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HOME FUEL CELLS

An Interactive Qualifying Project

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by

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Abstract

This project describes and analyzes the socioeconomics of fuel cell systems and their potential for use in a home. Working from literature and information from fuel cell companies, we developed a relational database that economically models, using Life Cycle Costing, a home fuel cell system. The database was used to optimize the parameters of a fuel cell system and to determine where a fuel cell is more economically feasible than the use of utility power.

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Introduction

Air pollution is a major problem in North America and around the globe. The combustion of fuel for heat and energy is the number one source of air pollution.[1] Approximately 70 percent of electricity in the United States is generated by fossil fuels, which are of limited supply and a major contributor to global warming.[2] The burning of fossil fuels, such as coal, oil, gasoline, and natural gas, by automobiles and power plants has serious, adverse biological effects.[3] Gases emitted from the combustion of these fuels pollute the atmosphere with NO_x and SO_x.[4] These pollutants adversely affect vegetation and animal life.

Fuel cells have the potential to change the way the world's electric power is produced. A fuel cell is an electrochemical device that converts hydrogen and oxygen into electricity, water, and heat. Other forms of power production (wind, solar, and geothermal) have been experimented with and used, but none are close to replacing the energy produced by coal, oil, and natural gas. Rather than searching for a method to abandon our natural resource fuels, a better approach to solving the energy problem could lie in fuel cells. Fuel cells have many advantages over traditional power generation. They run more efficiently when the waste heat is used, produce far less harmful emissions, and can be located at the point of use to virtually eliminate power outages due to storms and downed power lines.

Perhaps the most appealing quality of a fuel cell power plant is that the fuel cell itself utilizes hydrogen, producing zero emissions. If pure hydrogen is unavailable, the fuel cell system can extract hydrogen from hydrocarbon fuels through a reforming process. While reforming hydrocarbon fuels, the fuel processor subsystem (fuel reformer) produces emissions that are much lower than power systems that use combustion. Lower emissions mean a smaller amount of waste, and less waste means higher efficiency and cleaner air. Also, since fuel cells are more efficient, they require less fuel, which will help to slow the depletion of the earth's fossil fuel supply. Fuel cells are better for the environment in other ways as well. Eventually fuel cells will operate on renewable fuels such as biomass-based ethanol. Furthermore, fuel cell power plants can be more visually pleasing since large smokestacks and cooling towers are not needed.

There are small-scale fuel cell systems currently being developed for use in the home. Our major objective in this project is to conduct an extensive, in-depth analysis on the advantages and disadvantages of home fuel cell systems versus utility power. The purpose of this project is to determine how far the industry has to go in terms of raising fuel cell efficiency and reducing initial costs in order to make fuel cells competitive with utility power. There are two primary characteristics of fuel cells that will be researched and analyzed throughout the evaluation: cost and environmental implications. To a consumer, these are probably the two most important qualities of a fuel cell.

The cost of the fuel cell involves many different variables. It depends upon the initial unit cost, how much power it produces, energy efficiency (fuel consumption per power output), maintenance costs, etc. There are also other factors independent of the fuel cell system. It could be possible, depending on the state in which the home is located, to sell excess power produced by the fuel cell back to the utility. Furthermore, the cost differential between fuel cost (e.g. natural gas) and electricity is more favorable in some states than in others. Also, the availability of fuel varies from one state to the next. It might be more feasible for someone in one area to use natural gas because it is already being piped to their house, while another person might prefer to use propane, and so on. Different costs come with these different fuels. Therefore, it is necessary to determine which type of fuel would be best suited for use in a home fuel cell system. The appropriate present day fuel cost is then needed, as well as fuel cost data projected over the life of a fuel cell system. Also, it might be an option for a homeowner to use the waste heat produced by the fuel cell to heat their home in the winter or to heat water. If the heat produced by a fuel cell is captured and used to heat a home or water, the efficiency of the fuel cell system jumps from around 35 percent to well over 70 percent.[5]

The environmental implications and other advantages seem to lie in the favor of fuel cells. In systems being developed for home use, fuel cells have proven to be more than twice as efficient as an internal combustion engine. Fuel cells have no moving parts. They create no noise when in use. The byproducts of fuel cells running on hydrogen are nothing more than pure water and heat. When a fuel cell is run on a hydrogen rich fuel, such as natural gas or propane, emissions are negligible: 0.45 parts per million (ppm) NO_x, 2 ppm CO, 4 ppm HC.[6] This small amount of emissions is orders of magnitude lower than those emitted by conventional combustion power generators.[7] As a result of the cellular nature of fuel cell systems they can be sized to match the consumers' specific energy requirements and in many regions, may provide an attractive alternative to grid-supplied power. Another major benefit of fuel cells is the elimination of the cost and inconvenience associated with power outages. A fuel cell also contains no moving parts, so they run very quietly, and the structural components will not wear out quickly. Fuel cells have a very promising future in residential, commercial, and automotive power.

Overview

This IQP deals with fuel cells and their potential for use in a home. There are many different kinds of fuel cells that have been developed to date, and some are better suited for certain applications than others. Since this project deals with the use of fuel cells in a home, we first had to determine which type of fuel cell system would be best suited for this purpose. There are many different ways in which a fuel cell system can be judged. The first quality, and most important for the analysis in our project, is the cost. There were many different costs and cost factors to be researched and analyzed. Another important quality of fuel cells is their environmental friendliness. Fuel cells running on hydrogen and oxygen produce nothing but electricity, pure water, and heat. This is more appealing to consumers than the dirty exhaust created by internal combustion engines and power plants. All of these qualities were taken into account to create an accurate comparison of fuel cells versus other forms of energy production.

We intended to examine all of the different cost factors, environmental implications and any other benefits each type of fuel cell may provide. Our goal was to determine which type of fuel cell system presently available, or one which will be available in the near future, would be the best choice for a homeowner to install in their home.

Fuel cell companies that we contacted were reluctant to share information about their product, and those that did provided noncompetitive performance data and admitted to infeasible initial costs. In other words there is no market presently for home fuel cells. Realizing that our project was a bit ahead of its time, we decided to change the focus of our project. Instead we decided to develop a program that would compare fuel cell systems to the utility. Then we could find out what initial cost and performance a fuel cell would need to be competitive.

Background

History

Before we examine all of the different kinds of fuel cells and the benefits and drawbacks of each, let us take a quick glance at the history of the fuel cell. Sir William Grove is widely recognized as the "Father of the Fuel Cell."[8] In 1839, Grove conducted experiments involving the electrolysis of water and realized that by reversing the process electricity could be created from the reaction of hydrogen with water.[9] During electrolysis, when an electrical current is passed through a quantity of water, the electrical energy splits the water molecules into hydrogen and oxygen. Therefore, one can see that if the process is reversed, when hydrogen reacts with oxygen, the result is water and electrical energy.

Attempts in the early 20th century to build fuel cells that could convert coal or carbon directly to electricity failed because of a lack of understanding of materials and electrode kinetics.[10] Ludwig Mond and Charles Langer coined the phrase "fuel cell" in 1889 while attempting to build the first practical device using air and industrial coal gas.[11]

During the same time, the internal combustion engine was developed. Its progression, combined with the discovery of petroleum, caused the pursuit of electrical vehicles and other electrochemical energy processes to fade. The internal combustion engine became widely accepted as the premier form of energy for transportation and many other forms of power generation.

The fuel cell concept was not forgotten, however, and engineer Francis Bacon created the first successful fuel cell devices in 1932.[12] He improved on the expensive platinum catalysts used by Mond and Langer with a hydrogen-oxygen cell using a less corrosive alkaline electrolyte and inexpensive nickel electrodes.[13] For nearly twenty-five years Bacon was unable to overcome great technical obstacles, and it was not until 1959 that he and his coworkers were able to demonstrate a practical 5-kW system capable of powering a welding machine.[14] In October of 1959, the fuel cell finally began to catch the attention of large industries and organizations. It was at that time that Harry Karl Ihrig of Allis-Chalmers Manufacturing Company performed an impressive demonstration with his twenty horsepower, fuel cell powered tractor.[15]

In the late 1950s, the National Aeronautics and Space Administration (NASA) began to search for a compact electricity generator to provide onboard power for their newly developed manned space mission program. NASA ruled out batteries because of their relatively short lives and burdening weight. Nuclear power seemed excessively risky in an already precarious space program. Solar power technology at the time would prove to be too bulky to use in the space shuttle.[16] After discarding these more well known forms of power generation for their purpose, NASA finally turned to fuel cells. NASA has since funded more than 200 research contracts into all aspects of fuel cell technology.[17] Today, after reliably supplying electricity to the Apollo Space Shuttle missions, fuel cells have proven their role in space. NASA continues to use fuel cells to power their space shuttles, and since the primary byproduct of a fuel cell reaction is ultra pure water, the shuttle's fuel cell also supplies the astronauts with pure drinking water.

The success of fuel cells in the NASA space program brought about predictions for it to someday solve the world's environmental problems. No one had ever seen such a clean, quiet and efficient generator, and so excitement arose about its future. The same qualities that make fuel cells ideal for space exploration, small size, high efficiency, low emissions, and minimal water use or net water production are equally appealing to terrestrial power producers. However there are still some issues for residential fuel cell use. One of the biggest problems is that a common consumer cannot easily acquire pure hydrogen, which NASA has no problem supplying to a fuel cell for a space mission.

There is a potentially simple solution. Hundreds of thousands of homes in the United States today are, or can easily be, supplied with natural gas.[18] Fuel cells can run efficiently on natural gas that has been reformed into a hydrogen-rich fuel. This fuel reforming process converts the hydrocarbon into a mixture of hydrogen and carbon dioxide, the latter being inert, which is suitable for use in a fuel cell. Reforming natural gas, therefore, proves to be the best route for stationary fuel cell power plant producers to follow. It is necessary for these fuel cell units to incorporate fuel reformers, so that natural gas, or any other of the various fuels that are currently being proposed for use in fuel cell units, can be used. It is not necessary for all fuel reformers to extract pure hydrogen from the fuel. All that is necessary for efficient fuel cell functioning, in most cases, is a hydrogen-rich fuel. This means that although it would theoretically be better for the reformer to supply the fuel cell with pure hydrogen, it is much easier, and cheaper, to create a fuel cell that operates on a gas stream that contains hydrogen along with other inert molecules such as carbon dioxide. Unfortunately, it is not possible to avoid production of some carbon monoxide in the reformer. This molecule acts as a catalyst poison and can severely compromise the performance of lower temperature fuel cells, although it is not a significant issue at the higher temperatures.

Fortunately, during the past few decades, a number of manufacturers, research institutions, committed groups of electric and gas utilities, automotive companies, and various federal agencies have supported numerous fuel cell demonstrations and ongoing research and development into mobile as well as stationary applications.[19] In the 1960s and 1970s, natural gas companies and utilities saw that fuel cells could be fueled with natural gas and started contributing to research projects involving fuel cells. As technology advanced in the 1980s, the U.S. Departments of Energy and Defense and the

Electric Power Research Institute (EPRI), along with private companies, joined in spending money on the research and development of fuel cells. European and Japanese fuel cell programs have also received increased support and now comprise a large portion of global, government funded fuel cell research programs. Nearly one billion dollars in research has been devoted to addressing the problems facing the use of fuel cells for stationary applications.[20]

How a Fuel Cell Works

All fuel cells consist of three main parts: the cathode, the anode, and the electrolyte, which work together to turn oxygen (or air) and hydrogen (or a hydrogen-rich fuel) into electricity. This can be viewed as the reverse of electrolysis of water. This is the basic theory behind the fuel cell. The two related processes, broken down into their half-cell reactions, are as follows:

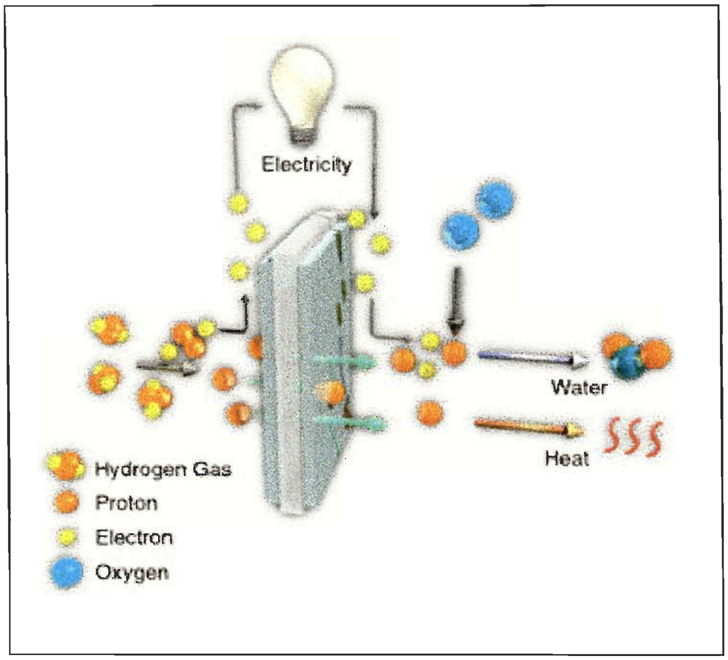
Electrolysis of water:

	Alkaline Electrolyte	Acid Electrolyte
Anode Reaction:	$4OH^- \rightarrow 2H_2O + O_2 + 4e^-$	$2H_2O \rightarrow O_2 + 4H^+ + 4e^-$
Cathode Reaction:	$4H_2O + 4e^- \rightarrow 2H_2 + 4OH^-$	$4H^+ + 4e^- \rightarrow 2H_2$
Total Reaction:	$2H_2O \rightarrow 2H_2 + O_2$	$2H_2O \rightarrow 2H_2 + O_2$

Fuel cell[21]:

	Alkaline Electrolyte	Acid Electrolyte
Anode Reaction:	$2H_2 + 4OH^- \rightarrow 4H_2O + 4e^-$	$2H_2 \rightarrow 4H^+ + 4e^-$
Cathode Reaction:	$4e^- + O_2 + 2H_2O \rightarrow 4OH^-$	$O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$
Total Reaction:	$2H_2 + O_2 \rightarrow 2H_2O$	$2H_2 + O_2 \rightarrow 2H_2O$

The chemical reaction begins when the anode electro-catalyst of the fuel cell is exposed to the hydrogen fuel, and it induces the hydrogen gas to dissociate into hydrogen atoms, and further causes the hydrogen atoms to give up their electrons, leaving a positively charged particle called a proton. On the opposite side of the cell, the cathode electro-catalyst adsorbs oxygen from the air. This generates a potential, which pulls the remaining electrons (from the original hydrogen atoms at the anode) through an external circuit. The electrons traverse to the cathode and meet up with the adsorbed oxygen atoms. Each atom of adsorbed oxygen bonds with two electrons forming negatively charged oxygen ions, called oxygen anions. Oxygen anions, at the cathode, then combine with the protons from the original hydrogen atoms to produce water. How does this happen? Fuel cells are designed such that the electrolyte membrane only allows protons to diffuse through it forcing the electrons to travel through the outer circuit. When two positively charged protons pass through the membrane and encounter a negatively charged oxygen atom they join together to form water. The cathode expels the water and absorbs more oxygen to start the reaction all over again. The electron flow through the external circuit is the direct current flow that can be used as electrical power.[22]



One of the best features of a fuel cell is its simple operation. There are no moving parts. Only water and a little waste heat are the byproducts of electricity produced by fuel cells. Each fuel cell will generate an electrical potential of up to one-volt depending on how much electrical current it is asked to produce (by the load or the device requesting power). Arranging cells together in series enables higher voltages to be created by the fuel cells as a system. A collection of individual cells is called a stack. The amount of electrical current a cell can produce is directly proportional to the total area of the cell. For example, as the surface area of the cell increases, so does the current that can be produced at a given voltage. Thus a fuel cell stack can produce any required amount of electrical potential and current by stacking the proper numbers of cells with each cell having a specific area or size. Power conditioners can be incorporated into the fuel cell unit to convert the direct current produced into alternating current.

Fuel cells can operate using a wide variety of reformed fuels including natural gas, methanol, hydrocarbon-based fuels such as gasoline, diesel, ethanol, propane, butane, etc., and renewable fuels such as biomass from human waste disposal plants.[23] Each of these fuels have a different cost associated with them, and each type of fuel cell works best with a different fuel. Because fuel cells harness the energy released when hydrogen and oxygen react to form water, all fuel cells need some form of hydrogen to function. In its pure state, hydrogen is rather expensive and difficult to supply to a homeowner. In order to utilize the availability of common, hydrogen-rich fossil fuels, most fuel cells incorporate a system to extract hydrogen from fossil fuels. This section of a fuel cell plant is called the *fuel reformer*.

The market for fuel cells is very diverse, and ranges from large utility power plants to transportation to low-wattage remote applications. Each market segment will be better suited for a specific type of fuel cell system. Fuel cells are broken up into two types: large-scale and small-scale. The larger scale fuel cells generally are the ones that produce the most heat during operation. Frequently, fuel cells that are to be used for small power applications would be better off producing less heat. For example, a fuel cell, which is to power a car or stereo, would be less practical if it generated a lot of heat.

Types of Fuel Cells

There are five types of fuel cells, each being classified by the type of electrolyte used to stimulate the reaction between the fuels in the cell, namely:

1. *Proton Exchange Membrane Fuel Cell (PEMFC, 50 - 100°C operating temperature)*
2. *Phosphoric Acid Fuel Cell (PAFC, 150-220°C operating temperature)*
3. *Alkaline Fuel Cell (AFC, 250°C operating temperature)*
4. *Molten Carbonate Fuel Cell (MCFC, 600-700°C operating temperature)*
5. *Solid Oxide Fuel Cell (SOFC, 650-1000°C operating temperature)*[24]

	PEMFC	**PAFC**	**MCFC**	**SOFC**
Electrolyte	Ion Exchange Membrane	Phosphoric Acid	Alkali Carbonates Mixture	Yttria Stabilized Zirconia
Operating Temp., °C	50-100	150-220	600-700	650-1000
Electrolyte State	Solid	Immobilized Liquid	Immobilized Liquid	Solid
Cell Hardware	Carbon- or Metal-Based	Graphite-Based	Stainless Steel	Ceramic
Catalyst	Platinum	Platinum	Nickel	Perovskites
Cogeneration Heat	Little	Low Quality	High	High
Efficiency, %LHV	40-45	40-45	50-60	50-60

Table 1: Summary of important characteristics of each fuel cell type.

Each fuel cell technology has its own operating characteristics (Table 1) that make it suitable for specific applications. Each fuel cell operates at different temperatures and this can be good or bad depending on the application. For example, the SOFC runs at an extremely high temperature. This would obviously not be a good choice to power a portable CD player or even a space shuttle. Given, however, cogeneration[1] technology today, an SOFC power plant could be used to provide electricity to an apartment building, and the waste heat can be reused to heat the building and/or provide hot water to the entire complex. PAFCs, MCFCs and SOFCs are designed for distributed power production in the range of a few hundred kW to a few MW. PEMs, which use a polymer electrolyte, are smaller and more lightweight. They are useful for applications such as automobiles, buildings, and smaller appliances.[25]

Proton Exchange Membrane Fuel Cells (PEMFC)

The main component of a PEM fuel cell consists of two electrodes (the anode and the cathode), separated by a polymer membrane electrolyte. Each of the electrodes is coated on one side with a thin platinum catalyst layer.[26] The backs of the electrodes are coated with a hydrophobic compound providing a path for gas diffusion to the catalyst layer. The electrodes, catalyst and membrane together form the membrane electrode assembly (MEA). Hydrogen, oxygen, and cooling fluid are typically introduced from the end plates of the PEM fuel cell stack and pass through small channels in the conducting plates, under pressure.[27] This method introduces hydrogen to the cell anode, oxygen to the cathode, and removes heat via the cooling fluid.[28]

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[1] Cogeneration is the process by which the waste heat given off by a fuel cell generator is put to use instead of being given off to the atmosphere.

Hydrogen fuel dissociates into free electrons and protons (positive hydrogen ions) in the presence of the platinum catalyst at the anode. The free electrons are conducted in the form of usable electric current through the external circuit. The protons migrate through the membrane electrolyte to the cathode. At the cathode, oxygen from air, electrons from the external circuit and protons combine to form pure water and heat. Individual fuel cells produce about 0.6 volts at optimum power density. Single cells are combined into a fuel cell stack to produce the desired level of electrical power.

A single fuel cell consists of a membrane electrode assembly and two flow field plates that supply and distribute the air and hydrogen fuel to the cell. The gases are supplied to the electrodes on either side of the PEM through channels formed in the flow field plates. The field flow plates have a corrugated structure, and are similar in appearance to the wave-like channels in a piece of cardboard. Hydrogen flows through the channels to the anode where the platinum catalyst promotes its reaction into protons and electrons. On the opposite side of the PEM, air flows through the channels to the cathode where oxygen in the air attracts the protons through the PEM. The electrons are captured as useful electricity through an external circuit and combine with the protons and oxygen to produce water vapor on the cathode side.

Phosphoric Acid Fuel Cells (PAFC)

Phosphoric acid fuel cells are currently the most commercially developed type of fuel cell. They are already being used in such diverse applications as hospitals, nursing homes, hotels, office buildings, schools, utility power plants, and an airport terminal. PAFCs generate electricity at more than 40 percent efficiency, and nearly 80 percent if the steam by-product is used for cogeneration, compared to 30 percent for the most efficient internal combustion engine.[29] Operating temperatures are in the range of 93°C.

Phosphoric acid technology is not well suited to small-scale applications due to the support systems required to manage liquid acids at such high operating temperatures, the use of more expensive materials, and greater maintenance requirements.[30] They can be used in large vehicles, such as buses and trains.

ONSI Corporation (ONSI stands for On Site energy production) created CLC, their European licensee, to develop, produce and market phosphoric acid on-site cogeneration systems for the European market. Germany is leading the way and by the end of 1997 at least ten of ONSI's PC25s were to have been installed there and in operation. Interest has also been shown in Spain, France and Switzerland.

CLC is promoting a 9 MW PAFC plant that would operate on waste hydrogen at the chloralkaline plant at Assemini. Chloralkaline plants produce hydrogen as a by-product of the electrolysis process used to manufacture chlorine. In most cases, the hydrogen is burnt to provide steam for the factory. CLC is investigating the opportunity to use the waste hydrogen to fuel a PAFC to produce high value electricity as well as process steam. Analysis has shown that even at current prices it would yield a satisfactory return in this application.

Utilities and independent power suppliers are working with International Fuel Cells to market an energy- based service built around the PC25. Customers of this service will purchase the electrical and thermal energy, not the generating plant. They will not bear the up front capital cost, the technology risk, or any maintenance cost. A number of utility companies in the United States, Japan, and Germany believe that a fuel cell energy service could provide them with a major strategic growth opportunity in the increasingly competitive and deregulated energy supply market.

Alkaline Fuel Cells (AFC)

In the space shuttle and other NASA programs alkaline fuel cell technology is used extensively but is not frequently used for terrestrial applications because of its low tolerance to carbon oxides, such as the CO_2 found in air.[31] These fuel cells use alkaline potassium hydroxide (KOH) as the electrolyte and can achieve power-generating efficiencies of up to 70 percent. Until recently they were too costly for commercial applications, but several companies are examining ways to reduce costs and improve operating flexibility. This involves searching for better materials that can withstand exposure to carbon dioxide, or high quality fuel reformers to remove contaminates from the air and hydrogen fuels. Alkaline fuel cells are very sensitive to CO_x poisoning. Any traces of CO_2 in the fuel can react with the KOH to form K_2CO_3, thus altering the chemical structure of the electrolyte.[32]

Molten carbonate Fuel Cells (MCFC)

Molten carbonate fuel cells operate at a much higher temperature than PAFCs (650 vs. 200°C) and are best suited for dispersed power applications in the 1-20 MW capacity range.[33] There are a limited number of MCFC demonstration sites around the world. The high operating temperature of MCFCs allows it to achieve high system efficiencies and also use a wide variety of available fuels.[34]

Solid Oxide Fuel Cells (SOFC)

SOFCs operate at even higher temperatures than MCFCs, and because of this, design and operation issues are very challenging.[35] Solid oxide fuel cells can be used in high power applications including industrial and large-scale central electricity generating stations. A solid oxide system usually uses a hard ceramic material instead of a liquid electrolyte, allowing operating temperatures to reach 1,800°F. Power generating efficiencies could reach 60 percent. One type of solid oxide fuel cell, produced by Ballard Power Systems, uses an array of meter-long tubes instead of the more traditional square-shaped cells.

Why PEM?

PEM fuel cells offer a number of advantages over other fuel cell technologies for many market applications because of the compact size, low weight, low operating temperature, low noise level (due to the relative simplicity of the support systems required), relatively quick start up and desirable load response characteristics.

PEM Performance

The performance of a PEM is dependent on several factors, such as temperature, pressure, water management, platinum loading, and fuel purity. To increase performance, PEM fuel cell stacks commonly incorporate a variety of subsystems managing heat, water, and pressure to service the stack itself.[36] These subsystems can include water pumps, water purifiers, air compressors, coolant pumps, and a radiator.[37]

A low temperature of around 80°C is typical for PEM fuel cells because of the materials presently used and the requirement of high relative humilities, since the membrane conducts most efficiently in the presence of liquid water. This low temperature operation has the advantages of high power densities, smaller scale applications and quick start-up. The disadvantage is that carbon monoxide binds strongly to platinum below 150°C and this reduces the catalyst surface area available to the hydrogen. Operation at higher temperatures also decreases the resistance of the membrane electrolyte thereby reducing the internal resistance of the cell. Also there is no excess heat available for the reforming processes. If the cell temperature is too high the membrane can become dehydrated resulting in reduced ionic conductivity. The changes in performance can also depend on pressure. The oxygen pressure and relative humidity can be increased resulting in higher performances, but these improvements must be weighed against the energy needed to pressurize the reactant gases.

The efficiency of the fuel cell is also dependent on the water content of the electrolyte. The water drag through the cell and diffusion through the cathode and anode determine the water content in the cell. Water drag occurs when the proton pulls some water with it through the cathode. Water drag increases at high current densities. The cell output is bounded by mass transport limitations on water formation and distribution. A balance between water production and evaporation in the cell is also important for other reasons. The more saturated the membrane is the better the ionic conductivity. However, if there is too much water being produced in the cell then the reactant gases may become diluted with steam and the electrodes can become flooded. Thus, water management can be a significant factor in cell performance.

The electrodes are typically made of platinum, which is of course expensive. It is therefore desirable to obtain a balance between performance and cost in platinum loading. Also most PEM fuel cells are made with graphite plates and titanium frames, which are also major factors in the cost of a fuel cell. The membranes used are also very expensive and have limited ranges of thickness and ionic conductivity. If these components were mass-produced then related costs could drop significantly.

The Future of Fuel Cells

During the 1980s, because of continued conservation and environmental concerns, utilization of fuel cells for automobiles, utility power production, and optimization of waste disposal solutions induced investment in fuel cell research and development across the world. ONSI Division of International Fuel cells is a leading producer of phosphoric acid fuel cell power plants, and they have already delivered 157 units of their 200-kW PC25 models. Trying to make their fuel cells even more environmentally friendly, ONSI has operated its fuel cells on methane from sewage treatment plants.[38] This concept makes the future of fuel cell power generation that much brighter.

Each type of fuel cell generator also requires installation and maintenance, the cost of which varies from one type of fuel cell to the next. For example, Ballard Power Systems Inc. (Burnaby, B.C.), a leading producer of commercial proton exchange membrane fuel cell generators, is hoping to be able to install a 250-kW stationary power plant for 1,500 dollars per kW by the year 2002.[39] In order to achieve this, they must improve manufacturing techniques and materials selection. Similar fuel cell systems produced by competing companies are expecting similar installation costs for their high-output generators.

Plug Power, L.L.C.

A leading company for PEM fuel cell generators is Plug Power, L.L.C. in Latham, New York. Plug Power is a joint venture of DTE Energy Co., and Mechanical Technology Inc. (MTI).[40] They aim to develop and manufacture affordable fuel cell systems for residential, small commercial and automotive applications.

Plug Power is the largest PEM fuel cell developing company in the United States. The company was formed in June 1997 with 22 people and 9 million dollars in funding.[41] Since then, the company has grown to over 300 people, and has also received a 15 million dollar grant from the US Department of Energy (DOE).[42] Three months after receiving this award, Plug Power, along with the DOE, successfully demonstrated a gasoline to electricity fuel cell.[43] The fuel cell used in this test continues to perform extremely well today.

In June of 1998, Plug Power introduced the world's first fuel cell powered home using their prototype system, the Plug Power 7000. This system, using pure hydrogen fuel, has been designed to provide the average-sized house (3,000-4,000 sq. ft) with its total electricity needs, independent of the utility grid. Commercial production of a similar system is planned for January of 2001.[44]

A complete system's operation on natural gas is an important step toward bringing Plug Power's residential units to market in 2001. The use of natural gas means that the more than 70 million U.S. homes that already use natural gas for heating and cooking will eventually be able to use natural gas-powered fuel cells to meet all their energy needs.[45] As the technology continues to develop and market forces evolve, this number will rise significantly. From a global perspective, the potential is much larger. Since it's installation in the demonstration house in Latham, New York, the Plug Power 7000 has been converted to run using natural gas or propane.[46] Consumers can begin the process of purchasing a system from Plug Power via their website.

Plug Power is designing systems to function using a variety of fuels, but the ability to utilize the existing natural gas infrastructure provides an important benefit to homeowners in the United States. By coupling the use of low cost fuels like natural gas with the high efficiency of fuel cell technology, it is estimated that the cost to consumers for electricity will be as much as 20 percent less than current electricity costs.[47]

Plug Power plans to create strategic partnerships with other fuel cell interested organizations, including utilities, distributors and other manufacturers. Most recently, Plug Power and GE Power Systems finalized an agreement to form GE Fuel Cell Systems.[48] This company will market, sell, install, and service Plug Power-designed and manufactured fuel cells, up to 35kW, for residential and small business power applications.[49]

GE Fuel Cell Systems, also known as GE MicroGen, expects to offer commercial units beginning in January 2001.[50] Field-testing was to begin in late 1999 and continue through the year 2000.[51] GE MicroGen will offer a PEM fuel cell system called the HomeGen 7000.[52] The HomeGen 7000 is a descendent of the Plug Power 7000 system and incorporates an internal fuel reformer and power conditioner. The HomeGen 7000 is designed to operate using natural gas or propane. The GE fuel cell technology has the potential to provide an environmentally friendly and economical alternative for customers seeking to generate power at the point of consumption.

GE Fuel Cell Systems plans to partner with carefully selected distributors that will market the systems to consumers in certain parts of the country. The distributors will likely include companies where GE Power Systems already has strong relationships, such as natural gas and propane distribution companies, electric utilities, electric service companies, and gas and power marketers.[53] GE Fuel Cell Systems also expects to partner with a select group of service providers, in order to offer distributors and consumers a global network of high quality, cost effective installation and maintenance support.[54]

The initial commercial units will operate on natural gas, propane, or methanol and are expected to achieve 40 percent electrical efficiency.[55] When excess heat generated by the fuel cell is captured and used for hot water or heating, overall efficiency can exceed 80 percent.[56]

Thanks to technical and production advances by Plug Power, GE Fuel Cell Systems expects to offer residential sized systems in 2001 for 7,500 dollars to 10,000 dollars.[57] Moreover, prices are expected to fall dramatically over time as production volumes increase and manufacturing efficiencies are achieved. In mass production, a residential fuel cell system is expected to retail for approximately 3,500 dollars.[58] At that price, GE projects that fuel cells can generate electricity at 7-10 cents per kilowatt-hour, depending on usage and the fuel costs in a given market.[59]

Northwest Power Systems, L.L.C.

Northwest Power Systems is a subsidiary of IDACORP Technologies, Inc. Located in Bend, Oregon, Northwest Power is a leading producer of PEM fuel cell components, subsystems, and fully integrated systems. This company is very important to our project because they have powered a 3-bedroom, 2,000 sq.-ft home with one of their own PEM fuel cell systems.[60] Northwest Power not only deals with the actual, power-producing fuel cell stacks, but also the extremely important and critical subsystems (such as fuel reformers) that must be optimized for efficiency and low cost before fuel cells can be practical as a form of home energy.[61] Northwest Power manufactures PEMFC stacks ranging from 1 kW to 10 kW of output power, as well as automated fuel processors that convert conventional fuels (methanol, propane, kerosene, diesel and, natural gas) into pure hydrogen, and power conditioning subsystems.[62]

Northwest Power's fuel processor is a patented, low-cost, fuel-flexible, modular, compact design that is capable of supplying hydrogen (greater than 99.8 percent purity) to PEM fuel cells for power generation.[63] They also manufacture a metal-membrane module that purifies hydrogen for use in a PEM fuel cell, thus eliminating cell damaging carbon monoxide from the fuel.[64] Like Plug Power, Northwest Power offers a promising future for PEM fuel cells as forms of home power generation. We expected these two companies to be major sources of technical data and information on the most current technological advances in fuel cells. However, these companies were unable to provide any useful data because of the competitive state of fuel cell technology.

Procedure

Basis of Comparison

In this project a fuel cell system is to be compared to the conventional electric utility. The economic part of this comparison is fairly straightforward. We simply applied a standard method of economic investment comparison known as life cycle costing. Through life cycle costing a value of the amount of financial savings over the life of an investment is determined. However, when comparing fuel cell systems to the electric utility there are a number of factors that are not accounted for by life cycle costing.

There are two types of non-economic factors that must be considered when ascertaining the value of a fuel cell system. The first type of non-economic factor to consider is the conveniences associated with owning a home fuel cell system. For example, a home fuel cell system is not subject to power outages caused by storms and downed power lines. The second type of non-economic factor to consider is the environmental impacts. A consumer who does not consider the environmental implications of home fuel cell use cannot fully understand the value of this investment. In other words, the environmental value of the investment must be considered.

Fuel cells produce clean energy. They emit far less harmful gases than automobiles and power plants. SO_x emissions standards in developed countries are four times the amount emitted by fuel cells.[65] In the future, fuel cells should help reduce the social and material costs of pollution. A study conducted in 1971 concluded that by reducing the pollution in major North American cities by 50 percent, an estimated 8 billion dollars would be saved per year at a cost of only 1.3 billion dollars per year.[2] These savings can be accumulated from the costs associated with illness and death due to air pollution.[66] Savings could be made due to an increase in the lives of buildings and structures, along with reduced cleaning and maintenance costs.[67] Also, not only will the lives of plants and animals be bettered, but also humans will benefit psychologically from better visibility, cleaner air to breathe, and more sunny days.[68] Fuel cells will be a major contributor towards this goal.

The U.S. Department of Energy estimates that if 10 percent of the automobiles in the nation were powered by fuel cells, it would result in a one million ton per day reduction in regulated air pollutants, and a sixty million ton per day reduction of the Greenhouse gas carbon dioxide.[69] This change would also reduce the amount of imported oil by 800,000 barrels a day.[70] This reduction in imported oil currently would make up 13 percent of the country's total imports.[71]

Fuel cells can operate on both renewable fuels such as biomass and hydrogen and nonrenewable fuels such as natural gas and other fossil fuels. As a result of this fuel compatibility fuel cells may serve as an excellent bridge for the market and consumers to move steadily towards renewable and sustainable power production. If a renewable supply of hydrogen were to meet the demands of a fuel cell driven market, then there would be zero emissions associated with this sustainable power production.

Environmental value is an important concept in the discussion of fuel cells and to the future of humanity. All too often decisions are made according to their economic ramifications. We live in an age where our carelessness and shortsightedness could cause the destruction of the earth's inhabitants including humanity. And so, it has become increasingly necessary to consider the implications of our

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[2] Both values expressed in 1971 dollars.

decisions on more than just our bank account. In order to determine the environmental value of a home fuel cell system one must consider the value of the quality of living for future generations.

Possible Fuel Cell Systems

A fuel cell system is most efficient when run at a constant kilowatt output. The electricity consumed by a home throughout the year does not remain constant although we assume the output of the fuel cell system does. For every hour of the day, the fuel cell will be over-producing or under-producing electricity. When the fuel cell is under-producing electricity, the homeowner needs to draw power from another source. Conversely, when the fuel cell is over-producing electricity, the homeowner needs to be compensated for it. Figure 2 shows how the electricity demanded by the home

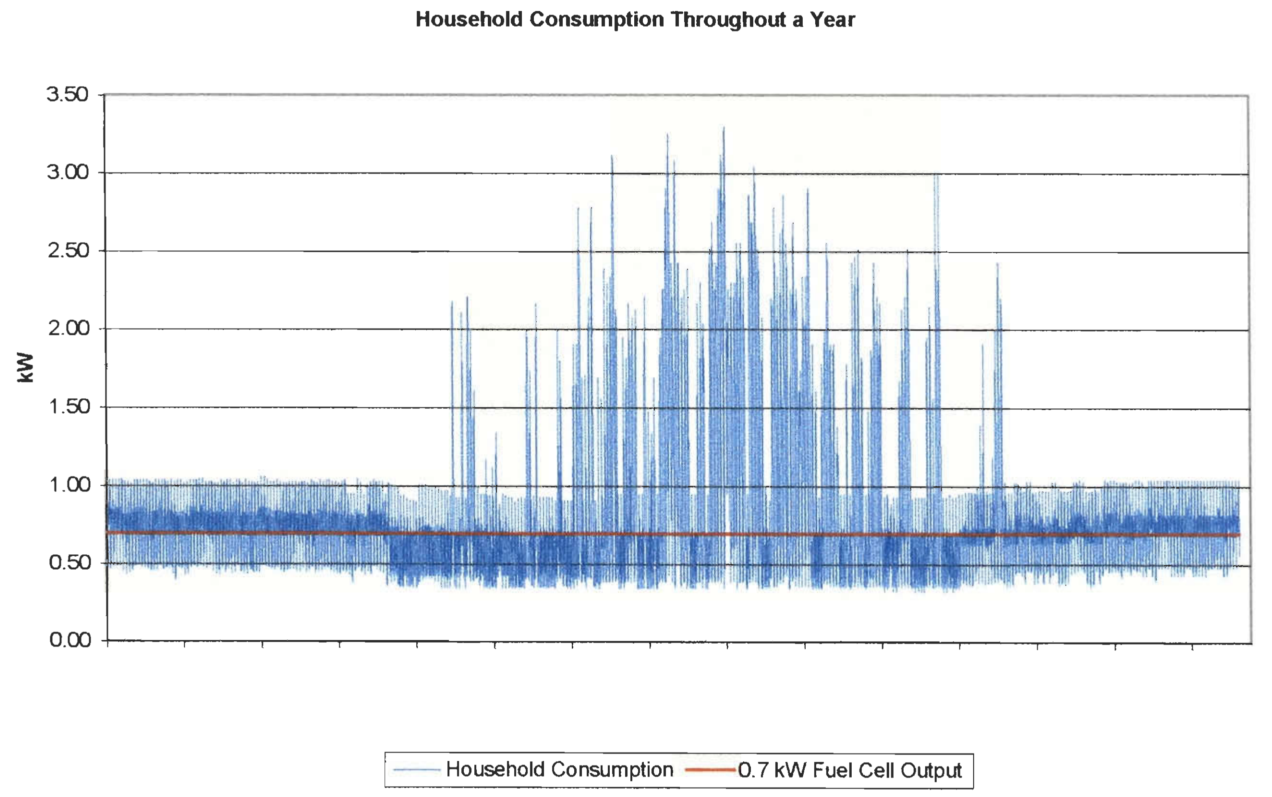


Figure 2: Hourly electricity demand throughout a year for one home.

fluctuates above and below the output of the fuel cell. The fuel cell system designer must decide at what constant output to run the fuel cell for maximum economic advantage over utility power alone.

In this project, we will give the homeowner two options for meeting peak loads. The homeowner's first option is to stay connected to the utility grid and draw power to meet peak loads and sell excess electricity produced by the fuel cell back to the utility. The second option is to install deep-cycle batteries in the fuel cell system and draw from them during times of peak load. These batteries would charge when the fuel cell is over-producing electricity.

Fuel Cell – Utility System

The first step in deciding how to configure a fuel cell system for a homeowner is considering the state in which it will operate. The main reason for this is that each state has different prices for utility power and natural gas. Since our economic analysis of fuel cells is versus utility power, this is very important information. There are two major questions to consider in the design phase: Should the system stay connected to the utility or use batteries for peak loads? At what constant kilowatt output should the fuel cell run?

In deciding to use utility power or batteries, the designer must be aware of all laws and costs that each state has regarding fuel cell utility systems. Some states have what is called net metering laws. With net metering, a utility company buys excess electricity produced by a consumer at the same rate that the consumer buys his electricity from the utility. The utility company, in effect, runs the homeowner's meter backward for any amount of electricity that leaves the house. If a state has a net metering law, then the fuel cell has a good chance of being economically advantageous over utility power. This is important to the design of a fuel cell system because a home fuel cell running at a constant output will be selling back quite a bit of electricity to the utility when it is over-producing power. However, many of those states that do have net metering laws will not allow fuel cell systems to sell back at net metering rates. Some states will only buy back at the net metering rate from systems such as solar, wind, hydroelectric, or other renewable energy systems. Unfortunately for fuel cells, only nine states have net metering laws encompassing fuel cell systems. These nine states are Colorado, Connecticut, Maine, Ohio, Oregon, Pennsylvania, Rhode Island, Vermont, and Wisconsin.

Net metering rates are only applied to excess electricity until the amount sold back equals the amount bought from the utility during the current month. For example, if the homeowner buys 100 kWh from the utility during a given month, he will only have his meter run backward for an amount of electricity less than or equal to 100 kWh. Net Excess Generation (NEG) is anything over the 100 kWh that is sold back, and will only be bought by the utility at a price equal to the amount it costs the utility to produce electricity. This rate is called the avoided cost rate, and is usually very small compared to the regular utility rate. For our project, we assume an avoided cost rate of 0.03 dollars per kWh. This rate is compared to a retail utility rate of around 0.07 to 0.13 dollars per kWh. It is easy to see that the fuel cell system should be designed such that the amount of NEG is minimized since it will only be bought at the avoided cost rate. The homeowner does want to produce enough excess electricity to sell back to the grid to offset some of the cost of utility power bought for peak loads. The homeowner does not, however, want to produce so much that he sells back more than he bought and is basically wasting the fuel used to produce the NEG.

In the other forty-one states that do not have net metering laws for fuel cells, the utilities are required to by back electricity from the homeowner at the avoided cost rate. Since 1978, the Public Utility Regulatory Policies Act (PURPA) has made it federal law to require all publicly owned electric utilities to buy electricity produced by its consumers at the avoided cost rate.[72] Even if the state does not have net metering laws for fuel cells, all public utilities must buy back electricity from consumers at the avoided cost rate. However, in order for the fuel cell system to be competitive with utility power in a particular state, the homeowner needs to be compensated for electricity sold back through a net metering program. Being compensated for excess electricity at only an avoided cost rate will diminish the chances of the fuel cell being economically viable.

Under what conditions would a fuel cell system designer choose to stay connected to the utility? It is important to understand and know the relationship between utility and natural gas rates, so the designer has an initial assessment as to the possibility of creating a fuel cell system that will save money compared to utility power. The comparison methods described below are the first steps in designing a fuel cell system.

Of the fifty possible states, forty-one are immediately eliminated because they do not have net metering laws for fuel cells, and we know that this is necessary for the fuel cell to be economically feasible. Of the nine states listed below that do have net metering programs, one must next compare the costs of natural gas and utility power in each state. These particular costs for the nine promising states are shown in Table 2.

State	**Electric Rate**[73] **$/kWh**	**Natural Gas Price**[74] **$/1000 ft^3**
Maine	0.1302	7.60
Connecticut	0.1195	10.29
Vermont	0.1161	6.90
Rhode Island	0.1091	9.32
Pennsylvania	0.0993	8.20
Ohio	0.0870	6.35
Colorado	0.0745	5.12
Wisconsin	0.0717	6.13
Oregon	0.0582	7.11

Table 2: State Utility and Natural Gas Prices.

The states shown in Table 2 are sorted by utility price, which decreases down the chart. In order for the fuel cell system to be better economically than utility power, it is necessary for the state in which the fuel cell will operate to have a high utility rate and a low natural gas price. At first, the states near the top of the chart appear promising because they have relatively high utility rates. Conversely, the states near the bottom of the chart have fairly low utility rates, which does not give fuel cells much of an advantage. Given the relationship between these states for utility prices, one must next look at the natural gas price. For fuel cells, it is better to choose a state with the highest utility rate possible that also has a low natural gas price. It is apparent from Table 2 that the two most promising states are Maine and Vermont. These states have two of the highest utility rates and also low natural gas prices. Connecticut has a utility rate favorable towards fuel cells, but the natural gas price is the highest of the nine states, and so will not be a good choice for a fuel cell system.

Given the respective costs of utility power and natural gas in a particular state, the fuel cell system can be optimized to minimize cost. For instance, the efficiency of the fuel cell system greatly affects the economic outcome. This project is designed as a tool for fuel cell system manufacturers to determine what efficiencies they must achieve with their potential systems. It will also determine what initial cost must be achieved in order for a homeowner to profit by investing in a fuel cell system.

Fuel Cell – Battery System

In states where it does not appear to be economical to remain connected to the utility, the fuel cell system can be designed to use batteries for meeting peak loads. A battery system would be advantageous in states that do not have net metering laws for fuel cells, but that have relatively low natural gas prices and a high electric utility rates. The designer would choose a fuel cell – battery system in this type of situation because it would be very uneconomical to sell back excess electricity to the grid if the utility will only compensate the homeowner at the avoided cost rate.

In a fuel cell – battery configuration, during times when the constant kilowatt output of the fuel cell is lower than what is demanded by the home, the fuel cell will draw power from the battery bank. The battery bank will have to be designed using a certain number and size of deep cycle batteries for each individual fuel cell system setup. The chosen constant output of the fuel cell system will determine what size battery or batteries will be needed.

It is important when designing a fuel cell – battery system that during times when power is being drawn from the batteries, they are not drawn to a point below half capacity. Deep cycle batteries that are drained below fifty percent of maximum capacity will operate at a lower efficiency and have a shorter life.

When the fuel cell system is over-producing electricity, the batteries will be charged by the fuel cell so that the battery bank will be charged enough to meet peak loads throughout the day.

Fuel Cell – Battery – Utility System

A third option for a fuel cell system is one that would incorporate both a local battery bank as well as remain connected to the utility for meeting higher peak loads. This system allows for a smaller, and less expensive battery bank, while still having the ability to meet peak loads that the fuel cell cannot handle itself. A battery - utility system would be advantageous in states that do not have net metering laws for fuel cells, but that have relatively low natural gas prices and a high electric utility rates. The designer would choose a fuel cell – battery – utility system in this type of situation because it would be very uneconomical to sell back excess electricity to the grid if the utility will only compensate the homeowner at the avoided cost rate, and because the size and cost of the necessary battery bank is too large.

In a fuel cell – battery – utility configuration, during times when the constant kilowatt output of the fuel cell is lower than what is demanded by the home, the fuel cell will draw power from the battery bank until the battery is drained to half capacity. At this time, the fuel cell will begin drawing power from the utility. By drawing power from the utility, the fuel cell system can be designed with a smaller battery bank, whereas a fuel cell – battery system must be designed such that the battery bank will never be drained below half capacity. As before, when the fuel cell system is over-producing electricity, the batteries will be charged by the fuel cell.

Fuel Cell System Modeling Program

Designing a fuel cell system for home use is not an easy task. There are many different variables that need to be considered, calculated, and optimized in order to create a system that is economically feasible. For example, each state has its own price for electricity and natural gas. Each state also has its own laws that regulate the selling back of excess electricity produced by a residential consumer. Some states will buy back electricity produced by a fuel cell at the same rate at which the consumer buys from the utility. Most states, however, will only buy back electricity at the avoided cost rate. A rate equal to the cost the utility is avoiding by not having to produce that amount of electricity. For the most part, this is only around one to three cents per kilowatt-hour, where the consumer typically pays the utility about seven to thirteen cents per kilowatt-hour. Most states that require utilities to buy back excess electricity have restrictions on the size of the fuel cell system that they will buy from. Utilities in Colorado, for example, will not buy back electricity from a fuel cell that has a maximum output greater than 10 kW. For residential fuel cell systems, this restriction does not come into play since the maximum amount of electricity demanded by a home remains well below four to six kilowatts throughout the year.

Knowing the electricity demand for a house over an entire year is crucial to designing a fuel cell system. As one might suspect, this data varies significantly from one state to the next. In order to perform our calculations, it was necessary to determine how many kilowatt-hours (kWh) of electricity would be needed for every hour throughout an entire year. Luckily, this data was obtained from a previous IQP entitled Energy Savings in the Home (May 1997) for the state of Massachusetts. For every hour of the year 1996 we entered into Microsoft Excel exactly how many kWh of electricity were consumed by a home in Boston, Massachusetts. We then used the average yearly kWh consumption per home for the other forty-nine states, and created conversion factors to convert the data from

Massachusetts into comparable data for every other state. For example, the average home in Connecticut consumes 8088 kWh over one year, compared to 7049 kWh in Massachusetts. Therefore, the conversion factor to go from Massachusetts to Connecticut is (8088 kWh) / (7049 kWh) = 1.1474. Therefore, to obtain hourly consumption data for Connecticut over an entire year, we multiplied all 8760 hourly consumption values for Massachusetts [(24 hr) * (365 days) = 8760 hr/yr] by 1.1474. This conversion process was repeated for all other states. It is true that not all states exhibit a similar pattern to Massachusetts when it comes to the electricity demand throughout the year. Electricity demand in a southern state would be dominated by air conditioning more than in the north. This would be of concern for us in this project, but as was explained before, there are only nine states that are promising for fuel cells because of certain laws and restrictions that adversely affect the possibility of a fuel cell being economical in the other states. We can assume similar demand patterns to that of Massachusetts for the other nine states because they are located in regions of similar climate. The nine states that this project will ultimately focus on are located in approximately the same latitude as Massachusetts; therefore the method explained above for converting demand data from state to state is valid.

The reason we needed to know how much electricity is needed per hour is to design a system that will cost the least with the greatest output. We assume the fuel cell system will be running at a constant output during the entire year. It is not possible for a PEM fuel cell system to efficiently follow the electricity demand throughout the year, meaning that the fuel cell will always be over-producing or under-producing electricity. Each state has different excess electricity sell back rates, either net metering or avoided cost. Therefore, if a state will compensate the homeowner fairly for excess electricity, the system will be designed accordingly. If a state will unfairly compensate the homeowner for excess electricity (i.e. avoided cost or no compensation at all), then he will want to strictly avoid producing too much excess electricity.

Conversely, the output of the fuel cell system is directly related to how much fuel it consumes. The higher the output, the more fuel it needs. It is necessary to find a precise balance between fuel consumption and excess electricity to create a system that is the most economically advantageous to a consumer. The balance, of course, varies from state to state, because some states have a high electricity rate and low natural gas prices, or vice versa. The idea is to find a fuel cell system configuration for each of the fifty states that will save a homeowner the most money compared to their neighbor who gets all of their electricity straight from the utility company. Granted, there will be some states where savings are impossible to achieve. Florida, for instance, has a high natural gas price of 11.58 dollars per 1000 ft^3, and a low electric rate of 7.89 cents per kWh, and would be a difficult state in which to create a home fuel cell system that would be less expensive over its lifetime than utility power alone.

Also, of the fifty states, only nine have net metering laws encompassing fuel cell systems. Each of these states will run the meter backwards as long as he does not produce more electricity than he consumes. Therefore, if in a particular month the consumer buys 700 kWh from the utility, they will only buy 700 kWh from him at the utility rate (running his meter backwards). Anything produced over that 700 kWh is called Net Excess Generation (NEG), and will only be bought by the utility at the avoided cost rate. Therefore, it is best to have an NEG each month as close to zero as possible, unless the fuel cell is operating in a state that has an NEG monthly carry over rule. The carry over rule states that any NEG produced in the first month will not be bought at the avoided cost rate, but rather gets carried over to the next month to offset that month's utility bill. In other words, any NEG at the end of the month gets carried over to the next month. This is good for a homeowner using a fuel cell because he is not unfairly compensated for NEG, but rather highly compensated for it. The four states that have NEG monthly carry over rules are Colorado, Maine, Rhode Island, and Vermont.

The efficiency achieved by the fuel cell system is a major factor in determining its economic feasibility. Typically, the efficiency for a PEM home fuel cell system ranges anywhere from 30 to 50 percent. This is a wide range, and can easily mean the difference between losing money or saving money. Since the biggest yearly cost of a fuel cell system throughout its lifetime is the fuel cost, having a more efficient system means that the fuel cell consumes less fuel for the same kilowatt output. In designing our fuel cell systems, it was difficult to decide on an efficiency to use for our calculations. After reading through the literature, visiting many web sites, and talking to various fuel cell experts at different companies across the country, we decided to run our calculations assuming a conservative 35 percent fuel cell system efficiency. This efficiency encompasses all parts of the fuel cell system, including the reformer and inverter. Therefore, to compute the fuel consumption for a given fuel cell system, one needs to know the constant kilowatt output of the fuel cell and the efficiency of the system. We'll use 1.2 kW for our example, which is a little higher than what is needed in most states. These calculations will be made for the state of Connecticut, where the cost for natural gas is 10.29 dollars per 1000 ft^3. The energy content of natural gas is also needed and was found to be 1032 Btu/ft^3 at 100 percent efficiency. In order to calculate the fuel consumption, one must multiply the constant kilowatt output of the system by the number of Joules in a kWh (3.6×10^6), then divide by the fuel cell system efficiency, the number of Btu in a cubic foot of natural gas (1032), the number of Joules in a Btu (1055), and the number of minutes in an hour. The result gives the answer with the desired units of ft^3/min. The following is a sample calculation of how the fuel consumption is computed:

$$\text{Fuel Consumption} = \begin{array}{c|c|c|c|c} 1.2\text{ kW} & 1\text{ft}^3 & 1\text{ Btu} & 3.6 \times 10^6\text{ J} & 1\text{ hr} \\ \hline 0.35\text{ eff} & 1032\text{ Btu} & 1055\text{ J} & 1\text{ kWh} & 60\text{ min} \end{array} = 0.189\text{ ft}^3/\text{min}$$

This value for consumption per minute is then used, along with the particular state's natural gas price, to calculate the yearly fuel cost as follows:

$$\text{Yearly Fuel Cost} = \begin{array}{c|c|c|c|c} 0.189\ \text{ft}^3 & \$10.29 & 60\ \text{min} & 24\ \text{hr} & 365\ \text{day} \\ \hline \text{min} & 1000\ \text{ft}^3 & 1\ \text{hr} & 1\ \text{day} & 1\ \text{yr} \end{array} = \$1021.89\ \text{per yr}$$

A slight increase in the efficiency of the fuel cell would make a big difference in fuel consumption and cost. For example, by the same calculations, if we were to increase this fuel cell system's efficiency to only 40 percent, the new fuel consumption equals 0.165 ft^3/min, and the yearly fuel cost drops to 894.15 dollars. To take the calculations even further, a 50 percent fuel cell system efficiency would yield a consumption of 0.132 ft^3/min and a yearly fuel cost of only 715.32 dollars. Now to make a comparison, the next step is to compute how much it would cost for utility power in that state for a year to see if it would be economical to have a fuel cell system in a home or not. The Energy Information Administration sector of the US Department of Energy (EIA of the DOE) has a listing on their web site of all the average utility and natural gas rates for each state. Connecticut has an average utility rate of 12 ¢/kWh. Multiplying this rate by the amount of electricity consumed by the average home in Connecticut tells us that the average yearly utility cost is 966.52 dollars. One can see that at a 40 percent efficiency for this particular fuel cell system would cost less than utility power each year.

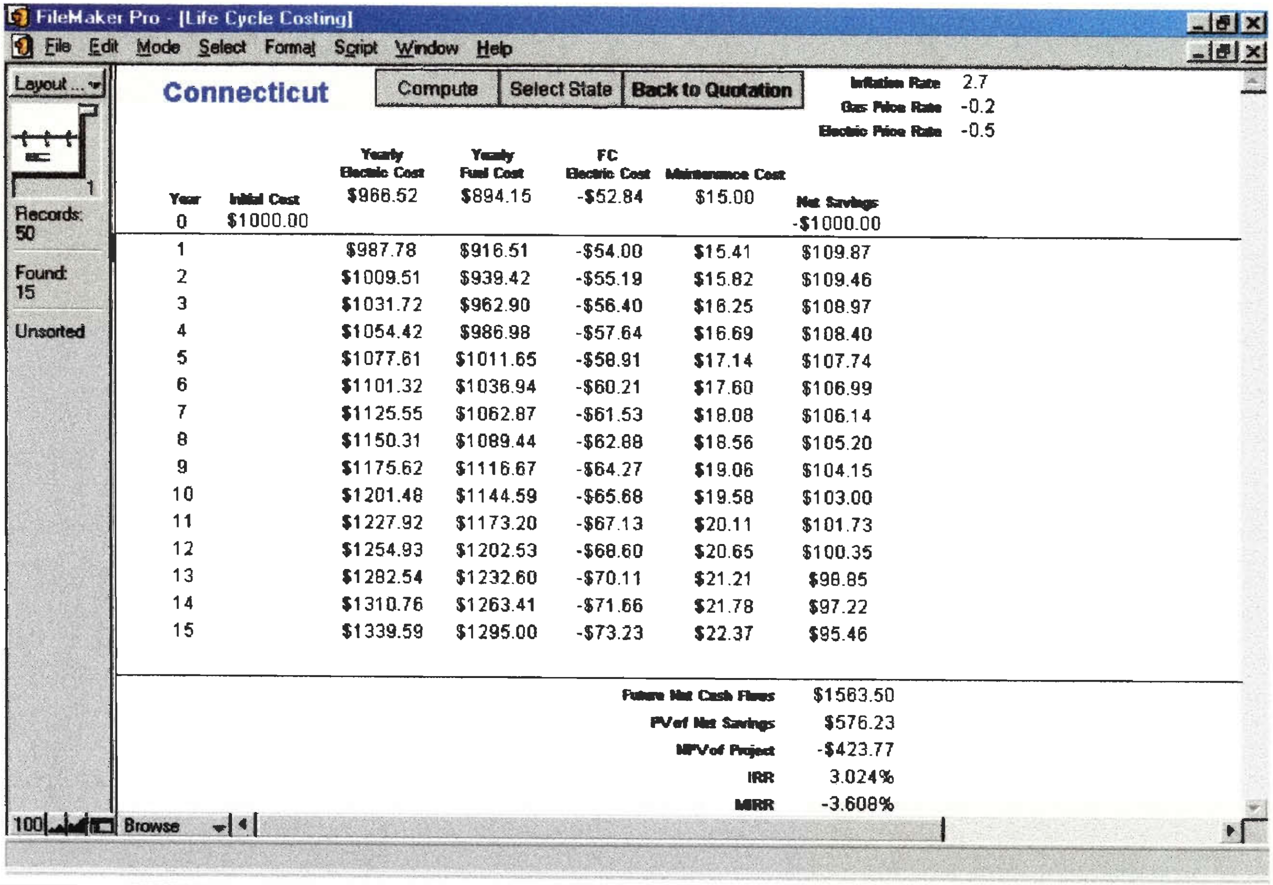
$$\text{Yearly Utility Cost} = \begin{array}{c|c|c} 12\ \text{¢} & \$1.00 & 8088\ \text{kWh} \\ \hline \text{kWh} & 100\ \text{¢} & 1\ \text{yr} \end{array} = \$966.52\ \text{per yr}$$

This method was used to determine the first year cost of a fuel cell versus utility power. This alone is not a valid assessment of the economic feasibility of a fuel cell system. We needed to take into account the lifetime of the investment. As with the efficiency, we concluded that the best assumption for the life of the fuel cell system is fifteen years, which is what most literature and fuel cell companies are estimating for home fuel cells. During a telephone interview, Scott Ehrenberg of Analytic Power in

Woburn, Massachusetts, whose company develops and builds residential sized PEM fuel cell systems, stated that their fuel cells could expect a fifteen-year replacement time.[75] A life cycle costing analysis was performed using a fifteen-year lifetime to determine future net cash flows, net present value, and the internal rate of return (IRR) of the fuel cell system compared to utility power. For a more in depth discussion of life cycle costing calculations see Section **Economic Analysis**.

In a life cycle costing evaluation of the fuel cell, we needed to consider three very important rates of change. The inflation rate is needed to give a more accurate impression of the amount of money spent or saved over the entire lifetime of the fuel cell. We used an inflation rate of 2.7 percent for our analysis. Consequently, for every 1.00 dollar spent on, for example fuel cell maintenance in year n, in year n+1 one would need to spend 1.027 dollars. The other two rates needed for accurate analyses are the rates of change of electric prices and natural gas prices in the United States. These values are key to the chances of fuel cells being economically advantageous over a fifteen-year life. We found the rate of change for electric prices to be around –0.5 percent and for natural gas prices to be –0.2 percent relative to inflation.[76] During the life of the fuel cell, the cost for its fuel will decline at a slower rate than the cost of its competition. The rates of change of utility power and natural gas are in real terms, that is, relative to inflation. When computing the costs over the lifetime of the fuel cell, we need to take into account the 2.7 percent change due to inflation plus a change of –0.5 percent and –0.2 percent for electricity and natural gas prices, respectively.

To complete the life cycle costing calculations, the initial cost and yearly maintenance costs of the fuel cell system are also required. For our example above, a 1,000 dollar fuel cell system in Connecticut running at a 40 percent efficiency and 1.2 kW with yearly maintenance costs of 15 dollars over a fifteen-year life will have a negative MIRR and negative net present value.

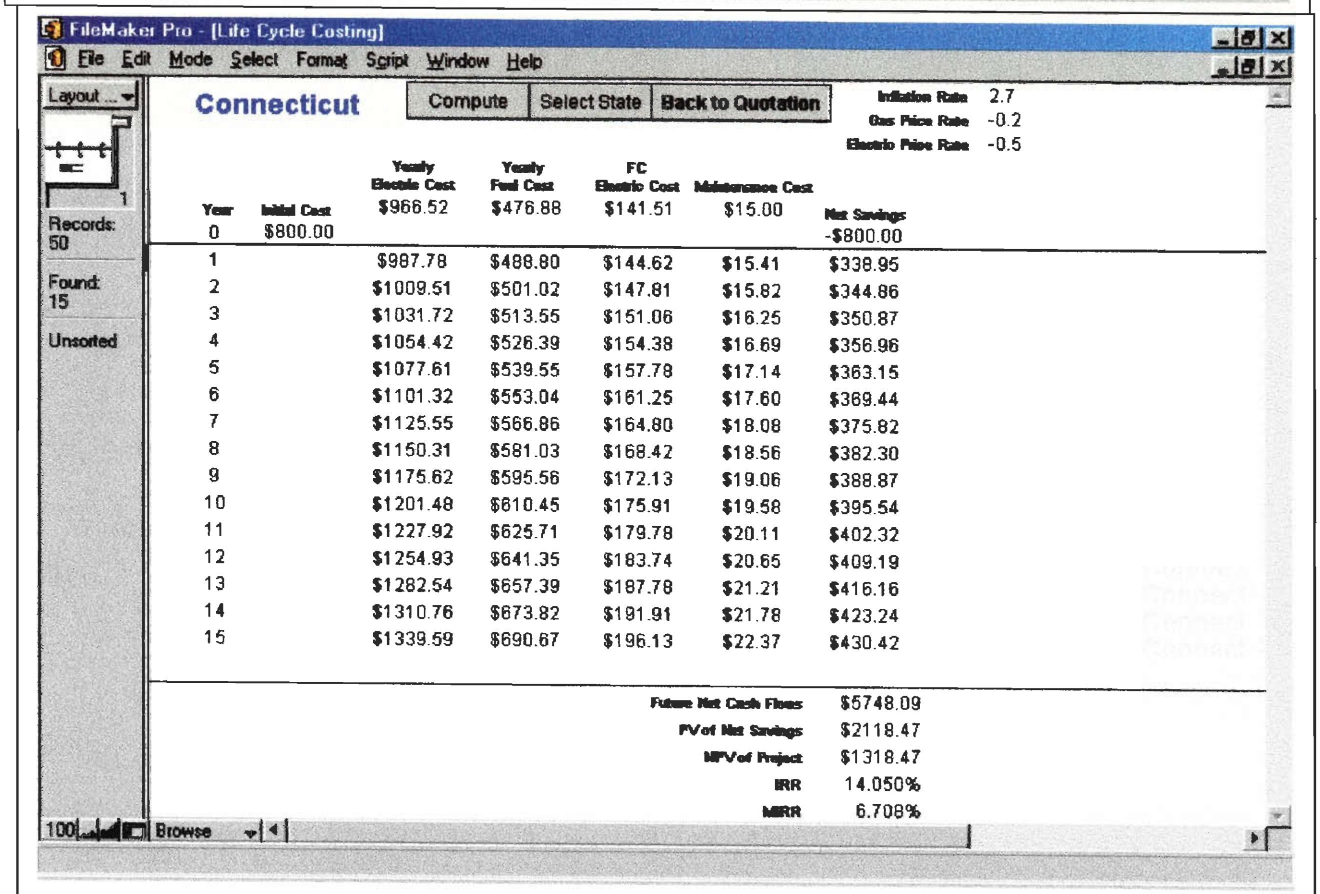


Connecticut

Inflation Rate 2.7
Gas Price Rate -0.2
Electric Price Rate -0.5

Year	Initial Cost	Yearly Electric Cost	Yearly Fuel Cost	FC Electric Cost	Maintenance Cost	Net Savings
0	$1000.00	$966.52	$894.15	-$52.84	$15.00	-$1000.00
1		$987.78	$916.51	-$54.00	$15.41	$109.87
2		$1009.51	$939.42	-$55.19	$15.82	$109.46
3		$1031.72	$962.90	-$56.40	$16.25	$108.97
4		$1054.42	$986.98	-$57.64	$16.69	$108.40
5		$1077.61	$1011.65	-$58.91	$17.14	$107.74
6		$1101.32	$1036.94	-$60.21	$17.60	$106.99
7		$1125.55	$1062.87	-$61.53	$18.08	$106.14
8		$1150.31	$1089.44	-$62.88	$18.56	$105.20
9		$1175.62	$1116.67	-$64.27	$19.06	$104.15
10		$1201.48	$1144.59	-$65.68	$19.58	$103.00
11		$1227.92	$1173.20	-$67.13	$20.11	$101.73
12		$1254.93	$1202.53	-$68.60	$20.65	$100.35
13		$1282.54	$1232.60	-$70.11	$21.21	$98.85
14		$1310.76	$1263.41	-$71.66	$21.78	$97.22
15		$1339.59	$1295.00	-$73.23	$22.37	$95.46

Future Net Cash Flows	$1563.50
PV of Net Savings	$576.23
NPV of Project	-$423.77
IRR	3.024%
MIRR	-3.608%



Connecticut

Inflation Rate 2.7
Gas Price Rate -0.2
Electric Price Rate -0.5

Year	Initial Cost	Yearly Electric Cost	Yearly Fuel Cost	FC Electric Cost	Maintenance Cost	Net Savings
0	$800.00	$966.52	$476.88	$141.51	$15.00	-$800.00
1		$987.78	$488.80	$144.62	$15.41	$338.95
2		$1009.51	$501.02	$147.81	$15.82	$344.86
3		$1031.72	$513.55	$151.06	$16.25	$350.87
4		$1054.42	$526.39	$154.38	$16.69	$356.96
5		$1077.61	$539.55	$157.78	$17.14	$363.15
6		$1101.32	$553.04	$161.25	$17.60	$369.44
7		$1125.55	$566.86	$164.80	$18.08	$375.82
8		$1150.31	$581.03	$168.42	$18.56	$382.30
9		$1175.62	$595.56	$172.13	$19.06	$388.87
10		$1201.48	$610.45	$175.91	$19.58	$395.54
11		$1227.92	$625.71	$179.78	$20.11	$402.32
12		$1254.93	$641.35	$183.74	$20.65	$409.19
13		$1282.54	$657.39	$187.78	$21.21	$416.16
14		$1310.76	$673.82	$191.91	$21.78	$423.24
15		$1339.59	$690.67	$196.13	$22.37	$430.42

Future Net Cash Flows	$5748.09
PV of Net Savings	$2118.47
NPV of Project	$1318.47
IRR	14.050%
MIRR	6.708%

Figure 3: LCC calculation screenshots.

This, obviously, is not a good investment, but that does not mean there is no fuel cell system configuration that would be more economical than utility power in Connecticut. For example, if the efficiency were boosted to 50 percent, the constant kilowatt output lowered to 0.8 kW and the initial cost lowered to 800 dollars, the fuel cell system would have an MIRR of 6.708 percent and a 1,318 dollar net present value. There is just one problem; these calculations are assuming that the fuel cell is always producing the desired amount of electricity. That, of course, is not what is really happening, but was used here initially to give a clearer understanding of how efficiency, output, and initial costs affect the overall economic analysis of the system. Figure 3 shows these LCC calculations as performed by a computer program we developed to model the economics of a fuel cell system.

In reality, the fuel cell is producing a constant kilowatt output throughout the year. If, for example, the fuel cell were producing 0.8 kW every hour of the year, each hour the fuel cell would either be producing less than what the home needed, exactly what was needed, or more than what was needed. The homeowner is required to make a decision: either stay connected to the utility grid to handle peak loads and sell back excess electricity produced by the fuel cell, or install batteries in the fuel cell system to meet peak loads and charge the batteries with the excess electricity. There are advantages and disadvantages to both setups. With a fuel cell–battery system, the initial cost is greater because the batteries required could cost a few hundred dollars. The advantages are that the homeowner would not have to pay anything for the rest of the life of the fuel cell in order to meet peak loads, where as without batteries, there would be a monthly utility bill determined by the amount of electricity drawn from the utility for meeting peak loads.

In order to calculate accurately the cost of a fuel cell system over its lifetime compared to utility power, and to optimize the configuration to create the most economical fuel cell system for each state, we decided to create a relational database program. Using FileMaker Pro, we setup a Fuel Cell System

Modeling Program that performs all of the aforementioned cost analyses, including life cycle costing, and which almost instantaneously tells us whether the particular configuration would be economical. In order to run the calculations, we enter into the program what state the system will be operating in, the efficiency, initial cost, maintenance cost, lifetime (ranging anywhere from 1 to 50 years), and whether it will be a fuel cell-battery or fuel cell-utility system. The program even allows us to determine the constant kilowatt output that would maximize the savings with the fuel cell.

How the Fuel Cell System Modeling Program Works

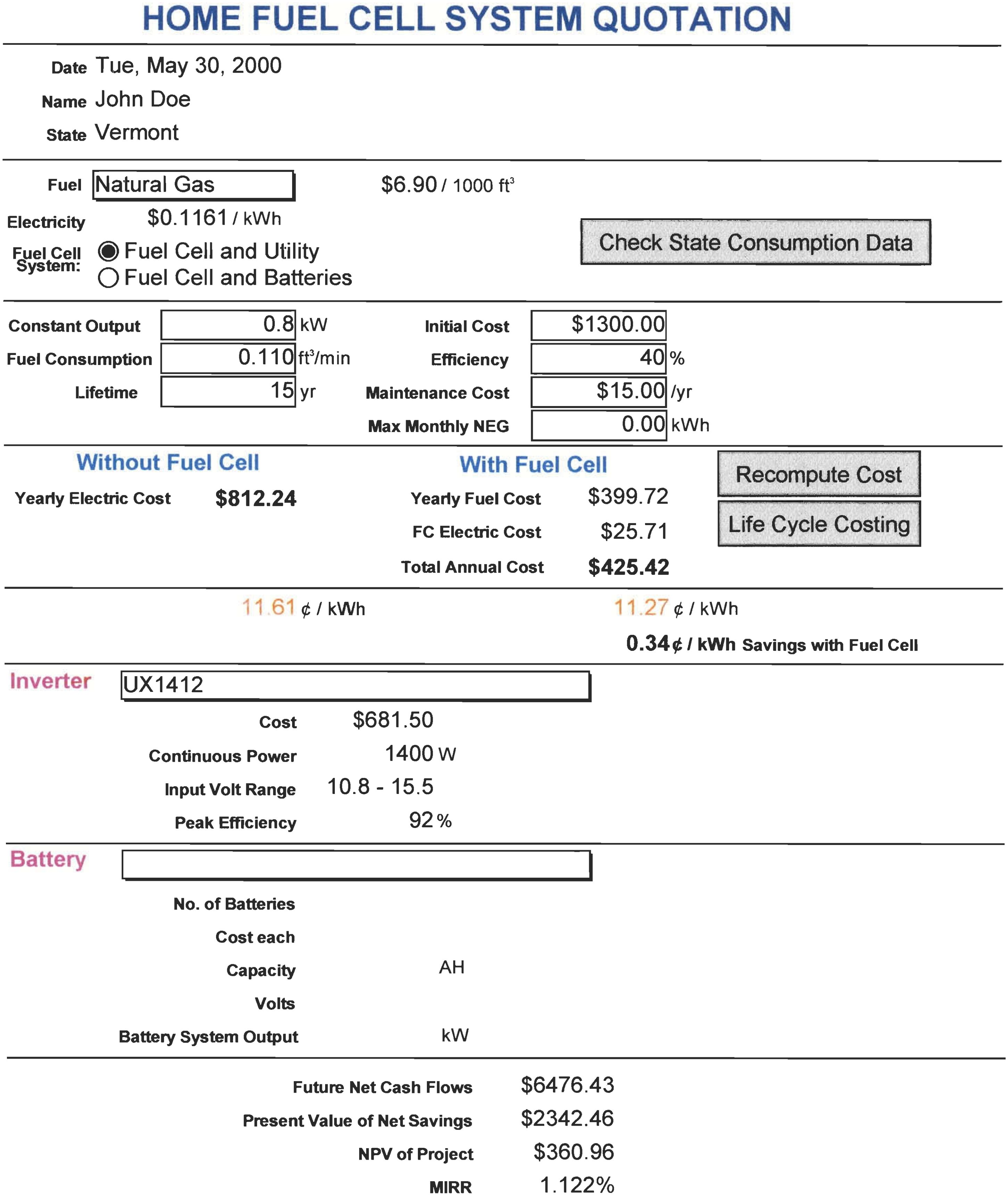
The greatest advantage in creating a relational database program to design an intricate system such as a fuel cell is the extreme simplicity in altering minor details of the system and watching how the final cost analysis changes. If we were to calculate how the net present value of a fuel cell system changes as the constant output varied from 0.63 to 0.64 to 0.65 kilowatts by hand, it would be a very time consuming and tedious operation. Once the FileMaker database was setup, however, we could determine the effect of such minor alterations almost instantaneously with the computer performing every single calculation. The difficult task was setting up the database program to calculate correctly while allowing us to easily modify every minute detail of the fuel cell system.

Before setting up the program's internal calculations, the first step was to create files where the program would look to find information that it needs to perform the basic calculations. Such files included natural gas and electricity prices by state, power inverters, fuel reformers, and batteries that are available for purchase from different companies across the country. Each of the categories of data occupied its own file. In that file, the program would find all relevant information necessary to perform each calculation required for an accurate cost analysis of a fuel cell system versus utility power. Appendix C contains printouts of all these files. The file for electricity prices, for example, contains information for each state concerning utility rate, sell back rate, consumption per household, fuel cell size limit, etc. This type of information is the source data used by the program to make all calculations.

The source data was gathered mostly from resources put out by the Energy Information Administration of the US Department of Energy. They annually publish books that report on current and projected costs of fuels and energy, as well as energy consumption. Fortunately for our project, the EIA separates almost all of their published data by state. Their data by state enabled us to develop the relational database such that it can accurately compute the costs of running a fuel cell in any of the fifty states.

Once all of the source data files were created and filled in with accurate information, the next step was to tie it all together with another new file which acts as the engine for the whole modeling program. This file uses relationships to lookup information needed for calculations by going to the source files and finding the related information for the fuel cell system being designed. For example, the main file, which we call the Specification Sheet (or Spec Sheet), is the file that the fuel cell system designer interacts with the most when setting up a system. The next page shows the Spec Sheet from the modeling program.

The first piece of information entered into the Spec Sheet is the state in which the fuel cell will be operating. With this first piece of information, the Spec Sheet knows what piece of data to extract from the source files. For example, when it goes looking for the state utility price, it opens up the source file containing that data, and then matches up the state selected on the Spec Sheet with the proper state in the source file. This is called a relationship, and without it, the Spec Sheet would not know which of the fifty possible utility prices in the source file to use for its calculations. In effect, we



HOME FUEL CELL SYSTEM QUOTATION

Date Tue, May 30, 2000
Name John Doe
State Vermont

Fuel Natural Gas $6.90 / 1000 ft^3
Electricity $0.1161 / kWh
Fuel Cell System:
● Fuel Cell and Utility
○ Fuel Cell and Batteries

Constant Output	0.8 kW	**Initial Cost**	$1300.00
Fuel Consumption	0.110 ft^3/min	**Efficiency**	40 %
Lifetime	15 yr	**Maintenance Cost**	$15.00 /yr
		Max Monthly NEG	0.00 kWh

Without Fuel Cell		With Fuel Cell	
Yearly Electric Cost	**$812.24**	**Yearly Fuel Cost**	$399.72
		FC Electric Cost	$25.71
		Total Annual Cost	**$425.42**
11.61 ¢ / kWh		11.27 ¢ / kWh	

0.34 ¢ / kWh Savings with Fuel Cell

Inverter UX1412

Cost	$681.50
Continuous Power	1400 W
Input Volt Range	10.8 - 15.5
Peak Efficiency	92 %

Battery

No. of Batteries	
Cost each	
Capacity	AH
Volts	
Battery System Output	kW

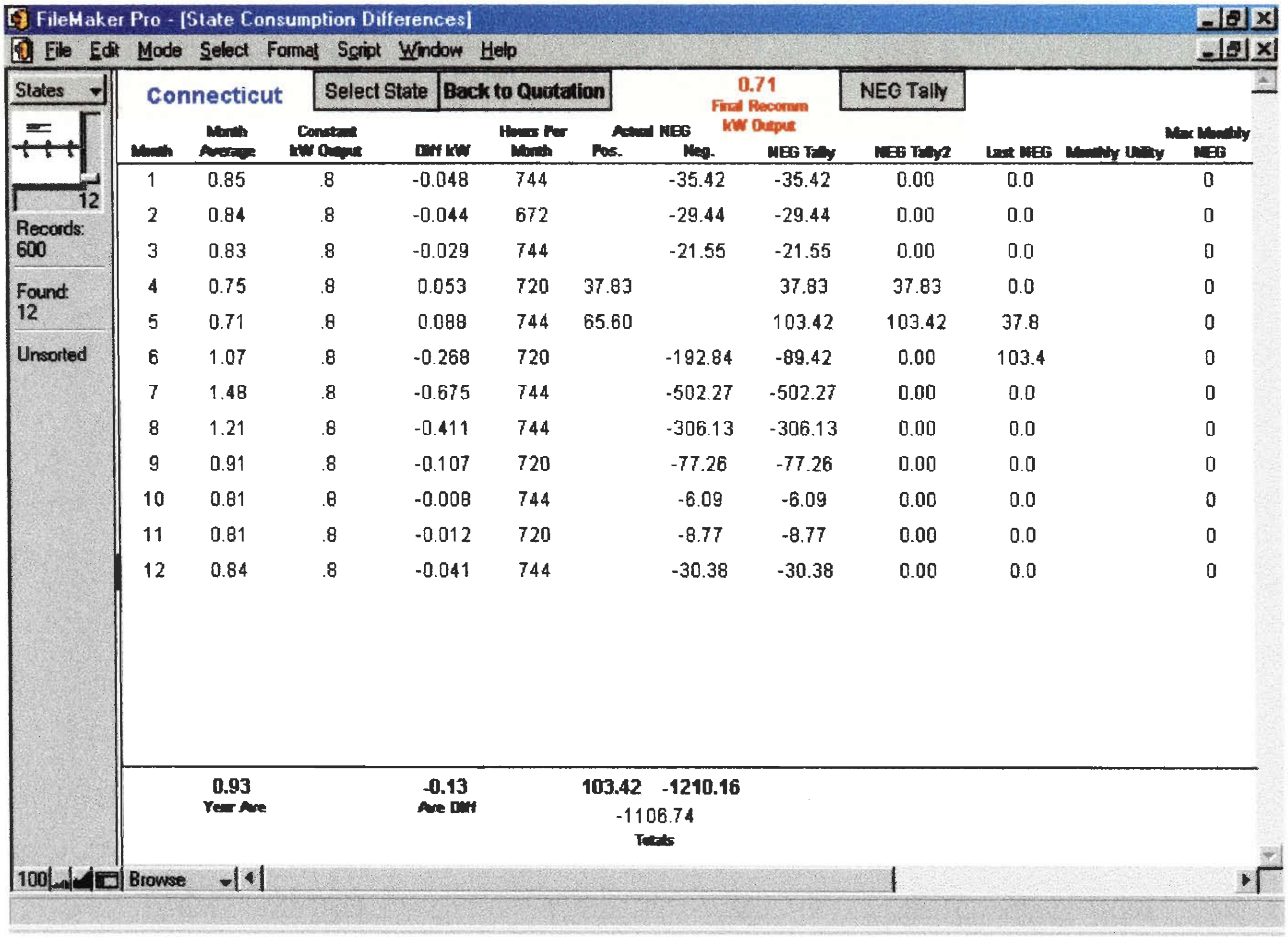
Future Net Cash Flows	$6476.43
Present Value of Net Savings	$2342.46
NPV of Project	$360.96
MIRR	1.122%

input all of the known variables in an organized manner, and then set up the Spec Sheet with all of the equations that use those variables. The base of the modeling program was now complete.

The next step was to gather all equations necessary to run the cost calculations, verify them by hand, and then input them into the database program. These equations included ones that calculate yearly utility cost without a fuel cell system, and a fuel cell system's annual fuel cost and consumption. In order to calculate the total annual cost of a fuel cell system, the program needed to know exactly how much electricity will be demanded by a house each month and at what constant output the fuel cell will be running. This data was necessary for computing the annual cost of a fuel cell-utility system as well as a fuel cell-battery system.

In order to compute the yearly fuel cell system cost, we needed to create two more source files for the Spec Sheet to reference. The first contains information for each state that computes how much the fuel cell over or under-produces each month of the year. This data is used to compute the cost of utility power bought to meet peak loads and to calculate how much money the utility gives back for excess electricity produced by the fuel cell system. The second source file contains the same data, but for every single hour of the year. This data is used for the case where the homeowner chooses to operate a fuel cell-battery system. The kilowatt differences are used to determine how much the battery is being drained and charged over the course of the year. This is important because it is very inefficient to drain batteries below fifty percent of capacity, and so the fuel cell system needs to be designed such that this scenario is always avoided. When the fuel cell is over producing electricity, the battery or batteries in the system are being charged, and although we don't have to worry about overcharging the batteries, it is uneconomical to overcharge them so much that the fuel cell system is wasting natural gas.

The Spec Sheet uses the state utility consumption file to determine for a specific constant fuel cell output, exactly how many kilowatt-hours the homeowner would be buying from the utility and how much would be sold back to the utility. The source file is set up in a table format, like in Figure 4. Each row in the table contains data for one month of the year. The first and second columns contain values that are the number representing the month of the year and the average hourly kilowatt consumption of the house for the state specified, respectively. The third column contains the constant



Connecticut

0.71
Final Recomm kW Output

Month	Month Average	Constant kW Output	Diff kW	Hours Per Month	Actual NEG Pos.	Neg.	NEG Tally	NEG Tally2	Last NEG	Monthly Utility	Max Monthly NEG
1	0.85	.8	-0.048	744		-35.42	-35.42	0.00	0.0		0
2	0.84	.8	-0.044	672		-29.44	-29.44	0.00	0.0		0
3	0.83	.8	-0.029	744		-21.55	-21.55	0.00	0.0		0
4	0.75	.8	0.053	720	37.83		37.83	37.83	0.0		0
5	0.71	.8	0.088	744	65.60		103.42	103.42	37.8		0
6	1.07	.8	-0.268	720		-192.84	-89.42	0.00	103.4		0
7	1.48	.8	-0.675	744		-502.27	-502.27	0.00	0.0		0
8	1.21	.8	-0.411	744		-306.13	-306.13	0.00	0.0		0
9	0.91	.8	-0.107	720		-77.26	-77.26	0.00	0.0		0
10	0.81	.8	-0.008	744		-6.09	-6.09	0.00	0.0		0
11	0.81	.8	-0.012	720		-8.77	-8.77	0.00	0.0		0
12	0.84	.8	-0.041	744		-30.38	-30.38	0.00	0.0		0
	0.93 Year Ave		-0.13 Ave Diff		103.42	-1210.16					

-1106.74
Totals

Figure 4: Source file showing differences between demand and constant kW output for a particular state.

kilowatt output of the fuel cell system, and the fourth column is equal to the third minus the second (i.e. the average hourly amount that the fuel cell over or under-produces by month). This kilowatt difference is then multiplied by the number of hours in that month, yielding the amount of Net Excess Generation for the fuel cell system. The source file now has calculated the amount of NEG for each month (billing period) of the year for this particular fuel cell system. Notice that if we go back to the Spec Sheet and change the constant kilowatt output and then come back to this source file, the new value for constant kilowatt output is automatically updated and new NEG values are instantaneously computed. The source file then sums the positive monthly NEG values and displays it alongside the sum of the negative NEG values. In our program, the positive NEG is the amount of kilowatt-hours that the fuel cell will sell back to the utility grid and negative NEG is how many kilowatt-hours the fuel cell system will need to draw from the utility company. The Spec Sheet then takes these two sums, multiplies the positive NEG by the sell back rate and the negative NEG by the state utility price. The yearly fuel cell cost (YFCC) is then calculated as follows:

YFCC = (Yearly Fuel Consumption*Fuel Price) – (Positive NEG*Sell Back Rate) + (Negative NEG*Utility Price)

Notice that the positive NEG value is subtracted from the yearly cost because it represents money returned to the homeowner from the utility for excess electricity. The negative NEG represents an amount of kilowatt-hours that the homeowner would need to purchase from the utility to meet loads above what the fuel cell is outputting.

Having this calculation done automatically by the computer makes it quick and easy to adjust the constant kilowatt output such that the yearly fuel cell cost is minimized. This value for the constant output is a fine balance between minimizing how much fuel is consumed while at the same time minimizing how much electricity needs to be bought from the utility. The main factors involved in this optimization are the utility cost, fuel cost, and fuel cell system efficiency. If, for example, the state being considered has a low utility price and a high natural gas price, it would be desirable to run the fuel cell at a lower output and buy more electricity from the utility. On the Spec Sheet, given the state in which the home is located and the fuel cell efficiency, it is simple to find the exact constant output of the fuel cell system that would minimize the yearly fuel cell cost. Adjusting the output by hundredths of a kilowatt up or down will unveil the lowest possible yearly fuel cell cost for any system configuration.

A similar sequence of calculations is used for the fuel cell-battery configuration. The difference is that positive NEG is not bought by the utility, but rather used to charge the batteries. Negative NEG represents how many kilowatt-hours must be drawn from the batteries to meet peak loads demanded by the home. The yearly fuel cell cost is calculated simply as the cost of fuel used by the fuel cell. The cost of the system is not necessarily cheaper than a fuel cell-utility system in this case because the initial cost increases with the number of batteries needed in the system.

Now that the program has calculated the yearly cost of the particular fuel cell system chosen, given all of its different parameters and the state of operation, the next step is to determine the economic feasibility of the system over its lifetime. Compared to the cost of utility power alone, a series of life cycle costing calculations need to be made to determine if the fuel cell system would be a good investment for a homeowner. These require more lengthy calculations, which we setup the database program to compute for us.

Another file was created to perform the life cycle costing calculations. The life cycle costing file takes the cost data from the Spec Sheet telling the annual fuel cost, maintenance cost, and utility power cost for the fuel cell system. It also takes the cost of utility power without a fuel cell to compare the two as investments. On the Spec Sheet, the fuel cell system designer selects the fuel cell lifetime, and this value determines over how many years the life cycle costing calculations will be carried through.

Figure 3 shows a sample computation of the life cycle costing analysis for a particular fuel cell system. The number of rows in the figure corresponds to the number of years in the fuel cell system's lifetime. This particular case illustrates a fifteen-year lifetime. This LCC sheet, generated by our fuel cell system modeling program, is very useful for determining the present worth, or present value, of the fuel cell system. It is computed instantaneously once the necessary data is entered into the Spec Sheet (i.e. lifetime, constant output, initial costs, maintenance costs, state of operation, and efficiency). At the top of the sheet, the LCC file displays the yearly cost of utility power alone in that state. It also retrieves from the Spec Sheet the first year costs of the fuel cell system, these being the fuel, initial, and maintenance costs and the cost of utility power needed for meeting peak loads (for fuel cell-utility systems only). All of these costs will occur each year except for the initial cost, which is only incurred at the beginning of the first year.

Next, the LCC file computes these costs over the lifetime of the fuel cell to determine if the investment is worthwhile to someone today. The idea is that for each year during the investment's lifetime, the consumer wants to have a positive difference between the costs of his system versus what it would have cost him to keep utility power alone. If at the end of the fuel cell's life the amount saved each year totals to a value higher than the initial cost of the fuel cell, then the investment is worthwhile. That means that the consumer saves enough money over the fuel cell's lifetime to at least pay for the initial cost of the system. If he does not accumulate a savings greater than the initial cost of the system, then it would be in the best interest of the consumer not to purchase the fuel cell system. Determining whether or not the system would be a good investment is not as simple as multiplying the first year fuel cell costs by the number of years in the fuel cell's life. One needs to take into account many different variables that will alter the costs over the lifetime of the fuel cell.

The rate of inflation is the first variable that needs to be accounted for. We determined that the inflation rate to use for our calculations is 2.7 percent. This means that if the maintenance cost for our fuel cell system is 100.00 dollars one year, the cost would be 102.70 dollars the next year, and so on.

Two other very important rates that the LCC file uses are the change in electric and natural gas prices. In addition to the prices of fuel and utility power changing over the years due to inflation, the market prices will also change. The Energy Information Administration of the United States Department of Energy releases annual reports on the present status and future of such things as fuels and utility power. In their 1999 edition, the EIA predicts a decline of 0.5 percent in the price of utility power over the next twenty years, and a decline of 0.2 percent for the price of natural gas. This, obviously, does not favor fuel cells, but the calculations will show that fuel cells can still be economical in some states.

Economic Analysis

The economic comparisons in this project were made using a method known as life cycle costing (LCC). Life cycle costing takes into account the time value of money in making an economic investment comparison or evaluation. LCC calculates how much an investment costs over its life. In this case the investment to be evaluated is a fuel cell system. Therefore the life cycle costing will be comparing the cost of electricity when bought from a utility to the cost of electricity when produced by a fuel cell system, where the life of the investment is defined by the life of the fuel cell. Since PEM fuel cell technology has not been on the market very long it is not known what the effective lifetime of a fuel cell actually is. However, fifteen years is the current estimate of the lifetime of a fuel cell being used in the home according to analytic power in Woburn Mass. (Scott Ehrenberg 10/6/99).

In order to provide clarity to the life cycle costing discussion, we will now restate the concepts involved in the cost analysis in further detail. The annual cost of purchased electricity is just the amount of kilowatt-hours consumed in one year multiplied by the cost per kilowatt-hour. The annual cost of the fuel cell system is the sum of the fuel cost, the cost of electricity purchased form the utility during periods of peak demand, and maintenance costs less the amount of funds received from selling electricity back to the utility during periods of low demand. The annual fuel cost is equal to the volume of fuel consumed in one year multiplied by the cost of the fuel per volume. The annual cost of purchased electricity is calculated by taking the number of kilowatt-hours bought from the utility multiplied by the cost per kilowatt-hour. Then there is the amount of money generated by selling electricity back to the utility. This amount is to be subtracted from the yearly cost because it is income. The amount of money received is determined by the number of kilowatt-hours sold multiplied by the price per kilowatt-hour at which the electricity is sold.

The annual maintenance cost was estimated to be fifteen dollars per year. Since home fuel cell systems are a new form of power generation, companies do not yet know what yearly maintenance costs will be. By assuming that maintenance costs will be on the order of the cost of the membrane required in the system, the maintenance costs can be estimated fairly easily. The cost of the membrane is approximately 100 dollars per kilowatt.[77] Most membranes have a lifetime of 50,000 hours, which is approximately equal to 6 years.[78] Therefore, the maintenance cost was estimated through the following calculation by assuming a one-kilowatt system.

$$\text{Yearly Maintenance Cost} = \begin{array}{c|c|c} 1\text{kW} & \$100 & \text{Membrane lifetime} \\ \hline & \text{kW} & 6\text{ yr} \end{array} = \$16.67\text{ per yr}$$

Thus, we assume an optimistic yearly maintenance cost of 15 dollars per year since membrane lifetime is bound to increase with technological advances.

Growth Rates and Inflation

The first order of business is to establish how much the fuel cell system will cost annually compared to purchased electricity throughout the life of the fuel cell. To do this it is necessary to know how the prices of electricity and natural gas will change over the life span of the investment. These are defined as the *growth rates* of the respective prices. However, the purchasing power of money can change through the years as well. This decrease in purchasing power is referred to as *inflation*. Thus if the inflation and growth rates are applied to the annual cost calculations it can be determined what the annual cost of the fuel cell system is compared to utility electricity for each year of the investment. The growth rate of real electricity prices was found to be -0.5 percent.[79] The growth rate of natural gas prices was projected to be –0.2 percent.[80] The current national inflation rate was 2.7 percent as reported by the Consumer Price Index for 1999.[81] The actual applied growth rates are the inflation rate plus the growth rate in real dollars or 2.7 percent for electric rates and 3.5 percent for natural gas rates.

In order to calculate the fuel cost in year n we simply multiply the cost in the first year by one plus the actual growth rate raised to the nth power. $C_f(n) = C_f(0) * (1+ 0.027+ 0.008)^n$. To calculate the electric cost in year n we use the same method. $C_e(n) = C_e(0) * (1+ 0.027 + 0.000)^n$. The maintenance cost is only subject to inflation and is projected accordingly. $C_m(n) = C_m(0) * (1+ 0.027)^n$. Now it is possible to predict the cost over n years of the fuel cell system compared to the utility by using the estimation method of a constant growth rate.

Future Net Cash Flows

The next step is to determine how the total cost of a fuel cell system compares to the standard utility cost for the entire life of the fuel cell. To do so we calculate the annual savings generated by the fuel cell as the difference between the cost of buying all electricity from the utility and the total operating cost of the fuel system over a year. These are the future cash flows. If we take the sum of net savings over the entire life of the investment then we have the total amount of savings obtained by the end of the investment. This amount is known as the total undiscounted *future net cash flows*.

Present Value & Net Present Value

The next logical step would be to subtract the initial costs from the total undiscounted future net cash flows and find out the effect of this investment on the owner's pocket book. However, this would not be a fair judgment. Since the initial investment could have been invested in some other investment on which interest is earned annually we must find some way of discounting the future net cash flows appropriately. In other words we must find the *present value* of the future net cash flows. The present value of the savings will take into account the time value of money.

An analogous situation that is more familiar is a bank investment. If one invests some amount PV in a bank for n years at an annual compound interest rate, k, then the future value of the investment, F, is a function of n and is determined in the following way:

$$F(n) = PV * (1+ k)^n.$$

For our purposes we wish to find the present value of the future net cash flows and therefore must work the calculation backwards using the formula

$$PV = F/ (1+ k)^n$$

This present value is the amount of money the future savings would be equal to now in terms of money in hand. The *net present value* can be found by subtracting the initial investments, I, from our present value as determined above.

$$NPV = PV - I$$

The net present value is a good estimate of the financial effect of the investment and is the basis of the economic comparisons done in this project.

Cost of Capital

The rate of interest used to discount future net cash flows to get the present value of savings is called the *cost of capital*. If the net present value is not positive then an investor should be advised that the capital would likely have better economic returns if invested in the stock or bond market. The cost of capital is therefore what determines the equivalent value for the interest rate value, k, in the bank analogy.

There are three factors that determine the cost of capital. The first is the long-term government bond rate, which is used to represent a risk free rate of return. The second is the risk of the investment relative to the stock market. The last is the tax rate, T_p, to which earnings in the stock market would be subject. The tax rate is necessary to account for the fact that the savings generated by a fuel cell system are tax-free where as an investment in the stock market is taxable income. The cost of capital before taxes, k_{BT}, is then calculated by adding the long-term bond rate, T, to the product of the risk factor, b, and market risk premium, M,

$$k_{BT} = T + (b * M)$$

The cost of capital after taxes, k_{AT}, is calculated by:

$$k_{AT} = k_{BT} (1 - T_p).$$

For this project a thirty-year United States Treasury bond was used to represent the risk free rate. The value used for the T-bond rate was 6.25 percent.[82] A value of thirty-three percent is assumed to be a reasonable tax rate to represent both state and federal taxes. The market risk premium, M, has historically been around 8.4 percent.[83]

The beta or risk factor of the project is determined by the following equation:

$$b = r_{PM} (s_P / s_M),$$

where r_{PM} is the correlation coefficient between the returns on the project and the stock market, s_P is the standard deviation of the project returns, and s_M is the standard deviation of returns on the market. The fuel cell system's ability to operate and the resultant savings will not be strongly dependent on or follow the trends of the stock market. We therefore assumed a low correlation coefficient of (r_{PM} = 0.5). The standard deviation of the returns of the project is assumed to be approximately equal to the standard deviation of the returns on the market. Therefore we determined the ratio of the standard deviations to be equal to one ($s_P / s_M = 1$). Thus the risk factor associated with a fuel cell system is calculated to be ($b = 0.5$).

Internal Rate of Return

The *internal rate of return (IRR)* is the percentage rate that would yield a net present value of zero. In other words it is the interest rate that the initial investment, I, would need to be invested at to return an amount equal to the future net cash flows, F, after n years. Therefore the internal rate of return, r, or IRR is the value of k that satisfies the equation:

$$I * (1+ r)^n = F.$$

Through some manipulation this equation can be written as:

$$r = (F/ I)^{-n} - 1.$$

The IRR is often used to measure profitability because it does not depend on the size of an investment. If the NPV is positive but much smaller than the initial investment it may appear at first glance to be a great investment when just looking at the NPV. For example, if the NPV was one thousand dollars but the initial investment was one hundred thousand dollars then the NPV alone would give a false impression of the profitability of the investment. Thus, to get an idea of the profitability of the investment that is independent of its size we can use the internal rate of return.

Modified Internal Rate of Return

A superior indicator to the internal rate of return is the *modified internal rate of return (MIRR)*. It is also known as the adjusted internal rate of return. The MIRR is based on the assumption that the cost of capital can be used as the reinvestment rate for future net cash flows as opposed to using the IRR. To determine MIRR the value of r in the IRR calculation is replaced by k as the future cash flows reinvestment rate. MIRR represents the annual compound rate that an investor would have to earn on an alternative investment to do as well as investing in a fuel cell. Again, the MIRR is assuming that the investor can find another investment with an interest rate equal to the cost of capital in which all future net cash flows could be then be reinvested to generate further profit.

Results

The Fuel Cell System Modeling program was designed and constructed as a tool to determine the economic feasibility of a fuel cell system as compared to utility power. We use it to evaluate the costs of different fuel cell systems in various states of the country. Some states prove to be better suited for fuel cell systems than others. The program requires certain variables from which economic calculations are made. The first piece of data entered into the program is the state in which the system will be operating. The average annual residential consumption, utility rate, and natural gas rate are identified by the state chosen. The program uses these values for its calculations since they vary for each state. The next variables entered into the program are the fuel cell system efficiency and constant kilowatt output, which determine the fuel consumption rate. The program then computes the annual cost of the fuel cell system, which includes fuel and, if the system remains connected to the utility, electricity costs.

Given the annual costs of the chosen fuel cell system, the program is then used to determine the initial system cost for break-even profitability. To do this, one must enter the yearly maintenance cost, lifetime of the system, and a trial value for the initial cost of the entire system. The initial cost for break-even profitability is determined by varying the initial cost until the Net Present Value of the investment is equal to zero. By performing this calculation, the program determines for each fuel cell system configuration what the initial cost would have to be in order for the homeowner to break even by investing in a fuel cell system. If a fuel cell company can provide a system to the homeowner for an initial cost less than the break-even value, then the homeowner will profit from the investment.

There were some assumptions we made in order to set up the program to compute the cost calculations. We assumed that the fuel cell would operate at a constant output throughout the year.

For fuel cell - battery systems, we also assumed that the fuel cell system would shut off when the batteries are fully charged, thereby preventing overcharging of the batteries. Another assumption is that the efficiency of the fuel cell will remain constant throughout its lifetime. The yearly maintenance cost for the system is assumed to be fifteen dollars per year for our comparative calculations. Finally, it was assumed that the fuel cell system size should be equal to twice the constant kW output chosen for maximum profitability, because the fuel cell runs most efficiently at half its maximum possible output.

Our goal was to compute the cost calculations for each state for many different fuel cell system configurations. We varied input values such as lifetime, efficiency, and constant output in order to compute break-even values. The break-even calculation is important because right now fuel cell companies are anticipating selling home fuel cell systems for approximately 1,500 dollars per kW.[84] By computing the break-even initial cost for a particular state and fuel cell system configuration, then dividing by twice the constant kW output, we can see how close a company's estimate is to the value we obtained. Similarly, if a fuel cell company claims that it can presently offer a 3 kW home fuel cell system for 3,500 dollars, our program can determine the states in which that system will be a profitable investment.

Fuel Cell – Utility Systems

Figure 5 shows our results for yearly costs of fuel cell systems versus utility power in the nine promising states. The nine states are the states that have net metering laws covering fuel cells. These fuel cell systems remain connected to the utility for meeting peak loads. We computed the yearly fuel cell cost for efficiencies of 30, 35, and 40 percent to show the effects of changing this variable. One can see that by increasing the efficiency, the cost of running the fuel cell drops. However, this yearly cost does not take into account the cost of buying or maintaining the fuel cell system. Only the fuel cost and the amount of electricity bought to meet peak loads are considered and compared to the yearly utility cost.

The feasibility of a fuel cell system is measured by finding the difference between the cost of utility power alone and the yearly fuel cell cost. The difference between utility cost and fuel cell cost at 35 percent efficiency was used to organize the states by the advantage fuel cells have over utility power. In Figure 5, the states are shown from left to right in order of most favorable for fuel cells to

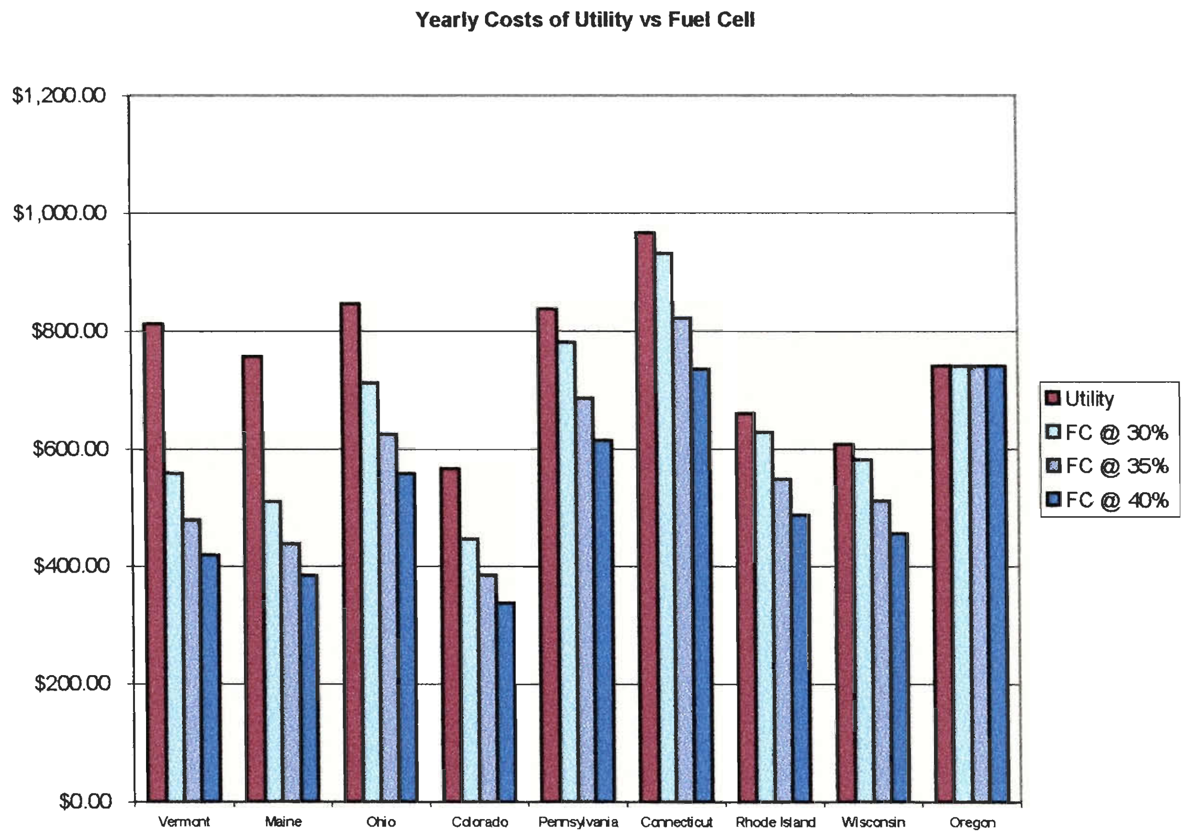


Figure 5: Yearly Costs of Utility vs. Fuel Cell.

least favorable. One can see that Vermont, Maine, and Colorado are the three best states for fuel cell systems running at 35 percent efficiency.

To make a comparison that took into account the initial and maintenance costs of the fuel cell system, more calculations were done. For each state, the efficiency and lifetime of the fuel cell was varied to calculate the effects on break-even initial cost. The results of these calculations are shown in Figures 6 and 7. From Figure 6, one can see that the ranking of the states by break-even initial cost changes as the fuel cell efficiency is varied. As the efficiency increases, the break-even initial cost

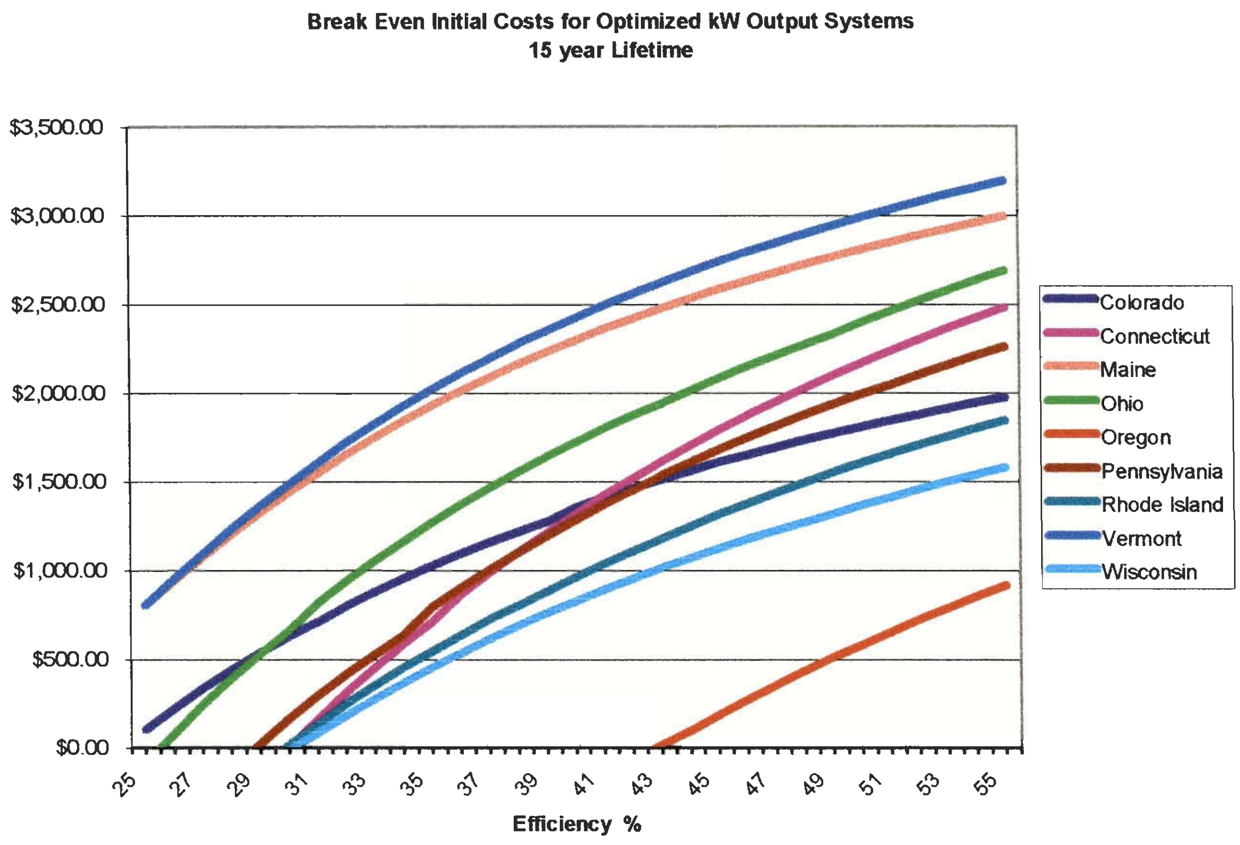


Figure 6: Break-even initial costs vs. efficiency.

increases in every state. For a particular state, any combination of initial cost and efficiency that lies below that state's curve will be an economically profitable investment. These graphs show what initial costs fuel cell companies need to achieve in order to market a feasible system to a particular state.

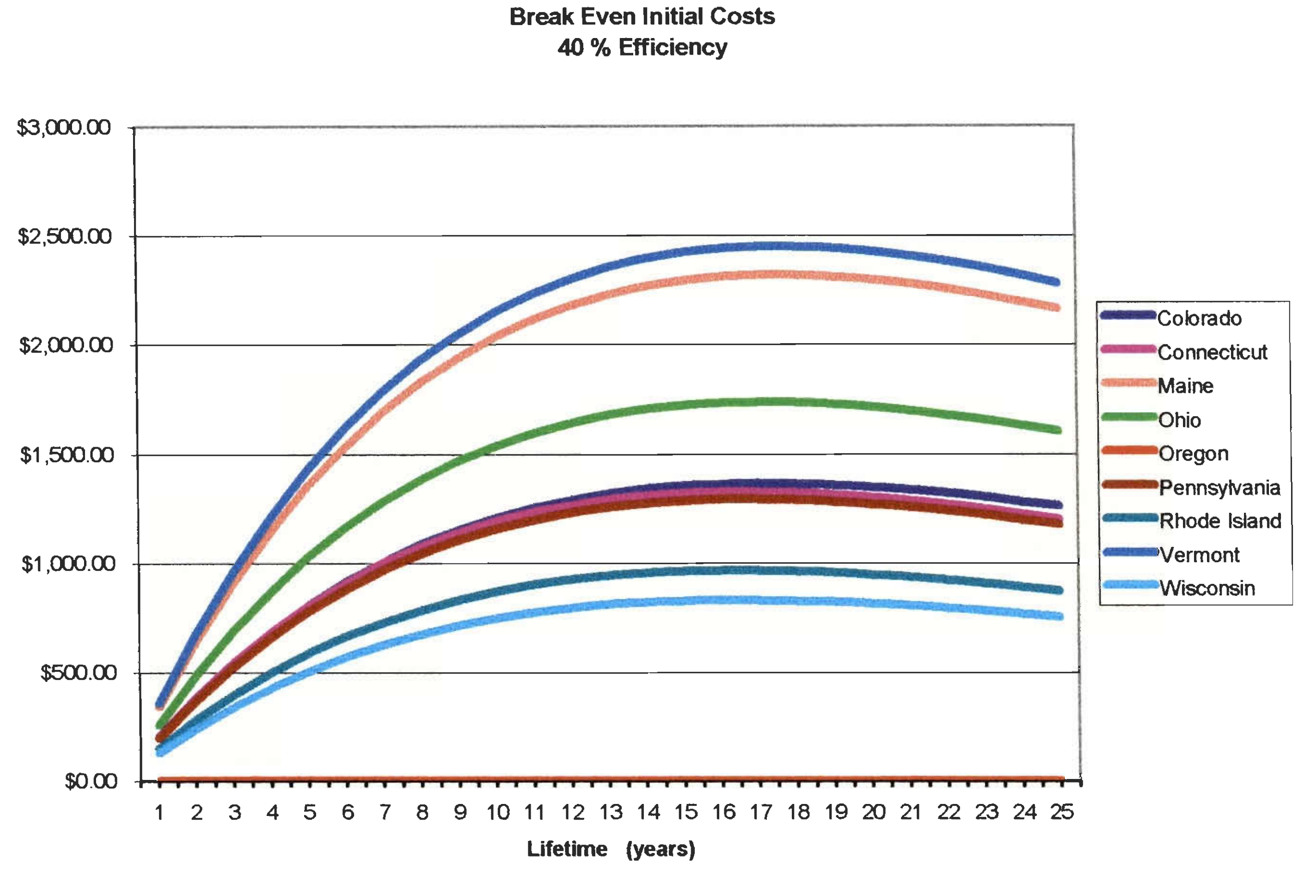


Figure 7: Break even initial costs vs. lifetime.

When designing a fuel cell – utility system, the data from these figures can be used to determine in what states fuel cells will save money for the homeowner. The Modeling Program shows that in certain states, fuel cell systems that stay connected to the utility can be economically feasible. Their feasibility depends on the efficiency and initial cost achieved by the manufacturer, as well as lifetime, maintenance costs, and the constant kilowatt output.

Fuel Cell – Battery Systems

For fuel cell – battery systems, creating a configuration that will be economically feasible is more difficult than it is for a fuel cell – utility system. The fuel cell must be designed to produce at a

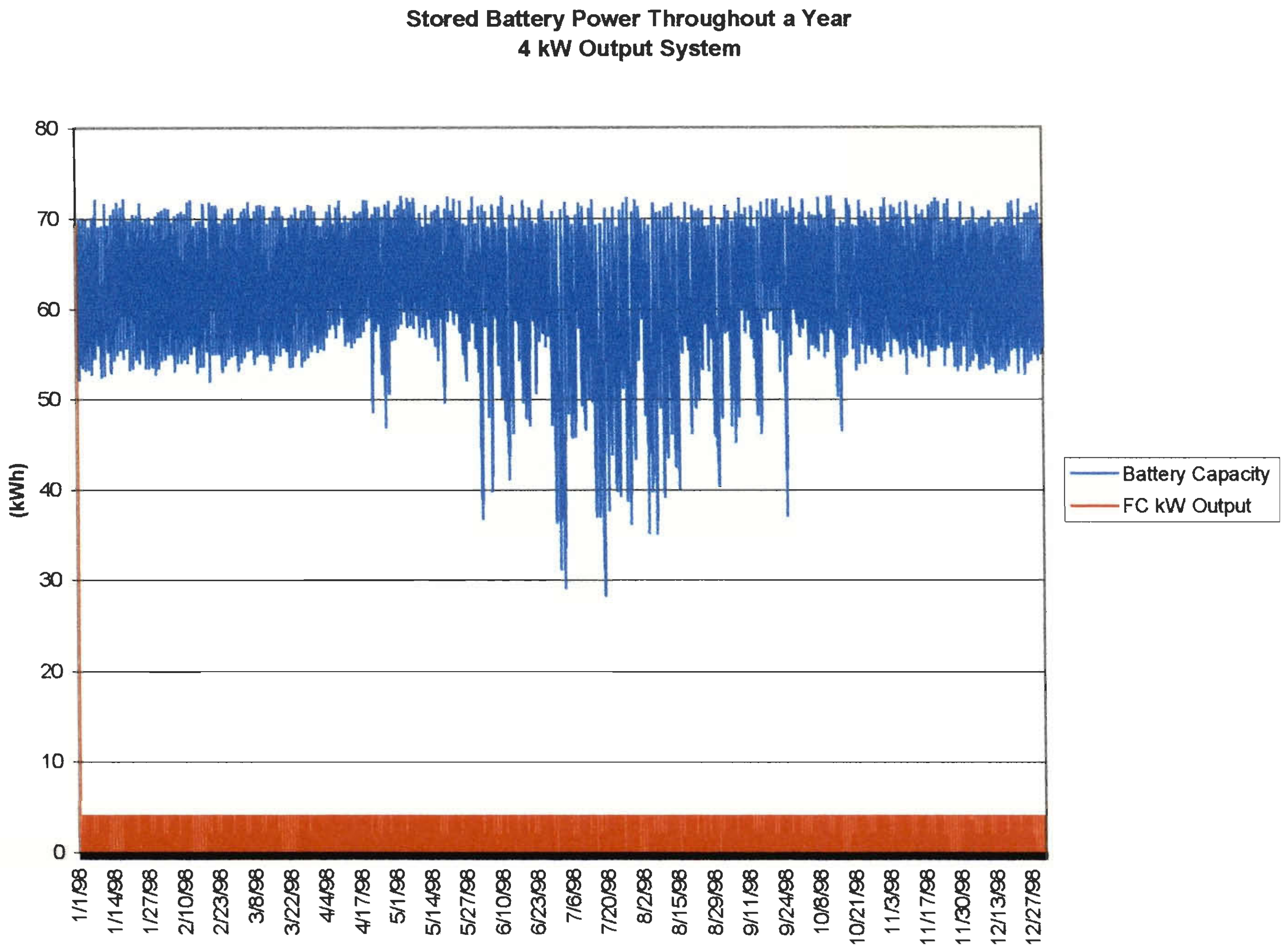
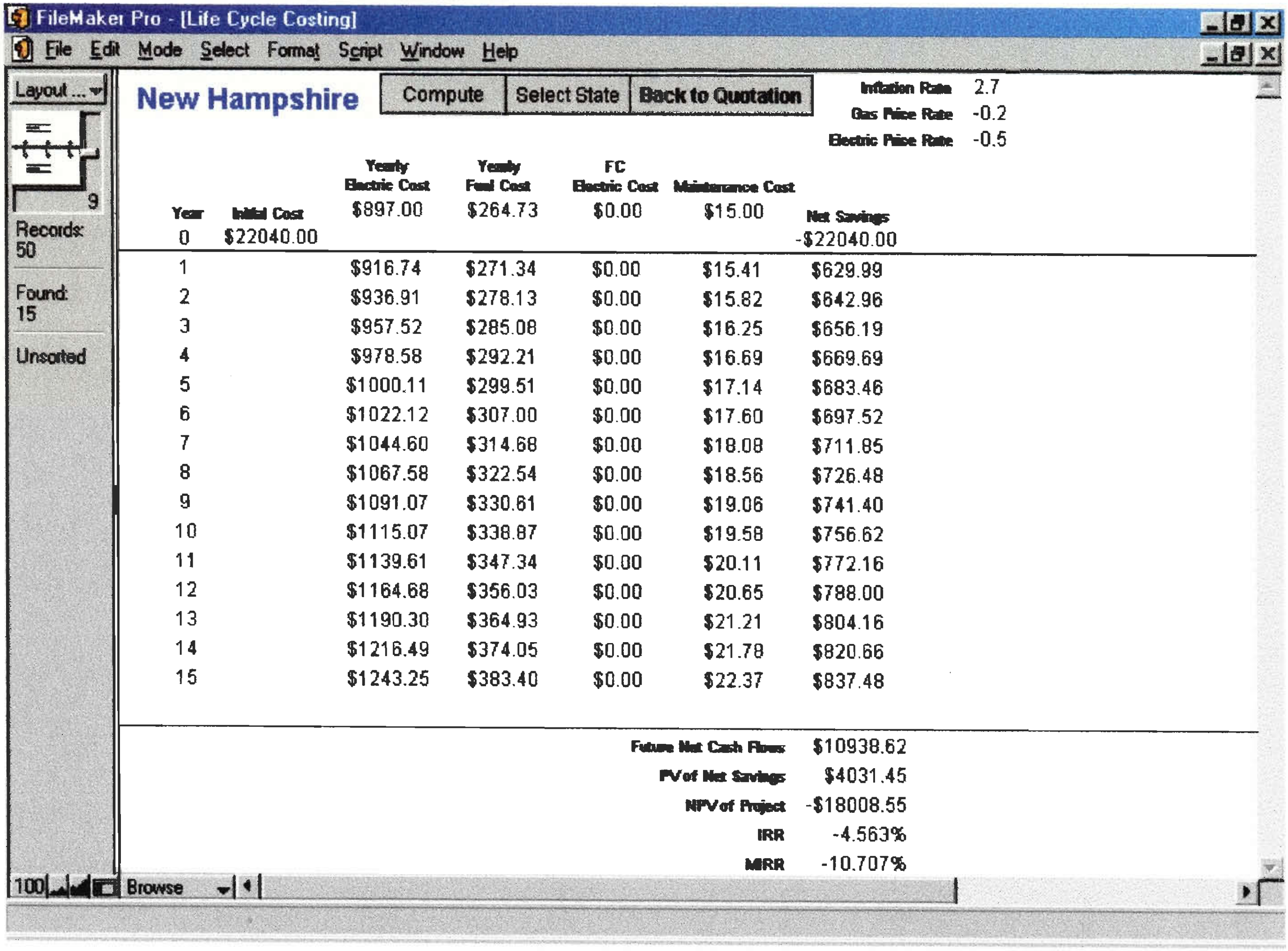


Figure 8: Stored battery power throughout a year.

certain constant output such that the battery is not over or undercharged at any time during the year. We set up the Modeling Program so that the fuel cell will automatically shut off for twenty-four hours whenever the battery bank is charged to full capacity. In order to avoid overdrawing from the battery bank, the fuel cell constant output, and/or the battery maximum capacity must be adjusted such that the battery bank is not drained below half capacity. Figure 8 shows the energy stored in the battery bank for a year in a fuel cell system. It is apparent that during the middle of the year the electricity demanded by the home greatly exceeds the output of the fuel cell, resulting in increased drainage of the batteries and less system shut downs. In order to design the fuel cell – battery system so that the battery bank is not drained below half capacity during the summer, the size of the battery bank must be large. Another way to avoid draining the battery bank below half capacity is to increase the constant kilowatt output of the fuel cell. This change would result in the fuel cell meeting a greater percentage of the summer demand, thus allowing for a smaller battery bank. Whether one increases the output of the fuel cell or the maximum capacity of the battery bank, the initial cost of the system is very high. One would think that by increasing the constant output of the fuel cell, the annual cost of fuel would also increase. However, the fuel cell will be shut down more often throughout the year, and as a result the annual fuel cost remains almost constant as the power output is increased.

Our results show that fuel cell – battery systems will not be feasible because of the high initial costs. In order for this type of fuel cell system to become economically feasible, the initial costs of fuel cells and batteries must be reduced. Figure 9 shows life cycle costing calculations of a fuel cell – battery system. The high initial costs of the system make it impossible for the fuel cell system to be competitive with utility power. This particular fuel cell system requires a maximum battery capacity of 68.88 kW (See Figure 8). We priced deep cycle batteries on the Internet and found that this size battery bank could cost around 10,000 dollars. The NPV and MIRR are negative confirming that the fuel cell – battery system is a poor investment. In order to reduce the size of the battery bank needed, the constant output of the fuel cell system could be increased, but this would not reduce the overall initial cost since the cost of the fuel cell will go up.



New Hampshire

Inflation Rate 2.7
Gas Price Rate -0.2
Electric Price Rate -0.5

Year	Initial Cost	Yearly Electric Cost	Yearly Fuel Cost	FC Electric Cost	Maintenance Cost	Net Savings
		$897.00	$264.73	$0.00	$15.00	
0	$22040.00					-$22040.00
1		$916.74	$271.34	$0.00	$15.41	$629.99
2		$936.91	$278.13	$0.00	$15.82	$642.96
3		$957.52	$285.08	$0.00	$16.25	$656.19
4		$978.58	$292.21	$0.00	$16.69	$669.69
5		$1000.11	$299.51	$0.00	$17.14	$683.46
6		$1022.12	$307.00	$0.00	$17.60	$697.52
7		$1044.60	$314.68	$0.00	$18.08	$711.85
8		$1067.58	$322.54	$0.00	$18.56	$726.48
9		$1091.07	$330.61	$0.00	$19.06	$741.40
10		$1115.07	$338.87	$0.00	$19.58	$756.62
11		$1139.61	$347.34	$0.00	$20.11	$772.16
12		$1164.68	$356.03	$0.00	$20.65	$788.00
13		$1190.30	$364.93	$0.00	$21.21	$804.16
14		$1216.49	$374.05	$0.00	$21.78	$820.66
15		$1243.25	$383.40	$0.00	$22.37	$837.48

Future Net Cash Flows	$10938.62
PV of Net Savings	$4031.45
NPV of Project	-$18008.55
IRR	-4.563%
MRR	-10.707%

Figure 9: LCC calculations for a fuel cell - battery system.

Fuel Cell – Battery – Utility Systems

Since a fuel cell – battery system did not turn out to be economically feasible and is not a realistic alternative to utility power, we decided to set up the Modeling Program to model a fuel cell – battery – utility system and analyze it economically. This kind of fuel cell system must be designed to produce at a low enough constant kilowatt output so that the battery is not overcharged at any time during the year. Similar to before, the Modeling Program is set up so that the fuel cell will automatically shut off for twenty-four hours whenever the battery bank is charged to full capacity. To

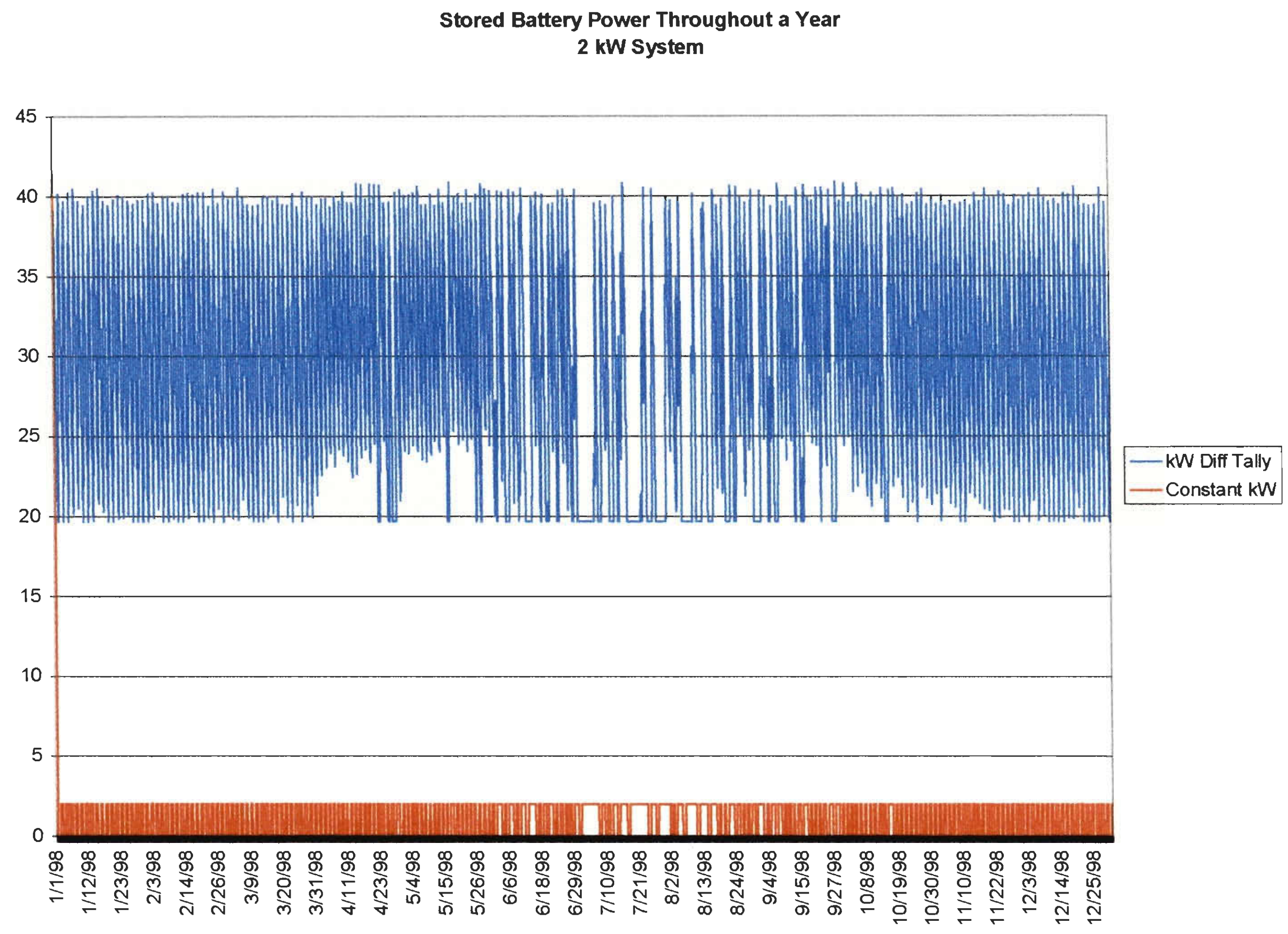


Figure 10: Stored battery power throughout a year.

prevent undercharging of the batteries the fuel cell will remain connected to the utility. When the battery bank is drained to half capacity, the fuel cell system begins drawing power from the utility. This enables the fuel cell system to be designed with a smaller battery bank than in a fuel cell – battery system. Figure 10 shows the energy stored in the battery bank for a year in a fuel cell – battery – utility system. It is clear to see that when the battery bank reaches full capacity the fuel cell shuts off and runs off the battery bank. Similarly, when the battery bank reaches half capacity it can be observed that the fuel cell stops drawing from the battery bank and begins drawing power from the utility. The system is advantageous over an independent battery system since the battery no longer has to be large enough to never become discharged to half capacity. Another advantage of a fuel cell – battery – utility system is that the fuel cell will only be drawing power from the utility, and not selling back excess electricity. This is advantageous because the system is not dependant on the economics of the state buy-back rate.

Our results show that fuel cell – battery – utility systems will also not be feasible because of the high initial costs. In order for this type of fuel cell system to become economically feasible, the initial costs of fuel cells and batteries must be reduced. Table 3 shows break-even initial costs and battery costs for fuel cell – battery – utility systems of different sized battery banks and system output. The table shows that the costs of the battery bank are always higher than the break-even initial costs, meaning that the systems will not be economically feasible. The high initial costs of the system make it impossible for the fuel cell system to be competitive with utility power. In order to reduce the size of the battery bank needed, the constant output of the fuel cell system could be increased, but this would not reduce the overall initial cost since the cost of the fuel cell will go up.

Vermont
40% eff
15 yr Life

FC size	Battery size	Battery Cost	B-E IC
2.5	20	$2,910.00	$681.51
2.5	30	$5,160.00	$3,443.02
2.5	40	$6,880.00	$3,821.77
2	30	$5,160.00	$3,716.56
1.5	30	$5,160.00	$3,984.31

Table 3: B-E initial costs for fuel cell - battery - utility systems.

Analysis of Results

Fuel cell – battery systems have been proven to be uneconomical unless the initial cost of the systems can be reduced. Table 4 shows some break-even initial costs that must be achieved in New Hampshire for different fuel cell sizes.

State	kW Output	Battery Capacity (kW)	B-E Initial Cost[†]	B-E $/kW[†]
New Hampshire	3	68.88	$4,479.76	$746.63
New Hampshire	4	68.88	$4,031.45	$503.93
New Hampshire	5	68.88	$3,583.13	$358.31

Assumptions: 40% Efficiency
15 year life
Fuel cell shuts off for 24 hrs when battery bank is fully charged.
[†] Including battery bank

Table 4: Break-even initial costs for fuel cell - battery systems.

The initial costs are in the range of 4,000 dollars. The size of the battery banks needed for this kind of system requires very high initial costs, on the order of 10,000 dollars. Unless these initial costs are reduced, fuel cell – battery systems will not be a feasible option for a homeowner. However, fuel cell – utility systems seem to have a very promising future for those states that have net metering laws favoring fuel cells.

Figure 6 shows the break-even initial costs for fuel cell systems as a function of efficiency in various states. This graph does not take into account the size of the optimum system for each state. In order to present information that does take system size into account, we created another graph showing the maximum feasible dollars per kilowatt versus efficiency. Similar to Figure 6, Figure 11 shows combinations of dollars per kilowatt and efficiency that would result in a profitable investment for a particular state. Any combination below a state's curve will be profitable in that state. From Figure 11, one can see that for efficiencies ranging from 35 to 45 percent, an economically feasible fuel cell system is possible if the initial costs range from 500 to 1,500 dollars per kilowatt (except in Oregon). It should be noted that when the size of the system is not considered it appears that Vermont is the most promising state for a fuel cell – utility system (see Figure 6). However, in the graph of dollars per

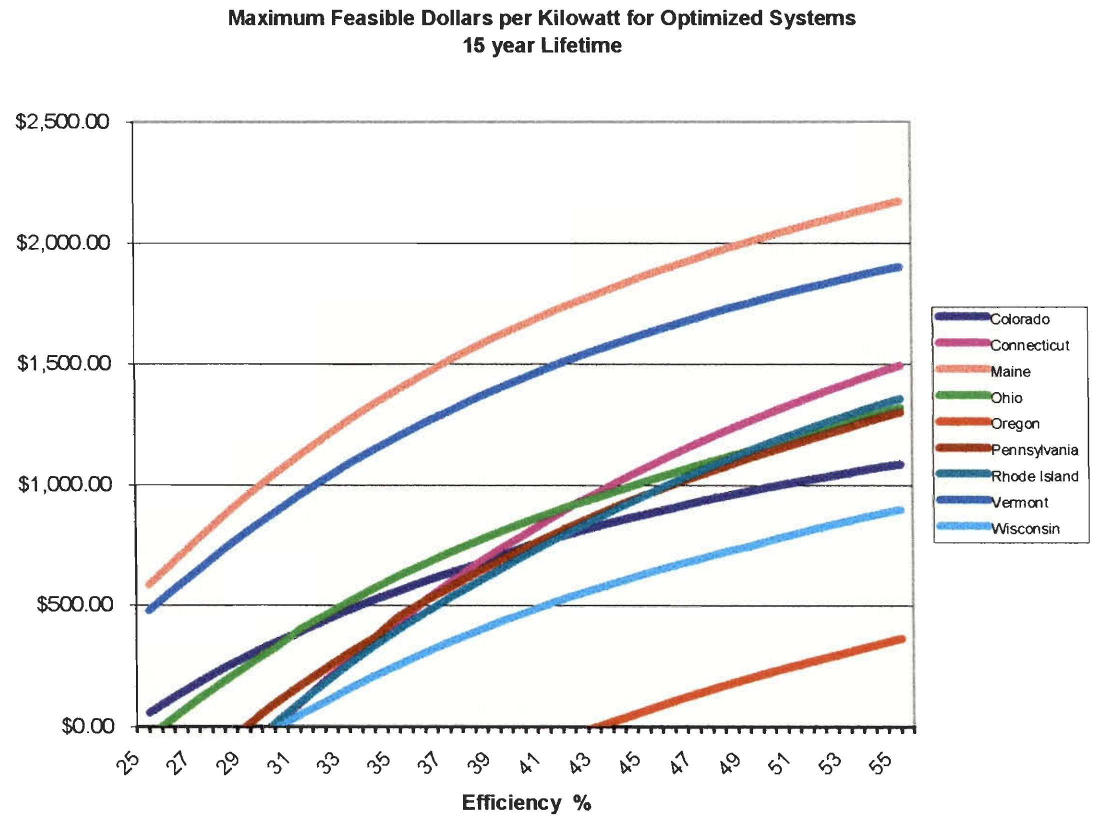


Figure 11: Maximum feasible dollars per kW for each state, as a function of efficiency.

kilowatt system size versus efficiency, Maine becomes more promising than Vermont. This change is due to the fact that in Maine the optimum output is 0.69 kW, where in Vermont the optimum output is 0.84 kW. Therefore, if both states required a 2,500 dollar system, in Maine the maximum feasible initial cost would be equal to $2,500 / (2*0.69 kW) = 1,811 $/kW. In Vermont, the system could cost up to $2,500 / (2*0.84 kW) = 1,488 $/kW and be a feasible system. Note that the output is doubled in the calculations because the fuel cell systems run most efficiently at half of their maximum output, so the actual size of the system is twice its optimum kilowatt output.

Conclusions

In this project we set out to determine the economical feasibility of fuel cell systems versus utility power. By developing a fuel cell modeling program, we were able to determine in which states and under what circumstances fuel cell systems are profitable. For fuel cell – battery and fuel cell – battery – utility systems, the initial cost of the system is the dominant factor in determining feasibility. The feasibility of fuel cell – utility systems is mostly determined by the difference between the present and future prices of natural gas and utility power. From our analyses, we believe that home fuel cell systems will become economically feasible over the next five to ten years.

Our results indicate that fuel cell – battery and fuel cell – battery – utility systems will not be feasible because of the high initial costs of fuel cells and batteries. For both configurations, the size of the battery bank needed for meeting peak loads necessitates a large initial investment in batteries. Increasing the constant output of the fuel cell can reduce the required battery bank size, but this also greatly increases the initial cost. The high initial costs of the system make it improbable for the fuel cell system to be competitive with utility power. The negative net present values returned from a life cycle costing analysis of a fuel cell – battery, and fuel cell – battery – utility, system confirm that these configurations are not economically feasible.

We found fuel cell – utility systems to be more economically competitive with utility power than battery systems. Fuel cell – utility systems are more feasible because at efficiencies ranging from 35 to 45 percent, the cost of natural gas needed to run the fuel cell is much lower than the cost of utility power alone.

Table 5 summarizes our results for the nine promising states for fuel cell – utility systems. The table shows optimum kilowatt outputs, break-even initial costs, yearly savings versus utility power, and cents per kilowatt savings versus utility for each state. The table assumes a constant system efficiency of 40 percent throughout a fifteen-year lifetime.

State	Optimum kW Output	Break-Even Initial Cost	Break-Even Price / kW	1st Year Savings vs Utility[†]	¢/kWh Savings vs Utility[‡]
Colorado	0.91	$1,353.36	$743.60	$228.86	-0.13
Connecticut	0.83	$1,320.35	$795.39	$231.36	-0.15
Maine	0.69	$2,293.41	$1,661.89	$372.16	0.91
Ohio	1.02	$1,722.51	$844.37	$288.01	0.15
Oregon	1.27	-$119.48	-$47.04	-$13.90	-0.95
Pennsylvania	0.87	$1,286.55	$739.40	$223.23	-0.17
Rhode Island	0.68	$961.81	$707.21	$172.66	-0.59
Vermont	0.84	$2,421.40	$1,441.31	$392.54	0.88
Wisconsin	0.88	$828.21	$470.57	$150.73	-0.53

Assumptions: 40% efficiency (except Oregon = 45%)
15 year lifetime
[†] Not including initial cost
[‡] Calculated using NPV of Net Savings

Table 5: Summary of our Results

Notice that the break-even initial costs in Oregon are negative. Under these circumstances fuel cells will not be feasible in this state. For the rest of the states, the initial costs are shown for both the total cost of the fuel cell system and the cost per kilowatt that will return a net present value of zero. These values are representative of the break-even costs, and show that in order for the fuel cell system to be feasible in a particular state, a fuel cell system will need to cost less than the break-even initial cost. Table 5 shows that initial costs for a feasible system should fall between 500 to 1,600 dollars. Most fuel cell companies are currently targeting initial costs of around 1,500 dollars per kilowatt, which our results show is an accurate estimate for an economical fuel cell system.

When evaluating a home fuel cell system the environmental benefits must be considered in order to fully understand the value of this investment. Use of high efficiency fuel cells results in less consumption of fossil fuels and less air pollution. Also, fuel cells have low emissions, which further helps to reduce the amount of air pollution caused through power generation. Fuel cells can run on renewable and nonrenewable fuels. Therefore, fuel cell technology may serve as a bridge for moving toward sustainable power generation. When all these factors are considered home fuel cell systems become an attractive investment.

States that do not have net metering laws for fuel cells should be motivated by these environmental considerations to develop the appropriate legislation. In fact, state governments should be motivated to offer rebates on home fuel cells as some states do on energy efficient light bulbs and appliances. If these rebates were equal to the difference between the actual initial cost and the break-even initial cost determined in this project, then fuel cell technology would quickly become a wise investment.

There are some other topics not within the scope of our project that deserve further research. One topic is modeling a fuel cell system in which the fuel cell follows the load with varying efficiencies. A second topic for research would be to analyze the economic effects of using different fuels such as pure hydrogen, propane, or biogas. Also further research could be done in quantifying the environmental value of a home fuel cell system and relating this to either government rebates or the value considered in the economic investment comparisons done in this project.

Much research is also currently being done in the area of fuel cell powered automobiles. Fuel cells may be the key to sustainable transportation as well as sustainable power generation. Using fuel cells in automobiles would also reduce pollution since fuel cells are more efficient and have fewer emissions then an internal combustion engine. Although this topic is beyond the scope of our project it is definitely deserving of a research project of its own.

In conclusion, over the next five to ten years, if fuel cell initial costs are driven downward by mass production and reductions in material costs, home fuel cell systems may become economically profitable investments for homeowners. When companies can provide a home fuel cell with efficiencies around 40 percent for the currently targeted 1,500 dollars per kilowatt, this project shows that home fuel cells will become a favorable investment in most states with net metering laws.

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Appendix A

Hourly consumption data for a year in Massachusetts

Boston

Date	Hour	kWh Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand
1-Jan	1	0.52	2-Jan	1	0.5	3-Jan	1	0.5	4-Jan	1	0.51	5-Jan	1	0.51	6-Jan	1	0.48	7-Jan	1	0.49
	2	0.5		2	0.48		2	0.49		2	0.49		2	0.49		2	0.47		2	0.47
	3	0.48		3	0.47		3	0.48		3	0.49		3	0.49		3	0.46		3	0.44
	4	0.48		4	0.49		4	0.49		4	0.49		4	0.49		4	0.47		4	0.45
	5	0.49		5	0.52		5	0.52		5	0.53		5	0.53		5	0.52		5	0.46
	6	0.54		6	0.62		6	0.62		6	0.64		6	0.62		6	0.61		6	0.56
	7	0.69		7	0.78		7	0.78		7	0.8		7	0.78		7	0.78		7	0.7
	8	0.81		8	0.85		8	0.85		8	0.86		8	0.86		8	0.82		8	0.82
	9	0.88		9	0.84		9	0.84		9	0.85		9	0.85		9	0.82		9	0.76
	10	0.89		10	0.83		10	0.83		10	0.86		10	0.84		10	0.82		10	0.74
	11	0.88		11	0.81		11	0.83		11	0.85		11	0.82		11	0.82		11	0.73
	12	0.87		12	0.79		12	0.82		12	0.82		12	0.81		12	0.8		12	0.7
	13	0.85		13	0.75		13	0.78		13	0.78		13	0.76		13	0.76		13	0.69
	14	0.82		14	0.72		14	0.74		14	0.74		14	0.74		14	0.73		14	0.67
	15	0.76		15	0.7		15	0.7		15	0.7		15	0.7		15	0.69		15	0.64
	16	0.78		16	0.71		16	0.72		16	0.72		16	0.72		16	0.71		16	0.66
	17	0.86		17	0.8		17	0.8		17	0.81		17	0.8		17	0.78		17	0.78
	18	0.97		18	0.95		18	0.95		18	0.95		18	0.95		18	0.95		18	0.95
	19	1.04		19	1.04		19	1.04		19	1.04		19	1.05		19	1.03		19	1.03
	20	1.02		20	1.02		20	1.02		20	1.03		20	1.02		20	1.02		20	1.01
	21	0.95		21	0.95		21	0.95		21	0.96		21	0.95		21	0.95		21	0.95
	22	0.87		22	0.87		22	0.87		22	0.87		22	0.87		22	0.86		22	0.85
	23	0.74		23	0.72		23	0.72		23	0.74		23	0.72		23	0.72		23	0.7
	24	0.59		24	0.59		24	0.58		24	0.6		24	0.58		24	0.59		24	0.55

Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand
8-Jan	1	0.49	9-Jan	1	0.49	10-Jan	1	0.51	11-Jan	1	0.51	12-Jan	1	0.5	13-Jan	1	0.5	14-Jan	1	0.49
	2	0.47		2	0.48		2	0.49		2	0.49		2	0.49		2	0.49		2	0.48
	3	0.45		3	0.46		3	0.49		3	0.49		3	0.48		3	0.48		3	0.47
	4	0.46		4	0.49		4	0.49		4	0.49		4	0.49		4	0.49		4	0.48
	5	0.51		5	0.52		5	0.53		5	0.53		5	0.53		5	0.52		5	0.52
	6	0.61		6	0.62		6	0.64		6	0.64		6	0.63		6	0.62		6	0.62
	7	0.76		7	0.78		7	0.8		7	0.8		7	0.78		7	0.78		7	0.78
	8	0.82		8	0.85		8	0.86		8	0.86		8	0.85		8	0.85		8	0.84
	9	0.82		9	0.84		9	0.85		9	0.85		9	0.83		9	0.84		9	0.83
	10	0.81		10	0.83		10	0.86		10	0.83		10	0.82		10	0.82		10	0.82
	11	0.8		11	0.82		11	0.85		11	0.82		11	0.81		11	0.8		11	0.8
	12	0.78		12	0.78		12	0.82		12	0.78		12	0.78		12	0.77		12	0.78
	13	0.74		13	0.75		13	0.78		13	0.74		13	0.75		13	0.75		13	0.74
	14	0.7		14	0.74		14	0.74		14	0.7		14	0.71		14	0.71		14	0.69
	15	0.69		15	0.7		15	0.7		15	0.69		15	0.69		15	0.69		15	0.69
	16	0.69		16	0.71		16	0.72		16	0.7		16	0.7		16	0.7		16	0.69
	17	0.78		17	0.8		17	0.81		17	0.8		17	0.8		17	0.78		17	0.78
	18	0.94		18	0.95		18	0.95		18	0.95		18	0.95		18	0.95		18	0.95
	19	1.02		19	1.04		19	1.04		19	1.04		19	1.04		19	1.04		19	1.03
	20	1.01		20	1.03		20	1.03		20	1.03		20	1.02		20	1.02		20	1.02
	21	0.95		21	0.95		21	0.96		21	0.95		21	0.96		21	0.95		21	0.95
	22	0.85		22	0.87		22	0.87		22	0.87		22	0.86		22	0.86		22	0.85
	23	0.71		23	0.74		23	0.74		23	0.74		23	0.73		23	0.72		23	0.71
	24	0.56		24	0.59		24	0.6		24	0.6		24	0.59		24	0.59		24	0.59

Date	Hour	Electricity Demand
15-Jan	1	0.49
	2	0.47
	3	0.46
	4	0.47
	5	0.52
	6	0.61
	7	0.61
	8	0.83
	9	0.79
	10	0.78
	11	0.75
	12	0.74
	13	0.69
	14	0.68
	15	0.65
	16	0.67
	17	0.74
	18	0.97
	19	1.01
	20	1.02
	21	0.95
	22	0.85
	23	0.7
	24	0.56

Date	Hour	Electricity Demand
16-Jan	1	0.49
	2	0.47
	3	0.46
	4	0.47
	5	0.52
	6	0.62
	7	0.78
	8	0.84
	9	0.83
	10	0.82
	11	0.81
	12	0.78
	13	0.74
	14	0.7
	15	0.69
	16	0.7
	17	0.8
	18	0.95
	19	1.04
	20	1.02
	21	0.96
	22	0.86
	23	0.72
	24	0.57

Date	Hour	Electricity Demand
17-Jan	1	0.49
	2	0.47
	3	0.46
	4	0.47
	5	0.52
	6	0.62
	7	0.78
	8	0.84
	9	0.83
	10	0.82
	11	0.81
	12	0.78
	13	0.75
	14	0.7
	15	0.69
	16	0.7
	17	0.8
	18	0.95
	19	1.04
	20	1.02
	21	0.97
	22	0.87
	23	0.74
	24	0.61

Date	Hour	Electricity Demand
18-Jan	1	0.51
	2	0.49
	3	0.49
	4	0.49
	5	0.53
	6	0.65
	7	0.8
	8	0.86
	9	0.85
	10	0.84
	11	0.83
	12	0.81
	13	0.78
	14	0.74
	15	0.69
	16	0.71
	17	0.82
	18	0.95
	19	1.04
	20	1.02
	21	0.95
	22	0.87
	23	0.74
	24	0.59

Date	Hour	Electricity Demand
19-Jan	1	0.5
	2	0.47
	3	0.47
	4	0.49
	5	0.52
	6	0.63
	7	0.8
	8	0.85
	9	0.84
	10	0.82
	11	0.81
	12	0.78
	13	0.75
	14	0.71
	15	0.69
	16	0.7
	17	0.79
	18	0.95
	19	1.04
	20	1.02
	21	0.95
	22	0.87
	23	0.73
	24	0.58

Date	Hour	Electricity Demand
20-Jan	1	0.5
	2	0.49
	3	0.48
	4	0.49
	5	0.52
	6	0.62
	7	0.78
	8	0.84
	9	0.84
	10	0.83
	11	0.82
	12	0.79
	13	0.76
	14	0.74
	15	0.7
	16	0.71
	17	0.79
	18	0.95
	19	1.03
	20	1.02
	21	0.95
	22	0.87
	23	0.74
	24	0.59

Date	Hour	Electricity Demand
21-Jan	1	0.49
	2	0.48
	3	0.47
	4	0.48
	5	0.52
	6	0.61
	7	0.78
	8	0.84
	9	0.83
	10	0.82
	11	0.81
	12	0.79
	13	0.76
	14	0.72
	15	0.7
	16	0.71
	17	0.8
	18	0.95
	19	1.04
	20	1.02
	21	0.95
	22	0.85
	23	0.72
	24	0.56

Date	Hour	Electricity Demand
22-Jan	1	0.49
	2	0.45
	3	0.44
	4	0.46
	5	0.51
	6	0.61
	7	0.76
	8	0.83
	9	0.82
	10	0.82
	11	0.8
	12	0.78
	13	0.7
	14	0.71
	15	0.69
	16	0.7
	17	0.78
	18	0.95
	19	1.03
	20	1.02
	21	0.94
	22	0.81
	23	0.68
	24	0.52

Date	Hour	Electricity Demand
23-Jan	1	0.43
	2	0.4
	3	0.44
	4	0.45
	5	0.5
	6	0.61
	7	0.77
	8	0.83
	9	0.82
	10	0.81
	11	0.8
	12	0.76
	13	0.75
	14	0.7
	15	0.69
	16	0.7
	17	0.78
	18	0.95
	19	1.04
	20	1.02
	21	0.87
	22	0.87
	23	0.73
	24	0.59

Date	Hour	Electricity Demand
24-Jan	1	0.5
	2	0.49
	3	0.48
	4	0.49
	5	0.52
	6	0.62
	7	0.78
	8	0.84
	9	0.82
	10	0.81
	11	0.79
	12	0.78
	13	0.75
	14	0.7
	15	0.69
	16	0.71
	17	0.79
	18	0.95
	19	1.04
	20	1.02
	21	0.95
	22	0.86
	23	0.71
	24	0.56

Date	Hour	Electricity Demand
25-Jan	1	0.49
	2	0.48
	3	0.47
	4	0.48
	5	0.52
	6	0.62
	7	0.78
	8	0.84
	9	0.83
	10	0.82
	11	0.8
	12	0.76
	13	0.74
	14	0.69
	15	0.68
	16	0.69
	17	0.77
	18	0.94
	19	1.02
	20	1.01
	21	0.95
	22	0.85
	23	0.7
	24	0.56

Date	Hour	Electricity Demand
26-Jan	1	0.49
	2	0.46
	3	0.43
	4	0.46
	5	0.51
	6	0.61
	7	0.77
	8	0.82
	9	0.82
	10	0.81
	11	0.8
	12	0.78
	13	0.75
	14	0.71
	15	0.69
	16	0.7
	17	0.8
	18	0.95
	19	1.03
	20	1.02
	21	0.95
	22	0.85
	23	0.7
	24	0.56

Date	Hour	Electricity Demand
27-Jan	1	0.48
	2	0.46
	3	0.44
	4	0.46
	5	0.5
	6	0.61
	7	0.76
	8	0.81
	9	0.8
	10	0.8
	11	0.79
	12	0.78
	13	0.75
	14	0.7
	15	0.69
	16	0.7
	17	0.8
	18	0.95
	19	1.04
	20	1.03
	21	0.95
	22	0.87
	23	0.73
	24	0.6

Date	Hour	Electricity Demand
28-Jan	1	0.51
	2	0.49
	3	0.48
	4	0.49
	5	0.52
	6	0.62
	7	0.78
	8	0.86
	9	0.85
	10	0.84
	11	0.83
	12	0.82
	13	0.77
	14	0.74
	15	0.71
	16	0.72
	17	0.82
	18	0.95
	19	1.04
	20	1.03
	21	0.95
	22	0.87
	23	0.74
	24	0.61

Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand
29-Jan	1	0.5	30-Jan	1	0.5	31-Jan	1	0.52	1-Feb	1	0.5	2-Feb	1	0.49	3-Feb	1	0.5	4-Feb	1	0.49
	2	0.49		2	0.49		2	0.5		2	0.49		2	0.48		2	0.49		2	0.47
	3	0.49		3	0.48		3	0.49		3	0.48		3	0.47		3	0.49		3	0.46
	4	0.49		4	0.49		4	0.51		4	0.49		4	0.49		4	0.49		4	0.47
	5	0.52		5	0.52		5	0.55		5	0.52		5	0.52		5	0.53		5	0.51
	6	0.63		6	0.62		6	0.67		6	0.62		6	0.62		6	0.63		6	0.61
	7	0.79		7	0.78		7	0.81		7	0.78		7	0.77		7	0.78		7	0.76
	8	0.86		8	0.83		8	0.87		8	0.84		8	0.84		8	0.85		8	0.83
	9	0.85		9	0.83		9	0.86		9	0.83		9	0.83		9	0.84		9	0.83
	10	0.82		10	0.82		10	0.84		10	0.82		10	0.82		10	0.82		10	0.82
	11	0.81		11	0.82		11	0.82		11	0.82		11	0.81		11	0.81		11	0.81
	12	0.79		12	0.8		12	0.8		12	0.77		12	0.78		12	0.77		12	0.78
	13	0.76		13	0.76		13	0.77		13	0.75		13	0.74		13	0.74		13	0.75
	14	0.74		14	0.72		14	0.71		14	0.72		14	0.7		14	0.69		14	0.7
	15	0.7		15	0.7		15	0.69		15	0.7		15	0.68		15	0.69		15	0.69
	16	0.71		16	0.72		16	0.71		16	0.71		16	0.69		16	0.69		16	0.7
	17	0.82		17	0.81		17	0.8		17	0.79		17	0.78		17	0.78		17	0.78
	18	0.95		18	0.97		18	0.97		18	0.95		18	0.95		18	0.95		18	0.95
	19	1.04		19	1.05		19	1.05		19	1.03		19	1.03		19	1.03		19	1.02
	20	1.03		20	1.04		20	1.04		20	1.02		20	1.02		20	1.02		20	1.01
	21	0.95		21	0.99		21	0.99		21	0.95		21	0.95		21	0.95		21	0.95
	22	0.87		22	0.89		22	0.89		22	0.86		22	0.87		22	0.86		22	0.85
	23	0.73		23	0.77		23	0.77		23	0.72		23	0.74		23	0.7		23	0.7
	24	0.59		24	0.61		24	0.61		24	0.56		24	0.59		24	0.56		24	0.55

Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand
5-Feb	1	0.48	6-Feb	1	0.48	7-Feb	1	0.47	8-Feb	1	0.49	9-Feb	1	0.5	10-Feb	1	0.49	11-Feb	1	0.49
	2	0.45		2	0.44		2	0.49		2	0.47		2	0.49		2	0.48		2	0.48
	3	0.44		3	0.43		3	0.49		3	0.45		3	0.47		3	0.44		3	0.45
	4	0.45		4	0.45		4	0.5		4	0.47		4	0.49		4	0.45		4	0.46
	5	0.51		5	0.51		5	0.53		5	0.51		5	0.53		5	0.51		5	0.51
	6	0.61		6	0.61		6	0.64		6	0.62		6	0.63		6	0.62		6	0.61
	7	0.76		7	0.77		7	0.8		7	0.76		7	0.79		7	0.77		7	0.77
	8	0.83		8	0.83		8	0.85		8	0.83		8	0.85		8	0.83		8	0.83
	9	0.82		9	0.82		9	0.83		9	0.82		9	0.84		9	0.82		9	0.83
	10	0.81		10	0.82		10	0.82		10	0.82		10	0.83		10	0.82		10	0.84
	11	0.78		11	0.8		11	0.8		11	0.81		11	0.82		11	0.81		11	0.82
	12	0.75		12	0.78		12	0.78		12	0.79		12	0.81		12	0.78		12	0.79
	13	0.72		13	0.76		13	0.75		13	0.76		13	0.78		13	0.75		13	0.75
	14	0.69		14	0.72		14	0.7		14	0.71		14	0.74		14	0.71		14	0.74
	15	0.68		15	0.7		15	0.69		15	0.69		15	0.71		15	0.69		15	0.7
	16	0.69		16	0.71		16	0.69		16	0.7		16	0.72		16	0.7		16	0.71
	17	0.76		17	0.81		17	0.78		17	0.79		17	0.75		17	0.8		17	0.82
	18	0.93		18	0.95		18	0.95		18	0.94		18	0.95		18	0.94		18	0.95
	19	1.02		19	1.04		19	1.03		19	1.04		19	1.04		19	1.02		19	1.04
	20	1.01		20	1.03		20	1.02		20	1.02		20	1.02		20	1.02		20	1.03
	21	0.95		21	0.97		21	0.95		21	0.95		21	0.95		21	0.95		21	0.96
	22	0.85		22	0.87		22	0.86		22	0.86		22	0.86		22	0.85		22	0.87
	23	0.7		23	0.74		23	0.71		23	0.74		23	0.72		23	0.72		23	0.74
	24	0.55		24	0.61		24	0.56		24	0.58		24	0.58		24	0.59		24	0.6

Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand
12-Feb	1	0.54	13-Feb	1	0.49	14-Feb	1	0.49	15-Feb	1	0.49	16-Feb	1	0.49	17-Feb	1	0.49	18-Feb	1	0.49
	2	0.51		2	0.48		2	0.45		2	0.45		2	0.48		2	0.46		2	0.45
	3	0.5		3	0.45		3	0.44		3	0.44		3	0.46		3	0.45		3	0.45
	4	0.49		4	0.46		4	0.46		4	0.46		4	0.49		4	0.47		4	0.46
	5	0.51		5	0.52		5	0.51		5	0.51		5	0.52		5	0.51		5	0.51
	6	0.55		6	0.61		6	0.61		6	0.61		6	0.62		6	0.61		6	0.62
	7	0.7		7	0.78		7	0.76		7	0.76		7	0.77		7	0.76		7	0.76
	8	0.81		8	0.83		8	0.83		8	0.82		8	0.83		8	0.83		8	0.83
	9	0.89		9	0.83		9	0.82		9	0.82		9	0.82		9	0.82		9	0.82
	10	0.89		10	0.82		10	0.81		10	0.82		10	0.8		10	0.81		10	0.81
	11	0.87		11	0.82		11	0.81		11	0.81		11	0.79		11	0.79		11	0.8
	12	0.86		12	0.8		12	0.78		12	0.79		12	0.76		12	0.77		12	0.79
	13	0.82		13	0.75		13	0.75		13	0.75		13	0.47		13	0.72		13	0.75
	14	0.79		14	0.7		14	0.72		14	0.71		14	0.7		14	0.69		14	0.71
	15	0.75		15	0.68		15	0.69		15	0.69		15	0.69		15	0.68		15	0.69
	16	0.75		16	0.69		16	0.71		16	0.7		16	0.7		16	0.69		16	0.7
	17	0.85		17	0.77		17	0.79		17	0.8		17	0.78		17	0.78		17	0.78
	18	0.95		18	0.92		18	0.95		18	0.95		18	0.95		18	0.94		18	0.94
	19	1.04		19	1.02		19	1.04		19	1.03		19	1.03		19	1.02		19	1.03
	20	1.02		20	1.01		20	1.02		20	1.02		20	1.02		20	1.01		20	1.02
	21	0.95		21	0.93		21	0.95		21	0.95		21	0.95		21	0.94		21	0.95
	22	0.87		22	0.85		22	0.86		22	0.86		22	0.85		22	0.84		22	0.86
	23	0.74		23	0.71		23	0.71		23	0.72		23	0.71		23	0.7		23	0.71
	24	0.6		24	0.56		24	0.57		24	0.59		24	0.57		24	0.56		24	0.59

Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand
19-Feb	1	0.49	20-Feb	1	0.52	21-Feb	1	0.51	22-Feb	1	0.5	23-Feb	1	0.49	24-Feb	1	0.49	25-Feb	1	0.5
	2	0.47		2	0.5		2	0.49		2	0.49		2	0.48		2	0.47		2	0.49
	3	0.45		3	0.49		3	0.49		3	0.48		3	0.47		3	0.46		3	0.48
	4	0.49		4	0.51		4	0.5		4	0.49		4	0.49		4	0.47		4	0.49
	5	0.53		5	0.54		5	0.54		5	0.53		5	0.52		5	0.51		5	0.53
	6	0.63		6	0.66		6	0.63		6	0.63		6	0.62		6	0.61		6	0.64
	7	0.8		7	0.82		7	0.8		7	0.8		7	0.77		7	0.77		7	0.8
	8	0.86		8	0.87		8	0.86		8	0.86		8	0.84		8	0.84		8	0.85
	9	0.85		9	0.86		9	0.83		9	0.84		9	0.83		9	0.83		9	0.82
	10	0.85		10	0.85		10	0.81		10	0.83		10	0.82		10	0.82		10	0.8
	11	0.83		11	0.83		11	0.8		11	0.82		11	0.82		11	0.8		11	0.79
	12	0.82		12	0.81		12	0.78		12	0.78		12	0.8		12	0.78		12	0.76
	13	0.78		13	0.77		13	0.74		13	0.75		13	0.77		13	0.75		13	0.74
	14	0.75		14	0.74		14	0.7		14	0.7		14	0.72		14	0.71		14	0.69
	15	0.71		15	0.7		15	0.69		15	0.69		15	0.7		15	0.69		15	0.68
	16	0.72		16	0.71		16	0.69		16	0.69		16	0.71		16	0.7		16	0.69
	17	0.81		17	0.8		17	0.78		17	0.77		17	0.8		17	0.8		17	0.77
	18	0.97		18	0.97		18	0.95		18	0.94		18	0.95		18	0.95		18	0.94
	19	1.06		19	1.06		19	1.04		19	1.03		19	1.03		19	1.04		19	1.03
	20	1.05		20	1.05		20	1.02		20	1.02		20	1.02		20	1.03		20	1.02
	21	1		21	1		21	0.97		21	0.95		21	0.95		21	0.97		21	0.95
	22	0.89		22	0.89		22	0.87		22	0.86		22	0.86		22	0.87		22	0.86
	23	0.78		23	0.78		23	0.74		23	0.71		23	0.72		23	0.73		23	0.72
	24	0.61		24	0.61		24	0.6		24	0.56		24	0.56		24	0.57		24	0.57

Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand
26-Feb	1	0.49	27-Feb	1	0.49	28-Feb	1	0.49	1-Mar	1	0.49	2-Mar	1	0.49	3-Mar	1	0.48	4-Mar	1	0.49
	2	0.47		2	0.46		2	0.47		2	0.48		2	0.48		2	0.46		2	0.46
	3	0.46		3	0.45		3	0.46		3	0.47		3	0.47		3	0.45		3	0.45
	4	0.47		4	0.47		4	0.47		4	0.48		4	0.49		4	0.47		4	0.46
	5	0.52		5	0.52		5	0.51		5	0.52		5	0.51		5	0.51		5	0.51
	6	0.62		6	0.61		6	0.61		6	0.62		6	0.62		6	0.62		6	0.62
	7	0.76		7	0.77		7	0.77		7	0.78		7	0.76		7	0.76		7	0.76
	8	0.84		8	0.83		8	0.83		8	0.83		8	0.83		8	0.82		8	0.83
	9	0.82		9	0.82		9	0.82		9	0.82		9	0.82		9	0.82		9	0.82
	10	0.79		10	0.8		10	0.82		10	0.82		10	0.82		10	0.8		10	0.81
	11	0.78		11	0.78		11	0.81		11	0.81		11	0.81		11	0.78		11	0.8
	12	0.75		12	0.75		12	0.79		12	0.78		12	0.78		12	0.75		12	0.77
	13	0.73		13	0.72		13	0.75		13	0.75		13	0.75		13	0.72		13	0.74
	14	0.69		14	0.69		14	0.7		14	0.72		14	0.7		14	0.69		14	0.7
	15	0.68		15	0.68		15	0.69		15	0.69		15	0.69		15	0.68		15	0.69
	16	0.69		16	0.69		16	0.69		16	0.7		16	0.7		16	0.69		16	0.69
	17	0.76		17	0.75		17	0.78		17	0.78		17	0.79		17	0.78		17	0.78
	18	0.92		18	0.92		18	0.93		18	0.94		18	0.95		18	0.92		18	0.94
	19	1.02		19	1.02		19	1.03		19	1.03		19	1.03		19	1.02		19	1.03
	20	1.01		20	1.01		20	1.02		20	1.02		20	1.02		20	1.01		20	1.02
	21	0.95		21	0.95		21	0.95		21	0.95		21	0.95		21	0.94		21	0.95
	22	0.85		22	0.85		22	0.86		22	0.85		22	0.85		22	0.85		22	0.86
	23	0.71		23	0.71		23	0.71		23	0.71		23	0.71		23	0.71		23	0.71
	24	0.58		24	0.59		24	0.58		24	0.55		24	0.56		24	0.56		24	0.56

Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand
5-Mar	1	0.49	6-Mar	1	0.49	7-Mar	1	0.49	8-Mar	1	0.5	9-Mar	1	0.49	10-Mar	1	0.48	11-Mar	1	0.49
	2	0.48		2	0.46		2	0.46		2	0.49		2	0.46		2	0.45		2	0.47
	3	0.47		3	0.45		3	0.46		3	0.48		3	0.45		3	0.45		3	0.46
	4	0.49		4	0.47		4	0.47		4	0.49		4	0.47		4	0.46		4	0.48
	5	0.52		5	0.51		5	0.51		5	0.53		5	0.51		5	0.52		5	0.52
	6	0.62		6	0.61		6	0.62		6	0.62		6	0.61		6	0.62		6	0.63
	7	0.77		7	0.75		7	0.78		7	0.78		7	0.76		7	0.78		7	0.78
	8	0.82		8	0.82		8	0.84		8	0.82		8	0.82		8	0.85		8	0.84
	9	0.81		9	0.82		9	0.84		9	0.82		9	0.82		9	0.84		9	0.82
	10	0.79		10	0.81		10	0.83		10	0.8		10	0.81		10	0.83		10	0.8
	11	0.77		11	0.75		11	0.82		11	0.79		11	0.8		11	0.82		11	0.79
	12	0.75		12	0.72		12	0.79		12	0.74		12	0.76		12	0.79		12	0.77
	13	0.72		13	0.69		13	0.76		13	0.74		13	0.69		13	0.76		13	0.74
	14	0.69		14	0.68		14	0.72		14	0.62		14	0.7		14	0.73		14	0.7
	15	0.68		15	0.63		15	0.69		15	0.68		15	0.69		15	0.7		15	0.68
	16	0.69		16	0.65		16	0.7		16	0.69		16	0.7		16	0.72		16	0.69
	17	0.76		17	0.71		17	0.79		17	0.76		17	0.78		17	0.81		17	0.78
	18	0.93		18	0.88		18	0.95		18	0.93		18	0.93		18	0.95		18	0.94
	19	1.03		19	1.02		19	1.04		19	1.03		19	1.02		19	1.04		19	1.03
	20	1.02		20	1.01		20	1.02		20	1.02		20	1.01		20	1.02		20	1.02
	21	0.95		21	0.95		21	0.96		21	0.95		21	0.92		21	0.95		21	0.95
	22	0.85		22	0.86		22	0.87		22	0.85		22	0.85		22	0.86		22	0.86
	23	0.71		23	0.7		23	0.73		23	0.71		23	0.71		23	0.72		23	0.72
	24	0.55		24	0.55		24	0.56		24	0.56		24	0.56		24	0.57		24	0.57

Date	Hour	Electricity Demand
12-Mar	1	0.49
	2	0.48
	3	0.47
	4	0.49
	5	0.52
	6	0.62
	7	0.78
	8	0.84
	9	0.84
	10	0.83
	11	0.83
	12	0.81
	13	0.78
	14	0.74
	15	0.7
	16	0.72
	17	0.82
	18	0.97
	19	1.04
	20	1.02
	21	0.96
	22	0.87
	23	0.74
	24	0.59

Date	Hour	Electricity Demand
13-Mar	1	0.5
	2	0.49
	3	0.48
	4	0.49
	5	0.52
	6	0.63
	7	0.79
	8	0.84
	9	0.83
	10	0.82
	11	0.82
	12	0.79
	13	0.76
	14	0.73
	15	0.69
	16	0.7
	17	0.78
	18	0.94
	19	1.04
	20	0.95
	21	0.95
	22	0.87
	23	0.72
	24	0.56

Date	Hour	Electricity Demand
14-Mar	1	0.49
	2	0.47
	3	0.46
	4	0.47
	5	0.52
	6	0.63
	7	0.78
	8	0.84
	9	0.83
	10	0.82
	11	0.82
	12	0.76
	13	0.74
	14	0.7
	15	0.69
	16	0.69
	17	0.78
	18	0.94
	19	1.03
	20	1.01
	21	0.95
	22	0.85
	23	0.71
	24	0.56

Date	Hour	Electricity Demand
15-Mar	1	0.48
	2	0.45
	3	0.45
	4	0.46
	5	0.52
	6	0.62
	7	0.76
	8	0.83
	9	0.83
	10	0.82
	11	0.82
	12	0.79
	13	0.75
	14	0.71
	15	0.69
	16	0.7
	17	0.78
	18	0.95
	19	1.03
	20	1.01
	21	0.95
	22	0.85
	23	0.7
	24	0.56

Date	Hour	Electricity Demand
16-Mar	1	0.47
	2	0.45
	3	0.44
	4	0.46
	5	0.51
	6	0.61
	7	0.76
	8	0.82
	9	0.81
	10	0.78
	11	0.77
	12	0.75
	13	0.72
	14	0.69
	15	0.68
	16	0.69
	17	0.75
	18	0.93
	19	1.02
	20	1.01
	21	0.95
	22	0.85
	23	0.71
	24	0.56

Date	Hour	Electricity Demand
17-Mar	1	0.48
	2	0.45
	3	0.44
	4	0.45
	5	0.51
	6	0.61
	7	0.76
	8	0.82
	9	0.8
	10	0.79
	11	0.78
	12	0.76
	13	0.73
	14	0.69
	15	0.68
	16	0.69
	17	0.78
	18	0.93
	19	1.03
	20	1.02
	21	0.95
	22	0.86
	23	0.72
	24	0.57

Date	Hour	Electricity Demand
18-Mar	1	0.49
	2	0.46
	3	0.46
	4	0.47
	5	0.52
	6	0.62
	7	0.8
	8	0.84
	9	0.84
	10	0.83
	11	0.82
	12	0.81
	13	0.77
	14	0.74
	15	0.7
	16	0.72
	17	0.81
	18	0.95
	19	1.04
	20	1.02
	21	0.96
	22	0.86
	23	0.73
	24	0.57

Date	Hour	Electricity Demand
19-Mar	1	0.49
	2	0.46
	3	0.45
	4	0.46
	5	0.52
	6	0.62
	7	0.78
	8	0.82
	9	0.82
	10	0.8
	11	0.79
	12	0.76
	13	0.69
	14	0.66
	15	0.63
	16	0.64
	17	0.71
	18	0.87
	19	0.95
	20	0.94
	21	0.88
	22	0.8
	23	0.68
	24	0.56

Date	Hour	Electricity Demand
20-Mar	1	0.46
	2	0.45
	3	0.43
	4	0.45
	5	0.5
	6	0.61
	7	0.76
	8	0.81
	9	0.74
	10	0.73
	11	0.72
	12	0.7
	13	0.69
	14	0.66
	15	0.62
	16	0.64
	17	0.72
	18	0.87
	19	0.95
	20	0.94
	21	0.87
	22	0.78
	23	0.65
	24	0.53

Date	Hour	Electricity Demand
21-Mar	1	0.43
	2	0.39
	3	0.38
	4	0.45
	5	0.51
	6	0.61
	7	0.75
	8	0.81
	9	0.75
	10	0.74
	11	0.73
	12	0.71
	13	0.69
	14	0.65
	15	0.62
	16	0.62
	17	0.71
	18	0.87
	19	0.95
	20	0.94
	21	0.93
	22	0.85
	23	0.72
	24	0.56

Date	Hour	Electricity Demand
22-Mar	1	0.49
	2	0.46
	3	0.46
	4	0.49
	5	0.53
	6	0.65
	7	0.8
	8	0.85
	9	0.83
	10	0.82
	11	0.81
	12	0.78
	13	0.75
	14	0.72
	15	0.69
	16	0.7
	17	0.8
	18	0.95
	19	1.05
	20	1.03
	21	0.97
	22	0.88
	23	0.75
	24	0.6

Date	Hour	Electricity Demand
23-Mar	1	0.51
	2	0.49
	3	0.48
	4	0.49
	5	0.53
	6	0.63
	7	0.8
	8	0.84
	9	0.82
	10	0.79
	11	0.78
	12	0.76
	13	0.74
	14	0.69
	15	0.68
	16	0.69
	17	0.75
	18	0.92
	19	1.02
	20	0.99
	21	0.94
	22	0.85
	23	0.71
	24	0.56

Date	Hour	Electricity Demand
24-Mar	1	0.49
	2	0.46
	3	0.45
	4	0.46
	5	0.51
	6	0.62
	7	0.76
	8	0.82
	9	0.81
	10	0.74
	11	0.72
	12	0.7
	13	0.69
	14	0.66
	15	0.62
	16	0.64
	17	0.72
	18	0.87
	19	0.95
	20	0.93
	21	0.87
	22	0.78
	23	0.67
	24	0.52

Date	Hour	Electricity Demand
25-Mar	1	0.46
	2	0.43
	3	0.43
	4	0.45
	5	0.5
	6	0.61
	7	0.75
	8	0.8
	9	0.79
	10	0.78
	11	0.77
	12	0.75
	13	0.73
	14	0.7
	15	0.68
	16	0.69
	17	0.75
	18	0.89
	19	1.01
	20	1
	21	0.95
	22	0.85
	23	0.71
	24	0.56

Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand
26-Mar	1	0.51	27-Mar	1	0.48	28-Mar	1	0.5	29-Mar	1	0.5	30-Mar	1	0.49	31-Mar	1	0.48	1-Apr	1	0.43
	2	0.49		2	0.45		2	0.49		2	0.48		2	0.46		2	0.45		2	0.38
	3	0.46		3	0.44		3	0.49		3	0.47		3	0.45		3	0.44		3	0.36
	4	0.46		4	0.46		4	0.49		4	0.49		4	0.47		4	0.46		4	0.37
	5	0.48		5	0.51		5	0.53		5	0.52		5	0.51		5	0.5		5	0.44
	6	0.53		6	0.61		6	0.66		6	0.63		6	0.61		6	0.61		6	0.54
	7	0.69		7	0.76		7	0.79		7	0.78		7	0.76		7	0.76		7	0.7
	8	0.78		8	0.84		8	0.85		8	0.82		8	0.83		8	0.82		8	0.76
	9	0.87		9	0.83		9	0.84		9	0.81		9	0.82		9	0.82		9	0.75
	10	0.88		10	0.82		10	0.79		10	0.79		10	0.81		10	0.75		10	0.75
	11	0.88		11	0.82		11	0.82		11	0.78		11	0.8		11	0.75		11	0.8
	12	0.81		12	0.81		12	0.78		12	0.76		12	0.78		12	0.71		12	0.77
	13	0.76		13	0.76		13	0.75		13	0.73		13	0.75		13	0.69		13	0.74
	14	0.73		14	0.72		14	0.7		14	0.69		14	0.7		14	0.67		14	0.7
	15	0.7		15	0.7		15	0.69		15	0.68		15	0.69		15	0.63		15	0.69
	16	0.71		16	0.71		16	0.69		16	0.69		16	0.69		16	0.65		16	0.7
	17	0.84		17	0.8		17	0.78		17	0.78		17	0.78		17	0.71		17	0.78
	18	0.95		18	0.95		18	0.95		18	0.88		18	0.93		18	0.87		18	0.93
	19	1.03		19	1.04		19	1.03		19	1.03		19	1.03		19	0.95		19	1.02
	20	1.02		20	1.02		20	1.02		20	1.02		20	1.02		20	0.93		20	1.01
	21	0.91		21	0.96		21	0.95		21	0.95		21	0.94		21	0.87		21	0.94
	22	0.85		22	0.87		22	0.87		22	0.86		22	0.85		22	0.78		22	0.84
	23	0.71		23	0.71		23	0.72		23	0.71		23	0.7		23	0.67		23	0.7
	24	0.56		24	0.57		24	0.57		24	0.57		24	0.55		24	0.52		24	0.56

Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand
2-Apr	1	0.43	3-Apr	1	0.44	4-Apr	1	0.44	5-Apr	1	0.37	6-Apr	1	0.37	7-Apr	1	0.43	8-Apr	1	0.39
	2	0.43		2	0.43		2	0.43		2	0.36		2	0.36		2	0.43		2	0.37
	3	0.43		3	0.43		3	0.43		3	0.36		3	0.42		3	0.43		3	0.36
	4	0.48		4	0.49		4	0.49		4	0.43		4	0.48		4	0.48		4	0.41
	5	0.51		5	0.51		5	0.51		5	0.44		5	0.5		5	0.47		5	0.44
	6	0.62		6	0.62		6	0.62		6	0.55		6	0.62		6	0.55		6	0.54
	7	0.7		7	0.7		7	0.7		7	0.67		7	0.69		7	0.67		7	0.67
	8	0.72		8	0.72		8	0.72		8	0.69		8	0.71		8	0.69		8	0.69
	9	0.74		9	0.74		9	0.74		9	0.7		9	0.7		9	0.73		9	0.69
	10	0.73		10	0.73		10	0.73		10	0.69		10	0.69		10	0.69		10	0.69
	11	0.7		11	0.7		11	0.69		11	0.68		11	0.67		11	0.69		11	0.67
	12	0.65		12	0.64		12	0.63		12	0.61		12	0.6		12	0.62		12	0.6
	13	0.6		13	0.59		13	0.58		13	0.55		13	0.55		13	0.57		13	0.55
	14	0.38		14	0.39		14	0.37		14	0.35		14	0.35		14	0.36		14	0.35
	15	0.51		15	0.51		15	0.46		15	0.46		15	0.46		15	0.49		15	0.48
	16	0.5		16	0.5		16	0.45		16	0.45		16	0.45		16	0.49		16	0.46
	17	0.55		17	0.56		17	0.55		17	0.52		17	0.52		17	0.53		17	0.52
	18	1.01		18	1		18	1		18	0.94		18	0.94		18	0.92		18	0.91
	19	0.7		19	0.71		19	0.7		19	0.68		19	0.68		19	0.7		19	0.68
	20	0.8		20	0.8		20	0.8		20	0.74		20	0.8		20	0.8		20	0.74
	21	0.79		21	0.79		21	0.8		21	0.73		21	0.75		21	0.79		21	0.73
	22	0.7		22	0.7		22	0.69		22	0.67		22	0.68		22	0.69		22	0.66
	23	0.57		23	0.59		23	0.57		23	0.52		23	0.52		23	0.57		23	0.53
	24	0.48		24	0.49		24	0.43		24	0.43		24	0.43		24	0.43		24	0.43

Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand
9-Apr	1	0.37	10-Apr	1	0.43	11-Apr	1	0.38	12-Apr	1	0.43	13-Apr	1	0.43	14-Apr	1	0.43	15-Apr	1	0.43
	2	0.4		2	0.42		2	0.37		2	0.43		2	0.42		2	0.43		2	0.43
	3	0.4		3	0.42		3	0.41		3	0.43		3	0.42		3	0.43		3	0.43
	4	0.46		4	0.47		4	0.46		4	0.48		4	0.49		4	0.49		4	0.49
	5	0.49		5	0.49		5	0.5		5	0.51		5	0.51		5	0.51		5	0.51
	6	0.61		6	0.61		6	0.61		6	0.61		6	0.62		6	0.62		6	0.61
	7	0.69		7	0.69		7	0.69		7	0.69		7	0.7		7	0.7		7	0.69
	8	0.67		8	0.71		8	0.71		8	0.71		8	0.73		8	0.73		8	0.71
	9	0.69		9	0.69		9	0.73		9	0.74		9	0.75		9	0.75		9	0.74
	10	0.69		10	0.69		10	0.72		10	0.73		10	0.74		10	0.75		10	0.73
	11	0.66		11	0.66		11	0.7		11	0.7		11	0.71		11	0.72		11	0.7
	12	0.6		12	0.59		12	0.66		12	0.65		12	0.67		12	0.68		12	0.67
	13	0.55		13	0.54		13	0.61		13	0.6		13	0.62		13	0.62		13	0.62
	14	0.35		14	0.35		14	0.39		14	0.4		14	0.41		14	0.41		14	0.41
	15	0.45		15	0.45		15	0.52		15	0.52		15	0.52		15	0.52		15	0.52
	16	0.5		16	0.44		16	0.51		16	0.51		16	0.52		16	0.51		16	0.51
	17	0.52		17	0.52		17	0.57		17	0.57		17	0.57		17	0.57		17	0.57
	18	0.91		18	0.9		18	1.01		18	1.01		18	1.01		18	0.99		18	0.99
	19	0.68		19	0.67		19	0.68		19	0.71		19	0.71		19	0.7		19	0.71
	20	0.75		20	0.74		20	0.8		20	0.81		20	0.81		20	0.8		20	0.8
	21	0.74		21	0.73		21	0.79		21	0.8		21	0.8		21	0.79		21	0.79
	22	0.67		22	0.66		22	0.69		22	0.7		22	0.7		22	0.7		22	0.7
	23	0.53		23	0.52		23	0.56		23	0.6		23	0.6		23	0.59		23	0.59
	24	0.46		24	0.43		24	0.45		24	0.48		24	0.46		24	0.46		24	0.46

Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand
16-Apr	1	0.44	17-Apr	1	0.44	18-Apr	1	0.43	19-Apr	1	0.43	20-Apr	1	0.43	21-Apr	1	0.43	22-Apr	1	0.41
	2	0.43		2	0.43		2	0.43		2	0.42		2	0.43		2	0.42		2	0.41
	3	0.43		3	0.43		3	0.43		3	0.42		3	0.42		3	0.42		3	0.41
	4	0.49		4	0.49		4	0.48		4	0.47		4	0.48		4	0.47		4	0.43
	5	0.51		5	0.52		5	0.51		5	0.49		5	0.51		5	0.5		5	0.43
	6	0.62		6	0.62		6	0.62		6	0.61		6	0.62		6	0.61		6	0.52
	7	0.7		7	0.7		7	0.69		7	0.69		7	0.69		7	0.69		7	0.65
	8	0.73		8	0.72		8	0.71		8	0.71		8	0.71		8	0.68		8	0.67
	9	0.74		9	0.75		9	0.73		9	0.73		9	0.72		9	0.69		9	0.69
	10	0.73		10	0.74		10	0.73		10	0.69		10	0.71		10	0.69		10	0.69
	11	0.7		11	0.7		11	0.65		11	0.68		11	0.67		11	0.67		11	0.65
	12	0.65		12	0.65		12	0.61		12	0.6		12	0.61		12	0.6		12	0.61
	13	0.61		13	0.61		13	0.54		13	0.54		13	0.56		13	0.54		13	1.37
	14	0.39		14	0.39		14	0.35		14	0.35		14	0.35		14	0.35		14	1.52
	15	0.53		15	0.51		15	0.45		15	0.45		15	0.45		15	0.45		15	1.95
	16	0.52		16	0.5		16	0.44		16	0.5		16	0.45		16	0.44		16	2.15
	17	0.58		17	0.56		17	0.55		17	0.55		17	0.52		17	0.52		17	2.13
	18	1		18	0.98		18	0.97		18	0.97		18	0.97		18	0.94		18	2.18
	19	0.71		19	0.7		19	0.7		19	0.7		19	0.69		19	0.68		19	1.56
	20	0.82		20	0.8		20	0.8		20	0.8		20	0.8		20	0.73		20	1.39
	21	0.81		21	0.79		21	0.79		21	0.79		21	0.79		21	0.72		21	0.69
	22	0.7		22	0.69		22	0.69		22	0.69		22	0.69		22	0.62		22	0.65
	23	0.6		23	0.58		23	0.58		23	0.58		23	0.57		23	0.51		23	0.48
	24	0.48		24	0.47		24	0.47		24	0.46		24	0.45		24	0.43		24	0.43

Date	Hour	Electricity Demand
23-Apr	1	0.39
	2	0.37
	3	0.36
	4	0.42
	5	0.44
	6	0.54
	7	0.62
	8	0.66
	9	0.69
	10	0.69
	11	0.67
	12	0.61
	13	0.54
	14	0.35
	15	0.46
	16	0.45
	17	0.52
	18	0.93
	19	0.68
	20	0.75
	21	0.74
	22	0.64
	23	0.52
	24	0.45

Date	Hour	Electricity Demand
24-Apr	1	0.43
	2	0.42
	3	0.42
	4	0.48
	5	0.49
	6	0.62
	7	0.69
	8	0.71
	9	0.69
	10	0.69
	11	0.66
	12	0.61
	13	0.54
	14	0.35
	15	0.46
	16	0.45
	17	0.52
	18	0.93
	19	0.67
	20	0.74
	21	0.72
	22	0.65
	23	0.52
	24	0.43

Date	Hour	Electricity Demand
25-Apr	1	0.43
	2	0.43
	3	0.43
	4	0.44
	5	0.48
	6	0.61
	7	0.65
	8	0.69
	9	0.69
	10	0.69
	11	0.67
	12	0.62
	13	1.1
	14	1.31
	15	1.74
	16	1.95
	17	1.95
	18	2.11
	19	1.48
	20	0.69
	21	0.69
	22	0.65
	23	0.51
	24	0.46

Date	Hour	Electricity Demand
26-Apr	1	0.43
	2	0.42
	3	0.41
	4	0.46
	5	0.49
	6	0.61
	7	0.69
	8	0.7
	9	0.72
	10	0.69
	11	0.66
	12	0.6
	13	0.55
	14	0.35
	15	0.45
	16	0.44
	17	0.52
	18	0.93
	19	0.68
	20	0.72
	21	0.71
	22	0.66
	23	0.56
	24	0.46

Date	Hour	Electricity Demand
27-Apr	1	0.43
	2	0.43
	3	0.43
	4	0.44
	5	0.47
	6	0.61
	7	0.62
	8	0.66
	9	0.68
	10	0.69
	11	1.52
	12	1.82
	13	2
	14	1.96
	15	2.19
	16	2.21
	17	2.16
	18	2.21
	19	0.65
	20	0.74
	21	0.73
	22	0.65
	23	0.52
	24	0.43

Date	Hour	Electricity Demand
28-Apr	1	0.39
	2	0.39
	3	0.39
	4	0.43
	5	0.43
	6	0.52
	7	0.61
	8	0.62
	9	0.68
	10	1.08
	11	1.56
	12	1.67
	13	1.74
	14	1.57
	15	1.95
	16	2
	17	1.97
	18	0.9
	19	0.65
	20	0.74
	21	0.73
	22	0.64
	23	0.52
	24	0.43

Date	Hour	Electricity Demand
29-Apr	1	0.41
	2	0.4
	3	0.39
	4	0.43
	5	0.44
	6	0.61
	7	0.63
	8	0.69
	9	0.71
	10	0.7
	11	0.69
	12	0.62
	13	1.17
	14	1.28
	15	1.61
	16	0.45
	17	0.51
	18	0.93
	19	0.65
	20	0.74
	21	0.73
	22	0.63
	23	0.53
	24	0.45

Date	Hour	Electricity Demand
30-Apr	1	0.43
	2	0.42
	3	0.42
	4	0.49
	5	0.5
	6	0.63
	7	0.69
	8	0.71
	9	0.75
	10	0.75
	11	0.71
	12	0.67
	13	0.62
	14	0.42
	15	0.52
	16	0.51
	17	0.59
	18	1
	19	0.71
	20	0.8
	21	0.79
	22	0.7
	23	0.55
	24	0.48

Date	Hour	Electricity Demand
1-May	1	0.43
	2	0.38
	3	0.37
	4	0.43
	5	0.45
	6	0.59
	7	0.69
	8	0.71
	9	0.74
	10	0.74
	11	0.68
	12	0.61
	13	0.56
	14	0.4
	15	0.52
	16	0.51
	17	0.56
	18	0.95
	19	0.68
	20	0.76
	21	0.75
	22	0.7
	23	0.55
	24	0.45

Date	Hour	Electricity Demand
2-May	1	0.43
	2	0.43
	3	0.43
	4	0.48
	5	0.5
	6	0.62
	7	0.69
	8	0.7
	9	0.72
	10	0.69
	11	0.65
	12	0.61
	13	0.55
	14	0.35
	15	0.45
	16	0.45
	17	0.52
	18	0.95
	19	0.67
	20	0.74
	21	0.73
	22	0.62
	23	0.52
	24	0.43

Date	Hour	Electricity Demand
3-May	1	0.37
	2	0.36
	3	0.36
	4	0.43
	5	0.44
	6	0.59
	7	0.63
	8	0.65
	9	0.69
	10	0.69
	11	0.65
	12	0.59
	13	1.17
	14	0.35
	15	0.45
	16	0.45
	17	0.52
	18	0.94
	19	0.65
	20	0.74
	21	0.72
	22	0.65
	23	0.52
	24	0.43

Date	Hour	Electricity Demand
4-May	1	0.37
	2	0.42
	3	0.41
	4	0.45
	5	0.49
	6	0.62
	7	0.62
	8	0.65
	9	0.69
	10	0.69
	11	0.65
	12	0.61
	13	0.54
	14	0.35
	15	0.45
	16	0.44
	17	0.52
	18	0.94
	19	0.67
	20	0.74
	21	0.73
	22	0.65
	23	0.51
	24	0.43

Date	Hour	Electricity Demand
5-May	1	0.37
	2	0.36
	3	0.36
	4	0.42
	5	0.44
	6	0.59
	7	0.62
	8	0.66
	9	0.69
	10	0.69
	11	0.67
	12	0.6
	13	1.12
	14	0.35
	15	0.46
	16	0.45
	17	0.52
	18	0.93
	19	0.67
	20	0.74
	21	0.73
	22	0.65
	23	0.52
	24	0.43

Date	Hour	Electricity Demand
6-May	1	0.37
	2	0.36
	3	0.36
	4	0.42
	5	0.43
	6	0.56
	7	0.65
	8	0.68
	9	0.69
	10	0.69
	11	0.67
	12	1.21
	13	0.54
	14	0.35
	15	0.48
	16	1.34
	17	0.52
	18	0.91
	19	0.68
	20	0.72
	21	0.71
	22	0.64
	23	0.52
	24	0.43

Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand
7-May	1	0.42	8-May	1	0.78	9-May	1	0.43	10-May	1	0.43	11-May	1	0.37	12-May	1	0.37	13-May	1	0.37
	2	0.43		2	0.43		2	0.43		2	0.43		2	0.36		2	0.36		2	0.36
	3	0.43		3	0.43		3	0.43		3	0.43		3	0.36		3	0.36		3	0.36
	4	0.46		4	0.47		4	0.47		4	0.48		4	0.42		4	0.42		4	0.42
	5	0.46		5	0.5		5	0.5		5	0.5		5	0.44		5	0.43		5	0.44
	6	0.54		6	0.63		6	0.64		6	0.62		6	0.56		6	0.56		6	0.57
	7	0.62		7	0.69		7	0.68		7	0.69		7	0.65		7	0.62		7	0.62
	8	0.68		8	0.7		8	0.67		8	0.67		8	0.67		8	0.68		8	0.67
	9	0.72		9	0.72		9	0.69		9	0.69		9	0.69		9	0.69		9	0.69
	10	0.74		10	0.71		10	0.69		10	0.69		10	0.69		10	0.69		10	0.69
	11	0.7		11	0.66		11	0.64		11	0.67		11	0.67		11	0.66		11	0.67
	12	0.65		12	0.6		12	0.61		12	0.61		12	0.61		12	0.61		12	0.61
	13	0.59		13	0.55		13	0.54		13	0.54		13	0.54		13	0.54		13	0.54
	14	0.85		14	0.35		14	0.35		14	0.35		14	0.35		14	0.35		14	0.35
	15	0.52		15	0.48		15	0.46		15	0.45		15	0.45		15	0.45		15	0.46
	16	0.51		16	0.45		16	0.44		16	0.45		16	0.44		16	0.45		16	0.45
	17	0.53		17	0.52		17	0.52		17	0.52		17	0.52		17	0.52		17	0.52
	18	0.89		18	0.95		18	0.94		18	0.93		18	0.93		18	0.9		18	0.92
	19	0.67		19	0.67		19	0.67		19	0.67		19	0.67		19	0.67		19	0.67
	20	0.72		20	0.74		20	0.72		20	0.73		20	0.74		20	0.74		20	0.74
	21	0.71		21	0.73		21	0.71		21	0.71		21	0.73		21	0.73		21	0.73
	22	0.65		22	0.69		22	0.65		22	0.65		22	0.65		22	0.64		22	0.65
	23	0.53		23	0.55		23	0.52		23	0.51		23	0.51		23	0.51		23	0.51
	24	0.49		24	0.45		24	0.43		24	0.43		24	0.43		24	0.43		24	0.43

Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand
14-May	1	0.37	15-May	1	0.37	16-May	1	0.43	17-May	1	0.41	18-May	1	0.37	19-May	1	0.42	20-May	1	0.37
	2	0.36		2	0.36		2	0.42		2	0.4		2	0.36		2	0.41		2	0.36
	3	0.36		3	0.36		3	0.41		3	0.39		3	0.36		3	0.41		3	0.36
	4	0.42		4	0.43		4	0.43		4	0.43		4	0.42		4	0.43		4	0.42
	5	0.43		5	0.45		5	0.44		5	0.44		5	0.44		5	0.44		5	0.45
	6	0.59		6	0.59		6	0.56		6	0.56		6	0.54		6	0.56		6	0.54
	7	0.63		7	0.62		7	0.61		7	0.61		7	0.63		7	0.61		7	0.62
	8	0.65		8	0.66		8	0.65		8	0.65		8	0.66		8	0.65		8	0.66
	9	0.68		9	0.68		9	0.68		9	0.68		9	0.69		9	0.68		9	0.68
	10	0.69		10	0.69		10	1.26		10	0.68		10	0.69		10	0.68		10	0.69
	11	0.67		11	0.67		11	1.54		11	1.04		11	0.67		11	1.04		11	0.67
	12	0.6		12	0.61		12	1.61		12	0.61		12	0.61		12	1.39		12	0.61
	13	0.55		13	0.54		13	1.74		13	1.34		13	0.56		13	1.69		13	0.54
	14	0.35		14	0.35		14	1.69		14	1.35		14	0.35		14	1.74		14	0.35
	15	0.46		15	0.46		15	1.82		15	1.74		15	0.48		15	2.17		15	0.45
	16	0.45		16	0.45		16	2		16	1.56		16	0.46		16	2.16		16	0.44
	17	0.52		17	0.52		17	1.91		17	0.52		17	0.52		17	2.04		17	0.52
	18	0.93		18	0.92		18	0.91		18	0.91		18	0.94		18	0.91		18	0.93
	19	0.67		19	0.67		19	0.65		19	0.65		19	0.67		19	0.65		19	0.67
	20	0.74		20	0.73		20	0.69		20	0.74		20	0.74		20	0.74		20	0.74
	21	0.73		21	0.72		21	0.69		21	0.73		21	0.73		21	0.73		21	0.73
	22	0.64		22	0.63		22	0.65		22	0.65		22	0.65		22	0.65		22	0.63
	23	0.51		23	0.51		23	0.52		23	0.52		23	0.52		23	0.52		23	0.51
	24	0.43		24	0.43		24	0.43		24	0.43		24	0.43		24	0.43		24	0.43

Date	Hour	Electricity Demand
21-May	1	0.37
	2	0.36
	3	0.36
	4	0.42
	5	0.44
	6	0.55
	7	0.62
	8	0.66
	9	0.68
	10	0.69
	11	0.67
	12	0.61
	13	0.53
	14	0.35
	15	0.45
	16	0.44
	17	0.52
	18	0.93
	19	0.67
	20	0.74
	21	0.73
	22	0.63
	23	0.51
	24	0.43

Date	Hour	Electricity Demand
22-May	1	0.37
	2	0.36
	3	0.36
	4	0.43
	5	0.45
	6	0.59
	7	0.65
	8	0.68
	9	0.69
	10	0.69
	11	0.67
	12	0.6
	13	0.55
	14	0.35
	15	0.45
	16	0.44
	17	0.52
	18	0.93
	19	0.67
	20	0.74
	21	0.73
	22	0.66
	23	0.52
	24	0.43

Date	Hour	Electricity Demand
23-May	1	0.37
	2	0.36
	3	0.36
	4	0.43
	5	0.45
	6	0.59
	7	0.65
	8	0.68
	9	0.69
	10	0.69
	11	0.67
	12	0.6
	13	0.55
	14	0.35
	15	0.45
	16	0.44
	17	0.52
	18	0.93
	19	0.67
	20	0.74
	21	0.73
	22	0.66
	23	0.52
	24	0.43

Date	Hour	Electricity Demand
24-May	1	0.37
	2	0.36
	3	0.36
	4	0.43
	5	0.46
	6	0.59
	7	0.63
	8	0.68
	9	0.69
	10	0.69
	11	0.68
	12	0.61
	13	0.55
	14	0.36
	15	0.45
	16	0.44
	17	0.52
	18	0.93
	19	0.68
	20	0.75
	21	0.74
	22	0.67
	23	0.51
	24	0.43

Date	Hour	Electricity Demand
25-May	1	0.37
	2	0.36
	3	0.36
	4	0.42
	5	0.45
	6	0.59
	7	0.63
	8	0.67
	9	0.69
	10	0.69
	11	0.67
	12	0.61
	13	0.53
	14	0.35
	15	0.45
	16	0.44
	17	0.52
	18	0.91
	19	0.67
	20	0.72
	21	0.71
	22	0.64
	23	0.51
	24	0.43

Date	Hour	Electricity Demand
26-May	1	0.42
	2	0.41
	3	0.39
	4	0.43
	5	0.44
	6	0.56
	7	0.61
	8	0.65
	9	0.67
	10	0.66
	11	0.65
	12	0.61
	13	1.31
	14	1.5
	15	1.95
	16	2
	17	0.52
	18	0.91
	19	0.67
	20	0.72
	21	0.71
	22	0.63
	23	0.52
	24	0.43

Date	Hour	Electricity Demand
27-May	1	0.42
	2	0.41
	3	0.41
	4	0.43
	5	0.44
	6	0.56
	7	0.61
	8	0.65
	9	0.67
	10	1.54
	11	1.76
	12	1.8
	13	0.52
	14	1.56
	15	0.45
	16	1.56
	17	0.52
	18	0.91
	19	0.67
	20	0.72
	21	0.71
	22	0.63
	23	0.52
	24	0.43

Date	Hour	Electricity Demand
28-May	1	0.38
	2	0.37
	3	0.36
	4	0.42
	5	0.45
	6	0.56
	7	0.63
	8	0.65
	9	0.68
	10	0.69
	11	0.67
	12	0.61
	13	0.54
	14	0.72
	15	0.45
	16	0.44
	17	0.52
	18	0.91
	19	0.67
	20	0.72
	21	0.71
	22	0.64
	23	0.51
	24	0.43

Date	Hour	Electricity Demand
29-May	1	0.38
	2	0.37
	3	0.36
	4	0.42
	5	0.43
	6	0.58
	7	0.63
	8	0.65
	9	0.68
	10	0.69
	11	0.66
	12	0.6
	13	0.54
	14	0.35
	15	0.45
	16	0.44
	17	0.52
	18	0.91
	19	0.67
	20	0.72
	21	0.71
	22	0.65
	23	0.51
	24	0.43

Date	Hour	Electricity Demand
30-May	1	0.38
	2	0.37
	3	0.36
	4	0.42
	5	0.45
	6	0.56
	7	0.63
	8	0.67
	9	0.69
	10	0.69
	11	0.66
	12	0.6
	13	0.54
	14	0.35
	15	0.45
	16	0.44
	17	0.52
	18	0.91
	19	0.67
	20	0.72
	21	0.71
	22	0.65
	23	0.51
	24	0.43

Date	Hour	Electricity Demand
31-May	1	0.42
	2	0.39
	3	0.38
	4	0.43
	5	0.43
	6	0.56
	7	0.63
	8	0.65
	9	0.69
	10	0.69
	11	0.65
	12	1.13
	13	0.52
	14	0.35
	15	1.32
	16	1.56
	17	1.73
	18	1.91
	19	0.65
	20	0.72
	21	0.71
	22	0.65
	23	0.51
	24	0.43

Date	Hour	Electricity Demand
1-Jun	1	0.41
	2	0.41
	3	0.41
	4	0.43
	5	0.43
	6	0.56
	7	0.61
	8	0.65
	9	0.67
	10	0.67
	11	0.66
	12	0.63
	13	0.56
	14	0.37
	15	1.08
	16	1.13
	17	1.39
	18	1.91
	19	1.29
	20	1.13
	21	0.69
	22	0.65
	23	0.52
	24	0.43

Date	Hour	Electricity Demand
2-Jun	1	0.43
	2	0.42
	3	0.41
	4	0.43
	5	0.43
	6	0.56
	7	0.61
	8	0.65
	9	1.52
	10	1.95
	11	2.17
	12	2.34
	13	2.43
	14	2.39
	15	2.65
	16	2.7
	17	2.69
	18	2.78
	19	2.17
	20	2
	21	1.82
	22	1.52
	23	1.26
	24	0.95

Date	Hour	Electricity Demand
3-Jun	1	0.78
	2	0.39
	3	0.39
	4	0.43
	5	0.43
	6	0.56
	7	0.61
	8	0.65
	9	0.67
	10	1.3
	11	1.49
	12	1.69
	13	1.56
	14	1.05
	15	0.45
	16	0.44
	17	0.48
	18	0.91
	19	0.65
	20	0.69
	21	0.69
	22	0.65
	23	0.52
	24	0.43

Date	Hour	Electricity Demand
4-Jun	1	0.42
	2	0.41
	3	0.39
	4	0.43
	5	0.43
	6	0.56
	7	0.61
	8	0.65
	9	0.67
	10	0.68
	11	0.65
	12	0.61
	13	0.59
	14	0.35
	15	1.54
	16	1.71
	17	0.52
	18	0.91
	19	0.65
	20	0.72
	21	0.71
	22	0.64
	23	0.52
	24	0.43

Date	Hour	Electricity Demand
5-Jun	1	0.42
	2	0.41
	3	0.41
	4	0.43
	5	0.43
	6	0.56
	7	0.61
	8	0.65
	9	0.67
	10	1.32
	11	1.69
	12	1.74
	13	1.74
	14	1.65
	15	1.91
	16	2.04
	17	2.04
	18	2.21
	19	0.67
	20	0.72
	21	0.71
	22	0.64
	23	0.52
	24	0.43

Date	Hour	Electricity Demand
6-Jun	1	0.42
	2	0.41
	3	0.41
	4	0.43
	5	0.43
	6	0.56
	7	0.61
	8	0.65
	9	0.67
	10	1.13
	11	1.61
	12	1.91
	13	2.08
	14	2.04
	15	2.43
	16	2.6
	17	2.59
	18	2.78
	19	2.08
	20	1.87
	21	1.65
	22	1.26
	23	0.91
	24	0.43

Date	Hour	Electricity Demand
7-Jun	1	0.37
	2	0.36
	3	0.36
	4	0.42
	5	0.43
	6	0.55
	7	0.62
	8	0.67
	9	0.69
	10	0.69
	11	0.68
	12	0.61
	13	0.54
	14	0.35
	15	0.46
	16	0.45
	17	0.52
	18	0.91
	19	0.67
	20	0.72
	21	0.71
	22	0.65
	23	0.51
	24	0.43

Date	Hour	Electricity Demand
8-Jun	1	0.39
	2	0.39
	3	0.38
	4	0.43
	5	0.43
	6	0.56
	7	0.61
	8	0.65
	9	0.67
	10	0.68
	11	0.67
	12	0.62
	13	0.61
	14	0.35
	15	1.34
	16	1.49
	17	1.43
	18	1.69
	19	0.65
	20	0.72
	21	0.71
	22	0.65
	23	0.51
	24	0.43

Date	Hour	Electricity Demand
9-Jun	1	0.39
	2	0.38
	3	0.37
	4	0.43
	5	0.43
	6	0.56
	7	0.61
	8	0.65
	9	0.67
	10	0.68
	11	0.67
	12	0.62
	13	0.61
	14	0.69
	15	1.26
	16	1.3
	17	1.29
	18	1.56
	19	1.17
	20	1.13
	21	0.74
	22	0.65
	23	0.52
	24	0.43

Date	Hour	Electricity Demand
10-Jun	1	0.39
	2	0.39
	3	0.39
	4	0.43
	5	0.43
	6	0.56
	7	0.61
	8	0.65
	9	0.69
	10	0.69
	11	0.65
	12	0.61
	13	1.13
	14	1.39
	15	2
	16	2.13
	17	2.17
	18	2.39
	19	1.82
	20	1.65
	21	1.39
	22	1.26
	23	0.87
	24	0.43

Date	Hour	Electricity Demand
11-Jun	1	0.39
	2	0.39
	3	0.39
	4	0.43
	5	0.43
	6	0.52
	7	0.61
	8	0.65
	9	0.69
	10	1.08
	11	1.39
	12	1.74
	13	1.91
	14	1.87
	15	2.08
	16	2.3
	17	2.21
	18	2
	19	1.65
	20	1.39
	21	1.21
	22	0.65
	23	0.52
	24	0.43

Date	Hour	Electricity Demand
12-Jun	1	0.39
	2	0.39
	3	0.39
	4	0.43
	5	0.43
	6	0.56
	7	0.61
	8	0.69
	9	0.69
	10	1.34
	11	1.69
	12	2.08
	13	2.17
	14	2
	15	2.34
	16	2.21
	17	2.21
	18	2.26
	19	1.61
	20	1.48
	21	1.21
	22	0.61
	23	0.52
	24	0.43

Date	Hour	Electricity Demand
13-Jun	1	0.39
	2	0.39
	3	0.39
	4	0.43
	5	0.43
	6	0.52
	7	1.13
	8	1.78
	9	2.26
	10	2.65
	11	2.82
	12	2.82
	13	2.99
	14	2.99
	15	3.12
	16	3.08
	17	2.82
	18	2.86
	19	2.26
	20	1.95
	21	1.69
	22	1.56
	23	1.3
	24	1.04

Date	Hour	Electricity Demand
14-Jun	1	0.87
	2	0.78
	3	0.39
	4	0.43
	5	0.43
	6	0.52
	7	1.39
	8	1.91
	9	2.13
	10	2.08
	11	2.04
	12	2.08
	13	2.08
	14	1.95
	15	1.61
	16	0.48
	17	0.52
	18	0.95
	19	0.65
	20	0.69
	21	0.69
	22	0.65
	23	0.52
	24	0.43

Date	Hour	Electricity Demand
15-Jun	1	0.39
	2	0.39
	3	0.35
	4	0.43
	5	0.43
	6	0.61
	7	0.61
	8	0.65
	9	0.69
	10	0.69
	11	0.65
	12	0.61
	13	0.52
	14	0.35
	15	0.48
	16	0.48
	17	0.52
	18	0.95
	19	0.65
	20	0.74
	21	0.74
	22	0.65
	23	0.52
	24	0.43

Date	Hour	Electricity Demand
16-Jun	1	0.39
	2	0.39
	3	0.39
	4	0.43
	5	0.43
	6	0.61
	7	0.65
	8	0.65
	9	0.69
	10	0.69
	11	0.65
	12	0.61
	13	0.56
	14	0.35
	15	0.43
	16	1.17
	17	1.52
	18	1.95
	19	0.65
	20	0.69
	21	0.69
	22	0.65
	23	0.52
	24	0.43

Date	Hour	Electricity Demand
17-Jun	1	0.39
	2	0.39
	3	0.39
	4	0.43
	5	0.43
	6	0.56
	7	0.61
	8	0.65
	9	0.65
	10	0.65
	11	1.21
	12	1.43
	13	1.52
	14	1.48
	15	1.78
	16	1.82
	17	0.52
	18	0.95
	19	0.65
	20	0.69
	21	0.69
	22	0.65
	23	0.52
	24	0.43

Date	Hour	Electricity Demand
18-Jun	1	0.39
	2	0.39
	3	0.39
	4	0.43
	5	0.43
	6	0.48
	7	0.56
	8	0.65
	9	0.69
	10	1.34
	11	1.65
	12	1.69
	13	1.82
	14	2.17
	15	1.95
	16	1.92
	17	1.87
	18	0.91
	19	0.65
	20	1.13
	21	0.69
	22	0.65
	23	0.52
	24	0.43

Date	Hour	Electricity Demand
19-Jun	1	0.39
	2	0.39
	3	0.39
	4	0.48
	5	0.52
	6	0.61
	7	0.65
	8	0.69
	9	1.48
	10	1.69
	11	1.78
	12	1.82
	13	1.87
	14	1.87
	15	1.95
	16	2
	17	1.87
	18	2.08
	19	0.65
	20	0.69
	21	0.69
	22	0.65
	23	0.52
	24	0.43

Date	Hour	Electricity Demand
20-Jun	1	0.39
	2	0.39
	3	0.39
	4	0.43
	5	0.43
	6	0.61
	7	0.65
	8	0.69
	9	0.69
	10	1.08
	11	1.52
	12	1.65
	13	1.65
	14	1.69
	15	1.95
	16	2
	17	1.91
	18	2.13
	19	1.43
	20	0.74
	21	0.74
	22	0.65
	23	0.52
	24	0.43

Date	Hour	Electricity Demand
21-Jun	1	0.39
	2	0.35
	3	0.35
	4	0.43
	5	0.43
	6	0.56
	7	0.61
	8	0.65
	9	0.69
	10	0.69
	11	0.65
	12	0.61
	13	0.52
	14	0.35
	15	0.48
	16	0.43
	17	0.52
	18	0.95
	19	0.65
	20	0.74
	21	0.74
	22	0.65
	23	0.52
	24	0.43

Date	Hour	Electricity Demand
22-Jun	1	0.39
	2	0.39
	3	0.35
	4	0.43
	5	0.43
	6	0.56
	7	0.61
	8	0.65
	9	0.69
	10	0.69
	11	0.65
	12	0.61
	13	0.56
	14	0.35
	15	0.48
	16	0.48
	17	0.52
	18	0.95
	19	0.65
	20	0.74
	21	0.74
	22	0.65
	23	0.52
	24	0.43

Date	Hour	Electricity Demand
23-Jun	1	0.39
	2	0.39
	3	0.35
	4	0.43
	5	0.43
	6	0.56
	7	0.61
	8	0.65
	9	0.69
	10	1.3
	11	1.61
	12	1.82
	13	1.91
	14	1.78
	15	1.91
	16	1.95
	17	2.04
	18	2.21
	19	1.52
	20	1.3
	21	0.69
	22	0.65
	23	0.52
	24	0.43

Date	Hour	Electricity Demand
24-Jun	1	0.39
	2	0.39
	3	0.35
	4	0.43
	5	0.43
	6	0.52
	7	0.61
	8	0.65
	9	0.69
	10	0.69
	11	0.65
	12	0.61
	13	0.56
	14	0.35
	15	0.48
	16	0.48
	17	0.52
	18	1.48
	19	0.65
	20	0.74
	21	0.74
	22	0.65
	23	0.52
	24	0.43

Date	Hour	Electricity Demand
25-Jun	1	0.39
	2	0.39
	3	0.35
	4	0.43
	5	0.43
	6	0.56
	7	0.61
	8	0.65
	9	0.69
	10	0.69
	11	0.65
	12	1.04
	13	0.56
	14	0.35
	15	0.48
	16	0.48
	17	1
	18	1.34
	19	0.65
	20	0.74
	21	0.69
	22	0.65
	23	0.52
	24	0.43

Date	Hour	Electricity Demand
26-Jun	1	0.39
	2	0.35
	3	0.35
	4	0.39
	5	0.43
	6	0.56
	7	0.61
	8	0.65
	9	0.65
	10	0.65
	11	0.61
	12	0.56
	13	0.52
	14	1.04
	15	1.34
	16	1.43
	17	1.52
	18	1.69
	19	0.65
	20	0.69
	21	0.69
	22	0.65
	23	0.52
	24	0.43

Date	Hour	Electricity Demand
27-Jun	1	0.39
	2	0.39
	3	0.35
	4	0.43
	5	0.43
	6	0.56
	7	0.61
	8	0.65
	9	0.65
	10	0.69
	11	0.65
	12	0.61
	13	0.56
	14	0.35
	15	0.48
	16	0.48
	17	0.52
	18	0.95
	19	0.65
	20	0.74
	21	0.74
	22	0.65
	23	0.52
	24	0.43

Date	Hour	Electricity Demand
28-Jun	1	0.39
	2	0.39
	3	0.39
	4	0.43
	5	0.43
	6	0.56
	7	0.61
	8	0.65
	9	0.69
	10	0.69
	11	1.43
	12	1.65
	13	1.82
	14	1.61
	15	1.78
	16	1.91
	17	1.95
	18	0.95
	19	0.65
	20	0.69
	21	0.69
	22	0.65
	23	0.52
	24	0.43

Date	Hour	Electricity Demand
29-Jun	1	0.39
	2	0.39
	3	0.39
	4	0.43
	5	0.43
	6	0.56
	7	0.61
	8	0.65
	9	0.69
	10	1.39
	11	1.74
	12	2
	13	2.13
	14	2
	15	2.21
	16	2.26
	17	2.13
	18	2.26
	19	1.61
	20	1.48
	21	1.39
	22	1.17
	23	0.95
	24	0.43

Date	Hour	Electricity Demand
30-Jun	1	0.39
	2	0.39
	3	0.39
	4	0.43
	5	0.43
	6	0.52
	7	0.61
	8	0.65
	9	1.48
	10	2.04
	11	2.21
	12	2.3
	13	2.52
	14	2.39
	15	2.6
	16	2.78
	17	2.6
	18	2.91
	19	2.17
	20	2.08
	21	1.74
	22	1.48
	23	1.39
	24	1.08

Date	Hour	Electricity Demand
1-Jul	1	1.04
	2	0.91
	3	0.78
	4	0.78
	5	0.43
	6	1.04
	7	1.56
	8	2.08
	9	2.43
	10	2.78
	11	2.95
	12	3.04
	13	3.08
	14	2.99
	15	3.25
	16	3.21
	17	3.12
	18	3.12
	19	2.39
	20	2.08
	21	1.91
	22	1.78
	23	1.39
	24	1.08

Date	Hour	Electricity Demand
2-Jul	1	1.04
	2	0.82
	3	0.74
	4	0.39
	5	0.43
	6	0.52
	7	1.08
	8	1.30
	9	1.65
	10	2.13
	11	2.34
	12	2.43
	13	2.43
	14	2.34
	15	2.34
	16	2.00
	17	1.95
	18	2.21
	19	1.74
	20	1.74
	21	1.69
	22	1.56
	23	1.30
	24	0.95

Date	Hour	Electricity Demand
3-Jul	1	0.87
	2	0.78
	3	0.35
	4	0.39
	5	0.43
	6	1.00
	7	1.34
	8	1.74
	9	2.00
	10	2.52
	11	2.56
	12	2.82
	13	2.95
	14	2.78
	15	2.99
	16	2.91
	17	2.78
	18	3.08
	19	2.26
	20	2.21
	21	2.04
	22	1.74
	23	1.48
	24	1.21

Date	Hour	Electricity Demand
4-Jul	1	0.52
	2	0.52
	3	0.65
	4	0.69
	5	0.78
	6	1.04
	7	1.08
	8	1.08
	9	1.13
	10	1.13
	11	1.48
	12	1.65
	13	2.00
	14	2.26
	15	2.43
	16	2.08
	17	2.17
	18	2.43
	19	2.00
	20	1.65
	21	1.30
	22	0.95
	23	0.78
	24	0.65

Date	Hour	Electricity Demand
5-Jul	1	0.39
	2	0.35
	3	0.35
	4	0.39
	5	0.48
	6	0.52
	7	0.61
	8	0.65
	9	0.65
	10	1.08
	11	1.52
	12	1.61
	13	1.61
	14	1.48
	15	1.74
	16	1.91
	17	1.91
	18	2.21
	19	1.65
	20	1.52
	21	0.69
	22	0.65
	23	0.52
	24	0.43

Date	Hour	Electricity Demand
6-Jul	1	0.39
	2	0.39
	3	0.39
	4	0.43
	5	0.43
	6	0.56
	7	0.61
	8	0.65
	9	0.69
	10	1.21
	11	1.56
	12	1.65
	13	1.82
	14	1.82
	15	2.08
	16	2.04
	17	2.13
	18	2.26
	19	1.65
	20	1.61
	21	0.74
	22	0.65
	23	0.52
	24	0.43

Date	Hour	Electricity Demand
7-Jul	1	0.39
	2	0.39
	3	0.35
	4	0.39
	5	0.43
	6	0.56
	7	0.61
	8	0.65
	9	1.39
	10	1.82
	11	1.91
	12	2.04
	13	2.08
	14	2.00
	15	2.13
	16	2.21
	17	2.13
	18	2.39
	19	1.74
	20	0.74
	21	1.30
	22	1.13
	23	0.95
	24	0.43

Date	Hour	Electricity Demand
8-Jul	1	0.39
	2	0.35
	3	0.35
	4	0.39
	5	0.43
	6	0.52
	7	0.61
	8	0.65
	9	0.69
	10	0.69
	11	0.65
	12	0.61
	13	0.52
	14	0.35
	15	0.48
	16	0.48
	17	0.52
	18	0.95
	19	0.65
	20	0.74
	21	0.74
	22	0.65
	23	0.52
	24	0.43

Date	Hour	Electricity Demand
9-Jul	1	0.39
	2	0.35
	3	0.35
	4	0.43
	5	0.43
	6	0.56
	7	0.61
	8	0.65
	9	0.69
	10	0.65
	11	0.65
	12	0.56
	13	0.56
	14	0.35
	15	0.48
	16	0.48
	17	0.52
	18	0.95
	19	0.65
	20	0.74
	21	0.74
	22	0.65
	23	0.52
	24	0.43

Date	Hour	Electricity Demand
10-Jul	1	0.39
	2	0.39
	3	0.39
	4	0.39
	5	0.43
	6	0.61
	7	0.65
	8	0.65
	9	0.69
	10	0.69
	11	0.65
	12	1.17
	13	1.56
	14	1.61
	15	2.00
	16	2.08
	17	2.17
	18	2.17
	19	1.48
	20	1.30
	21	1.21
	22	0.61
	23	0.52
	24	0.43

Date	Hour	Electricity Demand
11-Jul	1	0.39
	2	0.39
	3	0.39
	4	0.43
	5	0.43
	6	0.52
	7	0.61
	8	0.65
	9	0.69
	10	1.13
	11	1.52
	12	1.69
	13	1.82
	14	1.69
	15	1.91
	16	2.00
	17	2.13
	18	2.30
	19	1.52
	20	1.39
	21	1.26
	22	1.04
	23	0.48
	24	0.43

Date	Hour	Electricity Demand
12-Jul	1	0.39
	2	0.35
	3	0.39
	4	0.43
	5	0.43
	6	0.52
	7	0.61
	8	0.65
	9	1.08
	10	1.65
	11	1.87
	12	2.04
	13	2.04
	14	1.82
	15	1.69
	16	1.52
	17	1.65
	18	1.82
	19	1.30
	20	1.26
	21	1.17
	22	0.65
	23	0.52
	24	0.43

Date	Hour	Electricity Demand
13-Jul	1	0.39
	2	0.35
	3	0.35
	4	0.39
	5	0.43
	6	0.56
	7	0.61
	8	0.65
	9	0.69
	10	0.69
	11	0.65
	12	0.61
	13	0.56
	14	0.35
	15	0.48
	16	0.48
	17	0.52
	18	0.95
	19	0.65
	20	0.74
	21	0.74
	22	0.61
	23	0.52
	24	0.43

Date	Hour	Electricity Demand
14-Jul	1	0.39
	2	0.39
	3	0.39
	4	0.43
	5	0.43
	6	0.52
	7	0.61
	8	0.65
	9	0.65
	10	0.65
	11	0.61
	12	0.56
	13	1.39
	14	1.56
	15	2.08
	16	2.17
	17	2.34
	18	2.52
	19	1.82
	20	1.69
	21	1.39
	22	1.17
	23	0.95
	24	0.43

Date	Hour	Electricity Demand
15-Jul	1	0.43
	2	0.39
	3	0.39
	4	0.43
	5	0.43
	6	0.52
	7	0.61
	8	1.34
	9	1.82
	10	2.21
	11	2.26
	12	2.26
	13	2.39
	14	2.39
	15	2.69
	16	2.60
	17	2.39
	18	2.60
	19	2.08
	20	1.95
	21	1.74
	22	1.52
	23	1.26
	24	0.95

Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand
16-Jul	1	0.87	17-Jul	1	0.39	18-Jul	1	0.91	19-Jul	1	0.87	20-Jul	1	1.26	21-Jul	1	0.39	22-Jul	1	0.39
	2	0.39		2	0.39		2	0.82		2	0.43		2	1.08		2	0.39		2	0.39
	3	0.39		3	0.39		3	0.39		3	0.35		3	1.00		3	0.39		3	0.39
	4	0.43		4	0.43		4	0.43		4	0.43		4	0.95		4	0.39		4	0.39
	5	0.43		5	0.43		5	0.43		5	0.43		5	0.95		5	0.43		5	0.43
	6	0.52		6	0.52		6	0.52		6	0.52		6	1.08		6	0.52		6	0.52
	7	0.61		7	0.61		7	1.17		7	0.61		7	1.34		7	0.56		7	0.56
	8	0.65		8	1.39		8	1.61		8	0.65		8	1.69		8	0.65		8	0.65
	9	1.65		9	1.74		9	2.08		9	1.91		9	1.82		9	0.65		9	0.65
	10	1.95		10	2.13		10	2.47		10	2.26		10	1.95		10	0.65		10	0.65
	11	2.00		11	2.34		11	2.82		11	2.52		11	1.95		11	0.61		11	0.61
	12	2.13		12	2.47		12	2.86		12	2.56		12	1.91		12	1.48		12	1.48
	13	2.26		13	2.52		13	2.95		13	2.82		13	2.04		13	2.04		13	2.04
	14	2.17		14	2.39		14	2.69		14	2.78		14	1.82		14	2.08		14	2.08
	15	2.34		15	2.69		15	3.04		15	3.04		15	2.04		15	2.21		15	2.21
	16	2.34		16	2.78		16	3.12		16	3.21		16	2.26		16	2.21		16	2.21
	17	2.34		17	2.82		17	2.95		17	3.25		17	2.08		17	2.30		17	2.30
	18	2.43		18	2.91		18	3.08		18	3.30		18	2.08		18	2.30		18	2.30
	19	1.87		19	2.21		19	2.52		19	2.39		19	1.48		19	1.74		19	1.74
	20	1.69		20	2.00		20	2.21		20	2.34		20	1.39		20	1.69		20	1.69
	21	1.52		21	1.87		21	2.13		21	2.17		21	1.26		21	1.61		21	1.61
	22	1.21		22	1.65		22	1.69		22	1.95		22	1.04		22	1.30		22	1.30
	23	1.04		23	1.39		23	1.39		23	1.74		23	0.52		23	1.08		23	1.08
	24	0.43		24	1.08		24	1.04		24	1.39		24	0.43		24	0.87		24	0.87

Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand
23-Jul	1	0.39	24-Jul	1	0.39	25-Jul	1	0.39	26-Jul	1	0.39	27-Jul	1	0.39	28-Jul	1	0.82	29-Jul	1	0.82
	2	0.39		2	0.39		2	0.39		2	0.39		2	0.39		2	0.39		2	0.39
	3	0.35		3	0.39		3	0.39		3	0.35		3	0.39		3	0.39		3	0.39
	4	0.39		4	0.43		4	0.43		4	0.43		4	0.43		4	0.43		4	0.43
	5	0.43		5	0.43		5	0.43		5	0.43		5	0.43		5	0.43		5	0.43
	6	0.52		6	0.56		6	0.56		6	0.52		6	0.52		6	0.56		6	0.95
	7	0.61		7	0.61		7	0.61		7	0.61		7	0.61		7	0.61		7	1.26
	8	0.65		8	1.08		8	0.65		8	0.65		8	0.65		8	1.43		8	1.74
	9	1.48		9	1.56		9	0.69		9	0.69		9	1.52		9	2.00		9	2.08
	10	1.82		10	1.95		10	0.69		10	0.69		10	2.00		10	2.21		10	2.52
	11	2.21		11	2.08		11	1.82		11	0.65		11	2.26		11	2.69		11	2.69
	12	2.26		12	2.04		12	1.95		12	0.61		12	2.43		12	2.52		12	2.95
	13	2.34		13	2.21		13	2.08		13	0.56		13	2.56		13	2.47		13	3.04
	14	2.34		14	2.08		14	1.95		14	0.35		14	2.52		14	2.26		14	2.82
	15	2.56		15	2.26		15	2.26		15	0.48		15	2.82		15	2.65		15	2.95
	16	2.47		16	2.34		16	2.34		16	0.48		16	2.86		16	2.69		16	2.91
	17	2.30		17	2.43		17	2.26		17	0.52		17	2.82		17	2.56		17	2.65
	18	2.30		18	2.56		18	2.34		18	0.95		18	2.86		18	2.56		18	2.56
	19	1.78		19	1.91		19	1.69		19	0.65		19	2.08		19	1.91		19	1.69
	20	1.65		20	1.69		20	1.52		20	0.74		20	1.95		20	1.78		20	1.61
	21	1.52		21	1.48		21	1.34		21	0.74		21	1.74		21	1.56		21	1.52
	22	1.34		22	0.65		22	1.08		22	0.61		22	1.43		22	1.34		22	1.26
	23	1.08		23	0.52		23	0.52		23	0.52		23	1.26		23	1.13		23	1.04
	24	0.43		24	0.43		24	0.43		24	0.43		24	0.91		24	0.91		24	0.82

Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand
30-Jul	1	0.39	31-Jul	1	0.39	1-Aug	1	0.39	2-Aug	1	0.37	3-Aug	1	0.42	4-Aug	1	0.39	5-Aug	1	0.69
	2	0.39		2	0.39		2	0.38		2	0.36		2	0.41		2	0.36		2	0.39
	3	0.35		3	0.35		3	0.36		3	0.36		3	0.41		3	0.36		3	0.36
	4	0.39		4	0.39		4	0.42		4	0.41		4	0.43		4	0.43		4	0.42
	5	0.39		5	0.43		5	0.43		5	0.43		5	0.44		5	0.43		5	0.43
	6	0.48		6	0.56		6	0.56		6	0.54		6	0.56		6	0.59		6	0.56
	7	0.56		7	0.65		7	0.62		7	0.62		7	0.61		7	0.61		7	0.61
	8	0.65		8	0.69		8	0.65		8	0.65		8	0.65		8	1.23		8	0.65
	9	1.21		9	0.69		9	0.68		9	0.68		9	0.66		9	1.74		9	0.68
	10	1.74		10	0.69		10	0.67		10	0.68		10	1.52		10	2.13		10	1.87
	11	1.91		11	1.08		11	0.65		11	0.66		11	1.95		11	2.26		11	2.00
	12	2.00		12	0.61		12	1.00		12	0.59		12	1.96		12	2.26		12	2.15
	13	2.08		13	0.56		13	0.55		13	0.54		13	2.13		13	2.40		13	2.14
	14	2.52		14	0.35		14	0.35		14	0.35		14	1.95		14	2.30		14	2.13
	15	2.26		15	1.74		15	0.48		15	0.45		15	2.19		15	2.60		15	2.26
	16	2.30		16	1.87		16	0.47		16	0.44		16	2.20		16	2.65		16	2.26
	17	2.21		17	1.87		17	0.52		17	0.51		17	2.15		17	2.65		17	2.26
	18	2.26		18	2.08		18	0.95		18	0.91		18	2.16		18	2.78		18	2.34
	19	1.69		19	0.69		19	0.65		19	0.66		19	1.56		19	2.08		19	1.69
	20	1.61		20	0.74		20	0.74		20	0.72		20	1.54		20	2.00		20	1.52
	21	0.69		21	0.74		21	0.73		21	0.71		21	1.45		21	1.78		21	1.34
	22	0.65		22	0.65		22	0.63		22	0.62		22	1.24		22	1.52		22	1.13
	23	0.52		23	0.52		23	0.51		23	0.51		23	1.04		23	1.26		23	0.91
	24	0.43		24	0.43		24	0.43		24	0.43		24	0.43		24	0.95		24	0.43

Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand
6-Aug	1	0.39	7-Aug	1	0.39	8-Aug	1	0.95	9-Aug	1	0.36	10-Aug	1	0.41	11-Aug	1	0.39	12-Aug	1	0.39
	2	0.38		2	0.39		2	0.83		2	0.35		2	0.39		2	0.38		2	0.38
	3	0.38		3	0.38		3	0.79		3	0.35		3	0.39		3	0.36		3	0.36
	4	0.43		4	0.43		4	0.43		4	0.41		4	0.43		4	0.43		4	0.43
	5	0.43		5	0.43		5	0.43		5	0.43		5	0.44		5	0.43		5	0.43
	6	0.52		6	0.52		6	0.52		6	0.52		6	0.52		6	0.52		6	0.56
	7	0.61		7	0.56		7	1.13		7	0.61		7	0.56		7	0.61		7	0.61
	8	0.65		8	1.31		8	1.61		8	0.65		8	0.62		8	0.65		8	0.65
	9	1.65		9	1.82		9	2.00		9	0.67		9	1.58		9	0.69		9	0.69
	10	2.08		10	2.21		10	2.26		10	0.69		10	2.10		10	1.55		10	1.61
	11	2.18		11	2.43		11	2.34		11	0.65		11	2.20		11	1.91		11	1.48
	12	2.23		12	2.60		12	2.43		12	1.21		12	2.26		12	2.08		12	1.56
	13	2.24		13	2.65		13	2.56		13	1.52		13	2.18		13	2.18		13	1.61
	14	2.22		14	2.60		14	2.26		14	1.48		14	2.08		14	2.13		14	1.39
	15	2.62		15	2.86		15	2.39		15	1.91		15	2.60		15	2.26		15	1.52
	16	2.40		16	2.65		16	2.36		16	2.14		16	2.60		16	2.21		16	1.50
	17	2.39		17	2.69		17	2.34		17	2.13		17	2.60		17	2.13		17	1.48
	18	2.39		18	2.65		18	2.10		18	2.26		18	2.69		18	2.18		18	1.74
	19	1.74		19	2.08		19	0.61		19	1.69		19	2.08		19	1.58		19	1.34
	20	1.61		20	2.07		20	0.69		20	1.56		20	1.56		20	1.52		20	1.34
	21	1.39		21	1.82		21	0.66		21	1.43		21	1.46		21	1.39		21	1.31
	22	1.26		22	1.69		22	0.61		22	1.21		22	1.21		22	1.20		22	1.20
	23	1.04		23	1.39		23	0.50		23	1.00		23	0.95		23	0.95		23	1.00
	24	0.82		24	1.13		24	0.43		24	0.43		24	0.43		24	0.43		24	0.43

Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand
13-Aug	1	0.39	14-Aug	1	0.39	15-Aug	1	0.39	16-Aug	1	0.39	17-Aug	1	0.39	18-Aug	1	0.39	19-Aug	1	0.39
	2	0.38		2	0.38		2	0.38		2	0.38		2	0.38		2	0.38		2	0.37
	3	0.36		3	0.36		3	0.36		3	0.36		3	0.36		3	0.36		3	0.35
	4	0.43		4	0.43		4	0.43		4	0.43		4	0.43		4	0.43		4	0.42
	5	0.43		5	0.43		5	0.43		5	0.43		5	0.43		5	0.43		5	0.43
	6	0.56		6	0.52		6	0.52		6	0.52		6	0.53		6	0.53		6	0.53
	7	0.61		7	0.56		7	0.56		7	0.56		7	0.61		7	0.61		7	0.61
	8	0.65		8	1.04		8	0.61		8	0.61		8	0.66		8	0.66		8	0.65
	9	0.69		9	1.31		9	1.82		9	0.65		9	0.69		9	0.68		9	0.69
	10	1.37		10	1.56		10	2.26		10	0.65		10	0.69		10	0.69		10	0.69
	11	1.74		11	1.61		11	2.43		11	0.63		11	0.67		11	0.66		11	0.65
	12	1.78		12	1.74		12	2.65		12	0.61		12	0.58		12	0.59		12	0.56
	13	1.69		13	1.82		13	2.73		13	0.56		13	0.54		13	0.54		13	0.95
	14	1.65		14	1.91		14	2.59		14	0.35		14	0.35		14	0.35		14	0.35
	15	1.95		15	2.16		15	2.86		15	1.34		15	0.48		15	0.57		15	1.39
	16	2.13		16	2.34		16	2.91		16	1.52		16	0.95		16	0.48		16	1.52
	17	2.17		17	2.26		17	2.69		17	1.65		17	1.34		17	0.52		17	1.56
	18	2.34		18	2.34		18	2.43		18	1.91		18	1.61		18	0.93		18	1.78
	19	1.82		19	1.82		19	1.87		19	1.26		19	1.13		19	0.67		19	0.65
	20	1.74		20	1.78		20	1.69		20	1.17		20	1.13		20	0.72		20	0.74
	21	1.61		21	1.56		21	1.65		21	0.69		21	0.72		21	0.71		21	0.72
	22	1.39		22	1.34		22	1.34		22	0.65		22	0.65		22	0.65		22	0.65
	23	1.13		23	1.13		23	1.04		23	0.52		23	0.51		23	0.51		23	0.52
	24	0.87		24	0.91		24	0.43		24	0.43		24	0.43		24	0.43		24	0.43

Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand
20-Aug	1	0.39	21-Aug	1	0.39	22-Aug	1	0.39	23-Aug	1	0.39	24-Aug	1	0.39	25-Aug	1	0.39	26-Aug	1	0.39
	2	0.38		2	0.38		2	0.38		2	0.38		2	0.38		2	0.38		2	0.38
	3	0.38		3	0.38		3	0.36		3	0.36		3	0.36		3	0.36		3	0.36
	4	0.42		4	0.42		4	0.42		4	0.42		4	0.42		4	0.42		4	0.42
	5	0.43		5	0.43		5	0.43		5	0.43		5	0.43		5	0.43		5	0.43
	6	0.52		6	0.52		6	0.54		6	0.54		6	0.54		6	0.54		6	0.54
	7	0.56		7	0.56		7	0.61		7	0.61		7	0.61		7	0.61		7	0.61
	8	0.61		8	0.61		8	0.65		8	0.65		8	0.65		8	0.65		8	0.65
	9	0.65		9	0.65		9	0.68		9	0.68		9	0.68		9	0.68		9	0.68
	10	1.08		10	1.65		10	1.26		10	1.26		10	0.69		10	0.69		10	0.69
	11	1.48		11	1.95		11	1.52		11	1.52		11	0.65		11	0.65		11	0.67
	12	1.65		12	2.13		12	1.74		12	1.74		12	1.06		12	0.59		12	0.60
	13	1.82		13	2.26		13	1.87		13	1.87		13	1.21		13	0.54		13	0.54
	14	1.69		14	2.21		14	1.78		14	1.78		14	1.06		14	0.35		14	0.35
	15	1.91		15	2.56		15	1.91		15	1.91		15	1.11		15	0.49		15	0.49
	16	1.93		16	2.52		16	1.87		16	1.87		16	1.11		16	0.48		16	0.48
	17	1.91		17	2.39		17	1.69		17	1.69		17	1.10		17	0.52		17	0.52
	18	2.00		18	2.43		18	0.91		18	0.91		18	1.38		18	0.95		18	0.95
	19	1.39		19	1.78		19	0.65		19	0.65		19	1.07		19	0.68		19	0.68
	20	1.30		20	1.65		20	0.74		20	0.74		20	1.20		20	0.74		20	0.74
	21	1.21		21	1.52		21	0.69		21	0.69		21	1.15		21	0.73		21	0.73
	22	0.65		22	1.30		22	0.61		22	0.61		22	0.67		22	0.65		22	0.65
	23	0.50		23	1.13		23	0.52		23	0.52		23	0.89		23	0.51		23	0.51
	24	0.43		24	0.82		24	0.43		24	0.43		24	0.43		24	0.43		24	0.43

Date	Hour	Electricity Demand
27-Aug	1	0.39
	2	0.38
	3	0.36
	4	0.42
	5	0.43
	6	0.54
	7	0.61
	8	0.63
	9	0.64
	10	0.65
	11	0.64
	12	0.61
	13	0.59
	14	1.08
	15	1.48
	16	1.56
	17	1.58
	18	1.78
	19	0.65
	20	0.74
	21	0.73
	22	0.65
	23	0.51
	24	0.43

Date	Hour	Electricity Demand
28-Aug	1	0.39
	2	0.38
	3	0.36
	4	0.42
	5	0.43
	6	0.54
	7	0.61
	8	0.65
	9	0.68
	10	0.69
	11	0.67
	12	0.59
	13	0.54
	14	0.35
	15	0.49
	16	0.48
	17	0.52
	18	0.95
	19	0.68
	20	0.74
	21	0.73
	22	0.65
	23	0.51
	24	0.43

Date	Hour	Electricity Demand
29-Aug	1	0.39
	2	0.38
	3	0.36
	4	0.42
	5	0.43
	6	0.54
	7	0.61
	8	0.63
	9	0.65
	10	0.65
	11	1.21
	12	1.43
	13	1.78
	14	1.82
	15	2.21
	16	2.34
	17	2.26
	18	2.43
	19	1.74
	20	1.56
	21	1.34
	22	1.17
	23	0.91
	24	0.43

Date	Hour	Electricity Demand
30-Aug	1	0.39
	2	0.38
	3	0.36
	4	0.42
	5	0.43
	6	0.54
	7	0.56
	8	0.61
	9	1.26
	10	1.80
	11	2.08
	12	2.24
	13	2.34
	14	2.26
	15	2.47
	16	2.43
	17	2.39
	18	2.30
	19	1.56
	20	1.52
	21	1.43
	22	1.29
	23	1.08
	24	0.85

Date	Hour	Electricity Demand
31-Aug	1	0.39
	2	0.38
	3	0.36
	4	0.42
	5	0.43
	6	0.54
	7	0.59
	8	0.61
	9	0.65
	10	1.65
	11	2.00
	12	2.17
	13	2.34
	14	2.26
	15	2.52
	16	2.39
	17	2.21
	18	2.24
	19	1.65
	20	1.52
	21	1.39
	22	1.17
	23	1.04
	24	0.43

Date	Hour	Electricity Demand
1-Sep	1	0.39
	2	0.38
	3	0.36
	4	0.42
	5	0.43
	6	0.52
	7	0.56
	8	0.61
	9	0.65
	10	1.39
	11	1.65
	12	1.74
	13	1.82
	14	1.65
	15	1.78
	16	1.80
	17	1.72
	18	0.95
	19	0.65
	20	0.74
	21	0.73
	22	0.65
	23	0.52
	24	0.43

Date	Hour	Electricity Demand
2-Sep	1	0.39
	2	0.38
	3	0.36
	4	0.42
	5	0.43
	6	0.54
	7	0.61
	8	0.65
	9	0.68
	10	0.69
	11	0.67
	12	0.59
	13	0.54
	14	0.35
	15	0.49
	16	0.48
	17	0.52
	18	0.95
	19	0.68
	20	0.74
	21	0.73
	22	0.65
	23	0.51
	24	0.43

Date	Hour	Electricity Demand
3-Sep	1	0.39
	2	0.38
	3	0.36
	4	0.42
	5	0.43
	6	0.56
	7	0.61
	8	0.65
	9	0.68
	10	0.68
	11	0.67
	12	0.61
	13	0.54
	14	1.06
	15	1.48
	16	0.43
	17	0.52
	18	0.95
	19	0.68
	20	0.74
	21	0.73
	22	0.65
	23	0.51
	24	0.43

Date	Hour	Electricity Demand
4-Sep	1	0.39
	2	0.38
	3	0.36
	4	0.42
	5	0.43
	6	0.52
	7	0.56
	8	0.61
	9	0.65
	10	0.65
	11	0.63
	12	1.26
	13	1.56
	14	1.58
	15	1.82
	16	1.87
	17	1.78
	18	1.78
	19	1.28
	20	1.26
	21	1.13
	22	0.65
	23	0.52
	24	0.43

Date	Hour	Electricity Demand
5-Sep	1	0.39
	2	0.38
	3	0.36
	4	0.42
	5	0.43
	6	0.52
	7	0.57
	8	0.61
	9	0.65
	10	1.65
	11	1.95
	12	2.21
	13	2.30
	14	2.17
	15	2.43
	16	2.21
	17	2.04
	18	2.13
	19	1.61
	20	1.61
	21	1.48
	22	1.26
	23	1.08
	24	0.87

Date	Hour	Electricity Demand
6-Sep	1	0.39
	2	0.38
	3	0.36
	4	0.42
	5	0.43
	6	0.52
	7	0.56
	8	0.61
	9	0.65
	10	0.65
	11	0.64
	12	1.34
	13	1.65
	14	1.69
	15	2.17
	16	2.21
	17	2.17
	18	2.21
	19	1.61
	20	1.48
	21	1.34
	22	1.13
	23	0.52
	24	0.43

Date	Hour	Electricity Demand
7-Sep	1	0.39
	2	0.38
	3	0.36
	4	0.42
	5	0.43
	6	0.52
	7	0.56
	8	0.61
	9	0.65
	10	1.61
	11	2.08
	12	2.10
	13	2.17
	14	1.93
	15	1.48
	16	1.61
	17	1.62
	18	1.91
	19	0.65
	20	0.74
	21	0.73
	22	0.65
	23	0.52
	24	0.43

Date	Hour	Electricity Demand
8-Sep	1	0.39
	2	0.38
	3	0.36
	4	0.42
	5	0.43
	6	0.54
	7	0.61
	8	0.65
	9	0.68
	10	0.69
	11	0.65
	12	0.57
	13	0.52
	14	0.33
	15	0.47
	16	0.46
	17	0.50
	18	0.93
	19	0.68
	20	0.74
	21	0.73
	22	0.65
	23	0.51
	24	0.43

Date	Hour	Electricity Demand
9-Sep	1	0.39
	2	0.38
	3	0.36
	4	0.42
	5	0.43
	6	0.54
	7	0.61
	8	0.65
	9	0.68
	10	0.69
	11	0.65
	12	0.57
	13	0.52
	14	0.35
	15	0.95
	16	0.48
	17	0.50
	18	0.93
	19	0.68
	20	0.74
	21	0.73
	22	0.65
	23	0.51
	24	0.43

Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand
10-Sep	1	0.39	11-Sep	1	0.39	12-Sep	1	0.39	13-Sep	1	0.39	14-Sep	1	0.39	15-Sep	1	0.39	16-Sep	1	0.39
	2	0.38		2	0.38		2	0.38		2	0.38		2	0.38		2	0.38		2	0.38
	3	0.36		3	0.36		3	0.36		3	0.36		3	0.36		3	0.36		3	0.36
	4	0.42		4	0.42		4	0.42		4	0.42		4	0.42		4	0.42		4	0.42
	5	0.43		5	0.43		5	0.43		5	0.43		5	0.43		5	0.43		5	0.43
	6	0.48		6	0.54		6	0.54		6	0.56		6	0.56		6	0.56		6	0.54
	7	0.56		7	0.61		7	0.61		7	0.61		7	0.61		7	0.61		7	0.61
	8	0.67		8	0.65		8	0.65		8	0.65		8	0.65		8	0.65		8	0.63
	9	0.71		9	0.68		9	0.68		9	0.68		9	0.68		9	0.67		9	0.64
	10	0.72		10	0.69		10	0.69		10	0.68		10	0.68		10	0.68		10	0.65
	11	0.70		11	0.65		11	0.65		11	0.67		11	1.17		11	0.66		11	0.64
	12	0.66		12	0.57		12	0.57		12	0.59		12	1.48		12	1.24		12	1.95
	13	0.59		13	0.52		13	0.52		13	0.58		13	1.69		13	1.56		13	2.21
	14	0.82		14	0.33		14	0.33		14	1.17		14	1.78		14	1.78		14	2.26
	15	0.52		15	0.47		15	0.47		15	1.48		15	2.13		15	2.13		15	2.52
	16	0.51		16	0.46		16	0.46		16	1.67		16	2.00		16	2.21		16	2.52
	17	0.53		17	0.50		17	0.50		17	1.56		17	1.74		17	2.04		17	2.26
	18	0.89		18	0.93		18	0.93		18	1.58		18	1.78		18	2.00		18	2.21
	19	0.67		19	0.68		19	0.68		19	0.66		19	0.65		19	1.52		19	1.78
	20	0.72		20	0.74		20	0.74		20	0.71		20	0.74		20	1.48		20	1.65
	21	0.71		21	0.73		21	0.73		21	0.79		21	0.73		21	1.30		21	1.56
	22	0.65		22	0.65		22	0.65		22	0.65		22	0.65		22	1.08		22	1.39
	23	0.53		23	0.51		23	0.51		23	0.51		23	0.51		23	0.91		23	1.21
	24	0.43		24	0.43		24	0.43		24	0.43		24	0.43		24	0.43		24	0.95

Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand
17-Sep	1	0.80	18-Sep	1	0.39	19-Sep	1	0.39	20-Sep	1	0.39	21-Sep	1	0.39	22-Sep	1	0.39	23-Sep	1	0.39
	2	0.38		2	0.38		2	0.38		2	0.38		2	0.38		2	0.38		2	0.38
	3	0.36		3	0.36		3	0.36		3	0.36		3	0.36		3	0.36		3	0.36
	4	0.42		4	0.42		4	0.42		4	0.42		4	0.42		4	0.42		4	0.42
	5	0.43		5	0.43		5	0.43		5	0.43		5	0.43		5	0.43		5	0.43
	6	0.54		6	0.54		6	0.54		6	0.54		6	0.54		6	0.54		6	0.54
	7	0.61		7	0.61		7	0.61		7	0.61		7	0.61		7	0.61		7	0.61
	8	0.65		8	0.65		8	0.65		8	0.65		8	0.65		8	0.63		8	0.63
	9	0.68		9	0.68		9	0.68		9	0.68		9	0.68		9	0.65		9	0.65
	10	0.69		10	0.69		10	0.69		10	0.69		10	0.69		10	0.65		10	0.65
	11	0.66		11	0.65		11	0.65		11	0.65		11	0.65		11	1.08		11	0.64
	12	0.60		12	0.57		12	0.57		12	0.57		12	0.57		12	0.58		12	0.61
	13	0.54		13	0.52		13	0.52		13	0.52		13	0.52		13	1.43		13	1.80
	14	0.35		14	0.33		14	0.33		14	0.33		14	0.33		14	1.56		14	1.78
	15	0.49		15	0.47		15	0.47		15	0.47		15	0.47		15	1.91		15	2.13
	16	0.48		16	0.46		16	0.46		16	0.46		16	0.46		16	1.95		16	2.15
	17	0.52		17	0.50		17	0.50		17	0.50		17	0.50		17	0.52		17	1.91
	18	0.92		18	0.93		18	0.93		18	0.93		18	0.93		18	0.91		18	0.93
	19	0.68		19	0.68		19	0.68		19	0.68		19	0.68		19	0.65		19	0.65
	20	0.74		20	0.74		20	0.74		20	0.74		20	0.74		20	0.69		20	0.69
	21	0.73		21	0.73		21	0.73		21	0.73		21	0.73		21	0.68		21	0.69
	22	0.65		22	0.65		22	0.65		22	0.65		22	0.65		22	0.65		22	0.65
	23	0.51		23	0.51		23	0.51		23	0.51		23	0.51		23	0.51		23	0.51
	24	0.43		24	0.43		24	0.43		24	0.43		24	0.43		24	0.43		24	0.43

Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand
24-Sep	1	0.39	25-Sep	1	0.39	26-Sep	1	0.39	27-Sep	1	0.39	28-Sep	1	0.39	29-Sep	1	0.39	30-Sep	1	0.39
	2	0.38		2	0.38		2	0.38		2	0.38		2	0.38		2	0.38		2	0.38
	3	0.36		3	0.36		3	0.36		3	0.36		3	0.36		3	0.36		3	0.36
	4	0.42		4	0.42		4	0.42		4	0.42		4	0.42		4	0.42		4	0.42
	5	0.43		5	0.43		5	0.43		5	0.43		5	0.43		5	0.48		5	0.43
	6	0.54		6	0.54		6	0.54		6	0.54		6	0.54		6	0.65		6	0.54
	7	0.61		7	0.61		7	0.61		7	0.61		7	0.61		7	0.69		7	0.61
	8	0.65		8	0.65		8	0.65		8	0.65		8	0.65		8	0.68		8	0.65
	9	0.68		9	1.48		9	1.48		9	0.68		9	0.68		9	0.69		9	0.68
	10	0.69		10	2.13		10	2.13		10	0.69		10	0.69		10	0.69		10	0.69
	11	0.67		11	2.52		11	2.52		11	0.65		11	0.65		11	0.67		11	0.65
	12	1.30		12	2.69		12	2.69		12	0.57		12	0.57		12	0.61		12	0.57
	13	1.56		13	3.01		13	3.01		13	0.52		13	0.52		13	0.54		13	0.52
	14	0.35		14	2.78		14	2.78		14	0.33		14	0.33		14	0.35		14	0.33
	15	0.49		15	2.82		15	2.82		15	0.47		15	0.47		15	0.49		15	0.47
	16	0.48		16	2.69		16	2.69		16	0.46		16	0.46		16	0.48		16	0.46
	17	0.52		17	2.34		17	2.34		17	0.50		17	0.50		17	0.52		17	0.50
	18	0.95		18	2.39		18	2.39		18	0.93		18	0.93		18	0.95		18	0.93
	19	0.65		19	1.87		19	1.87		19	0.68		19	0.68		19	0.67		19	0.68
	20	0.72		20	1.82		20	1.82		20	0.74		20	0.74		20	0.73		20	0.74
	21	0.71		21	1.65		21	1.65		21	0.73		21	0.73		21	0.72		21	0.73
	22	0.65		22	1.39		22	1.39		22	0.65		22	0.65		22	0.65		22	0.65
	23	0.51		23	1.13		23	1.13		23	0.51		23	0.51		23	0.51		23	0.51
	24	0.43		24	0.82		24	0.82		24	0.43		24	0.43		24	0.43		24	0.43

Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand
1-Oct	1	0.37	2-Oct	1	0.37	3-Oct	1	0.42	4-Oct	1	0.43	5-Oct	1	0.42	6-Oct	1	0.43	7-Oct	1	0.43
	2	0.36		2	0.36		2	0.38		2	0.39		2	0.38		2	0.40		2	0.38
	3	0.36		3	0.42		3	0.37		3	0.38		3	0.37		3	0.37		3	0.37
	4	0.42		4	0.45		4	0.38		4	0.38		4	0.37		4	0.39		4	0.38
	5	0.45		5	0.49		5	0.44		5	0.44		5	0.45		5	0.45		5	0.45
	6	0.60		6	0.62		6	0.56		6	0.58		6	0.58		6	0.55		6	0.59
	7	0.64		7	0.69		7	0.69		7	0.69		7	0.69		7	0.69		7	0.69
	8	0.68		8	0.68		8	0.73		8	0.75		8	0.73		8	0.72		8	0.75
	9	0.69		9	0.69		9	0.72		9	0.75		9	0.72		9	0.73		9	0.74
	10	0.69		10	0.69		10	0.71		10	0.74		10	0.71		10	0.72		10	0.72
	11	0.66		11	0.66		11	0.71		11	0.73		11	0.71		11	0.71		11	0.71
	12	0.61		12	0.60		12	0.70		12	0.71		12	0.70		12	0.70		12	0.70
	13	0.54		13	0.54		13	0.69		13	0.69		13	0.69		13	0.69		13	0.69
	14	0.35		14	0.35		14	0.66		14	0.66		14	0.66		14	0.66		14	0.66
	15	0.46		15	0.48		15	0.63		15	0.63		15	0.63		15	0.63		15	0.63
	16	0.45		16	0.47		16	0.64		16	0.65		16	0.65		16	0.65		16	0.65
	17	0.52		17	0.52		17	0.71		17	0.71		17	0.71		17	0.70		17	0.71
	18	0.93		18	0.95		18	0.87		18	0.87		18	0.87		18	0.87		18	0.87
	19	0.67		19	0.67		19	0.95		19	0.96		19	0.96		19	0.96		19	0.96
	20	0.74		20	0.73		20	0.94		20	0.94		20	0.94		20	0.94		20	0.94
	21	0.73		21	0.72		21	0.87		21	0.87		21	0.87		21	0.87		21	0.87
	22	0.66		22	0.64		22	0.78		22	0.78		22	0.78		22	0.78		22	0.78
	23	0.51		23	0.51		23	0.67		23	0.67		23	0.67		23	0.67		23	0.67
	24	0.43		24	0.43		24	0.52		24	0.53		24	0.52		24	0.53		24	0.53

Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand
8-Oct	1	0.43	9-Oct	1	0.43	10-Oct	1	0.43	11-Oct	1	0.43	12-Oct	1	0.43	13-Oct	1	0.43	14-Oct	1	0.43
	2	0.40		2	0.39		2	0.40		2	0.39		2	0.39		2	0.39		2	0.41
	3	0.45		3	0.38		3	0.39		3	0.37		3	0.38		3	0.38		3	0.39
	4	0.41		4	0.39		4	0.40		4	0.40		4	0.39		4	0.39		4	0.41
	5	0.50		5	0.45		5	0.45		5	0.45		5	0.45		5	0.45		5	0.43
	6	0.62		6	0.56		6	0.56		6	0.57		6	0.59		6	0.57		6	0.56
	7	0.69		7	0.69		7	0.69		7	0.69		7	0.69		7	0.69		7	0.69
	8	0.74		8	0.74		8	0.74		8	0.74		8	0.75		8	0.74		8	0.74
	9	0.72		9	0.72		9	0.74		9	0.73		9	0.73		9	0.73		9	0.74
	10	0.72		10	0.72		10	0.74		10	0.72		10	0.72		10	0.72		10	0.74
	11	0.71		11	0.71		11	0.72		11	0.71		11	0.71		11	0.71		11	0.71
	12	0.70		12	0.70		12	0.70		12	0.70		12	0.70		12	0.70		12	1.17
	13	0.69		13	0.69		13	0.69		13	0.69		13	0.69		13	0.69		13	1.61
	14	0.66		14	0.65		14	0.66		14	0.66		14	0.66		14	0.66		14	1.87
	15	0.63		15	1.39		15	1.78		15	0.62		15	0.63		15	1.19		15	2.00
	16	1.00		16	0.63		16	1.91		16	0.64		16	0.64		16	0.65		16	1.95
	17	0.71		17	0.71		17	0.69		17	0.71		17	0.71		17	0.71		17	1.52
	18	0.87		18	0.87		18	0.87		18	0.87		18	0.87		18	0.87		18	1.30
	19	0.95		19	0.96		19	0.95		19	0.97		19	0.96		19	0.96		19	0.95
	20	0.94		20	0.93		20	0.93		20	0.93		20	0.93		20	0.93		20	0.93
	21	0.87		21	0.88		21	0.87		21	0.87		21	0.87		21	0.87		21	0.87
	22	0.78		22	0.78		22	0.78		22	0.78		22	0.78		22	0.78		22	0.78
	23	0.67		23	0.67		23	0.67		23	0.66		23	0.67		23	0.67		23	0.67
	24	0.52		24	0.52		24	0.52		24	0.52		24	0.52		24	0.53		24	0.51

Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand
15-Oct	1	0.43	16-Oct	1	0.43	17-Oct	1	0.43	18-Oct	1	0.43	19-Oct	1	0.43	20-Oct	1	0.43	21-Oct	1	0.48
	2	0.41		2	0.42		2	0.39		2	0.37		2	0.37		2	0.39		2	0.45
	3	0.39		3	0.41		3	0.38		3	0.36		3	0.36		3	0.37		3	0.44
	4	0.39		4	0.42		4	0.39		4	0.37		4	0.37		4	0.37		4	0.46
	5	0.43		5	0.44		5	0.44		5	0.44		5	0.45		5	0.38		5	0.51
	6	0.56		6	0.56		6	0.56		6	0.57		6	0.56		6	0.44		6	0.63
	7	0.69		7	0.69		7	0.69		7	0.69		7	0.69		7	0.55		7	0.75
	8	0.74		8	0.74		8	0.74		8	0.73		8	0.75		8	0.69		8	0.82
	9	0.74		9	0.74		9	0.73		9	0.72		9	0.73		9	0.72		9	0.81
	10	0.74		10	0.74		10	0.72		10	0.71		10	0.72		10	0.73		10	0.80
	11	1.34		11	0.72		11	0.71		11	0.71		11	0.71		11	0.73		11	0.79
	12	1.82		12	0.71		12	0.70		12	0.70		12	0.70		12	0.73		12	0.76
	13	2.13		13	1.93		13	0.69		13	0.69		13	0.69		13	0.71		13	0.69
	14	2.25		14	2.15		14	1.03		14	0.66		14	0.66		14	0.70		14	0.66
	15	2.43		15	2.20		15	0.62		15	0.63		15	0.63		15	0.68		15	0.63
	16	2.17		16	2.13		16	0.64		16	0.65		16	0.65		16	0.64		16	0.65
	17	1.82		17	1.69		17	0.71		17	0.71		17	0.71		17	0.66		17	0.78
	18	1.69		18	0.87		18	0.87		18	0.87		18	0.87		18	0.72		18	0.94
	19	1.50		19	0.91		19	0.95		19	0.96		19	0.96		19	0.88		19	1.02
	20	1.34		20	0.91		20	0.94		20	0.94		20	0.93		20	1.02		20	1.01
	21	0.87		21	0.87		21	0.87		21	0.87		21	0.87		21	1.01		21	0.93
	22	0.78		22	0.78		22	0.78		22	0.78		22	0.78		22	0.95		22	0.85
	23	0.66		23	0.67		23	0.64		23	0.64		23	0.67		23	0.86		23	0.69
	24	0.52		24	0.52		24	0.52		24	0.52		24	0.52		24	0.69		24	0.56

Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand
22-Oct	1	0.51	23-Oct	1	0.46	24-Oct	1	0.43	25-Oct	1	0.49	26-Oct	1	0.48	27-Oct	1	0.43	28-Oct	1	0.42
	2	0.47		2	0.45		2	0.39		2	0.47		2	0.46		2	0.39		2	0.39
	3	0.46		3	0.43		3	0.38		3	0.46		3	0.45		3	0.38		3	0.38
	4	0.45		4	0.46		4	0.39		4	0.47		4	0.46		4	0.41		4	0.39
	5	0.46		5	0.50		5	0.45		5	0.51		5	0.51		5	0.45		5	0.45
	6	0.56		6	0.62		6	0.56		6	0.65		6	0.61		6	0.61		6	0.55
	7	0.65		7	0.74		7	0.69		7	0.76		7	0.77		7	0.70		7	0.70
	8	0.78		8	0.75		8	0.75		8	0.81		8	0.81		8	0.76		8	0.77
	9	0.82		9	0.75		9	0.75		9	0.81		9	0.80		9	0.75		9	0.76
	10	0.83		10	0.74		10	0.79		10	0.80		10	0.74		10	0.72		10	0.75
	11	0.82		11	0.73		11	0.79		11	0.79		11	0.72		11	0.71		11	0.74
	12	0.81		12	0.71		12	0.78		12	0.78		12	0.70		12	0.70		12	0.72
	13	0.78		13	0.69		13	0.75		13	0.75		13	0.69		13	0.69		13	0.69
	14	0.75		14	0.67		14	0.72		14	0.71		14	0.66		14	0.66		14	0.67
	15	0.70		15	0.65		15	0.69		15	0.69		15	0.63		15	0.63		15	0.64
	16	0.71		16	0.66		16	0.70		16	0.70		16	0.65		16	0.65		16	0.66
	17	0.79		17	0.71		17	0.79		17	0.79		17	0.71		17	0.71		17	0.72
	18	0.89		18	0.87		18	0.95		18	0.94		18	0.87		18	0.87		18	0.88
	19	0.98		19	0.97		19	1.03		19	1.03		19	0.96		19	0.96		19	0.97
	20	1.00		20	0.95		20	1.02		20	1.02		20	0.94		20	0.94		20	0.95
	21	0.93		21	0.87		21	0.95		21	0.95		21	0.87		21	0.87		21	0.94
	22	0.85		22	0.78		22	0.86		22	0.86		22	0.78		22	0.78		22	0.85
	23	0.69		23	0.67		23	0.69		23	0.69		23	0.67		23	0.67		23	0.70
	24	0.56		24	0.52		24	0.57		24	0.58		24	0.52		24	0.52		24	0.56

Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand
29-Oct	1	0.46	30-Oct	1	0.43	31-Oct	1	0.48	1-Nov	1	0.42	2-Nov	1	0.46	3-Nov	1	0.47	4-Nov	1	0.43
	2	0.45		2	0.39		2	0.46		2	0.39		2	0.45		2	0.45		2	0.39
	3	0.44		3	0.38		3	0.45		3	0.38		3	0.44		3	0.45		3	0.38
	4	0.45		4	0.40		4	0.46		4	0.40		4	0.45		4	0.46		4	0.37
	5	0.50		5	0.45		5	0.46		5	0.45		5	0.52		5	0.51		5	0.45
	6	0.61		6	0.55		6	0.55		6	0.54		6	0.78		6	0.61		6	0.53
	7	0.76		7	0.70		7	0.70		7	0.70		7	0.81		7	0.76		7	0.69
	8	0.81		8	0.77		8	0.81		8	0.78		8	0.80		8	0.80		8	0.75
	9	0.80		9	0.76		9	0.76		9	0.76		9	0.79		9	0.79		9	0.75
	10	0.79		10	0.75		10	0.75		10	0.75		10	0.78		10	0.79		10	0.74
	11	0.75		11	0.74		11	0.74		11	0.74		11	0.76		11	0.79		11	0.73
	12	0.71		12	0.72		12	0.71		12	0.72		12	0.75		12	0.78		12	0.70
	13	0.69		13	0.69		13	0.69		13	0.69		13	0.72		13	0.69		13	0.69
	14	0.66		14	0.68		14	0.67		14	0.67		14	0.69		14	0.67		14	0.67
	15	0.63		15	0.65		15	0.64		15	0.65		15	0.68		15	0.64		15	0.64
	16	0.65		16	0.67		16	0.66		16	0.66		16	0.69		16	0.66		16	0.66
	17	0.71		17	0.72		17	0.72		17	0.72		17	0.78		17	0.72		17	0.71
	18	0.87		18	0.88		18	0.88		18	0.88		18	0.94		18	0.88		18	0.87
	19	0.97		19	0.97		19	0.97		19	1.03		19	1.03		19	0.97		19	0.97
	20	0.95		20	0.95		20	0.95		20	1.02		20	1.02		20	0.99		20	0.95
	21	0.87		21	0.88		21	0.88		21	0.94		21	0.94		21	0.94		21	0.87
	22	0.81		22	0.79		22	0.79		22	0.85		22	0.85		22	0.81		22	0.78
	23	0.67		23	0.67		23	0.67		23	0.71		23	0.71		23	0.67		23	0.67
	24	0.52		24	0.55		24	0.52		24	0.56		24	0.59		24	0.52		24	0.53

Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand
5-Nov	1	0.43	6-Nov	1	0.43	7-Nov	1	0.43	8-Nov	1	0.46	9-Nov	1	0.48	10-Nov	1	0.49	11-Nov	1	0.49
	2	0.39		2	0.69		2	0.39		2	0.44		2	0.46		2	0.47		2	0.48
	3	0.38		3	0.37		3	0.38		3	0.44		3	0.45		3	0.46		3	0.47
	4	0.39		4	0.38		4	0.39		4	0.45		4	0.47		4	0.49		4	0.48
	5	0.45		5	0.45		5	0.45		5	0.51		5	0.51		5	0.52		5	0.51
	6	0.54		6	0.54		6	0.54		6	0.62		6	0.62		6	0.62		6	0.62
	7	0.69		7	0.69		7	0.70		7	0.75		7	0.78		7	0.79		7	0.78
	8	0.75		8	0.74		8	0.78		8	0.81		8	0.83		8	0.84		8	0.82
	9	0.74		9	0.74		9	0.76		9	0.80		9	0.82		9	0.82		9	0.82
	10	0.73		10	0.73		10	0.75		10	0.79		10	0.82		10	0.81		10	0.81
	11	0.72		11	0.72		11	0.74		11	0.78		11	0.81		11	0.79		11	0.79
	12	0.70		12	0.70		12	0.71		12	0.77		12	0.79		12	0.77		12	0.76
	13	0.69		13	0.69		13	0.69		13	0.69		13	0.75		13	0.75		13	0.74
	14	0.67		14	0.67		14	0.66		14	0.67		14	0.70		14	0.70		14	0.69
	15	0.64		15	0.64		15	0.64		15	0.69		15	0.69		15	0.69		15	0.68
	16	0.65		16	0.66		16	0.65		16	0.67		16	0.70		16	0.70		16	0.69
	17	0.71		17	0.71		17	0.71		17	0.78		17	0.79		17	0.80		17	0.78
	18	0.87		18	0.87		18	0.88		18	0.94		18	0.95		18	0.95		18	0.94
	19	0.97		19	0.97		19	0.97		19	1.03		19	1.03		19	1.04		19	1.03
	20	0.94		20	0.95		20	0.95		20	1.02		20	1.02		20	1.02		20	1.02
	21	0.87		21	0.88		21	0.94		21	0.95		21	0.95		21	0.95		21	0.95
	22	0.78		22	0.78		22	0.85		22	0.85		22	0.86		22	0.86		22	0.85
	23	0.68		23	0.67		23	0.70		23	0.71		23	0.71		23	0.72		23	0.71
	24	0.53		24	0.52		24	0.56		24	0.57		24	0.57		24	0.58		24	0.56

Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand
12-Nov	1	0.47	13-Nov	1	0.43	14-Nov	1	0.43	15-Nov	1	0.43	16-Nov	1	0.47	17-Nov	1	0.43	18-Nov	1	0.46
	2	0.46		2	0.39		2	0.39		2	0.39		2	0.46		2	0.39		2	0.44
	3	0.45		3	0.38		3	0.36		3	0.37		3	0.46		3	0.38		3	0.44
	4	0.46		4	0.39		4	0.39		4	0.38		4	0.47		4	0.40		4	0.45
	5	0.50		5	0.45		5	0.45		5	0.45		5	0.51		5	0.45		5	0.51
	6	0.61		6	0.54		6	0.54		6	0.54		6	0.61		6	0.54		6	0.62
	7	0.76		7	0.69		7	0.70		7	0.70		7	0.76		7	0.69		7	0.77
	8	0.81		8	0.75		8	0.75		8	0.80		8	0.82		8	0.76		8	0.82
	9	0.80		9	0.75		9	0.75		9	0.79		9	0.81		9	0.75		9	0.88
	10	0.79		10	0.74		10	0.74		10	0.74		10	0.80		10	0.74		10	0.81
	11	0.73		11	0.73		11	0.73		11	0.72		11	0.74		11	0.73		11	0.81
	12	0.70		12	0.70		12	0.71		12	0.70		12	0.71		12	0.71		12	0.77
	13	0.69		13	0.69		13	0.69		13	0.69		13	0.69		13	0.69		13	0.74
	14	0.66		14	0.67		14	0.67		14	0.67		14	0.67		14	0.67		14	0.70
	15	0.63		15	0.64		15	0.64		15	0.64		15	0.64		15	0.64		15	0.69
	16	0.65		16	0.65		16	0.65		16	0.65		16	0.66		16	0.66		16	0.69
	17	0.71		17	0.69		17	0.71		17	0.71		17	0.71		17	0.71		17	0.79
	18	0.87		18	0.87		18	0.87		18	0.87		18	0.88		18	0.88		18	0.95
	19	0.97		19	0.96		19	0.97		19	0.97		19	0.97		19	0.97		19	1.04
	20	0.95		20	0.95		20	0.95		20	1.00		20	0.95		20	1.00		20	1.02
	21	0.87		21	0.88		21	0.87		21	0.94		21	0.89		21	0.94		21	0.96
	22	0.79		22	0.78		22	0.78		22	0.85		22	0.79		22	0.85		22	0.86
	23	0.67		23	0.67		23	0.67		23	0.70		23	0.67		23	0.71		23	0.71
	24	0.52		24	0.52		24	0.52		24	0.56		24	0.52		24	0.56		24	0.57

Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand
19-Nov	1	0.49	20-Nov	1	0.48	21-Nov	1	0.49	22-Nov	1	0.49	23-Nov	1	0.49	24-Nov	1	0.47	25-Nov	1	0.49
	2	0.48		2	0.46		2	0.47		2	0.47		2	0.47		2	0.46		2	0.47
	3	0.47		3	0.45		3	0.45		3	0.46		3	0.46		3	0.45		3	0.46
	4	0.49		4	0.46		4	0.46		4	0.48		4	0.47		4	0.42		4	0.47
	5	0.52		5	0.51		5	0.52		5	0.52		5	0.52		5	0.50		5	0.51
	6	0.62		6	0.62		6	0.62		6	0.62		6	0.62		6	0.61		6	0.62
	7	0.78		7	0.78		7	0.78		7	0.78		7	0.77		7	0.76		7	0.78
	8	0.83		8	0.83		8	0.83		8	0.84		8	0.82		8	0.78		8	0.79
	9	0.82		9	0.82		9	0.82		9	0.83		9	0.82		9	0.77		9	0.82
	10	0.81		10	0.82		10	0.82		10	0.82		10	0.81		10	0.76		10	0.82
	11	0.80		11	0.82		11	0.80		11	0.79		11	0.80		11	0.75		11	0.81
	12	0.77		12	0.81		12	0.78		12	0.77		12	0.72		12	0.73		12	0.77
	13	0.74		13	0.77		13	0.76		13	0.74		13	0.70		13	0.70		13	0.69
	14	0.69		14	0.74		14	0.71		14	0.69		14	0.68		14	0.72		14	0.67
	15	0.68		15	0.70		15	0.69		15	0.68		15	0.69		15	0.69		15	0.64
	16	0.69		16	0.71		16	0.70		16	0.69		16	0.70		16	0.70		16	0.66
	17	0.79		17	0.80		17	0.80		17	0.78		17	0.78		17	0.80		17	0.71
	18	0.94		18	0.95		18	0.95		18	0.94		18	0.94		18	0.95		18	0.94
	19	1.03		19	1.04		19	1.04		19	1.03		19	1.03		19	1.03		19	1.03
	20	1.02		20	1.02		20	1.02		20	1.02		20	1.02		20	1.02		20	1.02
	21	0.95		21	0.95		21	0.95		21	0.95		21	0.93		21	0.95		21	0.95
	22	0.86		22	0.86		22	0.87		22	0.87		22	0.85		22	0.86		22	0.85
	23	0.71		23	0.71		23	0.71		23	0.71		23	0.71		23	0.71		23	0.70
	24	0.56		24	0.58		24	0.59		24	0.57		24	0.55		24	0.56		24	0.56

Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand	Date	Hour	Electricity Demand
26-Nov	1	0.49	27-Nov	1	0.47	28-Nov	1	0.50	29-Nov	1	0.50	30-Nov	1	0.49	1-Dec	1	0.48	2-Dec	1	0.48
	2	0.47		2	0.45		2	0.48		2	0.49		2	0.48		2	0.43		2	0.43
	3	0.46		3	0.44		3	0.47		3	0.46		3	0.46		3	0.43		3	0.43
	4	0.47		4	0.45		4	0.49		4	0.47		4	0.48		4	0.43		4	0.43
	5	0.51		5	0.51		5	0.53		5	0.52		5	0.52		5	0.52		5	0.52
	6	0.62		6	0.61		6	0.62		6	0.62		6	0.62		6	0.61		6	0.61
	7	0.76		7	0.77		7	0.78		7	0.79		7	0.78		7	0.78		7	0.78
	8	0.83		8	0.82		8	0.85		8	0.86		8	0.85		8	0.82		8	0.82
	9	0.82		9	0.82		9	0.84		9	0.84		9	0.82		9	0.82		9	0.78
	10	0.82		10	0.81		10	0.82		10	0.82		10	0.82		10	0.78		10	0.78
	11	0.81		11	0.80		11	0.81		11	0.82		11	0.80		11	0.78		11	0.78
	12	0.70		12	0.72		12	0.79		12	0.80		12	0.78		12	0.74		12	0.78
	13	0.69		13	0.69		13	0.77		13	0.77		13	0.75		13	0.74		13	0.74
	14	0.67		14	0.68		14	0.73		14	0.71		14	0.70		14	0.69		14	0.69
	15	0.64		15	0.66		15	0.70		15	0.69		15	0.69		15	0.65		15	0.69
	16	0.66		16	0.68		16	0.72		16	0.70		16	0.70		16	0.69		16	0.69
	17	0.72		17	0.78		17	0.80		17	0.80		17	0.79		17	0.78		17	0.78
	18	0.91		18	0.94		18	0.97		18	0.95		18	0.95		18	0.95		18	0.95
	19	1.02		19	1.03		19	1.04		19	1.04		19	1.03		19	1.00		19	1.04
	20	1.01		20	1.02		20	1.03		20	1.03		20	1.02		20	1.00		20	1.00
	21	0.95		21	0.95		21	0.97		21	0.97		21	0.95		21	0.95		21	0.95
	22	0.85		22	0.86		22	0.87		22	0.87		22	0.86		22	0.82		22	0.82
	23	0.71		23	0.71		23	0.72		23	0.72		23	0.71		23	0.69		23	0.69
	24	0.56		24	0.58		24	0.59		24	0.59		24	0.57		24	0.56		24	0.56

Date	Hour	Electricity Demand
3-Dec	1	0.52
	2	0.48
	3	0.48
	4	0.48
	5	0.48
	6	0.52
	7	0.65
	8	0.78
	9	0.87
	10	0.87
	11	0.87
	12	0.87
	13	0.82
	14	0.78
	15	0.74
	16	0.74
	17	0.82
	18	0.95
	19	1.04
	20	1.00
	21	0.95
	22	0.82
	23	0.69
	24	0.56

Date	Hour	Electricity Demand
4-Dec	1	0.48
	2	0.43
	3	0.43
	4	0.43
	5	0.52
	6	0.61
	7	0.78
	8	0.82
	9	0.82
	10	0.78
	11	0.78
	12	0.78
	13	0.74
	14	0.69
	15	0.69
	16	0.69
	17	0.78
	18	0.95
	19	1.04
	20	1.00
	21	0.95
	22	0.82
	23	0.69
	24	0.56

Date	Hour	Electricity Demand
5-Dec	1	0.48
	2	0.39
	3	0.39
	4	0.39
	5	0.43
	6	0.56
	7	0.69
	8	0.78
	9	0.78
	10	0.74
	11	0.74
	12	0.74
	13	0.69
	14	0.69
	15	0.69
	16	0.69
	17	0.78
	18	0.95
	19	1.04
	20	1.00
	21	0.95
	22	0.87
	23	0.69
	24	0.56

Date	Hour	Electricity Demand
6-Dec	1	0.48
	2	0.48
	3	0.48
	4	0.48
	5	0.52
	6	0.61
	7	0.78
	8	0.82
	9	0.82
	10	0.82
	11	0.78
	12	0.78
	13	0.74
	14	0.69
	15	0.69
	16	0.69
	17	0.78
	18	0.95
	19	1.04
	20	1.00
	21	0.95
	22	0.82
	23	0.69
	24	0.56

Date	Hour	Electricity Demand
7-Dec	1	0.48
	2	0.48
	3	0.48
	4	0.48
	5	0.52
	6	0.61
	7	0.78
	8	0.82
	9	0.82
	10	0.82
	11	0.78
	12	0.78
	13	0.74
	14	0.69
	15	0.69
	16	0.69
	17	0.78
	18	0.95
	19	1.04
	20	1.00
	21	0.95
	22	0.87
	23	0.74
	24	0.56

Date	Hour	Electricity Demand
8-Dec	1	0.48
	2	0.48
	3	0.48
	4	0.48
	5	0.52
	6	0.61
	7	0.78
	8	0.82
	9	0.82
	10	0.82
	11	0.82
	12	0.78
	13	0.78
	14	0.74
	15	0.69
	16	0.74
	17	0.78
	18	0.95
	19	1.04
	20	1.04
	21	0.95
	22	0.87
	23	0.74
	24	0.56

Date	Hour	Electricity Demand
9-Dec	1	0.48
	2	0.48
	3	0.48
	4	0.48
	5	0.52
	6	0.65
	7	0.78
	8	0.82
	9	0.82
	10	0.82
	11	0.82
	12	0.78
	13	0.74
	14	0.74
	15	0.69
	16	0.69
	17	0.78
	18	0.95
	19	1.04
	20	1.00
	21	0.95
	22	0.87
	23	0.69
	24	0.56

Date	Hour	Electricity Demand
10-Dec	1	0.48
	2	0.48
	3	0.43
	4	0.48
	5	0.52
	6	0.61
	7	0.78
	8	0.82
	9	0.82
	10	0.82
	11	0.82
	12	0.78
	13	0.78
	14	0.74
	15	0.69
	16	0.74
	17	0.78
	18	0.95
	19	1.04
	20	1.00
	21	0.95
	22	0.82
	23	0.78
	24	0.56

Date	Hour	Electricity Demand
11-Dec	1	0.48
	2	0.48
	3	0.43
	4	0.48
	5	0.52
	6	0.61
	7	0.78
	8	0.82
	9	0.82
	10	0.78
	11	0.78
	12	0.78
	13	0.74
	14	0.69
	15	0.69
	16	0.69
	17	0.78
	18	0.95
	19	1.04
	20	1.00
	21	0.95
	22	0.82
	23	0.69
	24	0.56

Date	Hour	Electricity Demand
12-Dec	1	0.48
	2	0.48
	3	0.43
	4	0.48
	5	0.52
	6	0.61
	7	0.78
	8	0.82
	9	0.82
	10	0.82
	11	0.82
	12	0.78
	13	0.78
	14	0.74
	15	0.69
	16	0.69
	17	0.78
	18	0.95
	19	1.04
	20	1.00
	21	0.95
	22	0.82
	23	0.69
	24	0.56

Date	Hour	Electricity Demand
13-Dec	1	0.48
	2	0.48
	3	0.43
	4	0.48
	5	0.48
	6	0.61
	7	0.78
	8	0.82
	9	0.82
	10	0.82
	11	0.82
	12	0.78
	13	0.74
	14	0.74
	15	0.69
	16	0.69
	17	0.78
	18	0.95
	19	1.04
	20	1.00
	21	0.95
	22	0.82
	23	0.74
	24	0.56

Date	Hour	Electricity Demand
14-Dec	1	0.48
	2	0.48
	3	0.43
	4	0.48
	5	0.52
	6	0.61
	7	0.78
	8	0.82
	9	0.82
	10	0.82
	11	0.78
	12	0.78
	13	0.74
	14	0.69
	15	0.69
	16	0.69
	17	0.78
	18	0.95
	19	1.04
	20	1.00
	21	0.95
	22	0.87
	23	0.74
	24	0.56

Date	Hour	Electricity Demand
15-Dec	1	0.48
	2	0.48
	3	0.48
	4	0.48
	5	0.52
	6	0.61
	7	0.78
	8	0.87
	9	0.82
	10	0.82
	11	0.82
	12	0.78
	13	0.78
	14	0.74
	15	0.69
	16	0.74
	17	0.82
	18	0.95
	19	1.04
	20	1.04
	21	1.00
	22	0.87
	23	0.74
	24	0.56

Date	Hour	Electricity Demand
16-Dec	1	0.52
	2	0.48
	3	0.48
	4	0.48
	5	0.52
	6	0.65
	7	0.78
	8	0.82
	9	0.82
	10	0.82
	11	0.82
	12	0.78
	13	0.78
	14	0.74
	15	0.69
	16	0.69
	17	0.78
	18	0.95
	19	1.04
	20	1.00
	21	0.95
	22	0.87
	23	0.74
	24	0.56

Date	Hour	Electricity Demand
17-Dec	1	0.48
	2	0.48
	3	0.43
	4	0.48
	5	0.52
	6	0.61
	7	0.78
	8	0.82
	9	0.82
	10	0.82
	11	0.82
	12	0.78
	13	0.78
	14	0.74
	15	0.69
	16	0.74
	17	0.78
	18	0.95
	19	1.04
	20	1.00
	21	0.95
	22	0.87
	23	0.74
	24	0.56

Date	Hour	Electricity Demand
18-Dec	1	0.48
	2	0.48
	3	0.43
	4	0.48
	5	0.52
	6	0.61
	7	0.78
	8	0.82
	9	0.82
	10	0.82
	11	0.82
	12	0.82
	13	0.78
	14	0.74
	15	0.69
	16	0.74
	17	0.78
	18	0.95
	19	1.04
	20	1.00
	21	0.95
	22	0.82
	23	0.74
	24	0.56

Date	Hour	Electricity Demand
19-Dec	1	0.48
	2	0.43
	3	0.43
	4	0.48
	5	0.52
	6	0.61
	7	0.78
	8	0.82
	9	0.82
	10	0.82
	11	0.82
	12	0.78
	13	0.78
	14	0.74
	15	0.69
	16	0.69
	17	0.78
	18	0.95
	19	1.04
	20	1.00
	21	0.95
	22	0.82
	23	0.74
	24	0.56

Date	Hour	Electricity Demand
20-Dec	1	0.48
	2	0.43
	3	0.43
	4	0.48
	5	0.52
	6	0.61
	7	0.78
	8	0.82
	9	0.82
	10	0.82
	11	0.78
	12	0.74
	13	0.74
	14	0.69
	15	0.69
	16	0.78
	17	0.78
	18	0.95
	19	1.04
	20	1.00
	21	0.95
	22	0.82
	23	0.74
	24	0.56

Date	Hour	Electricity Demand
21-Dec	1	0.48
	2	0.48
	3	0.43
	4	0.48
	5	0.52
	6	0.61
	7	0.78
	8	0.82
	9	0.82
	10	0.82
	11	0.82
	12	0.78
	13	0.78
	14	0.74
	15	0.69
	16	0.69
	17	0.78
	18	0.95
	19	1.04
	20	1.00
	21	0.95
	22	0.87
	23	0.74
	24	0.56

Date	Hour	Electricity Demand
22-Dec	1	0.48
	2	0.48
	3	0.48
	4	0.48
	5	0.52
	6	0.61
	7	0.78
	8	0.82
	9	0.82
	10	0.82
	11	0.82
	12	0.78
	13	0.74
	14	0.74
	15	0.69
	16	0.69
	17	0.78
	18	0.95
	19	1.04
	20	1.00
	21	0.95
	22	0.87
	23	0.74
	24	0.56

Date	Hour	Electricity Demand
23-Dec	1	0.48
	2	0.48
	3	0.48
	4	0.48
	5	0.52
	6	0.61
	7	0.78
	8	0.82
	9	0.82
	10	0.82
	11	0.82
	12	0.78
	13	0.78
	14	0.74
	15	0.69
	16	0.69
	17	0.78
	18	0.95
	19	1.04
	20	1.00
	21	0.95
	22	0.87
	23	0.74
	24	0.56

Date	Hour	Electricity Demand
24-Dec	1	0.48
	2	0.48
	3	0.48
	4	0.52
	5	0.61
	6	0.78
	7	0.82
	8	0.82
	9	0.82
	10	0.82
	11	0.78
	12	0.78
	13	0.74
	14	0.69
	15	0.74
	16	0.78
	17	0.78
	18	0.95
	19	1.04
	20	1.04
	21	0.95
	22	0.87
	23	0.74
	24	0.56

Date	Hour	Electricity Demand
25-Dec	1	0.52
	2	0.48
	3	0.48
	4	0.48
	5	0.52
	6	0.65
	7	0.82
	8	0.87
	9	0.87
	10	0.82
	11	0.82
	12	0.78
	13	0.78
	14	0.74
	15	0.69
	16	0.69
	17	0.78
	18	0.95
	19	1.04
	20	1.00
	21	0.95
	22	0.87
	23	0.74
	24	0.56

Date	Hour	Electricity Demand
26-Dec	1	0.48
	2	0.48
	3	0.48
	4	0.48
	5	0.52
	6	0.61
	7	0.78
	8	0.82
	9	0.82
	10	0.82
	11	0.82
	12	0.78
	13	0.78
	14	0.74
	15	0.69
	16	0.69
	17	0.78
	18	0.95
	19	1.04
	20	1.00
	21	0.95
	22	0.87
	23	0.74
	24	0.56

Date	Hour	Electricity Demand
27-Dec	1	0.48
	2	0.43
	3	0.43
	4	0.48
	5	0.52
	6	0.61
	7	0.78
	8	0.82
	9	0.82
	10	0.82
	11	0.78
	12	0.78
	13	0.74
	14	0.69
	15	0.65
	16	0.69
	17	0.78
	18	0.95
	19	1.04
	20	1.00
	21	0.95
	22	0.82
	23	0.69
	24	0.56

Date	Hour	Electricity Demand
28-Dec	1	0.48
	2	0.48
	3	0.43
	4	0.48
	5	0.52
	6	0.61
	7	0.78
	8	0.82
	9	0.82
	10	0.82
	11	0.82
	12	0.78
	13	0.78
	14	0.74
	15	0.74
	16	0.74
	17	0.78
	18	0.95
	19	1.04
	20	1.00
	21	0.95
	22	0.87
	23	0.74
	24	0.56

Date	Hour	Electricity Demand
29-Dec	1	0.52
	2	0.48
	3	0.48
	4	0.48
	5	0.52
	6	0.65
	7	0.78
	8	0.82
	9	0.82
	10	0.82
	11	0.82
	12	0.78
	13	0.78
	14	0.74
	15	0.69
	16	0.74
	17	0.78
	18	0.95
	19	1.04
	20	1.04
	21	0.95
	22	0.87
	23	0.74
	24	0.56

Date	Hour	Electricity Demand
30-Dec	1	0.52
	2	0.48
	3	0.48
	4	0.52
	5	0.52
	6	0.65
	7	0.82
	8	0.87
	9	0.82
	10	0.82
	11	0.82
	12	0.78
	13	0.78
	14	0.74
	15	0.69
	16	0.74
	17	0.78
	18	0.95
	19	1.04
	20	1.00
	21	0.95
	22	0.87
	23	0.74
	24	0.56

Date	Hour	Electricity Demand
31-Dec	1	0.52
	2	0.48
	3	0.48
	4	0.48
	5	0.52
	6	0.61
	7	0.78
	8	0.82
	9	0.82
	10	0.82
	11	0.82
	12	0.78
	13	0.78
	14	0.74
	15	0.69
	16	0.69
	17	0.78
	18	0.95
	19	1.04
	20	1.00
	21	0.95
	22	0.87
	23	0.74
	24	0.56

Appendix B

Conversion Factors for the fifty states

	Boston '93	Alabama	Alaska	Arizona	Arkansas	California	Colorado	Connecticut	Delaware
Monthly Consump kWh		1216	661	984	1048	550	634	674	857
Yearly Consump kWh	7049	14592	7932	11808	12576	6600	7608	8088	10284
Conversion Index	1.0000	2.0701	1.1253	1.6751	1.7841	0.9363	1.0793	1.1474	1.4589

	Florida	Georgia	Hawaii	Idaho	Illinois	Indiana	Iowa	Kansas	Kentucky
Monthly Consump kWh	1165	1080	611	1095	696	925	814	888	1059
Yearly Consump kWh	13980	12960	7332	13140	8352	11100	9768	10656	12708
Conversion Index	1.9833	1.8386	1.0401	1.8641	1.1848	1.5747	1.3857	1.5117	1.8028

	Louisiana	Maine	Maryland	Massachusetts	Michigan	Minnesota	Mississippi	Missouri	Montana
Monthly Consump kWh	1256	484	969	552	617	728	1210	993	741
Yearly Consump kWh	15072	5808	11628	6624	7404	8736	14520	11916	8892
Conversion Index	2.1382	0.8239	1.6496	0.9397	1.0504	1.2393	2.0599	1.6905	1.2615

	Nebraska	Nevada	New Hampshire	New Jersey	New Mexico	New York	North Carolina	North Dakota	Ohio
Monthly Consump kWh	957	917	537	628	555	512	1056	958	810
Yearly Consump kWh	11484	11004	6444	7536	6660	6144	12672	11496	9720
Conversion Index	1.6292	1.5611	0.9142	1.0691	0.9448	0.8716	1.7977	1.6309	1.3789

	Oklahoma	Oregon	Pennsylvania	Rhode Island	South Carolina	South Dakota	Tennessee	Texas	Utah
Monthly Consump kWh	1102	1060	702	504	1166	875	1277	1207	670
Yearly Consump kWh	13224	12720	8424	6048	13992	10500	15324	14484	8040
Conversion Index	1.8760	1.8045	1.1951	0.8580	1.9850	1.4896	2.1739	2.0548	1.1406

	Vermont	Virginia	Washington	West Virginia	Wisconsin	Wyoming
Monthly Consump kWh	583	1086	1114	935	706	777
Yearly Consump kWh	6996	13032	13368	11220	8472	9324
Conversion Index	0.9925	1.8488	1.8964	1.5917	1.2019	1.3227

Appendix C

FileMaker Pro source files

NATURAL GAS PRICES

State	Natural Gas Price				Conversion Factor
Alabama	8.10	$\$ / 1000\ \text{ft}^3$	1032	Btu/ft^3 @ 100%eff	2.0701
Alaska	3.68	$\$ / 1000\ \text{ft}^3$	1032	Btu/ft^3 @ 100%eff	1.1253
Arizona	8.92	$\$ / 1000\ \text{ft}^3$	1032	Btu/ft^3 @ 100%eff	1.6751
Arkansas	6.74	$\$ / 1000\ \text{ft}^3$	1032	Btu/ft^3 @ 100%eff	1.7841
California	6.52	$\$ / 1000\ \text{ft}^3$	1032	Btu/ft^3 @ 100%eff	.9363
Colorado	5.12	$\$ / 1000\ \text{ft}^3$	1032	Btu/ft^3 @ 100%eff	1.093
Connecticut	10.29	$\$ / 1000\ \text{ft}^3$	1032	Btu/ft^3 @ 100%eff	1.1474
Delaware	8.50	$\$ / 1000\ \text{ft}^3$	1032	Btu/ft^3 @ 100%eff	1.4589
Florida	11.58	$\$ / 1000\ \text{ft}^3$	1032	Btu/ft^3 @ 100%eff	1.9833
Georgia	7.65	$\$ / 1000\ \text{ft}^3$	1032	Btu/ft^3 @ 100%eff	1.8386
Hawaii	18.56	$\$ / 1000\ \text{ft}^3$	1032	Btu/ft^3 @ 100%eff	1.0401
Idaho	5.27	$\$ / 1000\ \text{ft}^3$	1032	Btu/ft^3 @ 100%eff	1.8641
Illinois	5.12	$\$ / 1000\ \text{ft}^3$	1032	Btu/ft^3 @ 100%eff	1.1848
Indiana	6.75	$\$ / 1000\ \text{ft}^3$	1032	Btu/ft^3 @ 100%eff	1.5747
Iowa	5.85	$\$ / 1000\ \text{ft}^3$	1032	Btu/ft^3 @ 100%eff	1.3857
Kansas	5.97	$\$ / 1000\ \text{ft}^3$	1032	Btu/ft^3 @ 100%eff	1.5117
Kentucky	5.50	$\$ / 1000\ \text{ft}^3$	1032	Btu/ft^3 @ 100%eff	1.8028

NATURAL GAS PRICES

State	Natural Gas Price				Conversion Factor
Louisiana	6.38	\$ / 1000 ft^3	1032	Btu/ft^3 @ 100%eff	2.1382
Maine	7.60	\$ / 1000 ft^3	1032	Btu/ft^3 @ 100%eff	.8239
Maryland	8.16	\$ / 1000 ft^3	1032	Btu/ft^3 @ 100%eff	1.6496
Massachusetts	9.30	\$ / 1000 ft^3	1032	Btu/ft^3 @ 100%eff	.9397
Michigan	9.07	\$ / 1000 ft^3	1032	Btu/ft^3 @ 100%eff	1.0504
Minnesota	9.38	\$ / 1000 ft^3	1032	Btu/ft^3 @ 100%eff	1.2393
Mississippi	6.02	\$ / 1000 ft^3	1032	Btu/ft^3 @ 100%eff	2.0599
Missouri	6.05	\$ / 1000 ft^3	1032	Btu/ft^3 @ 100%eff	1.6905
Montana	5.05	\$ / 1000 ft^3	1032	Btu/ft^3 @ 100%eff	1.2615
Nebraska	4.80	\$ / 1000 ft^3	1032	Btu/ft^3 @ 100%eff	1.6292
Nevada	7.15	\$ / 1000 ft^3	1032	Btu/ft^3 @ 100%eff	1.5611
New Hampshire	7.42	\$ / 1000 ft^3	1032	Btu/ft^3 @ 100%eff	.9142
New Jersey	6.93	\$ / 1000 ft^3	1032	Btu/ft^3 @ 100%eff	1.0691
New Mexico	4.24	\$ / 1000 ft^3	1032	Btu/ft^3 @ 100%eff	.9448
New York	9.42	\$ / 1000 ft^3	1032	Btu/ft^3 @ 100%eff	.8716
North Carolina	7.95	\$ / 1000 ft^3	1032	Btu/ft^3 @ 100%eff	1.7977
North Dakota	4.98	\$ / 1000 ft^3	1032	Btu/ft^3 @ 100%eff	1.6309

NATURAL GAS PRICES

State	Natural Gas Price				Conversion Factor
Ohio	6.35	\$ / 1000 ft^3	1032	Btu/ft^3 @ 100%eff	1.3789
Oklahoma	5.41	\$ / 1000 ft^3	1032	Btu/ft^3 @ 100%eff	1.876
Oregon	7.11	\$ / 1000 ft^3	1032	Btu/ft^3 @ 100%eff	1.8045
Pennsylvania	8.20	\$ / 1000 ft^3	1032	Btu/ft^3 @ 100%eff	1.1951
Rhode Island	9.32	\$ / 1000 ft^3	1032	Btu/ft^3 @ 100%eff	.8580
South Carolina	8.48	\$ / 1000 ft^3	1032	Btu/ft^3 @ 100%eff	1.9850
South Dakota	5.54	\$ / 1000 ft^3	1032	Btu/ft^3 @ 100%eff	1.4896
Tennessee	6.58	\$ / 1000 ft^3	1032	Btu/ft^3 @ 100%eff	2.1739
Texas	5.74	\$ / 1000 ft^3	1032	Btu/ft^3 @ 100%eff	2.0548
Utah	5.28	\$ / 1000 ft^3	1032	Btu/ft^3 @ 100%eff	1.1406
Vermont	6.90	\$ / 1000 ft^3	1032	Btu/ft^3 @ 100%eff	.9925
Virginia	8.47	\$ / 1000 ft^3	1032	Btu/ft^3 @ 100%eff	1.8488
Washington	5.84	\$ / 1000 ft^3	1032	Btu/ft^3 @ 100%eff	1.8964
West Virginia	7.18	\$ / 1000 ft^3	1032	Btu/ft^3 @ 100%eff	1.5917
Wisconsin	6.13	\$ / 1000 ft^3	1032	Btu/ft^3 @ 100%eff	1.2019
Wyoming	5.21	\$ / 1000 ft^3	1032	Btu/ft^3 @ 100%eff	1.3227

ELECTRIC UTILITY PRICES

State	Alabama			
Census Division	East South Central			**Net Metering**
Utility Price	0.0694 $ / kWh	**Sell Back**	Avoided Cost	$0.0000
Consump / House	14592.0 kWh / yr	**Size Limit**	200 kW	$0.0300
				Avoided Cost

State	Alaska			
Census Division	Pacific Noncontiguous			**Net Metering**
Utility Price	0.1150 $ / kWh	**Sell Back**	Avoided Cost	$0.0000
Consump / House	7932.0 kWh / yr	**Size Limit**	kW	$0.0300
				Avoided Cost

State	Arizona			
Census Division	Mountain			**Net Metering**
Utility Price	0.0868 $ / kWh	**Sell Back**	Avoided Cost	$0.0000
Consump / House	11808.0 kWh / yr	**Size Limit**	kW	$0.0300
				Avoided Cost

State	Arkansas			
Census Division	West South Central			**Net Metering**
Utility Price	0.0751 $ / kWh	**Sell Back**	Avoided Cost	$0.0000
Consump / House	12576.0 kWh / yr	**Size Limit**	kW	$0.0300
				Avoided Cost

State	California			
Census Division	Pacific Contiguous			**Net Metering**
Utility Price	0.1060 $ / kWh	**Sell Back**	Avoided Cost	$0.0000
Consump / House	6600.0 kWh / yr	**Size Limit**	kW	$0.0300
				Avoided Cost

State	Colorado			
Census Division	Mountain			**Net Metering**
Utility Price	0.0745 $ / kWh	**Sell Back**	NM Carry Over	$0.0745
Consump / House	7608.0 kWh / yr	**Size Limit**	10 kW	$0.0000
				Avoided Cost

State	Connecticut			
Census Division	New England			**Net Metering**
Utility Price	0.1195 $ / kWh	**Sell Back**	Net Metering	$0.1195
Consump / House	8088.0 kWh / yr	**Size Limit**	100000 kW	$0.0300
				Avoided Cost

State	Delaware			
Census Division	South Atlantic			**Net Metering**
Utility Price	0.0913 $ / kWh	**Sell Back**	Avoided Cost	$0.0000
Consump / House	10284.0 kWh / yr	**Size Limit**	kW	$0.0300
				Avoided Cost

ELECTRIC UTILITY PRICES

State	Census Division	Utility Price ($ / kWh)	Consump / House (kWh / yr)	Sell Back	Size Limit (kW)	Net Metering	Avoided Cost
Florida	South Atlantic	0.0789	13980.0	Avoided Cost		$0.0000	$0.0300
Georgia	South Atlantic	0.0767	12960.0	Avoided Cost		$0.0000	$0.0300
Hawaii	Pacific Noncontiguous	0.1382	7332.0	Avoided Cost		$0.0000	$0.0300
Idaho	Mountain	0.0528	13140.0	Avoided Cost		$0.0000	$0.0300
Illinois	East North Central	0.0985	8352.0	Avoided Cost		$0.0000	$0.0300
Indiana	East North Central	0.0701	11100.0	Avoided Cost		$0.0000	$0.0300
Iowa	West North Central	0.0838	9768.0	Avoided Cost		$0.0000	$0.0300
Kansas	West North Central	0.0765	10656.0	Avoided Cost		$0.0000	$0.0300

ELECTRIC UTILITY PRICES

State Kentucky
Census Division East South Central
Utility Price 0.0561 $ / kWh **Sell Back** Avoided Cost
Consump / House 12708.0 kWh / yr **Size Limit** kW
Net Metering $0.0000
$0.0300 **Avoided Cost**

State Louisiana
Census Division West South Central
Utility Price 0.0707 $ / kWh **Sell Back** Avoided Cost
Consump / House 15072.0 kWh / yr **Size Limit** kW
Net Metering $0.0000
$0.0300 **Avoided Cost**

State Maine
Census Division New England
Utility Price 0.1302 $ / kWh **Sell Back** NM Carry Over
Consump / House 5808.0 kWh / yr **Size Limit** 100 kW
Net Metering $0.1302
$0.0300 **Avoided Cost**

State Maryland
Census Division South Atlantic
Utility Price 0.0844 $ / kWh **Sell Back** Avoided Cost
Consump / House 11628.0 kWh / yr **Size Limit** kW
Net Metering $0.0000
$0.0300 **Avoided Cost**

State Massachusetts
Census Division New England
Utility Price 0.1060 $ / kWh **Sell Back** Avoided Cost
Consump / House 6624.0 kWh / yr **Size Limit** kW
Net Metering $0.0000
$0.0300 **Avoided Cost**

State Michigan
Census Division East North Central
Utility Price 0.0867 $ / kWh **Sell Back** Avoided Cost
Consump / House 7404.0 kWh / yr **Size Limit** kW
Net Metering $0.0000
$0.0300 **Avoided Cost**

State Minnesota
Census Division West North Central
Utility Price 0.0733 $ / kWh **Sell Back** Avoided Cost
Consump / House 8736.0 kWh / yr **Size Limit** kW
Net Metering $0.0000
$0.0300 **Avoided Cost**

State Mississippi
Census Division East South Central
Utility Price 0.0703 $ / kWh **Sell Back** Avoided Cost
Consump / House 14520.0 kWh / yr **Size Limit** kW
Net Metering $0.0000
$0.0300 **Avoided Cost**

ELECTRIC UTILITY PRICES

State Missouri
Census Division West North Central
Utility Price 0.0708 $ / kWh **Sell Back** Avoided Cost
Consump / House 11916.0 kWh / yr **Size Limit** kW
Net Metering $0.0000
$0.0300 **Avoided Cost**

State Montana
Census Division Mountain
Utility Price 0.0650 $ / kWh **Sell Back** Avoided Cost
Consump / House 8892.0 kWh / yr **Size Limit** kW
Net Metering $0.0000
$0.0300 **Avoided Cost**

State Nebraska
Census Division West North Central
Utility Price 0.0646 $ / kWh **Sell Back** Avoided Cost
Consump / House 11484.0 kWh / yr **Size Limit** kW
Net Metering $0.0000
$0.0300 **Avoided Cost**

State Nevada
Census Division Mountain
Utility Price 0.0700 $ / kWh **Sell Back** Avoided Cost
Consump / House 11004.0 kWh / yr **Size Limit** kW
Net Metering $0.0000
$0.0300 **Avoided Cost**

State New Hampshire
Census Division New England
Utility Price 0.1392 $ / kWh **Sell Back** None
Consump / House 6444.0 kWh / yr **Size Limit** 10 kW
Net Metering $0.0000
$0.0300 **Avoided Cost**

State New Jersey
Census Division Middle Atlantic
Utility Price 0.1139 $ / kWh **Sell Back**
Consump / House 7536.0 kWh / yr **Size Limit** kW
Net Metering $0.0000
$0.0300 **Avoided Cost**

State New Mexico
Census Division Mountain
Utility Price 0.0885 $ / kWh **Sell Back**
Consump / House 6660.0 kWh / yr **Size Limit** kW
Net Metering $0.0000
$0.0300 **Avoided Cost**

State New York
Census Division Middle Atlantic
Utility Price 0.1366 $ / kWh **Sell Back**
Consump / House 6144.0 kWh / yr **Size Limit** kW
Net Metering $0.0000
$0.0300 **Avoided Cost**

ELECTRIC UTILITY PRICES

State	North Carolina					
Census Division	South Atlantic					**Net Metering**
Utility Price	0.0801	$ / kWh	**Sell Back**			$0.0000
Consump / House	12672.0	kWh / yr	**Size Limit**		kW	$0.0300
						Avoided Cost

State	North Dakota					
Census Division	West North Central					**Net Metering**
Utility Price	0.0649	$ / kWh	**Sell Back**			$0.0000
Consump / House	11496.0	kWh / yr	**Size Limit**		kW	$0.0300
						Avoided Cost

State	Ohio					
Census Division	East North Central					**Net Metering**
Utility Price	0.0870	$ / kWh	**Sell Back**	Net Metering		$0.0870
Consump / House	9720.0	kWh / yr	**Size Limit**	10000000	kW	$0.0300
						Avoided Cost

State	Oklahoma					
Census Division	West South Central					**Net Metering**
Utility Price	0.0657	$ / kWh	**Sell Back**			$0.0000
Consump / House	13224.0	kWh / yr	**Size Limit**		kW	$0.0300
						Avoided Cost

State	Oregon					
Census Division	Pacific Contiguous					**Net Metering**
Utility Price	0.0582	$ / kWh	**Sell Back**	Net Metering		$0.0582
Consump / House	12720.0	kWh / yr	**Size Limit**	25	kW	$0.0300
						Avoided Cost

State	Pennsylvania					
Census Division	Middle Atlantic					**Net Metering**
Utility Price	0.0993	$ / kWh	**Sell Back**	Net Metering		$0.0993
Consump / House	8424.0	kWh / yr	**Size Limit**	10	kW	$0.0300
						Avoided Cost

State	Rhode Island					
Census Division	New England					**Net Metering**
Utility Price	0.1091	$ / kWh	**Sell Back**	NM Carry Over		$0.1091
Consump / House	6048.0	kWh / yr	**Size Limit**	25	kW	$0.0300
						Avoided Cost

State	South Carolina					
Census Division	South Atlantic					**Net Metering**
Utility Price	0.0750	$ / kWh	**Sell Back**			$0.0000
Consump / House	13992.0	kWh / yr	**Size Limit**		kW	$0.0300
						Avoided Cost

ELECTRIC UTILITY PRICES

State	South Dakota					
Census Division	West North Central					**Net Metering**
						$0.0000
Utility Price	0.0727	$ / kWh	**Sell Back**			
						$0.0300
Consump / House	10500.0	kWh / yr	**Size Limit**		kW	**Avoided Cost**

State	Tennessee					
Census Division	East South Central					**Net Metering**
						$0.0000
Utility Price	0.0632	$ / kWh	**Sell Back**			
						$0.0300
Consump / House	15324.0	kWh / yr	**Size Limit**		kW	**Avoided Cost**

State	Texas					
Census Division	West South Central					**Net Metering**
						$0.0000
Utility Price	0.0765	$ / kWh	**Sell Back**			
						$0.0300
Consump / House	14484.0	kWh / yr	**Size Limit**		kW	**Avoided Cost**

State	Utah					
Census Division	Mountain					**Net Metering**
						$0.0000
Utility Price	0.0684	$ / kWh	**Sell Back**			
						$0.0300
Consump / House	8040.0	kWh / yr	**Size Limit**		kW	**Avoided Cost**

State	Vermont					
Census Division	New England					**Net Metering**
						$0.1161
Utility Price	0.1161	$ / kWh	**Sell Back**	NM Carry Over		
						$0.0300
Consump / House	6996.0	kWh / yr	**Size Limit**	15	kW	**Avoided Cost**

State	Virginia					
Census Division	South Atlantic					**Net Metering**
						$0.0000
Utility Price	0.0751	$ / kWh	**Sell Back**			
						$0.0300
Consump / House	13032.0	kWh / yr	**Size Limit**		kW	**Avoided Cost**

State	Washington					
Census Division	Pacific Contiguous					**Net Metering**
						$0.0000
Utility Price	0.0503	$ / kWh	**Sell Back**			
						$0.0300
Consump / House	13368.0	kWh / yr	**Size Limit**		kW	**Avoided Cost**

State	West Virginia					
Census Division	South Atlantic					**Net Metering**
						$0.0000
Utility Price	0.0629	$ / kWh	**Sell Back**			
						$0.0300
Consump / House	11220.0	kWh / yr	**Size Limit**		kW	**Avoided Cost**

ELECTRIC UTILITY PRICES

State	Wisconsin			
Census Division	East North Central			**Net Metering**
Utility Price	0.0717 $ / kWh	**Sell Back**	Net Metering	$0.0717
Consump / House	8472.0 kWh / yr	**Size Limit**	20 kW	$0.0300
				Avoided Cost

State	Wyoming			
Census Division	Mountain			**Net Metering**
Utility Price	0.0628 $ / kWh	**Sell Back**		$0.0000
Consump / House	9324.0 kWh / yr	**Size Limit**	kW	$0.0300
				Avoided Cost

BATTERIES

Model Name PVX-1234
Volts 12
Capacity 33 AH
Lifetime 5-8 years
Weight 23 lb
Cost $59.90

Model Name PVX-1248
Volts 12
Capacity 48 AH
Lifetime 5-8 years
Weight 32 lb
Cost $88.00

Model Name PVX-1260
Volts 12
Capacity 60 AH
Lifetime 5-8 years
Weight 43 lb
Cost $105.75

Model Name PVX-1272
Volts 12
Capacity 72 AH
Lifetime 5-8 years
Weight 50 lb
Cost $117.00

Model Name PVX-1285
Volts 12
Capacity 85 AH
Lifetime 5-8 years
Weight 61 lb
Cost $142.75

Model Name PVX-1295
Volts 12
Capacity 95 AH
Lifetime 5-8 years
Weight 63 lb
Cost $157.50

Model Name PVX-12105
Volts 12
Capacity 105 AH
Lifetime 5-8 years
Weight 68 lb
Cost $172.00

Model Name PVX-12210 (4D)
Volts 12
Capacity 210 AH
Lifetime 5-8 years
Weight 130 lb
Cost $311.00

Model Name PVX-12255 (8D)
Volts 12
Capacity 255 AH
Lifetime 5-8 years
Weight 158 lb
Cost $388.00

Model Name PVX-6220
Volts 6
Capacity 220 AH
Lifetime 5-8 years
Weight 65 lb
Cost $160.00

Model Name CH-375
Volts 6
Capacity 350 AH
Lifetime 8 years
Weight 129 lb
Cost $195.00

BATTERIES

Model Name 4 KS-21P
Volts 4
Capacity 1020 AH
Lifetime 10-20 years
Weight 230 lb
Cost $598.00

Model Name 6 CS-17PS
Volts 6
Capacity 546 AH
Lifetime 10-20 years
Weight 221 lb
Cost $485.00

Model Name 6 CS-21PS
Volts 6
Capacity 683 AH
Lifetime 10-20 years
Weight 271 lb
Cost $599.00

Model Name 6 CS-25PS
Volts 6
Capacity 820 AH
Lifetime 10-20 years
Weight 318 lb
Cost $860.00

INVERTERS

Model Name	DR1512	**Input Volt Range**	10.8 - 15.5		**Specified Temp Range**	0 - 50	º
		AC Surge	28	amp	**Peak Efficiency**	94	%
		AC Output	115	volt	**Continuous Power**	1500	V
		DC Input	12	volt	**Max Power**		V
		Lifetime			**Cost**	$816.00	

Model Name	DR2412	**Input Volt Range**	10.8 - 15.5		**Specified Temp Range**	0 - 50	º
		AC Surge	52	amp	**Peak Efficiency**	94	%
		AC Output	115	volt	**Continuous Power**	2400	W
		DC Input	12	volt	**Max Power**		W
		Lifetime			**Cost**	$1107.00	

Model Name	DR1524	**Input Volt Range**	21.6 - 31		**Specified Temp Range**	0 - 50	º
		AC Surge	40	amp	**Peak Efficiency**	94	%
		AC Output	115	volt	**Continuous Power**	1500	W
		DC Input	24	volt	**Max Power**		W
		Lifetime			**Cost**	$775.00	

Model Name	DR2424	**Input Volt Range**	21.6 - 31		**Specified Temp Range**	0 - 50	ºC
		AC Surge	72	amp	**Peak Efficiency**	95	%
		AC Output	115	volt	**Continuous Power**	2400	W
		DC Input	24	volt	**Max Power**		W
		Lifetime			**Cost**	$1107.00	

Model Name	DR3624	**Input Volt Range**	21.6 - 31		**Specified Temp Range**	0 - 50	ºC
		AC Surge	100	amp	**Peak Efficiency**	95	%
		AC Output	115	volt	**Continuous Power**	3600	W
		DC Input	24	volt	**Max Power**		W
		Lifetime			**Cost**	$1271.00	

Model Name	UX512E	**Input Volt Range**	10.8 - 15.5		**Specified Temp Range**	-40 - 60	ºC
		AC Surge	10	amp	**Peak Efficiency**	92	%
		AC Output	230	volt	**Continuous Power**	500	W
		DC Input	12	volt	**Max Power**	2500	W
		Lifetime			**Cost**	$458.00	

Model Name	UX612	**Input Volt Range**	10.8 - 15.5		**Specified Temp Range**	-40 - 60	ºC
		AC Surge	18	amp	**Peak Efficiency**	92	%
		AC Output	120	volt	**Continuous Power**	600	W
		DC Input	12	volt	**Max Power**	2500	W
		Lifetime			**Cost**	$458.00	

INVERTERS

Model Name	UX1112	**Input Volt Range**	10.8 - 15.5		**Specified Temp Range**	-40 - 60	
		AC Surge	32	amp	**Peak Efficiency**	90	
		AC Output	120	volt	**Continuous Power**	1100	
		DC Input	12	volt	**Max Power**	3000	
		Lifetime			**Cost**	$612.00	

Model Name	UX1412	**Input Volt Range**	10.8 - 15.5		**Specified Temp Range**		°
		AC Surge	30	amp	**Peak Efficiency**	92	%
		AC Output	120	volt	**Continuous Power**	1400	
		DC Input	12	volt	**Max Power**	3400	
		Lifetime			**Cost**	$681.50	

Model Name	SW4048	**Input Volt Range**			**Specified Temp Range**		°
		AC Surge	78	amp	**Peak Efficiency**	96	%
		AC Output	120	volt	**Continuous Power**	4000	W
		DC Input	48	volt	**Max Power**		W
		Lifetime			**Cost**	$2395.00	

Model Name	SW5548	**Input Volt Range**			**Specified Temp Range**		°
		AC Surge	78	amp	**Peak Efficiency**	96	%
		AC Output	120	volt	**Continuous Power**	5500	W
		DC Input	48	volt	**Max Power**		W
		Lifetime			**Cost**	$2819.00	

Model Name	SW4024	**Input Volt Range**			**Specified Temp Range**		°
		AC Surge	78	amp	**Peak Efficiency**	96	%
		AC Output	120	volt	**Continuous Power**	4000	W
		DC Input	24	volt	**Max Power**		W
		Lifetime			**Cost**	$2395.00	

Model Name	PS-2500/12	**Input Volt Range**	10 - 16		**Specified Temp Range**		°
		AC Surge		amp	**Peak Efficiency**	88	%
		AC Output	120	volt	**Continuous Power**	2500	W
		DC Input	12	volt	**Max Power**	4000	W
		Lifetime			**Cost**	$1895.00	

Model Name	ProW-2500	**Input Volt Range**	10 - 15		**Specified Temp Range**		°
		AC Surge		amp	**Peak Efficiency**	90	%
		AC Output		volt	**Continuous Power**	2500	W
		DC Input	12	volt	**Max Power**	5000	W
		Lifetime			**Cost**	$809.00	

INVERTERS

Model Name	RV458-10	**Input Volt Range**			**Specified Temp Range**	
		AC Surge		amp	**Peak Efficiency**	
		AC Output		volt	**Continuous Power**	1000
		DC Input		volt	**Max Power**	
		Lifetime			**Cost**	$637.00

Appendix D

State Net Metering Laws

SUMMARY OF STATE "NET METERING" PROGRAMS (CURRENT)

State	Eligible Fuel Types	Eligible Customers	Limit on System Size	Limit on Overall Enrollment	Treatment of Net Excess Generation (NEG)	Enacted	Citation / Reference
Arizona	Renewables & cogeneration	All customer classes	≤ 100 kW	None	NEG purchased at avoided cost	1981	AZ Corp. Comm. Decision No. 52345
California	Solar and Wind	Residential and small commercial customers	≤ 10 kW	0.1% of 1996 peak demand	Net metering customers are billed annually; excess generation is granted to the utility	1998	CA Public Utilities Code § 2827
Colorado	All resources	All customers	≤ 10 kW	None	NEG carried over month-to-month	1994	Public Service Co. of CO, Advice Letter 1265; Decision C96-901
Connecticut	Renewables & cogeneration	All customer classes	≤ 50 kW for cogeneration; ≤ 100 kW for renewables	None	NEG purchased at avoided cost	1990	CT Dept. of Public Utility Control, CPUCA No. 159
Delaware	Renewables	All customer classes	≤ 25 kW	None	Not specified	1999	DE Legislature, S Amend 1 to HB 10
Idaho	Renewables & cogeneration	Idaho Power only; residential and small commercial customers	≤ 100 kW	None	NEG purchased at avoided cost	1980	ID PUC Orders No. 16025 (1980); 26750 (1997)
Illinois	Solar and wind	ComEd only; all customer classes	< 40 kW	0.1% of annual peak demand	NEG purchased at avoided cost	1999	Special billing experiment (effective 4/1/00)
Indiana	Renewables & cogeneration	All customer classes	≤ 1,000 kWh/month	None	No purchase of NEG; excess is granted to the utility.	1985	170 IN Admin Code § 4-4.1-7
Iowa	Renewables	All customer classes	No limit	None	NEG purchased at avoided cost	1983	IA Legislature & IA Utilities Board, Utilities Division Rules § 15.11(5)
Maine	Renewables & cogeneration	All customer classes	≤ 100 kW	None	NEG purchased at avoided cost	1987	ME PUC, Code Me. R. Ch. 36, § 1(A)(18) & (19), § 4(C)(4)
Maryland	Solar only	Residential customers & schools	≤ 80 kW	0.2% of 1998 peak demand	NEG carried over to following month; otherwise not specified	1997	MD Legislature, Art. 78, Sec. 54M
Massachusetts	Renewables & cogeneration	All customer classes	≤ 60 kW	None	NEG purchased at avoided cost	1997	Mass. Gen. L. ch. 164, § 1G(g); Dept. of Tel. & Energy 97-111
Minnesota	Renewables & cogeneration	All customer classes	< 40 kW	None	NEG purchased at "average retail utility energy rate"	1983	Minn. Stat. § 261B.164(3)
Montana	Solar, wind or hydro	All customer classes	≤ 50 kW	None	NEG credited to following month; unused credit is granted to utility at end of 12-month period	1999	S.B. 409
Nevada	Solar and wind	All customer classes	≤ 10 kW	100 customers for each utility	Annualization allowed; no compensation required for NEG	1997	Nev. Rev. S. Ch. 704
New Hampshire	Solar, wind & hydro	All customer classes	≤ 25 kW	0.05% of annual peak	NEG carried over to following month	1998	NH Rev. Stat. §§362A:1-a & 362-A:9
New Jersey	Photovoltaic and wind	Residential and small commercial customers	No limit (100 kW limit proposed)	0.1% of peak or $2,000,000 annual financial impact	NEG credited to following month; unused credit is purchased at avoided cost.	1999	NJ Legislature, S.B. 7
New Mexico	Renewables & cogeneration	All customer classes	≤ 10 kW	None	At utility's option, customer is credited on the next bill for (1) purchase of NEG at utility's avoided cost; or (2) kilowatt-hour credit for NEG that carries over from month to month.	1999	NM PRC Order 2847 (9/7/99), amending previous Order from 11/30/98
New York	Solar only	Residential only	≤ 10 kW	0.1% of 1996 peak	NEG credited to following month; unused credit is purchased at avoided cost	1997	NY Public Service Law § 66-j
North Dakota	Renewables & cogeneration	All customer classes	≤ 100 kW	None	NEG purchased at avoided cost	1991	ND Admin. Code § 69-09-07-09
Ohio	Solar, wind, biomass, landfill gas, hydro, microturbines, or fuel cells	All customer classes	No limit	1.0% of peak demand for each retail electric provider	NEG purchased at unbundled generation rate, appears as credit on following bill	1999	S.B. 3 (effective 10/6/99)
Oklahoma	Renewables & cogeneration	All customer classes	≤ 100 kW and annual output ≤ 25,000 kWh	None	No purchase of NEG; excess is granted to the utility.	1990	OK Corp. Comm. Schedule QF-2
Oregon	Solar, wind, fuel cell and hydro	All customer classes	≤ 25 kW	No less than 0.5% of utility's historic single-hour peak load; beyond 0.5% eligibility can be limited by regulatory authority	NEG purchased at avoided cost or credited to following month; at end of annual period unused credits shall be granted to low-income assistance programs, credited to customer, or "dedicated to other use" as determined by regulatory authority	1999	H.B. 3219 (effective 9/1/99)
Pennsylvania	Renewables only (includes fuel cells)	All customer classes	≤ 10 kW	None	NEG granted to utility at end of month	1998	PA PUC, Miscellaneous Individual Utility Tariffs
Rhode Island	Renewables & fuel cells	All customer classes	≤ 25 kW	1 MW for Narragansett Electric	NEG credited to following month; unused credit is granted to utility at end of annual period	1998	RI PUC, Order, Docket No. 2710
Texas	Renewables only	All customer classes	≤ 50 kW	None	NEG purchased at avoided cost	1986	PUC of Texas, Substantive Rules, § 23.66(f)(4)
Vermont	Solar, wind, fuel cells using renewable fuel, anaerobic digestion	Residential, commercial, and agricultural customers	≤ 15 kW, except ≤ 100 kW for anaerobic digesters	1% of 1996 peak	NEG carried over month-to-month; any residual NEG at end of year is granted to the utility	1998	VT Legislature, H. 605
Virginia	Solar, wind and hydro	Residential and commercial customers	≤ 10 kW (residential); ≤ 25 kW (commercial)	0.1% of annual peak demand	Net metering customers are billed annually; excess generation is granted to the utility	1999	S.B. 1269 (effective by 7/1/2000)
Washington	Solar, wind and hydropower	All customer classes	≤ 25 kW	0.1% of 1996 peak	NEG credited to following month; unused credit is granted to utility at end of annual period	1998	WA Legislature, House Bill 2773
Wisconsin	All Resource	All retail customers	≤ 20 kW	None	NEG purchased at retail rate for renewables, avoided cost for non-renewables	1993	WI PSC, Schedule PG-4

SUMMARY OF STATE "NET METERING" PROGRAMS (PROPOSED)

State	Eligible Fuel Types	Eligible Customers	Limit on System Size	Limit on Overall Enrollment	Treatment of Net Excess Generation (NEG)(*)	Enacted	Citation / Reference
Connecticut (enacted) [replaces existing rule after 1/1/2000]	Solar, wind, hydro, fuel cell, sustainable biomass	Residential only	No limit	None	Not specified	1998	CT Legislature, Public Act 98-28
Maine (enacted) [replaces existing rule after 2/29/2000)	Renewables, fuel cells & recycled municipal solid waste	All customer classes	≤ 100 kW	None	NEG carried over month-to-month; any residual NEG at end of 12-month period is eliminated w/o compensation	1998	Code Me. R. Ch. § 313 (1998); see also Order No. 98-621 (December 19, 1998).
North Carolina	Solar, wind, hydro, and biomass	All customer classes	≤ 10 kW (residential); ≤ 100 kW (non-residential)	1.0% of annual peak demand	NEG credited to following month; unused credit is eliminated at end of annual billing period (residential customers only)	(Pending)	NC Utilities Commission, Docket No. E-100, Sub 83 (November 18, 1998)

(*)Net excess generation occurs only when total generation exceeds total consumption over the entire billing period, i.e. the customer has more than offset his/her total electricity use and has a negative meter reading.