EnergyRubix
Reaching For Zero Net Energy in The Residential Sector

A Feasibility Study in Developing an Energy Service Company for the Residential Sector of California

A 2010 Group Project Proposal

Researched and Produced By:

Linda Halabi
Andrea Lamartin
Anna Lin
Adam Rohloff
Aaron Wdowin

Faculty Advisors:

Jim Frew
Matt Kotchen
Gary Libecap
**EnergyRubix: The Cost Effective Approach to Energy Efficiency**

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Abstract

EnergyRubix (ER) is a business venture that will provide comprehensive home energy upgrades to existing buildings in the residential sector. By coupling energy efficiency retrofits with solar photovoltaic installations, EnergyRubix will help customers lower their utility bills and significantly reduce their greenhouse gas emissions in the most cost effective manner. By first reducing the overall energy use of a home through optimally selected retrofits and then employing a potentially smaller solar system to cover the remaining energy load, return on investment can be maximized. Through market analysis and cost research, EnergyRubix will develop optimization strategies to determine the most cost effective combination of retrofits and sizing of the solar photovoltaic installation. This will make it feasible for a greater number of customers to employ energy efficiency retrofits and solar system technologies, allowing EnergyRubix to expand the current market for clean energy. Ultimately, EnergyRubix aims to make achieving zero net energy homes simpler and more affordable for all of California.
Executive Summary

The buildings sector is the second largest greenhouse gas (GHG) contributor in California, comprising over 30 percent of statewide greenhouse gas emissions.\(^1\) According to the EPA’s 2009 U.S. Greenhouse Gas Inventory Report, the residential and commercial end-use sectors accounted for 21 and 18 percent, respectively, of total Carbon Dioxide (CO\(_2\)) emissions from fossil fuel combustion in 2007.\(^2\) Both sectors relied almost entirely on electricity and natural gas for meeting energy demands primarily attributed to lighting, heating, cooling, and appliances.\(^3\) Curbing greenhouse gas emissions from the residential sector will be a function of more efficient buildings, more efficient electrical generation, and consumer education about energy conservation.

The Challenge

Addressing greenhouse gas emissions from the building sector presents a significant challenge due to the dispersed and individual nature of the sources. It is ultimately up to the homeowner to pursue energy improvements for their homes and decide whether or not to increase their home’s efficiency and/or to employ renewable energy such as a solar photovoltaic (PV) system.

Solar PV systems have been looked to as the solution to home energy needs but high upfront and transaction costs and a lack of information make installing such a system unlikely for the majority of the population. In addition to high costs, residential solar systems rarely cover 100% of a home’s energy needs. Also, the energy generated by PV systems varies over time with seasonal changes and cloud cover, making the benefits and payback period less certain.

Likewise, energy efficiency building retrofits, such as sealing a building envelope through weatherization, can significantly reduce home energy use and GHG emissions, but alone can only address a portion of a home’s energy needs. The barriers to greater energy efficiency are not issues of cost-effectiveness, but rather a “lack of complete information, relatively high initial costs, and mismatches between who pays for and who benefits from efficiency investments.”\(^4\)

Significant Potential of Emissions Reductions

Current California climate legislation calls for significant reductions of greenhouse gas emissions across all economic sectors. The existing building sector has an enormous potential for emissions reductions but as of now has been slow to move in this regard. While solar photovoltaic systems alone are not a cost effective method of reducing GHG emissions, when coupled with energy efficiency retrofits greater energy and emissions reductions can be obtained at a lower cost. Energy efficiency has been identified as one of the few GHG mitigation strategies that actually have negative costs over the lifetime of their utility.\(^5\)

Reducing emissions from buildings is one of the most basic and cost effective opportunities for reducing global warming pollution, while yielding direct economic benefits by reducing utility bills and boosting green jobs.\(^6\) The California Energy Commission (CEC), California Air Resources Board (CARB), and The California Public Utilities Commission (CPUC) all recognize the continuing importance that energy efficiency will play in the future, and consider it to be the single most cost effective and low environmental impacting method to reduce GHG emissions.\(^7\)

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2 EPA. 2009 U.S. Greenhouse Gas Inventory Report
3 EPA. 2009 U.S. Greenhouse Gas Inventory Report
Demand

While a number of utilities and solar installation companies recommend energy audits and possible energy efficiency retrofits before installing a solar system, the complicated research and coordination required to complete such work is left up to the consumer. In many cases, a consumer is led through a series of steps, starting with an online energy efficiency audit focused on appliances in which the consumer enters information from their utility bills in order to obtain feedback in the form of estimates. Next the consumer must locate the last 12 months of utility bills from their electricity provider and contact multiple solar contractors for bids. The chosen solar contractor takes care of the rebate and permitting paperwork. Yet, the customer must claim their tax credit under the California Solar Initiative. This entire process is time consuming and does not involve actual energy efficiency building retrofits or demonstrations of alternative options to a solar PV system.

California’s existing residential building stock is substantial and future legislation will mandate energy efficiency improvements. Therefore, a quantifiable need exists for an energy service that will take care of the entire home energy improvement process from start to finish. The EnergyRubix service will not only eliminate the time consuming and complicated burden from the customer, but will utilize the most holistic and cost effective strategies for reducing energy use and GHG emissions. By applying building retrofits and solar system installations simultaneously, greater value is obtained and payback periods are shortened. Once overall home energy use has been reduced through energy efficiency retrofits, a solar photovoltaic system can be employed to cover the building’s remaining energy needs. In some cases, the size of the solar array required to cover the remaining home energy needs is reduced, making the entire system more affordable and more feasible for a greater number of homes in California.

Objectives

To address this problem EnergyRubix will streamline the entire home energy improvement process for our customers. EnergyRubix will evaluate the cost effectiveness of various energy efficiency retrofit and solar PV system combinations in order to create the optimal package for each home. Our comprehensive service will include a home energy assessment (audit), an energy efficiency tune-up using the most cost effective package of retrofits, and finally a solar PV installation. We will help customers significantly reduce their utility bills and greenhouse gas emissions by utilizing the most cost effective and affordable methods available.

EnergyRubix is among the first to offer such a comprehensive service in the central and southern California region and will guide its customers through the complicated multi-step process of reducing energy inefficiencies and GHG emissions. Our ultimate goal is to provide strategies for consumers to reduce their energy consumption, while offering an option of renewable energy to make it possible for Californians to achieve zero net energy homes.

Approach

EnergyRubix will develop a home energy package optimizer that will allow us to design the most cost effective retrofit package for customers based on energy audit data, utility bills, and financial considerations. We will also navigate through the various solar and energy efficiency incentives and tax rebates that exist. EnergyRubix will then develop a business plan that targets residential and small commercial clients interested in reducing their utility bills, total energy consumption, and GHG emissions; significantly contributing to California’s goal of zero net homes.

We have teamed with SolarCity, a national solar PV installation company, in order to gain valuable market insight and penetration. This mutually beneficial relationship will flourish as increased affordability and effectiveness of energy and emissions reductions will expand the current
solar installations market, reaching marginal customers that cannot currently afford a large solar system or do not have ideal roof space requirements.

The guiding principle behind the EnergyRubix Team is to provide a viable market based solution that reduces the GHG emissions that are associated with residential homes in California. Sufficiently lowering the upfront costs of achieving a highly efficient home will allow EnergyRubix to reach the mass market and make our solution for reducing GHG emissions in the residential sector a reality.
Project Objectives

The guiding principle behind the EnergyRubix Team is to provide a viable market based solution that reduces and can potentially eliminate GHG emissions that are associated with residential homes in California. Based on evidence that energy efficiency is the most cost effective emissions reduction method, we believe that by selecting the optimal combination of energy efficiency retrofits and a suitable solar system, we can provide the lowest cost zero emissions solution for the residential sector. Sufficiently lowering the upfront costs of achieving zero net energy will allow EnergyRubix to reach the mass market and lead the way in reducing GHG emissions from the residential sector.

The specific EnergyRubix Team objectives that will allow us to achieve our larger goal are divided into two major areas; developing core competencies that become our value proposition; and developing a strong business model that will make us marketable.

Our core competency objectives are to:

- Develop the partnerships necessary to create franchises. This will allow EnergyRubix to rapidly expand our company and have a real impact on the marketplace.
- Learn how to perform accredited home energy audits
- Develop a toolkit that will allow us to:
  - Systematically design the most cost effective home energy package for customers based on energy audit data, utility bills and financial considerations
  - Develop a carbon and financial calculator for customers so they can monitor the carbon footprint of their home, and the success of the EnergyRubix community
- Establish professional relationships with local contractor(s) that are willing and able to install retrofits that are beyond our own capabilities
- Continue to develop our relationship with SolarCity and work together on a pilot project.

Our business model objectives are to:

- Develop a comprehensive marketing platform that will allow us to reach our target market
- Develop a sound revenue model that will ensure our ability to sustain and expand our operations.
- Complete a presentable business plan with accurate financial projections that conveys the value of EnergyRubix for all potential stakeholders.
Project Significance

The confluence of events within the political, economic and social arenas creates an unprecedented opportunity for the private and public sectors to work together to achieve California’s energy reduction goals. California has established itself as a national leader in terms of climate change policies and incentives. The CPUC’s Long Term Energy Efficiency Strategic Plan (CLEESP) was enacted in November 2008 with goals of zero net energy for new residential buildings by 2020 and new commercial buildings by 2030. The CPUC has set a target for 25% of existing homes to cut their energy demand by 70% and 75% homes to cut their energy demand by 30% between 2016-2020. California’s Assembly Bill 32 (AB 32) mandates significant reductions in GHG emissions through regulatory and market strategies. The associated Scoping Plan has targeted the residential sector as a major area for improvement. Subsequent regulations under Assembly Bill 811 (AB 811) give municipalities the authority to provide loans to businesses and homeowners for energy efficiency upgrades that can be paid back as part of their property taxes.

The American Recovery & Reinvestment Act of 2009 (ARRA) offers significant financial assistance for building retrofits and solar installations in the form of rebates, tax credits, and competitive grants. Specifically, ARRA includes $65 billion in tax credits for homeowners and industrial energy efficiency projects and a separate $42 billion towards energy efficiency and renewable energy development and projects. California is allotted to receive about $1.1 billion for smart grid development, $5 billion for weatherization, and $2 billion for renewable grants, tax credits for energy efficiency experiments, and loan guarantees. The available funding can provide significant improvements and advances for California’s energy initiatives.

Locally, Santa Barbara County is in the process of developing a Climate Action Strategy (CAS) to respond to California’s climate change policies and the County’s GHG reduction goals. The CAS addresses potential financial, technological, and social strategies to reduce emissions and maximize energy efficiency. The plan aims to leverage funds from ARRA to create short term strategies that can be incorporated into longer term plans.

The progressive political environment affords the opportunity for major improvement to be made in the residential building sector, which will create a demand for a comprehensive energy use and emissions reduction service. EnergyRubix will capture the demand that will arise for energy efficient homes and will be able to maximize the extent of its business within the Tri-County area while simultaneously advancing local, county, and state climate goals.

Ultimately, if EnergyRubix can demonstrate the viability and effectiveness of its approach to the residential sector in Santa Barbara, there will be a potential for this business to spread throughout California and the country. In order for this to be a reality we must develop a simple, replicable, and cost effective methodology as the basis of our service. This will be critical in the franchising of our operation.

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8 Recovery.gov 2009.
9 At the national level, $11.3B are formula-based for efficiency, renewable, and green community plans and $30.7B are in the form of grants, loans, and loan guarantees for transportation, transmission, renewables, and research.
Literature Review

Greenhouse Gas Emissions and Climate Change

According to the Intergovernmental Panel on Climate Change (IPCC), Carbon Dioxide (CO₂) emissions from energy production are strongly related to climate change. Fossil fuel combustion is the primary energy source worldwide and the IPCC estimates that emissions from energy are likely to increase by nearly 50% by 2030. Improvements in building efficiency and GHG reductions have the potential to alleviate problems associated with fossil fuel energy such as energy security threats, air quality, and the dependence on foreign fuel imports. With increasing research and experience in the field, the costs and effectiveness of renewables are expected to improve. Major barriers to effective renewable energy generation and adoption are current high costs, economic implications, infrastructural capacities, and variability of the sources.

Energy Efficiency as a Cost Effective Means to Reduce GHG Emissions

Many proposed methods and technologies aimed to reduce dependency on fossil fuels, are costly, limited, and have unknown future implications. Energy efficiency has been identified as one of the few GHG mitigation strategies that has negative costs over the lifetime of their utility. Energy efficiency is considered to be “the least cost, most reliable, and most environmentally sensitive resource…” Efficiency reduces the demand for energy and resource consumption, thereby mitigating the environmental impact of any technology, whether it is burning coal or manufacturing photovoltaic cells.

The barriers to greater energy efficiency include a “lack of complete information, … high initial costs, and mismatches between who pays for and who benefits from efficiency investments.” Nevertheless, California is the only state in the country that has decreased per capita energy consumption over the past 30 years. California Energy Commission, California Air Resources Board, and The California Public Utilities Commission recognize the importance of energy efficiency in the future, and consider it to be the single most cost effective and environmentally benign method to reduce GHG emissions.

Residential Energy Use

The built environment consumes 48% of all energy in the country. In 2005, the U.S. residential sector contributed 18% of total greenhouse gas (GHG) emissions; 98% of these...
emissions were CO₂. Residential energy uses include heating, air conditioning, water heating, and powering home appliances. Curbing GHG emissions and achieving zero net energy homes will be a function of more efficient buildings, more efficient electrical generation, and consumer education about conservation.

New home construction accounted for only 1.5% of housing stock in 2005. Existing housing stock provides huge opportunities for efficiency improvements. Energy use per square foot of heated area of houses in the 20th and 21st centuries is roughly: 63,000 Btu, nearly 71,000 Btu for houses built between 1941 and 1949, and about 43,000 Btu for houses built between 1990 and 2001. As house size has increased, improvements in Heating Ventilation Air Conditioning (HVAC) equipment, better insulation, and enhanced windows make new homes more efficient. Home efficiency improvements for new homes are advantageous, yet high costs may curtail replacements of pre-1940 homes. Thus, older homes should be retrofitted to be comparable to current standards.

California Policies, Programs, and Incentives

In California, energy efficiency and GHG reductions fall under a three pronged system: (1) smarter growth and development; (2) improved efficiency in the built environment; and (3) changes in qualitative emissions from transportation. The latter of the two components are based on energy efficiency improvements. Smarter development includes such mechanisms as denser development and the creation of faster-formed economies of scales for implementation of renewables.

California Long Term Energy Efficiency Strategic Plan

The CPUC released the California Long Term Energy Efficiency Strategic Plan in September 2008. This document makes important implications for residential and commercial electricity users. Most notably, the document lists “Big Bold” energy efficiency strategies, which contain target goals specifically related to the residential sector. The CPUC set a ‘reach’ goal for all new homes to be zero net energy by 2020. This extremely ambitious goal, even if not fully achieved, will serve as the impetus for change for both new and existing homes.

A second goal of the CPUC is to transform home improvement markets to apply whole-house energy solutions to existing homes. This goal is even more relevant to the EnergyRubix business model. The CPUC has set a target for 25% of existing homes and 75% of homes to cut their energy demand between 70% to 75% and 30%, respectively, by between 2016 and 2020. These programs will include improving HVAC systems, the building shell, lighting, heating, water heating, and electronic and appliance plug loads. Strategies to achieve this include carbon labeling systems, financing options, enforcing compliance of updated Title 24 standards, and designing home rating system projects based on the CEC Home Energy Rating System (HERS).

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As the CPUC and other California agencies work to achieve these goals, it is anticipated that incentives and rebates for energy efficiency and self-generation will be increased, upfront costs will be lowered, consumers will become better educated, and financing options will be provided. This will serve to steadily increase the viable target market for EnergyRubix and allow us to achieve wide scale implementation of zero net energy homes.

Assembly Bill 32
California’s major initiatives for reducing climate change by cutting GHG emissions are outlined in California’s AB 32, which was signed into law 2006. The bill aims to reduce GHG emissions by 30% by 2020 to match 1990 levels. The Bill requires an additional 80% decrease GHG to below 1990 levels by 2050.

Assembly Bill 811
AB 811 was passed in 2008 to compensate for costs associated with building retrofits and renewable energy. The Bill gives all cities and counties in California “the ability to offer low-interest loans for energy-efficiency projects and solar panels to homeowners and small businesses. Residents would pay back the loans through assessments on property tax bills.” The Bill allows for cities and property owners to enter contractual assessments “to finance the installation of distributed generation renewable energy sources or energy efficiency improvements that are permanently fixed to real property.” The Bill implies the creation of special financial districts to support homeowners. If the home is sold, the remaining loan is to be paid off by the new owner. The financing options available through this bill, (municipal bonds, the municipal fund, or partnerships with local utilities to receive funding or create private funding) have direct implications on how individual County’s and Cities within the state to address the use of renewable technologies.

Santa Barbara County Climate Action Strategy
Santa Barbara County is developing a Climate Action Strategy to incorporate the goals of AB’s 32 and 811, promote energy efficiency, and maximize current ARRA funds. The CAS provides a holistic approach to GHG reduction and provides the public a “transparent public process to identify and prioritize goals, policies, and actions.” Proposed CAS projects are financial incentives for residential building retrofits and changes to the building code. Santa Barbara is weighing the option of creating a program that combines building retrofits and solar panel installation. Concerns such as, the economic feasibility and market demand, are similar questions that ER will need to answer to assure its success in the marketplace.

Title 24
Title 24 serves as California’s guide for residential and nonresidential buildings to reduce energy use and improve energy efficiency. According to the California CEC website, energy standards have “saved more than $56 billion in electricity and natural gas costs…” since the inception of the standards in 1978. The CEC has adopted the most recent permitting standards in

29 IBID
order to meet the energy efficiency initiatives pursuant to AB 32. The 2008 standards (in effect on August 1, 2009) make a number of significant changes for both residential and nonresidential buildings regarding time dependent valuation for energy efficiency calculations, changes to Mandatory Requirements for Insulation and Roofing Products and introduction of Solar Reflectance Index (SRI), and a number of other wall, roof, and lighting changes. Building changes may force the creation of businesses, such as EnergyRubix, to provide specialized assessment services.

**Home Energy Rating Systems Program (HERS)**

HERS is a home rating systems for Title 24 compliance. “The goal of the [HERS] program is to provide reliable information to differentiate the energy efficiency levels among California homes and to guide investment in cost-effective home energy efficiency measures.” HERS certifiers determine building efficiency by testing various aspects of a building including, but not limited to, building envelope, duct sealing, and airflow measurement. Energy use is rated as a combination of “space heating, space cooling, and service hot water.”

**California Solar Initiative (CSI)**

The California Solar Initiative (also known as the Million Solar Roofs program by the California Public Utility Commission) was signed in 2006 with the goal of installing one million solar roofs in California by 2016. The program provides $3 billion in incentives for solar energy projects with the objective of providing 3,000 megawatts (MW) of solar capacity by 2016. The CSI was designed such that the incentive level decreases over ten steps, after which it is eliminated, theoretically as the total demand for solar energy systems grows.

**Feed-in Tariffs**

The California Feed-in Tariff allows renewable energy generators to enter into contracts with their utilities to sell the electricity produced by their small renewable energy systems (system capacity up to 1.5 Megawatt). Any consumer-generator who sells power to a utility under this tariff may not participate in other state incentive programs. The tariffs will be available until the total statewide capacity of eligible electricity generation installed reaches 500 MW. Feed-in tariffs are designed for renewable energy systems that are beyond the scope of typical residential scale solar projects, those up to 1.5 MW in size, making very small systems (less than 50 kW) unable to compete with economies of scale. For residential and small commercial systems the CSI rebates provide greater. The guaranteed price that utilities are required to buy back electricity from self-generated plants is

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37 IBID
38 IBID
39 California Solar Initiative- dsireusa.org
40 The California Solar Initiative- CSI- www.gosolarcalifornia.ca.gov/csi/index.html
41 California Feed-in tariff- dsireusa.org
42 California Feed in Tariff- dsireusa.org
based on the CPUC’s market price referent (MPR) of natural gas. There is and likely will continue to be new legislation proposed yearly regarding the FIT, including the de-coupling for the MPR of natural gas.

Net Metering

Net metering is designed to allow utility consumers who self-generate electricity to receive credit for excess electricity that is fed back into the grid. This program is available for any California electricity customer that self-generates less than 1 MW of peak power output. Net metering can be used in conjunction with CSI rebates, among others. Net metering has recently been expanded to include time-of-use options, where electricity produced at peak times is valued at a higher price than electricity produced or used at non-peak hours. This works to the advantage of most solar systems that are usually producing power during peak hours. Time-of-use rate plans are beneficial to customers that use more than 400 kWh per month and avoid using most of their electricity between 10 am and 6 pm.

Property Tax Exclusion for Solar Energy Systems

Section 73 of the California Revenue and Taxation Code allows a property tax exclusion for certain types of solar energy systems installed between January 1, 1999 and December 31, 2016. These systems include solar space conditioning systems, solar water heating systems, active solar energy systems, solar process heating systems, PV systems, and solar thermal electric systems, and solar mechanical energy.

Federal Policies, Programs, and Incentives

American Recovery and Reinvestment Act of 2009 (ARRA)

ARRA, signed by President Obama in February of 2009, is a $787 billion package that includes $65 billion in tax credits for homeowners and industrial energy efficiency projects and a separate $42 billion towards energy efficiency and renewable energy development and projects. At the national level, $11.3 billion are formula-based for efficiency, renewable, and green community plans and $30.7 billion are in the form of grants, loans, and loan guarantees for transportation, transmission, renewables, and research. The grants can significantly boost local and state government’s efforts to transition into the realm of green economies while simultaneously achieving California’s stringent environmental goals.

Energy Improvement and Extension Act of 2008 (EIEA)

The Residential Energy Efficiency Tax Credit is a federal tax credit for energy efficient home improvements. The credit applies to eligible equipment purchased between January 1, 2009 and December 31, 2010 and includes high efficiency heating, cooling, and water heating equipment. Maximum credit available per homeowner is $1,500. Owners of existing homes receive a tax credit worth 30% of the cost of upgrading the efficiency of the building’s envelope, excluding labor costs.

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44 California Feed-in Tariff- dsireusa.org
47 Property Tax Exclusion for Solar Energy Systems- dsireusa.org
48 Property Tax Exclusion for Solar Energy Systems- dsireusa.org
49 Recovery.gov 2009.
50 Residential Energy Efficiency Tax Credit- dsireusa.org
This includes insulation materials and systems designed to reduce a home’s heat loss or gain and exterior doors and windows (including skylights). Taxpayers who purchase qualified residential energy-efficient property are eligible for a tax credit worth 30% of the system cost, including labor costs. This includes electric heat pump water heaters, central air conditioners, natural gas, propane or oil water heaters and furnaces, advanced main air circulating fans, and biomass stoves that burn plant derived fuel.

The Residential Renewable Energy Tax Credit is a federal tax credit for residential renewable energy that expires on December 31, 2016. The credit includes solar electric systems, solar water heating systems, fuel cells, small wind energy systems, and geothermal heat pumps. There is no maximum credit for any of these systems placed in service after 2008, except for fuel cells, which have a maximum credit of $500 per half kilowatt. A taxpayer may claim a credit of 30% of qualified expenditures including labor costs, installation, and piping/wiring to connect a system to the home.

Energy Audit (see Appendix I)

An energy audit is a well established method with tests designed to understand how efficiently a building functions. After testing is completed, the homeowner will have a detailed prescription for fixing any problems of inefficiency.

The energy analysis testing categories that can be included in an energy audit are:

1. Historical Electrical Consumption
2. Historical Gas Consumption
3. Lighting
4. Appliances
5. Pool/Hot Tub/Pond/Well Pump Analysis

Our service will not necessarily include every category listed but we will select the most cost effective and solar appropriate technologies to implement within our business model.

Home Energy Audits

Data from the Energy Information Administration shows that 48% of U.S. energy use can be attributed to the building sector. A home energy audit assesses how much energy a home consumes and to evaluate what measures can be taken to improve home energy efficiency. An audit will demonstrate problems that may, when corrected, save significant amounts of money over time. During the audit, an auditor can determine where a house is losing energy. In addition, audits determine the efficiency of a home's heating and cooling systems as well as methods to conserve hot water and electricity. The energy industry sees audits as a critical first step towards more efficient buildings, energy reductions and corresponding reductions in GHG emissions. As a result, the CEC has established regulations for home energy rating services in California.

Home Energy Rating Service (HERS): audit procedures

The California HERS Program includes field verification and diagnostic testing available through Commission-certified providers. The Energy Commission has a process for certifying Home Energy Rating System (HERS) raters who perform third-party inspections when verification of duct sealing, thermostatic expansion valves (TXVs), refrigerant charge, airflow measurement, and

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51 http://www.sustainablespaces.com/services-testing.html
building envelope sealing measures are used when complying with the 2005 Standards (effective October 1, 2005).  

There are four different levels of HERS certification; each requires 1 to 2 days of training.

**Carbon Footprint Calculators**

The Home Energy Saver Library provides a list of thirty carbon footprint calculators that are available on the Internet. Depending on geographical coverage, definitions, perspective, level of detail, and calculation methods, the quality of the calculators may vary. Currently, a few of the most widely suggested online calculators are SCE and SoCalGas for energy audit, DOE for home energy saver, and CEC for rebate calculations.

**Solar Technology Review**

First generation solar cells are small, silicon-wafer based silicon crystals. Single-crystal silicon cells are fragile and must be individually interconnected to a grid module, which creates high risk of breakdown, high cost for labor input, and low capital efficiency and cost-performance ratio. In addition, silicon crystals are fragile and do not absorb light strongly, so silicon-wafer cells must be thick.

Second generation solar cells are known as “thin-film” technology. Thin film cells are an emerging technology that is lower cost and lower efficiency than traditional PV, they are laminated in very thin, consecutive layers of atoms, molecules, or ions. They can be deposited on low-cost substrates, such as glass, stainless steel, or plastic. Unlike the first generation silicon-based crystalline, thin film cells are amorphous cells and can be made as a single unit (monolithic). Some materials used for this technology are Copper Indium Selenide (CIS), Copper Indium Gallium Diselenide (CIGS), and Cadmium Telluride (CdTe).

EnergyRubix’s client, SolarCity, uses CdTe, which is highly absorptive when alloyed with zinc and mercury and “proven to perform as predicted with a high performance ratio.” The advantage of thin film is the high throughput and high yield achieved by less material, which implies lower production costs. The challenge, however, is the need for larger substrate size and the risk of lower production, which is why EnergyRubix will focus on the residential sector for this product. Individual residential building power needs are far less than individual commercial building needs, thus thin film technology makes a better fit when weighing upfront costs for mid- to lower-income homeowners.

Types of solar power systems include: off-the-grid, grid-intertie, and grid-intertie with a battery. Both types of grid-intertie systems are designed to allow excess electricity to be sold to a utility company. System performance is affected by the such factors as day length, dirt and dust, building type, sun angle, house orientation, roof condition, local landscape features, wind current, solar exposure, and topography. The best orientation for a PV system is a south-facing roof with clear, unobstructed access to the sun for most of the day. The general guideline for shade-free space is about 175 sq. ft. for each kilowatt of thin film products.

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56 Meyers, Peter et. al. “Technology in Support of Thin Film CdTe PV Module Manufacturing.” First Solar, LLC. 2005
Approach

Our methodology is broken into four separate phases for organizational purposes; however, there will be continual overlap between all four.

I. Research and Analysis
The literature review initiated the research phase of our group project. It has provided important information on its own, but more significantly, it has allowed us to construct a framework that will lead to a more targeted and analytical approach to information gathering. These areas include:

Cost Research
The EnergyRubix service consists of an energy audit, a home energy retrofit package and software toolkit, and an outsourced solar installation from our client, SolarCity. Home retrofits may include the building envelope, HVAC system, lighting, appliances, and other electric loads, as briefly outlined in our literature review. We will need to acquire accurate and comprehensive upfront (material and labor) costs of all possible retrofits. We will also need estimated energy efficiency specifications from each retrofit, in order to calculate payback periods and energy savings over the lifetime of the installation. This data will then be used in the product development phase of our project. We intend to acquire retrofit and audit cost information through Internet research and industry relationships. Solar installation cost data will be provided by SolarCity.

Market Research
To accurately quantify the demand for our services in the Tri-County area and southern California, we must obtain housing and demographic data for the region, including, but not limited to, the number of households, cost of utility bills, age of buildings, and age and income distribution. We plan on leveraging the Bren school relationship with Southern California Edison (SCE) to obtain additional utility bill data and trends. We will also want to evaluate the solar potential for homes in the area using programs such as Sketch Up, by Google.

Policy & Financing Research
There are a number of policies and public documents that we have identified in our literature review that are critical to the success of EnergyRubix, including AB 32, AB 811, Title 24, the California Long Term Energy Efficiency Strategic Plan, the California Solar Initiative, and others. We must fully understand the details of AB 811 if we hope to influence the program’s design. Furthermore, we must be knowledgeable of all permitting requirements and municipal laws that affect the costs of project renovations in the region.

In addition to AB 811, we must track of the status of all existing and new legislation. Climate and energy policy is quickly changing, and includes important rebates, tax credits, financing options and other incentives that have pertinent implications on the value and cost of our services. This information must be fully synthesized in order to build it into our toolkit during, and after, our product development phase. Planners, David Matson (Deputy Director), Chris Rich (Senior Planner) and Angela Hacker (Associate Planner) from the Office of Long Range Planning (OLRP) will serve as local government policy advisors.

II. Product Development & Skills Acquisition
The breadth of knowledge and information that we will have synthesized in our research phase will allow us to begin product development. In this phase we will fine-tune our service package and
acquire the skills and certifications that give us expertise and credibility in our marketplace, and ultimately, value for our customers. The following are the anticipated components of our service that will need to be addressed:

**The Energy Audit**

The audit provides us with all the key inputs of a home that allow us to assess its current energy performance and make recommendations for future improvements. The Home Energy Rating System (HERS) is the official California state endorsed audit technique. To enhance our credibility, we plan to acquire its certification. We have approached the California Building Performance Contractors Association (CBPCA), a utility backed non-profit organization which offers HERS training. We plan on being trained and certified through the CBPCA while volunteering with them during the summer. We will also include a rooftop inspection in our audit to evaluate the potential for a solar system.

Other accreditations such as Greenpoint and Leadership in Energy and Environmental Design (LEED) for homes also exist and we will further research these as well.

**The Rubix Toolkit**

Using the acquired cost data, we will design a home energy package optimizer (e.g. Excel Solver-based) that will use the energy audit inputs, other home specifications, and budgetary constraints to derive the optimal retrofit package for each customer. Outputs will include:

- The Home Energy Package – a design description of recommended retrofit packages and an ideal sized solar system. Depending on individual customer needs and financial considerations, some homeowners will achieve zero net energy, 80% reduction, etc.
- Financial projections (payback periods, internal rate of return (IRR), and net present value (NPV) of potential investment scenarios
- Carbon savings projections for customers who value the positive environmental impacts that our service provides
- An online tool (trademark name to be determined) that customers can use to continually monitor their post-installation economic and environmental performance

Many of these calculator programs exist in various forms, and we will likely use a combination of these, along with our cost, market, and policy/financing research to create our own intellectual property (IP).

**Pilot Projects**

The feasibility and value of the EnergyRubix service will ultimately be tested by the success of our pilot projects. As of now, we have identified the following two potential pilot clients:

**The Bay Area**

Roberta Kashiwase has agreed to allow us to use her home as a case study for our group project. Using lawful human subject protocols, we intend to visit her home and perform an initial evaluation. As we will still be in the learning phase, we will contact Sustainable Spaces Inc., a notable green home retrofitter located in the Bay area to perform the actual work. In turn we will ask that they allow us to observe their work and learn from them. We will use the audit information from Sustainable Space to beta test our Rubix toolkit software.
Local Pilot Project (potentially in Isla Vista)
We intend to complete a second, local pilot strategy in which we would harness the skills learned through the first pilot project. When we begin this second project, we intend to be knowledgeable in performing energy audits and have a working Rubix Toolkit prototype. We also plan to have fully developed relationships with local contractors so that we can outsource the retrofit work. The solar PV installation task will go to SolarCity. The success of this project will give recognition, credibility and value to all stakeholders of EnergyRubix.

III. Fostering Organizational Relationships
As new entrants into the green building industry, we must forge relationships with all willing organizations that share our commitment and vision for green homes. Their professional expertise, skill sets, and access to information and customers are essential to our growth. As of now we have, found a client in SolarCity, a leading national thin-film solar installer; local government policy advisors; and promising relationships with a number of other organizations. As we move forward, we will want to nurture these existing relationships and forge new ones in the following areas:

- Energy Audit Providers (e.g. CBPCA, CHEERS, calCerts, USGBC)
- Home Retrofitters (e.g. Sustainable Spaces, EcoStructures, Allen & Associates)
- General Contractors (electricians, HVAC, carpenters, etc.)
- Other Solar Installers (Borrego, REC, California Solar, California Solar Electric)
- Southern California Edison
- Other local and state government agencies (Community Environmental Council, California Energy Commission, OLRP, Ventura Country Energy Alliance)
- Academia (Bren alum, students, professors, advisors, Institute for Energy Efficiency)

IV. Business Plan Development
Once our product and IP has been fully developed, our final hurdle is properly marketing the EnergyRubix brand. We will need to develop a complete business plan that conveys the value of our company to customers, competitors, investors, and all other stakeholders. The cornerstones of good business models include but are not limited to:

- PEST (political, environmental, social, technological) analysis
- Competitor analysis
- Value Chain Analysis
- Risk Analysis
- Marketing Plan
- Financial Plan
- Management Plan
- Timeline and Exit Strategy

By taking eco-entrepreneurship classes through the Technology Management Program (TMP) at UCSB, we have acquired the necessary skills to compile a successful business plan and will apply those skills to the EnergyRubix project. We will come up with financial projections and a solid marketing plan early on, during our product development phase. Research for our marketing plan will help us clearly define our target market, their needs, their purchasing ability, and other important
areas that will affect our product design. A financial model will also require target market research, as well as a detailed product cost estimates and ROI (return on investment) projections for our home energy packages. These will be very helpful in understanding the true value of our proposed service.
Opportunities

EnergyRubix has a unique opportunity to forge lasting relationships within the environmental planning community in the Santa Barbara area. Once the EnergyRubix service has been developed and is marketable, the possibility for its utilization across Central California will be great thanks to forming strong relationships within our community. Future expansion into Southern California and other regions will depend on the local success of our business.

EnergyRubix has developed relationships with employees of the Community Environmental Council, planners from the OLRP, and Jack Sahl of Southern California Edison. Additionally, EnergyRubix has renewable energy consultants from the private sector involved as advisors. These contacts are currently focused on developing renewable energy projects in the region and will connect EnergyRubix to future deals.

There are many additional stakeholders and relevant companies in the Santa Barbara community that EnergyRubix has the opportunity to learn from and work with. Allen and Associates is a green building firm whose President, Dennis Allen, is on the Dean’s Council at the Bren School.

These groups will provide the EnergyRubix team with invaluable support and guidance during the project’s development. Their knowledge and experience will strengthen our position as a possible investment opportunity on the future.

*some IEE conference speakers are no posted online. Charlie will try to send it to us
*we should talk to SC&E (and Jack) b/c they will probably be able to help us
*www.toolbase.org/Tecnology-Inentory/ViewAll.aspx
Management Plan:

Group Structure

**Project Manager** – Linda Halabi
- Schedule and lead meetings
- Formulate agendas
- Set deadlines, keep team on track
- Maintain group calendar

**Business Strategy & Product Development Manager** – Adam Rohloff
- Oversees business plan development
- Guides the development of core competencies and services

**Client Liaison and Communications Manager** – Aaron Wdowin
- Coordinate communication with clients
- Develop new investment and partnership opportunities

**Data and Web Manager** – Anna Lin
- Create and maintain group website
- Organize and manage documents and data

**Financial Manager and Secretary** – Andrea Lamartin
- Finalize and submit group documents
- Develop budgeting strategy
- Document group finances and provide advice
- Take meeting minutes and upload to Dropbox

Procedures/Organization

Meetings
- One hour team meetings will be held twice a week
- Agenda posted before meetings, group members to make additions
- Arrive at meetings prepared

Scheduling
- Group members will maintain their Corporate Time Calendars up to date
- Coordinate in advance to avoid rescheduling

Communications
- Communications log will be maintained in order to document client/partner interactions
- Keep all group members filled in on any communications
- Consult with team before pursuing significant communications
- Prior to any communication outside the group, members will inform the group of their intentions to communicate as well as keep the members posted of the results of the communication (the group email will maintain accountability).
It is expected that group members will make contacts and establish relationships when possible and assume the responsibility of communications with that contact, while relating this information to the rest of the group.

- Alert group to issues that arise

File and Data Storage

- All documents and files will be stored in Dropbox
- Follow labeling guidelines established by Data Manager
- Upload documents and files into corresponding folders

References

- All references will be documented and stored in Endnote and/or Zotero (TBD)
- Important sources will be stored in a references folder in Dropbox

Assignments and Deliverables

- Submit complete, quality work to editor by set deadlines
- Provide documents to advisor, partners, and/or client for review with at least a one week turnaround period
- Project Manager will set deadlines and enter them into group Google calendar
- Secretary will create task sheet for each week to outline responsibilities of each group member

Expectations of Faculty Advisor

- Attend weekly one hour meeting with group
- Provide advice and direction on proceedings of group project and client interactions
- Provide constructive and timely feedback on project documents
- Mediate conflict when necessary

Expectations of Client/Partner(s)

- Attend occasional meetings as necessary
- Provide group with relevant data and tools
- Provide constructive criticism and internal advice on the direction of our project

Conflict Resolution

Group members will put forth their best work and effort at all times during this project. As this is a learning experience, constructive criticism is encouraged and accepted in an open manner.

- We intend to allow for open dialogue, respect, and sharing of ideas within the group. In the event of a disagreement or issue, the concerned individual(s) will speak up right away and communicate it to the group.
- The issue of concern will be discussed seriously and resolved as fairly and expeditiously as possible.
- We will try to resolve conflicts unanimously, but in the event that we cannot achieve a unanimous decision, we will resolve problems with a 3:2 majority vote.
- In the case of a conflict arising with regards to clients, external advisors, legal issues, or
other, we will approach our faculty advisor for advice.

If problems cannot be resolved using these methods, assistance can be sought from the Group Project Coordinator and mediators are available at no cost throughout the year.
Deliverables

In addition to a final report and oral presentation, EnergyRubix will provide valuable data to our client, SolarCity, and to project stakeholders, such as the Santa Barbara Office of Long Range Planning.

General

- Pilot Project Demonstration
  - Energy audit
  - Energy retrofit and solar installation optimal package design
  - Financial/Carbon savings assessment and monitoring
  - EnergyRubix green-label
- Energy savings and carbon equivalent online calculators
- Business Plan

SolarCity

- Present a business case for the advantages of our service
  - Comparative financial advantage analysis
    - Customer ROI comparison
    - Certainty of energy bill reductions
  - Market expansion analysis
  - Political & regulatory environment analysis
- Home energy consulting services per request
- Contracted solar installation for a pilot demonstration project
Milestones

<table>
<thead>
<tr>
<th>Spring Quarter 2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 23 Submit final proposal to review committee</td>
</tr>
<tr>
<td>May 29 Final Proposal Review Meeting</td>
</tr>
<tr>
<td>June 6 Submit Final Proposal</td>
</tr>
<tr>
<td>June 12 EnergyRubix website operational</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Summer 2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>June Follow up with potential Case Study #1 (San Ramon)</td>
</tr>
<tr>
<td>Mid June Confirm energy audit certification process and requirements</td>
</tr>
<tr>
<td>Late June Confirm viability Case Study #2 (Isla Vista)</td>
</tr>
<tr>
<td>Early July Finalize decision on proceeding with Case Study #1</td>
</tr>
<tr>
<td>Late August Complete Case Study #1 (if the plan goes through)</td>
</tr>
<tr>
<td>Late August Complete HERS Certification</td>
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<table>
<thead>
<tr>
<th>Fall Quarter 2009</th>
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</thead>
<tbody>
<tr>
<td>September Finalize retrofit options and cost data to be used</td>
</tr>
<tr>
<td>September Finalize cost effectiveness analysis and optimization strategy of packaging options</td>
</tr>
<tr>
<td>September Conclusion and summary of Case Study #1</td>
</tr>
<tr>
<td>Late September Begin Case Study #2</td>
</tr>
<tr>
<td>November 13 Submit Progress Review</td>
</tr>
<tr>
<td>November Complete Case Study #2</td>
</tr>
<tr>
<td>December Conclusion and summary of Case Study #2</td>
</tr>
<tr>
<td>December 4 Submit Written Progress Report</td>
</tr>
<tr>
<td>December 4 Self/Peer Evaluation</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Winter Quarter 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 15 Begin final written report</td>
</tr>
<tr>
<td>TBA Project Defenses</td>
</tr>
<tr>
<td>February 15 Submit Final Report to Faculty Advisor(s)</td>
</tr>
<tr>
<td>March 10 Submit Presentation Abstract</td>
</tr>
<tr>
<td>March 19 Submit Final Report</td>
</tr>
<tr>
<td>March 19 Submit Project Brief</td>
</tr>
<tr>
<td>March 19 Submit Self/Peer/Faculty Advisor Evaluations</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Spring Quarter 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Late March Submit Draft PowerPoint Presentation</td>
</tr>
<tr>
<td>Late March Print Poster</td>
</tr>
<tr>
<td>Early April Final Project Presentation</td>
</tr>
<tr>
<td>Mid-April Submit Project Poster</td>
</tr>
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Budget

<table>
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<th>Total Budget</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Printing</strong></td>
<td>Posters and final report printing and binding</td>
</tr>
<tr>
<td><strong>CBPCA audit certification</strong></td>
<td>Regular price</td>
</tr>
<tr>
<td></td>
<td>Negotiated price</td>
</tr>
<tr>
<td><strong>Case Study #1</strong> (San Ramon)</td>
<td>Gas/car: (644 roundtrip*$2.60/gallon)/25MPG</td>
</tr>
<tr>
<td></td>
<td>Food: $20/person/day ($25*5 people)</td>
</tr>
<tr>
<td><strong>Meetings in Santa Barbara</strong></td>
<td>From UCSB/Isla Vista: 5 trips* [(20 miles roundtrip*$2.60/gallon)/25 MPG]</td>
</tr>
<tr>
<td><strong>Miscellaneous</strong></td>
<td>Phone calls, reading material, software, etc.</td>
</tr>
</tbody>
</table>

**Total Cost of project** $1045

Remaining funds $254.60

Of the $1300 available to us, we have calculated we have allotted a conservative figure of $200 for the printing. At least one member of the group will be trained to be a certified energy auditor. The group is currently communicating with the California Building Performance Contractors Association to negotiate a training plan that would cost between $200 and $600; regular class prices start at $595\(^58\). The budget calculations were made assuming a training cost of $400.

We will be conducting a case study in San Ramon. The trip is 644 miles roundtrip; calculations include three to five members will be making the trip from Santa Barbara and gas costs $2.60 per gallon (estimated miles per gallon (MPG) are 25).

It is expected that as a group we will need to attend meetings with the Office of Long Range Planning and SolarCity in downtown Santa Barbara. Trips were calculated assuming groups members would be traveling from UCSB/Isla Vista area.

Miscellaneous costs encompass any costs that have not been conceptualized at the time of this writing. Budget calculations are conservative and flexible. We will have an estimated $254.60 left over.

---

Appendix I: Preliminary Estimates of the Costs of Various Retrofits

<table>
<thead>
<tr>
<th>COMPLETE LIST OF RETROFIT OPTIONS</th>
<th>% of Bill</th>
<th>Upfront Cost</th>
<th>Annual kWhr savings</th>
<th>Annual Savings</th>
</tr>
</thead>
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<tr>
<td></td>
<td>Low Range</td>
<td>High Range</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Building Envelope</strong></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Low PE windows</td>
<td>-</td>
<td>3000 10000</td>
<td>1875</td>
<td>300</td>
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<tr>
<td>full home insulation</td>
<td>-</td>
<td>2500 5500</td>
<td>3750</td>
<td>600</td>
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<tr>
<td>weatherization</td>
<td>-</td>
<td>100 500</td>
<td>1125</td>
<td>180</td>
</tr>
<tr>
<td>insulated ducts</td>
<td>-</td>
<td>450</td>
<td>1125</td>
<td>180</td>
</tr>
<tr>
<td>shading</td>
<td></td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><strong>Ventilation</strong></td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>whole house fan</td>
<td>-</td>
<td>400 1000</td>
<td>1562.5</td>
<td>250</td>
</tr>
<tr>
<td>solar attic fan</td>
<td>-</td>
<td>400 700</td>
<td>1250</td>
<td>200</td>
</tr>
<tr>
<td>electric attic fan</td>
<td>-</td>
<td>250 400</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>kitchen, bathroom fans</td>
<td>-</td>
<td>150 300</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><strong>Heating</strong></td>
<td>11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>floor heating</td>
<td>-</td>
<td>4000</td>
<td>3437.5</td>
<td>550</td>
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<tr>
<td>heat pump</td>
<td>-</td>
<td>2000 5000</td>
<td>1250</td>
<td>200</td>
</tr>
<tr>
<td>efficient furnace</td>
<td>-</td>
<td>1000 2500</td>
<td>0</td>
<td></td>
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<tr>
<td>thermostat</td>
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<td>100 150</td>
<td>1125</td>
<td>180</td>
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<td><strong>Cooling</strong></td>
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<td>efficient central air</td>
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<td>3500 6000</td>
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<td>heat pump</td>
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<td>see heating</td>
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<tr>
<td>whole house fan</td>
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<td>0</td>
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<td><strong>Water Heating</strong></td>
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<td></td>
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<tr>
<td>solar water heater</td>
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<td>tankless water heater</td>
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<td>800 1300</td>
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<td>heat blanket</td>
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<td>40 100</td>
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<td>front load washer</td>
<td>-</td>
<td>600 1200</td>
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<tr>
<td><strong>Refrigeration</strong></td>
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<tr>
<td>high efficiency</td>
<td>-</td>
<td>1000 2000</td>
<td>75</td>
<td>12</td>
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<td><strong>Lighting</strong></td>
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<td></td>
<td></td>
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<tr>
<td>LED and CFL</td>
<td>-</td>
<td>60 250</td>
<td>625</td>
<td>100</td>
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<tr>
<td>CFL</td>
<td>-</td>
<td>40 100</td>
<td>500</td>
<td>80</td>
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<tr>
<td>remote sensors</td>
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<td>100 300</td>
<td>312.5</td>
<td>50</td>
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<tr>
<td>solar tubes</td>
<td>-</td>
<td>300 900</td>
<td>281.25</td>
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<tr>
<td>efficient fixtures</td>
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<td>100 400</td>
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<td>40</td>
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<td><strong>Laundry (W+D)</strong></td>
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<tr>
<td>front load washer</td>
<td>-</td>
<td>700 1400</td>
<td>see water heating</td>
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<tr>
<td><strong>Dishwasher</strong></td>
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<tr>
<td>high efficiency</td>
<td>-</td>
<td>400 800</td>
<td>81.25</td>
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<tr>
<td><strong>Electronics</strong></td>
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<tr>
<td>Remote Power Strips</td>
<td>-</td>
<td>25 100</td>
<td>150</td>
<td>24</td>
</tr>
</tbody>
</table>

*The following are estimates and the total does not represent the actual feasibility of doing all the following retrofits. Overlap of retrofits does not result in double savings.

http://www.greenandsave.com/
http://www.costhelper.com/
http://michaelbluejay.com/electricity/heating.html
Appendix I (cont.): Energy Audit Methodologies

Blower Door Tests
Professional energy auditors use blower door tests to help determine a home's air-tightness. Reasons for establishing the proper building tightness include: to reduce energy consumption due to air leakage, avoid moisture condensation problems and uncomfortable drafts from the outdoors, and to ensure a home's air quality is not too contaminated by indoor air pollution.

A blower door is a powerful fan that mounts into the frame of an exterior door. The fan pulls air out of the house, lowering the air pressure inside. The higher outside air pressure then flows in through all unsealed cracks and openings. The auditors may use a smoke pencil to detect air leaks. These tests determine the air infiltration rate of a building.59

Thermographic Inspections
Energy auditors may use thermography (infrared scanning) to detect thermal defects and air leakage in building envelopes. Thermography measures surface temperatures by using infrared video and still cameras. These tools detect light in the heat spectrum. Images on the video or film record the temperature variations of the building’s skin, ranging from white for warm regions to black for cooler areas. The resulting images help the auditor determine whether insulation is needed. They also serve as a quality control tool, to ensure that insulation has been installed correctly.60

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Appendix II: Energy Retrofitters/Green Construction Companies

The following companies offer residential green retrofit services or renovations and could be considered potential competitors of EnergyRubix. However each company is geared towards distinct clientele and is based in different geographic locations. Further detailed analysis of these companies operations and market will need to be thoroughly addressed.

Sustainable Spaces is self-defined as being home performance retrofitters. They offer testing, retrofits, and work with local solar installers to install PV. They are likely to be our closest competitor. The company examines all aspects of the home, including air quality, health, comfort, and water and energy efficiency. In the past few months (as of April 2009), their service offering has shifted more towards energy and further away from its previous focus of LEED. Sustainable Spaces targets new and existing homes, operates in the Bay area, and takes advantage of financing options that are offered by the Electric Industries and Gas Association, funded by Fannie Mac.61

Ecostructures, Inc. is a small firm based out of Ventura, California. The owner of this company is LEED and HERS certified and does design and consulting for new construction and gut rehab of existing homes. He works with architects and other local contractors on these projects.62 Ecostructures mainly focuses on large expensive projects and not on smaller upgrades of existing homes. There are likely several other small firms similar to Ecostructures that we should become aware of in order to properly differentiate ourselves.

The Performing Home: This audit company specializes only in green point rating and whole house audits in the Bay area.67

Building Energy Services Inc. This company specializes in residential and non–residential energy design, construction, and remodeling for new homes and buildings. They are located in Northern California and do not offer solar design.68

GRASSwerks, Inc.: This company specializes in LEED certification/remodeling/construction for homes, HERS certification/tests/consultation, solar design, Title 24 compliance. They are located in the Sacramento area.69

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64 Building Services, Inc. http://www.x15022082.onlinelibrary.us/8.html
Appendix III: Definitions

**Building envelope:** “the part of the structure that affects contact between the inside and outside air;” insufficient insulation can lead to heat loss or gain which would make a system work harder than it should to heat or cool a home, respectively.

**Carbon neutral:** emitting no carbon dioxide into the atmosphere

**HVAC:** Heating, ventilation, and air conditioning

**Commercial end-use sector:** refers to commercial customers that receive the functional of electricity and/or natural gas that can be generated elsewhere or on site.

**Gut rehab:** Complete renovation of a home, where the entire interior is torn down and then rebuilt.

**Load calculation:** determination of the size and capacity of a system required to heat and cool a home; a system that is too large will cycle too quickly and thus, will be incapable of properly adjust to indoor conditions; a system that is too small will have to work excessively to achieve comfortable conditions.

**Zero net energy:** zero net energy consumption and zero carbon emissions annually. The amount of electricity fed back into the grid is balanced by the amount used from the grid.

**Zero net homes:** a general term applied to a home with zero net energy consumption and zero carbon emissions annually.

**Solar photovoltaic (PV):** electricity generating by creating electrons in a PV cell from captured solar photons; estimated potential is 450,000TWh per year; limitations include: land, energy-storage, monetary constraints.
Appendix IV: Abbreviations and Acronyms

AB #: Assembly bill #
ARRA: American Recovery and Reinvestment Act of 2009; Recovery Act; Stimulus Package
BTU: British Thermal Unit
CAS: Climate Action Strategy
CARB: California Air Resources Board
CBPCA: California Building Performance Contractor’s Association
CdTe: Cadmium Telluride
CEC: California Energy Commission
CHEERS: California Home Energy Efficiency Rating Services
CIS: Copper Indium Selenide
CIGS: Copper Indium Gallium Deselinide
CLTEESP: California Long Term Energy Efficiency Strategic Plan
CO₂: Carbon Dioxide
CPUC: California Publicly Owned Utility
CSI: California Solar Initiative
DOE: Department of Energy
EEMS: Energy Efficient Mortgages
EPBD: Expected Performance Based Buy-Down
ER: EnergyRubix
HERS: Home energy rating system
HVAC: heating ventilation and air conditioning
GHG: Greenhouse gas
IP: Intellectual Property
IPCC: Intergovernmental Panel on Climate Change
IRR: Internal Rate of Return
LEED: Leadership in Energy and Environmental Design
MPR: market priced referent
NAHB: National Association of Home Builders
NHSP: New Home Solar Partnership
NPV: Net Present Value
OLRP: Office of Long Range Planning
PBI: Performance Based Incentives
SEP: State Energy Program
SGIP: Self Generation Incentive Program
USGBC: United States Green Building Council

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2 IBID
3 IBID