SPACE CITY SOLAR SYSTEMS:

Providing Detailed Solutions for the Integration of Solar Technology

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Executive Summary

This report conducts an assessment of Texas' current policies regarding financial incentives, and programs which are currently available to Houstonians regarding solar photovoltaic (PV) systems. The purpose of this report is to educate people on the benefits of installing a solar PV system, encourage community involvement in solar PV projects, discuss solar technology, and ultimately provide a policy plan to be implemented in order to receive the greatest and most beneficial impact for the greater Houston area.

There is a lot of misinformation, or lack of education, when it comes to solar PV systems. This report seeks to address these concerns, and provide a detailed analysis into various aspects of the solar industry. In this report we address the monetary side, which relates to the cost and maintenance, as well as the environmental impacts and societal implications of installing a PV system.

Upon researching each one of these topics thoroughly, and by reaching out to various community leaders, such as the Mayor of Houston Sylvester Turner's office, different solar societies, such as Houston's Solar Society, and through speaking with many solar installation and production companies in Houston, this report was able to clearly address and identify the key obstacles that affect a person's or a small business' ability to install a solar PV system.

Ultimately, this report will demonstrate to the reader that a solar PV system can be affordable to install and maintain, and provide a significant financial return for the system's owner.

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Background

Introduction

Since the discovery of the photovoltaic effect in 1839 by Edmund Becuerel, a French experimental physicist, people have been interested in a way to harness the Sun's seemingly limitless supply of energy [1]. Over the course of history, the United States, and in particular Houston, TX's history, there have been many initiatives taken to mobilize citizens and their governments toward sustainable communities.

Over the past 60 plus years there have been many economic instruments used to affect environmental policy in the Houston area. The financial tools help incentivize environmentally improved behavior, and disincentives damaging behavior. Such economic instruments include taxes, charges, subsides, tradable permits, deposit refund schemes, and performance bonds [2]. Economic instruments should be part of the structure of a community's management, and should reflect the wider objectives of environmental, economic, social, and ethical impacts of a community. In order for communities in Houston, and all over the United States, to integrate solar PV systems into their energy consumption people need to be aware of the range of policy initiatives that are available to them. This can be achieved through community involvement in the Texas chapter of the Solar Energy Society, and by rewarding people with a myriad of economic incentives that are already in place, and through the adoption of this reports recommendations.

The various financial incentives are great, but in a time of financial uncertainty the focus should be on how to appropriate the funds in the most effective way. With 61% of Houstonians making less than or equal to $60,000 annually [3], and 53% of Houstonians renting instead of

owning a home [4], the cultivation of financial incentives for the property management industry and community solar projects will help to increase their installation.

Another topic that needs to be addressed, especially for the Houston area, is how to avoid demonizing the Oil and Natural Gas industry. In 2013 close to 400,000 people living in the Houston area were employed by the Oil and Natural Gas industry [5]. This means that out of a population of about 2.196 million people [6], approximately 20% of the Houston community is dependent on the oil and natural gas industry. Despite the recent price drops in the oil and gas market, and thousands of people losing their jobs, the city of Houston and the state of Texas are not in any way prepared to make the complete switch from fossil fuels to 100% renewables. We do not have the infrastructure to support the switch, and making that switch would cause 20% of Houston's population to be without a job. A better way would be to showcase how solar is a great compliment to a person's usual energy consumption.

Environment

Solar energy systems derive clean and pure energy from the sun. Installing solar panels in your home helps combat greenhouse gas emissions and reduces our collective dependence on fossil fuel. Electricity is traditionally generated from fossil fuels such as coal and natural gas [7]. The utilization of solar energy to generate electricity will help to reduce our carbon footprint by not producing the waste and pollutants that are associated with traditional power plants. Solar energy does not contribute to global warming, acid rain, or smog, and therefore it actively helps to decrease harmful greenhouse gas emissions. Less pollution in the air means cleaner air for us to breathe, which increases the quality of life for people. Solar energy is currently providing only a small percentage of our total energy use, but by adopting these policy recommendations

we will achieve the 15% green energy target by 2020, as well as the global targets of 20%. Solar power is quiet; solar energy systems convert sun light into electricity without making any noise [8]. The sun provides a seemingly limitless resource for generation of clean and sustainable electricity without the toxic pollution or greenhouse gas emissions. The potential environmental impacts associated with solar power are: land use and habitat loss, water use, and the use of hazardous materials in manufacturing. All of which can vary greatly depending on the technology. Solar power technology can be broken down into two broad categories: photovoltaic (PV) solar cells and concentrating solar thermal plants (CSP). The scale of the system can range from small to large, such as a small distributed rooftop PV array to a large utility-scale PV and CSP projects. The size of the solar project also plays a significant role in the level of environmental impact [8].

Solar PV cells do not use water to generate electricity. However, as in all manufacturing processes, some water is used to manufacture solar PV components. Concentrating solar thermal plants (CSP), like all thermal electric plants, require water for cooling. Water use depends on the plant's design, location, and the type of cooling system that the power plant employs. CSP plants that use wet-recirculating technology with cooling towers withdraw between 600 and 650 gallons of water per megawatt-hour of electricity produced. CSP plants with once-through cooling technology have higher levels of water withdrawal, but lower total water consumption. This is because water is not lost as steam. Dry-cooling technology can reduce water use at CSP plants by approximately 90%. However, the tradeoffs to these water saving features are higher costs and lower efficiencies. In addition, dry-cooling technology is significantly less effective at temperatures above 100°F. Many regions in the United States that have the highest potential for

solar energy also tend to be those with the driest climates, which means that careful consideration of these water tradeoffs is essential [9].

The PV cell manufacturing process includes a number of hazardous materials, most of which are used to clean and purify the surface. These chemicals, similar to those used in the general semiconductor industry include: hydrochloric acid, sulfuric acid, nitric acid, hydrogen fluoride, 1,1,1-trichloroethane, and acetone. The amount and type of chemicals used depends on the type of cell, the amount of cleaning that is needed, and the size of silicon wafer. Workers also face risks associated with the inhalation of silicon dust. Thus, PV manufactures must follow U.S. safety guidelines to ensure that workers are not harmed from the exposure to these chemicals during the manufacturing and waste disposal. Thin-film PV cells contain more toxic materials than those used in traditional silicon photovoltaic cells, and they include: gallium arsenide, copper-indium-gallium-diselenide, and cadmium-telluride [11]. If not handled and disposed of properly, these materials could pose serious environmental and public health threats [9].

While there are no global warming emissions associated with the generation of electricity from solar energy, there are emissions associated with other stages of the solar life-cycle. These include: manufacturing, materials transportation, installation, maintenance, and decommissioning/dismantlement of the solar power system. Most estimates of life-cycle emissions for photovoltaic systems are between 0.07 and 0.18 pounds of carbon dioxide equivalent per kilowatt-hour, and for concentrating solar power range from 0.08 to 0.2 pounds of carbon dioxide equivalent per kilowatt-hour. In both cases, this is far less than the lifecycle emission rates for natural gas (0.6-2 lbs of CO2E/kWh) and coal (1.4-3.6 lbs of CO2E/kWh) [9].

Depending on the location a larger utility-scale solar facilities can raise concerns about land degradation and habitat loss. Total land area requirements vary, and are dependent on the technology, topography of the site, and the intensity of the solar resource. Estimates for utility-scale PV systems range from 3.5 to 10 acres per megawatt, while estimates for CSP facilities are between 4 and 16.5 acres per megawatt. Unlike wind facilities, there is less opportunity for solar projects to share land with agricultural uses. However, land impacts from a large utility-scale solar systems can be minimized by placing them in lower-quality land locations such as brownfields, abandoned mining land, or existing transportation and transmission corridors. Smaller scale solar PV arrays, which can be built onto homes or commercial buildings, have minimal land use impact [10].

A myth recently surfaced in a sequel to Freakanomics, called Superfreakanomics. Some people were very disappointed with the authors, who created quite a stir with their first book, which was written by Nathan Myhrvold, the former Chief Technology Officer of Microsoft. The prospect that solar panels, the main symbol of renewable energy, could be contributing more to greenhouse gas emissions would certainly be a shocking revelation. In addition to the anthropogenic greenhouse gas emissions, which disrupt the earth's energy balance by acting like a thermal insulating “blanket” around the planet, and causes a change in earth’s surface albedo. Albedo is just a fancy word for reflectivity, and the problem with changing the earth’s reflectivity has had a dramatic impact on the Artic Sea. The Arctic Sea ice acts like a giant mirror, reflecting sunlight back into space, but as the sea ice disappears it exposes the dark blue of the Arctic Ocean, which has a much lower albedo [11]. So, not only is the Arctic Sea melting caused by climate change, but it also contributing to it.

The color of photovoltaic panels range from blue to black hues. They are smooth and have an albedo around 0.3, but it is not the albedo itself that matters, it is the relative change in albedo from the status quo. Since most solar panels are roof-mounted, and most roofs are covered with dark tar and shingles, covering the roof with solar panels may actually represent a positive change in reflectivity. This brings up a great theoretical question: If the panels are mounted on a perfectly reflective surface and the solar panels absorb 30% of the solar energy that hits them, then since the average insolation (the amount of the sun's energy hitting the earth) is approximately 6 (kWh/m2)/day [11], it would mean that on an average day the solar panels would absorb 1.8 kWh per square meter per day. The same solar panel, assuming a 15% efficiency would generate 0.9 kWh of electricity per square meter per day [11].

A typical electricity generating power plant operates with an efficiency of 31%, meaning that 2.9 kWh worth of fuel, which is approximately 10,000 BTU, is needed for combustion to generate 0.9 kWh of electricity. The power plant directly adds approximately 1.6 times more heat to the atmosphere than the solar panels [11], and keeping in mind that the numbers for the solar panels are overestimates while the numbers for the power plant are much more realistic. Now to address the greenhouse gas emission portion of the myth when it comes to solar power systems. Naturally solar panels don't generate any greenhouse gas emissions during electricity production, but coal-fired power plants do. They emit about 2 pounds of carbon dioxide for every kWh [11]. The CO_2 builds up in the atmosphere, and contributes to global warming [11]. In conclusion, not only do solar panels add less heat to the atmosphere, but they also don't emit any greenhouse gasses.

Solar energy produces no air or water pollution or greenhouse gases. However, it has some indirect impacts on the environment. For example, the manufacturing of photovoltaic cells

(PV) produces some toxic materials and chemicals [12]. Ecosystems can also be affected by solar systems. Water from underground wells may be required to clean concentrators and receivers, and to cool the generator, which may harm the ecosystem in dry climates [12].

According to the Union of Concerned Scientists, each of these byproducts is associated with known environmental challenges including climate change, acid rains, smog and contaminated fisheries [13]. Solar panels can reduce these harmful effects by lowering energy demands from these fossil fuel power plants. Even if solar panels were only used to power household lighting, and if applied across a number of homes, solar panels would lead to a significant decrease in the emission of these dangerous byproducts. Using solar energy may also negatively impact the environment in other ways; the toxic materials and chemicals that are used in the manufacturing process of photovoltaic (PV) cells, which are used to convert sunlight into electricity and transfer heat, are potentially hazardous. The U.S. environmental laws regulate the use and disposal of these types of materials.

As with any type of power plant, large solar power plants can affect the environment where they are located. Clearing land for construction and the placement of the power plant may have long-term impacts on plant and animal life by reducing habitat areas for native plants and animals. Power plants may require water for cleaning solar collectors or concentrators and may require water for cooling turbine-generators. Using ground water or surface water in some arid locations with significant solar potential may affect the ecosystem. In addition, birds and insects can be killed if they fly into a concentrated beam of sunlight created by a solar power tower [14].

Society

There are many community planning tools available to stimulate a community's involvement such as community building problem diagnosis, which allows for the exchange of

communication in a community, and helps the people of a community to be a part of the decision making process. There are many other well-known community planning tools such as: Community Meetings, Brainstorming, Field Trips, Media Campaigns, Open Houses, and Community based Workshops. All of which will help to communicate and address the benefits of solar, and help builders get a better understanding of the financial and social limitations of the communities that they are developing. While the above mentioned community involvement programs are well known, and have a proven track record, people living in today's society tend to be extremely busy, and people do not always have the time to make it to such events, which is why figuring out other ways of stimulating a community involvement participation for a community solar project are needed.

The establishment and development of community based apps and social media postings would be a great way to get the word out about a community solar project. This is an essential part of the policy initiative. With 91% of adults owning a cell phone with Internet access in 2013, and those numbers continuing to grow [15], app's such as "Next Door" allows communities to exchange communication on a myriad of topics, and are essential to engaging a community's involvement in a solar project. Apps and Social media outlets would be a great way to address a specific community's concerns with regards to a solar project. It would provide people a place to voice their opinions and concerns about a project, and it would allow leaders the ability to address each individual's the unique concerns. It would also provide a platform upon which a community could have gatherings like round tables to discuss issues, allow for sustainable development auditing, and provide them with the ability to set sustainable development targets that need to be met in order to make sure the community solar project stays on target with its development.

Opposition

The top argument against the implementation of a solar PV system is the up-front cost, and the misinformation and/or lack of knowledge with regards to solar PV systems. A large part of the population in the US believes using solar power to generate electricity is a new concept that has only been around for the last 30 to 40 years. This helps to insinuate that the price tag of such technology would be very expensive to install and maintain [16]. With the many financial incentives a person has available to them such as: various tax credits, rebates, performance payments, property tax exemptions, and sales tax incentives. A person installing a solar PV system on their home would end up with close to 50% of their installation subsidized [17]. Couple this with the rising utility costs, and the homeowner/renter could see a return on their investment in as low as 5 years [18]. Just like with any investment, a return takes time, and if a person cannot afford to wait that period of time they should not invest in a large project alone, but rather a community solar, like the one we will be recommending in this report, to help mitigate their cost.

By installing a solar PV system, a person is not only helping the environment, but they are also helping the economy by creating jobs. According to the Bureau of Labor Statistics, PV installation jobs are projected to grow 24% from 2014 to 2024, "much faster than the average for all occupations" [11]. The United States solar industry experienced another record-breaking year in 2015, with 7,260 Megawatts of solar to reach 27.4 Gigawatts of total installed capacity, which is enough energy to power 5.4 million American homes [20]. Table 1, below, illustrates the Texas Solar Jobs growth from 2013 to the expected value for 2016.

Table 1: TEXAS SOLAR JOB

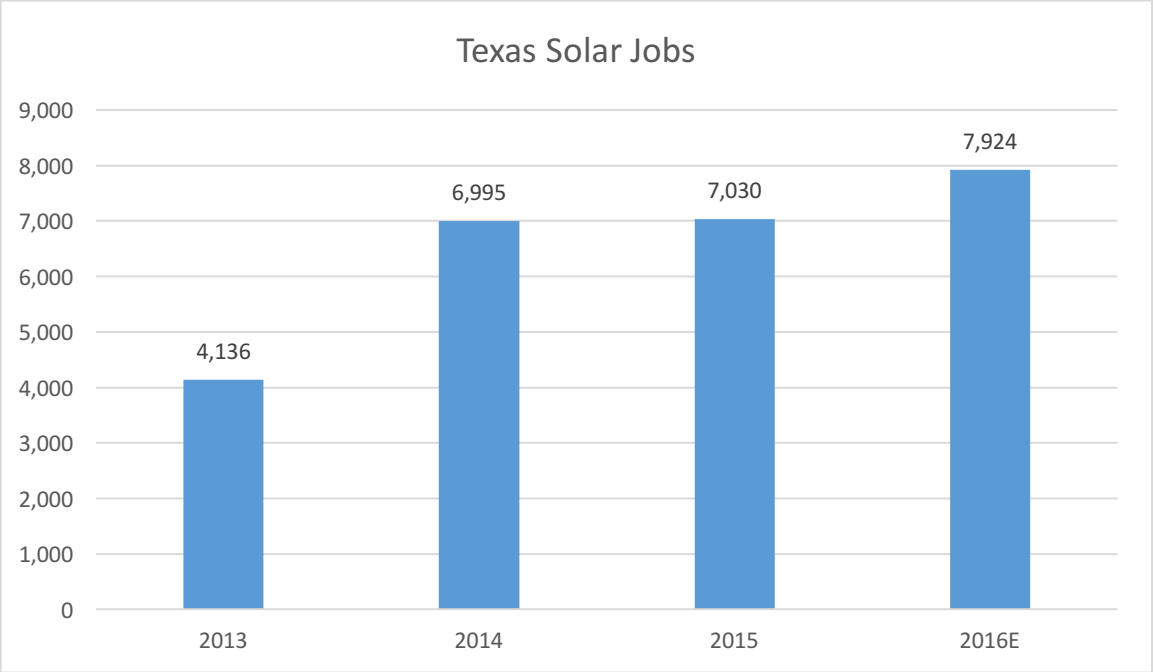

Table 2, below, compares the diversity of the Texas Solar Workforce to that of the total workforce in Texas, as well as the total US Solar workforce.

Table 2:TEXAS WORKFORCE COMPARISON

	Texas Solar Workforce	**Texas Overall Employment**	**U.S. Solar Workforce**
Women:	19.7%	44.5%	23.8%
African-American:	4.8%	22.8%	5.1%
Asian or Pacific Islander:	10.5%	4.6%	8.6%
Latino or Hispanic:	20.6%	37.5%	11.3%
Older Workers (55+):	14.9%	18.6%	18.6%
Union Members:	0.4%	-	5.5%
Veterans of the US Armed Forces:	8.6%	7.1%	8.1%

The Texas solar workforce is less diverse than the state's workforce, but even though it lacks diversity it still generates jobs, which help boost and stimulate local economies in Texas [21]. According to the Bureau of Labor Statistics, the top industries that employ solar experts are:

- Plumbing, Heating, and Air Conditioning Contractors, with an annual income of $41,520.
- Power and Communication Line and related Structures, with an annual income of $38,750.
- Electrical Contractors and Other Wiring Installation Contractors, with an annual income of $38,570.

The next significant argument against solar PV installation is upkeep and maintenance costs associated with a PV system. The public's perception being that the technology is relatively new, and that it is extremely intricate and very technical has lead people to believe that a solar PV system is very expensive to maintain. As of August 2013, the National Renewable Energy Laboratory, NREL, found the costs for electricity generating technologies such as a solar PV system to be (see Table 3, below):

Table 3:MAINENANCE AND COST OF PV SYSTEM

Type	Mean Installed Cost ($/kW)	Installed Cost Std. Dev (+/- $/kW)	Fixed O&M ($/kW-yr)	Fixed O&M Std. Dev. ($/kWh)	Lifetime (yr)	Lifetime Std. Dev. (yr)
PV<10 kW	$3,910	$921	$21	$20	33	11
PV 10-100kW	$3,819	$888	$19	$18	33	11
PV 100-1,000 kW	$3,344	$697	$19	$15	33	11
PV 1-10 MW	$2,667	$763	$20	10	33	9

Table 3, above, helps to illustrate the affordability of operating a solar PV system. It is not as financially cumbersome as a person might have originally thought. The technology has been around for 60+ years, and due to the length of time that it has been around there is a wealth of information on operating and maintaining a solar PV system. One company that has provided a comprehensive operating and maintenance manual is Next Phase Solar Inc, which was written by Josh Haney and Adam Burstein. Their manual titled, "PV System Operations and Maintenance Fundamentals" provides consumers with step-by-step trouble shooting, warranty information, the basics about solar PV systems, safety information, routine maintenance, and much more. The link to their pdf is provided below:

http://www.solarabcs.org/about/publications/reports/operations-maintenance/pdfs/SolarABCs-35-2013.pdf

This is a great resource for any person who is thinking about installing or maintaining a solar PV system. The literature provided goes hand in hand with the next major obstacle to solar, which is the lack of general knowledge about solar PV systems. This lack of knowledge helps to keep solar as a "pie in the sky" dream, and not a real option. From reaching out to many friends and family on social media, and through researching environmental public polling this report has found that people are mainly concerned about the initial cost, the operating and maintenance costs associated with the system, and worry about whether a system can generate enough electricity in bad weather. Figure 1, below, was obtained from NREL and shows the "Minimum Daily Solar Radiation Annual Totals for the United States."

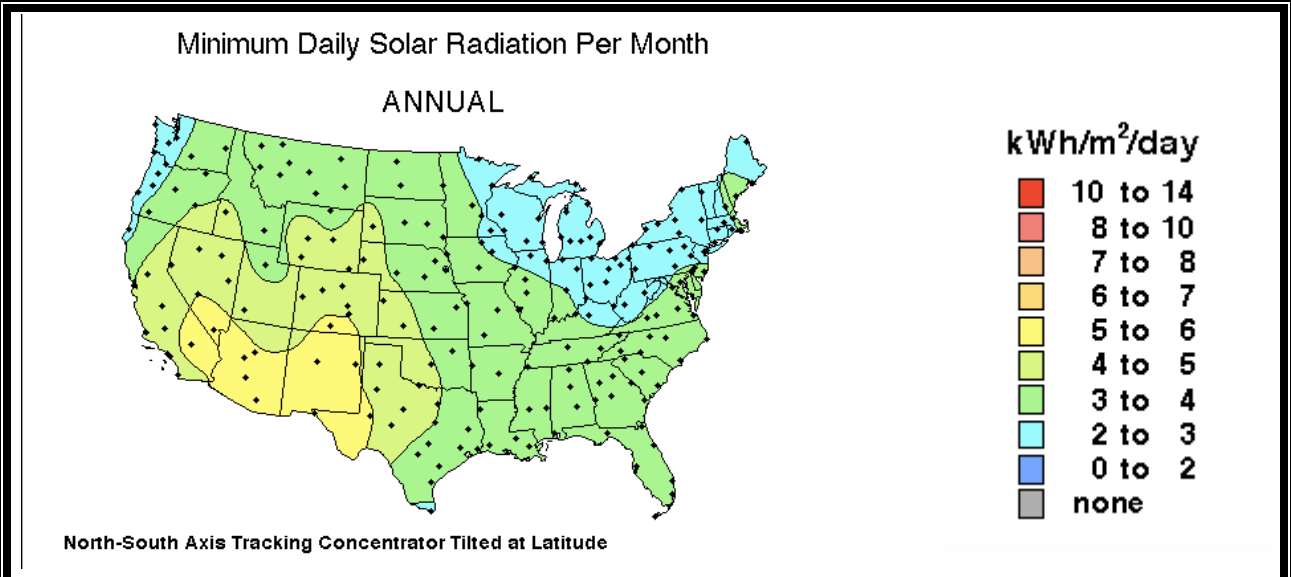

Figure 1:MINIMUM SOLAR RADIATION

This is the absolute minimum solar radiation, and with technological advances such as being able to tilt the panels to allow for maximum sun exposure and various smart metering devices that allow for energy transfer to another location [22]. This allows people the freedom to generate electricity in a more efficient manner.

Economics

The number one hurdle that must be overcome when installing a solar PV system is the cost, which is why the economics of the system is discussed in all areas of this report. There are many things that should be considered when installing a solar PV system such as cost, size, and maintenance.

Before installing a solar PV system on a home or commercial property, a person needs to be aware of the may financial incentive programs that are available to them. In this section we will showcase the various programs that are currently available to Houstonians and Texans, and

this report will go even further by recommending new policy initiatives that will incentivizes people to install solar PV systems. This report will also show you the approximate pay-off time for a unit given the current policies that are in place, and with the adaptation of our program.

Current Financial Programs for Houstonians

There are many ways for the city of Houston to help incentivize people to create solar communities. Financial incentives do not require people to change their behavior or values, and do not usually require as much enforcement as regulations. The principle behind "subsidiarity" maintains that policy making should occur at the lowest or most local level possible while maintaining effectiveness [23]. Property Taxes in Texas are assessed and collected by the county that the property resides, whether it's residential or business [42]. The median property tax in the state of Texas is $2,275, and the state of Texas has the 14th highest property tax in the nation [42]. Property taxes are used to fund county projects, schools, roads, and public services [42]. The figure below, figure 2, illustrates the flow of property tax dollars.

Figure 2:PROPERTY TAXES

Current Tax Code

One such financial incentive was introduced by state of Texas as a tax code incentive for renewable energy, 1 Tex. Tax Code 11.27. Texas offers this property tax exemption to help offset the homeowner's property taxes when they install Solar and Wind energy devices to their property. When a person installs a solar PV System to their home, they are increasing the property's value [24]. This increase to a property's value increases a home owner's property tax. By filing this tax exemption, the homeowner will continue to pay the property taxes associated with the value of their home pre-installation [25].

Another Texas Tax code incentive for solar deals with a business franchise tax exemption. 2 Tex. Tax Code 171.056 states, "An entity that is solely engaged in the business of manufacturing, selling or installing qualifying solar energy devices, as defined by Sec. 171.107, or certain component parts of such devices, may qualify for the franchise tax exemption under Sec. 171.056." [26]. This tax incentive helps companies and franchise owners offset the costs incurred from running a solar company, which in turn helps to free up money that can be invested in the employment of individuals, which creates jobs and boosts the Texas economy.

The next financial incentive that is in place is the Solar Investment Tax Credit, which is a federal tax credit that will subsidize 30% of the initial cost of a solar system. This program is a step-down process, which means that in 2020 the subsidy will be 26% of the initial cost, and 22% in 2021, and after 2023 the residential credit will drop to 0% while the commercial and utility will drop to a permanent 10% [27]. This program is a great opportunity for people to gain financial assistance with the initial installation cost. This program was part of the Energy Policy Act of 2005, and the program was extended through the Emergency Economic Stabilization Act of 2008 [27].

SECO, REAP, LoanSTAR

The State Energy Conservation Office (SECO) of Texas, which is run by the Texas Comptroller's office is a great resource for people to locate various financial incentives for renewable energy systems that are distributed at the federal and state levels. The USDA's Rural Energy for America Program (REAP) issues grants and loans for renewable energy systems [28]. Another program that can be found in Texas is the LoanSTAR Program, which is a revolving loan program that provides low interest rate loans to assist Texas public institutions by financing their energy related cost reduction retrofit projects, which include the installation of solar PV systems [29].

Other Sources of Funding Information

Many other sources are available to help with the implementation of residential and commercial solar development, and can be seen in the government publication "Guide to Federal Financing for Energy Efficiency and Clean Energy Deployment". Figure 3, below, provides a great overview of what federal financing is available to all consumers, whether residential or commercial. The link to the original document is provided below:

http://energy.gov/sites/prod/files/2014/10/f18/Federal%20Financing%20Guide%2009%2026%2014.pdf

FEDERAL FINANCE FACILITIES AT-A-GLANCE

MATRIX OF FEDERAL FINANCE FACILITIES BY TYPE AND AGENCY

Financing Type	USDA	DOE	EPA	HUD	SBA	DOT	Treasury
Loan Guarantee							
Advanced Technology Vehicles Manufacturing Loan Program		X					
Section 1703 Loan Program - Advanced Fossil Solicitation		X					
Section 1703 Loan Program - Renewable & Efficient Energy Solicitation		X					
The Rural Utilities Service - Electric Loan Program	X						
Rural Development Loan Assistance (Several Programs)	X						
Rural Development Biorefinery Assistance Program	X						
Clean Water State Revolving Fund			X				
7(a) Loan Program					X		
504 Loan Program					X		
Transportation Infrastructure Finance and Innovation Act Program						X	
Other Credit Enhancement							
Section 1703 Loan Program - Renewable & Efficient Energy Solicitation		X					
Rural Development Loan Assistance (Several Programs)	X						
Rural Development Repowering Assistance Program	X						
FHA Risk Sharing				X			
Transportation Infrastructure Finance and Innovation Act Program						X	
Market Rate Debt							
Rural Development Loan Assistance (Several Programs)	X						
Small Business Lending Fund							X
Rehabilitation Mortgage Assistance - Section 203 K Loans				X			
Energy Efficient Mortgage Program				X			
PowerSaver Home Improvement Loans Pilot Program				X			
Home Improvement Loan Program				X			
Refinancing of Existing Multifamily Housing				X			
Supplemental Multifamily Loans				X			
Small Business Investment Company				X			
Below Market Debt							
The Rural Utilities Service - Electric Loan Program	X						
Energy Efficiency & Conservation Loan Program	X						
Clean Water State Revolving Fund			X				
Drinking Water State Revolving Fund			X				
Transportation Infrastructure Finance and Innovation Act Program						X	
Qualified Energy Conservation Bonds							X
Performance Contracting							
Energy Savings Performance Contracts for Federal Buildings		X					
Public Housing Energy Performance Contracts				X			
Tax Credit							
New Markets Tax Credits							X
Grant							
The Rural Utilities Service - Electric Grant Program	X						
Rural Development Loan Assistance (Several Programs)	X						
Public Housing Capital Fund				X			
Payment							
Rural Development Advanced Biofuel Payment Program	X						

Figure 3:FEDERAL FINANCING OPTIONS

Economics of Our Policy

The table below, table 4, compares two different sized systems, their average initial cost to the solar provider, and payback period (with and without our policy recommendations). The State of Texas currently has a very limited number of financial programs that are available to homeowners, but the main incentive is issued at the federal level, which is the *30% Federal Tax Credit* [39]. The Federal Tax Credit rebates 30% of the installation cost of a solar power system [39]. One of the economic policies that this report is suggesting, is a feed-in tariff program that includes 20% off the original installation cost of a solar PV system to be issued by the state of Texas, and the export tariff program that allows homeowners to sell back their surplus power at a fixed cost of $0.05 kwh to utility companies. The specifics of how the program is to be orchestrated are located in the policy section of this paper.

Table 4:ECONOMICS TABLE

Roof Area Used	150ft^2	1000ft^2
Number of Panels 280 watts each	3.5	24
Power Produced	1kW	6.7kW
Electricity Produced	1400kWh	9380kWh
Cost at $3.80 per watt	$3,800	$25,460
Cost After 30% Federal Rebate	$2,660	$17,822
Cost After Proposed 20% State Rebate	$2,128	$14,258
Current Surplus Buy Back	$20-$35/year	$131-$225/year
Our Added Surplus Buy Back	$36-$60/year	$244-$400/year
Annual Savings With Our Surplus Buy Back	$204-$228	$1370-$1526
Payback Without Our Proposed Rebates	11.7-14.2 years	11.7-14.2 years
Payback With Our Proposed Rebates	9.3-10.4 years	9.3-10.4 years

Policy Initiatives

One of the most significant problems that affect a person's ability to install a solar PV system on their home is the cost. Even though 30% of the initial installation cost can be subsidized by the federal government through programs such as the Solar Investment Tax Credit (ITC), cost is still a major burden to the average consumer. The expensive price tag is due to the materials needed to create energy efficient PV systems. Photovoltaic solar energy is the direct conversion of light into electricity, and utilizes semi-conduction properties and materials [30]. The average efficiency of a solar PV system ranges from 10% to maximum recorded efficiency of 40% [31]. Due to these obstacles, the solar industry needs a rebirth of ingenuity and innovation, and in order to do that this report is proposing several financial incentives to help mitigate the financial burden, and a unique work-study program. The first group of policy recommendations will help make the cost of the system cheaper for consumers through the implementation of various programs that will be outlined below. The second being an educational/work-study program that will benefit the solar energy industry by providing the ingenuity and innovation that it needs.

Virtual Net Metering

A great incentive for property management companies, small business owners, or multiple property owners would be to offer them the ability to transfer surplus energy to other properties that they own in the area. In urban areas having the space to install a PV system is not always an option. This program would allow owners the freedom of installing a solar PV system where they have the space to do so, and transfer the power generated to another location. This concept is known as Virtual Net Metering, and it allows customers to share the electricity output

from a single power project. This policy is at its beginning stages, and is already being implemented in California, Colorado, Delaware, Minnesota, Wisconsin, and New York [32]. Each state has various restrictions to the policy, but if we were to remove such restrictions to allow people to supply other properties with electricity generated from another location, with the stipulation that they must own the other property. This would help to address the issue of limited space, and provide a significant financial incentive to install solar power.

Property Management Initiative

In most urban areas, as previously discussed, space is a major concern when developing a community. This leads to the next policy initiative for apartment and condominium communities, which would offer financial incentives like the one mentioned above, and provide low cost architectural design options that would showcase efficient uses of space for the installation of solar panels on carports and building rooftops. This would allow the developers to maximize the efficiency of the space that they are developing, without taking away livable square footage. A property with a solar PV system would be an attractive option to potential tenants who are environmentally and financially conscience. With a little over two thirds of the United States population "pro" some sort of environmental protection plan [33]. By adding solar panels to a community it would help make that community more attractive than others that do not have a solar PV system. This would help renters feel like they are making a significant impact towards helping the environment.

Feed-In Tariff Program

The Feed-Tariff Program is based on a German model that states such as California, Hawaii, Maine, Oregon, Rhode Island, Vermont, and Washington have already implemented with some variation [34]. The FIT program consists of two key components; the generation tariff and the export tariff.

Generation Tariff

The generation tariff would allow a person to earn a fixed income for every kilowatt hour of electricity that they generate. This would entail that for every kilowatt hour of electricity that is generated a person could earn money, even if they are generating electricity for their own property. This annual income would help offset the costs of the initial installation and maintenance by having their solar PV system earn money just for generating electricity for their own home. As mentioned previously, a similar system was implemented in Germany called the Erneuerbare-Energien-Gesetz, or EEG, but failed because the program was so attractive/lucrative that many people were quick to take advantage of the program, and this lead to a spike in the general cost of electricity. The brunt of this was shouldered by the people that either couldn't afford to place a system on their home or who were renting, were now subsidizing the people that could [35]. The EEG program is a great example of the poor subsidizing the rich, but our program takes the positives from this program, and attempts to correct the pitfalls.

The way our program is different is by not offering a twenty-year contract, but a five-year contract for the reimbursement for up to 20% of the initial installation cost of the solar PV system. The EEG program offered $0.43 for every kilowatt hour of electricity generated for a twenty-year period, we are proposing a five-year contract with monetary reimbursement of 20% of the installation cost. A person enrolled in the program would receive monthly checks over the

course of five years that would total to be 20% of their installation cost. The funds for this portion of the FIT program will come from the sales tax and property taxes generated by the state of Texas. There is no need to raise taxes in order to accomplish this goal, which will make conservatives happy, and the environmental benefits will make liberals happy. The reason why there is no need to raise sales or property taxes is that we are proposing the money come from a portion of the funds that has been allocated for public utilities [36]. This money is intended to be spent on helping to subsidize electricity companies, and since a person now is providing their own electricity production a small portion of that money can go to them to help them recoup some of the costs associated with installation and maintenance of the system. The loss of money going to an electricity utility provider will encourage them to build massive solar projects which would make them eligible for many federal government funding options and low to no interest loan programs that are already in place for commercial solar systems such as the Solar Investment Tax Credit (ITC) and the Electric Loan Program [37].

Export Tariff

The next component of this plan is the export tariff. The export tariff will be a part of the ten-year contract, where if a person generates a surplus of energy and would like to sell it back to the grid they can do so for a fixed price. The utility companies will buy it back for a fixed amount, and that fixed amount will be $0.05 per kwh. This amount is less than what a utility companies charge per kwh, which would mean that the utility company will still be able to make a profit from selling a person's surplus energy to other customers, and will offset the utility company's cost of electricity production [38]. The export tariff will encourage people to install solar PV system on their home that are capable of not only generating the electricity needed for their consumption, but enough to generate a surplus to sell back to the grid.

These programs will be regulated by a net metering system, which is a billing mechanism that credits solar energy system owners for the electricity that they add to the grid [39]. The FIT program will not only benefit the environment by reducing harmful emissions that are associated with the generation of electricity at a typical power plant, but it will also provide a significant financial incentive that will eventually help cover the majority of the cost for a solar system. Even if a person cannot afford to install a large solar system on their home, they will still be able to earn money through the generation tariff, and if they do need to purchase electricity from a utility company they will not need to purchase as much. The financial incentives also are a bonus to the utility companies, by having the consumers take over the burden of expensive costly upgrades in technology, offsetting of some of the incurred maintenance costs, the costs associated with the production of electricity, and by selling the electricity that it has acquired from a person at a profit utility companies will end up saving money and turning a profit.

Work-Study/Internship Program

Work-study and internship programs are designed to give college students an opportunity to complement their formal education with career related experience. The program that this report is proposing will allow students interested in an electrical engineering degree with an emphasis in solar technology, and who meet specific requirements, be able to work in the solar energy industry for a time of one year preforming manufacturing, installation, and maintenance duties in order to gain a scholarship and/or grant to help pay for their college education and living expenses that are incurred during the pursuit of their education. This program will not only provide financial assistance, but it will also provide students with valuable knowledge and insight into the solar energy industry, and preferential treatment when it comes to the college

admission process. Upon completion of their college degree, students will be required to work for the company that issued the scholarship for a term of five years in order for the company to recoup their investment into the student's training and education. Several companies such as OCI Solar Power in San Antonio, Austin Energy, PowerFin Partners in Austin, and American Electric Technologies in Houston have expressed interest in implementing a similar program. Also, universities such as the University of Houston and the University of Texas have expressed a similar interest in this program.

Each candidate will have to submit the following information in order to be considered for this amazing opportunity:

- All students must have a 3.0 GPA, or better in all math and science courses.
- Letters of recommendation from teachers or community leaders.
- A formal essay pertaining to their interest in solar energy and technology, and why they feel they should be considered for this opportunity.
- Students should have a documented interest in solar energy and technology, but it is not required.
- The students will need to be willing to commit to a year of work with the company prior to enrollment in college classes, and a five-year work contract with the company upon completion of their degree.
- Failure to complete this program within a reasonable amount of time (5 years to complete the degree plan) will result in loss of scholarship/grant, and result in a penalty. The amount of the penalty will be determined based on the amount of time and money that the

company has paid relating to the training and educational expenses. This amount will be paid to the company that the student has received his/her work-study/internship from.

There are several key laws affecting the issuance of scholarships/grants that pertain to private foundations. One being section 4945(g)(1) of the Internal Revenue Code, which specifies that amounts paid as a scholarship or fellowship grant to an individual for travel or study will not be considered a taxable expenditure if the grant is awarded on an objective and nondiscriminatory basis, and is to be used for study at an educational institution described in Section 170(b)(1)(A)(ii) of the Internal Revenue Code [41]. The summary of the Internal Revenue Tax Codes pertaining to the issuance of scholarships and grants are listed below:

- The scholarship must be awarded on an objective and nondiscriminatory basis.
- No grants may be awards to an officer, manager or trustees of the organization, nor to a member of the selection committee, nor to a substantial contributor, nor certain United States governmental officials.
- Family members of these individuals are also not eligible to receive grants.
- The group of applicants from which the recipients are selected must be sufficiently broad as to be considered a charitable class.

Each one of these issues are addressed in the detailed and rigorous application process that the applicants will have to go through in order to be considered for this amazing opportunity.

One of the major benefits of this program will be to help spur ingenuity and innovation in solar energy industry through exposing students to real world limitations and obstacles that the solar energy industry faces. Students who complete this program will be better equipped to

apply the skills that they learn in their formal education to solve these problems. In a formal educational setting students are provided with the theory and skills necessary to pursue a career in their field, but the typical student does not know how to apply what they have learned to real world problems without experience in the industry. This program would give students the experience necessary to be able to apply the skills that they learn at the university to real world situations, and through doing so bring about the innovation and ingenuity that the solar industry needs to become more competitive in the energy marketplace. Students who complete this program will be more sought out in the job marketplace due to their unique experience, and valuable skill sets. The program will also provide much needed financial assistance to help pay for college education as well as living expenses during this process.

Benefits to the University

This program will help aid in closer ties with the solar energy business community, by working with local companies to establish internships and work-study opportunities this will allow universities to build quality relationships with people in the solar energy industry. These relationships will also allow the university a distinct opportunity to interact with the solar industry in a way that will help them cultivate an innovative educational program that meets real world needs. Through this initiative, the university will be viewed as positive and responsive to business and student needs.

Benefits to the Companies

This program will provide companies with the ability to train students in their way of doing things. Consistency in procedure can be difficult to achieve, but with this unique opportunity companies will be able to train students in the way that their company wants things to be done, which will ensure that each company's strict standards and guidelines are met. This

will also provide the company with cheap and talented labor to perform tasks, and upon the student's completion of their degree the companies will be provided with competent and resourceful individuals that have the maturity needed to succeed in the industry. As well as, hopefully, provide the much needed ingenuity and innovation that the solar energy industry needs to compete in today's energy market.

Conclusion and Recommendation

This report's final recommendation is to ensure that funds are continued to be allocated for the programs that have already been established by the state and federal government. That some of the funds that were appropriated for utility companies for infrastructure and maintenance be made available to homeowners for the generation of electricity. To engage local companies and universities to adopt the work-study/internship program, which will help cultivate long-lasting and mutually beneficial relationships. Finally, to incentives property management companies, small business owners, and developers through the virtual net metering program, and by providing them with affordable architectural design options that encourage the installation of solar PV system's by demonstrating that it can be done without taking away livable square footage.

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DIVISION OF LABOR

1. Caleb Hawkesworth:
    a. Researched background topics for the functionality of photovoltaic solar cells.
    b. Interviewed two California solar company owners.
    c. Assisted teammates with research for economic impacts, and new virtual net meter technology.
    d. Built the respective Background page for the website.
2. Charles Claxton:
    a. Research and present energy sources used for electricity.
    b. Research and present national and local home electricity consumption.
    c. Research and present home electricity costs in Texas.
    d. Describe cost analysts and payback for home solar with and without our proposed rebates.
    e. Research and present Texas property taxes.
    f. Research and present amount of solar energy delivered throughout the U.S.
    g. Help formatting and editing website.
3. Monica Melek:
    a. Researched Societal Impacts and ways to stimulate community involvement, in an in-depth manor.
    b. Discussed the advantages and disadvantages for society.
    c. Discussed the Importance of people opinions with regards to solar pv projects.
    d. Discussed Communities' involvement in solar projects, and ways to increase community outreach and involvement for Solar Projects.

4. Siri Raustein:
    a. Researched general info on solar panels but focused mostly on the social impacts part of the project (with emphasis on new and existing policies in and around the greater Houston/Texas area).
    b. Helped to ensure quality control of the project through editing the policy paper (first and final draft) for grammar, spelling, cohesiveness and conciseness, in addition to parts of the formatting.
    c. Edited the website for grammar, spelling, citations, and overall cohesiveness, conciseness and visual presentation.
5. Muhanad Mohammed:
    a. Thoroughly Researched all aspect of the Environmental Impacts for Solar PV systems, from production, manufacturing, and installation.
    b. Thoroughly researched Climate Change, and what is currently being done to mitigate its effect.
        i. How integrating solar pv systems would help to alleviate the acceleration of climate change.
    c. Thoroughly researched the environmental benefits of using solar energy to produce electricity.
    d. Researched various different renewable energy sources, and contrasted them with solar energy.
    e. Generated the four pages associated with Environment for the website.
    f. Wrote/provided the Environmental section of the policy paper.

6. Travis Mikel:
    a. Strategized for the implementation and education of our written policy.
    b. Created strategy for passing our policy at the municipal level.
    c. Researched and contacted city officials.
    d. Contacted lobbyists for renewable energy.
    e. Targeted economics and education for Houston's populous.
    f. Contacted and interviewed government agencies.
    g. Expert interviews
        i. Expert interviews with city officials Marina Badoian Kriticos, Senior City Adviser to Mayor Sylvester Turner, and
        ii. Steve Stelzer, Green Building Resource Center.
        iii. Expert interview with community leader Raleigh Jenkins, ABC Home and Commercial Services.
    h. Helped with other areas of the project when needed: research, data analysis, charts, graphs, tables, proofreading, etc.
    i. Helped spear head group meetings.
    j. Helped cordinate between group members to ensure that the project remained on track.
    k. WEBSITE:
        i. Wrote, created, and generated:
        ii. Economics section.
        iii. Houston section of website.
        iv. Helped to edit, format, and proof the website.

7. Mary Reeves:
    a. Researched current energy sources for the United States and Texas.
    b. Researched current cost of energy in the United States, and Texas.
    c. Researched Societal Impacts and various ways to stimulate community involvement.
    d. Researched and provided research/information to the group on all major parts of this project.
    e. Organized group meetings
    f. Help to ensure group participation through creating the GROUPME account, and by constantly communicating with group members about how their portion of the project is coming.
    g. Contacted various solar companies that work in production, manufacturing, and installation of solar pv systems.
    h. Contacted State of Texas government officials to discuss current policies and programs that are available to Texans.
        i. My contact was Anne Drescher, who is chief of staff for representative R.D "Bobby" Guerra.
    i. Met with Dr. Teresa Tomkins-Walsh with the University of Houston's Historical Achieves to research Houston's involvement with Solar Energy.
        i. Went through several different collections at the Historical Archives.
    j. Contacted all of the advisors and professors with the University of Texas Law Center.

i. Met with Dr. Johnny Rex Buckes to discuss current tax programs, and laws regarding solar in the state of Texas.

k. Wrote the public policy paper, with the exception of the environmental section, but did help edit that section.

l. Created several unique policy programs to be implemented in the Houston area.

i. The policy that the mayor of Houston, Sylvester Turner is really interested in is the Work-study/internship program that I created.

m. WEBSITE DUTIES:

i. Helped to format, edit, and proof various sections of the website.

ii. My main area was the policy section, which included:

1. The policies homepage, current policies, and our policies.