948.697 | 1.347 .258 | 1.783.289 | 2.261.077 | 2.785.471 | 3.361 .972 |
| $\stackrel{3}{0}$ | 15,00\% | -798.255 | -548.622 | -277.519 | 17.326 | 338.468 | 688.778 | 1.071 .493 | 1.490 .266 | 1.949.225 | 2.453.044 | 3.007.021 |
| $\stackrel{9}{0}$ | 14,25\% | -991.589 | -752.281 | -492.336 | -209.567 | 98.484 | 434.583 | 801.845 | 1.203.788 | 1.644.387 | 2.128.143 | 2.660.159 |
| $\stackrel{1}{0}$ | 13,50\% | -1.180.808 | -951.570 | -702.508 | -431.516 | -136.231 | $18 \overline{6} .0 \overline{0} 0$ | 538.204 | 923.737 | 1.346.435 | 1.810 .631 | 2.321 .239 |
| 궁. | 12,75\% | -1.365.983 | -1.146.566 | -908.116 | -648.610 | -365.772 | -57.043 | 280.461 | 649.996 | 1.055 .244 | 1.500.374 | 1.990 .115 |
| $\stackrel{\sim}{\sim}$ | 12,00\% | -1.547.186 | -1.337.346 | -1.109.244 | -860.935 | -590.232 | -294.675 | 28.509 | 382.451 | 770.691 | 1.197.239 | 1.666 .643 |
|  | 11,25\% | -1.725.191 | -1.524.689 | -1.306.673 | -1.069.277 | -810.399 | -527.676 | -218.442 | 120.311 | 491.987 | 900.440 | 1.350.041 |


|  |  | SP-15 Equity |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | $\triangle$ Return on equity |  |  |  |  |  |  |  |  |  |  |
|  | 688.778 | 25\% | 24\% | 23\% | 22\% | 21\% | 20\% | 19\% | 18\% | 17\% | 16\% | 15\% |
|  | 7.500.000 | 616.280 | 877.468 | 1.160 .708 | 1.468 .313 | 1.802 .879 | 2.167.325 | 2.564.937 | 2.999.423 | 3.474 .970 | 3.996.316 | 4.568.830 |
|  | 8.000 .000 | 335.657 | 594.508 | 875.290 | 1.180.311 | 1.512 .155 | 1.873 .734 | 2.268 .323 | 2.699 .619 | 3.171 .796 | 3.689.579 | 4.258 .324 |
|  | 8.500 .000 | 53.955 | 310.485 | 588.830 | 891.286 | 1.220 .432 | 1.579.167 | 1.970.759 | 2.398.891 | 2.867.726 | 3.381.978 | 3.946.985 |
|  | 9.000.000 | -227.748 | 26.463 | 302.370 | 602.262 | 928.709 | 1.284 .601 | 1.673 .194 | 2.098 .162 | 2.563.657 | 3.074.376 | 3.635.647 |
| m | 9.500 .000 | -509.450 | -257.559 | 15.910 | 313.238 | 636.986 | 990.034 | 1.375 .629 | 1.797.434 | 2.259.587 | 2.766 .774 | 3.324.308 |
| ㄷ.. | 10.000.000 | -798.255 | -548.622 | -277.519 | 17.326 | 338.468 | 688.778 | 1.071 .493 | 1.490 .266 | 1.949.225 | 2.453.044 | 3.007.021 |
| 旁 | 10.500.000 | -1.088.101 | -840.717 | -571.971 | -279.596 | 38.953 | 386.540 | 766.393 | 1.182.154 | 1.637.941 | 2.138 .414 | 2.688.862 |
|  | 11.000.000 | -1.377.947 | -1.132.813 | -866.423 | -576.518 | -260. 5 ¢ 62 | 84.303 | 461.293 | 874.042 | 1.326 .656 | 1.823 .785 | 2.370 .703 |
|  | 11.500 .000 | -1.670.953 | -1.428.066 | -1.164:025 | -876.579 | -563.198 | -221.034 | 153.123 | 562.896 | 1.012 .381 | 1.506 .218 | 2.049.667 |
|  | 12.000.000 | -1.969.406 | -1.728.762 | -1.467.060 | -1.182.053 | -871.219 | -531.716 | -160.342 | 246.518 | 692.950 | 1.183.585 | 1.723.673 |
|  | 12.500.000 | -2.267.858 | -2.029.458 | -1.770.094 | -1.487.527 | -1.179.239 | -842.397 | -473.806 | -69.860 | 373.519 | 860.952 | 1.397.679 |

SP-15 Equity

|  | $\Delta$ Increase in power prices |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 688.778 | 11,25\% | 12,00\% | 12,75\% | 13,50\% | 14,25\% | 15,00\% | 15,75\% | 16,50\% | 17,25\% | 18,00\% | 18,75\% |
| 7.500 .000 | 967.688 | 1.197.024 | 1.431 .655 | 1.671 .677 | 1.917.192 | 2.167 .325 | 2.422 .435 | 2.683.337 | 2.950 .136 | 3.222.938 | 3.501 .849 |
| 8.000 .000 | 673.122 | 902.458 | 1.137 .088 | 1.377 .111 | 1.622 .626 | 1.873 .734 | 2.130 .538 | 2.393.141 | 2.661 .649 | 2.934.565 | 3.213 .476 |
| 8.500 .000 | 378.555 | 607.891 | 842.521 | 1.082.544 | 1.328.059 | 1.579.167 | 1.835.971 | 2.098.575 | 2.367.082 | 2.641 .600 | 2.922.236 |
| 9.000 .000 | 77.489 | 309.800 | 547.432 | 787.977 | 1.033.492 | 1.284.601 | 1.541 .405 | 1.804 .008 | 2.072 .516 | 2.347.034 | 2.627.669 |
| \% 9.500.000 | -224.748 | 7.562 | 245.194 | 488.247 | 736.820 | 990.034 | 1.246 .838 | 1.509.441 | 1.777 .949 | 2.052 .467 | 2.333.103 |
| 10.000.000 | -527.676 | -294.675 | -57.043 | 186.010 | 434.583 | 688.778 | 948.697 | 1.214.444 | 1.483.382 | 1.757.900 | 2.038 .536 |
| \% 10.500.000 | -838.357 | -601.591 | -359.439 | -116.228 | 132.345 | 386.540 | 646.460 | 912.207 | 1.183.887 | 1.461 .606 | 1.743.969 |
| 11.000.000 | -1.149.039 | -912.272 | -670.120 | -422.483 | -169.892 | 84.303 | $344.22{ }^{-1}$ | 609.969 | 881.649 | 1.159.368 | 1.443.235 |
| 11.500 .000 | -1.462.196 | -1.222.954 | -980.802 | -733.165 | -479.943 | 221.034 | 41.985 | 307.732 | 579.412 | 857.131 | 1.140.997 |
| 12.000.000 | -1.781.566 | -1.538.786 | -1.291.483 | -1.043.846 | -790.625 | -531.716 | -267.016 | 3.578 | 277.174 | 554.893 | 838.760 |
| 12.500.000 | -2.100.937 | -1.858.156 | -1.609.875 | -1.355.992 | -1.101.306 | -842.397 | -577.698 | -307.104 | -30.510 | 252.192 | 536.522 |


| Variation | $10 \%$ |
| :--- | :---: |
| System used | San Diego |
| Return on equity | $20,00 \%$ |
| Increase | $15 \%$ |
| Equipment | 10.000 .000 |


|  |  | San Diego Equity |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | $\Delta$ Return on equity |  |  |  |  |  |  |  |  |  |  |
|  | 3.153 .378 | 25\% | 24\% | 23\% | 22\% | 21\% | 20\% | 19\% | 18\% | 17\% | 16\% | 15\% |
|  | 18,75\% | 2.418 .793 | 2.823.233 | 3.261 .314 | 3.736 .542 | 4.252 .851 | 4.814.661 | 5.426 .947 | 6.095.319 | 6.826 .111 | 7.626 .487 | 8.504 .564 |
| - | 18,00\% | 2.157.745 | 2.547 .583 | 2.969 .877 | 3.428 .011 | 3.925.782 | 4.467 .458 | 5.057.844 | 5.702 .356 | 6.407 .112 | 7.179.030 | 8.025.950 |
| $\bar{\square}$ | 17,25\% | 1.902.241 | 2.277.826 | 2.684.710 | 3.126 .157 | 3.605 .835 | 4.127.861 | 4.696 .874 | 5.318 .103 | 5.997.452 | 6.741 .602 | 7.558.122 |
| ${ }^{\circ}$ | 16,50\% | 1.652 .187 | 2.013.859 | 2.405 .702 | 2.830 .865 | 3.292.885 | 3.795.737 | 4.343.895 | 4.942 .405 | 5.596.966 | 6.314.025 | 7.100 .887 |
| $\stackrel{\sim}{*}$ | 15,75\% | 1.407 .486 | 1.755 .581 | 2.132 .746 | 2.542.019 | 2.986 .810 | 3.470.952 | 3.998 .764 | 4.575 .110 | 5.205 .490 | 5.896.123 | 6.654 .055 |
| き | 15,00\% | 1.168 .046 | 1.502.892 | 1.865.735 | 2.259.504 | 2.687 .486 | 3.153.378 | 3.661 .341 | 4.216.069 | 4.822 .862 | 5.487 .720 | 6.217 .439 |
| $\stackrel{\square}{\circ}$ | 14,25\% | 933.773 | 1.255 .693 | 1.604.565 | 1.983.209 | 2.394.795 | 2.842.884 | 3.331 .488 | 3.865.131 | 4.448 .923 | 5.088.646 | 5.790.853 |
| $\stackrel{1}{0}$ | 13,50\% | 704.576 | 1.013.887 | 1.349.130 | 1.713 .022 | 2.108 .616 | 2.539 .3 - 74 | 3.009.069 | 3.522.151 | 4.083.514 | 4.698 .730 | 5.374 .113 |
| ) | 12,75\% | 480.366 | 777.378 | 1.099 .328 | 1.448 .834 | 1.828 .833 | 2.242 .631 | 2.693 .949 | 3.186 .984 | 3.726 .480 | 4.317.804 | 4.967 .039 |
| ® | 12,00\% | 261.052 | 546.070 | 855.058 | 1.190 .535 | 1.555 .329 | 1.952.621 | 2.385 .994 | 2.859 .487 | 3.377 .668 | 3.945.703 | 4.569 .452 |
|  | 11,25\% | 46.546 | 319.869 | 616.219 | 938.019 | 1.287 .991 | 1.669.193 | 2.085.072 | 2.539 .518 | 3.036.924 | 3.582.263 | 4.181.175 |


|  |  | San Diego Equity |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | $\Delta$ Return on equity |  |  |  |  |  |  |  |  |  |  |
|  | 3.153 .378 | 25\% | 24\% | 23\% | 22\% | 21\% | 20\% | 19\% | 18\% | 17\% | 16\% | 15\% |
|  | 7.500 .000 | 2.532.896 | 2.880 .140 | 3.256.021 | 3.663.512 | 4.105 .947 | 4.587.072 | 5.111.103 | 5.682 .792 | 6.307.504 | 6.991.306 | 7.741 .069 |
|  | 8.000 .000 | 2.262.364 | 2.607.068 | 2.980.280 | 3.384.962 | 3.824.440 | 4.302 .449 | 4.823.195 | 5.391 .417 | 6.012.468 | 6.692 .400 | 7.438.071 |
|  | 8.500 .000 | 1.991.831 | 2.333.997 | 2.704 .539 | 3.106 .413 | 3.542 .933 | 4.017 .826 | 4.535 .286 | 5.100 .042 | 5.717.431 | 6.393.495 | 7.135.073 |
|  | 9.000 .000 | 1.717.751 | 2.057.465 | 2.425.427 | 2.824.586 | 3.258.246 | 3.730 .124 | 4.244.403 | 4.805 .800 | 5.419 .642 | 6.091.953 | 6.829 .560 |
| m | 9.500 .000 | 1.442 .898 | 1.780 .178 | 2.145.581 | 2.542.045 | 2.972 .866 | 3.441.751 | 3.952 .872 | 4.510 .934 | 5.121.252 | 5.789.836 | 6.523 .500 |
| 嘌 | 10.000.000 | 1.168.046 | 1.502 .892 | 1.865.735 | 2.259.504 | 2.687 .486 | 3.153.378 | 3.661.341 | 4.216.069 | 4.822 .862 | 5.487.720 | 6.217.439 |
|  | 10.500.000 | 893.193 | 1.225.606 | 1.585.889 | 1.976.963 | 2.402 .106 | 2.865.005 | 3.369.810 | 3.921.203 | 4.524.473 | 5.185.604 | 5.911 .378 |
| $\stackrel{3}{7}$ | 11.000.000 | 617.177 | 947.177 | 1.304.921 | 1.693 .322 | 2.115 .650 | 2.575 .581 | 3.077 .255 | 3.625 .342 | 4.225.119 | 4.882 .556 | 5.604.422 |
|  | 11.500 .000 | 335.475 | 663.155 | 1.018.461 | 1.404.298 | 1.823.927 | 2.281014 | 2.779 .690 | 3.324.614 | 3.921.049 | 4.574.955 | 5.293 .083 |
|  | 12.000.000 | 53.772 | 379.132 | 732.001 | 1.115 .274 | 1.532 .203 | 1.986.447 | 2.482 .125 | 3.023.885 | 3.616 .980 | 4.267.353 | 4.981 .745 |
|  | 12.500.000 | -227.930 | 95.110 | 445.541 | 826.250 | 1.240.480 | 1.691 .881 | 2.184.561 | 2.723 .157 | 3.312 .910 | 3.959.751 | 4.670 .406 |

San Diego Equity

|  | $\triangle$ Increase in power prices |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 3.153.378 | 11,25\% | 12,00\% | 12,75\% | 13,50\% | 14,25\% | 15,00\% | 15,75\% | 16,50\% | 17,25\% | 18,00\% | 18,75\% |
| 7.500 .000 | 3.106.711 | 3.389.375 | 3.678.619 | 3.974.567 | 4.277 .343 | 4.587.072 | 4.903.881 | 5.227.901 | 5.559.260 | 5.898 .092 | 6.244 .531 |
| 8.000.000 | 2.822.088 | 3.104.752 | 3.393.997 | 3.689.945 | 3.992.720 | 4.302.449 | 4.619 .259 | 4.943.278 | 5.274 .638 | 5.613 .470 | 5.959.908 |
| 8.500 .000 | 2.534.312 | 2.817 .741 | 3.107 .750 | 3.404 .463 | 3.708 .003 | 4.017 .826 | 4.334 .636 | 4.658 .655 | 4.990 .015 | 5.328.847 | 5.675.285 |
| $\square \quad 9.000 .000$ | 2.245.939 | 2.529.368 | 2.819.377 | 3.116.090 | 3.419 .630 | 3.730 .124 | 4.047 .699 | 4.372 .483 | 4.704 .607 | 5.044.204 | 5.390 .662 |
| \% 9.500.000 | 1.957.566 | 2.240.995 | 2.531.004 | 2.827.717 | 3.131 .257 | 3.441.751 | 3.759 .325 | 4.084.110 | 4.416 .234 | 4.755.831 | 5.103.034 |
| ㄷ.. 10.000 .000 | 1.669.193 | 1.952.621 | 2.242.631 | 2.539.344 | 2.842 .884 | 3.153.378 | 3.470 .952 | 3.795 .737 | 4.127.861 | 4.467.458 | 4.814.661 |
| 3 10.500.000 | 1.375 .565 | 1.661.054 | 1.953.133 | 2.250.971 | 2.554 .511 | 2.865 .005 | 3.182 .579 | 3.507.363 | 3.839.488 | 4.179 .085 | 4.526 .288 |
| $\rightarrow$ 11.000.000 | 1.080 .998 | 1.366 .487 | 1.658.567 | 1.957.359 | 2.262 .988 | 2.575 .581 | 2.894 .206 | 3.218 .990 | 3.551.115 | 3.890.712 | 4.237 .915 |
| 11.500 .000 | 786.432 | 1.071.921 | 1.364000 | 1.662 .792 | 1.968 .422 | 2.281 .014 | 2.600 .696 | 2.927 .598 | 3.261.850 | 3.602.339 | 3.949.542 |
| 12.000.000 | 491.256 | 777.354 | 1.069.434 | 1.368.226 | 1.673.855 | 1.986 .447 | 2.306 .130 | 2.633.032 | 2.967.283 | 3.309.017 | 3.658.366 |
| 12.500.000 | 189.018 | 478.210 | 774.026 | 1.073.659 | 1.379.288 | 1.691 .881 | 2.011.563 | 2.338.465 | 2.672 .717 | 3.014.450 | 3.363.800 |


| Variation | $10 \%$ |
| :--- | :---: |
| System used | SoCal |
| Return on equity | $20,00 \%$ |
| Increase | $15 \%$ |
| Equipment | 10.000 .000 |


|  |  | SoCal Equity |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | $\Delta$ Return on equity |  |  |  |  |  |  |  |  |  |  |
|  | 721.157 | 25\% | 24\% | 23\% | 22\% | 21\% | 20\% | 19\% | 18\% | 17\% | 16\% | 15\% |
|  | 18,75\% | 251.504 | 558.090 | 890.756 | 1.252 .248 | 1.645 .647 | 2.074.419 | 2.542.466 | 3.054.189 | 3.614.564 | 4.229 .218 | 4.904 .530 |
| $\triangleright$ | 18,00\% | 39.231 | 334.081 | 654.060 | 1.001 .813 | 1.380 .313 | 11.792 .902 | 2.243 .346 | 2.735 .890 | 3.275 .335 | 3.867.110 | 4.517.374 |
| 亏 | 17,25\% | -168.567 | 114.830 | 422.424 | 756.767 | 1.120.726 | 1.517.522 | 1.950 .787 | 2.424 .617 | 2.943 .639 | 3.513 .092 | 4.138 .915 |
| กั๊ | 16,50\% | -371.964 | -99.747 | 195.760 | 517.017 | 866.785 | 1.248 .172 | 1.664 .675 | 2.120 .245 | 2.619 .342 | 3.167.019 | 3.769 .000 |
| $\stackrel{\sim}{\sim}$ | 15,75\% | -574.066 | -312.733 | -28.989 | 279.533 | 615.496 | 981.892 | 1.382 .094 | 1.819 .907 | 2.299.631 | 2.826.136 | 3.404.939 |
|  | 15,00\% | -772.212 | -521.494 | -249.225 | 46.878 | 369.378 | 721.157 | 1.105.464 | 1.525.964 | 1.986.801 | 2.492 .664 | 3.048.874 |
| $\stackrel{1}{1}$ | 14,25\% | -966.153 | -725.793 | -464.716 | -180.727 | 128.641 | 466.164 | 834.969 | 1.238 .586 | 1.681 .005 | 2.166 .743 | 2.700.923 |
| $\stackrel{\square}{0}$ | 13,50\% | -1.155.966 | -925.708 | -675.548 | -403.373 | -106.811 | $21 \overline{6} .810$ | 570.500 | 957.656 | 1.382 .118 | 1.848 .235 | 2.360 .938 |
| 궁. | 12,75\% | -1.341.722 | -1.121.316 | -881.802 | -621.149 | -337.073 | -27.006 | 311.948 | 683.055 | 1.090.013 | 1.537.004 | 2.028.774 |
| $\stackrel{\sim}{\sim}$ | 12,00\% | -1.523.494 | -1.312.695 | -1.083.561 | -834.140 | -562.238 | -265.384 | 59.204 | 414.670 | 804.566 | 1.232.917 | 1.704 .287 |
|  | 11,25\% | -1.701.353 | -1.499.921 | -1.280.907 | -1.042.435 | -782.399 | -498.424 | -187.836 | 152.385 | 525.655 | 935.842 | 1.387.333 |



|  |  | SoCal Equity |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | $\Delta$ Increase in power prices |  |  |  |  |  |  |  |  |  |  |
|  | 721.157 | 11,25\% | 12,00\% | 12,75\% | 13,50\% | 14,25\% | 15,00\% | 15,75\% | 16,50\% | 17,25\% | 18,00\% | 18,75\% |
|  | 7.500 .000 | 995.584 | 1.225.640 | 1.461 .007 | 1.701.784 | 1.948.070 | 2.198 .460 | 2.454.372 | 2.716 .094 | 2.983.730 | 3.257.388 | 3.537 .176 |
|  | 8.000 .000 | 701.018 | 931.074 | 1.166.441 | 1.407 .217 | 1.653 .503 | 1.905 .400 | 2.163 .010 | 2.426 .438 | 2.695 .357 | 2.969.015 | 3.248.803 |
|  | 8.500 .000 | 406.451 | 636.507 | 871.874 | 1.112.650 | 1.358 .936 | 1.610 .833 | 1.868.444 | 2.131.872 | 2.401.222 | 2.676 .602 | 2.958 .119 |
|  | 9.000 .000 | 106.051 | 339.091 | 577.307 | 818.084 | 1.064.370 | 1.316.267 | 1.573 .877 | 1.837.305 | 2.106 .656 | 2.382.035 | 2.663 .553 |
| m | 9.500 .000 | -196.186 | 36.853 | 275.232 | 519.048 | 768.401 | 1.021.700 | 1.279 .310 | 1.542 .738 | 1.812 .089 | 2.087.469 | 2.368 .986 |
| 느․ | 10.000.000 | -498.424 | -265.384 | -27.006 | 216.810 | 466.164 | 721.157 | 981.892 | 1.248.172 | 1.517.522 | 1.792 .902 | 2.074.419 |
| \% | 10.500.000 | -809.013 | -571.503 | -329.243 | -85.427 | 163.926 | 418.920 | 679.655 | 946.236 | 1.218.769 | 1.497.361 | 1.779.853 |
|  | 11.000.000 | -1.119.695 | -882.184 | -639.272 | -390.857 | -138.311 | $11 \overline{6} \cdot \overline{6} 8{ }^{\text {a }}$ | 377.417 | 643.999 | 916.532 | 1.195.123 | 1.479.881 |
|  | 11.500 .000 | -1.431.987 | -1.192.866 | -949.953 | -701.539 | -447.522 | -187.800 | 75.180 | 341.761 | 614.294 | 892.886 | 1.177.643 |
|  | 12.000.000 | -1.751.358 | -1.507.815 | -1.260.635 | -1.012.221 | -758.204 | -498.482 | -232.951 | 38.492 | 312.057 | 590.648 | 875.406 |
|  | 12.500 .000 | -2.070.729 | -1.827.186 | -1.578.125 | -1.323.445 | -1.068.885 | -809.163 | -543.633 | -272.189 | 5.274 | 288.411 | 573.168 |


[^0]:    ${ }^{1}$ The transactions are not arbitrage by definition because neither are the transactions between markets, nor do they occur at the same time. The phrase is coined because the ability to store electricity gives the possibility of a virtual risk free trading on a daily-cyclical market.

[^1]:    ${ }^{2} 45$ watt bulb lit continuously for a whole year uses: $45 \times 8760 \approx 400,000 \mathrm{~Wh}$ ( 400 kWh ). 4,000 billion divided by 400 is 10 billion.

[^2]:    ${ }^{3}$ http://www.ferc.gov

[^3]:    ${ }^{4}$ There was no constraint in the calculations that the lowest sum had to incur earlier in the day than the highest sum, but a sample check revealed that this was the case nonetheless in more than $99 \%$ of the time.

[^4]:    ${ }^{5}$ This is done in accordance with Generally Accepted Accounting Principles (GAAP) and European accounting legislation.

[^5]:    ${ }^{6}$ Interviews were conducted with academics in finance, economics, electrical engineering and chemistry and professionals from energy companies, electrical engineering consultancies, financial institutions and consulting firms.

