

Making Sustainability Affordable in Parlier



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Focus and Phases

This project is focused on examining the affordability of sustainable living in Parlier, California. This includes the various economic, social, and governmental factors that go along with creating sustainable communities in the Central Valley. Furthermore, this project will maintain its focus on the feasibility and affordability of creating energy efficient homes in a city that does not otherwise have a budget for sustainability. This examination will occur through a combination of case studies and research based recommendations that best fit Parlier's specific needs.

This report is covered in five phases:

Phase 1:

Introduction to the topic followed by a site description and brief community background report of Parlier that covers demographics, income, and location.

Phase 2:

Conduct a literature review on the nature of sustainability and its affordability in modern day America.

Phase 3:

Conduct two case studies on cities or developments that have made sustainability affordable through government intervention and a "do it yourself" mentality.

Phase 4:

Examine best practices to make Parlier homes more energy efficient. This section will look at energy, building design, appliances, fixtures, and sustainable education.

Phase 5:

What does this mean for Parlier? How can Parlier integrate some of these practices into their existing and future developments in an affordable way. This section will wrap up the report and provide next steps towards a sustainable and healthy future.

Introduction

As climate change continues to threaten everyday life on Earth, humans from every corner of this planet struggle to keep up with changes due access, attitudes, and most importantly affordability. Over the past decade, governments around the world have invested billions into renewable power. Private investors followed, hoping to cash in on what looked like a transformational shift in the way the world produced electricity and lived sustainability. It felt as though it was a way to add jobs, manage fossil-fuel prices, and curb the impending affects of global warming. Unfortunately, a sustainable world will not happen overnight and requires a sustained effort on all fronts, but are there communities that are more at risk than others?

According to the US National Library of Medicine National Institutes of Health, most North American studies have shown that areas where low socioeconomic status (SES) communities dwell experience higher concentrations of criteria air pollutants (Hajat, Hsia, & O'Neill, 2015). This has put a disproportionate burden on low income cities around the world placed pressure on public and private entities to deliver a sustainable future. However, as many low income families struggle to put food on their tables, the last thing on many of their minds is the environment, and the ones that do want change struggle to make a lasting effect due to a lack of affordability, education, and motivation.

According to the Greenhouse Gas Protocol, an organization that establishes comprehensive global standards for greenhouse gas (GHG) accounting and reporting, cities are responsible for more than 70 percent of global energy-related carbon dioxide (CO₂) emissions (Global Energy & CO₂ Status Report). Addressing climate change at the local level is imperative to reducing the amount of greenhouse gases emitted by cities. Through the incorporation of resilient and sustainable adaptation strategies, cities can reduce their GHG emissions as they work towards a cleaner, more resilient future. The purpose of this project is to spread affordable sustainability to lower income communities so that every resident can make a difference, no matter where they live or what they carry in their wallet.



Figure 1: Climate change impacts

Site Description - Parlier, California

According to a study by Jones and Stokes, Fresno County which is located in the Central Valley of California has the highest residential electricity use per capita within PG&E's service area due to the area's hot climate and industrial uses (2006). Lowering this energy use and the associated costs is crucial given the region's economic difficulties and its focus on agriculture. Approximately 20 miles Southeast of the City of Fresno, you will find the city of Parlier, a small agricultural town that faces a number of climate threats and has been otherwise ignored by the public and private agencies fighting these threats.



Figure 2: Parlier welcome sign

Incorporated in 1921, the City of Parlier is located in the center of the San Joaquin Valley and spans 2.2 square miles of flat agricultural land. The City is bisected by Manning Avenue, a commuter road that connects Parlier to the surrounding communities and to State Highway 99, serving as the primary ingress and egress road. As of 2010, Parlier was home to a population of 14,494. Current estimates by the U.S. Census indicate a population of over 15,286 (United States Census Bureau, 2010). The population is predominantly Hispanic of Mexican descent and 97.5% of the residents identify as Latinx, a gender-neutral term sometimes used in lieu of Latino or Latina. Many residents in Parlier immigrated directly from Mexico, and approximately 33% do not have legal citizenship status in the United States. Due to the predominantly Latino community, Spanish is the primary language followed by English, and some Asian or Pacific Islander languages. Overall, approximately 83% of the all residents over 5-years old don't speak English at home and 43% of them report speaking English "less than very well" (California Polytechnic State University, 2018)

The median age among Parlier residents is 25.9-years old, compared to the national median age of 38 years old. This indicates that the population of Parlier is relatively young more willing to change their lifestyle habits. About 37% of the population is under 18 years of age and the City's three largest age groups by population are 1) 9-years old or younger 2) 20 to 29-years old and 3) 10 to 19-years old. Roughly 88% of households are considered family households, meaning that the household consists of two or more people living together who are related by blood, marriage, or adoption, one of whom is the householder. Approximately 52% have a household size of four or more people, in comparison, only

25.6% of households nationwide have a size of four or more. These statistics show that Parlier has larger households and more families than the national average. Moreover, about 44% of the housing units in the City are owner occupied and 56% are renter occupied making it difficult for residents to make sustainable changes to their property.

The City of Parlier has a labor force of 6,610 people of which 5,649 people are employed. The Agriculture, Education and Social Services, Manufacturing, Wholesale, and Retail are the major industry employers for these residents. According to the US Census bureau , the median household income for the population is \$32,328, compared to the national median of \$56,516 (2010). This low median income has made it difficult for many residents to better their lives and the environment around them restricting what they can do to be more sustainable community.

Climate change impacts are expected to exacerbate existing problems while continuing to impose new ones. In the San Joaquin Valley, it is expected that there will be an increase in droughts, flooding, wildfires, heat waves and severe weather. These impacts pose an immediate and increasing threat to health of California's economy, environment, and people. The agricultural productivity in the Central Valley and Parlier depends heavily on the climate and nutrient levels, soil moisture, water availability will all vary depending on the climate (Koopman, Meis, & Corbett, 2011, p. 5). Changes in the frequency and severity of droughts can also pose huge challenges to farmers restricting their water supply and in turn their profits. In order to maintain productivity levels, growers will need to take adaptive measures in the areas of consumption, production, education, and research to avoid economic damages and decline in food quality while minimizing threats posed by climate stress.

Until recently, sustainable practices have been expensive and unfeasible to the everyday American and as a result have not been widely accepted or implemented in American cities. High upfront costs and a lack of incentive have deterred many from purchasing items like solar panels, low flow toilets, drought friendly lawns, or water filters. Furthermore, a lack of education at all levels has prevented people from making necessary lifestyle changes to better the environment. But do



Figure 3: Parlier City Hall

people need to be rich or wealthy to be environmentally friendly? The answer is no, there are a variety of affordable and sustainable practices that can help you become a greener citizen and fight against the threats of climate change.

Literature Review - Affordable Sustainability

In recent years, sustainability and affordability have not gone hand in hand, and living sustainably meant doling out cash for expensive solar panels, appliances, and double paned windows. However, in recent years things have shifted and sustainability has become more affordable than ever before through competition, government funding, and leasing programs.

As stated in the previous section, Fresno County has the highest residential electricity use per capita within PG&E's service area due to the area's hot climate and various industrial uses (Progress Through Performance, 2012). According to DataUSA, In 2017, 43.5% of the housing units in Parlier, CA were occupied by their owner. This percentage declined from the previous year's rate of 43.8%. Parlier's percentage of owner-occupation is lower than the national average of 63.9% meaning that many Parlier residents do not have the property or the means to invest in the changes necessary to decrease energy consumption and adopt a sustainable lifestyle (DataUSA).

Because the majority of Parlier residents do not own their homes, it is important to incentivise property owners (especially multi dwelling unit owners) to implement sustainable infrastructure and design into their existing and future construction. This includes utilizing solar and/or wind energy installing better insulation, and following sustainable design guidelines set out by the city. Throughout this report, I will cover energy, design, materials, appliances, and education that will guide us towards a healthier and more sustainable future.



Figure 4: Sustainability and money

Case Studies

In this section I will cover two case studies that give insight into what it takes to become a green and energy efficient city. To begin, we will start in Freiburg, Germany, a medium sized city that has become a standing example of how a city can make sustainability affordable through government programs, incentives, and subsidies. Lastly we will look at the Rancho Lindo Apartments development in Lamont, California from Self Help Enterprises. With a similar demographic, setting, and economy as Parlier, this small rural development in the Central Valley near Bakersfield has put affordability and sustainability on the forefront of growth.

Freiburg, Germany

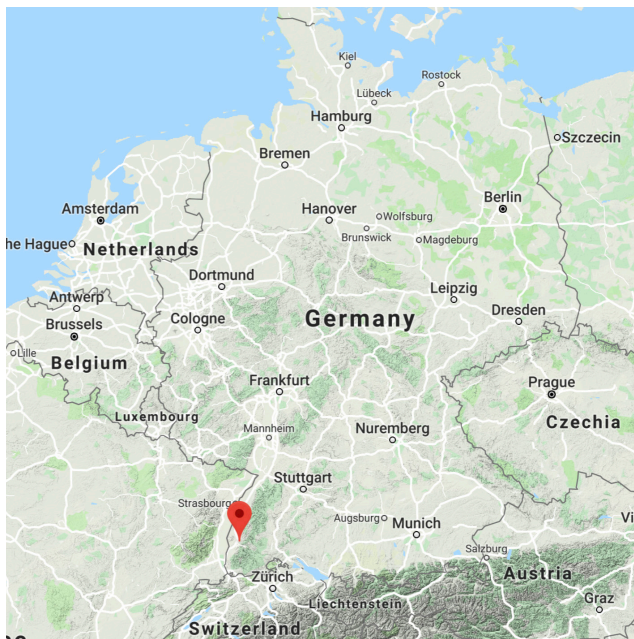


Figure 5: Location of Freiburg

Lamont, California

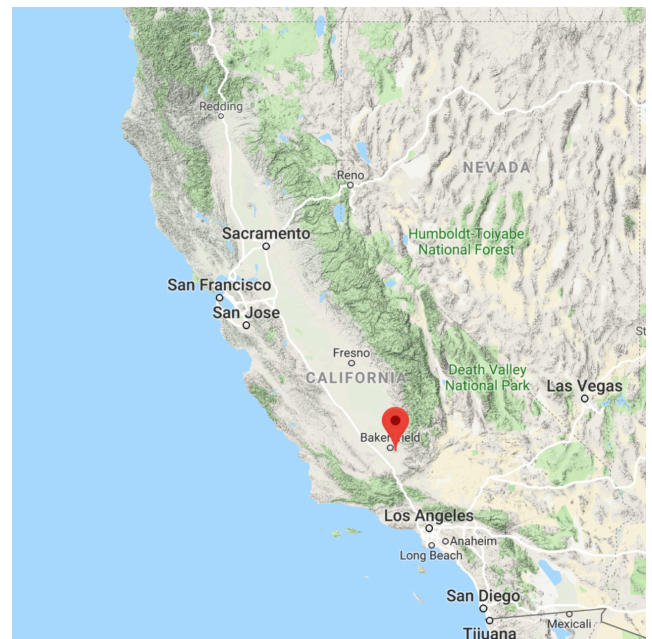


Figure 6: Location of Lamont

Freiburg, Germany

Situated in the southwest corner of Germany, at the edge of the Black Forest near the borders with France and Switzerland, Freiburg is a medium sized city of 227,590 people. According to Gregory (2011), with its large academic community, Freiburg was an early stronghold of the Green Movement in the 1970s after residents successfully protested against a nearby nuclear power plant. Furthermore, Freiburg's mayor and one-fourth of the city council are Green Party members making sustainability a top priority in their public policy. Freiburg promotes itself as a Green City—especially in the areas of transportation, energy, waste management, land conservation, and green economics. The city has also won various national and international environmental awards for its sustainable efforts (Gregory, 2011).



Figure 7: Sustainable Infrastructure in Freiburg

While Freiburg focuses on a variety of factors related to climate change, this report focuses primarily on energy production and efficiency. Freiburg's progressive energy policy has its roots in the early 1970s, when the state of Baden-Württemberg's plan to build a nuclear power plant in the town of Wyhl, just 30 km away, provoked intense protest among Freiburg residents. The plan was dropped in 1975, and in the years since, Freiburg has worked to become a model of sustainable energy development. Germany's national energy policy made the decision to phase out nuclear power while the 2001 federal renewable energy law, which requires utilities to buy power from independent producers, promotes such a policy as well. Freiburg's energy policy has three basic pillars: Energy saving, efficient technologies, and renewable energy sources (Yakoub, Elrayies, Abo El-Enien, & Mahmoud, 2019, p. 22).

In 1992, Freiburg's building design standards were amended to require that all new houses built on city land (or land sold by the city) use no more than 65 kilowatt-hours of heating energy per square meter per year, compared to the national standard of 75 kWh/m²/yr. This adds about 3% to the cost of the house, but the energy savings make it worthwhile in the long run. It is estimated that the standard reduces heating oil consumption from 12-15 liters to 6.5 liters per square meter (Freiburg Eco town, Germany). The entire new districts of Vauban and Rieselfeld were built according to this standard.



Figure 8: Solar powered homes

To improve energy efficiency in existing buildings, Freiburg instituted a support program for home insulation and energy retrofits. About 1.2 million Euros in subsidies were provided in 2002-2008, complementing about 14 million Euros of investments. Reduction of energy consumption averaged 38% per building (Gregory, 2011). In 2008, after the federal government revised its standard downward, so did Freiburg. A two-step revision was to be implemented in 2009 and 2011 to move new housing even closer to the “passive house” stan-

dard of just 15 kWh/m²/yr. These cost 10% more to build, but can achieve an 80-90% reduction in energy consumption.

While consumption of heating oil has decreased, Freiburg’s electricity consumption increased by 3% between 2004 and 2010. The goal had been a 10% reduction but missed its mark due to a population increase of about 1% per year and also to growing commercial and industrial demand. Per capita consumption actually went down by 1.6%.

Freiburg includes various sustainable uses including:

- The 19-story facade of the main train station
- The roof of the convention center
- The roof of the soccer stadium
- The Solarsiedlung (Solar Settlement) and its neighboring Solarschiff (Solar Ship) business park
- The Solar Factory (SolarFabrik)
- The “Heliotrope,” a structure that rotates to follow the sun
- The roof of the city’s waste management offices and its recycling center



Figure 9: Bicycle storage

Currently Freiburg’s 150,000 m² of photovoltaic cells produce over 10 million kWh/year. Furthermore, the 60 “plus-energy” homes of the Solar Settlement create more energy than they consume, and earn 6,000 euros per year for their residents (Öğretim, Solmaz, Bayam, & Gürler, p. 4). Solar thermal (mostly hot water) panels also cover 16,000 m², but their total contribution to Freiburg’s energy supply has not been quantified.

According to the World Wildlife Fund (2012), Freiburg’s success is credited largely to its democratic strength. Three keys are direct citizen participation, dynamic planning, and consensus (Thomas). It has evolved so that citizens are directly involved in land-use planning, the city budget, technical expertise committees, developing public information on sustainability, and as shareholders in local renewable energy (e.g. solar, wind). Due to a consensus on sustainable development across the major stakeholders, Freiburg has established clear cut goals for maintaining a sustainable city for years to come.

Self Help Enterprises

Self-Help Enterprises is a nationally recognized community development organization whose mission is to work together with low-income families to build and sustain healthy homes and communities (Self-Help Enterprises). Since 1965, Self-Help Enterprises' efforts have touched the lives of over 55,000 families living in the Central Valley. Self-Help Enterprises came to fruition in 1964 after a group of men and women helped three low-income families build their own homes in Goshen, California. It



Figure 10: Rancho Lindo Houses

has since grown exponentially in California to a nationally recognized community development organization serving the eight counties in the San Joaquin Valley – Fresno County, Kern County, Kings County, Madera County, Mariposa County, Merced County Stanislaus County and Tulare County (Self-Help Enterprises).

While Self Help Enterprises main priority is creating affordable homes for low-income communities, green building practices have always been central to their building model. By including features such as low volatile organic compound (VOC) paints and adhesives to promote healthy indoor air quality, Energy Star appliances, solar panels, energy efficient windows, and cool roof tiles, Self Help housing has been able to make sustainability affordable for an otherwise underrepresented population of California. One project in particular that has paved the way for sustainable housing in the Central Valley are the Rancho Lindo Apartments in Lamont, California near Bakersfield in Kern County. Completed in 2009, the Rancho Lindo Apartments are "Build It Green" certified and exceeds Title 24 by 37% (Self Help Enterprises). Established in 1978, Title 24 is a collection of energy standards that address the energy efficiency of new (and altered) homes and commercial buildings. Because energy efficiency reduces energy costs, increases reliability and availability of electricity improves building occupant comfort, and reduces impacts to the environment. This has made a big impact on the how lighting and other home fixtures are used in California homes (Energy Efficient Lighting, 2015).

Lamont, California is a census-designated place (CDP) in Kern County, California, located 9 miles south-southeast of downtown Bakersfield. The population as of 2010 was 15,120, up from 13,296 in the 2000 census. Similar to Parlier, the most common employment

sectors in Lamont, CA, are Agriculture, Forestry, Fishing & Hunting (3,037 people), followed by Health Care & Social Assistance (468 people), and Construction (389 people). Lamont's median annual income is also comparable to Parlier's at \$38,291, 28.13% lower than Kern County's median income of \$50,826 (DataUSA). The ethnic composition of Lamont, CA is also very similar to Parlier with 96.2% of residents identifying as Hispanic or Latino. This makes Lamont an ideal case study in analyzing affordable sustainability in Parlier and the Central Valley.

The Rancho Lindo Apartment complex is located within walking distance to schools, grocery stores, and a park. According to Mickelson (2016), all 44 units are exclusively targeted to low-income farmworker families earning less than 60 percent of the area median income (AMI). Nearly half of these units are limited to families earning less than 50 percent of AMI. Self-Help Enterprises also provides quality resident service programs at the incorporated Rancho Lindo community center. These programs are designed to enhance the everyday lives and futures of the residents, including an after-school program for children, financial fitness classes, computer literacy lessons, a free lunch program, nutrition classes, English as a Second Language (ESL) courses, and even Zumba-style exercise lessons (Enterprise).

With all of these amenities and sustainable uses, the \$12.9 million Rancho Lindo development was financed with \$2 million in HOME funds. HOME Investment Partnerships Program (HOME) is a type of United States federal assistance provided by the U.S. Department of Housing and Urban Development (HUD) to States in order to provide decent and affordable housing for low- and very low-income Americans. For Self-Help Enterprises and the rural, low-income communities of California's San Joaquin Valley, HOME is a vital investment in building vibrant and sustainable communities. The Rancho Lindo Apartments were also financed using Federal/State LIHTC, Bank of California L.P., USDA-RD Section 514 – all units of Rental Assistance, and NeighborWorks America (Self Help Enterprises). These programs have different income limits that can lead to apartments in the same property having different income requirements.



Figure 11: Rancho Lindo Playground

In addition to building new apartments and homes, Self Help Housing also utilizes green techniques in a Housing Rehabilitation program which updates and weatherizes older, dilapidated housing with new roofs, windows, appliances and other energy and cost saving upgrades. The rehabbed homes include radiant barrier roof sheathing, Energy Star appliances, upgraded attic insulation and windows and heating/cooling systems

that often exceed California's already stringent Title 24 building codes. Homes that are fully reconstructed through the Rehab program receive the same Universal Design elements included in Self Help Enterprises single family homes as well as the fire suppression sprinklers and carbon monoxide alarms (Self-Help Enterprises). This program is more tuned towards cities that are not looking for a new multi million dollar housing complex and want to upgrade their existing homes to be energy efficient on a budget similar to Parlier.

Since Rancho Lindo has both programs, the most restrictive of the income limits will apply for each unit. If the entire property is funded by LIHTC, the LIHTC income limit of 60% AMI would be used for all units. Apartments in properties with some units not funded by the LIHTC, but receiving Section 8 assistance, would be open to households making up to 80% AMI. Market rate units would have no subsidies or income restrictions (Affordable Housing Online).



Figure 12: Rancho Lindo Community Center

Energy

According to the National Climate Assessment, human influences are the number one cause of global warming, especially the carbon pollution we cause by burning fossil fuels and the pollution-capturing we prevent by destroying forests (Denchak, 2016). Climate change impacts are expected to exacerbate existing problems while continuing to impose new ones. The carbon dioxide, methane, soot, and other pollutants we release into the atmosphere act like a blanket, trapping the sun's heat and causing the planet to warm. This means more severe weather and higher average temperatures which will in turn lead to higher energy consumption in the form of air conditioning. These impacts pose an immediate and increasing threat to health of California's economy, environment, and people.

Addressing climate change at the local level is imperative to reducing the amount of greenhouse gases emitted by cities. Through the incorporation of resilient and sustainable adaptation strategies, cities can reduce their GHG emissions as they work towards a cleaner, more resilient future.

The City of Parlier's electricity and natural gas provider is Pacific Gas and Electric (PG&E), an American investor-owned utility with publicly traded stock. According to recent reports, PG&E is partnering with the County of Fresno and the Economic Development Corporation (EDC) to develop the Fresno Energy Watch program which helps small and medium businesses municipalities, and nonprofit organizations improve their energy efficiency. By increasing their energy efficiency, program customers can

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SUSTAINABLE ENERGY

Renewable energy is more popular than ever! Use this guide to find the one that's right for your next project.

Solar Power

What it is:	Main Benefits:	Possible Uses:
Solar Energy is from the sun. There are two types: • Photovoltaic: Sun's energy is turned directly into electrical energy • Solar Thermal: Captures the sun's energy as heat—producing steam and pushing a turbine to generate electricity	• Doesn't produce any air pollutants or carbon dioxide • Helps reduce stress on the grid and aging power production infrastructures	• New construction points for LEED certification • Renovation or retrofitting an existing structure to reduce annual energy cost and add value • Civil projects such as schools and street lighting

Wind Power

What it is:	Main Benefits:	Possible Uses:
Wind power converts the energy of the wind into electrical energy by turning generators in the wind turbine and can be used in two ways: • Mechanical (pumping water and turning machines) • To produce electricity	• No pollution at time of production • Easily scalable • High density of power compared to solar • A lot of wind resource in the U.S.	• Cities and counties can use wind as a way of producing energy • Offsetting costs of supplying energy to established facilities

Biomass Power

What it is:	Main Benefits:	Possible Uses:
Renewable energy from plants and animal byproducts, such as: • Wood and wood waste • Agricultural crop (sugar, corn, poplar trees) • Old garbage • Animal Waste	• Repurposes otherwise valueless material, reduces harmful emissions, is abundant, and can reduce dependence on fossil fuel for vehicle transportation	• Production plants at landfills • Vehicles and transportation • Heating and cooking

Hydro Power

What it is:	Main Benefits:	Possible Uses:
Hydro power is the largest renewable energy source for electrical generation in the U.S., accounting for 6% of all electric generation, but for more than half of renewable energy.	• Well established, massive power capability • Costs less than most energy sources • No emissions (greenhouse gases, combustion pollutants) • U.S. hydropower industry currently employs up to 300,000 workers, from project development to manufacturing	• Irrigation • Flood Control • Creating power

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Figure 13: Types of Energy

save money on their utility bill and energy while, benefiting the environment by conserving our natural resources and reducing greenhouse gas (PG&E, 2012).

In 2012, PG&E analyzed community-wide energy use data to help the program strategically deliver energy efficiency audits, incentives and financing tools to residential and small business customers (PG&E, 2012). This has become essential to Parlier's move away from fossil fuels and closer to meeting the goals set out in AB 32, the California Global Warming Solutions Act of 2006 which sets a goal for California to reduce its GHG emissions to 1990 levels by 2020 (Assembly Bill 32, California Global Warming Solutions Act of 2006, 2006).

The Clean Energy and Pollution Reduction Act (SB 350), establishes a goal for California to double state energy efficiency levels (State Bill 350, Clean Energy and Pollution Reduction Act, 2015). In an effort to meet these goals, PG&E has committed to both AB 32 and SB 350 to help lower GHG emissions through energy efficiency, demand response and solar installation. The City of Parlier is currently implementing policies and standards to reduce energy consumption including staggered or varied work hours, work at home options, facilities to improve public transportation and telecommunication improvements (City of Parlier, 2010). The City also hopes to encourage the use of energy conservation features and low-emission equipment for all new residential and commercial development. The high costs associated with large amounts of energy use in the area is an important incentive for these conservation efforts, but the high upfront costs of implementing them have slowed progress. There is currently no data for Parlier's specific energy usage amount.



Figure 14: Solar panels on roof

Solar

When the idea of solar first came to fruition, it seemed as though non renewable energy would be left in the past, what many did not know is how expensive it would be to integrate this revolutionary new system into our existing grid. Fortunately, in recent years, prices for solar systems have plummeted thanks to increased demand, mass production and intense competition among manufacturers. According to Solar Energy Industries Association (SEIA), California ranked first nationally in 2014 for installed solar electric capacity at 4,316 MW. California is now home to 2,226 solar companies (486 Manufacturers, 1,332 Installers/Developers, 989 Others) employing 54,700 people across the state (California Solar). SEIA has also reported that solar prices have fallen 47% over the last 5 years with a Growth Projection and Ranking of 14,683 MW over the next 5 years ranking first in the United States (California Solar).

Generous government financial incentives for solar power have also reduced the cost for homeowners, making a home solar electric system more affordable than ever before. In the following sections I will look at the various ways Parlier can introduce solar to its residents in an affordable and efficient way.

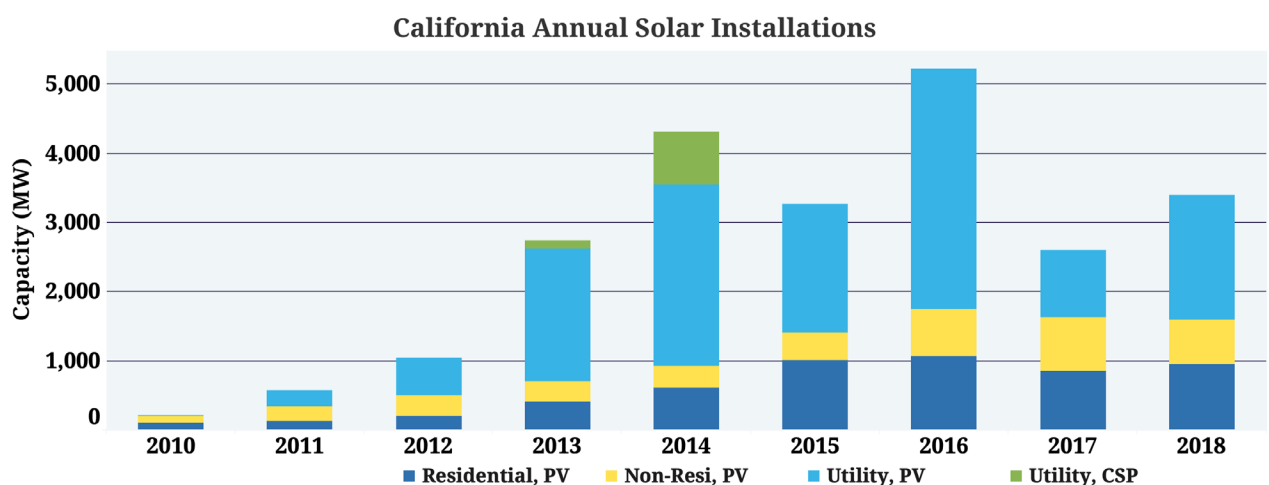


Figure 15: Annual Solar Installations

Solar Leasing

Since its initial burst in the 1970s, solar energy has spread remarkably slow, largely due to the high upfront cost of solar panels. Just five years ago, installing photovoltaic (PV) panels could cost \$40,000; today that same installment would cost \$25,000 to \$30,000 and take eight to 10 years to pay for itself, according to Tony Eason, owner of Elektron Solar (elektronsolar.com). In the last 10 years, some solar distributors such as Sunrun and SolarCity have initiated solar leasing programs which allows customers to pay as little as zero down on new solar panels. According to Goffman (2012), the company then installs and maintains solar panels in return for a monthly payment. Since the payment is typically less than the money saved, the customer ends up coming out ahead, perhaps by \$10 or \$20 a month which adds up in the long run (p. 1).

There are a variety of ways to pay for solar leasing programs. Some might pay zero down, full prepayment, or just about anything in between. This choice depends on the customer's financial situation and preferences, and many solar companies are more than willing to negotiate what works best for your situation.

When looking at leasing solar, establishing a payback time is critical. A zero-down lease means immediate, but modest, savings. Michelle Waldgeir, vice president of marketing for Astrum Solar, explains that for "homeowners who aren't looking to pay now," but are willing to wait for "payback in six or seven years, owning is very attractive" (Goffman, 2012, p.1). Another option is to prepay the entire lease, which generally costs less than buying. Typically from years 20 to 30 or 25 to 30 you'll start seeing the benefit of a purchase over a prepaid lease. However, buying may be the better option since the homeowner will come out ahead in the long run. Recently, many leasing companies are pushing

leasing because the profit margin is higher than an outright sale. They will then deliver a range of financial options for the customer, and with a good assessment, the customer can have a clear financial model of what this system will do over the next 25 years. Eason explains that "it really comes down to whether you can afford the out-of-pocket cost" (Goffman, 2012, p.1). Leasing in Parlier is a valuable option to becoming a healthier and more efficient city and with the amount of solar competition in California, residents are sure to find an option that works best for them.

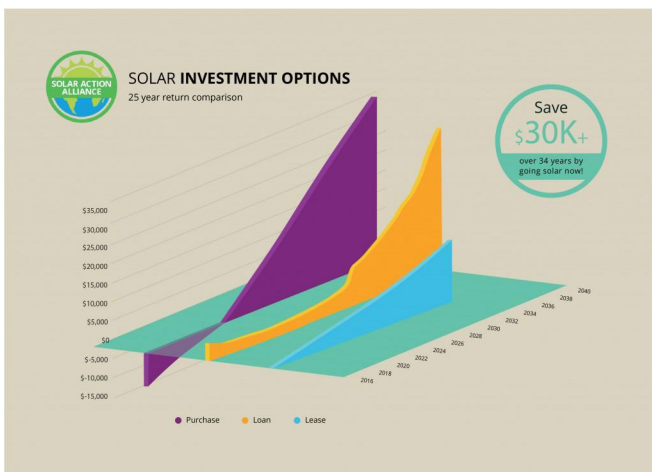


Figure 16: Solar purchase vs. loan vs. lease

Solar Pricing & Incentives

In order to understand what solar system works best for Parlier, we need to understand pricing and energy output. Most homes require a photovoltaic (PV) system in the range of 3,000 to 10,000 watts, and grid-connected systems today cost about \$5.50 per watt installed meaning a 5,000-watt system will therefore cost about \$27,500 (Chiras, 2012, p.4). Furthermore, Chiras explains that generous financial incentives may dramatically reduce the initial cost. For a 5,000-watt system, you'd receive an \$8,250 tax credit, and the system cost would drop to \$19,250 (p.4).

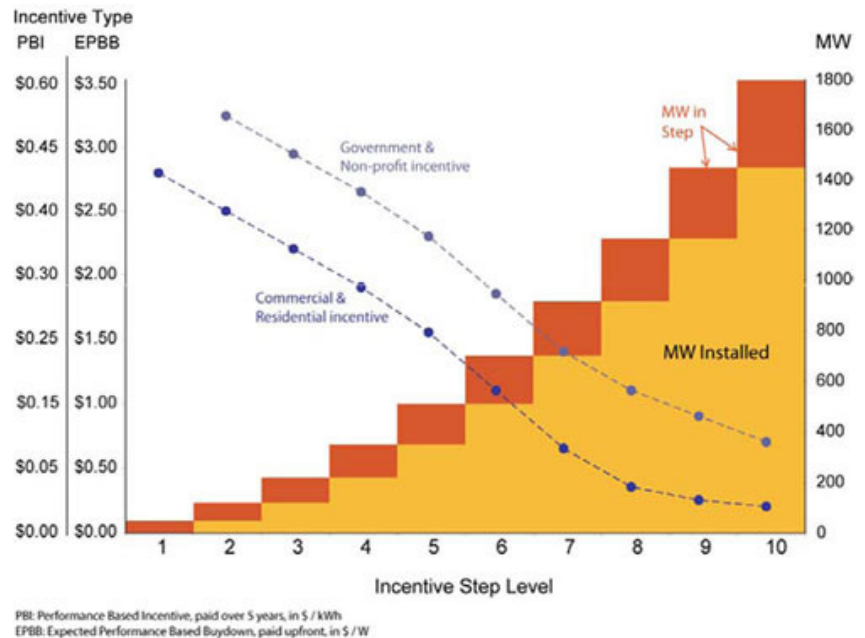


Figure 17: Solar incentive savings

Additional incentives are also available from forward-thinking states, either directly from the state or through utility providers. In parts of Missouri and Colorado, for instance, the investor-owned utilities provide a \$2-per-watt rebate. For a 5,000-watt system, a customer would receive a check for \$10,000 as soon as the system was operational. Thus, in these locations, the same 5,000-watt system would cost only \$9,250 (Zientara, 2018).

While solar companies make most of their income through customer's monthly payments, companies that take part in solar leasing programs may also make money through tax benefits. These benefits come when the solar company receives ownership of these credits and can "take these leases and repackage and resell" them on the financial market (Goffman, 2012). Buyers of tax credits are usually those most able to take advantage of them, so it could be a situation in which everyone wins (except the tax collector). In addition, businesses can also apply an accelerated depreciation to PV systems, meaning companies can depreciate the cost of the system in five years. This amounts to a tax benefit of 15 to 30 percent, depending on the business's tax bracket. A 15 percent benefit would lower the cost by \$4,125. With these incentives, the cost for a 5,000-watt PV system would be \$5,125 (Chiras, 2012, p.4). Businesses in rural areas can also apply for a 25 percent U.S. Department of Agriculture grant (REAP grant).

Passive Solar and Solar Tempering

The sun is the most valuable asset we have in creating affordable and sustainable homes. Not only is it an infinite source of clean energy, it also has natural properties that can cut down on heating and energy use from lights. Recent advances in building materials and techniques have convinced designers of cost-effective zero energy homes to reduce emphasis on full passive solar design in favor of “solar tempering.” Solar tempering provides a cost-effective alternative that involves taking advantage of solar heat gain without increasing window area or cost. There are many reasons for this shift among them are variable climate factors, the higher cost of low U-value/high SHGC windows, the benefits of having fewer windows, the high cost of thermal mass, and the risks of overheating if passive solar is not properly implemented (Twelve Steps to Affordable Zero Energy Home Construction and Design)

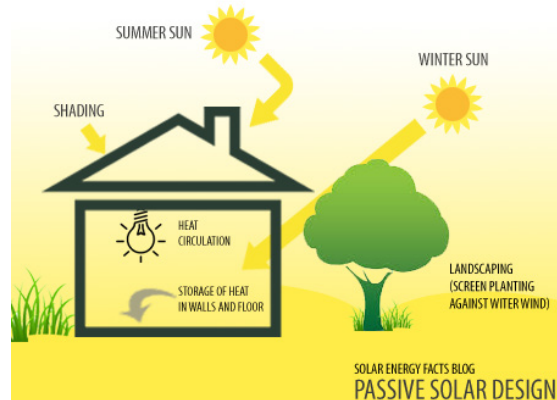


Figure 18: Passive solar diagram

Solar tempering works best when the common living areas and most windows face south letting in winter warmth and excluding summer heat. Solar tempering provides added warmth to the living areas and may reduce heating costs by 10% to 20% without added expense and without risk of overheating in summer.

The sun can also be a valuable in the form of natural lighting. With properly oriented windows and skylights, a home should be able to go the whole day without turning on a light. Natural lighting also has valuable health benefits including: boosted Vitamin D storage, higher productivity, improved mood, better sleep, and it benefits vision (Davis, 2012). By taking advantage of natural light, Parli-er residents will see benefits in not only their energy bill but in their mental and physical health.



Figure 19: Benefits of natural light

Wind

Wind energy is one of the oldest renewable energy sources in the world, and for a good reason. The Babylonians and Chinese were using wind power to pump water for irrigating crops 4,000 years ago, and sailing boats powered solely by the wind were around long before that (Energy Resources: Wind Power, 2012). Wind power was also used in Europe during the middle ages to grind corn and coining the term “windmill” in the process.



Figure 20: Windmills

According to USA.com, the average wind speed in Parlier California is 14.23 mph. Darvill Clara explains that the best places for wind farms are in coastal areas, at the tops of rounded hills, open plains and gaps in mountains. To be worthwhile, you need an average wind speed of around 15.53 mph. This puts Parlier just out of range for large scale wind energy production, but is still viable for small scale renewable energy production due to the cities low development and proximity to large plains with little wind blockage.

Wind energy is one of the most promising renewable energy resources for power generation, and rapid growth has been seen in its acceptance since the early 2000's. The most acceptable classification for wind turbines is by its axis of orientation: Horizontal Axis Wind Turbines (HAWT) and Vertical Axis Wind Turbines (VAWT). Historically, HAWTs are used in many countries for medium-to-large scale power projects, and a majority of commercial installations around the globe are solely based on these turbines (Kumar, Raahemifar, & Fung, 2018). HAWTs on the other hand are not recognized as a viable option to harness the energy of the wind in urban areas like Parlier, where the wind is less intense, much more chaotic and turbulent. VAWTs are suggested as a better choice for cities and isolated semi-urban areas in the Central Valley. Several attributes have been suggested for the large-scale deployment of VAWTs, e.g., good performance under the weak and unstable wind, no noise and safety concerns, and aesthetically sound for integration in urban areas (Kumar, Raahemifar, & Fung, 2018).

According to the office of Energy Efficiency and Renewable Energy, a non-profit organization working to promote sustainable energy solutions, wind energy is the cheapest form of new electricity generation available today. Recent technology innovations and market building incentives have helped to dramatically lower costs over the last 20 years and has made wind energy more available than ever before. When the first commercial-scale wind turbines were installed in the 1980s, wind generated electricity cost up to 30 cents per kilowatt-hour. Today, wind power plants can generate electricity for less than 5 cents per kilowatt-hour, a price that is competitive with new coal- or gas-fired power plants (Next-Generation Wind Technology).

Design

When researching how to make a home energy efficient, building and design techniques can be some of the most effective, affordable, and efficient ways of doing so. Design can include everything from the building envelope to home orientation, window size, and insulation. This chapter will look at the various factors of designing or retrofitting homes on a budget. In response to Parliers relatively small budget, this section will look primarily at retrofits to existing homes but will also lay some of the groundwork for new developments.



Figure 21: Sustainability diagram

Building Envelope

When designing a new home or looking to retrofit an existing structure, sealing the building envelope and creating an airtight environment that is resistant to outside temperatures should be one of the first things you look at. Air sealing a home is generally considered the most cost-effective way to reduce heating and cooling energy use, maintaining indoor temperature, and improving your comfort and indoor air quality.

According to Zero Energy Project, a non-profit educational organization whose goal is to help home buyers, builders, designers, and real estate professionals reduce their carbon footprint, high-performance homes should have a continuous air barrier that protects against the environment (Zero Energy Project). The key word here is continuous. The secret to continuity is to identify large sheets of material that already exist and bridge the gaps between them in order to completely seal the structural sheathing.

There are various methods to creating a continuous air barrier. Some are “homegrown” solutions based on skilled use of materials in the field, such as airtight drywall (ADA) and adhesive attachment (gluing) of the sheathing. While proprietary systems like SIGA membranes and ZIP Systems focus on prefabricated materials to be used in addition to conventional building techniques to seal a home or building, and are therefore slightly more expensive (Holladay, 2018)

In order to test your building envelope, one should set a goal for air changes per hour under 50 Pascals of pressure (ACH50) using a blower door test (Twelve Steps to Affordable Zero Energy Home Construction and Design). A pascal is a unit of pressure used to quantify internal pressure within a home, and is defined as one newton per square meter. During a blower door test, a machine is used to measure the airtightness of buildings. It can also be used to measure airflow between building zones, to test ductwork airtightness and to help physically locate air leakage sites in the building envelope. A typical airtightness goal for a cost-effective zero energy home would be from 0.6 to 2 ACH50 (Energy Vanguard).

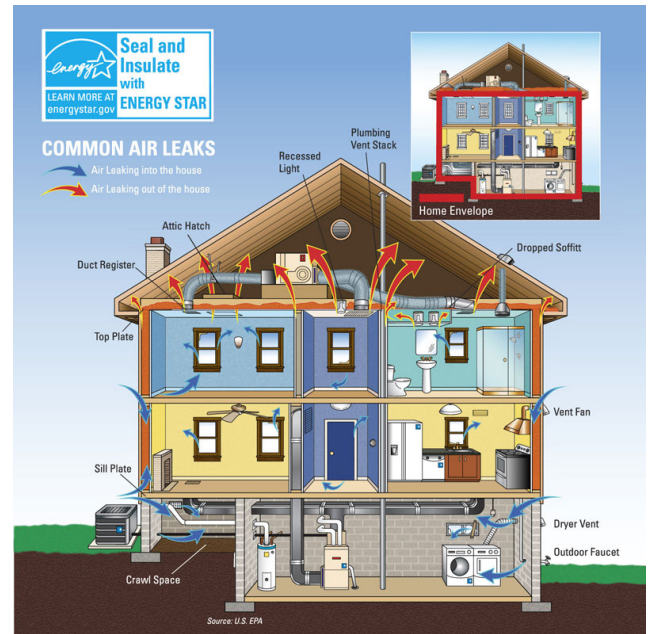


Figure 22: Building Envelope Diagram

Building Insulation

In addition to ensuring your building envelope is sealed, insulation is also an essential part to building a energy efficient home that will keep you cool in the warm months and warm in the cool months. Homes built after World War II—when many assumed that heating oil would stay cheap forever—were barely insulated at all, and Parlier is no exception (Schmidt, 2008, p. A27). It wasn't until after the oil shocks of the 1970s that builders began adding more insulation to their homes. Most conventional homes limit insulation to the inside of the frame; green homes also wrap the frame's exterior to create what's called a "thermal break." This is a critical step and if you insulate only between wall studs that you cover with wallboard, you haven't insulated any of the points where the studs meet the exterior wall. The consequence is that up to twenty percent of the house isn't really insulated at all. Providing a thermal break, or insulating around your studs, will maximize your coverage.



Figure 23: Insulation being installed

Insulations thermal resistance is rated on a value system known as an R-value. In hot climates like Parlier, the U.S. Department of Energy recommends unfinished attics have an R-value of 30 and floors have an R-Value of 19 to 25 (Insulation). Before you buy insulation, you should know what the R-value of your home or building should be and research the various types of insulation that will work for you.

Type	R-Value/inch	Price	Best Uses	DIY/Professional
Fiberglass Batts and Blankets	3.0-4.0	\$0.64 - \$1.19 per sq. ft.	Walls, floors, ceilings.	DIY
Rockwool Batts and Blankets	4.0-5.0	\$0.8 per sq. ft.	Walls, floors, ceilings.	DIY
Cotton Batts (aka "Blue Jeans")	3.5-4	\$0.74 - \$1.43 per sq. ft.	Walls	DIY
Loose-Fill Fiberglass	2.2-2.7	\$0.3 per cubic ft.	Ceilings	DIY
Loose-Fill Cellulose	3.2-3.8	\$0.31 per cubic ft.	Ceilings, enclosed existing wall or open new wall cavities, unfinished attic floors, hard to reach places.	Professional
Polystyrene SIPs	3.8 (EPS) to 5 (XPS)	EPS: \$6 for a 0.5-inch-thick, 4-by-8-ft. sheet XPS: \$15 for a 1-inch-thick, 4-by-8-ft. sheet.	New walls, ceilings, floors, roofs.	Professional
Polyisocyanurate SIPs	5.6-7.7	\$22 for a 1-inch-thick, 4-by-8-ft. sheet	New walls, ceilings, floors, roofs.	Professional
Open-Cell Polyurethane Spray Foam	3.5 to 3.6	\$0.44 - \$0.65 per board ft.	Walls, floors, ceilings.	Professional
Closed-Cell Polyurethane Spray Foam	6.0 to 6.5	\$1 - \$1.50 per board ft.	Walls, floors, ceilings	Professional

Figure 24: Insulation comparison

Appliances and Fixtures

In addition to the design for your home, the appliances and fixtures you use can have a huge impact on your energy savings. Identifying and purchasing the most energy efficient appliances at the lowest cost takes some effort but it can pay off in the long run. Similarly, making it easier for residents to deal with the energy use and phantom plug loads of their electronics is also challenging.

However, both efforts are critically important to the success of a energy efficient home where appliances and electronics have become the largest category of energy use – greater than the much reduced space heating and water heating energy use in these homes. Research is essential when looking for new appliances and it is important to balance efficiency with cost effectiveness in order to obtain the most affordable appliance for your home. In the following section, I will cover the 8 categories you should consider when trying to make your home more energy efficient.

Select Energy Star Appliances

Developed in 1992 by the US government and the Environmental Protection Agency (EPA), the Energy Star program is a voluntary measure that allows homes and businesses to find ways to reduce energy consumption and improve energy efficiency without the government stepping in and creating laws requiring it (Ryan, 2015). In response, appliance companies, car companies, home builders, and more have stepped in to create and promote more energy efficient products that carry the Energy Star logo on them. This has not only improved energy efficiency but has saved consumers an estimated \$295+ billion on their utility bills (Energy Star). Additionally, as of 2015, many Energy Star improvements come with a tax credit of up to 30% of the purchase price.

When searching for energy efficient appliances, you can look on the Energy Star Products page and select the most cost-effective models for appliances like refrigerators, and microwaves. In selecting appliances for a zero energy home, both cost and energy efficiency should be taken into consideration. Cost and energy features of appliances change frequently as new models are released, therefore it is important to stay up to date on the latest information as you decide what appliances you will use in you home.



Figure 25: Energy Efficient Appliances



Figure 26: Energy Star Logo

Fixtures

According to Energy.gov, energy-efficient light bulbs such as halogen incandescents, compact fluorescent lamps (CFLs), and light emitting diodes (LEDs) use about 25%-80% less energy than traditional incandescents and can last 3-25 times longer (How Energy-Efficient Light Bulbs Compare with Traditional Incandescents). While the initial price of energy-efficient bulbs is typically higher than traditional incandescents, newer bulbs cost less to operate, saving you money over the life of the bulb.



Figure 27: Energy Efficient Bulbs

Electronics

The biggest energy users in today's energy efficient homes are big screen TVs, gaming consoles, computers, and other electronics. Most electronics are energy hogs and almost all electronics have large "phantom loads" due to energy being used even when they are turned off. Buyers should consider purchasing the most energy efficient electronics available, install manual on-off switches, and use power strips for electronics in order to reduce these phantom loads. Install electric outlets in rooms where electronics are likely to be used so they can be turned completely off with a wall switch. Special switches are also available for turning off plug loads without prolonging the start-up time.

Microwave Ovens

Since their invention in 1942, the microwave oven has become significantly more energy efficient and faster at heating and cooking than traditional electric or gas ovens. Microwaves are also safe to have around your family because they do not use x-rays or gamma rays meaning they do not make food radioactive. Microwave ovens can cook food, but do not change the chemical or molecular structure of it (Microwaves, Radio Waves, and Other Types of Radiofrequency Radiation).

High RPM Washer with Cold Water

A front-loading high RPM clothes washer with a 1400 RPM spin cycle and a fan fresh option will take almost all of the moisture out of wet clothes without heat, minimizing the use of a dryer or time needed to line-dry laundry (Twelve Steps to Affordable Zero Energy Home Construction and Design). Most modern washers also have energy-saving cycles that use only cold water. Since hot water heating uses more energy, it makes sense to recommend cold water washing to zero energy home buyers.

Clothes Dryers

Standard electric or gas dryers use a considerable amount of energy and must be exhausted to the outside, creating the equivalent of a large air leak in the building shell. Outdoor clothes lines and indoor drying racks are cost effective but take longer than traditional dryers. In dry climates, indoor drying can also bring welcome moisture to household air, however, in a humid climate outdoor clothes lines are a better option.



Figure 28: Outdoor clothes drying

Heat Pump Dryers

If an automatic clothes dryer is needed, consider buying a heat pump condensing dryer. Using the same technology as refrigerators, and water heating heat pumps, heat pump clothes dryers (HPCDs) can be as much as 50% more energy-efficient than conventional electric resistance clothes dryers, and therefore have the potential to save substantial amounts of electricity down the line (Meyers, Franco, Lekov, Thompson, & Sturges, 2010, p.3). Heat pump clothes dryers have been used in Europe for many years but are new to the U.S. market. The models currently available are more costly than standard dryers, but may pay for themselves within about 5 years. Furthermore, as competition grows in this market, heat pump dryers will soon become the dryer of choice for households across the country.

Efficient Dishwashers

In selecting a dishwasher, ZeroEnergy recommends looking for those with an Energy Factor of 0.85 or greater. For example, the Bosch dishwasher is a highly energy efficient, water-saving dishwasher with an energy factor of about 1, however its price tag may make it less cost effective than other, somewhat less efficient, Energy Star dishwashers. It is important to do research into what dishwasher works best for your household and budget.



Figure 29: Energy Efficient Bosch Dishwasher

Induction Stove Tops

According to ZeroEnergy Project, an induction cooktop heats 30% more efficiently than a gas range and about 12% more efficiently than an ordinary electric range (Twelve Steps to Affordable Zero Energy Home Construction and Design). Induction cooktops also heat faster than traditional electric ranges and significantly faster than gas ranges since they heat the molecules in the pan rather than the cooktop itself. Gas stoves also create indoor air pollution that often exceeds EPA limits for indoor air quality, making it best to avoid installing them in very airtight homes.



Figure 30: Various energy efficient appliances

Appliance Size

When building a smaller house as part of your energy efficiency strategy, consider selecting smaller appliances. When the building itself costs hundreds of dollars per square foot, shaving a few square feet from the total can save thousands of dollars in construction costs. Similarly, a 20-cubic-foot refrigerator uses less energy, square footage, and purchasing power than a 30-cubic-foot model. You may also want to consider downsizing the dishwasher or switching to a drawer-type dishwasher to maximize efficiency.

As discussed in the site description section, the median age among Parlier residents is 25.9-years old, compared to the national median age of 38 years old. This indicates that the population of Parlier is relatively young and willing to adapt to the changing world around them. According to the United States Census Bureau (2010), about 37% of the population is under 18 years of age and the City's three largest age groups by population are 1) 9-years old or younger 2) 20 to 29-years old and 3) 10 to 19-years old. Peer education is an understudied yet valuable strategy for sustainability educators in shifting youth to take action towards a sustainable future. Committed and action-competent young people provide a valuable force which can influence change through fresh, optimistic views on sustainability. Keys to environmental educators more effectively promoting and supporting youth action are improving understanding of the personal and contextual factors associated with youth taking action, and developing educational strategies that are effective in facilitating youth action (De Vreede, Warner, & Pitter, 2013)

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The GAP focuses on generating action along five priority areas. These areas were developed to advance policy, transform learning and training environments, build the capacities of educators and trainers, empower and mobilize youth and accelerate sustainable solutions at a local level (UNESCO). The Education for Sustainable Development (ESD) program was created to provide people at all levels of education, but in particular youth, with the skills and knowledge necessary to impart values of sustainable development (UNESCO). The ESD program is essential for preparing youth for the ever growing green industry and for adapting to the world's ever changing cultural and physical environments. However, in order for ESD to work in Parlier's existing education system, the concept must be strengthened and promoted at all educational levels from preschool to vocational training. This means mainstreaming education for sustainable development into relevant national education policies, and developing effective mechanisms to link green growth labor market objectives to educational programs, particularly through technical and vocational education and training.

While UNESCO acts as an example of the sustainable education effort in Europe, the Center for Ecoliteracy based out of California is looking at education on a local level specific to California's problems. Working at multiple scales with local, regional, and national programs, Ecoliteracy provides education on everything from ecology to food and system changes (Ecoliteracy). One initiative, California Food for California Kids supports systems change by improving children's health, education, and the state's economy while teaching students where food comes from and how it reaches the table. The California



Figure 32: Agricultural education

Food for California Kids is a comprehensive statewide initiative designed to increase students' ecological understanding about where their food comes from and how it reaches the table, improve children's health and academic achievement, celebrate the abundance of California agriculture, enhance the state economy, and benefit the environment (Ecoliteracy).

Ecoliteracy is also at the forefront of system changes providing information on California's shift towards renewable energy on a local and regional scale. The American Association for the Advancement of Science defines a "system" as "any collection of things that have some influence on one another." Individual things – like plants, people, schools, communities, and watersheds – are all systems of interrelated elements (Seven Lessons for Leaders in Systems Change, 2011). Furthermore, Ecoliteracy provides extensive online resources for educators covering various aspects of sustainability. Through relatable content, youth oriented education, and free resources, Ecoliteracy has become a standing example of place specific sustainable education in California's Central Valley and can be used by Parlier in its shift towards a greener future.

What about Parlier?

Throughout this report I have shown that affordable sustainability is possible in low income communities like Parlier. From Self-Help Enterprises who has been providing affordable and sustainable housing to the Central Valley with a do it yourself (DIY) mentality for the last 30 years, to solar leasing programs that allow anyone access to clean renewable energy there are a plethora of techniques we can use to guide Parlier into a sustainable future. This report has focused on making sustainability less intimidating to Parliers community through practical and affordable uses. However, while this report should act as a guideline for Parlier and other low-income communities in the Central valley, it is up to the public to take action against climate change. In this section I have outlined eight steps Parlier residents should consider when building towards a greener tomorrow.



Figure 32: Sustainable Education Diagram

1. Utilize green building techniques in all new developments

While, many don't want to spend money on sustainable and energy efficient uses in their new home, it is important to encourage new homeowners to allocate funds when possible to see a payout in the long run. It is easy for one to pass up double paned windows for single paned windows or buy a large television that isn't Energy Star rated because it is cheaper, but these choices will hurt your wallet and the earth in the long run and should therefore be examined. Organizations like LEED and the US Green Building Council have made it easier than ever to assess your homes energy efficiency through materials and design. In order for Parlier to become greener, it is essential for developers, policy makers, and Parlier residents to know when and where sustainable uses can be implemented when developing the City.

2. Existing buildings should implement green building techniques where possible

Since most of Parlier's homes were built pre-21st century, most of them are lacking many of the energy efficient uses described throughout this report. Self-Help Enterprises has shown us that affordable and sustainable retrofits are possible in low income areas of the Central Valley through government subsidies and a DIY mentality. Retrofits and renovations do not have to be done through a developer or similar entity, instead, residents should learn how to make changes to their homes without outsourcing labor. Sealing your home and adding insulation is an example of a low cost DIY technique that can have serious savings down the line.

3. Educate homeowners about how they can become green citizens.

An essential part to making Parlier a sustainable and energy efficient city is educating its residents on the effects of climate change. While infrastructure, design, and appliances play a large role in decreasing residential energy use, without changing residents mentality about their effect on the climate, Parlier will fall behind.

Through community classes like those at Rancho Lindo or through public outreach events that highlight sustainability, Parlier can become more educated and begin to change not only their mentality, but the mentality of generations to come.

4. Capitalize on Parliers youth

Self-Help Enterprises Rancho Lindo Apartments provide quality resident service programs at the incorporated Rancho Lindo community center designed to enhance the everyday lives and futures of the residents. These programs include an after-school program for children, financial fitness classes, computer literacy lessons, nutrition classes, and English as a Second Language (ESL) courses (Self-Help Enterprises). The median age among Parlier residents is 25.9-years old, compared to the national median age of 38 years old with about 37% of the population being under 18 years of age. Through community outreach events conducted by Cal Poly students, it was found that Parlier residents (especially youth) want more programs in their schools and community centers (California Polytechnic State University, CRP 410, 2018). In order to have a lasting impact on Parlier, community centers and schools should integrate “Green Living” classes that help Parliers youth create and maintain a sustainable city.

5. Understand that residents do not need to get everything from a business

Practicality and affordability go hand in hand when transitioning a low-income city like Parlier into a healthy green city. Businesses like Self-Help Enterprises have shown us that there is value in practical education. By teaching residents about the techniques necessary to build affordably and sustainably, Parlier residents can cut out labor costs by making the changes themselves.

6. Make changes to daily habits

Expanding upon practical lifestyle changes, Parlier should also reimagine how they spend their time. Through community outreach conducted by Cal Poly students, it was found that Parliers youth does not spend enough time outdoors. In fact, most high school students explained that they usually spend time at home with friends playing video games or watching TV because there is not enough for them to do at public parks (California Polytechnic State University, CRP 410, 2018). By playing outdoors instead of playing video games, or by opening the blinds instead of turning on a light, Parlier residents can drastically reduce residential energy use.

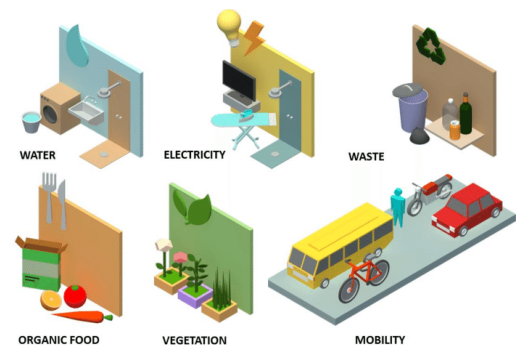


Figure 33: Sustainable uses

7. Utilize government funding and subsidies wherever possible

The funding is there, we just need to know where to find it. Whether it be through area specific programs like County of Kern HOME Program, and NeighborWorks America or through government programs like the Low Income Housing Tax Credit (LIHTC) program or HUD, residents of Parlier should learn when, where, and how to use these programs in order to maximize their sustainability.

8. Develop green building guidelines and standards

Though research done by Cal Poly student to update Parlier's General Plan, we learned that there is little to no regulation for sustainable and energy efficient development (California Polytechnic State University, CRP 410, 2018). By developing guidelines for new and old development, the city of Parlier can maximize efficiency by adopting a set standard for all development within the city and the sphere of influence. The guidelines should be integrated into the existing housing Element of the General Plan for all new development projects and include:

1. Demographic and community background information
2. Data on energy use, conservation, climate, greenhouse gases and air quality
3. Guidelines for new and old development including:
 - Energy: type, use, leasing programs, incentives, etc.
 - Design: Architecture, location, orientation, building materials, size, etc.
 - Appliances and Light Fixtures: types, size, efficiency, location, etc.
 - Land Use: location of new structures, adjacent uses, codes, etc.

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