Power **I**nformation **C**ollection **A**rchitecture

Business Plan

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Team 01: A. Ball, K. Wiersma, N. Jen, A. Sterk

CALVIN

College

MY HEART I OFFER TO YOU LORD • PROMPTLY AND SINCERELY •

Abstract

This business plan describes the formation and operation of PICA, LLC., a company formed around the products designed by Team PICA as a senior design project at Calvin College. The company proposes to design, produce, and distribute power-monitoring equipment that may replace typical components of modern electrical building infrastructure. In particular, PICA, LLC. will produce a smart power meter for power companies to install on their customers' buildings and with which much more information regarding power quality can be measured, "smart" solid-state circuit breakers that improve user safety and deliver information about how much power each circuit in the building uses, and a base station to collect, archive, and display these measurements in real time. Armed with this much information, power consumers will be able to make wiser decisions regarding their power usage.

The market for "smarter" electronics and power monitoring continues to grow, and smart meters are already entering deployment on houses in select parts of the country. PICA, LLC. intends to produce devices that gather more information and collect and display it in a user-friendly style. The design team believes that these products are completely possible to make and distribute, and can be designed using the knowledge of electrical engineering and systems gained from Calvin's engineering program.

The team estimates first-year costs close to $300 million, financed 60-40 from debt and equity. This means that about $120 million will come from investors. The estimated payout time will be 5 years, by which time production and distribution means will be established and enacted.

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1 Mission and Vision

1.1 Mission

PICA LLC seeks to help our clients better understand how their home or business consumes power through the transparent application of technology in a culturally appropriate manner. We seek to develop cost effective solutions that exhibit quality worksmanship using our expertise in Electrical and Computer Engineering.

1.2 Vision

PICA LLC seeks to help in building a future where power consumption is an active choice. By using modern technology to enhance power metering, we believe that a future with less dependence on fossil fuels comes one step closer to reality.

2 Industry Profile

2.1 Overview of the Problem

Standard electric meters were developed decades ago and are still used today, despite many technological advances in the last several years. Along with these technological advances, Americans have become accustomed to having access to large amounts of data, but due to the nature of the standard electric meter, data regarding the usage of power is severely limited. For the power companies, data from the meters is minimal and grid control is limited to manual operation, costing them time and money. As the cost of electricity becomes higher and higher, electricity use in buildings is becoming a bigger concern and people have few cheap or simple ways to monitor this. Of the options available, most only address part of the whole problem, giving some information to the consumer and none to the power company or vice-versa. While there are devices such as breakers and fuses that provide electrical safety for buildings, advances in technology have made it possible to further improve safety but have not been implemented in a cost-effective way or made easily available to an average consumer, which for the purpose of this project shall be defined as a person without a mathematical or scientific education beyond high-school.

2.2 Major Customer Groups

The two main customers of the PICA system are power companies and power consumers. The E-meter subsystem will only be sold to power companies, as they must in turn provide metering equipement to their customers. The base station and solid-state breakers will be sold to power consumers who are interested in knowing how much power they use in different regions of their buildings.

2.3 Regulatory Requirements

The PICA system must meet certain codes in order to be safe enough for the customer to use, which will also protect from unexpected lawsuits. Underwriters Laboratories (UL) is an independent product safety certification organization, which offers safety certifications to products [1]. In order to gain the confidence of customers, the devices of the PICA system will be UL certifiable. The specific qualifications of UL certification remain unknown to the design team, as the documents regarding the certification requirements are not publicly available. The system will also restrict electromagnetic (EM) radiation to comply with

Federal Communications Commission (FCC) Title 47 Part 15. It will also comply with American National Standards Institute (ANSI) C12.19 and ANSI C12.21 standards.

While these standards should ensure the general safety of the PICA devices, defects or unforeseen circumstances could imperil users or their property. The PICA system will provide a limited warranty against defects, but cannot be expected to foresee all possible circumstances. To this end, the devices will ship and work with a disclaimer regarding safe operating conditions and the hazards of tampering with the device.

In addition to ensuring the physical safety of the users, the system should also ensure the privacy and security of the users' information. While any wireless link runs the risk of packet interception and capture by a malicious observer, this will only affect the data currently being transferred, and data encryption schemes may greatly hinder these intrusions. The stored data will likely not be encrypted, but will not be actively transmitted: the only means of accessing this data will be through the software controls set in place by the base station or by physically removing the storage medium and removing the data from it. The base station software will use permissions-based file system access and will require a user to authenticate as an administrator before accessing this information. In this way, the user's data will be stored with access controls and will be kept private.

2.4 Significant Trends and Growth Rate

Recently, the demand for "smarter" and more informative devices has been increasing with the awareness of resource stewardship and the effects of human activity on the environment. Currently, power companies are investigating smart meters and deploying them to their customers in pilot programs. Power consumers are becoming more energy- and economically-aware, so the time is ripe for providing the products that PICA, LLC. proposes.

2.5 Barriers to Entry and Exit

The major barriers to entry is customer recognition. Although power companies may still be testing smart meters before deploying them to their customers, introducing them to a new product might be difficult if they are already near to making a decision. Additionally, power consumers will not be able to buy from PICA, LLC. unless they specifically know of it already.

3 Business Strategy

3.1 Desired image and position in market

PICA seeks to be known as a leader in making consumers energy aware. This primarily means providing relevant information in an easy-to-understand format that allows users to make informed decisions about their energy usage. Our position in the market will likely be a part of the “green” market, which has been rapidly growing. However, we would like to aim for the consumer oriented part of this market, rather than reaching out to the part of the market dealing with clean power generation.

3.2 SWOT analysis

3.2.1 Strengths

One big strength of the product is that in a single system it addresses problems that previously would require multiple, independent systems and products. Another strength is the solid state breakers, which in addition to providing usage information also have a faster response time and include a safe automatic reset option.

3.2.2 Weaknesses

The biggest weakness is the cost of the system. While users want to know the information provided, many are not willing to pay a lot for that information.

3.2.3 Opportunities

The idea of solid state breakers for home usage is relatively new and has not been taken advantage of, so there is a lot of potential growth in that area.

3.2.4 Threats

A big threat is that other companies have already started to establish themselves in similar fields. The PICA system may not provide enough of an advantage over these systems to be successful in an area where consumers have started to use these other systems.

3.3 Competitive strategy

As there is a high cost associated with the PICA products, the company will rely less on cost to remain competitive than on the differentiation and focus of the company. The company has already started to differentiate itself primarily through the development of the solid state breakers. The company is also different from many in how we provide solutions to more than one problem the consumer and power company may have. The company hopes to remain competitive by continuing to focus on more aspects of the problems associated with power usage than potential competitors do. Instead of providing a solution relating only to single outlet usage, PICA will provide devices that can all work together, leaving room for easy expansion when the customer decides they want even more information.

3.4 Target Market Definition

The target market for the entire PICA system comprises both electricity producers and electricity consumers, as set forth by the nature of the subsystems. As the power companies supply and own the electricity meters attached to the buildings to which they supply power, the PICA E-meter appeals only to the market of electricity-producing companies. The other two subsystems, the solid-state breakers and base station, target the power-consuming audience, as the devices will assist in monitoring power flow inside the building, where the power company has no presence. As these two markets are essentially exclusive in both membership and interest in the PICA subsystems, the E-meter will be able to function independently of the other consumer-targeted subsystems, and vice versa.

3.4.1 Power Companies

As power companies currently distribute the whole-building metering hardware that determines how much energy their customer used, the E-meter clearly targets power companies. In fact, the power companies own the power-measuring hardware external to the buildings to while they provide power, so only they may replace or upgrade those devices. At present, power companies send trained meter-readers to read the data from most traditional power meters under their control. The PICA E-meter subsystem aims to improve on this process by automatically sending the measurements to the power company using a means and protocol selected by the particular company. While this will require some hardware customization for each company, the volume of company-specific production should allow the cost to develop the design to spread into a small per-unit cost.

The PICA E-meter subsystem also provides numerous more measures of power than the simple spinning-dial meters. For example, the E-meter will measure the frequency and the RMS voltage of the incoming supply lines, which help indicate the overall quality of power delivered to the customers in the area. This information may also help diagnose any observed issues with power delivery without dispatching a worker to take measurements by hand. In this way, power companies using the PICA E-meter can improve the quality of the service they provide and can save on the labor costs associated with making a site visit.

3.4.2 Power Consumers

Although the power company's customers cannot modify the metering panel installed by the power company, they are free to modify the other power distribution components inside their own buildings. The solid-state breakers fall into this category, and provide previously unavailable measurements regarding power consumption and its location within the building. However, as these breakers will replace the pre-existing breakers inside the building, the consumer must be convinced that using the PICA system is worth the trouble and cost of replacing the mechanical circuit breakers with the more feature-rich PICA breakers. To this effect, the most receptive market for the solid-state breakers includes homeowners and building managers who are curious or concerned about power usage inside their building. That is, the people for whom this information can inspire a meaningful change in practice will likely become the first adopters of the subsystem.

The product may also gain a following as an alternative to mechanical breakers in during the construction of a new home or building. This would likely require that the product already have a proven history of reliability and safety, so the previous group of cost- or environmentally-concerned individuals might have to adopt the produce first. If the PICA solid-state breakers become an alternative during construction, the net cost to the user will be lessened, as the building-to-be will not have any pre-existing breakers to discard or replace.

The base station may apply to either of these two consumer groups, as its primary purpose is to manage and interface with the other systems. It does not specifically require the solid-state breakers or the E-meter, but provides little value in a building without any installed PICA systems. The base station exists solely to manage and collect data from other PICA subsystems, as well as format and display these measurements, so its target audience consists of power consumers whose buildings contain at least one of the E-meter or solid-state breakers.

3.4.3 Market Coordination

As the E-meter subsystem caters exclusively to power companies while the other subsystems target power consumers, the complete PICA system has no clearly-defined market; neither of the two markets involved desires the entire system. Despite this separation, a clever marketing strategy could motivate one market to pressure the other.

In one scenario, a power company installs the PICA E-meter onto a select set of their customers' buildings. On its own, this should be a transparent change to the consumer. However, marketing the base station as a way to "see what the power company sees" about the power delivered could motivate some of the power-consuming market to purchase a PICA subsystem. Giving the power-consuming market a feeling of empowerment or equality to the power company could therefore motivate more consumer-side subsystem sales.

Conversely, the interests of the power-consuming market could generate interest from the power-producing market. In particular, a consumer who already owns the PICA solid-state breakers may appeal to the power company to provide the PICA E-meter: it would expand the amount of information available and give an accurate sense for the upcoming utility bill. Even without any PICA subsystems, the consumer could prod the power company for a PICA E-meter because it would give the power company more information on power quality, which could in turn increase the quality of service provided to the consumer. In these scenarios, the desires of the power-consumer market could influence demand in the power-producing market.

3.5 Target Market Research

From the team's visit to Consumer's Energy in Jackson Michigan, power companies are very interested in smart home energy meters, such as PICA provides with the E-meter. The team presented a features list to the representative present. who affirmed that the features now included in the E-meter will be valuable to the power companies. However, power companies are already researching and testing smart meter prototypes and samples, so the E-meter will arrive fairly late relative to its competition. Still, of the thousands of power companies in the United States[2], the PICA system will surely prove interesting to others who may not have considered alternatives. Fewer than half of the homes expected to receive the smart-meter conversion have been converted to date, so the E-meter is still viable in the power company market[3].

The remainder of the system, the base station and the solid-state breakers, will compete in a market of power consumers. The devices currently face a market of 6,400,000 customers, according to an estimate from the project's Business 396 companion team. Of these customers, approximately 0.02% may be interested in PICA, giving 12800 expected sales[4] given that we are a start up company. Additionally, despite the recent economic downturn, housing spending has experienced an upward trend[5], which may indicate a possible increase in the number of houses that could be constructed with the PICA solid-state breaker technology. The market for the consumer-oriented subsystems seems to be healthy, and even growing, despite the recent economic slump.

In order for any product to succeed commercially, its perceived value must meet or exceed the price the customer would pay for it. If the PICA system as a whole is to be a feasible market success, it must surpass its competitors in providing value per price. From a practical standpoint, this involves either selling a comparable product for a lower price than the competition, or producing a superior product at a similar price. The PICA project generally aims to follow the second of these two paths. The solid-state circuit breakers include solid-station circuit breakers and circuit-by-circuit power monitoring, both of which seem to be unusual or even unique features, which in turn means that its feasibility depends on the value of its features rather than a lower price. The base station may be viewed as an accessory to the other subsystems, but its function as the output of the collected information gives it a very high value to anyone who desires the information collected by the other PICA devices, so its feasibility relies on its high perceived value, rather than on undercutting competition. The smart-metering aspects of the E-meter essentially meet the expectations set by other smart meters, so the market feasibility of the E-meter device depends more on the price than on the features, but its ties with the base station can provide additional feature value as well. Overall, the subsystems of the PICA project tend to focus on providing valuable features, rather than on reducing the price below that of the competitors.

3.6 Consumer Cost Recovery

In 2009, the residential monthly electricity bill in the United States averaged to $104.52[6]. If the PICA base station and solid-state breakers sell with a retail price around $400, then the investment will amount to approximately four months of electricity bills. If, as is intended, the PICA system allows users to more wisely manage their consumption habits, then homeowners who have purchased the base station and have either the solid-state breakers or the E-meter installed at their house should experience a decrease in their monthly bill, which could recover the initial cost of the system installation. A table summarizing the different savings and payback periods appears as table 1.

As cost reduction rates depend entirely upon the user's response to the information, the recovery period for any given customer cannot be predicted. While reduction rates of 20% and higher may be realized for some individuals, a savings rate of 3% may be somewhat more typical. Using the United States Department of

Table 1: Table of Cost Recovery Rates

Relative Billing Reduced	Average Monthly Savings ($)	Months to Recover $400
0%	0	-
0.5%	0.52	765
1%	1.05	382
2%	2.09	192
3%	3.14	128
5%	5.23	77
10%	10.45	38
20%	20.90	19

Energy (DOE)'s monthly average of 908 kWh consumed per residence, this represents a decrease in average consumption of about 27 kWh per month per household. This amounts to 113 watts saved for eight hours for each of thirty days per month, equivalent to slightly more than one typical incandescent lightbulb. Such a reduction yields a payback period of 128 months, or slightly less than eleven years. If, however, the system could reduce consumption by twice this amount, the payback period would halve to just over five years, or 64 months.

4 Parts and Project Costs

The project costs can be broken into fixed and variable costs, where fixed costs represent the costs the team will incur during the year and production start-up costs, while variable costs represent the long-term costs associated with production.

4.1 Fixed Costs

4.1.1 Prototype parts

Through the Senior Design class, the Calvin College Engineering department provided $750 for prototype parts. Since the project has a large scope, the team needs to minimize the cost of any single part to stay within the given budget. As such, the team chose several parts more because of their low cost rather than for functionality. As such, the team sought donations and free samples whenever possible, including the TI MSP430 development kit from Texas Instruments and the ADE7763 power monitoring chips from Analog Devices. The team also obtained a pre-purchased Xilinx Virtex-5 development board. Table 2 shows the part donations and to-date purchases.

Table 2: Prototype part costs.

Date	Item	Price	Quantity	Total	Running Total
12-Sept	ADE7763 Samples	$0.00	2	$0.00	$0.00
15-Oct	SSOP to DIP Adapter 20-Pin	$3.95	2	$7.90	$7.90
15-Oct	Break Away Headers – Straight	$2.50	1	$2.50	$10.40
3-Nov	TRANSF CURRENT .50" OPENING PCB	$14.25	2	$28.50	$38.90
15-Nov	TI Donation MSP430	$0.00	1	$0.00	$38.90
02-Feb	XO Oscillators DIP-14 3.579545M	$1.87 2 $3.74 $42.64			
02-Feb	Solid State Relay 25A	$24.07 2 $48.14 $90.78			
02-Feb	LCD Graphic Display Modules	$18.55 1 $18.55 $109.33			
02-Feb	FFC/FPC Connectors 0.5mm	$1.29 2 $2.58 $111.91			
02-Feb	Headers and Wire Housings	$1.13 2 $2.26 $114.17			
02-Feb	Synchro Chron LCD and Backlight	$22.75 1 $22.75 $136.92			

4.1.2 Labor

Throughout the semester, the team has kept a log of how many hours they worked. Determining the cost of labor for the past semester based on these records, the team can also more accurately forecast the labor cost for next semester. So far, the team has logged 348 hours, with another 40 estimated before the end of the semester. Extending this to next semester, assuming a similar workload with a little extra time for final presentations, the team expects to have 388 hours, putting the yearlong total at about 776 hours. Assuming engineers are paid $100 an hour, the first semester labor cost is $38,800, the second semester cost is $38,800, making the full labor costs for the project $77,600 as calculated in Table 3.

Table 3: Team hours and projected labor costs.

Timeframe	Hours Logged	Cost
first semester	388	38,800
second semester estimate	427	42,700
TOTAL	815	81,500

4.1.3 Manufacturing start-up

In determining the cost for start-up of manufacturing, the team looked strictly at the costs of the product, ignoring many costs associated with starting a business. The team decided to contract out the work needed to build the system. Due to the high volume of systems being manufactured, the cost to manufacture will be low and is included in the cost of parts for each subsystem. The cost of constructing a storage facility is then our largest up front cost.

4.2 Variable Costs

4.2.1 Parts

To calculate the overall cost of parts used in production, the team assumed large quantities for each of the individual components. This means that the low end of the cost range for parts is used. Based on this information and the estimated final cost of the prototype, the team calculates the cost of parts and manufacturing for the breakers, base station and e-meter to be $35, $100, and $200 per subsystem, respectively.

Table **??** shows the calculations used to determine the labor costs for manufacturing purposes. Estimates given during lecture [9] helped determine the hourly wage and additional costs of labor including insurance, vacation, holiday, sick time etc. The number of hours needed to assemble each system does not include the time needed to print and populate each circuit board as these will be completed by automatic machinery that requires minimal human interaction.

4.2.2 Marketing

The project includes two distinct advertising methods to better accommodate the different target consumers. The e-meter aspect of the project will be sold directly to the power company, and the breakers and base station will be sold to the home and business owners. As the number of power companies is significantly fewer than the number of home and business owners, and will be purchasing in much larger quantities, the team decided it makes sense to appeal to the power companies in a much more personal manner. This includes phone calls, letters, and visits and outside of the cost of paying a few employees will be negligible.

Most of the advertising will aim at the home and business owners, and the team decided that magazines and websites such as Popular Science and Green magazine are the best method of reaching out to potential buyers. Green magazine features news and products related to sustainable energy, reaching thousands of people every year. Approximately 36% of those people are in the building and contracting industry and would be beneficial in spreading news about the team's product [10]. The cost to put a medium size ad on their website is $150 dollars per month [10], so for a year would be $1800. Popular science reaches over 7 million people using printed material. For a 1/3 page ad in four color for 12 months, the cost is $59,900 [11]. The team would like to target 3 to 4 magazines and using Popular Science and Green magazine as boundary cases, estimates a total cost of $120,000 for marketing and advertising.

For the home and business owners' side of the project, the team also would like to work with distributers like Lowe's and Home Depot. The team would like to use a method of advertising similar to the one used for power companies, so the cost will not noticeably increase. The distribution companies may do additional advertising, but any costs associated with that will be their responsibility, so again the cost the design team expects will stay the same.

4.2.3 Legal, warranty and support

The team expects about 10 hours of work for basic legal documentation. Because of the potential for lawsuits, the team built in money to cover the costs of 200 hours of work, assuming $80 an hour, giving a total of $16,800. The team does not intend to pursue any patents, but recognizes there may be infringement lawsuits, which were built into the above 200 hours.

The team expects 5% of all PICA systems that include all three subsystems to fail and need replacement.

At a system cost of $260 per system with shipping of $30, the amount needed to cover warranties is $2,432,000.

5 Competitor Analysis

This section analyzes a few products with similar features to various components of the PICA system such as Kill-A-Watt, Cent-a-Meter, The Energy Dectective, and Watts Up? Smart Circuit. The table below gives a overview of these products compared to the PICA system.

Table 4: Comparison of PICA Competitors

Product	Monitoring features	Control Features	Cost (Fixed)	Cost (Recur-ring)	PICA Competitor
Kill-A-Watt	voltage, line frequency, amperage, KWH, and current leakage	N/A	$52 to $99	N/A	Ciruit-by-Circuit Monitors
Cent-A-Meter	Cost of electricity, temperature, humidity, kW of demand kg/hour greenhouse gas emissions	N/A	$140	N/A	E-Panel Meter
The Energy Detective	kW load, $/hour	N/A	$119.95 to $455.80	N/A	E-Panel Meter
Watts Up? Smart Circuit	Current, Voltage, kilowatts used	Remote On/Off	$194.95 /circuit	Free to $50.00 /month	Circuit-by-Circuit monitors
Smart-Watt	voltage, line frequency, amperage, KWH, current leakage, circuit load, on/off cycles	N/A	$169 to $249	N/A	Circuit-by-Circuit Monitors

5.1 Kill-A-Watt

Around the turn of the millennium P3 International introduced the Kill-A-Watt device, which they marketed as a "user-friendly power meter that enables people to calculate the cost to use their home appliances," [12]. According to Amazon.com these devices range in price from 52to99 Manufacturer Suggested Retail Price (MSRP) depending on features, most notably how many devices can be monitored simultaneously. P3 produces three models of the Kill-A-Watt devices:

1. Kill-A-Watt PS (P4320): A power strip capable of monitoring voltage, line frequency, amperage, KWH, and current leakage for up to eight devices simultaneously and includes built-in surge protection [13].
2. Kill-A-Watt (P4400): The original Kill-A-Watt device, capable of monitoring voltage, amperage, watts used, line frequency, KWH, uptime, power factor, and reactive power for 1 device [14].
3. Kill-A-Watt EZ (P4460): This device is functionally identical to the P4400 series except that it includes one extra feature, it can calculate how much a device costs the consumer, after being programmed with the $/KWH provided by the power company [15].

All of the Kill-A-Watt devices claim to be accurate to within 0.2% of the actual power the monitored device uses [13][14][15]. The Kill-A-Watt devices cannot replace a power meter, but simply provide a method of supplying a consumer with additional data about their power consumption.

5.2 Cent-a-Meter

The Australian company, Clipsal produces the Cent-a-meter also known as the Electrisave or the Owl in the UK. Clipsal only produces one version of the Cent-a-meter which displays the cost of the electricity used in the home along with the temperature and humidity [16]. The device can also measure kW of demand, and kg/hour of greenhouse gas emissions [17]. Unlike the Kill-A-Watt, the centimeter does not accumulate any data, just displays instantaneous data on a receiver unit mounted in the home [16]. Clipsal does not list an MSRP for the Cent-a-meter, however SmartHome USA sells Cent-a-meter devices for $140 [17].

5.3 The Energy Detective (TED)

Energy Inc., a division of 3M, recently introduced its TED (The Energy Detective) power monitor. Functionally, TED operates exactly as the meter on the exterior of a consumer's home or business but the display resides indoors in a more convenient viewing location. Energy Inc. currently produces two series of the TED device:

1. TED1000 series: The TED1000 devices monitor current energy consumption in killowatts, and current energy cost in $/hour, and log this data for 13 months to predict energy use for the current billing cycle. TED1000 devices can integrate with a proprietary software package, Footprints,

provided by Energy Inc. to visually display usage data [18]. TED1000 series devices range in price from $119.95 to $229.95 depending on the amp-rating of the service installation [19].

2. TED5000 series: The TED5000 sought to improve upon the TED1000 series by extending the functionality of the TED devices. The largest selling point for the TED5000 is integration with the Google Power service to track power usage data on the web [20]. TED5000 series units range in price from $239.95 to $455.80 depending on from how many measurement units the device gathers data [21].

5.4 Watts Up?

In 1997 Electronic Educational Devices Inc. introduced the Watts Up? product line to the education market. The product immediately became a hit, and soon utility companies across the United States began to take notice [22]. EED markets the Smart Circuit devices as a replacement for traditional circuit breaker devices for 100V to 250V, 20 amp 50/60Hz circuits [23]. Each Smart Circuit contains a built in web-server that allows for aggregation of collected data at a maximum rate of once per second [23]. These Smart Circuits are typically installed into a standard panel enclosure box, similar to standard circuit breakers, mounting directly to the industry-standard DIN rail inside the enclosure[23]. Alternatively, if needed at one local outlet, the Smart Circuit can be housed in a standard double gang electrical box [23]. Each Smart Circuit device can turn itself on or off when it receives a certain remote-control signal or when it detects one of many programmable stimuli. This self-waking feature makes these devices ideal for home-automation projects [23].

A single Smart Circuit, capable of controlling one circuit, costs $194.95, with enclosures for one, five, or ten Smart Circuits devices going for $325.95, $1495.95, and $2495.95 respectively [23]. A basic account, to view aggregated data and control the devices is free for residential use, but data rates, historical data and devices rules are limited [24]. A top-tier account, featuring the fastest update time, 1 second, up to 25 meters, 1 year of archival data, and 25 rules costs $50.00 a month [24].

5.5 Smart-Watt

The Smart-Watt device from Smartworks Inc. takes a similar approach to the Kill-A-Watt device in metering a single device at a time, but monitors much more information including circuit load over any period of time, and number of on/off cycles the attached device undergoes [25]. The biggest advantage to the Smart-Watt devices comes from the proprietary network Smartworks has developed for their devices. Each device attaches to a local network where a central server collects and collates all the data [25]. The Smart-Watt comes in two versions, one for International Electrotechnical Commision (IEC) plugs and receptacles and one for National Electrical Manufacturers Association (NEMA) plugs and receptacles. Both devices are similarly priced ranging from $169 to $249 depending on the current rating [25].

5.6 Standard Power Meter

Most homes or businesses attached to the electric grid are metered using a standard analogue power meter. This device provided by the power company, measures the amount of electrical energy consumed over a period of time. Typically, a power meter records in billing units, such as KWH. Each meter requires periodic readings based on the billing cycle of the power company; it is safe to assume that meters are read approximately once per month. In order to read the meter, an employee of the power company will physically go out to the meter and record usage data.

5.7 Nonintrusive Appliance Load Monitor

All of the products discussed here use a technique known as Non-intrusive Load Monitoring (NILM) to monitor power consumption without affecting the load on the circuit [26]. However, some more sophisticated products in this area use NILM to estimate the number of individual loads on the circuit [27]. If the research in this field proves that NILM provides accurate and useful data, devices based on the NILM technology would have a large advantage over other single-device power monitors, as such a device could be inserted into the feeder lines from the utility company and monitor all devices in the entire installation from a single point. Research turned up no significant products that claim to be capable of monitoring multiple loads on a circuit from a single point on the circuit. Thus this section is included to provide information, but does not represent a viable competitor in the market just yet.

5.8 PICA Competitors Comparison

In order to better understand the competition in the marketplace table 4 reproduces the information laid out above as a comparative table. The column on the far right side describes the PICA component that most directly competes with the product listed in the left column.

6 Plan of Operation

6.1 Legal form of ownership

The business shall be formed as a limited liability company under the name "PICA, LLC."

6.2 Company structure

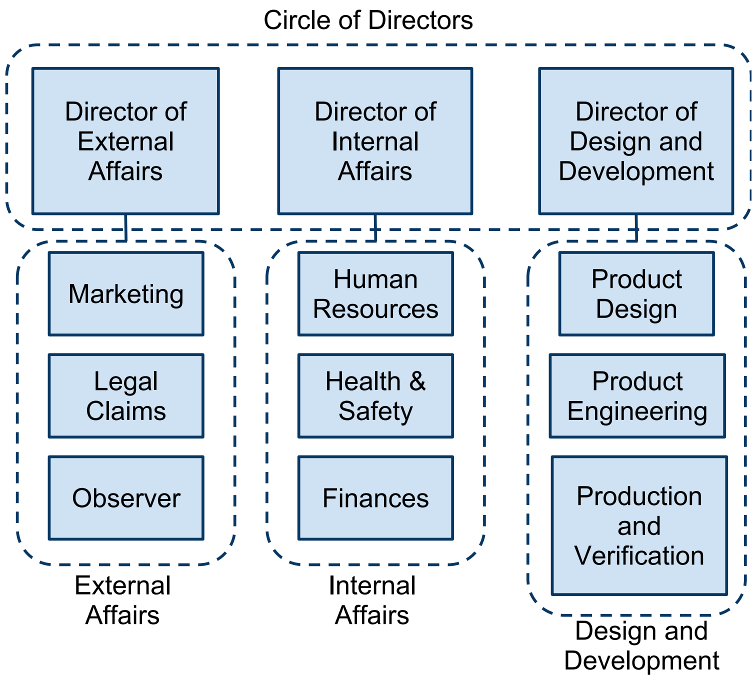

Figure 1: Proposed Organization Chart for PICA, LLC.

6.2.1 Select explanations of Figure 1

The Internal Affairs directorate shall provide certain services to the other directorates and departmetns. For example, Internal Affairs includes the Human Resources division, but the other directorates will of course require the services of the HR division in order to hire new employees. Similarly, the finances division will provide budgeting information to the other divisions and directorates.

The other two directorates do not provide services to the other directorates. The one exception to this is the Observer function of the External Affairs directorate: its purpose is to monitor the business and legal climate in terms to demands and regulations, then inform the appropriate divisions. This could be spun off into its own directorate, but will likely not employ enough people to grant it a director and a direct voice in the Circle of Directors.

6.3 Decision-making authority chain

The final authority on a decision shall be vested in the Circle of Directors, but their authority shall not be required in every decision. The Circle of Directors shall have the exclusive power to make decisions regarding the direction of the business and the relationships between the directorates. Other issues may rise to the Circle if they cannot be resolved at a lower level or if the scope of the decision cannot be contained to one directorate. Otherwise, decisions that are limited in scope to any particular group or body shall be resolved within that body with the advice of the applicable Internal Affairs departments.

6.4 Compensation/benefits package

All employees shall be compensated fairly and in proportion to the scope of their decisions and actions. The company shall provide benefits packages including medical- prescription, vision, and dental plans. In addition, the company shall also provide a cafeteria and snacks for its employees to enjoy within moderation. The lowest Engineering position shall pay an annual salary of $55,000, with up to 50% increases in pay for each level of management ascended. Employees in other directorates will earn an annual salary of $35,000, with a similar reward for ascending management. Employees shall receive raises in pay for distinguishing their work from that of their peers.

7 Ten-Year Financial Forecast

To assist in evaluating the financial viability of the product, the following graph and data illustrate predictions of sales in the first ten years of the product's life. In the first several years, the sales volume will grow as consumer recognition and demand increase. In the fifth year, rival companies will likely produce a competitive product; without any further product improvement, PICA will experience a shrinking market demand, but continue to make a profit through the end of the decade. If, however, PICA develops a new product, the long-term trend may become greater growth instead of loss. These predictions assume a per-unit cost of $337 and a sale price of $400.

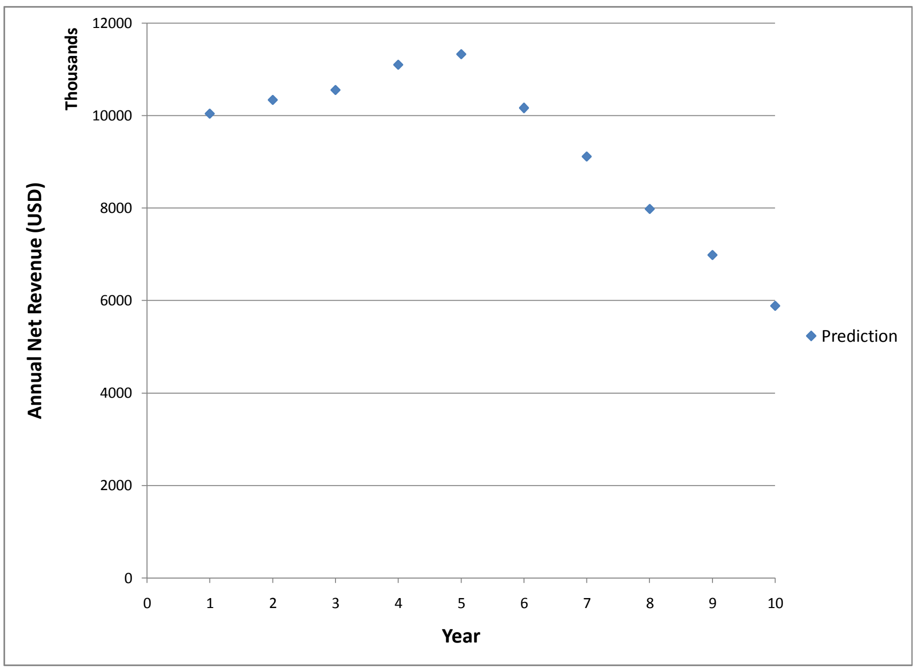

Figure 2: Graph of Ten-Year Revenue Predictions

Table 5: Ten-Year Financial Forecast

Year	Growth	Units Sold	Parts Cost	Other Cost	Income	Balance	Running Total
1	–	166000	56000000	242000	66000000	10283000	10283000
2	+2%	169000	57000000	149000	68000000	10587000	20870000
3	+2%	173000	58000000	149000	69000000	10801000	31671000

Continued on next page

Table 5: Continued from previous page

Year	Growth	Units Sold	Parts Cost	Other Cost	Income	Balance	Running Total
4	+5%	181000	61000000	149000	73000000	11349000	43020000
5	+2%	185000	62000000	149000	74000000	11579000	54599000
6	-10%	166000	56000000	149000	67000000	10406000	65005000
7	-10%	150000	50000000	149000	60000000	9350000	74355000
8	-12%	132000	44000000	149000	53000000	8210000	82565000
9	-12%	116000	39000000	149000	46000000	7207000	89772000
10	-15%	99000	33000000	149000	39000000	6104000	95876000

Table 6 shows the initial and recurring costs for our business. Recurring costs are further broken down into fixed and variable costs. Variable costs are shown as cost per system, independent of the volume of sales. All of the variable costs were calculated in table 6, and the initial costs were calculated in tables 4 and (hours worked; in text of document).

Table 6: Costs Overview

Cost Type	Detail	Amount
Initial Costs	Facilities	$11,000
	Prototyping	$82,000
	Total	$93,000
Fixed Recurring Costs	Marketing & Advertising	$120,000
	Legal	$17,000
	Facilities	$12,000
	Total	$149,000
Variable Costs Per System	Parts Cost	$277
	Labor	$44
	Shipping	$16
	Total	$337

Table **??** gives the cost of assembling each subsystem based on the number of hours needed to assemble each subsystem as estimated by the design team. Costs for wages are based on information from Professor Nielson's lecture first semester.

Table 7: Assembly Costs

Item	Value	Units
Hourly wage	20	USD/hour
Insurance, vacation, holiday, etc.	10	USD/hour
Per work-hour total	30	USD/hour
Time to assemble breakers	0.75	hour
Time to assemble base station	0.5	hour
Time to assemble E-meter	1.25	hour
Breakers per year	192000	
Base stations per year	64000	
E meters per year	830000	
Total time for breaker	144000	hour
Total time for base station	32000	hour
Total time for E-meter	1037500	hour
Breakers labor cost	4320000	USD
Base station labor cost	960000	USD
E-meter labor cost	31125000	USD
Per-breaker labor	22.5	USD/Device
Per-base-station labor	15	USD/Device
Per-E-meter labor	37.5	USD/Device
Total Labor Hours	1213500	hour/year
Total Labor Cost	36405000	USD/year

Table 8 calculates the cost for a storage facility where the manufactured systems can be stored until they are shipped to the customers. Floorspace needed was calculated based on the physical volume of each subsystem and how many pallets would be needed to hold a quarter of a year's supply. From this information we found the cost of a standard warehouse facility using information found at `www.buildingsguide.com`.

Table 8: Storage Costs

	Breaker Storage	E-Meter Storage	Base Station Storage	Total
Width (ft)	0.16	0.5	1	
Height (ft)	0.25	0.67	0.67	
Length (ft)	0.33	0.25	0.33	

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Table 8: Continued from previous page

	Breaker Storage	E-Meter Storage	Base Station Storage	Total
Volume (ft^3)	0.01	0.08	0.22	
Yearly Supply	38,000	166,000	13,000	
Quarterly Supply	9,500	41,500	3,250	
Pallet Height (ft)	3	3	3	
Pallet Stack	3	3	3	
Total Height (ft)	9	9	9	
Floor Area (ft^2)	14	384	80	479
Floor Length (sqare) (ft)	4	20	9	22
Cost	$323	$8,832	$1,844	$11,000
Per-unit Cost	$0.03	$0.21	$0.57	
Yearly Supply (Peak)	44,636	190,000	14,879	190,000
Quarterly Supply (Peak)	11,250	47,500	3,750	
Floor Area (At Peak) (ft^2)	17	440	80	549
Floor Length (Peak, Square) (ft)	4	21	10	23

Table 9 shows calculations for how many customers our business expects to have. Using the total number of electric companies and number of homes in the U.S., we determined our percentage of the market and combined this with the estimate of the total number of potential customers from the business team to find the number of systems we can expect to sell. Final numbers are given in terms of each subsystem.

Table 9: Expected Demand

	Number	Modified	
Customers	6,400,000	1,280,000	1,280,000
Percentage Interested	0.001	0.0002	0.0002
Customers Interested	64,000	12,800	13,000
Breakers/Customer	3	0.6	0.6
Breakers Needed	192,000	38,400	38,000
Base Stations Needed	64,000	12,800	13,000
US Power Companies	3200	640	640
Number Converted Homes	8,300,000	1,660,000	1,660,000
Number Expected Conversions	24,900,000	4,980,000	4,980,000

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Table 9: Continued from previous page

	Number	Modified	
Total Homes	130,000,000	260,000,000	260,000,000
Average Homes/Company	40,625	8,125	8000
Major Meter Providers	5	1	1
Minors Per Major	3	0.6	0.6
Minor Meter Providers	15	3	3
Ratio Homes Provided	3	0.6	0.6
Effective Meter Providers	30	6	6
PICA Homes	830,000	166,000	166,000
E-Meters Needed	830,000	166,000	166,000

Table 10 shows the costs of the subsystems as calculated in other tables and determines the cost of a full system for use in table 1.

Table 10: Cost Per Unit

System	Detail	Value
Breaker	Cost of Parts per	$35
	Cost of Assembly per	$23
	Shipping	$3
	Total Cost Per	$61
	Number	38000
	Storage Cost	$0.03
Base Station	Cost of Parts Per	$100
	Cost of Assembly per	$15
	Shipping	$8
	Total Cost Per	$123
	Number	13000
	Storage Cost	$0.57
E-Meter	Cost of Parts Per	$200
	Cost of Assembly Per	$38
	Shipping	$15
	Total Cost Per	$253
	Number	166000

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Table 10: Continued from previous page

System	Detail	Value
	Storage Cost	$0.21
System	Cost of Parts Per	$216
	Cost of Assembly Per	$44
	Shipping	$16
	Total Cost Per	$277
	Number	166000
	Storage Cost	$0.26

8 Loan or Investment Proposal

8.1 Amount Requested – Equity and/or Debt

In order to successfully enter the smart metering market, PICA LLC feels that they will require $290 million in assets. In order to have all these assets, we plan on using a 60-40 split for debt and equity. Thus, our debt-equity structure for startup becomes $174 million in debt and $116 million in equity. We hope to raise the $116 million through personal donations from venture capitalists while the remainder of the cash supply comes from a business loan.

8.2 Purpose and Uses of Funds

We plan to initially contract for the fabrication of the circuit boards until we gain enough operating capital to move production in-house. Our startup costs represent initial cost of parts to begin production and salary for our employees during the first year. Until our business proves to be successful we plan on renting office and warehouse space for the first year. After the first year, assuming financial success, we hope to build our own warehouse to store completed systems before shipment to retailers.

8.3 Repayment and Cash Out Schedule

By year 5 of business, PICA LLC forecasts enough financial success to being repaying our venture capitalists. The return on investment for these venture capitalists, assuming economic success will be 8-10% of the initial investment.

8.4 Timetable for Implementing and Launching a Business

PICA LLC projects a 6-month timeframe for starting the business. During these 6-months, PICA LLC intends to finish and prove the initial prototype and get all necessary contracts in place for office space, warehouse storage, shipping, and production facilities. After these are in place, PICA LLC projects that by the end of year 1, they will be shipping completed products to retail locations.

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A Acronyms

ANSI American National Standards Institute . . . 6

DOE United States Department of Energy . . . 12

EM electromagnetic . . . 5

FCC Federal Communications Commission . . . 6

IEC International Electrotechnical Commision . . . 21

NEMA National Electrical Manufacturers Association . . . 21

NILM Non-intrusive Load Monitoring . . . 21

UL Underwriters Laboratories . . . 5