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An Analysis of Net Zero Practices Within Rural California:

Affordable Multifamily New Construction

Prepared for:

Meghan Walsh – RD USDA

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Author
Victoria A. Menchaca
SRED: 6020 Directed Research
Master of Sustainable Real Estate Development
Tulane School of Architecture

Introduction:

Zero Net Energy is a topic of increasing interest. With each new development, the building industry strives for the next tier of energy, cost, and production efficiency. The construction materials, methodologies, education, and products available to the field are advancing with technology and new insights into passive design. Material science and engineering are continually turning out new products that will seal envelopes of buildings tighter, capture more sunlight, and repel more water. Within the context of this race towards energy efficiency and the benefits and status that comes with it, Zero Net Energy is reaching the top tier of buzzword height. It's a global trend as well as a national one, exemplified by France and California's initiatives at energy efficiency and reduction of carbon emissions.

In the latest effort to reduce air pollution and create energy efficiency, France has constructed a new law that mandates all new commercial construction be covered with at least 50% green roof or solar panels.[1] While states like California are drawing close to their 2020 and 2030 goals with policies that directly effect the way developers build. Items to this initiative have contributed to viable housing projects, adaptive technologies, and other sustainable areas of interest. These items are in the range of applicable software(s), policies, educations, and creative finance underwriting strategies. Aiding the feasibility and evolution of sustainable development of communities worldwide in an effort to curb the ill effects of human industrialization within the last century from non-renewable resources.

At one point, Zero Net Energy may have first been a lofty idea held in the private parties of environmentalists, but after the energy crisis endured by the Golden State in 2002 action was

[1] Chow, Lorraine. "France Mandates New Roofs Must Be Covered in Solar Panels or Plants » EcoWatch." EcoWatch. March 25, 2015. Accessed May 02, 2015. http://ecowatch.com/2015/03/25/france-roofs-solar-panels-plants/.

needed. It was at this time that the California Public Utilities Commission put together it's first rendition of the Energy Efficient Strategic Plan in 2007. Within the strategic plan, revisions and constant attention to the framework of the plan has been paid and with this attention the emergence of the four "Big Bold" Energy Efficiency strategies were outlined by the CPUC in D.07-10-032 and D.07-12-051 in California legislature[2]. These four "Big Bold" strategies are the following: All new residential construction in California will be zero net energy by 2020; 2) all new commercial construction in California will be zero net energy by 2030; 3) Heating Ventilation and Air Conditioning (HVAC) will be transformed to ensure that its energy performance is optimal for California's climate and 4) all eligible low-income customers will be given the opportunity to participate in the low income energy efficiency program by 2020.[3]

While all efforts to participate in a competitive market place where energy efficiency, good design, and environmental clause are at the forefront, discussion of implementing this technology in rural communities are often absent from the public dialogue. Urban cities, and the suburban partners to them, have taken up a majority of this exchange as farming communities are viewed in a picturesque setting without sustainability issues. These populations are viewed as "living off the land" or described as creating such little waste per square foot, so what good would Zero Net Energy do outside an urban environment? In July of 2014, the United Nations issued an article about the increasing population of urban areas, illustrated that at present 54% of the population resides in urban centers.[4] This means that 46% of the world's total population still resides in semi-rural and rural places on the earth. While the population of urban centers is expected to rise to 66%

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[2] CPUC, auth. *California Energy Efficiency Strategic Plan January 2011 Update*. Publication. Accessed April 29, 2015. http://www.cpuc.ca.gov/PUC/energy/Energy+Efficiency/eesp/.

[3] Ibid. 6.

[4] "World's Population Increasingly Urban with More than Half Living in Urban Areas." UN News Center. July 10, 2014. Accessed May 02, 2015. http://www.un.org/en/development/desa/news/population/world-urbanization-prospects-2014.html.

by 2050, the value of rural communities remains strong even if human capital is city-based. Rural communities provide food security and access to natural resources.[5] With this in mind, it is critical that sustainable rural development be assessed as a key step in approaching overall energy efficiency and effectiveness.

The United States Department of Agriculture's (USDA) agency known as Rural Development (RD) is a crucial part to the puzzle of bringing Zero Net Energy to the community it serves and one that is at the front of this paper. While housing subsets are often divided into two categories: Single and Multifamily, this paper will focus strictly on Affordable Multifamily New Construction within California. California is among the most progressive states within the nation that have striven for sustainable objectives. California's Governor, Edmund Brown issued the following quote in his address to set ambitious new goals to "green" state's buildings, save taxpayers money, "The order also sets a target of zero net energy consumption for 50% of the square footage of existing state-owned buildings by 2025 and zero net energy consumption from all new or renovated state buildings beginning design after 2025."[6] When this is placed in conjunction with the goals of 2020 and 2030 that states the zero net energy condition of all new residential and commercial buildings respectfully, the picture of how determined California is to energy efficiency comes to full color.

With the importance that California places on it's efforts towards becoming energy efficient, and it's status as one of the most populous state in the union, the evaluation of it's policies, procedures, and practices towards Zero Net Energy is critical to understanding and providing

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[5] "Rural Economies: The Basis of Food Security." The Importance of Rural Economies. Accessed May 02, 2015. http://www.syngenta.com/global/corporate/en/grow-more-from-less/caseStudy4/Pages/rural-communities.aspx.

[6] CA.gov. Office of the Governor. "GOVERNOR BROWN SETS AMBITIOUS NEW GOALS TO GREEN STATE'S BUILDINGS, SAVE TAXPAYER DOLLARS." News release, April 25, 2012. Http://gov.ca.gov/. Accessed May 2, 2015. http://gov.ca.gov/news.php?id=17506.

successful practices of zero net energy to rural zones across the nation. In an approach of research towards California's energy efficiency methodology, a report published in 2012 for the California Energy Commission by Global Green was used as a skeletal frame to draw contrasts for two projects provided by the USDA RD. The two projects in the report by Global Green were built in 2007 and 2009 that demonstrated the viability of affordable multifamily housing within the greater urban context of San Diego.

These projects are known as Solera Apartments and Los Vecinos Apartments. For the subject of this paper, two case studies were sought out for sustainable rural development. These developments are the Rancho Lindo in Lamont California and the Montgomery Crossing Housing Developments. By evaluating the urban case studies alongside their rural counterpoints, a greater understanding of California's overall system and the resources it gives to each will help to provide more information on both sectors. The understanding of this system will yield recommendations with respect to energy efficiency and net zero housing. These recommendations are designed to further develop a course of action for the cultivation of a survey. This particular survey is intended to carry the information found within the State of California to evaluate the whole U.S. in affordable multifamily new construction. Aiding in the future strides forward to promoting sustainable rural development practices at a larger extent.

This paper is not an end-all conclusion report, but a stage within a much larger effort to focus on successes and weaknesses of the current affordable multifamily net zero new construction rural development process within the most progressive state towards energy efficiency and subsequently the nation. The approach to the research and findings through this paper was developed with respect to the USDA resources, scholarly peer-reviewed articles, government issued documents, interviews conducted, and the analysis of state produced websites with respect to green building and energy efficiency.

Overview of Rural Housing Program

The difference between rural housing and its close relatives within the urban and suburban context is one fundamental aspect – density. Density within a rural zone is severely spaced out, starting from the town center to the fringes of town; the intense nature of building's clustering together is foreign to rural landscapes. Unlike the urban inner-core, buildings within suburban and rural landscapes are vastly more spaced out respectfully growing larger in distance as the more rural scene is embraced. It provides different aspects of life to that environment, and while many cities may have started in a rural sense – these urban cores are a manifestation of increased opportunity that pulled populations closer to its dense center. Urban centers have long been in the conversations of energy efficiency and sustainability. In many systems, the proximity of one amenity to another for the savings of embodied energies, costs, and end results is an old rationale. The city has strengths of density illustrated in walkability, public transportation access, and proximity of diverse amenities.

However, this is what rural communities lack – the goods of one resource to that of another can be purposely spaced out due to the lack of population within these communities and therefore the lack of goods. In response to the lack of density within the rural communities, the steps toward energy efficiency is in the utilization of that space between the uses as well as the compatibility of systems used within the site itself. From the exterior of the building envelope, the envelope itself, the systems within the structure, the structure itself, and items off-site – the investigation of energy conservation, generation, and green property management is addressed here.

The Multi-family Housing Energy Initiative ((MFHEI) was created by the USDA's RD agency relatively recently with the explicit goal of impacting the application process for multifamily new construction by incentivizing energy efficient practices of developers via a point system. These points are available to any builder "who seeks third-party energy efficiency certifications, use energy

efficient building materials and design strategies, generate energy on site, and make a commitment to energy efficient post-construction operation and maintenance".[7] With this initiative, the USDA RD enables the increased eligibility of developers within rural communities to other funding sources such as Multifamily Housing Sections 514,515, and 516, which total $179.49 Million for the 2015 Funding Year. With the goal of building affordable multifamily dwellings that are reduce the quantity of energy to operate, reduce the total amount of greenhouse gases and are economically viable, the development becomes an overall sustainable success.

Conservation:

Conservation is the most passive of all environmental sustainable approaches. It relies on the concept that whatever resource is used in high demand, must be reduced in order to sustain minimal use. Through the USDA's MFHEI only the following programs are currently available via certification for energy conservation: The Environmental Protection Agency Energy Star For Homes, The Enterprise Community Partner's Green Communities, The United States Green Building Council's LEED for Homes, and the National Association of Home Builders National Green Building Standard.[8] While the USDA does concede that all these programs are different, they also refer that many of these organizations have similar values in their programs and thus overlap is highly possible. Leading to multiple certifications if wanted and a flexible opportunity for developers to obtain points no matter what program they chose to partake.

Environmental Protection Agency Energy Star for Homes:

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[7] "USDA Rural Development-EE Program Details." USDA Rural Development-EE Program Details. September 28, 2012. Accessed May 03, 2015. http://rurdev.sc.egov.usda.gov/program_details.html.
[8] Ibid.

The Environmental Protection Agency Energy Star for Homes is a program was first put into practice in 1995. The beginning of these constraints was product-based with high performance windows, HVAC systems, and tight building envelopes to prevent the leaking of thermal comfort. It was also determined that a third-party rate would be consulted on each of the products so no bias could influence the integrity of the project. While the majority of these guidelines were followed for a decade, it wasn't until a mandatory update of federal model energy codes and local requirements took place that the EPA developed much stricter guidelines to their program. Through 2006 to 2012 two versions would pass through the EPA Energy Star for Homes.[9] This final version, known as Version 3 is structured on five fundamental guidelines of building science measures to achieve the level of energy efficiency set by the U.S. EPA. They are the following:

1. **A Complete Thermal Enclosure System – Comprehensive air sealing, properly installed insulation, and high-performance windows work together to enhance comfort, improve durability, reduce maintenance costs, and lower monthly utility bills.[10]**

2. **A Complete Heating and Cooling System – High-efficiency systems that are engineered and installed to deliver more comfort, better moisture control, improved indoor air quality, and quieter operation.[11]**

3. **A Complete Water Management System – A comprehensive package of best building practices and materials protects roofs, walls and foundations from water damage, provides added protection, and reduces the risk of indoor air quality problems.[12]**

4. **Energy-Efficient Lighting and Appliances – ENERGY STAR certified lighting, appliances, and fans are commonly installed throughout ENERGY STAR certified homes, helping to reduce monthly utility bills, while providing high-quality performance.[13]**

5. **Third Party Verification by a Certified Home Energy Rater is required in order to gain certification of Energy Star for Homes.[14]**

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[9] "History of the ENERGY STAR Guidelines for New Homes.": ENERGY STAR. Accessed May 03, 2015. http://www.energystar.gov/index.cfm?c=new_homes.nh_history.
[10] "How New Homes Earn the ENERGY STAR." How a Home Earns the ENERGY STAR : ENERGY STAR. Accessed May 03, 2015. http://www.energystar.gov/index.cfm?c=new_homes.nh_verification_process.
[11] Ibid.
[12] Ibid.
[13] Ibid.
[14] Ibid.

Starting January 2012, all homes have been certified as Version 3 with the exception of low-income housing that was kept under the guidelines of Version 2 until a year later as the funding had only been received for the 2011 year within April of 2012. [15] At that point in time Version 3 Energy Star requirements are unanimous unless they are within the states/territories of California, Delaware, District of Columbia, Florida, Guam, Hawaii, Illinois, Iowa, Maryland, Massachusetts, Minnesota, Nevada, Oregon, Puerto Rico, Rhode Island, Vermont, or Washington – these homes would use the regional specifications of energy star.

For the purpose of this paper, the focus of California's implementation on achieving Energy Star Version 3 would not completely enter until October 1, 2012. These requirements set for California are used within all types of homes in the state of California ranging from single-family homes to multi-family buildings ranging from 4 to 5 stories in height. It uses the Energy Star performance Path that allows for flexibility in setting up a combination of customary measures for each project that will yield a performance rating of at least 15% more efficiency than the California 2009 Building Energy Efficiency Standards.[i] The Energy Star Performance Path utilizes a formula to calculate the Size Adjustment Factor (SAF). The SAF is used to determine the Energy Star HERS Index Target, which is a measurement of a home's energy efficiency. Indicating that the smaller the number on the HERS Index, the more energy efficient the home.[16] According to the equation given by the California Energy Star Performance Path this must not exceed 1. This is calculated with regards to Conditioned Floor Areas of the Benchmark home over the home to built to quarter power as illustrated below:

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[15] History of the ENERGY STAR Guidelines for New Homes." : ENERGY STAR. Accessed May 03, 2015. http://www.energystar.gov/index.cfm?c=new_homes.nh_history.

[16] "Understanding the HERS® Index | RESNET." RESNET HERS Index. Accessed May 03, 2015. http://www.hersindex.com/understanding.

$$SAF = [CFA_{BENCHMARK\ HOME} / CFA_{HOME\ TO\ BE\ BUILT}]^{0.25}, \text{ not to exceed } 1$$

Where:

$CFA_{BENCHMARK\ HOME}$ = Conditioned Floor Area of the Benchmark Home, using Exhibit 2 below.

$CFA_{HOME\ TO\ BE\ BUILT}$ = Conditioned Floor Area of the Home to be Built, as calculated using RESNET Standards.

After which Energy savings is then calculated using the following formula:

California ENERGY STAR Savings Target = 1 –[SAF x 85%]

Since the regulations state that Condos and apartments within multifamily structures will always have the an SAF equal to 1.0, the formula proves that California Energy star savings will always equal at least 15%. Subsequent steps provide for verification of California's Energy Star Requirements using computer software that adheres to the California code of Regulations within Title 24. Through verification of the software (EnergyPro is most often used), the results should indicate that the project has met requirements as set by the Energy Star Savings target. By utilization of these techniques the construction of the home is followed using the measures, adding that in the final phase of construction verification by a third-party rater is met with all mandatory requirements regarding data input requirements and on-site inspection procedures with California HERS ratings.[17]

Most builders within California and throughout the nation have used Energy Star for homes as USGBC LEED for Homes Certification has only included housing three stories and smaller until recently. When interviewed about green certification projects within Rural America, Joe Belden of Housing Association Council spoke about how HAC had been working with Energy Star Certification for homes because of this history with USGBC's LEED for Homes history. Although,

[17] EPA. "ENERGY STAR Certified Homes, Version 3 (Rev. 04) Program Requirements for the State of California." Energystar.gov. June 1, 2013. Accessed May 1, 2015. http%3A%2F%2Fwww.energystar.gov%2Fia%2Fpartners%2Fbldrs_lenders_raters%2Fdownloads%2FCalifornia_v3_Guidelines.pdf%3Ffdfd-b2d3.

this paper is unable to add if a change will occur within how HAC might adjust with the emergence of the new LEED v.4, it isn't expected.

Enterprise Community Partner's Green Communities

Enterprise is a non-profit with a commitment to provide affordable housing to low and middle-income families throughout the United States. Founded in 1982 by James Rouse and his wife patty after investing in a low-income housing project with three fellow church members, Rouse and his wife became inspired to develop a company that would facilitate their goals as builders. Originally Enterprise Foundation in 1982, the company would change its name to Enterprise Community Partners. One of its primary initiatives is the Enterprise Community Partner's Green Communities initiative that strives towards "green" housing, community, and commercial buildings. This includes financial loans to cover extensive purchases to pre-existing multi-family structures that can greatly affect the environmental proximity with reduction to water and energy consumption.

Within the Green Communities initiative, the goals are to bring about improved health economic and environmental benefits of sustainable construction practices to low-income families.[18] The 2015 version of criteria and certification of the initiative for the Green Communities aims at expanding the original five components into eight: Integrative design, location + neighborhood fabric, site improvements, water conservation, energy efficiency, materials, healthy living environment, and operations, maintenance + resident engagement. It was Enterprise's goal that the "2015 criteria break new ground in the affordable housing and green building industries" particularly focusing on "resilience, location and energy data transparency, combined with a re-tooled approach to integrative design".[19]

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18 Enterprise. "About Us." About Us. Accessed May 02, 2015. http://www.enterprisecommunity.com/solutions-and-innovations/green-communities/about-us.

19 Enterprise. *2015 Enterprise Green Communities Criteria.* Update. April 7, 2015. Accessed May 2, 2015. http://www.enterprisecommunity.com/servlet/servlet.FileDownload?file=00P1400000dKEmFEAW.

The comparison of 2011 to the new 2015 versions of green communities illustrates a responsive effort to each new category with one mandatory and one optional credit each.[ii] Green Communities tries to facilitate its work across all housing and construction types and as a result the following toolkits can be found on their webpages. In addition to the green communities, affordable housing in Rural America is another program initiative facilitated under Enterprise. By creating rural housing using USDA 515 section loans and grants, the rehabilitation or acquisition of property to facilitate Green Communities criteria and other practices with construction, Enterprise has achieved it's goals of providing affordable housing to rural communities.

The United States Green Building Council LEED for Homes

The United State Green Building Council (USGBC) LEED program for Homes facilitates the design and construction of all homes ranging between single families to multifamily buildings that are low-rise and midrise containing up to eight stories. The aims of LEED for homes is to provide healthy, and environmentally responsible housing by enabling the use of clean indoor air, safe building materials, reduction of energy and water resources, and incorporating passive design. Certification of LEED for Homes is facilitated in a four-step process: registering for the lead certification, preparing an application, certifying the project through preliminarily, mid-construction, and final verification visits, and submitting the application in a two part review. Like many other systems, LEED for Homes is based on a point system with mandatory and optional settings. Due to the nature of the point systems, there are various levels of certification incremented at 10 points each: certified, silver, gold, and platinum.

These points are garnered in categories developed on project scorecards that will determine the total points gained.[iii] Although there is no LEED v4 program booklet for California's low and mid-rise buildings there is a 2008 LEED version for low-rise multi-family and a 2010 LEED version

for mid-rise multi-family. Both of these booklets illustrate the LEED for Homes rating system in 8 categories: Innovation & Design Process (ID), Location & Linkages (LL), Sustainable Sites (SS), Water Efficiency (WE), Energy & Atmosphere (EA), Materials& Resources (MR), Indoor Environmental Quality (EQ), and Awareness & Education. Although USGBC LEEDs rating systems are the most recognized among the public, Energy Star for Homes has been more prevalent among homebuilders in rural areas.

The National Association of Home Builders National Green Building Standard

National Green Building Standard (NGBS) is the under the green Multifamily program within the National Association of Home Builders (NAHB). At the NAHB, green building, remodeling and development is under the NAHB Green Program that strives to deliver high-performance, sustainable buildings that are energy-efficient, able to conserve water and resources, have effective HVAC equipment and reduce off-gassing of VOCs, utilize non-evasive site design, and educate owners and operators of the buildings constructed. Certification is referred to a national green home certification system by Home Innovation Research Labs as an independent third party. It is the only residential green rating system to have earned the approval of the American National Standards Institute (ANSI), a private non-profit organization that oversees the process of voluntary consensus standards for any product, service, system, personnel or process within the United States.

Through NGBS the effort is to bridge both the International Code Council with that of NAHB's buildings standards. Here all the green practices that are and can be used within construction are updated in each new edition that showcases the small (a kitchen) to the very large (neighborhood developments). Like the USGBC's LEED for Homes the NGBS also includes four levels of certification; Bronze, Silver, Gold and Emerald, with Emerald being the most esoteric in nature. By achieving emerald status, the homes will have incorporated a n energy savings of 50% or

more over national model codes adopted around the country and not specific to any one locale. Unlike the other rating systems, NGBS certification is broken into three forms of construction. While the NAHB is the association that conducts facilitation of research and houses the NGBS, it does not certify the projects. Instead, as referred to earlier, the certification is handed by Home Innovation Research Labs which assists in purchasing the materials, finding an architect, going through the certification process, finding a verifier, administering the fee payments, and keeping track of all analysis, marketing materials, and products. The verifier in turn is another third-party company that was trained under the verification standards to the NGBS.

Energy Generation

These energy point systems have all been referred by the USDA RD Multifamily Housing Energy Initiative with regards to Energy Conservation Certification programs, but can incorporate energy generation to their systems, as Zero Net Energy isn't about reduction of energy but also in the stimulus of gaining back what was lost. For that purpose, the second part of the initiative relies on the energy generation of on-site proprieties to lessen the need for outside energy sources. While the USDA does recognize that zero net energy is a difficult and not always viable option to developers it has allocated points to partial energy generation of 10% or more on projects that have demonstrated this initiative. Zero Net Energy can be achieved using the energy generation techniques like: biomass/biofuels, solar hot water systems, photovoltaics, micro-hydro power, wind turbines, micro-turbines, and geo-exchange systems.

Biomass/Biofuels

The conversion of biomass and bio fuels to energy has been around since the stone age, the most common method of converting mass into energy is to burn it for heat. Although this

procedure can be natural its effects can be detrimental to the environment as the particulates from the biomass combustion are released into the air. However, conversion of the biomass into liquid fuels in a process called gasification help to reduce the particulars and emissions from the combustion process.

By converting the biomass into a biofuel by these means is to carefully heat the biomass with oxygen and under the pressure is converted into a mixture called syngas – a combination of hydrogen and carbon monoxide. Once this is achieved, the carbon dioxide is removed and the syngas can be directly run through a gas or steam turbine to produce the electricity needed. Biomass/biofuels do have less energy density as opposed to the fossil fuels it aims to replace. It's typically hard to sustainably gather and process a large amount of this mass at any one particular location is difficult within urban settings, leading this to be much more efficient in rural communities as they can design energy systems that are adapted to their needs without a major strain on resources. These fuels are often found in rural settings, allowing for easy access and often categorized as waste products from the agricultural and forestry industries. They are usually energy crops not used as food, portions of crop waste such as wheat straw or corn stover, sustainably harvested woods and residues that aren't up to the standard used for furniture or paper, or clean municipal and industrial wastes.

The process by which to use this category of energy generation on-site is to incorporate an energy turbine close to the site. However, all reference materials haven't shown energy turbines with close proximity to the site, only that the biomass fuels would be installed into turbine to produce energy that could add to the generation of the electricity load. A few commercially viable products that can facilitate the burning of fuel into energy for short periods of time are the L.E.A.F. Generator, the Cyclone WHE Biomass Pellet Power Generator, and the most recent "Power Pallet".

Wind Turbine and Micro Turbines

The use of a turbine is to harvest energy from the surrounding environment, the use of the wind turbines and micro turbines is to harvest the wind load energies on-site and place them within the site's energy grid. The process by which the implementation of a turbine on-site is approximately $48,000 - $65,000 with the equipment at $40,00 for a 10 kW GridTek System with the rest of the remaining cost towards shipping and installation.[20] Due to the nature of on-site residential wind turbines they are usually placed away from obstacles and trees that may interfere with the wind load velocity, harvesting as much energy as possible. Large wind turbines are typically 80 to 140 ft. above ground, while micro turbines are latched on to roofs.

Although there is sufficient evidence to the advantages and disadvantages of wind farms, most being the audible noise, hazard to birds and wildlife, and changes to the local visual quality, they provide clean renewable energy. It is recommended that rural homes and large lot suburban homes foster the environment for a wind turbine as urban and suburban settings provide the most turbulence and would be unfit for producing adequate amounts of energy. It is also noted that with the smaller turbines these nuisances are often negligible and benefit the household overall.

Solar Hot Water Systems

Solar Hot Water Systems are used as a cost-effective measure to heat water for domestic use through two methods: active and passive. Through these methods, the systems themselves are broken further into two different system approaches. Through active methods, the systems are divided into direct and indirect circulation systems. The Direct Method allows the pumps to circulation the domestic water through the collector and into the home's final destination. They are typically well adapted to non-freezing climates. The Indirect Circulation system does not

[20] "Residential Wind Energy Systems - Bergey Wind Power." Bergey Wind Power. 2012. Accessed May 05, 2015. http://bergey.com/wind-school/residential-wind-energy-systems.

use the household water and instead pumps a non-freezing heat transfer fluid through the collects and heat exchange, that will in-turn heat the water that will then be used throughout the household. These systems do well in areas that are expected to freezing and frost climates.

With passive systems the exchange of solar energy to heat the household water is held between two different approaches. The first is an Integral Collector – Storage Passive system that tends to work well in warm, non-freezing climates. Since these climates rarely use hot water during the daytime, the water is heated throughout the day in a batch collecting system and then dispensed in the evening to facilitate the household needs. The second system in a passive method is the Thermosyphon system that allows water to flow through the system much like air does in a room. The warm water rises to replace the cold water within the tank as the cold water returns to the heat collector in an endless cycle of heated water. The design of the Thermosyphon system is one where roof design plays a crucial part in the success of the project as the water heater and movement of the recycled water is heavy and can cause damage to the envelope – reducing the effects of energy efficient approaches to the household overall. Typically passive systems are more cost-effective to the active systems, they are more reliable and often times may last longer, but lack the efficiency of an active system.[21]

Micro Hydro Power

Within Rural development projects, facilitation of a water source nearby is a power use of micro hydropower in harvesting energy. The micro hydro power is generated by water flowing through it's natural flow into a man-made turbine that allows the water to pass through or on top of the wheel, generating power as the water pushes through. In various forms, this source of power

[21] Solar Water Heaters." Energy.gov. December 14, 2014. Accessed May 02, 2015. http://energy.gov/energysaver/articles/solar-water-heaters.

has been in use for over a century. Typically classified as large, medium, small, mini, and micro, the micro classification of the system has a capacity of 100kW and 1000 kW with their small counterparts producing 1000 kW to 10,000 kW. Micro hydropower provides rural communities near streams an amble amount of renewable energy that is inflation-proof, economical, and stable. Easily it can facilitate the needs for lighting, appliances, and basic living needs for about 20 to 30 years.[22] Depending on the efficiency of the turbine or water wheel in use the efficiency can range from 25% to 95% efficiency depending on the full-load capacities of the generations in question. These generators are known as synchronous and synchronous generators.

Synchronous generators are standard for electrical power and used most commonly in power plants, while asynchronous are induction generators. Although the synchronous generators are more power, the asynchronous models are much smaller, inexpensive, and appropriate for private use. Determining whether synchronous or asynchronous generators will be the better option depends on the site itself. With this information, the type of turbine and generator for use can be figured via submersible or above water generators, types of power systems in use, and the amount of energy needed to harvest as synchronous generators can reliably produce 95% efficiency in comparison to their asynchronous competition.

Geo-Exchange Systems

Much like the Solar Hot Water Systems discussed earlier, the Geo-Exchange Systems within a home transfer heat and energy in the same manner. However, unlike the solar hot water system, geo-exchange uses refrigerant in all instances instead of water. The process of a geo-exchange system is to facilitate the neighboring soil of the site as a heat sink and storage device. Here, the refrigerant can constantly move in and out of the earth to provide a constantly level of thermal

[22] *Micro-hydropower Systems: A Buyer's Guide*. Ottawa: Natural Resources Canada, 2004. Accessed May 1, 2015. http://www.oregon.gov/energy/renew/hydro/docs/microhydroguide.pdf.

comfort to the home. The rate of heat transfer from ground to home is by temperature difference and a need to balance out large swings of temperature. If the house temperature is much cooler than the ground, the automatic transfer of heat is initiated; however if the temperature in the house is drastically different, the movement of the heat transfer is at a much faster rate to establish equilibrium. Unlike the regular heating and cooling systems associated with HVAC units, where the highest demands during seasons will lead to the most inefficiencies, the geo-exchange systems don't experience these lags.

Unlike typical HVAC systems that utilize air to warm and cool the temperatures of the homes they exist within, the geo exchange systems temperatures used to heat and cool the homes are at a constant temperature due to the ground temperature. Sometimes of 45 to 50 degrees Fahrenheit in colder climates while 50 to 70 degrees Fahrenheit is normal in warmer climates. There are two different geo-exchange systems: close loop and open loop systems. A close loop system will repeated use the same refrigerant over the course of it's lifetime, it will consist of several lengths of plastic pipe that will be installed in horizontal or vertical holes that are covered with earth and will be pumped to a heat exchanger within the system.

The length of the system will be the determining factor in heating and cooling loads used to regulate the temperature of the house. Due to the size of the house, the heating and cooling loads, temperatures, and climate, the length of the pipes will be adjusted to fit these parameters efficiently. Unlike the closed looped systems, open loop systems don't use refrigerants but instead use water and wells. Since these environments are typically located where water is abundant. The water is pumped out of one of the preexisting wells, into the heat exchanger within the system and then pumped into another well to return to the ground water and the internal temperature of the earth surrounding the site. When sized properly geo exchange systems are very efficient at regulating temperatures and able to last at least 50 years.

Photovoltaics

Photovoltaics are the most common and often thought of approach when it comes to energy efficiency and harvesting domestic energy. Often in the form of solar panels, photovoltaics are continually developed to facilitate better cost efficiency than in previous years. The U.S. Department of Energy has established the SunShot initiative, allowing the initial cost of a photovoltaic system to be handled more affordably than in previous years – anticipating that by 2020 - 75% of total system cost will be reduced.[23] Many of the photovoltaic systems require that their entire cost be made up front before allowing the PV systems to contribute, due to this, the costly nature of PV installation keeps many potential buyers at bay. In making significant headway towards improvement in solar cell efficiency, reliance and costs, the following semi conductors are being researched on PV efficiency: crystalline silicon, thin-film, multi-junction, organic, and dye-sensitized semiconductors.

The process of energy harvesting through PV systems is through the occurrence of when solar "photons strike and ionize semiconductor material on the solar panel, causing outer electrons to break free of their atomic bonds. Due to the semi conductor structure, the electrons are forced in one direction creating a flow of electrical current" much like that of micro turbine at an atoms scale.[24] From the solar cells the energy is collected in the PV array and pushed to the circuit combine that then distributes the raw energy to the ground-fault protector pushing it to the DC fused switch that transfers it to the DC/AC Inverter. From there the AC fused switch takes the

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[23] Goodrich, Alan, Ted James, and Michael Woodhouse. "Residential, Commercial, and Utility-Scale Photovoltaic (PV) System Prices in the United States: Current Drivers and Cost-Reduction Opportunities." *Residential, Commercial, and Utility-Scale Photovoltaic (PV) System Prices in the United States: Current Drivers and Cost-Reduction Opportunities*, February 1, 2012. Accessed May 5, 2015. http://www.nrel.gov/docs/fy12osti/53347.pdf.

[24] SEIA. "Photovoltaic (Solar Electric)." SEIA. 2014. Accessed May 05, 2015. http://www.seia.org/policy/solar-technology/photovoltaic-solar-electric.

processed energy to the utility switch giving it to the Main service panel that will distribute it to it's final utility.[iv] These solar cells and PV systems are typically arranged on the roofs, shade structures, and building-integrated PV Arrays with special attention to solar orientation so as to harvest the most significant outputs throughout the course of a year. According to California Energy Commission, Barstow, CA has the highest annual energy production among all California cities ranging from 1646 to 2058 kWh/kWstc, with Fresno and Sacramento following.[25] With zero net energy project in urban and rural settings, the typical fee associated once the PV system was in place and high yielding was a hook-up fee charged monthly.

Green Property Management

While all these systems are energy efficient ways of harvesting raw energy and converting it for the purpose of reducing energy costs or maintaining a zero energy net load it is the implementation and proper procedure that keep these systems managing at peak loads within their lifetimes. By utilize the right systems to benefit the climate the site is located; a developer can best determine the right costs before, during, and after construction. The next section demonstrates that post construction maintenance of energy efficient properties is equally important as the construction and implementation of the energy systems put in place.

The USDA RD calls this green property management and as an optional component of the application, if a property management company will assume operations and management post construction additional points will be gained. These credentials can be most easily gained through the follow associations: National Apartment Association, National Affordable Housing Management Association, The Institute for Real Estate Management, United States Green Building Council's

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25 California Energy Commission. *A GUIDE TO PHOTOVOLTAIC (PV) SYSTEM DESIGN AND INSTALLATION*, June 1, 2001. Accessed May 2, 2015. http://www.energy.ca.gov/reports/2001-09-04_500-01-020.PDF.

Leadership in Energy and Environmental Design for Operations and Maintenance. Other property management associations may be used to obtain certification and additional points. However, the associations would need to provide the credentials of those on the property management team in order for USDA RD to determine whether professional experience would allow them to look after the green properties sufficiently.

Financing

Major aspects of rural development for affordable multifamily developments are the loans and grants that make the projects financially viable. These financial elements are known as Multifamily Loan Guarantees, Multifamily Direct Loans, Section 538 Multi-family Housing Guarantee Program, Section 515 Rural Rental Housing, and Section 514/516 Farm Labor Housing Programs. While most of these programs are built primarily in house, the Section 538 program guarantees loans made by private lenders in a separate regulation. The following is an overview of these programs, their requirements, and function.

Multifamily Loan Guarantees

The Multifamily Loan guarantee program helps provide financing to borrowers within the eligible rural areas in the United States to increase the number of affordable housing developments for low and middle-income families and individuals via private sector lenders.[26] The lenders themselves may apply for the loan guarantee on a buyer that wouldn't be able to receive commercial credit on reasonable terms without the loan guarantee from the USDA RD. These lenders are from well-known lending institutions such as Fannie Mae, Freddie Mac, Ginnie Mae, and HUD. They

[26] "Multi-Family Housing Loan Guarantees." Multi-Family Housing Loan Guarantees. Accessed May 05, 2015. http://www.rd.usda.gov/programs-services/multi-family-housing-loan-guarantees.

may also be from Federal Home Loan Bank members and State or Local Housing Finance Agencies. While the borrowers themselves may be state or local government entities, nonprofit organizations, for-profit organizations, or federally recognized tribes. It is noted that under this loan guarantee, additional requirements including:

- Rent for individual units be capped at 30% of 115% AMI be used,
- Average rent for entire project including tenant paid utilities not exceed 30% of 100% AMI adjusted for family size,
- Overall Development must be of at least five units
- May contain units that are detached, semi-detached, row houses, or multi-family structures[27]

The funds from the loan may be used for acquisition and improvements, providing necessary infrastructure and any other use listed in the Federal Regulations Code in 7CFR Part 3565.205. Typically 97% for non-profit entities, 90% for-profit is the maximum guarantee towards the loan in question. The terms are usually set at a minimum of 25 years to a max. of 40 years, with fixed interest rates negotiated between the lender and borrower for the life of the loan as the lender services the loan as well.

Multi-family Direct Loan

Similar to the Multi-family loan guarantee, the conditions for the direct loan is that the loan be used within affordable multifamily housing, however there is a subtle difference as the direct loan would apply to low-income, elderly or disabled, and families in eligible rural areas and not just low to middle-income families and individuals. It's also different in the instance that the loan guarantee only allows lenders to apply for the guarantees with specifics on who the borrower must be; while a variety of applicants with the same mission can apply for the direct loan. These applicants can

[27] "Multi-Family Housing Loan Guarantees." Multi-Family Housing Loan Guarantees. Accessed May 05, 2015. http://www.rd.usda.gov/programs-services/multi-family-housing-loan-guarantees.

include: individuals, trusts, associations, partnerships, limited partnerships, nonprofits organizations, for-profit corporations, and consumer cooperatives as well as most state and local government entities and federally recognized tribes. The funds may be used to pay for construction, improvements, and acquisition of a multifamily structure for the programs intended beneficiaries. However, all these properties have to be rental housing. These loans are direct competitive loans that have a 30-year payback period with lowest rate at the beginning of the loan approval or loan closing.

Section 515 Loan

Similar to the direct loan program for multifamily rental housing, the Section 515 loan offers a direct loan to eligible borrowers that will design and construct housing and similar structures for very low-, low-, and moderate-income, elderly, and persons living with disabilities in rural areas. These projects can include family, elderly, congregate, group homes, rural cooperative housing and mixed projects and are facilitated by the following type of loans under Section 515: Initial loans, Subsequent loans, and Assumed loans.

The first is made with no pre-existing agency loan, these are either brand new properties or the rehabilitation of existing sites that best fit the agency's best interest. Interest on the loan is assisted by the agency, which reduces to the effective rate to 1 percent financing, only for units where eligible renters are paying at least 30 of their income for rent. The times established by the initial loan portion of the section 515 loan is set at a maximum of 30 years with an amortization payback period of not more than 50 years. Subsequent loans are in conjunction with the agency loan to help assist the borrower to pay for repairs or improvements to the property or in the instance where the property is transferred to another purchaser who is assuming the initial loan. Assumed Loans are these loans in which the property has been transferred to the new owner, establishing new rates and terms with the assumption of the property and loan for the most part.

When the same rates and terms are accepted with the transfer of the property from one set of hands to another, the existing note terms remain the same.

Section 514/516 Farm Labor Housing Loans

The Loans of Section 514/516 Farm Labor Housing are specifically designed with the intention of providing housing for farmworkers, that there are no rural restrictions, and that agency grants are available to support the development of these programs[28]. The differences between Section 514/516 and Section 514 loans is that while 514/516 assistance may be used for off-farm labor housing projects if limited partnerships with a general partner in a nonprofit entity is present. Meaning that the Section 516 assistance can only work for off-farm labor housing projects that might otherwise not be built. However, the Section 514 loan assistance must be used only for on farm labor housing projects and is the only assistance that may be used with Low Income Housing Tax Credit (LIHTC) credits. It is recognized that projects that leverage other funding sources gain preferential treatment, but strictly states that " no leveraging preference for on-farm labor housing applications will be given".[29]

Case Studies

In regard to the USDA Rural Development program nationwide, the concepts of green technologies, programs, and property management along with the financing to secure these project's financial viability two case studies were investigated in California's Rural Areas. These projects are known as Rancho Lindo Apartments in Lamont California and Montgomery Crossing in Lemoore California. These projects will show the project description, the financial analysis of each project and conclusions will be drawn respectfully in response to the state and federal initiatives, intentions and realities of each project.

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[28] USDA Rural Development. "CHAPTER 2: MULTI-FAMILY HOUSING PROGRAMS AND LOAN SERVICING." *CHAPTER 2: MULTI-FAMILY HOUSING PROGRAMS AND LOAN SERVICING*, February 24, 2005. Accessed May 2, 2015. http://www.rd.usda.gov/files/3560-3chapter02.pdf.
[29] Ibid.

Rancho Lindo

The Rancho Lindo Apartments are a development of 44 Units, containing 43 low-income units with 41 of those units set aside for rent lower than the rent/income ceiling of 60% AMGI. It was developed under the Section 515 Loan with Rural development Rental Assistance, and LITHC totally $885,798 annually. Self Help Enterprises is entity responsible for the construction and lease up of the Rancho Lindo Apartment Housing, describing the development as housing for Farm Worker families in the rural count of Lamont, CA. Its residential program provides services like job training, health and medical services, financial training and homebuyer education.[30] The energy efficiency properties of the site are Energy Star appliances, Tankless Water Heaters, Cool Tile Roof, PV Solar System for community Center, Build It Green Certification of the development, and the exceeding of CA Title 24 Energy Standard by 37% when first opened in 2009.

Montgomery Crossing

The development of Montgomery Crossing contains 57 units, 56 of which are low-income units, 66% of the units receive the California Section 515 assistance, while 65% receive National Section 515. The Low Income Ceiling is 50% or less of the AMI. The project was built with Section 515, Rural Development Rental Assistance Subsidies (16 units at the development site are eligible and do receive this subsidy), as well as $1,023,663 LITHC annual for the next 10 years. Energy efficiency functions within the development are listed as such:

- Flow Restrictors for kitchen & bath facets or water-saving fixtures
- CRI Green-label, low-VOC carpet and pad
- Bathroom fans in all bathrooms w/humidistat, timer and outdoor exhaust
- Recycled materials incorporated into: concrete carpet, road base or landscape
- Construction Indoor Air Quality Management Plan
- Project has nonsmoking buildings or contiguous sections within a building

[30] "Rental Homes." - NeighborWorks America. 2015. Accessed May 03, 2015. http://www.neighborworks.org/Homes-Finances/Rental-Homes.

The project was listed at exceeding CA Title 24 Energy Standard by 18% when opened in 2009.

Both projects used similar methods of financing, with similar levels of income, and each having a low income ceiling of 50 to 60% AMGI. While Rancho Lindo required $200,000 less and opened at 19% more efficiency than Montgomery Crossing, it's can be attributed that Rancho Lindo has 13 less apartments and a community center that has a PV system on the complex that could be an energy-generating factor for the development. It also states that unlike Montgomery Crossing, Rancho Lindo invested in cool tile roofs, energy star appliances, and is certified Build It Green. If a researcher were able to look at the developments energy efficiency methods and deduce that creation and exhaust of energy from each development may suggest that this is a probable cause for the large gap in energy saving measures when compared with CA Title 24.

Conclusion:

In the investigation of the USDA's Rural Development Multifamily Energy Efficient Initiative, the methods of different rating systems, the environmental technologies used by these systems, the concept of green property management, the financial means that produces financial viable projects and case studies of Rural California developments along with interviews from Joe Belden of Housing Assistance Council in Washington D.C. and Walker Wells of Global Green in California has aided in the production of a survey and findings that be used as a means to study findings from respective state offices in rural counties throughout the nation. These findings are the following:

1. That with respect to climate, the environmental technologies that are used in the respective point systems have the potential to be technologies that otherwise cannot be used in other development climates (if so):
    a. How do Climate systems differ around the United States?

   b. How many projects are in one climate zone versus another?
   c. Is there a preferential climate zone that is more receptive to sustainable technologies
   d. What are the weakest sustainable technologies found in these areas and why?
   e. What are possible improvements?
2. What are individual state initiatives to facilitate zero net housing?
   a. Preference to zero net housing initiatives?
   b. Regulations to which kind of sustainable technologies be used?
   c. Passive design, sustainable technologies or both: is there a preference?
3. Existing Developments
   a. Are there existing energy efficient developments within the state
   b. How many and where are they typically built?
   c. Who develops these properties?
   d. Is there a preference to which technologies are used in the developments?
   e. Energy loads of these properties
   f. Amount of Energy Saved on a monthly and annual basis
   g. Financial assistance that was given to each development
4. Developers:
   a. Licensed as what kind of professional?
   b. Team members consist of any sustainable technology employee i.e. LEED GA, BC+D…etc.
   c. Specialty in green building?
   d. Repeated projects?
   e. Application to Historical, State, Federal Tax Credits, and LITHC.

By gathering this data into a data spread sheet and distributing the survey to local and state offices, the USDA can begin to clearly see a pattern over the entire United States with regard to green building. It can begin to understand trends within the region and help other companies develop technologies within that region to better suit the climate. As well as begin to understand the demand of green building systems spanning from California and its progressive model of green technologies and sustainable methods to Massachusetts its progressive run toward sustainable technologies.

Appendix 1

ENERGY STAR® CERTIFIED NEW HOME

ENERGY STAR

Builder Name: Gamble Builders
Permit Date/Number: 4 April 2011
Home Address: 1310 L Street, Washington DC 20005

Rating Company: G Force Testing
Rater Identification Number: 2345678
Rating Date: 6 July 2011
Version: 3.0

Standard Features of an ENERGY STAR Certified New Home

Your ENERGY STAR certified new home has been designed, constructed, and independently verified to meet rigorous requirements for energy efficiency set by the U.S. Environmental Protection Agency (EPA), including:

Thermal Enclosure System

A complete thermal enclosure system that includes comprehensive air sealing, quality-installed insulation and high-performing windows to deliver improved comfort and lower utility bills.

Air Infiltration Test: **4 ACH50**

Primary Insulation Levels:
Ceiling: R30 **Floor: R-10**
Wall: R19 **Slab: R-6**

Primary Window Efficiency:
U-Value: 0.60 **SHGC: 0.27**

Water Management System

A comprehensive water management system to protect roofs, walls, and foundations.

Flashing, a drainage plane, and site grading to move water from the roof to the ground and then away from the home.

Water-resistant materials on below-grade walls and underneath slabs to reduce the potential for water entering into the home.

Management of moisture levels in building materials during construction.

Heating, Cooling, and Ventilation System

A high-efficiency heating, cooling system, and ventilation system that is designed and installed for optimal performance.

Total Duct Leakage:
6 CFM25 per 100 sq. ft.

Duct Leakage to Outdoors:
4 CFM25 per 100 sq. ft.

Primary Heating (System Type • Fuel Type • Efficiency):
Fuel-fired Hydronic Distribution • Natural Gas • 90 AFUE

Primary Cooling (System Type • Fuel Type • Efficiency):
Ground-source Heat Pump • Electric • 14.5 SEER

Energy Efficient Lighting and Appliances

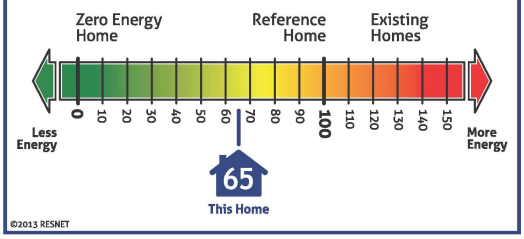
Energy efficient products to help reduce utility bills, while providing high-quality performance.

ENERGY STAR Qualified Lighting: **75%**

ENERGY STAR Qualified Appliances and Fans:
Refrigerators: 1 **Dishwashers: 1**
Ceiling Fans: 4 **Exhaust Fans: 3**

Primary Water Heater (System Type • Fuel Type • Efficiency):
Electric Resistance Heater • Electric • 0.94 EF

HERS® Index



This certificate provides a summary of the major energy efficiency and other construction features that contribute to this home earning the ENERGY STAR, including its Home Energy Rating System (HERS) score, as determined through independent inspection and verification performed by a trained professional. The Home Energy Rating System is a nationally-recognized uniform measurement of the energy efficiency of homes.

Note that when a home contains multiple performance levels for a particular feature (e.g., window efficiency or insulation levels), the predominant value is shown. Also, homes may be certified to earn the ENERGY STAR using a sampling protocol, whereby one home is randomly selected from a set of homes for representative inspections and testing. In such cases, the features found in each home within the set are intended to meet or exceed the values presented on this certificate. The actual values for your home may differ, but offer equivalent or better performance. This certificate was printed using REM/Rate™ (Version XX.XX).

Learn more at www.energystar.gov/homefeatures

2011 Enterprise Green Communities Criteria

1 Integrative Design

1.1a	M	**Green Development Plan: Integrative Design Meetings**
1.1b	M	**Green Development Plan: Criteria Documentation**
1.2a	2	**Universal Design** (New Construction only)
1.2b	2 or 3	**Universal Design** (Substantial & Moderate Rehab only)

2 Location and Neighborhood Fabric

2.1	M	**Sensitive Site Protection** (New Construction Only)
2.2	M	**Connections to Existing Development and Infrastructure** (New Construction only, except for projects
2.3	M	**Compact Development** (New Construction only)
2.4	5 or 6	**Compact Development**
2.5	M	**Proximity to Services** (New Construction only)
2.6	M	**Preservation of and Access to Open Space: Rural/Tribal/Small Town only** (New Construction only)
2.7	3 max	**Preservation of and Access to Open Space**
2.8	5	**Access to Public Transportation**
2.9	5	**Walkable Neighborhoods: Connections to Surrounding Neighborhood - Rural/Tribal/Small Town only**
2.10	7 max	**Smart Site Location - Passive Solar Heating / Cooling**
2.11	2	**Brownfield or Adaptive Reuse Site**
2.12	6	**Access to Fresh, Local Foods**
2.13	4	**LEED for Neighborhood Development certification**

3 Site Improvements

3.1	M	**Environmental Remediation**
3.2	M	**Erosion and Sedimentation Control** (Except for infill sites with buildable area smaller than one acre)
3.3	M	**Low Impact Development** (New Construction only)
3.4	M	**Landscaping**
3.5	M	**Efficient Irrigation and Water Reuse**
3.6	2 or 6 pts	**Surface Stormwater Management**

4 Water Conservation

4.1	M	**Water-Conserving Fixtures**
4.2	6 max	**Advanced Water-Conserving Appliances and Fixtures**
4.3	4 max	**Water Reuse**

5 Energy Efficiency

5.1a	M	**Building Performance Standard: Single family and Multifamily - three stories or fewer** (New
5.1b	M	**Building Performance Standard: Multifamily - four stories or more** (New Construction only)
5.1c	M	**Building Performance Standard: Single family & Multifamily - three stories or fewer** (Substantial and
5.1d	M	**Building Performance Standard: Multi-family - four stories or more** (Substantial or Moderate Rehab
5.2	15 max	**Additional Reductions in Energy Use**
5.3	M	**Sizing of Heating and Cooling Equipment and Ducts**
5.4	M	**ENERGY STAR Appliances**
5.5a	M	**Efficient Lighting: Interior Units**
5.5b	M	**Efficient Lighting: Common Areas and Emergency Lighting [Multi-family buildings]**
5.5c	M	**Efficient Lighting: Exterior**
5.6a	M	**Electricity Meter** (New Construction & Substantial Rehab only)
5.6b	3	**Electricity Meter** (Moderate Rehab only
5.7a	12 max	**Renewable Energy**
5.7b	1 or 2 pts	**Photovoltaic (PV) / Solar Hot Water Ready**
5.8	5	**Advanced Metering Infrastructure**

6 Materials Beneficial to the Environment

2015 Enterprise Green Communities Criteria

M indicates "Mandatory" criterion, depending upon location or construction type (new construction v.

1 Integrative Design

1.1a	M	**Goal Setting**
1.1b	M	**Criteria Documentation**
1.1c	9	**Designing for Project Performance**
1.2a	M	**Resident Health and Wellbeing: Design for Health**
1.2b	12	**Resident Health and Wellbeing: Health Action Plan**
1.3a	M	**Resilient Communities: Design for Resilience (New Construction & Substantial Rehab only)**
1.3b	15	**Resilient Communities: Multi-Hazard Risk / Vulnerability Assessment**

2 Location + Neighborhood Fabric

2.1	M	**Sensitive Site Selection** (New Construction only)
2.2	M	**Connections to Existing Development and Infrastructure** (New Construction only, except for projects
2.3	M	**Compact Development** (New Construction only)
2.4	5 or 7	**Compact Development**
2.5	M	**Proximity to Services** (New Construction only)
2.6	M	**Preservation of and Access to Open Space in Rural or Tribal Areas** (only for projects eligible for USDA
2.7	6 max	**Preservation of and Access to Open Space**
2.8	8 or 10	**Access to Public Transportation**
2.9	2 - 8	**Improving Connectivity to the Community**
2.10	5 max	**Passive Solar Heating / Cooling**
2.11	4	**Brownfield Site or Adaptive Reuse Building**
2.12	6	**Access to Fresh, Local Foods**
2.13	4	**LEED for Neighborhood Development Certification**
2.14	6 max	**Local Economic Development & Community Wealth Creation**

3 Site Improvements

3.1	M	**Environmental Remediation**
3.2	M	**Erosion and Sedimentation Control** (Except for infill sites with buildable area smaller than one acre)
3.3	M	**Low Impact Development** (Only for projects located on greenfields)
3.4	M	**Landscaping**
3.5a	M	**Efficient Irrigation and Water Reuse** (if irrigation is used)
3.5b	4 or 8	**Efficient Irrigation and Water Reuse**
3.6	4 or 8	**Surface Stormwater Management**
3.7	1	**Reducing Heat Island Effect: Paving**

4 Water Conservation

4.1	M	**Water-Conserving Fixtures**
4.2	6 max	**Advanced Water Conservation**
4.3	4	**Leaks & Water Metering**
4.4	4	**Efficient Plumbing Layout & Design**
4.5	6 max	**Water Reuse**
4.6	8	**Access to Potable Water during Emergencies**

5 Energy Efficiency

5.1a	M	**Building Performance Standard: New Construction: single family and low-rise multifamily**
5.1b	M	**Building Performance Standard: New Construction: mid-rise and high-rise multifamily**
5.1c	M	**Building Performance Standard: Substantial and Moderate Rehab: single family and low-rise**
5.1d	M	**Building Performance Standard: Substantial and Moderate Rehab: mid-rise and high-rise multifamily**
5.2a	5 - 12	**Additional Reductions in Energy Use**
5.2b	12	**Advanced Certification: Nearing Net Zero**
5.3	M	**Sizing of Heating and Cooling Equipment**
5.4	M	**ENERGY STAR Appliances**
5.5	M	**Lighting**
5.6	M or 6	**Electricity Meter** (Mandatory for New Construction and Substantial Rehab; Optional for Moderate
5.7a	4	**Photovoltaic / Solar Hot Water Ready**
5.7b	10 max	**Renewable Energy**
5.8a	8	**Resilient Energy Systems: Floodproofing**
5.8b	4 - 8	**Resilient Energy Systems: Islandable Power**

6 Materials

LEED v4 for Building Design and Construction: Homes and Multifamily Lowrise

Project Checklist

Project Name:
Date:

Y	?	N			
			Credit	Integrative Process	2

0	0	0	**Location and Transportation**	15
Y			Prereq	Floodplain Avoidance	Required
			PERFORMANCE PATH	
			Credit	LEED for Neighborhood Development Location	15
			PRESCRIPTIVE PATH	
			Credit	Site Selection	8
			Credit	Compact Development	3
			Credit	Community Resources	2
			Credit	Access to Transit	2

0	0	0	**Sustainable Sites**	7
Y			Prereq	Construction Activity Pollution Prevention	Required
Y			Prereq	No Invasive Plants	Required
			Credit	Heat Island Reduction	2
			Credit	Rainwater Management	3
			Credit	Non-Toxic Pest Control	2

0	0	0	**Water Efficiency**	12
Y			Prereq	Water Metering	Required
			PERFORMANCE PATH	
			Credit	Total Water Use	12
			PRESCRIPTIVE PATH	
			Credit	Indoor Water Use	6
			Credit	Outdoor Water Use	4

0	0	0	**Energy and Atmosphere**	38
Y			Prereq	Minimum Energy Performance	Required
Y			Prereq	Energy Metering	Required
Y			Prereq	Education of the Homeowner, Tenant or Building Manager	Required
			PERFORMANCE PATH		
			Credit	Annual Energy Use	29
			BOTH PATHS		
			Credit	Efficient Hot Water Distribution System	5
			Credit	Advanced Utility Tracking	2
			Credit	Active Solar Ready Design	1
			Credit	HVAC Start-Up Credentialing	1
			PRESCRIPTIVE PATH		
Y			Prereq	Home Size	Required
			Credit	Building Orientation for Passive Solar	3
			Credit	Air Infiltration	2
			Credit	Envelope Insulation	2
			Credit	Windows	3
			Credit	Space Heating & Cooling Equipment	4

			EA PRESCRIPTIVE PATH (continued)		
			Credit	Heating & Cooling Distribution Systems	3
			Credit	Efficient Domestic Hot Water Equipment	3
			Credit	Lighting	2
			Credit	High Efficiency Appliances	2
			Credit	Renewable Energy	4

0	0	0	**Materials and Resources**	10
Y			Prereq	Certified Tropical Wood	Required
Y			Prereq	Durability Management	Required
			Credit	Durability Management Verification	1
			Credit	Environmentally Preferable Products	4
			Credit	Construction Waste Management	3
			Credit	Material Efficient Framing	2

0	0	0	**Indoor Environmental Quality**	16
Y			Prereq	Ventilation	Required
Y			Prereq	Combustion Venting	Required
Y			Prereq	Garage Pollutant Protection	Required
Y			Prereq	Radon-Resistant Construction	Required
Y			Prereq	Air FIltering	Required
Y			Prereq	Environmental Tobacco Smoke	Required
Y			Prereq	Compartmentalization	Required
			Credit	Enhanced Ventilation	3
			Credit	Contaminant Control	2
			Credit	Balancing of Heating and Cooling Distribution Systems	3
			Credit	Enhanced Compartmentalization	1
			Credit	Enhanced Combustion Venting	2
			Credit	Enhanced Garage Pollutant Protection	2
			Credit	Low Emitting Products	3

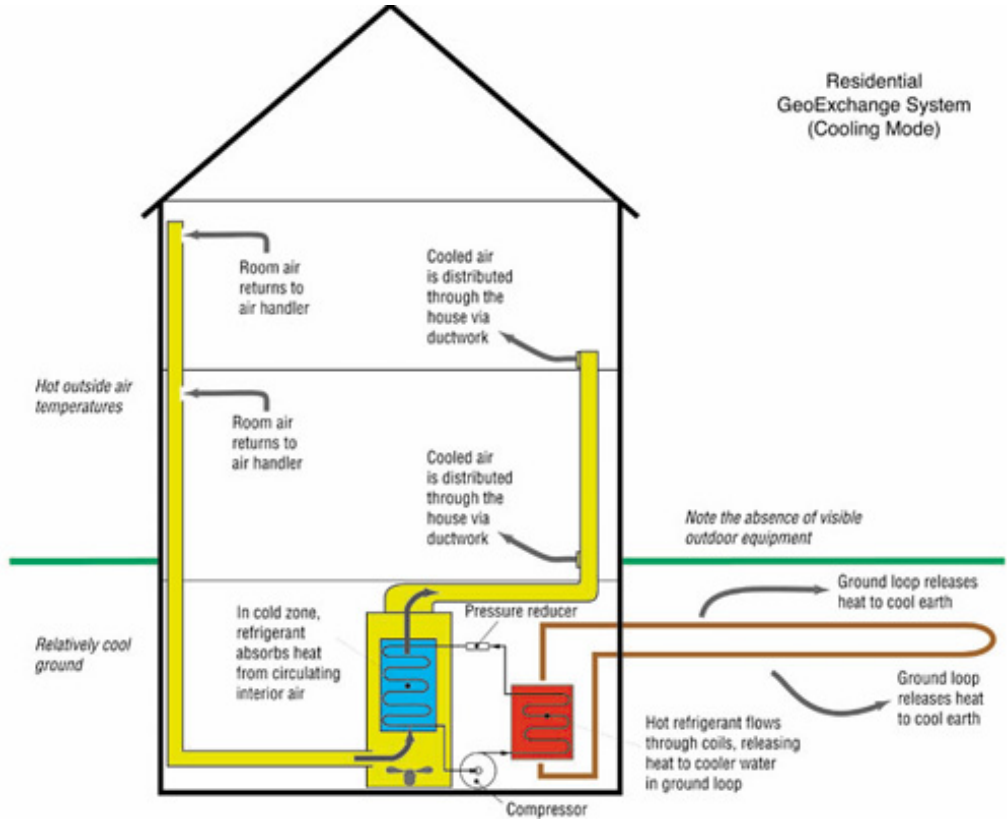
0	0	0	**Innovation**	6
Y			Prereq	Preliminary Rating	Required
			Credit	Innovation	5
			Credit	LEED AP Homes	1

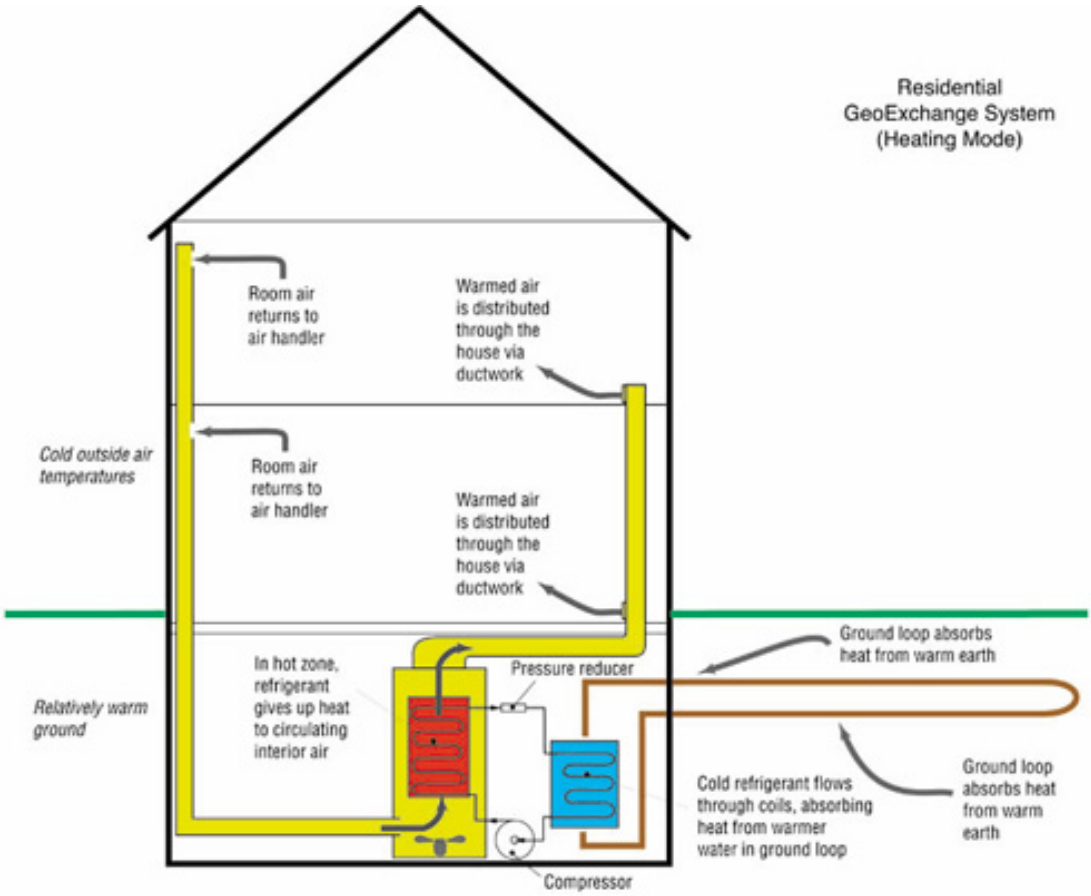
0	0	0	**Regional Priority**	4
			Credit	Regional Priority: Specific Credit	1
			Credit	Regional Priority: Specific Credit	1
			Credit	Regional Priority: Specific Credit	1
			Credit	Regional Priority: Specific Credit	1

0	0	0	**TOTALS**	Possible Points:	110

Certified: 40 to 49 points, **Silver:** 50 to 59 points, **Gold:** 60 to 79 points, **Platinum:** 80 to 110

Appendix 4


Residential
GeoExchange System
(Cooling Mode)
Room air returns to air handler
Cooled air is distributed through the house via ductwork
Hot outside air temperatures
Room air returns to air handler
Cooled air is distributed through the house via ductwork
Note the absence of visible outdoor equipment
Ground loop releases heat to cool earth
In cold zone, refrigerant absorbs heat from circulating interior air
Pressure reducer
Relatively cool ground
Ground loop releases heat to cool earth
Hot refrigerant flows through coils, releasing heat to cooler water in ground loop
Compressor


Residential
GeoExchange System
(Heating Mode)
Room air returns to air handler
Warmed air is distributed through the house via ductwork
Cold outside air temperatures
Room air returns to air handler
Warmed air is distributed through the house via ductwork
Ground loop absorbs heat from warm earth
In hot zone, refrigerant gives up heat to circulating interior air
Pressure reducer
Relatively warm ground
Ground loop absorbs heat from warm earth
Cold refrigerant flows through coils, absorbing heat from warmer water in ground loop
Compressor

Bibliography

"About ENERGY STAR." About ENERGY STAR. 2015. Accessed May 05, 2015. http://www.energystar.gov/about.

ANSI. "The HR Value Proposition." *Personnel Psychology* 59, no. 2 (2006): 478-80. Accessed May 5, 2015. doi:10.1111/j.1744-6570.2006.00043_7.x.

Beldon, Joe. "Interview about Housing Assistance Council." Telephone interview by author. March 10, 2015.

Bond, Christopher S. "How Rural Areas Are Defined Is of Critical Importance." Bipartisan Policy Center. October 1, 2013. Accessed May 05, 2015. http://bipartisanpolicy.org/blog/how-rural-areas-are-defined-critical-importance/.

CA.gov. Office of the Governor. "GOVERNOR BROWN SETS AMBITIOUS NEW GOALS TO GREEN STATE'S BUILDINGS, SAVE TAXPAYER DOLLARS." News release, April 25, 2012. Http://gov.ca.gov/. Accessed May 2, 2015. http://gov.ca.gov/news.php?id=17506.

California Energy Commission. *A GUIDE TO PHOTOVOLTAIC (PV) SYSTEM DESIGN AND INSTALLATION*, June 1, 2001. Accessed May 2, 2015. http://www.energy.ca.gov/reports/2001-09-04_500-01-020.PDF.

California Energy Commission. "Overview of Wind Energy in California." Overview of Wind Energy in California. Accessed May 05, 2015. http://www.energy.ca.gov/wind/overview.html.

"California Green Building Strategy." California Green Building Strategy. March 10, 2014. Accessed May 05, 2015. http://www.arb.ca.gov/cc/greenbuildings/greenbuildings.htm.

California Public Utilities Commission. "California Energy Efficiency Strategic Plan." *Engage 360*, January 2011. Accessed May 5, 2015. http://www.cpuc.ca.gov/NR/rdonlyres/A54B59C2-D571-440D-9477-3363726F573A/0/CAEnergyEfficiencyStrategicPlan_Jan2011.pdf.

"California's Net Zero Energy Building Mandate To Reshape US Construction Industry." CleanTechnica. April 15, 2014. Accessed May 05, 2015. http://cleantechnica.com/2014/04/15/californias-net-zero-energy-building-will-reshape-us-construction-industry/.

Chow, Lorraine. "France Mandates New Roofs Must Be Covered in Solar Panels or Plants » EcoWatch." EcoWatch. March 25, 2015. Accessed May 02, 2015. http://ecowatch.com/2015/03/25/france-roofs-solar-panels-plants/.

CPUC, comp. *California Energy Efficiency Strategic Plan - January 2011 Update.* Publication. Accessed April 29, 2015. http://www.cpuc.ca.gov/PUC/energy/Energy+Efficiency/eesp/.

Energy.gov. "Energy.gov." Photovoltaics. Accessed May 05, 2015. http://energy.gov/eere/sunshot/photovoltaics.

Enterprise. *2015 Enterprise Green Communities Criteria.* Update. April 7, 2015. Accessed May 2, 2015. http://www.enterprisecommunity.com/servlet/servlet.FileDownload?file=00P1400000dKEmFEAW.

Enterprise Green Communities. "2015 Enterprise Green Communities Criteria Checklist." Enterprisecommunity.com. 2015. Accessed May 5, 2015.

http%3A%2F%2Fwww.enterprisecommunity.com%2Fservlet%2Fservlet.FileDownload%3Ffile%3D00P1400000dKEjuEAG.

Enterprise. "About Us." About Us. Accessed May 02, 2015. http://www.enterprisecommunity.com/solutions-and-innovations/green-communities/about-us.

EPA. "ENERGY STAR Certified Homes, Version 3 (Rev. 04) Program Requirements for the State of California." Energystar.gov. June 1, 2013. Accessed May 1, 2015. http%3A%2F%2Fwww.energystar.gov%2Fia%2Fpartners%2Fbldrs_lenders_raters%2Fdownloads%2FCalifornia_v3_Guidelines.pdf%3Ffdfd-b2d3.

Farley, Kate. *Energy Efficiency Opportunities at USDA*. Washington, DC: American Council for an Energy-Efficient Economy, 2013. Accessed May 5, 2015. http://aceee.org/files/pdf/white-paper/USDA%20IRD.pdf.

Fogel, Cathleen, Ph.D. "California's Zero Net Energy Policies and Initiatives: NASEO Getting to Zero Conference." *California's Zero Net Energy*, September 18, 2013. Accessed May 5, 2015. http://www.cpuc.ca.gov/NR/rdonlyres/C27FC108-A1FD-4D67-AA59-7EA82011B257/0/3.pdf.

French, Roger L. "Ground Source Heat Exchange." Ground Source Heat Exchange Sustainable Sources: 20 Years of Online Green Building Information. Accessed May 5, 2015. http%3A%2F%2Fgeoexchange.sustainablesources.com.

"Global Green Interview." Telephone interview by author. March 30, 2015.

Goodrich, Alan, Ted James, and Michael Woodhouse. "Residential, Commercial, and Utility-Scale Photovoltaic (PV) System Prices in the United States: Current Drivers and Cost-Reduction Opportunities." *Residential, Commercial, and Utility-Scale Photovoltaic (PV) System Prices in the United States: Current Drivers and Cost-Reduction Opportunities*, February 1, 2012. Accessed May 5, 2015. http://www.nrel.gov/docs/fy12osti/53347.pdf.

Hb-3-3560. "CHAPTER 2: MULTI-FAMILY HOUSING PROGRAMS AND LOAN SERVICING." *CHAPTER 2: MULTI-FAMILY HOUSING PROGRAMS AND LOAN SERVICING*, February 24, 2005. Accessed May 2, 2015. http://www.rd.usda.gov/files/3560-3chapter02.pdf.

"History of the ENERGY STAR Guidelines for New Homes." : ENERGY STAR. Accessed May 03, 2015. http://www.energystar.gov/index.cfm?c=new_homes.nh_history.

Home Innovation Research Labs. "Find a Multifamily Verifier." Find an Home Innovation Research Labs Accredited Green Multifamily Verifier. 2015. Accessed May 05, 2015. http://www.homeinnovation.com/services/certification/green_homes/resources/find_a_multifamily_verifier.

"How Biomass Energy Works." Union of Concerned Scientists. Accessed May 05, 2015. http://www.ucsusa.org/clean_energy/our-energy-choices/renewable-energy/how-biomass-energy-works.html#.VUgx6M6JyOw.

"How New Homes Earn the ENERGY STAR." How a Home Earns the ENERGY STAR : ENERGY STAR. Accessed May 03, 2015. http://www.energystar.gov/index.cfm?c=new_homes.nh_verification_process.

Hurst, Timothy B. "Top Five Micro Wind Turbines." CleanTechnica. March 21, 2008. Accessed May 05, 2015. http://cleantechnica.com/2008/03/21/the-five-best-micro-wind-turbines/3/.

Mack, Eric. "Could This Little-known Biomass Generator Start an Energy Revolution?" Could This Little-known Biomass Generator Start an Energy Revolution? May 27, 2014. Accessed May 05, 2015. http://www.gizmag.com/power-pallet-20-gasifier-biomass-generator/32245/.

Martinez, Marco. "The Bright Future of Zero Net Energy Homes." The Bright Future of Zero Net Energy Homes. May 2, 2015. Accessed May 05, 2015. http://www.greenhomebuildermag.com/article/bright-future-zero-net-energy-homes.

Micro-hydropower Systems: A Buyer's Guide. Ottawa: Natural Resources Canada, 2004. Accessed May 1, 2015. http://www.oregon.gov/energy/renew/hydro/docs/microhydroguide.pdf.

"Multi-Family Housing Direct Loans." Multi-Family Housing Direct Loans. Accessed May 05, 2015. http://www.rd.usda.gov/programs-services/multi-family-housing-direct-loans.

"Multi-Family Housing Loan Guarantees." Multi-Family Housing Loan Guarantees. Accessed May 05, 2015. http://www.rd.usda.gov/programs-services/multi-family-housing-loan-guarantees.

Purvis, C. R., and J. D. Craig. "A Small Scale Biomass Fueled Gas Turbine Power Plant." Psu.edu. October 4, 1998. Accessed May 5, 2015. http%3A%2F%2Fciteseerx.ist.psu.edu%2Fviewdoc%2Fdownload%3Fdoi%3D10.1.1.215.7668%26rep%3Drep1%26type%3Dpdf.

"Quick Facts." *Chemical & Engineering News* 26, no. 1, 69. Accessed May 5, 2015. doi:10.1021/cen-v026n001.p069.

"Rental Homes." - NeighborWorks America. 2015. Accessed May 03, 2015. http://www.neighborworks.org/Homes-Finances/Rental-Homes.

"Residential Wind Energy Systems - Bergey Wind Power Bergey Wind Power." Bergey Wind Power. 2012. Accessed May 05, 2015. http://bergey.com/wind-school/residential-wind-energy-systems.

"Rural Economies: The Basis of Food Security." The Importance of Rural Economies. Accessed May 02, 2015. http://www.syngenta.com/global/corporate/en/grow-more-from-less/caseStudy4/Pages/rural-communities.aspx.

SEIA. "Photovoltaic (Solar Electric)." SEIA. 2014. Accessed May 05, 2015. http://www.seia.org/policy/solar-technology/photovoltaic-solar-electric.

"Small Wind Turbines." Small Wind Turbines. Accessed May 05, 2015. http://www.energywise.govt.nz/your-home/generating-your-own-energy/wind.

"Solar Water Heaters." Energy.gov. December 14, 2014. Accessed May 02, 2015. http://energy.gov/energysaver/articles/solar-water-heaters.

Star, EPA Energy. "ENERGY STAR Certified Homes, Version 3 (Rev. 07) National Program Requirements." *ENERGY STAR Certified Homes, Version 3 (Rev. 07) National Program Requirements*, June 1, 2013, 1-3. Accessed May 3, 2015. ENERGY STAR Certified Homes, Version 3 (Rev. 07) National Program Requirements.

http://www.energystar.gov/ia/partners/bldrs_lenders_raters/downloads/National_Program_Requirements.pdf.

"Understanding the HERS® Index | RESNET." RESNET HERS Index. Accessed May 03, 2015. http://www.hersindex.com/understanding.

"USDA Rural Development-EE Program Details." USDA Rural Development-EE Program Details. September 28, 2012. Accessed May 03, 2015. http://rurdev.sc.egov.usda.gov/program_details.html.

"USDA Rural Development-EE Project RL." USDA Rural Development-EE Project RL. September 28, 2012. Accessed May 05, 2015. http://rurdev.sc.egov.usda.gov/project_RL.html.

"USDA Rural Development-HMF-MPR." USDA Rural Development-HMF-MPR. Accessed May 05, 2015. http://rurdev.sc.egov.usda.gov/HMF_MPR.html.

USGBC. "California Version 2011 Update for Single-family and Low-rise Buildings." *LEED for Homes Rating System:* 74, no. 11 (September 13, 1958): 166. Accessed May 5, 2015. http://www.usgbc.org/sites/default/files/LEED%20for%20Homes%20Rating%20System%202008%20-%20California%202011%20update.pdf.

USGBC. "Getting Started with Homes | U.S. Green Building Council." Getting Started with Homes | U.S. Green Building Council. Accessed May 05, 2015. http://www.usgbc.org/articles/getting-started-homes.

USGBC. "Multifamily Mid-Rise October 2010 California Version, 2011 Update." *LEED for Homes Rating System:*, 2011. Accessed May 1, 2015. LEED for Homes Rating System:.

Wells, Walker. "Global Green Interview." Telephone interview by author. March 30, 2015.

"World's Population Increasingly Urban with More than Half Living in Urban Areas | UN DESA | United Nations Department of Economic and Social Affairs." UN News Center. July 10, 2014. Accessed May 05, 2015. http://www.un.org/en/development/desa/news/population/world-urbanization-prospects-2014.html.

Wray, Thomas. "California's Strict Energy Code Could Spread to Other States." Builder. February 27, 2015. Accessed May 05, 2015. http://www.builderonline.com/building/code/californias-strict-energy-code-could-spread-to-other-states_o.

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[i] See appendix 1.
[ii] See appendix 2.
[iii] See appendix 3 for USGBC LEED for Homes Scorecard v.4
[iv] see appendix 4 for PV set up.